

# Table of Contents

<b>Part I</b>	<b>Fundamentals and Framework</b>	<b>1</b>
<b>1</b>	<b>Motivation</b>	<b>3</b>
1.1	Software-Intensive Systems	4
1.2	Importance of Requirements Engineering	6
1.3	Embedding of Requirements Engineering in the Organisational Context	9
<b>2</b>	<b>Requirements</b>	<b>15</b>
2.1	The Term “Requirement”	16
2.2	Requirement Types	17
2.3	Problem vs. Solution	24
<b>3</b>	<b>Continuous Requirements Engineering</b>	<b>29</b>
3.1	Traditional Systems Analysis	30
3.2	Essential Systems Analysis	32
3.3	Requirements Engineering as an Early Development Phase	35
3.4	Shortcomings of Systems Analysis and Phase-Oriented Requirements Engineering	35
3.5	Continuous Requirements Engineering	38
<b>4</b>	<b>The Requirements Engineering Framework</b>	<b>41</b>
4.1	Goal of Requirements Engineering: Establishing a Vision in Context	42
4.2	Overview of the Framework	42
4.3	Four Context Facets	44
4.4	Three Core Activities	46
4.5	Two Cross-Sectional Activities	50
4.6	The Three Kinds of Requirements Artefacts	53
4.7	Overview of the Book	56
<b>Part II</b>	<b>System Context</b>	<b>59</b>
<b>5</b>	<b>System and Context Boundaries</b>	<b>63</b>
5.1	The Term “Context”	64
5.2	System Boundary	66
5.3	Context Boundary	68

5.4	Need to Document Context Aspects . . . . .	70
<b>6</b>	<b>Structuring the System Context . . . . .</b>	<b>75</b>
6.1	Structuring Principles . . . . .	76
6.2	Four Context Facets and Three Types of Context Aspects . . . . .	77
6.3	Relevant Context Aspects within the Four Context Facets . . . . .	82
6.4	Different Roles of a Context Aspect . . . . .	94
	<b>Recommended Literature for Part II . . . . .</b>	<b>97</b>
	<b>Part III Requirements Artefacts . . . . .</b>	<b>99</b>
	<b>Part III.a Goals . . . . .</b>	<b>103</b>
<b>7</b>	<b>Fundamentals of Goal Orientation . . . . .</b>	<b>105</b>
7.1	Motivation . . . . .	106
7.2	The Term “Goal” . . . . .	107
7.3	AND/OR Goal Decomposition . . . . .	107
7.4	Goal Dependencies . . . . .	108
7.5	Identifying Goal Dependencies . . . . .	112
<b>8</b>	<b>Documenting Goals . . . . .</b>	<b>113</b>
8.1	A Template for Documenting Goals . . . . .	114
8.2	Seven Rules for Documenting Goals . . . . .	116
8.3	Goal Modelling Languages and Methods . . . . .	119
8.4	Documenting Goals Using AND/OR Trees and AND/OR Graphs . . . . .	120
8.5	i* (i-Star) . . . . .	125
8.6	KAOS . . . . .	131
8.7	Deciding Which Goal Modelling Language to Use . . . . .	134
	<b>Recommended Literature for Part III.a . . . . .</b>	<b>137</b>
	<b>Part III.b Scenarios . . . . .</b>	<b>139</b>
<b>9</b>	<b>Fundamentals of Scenarios . . . . .</b>	<b>141</b>
9.1	Scenarios as Middle-Level Abstractions . . . . .	142
9.2	Scenarios as a Means for Putting Requirements in Context . . . . .	143
9.3	Developing Scenarios for Each Context Facet . . . . .	145
<b>10</b>	<b>Scenario Types . . . . .</b>	<b>147</b>
10.1	Current-State and Desired-State Scenarios . . . . .	149
10.2	Positive and Negative Scenarios . . . . .	150
10.3	Misuse Scenarios . . . . .	151
10.4	Descriptive, Exploratory, and Explanatory Scenarios . . . . .	152
10.5	Instance and Type Scenarios . . . . .	154
10.6	System-Internal, Interaction, and Context Scenarios . . . . .	156
10.7	Main Scenario, Alternative Scenarios, and Exception Scenarios . . . . .	161
10.8	Use Cases: Grouping Scenarios . . . . .	163
<b>11</b>	<b>Documenting Scenarios . . . . .</b>	<b>167</b>
11.1	Narrative Scenarios . . . . .	168
11.2	Structured Scenarios . . . . .	169

11.3	A Reference Template for Use Cases . . . . .	174
11.4	Eleven Rules for Documenting Scenarios . . . . .	178
11.5	Sequence Diagrams . . . . .	183
11.6	Activity Diagrams . . . . .	187
11.7	Use Case Diagrams . . . . .	189
11.8	Use of the Different Scenario Types in the Requirements Engineering Process . . . . .	193
<b>12</b>	<b>Benefits of Using Goals and Scenarios . . . . .</b>	<b>195</b>
12.1	Benefits of Goal Orientation . . . . .	196
12.2	Benefits of Using Scenarios . . . . .	198
12.3	Benefits of Goal–Scenario–Coupling . . . . .	202
	<b>Recommended Literature for Part III.b . . . . .</b>	<b>209</b>
	<b>Part III.c Solution-Oriented Requirements . . . . .</b>	<b>211</b>
<b>13</b>	<b>Fundamentals . . . . .</b>	<b>213</b>
13.1	Three Perspectives on a Solution . . . . .	214
13.2	Solution-Oriented Requirements, Goals, and Scenarios . . . . .	216
<b>14</b>	<b>Documenting Solution-Oriented Requirements . . . . .</b>	<b>221</b>
14.1	Documenting Requirements in the Data Perspective . . . . .	223
14.2	Documenting Requirements in the Functional Perspective . . . . .	237
14.3	Documenting Requirements in the Behavioural Perspective . . . . .	249
14.4	Documenting Quality Requirements in the Three Perspectives . . . . .	263
<b>15</b>	<b>Integration of the Three Perspectives . . . . .</b>	<b>265</b>
15.1	Extended Example . . . . .	266
15.2	Relationships between the Perspectives . . . . .	272
15.3	Integration Using UML 2 . . . . .	276
15.4	Integration Using SysML . . . . .	278
	<b>Recommended Literature for Part III.c . . . . .</b>	<b>285</b>
	<b>Part IV Core Activities . . . . .</b>	<b>289</b>
	<b>Part IV.a Documentation . . . . .</b>	<b>293</b>
<b>16</b>	<b>Fundamentals of Requirements Documentation . . . . .</b>	<b>295</b>
16.1	Motivation and Aims . . . . .	296
16.2	Documentation vs. Specification . . . . .	297
16.3	Quality Criteria for Requirements Artefacts . . . . .	299
16.4	Acceptance Criteria . . . . .	302
<b>17</b>	<b>Natural Language Documentation . . . . .</b>	<b>307</b>
17.1	Natural Language Requirements . . . . .	308
17.2	Requirements Documents . . . . .	309
17.3	Quality Criteria for Requirements Documents . . . . .	315
17.4	Use of Natural Language: Advantages and Disadvantages . . . . .	317
17.5	Techniques for Avoiding Ambiguity . . . . .	323

<b>18</b>	<b>Structuring Natural Language Requirements</b>	<b>331</b>
18.1	Reference Structures for Requirements Documents	332
18.2	Defining Attributes for Requirements	338
18.3	Requirements Attributes	340
18.4	Templates and Information Models	348
18.5	Establishing Views on Textual Requirements	355
<b>19</b>	<b>Fundamentals of Conceptual Modelling</b>	<b>359</b>
19.1	Physical vs. Conceptual Models	360
19.2	Model Properties	361
19.3	Semiotics of Conceptual Models	364
19.4	Quality of Conceptual Models	367
19.5	Modelling Languages	370
19.6	Model Creation and Model Interpretation	374
<b>20</b>	<b>Interrelation of Model-Based and Textual Requirements</b>	<b>377</b>
20.1	Requirements Models	378
20.2	Interrelating Requirements Models and Textual Requirements	380
20.3	Traceability Meta-models	381
20.4	Relationships between Conceptual Models and Textual Requirements	384
20.5	Technical Realisation	387
	<b>Recommended Literature for Part IV.a</b>	<b>389</b>
	<b>Part IV.b Elicitation</b>	<b>391</b>
<b>21</b>	<b>Fundamentals of Requirements Elicitation</b>	<b>393</b>
21.1	Goal of Requirements Elicitation	394
21.2	Requirements Elicitation: Definition	395
21.3	Use of Goals and Scenarios in Requirements Elicitation	395
21.4	Sub-activity: Identifying Relevant Requirement Sources	396
21.5	Sub-activity: Eliciting Existing Requirements	401
21.6	Sub-activity: Developing New and Innovative Requirements	404
<b>22</b>	<b>Elicitation Techniques</b>	<b>407</b>
22.1	Evaluation of the Techniques	408
22.2	Template for Describing the Techniques	408
22.3	Interview	409
22.4	Workshop	420
22.5	Focus Groups	430
22.6	Observation	434
22.7	Questionnaires	440
22.8	Perspective-Based Reading	445
<b>23</b>	<b>Assistance Techniques for Elicitation</b>	<b>451</b>
23.1	Evaluation of the Techniques	452
23.2	Brainstorming	452
23.3	Prototyping	458
23.4	KJ Method	463
23.5	Mind Mapping	470
23.6	Elicitation Checklists	474
	<b>Recommended Literature for Part IV.b</b>	<b>481</b>

<b>Part IV.c</b>	<b>Negotiation</b>	<b>483</b>
<b>24</b>	<b>Fundamentals of Requirements Negotiation</b>	<b>485</b>
24.1	Goal of Requirements Negotiation	486
24.2	Requirements Negotiation: Definition	487
24.3	Use of Goals and Scenarios in Requirements Negotiation	487
<b>25</b>	<b>Conflict Management</b>	<b>489</b>
25.1	Sub-activity: Identifying Conflicts	490
25.2	Sub-activity: Analysing Conflicts	490
25.3	Sub-activity: Resolving Conflicts	494
25.4	Sub-activity: Documenting Conflict Resolutions	498
<b>26</b>	<b>Negotiation Techniques</b>	<b>499</b>
26.1	The Win–Win Approach	500
26.2	Interaction Matrix	502
	<b>Recommended Literature for Part IV.c</b>	<b>505</b>
<b>Part V</b>	<b>Validation</b>	<b>507</b>
<b>27</b>	<b>Fundamentals of Requirements Validation</b>	<b>511</b>
27.1	Motivation and Goals	512
27.2	Validation vs. Verification	515
27.3	Sub-activity: Validating the Created Requirements Artefacts	517
27.4	Sub-activity: Validating the Consideration of the Context	521
27.5	Sub-activity: Validating the Execution of Activities	524
27.6	Capability Model for Validation with Three Levels	525
27.7	Goals and Scenarios in Validation	527
27.8	Principles of Validation	529
<b>28</b>	<b>Validation Techniques</b>	<b>537</b>
28.1	Inspections	538
28.2	Desk-Checks	545
28.3	Walkthroughs	548
28.4	Comparison: Inspections, Desk-Checks, and Walkthroughs	551
28.5	Validation Using Prototypes	551
<b>29</b>	<b>Assistance Techniques for Validation</b>	<b>557</b>
29.1	Validation Checklists	558
29.2	Perspective-Based Reading	568
29.3	Creation of Artefacts	572
	<b>Recommended Literature for Part V</b>	<b>587</b>
<b>Part VI</b>	<b>Management</b>	<b>589</b>
<b>30</b>	<b>Fundamentals of Requirements Management</b>	<b>593</b>
30.1	Goals of the Management Activity	594
30.2	Definition	595
30.3	Managing Requirements Artefacts	596
30.4	Observing the System Context	597
30.5	Managing the Requirements Engineering Activities	599

<b>31</b>	<b>Requirements Traceability</b>	<b>605</b>
31.1	Fundamentals of Traceability	606
31.2	Pre- and Post-traceability of Requirements	607
31.3	Traceability Relationship Types	609
31.4	Documenting Traceability Relationships	614
31.5	Presentation of Traceability Information	616
31.6	Project-Specific Traceability	619
<b>32</b>	<b>Prioritising Requirements</b>	<b>627</b>
32.1	Fundamentals of Requirements Prioritisation	628
32.2	Preparation Activities for Prioritisation	629
32.3	Techniques for Requirements Prioritisation	632
<b>33</b>	<b>Change Management for Requirements</b>	<b>645</b>
33.1	Configuration Management	646
33.2	Requirements Changes	649
33.3	Systematic Change Management	652
	<b>Recommended Literature for Part VI</b>	<b>661</b>
	<b>Part VII COSMOD-RE: the Goal- and Scenario-Based RE Method</b>	<b>663</b>
<b>34</b>	<b>Fundamentals</b>	<b>667</b>
34.1	Abstraction Layers	668
34.2	Co-development of Requirements and Architectural Artefacts	671
<b>35</b>	<b>The COSMOD-RE Method</b>	<b>677</b>
35.1	The Four COSMOD-RE Abstraction Layers	679
35.2	The Four COSMOD-RE Artefact Types	688
35.3	COSMOD-RE Co-design Processes	704
35.4	The Five Sub-processes of Each Co-design Process	708
<b>36</b>	<b>Applying COSMOD-RE: an Example</b>	<b>719</b>
36.1	Developing Initial Goals and Scenarios (SP <sub>1</sub> )	720
36.2	Developing an Initial Architecture (SP <sub>2</sub> )	724
36.3	Developing Component Goals and Scenarios (SP <sub>3</sub> )	726
36.4	Consolidating Requirements and Architectural Artefacts (SP <sub>4</sub> )	729
36.5	Specifying the Detailed System Requirements (SP <sub>5</sub> )	732
36.6	Summary	734
	<b>Part VIII Software Product Lines and Requirements-Based Testing</b>	<b>735</b>
<b>37</b>	<b>Requirements Engineering for Software Product Lines</b>	<b>739</b>
37.1	Core Concepts of Product Line Engineering	740
37.2	Challenges for Requirements Engineering in Software Product Line Engineering	743
37.3	Documenting Variability	745
37.4	Domain Requirements Engineering	750
37.5	Application Requirements Engineering	756
37.6	Summary	759

<b>38 Requirements-Based Testing: the ScenTED Approach . . . . .</b>	<b>761</b>
38.1 Motivation . . . . .	762
38.2 Main Concepts behind Testing . . . . .	762
38.3 The Role of Scenarios in Testing . . . . .	766
38.4 Requirements-Based Definition of Test Cases . . . . .	768
38.5 The ScenTED Approach . . . . .	771
38.6 Summary . . . . .	777
 <b>Appendix . . . . .</b>	 <b>779</b>
 <b>Glossary . . . . .</b>	 <b>781</b>
 <b>Literature . . . . .</b>	 <b>791</b>
 <b>Index . . . . .</b>	 <b>805</b>