Principles & Architecture

EPITA Bachelor of Science

Principles and Architecture of Information Systems

Chapter #1

Introduction & Organizations

Olivier BERTHET

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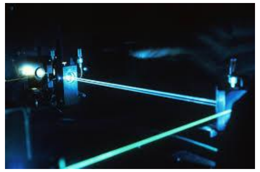
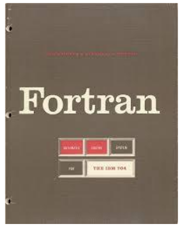
My background





Education

Professional experience

Hobbies

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My courses at EPITA

Green IT

CRM

PM Principles

PM Workshops

IT Purchasing

Introduction to 6σ

Tell me and I forget,
teach me and I may remember,
involve me and I learn.

Benjamin Franklin

Tool : Wooclap

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Wooclap

- **What are some important keywords in Information Systems ?**

For Instance Computer , Internet , 5G

Structure

Objectives

- **Review the panorama of Information Systems**
- **Understand the value of Information Systems for the Business**
- **Grasp the eco-systems of IS and the different components**
- **Recognize the various categories in Information Systems and Technologies**
  - Hardware
  - Software
  - Databases
  - Network
  - Applications

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Every business is a software business now

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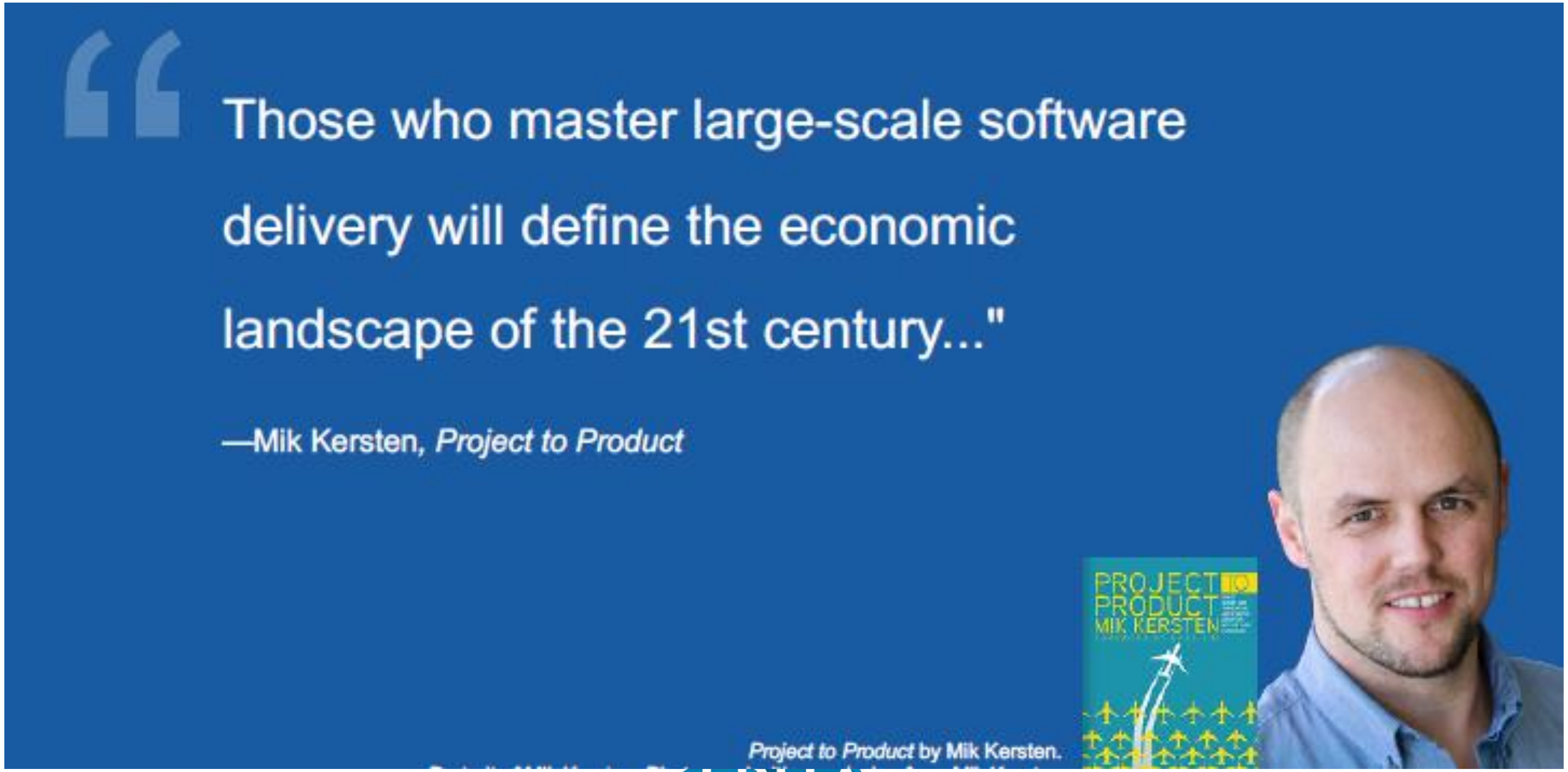
Product



Introduction

- Most functional areas of the business rely on information systems
- The value of information is directly linked to how it helps decision makers achieve the organization’s goals
- Computers and information systems help make it possible for organizations to improve the way they conduct business

Introduction

- System users, business managers, and information systems professionals must work together to build a successful information system
- Information systems must be applied thoughtfully and carefully so that society, businesses, and industries can reap their enormous benefits

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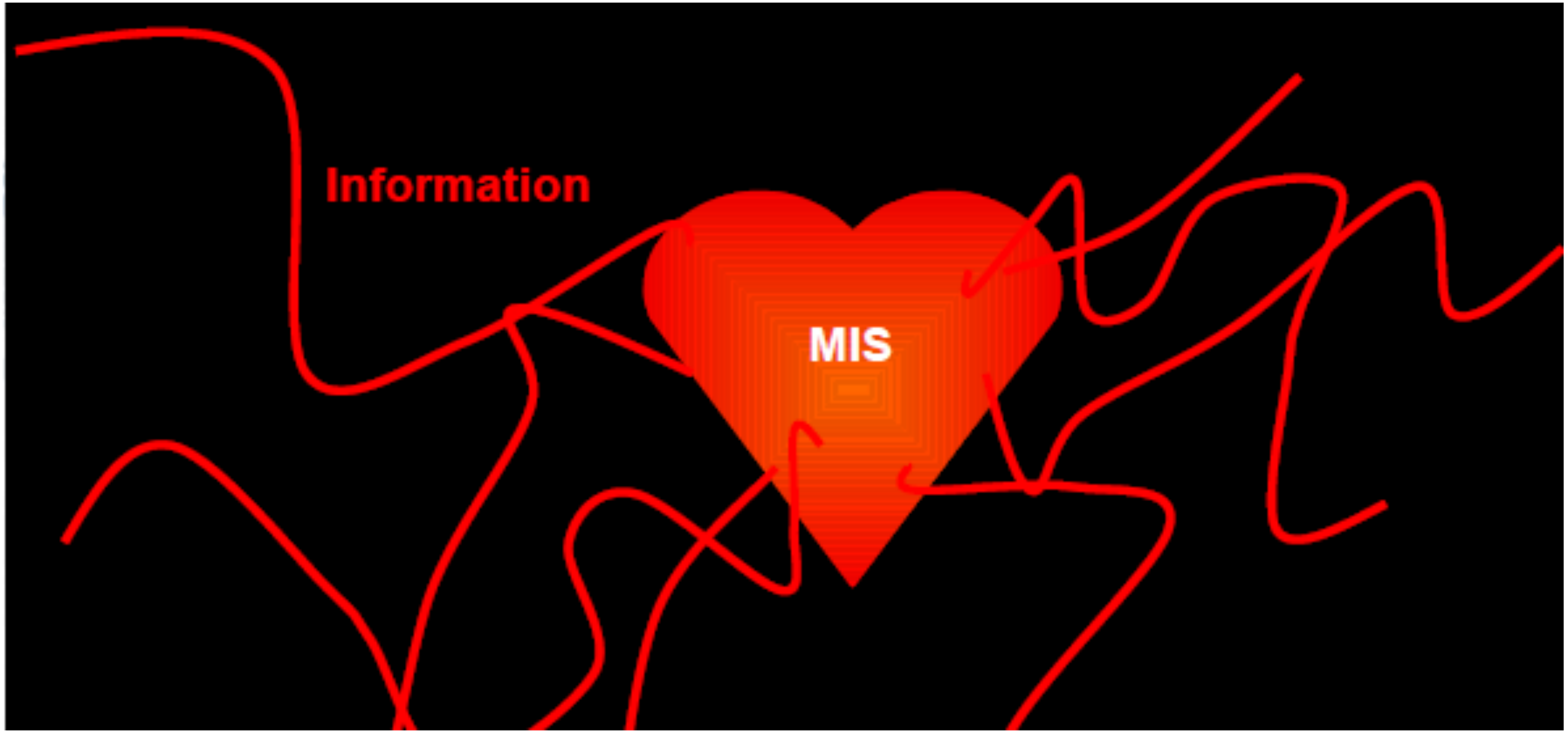
Definition of an Information System

- An Information System can integrate data from various sources to provide the information necessary for decision making at the management level.
- An organized assembly of resources and procedures required to collect, process, and distribute data for use in decision-making.

Role of Information System



Change Equation

$$R = Q \times A$$

Organizational resistance to change

- **Information systems become bound up in organizational politics because they influence access to a key resource : the information**
- **Information systems potentially change an organization’s structure, culture, politics, and work**
- **Most common reason for failure of large projects is due to organizational and political resistance to change.**
- **Employees may resist changes that disrupt their routines so IS cannot implemented**

Evolution

Once considered a technical specialist, today the IS Professional operates as an internal consultant to all functional areas of the organization, being knowledgeable about their needs and competent in bringing the power of information systems to bear throughout the entire organization.

Why Learn About Information Systems?

- **Information systems used by**
  - Engineers
  - Workers
  - Sales representatives
  - Managers
  - Financial advisors
  - Human Resources employees
- **Information systems**
  - Indispensable tools to help you achieve your career goals

Introduction

- **Information system (IS)**
  - **A set of interrelated components that collect, manipulate and disseminate data and information and provide feedback to meet an objective**
- **Businesses**
  - **Can use information systems to increase revenues and reduce costs**

Information Concepts

- **Information:**
  - **One of an organization's most valuable resources**
  - **Often confused with the term data**

Data, Information and Knowledge

- **Data**
  - Raw facts (employee number, part number, hours, amount in Euros)
- **Information**
  - Collection of facts organized and processed in such a way that they have value beyond the facts themselves (total sales of the month for France)
- **Process**
  - Set of logically related tasks performed to achieve a defined outcome
- **Knowledge**
  - Awareness and understanding of a set of information. Ways that information can be made useful to support a specific task or reach a decision

Information is data made more useful through the application of knowledge

Types of data

Data	Represented By
Alphanumeric data	Numbers, letters, and other characters
Audio data	Sounds, noises, or tones
Image data	Graphic images and pictures
Video data	Moving images or pictures

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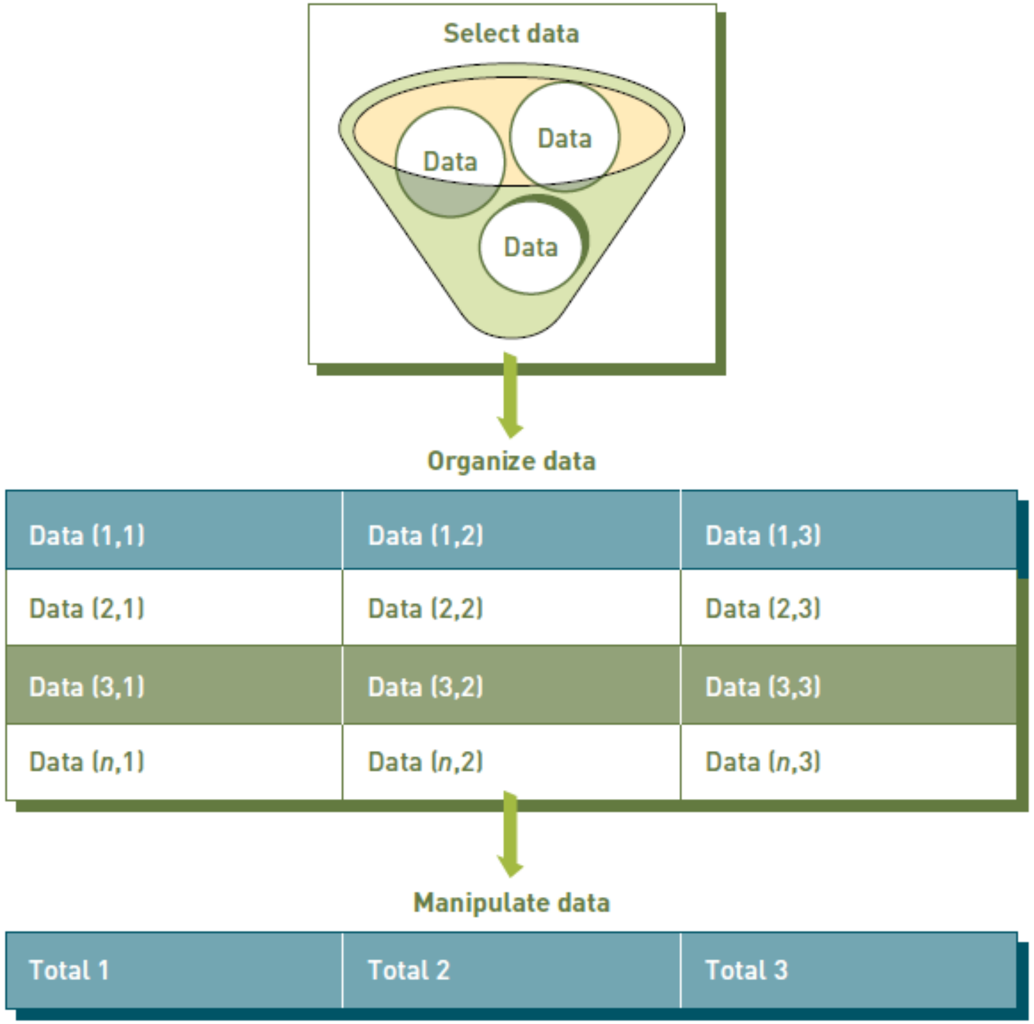
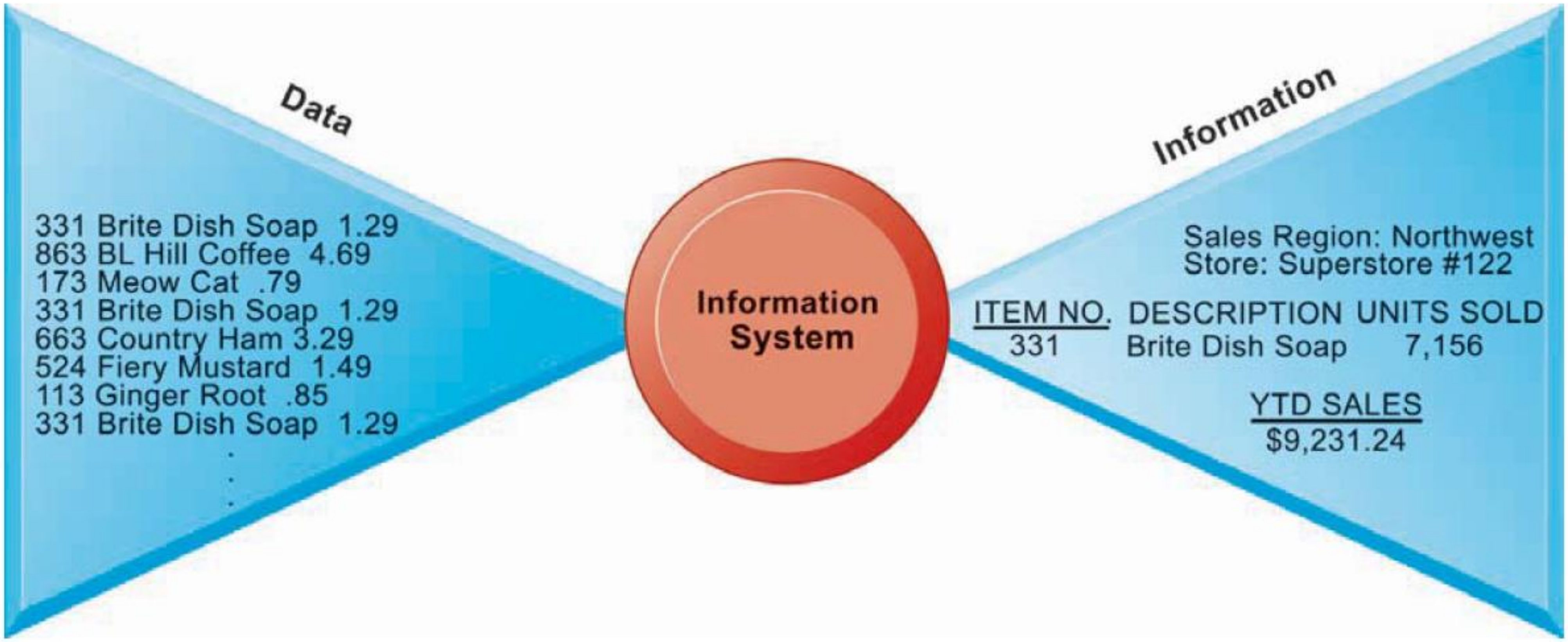
Process of transforming data into information



Data and Information



The Characteristics of Valuable Information

- **If an organization's information is not accurate or complete:**
  - **People can make poor decisions, costing thousands or even millions of dollars**
- **Depending on the type of data you need:**
  - **Some characteristics become more important than others**

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Characteristic	Definition
Accessible	Information should be easily accessible by authorized users so they can obtain it in the right format and at the right time to meet their needs.
Accurate	Accurate information is error free. In some cases, inaccurate information is generated because inaccurate data is fed into the transformation process. This is commonly called garbage in, garbage out.
Complete	Complete information contains all the important facts. For example, an investment report that does not include all important costs is not complete.
Economical	Information should also be relatively economical to produce. Decision makers must always balance the value of information with the cost of producing it.
Flexible	Flexible information can be used for a variety of purposes. For example, information on how much inventory is on hand for a particular part can be used by a sales representative in closing a sale, by a production manager to determine whether more inventory is needed, and by a financial executive to determine the amount of money the company has invested in inventory.

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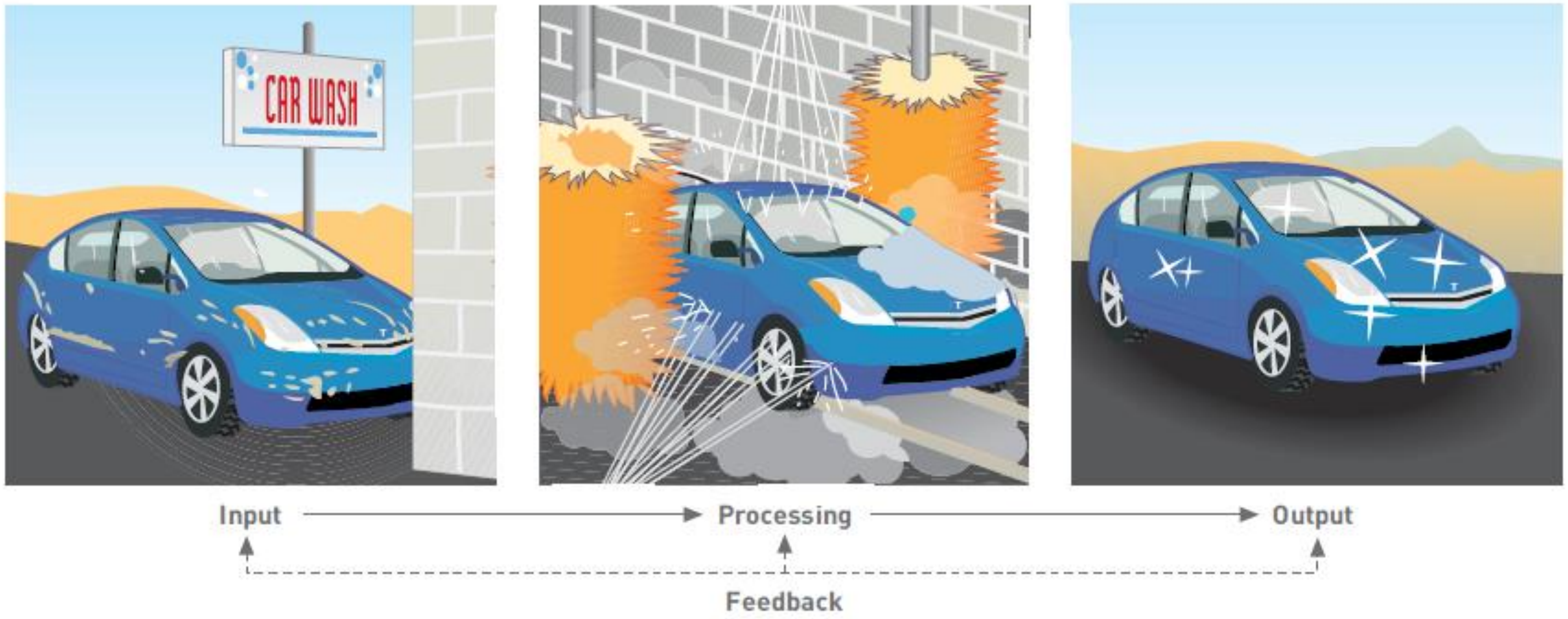
Characteristic	Definition
Relevant	Relevant information is important to the decision maker. Information showing that lumber prices might drop is probably not relevant to a computer chip manufacturer.
Reliable	Reliable information can be trusted by users. In many cases, the reliability of the information depends on the reliability of the data-collection method. In other instances, reliability depends on the source of the information. A rumor from an unknown source that oil prices might go up may not be reliable.
Secure	Information should be secure from access by unauthorized users.
Simple	Information should be simple, not complex. Sophisticated and detailed information might not be needed. In fact, too much information can cause information overload, whereby a decision maker has too much information and is unable to determine what is really important.
Timely	Timely information is delivered when it is needed. Knowing last week's weather conditions will not help when trying to decide what coat to wear today.
Verifiable	Information should be verifiable. This means that you can check it to make sure it is correct, perhaps by checking many sources for the same information.

System Concepts

- **System:**
  - Set of elements or components that interact to accomplish goals
- **Components of a system:**
  - Inputs
  - Processing mechanisms
  - Outputs
  - Feedback

System Concepts



What is an Information System?

- **Information system (IS) is a set of interrelated elements that:**
  - **Collect (input)**
  - **Manipulate (process)**
  - **Store**
  - **Disseminate (output) data and information**
  - **Provide a corrective reaction (feedback mechanism) to meet an objective**

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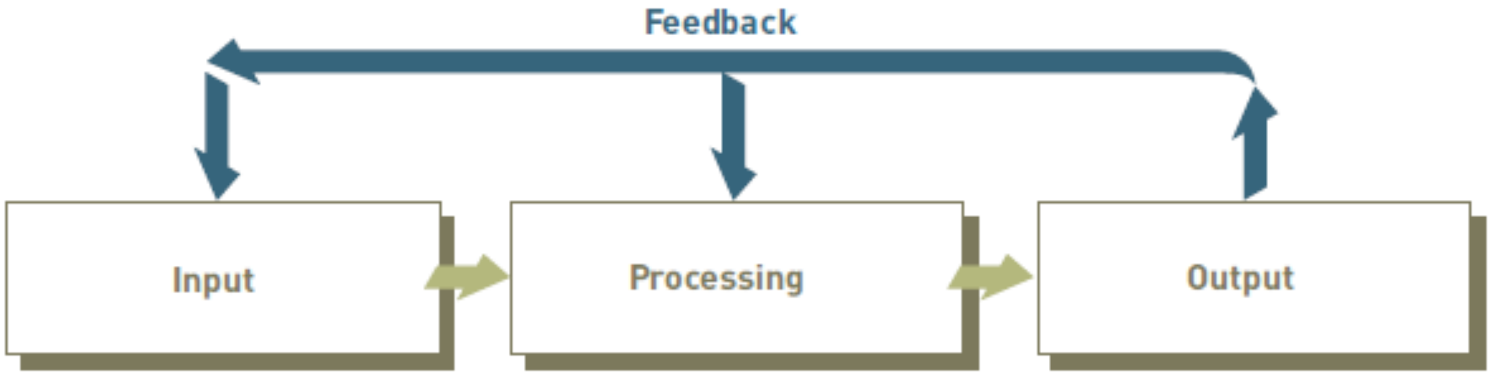
Feedback is critical to the successful operation



Input, Processing, Output, Feedback

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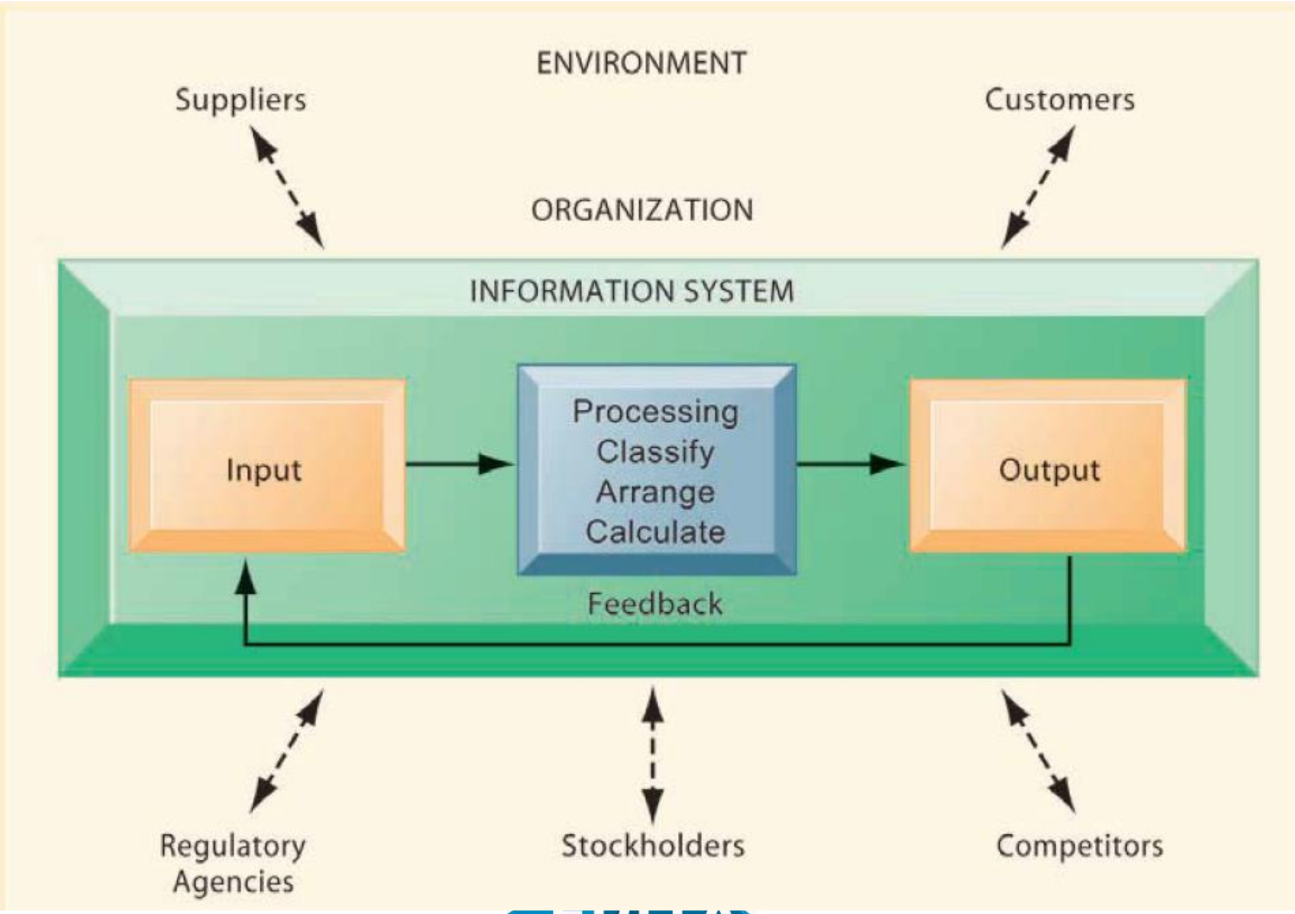
Functions of an Information System



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Input, Processing, Output, Feedback

- **Input**
  - Activity of gathering and capturing raw data
- **Processing**
  - Converting data into useful outputs
- **Output**
  - Production of useful information, usually in the form of documents and reports
- **Feedback**
  - Information from the system that is used to make changes to input or processing activities

Wooclap NYAMII

- **What are the key components of a computer based Information system ?**

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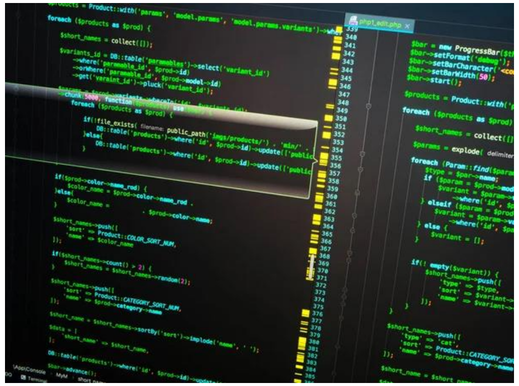
Computer-based Information system components



Computer-Based Information Systems

- **Hardware**
  - Consists of computer equipment used to perform input, processing, and output activities
- **Software**
  - Consists of the computer programs that govern the operation of the computer
- **People**
  - The most important element in most computer-based information systems
- **Procedures**
  - Include strategies, policies, methods, and rules for using the Information System

Network

- **Telecommunications, networks, and the Internet**
  - **The electronic transmission of signals for communications**
- **Networks**
  - **Connect computers and equipment to enable electronic communication**
- **Internet**
  - **World's largest computer network, consisting of thousands of interconnected networks, all freely exchanging information**

Another Word cloud

- **What are the key functional areas of a business or a company ?**

Information Systems in the Functional Areas of Business

- **Functional areas and operating divisions of business:**
  - Research & Development
  - Manufacturing
  - Logistics
  - Sales and marketing
  - Finance and accounting
  - Human resource management
  - Legal
  - Information systems
  - General Management

Information Systems in Industry

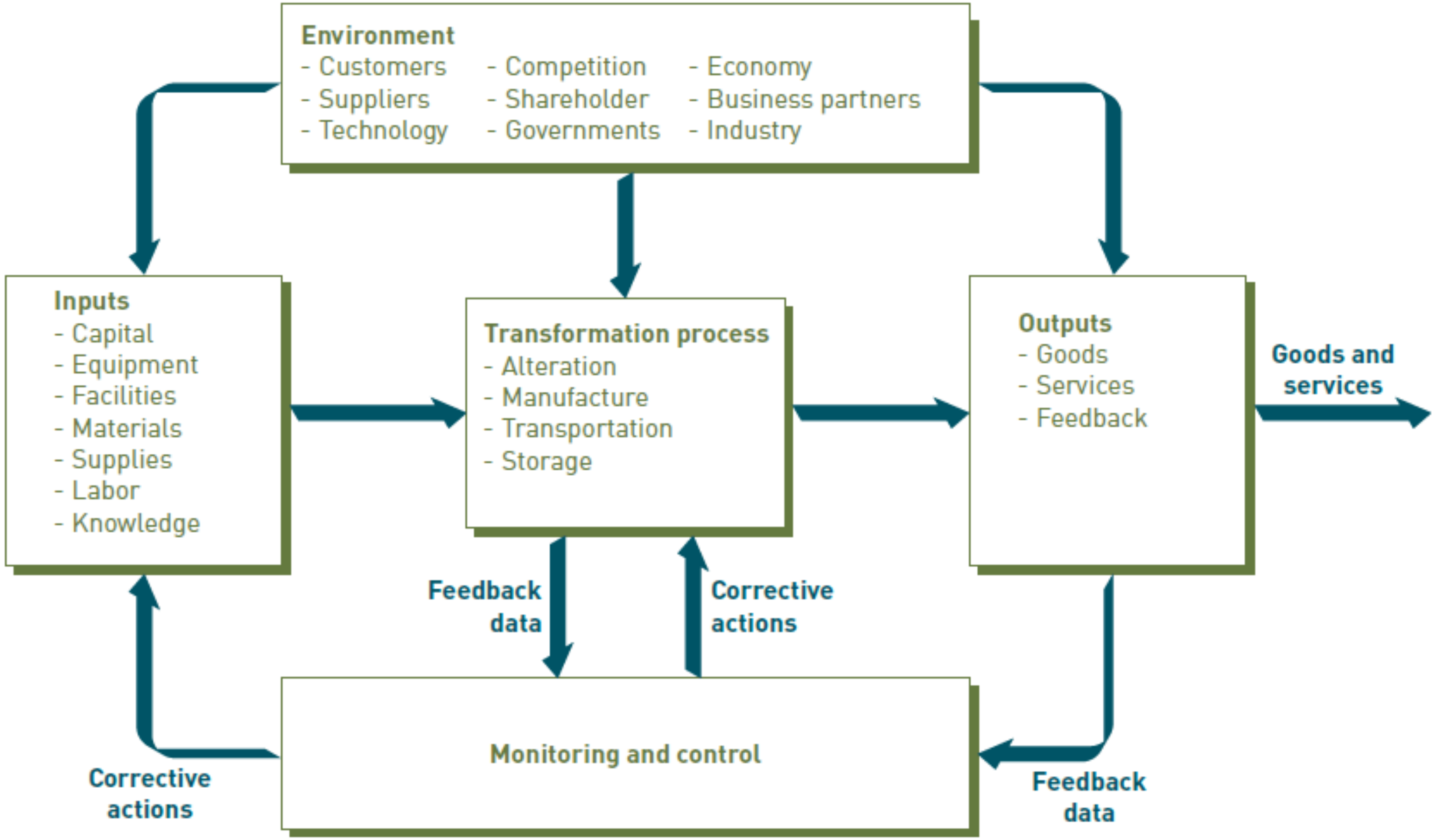
- **Industries:**
  - Airline industry
  - Chemicals
  - Steel
  - Automotive
  - Investment firms
  - Banks
  - Transportation industry
  - Publishing companies
  - Healthcare
  - Retail companies
  - Power management and utility companies
  - Professional services
  - Management consulting firms

I is EVERYWHERE

Organizations and Information Systems

- **Organization:**
  - Formal collection of people and other resources established to accomplish a set of goals
  - A system
  - Constantly uses money, people, materials, machines and other equipment, data, information, and decisions

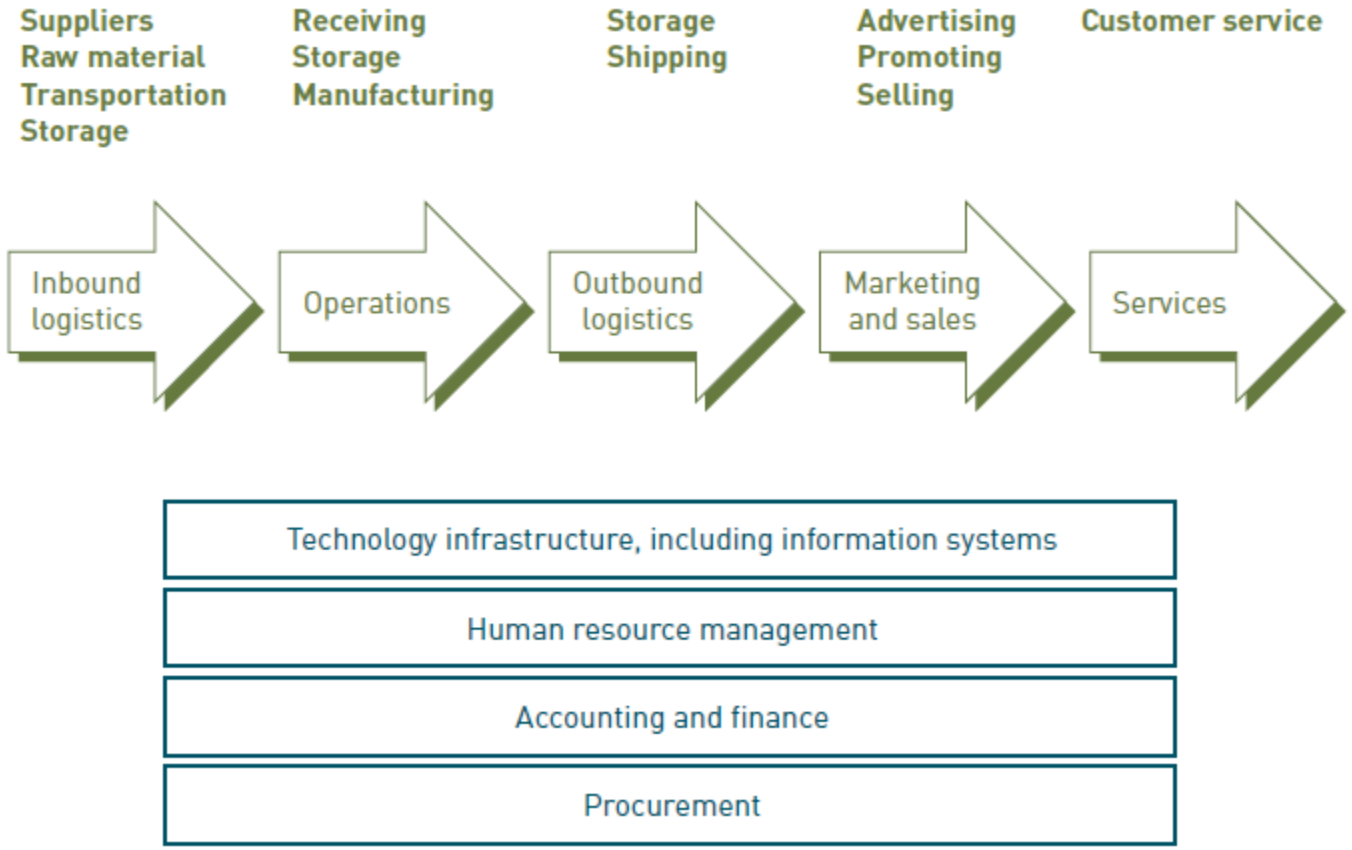
General model of an Organization



Organizations and Information Systems

- **Value chain**
  - Series (chain) of activities that includes inbound logistics and warehouse and storage
- **Supply chain management (SCM) determines**
  - What supplies are required for value chain
  - What quantities are needed to meet customer demand
  - How supplies should be processed into finished goods and services
  - How shipment of supplies and products to customers should be scheduled, monitored, and controlled

Supply chain



Organizational Structures

- **Organizational structure:**
  - Organizational subunits and the way they relate to the overall organization
- **Types of organizational structures:**
  - Traditional
  - Project
  - Team
  - Virtual

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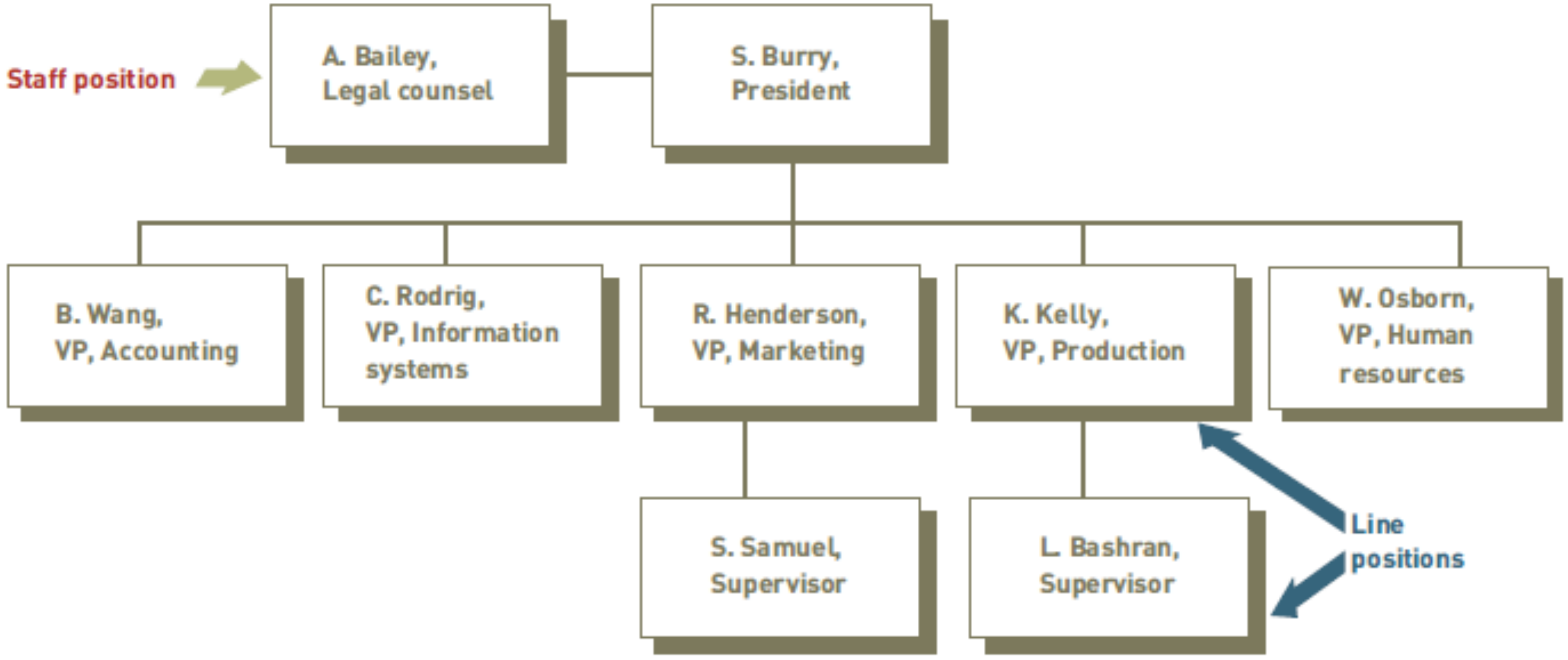
Traditional Organizational Structure



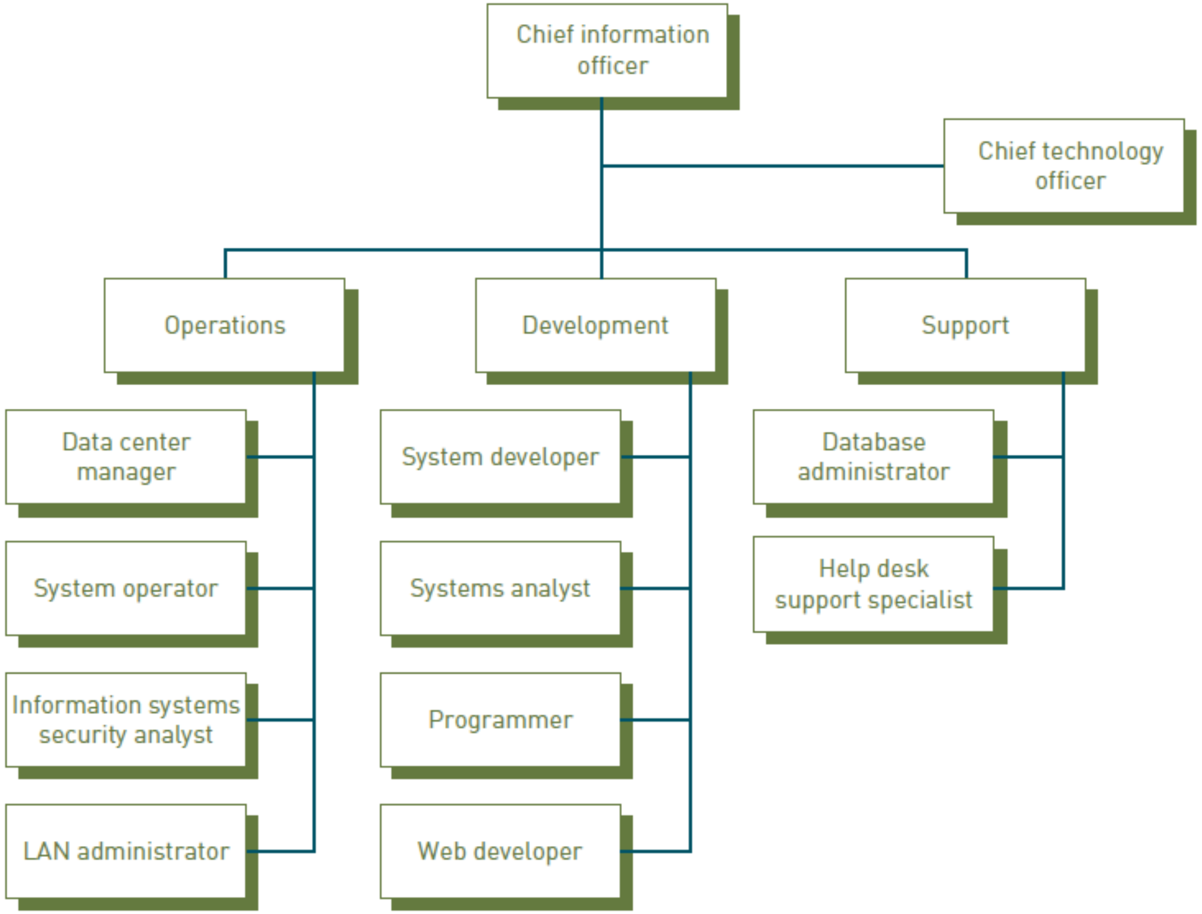
Roles, Functions, and Careers in IS

- **Primary responsibilities in information systems:**
  - **Operations**
    - **System operators primarily run and maintain IS equipment**
  - **Systems development**
    - **Focuses on specific development projects and ongoing maintenance and review**
  - **Support**
    - **Provides user assistance in hardware and software acquisition and use, data administration, user training and assistance, and Web administration**

Wooclap

- **Can you name some examples of IS job titles ? IS roles ?**

Typical IS Titles and Functions



Typical IS Titles and functions

- **CIO Chief Information Officer**
  - is to employ an IS department's equipment and personnel to help the organization attain its goals.
  - A good CIO is typically a visionary who provides leadership and direction to the IS department
- **Senior Managers**
  - A large organization may have several people employed in senior IS managerial levels with job titles such as Infrastructure Manager, Applications Manager , Project Office Manager, chief technology officer (CTO)
  - Together with the CIO, they can best decide what information systems will support corporate goals

Typical IS Titles and functions - Operations

- **Data center manager**
  - Data center managers are responsible for the maintenance and operation of the organization's computing facilities
- **Systems Operators**
  - System operators run and maintain IS equipment
- **Information systems security analyst**
  - IS security analysts are responsible for maintaining the security and integrity of their organizations' systems and data.
- **LAN administrator**
  - Local area network (LAN) administrators set up and manage network hardware, software, and security processes

Typical IS Titles and functions - Development

- **Software developer**
  - are involved in writing the software that customers and employees use
- **Systems analyst**
  - frequently consult with management and users, and they convey system requirements to software developers
- **Programmer**
  - convert a program design developed by a systems analyst or software developer into one of many computer languages.
- **Web developers**
  - These professionals design and maintain Web sites, including site layout and function, to meet the client's requirements.

Typical IS Titles and functions - Support

- **Database administrator**
  - Database administrators (DBAs) design and set up databases to meet an organization's needs.
- **System support specialist**
  - These skilled specialists respond to telephone calls, electronic mail, and other inquiries from computer users regarding hardware, software, networking, or other IS-related problems or needs.

New IT roles

- **Data scientist**
- **UX/UI Specialist**
- **Scrum Master**
- **Product manager/Product owner**
- **Agile coach**

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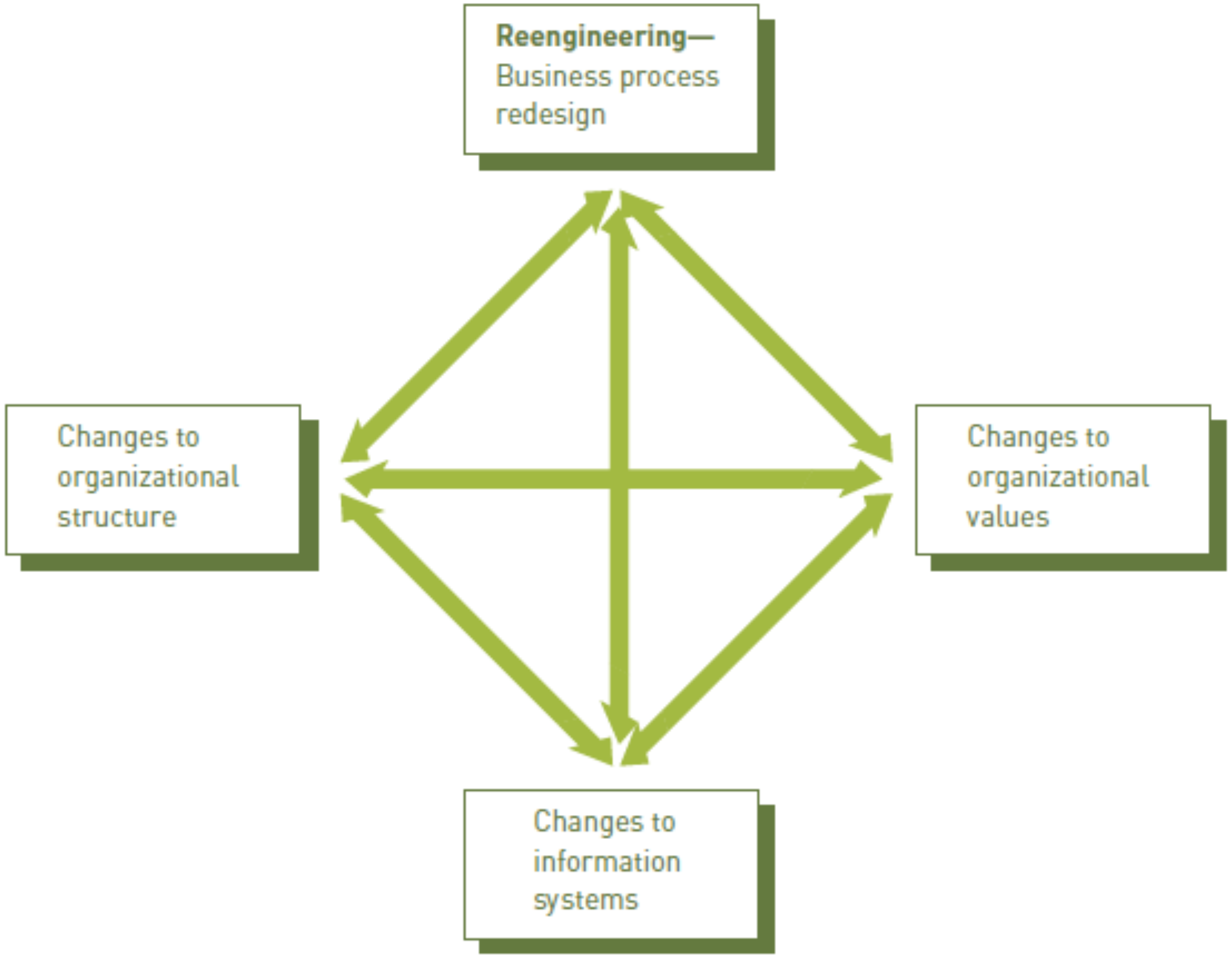
Reengineering and Continuous Improvement

- To stay competitive, organizations must occasionally make fundamental changes in the way they do business.
- In other words, they must innovate and change the activities, tasks, or processes they use to achieve their goals.
- Reengineering, also called process redesign and business process reengineering (BPR), involves the radical redesign of business processes, organizational structures, information systems, and values of the organization to achieve a breakthrough in business results.

- In contrast to reengineering, the idea of continuous improvement (often referred to by the Japanese word “Kaizen”) is a form of innovation that constantly seeks ways to improve business processes and add value to products and services.

Reengineering and Continuous Improvement



Outsourcing, On-Demand Computing and Downsizing

- **Outsourcing**
  - Contracting with outside professional services
- **Offshoring**
  - is an outsourcing arrangement in which the organization providing the service is located in a country different from the firm obtaining the services
- **Downsizing**
  - Reducing number of employees to cut costs

Certifications

- **Process for testing skills and knowledge resulting in an endorsement by the certifying authority**
  - Project Management Institute PMP
  - SCRUM Master certification
  - Citrix Certified Enterprise Engineer
  - Comp TIA Security+
  - GIAC Certified Windows System Administrator
  - AWS Certified SysOps Administrator-Associate (Cloud)
  - Mongo DB Certified DBA
  - Microsoft Certified Solution Developer: Applications Lifecycle Management
  - Cisco Certified Design Associate

Working in Teams

Types of Information Systems

- **Personal IS:** An information system that improves the productivity of individual users in performing stand-alone tasks. Examples ?
- **Group IS:** An information system that improves communications and support collaboration among members of a workgroup. Examples?
- **Enterprise IS:** An information system that an organization uses to define structured interactions among its own employees and/or with external customers, suppliers, government agencies and other business partners. Examples?

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Types of Information Systems

	Personal IS	Group IS	Enterprise IS
Examples	Personal productivity software, decision-support system	Email, instant messaging, project management software	Transaction processing systems, enterprise systems, interorganizational systems
Benefits	Improved productivity	Increased collaboration	Increased standardization and ability to monitor work
Organizational complements (including well-trained workers, better teamwork, redesigned processes, and new decision rights)	• Does not bring complements with it • Partial benefits can be achieved without all complements being in place	• At least some complements must be in place when IS "goes live" • Allows users to implement and modify complements over time	• Full complements must be in place when IS "goes live"
Manager's role	• Ensure that employees understand and connect to the change • Encourage use • Challenge workers to find new uses	• Demonstrate how technology can be used • Set norms for participation	• Identify and put into place the full set of organizational complements prior to adoption • Intervene forcefully and continually to ensure adoption

Organizational complements

- **Well-trained workers**
  - **Employees must be well trained and understand the need for the new system, what their role is in using or operating the system, and how to get the results they need from the system.**
- **System support**
  - **Trained and experienced users who can show others how to gain value from the system and overcome start-up problems.**
- **Better teamwork**
  - **Employees must understand and be motivated to work together to achieve the anticipated benefits of the system.**
- **Redesigned processes**
  - **New systems often require radical redesign of existing work processes as well as the automation of new processes.**
- **New decision rights**
  - **Employees must understand and accept their new roles and responsibilities including who is responsible for making what decisions.**

Global Challenges in Information Systems

- Cultural challenges
- Language challenges
- Time and distance challenges
- Infrastructure challenges
- Currency challenges
- Product and service challenges
- Technology transfer issues
- State, regional, and national laws
- Trade agreements

Exercise

Kroger's QueVision System Improves Customer Service

Critical Thinking Exercise Kroger’s QueVision System Improves Customer ServiceReview

- **Kroger has annual sales in excess of $100 billion and operates stores across the United States under various names, including Kroger’s, Ralph’s, and Harris Teeter. In surveys, Kroger’s customers have consistently rated waiting at the checkout lane as the worst part of the grocery shopping experience. In response, Kroger developed its QueVision computer-based information system, which relies on real-time data feeds from point-of-sale systems as well as infrared sensors over store doors and cash registers to count customers entering the store and standing at checkout lanes.**

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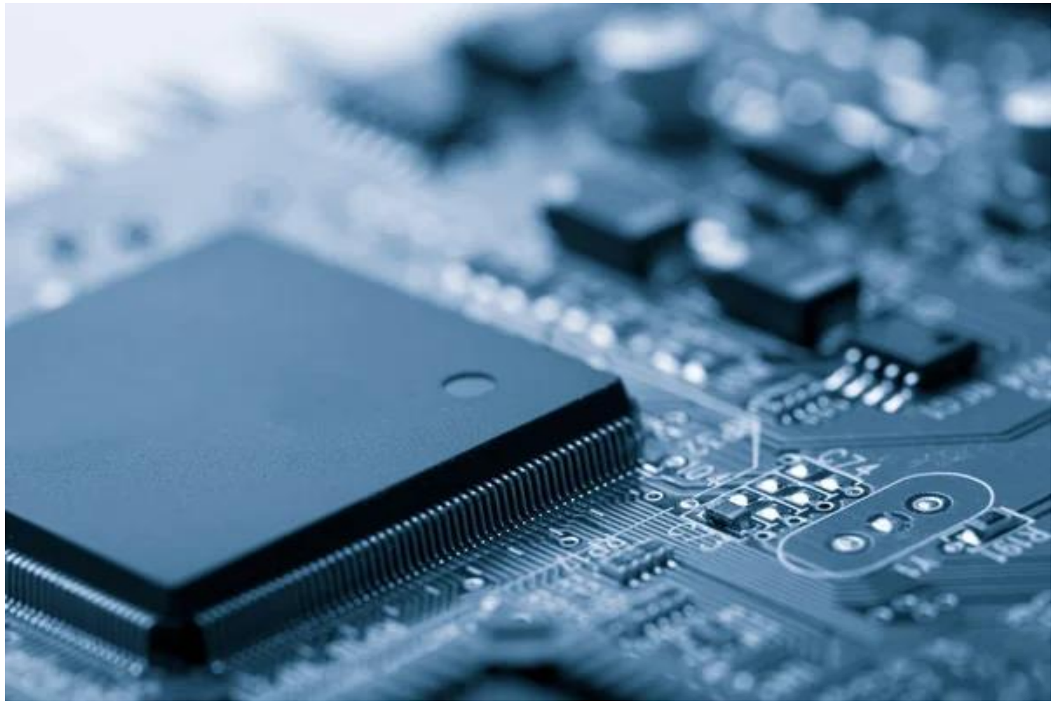

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Principles and Architecture of Information Systems

Chapter #2

Hardware

Olivier BERTHET

Structure

- Chapter 1 : Introduction and Organisations
- Chapter 2 : Hardware
- Chapter 3 : Software
- Chapter 4 : Database Systems
- Chapter 5 : Network
- Chapter 6 : Internet and E-Commerce
- Chapter 7 : Major Information Systems
- Chapter 8 : Systems Development
- Chapter 9 : Security, Privacy and Ethical issues

Objectives

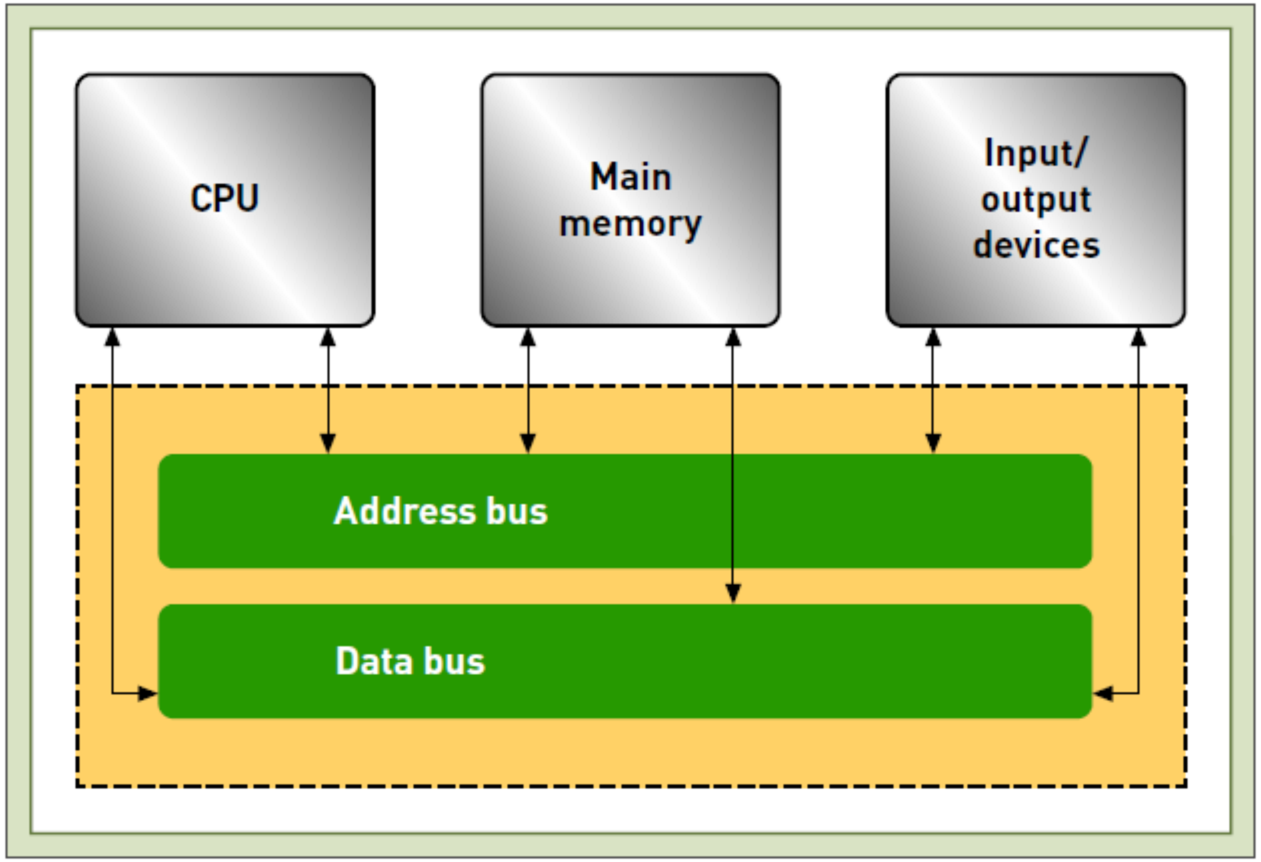
- **Computer hardware must be carefully selected to meet the evolving needs of the organization and of its supporting information systems**
- **The computer hardware industry is rapidly changing and highly competitive, creating an environment ripe for technological breakthroughs**
- **The computer hardware industry and users are implementing green computing designs and products**

Why Learn About Hardware?

- **Organizations invest in computer hardware to:**
  - Improve worker productivity
  - Increase revenue, reduce costs
  - Provide better customer service
  - Speed up time-to-market
  - Enable collaboration among employees
- **Managers:**
  - Are expected to help define the business needs that the hardware must support

Wooclap : What are the main components of a computer ?

Basic anatomy of a computer



Wooclap : What are the Input / Output devices ?

Input devices

- Personal computer input devices : keyboard, mouse, pen
- Speech recognition technology
- Digital cameras
- Terminals
- Scanning devices
- Optical data readers
- Barcode scanners
- Magnetic ink character recognition (MICR) devices
- Magnetic stripe card
- Radio Frequency Identification (RFID) Devices

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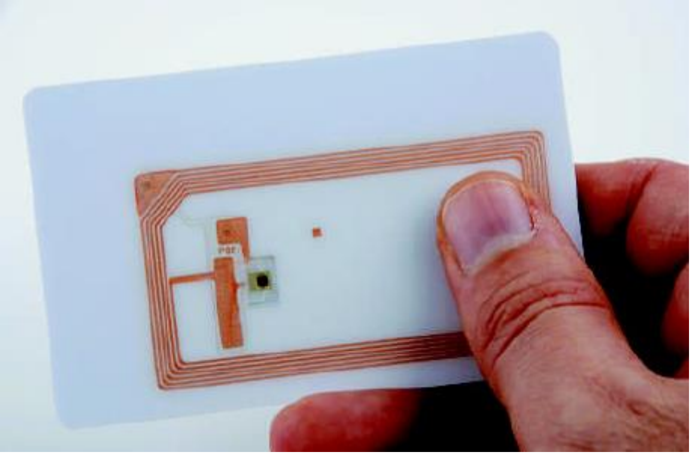
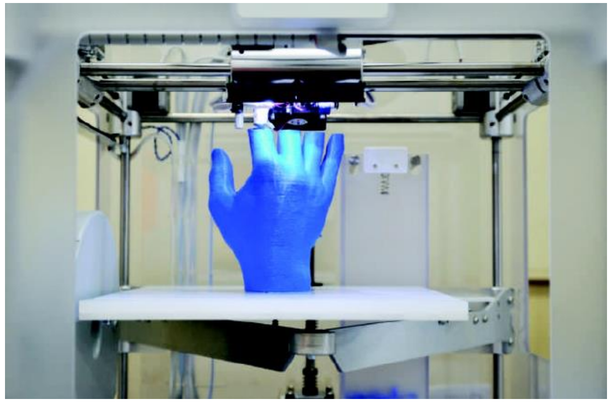
Radio Frequency Identification (RFID) Devices

- Radio frequency identification (RFID) is a technology that employs a microchip with an antenna to broadcast its unique identifier and location to receivers.
- The purpose of an RFID system is to transmit data by a mobile device, called a tag
- A tag can be read by an RFID reader and processed according to the needs of a computer program.
- One popular application of RFID is to place microchips on retail items and install in-store readers that track the inventory on the shelves to determine when shelves should be restocked.



Output devices

- **Display monitors : LCD, Plasma, LED**
- **Digital audio player**
- **Printers and plotters, 3D Printers**
- **Ebooks**



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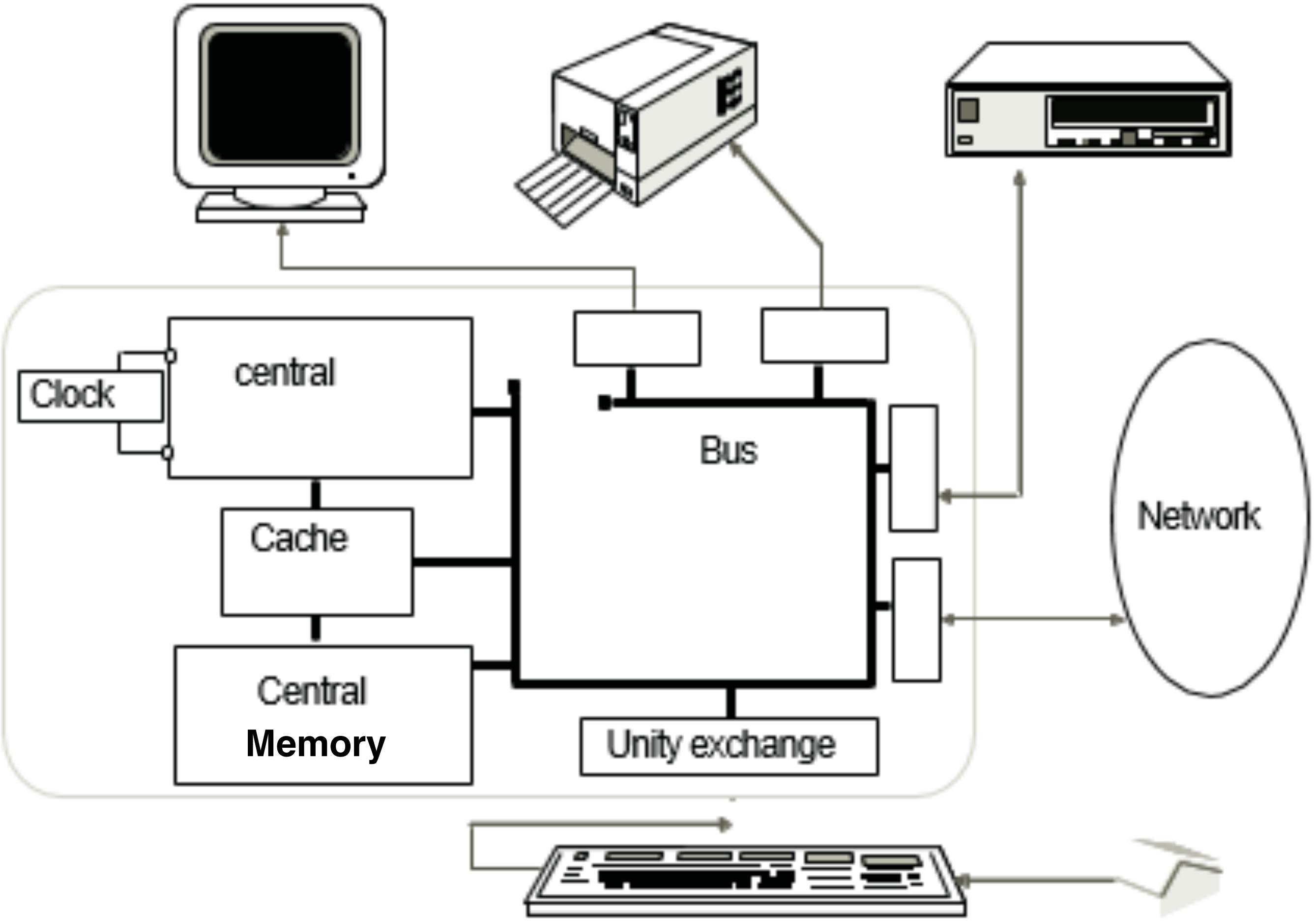
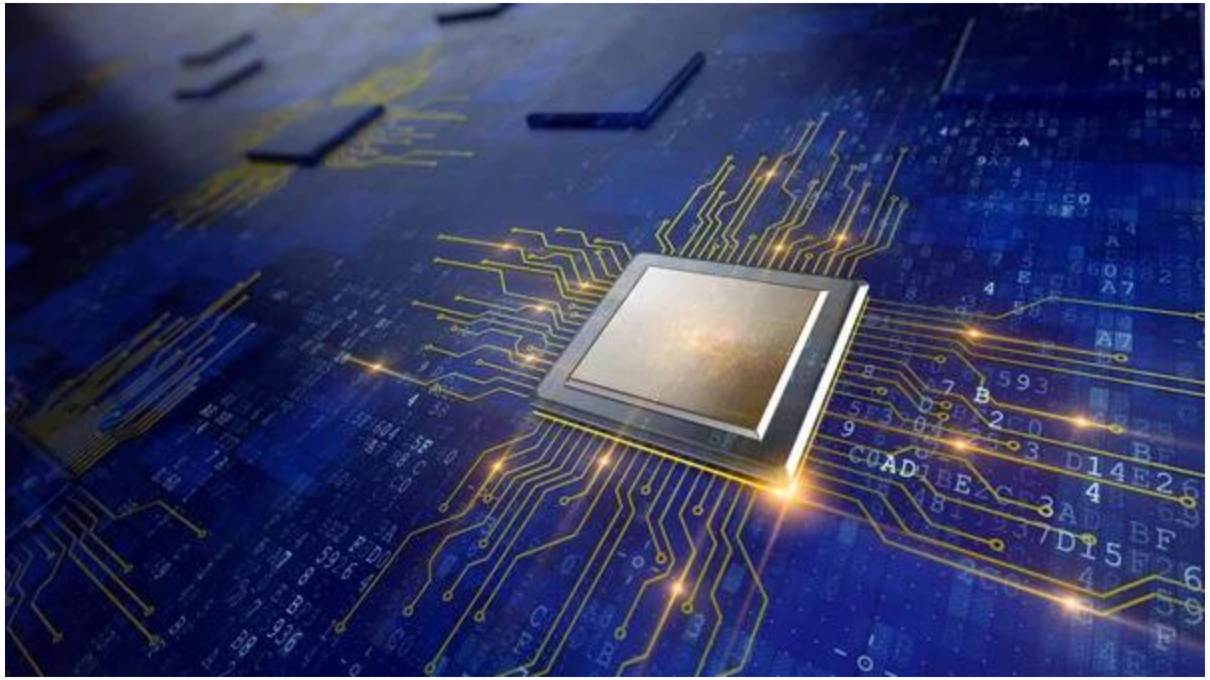
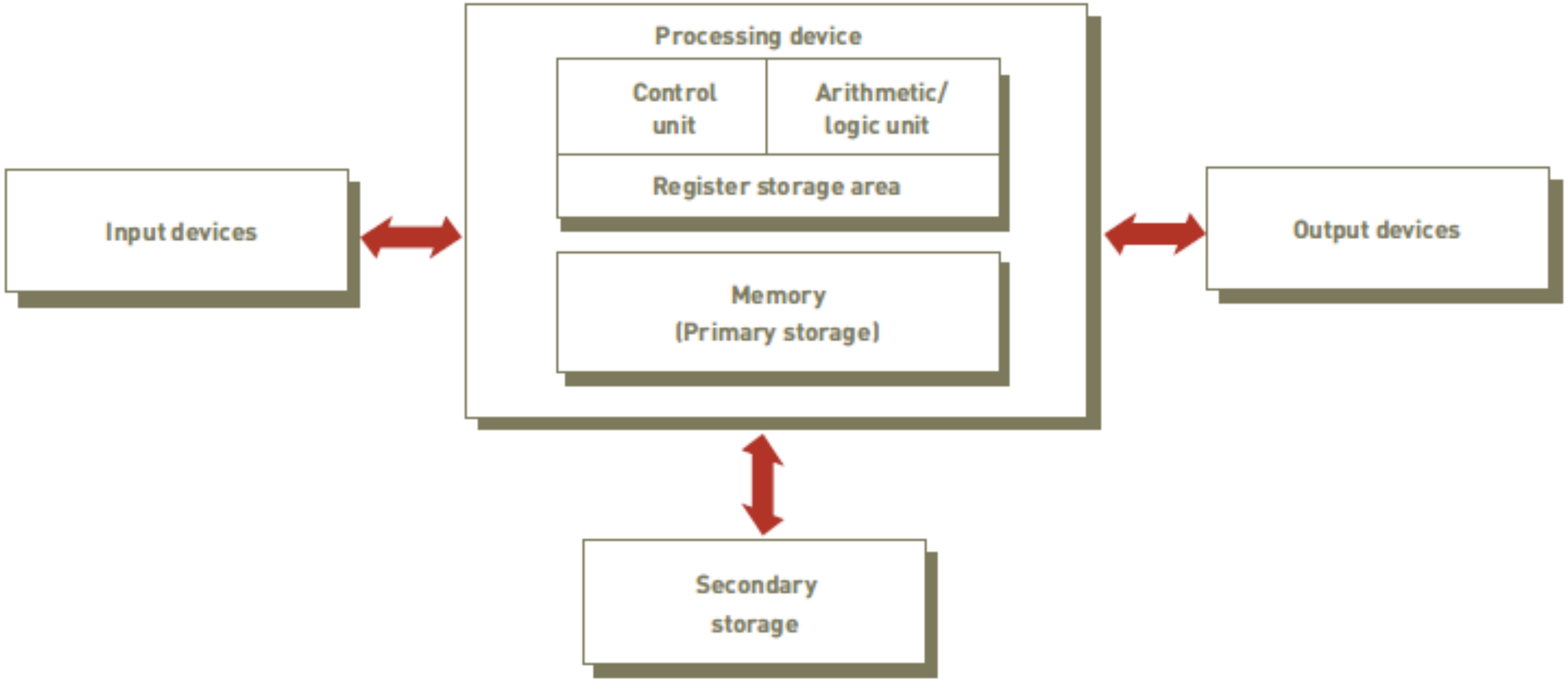
Hardware general structure



Let's go back to the CPU



Hardware components

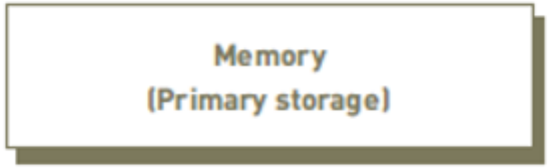


Central Processing Unit CPU

- **Each central processing unit consists of three associated elements**

- **Arithmetic Logic Unit (ALU)**
  - Performs mathematical calculations and makes logical comparisons
- **Control Unit**
  - Sequentially accesses program instructions, decodes them, and coordinates the flow of data in and out of the ALU, registers, primary storage, and even secondary storage and various output devices
- **Register storage area**
  - High-speed storage areas used to temporarily hold small units of program instructions and data

Memory

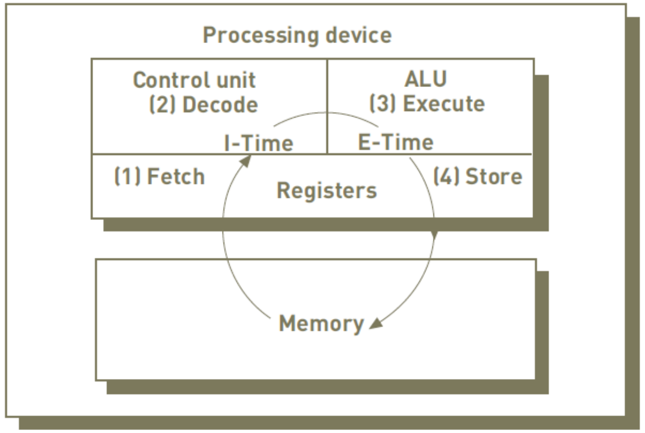


- **Primary storage**
  - Also called Main Memory
  - Closely associated with the CPU
  - Memory holds program instructions and data immediately before or after the registers

Hardware Components in Action

- To understand the function of processing and the interplay between the CPU and memory, let's examine the way a typical computer executes a program instruction

- **Two phases : instruction and execution**
- **Instruction : 2 steps**
  - Step 1: Fetch instruction
  - Step 2: Decode instruction
- **Execution : 2 steps**
  - Step 3: Execute instruction
  - Step 4: Store results



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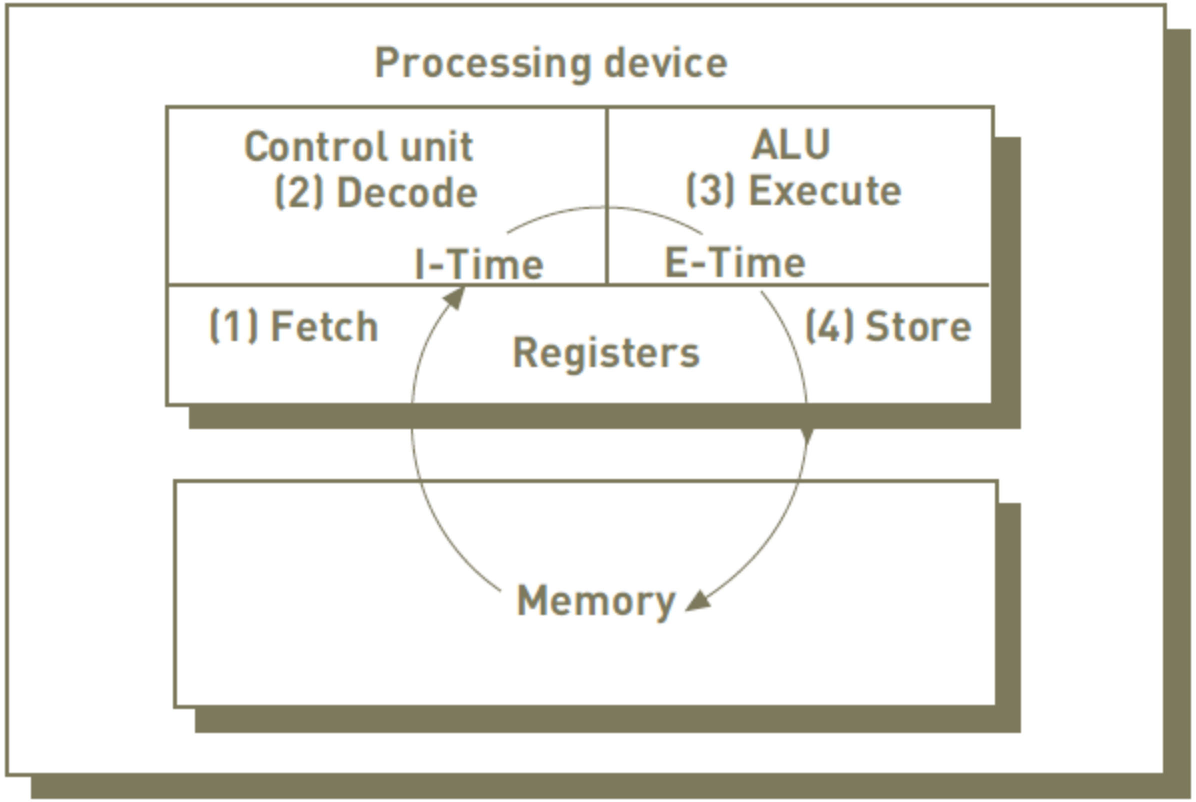
Execution of an instruction

Step 1 & 2
Instruction time
I-time



Step 3 & 4
Execution time
E-time

Processing Characteristics and Functions

- **Machine cycle time is measured in:**
  - **Nanoseconds (1 billionth of a second)**
  - **Picoseconds (1 trillionth of a second)**
  - **MIPS (millions of instructions per second)**
- **Clock speed:**
  - **Series of electronic pulses produced at a predetermined rate that affects machine cycle time**
  - **Often measured in:**
    - **Megahertz (MHz): millions of cycles per second 10^6 Hz**
    - **Gigahertz (GHz): billions of cycles per second 10^9 Hz**

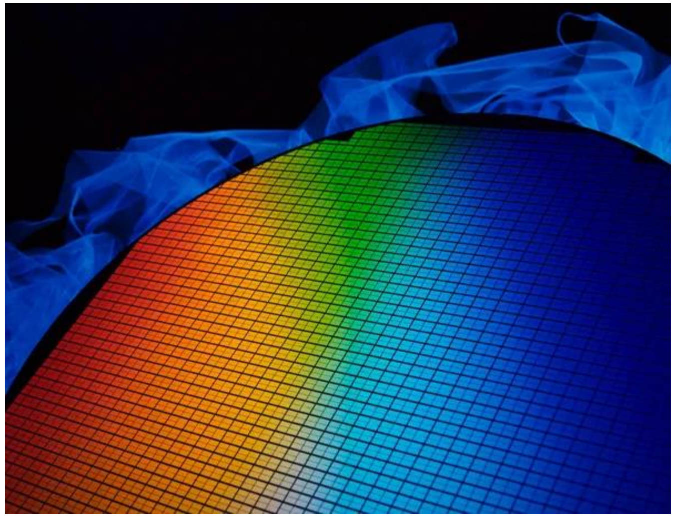
Exercise : What are the 10^n ?

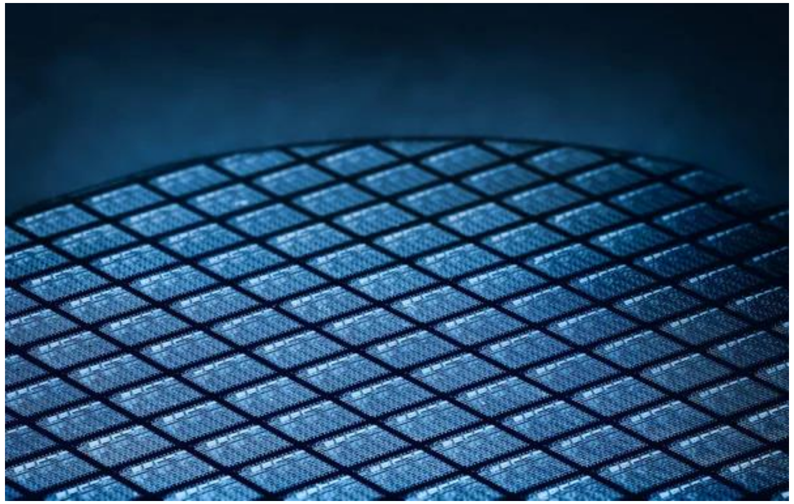
- n=3 10^3
- n=6 10^6
- n=9 10^9
- n=12 10^{12}
- n=15 10^{15}
- n=18 10^{18}
- n=21 10^{21}
- n=24 10^{24}

- Kilo
- Mega
- Giga
- Tera
- Peta
- Exa
- Zetta
- Yotta

Processing Characteristics and Functions

- Most CPUs are collections of digital circuits imprinted on silicon wafers, or chips, each no bigger than the tip of a pencil eraser

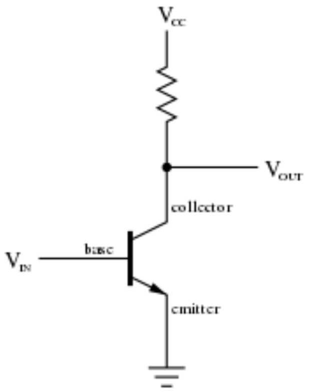


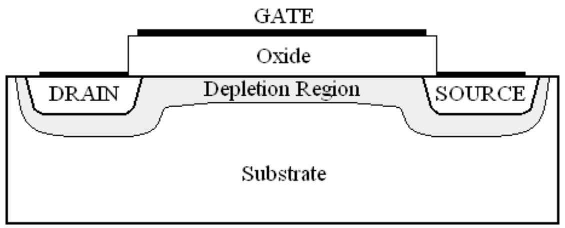


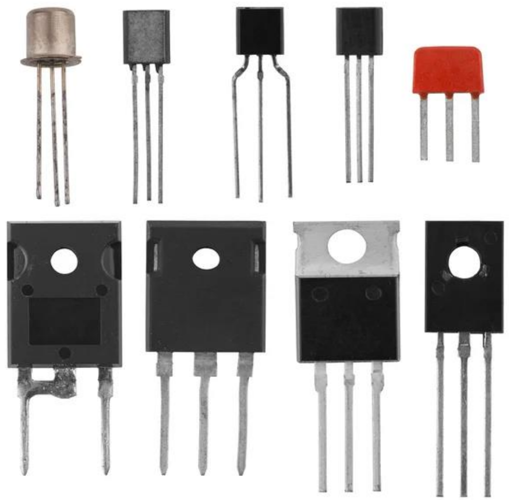
Principles & Architecture

Elementary constituents

- Almost all computers are built from electronic circuits
- Electronic circuits are made using transistors
- Elementary component, whose output current depends on two values input
  - A transistor therefore has three terminals called an emitter, a base, and a collector
- Analogous to an " electricity tap " : the more current arrives on the base, the more the current flows from the emitter to the collector



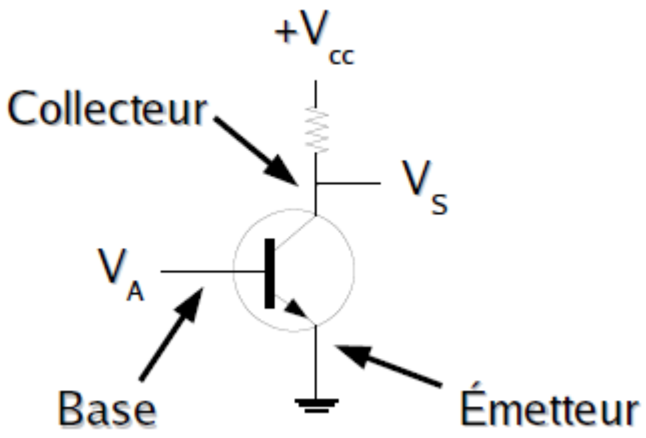


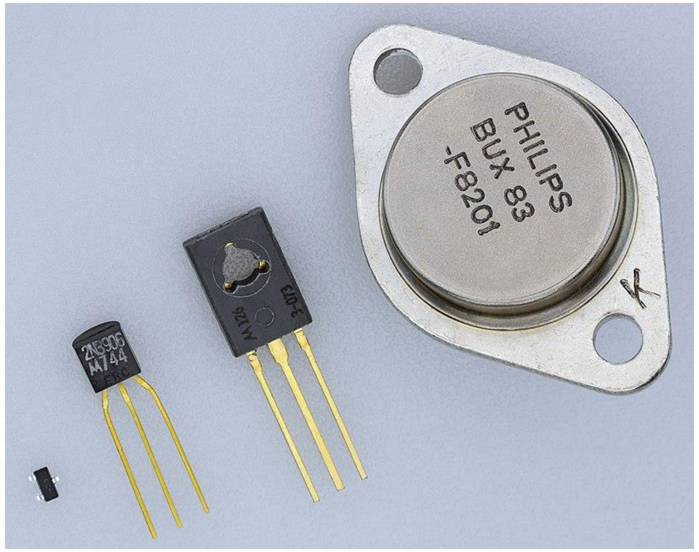


Transistors

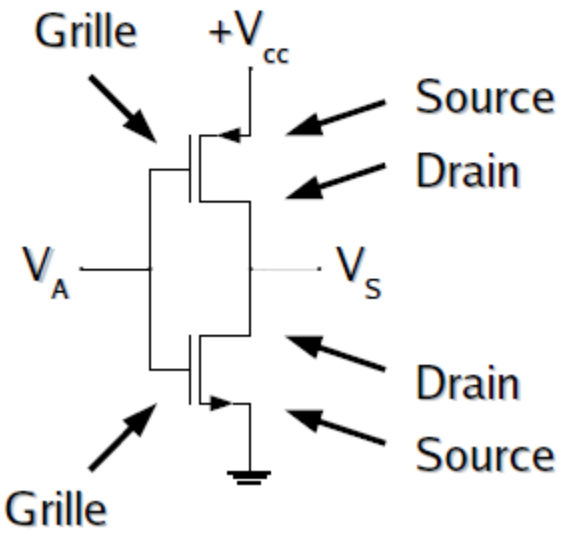
- **Electronics and Information Technology relies on the fact that a transistor can act as an extremely fast logical switch**
- **Two major technologies :**
  - **Bipolar : very fast switching time but power consumption high, used in Registers, SRAMs, circuits specialized**
  - **CMOS : Complementary Metal Oxide Semiconductor slower switching time but much lower power consumption, 90 % of circuits are made in CMOS**

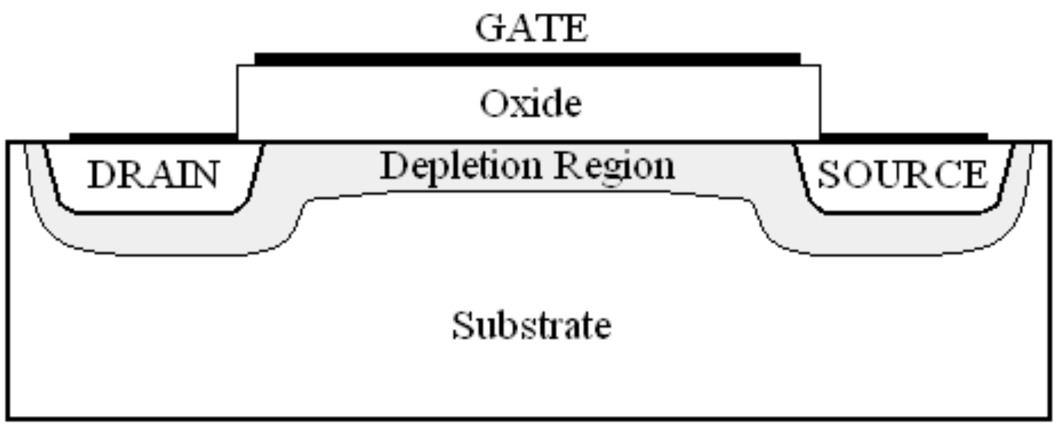
Bipolar junction transistor (BJT)



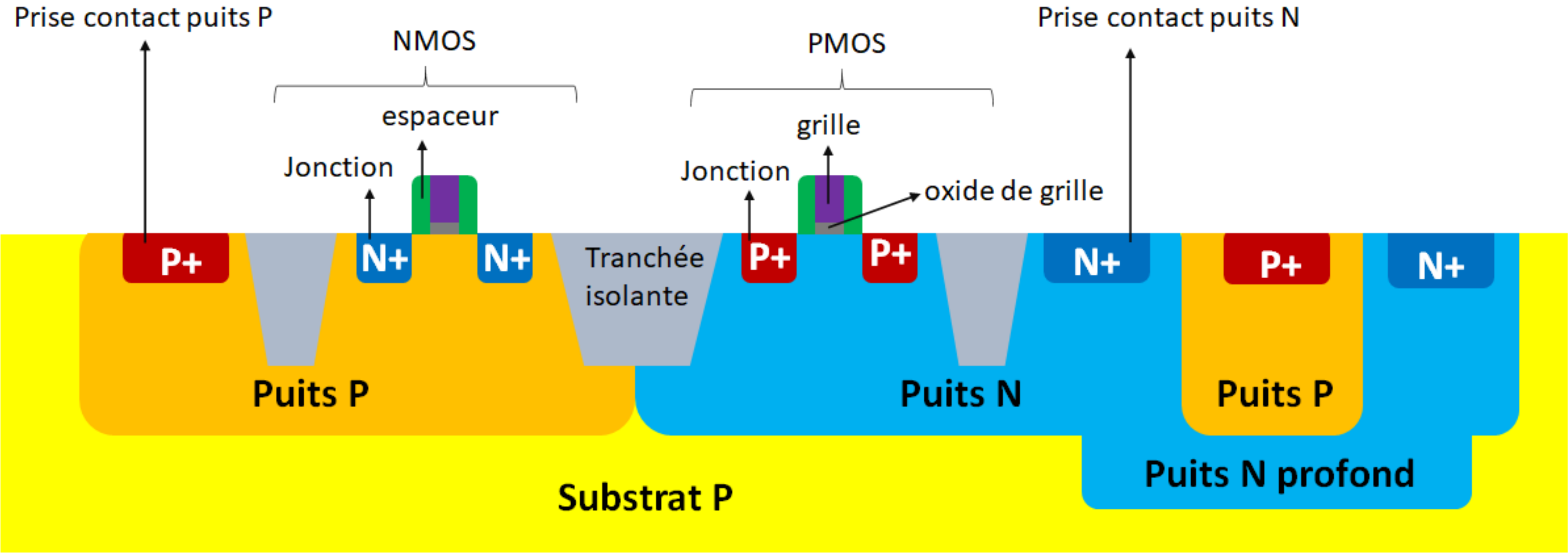


CMOS - Complementary metal oxide semi-conductor





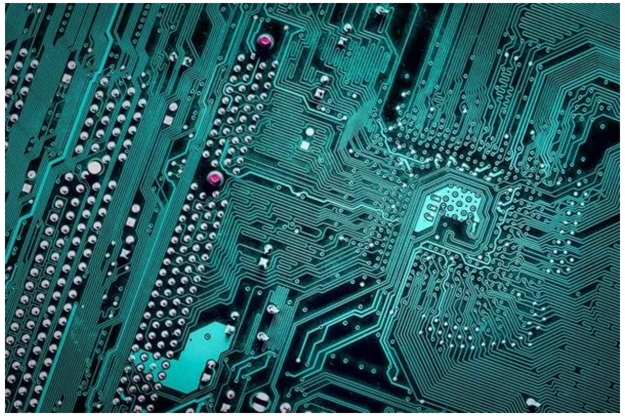
CMOS



Prise contact puits P
NMOS
espaceur
Jonction
PMOS
grille
Jonction
oxide de grille
Prise contact puits N
P+
N+
N+
Tranchée isolante
P+
P+
N+
P+
N+
Puits P
Puits N
Puits P
Puits N profond
Substrat P

Elementary constituents

- **In computers , transistors are used in saturated mode : “all or nothing”**
- **Operation similar to that of a switch**
  - **Valve closed or open**
  - **Either the current is flowing or it is not: none or everything**
- **Representation of binary values "0" and "1” called bit**
- **By combining several transistors, calculations can be made complex**
  - **On the basis of assembly in series or in parallel**
- **Grouping of transistors within integrated circuits**

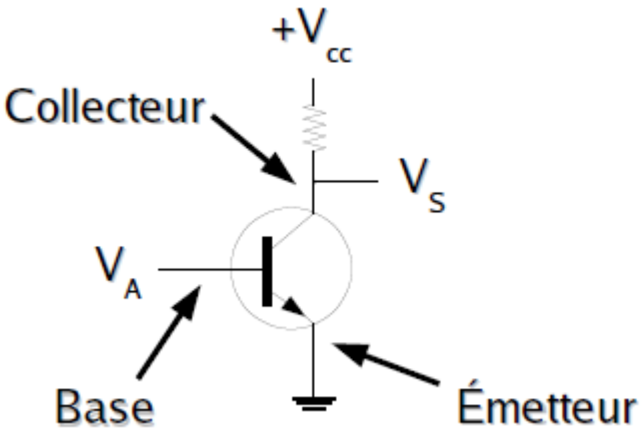


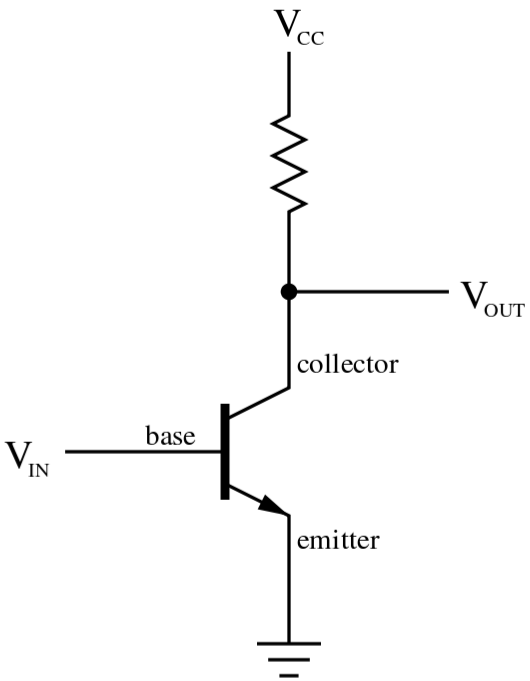
How to represent information ? 0 or 1

- **Information is represented within computer components as different states**
  - **" Hole " or "no hole " on the surface of a CD-ROM or DVD**
  - **North or south orientation of a magnetic material**
  - **Light or absence of light emitted by a laser**
  - **Electric current or not**
- **They are often two-state representations or binary**

Logic circuit

- **A logic circuit is a circuit that manipulates only two logic values : 0 and 1**
  - **Inside the circuits, we typically represent a state 0 by a low voltage signal (close to 0V) and a state 1 by a high voltage signal (5V, 3.3V, 2.5V, 1.8V or 0 .9V according to technologies)**



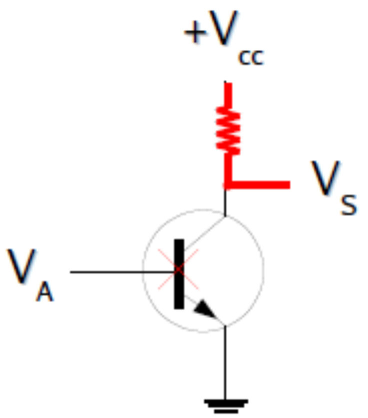


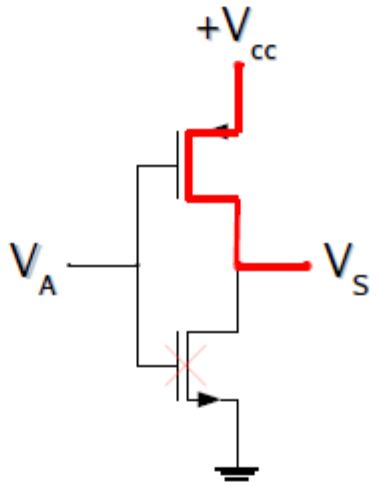
Simple logical exercises A,B and S

- **NON**
- **OR**
- **AND**

Logic circuit

- V_A is down(0), V_S is high(1)

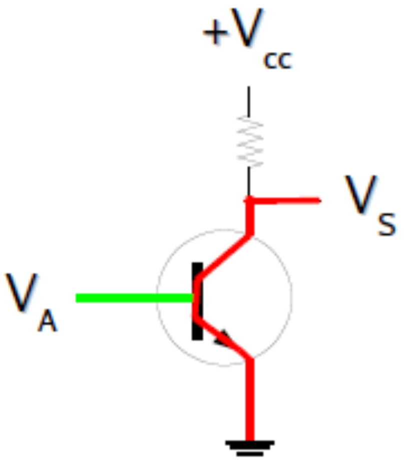


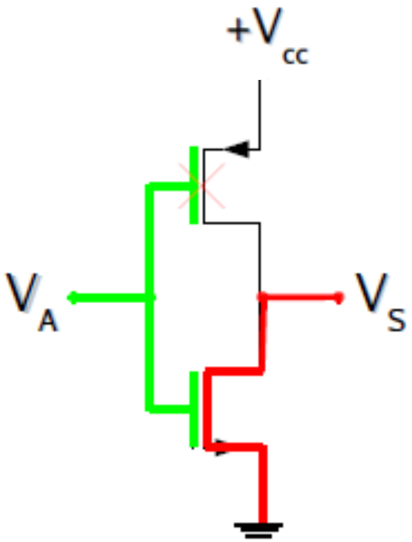


Logic circuit - NON

A	S
0	1
1	0

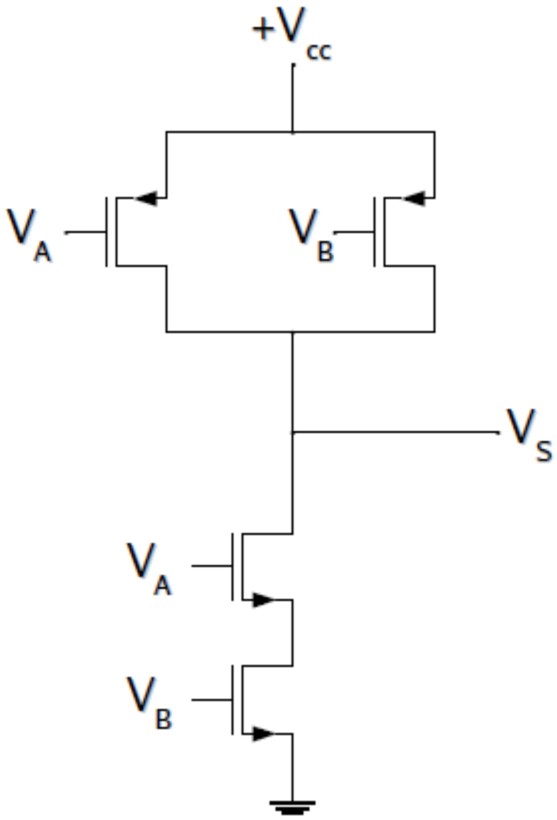
- And when V_A is high (1), V_S is low(0)
- this circuit is a inverter





Logic circuit - NAND

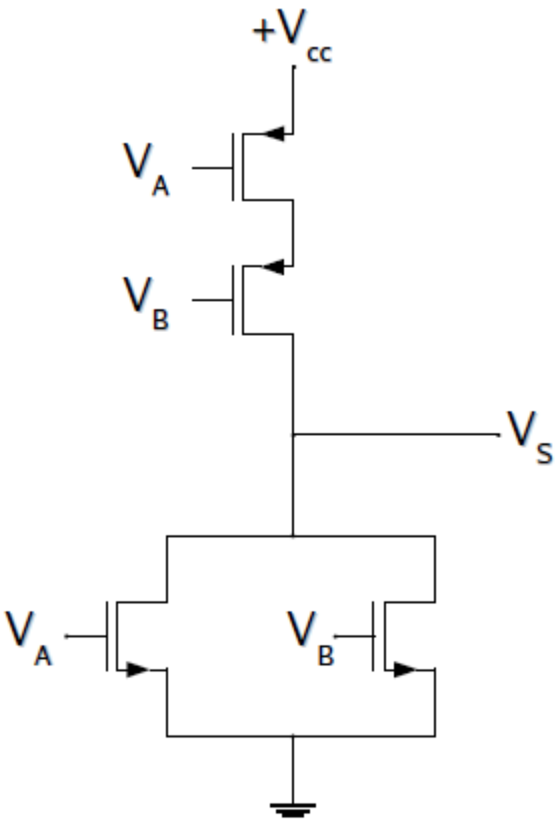
- By combining four transistors CMOS we can obtain a circuit or a gate such that V_S is low(0) only when V_A and V_B are both high(1)

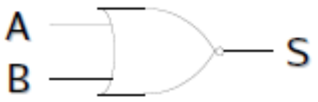


A	B	S
0	0	1
0	1	1
1	0	1
1	1	0

Logic circuit - NOR

- By combining four transistors CMOS we can obtain a circuit or a gate such that V_S is low(0) only when V_A or V_B or both are high(1)

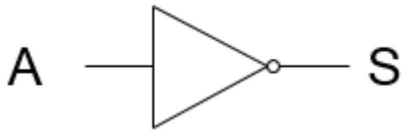




A	B	S
0	0	1
0	1	0
1	0	0
1	1	0

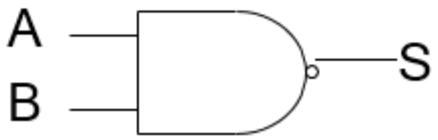
Logic gates

- **Tiny electronic devices called "gates“ can calculate different functions from these signals**



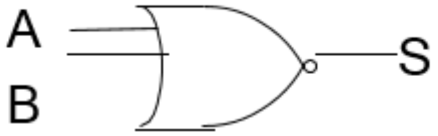
A	S
0	1
1	0

NON



A	B	S
0	0	1
0	1	1
1	0	1
1	1	0

NAND



A	B	S
0	0	1
0	1	0
1	0	0
1	1	0

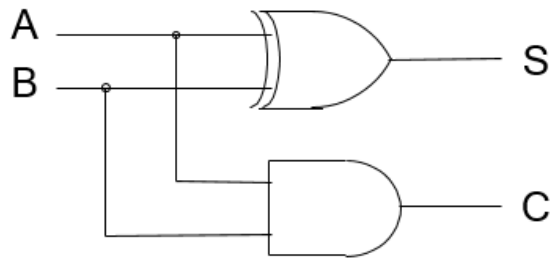
NOR

Logic gates

- Regardless of the technology, NAND and NOR gates require fewer transistors than AND and OR gates , which require in addition an inverter
- Computer circuits are therefore rather built with NAND and NOR gates
- All logical and arithmetical functions can be built from transistors, so NOR and NAND are called “complete” gates

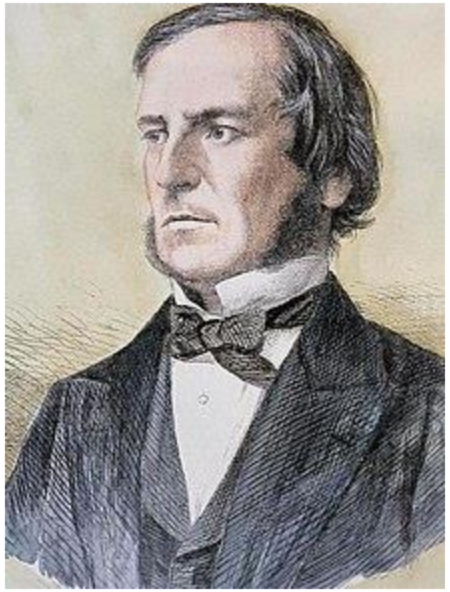
A	B	C	S
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0

S : Sum
C : Carry



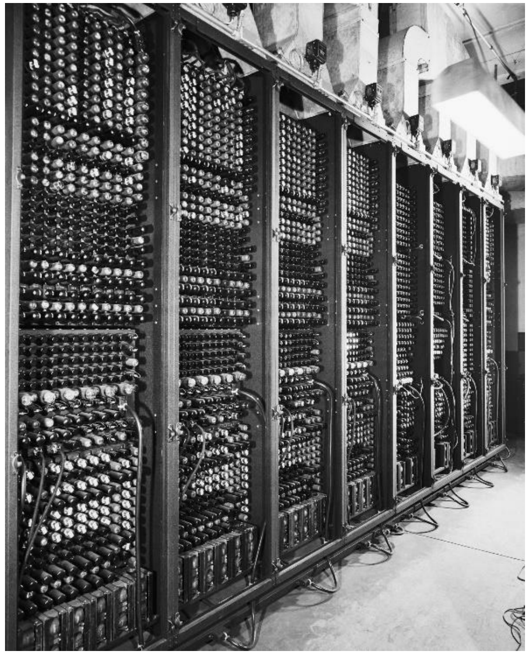
Boolean algebra

- To describe the circuits that can be realized by combining logic gates , we need an algebra operating on the variables 0 and 1
- Boolean algebra
  - G. Boole : 1815 – 1864
  - Binary algebra studied by Leibniz from 1703

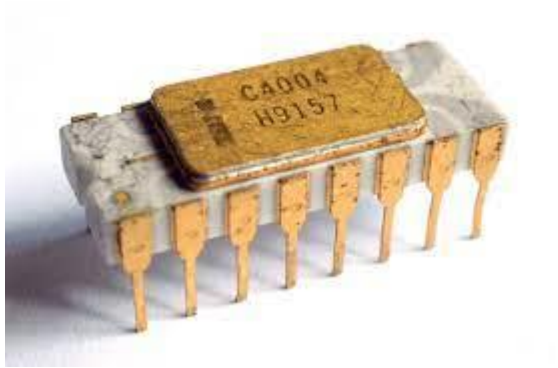


History of computers

- **1946 : Computer ENIAC**
  - **Architecture based on lamps and vacuum tubes: 30 tons, 170 m^2 on the ground, 5000 additions per second**
  - **So How many MIPS ?**
- **1947 : Invention of transistor**
- **1958 : Invention of the integrated circuit on silicon**
  - **Multiple transistors arranged on the same substrate**

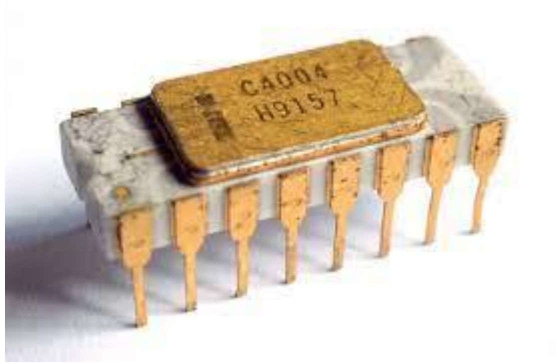


History of computers



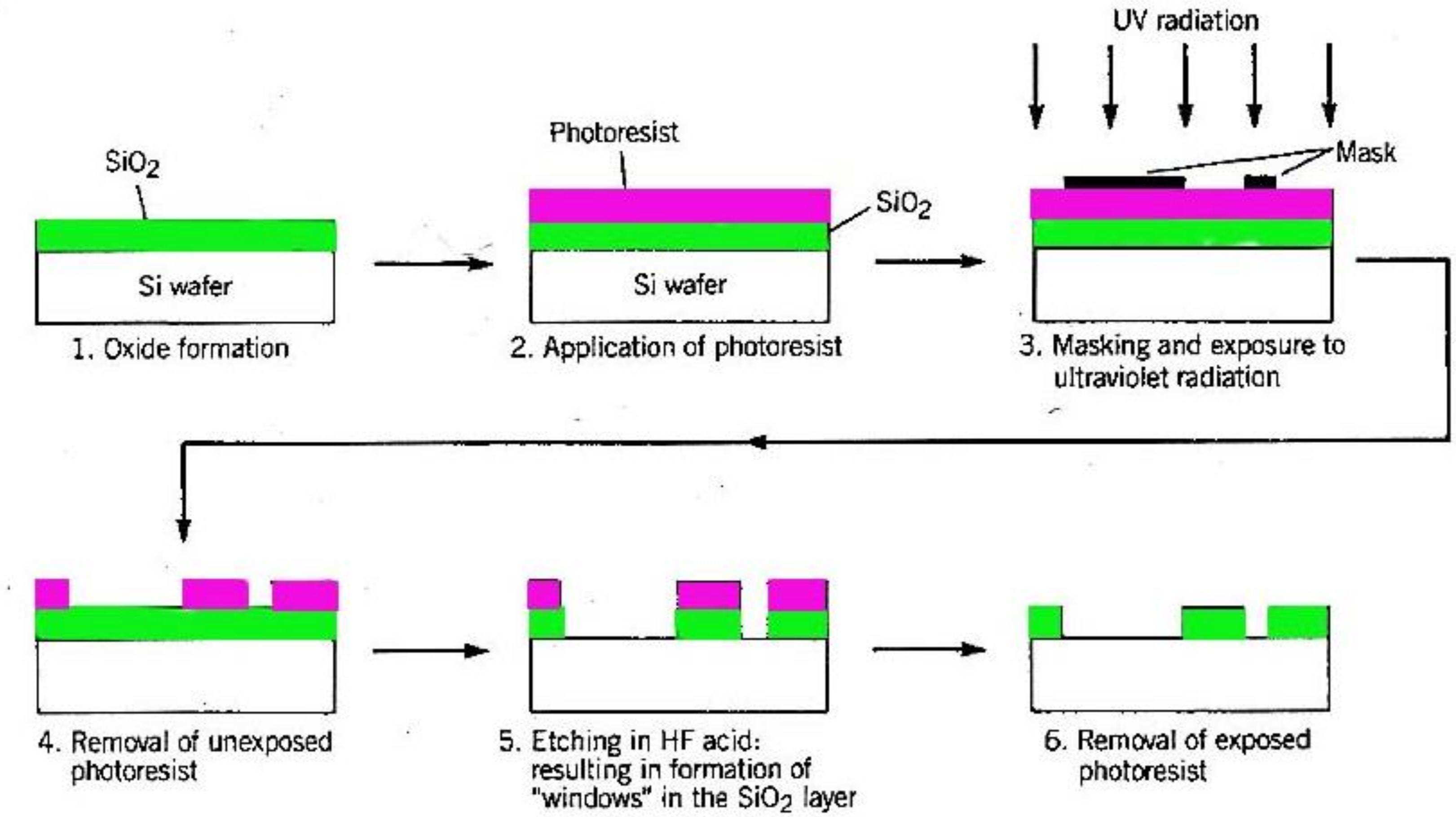
- **1971 : Intel processor 4004**
  - 2300 transistors in a single integrated circuit
  - Frequency of 740 kHz, 0.092 MIPS
- **2011 : Intel Core i7 processor 2600K**
  - More than 1.4 billion transistors
  - Frequency of 3.4 GHz
  - 4 cores, 8 threads
  - 128300 MIPS

History of computers

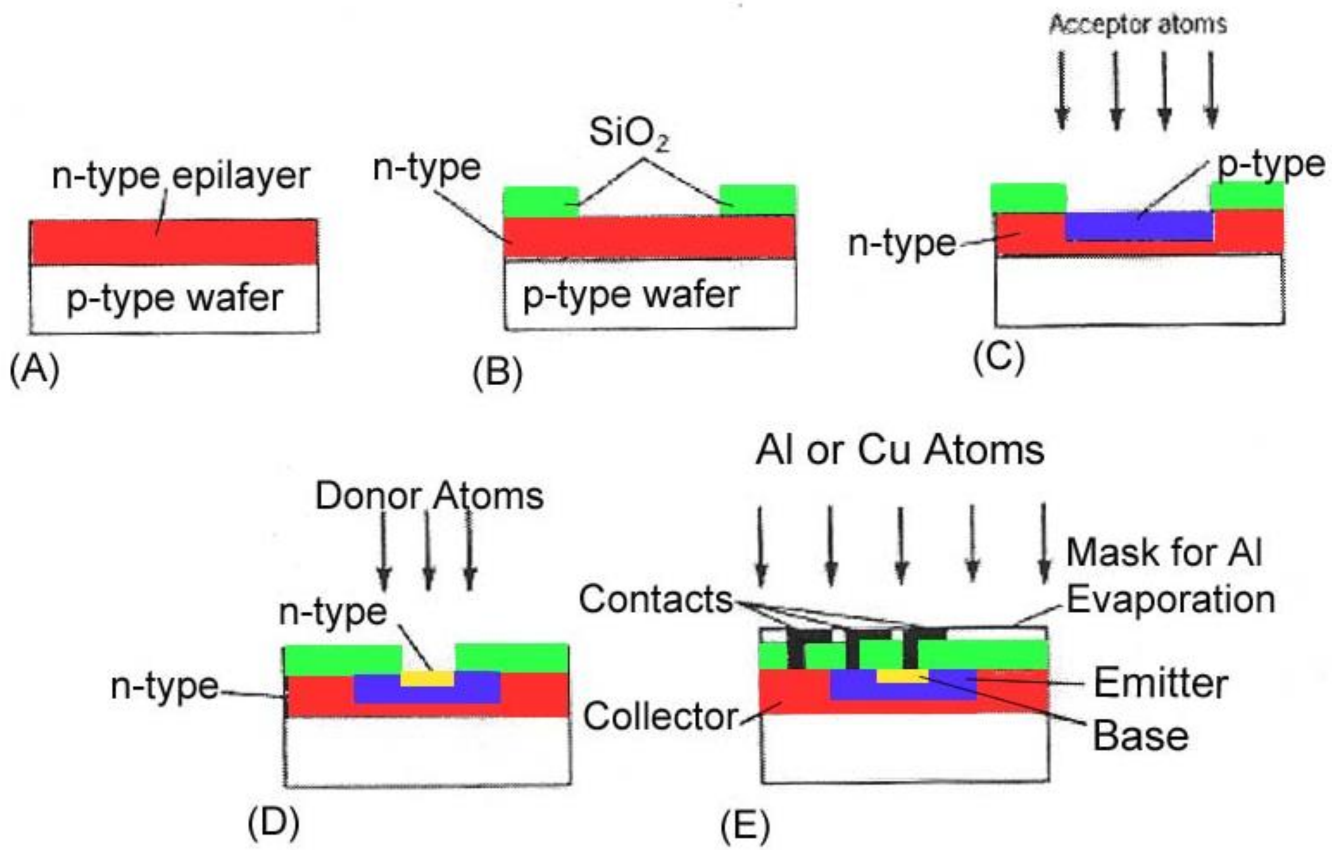


- **Between the 4004 and the Core i7 2600K :**
  - The frequency was multiplied by 4600
  - Power in MIPS has been increased by 1.4 times million
- **The power of a computer clearly does not depend only on its frequency !**
- **Interest in studying computer architecture to understand:**
  - Where the improvements were made
  - What to expect in the near future

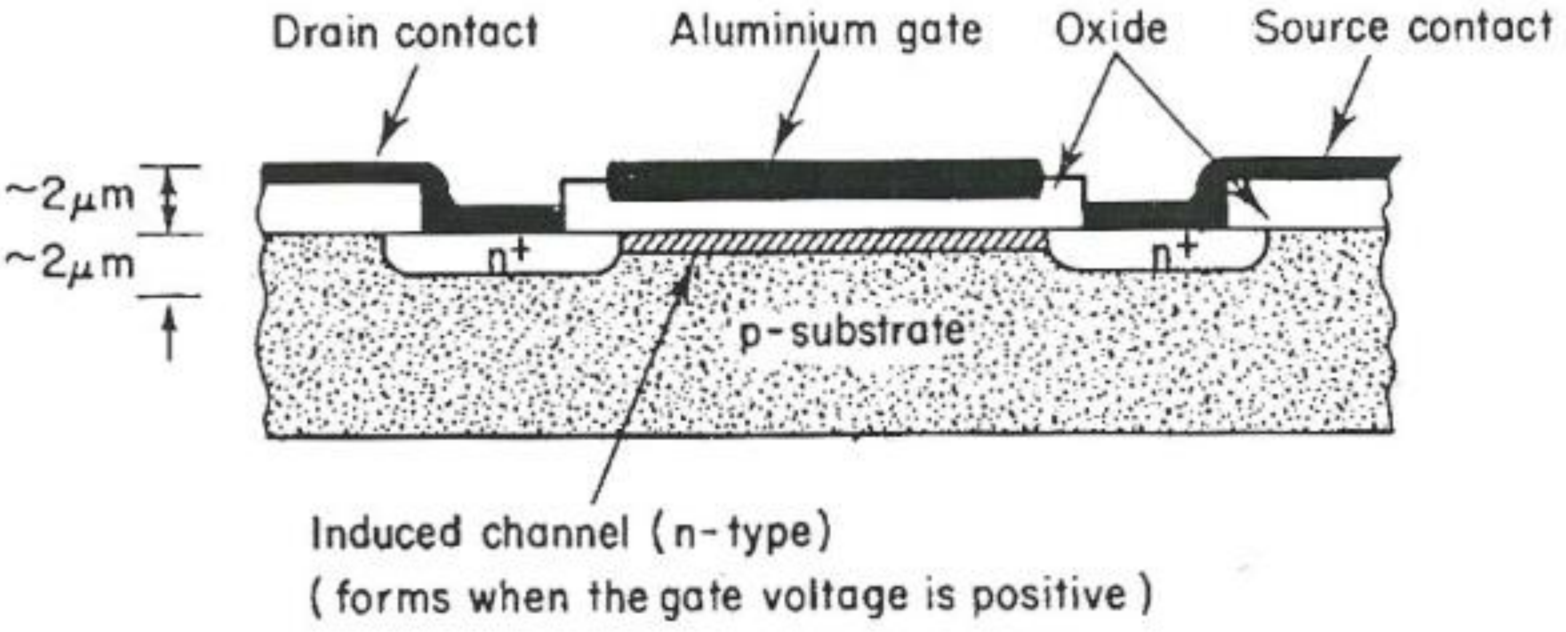
How a CPU processor is made - etching



Making the transistor

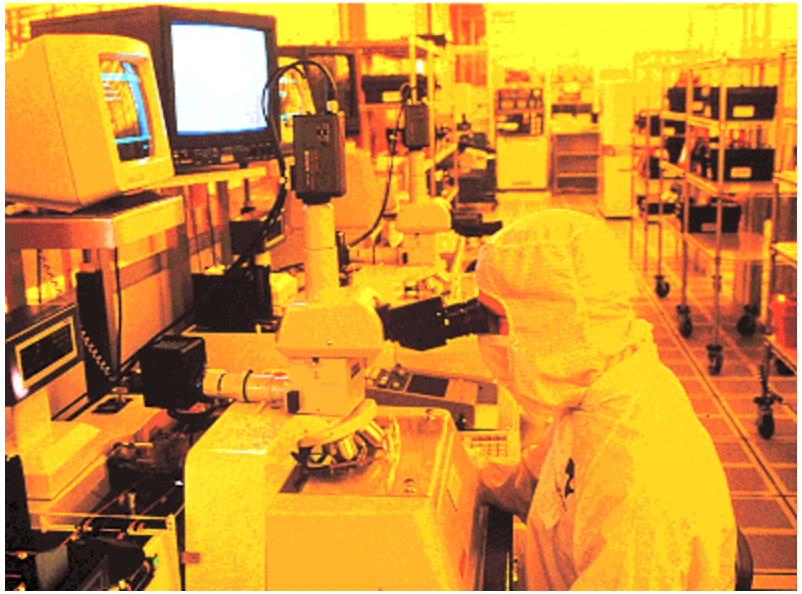


MOS transistor



Principles & Architecture

Clean room

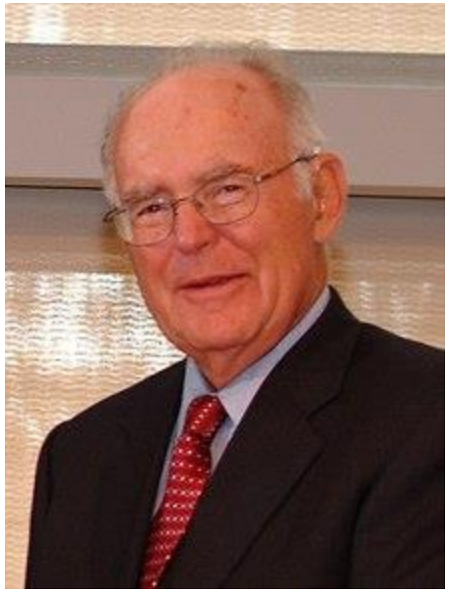


Heat barrier

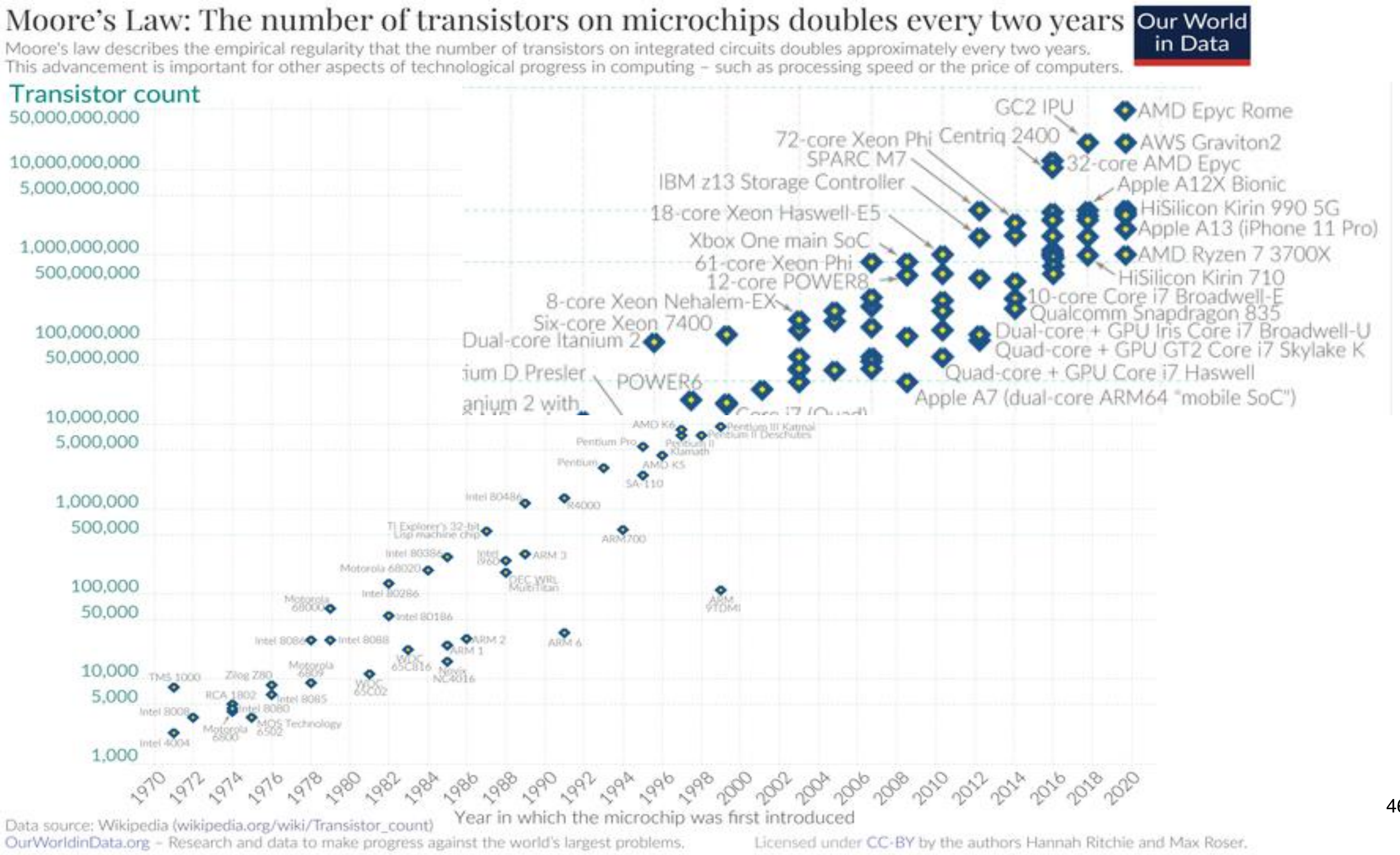
- The more transistors we have per unit area, the more energy we have to cool
- Heat dissipation changes proportionally to V^2 *F
  - The operating voltage of the circuits has been lowered
    - From 5V for the first generations to 0.9V now
  - It is no longer really possible to reduce it with technologies current
    - Thermal noise would cause too much errors
- The frequency cannot reasonably increase beyond 5 GHz because of the heat barrier
- The trend is rather reduction – “Greencomputing”
  - We are now interested in maximizing the number of operations per Watt
  - But we always want more computing power !

Moore's law

- **Any idea ?**



Principles & Architecture



Complexity barrier

- At constant surface, the number of transistors doubles every 2 year
  - Moore 's Law , named after Gordon Moore, co-founder of Intel, stated in 1965
- Continual decrease in the etching size of transistors and circuits on the chips of silicon
  - We currently engrave with a step of 10 nm
- Atomic limits soon reached...
  - So no longer possible to integrate more
  - But we always want more computing power !

Moore's law

Peak Quoted Transistor Densities (MTr/mm2)				
AnandTech	IBM	TSMC	Intel	Samsung
22nm			16.50	
16nm/14nm		28.88	44.67	33.32
10nm		52.51	100.76	51.82
7nm		91.20	237.18*	95.08
5nm		171.30		
3nm		292.21*		
2nm	333.33			

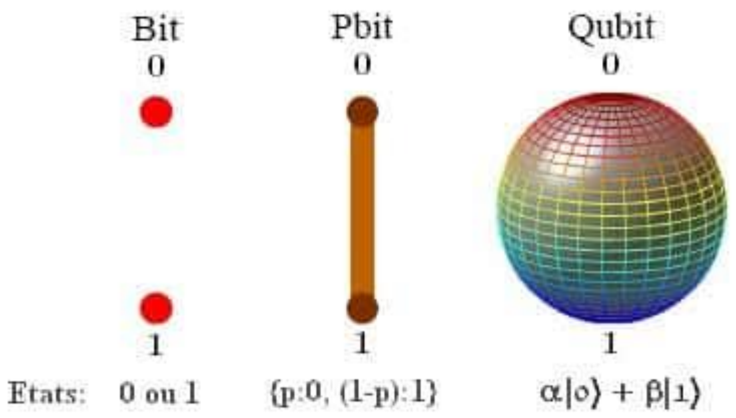
Data from Wikichip, Different Fabs may have different counting methodologies
* Estimated Logic Density

Complexity barrier

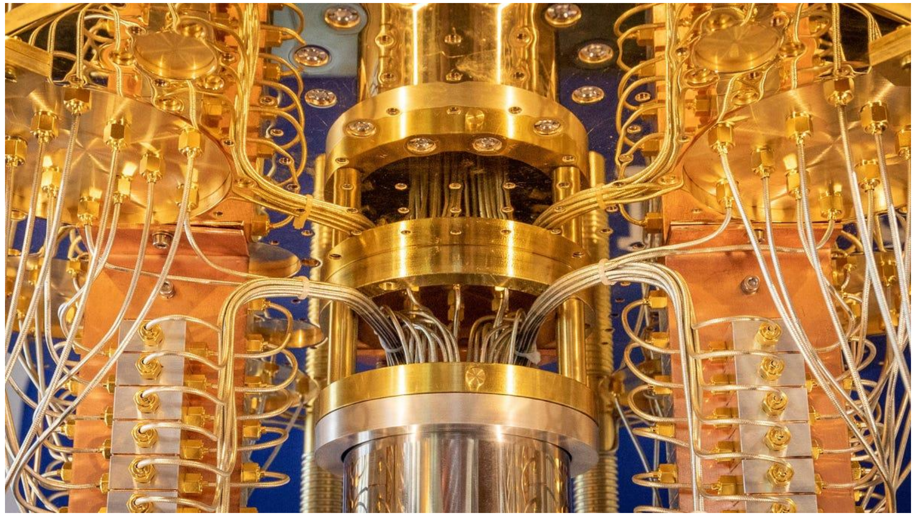
- **What to do with all these transistors ?**
  - **We no longer see how to use these transistors to individually improve the processors**
  - **Overly complex processors consume too much power without going much further quick**
- **only solution currently : make more processors on the same chip !**
  - **Dual-core, quad-core processors, octo-cores, … already up to 128 cores !**
  - **But how to program them effectively ?!**

Quantum computer

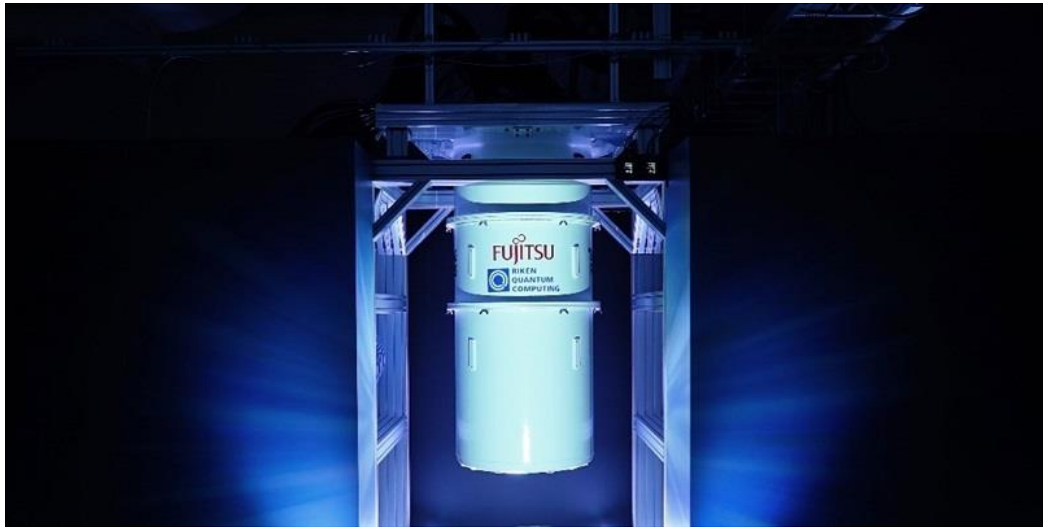
- **Classic computers are programmed with bits**
  - **Each bit can store either a 0 or a 1**
- **Quantum computers use Qubits**
  - **Based on the law of Quantum mechanics, a Qubit car represent a combination of 0 and 1 at the same time according to the principle of <u>superposition</u>**
  - **The quantum computer will thus exploit the <u>entanglement</u> between the qubits and the probabilities associated with the superposition to carry out a series of operations**
  - **We talk about Quantum logic gate**



Quantum computer

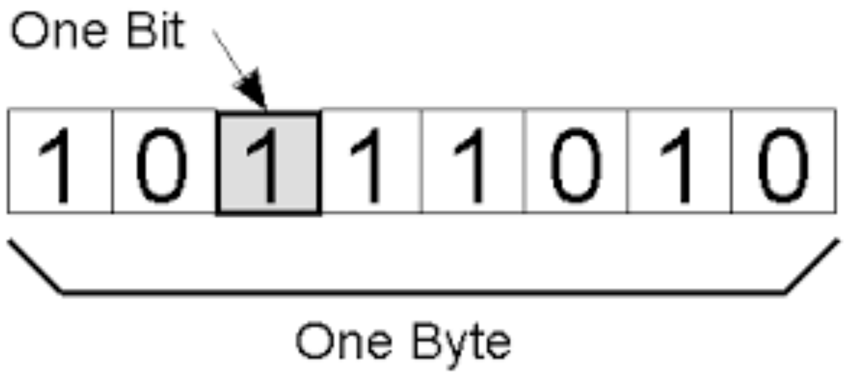


https://www.youtube.com/watch?v=-UlxHPIEVqA

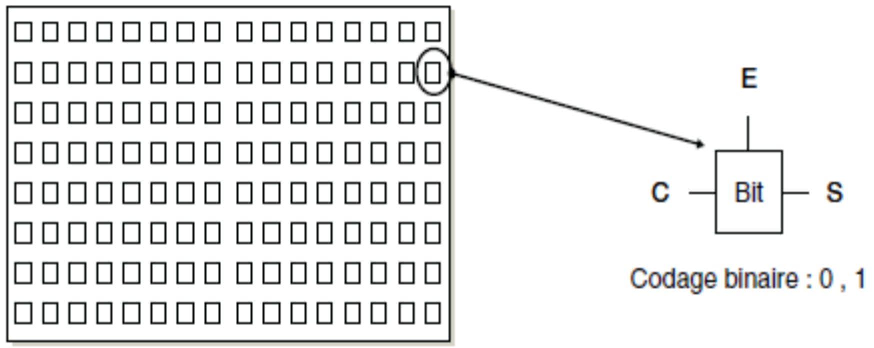


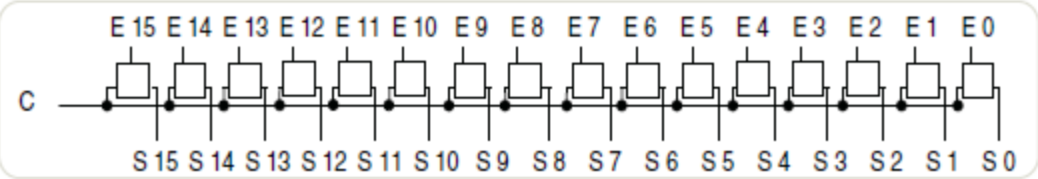
Memory

- **Main memory**
  - Provides the CPU with a working storage area for programs and data
  - Rapidly provides data and instructions to the CPU
- **Storage capacity**
  - Eight bits together form a byte (B)



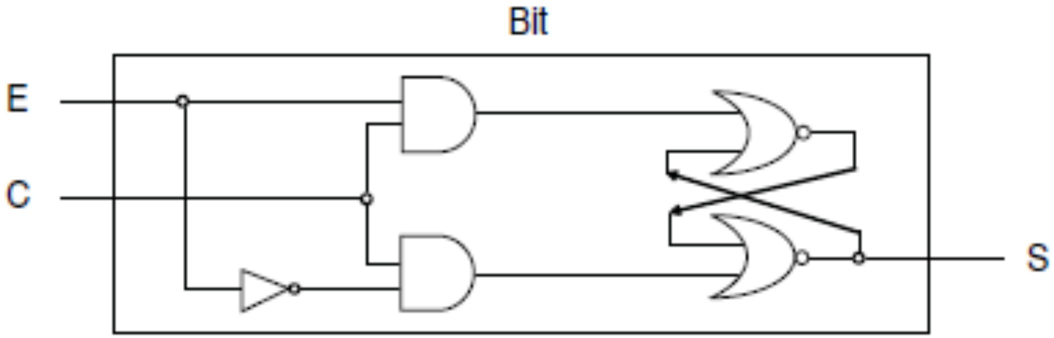
Memory


E
C
Bit
S
Codage binaire : 0 , 1


E 15 E 14 E 13 E 12 E 11 E 10 E 9 E 8 E 7 E 6 E 5 E 4 E 3 E 2 E 1 E 0
C
S 15 S 14 S 13 S 12 S 11 S 10 S 9 S 8 S 7 S 6 S 5 S 4 S 3 S 2 S 1 S 0

Flip-flop or Simple set-reset latch

- **Simple set-reset latches**



NOT

0	1
1	0

AND

0	0	0
0	1	0
1	0	0
1	1	1

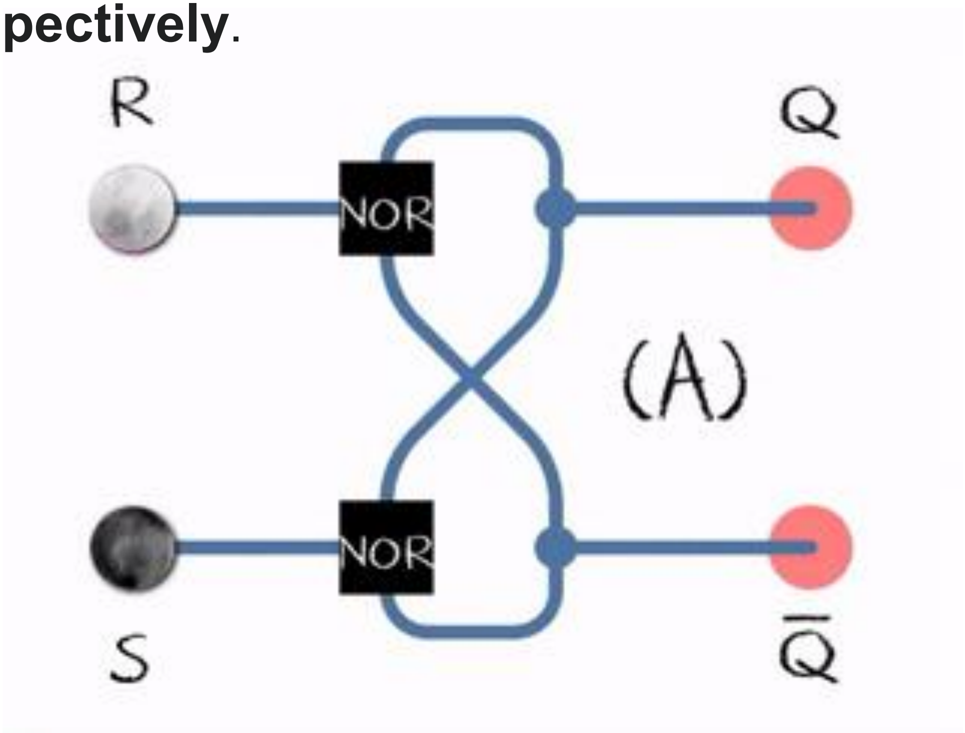
NOR

0	0	1
0	1	0
1	0	0
1	1	0

Set/Reset Latch (SR Bascule)

Black and white mean logical '1' and '0', respectively.

(A) S = 1, R = 0: set
(B) S = 0, R = 0: hold
(C) S = 0, R = 1: reset
(D) S = 1, R = 1: not allowed



Source : Marble machine

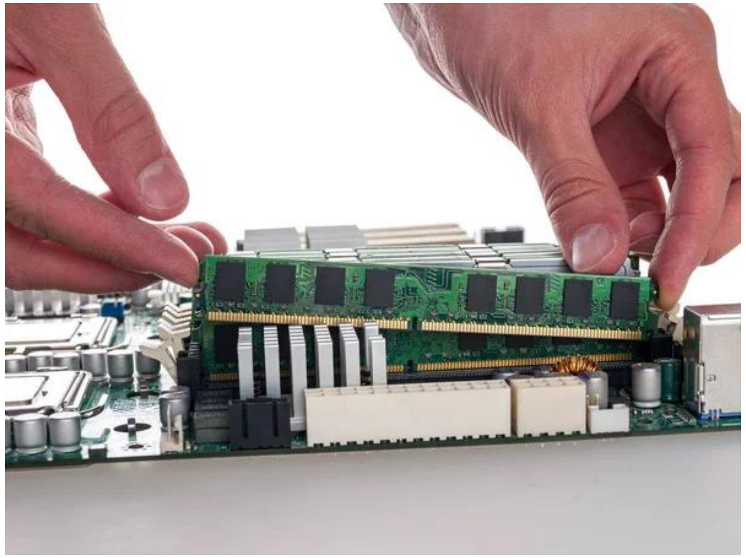
Memory units

Name	Abbreviation	Number of Bytes
Byte	B	1
Kilobyte	KB	1,000
Megabyte	MB	$1{,}000^2$
Gigabyte	GB	$1{,}000^3$
Terabyte	TB	$1{,}000^4$
Petabyte	PB	$1{,}000^5$
Exabyte	EB	$1{,}000^6$
Zettabyte	ZB	$1{,}000^7$
Yottabyte	YB	$1{,}000^8$

ROM

- Read Only Memory (ROM): Some applications need to be stored in a permanent way, even in the absence of electrical power, such as the computer boot program BIOS
- ROM is a type of non-volatile memory used in computers and other electronic devices.
- Data stored in ROM cannot be electronically modified after the manufacture of the memory device.
- Read-only memory is useful for storing software that is rarely changed during the life of the system, also known as firmware.

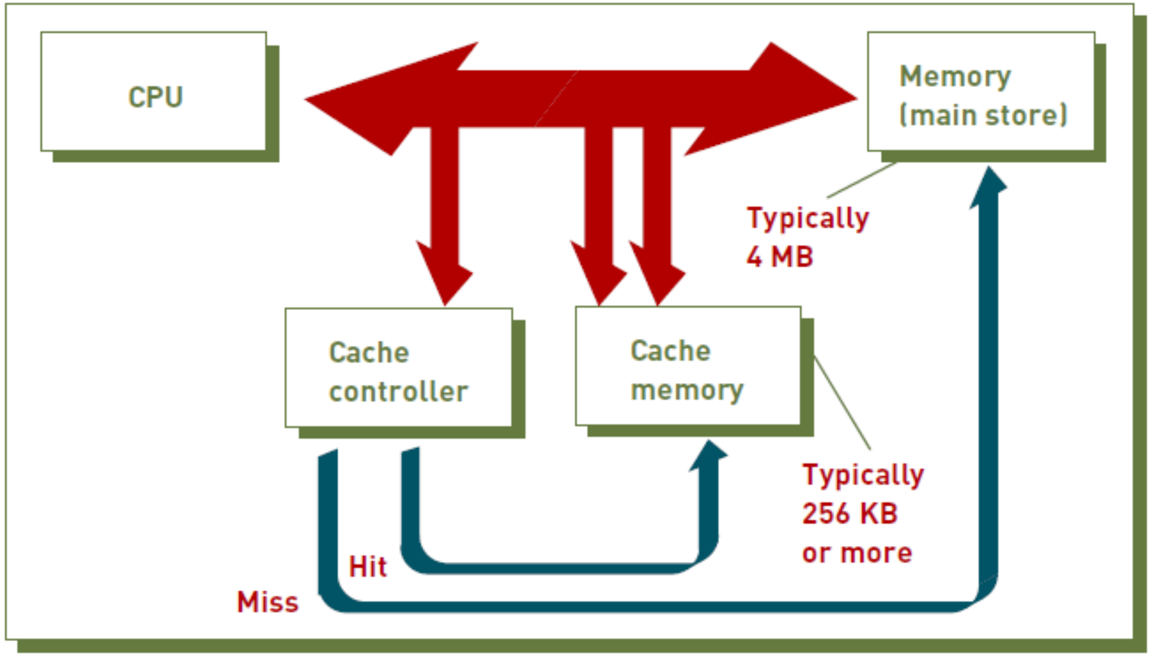
RAM



- **Random access memory (RAM):**
  - Temporary and volatile
- **Types of RAM:**
  - DRAM (Dynamic RAM)
  - DDR2 SDRAM and DDR3 SDRAM
  - Static Random Access Memory (SRAM)
  - Double Data Rate Synchronous Dynamic Random Access Memory (DDR SDRAM)

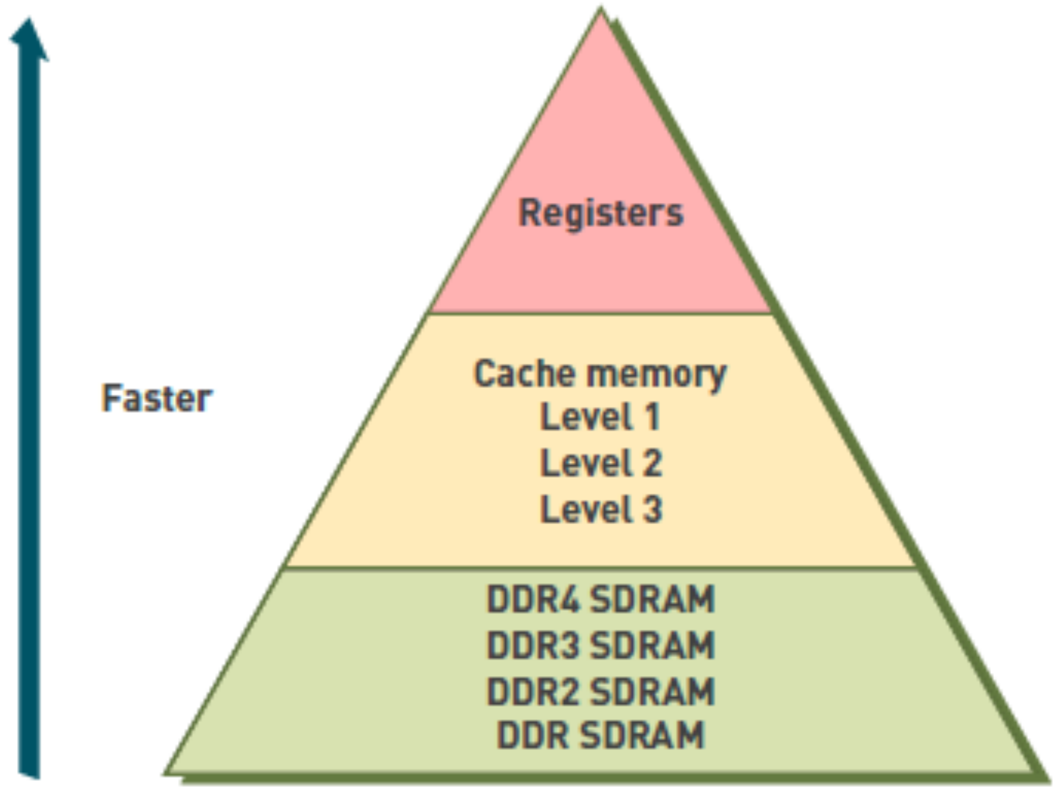
Cache

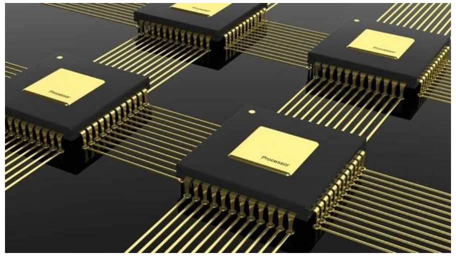
- Processors can access this type of high-speed memory faster than main memory
- Located on or near the CPU chip, cache memory works with main memory
- A cache controller determines how often the data is used, transfers frequently used data to cache memory, and then deletes the data when it goes out of use.



Principles & Architecture

Relative speed of various types of Memory





Multiprocessing

- **Multiprocessing**
  - Simultaneous execution of two or more instructions at the same time
- **Coprocessor**
  - Speeds processing by executing specific types of instructions while the CPU works on another processing activity
- **Multicore microprocessor**
  - Combines two or more independent processors into a single computer, thereby increasing the amount of processing that can be completed in a given amount of time.
- **Graphics processing unit (GPU)**
  - A specialized processor that offloads the tasks associated with 3D graphics rendering from the CPU
  - Can also be used in certain applications that require massive vector operations to provide performance several orders of magnitude higher than a traditional CPU

Parallel Computing

- **Parallel computing:**
  - Simultaneous execution of the same task on multiple processors to obtain results faster
- **Massively parallel processing:**
  - Links hundreds or thousands of processors to operate at the same time
- **Grid computing:**
  - Use of a collection of computers to work in a coordinated manner to solve a common problem

Principles & Architecture

Secondary storage

- Compared with memory, offers the advantages of non volatility, greater capacity, and greater economy
- On a cost-per-megabyte basis
  - Secondary storage is considerably less expensive than primary memory
- Determined by the information system's objectives:
  - The access methods, storage capacities, and portability required of secondary storage media

Access Methods

- **Sequential access:**
  - **Data must be retrieved in the order in which it is stored**
  - **Devices used called sequential access storage devices (SASDs)**
- **Direct access:**
  - **Records can be retrieved in any order**
  - **Devices used are called direct access storage devices (DASDs)**

Secondary storage devices

- **Magnetic tapes:**
  - Primarily for storing backups of critical organizational data
- **Magnetic disks:**
  - Direct-access storage device
- **Redundant array of independent/inexpensive disks (RAID):**
  - Method of storing data that generates extra bits of data from existing data, allowing the system to create a "reconstruction map" so that if a hard drive fails, it can rebuild lost data.
- **Optical secondary storage devices:**
  - Use special lasers to read and write data
  - Compact disc read-only memory (CD-ROM) Storage capacity is 740 MB
  - Digital video disc (DVD) looks like a CD but can store about 135 minutes of digital video data transfer rate is 1.352 MB per second

SSD

- **Solid state secondary storage devices:**
  - **Store data in memory chips rather than magnetic or optical media**
  - **Have few moving parts, so they are less fragile than hard disk drives**
- **Disadvantages of SSD**
  - **High cost per GB of data storage**
  - **Lower capacity compared to current hard drives**

Enterprise Storage Options

- **Attached storage**
  - **Methods include the tape, hard disks, and optical devices**
- **Network-attached storage (NAS)**
  - **Hard disk storage that is set up with its own network address rather than being attached to a computer**
- **Storage area network (SAN)**
  - **Special-purpose, high-speed network that provides direct connections among data-storage devices and computers**
- **Storage as a service:**
  - **A data storage model where a data storage service provider rents space to people and organizations (Amazon, EMC, Google, Microsoft…)**

Wooclap – Computers category

Single-user Computer Systems

- **Handheld computers:**
  - Single-user computers that provide ease of portability because of their small size
- **Laptop computer:**
  - Personal computer designed for use by mobile users
- **Notebook computer:**
  - Lightweight computer that weighs less than 5 pounds
- **Tablet computers:**
  - Portable, lightweight computers with no keyboard
- **Desktop computers:**
  - Single-user computer systems that are highly versatile
- **Thin client:**
  - Low-cost, centrally managed computer with no extra drives

Single-user Computer Systems

Multiple-User Computer Systems

- **Server**
  - Used by many users to perform a specific task, such as running network or Internet applications (Wintel or Unix)
- **Blade server**
  - Houses many computer motherboards
- **Mainframe computer:**
  - Large, powerful computer shared by dozens or even hundreds of concurrent users connected to the machine over a network
- **Supercomputers:**
  - The most powerful computers with the fastest processing speed and highest performance

Scalability is the ability to increase the processing capability of a computer system so that it can handle more users, more data, or more transactions

Principles & Architecture

Multiple-User Computer Systems

Green computing

- Green computing, Green IT or ICT Sustainability, is the study and practice of environmentally sustainable computing or IT.
- The goals of Green IT : reduce the use of hazardous materials, maximize energy efficiency during the product's lifetime, and promote the recyclability or biodegradability of defunct products and factory waste.
- The green IT or green computing, aims to reduce the carbon footprint generated by the Information Systems business while allowing them to save money.

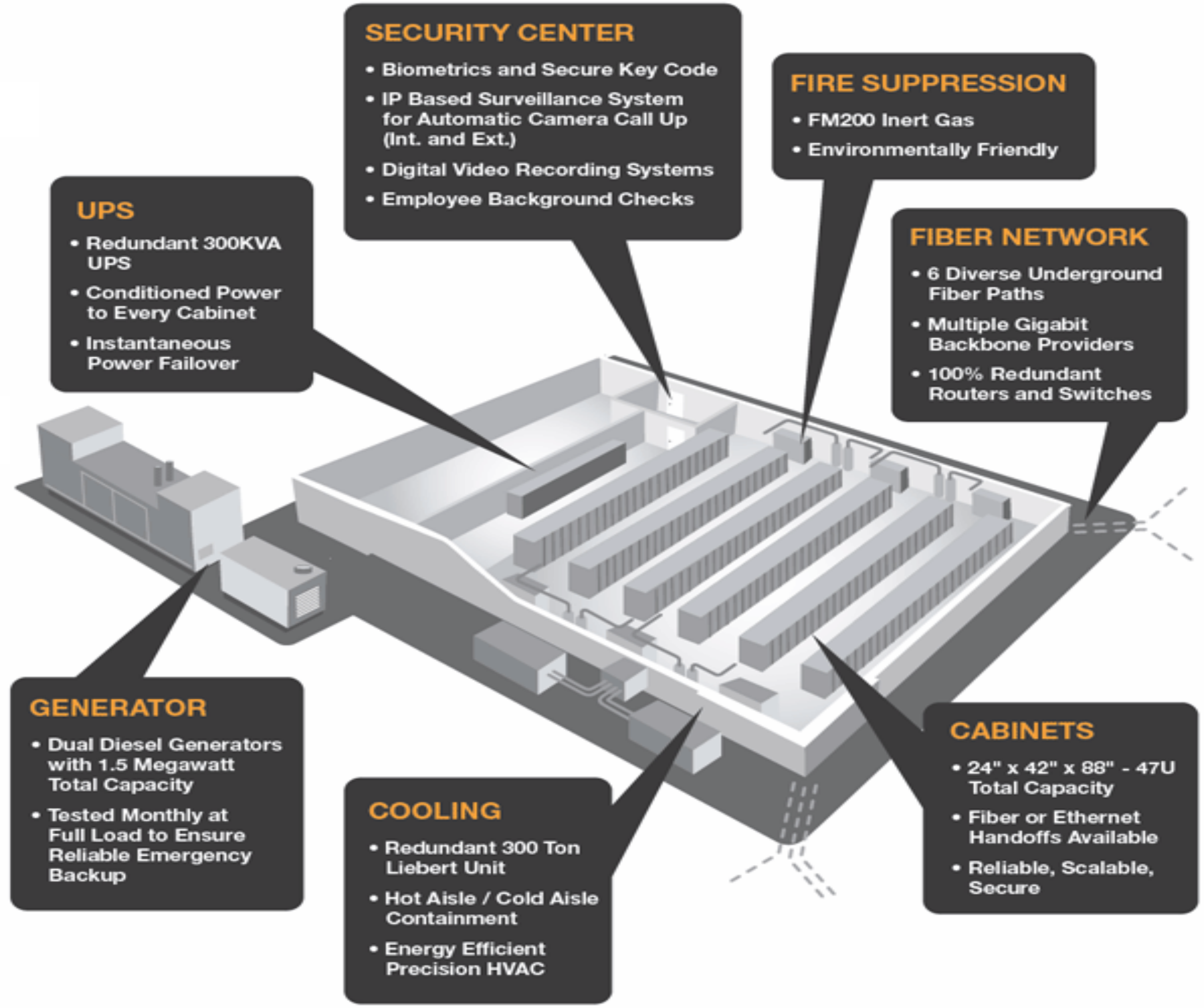
Wooclap : a simple survey

Green computing

- IT produces 4% of the world's CO2 emissions more than the airline industry
- A server has the same carbon footprint as an SUV
- IT worldwide uses 1500 TWh of electricity annually , it is about 10% of world electricity generation

Principles & Architecture

Visit a Data center



Principles & Architecture

EPITA Bachelor of Science

Principles and Architecture of Information Systems

Chapter #3

Software

Olivier BERTHET

Structure

- Chapter 1 : Introduction and Organisations
- Chapter 2 : Hardware
- Chapter 3 : Software
- Chapter 4 : Database Systems
- Chapter 5 : Network
- Chapter 6 : Internet and E-Commerce
- Chapter 7 : Major Information Systems
- Chapter 8 : Systems Development
- Chapter 9 : Security,Privaca and Ethical issues

Why Learn About Software?

- **Software is indispensable for any computer system and the people using it**
- **Applications software:**
  - **Key to helping you achieve your career goals and enrich your life**
  - **Stock trading, scientific, accounting, tax, etc.**

Wooclap : List several programming languages

Evolution of programming language

https://youtu.be/Og847HVwRSI

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Energy Efficiency across Programming Languages

Total

	Energy
(c) C	1.00
(c) Rust	1.03
(c) C++	1.34
(c) Ada	1.70
(v) Java	1.98
(c) Pascal	2.14
(c) Chapel	2.18
(v) Lisp	2.27
(c) Ocaml	2.40
(c) Fortran	2.52
(c) Swift	2.79
(c) Haskell	3.10
(v) C#	3.14
(c) Go	3.23
(i) Dart	3.83
(v) F#	4.13
(i) JavaScript	4.45
(v) Racket	7.91
(i) TypeScript	21.50
(i) Hack	24.02
(i) PHP	29.30
(v) Erlang	42.23
(i) Lua	45.98
(i) Jruby	46.54
(i) Ruby	69.91
(i) Python	75.88
(i) Perl	79.58

	Time
(c) C	1.00
(c) Rust	1.04
(c) C++	1.56
(c) Ada	1.85
(v) Java	1.89
(c) Chapel	2.14
(c) Go	2.83
(c) Pascal	3.02
(c) Ocaml	3.09
(v) C#	3.14
(v) Lisp	3.40
(c) Haskell	3.55
(c) Swift	4.20
(c) Fortran	4.20
(v) F#	6.30
(i) JavaScript	6.52
(i) Dart	6.67
(v) Racket	11.27
(i) Hack	26.99
(i) PHP	27.64
(v) Erlang	36.71
(i) Jruby	43.44
(i) TypeScript	46.20
(i) Ruby	59.34
(i) Perl	65.79
(i) Python	71.90
(i) Lua	82.91

	Mb
(c) Pascal	1.00
(c) Go	1.05
(c) C	1.17
(c) Fortran	1.24
(c) C++	1.34
(c) Ada	1.47
(c) Rust	1.54
(v) Lisp	1.92
(c) Haskell	2.45
(i) PHP	2.57
(c) Swift	2.71
(i) Python	2.80
(c) Ocaml	2.82
(v) C#	2.85
(i) Hack	3.34
(v) Racket	3.52
(i) Ruby	3.97
(c) Chapel	4.00
(v) F#	4.25
(i) JavaScript	4.59
(i) TypeScript	4.69
(v) Java	6.01
(i) Perl	6.62
(i) Lua	6.72
(v) Erlang	7.20
(i) Dart	8.64
(i) Jruby	19.84

Article here

Intermediate Quiz

- **Please enter your full name : first and last no nickname, no superman…**

- **WOOCLAP : GINREQ**

Principles

- Systems and application software are critical in helping individuals and organizations achieve their goals
- Organizations use off-the-shelf application software for common business needs and proprietary application software to meet unique business needs and provide a competitive advantage
- Organizations should choose programming languages with functional characteristics that are appropriate for the task at hand and well suited to the skills and experience of the programming staff
- The software industry continues to undergo constant change; users need to be aware of recent trends and issues to be effective in their business and personal life

An Overview of Software

- **Computer programs**
  - Sequences of instructions for the computer
- **Documentation**
  - Describes program functions to help the user operate the computer system
- **Types of software**
  - Systems software
  - Application software

Systems Software

- Set of programs that coordinates the activities and functions of hardware and other programs
- Types of systems software
  - Operating systems
  - Utility programs
  - Middleware

Application Software

- Helps users solve particular problems
- In most cases, resides on the computer’s hard disk
- Can be stored on CDs, DVDs, and even USB flash drives

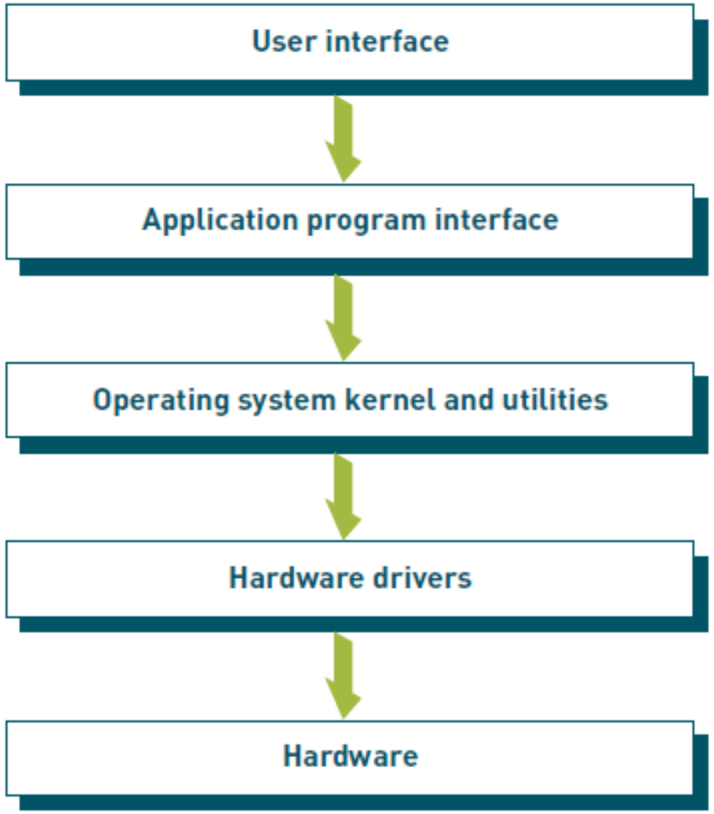
Principles & Architecture

Software supporting individuals, workgroups and enterprises

Software Type	Personal	Workgroup	Enterprise
Systems software	Smartphone, tablet, personal computer, and workstation operating systems	Network operating systems	Server and mainframe operating systems
Application software	Word-processing, spreadsheet, database, and graphics programs	Email, group-scheduling, shared-work, and collaboration applications	General-ledger, order-entry, payroll, and human-resources applications

Operating System

- Set of programs that controls computer hardware and acts as an interface with application programs
- Kernel:
  - Ties all components of the OS together and regulates other programs
- Combinations of OSs, computers, and users:
  - Single computer with a single user
  - Single computer with multiple simultaneous users
  - Multiple computers with multiple users
  - Special-purpose computers



Principles & Architecture

Activities performed by the operating system

- Perform common computer hardware functions
- Provide a user interface and input/output management
- Provide a degree of hardware independence
- Manage system memory
- Manage processing tasks
- Provide networking capability
- Control access to system resources
- Manage files
- Get input from keyboard or another input device
- Retrieve data from disks
- Store data on disks
- Display information on a monitor or printer

Principles & Architecture

Operating systems by sphere of influence

Personal	Workgroup	Enterprise
Microsoft Windows	Microsoft Windows Server	Microsoft Windows Server
Mac OS X, iOS	Mac OS X Server	
Linux	Linux	Linux
Google Android, Chrome OS	UNIX	UNIX
HP webOS	IBM i and z/OS	IBM i and z/OS
	HP-UX	HP-UX

History of Microsoft Windows

Year	Version	Highlights
1985	Windows 1.0	Ran as a graphical, 16-bit multitasking shell on top of an existing MS-DOS installation, providing an environment that could run graphical programs designed for Windows as well as existing MS-DOS software
1987	Windows 2.0	Introduced more sophisticated keyboard shortcuts as well as the ability to minimize and maximize Windows
1988	Windows 2.03	Allowed application Windows to overlap each other
1990	Windows 3.0	Introduced a multitasking capability with a protected/enhanced mode, which allowed Windows applications to use more memory; first widely successful version of Windows
1992	Windows 3.1	Introduced improved system stability and expanded support for multimedia, TrueType fonts, and workgroup networking
1995	Windows 95	Introduced numerous important features and functions, such as the taskbar, the Start button, and a new approach to user navigation; moved from a 16-bit architecture to a 32-bit architecture
1998	Windows 98	Introduced many features, such as the Quick Launch toolbar, the Active Desktop, single-click launching, Back and Forward navigation buttons, favorites, and the address bar in Windows Explorer, and image thumbnails; heavily criticized operating system, with major compatibility issues
1999	Windows 98 Second Edition	Included fixes for many Windows 98 problems and replaced Internet Explorer 4.0 with Internet Explorer 5.0; improved audio, modem, and USB support

History of Microsoft Windows

Year	Version	Highlights
2000	Windows 2000	An operating system for use on both client and server computers; marketed as the most secure Windows version ever, but it became the target of a number of high-profile virus attacks, such as Code Red and Nimda
2000	Windows ME	Rated Microsoft's worst OS by many industry observers; exhibited stability and compatibility issues; included Internet Explorer 5.5, Windows Media Player 7, and Windows Movie Maker software, which provided basic video editing functions that were designed to be easy for consumers to use
2001	Windows XP	Offered a major advance from the MS-DOS–based versions of Windows in terms of security, stability, and efficiency; introduced a significantly redesigned graphical user interface
2007	Windows Vista	Focused primarily on improving security; offered an updated graphical user interface and visual style dubbed "Aero" and a new search component called Windows Search; provided redesigned networking, audio, print, and display subsystems, as well as new multimedia capabilities, including Windows DVD Maker
2009	Windows 7	Provided an incremental upgrade to the operating system; intended to address Windows Vista's performance issues, while maintaining hardware and software compatibility; provided support for touch displays and 64-bit processors
2012	Windows 8	Introduced major changes to the operating system's platform and user interface to improve user experience on tablets; included a touch-optimized Windows shell, a Start screen that displays programs and dynamically updated content on a grid of tiles, the ability to sync apps and settings between devices, and the Windows Store for downloading and purchasing new software

History of Microsoft Windows

Year	Version	Highlights
2013	Windows 8.1	Included an improved Start screen, additional bundled apps, tighter OneDrive integration, Internet Explorer 11, a Bing-powered unified search system, and restoration of a visible Start button on the taskbar
2015	Windows 10	Brought back the familiar Start menu and desktop; introduced the Edge browser and the Cortana assistant, which responds to natural language and can perform a variety of organizational tasks for the end user, including setting reminders, scheduling calendar events, calculating math problems, and converting measurements and money

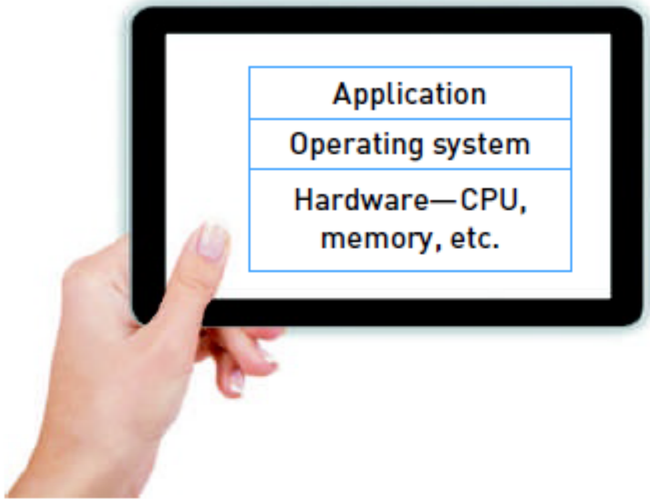
Principles & Architecture

User interface and input/output management

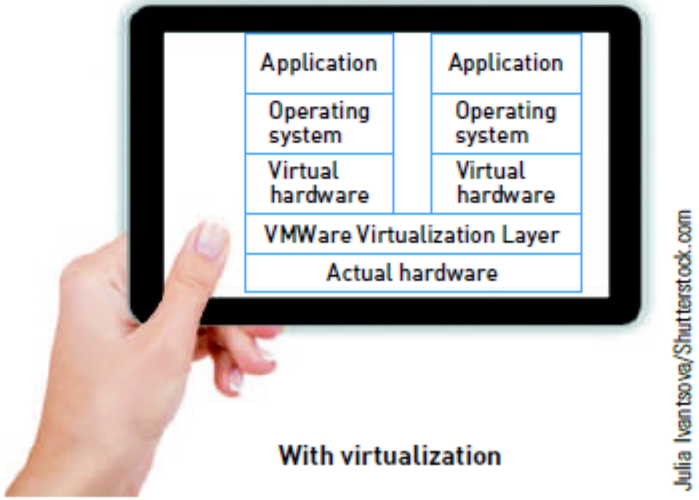
- **User interface:**
  - Allows individuals to access and command the computer system
- **Command-based user interface:**
  - Requires that text commands be given to the computer to perform basic activities
- **Graphical user interface (GUI):**
  - Uses icons and menus displayed on screen to send commands to the computer system
- **Networking capability:**
  - Allows computers in a network to send and receive data and share computing resources
- **Access to system resources and security:**
  - Protection against unauthorized access
  - OS establishes a logon procedure
- **File management:**
  - Ensures that files in secondary storage are available when needed and that they are protected from access by unauthorized users

Virtualization

- Virtual servers that separate a physical computing device into one or more “virtual” servers, each of which can be easily used and managed to perform computing tasks.



Without virtualization



With virtualization

Utility Programs

- **Help to perform maintenance or correct problems with a computer system**
- **Common types of utilities:**
  - **Hardware utilities**
  - **Security utilities**
  - **File-compression utilities**
  - **Spam-filtering utilities**
  - **Network and Internet utilities**
  - **Server and mainframe utilities**

Other Utilities

- Key logging software allows a manager to see every keystroke a worker makes on a computer system
- Monitoring software can catalog the Internet sites that employees visit
- Keyboard shortcut utilities allow users to map common tasks to defined keyboard combinations

Examples of Utility Programs

Personal	Workgroup	Enterprise
Software to compress data so that it takes less hard disk space	Software to provide detailed reports of work-group computer activity and status of user accounts	Software to archive contents of a database by copying data from disk to tape
Screen saver	Software that manages an uninterruptible power supply to do a controlled shutdown of the workgroup computer in the event of a loss of power	Software that compares the content of one file with another and identifies any differences
Antivirus and antispyware software	Software that reports unsuccessful user logon attempts	Software that reports the status of a particular computer job

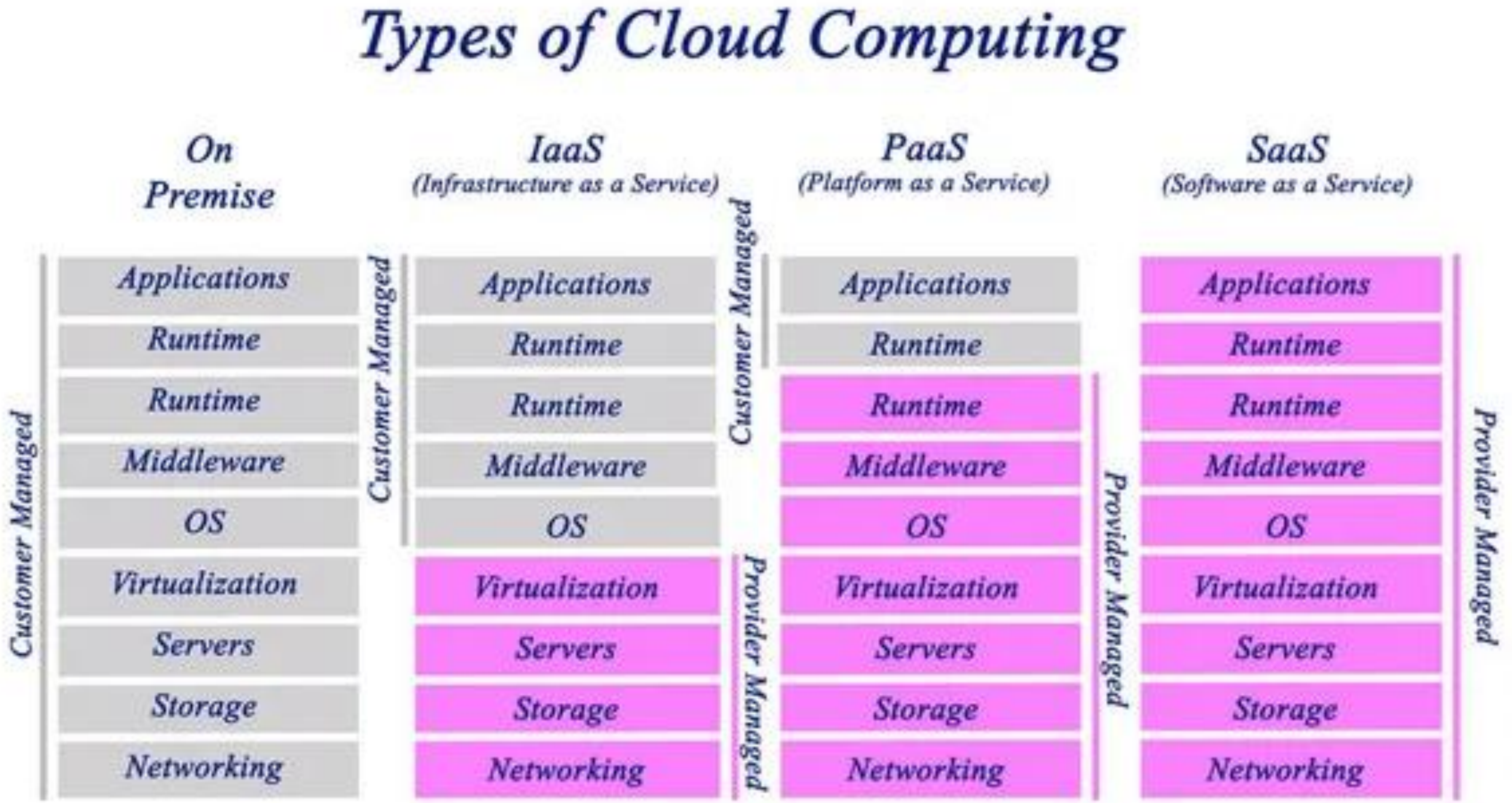
Principles & Architecture

One example PRTG Network monitoring

Middleware

- **Software that allows different systems to communicate and exchange data**
- **This systematic tying together of disparate applications, often through the use of middleware, is known as enterprise application integration (EAI).**
- **Can also be used as an interface between the Internet and older legacy systems**
- **Service-oriented architecture (SOA)**
  - **Uses modular application services to allow users to interact with systems, and systems to interact with each other**

Principles & Architecture



Principles & Architecture

Application software

- The primary function of application software is to apply the power of a computer system to enable people, workgroups, and entire enterprises to solve problems and perform specific tasks.
- Millions of software applications have been created to perform a variety of functions on a wide range of operating systems and device types

Business	Genealogy	Personal information manager
Communications	Language	Photography
Computer-aided design	Legal	Science
Desktop publishing	Library	Simulation
Educational	Multimedia	Video
Entertainment	Music	Video games

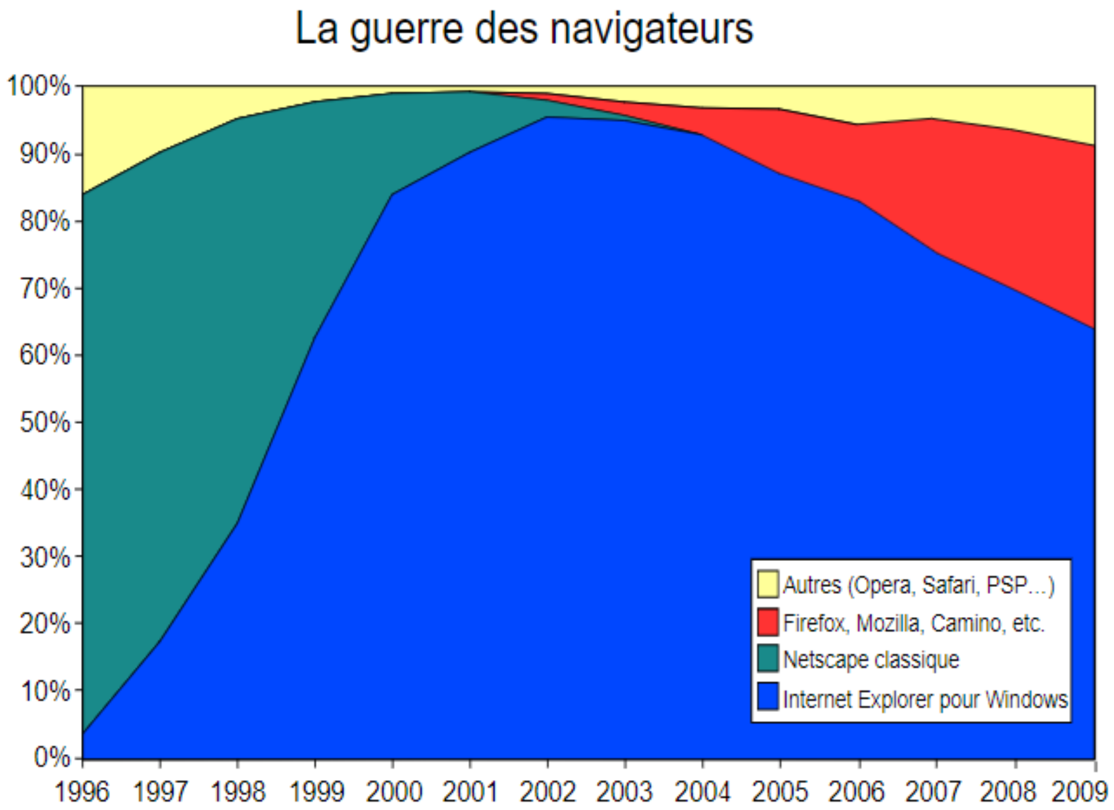
Wooclap ETFIAT : List several Web navigators

Principles & Architecture

One example : Web browser

You have the choice !

One has disappeared



Overview of Application software

- **Proprietary software:**
  - One-of-a-kind program for a specific application, usually developed and owned by a single company
- **Off-the-shelf software:**
  - Existing software program that is purchased
- **Application service provider (ASP):**
  - Company that can provide software, support, and computer hardware on which to run the software from the user's facilities over a network

Proprietary versus Off-the-shelf

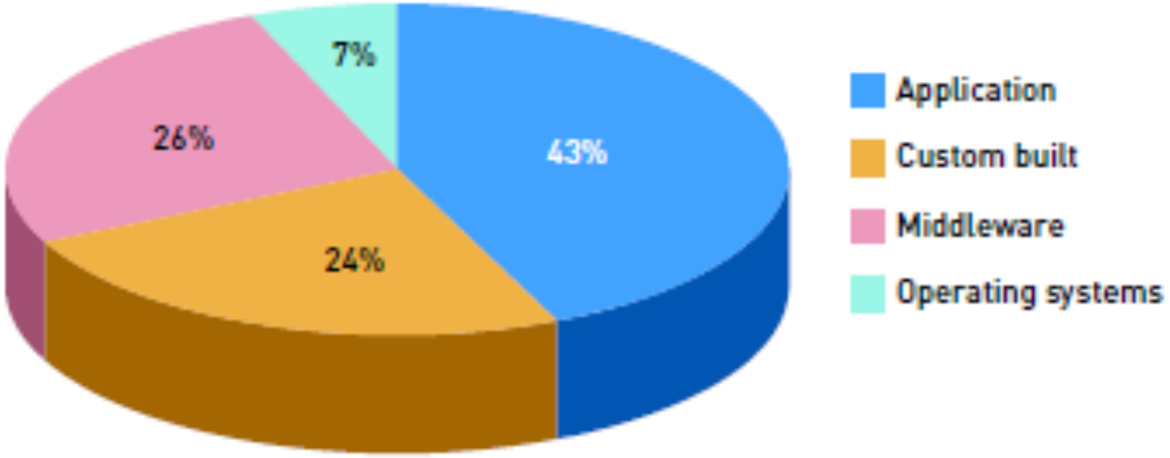
Proprietary Software		Off-the-Shelf Software	
Advantages	**Disadvantages**	**Advantages**	**Disadvantages**
You can get exactly what you need in terms of features, reports, and so on.	It can take a long time and a significant amount of resources to develop required features.	The initial cost is lower because the software firm can spread the development costs across many customers.	An organization might have to pay for features that it does not require and never uses.
Being involved in the development offers more control over the results.	In-house system development staff may be hard-pressed to provide the required level of ongoing support and maintenance because of pressure to move on to other new projects.	The software is likely to meet the basic business needs. Users have the opportunity to more fully analyze existing features and the performance of the package before purchasing.	The software might lack important features, thus requiring future modification or customization, which can be very expensive, and because users will eventually be required to adopt future releases of the software, the customization work might need to be repeated.
You can more easily modify the software and add features that you might need to counteract an initiative by competitors or to meet new supplier or customer demands.	The features and performance of the delivered software may fail to meet evolving business and end user needs.	The software is likely to be of high quality because many customer firms have tested the software and helped identify its bugs.	The software might not match current work processes and data standards.

Personal Application software

Type of Software	Use	Example
Word processing	Create, edit, and print text documents	Apache OpenOffice Writer Apple Pages Corel Write Google Docs Microsoft Word WordPerfect
Spreadsheet	Perform statistical, financial, logical, database, graphics, and date and time calculations using a wide range of built-in functions	Apache OpenOffice Calc Apple Numbers Google Sheets IBM Lotus 1-2-3 Microsoft Excel
Database	Store, manipulate, and retrieve data	Apache OpenOffice Base Microsoft Access IBM Lotus Approach
Graphics	Develop graphs, illustrations, drawings, and presentations	Adobe FreeHand Adobe Illustrator Apache OpenOffice Impress Microsoft PowerPoint
Personal information management	Helps people, groups, and organizations store useful information, such as a list of tasks to complete or a set of names and addresses	Google Calendar Microsoft Calendar Microsoft Outlook One Note
Project management	Plan, schedule, allocate, and control people and resources (money, time, and technology) needed to complete a project according to schedule	Microsoft Project Scitor Project Scheduler

Enterprise Application software

- **Worldwide spending on enterprise software was estimated to be about $310 billions in 2015. Most software spending goes to application software.**



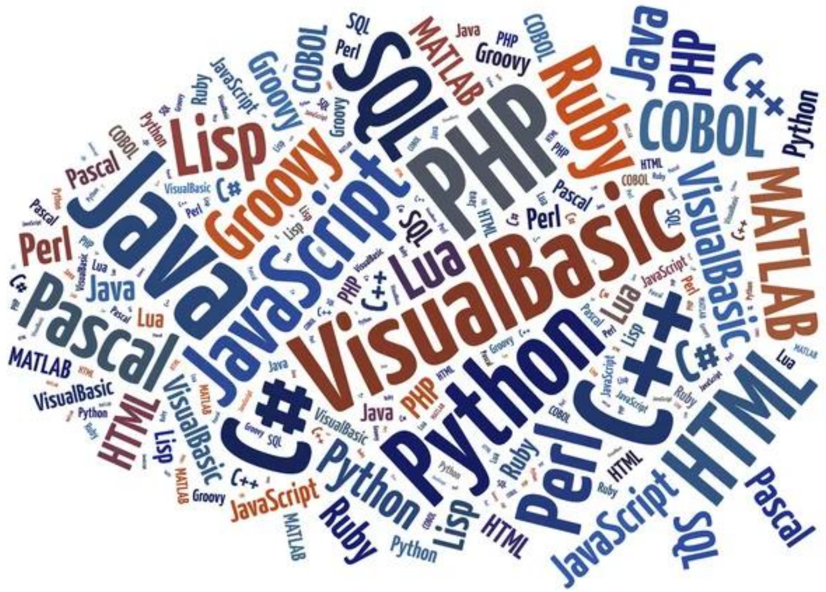
Principles & Architecture

Programming languages

- The primary function of a programming language is to provide instructions to the computer system so that it can perform a processing activity.
- Information systems professionals work with different programming languages, which are sets of keywords, commands, symbols and rules for constructing statements that people can use to communicate instructions to a computer.
- Programming involves translating what a user wants to accomplish into a code that the computer can understand and execute

Why so many programming languages ?

- The wide range of computational needs has prompted the creation of hundreds of programming languages.
- Different classes of problems may demand different levels of abstraction, and different programmers have different ideas on how abstraction should be done
- Language influences perception and perception creates new language
- New languages have in turn introduced new way of thinking about programming & improved upon old ones



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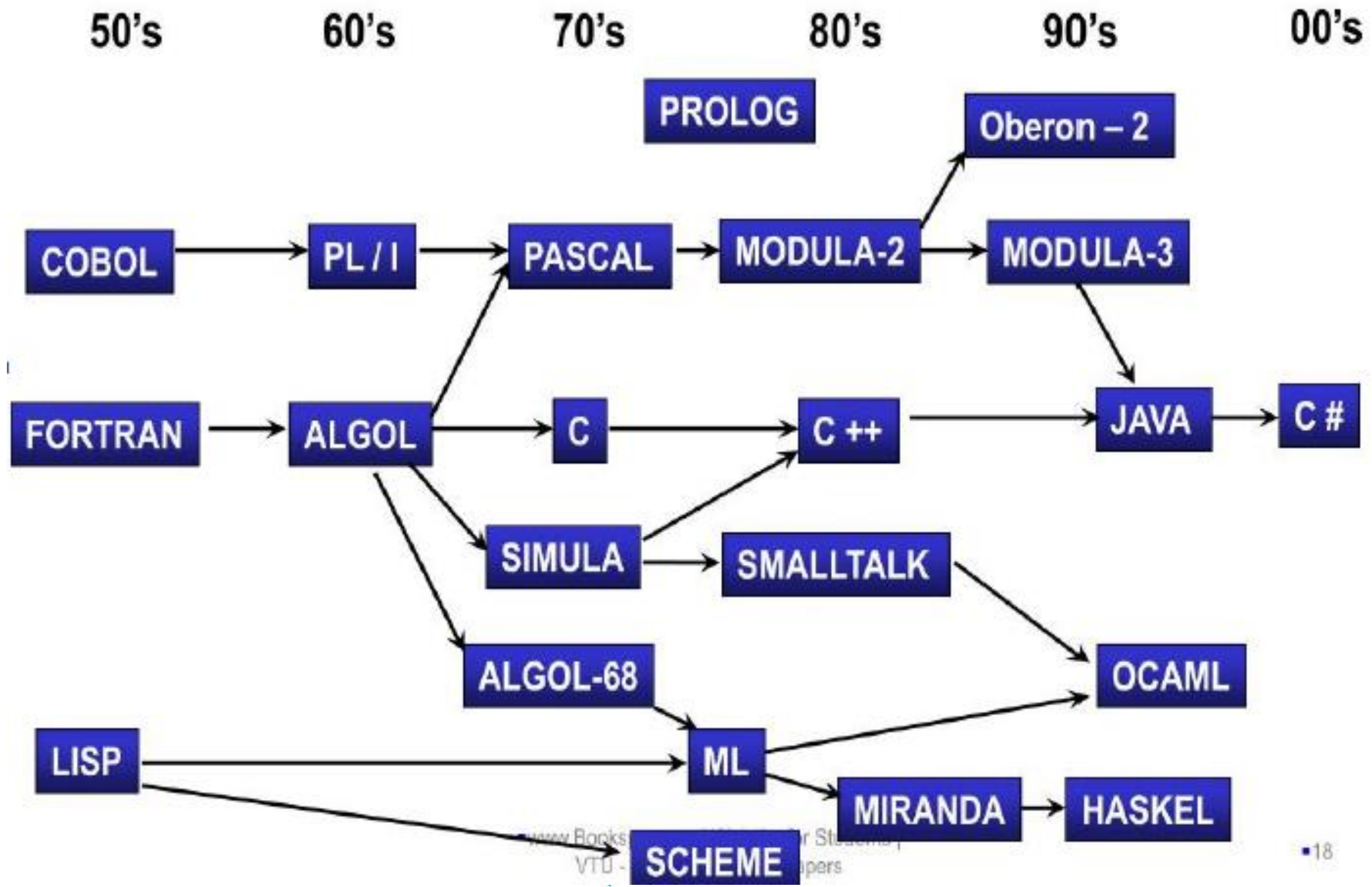
Evolution of Programming Languages



IBM APL

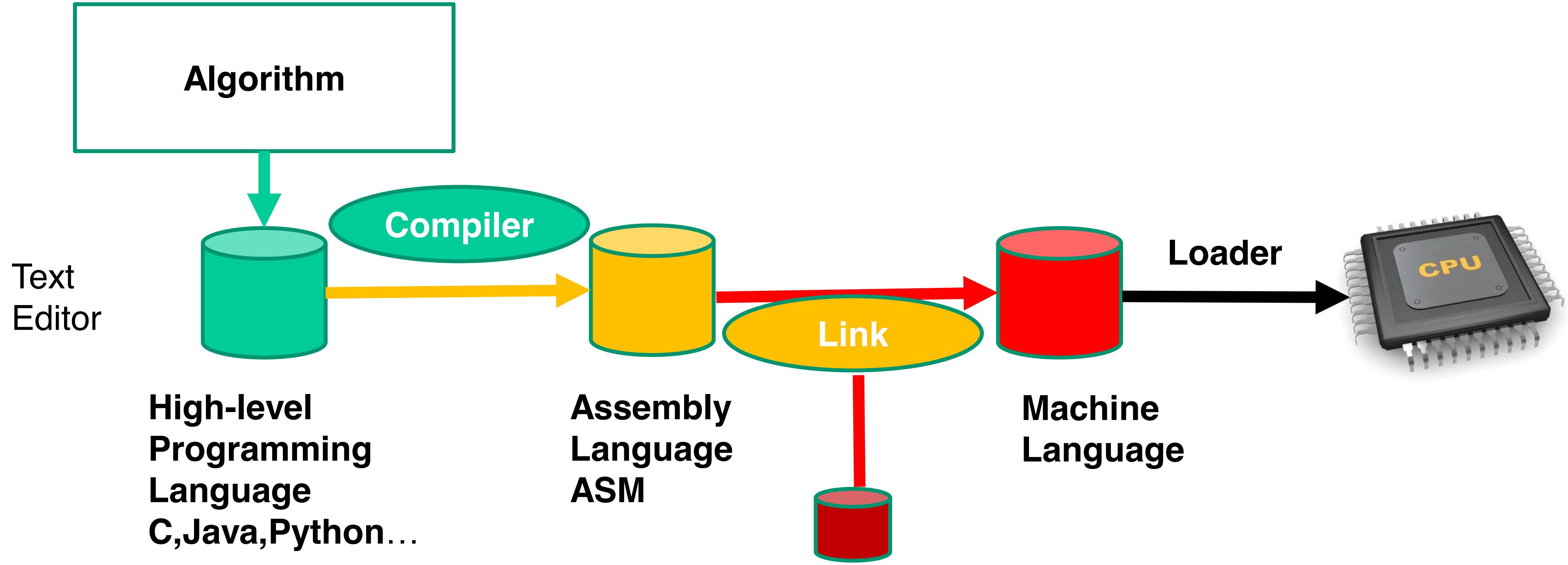
```
      ∇DET[⎕]∇
    ∇ Z←DET A;B;P;I
[1]   I←⎕IO
[2]   Z←1
[3]  L:P←(|A[;I])⍳⌈/|A[;I]
[4]   →(P=I)/LL
[5]   A[I,P;]←A[P,I;]
[6]   Z←-Z
[7]  LL:Z←Z×B←A[I;I]
[8]   →(0 1 ∨.=Z,1↑⍴A)/0
[9]   A←1 1 ↓A-(A[;I]÷B)∘.×A[I;]
[10]  →L
[11] ⍝EVALUATES A DETERMINANT
    ∇
```

Three levels of languages

- **High level programming language**
  - **the level of programming the more used today. It is a level of programming independent of the physical structure of the machine with syntax and grammar**
- **Assembly language**
  - **Assembly language or ASM is any low-level programming language with a very strong correspondence between the instructions in the language and the architecture's machine code instructions. It corresponds to a symbolic form of the machine language associated with the processor**
- **Machine language**
  - **machine language is a compound language on a binary alphabet. It is the only language executable directly by the processor.**

Principles & Architecture

Production of programs

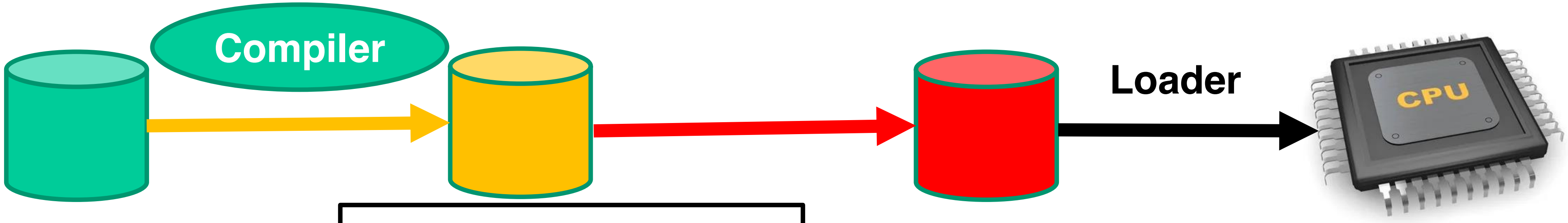


Principles & Architecture

One example

```
function perimeter (a, b : in integer) return integer is
begin
perimetre=(2*a)+(2*b);
end;
```

Text
Editor




```
perimeter : pop Rg1 R1
pop Rg1 R2
mul Im R1 2
mul Im R2 2
add Rg2 R1 R2
push Rg1 R1
ret
```

```
0110111011110011
01111010001011100
1011110111011111
0011101110111011
0011111000111101
```

What do Compilers do ?

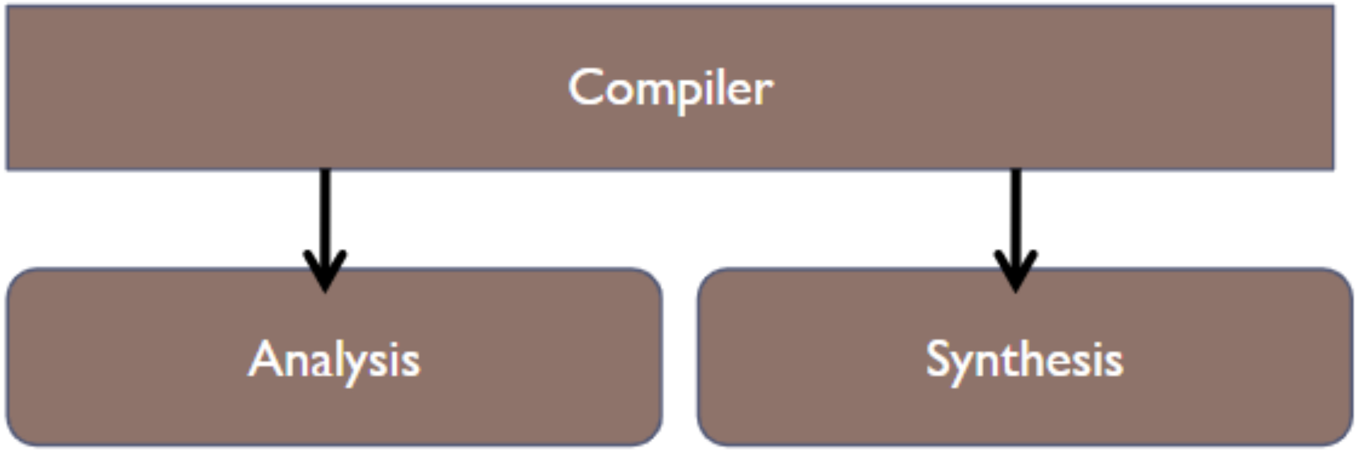
- **A compiler acts as a translator transforming human-oriented programming languages into computer-oriented machine languages**
- **Converts the programmer's source code into machine-language instructions**
- **Ignore machine dependent details for programmer**
- **The compiler is an application**

Phases of a compiler

- **Lexical analysis (recognition of the words of the language, i.e. apprehension of the vocabulary)**
- **Parsing (syntax checking , i.e. understanding grammar)**
- **Semantic analysis (verification of semantics, i.e. apprehension of the meaning)**
- **Code optimization and generation object**

Phases of a compiler

- Any compiler must perform two major tasks



  - *Analysis* of the source program
  - *Synthesis* of a machine-language program

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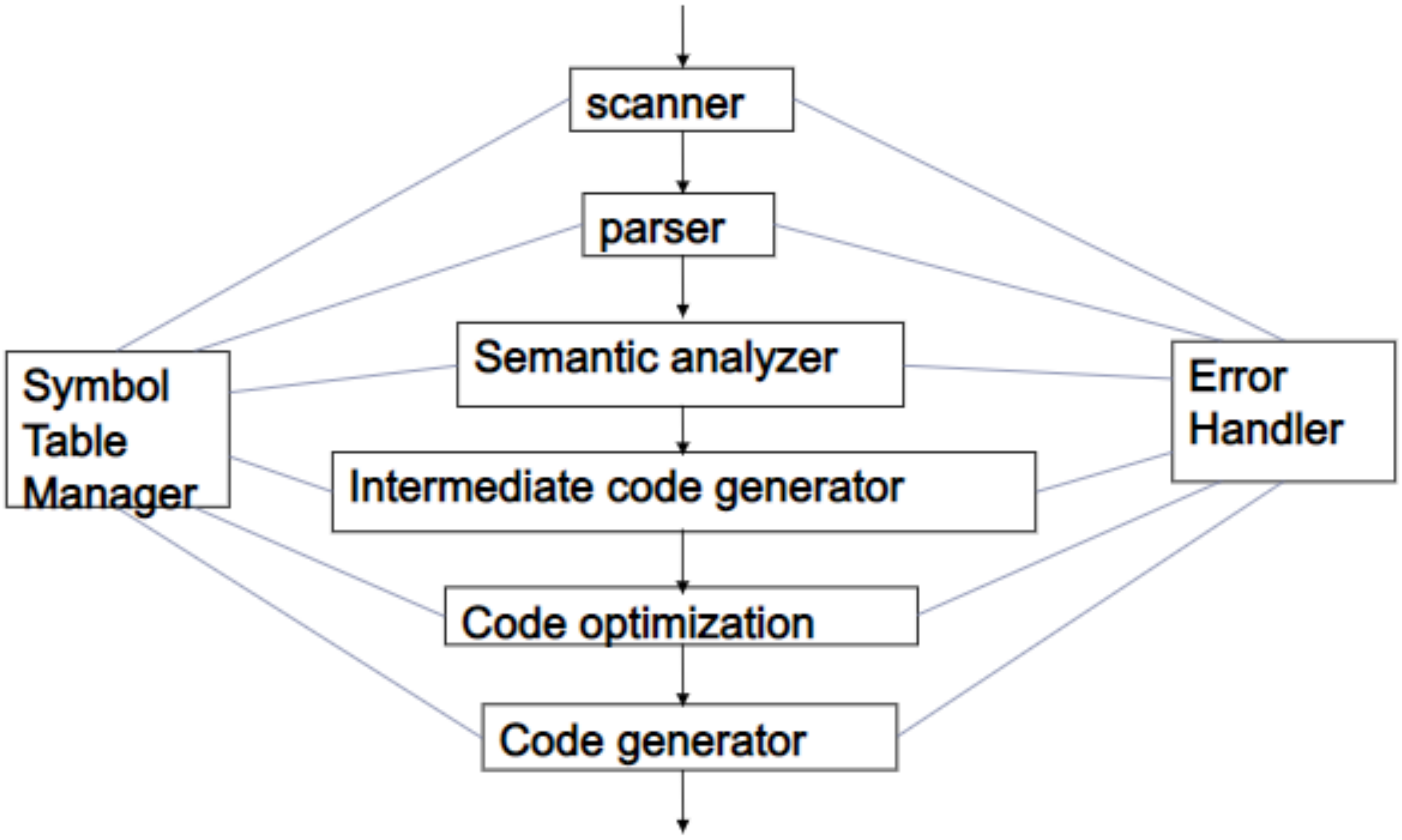
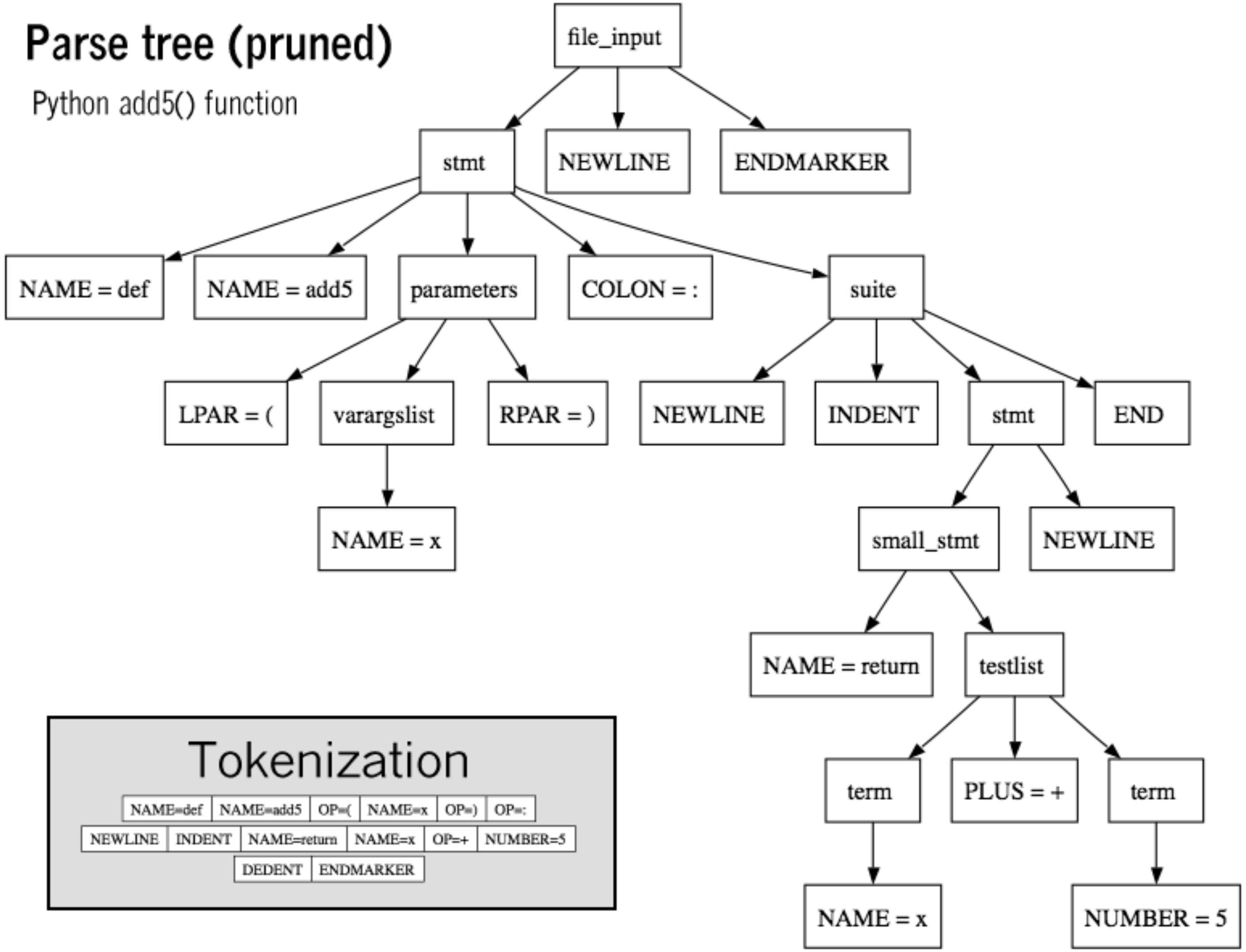
Process of a compiler

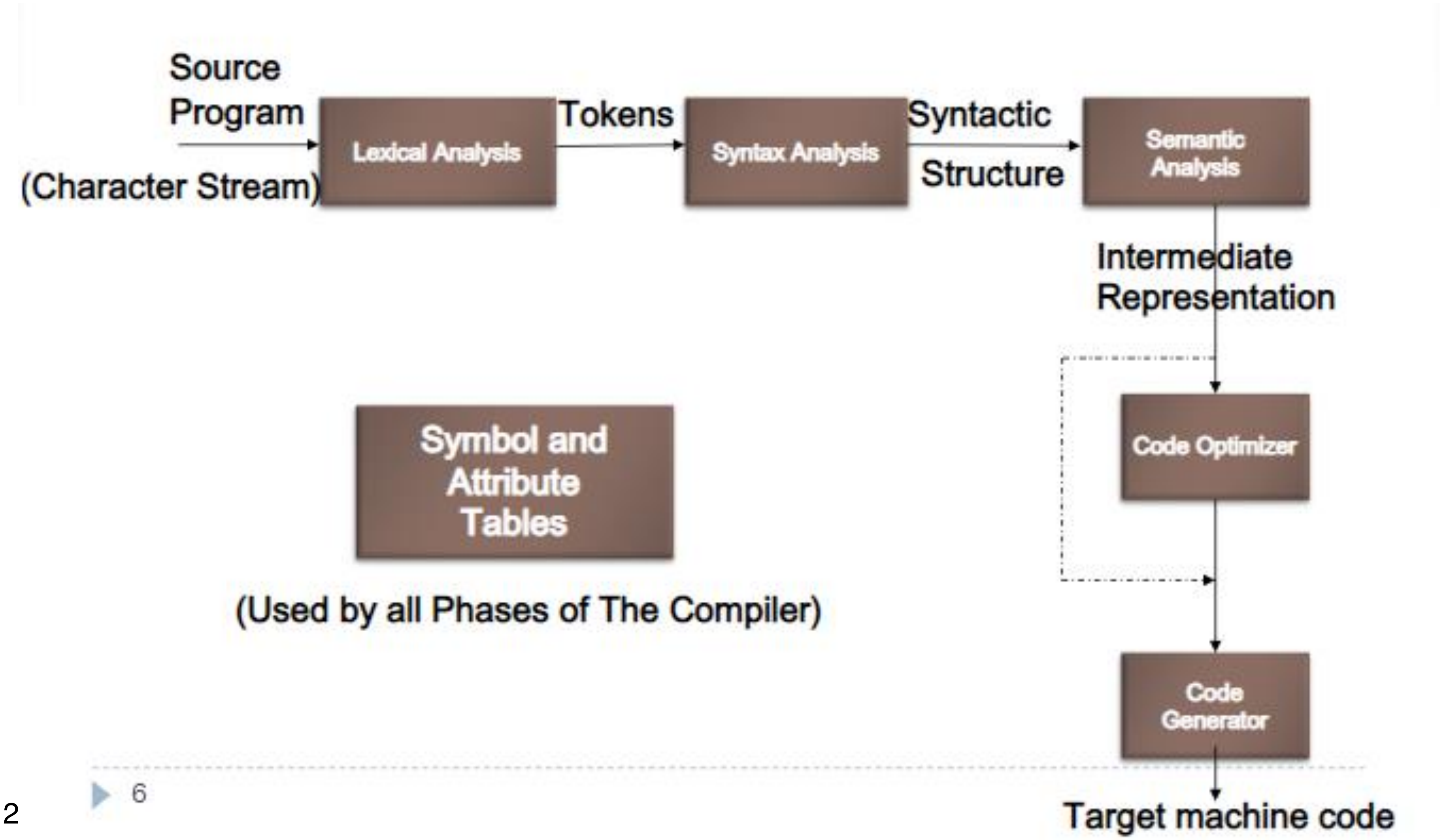


Example of a parser



Principles & Architecture

Phases of a compiler



Interpreter , AOT versus JIT compiler

- **AOT**
  - When all the code is transformed at one time before it reaches the platforms that run it, the process is called ahead-of-time (AOT) compilation.
- **Interpreter**
  - Interpreted code executes instructions in a program without compiling them into machine language.
  - The interpreted code parses the source code directly, is paired with a virtual machine that translates the code for the machine at the time of execution, or takes advantage of precompiled code.
  - Javascript is usually interpreted.

Interpreter , AOT versus JIT compiler

- **JIT**
  - **Just-in-time compilers are a combination of AOT compilers and interpreters.**
  - **Java and C# use just-in-time compilers.**
  - **After a Java program is written, the JIT compiler turns the code into bytecode rather than into code that contains instructions for a specific hardware platform's processor.**
  - **The bytecode is platform independent and can be sent and run on any platform that supports Java. In a sense, the program is compiled in a two-stage process.**

Pros and Cons of AOT and JIT Compilation

- **Ahead-of-time (AOT) compilation delivers faster startup time, particularly when much of the code executes at startup. However, it requires more memory and more disk space.**

- **Just-in-time (JIT) compilation profiles the target platform while it runs and re-compiles on the fly to deliver improved performance. JIT generates improved code because it targets the current platform, although it usually takes more time to run than AOT compiled code.**

Same program in different languages

- **A loop counting downward from 10 to 1**

```
#include <stdio.h>
main() {
 int k;
 for (k=10; k>=1; k--) {
  printf("%d\n",k);
 }
}
```

C

Same program in different languages

- **A loop counting downward from 10 to 1**

```
using namespace std;
#include <iostream>
main() {
 int k;
 for (k=10; k>=1; k--) {
  cout << k << endl;
 }
}
```

C++

Same program in different languages

- **A loop counting downward from 10 to 1**

```
public class revl {
 public static void main(String []
args) {
  int k;
  for (k=10; k>=1; k--) {
   System.out.println(k);
  }
 }
```

Java

Same program in different languages

- **A loop counting downward from 10 to 1**

```
<?php
for ($k=10; $k>=1; $k--) {
 print ("$k\n");
 }
?>
```

PHP

for k in range(10,0,-1):
 print k

Same program in different languages

- **A loop counting downward from 10 to 1**

```
for k in range(10,0,-1):
 print k
```

Python

Another Example

- https://www.geeksforgeeks.org/hello-world-in-30-different-languages/

Software issues and trends

- **Software bug:**
  - Defect in a program that keeps it from performing as it should
- **Some tips for reducing impact of software bugs:**
  - Register all software
  - Check read-me files for workarounds
  - Access support area of the manufacturer's Web site for patches
  - Install latest software updates

Copyrights and Licenses

- **Most software products are protected by law using copyright or licensing provisions:**
  - In some cases, you are given unlimited use of software on one or two computers
  - In other cases, you pay for your usage; if you use the software more, you pay more
- **Some software now requires that you register or activate it before it can be fully used**

Copyrights and Licenses

License	Description
Single-user license	Permits you to install the software on one computer, or sometimes two computers, used by one person.
Multiuser license	Specifies the number of users allowed to use the software, and can be installed on each user's computer. For example, a 20-user license can be installed on 20 computers for 20 users.
Concurrent-user license	Designed for network-distributed software, this license allows any number of users to use the software, but only a specific number of users to use it at the same time.
Site license	Permits the software to be used anywhere on a particular site, such as a college campus, by everyone on the site.

Freeware and Open-Source Software

- **Freeware**
  - Software that is made available to the public for free
- **Open-source software**
  - Distributed, typically for free, with the source code
- **General Public License GPL grants you the right to**
  - Run the program for any purpose
  - Study how the program works and adapt it to your needs
  - Redistribute copies so you can help others
  - Improve the program and release improvements to the public

Principles & Architecture

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Principles and Architecture of Information Systems

Chapter #4

Database Systems

Olivier BERTHET

Evaluation

Description	Percentage	Marks
Participation	20.0	4.0
Exercise and Wooclaps	30.0	6.0
Quiz	30.0	6.0
Case study	20.0	4.0

Principles & Architecture

Structure

- Chapter 1 : Introduction and Organisations
- Chapter 2 : Hardware
- Chapter 3 : Software
- Chapter 4 : Database Systems
- Chapter 5 : Network
- Chapter 6 : Internet and E-Commerce
- Chapter 7 : Major Information Systems
- Chapter 8 : Systems Development
- Chapter 9 : Security,Privaca and Ethical issues

Principles

- Data management and modeling are key aspects of organizing data and information.
- A well-designed and well-managed database is an extremely valuable tool in supporting decision making.
- The number and types of database applications will continue to evolve and yield real business benefits.

Principles & Architecture

Data Management

- **Without data and the ability to process it:**
  - **An organization could not successfully complete most business activities**
- **Data consists of raw facts**
- **To transform data into useful information:**
  - **It must first be organized in a meaningful way**

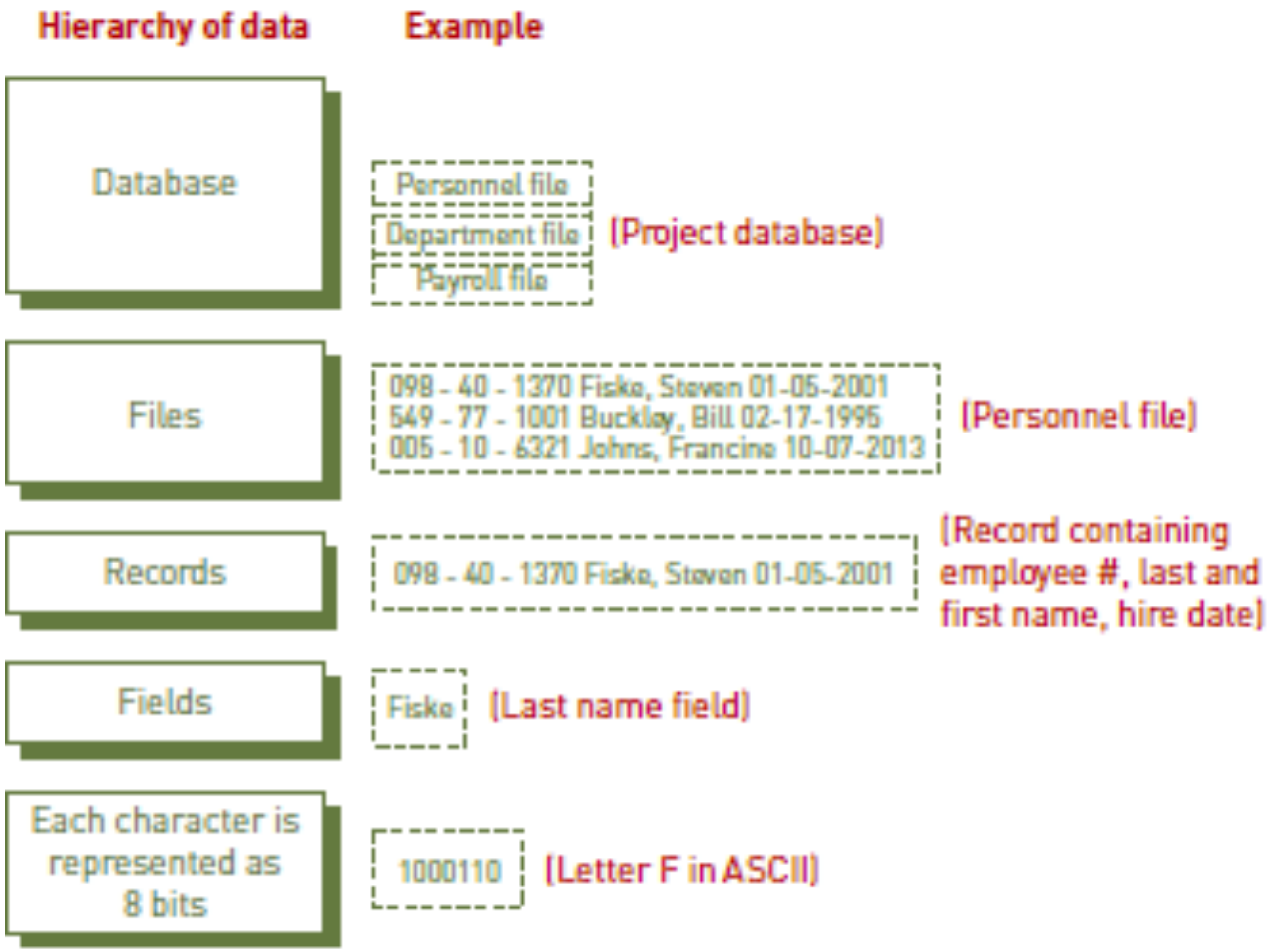
The Hierarchy of Data

- **Bit (a binary digit)**
  - Circuit that is either on or off
- **Byte**
  - Typically made up of eight bits
- **Character**
  - Basic building block of information
- **Field**
  - Name, number, or combination of characters that describes an aspect of a business object or activity

The Hierarchy of Data

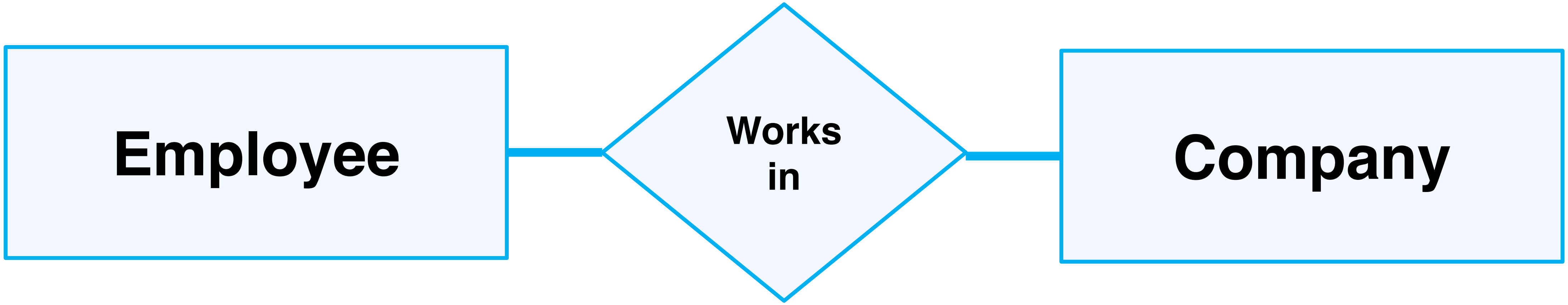
- **Record:**
  - Collection of related data fields
- **File:**
  - Collection of related records
- **Database:**
  - Collection of integrated and related files
- **Hierarchy of data:**
  - Bits, characters, fields, records, files, and databases

The Hierarchy of Data

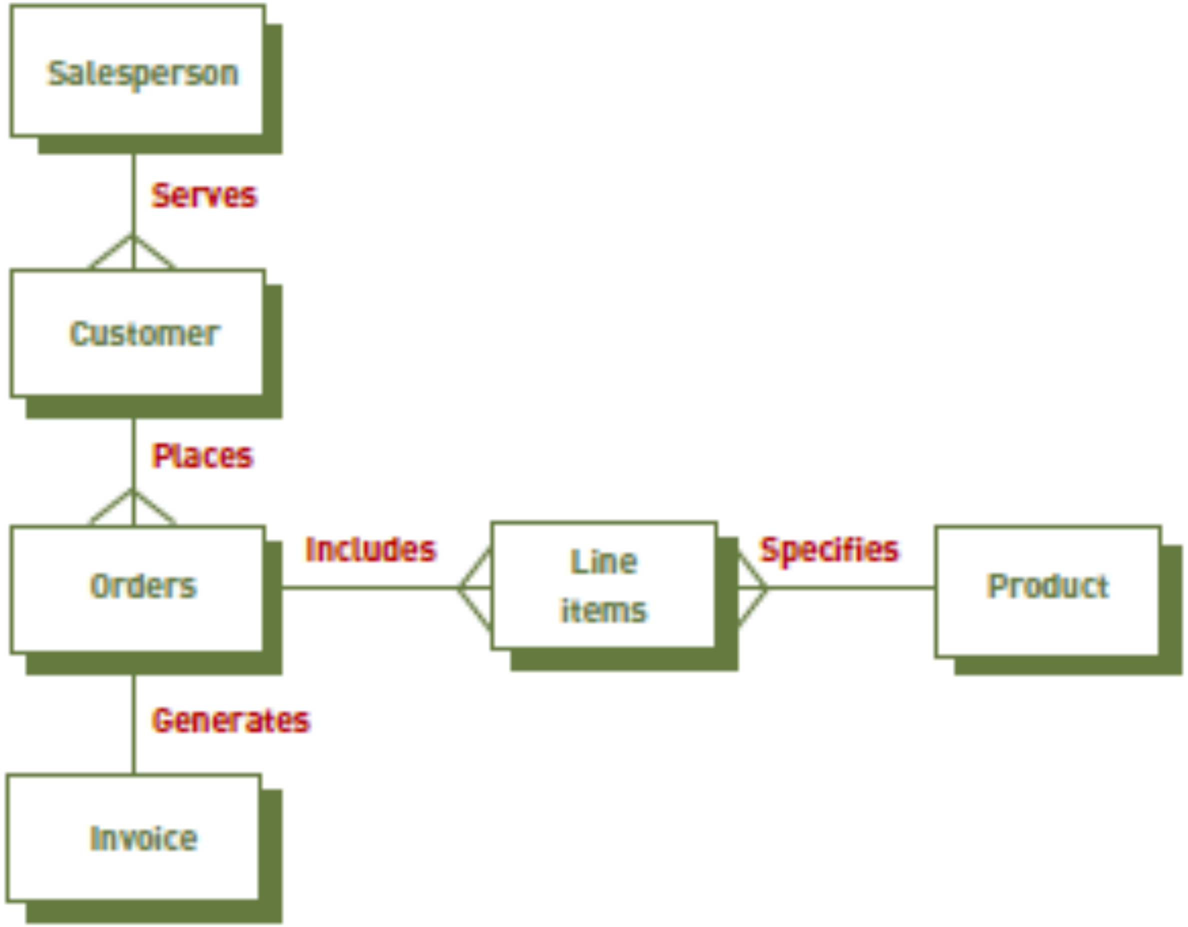


Entity-relationship (ER) diagram

Data models that use basic graphical symbols to show the organization of and relationships between data



Entity Relationship model



Data Entities, Attributes, and Keys

- **Entity:**
  - Generalized class of people, places, or things (objects) for which data is collected, stored, and maintained
- **Attribute:**
  - Characteristic of an entity
- **Data item:**
  - Specific value of an attribute

Entity : one example

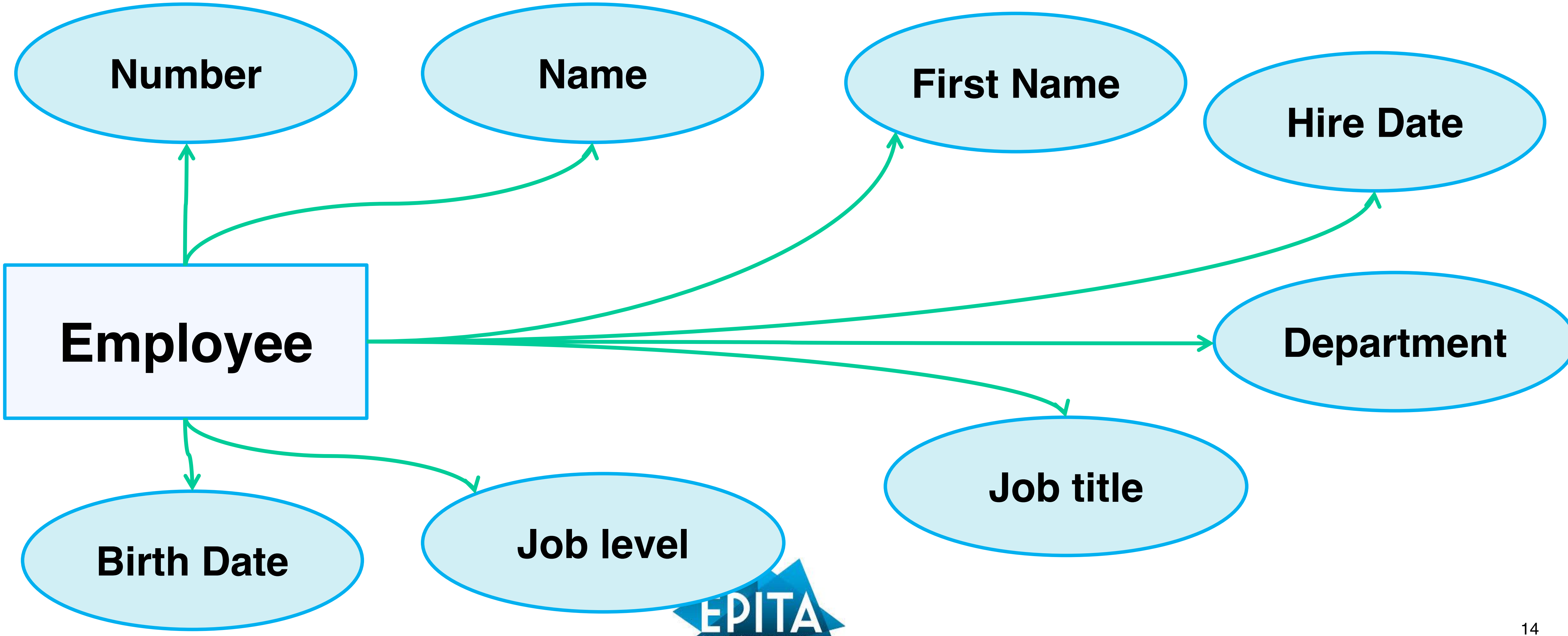
Employee

What are the attributes of the Entity Employee ?

Employee

Principles & Architecture

Attributes



Data Entities, Attributes, and Keys

Employee #	Last name	First name	Hire date	Dept. number
005-10-6321	Johns	Francine	10-07-2013	257
549-77-1001	Buckley	Bill	02-17-1995	632
098-40-1370	Fiske	Steven	01-05-2001	598

ENTITIES (records)

KEY FIELD

ATTRIBUTES (fields)

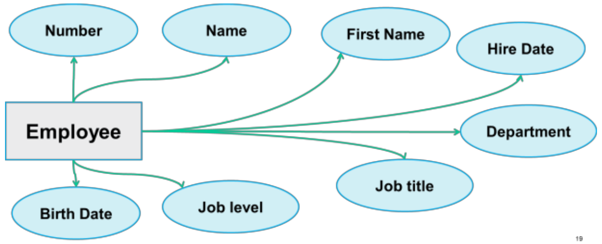
Another exercise with entity Student

Student

Conceptual, Logical and Physical Design

Conceptual

Logical



Physical

Employee #	Last name	First name	Hire date	Dept. number
005-10-6321	Johns	Francine	10-07-2013	257
549-77-1001	Buckley	Bill	02-17-1995	632
098-40-1370	Fiske	Steven	01-05-2001	598

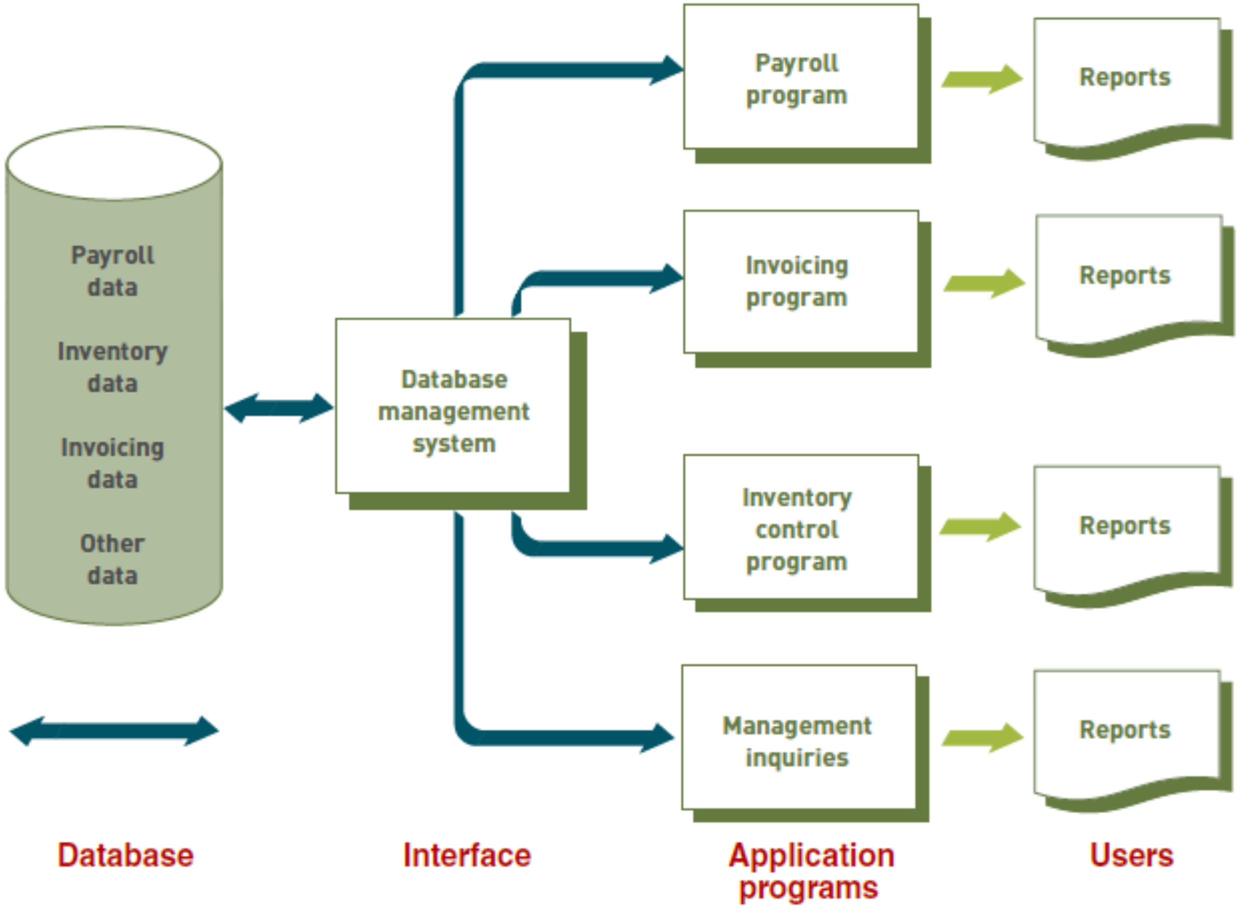
Keys

- **Key:**
  - **Field or set of fields in a record that is used to identify the record**
- **Primary key:**
  - **Field or set of fields that uniquely identifies the record**

The Database Approach

- **Traditional approach to data management:**
  - **Each distinct operational system used data files dedicated to that system**
- **Database approach to data management:**
  - **Pool of related data is shared by multiple application programs**

Database approach to data management



The Database Approach

- **When building a database, an organization must consider:**
  - **Content: What data should be collected and at what cost?**
  - **Access: What data should be provided to which users and when?**
  - **Logical structure: How should data be arranged so that it makes sense to a given user?**
  - **Physical organization: Where should data be physically located?**

Advantages of the Database approach

Advantages	Explanation
Improved strategic use of corporate data	Accurate, complete, up-to-date data can be made available to decision makers where, when, and in the form they need it. The database approach can also give greater visibility to the organization's data resources.
Reduced data redundancy	Data is organized by the DBMS and stored in only one location. This results in a more efficient use of system storage space.
Improved data integrity	With the traditional approach, some changes to data were not reflected in all copies of the data. The database approach prevents this problem because no separate files are maintained.
Easier modification and updating	The DBMS coordinates data modifications and updates. Programmers and users do not have to know where the data is physically stored. Data is stored and modified once. Modification and updating is also easier because the data is commonly stored in only one location.
Data and program independence	The DBMS organizes the data independently of the application program, so the application program is not affected by the location or type of data. Introduction of new data types not relevant to a particular application does not require rewriting that application to maintain compatibility with the data file.
Better access to data and information	Most DBMSs have software that makes it easy to access and retrieve data from a database. In most cases, users give simple commands to get important information. Relationships between records can be more easily investigated and exploited, and applications can be more easily combined.
Standardization of data access	A standardized, uniform approach to database access means that all application programs use the same overall procedures to retrieve data and information.
A framework for program development	Standardized database access procedures can mean more standardization of program development. Because programs go through the DBMS to gain access to data in the database, standardized database access can provide a consistent framework for program development. In addition, each application program need address only the DBMS, not the actual data files, reducing application development time.
Better overall protection of the data	Accessing and using centrally located data is easier to monitor and control. Security codes and passwords can ensure that only authorized people have access to particular data and information in the database, thus ensuring privacy.
Shared data and information resources	The cost of hardware, software, and personnel can be spread over many applications and users. This is a primary feature of a DBMS.

Disadvantages of the Database approach

Disadvantages	Explanation
More complexity	DBMSs can be difficult to set up and operate. Many decisions must be made correctly for the DBMS to work effectively. In addition, users have to learn new procedures to take full advantage of a DBMS.
More difficult to recover from a failure	With the traditional approach to file management, a failure of a file affects only a single program. With a DBMS, a failure can shut down the entire database.
More expensive	DBMSs can be more expensive to purchase and operate than traditional file management. The expense includes the cost of the database and specialized personnel, such as a database administrator, who is needed to design and operate the database. Additional hardware might also be required.

Principles & Architecture

The Relational Database Model

- The relational database model is a simple but highly useful way to organize data into collections of two-dimensional tables called relations. Each row in the table represents an entity, and each column represents an attribute of that entity

Data Table 1: Project Table

Project	Description	Dept. number
155	Payroll	257
498	Widgets	632
226	Sales manual	598

Data Table 2: Department Table

Dept.	Dept. name	Manager SSN
257	Accounting	005-10-6321
632	Manufacturing	549-77-1001
598	Marketing	098-40-1370

Data Table 3: Manager Table

SSN	Last name	First name	Hire date	Dept. number
005-10-6321	Johns	Francine	10-07-1997	257
549-77-1001	Buckley	Bill	02-17-1979	632
098-40-1370	Fiske	Steven	01-05-1985	598

The Relational Database Model

- **Relational model:**
  - Describes data using a standard tabular format
  - Each row of a table represents a data entity (record)
  - Columns of the table represent attributes (fields)
  - Domain: Allowable values for data attributes

Principles & Architecture

The Relational Database Model

Selecting

Projecting

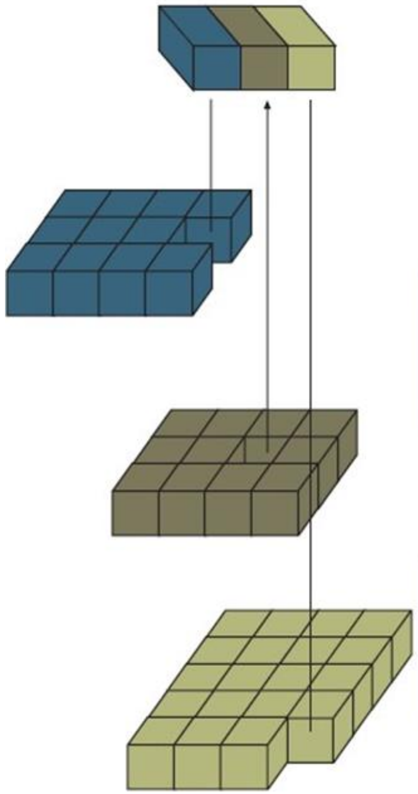
Joining

Linking

- **Manipulating data:**
  - **Selecting: Eliminates rows according to certain criteria**
  - **Projecting: Eliminates columns in a table**
  - **Joining: Combines two or more tables**
  - **Linking: Manipulating two or more tables that share at least one common data attribute**

Principles & Architecture

Linking



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Overview of Database Types

- **Flat file**
  - Simple database program whose records have no relationship to one another
- **Single user**
  - Only one person can use the database at a time
  - Examples: Access, FileMaker Pro, InfoPath
- **Multiple users**
  - Allow dozens or hundreds of people to access the same database system at the same time
  - Examples: Oracle, MS SQL Server , PostgreSQL, IBM DB2, MySQL

Some definitions

- **DBMS:**
  - Database Management System
- **Data definition language (DDL):**
  - Collection of instructions and commands used to define and describe data and relationships in a specific database
  - Allows database's creator to describe data and relationships that are to be contained in the schema
- **Data dictionary:**
  - Detailed description of all the data used in the database

Some definitions

- **Data manipulation language (DML):**
  - **Commands that manipulate the data in a database**
- **Structured query language (SQL):**
  - **Adopted by the American National Standards Institute (ANSI) as the standard query language for relational databases**
- **Once a database has been set up and loaded with data:**
  - **It can produce reports, documents, and other outputs**

Database administration

- **DBA:**
  - **Works with users to decide the content of the database**
  - **Works with programmers as they build applications to ensure that their programs comply with database management system standards and conventions**
- **Data administrator:**
  - **Responsible for defining and implementing consistent principles for a variety of data issues**

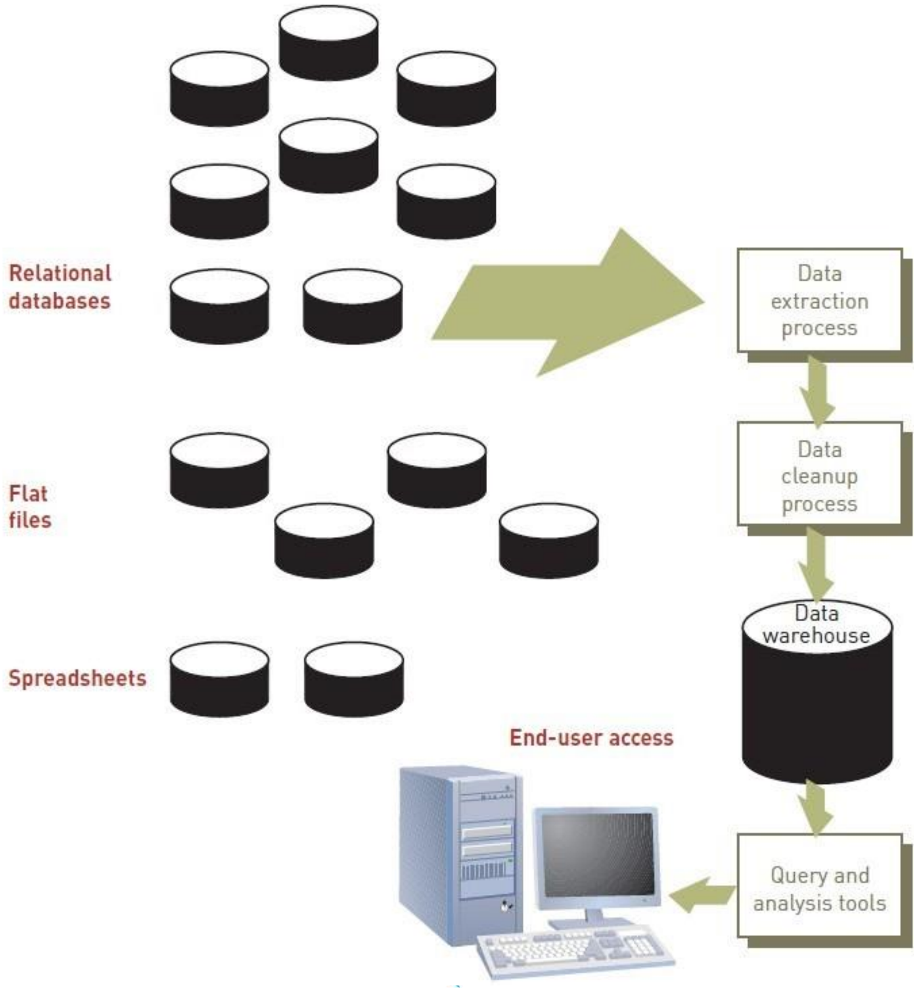
Principles & Architecture

Data Warehouses, Data Marts, and Data Mining

- **Data warehouse**
  - Database that holds business information from many sources in the enterprise
- **Data mart**
  - Subset of a data warehouse
- **Data mining**
  - Information-analysis tool that involves the automated discovery of patterns and relationships in a data warehouse

Principles & Architecture

Data Warehouses, Data Marts, and Data Mining



Predictive Analysis

- Form of data mining that combines historical data with assumptions about future conditions to predict outcomes of events
- Used by retailers to upgrade occasional customers into frequent purchasers
- Software can be used to analyze a company's customer list and a year's worth of sales data to find new market segments

Principles & Architecture

Data Warehouses, Data Marts, and Data Mining

Application	Description
Branding and positioning of products and services	Enable the strategist to visualize the different positions of competitors in a given market using performance (or other) data on dozens of key features of the product and then to condense all that data into a perceptual map of only two or three dimensions.
Customer churn	Predict current customers who are likely to switch to a competitor.
Direct marketing	Identify prospects most likely to respond to a direct marketing campaign (such as a direct mailing).
Fraud detection	Highlight transactions most likely to be deceptive or illegal.
Market basket analysis	Identify products and services that are most commonly purchased at the same time (e.g., nail polish and lipstick).
Market segmentation	Group customers based on who they are or on what they prefer.
Trend analysis	Analyze how key variables (e.g., sales, spending, promotions) vary over time.

Business Intelligence

- **Involves gathering enough of the right information:**
  - **In a timely manner and usable form and analyzing it to have a positive impact on business strategy, tactics, or operations**
- **Competitive intelligence:**
  - **Limited to information about competitors and the ways that knowledge affects strategy, tactics, and operations**

Principles & Architecture

Business Intelligence

- **Counterintelligence:**
  - **Steps organization takes to protect information sought by “hostile” intelligence gatherers**
- **Data loss prevention (DLP):**
  - **Refers to systems designed to lock down data within an organization**
  - **Powerful tool for counterintelligence**
  - **A necessity in complying with government regulations that require companies to safeguard private customer data**

Distributed Databases

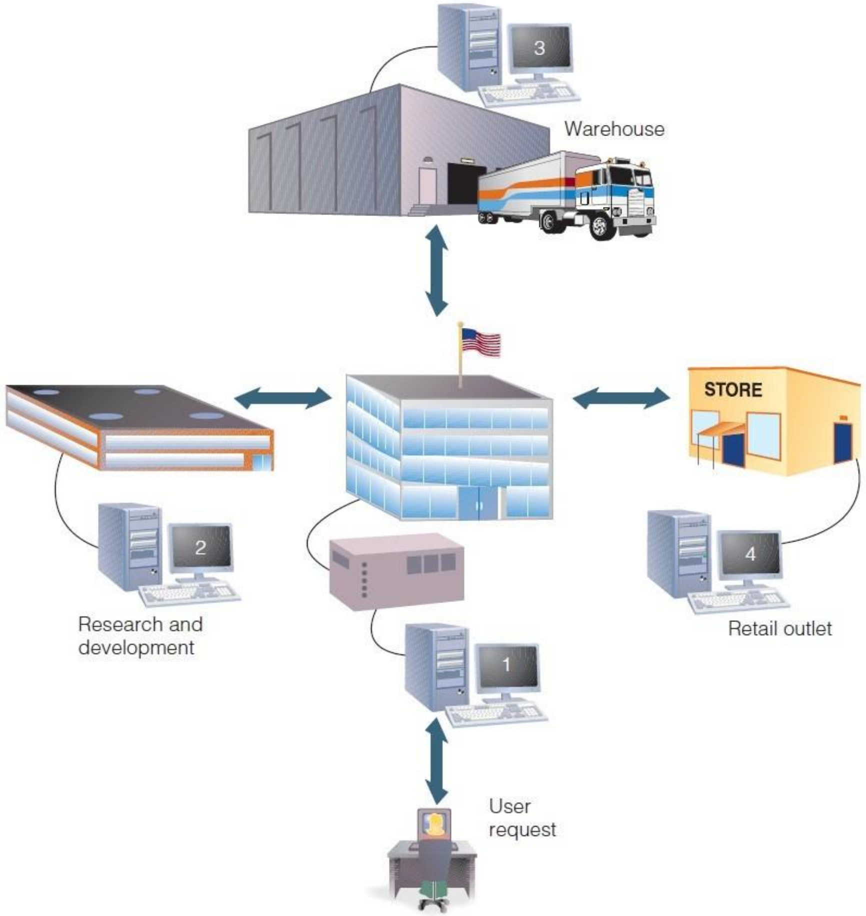
- **Distributed database:**
  - Database in which the data may be spread across several smaller databases connected via telecommunications devices
  - Gives corporations more flexibility in how databases are organized and used
- **Replicated database:**
  - Holds a duplicate set of frequently used data

Principles & Architecture

Distributed Databases

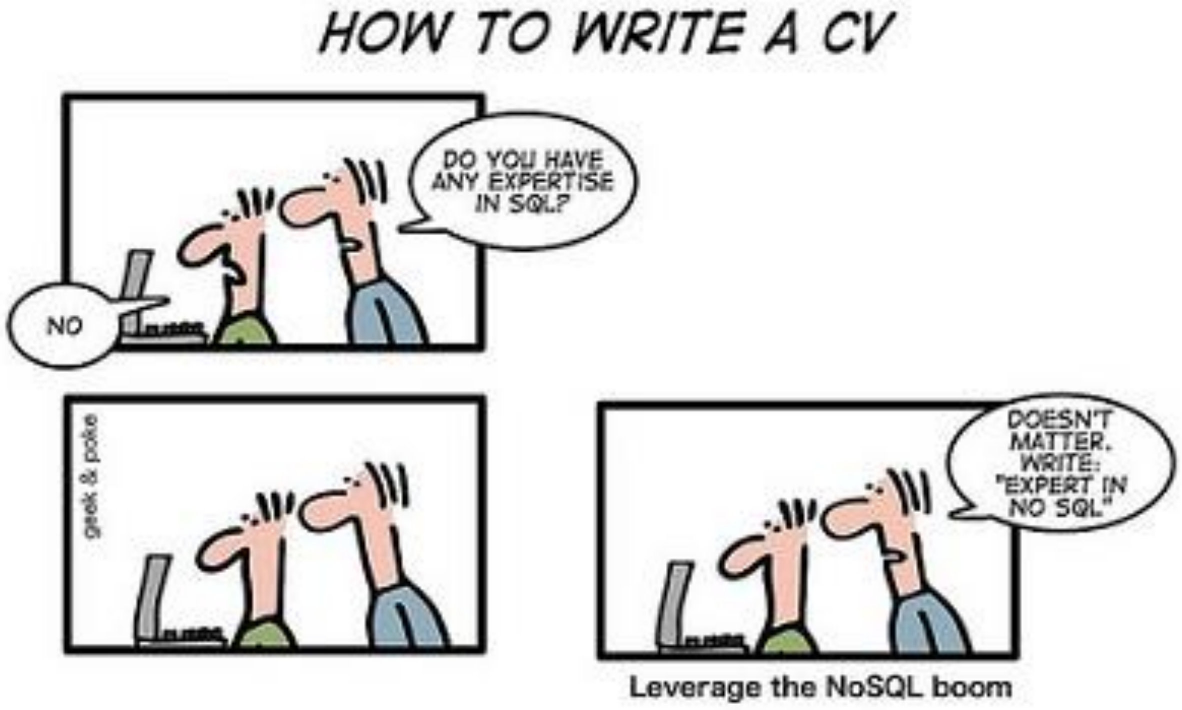
- For a clothing manufacturer, computers might be located at corporate headquarters, in the research and development center, in the warehouse, and in a company owned retail store.

- Telecommunications systems link the computers so that users at all locations can access the same distributed database no matter where the data is actually stored.



NoSQL

Two DBAs go into a NoSQL bar, but they leave right away because they can't find a table!



Where does NoSQL come from?

- Non-relational DBMSs are not new
- But NoSQL represents a new incarnation
  - Due to massively scalable Internet applications
  - Based on distributed and parallel computing
- Development
  - Starts with Google
  - First research paper published in 2003
  - Continues also thanks to Lucene's developers/Apache (Hadoop) and Amazon (Dynamo)
  - Then a lot of products and interests came from Facebook, Netfix, Yahoo, eBay, Hulu, IBM, and many more

NoSQL Not Only SQL

- **A NoSQL database provides a mechanism for storage and retrieval of data that is modeled in means other than the tabular relations used in relational databases.**
- **NoSQL databases are increasingly used in big data and real-time web applications.**
- **NoSQL systems are also sometimes called Not only SQL to emphasize that they may support SQL-like query languages or sit alongside SQL databases**
- **The data structures used by NoSQL databases (e.g. key–value pair, wide column, graph, or document) are different from those used by default in relational databases, making some operations faster in NoSQL. The particular suitability of a given NoSQL database depends on the problem it must solve.**

Principles & Architecture

NoSQL and Big Data

- NoSQL comes from Internet, thus it is often related to the “big data” concept
- How much big are “big data”?
  - Over few terabytes Enough to start spanning multiple storage units
- Challenges
  - Efficiently storing and accessing large amounts of data is difficult, even more considering fault tolerance and backups
  - Manipulating large data sets involves running immensely parallel processes
  - Managing continuously *evolving schema* and metadata for *semi-structured and un-structured* data is difficult

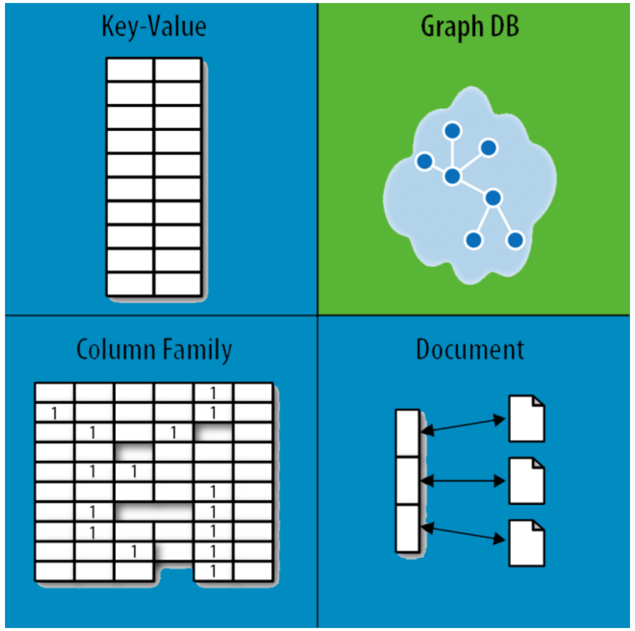
How did we get here?

- **Explosion of social media sites (Facebook, Twitter) with large data needs**
- **Rise of cloud-based solutions such as Amazon S3 (simple storage solution)**
- **Just as moving to dynamically-typed languages (Python, Ruby, Groovy), a shift to dynamically-typed data with frequent schema changes**
- **Open-source community**

Why are RDBMS not suitable for Big Data

- **The context is Internet**
- **RDBMSs assume that data are**
  - **Dense**
  - **Largely uniform (structured data)**
- **Data coming from Internet are**
  - **Massive and sparse**
  - **Semi-structured or unstructured**
- **With massive sparse data sets, the typical storage mechanisms and access methods get stretched**

NoSQL Database Types



Large variety of types:

- **Sorted ordered Column Store**
  - Optimized for queries over large datasets, and store columns of data together, instead of rows
- **Document databases:**
  - pair each key with a complex data structure known as a document.
- **Key-Value Store :**
  - are the simplest NoSQL databases. Every single item in the database is stored as an attribute name (or 'key'), together with its value.
- **Graph Databases :**
  - are used to store information about networks of data, such as social connections.

Principles & Architecture

NoSQL Main vendors by Types

Key–Value	Document	Graph	Column
HyperDEX	Lotus Notes	Allegro	Accumulo
Couchbase Server	Couchbase Server	Neo4J	Cassandra
Oracle NoSQL Database	Oracle NoSQL Database	InfiniteGraph	Druid
OrientDB	OrientDB	OrientDB	Vertica
	MongoDB	Virtuoso	HBase

Principles & Architecture

IMDB - In Memory Database

- **An in-memory database (IMDB) is a database management system that stores the entire database in random access memory (RAM).**
- **This approach provides access to data at rates much faster than storing data on some form of secondary storage (e.g., a hard drive or flash drive) as is done with traditional database management systems.**
- **IMDBs enable the analysis of big data and other challenging data-processing applications, and they have become feasible because of the increase in RAM capacities and a corresponding decrease in RAM costs.**
- **In-memory databases perform best on multiple multicore CPUs that can process parallel requests to the data, further speeding access to and processing of large amounts of data**

IMDB - In Memory Database

Database Software Manufacturer	Product Name	Major Customers
Altibase	HDB	E*Trade, China Telecom
Oracle	Times Ten	Lockheed Martin, Verizon Wireless
SAP	High-Performance Analytic Appliance (HANA)	eBay, Colgate
Software AG	Terracotta Big Memory	AdJuggler

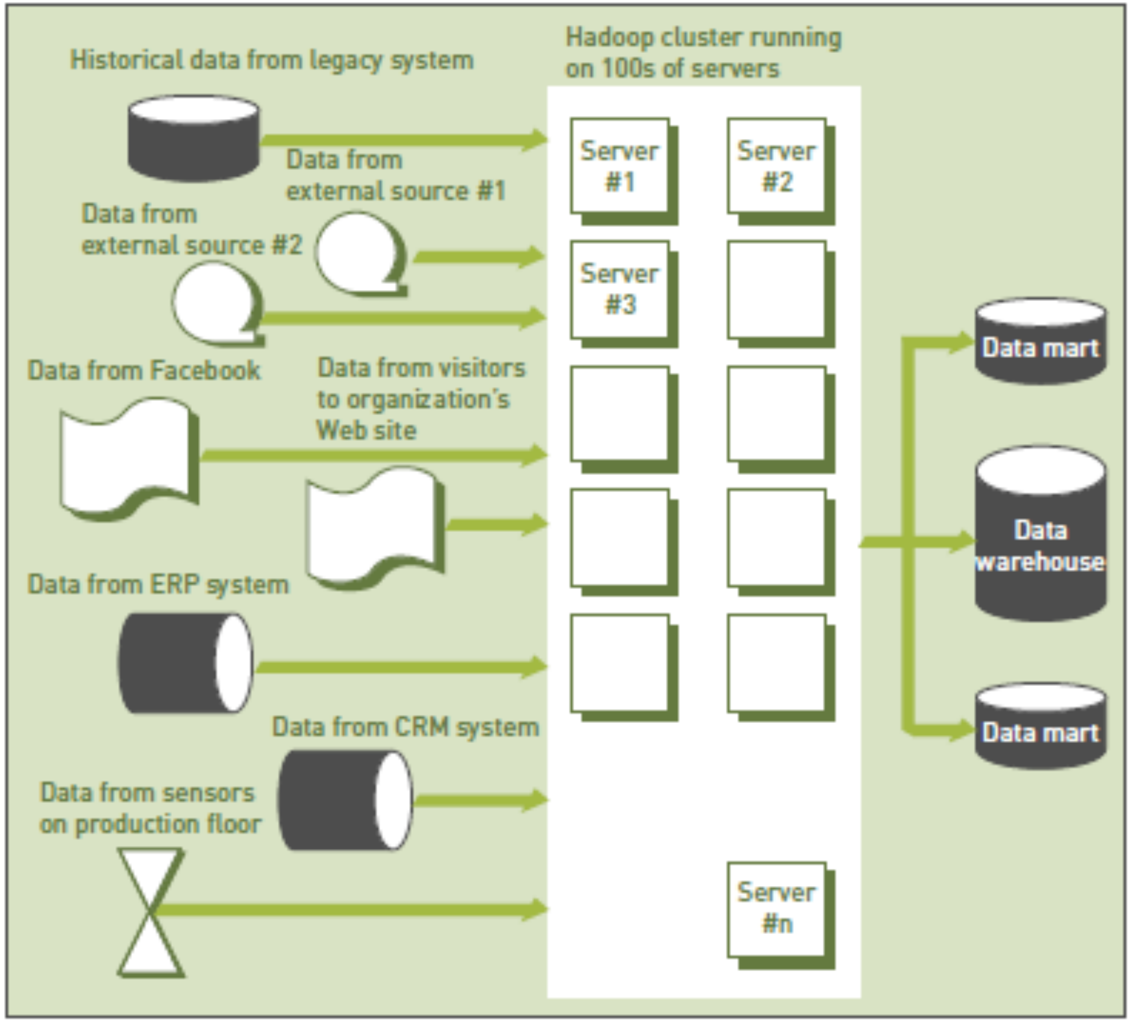
Principles & Architecture

Hadoop

– **Hadoop is an open-source software framework that includes several software modules that provide a means for storing and processing extremely large data sets,**
– **Hadoop has two primary components: a data processing component (a Java-based system called MapReduce and a distributed file system (Hadoop Distributed File System, HDFS) for data storage.**
– **Hadoop divides data into subsets and distributes the subsets onto different servers for processing.**
– **A Hadoop cluster may consist of thousands of servers. In a Hadoop cluster, a subset of the data within the HDFS and the MapReduce system are housed on every server in the cluster.**

Principles & Architecture

Hadoop



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Chapter #5

Network

Olivier BERTHET

Structure

- Chapter 1 : Introduction and Organisations
- Chapter 2 : Hardware
- Chapter 3 : Software
- Chapter 4 : Database Systems
- Chapter 5 : Network
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Introduction

- A computer network consists of communications media, devices, and software connecting two or more computer systems or devices
- Networks are an essential component of an organization’s information technology infrastructure
- Effective communication: Essential to the success of every major human undertaking

Discussion

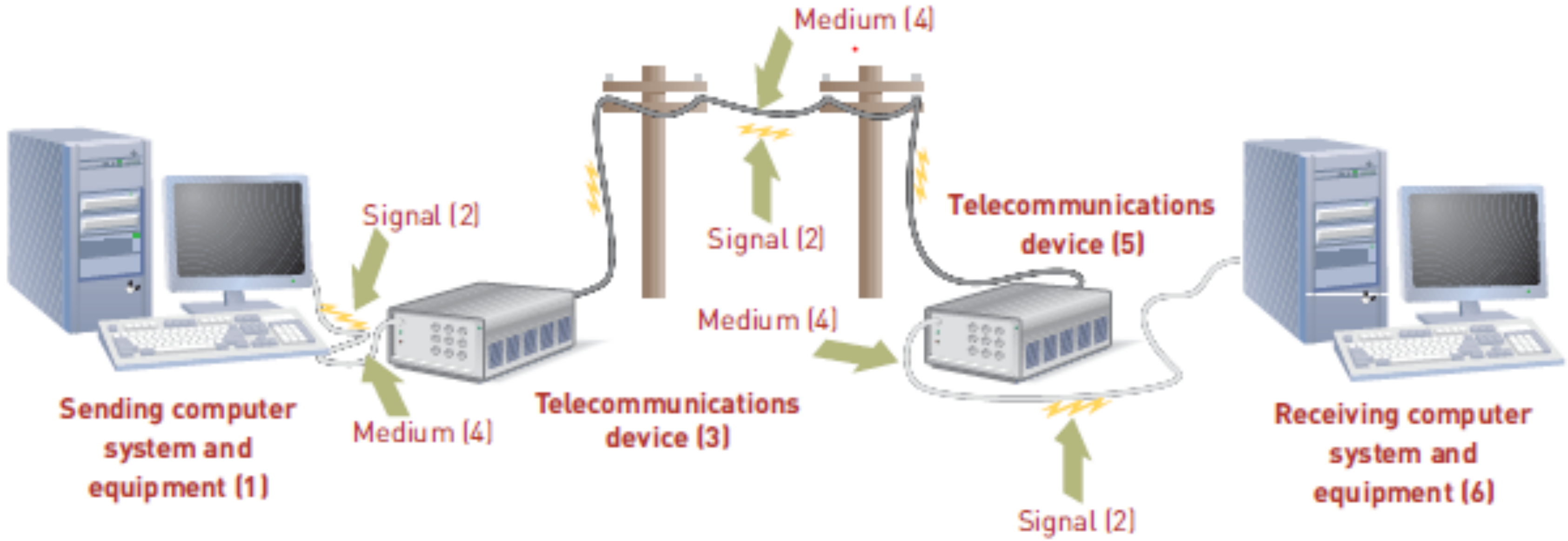
- **What are the applications that organizations benefit from the Network ?**

An Overview of Telecommunications

- **Telecommunications:**
  - Electronic transmission of signals for communications
- **Telecommunications medium:**
  - Any material substance that carries an electronic signal to support communications between a sending and receiving device
- **Networking protocol:**
  - Set of rules, algorithms, messages, and other mechanisms that enable software and hardware in networked devices to communicate effectively

Principles & Architecture

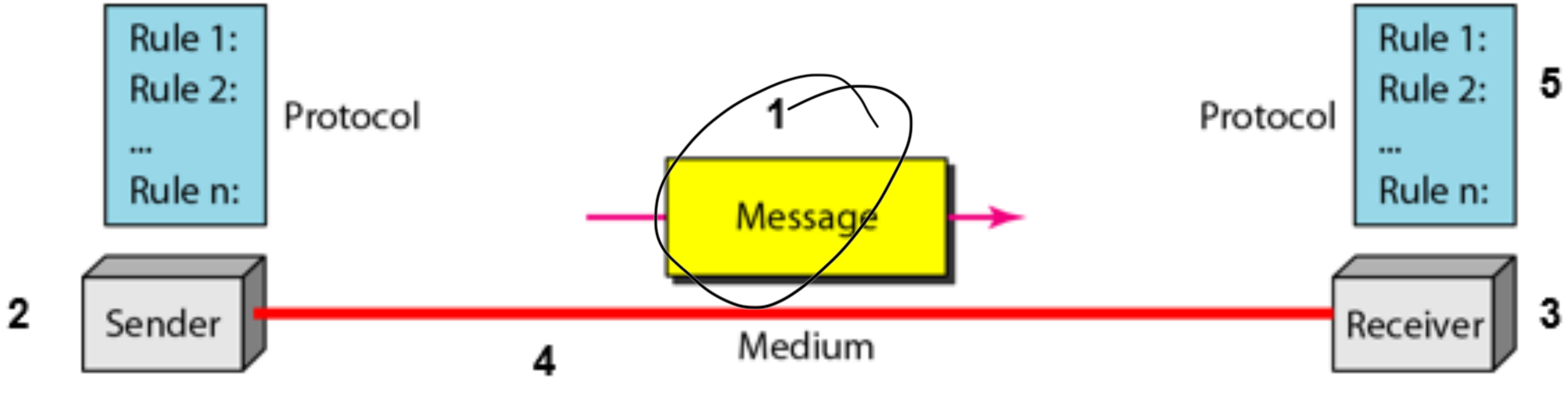
Elements of a Telecommunications System



Telecommunications devices relay signals between computer systems and transmission media

Principles & Architecture

The 5 components of data communication



1) Message
2) Sender
3) Receiver
4) Medium
5) Protocol

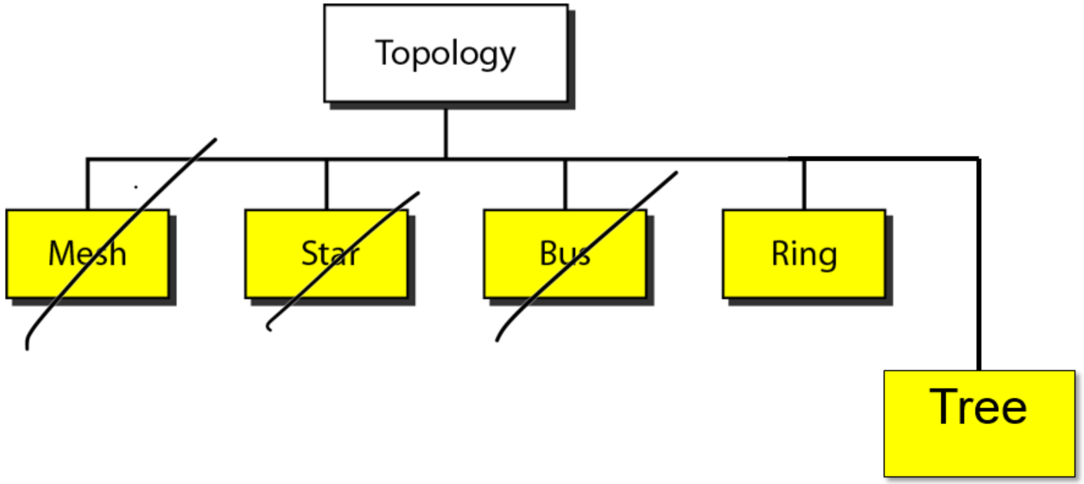
Delivery → Correct destination **Accuracy → Accurate data**

Principles & Architecture

Network Topology

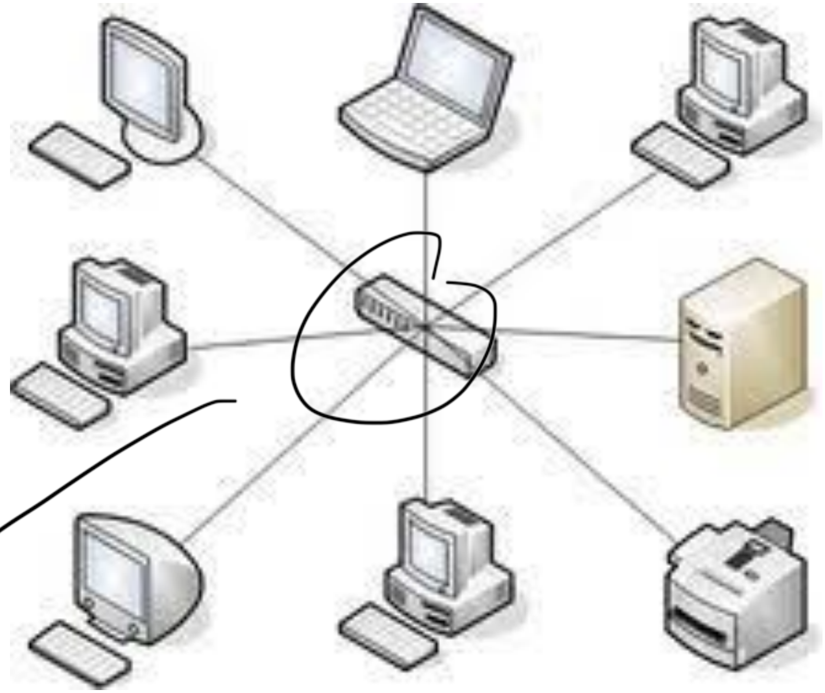
- Network topology is the shape or structure of a network, including the arrangement of the communication links and hardware devices on the network
- The three most common network topologies in use today are the star, bus, and mesh.

1) Star
2) Bus
3) Mesh
4) Ring
5) Tree



Star Network

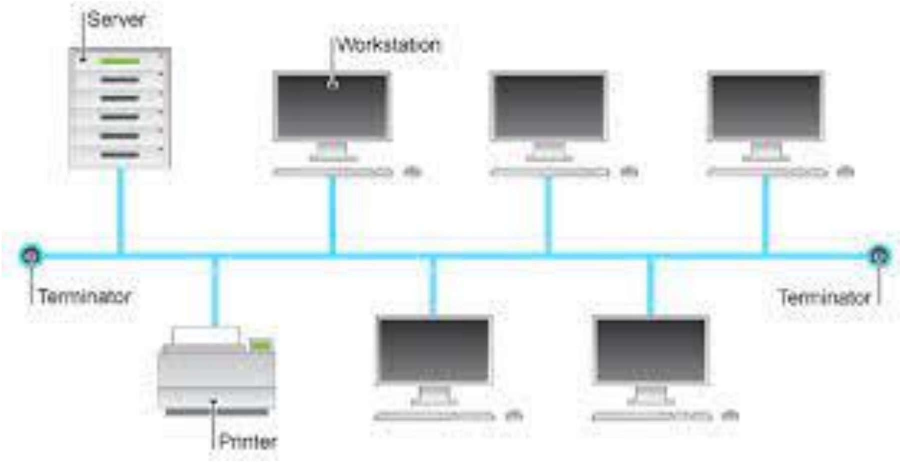
- In a star network, all network devices connect to one another through a single central device called the hub node.
- A failure in any link of the star network will isolate only the device connected to that link.
- However, should the hub fail, all devices on the entire network will be unable to communicate.



Hub node

Bus Network

- In a bus network, all network devices are connected to a common backbone that serves as a shared communications medium.
- To communicate with any other device on the network, a device sends a broadcast message onto the communications medium.
- All devices on the network can “see” the message, but only the intended recipient actually accepts and processes the message.



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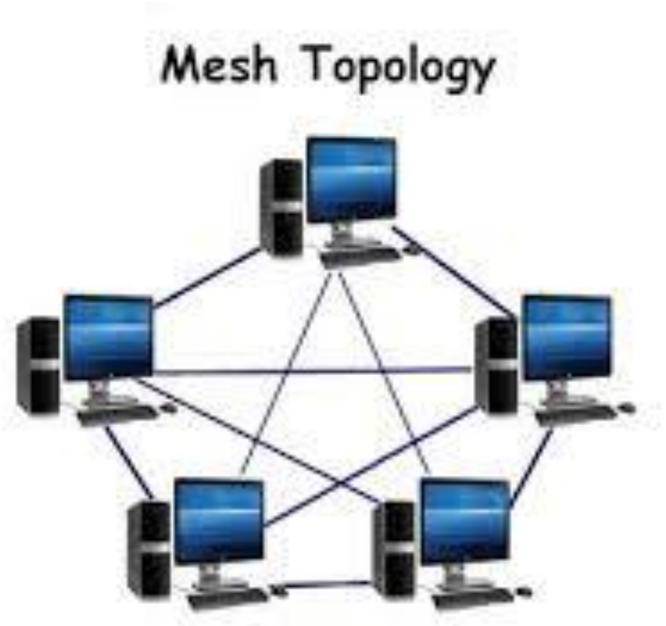
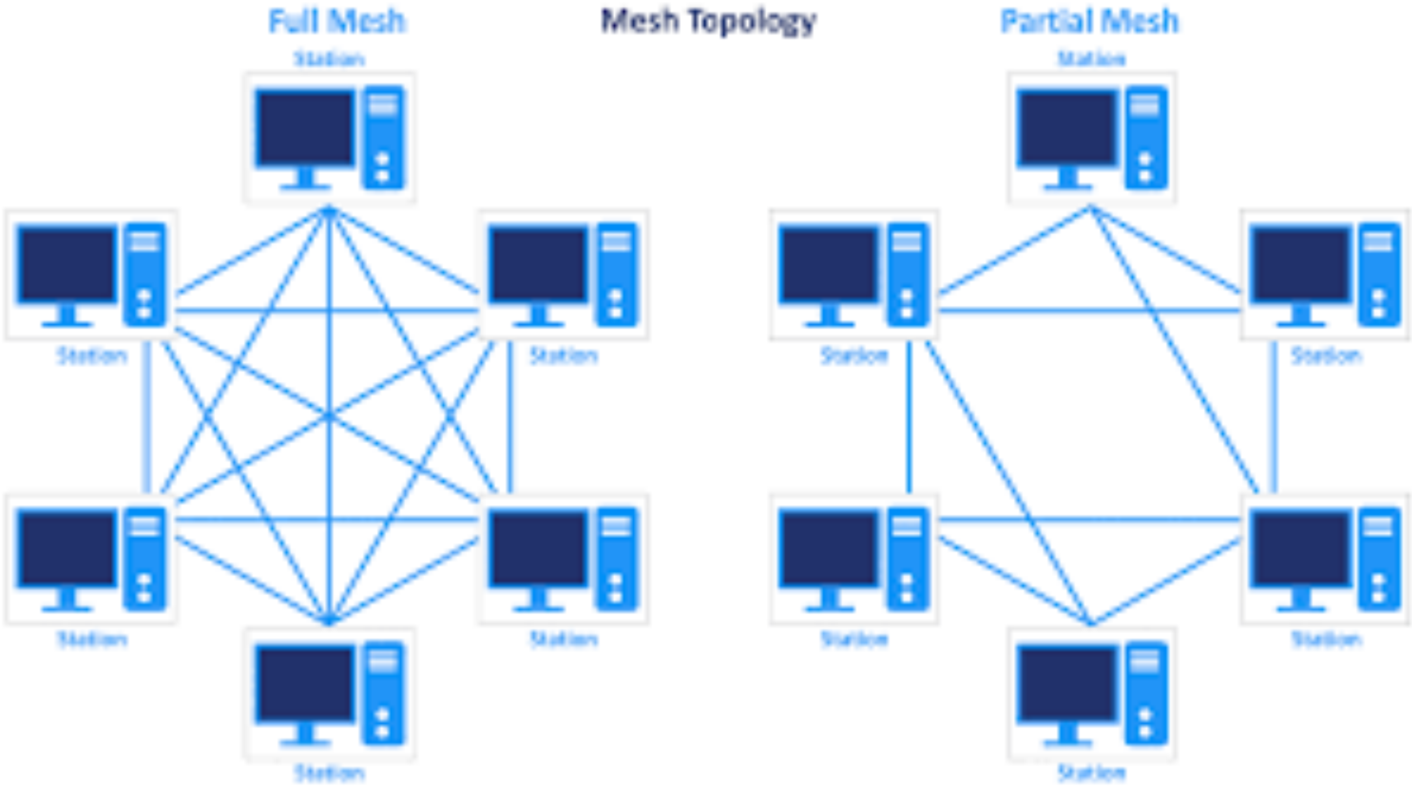
Mesh Network

- Mesh networks use multiple access points to link a series of devices that speak to each other to form a network connection across a large area.
- Communications are routed among network nodes by allowing for continuous connections and by bypassing blocked paths by “hopping” from node to node until a connection can be established.
- Mesh networks are very robust: if one node fails, all the other nodes can still communicate with each other, directly or through one or more intermediate nodes.



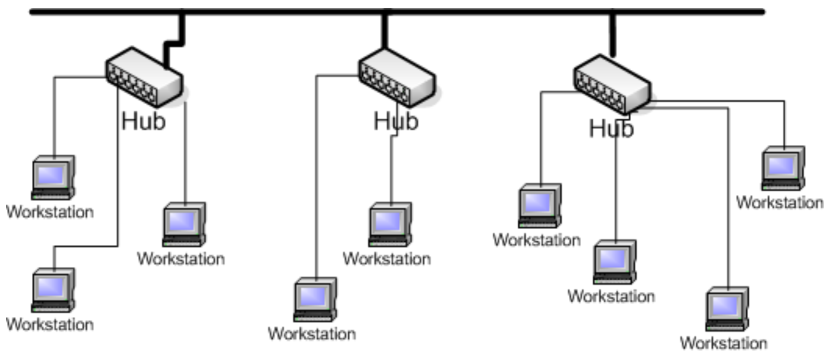
Full versus Partial Mesh Network



Principles & Architecture

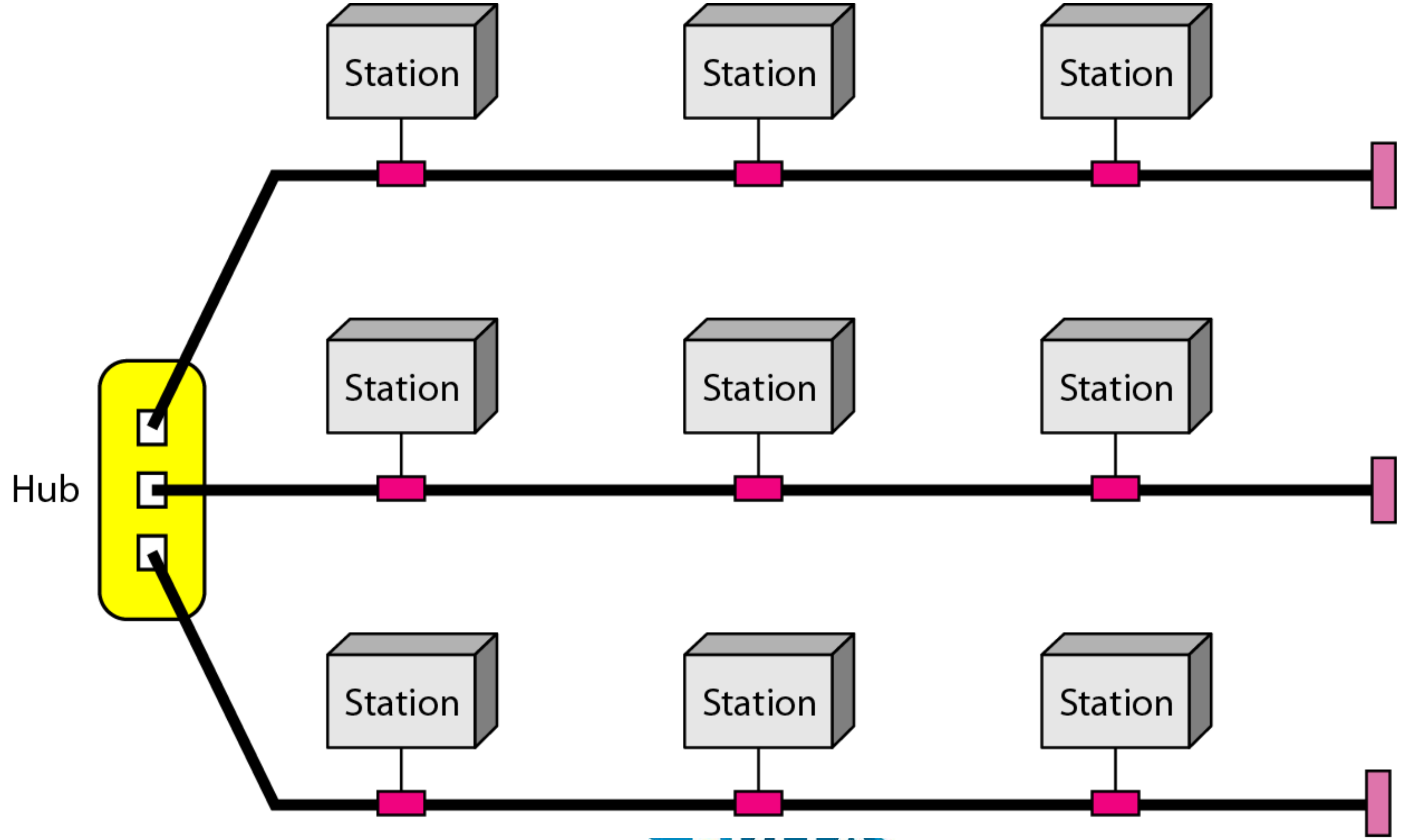
Tree topology

- Tree topologies integrate multiple topologies together
- Advantages:
  - Point-to-point wiring for individual segments.
  - Supported by several hardware and software venders.
- Disadvantages:
  - Overall length of each segment is limited by the type of cabling used.
  - If the backbone line breaks, the entire segment goes down.
  - More difficult to configure and wire than other topologies.



Principles & Architecture

A hybrid topology: a star backbone with three bus networks

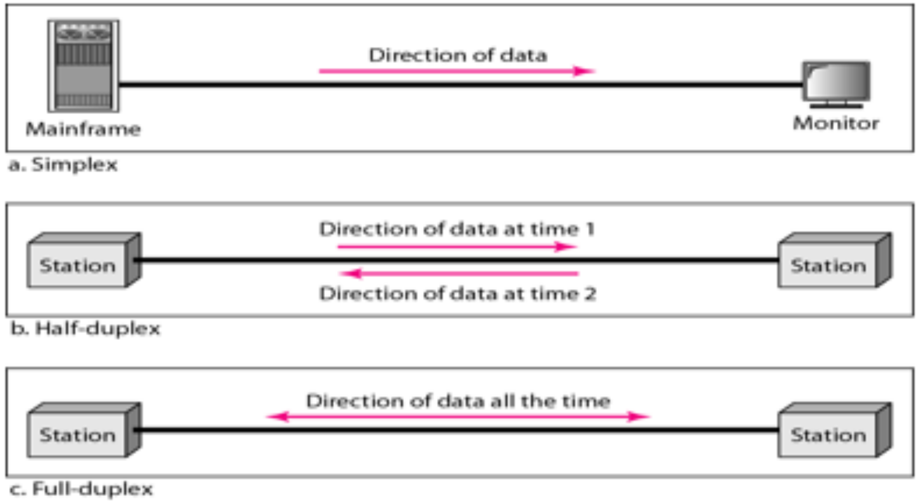


Synchronous versus Asynchronous

- **Synchronous communications:**
  - **Receiver gets message instantaneously**
- **Asynchronous communications:**
  - **Receiver gets message after some delay**

Basic Telecommunications Channel Characteristics

- **Simplex channel:**
  - Transmits data in only one direction
- **Half-duplex channel:**
  - Transmits data in either direction, but not simultaneously
- **Full-duplex channel:**
  - Permits data transmission in both directions at the same time

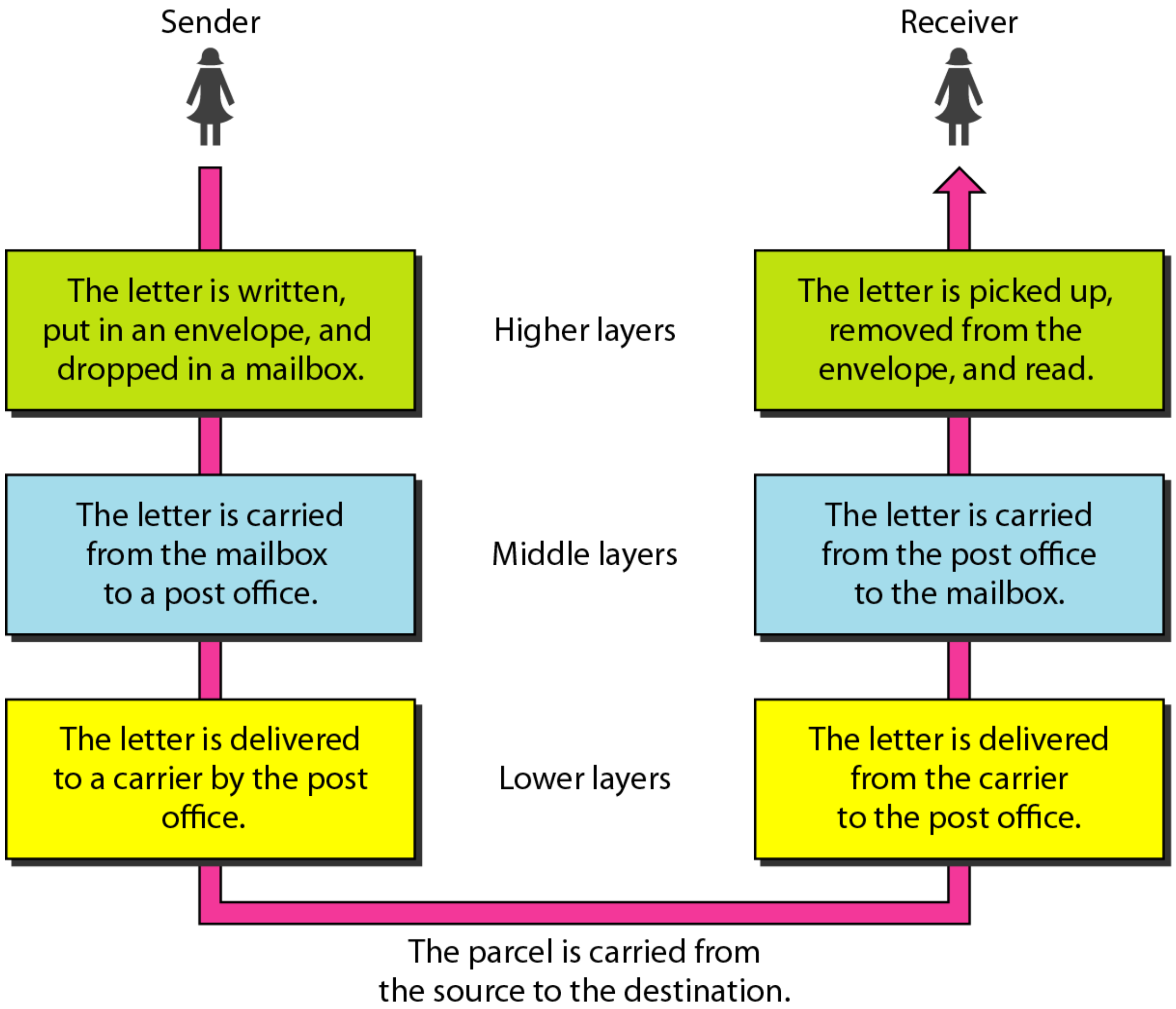


Protocol Concepts

- **Protocols are sets of rules.**
  - **What do you want to do? (Application)**
  - **Where are you going? (Addressing)**
  - **How do you get there? (Media types)**
  - **Did you get there? (Acknowledgments, Error checking)**

Principles & Architecture

Tasks for a mail



The OSI model

- **Established in 1947, the International Standards Organization (ISO) is a multinational body dedicated to worldwide agreement on international standards.**

- **An ISO is the Open Systems Interconnection (OSI) model is the standard that covers all aspects of network communications from ISO. It was first introduced in the late 1970s.**

- **ISO is the organization. OSI is the model.**

Network Protocol

- **A network model is a layered architecture**
  - **Task broken into subtasks**
  - **Implemented separately in layers in stack**
  - **Functions need in both systems**
  - **Peer layers communicate**

- **Protocol:**
  - **A set of rules that governs data communication**
  - **It represents an agreement between the communicating devices**

Principles & Architecture

Layered architecture of the OSI model

Layers

Layer 7. Application

Layer 6. Presentation

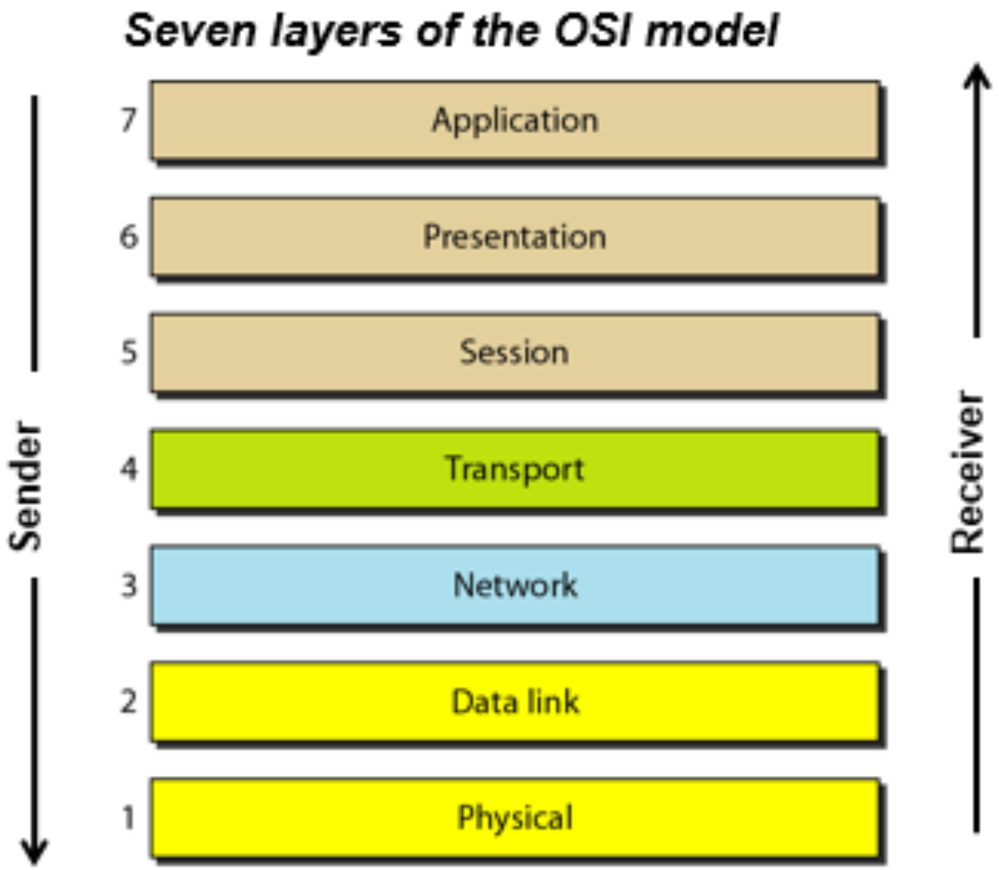
Layer 5. Session

Layer 4. Transport

Layer 3. Network

Layer 2. Data Link

Layer 1. Physical



Principles & Architecture

A layered architecture

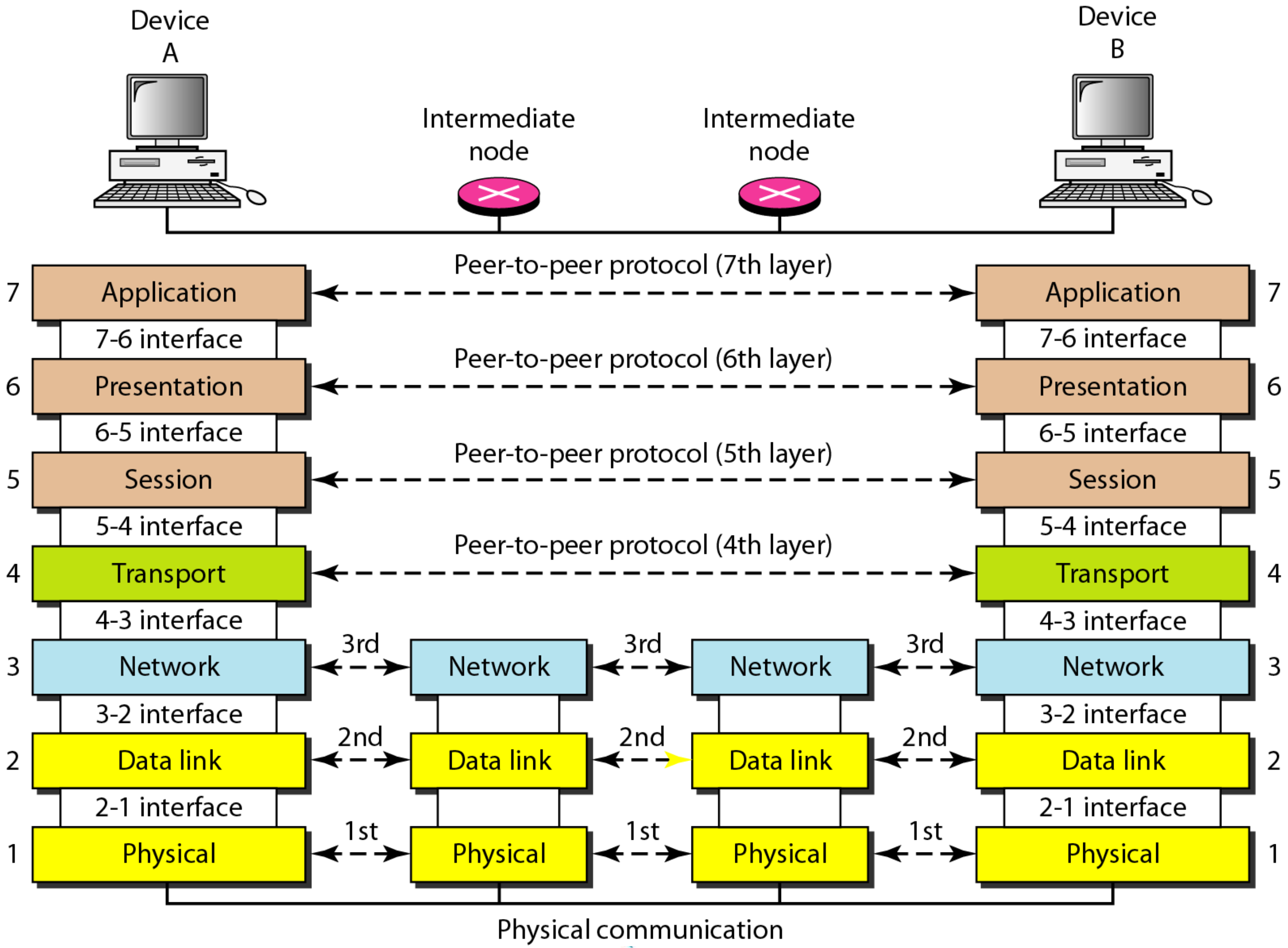
- **A layered model**
- **Each layer performs a subset of the required communication functions**
- **Each layer relies on the next lower layer to perform more primitive functions**
- **Each layer provides services to the next higher layer**
- **Changes in one layer should not require changes in other layers**
- **The processes on each machine at a given layer are called peer-to-peer process**

Principles & Architecture

Peer-to-peer process

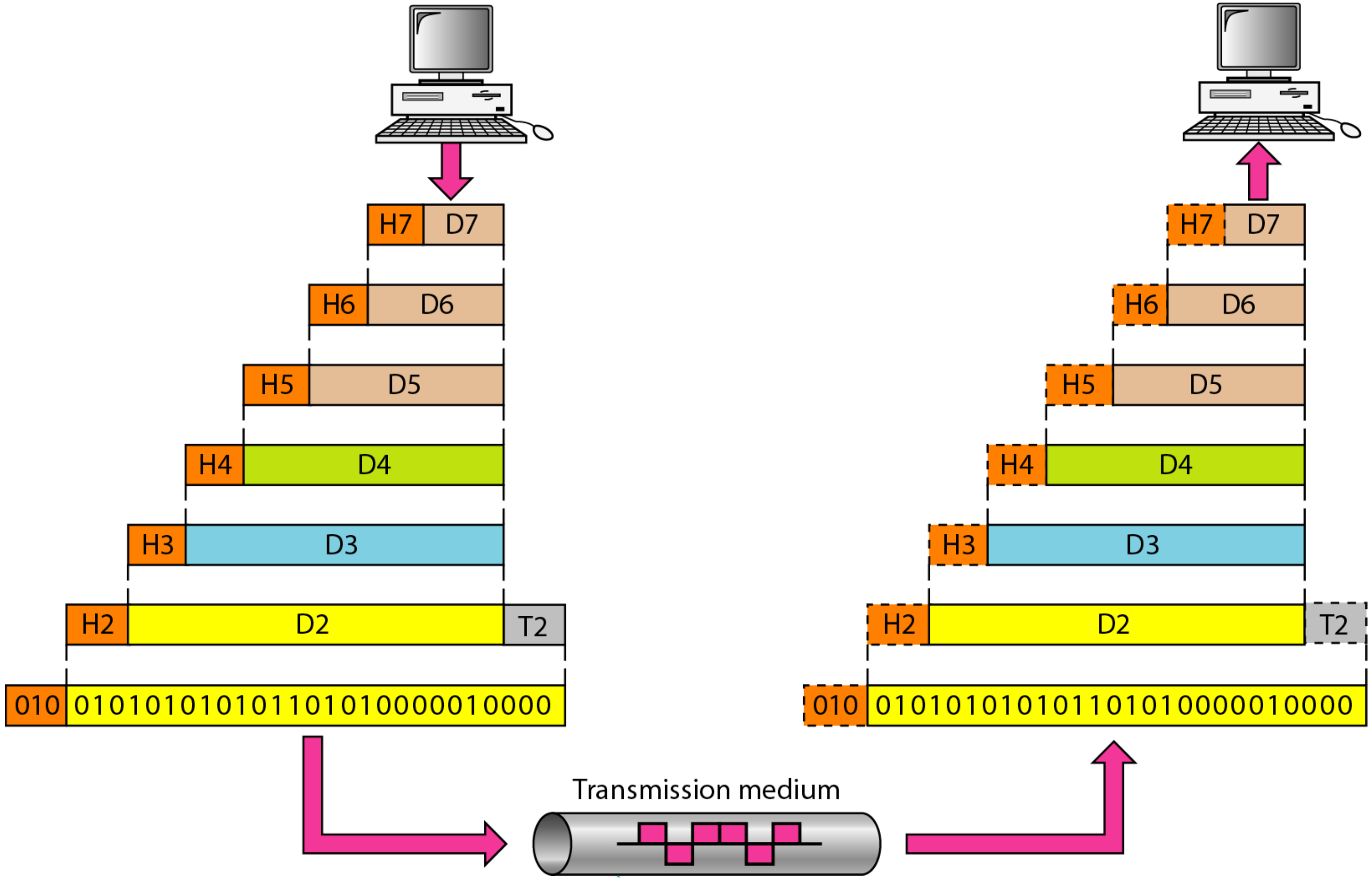
- **Communication must move downward through the layers on the sending device, over the communication channel, and upward to the receiving device**
- **Each layer in the sending device adds its own information to the message it receives from the layer just above it and passes the whole package to the layer just below it**
- **At the receiving device, the message is unwrapped layer by layer, with each process receiving and removing the data meant for it**
- **The passing of the data and network information down through the layers of the sending device and backup through the layers of the receiving device is made possible by interface between each pair of adjacent layers**
- **Interface defines what information and services a layer must provide for the layer above it.**

The interaction between layers in the OSI model

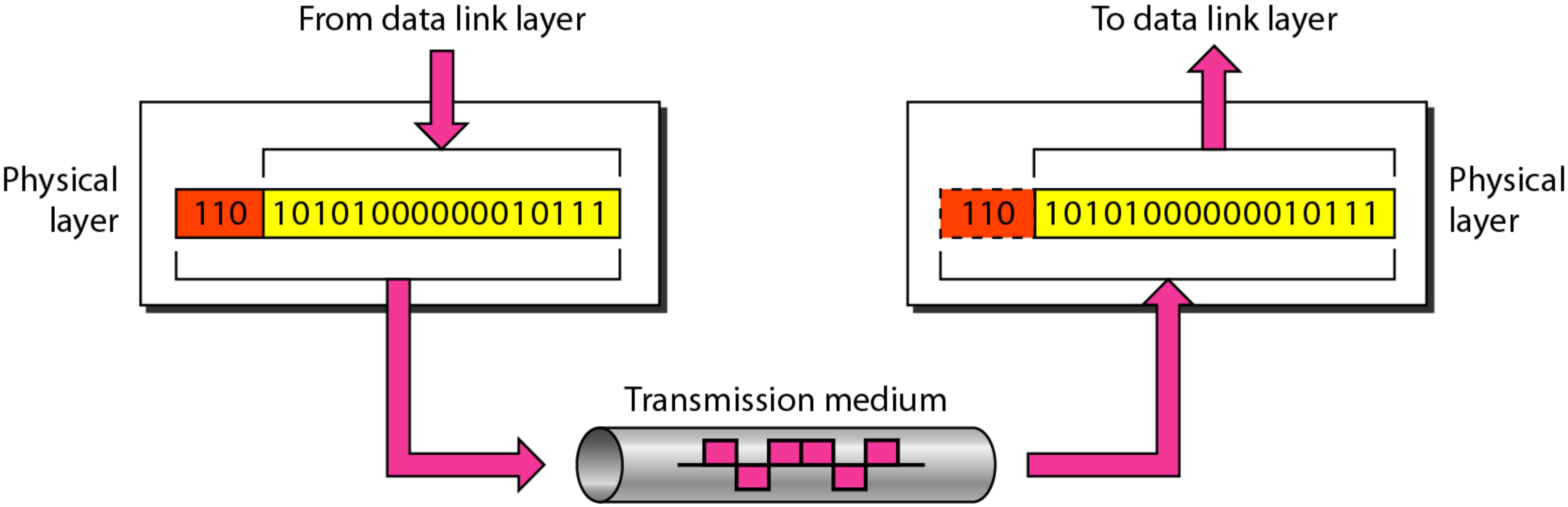


Principles & Architecture

An exchange using the OSI model

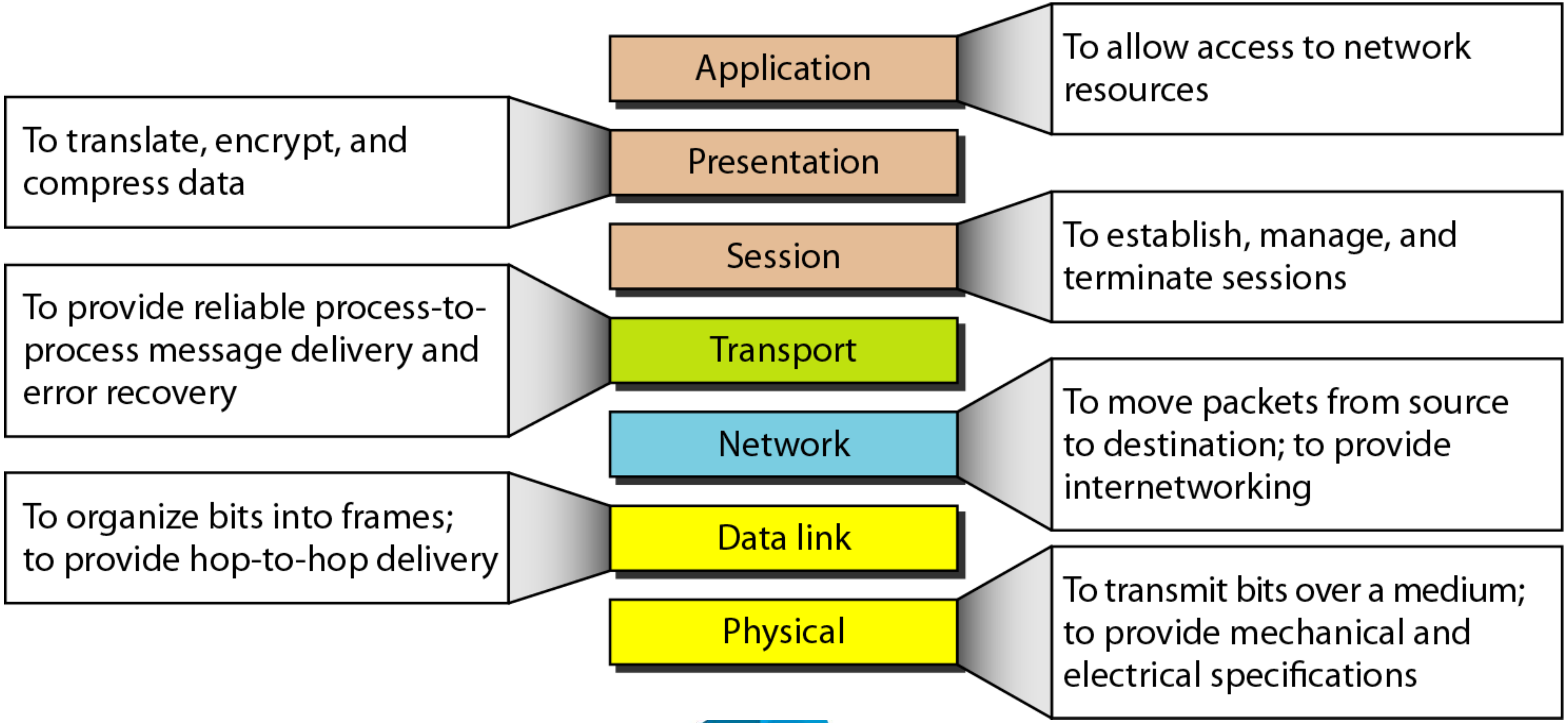


Physical layer



Principles & Architecture

Summary of layers

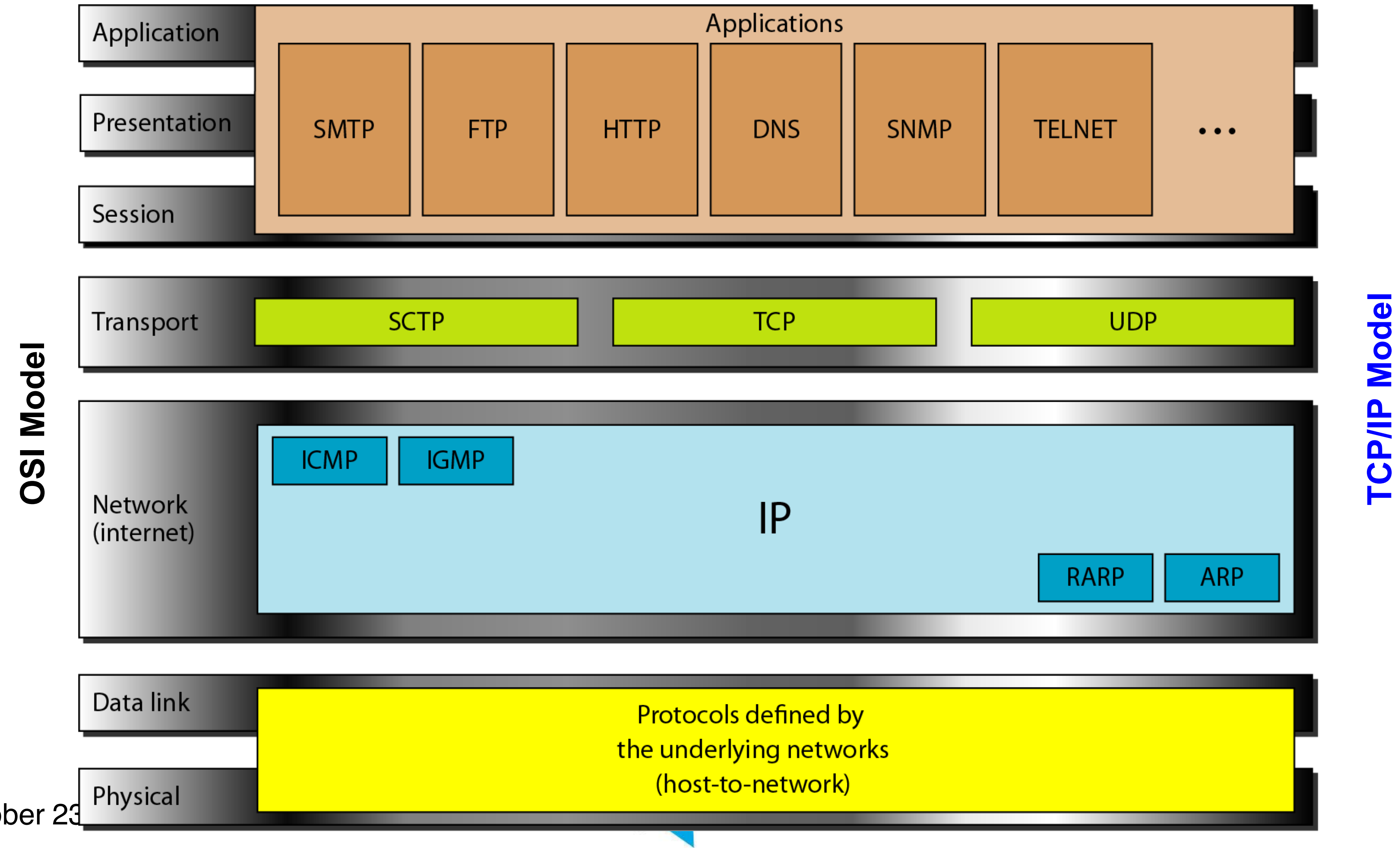


Example of TCP/IP Protocol

- **The layers in the TCP/IP protocol suite do not exactly match those in the OSI model.**
- **The original TCP/IP protocol suite was defined as having four layers: host-to-network, internet, transport, and application.**
- **However, when TCP/IP is compared to OSI, we can say that the TCP/IP protocol suite is made of five layers: physical, data link, network, transport, and application.**

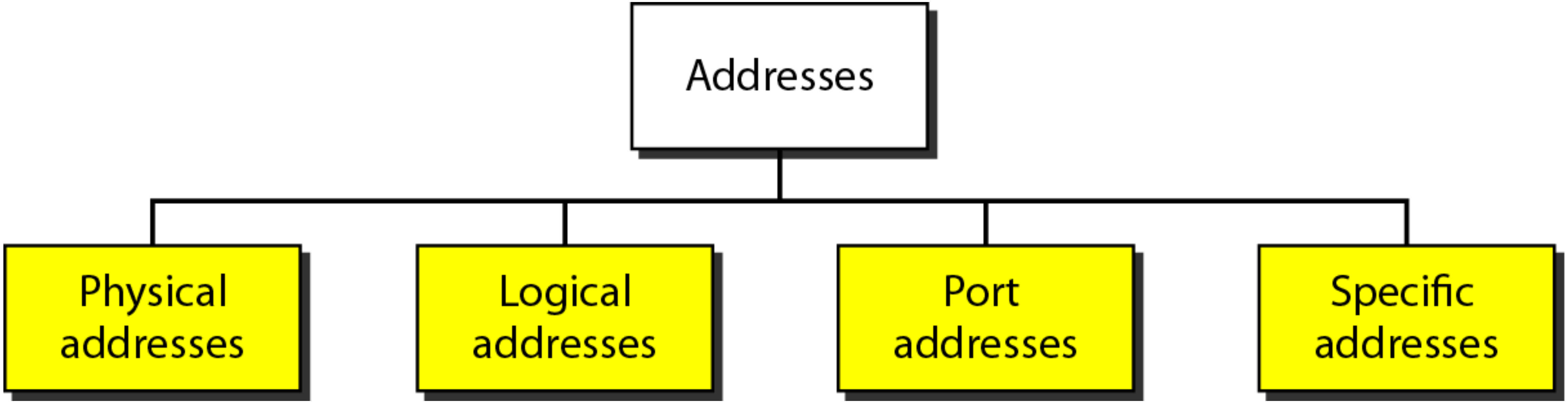
Principles & Architecture

Example of TCP/IP Protocol



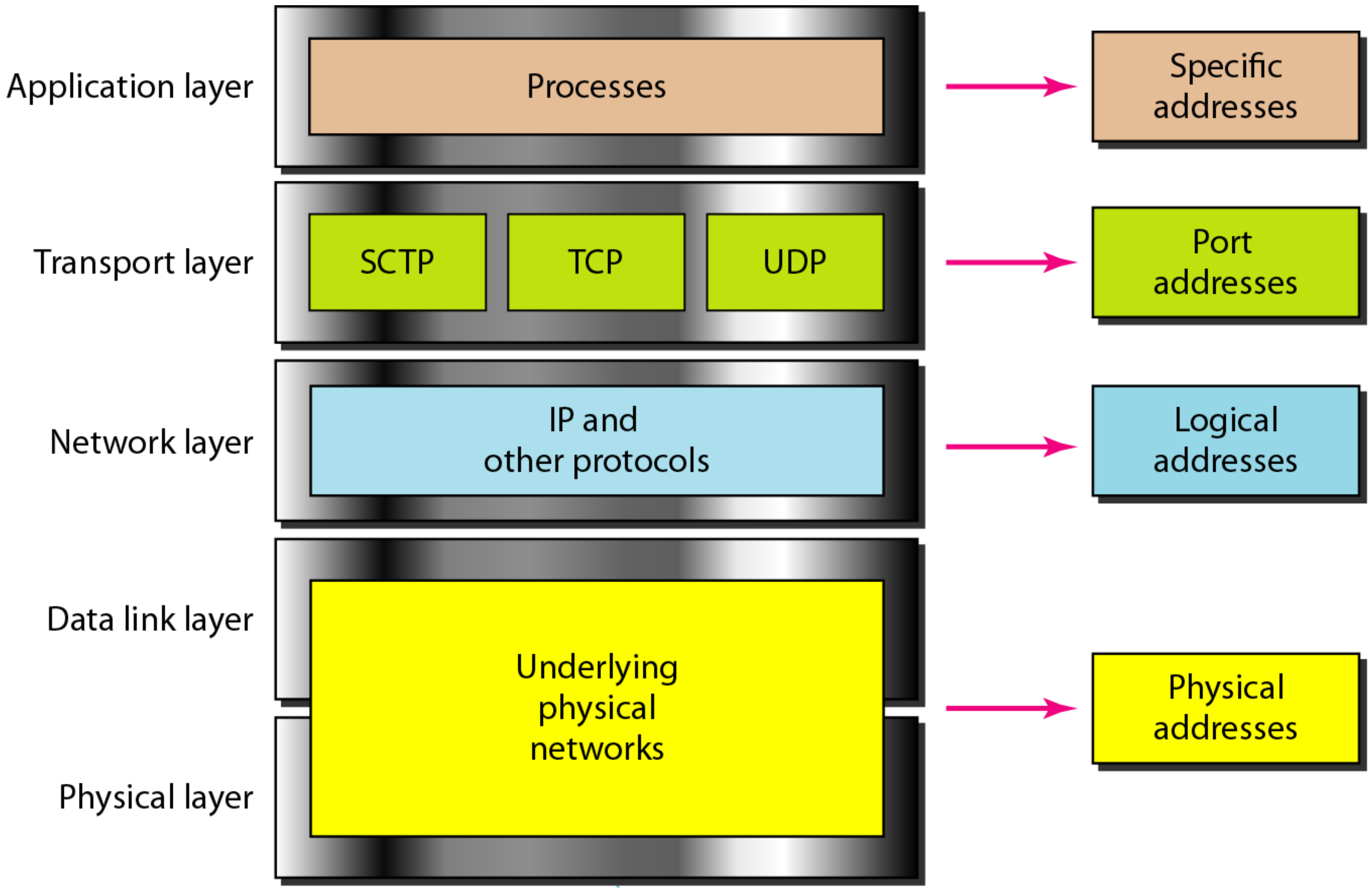
Principles & Architecture

Addresses in TCP/IP



Principles & Architecture

Relationship of layers and addresses in TCP/IP



Standard organizations

- International Organization for Standardization (ISO)
- International Telecommunication Union - Telecommunication Standards (ITU-T)
- American National Standards Institute (ANSI)
- Institute of Electrical and Electronics Engineers (IEEE)
- Electronic Industries Association (EIA)

Principles & Architecture

Basic Telecommunications Channel Characteristics

- **Channel bandwidth:**
  - **Rate at which data is exchanged usually in Mega Bits per second Mbps**
- **Circuit switching network:**
  - **Sets up a circuit between the sender and receiver before any communications can occur**
- **Packet switching network:**
  - **No fixed path is created between the communicating devices**
- **Telecommunications media**
  - **Categories: guided transmission media and wireless**

Network bandwith

56 kbit/s	Modem / Dialup
1.5 Mbit/s	ADSL Lite
1.544 Mbit/s	T1/DS1
2.048 Mbit/s	E1 / E-carrier
4 Mbit/s	ADSL1
10 Mbit/s	Ethernet
11 Mbit/s	Wireless 802.11b
24 Mbit/s	ADSL2+
44.736 Mbit/s	T3/DS3
54 Mbit/s	Wireless 802.11g
100 Mbit/s	Fast Ethernet
155 Mbit/s	OC3
600 Mbit/s	Wireless 802.11n
622 Mbit/s	OC12
1 Gbit/s	Gigabit Ethernet
1.3 Gbit/s	Wireless 802.11ac
2.5 Gbit/s	OC48
5 Gbit/s	SuperSpeed USB
7 Gbit/s	Wireless 802.11ad
9.6 Gbit/s	OC192
10 Gbit/s	10 Gigabit Ethernet, SuperSpeed USB 10 Gbit/s
20 Gbit/s	SuperSpeed USB 20 Gbit/s
40 Gbit/s	Thunderbolt 3
100 Gbit/s	100 Gigabit Ethernet

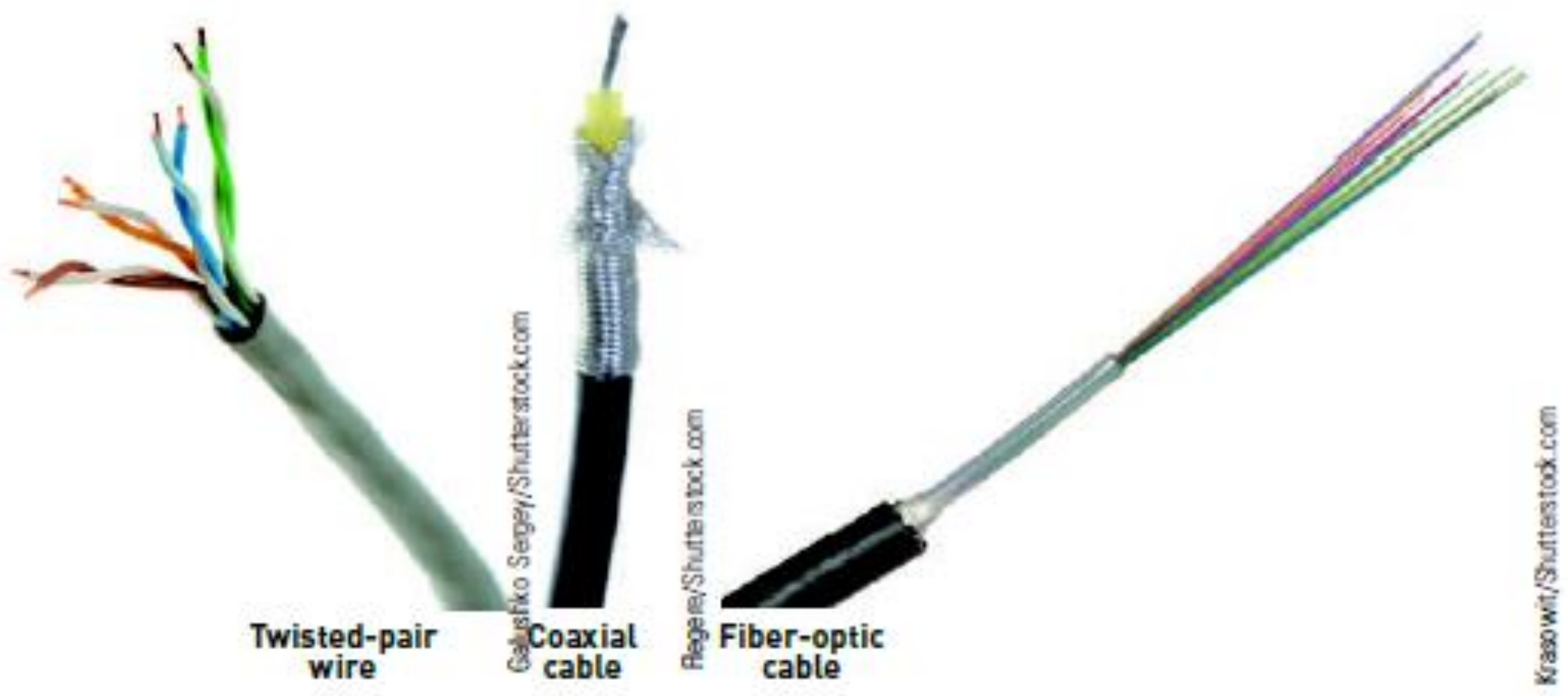
Principles & Architecture

Basic Telecommunications Channel Characteristics

- **Guided transmission media types:**
  - Available in many types
- **Twisted-pair wire:**
  - Classified by category: category 2, 3, 5, 5E, and 6
- **Coaxial cable:**
  - Offers cleaner and crisper data transmission (less noise) than twisted-pair wire
- **Fiber-optic cable:**
  - Transmits signals with light beams

Principles & Architecture

Type of guided transmission media



Principles & Architecture

Type of guided transmission media

Media Form	Description	Advantages	Disadvantages
Twisted-pair wire	Twisted pairs of copper wire, shielded or unshielded; used for telephone service	Widely available	Limitations on transmission speed and distance
Coaxial cable	Inner conductor wire surrounded by insulation	Cleaner and faster data transmission than twisted-pair wire	More expensive than twisted-pair wire
Fiber-optic cable	Many extremely thin strands of glass bound together in a sheathing; uses light beams to transmit signals	Diameter of cable is much smaller than coaxial cable; less distortion of signal; capable of high transmission rates	Expensive to purchase and install

Principles & Architecture

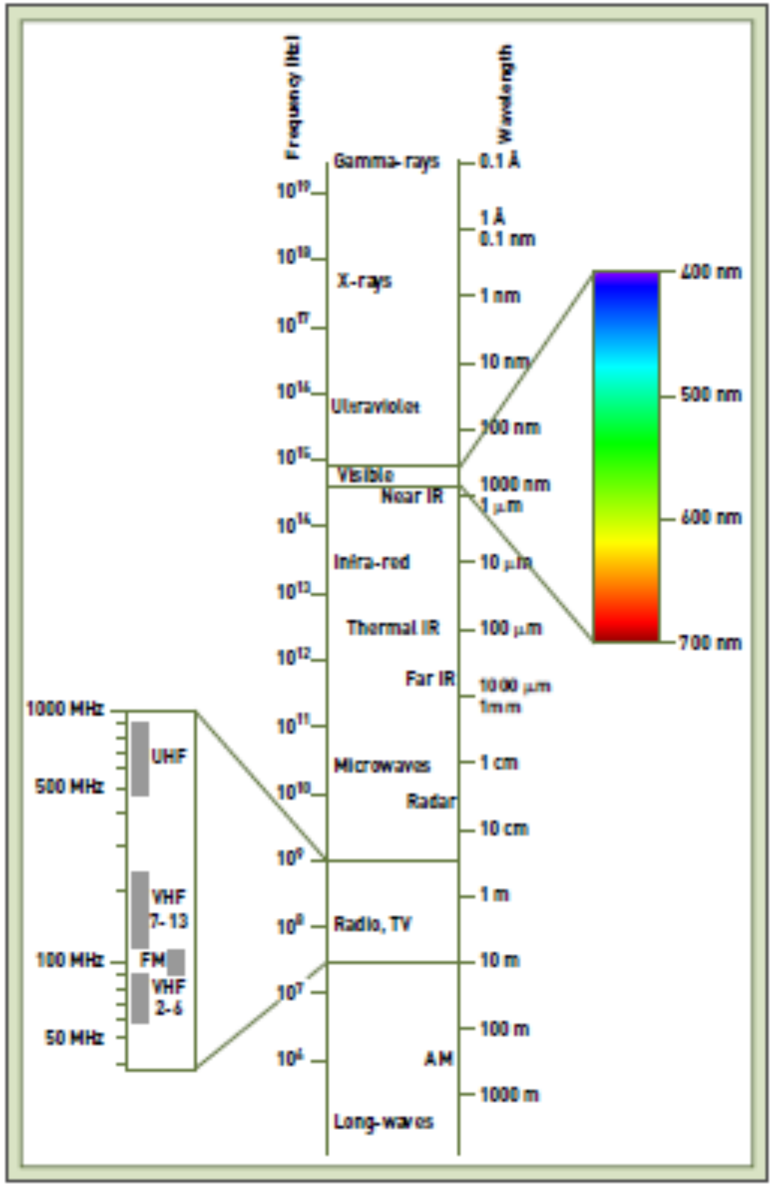
Basic Telecommunications Channel Characteristics

- **Broadband over power lines:**
  - Potential problem: transmitting data over unshielded power lines can interfere with both amateur (ham) radio broadcasts and police and fire radios
- **Wireless communications options:**
  - Wireless transmission involves the broadcast of communications in one of three frequency ranges : Radio, microwave, or infrared frequencies

Wireless communication

- **Wireless communication is the transfer of information between two or more points that are not connected by an electrical conductor.**
- **All wireless communications signals are sent within a range of frequencies of the electromagnetic spectrum that represents the entire range of light that exists from long waves to gamma rays**
- **Like any other wave, light has two fundamental properties that describe it**
  - **frequency, measured in hertz (Hz), which counts the number of waves that pass by a stationary point in one second.**
  - **wavelength, which is the distance from the peak of one wave to the peak of the next.**
  - **These two attributes are inversely related so the higher the frequency, the shorter the wavelength.**

Principles & Architecture



Olivier Berthet – October 23

Frequency ranges used for wireless communications

Technology	Description	Advantages	Disadvantages
Radio frequency range	Operates in the 3 KHz–300 MHz range	Supports mobile users; costs are dropping	Signal is highly susceptible to interception
Microwave—terrestrial and satellite frequency range	High-frequency radio signal (300 MHz–300 GHz) sent through the atmosphere and space (often involves communications satellites)	Avoids cost and effort to lay cable or wires; capable of high-speed transmission	Must have unobstructed line of sight between sender and receiver; signal is highly susceptible to interception
Infrared frequency range	Signals in the 300 GHz–400 THz frequency range	Lets you move, remove, and install devices without expensive wiring	Must have unobstructed line of sight between sender and receiver; transmission is effective only for short distances

Short Range Wireless Options

- **Near field communication (NFC)**
  - **Short-range wireless connectivity technology designed for cell phones and credit cards**
- **Bluetooth**
  - **Wireless communications specification that describes how cell phones, computers, personal digital assistants, etc., can be interconnected**
- **Infrared transmission**
  - **Sends signals at a frequency of 300 GHz and above**

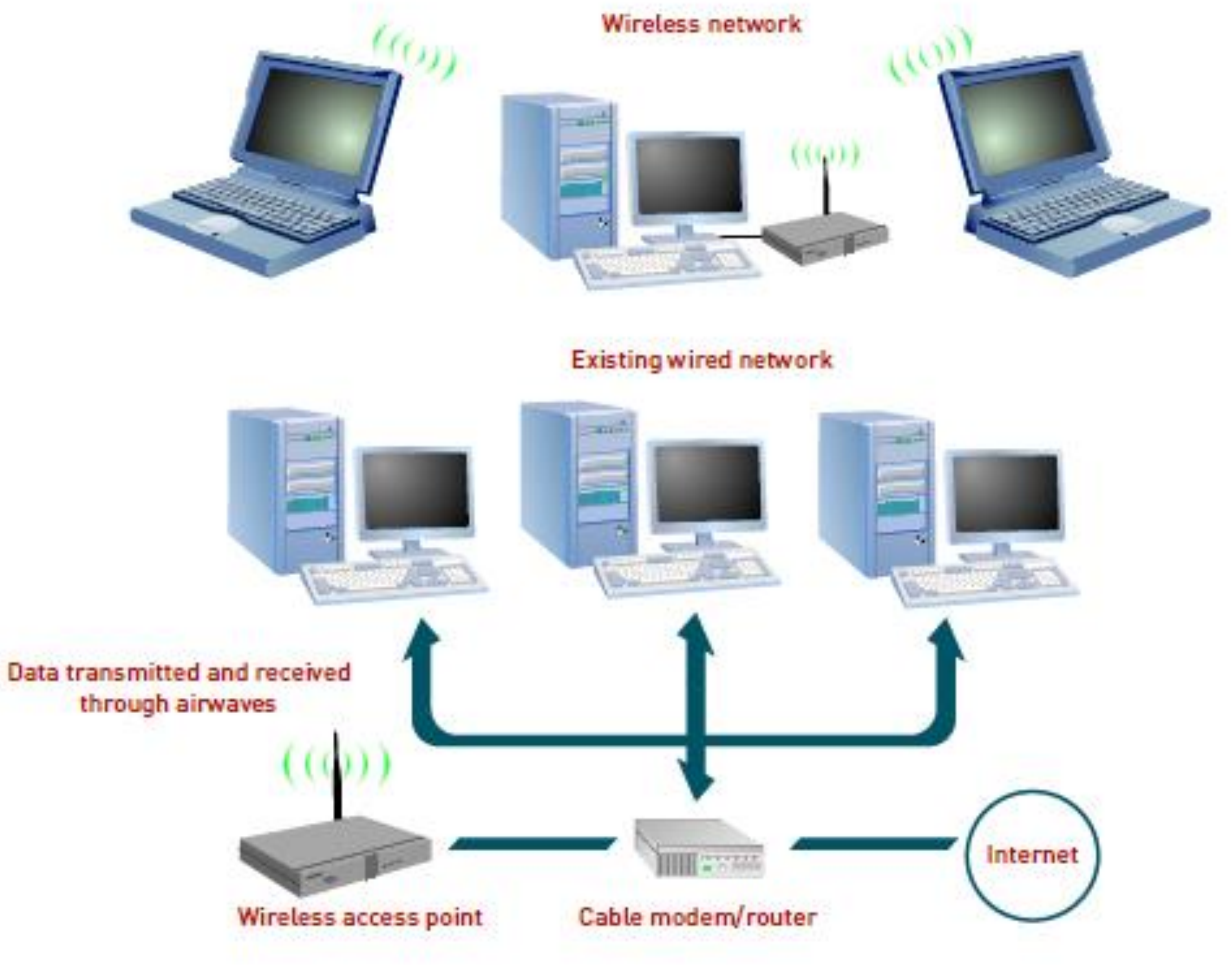
Principles & Architecture

Medium-Range Wireless Options

- **Wi-Fi:**
  - **Wireless telecommunications technology brand owned by the Wi-Fi Alliance**
- **Wireless access point:**
  - **Consists of a transmitter with an antenna**
  - **Receives the signal and decodes it**
- **Wi-Fi access points:**
  - **Have maximum range of about 300 feet outdoors and 100 feet within a dry-walled building**

Principles & Architecture

Wi-Fi network

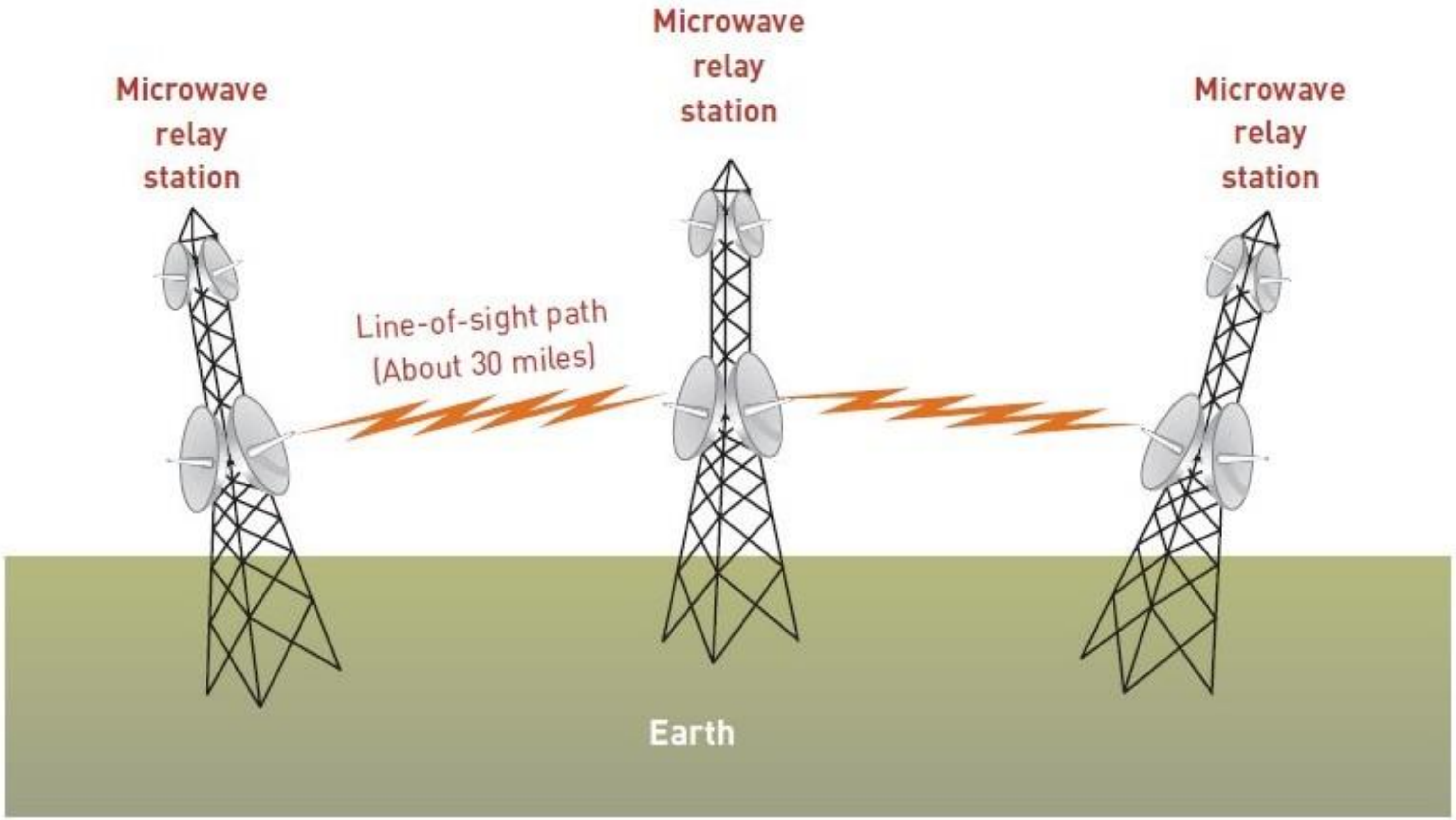


Wide Area Wireless Network Types

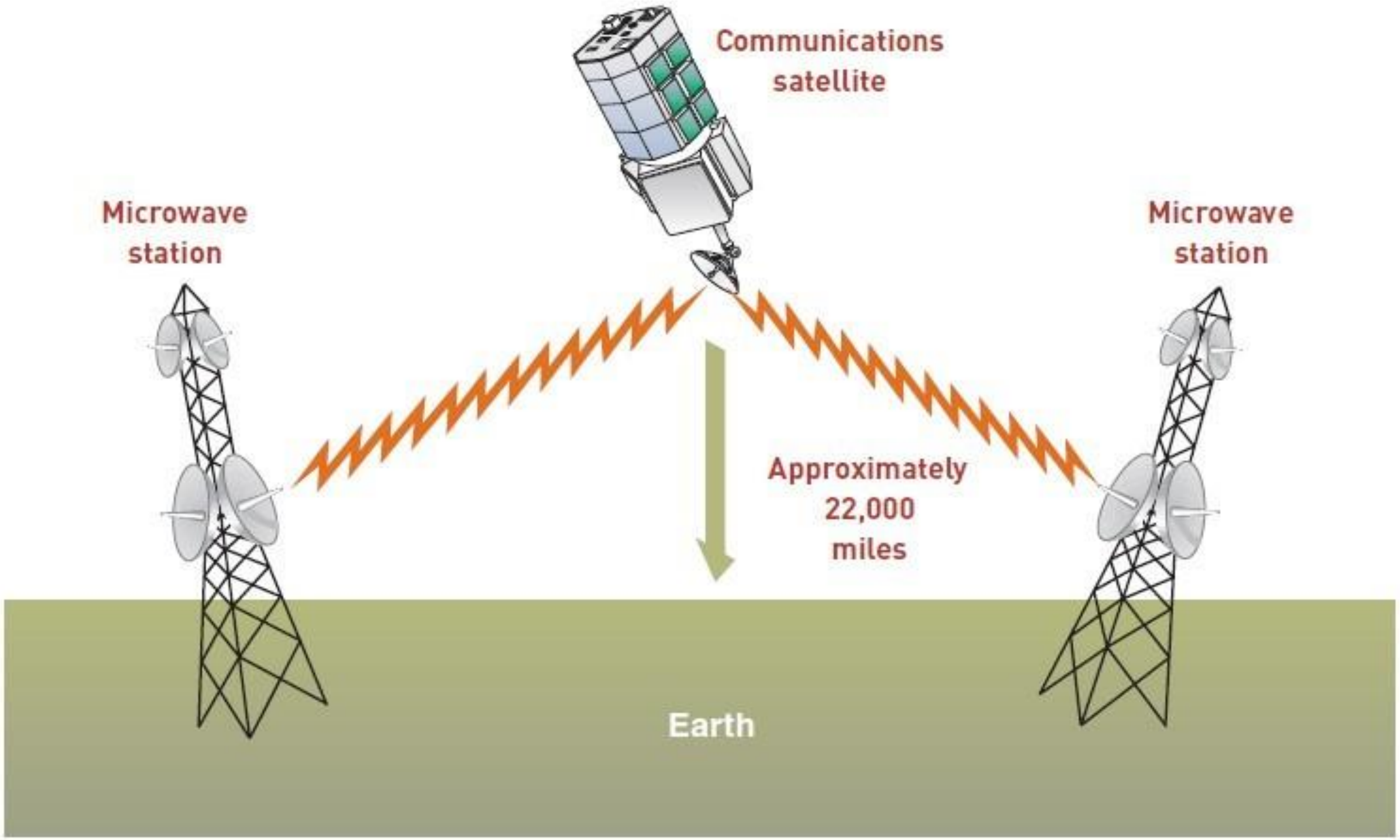
- **Microwave transmission:**
  - High-frequency (300 MHz–300 GHz) signal sent through the air
- **Common forms of satellite communications:**
  - Geostationary satellite
  - Low-earth orbit (LEO) satellite
  - Very small aperture terminal (VSAT)

Principles & Architecture

Microwave communications

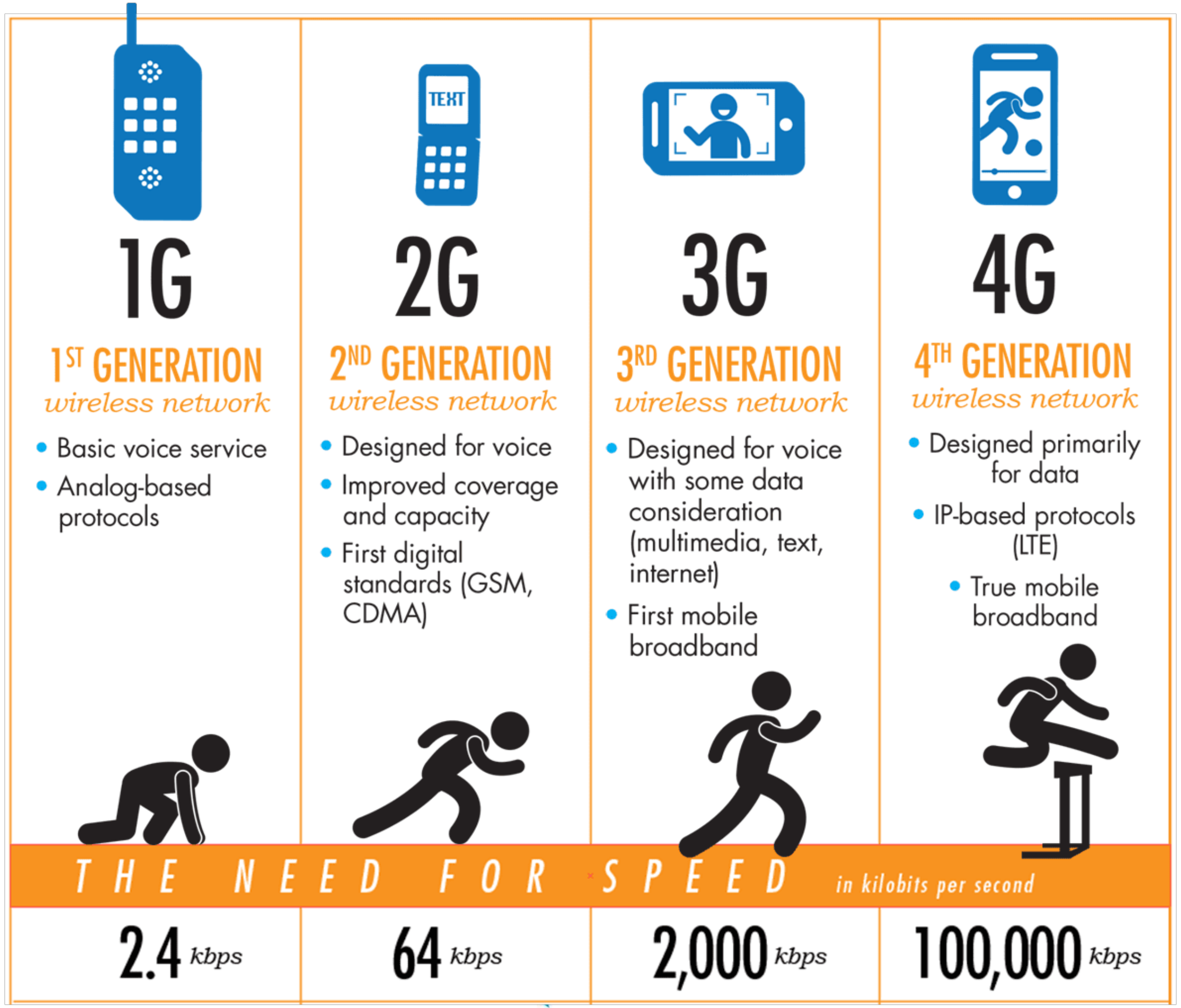


Satellite transmissions



Principles & Architecture

History of nG



History of nG

- **Wireless communications has evolved through four generations of technology and services.**
- **The first generation (1G) of wireless communications standards originated in the 1980s and was based on analog communications.**
- **The second-generation (2G) networks were fully digital, superseding 1G networks in the early 1990s.**
- **With 2G networks**
  - **phone conversations were encrypted**
  - **mobile phone usage was expanded, and short message services (SMS)—or texting—was introduced.**

History of nG

- 3G wireless communications supports wireless voice and broadband speed data communications in a mobile environment at speeds of 2 to 4 Mbps.
- Additional capabilities of 3G include mobile video, mobile e-commerce, location-based services, mobile gaming, and the downloading and playing of music
- 4G wireless communications provides increased data transmission rates in the 20–40 Mbps range
- 4G broadband mobile wireless delivers more advanced versions of enhanced multimedia, smooth streaming video, universal access, and portability across all types of devices; eventually 4G will also make possible worldwide roaming.
- 4G can deliver 3 to 20 times the speed of 3G networks for mobile devices such as smartphones, tablets, and laptops.

History of nG

- The frequencies used for 4G are in the 700, 800 and 900 MHz, 1800, 2100 and 2600 MHz bands
- The 3.5 GHz frequency band (3.4 - 3.8 GHz) is the one that will be used primarily for the 5G mobile network. This is the core 5G band. Of the 400 MHz of spectrum width, 310 MHz was available for 5G and it was assigned exclusively to 5G

Principles & Architecture

5G Wireless Communications

- **5G is a term used to identify the next major phase of mobile communications standards beyond 4G.**
- **5G will bring with it**
  - **higher data transmission rates**
  - **lower power consumption**
  - **higher connect reliability with fewer dropped calls**
  - **increased geographic coverage**
  - **lower infrastructure**

- **5G networks should meet the goal of a 50 times faster data rate than the most advanced Wi-Fi networks today, they will be able to stream a two-hourmovie in less than three seconds.**

Principles & Architecture

Worldwide Area Network – WAN

- **A wide area network (WAN) is a network that connects large geographic regions**
- **A WAN might be privately owned or rented and includes public (shared-users) networks.**
- **WANs usually consist of computer equipment owned by the user, together with data communications equipment and network links provided by various carriers and service providers.**
- **WANs often provide communications across national borders, which involves national and international laws regulating the electronic flow of data across international boundaries**
- **Some countries have strict laws limiting the use of networks and databases, making normal business transactions such as payroll processing costly, slow, or extremely difficult.**

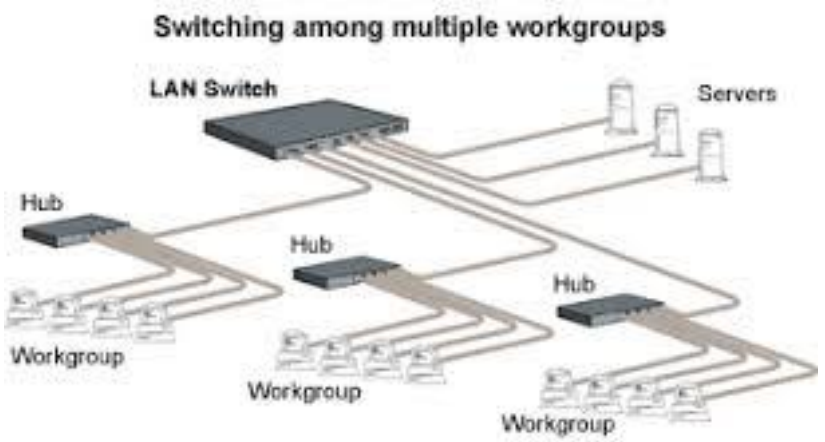
Principles & Architecture

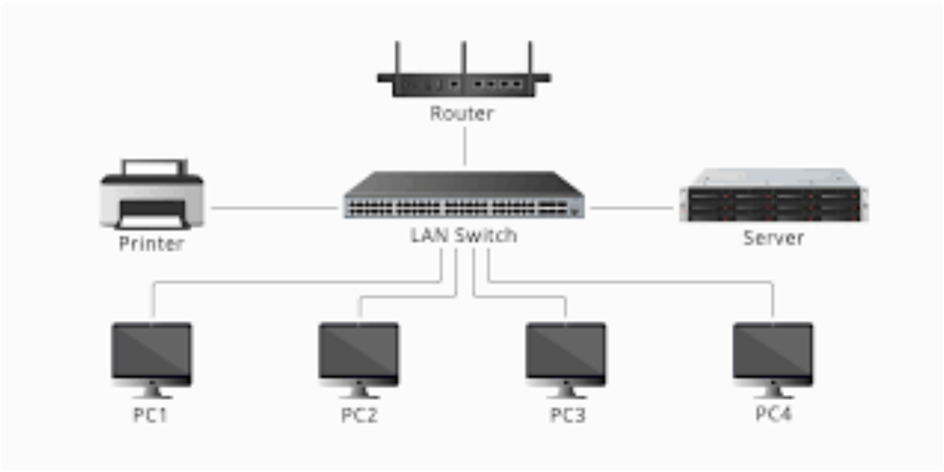
WAN & LAN

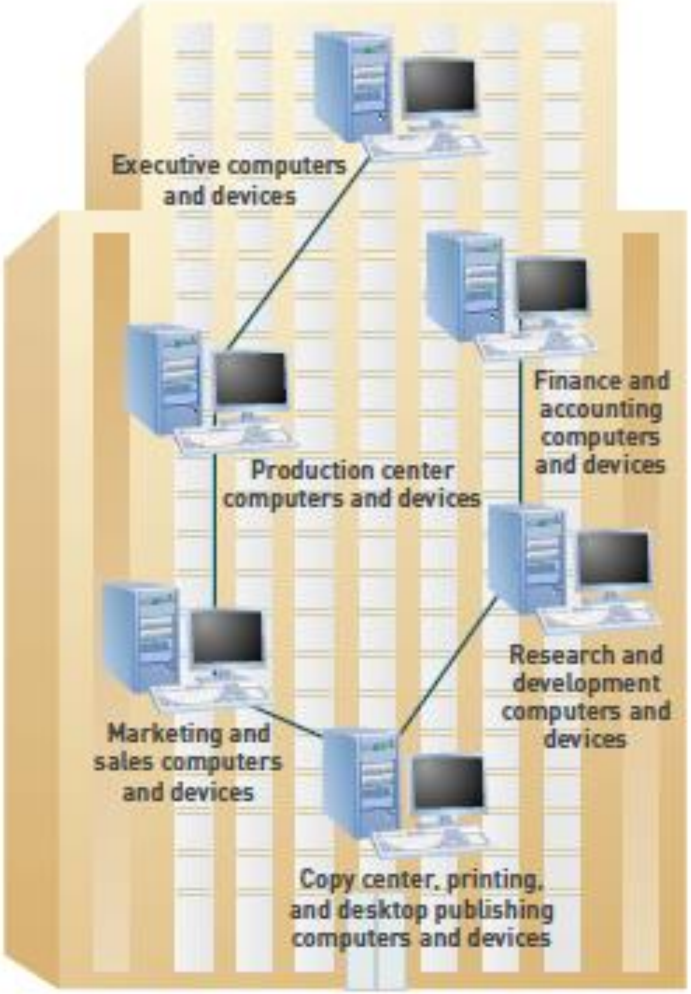
Local Area Network – LAN

- **A network that connects computer systems and devices within a small area, such as an office, home, or several floors in a building is a local area network (LAN)**
- **Typically, LANs are wired into office buildings and factories**
- **Although LANs often use unshielded twisted-pair copper wire, other media—including fiber-optic cable—is also popular.**
- **LANs can be used to connect personal computers, laptop computers, or powerful**
- **mainframe computers.**

Typical LAN

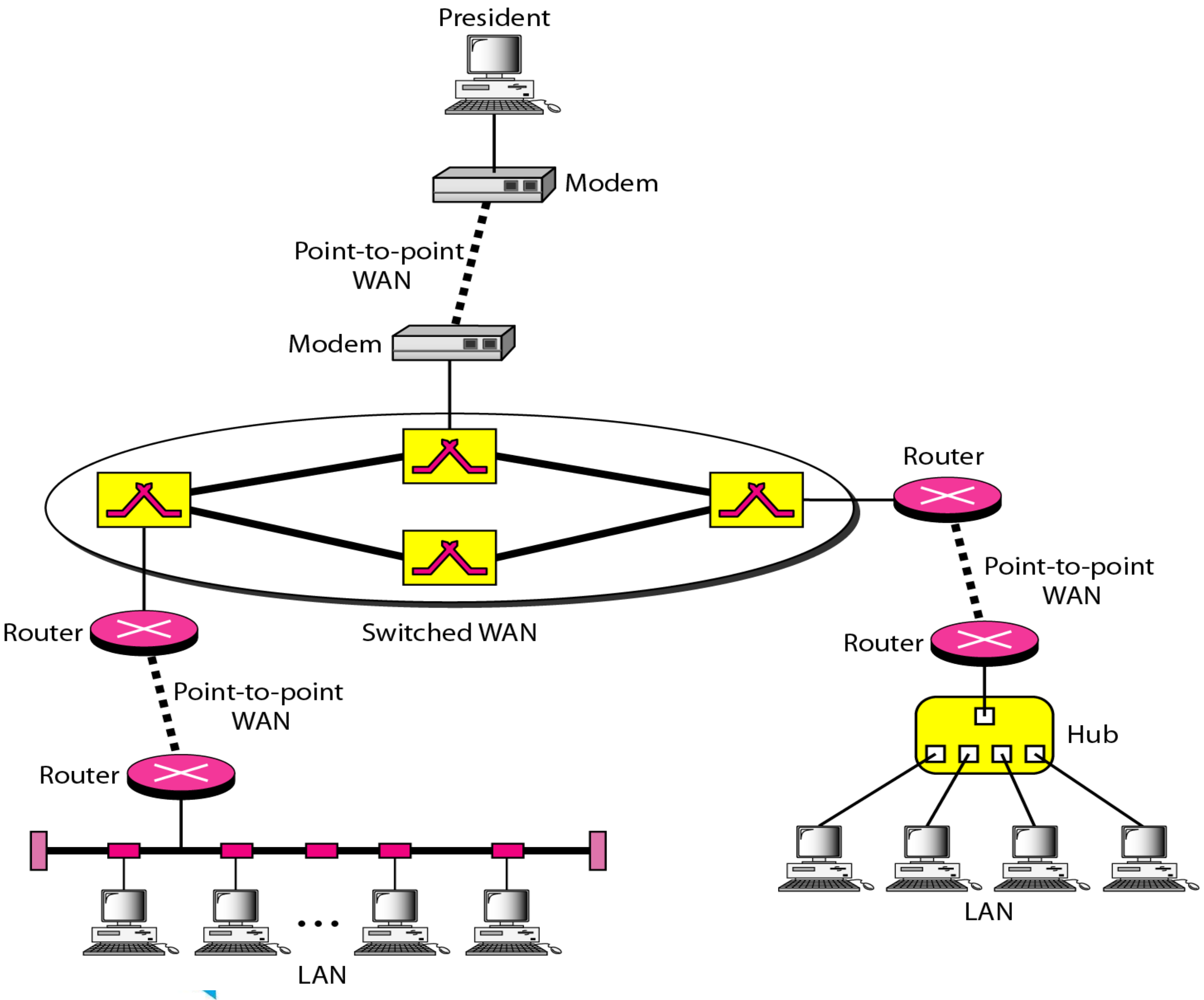

Switching among multiple workgroups
LAN Switch
Servers
Hub
Hub
Hub
Workgroup
Workgroup
Workgroup


Router
Printer
LAN Switch
Server
PC1
PC2
PC3
PC4


Executive computers and devices
Finance and accounting computers and devices
Production center computers and devices
Research and development computers and devices
Marketing and sales computers and devices
Copy center, printing, and desktop publishing computers and devices

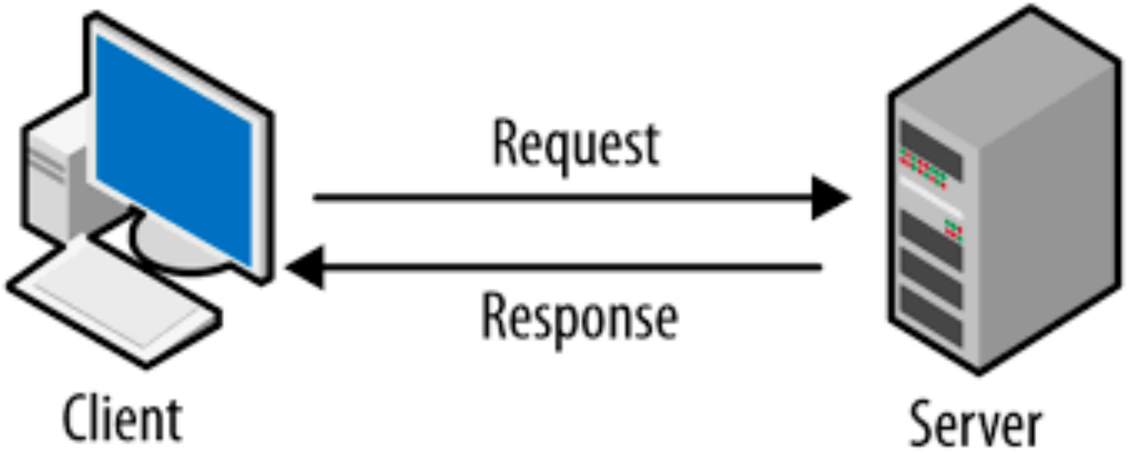
Principles & Architecture

A heterogeneous network made of four WANs and two LANs



Client/Server Systems

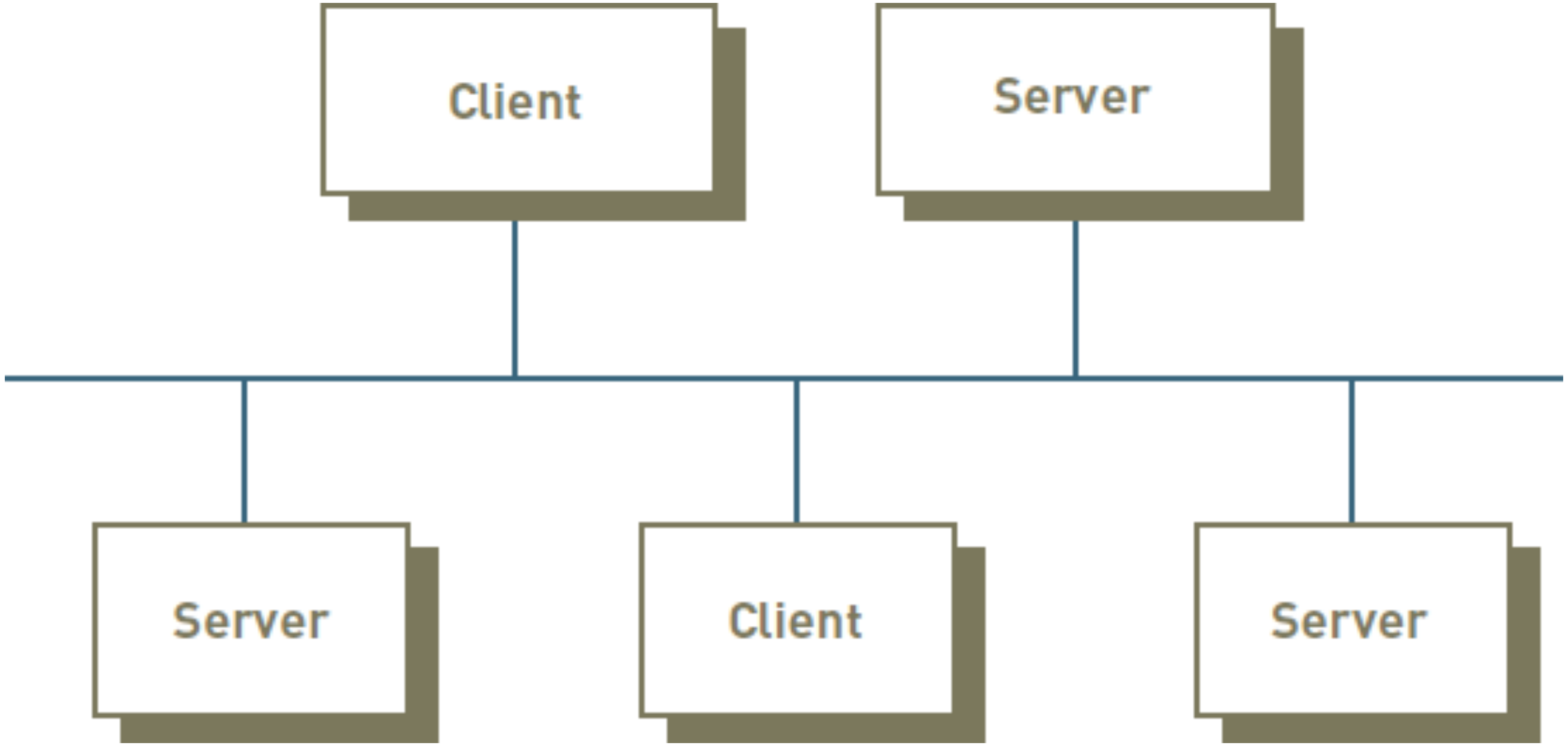
- A client is any computer (often a user's personal computer) that sends messages requesting services from the servers on the network.
- A client can converse with many servers concurrently.
- The client or the server might do the actual data processing.



Client/Server Systems

- **In client/server architecture, multiple computer platforms are dedicated to special functions, such as database management, printing, communications, and program execution.**
- **These platforms are called servers.**
  - **Each server is accessible by all computers on the network.**
  - **Servers can be computers of all sizes;**
  - **Servers store both application programs and data files and are equipped with operating system software to manage the activities of the network.**
  - **The server distributes programs and data to the other computers (clients) on them network as they request them.**
  - **An application server holds the programs and data files for a particular application, such as an inventory database.**
  - **A Database server sends only the data that satisfies a specific query, not the entire file**

Client/Server Systems



Telecommunications Hardware

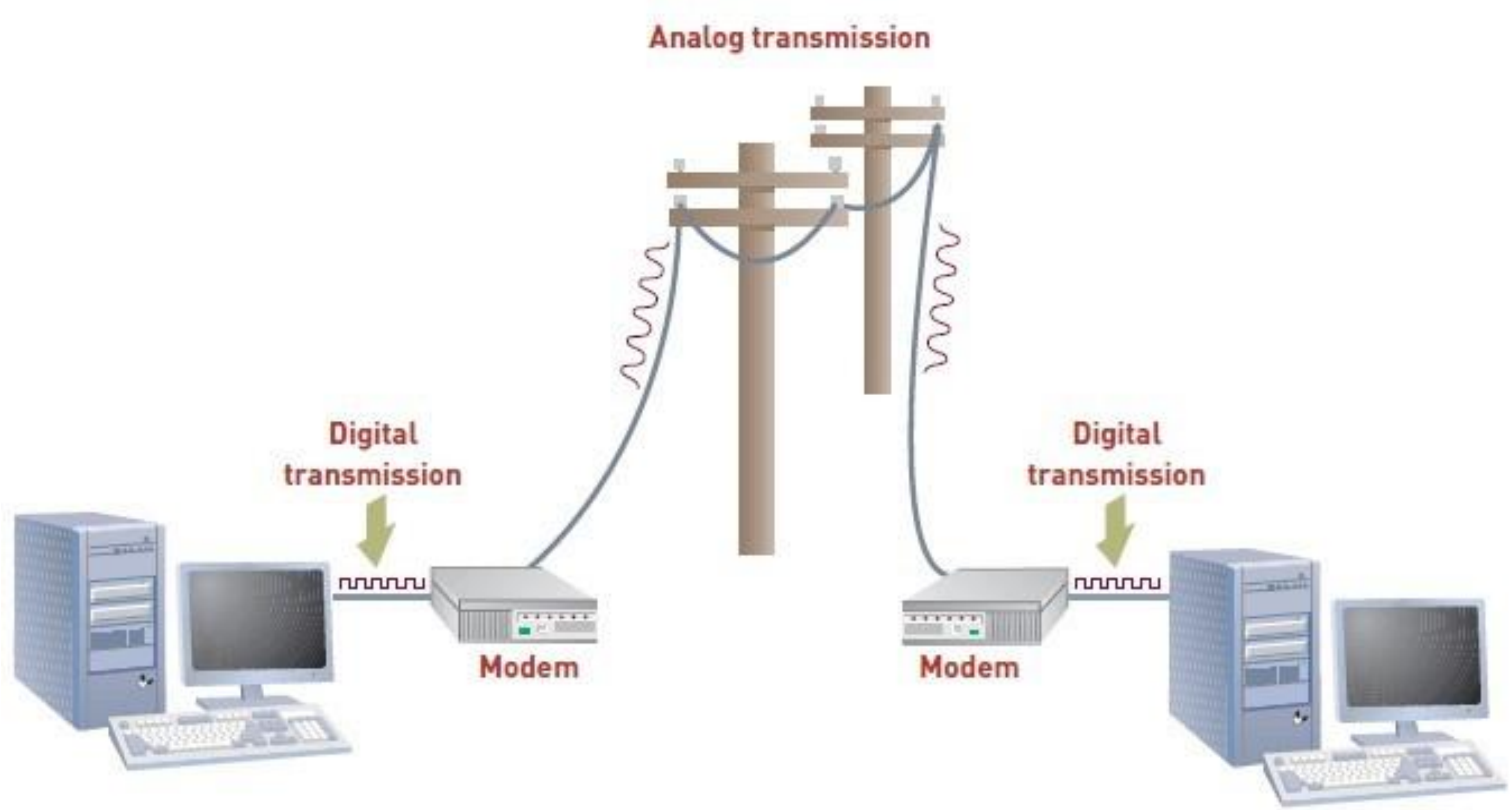
- **Smartphones**
  - Combine the functionality of a mobile phone, camera, Web browser, e-mail tool, MP3 player, and other devices
  - Have their own software operating systems
- **Modems**
  - Modulation/demodulation devices
- **Multiplexers**
  - Combine data from multiple data sources into a single output signal that carries multiple channels

Principles & Architecture

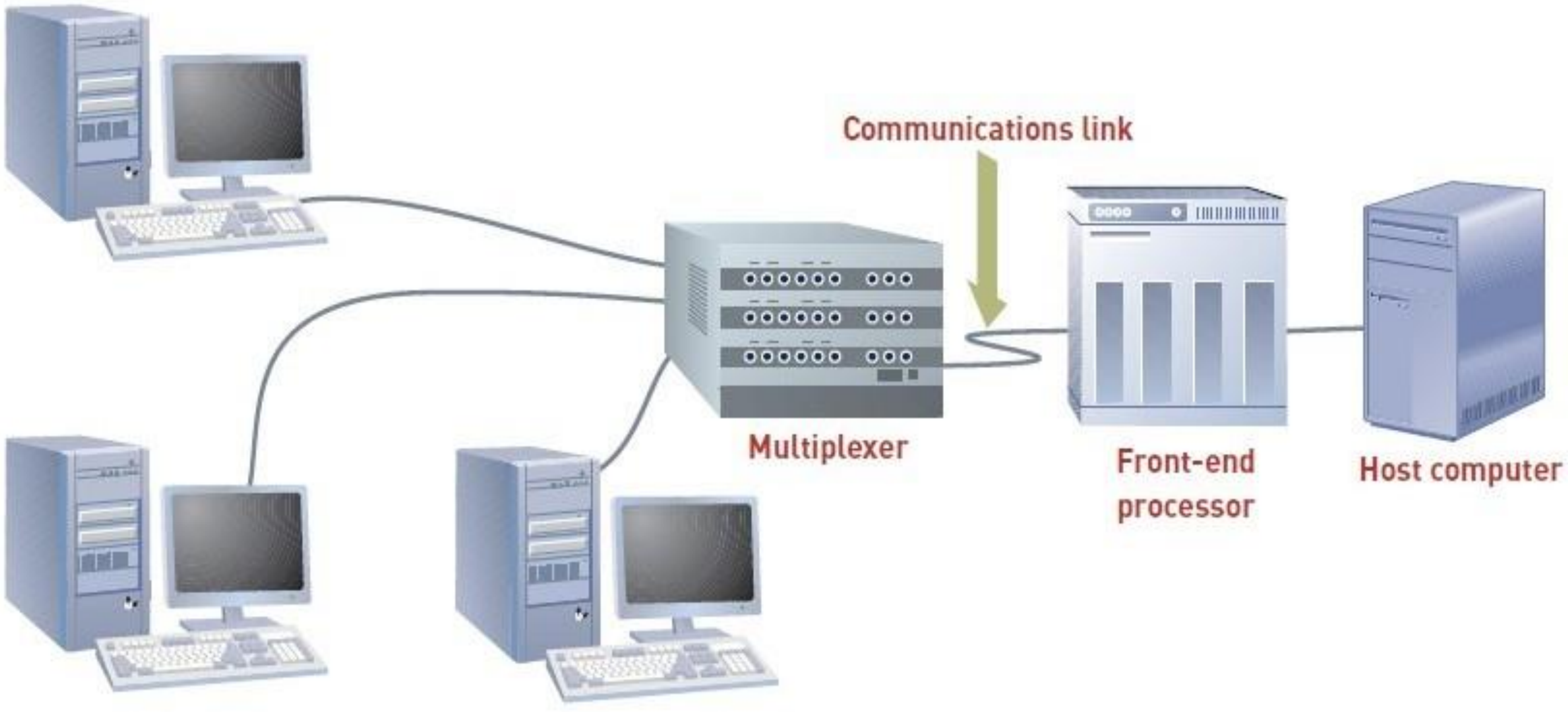
Telecommunications Hardware

- **Switch**
  - uses the physical device address in each incoming message on the network
- **Bridge**
  - connects two LANs together using the same telecommunications protocol
- **Router**
  - forwards data packets across two or more distinct networks toward their destinations
- **Gateway**
  - serves as an entrance to another network

Telecommunications Hardware



Telecommunications Hardware



Communications Software

- **Network operating system (NOS):**
  - Systems software that controls the computer systems and devices on a network
- **Network management software:**
  - Protects software from being copied, modified, or downloaded illegally
  - Locates telecommunications errors and potential network problems

Principles & Architecture

Software Defined Network (SDN)

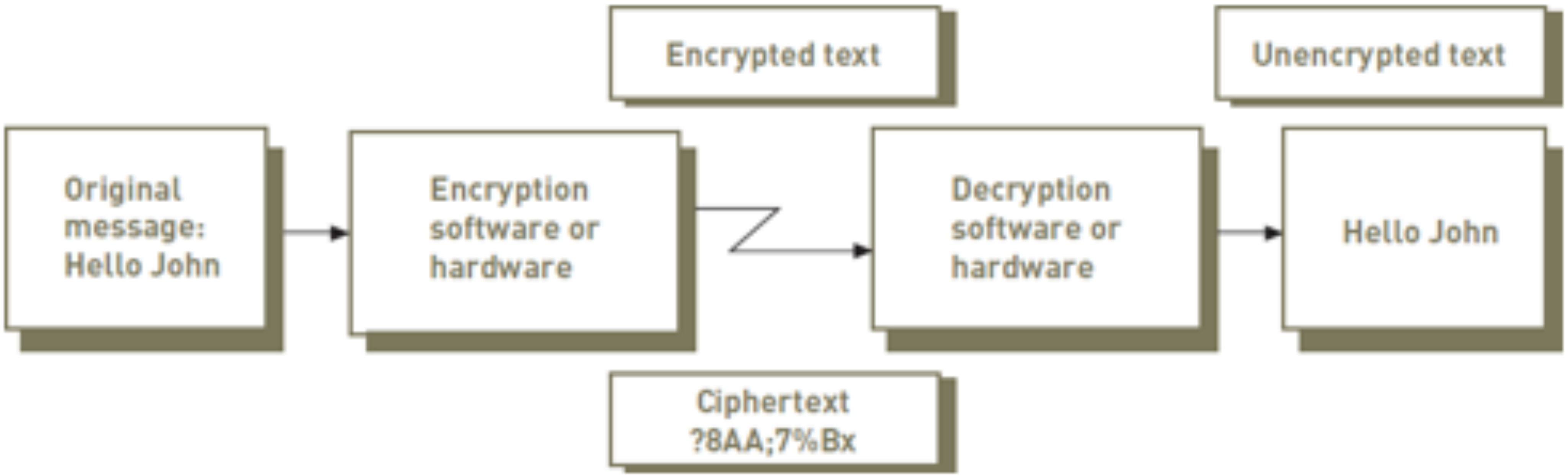
- Hundreds or thousands of network devices to perform such tasks as routing and switching of data through the network, providing network access and control
- Each network device must be configured individually and manually
- Labor-intensive and error prone effort, making it difficult to change the network so it can meet the changing needs of the organization.
- Software-defined networking (SDN) is an emerging approach to networking that allows network administrators to manage a network via a controller that does not require physical access to all the network devices.
- This approach automates tasks such as configuration and policy management and enables the network to dynamically respond to application requirements.
- Google is implementing Andromeda, Microsoft and Amazon also employ software-defined networks

Securing Data Transmission

- **Encryption:**
  - Converting an original message into a form that can only be understood by the intended receiver
- **Encryption key:**
  - Variable value that is applied (using an algorithm) to a set of unencrypted text to produce encrypted text or to decrypt encrypted text

Principles & Architecture

Securing Data Transmission



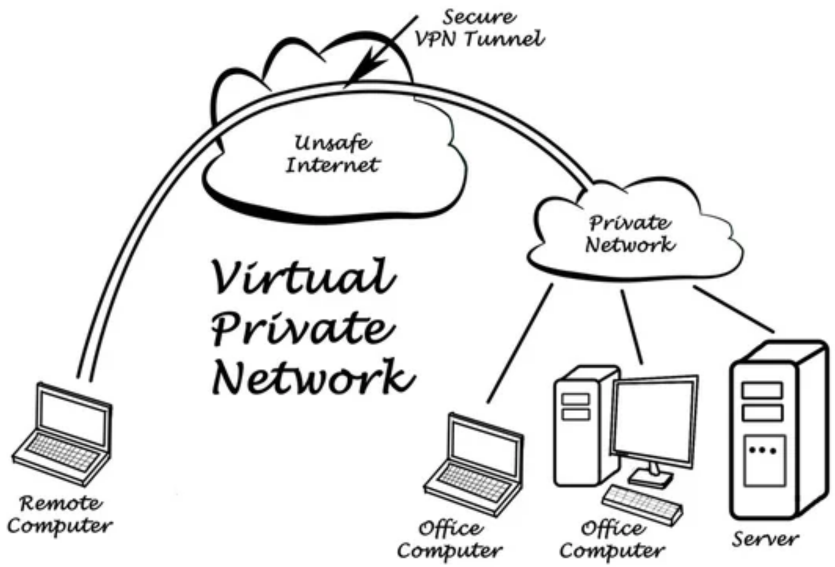
Securing wireless networks

- **Wired equivalent privacy (WEP):**
  - Used encryption based on 64-bit key, which has been upgraded to a 128-bit key
- **Wi-Fi Protected Access (WPA):**
  - Security protocol that offers significantly improved protection over WEP
- **War driving:**
  - Involves hackers driving around with a laptop and antenna trying to detect insecure wireless access points

Principles & Architecture

Virtual Private Network (VPN)

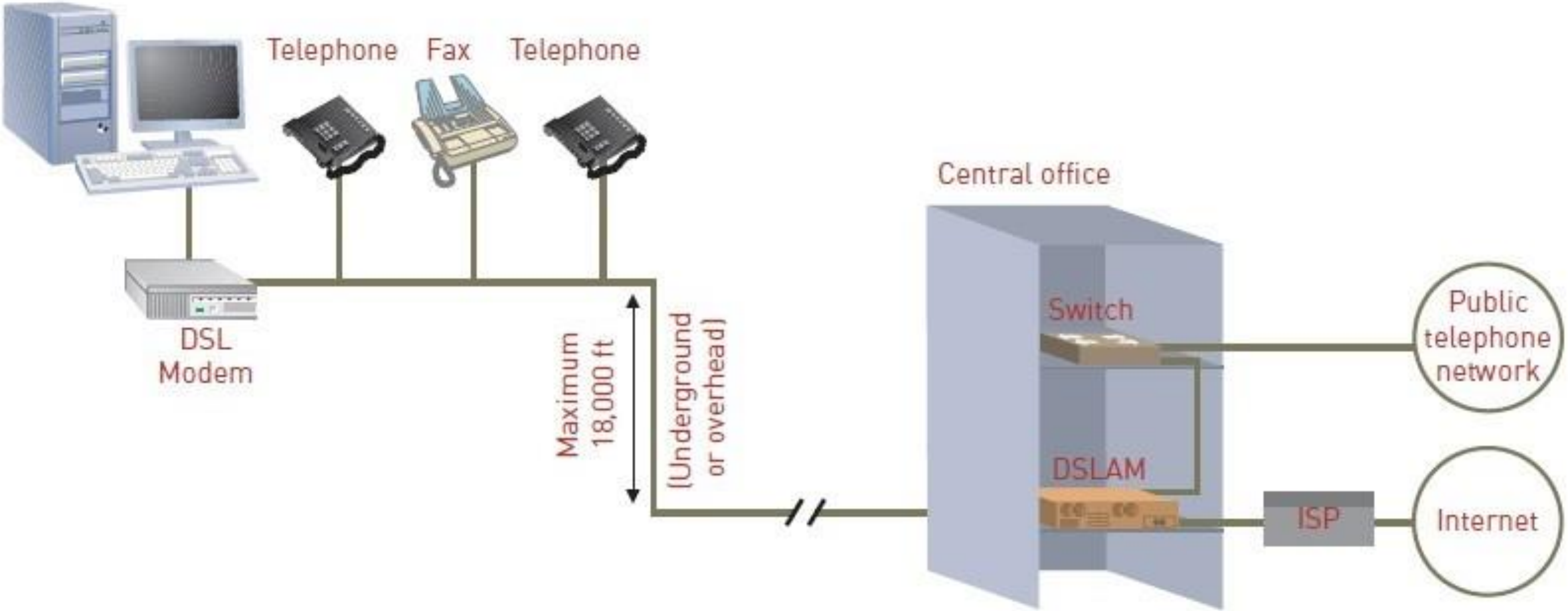
- Private network that uses a public network (usually the Internet) to connect multiple remote locations
- Provides network connectivity over a potentially long physical distance
- Supports secure, encrypted connections between a company's private network and remote users



Digital subscriber line (DSL) service

- **Telecommunications service that delivers high- speed Internet access**
- **Asymmetric DSL (ADSL) line:**
  - **Designed to provide download speed that is three to four times faster than upload speed**
- **Symmetric DSL (SDSL):**
  - **Used mainly by small businesses**
  - **Does not allow you to use the phone at the same time**
  - **The speed of receiving and sending data is the same**

Digital subscriber line (DSL) service



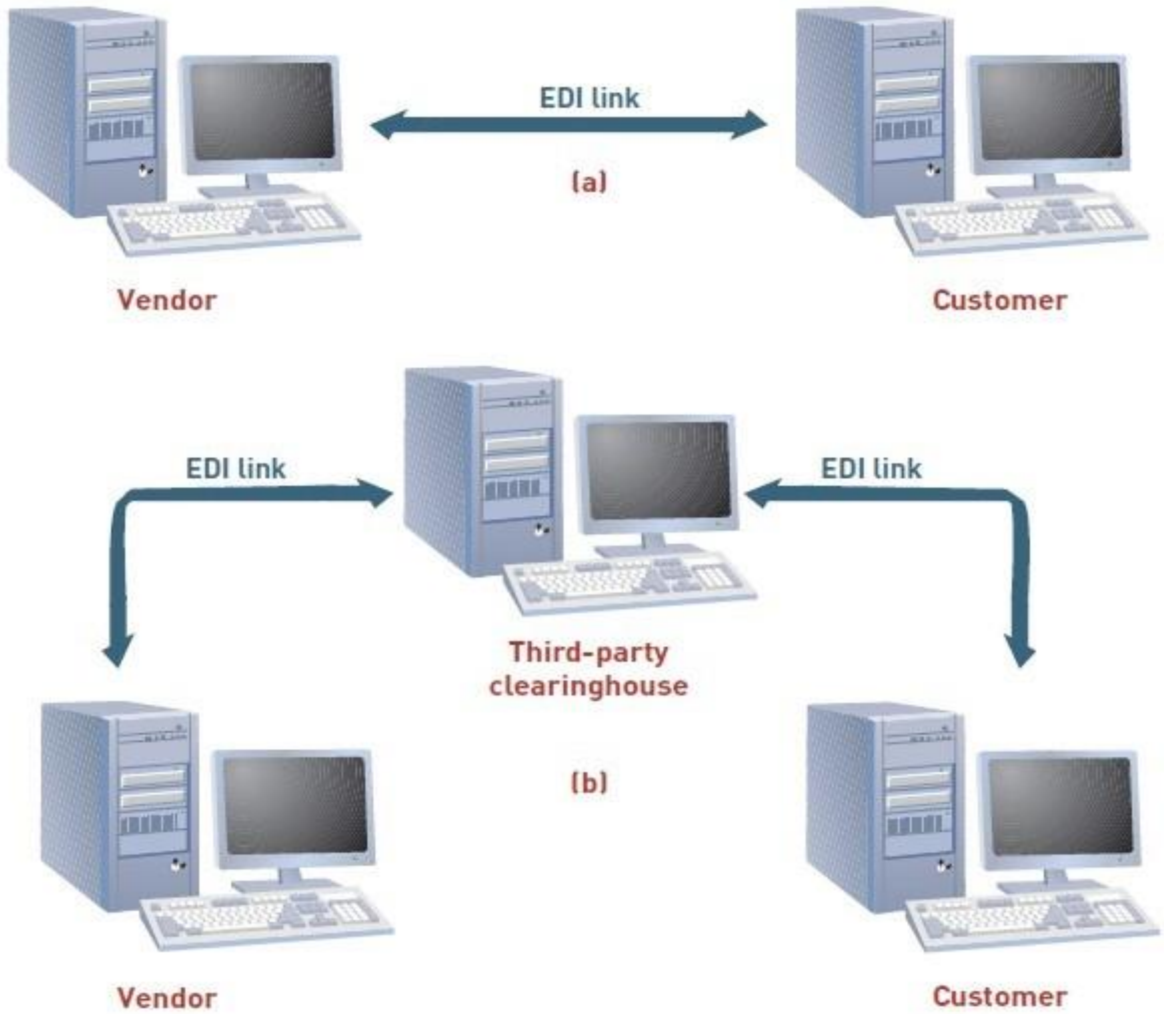
Home and Small Business Networks

- **DSL modem:**
  - Enables each computer in the network to access the Internet
- **Firewall:**
  - Filters the information coming from the Internet into your network
- **Router:**
  - Encrypts all wireless communications to keep your network secure

Electronic Data Interchange (EDI)

- **Idea behind EDI:**
  - Connecting corporate computers among organizations
- **EDI:**
  - Can link the computers of customers, manufacturers, and suppliers
  - Eliminates the need for paper documents and substantially cuts down on costly errors

Electronic Data Interchange (EDI)



Electronic funds transfer

- **System of transferring money from one bank account directly to another without any paper money changing hands**
- **Used for:**
  - **Credit transfers, such as payroll payments**
  - **Debit transfers, such as mortgage payments**
- **Benefits:**
  - **Reduced administrative costs**
  - **Increased efficiency**
  - **Simplified bookkeeping and greater security**

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Principles and Architecture of Information Systems

Chapter #6

Internet and E-Commerce

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Principles & Architecture

Structure

- Chapter 1 : Introduction and Organisations
- Chapter 2 : Hardware
- Chapter 3 : Software
- Chapter 4 : Database Systems
- Chapter 5 : Network
- Chapter 6 : Internet and E-Commerce
- Chapter 7 : Major Information Systems
- Chapter 8 : Systems Development
- Chapter 9 : Security,Privacy and Ethical issues

Introduction

- The Internet provides a critical infrastructure for delivering and accessing information and services
- Originally developed as a document-management system, the World Wide Web has grown to become a primary source of news and information, an indispensible conduit for commerce, and a popular hub for social interaction, entertainment, and communication
- The Internet and Web provide numerous resources for finding information, communicating and collaborating, socializing, conducting business and shopping, and being entertained

Discussion

- **Can you name some Internet utilities?**

Why Learn About the Internet?

- **Businesses use the Internet to:**
- **Sell and advertise their products and services, reaching out to new and existing customers**
- **People working in every field and at every level use the Internet in their work**
- **Most companies have Internet sites that:**
- **List job opportunities, descriptions, qualifications, salaries, and benefits**

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Popular uses for the Internet and Web

- **Publishing information**
- **Assisting users in finding information**
- **Supporting communication and collaboration**
- **Building online community**
- **Providing software applications**
- **Providing a platform for expressing ideas**
- **Delivering media of all types**
- **Providing a platform for commerce**
- **Supporting travel and navigation**

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Use and Functioning of the Internet

- **ARPANET:**
  - Ancestor of the Internet
  - Project started by the U.S. Department of Defense (DoD) in 1969
- **Internet Protocol (IP):**
  - Enables computers to route communications traffic from one network to another

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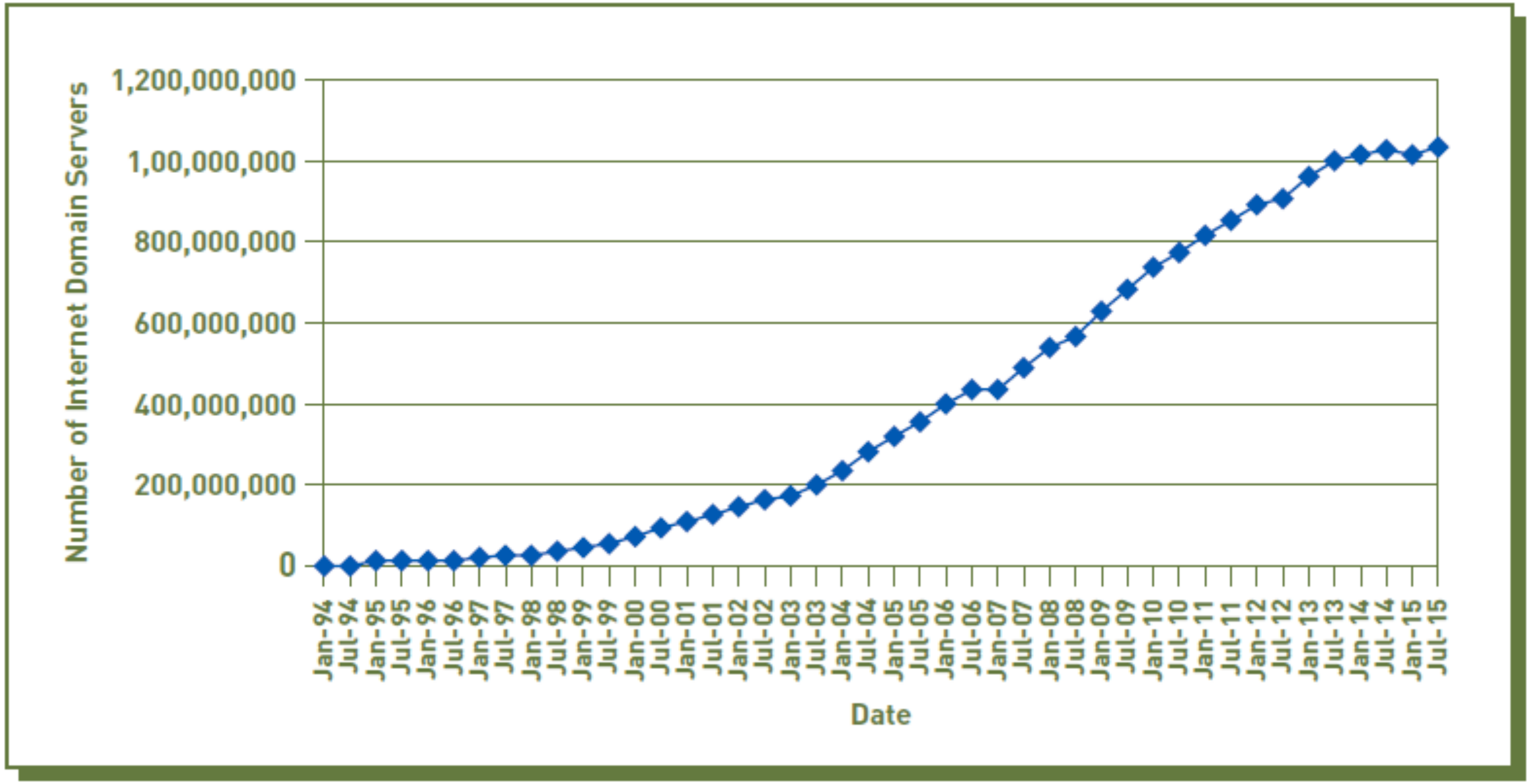
Internet growth



How the Internet works

- **Backbone:**
  - One of the Internet's high-speed, long-distance communications links
- **Transmission Control Protocol (TCP):**
  - Transport-layer protocol that most Internet applications use with IP
- **Uniform Resource Locator (URL):**
  - An assigned address on the Internet for each computer

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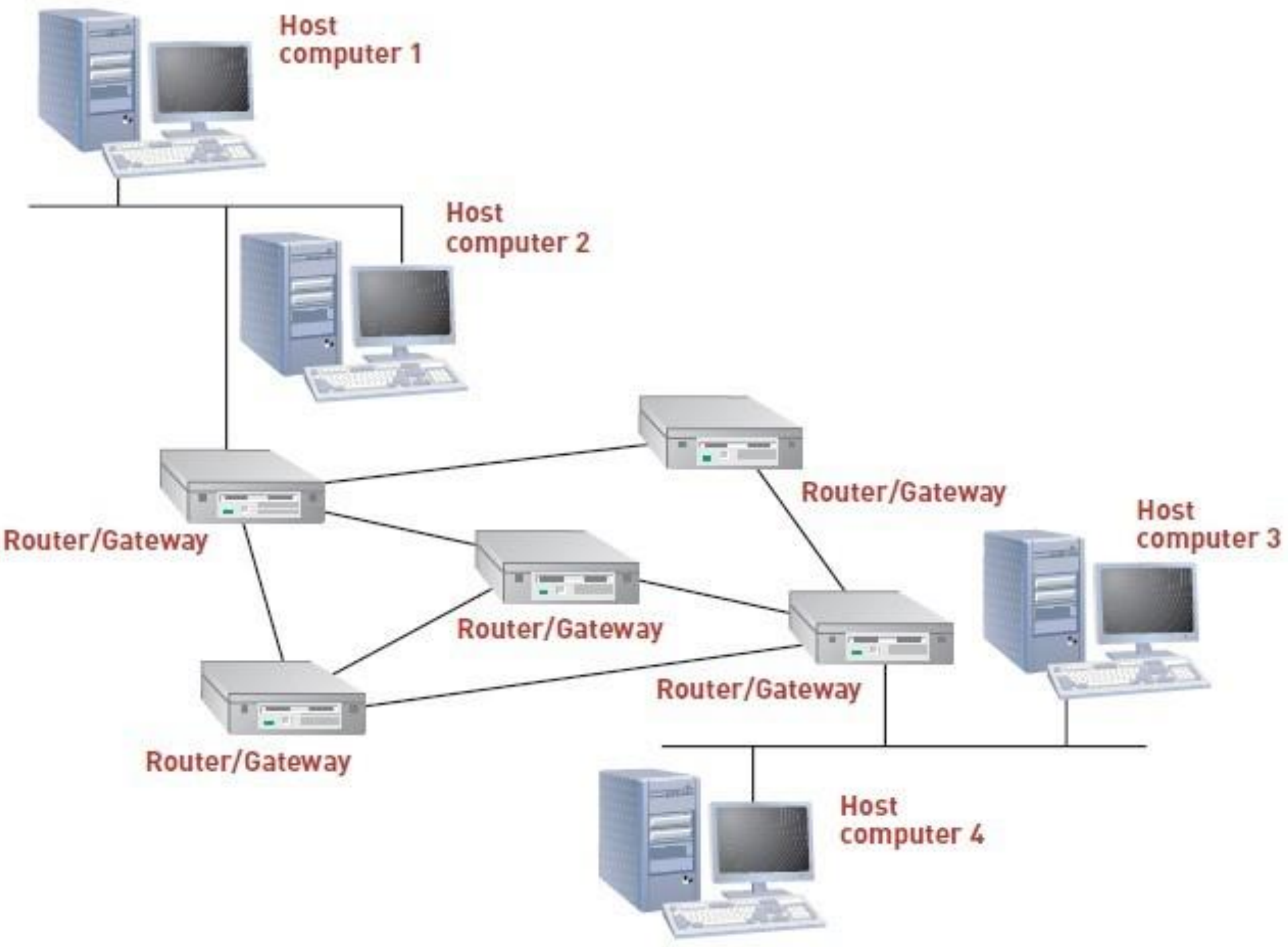
How the Internet works

- **IP address:**
  - **64-bit number that identifies a computer on the Internet**
- **Internet Corporation for Assigned Names and Numbers (ICANN)**
  - **Responsible for managing IP addresses and Internet domain names (.com, .fr, .org…)**
  - **Has authority to resolve domain name disputes**

Routing messages over the Internet



Cloud Computing

- **Computing environment in which:**
  - **Software and storage are provided as an Internet service and accessed with a Web browser**
- **Extremely scalable and often takes advantage of virtualization technologies**
- **Advantages to businesses:**
  - **Businesses can save on system design, installation, and maintenance**
  - **Employees can access corporate systems from any Internet-connected computer**

The World Wide Web

- Developed by Tim Berners-Lee at CERN in Geneva in 1992
- Originally conceived of as an internal document- management system
- The Web has grown to become:
  - A primary source of news and information
  - An indispensable conduit for commerce
  - A popular hub for social interaction, entertainment, and communication

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How the Web Works

- **The Internet:**
  - **Made up of computers, network hardware such as routers and fiber-optic cables, software, and the TCP/IP protocols**
- **The Web:**
  - **Consists of server and client software, the Hypertext Transfer Protocol (http), standards, and mark-up languages that combine to deliver information and services over the Internet**

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How the Web Works

- **Hyperlink:**
  - Highlighted text or graphics in a Web document that, when clicked, opens a new Web page
- **Web browser:**
  - Web client software such as Internet Explorer, Firefox, and Safari used to view Web pages
- **Hypertext Markup Language (HTML):**
  - Standard page description language for Web pages

How the Web Works

- **HTML tags:**
  - Tell the Web browser how to format text
- **Extensible Markup Language (XML):**
  - Markup language for Web documents containing structured information
- **Cascading Style Sheet (CSS):**
  - Markup language that defines the visual appearance of content in a Web page

Web Programming Languages

- **Java:**
  - **Object-oriented programming language from Sun Microsystems based on C++**
  - **Allows small programs (applets) to be embedded within an HTML document**
- **Other languages:**
  - **Asynchronous JavaScript and XML (AJAX)**
  - **Hypertext Preprocessor (PHP)**
  - **Adobe Flash and Microsoft Silverlight**

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Web Services

- **Standards and tools that streamline and simplify communication among Web sites**
- **XML: The key to Web services**
- **Other components used in Web service applications:**
  - **SOAP (Simple Object Access Protocol)**
  - **WSDL (Web Services Description Language)**
  - **UDDI (Universal Discovery Description and Integration)**

Search Engines and Web Research

- **Search engine:**
  - Enables you to find information on the Web by specifying keywords
  - Market is dominated by Google
  - Uses an automated approach that scours the Web with automated programs called spiders
- **Wikipedia:**
  - Can be used for online research
- **Wikimedia:**
  - Has wikis for books, news, media, and open learning

Communication and Collaboration

- **Web Portals**
- **Corporate Portals**
- **E-mail**
- **Instant messaging**
- **Microblogging, status updates, and news feeds**
- **Conferencing**

Online Media and entertainment

- **Podcast**
- **Music streaming**
- **Movies, video, and television**
- **E-books and audio books**
- **Online games**
- **Travel agencies**
- **Google map**

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Intranet and Extranet

Type	Users	Need User ID and Password?
Internet	Anyone	No
Intranet	Employees and managers	Yes
Extranet	Business partners	Yes

E-Commerce

- **Electronic commerce:**
  - **Conducting business activities electronically over computer networks**
- **Business activities that are strong candidates for conversion to e-commerce:**
  - **Paper based**
  - **Time-consuming**
  - **Inconvenient for customers**

Business-to-Business (B2B) E-Commerce

- **Subset of e-commerce**
- **All the participants are organizations**
- **Useful tool for connecting business partners in a virtual supply chain to cut resupply times and reduce costs**
- **An organization will use both:**
  - **Buy-side e-commerce to purchase goods and services and**
  - **Sell-side e-commerce to sell products to its customers**

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Business-to-Consumer (B2C) E-Commerce

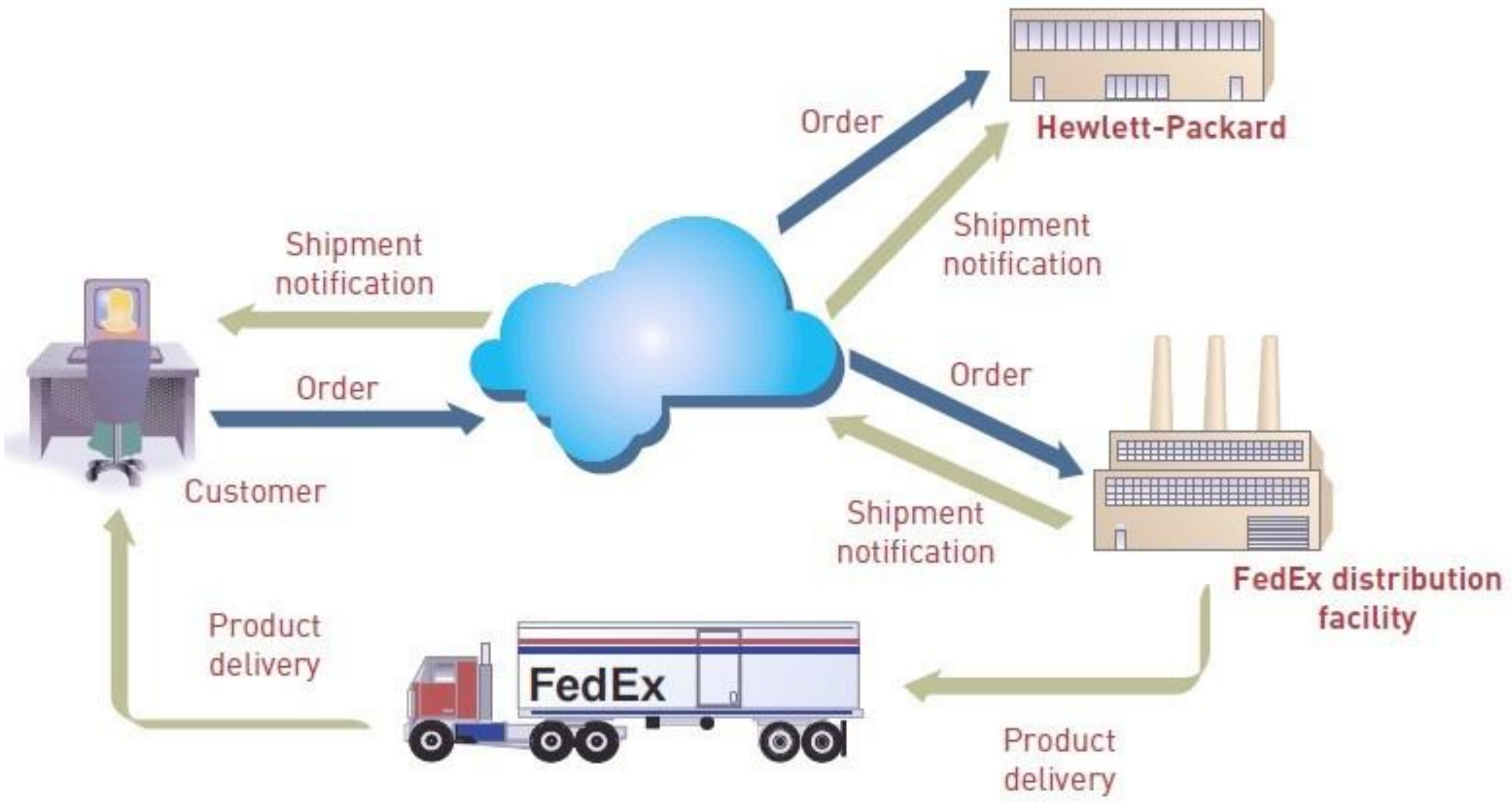
- **Form of e-commerce in which customers deal directly with an organization and avoid intermediaries**
- **Disintermediation: The elimination of intermediate organizations between the producer and the consumer**

Consumer-to-Consumer (C2C) E-Commerce

- **Subset of e-commerce that involves consumers selling directly to other consumers**
- **Popular sites: Le Bon Coin, Vinted, BlaBlaCar, AirBnB**

- **Etsy is a C2C Web site that:**
  - **Specializes in the buying and selling of handmade and vintage items**
  - **Facilitates sales worth more than $10 million each month**

Multistage model for e-Commerce



Multistage Model for E-Commerce

- **Search and identification**
- **Selection and negotiation**
- **Purchasing products and services electronically**
- **Product and service delivery**
- **After-sales service**

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Defining an Effective E-Commerce Model and Strategy

Advantages of Electronic and Mobile Commerce

- **What are the advantages ?**

Advantages of Electronic and Mobile Commerce

- **Reduce costs**
- **Speed the flow of goods and information**
- **Increase accuracy**
- **Improve customer service**

Investment and Finance

- **The Internet has revolutionized the world of investment and finance**
- **The brokerage business adapted to the Internet faster than any other arm of finance – Disruption**
- **Online banking customers:**
  - **Can check balances of their savings, checking, and loan accounts**
  - **Transfer money among accounts**
  - **Pay their bills**

Threats to Electronic and Mobile Commerce

- **Businesses must ensure that e-commerce and m-commerce transactions are safe and consumers are protected**
- **Methods to increase security:**
  - **Address Verification System**
  - **Card Verification Number technique**
  - **Visa's Advanced Authorization process**
  - **Federal Financial Institutions Examination Council's "Authentication in an Internet Banking Environment" guidelines**

Strategies for Successful E-Commerce and M-Commerce

- **Companies must develop effective Web sites that include the following characteristics:**
  - Easy to use
  - Accomplish the goals of the company
  - Safe and secure
  - Affordable to set up and maintain

Measures to attract customers

- Obtain and register a domain name
- Make your site search-engine friendly
- Include a meta tag in your store’s home page
- Building Traffic to Your Web Site
- Use Web site traffic data analysis software
- Provide quality, keyword-rich content
- Add new content to the Web site on a regular basis
- Acquire links to your site

E-Commerce Software

- Catalog management
- Product configuration
- Shopping cart
- E-commerce transaction processing
- Web traffic data analysis

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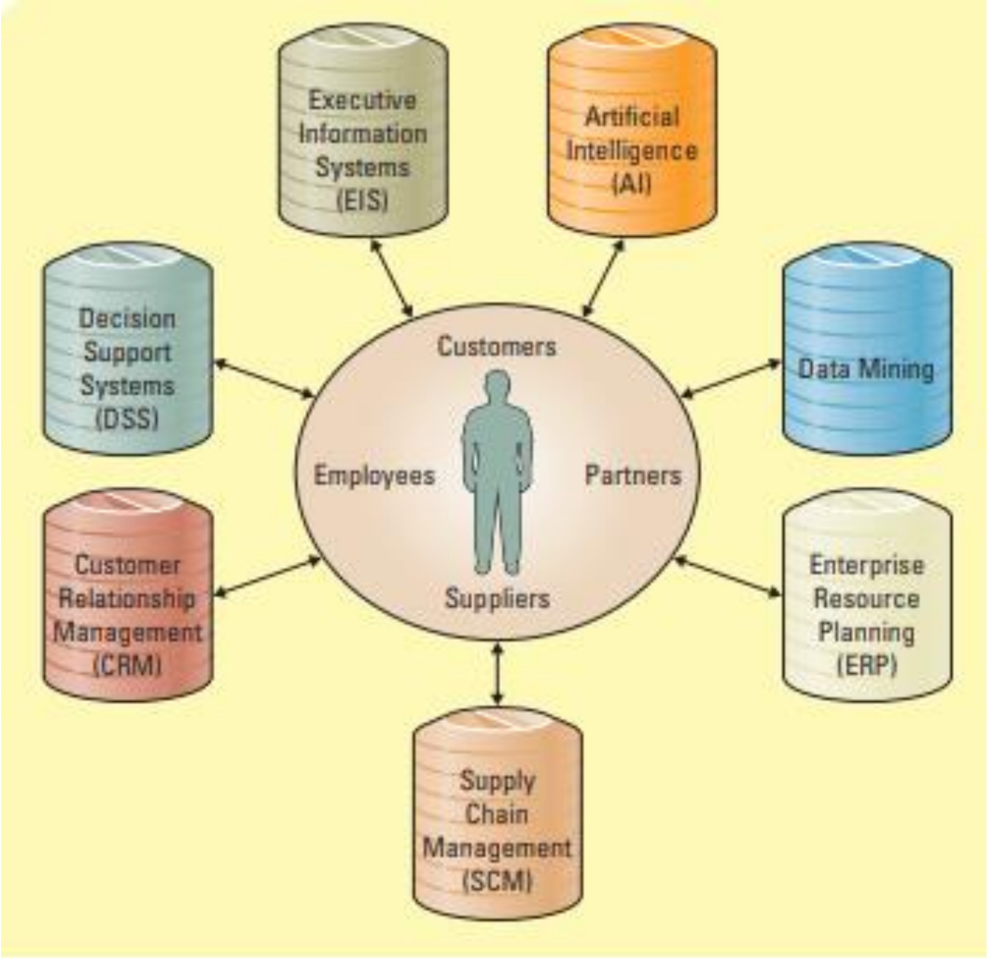

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Principles and Architecture of Information Systems

Chapter #7

Major Information Systems

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Introduction

- An organization must have information systems that support routine, day-to-day activities and that help a company add value to its products and services
- A company that implements an enterprise resource planning system is creating a highly integrated set of systems, which can lead to many business benefits

Why Learn About the Major Information Systems ?

- **Effective use of enterprise systems will be essential to raise the productivity of your firm, improve customer service, and enable better decision making**

An Overview of Transaction Processing Systems

- **Transaction processing systems (TPSs):**
  - Capture and process detailed data necessary to update records about fundamental business operations
  - Include order entry, inventory control, payroll, accounts payable, accounts receivable, general ledger, etc.
  - Provide valuable input to Management information systems, decision support systems, and knowledge management systems

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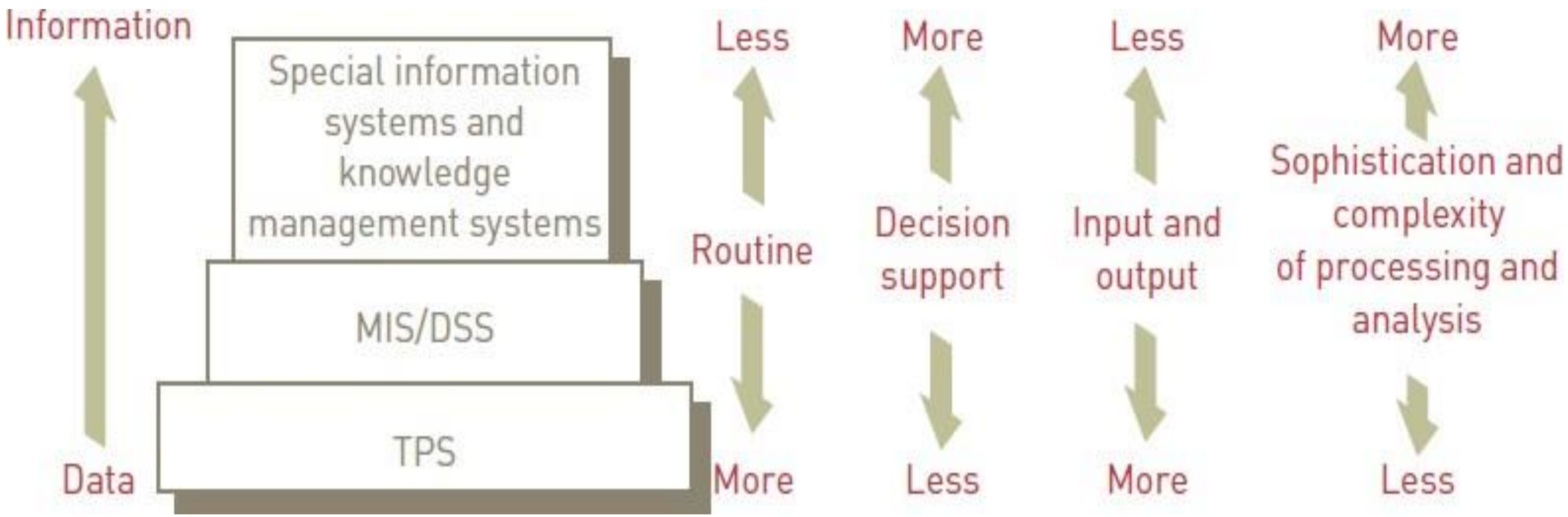
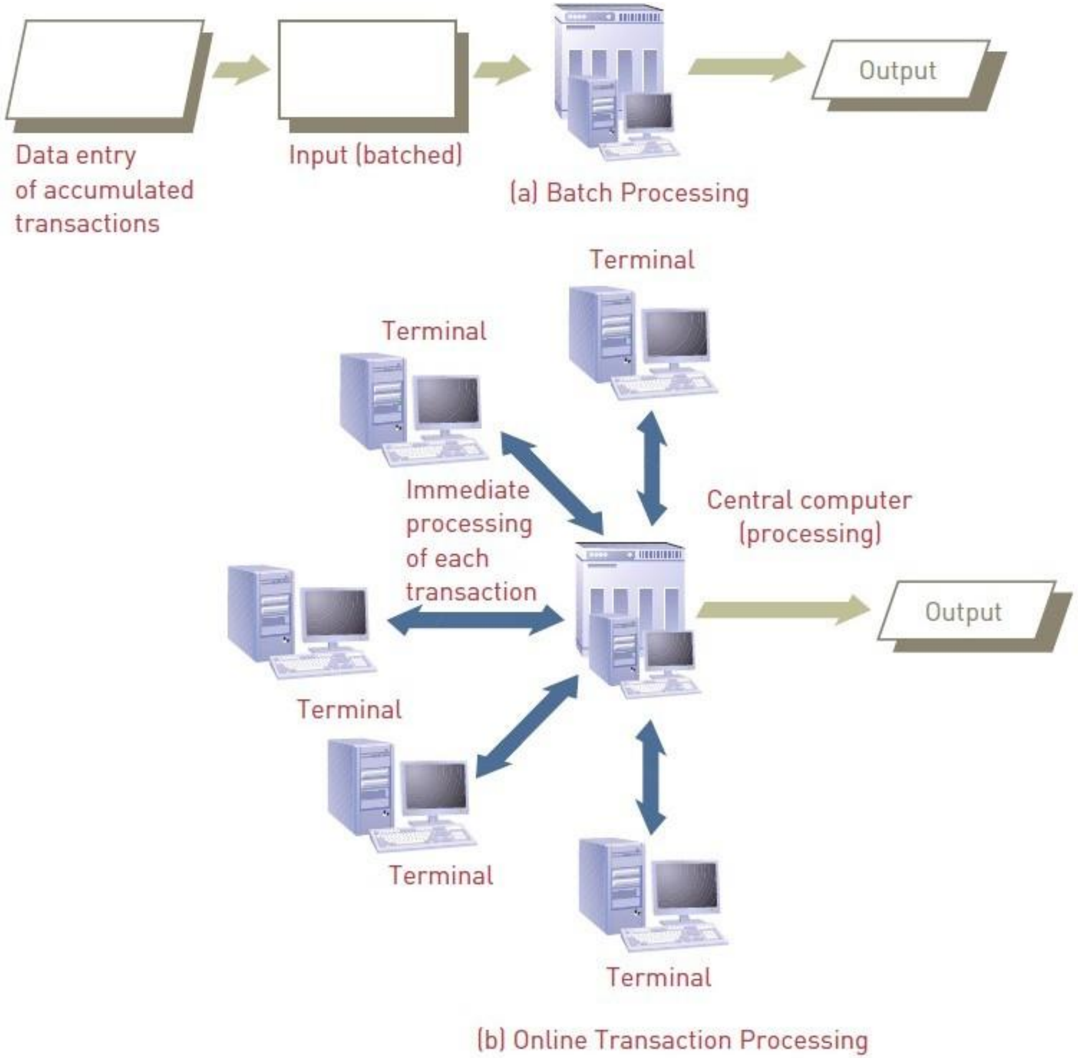
An Overview of Transaction Processing Systems



Batch versus Online Transaction processing



Traditional Transaction Processing Methods and Objectives

- **Batch processing system:**
  - Data processing in which business transactions are:
  - Accumulated over a period of time
  - Prepared for processing as a single unit or batch
- **Online transaction processing (OLTP):**
  - Data processing in which each transaction is processed immediately

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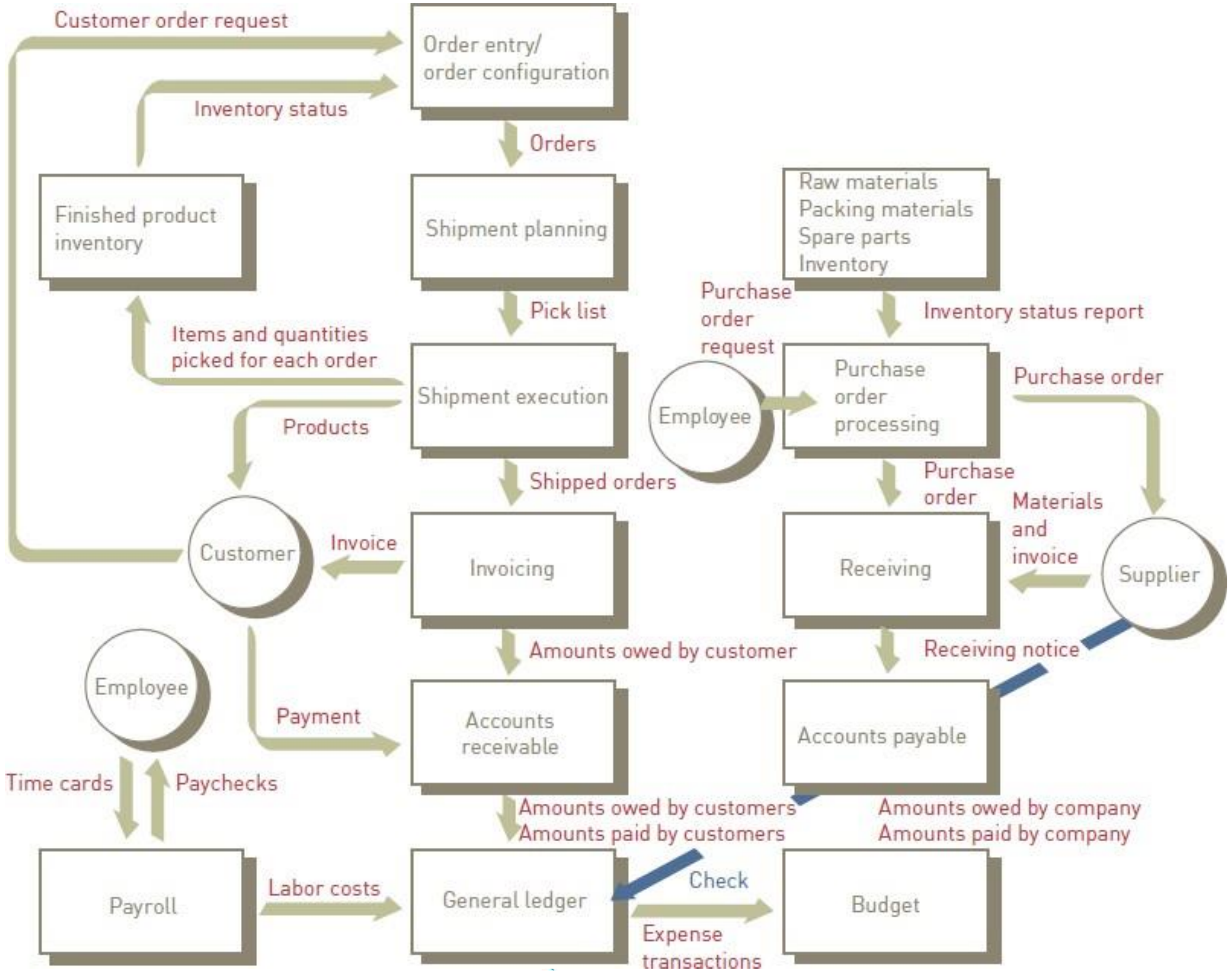
Batch versus Online Transaction processing



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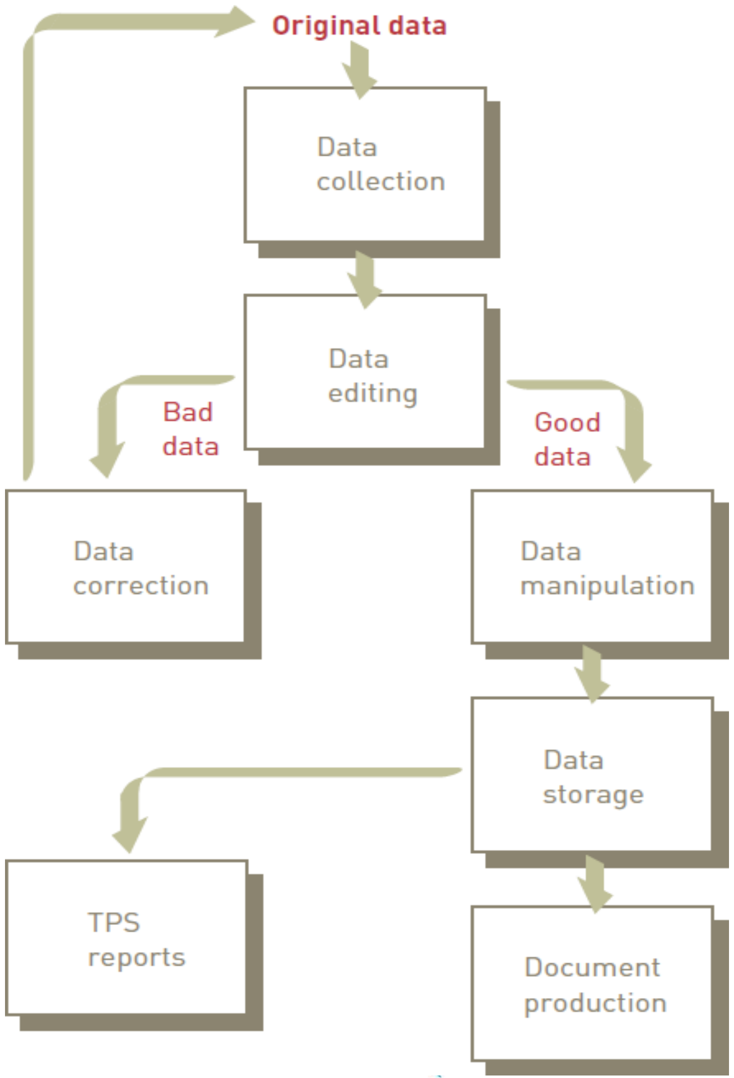
Traditional Transaction Processing Methods and Objectives

- **Organizations expect their TPSs to:**
  - Capture, process, and update databases of business data
  - Ensure that the data is processed accurately and completely
  - Avoid processing fraudulent transactions
  - Produce timely user responses and reports
  - Reduce clerical and other labor requirements
  - Help improve customer service
- **A TPS typically includes the following types of systems:**
  - Order processing systems
  - Accounting systems
  - Purchasing systems

Data processing activities



Data Collection

- **Capturing and gathering all data necessary to complete the processing of transactions**
- **Data collection can be:**
  - **Manual**
  - **Automated via special input devices**
- **Data should be:**
  - **Collected at source**
  - **Recorded accurately, in a timely fashion**

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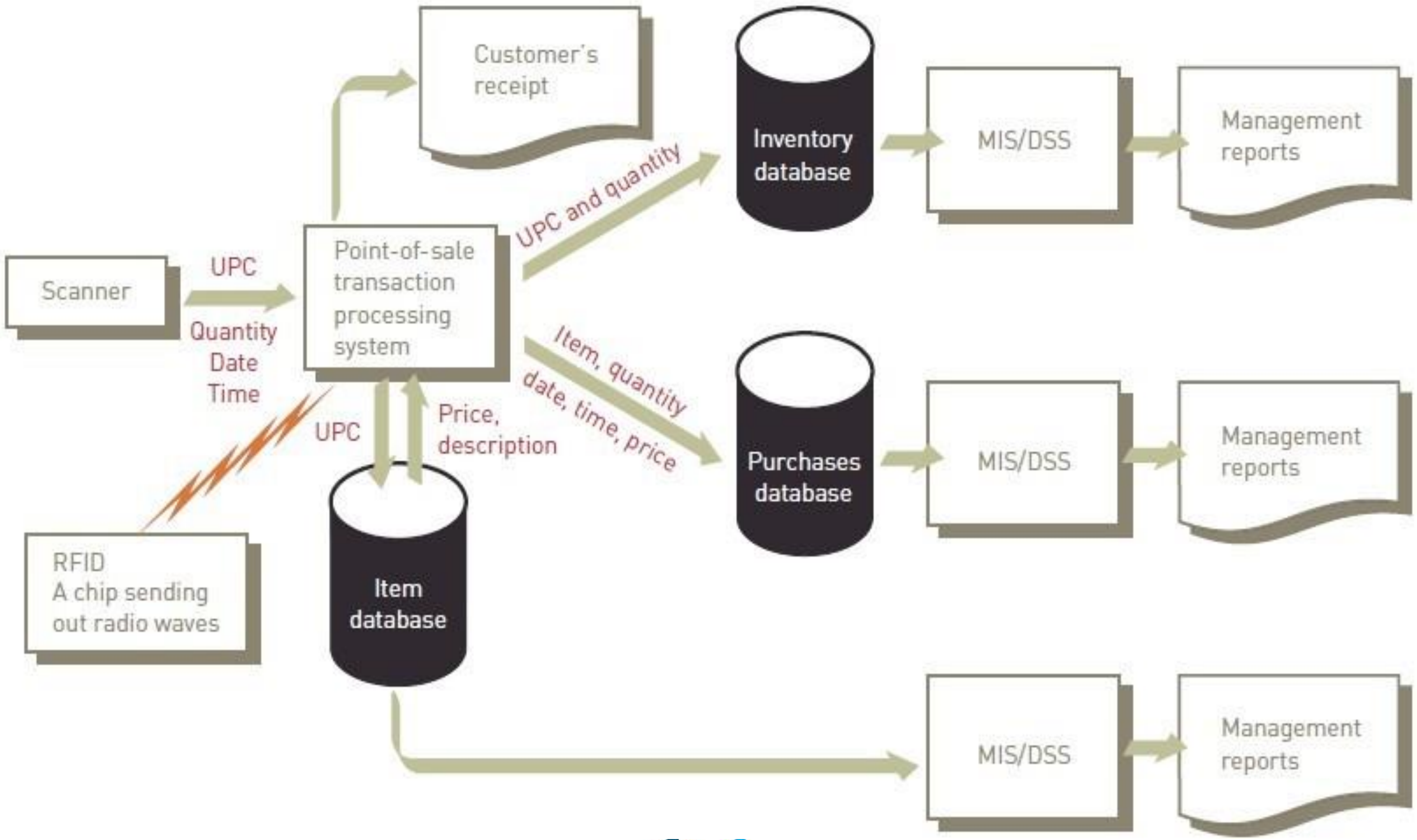
Point-of-Sale Transaction processing systems



Data Editing

- Checking data for validity and completeness to detect any problems
- Examples:
  - Quantity and cost data must be numeric
  - Names must be alphabetic

Data Correction

- Reentering data that was not typed or scanned properly
- Error messages must specify the problem so proper corrections can be made

Data Manipulation

- Performing calculations and other data transformations related to business transactions
- Can include:
  - Classifying data
  - Sorting data into categories
  - Performing calculations
  - Summarizing results
  - Storing data in the organization's database for further processing

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Data Storage

- Updating one or more databases with new transactions
- After being updated, this data can be further processed and manipulated by other systems

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Major Information Systems

- **MES : Manufacturing Execution System**
- **ERP : Enterprise Resource Planning**
- **SCM : Supply Chain Management**
- **CRM : Customer relationship Management**
- **HRM : Human Resources Management**
- **DSS : Decision Support System**
- **BI : Business Intelligence**
- **KM : Knowledge Management**

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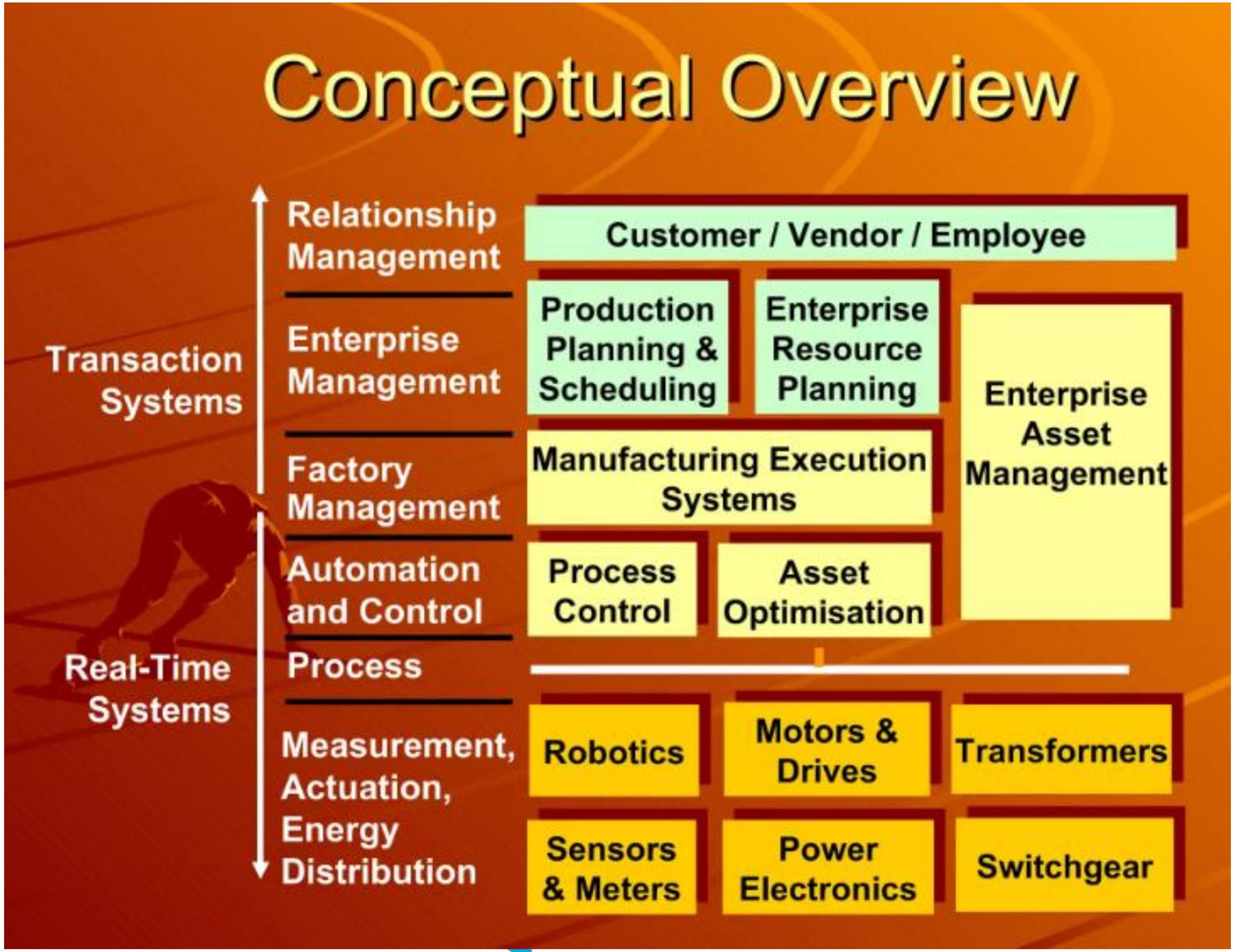

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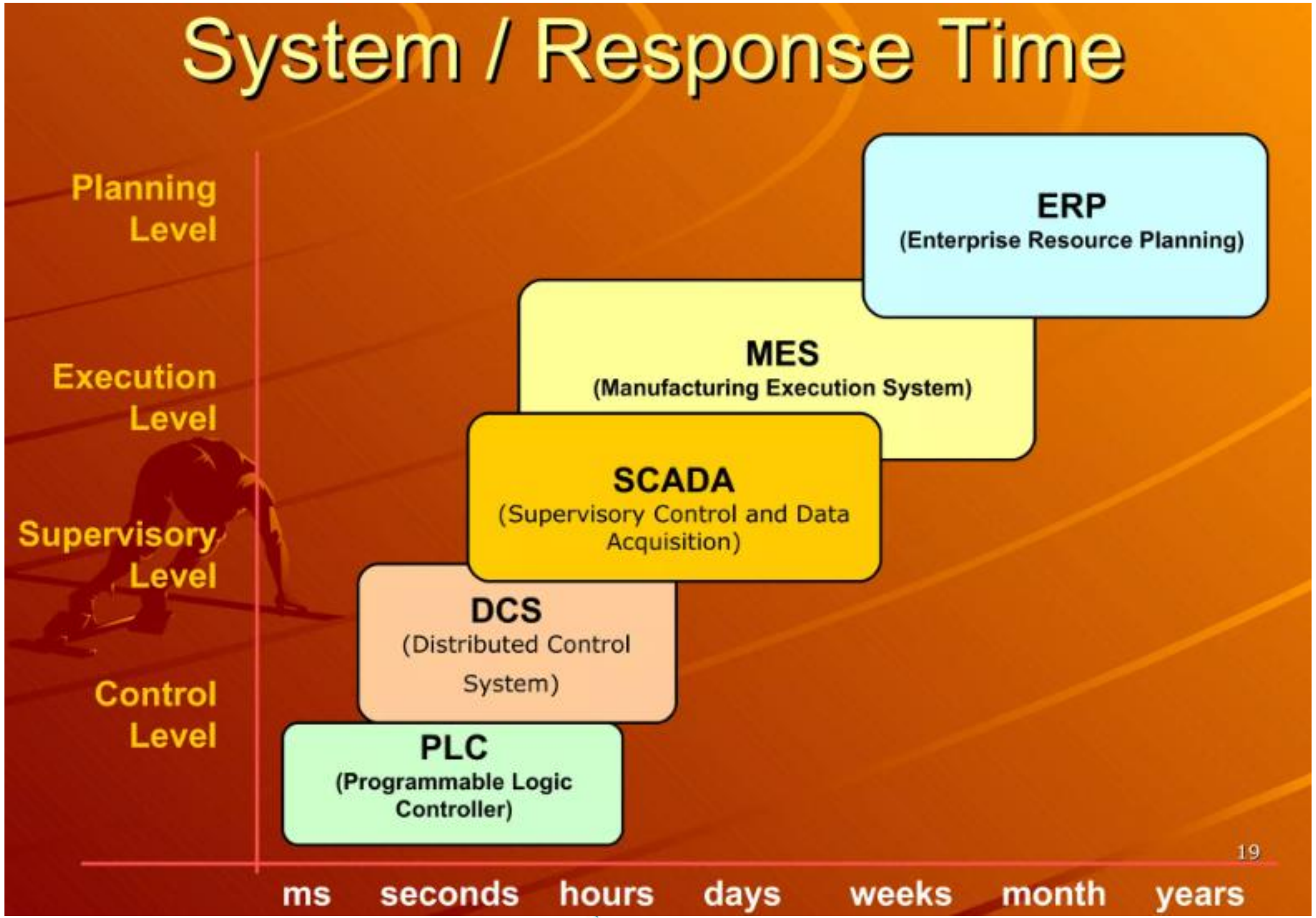
PLC, DCS, MES and ERP



MES

Principles & Architecture

MES

- MES have evolved to fill the communication gap between the manufacturing planning system (MRP,ERP) and the control systems to run equipment on the plant floor
- Coordinate functions on the shop floor to optimize the plant activities
- Provide visibility and flexibility to effectively manage supply chain

MES and ERP

- **ERP systems handle financial functions, customer orders and send production requests to the factory floor (shop-floor)**
- **MES provide overall control and management to the factory floor and provide updated information to the ERP systems**
- **The simplest model of CIM has MES as the middle ground between ERP systems and individual machine and automation controls**

ERP

ERP

- An ERP is a software solution which includes integration and automation of various business processes in a company to achieve operational efficiencies, improve business processes and facilitate effective decision making.
- ERP system when implemented effectively in an organization can have huge benefits in integration of the different business processes and also automating the repetitive and cumbersome processes.
- An ERP system in a company can integrate the areas such as HR, sales, purchase, marketing, delivery, engineering etc. It can also enable these different departments to share data and communicate easily.

ERP

- **ERP is now not only limited to the applications running on desktops and workstations. Instead there are mobile ERP devices like the radar guns in the warehouses which are very popular.**
- **There is also the added advantage of customization which is available with the ERP systems. Most or all activities in an organization can now be integrated and automated through an ERP system**

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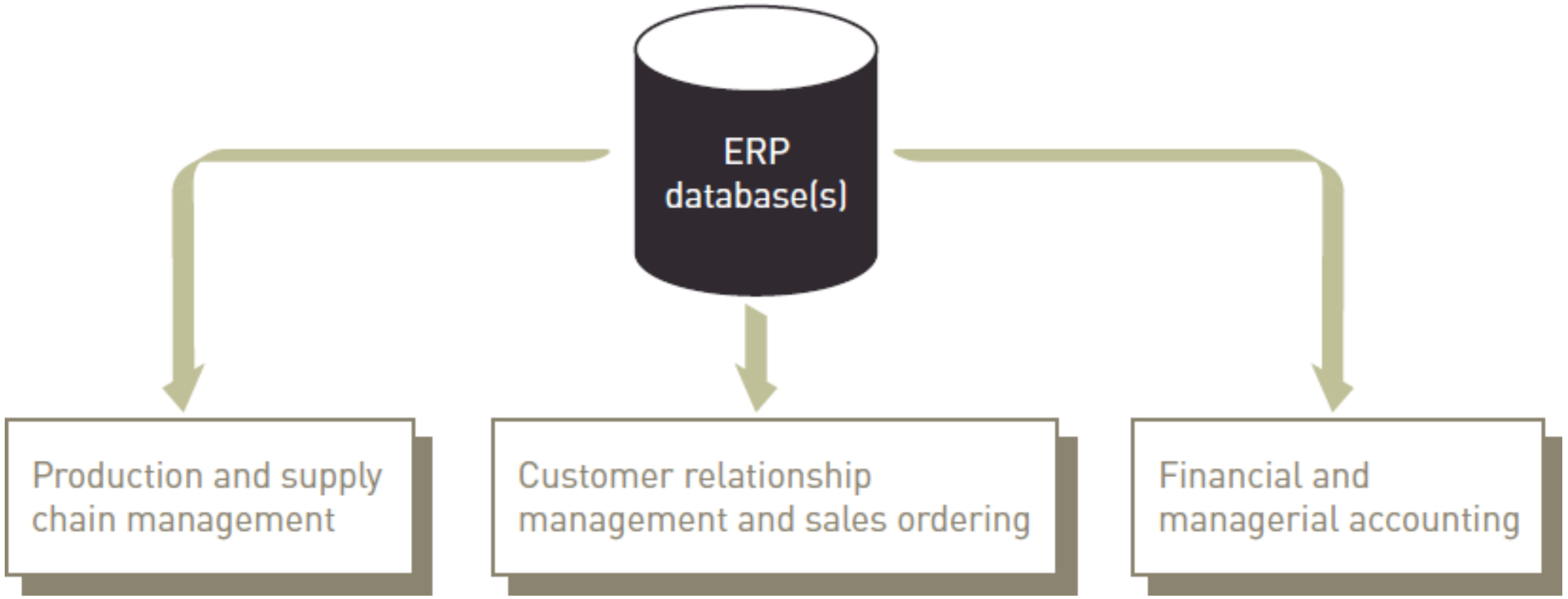
Integration between Systems



Pros and Cons of an ERP

- **Advantages**
  - Improved access to data for operational decision making
  - Elimination of costly, inflexible legacy systems Improvement of work processes
  - Upgrade of technology infrastructure
- **Disadvantages**
  - Expense and time in implementation
  - Difficulty implementing change
  - Difficulty integrating with other systems
  - Difficulty in loading data into new ERP system
  - Risks in using one vendor
  - Risk of implementation failure

Leading ERP Systems

IFS

infor

ORACLE

SAP

Microsoft

sage

EPICOR

DELMIA WORKS

workday

SYSPRO

Say Yes to Next

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Business Intelligence and ERP

- **Business intelligence (BI):**
  - **Gathering enough of the right information to shine a spotlight on the organization's performance**
  - **Essential component of an organization's ERP system**
- **BI tools are used to:**
  - **Access all the operational data captured in the ERP database, analyze performance on a daily basis**
  - **Highlight areas for improvement, and monitor the results of business strategies**

SCM

Supply Chain Management (SCM)

- **A system that includes:**
  - **Planning, executing, and controlling all activities involved in raw material sourcing and procurement**
  - **Converting raw materials to finished products, and warehousing and delivering finished product to customers**

Process for developing a production plan

- Sales forecasting
- Sales and operations plan (S&OP)
- Demand management
- Detailed scheduling
- Materials requirement planning (MRP)
- Purchasing
- Production
- Sales ordering

CRM

CRM Customer Relationship Management

- **Goal is to understand and anticipate the needs of current and potential customers**
- **Used primarily by people in:**
  - **The sales, marketing, and service organizations to capture and view data about customers and to improve communications**
- **CRM software:**
  - **Automates and integrates the functions of sales, marketing, and service in an organization**

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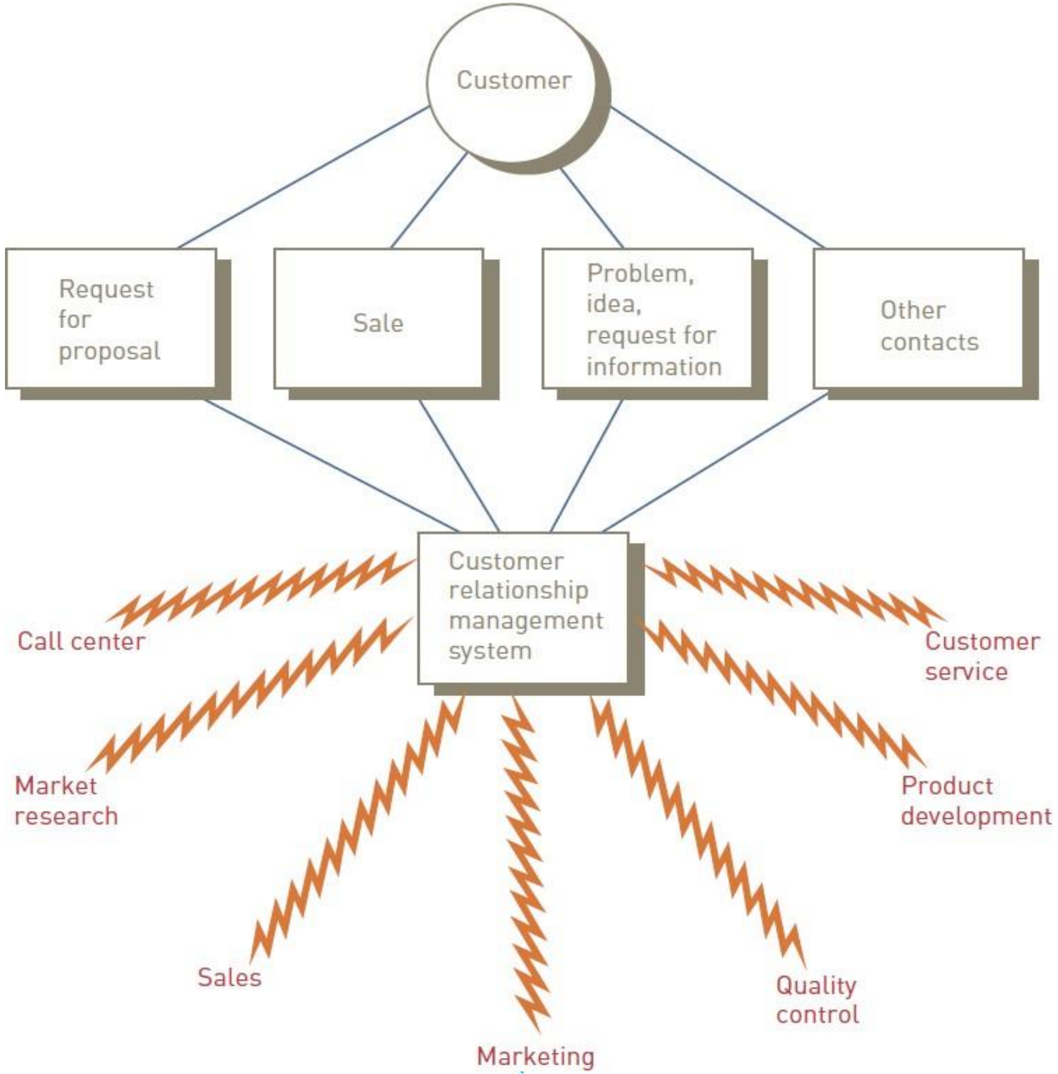
CRM



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Key features of a CRM system

- Contact management
- Sales management
- Customer support
- Marketing automation
- Analysis
- Social networking
- Access by smartphones
- Import contact data

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Leading CRM Systems

Principles & Architecture

Hosted Software Model for Enterprise Software

Advantages	Disadvantages
Decreased total cost of ownership	Potential availability and reliability issues
Faster system startup	Potential data security issues
Lower implementation risk	Potential problems integrating the hosted products of different vendors
Management of systems outsourced to experts	Savings anticipated from outsourcing may be offset by increased effort to manage vendor

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International Issues Associated with Enterprise Systems

- **Challenges that must be met by an enterprise system of a multinational company include:**
  - **Different languages and cultures**
  - **Disparities in IS infrastructure**
  - **Varying laws and customs rules**
  - **Multiple currencies**
  - **Lack of a robust or a common information infrastructure can create problems**
  - **Many countries' telecommunications services are controlled by a central government or operated as a monopoly**

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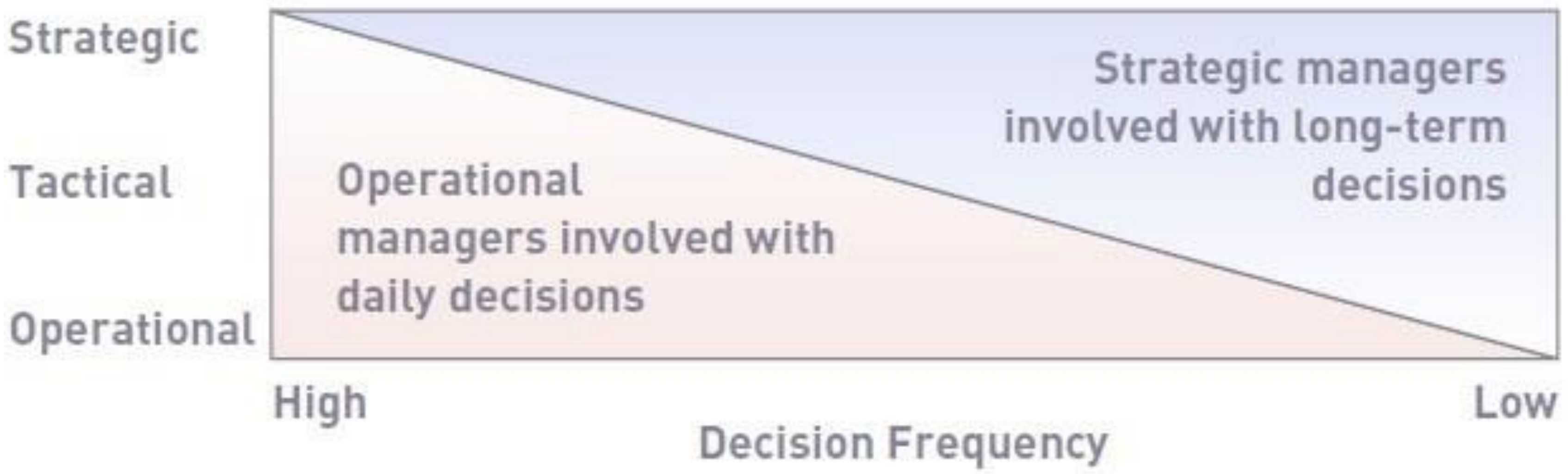
DSS

Principles & Architecture

Characteristics of a Decision Support System

- Provide rapid access to information
- Handle large amounts of data from different sources
- Provide report and presentation flexibility
- Offer both textual and graphical orientation
- Support drill-down analysis

Capabilities of a Decision Support System



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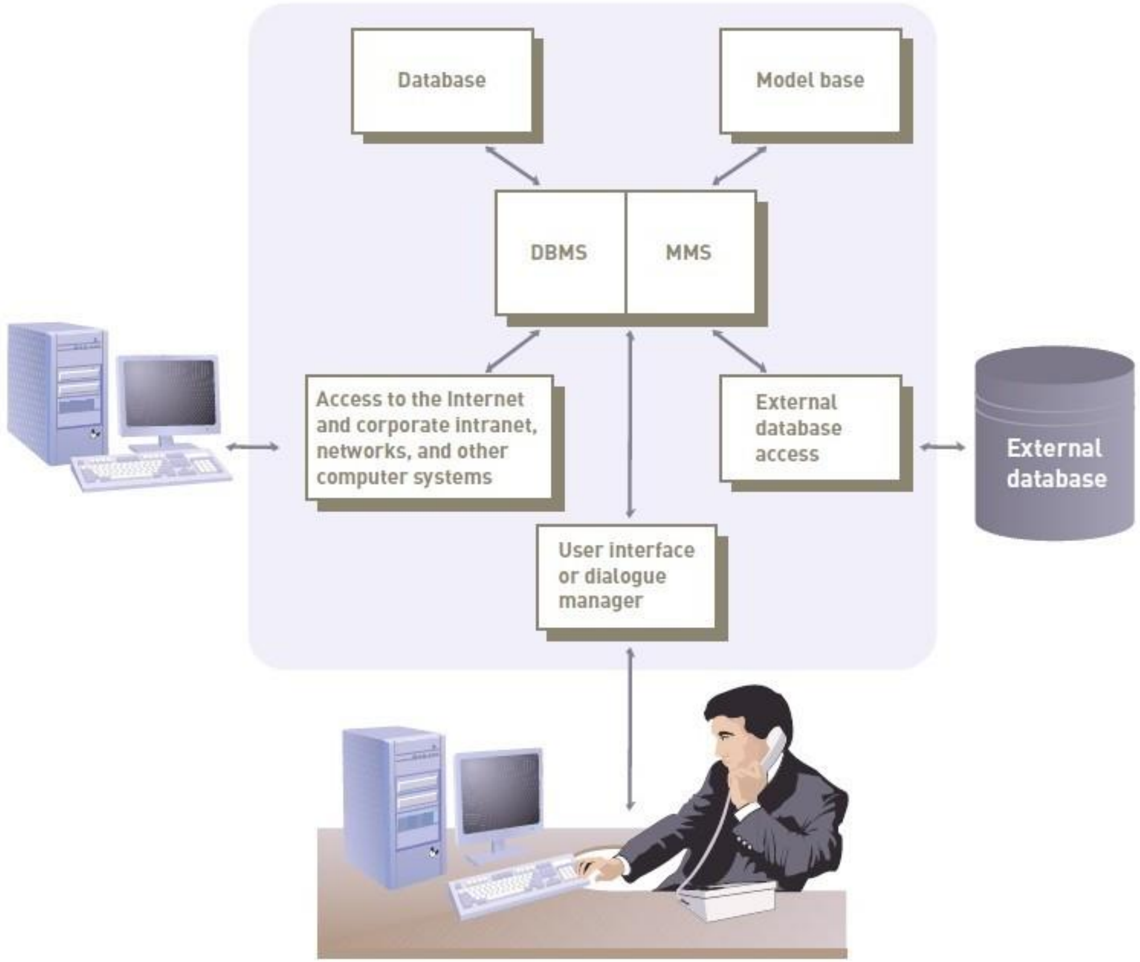
Capabilities of a Decision Support System



MMS
Model
Management
System

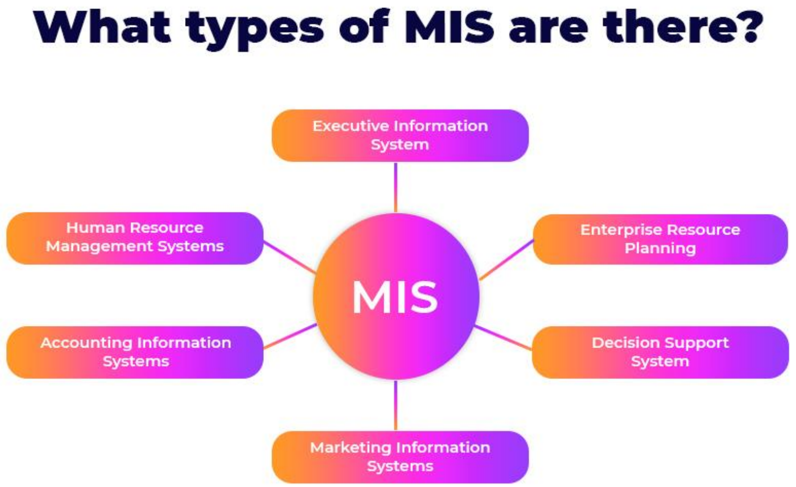
Characteristics of a Decision Support System

- Simulation model – calculates the simulated outcome of tentative decisions and assumptions
- Optimization model – determine optimal decisions based on criteria supplied by the user, mathematical search techniques, and constraints
- Online analytical processing (OLAP) : the use of data analysis tools to explore large databases of transaction data - Cubes
- Data mining : the use of analysis tools to find patterns in large transaction databases

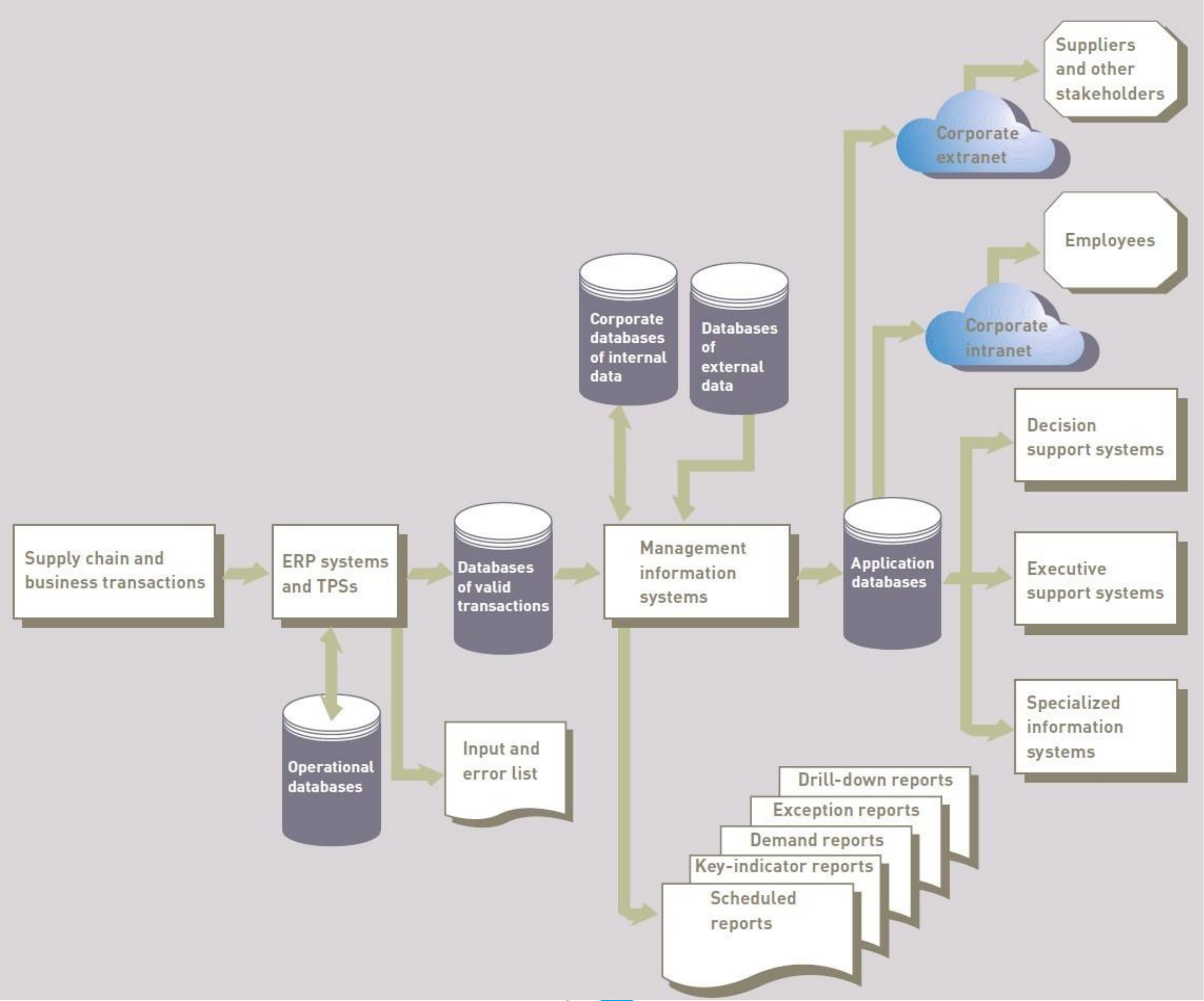
MIS

Management Information Systems

- Integrated collection of people, procedures, databases, and devices
- Can give the organization a competitive advantage
- To help an organization achieve its goals and give it a competitive advantage
- Provide the right information to the right person in the right format at the right time
- Can enter the organization through traditional methods, or via the Internet, or via an extranet



Management Information Systems in Perspective



KMS

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Knowledge Management Systems

- **Data consists of raw facts**
- **Information: Collection of facts organized so that they have additional value beyond the value of the facts themselves**
- **Knowledge: Awareness and understanding of a set of information and the ways that information can be made useful to support a specific task or reach a decision**
- **Knowledge management system (KMS):**
  - **Organized collection of people, procedures, software, databases, and devices**
  - **Used to create, store, share, and use the organization's knowledge and experience**

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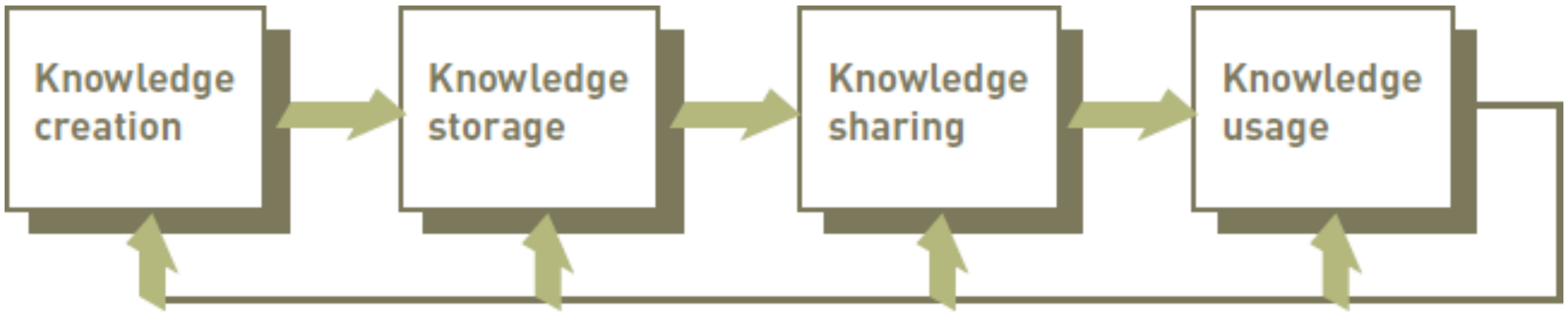
The difference between Data , Information and Knowledge

Data	There are 20 PCs in stock at the retail store.
Information	The store will run out of inventory in a week unless more is ordered today.
Knowledge	Call 800-555-2222 to order more inventory.

Data and Knowledge Management Workers

- **Data workers:**
  - Secretaries, administrative assistants, bookkeepers, etc.
- **Knowledge workers:**
  - Create, use, and disseminate knowledge
  - Professionals in science, engineering, or business; writers; researchers; educators; corporate designers; etc.

Knowledge Management Systems



AI

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AI

- **Artificial intelligence (AI):**
  - **Computers with the ability to mimic or duplicate the functions of the human brain**
- **Computer systems that use the notion of AI:**
  - **Help to make medical diagnoses**
  - **Explore for natural resources**
  - **Determine what is wrong with mechanical devices**
  - **Assist in designing and developing other computer systems**

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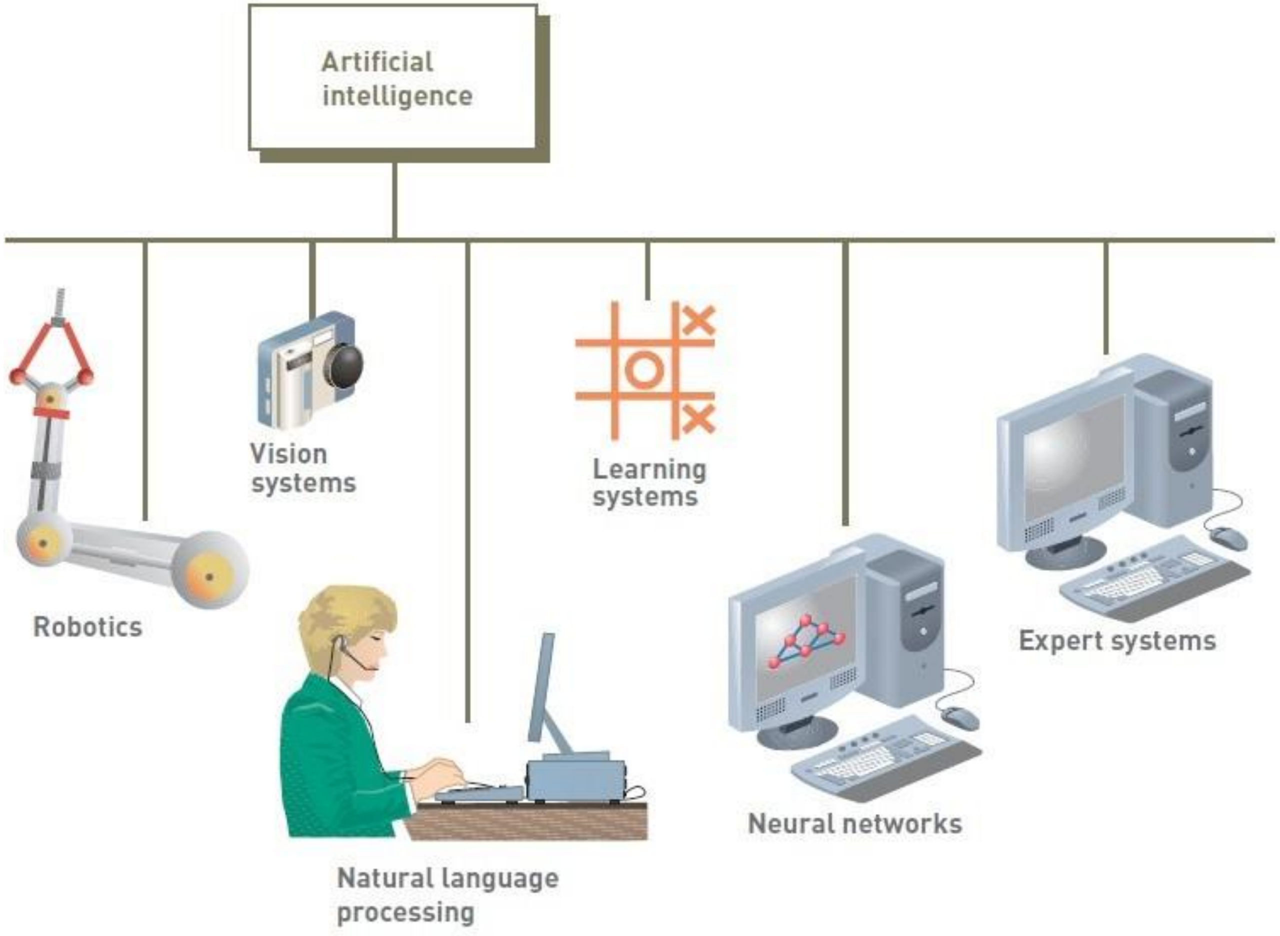
The Major Branches of Artificial Intelligence



Neural Networks

- Computer system that simulates functioning of a human brain
- Can process many pieces of data at the same time and learn to recognize patterns
- Neural network software simulates a neural network using standard computers

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Chapter #8
Systems Development

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Introduction

- Effective systems development requires a team effort from stakeholders, users, managers, systems development specialists, and various support personnel, and it starts with careful planning
- Systems development starts with investigation and analysis of existing systems

Participants in Systems Development

- Project Manager
- Development team
- Stakeholders
- Users
- Systems analysts
- Programmer

Acquiring Software: Make or Buy?

- **Make-or-buy decision:**
  - Whether to obtain software from external or internal sources
- **Externally acquired software and Software as a Service (SaaS)**
  - Commercial off-the-shelf (COTS) combines software from various vendors into a finished system
  - Software as a Service (SaaS) allows businesses to subscribe to Web-delivered application software by paying a monthly service charge

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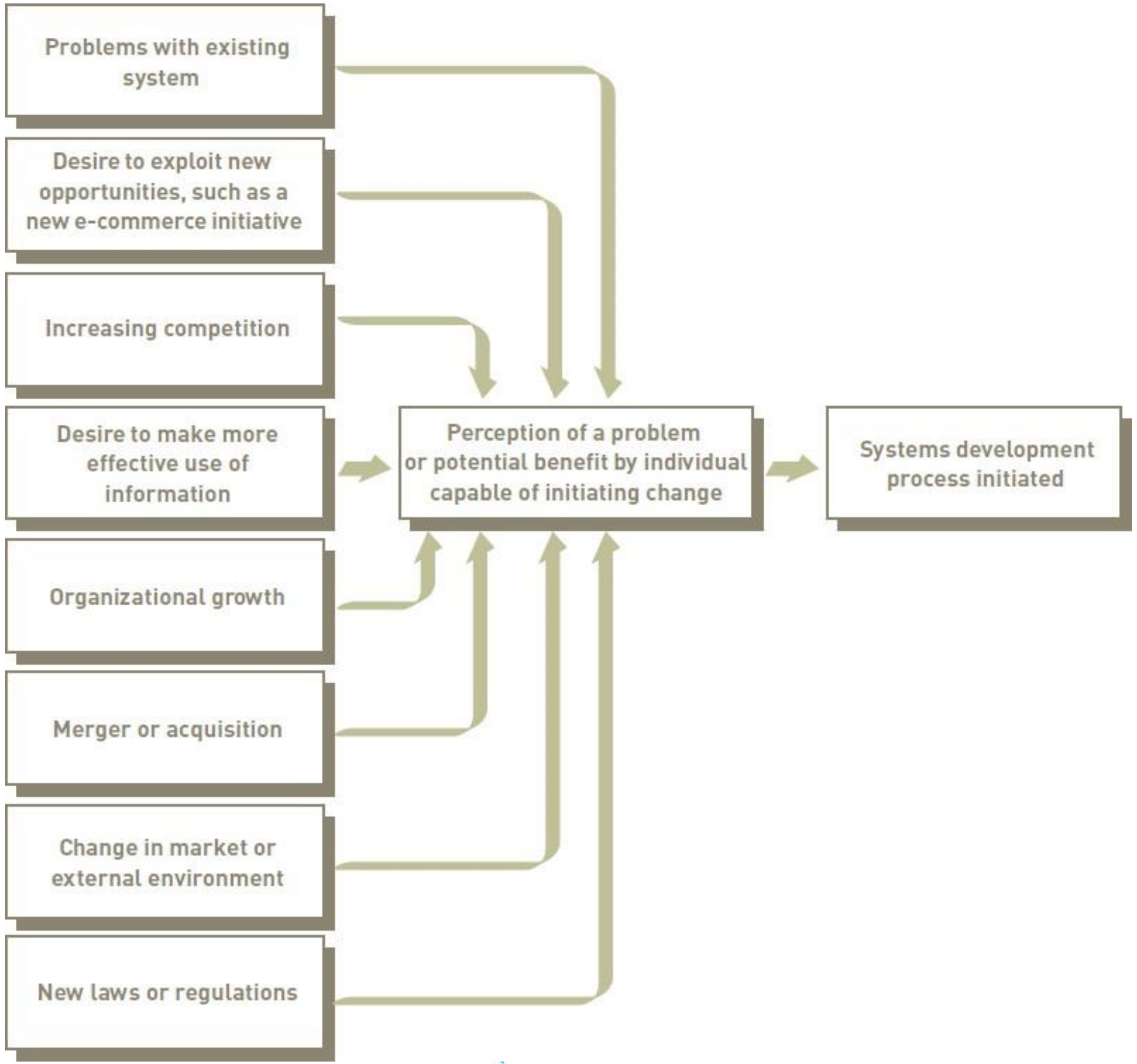
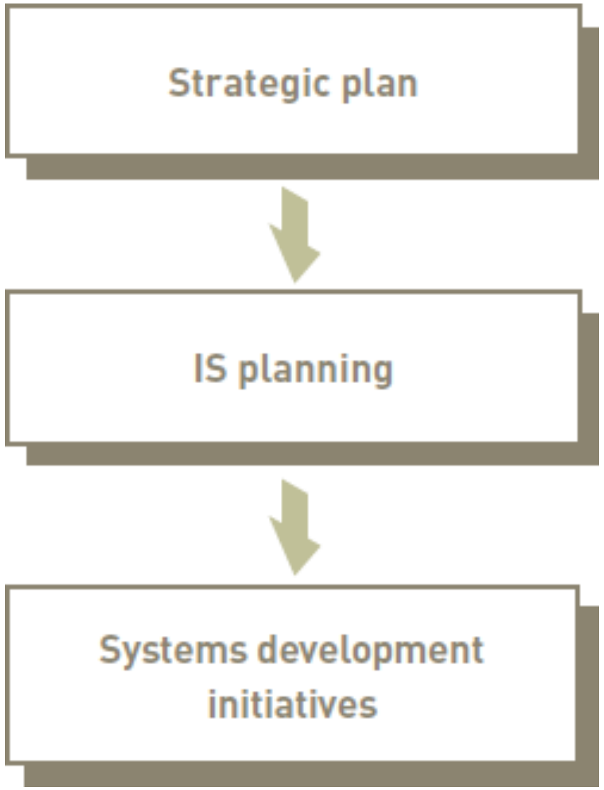
Typical reasons to initiate a project



Aligning corporate and IS Goals



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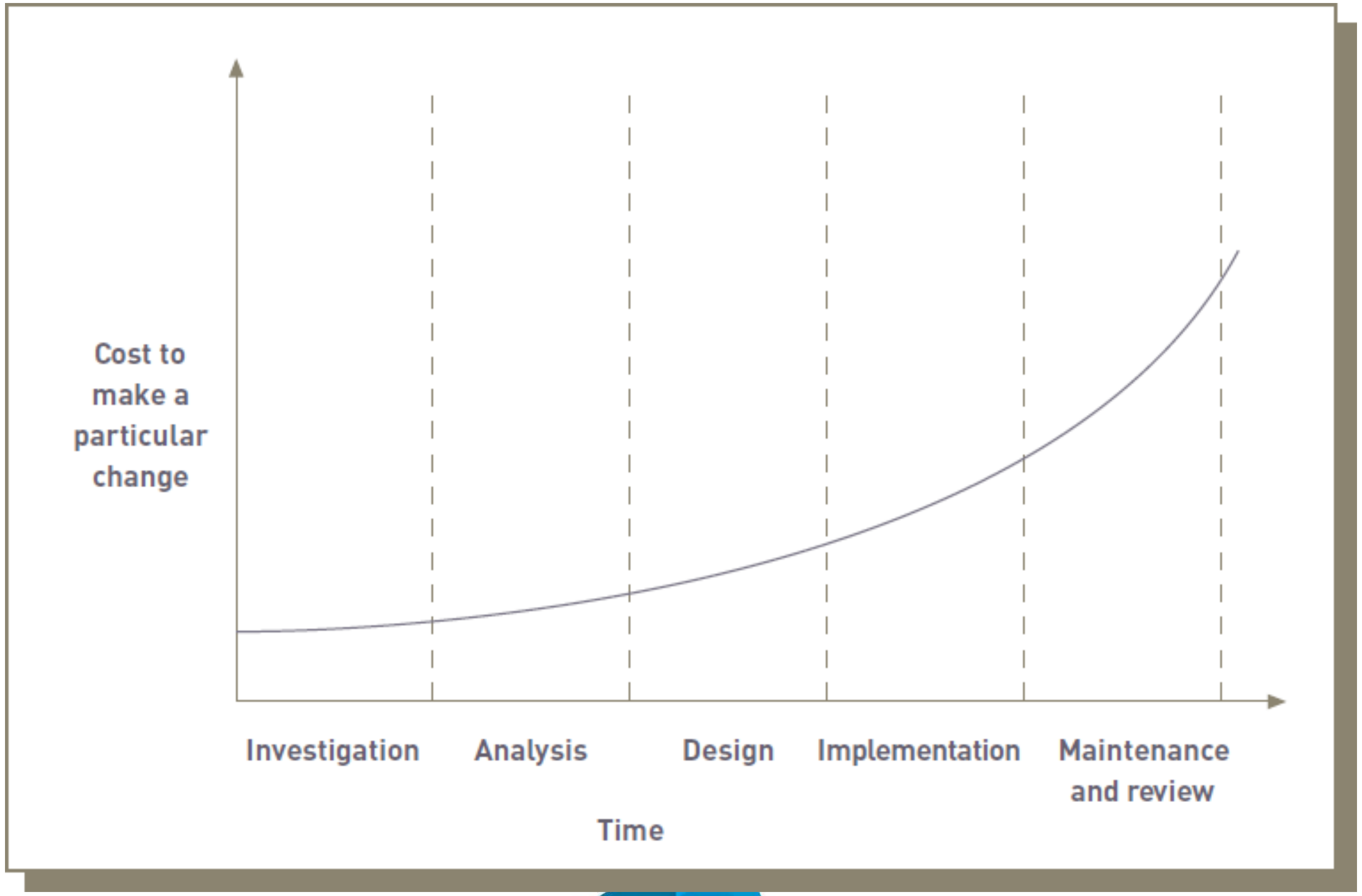
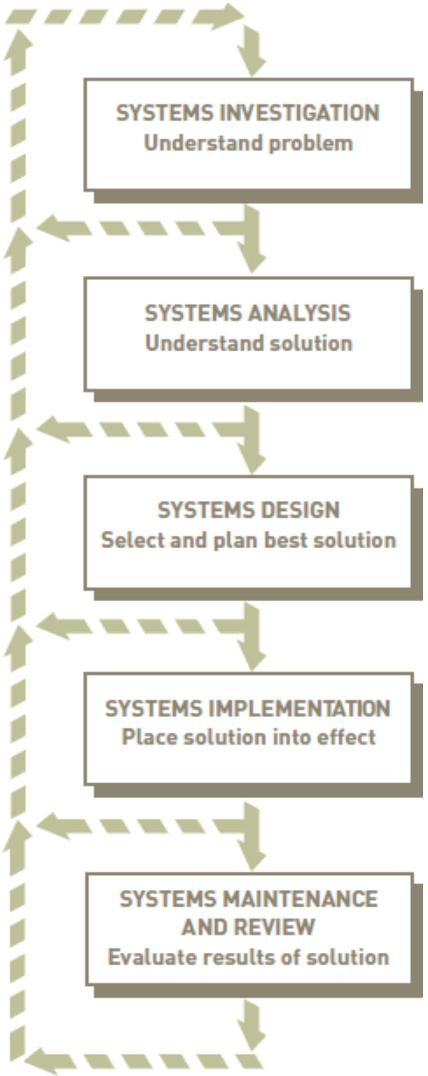
Relationships between timing of errors and costs



Traditional SDLC



SDLC

- **Systems investigation:**
  - Identifies problems and opportunities and considers them in light of business goals
- **Systems analysis:**
  - Studies existing systems and work processes to identify strengths, weaknesses, and opportunities for improvement
- **Systems design:**
  - Defines how the information system will do what it must do to obtain the problem's solution
- **Systems implementation:**
  - Creates or acquires various system components detailed in systems design, assembles them, and places new or modified system into operation
- **Systems maintenance and review:**
  - Ensures the system operates as intended
  - Modifies the system so that it continues to meet changing business needs

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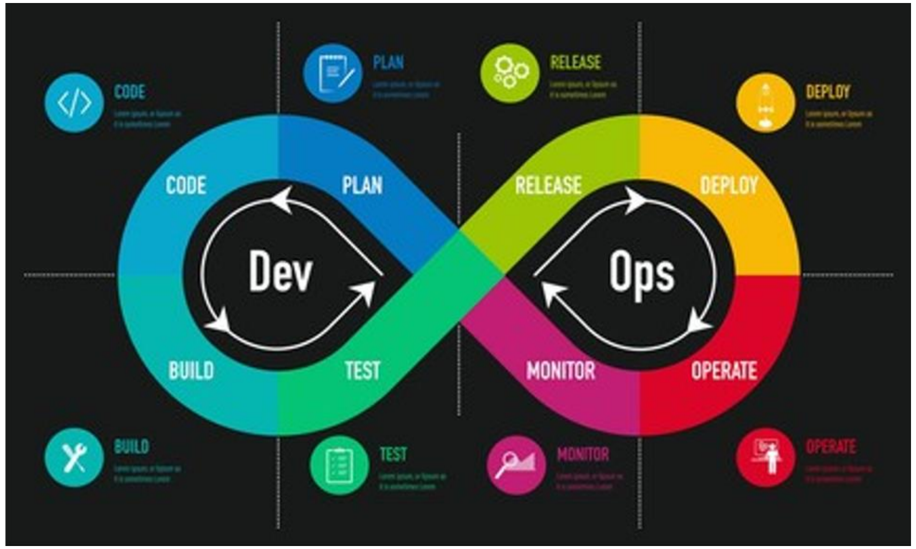
SDLC versus DevOps

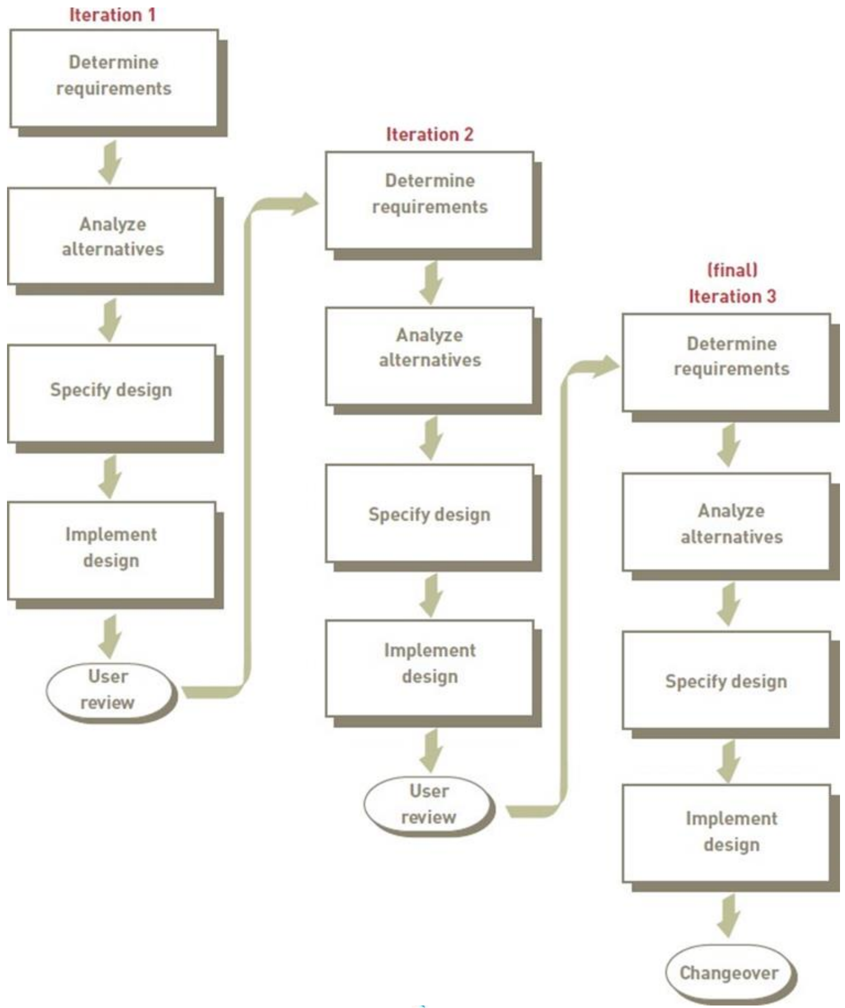


Relationship between design and total costs

Prototyping

- **An iterative approach**
- **Operational prototype:**
  - Prototype that works
  - Accesses real data files, edits input data, makes necessary computations and comparisons, and produces real output
- **Nonoperational prototype:**
  - A mock-up, or model
  - Includes output and input specifications and formats

Prototyping



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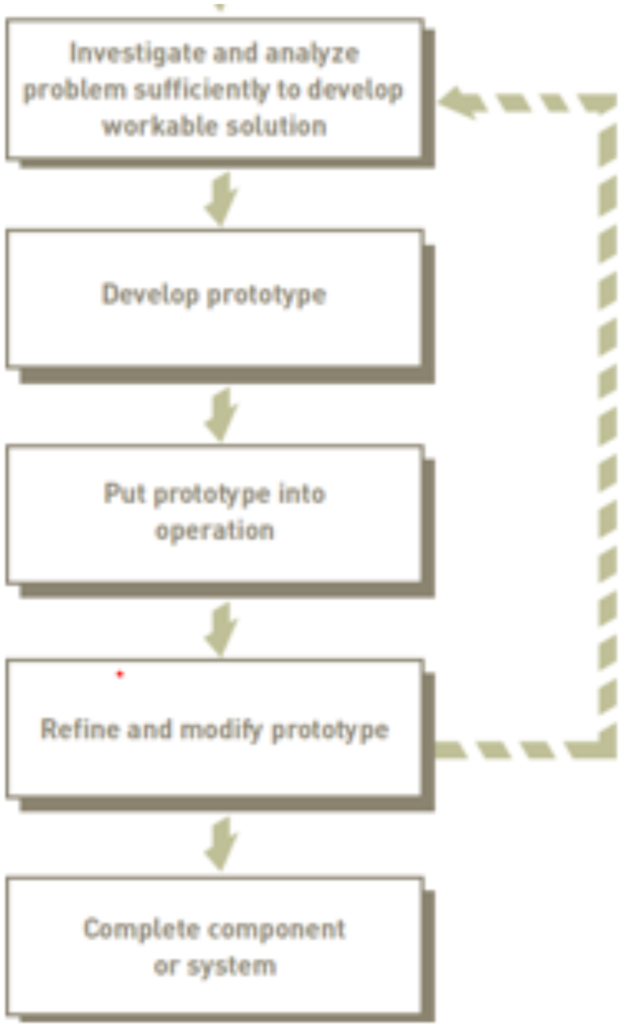
Refining during Prototyping



Agile Methodologies

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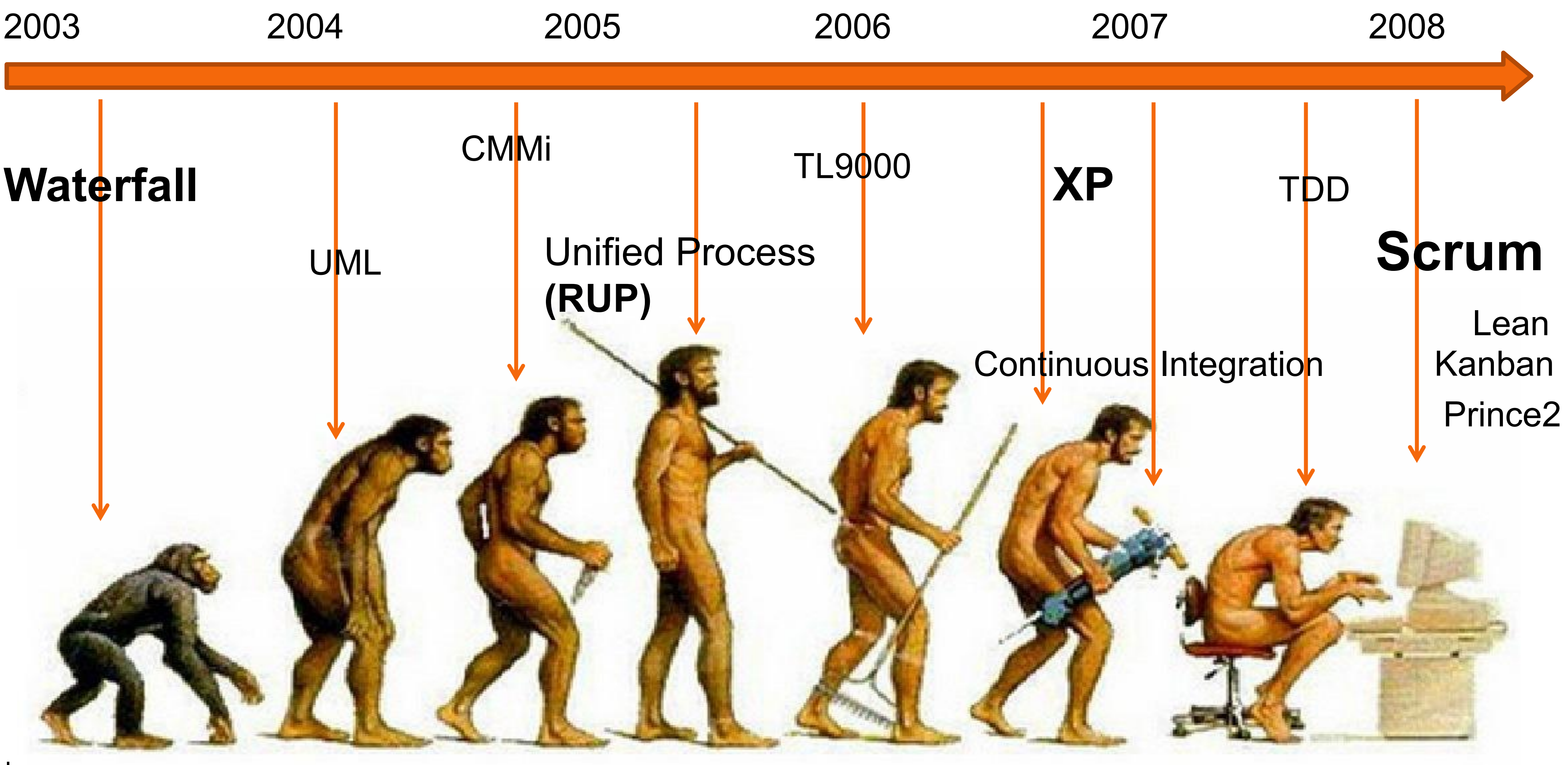
History of Evolution



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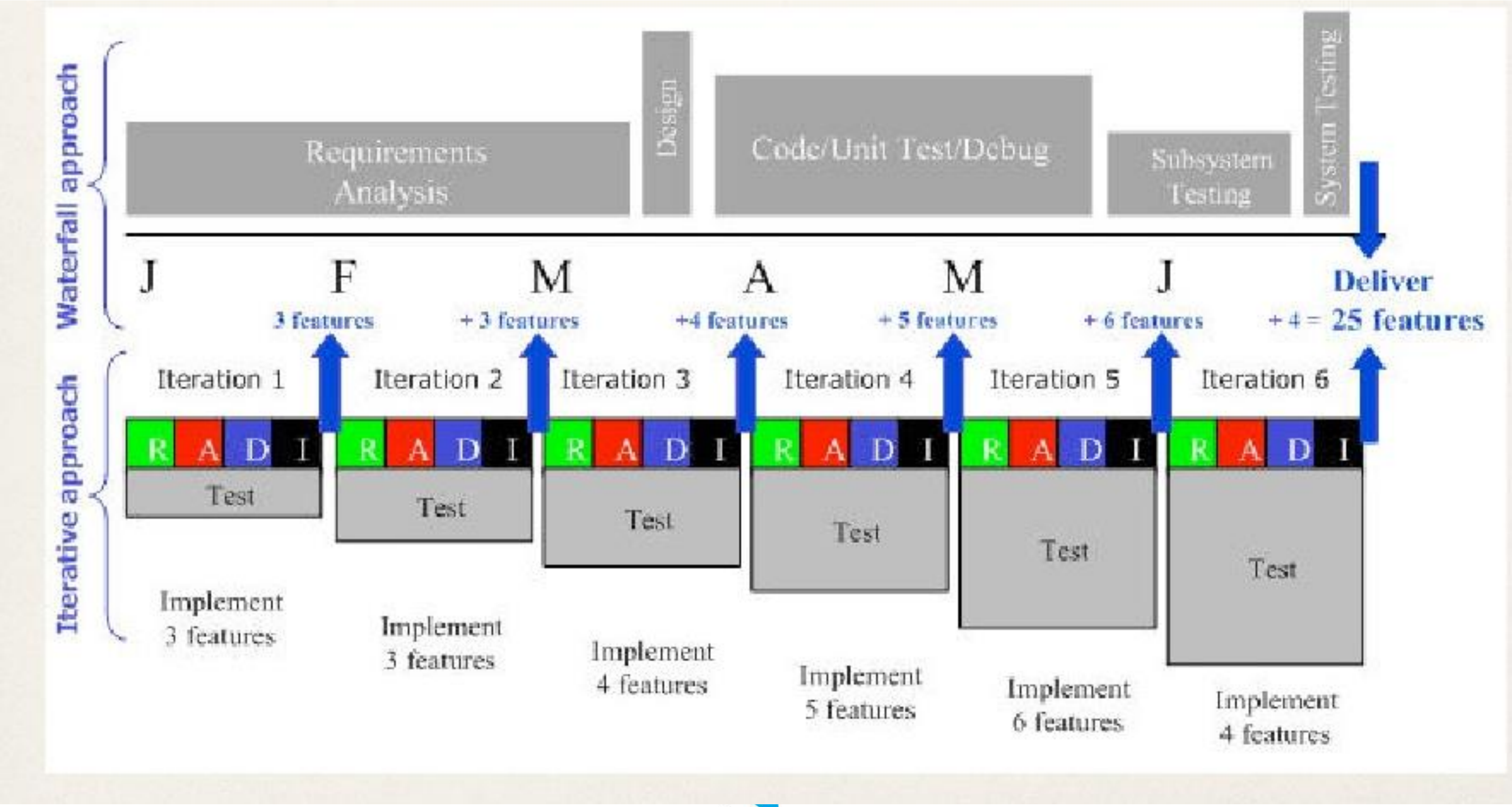
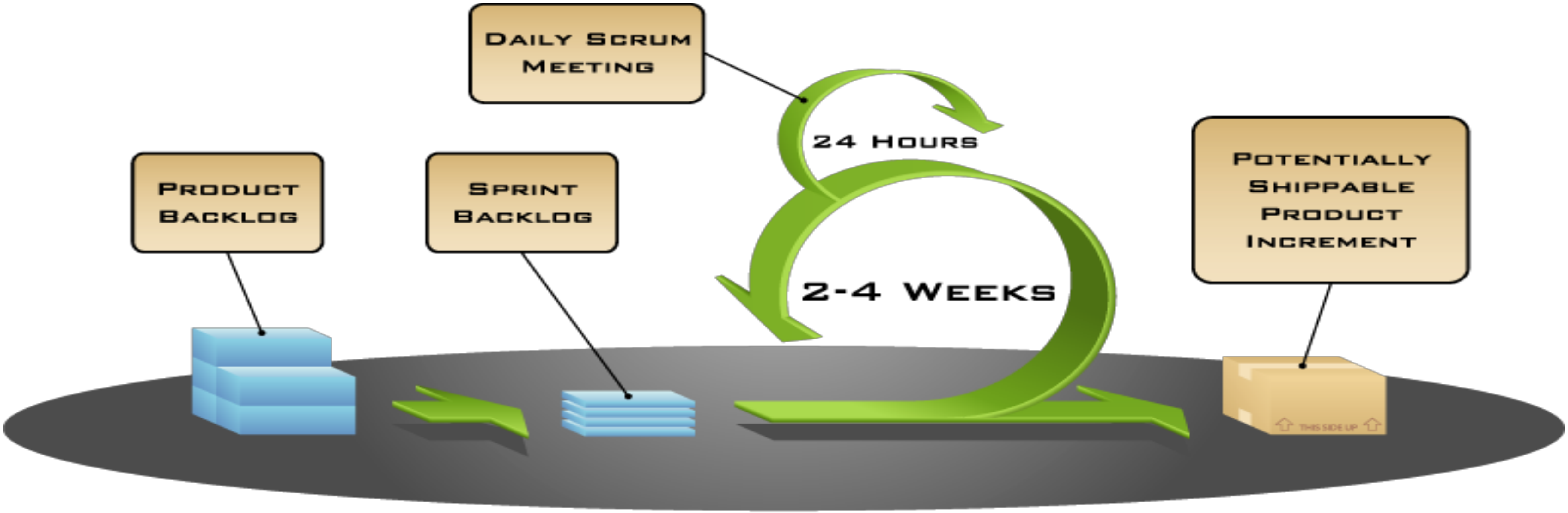
Scrum versus Waterfall



Putting it all together



Change Equation

$$R = Q \times A$$

Degree of Change

- **Continuous improvement projects versus reengineering:**
  - **Continuous improvement projects have a high degree of success**
  - **Reengineering projects tend to have a high degree of risk but also a high potential for benefits**
- **Managing change:**
  - **It is essential to recognize and deal with existing or potential problems**

Requirements Analysis

- **Purpose is to determine user, stakeholder, and organizational needs**
- **Techniques used to capture systems requirements:**
  - **Asking directly**
  - **Critical success factors (CSFs)**
  - **IS plan**
  - **Screen and report layout**
  - **Requirements analysis tools**

Converting Organizational goals into Systems Requirements

Use of Project Management Tools

- **Project schedule:**
  – Detailed description of what is to be done
- **Project milestone:**
  – Critical date for completion of a major part of the project
- **Project deadline:**
  – Date that the entire project is to be completed and operational
- **Critical path:**
  – Activities that, if delayed, would delay the entire project

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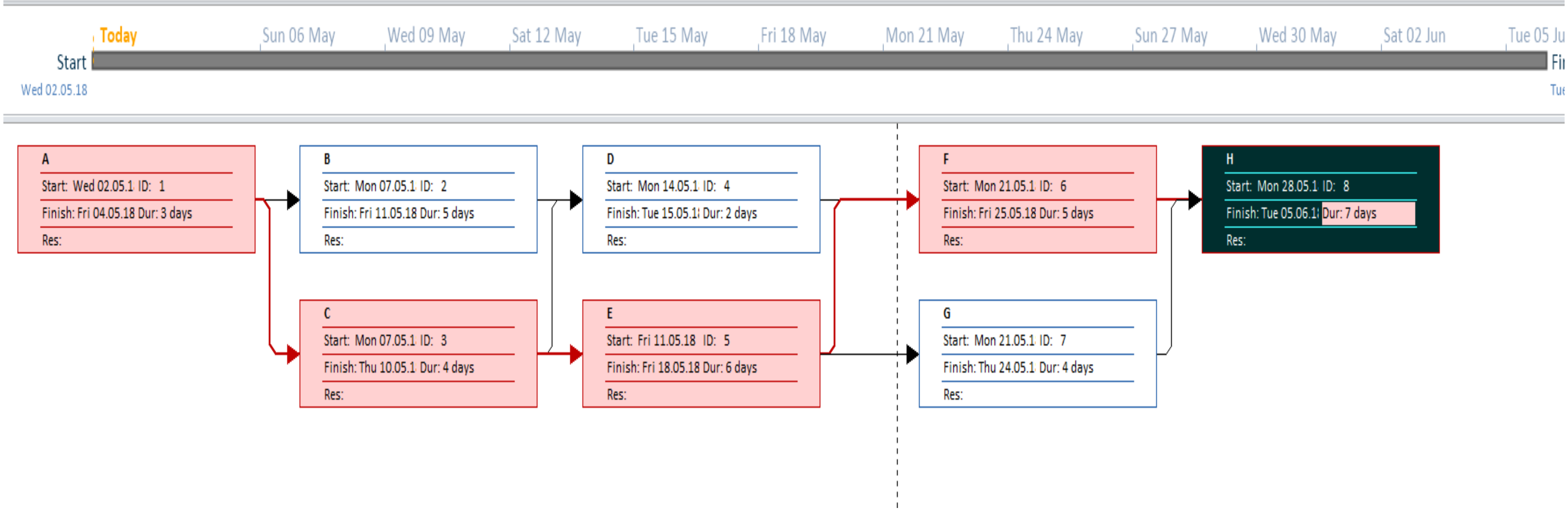
PERT



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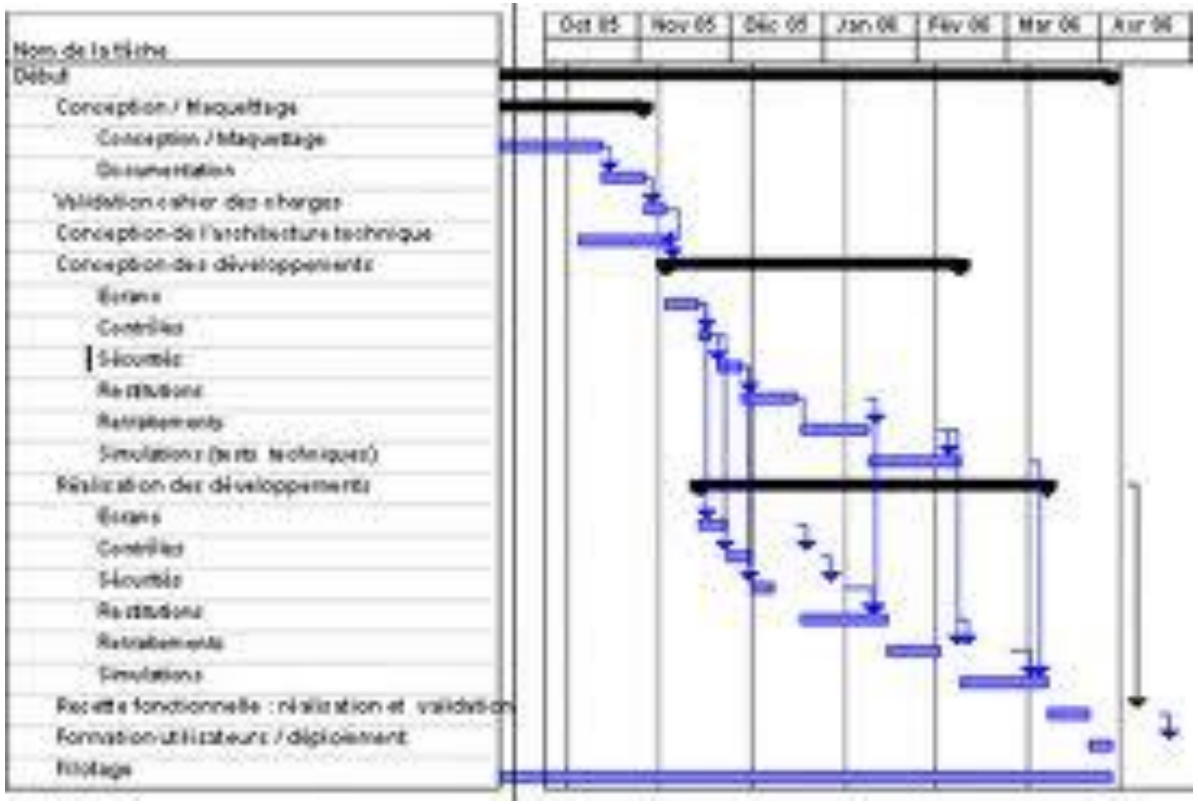
Gantt



Use of Project Management Tools

- **Program Evaluation and Review Technique (PERT):**
  - **Creates three time estimates for an activity:**
  - **Shortest possible time**
  - **Most likely time**
  - **Longest possible time**
- **Gantt chart:**
  - **Graphical tool used for planning, monitoring, and coordinating projects**