

Requirements engineering workshop

Putting theory into practice



oralius

aka:

What the customer really wanted needed

Agenda:

- Introduction
- System & context
- Requirements elicitation
- Requirements specification
- Requirements modeling
- Requirements analysis
- Show and tell



Goal of the workshop

After being overwhelmed with theory about requirements engineering it's time to put this in practice. Based on a business case we will go through every phase of the requirements engineering process.

Each exercise will be validated and tips will be given.

The greatest mistake you can make in life is to be continually afraid you will make one.

Elbert Hubbard (1856 - 1915)

Definition of a requirement

A requirement is “anything that drives design choices”

Lawrence 1997

- A requirement is a condition or capability needed by a user to solve a problem or achieve an objective (user's view)
- A requirement is a condition or capability that must be met or possessed by a system or system component to satisfy a contract, standard, specification or other formally imposed document (developer's view)

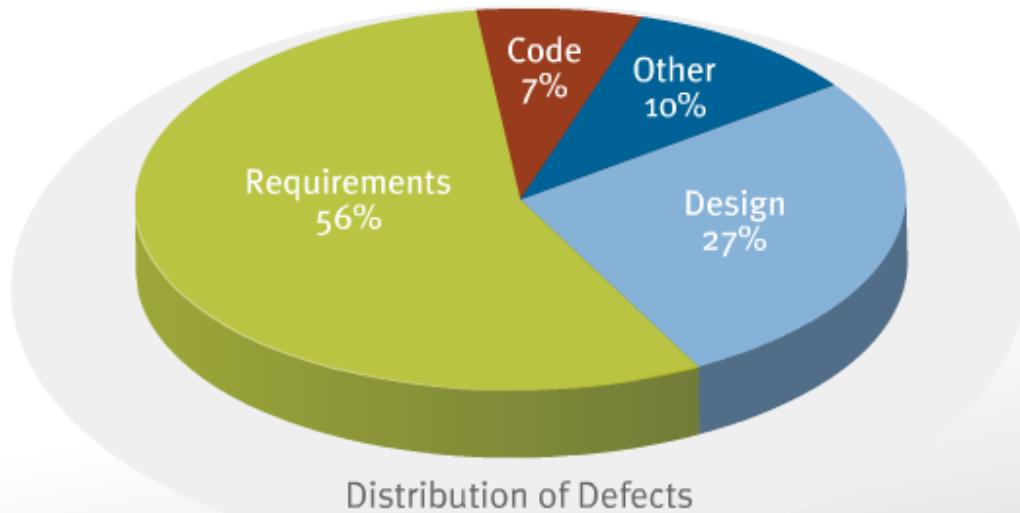
IEEE standard glossary of software engineering terminology (1990)

Facts

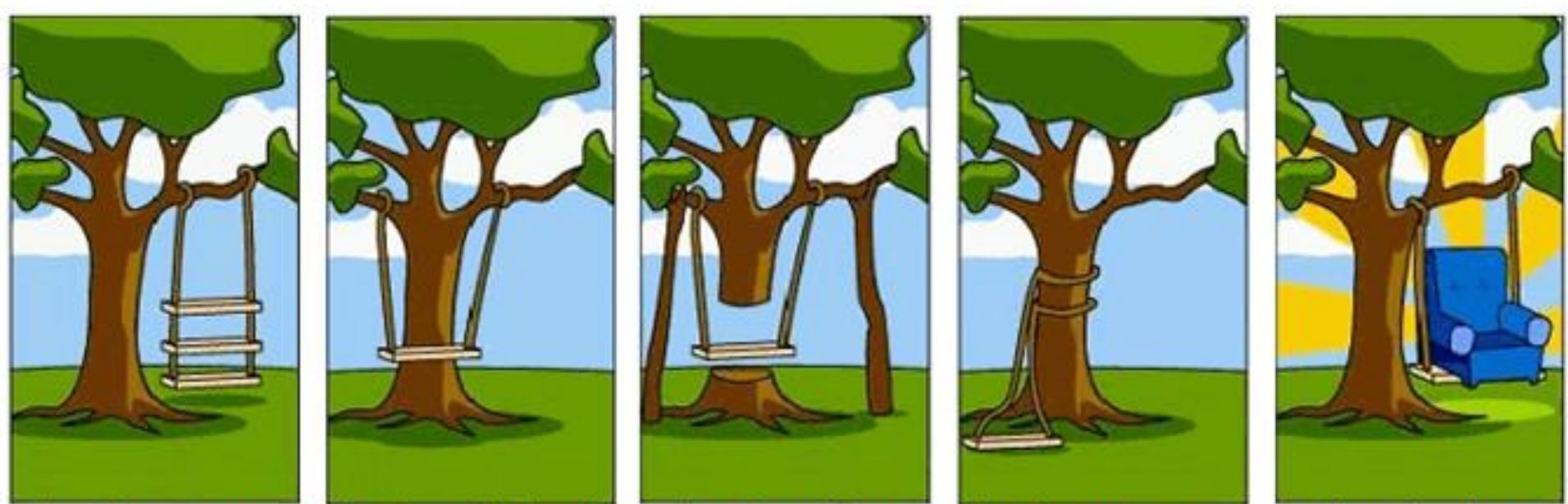
Requirements Errors

40% of effort in an average software project is rework

The largest contributor is requirements errors



Butler Group, April 2005



How the customer explained it

How the project leader understood it

How the engineer designed it

How the programmer wrote it

How the sales executive described it



How the project was documented

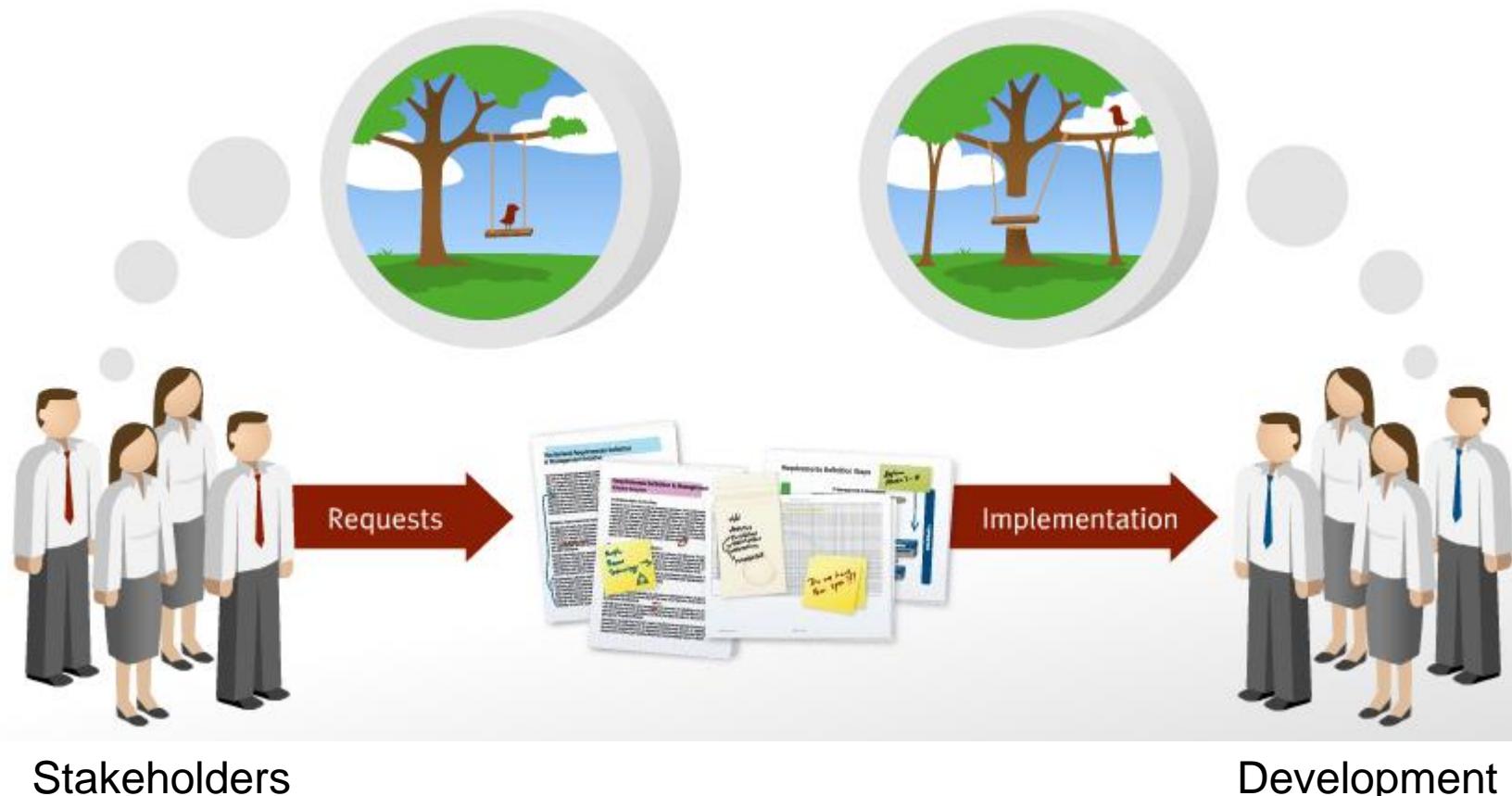
What operations installed

How the customer was billed

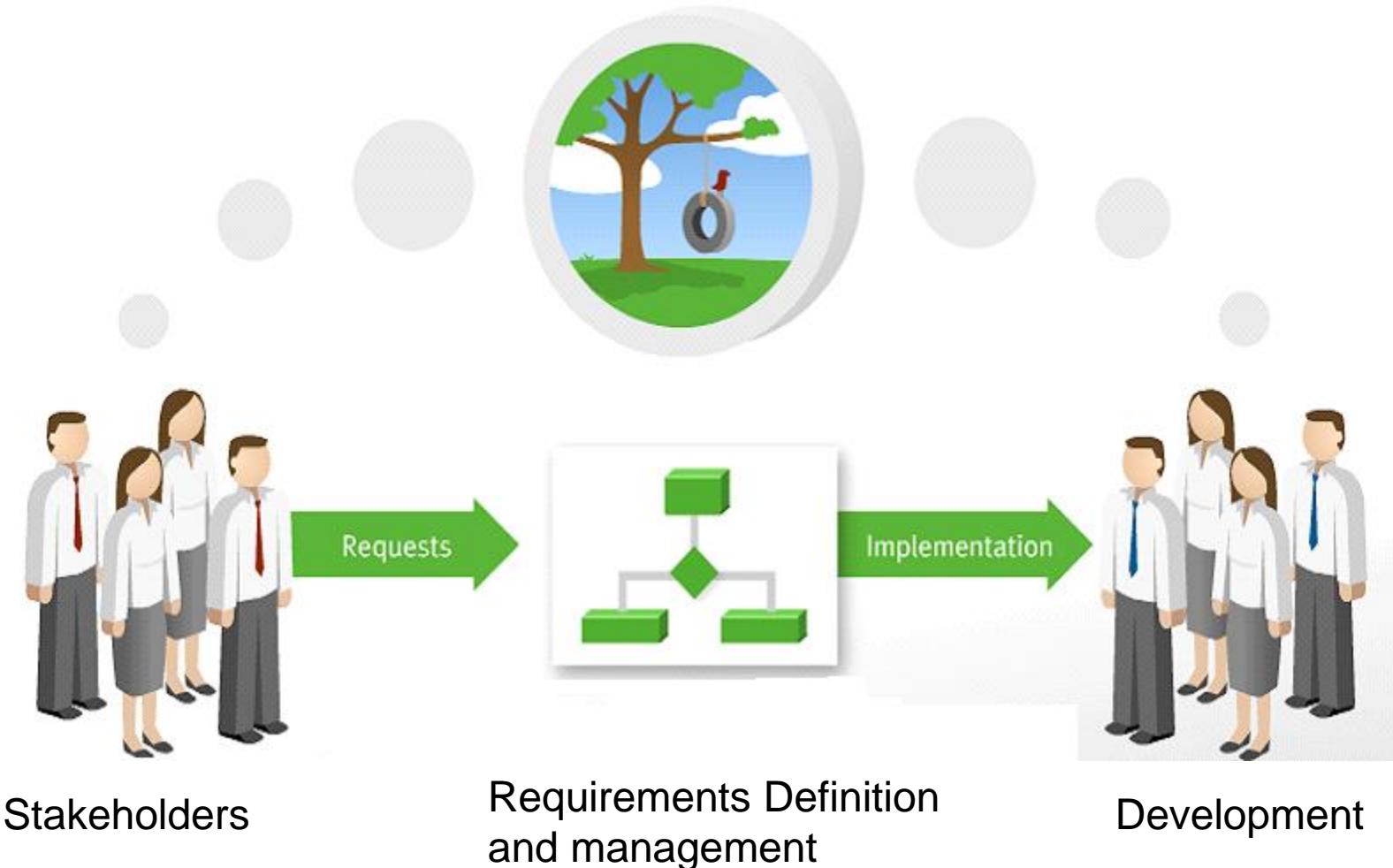
How the helpdesk supported it

What the customer really needed

What we do (and shouldn't do)



The requirements process



Who's who?
And what?

System and system context

Requirements can differ according to:

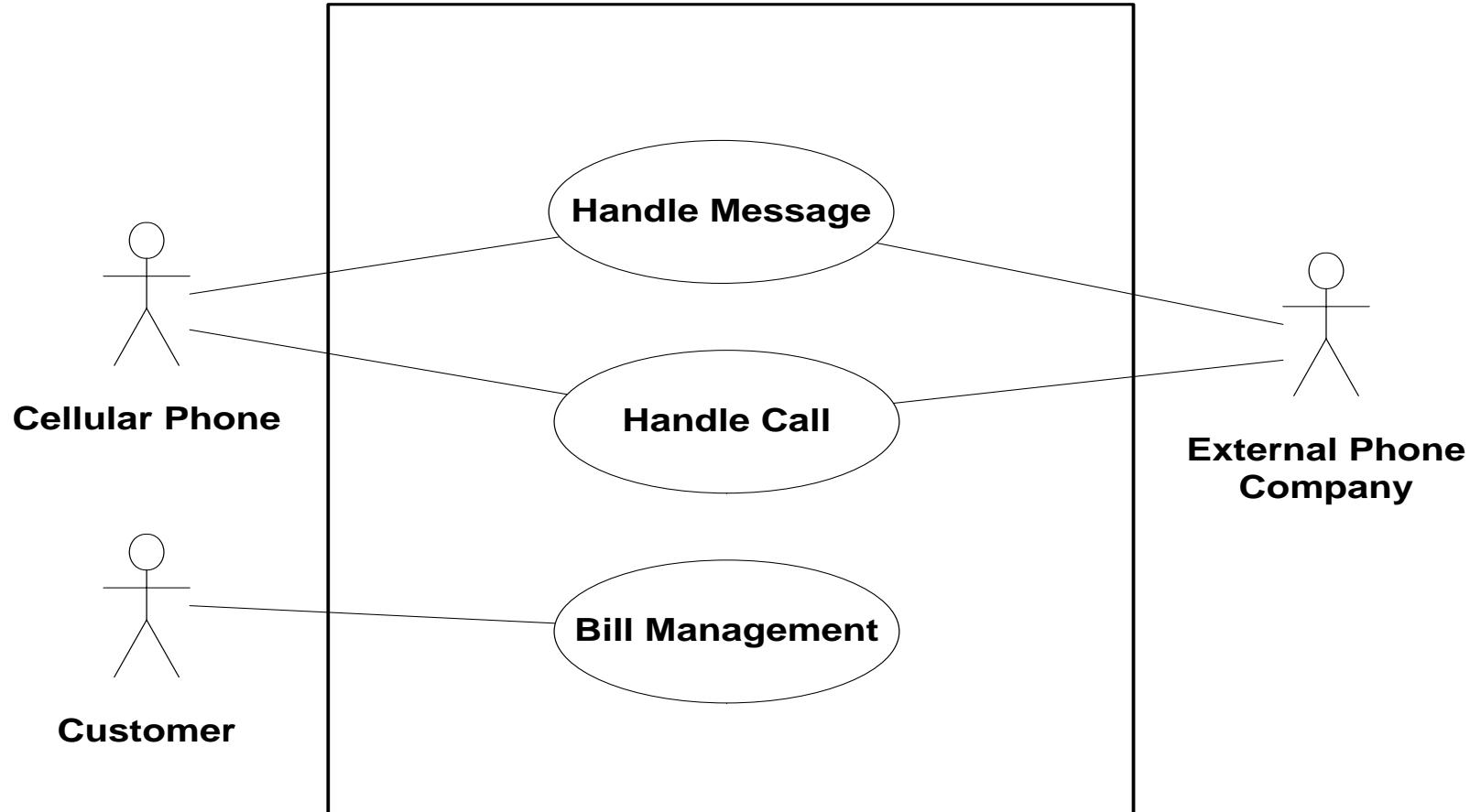
- Type of user
- Environment
- Type of use
- Frequency of use
- Etc.



Example: Bicycle

- Type of user: child, elderly person, man, woman, racer
- Environment: city, woods, country, mountains,...
- Type of use: race, transport material, sight seeing, ...
- Frequency of use: daily, monthly, occasionally, ...

Use Case Context Diagram



Stakeholder

A stakeholder is a person, group or organization that is actively involved in a project, who's affected by its outcome and who can influence its outcome.

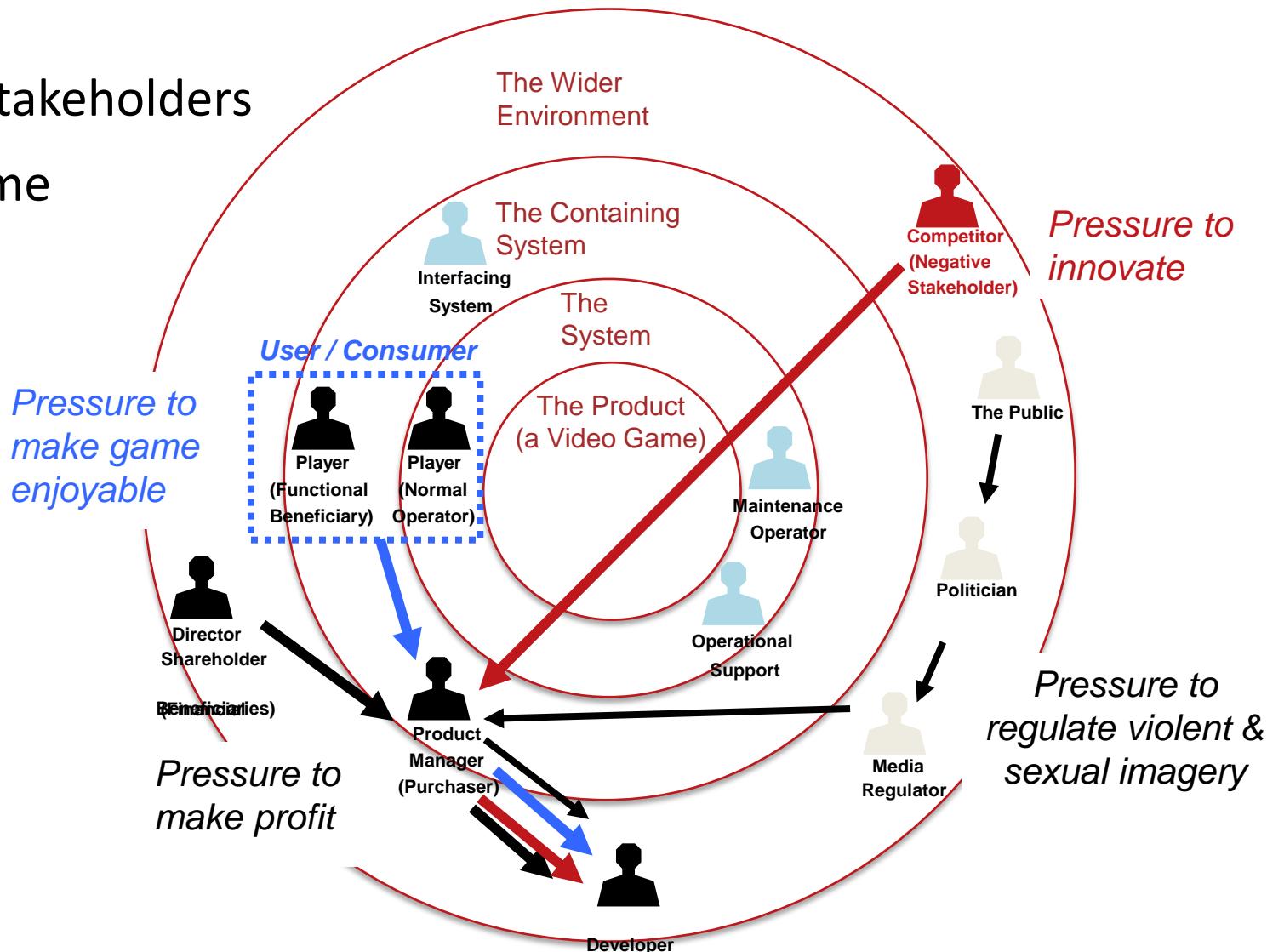


For this exercise the trainer will take the role of all stakeholders.

Stakeholders model

Influence of stakeholders

e.g. Video game



Requirement engineers

Trainees will take the role of the requirement engineers.

Developers

No developers required for the goal of this exercise.

Glossary

Global Exercise: During the whole exercise create a glossary with all terms used in this project.

Terms	Definition	Notes	Author

A speedometer face with the words "time to start!" written on it. The speedometer has a white face with black markings and a red needle. The text "time to start!" is written in red, 3D-style letters along the top edge of the speedometer face.

time to start!

GPS – Navigation device for...



Eco Locco

Profile	Economist
Gender	Male
Age	60
Occupation	Treasury Vatican City



Character

Capitalist, Intelligent, Autistic, Detailed, Extravagant,

Description

Eco is well known in the liberal social groups as a sound investor. His large experience in law helps him to ensure the safety of his investments. He is known as an extravagant person who values money the most. As the person responsible for the Vatican treasury he always seeks for the best return on investment. Without his approval nothing is bought or paid.

Activities:

Eco will ensure that:

- There is a good balance between cost and quality
- Wants to see different options and their cost in order to make a correct decision
- Does not like to spend a lot of money on maintenance
- He delivers the funds necessary for the new pope mobile and GPS system
- He will make the final decision on the maintenance budget

Pain points:

- Do not like risky investment where cost control is missing
- Better fixed price investment than time & material.

Quotes:

“Expensive does not always mean quality”

“Over budget is not a word in my dictionary”

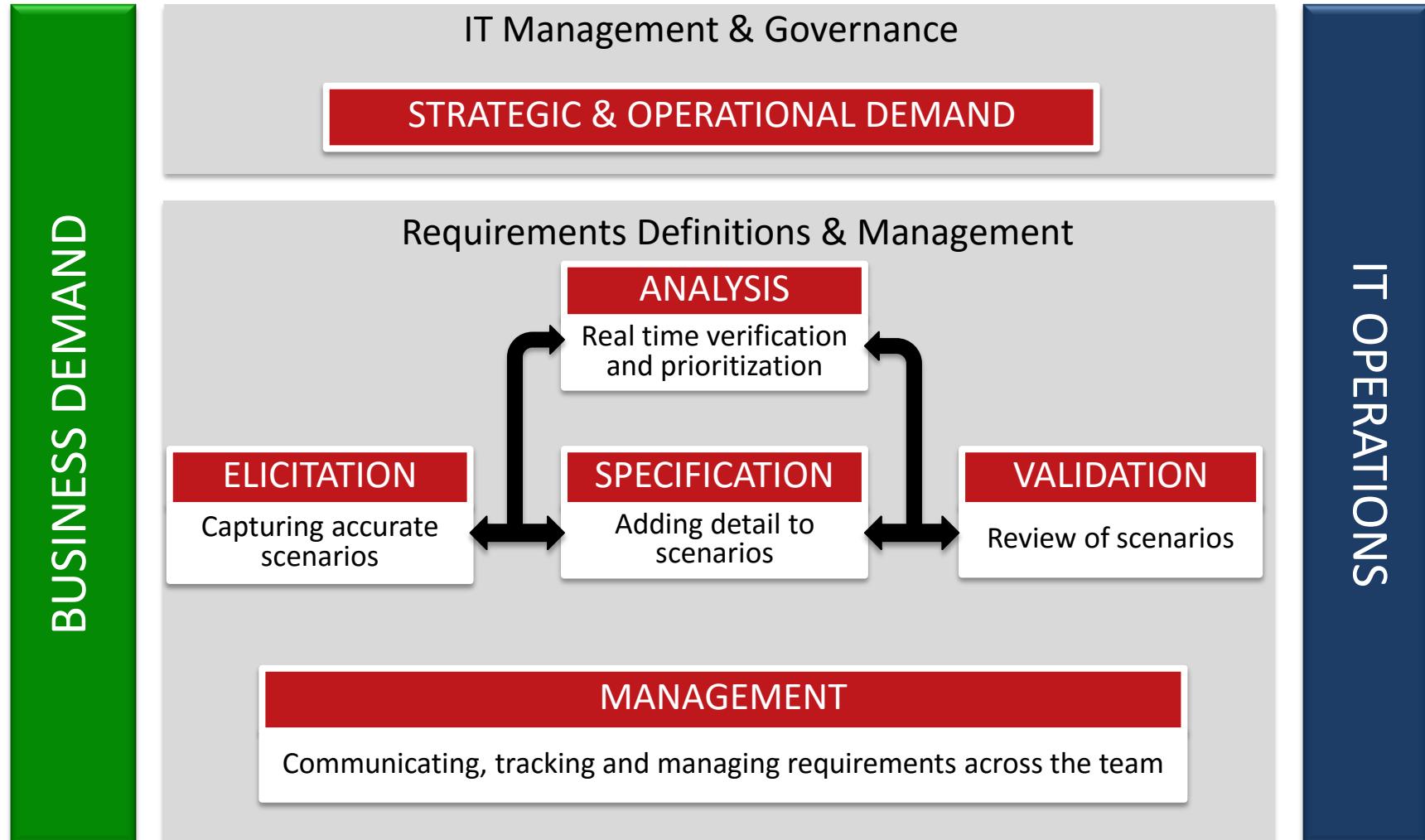
Stakeholder Exercise

Exercise :

Define the possible stakeholders and analyze them

- With whom am I going to talk?
- Who is the most important stakeholder?
- ...

Requirements engineering



Requirement elicitation

Requirements elicitation:

Requirements elicitation is the process of identifying software and/or system requirements from various sources through interviews, workshops, workflow and task analysis, document analysis and other mechanisms.

Requirement elicitation

Exercise :

Define in group which elicitation techniques you would use in real life to gather the requirements for this project.

- Define min 3 techniques
- Motivate your choice
- 15 min

Requirement elicitation

Overview requirement elicitation techniques:

- Interviews
- Questionnaires
- Brainstorming
- Paradox brainstorming
- Change of perspective
- Analogies
- Perspective based reading
- Document analysis
- Reverse engineering
- Observation of users
- Apprenticing
- Interface analysis
- Prototyping
- Elicitation workshops
- Focus groups
- Card sorting
- Mind mapping
- CRC cards

Requirement elicitation



Legend		good
		advised

		Attributes														
		Factor	Open-ended Interview	Structured interview	Task Observation	Critical incident	Card sorting	Questionnaires	Protocol Analysis	Brainstorming	Delphi technique	Participant Observation	Prototyping	Focus group	JAD workshop	Use case
Elicitor	Training in Elicitation technique															
	Elicitation Experience															
	Experience with elicitation technique															
	Familiarity with Domain															
	People per session															
	Consensus among informants															
	Informant interest															
	Expertise															
	Articulability															
Problem domain	Availability of time															
	Location/accessibility															
	Type of information to be elicited															
	Availability of information															
Process	Problem definedness															
	Project time constraint															
	Process time															

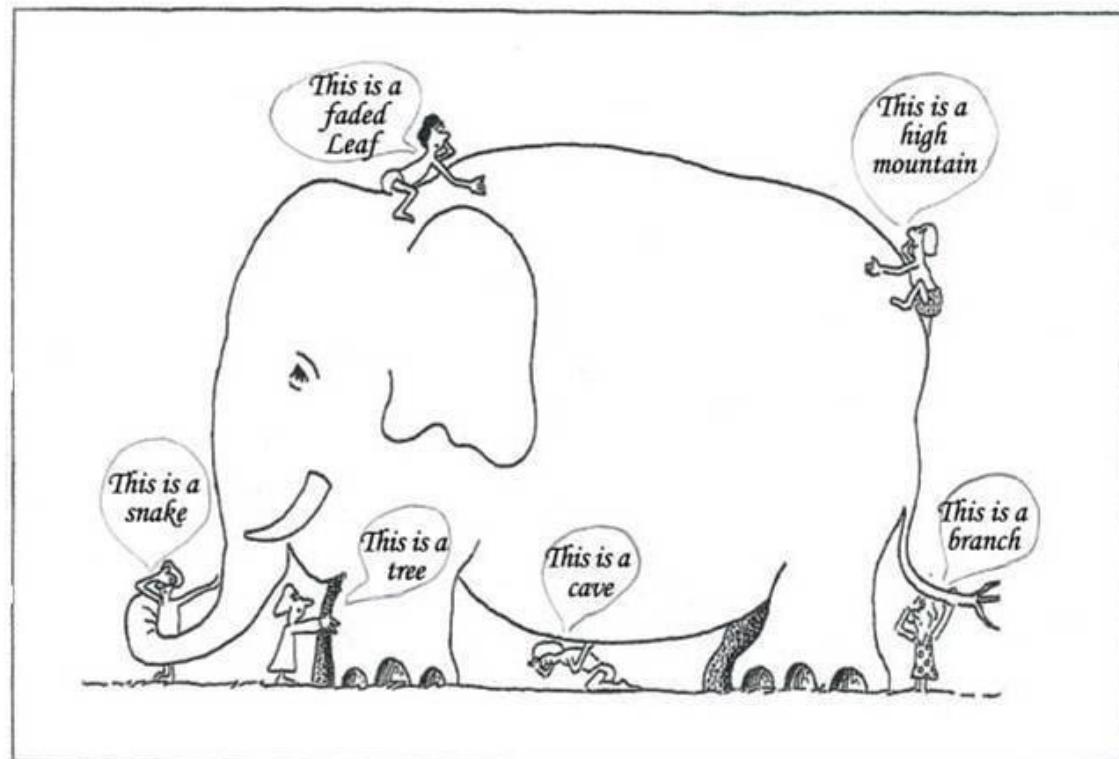
Requirement elicitation

Key Considerations when choosing a elicitation technique

- Avoid elicitation paralysis. Don't let the elicitation process eclipse project deadlines. Limit the number of techniques you choose to two or three. Any requirements that are missing after this phase can be caught when testing prototypes.
- Choose at least one face-to-face technique. Direct interaction with end users either through prototyping, interviewing, shadowing, or structured demonstrations can reveal valuable non-verbal information (e.g. reactions, difficulties, etc.) about requirements.
- Select an audience that is representative of key interest groups. Even a seemingly perfect combination of elicitation techniques can be undermined if the process ignores critical stakeholders. The elicitation techniques are of little help if key stakeholders are absent: missing stakeholders means missing requirements.

Elicitation

- Interviews
- Document analysis
- Brainstorming
- Requirements workshops
- Prototyping
- Use Cases
- *Modeling*



6 blind men describe an elephant (old indian fable)

No single view of the requirements tells us everything we need to know about them.

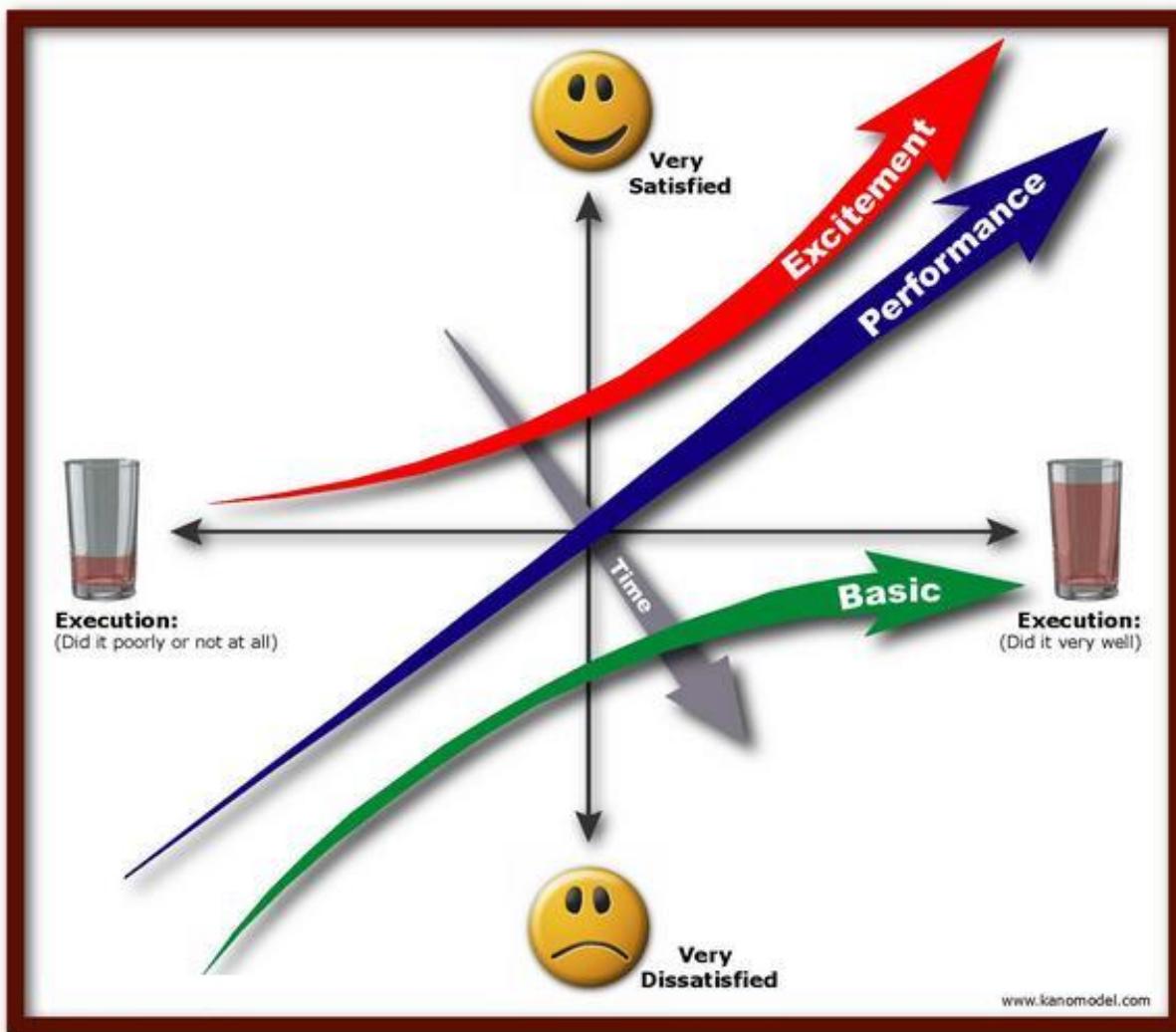
Davis (1995)

Requirement analysis

Requirements analysis:

Requirements analysis in systems engineering and software engineering, encompasses those tasks that go into determining the needs or conditions to meet for a new or altered product, taking account of the possibly conflicting requirements of the various stakeholders, such as beneficiaries or users.

Analyzing requirements



The Kano Model

Use modeling to cope with complex situations and to analyze



3 Modeling views

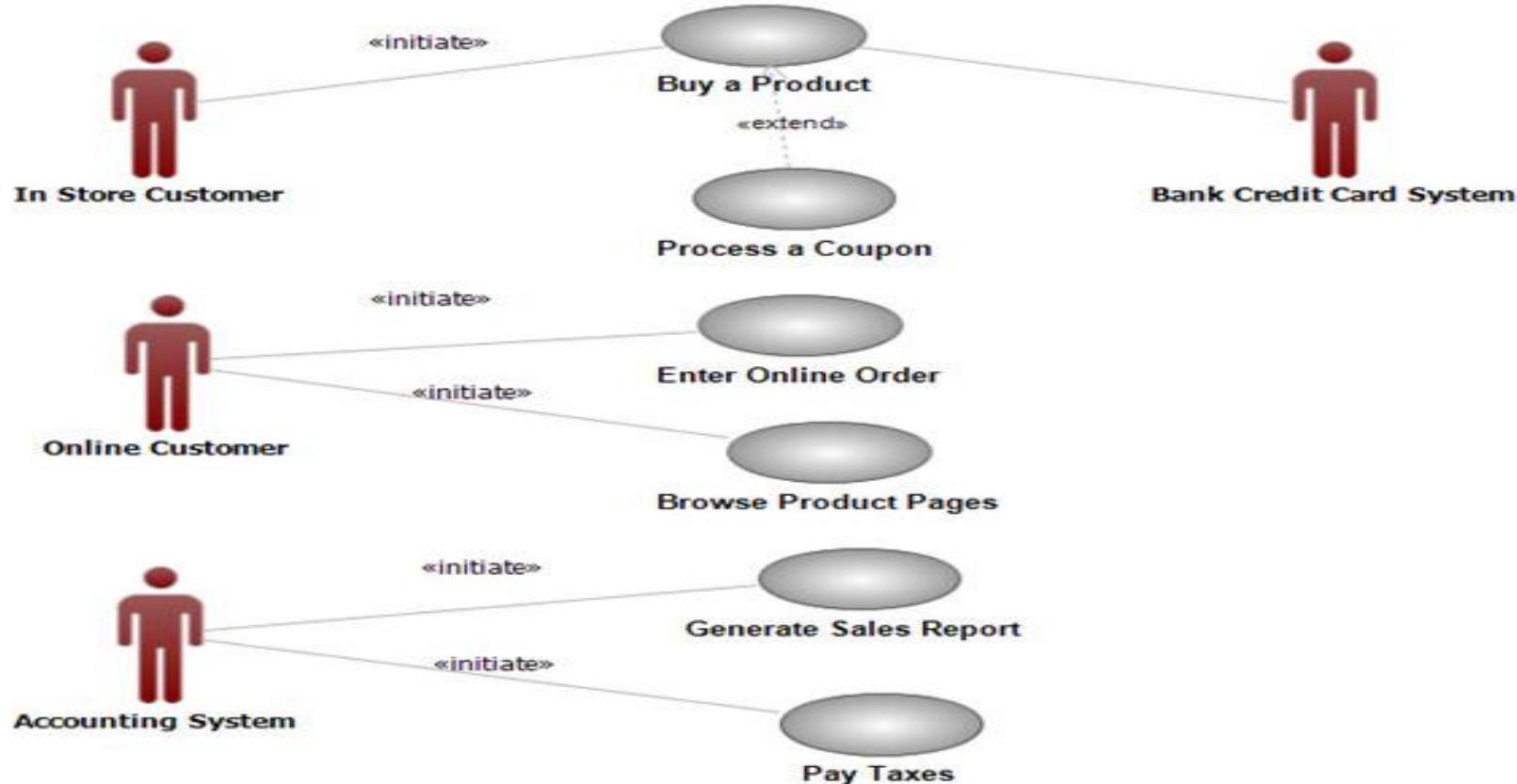
- Structural view: describes structure
 - Entity relationship diagrams
 - Class diagrams
 - Deployment diagrams (out of scope syllabus)
 - Object diagrams (out of scope syllabus)
- Functional view: describes functions, relation between in – output
 - Data flow diagram
 - Activity diagram

3 Modeling views

- Behavioral view: describes behavior, no focus on results
 - Activity diagrams
 - Interaction diagrams (sequence diagram, communication diagrams, timing diagrams)
 - Use Case Diagrams
 - State machine diagrams

Main UC techniques

- Model: Use Case Diagram



Use Case Diagram for a retail system

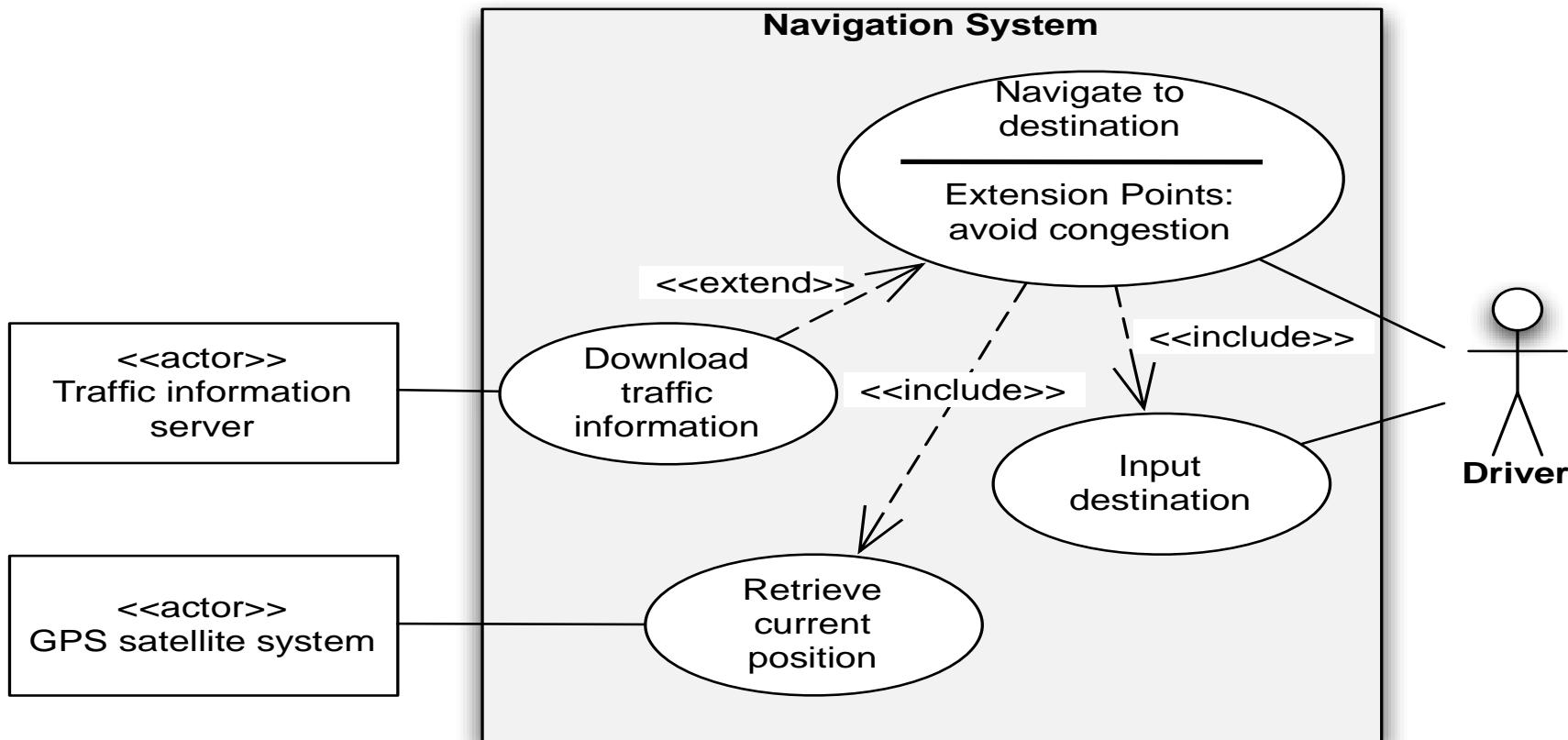
Exercise

- Create a System Context Diagram / Model by means of the use case diagram technique



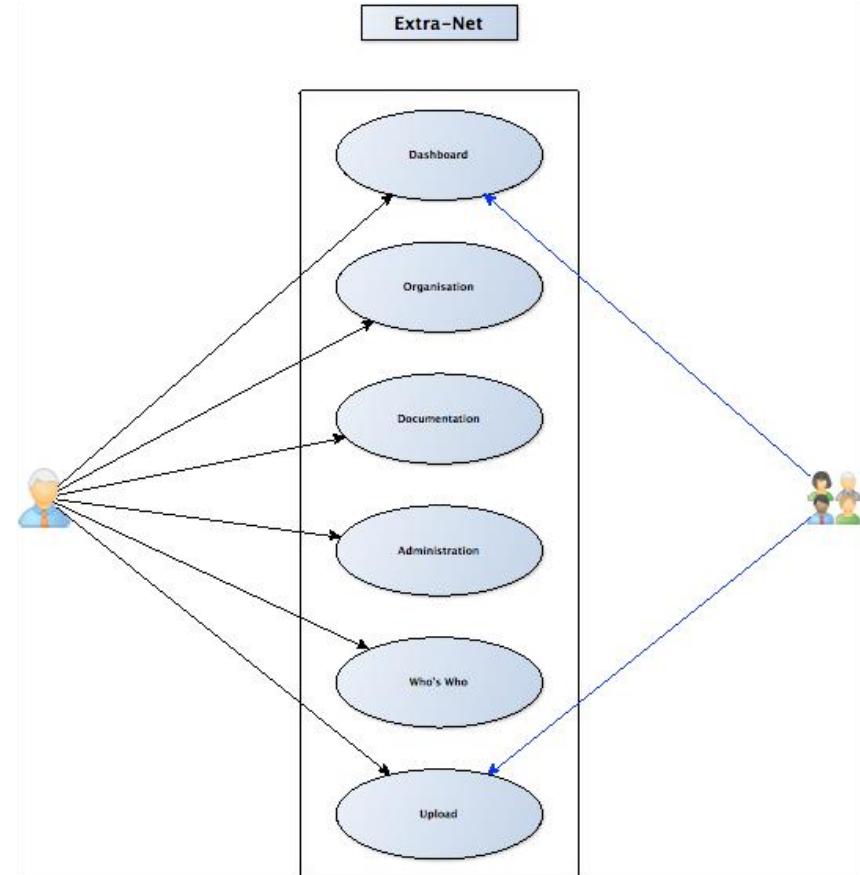
GPS: Use Case Model

Example solution



Requirement Validation Questions

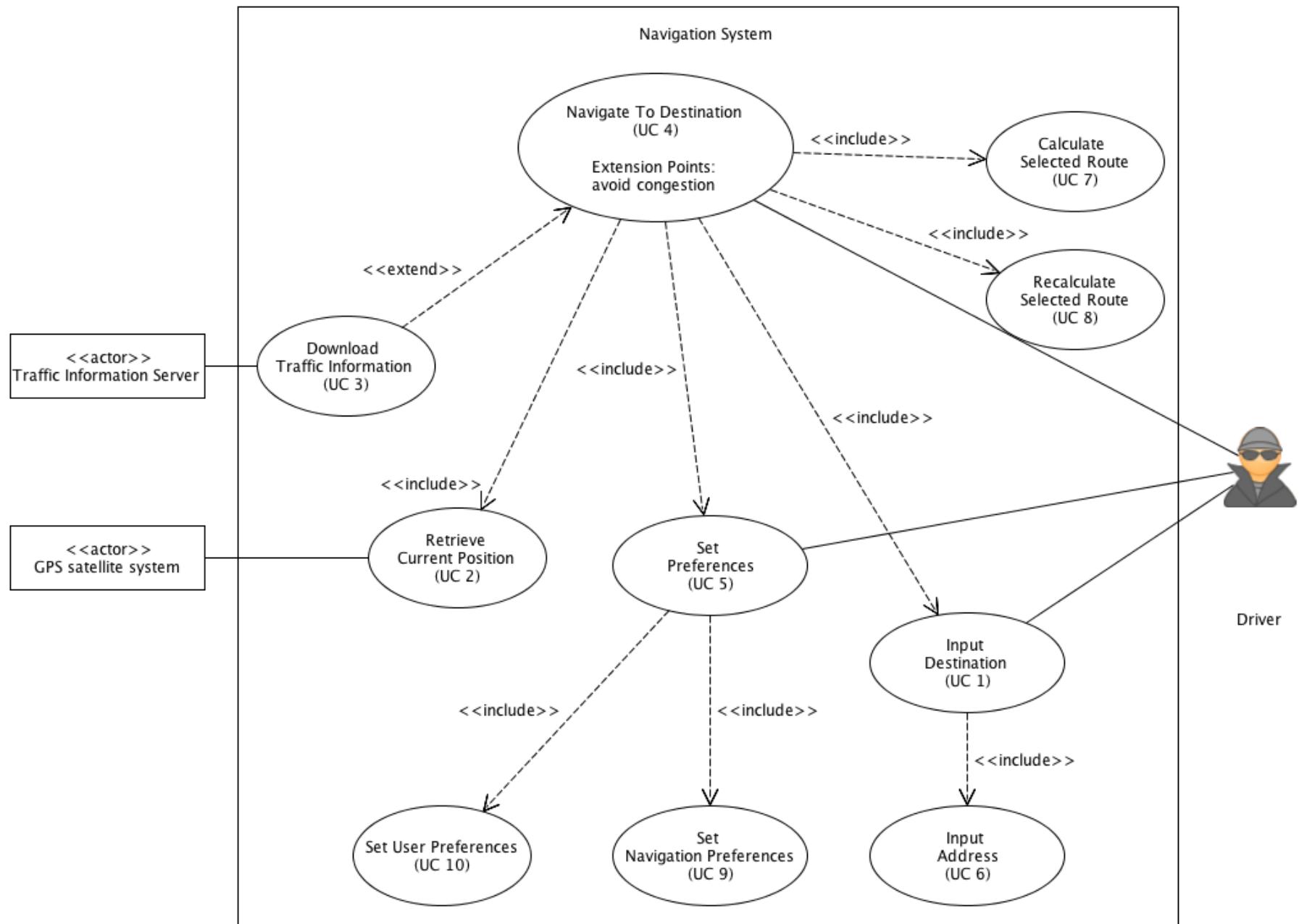
- Can we understand the Use Case Model?
- Can we form a clear idea of the system's over-all functionality?
- Can we see the relationship among the functions that the system needs to perform?
- Did we address all functional requirements?
- Does the use case model contain inconsistent behavior?
- Can the use case model be divided into use case packages? Are they divided appropriately?



Exercise



- Created a Level 2 detailed Use Case Model based on the first Level Model



Requirement Specification

Exercise :

Write one use case for a requirement of your choice using the provided template.

Requirement Specification

Elements of a Use case specification:

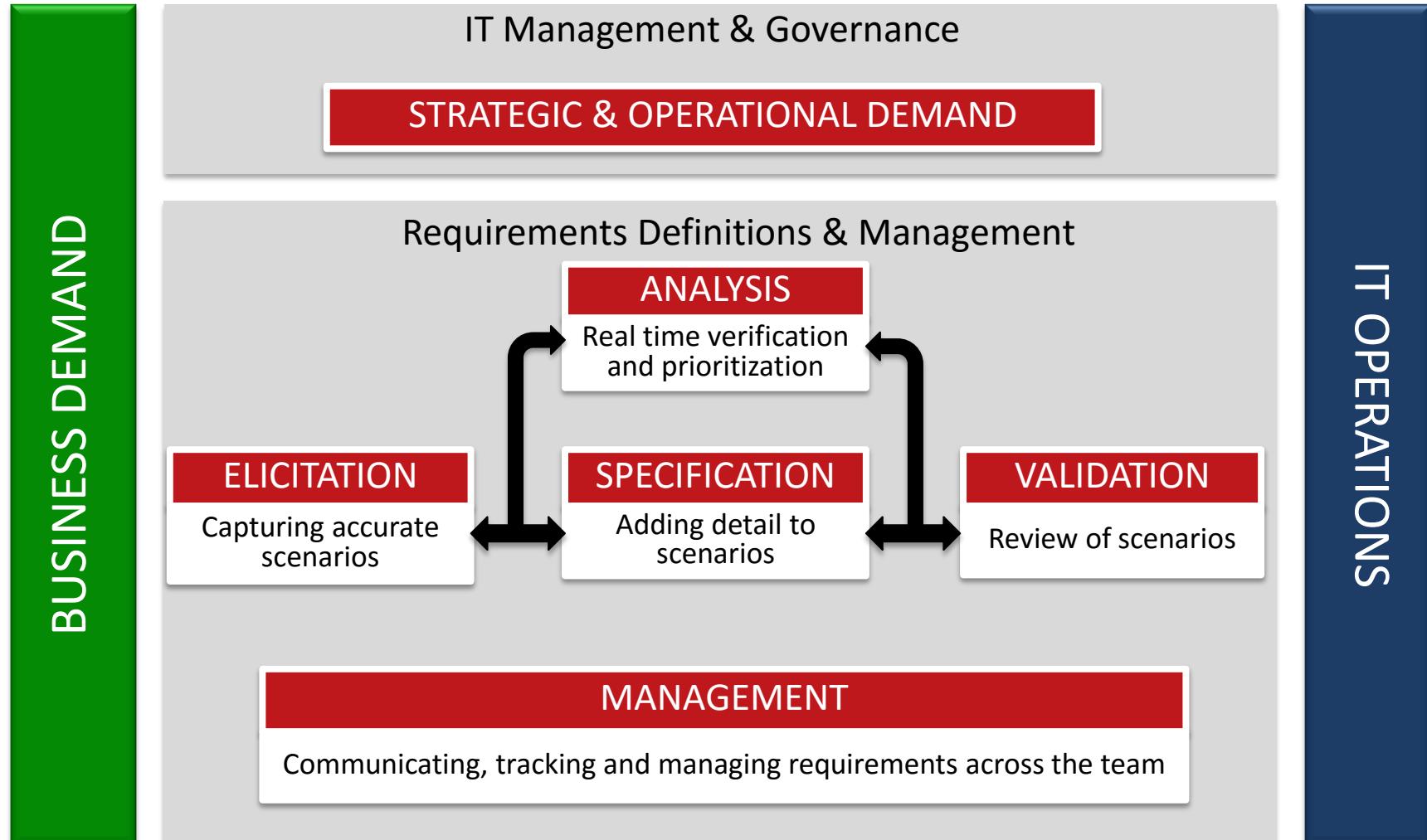
- Unique ID
- Name of the Use case
- Description of the Use case
- Triggering event
- Actors
- Result: beginning situation – end situation
- Pre-post conditions
- Different kind of scenarios (specify required behavior)
- Scenarios: Sequential steps.
 - Main scenario
 - Alternative scenarios
 - Exception scenarios
- Notes

Requirement Validation Checklist

- Is this use case in scope?
- Is this use case testable?
- Do the initiating actors exist on our context diagram?
- Can we clearly see who wishes to perform a use case?
- Is the purpose of the use case also clear?
- Is the use case description properly and clearly defined? Can we understand it? Does it encapsulate what the use case is supposed to do?
- Is it clear when the flow of events starts? When it ends?
- Is it clear how the flow of events starts? How it ends?
- Can we clearly understand the actor interactions and exchanges of information?



Requirements engineering



Requirement specification

Requirements specification:

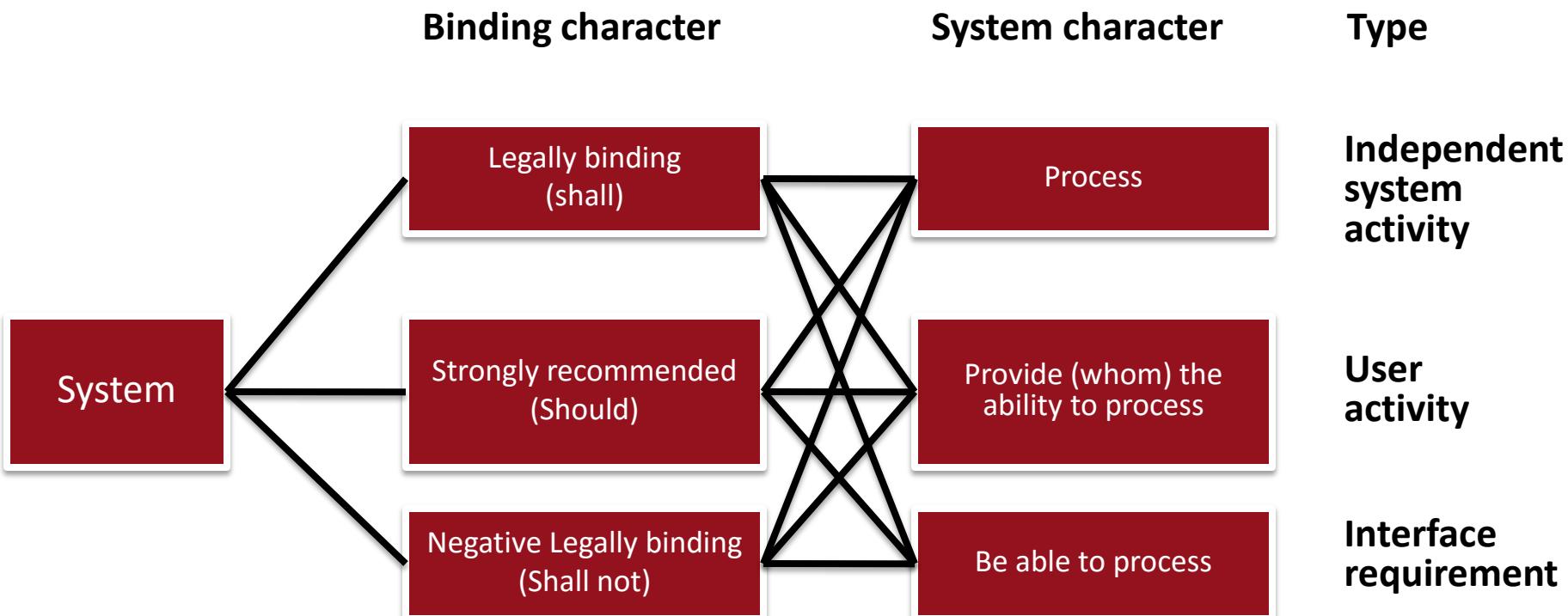
The process of describing a system's requirements in a structured, shareable, and manageable form. Also, the product from this process (see software requirements specification).

Five most important guidelines

- Short and concise sentences and paragraphs
- One requirement per sentence (no “and”), no nesting, active voice
- Consistent terminology
- Avoid generalizations (do not use “all” with an unclear reference, etc.), clear references
- Use “must”, “can” and similar words carefully.

Use a template (step 1)

Three requirements templates possible



Use a template (step 2)

Example: print job - option

- 1 Legally binding
- 2 Strongly recommended
- 3 Used in the future

and

- 1 Print is independent system activity
- 2 Print is user option

Suppose print is legally binding and is a user option

 *The system shall provide the administrator the ability to print.*

Use a template (step 3)

Include objects to be manipulated

- Further elements are necessary to complete the characterization of the process.
- Objects and implementations are always behind the core (verb) of a requirement.

e.g.  The system shall provide the administrator the ability to print *the error message to the network printer.*

Use a template (step 4)

Include logical and temporal conditions

- Functionality is only given or provided under certain logical or temporal conditions.
- Constraints are always located at the beginning of a requirement.

e.g.  *If an error message has been generated, the system shall provide the administrator the ability to print the error message to the network printer.*

What's wrong?

Exercise:

1. The system shall validate and accept credit cards and cashier's checks. High priority.

Problem: two requirements instead of one.

If the credit card processing works, but the cashier's check validation does not... is this requirement pass or fail? Has to be fail, but that is misleading.

- 👉 The system shall validate and accept credit cards.
- 👉 The system shall validate and accept cashier's checks.

What's wrong?

Exercise:

2. The system shall process all mouse clicks very fast to ensure user's do not have to wait.

Problem: This is not testable. Quantify how fast is acceptable?

What's wrong?

3. The application must be extremely stable with numerous users logged in simultaneously. Speed must not be sacrificed.

Problem: The words extremely and numerous are open to broad interpretation -- so this requirement is ambiguous

- ☞ Mean time between system failures shall be no greater than once per week.
- ☞ When doing queries against the database at the same time, the system shall support 1,000 simultaneous users, without crashing or losing data.
- ☞ With up to 1,000 simultaneous users, the average response time of the system shall be less than one second.



E.A.R.S.

- The<stakeholder type>shall be able to<capability>
- The<system>shall<function> not less than<quantity><object> while<operational condition>
- The<system>shall<function><object> every<performance><units>

It's a good practice to standardize the language used for requirements

Problem (granularity)

- The user must have the ability to enter an address

Requirements	Linked
Navigation System	
Input Destination	
The user must have the ability to enter an address	UC 6

.....
Input Address
.....

.....
The system must provide the ability to select a country
.....

.....
The system must provide the ability to select a postal code or a city
.....

.....
The system must provide the ability to select a streetname
.....

.....
The system must provide the ability to select a housenumber
.....

Requirement Specification

Exercise:

Write the requirements using natural language in the provided template.

Define at least 3 non-functional requirements.

Requirement Specification

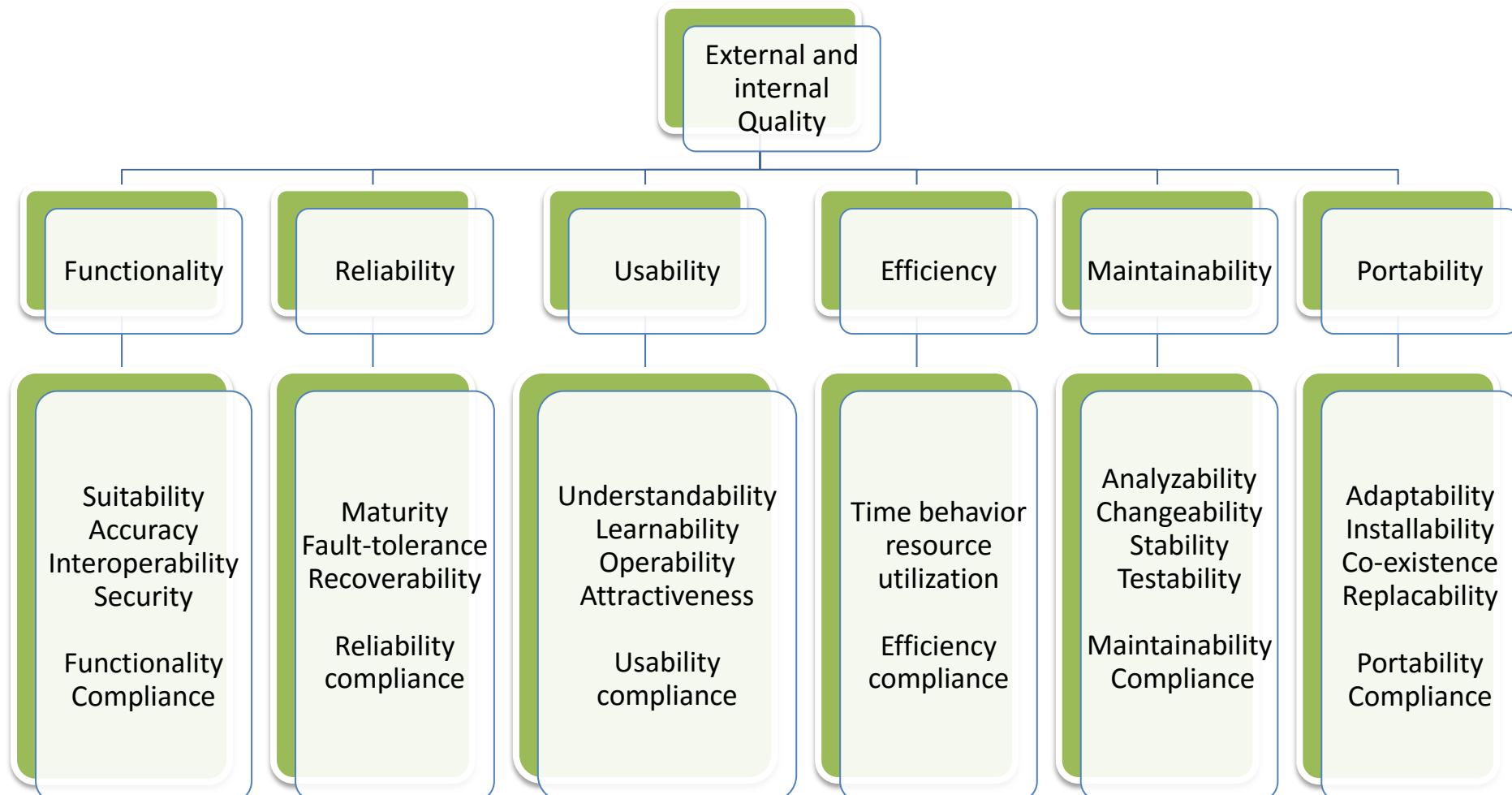
Exercise:

Requirements Tree						
ID	Priority	Requirements	Linked UC	Acceptance criteria	Rationale	
			-			

Define for each requirement

- ID
- Priority
- Requirement description
- Linked UC
- Acceptance criteria
- Rationale

Thinking tool quality attributes

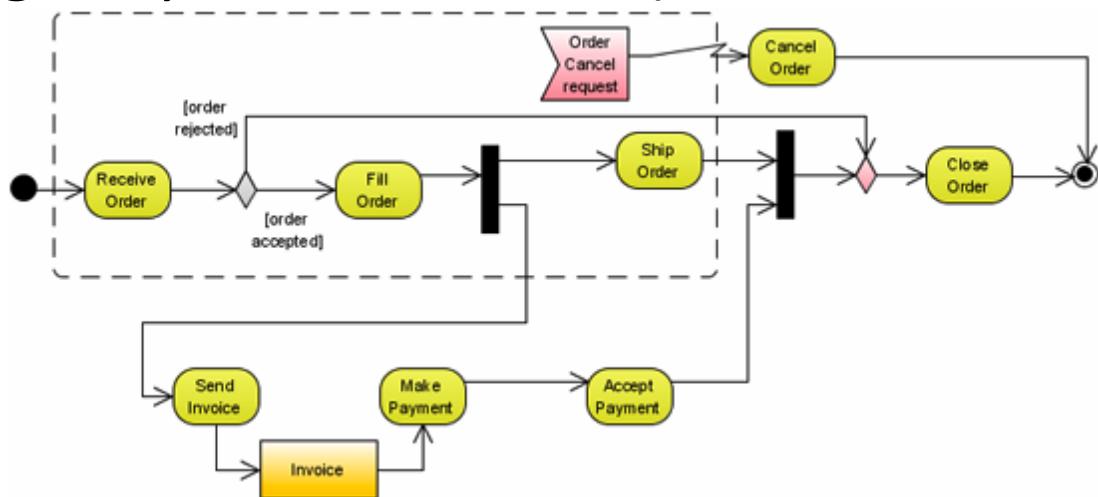


(Ref. ISO – 9126)

Requirement Specification

Exercise:

Create an activity diagram for one of your defined requirements. (e.g. “input destination”)



Totally non-related example

Requirement Specification

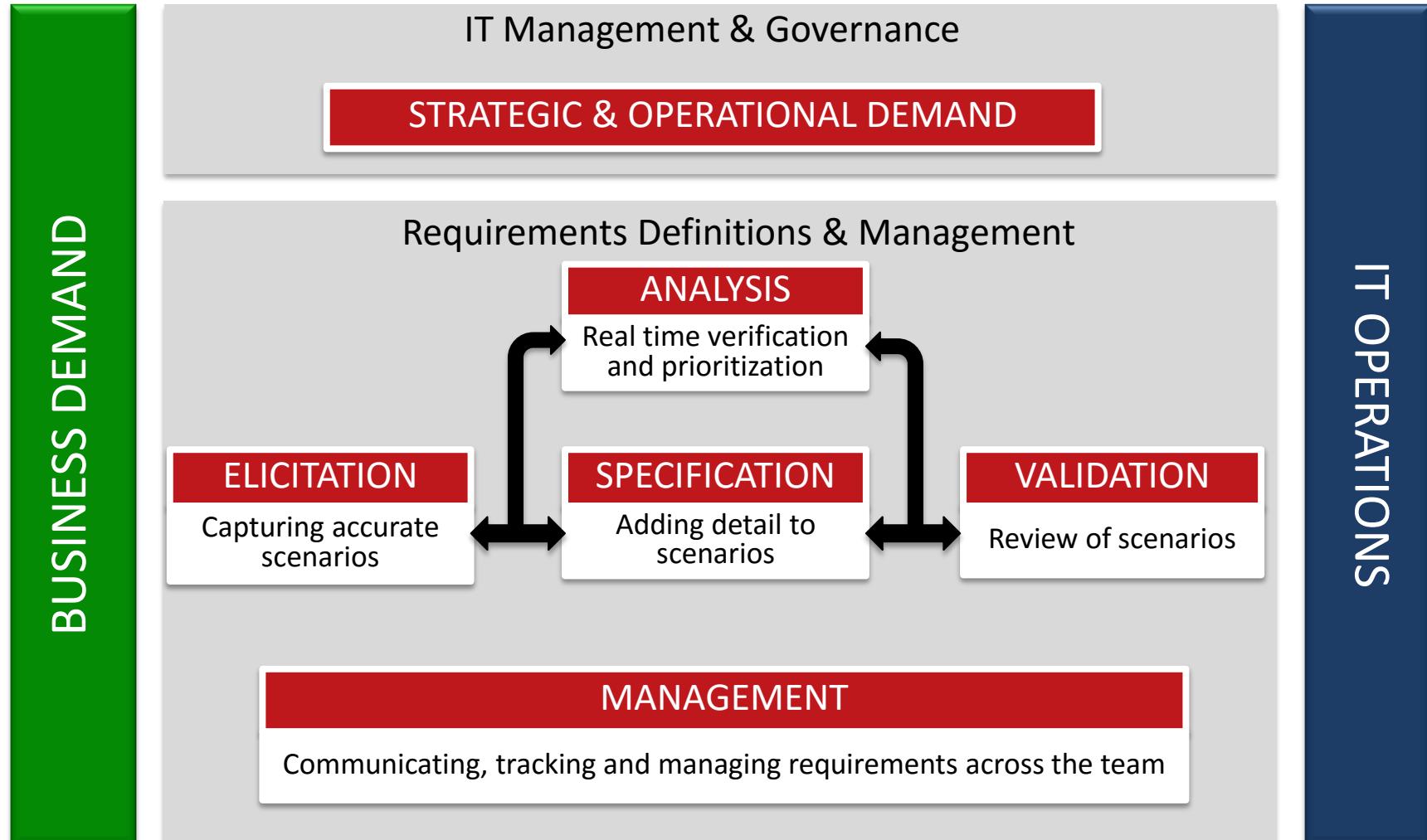
Validation

Flowcharting Operations Implies the Need to Simplify. A good rule of thumb is that if an operation is so complex you need to develop a UML Activity diagram to understand it that you should consider refactoring it.

- Less is more: don't make large diagrams
- No crossings: try to avoid that lines cross
- Work orthogonally : the use of vertical and horizontal lines increases the readability of your diagram
- Parents up: When drawing generalization or realization hierarchies on a diagram always make sure the parent elements are higher than the child elements so the arrows always point upwards.



Requirements engineering



Requirement management

Requirements management:

The process of working with a defined set of product requirements throughout the product's development process and its operational life. Includes tracking requirements status, managing changes to requirements and versions of requirements specifications, and tracing individual requirements to other project phases and work products.

Requirement Management

Change request

Business would like to change requirements:





Problem (why are you asking?)

- False

Positive



Negative



Requirement Management

Exercise:

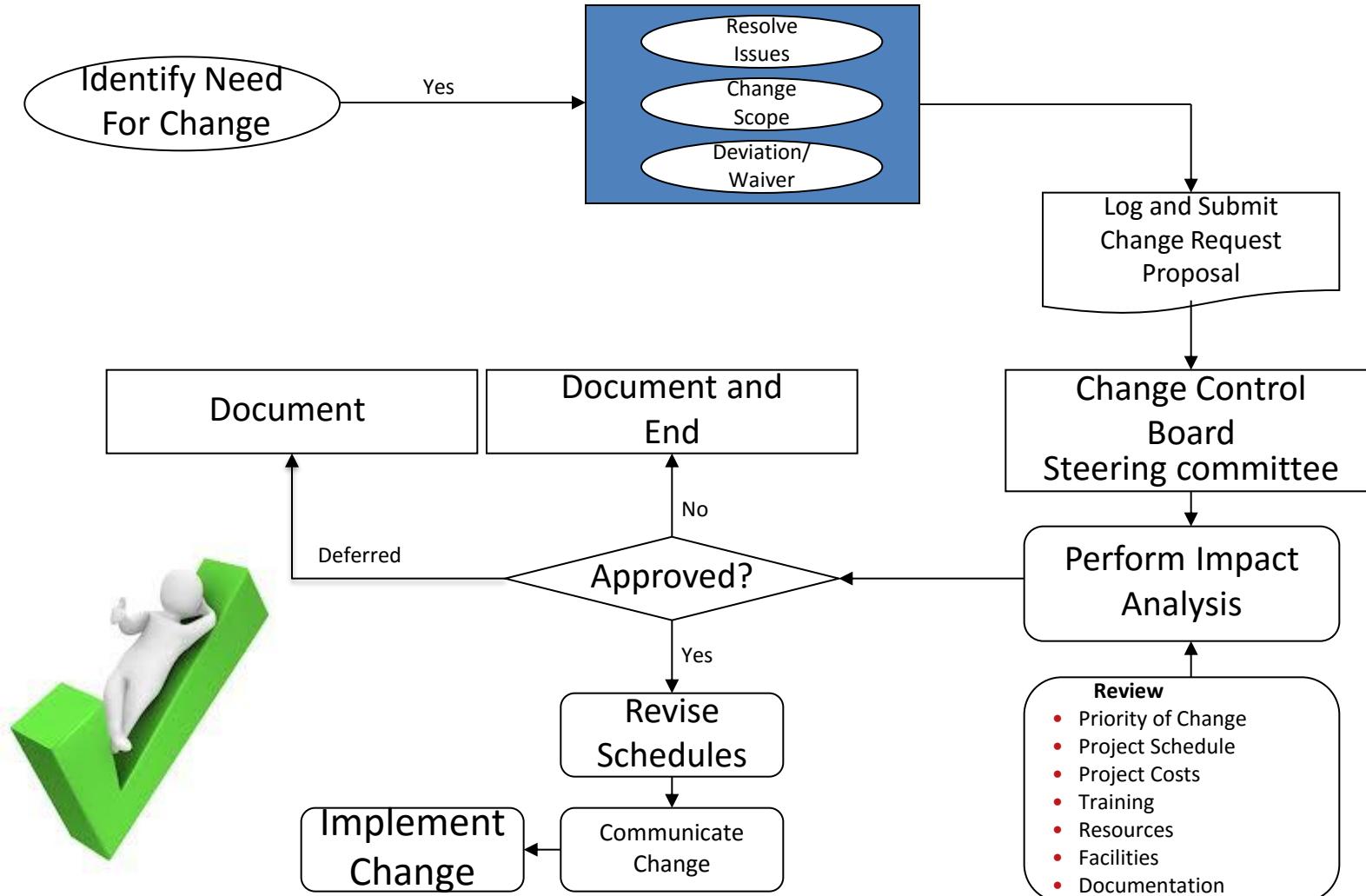
Brainstorm in your group how you will deal with this change request.

Define the actions you will take.

Problem (how will you validate?)



Requirement management



Requirement pitfalls

Exercise :

Evaluate with your group if you fell into one of the following pitfalls. Describe how you could have avoided this.

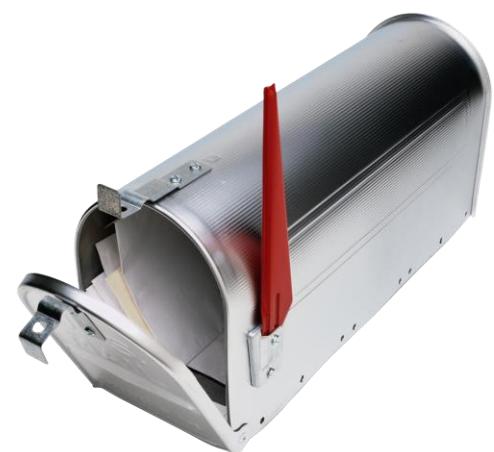
- Insufficient User Involvement
- Creeping User requirements
- Ambiguous requirements
- Goldplating
- Minimal specification
- Overlooked scenarios
- Inaccurate planning
- Requirements leakage

Contact

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Introduction

Exercise Company information

We are a company of about 100 co-workers. Most of the co-workers work on a project basis and are not stationed in the office premises. To improve the communication and share information with our co-workers we would like to create an extranet. With the extranet we want to share calendar appointments and documents, assign and manage tasks, sent invites for events and enable efficient communication – all accessible from anywhere in the world where there is an internet connection.

Introduction

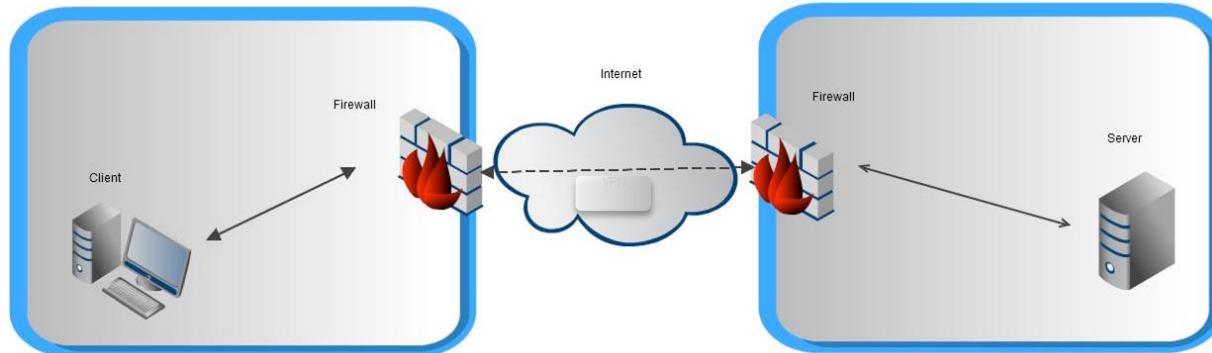
Rationale

The extranet will help the company to structure our organization in a way to become more efficient, flexible and responsive to employee demands.

Introduction

Extranet

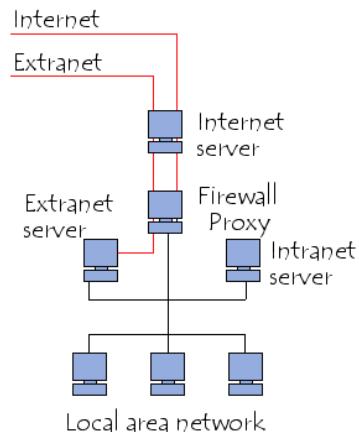
- a computer network that allows controlled access from the outside, for specific business or educational purposes
- extension of an organization's intranet that is extended to users outside the organization



Introduction

Extranet

- a computer network that allows controlled access from the outside, for specific business or educational purposes
- extension of an organization's intranet that is extended to users outside the organization



Introduction

Examples



The screenshot shows the homepage of the globalcorp | Extranet. The title bar reads "Microsoft Internet Explorer" and the address bar shows "http://www.intranetdashboard.com". The main header features the "globalcorp | Extranet" logo. The top navigation menu includes links for Home, Our Company, My Job & Career, Coffee Break, Office Admin, Knowledge Center, and Team Work. A search bar at the top right allows users to "Search for Staff" or "Search the Intranet". On the left, a "Site Navigation" sidebar lists Home, Our Company, My Job & Career, Coffee Break, Office Admin, Knowledge Centre, and Team Work. Below this is an "Internal Links" section with links to Company Wellness, Timesheets, Corporate Styleguide, Resources Folder, and Company Wellness. A "Sports Tipping" link is also present. The central content area features a large banner titled "Employee Network" with a green and blue background. Below it, a "Featured News" section discusses Globalcorp's steps towards a "Green Business", mentioning plans for electric vehicles, reduced air travel, and recycling. It also highlights incentives for employees to use greener transport methods. Other news items include "Book Annual Leave" and "Document Manager". The "Company News" section announces a profit announcement, stating that Globalcorp's revenues grew by more than 4% and net profit by 10%. A footer note mentions the introduction of the new intranet. The right sidebar contains sections for "Current Weather" (51°F - Showers, San Francisco) and "Clever Tools" (Brand Manager, Project Space, Meeting Room Booking, Forum, Sports Tipping, Acronym Manager, FAQ). A "More Clever Tools" dropdown is also available. The bottom right corner shows the Internet Explorer status bar with "100%".

Introduction

Examples

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

ABOUT NREL ENERGY ANALYSIS SCIENCE & TECHNOLOGY TECHNOLOGY TRANSFER APPLYING TECHNOLOGIES NREL HOME

Executive Energy Leadership Program



Welcome to the NREL Executive Energy Leadership Program (Energy Execs) information page. This site is exclusively for Executive Energy Leadership Program participants.

Here you will find information about:

- Upcoming class [agendas](#)
- Program information and [class materials](#)
- Participants' [contact information and bios](#)

If you have any questions or need more information, please contact [Janice Rooney](#).

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Introduction

High Level requirements from the stakeholders:

- We want an extranet to communicate with our employees
- The extranet should contain following items
 - Dashboard (single view with to do actions)
 - Company information (documentation, calendar, who's who, project overview, ...)
 - Company activities and queries (calendar, booking of trainings, subscription to events, ...)
 - Company communication (Did you know, upcoming events, ...)

Introduction

High Level requirements from the stakeholders:

- Access should be limited to co-workers
- Data can be made read-only or read-write
- Platform independent but secure access
- Supported platforms: Mac and PC
- Budget: 25 K
- Extranet hosting outside the existing network
- No (internal) sensitive data may be accessible
- ...

Requirement Management

Change request

Business would like to change following requirement:

We want an extranet to communicate with our employees

New requirement:

We want an extranet to communicate with our employees
and with selected customers