INTRODUCTION TO INFORMATION TECHNOLOGY



Luis Castellanos Hurtado



INT1010



INT 1010: Introduction to Information Technology (Second Edition)

Prince George's Community College

2026



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About the Book



Introduction to Information Technology is a survey course in evolving information technology and its relevance to individuals and society.

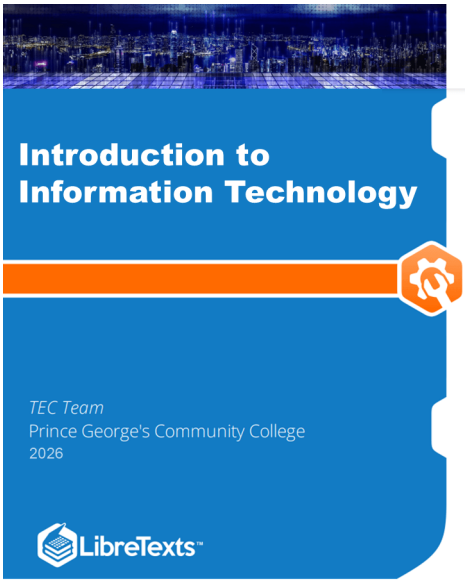
This book examines the categories of computing devices and different types of computer applications, software, and their uses. The emphasis is on enhancing skills in data analysis and programming.

Additionally, the book evaluates ethical principles related to privacy, security, intellectual property and how these apply to their academic and professional life. The book also explores strategies to manage risks related to systems security threats.

Lastly, the book includes basic principles of connectivity and data communications.

This is the 2nd Edition of the book, in which most of the content was updated.

PGCC's TEC Department team



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MLA	TEC/PGCC. *Introduction to Information Technology*. *LibreTexts*, 2026, Courses/Prince_Georges_Community_College/Introduction_to_Information_Technology.

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Acknowledgements



This is the Second Edition of "INT1010: Concepts in Computing", developed in 2021.

The development of this text was under the leadership of the Technology, Engineering, and Construction (TEC) Department, part of the STEM Division, at Prince George's Community College (PGCC).

We would like to thank those professors who participated in creating, reviewing, and commenting on drafts of this text:

- Your name here

Luis R Castellanos

Information Technology Academic Coordinator

Associate Professor

PGCC

2026

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1: INTRODUCTION - PRELIMINARIES



Learning Objectives

Upon successful completion of this course, you will be able to:

- Describe the categories of computing devices;
- Compare and contrast types of computer applications and software and their uses;
- Demonstrate basic proficiency in programming;
- Demonstrate basic proficiency in data analysis using the software;
- Evaluate ethical principles in emerging technologies as they apply to academic and professional life;
- Describe risk management strategies that address information systems security threats; and
- Explore data communications concepts and basic principles of connectivity including wired and wireless technologies;

Introduction to Information Technology is a survey course in evolving information technology and its relevance to individuals and society.

Students examine the categories of computing devices and different types of computer applications, software, and their uses.

The emphasis in this this course is on enhancing students' skills in data analysis and programming. Additionally, students evaluate ethical principles related to privacy, security, intellectual property and how these apply to their academic and professional life. They also explore strategies to manage risks related to systems security threats.

Lastly, students learn about the basic principles of connectivity and data communications.

1.1: Introduction

1.2: Communication Etiquette

1.3: Plagiarism

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"The harder the conflict, the greater the triumph."

— George Washington, *PotUS 1*

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1.1: Introduction



Introduction to Information Technology

INT 1010, is a survey course in evolving information technology and its relevance to individuals and society. The emphasis in this course is on enhancing students' skills in data analysis and programming and applying learned skills to their academic and professional life.

This course examines:

- Categories of computing devices and different types of computer applications.
- Software and their uses.
- Ethical principles related to privacy, security, intellectual property.
- Strategies to manage risks related to systems security threats.
- Students learn about the basic principles of connectivity and data communications.

Introduction to Information Technology course material utilizes Open Education Recourses (OER).

> **Open Educational Resources** (OER) are learning, teaching and research materials in any format and medium that reside in the public domain or are under copyright that have been released under an open license, that permit no-cost access, re-use, re-purpose, adaptation and redistribution by others.
>
> UNESCO

Purchase of a book is not required. Content will be presented in the form of both text (online) and activities.

Each chapter contains:

Objectives:

Description of what your accomplishments should be at the end of the chapters.

Content:

This is the content explained in each chapter about different topics.

Learning Activities:

Initially they are in the LMS site, but eventually they will be incorporated in this eBook.

These are activities assigned to assess your knowledge.

They include:

- Individual and group activities
- Quizzes
- Exams

The key to success in INT 1010 is planning your study schedule, using the instructor's office hours, using videos, and recognizing if you need to use the tutoring center.

Additional resources:

In each section, you will find the topics that will be covered (at the beginning of the page), as well as the references used (at the bottom of the page).

In the "Back Matter" you will find a glossary, an Acronym list, and a feedback page, in case you have a recommendation or you spotted a typo or a mistake.

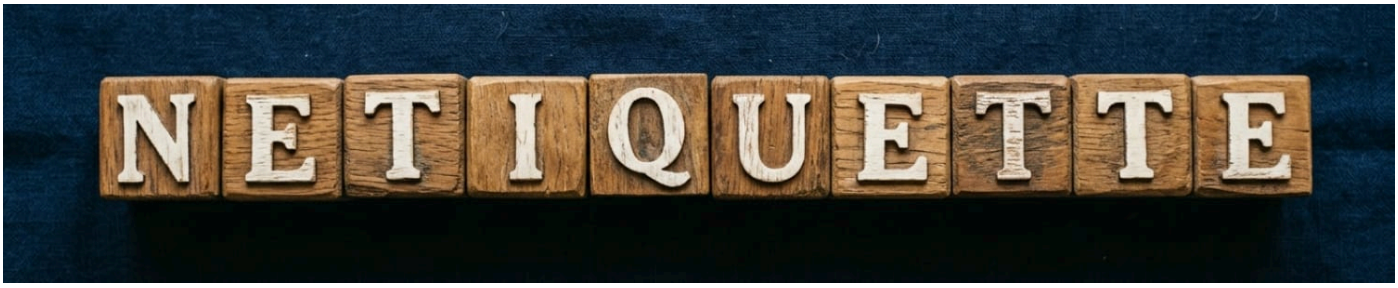


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1.2: Communication Etiquette



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1.2.1. Netiquette 101

1.2.2. Emailing Your Professor

Netiquette is a blend of the words "network" and "etiquette." It refers to the generally accepted set of unofficial rules, manners, and polite behavior governing respectful communication in digital spaces, such as emails, social media, forums, and video calls.

1.2.1. Netiquette 101

It's never been easier to connect with professors and classmates online, but along with ease and convenience comes a certain level of responsibility when you are posting or mailing information. Keep in mind this basic rule: don't do anything online that you wouldn't like someone else to do to you (i.e. sending an aggressive email, posting an overly critical reply, forwarding messages to third parties without permission). Remember, your online activity leaves a permanent digital trail. Here are some "netiquette" tips to remember in an academic setting:

Act Within the Law:

- Never send a message that threatens, harasses, or blatantly offends any member of the KCC community.
- Always give credit for words or ideas that belong to someone else.
- Identify yourself by name. Don't pretend to be someone else.

Be Courteous and Respectful:

- **Avoid using profanity** in an email or discussion forum.
- **Keep personal matters** between you and your classmates and/or professors **private**—both in online and face-to-face courses.
- Before you press "send" or post something in an online discussion forum, **re-read your text** to make sure it won't be misunderstood. Your readers will not necessarily know your mood or be able to read your body language.
- If you decide to send a message via cellphone, take the time to **punctuate your text properly**.
- Don't write in **all lowercase** letters.
- YOU'RE SHOUTING when you write in **all capital letters**!
- Abbreviations and emoticons can help convey tone or mood, but keep in mind that they wear thin on some readers. LOL

1.2.2. Emailing Your Professor - Ten Tips

1. Put your class/section in the subject line, followed by the nature of the communication. Example - Subject: (INT 1010 LD01) Assignments
2. Use an appropriate standard greeting, such as “Dear Professor Shaw” or “Good Morning.” Never “Hey.”
3. Keep the message on point. “My question about today’s assignment is this:”
4. Write in standard English—no “textspeak” or slang.
5. Always sign your name at the end (full name if you are unknown to the recipient or first name if you are known).
6. Never ask your professor if you missed anything important; of course you have.
7. Don’t share too much personal detail if you miss class. An absence is an absence.
8. If you will be missing class, always ask what you need to do to keep current.
9. Never forward jokes, memes, or chain letters to your professor.
10. Make readers want to respond. Your email is a reflection of you, your work habits, and your professionalism.

REFERENCES

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1.3: Plagiarism



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1.3.1. Basic concepts

1.3.2. The Most Common Types of Plagiarism

1.3.3. Why Does It Matter?

1.3.4. Main differences between popular citation styles

1.3.5. Which One Should You Use?

1.3.1. Basic concepts

> **Plagiarism** is presenting work or ideas from another source as your own, with or without consent of the original author, by incorporating it into your work without full acknowledgement.
>
> University of Oxford

Think of it as intellectual theft. Whether it's done intentionally (like buying a paper or copying and pasting paragraphs) or accidentally (like forgetting to cite a source), it boils down to the same issue: **misrepresenting the origin of the work**.

1.3.2. The Most Common Types of Plagiarism

Plagiarism isn't always just straight copying. It comes in several different forms:

- **Direct Plagiarism:** Word-for-word copying of a section of someone else's work without quotation marks or attribution.
- **Self-Plagiarism:** Submitting your own previous work (like a paper you wrote for a different class) for a new assignment without permission.
- **Paraphrasing Plagiarism:** Rewriting someone else's ideas in your own words but failing to cite the source. (Just changing a few words in a sentence still counts as plagiarism if you don't give credit!)
- **Patchwork (Mosaic) Plagiarism:** Stitching together sentences, phrases, and ideas from different sources, tweaking the wording slightly, and presenting it as your own cohesive thoughts.
- **Accidental Plagiarism:** Unintentionally neglecting to cite sources, misquoting them, or citing them incorrectly. Even if it is an accident, academic institutions still treat it seriously.

1.3.3. Why Does It Matter?

At its core, academic and professional environments rely on **intellectual honesty**. When you cite your sources, you are doing two major things:

1. Giving credit to the creators who did the original research or creative work.
2. Showing your audience the path you took to reach your conclusions, which actually makes your own arguments stronger and more credible.

> **The Golden Rule:** If it didn't come out of your own head, and it isn't common knowledge (like "the Earth is round" or "water freezes at 32°F"), it needs a citation.

1.3.4. Main differences between popular citation styles

Choosing the right citation style depends almost entirely on the **discipline** you are writing in. Each style has its own logic tailored to what researchers in that specific field care about most.

For example, scientists care deeply about *when* a study was published, so **APA** puts the year right up front. Historians care about the exact page and original source tracking, so **Chicago** relies heavily on footnotes. **MLA** is very much used in the academic world.

Here is a breakdown of how they compare, when to use them, and how they handle the exact same book.

Comparison of MLA, APA, and Chicago

Feature	MLA (Modern Language Assoc.)	APA (American Psychological Assoc.)	Chicago (Notes-Bibliography)
Primary Fields	Humanities (Literature, Art, Cultural Studies)	Social Sciences (Psychology, Education, Sociology, Business)	History, Fine Arts, and some Humanities
In-Text Focus	**Who** wrote it and **where** (Page #)	**Who** wrote it and **when** (Year)	Minimal in-text clutter; uses superscript numbers[1]
In-Text Example	`(Castellanos 42)`	`(Castellanos, 2026, p. 42)`	`...as argued in the text.`[1] (Details go in footnote)
Source List Name	**Works Cited**	**References**	**Bibliography**

Side-by-Side Reference List Examples

To see how the formatting changes, look at how the same hypothetical book is cited in each style's end-of-text source list:

MLA Style (9th Edition)

> Castellanos, Luis. *The Evolution of Information Technology*. Academic Press, 2026.

APA Style (7th Edition)

> Castellanos, L. (2026). *The evolution of information technology*. Academic Press.
>
> *Note: APA uses initials for first names to reduce gender bias and lowercase for book titles (sentence-case).*

Castellanos, Luis. *The Evolution of Information Technology*. Washington DC: Academic Press, 2026.

1.3.5. Which One Should You Use?

- **Use MLA if:** You are writing an English paper, analyzing a poem, reviewing a play, or discussing cultural trends. It keeps the focus on the author's words and the specific page you pulled them from.
- **Use APA if:** You are writing a lab report, a psychology paper, an education lesson plan, or a business case study. It emphasizes the timeliness of the research by highlighting the publication year.
- **Use Chicago if:** You are writing a history paper or an art history analysis. The footnote system (placing citations at the bottom of the page) keeps your actual writing clean and narrative-focused.

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The Chicago Manual of Style. 17th ed., University of Chicago Press, 2017.

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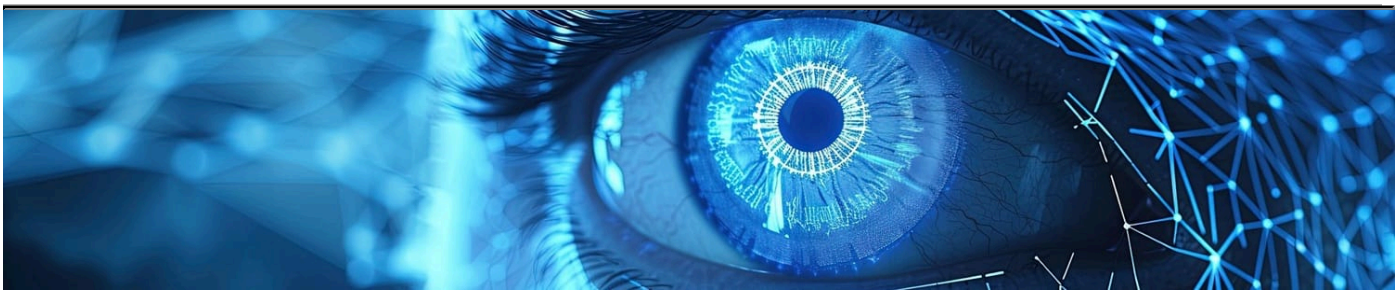
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1.4: Artificial Intelligence



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1.4.4. Real-World Applications & Current Impact

1.4.5. The Critical Wrap-Up: Ethics & Limitations

1.4.6. Generative AI

1.4.1. Artificial Intelligence definition

> **Artificial Intelligence** (AI) is a branch of computer science focused on creating systems capable of performing tasks that typically require human intelligence.
>
> Stanford University

1.4.2. How does AI works

Here is a quick breakdown of how AI actually ingest data to build a model:

- **Supervised Learning (Learning with a Teacher):**
  - *Concept:* The model is trained on labeled data (input data paired with the correct answer).
  - *Example:* Feeding a computer 10,000 photos explicitly labeled "Cat" or "Not Cat" until it learns the distinct features of a cat.
- **Unsupervised Learning (Finding Hidden Patterns):**
  - *Concept:* The model is given unlabeled data and must find inherent patterns, structures, or groupings on its own.
  - *Example:* Customer segmentation in marketing—grouping millions of buyers into distinct personas based solely on buying behavior.
- **Reinforcement Learning (Trial and Error):**
  - *Concept:* An agent learns to make decisions in an environment by performing actions and receiving rewards or penalties.
  - *Example:* Teaching an AI to play a video game or navigate a robotic arm by rewarding it for getting closer to the goal.

1.4.3. The AI hierarchy

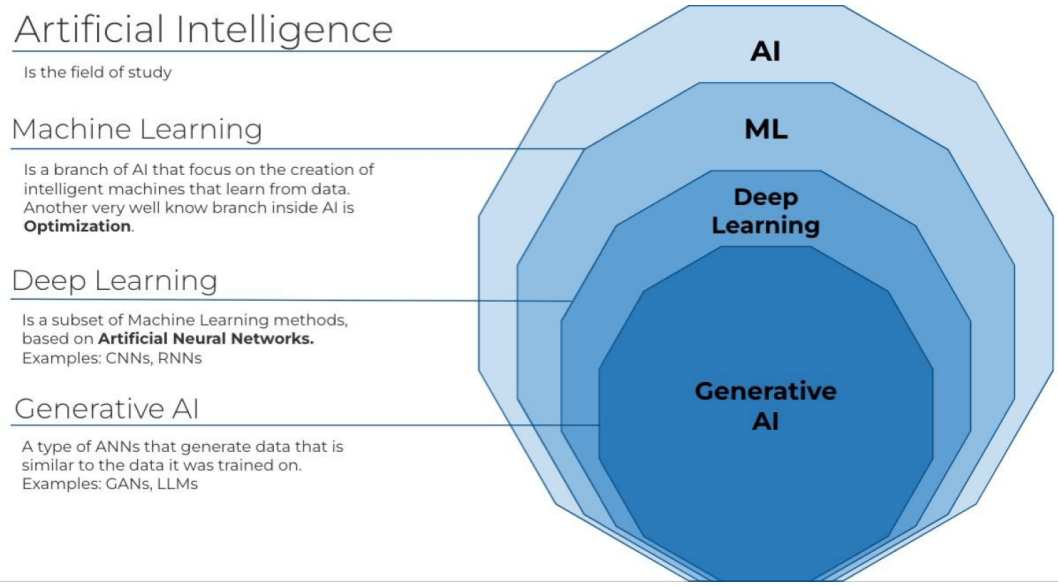


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1.4.4. Real-World Applications & Current Impact

Let's see how these subfields manifest in day-to-day industries:

- **Healthcare:** Computer vision algorithms analyzing X-rays and MRIs to detect anomalies faster than the human eye.
- **Finance:** Fraud detection systems scanning millions of credit card transactions per second to catch anomalies.
- **Transportation:** Autonomous vehicles utilizing sensor fusion (combining cameras, radar, and lidar data) to navigate traffic.
- **Generative AI:** Large Language Models (LLMs) and transformer architectures processing natural language to assist in coding, drafting text, and brainstorming.

Recommended movie

Her is a 2013 American science fiction romantic drama film written, co-produced, and directed by Spike Jonze.

Starring: Joaquin Phoenix, Amy Adams, Rooney Mara, Olivia Wilde, Scarlett Johansson.

YouTube Video

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1.4.5. The Critical Wrap-Up: Ethics & Limitations

Remember that AI isn't magic—it is math running on infrastructure, which comes with distinct human responsibilities:

- **Algorithmic Bias:** If an AI model is trained on historical data that contains human bias, the AI will perfectly reproduce and scale that bias.
- **Hallucinations:** Generative models predict the next most probable word or pixel; they do not possess a true "fact-checking" compass, meaning they can confidently assert falsehoods.
- **The "Black Box" Problem:** Deep learning models are incredibly complex. Often, engineers know *what* output a model produced, but it is incredibly difficult to map out the exact internal pathways of *why* it made that decision.

Some examples of biased outcomes in Generative AI applications:
• Meta AI creates ahistorical images • Why Google's AI tool was slammed for showing images of people of colour

---

1.4.6. Generative AI

> It is one of the most popular type of artificial intelligence that creates new, original content—such as text, images, audio, video, or software code—by learning patterns from massive datasets.

Instead of simply organizing existing information, it predicts what element should come next to build something entirely new.

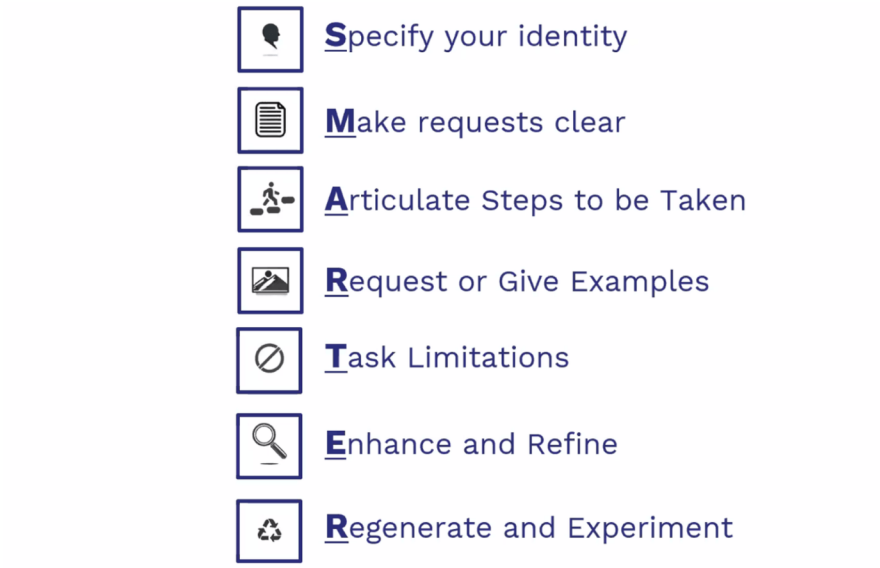
Benefits of Generative AI

1. **Automates repetitive tasks**: AI-informed workflows cut out duplicative work so users can focus on what matters.
2. **Generates personalized content**: Users crave personalized messaging that resonates with their individual needs. In a poll, a significant majority (61%) use generative AI primarily for content creation.
3. **Summarizes lengthy documents**: Get right to the heart of the matter with quick and easy assessment of source materials.
4. **Keeps employees informed**: Companies can offer smart pathways to information, processes, and policy to keep everyone up to speed and code-compliant.

Types of Generative AI and some examples

Text-based	Google Gemini, Chat GPT, MS Copilot, Claude, Perplexity, Notebook LM, Consensus, Jasper, Sudowrite.
Image-based	Midjourney, DALL-E 3, Stable Diffusion, Adobe Firefly, Google Imagen 3, Krea AI, Leonardo.ai, Wombo Dream.
Audio-based	Suno, Udio, ElevenLabs, Murf AI, AIVA, ToMusic.ai, Beatoven, Speechify, Descript.
Video-based	Sora, Runway Gen-3 Alpha, Luma Dream Machine, Pika, Kling AI, Haiper, Synthesia, HeyGen, Deforum Stable Diffusion, Kaiber.
Mixed / Multi-modal	Google Gemini, ChatGPT, Microsoft Copilot, Claude, Grok, Canva Magic Studio, Google Vids, Adobe Firefly, Hugging Face Spaces.

Recommendations to craft better prompts



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The ethics of erroneous AI-generated scientific figures

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1.5: Summary



1.1. Introduction

Introduction to Information Technology, INT 1010, is a survey course in evolving information technology and its relevance to individuals and society.

Each chapter contains learning activities and success tips.

1.2. Netiquette

Netiquette is a blend of the words "network" and "etiquette." It refers to the generally accepted set of unofficial rules, manners, and polite behavior governing respectful communication in digital spaces, such as emails, social media, forums, and video calls.

1.3. Plagiarism

Plagiarism is the act of taking someone else's work, ideas, words, or creative expressions and presenting them as your own.

Think of it as intellectual theft. Whether it's done intentionally (like buying a paper or copying and pasting paragraphs) or accidentally (like forgetting to cite a source), it boils down to the same issue: **misrepresenting the origin of the work**.

The Most Common Types of Plagiarism

Plagiarism isn't always just straight copying. It comes in several different forms:

- Direct Plagiarism
- Self-Plagiarism
- Paraphrasing Plagiarism
- Patchwork (Mosaic) Plagiarism
- Accidental Plagiarism

1.4. Artificial Intelligence

It is the subfield of computer science dedicated to building software and systems capable of performing tasks that typically require human intelligence—such as learning, reasoning, problem-solving, and understanding language.

How does AI works

- Supervised Learning (Learning with a Teacher)
- Unsupervised Learning (Finding Hidden Patterns
- Reinforcement Learning (Trial and Error)

Generative AI

It is one of the most popular type of artificial intelligence that creates new, original content—such as text, images, audio, video, or software code—by learning patterns from massive datasets.

Instead of simply organizing existing information, it predicts what element should come next to build something entirely new.

Benefits of Generative AI

1. Automates repetitive tasks.
2. Generates personalized content.
3. Summarizes lengthy documents.
4. Keeps employees informed.

Summary image banner by Luis R Castellanos

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2: INFORMATION SYSTEMS - INTRODUCTION



Introduction

If you are reading this, you are most likely taking a course in information systems, but do you even know what the course is going to cover? When you tell your friends or your family that you are taking a course in information systems, can you explain what it is about? For the past several years, I have taught an Introduction to Information Systems course. The first day of class I ask my students to tell me what they think an information system is. I generally get answers such as “computers,” “databases,” or “Excel.” These are good answers, but definitely incomplete ones. The study of information systems goes far beyond understanding some technologies. Let’s begin our study by defining information systems.

Learning Objectives

Upon successful completion of this chapter, you will be able to:

- Define Information Systems
- Describe the role of Information Systems
- Identify the Evolution Eras of Technology
- Describe Information System users
- Identify the five components of an Information system

2.1: Information Systems

2.2: Evolution Eras of Technology

2.3: Type of Users

2.4: What is Competitive Advantage

2.5: Components of an Information System

2.6: Summary

"I am a greater believer in luck, and I find the harder I work, the more I have of it."

— Thomas Jefferson, *PotUS 3*

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2.1: Information Systems



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2.1.4. Information Systems definitions

2.1.5. Types of Information Systems

2.1.6. What Are Information Systems Used For?

2.1.7. Future Trends in Information Systems

2.1.1. Introduction

If we want to know what is an Information Systems, a good starting point would be knowing about the two words that come together: Information + Systems.

We will see that today's world, is essentially technology driven, and the Information Systems are a very important part of our routine operations.

So, let's see what those words mean, by themselves, and then what do they mean when they come together.

2.1.2. Information

> **Data** is a raw and unorganized fact that requires to be processed to make it meaningful.

Generally, data comprises facts, observations, perceptions numbers, characters, symbols, image, etc.

> **Information** is a set of data which is processed in a meaningful way according to the given requirement.

Information is processed, structured, or presented in a given context to make it meaningful and useful.

For example, if we have a phone book, it would be data. Once we look for a specific person, we process the **data** and find the specific phone number, we generate **information**.

In another example, if we have the grades of the students in a specific course, that would be **data**. If we process the grades and find the average grade for the course, we will generate **information**.



Data - Processing - Information. Image created by Luis R Castellanos. Public Domain. Own work.

2.1.3. Systems

> **System** is a group of interacting or interrelated elements that act according to a set of rules to form a unified whole.

A classic and widely accepted classification of systems, categorizes them based on their **nature and relationship with their environment**.

Here is a breakdown of the classic classification:

1. By Interaction with the Environment

Systems are primarily divided based on how they exchange matter, energy, or information with their surroundings:

- **Open Systems:** Continuously interact with their environment, exchanging matter, energy, or information (e.g., biological organisms, human organizations, ecological systems).
- **Closed Systems:** Exchange energy or information with their environment, but *not* matter (e.g., a sealed piston-cylinder assembly, the planet Earth regarding matter).
- **Isolated Systems:** Exchange neither matter, energy, nor information with their environment (e.g., a theoretical universe; true isolated systems do not practically exist in nature).

2. By Origin and Creation

- **Natural Systems:** Systems that exist in nature without human design or intervention (e.g., solar systems, ecosystems, subatomic structures).
- **Human-Made (Designed / Artificial) Systems:** Systems created, structured, and maintained by humans to achieve specific purposes (e.g., transportation networks, software applications, organizational hierarchies).

3. By Predictability and Determinism

- **Deterministic Systems:** Systems in which the parts interact in a strictly predictable, cause-and-effect manner. Given an initial state, future states can be precisely calculated (e.g., a simple mechanical clock, basic computer algorithms).
- **Probabilistic (Stochastic) Systems:** Systems whose behavior cannot be predicted with absolute certainty; randomness and

probability play a role (e.g., weather patterns, market economies, queueing behavior).

Systems classification		
By Interaction with the Environment	By Origin and Creation	By Predictability and Determinism
• Open Systems • Closed Systems • Isolated Systems	• Natural Systems • Human-Made (Designed / Artificial) Systems	• Deterministic Systems • Probabilistic (Stochastic) Systems

2.1.4. Information Systems definitions

There are numerous definitions about "Information Systems", as we can see:

- a set of interconnected components that collect (or retrieve), process, store, and distribute information to support decision-making, coordination, and control in an organization (Laudon & Laudon).
- a specialized "work system" whose processes and activities are dedicated to processing, storing, and transmitting information to serve an organizational goal (S Alter).
- an integrated, user-machine system for providing information to support operations, management, analysis, and decision-making functions in an organization (Davis & Olson).
- any organized combination of people, hardware, software, communications networks, data resources, and policies/procedures that stores, retrieves, transforms, and disseminates information in an organization (O'Brien & Marakas).
- the formal means by which organizations and people—using information technologies—gather, process, store, use, and disseminate information to support business operations and managerial decision-making (Bocij, Greasley & Hickie).

Combining all of these definitions, we can conclude:

> **Information System** is an organized combination of people, technology, data, and procedures that collect, process, store, and distribute information to support operations, management, and decision-making in an organization.

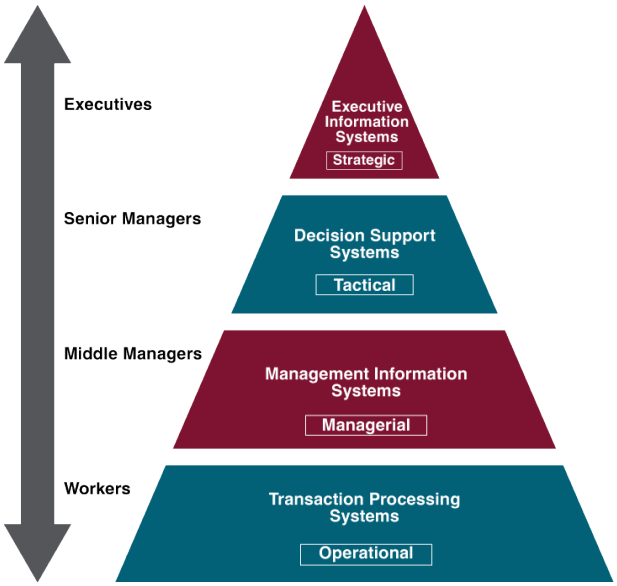
It has to store the data, process it, and show the outcomes of that process that would help the organization in making a decision. Today, that is possible using technology, which makes that process easier and faster.

2.1.5. Types of Information Systems

Information systems can be categorized into different types based on their scope and functionality. Executive information systems are used by an organization's executive staff, decision support systems are used by senior managers, management information systems are used by middle managers, and transaction processing systems are used by frontline workers.

- An executive information system (EIS) supports the strategic information needs of top executives, providing the information needed to handle executive functions, such as developing an organization's strategic goals and objectives and plans for achieving them. This includes providing the information needed for managers to understand and manage their organization's supply chain and value chain, which can be helpful to streamline production processes and provide better customer service. Supply chain management is an example of how an EIS can be used as an interorganizational information system, which occurs when two or more organizations use IS to conduct business electronically.
- A decision support system (DSS) assists in decision-making by providing interactive tools and access to data analysis. Typically, senior managers use a DSS to obtain tactical information that helps them make routine, short-term decisions about an organization's operations. This helps ensure that organizations stay on track to achieve long-term goals and objectives. Interactive tools available through a DSS enhance these efforts by providing information and technology needed for activities such as project management and employee training.

- A management information system (MIS) provides middle managers with reports and summaries to support decision-making and managerial functions. For example, middle managers may use an MIS to generate reports, such as budgeting documents and cash flow statements, to understand an organization's financial status. In many organizations, this type of system provides the data for an organization's balanced scorecard (BSC), which is a performance metric used by strategic managers to identify an organization's various functions and monitor outcomes. By providing the data necessary for the BSC, an organization's MIS function provides invaluable support.
- A transaction processing system (TPS) handles day-to-day transactions, such as order processing and payroll. For frontline staff, a TPS provides information necessary to handle an organization's daily operations, such as inventory reports and customer service records.



Information System Types Pyramid Model. CC-BY 3.0, from Fanshawe College

2.1.6. What Are Information Systems Used For?

Information systems help organizations collect, process, store, and analyze data so they can operate more efficiently. Across industries, they support everything from daily operations to long-term strategy.

Common uses of information systems in organizations include:

- **Strategic decision-making:** analyzing data to guide business strategy and planning.
- **Operations management:** streamlining workflows, supply chains, and internal processes.
- **Communication:** enabling collaboration through email, messaging platforms, and shared systems.
- **Data management:** storing and organizing large volumes of information for easy access.
- **Customer insights:** tracking user behavior to improve products, services, and experiences.

These tools are supported by different types of information systems, each designed for specific functions.

2.1.7. Future Trends in Information Systems

Our world is complex, and information helps us make sense of the people, places, things, and events that surround us. Through information systems, we can communicate and share information to learn from each other, solve challenging problems, and explore new opportunities to meet our needs, both personally and professionally.

To ensure that people can continue to communicate and manage the complexities of the world, information systems, including

processes to share information, continue to evolve. Emerging technologies, such as artificial intelligence (AI), machine learning (ML), and blockchain, have the potential to provide many benefits to much of the world's population, but can also raise or expand ethical concerns. As these systems continue to advance, we will need to balance these ethical concerns with the benefits they bring.

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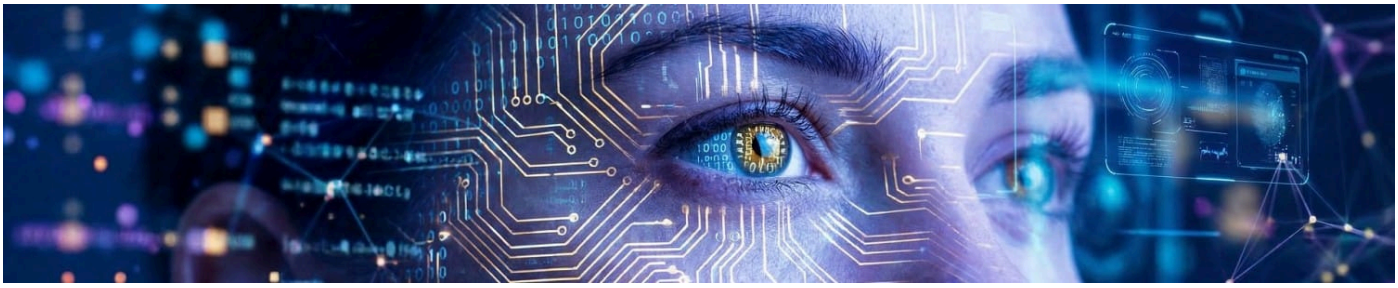
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2.2: Evolution Eras of Technology



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2.2.2. PC Revolution era

2.2.3. Client-server era

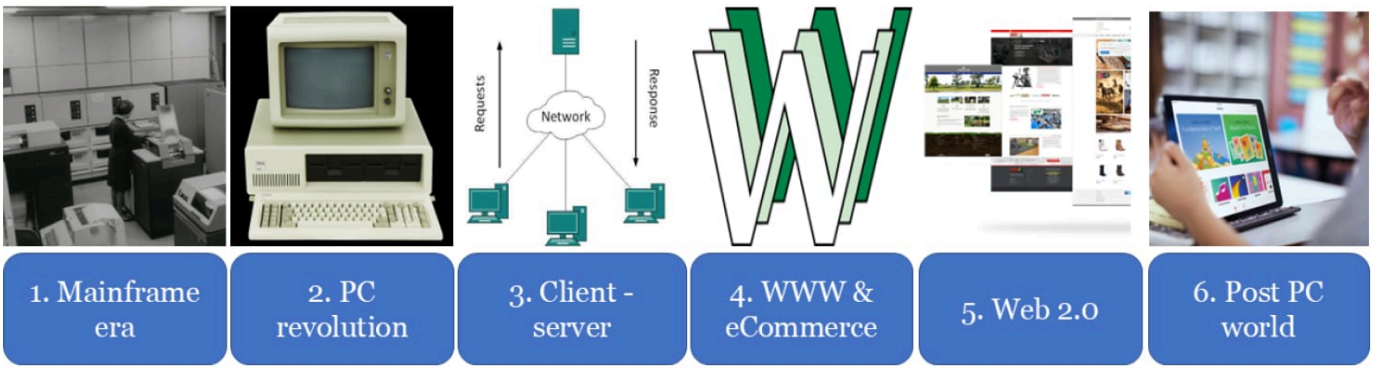
2.2.4. WWW & eCommerce era

2.2.5. Web 2.0 era

2.2.6. Post-PC World era

In this section, we will explore the role information systems play in an organization. Later in the text, you will learn how components collect, store, organize and distribute data throughout the organization. In fact, we might say that one of the roles of information systems is to take **data** and turn it into **information**, and then transform that into **organizational knowledge**.

Technology has changed, and it has changed the role of information systems. As technology has been developed, this role has evolved into the backbone of the organization. To get a full appreciation of the role information systems play, we will review how they have changed over the years.



Technology eras. Image created by Luis R Castellanos. Public Domain. Own work.

2.2.1. Mainframe Era

From the late 1950s through the 1960s, computers were seen as a way to more efficiently do calculations. These first business computers were room-sized monsters, with several refrigerator-sized machines linked together. The primary work of these devices was to organize and store large volumes of information that were tedious to manage by hand.

Only large businesses, universities, and government agencies could afford them, and they took a crew of specialized personnel and specialized facilities to maintain. These devices served dozens to hundreds of users at a time through a process called time-sharing. Typical functions included scientific calculations and accounting, under the broader umbrella of “data processing.”

“Dumb” terminals were a common thing to use...



Sperry Univac. Dumb Terminal.

By DPLA, Public Domain, from Wikimedia Commons

IBM logo.

By Viscovery, IBM, Amazon, Public Domain, from Wikim Commons

In the late 1960s, the Manufacturing Resources Planning (MRP) systems were introduced. This software, running on a mainframe computer, gave companies the ability to manage the manufacturing process, making it more efficient. From tracking inventory to creating bills of materials to scheduling production, the MRP systems (and later the MRP II systems) gave more businesses a reason to want to integrate computing into their processes.

IBM became the dominant mainframe company.

> IBM stands for "International Business Machines"

Nicknamed “Big Blue,” the company became synonymous with business computing.

Continued improvement in software and the availability of cheaper hardware eventually brought mainframe computers (and their little sibling, the minicomputer) into most large businesses.

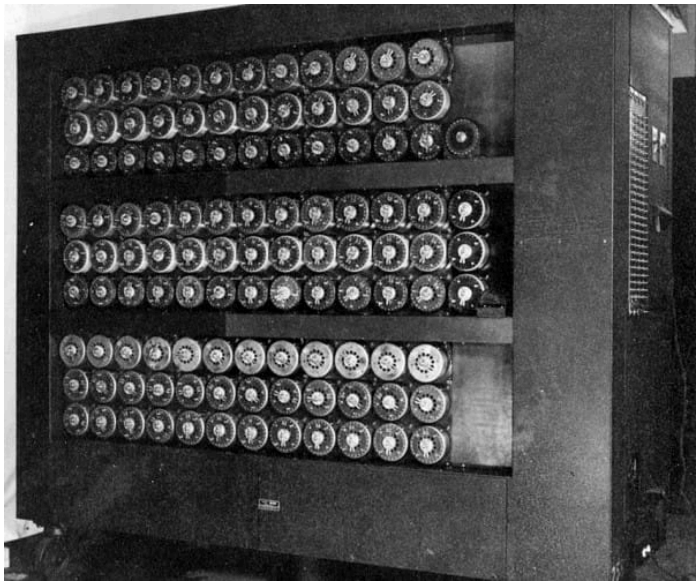
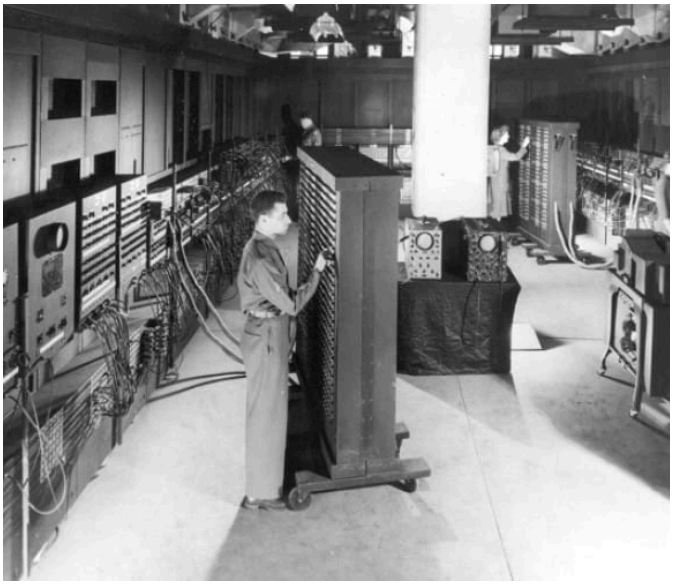
What is a Mainframe?

According to IBM, at their core, **mainframes** are high-performance computers with large amounts of memory and processors that process billions of simple calculations and transactions in real time.

The mainframe is critical to commercial databases, transaction servers, and applications that require high resiliency, security, and agility.

The '**Bombe**", computer designed by Alan Turing in 1939 for the British War Office, is considered the first modern computer. It began to function in 1940 and its initial purpose was to break (decypher) the German "Enigma" code. It is also known as the "Turing machine".

The **ENIAC** computer (Electronic Numerical Integrator and Computer) is considered to be the first commercial modern computer. It was designed by John Mauchly and J. Presper Eckert in the Moore School of Electrical Engineering (University of Pennsilvania) in 1946.

	
A wartime picture of the **Bombe.** By Unknown author - Set of wartime photos of GC&CS at Bletchley Park, Public Domain. Via Wikipedia Commons.	**ENIAC** computer at the Moore School of Electrical Engineerir This file is a work of a U.S. Army soldier or employee, taken c made as part of that person's official duties. As a work of the U.S. federal government, it is in the **public domain** in the United States. Via Wikipedia Commons.

> Computers in the future may weigh no more than 1.5 tons.
>
> — Popular Mechanics (1949)

Recommended movie

The Imitation Game is a 2014 American biographical thriller film directed by Morten Tyldum and written by Graham Moore, based on the life of Alan Turing.

Starring: Benedict Cumberbatch, Keira Knightley, Matthew Goode, Rory Kinnear, Charles Dance, Mark Strong

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

2.2.2. PC Revolution Era

In 1975, the first microcomputer was announced on the cover of Popular Mechanics: the **Altair 8800**.

Microcomputers' immediate popularity sparked the imagination of entrepreneurs everywhere, and there were quickly dozens of companies making these “personal computers.”

Though at first just a niche product for computer hobbyists, improvements in usability and the availability of practical software led to growing sales.

The most prominent of these early personal computer makers was a little company known as Apple Computer, headed by Steve Jobs and Steve Wozniak, with the hugely successful “**Apple II**.”

Not wanting to be left out of the revolution, in 1981 IBM (teaming with a little company called Microsoft for their operating-system software) hurriedly released their own version of the personal computer, simply called the “**PC**.”

Businesses, who had used IBM mainframes for years to run their businesses, finally had the permission they needed to bring personal computers into their companies, and the IBM PC took off.

The IBM PC was named Time magazine’s “Machine of the Year” in their January 1983 cover.

> Wired Magazine - Dec. 26, 1982: Time's Top Man? The Personal Computer

IBM PC’s had a closed architecture, but the demand for the PC's was so big, that they "opened" the architecture, and made it easy for other companies to copy, or “clone” it.



Altair 8800

By Swtpc6800. Public Domain. Wikipedia Commons.



Apple II

By Benoît Prieur, CC0, Wikimedia Commons.

During the 1980s, many new computer companies sprung up, offering less expensive versions of the PC.

This drove prices down and spurred innovation. **Microsoft** developed its **Windows** operating system and made the PC even easier to use.

Common uses for the PC during this period included word processing, spreadsheets, and databases.

These early PCs were not connected to any sort of network; for the most part, they stood alone as islands of innovation within the larger organization.

> *There is no reason for any individual to have a computer in his home.*

— Ken Olsen. CEO of DEC. 1970.

2.2.3. Client-Server Era

In the mid-1980s, businesses began to see the need to connect their computers together as a way to collaborate and share resources.

This networking architecture was referred to as “client-server” because users would log in to the local area network (LAN) from their PC (the “**client**”) by connecting to a powerful computer called a “**server**,” which would then grant them rights to different resources on the network (such as shared file areas and a printer).

Software companies began developing applications that allowed multiple users to access the same data at the same time.

This evolved into software applications for communicating, with the first real popular use of electronic mail appearing at this time.

This networking and data sharing all stayed within the confines of each business, for the most part.

While there was sharing of electronic data between companies, this was a very specialized function.

Computers were now seen as tools to collaborate internally, within an organization.

In fact, these networks of computers were becoming so powerful that they were replacing many of the functions previously performed by the larger mainframe computers at a fraction of the cost.

It was during this era that the first Enterprise Resource Planning (ERP) systems were developed and run on the client-server architecture.

An ERP system is a software application with a centralized database that can be used to run a company's entire business. With separate modules for accounting, finance, inventory, human resources, and many, many more, ERP systems, with Germany's SAP leading the way, represented the state of the art in information systems integration.

2.2.4. WWW & eCommerce Era

First invented in 1969, the Internet was confined to use by universities, government agencies, and researchers for many years.

Its rather arcane commands and user applications made it unsuitable for mainstream use in business.

One exception to this was the ability to expand electronic mail outside the confines of a single organization.

While the first e-mail messages on the Internet were sent in the early 1970s, companies who wanted to expand their LAN-based e-mail started hooking up to the Internet in the 1980s.

Companies began connecting their internal networks to the Internet in order to allow communication between their employees and employees at other companies.

It was with these early Internet connections that the computer truly began to evolve from a computational device to a communications device.



The historic **World Wide Web** logo. By Robert Cailliau. Public domain. From Wikimedia Commons.

In 1989, **Tim Berners-Lee** developed a simpler way for researchers to share information over the network at CERN laboratories, a concept he called the World Wide Web.

This invention became the launching point of the growth of the Internet as a way for businesses to share information about

themselves.

As web browsers and Internet connections became the norm, companies rushed to grab domain names and create websites.

In 1991, the National Science Foundation (NSF), which governed how the Internet was used, lifted restrictions on its commercial use.

The year 1994 saw the establishment of both **eBay** and **Amazon.com**, two true pioneers in the use of the new digital marketplace.

A mad rush of investment in Internet-based businesses led to the dot-com boom through the late 1990s, and then the dot-com bust in 2000.

While much can be learned from the speculation and crazy economic theories espoused during that bubble, one important outcome for businesses was that thousands of miles of Internet connections were laid around the world during that time.

The world became truly “wired” heading into the new millennium, ushering in the era of globalization.

As it became more expected for companies to be connected to the Internet, the digital world also became a more dangerous place.

Computer viruses and worms, once slowly propagated through the sharing of computer disks, could now grow with tremendous speed via the Internet.

Software written for a disconnected world found it very difficult to defend against these sorts of threats.

A whole new industry of computer and Internet security arose.

2.2.5. Web 2.0 Era

As the world recovered from the dot-com bust, the use of technology in business continued to evolve at a frantic pace.

Websites became interactive; instead of just visiting a site to find out about a business and purchase its products, customers wanted to be able to customize their experience and interact with the business.

This new type of interactive website, where you did not have to know how to create a web page or do any programming in order to put information online, became known as web 2.0.

Web 2.0 is exemplified by blogging, social networking, and interactive comments being available on many websites.

This new web-2.0 world, in which online interaction became expected, had a big impact on many businesses and even whole industries.

Some industries, such as bookstores, found themselves relegated to niche status.

Others, such as video rental chains and travel agencies, simply began going out of business as they were replaced by online technologies.

This process of technology replacing a middleman in a transaction is called **disintermediation**.

> Tweet why you’re leaving Netflix. The top three most creative tweets using #GoodbyeNetflix will win a 1-year subscription to Blockbuster!
>
> — Blockbuster (@blockbuster) September 21, 2011

In 2010, Blockbuster Corporate filed for bankruptcy. The once giant video store chain had fallen from over 9094 stores in 2004 to a mere 1700 struggling corporate locations. By April 2011 they were being auctioned off and the winning bid of 320 million dollars went to Dish Network, a satellite TV provider. Slowly the new operators began closing corporate owned stores and in January 2014 the final Blockbuster Corporate location closed.

Blockbuster failed because of heavy debt, fierce competition from Netflix and Redbox, and slow responses to changing technology. (BendBlockbuster)

As the world became more connected, new questions arose.

- Should access to the Internet be considered a right?
- Can I copy a song that I downloaded from the Internet?
- How can I keep information that I have put on a website private?
- What information is acceptable to collect from children?

Technology moved so fast that policymakers did not have enough time to enact appropriate laws, making for a Wild West–type atmosphere.

We will talk about Intellectual property and Copyright in **Chapter 5**.

2.2.6. Post-PC World Era

After 30 years as the primary computing device used in most businesses, sales of the PC are now beginning to decline as sales of laptops, tablets and smartphones are taking off.

Just as the mainframe before it, the PC will continue to play a key role in business, but will no longer be the primary way that people interact and do business.

The limited storage and processing power of these devices is being offset by a move to “cloud” computing, which allows for storage, sharing, and backup of the information on a massive scale.

This will require new rounds of thinking and innovation on the part of businesses as technology continues to advance.

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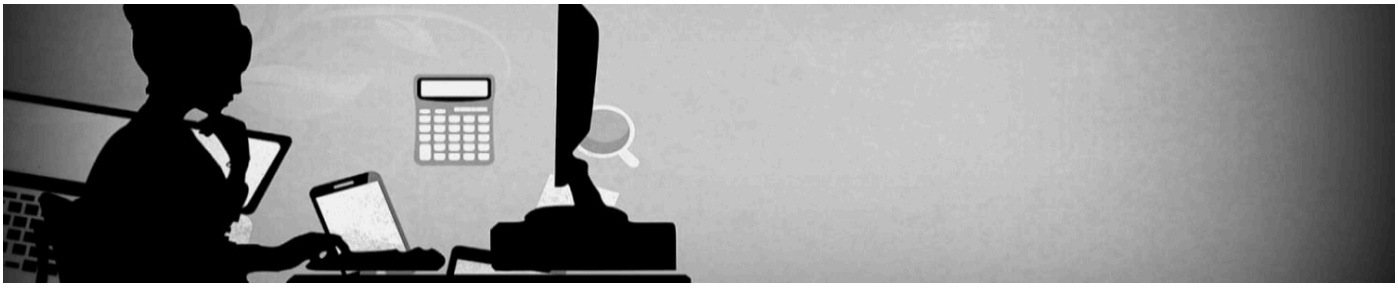
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2.3: Type of Users



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2.3.1. End user

2.3.2. Users according to how they adopt technology

2.3.1. End user

Besides the people who work to create, administer, and manage information systems (which we will talk about in Chapter 8), there is one more extremely important group of people, namely, the users of information systems. This group represents a very large percentage of an organization's employees. If the user is not able to successfully learn and use an information system, the system is doomed to failure.

Fred Beisse (2015) identifies "**End-user computing"** as the use of computer technology for both business and personal use. And he classifies the users according to many categories:

- **Environment:** Personal (home) user or work (corporate, organizational, enterprise) user
- **Skill level:** Novice, semiskilled, or expert
- **Frequency of use:** Occasional, frequent, or extensive
- **Software use:** Word processing, email, accounting, or others
- **Features used:** Basic, intermediate, or advanced (power users)
- **Relationship:** Internal user (coworker) or external user (client)



User. Image by Geralt from Pixabay.

2.3.2. Users according to how they adopt technology

One tool that can be used to understand how users will adopt a new technology comes from a 1962 study by Everett Rogers. In his book, *Diffusion of Innovation*, Rogers studied how farmers adopted new technologies and noticed that the adoption rate started slowly and then dramatically increased once adoption hit a certain point. He identified five specific types of technology adopters:

1. **Innovators**. Innovators are the first individuals to adopt new technology. Innovators are willing to take risks, are the youngest in age, have the highest social class, have great financial liquidity, are very social, and have the closest contact with scientific sources and interaction with other innovators. Risk tolerance is high so there is a willingness to adopt technologies that may ultimately fail. Financial resources help absorb these failures (Rogers, 1962, p. 282).
2. **Early adopters**. The early adopters are those who adopt innovation soon after a technology has been introduced and proven. These individuals have the highest degree of opinion leadership among the other adopter categories, which means that these adopters can influence the opinions of the largest majority. Characteristics include being younger in age, having a higher social status, possessing more financial liquidity, having advanced education, and being more socially aware than later adopters. These adopters are more discrete in adoption choices than innovators, and realize the judicious choice of adoption will help them maintain a central communication position (Rogers, 1962, p. 283).
3. **Early majority**. Individuals in this category adopt an innovation after a varying degree of time. This time of adoption is significantly longer than the innovators and early adopters. This group tends to be slower in the adoption process, has above average social status, has contact with early adopters, and seldom holds positions of opinion leadership in a system (Rogers, 1962, p. 283).
4. **Late majority**. The late majority will adopt an innovation after the average member of the society. These individuals approach an innovation with a high degree of skepticism, have below average social status, very little financial liquidity, are in contact with others in the late majority and the early majority, and show very little opinion leadership.
5. **Laggards**. Individuals in this category are the last to adopt an innovation. Unlike those in the previous categories, individuals in this category show no opinion leadership. These individuals typically have an aversion to change agents and tend to be advanced in age. Laggards typically tend to be focused on "traditions," are likely to have the lowest social status and the lowest financial liquidity, be the oldest of all other adopters and be in contact with only family and close friends.

These five types of users can be translated into information technology adopters as well, and provide additional insight into how to implement new information systems within the organization. For example, when rolling out a new system, IT may want to identify the innovators and early adopters within the organization and work with them first, then leverage their adoption to drive the rest of the implementation to the other users.

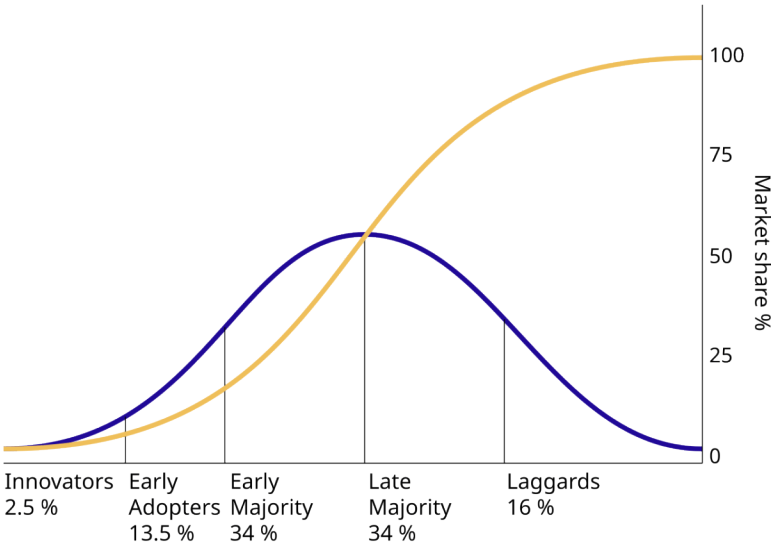


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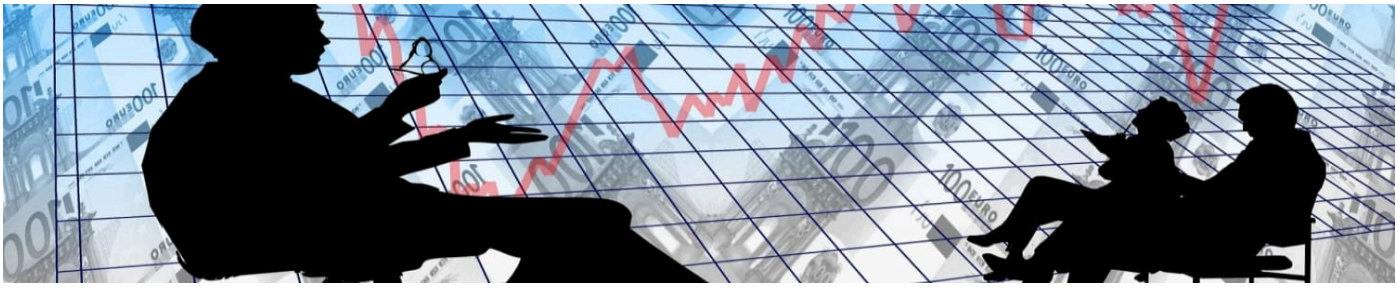
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2.4: What is Competitive Advantage



Contents

2.4.1. Competitive Advantage

2.4.2. Using Information Systems for Competitive Advantage

2.4.3. Collaborative Systems

2.4.4. Can Information Systems bring Competitive Advantage?

2.4.1. Competitive Advantage

What does it mean when a company has a competitive advantage? What are the factors that play into it? While there are entire courses and many different opinions on this topic, let's go with one of the most accepted definitions, developed by **Michael Porter** in his book *Competitive Advantage: Creating and Sustaining Superior Performance*. A company is said to have a competitive advantage over its rivals when it is able to sustain profits that exceed average for the industry. According to Porter, there are two primary methods for obtaining competitive advantage: cost advantage and differentiation advantage.

One of the ways that information systems participated in competitive advantage is through integrating the supply chain electronically. This is primarily done through a process called Electronic Data Interchange, or EDI.

EDI can be thought of as the *computer-to-computer exchange of business documents in a standard electronic format between business partners*. By integrating suppliers and distributors via EDI, a company can vastly reduce the resources required to manage the relevant information. Instead of manually ordering supplies, the company can simply place an order via the computer and the next time the order process runs, it is ordered.

2.4.2. Using Information Systems for Competitive Advantage

Now that we have an understanding of competitive advantage and some of the ways that IT may be used to help organizations gain it, we will turn our attention to some specific examples. A strategic information system is an information system that is designed specifically to implement an organizational strategy meant to provide a competitive advantage. These sorts of systems began popping up in the 1980s, as noted in a paper by **Charles Wiseman** entitled "*Creating Competitive Weapons From Information Systems*."

Specifically, a strategic information system is one that attempts to do one or more of the following:

- deliver a product or a service at a lower cost;
- deliver a product or service that is differentiated;

- help an organization focus on a specific market segment;
- enable innovation.

Following are some examples of information systems that fall into this category.

2.4.3. Collaborative Systems

As organizations began to implement networking technologies, information systems emerged that allowed employees to begin collaborating in different ways. These systems allowed users to brainstorm ideas together without the necessity of physical, face-to-face meetings. Utilizing tools such as discussion boards, document sharing, and video, these systems made it possible for ideas to be shared in new ways and the thought processes behind these ideas to be documented.

Broadly speaking, any software that allows multiple users to interact on a document or topic could be considered collaborative. Electronic mail, a shared Word document, social networks, and discussion boards would fall into this broad definition. However, many software tools have been created that are designed specifically for collaborative purposes. These tools offer a broad spectrum of collaborative functions. Here is just a short list of some collaborative tools available for businesses today:

- Google Drive. Google Drive offers a suite of office applications (such as a word processor, spreadsheet, drawing, presentation) that can be shared between individuals. Multiple users can edit the documents at the same time and threaded comments are available.
- Microsoft SharePoint. SharePoint integrates with Microsoft Office and allows for collaboration using tools most office workers are familiar with. SharePoint was covered in more detail in chapter 5.
- Cisco WebEx. WebEx is a business communications platform that combines video and audio communications and allows participants to interact with each other's computer desktops. WebEx also provides a shared whiteboard and the capability for text-based chat to be going on during the sessions, along with many other features. Mobile editions of WebEx allow for full participation using smartphones and tablets.
- Atlassian Confluence. Confluence provides an all-in-one project-management application that allows users to collaborate on documents and communicate progress. The mobile edition of Confluence allows the project members to stay connected throughout the project.
- IBM Lotus Notes/Domino. One of the first true "groupware" collaboration tools, Lotus Notes (and its web-based cousin, Domino) provides a full suite of collaboration software, including integrated e-mail.



Google Drive logo. By Google, Public Domain, from Wikimedia Commons	**Microsoft Sharepoint logo**. By Microsoft, Public domain, from Wikimedia Commons

2.4.4. Can Information Systems Bring Competitive Advantage?

It has always been the assumption that the implementation of information systems will bring a business competitive advantage. If installing one computer to manage inventory can make a company more efficient, then it can be expected that installing several computers can improve business processes and efficiency.

In 2003, **Nicholas Carr** wrote an article in the *Harvard Business Review* that questioned this assumption. Entitled "I.T. Doesn't Matter." (Link)

Carr was concerned that information technology had become just a commodity. Instead of viewing technology as an investment that will make a company stand out, Carr said technology would become as common as electricity – something to be managed to reduce costs, ensure that it is always running, and be as risk-free as possible.

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2.5: Components of an Information System



Contents

2.5.1. The Components of Information Systems

- Hardware
- Software
- Data
- People
- Process

2.5.1. The Components of Information Systems

Information systems can be viewed as having five major components: hardware, software, data, people, and processes. The first three are *technology*. These are probably what you thought of when defining information systems. The last two components, people and processes, separate the idea of information systems from more technical fields, such as computer science. In order to fully understand information systems, you will need to understand how all of these components work together to bring value to an organization.

Technology components

Technology can be thought of as the application of scientific knowledge for practical purposes. From the invention of the wheel to the harnessing of electricity for artificial lighting, technology has become ubiquitous in daily life, to the degree that it is assumed to always be available for use regardless of location. As discussed before, the first three components of information systems – hardware, software, and data – all fall under the category of technology. Each of these will be addressed in an individual chapter. At this point a simple introduction should help you in your understanding.

Hardware

Hardware is the tangible, physical portion of an information system – the part you can touch. Computers, keyboards, disk drives, and flash drives are all examples of information systems hardware. **How these hardware components function and work together will be covered in Chapter 3.**

Software

Software comprises the set of instructions that tell the hardware what to do. Software is not tangible – it cannot be touched. Programmers create software by typing a series of instructions telling the hardware what to do. Two main categories of software

are: Operating Systems and Application software. Operating Systems software provides the interface between the hardware and the Application software. Examples of operating systems for a personal computer include Microsoft Windows and Ubuntu Linux. The mobile phone operating system market is dominated by Google Android and Apple iOS. Application software allows the user to perform tasks such as creating documents, recording data in a spreadsheet, or messaging a friend. **Software will be explored more thoroughly in Chapter 4**.

Data

The third technology component is data. You can think of data as a collection of facts. For example, your address (street, city state, postal code), your phone number, and your social networking account are all pieces of data. Like software, data is also intangible, unable to be seen in its native state. Pieces of unrelated data are not very useful. But aggregated, indexed, and organized together into a database, data can become a powerful tool for businesses. Organizations collect all kinds of data and use it to make decisions which can then be analyzed as to their effectiveness. The analysis of data is then used to improve the organization's performance. **Chapter 7 will focus on data and databases**, and how it is used in organizations.

Information Systems co



Hardware

By Dexmac, from Pixabay



Software

By J Osborne, from Pixabay



Data

By WokAndApix, from F

Non technology components

People

When thinking about information systems, it is easy to focus on the technology components and forget to look beyond these tools to fully understand their integration into an organization. A focus on the people involved in information systems is the next step. From the front-line user support staff, to systems analysts, to developers, all the way up to the chief information officer (CIO), the people involved with information systems are an essential element. **The people component will be covered in Chapter 8**.

Process

The last component of information systems is process. A process is a series of steps undertaken to achieve a desired outcome or goal. Information systems are becoming more integrated with organizational processes, bringing greater productivity and

better control to those processes. But simply automating activities using technology is not enough – businesses looking to utilize information systems must do more.

The ultimate goal is to improve processes both internally and externally, enhancing interfaces with suppliers and customers. Technology buzzwords such as “business process re-engineering,” “business process management,” and “enterprise resource planning” all have to do with the continued improvement of these business procedures and the integration of technology with them. Businesses hoping to gain a competitive advantage over their competitors are highly focused on this component of information systems.

There is no chapter in this book about process, because when the software is developed, a process is followed. Overall, the process goes throughout all components of the Information Systems.

Networking Communication

Besides the technology components (hardware, software, and data) which have long been considered the core technology of information systems, it has been suggested that one other component should be added: communication. An information system can exist without the ability to communicate – the first personal computers were stand-alone machines that did not access the Internet. However, in today’s hyper-connected world, it is an extremely rare computer that does not connect to another device or to a network. Technically, the networking communication component is made up of hardware and software, but it is such a core feature of today’s information systems that it has become its own category. **Networking will be covered in Chapter 6**.

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2.6: Summary



2.1. Information Systems

Data is a raw and unorganized fact that requires to be processed to make it meaningful.

Information is a set of data which is processed in a meaningful way according to the given requirement.

A **system** is a group of interacting or interrelated elements that act according to a set of rules to form a unified whole.

Information System is an organized combination of people, technology, data, and procedures that collect, process, store, and distribute information to support operations, management, and decision-making in an organization.

2.2. Evolution Eras of Technology

- Mainframe Era
- PC Revolution Era
- Client-Server Era
- WWW & eCommerce Era
- Web 2.0 Era
- Post PC Era

2.3. Type of Users

Fred Beisse identifies "**End-user computing**" as the use of computer technology for both business and personal use.

And he classifies the users according to many categories:

- Environment
- Skill level
- Frequency of use
- Software use
- Features used
- Relationship

Everett Rogers identified five specific types of technology adopters:

1. Innovators
2. Early adopters
3. Early majority

4. Late majority
5. Laggards

2.4. Competitive Advantage

A company is said to have a competitive advantage over its rivals when it is able to sustain profits that exceed average for the industry.

According to Michael Porter, there are two primary methods for obtaining competitive advantage: cost advantage and differentiation advantage.

2.5. Components of an Information System

Technical Components of Information Systems

- Hardware
- Software
- Data
- Networking Communication: A Fourth Technology Piece?

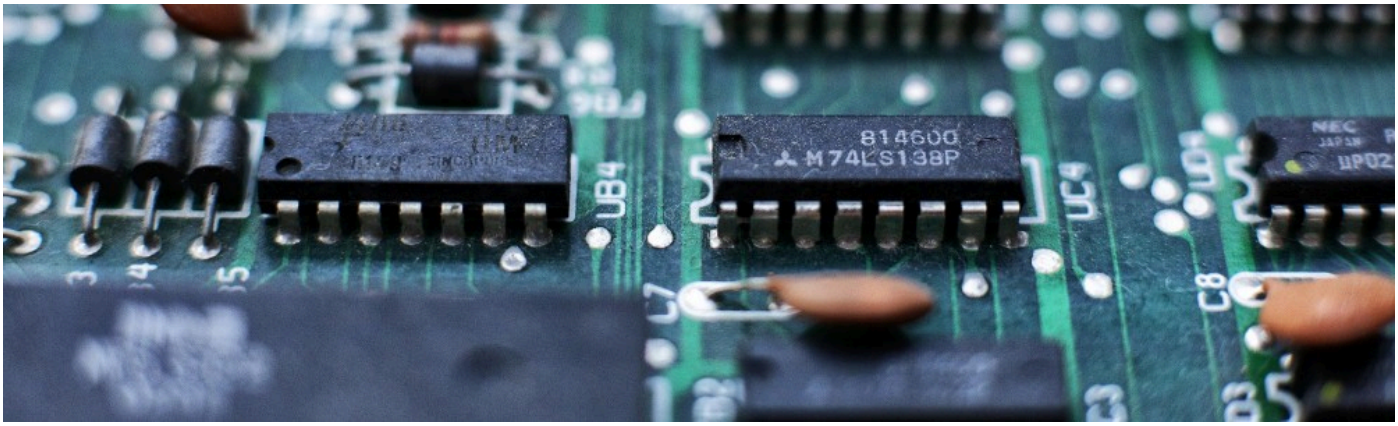
Non-Technical Components of Information Systems

- People
- Process

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3: INFORMATION SYSTEMS - HARDWARE



Introduction

An information system is made up of five components: hardware, software, data, people, and process. The physical parts of computing devices – those that you can actually touch – are referred to as **hardware**.

In this chapter, we will take a look at this component of information systems, learn a little bit about how it works, and discuss some of the current trends surrounding it.

Learning Objectives

Upon successful completion of this chapter, you will be able to:

- Describe different computer hardware that makes up the computer system;
- Identify peripheral devices that connect to the computer via various connection ports;
- Identify input devices that allow to send data to computers;
- Identify output devices that transform computer-readable data back into an information format.

3.1: Computer Systems Hardware
3.2: Hardware components
3.3: Peripherals
3.4: Input/Output devices
3.5: Summary

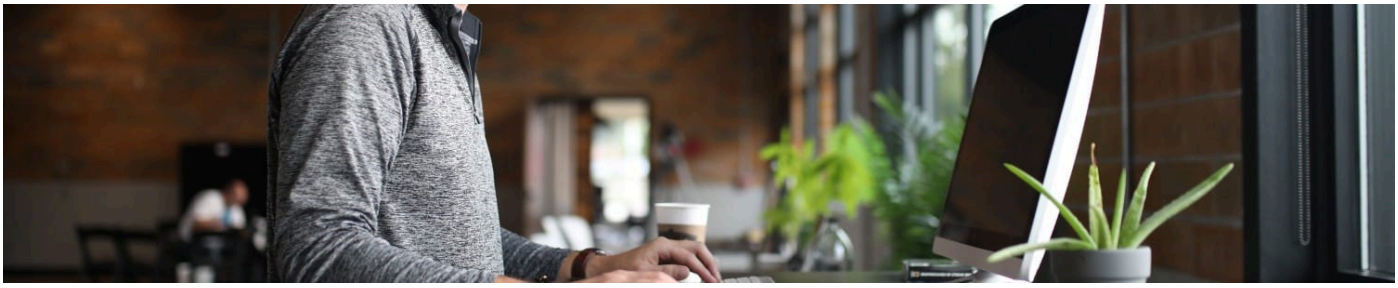
"When you get in debt, you become a slave."

— Andrew Jackson, *PotUS 7*

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3.1: Computer Systems Hardware



Contents

3.1.1. Different Computer Systems

3.1.2. The Rise of Mobile Computing

3.1.3. Integrated Computing

3.1.1. Different Computer Systems

There are a number of different types of computer systems in use today. The personal computer, also known as the PC or desktop, is one of the most common types of computer due to its versatility and relatively low price. Laptops (or Notebooks) are generally very similar, although may use lower-power or reduced size components. Others include tablets, mobile phones, and e-readers for work, home, and leisure activities.

Desktops

> The term "**Desktop**" originated from the fact that these computers were intended to be used on top of the desks.

Since the first desktop computers (Altair 8800, Apple I and Apple II, and the IBM PC), they featured a case, a monitor, and a keyboard. Eventually, a mouse was added. And modern desktops don't even have a case.

The common types of desktop computers, according to Lenovo, are:

- **Tower Desktop**: Separate big box and screen; easy to upgrade parts.
- **All-in-One (AIO)**: The computer parts are built right inside the back of the monitor screen.
- **Mini PC**: A very small box that saves space while doing basic tasks.

	
Tower Desktop Leon Brooks, Public Domain, from Wikimedia Commons	**Dell All In One Desktop** Intel Free Press, Public Domain, from Wikimedia Commons

Laptops

Portable computing improved tremendously over the years moving much of computing to the Internet. Laptop and Notebook computer users are making use of “the cloud” for data and application storage.

> The term "**Laptop**" originated from the fact that they were intended to be used on top of the lap.

The “luggable” computer has given way to a much lighter clamshell computer that weighs from 4 to 6 pounds and runs on batteries. In fact, the most recent advances in technology give us a new class of laptops that is quickly becoming the standard: these laptops are extremely light and portable and use less power than their larger counterparts.

The MacBook Air is a good example of this: it weighs less than three pounds and is only 0.68 inches thick!



GRiD Compass, model 1101. First Laptop.

Image by jmdo, GNU, from Wikimedia *Commons*

The Grid Compass, Model 1101 was the first real laptop that was portable, with an Intel 8086 processor, a **6-inch** 320×240-pixel bright **screen**, **256KB DRAM**, and **384K** internal magnetic bubble **memory**.

It was released in **April 1982**, at $8150. The manufacturer was GRiD Systems Corporation, Mountain View, California.

History Computer



MacBook Air.

Image by Pixel LA, Public Domain, from Wikimedia Commo

The original MacBook, available in black or white colors, wa released on **May 16, 2006**, and used the 32-bit Intel Core processor and 945GM chipset, with Intel's GMA 950 integr graphics on a 667 MHz front side bus.

Sales of the black polycarbonate MacBook ceased in Octob 2008, after the introduction of the aluminum MacBook.

Wikipedia

Mobile Phones

The first modern-day mobile phone was invented in 1973. Resembling a brick and weighing in at two pounds, it was priced out of reach for most consumers at nearly $4,000.

Since then, mobile phones have become smaller and less expensive; today mobile phones are a modern convenience available to all levels of society.

> **Martin Cooper**, from Motorola, invented that first mobile phone.

As mobile phones evolved, they became more like small computers. These smartphones have many of the same characteristics as a personal computer, such as an operating system and memory.

The first smartphone was the IBM Simon, introduced in 1994.

In January of 2007, Apple introduced the iPhone. Its ease of use and intuitive interface made it an immediate success and solidified the future of smartphones. Running on an operating system called iOS, the iPhone was really a small computer with a touch-screen interface. In 2008, the first Android phone was released, with similar functionality (HTC Dream).

		
Motorola "Brick" phone RFDigitalwpg, CC BY 2.0, Wikimedia Commons	**IBM Simon** Bcos47, Public domain, Wikimedia Commons	**Apple iPhone 1** Carl Berkeley, CC

Tablet Computers

A tablet computer is one that uses a touch screen as its primary input and is small enough and light enough to be carried around easily. They generally have no keyboard and are self-contained inside a rectangular case. The first tablet computers appeared in the early 2000s and used an attached pen as a writing device for input. These tablets ranged in size from small personal digital assistants (PDAs), which were handheld, to full-sized, 14-inch devices. Most early tablets used a version of an existing computer operating system, such as Windows or Linux.

These early tablet devices were, for the most part, commercial failures. In January 2010, Apple introduced the iPad, which ushered in a new era of tablet computing. Instead of a pen, the iPad used the finger as the primary input device. Instead of using the operating system of their desktop and laptop computers, Apple chose to use iOS, the operating system of the iPhone. Because the iPad had a user interface that was the same as the iPhone, consumers felt comfortable and sales took off. The iPad has set the standard for tablet computing. After the success of the iPad, computer manufacturers began to develop new tablets that used operating systems that were designed for mobile devices, such as Android.

		
Palm Pilot 1000. First PDA. Ndiggity, CC BY-SA 4.0, Wikimedia Commons	**Apple iPad 1st Generation** Evan-Amos, Public domain, Wikimedia Commons	**Samsung Galax** Havarhen, CC BY

Wearables

> **Wearables** are smart electronic devices (electronic device with micro-controllers) that are worn close to and/or on the surface of the skin, where they detect, analyze, and transmit information concerning e.g. body signals such as vital signs, and/or ambient data and which allow in some cases immediate biofeedback to the wearer.

According to market research firms (such as Grand View Research and Euromonitor), medical institutions (like the American College of Sports Medicine), and major industry analysts, the wearable technology market is rapidly expanding, with projections expected to reach between **$140B and $230B by 2030–2033**.

While smartwatches still lead in market volume, smaller and less intrusive form factors are growing at the highest rates, like the smart rings, smart glasses and smart textiles.

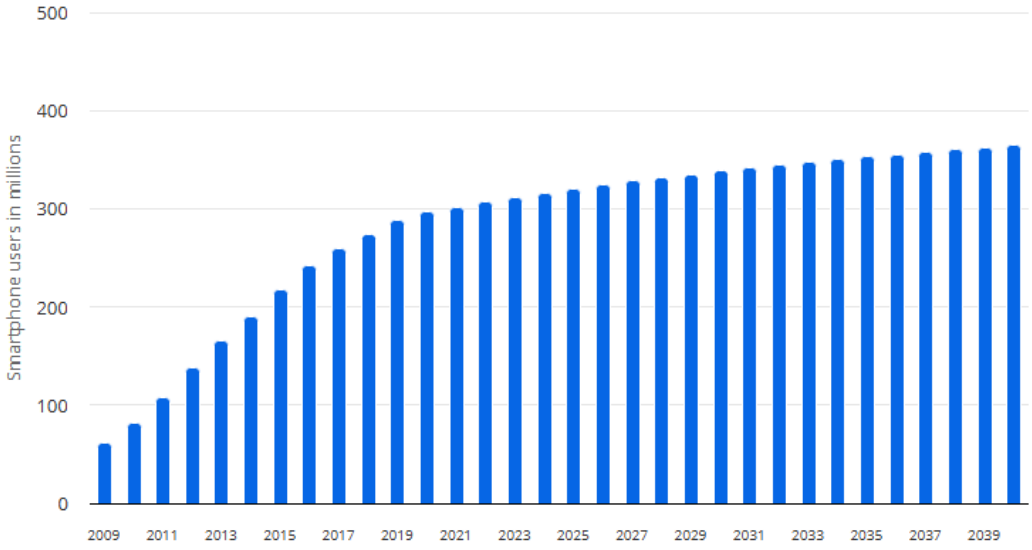
		
Earphones Image by Vinny1987 from Pixabay	**Smartwatch** Image by FancyCrave from Pixabay	**Smart ring** Image by Andrey

3.1.2. The Rise of Mobile Computing

In recent years, the market for personal computers (desktops and laptops) and mobile computing devices (smartphones and tablets) has been defined by **massive scale differences, shared post-pandemic volatility, and a pivot toward AI-driven upgrade cycles**.

The rise of mobile computing shifted technology from bulky desk machines to pocket-sized devices. This transformation started in the 1980s and 1990s with basic organizers and mobile phones, accelerated with internet-ready smartphones in the 2000s, and matured into today's fast, app-driven and AI-assisted digital world.

Mobile computing devices—led overwhelmingly by smartphones—dwarf PC shipments by roughly **4.5x to 5x in unit volume**. While global annual PC shipments hover between 250M and 290M units, annual smartphone shipments range between 1.15B and 1.35B units.

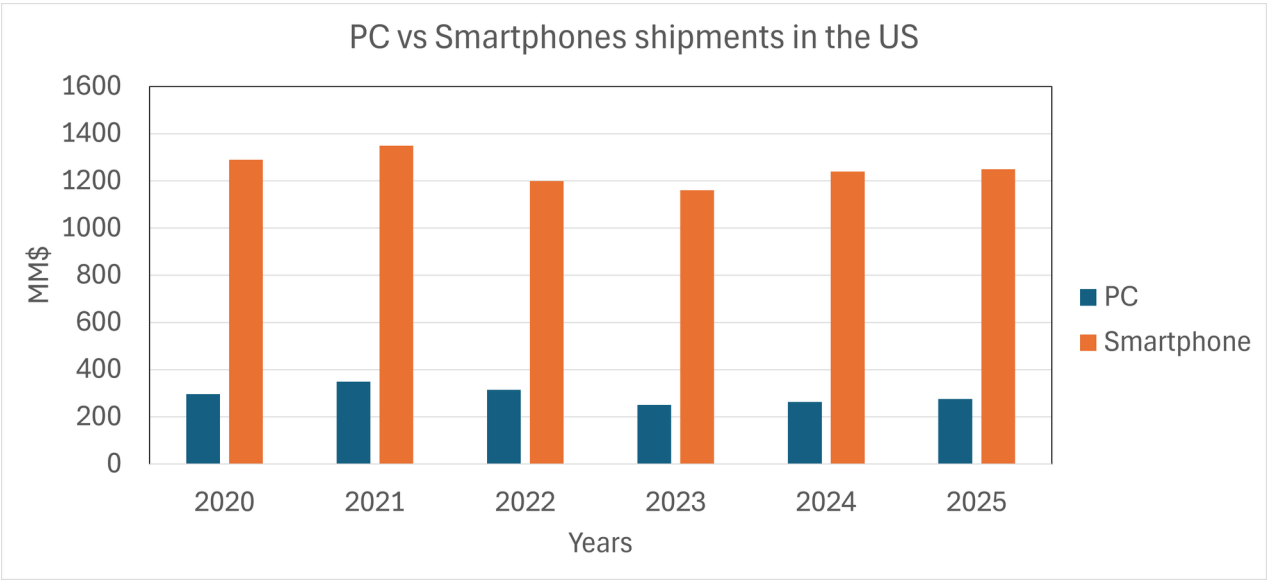


Number of smartphone users in the United States from 2009 to 2040 (in millions). Statista.

There are now two main aspects of the market that are worth looking at:

- **Smartphones as primary computing:** In developing and emerging economies, smartphones serve as the primary (or sole) internet gateway. As a result, smartphone market penetration is near-universal.
- **Longer PC Lifecycle:** Consumers replace smartphones every **2 to 3.5 years**, whereas PCs are typically upgraded every **4 to 6 years**. This difference in hardware longevity keeps PC replacement rates lower relative to total active users.

Here is a chart showing the shipment of PC's vs Smartphones, in the US, from 2020 to 2025:



PC vs Smartphone shipments from 2020 to 2025 in the US. Chart by Luis R Castellanos, Public Domain, Own work.

That would lead us to ask if the PC are going to disappear.

And we can see that the Personal Computer is not going to disappear. While smartphones and tablets have taken over as

the primary computing devices for daily digital consumption, the PC is undergoing a transformation rather than an extinction.

Mobile computing has not killed the PC; instead, it has **clarified the PC's distinct purpose**.

So the PC isn't dying; it's specializing. Just as laptops didn't make desktop computers completely obsolete, smartphones haven't eliminated the need for PCs. They exist side-by-side in a complementary digital ecosystem where mobile handles *ubiquity* and the PC handles *intensity*.

On the other hand, **information producers** (individuals, roles, automated systems, or entities responsible for collecting, creating, processing, and structuring raw data into meaningful, usable information) rely on PC's to generate information, while the **information consumers** (individuals, teams, systems, or external entities that receive, interpret, and act upon the information generated by **information producers**) rely on mobile computing to receive the information.

Information Producer vs. Information Consumer Comparison		
Attribute	**Information Producer**	**Information Consumer**
Primary Goal	Collect, clean, model, and format data.	Analyze, decide, execute, or monitor.
Typical Artifacts	Data pipelines, ML models, dashboards, databases.	Strategic plans, purchase decisions, audit reports, workflow actions.
Focus	Data quality, pipeline efficiency, governance, structure.	Business impact, problem-solving, insight extraction.
Examples	Data Engineers, Business Intelligence Analysts, Sensors, APIs.	Executives, Operations Teams, Customers, AI Decision Engines.
Devices	PCs, Laptops	Mobile computing devices

3.1.3. Integrated Computing

Along with advances in computers themselves, computing technology is being integrated into many everyday products. From automobiles to refrigerators to airplanes, computing technology is enhancing what these devices can do and is adding capabilities that would have been considered science fiction just a few years ago.

Here are two of the latest ways that computing technologies are being integrated into everyday products:

- Smart houses or Domotics
- Autonomous cars

Domotics

> Domotics (or home automation) refers to all the technologies and automated systems used to control and manage a home's equipment and infrastructure centrally and intelligently.
>
> Wattsense

This generally includes functions such as controlling lights, heating, air conditioning, security systems, household appliances and sometimes even entertainment equipment, via simple user interfaces such as mobile applications or voice assistants.

A domotic or home automation system typically connects controlled devices to a central smart home hub. The user interface for control of the system uses either wall-mounted terminals, tablet or desktop computers, a mobile phone application, or a Web interface.



Image by Geralt from Pixabay

Autonomous vehicles

> **Autonomous vehicle** is an automobile that employs driver assistance technologies to remove the need for a human operator.
>
> Brittanica

The stages of automation are defined by the Society of Automotive Engineers and were adopted by the U.S. Department of Transportation. The six stages follow.

Stages of Automation	
Stage 0	No automation. The vehicle is fully operated by the driver. Driver assistance is provided in the form of warnings; for example, blind spot or lane departure warnings.
Stage 1	The driver is fully in command of the vehicle with assistance from one automated feature. This may be in the form of automated acceleration and braking, as in the case of adaptive cruise control, in which the speed of the car adjusts automatically to keep up with the speed of traffic at a safe distance; or automated steering, in which the driver is assisted by features such as lane centering.
Stage 2	As in stage 1, the driver is fully in command of operating the vehicle. However, automation at stage 2 includes assistance from two automated features, for example, acceleration, braking, or steering.
Stage 3	Under specific conditions, automation at stage 3 enables a vehicle to operate autonomously, but a human driver must actively monitor conditions and immediately take control of the vehicle when the system alerts them.
Stage 4	In stage 4, a vehicle is fully self-operational within set boundaries, requiring no attention or assistance from a human driver, and indeed may not include features such as pedals or a steering wheel. Examples of stage 4 self-driving vehicles include local driverless taxis operating within “geofenced” boundaries.
Stage 5	Fully self-driving vehicles that require no driver assistance or monitoring and operate without boundaries or conditions. While there is work being done on this technology, experts’ predictions of the timing of its implementation and availability vary widely.

> Some useful links to go deeper in this field are: Inside Autonomous Vehicles, Car and Driver, and Self Drive News.



Yandex self driving Hyundai Sonata. By Retired electrician, CC0, from Wikimedia Commons

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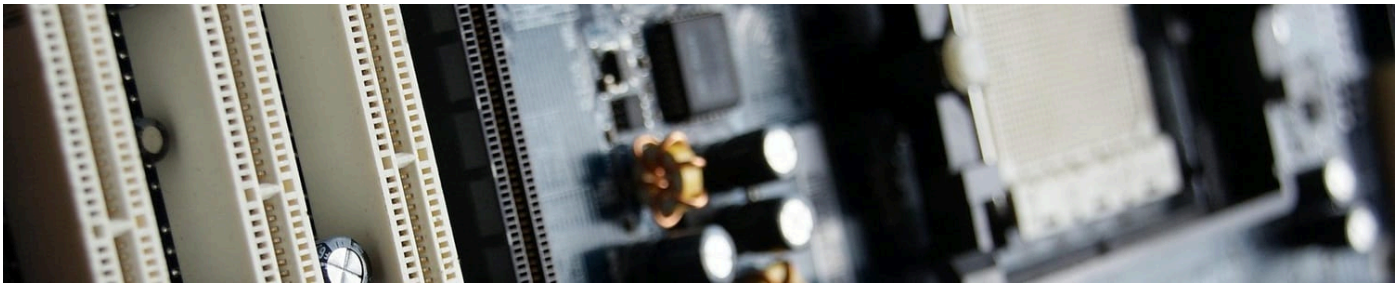
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3.2: Hardware components



Contents

3.2.1. Computer System Components

- Case or chassis
- Motherboard
- Central Processing Unit
- Chipset
- Random-Access Memory
- Read-Only Memory
- Buses
- CMOS Battery
- Sockets
- Slots
- Clock Generator
- Power Connectors
- Connectors for Hard Drives

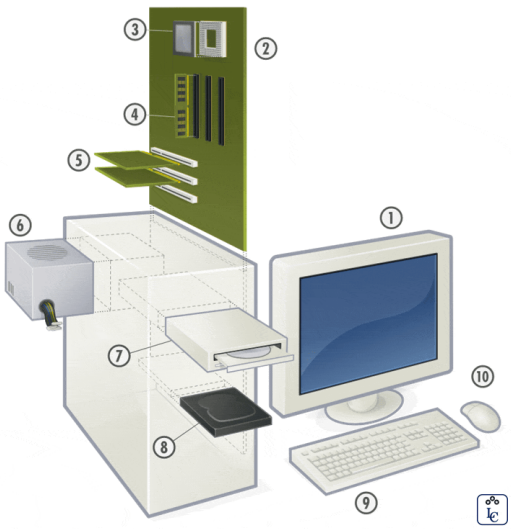
3.2.1. Computer System Components

> **Computer hardware** (usually simply called hardware when a computing context is concerned) is the collection of physical elements that constitutes a computer system.

Computer hardware is the physical parts or components of a computer, such as a monitor, mouse, keyboard, computer data storage, hard disk drive (HDD), graphic cards, sound cards, memory, motherboard, and so on, all of which are physical objects that are tangible.

In contrast, the software is the set of instructions that can be stored and run by hardware.

1. Monitor



GIF image created by Luis R Castellanos

Based on image by GustavB, GNU FDL, from Wikimedia Commons

In the following sections, we will examine the internal and external components of a computer.

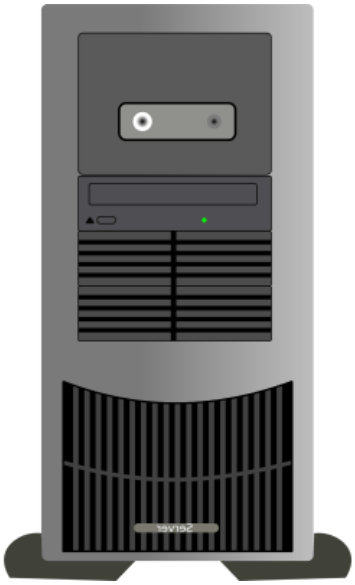
Case or chassis

The computer case or chassis is a plastic or metal enclosure that houses most of the components.

Those found on desktop computers are usually small enough to fit under a desk, however in recent years more compact designs have become more commonplace, such as the all-in-one style designs.

Though a case can basically be big or small, what matters more is which form factor of motherboard it's designed for.





Horizontal computer case	Mini Tower computer case
Image by OpenClipart-Vectors from Pixabay	Image by OpenClipart-Vectors from Pixabay

Motherboard

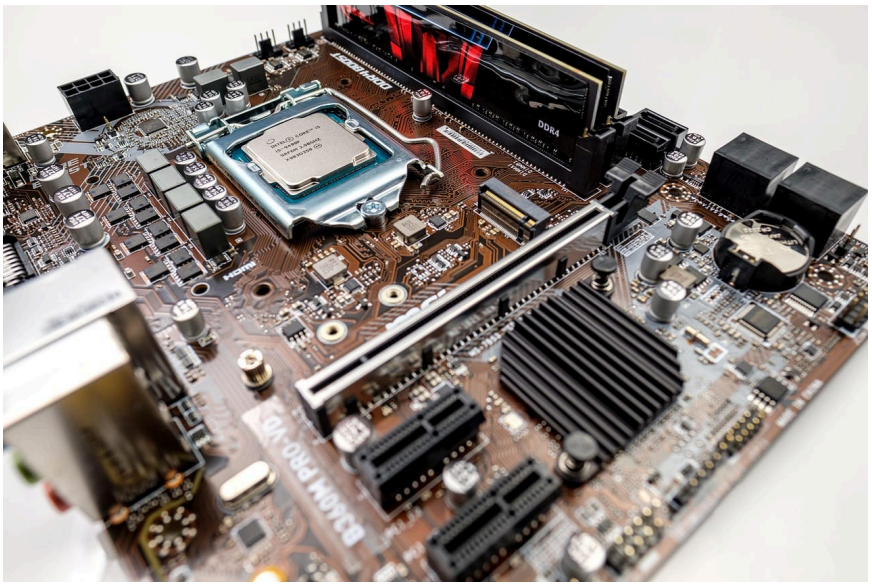
Prior to the invention of the microprocessor, the digital computer consisted of multiple printed circuit boards in a card-cage case with components connected by a backplane, a set of interconnected sockets. In very old designs the wires were discrete connections between card connector pins, but printed circuit boards soon became the standard practice. The Central Processing Unit (CPU), memory, and peripherals were housed on individual printed circuit boards, which were plugged into the backplate.

During the late 1980s and 1990s, it became economical to move an increasing number of peripheral functions onto the motherboard. In the late 1980s, personal computer motherboards began to include single ICs (also called Super I/O chips) capable of supporting a set of low-speed peripherals: keyboard, mouse, floppy disk drive, serial ports, and parallel ports. By the late-1990s, many personal computer motherboards supported a full range of audio, video, storage, and networking functions without the need for any expansion cards at all; higher-end systems for 3D gaming and computer graphics typically retained only the graphics card as a separate component.

> A motherboard is the main component of a computer.

Sometimes it is alternatively known as the mainboard, system board, planar board, or logic board, colloquially, a MoBo. It holds and allows communication between many of the crucial electronic components of a system that connects the other parts of the computer including the CPU, the RAM, the disk drives (CD, DVD, hard disk, or any others) as well as any peripherals connected via the ports or the expansion slots.

Components directly attached to or part of the motherboard include a central processing unit, chipset, random-access memory, read-only memory buses, and CMOS battery.



PC Desktop Motherboard. Image by Bruno, from Pixabay

Central Processing Unit

The **CPU** (Central Processing Unit), also called processor or microprocessor, performs most of the calculations which enable a computer to function, and is sometimes referred to as the "**brain**" of the computer.

The CPU has four (4) main components:

- **Control Unit (CU):** Directs operations, reads instructions, and turns them into signals that tell the rest of the computer what to do.
- **Arithmetic Logic Unit (ALU):** Performs math (addition, subtraction) and logic checks (comparing numbers or true/false choices).
- **Registers:** Tiny, ultra-fast storage spots inside the processor that hold the exact data the CPU is working on right now.
- **Cache Memory:** A small, fast type of memory on the chip that keeps frequently used data close by so the CPU avoids waiting on regular RAM.

It is usually cooled by a heat sink and fan. Most microprocessors include an on-die Graphics Processing Unit (GPU), memory, peripheral interfaces, and other components such as integrated devices also known as microcontrollers or systems on a chip (SoC).

Some computers employ a multi-core processor, which is a single chip containing two or more CPUs called "cores"; in that context, single chips are sometimes referred to as "sockets". Array processors or vector processors have multiple processors that operate in parallel, with no unit considered central.

> CPU speed is measured in Hertzs (Hz).

The most important CPU vendors for Personal Computers and Mobile computing are Intel, AMD, Apple and Qualcomm.

- Intel and AMD are the two primary CPU vendors that completely dominate the traditional x86 desktop computer market, powering the vast majority of custom builds, pre-built PCs, and workstations.
- Apple produces custom ARM-based (Advanced RISC Machine) silicon (M-series chips) for their own desktop lineup like the iMac and Mac mini/Studio, as the CPUs for the iPad and iPhone.
- Qualcomm focuses on tablet and smartphone CPUs.





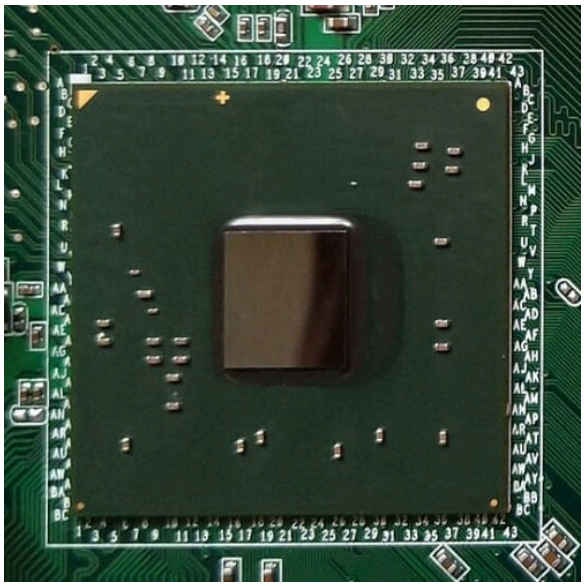
Intel Core i5 CPU	AMD Ryzen 5 CPU
Image by Bru-nO from Pixabay	Image by Cebbi from Pixabay

Chipset

The chipset is a set of electronic components in an integrated circuit that manages the data flow between the processor, memory, and peripherals.

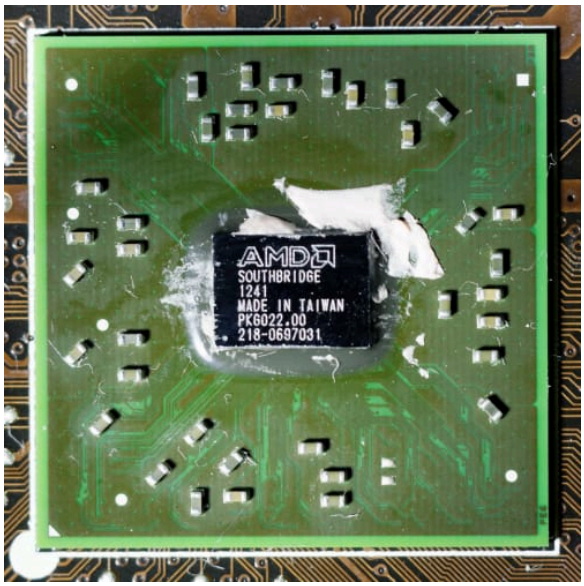
It is designed to work with a specific family of microprocessors.

Because it controls communications between the processor and external devices, the chipset plays a crucial role in determining system performance.



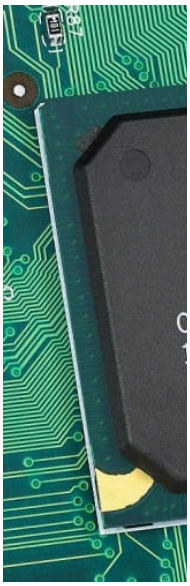
Intel i945GC Chipset

By JulianVilla26, CC BY-SA 4.0, Wikimedia Commons



AMD Chipset

By Brit Robin, CC BY-SA 4.0, Wikimedia Commons



VIA Chipset

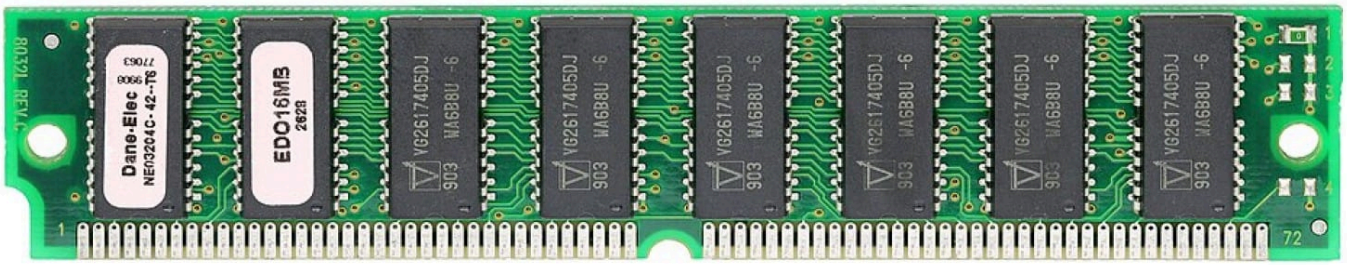
Mister RF, CC BY

Random-Access Memory

The Random-Access Memory (RAM), a volatile memory chip (where stored information is lost if power is removed) stores the code and data that are being actively accessed by the CPU. Today, random-access memory takes the form of integrated circuits.

Other types of non-volatile memory exist that allow random access for reading operations, but either do not allow write operations or have limitations on them.

These include most types of ROM and a type of flash memory called *NOR-Flash*.



SIMM RAM Card. Mister RF, CC BY-SA 4.0, Wikimedia Commons

Read-Only Memory

The Read-Only Memory (ROM), a non-volatile memory chip, stores data by permanently enabling or disabling selected transistors, such that the memory cannot be altered. It stores the BIOS that runs when the computer is powered on or otherwise begins execution, a process known as Bootstrapping, or “booting” or “booting up”.

The **BIOS** (Basic Input Output System) includes boot firmware and power management firmware. Newer motherboards use Unified Extensible Firmware Interface (UEFI) instead of BIOS.

There are other types of non-volatile memory that are not based on solid-state IC technology, including Optical storage media, such CD-ROM which is read-only (analogous to masked ROM). CD-R is Write Once Read Many (analogous to PROM), while CD-RW supports erase-rewrite cycles (analogous to EEPROM); both are designed for backward compatibility with CD-ROM.



BIOS AMIBIOS chip

MOS6502, CC BY-SA 2.5, Wikimedia Commons



UEFI Windbond chip

Raimond Spekking, CC BY-SA 4.0, W

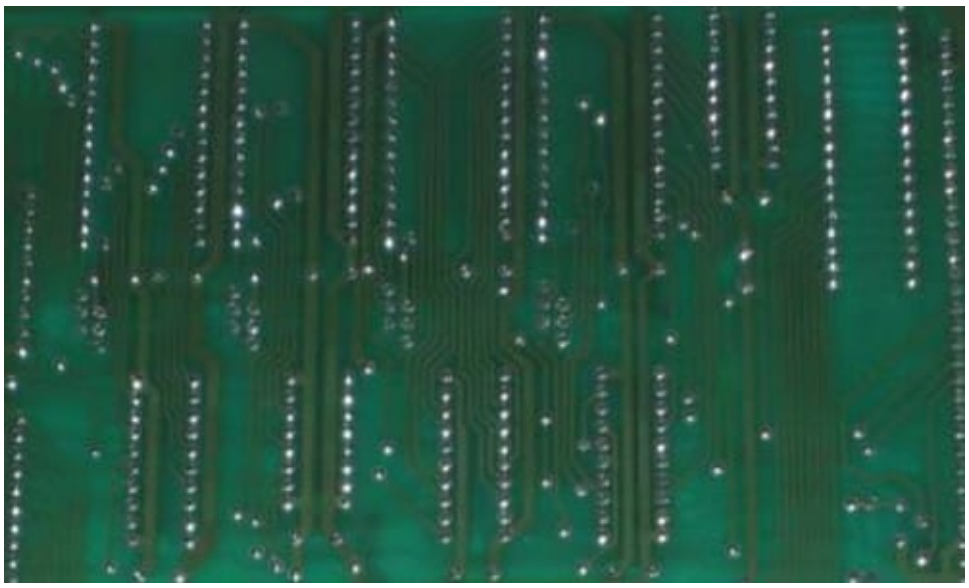
Buses

Buses are communication systems that transfer data between components inside a computer, or between computers.

This expression covers all related hardware components (wire, optical fiber, etc.) and software, including communication protocols.

An **internal bus** (also known as an internal data bus, memory bus, system bus, or Front-Side-Bus) expand cards for graphics and sound. Internal data buses are also referred to as local bus because they are intended to connect to local devices. This bus is typically rather quick and independent of the rest of the computer operations.

The **external bus**, or expansion bus, is made up of the electronic pathways that connect the different external devices, such as printers, etc., to the computer.



Internal Bus

Chris Whytehead, Chris's Acorns – CC-BY-SA-3.0, Wikimedia Commons



External Bus

Image CocoParisienne by from Pixab

CMOS Battery

The Complementary Metal-Oxide Semiconductor (CMOS) battery is also attached to the motherboard.

This battery is the same as a watch battery or a battery for a remote to a car's central locking system. Most batteries are CR2032, which powers the memory for date and time in the BIOS chip.

Sockets

Sockets (or slots) in which one or more microprocessors may be installed.

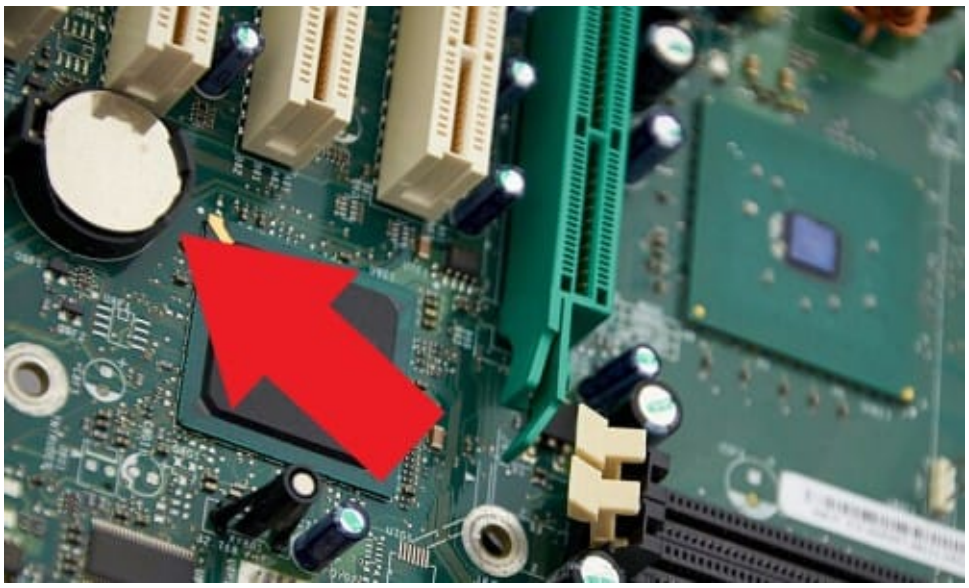
In the case of CPUs in ball grid array packages, such as the VIA C3, the CPU is directly soldered to the motherboard. A CPU socket (central processing unit) attaches to a Printed Circuit Board (PCB) and is designed to house a CPU (also called a microprocessor). It is a special type of integrated circuit socket designed for very high pin counts. A CPU socket provides many functions, including a physical structure to support the CPU, support for a heat sink, facilitating replacement (as well as reducing cost), and most importantly, forming an electrical interface both with the CPU and the PCB. CPU sockets on the motherboard can most often be found in most desktop and server computers (laptops typically use surface mount CPUs), particularly those based on the Intel x86 architecture.

A CPU socket type and motherboard chipset must support the CPU series and speed.

Slots

Slots into which the system's main memory is to be installed (typically in the form of DIMM modules containing DRAM chips). For

example, the slots for expansion cards (the interface to the system via the buses supported by the chipset)



CMOS on a motherboard

By Lenharth Systems, CC0, from Wikimedia Commons



CPU Socket

By Smial (FAL or GFDL 1.2), from Wik

Clock Generator

A clock generator produces the system clock signal to synchronize the various components.

Power Connectors

Power connectors receive electrical power from the computer power supply and distribute it to the CPU, chipset, main memory, and expansion cards. As of 2007, some graphics cards (e.g. GeForce 8 and Radeon R600) require more power than the motherboard can provide, and thus dedicated connectors have been introduced to attach them directly to the power supply.

Connectors for Hard Drives

Connectors for hard drives are typically Serial Advanced Technology Attachment (SATA) only. Disk drives also connect to the power supply.

Additionally, nearly all motherboards include logic and connectors to support commonly used input devices, such as USB connectors for a mouse and keyboard. Occasionally video interface hardware was also integrated into the motherboard.

Given the high thermal design power of high-speed computer CPUs and components, modern motherboards nearly always include heat sinks and mounting points for fans to dissipate excess heat.



Clock Generator chip

Raimond Spekking, CC BY-SA 4.0, Wikimedia Commons



Power connectors

Baran Ivo, Public domain, Wikimedia

Lifewire - A Beginner's Guide to Computer Hardware: From CPUs to SSDs

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Image by Krzysiup from Pixabay

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3.3: Peripherals



Contents

3.3.1. Peripheral Devices

3.3.2. Storage Devices

3.3.1. Peripheral Devices

> A peripheral device by definition is what a computer can read to receive or output information.

The mode of receiving this information is via removable media, storage devices, or Bluetooth.

In order for a personal computer to be useful, it must have channels for receiving input from the user and channels for delivering output to the user. These input and output devices connect to the computer via various connection ports, which generally are part of the motherboard and are accessible outside the computer case.

3.3.2. Storage Devices

Besides fixed storage components, removable storage media are also used in most personal computers. Removable media allows you to take your data with you. And just as with all other digital technologies, these media have gotten smaller and more powerful as the years have gone by.

Hard Disk Drives

A hard drive or **hard disk drive** (**HDD**) is a type of data storage device that is used in laptops and desktop computers. An HDD is a “non-volatile” storage drive, which means it can retain the stored data even when no power is supplied to the device. Operating systems (OS) tell the HDD to read and write data as needed by programs. The speed that the drive reads and writes this data is solely dependent on the drive itself.

HDDs started as massive, room-filling devices with a capacity of about 3.75 megabytes (MB). Today, by comparison, an HDD that fits easily in a desktop computer can have upwards of 18 terabytes worth of storage.

HDDs are the most affordable storage type because they have the most efficient cost per gigabyte. As storage capacity increases, the price of smaller HDDs decreases.

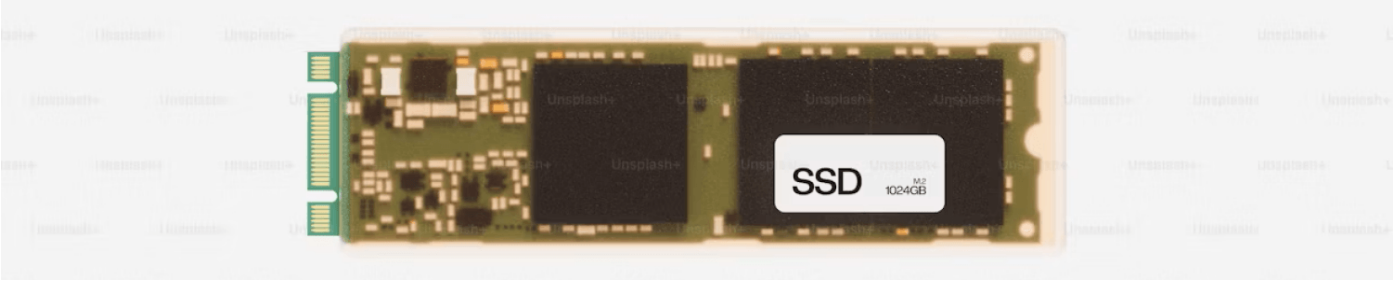


Hard Disk Drive. By Bohed from Pixabay

Solid State Drives

A **solid state drive** (**SSD**) is a storage device that saves your files, photos, and applications using memory chips instead of physical moving parts like an HDD. These chips are known as flash memory, and they can store data by harnessing electrical charges — even when powered off.

Unlike traditional hard drives with spinning parts, SSDs are — as their name implies — made of solid components. Without needing to wait for disks to start spinning or read/write heads to swing into place, solid state drives offer dramatically faster speeds, more durability, and better energy efficiency.



Solid State Drive. By Planet Volumes from Unsplash

Diskettes

Early computers used floppy disks, which could be inserted into a disk drive in the computer. Data was stored on a magnetic disk inside an enclosure. These disks ranged from 8″ in the earliest days down to 3 1/2″.

- 8" ⇒ 80 KB
- 5 ¼" ⇒ 360 KB (1.2 MB in HD)
- 3 ½" ⇒ 720 KB (1.44 MB HD)



Evolution of Diskettes. Image by George Chernilevsky, Public domain, Wikimedia Commons

External Drives

An external hard drive is a portable storage device that connects to your computer or other devices through interfaces like USB, Thunderbolt, or Wi-Fi. Unlike an internal drive, which is permanently installed within a computer and serves as the main storage for operating systems and essential software, external hard drives provide additional, portable storage options. They come in two main types:

1. Desktop external hard drives: These typically offer larger storage capacities and faster data transfer speeds, making them ideal for serious users who need extensive space for tasks like digital editing and large game installations.
2. Portable external hard drives: These are smaller, more compact devices designed for users who need to carry their data with them.

Modern external hard drives can range from traditional spinning disk drives (HDDs) to ultra-fast solid-state drives (SSDs), offering capacities from a few hundred gigabytes to multiple terabytes. For optimal performance, consider a high-capacity external SSD that combines speed and storage.



External Hard Drive. By Jan Van Bizar from Pixabay

Optical Discs

> An **optical disc** is a storage medium used to store digital data through optical technology. It consists of a flat, circular disc made of polycarbonate plastic, with a reflective layer and protective coating. Data is recorded and read using lasers, making it a popular storage format for various applications.
>
> Lenovo

Early versions of optical discs were created by researchers in the 1960s, and optical dick technologies appeared on the market in the early 1980s in the form of CDs and DVDs. At first these were used mainly for music and movies. CD-ROMs were read-only, and not a writable medium.

Standard CDs could hold about 700 megabytes of data, enough for 80 minutes of music or about 500 photos. But the ever-growing amount of computer-generated data created the need for a new form of high-capacity removable storage.

In recent years, optical discs have gradually lost popularity since large volumes of data can inexpensively be stored in the cloud. But the durability and high storage capacity of optical discs ensure they will continue to be used for years to come to create archives of important information for business and government.

Today's optical discs can store terabytes of data and offer up to 100 years of reliable data retrieval — a formidable combination of capacity and durability.

Optical Disks timeline

1982	The **Compact Disc (CD)** officially launches in the market, co-developed by Philips and Sony as a digital audio replacement for vinyl records (holding ~700 MB).
1984	**CD-ROM** is introduced, adapting the audio format for computer data storage.
1990	**CD-WO** (Write-Once / CD-R) arrives, allowing users to record data onto a disc a single time.
1995–1997	**CD-RW** (ReWritable) is introduced, enabling users to write, erase, and rewrite data multiple times.
1996–1997	The **DVD** format is launched, utilizing shorter laser wavelengths and tighter tracks to expand single-layer storage capacity to 4.7 GB.
1997–1999	Recordable DVD formats (**DVD-R**, **DVD-RW**, and **DVD+R**) emerge, creating a format war over rewritable standards before multi-format drives become common.
2006	The first commercial **Blu-ray** movies release, offering 25 GB (single layer) up to 50 GB+ of storage capacity using a blue-violet laser.



Optical Discs. Image by PublicDomainPictures from Pixabay.

USB Flash Drive

Around the turn of the century, a new portable storage technology was being developed: the USB flash drive. This device attaches to the universal serial bus (USB) connector, which became standard on all personal computers beginning in the late 1990s. As with all other storage media, flash drive storage capacity has skyrocketed over the years, from initial capacities of eight megabytes to current capacities of 64 gigabytes, and still growing.

In early personal computers, specific ports were designed for each type of output device. The configuration of these ports has evolved over the years, becoming more and more standardized over time. Today, almost all devices plug into a computer through the use of a USB port. This port type, first introduced in 1996, has increased in its capabilities, both in its data transfer rate and power supplied.



USB Flash Drives. Image EsaRiutta by from Pixabay.

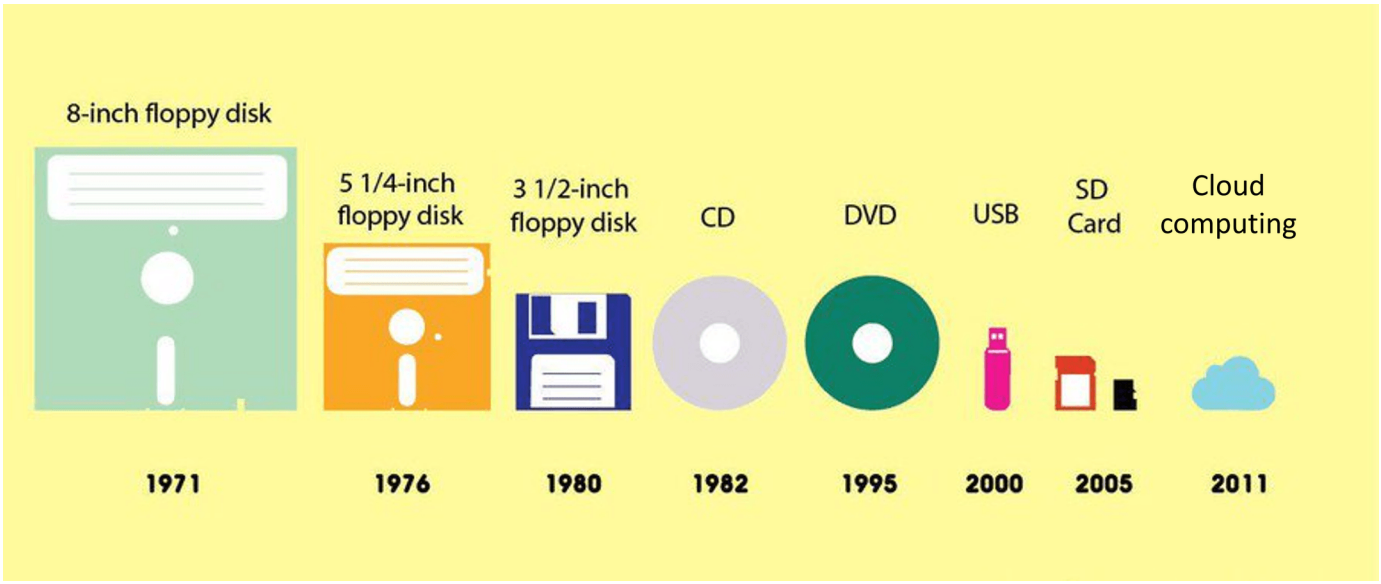
SD cards

Secure Digital card (SD) is a memory card format developed by the SD Card Association (SDA) for use in portable devices.

It was introduced in 1999 as a joint effort between SanDisk, Panasonic (Matsushita Electric) and Toshiba, as an improvement over MultiMediaCards (MMC), and has since become the industry standard.



SD Cards. Image by EsaRiutta from Pixabay.



Evolution of Digital Storage. Image by Palak from X.

Bluetooth

How do these devices connect? Besides USB, some input and output devices connect to the computer via a wireless-technology standard called Bluetooth. Bluetooth was first invented in the 1990s and exchanges data over short distances using radio waves. Bluetooth generally has a range of 100 to 150 feet. For devices to communicate via Bluetooth, both the personal computer and the connecting device must have a Bluetooth communication chip installed.

The latest version is 6.2 (Nov 2025).

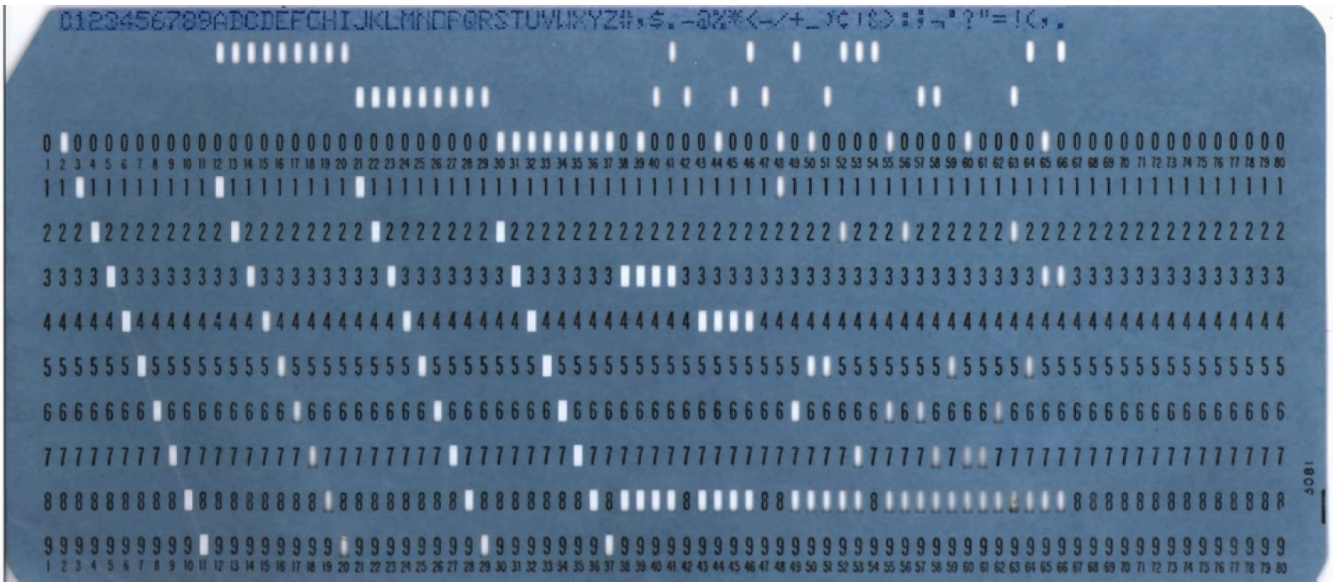
Bluetooth Official Page

Bluetooth logo. Bluetooth SIG, Public domain, Wikimedia Commons

Blast from the past: perforated cards

Perforated punch cards were the primary physical medium used to input data and write programs for early IBM Mainframe systems from the 1950s through the mid-1980s.

A standard IBM punched card had a data capacity of 80 characters (or bytes) per card.



Blue perforated (punch) card. Gwern, Public domain, from Wikimedia Commons

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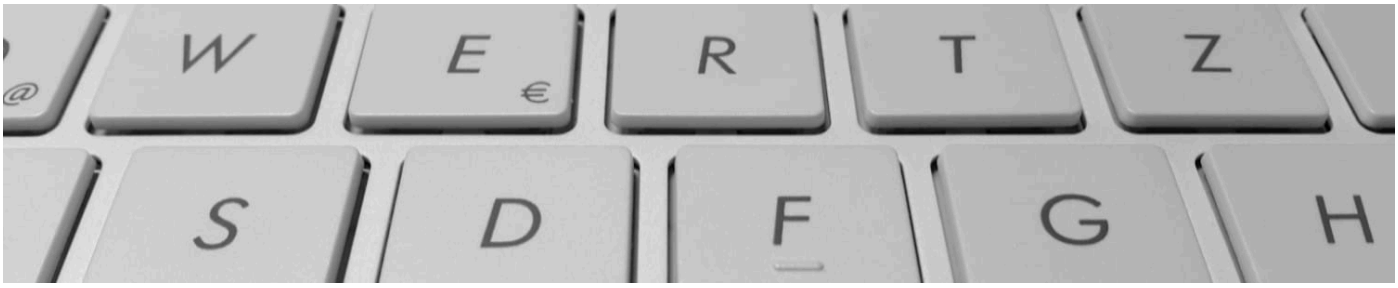
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3.4: Input/Output devices



Contents

3.4.1. Input devices

3.4.2. Output Devices

3.4.1. Input devices

Data may enter an information system in a variety of different ways, and the input device that is most appropriate will usually depend on the type of data being entered into the system, how frequently this is done, and who is responsible for the activity. For example, it would be more efficient to scan a page of typed text into an information system rather than retyping it, but if this happens very seldom, and if typing staff are readily available, then the cost of the scanner might not be justified. However, all of the input devices described in this chapter have at least one thing in common: the ability to translate non-digital data types such as text, sound or graphics into digital (i.e. binary) format for processing by a computer.

The keyboard

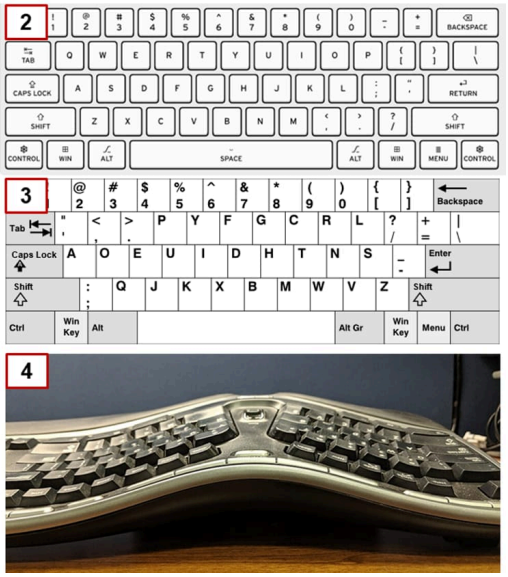
A lot of input still happens by means of a keyboard. Usually, the information that is entered by means of a keyboard is displayed on the monitor. The layout of most keyboards is similar to that of the original typewriter on which it was modeled.

Ironically, this “QWERTY” keyboard layout was originally designed to slow the operator down, so that the keys of the typewriter would not get stuck against each other. This layout now works counter-productively since a computer can process keyboard input many times faster than even the fastest typist can manage.

A brief history of the QWERTY keyboard

A number of attempts have been made to design alternative layouts by rearranging the keys (the Dvorak keyboard) or by reducing the number of keys. None of these alternative designs has really caught on. Special keyboards have also been designed for countries that use a non-Roman alphabet, and also for disabled people.





1. **Underwood typewriter**. Alf van Beem, CC0, Wikimedia Commons
2. **QWERTY Keyboard (US English)**. Tomíčo, CC BY-SA 4.0, Wikimedia Commons
3. **DVORAK Keyboard**. Public Domain, Wikimedia Commons
4. **Microsoft Natural Ergonomic Keyboard**. Mliu92, CC BY-SA 3.0, Wikimedia Commons

Pointing devices

The now-ubiquitous electronic *mouse* is an essential input device for use with any graphical user interface. It consists of a plastic molded housing, designed to fit snugly in the palm of the hand, with a small ball at its bottom. Moving the mouse across a flat surface will translate the movements into a rolling action of the ball. This is translated into electronic signals that direct the corresponding movement of a cursor on the computer monitor. Buttons on the mouse can then be used to select icons or menu items, or the cursor can be used to trace drawings on the screen.

Now, instead of a ball at the bottom, the mouse has a light beam, which makes it more accurate.

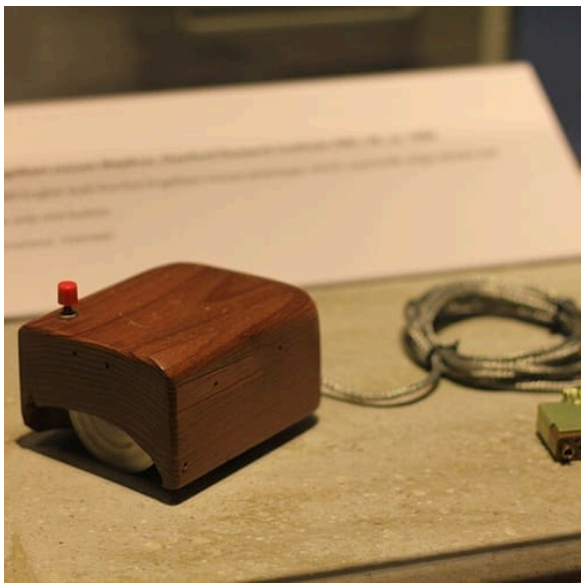
> Douglas Engelbart invented the mouse, in Stanford Research Institute (SRI) in 1964. The prototype had a wooden box, with 2 rolling wheels and 1 button.

The less popular *trackball* operated exactly like an “upside-down” mouse except that the ball is much larger and, instead of the mouse being moved over a surface, the user manipulates the ball directly. Since the trackball can be built into the side of the keyboard, it obviates the need for a free surface area and is therefore handy in situations where desktop surface area is at a premium or not available. Originally popular in educational laboratory settings and for laptop computers, trackballs are now mainly confined to exhibition displays and other public terminals.

The IBM TrackPoint is a small, pressure-sensitive isometric joystick embedded in the middle of computer keyboards, usually in laptops. It was carried later on by Lenovo.

Touch-screens are computer monitors that incorporate sensors on the screen panel itself or its sides. The user can indicate or select an area or location on the screen by pressing a finger onto the monitor. *Light and touch pens* work on a similar principle, except that a stylus is used, allowing for much finer control. Touch pens are more commonly used with handheld computers such as personal organizers or digital assistants. They have a pen-based interface whereby a stylus (a pen without ink) is used on the small touch-sensitive screen of the handheld computer, mainly by means of ticking off pre-defined options, although the fancier models support data entry either by means of a stylized alphabet, which resembles a type of shorthand, or some other more

sophisticated handwriting recognition interface.



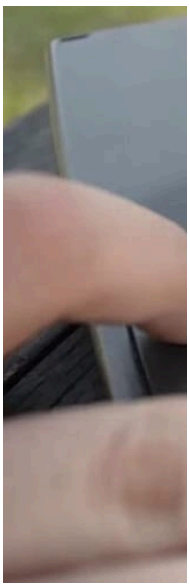
First mouse

Michael Hicks, CC BY 2.0, Wikimedia Commons



First Microsoft mouse

Erkaha, CC BY-SA 3.0, Wikimedia Commons



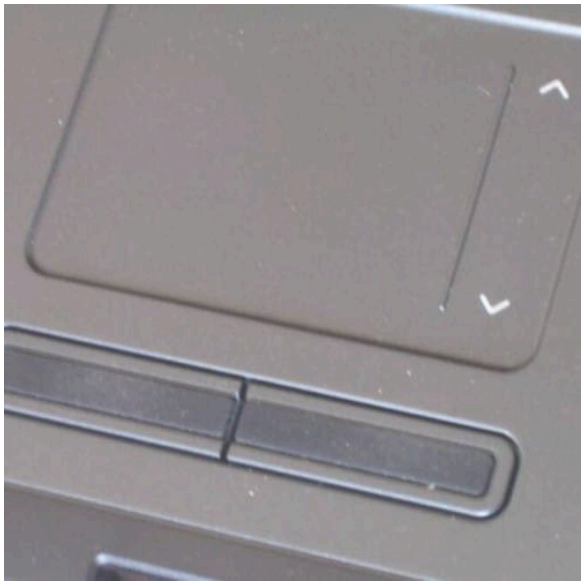
Compaq trackba

Zmaslo, CC BY 3.

Digitizer tablets also use a pressure-sensitive area with a stylus. This can be used to trace drawings. A similar conceptual approach is used for the touchpad that can be found on the majority of new notebook computers, replacing the more awkward joystick or trackball. The user controls the cursor by moving a finger across a fairly small rectangular touch-sensitive area below the keyboard, usually about 5 cm by 7 cm.

A large number of game interfaces have been developed to provide a more realistic and natural interface in various gaming situations and simulations: the joystick, steering wheel, foot pedal, and other gaming devices. They all perform functions similar to the mouse in that they allow the user to control a cursor or simulate generally real-time motion control. Contact your nearest game arcade for details.

Although the data glove also fits under the previous category, it is technically a lot more complex. It looks like a hand glove but contains a large number of sensors and has a data cable attached; though the latter is being replaced by means of infrared cordless data transmission. Not only does the data glove allow for full three-dimensional movement but it also senses the position of individual fingers, translating this into a grip. The glove is currently used in virtual reality simulators where the user moves around in an artificially rendered environment projected onto tiny LCD screens fitted into vision goggles. The computer generates various imaginary objects, which the user can “pick up” and manipulate by means of the glove. Advanced models even allow for tactile feedback by means of small pressure pockets built into the glove.

		
Lenovo Tablet and Stylus	**HP Touchpad**	**Atari Joystick**
Evan-Amos, Public domain, Wikimedia Commons	Public domain, Wikimedia Commons	Evan-Amos, Publi

Optical scanners and readers

There are a number of different optical scanner technologies on the market.

- Optical Scanners use light-emitting devices to illuminate the printing on paper. Depending on how much light is reflected, a light-sensor determines the position and darkness (or color) of the markings on the paper. Special-purpose optical scanners are in use by postal services to read and / interpret hand-written postal codes. General-purpose scanners are used with personal computers to scan in images or text. These vary from handheld devices to flatbed scanners which feed input documents one sheet at a time. A common use of optical scanners is the scanning of black-and-white or color images and pictures. When scanning text, it is necessary to load additional optical character recognition (OCR) software that converts the scanned raster-image of the text into the equivalent character symbols, so that they can be edited using word processing software.
- Barcode scanners detect sequences of vertical lines of different widths, the ubiquitous barcode is found also on the back of this book. These scanners have become very popular with retailers due to the fact that all pre-packaged products are now required to have a product bar code on their packaging, following the standard laid down by the South African Article Numbering Association (SAANA). Libraries and video shops now also commonly use bar code scanners. They are more generally used for tracking and routing large numbers of physical items such as for asset inventory purposes in many larger organizations, postal items by the postal services and courier services, or for luggage handling by airlines.
- Optical mark readers are capable of reading dark marks on specially designed forms. The red multiple-choice answer sheets in use at many educational and testing institutions are a good example.

Barcode

A **barcode**, consisting of bars and spaces, is a machine-readable representation of numerals and characters. The bars and spaces have a varying width that can be read with an optical barcode scanner.

Denso

		
Flatbed scanner Image by Skylar Kang from Pexels	**Handheld scanner** Image by iMin Technology from Pexels	**Bar code** Image by OpenC

Other input devices

A **magnetic card reader** reads the magnetized stripe on the back of plastic credit-card size cards. These cards need to be pre-recorded following certain standards. Although the cards can hold only a tiny amount of information, they are very popular for access (door) control and financial transactions (ATMs and point-of-sale terminals).

Contactless readers have been replacing those magnetic card readers nowadays. Contactless payment is a secure, convenient method to pay by tapping or waving a near-field communication (NFC)-enabled device, like a card, smartphone, or wearable, on a payment terminal. The technology uses encrypted, one-time codes to transmit your account information.

Magnetic ink character recognition (MICR) uses a special ink (containing magnetizable elements) and a distinct font type. It is used mainly in the banking sector for the processing of bank checks.

		
Magnetic card reader Image by Kaboompics from Pexels	**Contactless card reader** Image by Cottonbro Studio from Pexels	**Magnetic ink ch** Image by Luis R

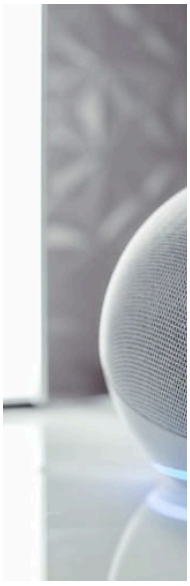
Touch-tone devices can use a voice telephone to contact computer-based switchboards or enter information directly into remote computers. Many corporate telephone help-lines rely on the customer pressing the touch-tone telephone buttons to route his/her call to the correct operator by selecting through a menu of possible options. Many banks also enable their clients to perform a number of banking transactions via telephone.

Digital cameras allow you to take pictures of physical objects directly in a digital, i.e. computer-readable, format. Relatively low-cost digital still-picture cameras are now available that capture images directly on electronic disk or RAM media instead of the traditional film. Apart from being very compact, most of these digital cameras can also interface directly with personal computers and are thus becoming a popular tool to capture pictures for e-mailing or loading on the worldwide Web.

Biometric devices are used to verify personal identity based on fingerprints, iris or retinal scanning, hand geometry, facial characteristics, etc. A scanning device is used to capture key measurements and compare them against a database of previously stored information. This type of authentication is becoming increasingly important in the control of physical access.

Finally, **voice input devices** are coming of age. Voice recognition has recently made a strong entry into the market with the availability of low-cost systems that work surprisingly well with today's personal computers. These systems allow for voice control of most standard applications (including the operating system). With voice control, the computer recognizes a very limited number (50 or less) of frequently used, programmable system commands ("save", "exit", "print"...) from a variety of users. In fact, these systems are not only used for the interface of computer programs; they are also slowly making an appearance in consumer appliances, novelty items, and even motor cars!

Much more difficult to achieve than voice control is true voice dictation used to dictate e.g. a letter to your word processor. The difficulty is that the computer must not only distinguish between many tens of thousands of possible words but it must also recognize the almost unnoticeable breaks in between words, different accents, and intonations. Therefore, voice dictation typically requires a user to train the voice recognition software by reading standard texts aloud. Nevertheless, for personal purposes and slow typists, voice recognition is rapidly becoming a viable alternative to the keyboard.

		
Digital camera Image by OpenClipart-Vectors from Pixabay	**Biometric device** Image by Susanne Plank from Pexels	**Voice input** Image by Jonath

3.4.2. Output Devices

The final stage of information processing involves the use of output devices to transform computer-readable data back into an information format that can be processed by humans. As with input devices, when deciding on an output device you need to consider what sort of information is to be displayed, and who is intended to receive it.

One distinction that can be drawn between output devices is that of hardcopy versus softcopy devices. Hardcopy devices (printers) produce a tangible and permanent output whereas softcopy devices (display screens) present a temporary, fleeting image.

Display screens

The desk-based computer **screen** is the most popular output device. The standard monitor works on the same principle as the normal TV tube: a “ray” gun fires electrically charged particles onto a specially coated tube (hence the name **Cathode-Ray Tube** or CRT). Where the particles hit the coating, the “coating” is being “excited” and emits light. A strong magnetic field guides the particle stream to form the text or graphics on your familiar monitor.

CRTs vary substantially in size and resolution. Screen size is usually measured in inches diagonally across from corner to corner and varies from as little as 12 or 14 inches for standard PCs, to as much as 40+ inches for large demonstration and video-conferencing screens. The screen resolution depends on a number of technical factors.

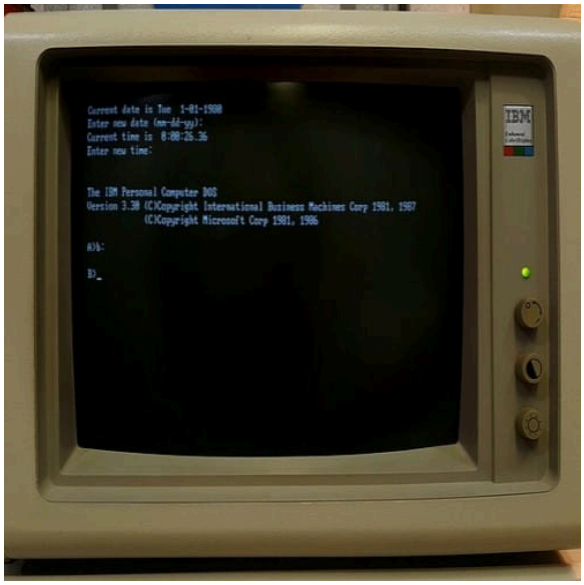
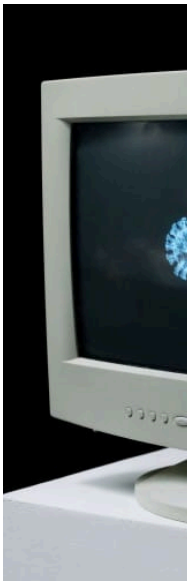
The most common CRT monitors were: CGA (Color Graphics Adapter), EGA (Enhanced Graphics Adapter), VGA (Video Graphics Array), and SVGA (Super Video Graphics Array).

A technology that has received much impetus from the fast-growing laptop and notebook market is the **liquid crystal display** (LCD). LCDs have matured quickly, increasing in resolution, contrast, and color quality. Their main advantages are lower energy requirements and their thin, flat size. Although alternative technologies are already being explored in research laboratories, they currently dominate the “flat display” market, and have replaced the old CRT monitors.

Organic light-emitting diodes (OLED) can generate brighter and faster images than LED technology and require thinner screens, but they have less stable color characteristics, making them more suitable for cellular telephone displays than for

computers.

Another screen-related technology is the **video projection unit**. Originally developed for the projection of video films, the current trend towards more portable LCD-based lightweight projectors is fueled by the need for computer-driven public presentations. Today's units fit easily into a small suitcase and project a computer presentation in very much the same way a slide projector shows a slide presentation. They are rapidly replacing the flat transparent LCD panels that needed to be placed on top of an overhead projection unit. Though the LCD panels are more compact, weigh less, and are much cheaper, their image is generally of much poorer quality and less bright.

		
CGA Monitor Rderijcke, CC BY 4.0, Wikimedia Commons	**IBM EGA Monitor** phreakindee, CC0, via Wikimedia Commons	**SVGA Monitor** Image by Cotton

Printers and plotters

Printers are the most popular output device for producing permanent, paper-based computer output. Although they are all hardcopy devices, a distinction can be made between impact and non-impact printers.

- With **impact printers**, a hammer or needle physically hits an inked ribbon to leave an ink impression of the desired shape on the paper. The advantage of the impact printer is that it can produce more than one simultaneous copy by using carbon or chemically-coated paper.
- **Non-impact printers**, on the other hand, have far fewer mechanically moving parts and are therefore much quieter and tend to be more reliable.

The following are the main types of printers currently in use.

- **Dot-matrix printers** used to be the familiar low-cost printers connected to many personal computers. The print head consists of a vertical row of needles each of which is individually controlled by a magnet. As the print head moves horizontally across the paper, the individual needles strike the paper (and ribbon in between) as directed by the control mechanism to produce text characters or graphics. A close inspection of a dot-matrix printout will reveal the constituent dots that make up the text. Although it is one of the cheapest printer options, its print quality is generally much lower than that of laser and ink-jet printers. However, today's models are quick and give a much better quality by increasing the number of needles.
- **Inkjet printers** are probably the most popular low-cost printing technology. Liquid ink is squirted onto the paper in the form of tiny droplets. These printers are about the same price as dot-matrix printers, albeit more expensive in terms of consumables. Their quality is close to that of the laser printers. Their great advantage is that the printers can easily be adapted to use colored ink, thus making popular color printers.

- **Laser printers** are quickly growing in market share. They work on the same principle as the photocopier. A laser beam, toggled on and off very quickly, illuminates selected areas on a photosensitive drum, where the light is converted into electrical charge. As the drum rotates into a “bed” of carbon particles (“toner”) with the opposite charge, these particles will adhere to the drum. The blank paper is then pressed against the drum so that the particles “rub off onto the paper sheet. The sheet then passes through a high-temperature area so that the carbon particles are permanently fused onto the paper. Current high-end laser printers can cope with extremely large printing volumes, as is required e.g. by banks to print their millions of monthly account statements. Laser technology continues to develop in tandem with photocopier technology. Laser printers can now handle color printing, double-sided printing, or combine with mail equipment to perforate, fold, address and seal automatically into envelopes. At the lower end of the scale are the low-cost “personal” laser printers, which give a very good printing quality at a relatively modest cost.



Epson dot matrix printer

Oguenther, CC BY-SA 3.0, Wikimedia Commons



Canon Ink jet printer

Canon, CC BY-SA 4.0, Wikimedia Commons



HP Laser printe

Achim Raschka, (

- **Thermal printers** use heat to print. The older thermal printers used heat-sensitive paper, similar to the special fax paper. A slight heat or pressure will leave a darker area. This produced very cheap but low-quality output. Currently, thermal-printing technology is used mainly for high-quality color printing. These new thermal printers use colored wax sticks and melt the wax onto the paper. Although they are slower than competing color laser and inkjet technologies, they give a much more vibrant, color-saturated image.
- **Plotters** are mainly used for engineering and architectural drawings. A plotter consists of one (or several—in the case of color plotters) pen(s) affixed to an arm. As the arm moves across the sheet of paper, the pen draws lines onto the paper. It is ideal for line drawings such as plans, especially in cases where the paper size exceeds that which can be accommodated by the other types of printers.
- **Chain and line printers** are still popular in mainframe environments for the quick production of large volumes of internal printing. The line printer consists of a horizontal, rotating “drum” with 132 cylinders, each containing a full character set. As the 132-column wide paper moves up past the drum, a line at a time, each one of the 132 hammers on the other side of the paper strikes at the exact moment that the corresponding cylinder “shows” the correct character. The hammer hits the drum (and ink ribbon) and leaves an imprint of the character on the paper. The chain printer works on the same principle, but uses a horizontally rotating chain with engraved characters, instead of a drum. As anyone with some working experience in a large organization knows, the print quality of these “computer printouts” is not very high.

		
Printronix Thermal printer PTX Marketing, CC BY-SA 4.0, Wikimedia Commons	**Gerber plotter** Lzur, GNU, Wikimedia Commons	**Printronix Line p** Printronix, Inc., C

Comparison of output devices

Device	Technology	Quality	Speed	Duplicates?	Graphics?	Fonts?	Colour?
CRT	softcopy	high	very fast	n/a	yes	yes	yes
LCD	softcopy	fair	very fast	n/a	yes	yes	yes
Plotter	hardcopy	fair	slow	no	yes	yes	yes
Chain/line printer	hardcopy	low	very fast	yes	no	no	no
Laser printer	hardcopy	high	fast/fair	no	yes	yes	yes
Dot-Matrix printer	hardcopy	fair	fast/fair	yes	yes	yes	some
Inkjet printer	hardcopy	good	fair	no	yes	yes	yes

Audio-output devices

A type of output that is becoming increasingly popular is different types of audio output.

- **Sound output** is required by most multimedia applications and sophisticated games. The sound card in many of today's personal computers synthesizes sound by drawing from a library of stored sounds, essentially using the same process as found in music keyboards. More advanced multimedia workstations are equipped for full stereo multi-channel surround sound and easily surpass many a modern hi-fi system in cabling and speaker complexity.
- **MIDI in/output**. Modern-day music production would be impossible without a vast array of electronic instruments and keyboards. These are typically controlled by a personal computer by means of Musical Instrument Digital Interface (MIDI), a common standard for linking, controlling, and processing electronic music.
- **Speech synthesis** is the production of speech-like output using an artificial voice. Although the lack of intonation still makes the voice sound artificial, the technology is reasonably mature and can be found anywhere from talking clocks and luxury cars to automated responses for telephonic directory inquiries.

Other Output Devices

Many other, extremely specialized input and output devices have been developed.

Process control, for example, is a very specialized field but extremely important for automated factories (car manufacturing, canneries), continuous process environments (nuclear plants, refineries), or hazardous places (microbiological research laboratories, space exploration).

For these applications, the computer relies on a multitude of sensors for its inputs: temperatures, speed, pressure, flow rates, weight, position, and others. These sensor inputs are then processed by the computers, which in turn control directly robot arms and other mechanical devices such as cutters, welding equipment, valves, switches, mixers, etc.

> There are some components that can be considered as Input/Output devices, as they can be used for both processes.
>
> Examples of such are the "touchscreen“ and the "headsets" (with earphones and microphone).

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3.5: Summary



3.1: Computer Systems Hardware

There are a number of different types of computer system in use today.

The personal computer, also known as the PC or desktop, is one of the most common types of computer due to its versatility and relatively low price.

Laptops (or Notebooks) are generally very similar, although may use lower-power or reduced size components.

Others include tablets, mobile phones, and e-readers for work, home, and leisure activities.

3.2: Hardware components

All computer devices have similar components in the inside. They may include:

- Chassis or case, motherboard, CPU, GPU, chipset, RAM cards, ROM chips, buses, CMOS, power connector, among others.

3.3: Peripherals

A peripheral device by definition is what a computer can read to receive or output information.

The mode of receiving this information is via:

- HDD/SSD
- removable storage devices (diskettes, optic discs, external HDD/SSD)
- removable media (USB Flash Drives, SD cards)
- Bluetooth.

3.4: Input/Output devices

Input devices

They allow the end-user to enter data into the computer system.

The most common input devices are the keyboard and the mouse.

Other input devices include: scanners, microphones, joysticks, card readers, digital cameras, biometric devices, voice input devices, among others.

Output devices

They allow the end-user to receive data or information from the computer system.

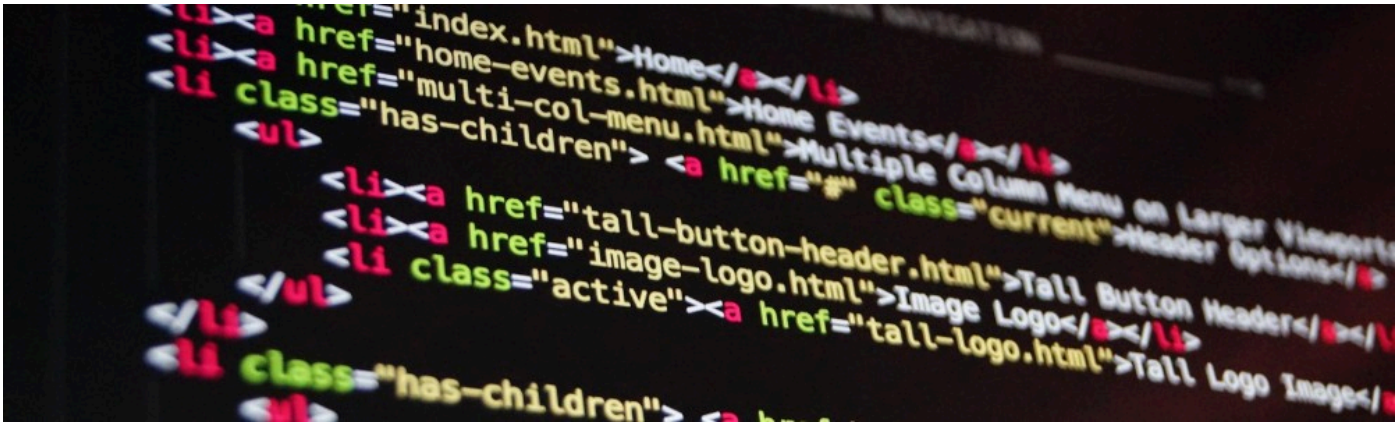
The most common output devices are the monitor (screen) and the printer.

Other output devices include: plotters, speakers, video projectors, Musical Instrument Digital Interface (MIDI), Speech synthesis devices.

Summary image banner by Luis R Castellanos

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4: INFORMATION SYSTEMS - SOFTWARE



Software and hardware cannot function without each other. Without software, hardware is useless. Without hardware, the software has no hardware to run on.

This chapter discusses the types of **software**, their purpose, and how they support different hardware devices, individuals, groups, and organizations.

Learning Objectives

Upon successful completion of this chapter, you will be able to:

- Define the term software;
- Describe the two primary categories of software;
- Describe the role ERP software plays in an organization;
- Describe the process to write a computer program;
- Describe cloud computing and its advantages and disadvantages for use in an organization;
- Define the term open-source and identify its primary characteristics; and
- Determine what operating system you have;
- Learn to manage files.

4.1: Computer Software

4.2: Operating Systems

4.3: File systems

4.4: Downloading Files

4.5: File Management

4.6: Appendix A - Microsoft Excel Basics

4.7: Summary

"The best way to predict your future is to create it."

— Abraham Lincoln, *PotUS 16*

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4.1: Computer Software



Contents

4.1.1. Types of Software

4.1.2. System Software

4.1.3. Application Software

4.1.4. Software Creation

4.1.5. Open-Source vs Closed-Source Software

4.1.6. Cloud Computing

The second component of an information system is software.

Software is the means to take a user's data and process it to perform its intended action. Software translates what users want to do into a set of instructions that tell the hardware what to do.

A set of instructions is also called a **computer program**.

For example, when a user presses the letter 'A" key on the keyboard when using a word processing app, it is the word processing software that tells the hardware that the user pressed the key 'A' on the keyboard and fetches the image of the letter A to display on the screen as feedback to the user that the user's data is received correctly.

Software is created through the process of programming. We will cover the creation of software in this chapter. In essence, hardware is the machine, and software is the intelligence that tells the hardware what to do. Without software, the hardware would not be functional.

4.1.1. Types of Software

The software component can be broadly divided into two categories: system software and application software.

System software is a collection of computer programs that provide a software platform for other software programs. It also insulates the hardware's specifics from the applications and users as much as possible by managing the hardware and the networks. It consists of:

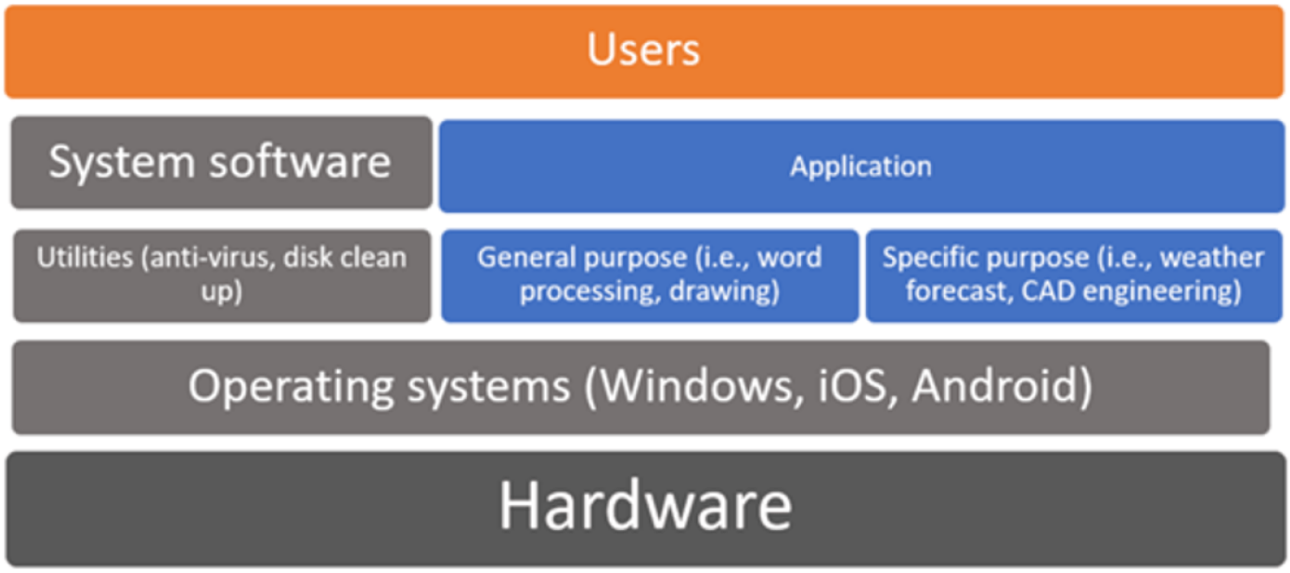
1. Operating System

2. Utilities

Application software is a computer program that delivers a specific activity for the users (i.e., create a document, draw a picture). It can be for either

1. a general-purpose (i.e., Microsoft Word, Google doc) or
2. for a particular purpose (i.e., weather forecast, CAD engineering)

Software categories	
System software	**Application software**
1. Operating System 2. Utilities	1. a general-purpose 2. for a particular purpose



Overview of software types. Image by Ly-Huong Pham is licensed under CC BY-NC

4.1.2. System Software

Operating Systems

The operating system provides several essential functions, including:

1. Managing the hardware resources of the computer
2. Providing the user-interface components
3. Providing a platform for software developers to write applications.

All computing devices run an operating system (OS), a key component of the system software.

> An **Operating System** is a set of programs that coordinate hardware components and other programs and acts as an interface with application software and networks.

Early personal-computer operating systems were simple by today's standards; they did not provide multitasking and required the user to type commands to initiate an action. The amount of memory that early operating systems could handle was limited as well, making large programs impractical to run. The most popular of the early operating systems was IBM's Disk Operating System, or DOS, which was actually developed for them by Microsoft.

For personal computers, some of the most popular operating systems today are Microsoft's Windows, Apple's macOS, Google Chrome OS, and different versions of Linux.

For tablets and smartphones, some of the most popular operating systems are Android and iOS.

> **Operating Systems** will be covered in more detail in the following Section 4.2.

Utility

Utility software includes software that is specific-purposed and focused on keeping the infrastructure healthy.

Examples include antivirus software to scan and stop computer viruses and disk desegmentation software to optimize files' storage.

Over time, some of the popular utilities were absorbed as features of an operating system, so in most cases there is no need to buy additional software.

4.1.3. Application Software

The second major category of software is application software.

While system software focuses on running the computers, application software allows the end-user to accomplish some goals or purposes. Examples include word processing, photo editor, spreadsheet, or a browser.

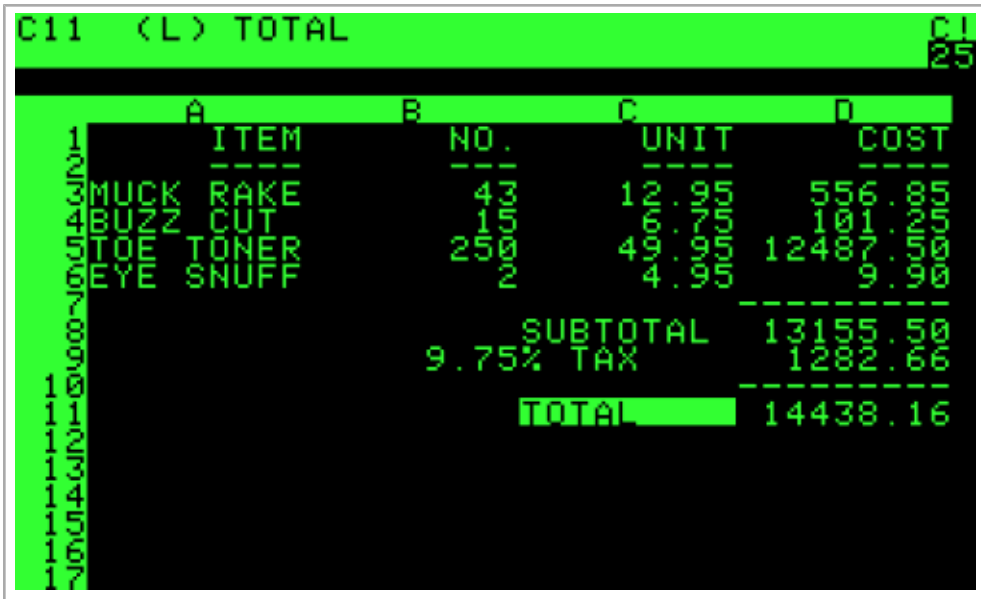
Applications software are grouped in many categories, including:

- Killer app
- Productivity
- Enterprise
- Mobile

The "Killer" App

When a new type of digital device is invented, there are generally a small group of technology enthusiasts who will purchase it just for the joy of figuring out how it works. A "killer" application runs only on one OS platform and becomes so essential that many people will buy a device on that OS platform just to run that application. For the personal computer, the killer application was the spreadsheet.

In 1979, **VisiCalc**, the first personal-computer spreadsheet package, was introduced. It was an immediate hit and drove sales of the Apple II. It also solidified the value of the personal computer beyond the relatively small circle of technology geeks. When the IBM PC was released, another spreadsheet program, **Lotus 1-2-3**, was the killer app for business users. Today, **Microsoft Excel** dominates as the spreadsheet program, running on all the popular operating systems.



Visicalc. Gortu, Public domain, Wikimedia Commons



Lotus 1-2-3 logo. Darklanlan, Public D

More recently, if you wanted to play "Mario Bros", you would have to buy a Nintendo console. And people bought Nintendo, in some cases, just to play "Mario Bros".

Similar thing happened with the "Kindle Fire", by Amazon. If you wanted to read an eBook (ePub format), you needed to have a "Kindle Fire".

Productivity Software

Along with the spreadsheet, several other software applications have become standard tools for the workplace. These applications, called productivity software, allow office employees to complete their daily work. Many times, these applications come packaged together, such as in Microsoft's Office suite. Here is a list of these applications and their basic functions:

- **Word processing**: This class of software provides for the creation of written documents. Functions include the ability to type and edit text, format fonts and paragraphs, and add, move, and delete text throughout the document. Most modern word-processing programs also have the ability to add tables, images, voice, videos, and various layout and formatting features to the document. Word processors save their documents as electronic files in a variety of formats. The most popular word-processing package is Microsoft Word, which saves its files in the .docx format. This format can be read/written by many other word-processor packages or converted to other formats such as Adobe's PDF.
- **Spreadsheet**: This class of software provides a way to do numeric calculations and analysis. The working area is divided into rows and columns, where users can enter numbers, text, or formulas. The formulas make a spreadsheet powerful, allowing the user to develop complex calculations that can change based on the numbers entered. Most spreadsheets also include the ability to create charts based on the data entered. The most popular spreadsheet package is Microsoft Excel, which saves its files in the .xlsx format. Just as with word processors, many other spreadsheet packages can read and write to this file format.
- **Presentation**: This software class provides for the creation of slideshow presentations that can be shared, printed, or projected on a screen. Users can add text, images, audio, video, and other media elements to the slides. Microsoft's PowerPoint remains the most popular software, saving its files in .pptx format.
- **Office Suite**: Microsoft popularized the idea of the office-software productivity bundle with their release of Microsoft Office. Some office suites include other types of software. For example, Microsoft Office includes Outlook, its e-mail package, and OneNote, an information-gathering collaboration tool. The professional version of Office also includes Microsoft Access, a database package. (Databases are covered more in chapter 7.) This package continues to dominate the market, and most businesses expect employees to know how to use this software. However, many competitors to Microsoft Office exist and are compatible with Microsoft's file formats (see table below). Microsoft now has a cloud-based version called Microsoft

Office 365. Similar to Google Drive, this suite allows users to edit and share documents online utilizing cloud-computing technology.

Suite	Word Processor	Spreadsheet	Presentation
MS Office	Word	Excel	Powerpoint
Apple iWorks	Pages	Numbers	Keynote
Apache OpenOffice	Writer	Calc	Impress
Google Drive	Docs	Sheets	Slides

"Powerpointed to Death"

As presentation software, specifically Microsoft PowerPoint, has gained acceptance as the primary method to formally present information in a business setting, the art of giving an engaging presentation is becoming rare. Many presenters now just read the bullet points in the presentation and immediately bore those in attendance who can already read it for themselves.

The real problem is not with PowerPoint as much as it is with the person creating and presenting. The book "*Presentation Zen*" by **Garr Reynolds** (Link) is highly recommended to anyone who wants to improve their presentation skills.

New opportunities have been presented to make presentation software more effective. One such example is Prezi. **Prezi** is a presentation tool that uses a single canvas for the presentation, allowing presenters to place text, images, and other media on the canvas and then navigate between these objects as they present.

Enterprise Software

As the personal computer proliferated inside organizations, control over the information generated by the organization began splintering. For example, the customer service department creates a customer database to track calls and problem reports. The sales department also creates a database to keep track of customer information. Which one should be used as the master list of customers? As another example, someone in sales might create a spreadsheet to calculate sales revenue, while someone in finance creates a different one that meets their department's needs. However, the two spreadsheets will likely come up with different totals for revenue. Which one is correct? And who is managing all this information? This type of example presents challenges to management to make effective decisions.

Enterprise Resource Planning

In the 1990s, the need to bring the organization's information back under centralized control became more apparent. The enterprise resource planning (ERP) system (sometimes just called enterprise software) was developed to bring together an entire organization in one software application. Key characteristics of an ERP include:

- An integrated set of modules: Each module serves different functions in an organization, such as Marketing, Sales, Manufacturing.
- A consistent user interface: An ERP is a software application that provides a common interface across all modules of the ERP and is used by an organization's employees to access information
- A common database: All users of the ERP edit and save their information from the data source. This means that there is only one customer database, there is only one calculation for revenue, etc.
- Integrated business processes: All users must follow the same business rules and process throughout the entire organization": ERP systems include functionality that covers all of the essential components of a business, such as how organizations track cash, invoices, purchases, payroll, product development, supply chain.



ERP Modules. Shing Hin Yeung, CC BY-SA 3.0, Wikimedia Commons

ERP systems were originally marketed to large corporations, given that they are costly. However, as more and more large companies began installing them, ERP vendors began targeting mid-sized and even smaller businesses. Some of the more well-known ERP systems include those from SAP, Oracle, and Microsoft.

To effectively implement an ERP system in an organization, the organization must be ready to make a full commitment, including the cost to train employees as part of the implementation.

All aspects of the organization are affected as old systems are replaced by the ERP system. In general, implementing an ERP system can take two to three years and several million dollars.

So why implement an ERP system? If done properly, an ERP system can bring an organization a good return on its investment. By consolidating information systems across the enterprise and using the software to enforce best practices, most organizations see an overall improvement after implementing an ERP.

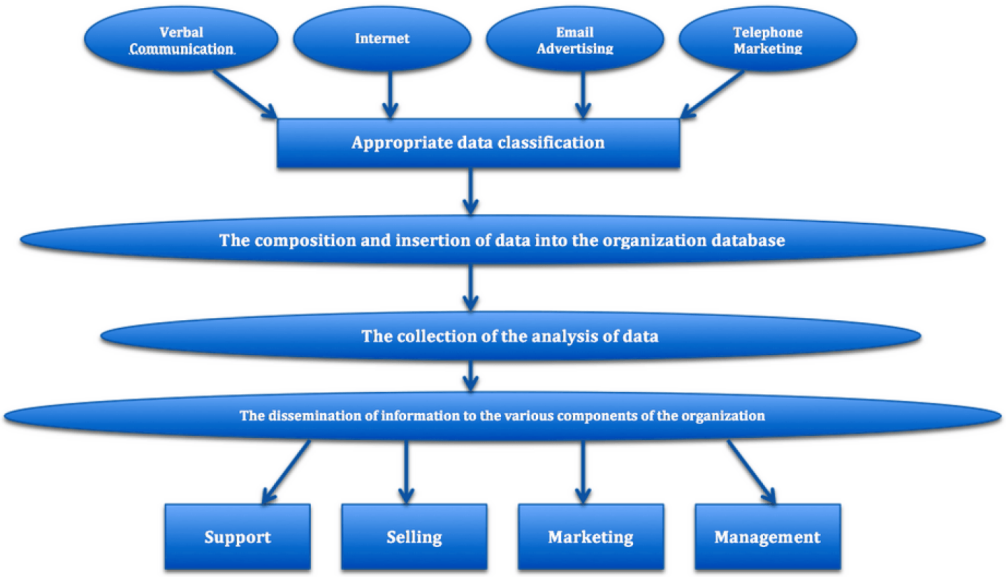
> Some of the most used ERP solutions are: SAP S/4, Oracle Netsuite, Microsoft Dynamics 365, Workday ERP.

Customer Relationship Management

A customer relationship management (CRM) system is a software application designed to manage customer interactions, including customer service, marketing, and sales. It collects all data about the customers. The objectives of a CRM are:

- Personalize customer relationship to increase customer loyalty
- Improve communication
- Anticipate needs to retain existing or acquire new customers

Some ERP software systems include CRM modules.



CRM components. Bgrigorov, CC BY-SA 4.0, Wikimedia Commons

Some of the most used CRM solutions are: Salesforce, Hubspot, Fresworks, Pipedrive.

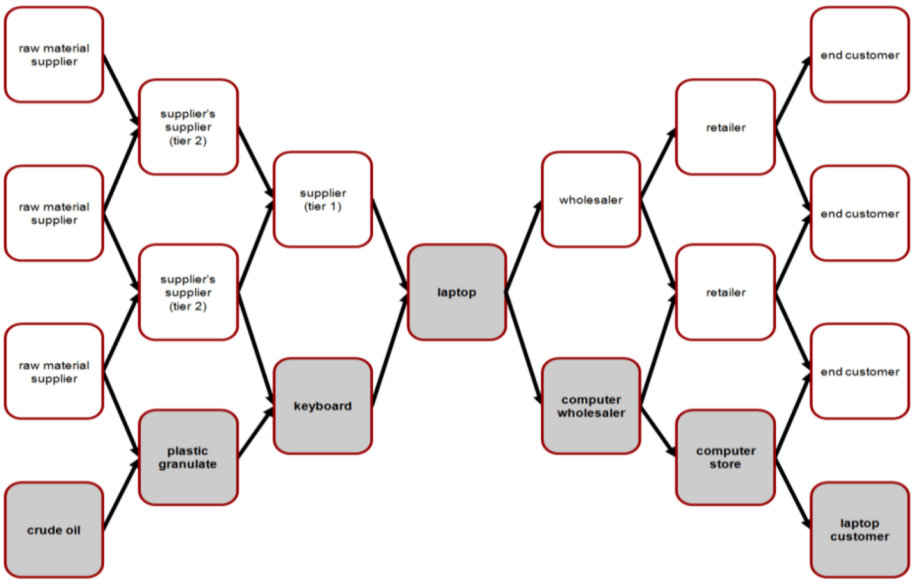
Supply Chain Management

Many organizations must deal with the complex task of managing their supply chains. At its simplest, a supply chain is a linkage between an organization's suppliers, its manufacturing facilities, and its products' distributors. Each link in the chain has a multiplying effect on the complexity of the process.

Walmart has more than 100,000 suppliers worldwide, with more than 10,600 stores.

TJ Maxx manages over 21,000 suppliers from more than 100 countries, with more than 1,300 stores.

For example, if there are two suppliers, one manufacturing facility, and two distributors, then there are 2 x 1 x 2 = 4 links to handle. However, if you add two more suppliers, another manufacturing facility, and two more distributors, then you have 4 x 2 x 4 = 32 links to manage.



Supply and demand network. Andreas Wieland, CC BY-SA 3.0, Wikimedia Commons

A supply chain management (SCM) system manages the interconnection between these links and the products' inventory in their various development stages. The Association provides a full definition of a supply chain management system for Operations Management: “The design, planning, execution, control, and monitoring of supply chain activities to create net value, building a competitive infrastructure, leveraging worldwide logistics, synchronizing supply with demand, and measuring performance globally.” 2 Most ERP systems include a supply chain management module.

> Some of the most used SCM solutions are: SAP SCM, CIN7, Tensoft, Shippabo.

Mobile Software

A mobile application, commonly called a mobile app, is a software application programmed to run specifically on a mobile device such as smartphones and tablets.

Smartphones and tablets are becoming a dominant form of computing, with many more smartphones being sold than personal computers.

This means that organizations will have to get smart about developing software on mobile devices to stay relevant.

With the rise of mobile devices' adoption, the number of apps is exploding in the millions (Forbes.com, 2020), and there is an app for just about anything a user is looking to do. Examples include apps as a flashlight, a step counter, a plant identifier, and games.

Current uses of apps include personal banking, ride share request, online buying, and many others processes. It is very important that apps be downloaded from trusted places, like the different app stores available.

Most popular trusted app stores			
GET IT ON Google Play	Download on the App Store	Available on Galaxy Store	Get it from Microsoft

Google Play, Public domain, Wikimedia Commons	Apple Inc., Public domain, Wikimedia Commons	Kontakte, MIT, Wikimedia Commons	Microsoft, Public domain, Wikimedia Commons

4.1.4. Software Creation

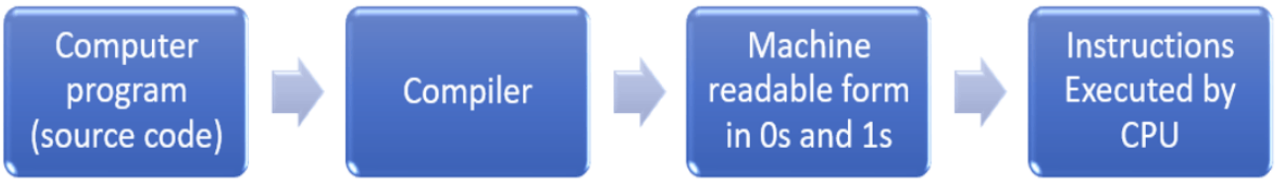
We just discussed different types of software and now can ask: How is software created?

If the software is the set of instructions that tells the hardware what to do, how are these instructions written? If a computer reads everything as one and zero, do we have to learn how to write software that way?

Thankfully, another software type is written, especially for software developers to write system software and applications - called **programming languages**. The people who can program are called coders, computer programmers or software developers.

Analogous to a human language, a programming language consists of keywords, comments, symbols, and grammatical rules to construct statements as valid instructions understandable by the computer to perform certain tasks.

Using this language, a programmer writes a program (called the source code). Another software then processes the source code to convert the programming statements to a machine-readable form, the ones, and zeroes necessary to execute the CPU. This conversion process is often known as compiling, and the software is called the compiler.



Convert a computer program to an executable. Image by Ly-Huong T. Pham, CC-BY-NC. Wikimedia Commons.

Most of the time, programming is done inside a programming environment; when you purchase a copy of Visual Studio from Microsoft, it provides the developers with an editor to write the source code, a compiler, and help for many of Microsoft's programming languages.

Examples of well-known programming languages today include Python, Java, PHP, and C's various flavors (Visual C, C++, C#).

Thousands of programming languages have been created since the first programming language in 1883 by a woman named **Ada Lovelace**. One of the earlier English-like languages called COBOL has been in use since the 1950s to the present time in services that we still use today, such as payroll, reservation systems. The C programming language was introduced in the 1970s and remained a top popular choice. Some new languages such as C#, Swift are gaining momentum as well. Programmers select the best-matched language with the problem to be solved for a particular OS platform. For example, languages such as HTML and JavaScript are used to develop web pages.

It is hard to determine which language is the most popular since it varies. However, according to TIOBE Index, one of the companies that rank the popularity of the programming languages monthly, you can see the monthly ranking of the programming languages according to its popularity.

> TIOBE provides an updated (every month) ranking of the most popular programming languages.

One person can write some programs. However, most software programs are written by many developers. For example, it takes hundreds of software engineers to write Microsoft Windows or Excel. To ensure teams can deliver timely and quality software with the least amount of errors, also known as bugs, formal project management methodologies are used.

Bug

The expression computer bug originated from **Grace Hopper** (1946), computer pioneer, because looking for the causes in a computer malfunction, her team found a bug inside.

Some of the most used software development methodologies are: Cascade or classic, Rapid Application Development (RAD), Open-source software development (OSSD), Joint application development (JAD), Software prototyping.

4.1.5. Open-Source vs Closed-Source Software

When the personal computer was first released, computer enthusiasts immediately banded together to build applications and solve problems. These computer enthusiasts were happy to share any programs they built and solutions to problems they found; this collaboration enabled them to innovate more quickly and fix problems.

As software began to become a business, however, this idea of sharing everything fell out of favor for some. When a software program takes hundreds of hours to develop, it is understandable that the programmers do not want to give it away. This led to a new business model of restrictive software licensing, which required payment for software to the owner, a model that is still dominant today. This model is sometimes referred to as closed source, as the source code remains private property and is not made available to others. Microsoft Windows, Excel, Apple iOS are examples of closed source software.

There are many, however, who feel that software should not be restricted. Like those early hobbyists in the 1970s, they feel that innovation and progress can be made much more rapidly if we share what we learn. In the 1990s, with Internet access connecting more and more people, the open-source movement gained steam.

Open-source software is software that has the source code available for anyone to copy and use.

For non-programmers, it won't be of much use unless the compiled format is also made available for users to use. However, for programmers, the open-source movement has led to developing some of the world's most-used software, including the Firefox browser, the Linux operating system, and the Apache webserver.

Open Source Initiative

Just about every type of commercial product has an open source equivalent. SourceForge.net lists over two hundred and thirty thousand such products! Many of these products come with the installation tools, support utilities, and full documentation that make them difficult to distinguish from traditional commercial efforts (Woods, 2008). In addition to the LAMP products, some major examples include the following:

- Firefox—a Web browser that competes with Internet Explorer
- OpenOffice—a competitor to Microsoft Office
- Gimp—a graphic tool with features found in Photoshop
- Alfresco—collaboration software that competes with Microsoft Sharepoint and EMC's Documentum
- Marketcetera—an enterprise trading platform for hedge fund managers that competes with FlexTrade and Portware
- Zimbra—open source e-mail software that competes with Outlook server
- MySQL, Ingres, and EnterpriseDB—open source database software packages that each go head-to-head with commercial products from Oracle, Microsoft, Sybase, and IBM
- SugarCRM—customer relationship management software that competes with Salesforce.com and Siebel
- Asterix—an open source implementation for running a PBX corporate telephony system that competes with offerings from Nortel and Cisco, among others
- Free BSD and Sun's OpenSolaris—open source versions of the Unix operating sys

Some people are concerned that open-source software can be vulnerable to security risks since the source code is available. Others counter that because the source code is freely available, many programmers have contributed to open-source software projects, making the code less buggy and adding features, and fixing bugs much faster than closed-source software.

Many businesses are wary of open-source software precisely because the code is available for anyone to see. They feel that this increases the risk of an attack. Others counter that this openness decreases the risk because the code is exposed to thousands of programmers who can incorporate code changes to patch vulnerabilities quickly.

OSS benefits

In summary, some benefits of the open-source model are:

- **The software is available for free:** Free alternatives to costly commercial code can be a tremendous motivator, particularly since conventional software often requires customers to pay for every copy used and to pay more for software that runs on increasingly powerful hardware. Big Lots stores lowered costs by as much as $10 million by finding viable OSS (Castelluccio, 2008) to serve their system needs. Online broker E*TRADE estimates that its switch to open source helped save over $13 million a year (King, 2008). And Amazon claimed in SEC filings that the switch to open source was a key contributor to nearly $20 million in tech savings (Shankland, et. al., 2001). Firms like TiVo, which use OSS in their own products, eliminate a cost spent either developing their own operating system or licensing similar software from a vendor like Microsoft.
- **Reliability:** There's a saying in the open source community, "Given enough eyeballs, all bugs are shallow" (Raymond, 1999). What this means is that the more people who look at a program's code, the greater the likelihood that an error will be caught and corrected. The open source community harnesses the power of legions of geeks who are constantly trawling OSS products, looking to squash bugs and improve product quality. And studies have shown that the quality of popular OSS products outperforms proprietary commercial competitors (Ljungberg, 2000). In one study, Carnegie Mellon University's Cylab estimated the quality of Linux code to be less buggy than commercial alternatives by a factor of two hundred (Castelluccio, 2008)!
- **Security:** OSS advocates also argue that by allowing "many eyes" to examine the code, the security vulnerabilities of open source products come to light more quickly and can be addressed with greater speed and reliability (Wheeler, 2003). High profile hacking contests have frequently demonstrated the strength of OSS products. In one well-publicized 2008 event, laptops running Windows and Macintosh were both hacked (the latter in just two minutes), while a laptop running Linux remained uncompromised (McMillan, 2008). Government agencies and the military often appreciate the opportunity to scrutinize open source efforts to verify system integrity (a particularly sensitive issue among foreign governments leery of legislation like the USA PATRIOT Act of 2001) (Lohr, 2003). Many OSS vendors offer **security focused** (sometimes called *hardened*) versions of their products. These can include systems that monitor the integrity of an OSS distribution, checking file size and other indicators to be sure that code has not been modified and redistributed by bad guys who've added a back door, malicious routines, or other vulnerabilities.
- **Scalability:** Many major OSS efforts can run on everything from cheap commodity hardware to high-end supercomputing. **Scalability** allows a firm to scale from start-up to blue chip without having to significantly rewrite their code, potentially saving big on software development costs. Not only can many forms of OSS be migrated to more powerful hardware, packages like Linux have also been optimized to balance a server's workload among a large number of machines working in tandem. Brokerage firm E*TRADE claims that usage spikes following 2008 U.S. Federal Reserve moves flooded the firm's systems, creating the highest utilization levels in five years. But E*TRADE credits its scalable open source systems for maintaining performance while competitors' systems struggled (King, 2008).
- **Agility and Time to Market:** Vendors who use OSS as part of product offerings may be able to skip whole segments of the software development process, allowing new products to reach the market faster than if the entire software system had to be developed from scratch, in-house. Motorola has claimed that customizing products built on OSS has helped speed time-to-market for the firm's mobile phones, while the team behind the Zimbra e-mail and calendar effort built their first product in just a few months by using some forty blocks of free code (Guth, 2006).
- **The software source code is available:** It can be examined and reviewed before it is installed.
- **Quick Updates:** The large community of programmers who work on open-source projects leads to quick bug-fixing and feature additions.

Closed source software benefits

Some benefits of the closed-source model are:

- Providing a financial incentive for software developers or companies

- Technical support from the company that developed the software.

Today there are thousands of open-source software applications available for download. An example of open-source productivity software is Open Office Suite.

Why Give It Away? The Business of Open Source

Open source is a sixty-billion-dollar industry (Asay, 2008), but it has a disproportionate impact on the trillion-dollar IT market. By lowering the cost of computing, open source efforts make more computing options accessible to smaller firms. More reliable, secure computing also lowers costs for all users. OSS also diverts funds that firms would otherwise spend on fixed costs, like operating systems and databases, so that these funds can be spent on innovation or other more competitive initiatives. Think about Google, a firm that some estimate has over 1.4 million servers. Imagine the costs if it had to license software for each of those boxes!

Commercial interest in OSS has sparked an acquisition binge. Red Hat bought open source application server firm JBoss for $350 million. Novell snapped up SUSE Linux for $210 million. And Sun plunked down over $1 billion for open source database provider MySQL (Greenberg, 2008). And with Oracle's acquisition of Sun, one of the world's largest commercial software firms has zeroed in on one of the deepest portfolios of open source products.

But how do *vendors* make money on open source?

One way is by selling support and consulting services. While not exactly Microsoft money, Red Hat, the largest purely OSS firm, reported half a billion dollars in revenue in 2008. The firm had two and a half million *paid* subscriptions offering access to software updates and support services (Greenberg, 2008). Oracle, a firm that sells commercial ERP and database products, provides Linux for free, selling high-margin Linux support contracts for as much as five hundred thousand dollars (Fortt, 2007). The added benefit for Oracle? Weaning customers away from Microsoft—a firm that sells many products that compete head-to-head with Oracle's offerings. Service also represents the most important part of IBM's business. The firm now makes more from services than from selling hardware and software (Robertson, 2009). And every dollar saved on buying someone else's software product means more money IBM customers can spend on IBM computers and services. Sun Microsystems was a leader in OSS, even before the Oracle acquisition bid. The firm has used OSS to drive advanced hardware sales, but the firm also sells proprietary products that augment its open source efforts. These products include special optimization, configuration management, and performance tools that can tweak OSS code to work its best (Preimesberger, 2008).

Here's where we also can relate the industry's evolution to what we've learned about standards competition in our earlier chapters. In the pre-Linux days, nearly every major hardware manufacturer made its own, incompatible version of the Unix operating system. These fractured, incompatible markets were each so small that they had difficulty attracting third-party vendors to write application software. Now, much to Microsoft's dismay, all major hardware firms run Linux. That means there's a large, unified market that attracts software developers who might otherwise write for Windows.

To keep standards unified, several Linux-supporting hardware and software firms also back the Linux Foundation, the nonprofit effort where Linus Torvalds serves as a fellow, helping to oversee Linux's evolution. Sharing development expenses in OSS has been likened to going in on a pizza together. Everyone wants a pizza with the same ingredients. The pizza doesn't make you smarter or better. So why not share the cost of a bigger pie instead of buying by the slice (Cohen, 2008)? With OSS, hardware firms spend less money than they would in the brutal, head-to-head competition where each once offered a "me too" operating system that was incompatible with rivals but offered little differentiation. Hardware firms now find their technical talent can be deployed in other value-added services mentioned above: developing commercial software add-ons, offering consulting services, and enhancing hardware offerings.

> Red Hat® Inc. began when a small businessman met a geek at a tech conference. Marc Ewing was the geek—hacking, debugging, and spinning his own distribution of Linux® on CDs from his home in Durham, North Carolina.
>
> Bob Young was the businessman—running a computer supply catalog business out of his home in Connecticut. He noticed a growing interest in Linux, so he began to buy Ewing's CDs. Young sold out of them so many times that he and Ewing joined forces, and Red Hat Software was born in 1995, with Young as CEO.

The name Red Hat came from Ewing's experience in his college computer lab. He would wear his grandfather's red Cornell lacrosse cap, and people would say, "If you need help, look for the guy in the red hat."

In 25+ years, Red Hat has grown from a small, home-based business into the world's leading provider of enterprise open source solutions. Today, more than 90% of Fortune 500 companies rely on Red Hat, and its products and solutions are trusted on a global scale.

Starting with the revolutionary foundation of Red Hat Enterprise Linux, Red Hat has built a broad portfolio spanning a full, modern IT stack, including hybrid cloud infrastructure, middleware, agile integration, cloud-native application development, and management and automation solutions. As always, everything continues to be made the open source way.

Red Hat official page

Red Hat products



Red Hat logo. Red Hat, Public domain, from Wikimedia Commons

Linux on the Desktop?

While Linux is a major player in enterprise software, mobile phones, and consumer electronics, the Linux OS can only be found on a tiny fraction of desktop computers. There are several reasons for this. Some suggest Linux simply isn't as easy to install and use as Windows or the Mac OS. This complexity can raise the **total cost of ownership (TCO)** of Linux desktops, with additional end-user support offsetting any gains from free software. The small number of desktop users also dissuades third party firms from porting popular desktop applications over to Linux. For consumers in most industrialized nations, the added complexity and limited desktop application availability of desktop Linux just it isn't worth the one to two hundred dollars saved by giving up Windows.

But in developing nations where incomes are lower, the cost of Windows can be daunting. Consider the OLPC (One Laptop Per Child project), Nicholas Negroponte's "one-hundred-dollar" laptop. An additional one hundred dollars for Windows would double the target cost for the nonprofit's machines. It is not surprising that the first OLPC laptops ran Linux. Microsoft recognizes that if a whole generation of first-time computer users grows up without Windows, they may favor open source alternatives years later when starting their own businesses. As a result, Microsoft has begun offering low-cost versions of Windows (in some cases for as little as seven dollars) in nations where populations have much lower incomes. Microsoft has even offered a version of Windows to the backers of the OLPC. While Microsoft won't make much money on these efforts, the low cost versions will serve to entrench Microsoft products as standards in emerging markets, staving off open source rivals and positioning the firm to raise prices years later when income levels rise.

A popular distribution of Linux is Ubuntu, which can be downloaded and installed in your computer. It is one of the most user-friendly distributions.



Ubuntu logo. Image by Ubuntu, Public domain, from Wikimedia Commons

MySQL: Turning a Ten-Billion-Dollars-a-Year Business into a One-Billion-Dollar One

Finland is not the only Scandinavian country to spawn an open source powerhouse. Uppsala Sweden's MySQL (pronounced "my sequel") is the "M" in the LAMP stack, and is used by organizations as diverse as FedEx, Lufthansa, NASA, Sony, UPS, and YouTube.

The "SQL" in name stands for the **structured query language**, a standard method for organizing and accessing data. SQL is also employed by commercial database products from Oracle, Microsoft, and Sybase. Even Linux-loving IBM uses SQL in its own lucrative DB2 commercial database product. Since all of these databases are based on the same standard, switching costs are lower, so migrating from a commercial product to MySQL's open source alternative is relatively easy. And that spells trouble for commercial firms. Granted, the commercial efforts offer some bells and whistles that MySQL doesn't yet have, but those extras aren't necessary in a lot of standard database use. Some organizations, impressed with MySQL's capabilities, are mandating its use on all new development efforts, attempting to cordon off proprietary products in legacy code that is maintained but not expanded.

Savings from using MySQL can be huge. The Web site PriceGrabber pays less than ten thousand dollars in support for MySQL compared to one hundred thousand to two hundred thousand dollars for a comparable Oracle effort. Lycos Europe switched from Oracle to MySQL and slashed costs from one hundred twenty thousand dollars a year to seven thousand dollars. And the travel reservation firm Sabre used open source products such as MySQL to slash ticket purchase processing costs by 80 percent (Lyons, 2004).

MySQL does make money, just not as much as its commercial rivals. While you can download a version of MySQL over the Net, the flagship product also sells for four hundred ninety-five dollars per server computer compared to a list price for Oracle that can climb as high as one hundred sixty thousand dollars. Of the roughly eleven million copies of MySQL in use, the company only gets paid for about one in a thousand (Ricadela, 2007). Firms pay for what's free for one of two reasons: (1) for MySQL service, and (2) for the right to incorporate MySQL's code into their own products (Kirkpatrick, 2004). Amazon, Facebook, Gap, NBC, and Sabre pay MySQL for support; Cisco, Ericsson, HP, and Symantec pay for the rights to the code (Ricadela, 2007). Top-level round-the-clock support for MySQL for up to fifty servers is fifty thousand dollars a year, still a fraction of the cost for commercial alternatives. Founder Marten Mickos has stated an explicit goal of the firm is "turning the $10-billion-a-year database business into a $1 billion one" (Kirkpatrick, 2004).

When Sun Microsystems spent over $1 billion to buy Mickos' MySQL in 2008, Sun CEO Jonathan Schwartz called the purchase the "most important acquisition in the company's history" (Shankland, 2008). Sun hoped the cheap database software could make the firm's hardware offerings seem more attractive. And it looked like Sun was good for MySQL, with the product's revenues growing 55 percent in the year after the acquisition (Asay, 2009).

But here's where it gets complicated. Sun also had a lucrative business selling hardware to support commercial ERP and database software from Oracle. That put Sun and partner Oracle in a relationship where they were both competitors and collaborators. Then in spring 2009, Oracle announced it was buying Sun. Oracle CEO Larry Ellison mentioned acquiring the Java language was the crown jewel of the purchase, but industry watchers have raised several questions. Will the firm continue to nurture MySQL and other open source products, even as this software poses a threat to its bread-and-butter database products? Will the development community continue to back MySQL as the de facto standard for open source SQL databases, or will they migrate to an alternative? Or will Oracle find the right mix of free and fee-based products and services that allow MySQL to thrive while Oracle continues to grow? The implications are serious for investors, as well as firms that have made commitments to Sun, Oracle, and MySQL products. The complexity of this environment further demonstrates why technologists need business savvy and market

monitoring skills and why business folks need to understand the implications of technology and tech-industry developments.



MySQL logo. Image by Oracle, Public domain, from Wikimedia Commons

Legal Risks and Open Source Software: A Hidden and Complex Challenge

Open source software isn't without its risks. Competing reports cite certain open source products as being difficult to install and maintain (suggesting potentially higher total cost of ownership, or TCO). Adopters of OSS without support contracts may lament having to rely on an uncertain community of volunteers to support their problems and provide innovative upgrades. Another major concern is legal exposure. Firms adopting OSS may be at risk if they distribute code and aren't aware of the licensing implications. Some commercial software firms have pressed legal action against the users of open source products when there is a perceived violation of software patents or other unauthorized use of their proprietary code.

For example, in 2007 Microsoft suggested that Linux and other open source software efforts violated some two hundred thirty-five of its patents (Ricadela, 2007). The firm then began collecting payments and gaining access to the patent portfolios of companies that use the open source Linux operating system in their products, including Fuji, Samsung, and Xerox. Microsoft also cut a deal with Linux vendor Novell in which both firms pledged not to sue each other's customers for potential patent infringements.

Also complicating issues are the varying open source license agreements (these go by various names, such as GPL and the Apache License), each with slightly different legal provisions—many of which have evolved over time. Keeping legal with so many licensing standards can be a challenge, especially for firms that want to bundle open source code into their own products (Lacy, 2006). An entire industry has sprouted up to help firms navigate the minefield of open source legal licenses. Chief among these are products, such as those offered by the firm Black Duck, which analyze the composition of software source code and report on any areas of concern so that firms can honor any legal obligations associated with their offerings. Keeping legal requires effort and attention, even in an environment where products are allegedly "free." This also shows that even corporate lawyers had best geek-up if they want to prove they're capable of navigating a twenty-first-century legal environment.

Software Licenses

The companies or developers own the software they create. The software is protected by law either through patents, copyright, or licenses. It is up to the software owners to grant their users the right to use the software through the terms of the licenses.

For closed-source vendors, the terms vary depending on the price the users are willing to pay. Examples include single user, single installation, multi-users, multi-installations, per network, or machine.

They have specific permission levels for open-source vendors to grant using the source code and set the modified version conditions. Examples include free to distribute, remix, adapt for non-commercial use but with the condition that the newly revised source code must also be licensed under identical terms. While open-source vendors don't make money by charging for their software, they generate revenues through donations or selling technical support or related services. For example, Wikipedia is a widely popular and online free-content encyclopedia used by millions of users. Yet, it relies mainly on donations to sustain its staff and infrastructure.

There Are Now 8.9 Million Mobile Apps, And China Is 40% Of Mobile App Spending (2020, Feb 28). Retrieved September 4, 2020, from https://www.forbes.com/

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

4.1.6. Cloud Computing

Historically, for software to run on a computer, an individual copy of the software had to be installed on the computer, either from a disk or, more recently, after being downloaded from the Internet. The concept of “cloud” computing changes this model.

> **Cloud computing**, or just "the cloud”, refers to applications, services, and data stored in data centers, server farms, and storage servers and accessed by users via the Internet.

In most cases, the users don’t know where their data is actually stored. Individuals and organizations use cloud computing.

You probably already use cloud computing in some forms. For example, if you access your email via your web browser, you are using a form of cloud computing. If you use Google Drive’s applications, you are using cloud computing. Simultaneously, these are free versions of cloud computing, big business in providing applications and data storage over the web. Commercial and large applications can also exist on the cloud, such as the entire suite of CRM from Salesforce is offered via the cloud. Cloud computing is not limited to web applications: it can also be used for phone or video streaming services.



Cloud computing. Image by Roman from Pixabay

Advantages of Cloud Computing

- No software to install or upgrades to maintain.
- Available from any computer that has access to the Internet.
- Can scale to a large number of users easily.
- New applications can be up and running very quickly.
- Services can be leased for a limited time on an as-needed basis.
- Your information is not lost if your hard disk crashes or your laptop is stolen.
- You are not limited by the available memory or disk space on your computer.

Disadvantages of Cloud Computing

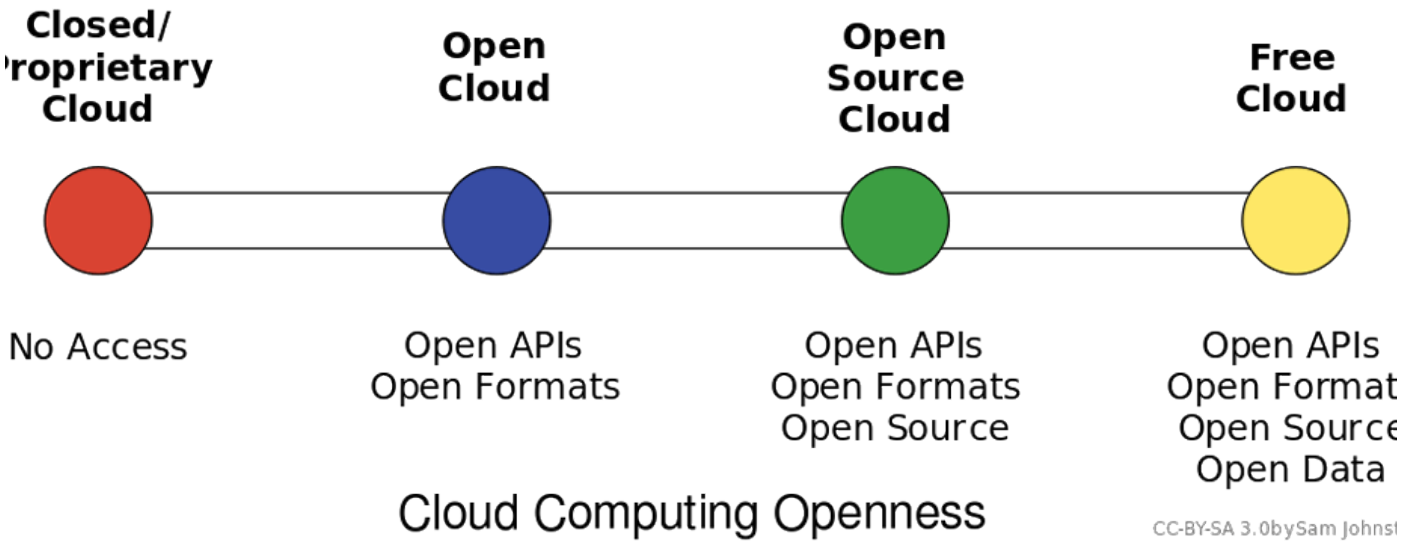
- You must have Internet access to use it. If you do not have access, you're out of luck.
- You are relying on a third party to provide these services.
- You don't know how your data is protected from theft or sold by your own cloud service provider.

Cloud computing can greatly impact how organizations manage technology. For example, why is an IT department needed to purchase, configure, and manage personal computers and software when all that is really needed is an Internet connection?

Using a Private Cloud

Many organizations are understandably nervous about giving up control of their data and applications using cloud computing. But they also see the value in reducing the need for installing software and adding disk storage to local computers. A solution to this problem lies in the concept of a private cloud. While there are various private cloud models, the basic idea is for the cloud service provider to rent a specific portion of their server space exclusive to a specific organization. The organization has full control over that server space while still gaining some of the benefits of cloud computing.

Cloud Emerging Technology/Current Trend



Cloud Computing Styles. By ObySam Johnson, CC-BY-SA 3.

Cloud computing can be loosely defined as the allocation of hardware and/or software under a service model (resources are assigned and consumed as needed).

Typically, what we hear today referred to as cloud computing is the concept of business-to-business commerce revolving around "Company A" selling or renting their services to "Company B" over the Internet. A cloud can be public (hosted on a public internet, shared among consumers) or private (cloud concepts of provisioning and storage are applied to servers within a fire wall or internal network that is privately managed), and can also fall into some smaller subsets in between, as depicted in the graphic above.

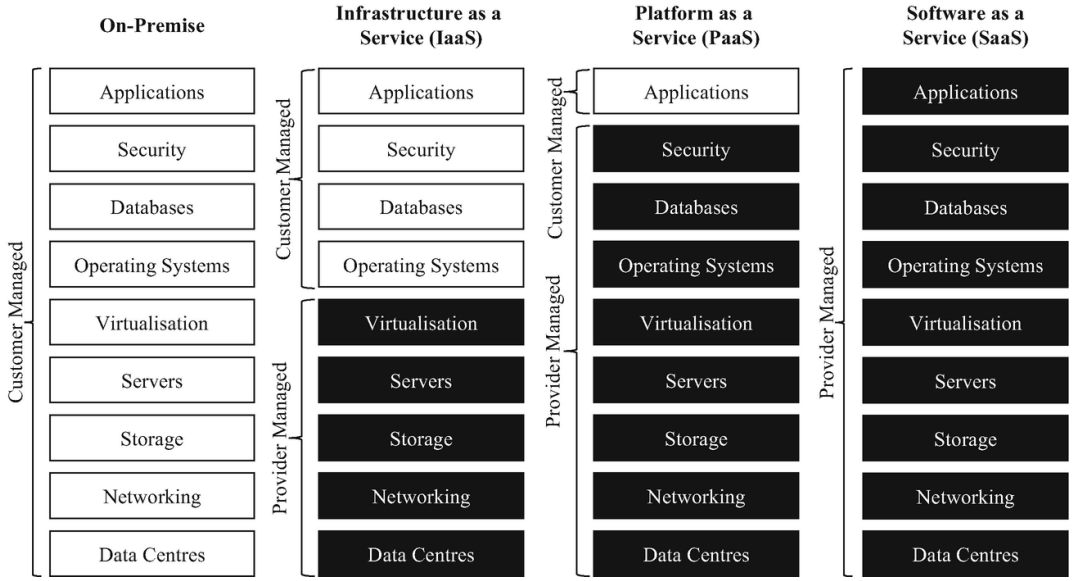
Under **Infrastructure as a Service** (IaaS) computing model, which is what is most commonly associated with the term cloud computing, one or more servers with significant amounts of processing power, capacity, and memory, are configured through hardware and/or software methods to act as though they are multiple smaller systems that add up to their capacity. This is referred to as virtualizing, or virtual servers. These systems can be "right sized" where they only consume the resources they need on average, meaning many systems needing little resources can reside on one piece of hardware. When processing demands

of one system expand or contract, resources from that server can be added or removed to account for the change. This is an alternative to multiple physical servers, where each would need the ability to serve not only the average but expected peak needs of system resources.

Software as a Service, **Platform as a Service**, and the ever-expanding list of "as-a-service" models follow the same basic pattern of balancing time and effort. Platforms as a service allow central control of end user profiles, and software as a service allows simplified (and/or automated) updating of programs and configurations. Storage as a service can replace the need to manually process backups and file server maintenance. Effectively, each "as-a-service" strives to provide the end user with an "as-good-if-not-better" alternative to managing a system themselves, all while trying to keep the cost of their services less than a self-managed solution.

The main types of cloud services are:

- **Infrastructure as a service (IaaS)**
  - Provides on-demand access to virtual and physical servers, storage, networking, and other IT infrastructure.
- **Platform as a service (PaaS)**
  - Allows users to create and deploy applications.
- **Software as a service (SaaS)**
  - Provides subscribers with access to software running on a cloud infrastructure. SaaS providers manage the network, servers, storage, and other aspects of the software.



Comparison of Cloud Computing Models. Rosati, Pierangelo; Lynn, Theo, Public domain, Wikimedia Commons

Virtualization

The reduced costs and increased power of commodity hardware are not the only contributors to the explosion of cloud computing. The availability of increasingly sophisticated software tools has also had an impact. Perhaps the most important software tool in the cloud computing toolbox is **virtualization**.

Virtualization is using software to create a virtual machine that simulates a computer with an operating system.

For example, using virtualization, a single computer that runs Microsoft Windows can host a virtual machine that looks like a computer with a specific Linux-based OS. This ability maximizes the use of available resources on a single machine. Companies

such as EMC provide virtualization software that allows cloud service providers to provision web servers to their clients quickly and efficiently. Organizations are also implementing virtualization to reduce the number of servers needed to provide the necessary services. For more detail on how virtualization works, see this informational page from VMWare.

Think of virtualization as being a kind of operating system for operating systems. A server running virtualization software can create smaller compartments in memory that each behave as a separate computer with its own operating system and resources. The most sophisticated of these tools also allow firms to combine servers into a huge pool of computing resources that can be allocated as needed (Lyons, 2008).

Virtualization can generate huge savings. Some studies have shown that on average, conventional data centers run at 15 percent or less of their maximum capacity. Data centers using virtualization software have increased utilization to 80 percent or more (Katz, 2009).This increased efficiency means cost savings in hardware, staff, and real estate. Plus it reduces a firm's IT-based energy consumption, cutting costs, lowering its carbon footprint, and boosting "green cred" (Castro, 2007). Using virtualization, firms can buy and maintain fewer servers, each running at a greater capacity. It can also power down servers until demand increases require them to come online.

While virtualization is a key software building block that makes public cloud computing happen, it can also be used in-house to reduce an organization's hardware needs, and even to create a firm's own private cloud of scalable assets. Bechtel, BT, Merrill Lynch, and Morgan Stanley are among the firms with large private clouds enabled by virtualization (Brodkin, 2008). Another kind of virtualization, **virtual desktops** allow a server to run what amounts to a copy of a PC—OS, applications, and all—and simply deliver an image of what's executing to a PC or other connected device. This allows firms to scale, back up, secure, and upgrade systems far more easily than if they had to maintain each individual PC. One game start-up hopes to remove the high-powered game console hardware attached to your television and instead put the console in the cloud, delivering games to your TV as they execute remotely on superfast server hardware. Virtualization can even live on your desktop. Anyone who's ever run Windows in a window on Mac OS X is using virtualization software; these tools inhabit a chunk of your Mac's memory for running Windows and actually fool this foreign OS into thinking that it's on a PC.

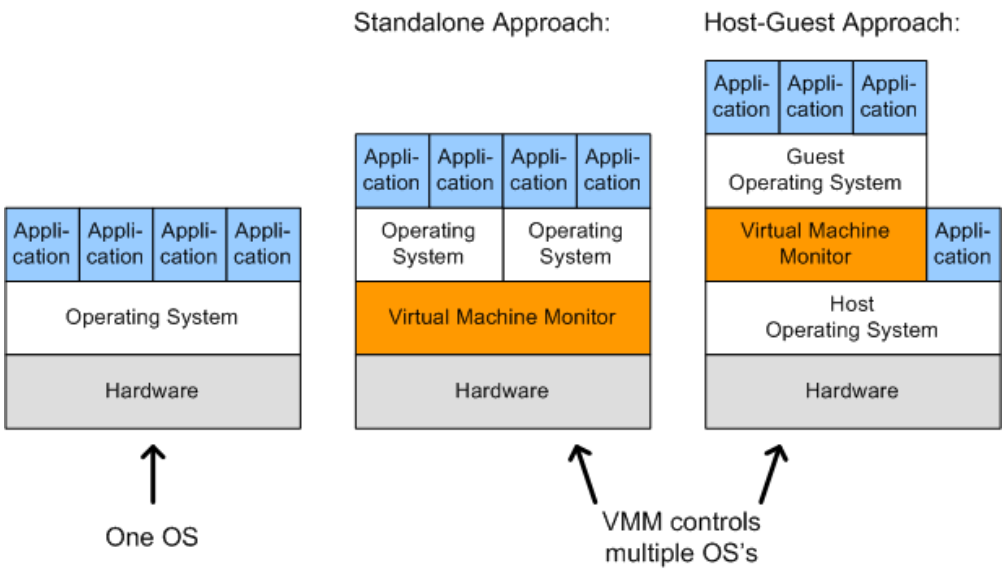
Interest in virtualization has exploded in recent years. VMware, the virtualization software division of storage firm EMC, was the biggest IPO of 2007. But its niche is getting crowded. Microsoft has entered the market, building virtualization into its server offerings. Dell bought a virtualization software firm for $1.54 billion. And there's even an open source virtualization product called Xen (Castro, 2007).

Virtualization Emerging Technology/Current Trend

Server virtualization is the act of running multiple operating systems and other software on the same physical hardware at the same time, as we discussed in Cloud Computing. A hardware and/or software element is responsible for managing the physical system resources at a layer in between each of the operating systems and the hardware itself. Doing so allows the consolidation of physical equipment into fewer devices, and is most beneficial when the servers sharing the hardware are unlikely to demand resources at the same time, or when the hardware is powerful enough to serve all of the installations simultaneously.

The act of virtualizing is not just for use in cloud environments, but can be used to decrease the "server sprawl," or overabundance of physical servers, that can occur when physical hardware is installed on a one-to-one (or few-to-one) scale to applications and sites being served. Special hardware and/or software is used to create a new layer in between the physical resources of your computer and the operating system(s) running on it. This layer manages what each system sees as being the hardware available to it, and manages allocation of resources and the settings for all virtualized systems. Hardware virtualization, or the stand alone approach, sets limits for each operating system and allows them to operate independent of one another. Since hardware virtualization does not require a separate operating system to manage the virtualized system(s), it has the potential to operate faster and consume fewer resources than software virtualization. Software virtualization, or the host-guest approach, requires the virtualizing software to run on an operating system already in use, allowing simpler management to occur from the initial operating system and virtualizing program, but can be more demanding on system resources even when the primary operating system is not being used.

Ultimately, you can think of virtualization like juggling. In this analogy, your hands are the servers, and the balls you juggle are your operating systems. The traditional approach of hosting one application on one server is like holding one ball in each hand. If your hands are both "busy" holding a ball, you cannot interact with anything else without putting a ball down. If you juggle them, however, you can "hold" three or more balls at the same time. Each time your hand touches a ball is akin to a virtualized system needing resources, and having those resources allocated by the virtualization layer (the juggler) assigning resources (a hand), and then reallocating for the next system that needs them.



Virtualization Styles. *By Daniel Hirschbach [CC-BY-SA-2.0 Germany] via Wikimedia*

The addition of a virtual machine as shown above allows the hardware or software to see the virtual machine as part of the regular system. The monitor itself divides the resources allocated to it into subsets that act as their own computers.

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

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4.2: Operating Systems



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4.2.3. Do you have Win or macOS?

4.2.1. Introduction

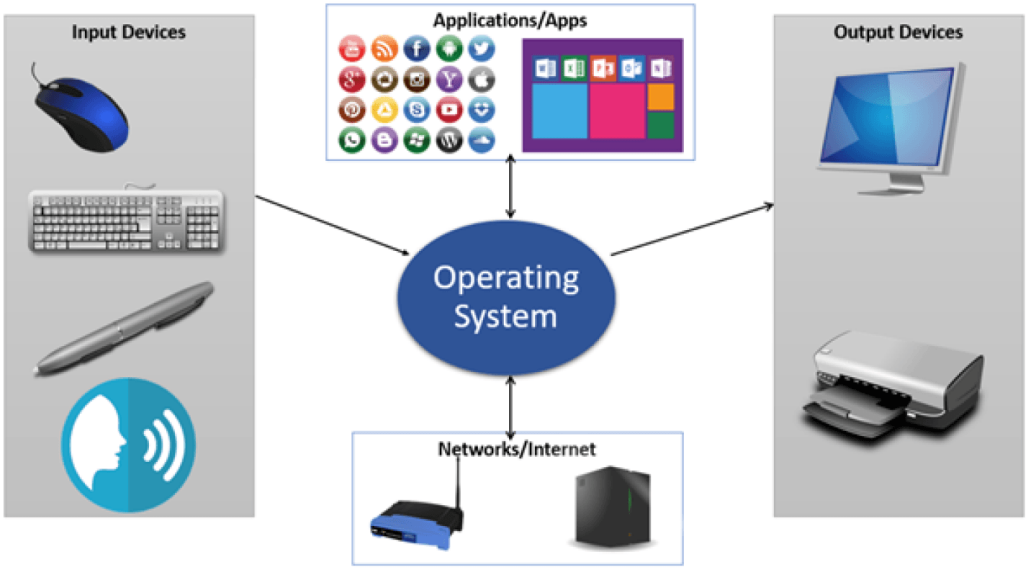
An **Operating System** is a set of programs that coordinate hardware components and other programs and acts as an interface with application software and networks.

The operating system provides several essential functions, including:

1. Managing the hardware resources of the computer
2. Providing the user-interface components
3. Providing a platform for software developers to write applications.

Nearly every computer program requires an operating system to function.

The next figure displays how the operating system accepts input from various input devices, outputs to various output devices; acts an intermediary between applications and apps, and access the internet via network devices such as a router or a web server.



Operating System Role. Image by Ly-Huong Pham is licensed under CC BY-NC

For personal computers, some of the most popular operating systems today are Microsoft's Windows, Apple's macOS, Google Chrome OS, and different versions of Linux.

Windows 11 logo. Microsoft, Public domain, Wikimedia Commons	**macOS logo**. Apple Inc., Public domain, Wikimedia Commons	**Tux. Lir**

For tablets and smartphones, some of the most popular operating systems are Android and iOS.

Android logo. Google, Public domain, Wikimedia Commons	**iOS logo.** Apple Inc., Public domain, Wikimedia Commons	

4.2.2. Chronology and evolution of different OS versions

macOS, DOS and Windows

As mentioned in chapter 2, Apple II was the first commercial personal computer sold, and the first models came with Applesoft BASIC firmware in the computers without floppy disks, and with Apple DOS in the computers with floppy disks.

IBM PC, in the 1980's, came with PC-DOS (Personal Computer Disk Operating System, developed by Microsoft). Later, the PC-clones started to use MS-DOS (which was the same software, but licensed for any Original Equipment Manufacturer - OEM - who built the clones).

In 1984, Apple introduced the Macintosh computer, featuring an operating system with a graphical user interface, now known as macOS.

Apple has different names for its OS running on different smaller devices such as iOS, iPadOS, watchOS, and tvOS. Eventually, they decided to use macOS on the desktops and laptops, and iOs in the mobile devices.

In 1986, as a response to Apple, Microsoft introduced the MS Windows OS, commonly known as Windows, as a new graphical user interface for MS-DOS.

By the 1990s, Windows dominated the desktop personal computers market as the top OS and overtaken Apple's OS.

Since 1990, both Apple and Microsoft have released many new versions of their operating systems, with each release adding the ability to process more data at once and access more memory.

Features such as multitasking, virtual memory, and voice input have become standard features of both operating systems.

> How many people use Windows or macOS? Visit Statista to find out.

Windows versions

• Windows 1: 1985 • Windows 2: 1987 • Windows 3: 1990 • Windows 3.1: 1992 • Windows NT: 1993 (Server) • Windows 3.3: 1994	• Windows 95: 1995 • Windows 98: 1998 • Windows 2000: 2000 (Server) • Windows ME: 2000 • Windows XP: 2001 • Windows Vista (2007)	• Windows 7: 2009 • Windows 8: 2012 • Windows 8.1: 2013 • Windows 10: 2014 • Windows 11: 2021 • Windows 12: ?
Windows versions		

macOS versions

• System 1: 1984 • System 2: 1985 • System 3: 1986 • System 4: 1987 • System 5: 1987 • System 6: 1988 • System 7: 1991	• Mac OS 8: 1997 • Mac OS 9: 1999 • Mac OS X: 2001 • OS X: 2012 • Mac OS X: 2016 • Mac OS 11: 2020 • Mac OS 12: 2021	• Mac OS 13: 2022 • Mac OS 14: 2023 • Mac OS 15: 2024 • Mac OS 26: 2025 • Mac OS 27: 2026
Classic Mac OS, macOS		

Unix and Linux

Unix is an operating system used primarily by scientists and engineers on larger minicomputers.

These computers, however, are costly, and software developer **Linus Torvalds** wanted to find a way to make Unix run on less expensive personal computers: Linux was the result. Linux is a version of the Unix operating system that runs on a personal computer.

> The name of the operating system was proposed by the development team: **Linu**s + Uni**x** = Linux.

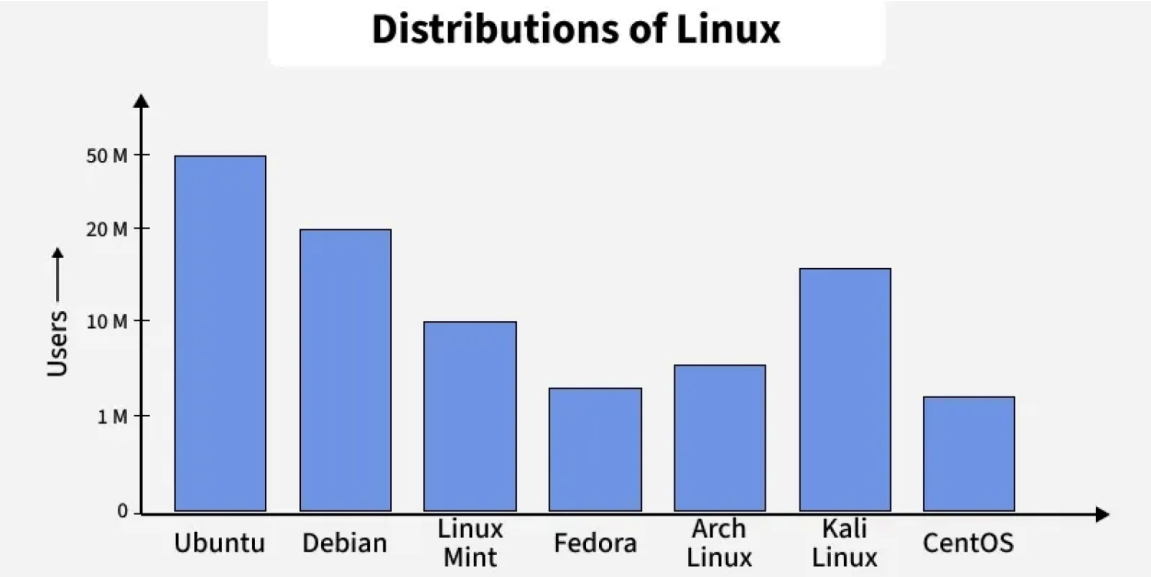
Linux has many variations and now powers a large percentage of web servers in the world.

It is also an example of open-source software, as it was mentioned in the previous section.

However, Linux in its pure form is not usually used in a computer system: usually a distribution (distro) is used.

> A Linux **distribution** (or distro) is a complete operating system built around the Linux kernel (core).

It bundles the core code with system tools, user interfaces, and software application stores so you can easily install and use the computer.



Distributions of Linux (2026). Graph via Geeks for Geeks

iOS and Android

Smartphones and tablets run operating systems as well, such as Apple's iOS (2006), Google's Android (2007), Microsoft's Windows Mobile, and Blackberry.

Android is based on the Linux kernel, and a consortium of developers developed other open-source software.

It quickly became the top OS for mobile devices and overtook Microsoft.

> macOS and iOS are based on the Unix kernel.

iOS versions

• iPhone OS 1: 2007 • iPhone OS 2: 2008 • iPhone OS 3: 2009 • iOS 4: 2010 • iOS 5: 2011 • iOS 6: 2012 • iOS 7: 2013 • iOS 8: 2014	• iOS 9: 2015 • iOS 10: 2016 • iOS 11: 2017 • iOS 12: 2018 • iOS 13: 2019 • iOS 14: 2020 • iOS 15: 2021 • iOS 16: 2022	• iOS 17: 2023 • iOS 18: 2024 • iOS 26: 2025 • iOS 27: 2026
iOS versions		

Android versions

• 1.0-1.1, Apple Pie: Sep 2008 • 1.5, Cupcake: Apr 2009 • 1.6, Donut: Sep 2009 • 2.0-2.1, Eclair: Oct 2009 • 2.2-2.2.3, Froyo: May 2010 • 2.3-2.3.7, Gingerbread: Dec 2010 • 3.0-3.2.6, Honeycomb: Feb 2011 • 4.0-4.0.4, Ice Cream Sandwich: Oct 2011	• 4.1-4.3.1, Jelly Bean: Jul 2012 • 4.4-4.4.4, KitKat: Oct 2013 • 5.0-5.1.1, Lollipop: Nov 2014 • 6.0-6.0.1, Marshmallow: Oct 2015 • 7.0-7.1.2, Nougat: Aug 2016 • 8.0-8.1, Oreo: Aug 2017 • 9.0, Pie: Aug 2018 • 10.0: Sep 2019	• 11.0: Sep 2020 • 12.0: Oct 2021 • 13.0: Aug 2022 • 14.0: Oct 2023 • 15.0: Oct 2024 • 16.0: Jun 2025 • 17.0: Jun 2026
Android versions		

> How many people use Android or iOS? Visit Statista to find out.

4.2.3. Do you have Win or macOS?

Apple macOS

To identify your operating system, start by narrowing down which brand of OS you have.

Often you can determine whether you are running Windows or macOS without even turning on your computer:

- Is there an Apple logo somewhere on your computer?
- Does your computer have a Command key (⌘) on the keyboard?
- Was your computer purchased at an Apple store?

If the answer to any of those questions is yes, then you most likely have a computer that runs macOS.

Another good way to see whether you are running Windows or Mac is simply to turn the computer on.

As the operating system boots up, it will display a logo.

A Windows logo means you are running Windows, while an Apple logo means you are running macOS.

If you have determined that you are running Windows, there are many methods to determine your specific operating system, not all of which are listed here.

It doesn't matter which method you use; what's important is figuring out which operating system you have. If one method doesn't work, try another.

Microsoft Windows

It's a good thing to know, if you are using Windows, which specific version and build is installed in your device. Usually, support agents will need that information.

You follow several processes, and here 2 of them are presented:

- Press the Windows key (at the bottom of the keyboard, looks like four squares ) and R key at the same time to open the Run dialog box. Type in "winver." Click OK.
- Open the Start menu by clicking the bottom left-hand corner of your screen. If you see a search text box, select it and then type "about" or "about your pc." If you do not see a search text box, then just start typing "about" or "about your pc." Select About your PC.



About Windows. Windows 10. Image by Luis R Castellanos, Public Domain, Own work.



About Windows. Windows 11. Image by Luis R Castellanos, Public Domain, Own work.

Team Apple or Team PC?

Ever since its introduction in 1984, users of the Apple Macintosh have been quite biased about their preference for the Macintosh operating system over Microsoft's.

When Microsoft introduced Windows, Apple sued Microsoft, claiming that they copied the "look and feel" of the Macintosh operating system.

In the end, Microsoft successfully defended themselves.

Over the past few years, Microsoft and Apple have traded barbs with each other, each claiming to have a better operating system and software.

While Microsoft has always had the larger market share, Apple has been the favorite of artists, musicians, and the technology elite.

Apple also provides a lot of computers to schools, thus gaining a following among the younger generation.

If you've worked in the world of business, you may have noticed that almost all of the computers run a version of Microsoft's Windows operating system. Why is this?

On almost all college campuses, you see a preponderance of Apple Macintosh laptops. In schools, Apple reigns as well.

Why has this not extended into the business world?

Almost all businesses used IBM mainframe computers back in the 1960s and 1970s.

These same businesses shied away from personal computers until IBM released the PC in 1981.

When executives had to make a decision about purchasing personal computers for their employees, they would choose the safe route and purchase IBM.

The saying then was:

> "No one ever got fired for buying **IBM**."

So, over the next decade, companies bought IBM personal computers (or those compatible with them), which ran an operating system called DOS.

DOS was created by Microsoft, so when Microsoft released Windows as the next iteration of DOS, companies took the safe route and started purchasing Windows.

Microsoft soon found itself with the dominant personal-computer operating system for businesses.

As the networked personal computer began to replace the mainframe computer as the primary way of computing inside businesses, it became essential for Microsoft to give businesses the ability to administer and secure their networks.

Microsoft developed business-level server products to go along with their personal computer products, thereby providing a complete business solution.And so now, the saying goes:

> "No one ever got fired for buying **Microsoft"**.

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4.3: File systems



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4.3.2. Disk Devices

4.3.3. File names and extensions

4.3.4. Directory Hierarchies and Paths

4.3.5. Storage Operations and Maintenance

4.3.6. File Systems used by some Operating Systems

When a process completes (or crashes), any data stored in the main memory is lost. But data stored on a hard disk drive (HDD) or solid-state drive (SSD) is “persistent;” that is, it survives after the process completes, even if the computer shuts down.

Hard disk drives (HDD) are complicated. Data is stored in blocks, which are laid out in sectors, which make up tracks, which are arranged in concentric circles on platters.

Solid-state drives (SSD) are simpler in one sense because blocks are numbered sequentially, but they raise a different complication: each block can be written a limited number of times before it becomes unreliable.

So, you don’t want to deal with these complications. What you want is an appropriate abstraction of persistent storage hardware. The most common abstraction is called a “file system.”



Hard Disk Drive.

Image by Azamat Esenaliev from Pexels



Seaga

Image by A

4.3.1. Files, File Systems, Directories, and File Management

A **file** is a collection of related information that is stored on a storage instrument such as a disk or secondary/virtual storage.

It is the smallest storage unit from the user's perspective. The file name includes two parts: name and extension (e.g., filename.txt). Each extension is for a specific purpose such as .exe (in Windows OS) to run a program and .txt for text files.

A **File System** is a data structure that stores data and information on storage devices (hard drives, floppy disc, etc.), making them easily retrievable.

NC State

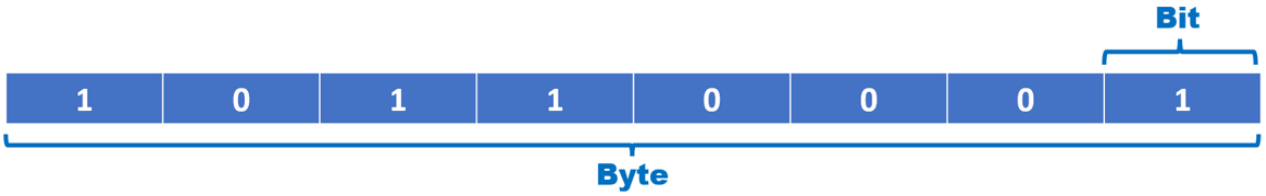
A **file system** is responsible for defining file names, storing files on a storage device, and retrieving files from a storage device. When designing a file system for managing many files, some issues to consider are as follows: most files are small so per-file overheads must be low; most of the disk space is in large files; many of the I/O operations are for large files so performance must be good for large files; files may grow unpredictably over time; users want to use text names to refer to files.

Special disk structures called directories are used to map names to support hierarchical directory structures. A **directory** is a set of files that is managed by the OS, and it also contains all the required information about the files, such as attributes, location, and ownership. The UNIX/Linux approach is as follows: directories are stored on disk just like regular files except with extra information to indicate that it is a directory. Each directory contains pairs. The file referred to by the address may be another directory; hence, we can have nested and hierarchical directory structures.

The problems facing modern file systems include disk management, naming, and protection. File systems are often trying to improve access to files by minimizing seeks, sharing space between users, and making efficient use of disk space. A system's ability to reduce faults and ensure that the information in the system survives OS crashes and hardware failures is called its

reliability. In addition to improving reliability, a file system should guarantee a high level of protection by maintaining isolation between users and controlling the sharing of resources.

> Everything that is stored in a computer system, comes in bits and bytes.
>
> **Bit** is short for "binary digit“. It is the smallest unit of digital information in computing, and it can have only two possible values: 0 or 1.
>
> **Byte** is a group of binary digits or bits (usually eight) operated on as a unit. It is considered as a unit of memory size.



Bit and Byte. Image by Luis R Castellanos, Public Domain, Own work.

4.3.2. Disk Devices

While file systems are a layer of abstraction that provides structured storage and defines logical objects such as files and directories, disk devices are considered raw storage.

Data that can be directly accessed by the CPU with minimum or no delay and does not survive a power failure is held in **primary storage** (usually RAM).

Persistent memory that survives power failures most of the time, such as spinning disks, SSDs, and USB drives, is considered **secondary storage**. Routines that interact with disks are typically at a very low level in the OS and are used by many components such as file systems and virtual machines. These secondary storage devices may handle the scheduling of disk operations, error handling, and often the management of space on disks. A trend is for disks to do more of this themselves.

4.3.3. File names and extensions

Operating systems impose technical restrictions on filenames to prevent conflicts with file system commands and internal paths. In a directory or folder, there can´t be more that one file with the same name, making it unique per file. It can have the same name if you have different copies in different directory or folder.

File names

Some considerations:

- Each file system has different reserved or forbidden characters to use in the file names.
- There are also some reserved names that can´t be used as a file name.
- The majority of the modern file systems limit the individual names to 255 or 260 characters (or bytes).
- By default, in Windows and macOS the names are case-insensitive, but in Linux they are strictly case-sensitive.

> Information about naming rules and restrictions in Windows can be found in Learn Microsoft.

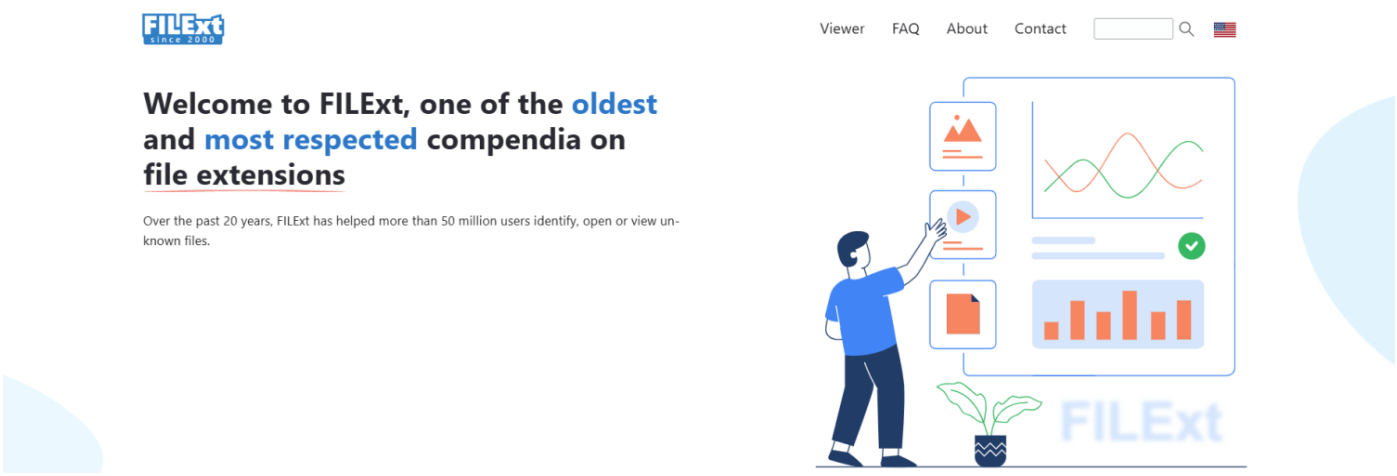
File Extensions

A file extension is a suffix added to the end of a computer file string (separated by a period).

The purpose of file extensions are:

- **Format Identification:** Informs the operating system and applications how the internal binary or text data is formatted.
- **Default Application Mapping:** The OS maintains an association table mapping specific extensions to default software (e.g., opening `.pdf` files in Adobe Acrobat or web browsers).
- **Execution & Security Context:** Signals to the system whether a file contains static data (e.g., `.png`) or executable program instructions (e.g., `.exe`, `.sh`).

> **FILExt** is one of the oldest and most respected compendia on file extensions



FILExt portal. Screenshot image by Luis R Castellanos, Public Domain, Own work.

4.3.4. Directory Hierarchies and Paths

Let's see how operating systems structure file system trees, resolve file locations using path syntax, and translate directory strings into internal data structures.

Directory tree and paths

A **file system directory tree** is a hierarchical structure that modern operating systems use to organize files and folders. It is visualized as an inverted tree, where a single **root directory** sits at the top, and subdirectories branch downward into further folders and files.

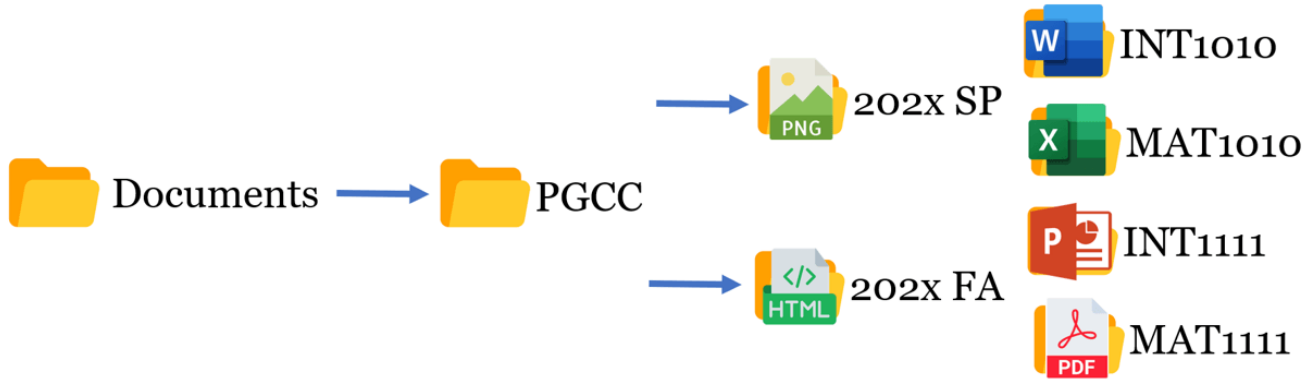
The **root directory** is the base of the file system. The **folders** act as branches that contain files or other subdirectories. **Files** represent the endpoints or leaves of the tree.

The specific route taken through the branches to reach a file is called a **pathname**.

Advantages of Maintaining Directories

- **Efficiency:** A file can be located more quickly.
- **Naming:** It becomes convenient for users as two users can have same name for different files or may have different name

for same file.
- **Grouping:** Logical grouping of files can be done by properties e.g. all java programs, all games etc.



Folders tree hierarchy. Image by Luis R Castellanos, Public Domain, Own work.

4.3.5. Storage Operations and Maintenance

Basic operations

The basic File Systems operations are:

- Create/Delete: Allocates or frees up space in the system's directory structure and storage sectors.
- Read/Write: The OS locates the specific data blocks on the drive, reads them into RAM, or writes new data from RAM back to the drive.
- Open/Close: Operations that grant an application a "handle" or "lock" on a file, preventing other programs from modifying it simultaneously.

Physical Storage Realities: HDD vs. SSD

File systems must manage different types of hardware differently to maintain performance and hardware lifespan.

- **Hard Disk Drives (HDDs) & Fragmentation:** HDDs use spinning magnetic platters. When large files are written, they may be broken into non-contiguous blocks scattered across the disk. This **fragmentation** increases the mechanical seek time of the read/write head. Operating systems use defragmentation tools to physically reorganize these blocks into contiguous spaces.
- **Solid-State Drives (SSDs) & TRIM:** SSDs use flash memory with no moving parts, making fragmentation irrelevant. However, SSD flash cells must be completely erased before they can be rewritten (erase-before-write). The OS issues a **TRIM** command to tell the SSD which data blocks are no longer in use by the file system. This allows the SSD's internal controller to erase those blocks in the background (garbage collection), keeping write speeds fast and extending the drive's lifespan.

File System Integrity & Recovery

Power outages or system crashes during a write operation can corrupt the entire file system.

- **Journaling:** Modern file systems (like NTFS, ext4, and APFS) use a "journal." Before writing actual data to the main disk structure, the OS logs its intent to make a change in a dedicated journal area. If the system crashes mid-write, the OS reads the journal upon reboot and either completes the pending operation or rolls it back, preventing corruption.
- **Integrity Tools:** Utilities like `chkdsk` (Windows) or `fsck` (Linux/macOS) scan the file allocation tables to locate and repair "orphaned" files or bad storage sectors.

4.3.6. File Systems used by some Operating Systems

The most important part of the file system is the method used to index files on the hard drive. This index allows the OS to locate specific files. Typically, this index is based on file names, but different operating systems and file systems use different indexing methods.

Windows: 3 file systems

In the Windows environment, you will find one of three file systems, each with different indexing methods.

1. The **File Allocation Table** (FAT) file system
2. The **NTFS** (New Technology File System)
3. **exFAT** (extensible FAT): A lightweight file system used primarily in flash storage applications and SD cards.

> More information about NTFS can be found in Learn Microsoft site.

Mac OS

In the macOS environment you will find the **HFS+** file system, or in newer computers you may find **APFS**.

> More information about Apple File Systems can be found in the Apple Developer site.

Linux

Depending on which type of Linux environment you are running, you may run into several different file systems. Some of them are ext2, ext3, and ext4. XFS, JFS, and a few others are also used. ext3 is a journaling extension to the ext2 file system on Linux. ext4 is the successor to ext3.

> More information about Linux File Systems can be found in the Linux Kernel site.

Android

Android uses a mix of file systems depending on the partition (`/data`, `/system`, `/sdcard`) and hardware manufacturer:

1. Internal Storage Partitions (`/data`, `/system`)

- F2FS (Flash-Friendly File System)
- ext4 (Fourth Extended File System)
- EROFS (Enhanced Read-Only File System)

2. Removable / External Storage (`/sdcard`, USB drives)

- exFAT (Extended File Allocation Table)
- FAT32 / VFAT

iOS

The primary file system across all modern iOS devices is APFS, which is optimized for flash storage and Solid State Drives (SSDs).

Most used File Systems

Windows 11	macOS	
FAT NTFS exFAT	HFS+ APFS	
Windows 11 logo. Microsoft, Public domain, Wikimedia Commons	**macOS logo**. Apple Inc., Public domain, Wikimedia Commons	**Tux. Li**

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4.4: Downloading Files



Links don't always go to another website.

In some cases, they point to a file that can be downloaded, or saved, to your computer.

If you click a link to a file, it may download automatically, but sometimes it just opens within your browser instead of downloading.

To prevent it from opening in the browser, you can right-click the link and select Save link as (different browsers may use slightly different wording, like Save target as).

Files downloaded from the internet are often downloaded to your download folder, which is a quick access folder accessible on the left navigation pane of windows explorer.

Sometimes you may want to save an image from a website to your computer.

To do this, right-click the image and select Save image as (or Save picture as).

Make sure you trust the file that you downloaded to your computer, as downloading any file or program to your computer contains security risks to your computer (links).

Download	**Upload**
You copy data from the Internet or from a portable storage device to your computer.	You copy data from your computer to the Internet or to a pc storage device.



Image by TheHalalDesign from Pixabay



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REFERENCES

PGCC. *INT1010: Concepts in Computing*. 2021. Link.

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4.5: File Management



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4.5.1. What is file management?

4.5.2. Best practices for effective file management

4.5.3. What is Microsoft Windows File Explorer?

4.5.4. Using Microsoft Windows File Explorer

4.5.5. File Management with Microsoft Windows File Explorer application

4.5.1. What is file management?

File management refers to the systematic organization, storage, and control of digital information within an organization.

It's the foundation of efficient digital operations, encompassing everything from basic file naming conventions to complex automated workflows and bypassing **email file size limits** with compression and storage solutions.

File management is about creating logical systems that allow users to store, locate, and retrieve information quickly and efficiently.

The core functions of file management include:

- Organizing files into coherent structures
- Implementing naming conventions
- Controlling access permissions
- Maintaining version control

> Strong file management = better productivity, easier access, and tighter security.

4.5.2. Best practices for effective file management

Effective file management practices are crucial for maintaining an organized and efficient digital workspace.

The following best practices can help organizations establish a robust system that promotes productivity while ensuring data

security and accessibility.

- Establish consistent naming conventions
- Create a logical folder hierarchy
- Implement version control procedures
- Set up automated backup systems
- Archive outdated files regularly
- Establish access control protocols
- Perform regular system audits
- Document management procedures
- Implement file retention policies
- Set up automated organization tools

4.5.3. What is Microsoft Windows File Explorer?

Microsoft Windows File Explorer is a graphical file management utility for the Windows operating system (OS). Windows Explorer was introduced with Windows 95 and later renamed File Explorer. Each time a computer user accesses a disk or opens a folder containing files, they are using the Windows File Explorer utility.

File Explorer in Windows 11 has been redesigned and has a new structure.

> The equivalent tool in Mac OS is Apple Finder. The equivalent tools in Linux are (depends on the desktop environment): Nautilus, Dolphin, Thunar, Nemo, Caja.

4.5.4. Using Microsoft Windows File Explorer

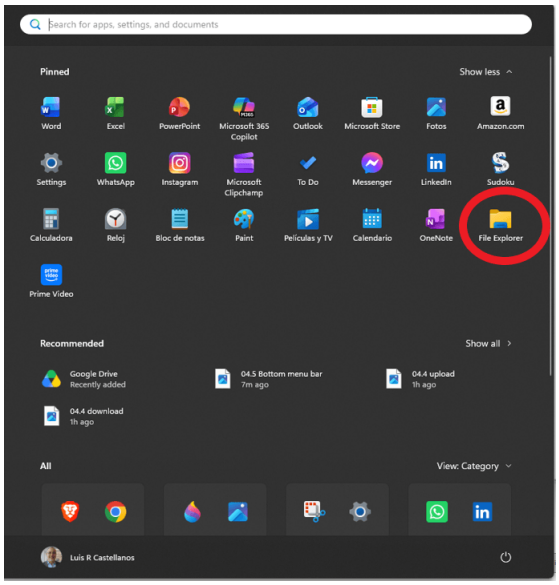
Opening File Explorer

To open File Explorer, click on the File Explorer icon located in the taskbar.



Windows bottom menu bar. Image by Luis R Castellanos, Public Domain, Own work.

Alternatively, you can open File Explorer by clicking on the Start button and then clicking on **File Explorer**.



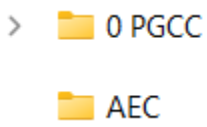
Windows menu. Image by Luis R Castellanos, Public Domain, Own work.

Displaying Subfolders

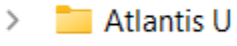
If you've used previous versions of Windows, you know that a folder name would have a plus sign next to it if that folder contains documents or subfolders.

With Windows 11, if a folder contains subfolders, that folder name will instead have a small right-pointing triangle next to it.

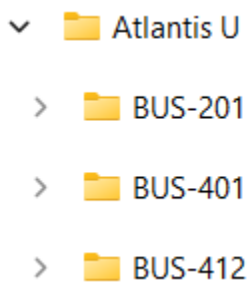
- No triangle next to a folder name means that the folder has no subfolders.



- To view a folder's subfolders, click on the right-pointing triangle next to the folder. The right-pointing triangle will turn into a down-pointing triangle, and the subfolders will be displayed, as shown below.



- Down-pointing triangle next to a folder name means that subfolders are currently displayed for that folder.



- To hide a folder's subfolders, click on the down-pointing triangle of that folder so that the subfolders will no longer be

displayed.

Accessing Your Files and Folders

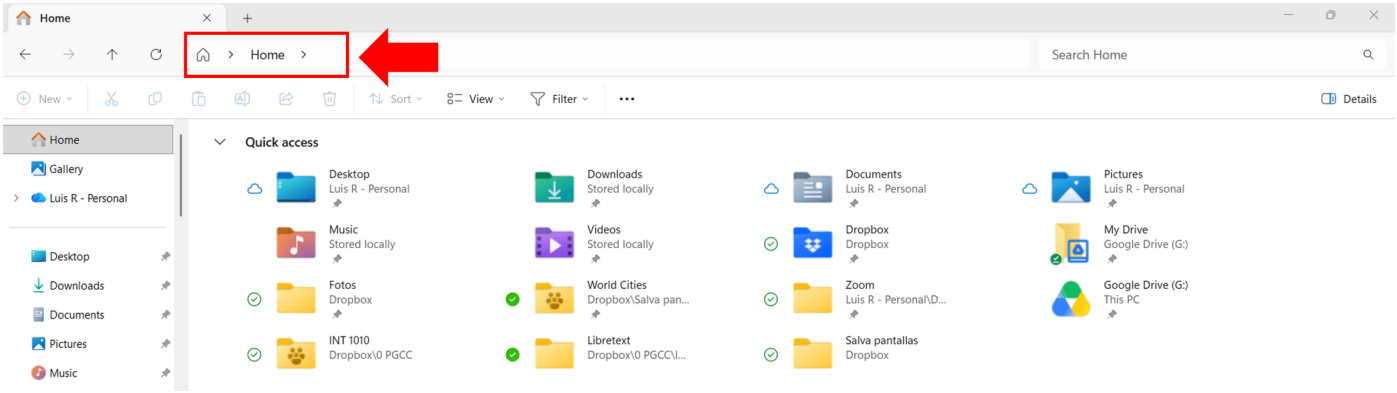
There are number of ways you can navigate to your files and folders in File Explorer:

- Using the **Address bar** (located at the top of File Explorer). The Address bar shows the full path of your current location.
- Forward and Backward buttons
- From the Folders pane
- Using the **Search function** (searches file names and file and folder contents in the current folder to find items containing your search term)

Using the Address Bar

The **Address bar**, which is located at the top of File Explorer as shown below, displays the path of the currently selected folder.

File Explorer drop-down menus are available for each subfolder in the Address bar. So you can easily go backward or forward in the folder path by clicking on the right-pointing arrow next to a folder and selecting a subfolder from the drop-down menu.

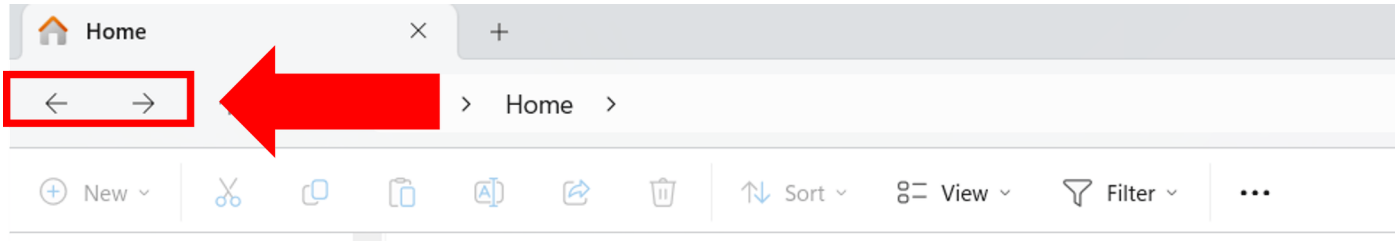


File Explorer Address Bar. Image by Luis R Castellanos, Public Domain, Own work.

Viewing Previously Visited Folders in the Address Bar

To view folders you've been to previously, you can do any of the following:

Click on the Forward or Back buttons. (These buttons work just like the Forward and Back buttons on a Web browser.)



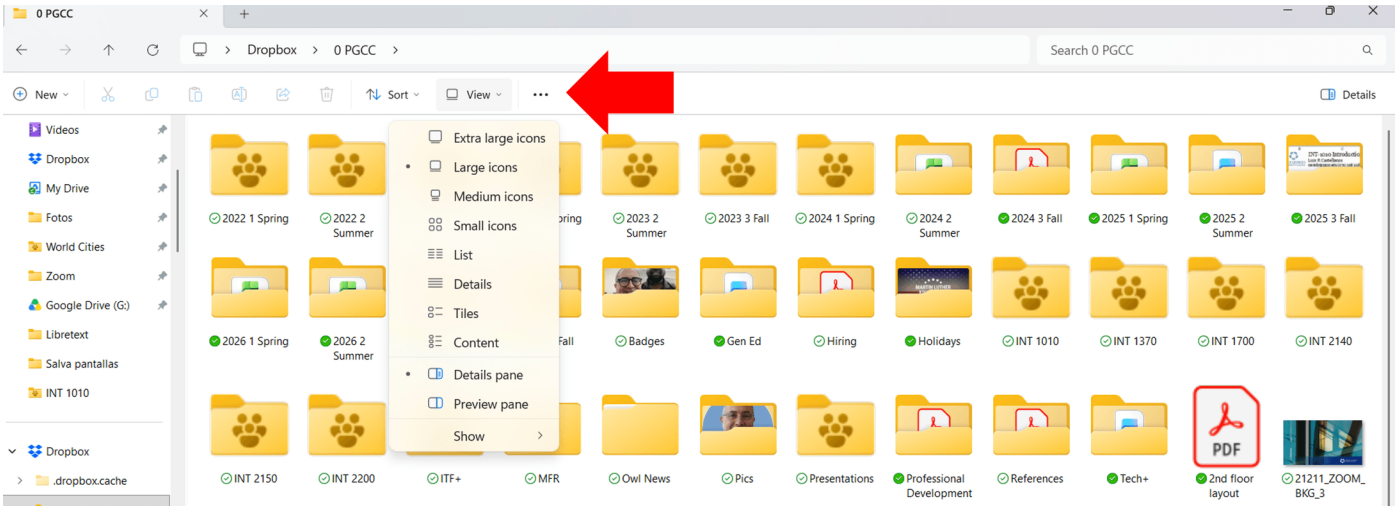
File Explorer Forward and Back buttons. Image by Luis R Castellanos, Public Domain, Own work.

Click on a folder name in the Address bar.

Changing How Your Files and Folders are Displayed

You can change how your folder and file icons look, as well as display different information about them. ***Note*:** Changes you make will apply to the contents of the current folder only.

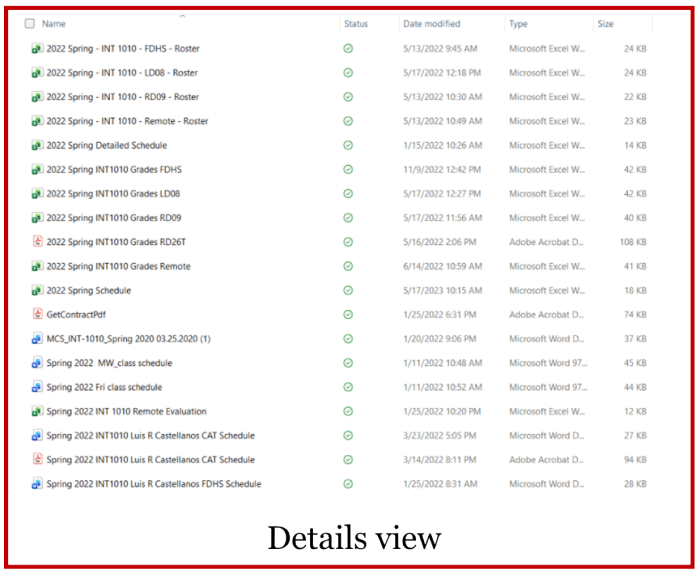
1. Navigate to the folder whose display you want to change.
2. Click on the **View** tab to display the Ribbon.
3. In **View**, you'll see the following available display options:

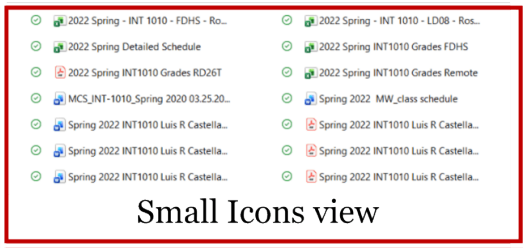


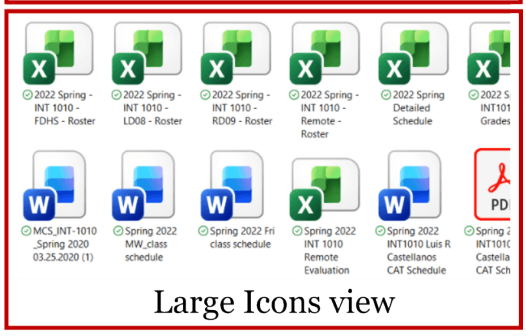
File Explorer View Options. Image by Luis R Castellanos, Public Domain, Own work.

(***Note*:** If some of your files or folders are hidden when the Ribbon is displayed, you can pin the Ribbon to File Explorer (keep it displayed, or expanded, in File Explorer even if you're doing another task) by clicking on the up-pointing arrow on the top right-hand side of your File Explorer window; once you pin the Ribbon, you'll be able to see those previously hidden files or folders.)

1. Move your mouse over each option to see a quick preview of that option in the area where your files and folders are displayed.
2. To choose an option, just click on it.
3. To show more information about files and folders from display views that show little or no information (e.g., Large icons), you can open the Details Pane by clicking on the **View** menu, and then clicking on **Details Pane**.
4. Click on an item to view the details of that item in the Details Pane.



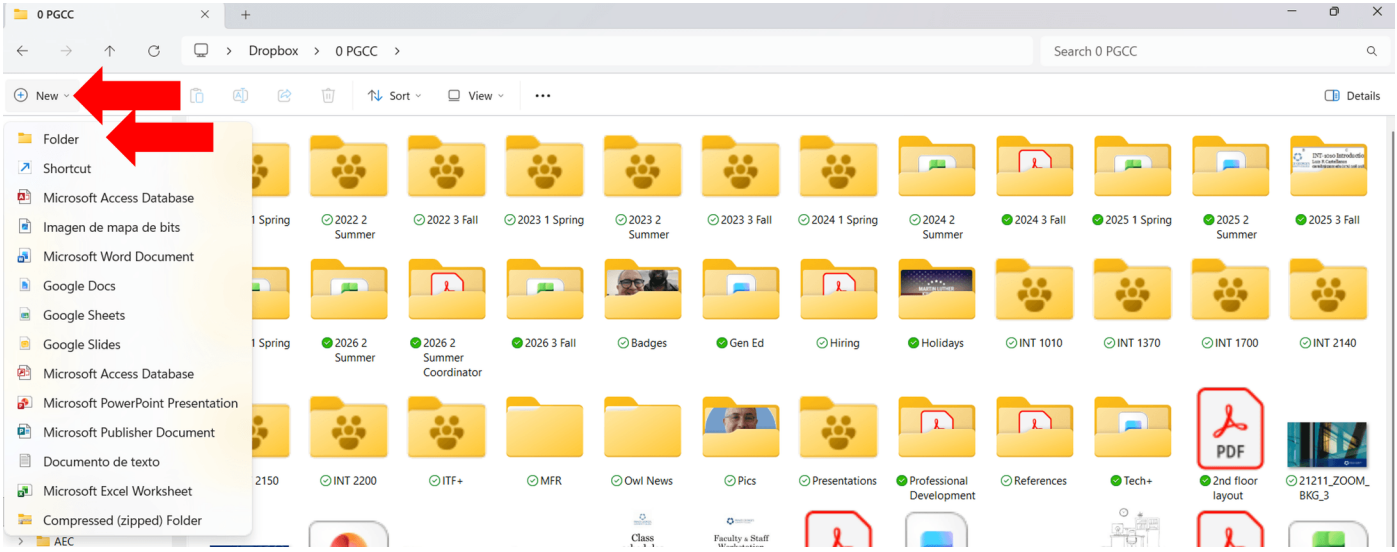




File Explorer View Options Examples. Image by Luis R Castellanos, Public Domain, Own work.

Creating a New Folder

1. Navigate to the location where you want to add your folder.
2. In File Explorer, click on the **New** menu item (located on the top left corner.)
3. From the **drop down menu**, click on the **New folder** button.
4. Enter the name of your new folder.
5. After you enter the folder name, click anywhere outside the text area to complete creation of the folder name.



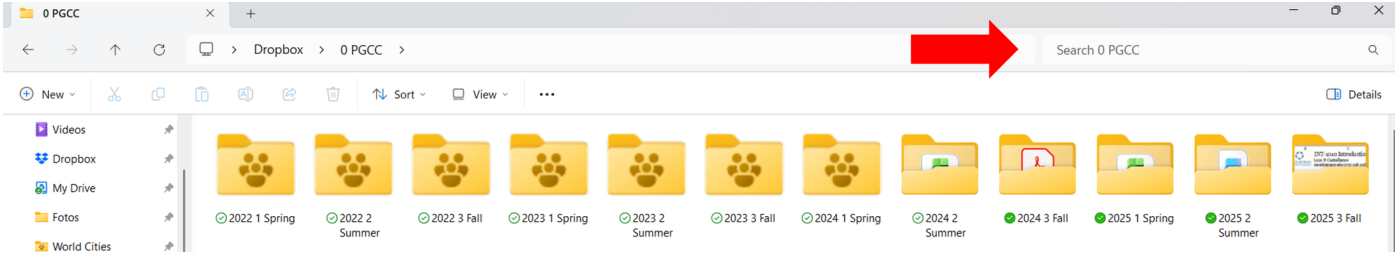
File Explorer New Folder. Image by Luis R Castellanos, Public Domain, Own work.

Searching for Files

Windows 11 comes with a powerful search capability.

Windows 11 will search all file types—documents, images, music, Web pages—as well as bookmarks and program shortcuts on your Desktop. Windows 11 will search file content, as well as file and folder names.

1. Navigate to the folder where you want to search for items. You will see the Search box in the upper right-hand corner of the Windows Explorer window. (You should see a small magnifying glass icon on the right-hand side of the text area.)
2. Type the desired search text in the Search box. Choose the desired search criteria from **Search Options**. (Some of the search criteria you select might be added to the Search text area; Windows updates the search results automatically as you enter search criteria.)As you type your search text, Windows automatically displays in the file and folder list area any items that match your search criteria. The Address bar will also display **Search results in** [***current folder name***]; in the example below, **Search results in Documents** is displayed in the Address bar. If not already displayed, expand the File Explorer window to also display file or folder location, text snippet for text documents, or dimensions for image files.
3. If you've set up search criteria you want to retain for a future search, you can save that search by clicking **Save search**.



File Explorer Search. Image by Luis R Castellanos, Public Domain, Own work.

Windows 11 searches in your current folder. So, for example, if you're looking for a file that you know exists somewhere in your **Documents** folder, you may want to conduct your search from the top level of the **Documents** folder [not from a subfolder in **Documents**] to have the best chance of finding that file.)

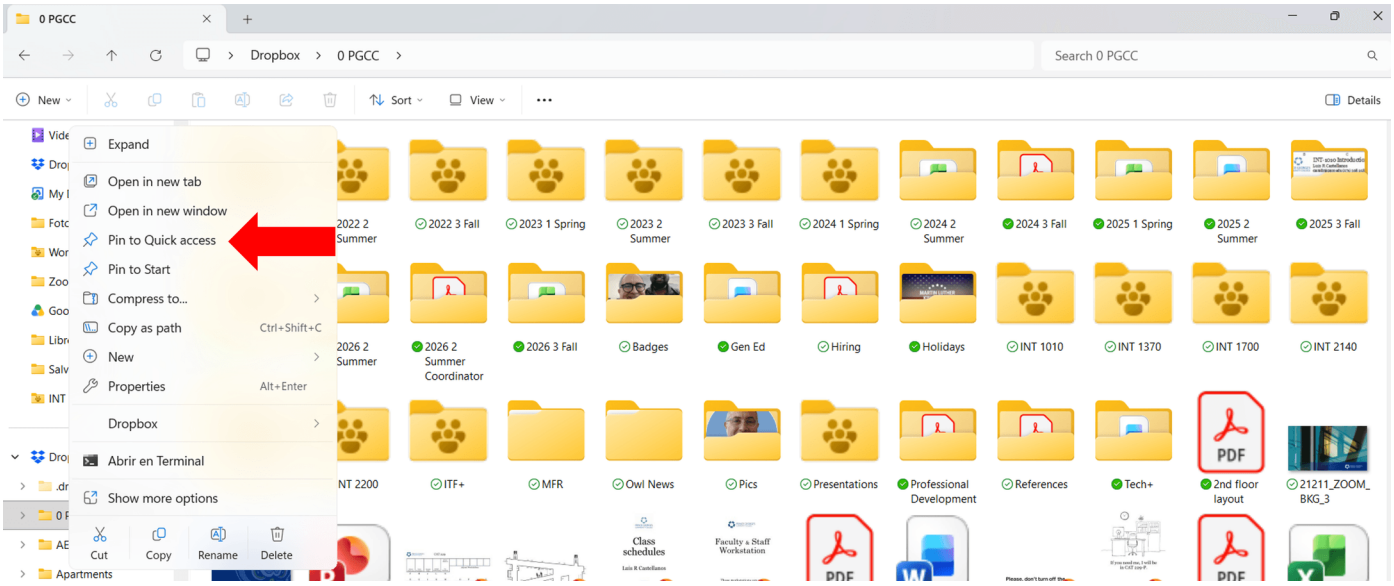
Creating a Shortcut to a Folder

You can add a folder in the **Quick access** area of the Navigation Pane as a shortcut, much like you might add a bookmark in a Web browser. Creating a shortcut enables you to quickly and easily get to any folder you use frequently.

1. Open Windows Explorer.
2. Navigate to the folder for which you want to create a shortcut.
3. Click on the folder icon and drag it to the "Favorite Links" section, and then drop it in the position you want it to appear. (A horizontal line changes position as you move your mouse. The line indicates where your icon will appear.)

The folder will be displayed in the **Quick access** area.

Or, you can click on the folder with the right mouse button, and chose "Pin to Quick access" on the menu.



File Explorer Quick Access. Image by Luis R Castellanos, Public Domain, Own work.

Compress and Extract (Zip and Unzip) files and/or folders

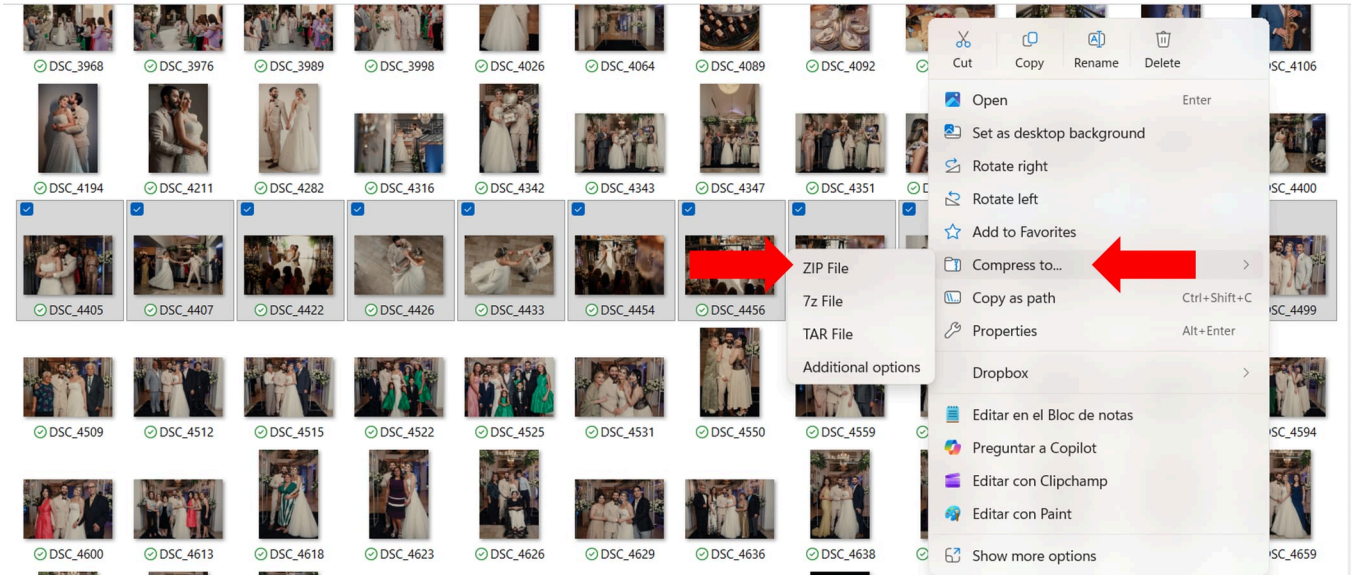
Zipped (compressed) files reduce file size and bundle multiple files for easier sharing. In Windows, users can create ZIP files via the right-click menu or File Explorer tools. Contents can be extracted using "Extract All" or by dragging files out of the archive. Zipped folders behave like regular folders but may affect encryption and compression outcomes.

Zipped (compressed) files take up less storage space and can be transferred to other computers more quickly than uncompressed files. In Windows, you work with zipped files and folders in the same way that you work with uncompressed files and folders. Combine several files into a single zipped folder to more easily share a group of files.

To zip (compress)

1. Locate the file or folder that you want to zip.
2. Right-click (or press and hold) the file or folder, select **Show more options** > **Send to** > **Compressed (zipped) folder**.

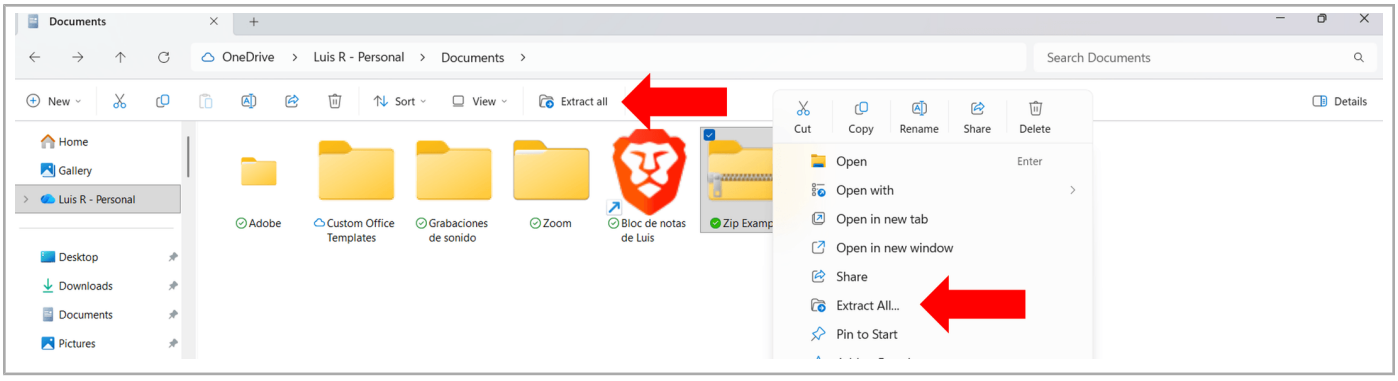
   A new zipped folder with the same name is created in the same location. To rename it, press and hold (or right-click) the folder, select **Rename**, and then type the new name.



File Explorer Compress. Image by Luis R Castellanos, Public Domain, Own work.

To unzip (extract)

1. Locate the zipped folder that you want to unzip (extract) files or folders from.
2. Do one of the following:
   - To unzip a single file or folder, open the zipped folder, then drag the file or folder from the zipped folder to a new location.
   - To unzip all the contents of the zipped folder, right-click (or press and hold) the folder, select **Extract All...**, and then follow the instructions.
   - Or you can open the folder and click on the "Extract all" option.



File Explorer Extract. Images by Luis R Castellanos, Public Domain, Own work.

Move files

1.Use Drag and Drop to move

- Click and hold the file you want to move, drag it to the desired folder, and release it.
- To Copy: Hold down the CTRL key while dragging the file to create a copy instead of moving it.

2. Keyboard Shortcuts

- Copy Files: Select the file(s) you want to copy and press CTRL + C. Then navigate to the destination folder and press CTRL + V to paste.
- Move Files: Select the file(s) you want to move and press CTRL + X to cut them. Navigate to the destination folder and press CTRL + V to paste them.

3. Context Menu Options

- Right-click Method: Right-click on the file and select "Copy" or "Cut." Then navigate to the destination folder, right-click in the folder, and select "Paste."

4. Quick Access and Navigation Pane

- Use Quick Access: Pin frequently used folders to Quick Access for easier navigation.
- Navigate Easily: Use the navigation pane on the left side to quickly switch between folders

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4.5.5. Keyboard shortcuts in Microsoft Windows

Keyboard shortcuts are keys or combinations of keys that provide an alternative way to do something that you'd typically do with a mouse.

The Windows shortcuts combine the Control (Ctrl), Alternate (Alt), Shift and Function keys with the alphabet letters.

The most common are:

Ctrl + A	Select all text		Ctrl + H	Find and replace text
Ctrl + B	Apply the bold format to the selected text		Ctrl + V	Paste the last item from the clipboard
Ctrl + C	Copy the selected text		Ctrl + X	Cut the selected text
Ctrl + F	Find text		Ctrl + Z	Undo the last typing

> More shortcuts in Keyboard shortcuts in Windows

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Mailchimp. *What is file management?* Link.

Microsoft. *Keyboard shortcuts in Windows*. Link.

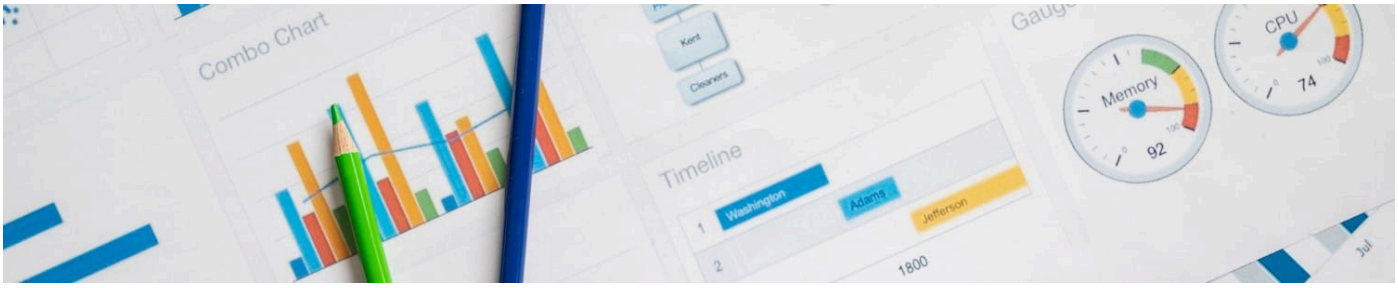
Microsoft. *Zip and unzip files*. Link.

UC Davis. *Working with the File Explorer in Windows 11*. Link.

Image by Serdar Barış from Pexels

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4.6: Appendix A - Microsoft Excel Basics



Learning Objectives

By the end of this section, you will be able to:

- Identify common uses for Excel spreadsheets
- Use basic features of Excel
- Describe the essential functions of each tab on the ribbon
- Differentiate between worksheets and workbooks
- Create worksheets and navigate existing files
- Print a workbook and a worksheet

WorldCorp sells many consumer electronics, including tablets, HD antennas, headphones, and TVs. The Portland location is in a port city, so it can dispatch orders anywhere in the world, but most of its orders go to the northern United States and Canada. As you receive more and more orders from clients, you need a spreadsheet or database to keep all data flowing so that the warehouse knows where the shipment will be sent, what products are in the order, and how much the total shipment costs. This data, in turn, can be added to the financial statements in the accounting system, which will help the senior managers analyze the sales results of the company. Microsoft Excel is a powerful tool that can be used for creating sales order tables.

Common Uses of Spreadsheets

Excel is a spreadsheet software application type that has rows and columns in a grid pattern. A cell is the intersection of a row and a column, and it looks like a rectangle. You can enter data into the cells to design tables and graphs and perform data analysis. A workbook is a file that contains at least one worksheet, which is a tab within a workbook where you can input data and design tables and graphs that use the data (Figure 9.2). The terms *worksheet* and *spreadsheet* are interchangeable, but Excel uses the *worksheet* terminology.

A workbook may contain several worksheets, similar to taking a hard copy of a set of data and adding it to another hard copy in a file folder. One benefit of using a workbook is that the worksheets within it can communicate with each other. Having multiple worksheets in one workbook gives you flexibility in organizing and analyzing your data. Data analysis grows in complexity as a business grows. Even a simple accounting system for a small business designed in Excel will require many sheets, and each worksheet can feed or receive data from other worksheets. One workbook can contain all of these worksheets together, as in a manila file folder.

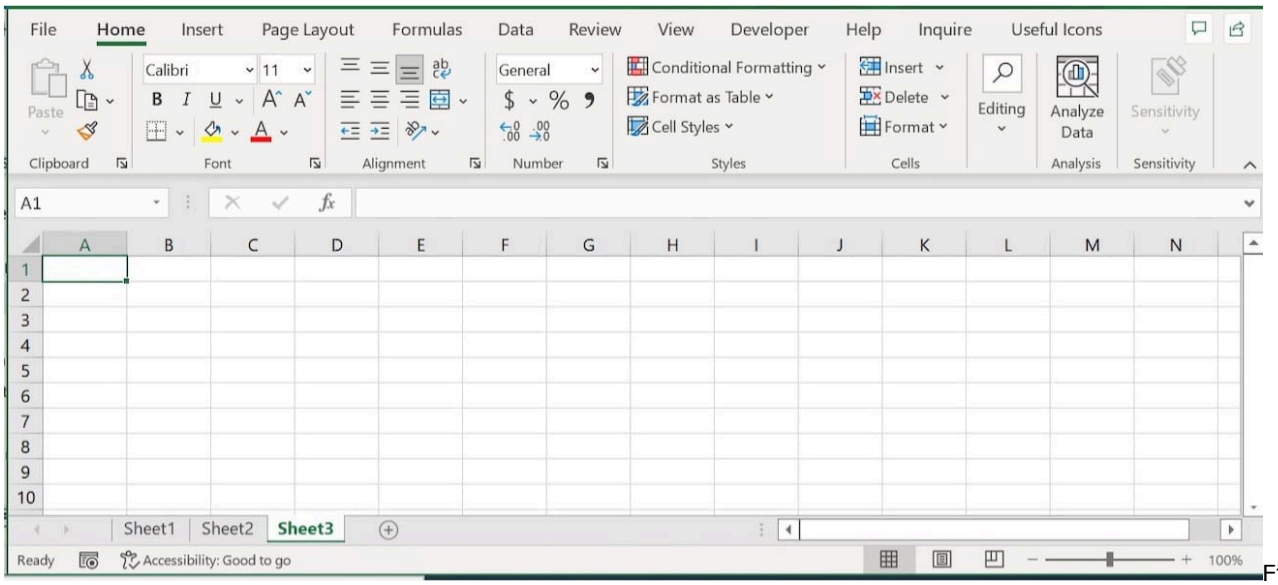


Figure 9.2: An Excel workbook contains individual worksheets made up of cells. (Used with permission from Microsoft)

The cells are named based on their location. For example, the upper-left cell is in column A and row 1, so Excel designates its address relative to the other cells in the worksheet, or its cell reference, as A1. You can use these cell references to perform operations that use either formulas or functions. A formula is a mathematical operation that may use constants or cell references, or a combination of constants and cell references. All formulas must begin with "=." For example, you can calculate 4 + 4 by typing "=4+4" in a cell, or you can add the contents of cell A1 and 4 by typing "=A1+4" or typing "=" and then clicking on cell A1 and then completing the formula.

A function is a mathematical or analytical operation that uses words instead of mathematical operators. All functions must also begin with "=" in Excel. For example, to calculate 4 + 4, you can type "=sum(4,4)." Excel can do the calculations for you just as you would using a calculator. Excel's formulas and functions can take the place of a calculator.

One use for spreadsheets is to create a monthly food budget. You can keep track of how much you spend on groceries by category and on eating out at restaurants. You could list it by the type of product (i.e., milk) and by restaurant. Over time, you can use these numbers to determine your average cost for groceries and for eating out, and you will then be able to predict what you will spend on groceries. This tracking can serve as a control on your budget and will help you save money in the long run. You can use a similar process for all your personal finance and family expenses to enable you to create a budget that works for your situation by tracking expenses.

In business, the same principles apply. If you can track business sales, you will be able to allocate the money more effectively. In other words, by having a better accounting system and dispatching of orders, a manager will be able to see where money is being generated. If the manager realizes that a certain product is generating a higher profit, then the manager can allocate resources to increase the sales of that product. For example, the company could increase the unit production and hire more sales agents to sell that product, which in turn will increase distribution venues, such as corporate retail clients that sell the products in their stores. Not only that, the company may also increase the marketing and advertisement expenses of these products, to gain new clients. All of these actions stemmed from the tracking of sales and analyzing what products sell the most units. In all these layers of actions, there will be many worksheets tracking data, such as an order-dispatching spreadsheet or the unit cost manufacturing sheets.

Link to Learning

Mallory is an Australian website that offers career advice and tips to recent college grads or high-school students about to enter the job market. Read the article that discusses different ways businesses use Excel to learn more.

Basic Features

The most salient Excel feature is the arrangement of cells in columns and rows. The appearance of Excel is similar to graph paper. You can easily customize the width or height to fit words or numbers in the cells. To navigate through the cells in the spreadsheet, you can click on the cell and then use the Enter or Return key to move down to the next row, use the Tab key to move to the next column, or use the arrows on your keyboard to move around the worksheet.

Spreadsheets are designed for data analysis. Each cell has its own integrated calculators that automatically compute the result when you type in a formula or function. Another major benefit to Excel is that you can quickly and easily copy an equation into other cells, so that you do not have to retype it. Excel has many other features that can save you time over using a calculator.

To demonstrate how efficient Excel can be in organizing and analyzing data, let's look at an order-dispatching spreadsheet (Figure 9.3). Each row represents one order, and each column represents a different characteristic of the order, identified by the labels in the top row (called the headers), with the data separated into different cells.

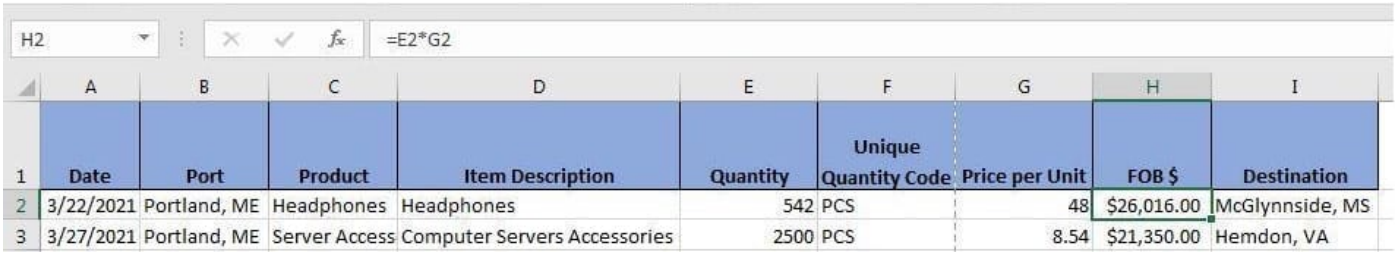
A1

	A	B	C	D	E	F	G	H	I
1	Date	Port	Product	Item Description	Quantity	Unique Quantity Code	Price per Unit	FOB $	Destination
2	3/22/2021	Portland, ME	Headphones	Headphones	542	PCS	48	$26,016.00	McGlynnside, MS
3	3/27/2021	Portland, ME	Server Access	Computer Servers Accessories	2500	PCS	8.54	$21,350.00	Hemdon, VA
4	3/29/2021	Portland, ME	Tablets	Tablets 7in	143	PCS	74	$10,582.00	Norristown, PA
5	3/21/2021	Portland, ME	TVs	LCD TVs 32in and 45in	53	PCS	275	$14,575.00	Charleston, WV
6	3/17/2021	Portland, ME	TVs	LED TVs, 55in and 65in	97	PCS	665	$64,505.00	Metaire, LA
7	3/15/2021	Portland, ME	Phone Access	Cellular Phone Accessories	3000	PCS	7.64	$22,920.00	Hemdon, VA
8	3/10/2021	Portland, ME	Stereos	Home Stereo Systems	74	PCS	98	$7,252.00	Charleston, WV
9	3/7/2021	Portland, ME	Media Players	Blu-Ray Players	127	PCS	86	$10,922.00	Metaire, LA
10	3/5/2021	Portland, ME	Antennas	HDTV Antennas	768	PCS	28	$21,504.00	McGlynnside, MS
11	3/1/2021	Portland, ME	Antennas	HDTV Antennas	453	PCS	28	$12,684.00	Norristown, PA
12	2/28/2021	Portland, ME	Media Players	Blu-Ray Players	241	PCS	86	$20,726.00	Hemdon, VA
13	2/25/2021	Portland, ME	Stereos	Home Stereo Systems	99	PCS	98	$9,702.00	Charleston, WV
14	2/22/2021	Portland, ME	Tablets	Tablets 7in	241	PCS	74	$17,834.00	Metaire, LA
15	2/20/2021	Portland, ME	Headphones	Headphones	753	PCS	48	$36,144.00	McGlynnside, MS
16	2/17/2021	Portland, ME	Headphones	Headphones	235	PCS	48	$11,280.00	Norristown, PA
17	2/18/2021	Portland, ME	TVs	LED TVs, 55in and 65in	87	PCS	665	$57,855.00	Hemdon, VA
18	2/14/2021	Portland, ME	Antennas	HDTV Antennas	214	PCS	28	$5,992.00	Charleston, WV

Figure 9.3: Separating data by columns makes it easier to analyze and perform calculations with the data. (Used with permission from Microsoft)

Separating the data by columns serves multiple purposes. First, it allows a user to organize the information by any one or more of the columns. For example, you could organize the data by date, as shown in Figure 9.3 or by destination. You can also keep different types of data, such as item description (column D) and price per unit (column G), separated. That way, if the price per unit changed, it could be updated quickly and easily. Further, if they were combined in a single column, you would be unable to use formulas to do calculations, because Excel cannot perform calculations when there are both letters and numbers in a cell. Excel recognizes numerals for calculations but cannot perform calculations with words or letters, just as a calculator cannot calculate letters. Another benefit of separating data into categories by column is that each column can later become a graph and help the user visually analyze the information.

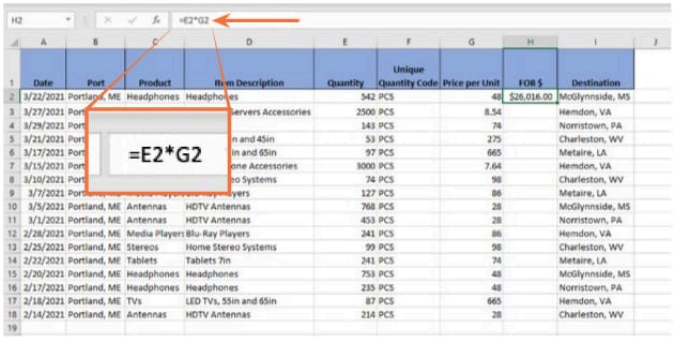
The data in column E and column G in Figure 9.3 are not linked to other columns; in other words, they do not contain formulas or functions but are raw quantities entered into the spreadsheet. Column H, however, is a quantity based on the data in columns E and G. The FOB $ is the number of products (column E) multiplied by the price per unit (column G). The formula is displayed at the top of the Excel worksheet in the Formula Bar, which is next to the "f_x" symbol. You can see in the Formula Bar in Figure 9.4 that the formula is "=E2*G2," yet the cell displays the result of the multiplication. The "*" is the mathematical symbol Excel uses for multiplication. This simple multiplication formula shows how Excel calculates numbers.



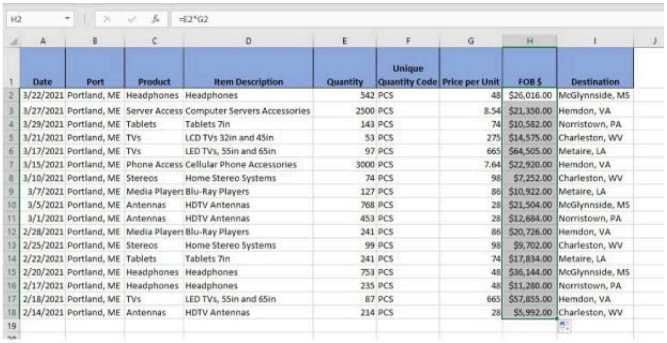
	A	B	C	D	E	F	G	H	I
1	Date	Port	Product	Item Description	Quantity	Unique Quantity Code	Price per Unit	FOB $	Destination
2	3/22/2021	Portland, ME	Headphones	Headphones	542	PCS	48	$26,016.00	McGlynnside, MS
3	3/27/2021	Portland, ME	Server Access	Computer Servers Accessories	2500	PCS	8.54	$21,350.00	Hemdon, VA

Figure 9.4: Clicking on a cell reveals the formula above the headers in the Formula Bar, while the result of the calculation shows in the cell. (Used with permission from Microsoft)

In order to apply this calculation to the rest of the data, you can repeat the formula in other cells in the same column. In Figure 9.5a, all data has been removed from column H, except for the first cell, which contains our formula "=E2*G2." The easiest way to repeat the formula is to use AutoFill. Place the cursor on the lower-right corner of the cell, until the cursor changes to a black cross. Then, click and drag the cross to the end of your column of data, which copies the formula into each cell. Figure 9.5b shows the result of dragging the formula from H2 to H18. AutoFill is also a useful feature for repeating text. The text could be a static value, such as when you enter multiple orders that contain the same item, or a time value, such as months of the year or days of the week. You can simply type in "January" and then use AutoFill to drag across or down to fill in the rest of the months. This method works for dates, days of the week, other text such as Quarter 1 and Quarter 2, and nearly any pattern of numbers (i.e., odd numbers or counting by 5). When using AutoFill for a pattern of numbers or text you want to repeat, you need to select enough of the pattern so that Excel can recognize the repetition. For example, if you want to generate a list of numbers counting up by 5, you will need to select at least the cells that contain 5 and 10 so that Excel understands you want to increase the value in each row in the AutoFill by 5.



(a)



(b)

Figure 9.5: The AutoFill feature is useful to get the results without retyping or copying and pasting the formula. (a) Column H is empty, except for the first cell, which contains the formula, as seen in the Formula Bar. Clicking and dragging the formula to the end of the column automatically applies the same formula to subsequent rows. (b) By dragging the formula down the column using the AutoFill feature (small black cross sign in the lower-right corner of a cell), the values are calculated for each row. (Used with permission from Microsoft)

Mac Tip

On a Mac, you can simply double-click on the cross, and the formula will copy down the column to the last row that contains data.

The Ribbon

As you recall from Essentials of Software Applications for Business, Excel's interface includes a ribbon of commands, grouped into categories that are similar across Microsoft Office programs. The Home tab for Excel (Figure 9.6a) has commands such as conditional formatting and inserting/deleting columns or cells. The Insert tab (Figure 9.6b) includes inserting a chart or equation, which is not included on the Insert tab of other programs such as Microsoft Word. The Formulas (Figure 9.6c) and Data (Figure 9.6d) tabs are specific to Excel. These tabs include commands for analyzing data in various ways.

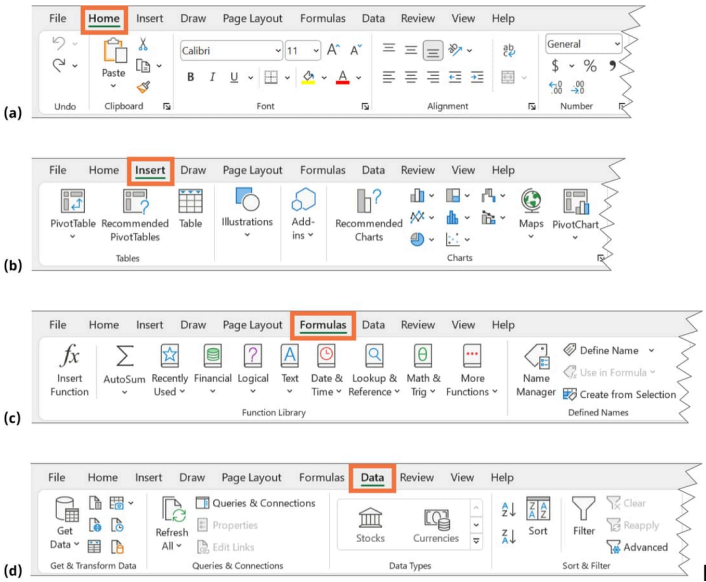


Figure 9.6: The Excel interface uses a ribbon to organize commands into tabs, which include (a) the Home tab and (b) the Insert tab, which are similar to other Office programs. The Excel ribbon also includes tabs specific to Excel, including (c) the Formulas tab, and (d) the Data tab. (Used with permission from Microsoft)

Creating Worksheets and Navigating Existing Files

Now that you understand how to navigate a worksheet, let's see how to apply this skill. Suppose you need to build sales figures of different retail store locations. Each location will have its own worksheet, and then you'll add one more sheet to total the sales figures and make a comparison using a table. Figure 9.7a gives the data for location X. You will need to use the copy-and-paste method to use this table to make the table for location Y. In the copy-and-paste method, copy text or objects by typing Ctrl+C (or right-click to Copy or use the Clipboard command group on the Home tab), and then typing Ctrl+V to paste the text or object in the new area. To use this procedure in this workbook, follow these steps:

1. Highlight the table, as shown in Figure 9.7a.
2. Press Ctrl+C to copy the table.
3. Create a new sheet by clicking on the circled plus sign at the bottom of the worksheet.
4. Click on cell A1.
5. Press Ctrl+V to paste the table into your new sheet.

This process copies the table exactly, so you will need to change the data so that it reflects the sales figures of location Y using the sales figures received from the finance department.

Mac Tip

Macs use a Command key, whereas PCs use a Ctrl (control) key. These keyboard shortcuts on a Mac are Command+C to copy and Command+V to paste. Mac also uses Ctrl+click to bring up the right-click menu Windows uses.

Data that you provide or that is provided to you is often raw data, and designing a worksheet or even a workbook helps to organize it. Replace the data from location X with the data from location Y and change the location, as shown in Figure 9.7b. Using the copy-and-paste procedure saves time when dealing with the same or similar scenarios because it eliminates the need to create a new table from scratch. Note, however, that this process works with cells that contain numbers and not formulas; copying and pasting tables with formulas requires additional work after the initial copy and paste to retain the correct formulas and cell references.

	A	B	C	D
1	Model	Inches	Price	Units Sold
2	E-900s	32	$ 170.00	8752
3	E-900m	42	$ 380.00	10563
4	E-900l	55	$ 550.00	9543
5	E-900xl	65	$ 780.00	4326
6				
7	Location	X		

(a)

	A	B	C	D
1	Model	Inches	Price	Units Sold
2	E-900s	32	$ 170.00	6576
3	E-900m	42	$ 380.00	8757
4	E-900l	55	$ 550.00	5643
5	E-900xl	65	$ 780.00	2867
6				
7	Location	Y		

(b)

Figure 9.7: The copy-and-paste process makes it easy to create multiple tables that are similar to each other. Start with a formatted data table for location X. (a) Highlight (select) the table and copy it. Notice the dotted line around the selection to show that it has been copied. (b) Paste the table in a new worksheet and update it with the data for location Y. (Used with permission from Microsoft)

Now, replicate the steps for location Z: copy and paste the table, and then retype the real data. Next, focus on creating the final sheet that displays the totals. In the workbook, this would be “Sheet 4.” Because the summary table needs to be a similar structure to the other tables, you can copy and paste the same table here, but you will need to modify Column D so that it adds up the units sold in each location. However, the summary table will need to use the data from Sheets 1, 2, and 3.

To calculate the totals, you need an addition formula. Follow the same process used previously to insert a formula. First, in cell D2, type “=,” which tells Excel that a formula or a function is being entered. Next, click on the tab for Sheet 1 and then on cell D2 in that sheet (Figure 9.8a). Then, type the operator (in this case +), and then repeat the process for the appropriate cells in Sheets 2 and 3. When finished, press Enter, and Excel will display the total in the cell. Notice in the syntax that Excel has inserted “Sheet1!” before the cell designation in the first part of the formula. This tells Excel that it needs to use the contents of cell D2 in Sheet 1 for that portion of the calculation. The next element is “Sheet2!D2,” which is cell D2 in Sheet 2.

D2 =Sheet1!D2

	A	B	C	D	E
1	Model	Inches	Price	Units Sold	
2	E-900s	32	$ 170.00	8752	
3	E-900m	42	$ 380.00	10563	
4	E-900l	55	$ 550.00	9543	
5	E-900xl	65	$ 780.00	4326	
6					
7	Location	X			
8					

(a)

J2

	A	B	C	D
1	Model	Inches	Price	Units Sold
2	E-900s	32	$ 170.00	25186
3	E-900m	42	$ 380.00	30562
4	E-900l	55	$ 550.00	25719
5	E-900xl	65	$ 780.00	12661
6				
7	All three locations			
8				

(b)

Figure 9.8: Excel allows formulas to reference data appearing on any worksheet in the workbook. To create a total of the number of units sold at each location, begin the equation with an equals sign. (a) Then, click on the relevant cell in the first worksheet. Insert the mathematical operator and click on another cell you want in the formula. The formula shows the references to other worksheets. AutoFill can complete the table with formulas that reference the relevant cells. (b) The completed table uses data from other worksheets. (Used with permission from Microsoft)

Now that the formula is in place for cell D2, use the AutoFill feature to apply the formula to subsequent rows. Highlight cell D2, click on the cross, and drag it to the bottom of the table. If you then click on cell D3, for example, you will see that the formula has been repeated but references cells D3 in the other sheets. Figure 9.8b shows the completed table.

This summary table can be very useful. In addition to providing a straightforward list of the totals, you could create graphs using this data and have a visual representation of sales trends. This is a simple scenario assumption; in the real-world sales totals, you would have much more than just five TV models. Imagine adding all the unit and dollar sale figures of three Best Buy locations in a given city; there would be hundreds of different products. You will learn increased complexity that will help in analyzing real-world problems such as this as your knowledge of Excel grows. The sorting and filtering feature is covered in Data Tables and Ranges, where you will learn how to set up a condition and a criterion to hide or show values for analysis.

Printing Worksheets

Excel offers two options for printing: either printing each worksheet separately or printing the whole workbook. To do either, first go to the File tab, and then click on Print (Figure 9.9). The default is to print only the currently opened worksheet, so we'll do that first. Choose the number of copies you want for this page, then choose the correct printer. There are other options for printing, include changing the size of the paper, changing vertical or horizontal orientation of the paper, adjusting the margins, and regulating the scaling (i.e., zooming in or not while printing). Once you have chosen your settings, click on the Print icon, and Sheet 1 will come out of the printer. Different printers might have different options for you to choose from.

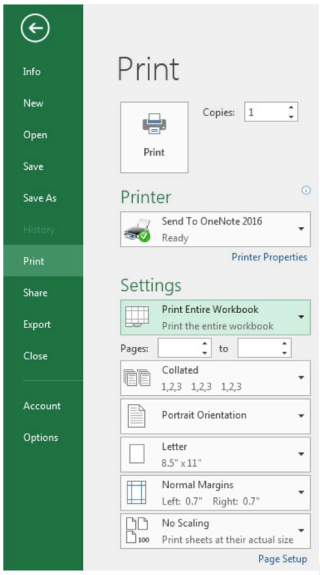


Figure 9.9: The options for printing are on the File tab. Click on Print. To print only a worksheet, leave the default selection of Print Active Sheets and make any necessary changes to the options. To print the whole workbook, select Print Entire Workbook from the first menu in the Settings. On a Mac, the steps are the same, but the appearance will differ slightly. (Used with permission from Microsoft)

It is important to note that, when constructing spreadsheets, what you see on the computer screen is rarely how it looks when you actually print the workbook. When you have large spreadsheets with multiple rows or columns, they may not always fit within the bounds of the printed page. When you print the document, the result could be columns of data split oddly across several pages. Be sure to preview the printed version prior to printing. When you select Print, you will see the print preview on the right of the screen. Double-check that the columns and rows are displayed in the way you would like them to print. If not, you can change the margins of the worksheet or insert a page break as appropriate to print a final, professional workbook. More will be covered about formatting the worksheets and workbook in Formatting and Templates in Excel.

Mac Tip

You can get to the Print menu with Command+P, but you can also use the File tab at the top of the window. There is a separate menu in the File menu to set your print area, and you can select which worksheets to print from the Print menu.

If you want to print all the sheets in the workbook, select Print Entire Workbook from the drop-down menu under Settings (Figure 9.9). Then, click on the Print icon, and this time all the worksheets will be printed (including any blank worksheets that are in the workbook), instead of individual worksheets.

Real-World Application - Using Excel for Personal Finance

Excel is a powerful tool for business; however, it can also be a very useful tool for managing personal finances. You can set up Excel to manage all your personal finances, link bank accounts and other financial documents, help with managing documentation for income taxes, and perform many other personal finance tasks. Excel has all the features needed to set up a budget and manage personal and projected income, track expenditures, and analyze investments and other personal revenue trends. You will want to organize your financial information into separate functional worksheets within your budget workbook to ensure you keep your finances organized from the start. For instance, consider keeping separate worksheets to record income, expenditures, savings, and investments. You can start small as you grow in your comfort level in using Excel to record your financial transactions; for instance, you might want to start with a weekly or monthly expenditure sheet to track what you spend your money on, then move into savings and tracking interest accrued. This disciplined approach will ensure data is recorded in a timely manner, reducing the potential for missed information and errors, ultimately helping you maximize your dollars. What's more, there are a number of free templates available online and through Microsoft to help set up your budget workbook with little effort.

What software or other tools do you use now to help you track your budget? Do a Google or template search in Excel and identify a budget template you might adopt. Once you find one you like, set up your monthly budget.

REFERENCES

Chvosta. P. & Teran, J.: *Spreadsheet Software for Engineering: an Applied Guide*. NCSU. Libretexts. Link.

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4.7: Summary



4.1: Computer Software

Software is the means to take a user's data and process it to perform its intended action. Software translates what users want to do into a set of instructions that tell the hardware what to do.

A set of instructions is also called a **computer program**.

The software component can be broadly divided into two categories: system software and application software.

System software is a collection of computer programs that provide a software platform for other software programs. It also insulates the hardware's specifics from the applications and users as much as possible by managing the hardware and the networks. It consists of:

1. Operating System (a set of programs that coordinate hardware components and other programs and acts as an interface with application software and networks)
2. Utilities (includes software that is specific-purposed and focused on keeping the infrastructure healthy)

Application software is a computer program that delivers a specific activity for the users (i.e., create a document, draw a picture). It can be for either

1. a general-purpose (i.e., Microsoft Word, Google doc) or
2. for a particular purpose (i.e., weather forecast, CAD engineering)

It can be grouped in many categories, including:

- Killer app
- Productivity
- Enterprise
- Mobile

Using a **programming language**, a programmer writes a program (called the source code). Another software then processes the source code to convert the programming statements to a machine-readable form, the ones, and zeroes necessary to execute the CPU. This conversion process is often known as compiling, and the software is called the compiler.

Software can be open source or closed source. **Open-source software** is software that has the source code available for anyone to copy and use. **Closed-source software** doesn't show the source code.

Cloud computing can be loosely defined as the allocation of hardware and/or software under a service model (resources are assigned and consumed as needed).

The main types of cloud services are:

- **Infrastructure as a service (IaaS)**
  - Provides on-demand access to virtual and physical servers, storage, networking, and other IT infrastructure.
- **Platform as a service (PaaS)**
  - Allows users to create and deploy applications.
- **Software as a service (SaaS)**
  - Provides subscribers with access to software running on a cloud infrastructure. SaaS providers manage the network, servers, storage, and other aspects of the software.

Virtualization is using software to create a virtual machine that simulates a computer with an operating system.

4.2: Operating Systems

The operating system provides several essential functions, including:

1. Managing the hardware resources of the computer
2. Providing the user-interface components
3. Providing a platform for software developers to write applications.

Nearly every computer program requires an operating system to function.

For personal computers, some of the most popular operating systems today are Microsoft's Windows, Apple's macOS, Google Chrome OS, and different versions of Linux.

For tablets and smartphones, some of the most popular operating systems are Android and iOS.

4.3: File systems

A **file** is a collection of related information that is stored on a storage instrument such as a disk or secondary/virtual storage.

A **File System** is a data structure that stores data and information on storage devices (hard drives, floppy disc, etc.), making them easily retrievable.

Data that can be directly accessed by the CPU with minimum or no delay and does not survive a power failure is held in **primary storage**.

Persistent memory that survives power failures most of the time, such as spinning disks, SSDs, and USB drives, is considered **secondary storage**.

File names have different considerations and they change depending on the Operating System. **File extension** is a suffix added to the end of a computer file string (separated by a period), and the main purpose is to identify the format of file and let the Operating System know which application will be used to open it.

A **file system directory tree** is a hierarchical structure that modern operating systems use to organize files and folders. The specific route taken through the branches to reach a file is called a **pathname**.

The Advantages of Maintaining Directories are: Efficiency, Naming and Grouping.

The basic File Systems operations are:

- Create/Delete
- Read/Write
- Open/Close

Most used File Systems

Windows	macOS	Linux	Android	iOS

FAT NTFS exFAT	HFS+ APFS	ext4 XFS JFS btrfs	exFAT FAT32 F2FS ext4	HFS+ APFS

4.4: Downloading Files

Download: You copy data from the Internet or from a portable storage device to your computer.

Upload: You copy data from your computer to the Internet or to a portable storage device.

4.5: File Management

File management refers to the systematic organization, storage, and control of digital information within an organization.

Best practices can help organizations establish a robust system that promotes productivity while ensuring data security and accessibility.

Microsoft Windows **File Explorer** is a graphical file management utility for the Windows operating system (OS). The equivalent tool in Mac OS is Apple Finder. The equivalent tools in Linux are (depends on the desktop environment): Nautilus, Dolphin, Thunar, Nemo, Caja.

File Explorer can be used following the instructions in order to perform the correspondent tasks.

Keyboard shortcuts are keys or combinations of keys that provide an alternative way to do something that you'd typically do with a mouse. The Windows shortcuts combine the Control (Ctrl), Alternate (Alt), Shift and Function keys with the alphabet letters.

4.6. Microsoft Excel Basics

Excel is a spreadsheet software application type that has rows and columns in a grid pattern.

A cell is the intersection of a row and a column, and it looks like a rectangle.

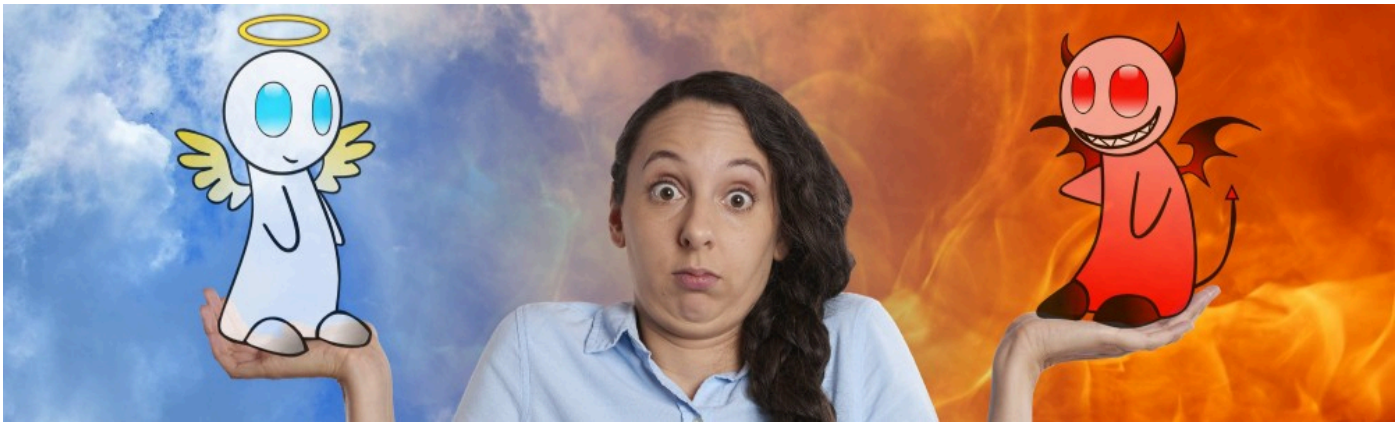
You can enter data into the cells to design tables and graphs and perform data analysis.

A workbook is a file that contains at least one worksheet, which is a tab within a workbook where you can input data and design tables and graphs that use the data.

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5: ISSUES IN COMPUTING



As computing and networking resources have become more and more an integral part of business, they have also become a target of criminals. Organizations must be vigilant with the way they protect their resources.

The same holds true for us personally: as digital devices become more and more intertwined with our lives, it becomes crucial for us to understand how to protect ourselves. Information systems have had an impact far beyond the world of business. New technologies create new situations that we have never dealt with before. How do we handle the new capabilities that these devices empower us with? What new laws are going to be needed to protect us from ourselves?

This chapter will kick off with a discussion of the impact of information systems on how we behave (ethics). This will be followed by the new legal structures being put in place, with a focus on intellectual property and privacy.

Objectives

Upon successful completion of this chapter, you will be able to:

- Describe what the term information systems ethics means;
- Explain what a code of ethics is and describe the advantages and disadvantages;
- Define the term intellectual property and explain the protections provided by copyright, patent, and trademark; and
- Describe the challenges that information technology brings to individual privacy.

5.1: Information Systems Security

5.2: The Ethical and Legal Implications of Information Systems

5.3: Windows Security

5.4: Summary

"The most confident critics are generally those who know the least about the matter critized."

— Ulysses S Grant, *PotUS 18*

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5.1: Information Systems Security



Contents

5.1.1. Authentication and Identification

5.1.2. Information Security Triad

5.1.3. Mobile Security

5.1.1. Authentication and Identification

Authentication

> **Authentication** is the process of verifying whether someone (or something) is, in fact, who (or what) it is declared to be.

According to the **National Institute of Standards and Technology** authentication is defined as “verifying the identity of a user, process, or device, often as a prerequisite to allowing access to resources in an information system".

Notice that this definition does not restrict authentication to human users. It includes processes or devices.

he ways in which someone may be authenticated fall into four categories, based on what is known as **the factors of authentication**:

Each **authentication factor** covers a range of elements used to authenticate or verify a person's identity prior to being granted access, approving a transaction request, signing a document or other work product, granting authority to others, and establishing a chain of authority.

Security research has determined that for a positive authentication, elements from at least 2, and preferably all 3, of the main factors should be verified.

The four factors (classes) and some of the elements of each factor are:

- **Knowledge**: Something the user knows (e.g., a password, partial password, passphrase, personal identification number (PIN), challenge-response (the user must answer a question or pattern), security question).
- **Ownership or possession**: Something the user possesses (e.g., wrist band, ID card, security token, implanted device, cell phone with a built-in hardware token, software token, or cell phone holding a software token).
- **Inherence**: Something the user is or does [e.g., fingerprint, retinal pattern, DNA sequence (there are assorted definitions of what is sufficient), signature, face, voice, unique bio-electric signals, or other biometric identifiers].

- **Location**: Somewhere the user is (e.g. connection to a specific computing network or using a GPS signal to identify the location).

Multi-factor authentication

Multi-factor authentication is an electronic authentication method in which a computer user is granted access to a website or application only after successfully presenting two or more pieces of factors to an authentication mechanism:

- knowledge,
- possession, and
- inherence.

It protects the user from an unknown person trying to access their data such as personal ID details or financial assets.

Authentication takes place when someone tries to log into a computer resource (such as a network, device, or application).

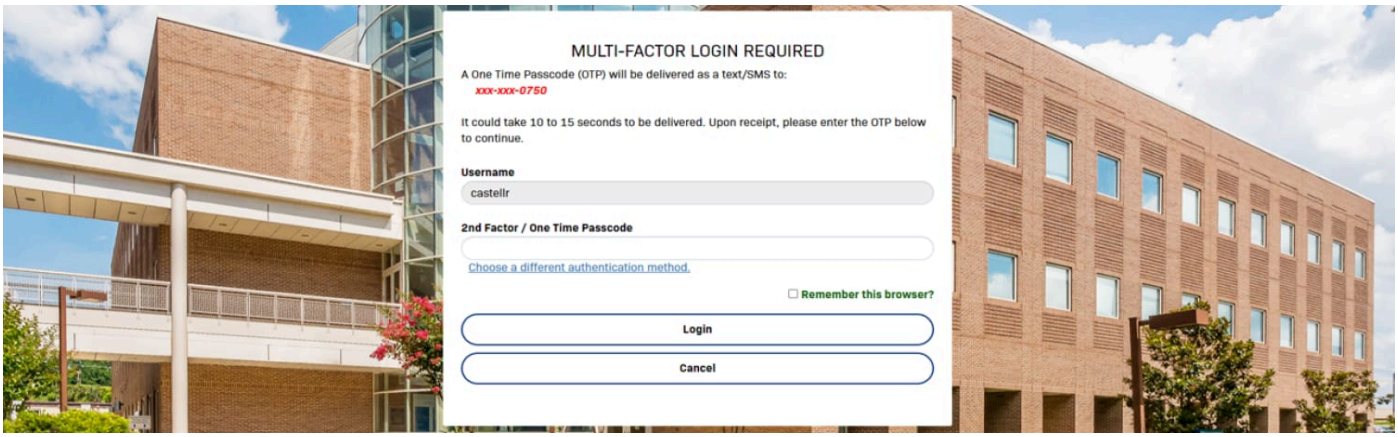
The resource requires the user to supply the identity by which the user is known to the resource, along with evidence of the authenticity of the user's claim to that identity.

Simple authentication requires only one such piece of evidence (factor), typically a password.

For additional security, the resource may require more than one factor—multi-factor authentication, or two-factor authentication in cases where exactly two pieces of evidence are to be supplied.

The use of multiple authentication factors to prove one's identity is based on the premise that an unauthorized actor is unlikely to be able to supply the factors required for access.

If in an authentication attempt, at least one of the components is missing or supplied incorrectly, the user's identity is not established with sufficient certainty and access to the asset (e.g., a building, or data) being protected by multi-factor authentication then remains blocked.



PGCC MFA screen. Image by Luis R Castellanos, Public Domain, Own work.

Mutual authentication

Mutual authentication or **two-way authentication** (not to be confused with two-factor authentication) refers to two parties authenticating each other at the same time in an authentication protocol.

It was previously referred to as “mutual entity authentication,” as two or more entities verify the others' legality before any data or information is transmitted.

Mutual authentication is a desired characteristic in verification schemes that transmit sensitive data, in order to ensure data

security.

Mutual authentication is found in two types of schemes: username-password-based schemes and certificate-based schemes, and these schemes are often employed in the Internet of Things (IoT).

Writing effective security schemes in IoT systems can become challenging, especially when needing schemes to be lightweight and have low computational costs.

Mutual authentication is a crucial security step that can defend against many adversarial attacks, which otherwise can have large consequences if IoT systems (such as e-Healthcare servers) are hacked.

In scheme analyses done of past works, a lack of mutual authentication had been considered a weakness in data transmission schemes.

Password

> A **password**, sometimes called a passcode, is a memorized secret, typically a string of characters, usually used to confirm a user's identity.

According to NIST:

> "The secret is memorized by a party called the claimant while the party verifying the identity of the claimant is called the verifier. When the claimant successfully demonstrates knowledge of the password to the verifier through an established authentication protocol, the verifier is able to infer the claimant's identity".

In general, a password is an arbitrary string of characters including letters, digits, or other symbols.

If the permissible characters are constrained to be numeric, the corresponding secret is sometimes called a personal identification number (PIN).

Despite its name, a password does not need to be an actual word; indeed, a non-word (in the dictionary sense) may be harder to guess, which is a desirable property of passwords.

A memorized secret consisting of a sequence of words or other text separated by spaces is sometimes called a **passphrase**. A passphrase is like a password in usage, but the former is generally longer for added security.

Choosing a secure and memorable password

The easier a password is for the owner to remember generally means it will be easier for an attacker to guess. However, passwords that are difficult to remember may also reduce the security of a system because

1. users might need to write down or electronically store the password,
2. users will need frequent password resets
3. users are more likely to re-use the same password across different accounts.

Similarly, the more stringent the password requirements, such as "have a mix of uppercase and lowercase letters and digits" or "change it monthly", the greater the degree to which users will subvert the system.

Others argue longer passwords provide more security (e.g., entropy) than shorter passwords with a wide variety of characters.

J Yan et al (and others) found that passwords based on thinking of a phrase and taking the first letter of each word are just as memorable as naively selected passwords, and just as hard to crack as randomly generated passwords.



Password generated by a passphrase. Image by Luis R Castellanos, Public Domain, Own work.

Combining two or more unrelated words and altering some of the letters to special characters or numbers is another good method, but a single dictionary word is not.

Having a personally designed algorithm for generating obscure passwords is another good method.

> **Leet**, or leetspeak, is a method of typing words using alternate characters. (P.e. apple --> @pp13)
>
> Techterms

In 2013, Google released a list of the most common password types, all of which are considered insecure because they are too easy to guess (especially after researching an individual on social media):

- The name of a pet, child, family member, or significant other
- Anniversary dates and birthdays
- Birthplace
- Name of a favorite holiday
- Something related to a favorite sports team
- The word "password"

> Top 200 Most Common Passwords, according to Nordpass

Strong Password

A strong password is hard to detect both by humans and by the computer.

Two things make a password stronger:

1. a larger number of characters (and the more characters, the stronger the password),
2. mixing numeric digits, upper and lower case letters, and special characters ($, #, etc.).

Passwords are typically case-sensitive, so a strong password contains letters in both uppercase and lowercase.

A strong password is not a word that can be found in a dictionary or the name of a person, character, product, or organization, significantly different from your previous passwords, and easy for you to remember but difficult for others to guess.

Consider using a memorable phrase like "6MonkeysRLooking^".

Limits on the # of password guesses

An alternative to limiting the rate at which an attacker can make guesses on a password is to limit the total number of guesses that can be made.

Password can be disabled, requiring a reset, after a small number of consecutive bad guesses (let's say 3 or 5); and the user may be required to change the password after a larger cumulative number of bad guesses (let´s say 30).

Attackers may conversely use knowledge of this mitigation to implement a **denial of service** attack against the user by intentionally locking the user out of their own device.

This **denial of service** may open other avenues for the attacker to manipulate the situation to their advantage via social engineering.

Brute force

A brute force attack is a hacking method that uses trial and error to crack passwords, login credentials, and encryption keys.

It is a simple yet reliable tactic for gaining unauthorized access to individual accounts and organizations' systems and networks.

The hacker tries multiple usernames and passwords, often using a computer to test a wide range of combinations, until they find the correct login information.

> Time it takes a hacker to brute force your password, according to Hive Systems

Identification

Identification is basically the process of someone claiming to be a specific person. They can identify themselves as "Pat", show an id card of some type of card with a name on it, or have an email address showing their name.

In the current context of online transactions, users "identify" themselves by providing a name, an email address, or phone number to a web request.

For example, using a process of identification alone, as long as a buyer has the card's proper information that is associated with the card being used, the user is pretty much accepted as is.

A business that allows identification by itself is essentially saying, "We have no reason to doubt that you are indeed the person you claim to be", despite having not independently verified if the information is truthful.

It's like asking, "Who are you?" and simply accepting whatever answer is given.

For transactions where there is not a lot at stake, like registering for a class or checking out a book, simply having someone declare their identity without providing any verification may be good enough.

It is becoming more and more frequent that identification alone is adequate. It's like having a username without a password.

So how can we determine the person is who they say they are? That's where verification comes in.

Verification

Verification goes beyond the basic question, "Who are you?"

Identity verification goes the extra mile and asks, "Are you really who you say you are?" the response needs to provide, a high degree of confidence that, the answer is accurate.

The most accurate way to verify someone's identity is to request and validate more than one form of identification against the person standing in front of you, with at least one of them being a photo ID.

A driver's license, a valid passport, or military photo identification are some forms of identification.

Verifying someone's identity to a high degree of certainty takes effort.

At a time when service providers want to provide a "frictionless" onboarding process, some may cut corners and require a low barrier to entry.

Typical social media accounts, for example, only ask new users to provide a name, email address, username, and password.

A phone number may be thrown in there for good measure.

Depending on the organization and the level of assurance needed, a university ID or other non-government issued identification card may suffice for one form of ID.

Identity verification in the electronic sense also called identity "**proofing**" or "**vetting**", is used to confirm an identity where the individual is not standing before you to show some sort of picture ID.

In these cases, most organizations require a real-time process that validates the personal information provided by the individual.

Apply for a bank account, though, and you may be expected to provide a social security number, photo ID or passport, and proof of your current address.

The stakes associated with a bank account are much greater than those with a TikTok account, therefore the verification requirements are more stringent.

In fact, in the financial sector alone, there are numerous regulatory acts to prevent fraudsters from setting up false bank accounts, laundering money, and other unseemly criminal activities.

The compliance mandates associated with these regulations are not satisfied by traditional verification methods, which is why businesses are beginning to make a shift to pairing a customer's identity information with one of their biometric markers at the point of onboarding.

> Verification in Bank of America, in order to open an account:
>
> To open a personal bank account at Bank of America, you need a Social Security number or ITIN, a valid U.S. residential address, an email address, a primary photo ID like a driver's license or passport, and funds for your opening deposit.

5.1.2. Information Security Triad

The Information Security Triad, also known as the CIA triad, is a guide for organizations. This guide helps them make policies to protect information security. In this context, the CIA means the following:

- **C**onfidentiality – set of rules that limit access to information
- **I**ntegrity – the assurance that the information is reliable and correct
- **A**vailability – a guarantee of reliable access to the information

Confidentiality

When protecting information, we want to be able to restrict access to those who are allowed to see it; everyone else should be disallowed from learning anything about its contents. This is the essence of confidentiality.

For example, federal law requires that universities restrict access to private student information. The university must be sure that

only those who are authorized have access to view the grade records.

Integrity

Integrity is the assurance that the information being accessed has not been altered and truly represents what is intended. Just as a person with integrity means what he or she says and can be trusted to consistently represent the truth, information integrity means information truly represents its intended meaning.

Information can lose its integrity through malicious intent, such as when someone who is not authorized makes a change to intentionally misrepresent something.

An example of this would be when a hacker is hired to go into the university's system and change a grade.

Integrity can also be lost unintentionally, such as when a computer power surge corrupts a file or someone authorized to make a change accidentally deletes a file or enters incorrect information.

Availability

Information availability is the third part of the CIA triad.

Availability means that information can be accessed and modified by anyone authorized to do so in an appropriate timeframe.

Depending on the type of information, an appropriate timeframe can mean different things.

For example, a stock trader needs information to be available immediately, while a salesperson may be happy to get sales numbers for the day in a report the next morning.

Companies such as Amazon.com will require their servers to be available twenty-four hours a day, seven days a week. Other companies may not suffer if their web servers are down for a few minutes once in a while.

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Tools for Information Security

In order to ensure the confidentiality, integrity, and availability of information, organizations can choose from a variety of tools. Each of these tools can be utilized as a part of an overall information-security policy.

- Access Control
- Encryption
- Backups
- Firewalls
- Intrusion Detection Systems
- Physical Security
- Security Policies

Access control

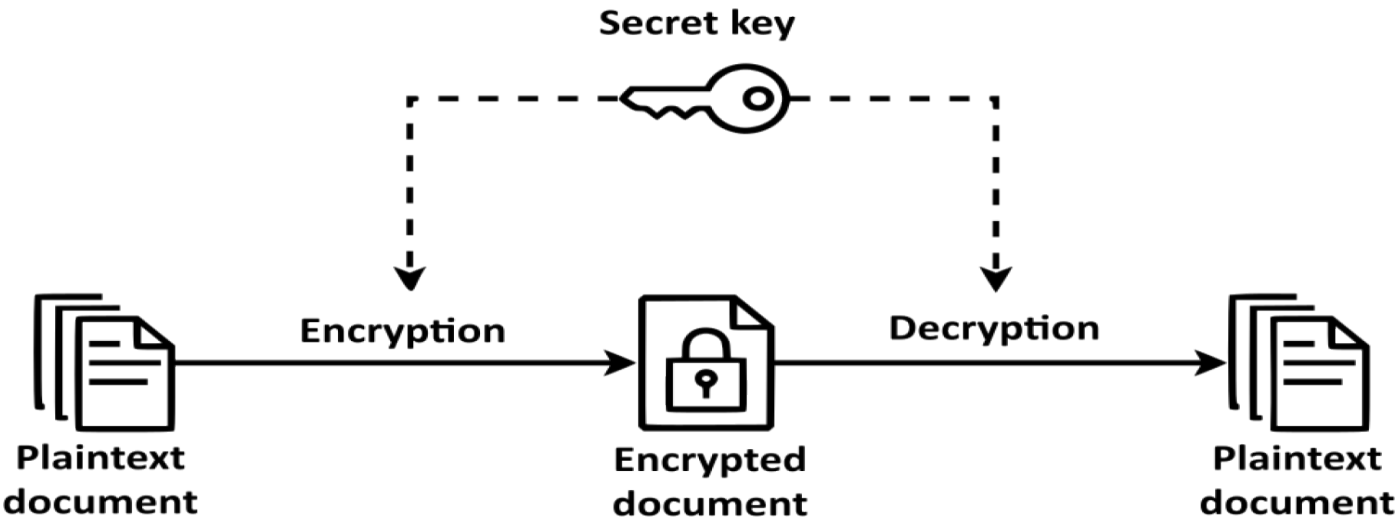
Access control determines which users are authorized to read, modify, add, and/or delete information.

- For each information resource that an organization wishes to manage, a list of users who have the ability to take specific actions can be created. This is an access control list or ACL.
- With RBAC (role based access control), instead of giving specific users access rights to an information resource, users are assigned to roles and then those roles are assigned access.

Encryption

Encryption is a process of encoding data upon its transmission or storage so that only authorized individuals can read it. This encoding is accomplished by a computer program, which encodes the plain text that needs to be transmitted; then the recipient receives the ciphertext and decodes it (decryption).

The sender and receiver need to agree on the method of encoding so that both parties can communicate properly.



Simple Encryption. Michel Bakni, CC BY-SA 4.0, Wikimedia Commons

Backups

Not only should the data on the corporate servers be backed up, but individual computers used throughout the organization should also be backed up.

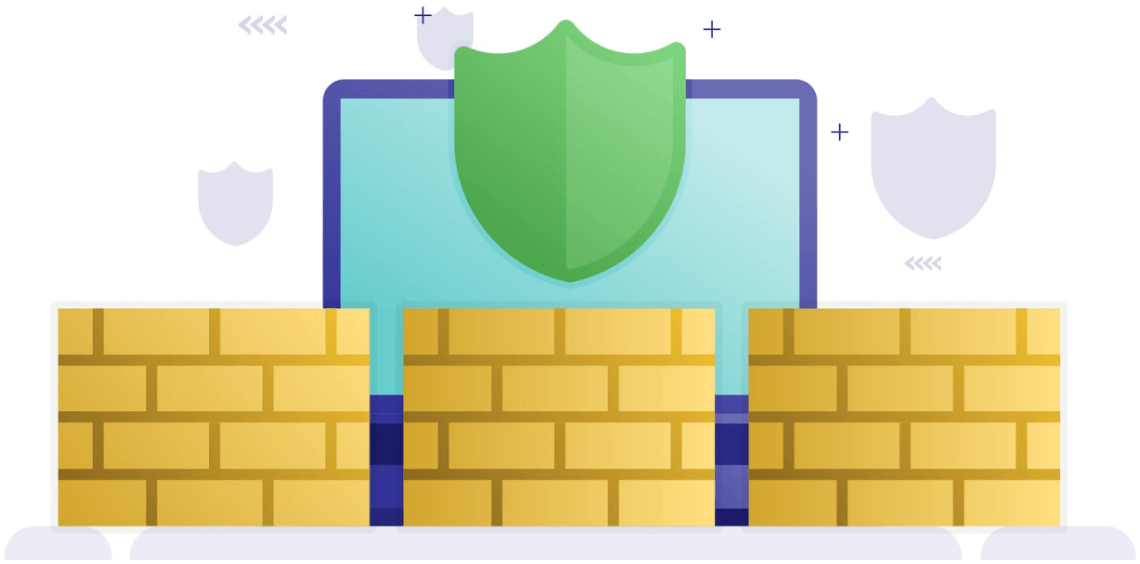
- An organization should make a full inventory of all of the information that needs to be backed up and determine the best way to back it up.
- Regular backups of all data
- Offsite storage of backup data sets
- Test of data restoration

Firewalls

A firewall can exist as hardware or software (or both).

A **hardware firewall** is a device that is connected to the network and filters the packets based on a set of rules. A **software firewall** runs on the operating system and intercepts packets as they arrive at a computer.

A firewall protects all company servers and computers by stopping packets from outside the organization's network that does not meet a strict set of criteria.



Firewall. Image by YuguDesign from Pixabay.

Intrusion Detection Systems (IDS)

- An IDS does not add any additional security; instead, it provides the functionality to identify if the network is being attacked.
- An IDS can be configured to watch for specific types of activities and then alert security personnel if that activity occurs.
- An IDS also can log various types of traffic on the network for analysis later.
- An IDS is an essential part of any good security setup.

Physical Security

Physical security is the protection of the actual hardware and networking components that store and transmit information resources.

To implement physical security, an organization must identify all of the vulnerable resources and take measures to ensure that these resources cannot be physically tampered with or stolen. These measures include the following:

- Locked doors
- Physical intrusion detection
- Secured equipment
- Environmental (temp) monitoring
- Employee training

Security Policies

According to the SANS Institute, a good policy is

> "a formal, brief, and high-level statement or plan that embraces an organization's general beliefs, goals, objectives, and acceptable procedures for a specified subject area."

Policies require compliance; failure to comply with a policy will result in disciplinary action. A policy does not lay out the specific technical details, instead it focuses on the desired results. A security policy should be based on the guiding principles of confidentiality, integrity, and availability.

Usability

When looking to secure information resources, organizations must balance the need for security with users' need to effectively access and use these resources. If a system's security measures make it difficult to use, then users will find ways around the security, which may make the system more vulnerable than it would have been without the security measures!

Take, for example, password policies. If the organization requires an extremely long password with several special characters, an employee may resort to writing it down and putting it in a drawer since it will be impossible to memorize.

Personal Information Security

Some measures that each of us, as individual users, can take to secure our computing technologies.

There is no way to have 100% security, but there are several simple steps we, as individuals, can take to make ourselves more secure.

- **Keep your software up to date**. Whenever a software vendor determines that a security flaw has been found in their software, they will release an update to the software that you can download to fix the problem. Turn on automatic updating on your computer to automate this process.
- **Install antivirus software and keep it up to date**. There are many good antivirus software packages on the market today, including free ones.

- **Back up your data**. Just as organizations need to back up their data, individuals need to as well. And the same rules apply: do it regularly and keep a copy of it in another location. One simple solution for this is to set up an account with an online backup service, such as Mozy or Carbonite, to automate your backups, or storage applications as Dropbox, OneDrive, Google Drive.
- **Be smart about your connections**. You should be aware of your surroundings. When connecting to a Wi-Fi network in a public place, be aware that you could be at risk of being spied on by others sharing that network. It is advisable not to access your financial or personal data while attached to a Wi-Fi hotspot. You should also be aware that connecting USB flash drives to your device could also put you at risk. Do not attach an unfamiliar flash drive to your device unless you can scan it first with your security software.
- **Secure your accounts with two-factor authentication**. Most e-mail and social media providers now have a two-factor authentication option. The way this works is simple: when you log in to your account from an unfamiliar computer for the first time, it sends you a text message with a code that you must enter to confirm that you are really you. This means that no one else can log in to your accounts without knowing your password and having your mobile phone with them.
- **Make your passwords long, strong, and unique**. For your personal passwords, you should follow the same rules that are recommended for organizations. Your passwords should be long (ten or more characters) and contain at least two of the following: upper-case letters, numbers, and special characters. You also should use different passwords for different accounts, so that if someone steals your password for one account, they still are locked out of your other accounts.
- **Be suspicious of strange links and attachments.** When you receive an e-mail, tweet, or Facebook post, be suspicious of any links or attachments included there. Do not click on the link directly if you are at all suspicious. Instead, if you want to access the website, find it yourself and navigate to it directly.

5.1.3. Mobile Security

As the use of mobile devices such as smartphones and tablets proliferates, organizations must be ready to address the unique security concerns that the use of these devices brings.

One of the first questions an organization must consider is whether to allow mobile devices in the workplace at all.

Many employees already have these devices, so the question becomes: Should we allow employees to bring their own devices and use them as part of their employment activities? Or should we provide the devices to our employees?

Creating a **BYOD** ("Bring Your Own Device") policy allows employees to integrate themselves more fully into their job and can bring higher employee satisfaction and productivity.

In many cases, it may be virtually impossible to prevent employees from having their own smartphones or iPads in the workplace.

If the organization provides the devices to its employees, it gains more control over use of the devices, but it also exposes itself to the possibility of an administrative (and costly) mess.

Mobile devices can pose many unique security challenges to an organization.

Probably one of the biggest concerns is the theft of intellectual property.

For an employee with malicious intent, it would be a very simple process to connect a mobile device either to a computer via the USB port, or wirelessly to the corporate network, and download confidential data.

It would also be easy to secretly take a high-quality picture using a built-in camera.

When an employee does have permission to access and save company data on his or her device, a different security threat emerges: that device now becomes a target for thieves. Theft of mobile devices (in this case, including laptops) is one of the primary methods that data thieves use.

So, what can be done to secure mobile devices? It will start with a good policy regarding their use.

According to a 2013 SANS study, organizations should consider developing a mobile device policy that addresses the following issues: use of the camera, use of voice recording, application purchases, encryption at rest, Wi-Fi auto-connect settings, Bluetooth settings, VPN use, password settings, lost or stolen device reporting, and backup.

Besides policies, there are several different tools that an organization can use to mitigate some of these risks.

For example, if a device is stolen or lost, geolocation software can help the organization find it.

In some cases, it may even make sense to install remote data-removal software, which will remove data from a device if it becomes a security risk.

> Google: Find your phone
>
> Apple: Find your device

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5.2: The Ethical and Legal Implications of Information Systems



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5.2.1. Information Systems Ethics

> The term **ethics** is defined as “a set of moral principles” or “the principles of conduct governing an individual or a group.”

Since the dawn of civilization, the study of ethics and its impact has fascinated mankind.

But what do ethics have to do with information systems?

The introduction of new technology can have a profound effect on human behavior. New technologies give us capabilities that we did not have before, which in turn create environments and situations that have not been specifically addressed in ethical terms.

Those who master new technologies gain new power; those who cannot or do not master them may lose power. In 1913, Henry Ford implemented the first moving assembly line to create his Model T cars. While this was a great step forward technologically (and economically), the assembly line reduced the value of human beings in the production process.

The development of the atomic bomb concentrated unimaginable power in the hands of one government, which then had to wrestle with the decision to use it. President Harry Truman made the decision in 1945, launching two bombs, in Hiroshima and in Nagasaki, Japan.

	Oth
	
Dolly was a female sheep and the first mammal that was **cloned** from an adult somatic cell (in Scotland, 1996) using the process of nuclear transfer from a cell taken from a mammary gland.	The **Human Genome Project** (HGP) DNA. It identified, mapped and sequ both a physical and a functional stan
Image by Toni Barros, CC BY-SA 2.0, from Wikimedia Commons	Image

Today's digital technologies have created new categories of ethical dilemmas.

For example, the ability to anonymously make perfect copies of digital music has tempted many music fans to download copyrighted music for their own use without making payment to the music's owner.

Many of those who would never have walked into a music store and stolen a CD find themselves with dozens of illegally downloaded albums.

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Many of those who would never have walked into a music store and stolen a CD find themselves with dozens of illegally downloaded albums.

Digital technologies have given us the ability to aggregate information from multiple sources to create profiles of people.

What would have taken weeks of work in the past can now be done in seconds, allowing private organizations and governments to know more about individuals than at any time in history.

This information has value but also chips away at the privacy of consumers and citizens.

> Do you want to read more?
>
> **Ethical Issues in Information Technology (IT)**
>
> Purdue Global

5.2.2. Code of Ethics

One method for navigating new ethical waters is a code of ethics.

> A **code of ethics** is a document that outlines a set of acceptable behaviors for a professional or social group; generally, it is agreed to by all members of the group.

The document details different actions that are considered appropriate and inappropriate.

A good example of a code of ethics is the Code of Ethics and Professional Conduct of the ACM, an organization of computing professionals that includes academics, researchers, and practitioners.

Here is a quote from the preamble:

> Commitment to ethical professional conduct is expected of every member (voting members, associate members, and student members) of the Association for Computing Machinery (ACM).

This Code, consisting of 24 imperatives formulated as statements of personal responsibility, identifies the elements of such a commitment. It contains many, but not all, issues professionals are likely to face. In the ACM's code, you will find many straightforward ethical instructions, such as the admonition to be honest and trustworthy.

But because this is also an organization of professionals that focuses on computing, there are more specific admonitions that relate directly to information technology:

> No one should enter or use another's computer system, software, or data files without permission. One must always have appropriate approval before using system resources, including communication ports, file space, other system peripherals, and computer time.
>
> Designing or implementing systems that deliberately or inadvertently demean individuals or groups is ethically unacceptable.
>
> Organizational leaders are responsible for ensuring that computer systems enhance, not degrade, the quality of working life.

> ACM Code of Ethics and Professional Conduct

You can also check PGCC's **Student Code of Conduct**.

Advantages

One of the major advantages of creating a code of ethics is that it clarifies the acceptable standards of behavior for a professional group.

The varied backgrounds and experiences of the members of a group lead to a variety of ideas regarding what is acceptable behavior.

While too many the guidelines may seem obvious, having these items detailed provides clarity and consistency.

Explicitly stating standards communicates the common guidelines to everyone in a clear manner.

Drawbacks

Having a code of ethics can also have some **drawbacks**.

First of all, a code of ethics does not have legal authority; in other words, breaking a code of ethics is not a crime in itself.

So, what happens if someone violates one of the guidelines? Many codes of ethics include a section that describes how such situations will be handled. In many cases, repeated violations of the code result in expulsion from the group.

In the case of ACM:

> "Adherence of professionals to a code of ethics is largely a voluntary matter. However, if a member does not follow this code by engaging in gross misconduct, membership in ACM may be terminated."

Expulsion from ACM may not have much of an impact on many individuals, since membership in ACM is usually not a requirement for employment. However, expulsion from other organizations, such as a state bar organization or medical board, could carry a huge impact.

Another possible disadvantage of a code of ethics is that there is always a chance that important issues will arise that are not specifically addressed in the code.

Technology is quickly changing, and a code of ethics might not be updated often enough to keep up with all of the changes.

A good code of ethics, however, is written in a broad enough fashion that it can address the ethical issues of potential changes to technology while the organization behind the code makes revisions.

Finally, a code of ethics could have also been a disadvantage in that it may not entirely reflect the ethics or morals of every member of the group.

Organizations with a diverse membership may have internal conflicts as to what is acceptable behavior. For example, there may be a difference of opinion on the consumption of alcoholic beverages at company events. In such cases, the organization must make a choice about the importance of addressing a specific behavior in the code.

Ethical Principles in Cybersecurity

They are the moral standards and practices that guide cybersecurity professionals:

1. **Confidentiality** (Part of the CIA triad)
2. **Privacy protections** (Safeguarding personal information from unauthorized use)
3. **Laws** (Rules recognized by a community and enforced by a governing entity).

Hackers

A **hacker** is a person who uses technical skill to gain unauthorized access to computer systems, or an expert programmer who deeply understands computer technology.

Merriam-Webster



Hacker. Image by Mohamed_hassan from Pixabay.

According to Mitnick Security, there are different types of hackers:

White Hat Hackers (Ethical Hackers)

White hat hackers operate on the side of defense. Whether they work as penetration testers, security consultants, or internal red teams, they use their expertise to find and patch system weaknesses.

Black Hat Hackers (Malicious Actors)

Black hats are the bad actors, motivated by monetary gain, disruption, or sabotage. They deploy malware, ransomware, credential theft, and other malicious tactics to exploit vulnerabilities, steal data, or damage systems. Their work often underpins cybercrime ecosystems.

Grey Hat Hackers

Occupying the gray area between hacker categories, grey hats may test systems without authorization, but without purely malicious intent. Sometimes they disclose vulnerabilities publicly, hoping to prompt a fix. Their actions may be controversial, but not definitively criminal in motive.

Hacktivists

Hacktivists leverage hacking to advance social or political causes, think cyber protests, data leaks, and digital disruption. Groups like Anonymous fit this category, balancing activism and cyber risk.

Script kiddies

Script kiddie is a derogative term that computer hackers coined to refer to immature, but often just as dangerous, exploiters of internet security weaknesses. They are typically motivated by simple, personal reasons -- to have fun, create chaos, seek attention or take revenge.

5.2.3. Acceptable Use Policy

Many organizations that provide technology services to a group of constituents or the public require agreement to an **acceptable use policy** (AUP) before those services can be accessed.

Similar to a code of ethics, this policy outlines what is allowed and what is not allowed while someone is using the organization's services.

An everyday example of this is the terms of service that must be agreed to before using the public Wi-Fi at Starbucks, McDonald's, or even a university.

Here is an example of an acceptable use policy from Virginia Tech:

> ...
>
> Acceptable use is always ethical, reflects academic honesty, and shows restraint in the consumption of shared resources. It demonstrates respect for intellectual property, ownership of data, system security mechanisms, and individuals' rights to privacy and to freedom from intimidation and harassment.
>
> ...

Virginia Tech

Just as with a code of ethics, these acceptable use policies specify what is allowed and what is not allowed.

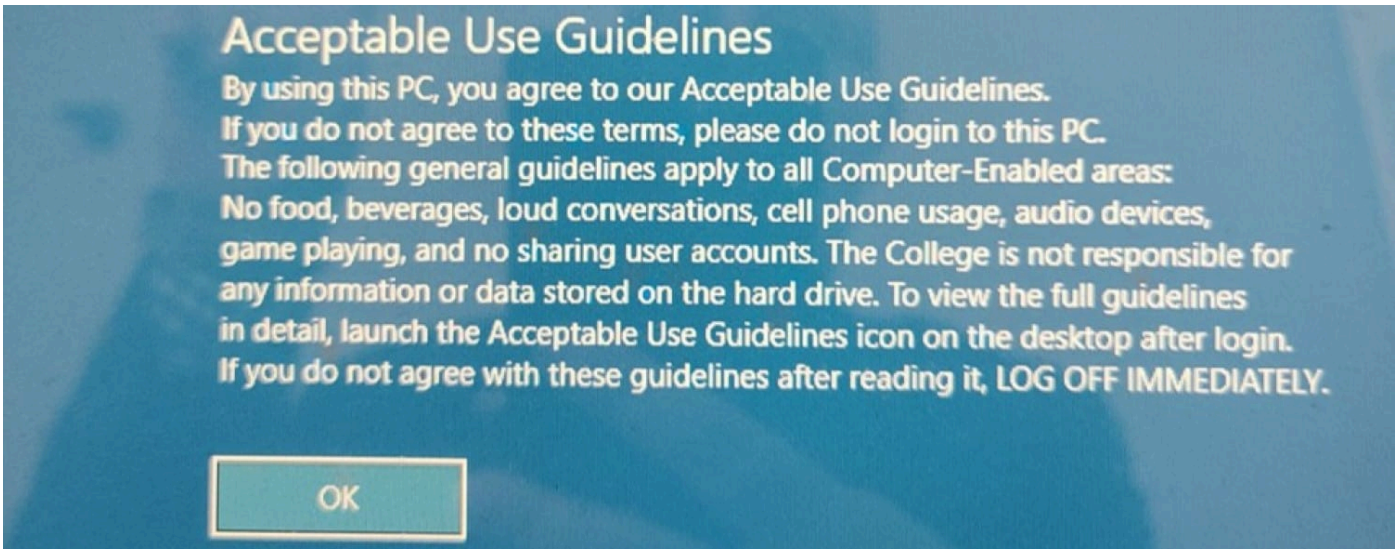
Again, while some of the items listed are obvious to most, others are not so obvious:

- "Borrowing" someone else's login ID and password is prohibited.
- Using the provided access for commercial purposes, such as hosting your own business website, is not allowed.
- Sending out unsolicited emails to a large group of people is prohibited.

Also, as with codes of ethics, violations of these policies have various consequences.

In most cases, such as with Wi-Fi, violating the acceptable use policy will mean that you will lose your access to the resource.

While losing access to Wi-Fi at Starbucks may not have a lasting impact, a university student getting banned from the university's Wi-Fi (or possibly all network resources) could have a large impact.



PGCC AUP. Screenshot by Luis R Castellanos, Public Domain, Own work.

5.2.4. Intellectual Property

One of the domains that have been deeply impacted by digital technologies is the domain of intellectual property. Digital technologies have driven a rise in new intellectual property claims and made it much more difficult to defend intellectual property.

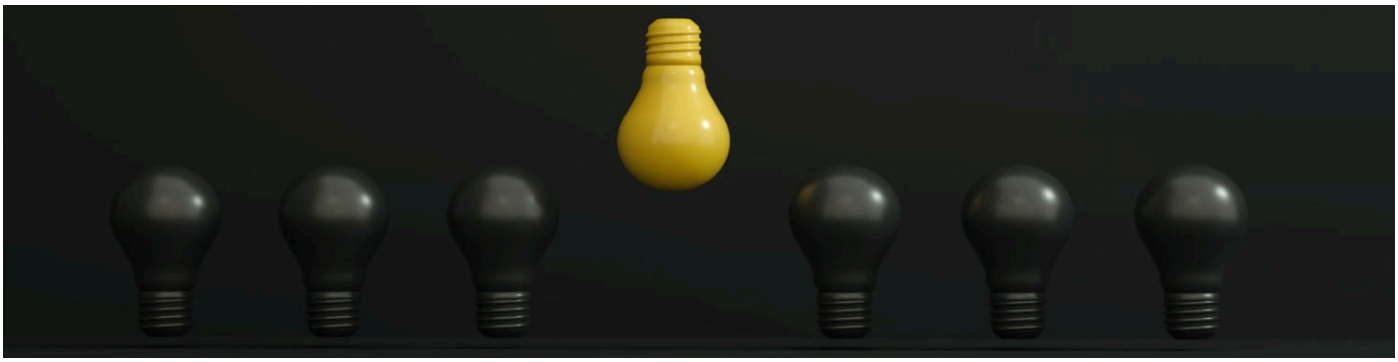
> **Intellectual property** is defined as "property (as an idea, invention, or process) that derives from the work of the mind or intellect."

This could include creations such as song lyrics, a computer program, a new type of toaster, or even a sculpture.

Practically speaking, it is very difficult to protect an idea. Instead, intellectual property laws are written to protect the tangible results of an idea. In other words, just coming up with a song in your head is not protected, but if you write it down it can be protected.

Protection of intellectual property is important because it gives people an incentive to be creative.

Innovators with great ideas will be more likely to pursue those ideas if they have a clear understanding of how they will benefit.



Intellectual property. Image by Crazy Motions from Pexels.

In the US Constitution, Article 8, Section 8, the authors saw fit to recognize the importance of protecting creative works:

> Congress shall have the power . . . To promote the Progress of Science and useful Arts, by securing for limited times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries.

An important point to note here is the "limited time" qualification.

While protecting intellectual property is important because of the incentives it provides, it is also necessary to limit the amount of benefit that can be received and allow the results of ideas to become part of the public domain.

> The **public domain** is the realm of creative works that are not protected by copyright and are free for anyone to use, reproduce, distribute, and create derivative works from, without permission or payment to a former copyright owner.

Outside of the US, intellectual property protections vary. You can find out more about a specific country's intellectual property laws by visiting the World Intellectual Property Organization.

5.2.5. Copyright

> **Copyright** is the protection given to songs, computer programs, books, and other creative works.

Any work that has an “author” can be copyrighted. Under the terms of copyright, the author of work controls what can be done with the work, including:

- Who can make copies of the work.
- Who can make derivative works from the original work.
- Who can perform the work publicly.
- Who can display the work publicly.
- Who can distribute the work.

Many times, work is not owned by an individual but is instead owned by a publisher with whom the original author has an agreement.

In return for the rights to the work, the publisher will market and distribute the work and then pay the original author a portion of the proceeds.

Copyright protection **lasts for the life of the original author plus seventy years**.

In the case of a copyrighted work owned by a publisher or another third party, the protection lasts for ninety-five years from the original creation date.

For works created before 1978, the protections vary slightly.

You can see the full details on copyright protections by reviewing the Copyright Basics document available at the US Copyright Office’s website.

Obtaining Copyright Protection

In the United States, copyright is obtained by the simple act of creating the original work.

In other words, when an author writes down that song, makes that film, or designs that program, he or she automatically has the copyright.

However, for a work that will be used commercially, it is advisable to register for a copyright with the US Copyright Office.

A registered copyright is needed in order to bring legal action against someone who has used a work without permission.

First Sale Doctrine

If an artist creates a painting and sells it to a collector who then, for whatever reason, proceeds to destroy it, does the original artist have any recourse?

What if the collector, instead of destroying it, begins making copies of it and sells them?

Is this allowed?

The first sale doctrine is a part of copyright law that addresses this, as shown.

The first sale doctrine, codified at 17 U.S.C. § 109, provides that an individual who knowingly purchases a copy of a copyrighted work from the copyright holder receives the right to sell, display or otherwise dispose of that particular copy, notwithstanding the interests of the copyright owner.

So, in our examples, the copyright owner has no recourse if the collector destroys the artwork. But the collector does not have the

right to make copies of the artwork.

Fair Use

Another important provision within copyright law is that of fair use.

Fair use is a limitation on copyright law that allows for the use of protected works without prior authorization in specific cases.

For example, if a teacher wanted to discuss a current event in his/her class, the teacher could pass out copies of a copyrighted news story to the students without first getting permission.

Fair use is also what allows a student to quote a small portion of a copyrighted work in a research paper.

The following four factors are considered when determining if something constitutes fair use:

- The purpose and character of the use, including whether such use is of commercial nature or is for nonprofit educational purposes;
- The nature of the copyrighted work;
- The amount and substantiality of the portion used in relation to the copyrighted work as a whole;
- The effect of the use upon the potential market for, or value of, the copyrighted work.

Copyleft

Copyleft is the practice of granting the right to freely distribute and modify intellectual property with the requirement that the same rights be preserved in derivative works created from that property.

Copyleft is an arrangement whereby software or artistic work may be used, modified, and distributed freely on condition that anything derived from it is bound by the same conditions.

Creative Common

A Creative Commons license is a public copyright license that enables the free distribution of an otherwise copyrighted "work".

A CC license is used when an author wants to give other people the right to share, use, and build upon a work that the author has created.

CC protects the people who use or redistribute an author's work from concerns of copyright infringement as long as they abide by the specified conditions.



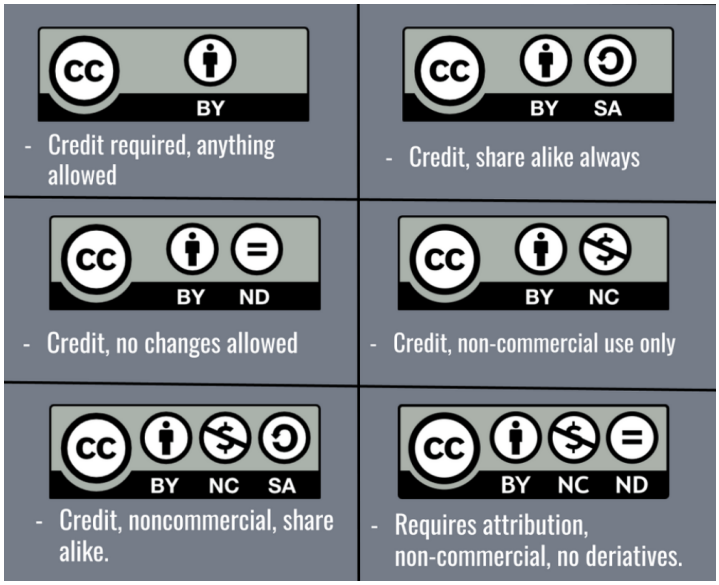
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5.2.6. Patents

Another important form of intellectual property protection is the patent. A patent creates protection for someone who invents a new product or process. The definition of invention is quite broad and covers many different fields. Here are some examples of items receiving patents:

• circuit designs in semiconductors; • prescription drug formulas; • firearms; • locks;	• plumbing; • engines; • coating processes; and • business methods.

Once a patent is granted, it provides the inventor with protection from others infringing on his or her patent.

A patent holder has the right to exclude others from making, using, offering for sale, or selling the invention throughout the US or importing the invention into the US for a limited time in exchange for public disclosure of the invention when the patent is granted.

As with copyright, patent protection lasts for a limited period of time before the invention or process enters the public domain.

In the US, a patent lasts twenty years. This is why generic drugs are available to replace brand-name drugs after twenty years.



Generic medicine. By Tima Miroshnichenko from Pexels

Business Method Patents

Most patents protect a physical object. However, a **business method patent** is a type of utility patent that protects a process such as one created in a software program. It has proved especially useful to online companies that use software for their business.

Protection through a business method patent, also known as an Internet patent, allows the owner to control rights to that business method during the life of the patent. This means that they can prevent other companies from using the process, or they can license the process to other companies for a fee.

There are five main requirements for patenting a business method.

1. The business method **must be patentable subject** matter rather than an abstract idea.
2. It also must meet the **usefulness requirement**, but this is a low threshold to meet.
3. The method only must **produce a concrete result**.
4. Show that the method is **novel** and
5. Show that it is **not obvious**.

A **novel business method** must be different from any previous method or invention, and it must not have been exposed to the public. A method is exposed to the public if it was used publicly or described in a publication before the application was filed.

A business method that is **non-obvious** must produce a result that is new or unexpected to someone in the relevant field. This is often determined by assessing whether someone in the field would have seen the new method as a natural evolution of previous methods.

> Two examples of patented business methods are: Hay Job evasluation method, and Six Sigma.

The Digital Millennium Copyright Act

As digital technologies have changed what it means to create, copy, and distribute media, a policy vacuum has been created. In 1998, the US Congress passed the Digital Millennium Copyright Act (DMCA), which extended copyright law to take into consideration digital technologies.

Two of the best-known provisions from the DMCA are the **anti-circumvention** provision and the "**safe harbor**" provision.

- The **anti-circumvention** provision makes it illegal to create technology to circumvent technology that has been put in place to protect a copyrighted work.
- The "**safe harbor**" provision limits the liability of online service providers when someone using their services commits copyright infringement. This is the provision that allows YouTube, for example, not to be held liable when someone posts a clip from a copyrighted movie.

5.2.7. Privacy

The term privacy has many definitions, but for our purposes, **privacy** will mean the ability to control information about oneself. Our ability to maintain our privacy has eroded substantially in the past decades, due to information systems.

Personally Identifiable Information

Information about a person that can be used to uniquely establish that person's identity is called personally identifiable information, or PII. This is a broad category that includes information such as:

• name; • social security number; • date of birth; • place of birth; • mother‘s maiden name;	• biometric records (fingerprint, face, etc.); • medical records; • educational records; • financial information; and • employment information.

Though recently, there has been used another category in the private information:

Personally Identifiable Information	Sensitive Personally Identifiable Information
Any information that can be used to identify an individual directly or indirectly, such as a name, email address, Social Security Number or IP address. • Email • Home Address • IP Address • Name • Phone Number • Any other that can uniquely identify	Any PII that if lost, stolen, or disclosed without authorization could result in significant harm to an individual. • Alien registration number • Biometric identifiers • Credit card number • Driver's license or state ID number • Financial account number • Passport number • Social Security number (SSN)

Just because companies are required to protect your information does not mean they are restricted from sharing it. In the US, companies can share your information without your explicit consent, though not all do so. Companies that collect PII and SPII are urged to create a privacy policy and post it on their website.

While the privacy laws in the US seek to balance consumer protection with promoting commerce, in the European Union privacy is considered a fundamental right that outweighs the interests of commerce.

Restrictions on Record Collecting

In the US, the government has strict guidelines on how much information can be collected about its citizens. Certain classes of information have been restricted by laws over time, and the advent of digital tools has made these restrictions more important than ever. Let's see some Privacy Laws in the US.

Children's Online Privacy Protection Act

Websites that are collecting information from children under the age of thirteen are required to comply with the Children's Online Privacy Protection Act (COPPA), which is enforced by the Federal Trade Commission (FTC).

To comply with COPPA, organizations must make a good-faith effort to determine the age of those accessing their websites and, if users are under thirteen years old, must obtain parental consent before collecting any information.

Children's Online Privacy Protection Rule (COPPA) Text of Rule

Family Educational Rights and Privacy Act

The Family Educational Rights and Privacy Act (FERPA) is a US law that protects the privacy of student education records.

In brief, this law specifies that parents have a right to their child's educational information until the child reaches either the age of eighteen or begins attending school beyond the high school level. At that point, control of the information is given to the child.

While this law is not specifically about the digital collection of information on the Internet, the educational institutions that are collecting student information are at a higher risk for disclosing it improperly because of digital technologies.

Family Educational Rights and Privacy Act (FERPA) Text of Rule

Health Insurance Portability and Accountability Act

Health Insurance Portability and Accountability Act (HIPAA) of 1996 is the law that specifically singles out records related to health care as a special class of personally identifiable information.

This law gives patients specific rights to control their medical records, requires health care providers and others who maintain this information to get specific permission in order to share it, and imposes penalties on the institutions that breach this trust.

Since much of this information is now shared via electronic medical records, the protection of those systems becomes paramount.

Health Insurance Portability and Accountability Act (HIPAA) Text of Rule

Non-Obvious Relationship Awareness

Digital technologies have given us many new capabilities that simplify and expedite the collection of personal information.

Non-Obvious Relationship Awareness (NORA) is a data analysis technology used to find hidden connections between people, places, and events across different databases, rather than a standalone legal statute.

It is a data-mining and entity-resolution process that combines separate pieces of information—like shared phone numbers, addresses, or transaction logs—to reveal relationships that are not immediately clear

Every time we come into contact with digital technologies, information about us is being made available. From our location to our web-surfing habits, our criminal record to our credit report, we are constantly being monitored. This information can then be aggregated to create profiles of each and every one of us.

While much of the information collected was available in the past, collecting it and combining it took time and effort. Today, detailed information about us is available for purchase from different companies. Even information not categorized as PII or SPII can be aggregated in such a way that an individual can be identified.

So, this process of collecting large quantities of a variety of information and then combining it to create profiles of individuals is known as Non-Obvious Relationship Awareness or NORA.

First commercialized by big casinos looking to find cheaters, NORA is used by both government agencies and private organizations, and it is big business. In some settings, NORA can bring many benefits, such as in law enforcement. By being able to identify potential criminals more quickly, crimes can be solved more quickly or even prevented before they happen. But these advantages come at a price: our privacy.







Children's Online Privacy Protection Act (COPPA) logo	US Department of Education logo	Health Insuran
By KeremMK6162, Public domain, from Wikimedia Commons	By U.S. Army Heraldry Directorate, Public domain, from Wikimedia Commons	By GOV, Public

Flock cameras

Flock Safety cameras—automated license plate readers (ALPRs) powered by AI—have sparked widespread debate among civil liberties groups, law enforcement agencies, and local governments. While marketed as crime-fighting tools to locate stolen vehicles or wanted suspects, critics argue that they create an invasive, warrantless mass surveillance network.

Read more in MalwareBytes portal

View this post on Instagram

A post shared by The Daily Signal (@thedailysignal)

Recommended TV Show

Person of Interest (2011 - 2016) is a science-fiction crime thriller television series about a reclusive billionaire who builds a mass-surveillance AI to stop violent crimes.

Cast: Jim Caviezel, Taraji P. Henson, Kevin Chapman, Michael Emerson, Amy Acker, Sarah Shahi.

YouTube Video

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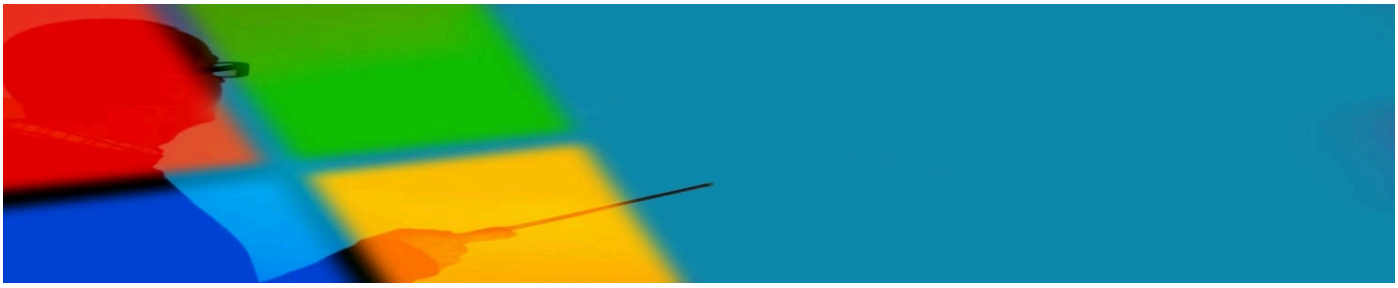
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5.3: Windows Security



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5.3.1. Computer viruses

A computer virus, much like a flu virus, is designed to spread from host to host and can replicate itself.

> **Computer virus** is a type of malicious code or program written to alter the way a computer operates and is designed to spread from one computer to another.

A virus operates by inserting or attaching itself to a legitimate program or document that supports macros in order to execute its code.

In the process, a virus has the potential to cause unexpected or damaging effects, such as harming the system software by corrupting or destroying data.

> The expression computer virus was coined by Fred Cohen (1986), because he said that a program that could infect other programs acted as a “virus”.

How does a computer virus attack?

Once a virus has successfully attached to a program, file, or document, the virus will lie dormant until circumstances cause the computer or device to execute its code.

For a virus to infect your computer, you must run the infected program, which in turn causes the virus code to be executed.

This means that a virus can remain dormant on your computer, without showing major signs or symptoms.

However, once the virus infects your computer, the virus can infect other computers on the same network.

Stealing passwords or data, logging keystrokes, corrupting files, spamming your email contacts, and even taking over your machine are just some of the devastating and irritating things a virus can do.

While some viruses can be playful in intent and effect, others can have profound and damaging effects. This includes erasing data or causing permanent damage to your hard disk. Worse yet, some viruses are designed with financial gains in mind.

How do computer viruses spread?

In a constantly connected world, you can contract a computer virus in many ways, some more obvious than others. Viruses can be spread through email and text message attachments, Internet file downloads, and social media scam links. Your mobile devices and smartphones can become infected with mobile viruses through shady App downloads. Viruses can hide disguised as attachments of socially shareable content such as funny images, greeting cards, or audio and video files.

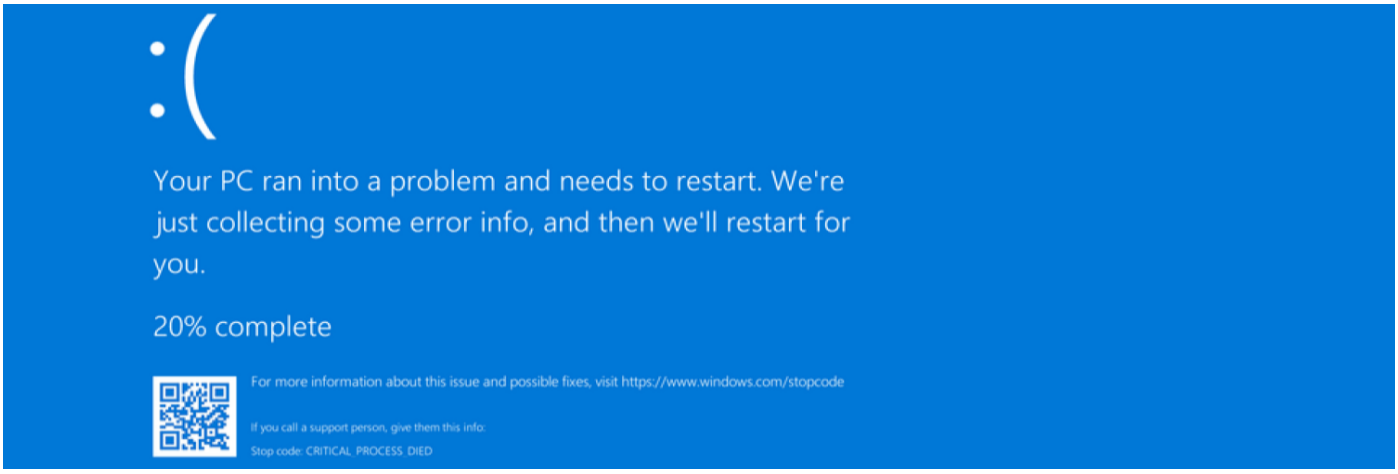
To avoid contact with a virus, it's important to exercise caution when surfing the web, downloading files, and opening links or attachments. To help stay safe, never download text or email attachments that you're not expecting, or files from websites you don't trust.

> Usually, the best defense is just **common sense**.

What are the signs of a computer virus?

A computer virus attack can produce a variety of symptoms. Here are some of them:

- **Frequent pop-up windows**. Pop-ups might encourage you to visit unusual sites. Or they might prod you to download antivirus or other software programs.
- **Changes to your homepage**. Your usual homepage may change to another website, for instance. Plus, you may be unable to reset it.
- **Mass emails being sent from your email account**. A criminal may take control of your account or send emails in your name from another infected computer.
- **Unusually slow computer performance**. A sudden change in processing speed could signal that your computer has a virus.
- **Unknown programs that startup when you turn on your computer**. You may become aware of the unfamiliar program when you start your computer. Or you might notice it by checking your computer's list of active applications.
- **Unusual activities like password changes**. This could prevent you from logging into your computer.
- **Frequent crashes**. A virus can inflict major damage on your hard drive. This may cause your device to freeze or crash. It may also prevent your device from coming back on.



"**Blue screen of death**". By MitrandirLK, Public Domain, from Wikimedia Commons.

5.3.2. Computer Malware

Malware is an abbreviated form of "**MAL**icious soft**WARE**."

This is software that is specifically designed to gain access to or damage a computer, usually without the knowledge of the owner.

There are various types of malware, including spyware, ransomware, viruses, worms, **Trojan horses**, adware, or any type of malicious code that infiltrates a computer.

Generally, the software is considered malware based on the intent of the creator rather than its actual features.

> **Trojan Horse** is based on "The Iliad", epic poem in 24 books traditionally attributed to the ancient Greek poet Homer, about the Trojan War.

Recommended movie

Troy (2004) is a epic historical action film directed by Wolfgang Petersen and written by David Benioff, loosely based[3] on Homer's Iliad.

Cast: Brad Pitt, Eric Bana, Orlando Bloom, Diane Kruger, Brian Cox, Sean Bean, Brendan Gleeson, Rose Byrne, Peter O'Toole.

YouTube Video

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Malware creation is on the rise due to money that can be made through organized Internet crime. Originally malware was created for experiments and pranks, but eventually, it was used for vandalism and destruction of targeted machines.

Today, much of malware is created to make a profit from forced advertising (adware), stealing sensitive information (spyware), spreading email spam or child pornography (zombie computers), or extorting money (ransomware).

Various factors can make computers more vulnerable to malware attacks, including defects in the operating system (OS) design, all the computers on a network running the same OS, giving users too many permissions, or just because a computer runs on a particular operating system, such as Windows, for example.

The best protection from malware — whether ransomware, bots, browser hijackers, or other malicious software — continues to be the usual, preventive advice: be careful about what email attachments you open, be cautious when surfing by staying away from suspicious websites, and install and maintain an updated, quality antivirus program.

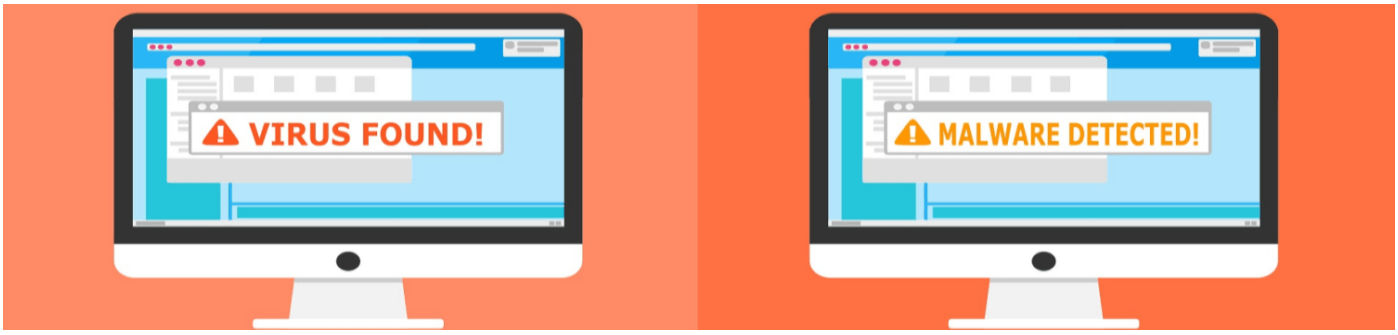
Some notorious malware are:

- The first computer virus, called "**Creeper**", was an experimental self-replicating virus released in **1971**. It was filling up the hard drive until a computer could not operate any further. This virus was created by BBN technologies in the US.
- The first computer virus for MS-DOS was "**Brain**" and was released in **1986**. It would overwrite the boot sector on the floppy disk and prevent the computer from booting. It was written by two brothers from Pakistan and was originally designed as a copy protection.
- "**The Morris**" was the first Computer virus which spread extensively in the wild in **1988**. It was written by Robert Morris, a graduate student from Cornell University who wanted to use it to determine the size of the internet. It infected around 15,000 computers in 15 hours.

Sentrian

Ranking of best antiviruses:

- Techradar
- PC Magazine
- CyberNews



Anti-malware. Image by 200degrees from Pixabay.

5.3.3. Vulnerabilities and attacks

A vulnerability is a system susceptibility or flaw.

Many vulnerabilities are documented in the Common Vulnerabilities and Exposures (CVE) database.

An exploitable vulnerability is one for which at least one working attack or “exploit” exists.

To secure a computer system, it is important to understand the attacks that can be made against it, and these threats can typically be classified into one of the following categories.

Backdoors

A backdoor in a computer system, a cryptosystem, or an algorithm, is any secret method of bypassing normal authentication or security controls.

They may exist for a number of reasons, including by original design or poor configuration.

They may have been added by an authorized party to allow some legitimate access, or by an attacker for malicious reasons; but

regardless of the motives for their existence, they create a vulnerability.

Denial-of-service attack

Denial of service attacks are designed to make a machine or network resource unavailable to its intended users.

Attackers can deny service to individual victims, such as by deliberately entering a wrong password enough consecutive times to cause the victim account to be locked, or they may overload the capabilities of a machine or network and block all users at once.

While a network attack from a single IP address can be blocked by adding a new firewall rule, many forms of Distributed denial of service (DDoS) attacks are possible, where the attack comes from a large number of points – and defending is much more difficult.

Such attacks can originate from the zombie computers of a botnet, but a range of other techniques are possible including reflection and amplification attacks, where innocent systems are fooled into sending traffic to the victim.

Direct-access attacks

An unauthorized user gaining physical access to a computer is most likely able to directly copy data from it.

They may also compromise security by making operating system modifications, installing software worms, keyloggers, covert listening devices, or using wireless mice.

Even when the system is protected by standard security measures, these may be able to be bypassed by booting another operating system or tool from a CD-ROM or other bootable media.

Disk encryption and Trusted Platform Module are designed to prevent these attacks.

Eavesdropping

It is the act of surreptitiously listening to a private conversation, typically between hosts on a network.

For instance, programs such as Carnivore and Narus Insight have been used by the FBI and NSA to eavesdrop on the systems of internet service providers.

Even machines that operate as a closed system can be eavesdropped upon via monitoring the faint electro-magnetic transmissions generated by the hardware.

Tampering

Tampering describes a malicious modification of products.

So-called “Evil Maid” attacks and security services planting surveillance capability into routers are examples.

An evil maid attack is an attack on an unattended device, in which an attacker with physical access alters it in some undetectable way so that they can later access the device, or the data on it.

The name refers to the scenario where a maid could subvert a device left unattended in a hotel room – but the concept itself also applies to situations such as a device being intercepted while in transit, or taken away temporarily by airport or law enforcement personnel.

Spoofing

Spoofing, in general, is a fraudulent or malicious practice in which communication is sent from an unknown source disguised as a source known to the receiver. Spoofing is most prevalent in communication mechanisms that lack a high level of security.

Spam

One of the most annoying emails to receive is junk email. This is also referred to as spam, unsolicited bulk email from cyber criminals or unethical companies. It comes in the form of images and videos.

Phishing

Phishing is a cyber-attack that uses disguised email as a weapon.

The goal is to trick the email recipient into believing that the message is something they want or need — a request from their bank, for instance, or a note from someone in their company — and to click a link or download an attachment.

What really distinguishes phishing is the form the message takes: the attackers masquerade as a trusted entity of some kind, often a real or plausibly real person, or a company the victim might do business with.

It's one of the oldest types of cyberattacks, dating back to the 1990s, and it's still one of the most widespread and pernicious, with phishing messages and techniques becoming increasingly sophisticated.

While there are several paid-for and free applications that protect against viruses and malware, Windows has built-in applications to monitor the health of your PC and protect it against hostile threats.

Spear phishing

Spear phishing targets a specific group or type of individual such as a company's system administrator.

Whaling

Is an even more targeted type of phishing that goes after the whales. Typically target a CEO, CFO, or any CXX within a specific business.

Smishing

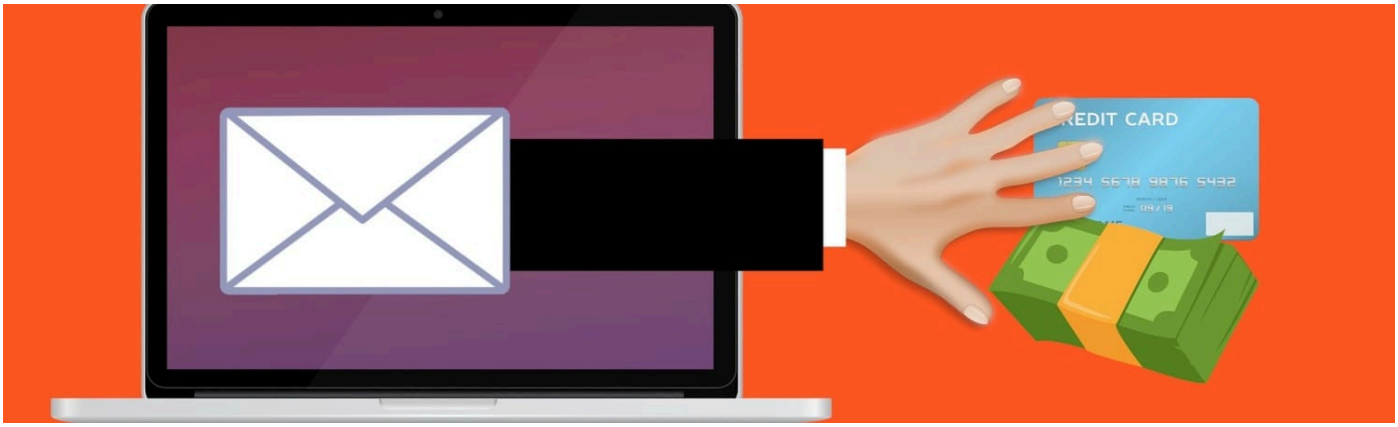
Is an attack that uses text messaging or short message service (SMS) to execute the attack.

Vishing

This attack is accomplished through a voice call. Hence the "v" rather than the "ph" in the name.

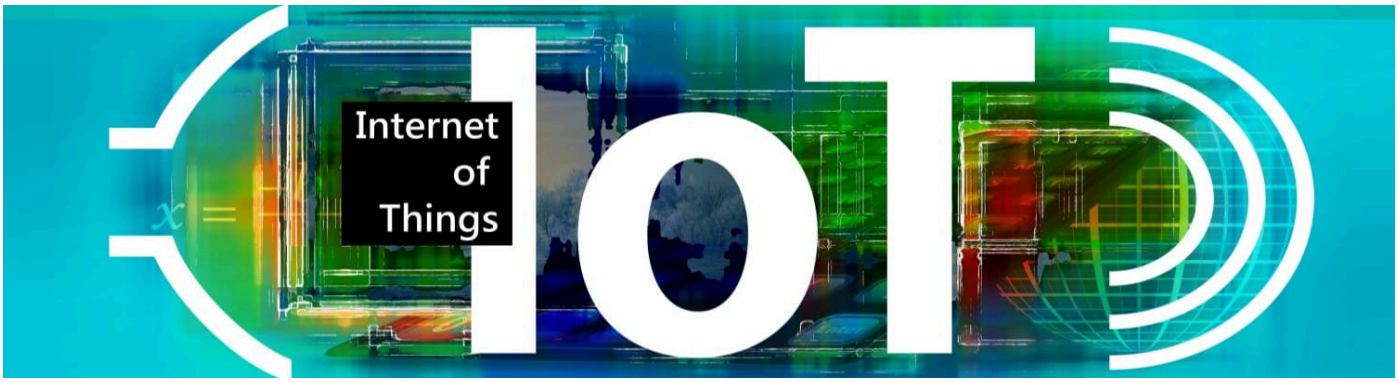
Quishing

Attackers use QR codes to redirect victims to malicious websites or prompt them to download harmful content.



Phishing. Image by Mohamed_Hassan from Pixabay.

5.3.4. Internet of Things



IoT. Image by Geralt from Pixabay.

The Internet of Things (IoT) is the network of physical objects such as devices, vehicles, and buildings that are embedded with electronics, software, sensors, and network connectivity that enables them to collect and exchange data – and concerns have been raised that this is being developed without appropriate consideration of the security challenges involved.

While the IoT creates opportunities for more direct integration of the physical world into computer-based systems, it also provides opportunities for misuse.

In particular, as the IoT spreads widely, cyber-attacks are likely to become an increasingly physical (rather than simply virtual) threat.

If a front door's lock is connected to the Internet and can be locked/unlocked from a phone, then a criminal could enter the home at the press of a button from a stolen or hacked phone.

People could stand to lose much more than their credit card numbers in a world controlled by IoT-enabled devices.

Thieves have also used electronic means to circumvent non-Internet-connected hotel door locks.

Medical devices have either been successfully attacked or had potentially deadly vulnerabilities demonstrated, including both in-hospital diagnostic equipment and implanted devices including pacemakers and insulin pumps.

YouTube Video

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5.4: Summary



5.1. Information Systems Security

Authentication is the process of verifying whether someone (or something) is, in fact, who (or what) it is declared to be.

The four factors (classes) and some of the elements of each factor are:

- **Knowledge**
- **Ownership or possession**
- **Inherence**
- **Location**

Simple authentication requires only one such piece of evidence (factor), typically a password.

Multi-factor authentication is an electronic authentication method in which a computer user is granted access to a website or application only after successfully presenting two or more pieces of factors to an authentication mechanism.

Mutual authentication refers to two parties authenticating each other at the same time in an authentication protocol.

A **password** is a memorized secret, typically a string of characters, usually used to confirm a user's identity.

Leet is a method of typing words using alternate characters.

Identification is basically the process of someone claiming to be a specific person.

The Information Security Triad consists in:

- **C**onfidentiality
- **I**ntegrity
- **A**vailability

In order to ensure the CIA of information, organizations can choose from a variety of tools:

- Access Control
- Encryption
- Backups
- Firewalls
- Intrusion Detection Systems
- Physical Security
- Security Policies

BYOD allows the employees or members of an organization to bring their own device to work or school.

5.2. The Ethical and Legal Implications of Information Systems

The term **ethics** is defined as “a set of moral principles” or “the principles of conduct governing an individual or a group.”

The introduction of new technology can have a profound effect on human behavior. New technologies give us capabilities that we did not have before, which in turn create environments and situations that have not been specifically addressed in ethical terms.

A **code of ethics** is a document that outlines a set of acceptable behaviors for a professional or social group; generally, it is agreed to by all members of the group. It has advantages and drawbacks.

A **hacker** is a person who uses technical skill to gain unauthorized access to computer systems, or an expert programmer who deeply understands computer technology.

There are different types of hackers, as: white hat hackers, gray hat hackers, black hat hackers, hacktivists, script kiddies, among others.

Many organizations that provide technology services to a group of constituents or the public require agreement to an **Acceptable Use Policy** (AUP) before those services can be accessed.

Intellectual property is defined as “property (as an idea, invention, or process) that derives from the work of the mind or intellect.”

Public domain is the realm of creative works that are not protected by copyright and are free for anyone to use, reproduce, distribute, and create derivative works from, without permission or payment to a former copyright owner.

Copyright is the protection given to songs, computer programs, books, and other creative works.

Business method patent is a type of utility patent that protects a process such as one created in a software program.

Personally Identifiable Information (PII) is any information that can be used to identify an individual directly or indirectly, such as a name, email address, Social Security Number or IP address.

Sensitive Personally Identifiable Information (SPII) is any PII that if lost, stolen, or disclosed without authorization could result in significant harm to an individual.

5.3. Windows Security

Computer virus is a type of malicious code or program written to alter the way a computer operates and is designed to spread from one computer to another.

For a virus to infect your computer, you must run the infected program, which in turn causes the virus code to be executed.

Some signs of a computer virus:

- Frequent pop-up windows
- Changes to your homepage
- Mass emails being sent from your email account
- Unusually slow computer performance
- Unknown programs that startup when you turn on your computer
- Unusual activities like password changes
- Frequent crashes

Malware is an abbreviated form of “**MAL**icious soft**WARE**.”

There are various types of malware, including spyware, ransomware, viruses, worms, **Trojan horses**, adware, or any type of malicious code that infiltrates a computer.

A vulnerability is a system susceptibility or flaw.

Some of the most common computer vulnerabilities are:

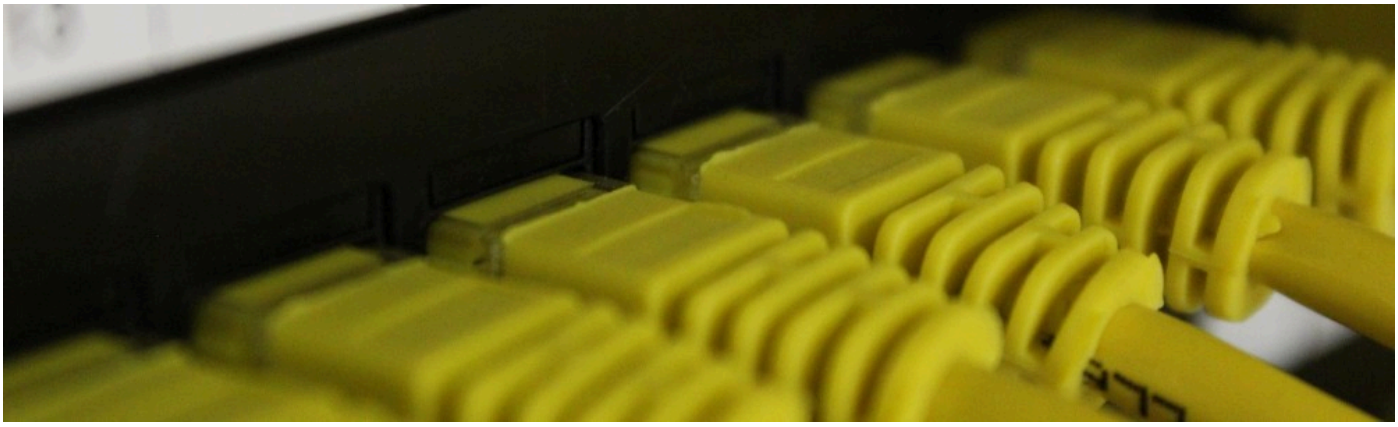
• Backdoors • Denial-of-service attack • Direct-access attacks • Eavesdropping	• Tampering • Spoofing • Spam • Phishing

The Internet of Things (IoT) is the network of physical objects such as devices, vehicles, and buildings that are embedded with electronics, software, sensors, and network connectivity that enables them to collect and exchange data – and concerns have been raised that this is being developed without appropriate consideration of the security challenges involved.

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6: NETWORKS AND COMMUNICATION



Today's computing and smart devices are expected to be always-connected devices to support the way we learn, communicate, do business, work, and play, in any place, on any devices, and at any time. In this chapter, we review the history of networking, how the Internet works, and the use of multiple networks in organizations today.

Learning Objectives

Upon successful completion of this chapter, you will be able to:

- Understand how multiple networks are used in everyday life.
- Define how topologies and devices are connected in a small to medium-sized business network.
- Understand the basic characteristics of a network that supports communication in a small to medium-sized business.
- Describe trends in networking that will affect the use of networks in small to medium-sized businesses.

6.1: Introduction to Networks and Communication

6.2: Network Basics

6.3: Providing Resources in a Network

6.4: Internet Connections

6.5: The Changing Network Environment Network Trends

6.6: Network Security

6.7: Summary

"In calm water, every ship has a good captain."

— Grover Cleveland, *PotUS 22 & 24*

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6.1: Introduction to Networks and Communication



Contents

6.1.1 Arpanet & Internet

6.1.2. WWW

6.1.3. Networks in our daily life

We are at a basic turning point with many **innovations to expand** and engage our **capacity to communicate**.

The **globalization of the Web** has succeeded faster than anybody has envisioned.

The way social, commercial, political, and individual **motivation** happens is quickly **changing** to keep up with the advancement of this worldwide network.

Within our improvement network, innovators will utilize the **Web as a beginning point** for their efforts, creating modern items and administrations particularly planned to require **advantage of the network capabilities**.

6.1.1 Arpanet & Internet

The story of the Internet and networking can be traced back to the late **1950s**.

The US was in the **Cold War**'s depths with the USSR, and each nation closely watched the other to determine which would gain a **military or intelligence advantage**.

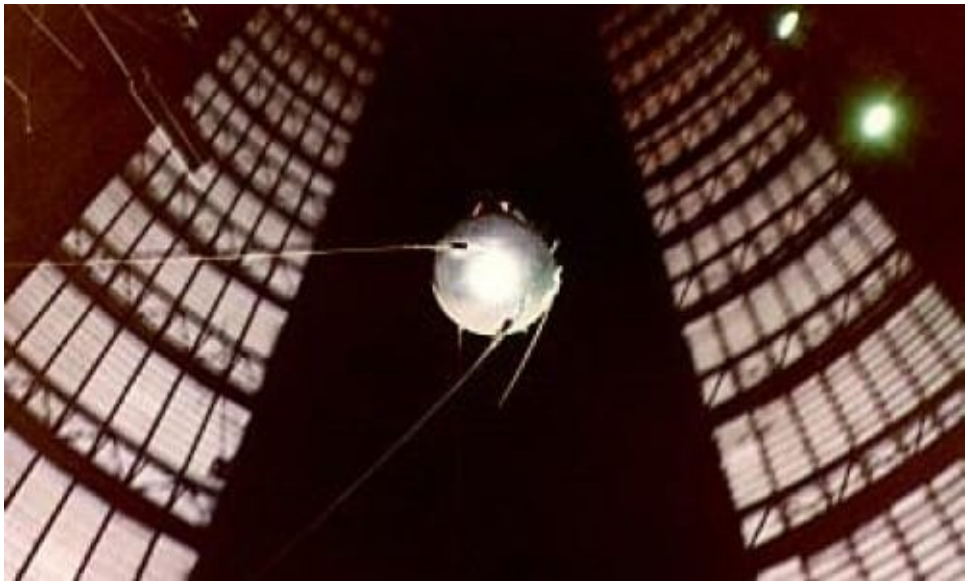
In **1957**, the Soviets surprised the US with the launch of **Sputnik**, propelling us into the space age.

Sputnik 1 was the first artificial Earth satellite. It was launched into space by the USSR on 4 October 1957 as part of the Soviet space program.

Aerodynamic drag caused it to fall back into the atmosphere on 4 January, 1958. The total duration of the mission was 22 days.

The satellite's success was unanticipated by the United States. This precipitated the American Sputnik crisis and triggered the start of the Space Race. The launch was the beginning of a new era of political, military, technological, and scientific developments.

Wikipedia



Sputnik 1. Image by Mark Wade, Public Domain, from Astronautix.

In response to Sputnik, the **US** Government created the Advanced Research Projects Agency (**ARPA**), whose initial role was to ensure that the **US was not surprised again**.

From ARPA, now called DARPA (Defense Advanced Research Projects Agency), the Internet first sprang. ARPA was the center of computing research in the 1960s, but there was just one problem: **many computers could not talk to each other**. In 1968, ARPA sent out a request for a communication technology proposal that would allow **different computers** located **around the country** to be **integrated into one network**.

Twelve companies responded to the request, and a company named Bolt, Beranek, and Newman (BBN) won the contract and developed the first protocol for the network. They began work right away and completed the job just one year later: in **September 1969**, the **ARPANET was turned on**. The **first four nodes** were at University of California at Los Angeles (**UCLA),** University of California at Santa Barbara **(UCSB),** Stanford Research Institute **(SRI),** and **the University of Utah**.



Evolution of the Arpanet from 1969 to 1977. GIF by Smithsonian Institute, Public Domain, from CFR Education.

Over the next decade, the ARPANET grew and gained popularity. During this time, other networks also came into existence. **Different organizations were connected to different networks**.

This led to a problem: the **networks could not talk to each other**. Each network used its own proprietary language or protocol to send information back and forth. This **problem** was **solved using** the transmission control protocol/Internet protocol (**TCP/IP**).

TCP/IP was designed to allow networks running on different protocols to have an intermediary protocol that would allow them to **communicate**. So as long as a network supporting TCP/IP, users could communicate with all other networks running TCP/IP, which quickly became the **standard protocol** and allowed networks to communicate with each other.

We first got the term **Internet** from this breakthrough, which means "an **inter**connected **net**work of networks."

> **Internet** means "**inter**connected **net**work of networks."

As we moved into the **1980s**, **computers were added to the Internet** at an increasing rate. These computers were primarily from government, academic, and research organizations. Much to the engineers' surprise, the early **popularity** of the Internet **was driven by the use of electronic mail**.

Using the Internet in these early days was not easy. To access information on another server, you had to know how to type in the commands necessary to access it and know the name of that device.

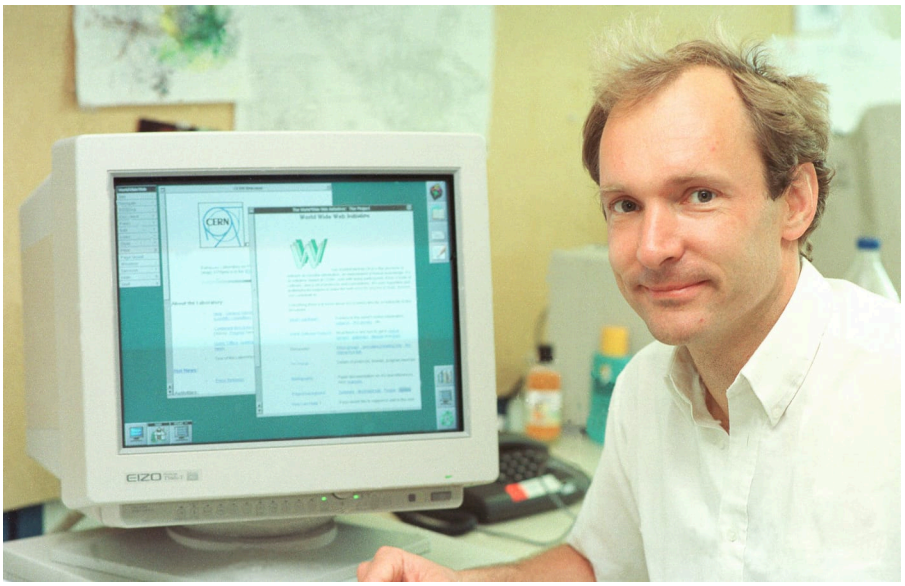
YouTube Video

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View this YouTube Video online

6.1.2. WWW

That all changed in 1990 when **Tim Berners-Lee** introduced his **World Wide Web (WWW) project**, which provided an easy way to navigate the Internet through the use of linked text (**hypertext**) and Hypertext Markup Language (**HTML**). The World Wide Web gained even more steam with the release of the **Mosaic browser** in **1993**, which allowed graphics and text to be combined to present information and navigate the Internet.



Tim Berners Lee. Image embedded. By ITU Pictures from Flickr.

The Mosaic browser took off in popularity and was soon superseded by **Netscape Navigator**, the first commercial web browser, in 1994.

The Internet has evolved from Web 1.0 to 2.0 to the many popular social media websites today.

According to Meltwater, there were 6.04 billion internet users by October 2025, which represents 73.2% of the total world population.

> Annual reports can be downloaded in Meltwater.

6.1.3. Networks in our daily life

Among all of the fundamentals for human presence, the **need to interact with others** ranks underneath our need to maintain life.

Communication is nearly as **imperative** to us as our dependence on air, water, nourishment, and shelter.

Today, networking systems have enabled people to **connect from anywhere**. Individuals can communicate and collaborate **immediately** with others. News ideas and discoveries are **shared** with the world in seconds.

People can indeed interface and play with others without the physical barriers of seas and landmasses from wherever they locate.

Technology Then and Now

Envision a world without the Internet.

No more Google, YouTube, texting, Facebook, Wikipedia, web-based gaming, Netflix, iTunes, and simple access to current data. **No more** social media, staying away from lines by shopping on the web, or rapidly looking into telephone numbers and guide headings to different areas at the snap of a finger.

How unique would our lives be without the entirety of this? That was the world we lived in only 15 to 20 years back. Throughout the years, information systems have gradually extended and been repurposed to improve personal satisfaction for individuals all over the place.

No boundaries

Progressions in systems administration advancements are maybe the most noteworthy changes on the planet today. They assist with making a world where national fringes, geographic separations, and physical confinements become less important, introducing ever-lessening obstacles.

Cisco Systems alludes to this as the **human network**. The human network fixates on the effect of the Internet and networks on individuals and organizations.

> Technology brings us closer to the furthest... and distances us from the closest.

— Michele Norsa

YouTube Video

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6.2: Network Basics



Contents

6.2.1. IP addresses

6.2.2. URL & ports

6.2.3. Hosting & Domains

6.2.1. IP Addresses

An **IP** (Internet Protocol) **address** is a unique code that identifies a piece of equipment connected to a network.

These addresses are used in messages between network devices like the network or wireless card in your computer, the equipment from your ISP (Internet Service Provider), and all pieces of equipment between your machine and the one your computer needs to talk to.

How can you find your IP address?		
What is my IP	My IP finder	IP location

The IP Address can be hidden (or masked) with 3 tools:

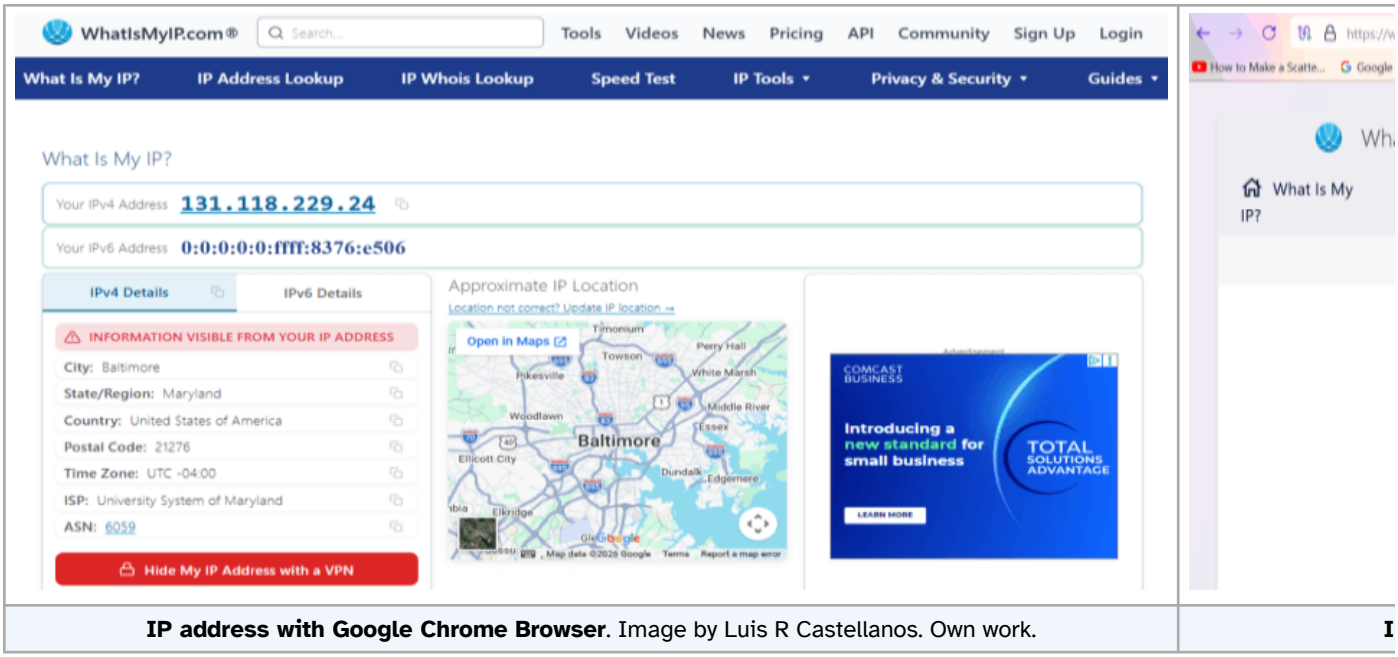
- **VPN** (Virtual Private Network): establishes a protected network connection when using public networks. It encrypts your internet traffic and disguises your online identity.
- **Proxy** Server: provides a gateway between users and the internet. It helps prevent cyber attackers from entering a private network.
- **TOR browser** (The Onion Router): anonymizes your web traffic using the Tor network, making it easy to protect your identity online.

Tor Browser is a privacy-focused web browser that routes your traffic through the Tor network, hiding your real IP address, preventing tracking, and protecting you against surveillance and censorship.

Tor Project

This is an example about how the IP address can be masked.

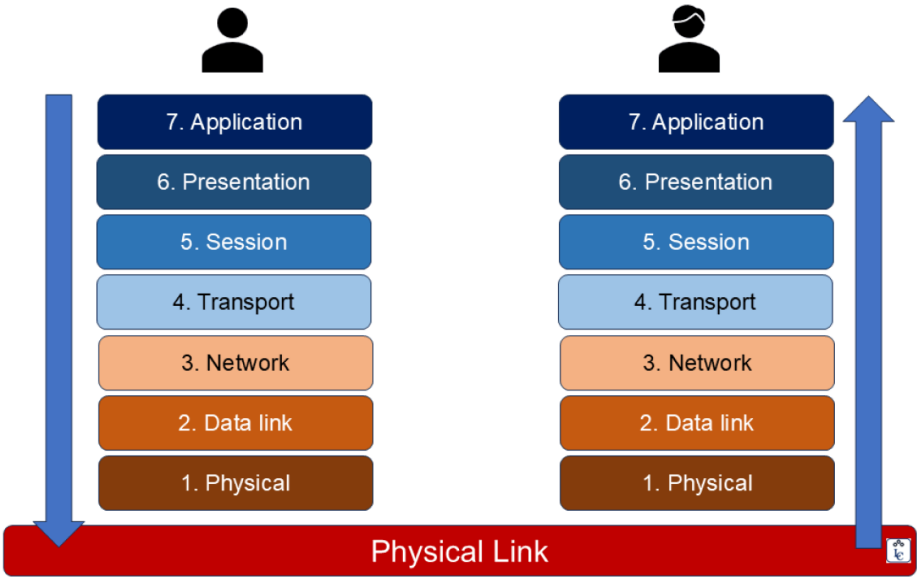
- On the left side, the IP address obtained using a "Chrome Browser" and the "What is my IP" portal. Shows a location in Maryland, USA.
- On the right side, the IP address obtained using a "TOR Browser" and the "What is my IP" portal. Shows a location in Ivanovo, Russia.



IP address with Google Chrome Browser. Image by Luis R Castellanos. Own work.

IP Addresses live in the network layer, which is one of seven layers in the protocol suite defined in the OSI Model.

The OSI model stands for **Open Systems Interconnection**, and was created by the **International Organization for Standardization** (ISO), an international non-governmental group of professionals who strive to establish standards and best practices in a variety of fields. [About ISO].



OSI model. Image by Luis R Castellanos. Own work.

The OSI Model for networking breaks the system of transmitting data into the layers show below in an attempt to delineate where certain actions should take place.

The seven layers depicted in the figure shown above make up the OSI body's recommended protocol suite. In the diagram, transmission of data crosses two routers and over the Internet to reach its destination. By following the data along the arrows, we see it pass through various layers of communication and processing as it crosses the internal network, through the first router, across the public network (internet connection), into the recipient's router, and then is reassembled into its original form.

Until recently, most network equipment has operated on **IPv4**, the fourth standard released for IP addresses, which has been in place for about thirty years. Addresses in this format are typically represented as a pattern of four blocks of up to three digits separated by periods, with no block of numbers exceeding 255 such as 127.0.0.1 or 24.38.1.251. This is referred to as dot-decimal representation, and although it is not the only way to express an IPv4 address it is the most recognized form.

Although this scheme allows for almost **4.3 billion** addresses, the last one was officially assigned on February 4th, 2012.

> In 2012, there were approximately 2.4 billion Internet users in the world. IANA (Internet Assigned Numbers Authority) ran out of unallocated IPv4 blocks to distribute.

To sustain growing number of devices in the future, **IPv6** was created, which is depicted as eight blocks of four hexadecimal digits now separated by colons. These new addresses might look like 2001:0db8:85a3:0042:1000:8a2e:0370:7334, and can support roughly 3.4 undecillion unique addresses (3.4 x 10^{38}). IPv6 was ratified and started officially in July 2017.

> **Hexadecimal system** uses sixteen (16) distinct symbols: numbers 0 through 9 (representing values 0 to 9) and letters A through F (representing values 10 to 15).

Since the new range is so staggeringly large, additional protocols were created that specify when certain values or ranges are used in addresses. This allows additional information about the device to be conveyed just from the address.

	IPv4	**IPv6**
Number of bits	32	128
Possible addresses	4.3 billion	3.4 undecillion
Format	4 blocks, in decimal system, separated by dots	8 blocks, in hexadecimal system, separated by colons
Example	192.0.1.246	2002:db8:8a3f:362:789c:a45:63f1:2026

> **Why hasn't IPv6 been fully implemented yet?**
>
> Unlike the IPv4 protocol, IPv6 won't ever run out of unique IP addresses. Furthermore, some argue that IPv6 is a more efficient technology, providing better quality and connectivity. However, IPv6 has not been fully implemented for two reasons:
>
> 1. IPv6 isn't backward compatible with IPv4. You can't access IPv4 websites if your device runs on an IPv6 protocol.
> 2. It's hard to adopt the new technology without immediate gain. IPv4 still suits our needs, and until we reach its limit, a worldwide shift is unlikely.
>
> NordVPN

Packets

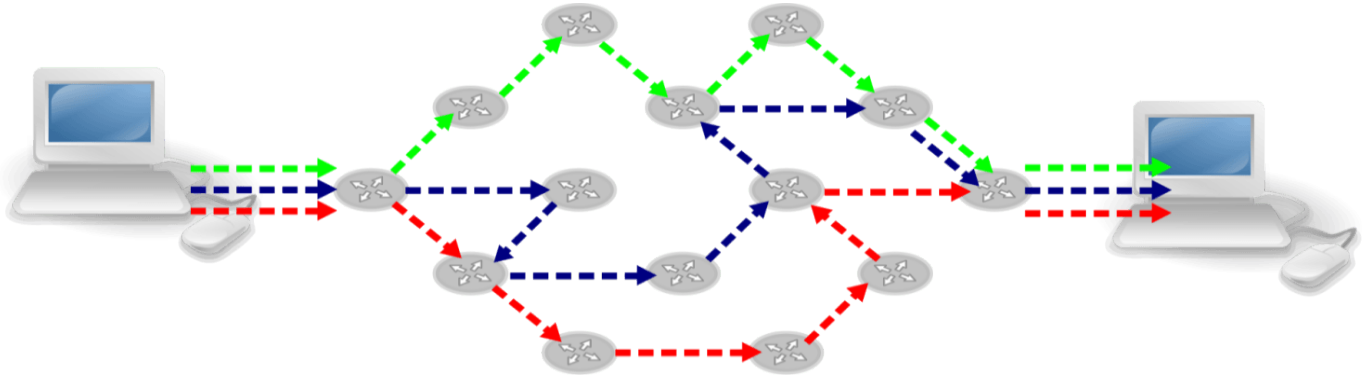
The actual messages sent between machines are broken down into multiple pieces. These pieces, called **packets**, are sent piece by piece from sender to recipient. It is the fundamental unit of data transmitted over the Internet.

When a device intends to send a message to another device (for example, your PC sends a request to YouTube to open a video), it breaks the message down into smaller pieces, called packets. Each packet has the sender's address, the destination address, a

sequence number, and a piece of the overall message to be sent.

Each packet is sent the fastest way possible, which means some packets may take different routes—picture a short cut, or getting off a congested road to take a different one. This helps to ensure that the message gets from sender to receiver as fast as possible, but also means packets may arrive in a different order than they were sent.

After the packets are reassembled, the receiving computer sends any necessary responses, and the process repeats. This all takes place in fractions of a second, beginning with the “hello”, or handshake packet to announce a communication request, to the last piece of the packet.



Packet switching. Image by Computer-blue, CC0, from Wikimedia Commons

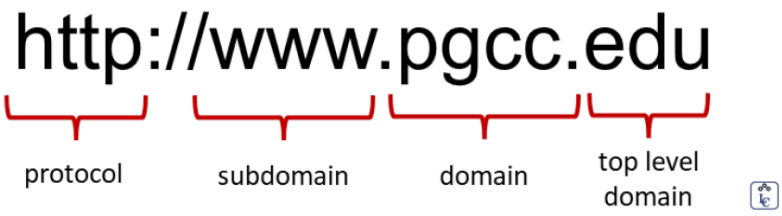
6.2.2. URL and Ports

URL

Seeing as most of us would have a hard time remembering what IP address is needed to get to, say, Facebook (173.252.100.16) or the Weather Channel (96.8.80.132) we instead use URLs, Uniform Resource Locators.

> **URL** is the unique web address used to find a specific page, file, or image on the internet.

This allows us to use www.facebook.com and www.weather.com to get to where we want to go without referring to a long list of IP addresses. Specialized servers (called name servers) all around the world are responsible for responding to requests from computers for this information.



URL structure. Image by Luis R Castellanos, Own work.

When you type facebook.com into your address bar, if your router does not have a note of its own as to where that is, it will “ask” a name server, which will look it up in its records and reply.

There are three parts to a network address: the protocol, name, and resource id. The protocol represents how we want to send

and receive messages, for example we can use http:// for accessing websites and ftp:// for moving files.

> **http** stands for Hypertext Transfer Protocol. **ftp** stands for File Transfer Protocol.

The name is what we associate with the site, like www.facebook.com, and the resource id, or URI, is everything after that, which points to the particular file we want to see.

If you had to try to remember the IP address of every web server you wanted to access, the Internet would not be nearly as easy to use. A domain name is a human-friendly name for a device on the Internet.

A DNS server is queried when a request to access a device with a domain name is given. It returns the IP address of the device requested, allowing for proper routing. DNS stands for “domain name system,” which acts as the directory on the Internet.

Ports

While an IP address and a URL will bring you to a particular web server, there may be more than one way you want to interact with it, or more than one thing you want it to do. Maybe you also want the server to provide email services, or you want to use FTP to update your files.

The **ports** act as different doors into your server, so different applications can communicate without getting in each other’s way.

> **Port** is a software-based location that organizes the sending and receiving of data between devices on a network.

The Internet Assigned Numbers Authority (IANA) has assigned port numbers to commonly used services like SSH, FTP, HTTP, HTTPS, and others. Here are some of the most common ones:

20: File Transfer Protocol (FTP) Data Transfer 21: File Transfer Protocol (FTP) Command Control 22: Secure Shell (SSH) 23: Telnet - Remote login service, unencrypted text messages 25: Simple Mail Transfer Protocol (SMTP) E-mail Routing 53: Domain Name System (DNS) service 80: Hypertext Transfer Protocol (HTTP) used in World Wide Web	110: Post Office Protocol (POP3) used by e-mail clients to retrieve e-mail from a server 119: Network News Transfer Protocol (NNTP) 123: Network Time Protocol (NTP) 143: Internet Message Access Protocol (IMAP) Management of Digital Mail 161: Simple Network Management Protocol (SNMP) 194: Internet Relay Chat (IRC) 443: HTTP Secure (HTTPS) HTTP over TLS/SSL 500: Internet Security Association and Key Management Protocol (ISAKMP)

6.2.3. Hosting and Domains

Hosting Facilities

If you are using a server that is not under your physical care, and is managed by an off-site third party, then you likely have an agreement with a hosting facility.

> **Hosting facilities** are typically for-profit companies that manage the physical equipment necessary to provide access to websites for a number of clients.

Many offer web development and management services as well, but if you are still reading, then that tidbit is probably of little interest as you are here to build it yourself.

Additionally, hosting facilities are equipped with backup power sources as well as redundant connections to the internet, and may even have multiple facilities that are physically dispersed, ensuring their clients have the best up time as possible.

Price competition makes for relatively affordable hosting for those who are not looking for dedicated servers and are comfortable with sharing their (virtual) server resources with other customers.

Hosting facilities should have enough data servers, skilled staff and top notch security on their premises.



Server racks. Image by Pete Linforth from Pixabay.

Hosting providers

According to Hostinger, some of the most popular hosting providers in the United States are:

- Hostinger, Bluehost, Scala, GreenGeeks, Dreamhost, Siteground, InMortion Hosting, HostGator, Namecheap, GoDaddy.

The cost of a web hosting plan in the United States varies depending on the type of hosting, server specifications, and contract length.

Most hosting providers advertise rates (e.g., $2.99/mo) that apply only when pre-paying for 24–48 months upfront. Upon renewal, the price often increases to standard rates ($9.99–$15.99/mo).

> All web pages must have a hosting and a domain name (which must be unique).

Domains

A website **domain** is a web site's unique text address on the internet. I.e. pgcc.edu.

Domain registrars

Domain registrars coordinate the name servers that turn URLs into the IP addresses that get us to our destinations. These companies are where you register available names in order to allow others to find your site.

According to Forbes, some of the most popular domain registrars in the United States are:

- Porkbun, Spaceship, GoDaddy, Cloudflare, NameSilo, DNSimple, Namecheap, INWX, Dreamhost, Dynadot, IONOS.

Standard web domains cost between $10 and $20 per year for initial registration and annual renewal. Prices change based on the extension you choose, such as .com, .net, or .org, as well as the registrar you use to buy it. Promotional first-year deals can be cheaper, but renewal rates are usually higher.

The most popular top-level domain (TLD) by far is .com, which powers roughly 41% to 44% of all websites globally. Other dominant legacy extensions include .net, .org, and popular country codes like .de (Germany) and .uk (United Kingdom). Modern tech and startup alternatives like .ai, .io, and .co have also surged in popularity.

Generic TLDs

The first generic TLDs are:

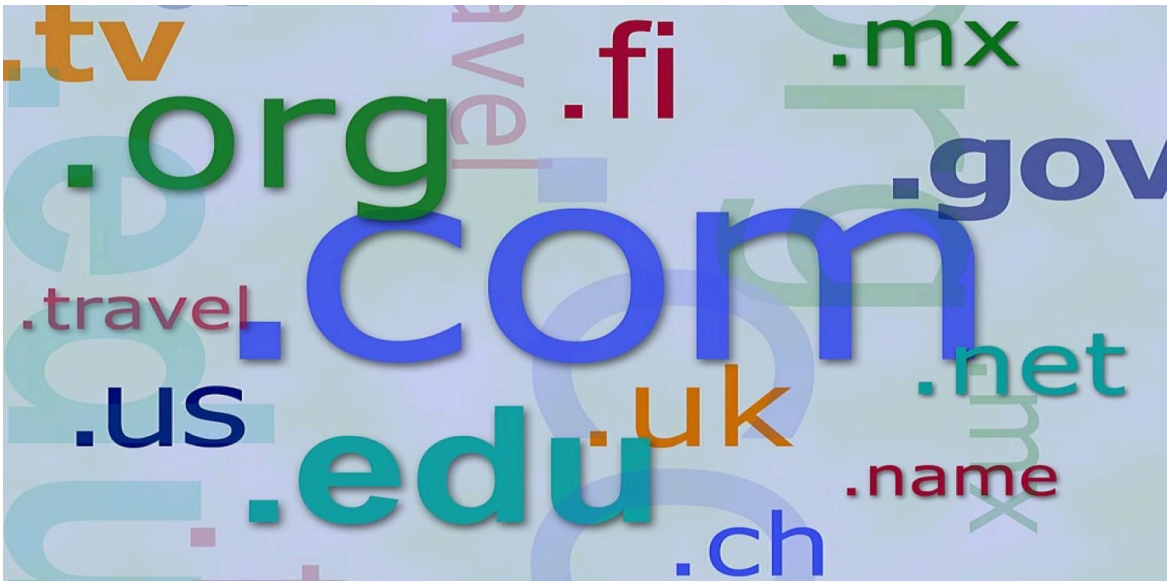
- .com = commercial (for companies)
- .org = organization (for organizations)
- .net = network (for Internet service providers)
- .edu = education **(sponsored)**(for educational institutions)
- .gov = government **(sponsored)**(for government institutions)
- .mil = military **(sponsored)**(for the military)

Eventually, today there are more than 1500 TLDs. A list of all valid top-level domains is maintained by the IANA and is updated from time to time. To view the list, click **here**.

Country specific domains

There are also country-specific domain extensions, like for example:

- .us (USA)
- .uk (United Kingdom)
- .il (Israel)
- .au (Australia)
- .nl (Netherlands)
- .jp (Japan)
- .fr (France)
- .se (Sweden)
- .kr (South Korea)
- .de (Germany)
- .fi (Finland)



Top level domains. By NIST, Public domain, from Wikimedia Commons

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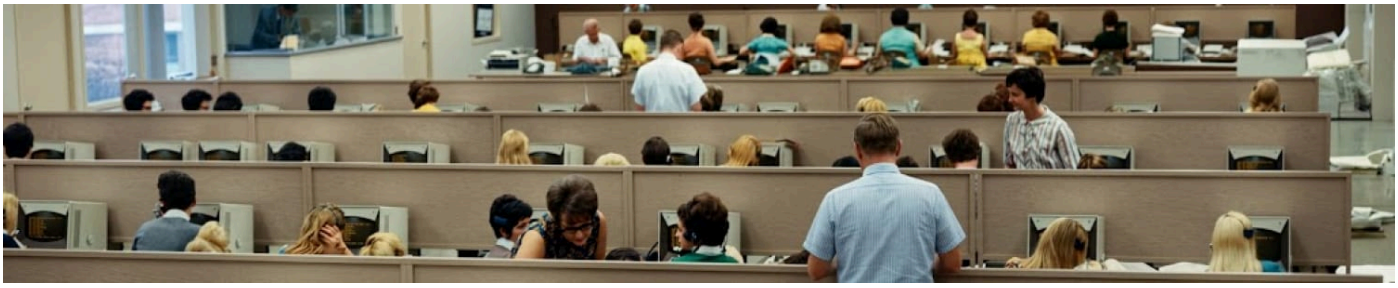
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6.3: Providing Resources in a Network



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6.3.2. Clients and Servers

6.3.3. Network Components

6.3.4. Network Representations

6.3.1. Networks in many sizes

Networks come in all sizes. They can go from basic networks consisting of two PCs to networks interfacing with many gadgets.

Basic networks introduced in homes empower sharing of assets, for example, printers, archives, pictures, and music between a couple of nearby PCs. Worldwide internet users expect always to stay connected to the internet. They expect their connected devices to do the following:

- Stay connected to the internet to complete their work.
- Have the ability to send and receive data fast.
- Have the ability to send small and large quantities of data globally via any device connected to the internet.

Home office networks and small office networks are regularly set up by people who work from home or remote offices. They need to associate with a corporate network or other concentrated assets. Moreover, numerous independently employed business people utilize home office and small office networks to publicize and sell items, request supplies and speak with clients.

> Despite return-to-office (RTO) mandates from major employers, new federal data suggests remote work has settled into a lasting feature of the U.S. workplace rather than a temporary pandemic-era trend.
>
> According to the U.S. Bureau of Labor Statistics' latest American Time Use Survey, 34.9% of full-time workers — approximately 32.5 million people — performed at least part of their job from home on an average day in 2025. That marks a modest increase from 33.4% in 2024 and leaves remote work participation more than 10 percentage points above pre-pandemic levels.
>
> The findings indicate that while many organizations have pushed employees back to the office, those efforts have largely plateaued. The latest figures add to a growing body of evidence suggesting hybrid work has become a permanent feature of the labor market rather than an exception.

Society for Human Resource Management (SHRM)

The Internet is the biggest network presently. Indeed, the term Internet implies an interconnected network of networks. The Internet is the global worldwide network that connects billions of computers around the world. A computer can connect to another computer in a different country via the internet.

Let us see three types of computer networks:

1. Geographical area networks,
2. Access level networks, and
3. Special purpose networks.

Geographical area networks

Typically, geographical areas define computer networks. A local area network (LAN) connects computers within a defined physical space, while a wide area network (WAN) can connect computers across continents.

However, networks are also defined by the protocols they use to communicate, the physical arrangement of their components, how they manage network traffic and the purpose they serve in their respective environments.

The network types by geographical area are distinguished by the area they cover.

Body area network (BAN)

A BAN is a wireless network of wearable computing devices. It is also referred to as a wireless body area network (WBAN).

Personal area network (PAN)

A PAN serves one person. If a user has multiple devices from the same manufacturer (an iPhone and a MacBook, for instance), it's likely they've set up a PAN. The PAN shares and syncs content, text messages, emails, photos and more, across devices.

Local area network (LAN)

A LAN connects computers over a relatively short distance, such as those within an office building, school or hospital. LANs are typically privately owned and managed.

Metropolitan area network (MAN)

MANs are larger than LANs but smaller than WANs. Cities and government entities typically own and manage MANs.

Major Cities with Extensive Public Wi-Fi

- **Seoul, South Korea:** Offers dense public Wi-Fi coverage across streets, public transit, and tourist hubs via government-backed networks.
- **Barcelona, Spain:** Features one of Europe's largest municipal Wi-Fi networks, blanketing parks, plazas, beaches, and municipal buildings.
- **Taipei, Taiwan:** Provides thousands of free hotspots across public areas, transit stations, and major commercial districts.
- **Singapore:** Delivers extensive Wireless@SG coverage across public housing estates, malls, MRT stations, and civic spaces.

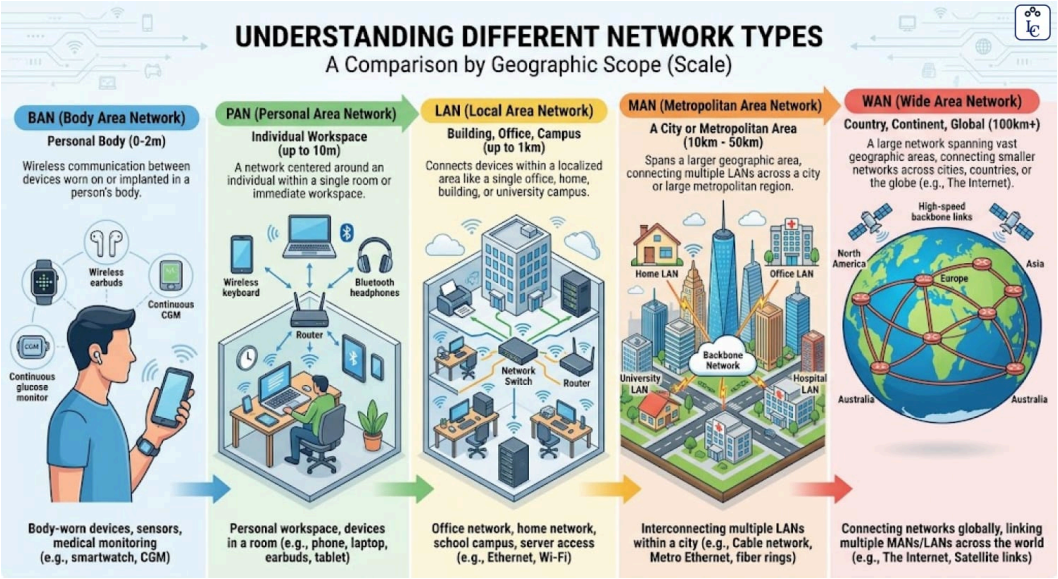
Wide area network (WAN)

As the name implies, a WAN connects computers across large geographical areas, such as regions and continents. WANs often have collective or distributed ownership models for network management purposes.

Cloud network

A cloud network is a type of wide-area network (WAN) where networking resources—such as routers, firewalls and switches—are virtualized and delivered through public or private cloud platforms.

Unlike traditional WANs, which depend heavily on physical infrastructure, cloud networks offer on-demand scalability, automation and global availability. These networks are ideal for businesses running applications in hybrid or multicloud environments because they allow seamless and secure connectivity between cloud services and on-premises systems.



Understanding different Network types. Image created by Luis R Castellanos, Public Domain, from Google Gemini.

Access level networks

The Internet, Intranet, and Extranet are grouped by their access level, meaning who can use them, and their **scope of security**. They form a tiered structure based on public and private network boundaries.

Internet

Open to the public. Anyone in the world can connect. Global reach with no central owner. Security is up to each user.

The Internet is an overall assortment of **inter**connected **net**works.

A portion of the LAN models is associated with one another through a WAN association. WANs are then associated with one another. The WAN association lines speak to all the assortments of ways we interface networks. WANs can connect through copper wires, fiber optic cables, and wireless transmissions.

No individual or group own the Internet. Guaranteeing compelling correspondence over this various framework requires the use of steady and generally perceived advances and norms, just as the collaboration of many network organization offices. Some associations have been produced to keep up the structure and normalization of Internet conventions and procedures.

These organizations incorporate the Internet Engineering Task Force (**IETF**), Internet Corporation for Assigned Names and

Numbers (**ICANN**), and the Internet Architecture Board (**IAB**), in addition to numerous others.

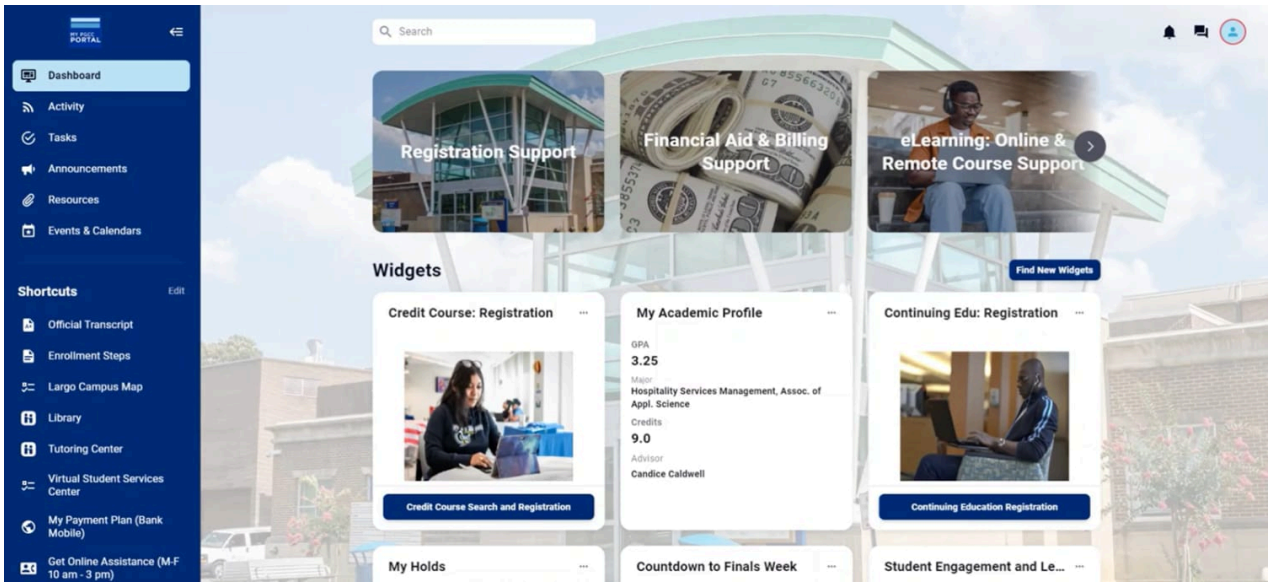
Intranet

> **Intranet** is a term frequently used to describe a private association of LANs and WANs that has a place with an association.

It is intended to be available only for approved individuals, workers, or others of an organization. Only internal staff and employees can log in. Fully private and protected by company firewalls.



PGCC Intranet menu (MyPGCC). Image by Luis R Castellanos, Public domain, Own work.



PGCC Student Menu. Image by Luis R Castellanos, Public Domain, own work.

Extranet

> An **extranet** is a term used to describe the case when an organization wants to give secure and safe access to people who work for another organization yet expect access to the association's information.

Shared with specific outsiders. Trusted partners, vendors, and clients get access. Semi-private. Uses the public web as a bridge, but blocks the general public using secure passwords and VPNs.

Examples of extranets include:

- An organization that is giving access to outside providers and temporary workers.
- An emergency clinic gives a booking system to specialists so they can make arrangements for their patients.
- A nearby office of training gives spending plans and staff data to the schools in its region.

Aspect	Internet	Intranet	Extranet
Accessibility	Accessible to anyone with internet connection	Restricted to authorized users within organization	Extends access to select external stakeholders with controlled permissions
Audience	Global audience, including individuals, businesses, organizations	Internal users within the organization	A mix of select internal users and external members
Security	Varies; may include encryption, firewalls, secure connections	Stringent access controls, user authentication, encryption	Authentication mechanisms, role-based permissions, encryption
Usage	Communication, research, entertainment, e-commerce, etc.	Internal communication, collaboration, knowledge sharing, workflows	Collaboration, secure data exchange, client/vendor interaction

Key differences between the internet, intranet, and extranet. Thoughtfarmer.



Networks according to the access level. Image by Luis R Castellanos. Public Domain, own work.

Special Purpose Networks

WLAN (Wireless LAN)

A LAN that uses radio waves like Wi-Fi instead of physical cables.

SAN (Storage Area Network)

A high-speed network that links servers to data storage devices.

VPN (Virtual Private Network)

A secure tunnel that lets you connect safely to a private network over a public one like the internet.

6.3.2. Clients and Servers

All PCs associated with a network are named hosts. Hosts are also called end devices. Servers are PCs with programming that empower them to give data, similar to emails or website pages, to other network devices called clients. Each assistance requires separate server programming.

For instance, a server requires web server programming to give web administrations to the network. A PC with server programming can offer types of assistance at the same time to one or numerous customers.

Furthermore, a solitary PC can run numerous sorts of server programming. It might be vital for one PC to go about as a document server, a web server, and an email server in a home or private company. Clients are PCs with programming introduced that empower them to ask for and show the server's data.

A case of client programming is an internet browser, similar to Chrome or Firefox. A solitary PC can likewise run different kinds of custom programming. For instance, a client can browse email and view a site page while texting and tuning in to Internet radio.

> A **client-server network** is a computing model in which multiple clients connect to a central server to access resources, such as files, applications, and data.
>
> Lenovo

The server acts as a central hub, managing and providing services to the connected clients.

In a client-server network, clients send requests to the server, which processes these requests and sends back the requested information or performs the necessary tasks. The server handles tasks like data storage, security, and resource management, while the clients focus on interacting with the user.

6.3.3. Network Components

The link between the sender and the receiver can be as simple as a single cable connection between these two devices or more sophisticated as a set of switches and routers between them. The network framework contains three classes of network segments:

- Devices
- Media
- Services

Devices and media are the physical components, or equipment, of the network. Equipment is regularly the noticeable segment of the network stage, for example, a PC, switch, remote passageway, or the cabling used to associate the devices.

Administrations incorporate a significant number of the basic network applications individuals utilize each day, similar to email facilitating administrations and web facilitating administrations.

Procedures give the usefulness that coordinates and moves the messages through the network. Procedures are more subtle to us yet are basic to the activity of networks.

End Devices

> An **end device** is either the source or destination of a message transmitted over the network.

Each end device is identified by an IP address and a physical address. Both addresses are needed to communicate over a network. IP addresses are unique logical IP addresses that are assigned to every device within a network. If a device moves from one network to another, then the IP address has to be modified.

Physical addresses, also known as **MAC** (Media Access Control) addresses, are unique addresses assigned by the device manufacturers. These addresses are permanently burned into the hardware.



Modem Router´s MAC address. Image by Luis R Castellanos, Public Domain, own work.

Intermediary Network Devices

Some devices act as intermediaries between devices. They are called delegated devices. These delegated devices give availability and guarantee that information streams over the network.

> **Intermediary network devices** are hardware components that connect end devices and manage how data flows across a computer network.

Routers use the destination end device address, related to data about the network interconnections, to decide how messages should take through the network.

Some Intermediary Network devices:

- **Bridge**: A network device that connects two networks and only allows packets through that are needed.
- **Hub**: A simple network device connects other devices to the network and sends packets to all the devices connected to it.
- **Modem**: is a hardware device that connects your home or office network to your Internet Service Provider (ISP).
- **Router**: A device that receives and analyzes packets and then routes them towards their destination. In some cases, a router will send a packet to another router; it will send it directly to its destination in other cases.
- **Modem-router**: is a single device that performs the jobs of both a modem and a router. It connects your home to your internet provider and creates your local Wi-Fi network at the same time.

- **Switch**: A network device that connects multiple devices and filters packets based on their destination within the connected devices.

		
Modem Image by Wilton de Carvalho, GNU FDL, from Wikimedia Commons	**Router** Image by Simon from Pixabay	Imag

Network Media

A medium called network media carries the act of transport data.

The medium gives the channel over which the message makes a trip from source to destination.

Present-day organizations basically utilize three sorts of media to interconnect devices and give the pathway over which information can be transmitted.

These media are:

- Metallic wires within cables (Copper) - information is encoded into electrical driving forces.
- Glass or plastic fibers (fiber optic cable) - information is encoded as beats of light.
- Wireless transmission - information is encoded utilizing frequencies from the electromagnetic range.

Various sorts of network media have various highlights and advantages. Not all network media have similar qualities, nor are they all appropriate for the same purpose.



Copper cables. Image by Kier in Sight Archives from Unsplash

Bluetooth

While Bluetooth is not generally used to connect a device to the Internet, it is an important wireless technology that has enabled many functionalities that are used every day.

When created in 1994 by Ericsson, it was intended to replace wired connections between devices. Today, it is the standard method for connecting nearby devices wirelessly.

Origin of the name

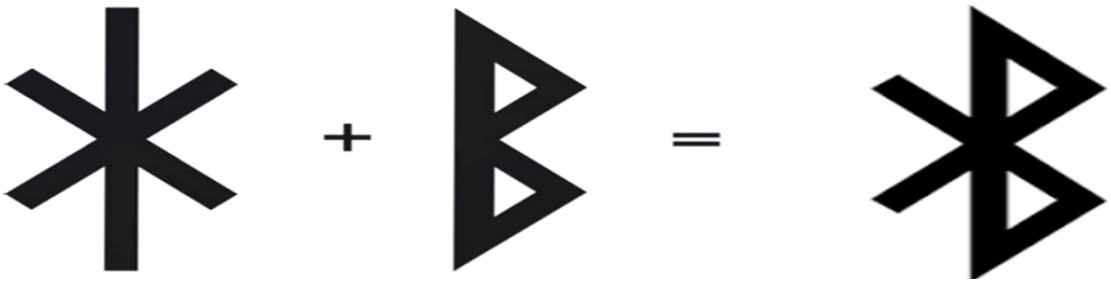
“King Harald Bluetooth...was famous for uniting Scandinavia just as we intended to unite the PC and cellular industries with a short-range wireless link.”

Bluetooth was only intended as a placeholder until marketing could come up with something really cool.

King Harald's dead tooth, which was a dark blue/grey color, earned him the nickname Bluetooth.

The Bluetooth logo is a bind rune merging the Younger Futhark runes (Hagall) (ᚼ) and (Bjarkan) (ᛒ), Harald’s initials.

Bluetooth name origin



Bluetooth logo with runes. Image by Luis R Castellanos, Public Domain, own work.

Bluetooth has a range of approximately 300 feet and consumes very little power, making it an excellent choice for various purposes. Initially, Bluetooth was under the IEEE 802.15.1. Now Bluetooth is under the Bluetooth Special Interest Group (SIG).

Bluetooth official page

Some applications of Bluetooth include: connecting a printer to a personal computer, connecting a mobile phone and headset, connecting a wireless keyboard and mouse to a computer, and connecting a remote for a presentation made on a personal computer.



Bluetooth official logo. By Bluetooth SIG, Public domain, from Wikimedia Commons

6.3.4. Network Representations

To draw a diagram of a network, symbols are utilized by network professionals to represent the different devices and connections which make up a network. A diagram gives a simple method to see how devices in a huge network are associated. This kind of "picture" of a network is known as a topology diagram.

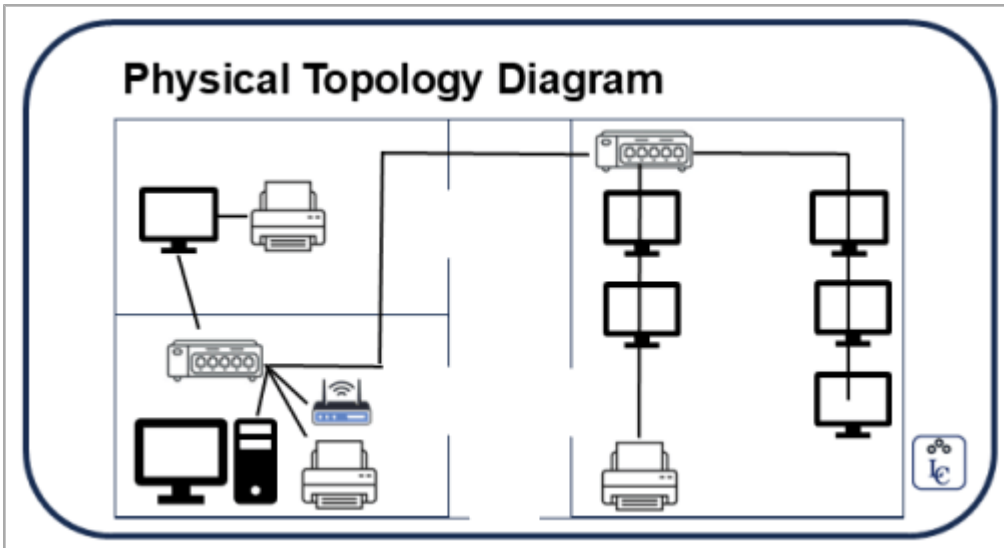
> **Network topology** refers to the physical and logical arrangement of nodes and connections in a computer network, which governs how data flows between devices.
>
> IBM

The capacity to perceive the legitimate portrayals of the physical systems administration segments is basic to have the option to imagine the association and activity of a network.

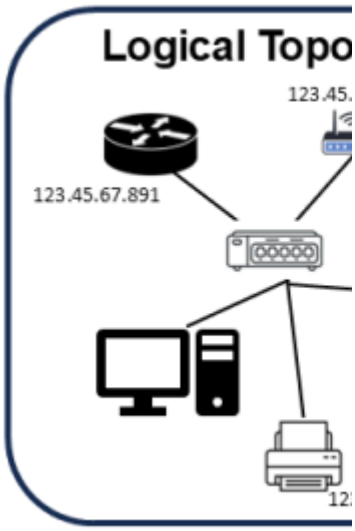
Topology Diagrams

Understanding topology diagrams are required for anybody working with a network. They give a visual guide of how the network is associated. There are two types of Topology diagrams:

- **Physical topology diagrams**. Identifies the physical location of intermediary devices and cable installation. It is how they are interconnected with cables and wires physically.
- **Logical topology diagrams**. Identifies devices, addressing schemes, and ports. It is how connected devices are seen to the user.



Physical Topology Diagram. By Luis R Castellanos, Public Domain, own work.



Logical Topology Diagr

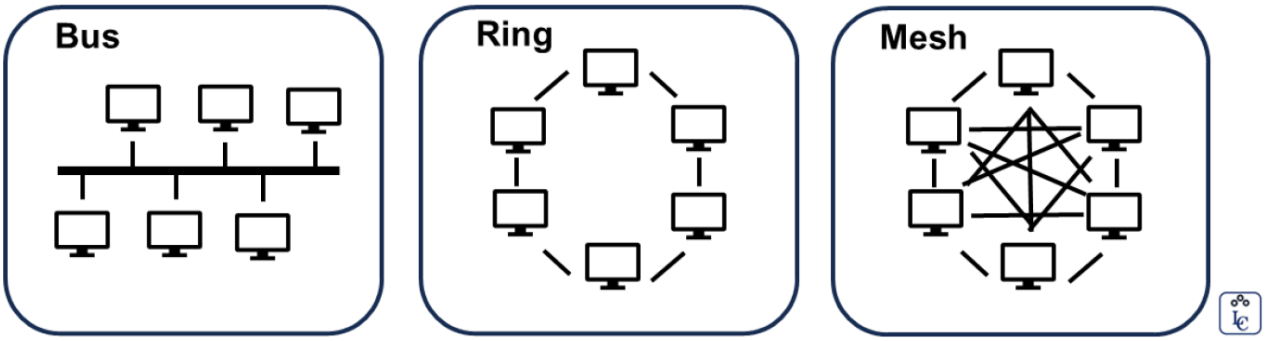
Types of Network topologies

Point-to-point: It consists of two nodes that are connected by a single link. Data travels back and forth between these two endpoints.

Bus: all nodes are connected to a single cable—known as the bus or backbone—like bus stops branching off from a bus route. Data travels in both directions along the cable.

Ring: nodes are connected in a circular fashion, with each node having exactly two neighbors. Data flows in one direction around the ring, though dual-ring systems can send data in both directions.

Mesh: each node is directly linked to multiple other nodes. In a full mesh configuration, every node connects to every other node within a single network, creating redundant paths for data transmission.

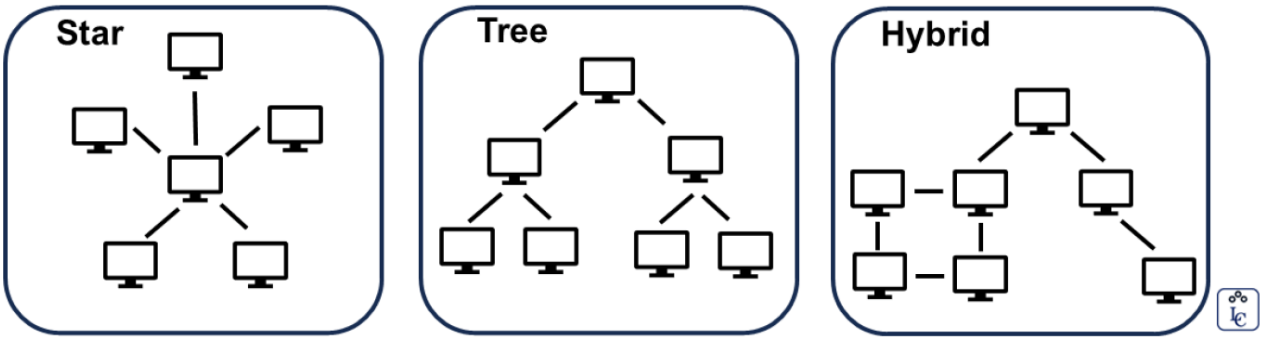


Bus, Ring, Mesh network topologies. Image by Luis R Castellanos, Public Domain, own work.

Star: all the nodes are connected to a central hub. The nodes are positioned around that central hub in a shape that roughly resembles a star.

Tree: combines elements of both bus and star networks, creating a hierarchical structure. In this configuration, a central hub serves as the root node, connecting to multiple star networks rather than individual nodes.

Hybrid: combines elements of different topologies to meet specific needs.



Star, Tree, Hybrid network topologies. Image by Luis R Castellanos, Public Domain, own work.

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6.4: Internet Connections



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6.4.2. Home and Small Office Internet Connections

6.4.3. Business Internet Connections

6.4.4. Most popular Internet providers in the USA

6.4.1. Internet Access Technologies

There is a wide range of approaches to associate users and associations with the Internet.

Home clients (telecommuters) and workplaces regularly require an association with an Internet Service Provider (ISP) to access the Internet. Association alternatives change significantly among ISP and topographical areas. Notwithstanding, companies incorporate a broadband link, broadband computerized endorser line (DSL), remote WANs, and versatile administrations.

Associations commonly expect access to other corporate destinations and the Internet. Quick associations are required to help business administrations, including IP telephones, video conferencing, and server farm stockpiling.

Business-class interconnections are normally given by specialist organizations (SP). Well-known business-class administrations incorporate business DSL, rented lines, and Metro Ethernet.

> Residential and Home Office clients ⇒ Internet Service Providers
>
> Business and Commercial clients ⇒ Specialist Organizations

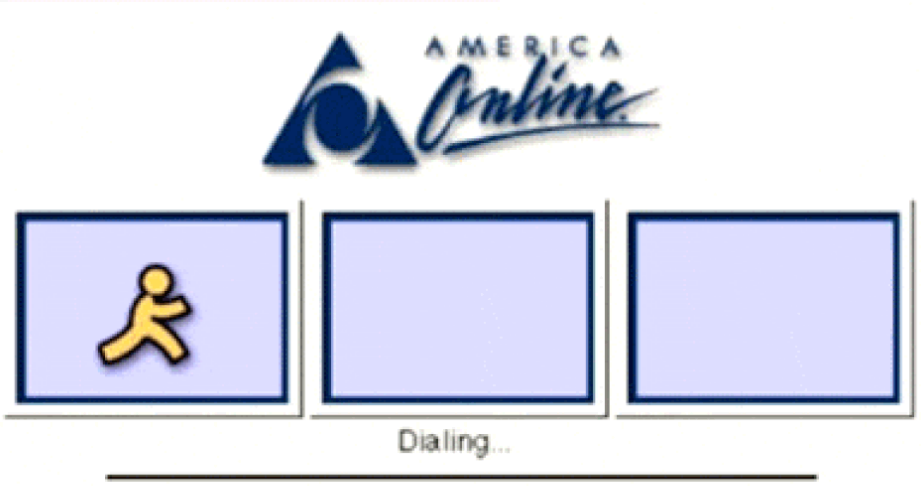
6.4.2. Home and Small Office Internet Connections

Regular connection choices for Home and Small Office users:

Dial-up telephone

An economical choice that utilizes any telephone line and a modem. The low transmission capacity supported by a dial-up modem

association is normally not adequate for huge information transfer. However, it is still a valuable choice wherever other options are not available such as in rural areas or remote locations where phones are the only means of communication.



Dial up. Giphy, CC0, via Wikimedia Commons

DSL

Digital Subscriber Lines gives a high data transmission, consistently on, association with the Internet. DSL runs over a phone line when all is said in done, small office and home office clients associate utilizing Asymmetrical DSL (ADSL), which implies that the download speed is quicker than the upload speed.

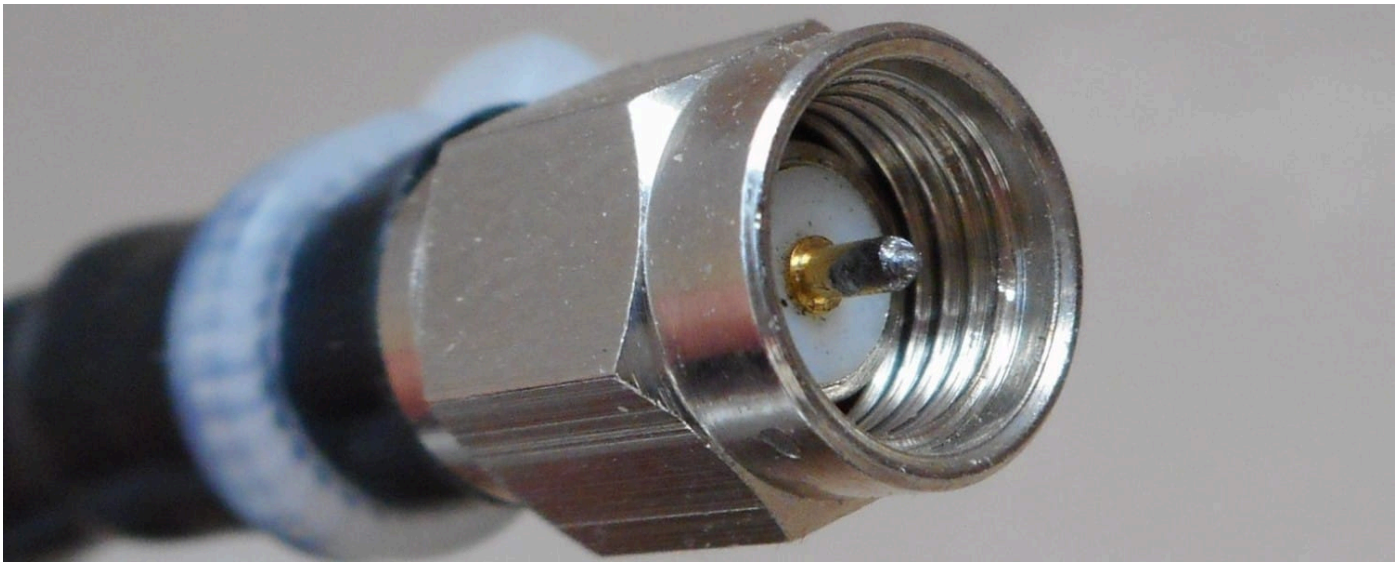


DSL connector. Image by Behnam Norouzi from Unsplash

Cable

Typically offered by digital TV specialist co-ops, the Internet information signal is carried on a similar link that conveys satellite TV. It gives a high transmission capacity, consistently on, association with the Internet. Usually, coaxial cable is used for this

setting.



Coaxial cable. Image by Markus Bärlocher, CC0, from Wikimedia Commons

Fiber Optic

Fiber optic Internet connections are a type of broadband connection which utilizes light to transmit data signals. They use thin strands of optical glass or plastic to deliver high-speed Internet and data over great distances. This is much faster than traditional copper wires – providing speeds up to 10 Gbps and beyond!



Fiber Optic cable. Image by Blickpixel from Pixabay.

Cellular

Portable internet relies on 4G LTE and 5G mobile hotspots to deliver secure, travel-friendly connectivity for remote workers and travelers. Most portable data plans feature data caps, requiring users to monitor their monthly usage to avoid throttled speeds or overage fees. Modern 5G mobile hotspots now offer superior speeds, making them a viable backup connection for smart homes and daily web tasks.

Satellite

Internet access through satellite is a genuine advantage in those territories that would somehow or another have no Internet availability by any means. Satellite dishes require a clear line of sight to the satellite.



Satellite dish. Image by Etherr, CC0, from Wikimedia Commons

6.4.3. Business Internet Connections

Corporate connection choices contrast from home client alternatives. Organizations may require higher transmission capacity, devoted data transmission, and oversaw administrations.

Business connection options include:

- **Dedicated Leased Line (DLL)**: Leased lines are really saved circuits inside the specialist organization's system that interface geologically isolated workplaces for private voice or potentially information organizing. The circuits are ordinarily leased at a month-to-month or yearly rate. They can be costly.
- **Ethernet WAN**: Ethernet WANs broaden LAN access into the WAN. Ethernet is a LAN innovation you will find out about in a later section. The advantages of Ethernet are currently being reached out into the WAN.
- **DSL**: Business DSL is accessible in different organizations. A famous decision is Symmetric Digital Subscriber Lines (SDSL) which is like the purchaser rendition of DSL. However, it gives transfers and downloads at similar paces.
- **Satellite**: Like small office and home office clients, satellite help can give an association when a wired arrangement isn't accessible.

The decision of connection shifts relying upon geographical area and specialist organization accessibility.

6.4.4. Most popular Internet providers in the USA



Image by TheDigitalArtist from Pixabay.

Most popular ISP providers in the USA	Most popular SP providers in the USA

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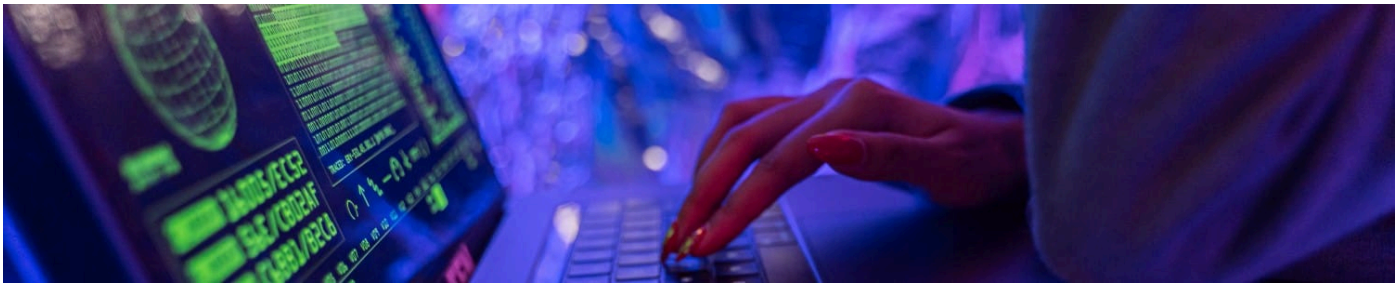
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6.5: The Changing Network Environment Network Trends



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6.5.1. New trends

As new technologies and end-user devices come to market, businesses and purchasers must keep on acclimating to this ever-evolving condition. The job of the network is changing to empower the connections between individuals, devices, and data. There are a few new networking trends that will impact organizations and purchasers.

A portion of the top trends include:

- Bring Your Own Device (BYOD)
- Online collaboration
- Video communications
- Cloud computing
- Home trends

Bring Your Own Device

Bring Your Own Device (BYOD) is about end users having the opportunity to utilize individual tools in order to get to data and convey over a business or campus network. With the development of customer devices and the related drop in cost, representatives and students can be relied upon to have probably the most progressive computing and networking tools for individual use. These individual tools can be laptops, e-books, cell phones, and tablets. These can be devices bought by the organization or school, bought by the individual, or both.

BYOD implies any device, with any possession, utilized anyplace. For instance, previously, a student who expected to get access to the campus network or the Internet needed to utilize one of the school's PCs. These devices were commonly constrained and seen as instruments just for work done in the study hall or in the library. Expanded availability through portable and remote access to the campus network gives students a lot of adaptability and opens doors of learning for the student.

Online collaboration

People want to connect with the network, for access to data applications, in addition to team up with each other. Collaboration is characterized as "the demonstration of working with another or others on a joint venture." Collaboration tools, give representatives, students, instructors, clients, and accomplices an approach to quickly interface, connect, and accomplish their targets.

For businesses, collaboration is a basic and vital need that associations are utilizing to sustain their competition. Collaboration is additionally a need in training. Students need to work together to help each other in learning, to create group abilities utilized in the workplace, and to cooperate on group based projects.

Video communication

Another trend in networking that is basic to the correspondence and joint effort exertion is video. Video is being utilized for interchanges, cooperation, and amusement. Video calls can be made to and from anyplace with an Internet connection.

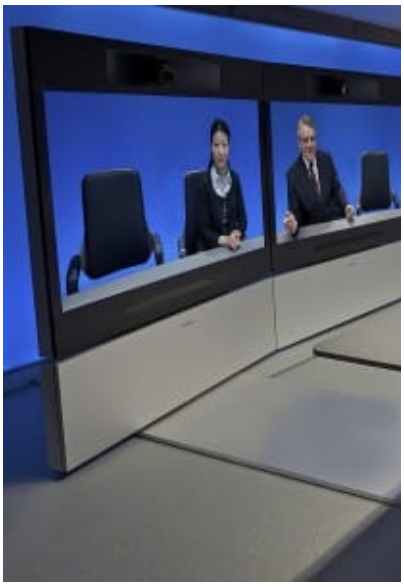
Video conferencing is an incredible asset for speaking with others from a distance, both locally and worldwide. Video is turning into a basic necessity for successful joint effort as associations stretch out across geographic and social limits.

Telepresence is designed to eliminate the feeling of looking at a computer screen, replacing traditional video calls with a highly immersive, lifelike environment. It can be done with immersive video. An immersive video room is a space intentionally designed to make remote participants feel present and actively involved, rather than faces on a screen.

Holographic communication is the real-time transmission of three-dimensional, photorealistic images of people and objects across a network. Unlike flat 2D video conferencing, it captures spatial depth, allowing participants to experience eye contact, parallax, and natural spatial physical cues as if they were sharing the same physical room.



Video conference. By Getty Images from Unsplash



Telepresence. Courtesy of

Cloud computing

Cloud computing is another worldwide trend changing how we access and store information. Cloud computing permits us to store individual files, even backup our whole hard disk drive on servers over the Internet. Applications, for example, word processing, and photograph editing, can be accessed utilizing the Cloud.

As it was said in Chapter 4:

> "**The cloud**" refers to applications, services, and data stored in data centers, server farms, and storage servers and accessed by users via the Internet.

Check Cloud Computing

When it comes to businesses, cloud computing expands IT's capabilities without requiring interest in new infrastructure, preparing new faculty, or permitting new software. These services are accessible on request and conveyed economically to any device on the planet without trading off security or capacity.

There are three essential Clouds: Public Clouds, Private Clouds, and Hybrid Clouds.

Cloud computing is conceivable because of **data centers**. A data center is an office used to house PC frameworks and related parts. A data center can consume one room of a building, at least one story, or the whole thing. Data centers are commonly over the top expensive to manufacture and keep up.

> **Data center** is a physical facility that organizations use to house their critical applications and data.

Therefore, just huge associations utilize secretly fabricated data centers to house their information and offer users assistance. Smaller associations that can't afford to keep up their own private data center can lessen the general expense of ownership by renting server and capacity services from a bigger data center association in the Cloud.

Top clou	
	
AWS logo. By Saquibsk88, CC0, from Wikimedia Commons	**Microsoft Azure logo**. By

Domotics

Networking trends are not just influencing how we work or study, and they are also changing pretty much every part of the home.

The most up-to-date home trends incorporate smart home technology, a technology that is coordinated into habitual appliances, permitting them to interconnect with different devices, making them progressively 'smart' or automated.

As it was said in chapter 3:

> Domotics (or home automation) refers to all the technologies and automated systems used to control and manage a home's equipment and infrastructure centrally and intelligently.
>
> Wattsense

For instance, envision having the option to set up a dish and spot it in the broiler for cooking before going out for the afternoon. Envision if the stove knew of the dish it was cooking and was associated with your 'schedule of occasions' so it could figure out what time you will be eating and change start times and length of cooking accordingly. It could even modify cooking times and temperatures dependent on plan changes.

Furthermore, a cell phone or tablet connection permits the user to interface with the broiler straightforwardly to make any ideal changes. When the dish is "accessible," the stove sends an alarm message to a predefined end-user device that the dish is done and warming.This situation isn't long-off. Actually, smart home technology is being created for all rooms inside a house.

It will turn out to be a greater degree of reality as home networking and high-speed Internet technology become progressively far-reaching. New home networking technologies are being grown day by day to meet these sorts of developing technology needs.



Domotics. Image by Gerd Altmann from Pixabay

6.5.2. Powerline Networking

Powerline networking is a rising trend for home networking that utilizes existing electrical wiring to connect devices. The idea of "no new wires" signifies the capacity to connect a device to the network where there is an electrical outlet. This spares the expense of introducing data cables and with no extra expense to the electrical bill. Utilizing similar wiring that conveys power, Powerline networking sends information by sending data on specific frequencies.

> A **Powerline network** uses your home's existing electrical wiring to send internet signals from your router to another room.

Using a standard Powerline adapter, devices can connect with the LAN any place there is an electrical outlet. Powerline networking is beneficial when wireless access points can't be utilized or can't arrive at all to the devices in the home. Powerline networking isn't intended to fill in for committed cabling in data networks. But it is an alternative when data network cables or wireless communications are not a reasonable choice.

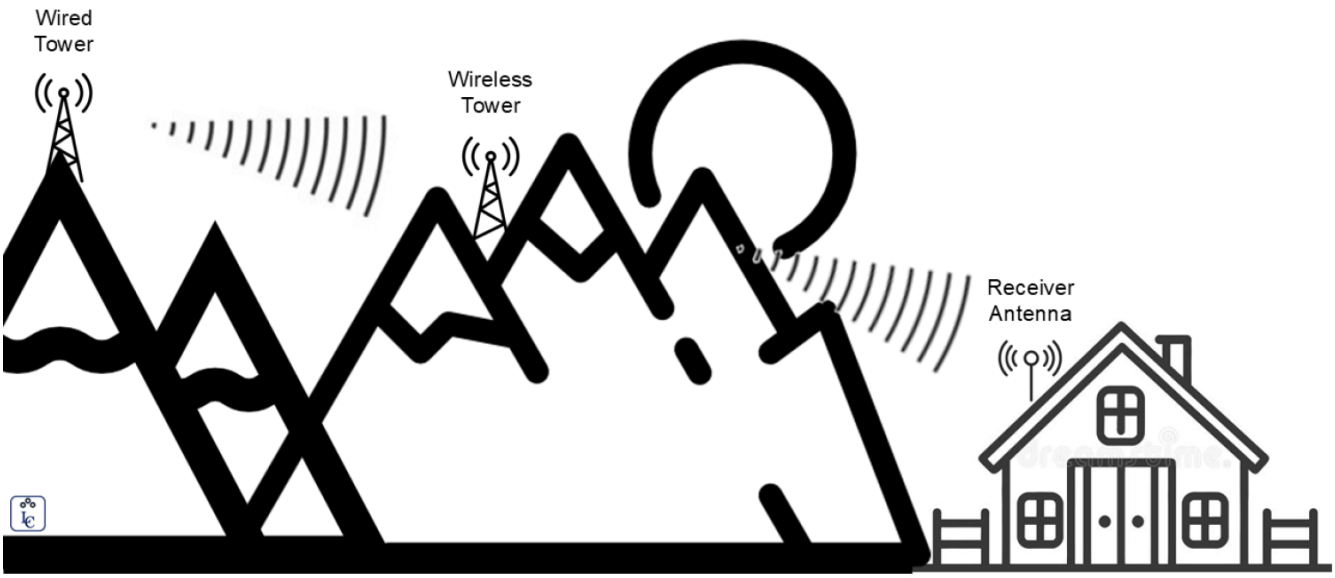


Powerline Network. Image by Luis R Castellanos, Public Domain, with Google Gemini

6.5.3. Wireless Broadband

Connecting with the Internet is indispensable in savvy home innovation. DSL and cable are basic advances used to connect homes and private companies to the Internet. Nonetheless, remote access might be another choice in numerous regions.

Another remote answer for home and independent companies is **wireless broadband**. This uses the equivalent cell innovation to get to the Internet with an advanced mobile phone or tablet. A radio wire is introduced outside the house, giving either remote or wired availability for home devices. In numerous zones, home wireless broadband is contending legitimately with DSL and cable services.



Wireless broadband. Image by Luis R Castellanos, Public Domain, own work.

6.5.4. Wireless Internet Provider

Wireless Internet Service Provider (**WISP**) is an ISP that connects subscribers of an assigned passage or problem area utilizing comparable remote innovations found in-home wireless local area networks (WLANs).

WISPs are all the more usually found in provincial situations where DSL or cable services are not accessible. Though a different transmission tower might be introduced for the antenna, the antenna is usually connected to a current raised structure, such as a water tower or a radio pinnacle.

A little dish or radio wire is introduced on the subscriber's rooftop in the **WISP** transmitter's scope. The subscriber's entrance unit is associated with the wired system inside the home. From the home user's point of view, the arrangement isn't vastly different from DSL or cable service. The main distinction is that the home's connection to the ISP is remote rather than a physical link.

6.5.5. Cell phones and Roaming

> Mobile phone system gets its name from dividing the service area into many small **cells**, each with a base station with a useful range on the order of a mile.

As mobile phone technologies have evolved, providers in different countries have chosen different communication standards for their mobile phone networks. In the US, both of the two competing standards exist GSM (used by AT&T and T-Mobile) and CDMA (used by the other major carriers). Each standard has its pros and cons, but the bottom line is that phones using one standard cannot easily switch to the other.

> GSM stands for Global System for Mobile Communications. CDMA stands for Code Division Multiple Access.

In the US, this is not a big deal because mobile networks exist to support both standards. But when you travel to other countries, you will find that most of them use GSM networks, with the one big exception being Japan, which has standardized on CDMA. It is possible for a mobile phone using one type of network to switch to the other type of network by switching out the SIM card, which controls your access to the mobile network. However, this will not work in all cases.

If you are traveling abroad, it is always best to consult with your mobile provider to determine the best way to access a mobile network.

> Data **roaming** is the **use** of cellular data **services** on a mobile device **outside** of the coverage area of the **home network**. This can result in additional charges from your mobile service provider, which can vary depending on the destination and the type of data usage.
>
> T-Mobile



Roaming. Image by Andrea Piacquadio from Pexels.

Some Roaming plans for International travel		
T-Mobile	AT&T	Verizon

Cell phone generations

1G	2G	3G	4G	5G
1980's Analog voice. Unable to transmit any data. Used to make and receive phone calls.	1990's Digital voice. SMS or text messages.	2000's Brought mobile data (email, WWW). Video calling. Play games.	2010's Faster than 3G. Better broadband.Videos and games in HD. Smooth streaming.	2020´s Low latency. High speed. Superior reliability.

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6.6: Network Security



Contents

6.6.1. Security Threats

6.6.2. Security Solutions

6.6.1. Security Threats

Network security is an indispensable piece of computer networking today, whether or not the network is restricted to a home domain with a solitary connection with the Internet or as extensive as an organization with many users.

The network security that is executed must consider the environment, just as the system's devices and prerequisites. It must have the option to keep the data secure while considering the quality of service anticipated from the network.

Ensuring a network is secure includes technologies, protocols, devices, tools, and techniques to keep data secure and moderate threat vectors. Threat vectors might be external or internal. Numerous external network security threats today are spread over the Internet.

The most widely recognized threats (internal or external) to networks include:

- **Viruses, worms, and Trojan horses-** malignant programming and subjective code running on a client device
- **Spyware and adware** - software installed on a user device that covertly gathers data about the user Zero-day attacks, likewise called zero-hour attacks - an assault that happens on a principal day that a defenselessness gets known
- **Hacker attacks-** an assault by an educated individual to user devices or network assets
- **Denial of service attacks DOS-** assaults intended to slow or crash applications and procedures on a network device
- **Data interception and theft** - an assault to catch private data from an association's network
- **Identity theft-** an assault to take the login qualifications of a user to get to private information

There have been numerous examinations showing that the most well-known data breaches happen due to the network's internal users. This can be credited to lost or taken devices, inadvertent abuse by workers, and in the business condition, even malignant representatives.

With the advancing BYOD systems, corporate information is considerably more powerless. Accordingly, it is critical to address both outside and interior security dangers when building up a security strategy.

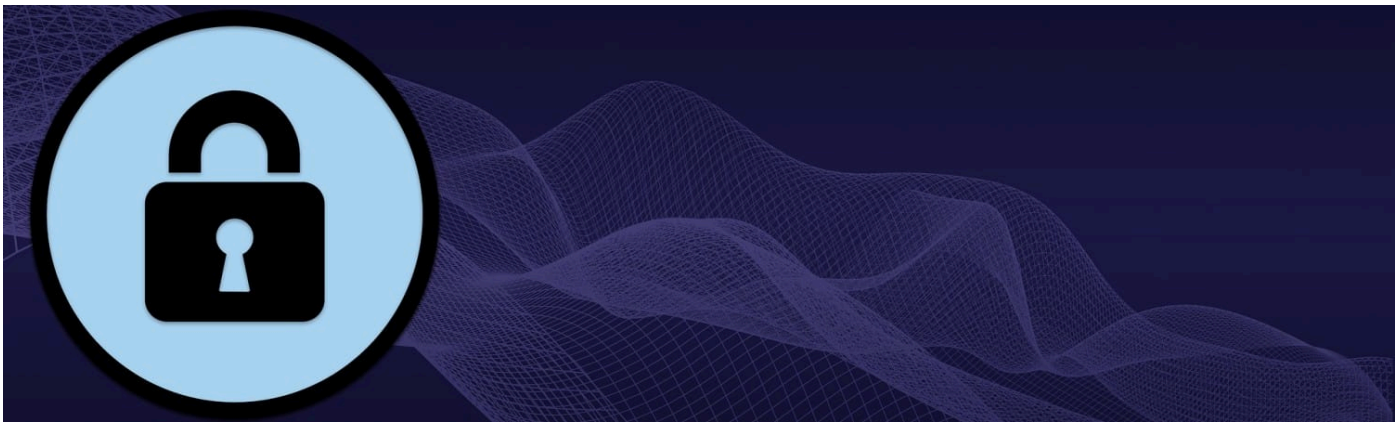


Image by TheDigitalArtist from Pixabay

6.6.2. Security Solutions

No single arrangement can shield the network from the many threats that exist. Consequently, security ought to be implemented in various layers, utilizing more than one security arrangement.

If one part of the security fails to recognize and shield the network, others will stand. A home network security execution is typically rather essential. It is commonly executed on the interfacing end devices, just as connected with the Internet, and can even depend on contracted services from the ISP.

Conversely, the network security implementation for a corporate network, for the most part, comprises numerous segments incorporated with the network to screen and channel traffic. In a perfect world, all segments cooperate, which limits maintenance and improves overall security.

Home and Small Office Networks

Network security parts for a home or small office network should at least incorporate the following:

- **Antivirus and antispyware**: These are utilized to shield end devices from getting contaminated with vindictive software.
- **Firewall filtering**: This is utilized to prevent unapproved access to the network. This may incorporate a host-based firewall system that is actualized to forestall unapproved access to the end device or an essential separating service on the home router to keep unapproved access from the outside world into the network.

Business and Corporate Networks

Bigger networks and corporate networks frequently have other security necessities:

- **Dedicated firewall systems**: These are utilized to develop further firewall abilities that can channel a lot of traffic with greater granularity.
- **Access control lists** (ACL): These are utilized to channel access and traffic sending additionally.
- **Intrusion prevention systems** (IPS): These are utilized to distinguish quick-spreading dangers, for example, zero-day or zero-hour assaults.
- **Virtual Private Networks** (VPN): These are utilized to give secure access to telecommuters.

Conclusions

Networks security necessities must consider the network condition, just like the different applications and processing prerequisites. Both home situations and organizations must have the option to secure their data yet consider the quality of service that is anticipated from every innovation.

Furthermore, the security arrangement executed must be versatile to the developing and changing trends of the network. The study of network security dangers and relief strategies begins with a concise understanding of the underlying switching and routing infrastructure utilized to organize network services.

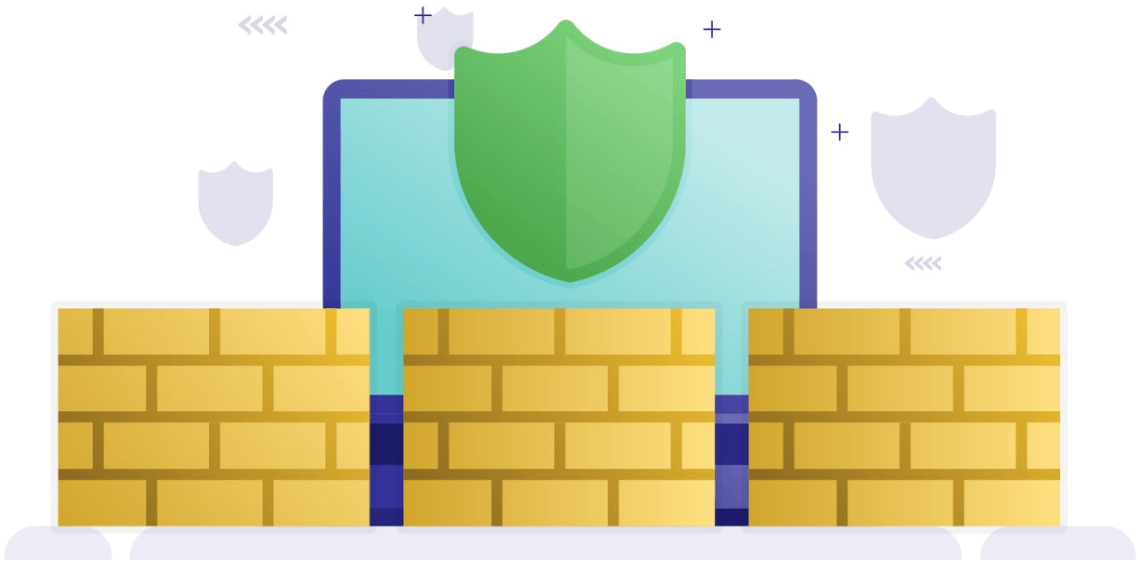


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6.7: Summary



6.1. Introduction to Networking and Communication

The Internet (**Inter**connected **Net**work of Networks) started in 1969, as ARPANET, in the United States. And it had grown so much, that it has more than 6 billion users world wide. The Internet was made possible with the creation of the Transmission Control Protocol / Internet Protocol (**TCP/IP**), which allowed all networks to be able to communicate.

The World Wide Web (WWW) project was created by Tim Berners-Lee in 1990, allowing (through HTML) the use of hypertext in documents, which prompted what is now called "web navigation".

The first browser was the "Mosaic", which was later replaced by the first commercial browser: "Netscape Navigator", when the Internet was released to the general public in 1994.

6.2. Network Basics

IP addresses

An **IP** (Internet Protocol) **address** is a unique code that identifies a piece of equipment connected to a network.

The IP Address can be hidden (or masked) with 3 tools:

- **VPN** (Virtual Private Network): establishes a protected network connection when using public networks. It encrypts your internet traffic and disguises your online identity.
- **Proxy** Server: provides a gateway between users and the internet. It helps prevent cyber attackers from entering a private network.
- **TOR browser** (The Onion Router): anonymizes your web traffic using the Tor network, making it easy to protect your identity online.

In July 2017, IPv6 was officially ratified to replace IPv4. But in reality, both standards are being used. IPv4 allowed up to 4.3 billion addresses. IPv6 allows up to 3.4 undecillion addresses.

The actual messages sent between machines are broken down into multiple pieces. These pieces, called **packets**, are sent piece by piece from sender to recipient.

URL & ports

URL is the unique web address used to find a specific page, file, or image on the internet.

Port is a software-based location that organizes the sending and receiving of data between devices on a network.

Hosting & Domains

Hosting facilities are typically for-profit companies that manage the physical equipment necessary to provide access to websites for a number of clients.

According to Hostinger, some of the most popular hosting providers in the United States are:

- Hostinger, Bluehost, Scala, GreenGeeks, Dreamhost, Siteground, InMortion Hosting, HostGator, Namecheap, GoDaddy.

All web pages must have a hosting and a domain name (which must be unique).

A website **domain** is a web site's unique text address on the internet. I.e. pgcc.edu.

Domain registrars coordinate the name servers that turn URLs into the IP addresses that get us to our destinations.

According to Forbes, some of the most popular domain registrars in the United States are:

- Porkbun, Spaceship, GoDaddy, Cloudflare, NameSilo, DNSimple, Namecheap, INWX, Dreamhost, Dynadot, IONOS.

The first generic TLDs are:

- .com = commercial (for companies)
- .org = organization (for organizations)
- .net = network (for Internet service providers)
- .edu = education **(sponsored)**(for educational institutions)
- .gov = government **(sponsored)**(for government institutions)
- .mil = military **(sponsored)**(for the military)

6.3. Providing Resources in a Network

Let us see three types of computer networks:

1. Geographical area networks
    - Body area network (BAN)
    - Personal area network (PAN)
    - Local area network (LAN)
    - Metropolitan area network (MAN)
    - Wide area network (WAN)
    - Cloud network
2. Access level networks
    - Internet
    - Intranet
    - Extranet
3. Special purpose networks
    - WLAN (Wireless LAN)
    - SAN (Storage Area Network)
    - VPN (Virtual Private Network)

A **client-server network** is a computing model in which multiple clients connect to a central server to access resources, such as files, applications, and data.

The network framework contains three classes of network segments:

- Devices
    - End devices: either the source or destination of a message transmitted over the network

    - Intermediary Network devices: act as intermediaries between devices
- Media
    - Metallic cable
    - Fiber optic cable
    - Wireless transmission
- Services

Network topology refers to the physical and logical arrangement of nodes and connections in a computer network, which governs how data flows between devices.

There are two types of Topology diagrams:

- Physical topology diagrams
- Logical topology diagrams

Types of Network topologies:

- Point-to-point
- Bus
- Ring
- Mesh
- Star
- Tree
- Hybrid

6.4. Internet Connections

Residential and Home Office clients are served ⇒ Internet Service Providers. Business and Commercial clients are served ⇒ Specialist Organizations

Regular connection choices for Home and Small Office users:

- Dial-up telephone
- DSL
- Cable
- Fiber Optic
- Cellular
- Satellite

Business connection options include:

- Dedicated Leased Line (DLL)
- Ethernet WAN
- DSL
- Satellite

6.5. Network Trends

Each day we find new trends in technology, and in Networks. Here are some of those trends:

- Bring Your Own Device
- Online collaboration
- Video communications
- Cloud computing
- Home trends

- Powerline Networks
- Wireless broadband and Wireless ISP
- Cellphone platforms and roaming services

6.6. Network Security

Network security is an indispensable piece of computer networking today, whether or not the network is restricted to a home domain with a solitary connection with the Internet or as extensive as an organization with many users.

The most widely recognized threats (internal or external) to networks include:

- Viruses, worms, and Trojan horses
- Spyware and adware
- Hacker attacks
- Denial of service attacks - DOS
- Data interception and theft
- Identity theft

No single arrangement can shield the network from the many threats that exist. Consequently, security ought to be implemented in various layers, utilizing more than one security arrangement.

Home and Small Office Networks Solutions:

- Antivirus and antispyware
- Firewall filtering

Business and Corporate Networks Solutions:

- Dedicated firewall systems
- Access control lists (ACL)
- Intrusion prevention systems (IPS)
- Virtual Private Networks (VPN)

The security arrangement executed must be versatile to the developing and changing trends of the network. The study of network security dangers and relief strategies begins with a concise understanding of the underlying switching and routing infrastructure utilized to organize network services.

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7: INFORMATION SYSTEMS - DATA



You have already been introduced to the first two components of information systems: hardware and software. However, those two components by themselves do not make a computer useful.

Imagine if you turned on a computer, started the word processor, but could not save a document. Imagine if you opened a music player but there was no music to play. Imagine opening a web browser but there were no web pages. Without **data**, hardware and software are not very useful!

Data is the third component of an information system.

Learning Objectives

Upon successful completion of this chapter, you will be able to:

- Describe the differences between data, information, and knowledge
- Describe Database, Database Management System, and Database Types
- Characterize the contribution of databases to websites
- Identify relational database elements
- Identify Fields, Records, and Tables
- Recognize that tables can have relationships
- Identify Data Warehouse and Data Mining
- Recognize Meta Data and their use
- Recognize the need for database security

7.1: Data and Databases
7.2: Before Database Systems
7.3: The Relational Data Model and others
7.4: Databases and Security Issues
7.5: Fundamental Database Concepts
7.6: Appendix B - Designing a Database
7.7: Summary

"It is hard to fail, but is is worse never to have tried to succeed."

— Theodore Roosevelt, *PotUS 26*

Banner image by WokAndApix, via Pixabay

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7.1: Data and Databases



Contents

7.1.1. Data, Information & Knowledge

7.1.2. Data types

You have already been introduced to the first two components of information systems: **hardware** and **software**. However, those two components by themselves do not make a computer useful.

Imagine if you turned on a computer, started the word processor, but could not save a document. Imagine if you opened a music player but there was no music to play. Imagine opening a web browser but there were no web pages.

Without data, hardware and software are not very useful! **Data** is the third component of an information system.

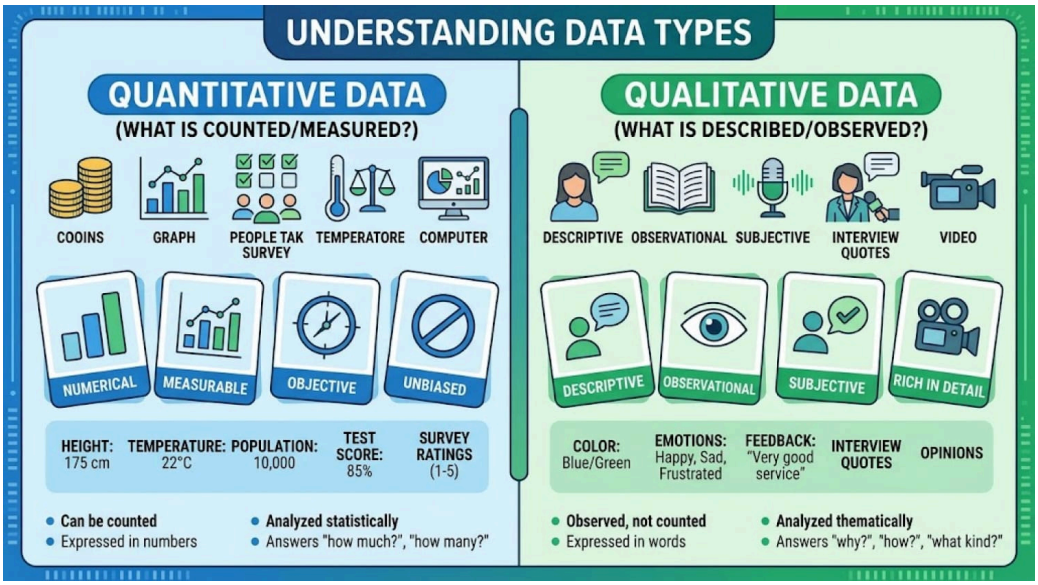
7.1.1. Data, Information & Knowledge

Data are the raw bits and pieces of information with no context. If you hear, “15, 23, 14, 25,” you would not have learned anything. You would have been given data.

Data can be quantitative or qualitative.

- **Quantitative data** is numeric, the result of a measurement, count, or some other mathematical calculation. [**QUANTITY**]
- **Qualitative data** is descriptive. “Ruby Red,” the color of a car, is an example of qualitative data. [**QUALITY**]

A number can be qualitative too: if you that your favorite number is 7, that is qualitative data because it is descriptive, not the result of a measurement or mathematical calculation.



Quantitative vs Qualitative data. Image by Luis R Castellanos, Public domain, generated by Google Gemini.

By itself, data is not that useful. To be useful, it needs to be given context.

Returning to the previous example, if you are told that "15, 23, 14, and 25" are the **numbers of students** of a course that had registered for upcoming classes, that would be information.

By adding the context – that the numbers represent the count of students registering for specific classes – the data has been converted data into information.

Once we have put our data into context, aggregated and analyzed it, we can use it to make decisions for our organization.

We can say that this consumption of information produces **knowledge**. This knowledge can be used to make decisions, set policies, and even spark innovation.

The final step up the information ladder is the step from knowledge (knowing a lot about a topic) to **wisdom**. We can say that someone has wisdom when they can combine their knowledge and experience to produce a deeper understanding of a topic. It often takes many years to develop wisdom on a particular topic and requires patience.

7.1.2. Data types

The goal of many information systems is to transform data into information in order to generate knowledge that can be used for decision making. In order to do this, the system must be able to take data, put the data into context, and provide tools for aggregation and analysis.

A database is designed for just such a purpose.

> A **database** is an organized collection of related information.

It is an **organized** collection, because in a database, all data is described and associated with other data.

All information in a database should be **related** as well; separate databases should be created to manage unrelated information. For example, a database that contains information about students should not also hold information about company stock prices.

Databases are not always **digital** – a filing cabinet, for instance, might be considered a form of a database.

We will look at the **four data types** that you are most likely to come across in the web development world, but this is still not an exhaustive representation of every approach available.

1. Flat file
2. Structured Data
3. Unstructured Data
4. Semi-structured Data

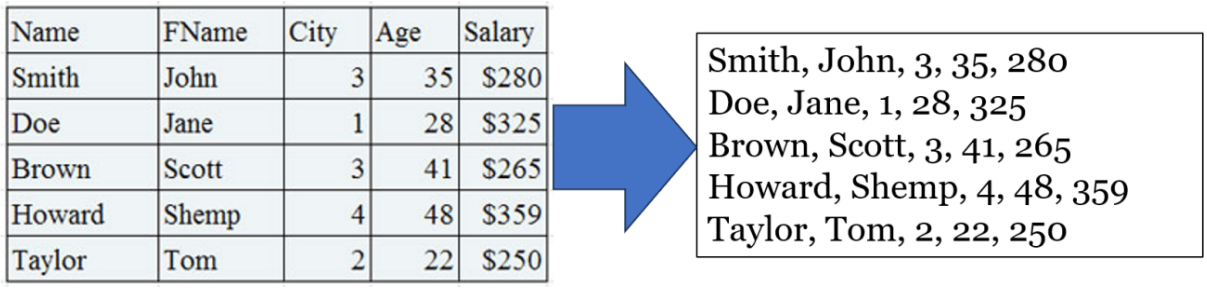
1. Flat file

> Flat files store information in a plain text file, with one record per line. Each record contains fields separated by a delimiter, such as commas, tabs, or spaces. So the entire database is stored in one file.
>
> Clustox

If you have ever used Excel or another spreadsheet program, then you have already interacted with a flat-file database. This structure is useful for smaller amounts of data, such as spreadsheets and personal collections of movies.

Typically, flat files are comma-separated value files, with .csv being a common extension.

This refers to the fact that values in the file are separated by commas to identify where they start and end, with records marked by terminating characters like a new line, or by a different symbol like a colon or semi-colon.



Name	FName	City	Age	Salary
Smith	John	3	35	$280
Doe	Jane	1	28	$325
Brown	Scott	3	41	$265
Howard	Shemp	4	48	$359
Taylor	Tom	2	22	$250

Comma separated values. Image by Luis R Castellanos, Public Domain, own work.

So, let's say that we want to keep a record of all of our personal movie collection...

Title	Lead Actor/Actress	Director	Producer	Year	Genre
Die Hard	Bruce Willis	J McTiernan	L Gordon	1988	Action
Die Hard 2	Bruce Willis	R Harlin	L Gordon	1990	Action
Coco	Ben Bratt	L Unkrich	D Anderson	2017	Animated
Top Gun	Tom Cruise	T Scott	D Simpson	1986	Action
Top Gun Maverick	Tom Cruise	J Kosinski	J Bruckheimer	2022	Action
...					
Barbie	Margot Robbie	G Gerwig	D Heyman	2023	Comedy

Movie Flat File Database. Image by Luis R Castellanos, Public Domain, own work.

Advantages

- **Simplicity And Ease Of Use:** Flat file databases are incredibly straightforward to set up and maintain. They require no database management systems, just a text editor, spreadsheet application, or basic scripting. This accessibility makes them ideal for rapid deployment in small-scale or temporary projects.
- **Lightweight And Fast:** With data stored in a single, unindexed file, flat files often outperform complex systems when handling small to moderate datasets. As the survey shows, organizations frequently experience noticeably faster retrieval and processing times.
- **High Portability:** Flat file formats like CSV, TSV, and JSON are universally accepted across applications, platforms, and languages. A CSV file, for instance, can be opened in Microsoft Excel, imported into SQL databases, or parsed by Python, making it perfect for cross-system data exchange.
- **Low Resource Requirements:** Without the need for database servers or dedicated infrastructure, flat file databases run with minimal overhead. They're particularly suited for embedded systems, lightweight apps, or environments with constrained hardware resources.
- **Ideal For Quick Data Exchange:** Flat files remain the go-to choice for data migration, system integration, and API-based transfers. They don't require complex conversions or adapters, enabling smooth and reliable data interchange across diverse systems.
- **Transparency And Human-Readability:** Because the data is stored in plain text, flat files are easy to inspect, debug, and manually edit. This transparency simplifies troubleshooting and supports quick corrections without specialized query tools.

Drawbacks

- **Data Redundancy and Inconsistency:** Because information is stored in a single table without relational links, duplicate data is common. Updating an entry in one place does not automatically update it elsewhere, which leads to errors
- **Weak Concurrency Control:** Flat files lack safe multi-user support. If two users or programs try to write or edit the file at the same time, it can overwrite changes or corrupt the entire file.
- **Poor Scalability and Performance:** Searching and reading data requires scanning the file sequentially. As the dataset grows, performance slows down significantly because there are no built-in indexes.
- **Limited Security:** Flat files lack built-in user accounts, encryption, or granular access permissions. Anyone with file system access can usually read or modify the data.
- **No Relationships or Constraints:** You cannot enforce data types, foreign keys, or complex rules natively within the file structure.
- **Structural Dependence:** Programs or scripts often rely on exact field positions or column indexes. Changing the structure (like adding a column) can break dependent applications.

> Data **concurrency** means that many users can access data at the same time.

Title	Lead Actor/Actress	Director	Producer	Year	Genre
Die Hard	Bruce Willis	J McTiernan	L Gordon	1988	Action
Die Hard 2	Bruce Willis	R Harlin	L Gordon	1990	Action
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Top Gun Maverick	Tom Cruise	J Kosinski	J Bruckheimer	2022	Action
...					
Barbie	Margot Robbie	G Gerwig	D Heyman	2023	Comedy

Movie Flat File Database, showing redundancy. Image by Luis R Castellanos, Public Domain, own work.

2. Structured Data

> **Structured data** refers to a standardized format for organizing and storing information, typically in rows and columns within a database. This allows for easy querying, indexing, and retrieval of data, making it highly efficient for various computational tasks.
>
> Lenovo

The primary purpose of structured data is efficient querying, reporting, and analytics. With its well-defined organization, it's easy for business intelligence tools and applications to extract insights quickly and accurately — and then use that data to make business decisions.

You will find structured data in almost every industry.

- In finance, it powers transaction records and performance analysis.
- Similarly, in retail, structured data supports inventory management, sales tracking, and customer behavior analysis.

The structured data is managed with the "Structured Query Language" (SQL).

> **Structured query** is a human-readable (relatively) sentence-style **language** that uses a fixed vocabulary to describe what data we want and how to manipulate it.

The data is organized with SQL, and it is broken into different groups, called tables. Within these tables are **rows** and **columns**, in which each row is a record of data and each column identifies the nature of the information in that position. The intersection of a row and column is a **cell** or one piece of information.

We can use our query language to ask the database to find all records where the movie ID matches the movie ID in the movie table, and also where the movie name is "**Die Hard**." The query will come back with a list of rows that has the value in the movie ID column. We can also match the actor IDs from a table that pairs actors with movies to records in the actor table in order to get their names.

It is a more efficient way of managing the data.

Advantages

Using structured data comes with many advantages, including the four below.

- **Simplifies data querying and reporting**: Structured data enables fast and precise querying using tools like SQL. The organized nature of the data allows you to quickly retrieve specific information without sifting through irrelevant details. The structured format also makes it easier for you to create detailed reports, ensuring accuracy and clarity in presenting data-driven findings.

- **Supports robust analytics and insights**: Structured data is an ideal foundation for advanced analytics and business intelligence (BI) tools. Its standardized organization makes it simple to integrate with analytical platforms to uncover trends, patterns, and anomalies. Predictive modeling and strategic planning also rely heavily on structured data. For instance, a company might use historical sales data to forecast future demand or identify key drivers of customer retention.

- **Ensures high data accuracy and reliability**: The schema used for structured data can help improve data accuracy and reliability. By defining data types and constraints, schemas minimize errors during data input and management, which can then help maintain data integrity and quality. For example, database rules might restrict a phone number field to numeric values of a specific length, and that helps data entries remain consistent. This high level of accuracy makes structured data trustworthy for critical operations.

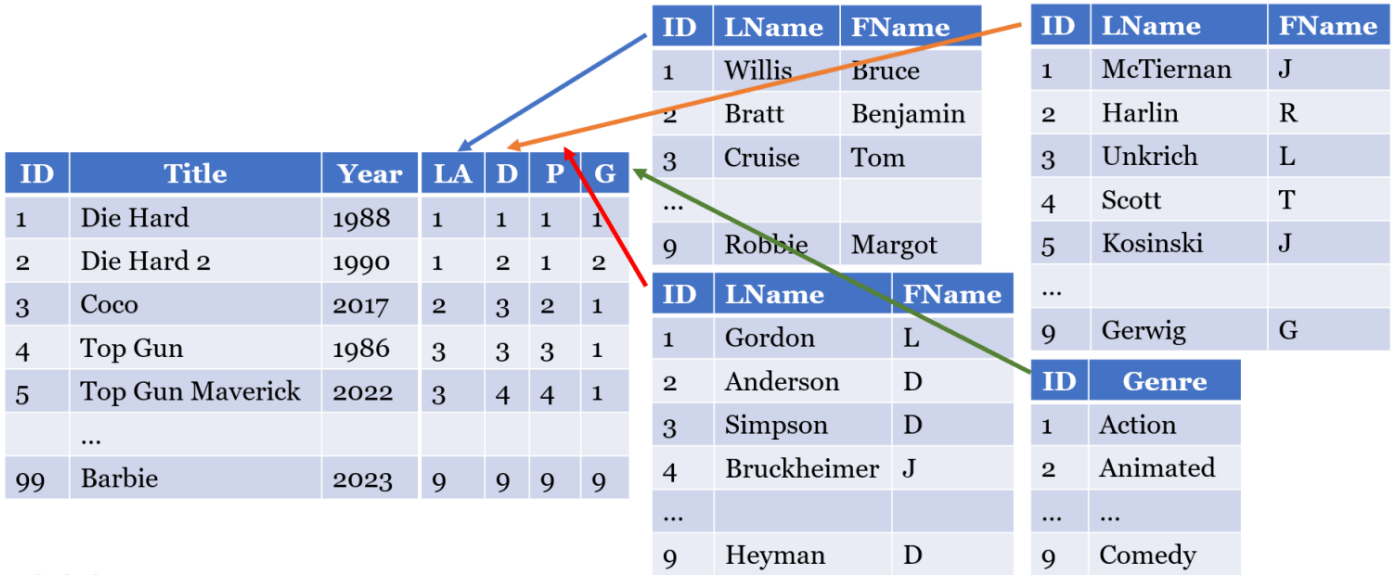
- **Integrates easily with existing systems**: One of the significant advantages of structured data is its compatibility with existing systems including legacy infrastructure and modern platforms. Structured data also supports cross-platform data exchange and is highly adaptable in multi-system environments. For example, customer data stored in a relational database can easily be shared with marketing automation platforms or customer relationship management (CRM) systems. This interoperability improves efficiency and reduces the complexity of managing data across disparate systems.

Drawbacks

- **Limited to predefined formats**: Structured data while that creates consistency, it also limits adaptability to data that doesn't fit neatly into predefined formats. For example, social media comments or free-text feedback are unstructured by nature and cannot be easily captured within a traditional structured data system.

- **Lacks flexibility for unstructured inputs**: Another challenge is the inability of structured data to accommodate diverse data types, such as video files, images, or audio recordings. Relational databases, which are ideal for handling text and numerical data, are not designed to store or analyze multimedia content or other unstructured formats data directly.

- **Can't scale well with large datasets**: As datasets grow larger, structured databases may cause performance bottlenecks, longer query times, and increased costs for infrastructure upgrades. These scalability challenges often necessitate transitioning to more modern, distributed database systems or hybrid approaches that can handle high volumes of diverse data efficiently.



ID	Title	Year	LA	D	P	G
1	Die Hard	1988	1	1	1	1
2	Die Hard 2	1990	1	2	1	2
3	Coco	2017	2	3	2	1
4	Top Gun	1986	3	3	3	1
5	Top Gun Maverick	2022	3	4	4	1
	...					
99	Barbie	2023	9	9	9	9

ID	LName	FName
1	Willis	Bruce
2	Bratt	Benjamin
3	Cruise	Tom
...		
9	Robbie	Margot

ID	LName	FName
1	McTiernan	J
2	Harlin	R
3	Unkrich	L
4	Scott	T
5	Kosinski	J
...		
9	Gerwig	G

ID	LName	FName
1	Gordon	L
2	Anderson	D
3	Simpson	D
4	Bruckheimer	J
...		
9	Heyman	D

ID	Genre
1	Action
2	Animated
...	...
9	Comedy

Movie Structured Database. Image by Luis R Castellanos, Public Domain, own work.

3. Unstructured Data

> **Unstructured data** is data, such as images, text documents, social posts, internet of things (IoT), videos, emails, photos, and audio files, that lacks a set format and is hard to organize in rows, columns or fields.
>
> Data360

That's why it doesn´t fit easily into predefined tables or standardized formats, and cannot be organized, indexed, or queried effectively in a legacy relational database management system (RDBMS).

Unstructured data can contain both textual and nontextual data and both qualitative (social media comments) and quantitative (figures embedded in text) data. As it doesn't have a predefined data model, it is not easily processed and analyzed through conventional data tools and methods. It is best managed in nonrelational or NoSQL databases or in data lakes, which are designed to handle massive amounts of raw data in any format.

The importance of unstructured data is rapidly increasing. Recent projections indicate that unstructured data is over 80% of all enterprise data, while 95% of businesses prioritize unstructured data management.

The most common sources for Unstructured Data are:

- **Text files:** Text files are usually rich with unstructured data. You'll find it in customer emails, notes, customer logs, and chatbot chats. Your pdfs can also contain unstructured data.
- **Multimedia content:** According to one estimate, our digital world generates over 400 terabytes of data daily — much of it in the form of videos, digital photos, audio files, podcasts, and medical images. Every time you join a digital meeting or conference you generate unstructured data. Your security camera footage is full of unstructured data, and so is every customer video and webinar you record.
- **Social media:** X, LinkedIn, Facebook, TikTok, Instagram, and YouTube are some of the most popular social media sites. Each channel contains troves of unstructured data. YouTube videos, customer interviews, Instagram comments on your recent post, and Facebook posts are examples of unstructured data.
- **Websites and markup language:** Your organization's website is brimming with unstructured data. HTML and XHTML provide markup tags that serve as the building blocks for web display, but the content between the tags is unstructured.
- **Mobile and communications data:** How long can you go without your phone? Each voicemail you generate and retrieve and each customer message is rich with unstructured data. Messaging data falls in this category too.

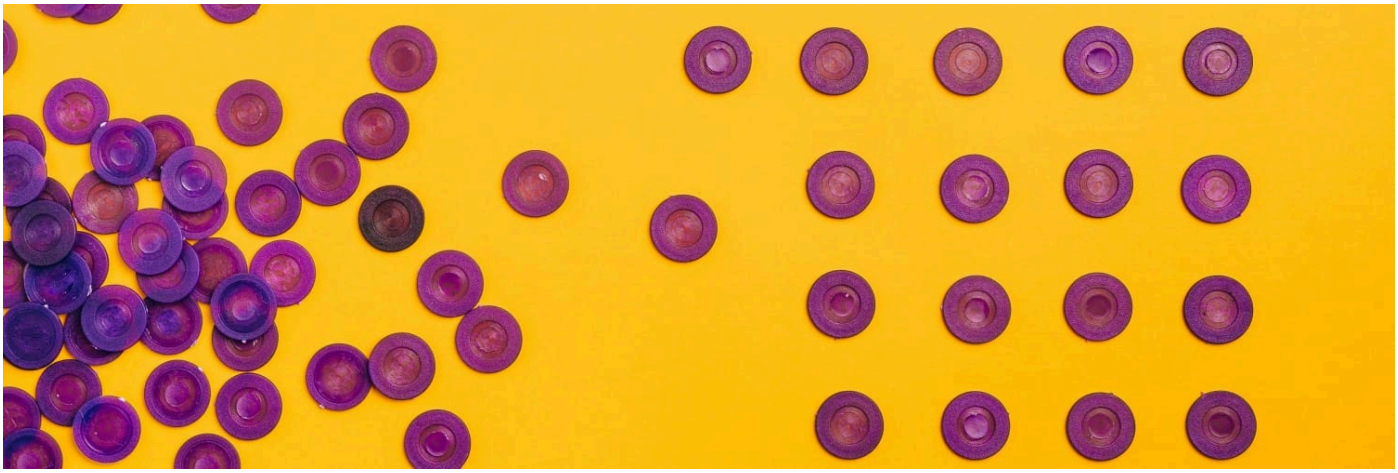
- **Machine and sensor data:** IoT devices and sensors are loaded with unstructured data. A grocery retailer, for example, may use IoT sensors to monitor and optimize food storage temperatures. Data from medical testing, weather monitoring systems, motion sensors, and GPS systems is also unstructured.
- **Historical archives:** Archived documents, scanned historical records, and other such data you have collected over the years in external hard drives or network drives is often unstructured. Government agencies usually retain a lot of unstructured historical data in their archives.

Advantages

- **Flexibility**: Unstructured data is stored in its native format and remains undefined until needed. This file format flexibility widens the pool of available data and enables data scientists to use data for multiple use cases.
- **Fast accumulation rates**: For most organizations, this type of data is growing at 3x the rate of structured data. Since there is no need to predefine unstructured data, it can be collected quickly and easily, which is helpful for generative AI and large language model (LLM) fine-tuning.
- **Easy and cheap to store**: Unstructured data has more storage options than structured data. For instance, file systems or data lakes allow for massive storage and pay-as-you-use pricing, which cuts costs and eases scalability.
- **Enhanced insights**: Unstructured data can lead to qualitative information that adds rich context and can improve business-critical decisions. With the right technologies and expertise you can identify problem areas, streamline operations, enhance your services or products, and improve marketing performance.

Drawbacks

- **Requires expertise**: Due to its undefined or nonformatted nature, data science expertise is required to prepare and analyze unstructured data. This can alienate business users who might not fully understand specialized data topics or analysis.
- **Specialized tools**: Traditional tools such as Excel are not adequate for manipulating unstructured data, and product choices are limited for data managers. Some tools for unstructured data management include: MongoDB, DynamoDB, Hadoop and Azure.
- **Data cleanliness**: The large volume and nonuniform data structure of unstructured data can introduce inconsistencies, inaccuracies and data quality issues. Data cleaning might be necessary before data processing.



Unstructured (left) vs Structured (right) data. Image by Arturo EG from Pexels.

4. Semi-structured data

> **Semi-structured** data is the “bridge” between structured and unstructured data. It is useful for web scraping and data integration.
>
> Jonker & Gomstyn

Semi-structured data does not have a predefined data model. However, it uses metadata (for example, tags and semantic markers) to identify specific data characteristics and scale data into records and preset fields. Metadata ultimately enables semi-structured data to be better cataloged, searched and analyzed than unstructured data.

Examples of semi-structured data include JavaScript Object Notation (JSON), comma-separated values (CSV) and eXtensible Markup Language (XML) files. A more commonly cited example is email where some data sections have a standardized format (such as headers and subject lines) but unstructured data content within those sections.

Semi-structured data uses “metadata” to identify specific data characteristics and scale data into records and preset fields. Metadata ultimately enables semi-structured data to be better cataloged, searched, and analyzed than unstructured data.

> The simple definition of **metadata** is “data about data.”
>
> IBM

That is, it provides details about data that is separate from the content of the data itself.

For example, a table of recent customer orders constitutes a dataset, while information about that data set—such as who owns it or what type of file it is—is the metadata.

Different types of metadata serve different functions. For example, descriptive metadata for a document might include the author, creation date, file size and keywords. Technical metadata for a relational database might describe the structure of tables, data types and relationships between tables.

Social media platforms, such as Facebook and X, use metadata to organize posts and recommend content. Metadata, such as hashtags and geolocation, can help users find and share relevant information.



Metadata. Image by Markus Winkler from Pexels

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7.2: Before Database Systems



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7.2.1. File-based System

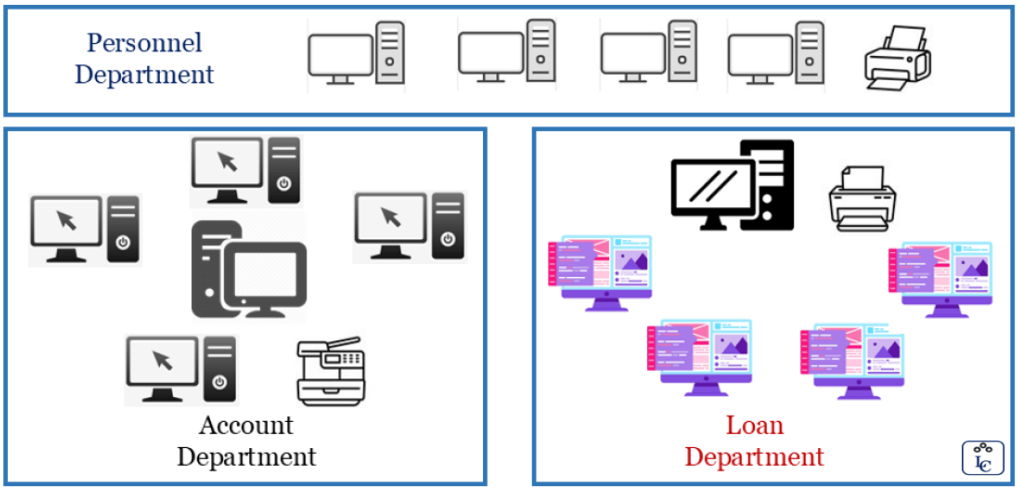
The way in which computers manage data has come a long way over the last few decades. Today's users take for granted the many benefits found in a database system. However, it wasn't that long ago that computers relied on a much less elegant and costly approach to data management called the file-based system.

One way to keep information on a computer is to store it in permanent files. A company system has a number of application programs; each of them is designed to manipulate data files. These application programs have been written at the request of the users in the organization. New applications are added to the system as the need arises.

The system just described is called the file-based system.

Consider a traditional banking system that uses the file-based system to manage the organization's data. As we can imagine, there are different departments in the bank. And each has its own applications that manage and manipulate different data files. For banking systems, the programs may be used to debit or credit an account, find the balance of an account, add a new mortgage loan, and generate monthly statements.

And for a new employee, just hired by the bank, there will be a different file on him/her in different departments across the bank. If one of those files gets updated, the other files will remain without those updates.



Account, Loan and Personnel Departments in a bank. By Luis R Castellanos, Public domain, own work.

7.2.2. File-based System: Disadvantages

Using the file-based system to keep organizational information has a number of disadvantages. Listed below are five examples.

1. Data redundancy
2. Data isolation
3. Integrity problems
4. Security problems
5. Concurrency access

1.Data redundancy

Often, within an organization, files and applications are created by different programmers from various departments over long periods of time. This can lead to data redundancy, a situation that occurs in a database when a field needs to be updated in more than one table.

This practice can lead to several problems such as:

- Inconsistency in data format
- The same information being kept in several different places (files)
- Data inconsistency, a situation where various copies of the same data are conflicting, wastes storage space and duplicates effort

2.Data isolation

Data isolation is a property that determines when and how changes made by one operation become visible to other concurrent users and systems. This issue occurs in a concurrency situation. This is a problem because:

- It is difficult for new applications to retrieve the appropriate data, which might be stored in various files.

3.Integrity problems

Problems with data integrity is another disadvantage of using a file-based system. It refers to the maintenance and assurance that the data in a database are correct and consistent. Factors to consider when addressing this issue are:

- Data values must satisfy certain consistency constraints that are specified in the application programs.

- It is difficult to make changes to the application programs in order to enforce new constraints.

4.Security problems

Security can be a problem with a file-based approach because:

- There are constraints regarding accessing privileges.
- Application requirements are added to the system in an *ad-hoc* manner so it is difficult to enforce constraints.

> *Ad hoc* is a word that originally comes from Latin and means “for this” or "for this situation." It is used to describe something that has been formed or used for a special and immediate purpose, without previous planning.

5.Concurrency access

Concurrency is the ability of the database to allow multiple users access to the same record without adversely affecting transaction processing. A file-based system must manage, or prevent, concurrency by the application programs. Typically, in a file-based system, when an application opens a file, that file is locked. This means that no one else has access to the file at the same time. In database systems, concurrency is managed thus allowing multiple users access to the same record. This is an important difference between database and file-based systems.

7.2.3. Database Approach

The difficulties that arise from using the file-based system have prompted the development of a new approach in managing large amounts of organizational information called the **database approach**. Databases and database technology play an important role in most areas where computers are used, including business, education and medicine.

Role of databases in business

Everybody uses a database in some way, even if it is just to store information about their friends and family. That data might be written down or stored in a computer by using a word-processing program or it could be saved in a spreadsheet. However, the best way to store data is by using database management software.

This is a powerful software tool that allows you to store, manipulate and retrieve data in a variety of different ways. Most companies keep track of customer information by storing it in a database. This data may include customers, employees, products, orders or anything else that assists the business with its operations.

The meaning of data

Data are factual information such as measurements or statistics about objects and concepts. We use data for discussions or as part of a calculation. Data can be a person, a place, an event, an action or any one of a number of things. A single fact is an element of data, or a data element. If data are information and information is what we are in the business of working with, you can start to see where you might be storing it.

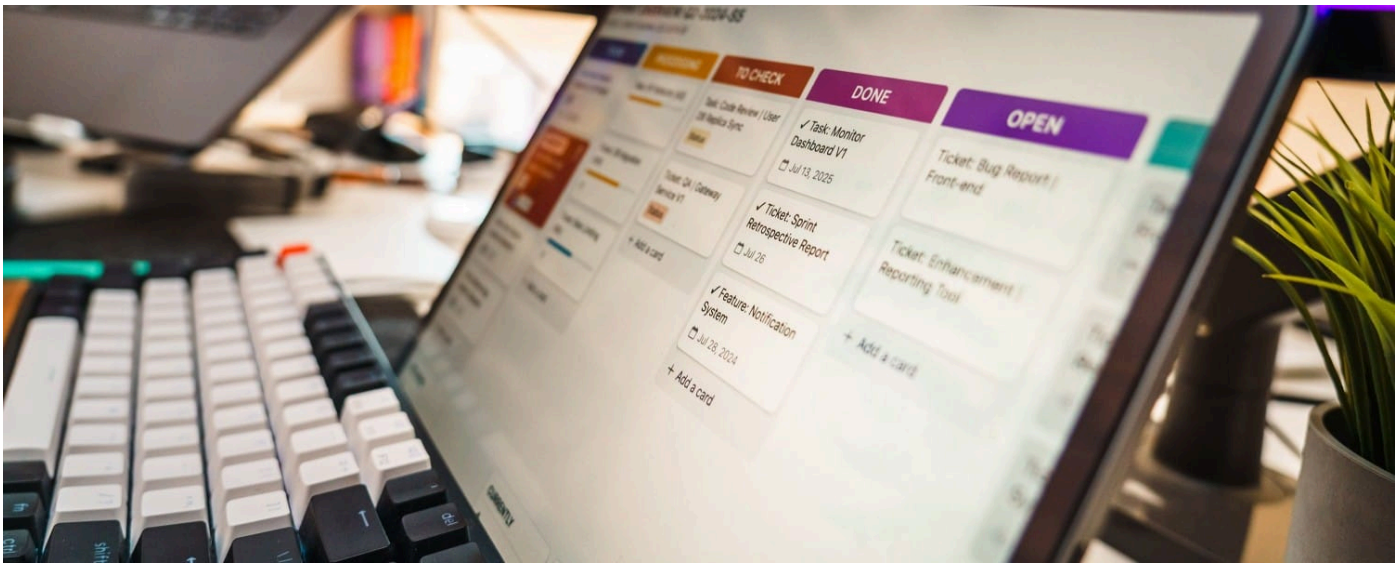
Data can be stored in:

- Filing cabinets
- Spreadsheets
- Folders
- Ledgers
- Lists
- Piles of papers on your desk

All of these items store information, and so too does a database. Because of the mechanical nature of databases, they have terrific power to manage and process the information they hold. This can make the information they house much more useful for your work.

With this understanding of data, we can start to see how a tool with the capacity to store a collection of data and organize it, conduct a rapid search, retrieve and process, might make a difference to how we can use data.

This section and those that follow are all about managing information.



Database approach. Image by Jakub Zerdzicki from Pexels

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7.3: The Relational Data Model and others



Contents

7.3.1. Relational Model

7.3.2. Data Warehouse

7.3.3. Data Mining

7.3.4. Business Intelligence and Business Analytics

7.3.1. Relational Model

The relational data model was introduced by E. F. Codd in 1970. Currently, it is the most widely used data model.

> Edgar F. Codd. The inventor made relational databases possible.
>
> IBM

The relational model has provided the basis for:

- Research on the theory of data/relationship/constraint
- Numerous database design methodologies
- The standard database access language called structured query language (SQL)
- Almost all modern commercial database management systems

The relational data model describes the world as "**a collection of inter-related relations** (or tables)."

> In 2002, **Forbes** listed Codd's relational model as one of the most important innovations of the previous 85 years.
>
> Forbes Magazine. *85 Years & Ideas*. December 23, 2002.

Relation

A relation, also known as a table or file, is a subset of the Cartesian product of a list of domains characterized by a name.

And within a table, each row represents a group of related data values. A row, or record, is also known as a tuple.

The columns in a table are fields and they are also referred to as attributes.

You can also think of it this way: an attribute is used to define the record and a record contains a set of attributes.

> Relation = Table = File.
>
> Row = Record = Tuple
>
> Columns = Fields = Attributes

There are three (3) possible relationships in a database:

- 1:1 (one-to-one) ⇒ Connects one entity to one other entity. Example: A row in Table A links to exactly one row in Table B.
- 1:m (one-to-many) ⇒ Connects one entity to one or more other entities. Example: A row in Table A links to multiple rows in Table B, but Table B links to only one in Table A.
- m:n (many-to-many) ⇒ Connects many entities to many other entities. Example: Multiple rows in Table A link to multiple rows in Table B.

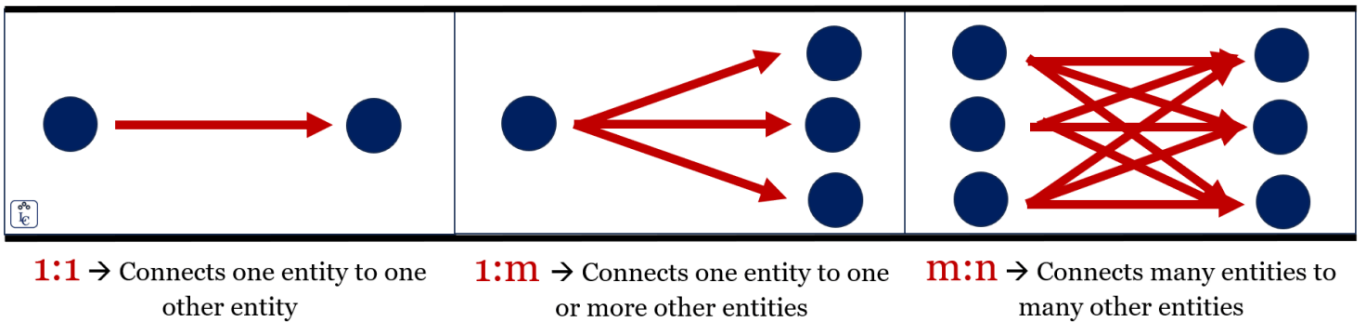
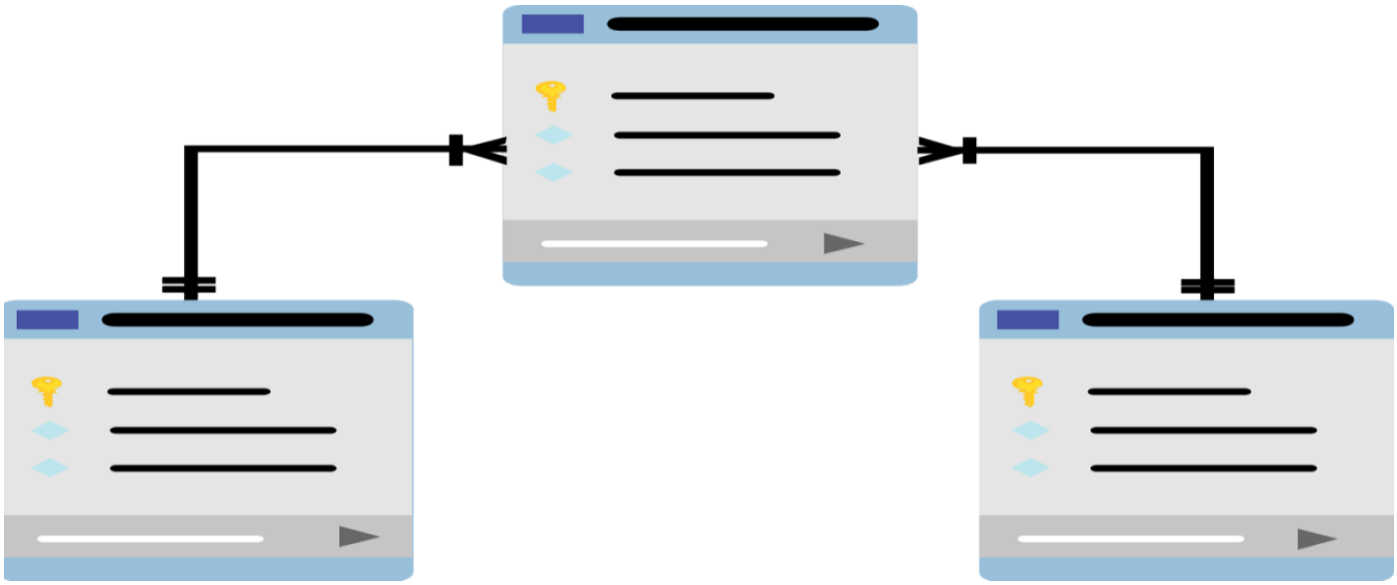


Table relationships in a database. Image by Luis R Castellanos, Public domain, own work.

Table

A database is composed of multiple tables and each table holds the data. Here is shown a database that contains three tables.



Database with 3 tables. Image by mcmurryjulie from Pixabay

Column

A database stores pieces of information or facts in an organized way. Understanding how to use and get the most out of databases requires us to understand that method of organization. The principal storage units are called **columns** or **fields** or **attributes**. These house the basic components of data into which your content can be broken down.

Let's take a look at the following table:

First Name	Fam Name	Nationality	Salary	DoB	Marital Sta	Shift	Place Issue	Valid until
James	Corning	Canadien	98,500	25Oct1990	Married	Tue, Thu	London	15Nov2004
Taylor	Gomez	Mexican	101,200	05Apr1986	Divorced	Fri, Sat	Oaxaca	23May2005
Isabelle	Whelan	British	109,900	15Sep1983	Single	Mon, Wed	Addis Ababa	17Dec2003

Employee table. Image by Luis R Castellanos, Public domain, own work.

Now, let's look at the example of an ID card in the next figure to see the relationship between fields and their data.

Field Name	Data
First Name	Isabelle
Fam Name	Whelan
Nationality	British
Salary	109,900
Date Birth	15Sep1993
Marital Sta	Single
Shift	Mon, Wed
Place Issue	Addis Ababa
Valid until	17Dec2033

Isabelle Whelan from the employee table. Image by Luis R Castellanos, Public domain, own work.

Domain

A domain is the original set of atomic values used to model data. By atomic value, we mean that each value in the domain is indivisible as far as the relational model is concerned. For example:

- The domain of Marital Status has a set of possibilities: Married, Single, Divorced, Widow.
- The domain of Shift has the set of all possible days: {Mon, Tue, Wed...}.
- The domain of First Name is the set of character strings that represents names of people.
- The domain of Salary is the set of all floating-point numbers greater than 0 and less than 200,000.

In summary, a domain is a set of acceptable values that a column is allowed to contain. This is based on various properties and the data type for the column.

Records

Just as the content of any one document or item needs to be broken down into its constituent bits of data for storage in the fields, the link between them also needs to be available so that they can be reconstituted into their whole form.

Records allow us to do this. Records contain fields that are related, such as a customer or an employee. As noted earlier, a tuple is another term used for record.

Records and fields form the basis of all databases. A simple table gives us the clearest picture of how records and fields work together in a database storage project.

The simple table example in the figure shows us how fields can hold a range of different sorts of data.

RecordID	PubDate	Author	Title
1	7/26/1968	B Pitt	Rights and Wrongs online
2	5/3/2000	A Jolie	Networking for Change
3	2/27/1971	J Carter	The Myth of Cyber Crimes
4	9/15/1983	I Wheaton	Connecting the disconnected

Author´s table. Image by Luis R Castellanos, Public domain, own work.

This one has:

- A Record ID field: this is an ordinal number; its data type is an integer.
- A PubDate field: this is displayed as month/day/year; its data type is date.
- An Author field: this is displayed as Initial. Surname; its data type is text.
- A Title field text: free text can be entered here.

You can command the database to sift through its data and organize it in a particular way. For example, you can request that a selection of records be limited by date:

1. all before a given date,
2. all after a given date or
3. all between two given dates.

Similarly, you can choose to have records sorted by date. Because the field, or record, containing the data is set up as a Date field, the database reads the information in the Date field not just as numbers separated by slashes, but rather, as dates that must be ordered according to a calendar system.

Degree

The degree is the number of attributes in a table. In our example the above figure we have been working with, has a 4 degree.

Table Properties

- A table has a name that is distinct from all other tables in the database.
- There are no duplicate rows; each row is distinct.
- Entries in columns are atomic. The table does not contain repeating groups or multivalued attributes.
- Entries from columns are from the same domain based on their data type including:
  - number (numeric, integer, float, smallint,...)
  - character (string)
  - date
  - logical (true or false)
- Operations combining different data types are disallowed.
- Each attribute has a distinct name.
- The sequence of columns is insignificant.
- The sequence of rows is insignificant.

7.3.2. Data Warehouse

> A **data warehouse** aggregates data from various sources into a central data store optimized for querying and analysis.
>
> It typically uses extract, transform and load (ETL) or extract, load and transform (ELT) processes to clean, prepare and organize data for business intelligence (BI) and other data analytics use cases.
>
> Holdsworth, Jim; Kosinski, Matthew & Jonker, Alexandra

The concept of the data warehouse is simple: extract data from one or more of the organization's databases and load it into the data warehouse (which is itself another database) for storage and analysis.

Data warehousing systems can integrate large amounts of data from a wide range of source systems, including operational databases, transactional systems and customer relationship management (CRM) platforms.

Its analytical capabilities allow organizations to derive valuable business insights from their data to improve decision-making. Over time, it builds a historical record that can be invaluable to data scientists and business analysts. Because of these capabilities, a data warehouse can be considered an organization's "single source of truth."

Types of data warehouses

There are three main types of data warehouses:

- Enterprise data warehouse (EDW)
- Operational data store (ODS)
- Data mart

Enterprise data warehouse (EDW)

An enterprise data warehouse (EDW) is a data warehouse that services the entire enterprise. It acts as a centralized information repository of historical data for all teams and subject areas. An enterprise data warehousing environment can also include an operational data store (ODS) and department-specific data marts.

Operational data store (ODS)

An operational data store (ODS) contains the most recent snapshot of operational data. An ODS is updated frequently, enabling quick access to near-real-time data. Organizations often use an ODS for day-to-day operational decision-making and real-time analysis. It can also be a data source for an EDW or other data systems.

Data mart

A data mart is a subset of an existing data warehouse (or other data sources) and contains data tailored to a specific business line or department rather than the entire enterprise. For example, a company can have a data mart that aligns with the marketing department. Those users can access more-focused insights for customer segmentation and campaign performance without navigating the broader enterprise data set.

Data warehouse benefits

Data warehouses make insights and information available to users across an organization, offering many benefits, such as:

- **Improved data quality**: Data warehouses process incoming data, applying data cleansing, standardization, deduplication, and governance to ensure accuracy. By integrating this high-quality, reliable data into a single central repository, organizations eliminate data silos and establish a single source of truth for confident business decision-making.
- **Support for AI and machine learning**: Modern data warehouses supply clean, structured data necessary for building and fine-tuning custom AI and machine learning models. However, because not all traditional data warehouses are optimized to handle AI workloads efficiently, data lakehouses are rapidly becoming the preferred platform for modern AI infrastructure.
- **Enhanced decision support**: Data warehouses centralize and cleanse multi-source data into a single source of truth, enabling self-service BI tools to query it across the enterprise. This empowers non-technical business users to easily extract insights, spot trends, and help leaders make data-driven decisions across processes, finances, and operations.
- **Time-Variant**: Unlike operational databases, which constantly update and overwrite records to reflect only the current state, a data warehouse acts as a continuous time-series repository. It captures, timestamps, and preserves snapshots of enterprise data over long periods (often years or decades). Data in the warehouse is not updated or deleted; it is only loaded and queried.

Data Warehouse drawbacks

- **Complexity**: Designing and maintaining a normalized data warehouse can be complex and resource-intensive.
- **Time-Consuming**: Requires significant time and effort to implement.
- **Cost**: It requires a high initial investment in infrastructure, tools, and expertise.
- **Changing Requirements**: Adapting the data warehouse to evolving business needs can be challenging.

Big data: refers to massive, complex datasets that traditional data management systems cannot handle.

Data lake: is a repository designed to store large volumes of raw data, typically using low-cost cloud object storage.

Data lakehouse: is a modern data platform that combines the low-cost, flexible data storage of a data lake with the high-performance analytics and data management capabilities of a data warehouse.

Data silo: isolated collection of data that prevent data sharing between different departments, systems and business units.

IBM topics

YouTube Video

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View this YouTube Video online

7.3.3. Data Mining

Data mining is the use of machine learning and statistical analysis to uncover patterns and other valuable information from large data sets.

Given the evolution of machine learning (ML), data warehousing, and the growth of big data, the adoption of data mining has rapidly accelerated over the last decades.

The data mining techniques that underpin data analyses can be deployed for two main purposes. They can either describe the target data set or they can predict outcomes by using machine learning algorithms.

Benefits

- **Discover hidden insights and trends**: Data mining takes raw data and finds order in the chaos: seeing the forest for the trees. This can result in better-informed planning across corporate functions and industries, including advertising, finance, government, healthcare, human resources (HR), manufacturing, marketing, research, sales and supply chain management (SCM).
- **Save budget**: By analyzing performance data from multiple sources, bottlenecks in business processes can be identified to speed resolution and increase efficiency.
- **Solve multiple challenges**: Data mining is a versatile tool. Data from almost any source and any aspect of an organization can be analyzed to discover patterns and better ways of conducting business. Almost every department in an organization that collects and analyzes data can benefit from data mining.

Drawbacks

- **Complexity and risk:** Useful insights require valid data, plus experts with coding experience. Knowledge of data mining languages including Python, R and SQL is helpful. An insufficiently cautious approach to data mining might result in misleading or dangerous results. Some consumer data used in data mining might be personally identifiable information (PII) which should be handled carefully to avoid legal or public relations issues.
- **Cost:** For the best results, a wide and deep collection of data sets is often needed. If new information is to be gathered by

an organization, setting up a data pipeline might represent a new expense. If data needs to be purchased from an outside source, that also imposes a cost.
- **Uncertainty:** First, a major data mining effort might be well run, but produce unclear results, with no major benefit. Or inaccurate data can lead to incorrect insights, whether incorrect data was selected or the preprocessing was mishandled. Other risks include modeling errors or outdated data from a rapidly changing market.

Privacy Concerns

The increasing power of data mining has caused concerns for many, especially in the area of privacy. In today's digital world, it is becoming easier than ever to take data from disparate sources and combine them to do new forms of analysis. In fact, a whole industry has sprung up around this technology: **data brokers**. These firms combine publicly accessible data with information obtained from the government and other sources to create vast warehouses of data about people and companies that they can then sell.

YouTube Video

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7.3.4. Business Intelligence and Analytics

With tools such as data warehousing and data mining at their disposal, businesses are learning how to use information to their advantage.

Business Intelligence

> **Business intelligence** (BI) is a set of technological processes for collecting, managing and analyzing organizational data to yield insights that inform business strategies and operations.
>
> IBM

Transforms raw data into meaningful insights that drive strategic decision-making within an organization.

Benefits of BI:

- **Clearer reporting:** BI gives organizations the ability to ask questions in plain language and get answers they can understand. Dashboards can prioritize the most important insights, saving time for both data experts and nontechnical team members. Instead of using best guesses, staff can base decisions on what their business data is telling them whether it relates to production, supply chain, customers or market trends. The data can help answer an organization's pressing questions: Why are sales dropping in this region? Where do we have excess inventory? What are customers saying on social media?
- **Consolidated data:** BI delivers business insights by pulling in and consolidating data from multiple sources, internal and external, for complete analysis. By providing an accurate picture of the business and market, BI provides an organization with the means to design a business strategy.
- **Creates new efficiencies:** Organizations can monitor business operations against benchmarks and fix or make improvements on an ongoing basis, all fueled by data insights. Analytics can discover and help eliminate manufacturing or supply chain bottlenecks. Managers can monitor staff performance to help pinpoint where organizational changes can be made. Supply chain management can be improved by monitoring activity up and down the line and communicating results

with partners and suppliers.
- **Deeper data insights:** BI helps organizations become more data-driven, to continually improve business performance, gain competitive advantage, and locate new customers and new opportunities. They can improve ROI by understanding their business and market, and intelligently allocating resources to meet strategic objectives. New data insights can reveal customer behavior, preferences and market trends. Those insights enable marketers to better target prospects or tailor products to changing market needs.
- **Faster decision making:** As progress is monitored and analyzed digitally, better informed decisions can be made more quickly for faster adjustments in the marketplace.
- **Increase customer satisfaction:** When customer service staff have access to customer data and insights, they can provide requested information and resolve issues more quickly.
- **Increase employee satisfaction:** Self-help access to important business data can optimize workflows so that staff can do their jobs faster, with fewer added or repetitive steps.

Challenges of BI

- **Contradictory conclusions:** Self-service BI empowers multiple teams to search for the insights they need, but can also lead to divergent conclusions, which can create more friction instead of a unified plan of action. This can be especially true if human bias creeps into the analysis.
- **Skills shortfall:** The need for data integration might be difficult, given a wide variety of sources, and integration might exceed current capabilities. Expertise in data science, engineering and architecture is required to help ensure that analysis yields insights that reflect reality.
- **Up-front costs:** The initial costs to develop a powerful, modern BI system might appear large, but the cost savings generated by analysis will offset the investment.

Business Analytics

> **Business analytics** (BA) refers to the statistical methods and computing technologies for processing, mining and visualizing data to uncover patterns, relationships and insights that enable better business decision-making.
>
> IBM

Benefits of BA

- **Faster and better-informed decisions:** Having a flexible and expansive view of all the data an organization possesses can eliminate uncertainty, prompt an organization to take action faster, and improve business processes. If an organization's data suggests that sales of a particular product line are declining precipitously, it might decide to discontinue that line. If climate risk impacts the harvesting of a raw material another organization depends on, it might need to source a new material from somewhere else. It's especially helpful when considering pricing strategies. How a company prices its goods or services is based on thousands of data points, many of which do not remain static over time. Whether a company has a fixed or dynamic pricing strategy, being able to access real-time data to make smarter short- and long-term pricing data is critical. For organizations that want to incorporate dynamic pricing, business analytics enables them to use thousands of data points to react to external events and trends to identify the most profitable price point as frequently as necessary.
- **Single-window view of information:** Increased collaboration between departments and line-of-business users means that everyone has the same data and is talking from the same playbook. Having that single pane of glass shows more unseen patterns, enabling different departments to understand the company's holistic approach and increase an organization's ability to respond to changes in the marketplace.
- **Enhanced customer service:** By knowing what customers want, when and how they want it, organizations encourage happier customers and build greater loyalty. In addition to an improved customer experience, by being able to make smarter decisions on resource allocation or manufacturing, organizations are likely able to offer those goods or services at a more affordable price.

Knowledge Management

All companies accumulate knowledge over the course of their existence. Some of this knowledge is written down or saved, but

not in an organized fashion. Much of this knowledge is not written down; instead, it is stored inside the heads of its employees.

> **Knowledge management** is the process of formalizing the capture, indexing, and storing of the company's knowledge in order to benefit from the experiences and insights that the company has captured during its existence.

Knowledge Management tools enable experts to upload their knowledge into a searchable platform where employees can access procedures, best practices, and answers to common questions. This promotes a knowledge-sharing culture where employees always have the information they need to work effectively.

There are 5 main types of knowledge management tools:

- **Knowledge bases** are self-service libraries of FAQs, documentation, tutorials, videos, how-to guides, and more. An internal knowledge base is for employees, while an external one is for customers. Both facilitate quick answers to questions via a search function and organized company knowledge storage.
- **Learning management systems** facilitate employee development by storing and delivering quizzes, online courses, training programs, and other learning-focused materials.
- **Document management software** is a tool for creating, storing, accessing, and collaborating on documents across teams.
- **Content management systems** empower businesses to create, manage, and publish content on the Internet. These are usually no-code tools.
- **Customer relationship management systems** track customer information and communications, ensuring no correspondences get lost.

> Top Knowledge Management tools



Knowledge Management. Image by Getty Images from Unsplash

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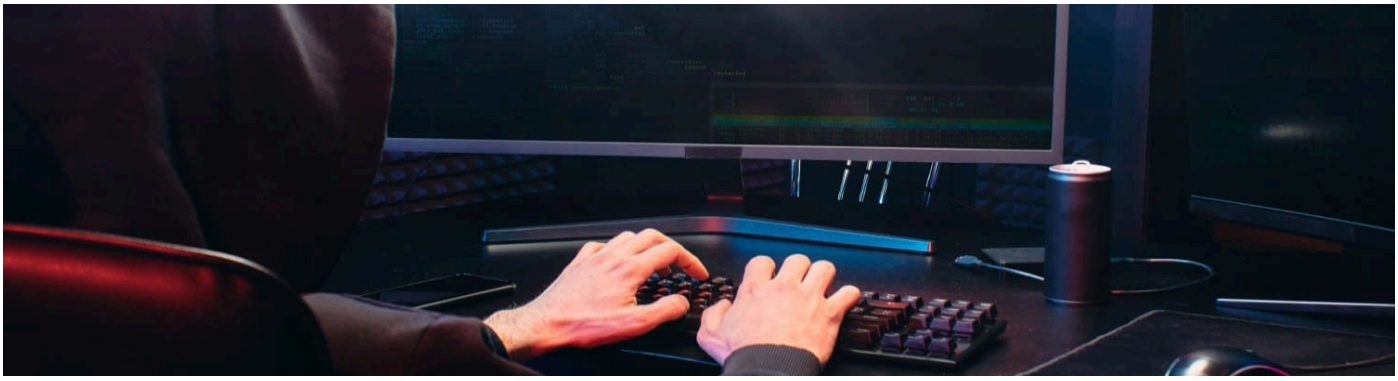
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7.4: Databases and Security Issues



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7.4.1. Data Security

It is the confidentiality, integrity, and availability (CIA) of the data in a database that need to be protected.

Confidentiality can be lost if an unauthorized person gains entry or access to a database, or if a person who is authorized to view selected records in a database accesses other records he or she should not be able to view.

If the data is altered by someone who is unauthorized to do so, the result is a loss of data **integrity**.

And if those who need to have access to the database and its services are blocked from doing so, there is a resulting loss of **availability**.

Check **Information Security Triad**

Security of any database is significantly impacted by any one or more of these basic components of CIA being violated. There are various reasons for spending money, time, and effort on data protection.

The main reason is reducing financial loss, followed by compliance with regulatory requirements, maintaining high levels of productivity, and meeting customer expectations.

Both businesses and home computer users should be concerned about data security.

The **information** stored in databases—client information, payment information, personal files, bank account details, and

more—**can be hard to replace**, whether the loss results from

- physical threats such as a fire or a significant power outage
- human error that results in errors in the processing of information or unintended deletion of data, or from erroneous input
- corporate espionage, theft, or malicious activity.

Loss of this data is potentially dangerous if it falls into the wrong hands.

It is in these three areas that a risk assessment of the database's security and protection of the data should focus. Is there a backup procedure that would allow access to the data if the primary database is destroyed by a physical threat? That same backup procedure might be important in case the CIA of the database is inadvertently affected by human error. And **what safeguards can/should be put in place** to prevent incidents of espionage, theft, or other malicious activity?

7.4.2. Data Breaches

Just how prevalent are the threats against databases? Is it worth the time, money, and personnel effort to ensure that the database is safeguarded?

> A **data breach** is any security incident in which unauthorized parties access sensitive or confidential information, including personal and corporate data.
>
> IBM

Why do Data Breaches happen?

Data breaches are caused by:

- **Innocent mistakes**, such as an employee emailing confidential information to the wrong person.
- **Malicious insiders**, including angry or laid-off employees who want to hurt the company or cause reputational damage, and greedy employees who want to profit off the company's data.
- **Hackers**, malicious outsiders who commit intentional cyber crimes to steal data. Hackers can act as lone operators or part of an organized ring.

Financial gain is the primary motivation for most malicious data breaches. Hackers steal credit card numbers, bank accounts or other financial information to directly drain funds from people and companies.

No database, and no government agency, company, or business is as secure as the owners of that database think. It is difficult for database administrators and security managers to keep pace with the new threats and vulnerabilities that continually emerge.

How do Data Breaches happen?

Most intentional data breaches caused by internal or external threat actors follow the same basic pattern:

1. **Research**: The threat actor identifies a target and looks for weaknesses that they can use to break into the target's system. These weaknesses can be technical, such as inadequate security controls, or human, such as employees susceptible to social engineering.
2. **Attack**: The threat actor starts an attack on the target by using their chosen method. The attacker might send a spear-phishing email, directly exploit vulnerabilities in the system, use stolen login credentials to take over an account or leverage other common data breach attack vectors.
3. **Compromise or extract the data**: Inside the system, the attacker locates the data they want and does what they came to do. Common tactics include exfiltrating data for sale or use, destroying the data or locking up data to demand a ransom.

Some consequences of Data Breaches

- **Financial losses**: Financial losses are one of the major impacts that will result from a data breach at a business.
  - Remediation expenses are one of the more immediate consequences of a data breach at a business. This includes the costs associated with investigating the breach, mitigating its impact, and finally restoring systems and data integrity.
  - Data breaches can lead to a loss of revenue and market value as a result of diminished customer trust, reputational damage, and decreased sales. Customers may choose to take their business elsewhere following a breach, resulting in lost sales and reduced revenue over the long term.
  - Businesses may need to allocate resources to communicate transparently with affected customers, offer compensation or incentives to regain their loyalty, and reassure prospective customers about the company's commitment to data security.
  - Additionally, businesses may incur costs associated with implementing customer retention programs, such as loyalty rewards and promotional campaigns, to mitigate churn and preserve customer relationships in the aftermath of a breach.
- **Reputational Damages**: The trust and confidence that customers place in a business are invaluable assets. However, a data breach can shatter this trust overnight, resulting in long-term reputational damage. When news of a breach breaks, businesses often face a number of implications as a result.
- **Legal and Compliance Consequences**: There are also a number of legal ramifications as a direct result of a data breach. Whilst the breach itself is already an impact, there are rules and regulations that must be followed when handling personal, and at times, sensitive data of individuals and businesses. Failing to comply with these guidelines brings about legal and compliance consequences.
- **Operational Disruption**: Operational disruption resulting from a data breach can significantly impede a business's ability to function effectively. Not only are the previously mentioned impacts significantly damaging, but internally, there are ramifications that can impact the day to day running of a business.
- **Long Term Fallout**: The long-term fallout of a data breach can extend well beyond the immediate aftermath, affecting various aspects of a business's operations, reputation, and bottom line. All previously mentioned aspects are individual in their nature, however in combination can be incredibly detrimental to a business and their success.

Some all time top Data Breaches

- **Yahoo (2013–2014):** 3 billion accounts. Exposed names, email addresses, phone numbers, and hashed passwords.
- **Mother of All Breaches / MOAB (2024):** 26 billion aggregated records. A massive compilation of previously leaked data from various separate breaches combined into a single searchable trove.
- **National Public Data (2024):** 2.9 billion records. Exposed personal details including Social Security numbers due to an unsecured background-check database.
- **CAM4 (2020):** 10.88 billion records. An insecure database left names, email addresses, and passwords exposed.
- **Chinese Surveillance Network (2025):** 4 billion records. An exposed, unencrypted database leaked sensitive personal profiling data.
- **Aadhaar (2018):** This breach exposed the personal and biometric information of over 1.1 billion Indian citizens.

A not so big data breach, but that probably we would remember, is the Colonial Pipeline breach:

- **Colonial Pipeline Company (2021)**: The Colonial Pipeline carries roughly 45% of the fuel consumed on the U.S. East Coast, running from Houston, Texas, to Linden, New Jersey. Hackers used a compromised password for an inactive virtual private network (VPN) account that did not have multi-factor authentication enabled. The attack was attributed to **DarkSide**, an Eastern European cyber crime group known for ransomware-as-a-service. Colonial Pipeline Company proactively shut down the entire pipeline system to contain the malware infection. The company paid a ransom of 75 bitcoins—worth about $4.4 million at the time—within hours of the attack to receive a decryption tool. (NordVPN)

Check: The biggest data breaches in history, from NordVPN (updates annually)

Even if you were not impacted by any of these data breaches, if you have used a credit card, made an airline reservation,

subscribed to a magazine, been a patient in a hospital, or shopped at a chain store (supermarket or department store), or if you are a member of an online social media site, **your personally identifiable information (PII) is stored in a database**.

Ask yourself: **how vulnerable is your PII?**

Every company/business/government has different security issues, making it a particularly hard challenge to standardize any one solution that fits all. However, there are some common threats and vulnerabilities that seem to occur repeatedly.



Data breach. Image generated by Luis R Castellanos, Public Domain, with Google Gemini.

7.4.3. Threats

> A cyber or cybersecurity **threat** Is a potential risk that could harm a system, network, or data.
>
> A cyber **attack**, however, is when that risk becomes a deliberate action.
>
> Fortinet

They can jeopardize sensitive data, disrupt operations, or damage critical digital infrastructure such as computer systems and online networks.

The most common cybersecurity threats, according to NordVPN are:

Malware attacks

A malware attack occurs when malicious software—code written by cyber criminals—infiltrates a computer, network, or device to steal data, compromise systems, or extort money.

The most common types of Malware are:

- **Ransomware:** Encrypts your files or locks your system, demanding a payment (usually in cryptocurrency) to restore access.
- **Trojans:** Disguises itself as legitimate software to trick users into downloading and executing it.
- **Spyware:** Runs silently in the background to monitor your activity, record keystrokes, or steal login credentials.
- **Viruses:** Attaches to clean files and spreads through host systems, corrupting data as it executes.

- **Worms:** Self-replicating programs that spread across entire networks automatically without requiring human action.
- **Adware:** Automatically generates unwanted advertisements, often tracking browsing habits to serve targeted spam.
- **Rootkits:** Grants attackers administrator-level access while hiding its presence deep within the operating system.

Social engineering attacks

A **Social Engineering** attack is a security threat that relies on human interaction and psychological manipulation rather than technical exploits. Instead of searching for vulnerabilities in software or firewalls, cyber criminals trick individuals into breaking standard security procedures, revealing sensitive information, or transferring funds.

The most common attack types are:

- **Phishing:** Deceptive emails designed to look like legitimate institutions (banks, software providers) asking users to reset passwords or verify billing.
- **Spear Phishing & Whale Phishing:** Targeted attacks custom-tailored to a specific individual or executive based on detailed personal reconnaissance.
- **Business Email Compromise (BEC):** Spoofing or hacking a corporate email account to direct employees to route fraudulent wire transfers or share tax records.
- **Smishing & Vishing:** Social engineering conducted via text messages (SMS phishing) or direct phone calls (voice phishing).
- **Pretexting:** Inventing a fabricated scenario (pretext) to justify asking for access, such as pretending to conduct a security audit.
- **Baiting & Tailgating:** Enticing victims with a free offer (baiting) or physically following an authorized person through a secure doorway (tailgating).

Denial-of-Service attacks (DoS)

A **Denial of Service (DoS)** attack is a cyber attack aimed at shutting down a machine, network, or online service to make it unavailable to its intended users. Attackers accomplish this by flooding the target with fake traffic or sending information that triggers a crash, exhausting system resources like bandwidth, memory, or CPU capacity.

- **DoS (Denial of Service):** Uses a **single computer** and internet connection to flood a target server or network with malicious traffic.
- **DDoS (Distributed Denial of Service):** Uses a **network of multiple compromised devices** (known as a botnet) scattered globally. Because the traffic originates from thousands of different IP addresses simultaneously, it is much harder to block.

Man-in-the-middle attacks (MitM)

A **Man-in-the-Middle (MitM)** attack occurs when a cyber criminal secretly positions themselves between two communicating parties (such as a user and a website, server, or application). Once positioned, the attacker can silently intercept, eavesdrop on, or alter the data passing between the two parties without either side knowing the connection has been compromised.

Supply chain attacks

A **Supply Chain** attack occurs when an attacker targets a less-secure third-party vendor, software dependency, or service provider to breach a final, higher-value organization. Instead of attacking a target directly, cyber criminals compromise the tools, hardware, or software updates the target trusts and uses daily.

Injection attacks

An **Injection** attack occurs when untrusted user input is directly passed to an interpreter or compiler without proper validation, sanitization, or filtering. Cyber criminals supply malicious code or commands into an application's input field (such as a search bar, login form, or API query), tricking the application into executing arbitrary commands or altering database queries.

Internet of Things (IoT) attacks

An **IoT** attack targets connected non-traditional computing devices—such as smart home appliances, medical monitors, industrial sensors, and security cameras. Because many IoT devices possess limited processing power and lack robust built-in security controls, attackers exploit them to breach private networks or enlist thousands of compromised devices into "botnets" to execute massive Distributed Denial of Service (DDoS) attacks.

Advanced persistent threats (APTs)

An **Advanced Persistent Threat (APT)** is a prolonged, highly targeted cyber campaign in which an unauthorized intruder gains access to a network and remains undetected for an extended period. APTs are typically executed by state-sponsored cyber units or well-funded criminal organizations targeting high-value assets, intellectual property, or government infrastructure.

Zero-day exploits

A **Zero-Day Exploit** occurs when an attacker launches a cyber attack using a software, hardware, or firmware vulnerability that is completely unknown to the vendor and system developers. Because the vendor has had "zero days" to create and release a patch, traditional antivirus tools and signature-based defenses are often ineffective.

Password attacks

A **Password** attack encompasses any technique aimed at illegally acquiring or guessing a user's authentication password to compromise an account or system. Cybercriminals exploit weak password choices, reused credentials, and unencrypted databases to bypass access controls.

Primary Tactics:

- **Brute Force:** Testing random combinations of characters until the correct password is found.
- **Credential Stuffing:** Automated testing of stolen username/password pairs across hundreds of websites.
- **Password Spraying:** Trying a few common passwords (e.g., `Password123`) against a massive number of usernames to avoid account lockouts.



Password attack. Image by Mohamed_Hassan from Pixabay.

7.4.4. Vulnerabilities

> A **vulnerability** is a weakness that can be exploited by cyber criminals to gain unauthorized access to a computer system.
>
> Upguard

There are other means by which databases are exposed to security breaches, and these are considered vulnerabilities that may subject a database to a security breach. These are more passive, but they can do as much harm as direct threats:

Data at rest

Refers to static information that is inactive and physically stored on a stable media device or platform. The data is not actively moving across a network or being processed in active memory (RAM).

Data at rest typically is not as well protected as data that has been entered into the database and enjoys the database security measures.

Data in motion

Refers to information that is actively moving from one location to another across a network. This includes data moving across the public internet, over local area networks (LAN), between microservices, or through cloud environments.

For example, the data might be transferred to a backup facility that is not part of the internal storage media used for daily work.

Poor architecture

Security was not adequately factored into the design and development of the database structure. This vulnerability may not be discovered until there is an attempted or successful data breach.

Vendor bugs

Particularly programming flaws that allow actions to take place within the database and with the data that were not intended or

planned. Much like poor application architecture, this vulnerability may not be uncovered until there is an attempted or successful data breach.

Unlocked database

Is a database that has no security measures in place to control access or auditing. This seems counterintuitive, but many home users employing a database for personal needs, or even for working on company data while at home, maybe working with an unlocked database.

7.4.5. Risks

> A cybersecurity **risk** is the probability that a threat will exploit a vulnerability, resulting in financial loss, operational disruption, or reputational damage.
>
> NIST

One of the main objectives of cybersecurity staff is to do continuous risk assessment.

> **Risk Assessment** is the process of identifying risks to organizational operations (including mission, functions, image, reputation), organizational assets, individuals, other organizations, and the Nation, resulting from the operation of an information system.

In the business environment, it is critical that a thorough risk assessment takes place and be periodically reviewed. Every organization must decide which are the cybersecurity risk levels and how they can describe each one of them, according to their risk assessment.

The most common classification of the **core risk levels** is:

- **Low Risk:** Minor vulnerabilities with low impact. They pose little danger to core operations and often require routine or scheduled patching.
- **Moderate / Medium Risk:** Issues that could cause noticeable disruption or localized harm, such as a targeted phishing campaign or a misconfigured internal tool. These require planned remediation.
- **High Risk:** Severe vulnerabilities or active threats that threaten sensitive data, regulatory compliance, or business continuity. These demand immediate technical and executive intervention.
- **Critical / Severe Risk:** Catastrophic failures or active exploits causing widespread system outages or data exfiltration. These require emergency response protocols

Steps to perform a Cybersecurity **Risk Assessment**:

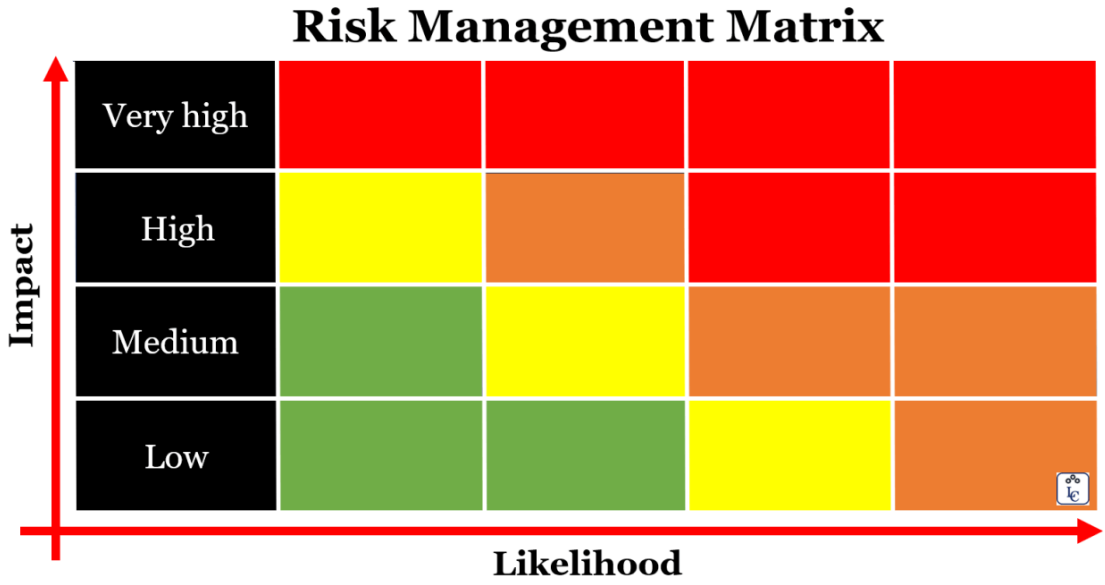
1. Define objectives and scope
2. Prioritize IT assets
3. Identify threats and vulnerabilities
4. Determine risk levels and prioritize risks
5. Address risks with security measures
6. Implement secure coding practices
7. Conduct continuous monitoring and document risks

There are identified solutions for each of the threats and vulnerabilities discussed here, including well-defined and enforced access policies, use of strong data encryption, vulnerability assessments, policies related to strong passwords, and installation of

firewalls.

There are companies that specialize in designing plans, procedures, and software to prevent data loss or data leakage.

With data loss, the data is lost forever, either by deletion, theft, or data corruption. Data leakage allows unauthorized people to get access to the data, either by intentional action or by mistake. So, data loss and data leakage can be intentional or unintentional, and both can be malicious or just human errors.



Risk Management Matrix. Image by Luis R Castellanos, Public Domain, own work.

7.4.6. Protect PII

Protecting databases and the data contained within can be a costly and all-consuming activity.

But what does this mean for you, the individual who uses that credit card, makes airline reservations, files taxes online, subscribes to a magazine, has been a patient in a hospital, shops at a chain store, or is a member of an online social media site?

Your PII is out there, stored in multiple databases. Obviously, you cannot implement security measures for the company, business, or government agency that holds your PII. But are there many measures you can take to better protect yourself? Let's see some few rules of thumb that you can implement...

Keep your passwords to yourself

Do not leave a slip with a list of passwords under your computer, or anywhere where it can be viewed or taken by someone. Just giving your password to a friend is not a good idea, either.

Use strong passwords

Many of your user IDs must have strong passwords to gain entry into one or more systems. In those instances when you can choose any password configuration, pick a strong password to protect your information.

Use different passwords for different accounts

Remembering multiple passwords can be a challenge, and it's often convenient to use the same password for multiple accounts, ranging from Facebook and your bank account to your X (formerly Twitter) page. The danger here is that a compromise of any one

of these accounts could also result in the compromise of others if the same password is used for multiple accounts.

Check your credit reports annually

Sometimes people don't learn that they're victims of identity theft until their credit rating and identity are destroyed. It's proactive to get copies of your credit reports from the credit bureaus and carefully review them for any errors. Be sure to follow-up with the credit bureaus to make any corrections to your reports, if needed. By law, you can get one free credit report from each of the three credit bureaus every year.

The three nationwide consumer reporting companies are:		
Equifax	Experian	TransUnion

Google yourself

Enter your own name in Google, Yahoo or other search engine and see what data comes up. Investigate any postings about yourself in the information that you find. Look for any suggestions that your PII may be compromised.

Remember that people can be a very weak link in security

No matter how secure you make your passwords and how careful you are with your technology, there is always a human element to protecting your information.

Control physical access to your devices

It's important not leave laptops and other mobile devices unattended in public locations, like a coffee shop or other location with free WiFi. An unattended machine is at risk, for both theft and other security threats. When you aren't controlling physical access to your machine, you shouldn't let it out of your sight.

Remember to logout of a website when you are finished using it

Whether it's your email, bank account, retail store shopping account or library account, always remember to logout when you leave the website.

Remember to lock your computer with a password when you are finished using it

By requiring a password to access your computer (or other electronic device) you are protecting your information. You are also making your computer useless to a thief who cannot break password locks.



Protect PII. Image by **Mike Hindle** from Unsplash.

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7.5: Fundamental Database Concepts



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7.5.1. Database Properties

In section 7.1.2 a simple definition of Database was given: a **database** is an organized collection of related information.

Now, it can be expanded a little bit more.

> A **database** is a organized collection of related information used to support the activities of a particular organization.

A database can be viewed as a repository of data that is defined once and then accessed by various users.

Properties

A database has the following properties:

- It is a representation of some aspect of the real world or a collection of data elements (facts) representing real-world information.
- A database is logical, coherent and internally consistent.
- A database is designed, built and populated with data for a specific purpose.
- Each data item is stored in a field.
- A combination of fields makes up a table.
- Many tables are contained in a database.

For example, each field in an employee table contains data about an individual employee.

7.5.2. Database Management System (DBMS)

With the database approach, we can have the traditional banking system mentioned in section 7.2.1. (File-based Approach) using one shared corporate database. Usually, the data in that database, is accessed through a specific software, called "Database Management System" (DBMS).

> A **Database Management System** (DBMS) is a software technology that manages the information in your database.
>
> AWS

A DBMS makes storing data easy while increasing availability, reliability, and performance. It also provides tools to identify data correlations and perform analytics within the system as needed. A DBMS helps organizations manage small and large volumes of data in an organized manner.

The DB-Engines Ranking ranks database management systems according to their popularity. The ranking is updated monthly.

Database features

Managing information means taking care of it so that it works for us and is useful for the tasks we perform. By using a DBMS, the information we collect and add to its database is no longer subject to accidental disorganization. It becomes more accessible and integrated with the rest of our work. Managing information using a database allows us to become strategic users of the data we have.

We often need to access and re-sort data for various uses. These may include:

- Creating mailing lists
- Writing management reports
- Generating lists of selected news stories
- Identifying various client needs

The processing power of a database allows it to manipulate the data it houses, so it can:

- Sort
- Match
- Link
- Aggregate
- Skip fields
- Calculate
- Arrange

Because of the versatility of databases, we find them powering all sorts of projects. A database can be linked to:

- A website that is capturing registered users
- A client-tracking application for social service organizations
- A medical record system for a health care facility
- Your personal address book in your email client
- A collection of word-processed documents
- A system that issues airline reservations

Database benefits

There are a number of characteristics that distinguish the database approach from the file-based system or approach.

Some of the benefits of a DB are:

- **Self-describing nature of a database system**: A database system is referred to as self-describing because it not only contains the database itself, but also metadata which defines and describes the data and relationships between tables in the database. This information is used by the DBMS software or database users if needed. This separation of data and information about the data makes a database system totally different from the traditional file-based system in which the data definition is part of the application programs.
- **Insulation between program and data**: In the file-based system, the structure of the data files is defined in the application programs so if a user wants to change the structure of a file, all the programs that access that file might need to be changed as well. On the other hand, in the database approach, the data structure is stored in the system catalog and not in the programs. Therefore, one change is all that is needed to change the structure of a file. This insulation between the programs and data is also called program-data independence.
- **Support for multiple views of data**: A database supports multiple views of data. A view is a subset of the database, which is defined and dedicated for particular users of the system. Multiple users in the system might have different views of the system. Each view might contain only the data of interest to a user or group of users.
- **Sharing of data and multi-user system**: Current database systems are designed for multiple users. That is, they allow many users to access the same database at the same time. This access is achieved through features called concurrency control strategies. These strategies ensure that the data accessed is always correct and that data integrity is maintained. The design of modern multi-user database systems is a great improvement from those in the past which restricted usage to one person at a time.
- **Control of data redundancy**: In the database approach, ideally, each data item is stored in only one place in the database. In some cases, data redundancy still exists to improve system performance, but such redundancy is controlled by application programming and kept to minimum by introducing as little redundancy as possible when designing the database.
- **Data sharing**: The integration of all the data, for an organization, within a database system has many advantages. First, it allows for data sharing among employees and others who have access to the system. Second, it gives users the ability to generate more information from a given amount of data than would be possible without the integration.
- **Enforcement of integrity constraints**: Database management systems must provide the ability to define and enforce certain constraints to ensure that users enter valid information and maintain data integrity. There are many types of database constraints.
    - **Data type**, for example, determines the sort of data permitted in a field, for example numbers only.
    - **Data uniqueness** such as the primary key ensures that no duplicates are entered.

> A **database constraint** is a restriction or rule that dictates what can be entered or edited in a table such as a postal code using a certain format or adding a valid city in the City field.
>
> Constraints can be simple (field based) or complex (programming).

- **Restriction of unauthorized access**: Not all users of a database system will have the same accessing privileges. For example, one user might have read-only access (i.e., the ability to read a file but not make changes), while another might have read and write privileges, which is the ability to both read and modify a file. For this reason, a database management system should provide a security subsystem to create and control different types of user accounts and restrict unauthorized access.
- **Data independence**: Another advantage of a database management system is how it allows for data independence. In other words, the system data descriptions or data describing data (metadata) are separated from the application programs. This is possible because changes to the data structure are handled by the database management system and are not embedded in the program itself.
- **Transaction processing**: A database management system must include concurrency control subsystems. This feature ensures that data remains consistent and valid during transaction processing even if several users update the same information.
- **Provision for multiple views of data:** By its very nature, a DBMS permits many users to have access to its database either individually or simultaneously. It is not important for users to be aware of how and where the data they access is stored.
- **Backup and recovery facilities**: Backup and recovery are methods that allow you to protect your data from loss. The database system provides a separate process, from that of a network backup, for backing up and recovering data. If a hard

drive fails and the database stored on the hard drive is not accessible, the only way to recover the database is from a backup. If a computer system fails in the middle of a complex update process, the recovery subsystem is responsible for making sure that the database is restored to its original state.



DBMS. Image by Tumisu from Pixabay

7.5.3. DBMS Classification

Database management systems (DBMS) can be classified based on several criteria, such as:

1. data model,
2. user number, and
3. database distribution

Data model

The most popular data model in use today is the **relational** data model (Oracle, MS SQL Server, IBM DB2, PostgreSQL, MySQL).

Other traditional models, such as **hierarchical** data models and **network** data models, are still used in industry mainly on mainframe platforms (hierarchical: IBM IMS, RDM; network: IDMS, Raima).

In recent years, the newer **object-oriented** data models were introduced. This model is a DBMS in which information is represented in the form of objects as used in object-oriented programming (OOP). Object-oriented (OO) databases are different from relational databases, which are table-oriented. OODBMS combine database capabilities with OOP language capabilities. The OO models have not caught on as expected so are not in widespread use. Some examples of object-oriented DBMSs are O2, ObjectStore and Jasmine.

There are also some **NoSQL** or **NoRel** DBMS, as

- MongoDB, CouchDB, CouchBase are document-oriented NoSQL databases.
- Redis and Riak are key-value databases.
- Cassandra and HBase are column family stores.
- Neo4J is a graph database.

User number

A DBMS can be classified based on the number of users it supports.

- It can be a single-user database system, which supports one user at a time,
- or a multiuser database system, which supports multiple users concurrently.

Database distribution

There are two main distribution systems for database systems and these, in turn, can be used to classify the DBMS.

- **Centralized systems**: the DBMS and database are stored at a single site that is used by several other systems too.
- **Distributed database system**: the actual database and the DBMS software are distributed from various sites that are connected by a computer network.
  - Homogeneous distributed database systems: use the same DBMS software from multiple sites. Data exchange between these various sites can be handled easily.
  - Heterogeneous distributed database systems: different sites might use different DBMS software, but there is additional common software to support data exchange between these sites.

7.5.4. Database Users

End Users

End users are the people whose jobs require access to a database for querying, updating and generating reports.

Application user

The application user is someone who accesses an existing application program to perform daily tasks.

Application Programmers

These users implement specific application programs to access the stored data. They must be familiar with the DBMSs to accomplish their task.

Sophisticated user

Sophisticated users are those who have their own way of accessing the database. This means they do not use the application program provided in the system. Instead, they might define their own application or describe their need directly by using query languages. These specialized users maintain their personal databases by using ready-made program packages that provide easy-to-use menu driven commands, such as MS Access.

Database Administrator (DBA)

This may be one person or a group of people in an organization responsible for authorizing access to the database, monitoring its use and managing all of the resources to support the use of the entire database system.

REFERENCES

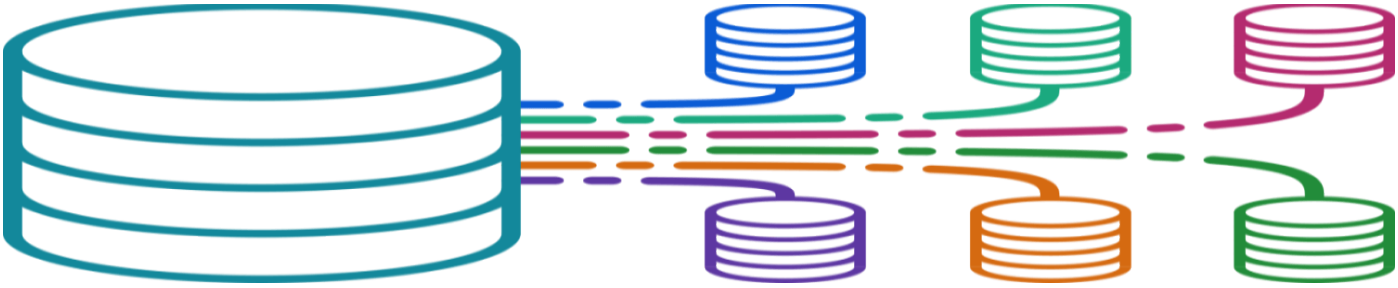
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7.6: Appendix B - Designing a Database



Content

7.6.1. Some technical tools

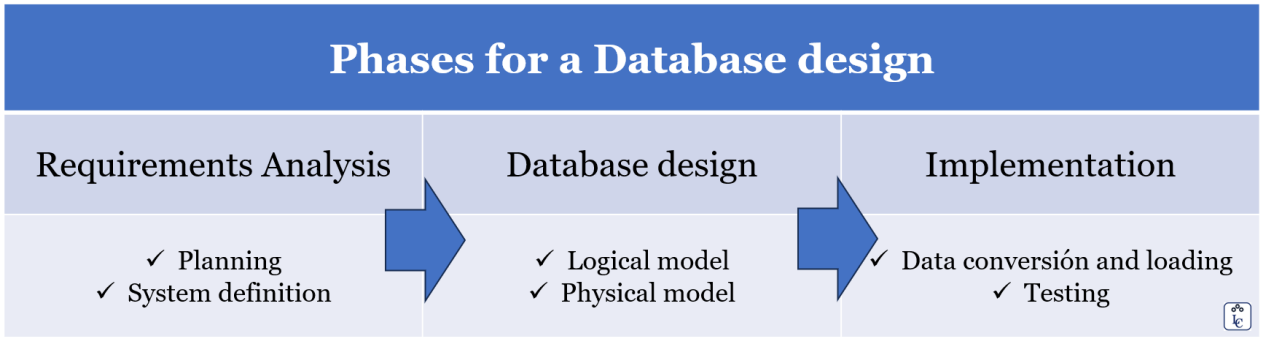
7.6.2. The project

7.6.1. Some technical tools

Phases for a Database design

Before we start to design the database for the university, we should know that there are three classic phases for a Database design:

1. Requirements Analysis
    - Planning
    - System definition
2. Database design
    - Logical model
    - Physical model
3. Implementation
    - Data conversion and loading
    - Testing



Phases for a Database design. Image by Luis R Castellanos, Public domain, own work.

Tools for the Database design

Table Relationship

There are three (3) possible relationships in Database:

- 1:1 (one-to-one)
- 1:m (one-to-many)
- m:n (many-to-many)

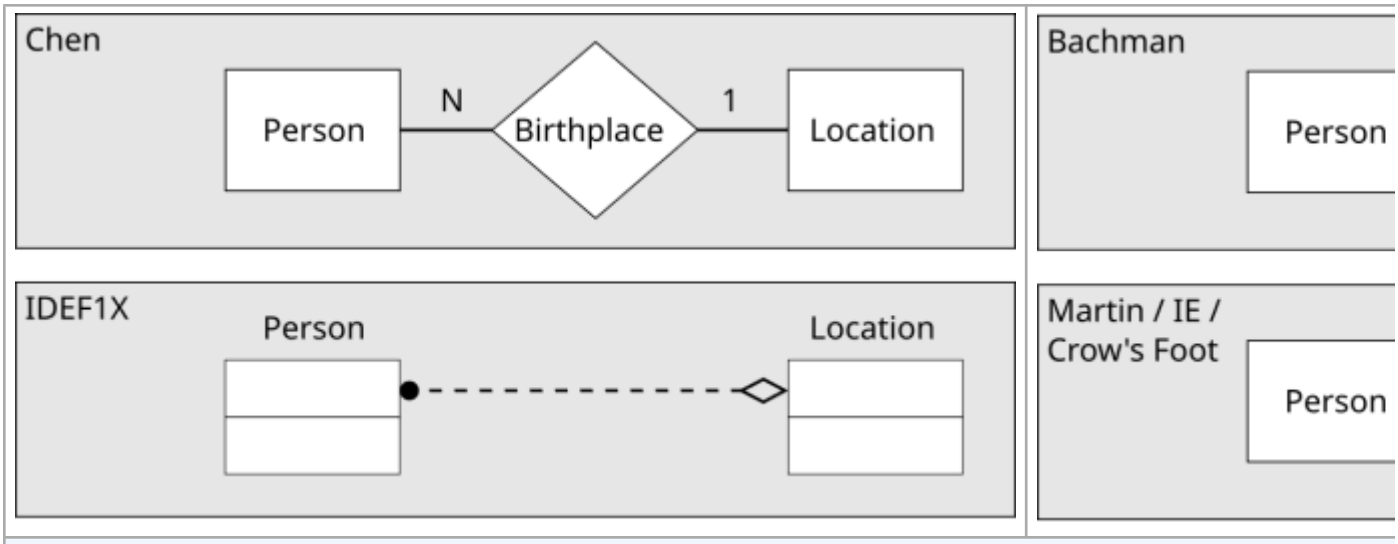
Check Relations

Entity Relation Diagram (ERD)

> An **Entity Relationship Diagram** (ERD) is a visual representation of how items in a database relate to each other.
>
> IBM

ERDs are a specialized type of flowchart that conveys the relationship types between different entities within a system. It is usually used to represent the **logical design** of a database.

There are several notations, as Peter Chen´s notation, Crowbar notation, Jame Martin´s notation and some more. The important thing is that the different entities (tables) are shown, as their relationships.



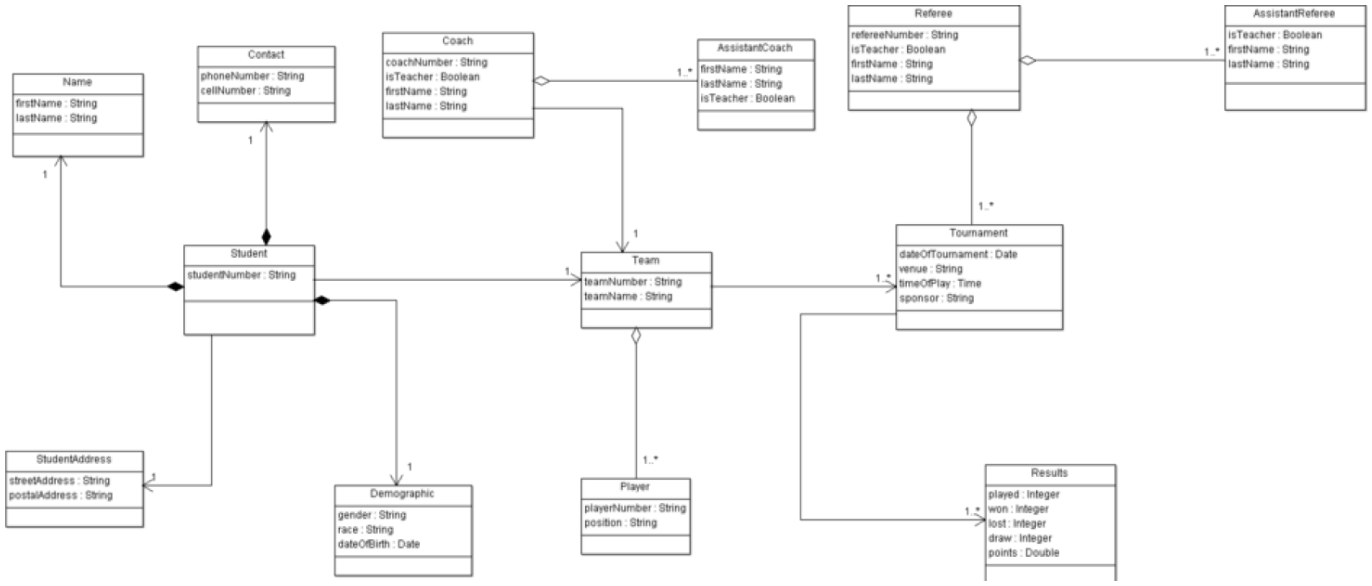
Different ERD notations. By Benth

Data Structure Diagram (DSD)

A **data structure diagram**, visually represents the way data entities are related physically.

The basic graphic notation elements of DSDs are boxes which represent entities. Arrow symbols represent relationships. Data structure diagrams are most useful for documenting complex data entities, and are usually used for the physical design. They also need to show the different fields in each table, the primary and foreign keys, and how the different tables are related.

Today, there are many people that merge both diagrams (ERD & DSD) into one. And that is a valid action once you have enough experience and skills.



Data Structured Diagram. Image by Zamzam01, CC BY 4.0, Wikimedia Commons

Normalization

> Database **normalization** is a process used to organize a database into tables and columns.
>
> Essential SQL

There are three main forms: 1st normal form, 2nd normal form, and 3rd normal form.

The main idea is each table should be about a specific topic and only supporting topics included.

There are three main **reasons** to normalize a database.

1. to minimize duplicate data
2. to minimize or avoid data modification issues, and
3. to simplify queries.

> Normal forms are a series of **guidelines** for ensuring that databases are normalized. They are numbered from one (the lowest form of normalization, referred to as first normal form or 1NF) through five (fifth normal form or 5NF).
>
> Lifewire

1NF (1st Normal Form)

- Eliminate duplicative columns from the same table.
- Create separate tables for each group of related data and identify each row with a unique column or set of columns (the primary key).

2NF (2nd Normal Form)

- Remove subsets of data that apply to multiple rows of a table and place them in separate tables.
- Create relationships between these new tables and their predecessors through the use of foreign keys.

3NF (3rd Normal Form)

- Remove columns that are not dependent upon the primary key.

7.6.2. The project

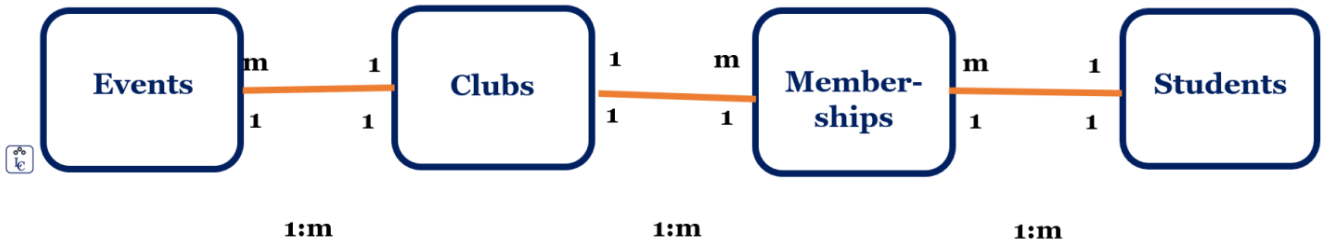
Requirements Analysis

Atlas University wants to create an information system to track participation in student clubs. After interviewing several people, the design team learns that the goal of implementing the system is to give better insight into how the university funds clubs. This will be accomplished by tracking how many members each club has and how active the clubs are. From this, the team decides that the system must keep track of the clubs, their members, and their events.

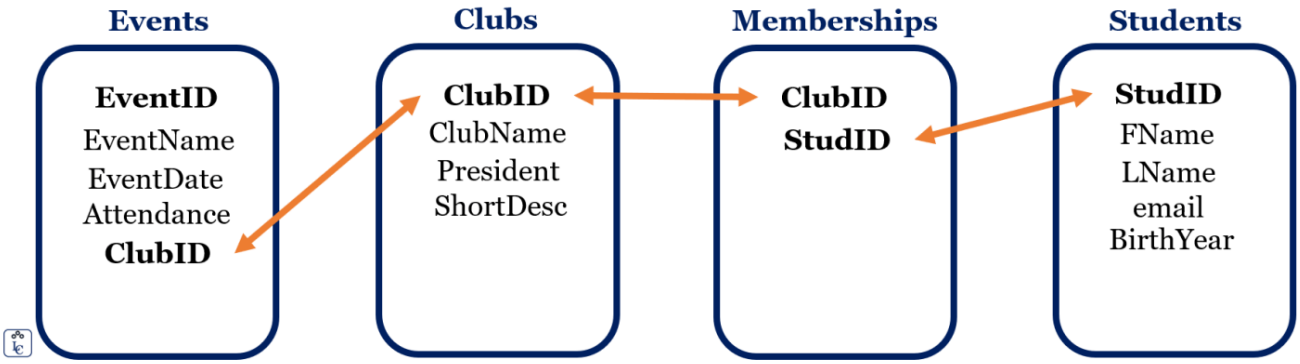
Using this information, the design team determines that the following tables need to be created:

- **Clubs**: this will track the club name, the club president, and a short description of the club.
- **Students**: student name, e-mail, and year of birth.
- **Memberships**: this table will correlate students with clubs, allowing us to have any given student join multiple clubs.
- **Events**: this table will track when the clubs meet and how many students showed up.

Database design



Atlas University - ERD. Image by Luis R Castellanos, Public domain, own work.



Atlas University - DSD. Image by Luis R Castellanos, Public domain, own work.

Implementation

SalesStaffInformation

EmployeeID	SalesPerson	SalesOffice
1003	Mary Smith	S10
1004	John Hunt	S20
1005	Martin Hap	S10

SalesOffice

SalesOfficeID	SalesOffice	OfficeNumber
S10	Chicago	312-555-1212
S20	New York	212-555-1212

SalesStaffCustomer

CustomerID	EmployeeID
C1000	1003
C1010	1003
C1020	1004
C1030	1004
C1040	1004
C1050	1005

PostalCode

PostalCode	City
48123	Dearborn
48213	Detroit
60601	Chicago
78720	Austin
94303	Palo Alto
95014	Cupertino

Customer

CustomerID	CustomerName	CustomerPostalCode
C1000	Ford	48123
C1010	GM	48213
C1020	Dell	78720
C1030	HP	94303
C1040	Apple	95014
C1050	Boeing	60601

Atlas University - Database in 3NF. Image by Luis R Castellanos, Public domain, own work.

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7.7: Summary



7.1. Data and Databases

Quantitative data is numeric, the result of a measurement, count, or some other mathematical calculation.

Qualitative data is descriptive.

Data are the raw bits with no context.

Information is data with context or meaning.

The consumption of information produces **knowledge**.

Wisdom comes when we combine knowledge and experience.

The most used data type are:

1. Flat File
2. Structured Data
3. Unstructured Data
4. Semi-structured Data

7.2. Before Databases

Before the Database approach, the file-based system was in place in some of the organizations around the world.

The file-based system disadvantages are:

1. Data redundancy
2. Data isolation
3. Integrity problems
4. Security problems
5. Concurrency access

7.3. Relational Model

The **relational data model** describes the world as “a collection of inter-related relations (or tables).” It was created by E.F. Codd in the 1970’s.

A **database** is composed of multiple tables and each table holds the data.

Tables are composed by records and fields.

The **degree** is the number of attributes in a table.

A **data warehouse** aggregates data from various sources into a central data store optimized for querying and analysis.

There are three **main types** of data warehouses:

- Enterprise data warehouse (EDW)
- Operational data store (ODS)
- Data mart

Some **benefits** of Data Warehouses are:

- Improved data quality
- Support for AI and machine learning
- Enhanced decision support
- Time-Variant

Some Data Warehouses **drawbacks** are:

- Complexity
- Time-Consuming
- Cost
- Changing Requirements

Data mining is the use of machine learning and statistical analysis to uncover patterns and other valuable information from large data sets.

Some Data Mining **benefits** are:

- Discover hidden insights and trends
- Save budget
- Solve multiple challenges

Some Data Mining **drawbacks** are:

- Complexity and risk
- Cost
- Uncertainty

Data brokers combine publicly accessible data with information obtained, to create vast warehouses of data about people and companies that they can then sell.

Business intelligence (BI) is a set of technological processes for collecting, managing and analyzing organizational data to yield insights that inform business strategies and operations.

Benefits of BI:

- Clearer reporting
- Consolidated data
- Creates new efficiencies
- Deeper data insights
- Faster decision making
- Increase customer satisfaction
- Increase employee satisfaction

Challenges of BI:

- Contradictory conclusions
- Skills shortfall
- Up-front costs

Business analytics (BA) refers to the statistical methods and computing technologies for processing, mining and visualizing data to uncover patterns, relationships and insights that enable better business decision-making.

Benefits of BA:

- Faster and better-informed decisions
- Single-window view of information
- Enhanced customer service

Knowledge management is the process of formalizing the capture, indexing, and storing of the company's knowledge in order to benefit from the experiences and insights that the company has captured during its existence.

There are 5 main types of knowledge management tools:

- Knowledge bases (KB)
- Learning management systems (LMS)
- Document management software (DMS)
- Content management systems (CMS)
- Customer relationship management systems (CRM)

7.4. Databases and security

It is the confidentiality, integrity, and availability (CIA) of the data in a database that need to be protected.

The **information** stored in databases **can be hard to replace**, whether the loss results from

- physical threats such as a fire or a significant power outage
- human error that results in errors in the processing of information or unintended deletion of data, or from erroneous input
- corporate espionage, theft, or malicious activity.

A **data breach** is any security incident in which unauthorized parties access sensitive or confidential information, including personal and corporate data.

Data breaches are **caused** by:

- Innocent mistakes
- Malicious insiders
- Hackers

Most intentional data breaches follow the same basic pattern:

1. Research
2. Attack
3. Compromise data

Which could be some **consequences** of Data Breaches?

- Financial losses
- Reputational Damages
- Legal and Compliance Consequences
- Operational Disruption
- Long Term Fallout

A cyber or cybersecurity **threat** is a malicious act that seeks to damage data, steal data, or disrupt digital life in general.

The most common cybersecurity **threats** are:

- Malware attacks
- Social engineering attacks
- Denial-of-Service attacks (DoS)
- Man-in-the-middle attacks (MitM)
- Supply chain attacks
- Injection attacks
- Internet of Things (IoT) attacks
- Advanced persistent threats (APTs)
- Zero-day exploits
- Password attacks

A **vulnerability** is a weakness that can be exploited by cyber criminals to gain unauthorized access to a computer system.

Data can be vulnerable under these circumstances:

- Data at rest
- Data in motion
- Poor architecture
- Vendor bugs
- Unlocked database

A cybersecurity **risk** is the probability that a threat will exploit a vulnerability, resulting in financial loss, operational disruption, or reputational damage.

Risk Assessment is the process of identifying risks to organizational operations (including mission, functions, image, reputation), organizational assets, individuals, other organizations, and the Nation, resulting from the operation of an information system.

The most common classification of the core **risk levels** is:

- Low Risk
- Moderate / Medium Risk
- High Risk
- Critical / Severe Risk

Steps to perform a Cybersecurity **Risk Assessment**:

1. Define objectives and scope
2. Prioritize IT assets
3. Identify threats and vulnerabilities
4. Determine risk levels and prioritize risks
5. Address risks with security measures
6. Implement secure coding practices
7. Conduct continuous monitoring and document risks

Remember some measures you can take to better **protect your PII**:

- Keep your passwords to yourself
- Use strong passwords
- Use different passwords for different accounts
- Check your credit reports annually
- Google yourself
- Remember that people can be a very weak link in security
- Control physical access to your devices
- Remember to logout of a website when you are finished using it
- Remember to lock your computer with a password when you are finished using it

7.5. Database concepts

Expanding our previous definition, we have that a **database** is a organized collection of related information used to support the activities of a particular organization.

A database has the following **properties**:

- It is a representation of some aspect of the real world or a collection of data elements (facts) representing real-world information.
- A database is logical, coherent and internally consistent.
- A database is designed, built and populated with data for a specific purpose.
- Each data item is stored in a field.
- A combination of fields makes up a table.
- Many tables are contained in a database.

A **Database Management System** (DBMS) is a software technology that manages the information in your database.

A database can be linked to:

- A website that is capturing registered users
- A client-tracking application for social service organizations
- A medical record system for a health care facility
- Your personal address book in your email client
- A collection of word-processed documents
- A system that issues airline reservations

Some of the **benefits** of a DB are:

- Self-describing nature of a database system
- Insulation between program and data
- Support for multiple views of data
- Sharing of data and multi-user system
- Control of data redundancy
- Data sharing
- Enforcement of integrity constraints
- Restriction of unauthorized access
- Data independence
- Transaction processing
- Backup and recovery facilities

Database Management Systems (DBMS) can be classified based on several criteria, such as:

1. data model,
2. user number, and
3. database distribution

Some Database users are:

- End users
- Application users
- Application programmer
- Sophisticated users
- DBA’s

7.6. Database design

There are three classic phases for a Database design:

1. Requirements Analysis
    - Planning
    - System definition
2. Database design
    - Logical model
    - Physical model
3. Implementation
    - Data conversion and loading
    - Testing

There are three (3) possible relationships in Database:

- 1:1 (one-to-one)
- 1:m (one-to-many)
- m:n (many-to-many)

An **Entity Relationship Diagram** (ERD) is a visual representation of how items in a database relate to each other.

A **data structure diagram**, visually represents the way data entities are related physically.

Database **normalization** is a process used to organize a database into tables and columns.

There are three **main forms**: 1st normal form, 2nd normal form, and 3rd normal form.

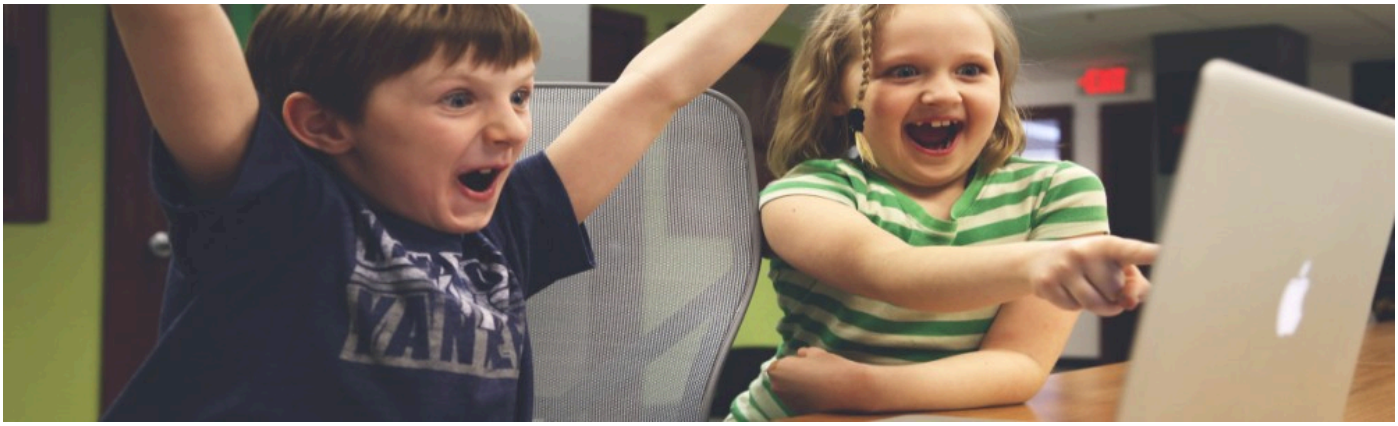
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8: INFORMATION SYSTEMS - PEOPLE



In the opening chapters of this text, we focused on the technology behind information systems: hardware, software, data, and networking. In the last chapter, we discussed business processes and the key role they can play in the success of a business. In this chapter, we will be discussing the last component of an information system: people.

People are involved in information systems in just about every way you can think of: people imagine information systems, people develop information systems, people support information systems, and, perhaps most importantly, people *use* information systems.

Learning Objectives

Upon successful completion of this chapter, you will be able to:

- describe each of the different roles that people play in the design, development, and use of information systems;
- understand the different career paths available to those who work with information systems;
- explain the importance of where the information-systems function is placed in an organization; and
- describe the different types of users of information systems.

8.1: Creators

8.2: Operations and Administration

8.3: Managers

8.4: Computer and Information Technology Occupations

8.5: Appendix C. Cybersecurity domains

8.6: Summary

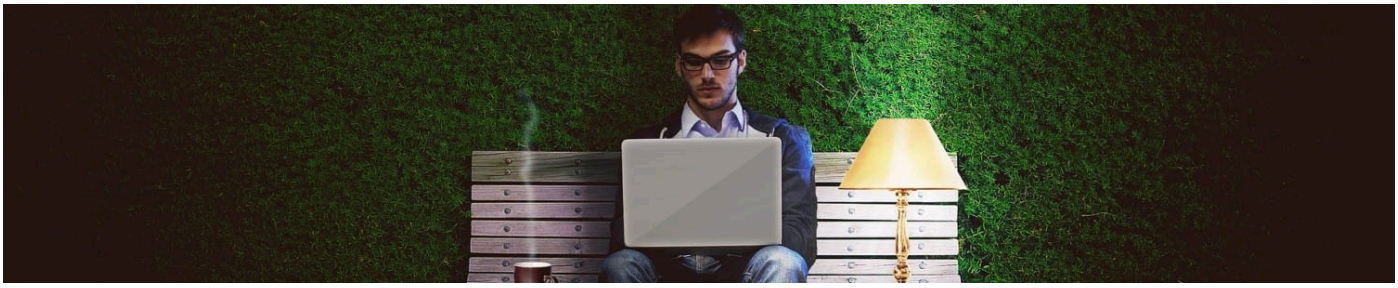
"My fellow Americans: ask not what your country can do for you, ask what you can do for your country."

— John F Kennedy, *PotUS 35*

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8.1: Creators



Contents

8.1.1. Systems Analyst

8.1.2. Programmer

8.1.3. Computer Engineer

In the opening chapters of this course, we focused on the technology behind information systems: Hardware, Software, Data, and Networking. In this chapter, we will be discussing the last component of an information system: **people**. People are involved in information systems in just about every way you can think of: people imagine information systems, people develop information systems, people support information systems, and, perhaps most importantly, people use information systems.

The first group of people we are going to look at, play a role in designing, developing, and building information systems. These people are generally very technical and have a background in programming and mathematics. Just about everyone who works in the creation of information systems has a minimum of an **associate** or **bachelor's degree** in computer science or information systems, though lately that is not necessarily a requirement.

> Google's Sergey Brin (co-founder) admits he's hiring 'tons' of workers without degrees: 'They just figure things out on their own in some weird corner'
>
> Fortune

8.1.1. Systems Analyst

The role of the systems analyst is to straddle the divide between identifying business needs and imagining a new or redesigned computer-based system to fulfill those needs. This individual will work with a person, team, or department with business requirements and identify the specific details of a system that needs to be built.

> The Systems Analyst takes a picture of the **current** processes and gathers **current** needs.

Generally, this will require the analyst to have a good understanding of the business itself, the business processes involved, and the ability to document them well. The analyst will identify the different stakeholders in the system and work to involve the appropriate individuals in the process.

Once the requirements are determined, the analyst will begin the process of translating these requirements into an information-systems design. A good analyst will understand what different technological solutions will work and provide several different alternatives to the requester, based on the company's budgetary constraints, technology constraints, and culture.

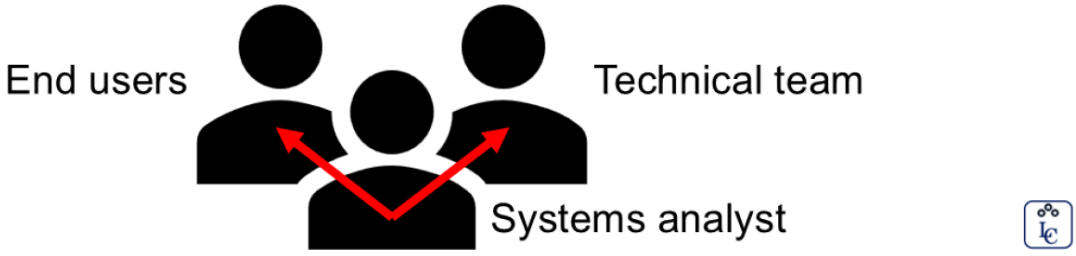
Once the solution is selected, the analyst will create a detailed document describing the new system. This new document will require that the analyst understand how to speak in the technical language of systems developers.

The design document created by the systems analyst provides the detail needed to create the system and is handed off to a programmer (or team of programmers) to do the actual creation of the system.

A systems analyst generally is not the one who does the actual development of the information system. In some cases, however, a systems analyst may go ahead and create the system that he or she designed. This person is sometimes referred to as a **programmer-analyst**.

In other cases, the system may be assembled from off-the-shelf components by a person called a **systems integrator**. This is a specific type of systems analyst that understands how to get different software packages to work with each other.

To become a systems analyst, you should have a background both in the business and in systems design. Many analysts first worked as programmers and/or had to experience in the business before becoming systems analysts.



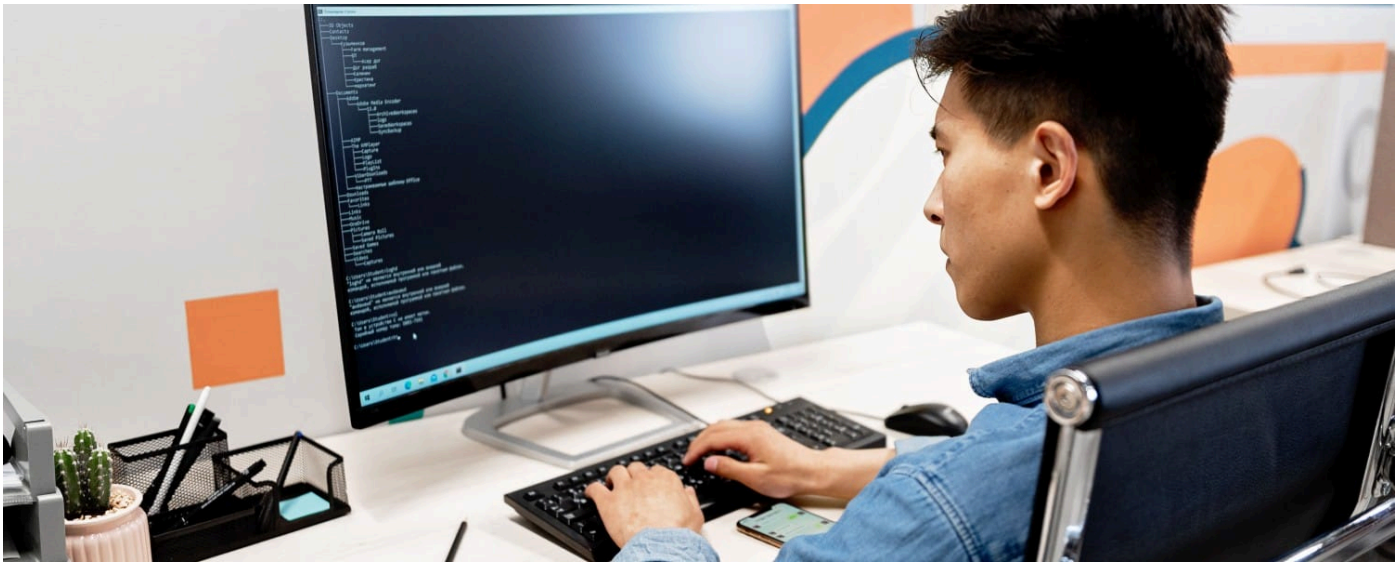
Systems Analyst. Image by Luis R Castellanos, Public Domain, own work.

8.1.2. Programmer

Programmers spend their time writing computer code in a programming language. In the case of systems development, programmers generally attempt to fulfill the design specifications given to them by a systems analyst.

Many different styles of programming exist: a programmer may work alone for long stretches of time or may work in a team with other programmers. A programmer needs to be able to understand complex processes and also the intricacies of one or more programming languages.

Generally, a programmer is very proficient in mathematics, as mathematical concepts underlie most programming code.



Computer programmer. Image by Mikhail Nilov from Pexels.

8.1.3. Computer Engineer

Computer engineers design the computing devices that we use every day. There are many types of computer engineers, who work on a variety of different types of devices and systems.

Some of the more prominent engineering jobs are as follows:

Hardware engineer

A hardware engineer designs hardware components, such as microprocessors. Many times, a hardware engineer is at the cutting edge of computing technology, creating something brand new. Other times, the hardware engineer's job is to engineer an existing component to work faster or use less power. Many times, a hardware engineer's job is to write code to create a program that will be implemented directly on a computer chip.

Software engineer

Software engineers do not actually design devices; instead, they create new programming languages and operating systems, working at the lowest levels of the hardware to develop new kinds of software to run on the hardware.

Network engineer

A network engineer's job is to understand the networking requirements of an organization and then design a communications system to meet those needs, using the networking hardware and software available.

Systems engineer

A systems engineer takes the components designed by other engineers and makes them all work together. For example, to build a computer, the motherboard, processor, memory, hard disk and operating systems all have to work together. A systems engineer has experience with many different types of hardware and software and knows how to integrate them to create new functionality.

Others

There are many different types of computer engineers, and often the job descriptions overlap. Like Cybersecurity Engineer, Cloud Engineer, DevOps Engineer, Data Engineer, Full Stack Engineer, and much more.

While many may call themselves engineers based on a company job title, there is also a professional designation of “professional engineer,” which has specific requirements behind it. In the US, each state has its own set of requirements for the use of this title, as do different countries around the world. Most often, it involves a professional licensing exam.

Some professional engineer associations:		
Association for Computing Machinery (ACM)	National Society of Professional Engineers (NSPE)	Institute of Electrical and Electronics Engineers (IEEE)

REFERENCES

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8.2: Operations and Administration



Contents

8.2.1. Computer Operator

8.2.2. Help-Desk Agent/Support Analyst

8.2.3. Trainer

8.2.4. Database Administrator

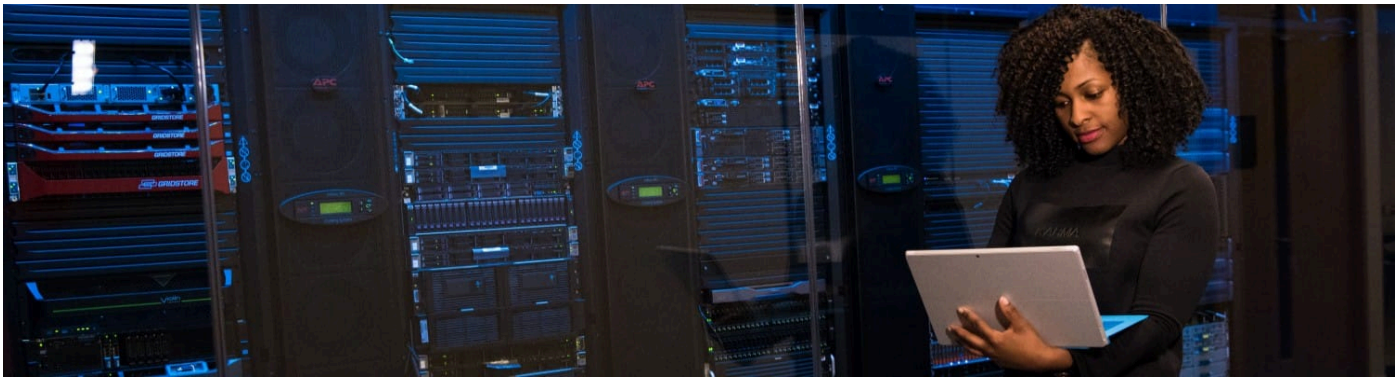
Another group of information-systems professionals is involved in the day-to-day operations and administration of IT.

These people must keep the systems running and up-to-date so that the rest of the organization can make the most effective use of these resources.

8.2.1. Computer Operator

A computer operator is a person who keeps large computers running. This person's job is to oversee the mainframe computers and data centers in organizations. Some of their duties include keeping the operating systems up to date, ensuring available memory and disk storage, and overseeing the physical environment of the computer.

Since mainframe computers increasingly have been replaced with servers, storage management systems, and other platforms, computer operators' jobs have grown broader and include working with these specialized systems.



Computer Operator. Image by Christina Morillo from Pexels.

8.2.2. Help-Desk Agent/Support Analyst

Most mid-size to large organizations have their own information-technology help desk. The help desk is the first line of support for computer users in the company. Computer users who are having problems or need information can contact the help desk for assistance.

Many times, a help-desk worker is a junior-level employee who does not necessarily know how to answer all of the questions that come his or her way. In these cases, help-desk analysts work with senior-level support analysts or have a computer knowledge base at their disposal to help them investigate the problem at hand.

The help desk is a great place to break into working in IT because it exposes you to all of the different technologies within the company. A successful help-desk analyst should have good people and communications skills, as well as at least junior-level IT skills.

8.2.3. Trainer

A computer trainer conducts classes to teach people specific computer skills. For example, if a new ERP system is being installed in an organization, one part of the implementation process is to teach all of the users how to use the new system.

A trainer may work for a software company and be contracted to come in to conduct classes when needed; a trainer may work for a company that offers regular training sessions, or a trainer may be employed full time for an organization to handle all of their computer instruction needs.

To be successful as a trainer, you need to be able to communicate technical concepts well and also have a lot of patience!



Computer trainer. Image by Tuấn Nguyễn Văn from Pexels.

8.2.4. Database Administrator

A Database Administrator (DBA) is the person who manages the databases for an organization. This person creates and maintains databases that are used as part of applications or the data warehouse. The DBA also consults with systems analysts and programmers on projects that require access to or the creation of databases.

REFERENCES

PGCC. *INT1010: Concepts in Computing*. Libretexts. 2021. Link.

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8.3: Managers



Contents

8.3.1. CIO

8.3.2. Functional Manager

8.3.3. ERP Manager

8.3.4. Project Manager

8.3.5. Information-Security Officer

The management of information systems functions is critical to the success of information systems within the organization.

Here are some of the jobs associated with the management of information systems.

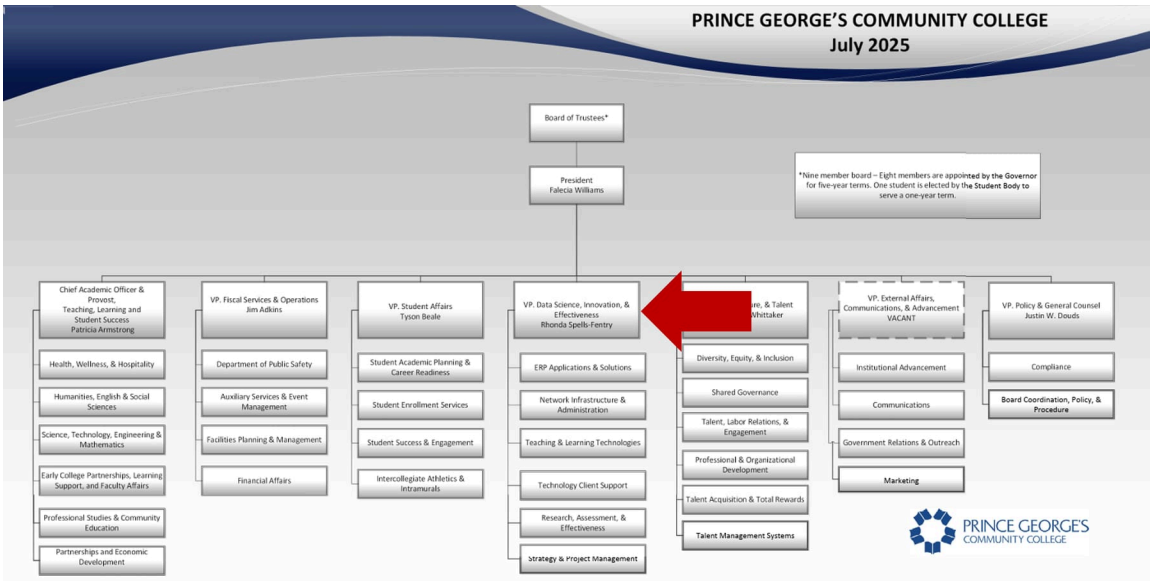
8.3.1. CIO

The CIO, or Chief Information Officer, is the head of the information systems function. This person aligns the plans and operations of the information systems with the strategic goals of the organization. This includes tasks such as budgeting, strategic planning, and personnel decisions for the information systems function.

The CIO must also be the face of the IT department within the organization. This involves working with senior leaders in all parts of the organization to ensure good communication and planning. Interestingly, the CIO position does not necessarily require a lot of technical expertise.

> Requires more **Soft Skills** than **Hard Skills**.

While helpful, it is more important for this person to have good management skills and understand the business. Many organizations do not have someone with the title of CIO; instead, the head of the information-systems function is called vice president of information systems or director of information systems.



PGCC Organizational Chart (July 2025) showing CIO. Screenshot by Luis R Castellanos, Public Domain, from PGCC.

8.3.2. Functional Manager

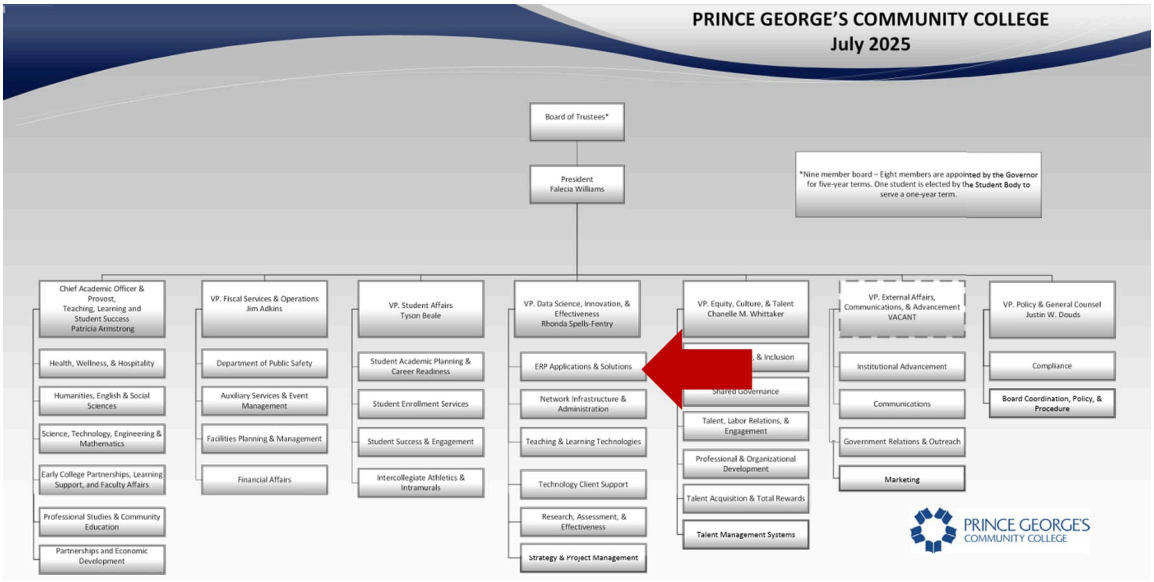
As an information systems organization becomes larger, many of the different functions are grouped together and led by a manager. These functional managers report to the CIO and manage the employees specific to their functions.

For example, in a large organization, there is a group of systems analysts who report to a manager of the systems analysis function.

8.3.3. ERP Manager

Organizations using an ERP require one or more individuals to manage these systems.

These people make sure that the ERP system is completely up to date, work to implement any changes to the ERP that are needed, and consult with various user departments on needed reports or data extracts.



PGCC Organizational Chart (July 2025) showing ERP Manager. Screenshot by Luis R Castellanos, Public Domain, from PGCC.

8.3.4. Project Manager

Information systems projects are notorious for going over budget and being delivered late. In many cases, a failed IT project can spell doom for a company. A project manager is responsible for keeping projects on time and on budget.

This person works with the stakeholders of the project to keep the team organized and communicates the status of the project to management. A project manager does not have authority over the project team; instead, the project manager coordinates schedules and resources in order to maximize the project outcomes.

A project manager must be a good communicator and an extremely organized person. A project manager should also have good people skills. Many organizations require each of their project managers to become certified as a project management professional (PMP).

> The Project Management Professional (PMP) certification is a globally recognized credential awarded by the Project Management Institute (PMI) that validates a project manager's knowledge, skills, and experience in leading and directing projects.
>
> Project Management Institute

8.3.5. Information-Security Officer

An information security officer is in charge of setting information-security policies for an organization and then overseeing the implementation of those policies. This person may have one or more people reporting to them as part of the information security team.

As information has become a critical asset, this position has become highly valued. The information-security officer must ensure that the organization's information remains secure from both internal and external threats. Also called **Chief Information Security Officer (CISO)**.

REFERENCES

PGCC. *INT1010: Concepts in Computing*. Libretexts. 2021. Link.

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8.4: Computer and Information Technology Occupations



Contents

8.4.1. IT demanding fields

8.4.2. Median Wage

8.4.3. Computer and IT Occupations

These workers create or support computer applications, systems, and networks.

According to the Bureau of Labor Statistics, overall employment in computer and information technology occupations is projected to grow faster than the average for all occupations from 2025 to 2035.

About 280,000 openings are projected each year, on average, in these occupations due to employment growth and the need to replace workers who leave the occupations permanently.

US Bureau of Labor Statistics Logo. By Unknown author, Public Domain, from Wikimedia Commons

8.4.1. IT demanding fields

Demand for these workers will stem from greater emphasis on:

- Cloud computing
- Big Data
- CyberSecurity

8.4.2. Median Wage

The median annual wage for computer and information technology occupations has been:

Date	IT median wage	Others median wage
May 2020	$ 91,250	$ 41,950
May 2021	$ 97,430	$ 45,760
May 2022	$ 100,530	$ 46,310
May 2023	$ 104,420	$ 48,060
May 2024	$ 105,990	$ 49,500
May 2025	$109,470	$50,980

8.4.3. Computer and IT Occupations

	Occupation	Job Summary	Education	2025 Median pay
	Computer and Information Research Scientists	Computer and information research scientists design innovative uses for new and existing computing technology.	Master's degree	$140, 300
	Computer Network Architects	Computer network architects design and build data communication networks, including local area networks (LANs), wide area networks (WANs), and Intranets.	Bachelor's degree	$134,050
	Computer Programmers	Computer programmers write and test code that allows computer applications and software programs to function properly.	Bachelor's degree	$100,390
	Computer Support Specialists	Computer support specialists provide help and advice to computer users and organizations.	Education requirements vary	$62,890

	Occupation	Job Summary	Education	2025 Median pay
	Computer Systems Analysts	Computer systems analysts study an organization's current computer systems and find a solution that is more efficient and effective.	Bachelor's degree	$105,850
	Database Administrators and Architects	Database administrators and architects create or organize systems to store and secure data.	Bachelor's degree	$126,760
	Information Security Analysts	Information security analysts plan and carry out security measures to protect an organization's computer networks and systems.	Bachelor's degree	$129,180
	Network and Computer Systems Administrators	Network and computer systems administrators are responsible for the day-to-day operation of computer networks.	Bachelor's degree	$99,130
	Software Developers, Quality Assurance Analysts, and Testers	Software developers design computer applications or programs. Software quality assurance analysts and testers identify problems with applications or programs and report defects.	Bachelor's degree	$134,040
	Web Developers and Digital Designers	Web developers create and maintain websites. Digital designers develop, create, and test website or interface layout, functions, and navigation for usability.	Bachelor's degree	$99,520

Data updated in August 2026.

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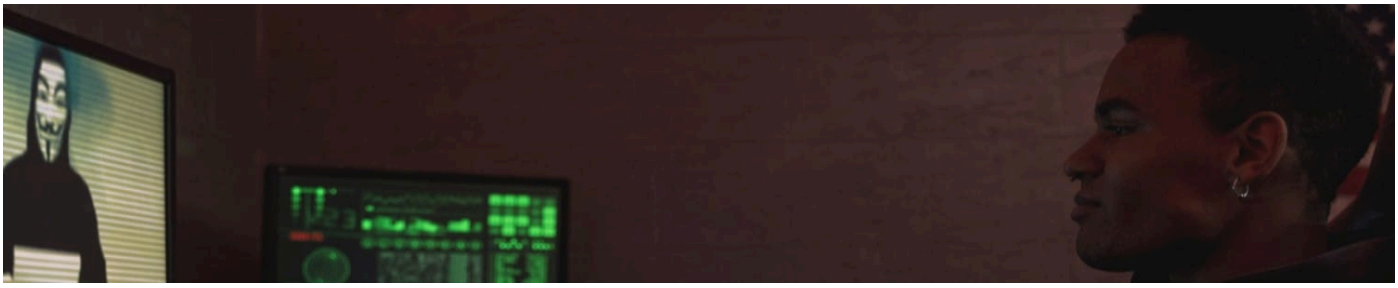
Bureau of Labor Statistics. *Computer and Information Technology Occupations*. US Department of Labor. 2026. Link.

PGCC. *INT1010: Concepts in Computing*. Libretexts. 2021. Link.

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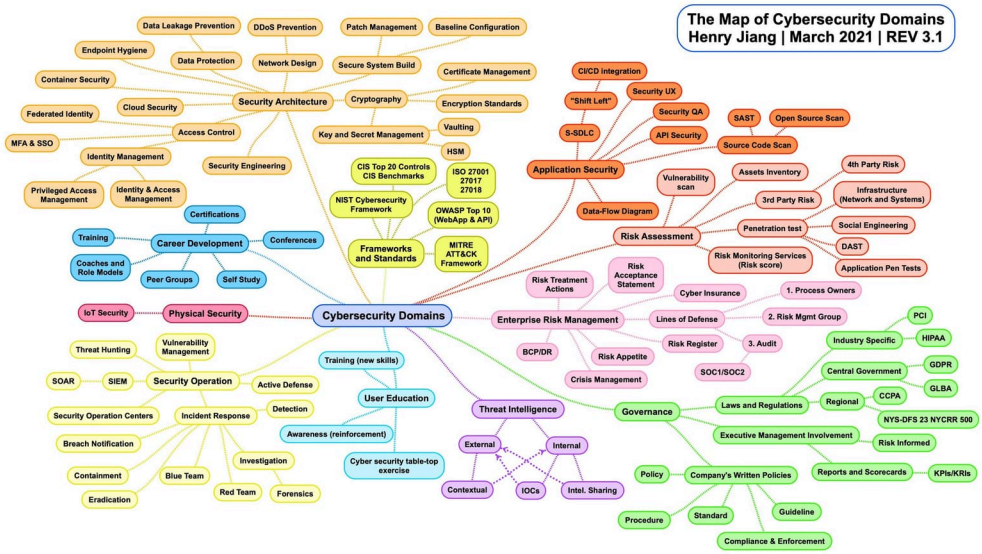
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8.5: Appendix C. Cybersecurity domains



As we saw that Cybersecurity is one of the growing fields in IT, here we bring a list of the Cybersecurity Domains, by Henry Jiang.

Most people think that Cybersecurity is just about being a "hacker". But as you will see here, there much more than that in this field.



Map of Cybersecurity Domains. By Henry Jiang, from LinkedIn.

The Map and its entire content is for public consumption, it can be shared and re-used.

1 Application security	• Source code scan • API security • SDLC • Security UX • Data Flow diagrams • Security Q&A		7 Security operation	• Incident response • Active defense • Security Operations Center • Threat hunting • Vulnerability management

2 Risk assessment	• Vulnerability scan • Assets inventory • Penetration test • Risk monitoring service • 3rd party risk		8 Physical security	• Physical Access • Facilities security
3 Risk Management	• Risk treatment actions • Risk acceptance statement • Cyber insurance • Lines of defense • Risk register • Risk apetite • Crisis management		9 Security architecture	• Security engineering • Systems access control • Data protection • Cryptography • Secure system build • Network design
4 Governance	• Laws and regulations • Executive management involvement • Written policies		10 Career development	• Conferences • Training • Tutors and coaches • Certifications • Self study • Peer groups
5 Threat Intelligence	• Internal • External		11 Cybersecurity Frameworks	• CIS Top 20 Controls • CIS Benchmarks • NIST Cybersecurity Framework • ISO 27001, 27017, 27018 • OWASP Top 10 • MITRE ATT&CK Framework
6 User education	• Training • Awareness • Exercises (drills)			

REFERENCES

Jiang, Henry. Cybersecurity Domains. LinkedIn. 2021. Link.

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8.6: Summary



8.1. Creators

- **Systems Analyst**: Identifies business needs and imagines a new or redesigned computer-based system to fulfill those needs.
- **Programmer**: Writes computer code in a programming language.
- **Computer Engineers**:
  - Hardware engineer: Designs hardware components, such as microprocessors.
  - Software engineer: Creates new programming languages and operating systems, and develop new kinds of software to run on the hardware.
  - Network engineer: Understands the networking requirements of an organization and then design a communications system to meet those needs.
  - Systems engineer: Takes the components designed by other engineers and makes them all work together.
  - Others: Cybersecurity Engineer, Cloud Engineer, DevOps Engineer, Data Engineer, Full Stack Engineer...

8.2. Operations and Administration

- **Computer Operator**: oversees the mainframe computers, servers and data centers in organizations.
- **Help-Desk / Support Analyst**: First line of support for computer users in the company.
- **Trainer**: Conducts classes to teach people specific computer skills.
- **Database Administrator**: Manages the databases for an organization.

8.3. Managers

- **CIO - Chief Information Officer**: is the head of the information systems function.
- **Functional Manager**: manages different IT functions that are grouped together.
- **ERP Manager**: keeps ERP systems up to date, controls changes and maintenance.
- **Project Managers**: keeps IT projects on time and on budget.
- **Information Security Officer**: sets information security policies and oversees its implementation.

8.4. Computer and Information Technology Occupations

According to the Bureau of Labor Statistics, overall employment in computer and information technology occupations is projected to grow faster than the average for all occupations from 2025 to 2035.

About 280,000 openings are projected each year, on average, in these occupations due to employment growth and the need to replace workers who leave the occupations permanently.

Demand for IT workers will stem from greater emphasis on:

- Cloud computing
- Big Data
- CyberSecurity

8.5 Cybersecurity Domains

Henry Jiang (2021) identifies 11 Cybersecurity domains:

1. Application security	5. Threat Intelligence	9. Security architecture
2. Risk assessment	6. User education	10. Career development
3. Risk Management	7. Security operation	11. Cybersecurity Frameworks
4. Governance	8. Physical security	

Summary image banner by Luis R Castellanos

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9: INTRODUCTION TO WEB DEVELOPMENT



Learning Objectives

Upon successful completion of this chapter, you will be able to:

- the ability to create an HTML document structured to support CSS styling
- the ability to create a CSS file that adapts styling based on device capabilities
- the ability to insert basic images in a Web page
- the ability to integrate audio and video to a page
- the ability to utilize special device features
- the ability to integrate external font styles

9.1: An Introduction

9.2: HTML 101

9.3: Appendix D - Basic HTML Instructions

9.4: Summary

"If you're walking down the right path and you're willing to keep walking, eventually you'll make progress."

— Barack H Obama, *PotUS 44*

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- 9.2: HTML 101 by Michael Mendez has no license indicated.
- 1: Web Development by Michael Mendez has no license indicated.
- 9: Introduction to Web Development by Michael Mendez has no license indicated.

9.1: An Introduction



Contents

9.1.1. Brief history of HTML

9.1.2. Website Design

9.1.3. Development

9.1.4. IDE

Web development is an evolving amalgamation of languages that work in concert to receive, modify, and deliver information between parties using the Internet as a mechanism of delivery. While it is easy to describe conceptually, implementation is accompanied by an overwhelming variety of languages, platforms, templates, frameworks, guidelines, and standards. Navigating a project from concept to completion often requires more than mastery of one or two complementing languages, meaning today's developers need both breadths, and depth, of knowledge to be effective.

9.1.1. Brief history of HTML

> **Hypertext Markup Language** (HTML) is a standard markup language for tagging text files to achieve font, color, graphic, and hyperlink effects to be displayed in a web browser.

It can be assisted by technologies such as **Cascading Style Sheets** (CSS) and scripting languages such as **JavaScript** (JS).

Web browsers obtain HTML documents from either a web server or local storage and produce the documents into multimedia web pages.

The first version of HTML was written by Tim Berners-Lee in 1993.

Since then, there have been many different versions of HTML. The most widely used version throughout the 2000's was HTML 4.01, which became an official standard in December 1999. HTML 5 was released in 2014.

HTML elements are the foundation of HTML pages. Images and other objects such as interactive forms may be embedded into the rendered page using HTML constructs. HTML provides a means to create structured documents by denoting structural semantics for text such as headings, paragraphs, lists, links, quotes, and other items. Tags are written using angle brackets to delineate HTML elements. Browsers do not display the HTML tags but use them to interpret the content of the page.



HTML 5 official logo. By b3nj5m1n from Pixabay.

9.1.2. Website Design

Website design is a topic of study often neglected until after a programming background has been developed. Worse, it may be entirely ignored or missed by computer science students when courses covering the topic are in other programs like graphic arts or media.

This results in programmers trying to understand how to write code meant for layout and design elements without understanding design. By studying these elements first, we can develop a better knowledge of the concepts of web design before we write code.

Progressing through the topics in this section during your site design will greatly ease your development efforts in the future, allowing stakeholders to understand the project and provide feedback early on, reducing (re)development time. A number of factors affect design in web development, complicating what would otherwise appear to the end-user to be a relatively simple process of displaying a picture or document.

In truth, the development process involves not only the HTML and multimedia that make up the visual aspects of the page but also considerations of software engineering, human-computer interaction, quality assurance and testing, project management, information and requirement engineering, modeling, and system analysis and design.

Today's sites are now becoming more application-centered than traditional sites. This further complicates our projects as we integrate with legacy software and databases, strive to meet real-time data demands, address security vulnerabilities inherent to the environment we are working in, and ongoing support and maintenance typical of robust software applications.

Planning Cycle

Web development is best achieved as a linear process but is usually completed asynchronously. The planning process described is intended to build upon itself to refine project requirements, look and feel, and development plans. However, limitations in timelines, mid-project revisions, and the extensive time that can be invested in the early stages of design lead many programmers to begin development while a project is still in design.

The **website development life cycle** (WDLC), is a structured approach to building and maintaining a website.

It typically involves seven key phases:

1. Planning.
2. Analysis.
3. Design.
4. Development.
5. Testing.
6. Implementation.
7. Maintenance.

Starting early with programming during design planning can accelerate a project when the elements created early on are unlikely to be affected by later changes in the scope. When done carefully, early programming also allows an opportunity to test concepts

before investing time into an idea that may not work. It is important to avoid aspects that are assumed to change, like the visual layout or particular pieces of content, instead focusing on the data structure, frameworks, and other components that are easily adapted to design changes.

While you are planning, keep an eye out for indicators that things are going off-track.

Some of the more important flags that should be resolved include:

1. Vaguely defined use cases and inadequate project requirements
2. Overly broad or undefined scope of features
3. Unresolved disputes between stakeholders about project features
4. Unrealistic timetable, budget, or inadequate resources

When considering your milestones, tasks, objectives, or whatever label you or your team place on objectives, a handy acronym to reference is SMART.

> SMART stands for **S**pecific, **M**easurable, **A**chievable, **R**ealistic, and **T**imely.

The idea is to check all of your objectives against these criteria to determine if they are appropriate and well-developed. By ensuring all of your objectives meet the SMART criteria, you will have a better chance of keeping your project on time and well planned.



SMART. Image by Geralt from Pixabay.

The Fold

As we begin to develop our pages, we need to begin to consider where we want to place pieces of our content.

If you look at newspapers, you will find that the most attractive story of the day (as decided, at least, by the publisher) is emblazoned in large letters near the middle or top of the front page, surrounded by the name of the paper, the date, and other pieces of information that quickly lend to your decision of whether or not to purchase a given paper.

This is done intentionally, to make the paper attract your attention and get you to buy their edition over their competitors. In the printed news industry, the prime retail space in the paper is the top half of the front page, or what you see when the newspaper is folded normally at a newsstand. This is referred to as "**above the fold**," and is crucial to get their audience's attention. This also applies to websites, except in our case, our "**above the fold**" is what the user sees on the landing page for our site, without having to scroll down or use any links.



Newspapers folded in a Newstand. Image by Feyza Yıldırım from Pexels

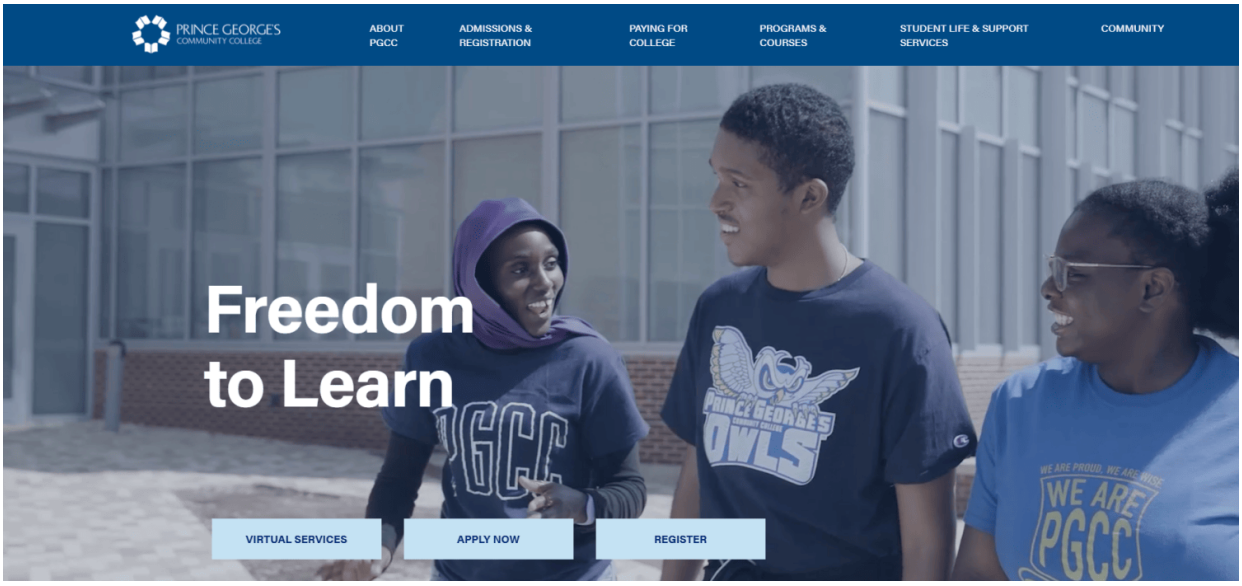


Boston Globe front page (Nov 5th 1947), with "the fold" framed. The Boston Globe, Public domain, from Wikimedia Commons

What you typically find here is the name and or logo of the company, and what they feel is most important for you to see first. As you begin to analyze web pages in this light, you will find it very easy to determine what kind of site they are, or what they want or expect from you as their guest. News sites will typically follow a similar setting to a printed paper, leading with headlines and links to other sections.

Companies will lead with a featured product or sale to attract your attention, and search engines will make the search bar prominent, usually with ad space close by to increase their revenue streams. The concept of “The Fold” is another of the many highly argued concepts in web development.

Proponents are quick to point out the same example we used about traditional print media methods, while detractors will argue that if it were true, scrolling would never have been created, or users would lose interest in following links.



The Fold at PGCC Website. GIF by Luis R Castellanos. Public domain, own work.

Typography

> **Typography** is the study of the font.

While an important topic in media arts, it has until recently received little attention in web development. Utilizing unusual fonts used to be a complicated process that required the end user to have your font(s) installed in order to see the site as you intended. Now, advances in CSS allow us to use unusual fonts by connecting to them through our styling.

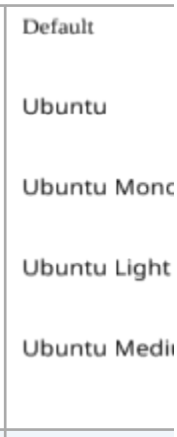
This allows us to use a tremendous variety of fonts in our sites to add to our look and feel, adding an aspect that has unlocked new approaches to design. Some of the elements of typography include the study of features like readability, conveying meaning or emotion through impression, and the artistic effect of mixing styles. For ease of reading and to avoid a cluttered appearance, most sites keep to two or three fonts when creating their design.

This allows us to use a tremendous variety of fonts in our sites to add to our look and feel, adding an aspect that has unlocked new approaches to design. Some of the elements of typography include the study of features like readability, conveying meaning or emotion through impression, and the artistic effect of mixing styles. For ease of reading and to avoid a cluttered appearance, most sites keep to two or three fonts when creating their design.

One for text, and one or two for headings, titles, and distinguishing marks. All of these should be kept in the same family for a more congruous experience, and each unusual font defined in your site should include fallback definitions in case there are problems loading your primary style. You may want to set your regular text as one of the standards supported by all browsers as users are most familiar and usually comfortable with that set.



Difference between Serif and Sans Serif font. By GJo, GNU FDL, from Wikimedia Commons



Ubuntu font fa

Web Fonts

To tap into this aspect of design, a great place to start is with the Google Fonts website. This site is a repository of character sets for a great variety of fonts that you can link to or download and include in your own site's files. We will look at connecting to these later, but browsing the site now will give you an initial look at the amount of variety that is available for design.

Google Fonts web page

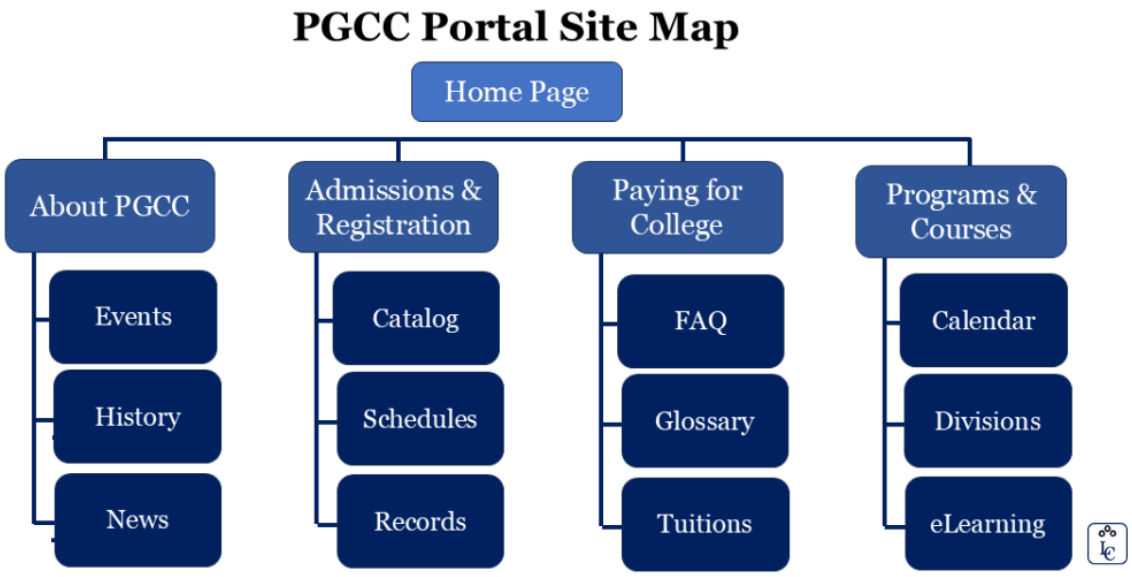
Sitemaps

A sitemap is a file that contains a master list of links to the pages on your site and can provide information about those pages like how often they are updated, how pages connect to each other, and how important it is relative to the other pages. It can be a reference tool to both **Bots** that index your site for search engines, as well as your visitors trying to find particular content.

A **bot** is a programmed software application that runs programmed tasks. The bots are automated. They conduct as programmed instructions without any initiation from a human.

Jigsaw Academy

Sitemap files are XML documents arranged in the hierarchical format that bots read to gain an understanding of your site layout, page relevance, and organization. The file may also be a human-readable page that diagrams how pages relate to one another and serve as a master list of the pages in your site. Sitemaps are best kept in the root of your website, at the same level as your initial index page.



PGCC portal Sitemap. Image by Luis R Castellanos, Public domain, own work.

While a complete sitemap cannot be finished until after your site is ready to be published, we can include sitemaps under development methods because laying out your site's organization on paper will help with developing your menu system, logically organizing content, and in defining the scope and purpose of your site. The more content or pages you can define at the beginning of the process will reveal information that will help during your design phase.

To create a sitemap, you can start by creating a running list of all the content you wish to have on your site. Anyone involved in the production or validation of content should be in the room! In each of these steps, it is important to identify your stakeholders. As you are creating your running list, it is often helpful to use index cards so you can determine by card color or pile where a particular piece of content should be.

This will help you discover your menu system, as you create names for piles of cards as your menu title. After, as you diagram what cards are with what pile and where that pile is relative to others, your sitemap will begin to take shape.

A **website** is a collection of webpages that are accessed with a single domain name or URL.

A **webpage** is a document written in HTML and can be viewed on any web browser.

Robots.txt

Robots are automated scripts typically used to index or take inventory, of the content in a website for use in things like web searching sites or collecting statistics. A robots file is a basic text file kept in the root folder of your website that instructs these

robots on what sections or types of content in your site you do or do not want them to index. Legitimate robots will read this file when they first arrive on your site to honor your request.

Keep in mind this is an enforceable act, and malicious or less-than-reputable robots are still perfectly capable of reading through all non-privileged (i.e. no login required) content on your site.

SEO stands for “search engine optimization.” In simple terms, it means the process of improving your site to increase its visibility when people search for products or services related to your business in Google, Bing, and other search engines. The better visibility your pages have in search results, the more likely you are to garner attention and attract prospective and existing customers to your business.

Search engines such as Google and Bing use bots to crawl pages on the web, going from site to site, collecting information about those pages and putting them in an index.

Search Engine Land

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Wireframes

Wireframes in the web development world are not exactly their literal three-dimensional counterparts in the real world, but they bear a similar purpose. A wireframe may include things like location and size of elements such as a login button, where banners and content sections will sit, and provide an overall idea of how a site will operate. When wireframing a website, the idea is to create a mockup of one or more designs that portray how the interface might appear to the user.

By the end of your wireframing process, you should have an idea of how the site will operate, and have resolved questions over where users will find particular features and elements. Wireframes typically do not include color, actual content, or advanced design decisions like typography. Some of these considerations will have been at least partly addressed when creating your sitemap, and the rest will come once we begin storyboarding.

Storyboarding

Storyboarding a website is quite similar to storyboarding a TV show, comic, or other forms of media. Using our wireframes, we can begin to add color, font, and rough images to our documents. Keep in mind at this point we are probably still in a graphics editor or document style program like PowerPoint, Photoshop, etc. Real code is coming soon, but we can do more mock-ups faster without taking the time to make it function.

As you storyboard, you will create separate pages, or panels, for the screen a user would see as they complete the most important processes on your site. If you are selling something, for example, your storyboard may include examples of product pages, adding items to their cart, logging in, and completing their purchase.

By paging through these panels, you can see how the user experience will progress and identify potential problems like a confusing check out process, or you may discover that your shopping cart block from wireframing may be better off in a different, more predominant location. This process may be repeated several times until a final version is accepted by everyone in the decision process.

Color Schemes

The process of determining the color(s) involved in your site could fill a book.

In fact, it does.

Regardless of the varying opinions of what emotions colors instill, or represent, the quickest way to alienate a user is to give them a visual experience that is unappealing. The layout, appearance, and cohesiveness of your site are something that is immediately judged when a user first visits.



Color schemes combinations. Image by Luis R Castellanos, Public domain, own work.

These elements influence everything from their impression of what the site represents, its reputability, and even its trustworthiness as an ecommerce option. If your site appears to be disorganized, dated and out of style, or seems too “busy” or complicated, you can lose users in less than ten seconds.

You can address this issue (even without an artistic eye) by following the techniques we discussed earlier to plan out a simple, intuitive interface, and by using tools to help you select and compare color schemes like “Paletton” or “Colors on the Web”.

Whether you choose to study other books on the subject or not, a great way to keep current is to get ideas from what others are doing by following sites that list or rate sites by appearances such as the annual “Times” review and “The Best Designs” (web page not updated anymore).

Paletton	Colors on the Web

9.1.3. Development

File Organization

As more and more files are created to complete the website, keeping everything in one folder will quickly grow cluttered. To address this, sub- folders can be created just like when files are sorted in "My Documents".

Traditionally folders can be created for images, scripts, pages or files, or for different sections of content or tasks. How and why these folders are created varies to personal taste or group determinations, and in some cases it may be done to maintain a particular method of writing code, such as model-view-controller.

> It is highly recommended, that if the project will be stored in a device, it will be stored in a proper sub-folder, with all the files, images and documents.

Pseudo-Code First!

Whiteboards, notepads, and napkins can be used to write down some pseudo-code, before the real coding begins. Writing out the plan to tackle a particular problem will help to identify logic problems before the coding begins, and will help to keep track of what is needed to work on as the project progresses.

> **Algorithm** is a set of well-defined instructions to solve a particular problem. It takes a set of input and produces a desired output.
>
> Programiz

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Creating pseudo-code is the process of writing out in loosely structured sentences what needs to be done.

> **Pseudocode** is a technique used to describe the distinct steps of an algorithm in a manner that is easy to understand for anyone with basic programming knowledge.
>
> Towards Data Science

Benefits of Pseudocode

- **Improves Readability:** Written in plain, everyday language, it lets anyone understand the logic quickly without needing to know a specific programming language
- **Easier collaboration:** It provides a common denominator. A Python developer and a C++ developer can easily read and discuss the same pseudocode block.
- **Simplifies complex ideas:** Pseudocode breaks down massive algorithms into bite-sized, logical steps.
- **Focuses on logic:** By stripping away syntax errors (like missing curly braces), programmers can focus purely on "Does this logic actually solve the problem?".

Examples of Algorithm and Pseudocode

Algorithm	**Pseudocode**
An **Algorithm** to add two numbers: 1. Take two number inputs 2. Add numbers using the + operator 3. Display the result.	A **Pseudocode** to add two numbers: 1. GET a 2. GET b 3. Sum = a + b 4. PRINT Sum

An **Algorithm** to calculate how much to pay for some bananas at a supermarket:	A **Pseudocode** to calculate how much to pay for some bananas at a supermarket:
1. Find out the price of a pound of bananas 2. Find out the weight of the bananas 3. Multiply price * weight of bananas 4. Display the result.	1. GET BananaPrice 2. GET BananaWeight 3. Payment = BananaPrice*BananaWeight 4. PRINT(Payment)
Check Pseudocode commands in Pseudocode Editor	

Brackets

Some languages require the programmer to use a combination of parenthesis and brackets to identify what pieces of code belong together. This allows the engine or compiler to delineate between the code that should be tested as a logic statement, code that gets executed if that statement is true, and code that belongs to functions or classes.

> Angle brackets (< and >) are the primary brackets used in HTML to enclose elements and create tags.

HTML tags come in pairs consisting of an opening tag and a closing tag to wrap around text or other elements.

- **Opening Tag**: Uses a less-than sign (<) and a greater-than sign (>) to enclose the tag name, like .
- **Closing Tag**: Includes a forward slash (/) right after the opening angle bracket to tell the browser the element has ended, like .

As the code is written, it is a good practice to immediately enter both the starting and ending marker first, then create space between them to enter the code. This will help ensure that the opening bracket will have its closing bracket when nesting the code.

Depending on the text editor, it may assist in the coding by automatically adding closing brackets and helping identify which opening and closing brackets go together.

Comments

In HTML, comments are used to add explanatory notes, reminders, and organization to the source code while keeping those notes invisible to the people visiting the website. When a web browser reads the HTML file, it completely ignores anything placed inside a comment tag.

> In HTML, comments are written by placing your text between .

It is natural to feel that we will remember the programming logic as they are so obvious when the code is been created. The need for good commenting becomes immediately apparent when reviewing someone else's work, and we may be wallowing in frustration trying to figure out what the other person was trying to do.

> Any code of your own that you haven't looked at for six or more months, might as well have been written by someone else.

— Peter S Eagleson, *MIT*

This is not meant to endorse comments that are obvious to the reader from the line, like:

```
$int = 2 + 2
```

Rather, comments are best suited to explaining why agreed upon methods were not used or what difficult to understand code might be doing, like:

Spacing

Just as spacing is used in documents to convey that a topic change is occurring, it can break up a longer string of commands by putting spaces around lines that are grouped together to complete a particular task, signifying that the next set of lines is for another task.

Indentation

To make the code easier to read, indentation can be used to give the reader an idea of what lines of code belong to different sections. This is typically done inside functions, classes, and control structures. When the code is nested, extra indentations are added for each layer within, moving those blocks of text further right to visually distinguish.

As the contents of a loop or function ends, the closing bracket is lined up with the function definition or logic statement to show that the section of code belonging to it, is complete.

While the program **will run just fine without indentation (and without spacing)**, it makes it easier for humans to read and understand the program and its logic.

Meaningful Variable Names

When variables and functions are created, their assigned names should have meaning, not only for the coder, but also to others who may read the code. While it can be tempting to use a lot of short variable names while writing the code, it will be more difficult later to follow what the variable is supposed to represent.

Short names, like *queryResult* or *query_result* can be used, or something longer like *numberOfResumesReceived*.

While the latter takes longer to type while coding, the name is very clear on what it represents. As spaces are generally prohibited in variable names, these examples show us a few ways to approach longer names.

The method used depends on the coder, but it should be used consistently throughout all the code to reduce confusion. Differences in how and where capitalization or underscores are used, can represent different types of variables, like classes or groups of variables.

Short variable names like a simple *x* or generic name like *temp* may have their places in the code, but are best reserved for when they identify a small variable or one which will have a very short shelf life in the code.

> **Camel case** (sometimes stylized autologically as camelCase or CamelCase, also known as camel caps or more formally as medial capitals) is the practice of writing phrases without spaces or punctuation and with capitalized words.
>
> Wikipedia

It has been one of the best practices in coding, to use camel case when naming variables and functions.

DateOfBirth, OldAddress, EmployeeFirstName, TotalVolume, StudentZipCode, ClientID.

Versioning

This is the process of creating multiple versions of the software, instead of continuously overwriting the sole edition of the code. By creating different copies of the program as new features are added or created, can preserve working copies or even create different versions of the program.

This allows to “roll back” or restore previous versions if unforeseen errors are created in the new code, or to allow different features to be tried and discarded over time.

Naming conventions for different versions of the code might involve numbers, letters, release stages (i.e. alpha, beta, release candidate, and release), a combination of all of these, or just “development” and “live.”

Templates

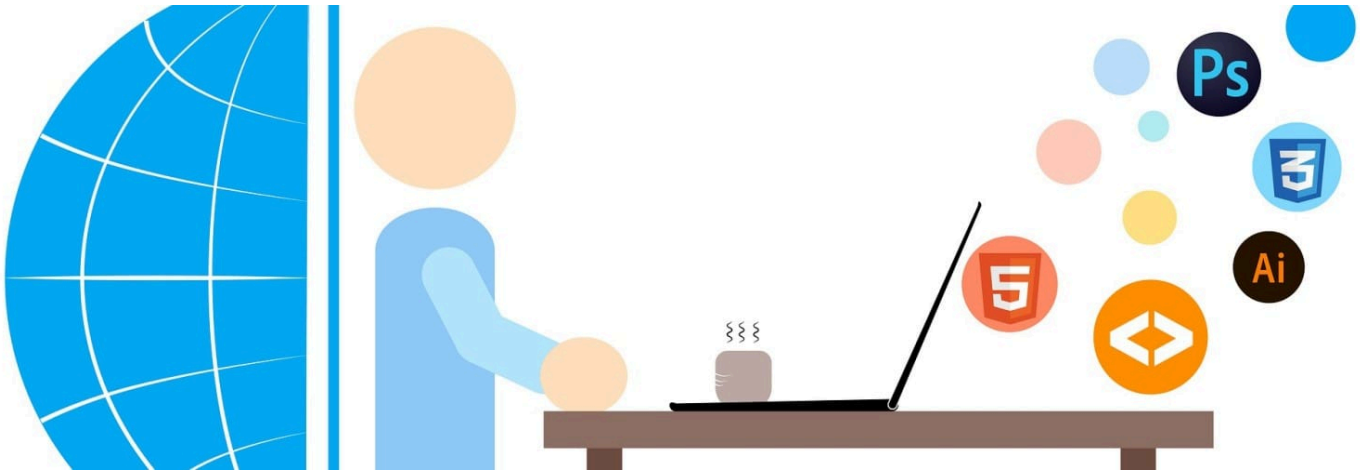
Similar to the idea behind frameworks, templates are sets of files that dictate the basic structure that provides a layout to the web page. Templates typically create a grid format that can be selected from, like two or three columns, fixed or relative width and height, etc.

> An **HTML template** is a pre-written, downloadable file (or package of files) containing structured HTML code, CSS stylesheets, and images.
>
> VTEX

Templates are useful for getting the look and feel of a site up and running fast and there is little concern about the particulars of appearance, or whenever the template meets the needs well. When inserting the content dynamically, multiple templates can be used for one site to change the look and feel quickly based on which one is applied. This might be determined by what type of device the visitor is using, or what type of authentication they are using. Templates can be both freestanding or can be an extension of a **content management system** or framework.

> A **Content Management System** (CMS) is a software application that allows you to create, manage, and publish digital content for websites and apps without the requirement of coding knowledge.
>
> Erie IT

Some of the most popular CMS platforms for beginners are:				
Wix	Wordpress	Squarespace	Shopify	Joomla



HTML coder. Image by Earvine95 from Pixabay.

9.1.4. IDE

> An **integrated development environment** (IDE) is a software application that helps programmers develop software code efficiently.
>
> AWS

Instead of using a basic text editor and running separate tools for compiling or previewing, an IDE combines key features into a single application:

- **Source Code Editor:** Provides syntax highlighting, auto-completion, and tag matching.
- **Build Automation & Execution:** Tools to preview, run, or build projects quickly.
- **Debugger:** Helps identify and fix errors in code.
- **Project Management:** Organizes files, assets, and directories within a workspace.

IDEs for HTML

While pure HTML doesn't require a heavy IDE (since it's a markup language rather than a compiled programming language), developers typically use feature-rich code editors or specialized web IDEs that support HTML along with CSS and JavaScript.

> HTML source code can be written with any text editor. The IDE provides and editor that allows syntax highlighting and a template library, among other things, that makes it easier to code.

1. Visual Studio Code (VS Code)

- **Type:** Source Code Editor / Lightweight IDE
- **Cost:** Free (Open-source)
- **Platforms:** Windows, macOS, Linux
- **Highlights:** The industry standard for web development. It features **Emmet** integration (shortcodes for quick HTML generation), **Live Server** (instant browser previews on save), and thousands of extensions.

Visual Studio Code

2. WebStorm

- **Type:** Full-featured Web IDE
- **Cost:** Paid (Subscription; free for students/educators)
- **Platforms:** Windows, macOS, Linux
- **Highlights:** Built specifically for JavaScript and web technologies by JetBrains. It provides out-of-the-box smart code completion, refactoring, and deep framework integration without requiring extra plugins.

WebStorm

3. Sublime Text

- **Type:** Lightweight Code Editor
- **Cost:** Free evaluation / Paid license
- **Platforms:** Windows, macOS, Linux
- **Highlights:** Ultra-fast startup time and smooth performance. Excellent for quick HTML edits with strong syntax highlighting and customizable keyboard shortcuts.

Sublime Text

4. Adobe Dreamweaver

- **Type:** WYSIWYG Editor / Visual IDE
- **Cost:** Paid (Adobe Creative Cloud)
- **Platforms:** Windows, macOS
- **Highlights:** Combines a visual design interface (drag-and-drop / live visual preview) with a code editor. Popular for visual designers who want to see layout changes immediately alongside source code.

Adobe Dreamweaver

5. CodePen / Replit (Browser-Based Web IDEs)

- **Type:** Cloud IDEs
- **Cost:** Free with premium tiers
- **Platforms:** Web Browser
- **Highlights:** Require zero installation. They allow you to write HTML, CSS, and JS side-by-side with an instant live preview, making them ideal for quick testing, sharing code snippets, or learning.

CodePen	Replit

REFERENCES

AWS. *What is an IDE (Integrated Development Environment)?* nd. Link.

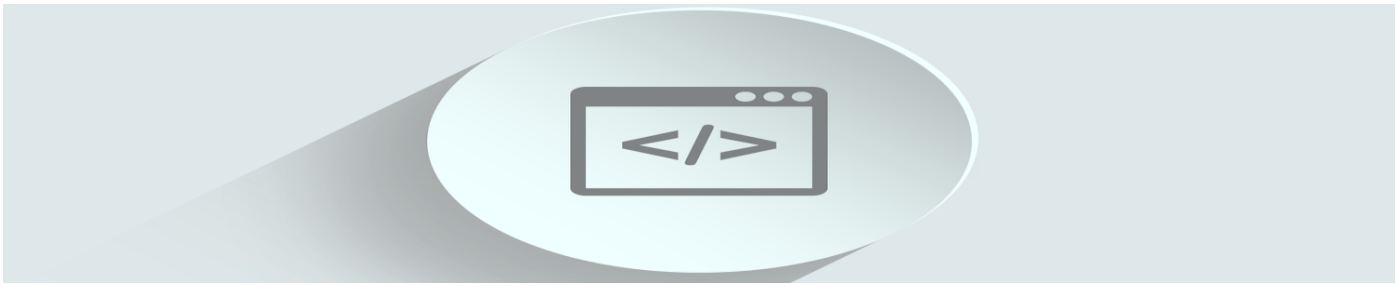
PGCC. *INT1010: Concepts in Computing*. LibreTexts. 2021. Link.

PseudoEditor. *What is Pseudocode?* nd. Link.

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9.2: HTML 101



Contents

9.2.1. Creating HTML files

9.2.2. Fonts and Text decorations

9.2.1. Creating HTML files

File Format

Before we can create our first web page, we need to create a file that our service will recognize as a web page. They are opened with a browser.

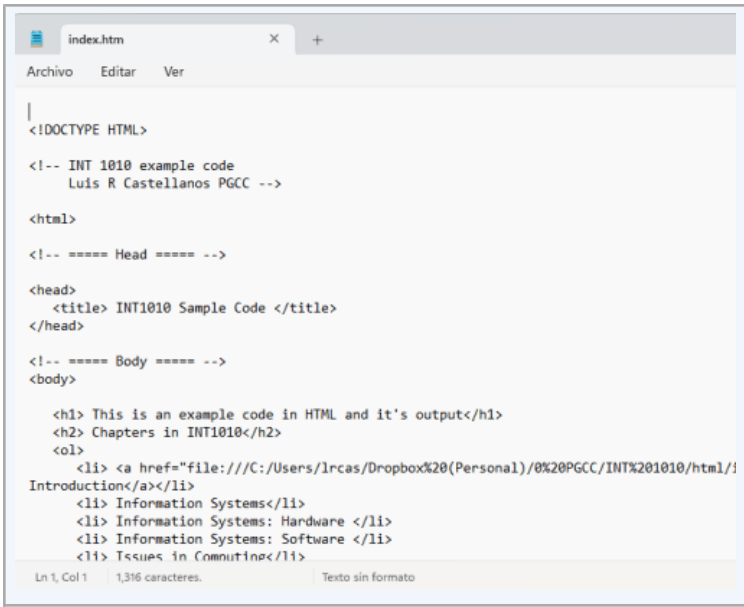
There are several options that we may follow:

With a text editor

1. Open the text editor of your preference.
2. Start writing the source code for the "Home" (main) page.
3. Save it in the working folder for the project (create it if it has not been created yet), as "index.htm" or "index.html".
4. Double click on the newly created file to open the file.
5. Correct the errors, if identified.
6. If it is a multipage website, create the other webpages, and link them to the Home page.

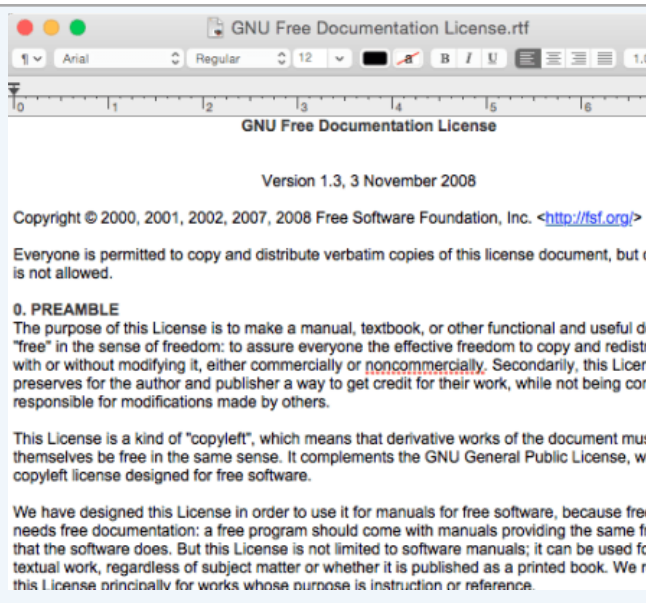
(The main page is always named "index.htm" or "index.html". You can use the extension "htm" or "html". But it is recommended that you use the same extension throughout the whole project).

Most common “normal” editors:



MS Windows: **Notepad**

By Luis R Castellanos, Public domain, own work



Apple macOs: **TextEdit**

By JollyRogerBay, BSD, Wikimedia Commons

With an IDE

1. Open your selected IDE (check on IDE for guidance on available options), and create a new project.
2. Start from scratch or use any of the templates or frameworks available.
3. Run the project.
4. Correct the errors, if identified.
5. If it is a multipage website, create the other webpages, and link them to the Home page.

With a CMS

1. If you don´t have an account, create it (check on CMS for guidance on available options). Access your CMS account and create a new project.
2. Start from scratch or use any of the templates or frameworks available.
3. Run the project.
4. Correct the errors, if identified.
5. If it is a multipage website, create the other webpages, and link them to the Home page.

Usually, with a CMS, a visual editor is used and the HTML commands don´t have to be used. Just a normal editor as you would use it in any word processor.

"index" page

The **index** is the default file name most web servers look for in any folder of your website; it saves your users from having to know and type the page name as part of the URL. In many text editors, underneath or near where you enter the file name is another drop-down selector that allows you to pick a file type. This is the extension (what comes after the period in the file name), or file type, that identifies what kind of data the file represents.

This tells our operating system, applications, and browsers what conventions were used to create the content so it can be reassembled into a usable form. Since we are creating a basic web page, we will use the **.htm** extension (**.html** is also acceptable, just be consistent to make your life easier). If your editor does not have .htm or .html in its list, then select “All” and make index.htm your file name.

Note

If you ever come across an unfamiliar extension and want to know more about it, sites like **filext.com** can help you determine what programs can open it and what it is for.

Once we have saved our file as **index.htm**, we are ready to begin. Saving as soon as we create a file is useful as the text editor will then know what syntax is expected. This will enable features like color coding and highlighting that your editor supports.

Check File Extensions.

Document Type

Every HTML page we create should declare its document type (doctype) in the first line. This will identify which version of HTML is included so the browser knows how to interpret the tags within. Earlier version of the HTML specifications used two definitions for HTML: HTML 4.01 and XHTML. Both of these contained two additional properties of strict and transitional.

As said in thew previous section, the current version, since its release in 2014, is HTML 5.

Doctype \(\PageIndex{1}\)

To identify a web document as HTML version 5, the first line in the document should be:

The World Wide Web Consortium (W3C) is an international community that develops open standards to ensure the long-term growth of the Web.

Official page

Official documentation:		
HTML	CSS	XML

We will not cover the older "doctype" formats as all of our examples will focus on HTML 5. Keep in mind, though, that code examples you find online with anything other than the tag above may be outdated approaches to what is shown.

container

Immediately after the "doctype" declaration, the "html" container has to be written down. The element serves as the root container for the entire webpage, telling the browser that everything inside it is HTML content. The "html" container must have the opening tag and the closing tag.

\(\PageIndex{1}\)

After the "doctype" declaration, add the "html" container".

Most HTML tags come in pairs: an **opening tag** and a **closing tag**, wrapping around the content they modify. Together, the tags and the content between them make up an **HTML element.**

Tags are written using angle brackets to delineate HTML elements. Browsers do not display the HTML tags but use them to

interpret the content of the page.

HTML sections

HTML documents have three sections, inside the container:

- **head**: This section holds metadata like the page title, character encoding (), style sheets, and scripts. Nothing inside the head is directly visible on the page itself. It´s an optional section.
- **body**: This section holds all the visible content, interactive elements, text, images, and links that users see and interact with in their browser. It's a mandatory section. It should only use once in the whole HTML document.
- **footer**: This section is used to define the closing or supplementary section of a webpage or a specific content segment. It holds concluding information, metadata, and licensing details that do not belong in the main body content. It´s an optional section.

Sections \(\PageIndex{1}\)

Sections are included in the "html" container".

/html>

Graphics

Images are the greatest contributors to the visual appeal of your site, and typically account for the majority of bandwidth used in loading your pages. By using a combination of image types, and newer techniques found in HTML5 like canvas, and reproducing images using CSS, we can balance quality against size to reduce our bandwidth needs and allow our site to be more flexible.

Formats

Images are files, just like any other document in your computer, but they can be coded and formatted differently to reproduce the image you want to see. We find these referred to as **raster** and **vector** graphics. These formats represent two very different methods of creating an image.

Raster

The image files most of us are already familiar with using are typically raster format. When we interact with pictures we took on digital cameras for example, we are dealing with JPEG or JPG files. Raster files recreate an image by recording the color value of pixels, which represent the smallest single point on a screen that can be assigned a color by the display.

> A **pixel** is the smallest unit of a digital image or graphic that can be displayed and represented on a digital display device. A pixel is the basic logical unit in digital graphics. Pixels are combined to form a complete image, video, text, or any visible thing on a computer display. A pixel is represented by a dot or square on a computer monitor display screen.
>
> Techopedia

The higher the number of pixels (or density, measured as pixels per inch) translates to how sharp the image is, and how large it can be rendered without losing quality. The number of colors available in the image file is based on the length of the value available to each point. If we only allowed a single binary character for each pixel point, we would be able to keep our file size as small as possible. This however would mean we could only represent our image in black and white (binary only allows us two options, 0 or 1, so we can only represent two colors).

When we allow longer values to represent a single point, we can assign values a larger range of colors. Once we scale these up, however, we trade away our smaller image sizes in order to have more colorful pictures. Large images can slow down the user experience, and if loading takes too long, users will leave. Traditionally, we have faced this trade off by using different image formats in different areas of our site. While reserving JPG for our larger images or photos, we can use GIF for smaller icons and indicators.

GIFs limit us to 256 colors, but since most icons use few colors, we are able to capitalize on the benefits of this format here. It is important to note that raster images will quickly lose quality when rendered at sizes larger than the original image's width or height.

Examples of these are JPEG/JPG, PNG, GIF, TIFF/TIF, WEBP, BMP, HEIF/HEIC.

Vector

Vector images store information about colors and locations as definitions of angles, lines, and curves in mathematical format.

The benefit of a vector formatted image is that it can be scaled both up and down in size without distortion or degradation in quality. This is due to the fact that the image is "drawn" by the browser each time it is loaded, and the processor performs the steps necessary to recreate the image. Since the image can be scaled, the same image file can be drawn very large, or very small, without changing the file size.

Popular file formats for vector graphics are SVG, CGM, EPS, CDR, AI, and PDF

Compression

This is the act of removing or modifying the data that represents a file in a manner that makes its overall file size smaller. By doing this, we can transmit files faster, and they will take up less space in memory. When we discuss compression in terms of graphics we need to consider whether it will result in a lossy or lossless result.

- A **lossless** result means the compression techniques used do not remove data from the original copy, so we can restore the image to its exact original size and appearance.
- A **lossy** compression structure can result in greater compression, but achieves the extra advantage by removing information from the file.

As an example, imagine a picture of you and your friends on the beach with a clear blue sky behind you.

The data in the image file will measure the "blueness" of the sky in varying colors of blue, at a level greater than the eye can distinguish. By averaging the blueness and making more of the sky pixels the same color, we have eliminated information. Certain levels of lossy compression will still be indistinguishable from the original, but at any level, the lossy-compressed version of the file will not be restorable to the original because the extra values were eliminated.

Bottom line

Which is better? As usual, it depends on your intent.

If the image can be lossy compressed and is still acceptable to you and your users, and having the smallest possible file sizes (good, of course, for mobile devices) is a priority, then go for it.

Quality optimized scenarios will likely call for a lossless compression, like in sites that use large images as their background.

9.2.2. Fonts and Text decorations

Title

In HTML, "titles" primarily refer to the



> SEO stands for Search Engine Optimization.
>
> It means the process of improving your site to increase its visibility when people search for products or services related to your business in all search engines.
>
> Search Engine Land

Headings

In HTML, headings are used to define the titles and subtitles of sections on a webpage, establishing a clear content hierarchy and document structure. Possible options go from H1 (biggest) to H6 (smallest).

Search engines use the headings to index the structure and content of your web pages. Users often skim a page by its headings. It is important to use headings to show the document structure.

Source code	Outcome

# This is an H1 header ## This is an H2 header ### This is an H3 header #### This is an H4 header ##### This is an H5 header ###### This is an H6 header	This is an H1 header This is an H2 header This is an H3 header **This is an H4 header** **This is an H5 header** **This is an H6 header**

Navigation

A feature found on almost every website is a navigation system for moving between pages. These are typically menus, where groups of common pages are created to give the site a hierarchical organization. While the approach to visual styling and interaction with menus comes in great variety, most follow a basic principle of using unordered lists of links, and the application of **CSS** to those lists in order to turn them into colorful, interactive elements we are accustomed to.

> Remember that **Cascading Style Sheets** (CSS) is a core language of the **open web platform**, and is used for adding style (e.g., fonts, colors, spacing) to Web documents.
>
> W3C

Some popular approaches to providing a means of navigation are menu bars with dropdowns, **bread crumbs**, and event driven responses. Menu bars are the most frequently utilized element, where hovering or clicking over an item in the menu brings up additional choices related to the main item. Typically referred to as drop-down menus, they can be styled to move in any direction.

Lists can be used to show a menu. Nesting lists within lists can give us a multi-tier menu that allows us the ability to select from a large number of pages with little effort.

Lists

HTML lists allow to group a set of related items in lists. There are 3 types of lists that can be used:

- **Unordered Lists** (Bulleted): Uses the
    tag to create a list where the order of items does not matter. Each item is placed inside an
    - (list item) tag.
    - **Ordered Lists** (Numbered): Uses the
        tag for sequences where the order does matter (like a recipe or instructions). By default, it displays items with numbers.
        1. **Description Lists**: Uses the
            tag to create a list of terms and descriptions, which is ideal for glossaries or dictionary-style layouts. Instead of
        2. , it uses:
            - **for the description term**
                - for the **description details**

Bullet list \(\PageIndex{1}\)

- Cats
- Dogs
- Hamsters

Outcome

- Cats
- Dogs
- Hamsters

Numbered list\(\PageIndex{1}\)

1. Cats
2. Dogs
3. Hamsters

Outcome

1. Cats
2. Dogs
3. Hamsters

Description list \(\PageIndex{1}\)

Cat

Small feline animal.

Outcome

Cat

Small feline animal

Links

The HTML anchor tag () is used to create hyperlinks that connect one web page or resource to another. Its most critical component is the href attribute, which specifies the destination URL or file path. When a user clicks the text or element wrapped inside the tags, the browser navigates to that destination.

Links with anchor tags \(\PageIndex{1}\)

https://pgcc.edu">Visit PGCC

Outcome

Visit PGCC

Absolute and relative path

Links in HTML can take two forms, both of which are created with the anchor tag ( ).

- Absolute (external)
- Relative (internal)

They can either point to a resource in another location, or to a location within the document. The former is used far more frequently than the latter, however, internal links are coming back into popularity with the rise of infinite scrolling.

The ***href*** attribute of an anchor tag defines the actual location the link will represent. Absolute and relative paths are two reference methods for connecting sites and pages. While both methods can be used when creating links that point to content in our own site, only absolute can be used when pointing to content that is outside of your domain.

> Absolute link is external to the webpage and website. Relative link is internal in the webpage.

An absolute link example may be pointing to the college website (external): PGCC.

A relative link example may be pointing to a page inside this eBook: Check the Index page.

Anchor targets

While the anchor tag supports several attributes, one of the most important of these is “target.” This attribute describes where links will be loaded, like a new tab or the same tab/browser window we are already using.

The attribute can take any of the following values to define that location.

- _self: Opens the link in the **same browsing context** (tab or frame) where it was clicked.
- _blank: Opens the link in a **new tab** or a new window, depending on the user's browser settings.
- _parent: Opens the link in the **parent browsing context**. If there is no parent (the page isn't in an iframe), it defaults to `_self`.
- _top: Opens the link in the **topmost browsing context** (the full body of the window), breaking out of any deeply nested frames.
- custom_name: Opens the link in a **specifically named**

Outcome

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

REFERENCES

PGCC. *INT1010: Concepts in Computing*. LibreTexts. 2021. Link.

W3 Schools. HTML. Link.

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9.3: Appendix D - Basic HTML Instructions



Contents

9.3.1. Overview

9.3.2. What is HTML?

9.3.3. HTML Structure

9.3.4. CSS

9.3.5. HTML Basics

9.3.1. Overview

> The first version of HTML was written by Tim Berners-Lee in 1993. Since then, there have been many different versions of HTML. The most widely used version is HTML 5.
>
> University of Washington

9.3.2. What is HTML?

HTML is at the core of every web page. Behind every web page you've ever visited there is HTML code that your web browser uses to display elements like text, images and tables.

> **HTML** is the standard language for documents designed to be displayed in a web browser.

Web browsers read HTML documents (containing HTML code) to display the resulting web page. An HTML document can include different elements such as text headings, paragraphs, images or tables. These elements are defined using different tags. HTML is based on tags. You can tell the web browser that you want to include a paragraph of text in your web page by enclosing the text in paragraph tags

.

9.3.3. HTML Structure

An HTML 5 document must always start with the declaration as its very first line. It officially informs the browser that the document should be interpreted as a standard HTML 5 page.

An HTML page follows a standard hierarchical structure consisting of three sections:

- "head" section (metadata) (optional)
  - Highly recommended to include (Sets the text displayed on the browser tab)
- "body" section (visible content) (mandatory)
- "footer" section (usually shows copyright indicators, terms of service, or contact details) (optional)

Most HTML tags come in pairs: an **opening tag** and a **closing tag**, wrapping around the content they modify. Together, the tags and the content between them make up an **HTML element.**

Tags are written using angle brackets to delineate HTML elements. Browsers do not display the HTML tags but use them to interpret the content of the page.

- **Opening Tag:** Consists of the element name inside angle brackets (e.g.,

). It signals where an effect or section begins.

- **Content:** The actual text, image, or media you want to display.
- **Closing Tag:** Looks just like the opening tag but includes a forward slash (`/`) before the element name (e.g.,

). It signals the end of that section.

```
<!DOCTYPE html>
<html>
    <head>
        <title>Title</title>
    </head>
    <body>
        <p> The content of the document </p>
    </body>
    <footer>
        <h3>Your name</h3>
    </footer>
</html>
```

Structure for an HTML document. By Luis R Castellanos, Public domain, own work.

9.3.4. CSS

Cascading Style Sheets (CSS) is the design language used to style and lay out HTML elements on a webpage. While HTML provides the raw structure and text content, CSS controls how that content looks visually.

What CSS Is Used For

- **Styling Appearance:** Customizing colors, background shades, typography, font sizes, and borders.
- **Layout Management:** Arranging elements into side-by-side columns, grids, or flexible alignments using modern layout engines like Flexbox and CSS Grid.
- **Responsive Design:** Adapting layouts across phones, tablets, and desktop displays using media queries (`@media`).
- **Animations & Transitions:** Creating interactive hover effects, smooth color changes, and keyframe animations.

Basic Syntax & Structure

CSS applies styles using **rulesets**. A ruleset consists of a selector pointing to an HTML element, followed by a declaration block containing CSS property-value pairs.

> Check the CSS official page at W3C

9.3.5. HTML Basics

> Check the list of HTML tags, from A to Z, from Geeks for Geeks

Headings

Source code	Outcome
# This is an H1 header ## This is an H2 header ### This is an H3 header #### This is an H4 header ##### This is an H5 header ###### This is an H6 header	This is an H1 header This is an H2 header This is an H3 header This is an H4 header This is an H5 header This is an H6 header

Paragraphs

Source code	Outcome
This is a normal paragraph, about history. Philadelphia was founded in 1682 by William Penn, an English Quaker.	This is a normal paragraph, about history. Philadelphia was founded in 1682 by William Penn, an English Quaker.

# United States capital cities ## New York New York City served as the capital of the United States from 1785 to 1790. ## Philadelphia Philadelphia served as the capital of the United States from 1790 to 1800. ## District of Columbia Washington, D.C. serves as the capital of the United States since 1800.	## United States capital cities ### New York New York City served as the capital of the United States from 1785 to 1790. ### Philadelphia Philadelphia served as the capital of the United States from 1790 to 1800. ### District of Columbia Washington, D.C. serves as the capital of the United States since 1800.

Lists

Source code	Outcome

The days of the week are: • Sunday • Monday • Tuesday • Wednesday • Thursday • Friday • Saturday	**The days of the week are:** • Sunday • Monday • Tuesday • Wednesday • Thursday • Friday • Saturday

The days of the week are:

1. Sunday
2. Monday
3. Tuesday
4. Wednesday
5. Thursday
6. Friday
7. Saturday

The days of the week are:

1. Sunday
2. Monday
3. Tuesday
4. Wednesday
5. Thursday
6. Friday
7. Saturday

These are my classes during the week:

1. Monday
    - INT1010
    - MAT1010
2. Tuesday
    - SOC1011
    - BIO1011
3. Wednesday
    - INT1010
    - MAT1010
4. Thursday

These are my classes during the week:

1. Monday
    - INT1010
    - MAT1010
2. Tuesday
    - SOC1011
    - BIO1011
3. Wednesday
    - INT1010
    - MAT1010
4. Thursday
    - SOC1011
    - BIO1011

◦ SOC1011 ◦ BIO1011	
Some acronyms used in Web development: **CSS** Cascading Style Sheets **HTML** HyperText Markup Language **WWW** World Wide Web	**Some acronyms used in Web development:** **CSS** Cascading Style Sheets **HTML** HyperText Markup Language **WWW** World Wide Web

Images and Videos

Source code	Outcome

https://colonialbrewer.com/wp-conten...06/image-8.png" alt="Historic Philadelphia">	
	YouTube Video *This interactive element is not a* *Visit the link or scan the QR cod* View this YouTube Video online

Links

	Source code	Outcome
Link opens in the same tab	https://www.pgcc.edu/" target="_self">Visit PGCC	Visit PGCC
Link that opens in a new tab	https://www.pgcc.edu/" target="_blank">Visit PGCC	Visit PGCC

Quotes and citations

	Source code	Outcome
How to quote	That's one small step for man, one giant leap for mankind.	That's one small step for man, one giant leap for mankind.
How to cite	— Neil Armstrong, *Apollo 11 astronaut*	— Neil Armstrong, *Apollo 11 astronaut*

CSS

	Source code	Outcome
Normal paragraph	The "DMV" area in the United States refers to the metropolitan region surrounding Washington, D.C., including the District of Columbia, Maryland, and Virginia.	The "DMV" area in the United States refers to the metropolitan region surrounding Washington, D.C., including the District of Columbia, Maryland, and Virginia.
Center alignment in a paragraph	The "DMV" area in the United States refers to the metropolitan region surrounding Washington, D.C., including the District of Columbia, Maryland, and Virginia.	The "DMV" area in the United States refers to the metropolitan region surrounding Washington, D.C., including the District of Columbia, Maryland, and Virginia.
Right alignment in a paragraph	The "DMV" area in the United States refers to the metropolitan region surrounding Washington, D.C., including the District of Columbia, Maryland, and Virginia.	The "DMV" area in the United States refers to the metropolitan region surrounding Washington, D.C., including the District of Columbia, Maryland, and Virginia.
Bold word in a paragraph	The current capital of the United States is **Washington, D.C.,** since 1800.	The current capital of the United States is **Washington, D.C.,** since 1800.
Change color in header and in paragraph	**This H2 heading will be shown in red.** This whole paragraph will be shown all in blue.	**This H2 heading will be shown in red.** This whole paragraph will be shown all in blue.

REFERENCES

W3C. HTML Living Standard. 2026. Link.

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9.4: Summary



9.1. An Introduction

Hypertext Markup Language (HTML) is a standard markup language for tagging text files to achieve font, color, graphic, and hyperlink effects to be displayed in a web browser.

It can be assisted by technologies such as **Cascading Style Sheets** (CSS) and scripting languages such as **JavaScript** (JS).

Web browsers obtain HTML documents from either a web server or local storage and produce the documents into multimedia web pages.

The first version of HTML was written by Tim Berners-Lee in 1993.

The current version is HTML 5.

The **website development life cycle** (WDLC) typically involves seven key phases:

1. Planning.
2. Analysis.
3. Design.
4. Development.
5. Testing.
6. Implementation.
7. Maintenance.

In the website planning, it is recommended to use SMART objectives. SMART stands for **S**pecific, **M**easurable, **A**chievable, **R**ealistic, and **T**imely.

There are some tools that can be used during the planning, like: the Fold, Typography, Wireframes, Storyboards, and color palettes.

Before coding, using Pseudocode is a very good idea.

Once the coding begins, attention must be paid upon: bracket use, spacing and indentation, comments, versions and meaninful variable names.

Templates can be used, as CMS and IDEs.

9.2. HTML 1010

An HTML 5 document must always start with the declaration as its very first line. It officially informs the browser that the document should be interpreted as a standard HTML 5 page.

An HTML page follows a standard hierarchical structure consisting of three sections:

- "head" section (metadata) (optional)
  - Highly recommended to include (Sets the text displayed on the browser tab)
- "body" section (visible content) (mandatory)
- "footer" section (usually shows copyright indicators, terms of service, or contact details) (optional)

Most HTML tags come in pairs: an **opening tag** and a **closing tag**, wrapping around the content they modify. Together, the tags and the content between them make up an **HTML element.**

Tags are written using angle brackets to delineate HTML elements. Browsers do not display the HTML tags but use them to interpret the content of the page.

- **Opening Tag:** Consists of the element name inside angle brackets (e.g.,

). It signals where an effect or section begins.

- **Content:** The actual text, image, or media you want to display.
- **Closing Tag:** Looks just like the opening tag but includes a forward slash (/) before the element name (e.g.,

). It signals the end of that section.

Cascading Style Sheets (CSS) is the design language used to style and lay out HTML elements on a webpage. While HTML provides the raw structure and text content, CSS controls how that content looks visually.

9.3. Appendix D: Basic HTML

Check the W3C's "HTML Living Standards", to see all HTML elements: Link.

Summary image banner by Luis R Castellanos

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10: INTERNET PRIVACY, INTERNET SECURITY, AND NETIQUETTE



The growing internet intrusions have devastating implications for our right to privacy. But more than just privacy is threatened when everything we say, everywhere we go, and everyone we associate with is fair game. There are certain rules required to protect your data and ensure proper etiquette when using the internet.

Learning Objectives

Upon successful completion of this chapter, you will be able to:

- Define computer security
- Understand what industries are affected by computer security
- Use tools for communicating online

10.1: Internet Privacy

10.2: Internet Security

10.3: Netiquette

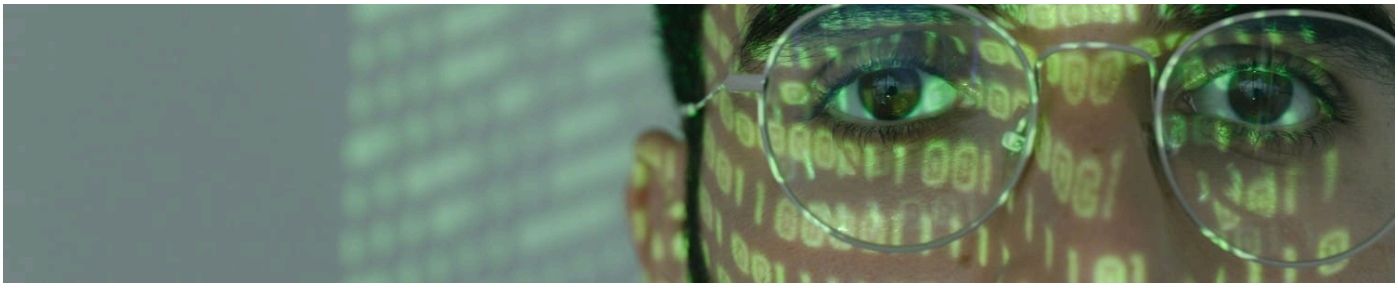
10.4: Summary

> "The most important thing in life is to love what you're doing, because that's the only way you'll ever be really good at it."
>
> — Donald J Trump, *PotUS 45 & 47*

Banner image by Geralt, via Pixabay

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10.1: Internet Privacy



Contents

10.1.1. Levels of Privacy

10.1.2. Risks to Internet Privacy

10.1.3. Cookies

10.1.4. Photos on Internet

The growing internet intrusions have devastating implications for our right to privacy. But more than just privacy is threatened when everything we say, everywhere we go, and everyone we associate with is fair game. There are certain rules required to protect your data and ensure proper etiquette when using the internet.

> **Internet privacy** involves the right or mandate of personal privacy concerning the storing, re-purposing, provision to third parties, and displaying of information pertaining to oneself via the Internet.

Internet privacy is a subset of data privacy. Privacy concerns have been articulated from the beginnings of large-scale computer sharing.

Privacy can entail either Personally Identifying Information (**PII**), Sensitive Personally Identifying Information (S**PII**) or **non-PII** information such as a site visitor's behavior on a website.

> **PII** refers to any information that can be used to identify an individual.

For example, age and physical address alone could identify who an individual is without explicitly disclosing their name, as these two factors are unique enough to typically identify a specific person.

Some experts such as **Steve Rambam**, a private investigator specializing in Internet privacy cases, believe that privacy no longer exists; saying, "**Privacy is dead – get over it**".In fact, it has been suggested that the "appeal of online services is to broadcast personal information on purpose".

On the other hand, in his essay The Value of Privacy, security expert **Bruce Schneier** says, "**Privacy protects us from abuses by those in power, even if we're doing nothing wrong at the time of surveillance**."

10.1.1. Levels of Privacy

Internet and digital privacy are viewed differently from traditional expectations of privacy. **Internet privacy is primarily concerned with protecting user information.**

Law Professor **Jerry Kang** explains that the term privacy expresses space, decision, and information.

In terms of space, individuals have an expectation that their physical spaces (i.e. homes, cars) not be intruded on.

Privacy within the realm of decision is best illustrated by the landmark case Roe vs Wade.

(Norma McCorvey was known as Jane **Roe**, in the initial trial. Henry **Wade**, was the district attorney for Dallas County, Texas).

Roe v. Wade was a landmark 1973 decision that ruled abortion as a constitutional right. In this case, the **Supreme Court** ruled that a woman's choice to have an abortion outweighs the state's concern for prenatal life up until the "point of fetal viability", or the point when a fetus can survive outside the womb (in 1973, this was determined to be 24-28 weeks).

Since this decision, abortion has been a federally protected right, regardless of state laws.

In 2022, the **Supreme Court** overturned Roe v. Wade and ruled that abortion was not going to be regulated at federal level, but at the State level.

You have alternatives

Lastly, information privacy is in regards to the collection of user information from a variety of sources, which produces great discussion. The 1997 Information Infrastructure Task Force (**IITF**) created under President Clinton gave this definition:

Information privacy is an individual's claim to control the terms under which personal information–information identifiable to the individual–is acquired, disclosed, and used.

At the end of the 1990s, with the rise of the internet, it became clear that the internet and companies would need to abide by new rules to protect individuals' privacy.

With the rise of the internet and mobile networks, the salience of internet privacy is a daily concern for users. People with only a casual concern for Internet privacy need not achieve total anonymity. Internet users may protect their privacy through controlled disclosure of personal information.

The revelation of IP addresses, non-personally-identifiable profiling, and similar information might become acceptable trade-offs for the convenience that users could otherwise lose using the workarounds needed to suppress such details rigorously.

Check IP address

With the rise of the internet and mobile networks, the salience of internet privacy is a daily concern for users. People with only a casual concern for Internet privacy need not achieve total anonymity. Internet users may protect their privacy through controlled disclosure of personal information.The revelation of IP addresses, non-personally-identifiable profiling, and similar information might become acceptable trade-offs for the convenience that users could otherwise lose using the workarounds needed to suppress such details rigorously.

On the other hand, some people desire much stronger privacy. In that case, they may try to achieve Internet anonymity to ensure privacy — use of the Internet without giving any third parties the ability to link the Internet activities to personally-identifiable information of the Internet user. In order to keep their information private, people need to be careful with what they submit and look at online. When filling out forms and buying merchandise, that becomes tracked and because the information was not private, companies are now sending Internet users **spam** and advertising on similar products.

Email spam, also referred to as junk email or simply **spam**, is unsolicited messages sent in bulk by email (spamming).

The name comes from a Monty Python sketch in which the name of the canned pork product Spam is ubiquitous, unavoidable, and repetitive.

Wikipedia

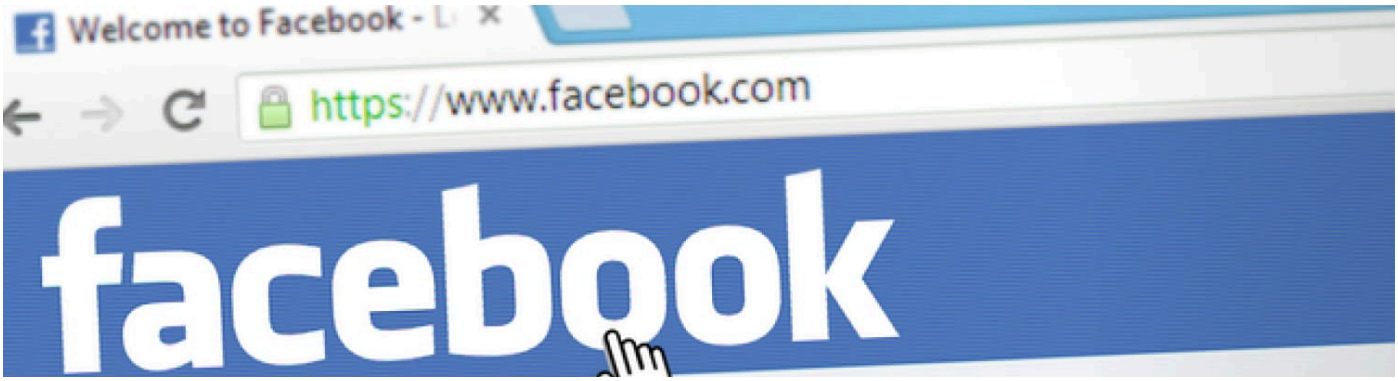
There are also several governmental organizations that protect individuals' privacy and anonymity on the Internet, to a point. In an article presented by the Federal Trade Comission (FTC), , a number of pointers were brought to attention that helps an individual internet user avoid possible identity theft and other cyber-attacks.

Preventing or limiting the usage of Social Security numbers online, being wary and respectful of emails including spam messages, being mindful of personal financial details, creating and managing strong passwords, and intelligent web-browsing behaviors are recommended, among others.

Posting things on the Internet can be harmful or in danger of malicious attack. All of the information posted on the Internet is permanent, depending on the terms of service, and privacy policies of particular services offered online. This can include comments written on blogs, pictures, and Internet sites, such as Facebook and X (Twitter). It is absorbed into cyberspace and once it is posted, anyone can potentially find it and access it.

Digital Identity is a set of characteristics or traits that represent a person or institution through a digital medium, such as the internet.

Chunga (2013). Identidad Digital.



Facebook. Image by Simon from Pixabay.

10.1.2. Risks to Internet Privacy

Companies are hired to watch what internet sites people visit, and then use the information, for instance by sending advertising based on one's browsing history. There are many ways in which people can divulge their personal information, for instance by use of "social media" and by sending bank and credit card information to various websites.

Moreover, directly observed behavior, such as browsing logs, search queries, or contents of the Facebook profile can be automatically processed to infer potentially more intrusive details about an individual, such as sexual orientation, political and religious views, race, substance use, intelligence, and personality.

Those concerned about Internet privacy often cite a number of privacy risks — events that can compromise privacy — which may be encountered through Internet use.

These range from the gathering of statistics on users to more malicious acts such as the spreading of spyware and the exploitation of various forms of bugs (software faults).

Several social network sites try to protect the personal information of their subscribers.

On Facebook, for example, privacy settings are available to all registered users: they can block certain individuals from seeing their profile, they can choose their “friends”, and they can limit who has access to one’s pictures and videos.

Privacy settings are also available on other social network sites such as Instagram and X (Twitter). The user can apply such settings when providing personal information on the internet.

Back in 2007, Facebook launched the "Beacon program" where user rental records were released to the public for friends to see. Many people were enraged by this breach of privacy, and the Lane v. Facebook, Inc. case ensued.

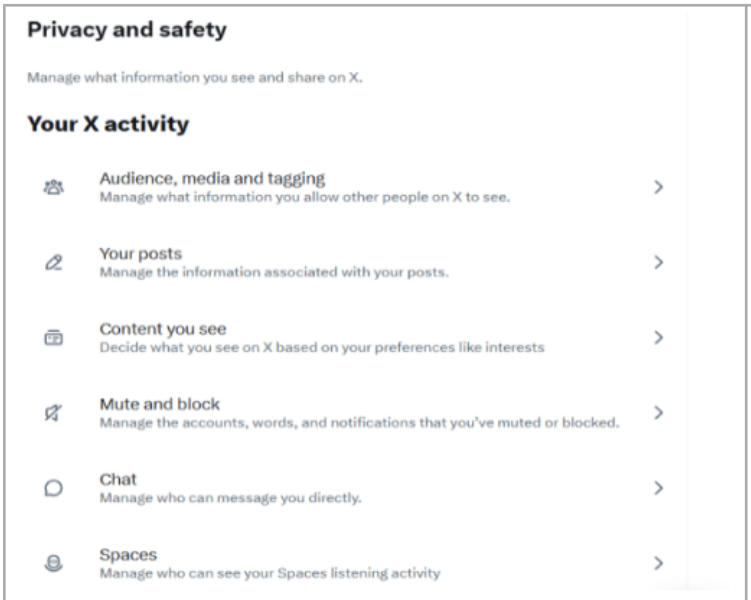
Facebook's "Beacon program": Beacon settlement gets preliminary OK - CNET

Children and adolescents often use the Internet (including social media) in ways that risk their privacy: a cause for growing concern among parents. Young people also may not realize that all their information and browsing can and may be tracked while visiting a particular site and that it is up to them to protect their own privacy. They must be informed about all these risks.

For example, on X (Twitter), threats include shortened links that lead one to potentially harmful places.

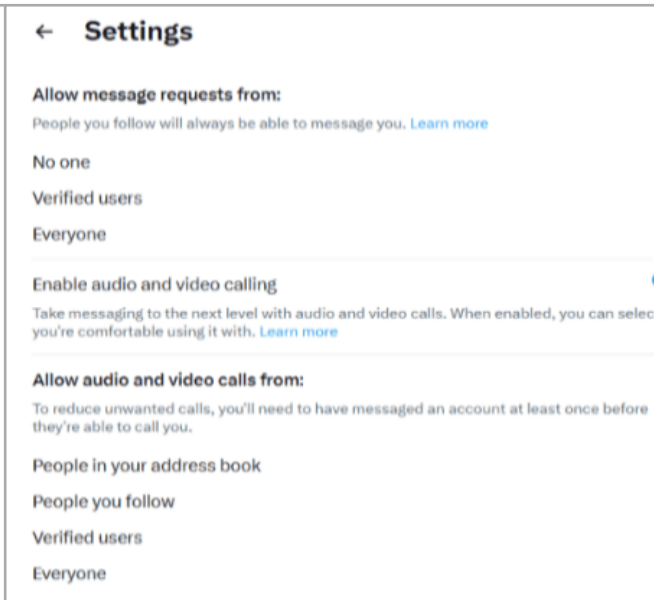
In their e-mail inbox, threats include email scams and attachments that get them to install malware and disclose personal information. On Torrent sites, threats include malware hiding in video, music, and software downloads. Even when using a smartphone, threats include geolocation, meaning that one’s phone can detect where they are and post it online for all to see.

Users can protect themselves by updating virus protection, using security settings, downloading patches, installing a firewall, screening e-mail, shutting down spyware, controlling cookies, using encryption, fending off browser hijackers, and blocking pop-ups.



Privacy and safety settings in X.

By Luis R Castellanos, Public Domain, own work.



Privacy settings in X.

By Luis R Castellanos, Public Domain, own work.

However, most people have little idea how to go about doing many of these things.

How can the average user with no training be expected to know how to run their own network security (especially as things are

getting more complicated all the time)?

Many businesses hire professionals to take care of these issues, but most individuals can only do their best to learn about all this.

In 1998, the FTC considered the lack of privacy for children on the Internet and created the Children Online Privacy Protection Act (COPPA). COPPA limits the options which gather information from children and created warning labels if potential harmful information or content was presented.

In 2000, Children's Internet Protection Act (CIPA) was developed to implement safe Internet policies such as rules and filter software.

These laws, awareness campaigns, parental and adult supervision strategies, and Internet filters can all help to make the Internet safer for children around the world.

Children's Internet Protection Act (CIPA): text of rule

10.1.3. Cookies

> An **HTTP cookie** is data stored on a user's device that assists in automated access to websites or web features, or other state information required in complex websites.

It may also be used for user-tracking by storing special usage history data in a cookie, and such cookies—for example, those used by Google Analytics—are called tracking cookies. Cookies are a common concern in the field of Internet privacy.



HTTP Cookies. Image by Luis R Castellanos, Public Domain, generated from Google Gemini

Although website developers most commonly use cookies for legitimate technical purposes, cases of abuse occur.

In 2009, two researchers noted that social networking profiles could be connected to cookies, allowing the social networking profile to be connected to browsing habits.

In the past, websites have not generally made the user explicitly aware of the storing of cookies, however, tracking cookies and especially third-party tracking cookies are commonly used as ways to compile long-term records of individuals' browsing histories — a privacy concern that prompted European and US lawmakers to take action in 2011.

Cookies can also have implications for computer forensics. In past years, most computer users were not completely aware of cookies, but recently, users have become conscious of possible detrimental effects of Internet cookies:

58% have deleted cookies at least once | 39% delete cookies every month from their device

Since cookies are advertisers' main way of targeting potential customers, and some customers are deleting cookies, some advertisers started to use persistent **Flash cookies** and **zombie cookies**, but modern browsers and anti-malware software can now block or detect and remove such cookies.

The original developers of cookies intended that only the website that originally distributed cookies to users could retrieve them, therefore returning only data already possessed by the website.

However, in practice programmers can circumvent this restriction. Possible consequences include:

- the placing of a personally-identifiable tag in a browser to facilitate web profiling, or,
- use of cross-site scripting or other techniques to steal information from a user's cookies.

Cookies do have **benefits** that many people may not know.

- One benefit is that for websites that one frequently visits that require a password, cookies make it so they do not have to sign in every time.
- A cookie can also track one's preferences to show them websites that might interest them.
- Cookies make more websites free to use without any type of payment.

Some of these benefits are also seen as negative. For example, one of the most common ways of theft is hackers taking one's user name and password that a cookie saves. While a lot of sites are free, they have to make a profit somehow so they sell their space to advertisers.

These ads, which are personalized to one's likes, can often freeze one's computer or cause annoyance. Cookies are mostly harmless except for **third-party cookies**. These cookies are not made by the website itself, but by web banner advertising companies. These third-party cookies are so dangerous because they take the same information that regular cookies do, such as browsing habits and frequently visited websites, but then they give out this information to other companies.

Cookies are often associated with pop-up windows because these windows are often, but not always, tailored to a person's preferences. These windows are an irritation because they are often hard to close out of because the close button is strategically hidden in an unlikely part of the screen. In the worst cases, these pop-up ads can take over the screen and while trying to exit out of it, can take one to another unwanted website.

Cookies are seen so negatively because they are not understood and go unnoticed while someone is simply surfing the Internet. The idea that every move one makes while on the Internet is being watched, would frighten most users. Some users choose to disable cookies in their web browsers. Such an action can reduce some privacy risks, but may severely limit or prevent the functionality of many websites.

All significant web browsers have this disabling ability built-in, with no external program required. As an alternative, users may frequently delete any stored cookies. Some browsers (such as Mozilla Firefox and Opera) offer the option to clear cookies automatically whenever the user closes the browser. A third option involves allowing cookies in general, but preventing their abuse.

Browser Market Share Worldwide

Source: StatCounter Global Stats - Browser Market Share

There are also a host of wrapper applications that will redirect cookies and cache data to some other location. Concerns exist that the privacy benefits of deleting cookies have been over-stated.

The process of profiling (also known as “tracking”) assembles and analyzes several events, each attributable to a single originating entity, in order to gain information (especially patterns of activity) relating to the originating entity.

Some organizations engage in the profiling of people’s web browsing, collecting the URLs of sites visited. The resulting profiles can potentially link with information that personally identifies the individual who did the browsing. Some web-oriented marketing-research organizations may use this practice legitimately, for example: in order to construct profiles of ‘typical Internet users’.

Such profiles, which describe average trends of large groups of Internet users rather than of actual individuals, can then prove useful for market analysis. Although the aggregate data does not constitute a privacy violation, some people believe that the initial profiling does. Profiling becomes a more contentious privacy issue when data-matching associates the profile of an individual with personally identifiable information of the individual.

Governments and organizations may set up **honeypot websites** – featuring controversial topics – with the purpose of attracting and tracking unwary people. This constitutes a potential danger for individuals.

10.1.4. Photos on Internet

Today many people have smart phone cameras and/or digital cameras and post their photographs online, for example, street photography practitioners do so for artistic purposes and social documentary photography practitioners do so to document the common people in everyday life. The people depicted in these photos might not want to have them appear on the Internet.

Police arrest photos, considered public records in many jurisdictions, are often posted on the internet by numerous online mug-shot publishing sites.

Some organizations attempt to respond to this privacy-related concern.

For example, in some conferences, the organizers required that photographers have the prior permission of the people in their pictures, albeit this made it impossible for photographers to practice candid photography, and doing the same in a public place would violate the photographers' free speech rights.

Some people wore a 'no photos' tag to indicate they would prefer not to have their photo taken.

The Harvard Law Review published a short piece called "In The Face of Danger: Facial Recognition and Privacy Law", much of it explaining how "privacy law, in its current form, is of no help to those unwillingly tagged".

Any individual can be unwillingly tagged in a photo and displayed in a manner that might violate them personally in some way, and by the time Facebook gets to taking down the photo, many people will have already had the chance to view, share, or distribute it.

In the Face of Danger: Facial Recognition and the Limits of Privacy Law

Furthermore, traditional tort law does not protect people who are captured by a photograph in public because this is not counted as an invasion of privacy.

The extensive Facebook privacy policy covers these concerns and much more. For example, the policy states that they reserve the right to disclose member information or share photos with companies, lawyers, courts, government entities, etc. if they feel it absolutely necessary. The policy also informs users that profile pictures are mainly to help friends connect to each other. However, these, as well as other pictures, can allow other people to invade a person's privacy by finding out information that can be used to track and locate a certain individual.

In an article featured in ABC News, it was stated that two teams of scientists found out that Hollywood stars could be giving up information about their private whereabouts very easily through pictures uploaded to the Internet.

Moreover, it was found that pictures taken by some phones and tablets including iPhones automatically attach the latitude and longitude of the picture taken through metadata unless this function is manually disabled [Geotags].

Face recognition technology can be used to gain access to a person's private data, according to a new study. Researchers at Carnegie Mellon University combined image scanning, cloud computing, and public profiles from social network sites to identify individuals in the offline world.

How to disable "Geotags" on your cell phone:	
Android	**iPhone**
1. Open your Camera app, 2. Go to Settings (usually represented by a gear icon), and 3. Toggle off the "GPS" or "Geotag" option, which may also be labeled as "Location Info" depending on your device.	1. Go to Settings 2. Tap Privacy & Security 3. Tap Location Services 4. Tap Camera 5. Select Never

Data captured even included a user's social security number. Experts have warned of the privacy risks faced by the increased merging of our online and offline identities.

The researchers have also developed an augmented reality mobile app that can display personal data over a person's image captured on a smartphone screen. Since these technologies are widely available, our future identities may become exposed to anyone with a smartphone and an Internet connection. Researchers believe this could force us to reconsider our future attitudes to privacy.



Photographer. Image by Ivana Tomášková en Pixabay

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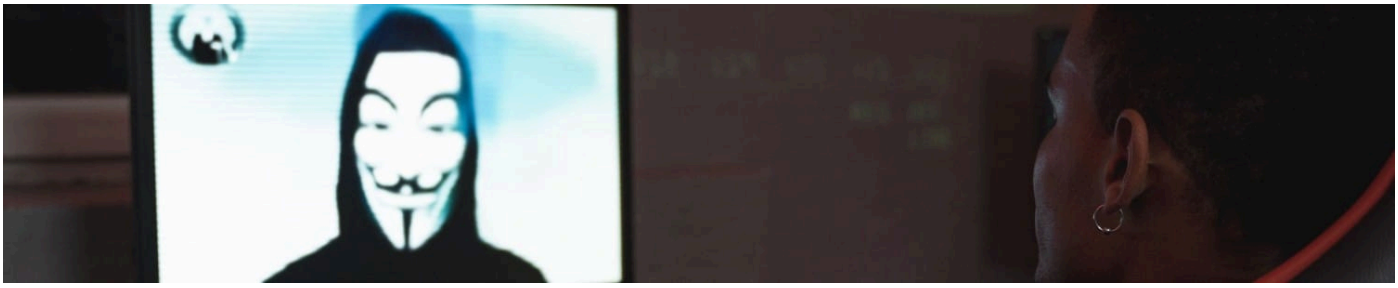
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10.2: Internet Security



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10.2.1. Computer Security

Computer security, also known as cyber security or IT security, is the protection of information systems from theft or damage to the hardware, the software, and to the information on them, as well as from disruption or misdirection of the services they provide.

It includes controlling physical access to the hardware, as well as protecting against harm that may come via network access, data and code injection, and due to malpractice by operators, whether intentional, accidental, or due to them being tricked into deviating from secure procedures.

The field is of growing importance due to the increasing reliance on computer systems and the Internet in most societies, wireless networks such as Bluetooth and Wi-Fi – and the growth of “smart” devices, including smartphones, televisions and tiny devices as part of the Internet of Things.

Check Bluetooth, Internet of Things.

10.2.2. Systems at Risk

Computer security is critical in almost any industry which uses computers. Currently, most electronic devices such as computers, laptops and cellphones come with built in firewall security software, but despite this, computers are not 100 percent accurate and dependable to protect our data.

There are many different ways of hacking into computers. It can be done through a network system, clicking into unknown links, connecting to unfamiliar Wi-Fi, downloading software and files from unsafe sites, power consumption, electromagnetic radiation waves, and many more.

However, computers can be protected through well built software and hardware. By having strong internal interactions of properties, software complexity can prevent software crash and security failure.

10.2.3. Financial Systems

Web sites and apps that accept or store credit card numbers, brokerage accounts, and bank account information are prominent hacking targets, because of the potential for immediate financial gain from transferring money, making purchases, or selling the information on the black market.

In-store payment systems and ATMs have also been tampered with in order to gather customer account data and PINs.

> The Equifax data breach (2017) has been one of the biggest occurred within Financial Systems.
>
> Read more in EPIC.





Credit cards. Image by Starsi from Pixabay.

10.2.4. Utilities and Industrial Equipment

Computers control functions at many utilities, including coordination of telecommunications, the power grid, nuclear power plants, and valve opening and closing in water and gas networks.

The Internet is a potential attack vector for such machines if connected, but the **Stuxnet worm** demonstrated that even equipment controlled by computers not connected to the Internet can be vulnerable to physical damage caused by malicious commands sent to industrial equipment (in that case uranium enrichment centrifuges) which are infected via removable media.

Stuxnet is a malicious computer worm first uncovered in 2010 and thought to have been in development since at least 2005. **Stuxnet** targets supervisory control and data acquisition (SCADA) systems and is believed to be responsible for causing substantial damage to the nuclear program of Iran.

Wikipedia

In 2014, the Computer Emergency Readiness Team, a division of the Department of Homeland Security, investigated 79 hacking incidents at energy companies. Vulnerabilities in smart meters (many of which used local radio or cellular communications) caused some problems with billing fraud.

During 2026, Iranian hackers attacked Water plants in the US and Power plants in the UK.

CSIS report on US Water Plants - CyberMagazine report on UK Power Plants

10.2.5. Aviation

The aviation industry is very reliant on a series of complex system which could be attacked. A simple power outage at one airport can cause repercussions worldwide, much of the system relies on radio transmissions which could be disrupted, and controlling aircraft over oceans is especially dangerous because radar surveillance only extends 175 to 225 miles offshore. There is also potential for attack from within an aircraft.

The consequences of a successful attack range from loss of confidentiality to loss of system integrity, which may lead to more serious concerns such as exfiltration of data, network and air traffic control outages, which in turn can lead to airport closures, loss of aircraft, loss of passenger life, damages on the ground and to transportation infrastructure. A successful attack on a military aviation system that controls munitions could have even more serious consequences.

2023 FAA Outage.

In January 2023, airports were closed and airplanes were grounded in the US. News by CNBC. Official FAA statement.

Europe has started to move towards centralized aviation network **PENS** (Pan-European Network Service) which do provide a common IP-based network service across the European region covering voice and data communication and later on even more with NewPENS, similar USA has in NextGen program.



Airplane. Image by Scarlett_z10 from Pixabay.

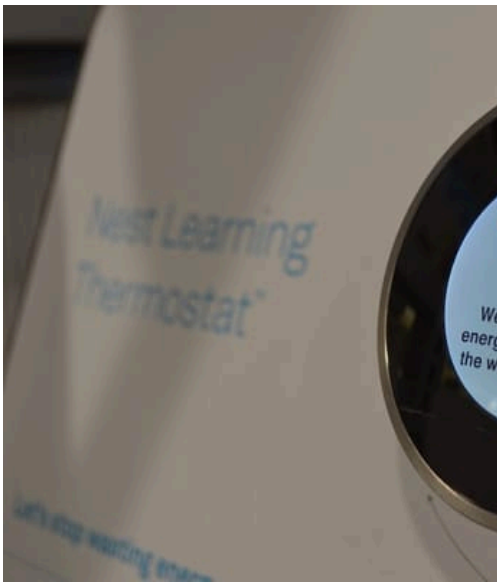
10.2.6. Consumer Devices

Desktop computers and laptops are commonly infected with malware either to gather passwords or financial account information, or to construct a botnet to attack another target. Smart phones, tablet computers, smart watches, and other mobile devices such as Quantified Self devices like activity trackers have also become targets and many of these have sensors such as cameras, microphones, GPS receivers, compasses, and accelerometers which could be exploited, and may collect personal information, including sensitive health information.

Wifi, Bluetooth, and cell phone networks on any of these devices could be used as attack vectors, and sensors might be remotely activated after a successful breach. Home automation devices such as the **Nest** thermostat and the **Ring** doorbell are also potential targets.



Ring door camera. Image by Luis R Castellanos, Public domain, own work.



Nest Thermostat. Image by Raysonho, C

10.2.7. Large Corporations

Large corporations are common targets. In many cases this is aimed at financial gain through identity theft and involves data breaches such as the loss of millions of clients' credit card details by Home Depot, Staples, and Target Corporation. Medical records have been targeted for use in general identify theft, health insurance fraud, and impersonating patients to obtain prescription drugs for recreational purposes or resale.

Not all attacks are financially motivated however; for example security firm HB Gary Federal suffered a serious series of attacks in 2011 from hacktivist group Anonymous in retaliation for the firm's CEO claiming to have infiltrated their group, and Sony Pictures was attacked in 2014 where the motive appears to have been to embarrass with data leaks, and cripple the company by wiping workstations and servers.

Biggest Data Breaches in US History

10.2.8. Automobiles

If access is gained to a car's internal controller area network, it is possible to disable the brakes and turn the steering wheel. Computerized engine timing, cruise control, anti-lock brakes, seat belt tensioners, door locks, airbags and advanced driver

assistance systems make these disruptions possible, and self-driving cars go even further.

Connected cars may use Wifi and Bluetooth to communicate with onboard consumer devices, and the cell phone network to contact concierge and emergency assistance services or get navigational or entertainment information; each of these networks is a potential entry point for malware or an attacker.

Researchers were even able to use a malicious compact disc in a car's stereo system as a successful attack vector, and cars with built-in voice recognition or remote assistance features have onboard microphones which could be used for eavesdropping.

10.2.9. Government

Government and military computer systems are commonly attacked by activists and foreign powers. Local and regional government infrastructure such as traffic light controls, police and intelligence agency communications, personnel records, student records, and financial systems are also potential targets as they are now all largely computerized.

Passports and government ID cards that control access to facilities which use RFID can be vulnerable to cloning.

> Radio-frequency identification (RFID) uses electromagnetic fields to automatically identify and track tags attached to objects.

10.2.10. Internet of Things and physical vulnerabilities

The Internet of Things (IoT) is the network of physical objects such as devices, vehicles, and buildings that are embedded with electronics, software, sensors, and network connectivity that enables them to collect and exchange data – and concerns have been raised that this is being developed without appropriate consideration of the security challenges involved.

While the IoT creates opportunities for more direct integration of the physical world into computer-based systems, it also provides opportunities for misuse. In particular, as the Internet of Things spreads widely, cyber attacks are likely to become an increasingly physical (rather than simply virtual) threat. If a front door's lock is connected to the Internet, and can be locked/unlocked from a phone, then a criminal could enter the home at the press of a button from a stolen or hacked phone.

People could stand to lose much more than their credit card numbers in a world controlled by IoT-enabled devices. Thieves have also used electronic means to circumvent non-Internet-connected hotel door locks. Medical devices have either been successfully attacked or had potentially deadly vulnerabilities demonstrated, including both in-hospital diagnostic equipment and implanted devices including pacemakers and insulin pumps.

YouTube Video

This interactive element is not available in this format. Visit the link or scan the QR code to access it online.

View this YouTube Video online

Check Internet of Things.

10.2.11. Attacker motivation

The motivations for breaches of computer security vary between attackers. Some are thrill-seekers or vandals, others are activists or criminals looking for financial gain. State-sponsored attackers are now common and well resourced, but started with amateurs such as Markus Hess who hacked for the KGB, as recounted by Clifford Stoll, in The Cuckoo's Egg.

A standard part of threat modeling for any particular system is to identify what might motivate an attack on that system, and who might be motivated to breach it. The level and detail of precautions will vary depending on the system to be secured. A home personal computer, bank, and classified military network face very different threats, even when the underlying technologies in use are similar.

Cybercriminals aren't just faceless entities; they're driven by specific goals that shape their tactics and targets. Understanding their motivations empowers you to recognize potential threats and better protect yourself, your family, and colleagues.

McAfee presents the following motivations that could drive a cybercriminal:

Financial gain

Money remains the most common motivator. These profit-driven attacks directly impact your personal finances through methods such as ransomware, credit card fraud, and identity theft. In your home, financially motivated hackers target your banking apps, shopping accounts, and personal devices to steal payment information or hold your data hostage. In the workplace, they focus on payroll systems, customer databases, and business banking credentials.

Ideological motivations

Ideologically driven hackers, called hacktivists, pursue political or social causes through cyber means. These attacks can disrupt services that you rely on daily, from public utilities to private organizations that provide essential services or take public stances on divisive issues. Your best defense involves staying informed about potential disruptions and maintaining backup communication methods for essential services.

Curiosity and learning

Many hackers begin their journey with genuine curiosity about how systems work. They might probe your home network, test website security, or experiment with app vulnerabilities, not necessarily for malicious purposes, but their activities can still expose your data or disrupt services. In professional environments, these individuals might target systems or databases simply to see if they can gain access.

Recognition and reputation building

Some hackers seek fame, respect within hacker communities, or professional advancement rather than immediate financial benefit. They often target high-profile individuals, popular websites, or well-known companies to maximize the visibility for their exploits. If you have a significant social media following, your accounts could become targets for these attacks. They might also focus on defacing company or government websites, or leaking non-sensitive but embarrassing information.

State and corporate intelligence

Nation-state and corporate espionage are some of the most sophisticated threats in cyberspace, making it a top national security concern for both government and private sector. These operations compromise daily services and infrastructure such as internet service providers, email platforms, or cloud storage services to gather intelligence such as intellectual property, customer lists, or strategic planning documents.

Coercion and extortion

Some hackers use cyber capabilities to intimidate or coerce victims into specific actions. In the FBI's Internet Crime Complaint Center report for 2024, extortion was the 2nd top cybercrime by number of complaints, demonstrating the growing prevalence

of coercion-based attacks. Coercion might involve compromising personal photos, social media accounts, or private communications to demand payment or behavioral changes. Workplace coercion could target executives with embarrassing information or threaten to leak sensitive business data unless demands are met.

The intersection of motivations

Many real-world attacks combine multiple motivations—a financially driven criminal might also seek recognition within hacker communities, or an ideological hacker might generate revenue through ransomware. The contrast between ethical hacker motivations and malicious ones often lies in the permission, legality, and intent. Understanding why people become hackers helps you recognize that not all hacking activity is inherently malicious, although all unauthorized access ultimately poses risks to your security and privacy.

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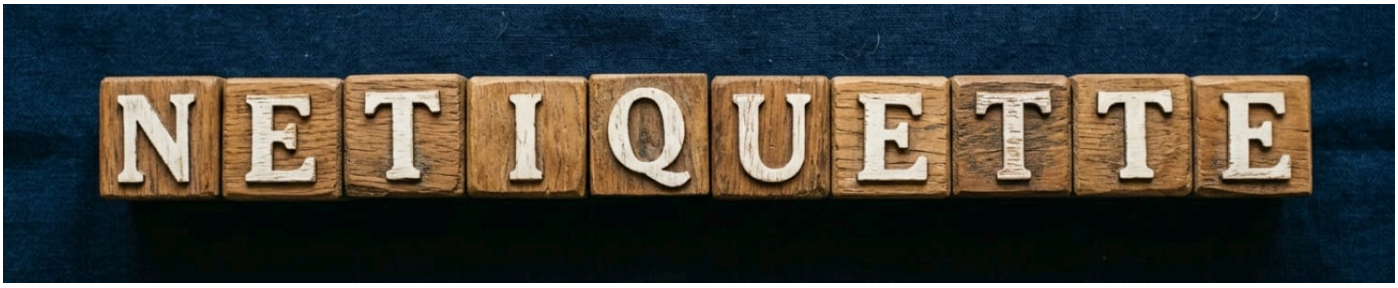
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10.3: Netiquette



Netiquette is short for "Network Etiquette". Just like etiquette - a code of polite behavior in society - Netiquette is a code of good behavior on the Internet.

> Network etiquette (**Netiquette**) is the set of rules that determines how to properly communicate and browse the web.

One important part of netiquette concerns your online safety. By following these basic rules and tips you will avoid most online threats such as phishing attempts, malware infections and more.

Why is this important for us?

Given the rise of cybercriminal activity in recent years, the need to stay safe on the Internet has never been more pronounced. Most people believe all they need to be secure online is to have an antivirus program and do frequent back-ups, but the truth is, cybercriminals know lot of ways around these. What really keeps you safe is the ability to recognize online threats and how to avoid them, and this is why netiquette is so important.

A study from University of Maryland analyzed users' knowledge on cyber-security and came up with a few interesting conclusions:

- the more you know about cybersecurity, the likelier you are to adopt online safety measures;
- cybersecurity training and education will make you more open to new online safety methods.

Netiquette is important, so here are the 10 best internet safety tips and netiquette rules you need to be aware of when online.

1. Keep your software/apps updated and delete the ones you don't use.

Developers and cybercriminals are almost always caught in a cat and mouse game, where cybercriminals search for exploits and developers rush to patch them before too much damage is done. Most of the times, vulnerabilities are quickly updated, but the real issue is that most users will still use an outdated version and will be vulnerable to the exploit.

Keeping your software up-to-date will go a long way into keeping you safe. But an equally important step is to remove software and apps you no longer use. Many of these programs still communicate in the background with various servers, and in case of a breach, this data might fall into the wrong hands.

2. Be careful when dealing with emails from unknown sources

Have you received an email from an unknown source? Do you frequently receive emails from people you don't know?

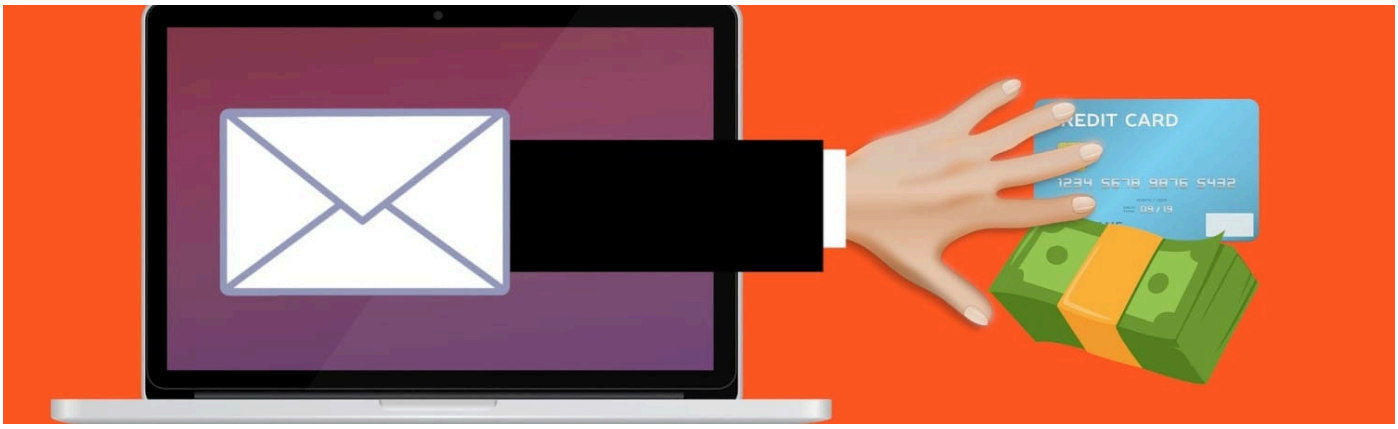
Just as in real life, an important rule to stay safe on the internet is to be suspicious of strangers. First, don't trust emails from

people you have never met, especially those that ask you to click a link, open an attachment or send a file to the sender. It's pretty easy to spot phishing emails.

What gives most of the away is the urgency with which they ask you to do something, either because your account may be compromised or your online purchase may have encountered some issues you need to sort. To fool the potential victims, the latest trend in e-crime is to deploy spear phishing attacks, where emails appear to come from well-known individuals or banking authority.

Check Phishing

But in order for a phishing attack to be successful, it needs to appear as genuine and believable. So, they launch an elaborate identity theft operation to target and steal your sensitive information. So, when you do get a phishing email, ignore it completely and don't reply to the e-mail, don't click the (malicious) attachment, and don't click the dangerous links in the e-mail that could download malware on the system.



Phishing. Image by Mohamed_Hassan from Pixabay.

3. Don't click that link or online ad

You found a pretty cool link on the Internet and it keeps tempting you to click it. But the source of the link (website or email) seems fishy. You ask yourself: What can the bad guys do to me if I click this link?

The answer is simple: a lot of things could go wrong.

Just by clicking a link in an email or a pop-up window, you could turn your PC into a botnet slave, allow cybercriminals to inject malware into your device, or expose your personal information.

You may think that you are safe from all these dangers because you have a good antivirus product, but nowadays traditional antivirus protection isn't enough anymore and you need additional weapons in the fight against online dangers.

4. Just because it's free, it doesn't mean it's safe

As a rule of thumb, paid software is almost always secure and safe. It wouldn't make sense for a cybercriminal to limit the number of victims by imposing a paywall.

Double check free software using Google, especially if it's not a well-known one, such as WinRAR. This filtering process can expose bad reviews, or reveal that the free software is actually a vehicle for malware.

> The popular file archiving tool **WinRAR** has had a bug for at least 14 years that can be exploited to take over your PC.
>
> The bug can pave the way for archive files that can trigger **WinRAR** to actually install whatever malware is secretly inside, according to the security firm Check Point, which discovered the software flaw.
>
> "The exploit works by just extracting an archive, and puts over 500 million users at risk," the company said in a detailed report published.
>
> PC Magazine

While the free software itself might be safe and legit, the website itself may try to compromise your security through drive-by downloads. These are secret downloads carried in the background, that target software vulnerabilities and system exploits. Make sure you use a trusted, free program that automatically updates your vulnerable software applications to close security holes in your system.

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5. Do not reveal sensitive information online

Social media is the first place criminals check to gather information on you. They will use any piece of information they can find, such as your name, birthdate, address, city, your spouse/partners name, what sort of pet you have, name of the pet. Literally, anything that you can think of.

Improving your social media security settings is a good first step in preventing an identity theft or doxxing. So, be a bit skeptical about people you meet online and about their intentions. Many people exaggerate their Facebook lives, and depending on how you use it, social media may come back to haunt you.

> **Doxing** or **doxxing** is the act of publicly revealing previously private personal information about an individual or organization, usually via the Internet.
>
> Wikipedia

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6. Keep your account information for yourself

Our credentials for online accounts, user names and passwords, hold the keys to a lot of important information, and for that reason they are the most sought after targets by cybercriminals. Using the same password for more than one site is a risky move, since if a malicious hacker breaks into just one account, he can then take over the others.

One of the better online safety tips is to use a different password for every website you register. The downside however is the difficulty of memorizing them. One workaround is to use password managers, these will remember the login details of every site you use and can even generate some strong password for you to use.

Best password managers, according to Forbes



Login credentials. Image by AchinVerma from Pixabay.

7. Report illegal activities or offending content

If you notice offending language attacks, like cyber-bullying, hate speech or any form of harassment, do not hesitate to report it.

Using the “Flag as offensive” or “Flag as spam” buttons is proper internet etiquette and should be sufficient to fight back against minor online threats, but other types of content, such child pornography or arms trafficking should be immediately reported to the police.

Reporting cyberbullying takes a different direction when children are the targets. A recent report on cyber bullying gave the following troublesome conclusions:

- 25% of teenagers report that they have experienced repeated bullying
- 52% of young people report being cyber bullied
- 95% of teens who witnessed bullying on social media, report they have ignored the behavior
- cyber bullying affects everyone
- the most common types of cyber bullying tactics reported are mean, hurtful comments.

8. What you post online stays online forever

We post photos, remarks, location updates and similar content, which we think is fine because we use an anonymous username on a small niche forum.

But niche forums are also indexed by search results, and if you reuse the username, other people can start to connect the dots.

To keep it short, when it comes to posting personal content on forums and similar places, follow these guidelines:

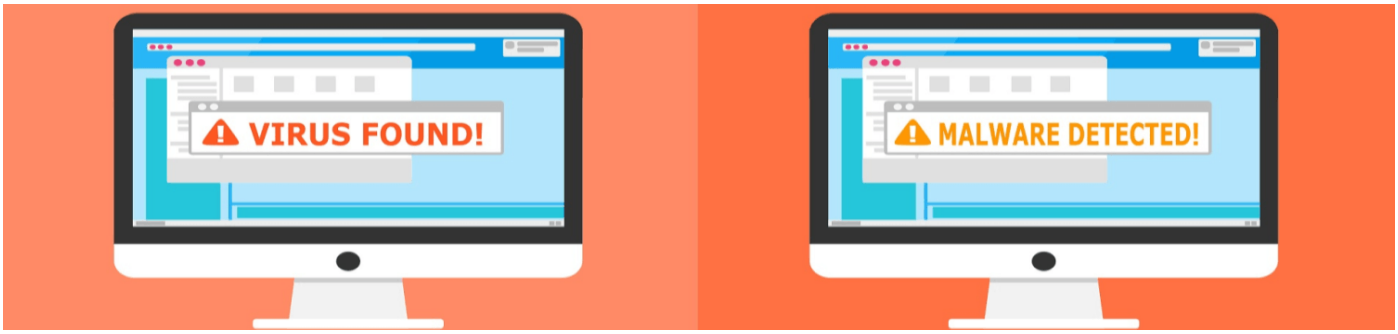
- is this information too personal?
- delete/edit past posts which reveal too much about you
- could your content affect your personal or professional life in the future?

Check the "**Internet Archives Wayback Machine**" ⇒ it has 30 years of web history

9. Use anti malware protection before you go online

Don’t go online until you have the best anti-malware protection that money can buy. You may think that avoiding adult websites and that sort of thing will keep you safe, but did you know that hackers now hide malicious code even in legitimate websites?

And sometimes not even that is enough. Some ransomware programs are so sophisticated, it is technologically impossible to decrypt them, no matter how much you try. And in this case, you really need the best tools out there.



Anti-malware. Image by 200degrees from Pixabay.

10. Create back-up copies for your important stuff

Though you may have all the security protection in the world, disaster may still hit your system and your valuable files. It may be a system crash, a hard disk failure, a ransomware attack that encrypts your entire operating system or it may be a human mistake.

There are so many reasons something can go wrong for you and your sensitive information, even if you have followed all the netiquette rules in the book. To emphasize the importance of this point, a while ago a series of security experts in the IT industry were interviewed, and one recurring theme was the importance of backing up your information.

Conclusion

Common sense is vital on the internet. Most of the threats you will find online rely on human error to break into your system. Technology hasn't made us safer because safety is not a function of technology. Real security comes from people. Technology is just a security tool. In the end, knowledge and netiquette become the two sides of the same coin: Internet protection.

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10.4: Summary



10.1. Internet Privacy

Internet and digital privacy are viewed differently from traditional expectations of privacy. **Internet privacy is primarily concerned with protecting user**

information.

Information privacy is an individual's claim to control the terms under which personal information – information identifiable to the individual–is acquired, disclosed, and used.

Email spam, also referred to as junk email or simply **spam**, is unsolicited messages sent in bulk by email (spamming).

Digital Identity is a set of characteristics or traits that represent a person or institution through a digital medium, such as the internet.

Privacy settings are available in social network sites. The user can apply such settings when providing personal information on the internet.

In 2000, Children's Internet Protection Act (CIPA) was developed to implement safe Internet policies such as rules and filter software.

An **HTTP cookie** is data stored on a user's device that assists in automated access to websites or web features, or other state information required in complex websites.

Since cookies are advertisers' main way of targeting potential customers, and some customers are deleting cookies, some advertisers started to use persistent **Flash cookies** and **zombie cookies**, but modern browsers and anti-malware software can now block or detect and remove such cookies.

Cookies are mostly harmless except for **third-party cookies**. These cookies are not made by the website itself, but by web banner advertising companies.

The process of profiling (also known as "tracking") assembles and analyzes several events, each attributable to a single originating entity, in order to gain information (especially patterns of activity) relating to the originating entity.

10.2. Internet Security

Computer Security. Systems at Risk. Financial Systems. Utilities and Industrial Equipment. Aviation. Consumer Devices. Large Corporations. Automobiles. Government. Internet of Things and physical vulnerabilities. Impact of security breaches. Attacker motivation.

10.3. Netiquette

> Network etiquette (**Netiquette**) is the set of rules that determines how to properly communicate and browse the web.

Netiquette is important, so here are the 10 best internet safety tips and netiquette rules you need to be aware of when online:

1. Keep your software/apps updated and delete the ones you don't use.
2. Be careful when dealing with emails from unknown sources
3. Don't click that link or online ad
4. Just because it's free, it doesn't mean it's safe
5. Do not reveal sensitive
6. Keep your account
7. Report illegal activities or offending content
8. What you post online stays online forever
9. Use anti malware protection before you go online
10. Create back-up copies for your important stuff

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GLOSSARY

A

Artificial Intelligence | It is the subfield of computer science dedicated to building software and systems capable of performing tasks that typically require human intelligence—such as learning, reasoning, problem-solving, and understanding language.

Authentication | Is verifying the identity of a user, process, or device, often as a prerequisite to allowing access to resources in an information system.

Availability | A guarantee of reliable access to the information.

B

Big Data | refers to massive, complex datasets that traditional data management systems cannot handle.

Bit | Is short for "binary digit".

Brute force | Is a hacking method that uses trial and error to crack passwords, login credentials, and encryption keys.

Byte | Is a group of binary digits or bits (usually eight) operated on as a unit.

C

Collaborative software | Any software that allows multiple users to interact on a document or topic.

Concurrency | Occurs when many users can access data at the same time.

Confidentiality | Set of rules that limit access to information.

Copyright | Is the protection given to songs, computer programs, books, and other creative works.

Cyber attack | Is when the cyber threat becomes a deliberate action.

Cybersecurity threat | Is a potential risk that could harm a system, network, or data.

Cyberthreat | Is a potential risk that could harm a system, network, or data.

D

Data | Raw and unorganized fact that requires to be processed to make it meaningful.

Data Lake | is a repository designed to store large volumes of raw data, typically using low-cost cloud object storage.

Data Lakehouse | is a modern data platform that combines the low-cost, flexible data storage of a data lake with the high-performance analytics and data management capabilities of a data warehouse.

Data Silo | Isolated collection of data that prevent data sharing between different departments, systems and business units.

Database | Is an organized collection of related information.

Digital Identity | Is a set of characteristics or traits that represent a person or institution through a digital medium, such as the internet.

Disintermediation | The process of technology replacing a middleman in a transaction.

E

End-user computing | The use of computer technology for both business and personal use.

F

File Explorer | It is a graphical file management utility for the Windows operating system.

File management | It is the systematic organization, storage, and control of digital information within an organization.

G

Generative AI | It is one of the most popular type of artificial intelligence that creates new, original content—such as text, images, audio, video, or software code—by learning patterns from massive datasets.

H

Hacker | Is a person who uses technical skill to gain unauthorized access to computer systems, or an expert programmer who deeply understands

computer technology.

Hardware | Is the tangible, physical portion of an information system – the part you can touch.

Hosting facilities | Are typically for-profit companies that manage the physical equipment necessary to provide access to websites for a number of clients.

I

Identification | Is basically the process of someone claiming to be a specific person.

Information | Set of data which is processed in a meaningful way according to the given requirement.

Information privacy | Is an individual's claim to control the terms under which personal information–information identifiable to the individual–is acquired, disclosed, and used.

Information System | An organized combination of people, technology, data, and procedures that collect, process, store, and distribute information to support operations, management, and decision-making in an organization.

Integrated Development Environment | Is a software application that helps programmers develop software code efficiently.

Integrity | The assurance that the information is reliable and correct.

Intellectual property | Is defined as "property that derives from the work of the mind or intellect."

Internet privacy | Involves the right or mandate of personal privacy concerning the storing, re-purposing, provision to third parties, and displaying of information pertaining to oneself via the Internet.

IP Address | Is a unique code that identifies a piece of equipment connected to a network.

K

Keyboard shortcuts | Keys or combinations of keys that provide an alternative way to do something that you'd typically do with a mouse.

L

Leet | Is a method of typing words using alternate characters.

M

Mainframe | High-performance computers with large amounts of memory and processors that process billions of simple calculations and transactions in real time.

Metadata | Data about the data.

N

Netiquette | Refers to the generally accepted set of unofficial rules, manners, and polite behavior governing respectful communication in digital spaces, such as emails, social media, forums, and video calls.

O

Open-source software | Is software that has the source code available for anyone to copy and use.

Operating System | Is system software that manages computer hardware and software resources and provides common services for computer programs.

Optical disc | Is a storage medium used to store digital data through optical technology.

P

Passphrase | Is a memorized secret consisting of a sequence of words or other text separated by spaces.

Password | Is a memorized secret, typically a string of characters, usually used to confirm a user's identity.

Personally Identifiable Information | Any information that can be used to identify an individual directly or indirectly.

Plagiarism | Is presenting work or ideas from another source as your own, with or without consent of the original author, by incorporating it into your work without full acknowledgement.

Port | Is a software-based location that organizes the sending and receiving of data between devices on a network.

Public domain | Is the realm of creative works that are not protected by copyright and are free for anyone to use, reproduce, distribute, and

create derivative works from, without permission or payment to a former copyright owner.

S

Software | Comprises the set of instructions that tell the hardware what to do.

Spam | Is unsolicited messages sent in bulk by email

T

Technology | Application of scientific knowledge for practical purposes.

V

Vulnerability | Is a weakness that can be exploited by cybercriminals to gain unauthorized access to a computer system.

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Acronyms, initialisms & abbreviations



Acronym: formed from the initial letter or group of letters of two or more words. [Brittanica]

Initialism: is an abbreviation formed from the initial letters of a phrase, where each letter is pronounced individually. [Brittanica]

Abbreviation: the process or result of representing a word or group of words by a shorter form of the word or phrase. [Brittanica]

Words (or words that have the same definition)	The definition is case sensitive	(Optional) Image to display with the definition [Not displayed in Glossary, only in pop-up on pages]	(Optional) Caption for Image	(Optional) External or Internal Link	(Optional) Source for Definition
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Glossary Entries

Word(s)	Definition	Image	Caption	Link	Source
1NF	1st Normal Form				
2NF	2nd Normal Form				
3NF	3rd Normal Form				
ACL	Access control list				
ADSL	Asymmetric Digital Subscriber Lines				
AI	Artificial Intelligence				
APFS	Apple File System				
API	Application Programming Interface				
APT	Advanced Persistent Threats				
ARPA	Advanced Research Projects Agency				
AUP	Acceptable Use Policy				

Word(s)	Definition	Image	Caption	Link	Source
BA	Business Analytics				
BAN	Body Area Network				
BI	Business Intelligence				
BIOS	Basic Input Output System				
BYOD	Bring Your Own Device				
CD	Compact Disc				
CDMA	Code Division Multiple Access				
CGA	Color Graphics Adapter				
CIA	Confidentiality - Integrity - Availability				
CIO	Chief Information Officer				
CISO	Chief Information Security Officer				
CMOS	Complementary Metal-Oxide Semiconductor				
CMS	Content Management System				
CPU	Central Processing Unit				
CRM	Customer Relationship Management				
CRT	Cathode-Ray Tube				
CSS	Cascade Style Sheets				
CSV	Comma Separated Values				
DARPA	Defense Advanced Research Projects Agency				
DBA	Database Administrator				
DBMS	Database Management System				
DOS	Disk Operating System				
DLL	Dedicated Leased Line				
DMS	Document management software				
DSD	Data Structure Diagram				
DSL	Digital Subscriber Lines				
DVD	Digital Versatile Disc				
EDI	Electronic Data Interchange				
EDW	Enterprise Data Warehouse				
EGA	Enhanced Graphics Adapter				
ERD	Entity Relation Diagram				
ERP	Enterprise Resource Planning				
exFAT	extensible File Allocation Table				
FAT	File Allocation Table				

Word(s)	Definition	Image	Caption	Link	Source
FTP	File Transfer Protocol				
GPU	Graphic Processing Unit				
GSM	Global System for Mobile Communications				
HDD	Hard Disk Drive				
HTML	Hypertext Markup Language				
http	Hypertext Transfer Protocol				
JSON	JavaScript Object Notation				
IaaS	Infrastructure as a Service				
IANA	Internet Assigned Numbers Authority				
ICANN	Internet Corporation for Assigned Names and Numbers				
IDE	Integrated Development Environment				
IEEE	Institute of Electrical and Electronics Engineers				
IoT	Internet of Things				
IPS	Intrusion Prevention System				
ISO	International Organization for Standardization				
ISP	Internet Service Provider				
LAN	Local Area Network				
LCD	Liquid Crystal Display				
LiDAR	Light Detection and Ranging				
LLM	Large Language Model				
LMS	Learning Management System				
MAC	Media Access Control				
MAN	Metropolitan Area Network				
MICR	Magnetic ink character recognition				
MIDI	Musical Instrument Digital Interface				
MitM	Man in the Middle (attack)				
MMC	Multi Media Cards				
NFC	Near-Field Communication				
NTFS	New Technology File System				
OCR	Optical Character Recognition				
ODS	Operational Data Store				
OO	Object Oriented				
OODBMS	Object Oriented Database Management System				
OOP	Object Oriented Programming				
OS	Operating System				
OSI	Open Systems Interconnection				

Word(s)	Definition	Image	Caption	Link	Source
PaaS	Platform as a Service				
PAN	Personal Area Network				
PC	Personal Computer				
PCB	Printed Circuit Board				
PDA	Personal Digital Assistant				
PENS	Pan-European Network Service				
PII	Personally Identifiable Information				
PIN	Personal Identification Number				
PMP	Project Management Professional				
RAM	Random Access Memory				
RBAC	Role Based Access Control				
RDBMS	Relational Database Management System				
RFID	Radio-Frequency IDentification				
ROM	Read Only Memory				
SaaS	Software as a Service				
SCADA	Supervisory Control And Data Acquisition				
SCM	Supply Chain Management				
SD Card	Secure Digital Card				
SDLC	Systems Development Life Cycle				
SDSL	Symmetric Digital Subscriber Lines				
SEO	Search Engine Optimization				
SIM	Subscriber Identity Module				
SoC	Systems on a chip				
SOC	Security Operations Center				
SQL	Structured Query Language				
SP	Specialist Organizations				
SPII	Sensitive Personally Identifiable Information				
SSD	Solid State Drive				
SVGA	Super Video Graphics Array				
TCO	Total Cost of Ownership				

Word(s)	Definition	Image	Caption	Link	Source
TCP/IP	Transmission Control Protocol / Internet Protocol				
TLD	Top Level Domain				
UEFI	Unified Extensible Firmware Interface				
URL	Uniform Resource Locator				
USB	Universal Serial Bus				
UX	User Experience				
VGA	Video Graphics Array				
WAN	Wide Area Network				
WBAN	Wireless Body Area Network				
WDLC	Website Development Life Cycle				
WLAN	Wireless Local Area Network				
WWW	World Wide Web				
XHTML	Extensible HyperText Markup Language				
XML	eXtensible Markup Language				

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Luis R Castellanos

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