Use of Requirements in Model-Based Systems Engineering for a Legacy Design

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Abstract

Requirements are known as one of the pillars of the systems engineers' repertoire, but sometimes they are either overlooked or under emphasized in Model-Based Systems Engineering (MBSE). For instance, Department of Defense Architecture Framework (DoDAF) 2.0 does not currently have requirements represented in any of its 52 views. Systems Modeling Language (SysML) utilizes requirements, but they are not prevalent in many of the diagrams within SysML. Requirements are impacted, and can be influenced, by many stakeholders. Stakeholders, themselves, can affect the intent of a requirement by how they define, constrain, or propose to implement a requirement. If the stakeholders do not fully explain their desired need, the requirement can be misinterpreted, thus impacting full and correct implementation. Thus, it is critical for all stakeholders to understand the ramifications of poorly documented requirements and to directly participate in the requirements development process.

Requirements identification/definition plays a vital role in the initial creation of a project, but are sometimes put on the shelf until the final verification and validation stage of the design. Requirements should be checked and verified throughout the development of a product or project and a baseline developed and approved to eliminate scope creep and to verify the direction of the design. By reviewing the design progression against the approved requirements set, the tendency for a design drifting away from the stakeholder's operational capabilities can be minimized. This also assists the correction/elimination of obsolete requirements before they can adversely impact future enhancements. The requirements should be linked and traceable from start to finish of a design. The evolution of new system requirements can take place over several years, even 40 years after the original design. This traceability helps assess the original intent and the users' needs versus what we think the stakeholders initially wanted or needed. A requirements management plan approach as part of an MBSE design program has been successfully used for the sustainment of US Air Force assets.

Requirements Management Plan

Requirements Management Plan

Process

- Stakeholders
- Configuration Control
- Engineering Configuration Baseline Review
  - Requirements Development
  - Requirement Review
- Approved by the CC
  - Verification and Validation
- Reports
- Developmental Forms

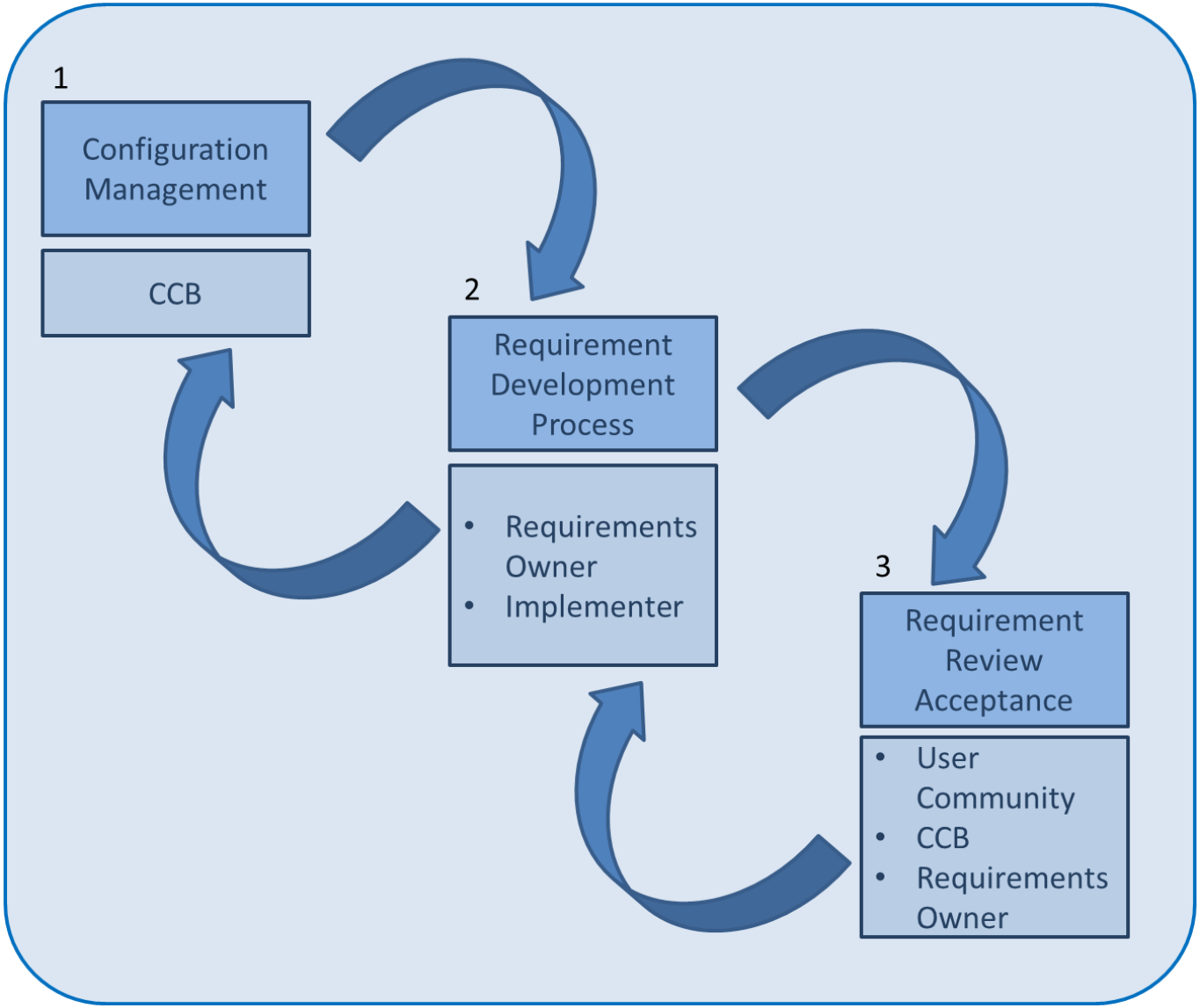
Stakeholders

- The User Community
  - The Stakeholders that will actually be utilizing the product.
- Configuration Control Board (CCB)
  - Provides final approval of any system modifications
- Requirements Owner
  - Develops and establishes the Engineering Configuration Baseline
- Implementers of the Modification
  - Entities that develop work packages
  - Develop system physical requirements

Establish Configuration Control (CC)

- The User Community
  - Documents/databases defining the operational requirements
  - Documents/databases describing capabilities
- Configuration Control Board
  - Configuration Management Plan
- Requirements Owner
  - Engineering Configuration Baseline
    - Design Requirements database / document establishing the minimum set of requirements
  - Requirements Management Plan
- Implementers of the Modification
  - Work Packages
  - Test Plans

Engineering Configuration Baseline Development



Configuration Management

- Establish Engineering Controlled Baseline (ECB)
- Define configuration management guidelines
  - Configuration Management Plan
  - CCB

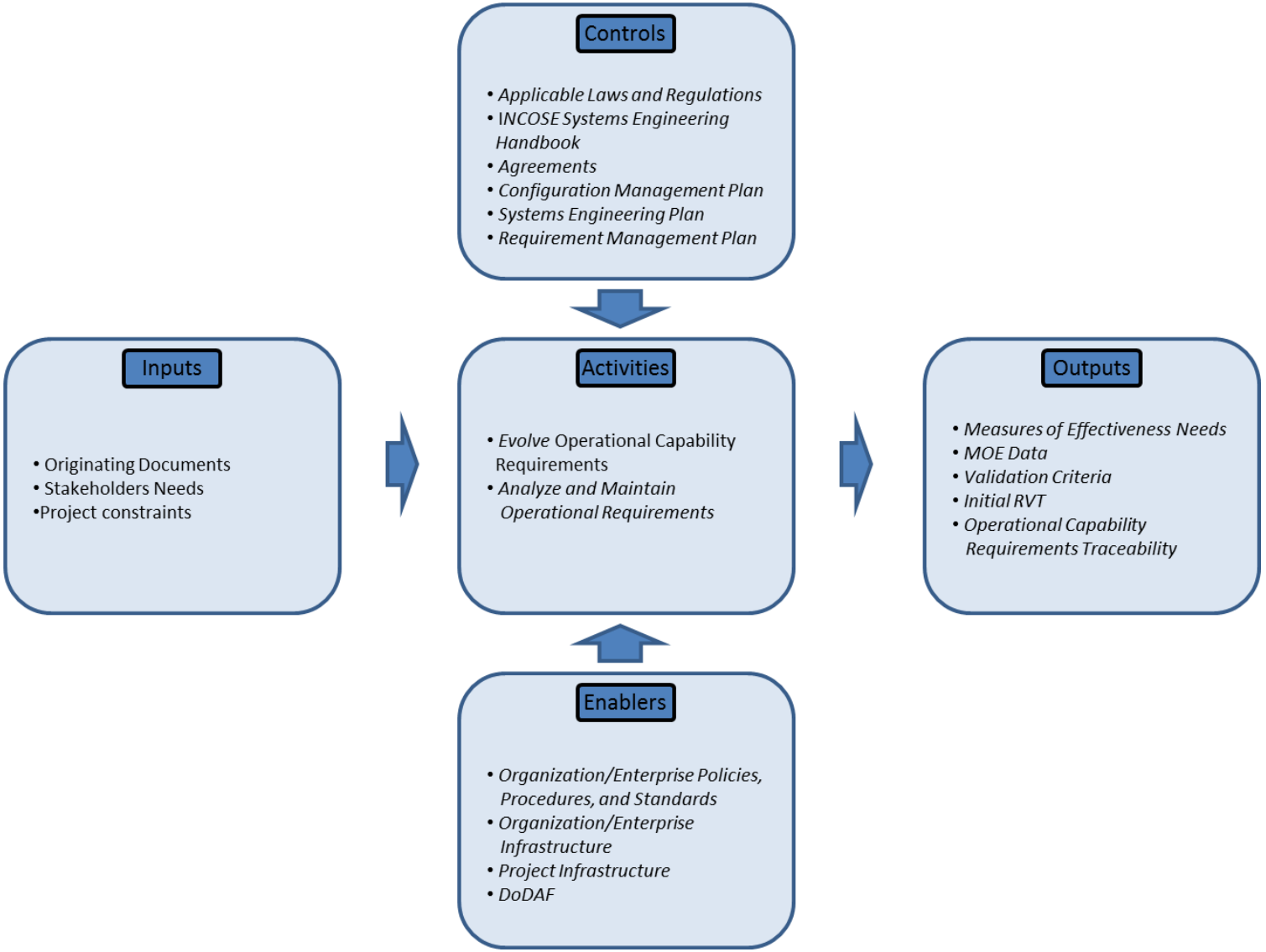
Requirement Development Process

- Gather Stakeholder Requirements
- Develop Key Performance Parameters
- Requirements Analysis
  - Establish set of Impacted Requirements
    - Maybe all the requirements as in a new Design
    - Defined set of requirements for a redesign or modification
    - Reviewed against the Engineering Controlled Baseline (ECB)
  - Operational Assessment
  - Track impacted Requirements
  - Trace the requirements to functions
  - Trace the requirements to components

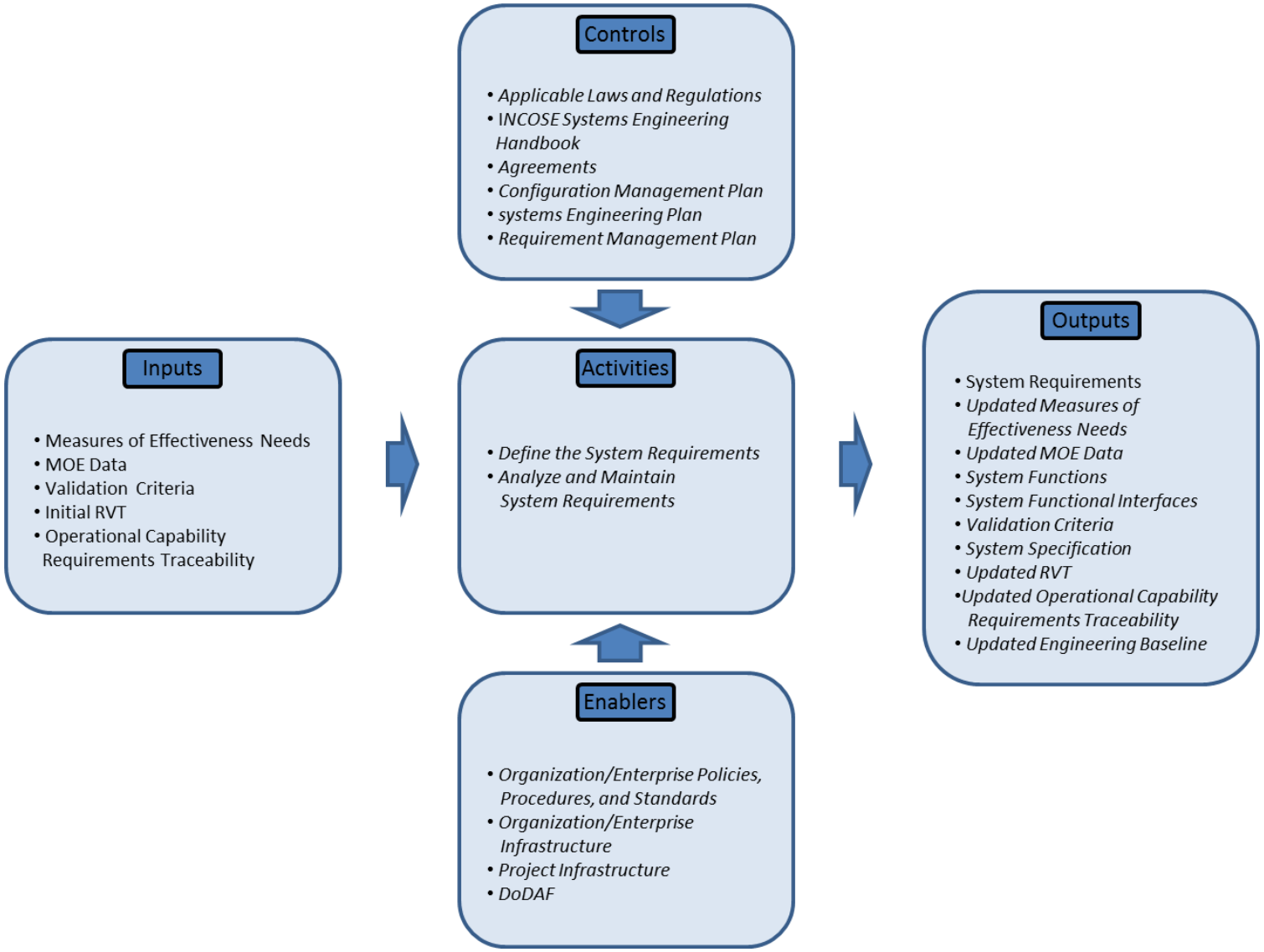
Requirement Review and Acceptance

- Requirements Reviewed by the CCB and Requirements Owner
  - CCB coordinates with the requirements owner
  - Verification
    - Use a Verification Matrix
    - Review the ECB to verify if/how the ECB has evolved from the origin of the Impacted Requirements
      - » System Requirements Review (SRR),
      - » Preliminary Design Review (PDR),
      - » Critical Design Review (CDR)
    - Notify owner of any discrepancy
  - Validation by the User Community

Technical Requirements



Technical Requirement Analysis



Communicated, Traced, and Verified

- Commercially available software package.
  - Capability to verify the requirements.
  - The verification table should at least have these minimum values

Requirement	Impacted Function	Solution Component	Drawing #
Requirement # and description of the requirement impacted by the upgrade.	Function # and description of function or functions that specify the requirement	Component # and description of component which is allocated to the function.	Drawing # or numbers and titles where solution is displayed.

Reports

- Verification Table
- Status Table
- Verification Report
- Custom Reports

Status Table

Number	Requirement	Type	Status
Number of the Requirement	Description of the Requirement impacted by the Modification.	The attribute in the database that describes that type of requirement that is listed. They can be : 1. Capability 2. Composite 3. Constraint 4. Functional 5. Non-Functional 6. Operational 7. Performance 8. Program 9. Test 10. Verification	The defined Status of the requirement: 1. Proposed 2. Approved 3. Implemented

Verification Report

Verification Requirement	Verification article (Document or Drawing)	Type of Verification (Review, Test, or Analysis)
Req # and description of the Verification Requirement	Comp # and Description of component which is allocated to the function.	Drawing # or numbers and Titles where solution is displayed.

Requirements Evaluation Checklist

Evaluation Criteria - All Requirements	Yes	No	IDs	Remarks
A test case is associated with the requirement.				
The requirement can be understood by affected parties (e.g., SME, developers, testers).				
Unacceptable words and phrases are absent (e.g., adverbs, adjectives, as appropriate, at a minimum).				
Adheres to defined terms in the requirements glossary.				
Requirement conforms to standard format.				
Requirement is at the appropriate level of detail for its position in the hierarchy.				
Requirement has the associated information required by the RMP.				

Questions?

Thank You!

Contact

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Biography

Philip J. Simpkins is a Senior Systems Engineer at KIHOMAC Inc. He has over 20 years of collective experience in aerospace requirements development, systems engineering, nuclear operations, and nuclear safety analysis. Mr. Simpkins has extensive knowledge in systems engineering, functions and requirements analysis, risk management, interface management, and analytical software He has delivered presentations to various professional societies, and user group events. He remains active in the International Council on Systems Engineering (INCOSE) and served as 2006-2010 Region V Member Board Representative, in 2011 he was the Director-at-Large for the Alamo Chapter in Texas, and has been Past President of Alamo and the Central Savannah River chapters. Mr. Simpkins also participates on several INCOSE international committees.

Mr. Simpkins is a Certified System Engineering Professional (CSEP) and holds a Bachelor of Science degree in Electrical Engineering and a Master's degree in Engineering Management from the Missouri University of Science and Technology.