



Lisbon School  
of Economics  
& Management  
Universidade de Lisboa



# IT INFRASTRUCTURE

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# Goals



## Learning Goals

- Students will be able to:
  - Describe and analyze IT in the context of society and organizations
  - **Propose, select, choose and build solutions of IT infrastructure** and IT applications
  - Reflect and evaluate IT management and development

# Table of Contents

1. Overview of IT infrastructure
2. Data Management and Business Intelligence
3. Telecommunications
4. Securing Information Systems

# IT Infrastructure

# IT Infrastructure and Emerging Technologies

Set of physical devices and software required to operate an enterprise

Set of firm-wide services including:

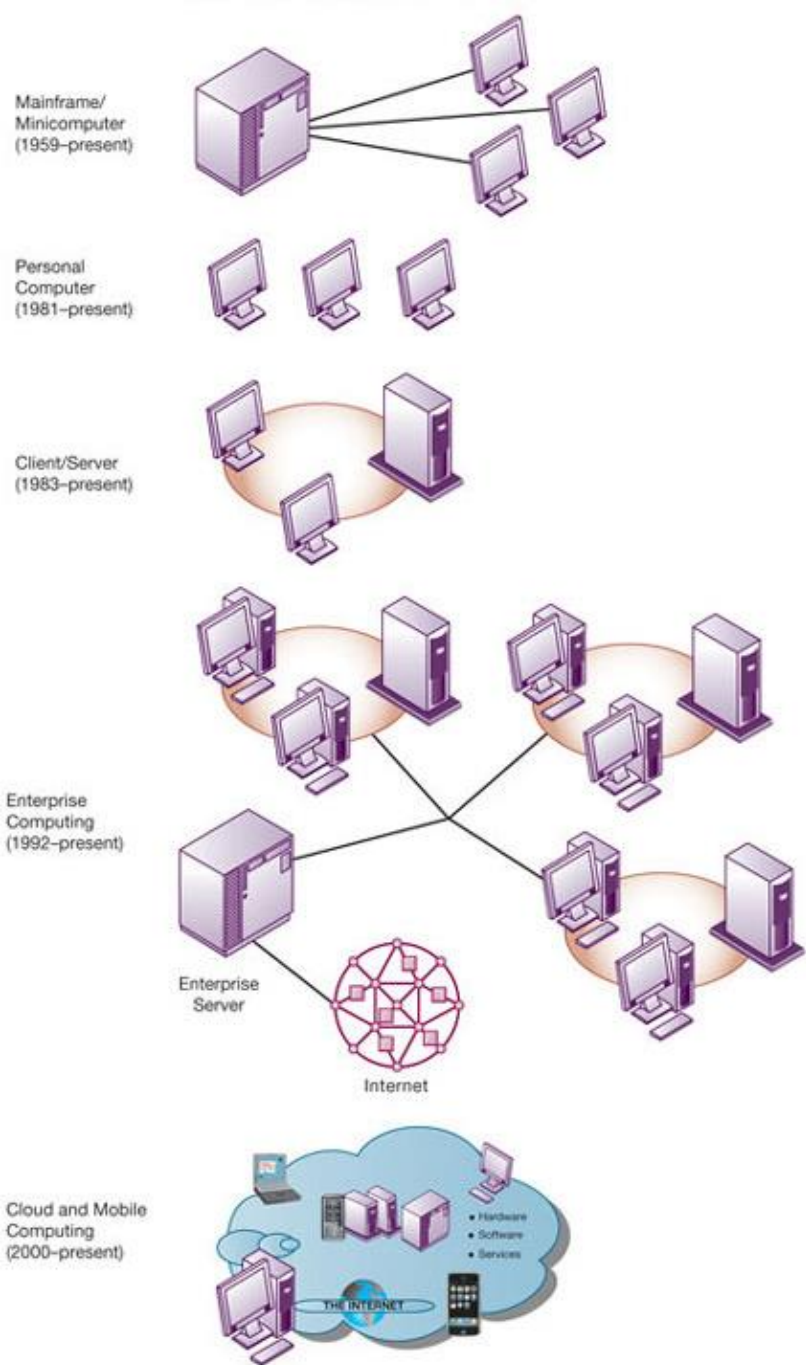
- Computing platforms providing computing services

- Physical facilities management services

- IT management, education, and other services

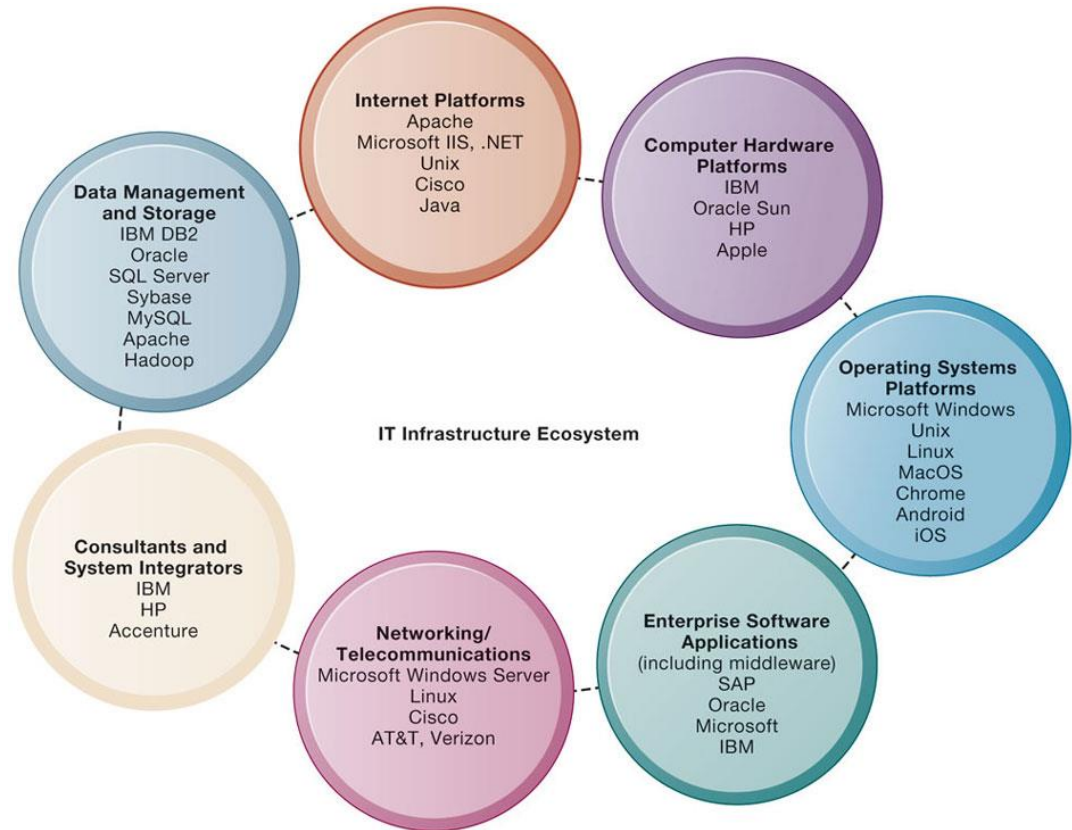
“Service platform” perspective

More accurate view of value of investments



- What is IT infrastructure, and what are the stages and drivers of IT infrastructure evolution?

# Components of IT infrastructure

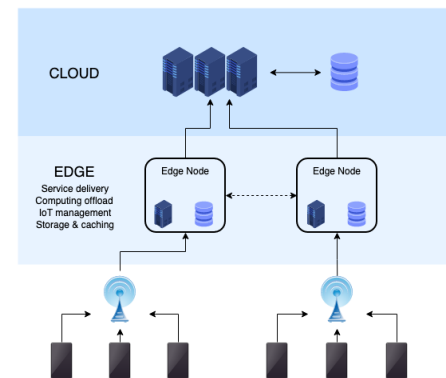


# Current trends in computer hardware platforms

- The mobile digital platform
- Consumerization of IT and BYOD (*bring your own device*)
- **Quantum computing**
- Virtualization
- Cloud computing (SAAS, PAAS, IAAS)



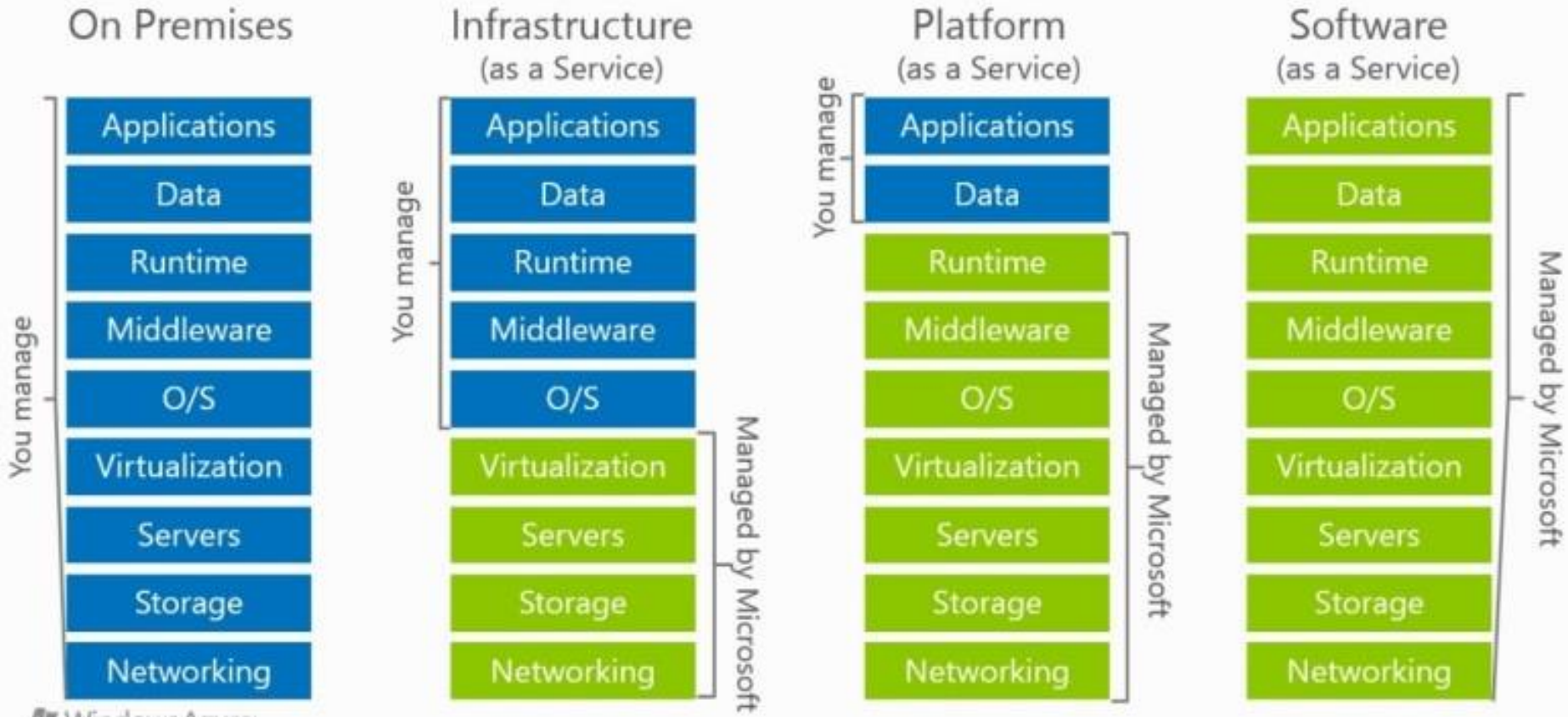
- Edge computing
- Green computing (Green IT)
- Metaverse





# Cloud Computing (Pearlson & Saunders, 2009)

- **Software as a Service (SaaS)**—provides **software application** functionality through a Web browser. Both the platform and the infrastructure are fully managed by the cloud provider with means that if the operating system or underlying service isn't configured correctly, the data at the higher application layer may be at risk. This is the most widely known and used form of cloud computing. SaaS is sometimes calls an ASP, or Application Service Provider.
- **Platform as a Service (PaaS)**—provides services using virtualized servers on which clients can run **existing applications or develop new ones** without having to worry about maintaining the operating systems, server hardware, load balancing, or computing capacity; the cloud provider manages the hardware and underlying operating system, which limits their enterprise risk management capabilities.
- **Infrastructure as a Service (IaaS)**—provides infrastructure through grids or clusters or **virtualized servers**, networks, storage, and systems software designed to augment or replace the functions of an entire data center; the customer may have full control of the actual server configuration allowing more risk management control over the data and environment.



# Types of cloud (Pearlson & Saunders, 2009)

Type of Cloud	Description	Managed By	Uses
Public cloud	Third-party service offering computing, storage, and software services to multiple customers and that is available to the public	Third-party service providers	Companies without major privacy concerns Companies seeking pay-as-you-go IT services Companies lacking IT resources and expertise
Private cloud	Cloud infrastructure operated solely for a single organization and hosted either internally or externally	In-house IT or private third-party host	Companies with stringent privacy and security requirements Companies that must have control over data sovereignty
Hybrid cloud	Combination of private and public cloud services that remain separate entities	In-house IT, private host, third-party providers	Companies requiring some in-house control of IT that are also willing to assign part of their IT infrastructures to a public cloud

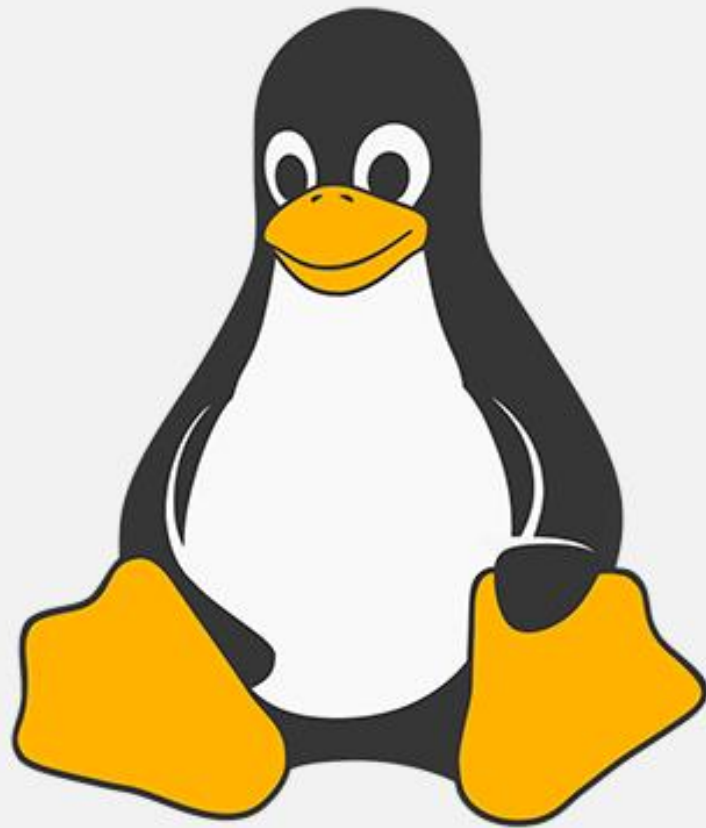
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# Cloud Computing

<https://youtu.be/36zducUX16w>

<https://youtu.be/whkyRvugqIM>





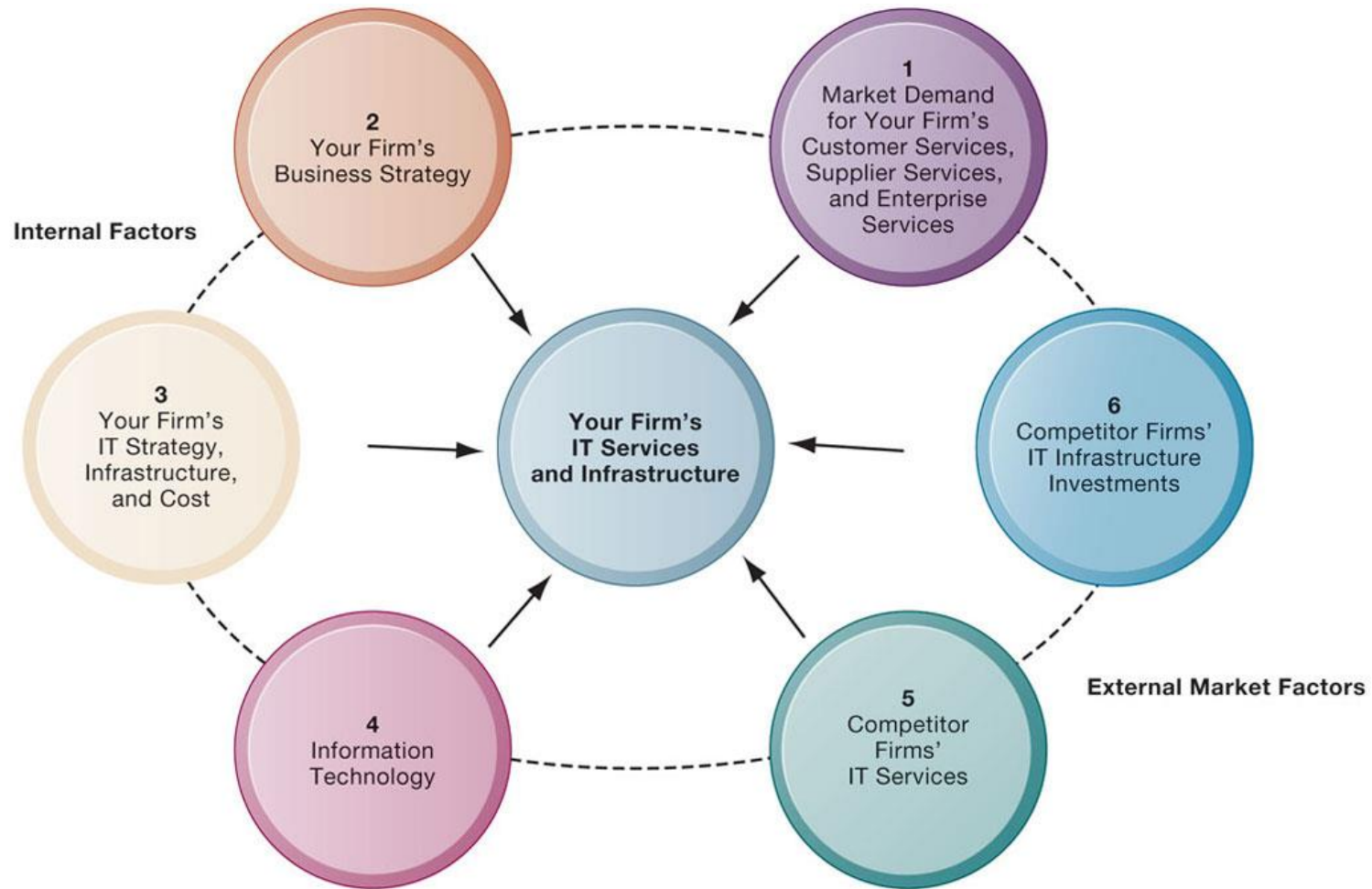
Linux™

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## Current computer software platforms and trends

- Linux and open-source software
- Software for the web: NodeJS, Python, PHP, Java HTML, and HTML5
- Web services and service-oriented architecture
- Software outsourcing

# Competitive Force Model for IT Infrastructure



# Total Cost Ownership (TCO)

Total cost of ownership (TCO)- help CIO to know all the costs (direct/indirect) when deciding to purchase/development (Gartner Group, 1986)

main cost categories:

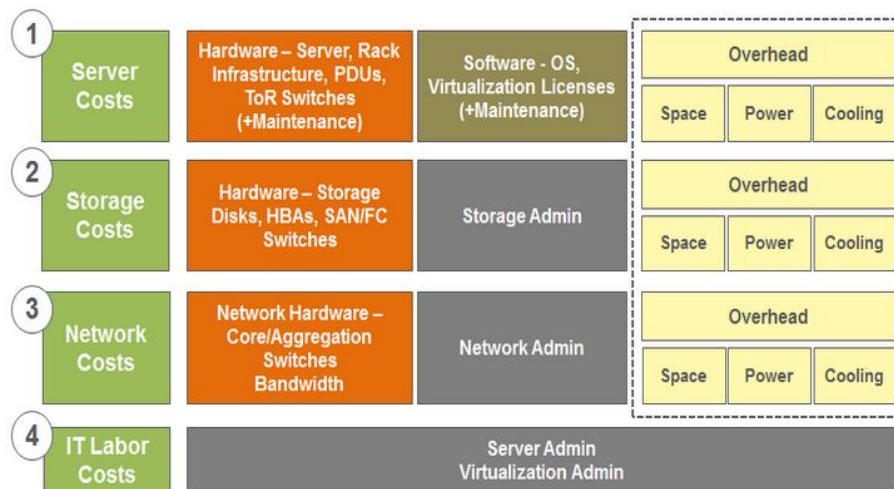
- **Direct costs:** SW Licence (proprietary systems / premium versions FOSS); deployment costs, training costs, technical support services costs
- **Indirect costs:** hardware upgrades, digital preservation (data information)
- **Hidden Costs:** cost derive from diminish of production, because of reactions against change, time for more training, lock-in
- **Fixed Costs:** licence fees, technical support
- **Variable Costs:** upgrades, electricity, digital space, training hours, among others.





# TCO- Elements


- Desktop environment
- Human Resources
- Help-desk/ support
- Productivity loss
- Training
- Software (upgrades)
- Integration with other platforms
- Network security
- Operating systems Upgrades
- Applications Upgrades
- Server costs
- Backups
- Storage



- Digital preservation
- Memory
- Energy
- Reposition

<https://www.citrix.com/products/xendesktop/tech-info/savings-calculator.html>

# Example: TCO calculator

Contact Sales

## AWS Total Cost of Ownership (TCO) Calculator Basic

Use this calculator to compare the cost of running your applications in an on-premises or colocation environment to AWS. Describe your on-premises or colocation configuration to produce a detailed cost comparison with AWS. You can switch between the basic and advanced views to provide additional configuration details.

Select Currency: United States Dollar

What type of environment are you comparing against?  On-Premises  Colocation

Which AWS region is ideal for your geo requirements? US East (N. Virginia)

### Servers

Are you comparing physical servers or virtual machines?  Physical Servers  Virtual Machines

Provide your configuration details:

App. Name <i>i</i>	Number of VMs <i>i</i>	CPU Cores <i>i</i>	Memory(GB) <i>i</i>	Hypervisor <i>i</i>	Guest OS <i>i</i>	
<input type="text"/>	<input type="text" value="1 - 10000"/>	<input type="text" value="1 - 32"/>	<input type="text" value="1 - 256"/>	<span>VMware</span>	<span>Linux</span>	

Total no.of VMs: + Add Row

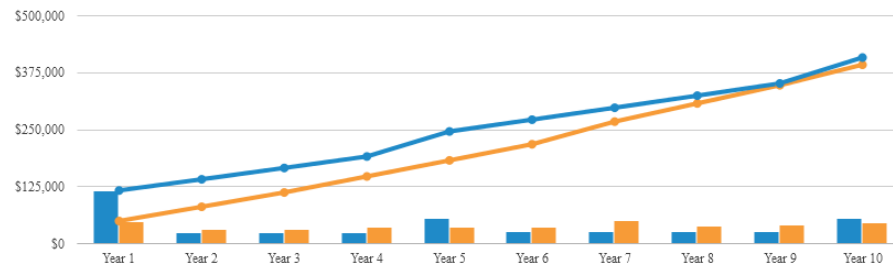
<https://calculator.aws/>



# Example: TCO calculator

On-Premise vs. Software as a Service

Share ↗



On-Premise

Software as a Service

License & Subscription

License type:

License fee:

Additional license costs each year:

Years until major upgrade:

Subscription fee (annual):

Subscription term in years:

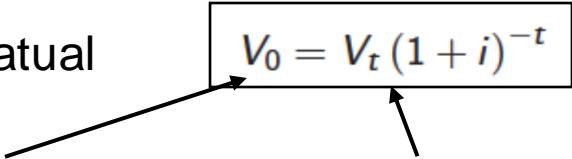
Price increase at end of each term:

Years until major upgrade:

<http://www.softwareadvice.com/tco/>

# Capital Budgeting | Investment Appraisal

- Present Value = Valor atual
- Cash-Flow
- NPV (Net Present Value) = VAL (Valor Atualizado Liquido)
- Pay Back Period
- IRR (Internal Rate of Return) = TIR (Taxa Interna de Rentabilidade) (VAL=0)
- CAPEX (Capital Expense)
- OPEX (Operating Expense)
- TCO (Total Cost Ownership)

$$V_0 = V_t (1 + i)^{-t}$$


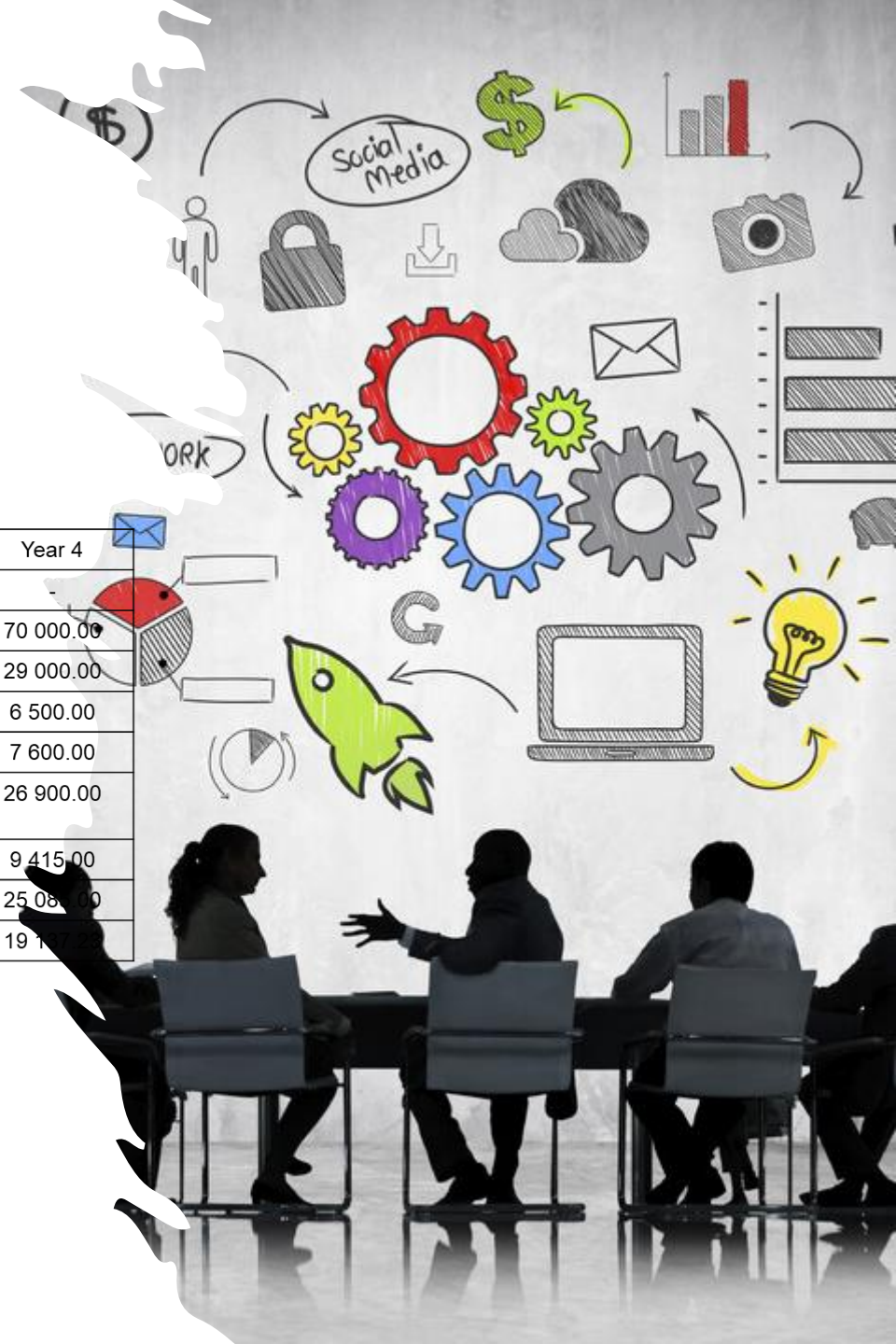


# Example

Description	0	Year 1	Year 2	Year 3	Year 4
Investment	40 000.00	-	-	-	-
Sales	-	70 000.00	70 000.00	70 000.00	70 000.00
HR	-	29 000.00	29 000.00	29 000.00	29 000.00
Rental	-	6 500.00	6 500.00	6 500.00	6 500.00
Depreciations	-	7 600.00	7 600.00	7 600.00	7 600.00
Earning before interest (EBITA)	-	26 900.00	26 900.00	26 900.00	26 900.00
Taxes	-	9 415.00	9 415.00	9 415.00	9 415.00
Cash-Flow (1)	40 000.00	25 085.00	25 085.00	25 085.00	25 085.00
Current Cash-Flow (2)	40 000.00	23 443.93	21 910.21	20 476.83	19 110.00

(1) Cash-Flow = Sales – (HR + Rental + Interest)

(2) Current Cash-Flow = Cash-Flow , “i” Rate , “n” years  $(1 + i)^{-n}$



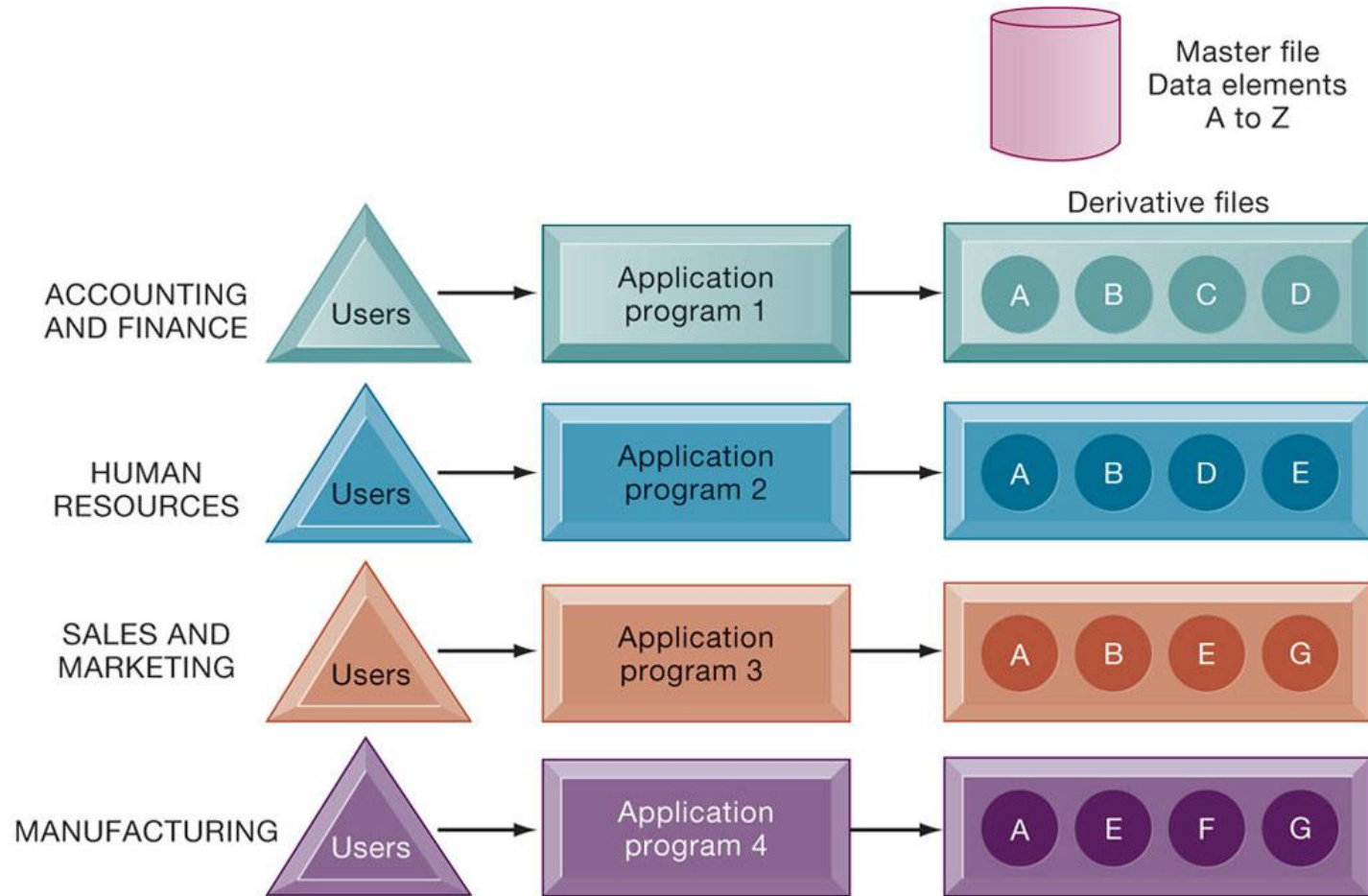






# **Data Management & Business Intelligence**

# Problems of managing data resources in a traditional file environment





ORACLE  
DATABASE



- Database
  - Serves many applications by centralizing data and controlling redundant data
- Database management system (DBMS)
  - Interfaces between applications and physical data files
  - Separates logical and physical views of data
  - Solves problems of traditional file environment



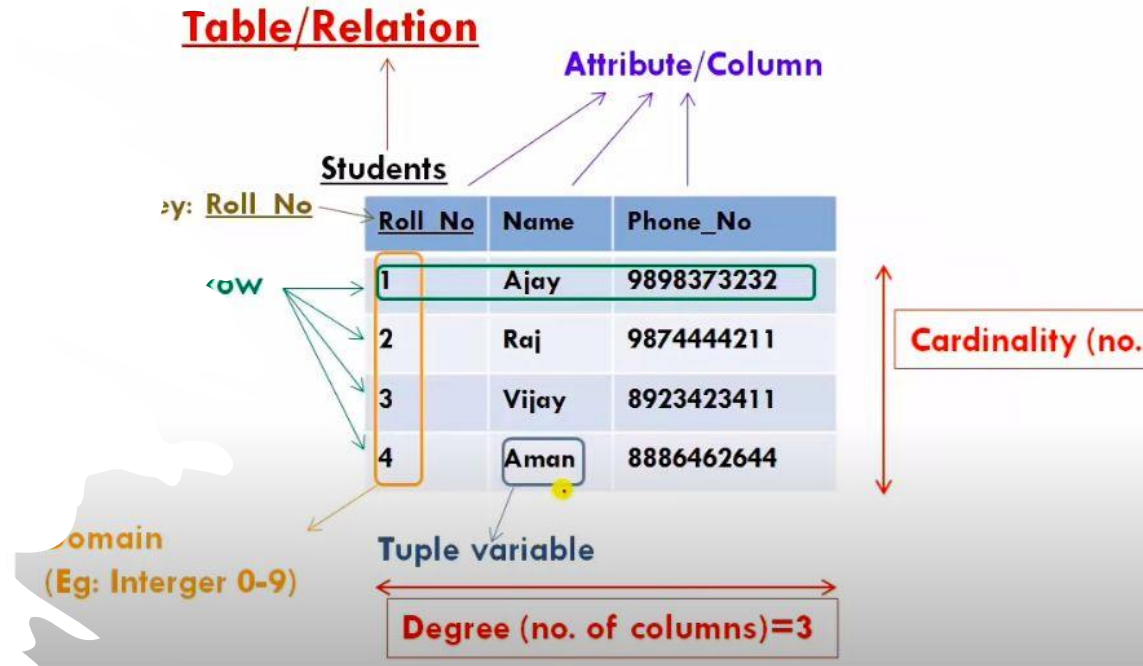
## Database Management System (DBMS)

# How DBMS solves the problems of traditional file environment

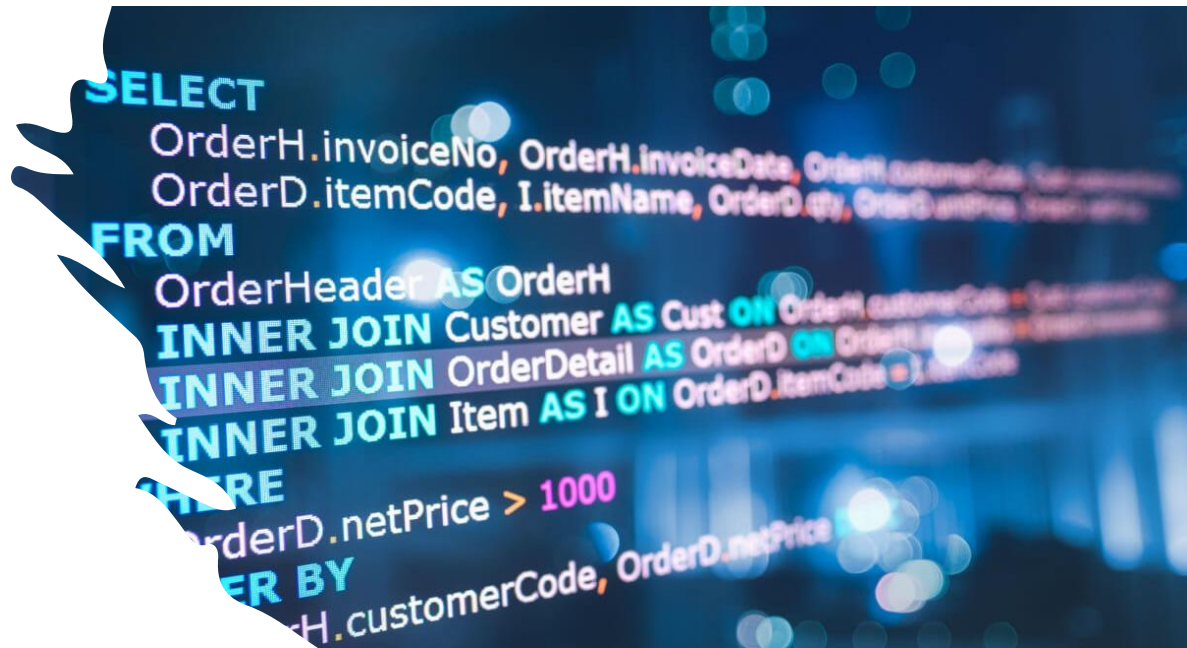
- Controls redundancy
- Eliminates inconsistency
- Uncouples programs and data
- Enables organization to centrally manage data and data security

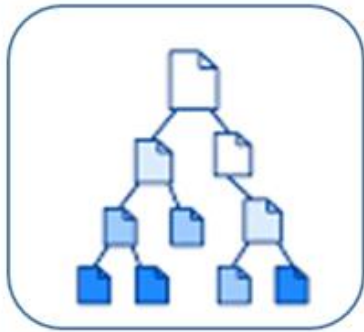
# Relational Model

- Structured query language (SQL) is a programming language for storing and processing information in a relational database.

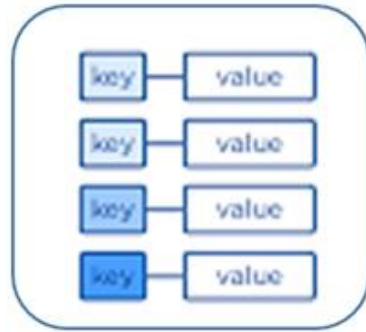


- Create Table
  - `CREATE TABLE Employee (EmpId int, LastName varchar(255), FirstName varchar(255), Address varchar(255), City varchar(255));`
- Insert
  - `INSERT INTO Employee (EmpId, LastName, FirstName, ADDRESS, City) VALUES (1, 'XYZ', 'ABC', 'India', 'Mumbai');`
- Select
  - `Select EmpId, LastName from Employee;`
  - `Select * from Employee;`
- Update
  - `UPDATE Employee SET FirstName= 'KS', City= 'Pune' WHERE EmpId= 1;`
- Delete
  - `DELETE FROM Employee WHERE EmpId=1;`

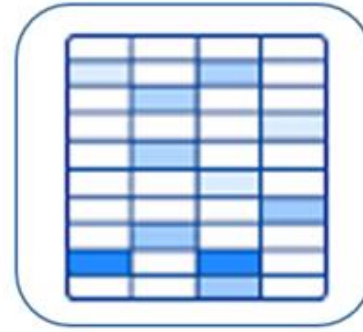




Document Store



Key-Value Store



Wide-Column Store



Graph Store

# Type of Database

- Relational DB (SQL-based)
  - Oracle, SQL Server, PostgreSQL, MySQL
- DB (NoSQL – Not Only SQL)
  - MongoDB, Cassandra, Amazon DynamoDB
- Cloud DB
  - Amazon AWS, Microsoft Azure, Google Cloud SQL

# Database

- <https://www.youtube.com/watch?v=TmpU5r1BKHg&t=1s>
- <https://www.youtube.com/watch?v=W6XFNMQyuU0&t=204s>
- [https://www.youtube.com/watch?v=Zk7P5JnJL\\_c&t=200s](https://www.youtube.com/watch?v=Zk7P5JnJL_c&t=200s)
- <https://www.youtube.com/watch?v=wOCOzzgwpcl>

# BLOCKCHAIN



Block



Ledger



Distribution



Transaction



Confirmation



Proof of work



Result

## Blockchain

- Is a decentralized and distributed ledger technology that has gained prominence due to its application in cryptocurrencies like Bitcoin
- Distributed and decentralized Database.
- Guarantees the security of a record of data and generates trust without the need for a trusted third party
- A blockchain collects information together in groups, known as blocks, that hold sets of information.
- All transactions within the blocks are validated and agreed upon by a consensus mechanism, ensuring that each transaction is true and correct.
- The goal of blockchain is to allow digital information to be recorded and distributed, but not edited, deleted or destroyed.
- Bitcoin built on blockchain.





- NFT
  - non-fungible token
  - unique digital identifier
  - is recorded on a blockchain
  - is used to certify ownership and authenticity.
- Web3
  - concept for an updated version of the World Wide Web
  - integrates principles like
    - decentralization,
    - blockchain technology,
    - economy driven by tokens



- [https://www.youtube.com/watch?v=SSo\\_ElwHSd4&t=4s](https://www.youtube.com/watch?v=SSo_ElwHSd4&t=4s)
- <https://andersbrownworth.com/blockchain/>
- <https://www.youtube.com/watch?v=WEsO8OuAnjE>
- <https://www.youtube.com/watch?v=EucwiDsfilg&t=2s>







# Big Data

- **Three V of Big Data**
  - Volume
    - The amount of data matters. With big data, you'll have to process high volumes of low-density, unstructured data.
  - Velocity
    - Velocity is the fast rate at which data is received and (perhaps) acted on.
  - Variety
    - Variety refers to the many types of data that are available.

# Big data use cases

Product  
Development

Predictive  
Maintenance

Customer  
Experience

Fraud and  
compliance

Machine  
learning

Operational  
efficiency

Drive  
innovation



How data science and analytics can contribute to sustainable development



[www.unglobalpulse.org](http://www.unglobalpulse.org)

@UNGlobalPulse 2017

**1 NO POVERTY**

Spending patterns on mobile phone services can provide proxy indicators of income levels

**2 ZERO HUNGER**

Crowdsourcing or tracking of food prices listed online can help monitor food security in near real-time

**3 GOOD HEALTH AND WELL-BEING**

Mapping the movement of mobile phone users can help predict the spread of infectious diseases

**4 QUALITY EDUCATION**

Citizen reporting can reveal reasons for student drop-out rates

**5 GENDER EQUALITY**

Analysis of financial transactions can reveal the spending patterns and different impacts of economic shocks on men and women

**6 CLEAN WATER AND SANITATION**

Sensors connected to water pumps can track access to clean water

**7 AFFORDABLE AND CLEAN ENERGY**

Smart metering allows utility companies to increase or restrict the flow of electricity, gas or water to reduce waste and ensure adequate supply at peak periods

**8 DECENT WORK AND ECONOMIC GROWTH**

Patterns in global postal traffic can provide indicators such as economic growth, remittances, trade and GDP

**9 INDUSTRY, INNOVATION AND INFRASTRUCTURE**

Data from GPS devices can be used for traffic control and to improve public transport

**10 REDUCED INEQUALITY**

Speech-to-text analytics on local radio content can reveal discrimination concerns and support policy response

**11 SUSTAINABLE CITIES AND COMMUNITIES**

Satellite remote sensing can track encroachment on public land or spaces such as parks and forests

**12 RESPONSIBLE CONSUMPTION AND PRODUCTION**

Online search patterns or e-commerce transactions can reveal the pace of transition to energy efficient products

**13 CLIMATE ACTION**

Combining satellite imagery, crowd-sourced witness accounts and open data can help track deforestation

**14 LIFE BELOW WATER**

Maritime vessel tracking data can reveal illegal, unregulated and unreported fishing activities

**15 LIFE ON LAND**

Social media monitoring can support disaster management with real-time information on victim location, effects and strength of forest fires or haze

**16 PEACE, JUSTICE AND STRONG INSTITUTIONS**

Sentiment analysis of social media can reveal public opinion on effective governance, public service delivery or human rights

**17 PARTNERSHIPS FOR THE GOALS**

Partnerships to enable the combining of statistics, mobile and internet data can provide a better and real-time understanding of today's hyper-connected world



# Business Intelligence (BI)

Goal is to deliver accurate real-time information to decision makers

- Main analytic functionalities of BI systems
- Production reports
- Parameterized reports
- Dashboards/scorecards
- Ad hoc query/search/report creation
- Drill down
- Forecasts, scenarios, models
- Example: A company that wants to better manage its supply chain needs BI capabilities to determine where delays are happening and where variabilities exist within the shipping process

VALUE

### **Descriptive analytics**

tracks key performance indicators (KPIs) to understand the present state of a business.

### **Predictive analytics**

analyzes trend data to assess the likelihood of future outcomes.

### **Prescriptive analytics**

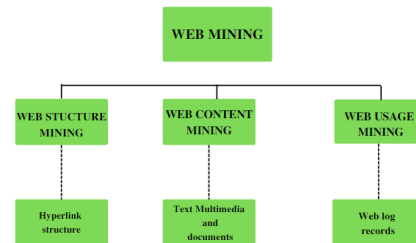
uses past performance to generate recommendations about how to handle similar situations in the future.

# Business Analytics (BA)

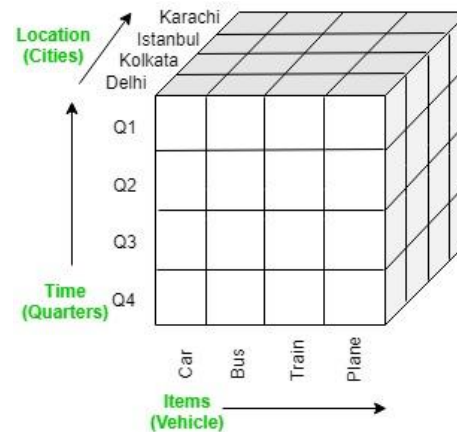
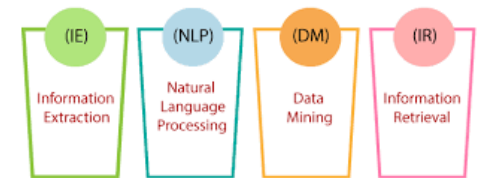
- Using data analysis techniques to get insights about what will probably happen in the future?
- Predictive analysis
- Define trends and patterns
- Example: Improving Productivity and Collaboration, forecast demands

# Analytics tools

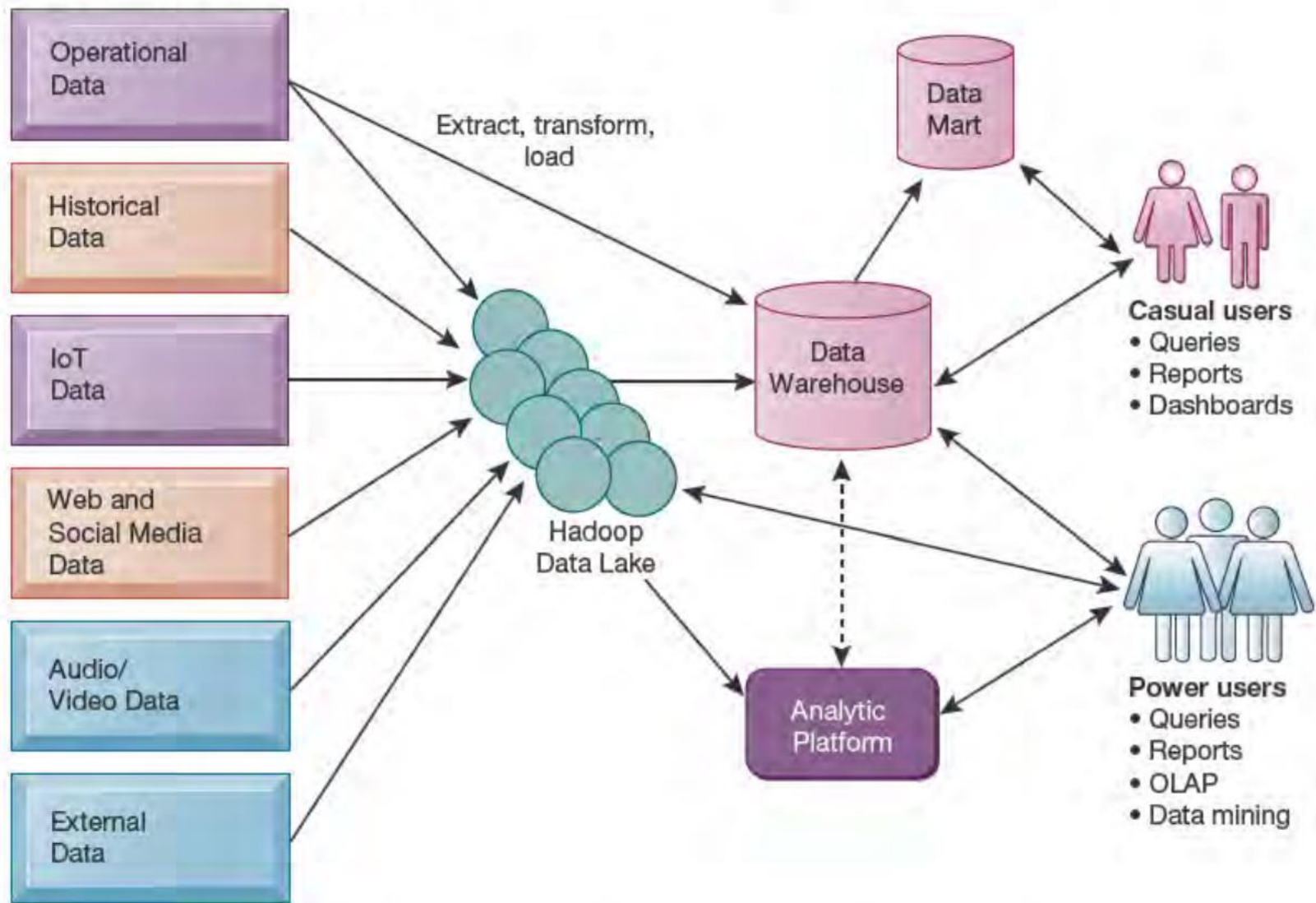
- OLAP
- Data Mining
- Text Mining
- Web Mining



## Area's of Text Mining





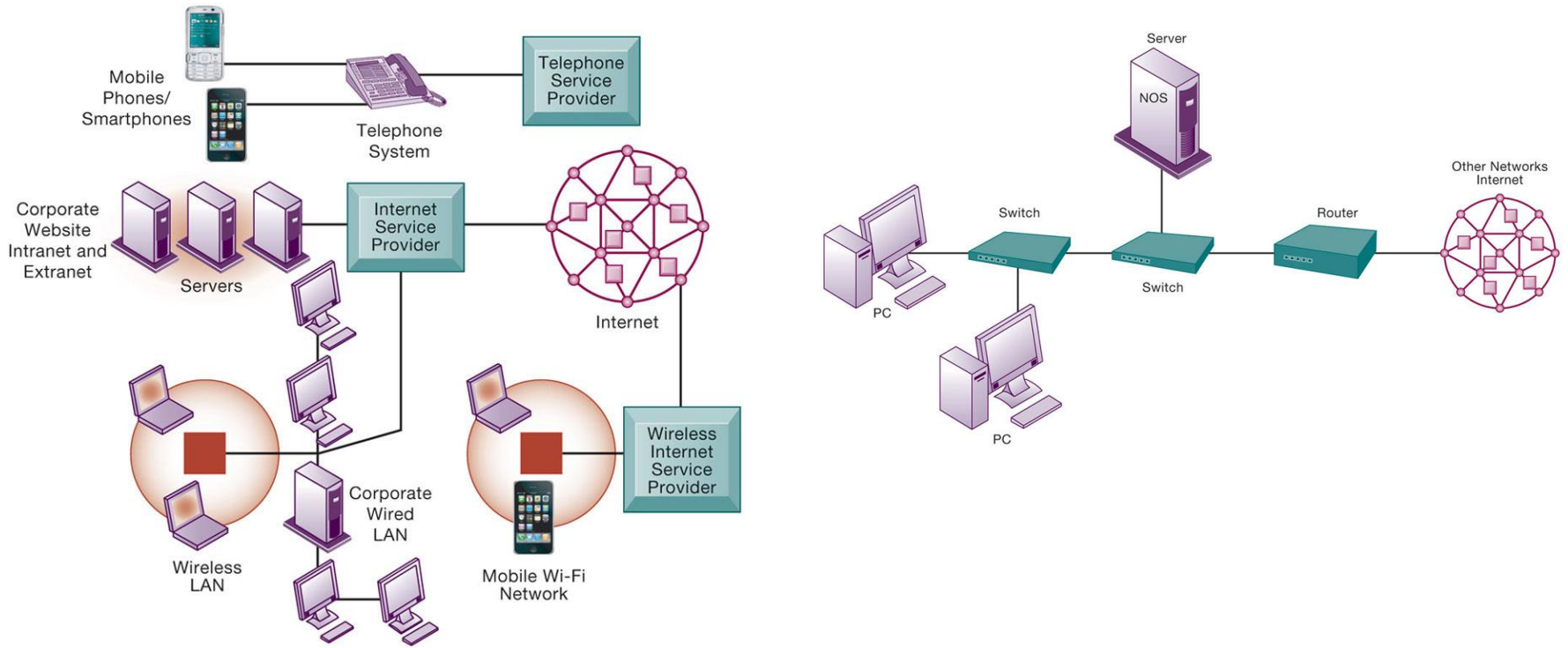




# Data Governance, data administration, and data quality

- Firm's rules, procedures, roles for sharing, managing, standardizing data
- **Data administration**
  - Establishes policies and procedures to manage data
- **Data governance**
  - Deals with policies and processes for managing availability, usability, integrity, and security of data, especially regarding government regulations
- **Database administration**
  - Creating and maintaining database

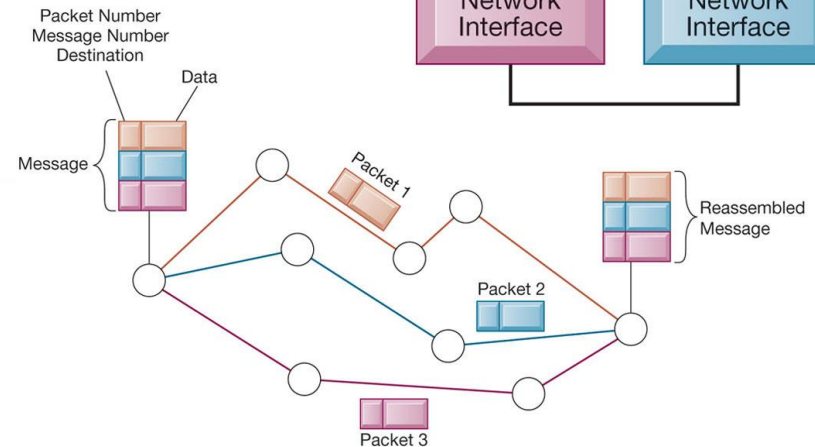
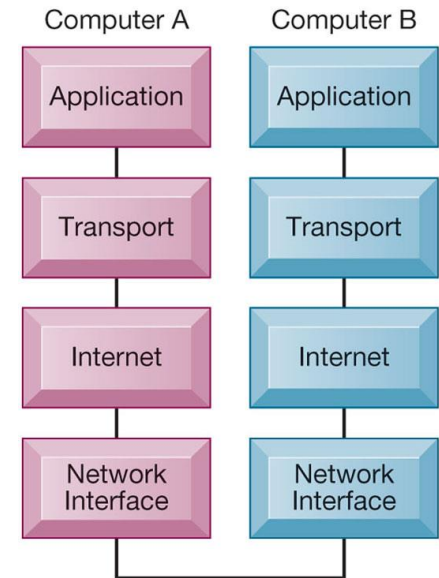
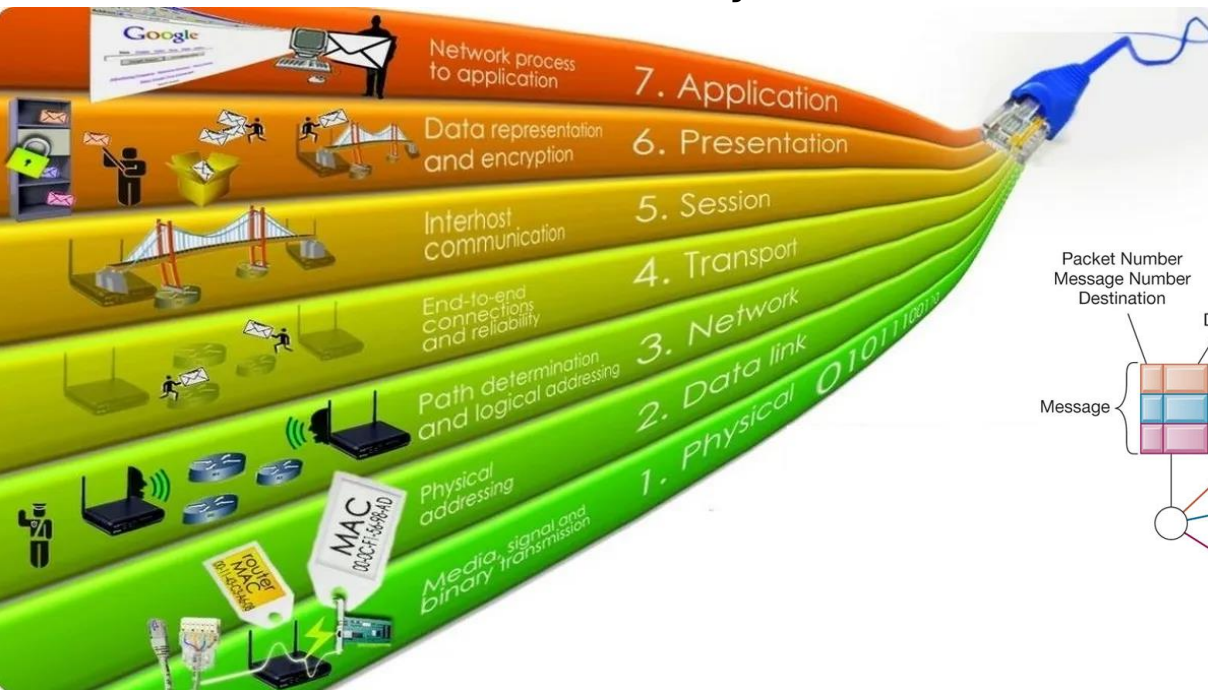
# Telecommunications



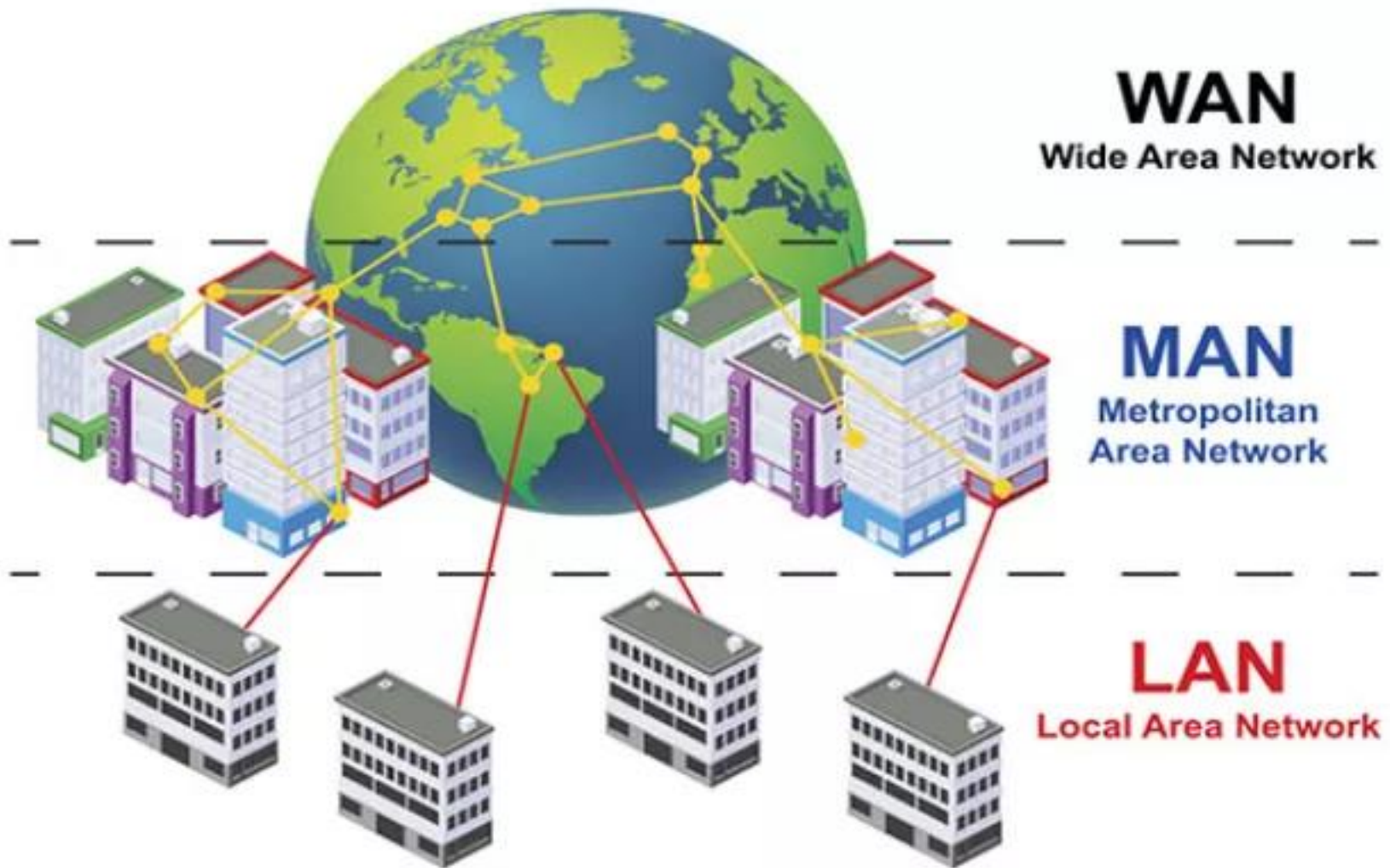
Main components of network

# Main components of telecommunications

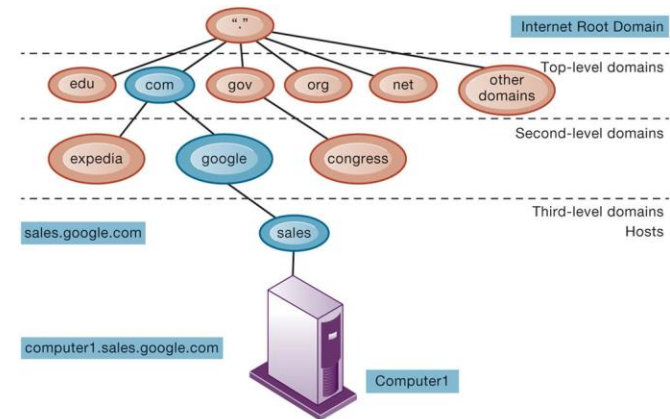
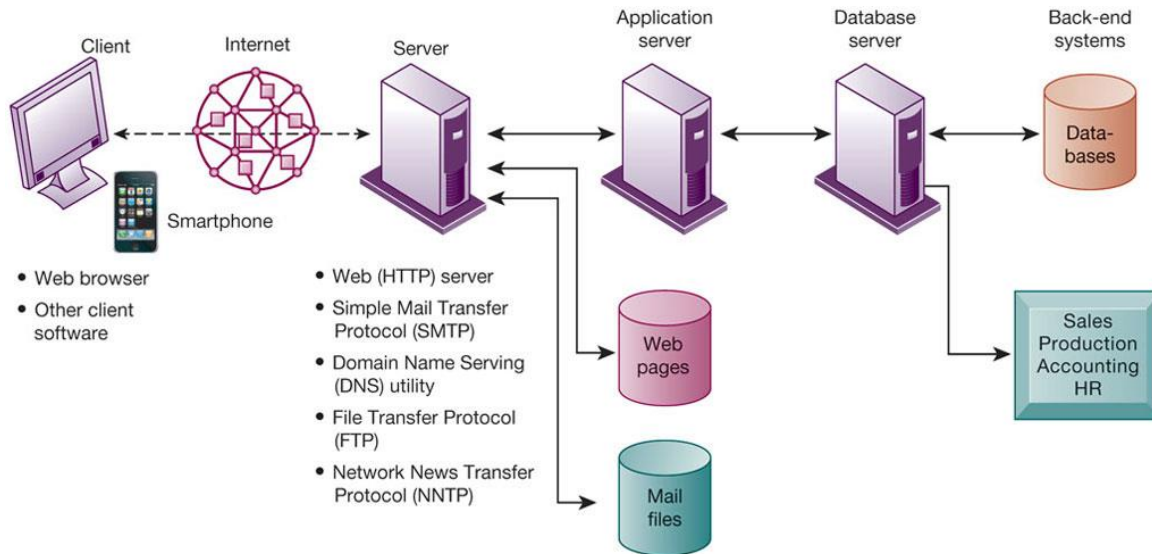
- Client/server computing
- Packet switching
- TCP/IP and connectivity



# Different types of networks



# How do the Internet and Internet technology work, and how do they support communication and e-business?

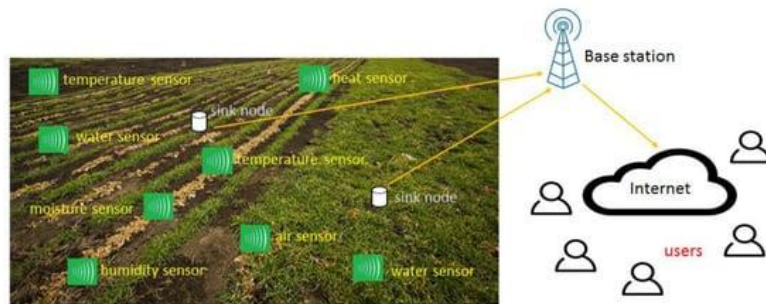




# principal technologies and standards for wireless networking, communication, and Internet access



- Cellular Systems
- Wireless Computer Networks and Internet Access  
Bluetooth (IEEE 802.15), Wi-Fi (IEEE 802.11), WiMax (IEEE 802.16)
- Radio Frequency Identification (RFID)
- Wireless Sensor Networks (WSN)



Haseeb, K., Ud Din, I., Almogren, A., & Islam, N. (2020). An Energy Efficient and Secure IoT-Based WSN Framework: An Application to Smart Agriculture. *Sensors*, 20(7), 2081. MDPI AG. Retrieved from <http://dx.doi.org/10.3390/s20072081>



# Securing Information Systems

# Cyber Security

- Cybersecurity is the practice of protecting systems, networks, and programs from digital attacks.
- Critical infrastructure cyber security
- Network security
- Cloud security
- IoT (Internet of Things) security
- Application security





## Types of Cyber Threats

- **Malware**, such as ransomware, botnet software, RATs (remote access Trojans), rootkits and bootkits, spyware, Trojans, viruses and worms.
- **Backdoors**, which allow remote access.
- **Formjacking**, which inserts malicious code into online forms.
- **Cryptojacking**, which installs illicit cryptocurrency mining software.
- **DDoS (distributed denial-of-service) attacks**, which flood servers, systems and networks with traffic to knock them offline.
- **DNS (domain name system) poisoning attacks**, which compromise the DNS to redirect traffic to malicious sites.

# What is the business value of security and control?

- Failed computer systems can lead to significant or total loss of business function
- Firms now are more vulnerable than ever
  - Confidential personal and financial data
  - Trade secrets, new products, strategies
- A security breach may cut into a firm's market value almost immediately
- Inadequate security and controls also bring forth issues of liability

# What are the components of an organizational framework for security and control?

- IS controls may be automated or manual
- General controls
  - Govern design, security, and use of computer programs and security of data files in general throughout organization
  - Software controls, hardware controls, computer operations controls, data security controls, system development controls, administrative controls,
- Application controls
  - Controls unique to each computerized application
  - Input controls, processing controls, output controls

# What are the most important tools and technologies for safeguarding information resources?

- Identity management software
  - Automates keeping track of all users and privileges
  - Authenticates users, protecting identities, controlling access
- Authentication
  - Password systems
  - Tokens
  - Smart cards
  - Biometric authentication
  - Two-factor authentication
- Firewall
  - Combination of hardware and software that prevents unauthorized users from accessing private networks
  - Packet filtering
  - Stateful inspection
  - Network address translation (NAT)
  - Application proxy filtering



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## Discussion

- Facebook Case study
- Metaverse
- Augmented Reality
- Virtual Reality



Facebook Me



# Cyber Security

- <https://www.youtube.com/watch?v=NR8QID3bFqw&t=2s>
- [https://www.youtube.com/watch?v=\\_\\_EECGrqDeE](https://www.youtube.com/watch?v=__EECGrqDeE)
- [https://www.youtube.com/watch?v=\\_Lx5VmAdZSI](https://www.youtube.com/watch?v=_Lx5VmAdZSI)

# Next Session

- IT in Business and Society
- IT Infrastructure
- **Key Systems Applications**
- Build and Manage Systems