Chapter 3
Requirements Elicitation

Object-**O**riented
Software**C**onstruction

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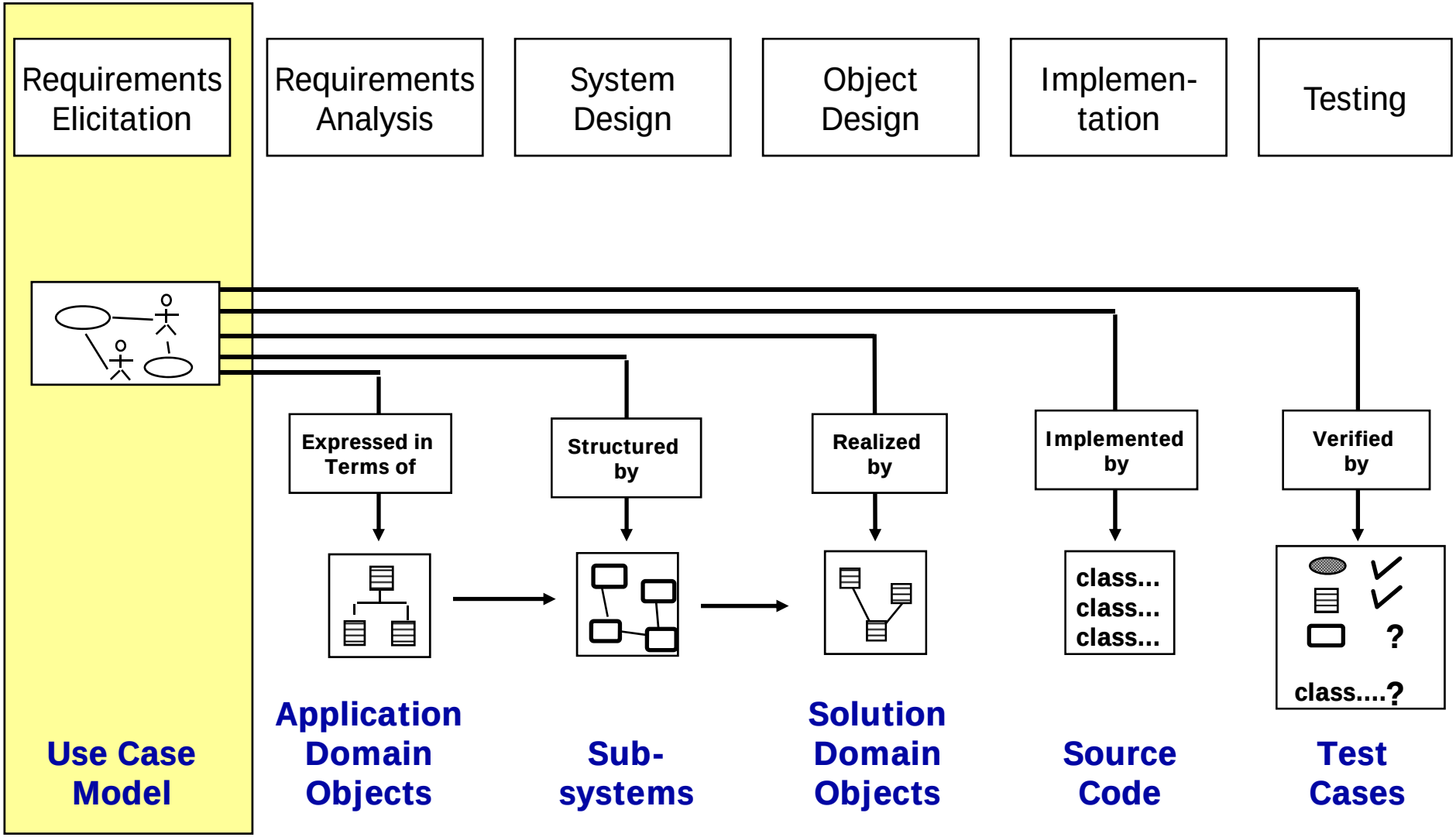
(based on Bruegge & Dutoit)

Overview

- Introduction to requirements engineering
- General view on requirements elicitation
- Process of requirements elicitation (and analysis)
- Elicitation Techniques
  - Scenarios
  - Interviews
  - Observation
- From scenarios to use cases
- Conclusions

Software Development Process:
A Brief Overview



First View on
Requirements Engineering

- Requirements Engineering is the first phase of the Software Lifecycle
- Production of a specification from informal ideas
- Goal: Requirements Specification
  - System requirements specification: requirements describe Software and Hardware
  - Software requirements specification: describe only Software
- RE is about *what* the system should do (not *how* to do it)
- Key influencing factor to the development process
  - Failures made here result in high costs in later development phases
  - System will meet the user/customer needs

Requirements Engineering:
Input and Output

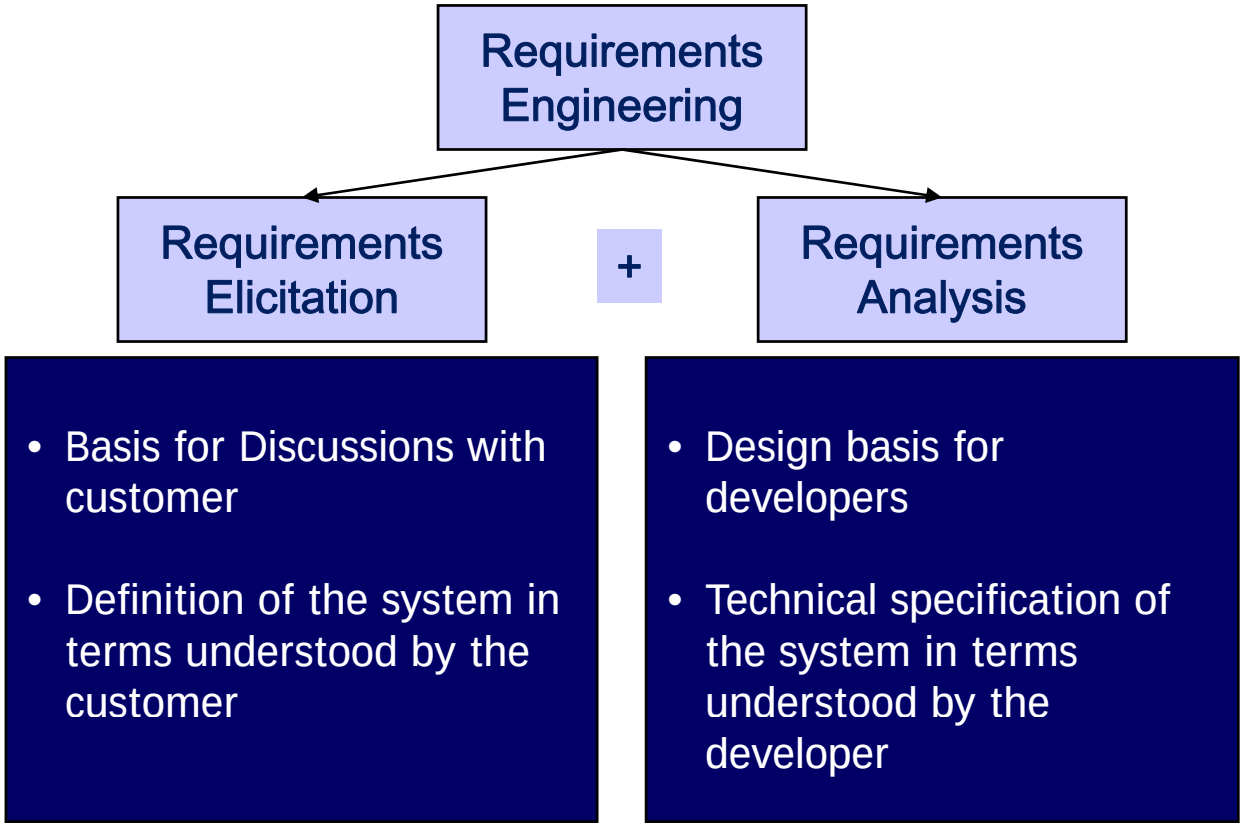
- Initial Input
  - A Vision of a system to be created (vague)
  - Different stakeholders with different interests
  - → Problem Statement

- Desired Output
  - Specification as complete as possible
    - ➔ Complete coverage of the problem (all relevant requirements are captured)
    - ➔ Complete and exact definition of each requirement

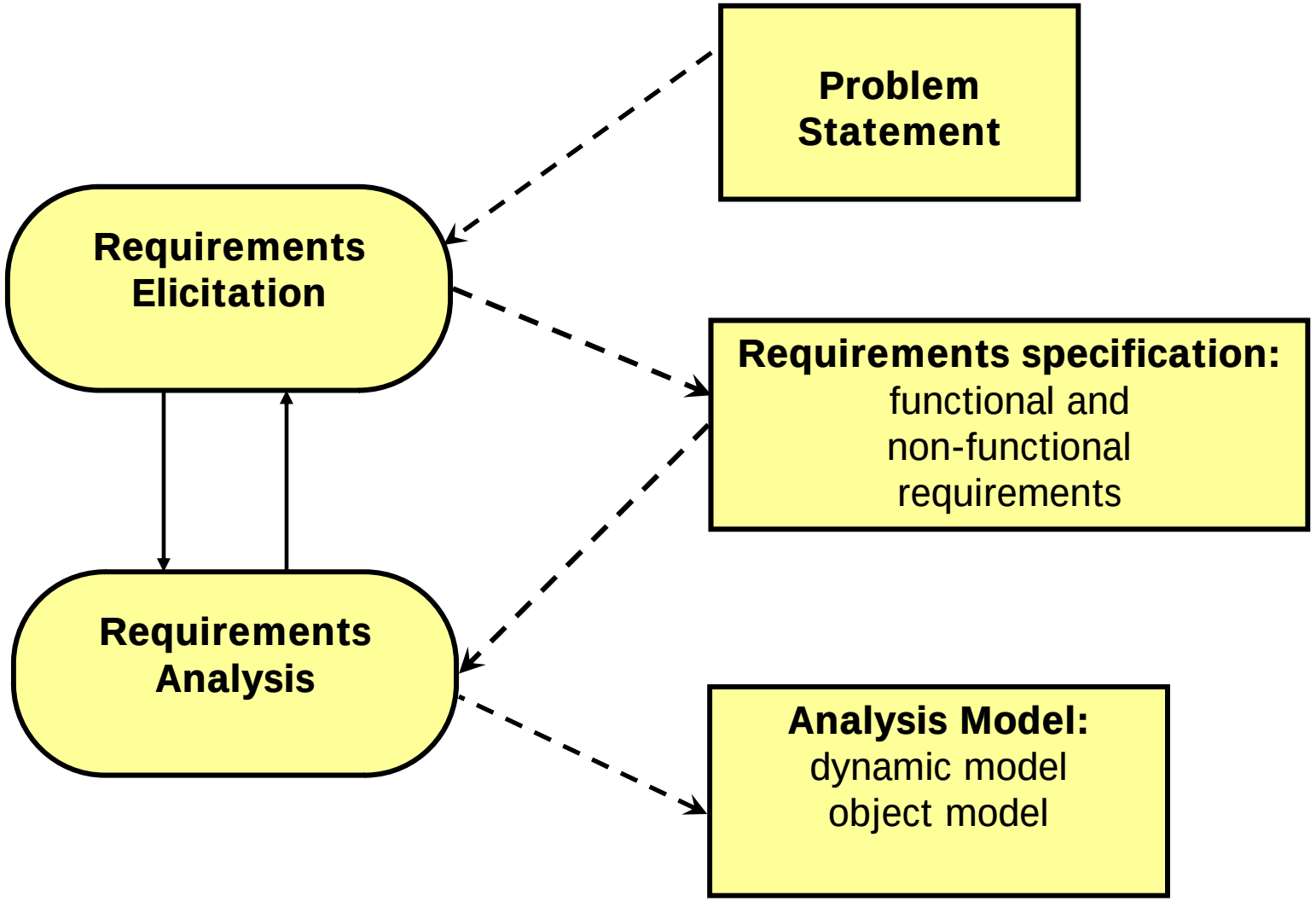
Requirements Elicitation
First view

- Encompass all activities involved in discovering the requirements of a system
- System developers and engineers work in close relationship with customer and end-users to
  - Find out more about the problem to be solved
  - To describe the functionality of the system
  - Understand the application domain (“speak its language”)
  - Hardware constraints ... and so forth
- Not just a simple process about fishing for requirements, but a highly complex process:
  - Customer rarely have a clear picture of their requirements
  - Different people have conflicting requirements

Requirements Elicitation
Relation to Requirements Analysis



Process of Requirements Elicitation:
Products of Requirements Process



Requirements and their Meaning

- Definition of term “Requirement”
  - A condition or capability of the system needed by a user to solve a problem or to achieve an objective
  - Condition or capability that must be met by a system
    - ➔ Satisfies a contract, standard, specification
  - Requirements might be expressed by the customer in different forms:
    - ➔ Information, Ideas, Constraints

Functional and Non-Functional Requirements

- Functional requirements
  - Describe the interactions between the system and its environment independent from implementation
- Non-functional requirements (Most typical)
  - Quality aspects of the system not directly related to functional behavior.
  - Reliability, Performance, Availability, Supportability, Usability, Tailorability, Security
- Pseudo requirements (Non-functional requirements B)
  - Imposed by the client or the environment in which the system operates
  - Legal requirements
  - Design and Implementation Constraints
- Project Management (Non-functional requirements C)
  - Budget, Release Date

The Goal: Analysis Model (vs. Requirements Specification)

- Both models focus on the requirements from the user's view of the system.
- Requirements specification uses natural language (derived from the *problem statement*)
- The analysis model uses formal or semi-formal notation.

- Our graphical language UML can be used in a formal as well as in a semi formal way. (http://martinfowler.com/bliki/UmlMode.html)
- Formal notations encompass an exact mathematical syntax and semantic

- The starting point is the problem statement

Starting with the Problem Statement

- The problem statement is developed by the client as a condensed description of the requirements that should be addressed by the system
- Describes the problem that should be solved
- It describes “what” is needed, not “how” it should be reached

Starting with the Problem Statement: Ingredients

- Current situation: The Problem to be solved
  - A few pages
- Description of one or more scenarios
- Some initial requirements
  - Functional and Non-functional requirements
  - No complete description
- Project Schedule
  - Major milestones that involve interaction with the client including deadline for delivery of the system
- Target environment
  - The environment in which the delivered system has to perform a specified set of system tests
- Client Acceptance Criteria
  - Criteria for the system tests

Starting with the Problem Statement: Problem vs. Change

- There is a problem in the current situation
  - Examples:
    - ➔ The response time in a travel booking system is far too slow
    - ➔ There have been illegal attacks to the system

- A change either in the application domain or in the solution domain has appeared
  - Change in the application domain
    - ➔ A new function (business process) is introduced into the business
    - ➔ Example: A function is provided for credit payment with fingerprint as authorization
  - Change in the solution domain
    - ➔ A new solution (technology enabler) has appeared
    - ➔ Example: New standards (implementation) for secure network communication

Example: Library System

- Idea: A Library Management System should be designed. Information on books, CDs, DVDs, Journals, etc. can be stored and retrieved

Problem Statement

- Possible Requirements:
  - Searching by Title, Author, and/or ISDN should be possible
  - User Interface should be web-based (accessible via WWW Browser)
  - At least 20 transactions per seconds should be possible
  - All services should be available within 10 minutes
  - Users have no access to personal data of other users

functional requirement

Implementation requirement

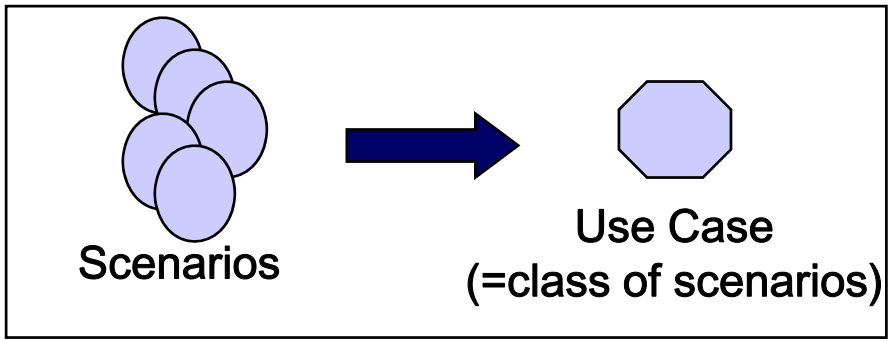
performance requirement

availability requirement

Security requirement

Process of Requirements Elicitation:
Activities during Requirements Elicitation

- Identifying Actors
  - Types of users, roles, external systems
- Identifying Scenarios
  - Interactions between users and the systems (one possible case)
  - → *Later on in this lesson*
- Identifying Use Cases
  - Abstractions of Scenarios (Many possible cases)



- Refining Use Cases
  - Refinements, adding exceptions, etc.
- Identifying Relationships among Use Cases
- Identifying Non-Functional Requirements
  - Security issues, Performance, etc.

Process of Requirements Elicitation:
How to elicit Requirements?

- Sources of information
  - Documents about the application domain
  - Manual and technical documents of legacy systems
- User Participation
  - Elicitation Techniques (see next slides)
- Approach
  - First describe a set of scenarios with elicitation techniques
  - Then aggregate the identified scenarios towards use cases
  - = Bottom → Up, Avoids misunderstandings of abstractions

Elicitation techniques - Idea

- Specific techniques which may be used to collect knowledge about system requirements
- Requirements elicitation is cooperative process involving requirements engineers and system stakeholders.
- Some possible problems:
  - Not enough time for elicitation
  - Inadequate preparation by engineers
  - Stakeholders are unconvinced of the need for a new system
- Types of Selection Criteria:
  - **Interviews**
  - **Observations**
  - Scenarios
  - Brainstorming

Selection Criteria

- System to be created (I)
  - Greenfield Engineering (completely new)
  - Reengineering (revise an existing system)
  - Interface Engineering (put a new front to an existing system)
- System to be created (II)
  - Highly interactive (Cooperation Support System)
  - Specific applications like Games
  - Criticality (Comfort, Essential Money, Lives)
- Budget/Time
- Degree of User Participation
  - Time
  - Experience of users
- .... (many more)

Interviews
Essentials

- Probably the most common technique of requirements elicitation.
- Interviewers must be open-minded and should not approach the interview with pre-conceived notions about what is required
- Stakeholders must be given a starting point for discussion
  - a question
  - a requirements proposal
  - an existing system
- Interviewers must be aware of organizational politics
  - Some requirements may not be discussed because of their political implications
- Types of interviews:
  - Structured vs. unstructured
  - Oral vs. written interviews
  - Interview of a group vs. a single person

Interviews:
Different Goals

- During elicitation (early)
  - Understanding role of interviewee within organization
  - Understanding the work context
  - Getting requirements on new system
  - **Goal: Description of complete scenarios**
- During analysis
  - Discussing use cases with client and users
  - Correction and refinement (requirements and functionality)
  - **Goal: Getting complete use cases**

Observation

- People often find it hard to describe what they do because it is so natural to them.
- Actual work processes often differ from formal, prescribed processes
  - → Sometimes the best way to understand it is to observe them at work
- Approach: adopt methods e.g. from the social sciences which proved to be valuable in understanding actual work processes
- Suitable Approach: Ethnography (Lecture ORE)

Scenarios – Overview 1

Motivation:

- System stakeholder find it more intuitive to reason about concrete examples rather than abstract descriptions of the functions provided by a system (use cases)

Solution: Scenario

- “A narrative description of what people do and experience as they try to make use of computer systems and applications”
  [M. Carrol, Scenario-based Design, Wiley, 1995]
- A concrete, focused, informal description of a single feature of the system used by a single actor
- Discovering scenarios exposes possible system interactions and reveals system facilities which may be required

Scenarios – Overview 2

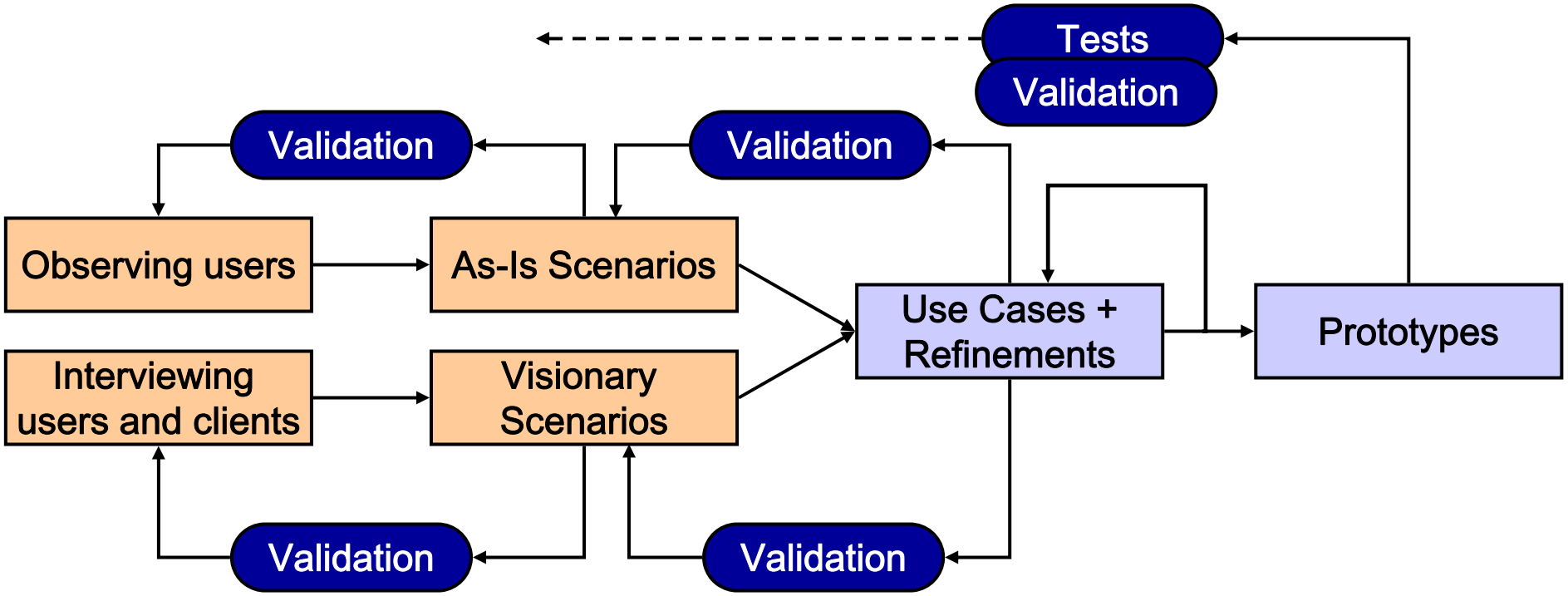
- Scenarios are *stories* which explain how a system might be used. They should include:
  - a description of the system state before entering the scenario
  - the normal flow of events in the scenario
  - exceptions to the normal flow of events
  - information about concurrent activities
  - a description of the system state at the end of the scenario

- Scenarios can have many different uses during the software lifecycle:
  - **Requirements Elicitation**: As-is scenario, visionary scenario
  - **Client Acceptance Test:** Evaluation scenario
  - **System Deployment:** Training scenario.

Scenarios:
Different Types

- As-is scenario
  - Used in describing a current situation
  - Usually used in re-engineering projects
  - The user describes the system
- Visionary scenario
  - Used to describe a future system
  - Usually used in Greenfield engineering and reengineering projects
  - Can often not be done by the user or developer alone
    - ➔ brainstorming sessions
    - ➔ needs and possiblities
- Evaluation scenario
  - User tasks against which the system is to be evaluated
- Training scenario
  - Step by step instructions that guide a novice user through a system

Process of Requirements Elicitation:
The Requirements Elicitation Cycle



Stable Requirements Specification (System Specification)

- Functional Requirements
- Non-Functional Requirements
- Use Cases
- Scenarios

Scenarios:
Example - Accident Management System

b-it

Your Task (Problem Statement):

- Build a requirements model for a system that allows to report fire incidents. It should be able to report incidents for many types of buildings and things.

The approach: Start with single Scenario, e.g. “Warehouse in fire”. Interview Guideline:

- What do you need to do if a person reports “Warehouse on Fire?”
- Who is involved in reporting an incident?
- What does the system do, if no fire cars are available?
- Can the system cope with a simultaneous incident report “Warehouse on Fire?”
- What do you need to do if the “Warehouse on Fire” turns into a “Cat in the Tree”?

Scenario:
Example - Warehouse on Fire (Bruegge)

- *Bob*, driving down main street in his patrol car notices smoke coming out of a warehouse. His partner, *Alice*, reports the emergency from her car by using the SYSTEM.
- *Alice* enters the address of the building, a brief description of its location (i.e., north west corner), and an emergency level. In addition to a fire unit, she requests several paramedic units on the scene. She confirms her input and waits for an acknowledgment.
- *John*, the Dispatcher, is alerted to the emergency by a beep of his workstation. He reviews the information submitted by Alice and acknowledges the report. He allocates a fire unit and two paramedic units to the Incident site and sends their estimated arrival time (ETA) to Alice.
- *Alice* received the acknowledgment and the ETA.

Scenarios:
Observations about “Warehouse on Fire”

- Concrete scenario
  - Describes a single instance of reporting a fire incident.
  - Does not describe all possible situations in which a fire can be reported.
- Normal behavior (“lucky day” scenario)
  - No exceptional cases
- Participating actors
  - Bob, Alice and John = concrete names

Scenarios:
Observations about “Warehouse on Fire”

- ... ok, but we have even more scenarios available and identified:
  - Report fire in a car
  - Report flat on fire
  - Report cat on fire
  - Report truck on fire

- Next step: aggregate these scenarios towards a coherent use case to describe the possible sequence of events to “report a fire incident”

Use Case:
Example – ReportFireIncident

- *The Fireman* on duty notices a fire incident. The *Fireman* or his *Replacement (*hereafter termed *Initiator*) reports the emergency from their car by using the SYSTEM.

- *The Initiator* enters the address of the corresponding fireplace, a brief description of its location (i.e., north west corner), and an emergency level. In addition to a fire unit, the *Initiator* requests several paramedic units on the scene. He confirms his input and waits for an acknowledgment.

- The *Dispatcher* on duty, is alerted to the emergency by a beep of his workstation. He reviews the information submitted by the Initiator and acknowledges the report. He allocates a fire unit and a suitable number of paramedic units to the Incident site and sends their estimated arrival time (ETA) back to the *Initiator*.

- The *Initiator* receives the acknowledgment and the ETA.

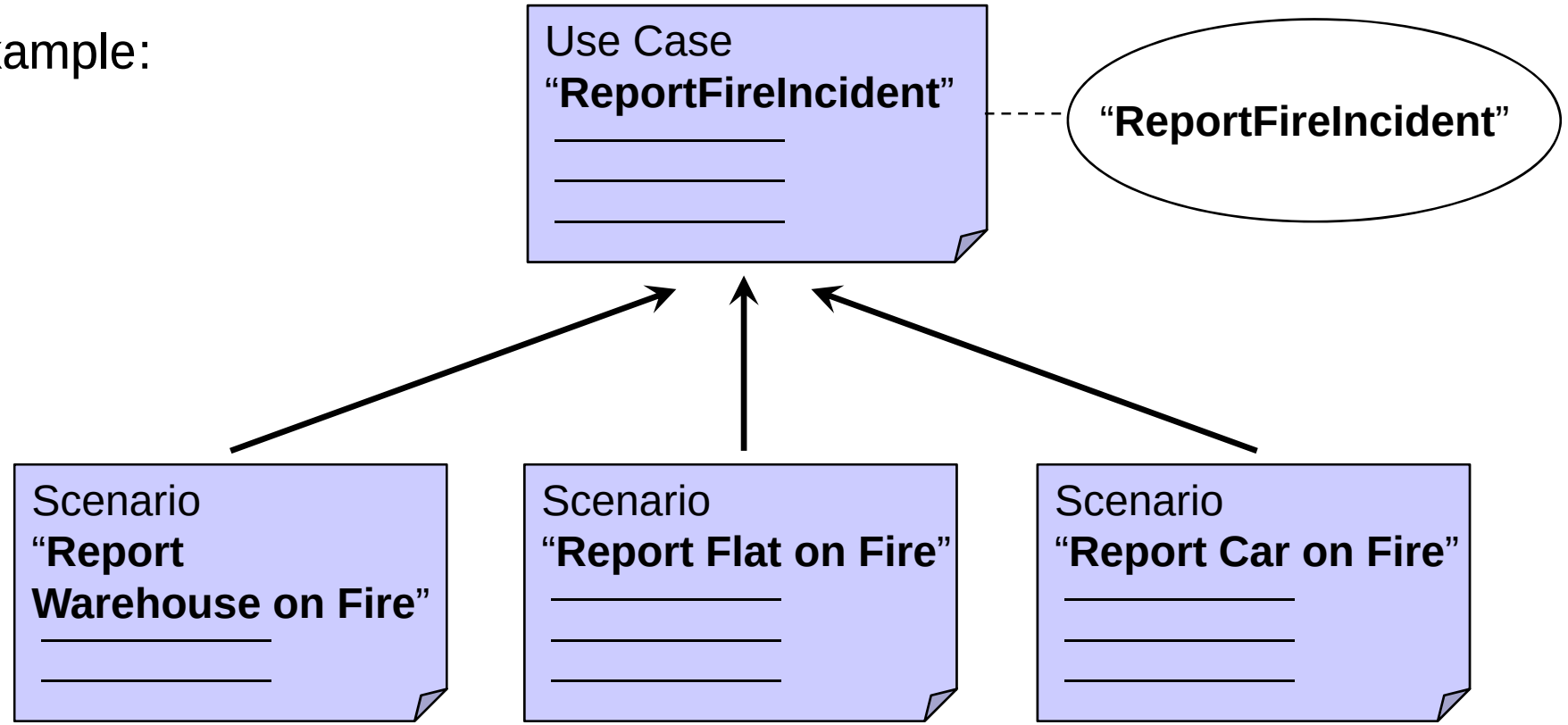
Use Case:
Observations about “ReportFireIncident”

- A more abstract use case
  - Describes a potentially huge number of instances of reporting a fire incident,
  - Describe all possible situations in which a fire can be reported.
- Normal behavior (“lucky day” use case)
  - No exceptional cases
- Participating actors
  - Initiator, Fireman, Representative

From Scenarios to use cases
First pass

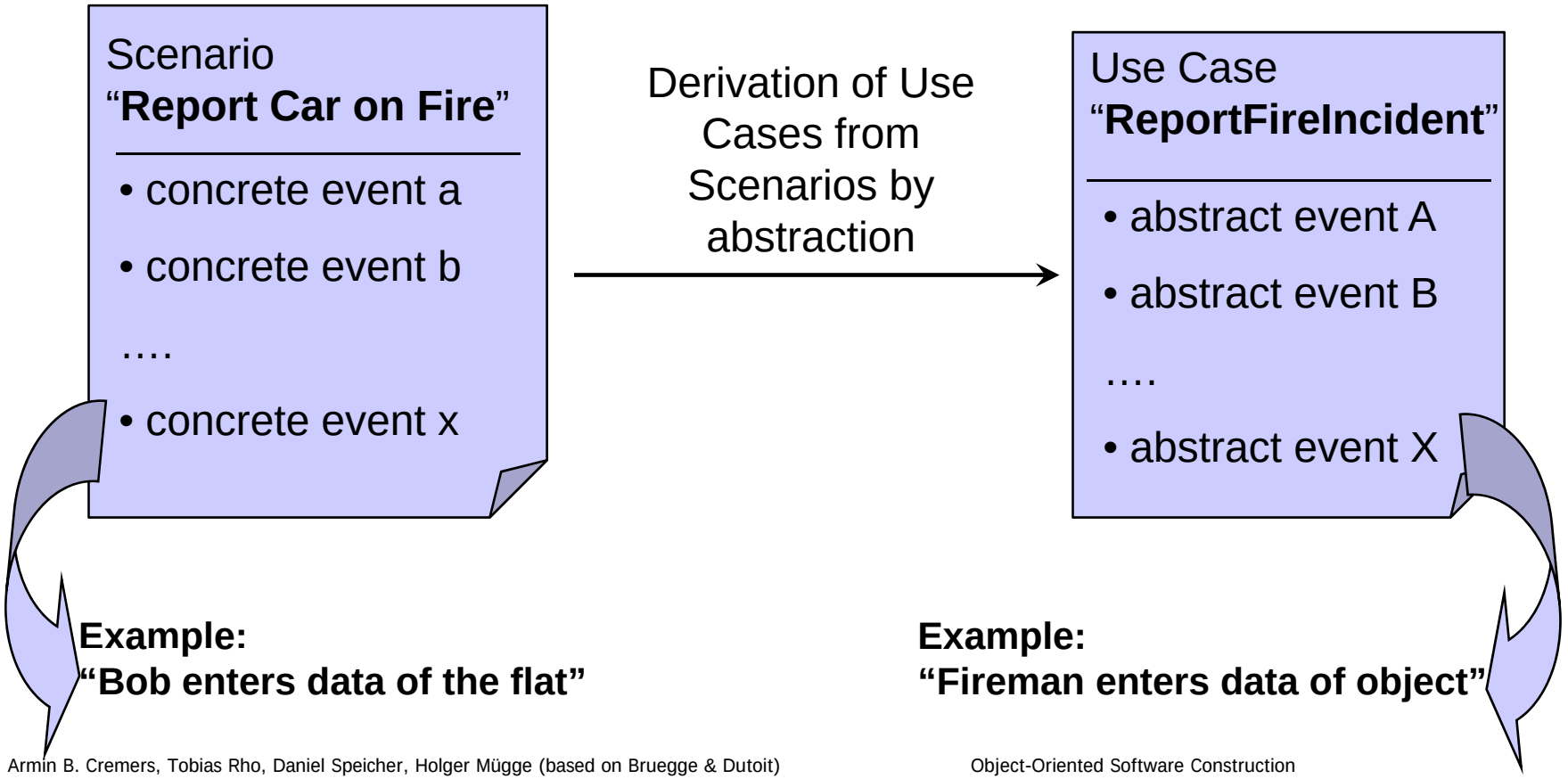
- Use case: an abstraction of possible coherent scenarios
- Scenario: a single example of a scenario
  → instance of a use case!

Example:



From Scenarios to use cases
Relationship of events

- Use case: abstract events
- Scenario: concrete events



How to create a use case from a set of scenarios? (1/7)

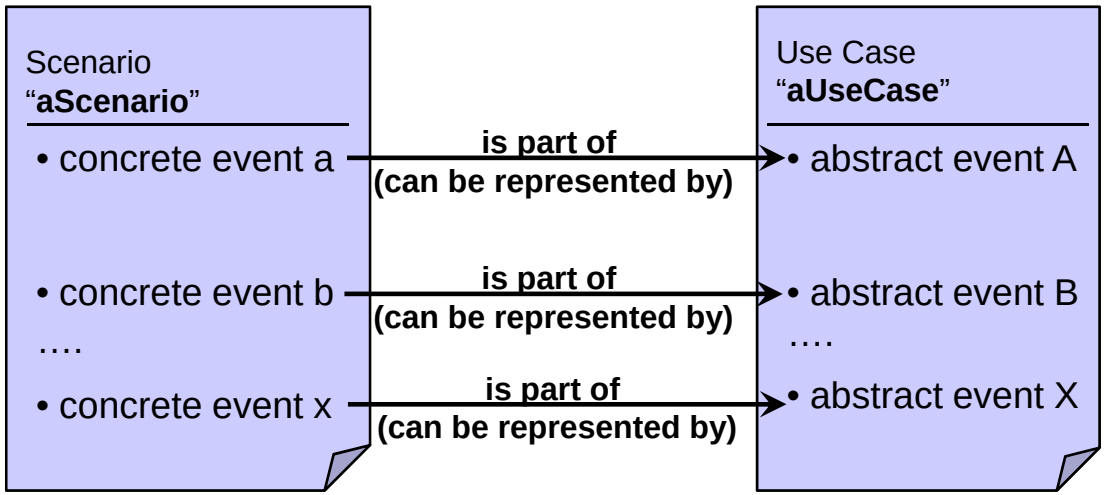
- Start with an arbitrary chosen scenario.
- Identify the actors taking part in it.
  - An actor is an abstraction of (or role assumed by) concrete persons, a subject or entities.
    Example: “Bob" can be seen as an instance of an actor named “Fireman“
  - Identify the actor that *initiates* the use case ("primary" actor)
    → inspect substantives!
  - Identify the "secondary" actors, who typically react to the system rather than taking initiative themselves.
- Create a new Use Case bubble and Symbols for all involved Actors. Connect each of the actors with the use case.
  - For primary actors: annotate them with <<initiates>>

How to create a use case from a set of scenarios? (2/7)

- Write down the flow of events of the use case. For the first scenario under inspection, this is mostly a copy&paste operation:
- Take the events of the scenarios, replace references to concrete concepts with abstractions:
  - Person names (e.g. “Bob” → “User”)
  - Attributes (e.g. skip “on the road to home”)
  - Locations (e.g. “Flat” → “Fireplace”)
  - Job specifications (e.g. “Enter data with a Palm PDA OS 4.0” → “Enter data with a user terminal”)

How to create a use case from a set of scenarios? (3 / 7)

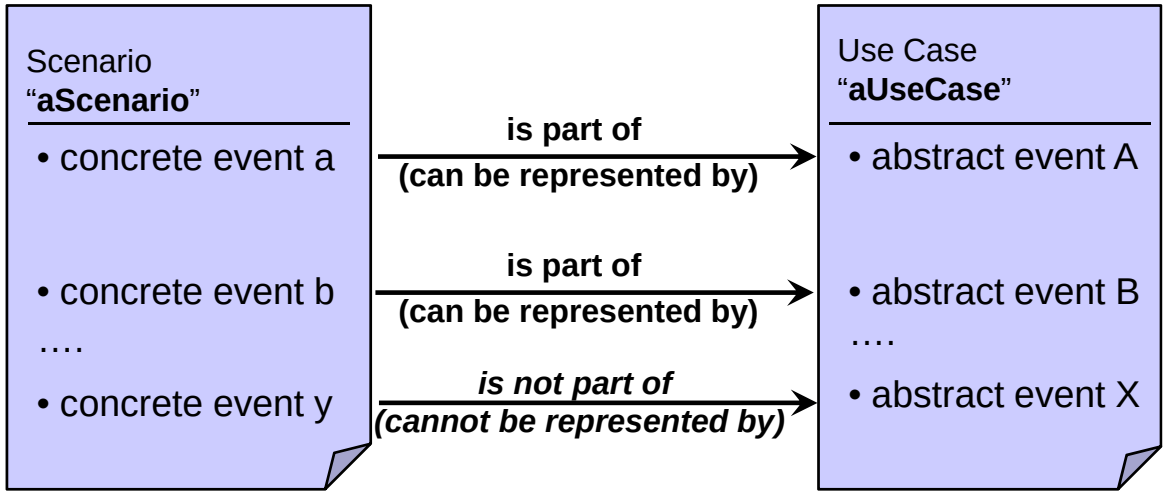
- As long as there are scenarios remaining, repeat the following:
  - Pick a scenario that is not dealed with yet.
  - If the scenario is *exactly* an instance of one of the use cases in your current model, you can just skip it



  - If there is *no* matching, then create a new use case

How to create a use case from a set of scenarios? (4/7)

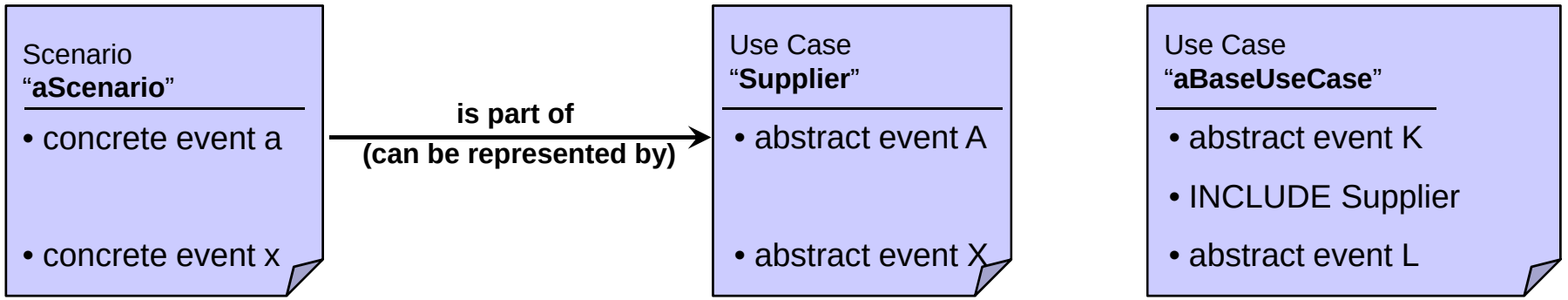
- Update the use case if there are *some* incompatible events
  - *Some* concrete Event cannot be represented by an abstract event
  - The number of concrete events does not fit the number of abstract events

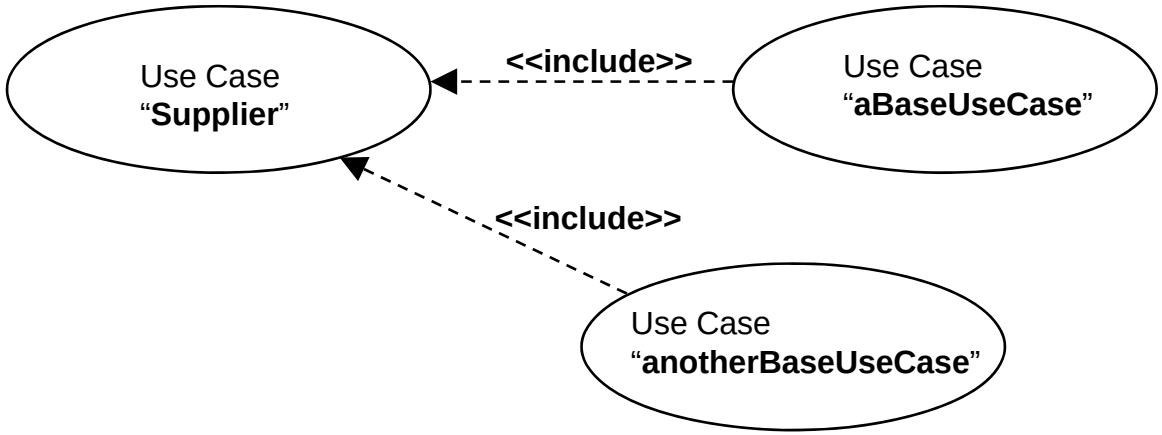


  - What to do? (Suggestions: *Include* an abstract Use Case, Describe an *generalized* Use Case, Let two Use Cases *extend* this Use Case)

How to create a use case from a set of scenarios? (5/7)

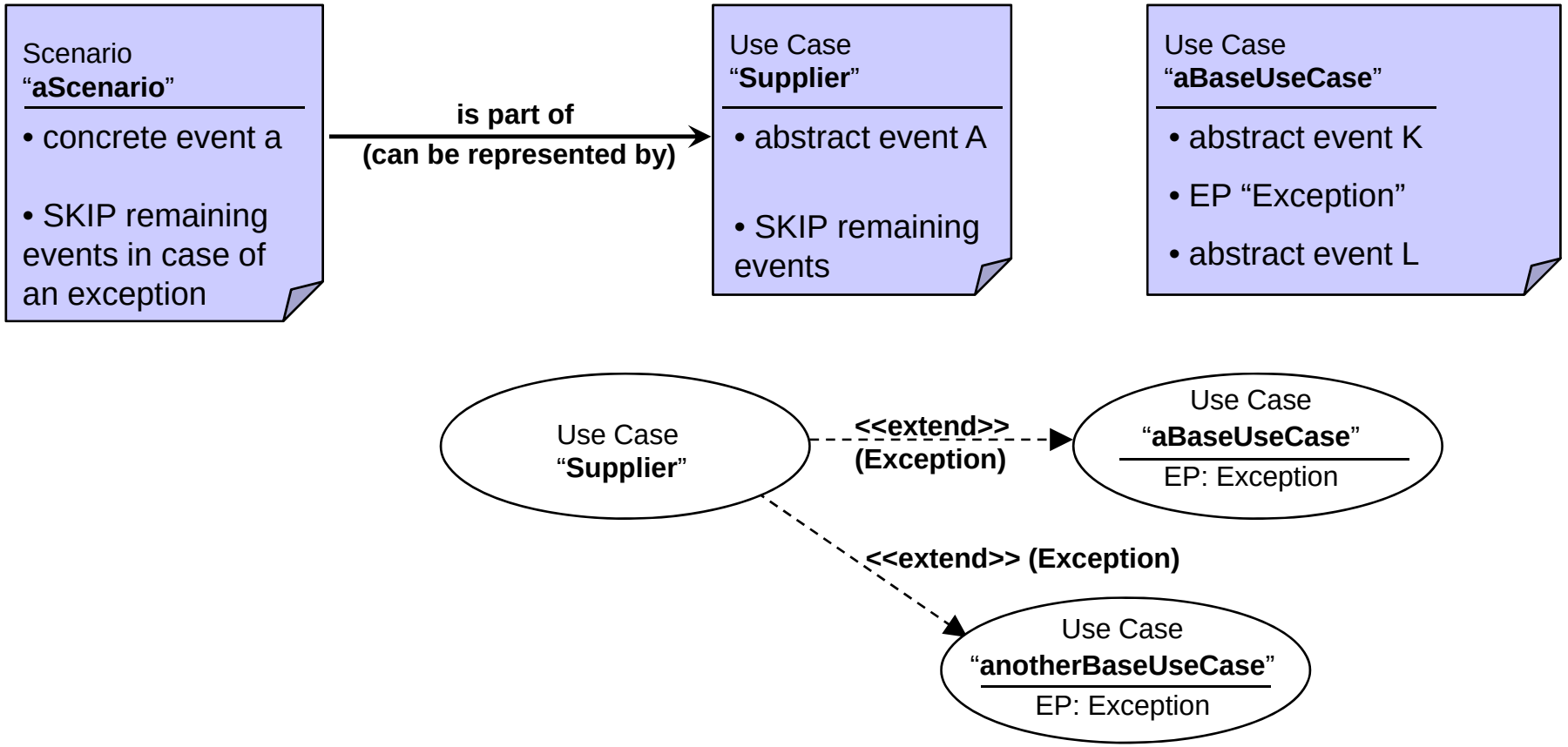
- If you detect (partial) scenarios that can be potentially shared by many use case, include them (reuse):





How to create a use case from a set of scenarios? (6 / 7)

- If you think the new scenario represents optional or exceptional behavior, introduce an extension point in the flow of the original use case, and add the diverging behavior as an extension:



How to create a use case from a set of scenarios? (7/7)

- Some more Pseudo Codes can be used in textual use cases:
  - INCLUDE <use case name>
  - SKIP <events>
  - REPEAT n times (subsequence)
  - EP-Cross <extension point name> (denotes that this extension point is valid throughout the next events)
  - IF <condition> THEN <events> ELSE <events>
  - INHERIT <events>
  - OVERIDE <event> <newEvent>

- Further Heuristics can be applied:
  - Number of use cases should moderate
  - Avoid a functional decomposition of the system (too detailed)

Scenarios:
Possible questions in an interview

- What are the primary tasks that the system needs to perform?
- How do you currently perform your primary task?
- Do you know about any kind of system or service that already fulfills some task?
- What data will the (main) actor create, store, change, remove or add in the system?
- Are there other actors in the system (explain the term actor!)
- Do the actors need assistance during carrying out their tasks?
- What external changes does the system need to know about?
- What changes or events will the actor of the system need to be informed about?
- What kind of exceptions can you suggest?
- Can actors interrupt a sequence of interaction? What happens, if so?
- What about extra-ordinary events and tasks?

Summary
(Requirements Elicitation Overview)

- The goal of this phase is a model representing the requirements of the system seen from the user‘s perspective
- First steps are:
  - Write the Problem Statement
  - Elicit Requirements (with Interviews, task observation)

- First step of elicitation is understanding scenarios
- Consolidate the list of scenarios by abstracting use cases

- Requirements elicitation is a cyclic process

Upcoming Lecture, WS08: ATSC
(Advanced Topics in Software Construction)

- Prof. Dr. Armin B. Cremers, Daniel Speicher, Tobias Rho
- Number of ECTS Credits: 4, Typ/SWS: V2/Ü1
- Methodologies and crafts supporting the following factors:
  - Quality of requirements
  - Seamless translation of requirements into design
  - Choice of a flexible architecture
  - Selection of an appropriate process
- Focus on the conceptual consistency through the process phases.
  => First introduction to some of the latest technologies
  - Model driven architecture
  - Product lines
  - Aspect-oriented software