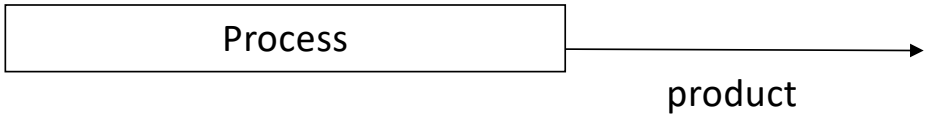
Requirement Engineering

Version 2.0

Requirement Engineering

- Requirement engineering is about defining the product properties before starting development



Requirements

Properties

Without RE

- Product properties are unclear
- Testing is not feasible

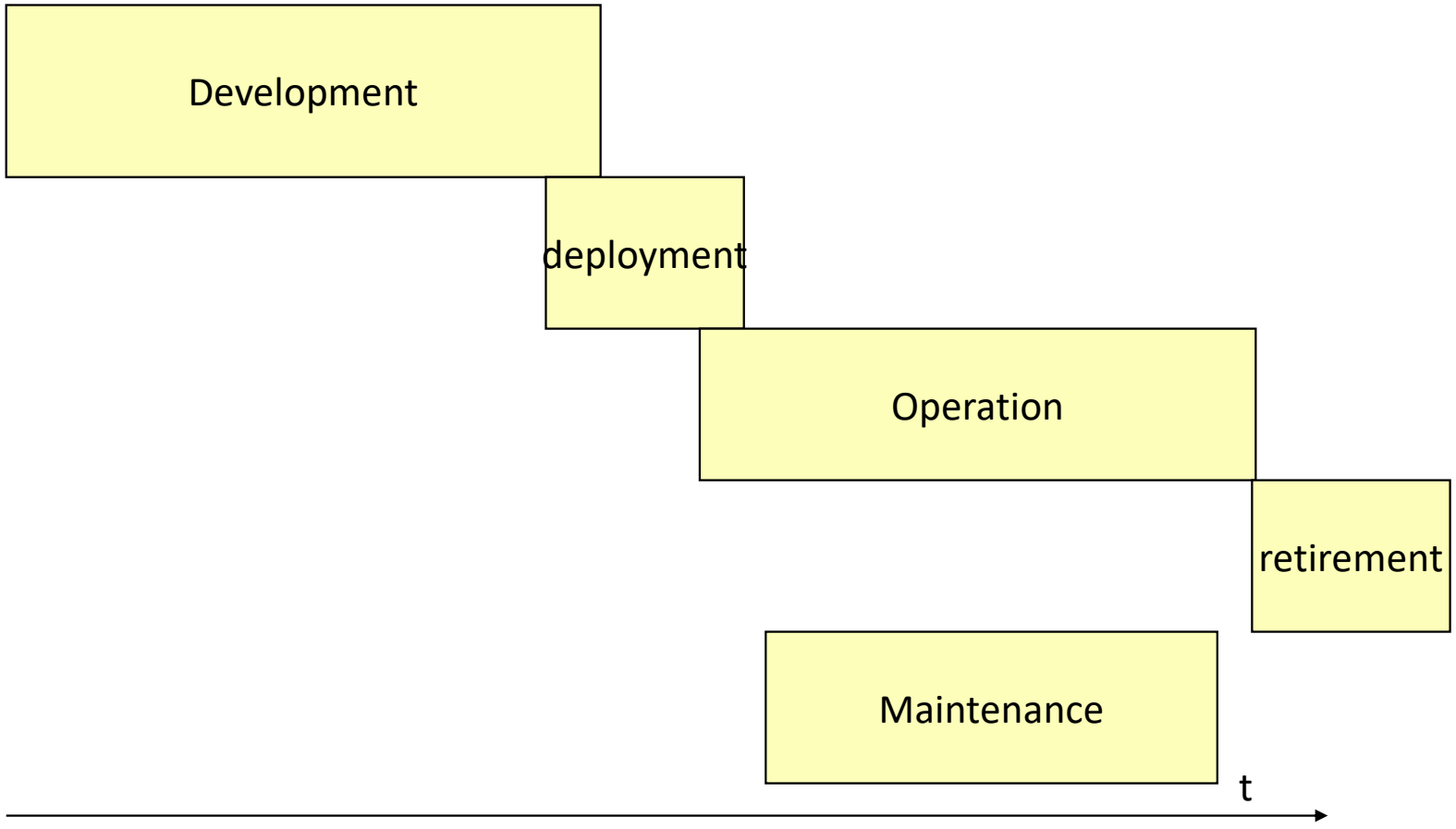
Product properties

- Functional
  - what should the program do
- Non-functional
  - Modalities applied to functions offered
  - Reliability
  - Usability
  - Performance
  - Maintainability
  - Security
  - …

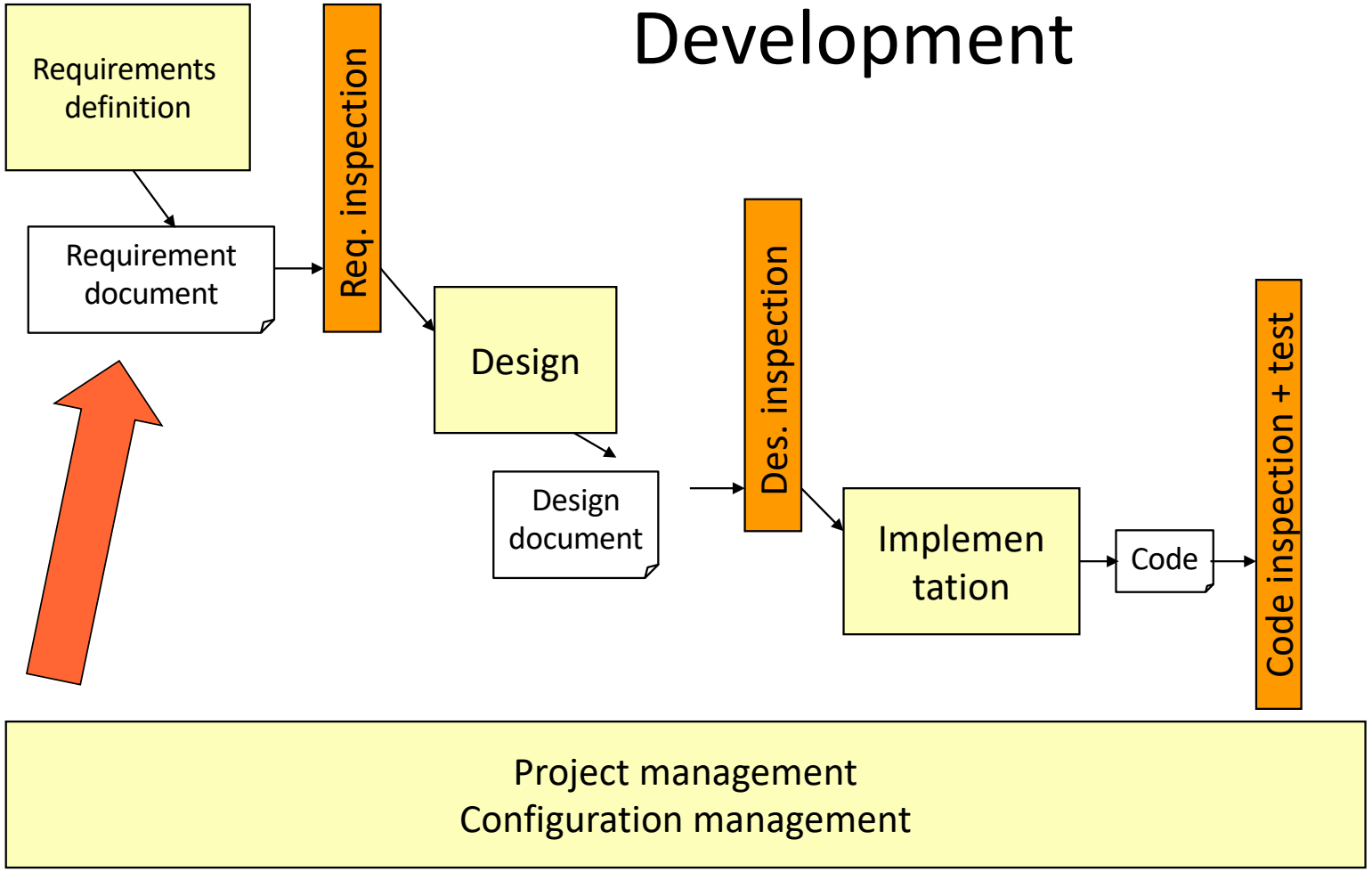
Outline

- Concepts and definitions
- Techniques for formalization
- Techniques for elicitation
- Techniques for V and V

Main Phases

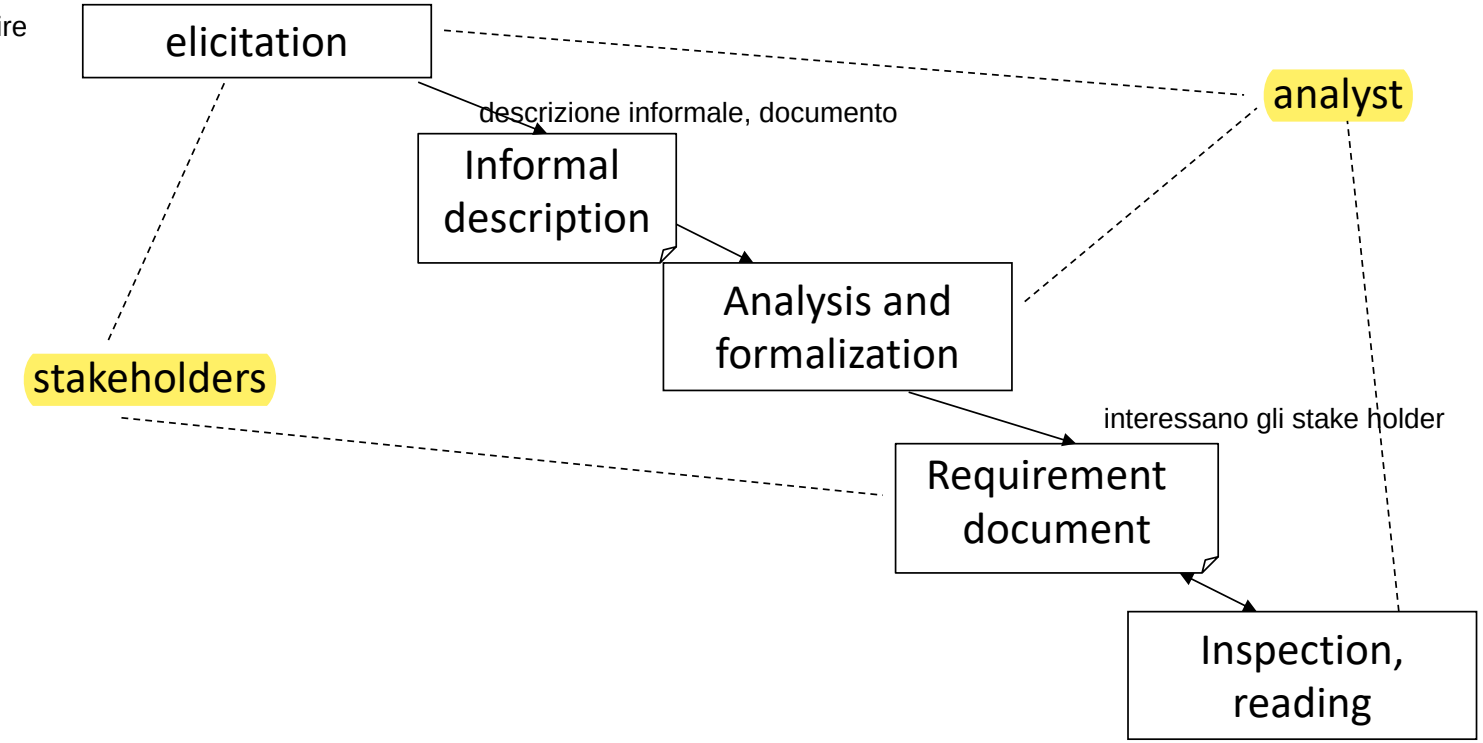


Development



Requirement engineering

parli coi utenti e cerchi di capire gli obbiettivi



Requirement

- Description of product property
  - Functional – not functional
- The final product may, or may not, have properties that match the requirements

Da qualcosa di astratto -> arrivo con qualcosa di formale e preciso

Requirements

Properties

Requirements vs. properties

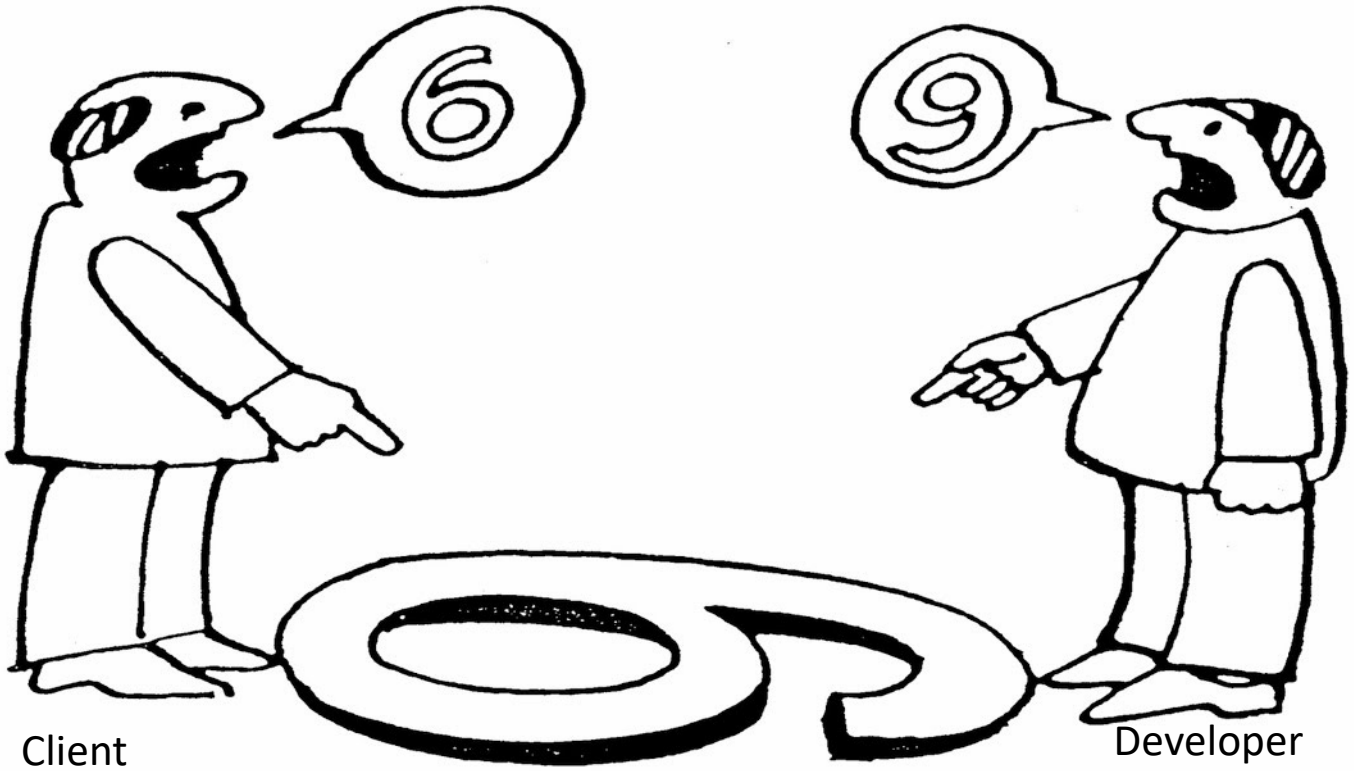
Requirements are requests, that may or may not become properties of the product

- Ex.
- Requirement: response time of all functions <0,5 sec
- Property: response time of functions between 2secs and 10 secs

alla pratica: quello che era la richiesta iniziale non era stata impossibile implementarla, quindi vaffeculè

Starting point

- Usually an informal description by a client or a potential user to the developer



Requirements - informal

terminale di pagamento

- A POS (Point-Of-Sale) system is a computer system typically used to manage the sales in retail stores. It includes hardware components such as a computer, a bar code scanner, a printer and also software to manage the operation of the store.
- The most basic function of a POS system is to handle sales.

stampare scontrini

Requirements - informal

- Problems arise when requirements are not precisely stated.
- Ambiguous requirements may be interpreted in different ways by developers and users.
  - ‘manage sales’ and ‘handle sales’ do mean the same thing?
  - What is a sale? Exchange of items? Payment?

Completeness and consistency

- In principle, requirements should be both complete and consistent.
  - Complete
    - They should include descriptions of all features required.
  - Consistent
    - There should be no conflicts or contradictions in the descriptions of the system features.
  - In practice, it is quite utopistic to produce a complete and consistent requirements document.

Requirements - defects

- Omission/ incompleteness omettere i dettagli incompleto
- Incorrect Fact non corretto (errore)
- Inconsistency/contradiction contradditzioni
- Ambiguity ambiguo
- Extraneous Information
  - Overspecification (design)
- Redundancy rindondnande

Requirements - defects

- Omission/ incompleteness
  - Log of daily sales should be made and kept for 5 years (omitted)
- Incorrect Fact
  - Sales are subject to 22% VAT (page 3 of document)
    - No, VAT depends on item, 10% for some, 22% for others
- Inconsistency/contradiction
  - Sales are subject to 21% VAT (page 10 of document)
- Ambiguity
  - ‘handle sales’ and ‘manage sales’ are same thing or not?
- Extraneous Information
  - The sales should be stored using a hash table
- Redundancy
  - Sales are subject to 22% VAT (page 3 of document)
  - Sales are subject to 21% VAT (page 10 of document)

Techniques - formalization

- Stakeholders
- Personas, stories
- Context diagram and interfaces
- Requirements, F, NF
- Scenarios, sequence diagrams
- Use cases
- Glossary

Stakeholder

- Basic idea: ask the client an (informal) description of the product to build
- Who exactly is the ‘client’?

Stakeholder

- Role person company or system that is directly or indirectly involved in the project and who may affect or get affected by the outcome of the project
- User
  - Uses the application
  - Can include different user profiles
- Buyer/commissioner
  - Pays for the application
- Administrator
- Analyst
  - Expert in requirement engineering and or in the domain
- Developer

Stakeholders - example

- Point Of Sale (POS) in a supermarket
- User
  - Cashier at POS (profile 1)
  - Supervisor, inspector (profile 2)
  - Customer at POS (indirectly through cashier)
- Administrator
  - POS application administrator (profile 3)
  - IT administrator (profile 4)
    - Manages all applications in the supermarket
  - Security manager (profile 5)
    - Responsible for security issues
  - DB administrator (profile 6)
    - Manages DBMSs on which applications are based
- Buyer
  - CEO and/or CTO or CIO of supermarket

Stakeholders

- Listing the relevant stakeholders is essential to consider relevant points of view (and therefore relevant requirements) for an application

Stories and personas

- A technique to informally define what the application should do
- Best suited for mass market applications where ‘end user’ has little meaning

- AKA profiling / segmentation in marketing, adapted to software products

Profiling / segmentation

- Characterize people under a number of dimensions, to better define and sell targeted products / services

Demographic profile

- Age
- Gender
- Ethnicity
- Income
- Level of education
- Religion
- Profession/role in a company

Psychographic profile

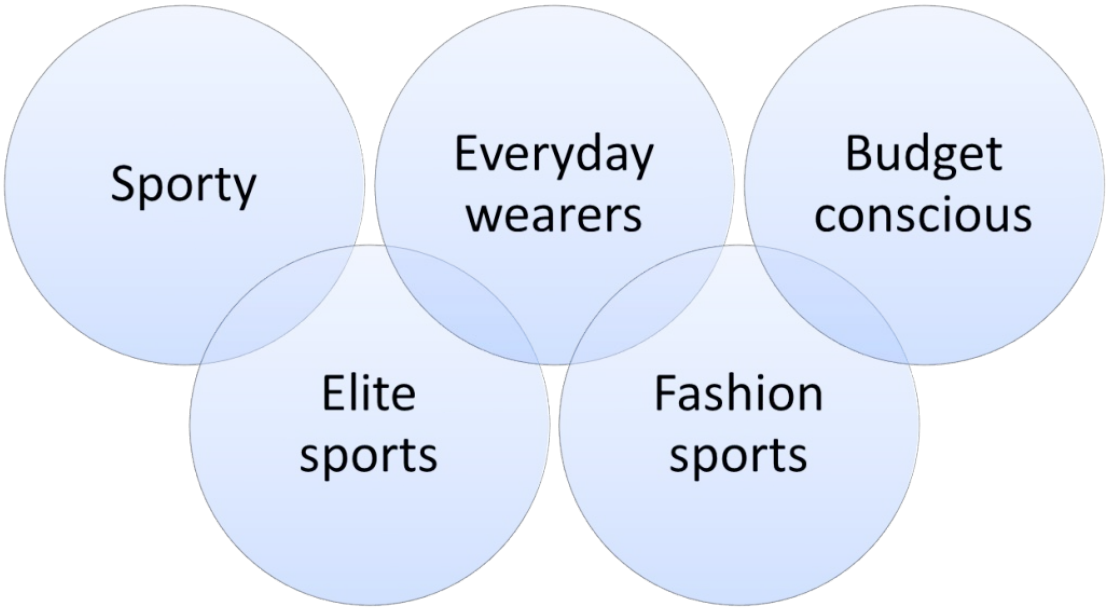
- Personality traits
- Hobbies
- Life goals
- Values
- Beliefs
- Lifestyles

Geographic profile

- Country
- Region
- City
- Postal code

Ex market segments

In garments business, segments could be:



Profiling in e-commerce

Web site behaviour

- Number of sessions website
- Number of pages visited
- Time spent on site
- URLs visited
- Page types visited
- Shopping cart value
- Referral source
- Inactivity

Web site behaviour - 2

- First time visitor
- Returning visitor
- Returning customer

Use of profiles

- First time visitor
  - Offer x% discount on first order
- Returning visitor
  - Remind of x% discount
- Returning customer
  - Propose products similar to ones previously bought

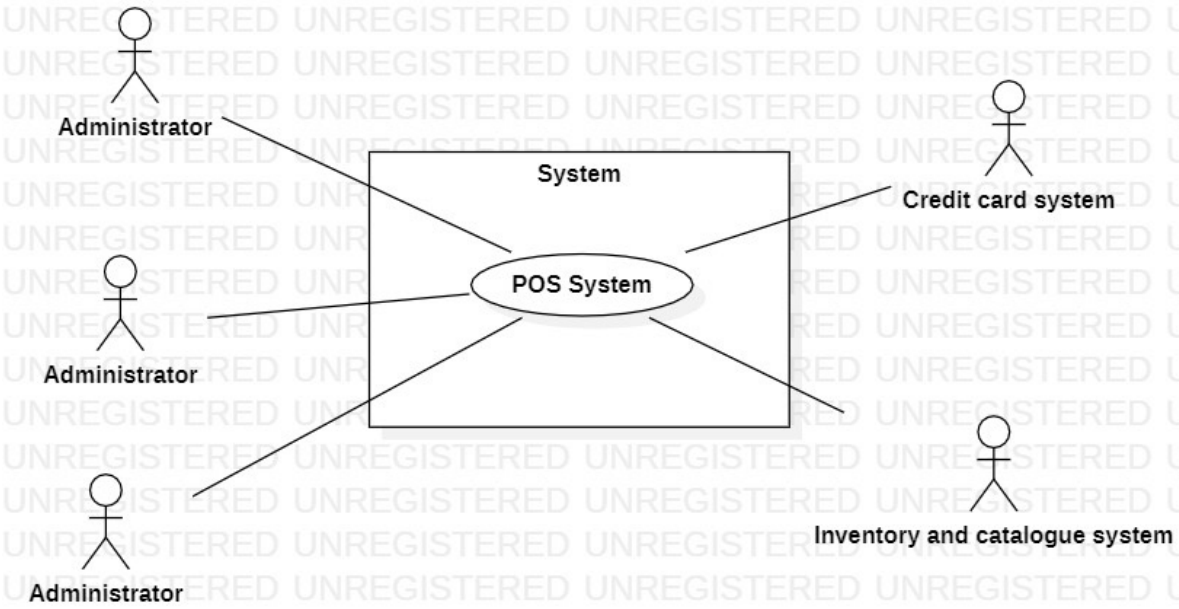
Context diagram

- To understand ‘in’ and ‘out’

Context diagram

- Defines what is **inside** the application to be developed, what is **outside**
  - Entity outside = actor
  - {actor} ⊂ {stakeholder}
  - Other systems/subsystems/applications
  - Human users (can specialize in one or more personas)
- Defines **interfaces** between inside and outside

Context diagram



Interfaces

- With cashier / administrator
  - Physical level: Screen, keyboard
  - Logical: GUI (to be described)
- With product
  - Physical level: laser beam (bar code reader)
  - Logical level: bar code
- With credit card system
  - Physical level: internet connection
  - Logical: web services (functions to be described, data exchanged, ex http/REST + json)

Interfaces – tabular form

Actor	Physical interface	Logical interface
Cashier	Screen, keyboard	Graphical User Interface (to be described, ex slide 46)
Product	Laser beam	ReadBarCode (to be specified, ex slide 44)
Credit card system	Internet connection	API description (ex https://developer.visa.com/docs for ViSA APIs
Administrator	Screen, keyboard	Graphical User Interface + command line interface

Interface specification

- Three types of interface may have to be defined
  - User interfaces, GUIs
  - Procedural interfaces;
  - Data exchanged;
- Formal notations are an effective technique for interface specification.

Procedural interface description

```
interface PrintServer {

// defines an abstract printer server
// requires:          interface Printer, interface PrintDoc
// provides: initialize, print, displayPrintQueue, cancelPrintJob, switchPrinter

        void initialize ( Printer p ) ;
        void print ( Printer p, PrintDoc d ) ;
        void displayPrintQueue ( Printer p ) ;
        void cancelPrintJob (Printer p, PrintDoc d) ;
        void switchPrinter (Printer p1, Printer p2, PrintDoc d) ;
} //PrintServer
```

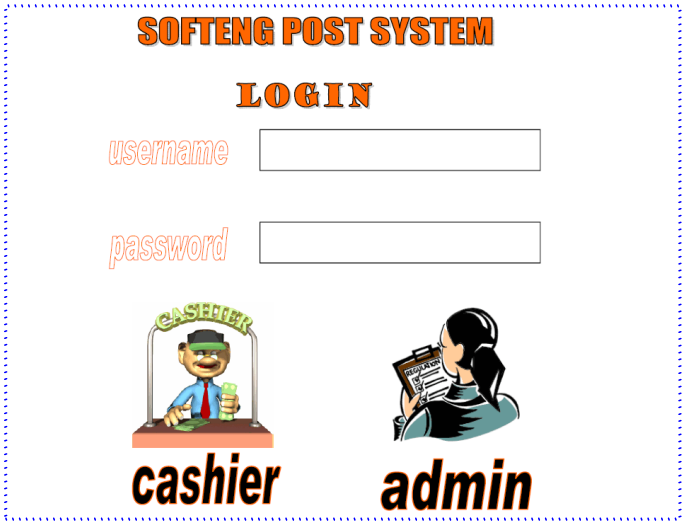
Data interface (XML)

```
<food>
<name>Belgian Waffles</name>
<price>$5.95</price>
<description>
two of our famous Belgian Waffles with plenty of real maple syrup
</description>
<calories>650</calories>
</food>

<food>
<name>Strawberry Belgian Waffles</name>
<price>$7.95</price>
<description>
light Belgian waffles covered with strawberries and whipped cream
</description>
<calories>900</calories>
</food>
```

GUI interface

- Sketch of interface, typically built with GUI builder



Context diagram and interfaces

- Are essential to agree on
  - What is the scope of the system (and therefore which requirements should offer / which functions should use from outside)
- The scope changes radically cost and time to develop
  - Ex. Inventory and catalogue system could cost 100K to develop
    if outside (as in current context diagram) that cost should not be included
    if inside that cost (and time) should be added

Requirement types

- Functional
  - Description of services / behaviors provided by the system
  - Application vs. domain
- Non functional
  - Constraints on the services
  - Application vs. domain

  - (Domain
    - From the domain (= set of related applications, ex banking, telecom))

Functional requirements

- Techniques
  - Clearly separating and numbering requirement

Functional requirements

Requirement ID	Description
F1	Handle sale transaction
F2	Start sale transaction
F3	End sale transaction
F4	Log in
F5	Log out
F6	Read bar code

Functional requirements

- Techniques
  - Clearly separating and numbering requirements
  - Hierarchical numbering

Functional requirements

Requirement ID	Description
F1	Handle sale transaction
F1.2	Start sale transaction
F1.3	End sale transaction
F2	Authorize and authenticate
F2.1	Log in
F2.2	Log out
F2.3	Define account

Naming the FR is useful for

- Management
  - FR_x is ready or not?
  - Is it released or not?
  - Paid or not?
- Testing level
  - Tested or not?

ISO 9126 / ISO 25010

- Defines 6 properties of software systems – 5 non-functional
  - Functionality
  - Usability
  - Efficiency
  - Reliability
  - Maintainability
  - Portability
  - Security

- Usability
  - Effort needed to learn how to use the product (installation, day-to-day usage)
  - Satisfaction expressed by the user
  - Existence of functions needed by the user
- Efficiency
  - For a given function in a given context: response time
  - For a given function / for a complete product: memory / cpu/ bandwith/ energy used

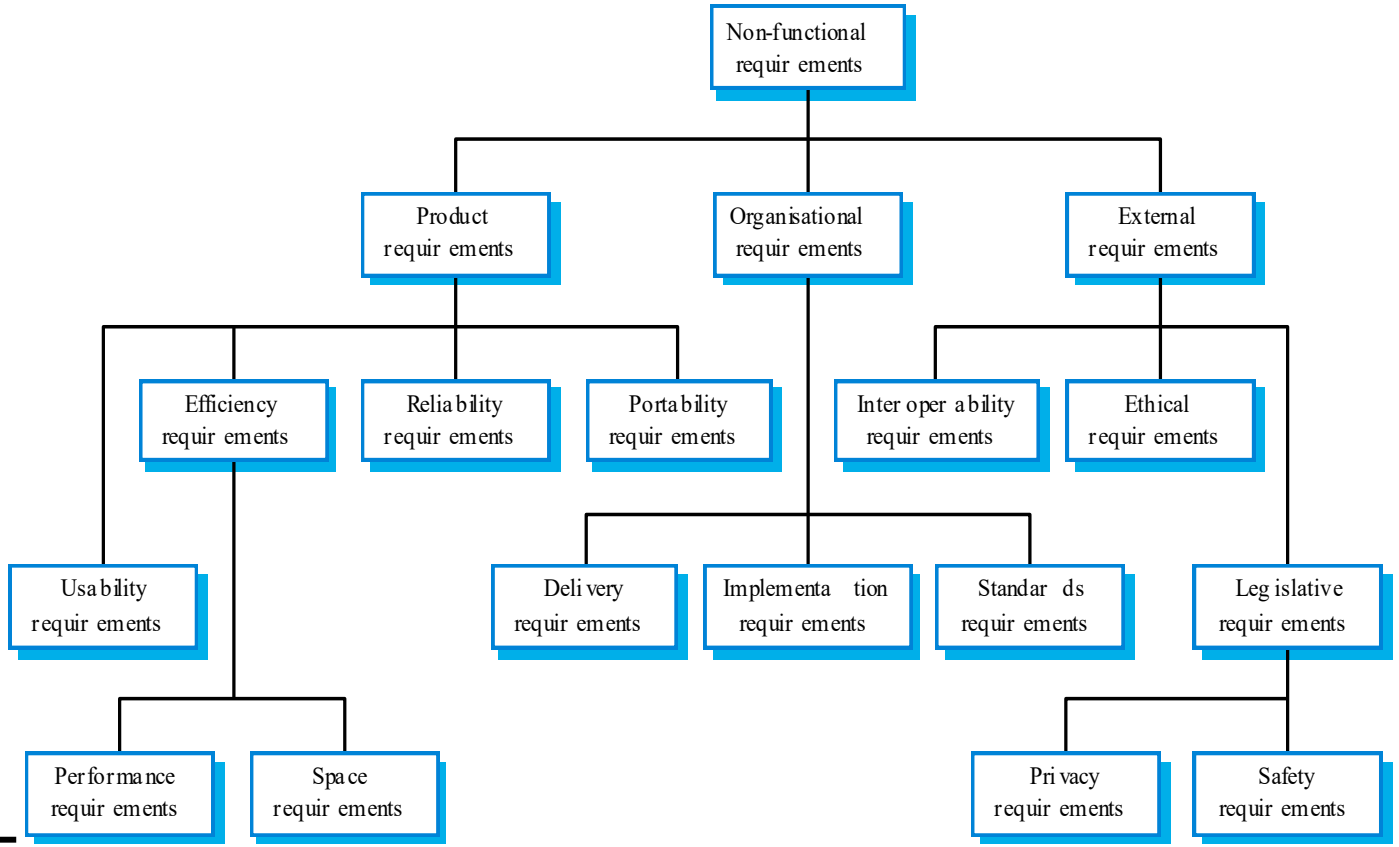
- Correctness
  - Capability to provide intended functionality in ALL cases
- Reliability / availability
  - Defects visible by end user per time period / Probability of defect over a time period
  - Percentage of time the product is / is not available to end user

- Maintainability
  - Effort (person hours) needed to add /modify / cancel a software function
  - Effort to fix a defect
  - Effort to deploy on a different platform (DB, OS, ..)
- Portability
  - Effort to redeploy application on another platform
    - Os, database, network, screen

- Security
  - Protection from malicious access
  - Access only to authorized users
  - Sharing of data
- Safety
  - Absence of harm to persons
  - Absence of hazardous situations for persons
- Dependability
  - Safety + security + reliability

GDPR (EU)
CCPA (California)

Non-functional reqs



Non-functional reqs

- Product requirements
  - Requirements which specify that the delivered product must behave in a particular way e.g. execution speed, reliability, etc.
- Organisational requirements
  - Requirements which are a consequence of organisational policies and procedures e.g. process standards used, implementation requirements, etc.
- External requirements
  - Requirements which arise from factors which are external to the system and its development process e.g. interoperability requirements, legislative requirements, etc.

Perception of waiting times

- <0.1 sec – not percepted
- >1 sec - annoying

Non-functional

Requirement ID	Description
NF1(efficiency)	Function F1.1 less than 1msec
NF2 (efficiency)	Each function less than ½ sec
Domain1	Currency is Euro – VAT is computed as ..

Non-functional requirements

- Non-functional requirements may be more critical than functional requirements. If these are not met, the system is useless.

NF Req must be measurable

- **Not measurable**
  - The system should be easy to use by experienced controllers and should be organised in such a way that user errors are minimised.
- **Measurable**
  - Experienced controllers shall be able to use all the system functions after a total of two hours training. After this training, the average number of errors made by experienced users shall not exceed two per day.

Measures for NF reqs

Property	Measure
Speed	Processed transactions/second User/Event response time Screen refresh time
Size	M Bytes Number of ROM chips
Ease of use	Training time Number of help frames
Reliability	Mean time to failure Probability of unavailability Rate of failure occurrence Availability
Robustness	Time to restart after failure Percentage of events causing failure Probability of data corruption on failure
Portability	Percentage of target dependent statements Number of target systems

- NF requirements such as
  - «The system should be easy to use»
  - «The system should be maintainable»
  - «The system should be portable»

- Are not testable, and therefore useless

Requirements interaction

- Conflicts between different non-functional requirements are common in complex systems.
- Spacecraft system
  - To minimise weight, the number of separate chips in the system should be minimised.
  - To minimise power consumption, lower power chips should be used.
  - However, using low power chips may mean that more chips have to be used. Which is the most critical requirement?

Requirements interaction

- Efficiency vs security
  - Efficiency → minimize number of software components and calls between them
  - Security → add components (and layers and calls)

Requirements interaction

- In the end key stakeholders must decide the ranking of NF requirements
  - More important security or efficiency?

- This decision is a business decision (not a technical one) and should NOT be taken by developers

Domain requirements

- Derived from the application domain and describe system characteristics and features that reflect the domain.
- Domain requirements can be new functional requirements, constraints on existing requirements or define specific computations.
- If domain requirements are not satisfied, the system may be unworkable.

Train protection system

- The deceleration of the train shall be computed as:
  - $D_{train} = D_{control} + D_{gradient}$

  where $D_{gradient}$ is $9.81ms^2$ * compensated gradient/alpha and where the values of $9.81ms^2$ /alpha are known for different types of train.

Domain req. problems

- Understandability
  - Requirements are expressed in the language of the application domain;
  - This is often not understood by software engineers developing the system.
- Implicitness
  - Domain specialists understand the area so well that they do not think of making the domain requirements explicit.

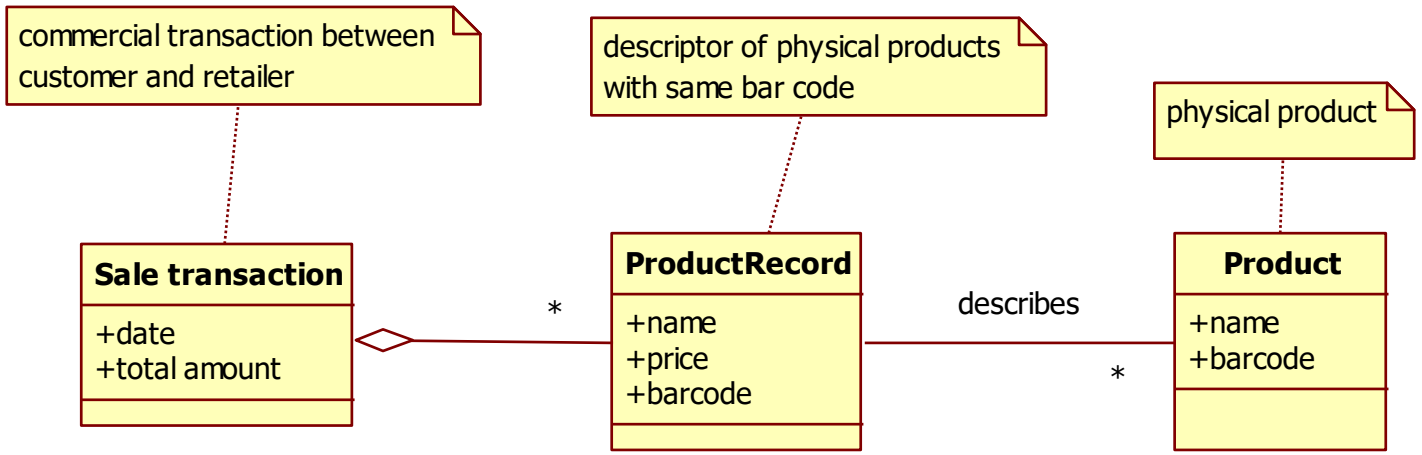
Glossary

- Sale = commercial transaction between customer and retailer, where customer buys a number of products from the retailer
- Product = ..

Class diagram

- See UML slides
- Can be used
  - To refine glossary
  - To describe application model
  - To describe system design

Glossary with Class diagram



What classes in UML for glossary?

- For physical objects
  - Ex Pilot, Aircraft, Airline, Airport
- For legal / organizational entities
  - Company, airline, university, department
- Descriptors
  - Ex Aircraft type, Pilot Qualification
- Time (events)
  - Departure of aircraft
- Commercial transaction
  - Event + exchange of money / good / service
- Time (intervals)
  - Flight, Internship

Scenario and Use Cases

Scenario

- Sequence of steps (events) that describe a typical interaction with the system

- Sequence: time is key part of this model
  - Time is NOT part of Functional requirements, Glossary, Context diagram, Use cases

Scenario sale1

Step	Description
1	Start sales transaction
2	Read bar code X
3	Retrieve name and price given barcode X
	Repeat 2 and 3 for all products
4	Compute total T
5	Manage payment cash amount T
6	Deduce stock amount of product
7	Print receipt
8	Close transaction

Sale1

- Precondition
  - Cashier is authenticated

Scenario login

Step	Description
1	Cashier starts application
2	Application asks account name, pwd
3	Cashiers enters account name, pwd
4	
5	
6	

- Scenario login
  - Precondition: cashier is not authorized
  - Post condition: cashier is authorized and authenticated

Other scenarios

- (payment cash)
- Payment with credit card
- Payment with loyalty card

- Payment does not succeed, abort sale
- Customer refuses an item

Scenario / pre post conditions

- Precondition
  - Condition to be satisfied before starting the scenario
    - Ex: bar code X is valid
    - Ex: bar code X corresponds to a product available in the shop
- Postcondition
  - Condition satisfied at end of the scenario
    - Ex: amount in cash after transaction = amount in cash before transaction + T

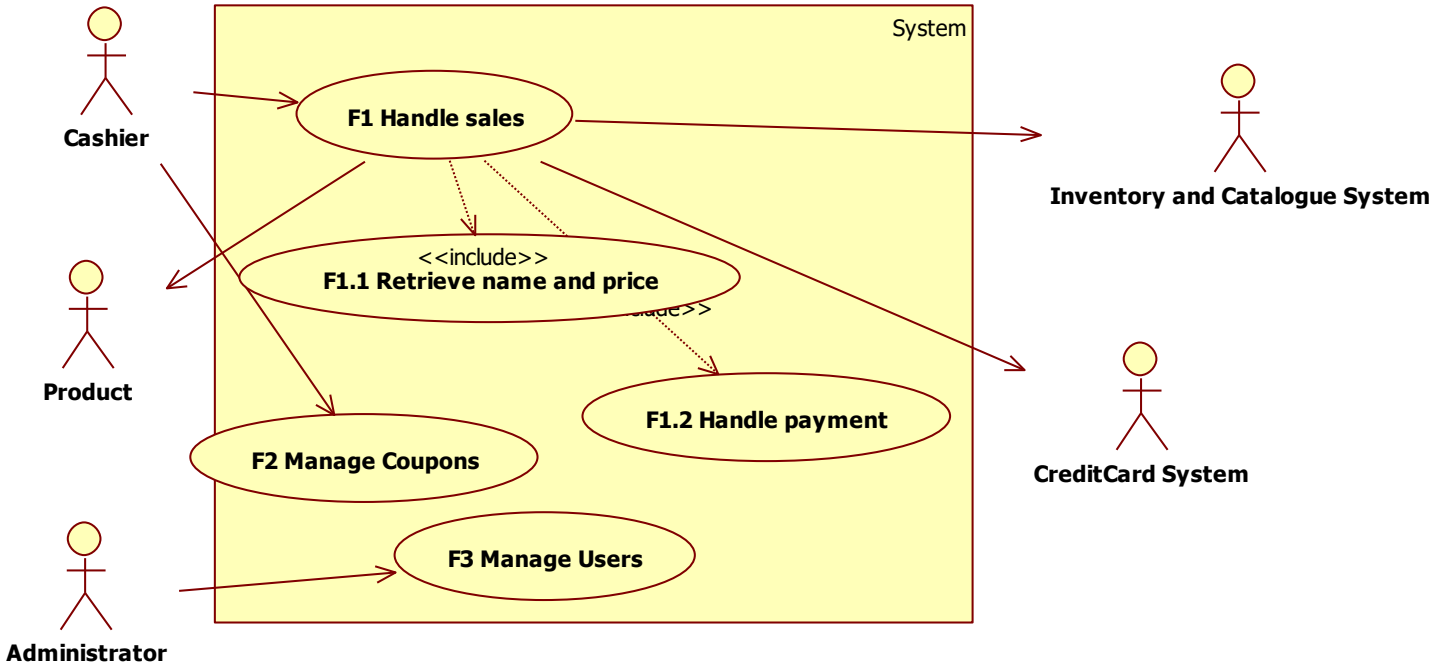
Use case

- Set of scenarios with common user goal

- Ex: use case: Handle sales
  - Scenario1: sell 2 products
  - Scenario2: sell 3 products
  - Scenario3: sell n products, abort sale because customer has no money
  - Scenario 4: sell n products, customer changes one of the products

- Ex other use cases
  - Handle coupons
  - Handle users

Use case diagram



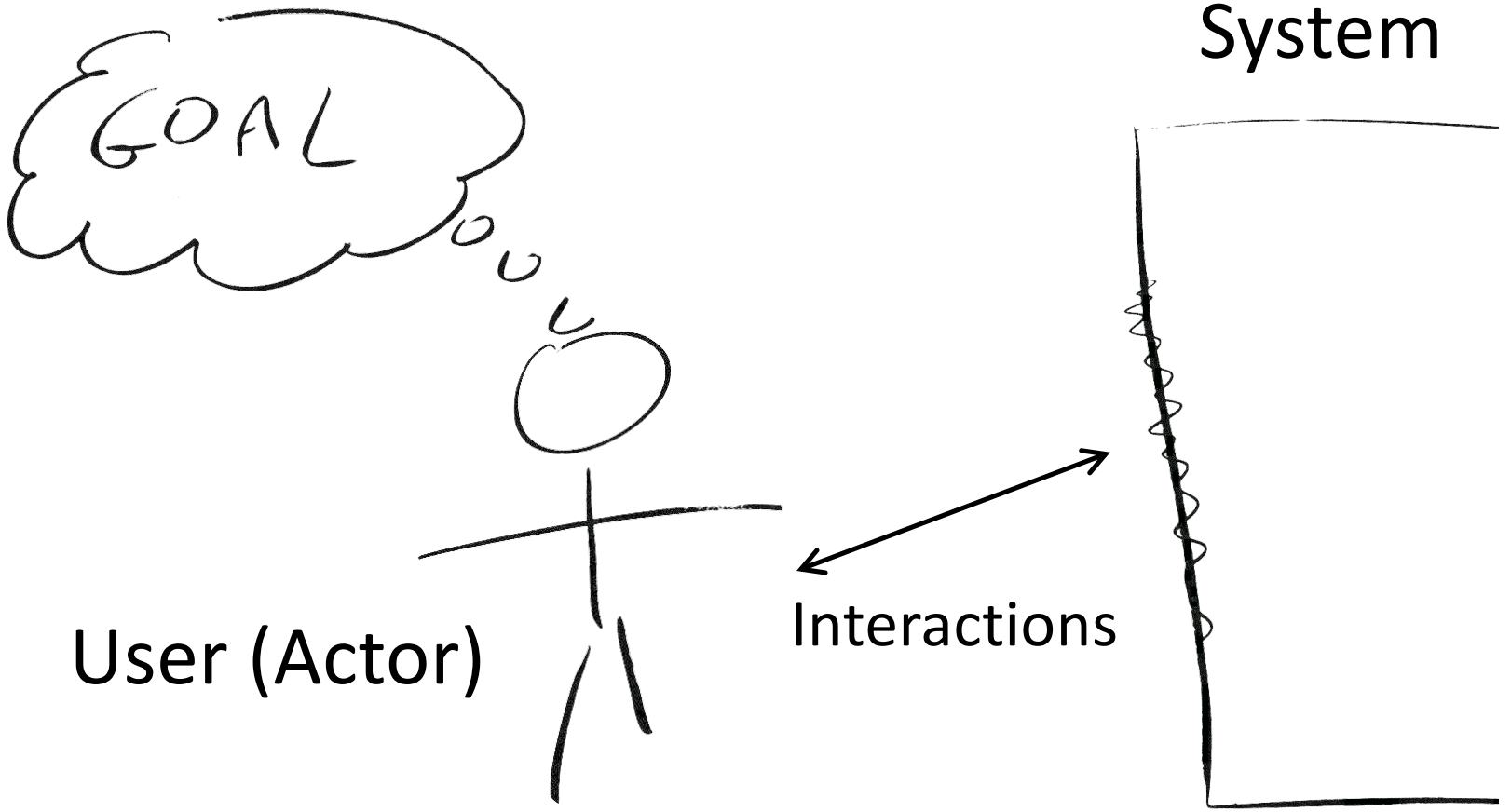
Use case

- Captures a contract between the actors of a system about its behavior.
- Describes the system's behavior under various conditions as it responds to a request
  - from the *primary actor.*
- The primary actor initiates an interaction with the system to accomplish some goal.
- The system responds, protecting the interests of all the stakeholders.

Use case

- A scenario is a sequence of steps describing an interaction between a user and a system
- A use case is a **set of scenarios** tied together by a **common *user* goal**.
  - Use case similar to Class (Model)
  - Scenario similar to instance of class

Key elements



Key Elements

- The actor involved
  - type of user that interacts with the system
- The system being used
  - treated as a black-box
- The functional goal that the actor achieves using the system
  - the reason for using the system

Actors, stakeholders

- Actor <= stakeholders
- External to system
- Actors can be
  - Humans
  - Other machines / systems
- Actors can be
  - Primary: start the interaction with the system
  - Secondary: are passive wrt the system

Goals

- The use case cares only about the relationship of the actor to the system
- The goal must be of value to the (primary) actor:
  - “Enter PIN code” is not
  - “Withdraw cash” is

Goal

As a *<actor type>*

I want *<to do something>*

So that *<some value is created>*

Goal

bank customer

As a *<actor type>*

to perform a withdrawal

I want *<to do something>*

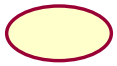
I get some cash for me

So that *<some value is created>*

Elements of a Use Case

Actor

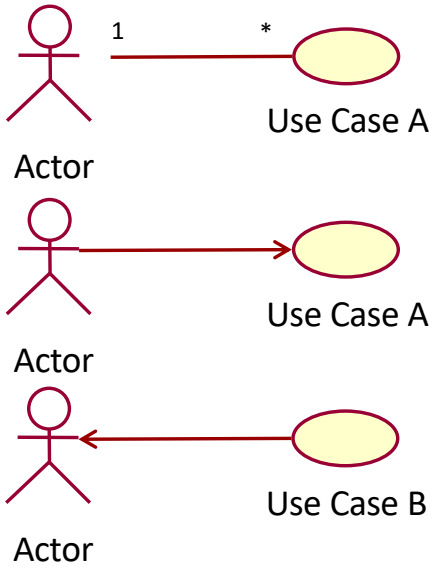
- Someone (user) or something (external system, hardware) that
  - Exchanges information with the system
  - Supplies input to the system or receives output from the system



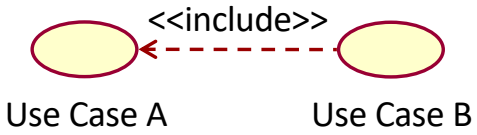
Use Case

- A functional unit (functionality) part of the system

Relationships



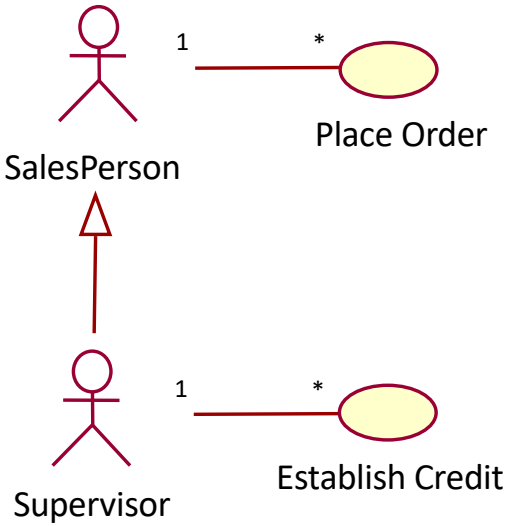
- Association models:
  - Which actors participate in a use case
  - Where execution starts
  - Adornments (e.g. multiplicity, direction) allowed
  - Actor1 participates in Use CaseA and is the trigger of the use case
  - Actor2 participates in UseCaseB and UseCaseB is the trigger



- Include
  - Models that functionality A is used in the context of functionality B (one is a phase of the other)

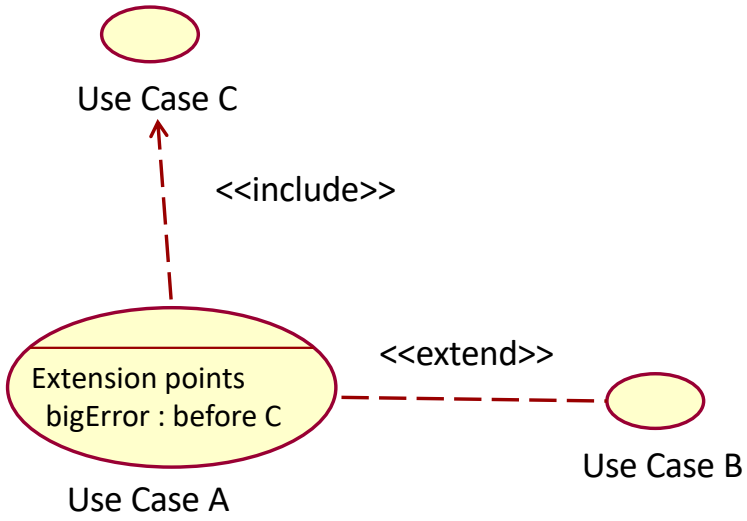
Relationships: generalization

- Generalization
  - Defines functionality B as a specialization of functionality A (e.g. a special case)



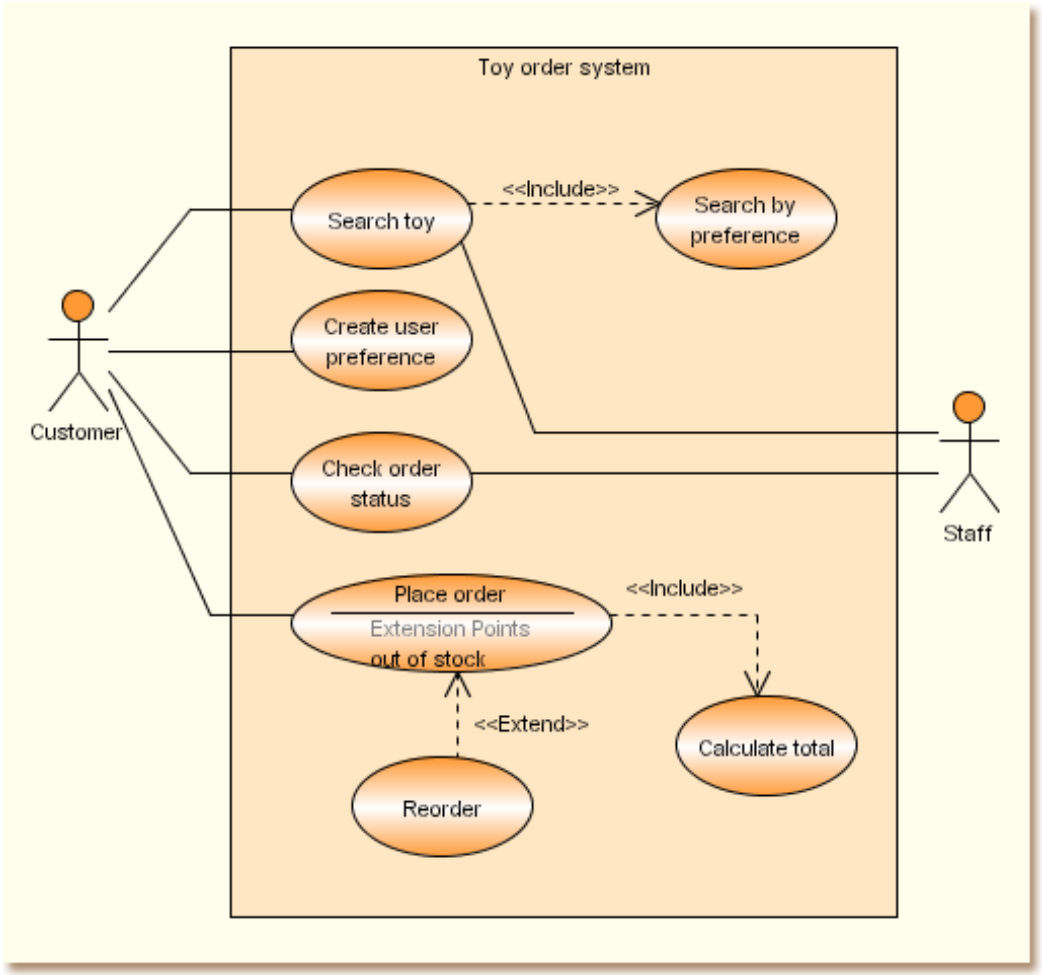
- Generalization
  - A generalization from an actor B to an actor A indicates that an instance of B can communicate with the same kinds of use-case instances as an instance of A

Relationships: extension



- Extension
  - An extend relationship from use case B to use case A indicates that an instance of use case A may be augmented by the behavior specified by B.
  - The behavior is inserted at the location defined by the extension point (name: where) in A, which is referenced by the extend relationship.

Use case - Example



Use case

- A scenario is a sequence of steps describing an interaction between a user and a system
- A use case is a set of scenarios tied together by a common user goal.

Use cases vs requirements

- Requirement (functional)

- Use case
  or
  scenario in the use case or
  step in scenario

- Mapping is not 1:1
- The requirement purpose is to support traceability and tends to be finer-grained than the use case
- The use case purpose is to understand how the system works

Use cases vs requirements

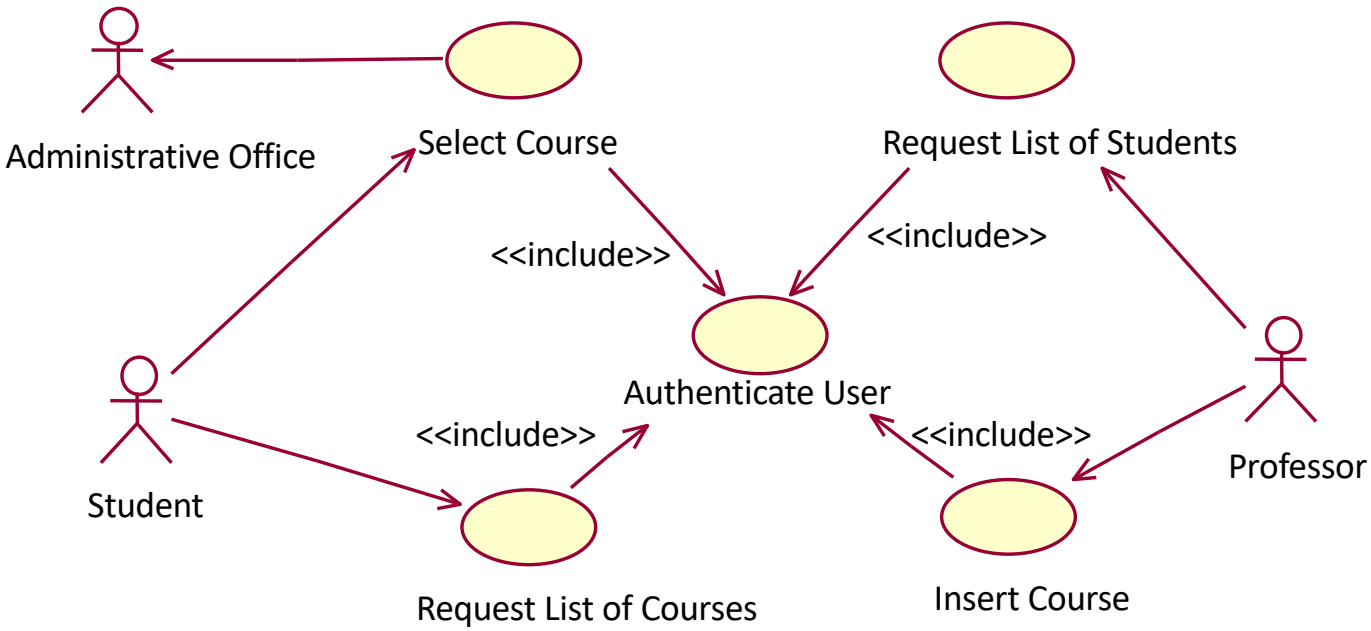
- High level requirement (ex F1, F2)
- Low level requirement (ex F1.1 F1.2)

- Use case that includes other use cases
- Use case <included> by other use case

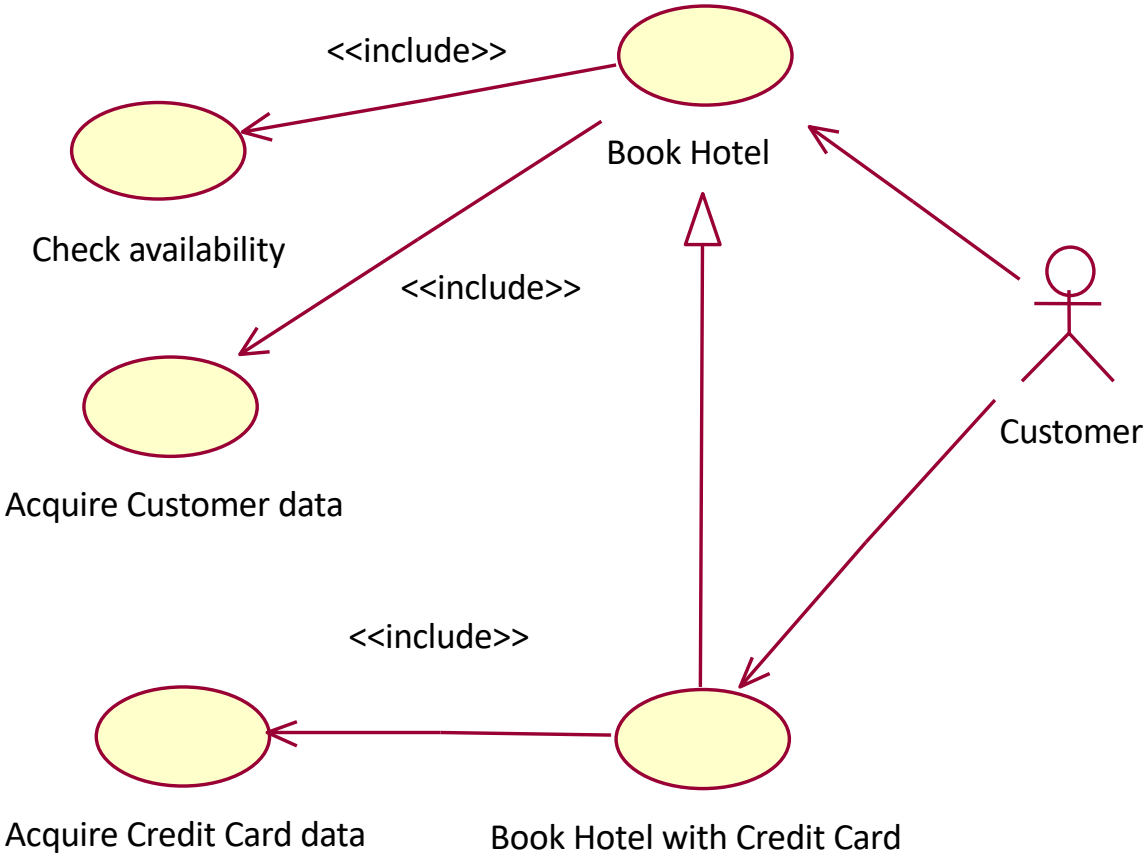
Example: student management

- students select courses
- professors update the list of available courses
- professors plan exams for each course
- professors can access the list of students enrolled in a course
- professors perform exams and then record issues of exam for students (pass/no pass, grade)
- all users should be authenticated

Example



Example



Use Case Diagram and Class Diagram

- They must be consistent.
  - Use case diagram
    - actor
    - use case
    - interaction
  - Class diagram
    - may become a class
    - must become one operation on a class - may originate several operations on several classes (see sequence diag)
    - not represented (see dynamic diagrams)

Use case briefs

- Summary consisting of 2-6 sentences
  - What is going on
  - Most significant activities

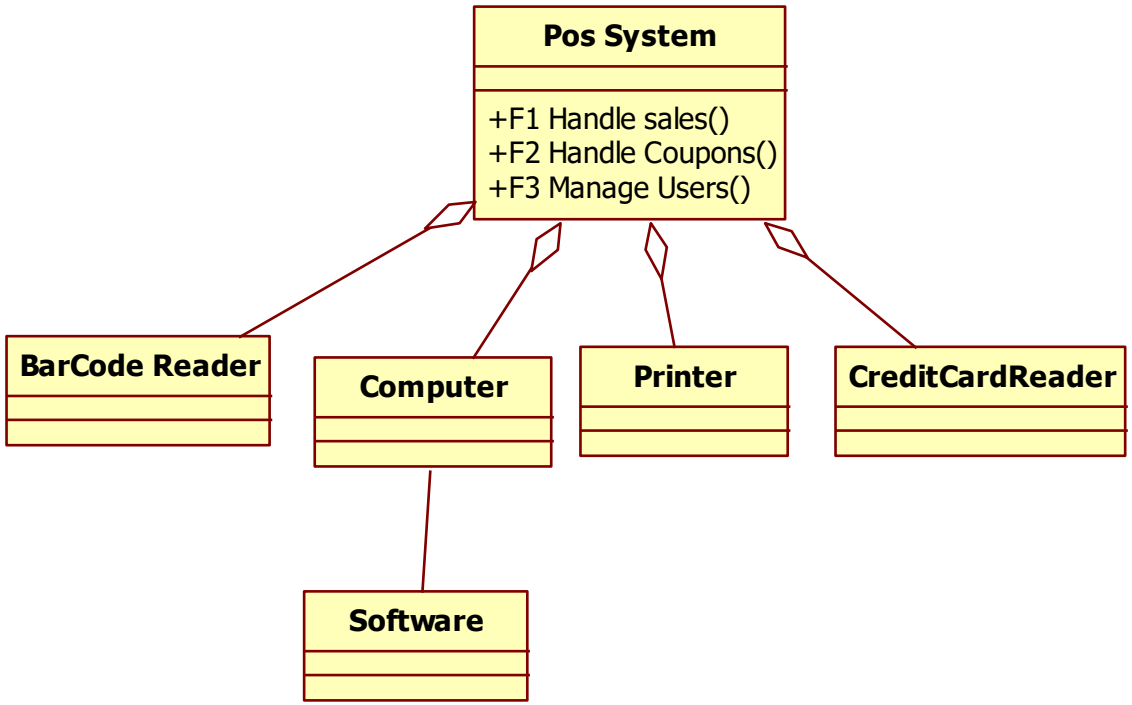
Actor	Goal	Brief
Production Staff	Modify the administrative area lattice	Production staff add admin area metadata (administrative hierarchy, currency, language code, street types, etc.) to reference database and contact info for source data is cataloged. This is a special case of updating reference data.
Production Staff	Prepare digital cartographic source data	Production staff convert external digital data to a standard format, validate and correct it in preparation for merging with an operational database. The data is catalogued and stored in a digital source library.
Production & Field staff	Commit update transactions of a shared checkout to an operational database	Staff apply accumulated update transactions to an operational database. Non-conflicting transactions committed to operational database. Application context synchronized with operational database. Committed transactions cleared from application context. Leaves operational database consistent, with conflicting transactions available for manual/interactive resolution.

UC

- Nominal scenario
  - Payment via credit card
  - All correct (credit card number, amount, exp date...)
- Exception scenarios
  - Credit card number incorrect
  - Exp date incorrect
  - Amount too high
  - ...

System design

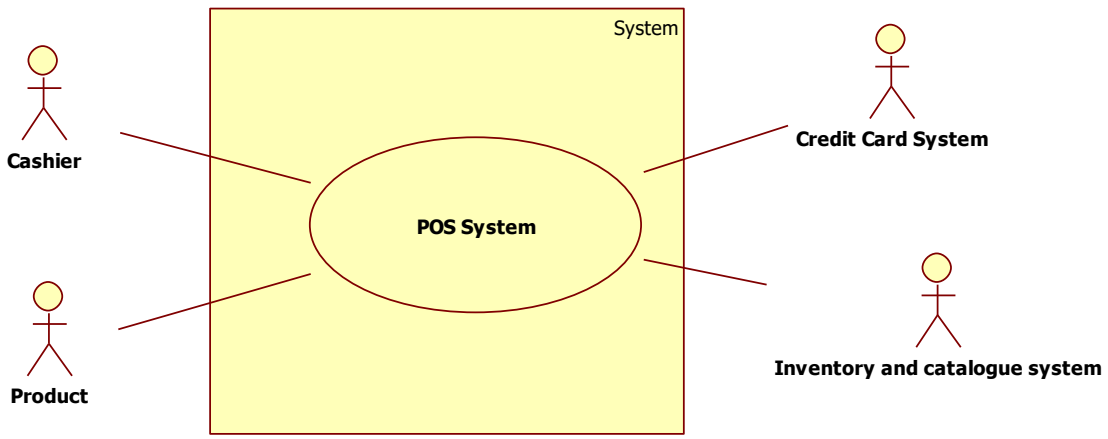
- Subsystems (software and not software) that compose the system

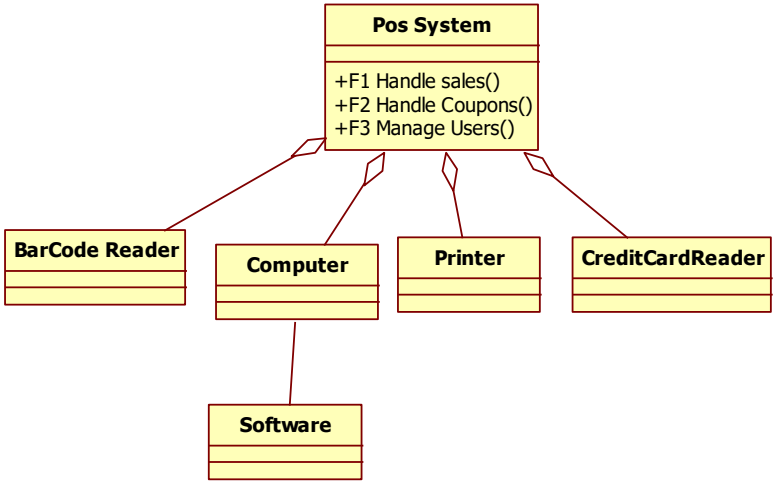


System design and context diagram

- System design lists all subsystems (or components) that are INSIDE the context diagram
- System design must be consistent with context diagram

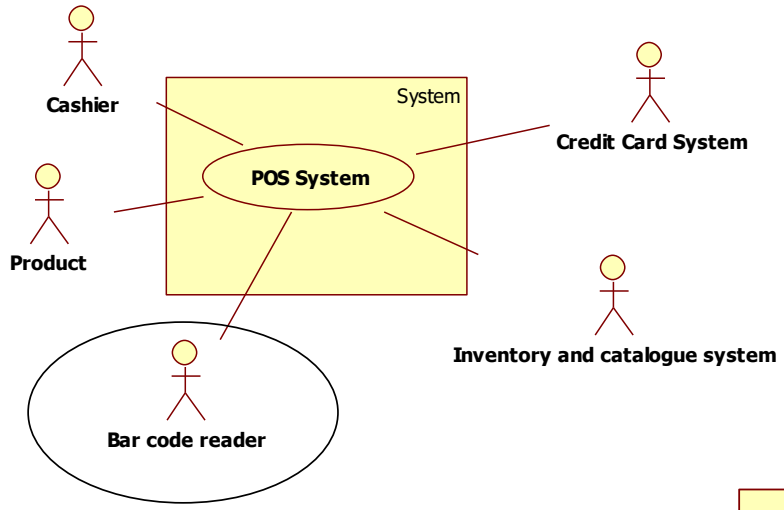
Example

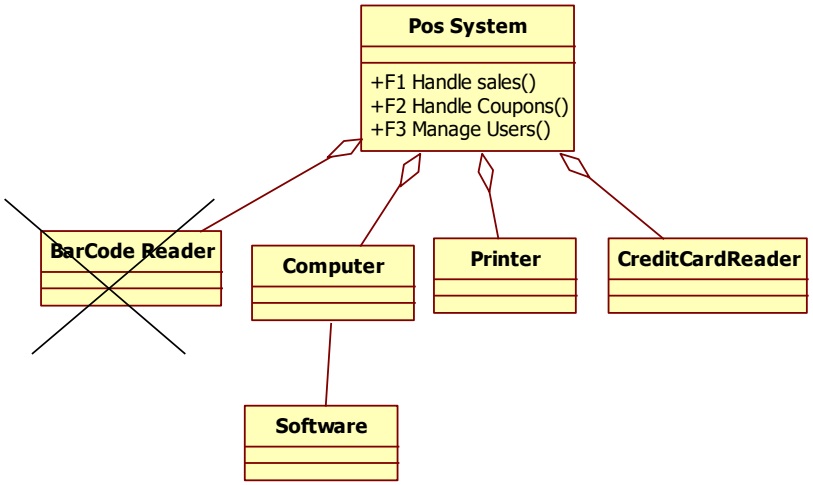




- Bar code reader is IN

Example

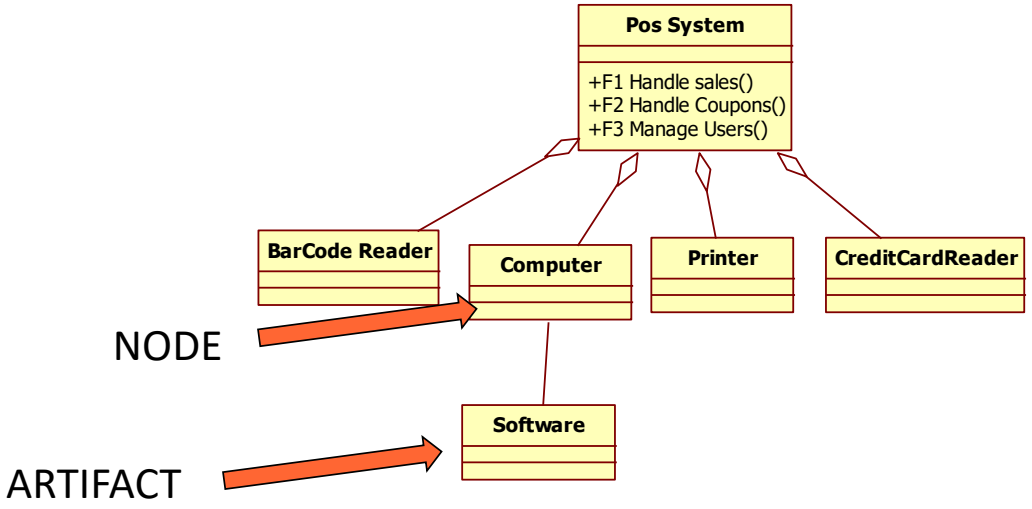




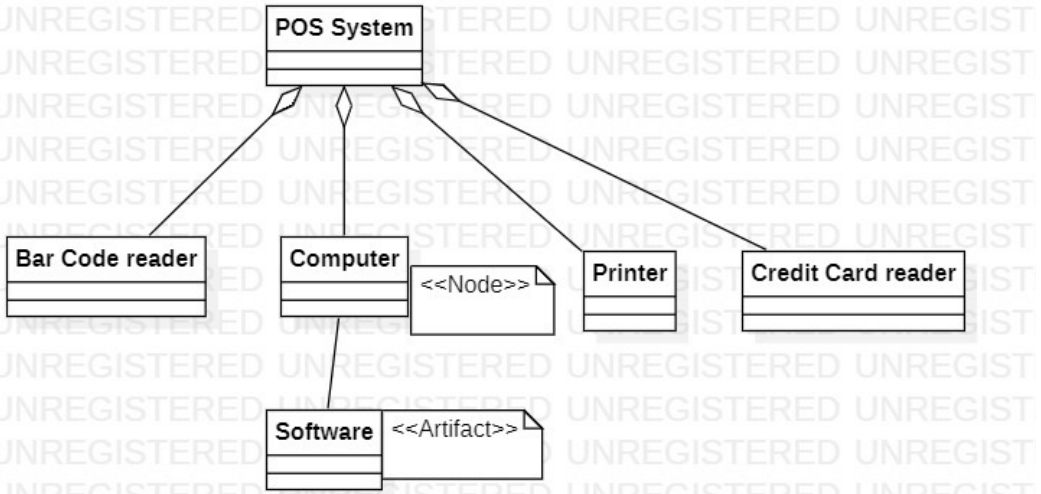
- Bar code reader is OUT

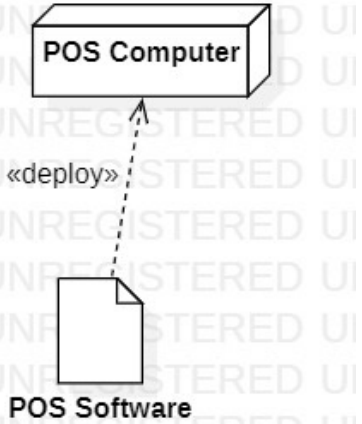
System design vs deployment d

- Class that represents a computing component → Node
- Class that represents a software component → Artifact



System design vs deployment





The requirement document

- Result of RE
- Formalizes the requirements

Requirement doc structure

1 Overall description
2 Stakeholders
3 Context diagram and interfaces
4 Requirements
- Functional
- Non functional
- Domain

5 Use case diagram
6 Scenarios
7 Glossary
8 System design

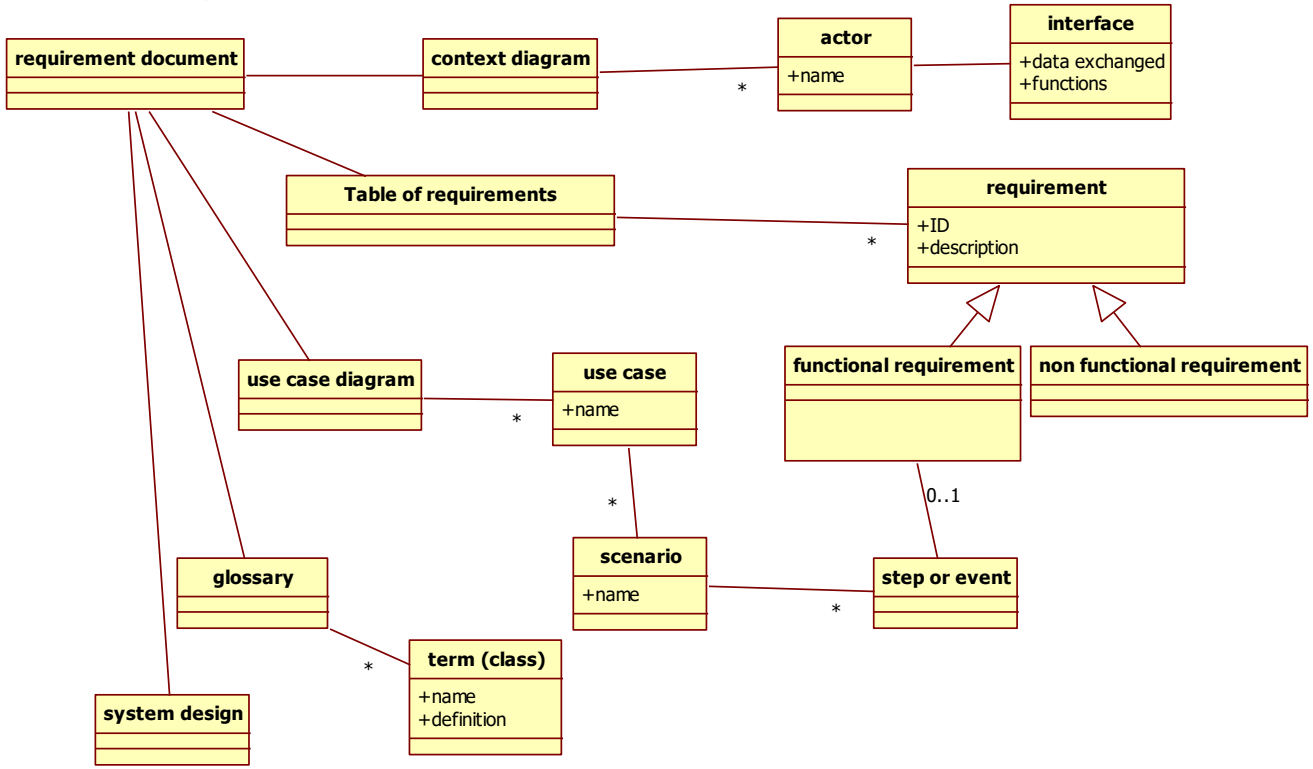
Req document and techniques

- The requirements document provides a structure
- Within the structure different techniques can be used
- The structure may change, order of parts is less important than precise description of parts

Req document vs. techniques

• Overall description	• Text
• Stakeholders	• Text
• Context diagram	• UML UCD
• Interfaces	• Text, PDL, XML, screenshots
• Requirements	• Type, numbering
• Use cases	• UML UCD, UC briefs
• Scenarios	• Tables, text
• Glossary	• Text, UML CD
• System design	• UML CD

RE - techniques



Other requirement structures

- http://readyset.tigris.org

- IEEE Std 830 1994
  - Introduction.
  - General description.
  - Specific requirements.
  - Appendices.
  - Index.

Techniques - elicitation

- Focus group
- Interviews
- Questionnaire
- Ethnography

Focus group

- Moderator + group of homogeneous people
- The moderator starts and monitors discussion on defined topics
- Open or script-guided

- Long
- Group interaction

Questionnaire

- Written questions with open /close answers
- Statistical analysis, more data points possible

Interview

- Deep discussion, one to one
- Open or guided by script / questions

- Interviewer reports log

- Long, detailed

Ethnographics

- Researcher is ‘hidden’ in an environment and observes facts and behaviour of user / population

- Expensive, long
- Risk of being invasive

Styles in RD

- Operational vs descriptive
- Formal, semiformal, informal
- Software vs System and software

Techniques – V and V

- Inspections/reading
- Prototyping
- Iterations
- (Model checking on formal languages)

Inspections

- See V&V chapter

Prototyping

- Develop a running prototype
  - Capable of implementing the key functional requirements
  - Loose on non-functional requirements
  - Fast (must be ready in a fraction of the time needed to develop the complete application)
  - Possibly using a dedicated technology, different from the one used for the final system (ex prototype in matlab, application in C)

Iterations

- Develop a first running version of product, with most important requirements
  - 60 requirements -> 6 months
  - 10 requirements -> 1 month
- To be evolved in final system

  - See process chapter

MVP

- Minimum viable product
- Develop essential functionality
- Try it with end users

Support Tools for RE

- RequisitePro, Doors, Serena RM
- Word, Excel
- UML tools
  - Powerpoint, Visio, specialized tools (StarUML, Astah, PlantUml, ..)

Summary

- Goal of requirement engineering is describing *what* the system should do in a requirement document
- Many stakeholders are involved in the process
- Techniques to make the document more precise are
  - Context diagram and interfaces
  - Identifying requirements and classifying them (functional, non functional, domain)
  - Scenarios
  - Use cases

Summary

- Requirements engineering is a key phase
  - Most defects come from this phase, and they are the most disruptive and most costly to fix
- Verification and validation is essential
  - Inspection
  - prototype

Appendix

Domain

- Collection of related functionality

  or

- collection of applications with similar functionality)
  - Ex. banking, that includes subdomains account management, portfolio managemenmt, etc
  - Ex. telecommunication, that includes subdomains switching, protocols, telephony, switching

Application

- Or system
- Software system supporting a specific set of functions. Belongs to one or more domains

Other techniques for RE

Structured presentation

2.6.1 Grid facilities

The editor shall provide a grid facility where a matrix of horizontal and vertical lines provide a background to the editor window. This grid shall be a passive grid where the alignment of entities is the user's responsibility.

Rationale: A grid helps the user to create a tidy diagram with well-spaced entities. Although an active grid, where entities 'snap-to' grid lines can be useful, the positioning is imprecise. The user is the best person to decide where entities should be positioned.

Specification: ECLIPSE/WS/Tools/DE/FS Section 5.6
Source: Ray Wilson, Glasgow Office

Form-based specifications

- Definition of the function or entity.
- Description of inputs and where they come from.
- Description of outputs and where they go to.
- Indication of other entities is required.
- Pre and post-conditions (if appropriate).
- The side effects (if any) of the function.

Form-based

Insulin Pump/Control Software/SRS/3.3.2	
Function	Compute insulin dose: Safe sugar level
Description	Computes the dose of insulin to be delivered when the current measured sugar level is in the safe zone between 3 and 7 units.
Inputs	Current sugar reading (r2), the previous two readings (r0 and r1)
Source	Current sugar reading from sensor. Other readings from memory.
Outputs	CompDose Š the dose in insulin to be delivered
Destination	Main control loop
Action:	CompDose is zero if the sugar level is stable or falling or if the level is increasing but the rate of increase is decreasing. If the level is increasing and the rate of increase is increasing, then CompDose is computed by dividing the difference between the current sugar level and the previous level by 4 and rounding the result. If the result, is rounded to zero then CompDose is set to the minimum dose that can be delivered.
Requires	Two previous readings so that the rate of change of sugar level can be computed.
Pre-condition	The insulin reservoir contains at least the maximum allowed single dose of insulin..
Post-condition	r0 is replaced by r1 then r1 is replaced by r2
Side-effects	None

Tabular specification

- Used to supplement natural language.
- Particularly useful when you have to define a number of possible alternative courses of action.

Tabular specification

Condition	Action
Sugar level falling (r2 < r1)	CompDose = 0
Sugar level stable (r2 = r1)	CompDose = 0
Sugar level increasing and rate of increase decreasing ((r2-r1)<(r1-r0))	CompDose = 0
Sugar level increasing and rate of increase stable or increasing. ((r2-r1) (r1-r0))	CompDose = round ((r2-r1)/4) If rounded result = 0 then CompDose = MinimumDose

The POS system – requirement document

Requirements document

1 Overall description
2 Stakeholders
3 Context diagram and interfaces
4 Requirements
- Functional
- Non functional
- Domain

5 Use case diagram
6 Scenarios
7 Glossary
8 System design

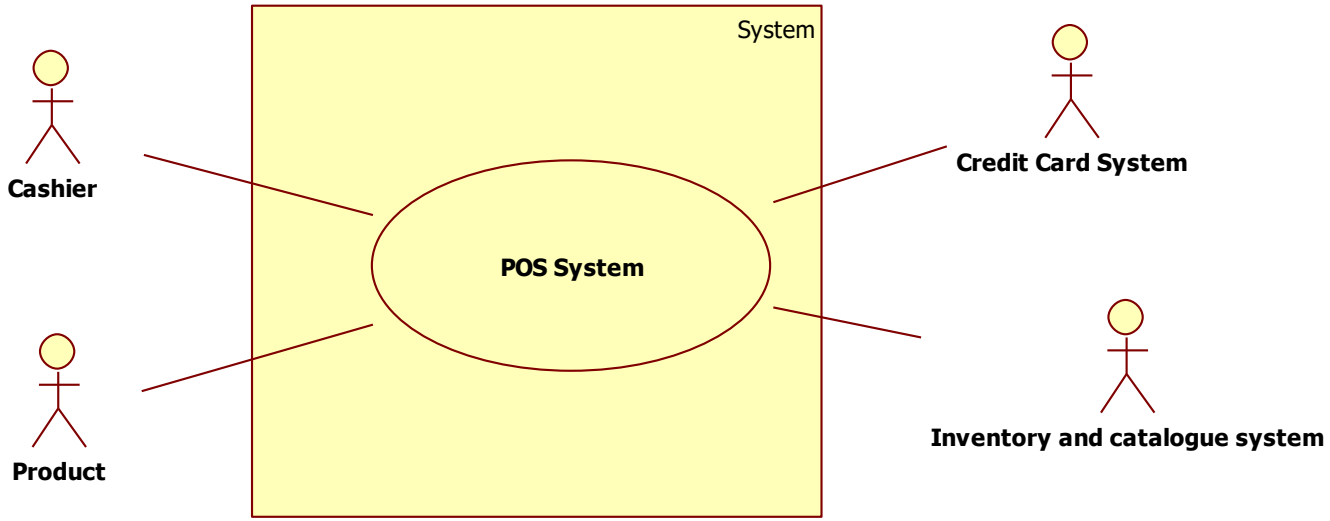
1 Overall description

- A POS (Point-Of-Sale) system is a computer system typically used to manage the sales in retail stores. It includes hardware components such as a computer, a bar code scanner, a printer and also software to manage the operation of the store.
- The most basic function of a POS system is to handle sales
- …

2 Stakeholders

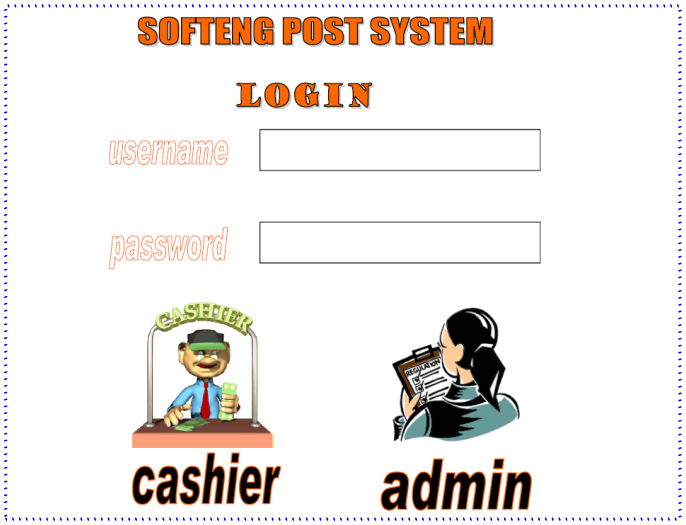
- User
  - Cashier at POS (profile 1)
  - Supervisor, inspector (profile 2)
  - Customer at POS (indirectly through cashier)
- Administrator
  - POS application administrator (profile 3)
  - IT administrator (profile 4)
    - Manages all applications in the supermarket
  - Security manager (profile 5)
    - Responsible for security issues
  - DB administrator (profile 6)
    - Manages DBMSs on which applications are based
- Buyer
  - CEO and/or CTO of supermarket

3.1 Context diagram



3.2 GUI interface

- Sketch of interface, typically built with GUI builder



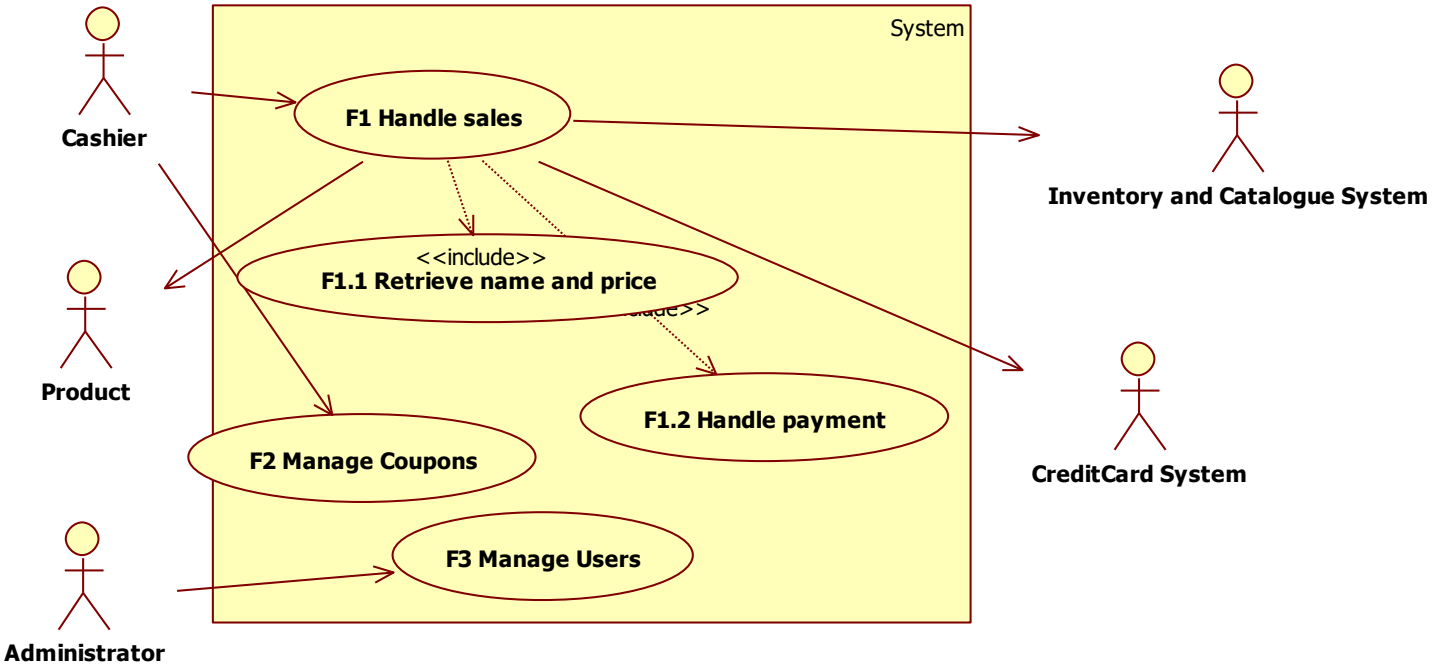
4.1 Functional requirements

Requirement ID	Description
F1	Start sale transaction
F2	End sale transaction
F3	Log in
F4	Log out
F5	Read bar code

4.2 Non-functional requirements

Requirement ID	Description
NF1(efficiency)	Function F1 less than 1msec
NF2 (efficiency)	Each function less than ½ sec
Domain1	Currency is Euro – VAT is computed as ..

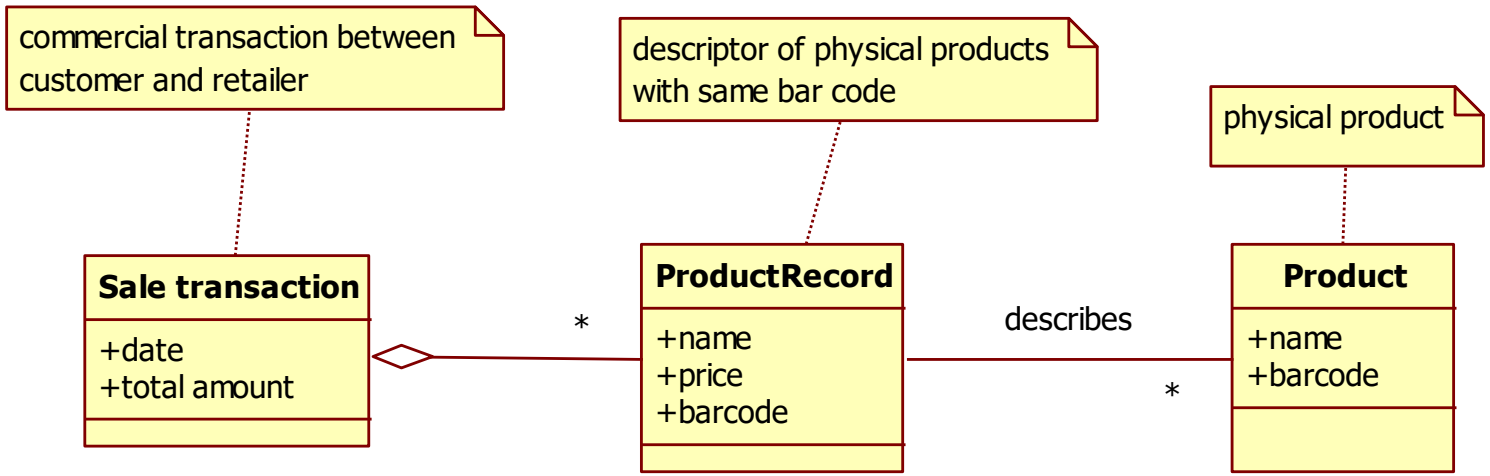
5 UCD



6 Scenarios

Step	Description
1	Start sales transaction
2	Read bar code
3	Retrieve name and price given barcode
	Repeat 2 and 3 for all products
4	Compute total
5	Manage payment cash
6	Deduce stock amount of product
7	Print receipt
8	End sales transaction

7 Glossary



8 System design