Definitions

SoftEng
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Outline

- Definitions
- An example
- Modelling

Definitions

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

Organization

- 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)
    - Ex enroll student; sell product, produce car

Activity

- Activity: time spent by one or more person in organization to do a task
  - Activity is simpler and shorter than process
- Ex: process : enroll a student
  - activity: get student name + surname
  - activity: get student past school history
  - activity: check / get student tax payment

Business function

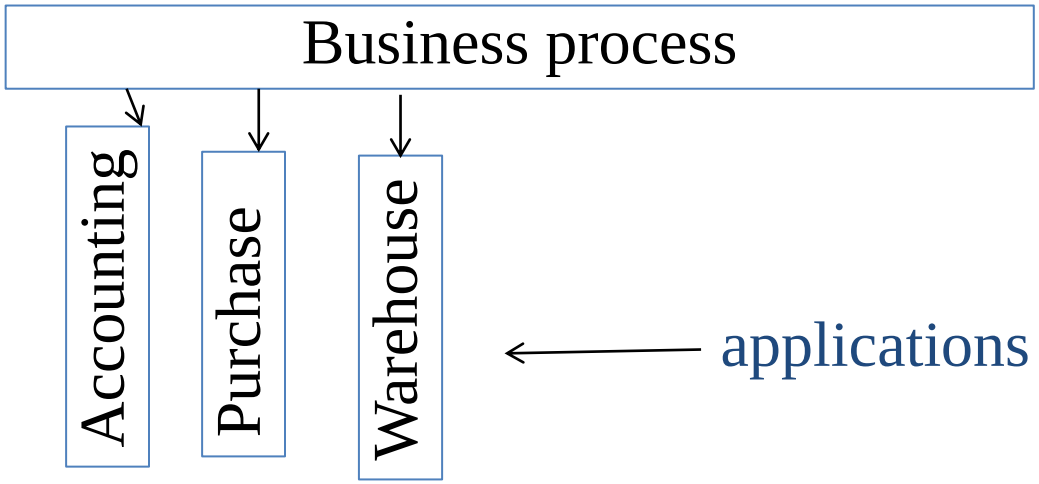
- Group of people (and other resources) in an organization performing functionally similar activities
- Major business functions
  - Manufacturing
  - Sales & marketing
  - Finance
  - Accounting
  - Human resources

Application

- Application
  - Software program to support an activity or process
    - Ex accounting, warehouse management, employee management..
- Software function
  - Function offered by an application, to support an activity or part of it
    - Ex record an expense/an income (accounting), record reception of item (warehouse)
- Application portfolio
  - Set of applications used by an organization

Processes – applications

- A business process often requires software functions from many applications
  - See later EAI



Legacy (software /applications)

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

Information systems

Information system

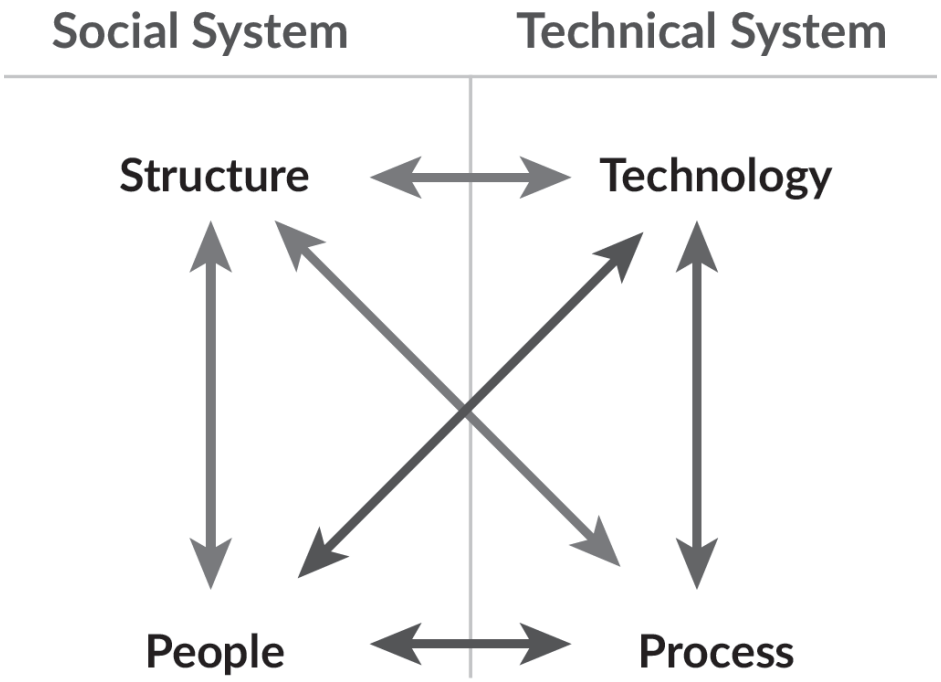
formal, *sociotechnical*, organizational systems designed to collect, process, store, and distribute information

[Piccoli Pigni]

- Formal: built and managed with a goal for the organization
- Informal: whatsapp, gmail, used ad hoc

Socio technical system

- IS are socio technical systems
- With 4 components (or dimensions)
  - Technology
  - Process
  - People
  - Structure



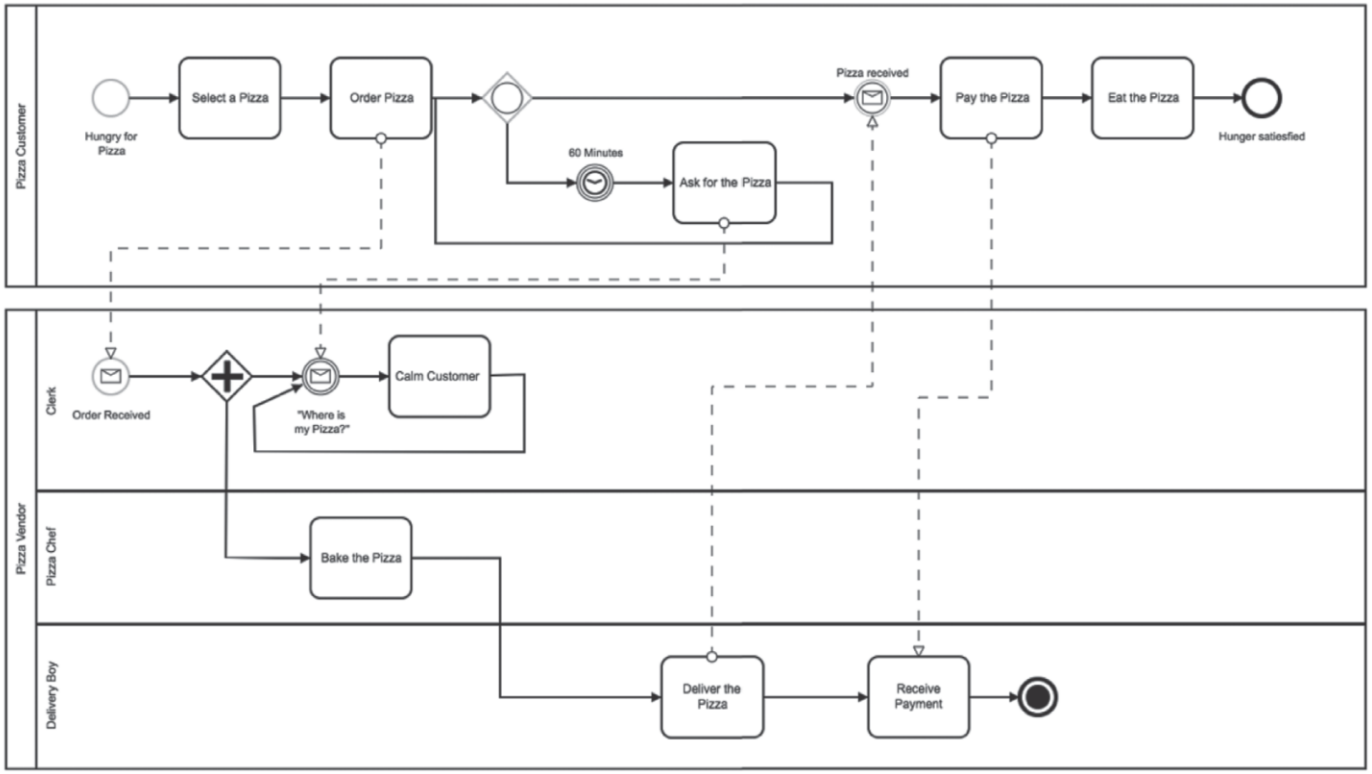
[Piccoli Pigni, IS for managers]

Technology

- Computers
- Networks
- Applications
  - See later

Process

- See definitions above: business process, activity



Process

- An organization may define different business processes to achieve the same organizational goal

People

- Individuals or groups directly involved in the information system:
  - end users
  - managers
  - IT professionals
- A genuine understanding of the people involved, including their skills, interests, and motivations, is necessary when designing and implementing a new IS or when troubleshooting an existing IS that is not performing as expected

People

- End users
  - Years ago end users were inside the organization only
  - Today, more and more a company IS is used (at least partially) outside the organization by customers, suppliers, others

Structure

- The implicit or explicit rules that govern relationships between the people involved in the IS
  - hierarchy vs decentralized
  - functional, divisional, matrix
  - communication lines
  - reward mechanisms

- See later chapter on organizations

Structure

- Understanding the structure component is crucial
  - Hidden or missing communication lines
  - User resistance
- are often causes of IS failure

IS failure and success

- Success: supporting the organization goals
  - Notably fulfilling the need of the organization about information processing
  - In general terms, supporting
    - efficiency (lower costs, delays)
    - and effectiveness (do the right thing)

IS failure and success

- Success
  - Ex retailer (Walmart, Carrefour)
  - Organizational goal: increase ease and speed of checkout for customers
    - See later CSF and KPI to express these goals precisely and quantitatively
  - Result:
    - Option0, traditional checkout (employee, register)
    - Option1, self service checkout
    - Option2, RFID on each item, invisible checkout

IS failure and success

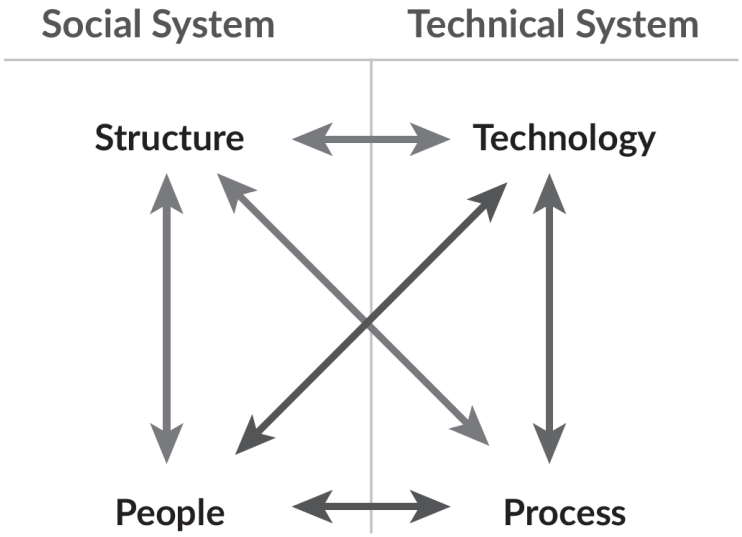
- Failure
  - The IS (or part of it, ex an application) is never completed
  - The IS (or part of it) is never used, or usage is abandoned
  - The IS (or part of it) is working against the organization goals

    «sorry, dear customer, the system does not allow to do this»

IS outcomes

- Beyond achieving the goals an IS has other outcomes
  - On people
    - Positive: empowering employees and widening the scope of their responsibility
    - Negative: deskilling, loss of responsibility, and the creation of a monotonous working environment
  - On the organization and its future opportunities
    - See the time dimension,
    - see ‘legacy’ definition

Systemic effects



- The four components of an IS are *interdependent*
- changes in one component may affect all other components and, if not properly managed, its outputs
- systemic effects are critical
  - when designing a new system
  - when troubleshooting an existing one

Cfr key message from introduction

«To build an effective IS you need to understand the organization»

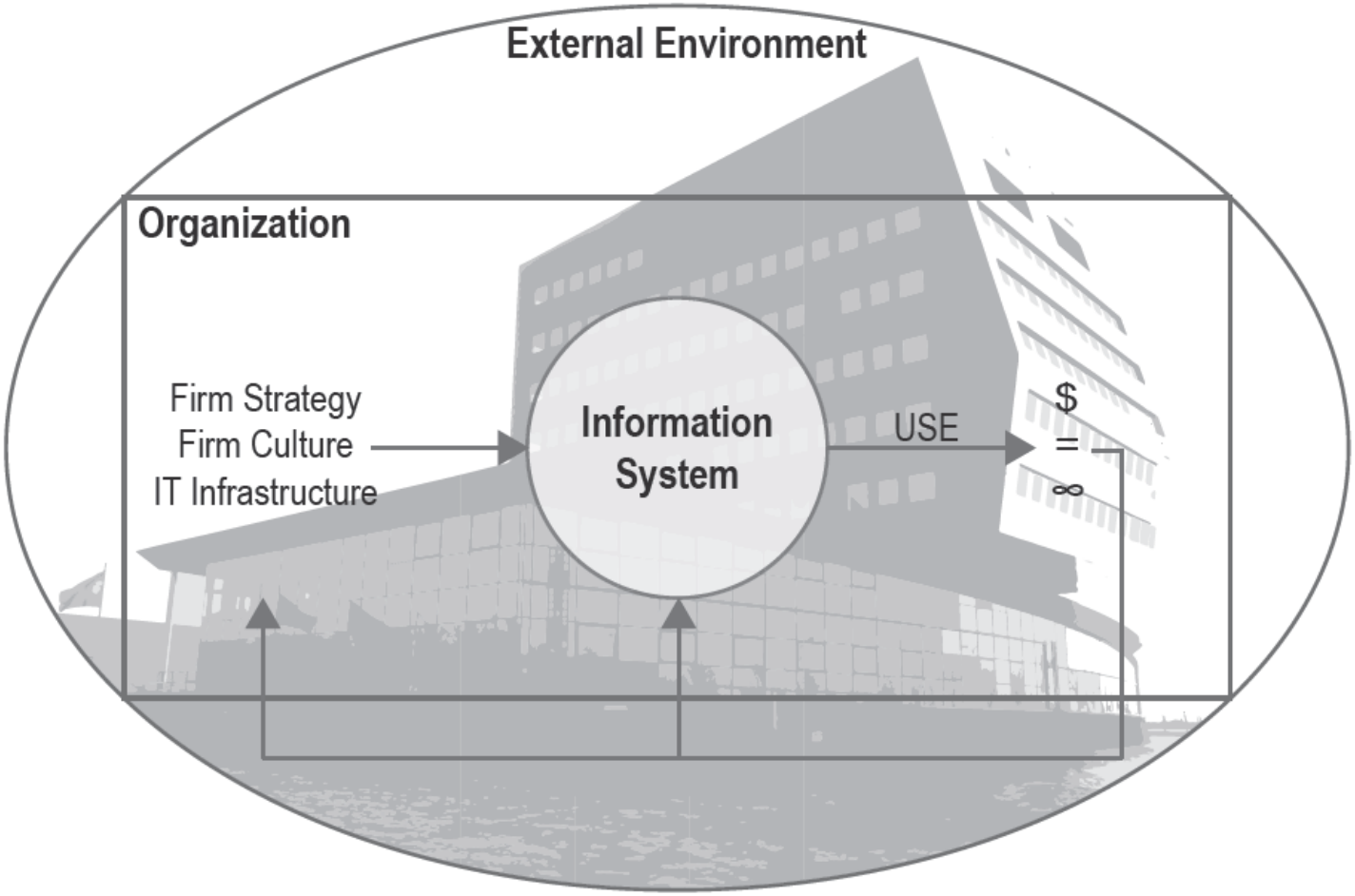
Technology only?

- Considering only the technology dimension of an IS (computers, applications, database) (often called CB IS- computer based IS) is a mistake
  - Lack of understanding of systemic relationships
  - Lack of considering information outside the technology component (in people's brain, in paper, or else)

Technology only?

- To design, modify, understand an IS we need to consider the 4 components and their interactions

IS in context



IS in context

- The design of an IS must take into account
  - The organization: each organization is unique
    - People, structure, processes
    - culture
    - See later ‘organizational variables’
  - The environment of the organization
    - Customers, suppliers, regulations, competitors

Change

- Changing an organization (and its IS) is needed
  - Organizations must change to adapt to the changing environment
- But delicate and failure prone

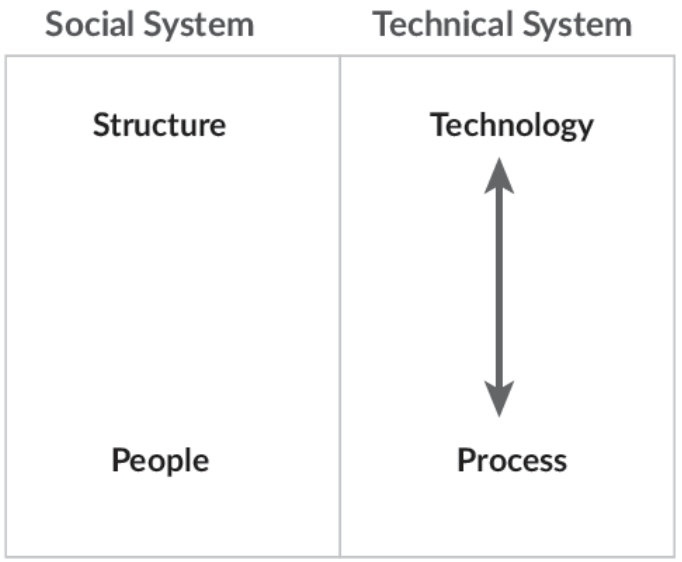
IS and Organizational Change

Three levels of organizational change:

- First-Order: **Automate**
- Second-Order: **Informate**
- Third-Order: **Transform**

First-Order Change: Automate

- First-order change only affects the **Technical** system
- It occurs when an IT innovation is introduced that modifies how an existing process is performed
- Managing it is:
  - Easiest to envision
  - Easiest to justify
  - Easiest to manage
- First order change requires little executive sponsorship or involvement



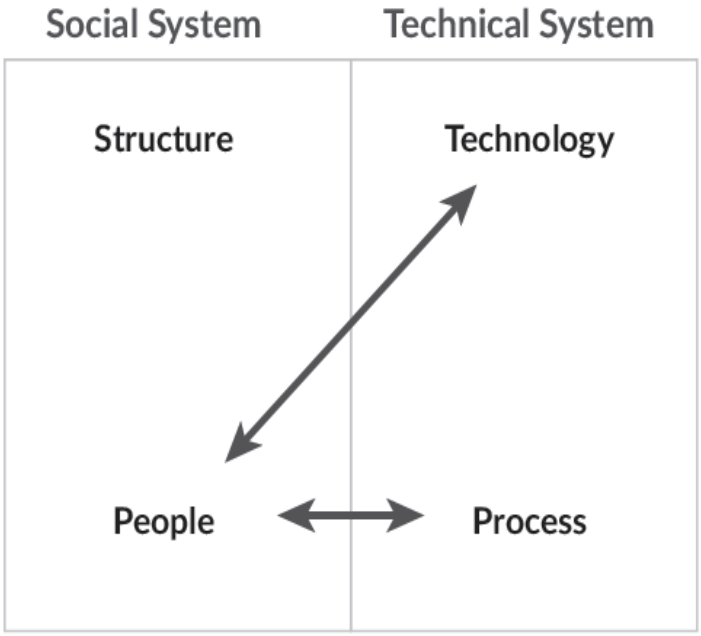
Example

- Bank transfer, using phone with keys

- Bank transfer, using smartphone

Second-Order Change: Informate

- Second-order change affects the **People** component:
  - The way individuals perform processes and the manner in which they interact with the technology change
- It occurs when the information intensity of the process being performed changes substantially due to the introduction of new IT
- Key challenges on managing it are:
  - Provide appropriate training
  - Overcome the human tendency to resist change



- Flight checkin – at counter
- Flight check in – self service

- Customer goes at counter
- Employee performs check in
- Customer passive

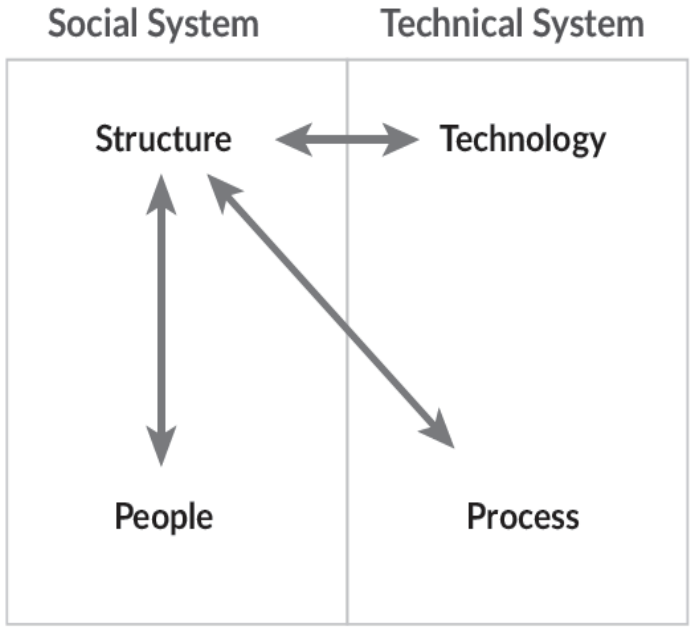
- Customer self performs checkin using (web / mobile) app
- Customer active

Process does not change much, but (some to all) tasks are delegated to the customer

This has happened everywhere in the last 10 years

Third-Order Change: Transform

- Third-order change affects the **Structure** component:
  - Technology → a change in the way the organization selects, uses, and manages technology
  - People → a change in the reporting and authority structure of the organization
  - Process → a novel way of task accomplishment or a new set of task
- Managing it requires significant managerial and executive involvement



- Traditional encyclopedia
- Content is created by (paid) editors, the process if hierarchical and controlled

- Wikipedia
- Content is created by ‘anyone’, for free, the process is peer to peer

Implications

- IT product should not be the point of departure but rather the point of arrival of your information system design effort
  - Strategy may be inspired, not driven, by IT
- Never forget the systemic effects: the components of an IS mutually influence one another
  - Anticipate these ripple effects and proactively manage them before they become a cause for concern
- An information system is not designed “once and for all” as if it were a static artifact

Implications

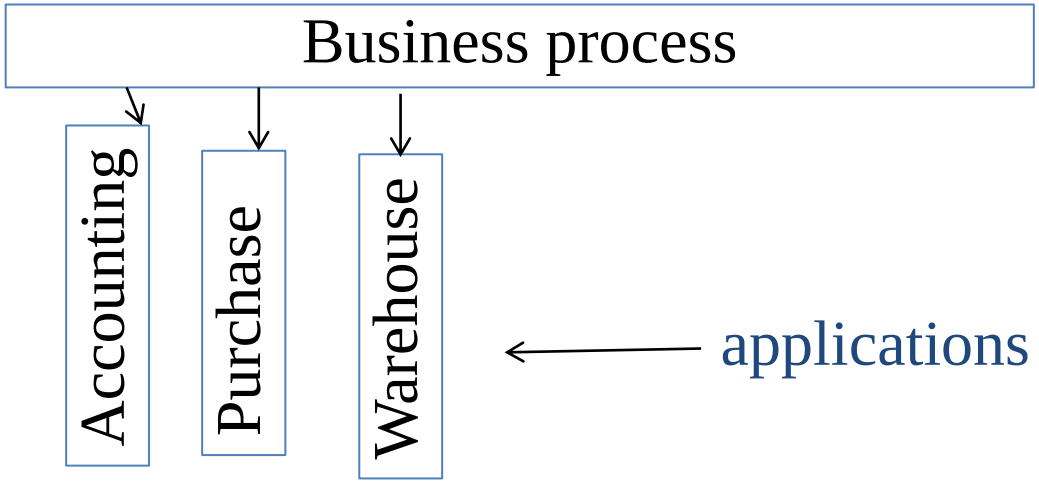
- Organizations are dynamic: IS goals and needed information processing functionalities need to be re-evaluated often
- The design and use of an IS should be seen as an iterative process involving:
  - The cyclical evaluation of individual IS components
  - The assessment of how different organizational systems work together to support the business
  - A reevaluation of the current IS design any time a major change occurs
- Optimize the Information System *as a whole*, not the components individually

Technical system

- Essentially made of several applications that (read / write) on several databases
- The databases contain
  - Master data (list of entities)
    - Ex products, customers, suppliers
  - Transactional data (events)
    - Ex sale, purchase

Technical system

- A business process uses one or more functions of one or more applications



- This creates the Integration problem

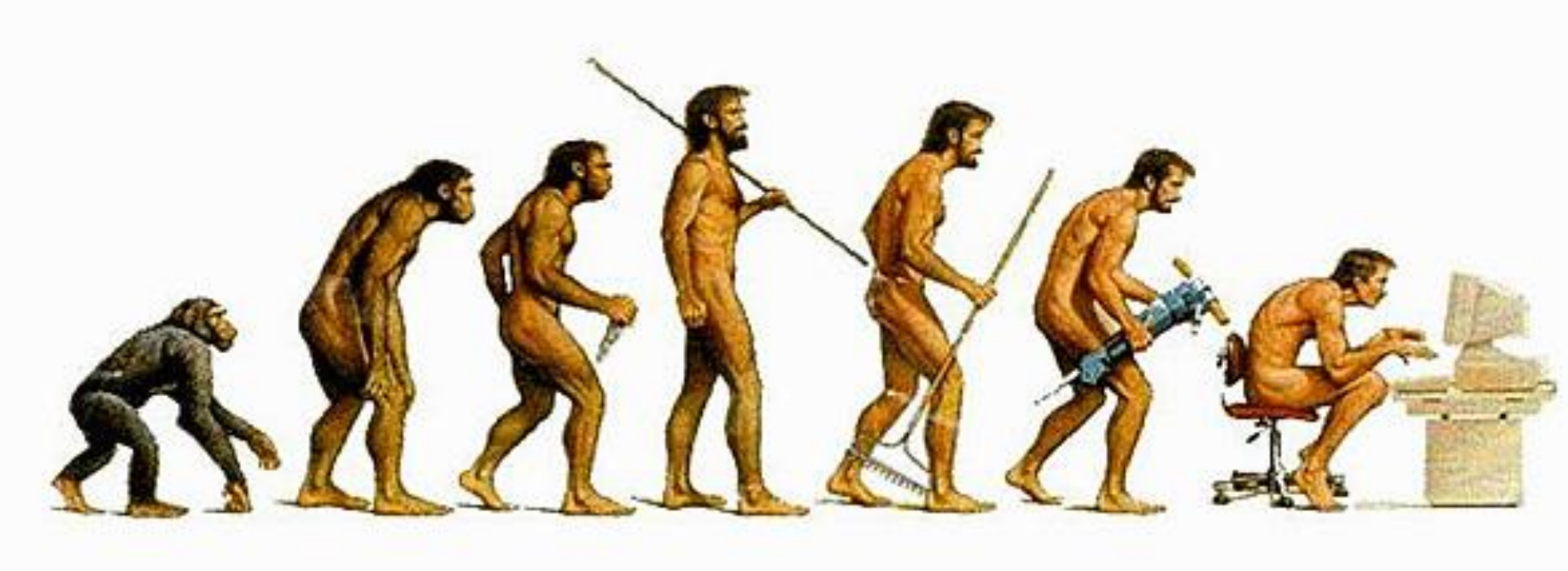
Integration

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

Views / dimensions

- Better to handle IS complexity considering several orthogonal views (or dimensions)
  - People
  - Structure
  - Processes
  - Technology
- Time is yet another dimension

Time dimension



- IS are most important and more complex in larger organizations
- That likely are long lasting entities
  - 10 –20 – 30 … 100+ years old
- So time becomes a factor too
  - Changes happen in all dimensions

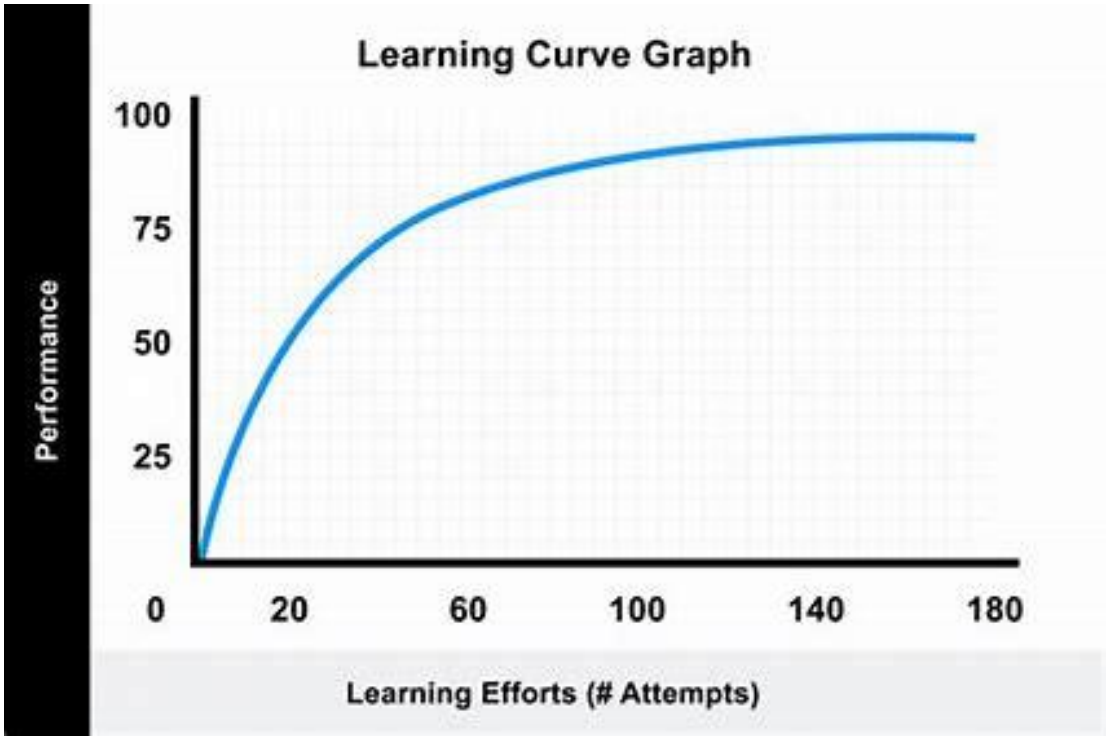
Technology waves

- Mainframe
- Minicomputers
- PCs
- Internet
- Mobile internet, smartphones
- Cloud and services

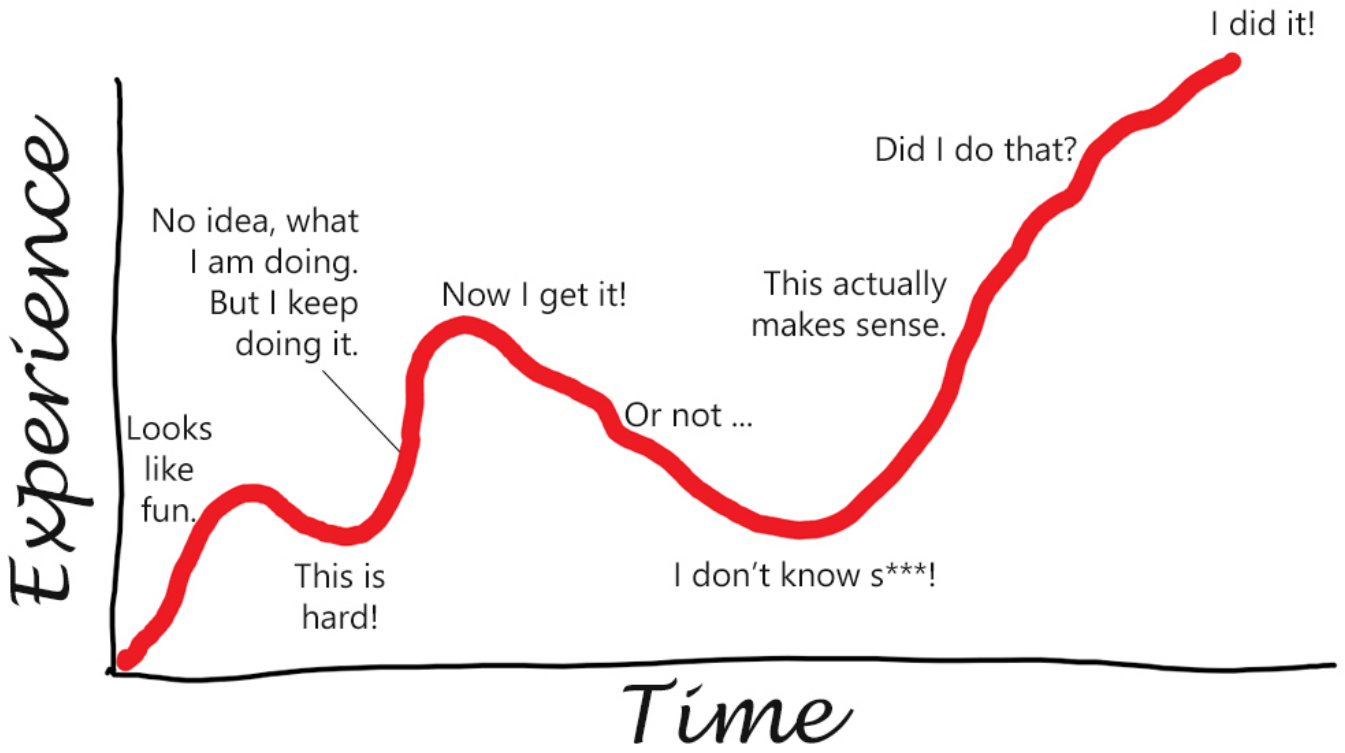
Issues with technology changes

- The next wave is just fashion, or really gives an advantage?
  - New does not always mean better
- Resistance to change
- Cost and learning curves

Learning curve



Learning curve



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 applications 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
    - Vendor unavailable (closed, sold, ..)
  - Consequence
    - They are unchangeable
    - But substituting them is costly and risky

AN EXAMPLE

Factory + warehouse

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.

Organizational units (1)

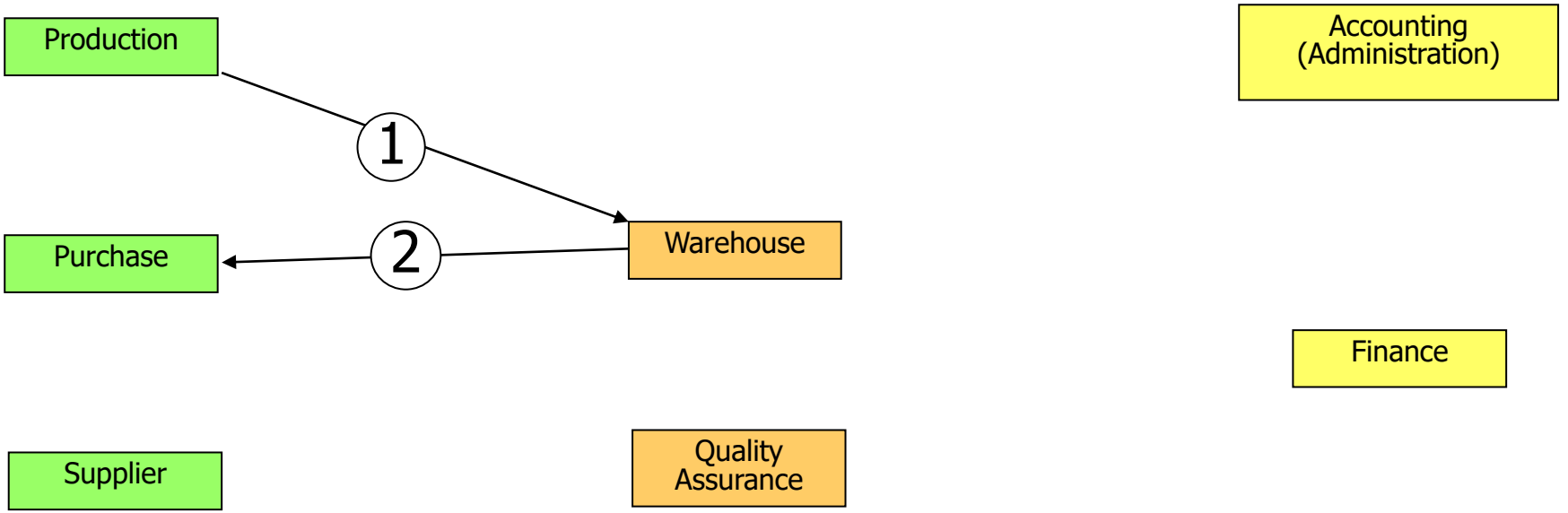
- Production: requires the raw materials needed for the production plans from the warehouse
- Warehouse: when the raw material is not available, first make a request to the purchase office; once the order has been received checks the quality, conformance to request, and stores it.
- Purchase office: 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

Organizational units (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.

This is the structure - people dimension

Flow (items + information)

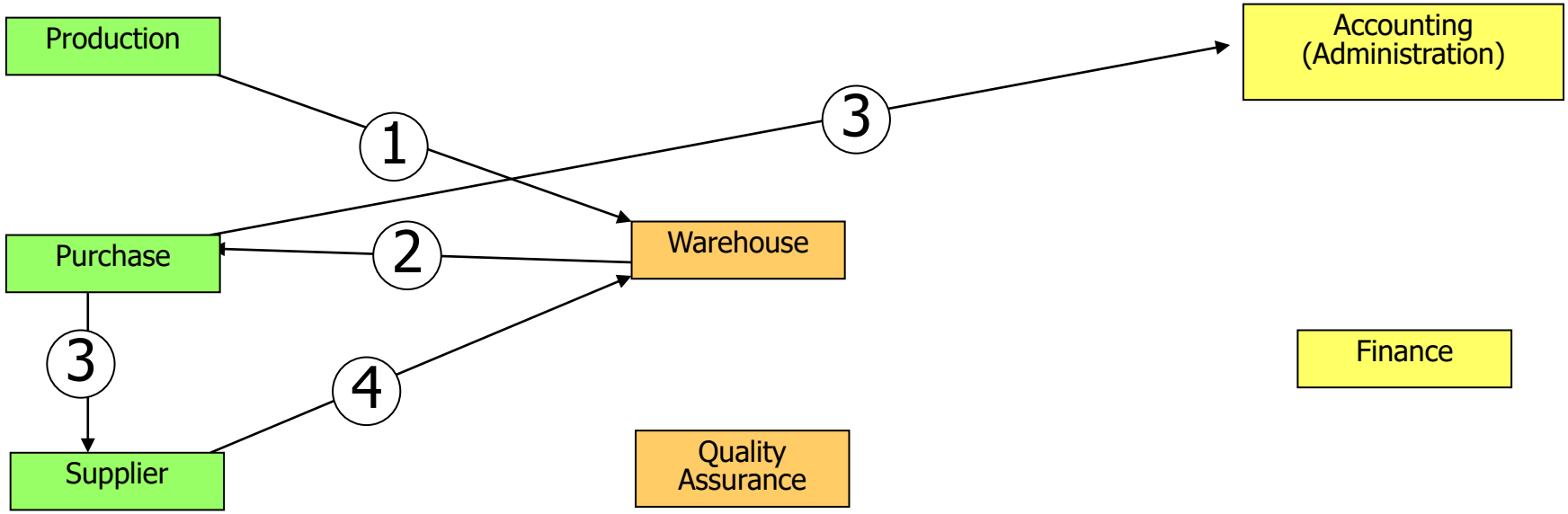


1. Production asks Warehouse for raw materials

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

This is the process dimension

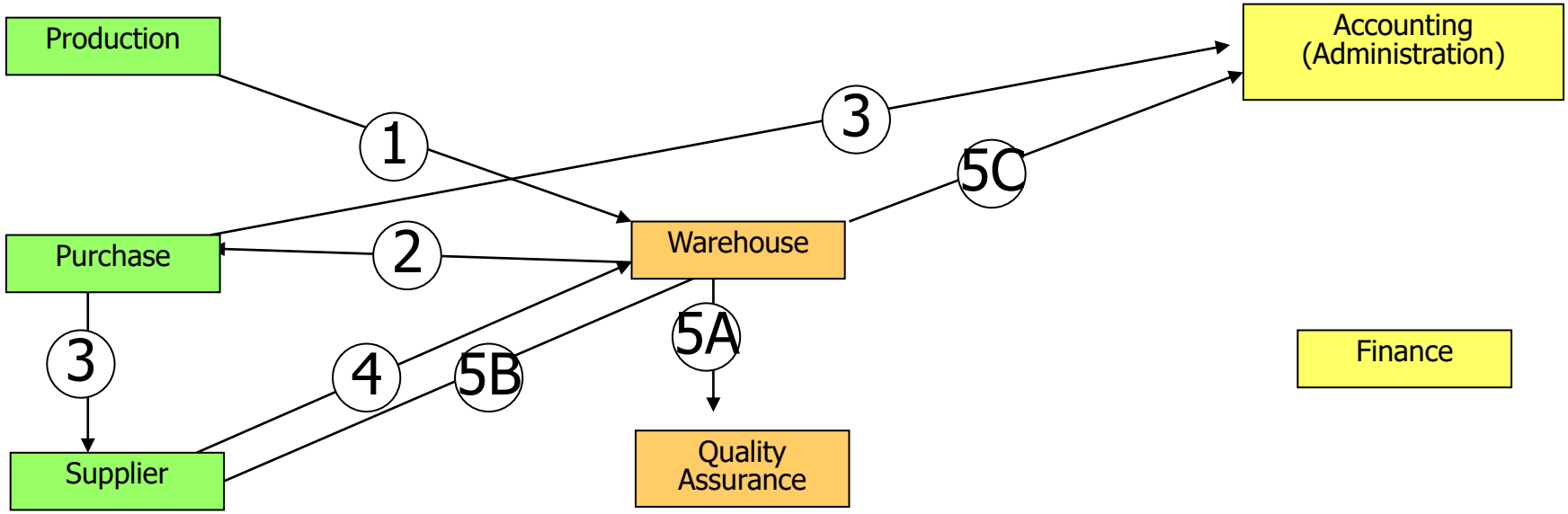
Flow (1)



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)

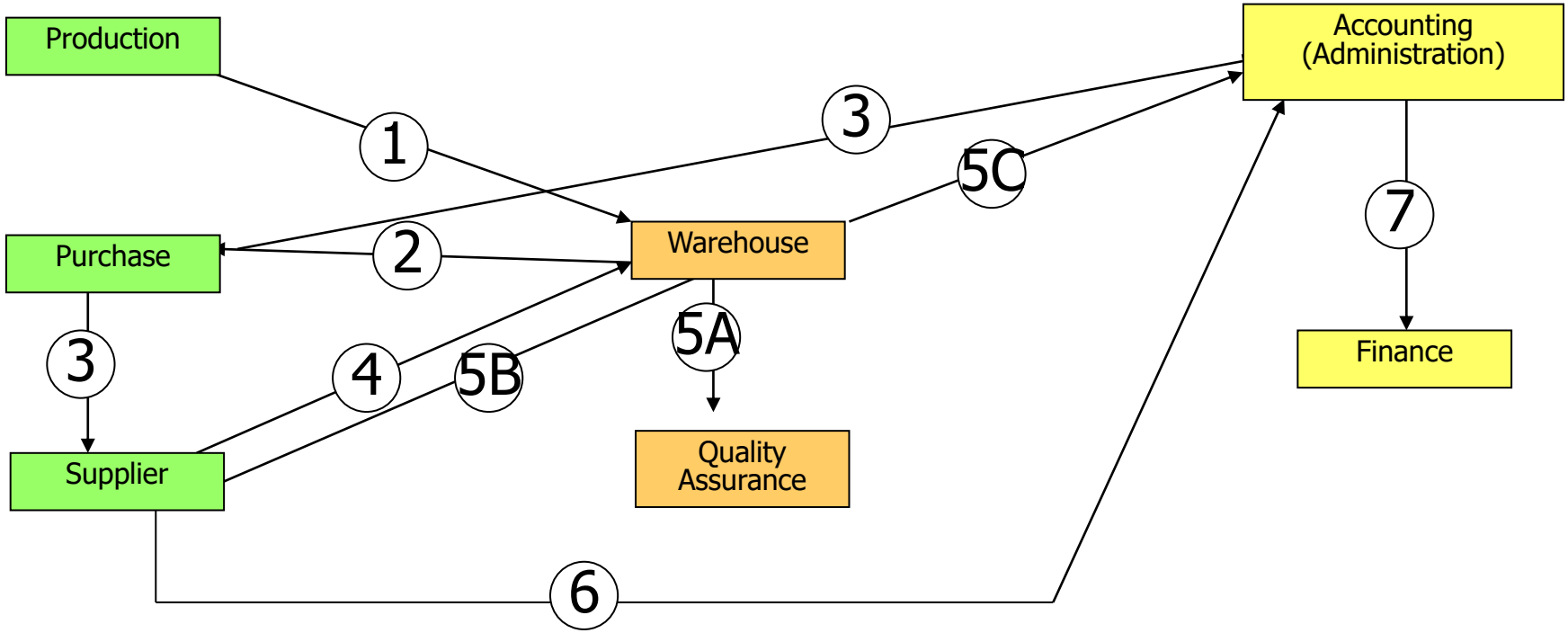
5C.Accounting receives copies of the delivery notes and the amount of returned materials



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

5B. Warehouse returns possibly defective goods to Supplier

Flow (3)

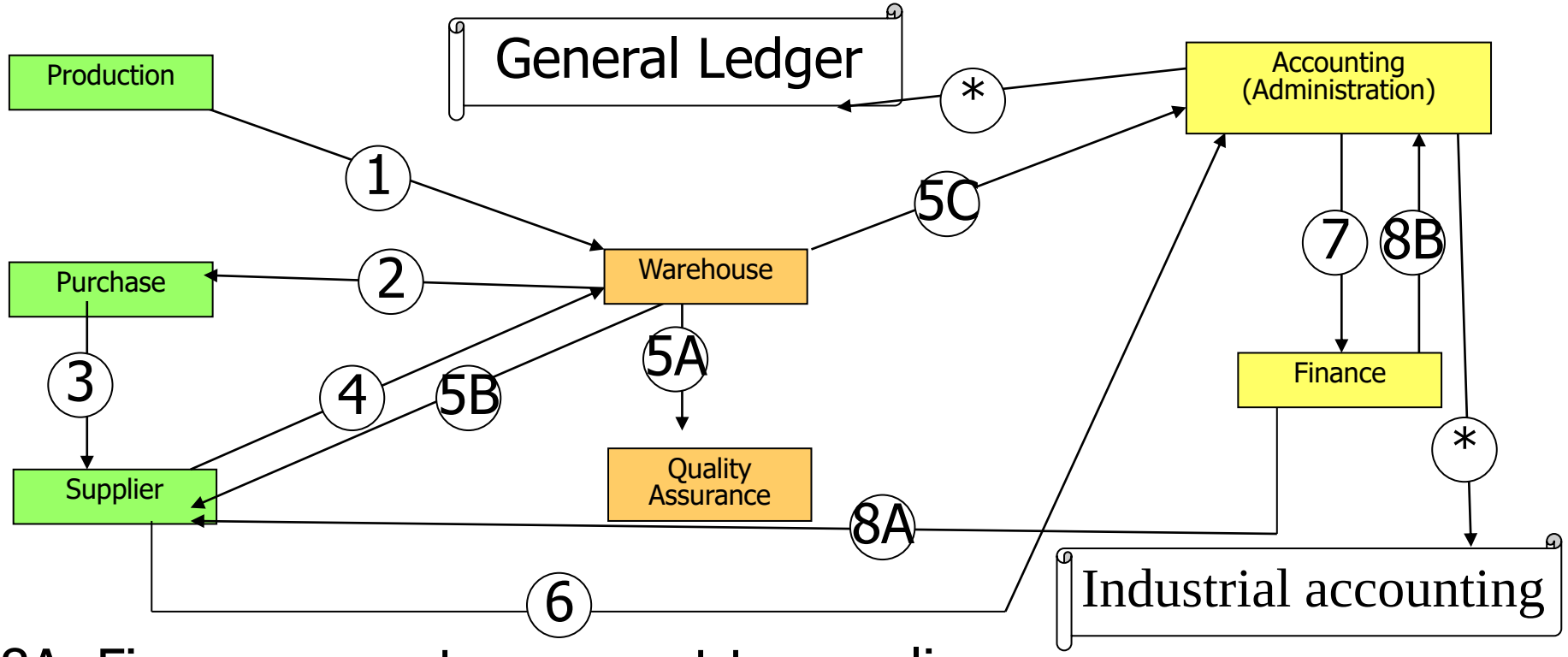


6. Supplier sends invoice to Accounting
7. Accounting checks the invoice (compare with orded and delivery note) and ask Finance to proceed with payment.

Flow (4)

General ledger: data dimension

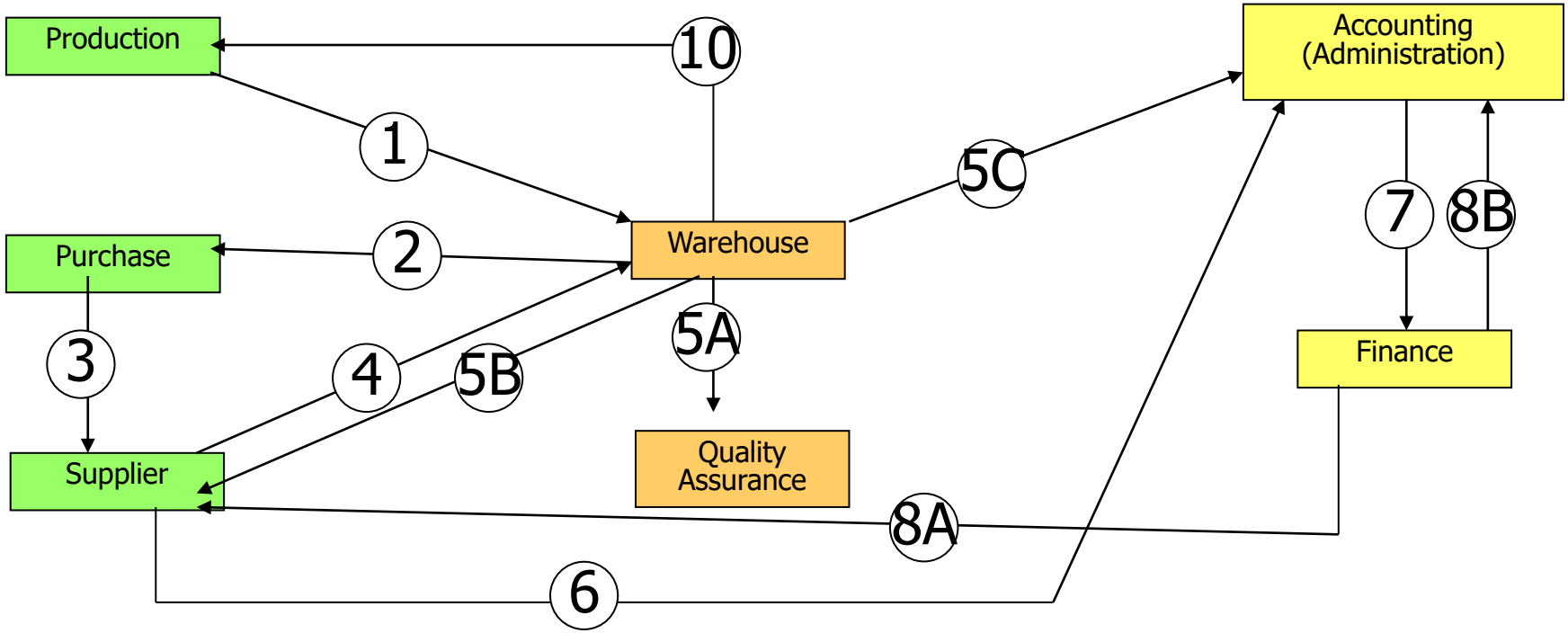
*. Accounting records all steps in the general ledger and in the internal industrial accounting books



8A. Finance execute payment to supplier

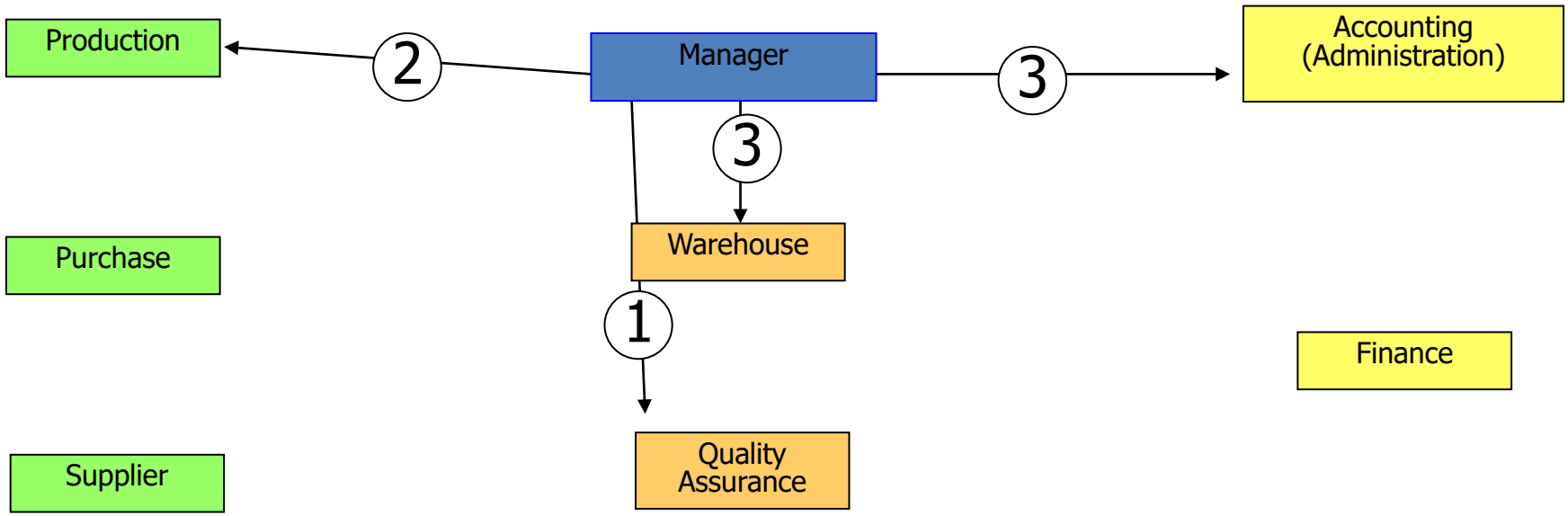
8B. Finance informs Accounting of the payment

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

IS is needed to

- Transfer 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

Dimensions

- Process (flow)
  - Flow : 1 Materials request, 2 ..
  - Data: Order, Delivery note, Invoice, General ledger
  - Business rules: Payment must be performed < 60 days
- Structure / people
  - Warehouse, Production, ..
- Technology

Technology – option 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

Technology – option 2

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

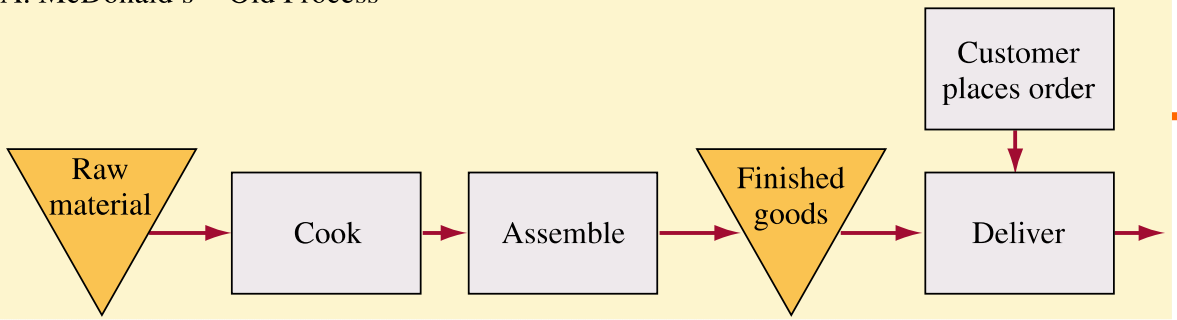
- In the case presented the IS manages the information flow parallel to a physical flow
- In other cases there is no physical flow at all
  - Ex bank, insurance, (service organizations)

YET ANOTHER EXAMPLE

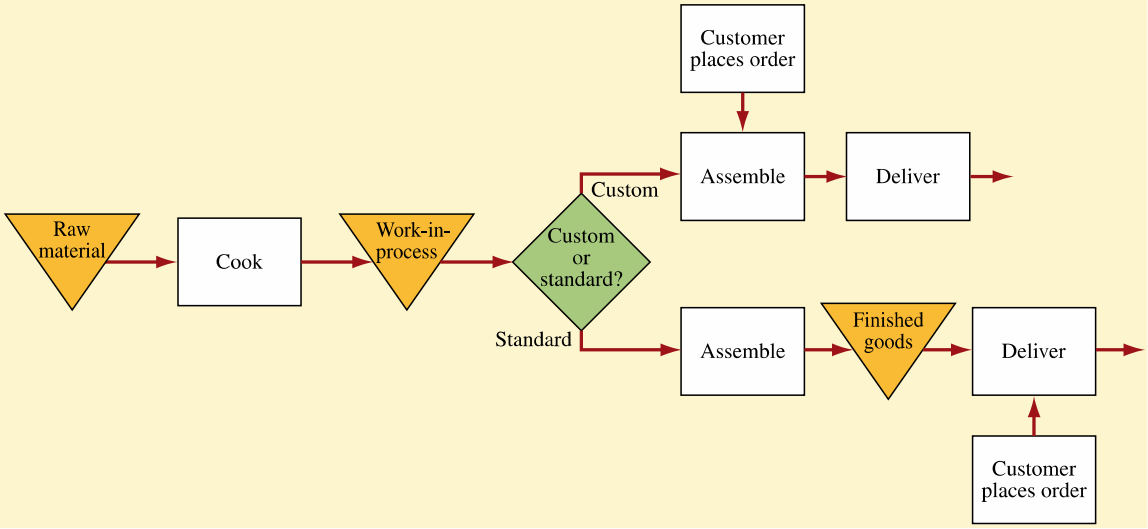
Fast food – information flows

- 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

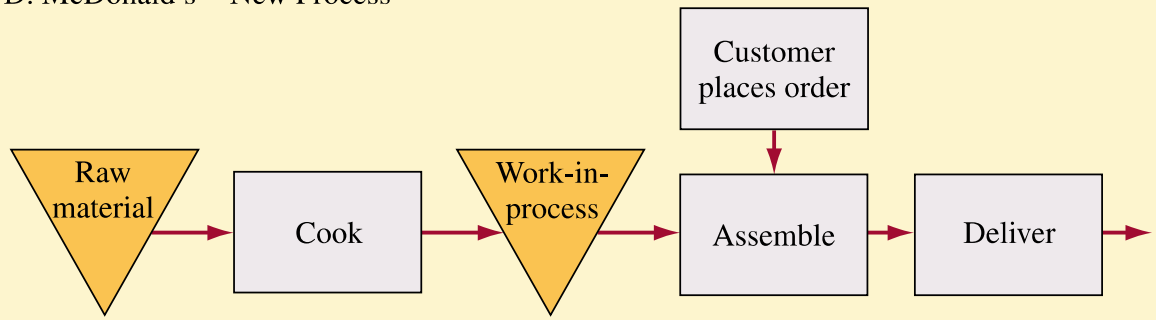
A. McDonald's—Old Process



B. Burger King



D. McDonald's—New Process



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
  - …..

Summary

- IS are sociotechnical systems
  - People, structure, technology, processes
- to manage information and support an organization achieving its goals
- 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

Summary

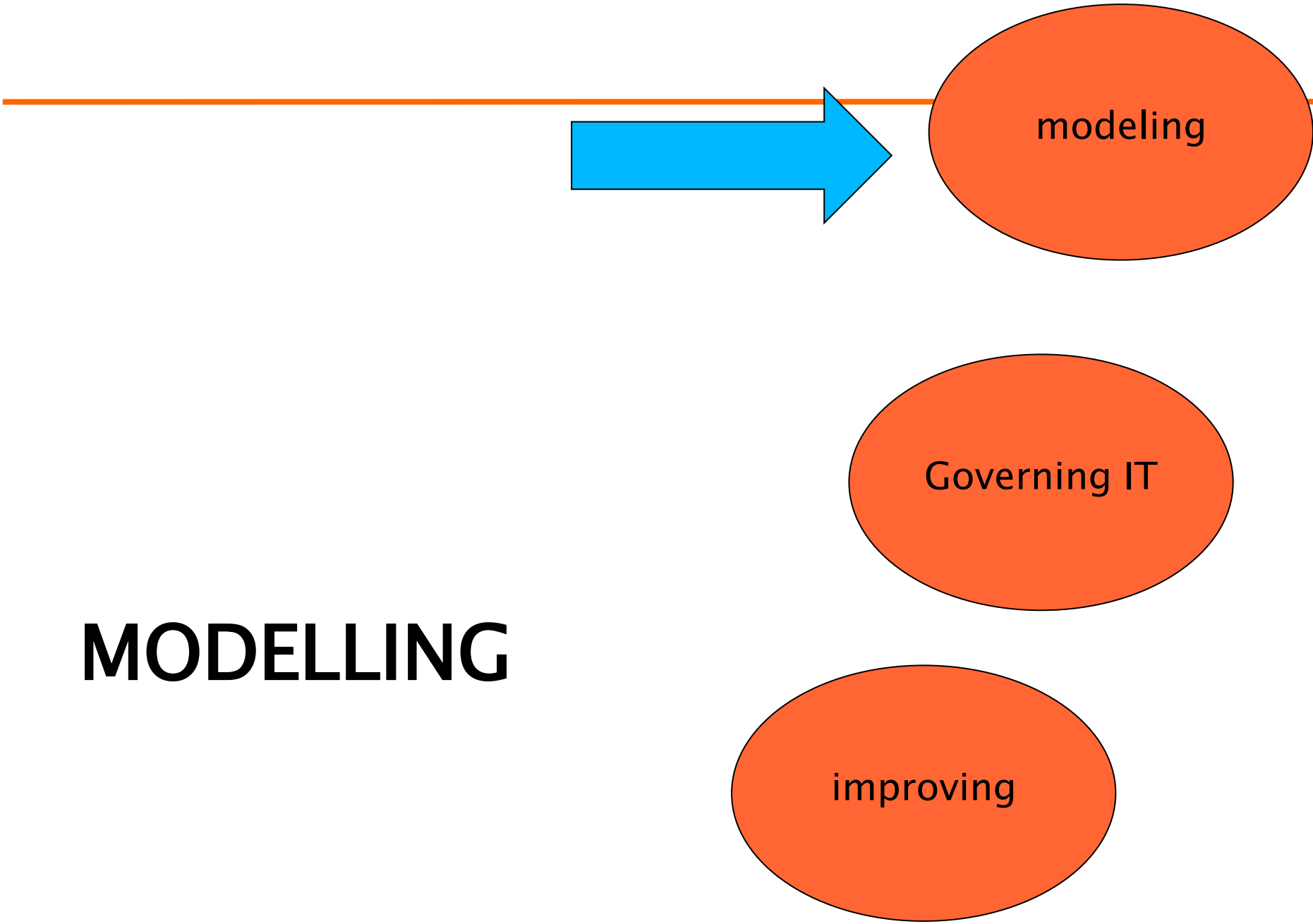
- From a strictly technical point of view an IS is made of databases and applications
  - Integration problem
- From a larger perspective, IS must consider in an olystic way its 4 components and their relationships
  - Systemic effects

Summary

- IS are unique, since each organization is unique
  - Context is different
  - People, structure, process, technology are different, their combination is unique
  - Tension between tailor-made IS and cost
- Organizations change, and the IS should follow
  - Time dimension

Summary

- Organizational change and IS change can be seen at different levels
  - Automate
  - Informate
  - Transform
- IS can succeed or fail. Usually, failures depend on not considering systemic effects
  - DO NOT focus on technology only
  - DO NOT start from technology



MODELLING

Goals of models

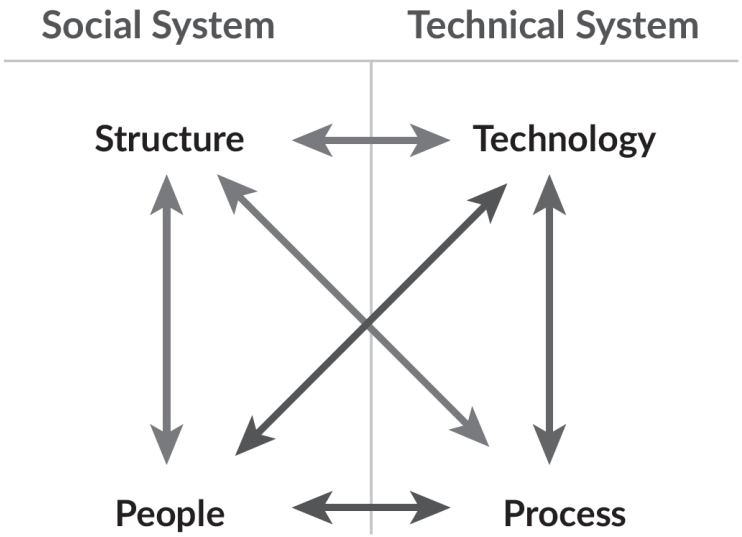
- Models of IS are needed to
  - understand
  - Improve
- Models are always imprecise and incomplete
- However, a model is better than nothing..

Model types

- High level
  - Scope: (families of) organizations
- Low level
  - Specific organization, specific process

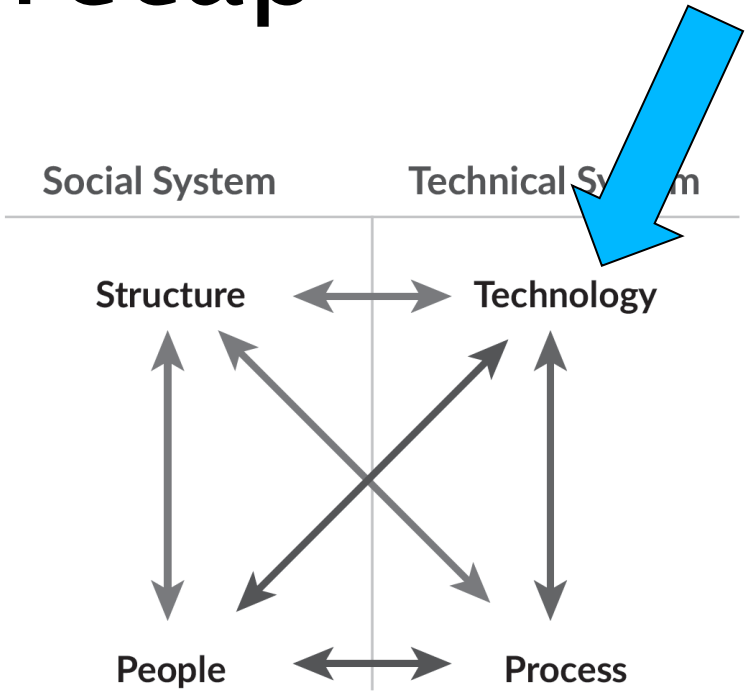
Model dimensions

- Process
  - Data
  - Business rules
- Organization
  - People, structure
- Technology (or IT model)

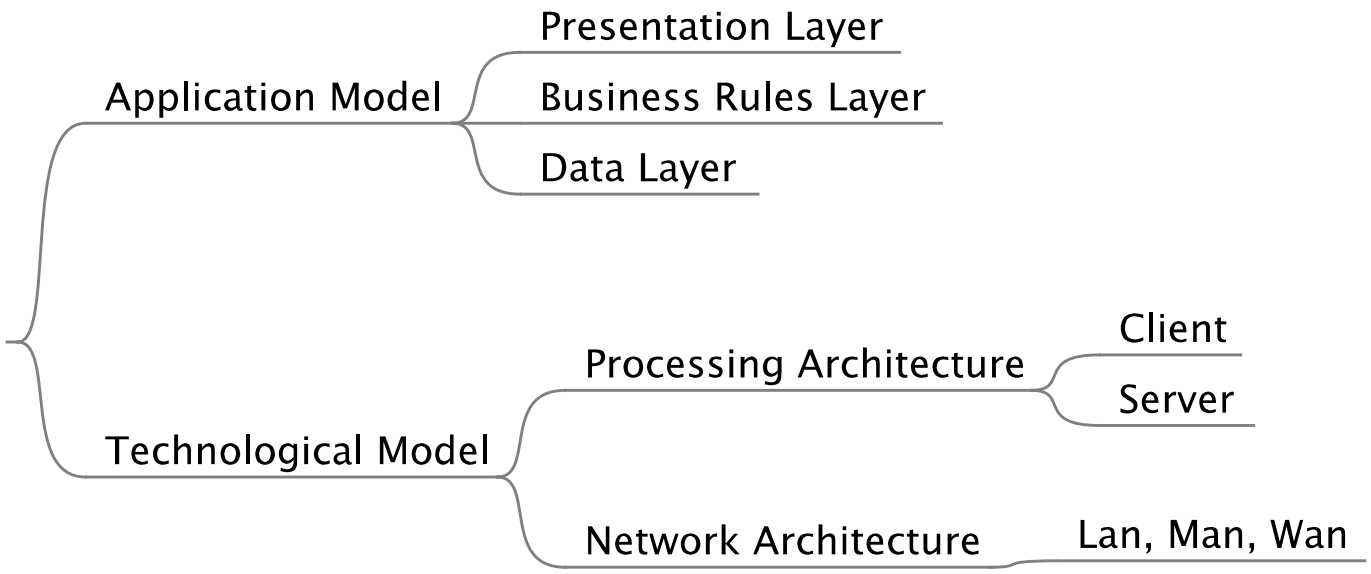


- Time

IT dimension – recap



IT dimension



IT Dimension

Two main parts:

- 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

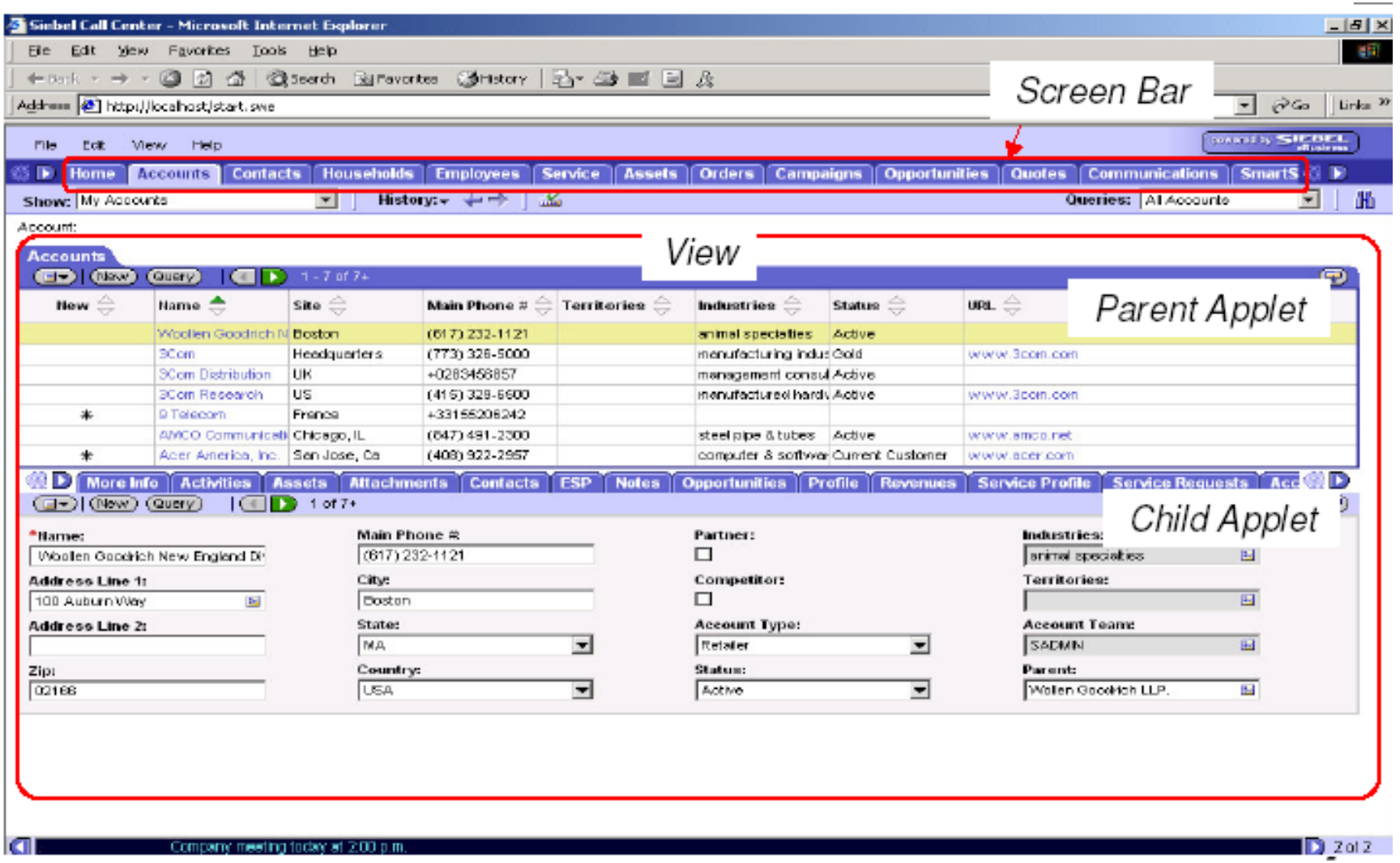
Example

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 communicates 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
  - Usability

Ex: presentation, customer data



Business Rules Layer

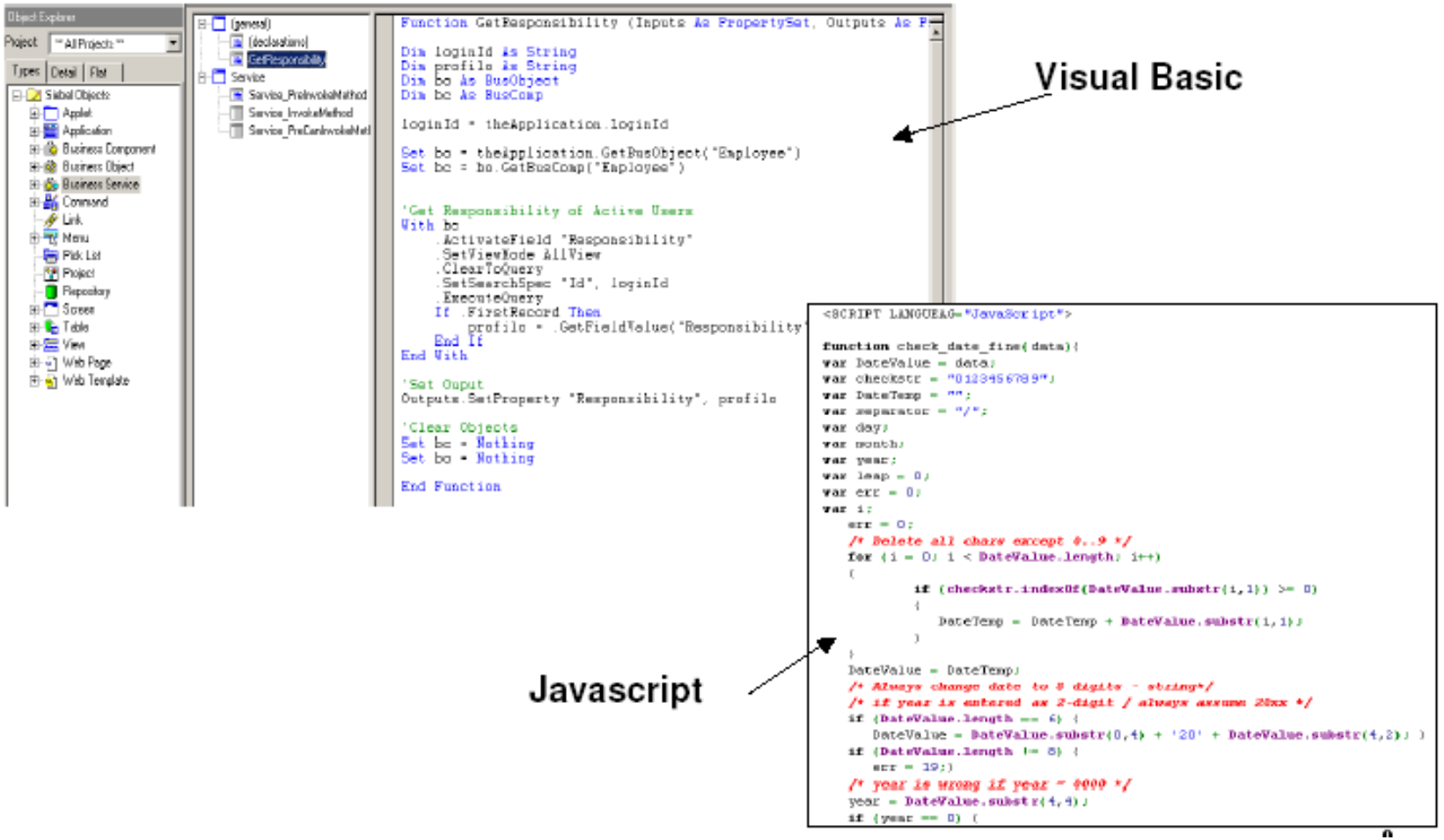
Rules consitute the logic driving the processing of data entered in the IS through the Presentation layer

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
```

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

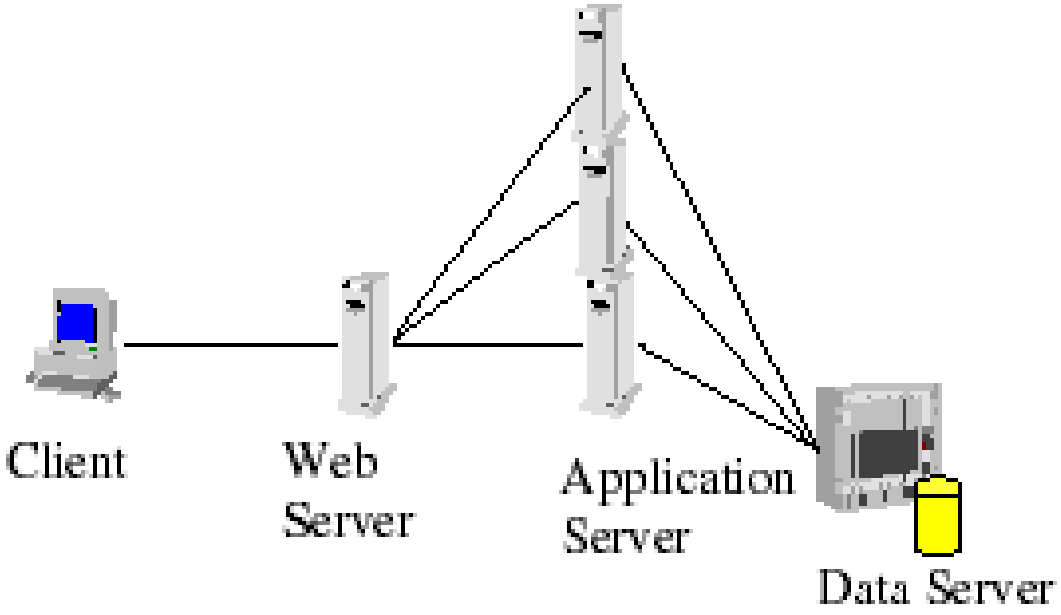
- Extremely powerful computer (mainframe) where all three layers reside
- Terminal performs only I/O

Client-server(C/S)

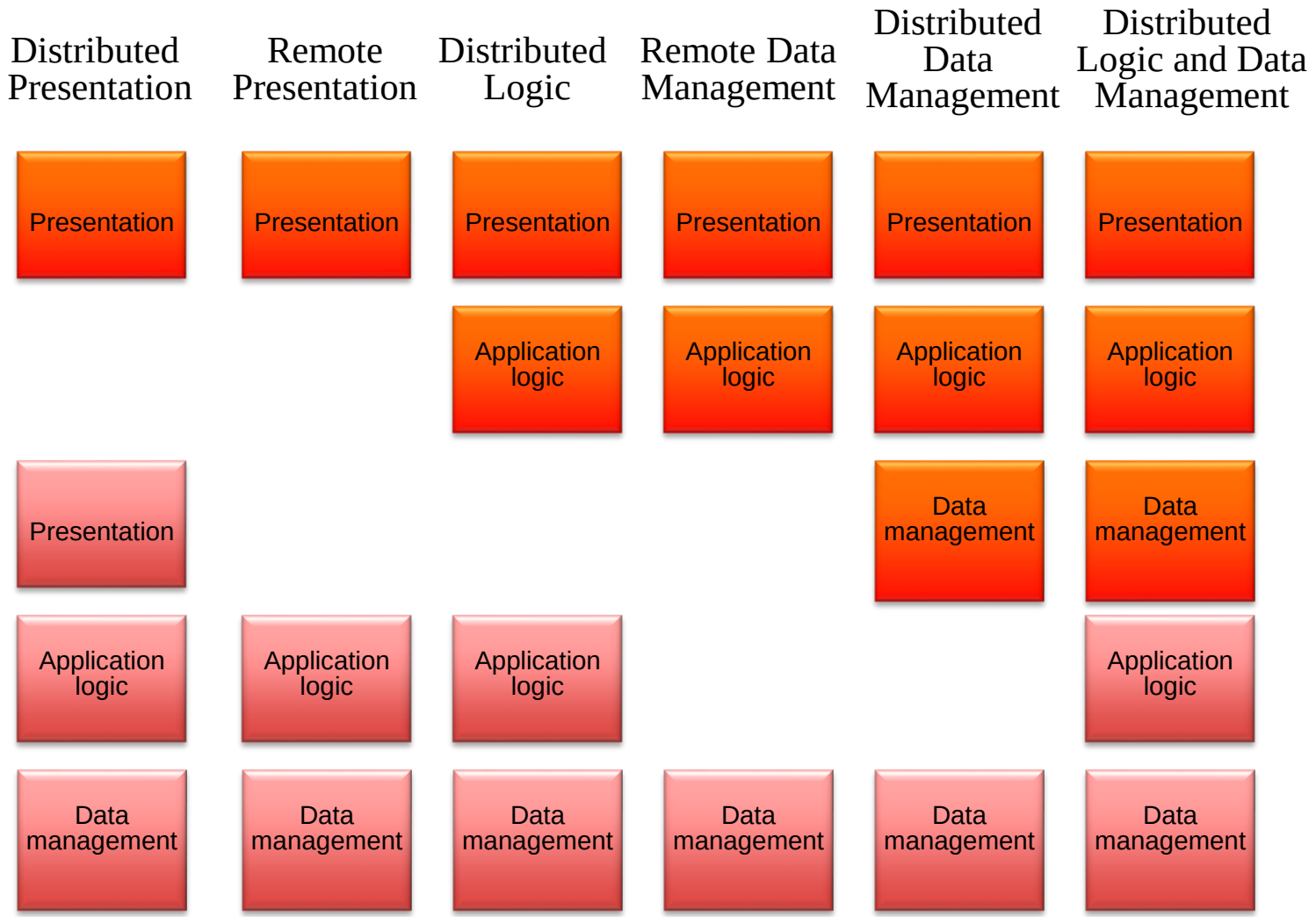
Architecture where client processes request services offered by server processes

- 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:
  - Response 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.

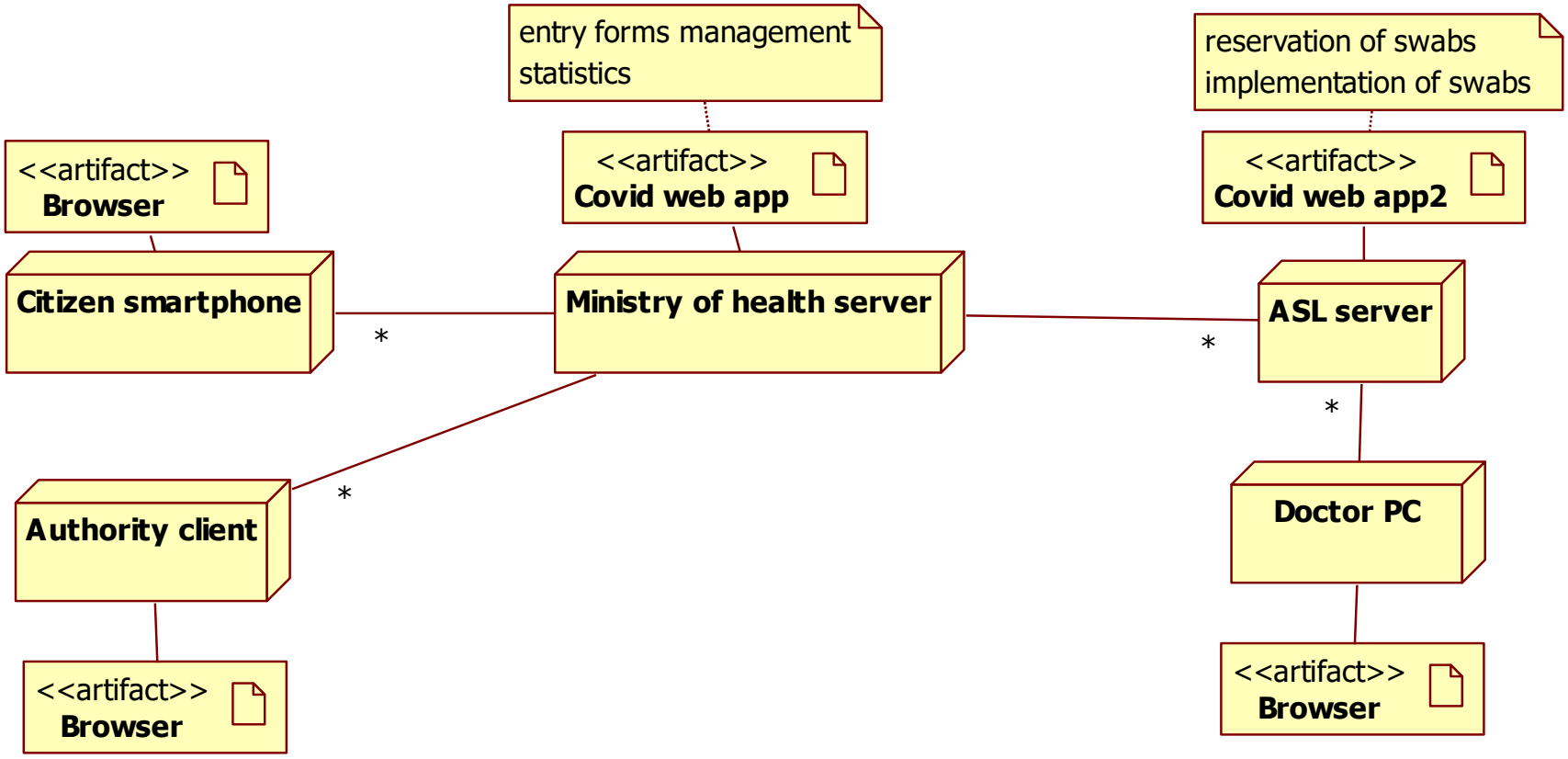
Network working mode

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

Modeling IT dimension

- UML deployment diagram



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

Summary

- IS have several dimensions
  - Process, people, structure, technology (IT)
  - Time
- Modelling IS is a tool to understand (and possibly improve them)
- IT models are further divided in
  - Application (sw) dimension
  - Technological dimension (hw, networks)