Definition and views of Information Systems

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Outline

1. Definitions
   1. Example order management
   2. Example fast food
2. Views (models) of IS

1. Definitions

Definitions

- Organization
- Business function
- Business process
- Application
- Application portfolio
- Information system

应用组合

Organization

为了完成一个或者一系列目标，而有意组织起来的一群人

- Group of people intentionally organized to accomplish an overall, common goal or set of goals
  - enterprise, army, church, public administration, football team, hospital, university
  - Organizations include and manage resources (people, machines, buildings)
  - Organizations implement business processes to achieve the goals
  - Enterprises/companies are organizations working for profit

Business process

- Set of activities
  - (executed in some parallel or sequential order)
  - performed by an organization,
  - to deliver a service /product
  - With defined inputs/outputs (information and things)

交付

  - Ex enroll student; sell product, produce car
- Activity: time spent by one or more people to do a task
  - Activity is simpler and shorter than process

Business function

- Group of people (and other resources) in an organization performing functionally similar activities
- Major business functions
  - Manufacturing 制造
  - Sales & marketing
  - Finance
  - Accounting
  - Human resources

Application

- Application
  - Software program to support an activity or process
- Application portfolio
  - Set of applications used by an organization

Legacy (software /applications)

传承

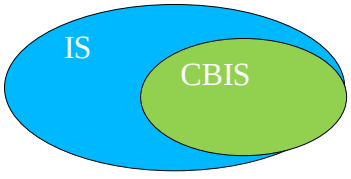
- Old software applications running in a company since 10-20-30 years

Information system

- IS – Definition, larger scope
  - System to store and process information used by organizations
    - Includes paper, people, computers and software
- (CB)IS – Definition, reduced scope
  - Computer based system to store and process information used by organizations
  - Also known as CBIS (Computer based IS)

Warning

- in organizations lots of information and processes are, at least partially, on paper and in people



- Considering the CBIS only is a mistake

只在CBIS报错的情况下考虑

Information system

- IS – Definition, Laudon
- Interrelated components working together to 收集，处理，存储，传播
  - collect, process, store, and disseminate
- information to support
  - decision making, coordination, control, analysis, and visualization
- in an organization 决策制定，协调，控制，分析，和可视化

IS in short

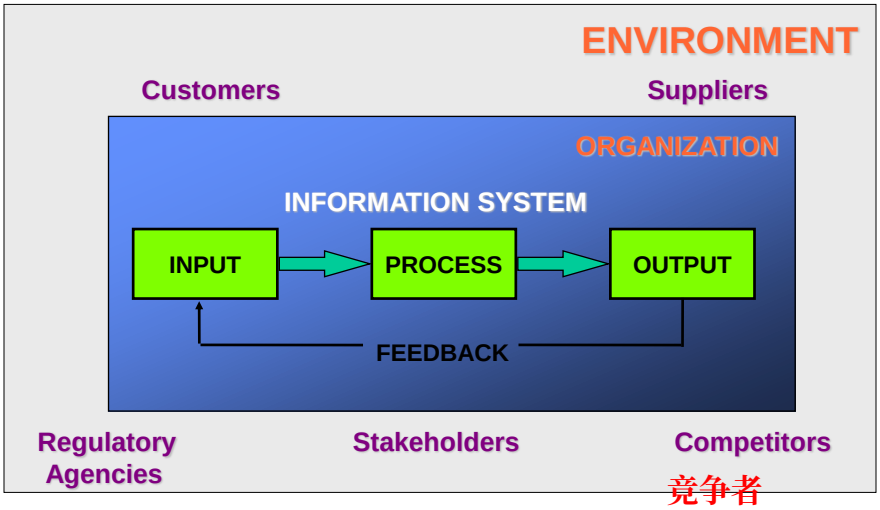
- Essentially an IS is made of several applications that (read / write) on several databases
- The databases contain
  - Master data (list of entities) 主数据（实体列表）
    - Ex products, customers, suppliers
  - Transactional data (events) 事务数据（事件）
    - Ex sale, purchase
- A business process uses one or more functions of one or more applications

Warning

- Ideally many applications read/write on one database
  - Application integration problem (EAI topic, Enterprise Application Integration) （EAI 话题，企业用户整合）
- In practice many databases are used
  - Data integration problem
- Integration (of data / application) is a never ending problem in ISs

整合（数据/应用）是一个解决不了的问题，在IS中

IS, high level model



- Input
  - The capture or collection of raw data from within the organization or from its external environment for processing in an information system
- Output
  - The distribution of processed information to the people who will use it or to the activities for which it will be used

- Processing 原始数据的转化，操作，分析，输入一个对人类更加有意义的表格中
  - The conversion, manipulation, and analysis of raw input into a form that is more meaningful to humans
- Feedback
  - Output that is returned to the appropriate members of the organization to help them evaluate or correct input

用来改进或者纠正输入

PROCESS ANALYSIS: EXAMPLE

Description of current situation

一家中型企业的部门需要订购原材料来满足产品过程

The production department of a medium-sized company needs to place orders for raw materials, required to feed the production processes.

Such raw materials have to be:

- Ordered (negotiation about price, quantity, delivery time; coordination with production needs)
- Examined to verify quality
- Stored in the warehouse
- Registered in the accounting system
- Paid

- The above operations must also be checked

There are 8 actors involved in the scenario.

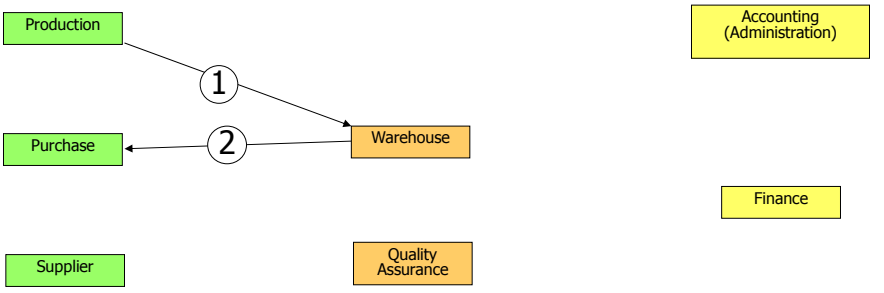
Actors (1)

- Production: requires the raw materials needed for the production plans from the warehouse
- Warehouse: when the raw material is not available, first make a request to the purchase office; once the order has been received checks the quality, conformance to request, and stores it.
- Purchase office: in charge of negotiating price, quantity, and delivery time with different suppliers
- Supplier: the one chosen to fulfill the order, must deliver the raw materials to the warehouse, and possibly get back the portion not complying with the specifications

Actors (2)

- Quality assurance: monitors the efficiency and quality of suppliers by producing statistics for the management
- Accounting: check the orders, receive the delivery receipt from the warehouse, ask the finance department to execute the payment of the supplier invoice, records all transactions
- Finance department: fiscally performs the payment to the supplier and then informs the accounting
- Manager: is a role external to the individual business process that supervises the good working of the enterprise system and controls the economical efficiency. Needs information to take decisions.

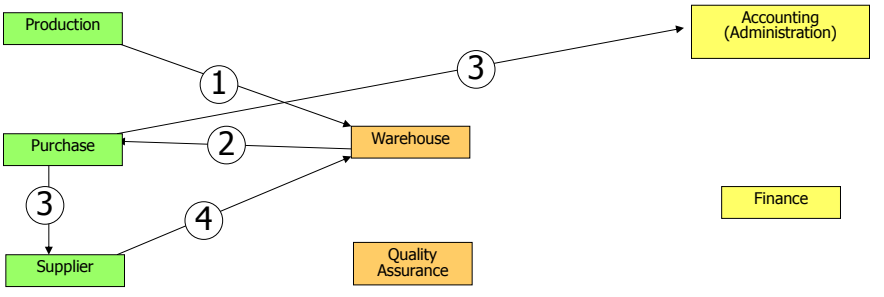
Flow representation



1. Production asks Warehouse for raw materials

2. Warehouse has not the RM and forwards a request to the Purchase office

Flow (1)

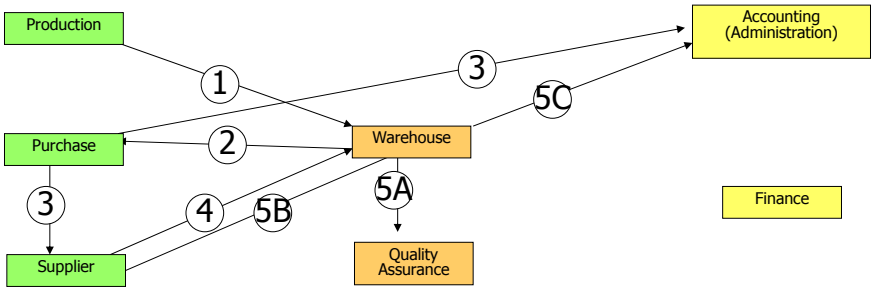


3. Purchase office negotiates with the chosen supplier, price, quantity, and delivery; issues the order and sends a copy to the accounting department

4. The Supplier delivers the materials to the warehouse together with the relative delivery note

Flow (2)

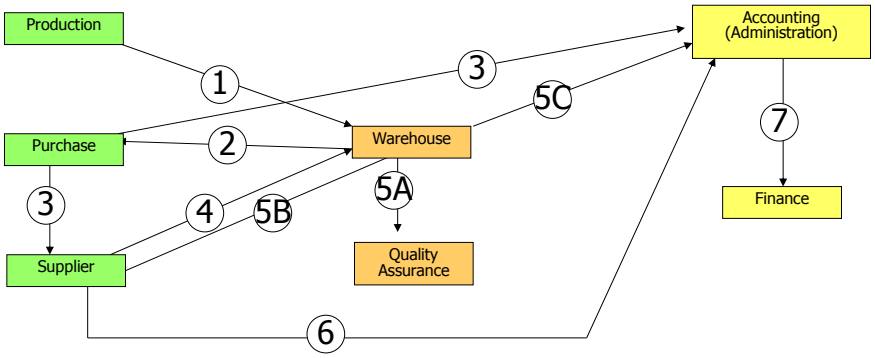
5C.Accounting receives copies of the delivery notes and the amount of returned materials



5A. Warehouse checks the received materials and sends a report to Quality Assurance concerning the complieance with the order specifications.

5B. Warehouse returns possibly defective goods to Supplier

Flow (3)

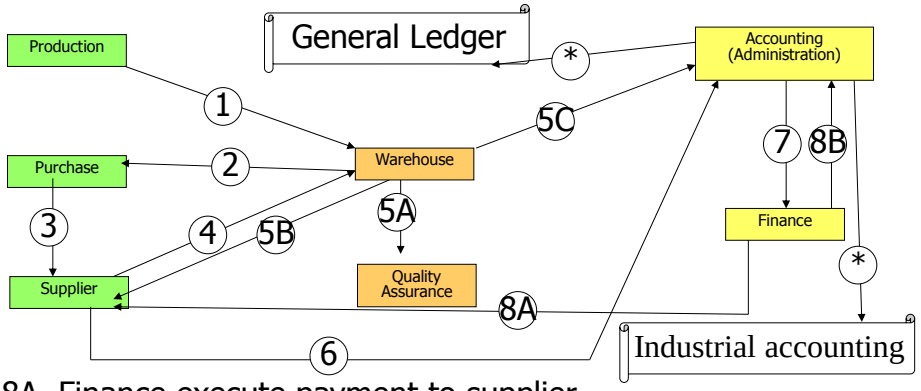


6. Supplier sends invoice to Accounting

7. Accounting checks the invoice (compare with orded and delivery note) and ask Finance to proceed with payment.

Flow (4)

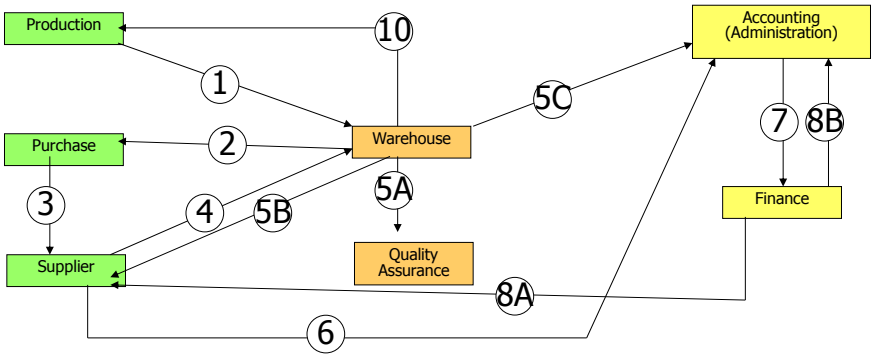
*. Accounting records all steps in the general ledger and in the internal industrial accounting books



8A. Finance execute payment to supplier

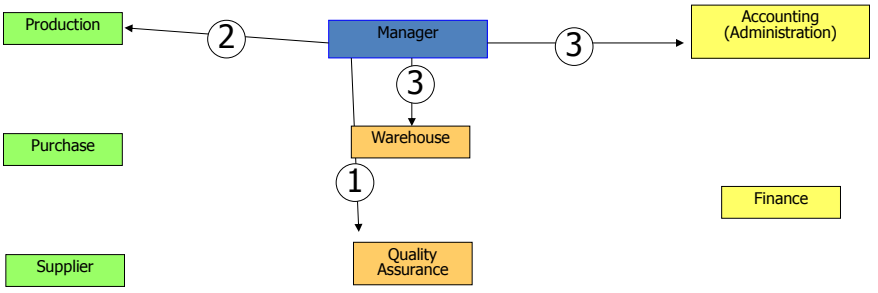
8B. Finance informs Accounting of the payment

Flow (5)



10. The warehouse sends the materials to Production that can start operations.

Flow (6)



1. Manager checks the performance of suppliers through QA
2. Manager checks productivity and total provisioning time
3. Manager checks financial trend though periodic reports from Accounting and supply levels from Warehouse

Items to be modeled

- Information: which, exchanged between
  - Order, Delivery note, Invoice, ..
- Actors
  - Warehouse, Production, ..
- Activities and their sequence
  - 1 Materials request, 2 ..
- Business rules
  - Payment must be performed < 60 days

IS is needed to

- Transmit information (real time)
- Document (past and present)
  - Who did what when how
  - Instructions for the activities to be performed
- Monitor (past and present)
  - Summary data for managers
- The more people and locations are involved the more an IS is required
  - SME single location: sight navigation
  - Multinational: IS essential

IS – possible implementation 1

- Production
  - Local db, application
    - List of products, bill of material per product
- Purchase office
  - Local db and application
    - List of orders, list of suppliers
- Warehouse
    - List of components and products
- Accounting
    - All expenses and incomes

IS – possible implementation 2

- One overall db, one single application with functions to
  - Define and monitor orders
  - Define and update suppliers
  - Record expense

Remarks(1)

- It is a simplified scenario, e.g. because:
  - No request for quotation is sent to different suppliers to select the most suitable one
  - Materials are sent to warehouse and not directly to production, so there is no need to"synchronize" delivery and reception
  - Supplier delivers directly the goods, without using a logistics company
  - The order needs to be delivered at a single location only
  - Purchase office has the sufficient authority to chose by itself the supplier and the price
  - There is not a recording of the physical location where the materials are stored
  - Etc.
- Further complications may stem from the number of currently active orders, the delivery locations, the number of supplier, etc.

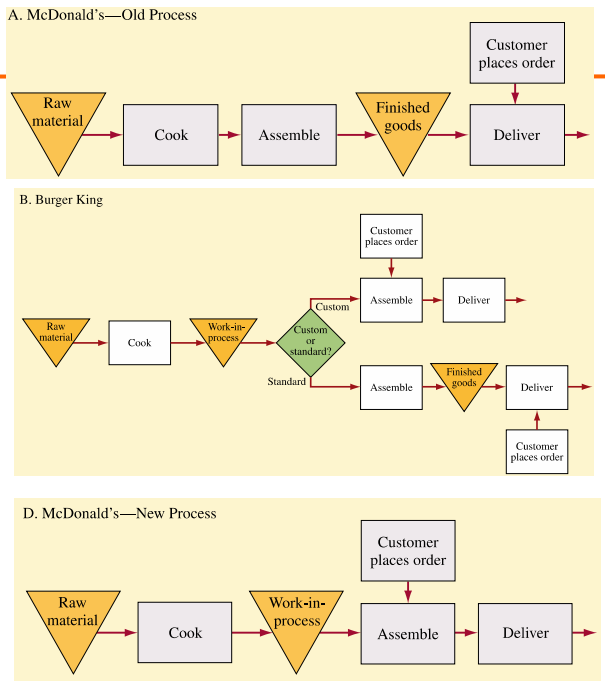
Remarks(2)

- Behind an apparently simple operation (ordering raw materials) there are several flows of information both within the organization and outside.
- The management of all the information has high direct costs (the same is true for a "bad" management)
- Controlling all those operations is very difficult in the day by day business of an enterprise, because there is not a single order but hundreds of orders per day with the relative information flows
- The speed of reaction of an enterprise to specific events (e.g. lack of raw materials) can be critical to fulfill customer requests and keep up with the production plans
- These are just a few of the reasons that point towards the need for investment in Information Systems

YET ANOTHER EXAMPLE

Fast food – information flows

- Goal: constant quality and short waiting time (2–3 min)
- How: few products, standard (fixed production procedure, only 'without' exception allowed e.g. no onion)
  - Basic operations: cook meat, cook bread, assemble



Possible choices (1980)

McDonalds'

- 3 types of burgers (large, small, fish), 1 bread type – 6 final products
- Operations: grill burger, heat bread, assembly
- Batch of meat grill (one burger type at a time), Storage pre-assembly + assembled
- Dispose product if not sold within x min.
- Information
  - Orders (which and how many) (monitor in assembly room)
  - Timestamp of production (+ discard) (written on package)
  - Product type (written on package)
  - Customer waiting time
  - Discard proportion
- Decisions
  - Batch (which and how many elements)
  - Number of employee (planning based on sale history)
- Actions
  - Manage exceptions (in assembly, from order)
  - Dispose expired products

Burger King

- 2 burger types (large small), 1 bread – various final products (filling, dressing)
- Operations: grill burger, heat bread, assembly, microwave
- Continous grill (chain), WiP stores, assembly
- Dispose product if not sold within x min
- Information
  - Orders (which and how many) (text slip)
  - Timestamp of production (+ discard) (written on package)
  - Product type (written on package)
  - Customer waiting time
  - Discard proportion
- Decisions
  - Which products in continuous (standard table with amount of sales per hour)
- Actions
  - Manage exceptions (in assembly, from order)
  - Dispose expired products

Alternative choices

- In both cases production is partially disjoint from demand
  - Possible due to standardization
  - Required by short response times
  - Take advantage of slack
- Assembly is linked to demand
  - Takes from intermediate buffers
  - Manages standard and exceptions
  - If not sold must be disposed

Differences: McD's vs. BK

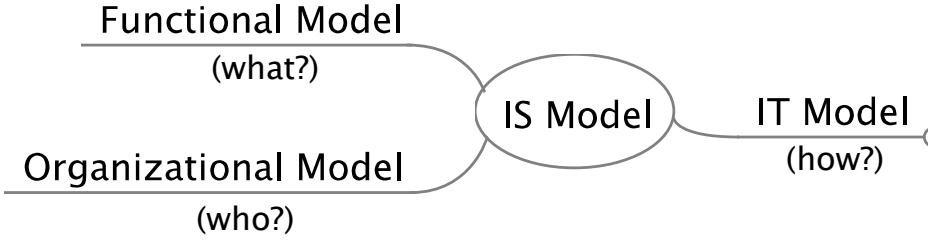
- Type of information:
  - Selling forecast vs. actual demand
  - Flow from counter to production vs. production to counter
  - Quick delivery vs. client wait
  - Usage of WiP storage vs. production just-in-time
  - Standardization vs. customized production
  - Stability vs. variability of demand in time
  - Variability vs. stability of work force
  - Procedural execution vs. decisional capability of employees
  - Characeristics and habits of customers
  - …..

2. VIEWS (MODELS) ON IS

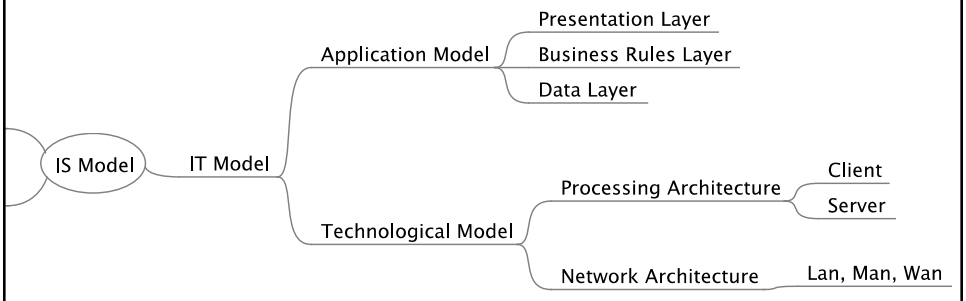
View points on IS

- There are several view points in the analysis and design of ISs
  - IT: tech components, architectures
  - Functional: what (information, processes)
  - Organizational: who (functions, roles)
  - Evolutional: time evolution of 3 models above
- For each view one or more models can be developed

IS views (models)



IT View / Model



IT Model

How IS are built

Two main models:

- Application Model: describes the software architecture
- Technological Model: describes the hardware architecture

Application Model

- IS as software at application level,
- Typically with three layers
  - Presentation
    - Interaction with end user via GUI (or character based forms)
  - Business rules / business logic
    - Algorithms and rules to process, control and extract data
  - Data
  - cfr. three tier architecture in technological view

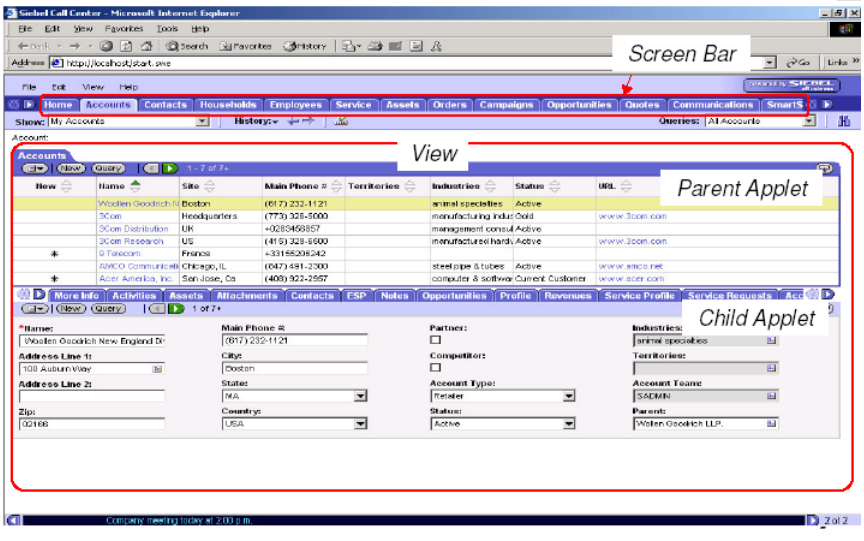
Example

Presentation layer	Rule layer	Data layer
Show GUI screen "Withdrawal request": Acquire data entered by the customer	IS the required amount between the valid thresholds	Access to data tables and read thresholds
Show a message "Correct/Cancel"; Acquire data from customer	If the request is not valid require to correct or cancel; if then the input is cancel, stop processing, otherwise read the value of the account	Access to data tables and read values
Show a message; Acquire data from client	If the request is greater than the account ask to correct or cance and re-read the value; if then the choice is to cancel stop processing, otherwise update the account value	Access to data tables and change values

Presentation layer

- An interactive application communicate with the user through a GUI (Graphical User Interface) and different inputs (e.g. keyboard, mouse)
- GUI both show and record data
- The form of the interface should reflect the needs and functions of each individual user

Ex: presentation, customer data



Business Rules Layer

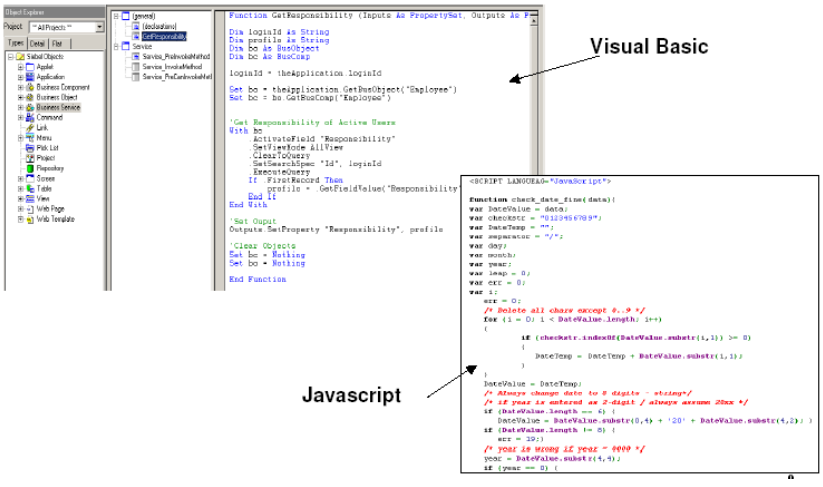
Rules consitute the logic driving the processing of data entered in the IS through the Presentation layer

Rules interact with the presentation and/or the data layer

Rules may include:

- Computations (eg. computing the average)
- Logical operations (eg. comparison)
- Data analysis (eg. a chronological list)

Ex: business rules



Ex: business rules: Drools

The mission is accepted only if the available budget for the employee is higher than the presumed cost.

```
rule "maxCost"
when
      $e : Employee( $b : budget )
      Mission( employee = "$e" and presumedCost > $b )
then
      m.reject();
end
```

SOftEng http://softeng.polito.it

Data layer

- The data base is a permanent storage of data organized according to a schema
  - E.g. Oracle, MySQL, Access
- The selection of data to be stored is linked to the organizational needs and may imply various costs
- Question: how to select the database technology?

Technological model

- IS as hardware systems and their connections
- Client server architectures
  - Two tiers
    - Data + application server;
  - Three tiers
    - Data server, application server (business rules), presentation server
  - …

Processing architecture

- Mainframe + dumb terminals
  - Until 80s
- Client server
  - Currently
  - Clients: PCs / smartphones
- Peer to peer
  - Not much widespread in IS

Mainframe

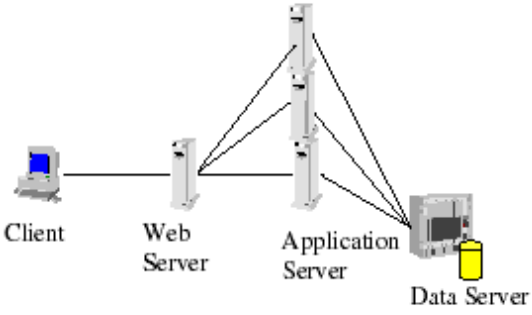
- Extremely powerful computer (mainframe) where all three layers reside
- Terminal performs only I/O

Client-server(C/S)

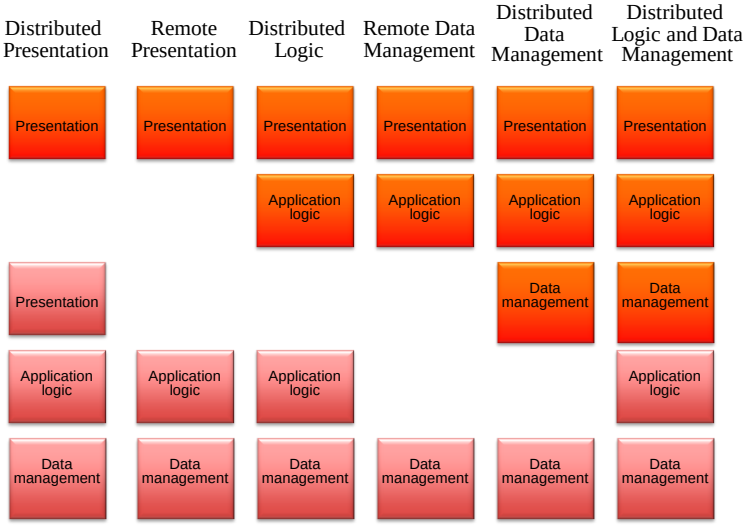
Architecture where client processes request services offered by server processes

- Client system: typically running on wide range of devices (e.g. work station, smartphone, tablet) where a portion of the presentation layer reside
- Server system: hosting the rule processing (application server) and data management (data server)

Three tiers



CS – fat to thin client



Quality requirements

- A processing architecture must satisfy a few basic requirements:
  - Reponse time: the interval between the request and the display of the response; depending on the application the system shall be more or less reactive (e.g. ATM vs. electricity meter)
  - Scalability: the work load a system is able to sustain, typicaly expressed in number of concurrent users
  - Availability: percentage of time the system is working (typical SI should be around 99.95%)
  - Etc.

Network architectures

The distinct components of a processing architecture communicate by means of networks that transmit digital information

Network characteristics

- Extension
- Hierarchical levels
- Working mode

Network levels

According to the level they can be:

- Access
- Backbone
- MAN

Network extension

- LAN *(Local Area Network),* range few km, bandwidth 10-100 M bps
- MAN (*Metropolitan Area Network),* urban area range, bandwidth 100 M – 1 G bps
- WAN *(Wide Area Network),* regional or national range, bandwith 1 T bps.

Network working mode

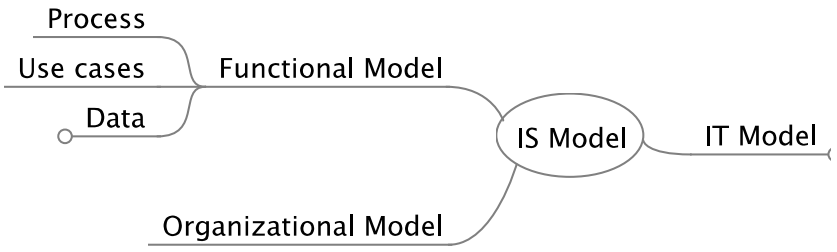
Three main working modes:

- Internet
- Intranet: private network within an organization, used to share information inside it
- Extranet: portion of intranet that a company opens to customers and external users

IT selection

- The selection of the IT model takes into consideration costs, performance, sizing etc.
- Looking at the technology evolution allows considering long-term costs
- Other analysis dimensions include the growth perspectives of the organization

Functional model



Functional Model

What the IS should do, abstracting from how it can be done (IT model)

Processes

- Activities, functions
- (CRASO, BPMN, UML activity diagram)

Data

- UML class diagram, Entity Relationship diagram

Interaction

- Use cases

Functional model

- High level description
  - CRASO
- Detailed description
  - BPMN, Activity diagrams, class diagrams

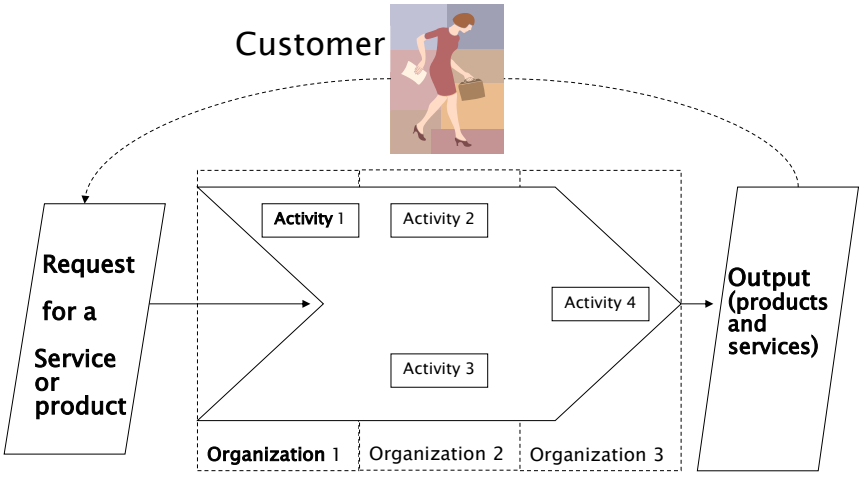
CRASO Model

- Business process = CRASO
  - Customer
  - Request
  - Activity
  - organiSation
  - Output

CRASO

- Simple high level model shows
  - Activities
  - Actors / roles doing activities
  - Material / immaterial objects treated by activities

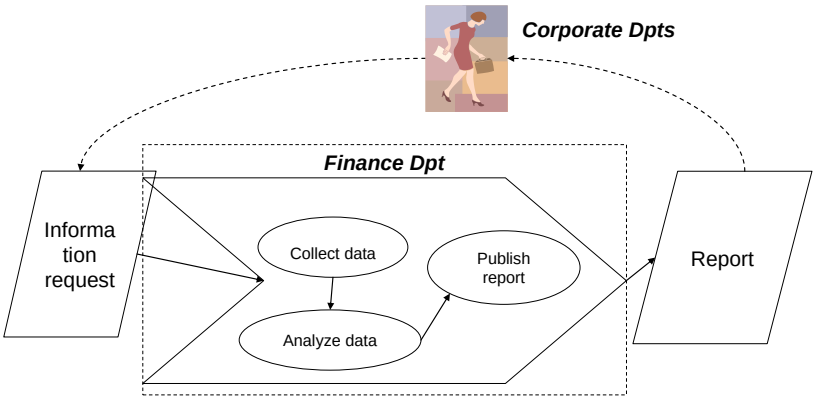
CRASO



Process span 跨度

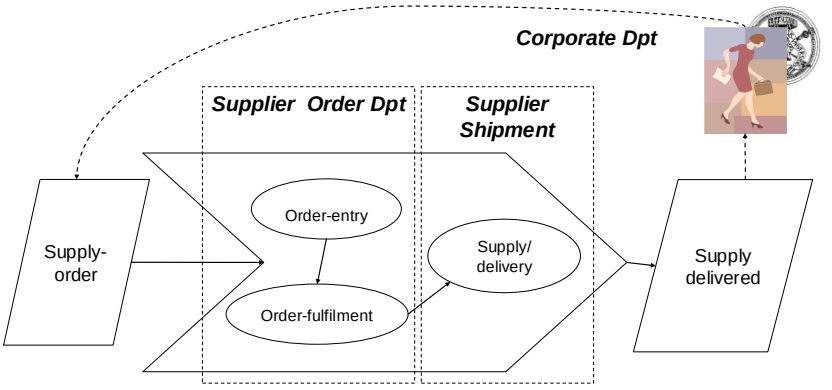
- Mono – organizational
  - Mono-functional
  - Inter-functional
- Inter-organizational

Intra-function process



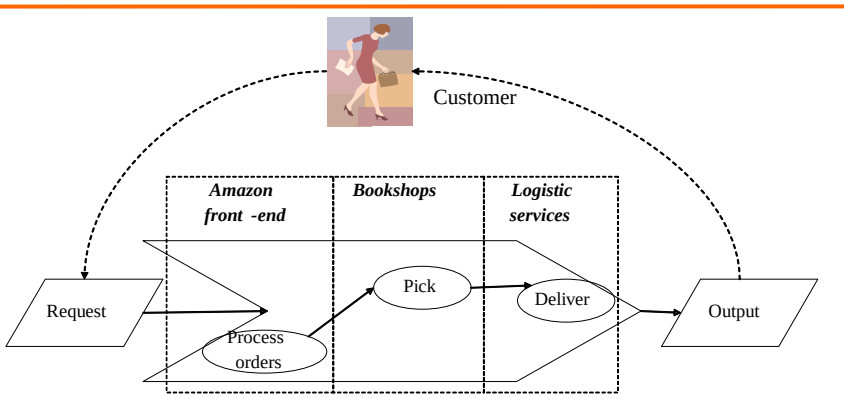
Business Process	Customer	Request	Activities performed (summary)	Organizations involved (summary)	Output (summary)
Management reporting	Corporate Departments	Information request	Data-collection Data-analysis Report-publication	Finance	Report

Inter-function process



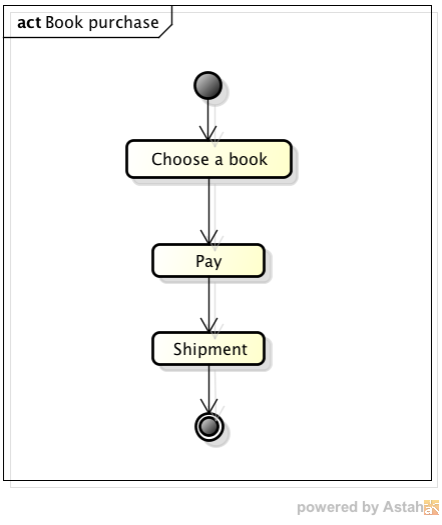
Business Process	Customer	Request	Activities performed (summary)	Organizations involved (summary)	Output (summary)
Production Planning	Sales-dpt	Production-request	Assemble-production-plan, Give-information, Negotiate and execute the plan	Production-planning-dpt, Materials-management-dpt, Factories	Approved production plan

Inter-organization process

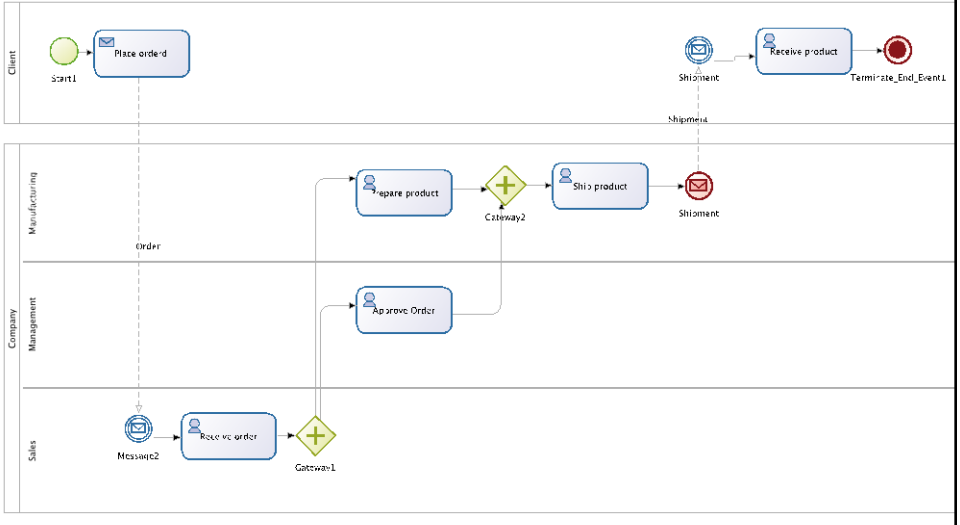


Customer	Request	Activities performed (summary)	Organizations involved (summary)	Output (summary)
Private customer	Book order	Process -order, Order -picking, Book-delivery	Front -end, Bookshop, Logistic services	Delivery of books

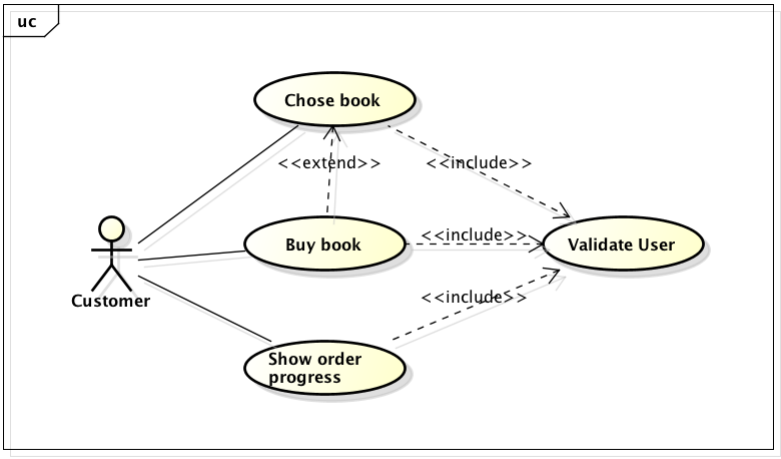
Activity diagram



BPMN



Use cases



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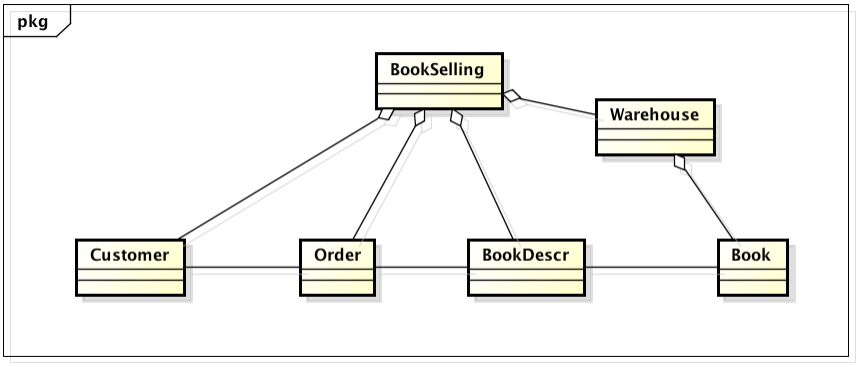
Conceptual model



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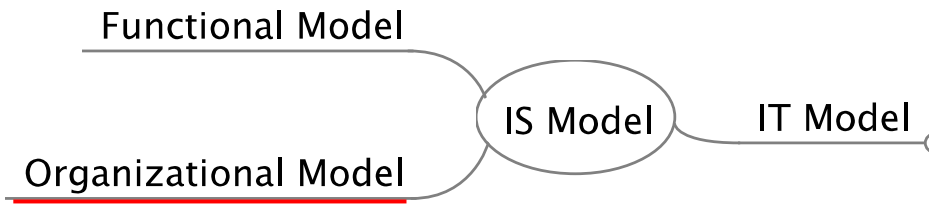
Organizational model



Organizational view

- IS as service offered to organizational level (and group) of organization

Organizational model

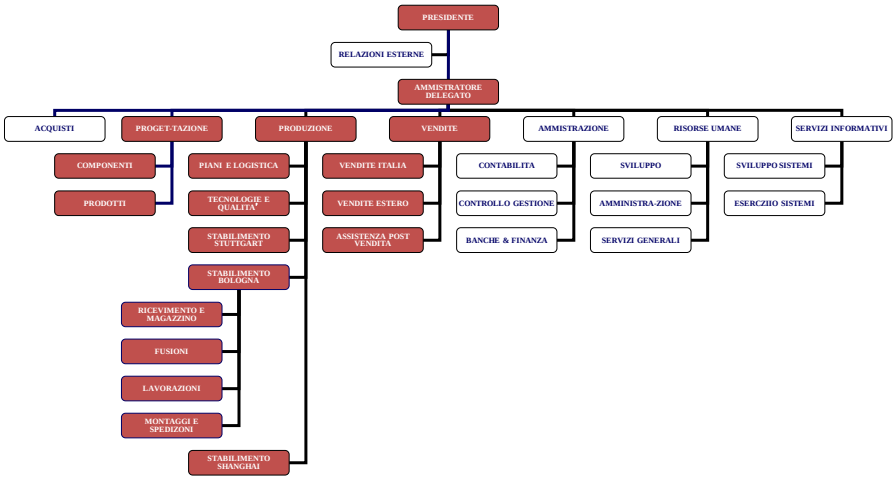
- Organization =
  - Group of people gathered for a common purpose
  - Command and control structure that manages operational processes
- Organizational unit
  - Part of organization:
    - Division, office, department ..
- IS as a service offered to a unit

Organizational models

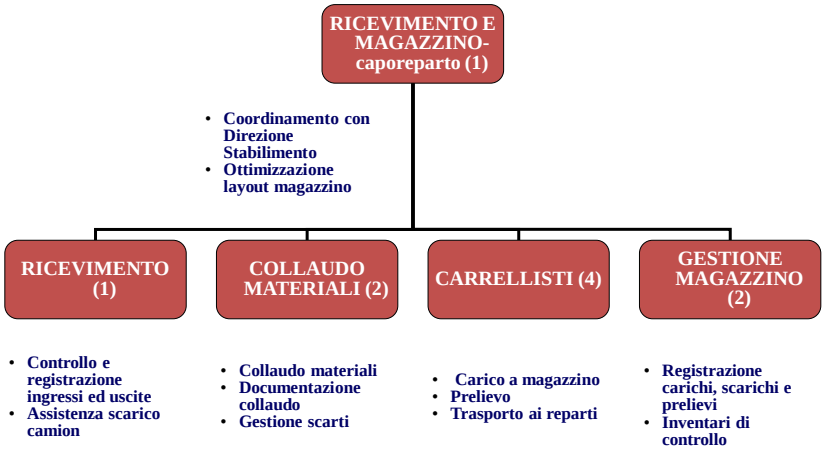
- Organizational chart
  - Macro level 宏观
  - Micro level 微观
- Linear Responsibility Chart (LRC)
- Swimlane (in activity diagrams UML, in BPMN)

Organizational chart

Organizational chart – macro



Organisational chart – micro

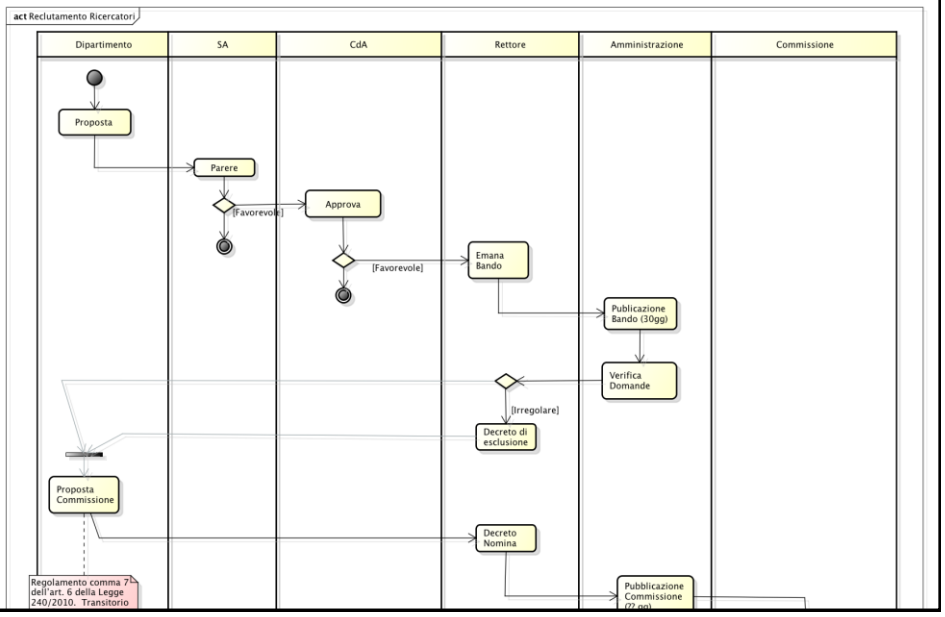


Linear Responsibility Chart (LRC)

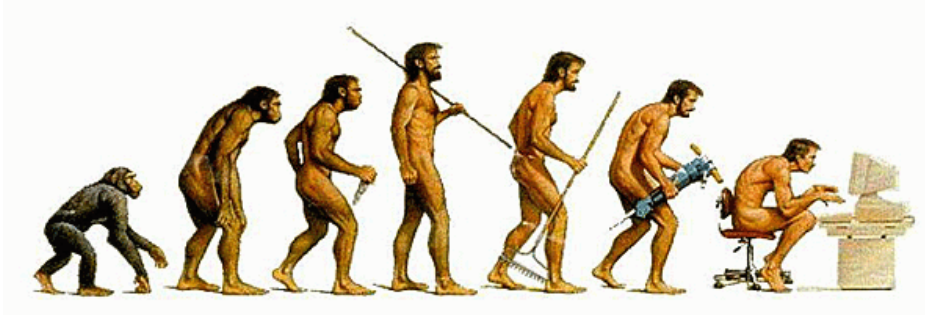
Processes (samples)	Organization's Structures							External Actors	
	Purchase	Design	Production	Sales	Admin.	Human Reources	Information Systems	Supplier	Customer
Management Report Production	C	C	C	C	P	C	C		
Customer Order Processing			P	P					C
Procurement	P		P					P	

P=Participant C=Client

Swimlane

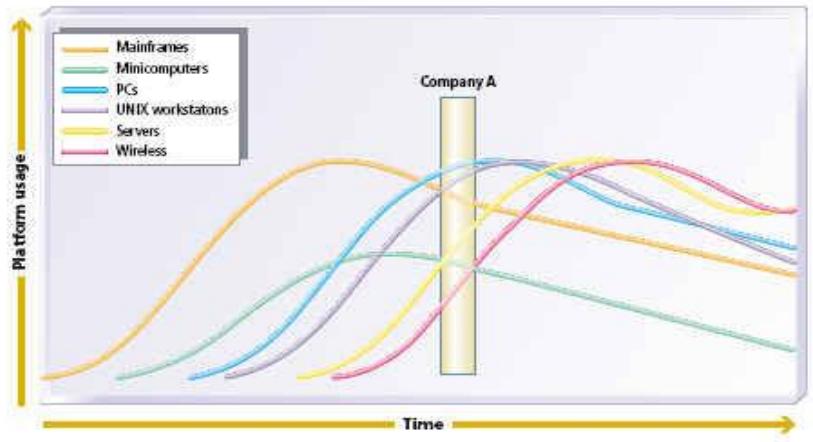


Evolutional



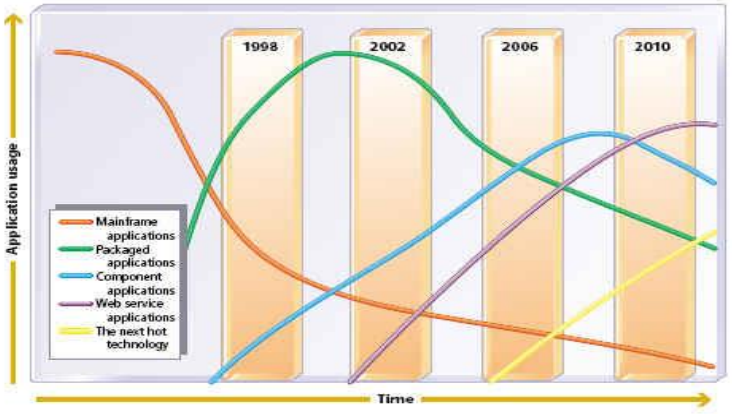
Evolutional view point

FIGURE 1: SUCCESSIVE WAVES OF TECHNOLOGY



Evolutionary view point

FIGURE 5: SUCCESSIVE TECHNOLOGY ARCHITECTURES



Issues with technology changes

- Fashionable trends:
  - The “last version syndrome”
  - The “Modern Times syndrome” (emphasis on automation of often irrelevant operations)
  - The “Internet syndrome” (need of a web site)
  - The “CRM syndrome”
- Economy:
  - “it doesn’t interest me much / it is not relevant”
- Efficacy and ease of use:
  - “The user must learn how to use it and not resist the change”

Issues with time

- What is the application portfolio?
  - In a medium-large organization after years of evolution it is quite difficult to make a census of present application with their goals
  - Easily 200-400 applications in a large company
  - AP knowledge is fundamental to
    - Evaluate the organization’s IS
    - Define acquisitions/changes of applications

Issues with time

- Integration of data and applications
  - Applications have been bought / maintained by different vendors, use different technologies (DBs, Oss, ..)

Issues with time

- Legacy software
  - Common problems
    - Development environment unavailable
    - Documentation unavailable
    - Source code unavailable
  - Consequence
    - They are unchangeable
    - But substituting them is costly and risky

Summary

- Many views are possible (and needed) to analyze, design, evaluate ISs
- Each view can be described with modeling notations
  - Ex Craso, UML, BPMN

Summary

- An organization is made of parts (divisions, functions..) that collaborate to achieve a goal, performing business processes
- IS are meant to support the organization, at least storing and processing the information needed by the organization
- There are many, complex links between business functions, processes and IS

Summary

- In short, IS are made of databases and applications
- Given the complexity of the links, it is important to model separately organizations and IS from different points of views: organizational, functional, technical, evolutionary