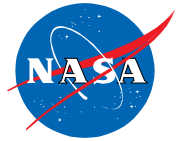

Interim Report to Trilateral: Comparison of Reliability and Maintainability Activities across ESA, JAXA, and NASA

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Original Proposal

- The R&M taskforce proposes a comparative evaluation of the scope of R&M considerations (technical objectives and strategies) across the three agencies, and common tools, techniques, and standards used to implement those strategies.
- The task force proposes to consider the elements of the NASA R&M framework, as captured in the hierarchy of R&M considerations, to identify commonalities and differences in the way reliability and maintainability is addressed by the flight projects.
- In addition, the task force will consider lessons learned from past projects concerning international cooperation.

Implementation Plan Overview

- Kick-off Project
- Task Set 1
  - Review NASA Hierarchy
  - Review NASA Evidence Compilation Tables
- Task Set 2
  - Fill in template
  - Compile list of standards corresponding to R & M activities
- Task Set 3
  - Compile results
  - Integrate templates
  - Team review of results
- Report and Presentation

Status

- Completed Review of NASA Heirarchy
- Initial Review of NASA Scope Tables as referenced in NASA STD 8729.1
- Compiled Evidence Section of Scope Tables through SMA team
- Reviewed recommendations by JAXA and ESA
- Currently Compiling a Report

NASA & ESA

NASA entries list individual activities

ESA entries list classes of activities and relate to requirements

	NASA's Evidence column	ESA's Evidence column
Strategy: Test, inspect, and demonstrate to an acceptable level to ensure that issues are found	Testing and Analysis Methods such as: Sneak circuit analysis, EMC emissions test, EMC isolation test, EMC susceptibility test, ESD discharge test, HALT, HAST, Life testing, Regression Testing, Stress Testing, Static Code Analysis	screening, qualification and acceptance verification as defined in the applicable procurement policies for EEE and mechanical parts, materials and manufacturing processes. For instance for EEE parts, Non Desctructive Inspection and Destructive Physical Analysis are performed during the qualification activities as part of EEE parts requirements. Specific approaches for some elements like solar cells / battery cells which are not covered as parts of the EEE requirements

	NASA's Evidence column	ESA's Evidence column
Strategy: Apply design standards to incorporate margin to account for variable and unknown stresses	Derating, structural safety margins, thermal, aging, radiation design margins	Design and safety factors for structural items Safety/Design factors for mechanisms Fracture control plan for critical mechanical items Derating factors for EEE parts

In general, good agreement (e.g., Derating in both)

Occasionally an item not in NASA's list (e.g., Fracture control plan)

ESA Comments and Recommendations

- No major comments on the NASA Objectives Hierarchy
- Hierarchy is comprehensive
- A true comparison should involve comparing an independently developed GSN hierarchy from ESA with the NASA Hierarchy
- Further work on scope tables would require coordination across several ESA organizations and domains
- Recommend concluding project at this point

NASA & JAXA

JAXA asks penetrating questions as they go through the NASA matrix

2.A.1.D	Strategy: Perform qualification testing and life demonstration to verify design for intended use 意図された使用のための設計検証のための認定試験と寿命実証実施 認定試験、寿命試験/解析による使用条件内での設計の検証	Test Results, Life Analysis, Fatigue Analysis, Worst Case Analysis, acoustic test, constant acceleration test, HALT, HAST, magnetic test, mechanical shock test, powered-on vibration test, pyrotechnic shock test, random vibration test, sine dynamic test, Structural Proof Loading Test, thermal testing, thermal test, voltage/temperature margin test	Demonstrate class-specific positive safety margins and specific safety factors consistent with requirements based on material, function, environment and flight dynamics (where applicable)
HSF		Nothing special to add	Same as above
Satellite	4.4.3 Testing 4.4.3.1 Test plan 4.3.10.2 Life analysis 4.3.10.4 Cumulative fatigue damage	Nothing special to add	Demonstrate mission-s… positive safety margins and specific sa… tors consistent with requirements base… terial, function, environment and flight … (where applicable)
Ground	N…		N/A

Are these testings include the test conducted during early phase of development? I think it should be "yes". But the description of strategy is too much focusing in qualification.
JAXA considers coupon testing to understand the design limitation (lik… ultimate load) in early phase of design (tests using B… M or EM) is important.

JAXA entries relate to requirements (of their Reliability Program Standard)

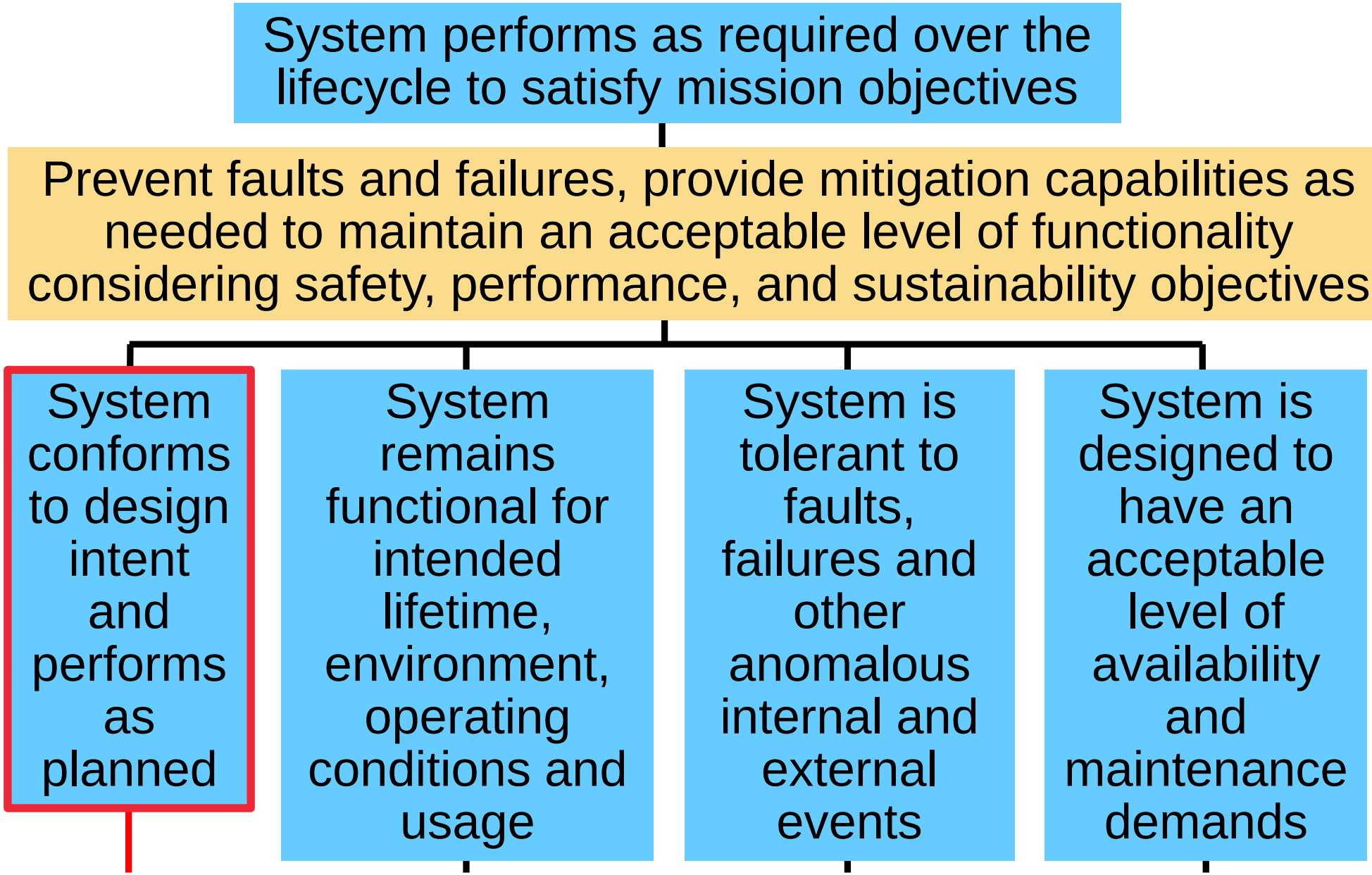
Occasionally an item not in NASA's list (e.g., coupon testing)

JAXA Comments and Recommendations

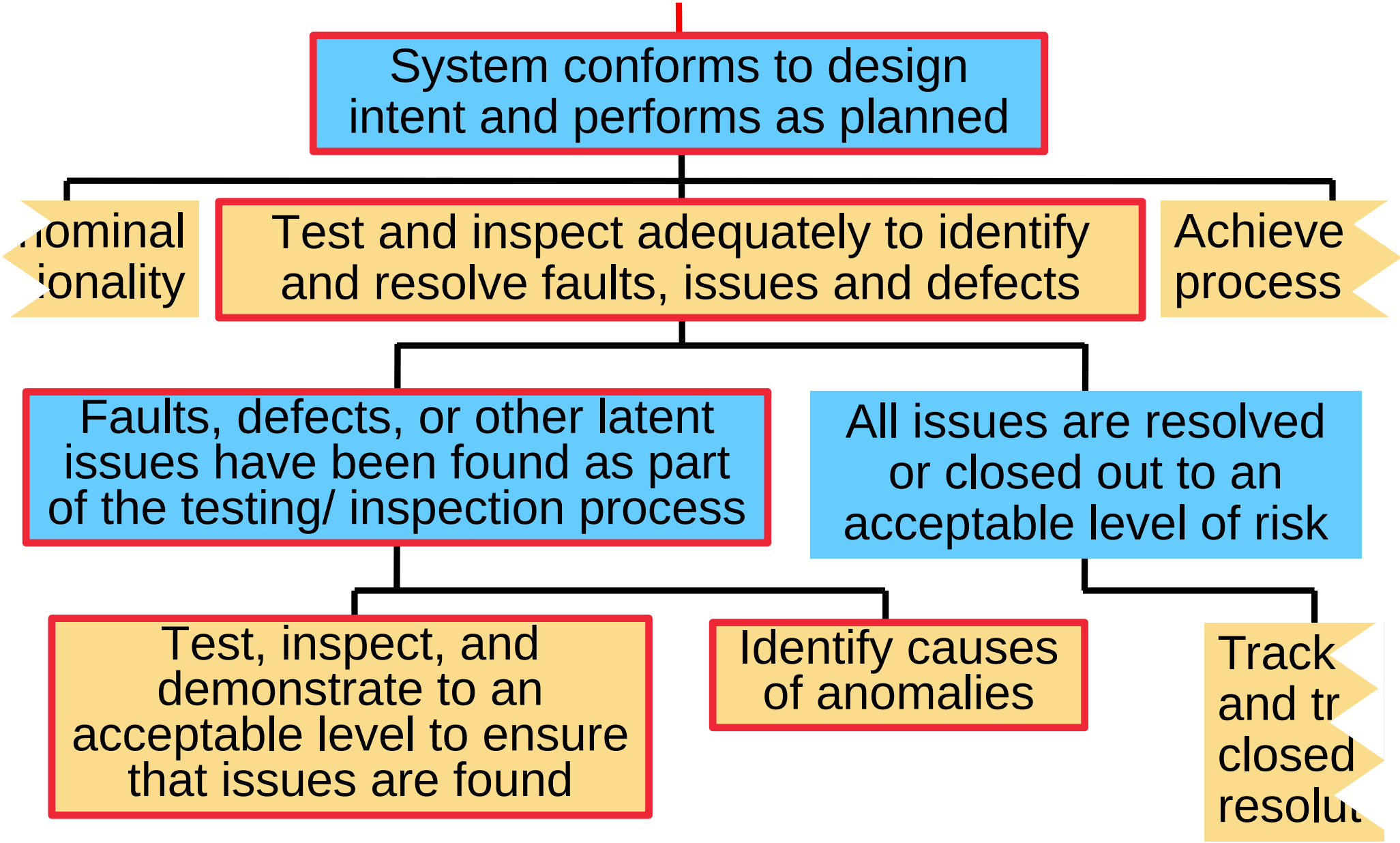
- No major comments on the NASA Objectives Hierarchy
- Hierarchy is comprehensive
- Internal coordination within JAXA needed for further work on Scope Tables
- Recommend team members review JAXA JMR 004C
- Recommend extending project 4-6 months for a more comprehensive result

BACK UP MATERIALS

Reliability & Maintainability Objective Hierarchy



Reliability & Maintainability Objective Hierarchy



Assurance Objectives and the Activities that fulfil them

Example:

Assurance Objectives

Test, inspect, and demonstrate to an acceptable level to ensure that issues are found

A mix of these activities fulfils the objective

Assurance Activities

- EMC emissions test
- EMC isolation test

…

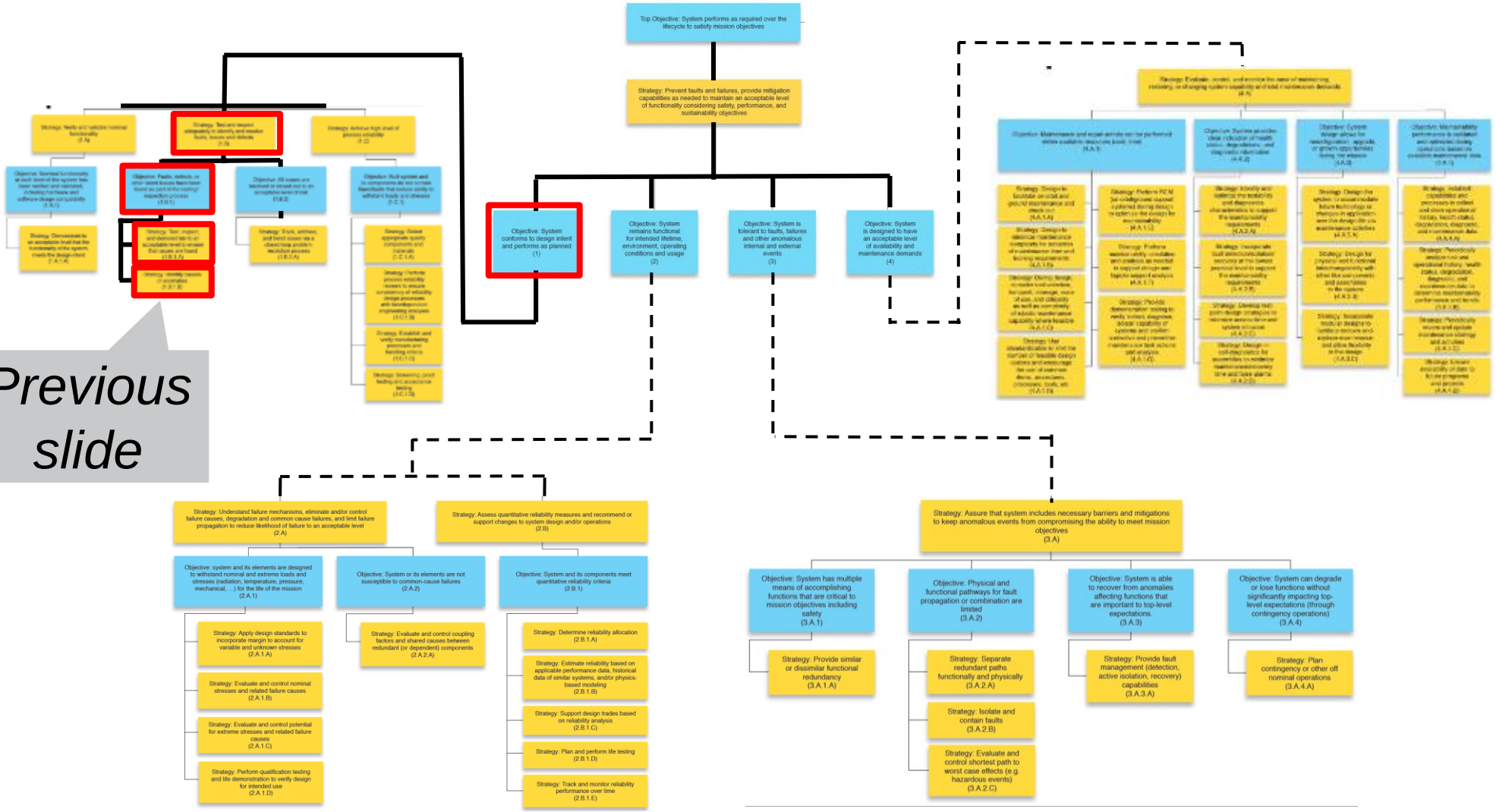
- Highly Accelerated Life Test (HALT)

…

- Static Code Analysis

…

The entire R&M Objectives Hierarchy



Previous slide

Assurance Activities

- **Acceptance Test Plan**
- **Accessibility Analysis**
- **Acoustic test**
- **Aging margins**
- **Allocation Analysis**
- **Ambiguity Analysis**

Some of the 55 activities in NASA's list

- **Thermal test**
- **Trade Study Analysis**
- **Training Plan and Material**
- **Verification and Validation Testing**
- **Voltage/temperature margin test**
- **Worst Case Analysis**

Also identified: applicability to classes of missions (e.g., Human Space Flight, Unmanned Missions, Ground Systems, Research & Technology)

Bird's Eye View of NASA's Assurance Activities x Strategies

55 Assurance Activities

42 Objectives