Requirement Development Process and Tools

Robert Bayt
Verification and Validation Manager
NASA Commercial Crew Program

Objective: Develop System Requirements Document

- Capture the system-level capabilities in a set of complete, necessary, clear, attainable, traceable, and verifiable statements of need (Requirements)
  - Should not be unduly restrictive[1]
  - Sets limits that eliminate items outside the boundaries drawn
  - Encourage competition (or alternatives)
  - Capture source and reason of requirement

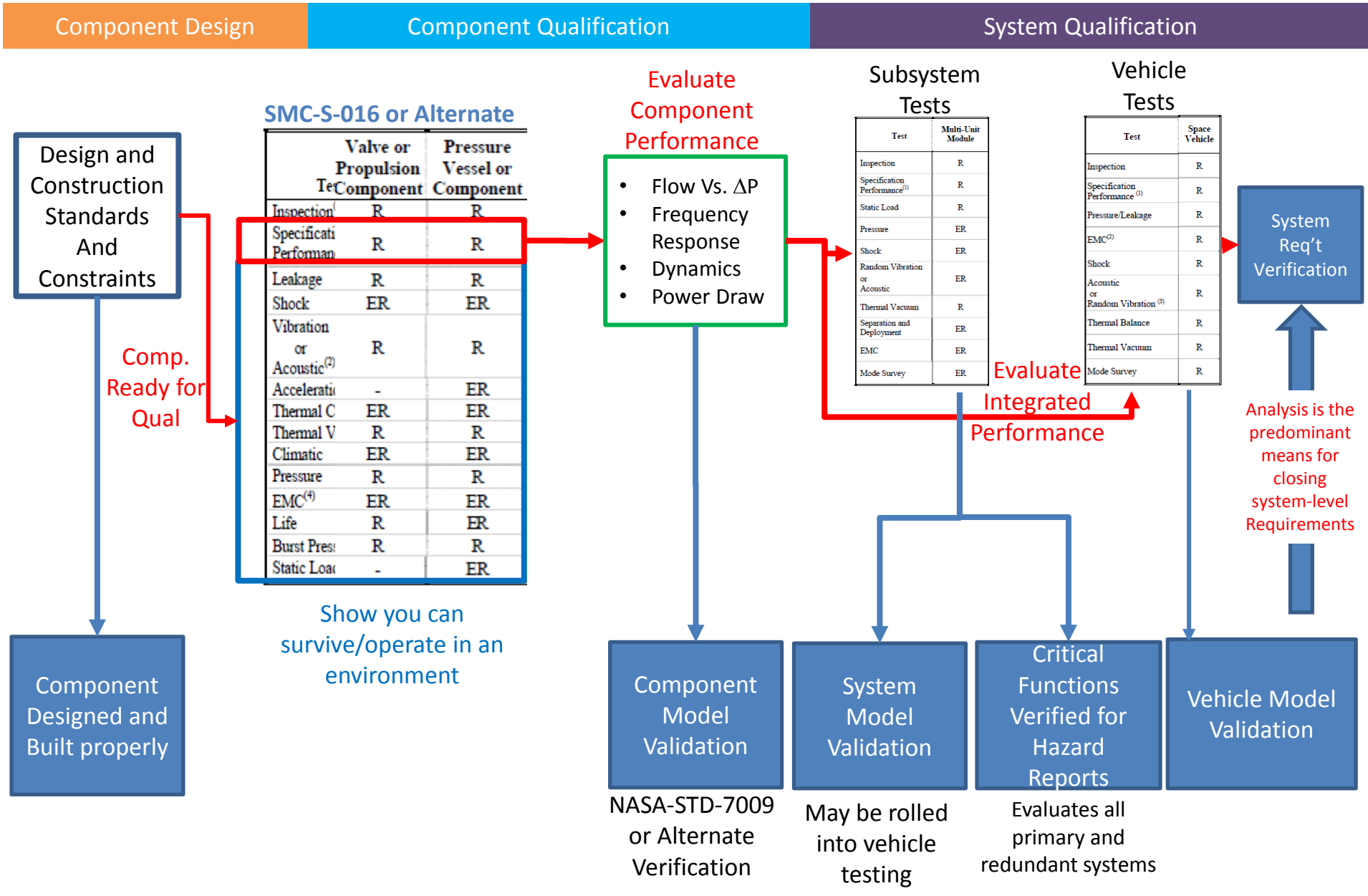
If it is not needed by the customer, it is not a requirement

- Establish the verification methods that will lead to product acceptance
  - These must be reproducible assessment methods

The SRD sets the standards by which the Product will be evaluated

[1]MIL-STD-961E - Reference

System Qualification and Requirements Verification



Importance of Process Discipline and Supporting Tools in Requirements Development

- SRR ensures the requirements and concept satisfy the mission.
- Requirements Validation builds the case as to “why” each requirement is levied. Ensures:
  - Necessity
  - Traceability
- Requirements Maturation ensures:
  - Achievability
  - Clarity
  - Verifiability
- Requirement Owners
  - Drive the development of requirements and validation products
  - Maintain the corporate knowledge of decisions that lead to those products
  - Represent their discipline in providing requirement oversight (compliance and verification) throughout the life cycle.

RO’s synthesize the needs of stakeholders and develops a balanced set of requirements trading needs and affordability

Choose the Tool to Support Your Process

"Scope, constraints, operational concepts, interface details, verification assessments, requirement, and review notes, you may feel like you are smothered in lists before your team finishes the first iteration of requirement definitions….The process must be repeated for every requirement level in the product's development."

- Ivy Hooks, Customer-Centered Products

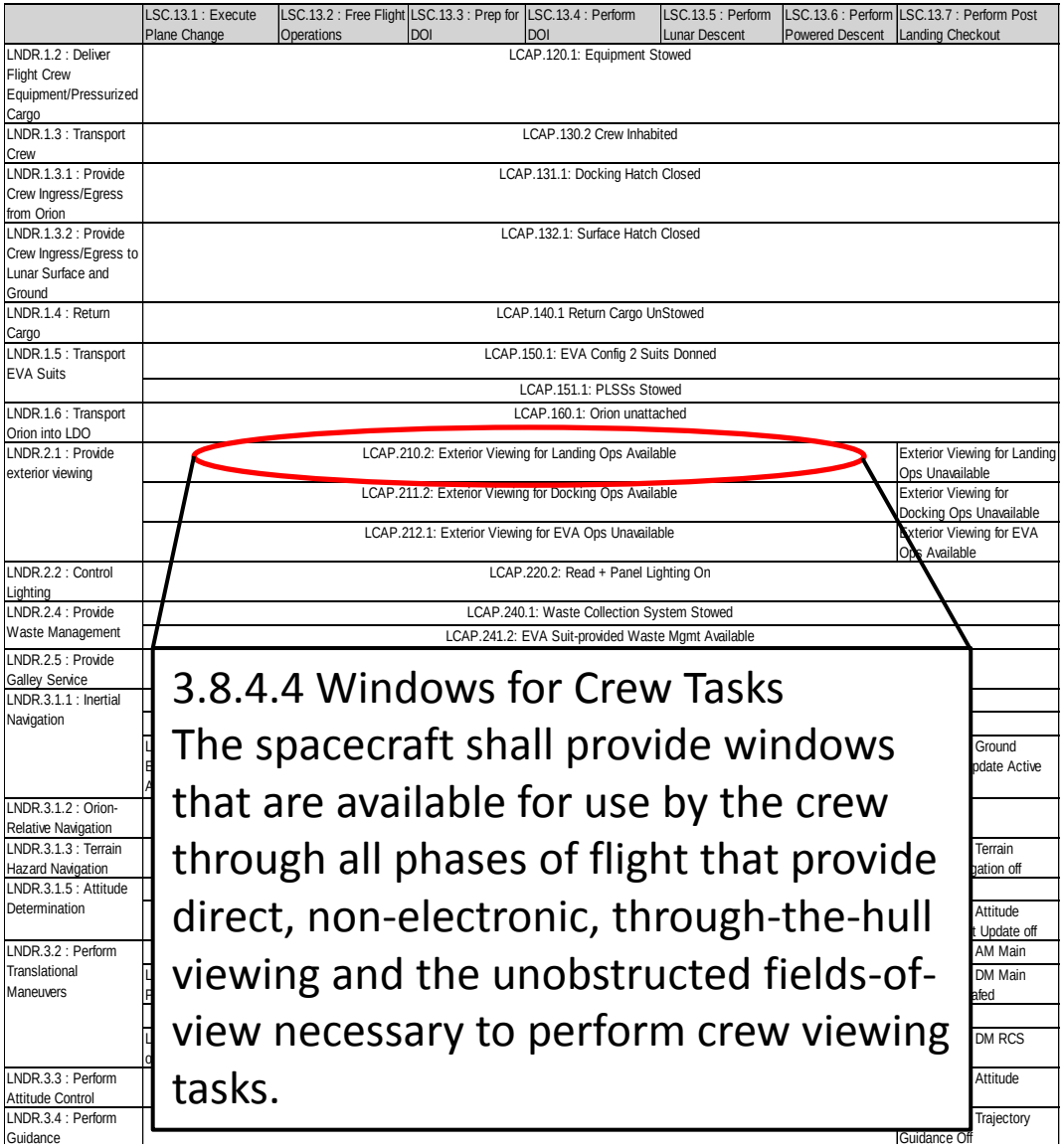
"Begin with the end in mind"

- Stephen Covey, 7 Habits of Highly Effective People

- Requirements Development, Maturation, Configuration Management, and Risk are best supported through implementation of a database
  - Central Repository to which multiple organizations can contribute
  - Provides framework for expounding upon the data typically found in the Req Doc
  - Maintain relationships amongst data that live in different domains
  - Allow varying views into the data to support different work plans

Requirements Development

- At SRR we want to understand why each of these requirements has been levied
- Requirements must be traced to other products to justify their existence
  - Functional Architecture, OPSCON, Parent Requirements, Station IRD
  - Database allows different views into these relationships; hides complexity in the final document
  - Uncovers gaps when looked at as sets of requirements



Role of Requirement Owners

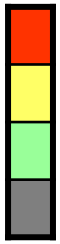
- Single Owners of the groups of requirements manage them as a set to:
  - Reveal omissions
  - Prevent loss of requirements by stakeholders
  - Capitalize on a broad experience base
- Secondary benefits
  - Single POC for reconcile disparate comments from various stakeholders by a deadline
  - Develop a broader verification strategy for the discipline
  - Reconcile with other requirement books and standards
  - Drive resolution of TBXs
  - Ensure common terminology across discipline

Process Automation: Tool Selection

- Divide and Conquer – A central repository allows multiple users to log-in and maintain their own set.
- Shift focus from document mgmt to content mgmt
- Configuration Management – Database tools have rich baselining capabilities
  - Allows Requirements to mature independently
  - Manage TBD's more effectively
- Implementation – Database allows us to create cross references to lower level specs
  - Queries can report whether all the requirements have been matched
  - Reports can assess the sufficiency of the matched requirements to meet the totality of the parent.

Requirement Risk Tracking

- Requirements Risk Identification
  - Assess each requirement for:
    - Criticality - Impact on the design
    - Achievability - Potential for meeting the requirement through normal development
    - Criticality
  - Purpose is to provide priority on addressing requirement deficiencies
    - C1 - Requirement is a Key Driving Requirement, an MOE, the Requirement Describes Functionality that costs >3% dry mass, or directly drives LOC (to first order)
    - C2 - the Requirement Describes Functionality that costs 1-3% dry mass or directly drives LOM (to first order), or represents substantial cost investment or schedule implication
    - C3 - Requirement Describes Functionality that costs <1% dry mass
- Achievability Assessment



r – Low Likelihood of Compliance (<50% chance)

y – Medium Likelihood of Compliance (50-80% chance)

g – High Likelihood of Compliance (>80% chance)

grey - Unassessed

A	C	D
ID	Name	Requirement Text
R.EA3137	Altair Vestibule Pressurization Cycles	Altair shall provide not less than two vestibule pressurization cycles per mission for Lunar Sortie and Lunar Outpost crew missions.
R.EA3139	Altair Fire Detection and Suppression	Altair shall provide fire detection and suppression for the Altair pressurized volume for Lunar Sortie and Lunar Outpost crew missions.
R.EA3141	Lunar Surface Location	The Constellation Architecture shall determine stationary element location anywhere on the lunar surface to within (TBD-001-068) m ((TBD-001-068) ft) with 95% probability.
R.EA3144	Altair navigation and attitude determination	Altair shall perform navigation and attitude determination beginning with Earth orbital operations through Altair disposal.
R.EA3145	Altair Lunar Descent	Altair shall compute maneuvers associated with lunar descent and landing beginning with DOI.
		Altair shall provide a habitable environment for a crew of four for a

Assessments are dashboard of performance

Implementation Risks

- Process and tools requires support
  - Facilitated by SE&I
- Systems requires training
  - Insight Teams/Mgmt
  - Reqmnt Owners/Developers
  - Database Admins
- System on the Critical Path
  - Development dependent upon system availability
  - Mitigated by enterprise solutions that share burden across projects

Summary

- Utilizing Requirement Owners and a database to facilitate Requirements Engineering and Requirements Management increases requirement quality and uncertainty throughout the lifecycle
- Rationale:
  - Integrates Requirements Development and statusing into a common framework
  - Maintains detailed history of requirement evolution
  - Allows cross-references more elaborate datasets
  - Establishes clear ownership and coordination channels