IT INFRASTRUCTURE

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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

Index

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

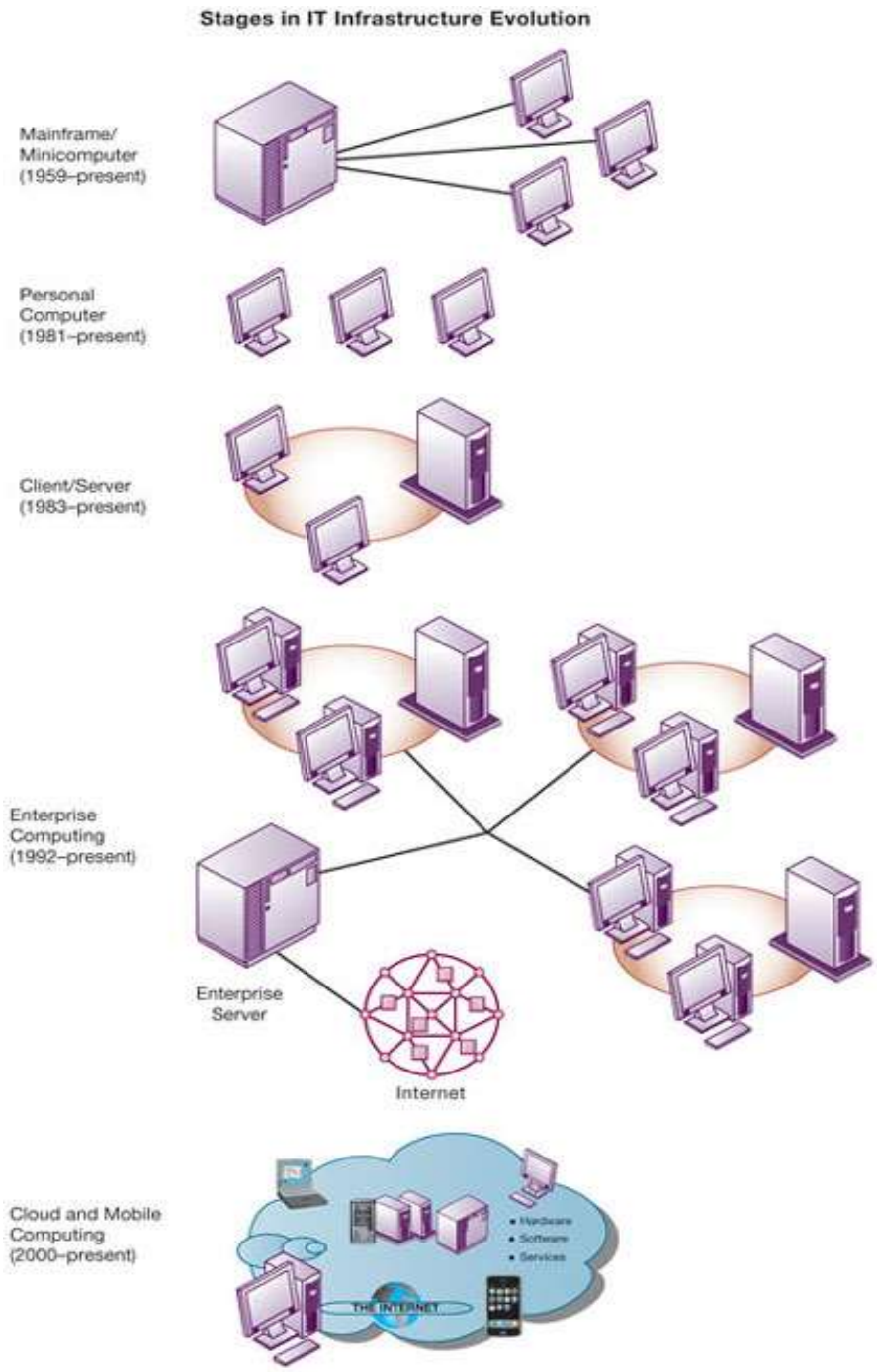
Set of firm-wide services including:

- Computing platforms providing computing services
- Physical facilities management services
- IT management, education, and other services

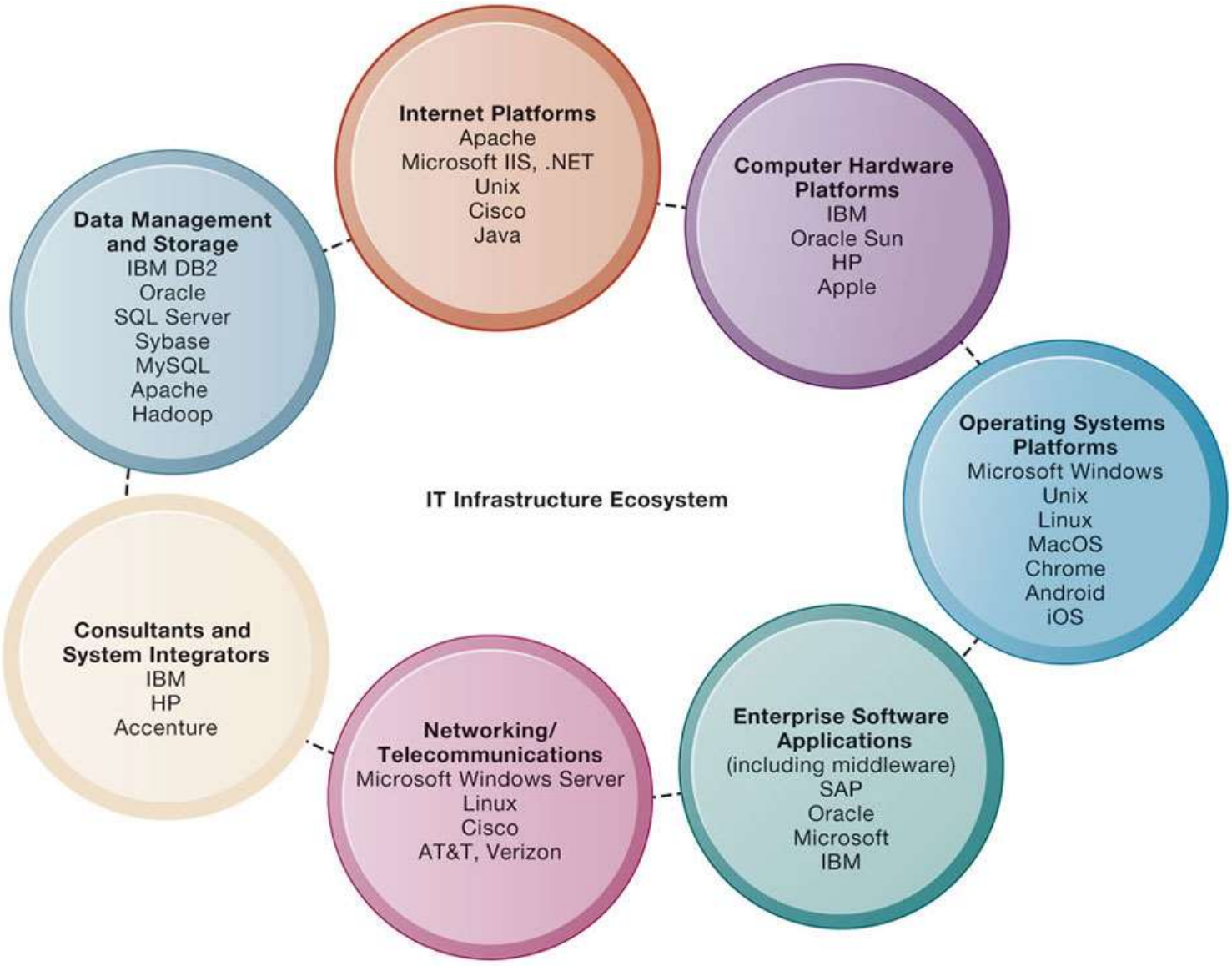
"Service platform" perspective

- 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)

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

Cloud Computing

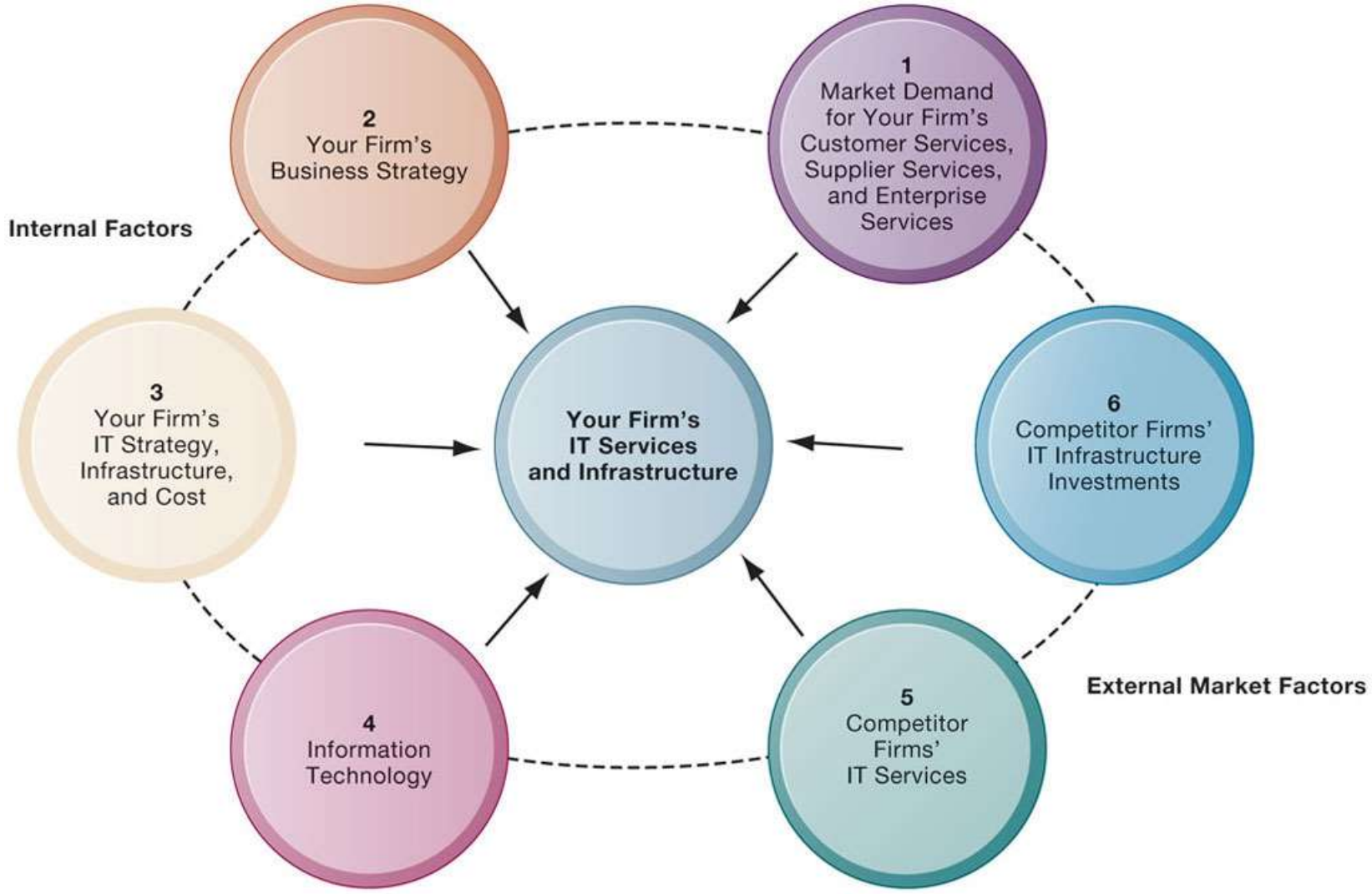
https://youtu.be/36zducUX16w

https://youtu.be/whkyRvuggIM

Current computer software platforms and trends

- Linux and open-source software
- Software for the web: 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 tha purchase/development

  (Gartner Group, 1986)

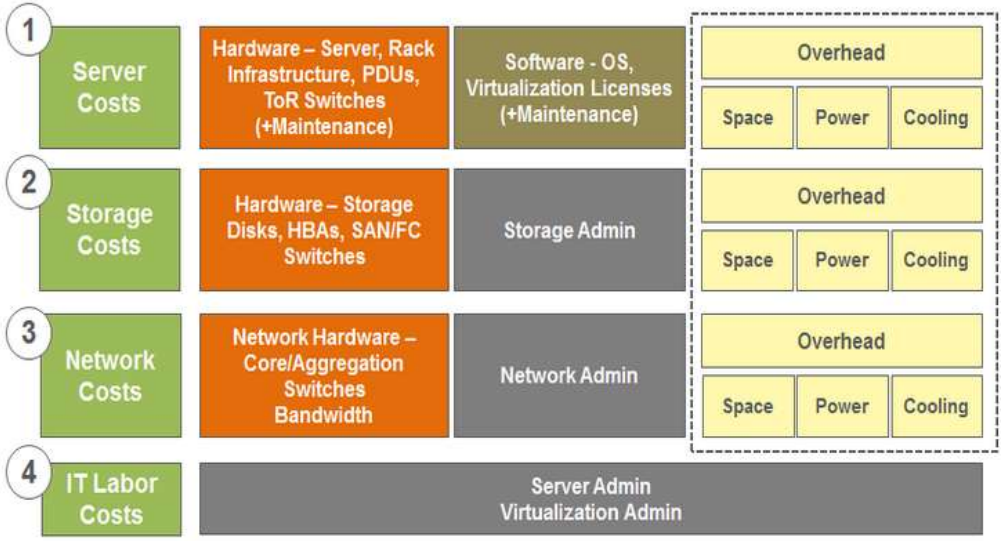
- Principal cost categories:
  - Direct costs: SW Licence (proprietary systems / premium versions FOSS); deployment costs, training costs, technical support services costs
  - Indirect costs: hardware upgrades, digital preservation (data information)
  - Hidden Costs: cost derive from diminish of production, as a result 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.

Total costs specifications

- Training total costs:
  - Transition costs
  - Hostility costs
  - Learning costs (learning capabilities reposition)
- Software costs:
  - Licenses (if applicable)
  - Other modules
  - Support
  - Interoperability (…)
- Staff costs:
  - IT-staff,
  - End user
  - Decisors (…)

TCO- Elements

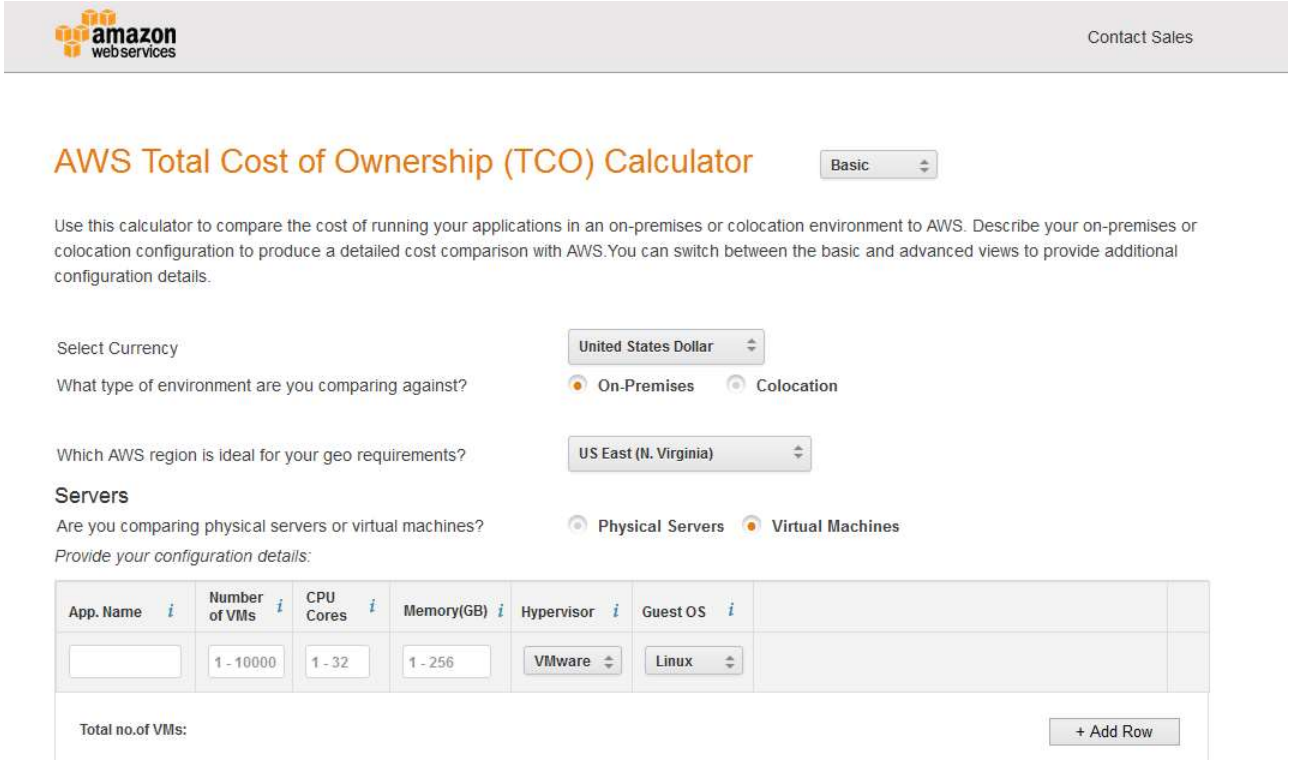
- Desktop environment
- Human Resources
- Help-desk/ support
- Productivity loss
- Training
- Software (upgrades)
- Integration with other platforms
- Network security
- Operating systems Upgrades
- Applications Upgrades
- Server costs
- Backups
- Storage



- Digital preservation
- Memory
- Energy
- Reposition

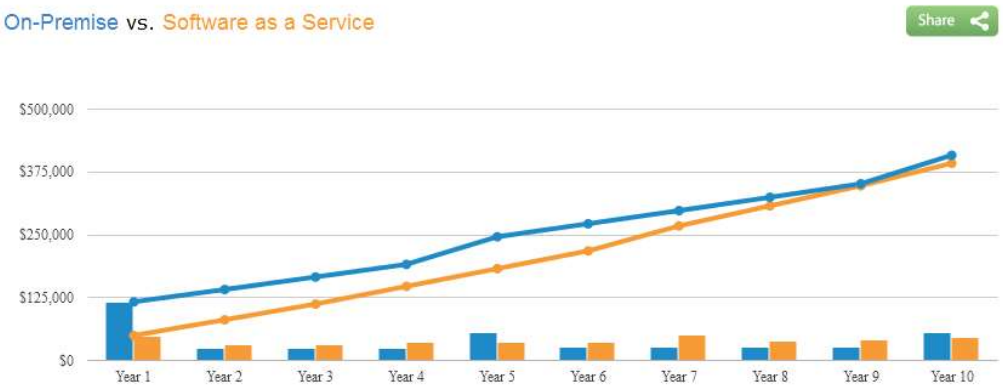
https://www.citrix.com/products/xendesktop/tech-info/savings-calculator.html

Example: TCO calculator



https://calculator.aws/

Example: TCO calculator



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

Capital Budgeting | Investment Appraisal

- Present Value = Valor atual

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

- 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)

Example

Decision of buying a certain technology license:

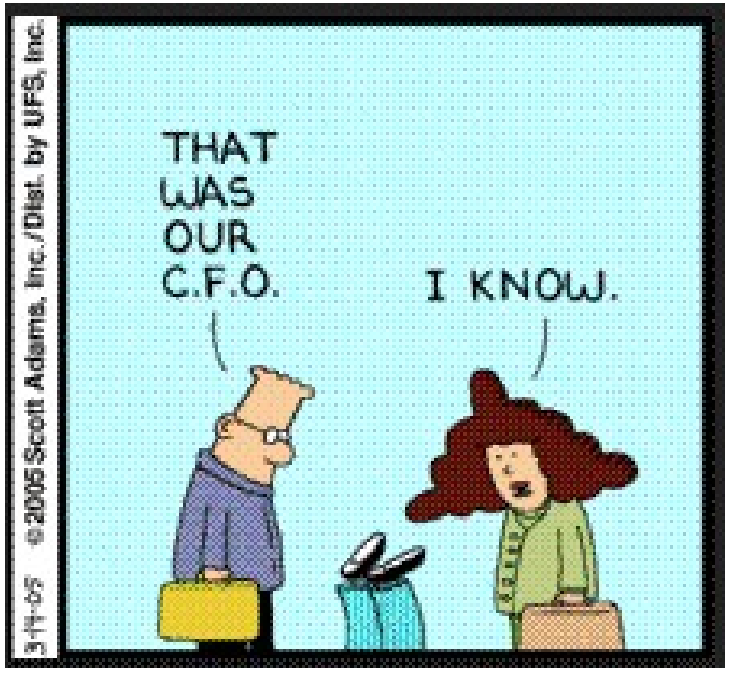
- Total inicial investment– 40 000€
- Anual sales – 70 000€
- Estimated HR – 29 000€
- Rental expenses – 6 500€
- Depreciation – 38 000€ (Rate 20%)
- Interest rate – 35%
- Capital rate – 7% per year

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	19 137.23

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

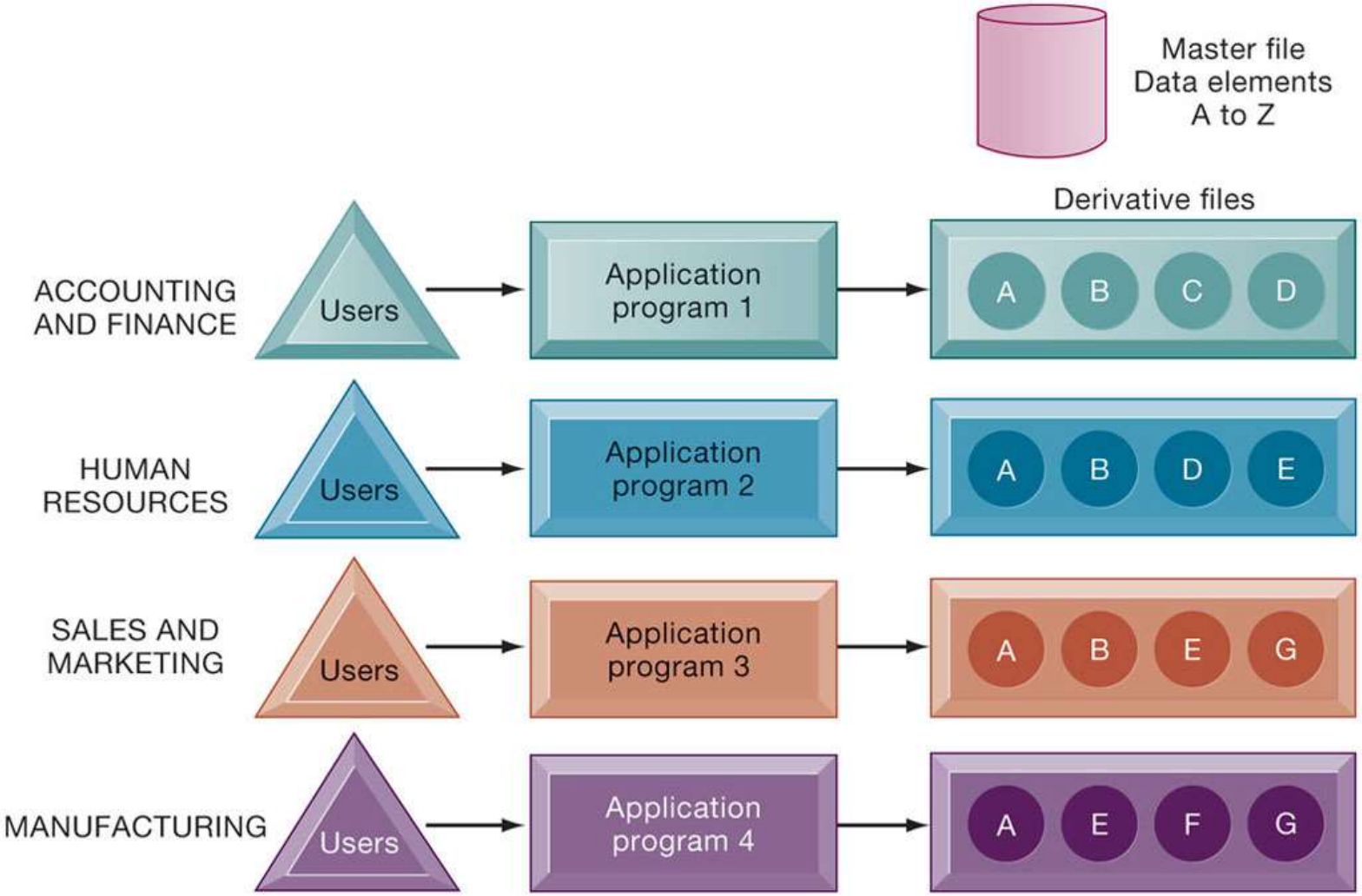
(2) Current Cash-Flow = Cash-Flow , “i” Rate , “n” years $(1 + i)^{-n}$

$$\text{Payback period} = \frac{Investment}{Cash\text{-}Flow} = \frac{40\ 000}{25\ 085} = 1.6 \text{ years}$$


THAT WAS OUR C.F.O.
I KNOW.
3-11-05 ©2005 Scott Adams, Inc./Dist. by UFS, Inc.

Data Management
&
Business Intelligence

Problems of managing data resources in a traditional file environment



Database Management System (DBMS)

- 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

How DBMS solves the problems of traditional file environment

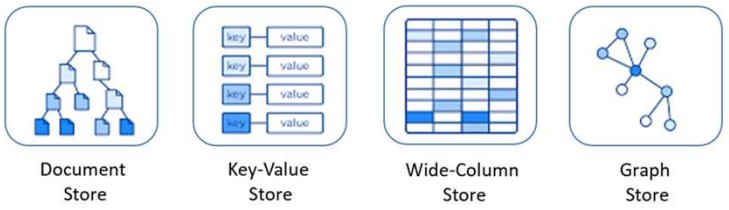
- Controls redundancy
- Eliminates inconsistency
- Uncouples programs and data
- Enables organization to centrally manage data and data security

Basic Queries

- 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;
-

Type of Database

- Relational DB (SQL-based)
  - Oracle, SQL Server, PostgreSQL, MySQL
- Non-relational DB (NoSQL)
  - MongoDB, Cassandra, Amazon DynamoDB
- Cloud DB
  - Amazon AWS, Microsoft Azure, Google Cloud SQL



Database

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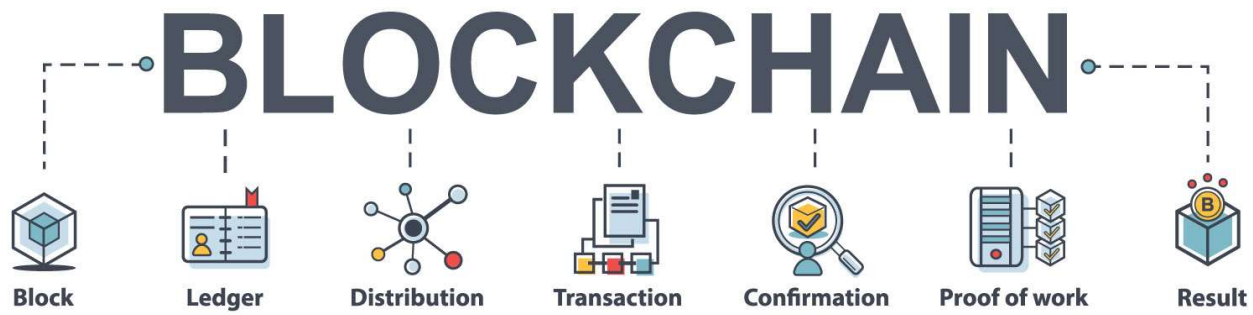
- https://www.youtube.com/watch?v=W6XFNMQyuU0&t=204s
- https://www.youtube.com/watch?v=Zk7P5JnJL_c&t=200s
- https://www.youtube.com/watch?v=wOCOzzgwpcI



- 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.

Web3, Blockchain and NFT

- https://www.youtube.com/watch?v=SSo_EIwHSd4&t=4s
- https://andersbrownworth.com/blockchain/
- https://www.youtube.com/watch?v=WEsO8OuAnjE
- https://www.youtube.com/watch?v=EucwiDsfilg&t=2s

Discussion: Impact of Cryptos on Society and Environment

- Transparency
- Supply chain management
- Digital identity
- Personal data protection
- Legitimacy and regulation
- Trust
- Energy consumption
- CO2 emission

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

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

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Business Intelligence (BI)

- Leverages software and tools to transform data into actionable insights and make better data-driven decisions.
- Telling you what is happening now or in the past
- Managerial Dashboards and Reporting
- 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

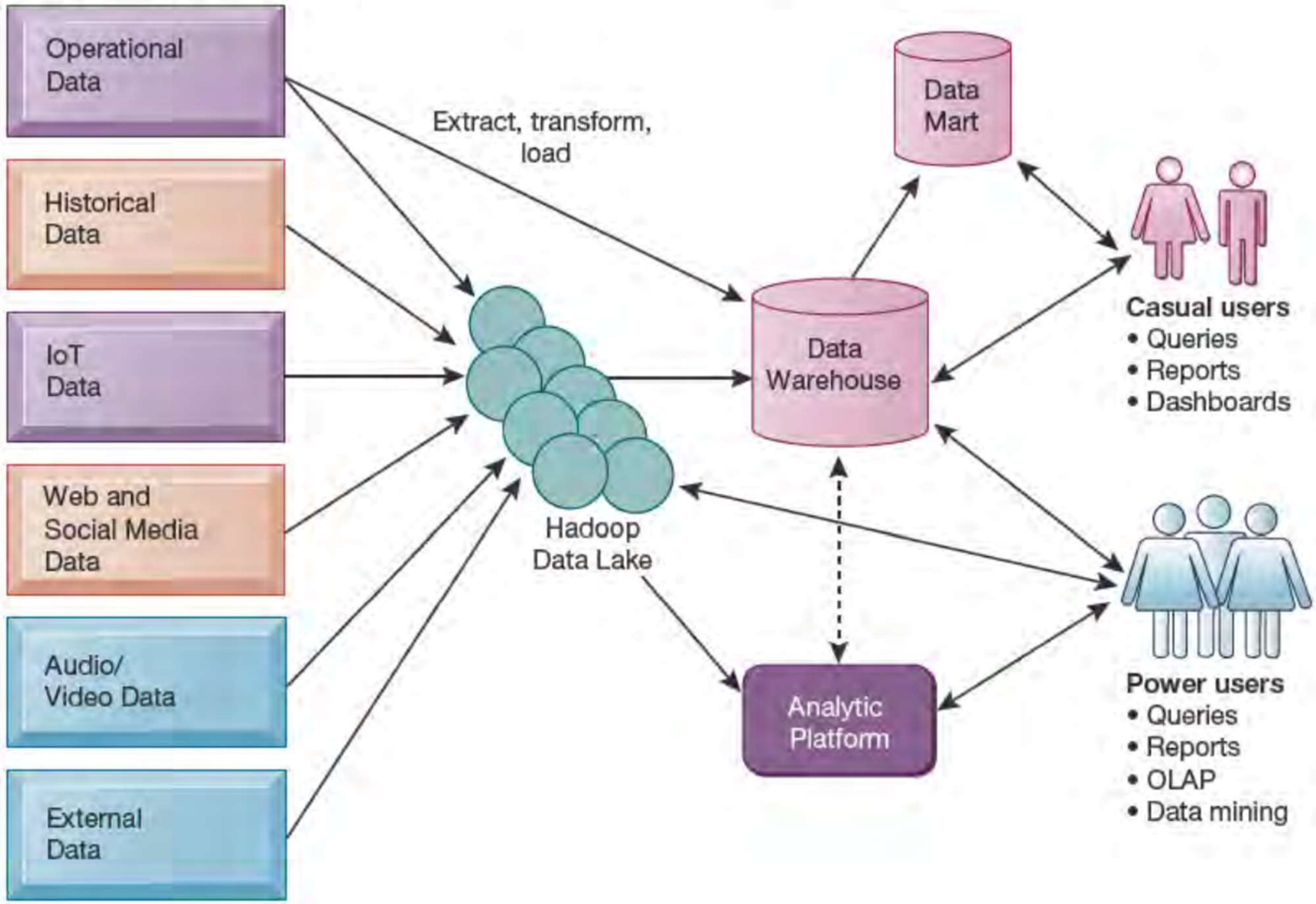
Business Analytics (BA)

- 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

BI Infrastructure



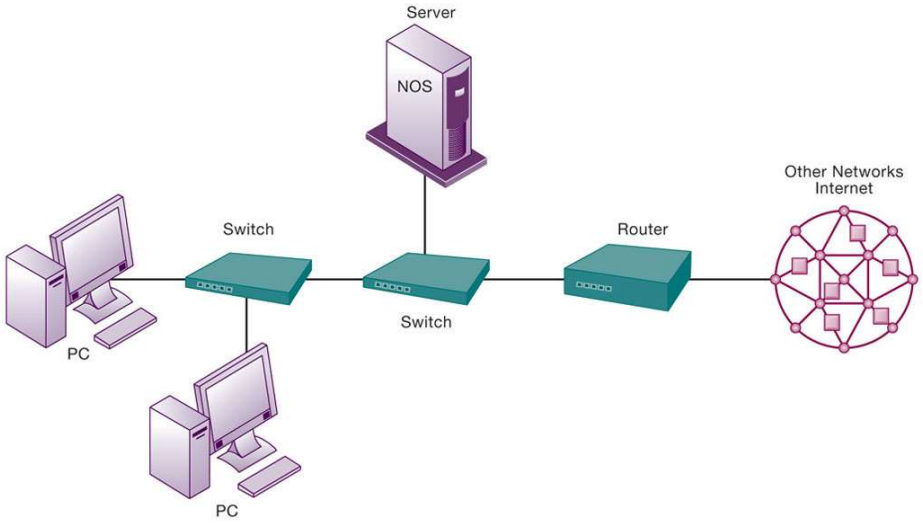
Data Governance, data administration, and data quality

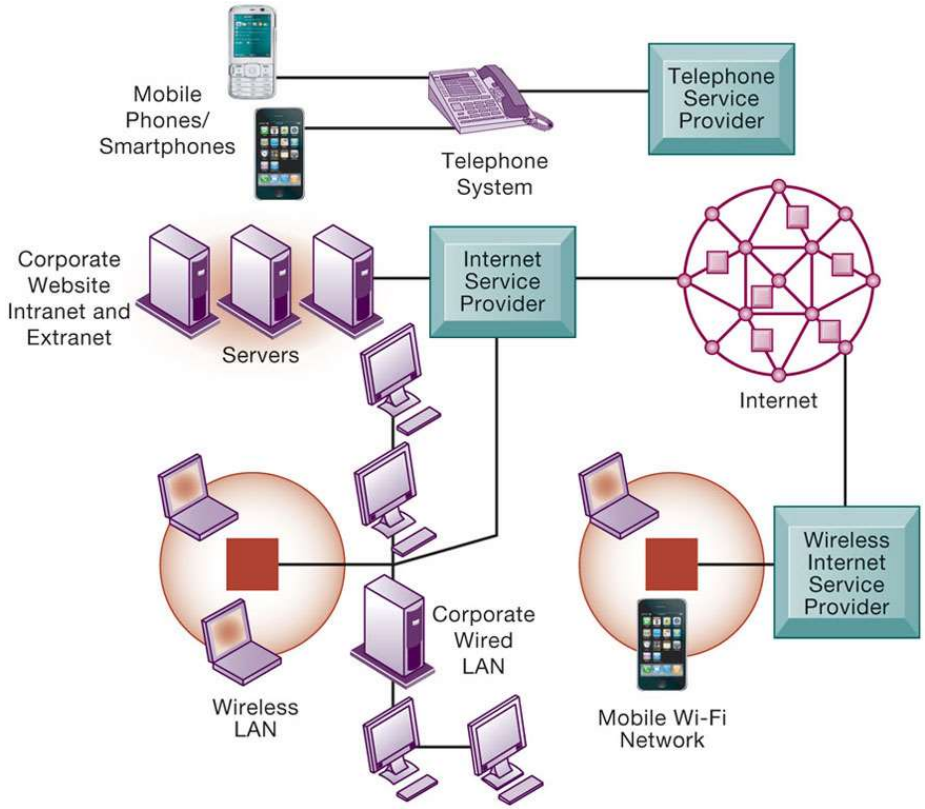
- Firm's rules, procedures, roles for sharing, managing, standardizing data

- **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

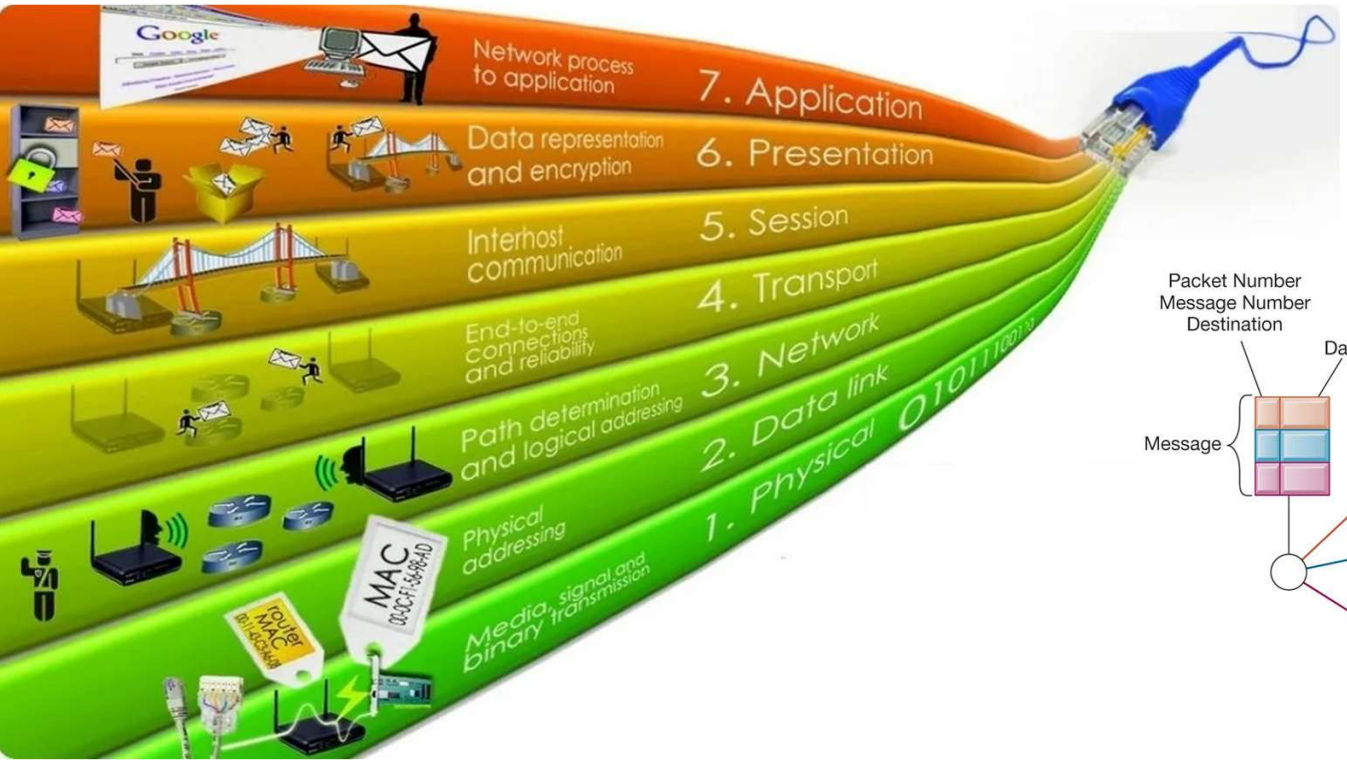
Principal components of network

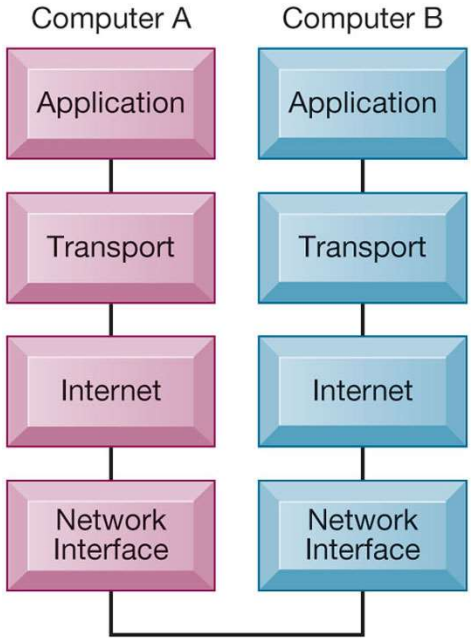


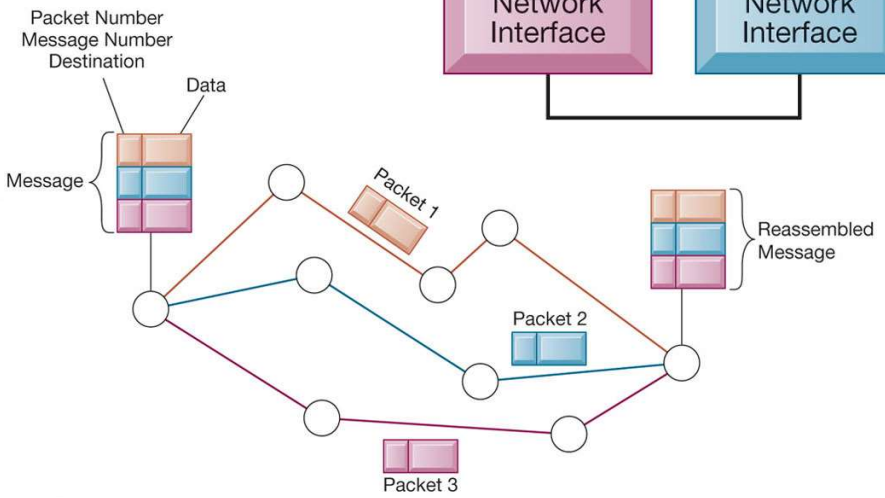


Principal components of telecommunications

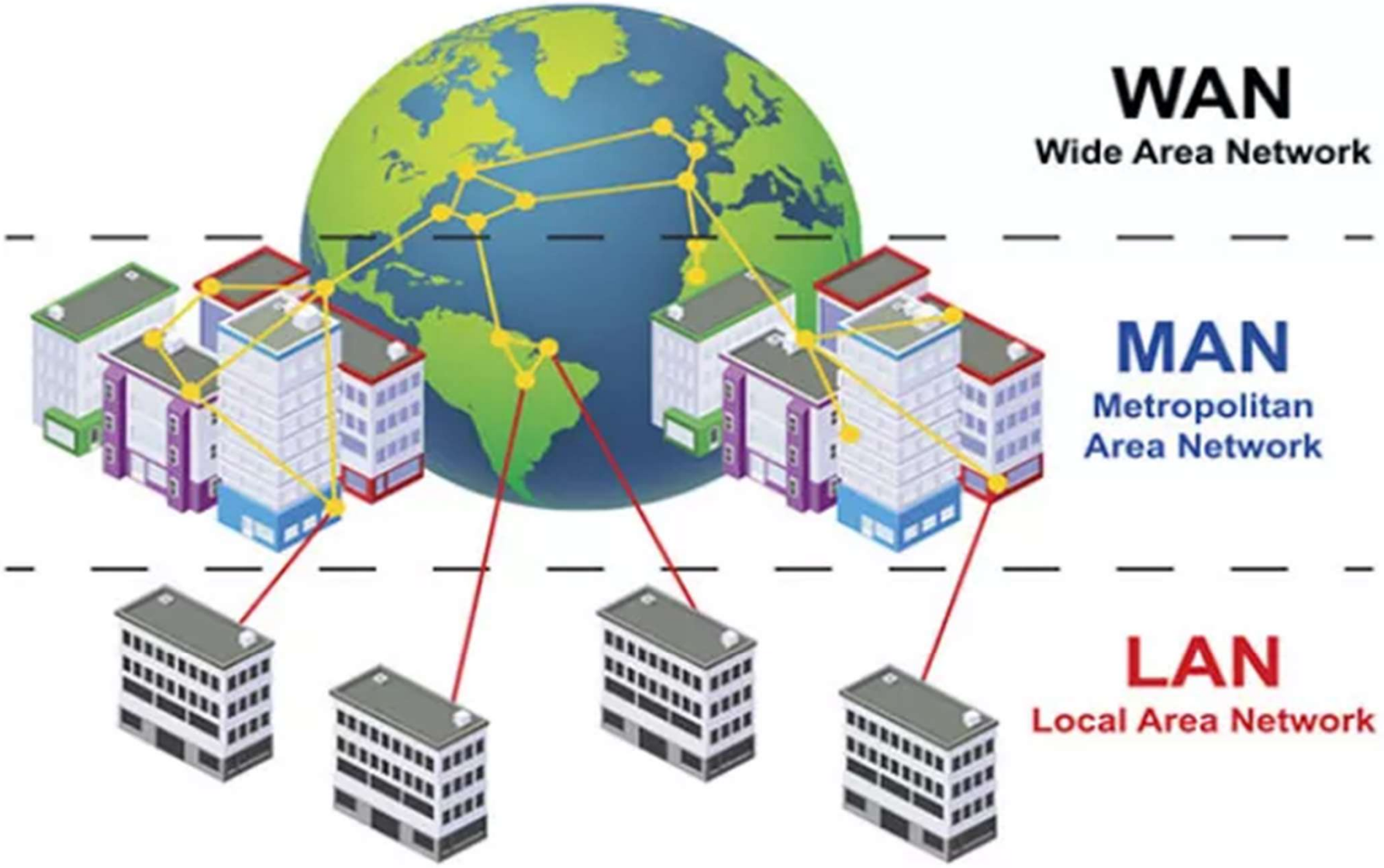
- Client/server computing
- Packet switching
- TCP/I P and connectivity



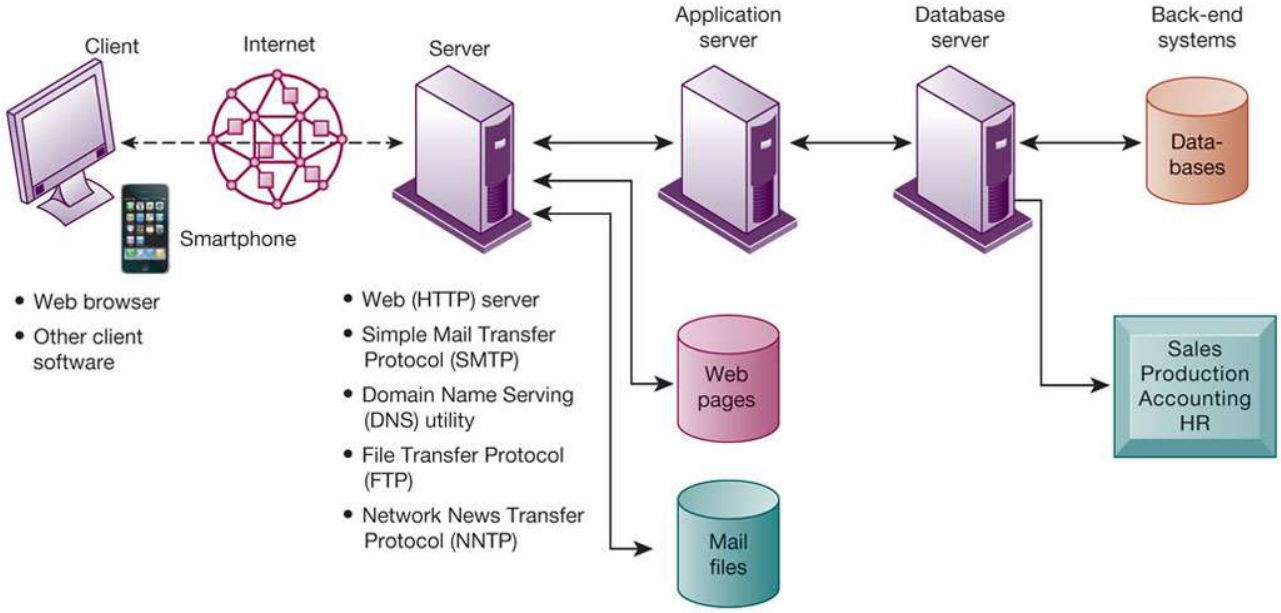


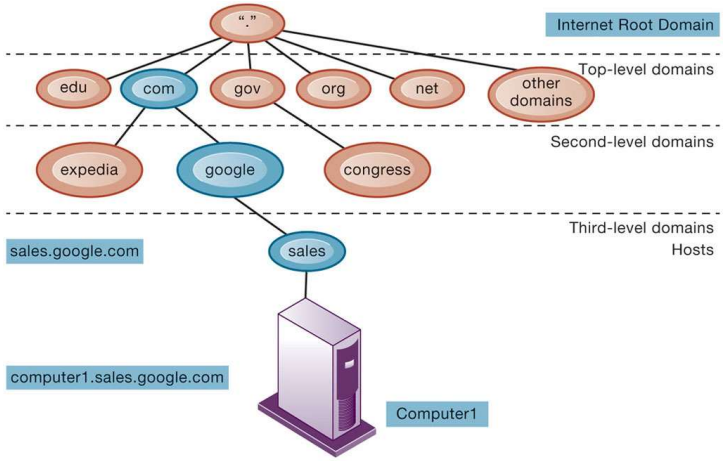


Different types of networks



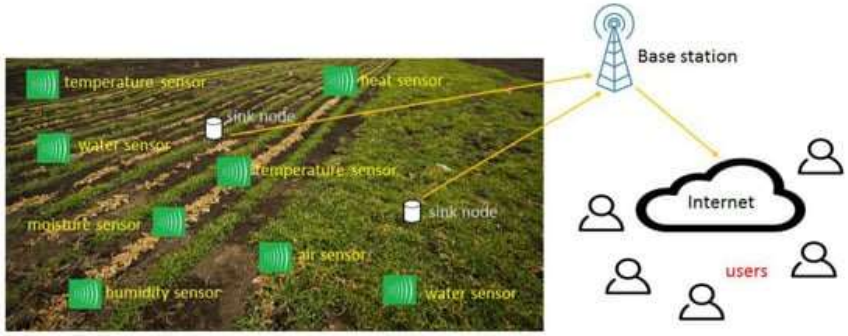
How do the Internet and Internet technology work, and how do they support communication and e-business?





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?

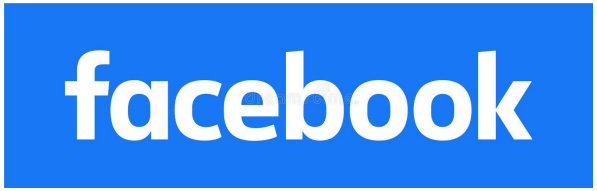
- IS controls may be automated or manual
- General controls
  - Govern design, security, and use of computer programs and security of data files in general throughout organization
  - Software controls, hardware controls, computer operations controls, data security controls, system development controls, 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

Discussion

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



Cyber Security

- https://www.youtube.com/watch?v=NR8QID3bFqw&t=2s
- https://www.youtube.com/watch?v=__EECGrqDeE
- https://www.youtube.com/watch?v=_Lx5VmAdZSI

Next Session

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