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An Improved Taxonomy for Major Needs and Requirements Artifacts

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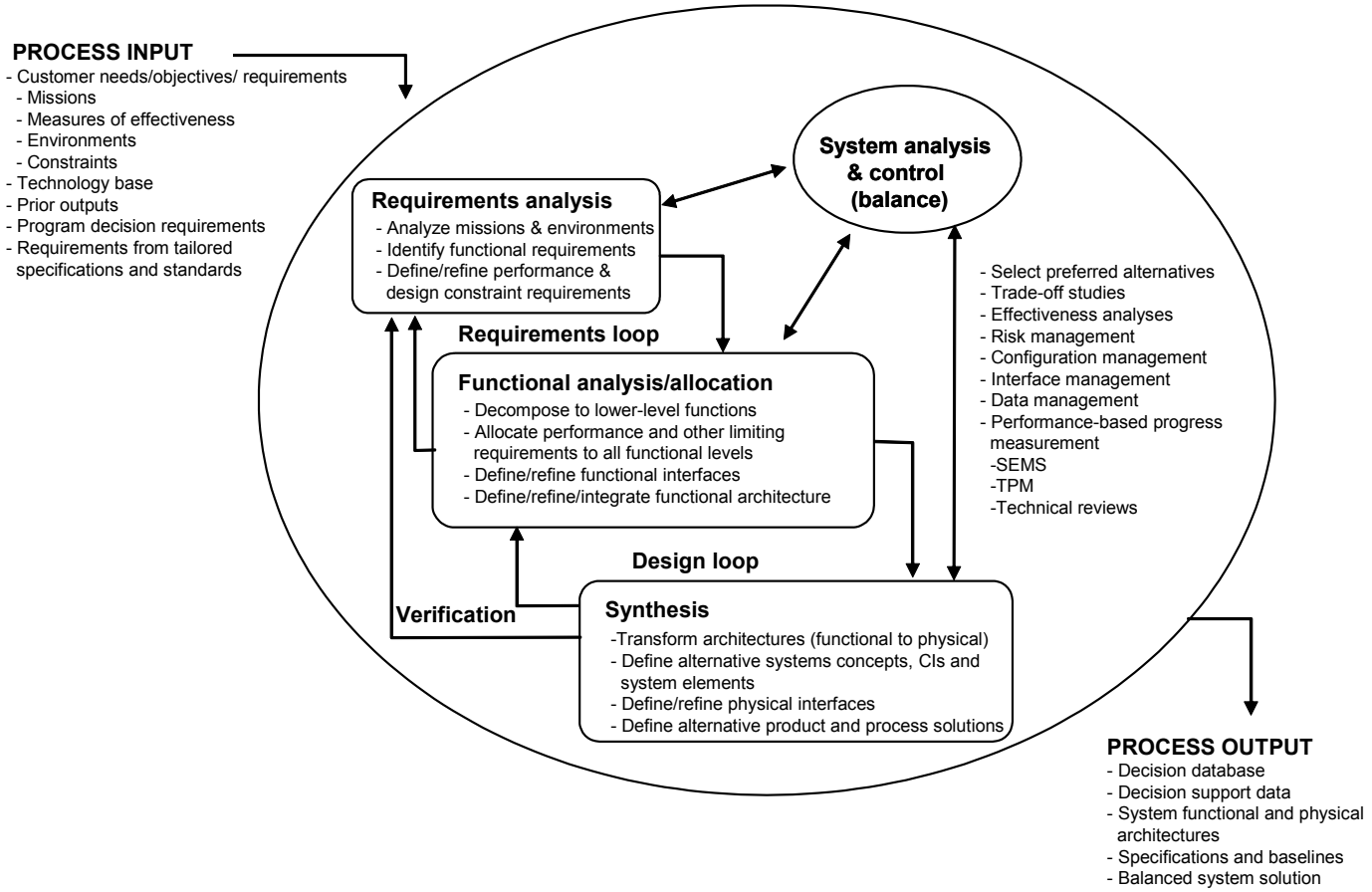
Scope

- Each major SE standard has a slightly different focus and emphasis on needs and requirements artifacts.
- Little attention is paid in most standards to business needs and requirements.
- A taxonomy is proposed here for the major artifacts of the early system life cycle.

MIL-STD-499B (EIA/IS-632)

- Modern SE is heavily influenced by 499.



MIL-STD-499B (EIA/IS-632)

- *Inputs.* Inputs include:
  - Customer needs and objectives.
  - Some form of operational requirements document.
  - ...
- *Outputs.* Expressed in three perspectives:
  - *Operational View*. Operational Concept Document.
  - *Functional View*. System Specification.
  - *Physical View*. Subsystem Specifications.

IEEE 1220

- *Inputs.* Not defined directly:
  - Assumed to exist as stakeholder expectations, constraints, operational scenarios, measures of effectiveness, system boundaries, interfaces, utilization environments, and life-cycle process concepts.
- *Outputs.* Again, three perspectives:
  - *Operational View*. What it must do, how well, and under what conditions; who operates it, and how it is supported.
  - *Functional View*. What the system must do to achieve the operational behaviors described in the operational view.
  - *Design View*. How the system will be designed and constructed and how it interfaces with other systems.

ISO/IEC 15288

- Needs and requirements are discussed in two processes. The transformation of stakeholder needs into stakeholder requirements in the *Stakeholder Requirements Definition Process*.
- *Inputs.* Inputs to this process are not stated directly.
  - Rather, the purpose of the activity is defined as "... to define the requirements for a system that can provide the services needed by users and other stakeholders in a defined environment.". The process is assumed, therefore, to have as its input an understanding of stakeholders needs for the system's services.

ISO/IEC 15288

- *Outputs.* Outputs (or outcomes) of the *Stakeholder Requirements Definition Process* are defined as:
  - Individual stakeholders or stakeholder classes.
  - Required characteristics and context of use of the services.
  - Operational concepts.

    The constraints on a system solution.
  - Interactions between the users and the system.
  - The stakeholder requirements.
  - Traceability of stakeholder requirements to stakeholders and their needs.
  - Stakeholder requirements for validation.

ISO/IEC 15288

- Stakeholder requirements are transformed into system requirements in the Requirements Analysis Process.
- *Inputs.*
  - Again, inputs to this process are not stated directly but assumed to be the stakeholder requirements and other artifacts defined in the preceding Stakeholder Requirements Definition Process.

ISO/IEC 15288

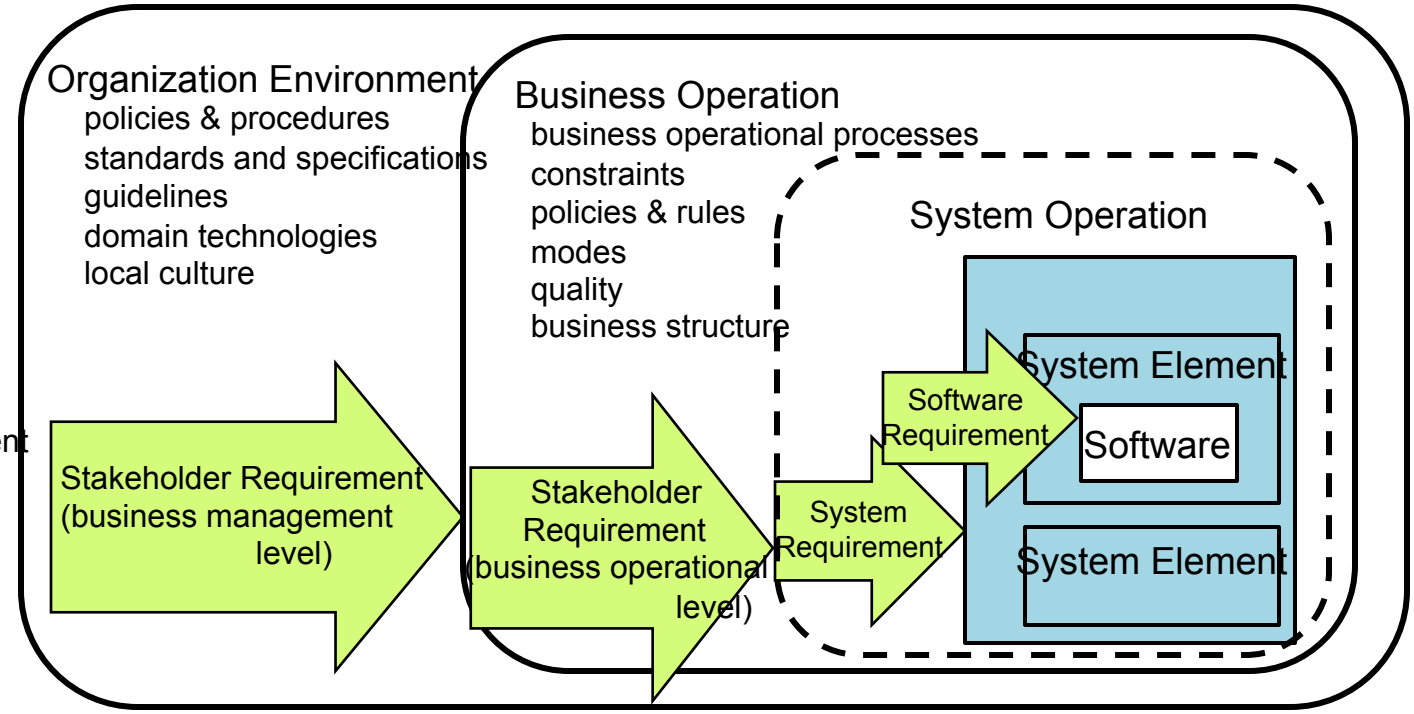
- *Outputs.* The outputs (or outcomes) of the *Requirements Analysis Process* are defined as (as synthesized from the stated activities and tasks stated by the standard for the process):
  - The required characteristics, attributes, and functional and performance requirements for a product solution.
  - Constraints that affect the architectural design.
  - The integrity and traceability of the system requirements to the stakeholder requirements.
  - A basis for verifying the system requirements.

ISO/IEC 29148

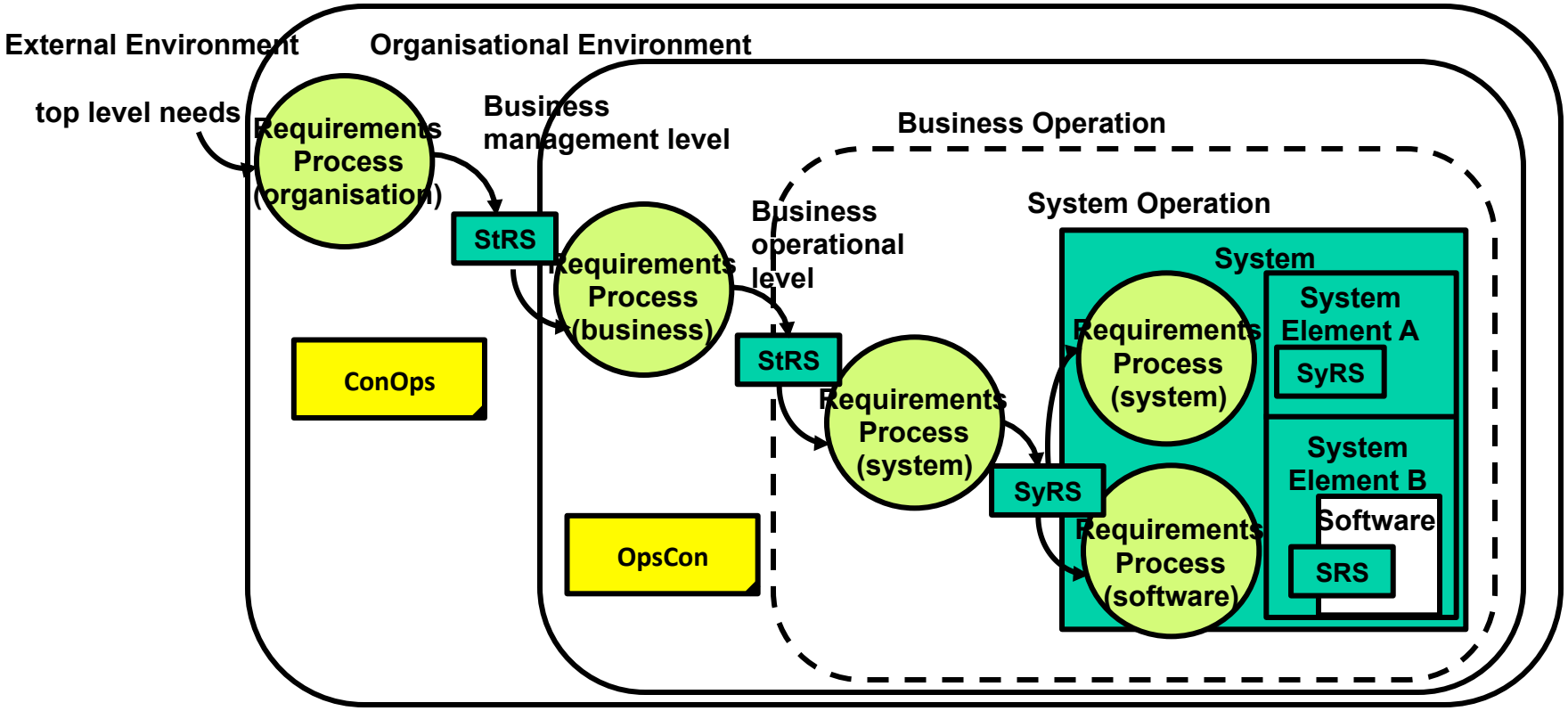
- ISO/IEC 29148 describes the transformation of needs into requirements as:
  - Requirements definition begins with stakeholder intentions (also referred to as needs, goals and objectives), which are called *Stakeholder Needs* in the SEBoK and ISO/IEC 15288, so that term is used from this point on.
  - Using the ConOps and the OpsCon as guidance, requirements engineers lead stakeholders from Stakeholder Needs to the more-formal set of Stakeholder Requirements, which are documented in the *Stakeholder Requirement Specification (StRS)*.
  - The requirements in the StRS are then transformed by requirements engineers into System Requirements, in the *System Requirement Specification (SyRS)*.

ISO/IEC 29148

External Environment
- market trends
- laws & regulations
- legal liabilities
- social responsibilities
- technology base
- labor pool
- competing products
- standards & specifications
- public culture
- physical/natural environment



ISO/IEC 29148



BABOK® Guide

- The BABOK® Guide lists the following requirements:
  - *Business Requirements:* "... the goals, objectives, or needs of the enterprise ... why a project has been initiated ... describe needs of the organization, not stakeholders. ... developed and defined through enterprise analysis."
  - *Stakeholder Requirements*: "... statements of the needs of a particular stakeholder or class of stakeholders ... developed and defined through requirements analysis."
  - *Solution Requirements*: "... describe the characteristics of a solution that meet business requirements and stakeholder requirements ... developed and defined through requirements analysis."
  - *Transition Requirements*: "... capabilities that the solution must have in order to facilitate transition."

BABOK® Guide

- The BABOK® Guide states that some of the most common types of requirements documents include:
  - *Business Requirements Document* (the Guide notes that: many "Business Requirements Document" templates also include stakeholder requirements).
  - *Software/System Requirements Specification*.
  - *Supplementary Requirements Specification*.
- Note that the Guide states that the Business Requirements Document contains Business Requirements and may also contain Stakeholder Requirements (the Guide does not suggest any document at the equivalent level as the StRS).

SEBoK v1.0

- Relevant knowledge areas of the Guide to the Systems Engineering Body of Knowledge :
  - *Concept Definition*:
    - *Mission Analysis* initiates the system life cycle by defining the problem domain, identifying stakeholders, developing preliminary operational concepts, and identifying environmental conditions and constraints.
    - *Stakeholder Needs and Requirements* captures *Stakeholder Needs* which are then used to produce a clear, concise, and verifiable set of *Stakeholder Requirements*.
  - *System Definition*: transforms the *Stakeholder Requirements* from the problem domain into *System Requirements* in the solution domain.

Revised ISO/IEC 15288 View

- ISO/IEC 15288 technical processes are to be amended in the next revision to reflect the SEBoK description.
- Consequently, the two current technical processes of (*Stakeholder Requirements Definition Process* and *Requirements Analysis Process*) will be expanded to:
  - *Business or Mission Analysis Process*.

    Stakeholder Needs and Requirements Definition Process.
  - *System Requirements Definition Process*.

A Synthesized View of Needs and Requirements Artifacts

- Each of the standards and guides reviewed above has slightly different terms for the various needs and requirements artifacts and provides different emphasis on each of the activities from the enterprise level down to the system level.
- A number of aspects need to be addressed to remove confusion.

Needs and Requirements

- The documents and guides reviewed earlier are not very careful in the delineation between *needs* and *requirements*—while they tend to coexist at each level of consideration, they are different:
  - Needs are generally capabilities stated in the language of the stakeholders at the business management or business operations levels.
  - Requirements are formal statements that are structured and can be validated—there may be more than one requirement that can be defined for any need.

Business Requirements Specification

- ISO/IEC 29148 begins with the StRS, which belies the considerable business analysis required to develop the Business Requirements.
- ISO/IEC 29148 identifies the Business Requirement Specification (BRS) as often being synonymous with the StRS in many industries—presumably it therefore means that the StRS includes Business Requirements and Stakeholder Requirements.
- This accords (in a round-about way) with the BABOK® Guide which states that the Business Requirements Document contains Business Requirements and Stakeholder Requirements

Business Requirements Specification

It is important that the Business Requirements are considered separately to the Stakeholder Requirements—the latter flows from the former and the two sets of requirements are separately developed and ratified by different groups.

- The Business Needs and the subsequent Business Requirements are the province of business management (of the organization as a whole); the Stakeholder Needs and the subsequent Stakeholder Requirements are the province of the business operations level.

Business Requirements Specification

- Consequently, it is suggested that the Business Requirements Specification (BRS) should be formally identified as the artifact that documents the Business Requirements.
- There are therefore three formal requirements documents required:
  - *Business Requirement Specification (BRS)*.
  - *Stakeholder Requirement Specification (StRS)*.
  - *System Requirement Specification (SyRS)*.

ConOps and OpsCon

- ANSI/AIAA G-043A-2012 identifies that the terms ‘concept of operations’ and ‘operational concept’ are often used interchangeably but notes that an important distinction exists because each has a separate purpose and is used to meet different ends.
- It is essential that these terms are used so that they are consistent with ANSI/AIAA G-043A-2012 (ANSI/ AIAA 2012) and ISO/IEC 29148 (ISO/IEC 2011), as well as the way in which the terms are used in the U.S. DoD and many other defense forces.

ConOps

- ISO/IEC 29148 describes the ConOps as:
  - *… at the organization level, addresses the leadership's intended way of operating the organization … may refer to … one or more systems, as black boxes, to forward the organization's goals and objectives … describes the organization's assumptions or intent in regard to an overall operation or series of operations of the business with using the system to be developed, existing systems, and possible future systems … frequently embodied in long-range strategic plans and annual operational plans … serves as a basis for the organization to direct the overall characteristics of the future business and systems, for the project to understand its background, and … to implement the stakeholder requirements elicitation.*

OpsCon

- ISO/IEC 29148 describes the OpsCon as:
  - *A system OpsCon document describes what the system will do (not how it will do it) and why (rationale). An OpsCon is a user-oriented document that describes system characteristics of the to-be-delivered system from the user's viewpoint. The OpsCon document is used to communicate overall quantitative and qualitative system characteristics to the acquirer, user, supplier and other organizational elements.*

ConOps and OpsCon

- The ConOps is developed by the organization leadership at the enterprise level. The OpsCon is prepared at the business level.
- Business management begins with the preparation of the Preliminary OpsCon, which summarizes the needs, goals, and characteristics of the system's user and operator community—the Business Needs.
- The Preliminary OpsCon is then elaborated and refined by business operations into the OpsCon by engagement with stakeholders—the OpsCon therefore contains Business and Stakeholder Needs.

Other Life-cycle Concepts

- The OpsCon, however, is just one of the concepts required to address the Business and Stakeholder Needs across the system life cycle:
  - Acquisition Concept.
  - Deployment Concept.
  - Support Concept.
  - Retirement Concept.

Revised ISO/IEC 29148

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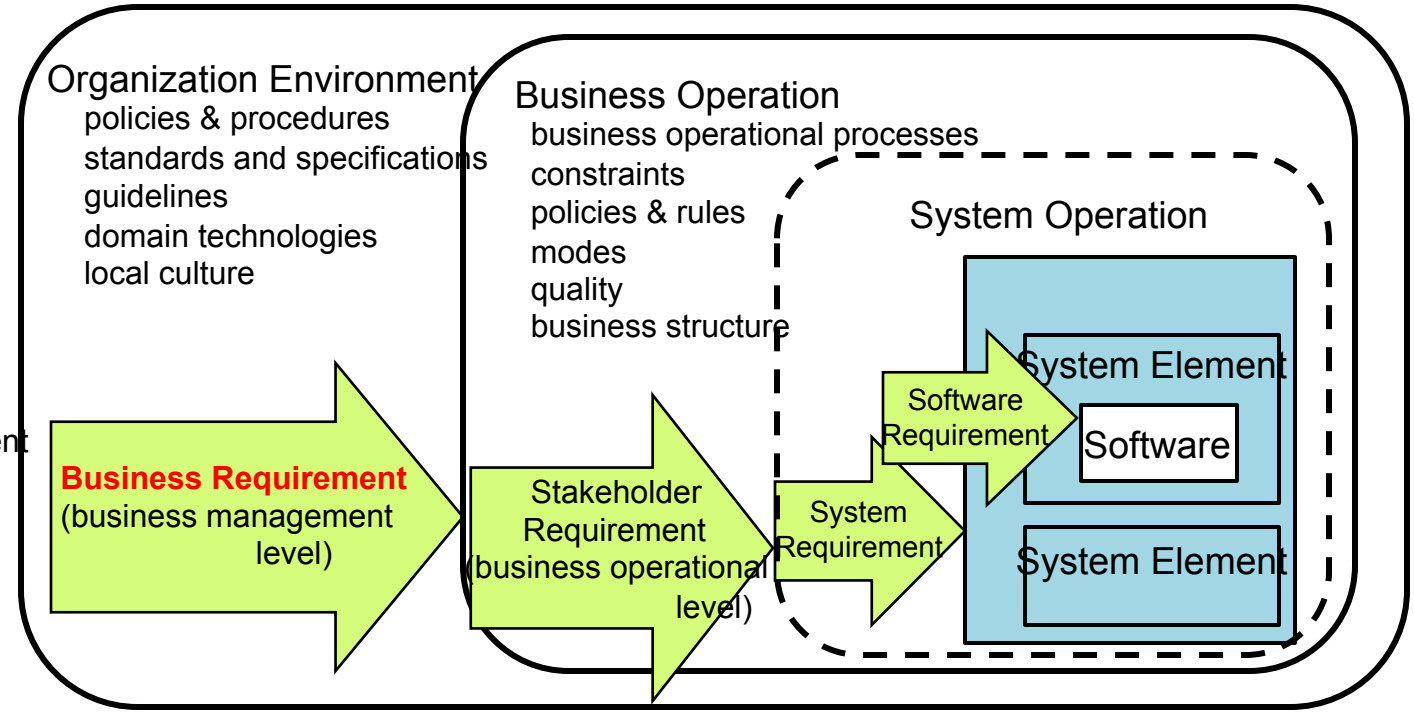
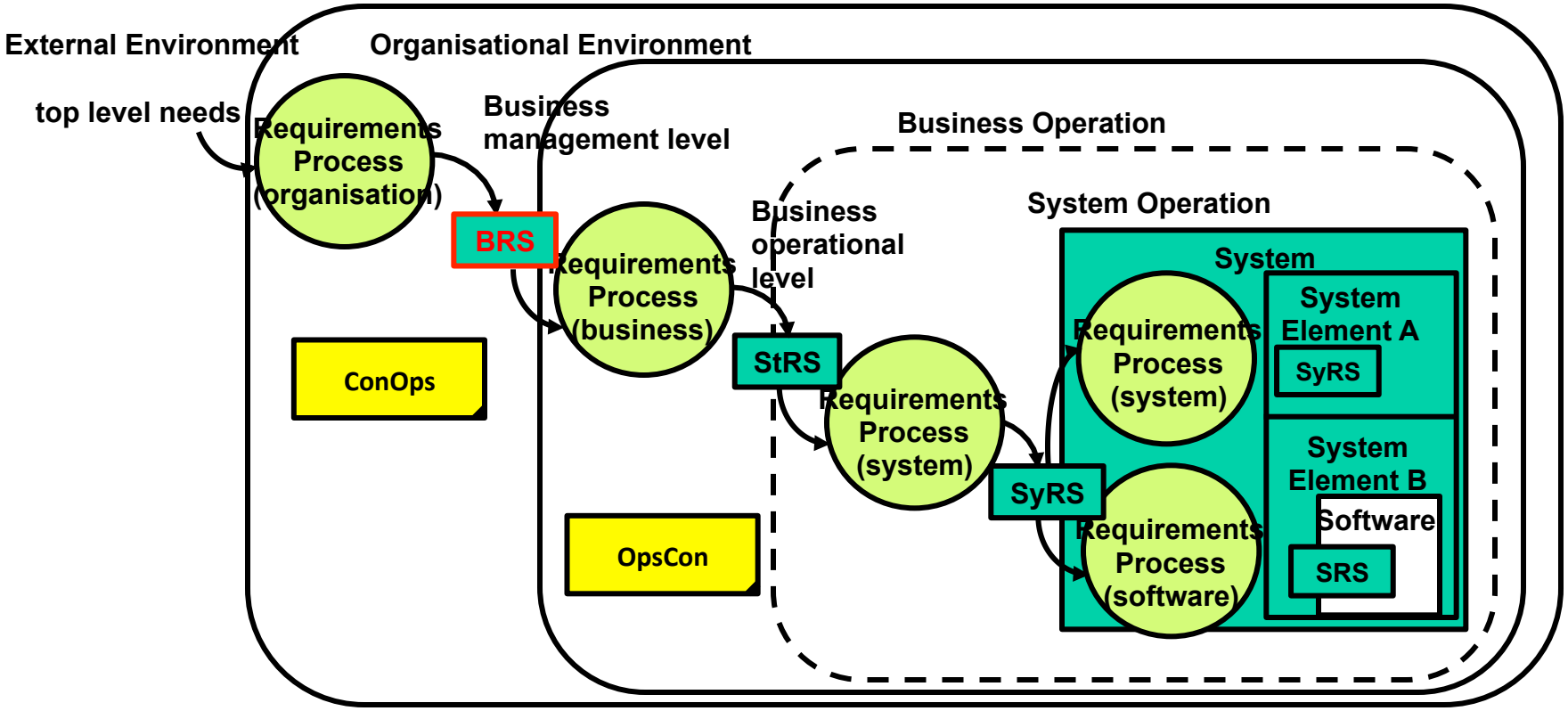
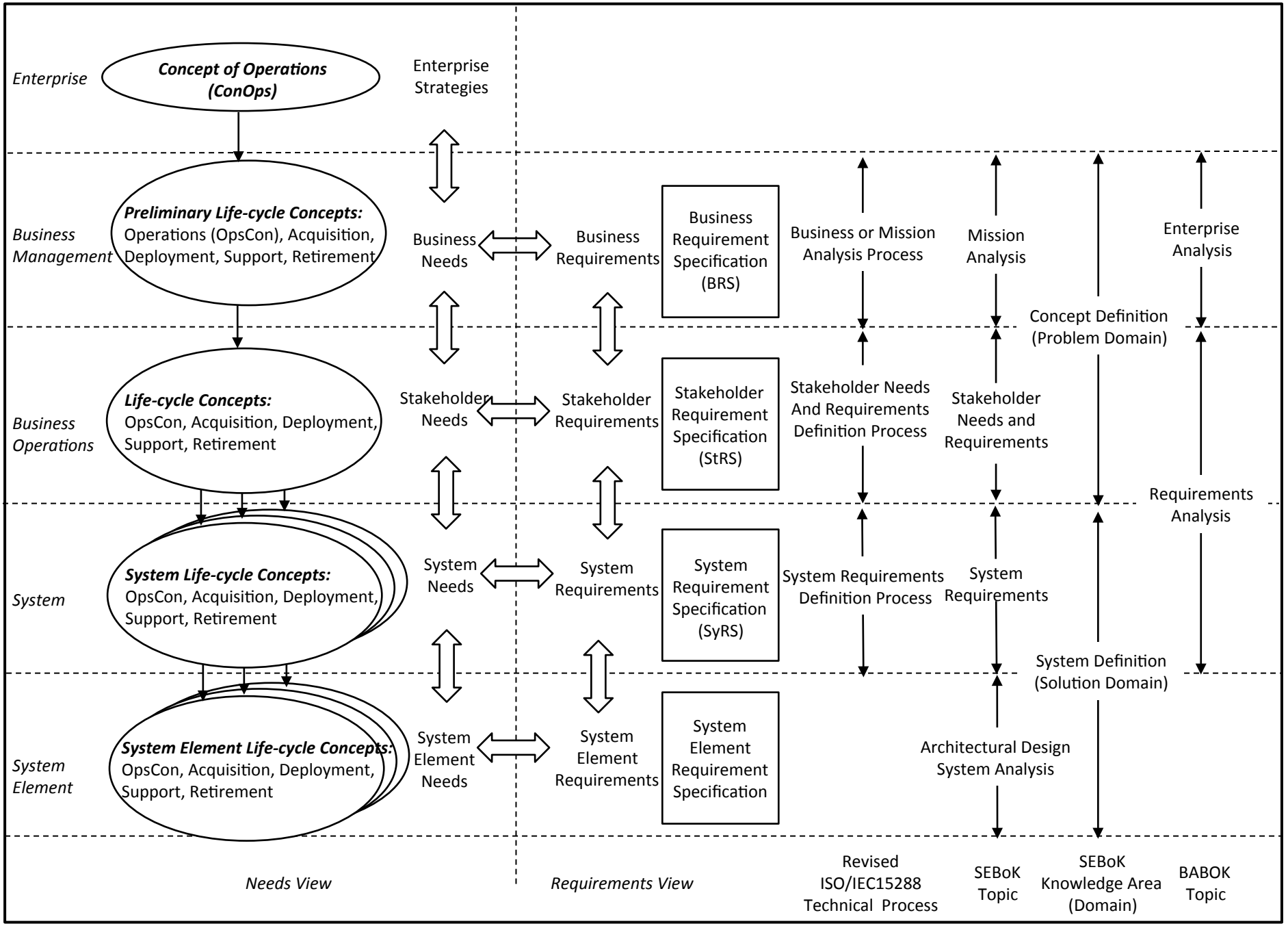
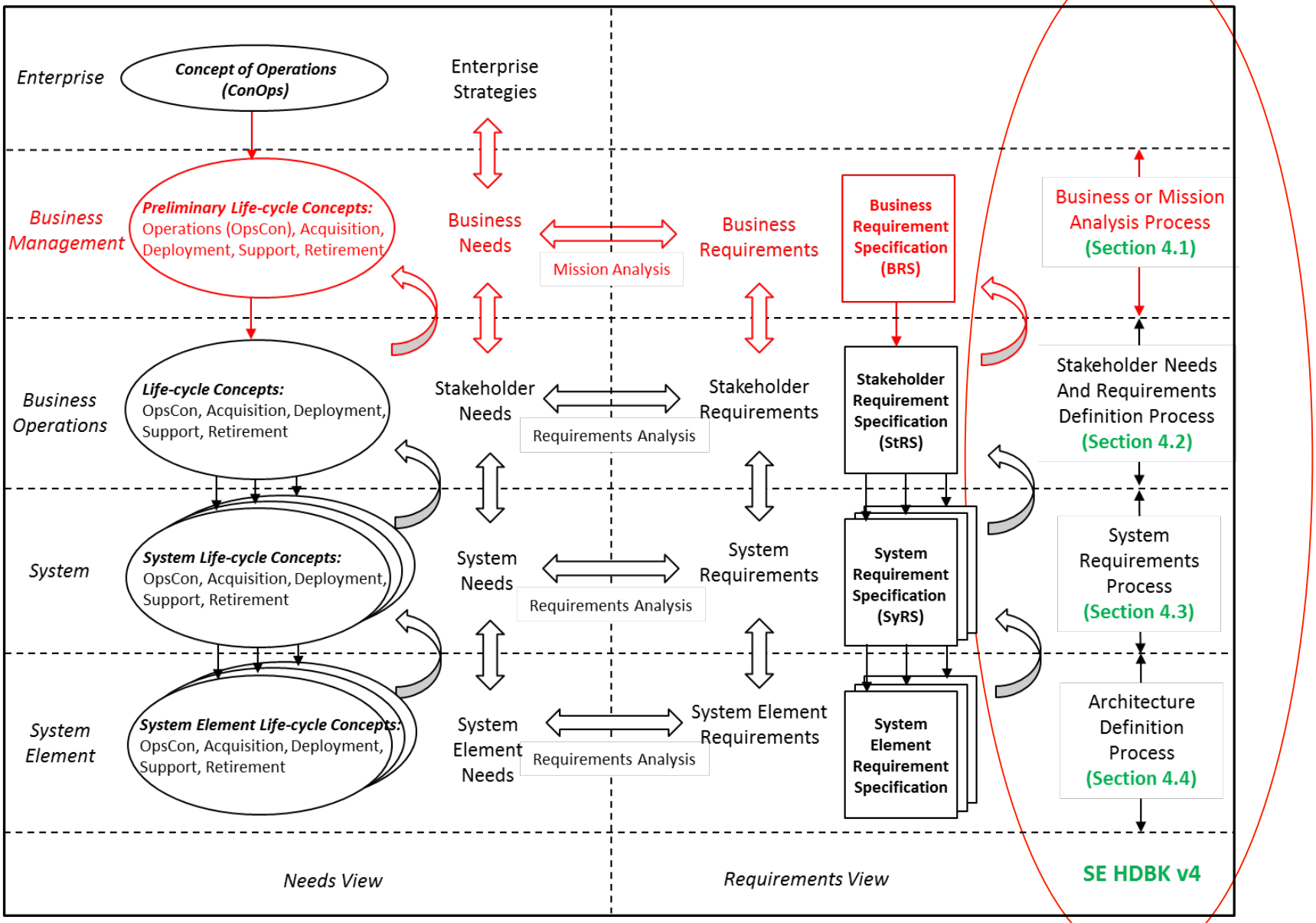


Revised ISO/IEC 29148

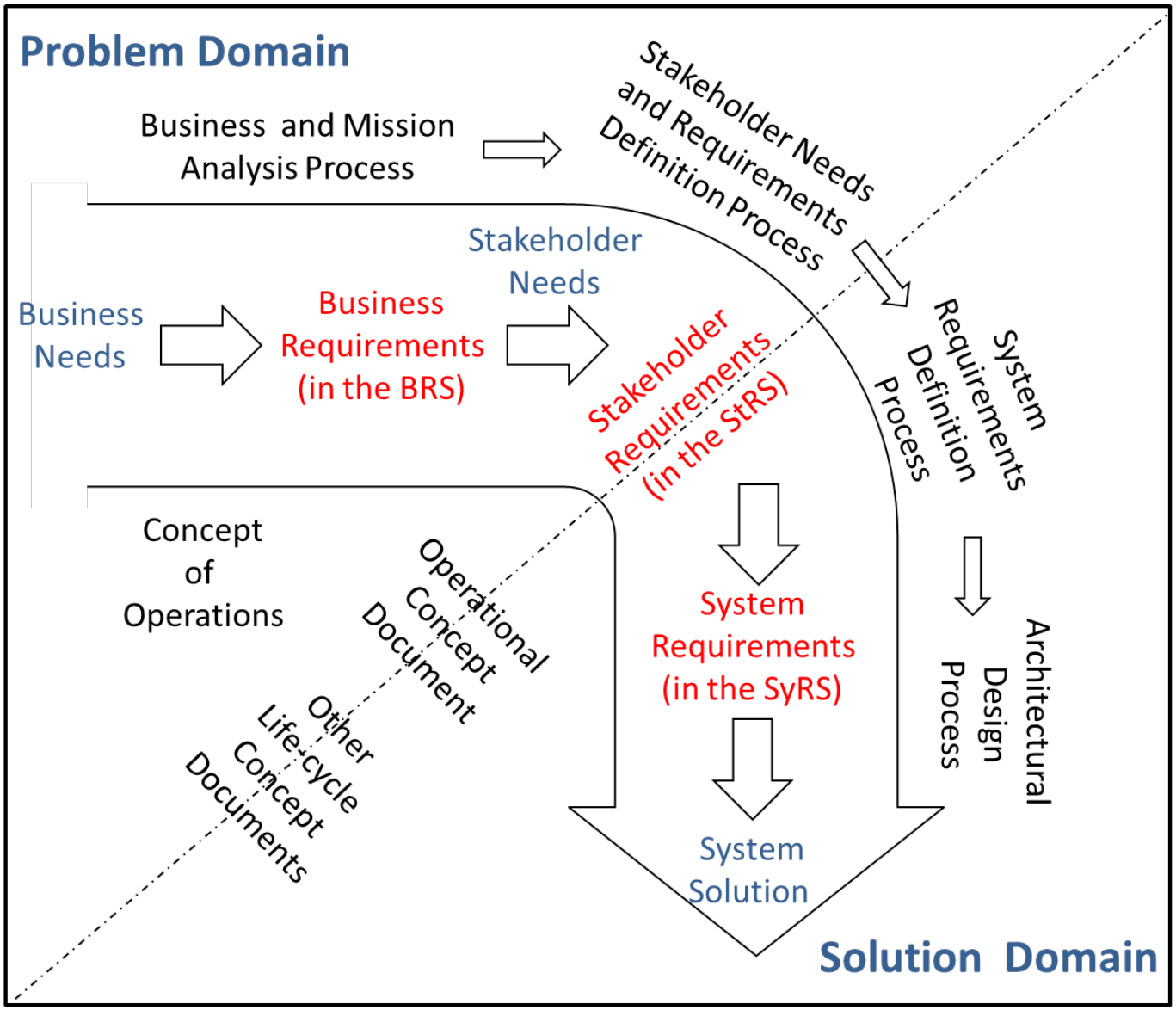



Enterprise
Concept of Operations (ConOps)
Enterprise Strategies
Business Management
Preliminary Life-cycle Concepts: Operations (OpsCon), Acquisition, Deployment, Support, Retirement
Business Needs
Business Requirements
Business Requirement Specification (BRS)
Business or Mission Analysis Process
Mission Analysis
Enterprise Analysis
Concept Definition (Problem Domain)
Business Operations
Life-cycle Concepts: OpsCon, Acquisition, Deployment, Support, Retirement
Stakeholder Needs
Stakeholder Requirements
Stakeholder Requirement Specification (StRS)
Stakeholder Needs And Requirements Definition Process
Stakeholder Needs and Requirements
Requirements Analysis
System
System Life-cycle Concepts: OpsCon, Acquisition, Deployment, Support, Retirement
System Needs
System Requirements
System Requirement Specification (SyRS)
System Requirements Definition Process
System Requirements
System Definition (Solution Domain)
System Element
System Element Life-cycle Concepts: OpsCon, Acquisition, Deployment, Support, Retirement
System Element Needs
System Element Requirements
System Element Requirement Specification
Architectural Design System Analysis
Needs View
Requirements View
Revised ISO/IEC15288 Technical Process
SEBoK Topic
SEBoK Knowledge Area (Domain)
BABOK Topic

A Revised Taxonomy



A Consolidated View



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