Requirements Engineering for Decision Support Systems

Ruth Raventós
July 10th, 2014
Berlin, Germany

Fourth European Business Intelligence
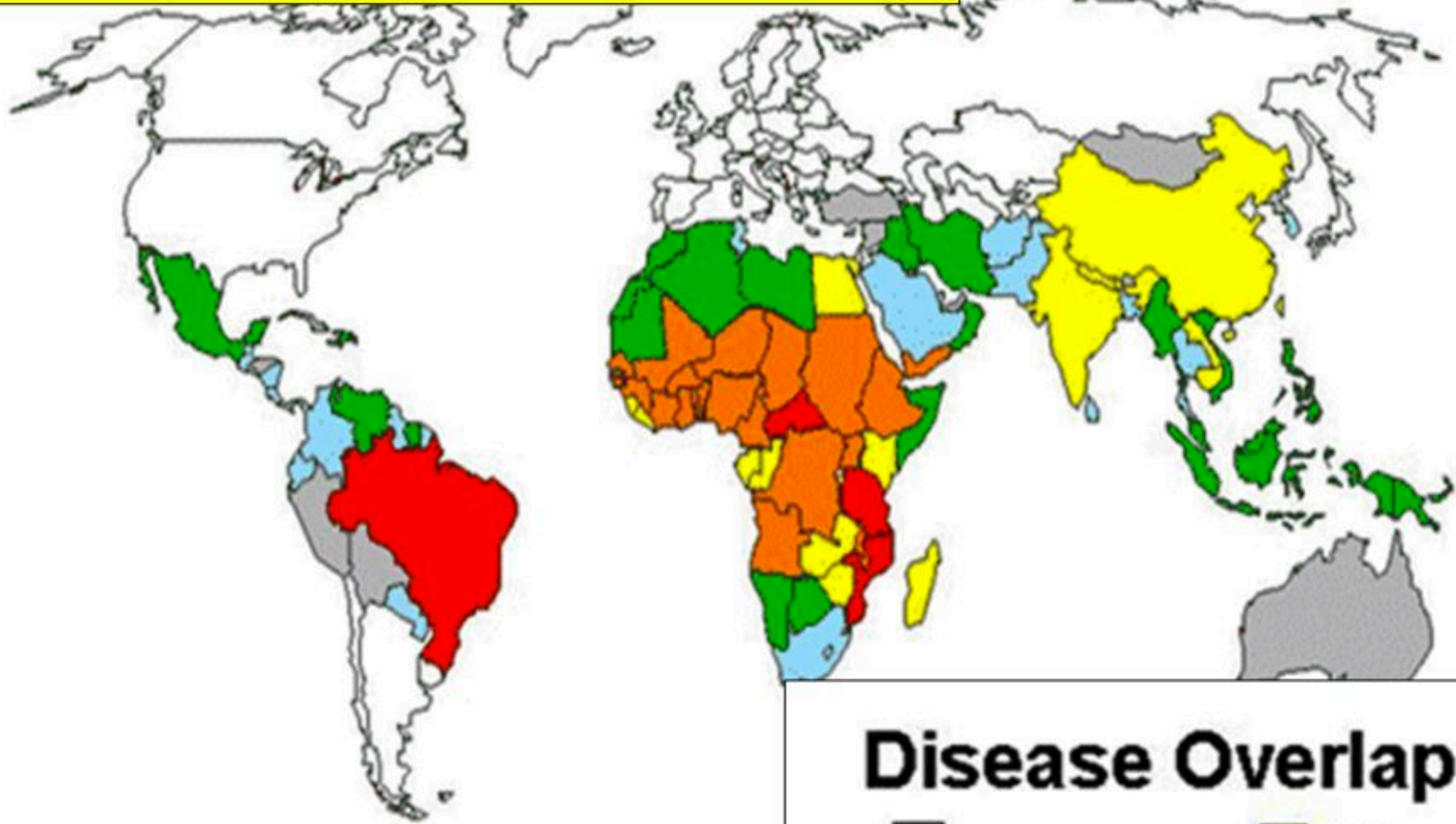Summer School
(eBISS 2014)

World Health Organization

United Nation agency founded 1948 to
rect and coordinate authority for health

Neglected Tropical Diseases (NTDs)

Disease Overlap

Color	Overlap
Gray	1 Disease
Light blue	2 Diseases
Green	3 Diseases
Yellow	4 Diseases
Orange	5 Diseases
Red	6 Diseases

World Health Organization

2010 1st Report on NTD
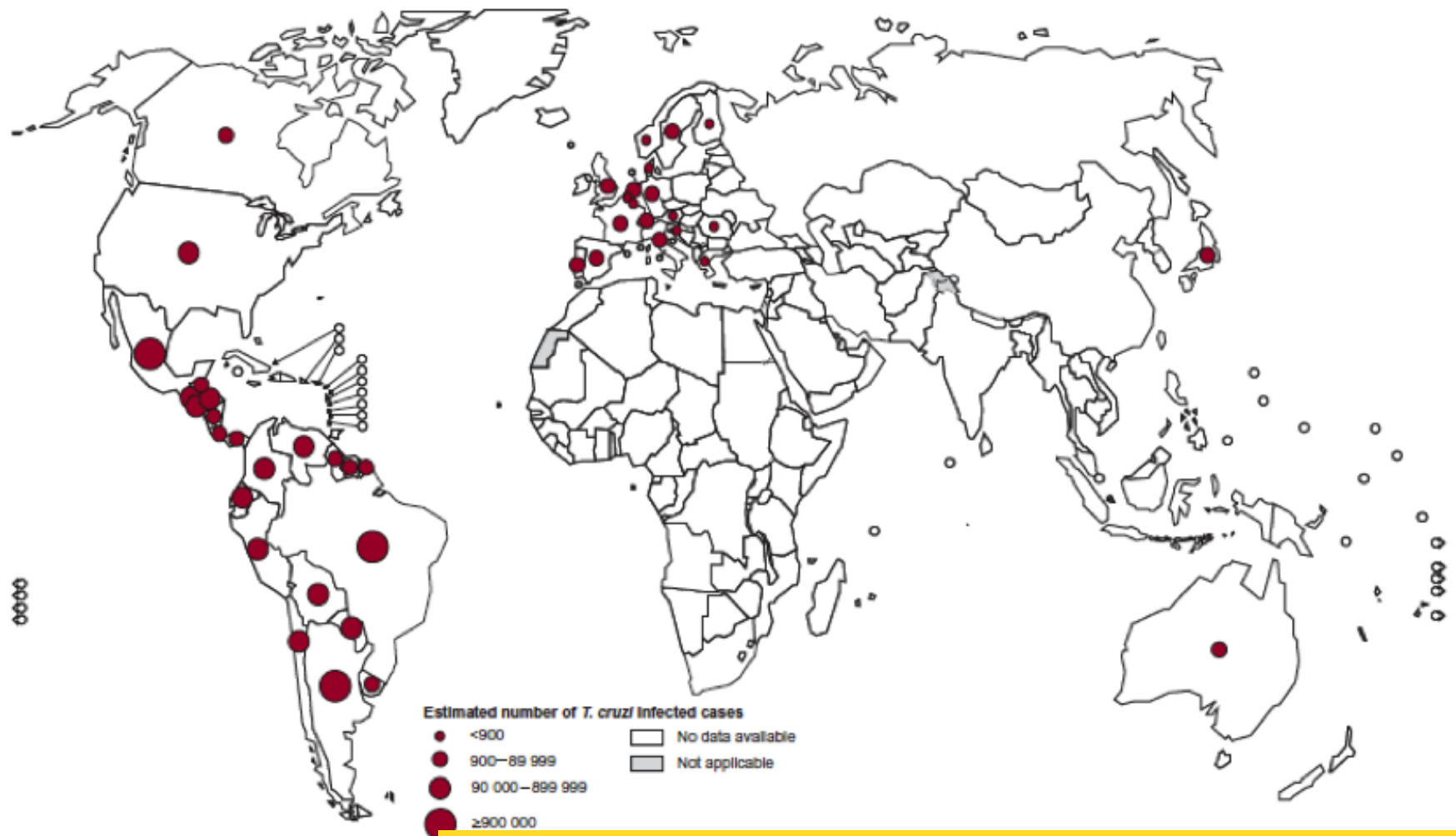
Over 90% of NTD burden is in Africa

3

13

Human American Trypanosomiasis ([Chagas Disease](#))

A potentially life-threatening illness caused by the parasite *Trypanosoma cruzy*

4

Global distribution of Chagas disease
(based on official estimates, 2006-2008)

Estimated number of *T. cruzi* infected cases

● <900	□ No data available
● 900–89 999	▨ Not applicable
● 90 000–899 999	
● ≥900 000	

7 to 8 million people worldwide are estimated to be infected

2010 - World Health Assembly (WHA)
Approve the
"Chagas disease: control and elimination"
resolution

6

2013 – New Strategy with a Vision: *Advance in disease control based on creating a DSS for surveillance to raise awareness on the Chagas disease.*

2013 – New Strategy with a Vision: *Advance in disease control based on creating a DSS for surveillance to raise awareness on the Chagas disease.*

Alberto Abelló
Oscar Romero
Jaume Viñas
Ruth Raventós

UNIVERSITAT POLITÈCNICA
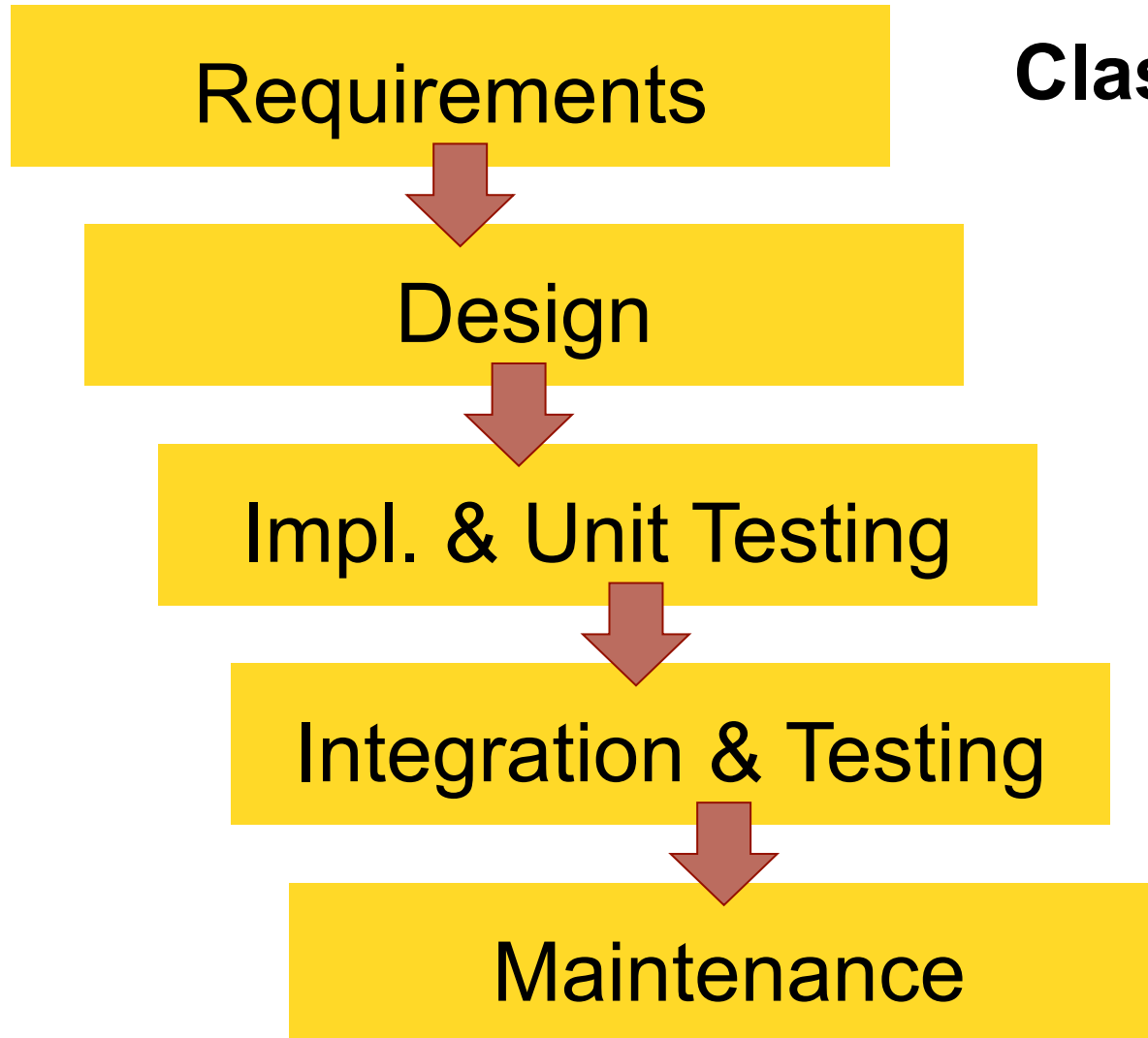DE CATALUNYA
UPC BARCELONATECH

Initial Vision

To develop a software system to change the current reality

First, we wanted to develop a Data Warehouse for the global WHO information & surveillance system to control /eliminate Chagas disease

Software Development Process

Requirements

Design

Impl. & Unit Testing

Integration & Testing

Maintenance

Classic Waterfall Model

Agile Methodologies
(like SCRUM, with iterations)

10

SOMMERVILLE, I. Software Engineering, 9 ed. Addison-Wesley, 2010

Requirements Engineering

The hardest single part of building a software is deciding precisely
what to build.

Requirements engineering refers to the process of formulating, documenting and maintaining software requirements.

11

Requirements Engineering

A sub-discipline of systems engineering and software engineering
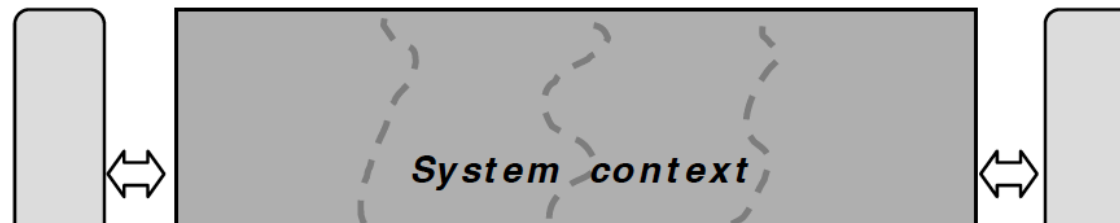
That is concerned with determining:
- the goals,
- function, and
- constraints

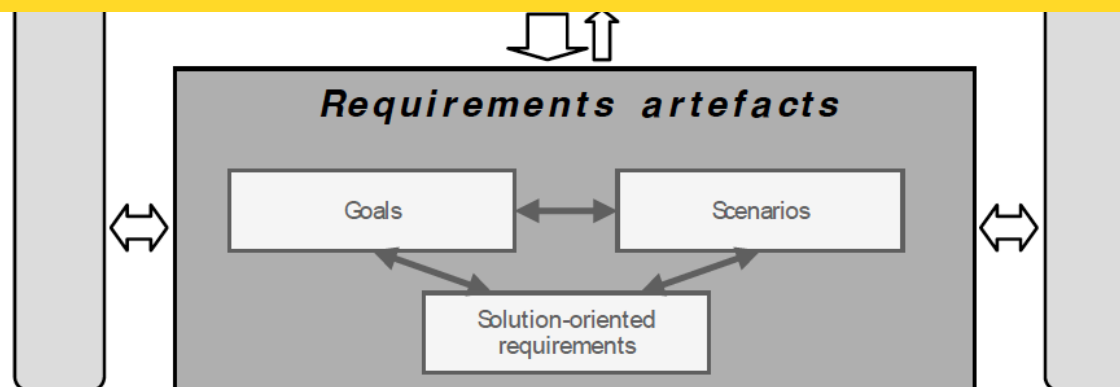of hardware and software systems

12

LAPLANTE, Phil. Requirements Engineering for Software Systems. Redmon, WA: CRC Press.

Complexity of the project

Method

We followed a systematic approach to perform the requirements engineering process by applying the Pohl's Framework

System context

Requirements artefacts

| Goals | Scenarios |

Solution-oriented requirements

POHL, K. Requirements Engineering: Fundamentals, Principles and Techniques, Springer, 2010

Pohl's Framework

This framework has been successfully introduced in a number of organisations and companies as a reference for structuring their requirements engineering processes, as a reference for the training managers, requirements engineers, and developers, and for analysing the strengths and weaknesses of their requirements processes.

Requirements artefacts

Goals ⟷ Scenarios

Solution-oriented requirements

15
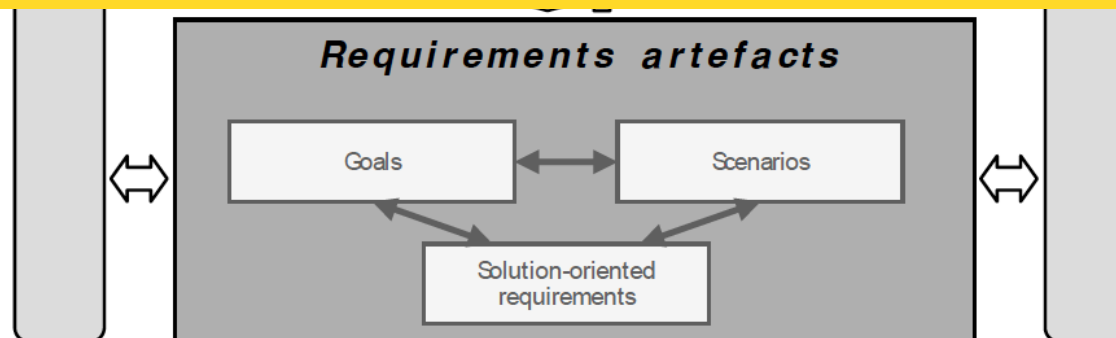
Complexity of the project

RE resulted to be extremely challenging!

Complexity of the project

Similar complexity issues can be found when building any other DSS

The challenge motivated:

To propose a systematic approach for Requirements Engineering on Decision Support systems:
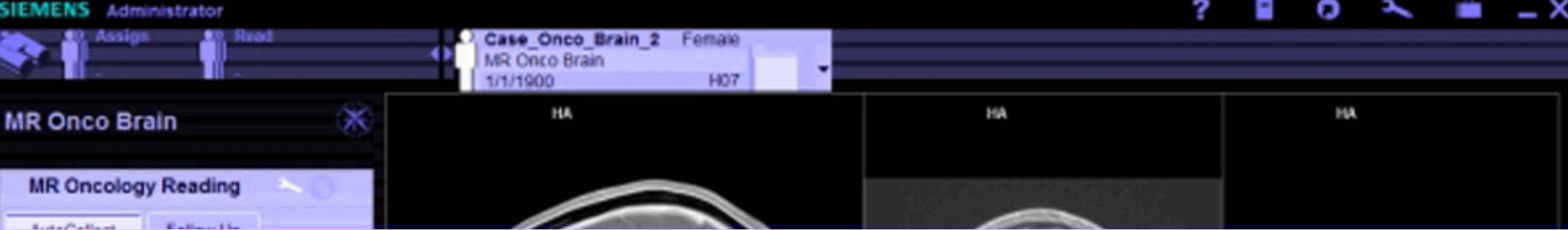**RE$_4$DSS**

outline

19

We cannot run the **modern world** without **software**
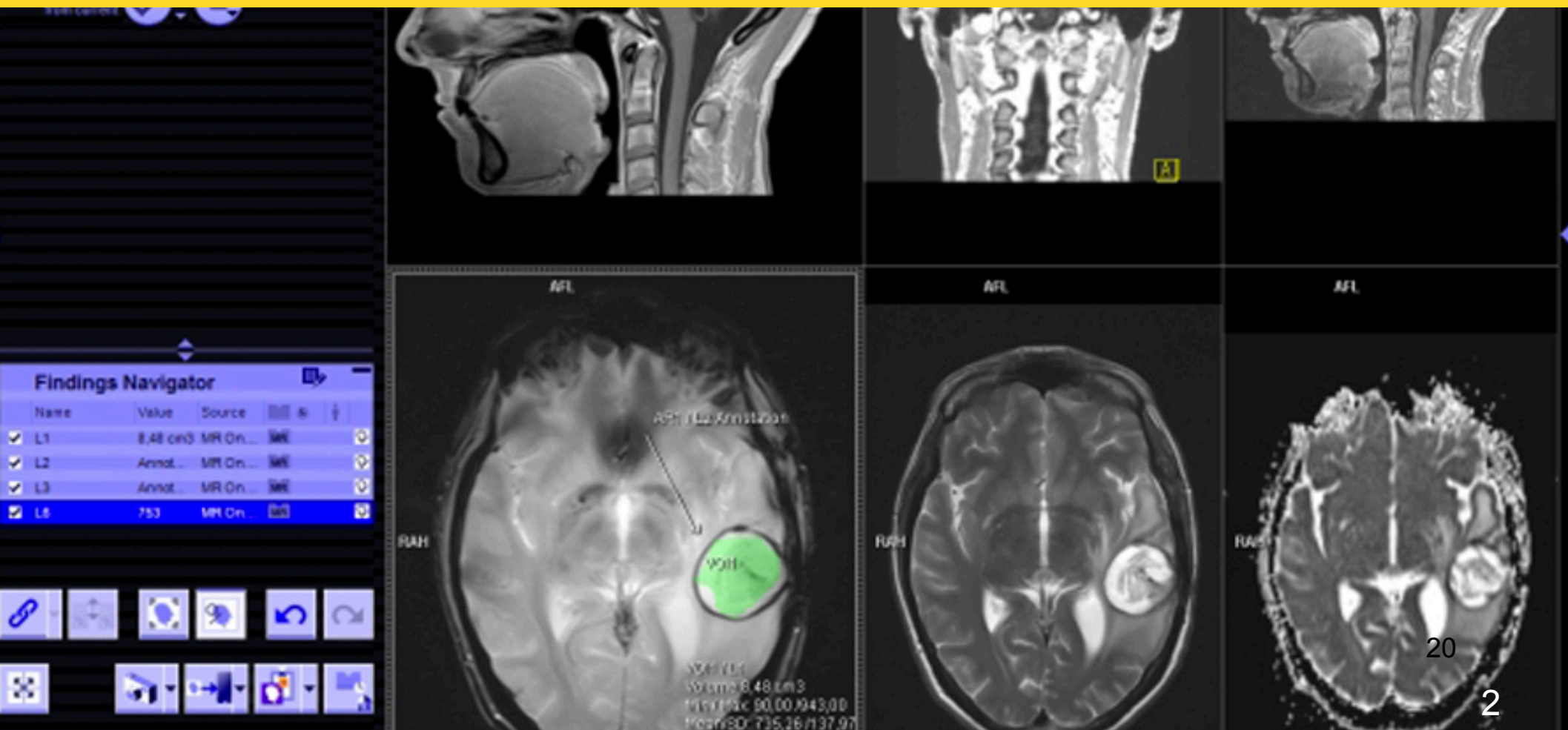
Software Development Process
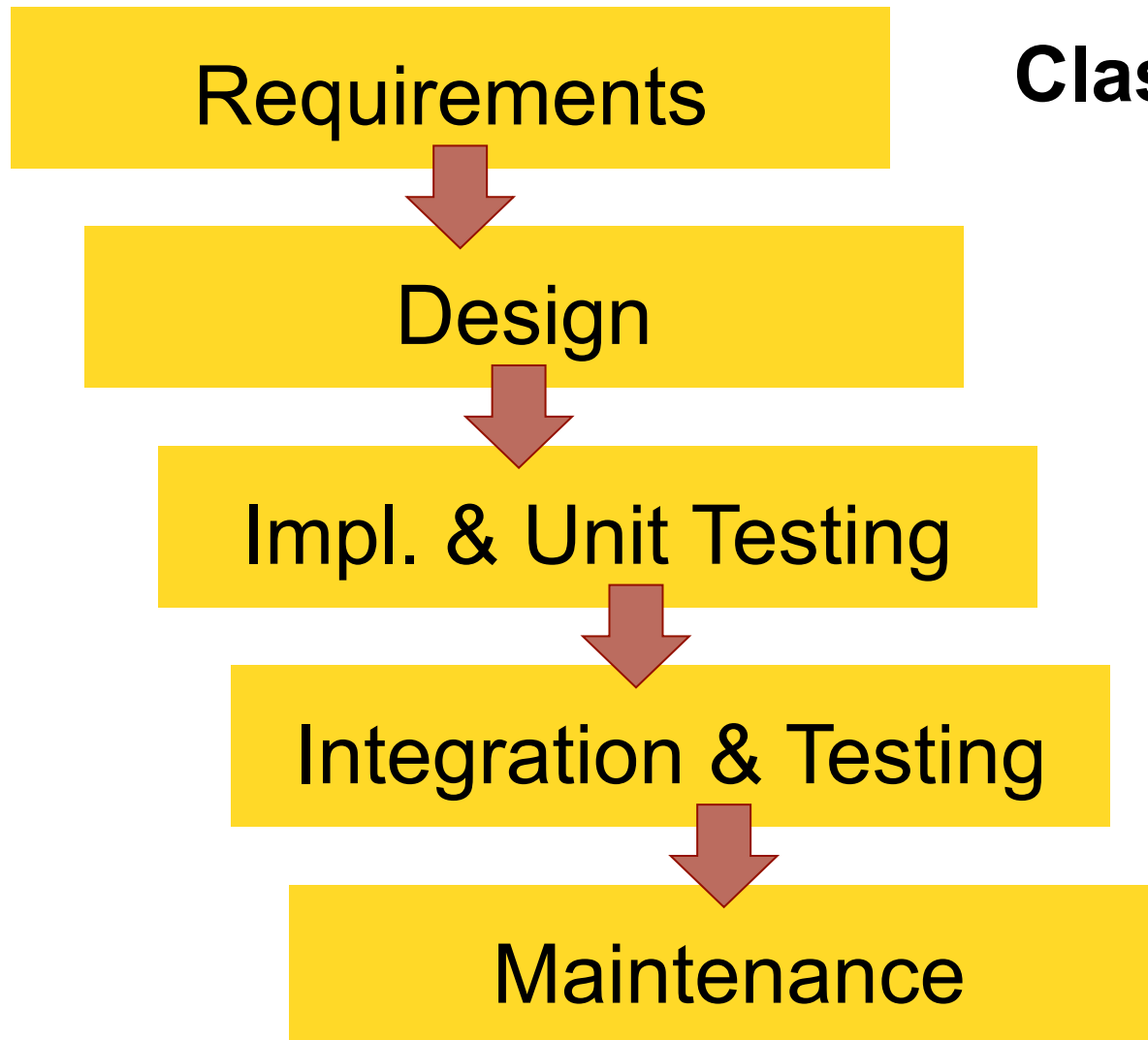
Requirements

↓

Design

↓

Impl. & Unit Testing

↓

Integration & Testing

↓

Maintenance

Classic Waterfall Model

Agile Methodologies
(like SCRUM, with iterations)

21

SOMMERVILLE, I. Software Engineering, 9 ed. Addison-Wesley, 2010

6

Software Development Process

Requirements

$\downarrow$

Design

The hardest single part of building a software
is deciding precisely
what to build.

Integration & Testing

$\downarrow$

Maintenance

22

SOMMERVILLE, I. Software Engineering, 9 ed. Addison-Wesley, 2010

6

Chagas disease project

Signs and symptoms

Acute Phase

- Last 2 months.
- Usually detected before the age of 15
- Most present mild symptoms or a characteristic visible sign

Chronic Phase

- The parasite fall to undetectable level and hidden usually in the heart and digestive muscle.
- Up to 30% of patients will suffer from cardiac disorders (heart failure, arrhythmias and sudden death) 10-20 years after the acute phase.

24

Transmission

- Vectorial
- Oral
- Blood transfusion
- Organ transplantation
- Laboratory accident

One of the most important challenges to control/eliminate Chagas is to interrupt its transmission

25

Initial complexity of the project

The WHO Programme did not have a pre-determined/define proposal of the information and surveillance system

Initial complexity of the project

Our knowledge about the medical and entomological domain was very scarce

Communication would not be easy 27

Software Development Process

Requirements

Design

The hardest single part of building a software
is deciding precisely
what to build.

Integration & Testing

Maintenance

28

SOMMERVILLE, I. Software Engineering, 9 ed. Addison-Wesley, 2010

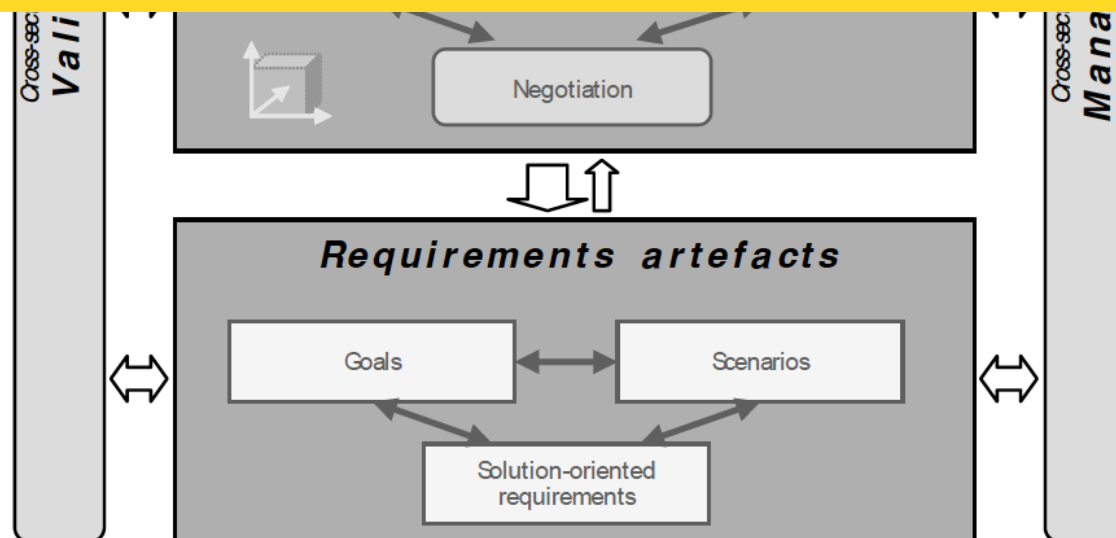# Requirements Engineering

Essential Activity in the
Software Development Process

The Problem

Requirements Engineering
is a complex and difficult activity,
and there's a **lot of work** in this field,
but the **support DSS developers get
from it is scarce**.

Specific Objectives

To apply a systematic approach for the Requirements Engineering for the creation of the Chagas disease control and elimination system

POHL, K. Requirements Engineering: Fundamentals, Principles and Techniques, Springer, 2010

31

Specific Objectives

To apply Pohl's Framework seemed the best option in this case

POHL, K. Requirements Engineering: Fundamentals, Principles and Techniques, Springer, 2010

32
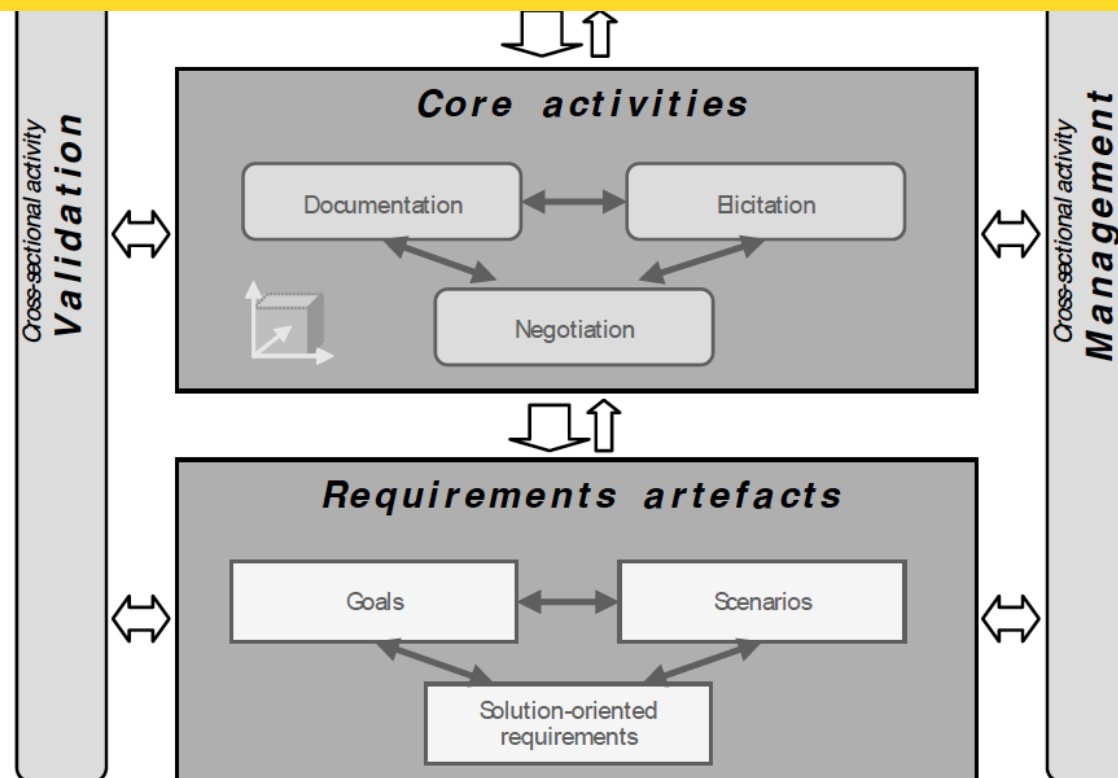
Goal of this session

After this presentation, you should understand:

➢ The Requirements Engineering Pohl's Framework.

➢ Complexity of Chagas project (a Req. Eng. DSS Project)

➢ Requirements Engineering in DSS.
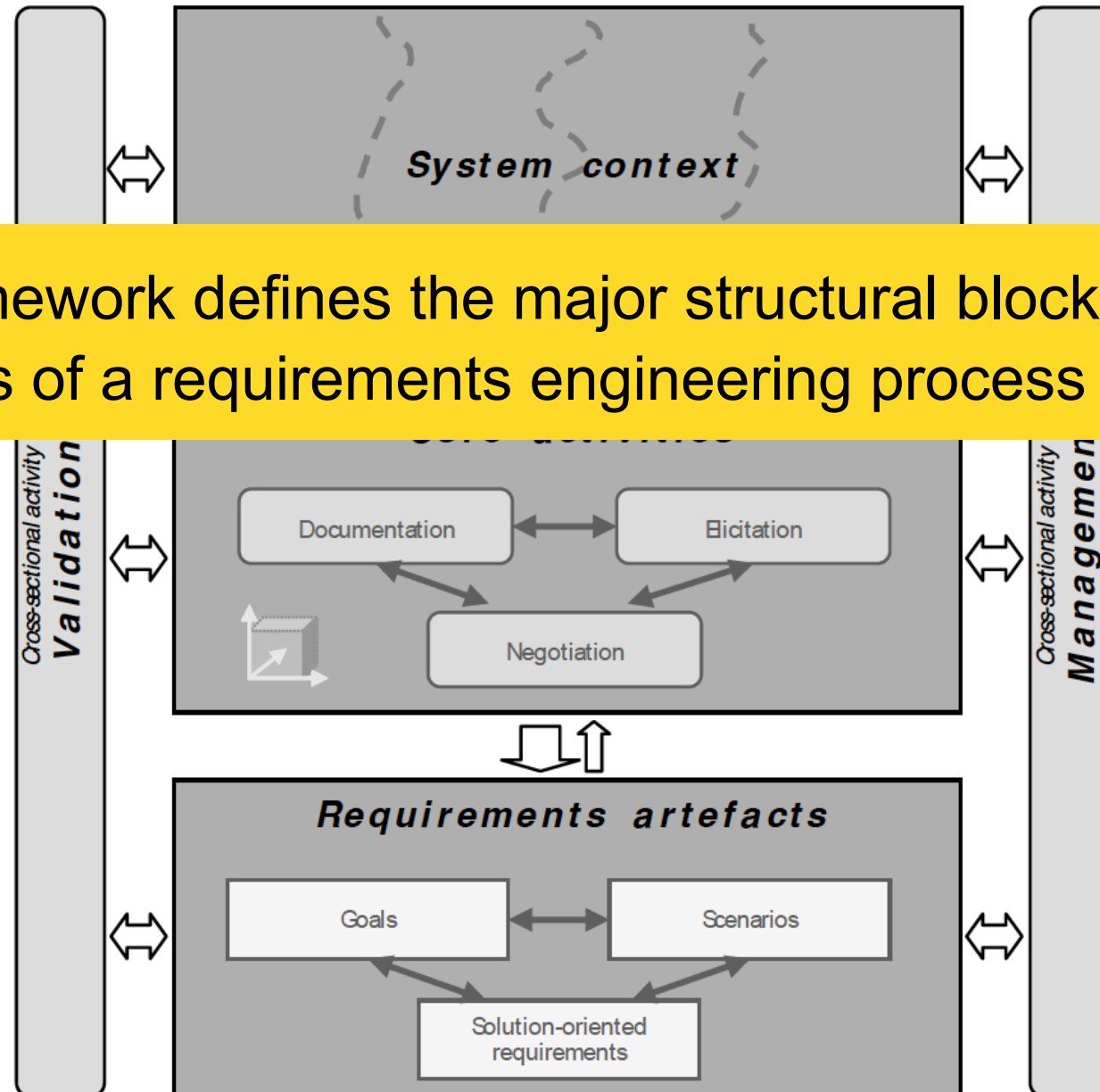
➢ RE$_4$DSS: a new proposed approach for RE in DSS.
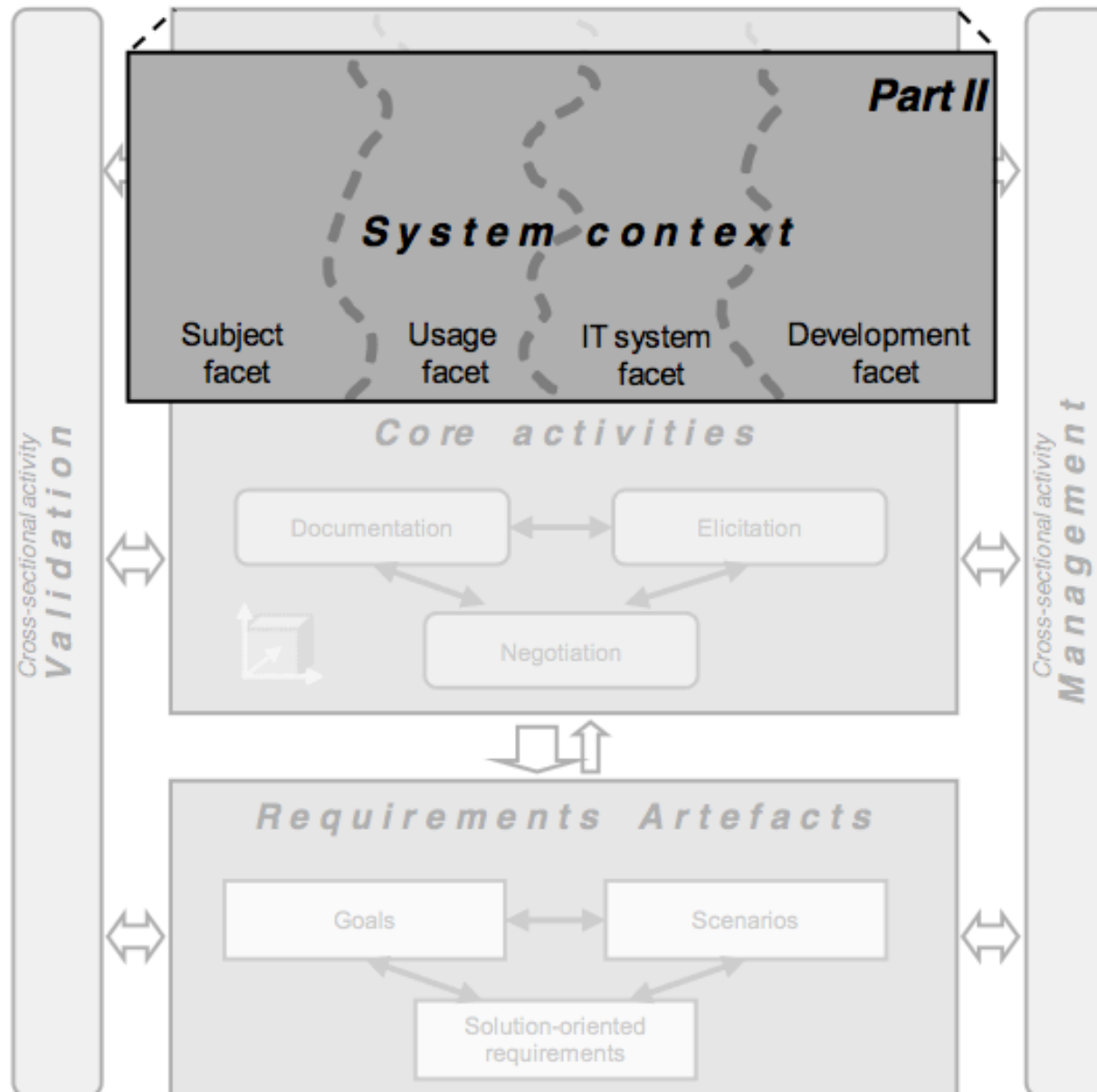
33

outline

34

Klaus Pohl's Requirements Engineering framework

The framework defines the major structural blocks and elements of a requirements engineering process

35

POHL, K. Requirements Engineering: Fundamentals, Principles and Techniques, Springer, 2010

The system context

POHL, K. Requirements Engineering: Fundamentals, Principles and Techniques, Springer, 2010

The system context

System boundary

System

System context

Context boundary

Irrelevant environment
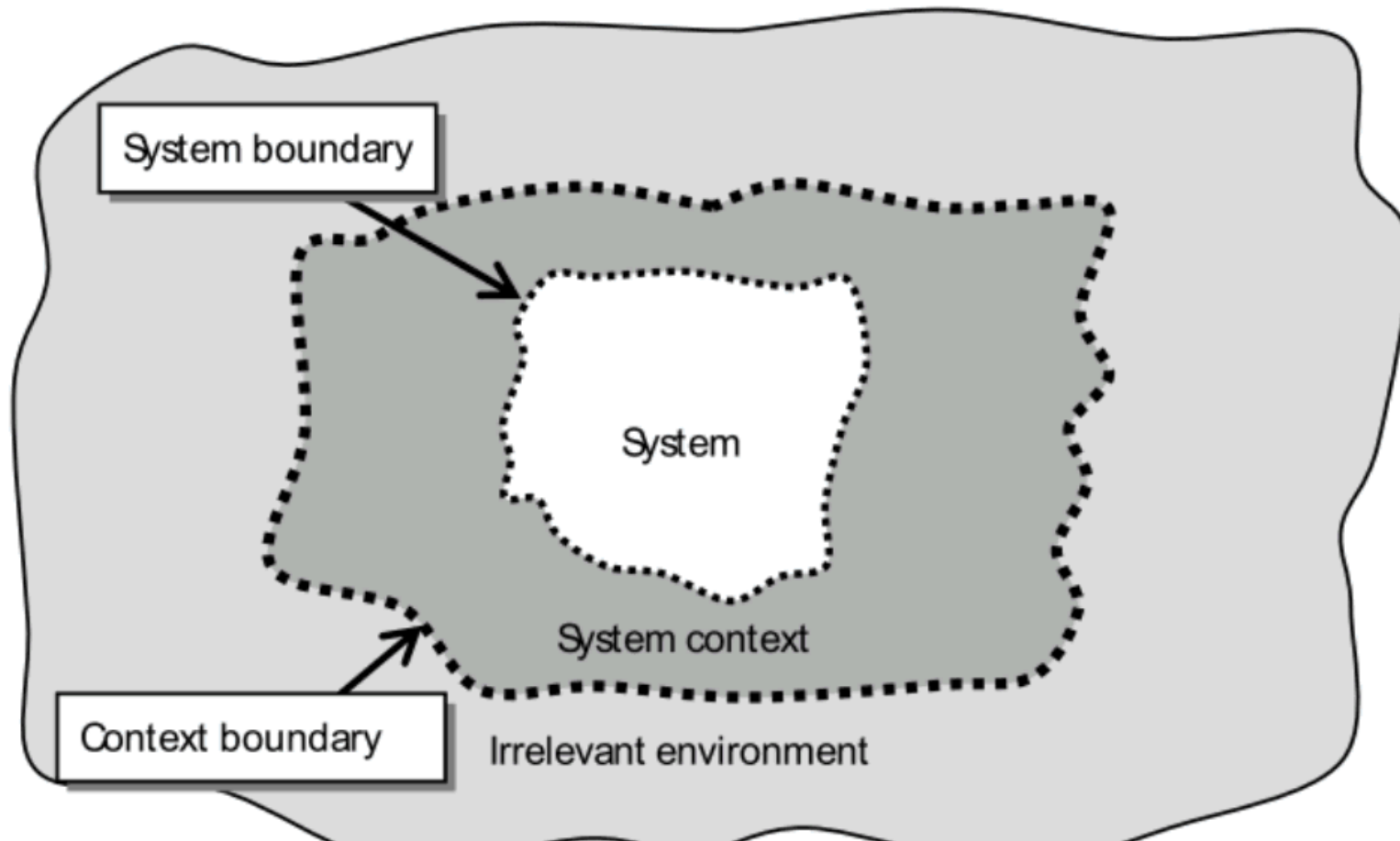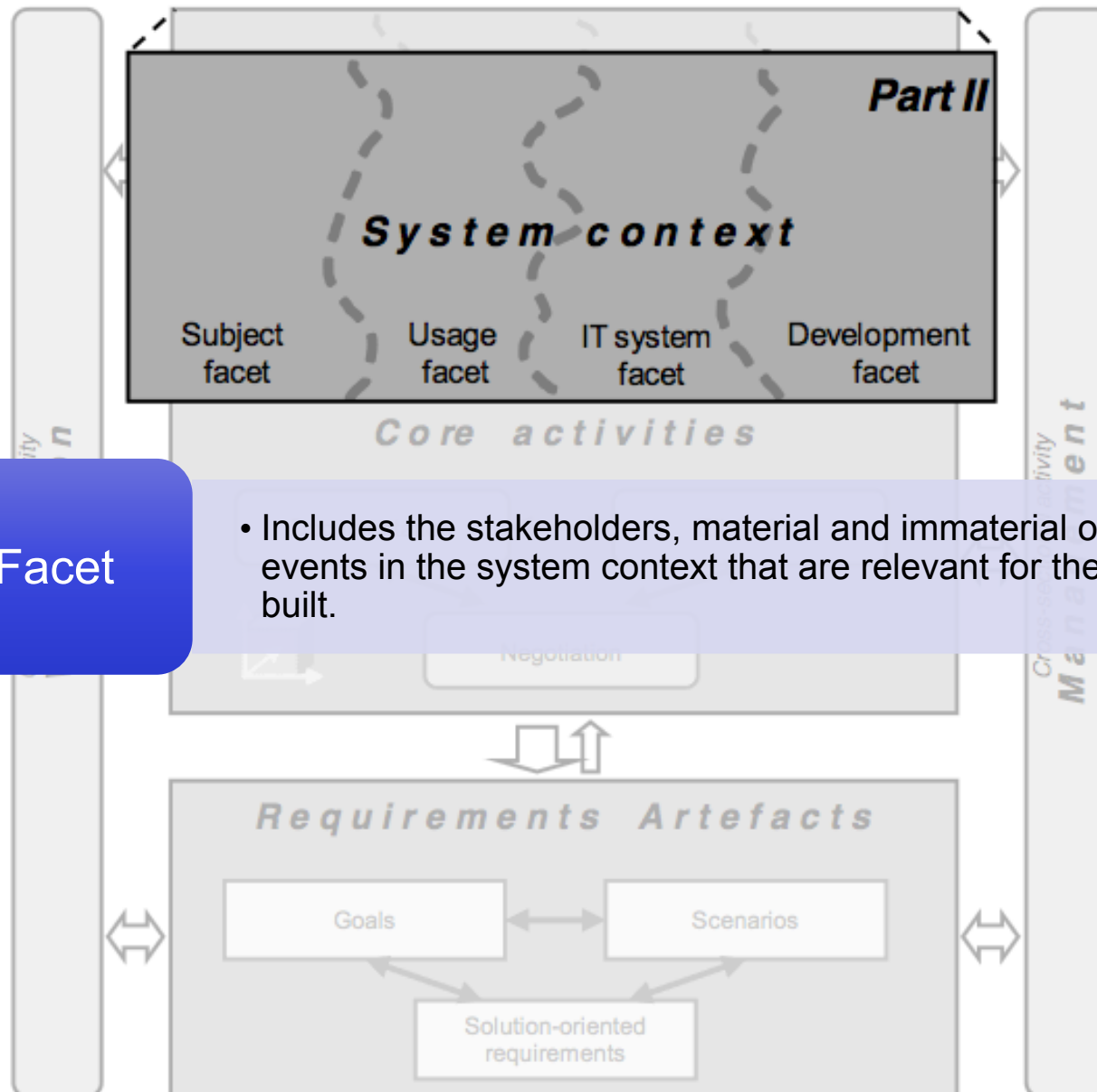
The system context is the part of the system environment for defining, understanding, and interpreting the system requirements.

POHL, K. Requirements Engineering: Fundamentals, Principles and Techniques, Springer, 2010

The system context

Subject Facet

- Includes the stakeholders, material and immaterial objects and events in the system context that are relevant for the system to be built.
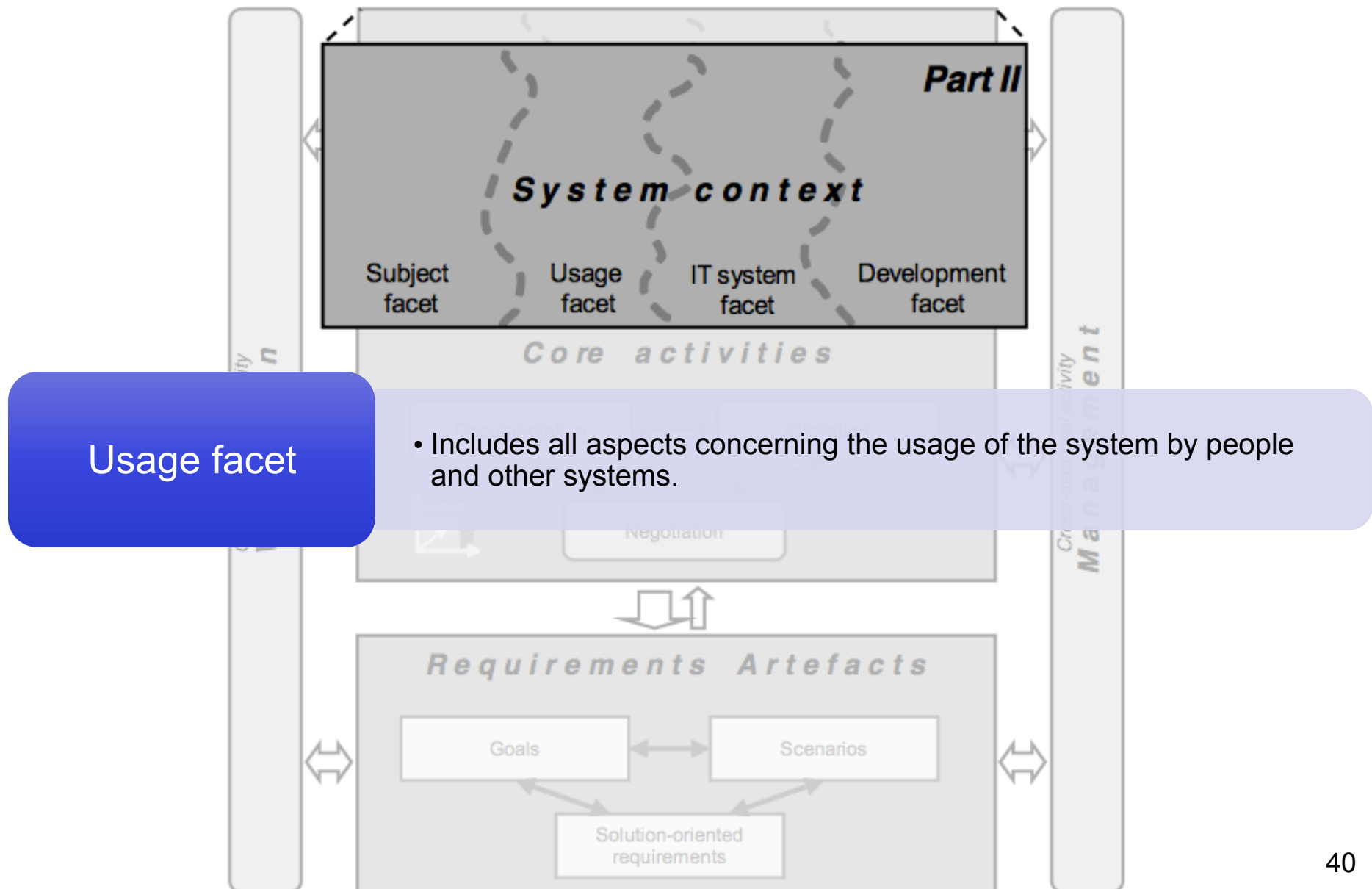
38

Documenting the subject facet

Critical stakeholders & Information Sources

- WHO
- Health Ministry Officers: Countries
- Researchers & NGOs
- Technical groups
- Information Systems
  - ◇ ProMED
  - ◇ PubMed
  - ◇ Global Alert and Response (GAR)
  - ◇ Google Alerts

43

The system context

Usage facet

- Includes all aspects concerning the usage of the system by people and other systems.

40

POHL, K. Requirements Engineering: Fundamentals, Principles and Techniques, Springer, 2010
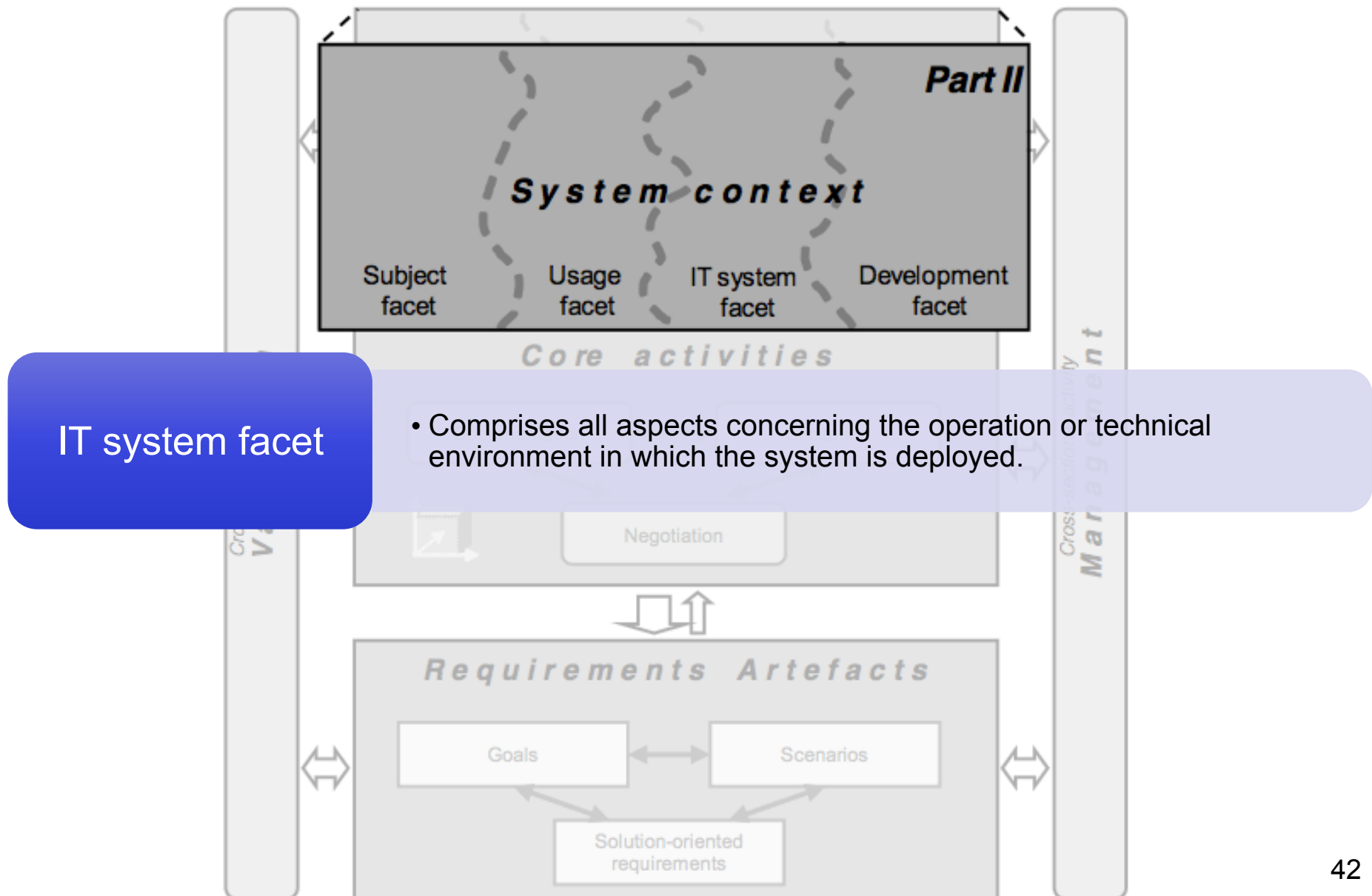
Documenting the usage facet

Users

- WHO
- Health Ministry Officers: Countries
- Researchers & NGOs
- Technical groups

How they would introduce, manage, delete, querying, analyze or visualize information with the system

The system context

IT system facet

- Comprises all aspects concerning the operation or technical environment in which the system is deployed.

42

Documenting the IT system facet

Similar IT systems for other diseases

- Global Health Observatory (GHO) system (WHO's gateway to health-related statistics).
- Leishmaniasis information sytem
- Human African Trypanosomiasis information system
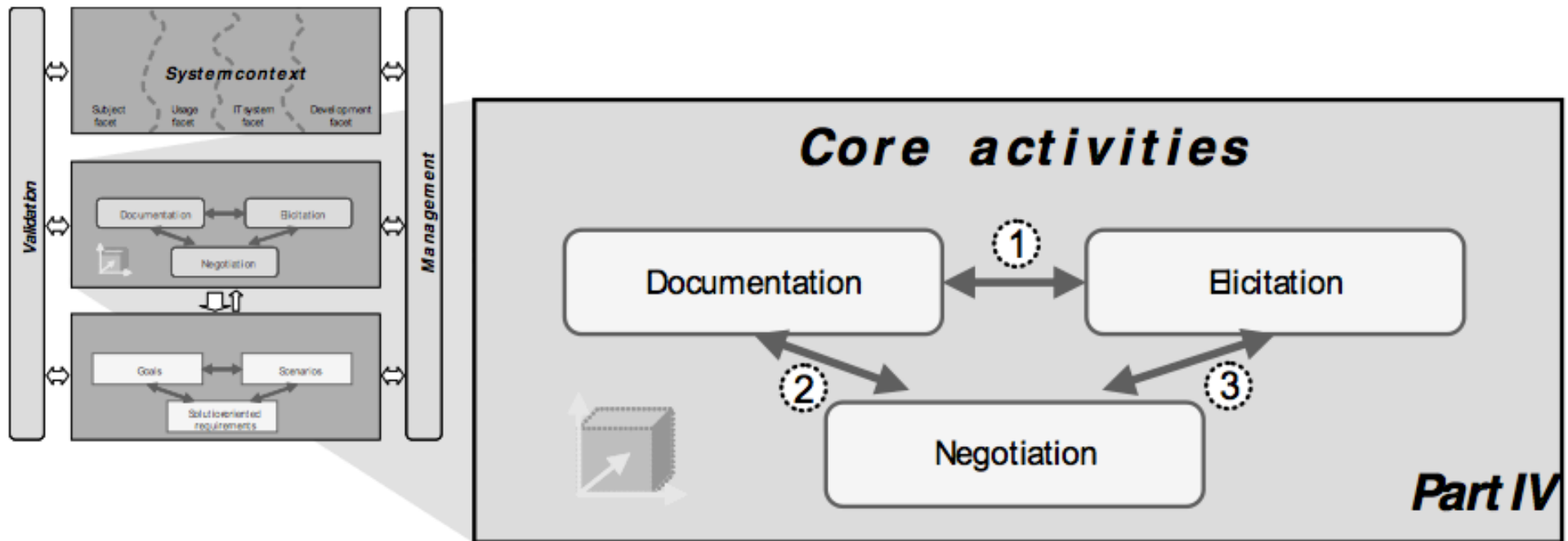- Event Management System (EMS)
- WHO maps

The system context

Development • Comprises all aspects that influence the development of the system

44
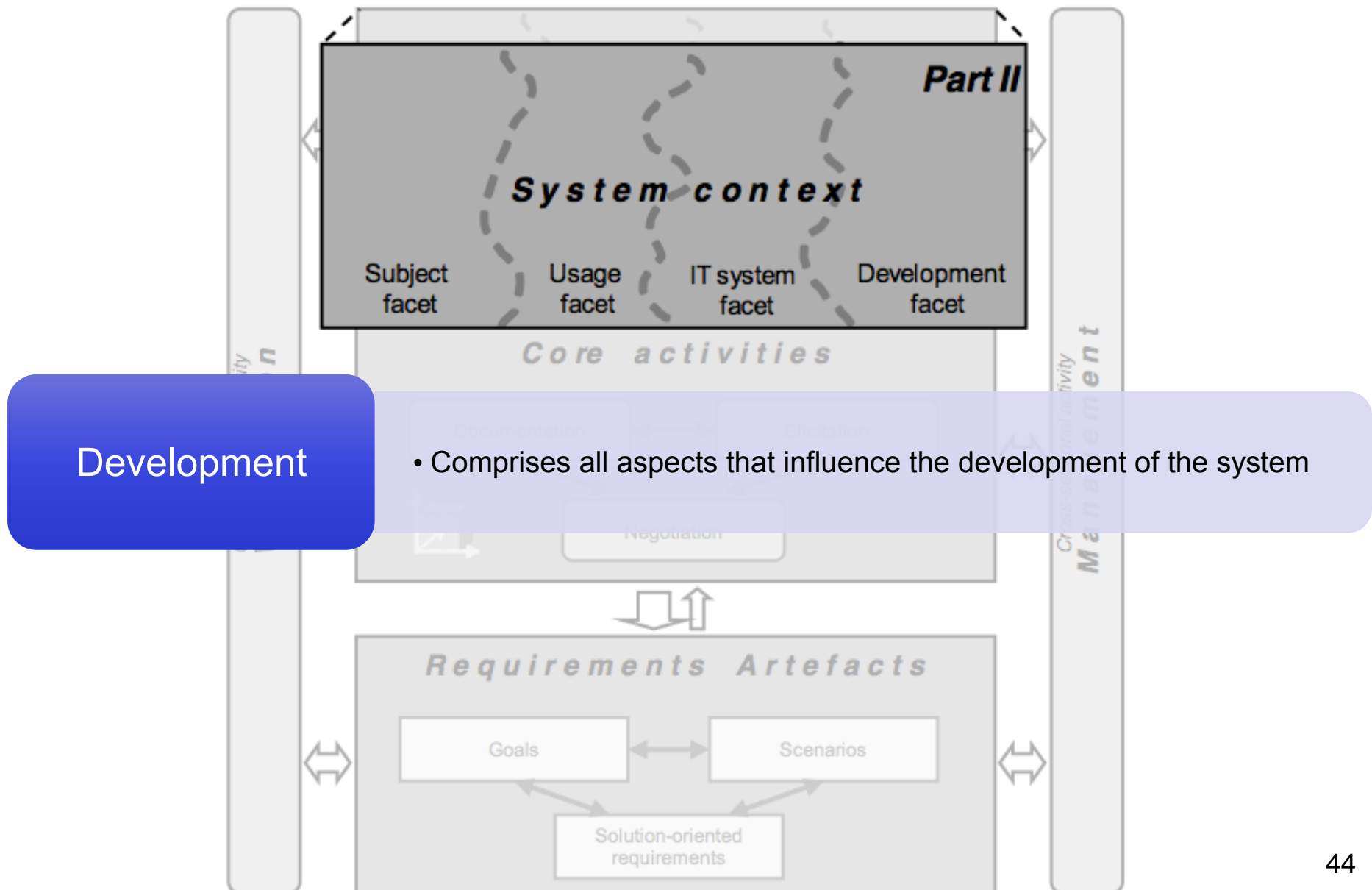
Documenting the development facet
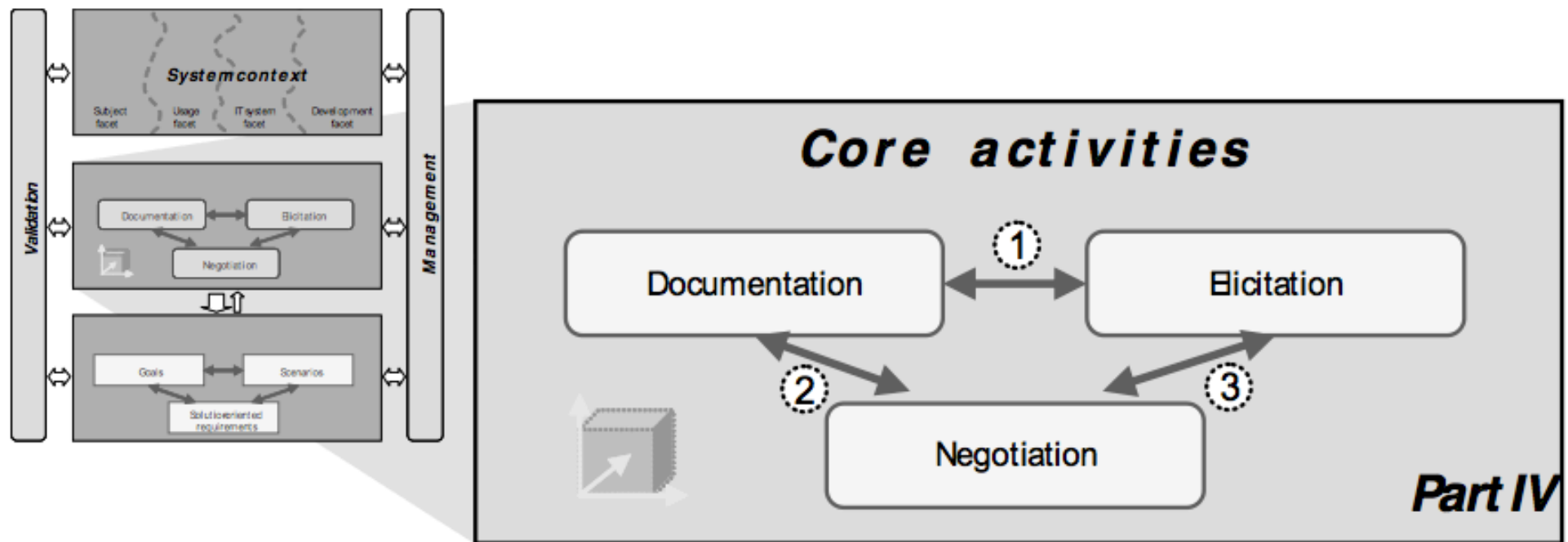
Due to the complexity of the project:

- It was decided to, in an initial phase, to perform only the requirements and design part of the project.

- The implementation of the project would be postpone until approvation of budget by WHO.
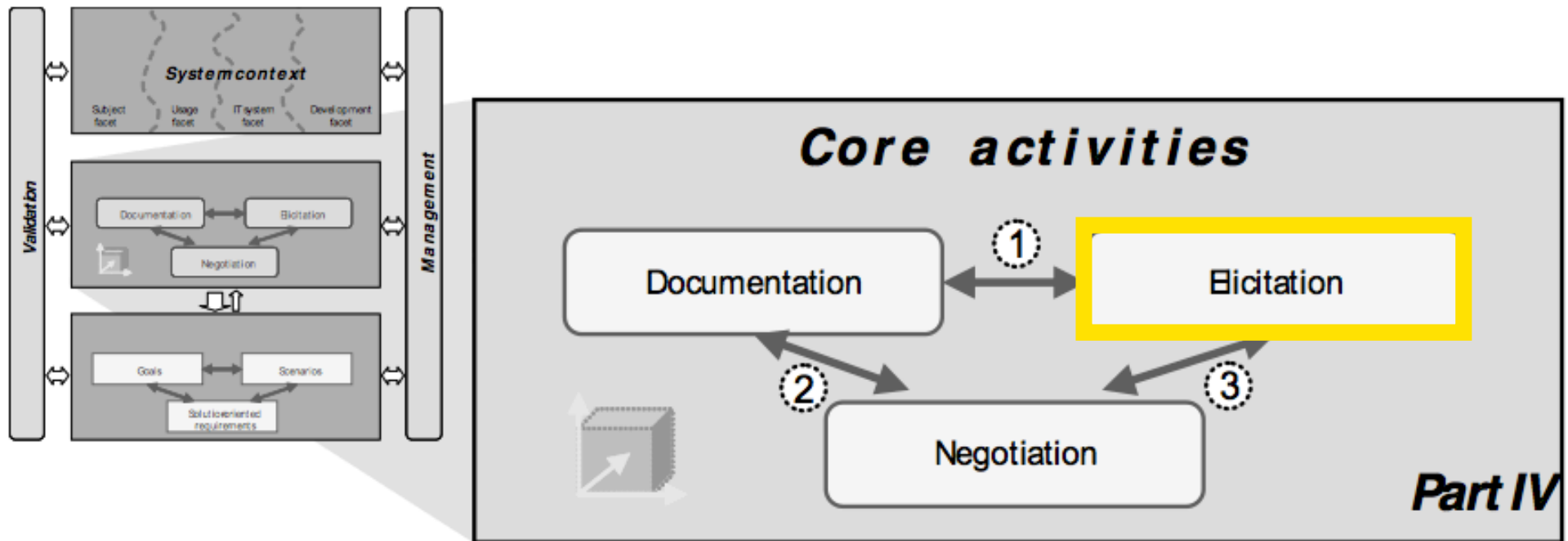
Core activities

POHL, K. Requirements Engineering: Fundamentals, Principles and Techniques, Springer, 2010

Core activities

Activities to perform the requirement engineering process

POHL, K. Requirements Engineering: Fundamentals, Principles and Techniques, Springer, 2010

Elicitation

POHL, K. Requirements Engineering: Fundamentals, Principles and Techniques, Springer, 2010

Elicitation

Goal:

➢ Identify relevant requirement sources

➢ Elicit existing requirements from the identified sources

➢ Develop new and innovative requirements

Process:

➢ Define goals first to define the purpose of the system at an abstract level

➢ Define scenarios to put requirements in context

➢ Iterative goal and scenario definition

➢ New and innovative requirements can be derived from goals and scenarios

49

Elicitation

Basic Techniques (with examples):

➤ Interviews: mostly exploratory interviews with qualitative results.

  ➤ To understand all the variables related to co-infection when defining the conceptual model related to diagnosis.

➤ Workshops:

  ➤ 2-3 days sessions including brainstorming, iterative goal and scenario definitions

➤ Questionnaires:

  ➤ Lists of questions to the health and vectorial experts to validate our conceptual model

➤ Observation:

  ➤ Existing developed systems for other diseases

Elicitation

Assistance Techniques (with examples):

➢ Brainstorming: to generate new ideas

   ➢ To define the main goals of the project and initial phases.

➢ Mind mapping: presentation of information with text and graphics

   ➢ To represent the context of the project and to group use cases

➢ Prototyping: to better understand the requirements

   ➢ UML conceptual models were difficult to understand to Health and Vectorial experts

   ➢ The creation of mock-ups facilitated the feedback from experts.

Elicitation

Negotiation

POHL, K. Requirements Engineering: Fundamentals, Principles and Techniques, Springer, 2010

Negotiation

Goal:

➢ Identify conflicts

➢ Analyse the cause of each conflict

➢ Resolve the conflicts

➢ Document the conflict resolution and the rationale

Process:

➢ Goals support the resolution of conflicts

➢ Find creative solutions for conflicts at the goal level

➢ Goals can be used to support decision-making

➢ Scenarios support the analysis of conflicts

➢ Concrete examples (scenarios) facilitate agreement

Negotiation

Example:

➢ To reach a consensus between:

   a) to collect as much information as possible to the maximum level of detail from the countries

   b) to the actual ability to collect such information

   The a) option was the desired one, but it entailed the risk that the system would never be used or that the information entered would not be accurate enough.

Mock-ups were indispensable to resolve these conflicts and reach a consensus!

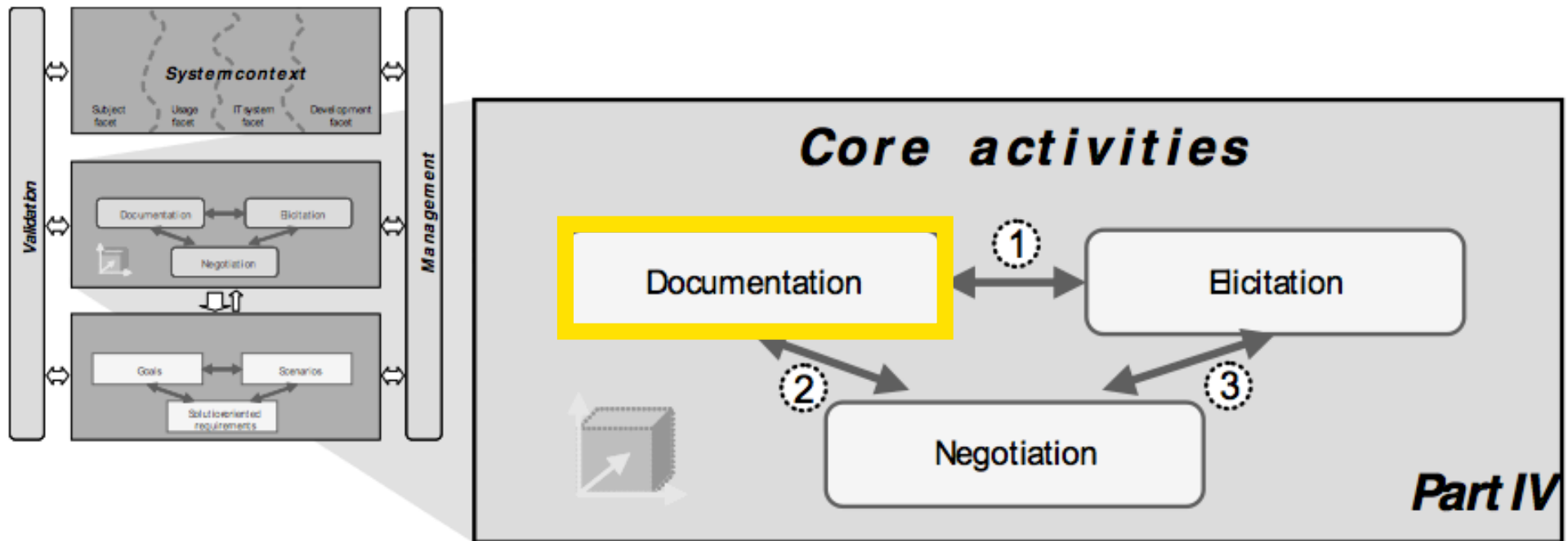# **Negotiation**

Example:

➢ To reach a consensus between:

    a) to collect as much informati~~~~ ~~~~ ~~~~ num level of detail fro~~~~

    b) to t~~~~

~~~~ ~~~~ntailed the risk that the system would ~~~~ or that the information entered would not be ~~~~urate enough.

Priority-> to get the minimum information necessary to obtain the maximum impact to combat Chagas.

Mock-ups were indispensable to resolve these conflicts and reach a consensus!

Documentation

Documentation

Goal

- Importance of Documentation

  ➢ Persistence

  ➢ Common reference

  ➢ Promotes communication

  ➢ Promotes objectivity

  ➢ Supports training of new employees

  ➢ Preserves expert knowledge

  ➢ Helps to reflect the problem

- Each requirements activity produces many different kinds of information

Documentation

Quality criteria for Requirements Artefacts

- **Complete**: no missing information

- **Traceable**: source, evolution, impact and use

- **Correct**: confirmed by stakeholders

- **Unambiguous**: single valid interpretation

- **Comprehensible**: content is easy to comprehend

- **Consistent**: statements within the artefact do not contradict each other

- **Verifiable**: implemented system can be checked

- **Rated**: relevance and/or stability have been determined and documented

- **Up to d**ate: reflects the current status of the system in the system context

- **Atomic**: one artefact describes a single, coherent fact

59

Documentation

Standard structure for a software requirements specification according to [IEEE Std. 830-1998]

Table of Contents
1. Introduction
    1.1   Purpose
    1.2   Scope
    1.3   Definitions, acronyms, and abbreviations
    1.4   References
    1.5   Overview
2. Overall Description
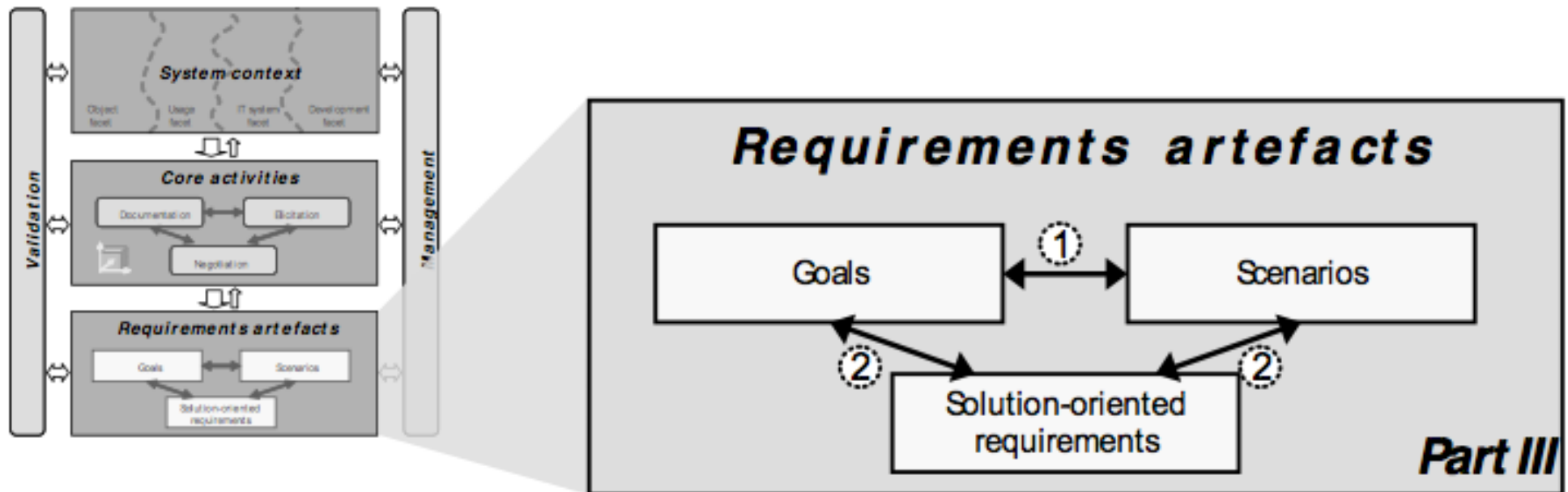   2.1   Product perspective
    2.2   Product functions
    2.3   User characteristics
    2.4   Constraints
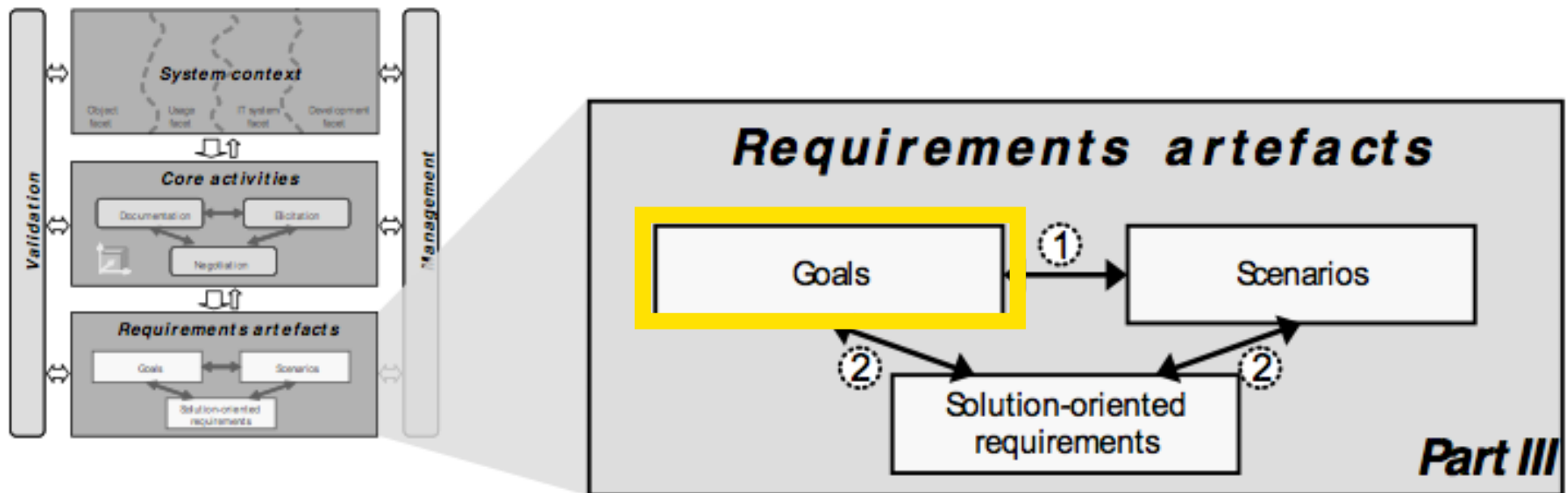   2.5   Assumptions and dependencies
3. Specific Requirements
Appendixes
Index

60

Requirements Artefacts

POHL, K. Requirements Engineering: Fundamentals, Principles and Techniques, Springer, 2010

Goals

Goal Orientation Artefacts

"Goal"

An intention of stakeholders with regard to the objectives, properties

Motivation n.

- Facilitate common understanding of the system

- Support requirements elicitation with goals

- Identify and evaluate alternative realisations

- Detect irrelevant requirements

- Justification of requirements with rationales

- Proof of completeness for requirements specifications

- Goals have greater stability than requirements

63

Documenting Goals

1. **Possible: using unstructured natural language**
   - e.g. Researchers should be able to register individual diagnosis

2. **Better: using templates with attributes**
   - Unique identifiers for goals
   - Management attributes
   - References to the context
   - Specific goal attributes
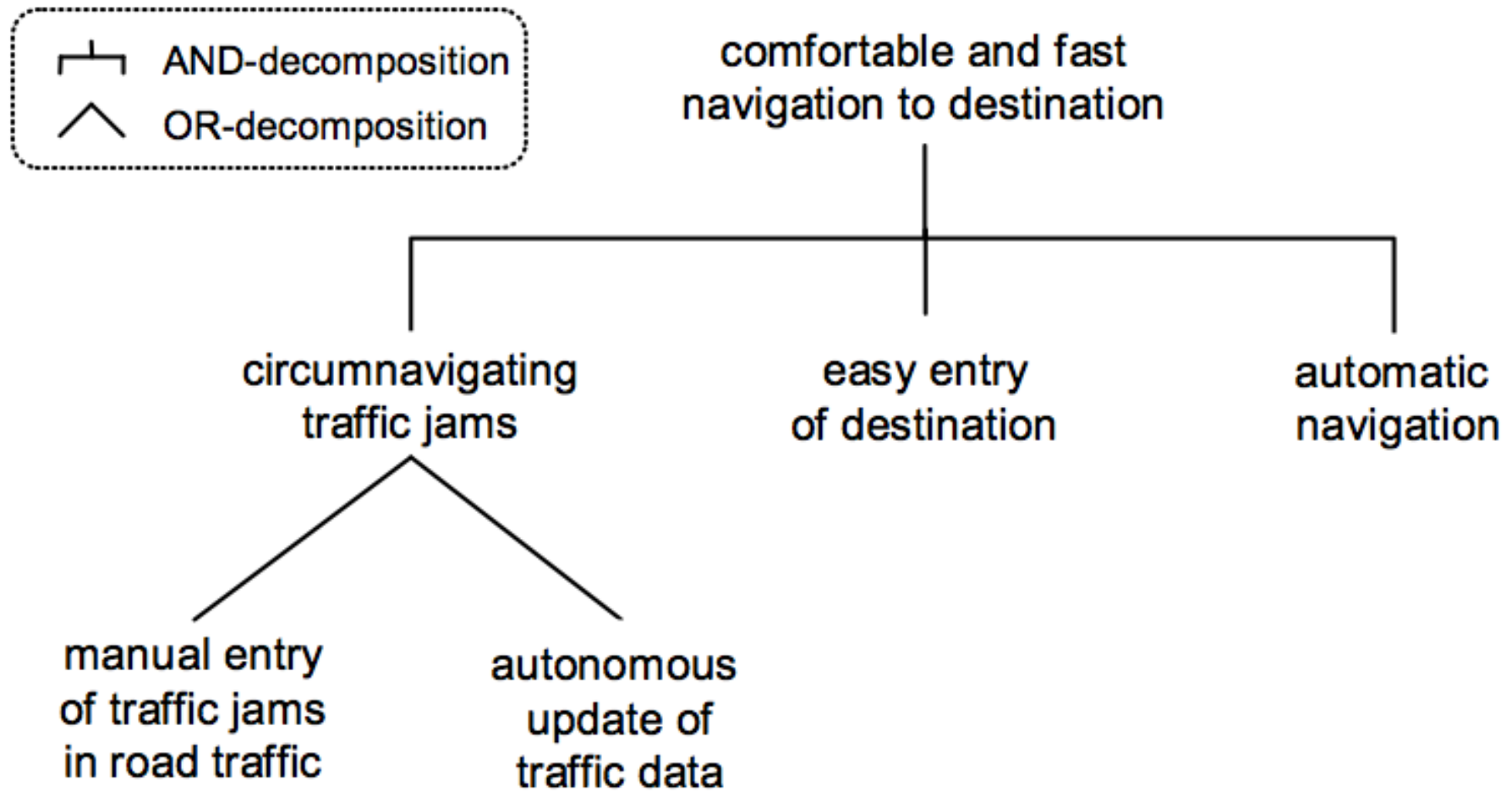   - Possibly to include additional information

3. **Goal Modelling Languages and Methods**
   - Goal Modelling using AND/OR Trees
   - Goal Modelling using AND/OR Graphs
   - i* (i-Star)
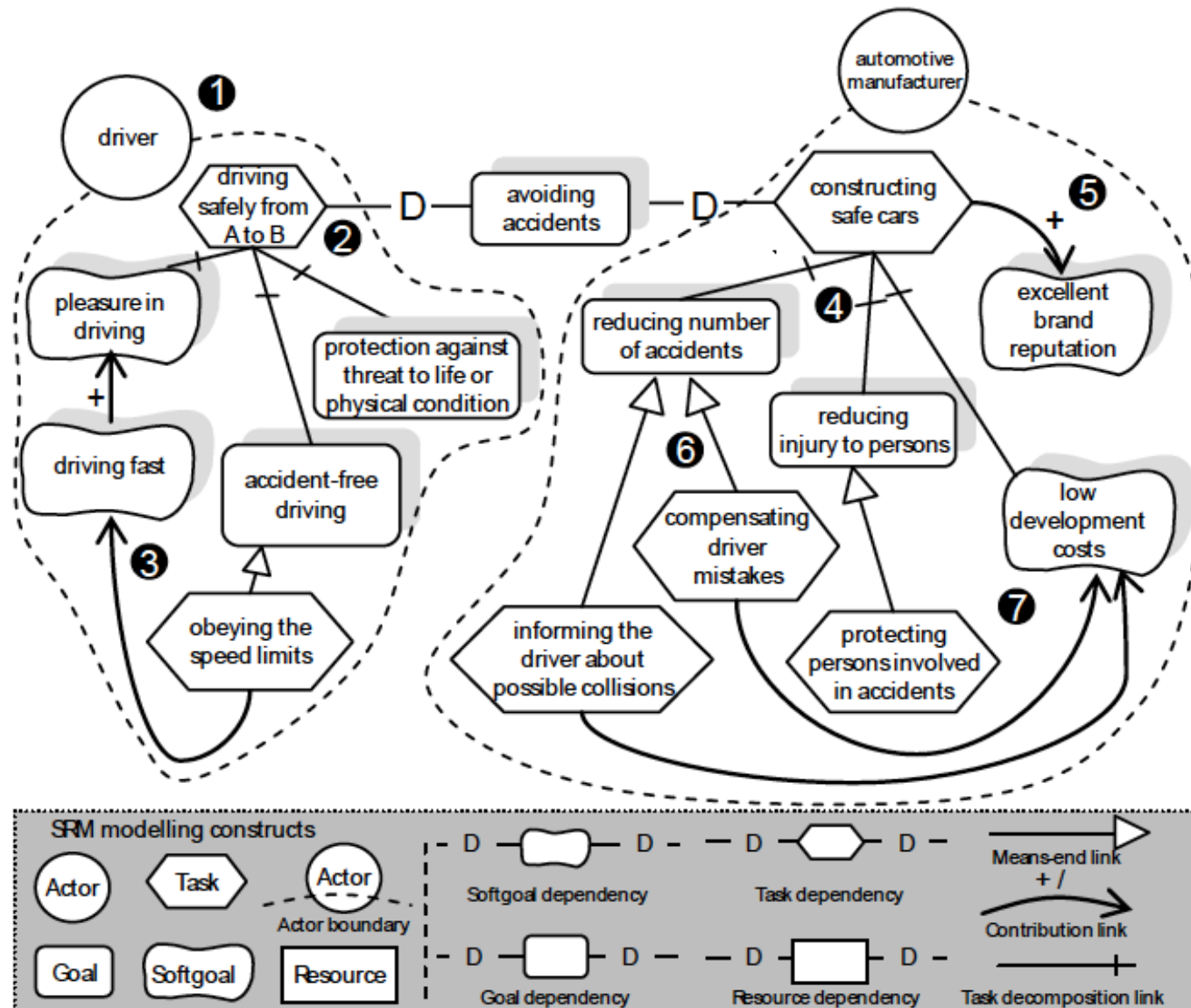   - KAOS

64

AND/OR Trees

Example of goalmodelling using AND/OR trees.
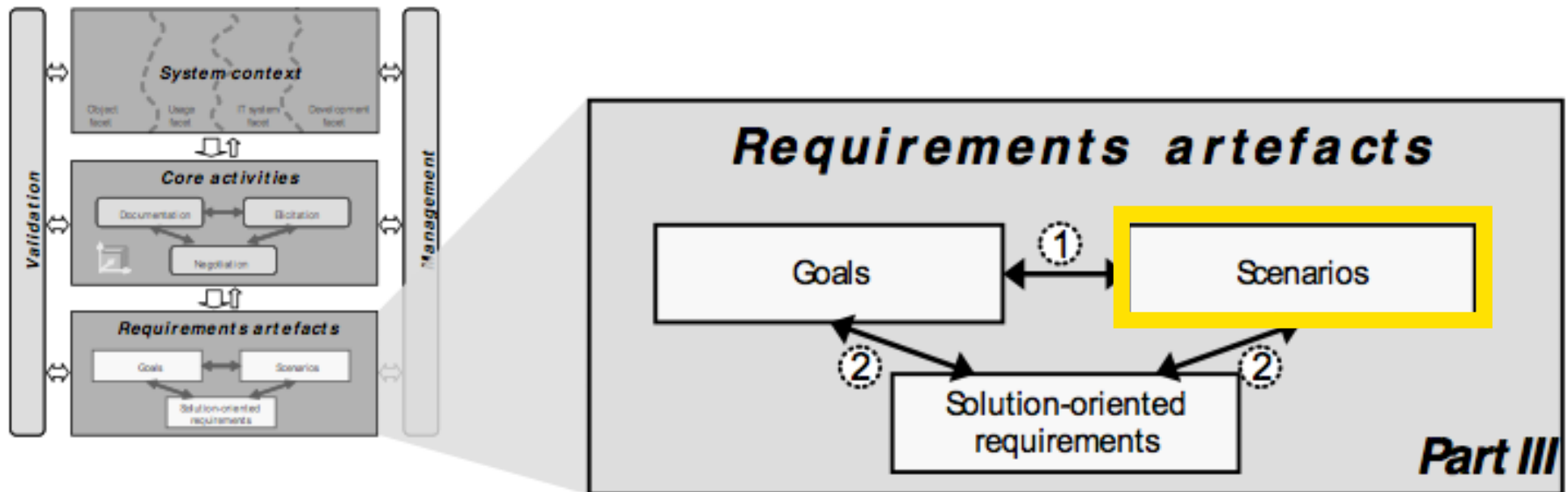
Reprinted from: (Pohl 2010)

I* (i-star)

Example of a strategic rationale model in i*.

POHL, K. Requirements Engineering: Fundamentals, Principles and Techniques, Springer, 2010

Scenarios

POHL, K. Requirements Engineering: Fundamentals, Principles and Techniques, Springer, 2010

Scenarios Orientation Artefacts

"Scenario"

Scenarios document sequences of interactions in which the system either satisfies some goals or fails to satisfy them

Motivation

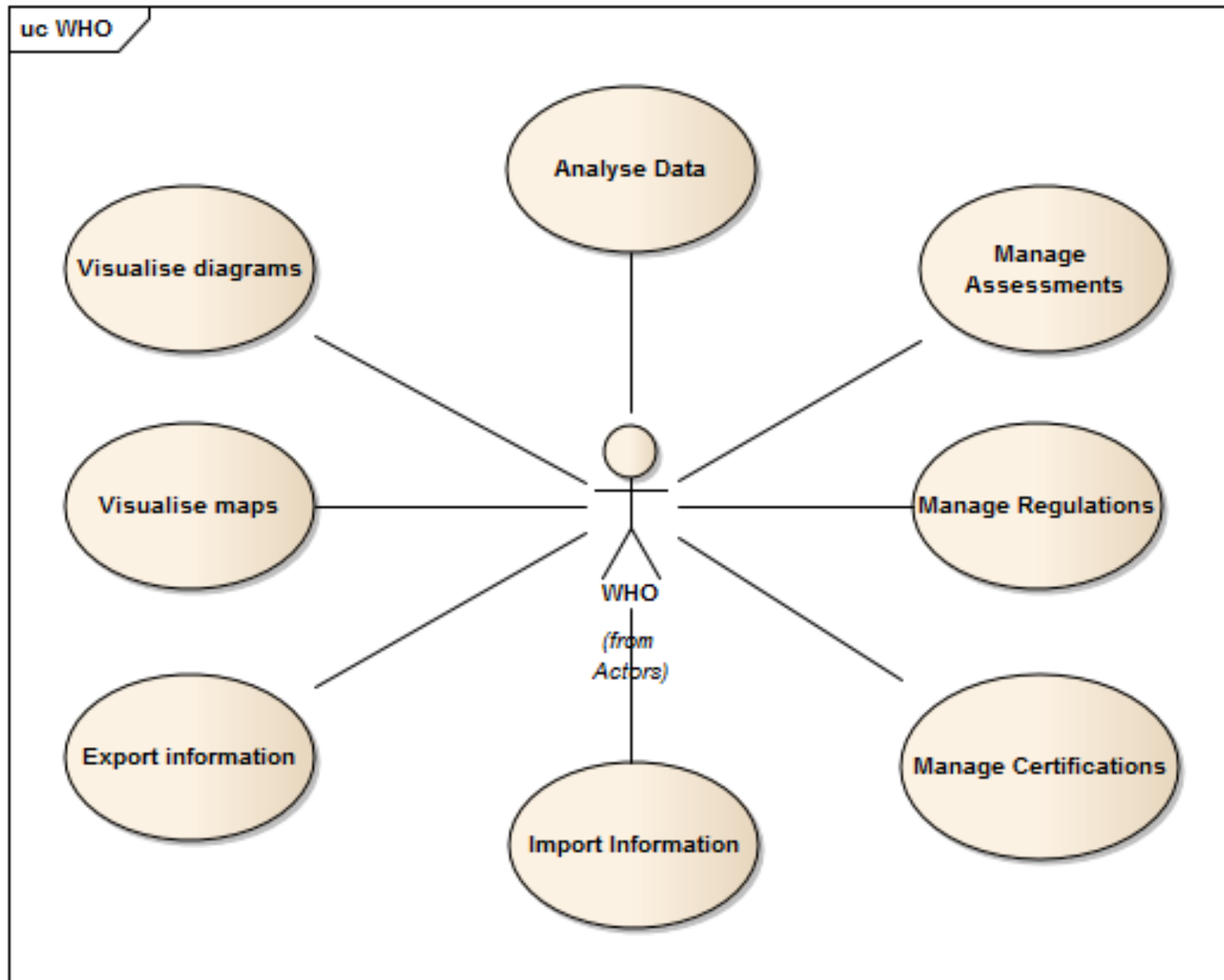Goals alone do not sufficiently support requirements elicitation

• Scenarios are intermediary abstractions between abstract models and reality

• Aspects documented in scenarios have different abstraction levels

• Scenarios may contain aspects

  – very close to the considered fragment of reality

  – abstraction level may also come close to the abstraction level of conceptual level

68

Documenting scenarios

1. Narrative scenarios (documented in natural language)

2. Structured scenarios

3. Reference Template for Use Cases

4. Sequence Diagrams

5. Activity Diagrams

6. Use Case Diagrams

UML use case diagram

uc WHO

Analyse Data

Visualise diagrams

Manage Assessments

Visualise maps

Manage Regulations

WHO
(from Actors)

Export information

Manage Certifications

Import Information

70

Use case

Use Case Name: Visualise Maps
Active Actor: WHO user
Trigger: WHO user indicates to visualise a map
Preconditions: The WHO user must be identified and authenticated.

Stakeholders and interests: WHO user: visualise maps about information gathered in the CID system, which includes: Inspections, Diagnosis, Treatments, Fumigations, Triatomine bug studies, Climatological data, Systemic information and normative information.
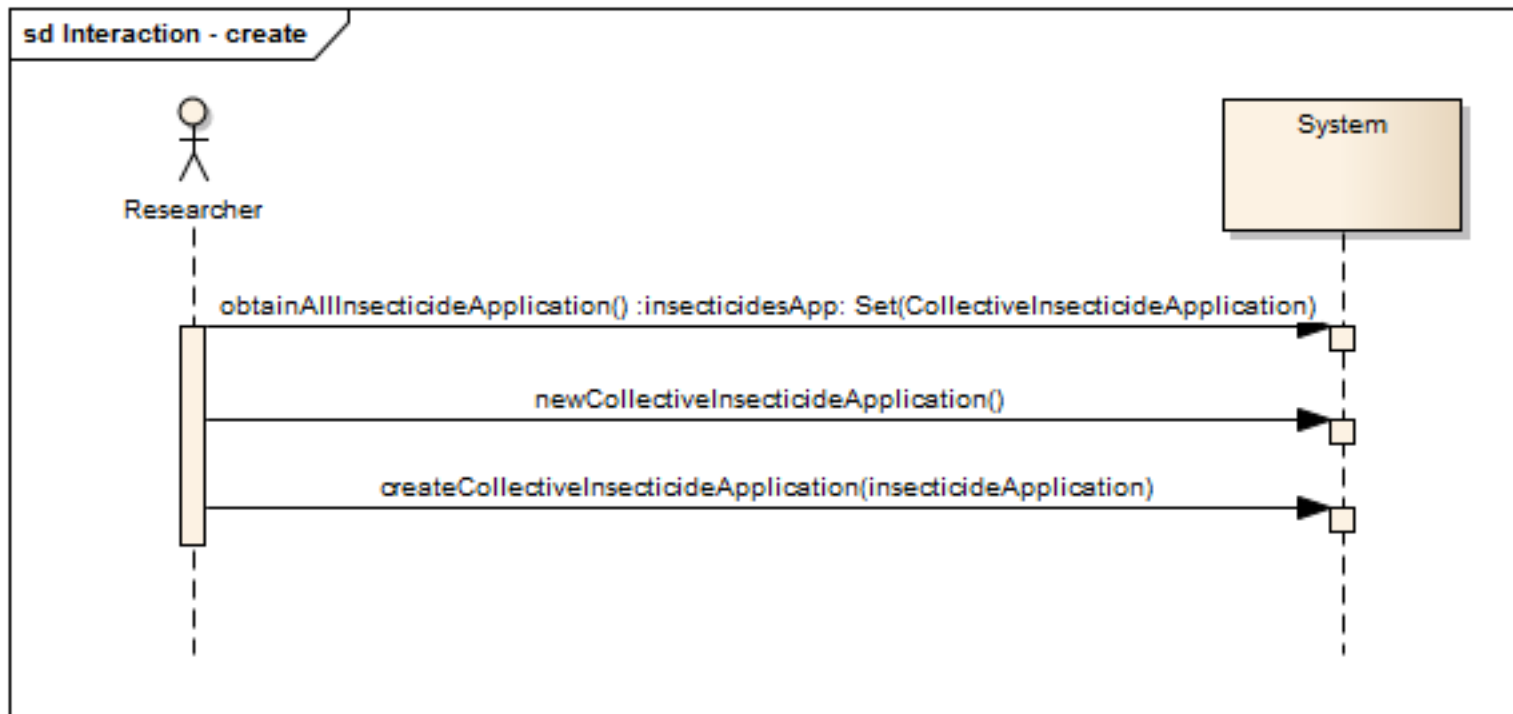
Main Success Scenario
1. User indicates visualise a map
2. System presents all different types of information that can be visualised: Inspection variables, Diagnosis variables, Insecticide Application variables, Triatomine Bug variables, Climatological variables, Treatment variables, Systemic variables and Normative variables.
3. User selects all variables he wants to visualise in the map
4. System shows all available countries and their first administrative divisions
5. User selects the geographic objects and then confirms the creation of the map
6. System processes all information and generates the map
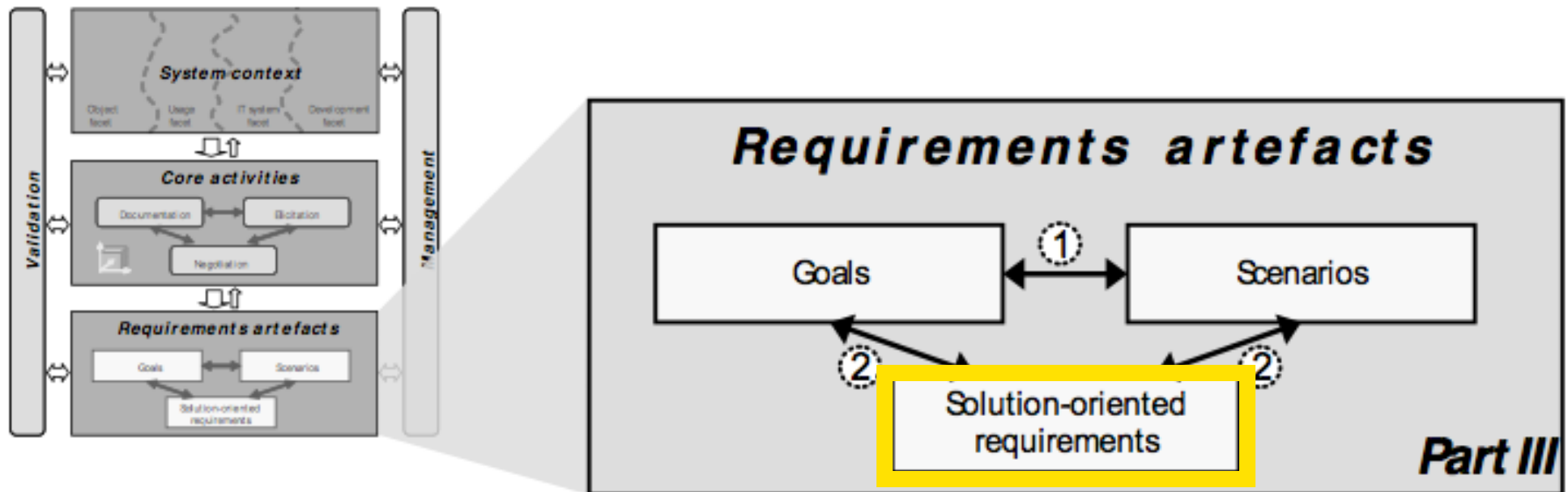- User repeats steps 3,4 and 5 for each map he wants to generate

Outcome
A map with information selected by the WHO user has been generated.

71

Sequence diagram

System sequence diagram of UCR10 : Create Interaction

Solution-oriented requirements

Solution-oriented requirements

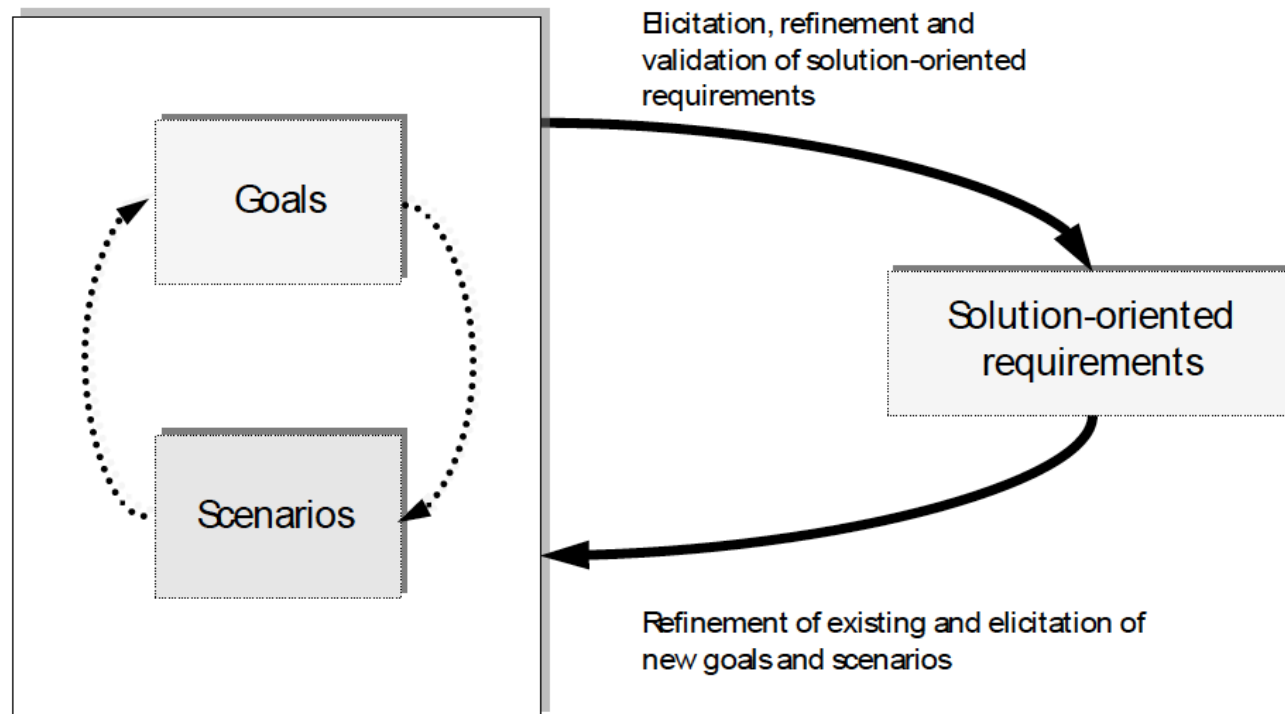Describe the properties and features to be fulfilled by the system.

Motivation

- Agreement: all the requirements should be agreed on by all stakeholders

- Completeness: all requirements must be complete

- Conflicts: requirements should be free of conflicts

- Level of detail: requirements contain far more details than goals and scenarios

- Intended solution: typically partly specify the intended solution

Solution-oriented requirements

Key relationships among requirements, goals and scenarios

➢ Solution-oriented requirements can be elicited from scenarios and goals

➢ Refinement of solution-oriented requirements is facilitated through analysis scenarios and goals

➢ Scenarios and goals facilitate validation of solution-oriented requirements

➢ New goals and scenarios can be derived from analysing solution-oriented requirements

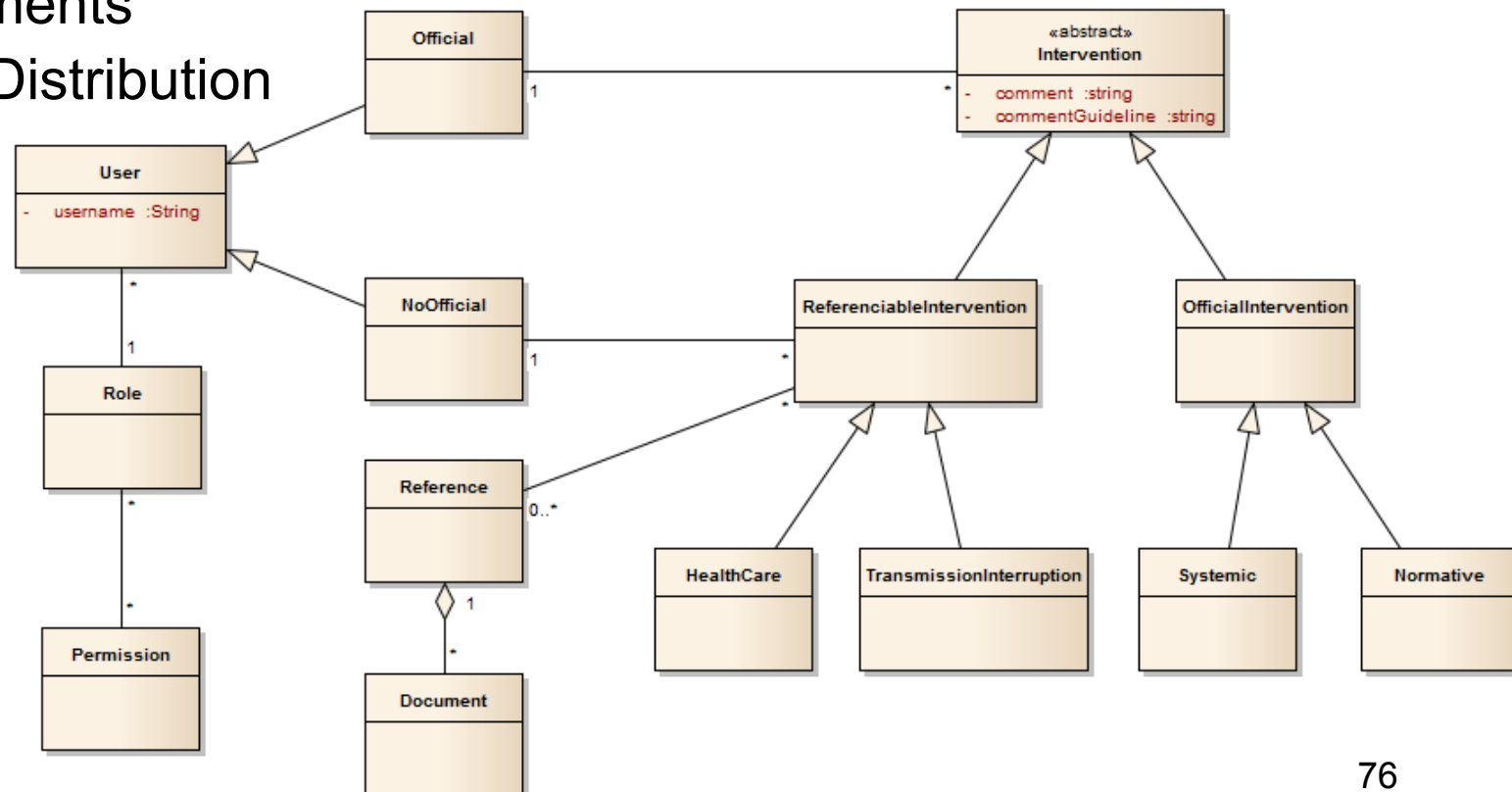➢ Normally the definition of solution-oriented requirements is an iterative process

Elicitation, refinement and validation of solution-oriented requirements

Refinement of existing and elicitation of new goals and scenarios

75

POHL, K. Requirements Engineering: Fundamentals, Principles and Techniques, Springer, 2010

Conceptual model

Healthcare component

Gathering information about
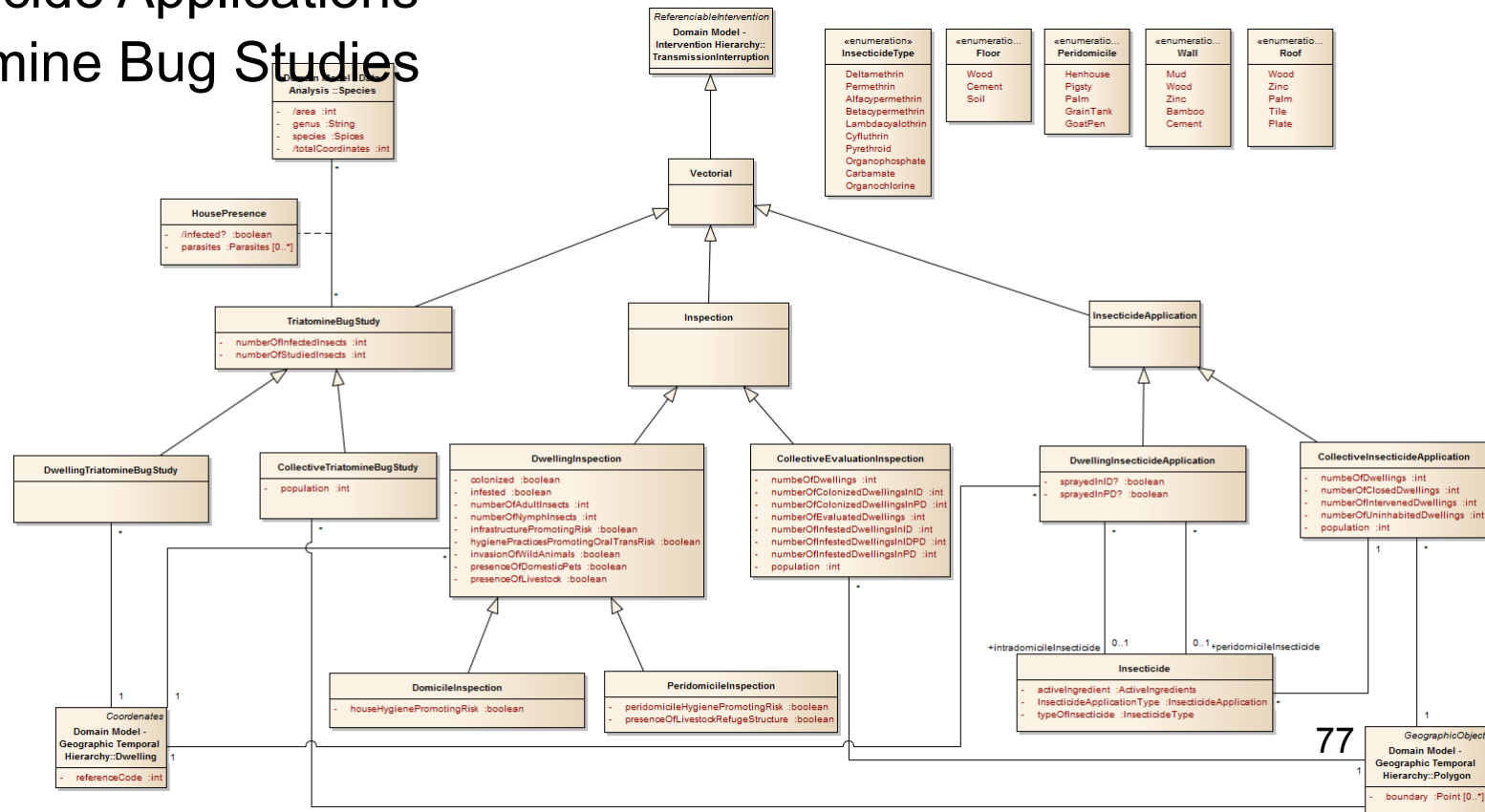- Diagnosis
- Treatments
- Drug Distribution

Conceptual model

Vectorial component

Gathering information about
- Dwelling Inspections
- Insecticide Applications
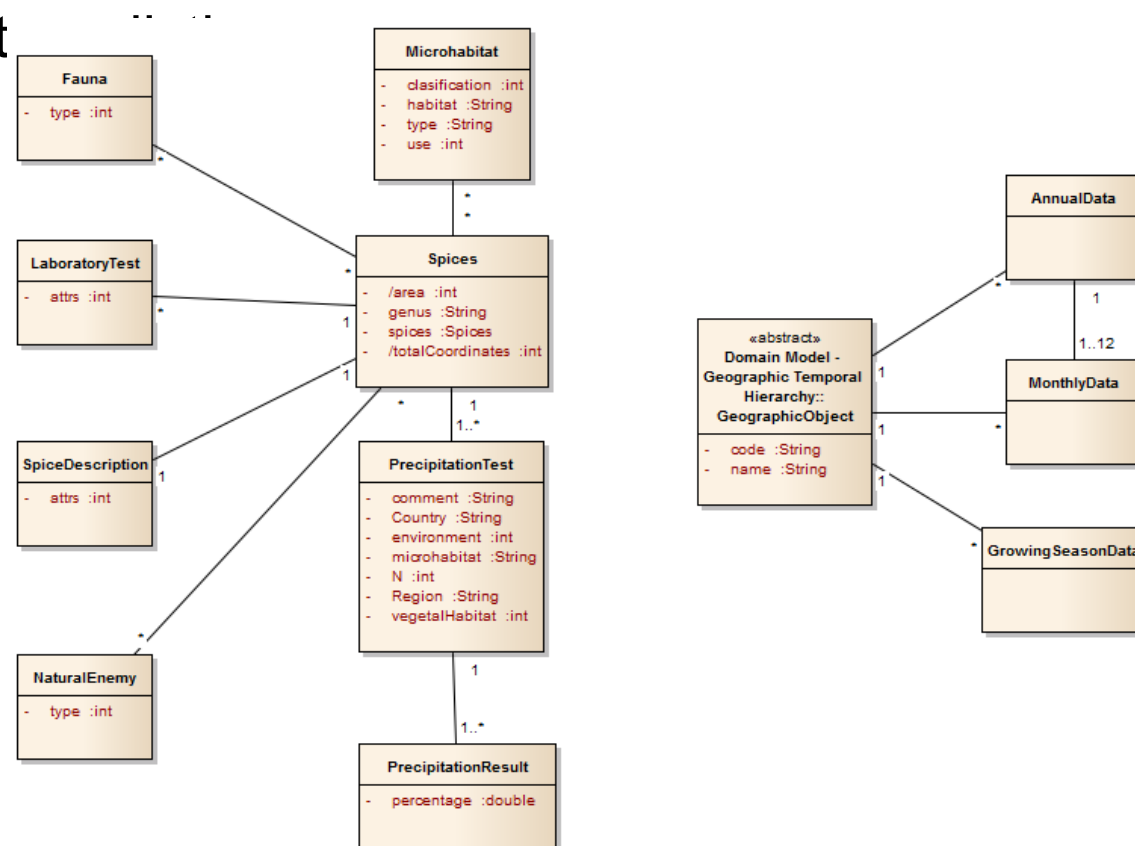- Triatomine Bug Studies

77

Conceptual model

Wildlife component

METATRI database
- Information related to flora, fauna and climatology
- Most completed triatomine bug database in the world
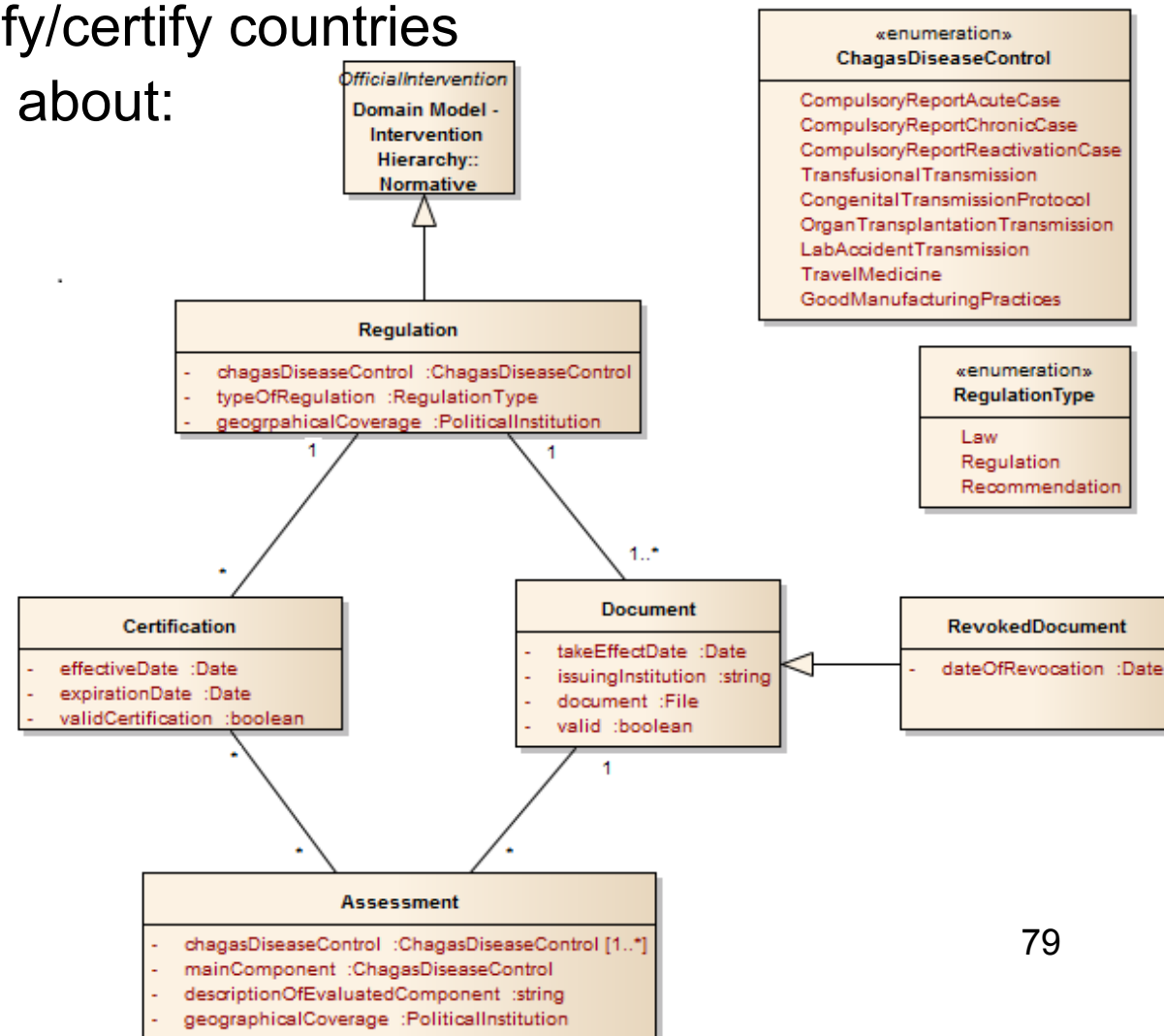- Used to make forecast

Conceptual model

Normative component

Enabling WHO to verify/certify countries
Gathering information about:
- Laws
- Regulations
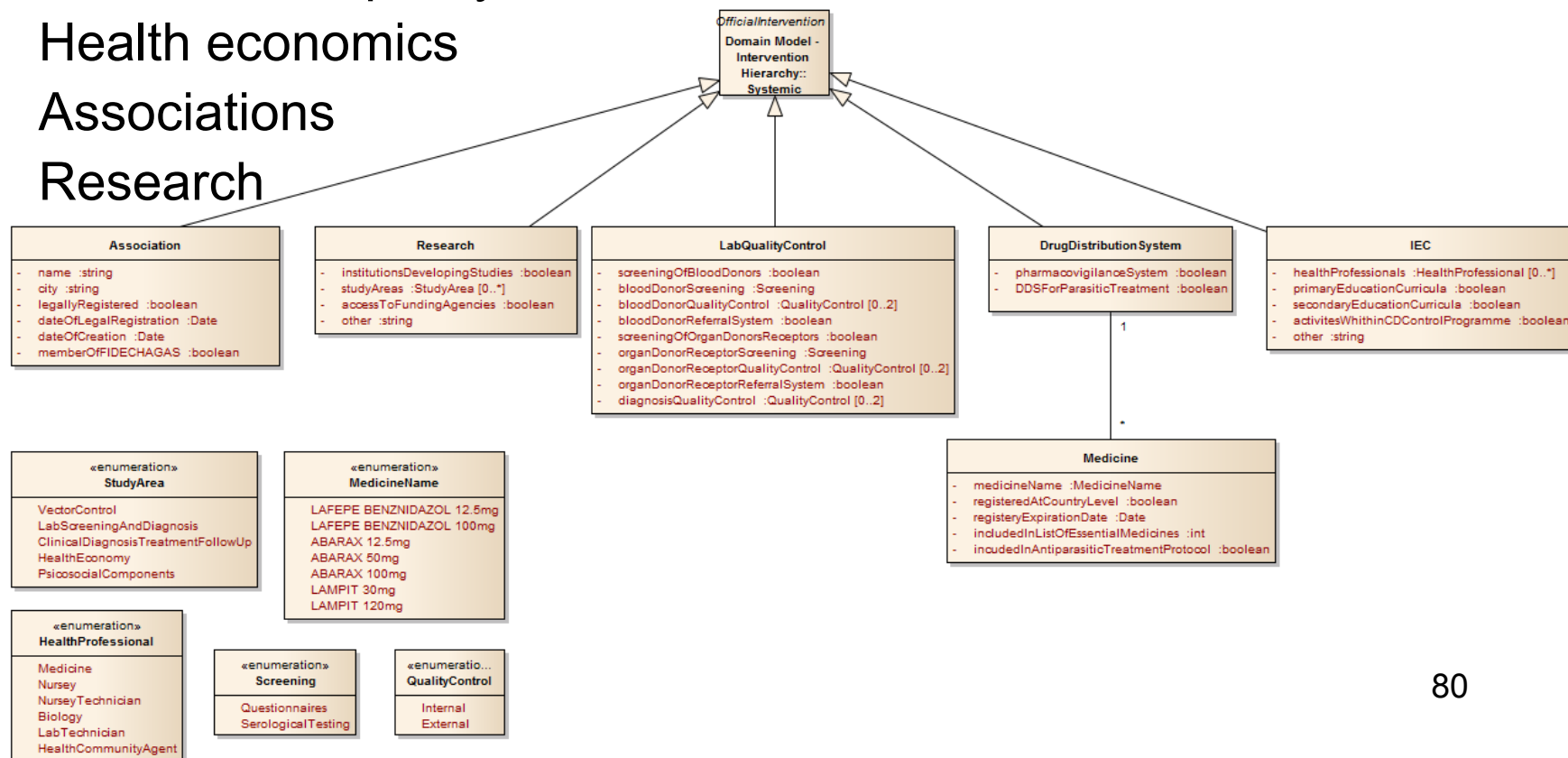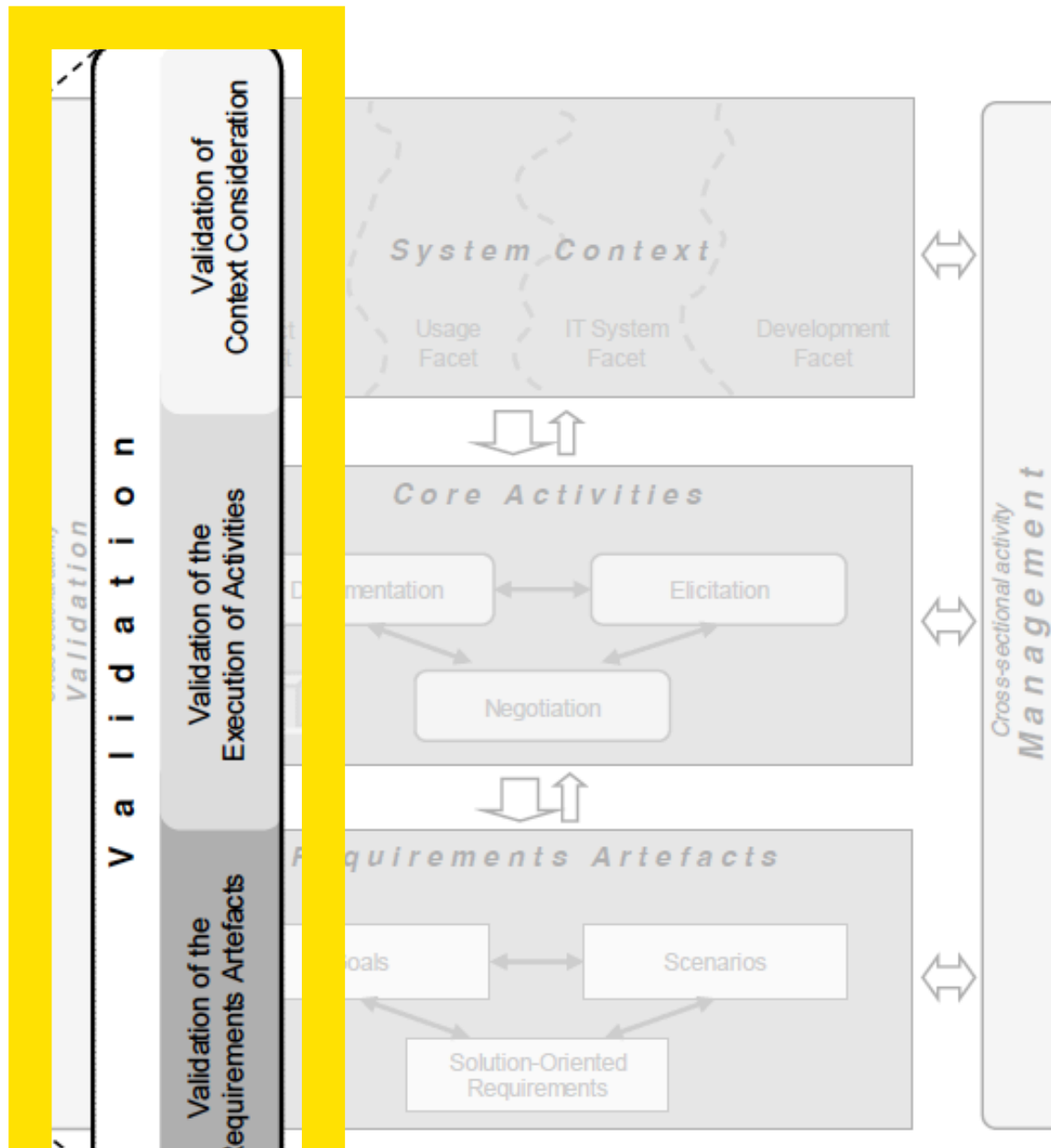- Recommendations
- Assessments

79

Conceptual model

Systemic component

Gathering information about:

- Information, Education and Communication
- Laboratories quality
- Health economics
- Associations
- Research

Validation

POHL, K. Requirements Engineering: Fundamentals, Principles and Techniques, Springer, 2010

Validation

Goal

➢ To check whether:

inputs,

performed activities, and

created outputs (requirements artefacts)

of the requirements core activities fulfil defined quality criteria.

Process

➢ Validation is performed by involving relevant stakeholders, other requirements sources (standards, laws, etc.) as well as external reviewers, if necessary.

Validation

Basic Techniques

➢ Inspections: to detect defects in development artefacts by means of pre-defined phases in teams.

➢ Desk Checks: checking an artefact individually by a stakeholder.

➢ Walkthroughs: informal procedure to check any artefact for its approval.

➢ **Prototyping**

Validation

Example: Desk-check

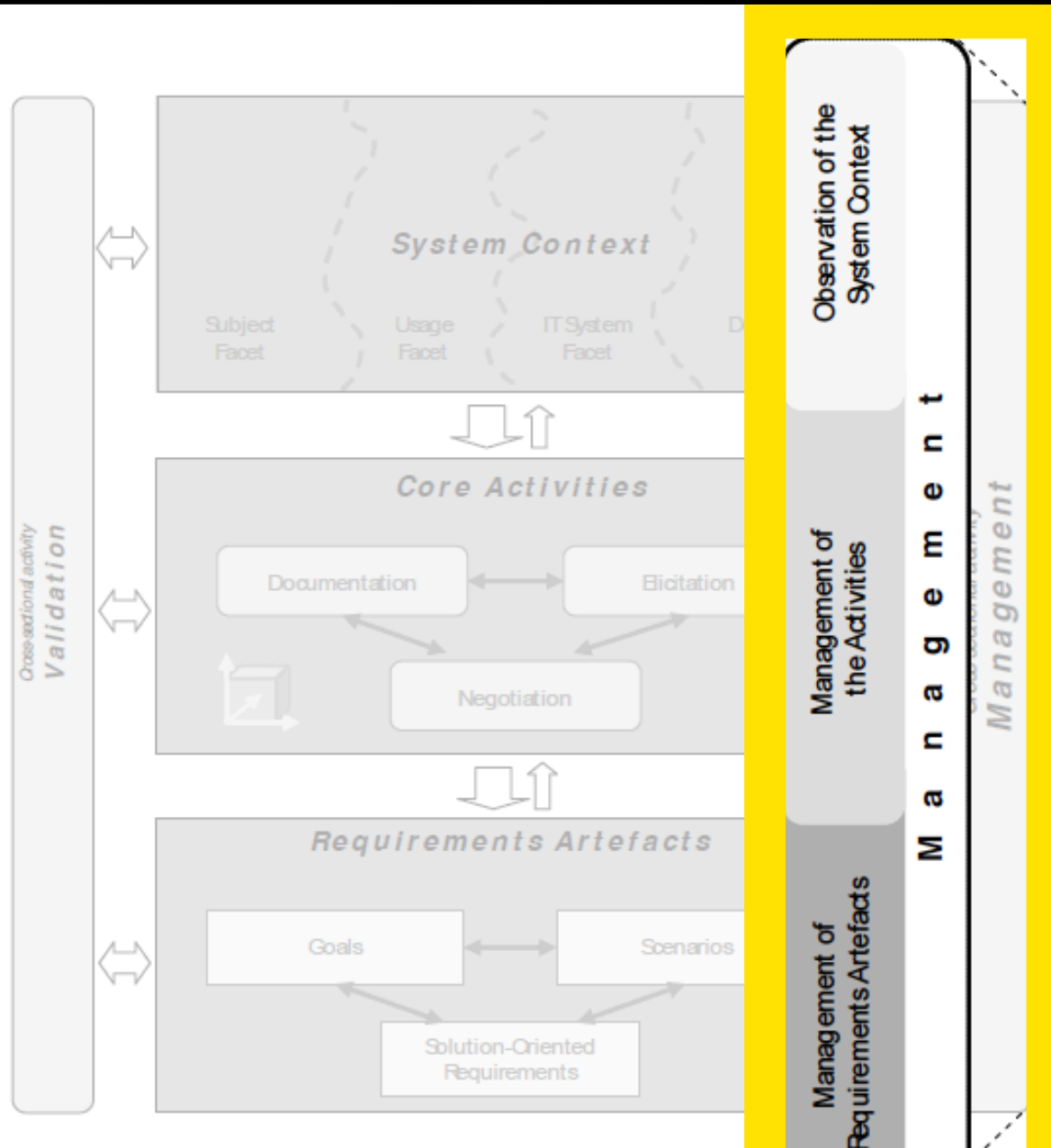| Attribute	Definition
Intradomicile Infested	The dwelling's intradomicile has at least one adult living inside.
Intradomicile Colonized	The dwelling's intradomicile has at least one nymph living inside.
Peridomicile Infested	The dwelling's peridomicile has at least one adult living inside.
Peridomicile Colonized	The dwelling's peridomicile has at least one nymph living inside.
Number of adult insects Intradomicile	Number of adult insects found in the ddwelling's intradomicile
Number of nymph insects Intradomicile	Number of nymph insects found in the dwelling's intradomicile
Number of adult insects Peridomicile	Number of adult insects found in the dwelling's peridomicile
Number of nymph insects Peridomicile	Number of nymph insects found in the dwelling's peridomicile
Infrastructure promoting risk (Domicile)	House structure (roof, walls or floor) at risk of colonization, facilitated by the use of organic materials or presence of cracks and crevices.
House hygiene promoting risk (Domicile)	Lack of house hygiene with disordered accumulation of domestic goods.
Hygiene practices oromoting oral transmission risk (Domicile)	Lack of hygiene practices and sanitation and lack of good manufacturing practices.

Part of the definition of the attributes of the DwellingInspection class

Validation

Example: Prototyping

Management

POHL, K. Requirements Engineering: Fundamentals, Principles and Techniques, Springer, 2010

Management

<mark>Goal and Techniques</mark>

➤ To observe the system context to detect context changes

    ➤ To participate in worldwide events related to Chagas

➤ To manage the execution of requirements engineering artefacts

    ➤ To perform the activities sequentially or interactively

➤ To manage the requirements artefacts

    ➤ To define: requirements attribute techniques,

    ➤ Requirements traceability,

    ➤ Requirements change management,

    ➤ Requirements configuration management,

    ➤ Requirements prioritisation.

87

Management

Management of requirement artefacts

➢ TortoiseSVN, a free open-source tool was used for controlling the different versions of all documentation created

➢ Enterprise Architech was the software tool to specify all requirement artefacts and ensure the traceability among the different software models.

outline

Initial complexity of the project

Our knowledge about the medical and entomological domain was very scarce

Communication would not be easy

90

Initial complexity of the project

The WHO Programme did not have a pre-determined/define proposal of the information and surveillance system

Different information sources

- WHO
- Health Ministry Officers: Countries
- Researchers & NGOs

- Technical groups

- Information Systems
  - ✧ ProMED
  - ✧ PubMed
  - ✧ Global Alert and Response (GAR)
  - ✧ Google Alerts

92

Integration of data

Vector control	**Healthcare**	**Systemic**	**Normative**
Dwelling inspections	Diagnosis	Implementation of regulations	Regulations, laws and recommendations
Insecticide applications	Treatments	Health economics	
Research			

93

Maps

- **United Nations Maps**
  - Define a very strict representation of country boundaries
  - Define the first administrative division of each country
    - *Länder* in Germany
    - *Provincia* in Argentina
    - *Estado* in Mexico

Geographic & Temporal Components

- Coordinates   - Polygons

Types of Data

Individual Data

• Specific for patiens and dwellings

• Smallest meaninful unit of information

• Not aggregated data

• Always related to Coordinates

Age = 23
Gender = Female
Nationality = Brazilian
Phase = Chronic
Blood donor = YES
Pregnant = NO

Types of Data

Number of evaluated people = 273,021
Number of infected people = 161,874
Number of pregnant women = 10,325
Mortality rate = 2,31%

Collective Data

• Aggregated Data

• Always related to Polygons

   ➢ First administrative divisions

   ➢ Countries

   ➢ Supranational entities

• Reports from hospitals, annual reports from each country,...

Types of Data

Estimated Data

• Calculations based on specific particular studies

• Aggregated Data

• Always related to Polygons
  - ➢ First administrative divisions
  - ➢ Countries
  - ➢ Supranational entities

Users

Official users
- Directly related to Governments
- Official source: Health Ministries
- Data without verification
- Can provide any type information

Non-official users
- Not related to Governments
- Non-Official source
- Data verified through publications
- Cannot provide or systemic information

Requirements Engineering

To deal with this complexity has been the most difficult part of the requirements engineering.

outline

101

Requirements Engineering in DSS

The Pohl's framework has been defined to be useful for the development of any software but more particularly for the development of traditional software.

Requirements Engineering in DSS

The Pohl's framework has been defined to be useful for the development of any software but more particularly for the development of traditional software.

Is it so useful for requirements engineering of Decision Support System?

103

Requirements Engineering in DSS

From the scope of Requirement Engineering, which are the main differences between DSS and traditional ones?

Requirements Engineering in DSS

We could analyze and compare the different existing approaches of RE in DSS

See the main characteristics and propose a new generic approach appropriate for RE in DSS…

Requirements Engineering in DSS

It could be a great Master Thesis!!!

Stephany Garcia

But…

Requirements Engineering in DSS

How do we analyze and <u>compare </u>existing works?

Which methodology do we use to propose our approach?

Methodology

Design Science Research

"its fundamental principle is that **knowledge** and **understanding** of a **design problem** and its **solution** are acquired in the **building** and **application** of an **artifact**".

HEVNER, A. R., MARCH, S. T., PARK, J., AND RAM, S. Design science in information systems research, MIS Q. 28, 1 (2004) 75-105

Pohl's Framework

It could be a good candidate to use it as a reference framework for comparing existing works.

Our Approach

<u>Challenge</u>
Improve the RE for DSS

RE4DSS

Characterization of DSS in Pohl's Framework

Searching
Adapting
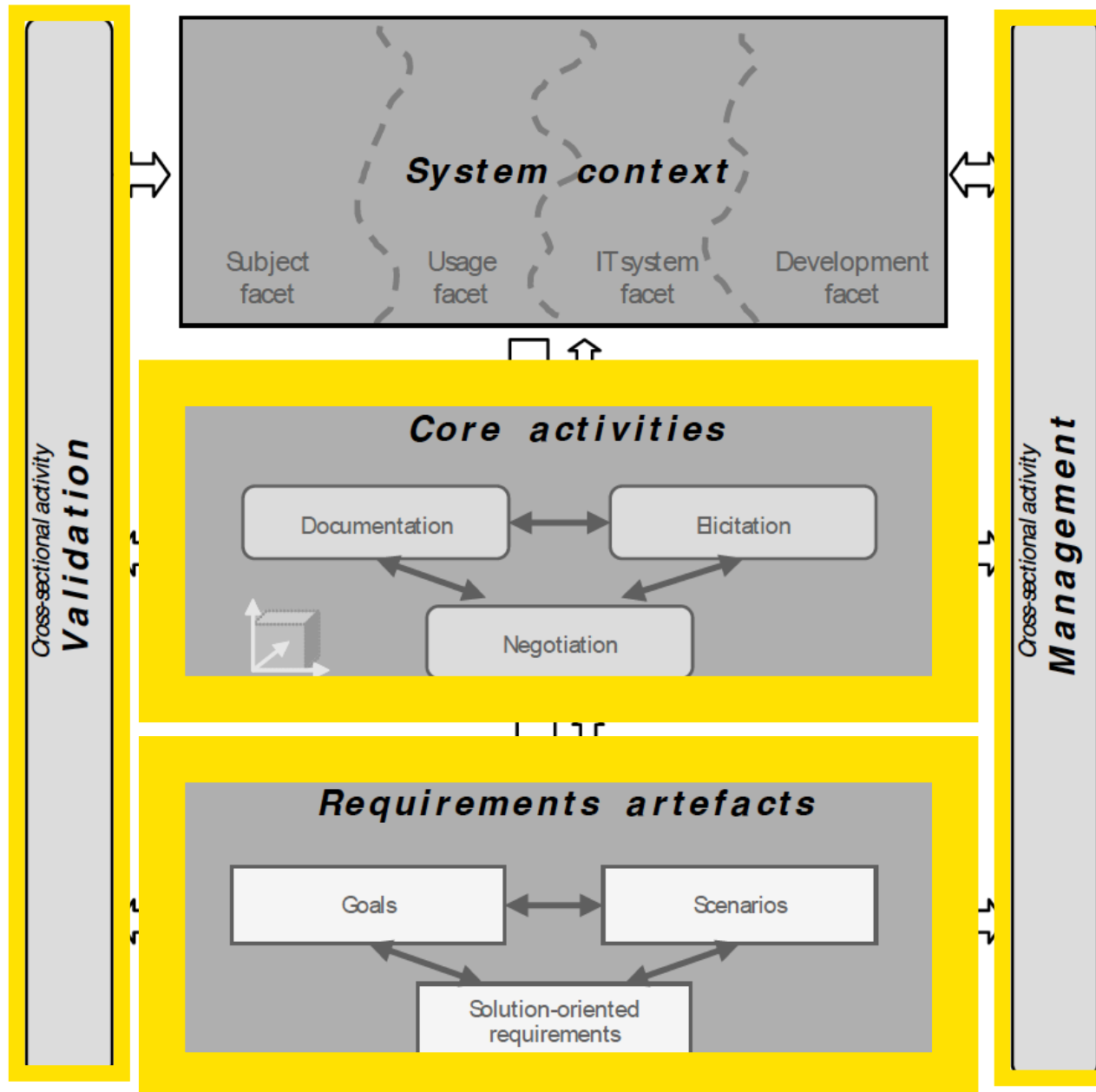Testing

RE in DSS Literature

Pohl's Framework

<u>State of the Art</u>

110

Characterization of DSS

POHL, K. Requirements Engineering: Fundamentals, Principles and Techniques, Springer, 2010

Search on current literature

Search on current literature

Requirements Engineering Framework Definitions by K.Pohl							
Requirements Artifacts			Core Activities			Management	Validation
Goals	Scenarios	Solution-Oriented Requirements	Documentation	Elicitation	Negotiation		
Intention with regard to the objectives, properties or use of the system	Describes a concrete example of satisfying or failing to satisfy a goal (or a set of goals)	Define the data, functions, behavior, quality and constraints Often imply a conceptual solution	Documentation and specification of the elicited requirements according to the defined documentation and specification rules.	Identify the relevant resources. Elicit existing requirements from the identified sources. Develop new and innovate requirements.	Identify conflicts. Analyze the cause of each conflict. Resolve the conflict by means of appropriate strategies. Document the conflict resolution and the rationales.	Observe the system context to detect context changes. Manage the execution of requirements engineering activities. Manage the requirements artifacts.	Denotes checking whether the inputs, performed activities, and created outputs (requirements artifacts) of the requirements engineering core activities fulfill defined quality criteria.

Search on current literature

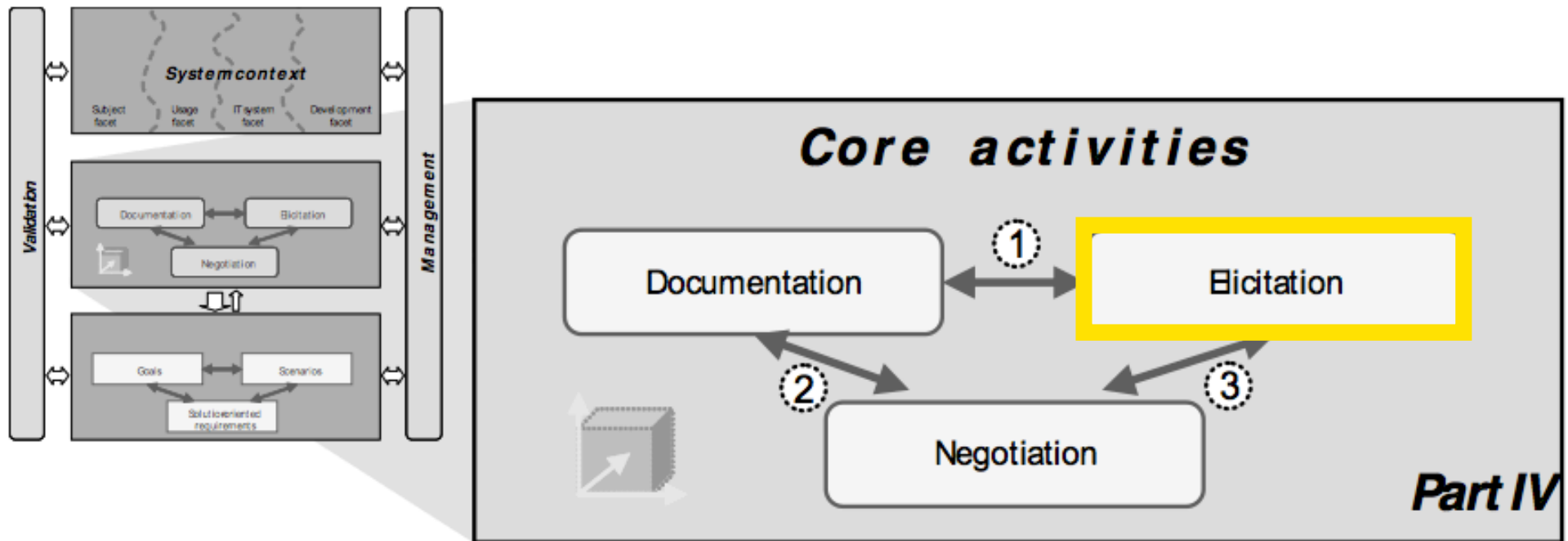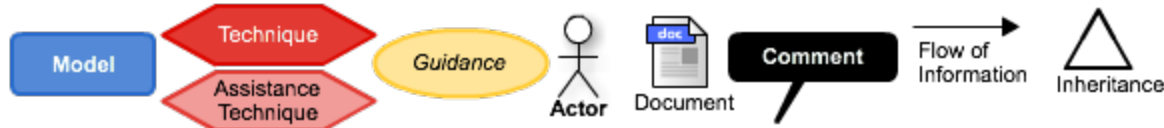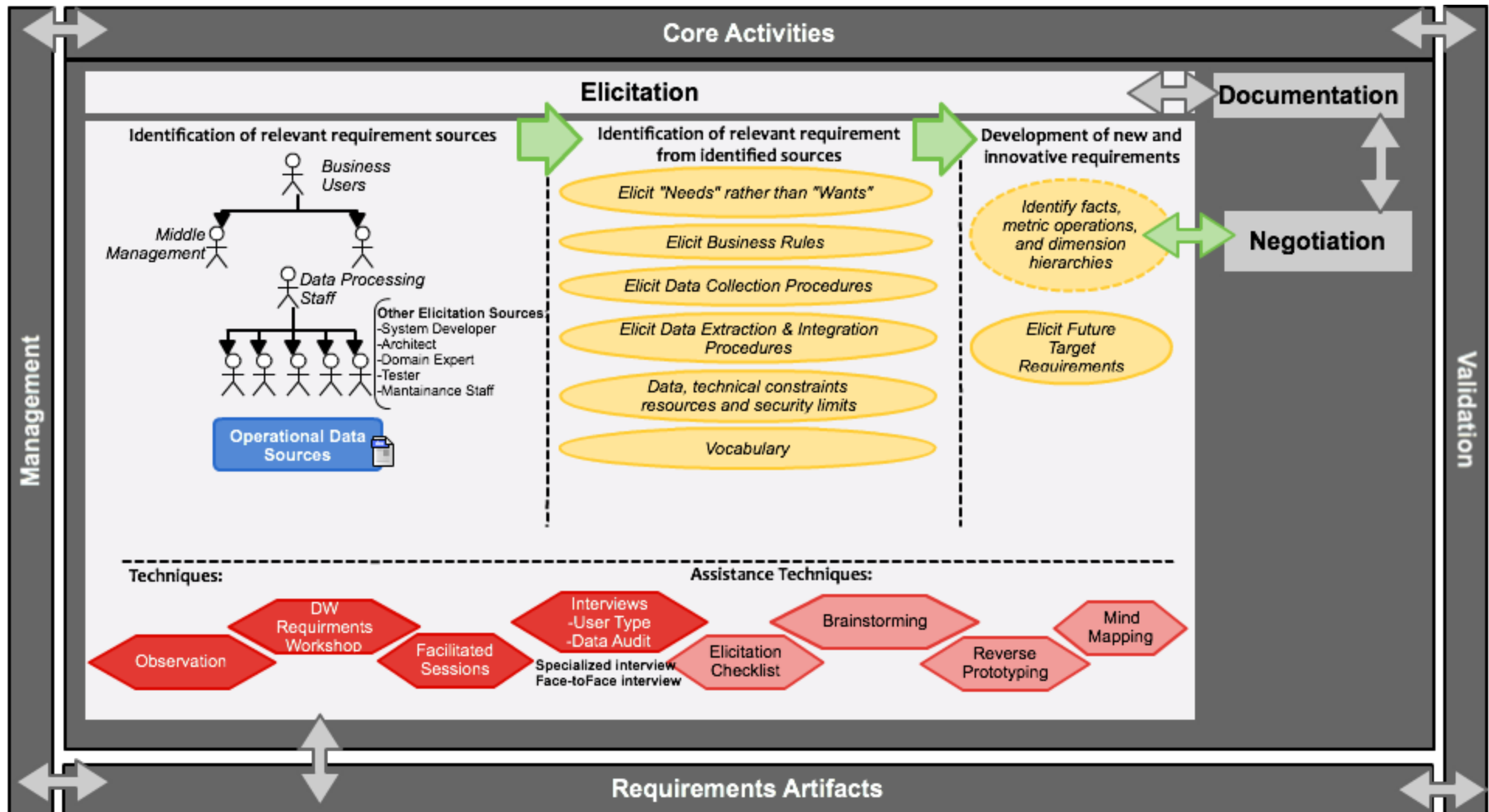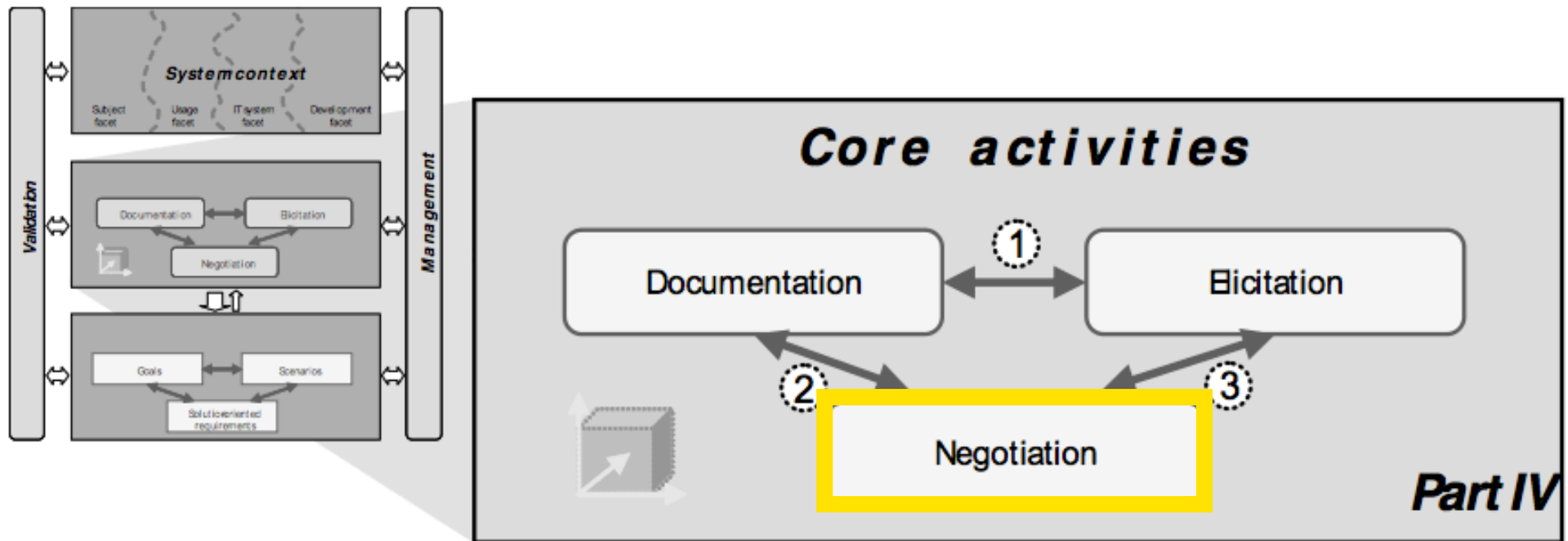| Specifications for Requirement's Table	
BOLD **Blue**	– Documented Specification **Model** (e.g. Conceptual Model, Use Case, Prioritization Grid, Traceability Matrix, etc.)
Technique Red	– Documented **Technique** (Interviews, Workshops, Checklists, Prototypes, etc.)
Italics *Yellow*	– **Guidance** (e.g. Identify Customer Needs, Traceability, Prioritization, etc.)
✓	– Related activity to the specific method or guidance

Core Activities - Elicitation

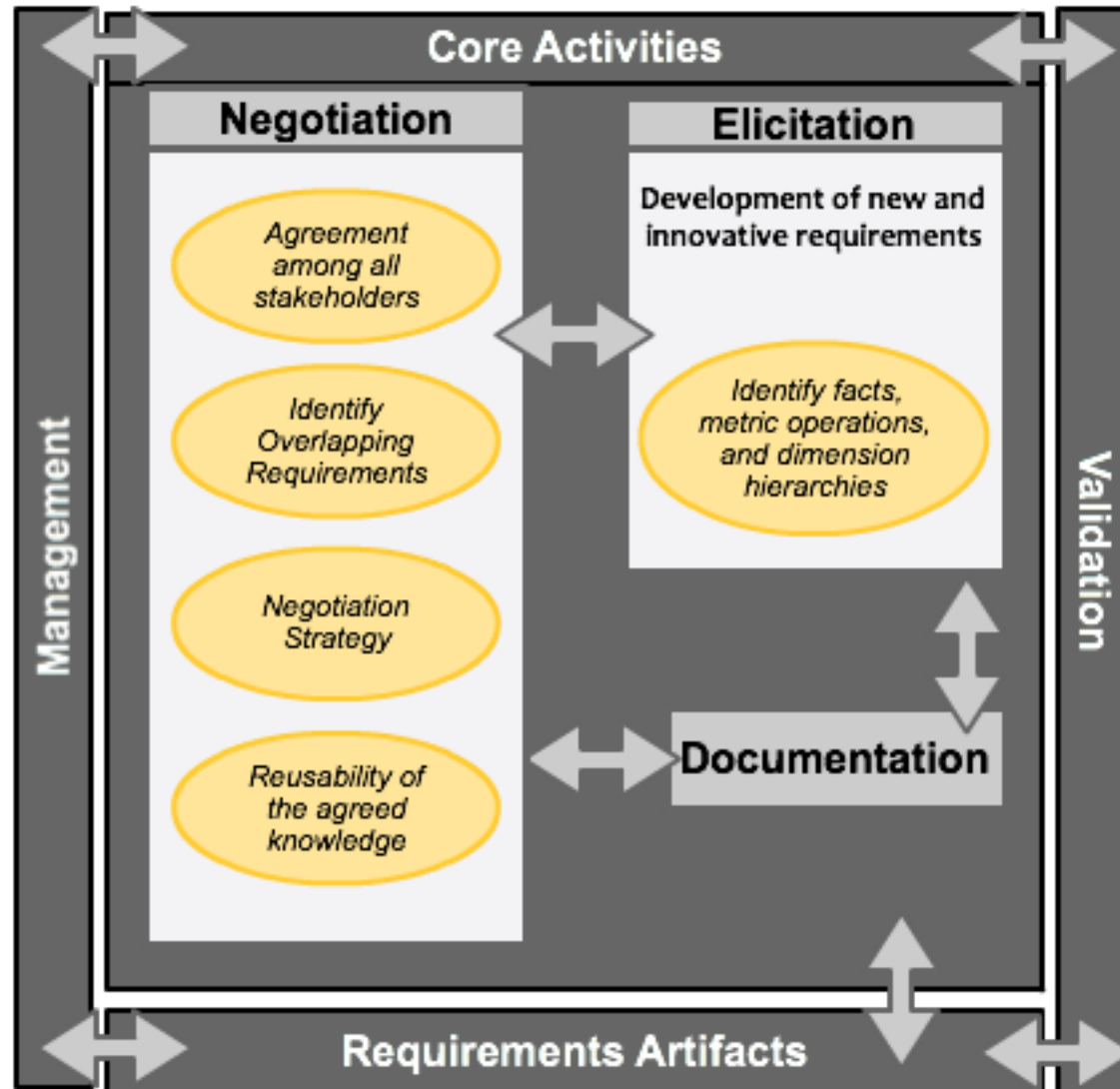# Core Activities - Elicitation

Core Activities - Negotiation

Core Activities - Negotiation

Core Activities - Documentation

POHL, K. Requirements Engineering: Fundamentals, Principles and Techniques, Springer, 2010

Requirements artefacts

Goals

POHL, K. Requirements Engineering: Fundamentals, Principles and Techniques, Springer, 2010

Goals

Goals

Tropos

Soft-goal interdependency graph

Scenarios

POHL, K. Requirements Engineering: Fundamentals, Principles and Techniques, Springer, 2010

Scenarios

CRUD Matrix & BUS Matrix

COMMON DIMENSIONS

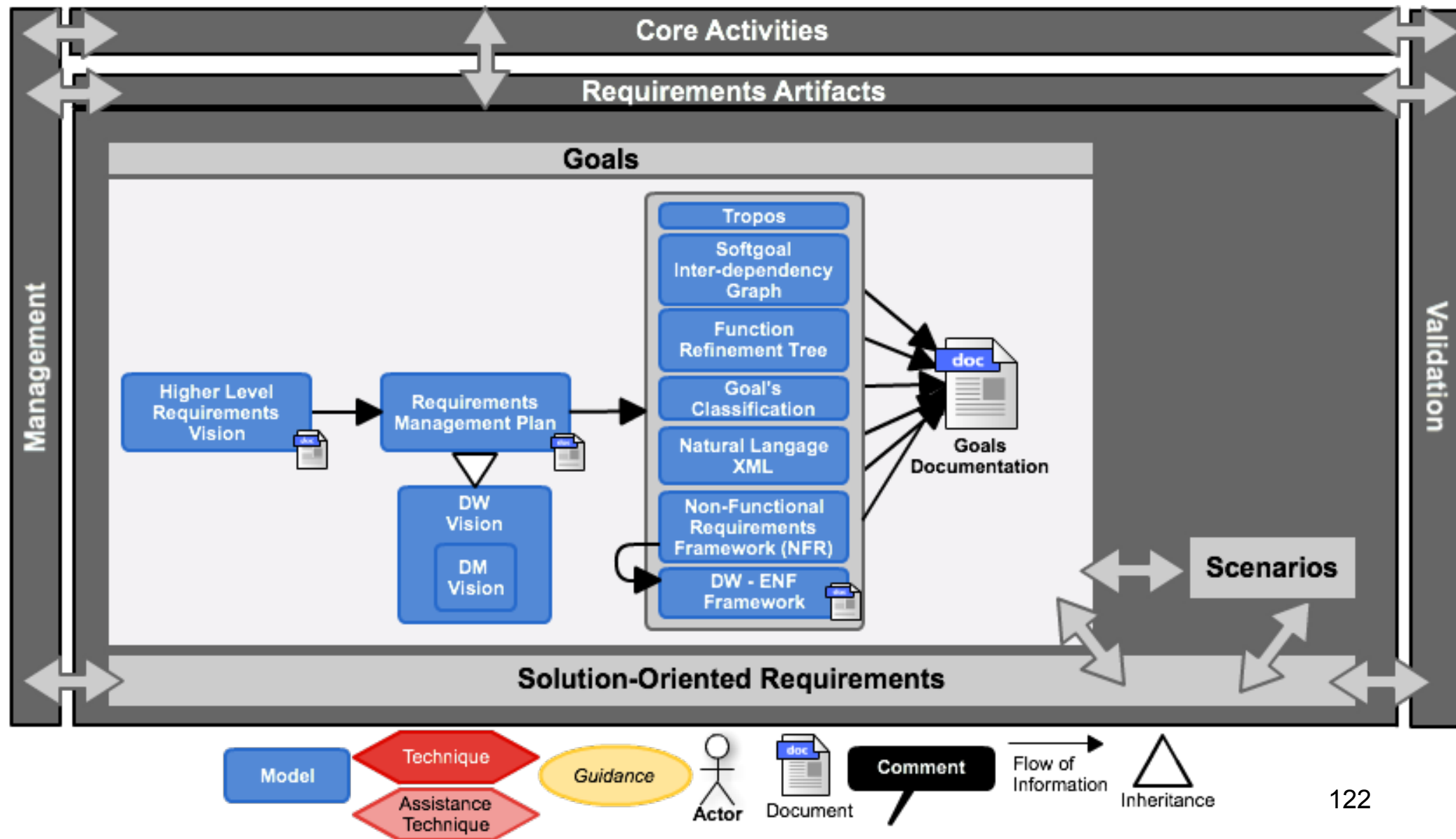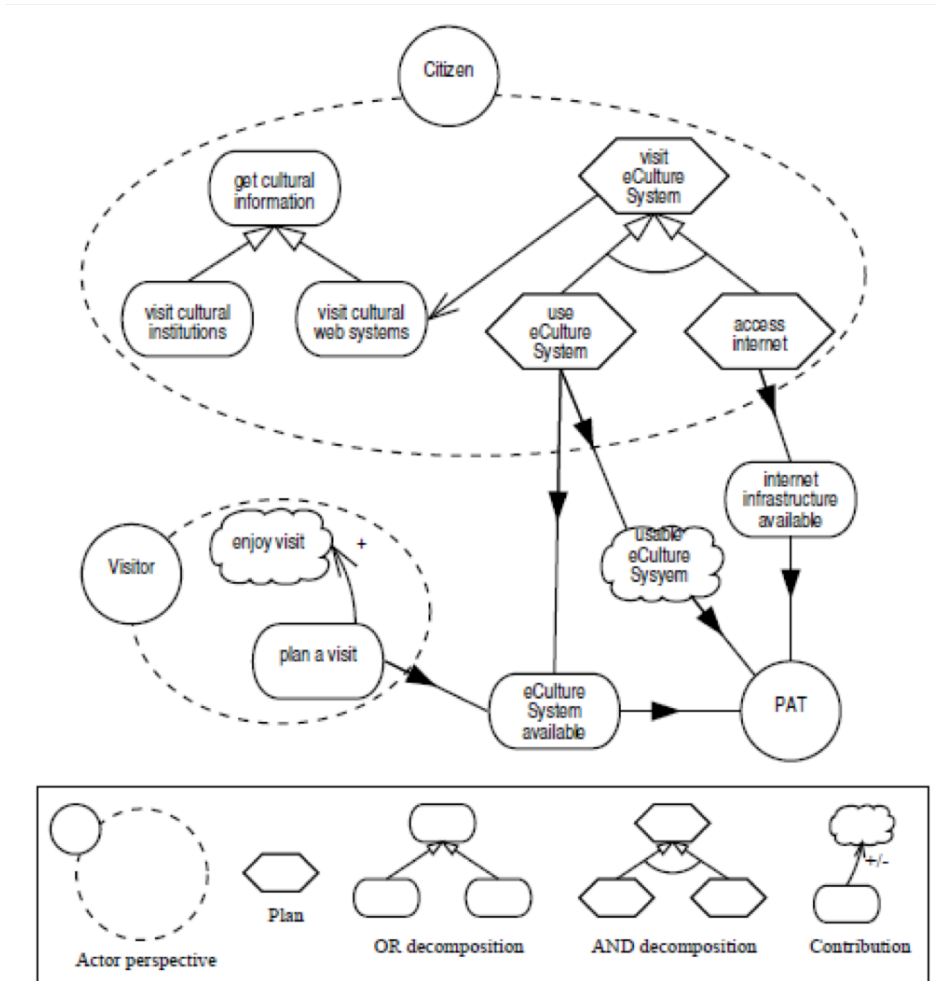| BUSINESS PROCESSES	Date	Product	Warehouse	Store	Promotion	Customer	Employee
Issue Purchase Orders	X	X	X				
Receive Warehouse Deliveries	X	X	X				X
Warehouse Inventory	X	X	X				
Receive Store Deliveries	X	X	X	X			X
Store Inventory	X	X		X			
Retail Sales	X	X		X	X	X	X
Retail Sales Forecast	X	X		X			
Retail Promotion Tracking	X	X		X	X		
Customer Returns	X	X		X	X	X	X
Returns to Vendor	X	X		X			X
Frequent Shopper Sign-Ups	X			X		X	X

	Sale item	Return purchased item	...
Cashier			
Sale	C		
Sale_line	C		
Item	RU	RU	
Order	C		
Return		C	
Return line		C	
...			

Bus Matrix   **CRUD Matrix**

Solution-oriented requirements

POHL, K. Requirements Engineering: Fundamentals, Principles and Techniques, Springer, 2010

Core Activities

Requirements Artifacts

Management

Validation

Goals

Stakeholder's Intentions

- Tropos
- Softgoal Inter-dependency Graph
- Function Refinement Tree
- Goal's Classification
- Natural Langage XML
- Non-Functional Requirements Framework (NFR)
- DW - ENF Framework

Higher Level Requirements Vision

Requirements Management Plan

DW Vision / DM Vision

Goals Documentation

Scenarios

Documenting examples of system's usage

- Use Cases
- Sequence Diagrams
- Process Diagrams
- Workflow Models

Scenarios

- CRUD Matrix
- Bus Matrix

Solution-Oriented Requirements

Document conceptual solution which satisfy goals and scenarios and define basis to realize system

Shared Ontology

Business Vocabulary → Glossary Cross-References

MD Vocabulary

All Sources

Information Map Sources

DW/DM Conceptual Model → ETL Workflow

Data Warehouse Specification Document

Legend:
- Model
- Technique
- Assistance Technique
- Guidance
- Actor
- Document
- Comment
- Flow of Information
- Inheritance

128

Core Activities

Elicitation

Identification of relevant requirement sources

Identification of relevant requirement from identified sources

Development of new and innovative requirements

Negotiation

Business Users

Middle Management — Decision-Making Competence

Data Processing Staff

Other Elicitation Sources:
-System Developer
-Architect
-Domain Expert
-Tester
-Mantainance Staff

Operational Data Sources

- Elicit "Needs" rather than "Wants"
- Elicit Business Rules
- Elicit Data Collection Procedures
- Elicit Data Extraction & Integration Procedures
- Data, technical constraints resources and security limits
- Vocabulary

Identify facts, metric operations, and dimension hierarchies

Elicit Future Target Requirements

Identify Overlapping Requirements

Agreement among all stakeholders

Negotiation Strategy

Reusability of the agreed knowledge

Techniques:

Observation | DW Requirements Workshop | Facilitated Sessions

Assistance Techniques:

Interviews -User Type -Data Audit
Specialized interview Face-toFace interview

Elicitation Checklist | Brainstorming | Reverse Prototyping | Mind Mapping

Documentation

Management

Validation

Requirements Artifacts

Goals

Stakeholder's Intentions

Tropos
Softgoal Inter-dependency Graph
Function Refinement Tree
Goal's Classification
Natural Langage XML
Non-Functional Requirements Framework (NFR)
DW - ENF Framework

Higher Level Requirements Vision → Requirements Management Plan

DW Vision
DM Vision

Goals Documentation

Scenarios

Documenting examples of system's usage
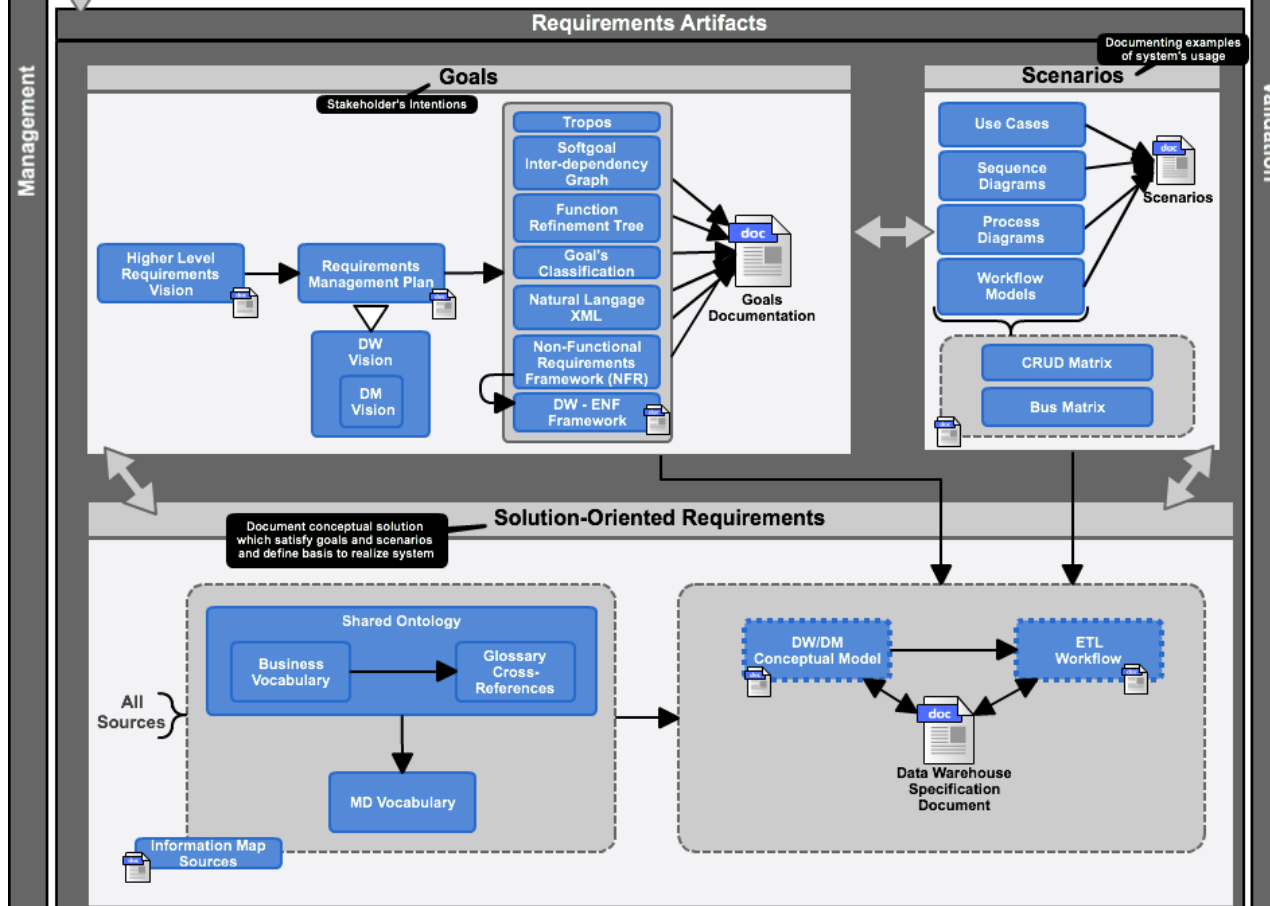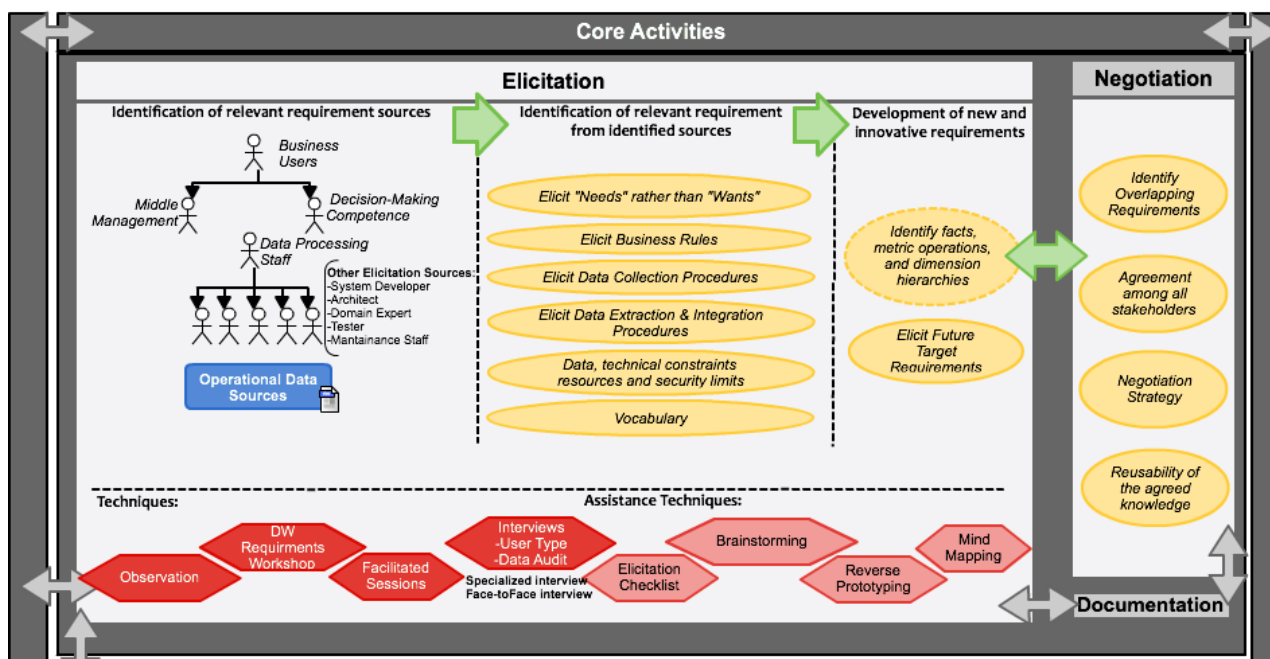
Use Cases
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Bus Matrix

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Data Warehouse Specification Document

129

Validation

POHL, K. Requirements Engineering: Fundamentals, Principles and Techniques, Springer, 2010

Management

POHL, K. Requirements Engineering: Fundamentals, Principles and Techniques, Springer, 2010
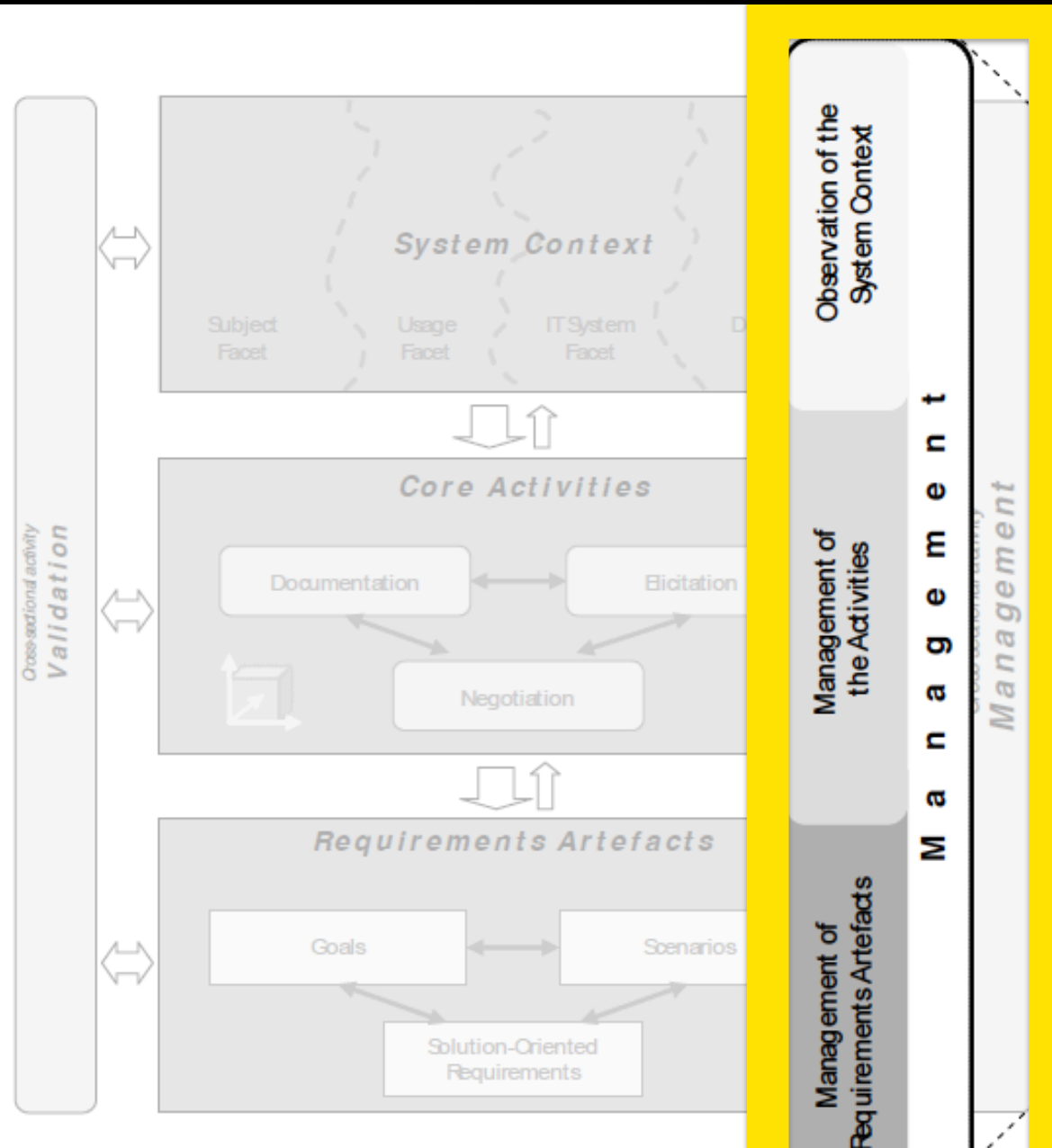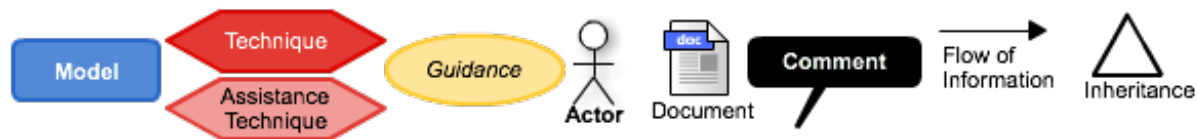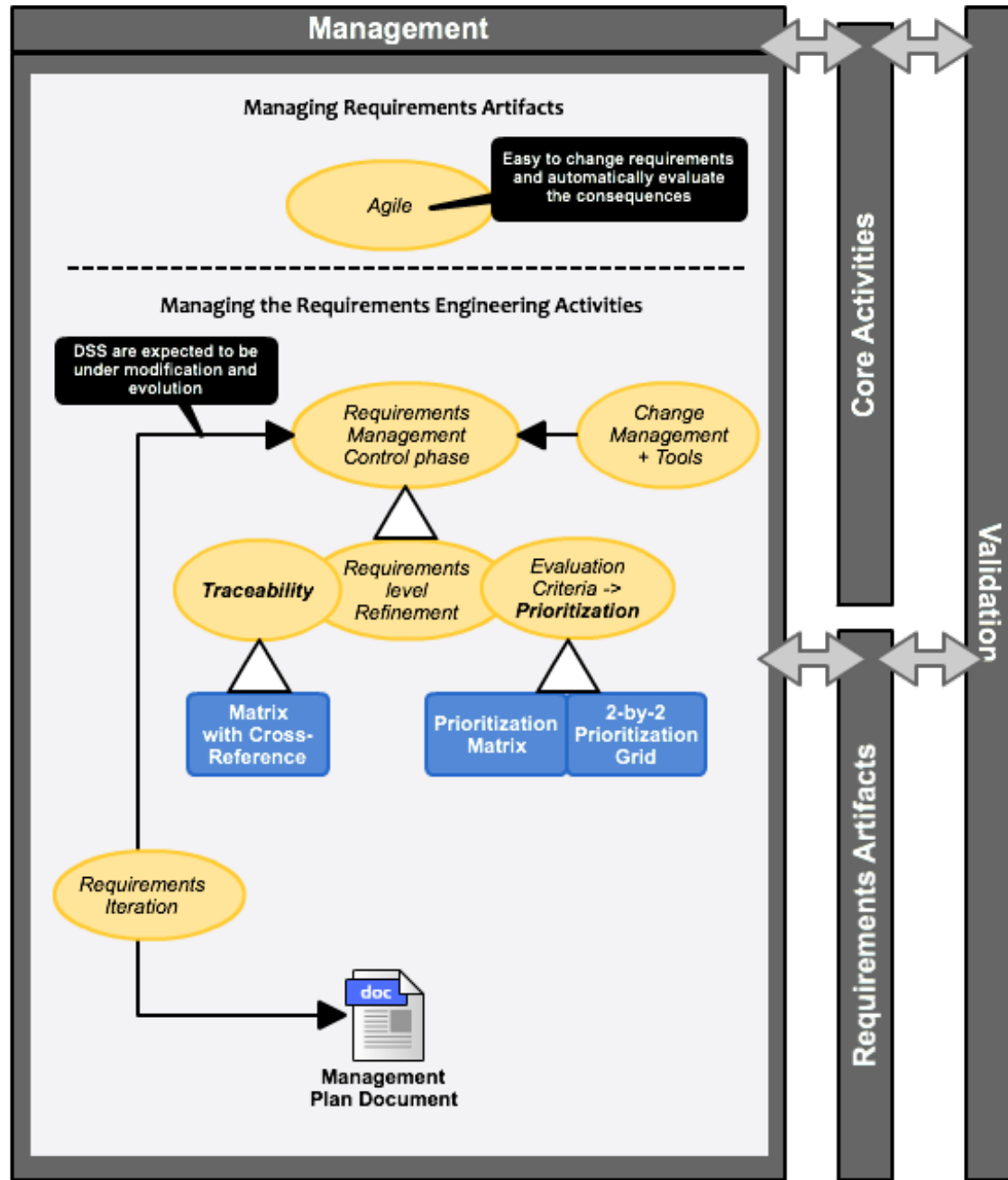
Our Approach

Challenge

To define a systematic RE approach tailored to DSS

RE4DSS

Characterization of DSS in Pohl's Framework

Searching
Adapting
Testing

RE in DSS Literature

Pohl's Framework

State of the Art

134

RE$_4$DSS

Requirements Engineering for Decision Support Systems

- To deal with:
    - Complex processes to extract,
    - Integrate heterogeneous sources,
    - Transform and aggregate data,
    - Create analytical results

        …

RE$_4$DSS

Requirements Engineering for Decision Support Systems

- Making the requirement specification more manageable, while also enabling to deliver the expected decision-support facilities in a systematic manner.
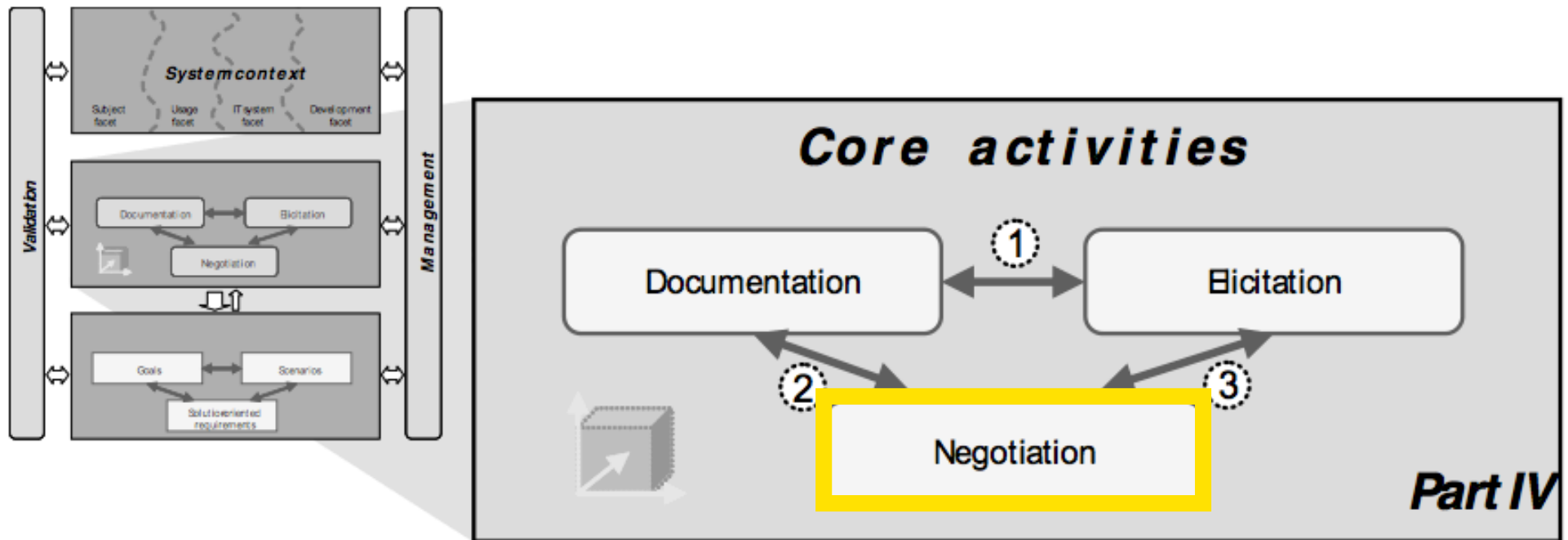
RE4DSS

137

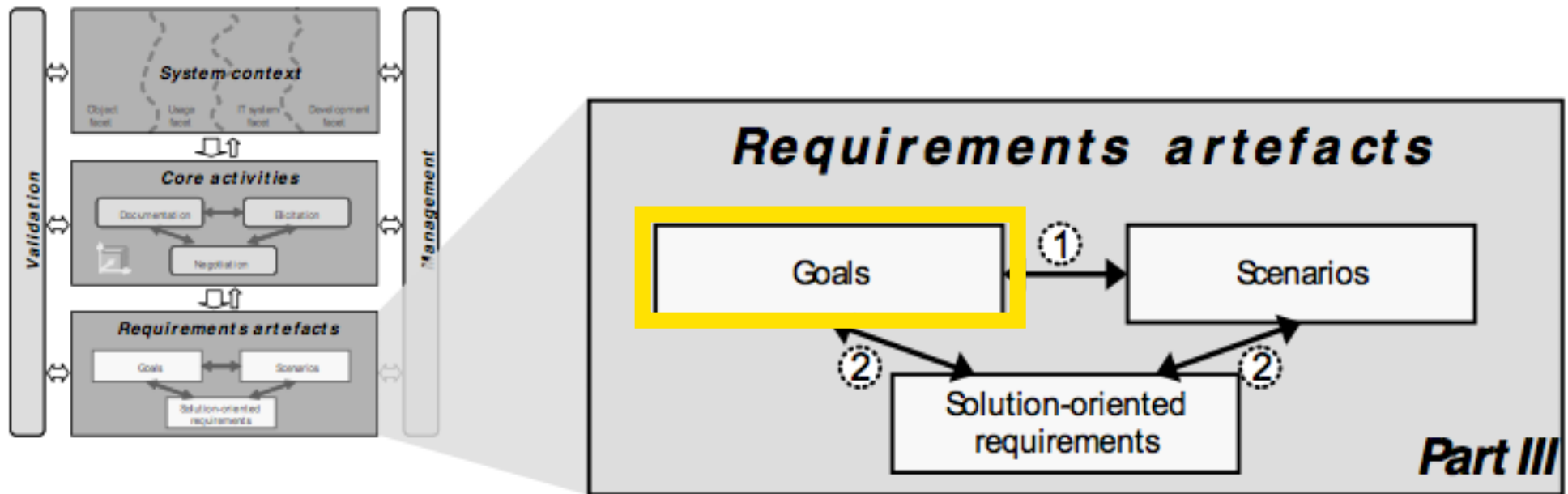# Core Activities - Eliciation

Core Activities - Elicitation

Core Activities - Negotiation

Core Activities - Negotiation

Goals

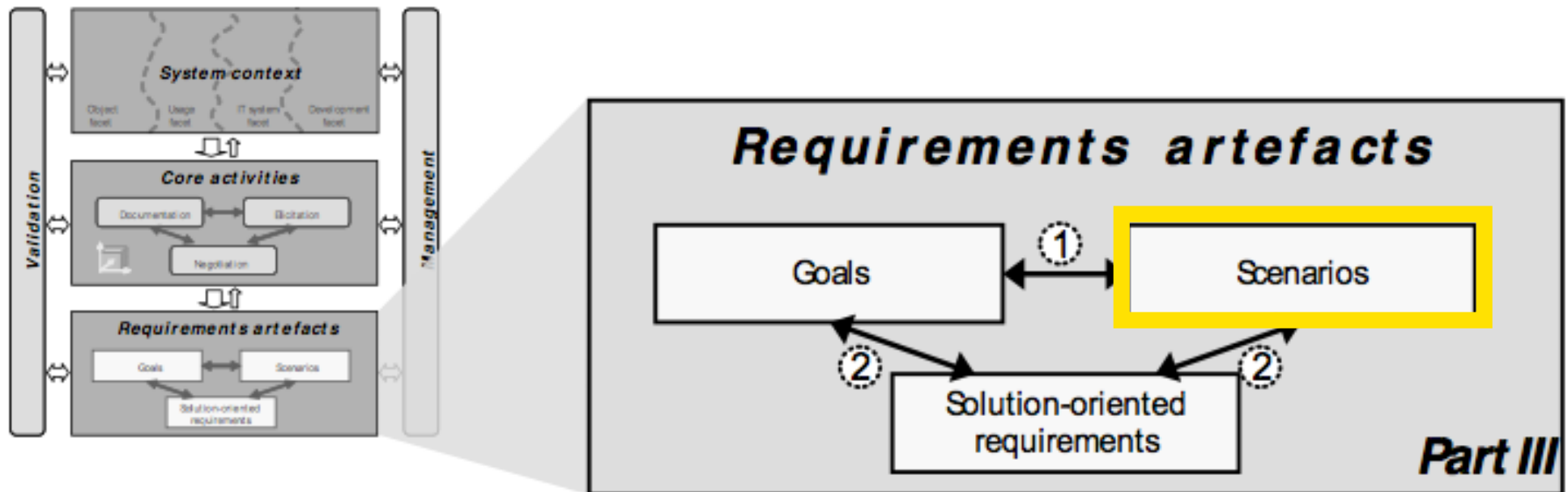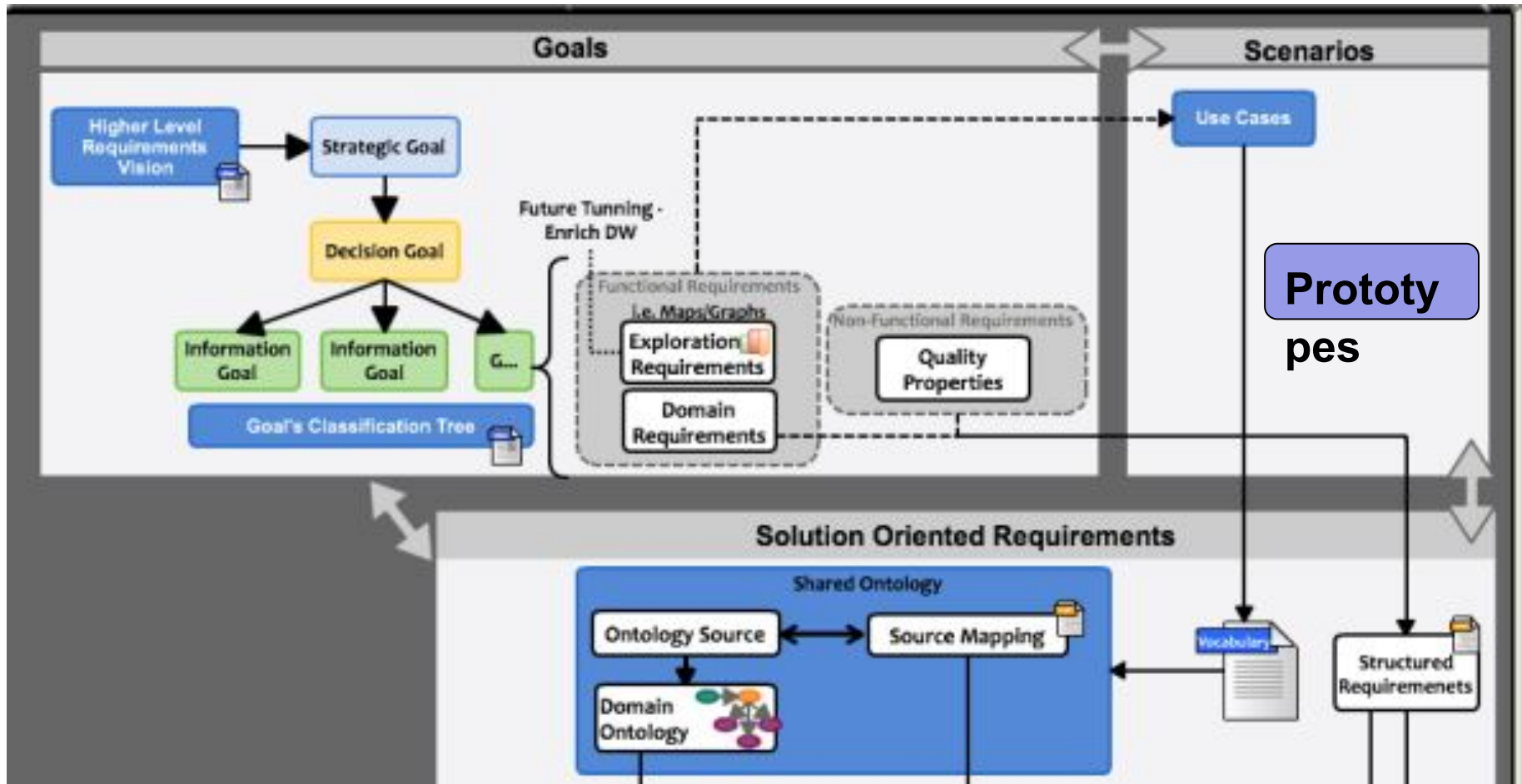POHL, K. Requirements Engineering: Fundamentals, Principles and Techniques, Springer, 2010

Goals

- Strategic goal: highest level of abstraction ("increase sales")
- Decisional goal: how the strategic goal can be achieve ("launch a promotion")

143

Scenarios

POHL, K. Requirements Engineering: Fundamentals, Principles and Techniques, Springer, 2010
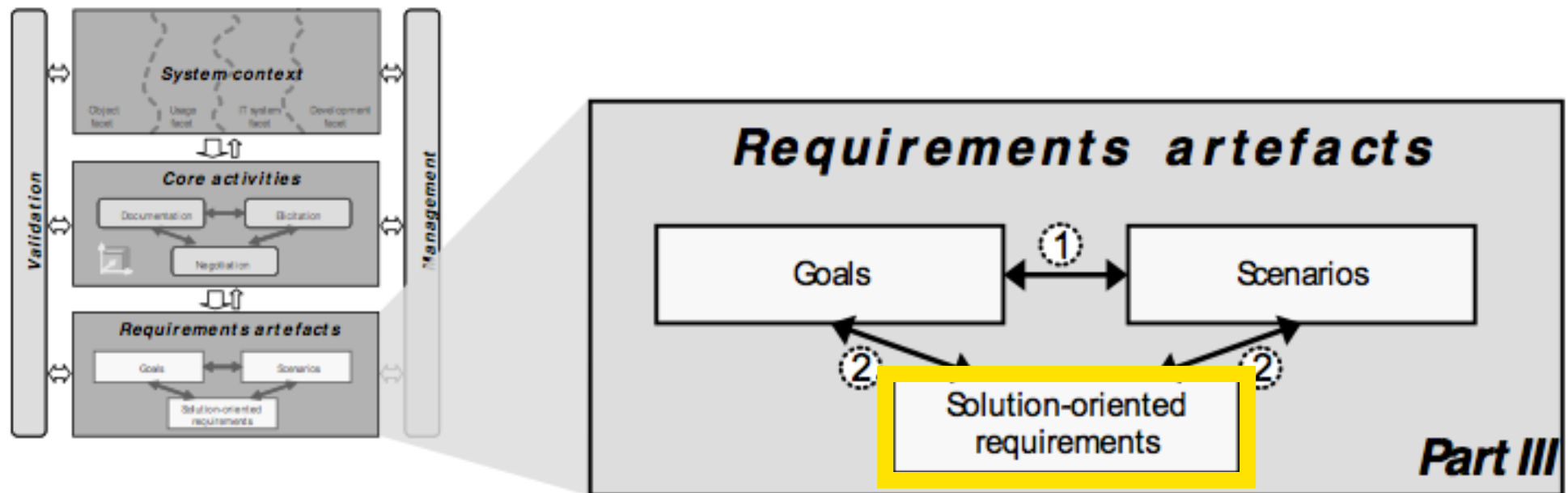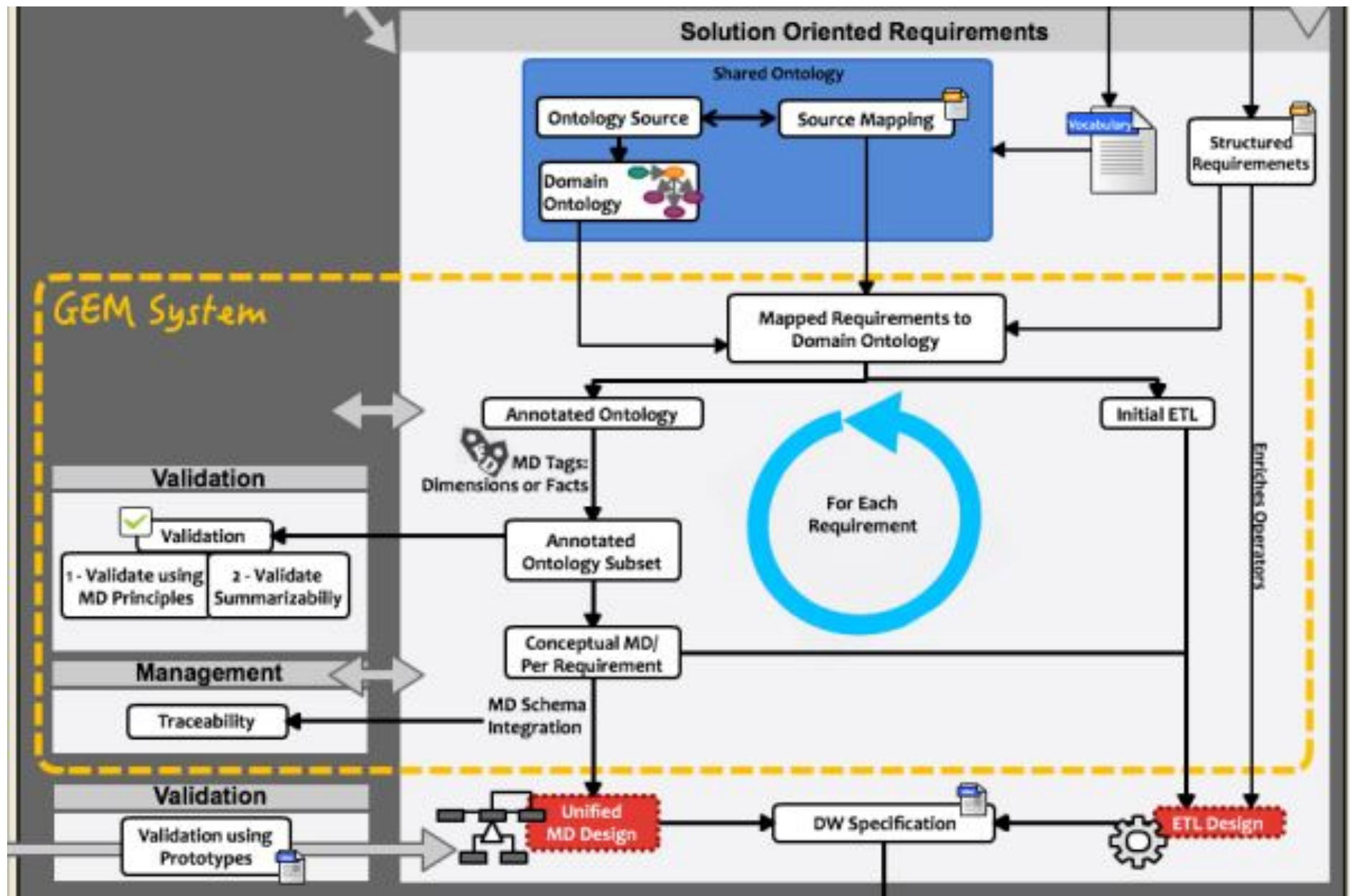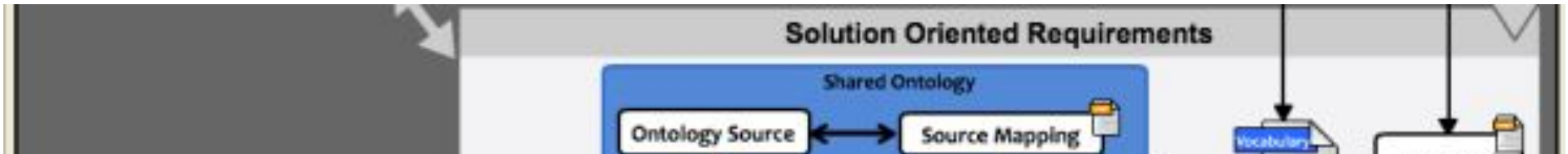
Scenarios

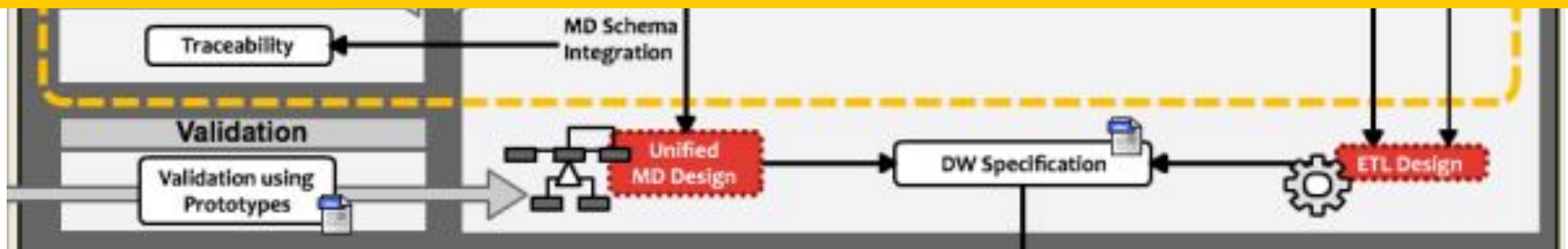# Solution-oriented requirements

<u>Solution-oriented requirements</u>

Solution-oriented requirements

E.g. of Structured Requirements: "examine income per customer"

<dimensions><concept id = "customers"></dimensions>

<measures><concept id = "income"></measures>

Source Table:

```
<!--definition of the ontology class that represents source table Region-->

<owl:Class rdf:ID="Region">

...

  </owl:Class>
```

Attributes of the Source Table:

```
<!--Definition of the attribute r_regionkey, i.e., primary key, of the table Region -->

<owl:DatatypeProperty rdf:about="#Region_r_regionkeyATRIBUT">

   <rdfs:range rdf:resource="http://www.w3.org/2001/XMLSchema#int"/>

   <rdfs:domain rdf:resource="#Region"/>

</owl:DatatypeProperty>
```

```
<!--Definition of the attribute r_name of the table Region -->

<owl:DatatypeProperty rdf:about="#Region_r_nameATRIBUT">

   <rdfs:range rdf:resource="http://www.w3.org/2001/XMLSchema#string"/>

   <rdfs:domain rdf:resource="#Region"/>

</owl:DatatypeProperty>
```
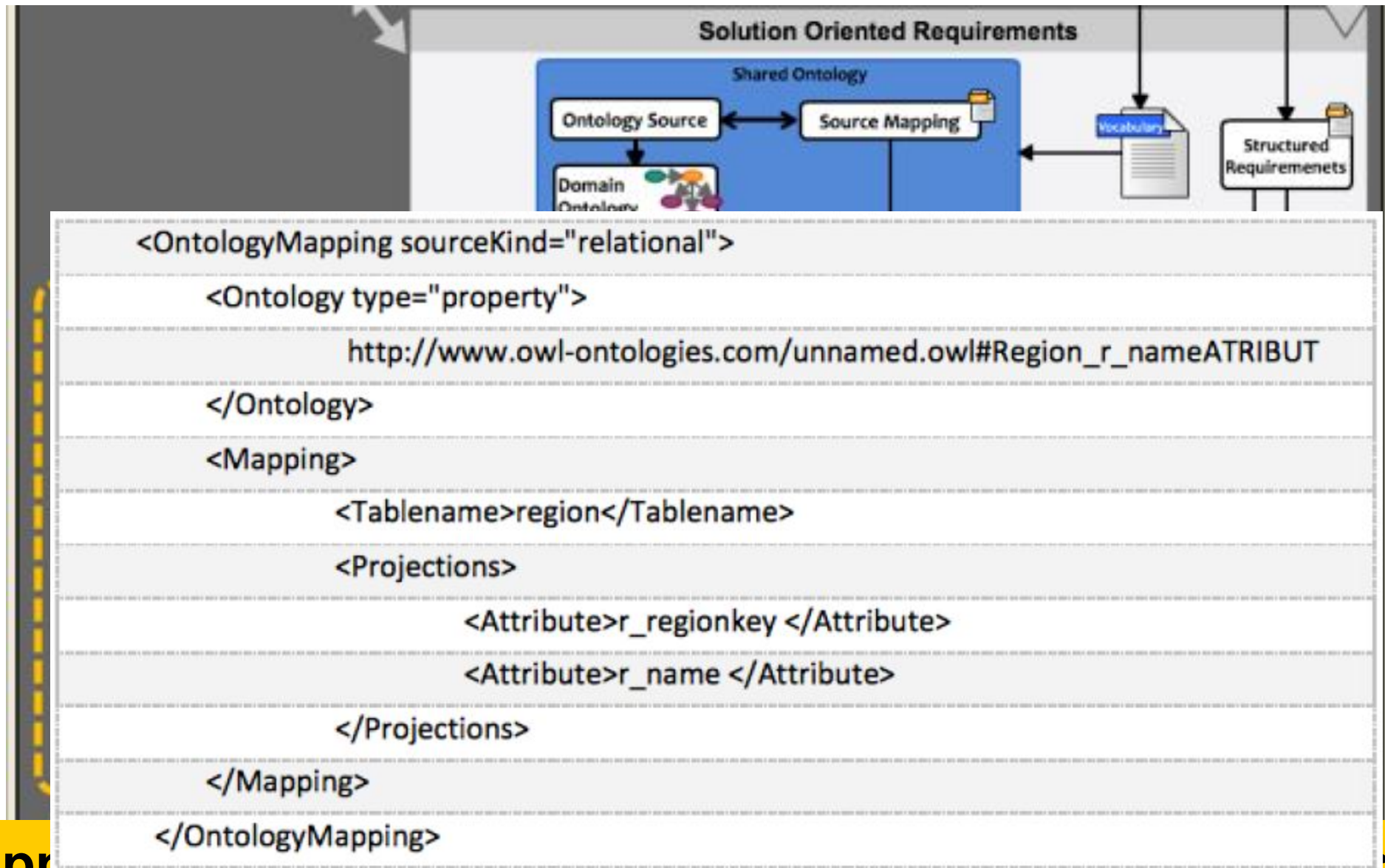
Source Associations:

```
<!-- Definition of the IsFrom relationship between the tables Nation and Region -->

<owl:ObjectProperty rdf:about="#IsFrom">
```

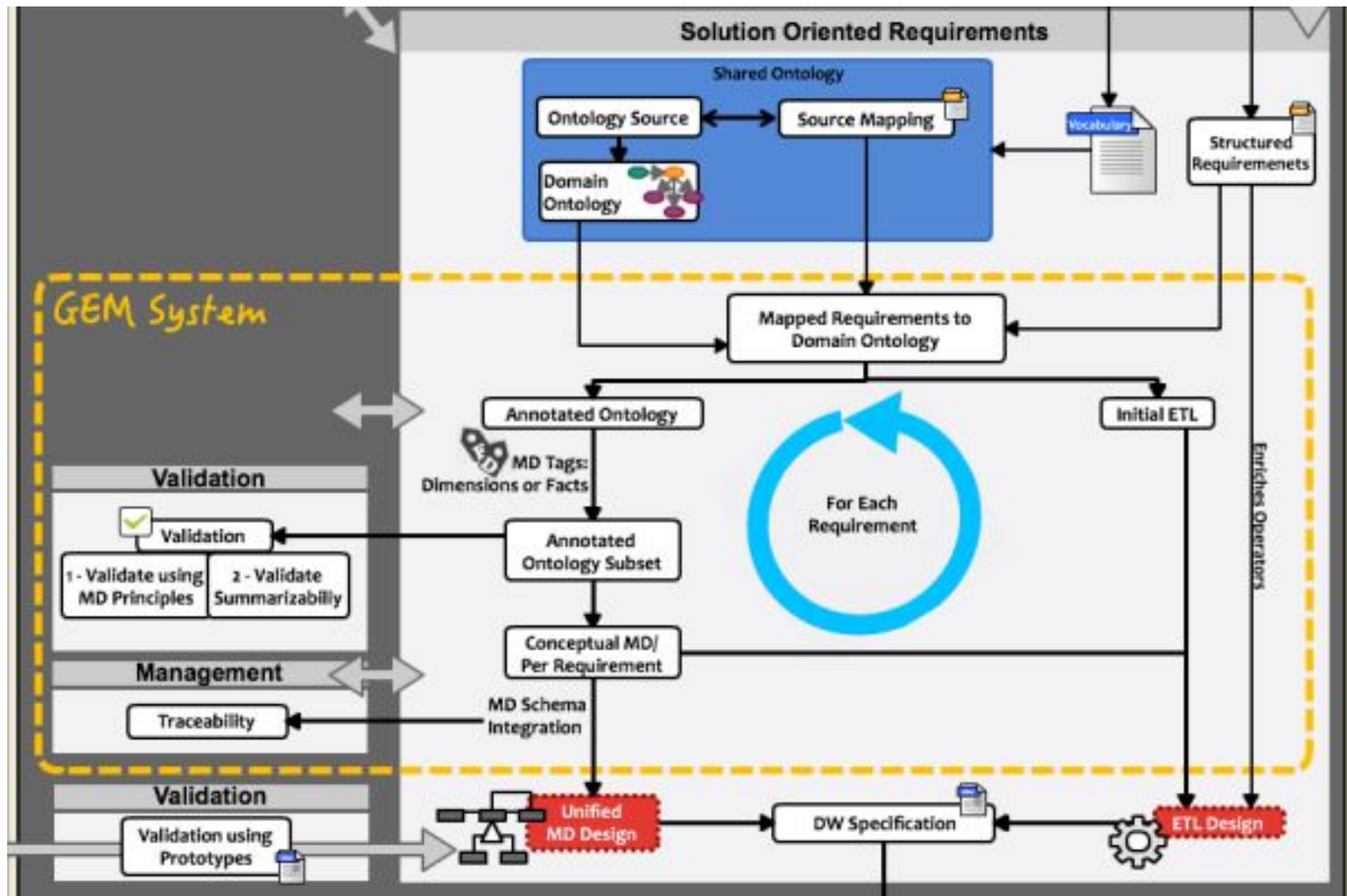**Relational Data Source represented by means of an OWL Ontology (P. Jovanovic MT)**
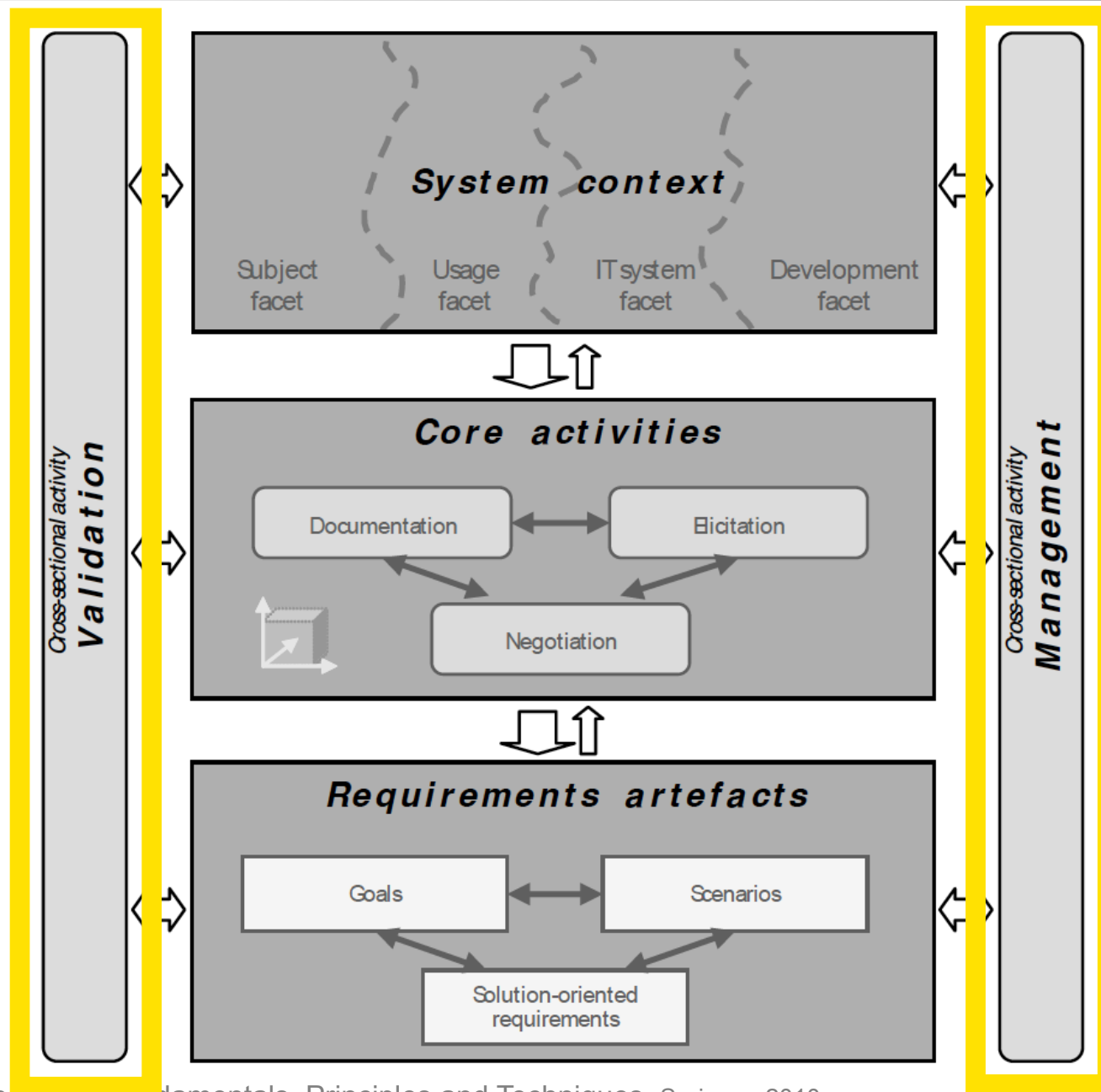
Solution-oriented requirements

Solution Oriented Requirements

Shared Ontology

Ontology Source ⟷ Source Mapping

Vocabulary   Structured Requiremenets

Domain Ontology

```
<OntologyMapping sourceKind="relational">
    <Ontology type="property">
            http://www.owl-ontologies.com/unnamed.owl#Region_r_nameATRIBUT
    </Ontology>
    <Mapping>
        <Tablename>region</Tablename>
        <Projections>
                <Attribute>r_regionkey </Attribute>
                <Attribute>r_name </Attribute>
        </Projections>
    </Mapping>
</OntologyMapping>
```

Mapping of an ontology datatype property (Freevalev12 MT)

Solution-oriented requirements

Cross-sectional activities – Management & Validation

POHL, K. Requirements Engineering. Fundamentals, Principles and Techniques, Springer, 2010
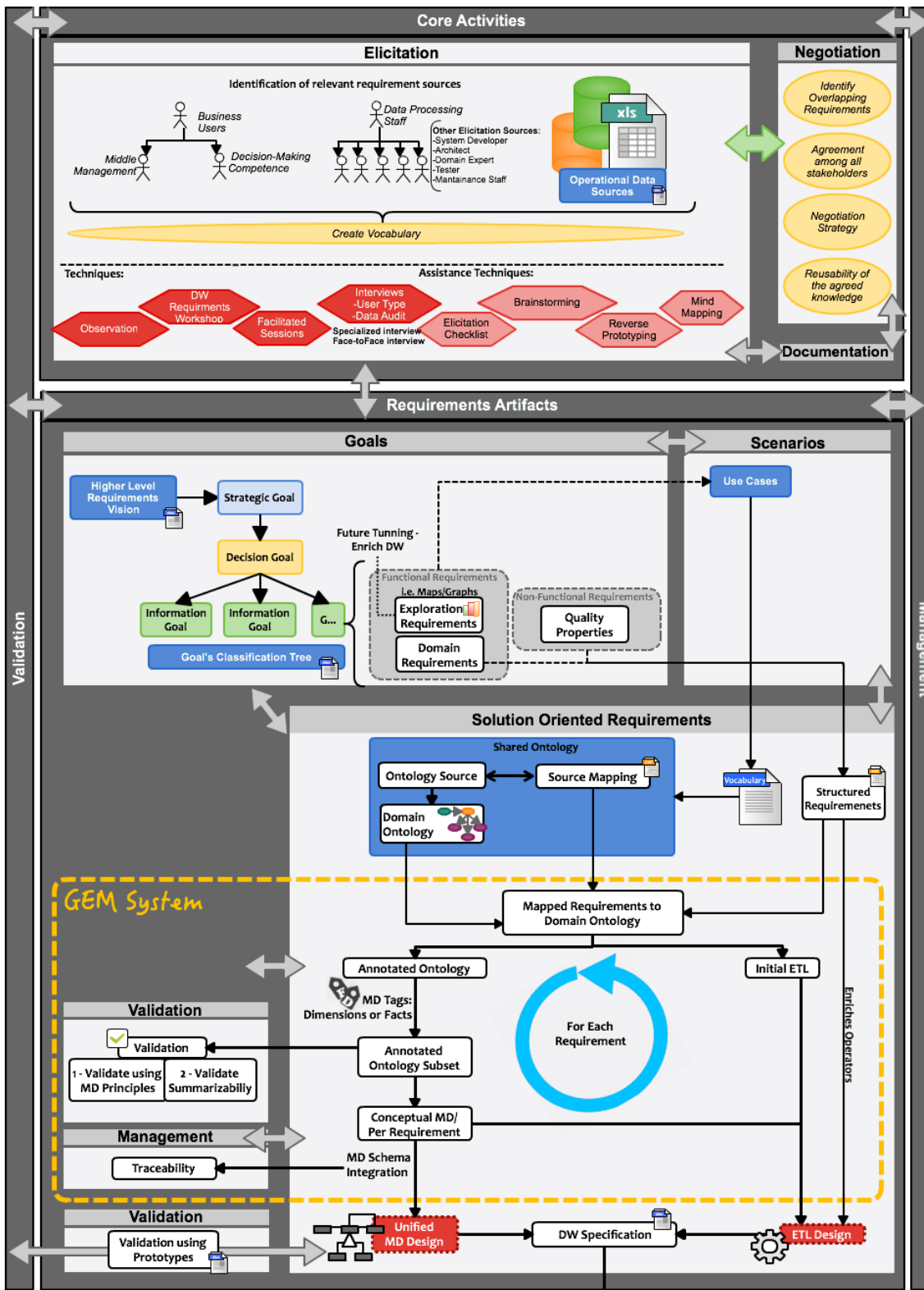
Cross-sectional activities – Management & Validation
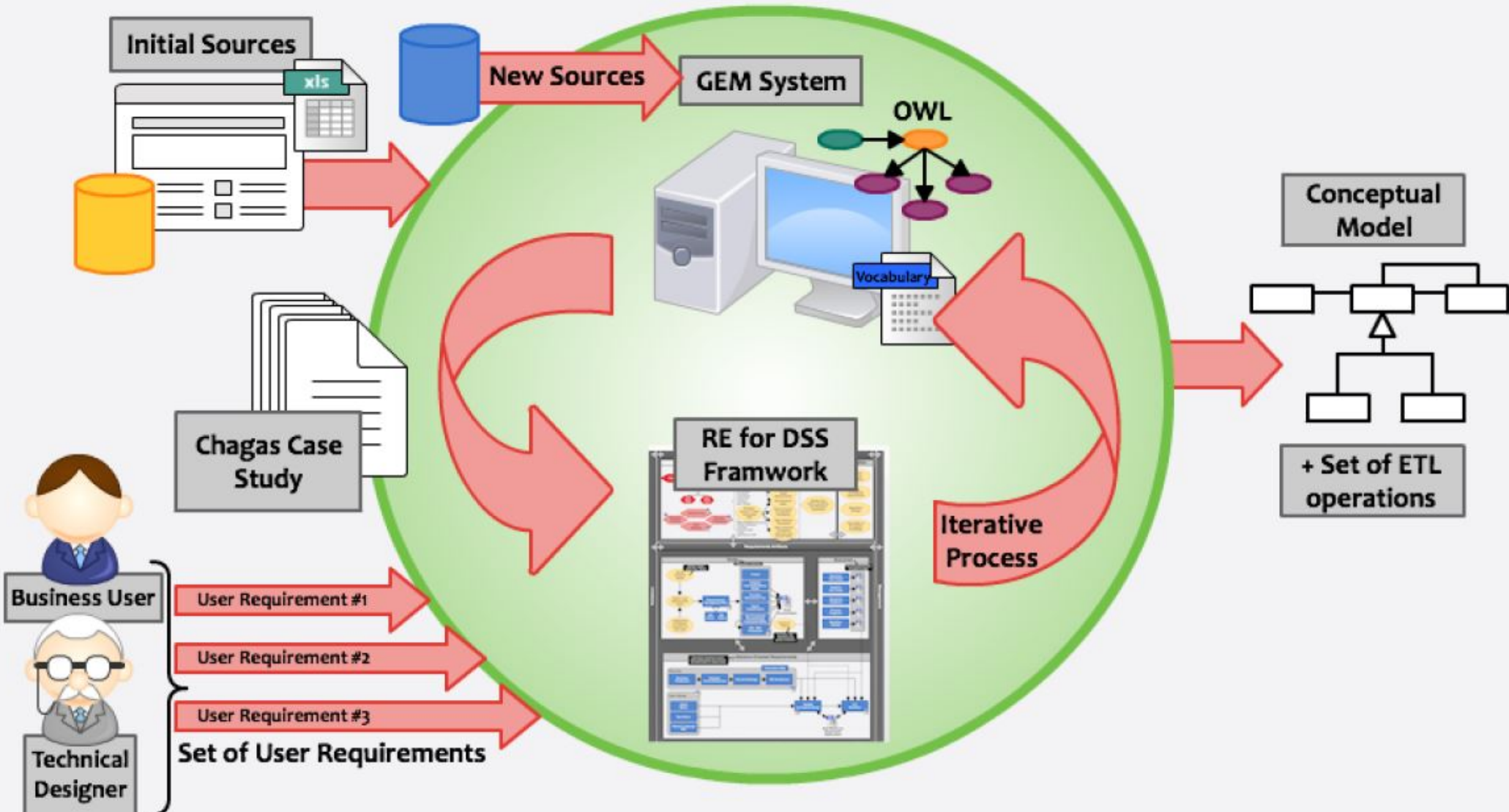
RE4DSS

154

Methodology of "Chagas" Case Study using GEM System - RE for DSS

Conclusions

Related to the Chagas Project

- The existing different information sources provide:
  - Detection of partial/total epidemiological silences
  - Confirmation of true/false data
  - Help to update the verication/ certifications status of different territories of the world

Conclusions

Related to the Chagas Project

- For users was particularly difficult to define the requirements for the decision-making process

- Using visual tools was very useful for this task.

Conclusions

Related to the Chagas Project

- Differences between the informatics and medical domain:

Prototyping was the best tool to validate the elicited requirements

Conclusions

Related to the Chagas Project

- Balance between complexity and simplicity

"Everything simple is false,
        Everything which is complex is
unusable"

- Paul Valéry

Conclusions

Related to RE in DSS literature

- The use of Pohl's Framework helped the classification of the literature and detect key characteristics of DSS.

Conclusions

<mark>Related to RE in DSS literature</mark>

- Decision Support Systems have some particular characteristics different than Traditional Software Systems.

- There is a need of developing a common generic approach for requirements engineering to better deal with these systems.

Conclusions

Related to RE4DSS

- Pohl's Framework was very useful to:
  - Formally present the new proposal RE4DSS.

Conclusions

Related to RE4DSS

- The application of RE4DSS to the Chagas case study validates our approach.

- Future work: to apply it to new projects!!

Thanks for your attention

Ruth Raventós

July 10th, 2014
Berlin, Germany

Fourth European Business Intelligence
Summer School
(eBISS 2014)