Certified Professional for Requirements Engineering

Syllabus

Requirements Modeling Practitioner | Specialist

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Foreword

This module is a basis for further education and training for requirements engineers, business analysts, process and system analysts, and any other project participants who want to model requirements in requirements engineering or who want to work with requirements models. The aim of the module is to convey knowledge about how to model requirements usefully and effectively in requirements engineering. Furthermore, the module explains how requirements modeling can be used in practice (where applicable, in addition to textual requirements) to do the following: to communicate requirements such that they are easier to understand; to make the complexity of the requirements of a system more manageable; and, through the high level of formalization of the requirements modeled, to enable a greater degree of automation in system development activities (for example, quality assurance for the requirements specification, derivation of system test cases).

Purpose of the document

This syllabus defines educational objectives and a summary of the educational content for the Requirements Modeling Practitioner and Specialist established by the International Requirements Engineering Board (IREB). The syllabus provides training providers with the basis for creating their course materials. Students can use the syllabus to prepare themselves for the examination.

Contents of the syllabus

The module Requirements Elicitation addresses professionals with career profiles like *Requirements Engineering*, *business analysis*, *business engineering*, *and organizational design*, who wish to extend their knowledge and skills in the area of requirements elicitation.

Content scope

This Parctitioner/Specialist level covers the topic "Model-based Specification of Requirements" in more detail compared to the foundation level. The training focuses on modeling requirements in relation to information structures, functions, and behavior. It also covers scenario modeling in requirements engineering. Separate modules have already been published for a more detailed study of the other educational units in the foundation level of the Certified Professional for Requirements Engineering certificate (for example, Requirements Elicitation, Requirements Management) and RE@Agile.

This syllabus is not based on any specific software development approach and associated process model that makes a statement about the planning, control and sequence of application of the addressed Requirements Engineering concepts and techniques in practice. It is not intended to particularly emphasize a specific approach, neither for Requirements Engineering nor for software engineering overall. It defines what constitutes the knowledge of Requirements Engineers, but not the exact interfaces with other disciplines and processes of software engineering.

The following table gives an overview of the course content of the CPRE Modul Requirements Modeling and the proposed duration of training for the different topic areas.

	Topic	Content	Time required
1	Basic principles of requirements modeling	Reasons for requirements modeling, forms of requirements modeling, terms and concepts, views, benefits of requirements modeling, quality of requirements models	90 minutes
2	Context modeling	Purpose of context modeling, terms, basic elements, data flow-oriented context modeling, and further forms of context modeling	120 minutes
3	Modeling information structures	Purpose of information structure modeling in requirements engineering; modeling classes, attributes, and data types; modeling associations; generalization and specialization relationships; aggregation and composition relationships; further modeling concepts	270 minutes

	Topic	Content	Time required
4	Modeling dynamic views	Dynamic views in requirements modeling, use case modeling, data flow-oriented and control flow-oriented modeling, state-oriented modeling	435 minutes
5	Modeling scenarios	Purpose of scenario modeling, the relationship between scenarios and use cases, scenario modeling with sequence diagrams and communication diagrams	165 minutes

Level of Detail

The level of detail of this syllabus allows internationally consistent teaching and examination. To reach this goal, the syllabus contains the following:

- General educational objectives,
- Contents with a description of the educational objectives and
- References to further literature (where necessary).

The syllabus was developed based on the IREB Certified Professional for Requirements Engineering Foundation Level and covers the modeling of requirements in the form of diagrams. The Modul Requirements Modeling uses a more differentiated view concept compared to the concept used in the foundation level. This more differentiated view allows you to specify the requirements of very extensive and complex systems in a well-structured and more formal way in order to cope with the large extend and complexity of the requirements specification. In this module, requirements are modeled in the information structure view, the data flow-oriented view, the control flow-oriented view, the state-oriented view, and the scenario view using suitable types of diagrams. An important aspect of this module is also to convey knowledge about the relationships between the different views in requirements modeling. To achieve this objective, the module looks at the basic principles from the foundation level in more detail, adding aspects that cover expert knowledge and best practices.

Educational objectives / Cognitive knowledge levels

All modules and educational objectives in this syllabus are assigned a cognitive level. The levels are classified as follows:

- **L1: Know** (describe, enumerate, characterize, recognize, name, remember, ...) — The candidate can remember or retrieve previously learned material.
- **L2: Understand** (explain, interpret, complete, summarize, justify, classify, compare, ...) — The candidate can grasp/construct meaning from given material or situations.

- **L3: Apply** (specify, write, design, develop, implement, ...) — The candidate can apply knowledge and skills in given situations.
- **L4: Analyze** (investigate, conclude from, provide arguments for, ...) — The candidate can analyze a given problem, argue what should/can be done, break down the problem into parts, apply critical thinking, argue about causes and effects.
- **L5: Evaluate** (critique, judge) — The candidate can give a well-argued critique of a given artifact; make a profound judgment in a given case. Note that an educational objective at cognitive knowledge level Ln also contains elements of all lower cognitive knowledge levels (L1 through Ln-1).

Note that an educational objective at cognitive knowledge level Ln also contains elements of all lower cognitive knowledge levels (L1 through Ln-1).

Example:
An educational objective of the type "Apply the RE technique xyz" is at the cognitive knowledge level (L3). However, the ability to apply requires that students first know the RE technique xyz (L1) and that they understand what the technique is used for (L2).

All terms used in this syllabus and defined in the IREB Glossary have to be known (L1), even if they are not explicitly mentioned in the educational objectives.

The glossary is available for download on the IREB homepage at https://www.ireb.org/en/downloads/#cpre-glossary-2-0

This syllabus and the related handbook use the abbreviation "RE" for Requirements Engineering.

Structure of the syllabus

The syllabus consists of five main chapters. Each chapter covers one educational unit (EU). Main chapter titles contain the cognitive level of their chapters, which is the highest level of their sub-chapters. Furthermore, the teaching time is suggested that is the minimum a course should invest for that chapter. Training companies are free to devote more time to the EUs and the exercises, but make sure that the proportions between the EUs are maintained. Important terms within the chapter are listed at the beginning of the chapter.

Example:
Chapter 1: Basic Principles of Requirements Modeling (L1)
Duration: 120 minutes
Terms: Model, graphical model, view, requirements view, requirements model, modeling constructs, model element, modeling language

The example shows that Chapter 1 contains educational objectives at level L1 and 120 minutes are intended for teaching the material in this chapter.

Each chapter contain subchapters. Their titles also contain the cognitive level of their content.

The educational objectives are listed before the actual text. The numbering shows to which sub-chapter they belong.

Example: EO 3.1.2
This example shows that educational objective EO 3.1.2 is described in sub-chapter 3.1.

The examination

This syllabus covers educational units and educational objectives for the certification exams of the

- Requirements Modeling Practitioner
- Requirements Modeling Specialist

The exam to achieve the Requirements Modeling Practitioner certificate consists of **a multiple-choice exam**.

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The exam to achieve the Requirements Modeling Specialist certificate consists of a **written assignment**.

Both exams include exam questions covering all educational units and all educational objectives in the syllabus.

Each exam question may include material from multiple chapters of the syllabus as well as from multiple educational objectives or portions of an educational objective.

The **multiple-choice exam** for the **Practitioner** certificate

- tests all educational objectives of the syllabus. However, for the educational objectives at cognitive knowledge levels L4 and L5, the exam questions are limited to items at cognitive levels L1 through L3.
- can be taken immediately following a course, but also independently of that (e.g., remotely or at a test center).

The **written assignment** for the **Specialist** certificate

- tests all educational objectives of the syllabus at the cognitive knowledge levels indicated for each educational objective.
- follows the task description for Requirements Modeling – Specialist –, found at https://www.ireb.org/en/downloads/tag:advanced-level-written-assignment#top.
- is self-paced and submitted to a licensed Certification Body.

The following generic educational objectives also apply to the **written assignment** for the **Specialist** certificate:

EO G1: Analyze and illustrate Requirements Elicitation problems in a context that the candidate is familiar with, or which is similar to such a context (L4).

EO G2: Evaluate and reflect on the usage of Requirements Elicitation practices, methods, processes, and tools in projects in which the candidate was involved (L5).

A list of IREB licensed certification bodies can be found on the website https://www.ireb.org.

Version History

Version	Date	Comment
2.0.0	September 9, 2015	Initial version
2.1.0	July 11, 2016	Corrections of the effort distribution
2.2.0	August 31, 2016	Topic "Association classes" added to EU 3.3
3.0.0	July 1, 2022	Information about Advanced Level exam split added. Switched to new cognitive Levels of knowledge (5 levels). Educational objectives modified accordingly.
3.1.0	May 24, 2024	New Corporate Design implemented, Cognitive Knowledge Levels synchronized, Term "Advanced Level removed"

Table of Contents

1 Basic principles of requirements modeling (L1)

Duration: 90 minutes (theory)

Terms: Model, graphical model, view, requirements view, requirements model, modeling constructs, model element, modeling language

Educational objectives

EO 1.1 Know the motivation for modeling requirements, as well as applications and basic terms of requirements modeling

EO 1.2 Know the views and related languages of requirements modeling at a general level

EO 1.3 Know the possibilities for adapting modeling languages and integrating textual and modeled requirements

EO 1.4 Know the benefits of requirements modeling as well as quality criteria for requirements models

Prerequisite: Basic knowledge of conceptual modeling, basic views in requirements modeling (foundation level), understanding of simple requirements diagrams

Topic overview: This educational unit looks at the basic principles of requirements modeling. It covers the reasons why requirements are (also) modeled, as well as the various fields of use and the main terms for requirements modeling. Furthermore, this unit introduces the more differentiated views used in requirements modeling compared to the CPRE foundation level and looks at the link between textual requirements and modeled requirements. The unit also discusses the benefits of requirements modeling and introduces the general criteria for assessing the quality of requirements models.

Literature reference: Chapter 1, Handbook Requirements Modeling, https://www.ireb.org/en/downloads/#handbook-cpre-advanced-level-requirements-modeling

1.1 Motivation for requirements modeling and fundamentals (L1)

Duration: 30 minutes (theory)

Content: In this educational unit you become familiar with the difference between textual and modeled requirements and learn about the different benefits of modeling requirements. You learn that you can use requirements models to make the scope and complexity of requirements more manageable, for example, and that modeling requirements makes it easier to specify and communicate requirements clearly to prevent misunderstandings. You also learn the different applications of requirements modeling (e.g., for the precise and unique specification of requirements or for structuring and visualizing complex circumstances), as well as the main terms and concepts of requirements modeling (e.g., requirements model, notation element, model element, modeling language).

1.2 Overview of the views and languages of requirements modeling (L1)

Duration: 15 minutes (theory)

Content: In this educational unit you become familiar with the more differentiated view concept used in requirements modeling compared to the CPRE foundation level. At the highest level, this concept differentiates between the context view, the information structure view, and the dynamic view. The dynamic view in turn looks at the behavior of the system from various viewpoints. It also differentiates between the use case view, the data flow-oriented view, and the control flow-oriented view (also referred to as the process-oriented view), as well as the scenario view and the state-oriented view. This unit gives you a general overview of the relationships between the individual views and the languages suitable for modeling the different views in requirements modeling.

1.3 Adapting modeling languages and integrating textual requirements (L1)

Duration: 15 minutes (theory)

Content: In this educational unit you become familiar with the different options for adapting modeling languages for requirements modeling, for example to increase the informative value of the requirements models created and to adapt the modeling languages to the demands of specific application areas (e.g., the development of information systems versus embedded systems; the development of systems in the banking and insurance area versus the development of systems for the automotive segment or for automated systems). Furthermore, this unit gives you a general overview of how you can combine textual requirements with modeled requirements. It explains which relationships can be used to place model elements (graphical and/or textual) in relation to one another in the requirements model.

1.4 The benefits of requirements modeling and the quality of requirements models (L1)

Duration: 30 minutes (theory)

Content: In this educational unit you become familiar with the various benefits of modeling requirements compared to documenting them in text form. These benefits include the inherent support for the principle of "divide and conquer", the lower risk of ambiguity, and the improved options for processing modeled requirements automatically. Furthermore, you become familiar with the three quality criteria for requirements models: syntactic, semantic, and pragmatic quality. You can use these criteria to assess and improve the quality of requirements models in a systematic way.

2 Context modeling in requirements engineering (L3)

Duration: 60 minutes (theory); 60 minutes (exercises)

Terms: System boundary, context boundary, context diagram

Educational objectives

EO 2.1 Know the purpose of context modeling in requirements engineering
EO 2.2 Apply the basic elements of context modeling
EO 2.3 Master and use the notation and rules for context modeling with data flow diagrams
EO 2.4 Master and use other types of context modeling and their specific properties

Prerequisite: Basic knowledge of the importance of the system boundaries and the system context for requirements engineering (CPRE foundation level), understanding of simple requirements diagrams and in particular, use case diagrams

Topic overview: This educational unit establishes the importance of context modeling for requirements engineering. It explains the knowledge that has to be obtained about the context of a system under consideration and how you can document the context view effectively. The unit introduces the basic elements of a data flow-oriented context modeling for documenting the operational context of a system under consideration. In addition to discussing notation elements for context modeling with data flow diagrams, the unit also looks at pragmatic rules for using data flow diagrams for context modeling. The unit gives an outlook with regard to other forms of context modeling in the use case view and the scenario view.

Literature reference: Chapter 2 and Section 4.2.3, Handbook Requirements Modeling, https://www.ireb.org/en/downloads/#handbook-cpre-advanced-level-requirements-modeling

2.1 The purpose of context modeling and conceptual fundamentals (L1)

Duration: 15 minutes (theory)

Content: In this educational unit you refresh your knowledge of the terms system boundary and context boundary (CPRE foundation level). You deepen your understanding of the purpose of the context view and the importance of the context for system requirements. You learn what knowledge about the operational context of a system should be documented, how the context view differs from the other views in requirements modeling, and the value this view has for the work of a requirements engineer.

2.2 Basic elements of context modeling (L3)

Duration: 15 minutes (theory)

Content: In this educational unit you become familiar with the basic elements of context modeling and learn about the focus of data flow-oriented context modeling. Examples help you become familiar with the results of data flow-oriented context modeling in various forms of notation and the unit discusses the properties of the diagrams used for context modeling.

2.3 Notation and rules for context modeling with data flow diagrams (L3)

Duration: 15 minutes (theory); 30 minutes (exercises)

Content: In this educational unit you become familiar with possible modeling constructs for data flow-oriented context modeling based on the data flow diagrams of the Structured Analysis method according to DeMarco. You learn how these modeling constructs are used to represent a system in its context. Furthermore, you learn simple and pragmatic rules that you can use to check the completeness, the clarity, and the correct understanding of the knowledge modeled via the system context.

2.4 Other types of context modeling (L2)

Duration: 15 minutes (theory); 30 minutes (exercises)

Content: It is not only data flow-oriented context modeling that focuses on the interfaces of a system to its neighboring systems or human users; the cooperation of a system with the neighboring systems or human users in its context is also a topic for the use case view and the scenario view. In this educational unit you gain some first insights into context modeling with use case diagrams and scenarios. Via examples, you learn the difference between context modeling with use case diagrams or scenarios, and data flow-oriented context modeling. The topic in this educational unit is covered in more detail in educational units EU 4 and EU 5.

3 The information structure view in requirements modeling (L3)

Duration: 120 minutes (theory); 150 minutes (exercises)

Terms: Information structure, UML class diagram, class, attribute, data type, binary association, aggregation, composition, generalization, specialization

Educational objectives

EO 3.1 Know the purpose and importance of information structure modeling
EO 3.2.1 Master and use the syntax and semantics of the elements class, attribute, and data type in UML class diagrams for modeling information structures
EO 3.2.2 Master and use heuristics for determining classes, attributes, and data types
EO 3.3.1 Master and use the syntax and semantics of simple relationships (binary associations) as well as aggregations and compositions
EO 3.3.2 Master and use heuristics for determining simple relationships
EO 3.3.3 Master and use heuristics for determining aggregations
EO 3.3.4 Master and use practical tips for modeling relationships
EO 3.4.1 Master and use the syntax and semantics of generalizations
EO 3.4.2 Master and use heuristics for determining generalizations
EO 3.4.3 Master and use practical tips for modeling generalizations
EO 3.5 Know further modeling concepts

Prerequisite: Basic knowledge of requirements modeling in the structure perspective (CPRE foundation level), understanding of simple UML class diagrams

Topic overview: In requirements engineering, it is vitally important to understand and specify the specific terms and data of an application domain. The diagrams of the information structure view allow you to document relationships and properties of the terms beyond the textual definitions of a glossary and thus create a deeper understanding of the application domain. The diagrams are also suitable for specifying requirements that relate to the structure of information and data. The aim of this educational unit is to build up the theoretical and practical knowledge necessary for developing stable information structure models. It introduces the UML class diagrams for modeling. The unit looks at the syntax and semantics of the elements and relationships that appear in class diagrams and goes into more detail about how to create class diagrams. It focuses in particular on describing heuristics that make it easier to start modeling information structures, as well as on recommendations and tips from practice.

Literature reference: Chapter 3, Handbook Requirements Modeling, https://www.ireb.org/en/downloads/#handbook-cpre-advanced-level-requirements-modeling

3.1 The purpose of information structure modeling (L1)

Duration: 15 minutes (theory)

Content: In this educational unit you learn why information structure modeling is so important within requirements modeling. The unit demonstrates which additional knowledge about specific terms and data you can document in the information model compared to a purely textual glossary. Furthermore, you learn how modeling the information structure contributes to specifying requirements. The unit introduces UML class diagrams as a means of expression for modeling information structures. You learn about the opportunities these diagrams provide for the requirements engineers when specifying the requirements for a system.

3.2 Modeling classes, attributes, and data types (L3)

Duration: 30 minutes (theory); 30 minutes (exercises)

Content: This educational unit introduces the central elements of information structure models based on UML class diagrams: class, attribute, data type. You learn the difference between classes and objects as well as the syntax and semantics of classes. To enable you to begin modeling information structures, you learn how to derive the classes, attributes, and data types from the terms known in the application domain. This educational unit offers you different heuristics for this purpose. You learn how to specify classes more precisely using attributes and how to differentiate classes from attributes. You also become familiar with the syntax and semantics of attributes, as well as heuristics for identifying attributes. The unit introduces three forms of attributes types. It also explains the syntax and semantics of these form of attribute types and presents heuristics for modelling them in a correct way. Furthermore, the unit provides tips for modeling classes, attributes, and data types in practice.

3.3 Modeling simple relationships, aggregations, and compositions (L3)

Duration: 30 minutes (theory); 60 minutes (exercises)

Content: It is not only classes that contain important information about the application domain; the relationships that connect the objects of classes also contain important information. This educational unit presents the most common types of relationships in requirements modeling: simple relationships (binary associations), aggregations, and compositions as well as the modeling of attributes of relationships by using association classes. You become familiar with the syntax and semantics of these three types of relationship according to UML.

The unit provides you with heuristics for determining simple relationships, aggregations, and compositions. Furthermore, for modeling in practice, the unit also gives recommendations on topics such as navigability versus reading direction and interpretation of multiplicities.

3.4 Modeling generalization and specialization (L3)

Duration: 15 minutes (theory); 60 minutes (exercises)

Content: Modeling generalization relationships allows you to further structure an information model and to cope with complexity by abstracting from commonalities of different classes. In this educational unit you learn the syntax and semantics of generalizations. The unit introduces the concept of the abstract class. You learn how to use generalization sets and become familiar with their typical constraints. The unit provides heuristics for determining generalizations. It also gives practical recommendations for modeling generalizations.

3.5 Further modeling concepts (L1)

Duration: 30 minutes (theory)

Content: Information models in requirements engineering often contain similar specialized facts and there are solutions in the form of patterns for modeling these facts. This educational unit focuses on providing an overview of the most important analysis patterns for information models as a further modeling concept. It also gives various structuring tips for creating information structure models of high quality.

4 Dynamic views in requirements modeling (L4)

Duration: 255 minutes (theory); 180 minutes (exercises)

Terms: Dynamic view, use case, use case diagram, use case model, data flow, control flow, object flow, data flow diagram, use case specification, activity diagram, function, activity, action, state, state machine, event, hierarchization, concurrency

Educational objectives

EO 4.1 Know the dynamic views in requirements modeling
EO 4.2 Know the purpose and modeling constructs of use case diagrams
EO 4.3 Master the finding and specification of use cases
EO 4.4 Master the structuring and packaging of use cases
EO 4.5 Understand the purpose of data flow modeling and control flow modeling as well as related diagram types and modeling constructs
EO 4.6 Master requirements modeling with data flow diagrams and relationships to use case modeling, control flow modeling, and information structure modeling
EO 4.7 Master requirements modeling with activity diagrams and relationships to use case modeling and scenario modeling
EO 4.8 Analyze the combination, decomposition, and specification of functions and assessment of the consistency between different levels of abstraction
EO 4.9 Know the purpose of state-oriented modeling of requirements and modeling constructs of state machines
EO 4.10 Master requirements modeling with state machines

Prerequisite: Knowledge of the functional and behavioral views in requirements modeling (foundation level); the ability to read use case diagrams, simple data flow diagrams, simple activity diagrams, and simple state machines

Literature reference: Chapter 4, Handbook Requirements Modeling, https://www.ireb.org/en/downloads/#handbook-cpre-advanced-level-requirements-modeling

Topic overview: A significant proportion of the requirements for a system relates to the behavior required of the system to allow it to fulfill its purpose during operation. Typically, today's systems must have a very complex behavior toward their environment to be able to fulfill the intended purpose during operation. This behavior has to be understood and specified from various perspectives and at various levels of detail in order to make the complexity of the required system behavior toward the environment manageable in requirements engineering. The aim of this educational unit is to build up the theoretical and practical knowledge required for specifying the requirements of the behavior of systems in the form of requirements models. It introduces use case modeling to enable a general modeling of the user-related functions of the system under consideration. To enable you to model detailed requirements, the unit looks at function modeling in the form of data flow diagrams and UML activity diagrams. Special attention is given to the differentiation between data flow modeling and control flow modeling. One focus of this educational unit is on describing heuristics for function modeling with data flow diagrams and activity diagrams in order to create meaningful, high-quality requirements models. In addition to use case

modeling and function modeling, the unit also covers state-oriented requirements modeling using the modeling of UML statecharts and state machine diagrams.

For all diagram types considered, the unit looks at the syntax and semantics of the different modeling constructs and uses exercises to demonstrate the creation of diagrams of the various types in more detail. The unit covers the integration of diagrams of different types in the dynamic view of requirements modeling and the relationship to the information structure view. It focuses in particular on describing heuristics that make it easier for you to start modeling dynamic views in requirements modeling, as well as on recommendations and tips from practice.

4.1 Overview of the dynamic views of requirements modeling (L1)

Duration: 15 minutes (theory)

Content: This educational unit provides an overview of the different dynamic views of requirements modeling. In requirements modeling, the dynamic views contain requirements for the required behavior of the system under consideration. In order to make complex system behavior manageable in the requirements, in the dynamic views the following different views for modeling requirements are differentiated: use case view, data flow-oriented view, control flow-oriented view, and the state-oriented view and scenarios. This educational unit characterizes each of these views and demonstrates the relationships between the different dynamic views. It also looks at the general relationships of dynamic views to the information structure view.

4.2 The purpose and modeling constructs of use case modeling (L2)

Duration: 15 minutes (theory)

Content: In this educational unit you become familiar with the purpose of use case modeling in requirements engineering and refresh the knowledge you gained about use case diagrams in the CPRE foundation level. For this purpose, the unit looks at the syntax and semantics of the basic modeling constructs of use case diagrams, such as system boundary, actor, use case, and association.

4.3 Identifying use cases and specifying them in text form (L3)

Duration: 30 minutes (theory); 30 minutes (exercises)

Content: This educational unit provides practical help to support you in identifying use cases and determining the correct level of granularity or functional scope for use cases in requirements modeling. You learn how to identify use cases for a system under consideration by deriving them systematically from the identification of events. Furthermore, you learn how to specify individual use cases in detail using structured text based on templates. In use case diagrams, use cases are presented in relation to actors in the system context and, if applicable, to other use cases. This unit also contains exercises for two areas: identifying use cases by identifying events in context or time-based events, and specifying use cases in text form based on a use case template.

4.4 Structuring use cases and packages (L3)

Duration: 30 minutes (theory); 30 minutes (exercises)

Content: In this educational unit you learn how to structure use cases effectively by explicitly modeling relationships between uses cases within use case diagrams. To refresh the knowledge gained from the CPRE foundation level, the unit first looks at the syntax and semantics of the different relationships that can exist between use cases. You learn how to model include and extend relationships between use cases. Furthermore, you learn how to model generalization relationships for use cases. Similarly to modeling generalization relationships between classes in the information structure view, this enables you to also model generalized use cases and, based on these, specialized use cases. Finally, the unit looks at packaging use cases, which enables you, for example, to regard the user-related functions at various levels of granularity using use case diagrams.

4.5 Data flow modeling, control flow modeling, and diagram types (L2)

Duration: 15 minutes (theory)

Content: This educational unit covers the purpose of data flow modeling and control flow modeling. In particular, it addresses the difference between modeling data flows and modeling control flows. To refresh the knowledge gained from the CPRE foundation level, the unit also covers the syntax and semantics of the elementary modeling constructs of data flow modeling (processes) and control flow modeling (activities, actions).

4.6 Requirements modeling with data flow diagrams (L3)

Duration: 30 minutes (theory); 30 minutes (exercises)

Content: In this educational unit you become familiar with requirements modeling in the data flow-oriented view using data flow diagrams. The unit looks at the syntax and semantics of the different modeling constructs of data flow diagrams and offers tips for good data flow diagrams. These tips cover, for example, using meaningful (expressive) designations for processes, data flows, and data stores, as well as sources and sinks in the system context. Finally, the unit addresses the relationships between modeling data flows and modeling use cases, control flows, and information structures.

4.7 Requirements modeling with activity diagrams (L3)

Duration: 30 minutes (theory); 30 minutes (exercises)

Content: In this educational unit you learn about requirements modeling in the control flow-oriented view using activity diagrams. You become familiar with the syntax and semantics of different modeling constructs of activity diagrams as well as rules and tips for requirements modeling with activity diagrams. The unit also covers the modeling of object flows and data flows with the aid of pins. Furthermore, it demonstrates the relationships between activity diagrams and use case and scenario modeling. The unit focuses in particular on the common modeling of the control flow of use cases, i.e., the main, alternative, and exception scenarios within an activity diagram. It also covers the modeling of interruptible activity regions as well as the sending and receiving of signals.

4.8 Combining and decomposing functions, and ensuring consistency (L4)

Duration: 30 minutes (theory); 30 minutes (exercises)

Content: In this educational unit you learn how to combine and decompose functions (i.e., processes or activities and actions) in data flow diagrams and activity diagrams, allowing you to manage the scope and complexity of the requirements in the data flow-oriented and control flow-oriented views in requirements modeling. This enables you to define hierarchy levels for requirements and thus, for example, to model requirements for different stakeholders more abstractly and in more detail consistently at the respective appropriate level of abstraction or detail. The unit also addresses the specification of functions in text form. You also become familiar with simple rules for defining consistent hierarchies for data flow diagrams (visible balancing as well as data dictionary balancing between hierarchy levels). Example exercises allow you to practice combining and decomposing processes in data flow diagrams as well as activities and actions in activity diagrams.

4.9 The purpose of state-oriented modeling and modeling constructs (L1)

Duration: 15 minutes (theory)

Content: In this educational unit you become familiar with the purpose of state-oriented modeling of requirements in requirements engineering and refresh the corresponding knowledge you gained from the CPRE foundation level. For this purpose, the unit looks at the syntax and semantics of the basic modeling constructs of state machines, such as state, state transition, event, and condition. The unit also addresses the relationship to data flow modeling and control flow modeling and to information structure models.

4.10 Requirements modeling with state machines (L3)

Duration: 45 minutes (theory); 30 minutes (exercises)

Content: In this educational unit you learn about requirements modeling in the state-oriented view using UML state machine diagrams. The unit looks at the syntax and semantics of the various modeling constructs of state machine diagrams and provides rules and tips on, for example, finding states and state transitions. You learn how to model entry, exit, and do functions in the states of a state machine diagram and how to model deferred triggers and functions in states. Furthermore, you learn how to model state transitions with events, boolean conditions (guards), and functions (effects). The focus of this educational unit is on modeling composite states and substate machines. For complex state-oriented behavior, this allows you to abstract hierarchically from partial behavior and thus manage the complexity of the state-oriented behavior in the requirements. You learn how to model histories (i.e., the memory of hierarchical state machines) and rules so that you can identify composite states and substate machines and define effective and consistent hierarchies for state machine diagrams. You learn how to model orthogonal regions in state-oriented behavior and how to model synchronization point for orthogonal behavior.

5 Scenario modeling in requirements engineering (L3)

Duration: 90 minutes (theory); 75 minutes (exercises)

Terms: Model, graphical model, view, requirements view, requirements model, modeling constructs, model element, modeling language

Educational objectives

EO 5.1 Master and use the purpose and different approaches for scenario modeling in requirements engineering as well as the relationship to use cases
EO 5.2 Master and use simple scenario modeling with sequence diagrams
EO 5.3 Master and use advanced scenario modeling with sequence diagrams
EO 5.4 Master and use scenario modeling with communication diagrams

Prerequisite: Basic views of requirements modeling (foundation level), use case diagrams, use case specifications

Topic overview: In requirements engineering, scenarios describe sequences of messages between the system to be developed and actors in the system context. These sequences lead to the goals of one or more actors being achieved, in other words, the use of the system provides a desired added value for actors. In both conventional requirements engineering as well as agile development processes, scenarios document the central requirements of the behavior in respect of the use of the system under consideration. They do so, for example, in the form of main, alternative, and exception scenarios or in the form of user stories. The aim of this educational unit is to build up the theoretical and practical knowledge required for documenting scenarios in the form of diagrams. Modeled scenarios have a higher level of formalization in comparison to textual documentation. This produces clearer, more understandable, and more precise scenario descriptions — even if the usage behavior of the system is very complex. Furthermore, modeled scenarios have clear advantages in terms of automatic analysis and the ability to be integrated with other requirements models, as well as in relation to the automatic derivation of further development artifacts (e.g., test cases for the system test). This educational unit focuses on documenting scenarios using UML sequence diagrams. It also looks at scenario modeling with communication diagrams. For both types of diagrams, the unit covers the syntax and semantics of the different modeling constructs and the integration of modeled scenarios with other diagrams from requirements modeling. Furthermore, the unit offers heuristics that make it easier for you to start modeling scenarios.

Literature reference: Chapter 5, Handbook Requirements Modeling, https://www.ireb.org/en/downloads/#handbook-cpre-advanced-level-requirements-modeling

5.1 Basic principles of scenario modeling in requirements engineering (L3)

Duration: 15 minutes (theory)

Content: In this educational unit you become familiar with the purpose of scenario modeling in requirements engineering. One aim of the unit is to convey the importance of scenarios in requirements engineering. Scenarios are used to document example usage sequences between the system under consideration and the actors in context at the interface of the system under consideration to its context. The unit also introduces the different forms of representation for scenarios (narrative text, structured text, diagram) and the link between scenarios and use case. It also gives an overview of the different approaches for scenario modeling, such as the ITU Message Sequence Charts (MSCs) and UML sequence diagrams and communication diagrams.

5.2 Simple scenario modeling with sequence diagrams (L3)

Duration: 30 minutes (theory); 30 minutes (exercises)

Content: In this educational unit you learn how to model simple scenarios using UML sequence diagrams. You become familiar with the syntax and semantics of the different basic modeling constructs of sequence diagrams for scenario modeling in requirements engineering, as well as rules and tips for modeling simple scenarios. You learn how to model interaction frames and lifelines for the system under consideration and the actors in the system context. The unit also explains the importance and modeling of the following: the activation of instances in scenarios; the termination of lifelines; and asynchronous and synchronous messages in scenario modeling (using sequence diagrams). This unit looks at the relationships of scenario modeling in requirements engineering to context modeling and use case modeling. It also discusses the relationships of messages in scenarios to the modeling of requirements in the state-oriented view, the data flow-oriented view, and the information structure view in requirements modeling.

5.3 Advanced scenario modeling with sequence diagrams (L3)

Duration: 30 minutes (theory); 30 minutes (exercises)

Content: This educational unit looks at advanced scenario modeling using sequence diagrams. You become familiar with the syntax and semantics of the different advanced modeling constructs of sequence diagrams for scenario modeling in requirements engineering. The unit also offers rules and tips for advanced scenario modeling. You become familiar with using combined fragments to model alternative interactions in scenarios ("alt") as well as optional interactions ("opt"). You also learn how to abstract from interactions within complex scenarios by modeling the abstracted interactions in a separate sequence diagram and, in the original scenario, referring to the "outsourced" (abstracted) partial scenario using the combined fragment ("ref"). Furthermore, you learn how to model repetitions ("loop") of interactions linked to boolean conditions as well as how to model exception handling ("break") in scenarios. The unit also addresses the modeling of assumptions for scenarios and nesting combined fragments in scenario modeling.

5.4 Scenario modeling with communication diagrams (L3)

Duration: 15 minutes (theory); 15 minutes (exercises)

Content: In this educational unit you learn how to model simple scenarios using UML communication diagrams. You become familiar with the syntax and semantics of the different modeling constructs of communication diagrams for scenario modeling in requirements engineering. The unit also offers rules and tips for modeling simple scenarios with UML communication diagrams. It focuses on the different representation of scenarios compared to scenario modeling with sequence diagrams. Scenario modeling with sequence diagrams concentrates on the order in which messages are exchanged, whereas in scenario modeling with communication diagrams, it is the interfaces of the system to actors in the system context that is the focus. This is why, when communication diagrams are used, the individual interfaces and the message exchange at these interfaces is visualized.

Glossary

See chapter 6, Handbook Requirements Modeling, https://www.ireb.org/en/downloads/#handbook-cpre-advanced-level-requirements-modeling.

Literature

Primary literature: Cziharz, T.; Hruschka, P.; Queins, S.; Weyer, T.: Handbook of Requirements Modeling IREB Standard – Education and training for IREB Certified Professional for Requirements Requirements Modeling, International Requirements Engineering Board, Karlsruhe, available online at: https://www.ireb.org/en/downloads/#handbook-cpre-advanced-level-requirements-modeling

References: See chapter 8, Handbook Requirements Modeling, https://www.ireb.org/en/downloads/#handbook-cpre-advanced-level-requirements-modeling.