Engineering and Architecting Multidisciplinary Systems

Volume 2

SYSTEMS OPPORTUNITIES AND REQUIREMENTS

ALAIN FAISANDIER

Practical Guidelines

Sinergy'Com

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FOREWORD

Purpose of this volume

This volume, dedicated to Systems Opportunities and Requirements, is part of the series of books entitled “Engineering and Architecting Multidisciplinary Systems”.

This practical guideline is intended primarily for professionals, either customer or supplier, who want to understand and apply daily engineering of systems, and in particular to those who will have to initiate engineering of potential complex or multidisciplinary systems, and then to work out corresponding stakeholder requirements and system requirements. Here they will find methods, processes, modelling and analysis techniques, reasoning elements, useful recommendations for application, as well as case studies or examples to start using this approach.

Other people having to understand or to exchange with system engineers will find simple and concrete explanations. They will then be able to judiciously apply certain precepts and concepts to their own job. For example, they can be responsible for architecture, design, integration, verification and validation, program and project managers, technological study engineers, service developers, etc.

This guideline is most useful to University professors who desire teaching System Needs and Requirements Definition, to university students, and to researchers, as a certain number of topics discussed in this book could possibly lead to more extensive studies, as well as studies which have not yet been tackled by the engineering community.

In this book, the approach used to present processes, activities, methods, and techniques related to opportunity or mission analysis and to system needs and requirements is gradual. It includes definitions, descriptions, discussions; examples and case studies illustrate practices. The case studies explain step by step how to perform the activities and tasks. Readers can directly transpose the step-by-step and use provided templates for their current or future projects.

Content abstract

The present volume contains what is necessary to know for characterizing a contextual situation, identifying issues, problems, or opportunities, initiating the engineering of a potential system (product, service, enterprise/organisation) that could answer, and to define the corresponding stakeholder needs and requirements, as well as the corresponding system requirements:

- Fundamentals related to the notions of system, context of use, operational concept, market analysis, stakeholder, need, stakeholder requirement, system requirement; as well as the relationships between these notions
- Principles and approaches related to Business and Mission Analysis, Stakeholder Needs and Requirements Definition, and System Requirements Definition processes
- Classification or typology of Stakeholder Requirements and System Requirements
- For each concerned process, the description of the process approach including the detail of activities, tasks, ontology elements, the generic verification and validation actions
- Some applicable methods, modelling techniques, and their utilisation on examples and case studies
- Some pitfalls, proven practices, recommendations and Frequently Asked Questions related to concerned processes
- Useful templates of major documents generated by the execution of these processes

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3 REMINDERS AND OVERVIEW ABOUT FUNDAMENTALS OF SYSTEM DEFINITION

This chapter provides necessary fundamentals to know about System Definition before reading and studying concepts, principles, approaches and processes dedicated to business and mission analysis, to stakeholder needs and requirements definition, and to system requirements definition. You will only find reminders about those fundamentals here; they are detailed in other volumes: in volume 1 “System Notion and Engineering of Systems”, for general approaches, and in volume 3 “Systems Architecture and Design”, for architecting and designing solutions.

The following topics are discussed hereafter:

- The notion of system and the notion of life-cycle processes – section 3.1
- The top-down and bottom-up engineering approaches – section 3.2
- How these engineering approaches are supported by system development ontology elements – section 3.3
- The top-down and recursive approach to System decomposition – section 3.4
- General principles related to Requirements Engineering – section 3.5 including:
  - What does Requirements Engineering cover?
  - Different understandings of “requirements” in Systems Engineering

4 BUSINESS AND MISSION ANALYSIS

This chapter deals with specific concepts and principles related to Business and Mission Analysis, and provides *What to do* (the activities and detailed tasks of the process), and *How to do* (concepts, approaches, modelling techniques and practical considerations). The following topics are described and discussed:

- Introduction, purpose and definitions of this topic – section 4.1
- Principles and concepts – section 4.2, including:
  - Mission, Business, Market analyses
  - Operational Concept and Technical Concept
  - Operational Scenario and Operational Mode
  - Market study
  - Context of use or environment
- Process approach – What to do? – section 4.3, including:
  - Location of the process in the development cycle
  - Purpose of the process, inputs and outputs
  - Activities of the process
  - Ontology elements
  - Verification and validation of Business and Mission Analysis
  - Artefacts
- Practice – How to do? – section 4.4, including:
  - Discussion about the utility of models for the context of use
  - Main modelling techniques
- Practical considerations: Pitfalls and Proven Practices, Our Recommendations, Frequently Asked Questions – section 4.4.4

5 STAKEHOLDER NEEDS AND REQUIREMENTS DEFINITION

This chapter deals with concepts and principles related to Stakeholder Needs and Requirements Definition, and provides *What to do* (the activities and detailed tasks of the related process), and *How to do* (concepts, approaches, modelling techniques and practical considerations). The following topics are described and discussed:

- Introduction, purpose and definitions of this topic – section 5.1
- Principles and concepts – section 5.2, including:
  - Need versus solution
  - Cycle of needs
  - Stakeholders and their requirements
  - Classification of Stakeholder Requirements
- Process approach – What to do? – section 5.3, including:
  - Location of the process in the development cycle
  - Purpose of the process, inputs and outputs
  - Activities of the process
  - Ontology elements
  - Verification and validation of Stakeholder Requirements
  - Documentation templates
- Practice – How to do? – section 5.4, including:
  - Methods and modelling techniques
- Practical considerations: Pitfalls and Proven Practices, Our Recommendations, Frequently Asked Questions – section 5.4.1

6 SYSTEM REQUIREMENTS DEFINITION

This chapter deals with concepts and principles related to System Requirements Definition, and provides *What to do* (the activities and detailed tasks of the related process), and *How to do* (concepts, approaches, modelling techniques and practical considerations). The following topics are described and discussed:

- Introduction, purpose and definitions of this topic – section 6.1
- Principles and concepts – section 6.2, including:
  - Notion of System Requirement
  - Translation of Stakeholder Requirements into System Requirements
  - Refinement of System Requirements
  - Traceability of requirements
  - Assignment of System Requirements during system architecture and design
  - Classification of System Requirements
- Process approach – What to do? – section 6.3, including:
  - Location of the process in the development cycle
  - Purpose of the process, inputs and outputs
  - Activities of the process
  - Ontology elements
  - Verification and validation of System Requirements
  - Documentation templates
- Practice – How to do? – section 6.4 including:
  - Modelling techniques
  - Best practices for writing System Requirements
  - Considerations about requirements management tools
- Practical considerations: Pitfalls and Proven Practices, Our Recommendations, Frequently Asked Questions – section 6.4.5

8 CASE STUDIES

Case studies are presented in the form of exercises. The reader is invited to do the exercises using material included in the previous chapters. Elements of solutions are provided afterwards for the two first case studies. The exercises have the goal to illustrate what should be done and how to obtain progressively the outcomes of the engineering activities. The goal here is not to provide complete solutions.

The following two case studies are treated:

- Case study 1 – SIBERIA, section 8.1
  - This case provides guidance about the progression of the definition using major activities and tasks of the processes.
  - In particular the context of use of this system is modelled; Stakeholders Requirements are drafted, and then translated into System Requirements applicable to this system.
  - This system is “services oriented” and in particular processes information.
- Case study 2 – FITVEE, section 8.2
  - This case also provides guidance about the progression, using the same guidance template as the previous one.
  - The same methodological elements are provided.
  - This system is more “product oriented”.

Two other case studies are suggested, but solution elements are not provided. Readers can try to answer suggested questions, and may also use the previous case studies which have more guidance. These case studies can serve as exercises for mature students in engineering discipline who would like to explore the relationships between Systems Engineering and socio-economical environment:

- Case study 3 – Automobile sector transformation, section 8.3
- Case study 4 – House and building adaptation to environmental awareness, section 8.4