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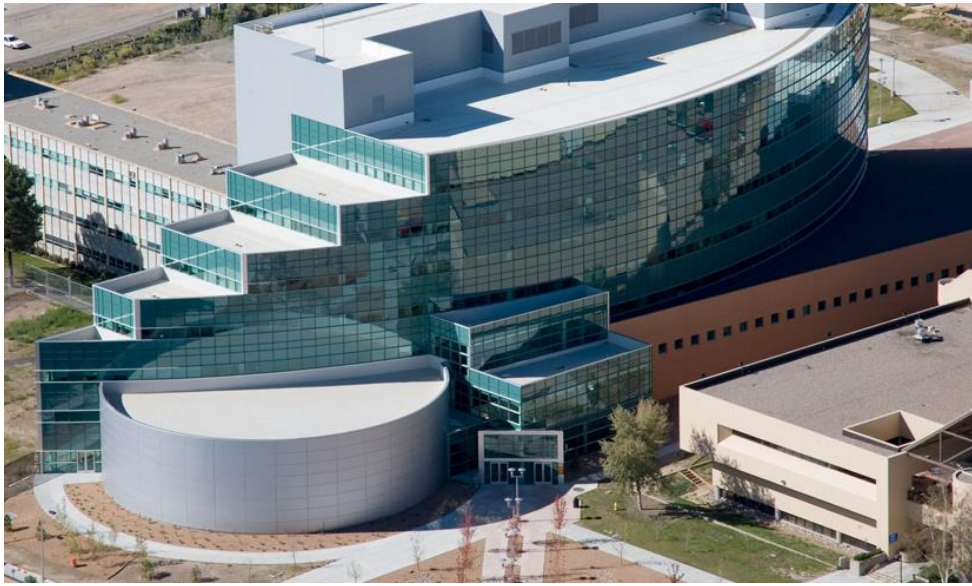

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Q-18 Advanced Systems Development - Future Systems Architects

MBSE Methodology: Risk Analysis and Requirements Management

LA-UR-24-24073

Hi! Barbie

Then


LOS ALAMOS
PROJECT
MAIN GATE
PASSES MUST BE
PRESENTED TO
GUARDS
PLEASE
KEEP
TO
RIGHT

Now


LOS ALAMOS
PROJECT
MAIN GATE
PASSES MUST BE
PRESENTED TO
GUARDS
SECURE
PASSES
HERE
POST
No. 1

Disclaimer

Some text in this presentation is very small. Please do not try to read it, you might hurt your eyes!

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We will discuss or draw your attention to the pertinent information as we go.

Outline

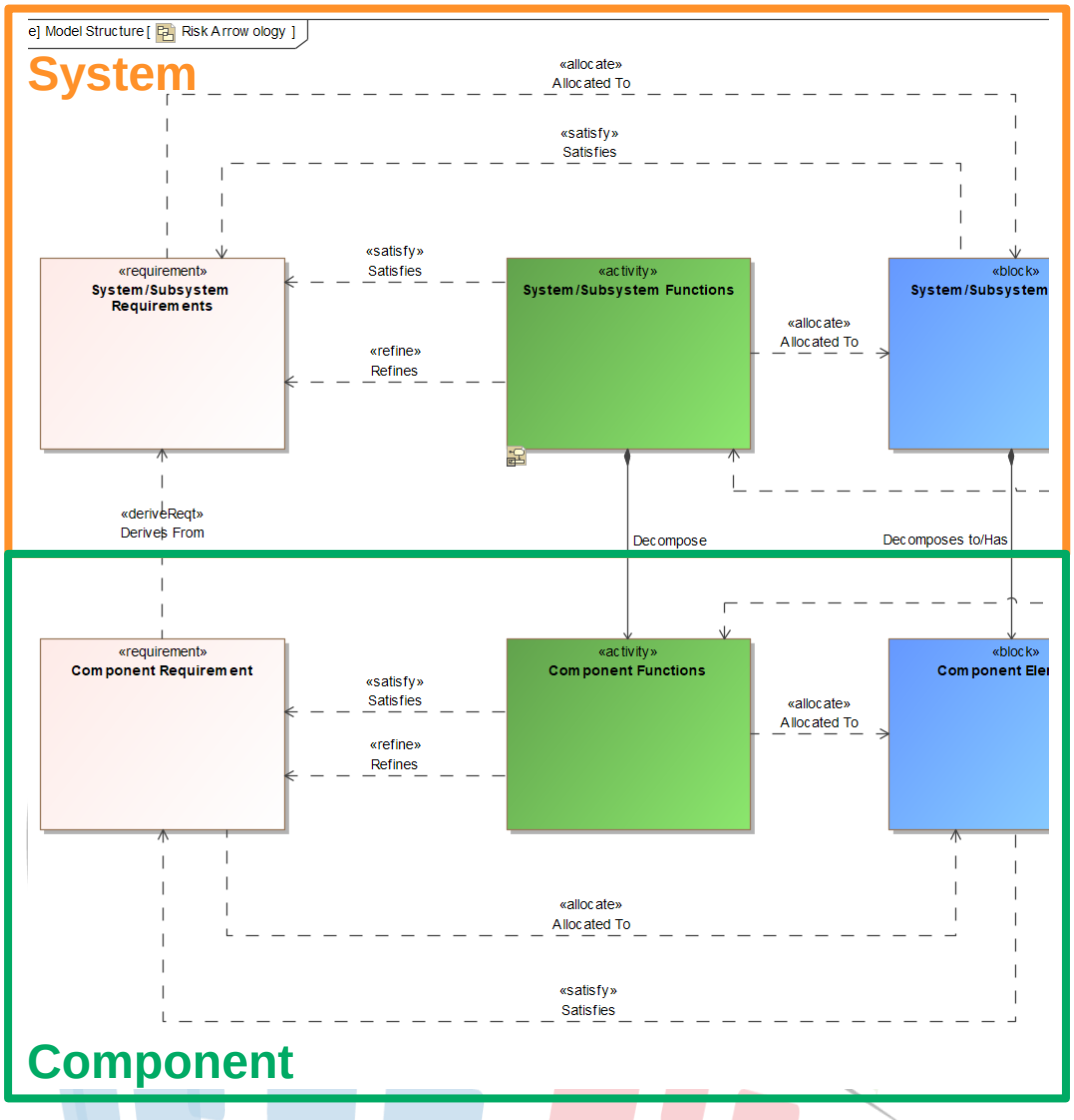
Orienting the System of Systems Model Structure

- Application: Performing technical risk analysis & informed trade studies via Failure Modes and Effects Analysis (FMEA)

Defining model boundaries & custom stereotypes

- Application: Building Verification & Test Requirement models

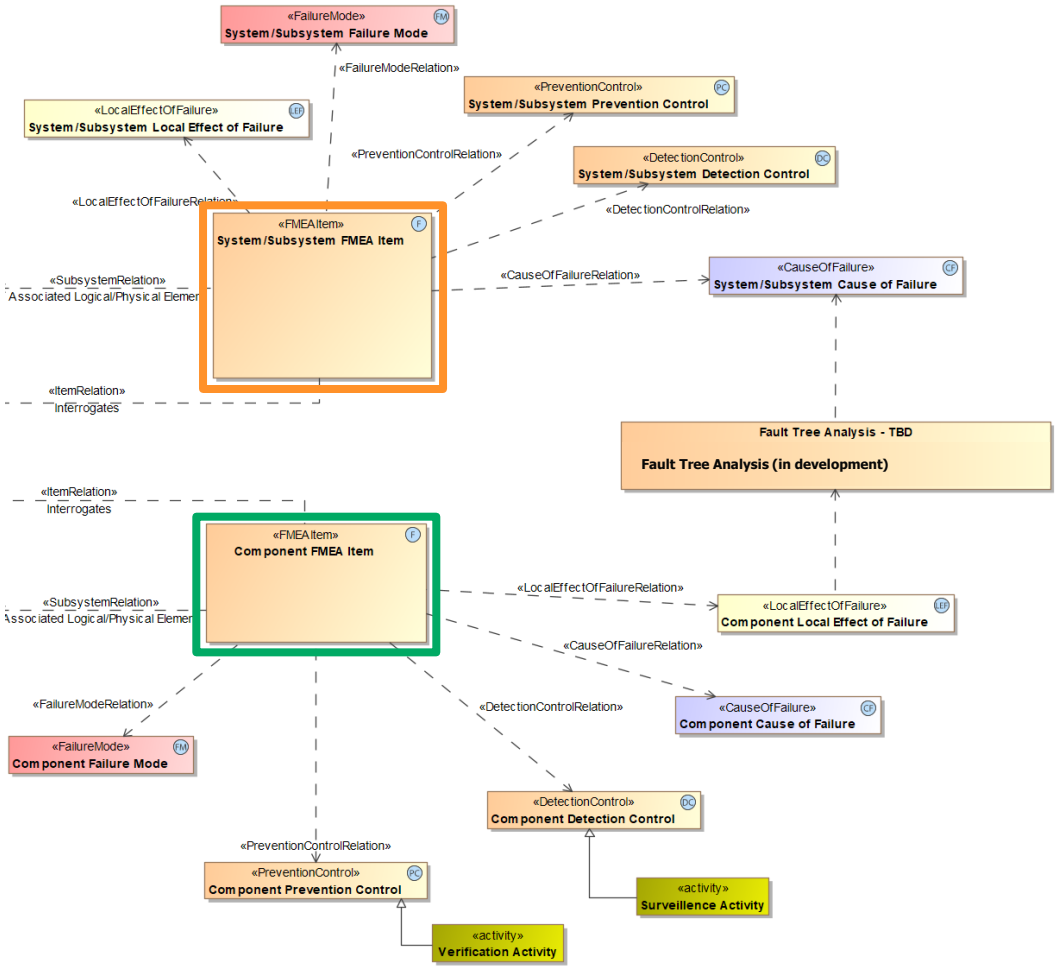
Key Elements From System Architecture



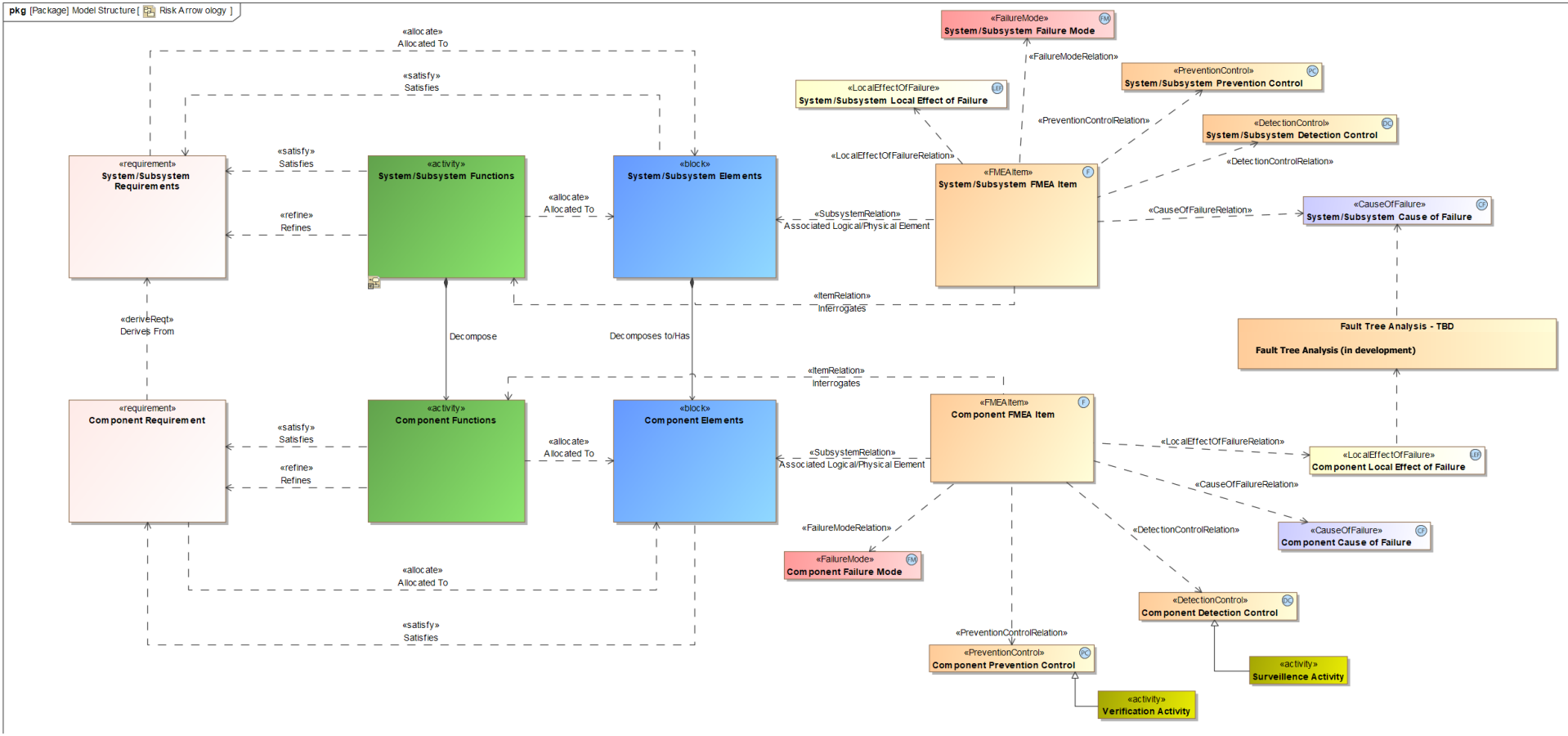
- Built System of Interest (SOI) architectures recursively in Models-Based Systems Engineering tool (Cameo)
- Created a backbone for systems engineering processes
  - Requirements
  - Risk
  - Verification
  - Validation

Generating a Risk Architecture

- What do I need to verify against?
- FMEA profile in Cameo Safety and Reliability Analyzer
- Risk Architecture crosscuts system architecture
- Distinct from product definition
- Informed by more than just design choices



Merging Risk and System Architectures



- Creating an integrated risk framework
- Closing the loop on hierarchical system

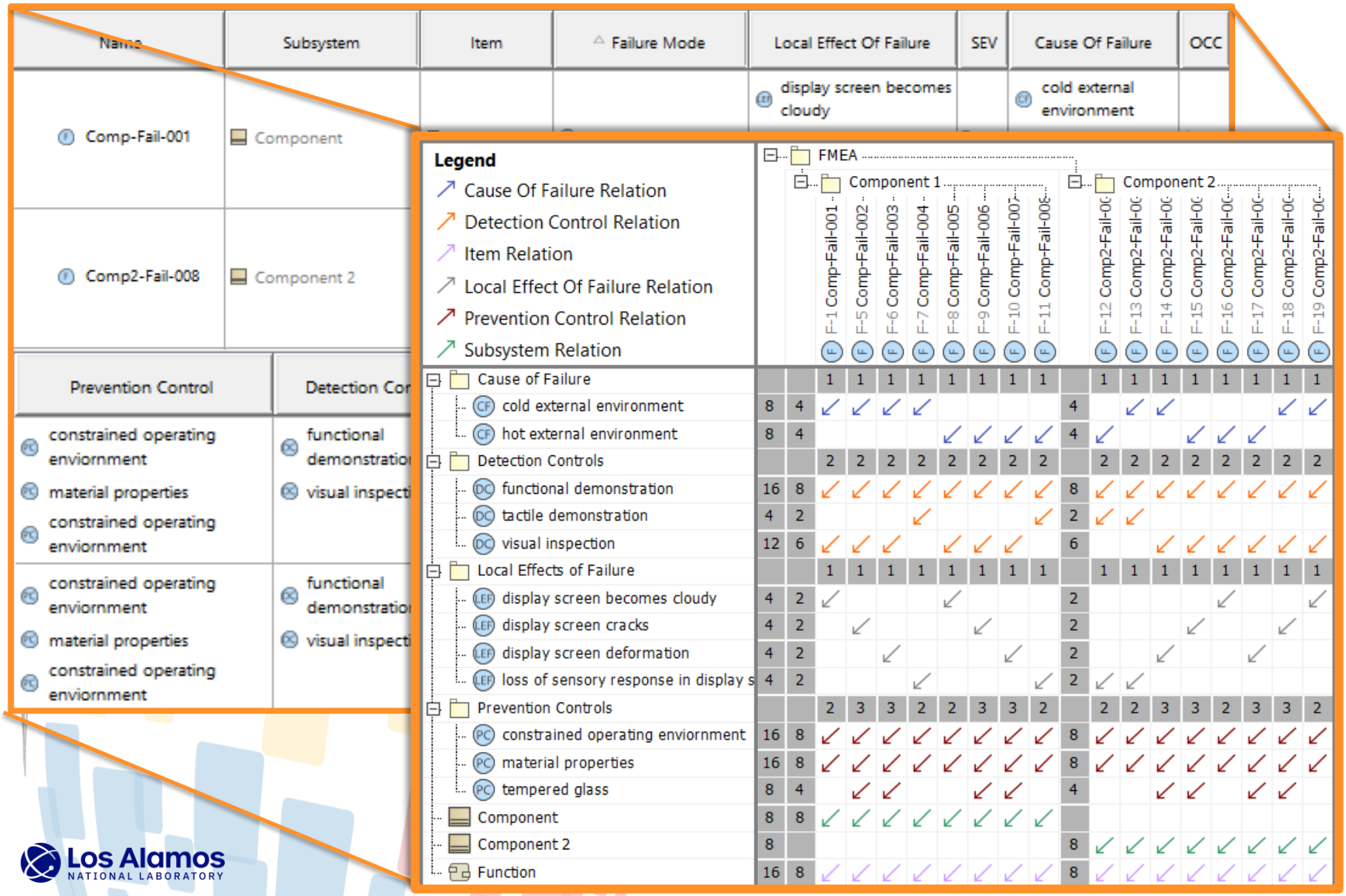
Risk Informed Trade Studies

Name	Subsystem	Item	Failure Mode	Local Effect Of Failure	SEV	Cause Of Failure	OCC
Comp-Fail-001	Component	Function	Failure to Function	display screen becomes cloudy	7	cold external environment	1
Comp2-Fail-008	Component 2	Function	Failure to Function	display screen becomes cloudy	7	cold external environment	3

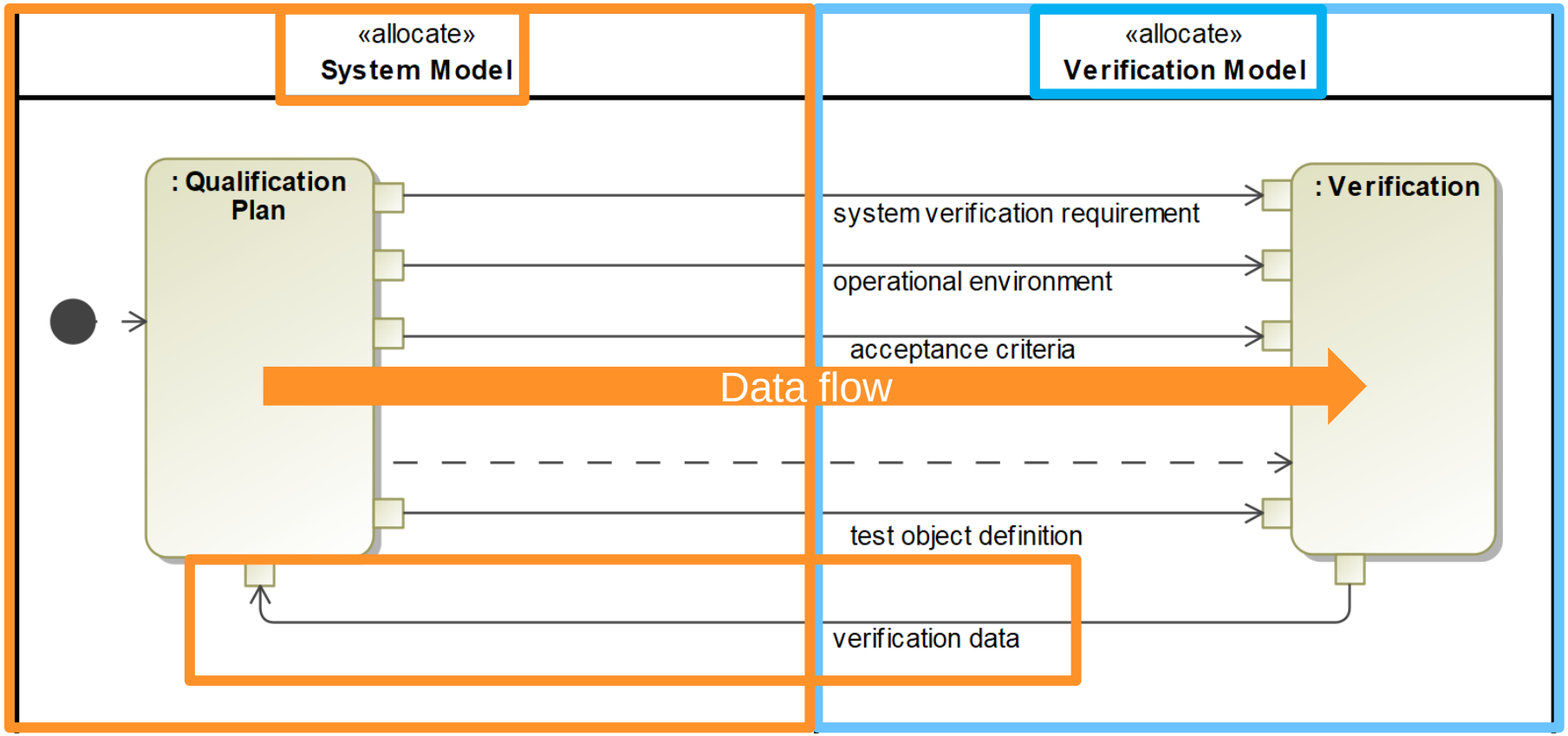
Prevention Control	Detection Control	DET	Ox D	RPN	Recommended Action	Reduced OCC	Reduced RPN
constrained operating enviornment material properties constrained operating enviornment	functional demonstration visual inspection	3	3.0	21.0	Perform component verification test	0	0.0
constrained operating enviornment material properties constrained operating enviornment	functional demonstration visual inspection	3	9.0	63.0	Perform component verification test	0	0.0

- Risk analysis techniques ensure robust design options
- Side-by-side risk comparisons of components or prevention/detection controls in MBSE software

Risk Informed Trade Studies

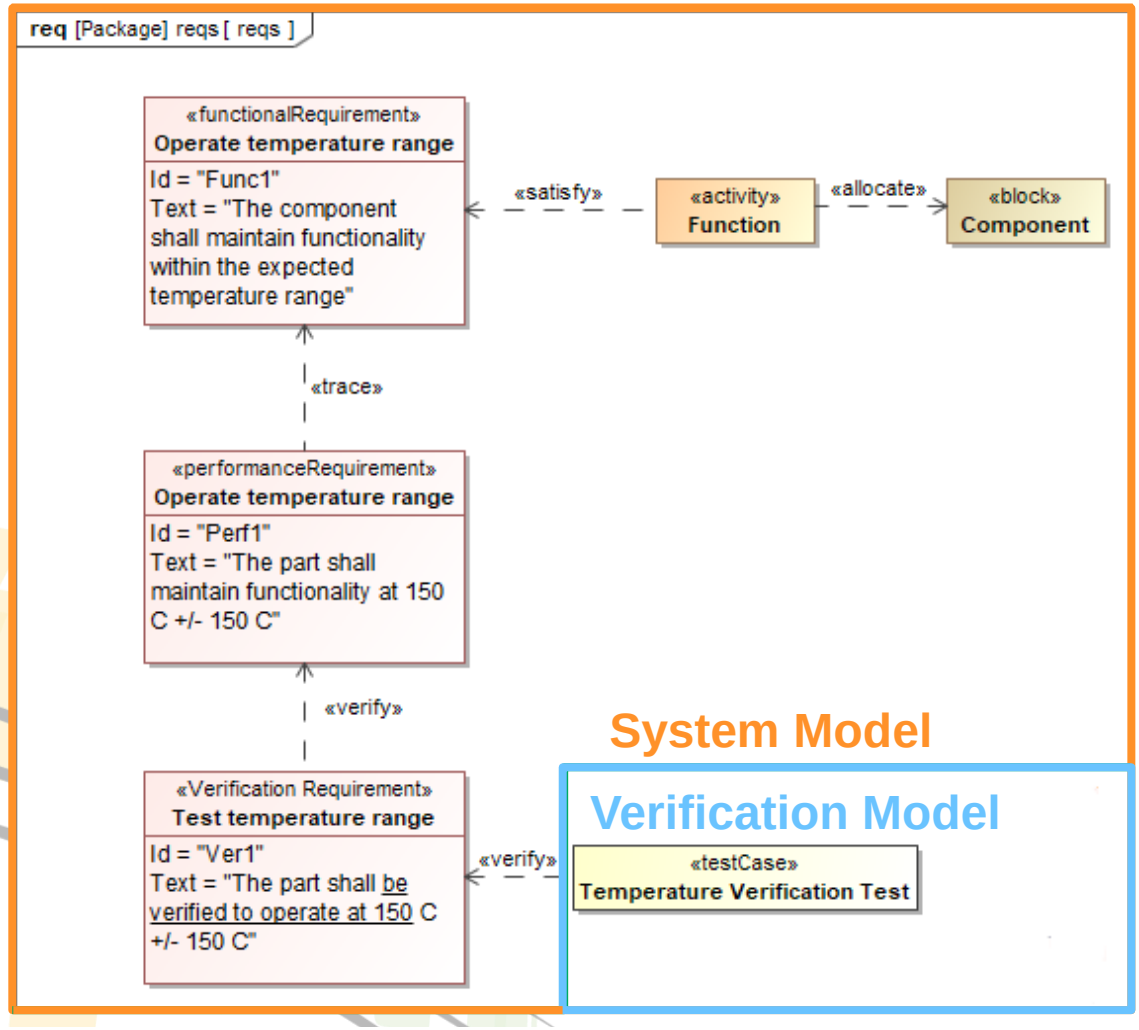


Defining Needs for System Verification Activities



- Enables modular architecture by defining data needs across models
- Allows for reusable verification models

Deriving System Requirements



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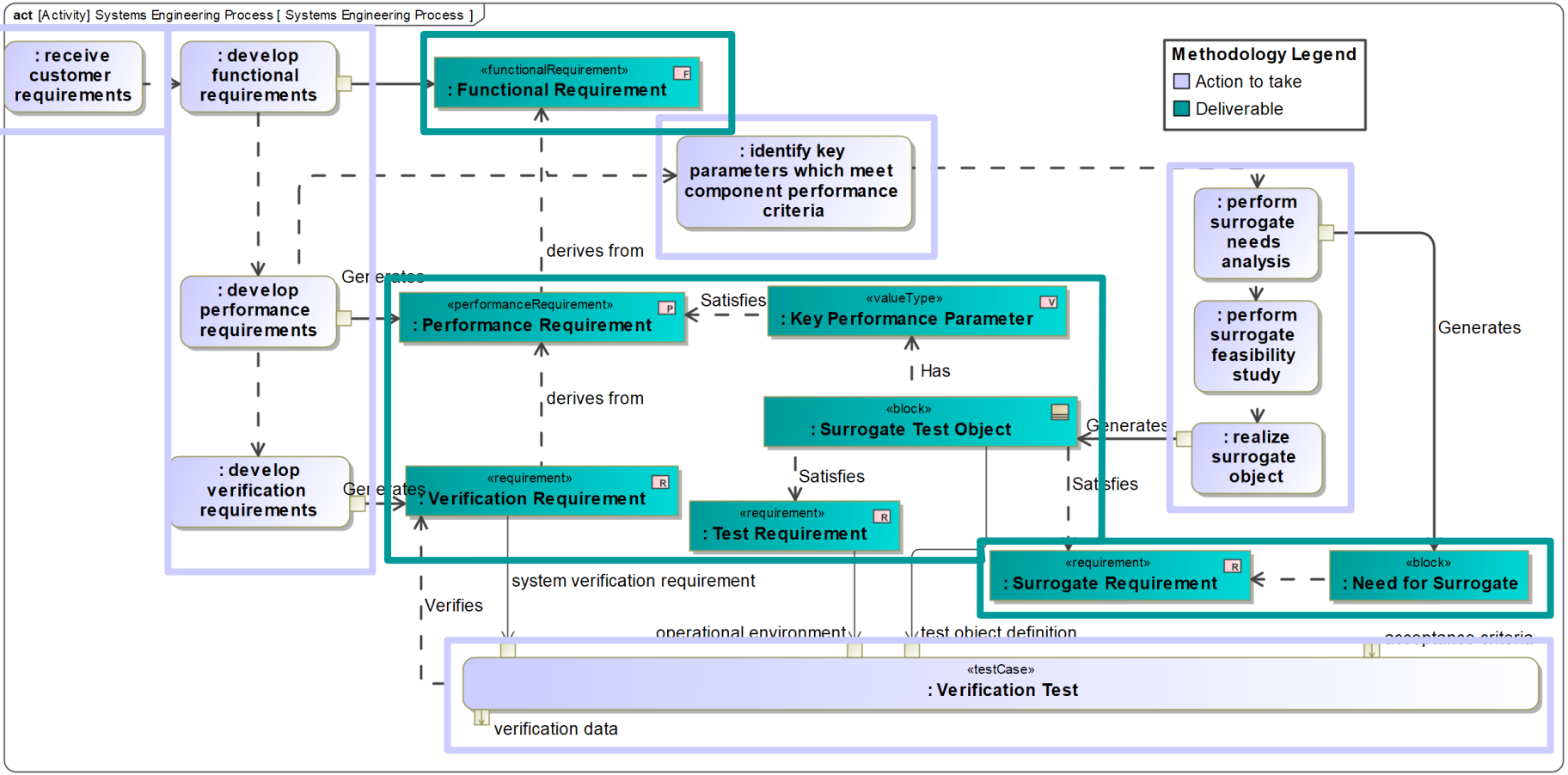
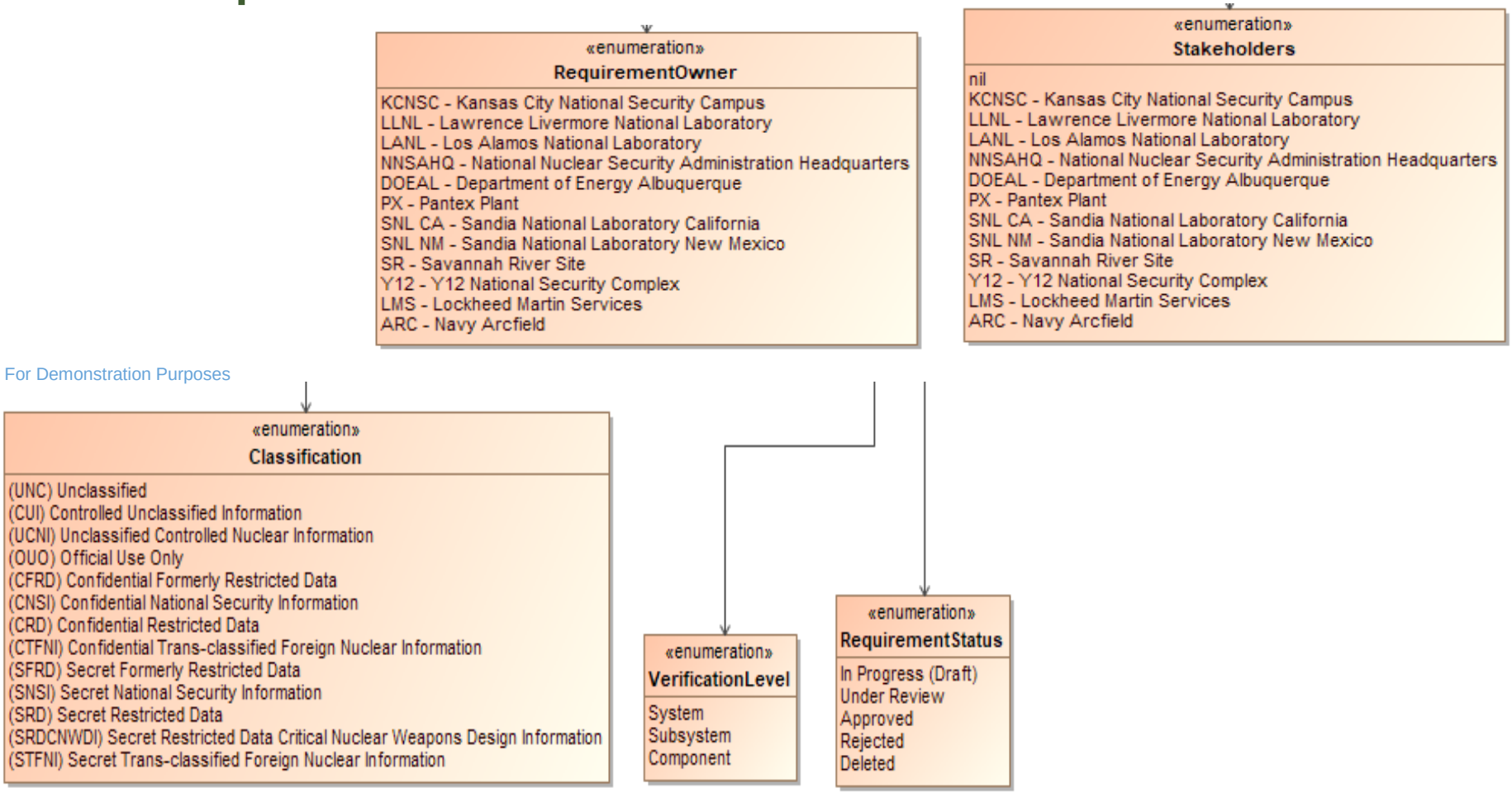
Defining Needs for System Verification Activities



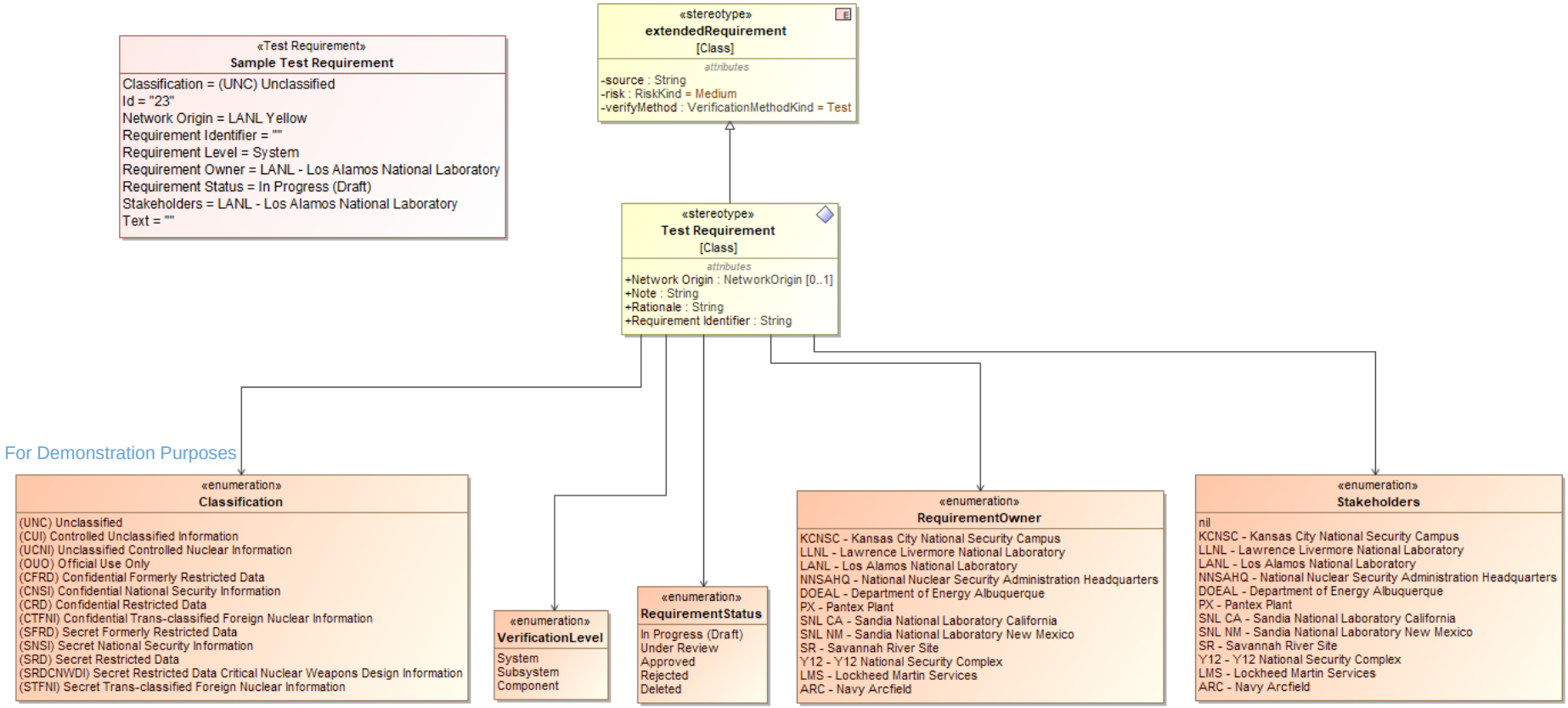
- Traces requirements needs to verification activities
- Builds rationality for specific test objects used in test verification activities
  - e.g., Surrogate Objects, experimental test series setup

Test Requirement Attributes



- Custom stereotype allows the addition of properties to a requirement element
- Classification, status, stakeholders, owner, etc.
- Enables digital thread

Test Requirement Stereotype



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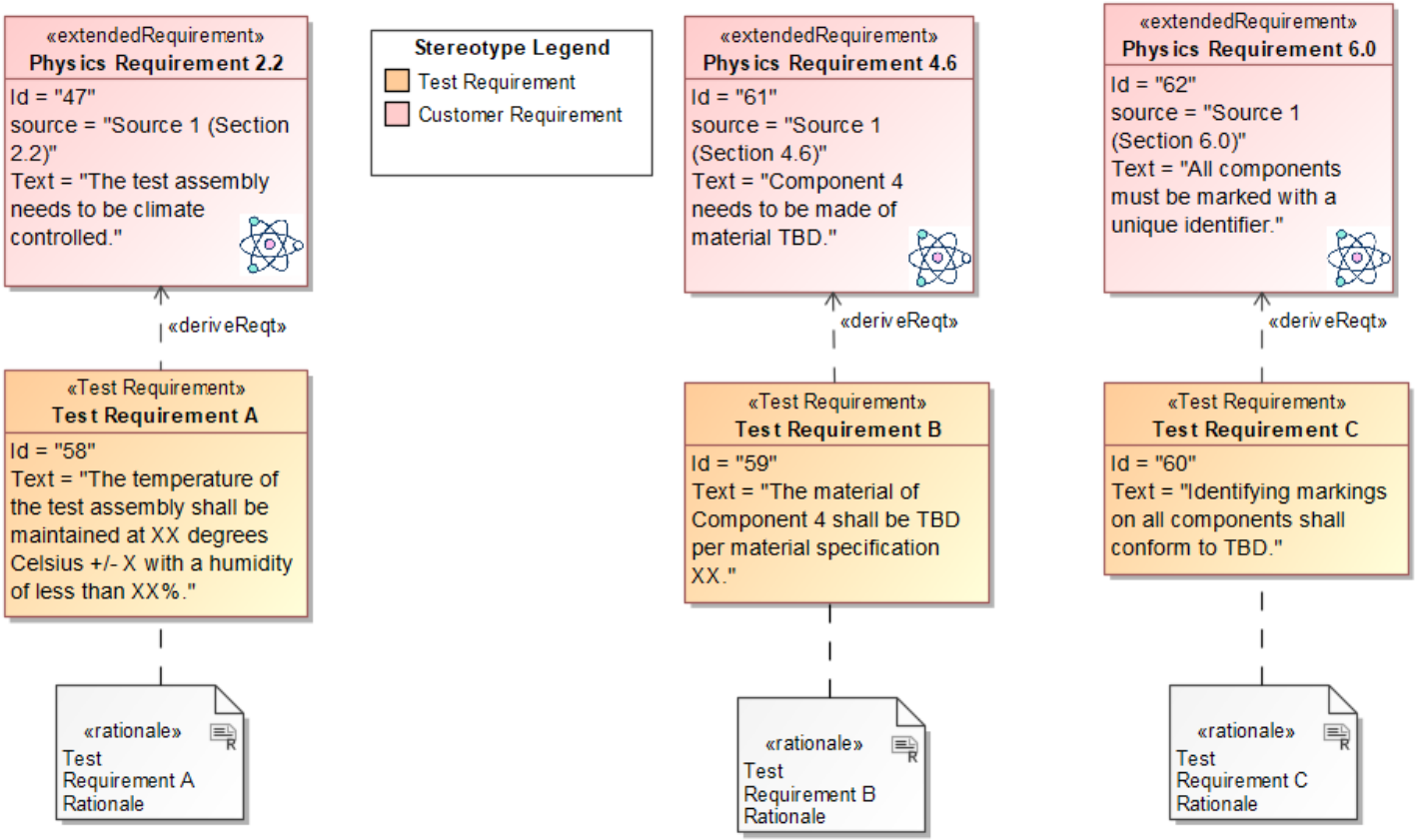
Deriving Test Requirements from Customer Requirements

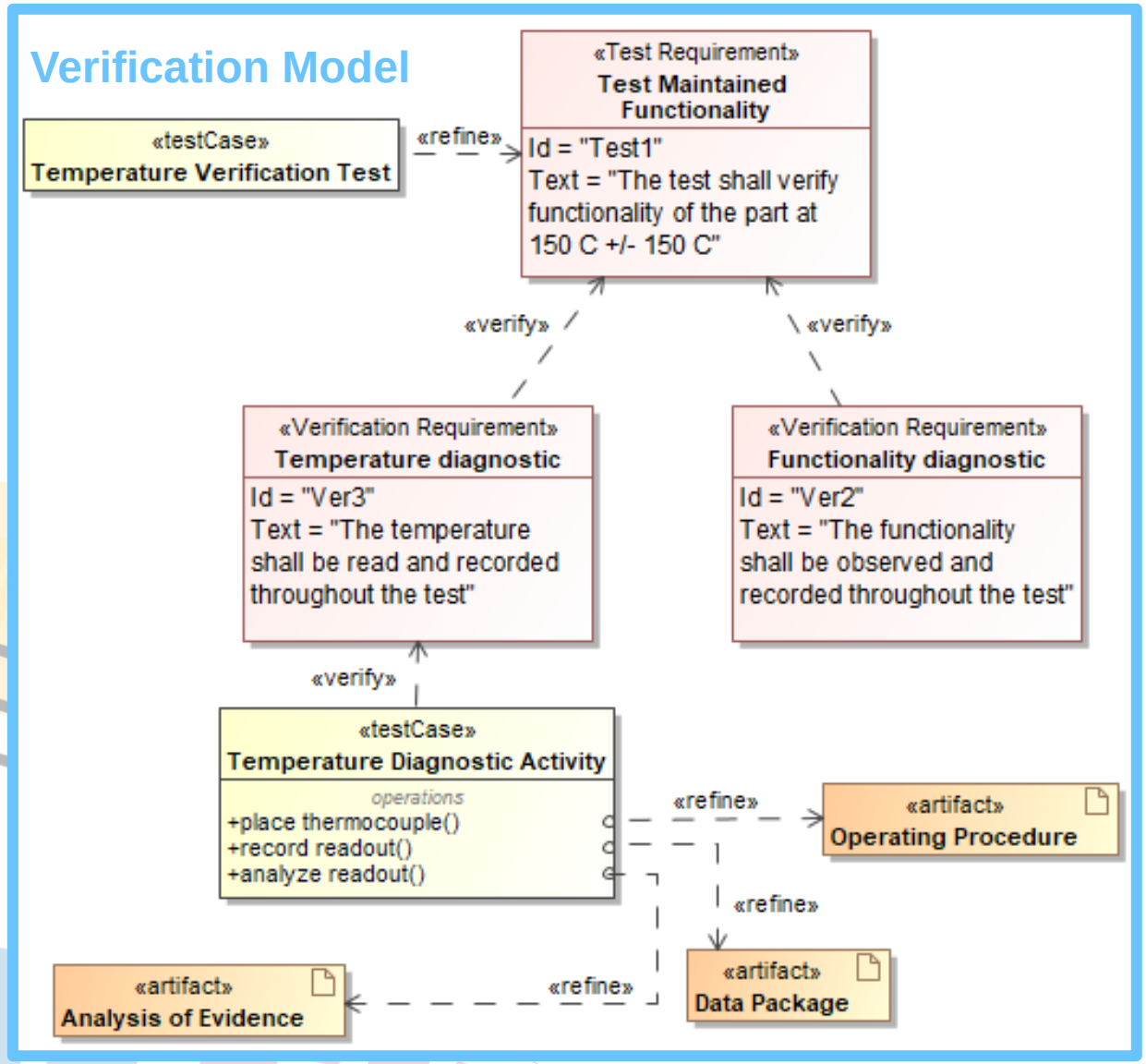


- Customer requirements could be in the form of an official memo, an email, Excel spreadsheet or captured in a requirements review
- All customer requirements are imported into the tool

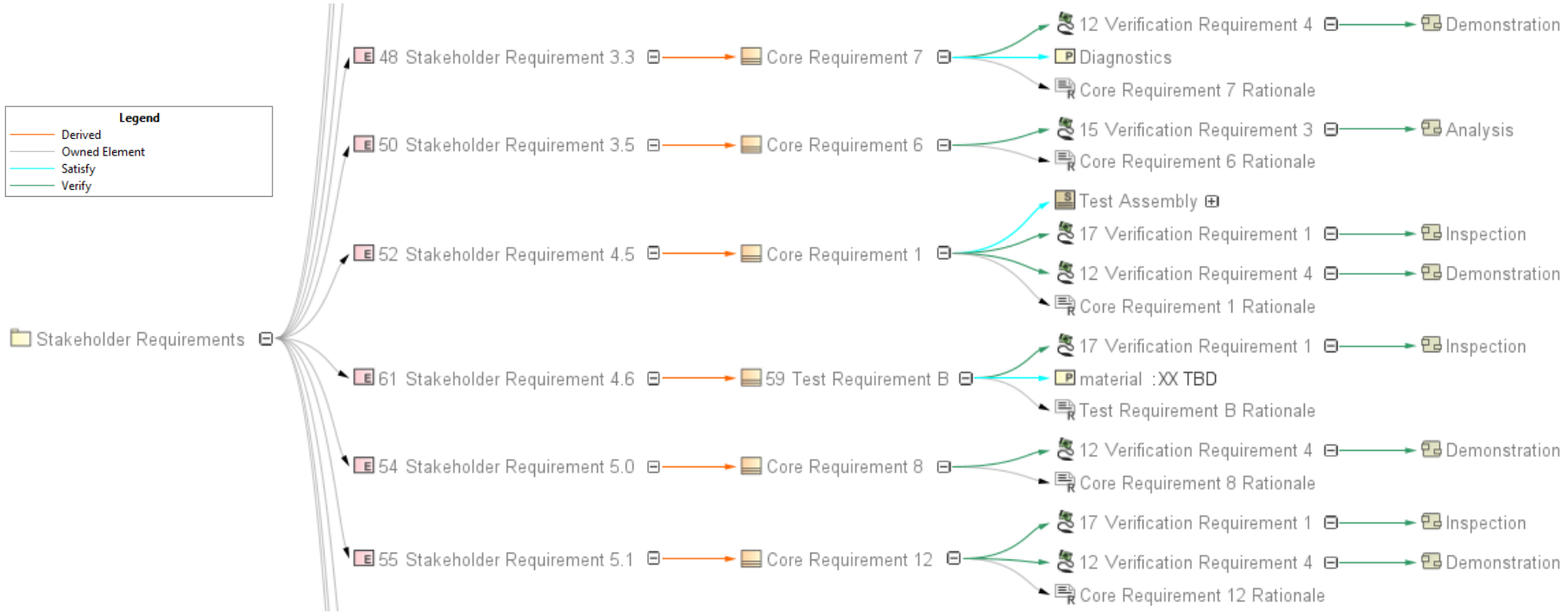
Methodology for Verification Model

- The test requirement defines the test needs or goals.
- The test requirement's verification method is further described as a verification requirement.
- The verification activity represents the specific verification method(s).
- The verification evidence is refined into a report, represented as an artifact.
- Design Leads understand the verification requirement.
- Test Leads understand the verification activity.

Test Requirement Derivation



Relation Map to Show Traceability



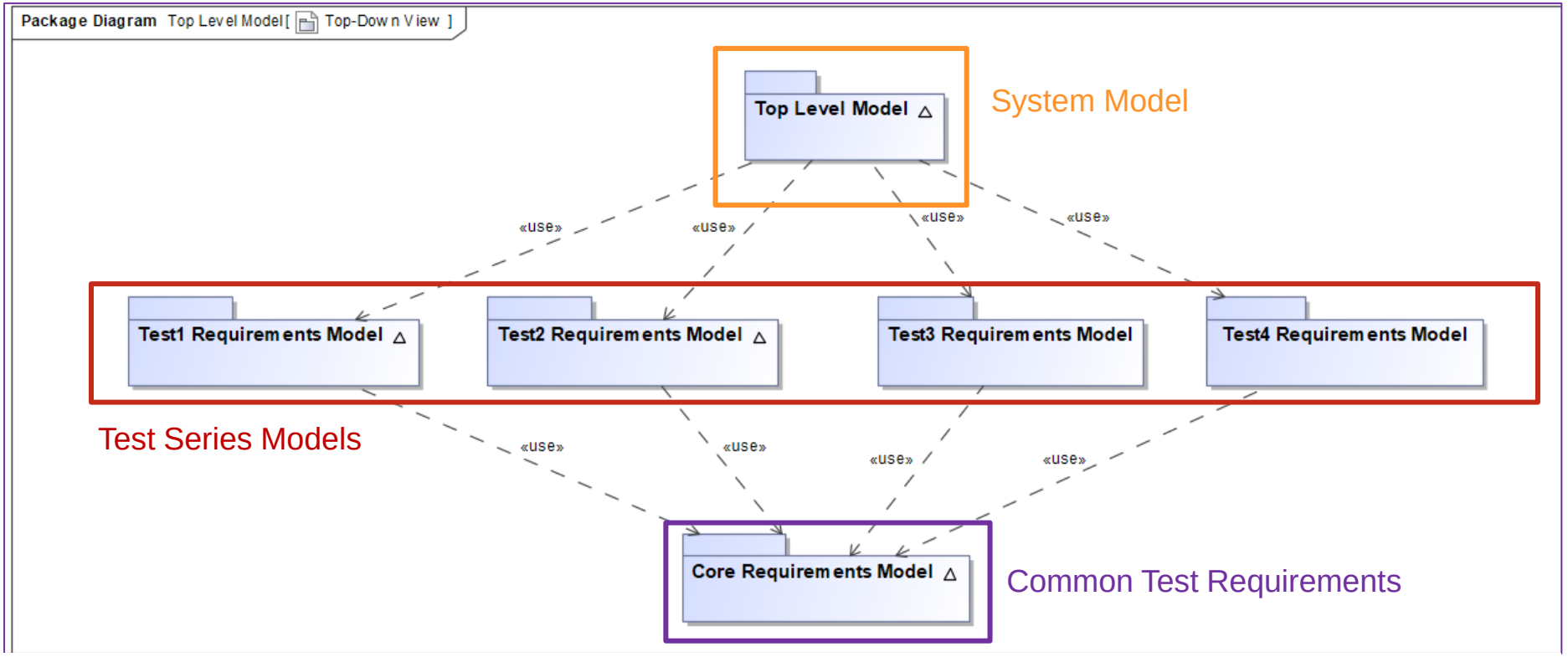
- Can generate views that show the complete traceability through all tests within a test series

Requirements Traceability Tables

#	Name	Text	Source	Derived From	Stakeholder Req. Text	Verified By	Verification Req. Status	Verification Method
1	58 Test Requirement A	The temperature of the test assembly shall be maintained at XX degrees Celcius +/- X with a humidity of less than XX%.	Source 1 (Section 2.2)	47 Physics Requirement 2.2	The test assembly needs to be climate controlled.	12 Verification Requirement 4	In Progress	Demonstration
2	59 Test Requirement B	The material of Component 4 shall be TBD per material specification XX.	Source 1 (Section 4.6)	61 Physics Requirement 4.6	Component 4 needs to be made of material TBD.	17 Verification Requirement 1	In Progress	Inspection
3	60 Test Requirement C	Identifying markings on all components shall conform to TBD.	Source 1 (Section 6.0)	62 Physics Requirement 6.0	All components must be marked with a unique identifier.	17 Verification Requirement 1	In Progress	Inspection
4	Core Requirement 1	The test assembly shall fit inside a XX ft containment vessel for execution.	Source 1 (Section 4.5)	52 Test Facility Requirement 4.5	The test assembly shall be fully contained.	12 Verification Requirement 4 17 Verification Requirement 1	In Progress	Demonstration Inspection
5	Core Requirement 2	The test assembly shall utilize diagnostics to measure dynamic motion.	Source 1 (Section 3.2)	49 Stakeholder Requirement 3.2	Measurements of the dynamic motion within the test assembly need to be recorded.	12 Verification Requirement 4	In Progress	Demonstration
6	Core Requirement 3	The test components and assemblies shall be stored, transported, assembled and fired in a climate controlled environment.	Source 1 (Section 2.2)	47 Physics Requirement 2.2	The test assembly needs to be climate controlled.	14 Verification Requirement 2	In Progress	Test
7	Core Requirement 4	Inspection reports for all subassemblies and assemblies shall be provided to the lead physicist and test engineer for acceptance prior to test execution.	Source 1 (Section 4.4)	51 Stakeholder Requirement 4.4	Inspection reports are required for all components, subassemblies and assemblies.	12 Verification Requirement 4	In Progress	Demonstration
8	Core Requirement 5	Diagnostic data shall be provided to the lead physicist within XX months of the test execution.	Source 2 (Section 2.1)	53 Stakeholder Requirement 2.1	The lead physicists require the diagnostic data within a reasonable time-frame after test execution.	12 Verification Requirement 4	In Progress	Demonstration
9	Core Requirement 6	The radiographs shall be analyzed and provided to the lead physicist within XX months of the test execution.	Source 2 (Section 3.5)	50 Stakeholder Requirement 3.5	The lead physicists require the radiographs to be analyzed.	15 Verification Requirement 3	In Progress	Analysis
10	Core Requirement 7	The test assembly shall utilize diagnostics to measure shock propogation.	Source 1 (Section 3.3)	48 Stakeholder Requirement 3.3	Measurements of the shock propagation through the test assembly need to be recorded.	12 Verification Requirement 4	In Progress	Demonstration
11	Core Requirement 8	An as-built record of the test assembly shall be provided to the lead physicist and test engineer.	Source 1 (Section 5.0)	54 Stakeholder Requirement 5.0	The lead physicist and test engineer require an as-built record of the test assembly.	12 Verification Requirement 4	In Progress	Demonstration

- Unique views generated based on customer preference

Model Structure and Usages



- The top level model has a project usage of every test model.
- This structure allows one to “see” all the models in one and create desired reports.
- The common modeling methodology enables the use of a common dashboard.
- Models are easily “queriable”

Lessons Learned

- Risk development involved a significant amount of collaboration – all subject matter experts should provide input to be adjudicated
- Risk identification is a continuous effort – new data, new configurations, new modes of potential failure should be reevaluated as they're received
- Developing requirements was a challenge – converging on an acceptable, achievable, well-written requirement takes time
- Models get big & complex extremely quickly – it's worth the time to establish model frameworks and clear interfaces early
- Generating reports straight from the tool can save time and provided consistency – this also helps with post-project knowledge capture and information archiving!

Thank you!

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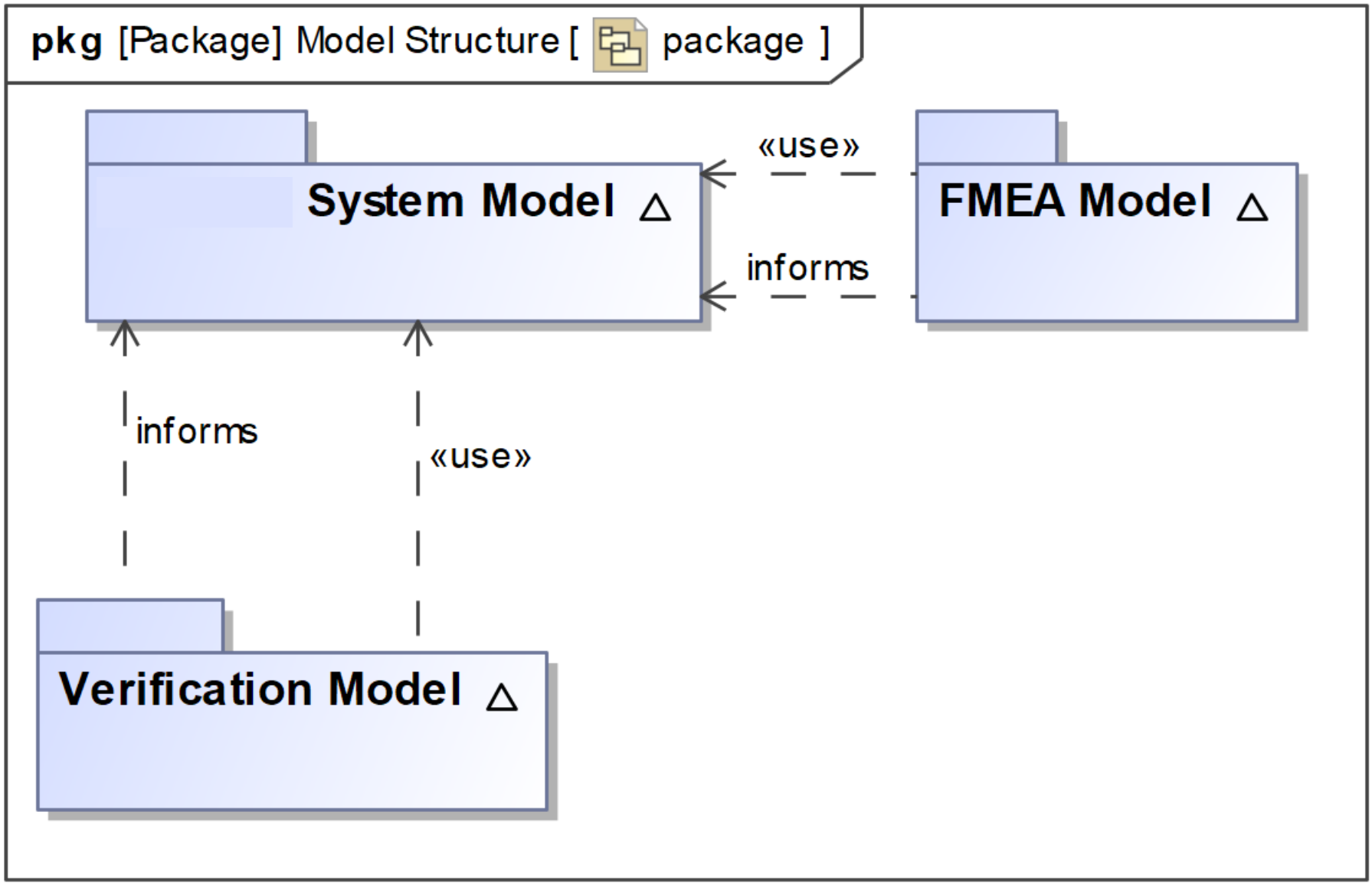
Backup Slides

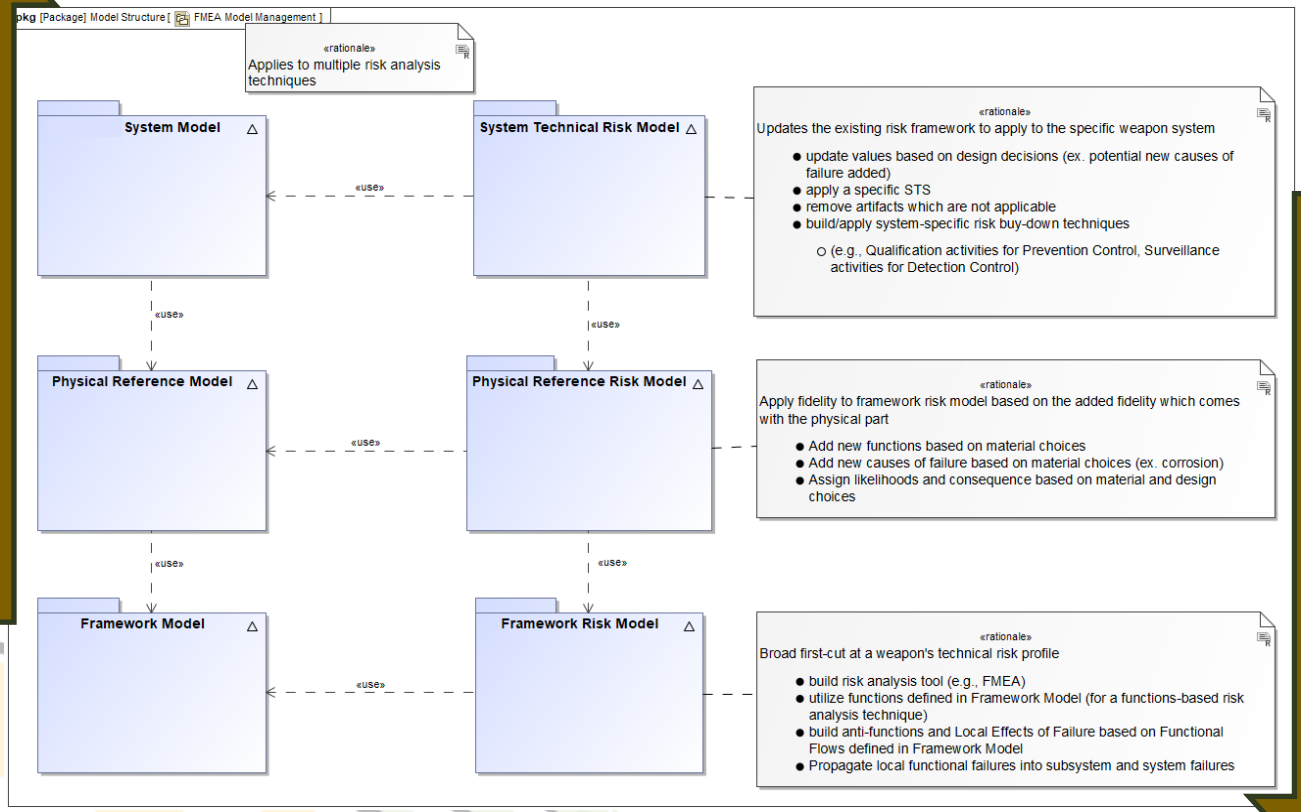

pkg [Package] Model Structure [package]
System Model
FMEA Model
«use»
informs
informs
«use»
Verification Model

• Model Management Structure

High

Fidelity & Specificity

Low



Low

Reusability

High

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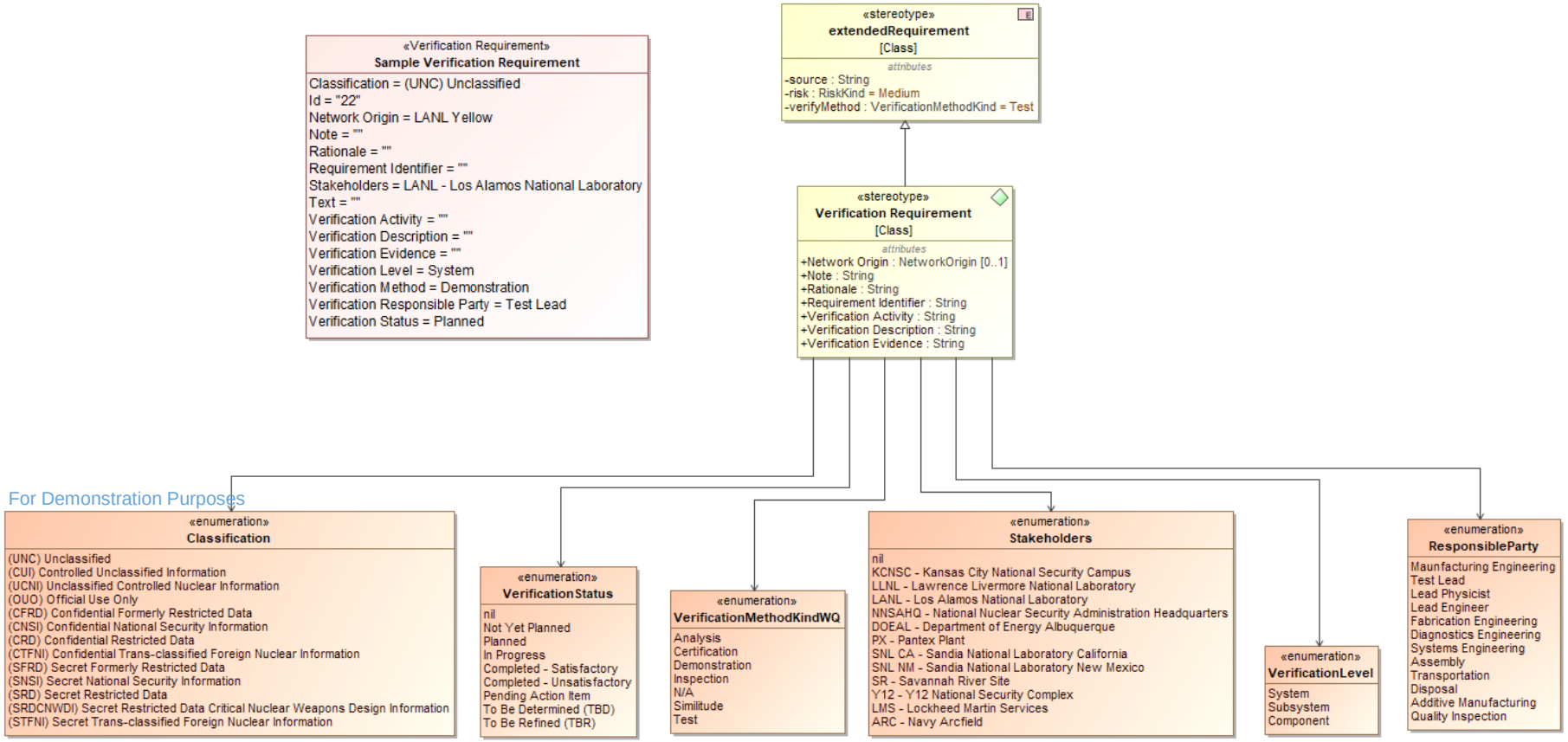
Future Systems Architecture Team Lead

Los Alamos NATIONAL LABORATORY

Test Requirement Stereotype

- Custom stereotype allows the addition of properties to a requirement element
- Classification, status, stakeholders, owner, etc.
- Enables digital thread

Verification requirement Stereotype



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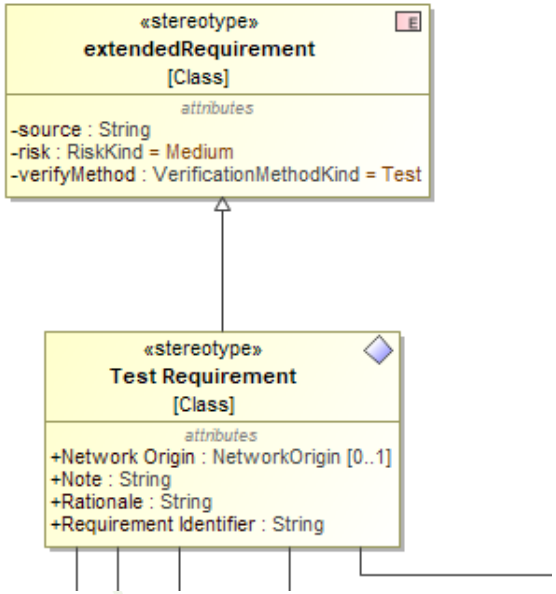
Test Requirement Stereotype



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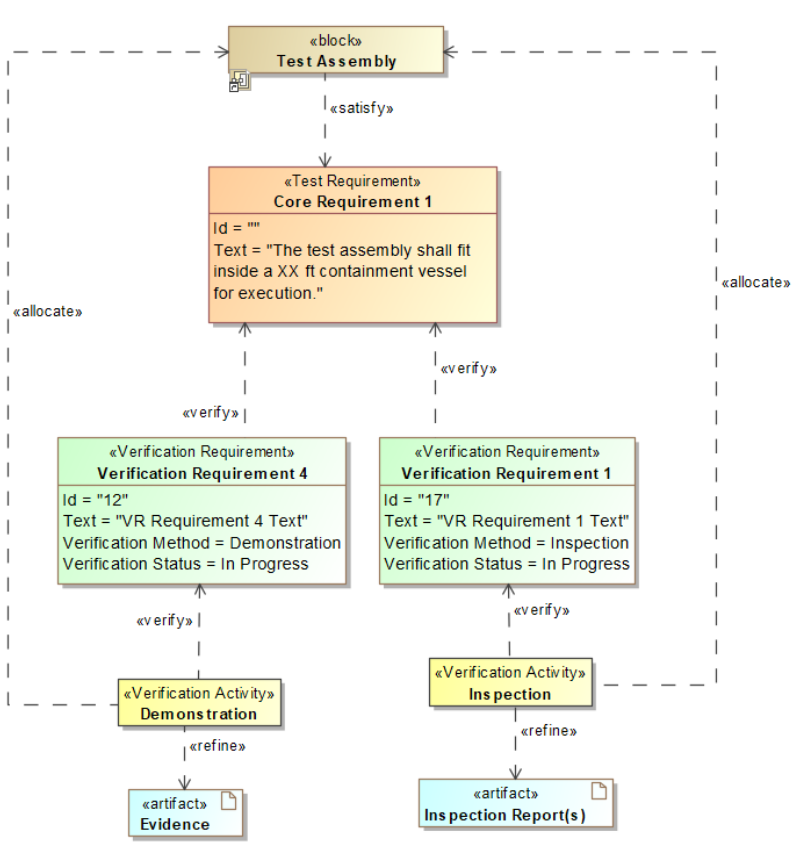
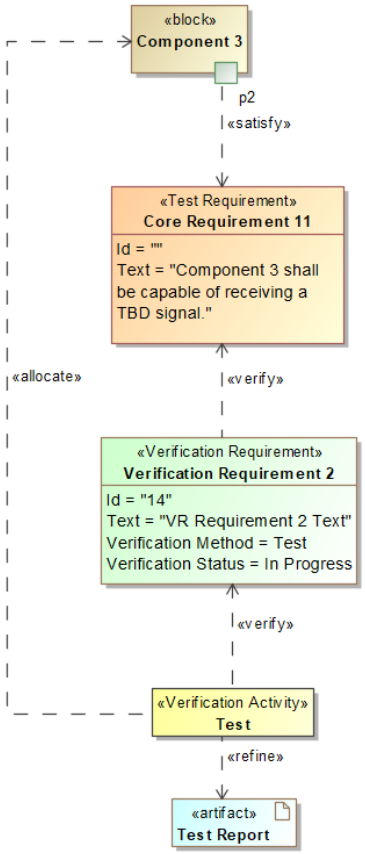
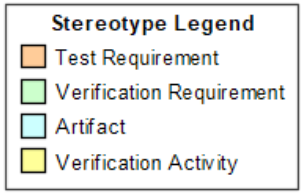
Apply Arrow Methodology

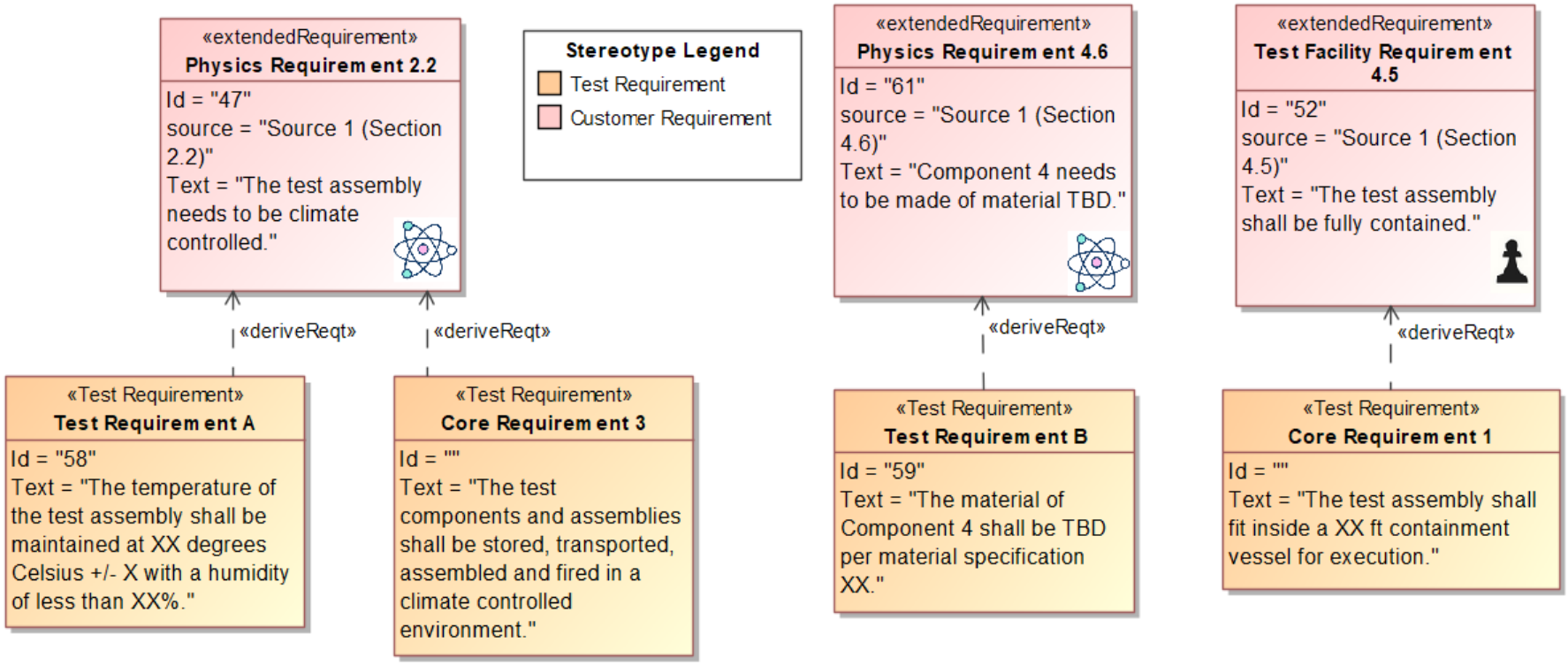




- Verify verification requirements with activities
- The artifact is the concrete evidence for the verification activity
- Verification activity allocates to a block

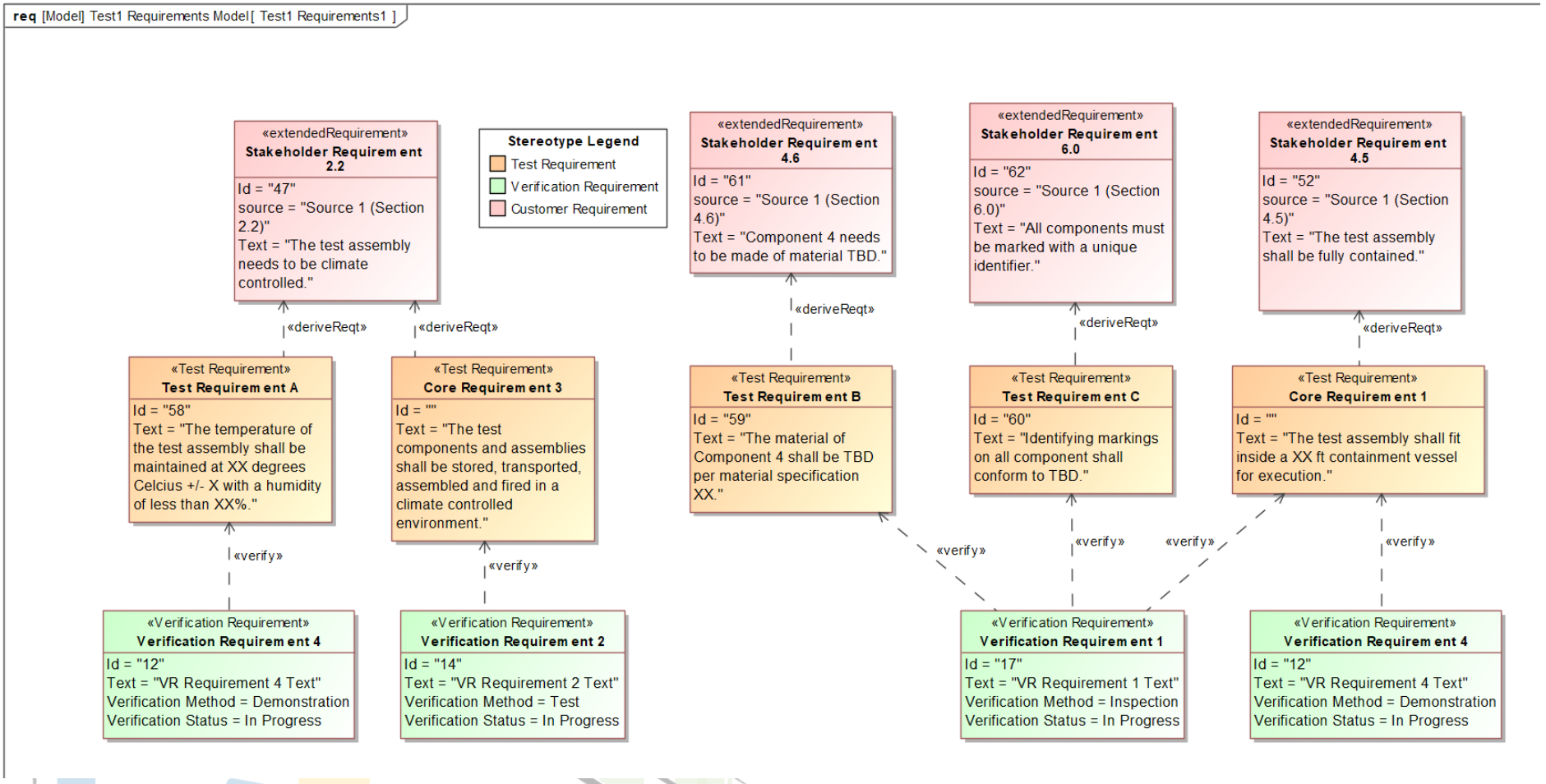


- Identifying Core Requirements



- Core requirements identified as being consistent throughout a test series
- Core requirements form a framework of requirements for the test series

• Developing Verification Requirements

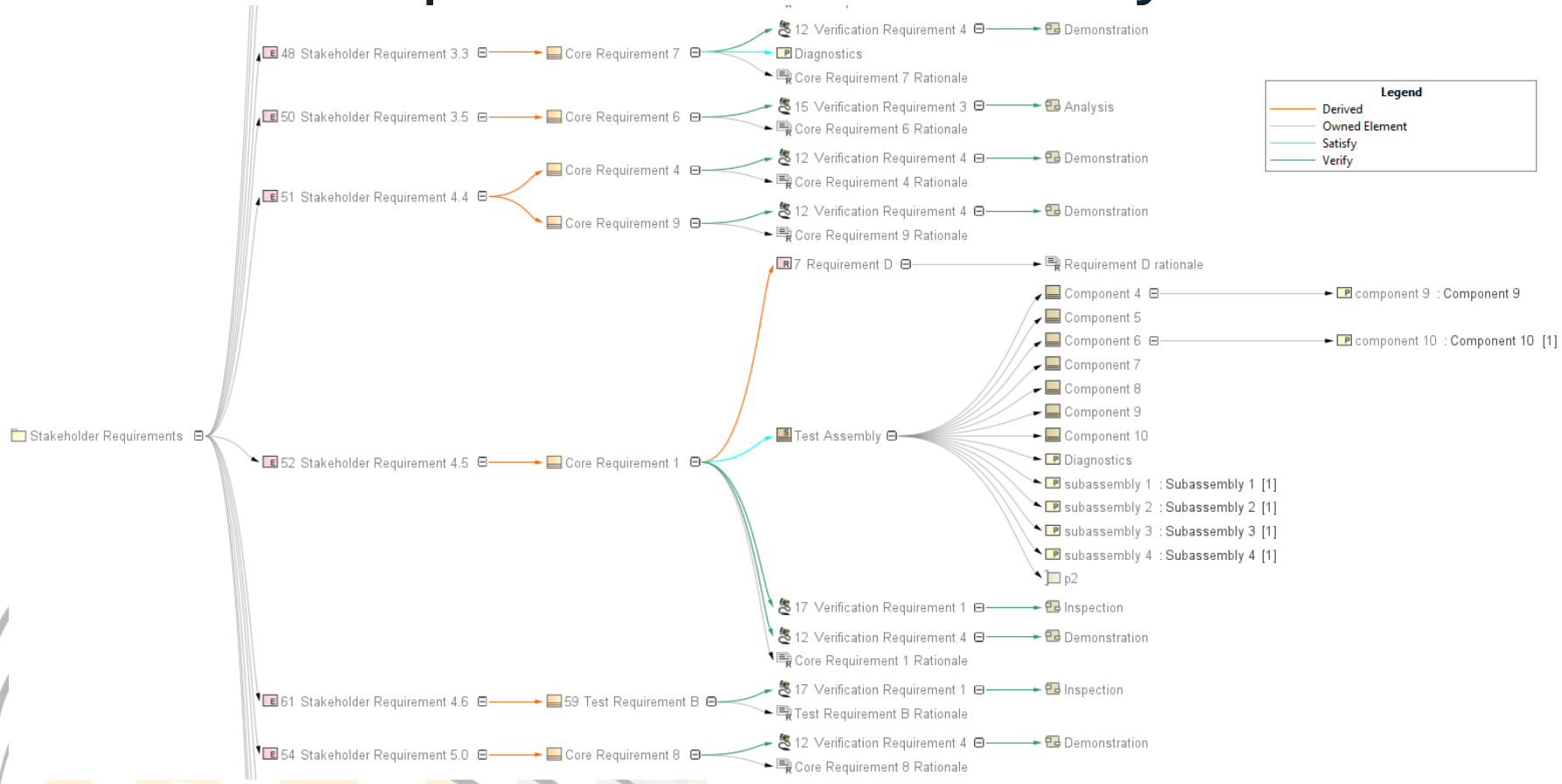


- Identifying Core Requirements

#	Name	Text	Rationale
1	58 Test Requirement A	The temperature of the test assembly shall be maintained at XX degrees Celcius +/- X with a humidity of less than XX%.	Test Requirement A Rationale
2	59 Test Requirement B	The material of Component 4 shall be TBD per material specification XX.	Test Requirement B Rationale
3	60 Test Requirement C	Identifying markings on all component shall conform to TBD.	Test Requirement C Rationale
4	Core Requirement 1	The test assembly shall fit inside a XX ft containment vessel for execution.	Core Requirement 1 Rationale
5	Core Requirement 2	The test assembly shall utilize diagnostics to measure dynamic motion.	Core Requirement 2 Rationale
6	Core Requirement 3	The test components and assemblies shall be stored, transported, assembled and fired in a climate controlled environment.	Core Requirement 3 Rationale
7	Core Requirement 4	Inspection reports for all subassemblies and assemblies shall be provided to the lead physicist and test engineer for acceptance prior to test execution.	Core Requirement 4 Rationale
8	Core Requirement 5	Diagnostic data shall be provided to the lead physicist within XX months of the test execution.	Core Requirement 5 Rationale
9	Core Requirement 6	The radiographs shall be analyzed and provided to the lead physicist within XX months of the test execution.	Core Requirement 6 Rationale
10	Core Requirement 7	The test assembly shall utilize diagnostics to measure shock propogation.	Core Requirement 7 Rationale
11	Core Requirement 8	An as-built record of the test assembly shall be provided to the lead physicist and test engineer.	Core Requirement 8 Rationale
12	Core Requirement 9	Inspection reports for all components,shall be provided to the lead physicist and test engineer for acceptance prior to assembly.	Core Requirement 9 Rationale
13	Core Requirement 10	Component 1 shall interface with Component 2.	Core Requirement 10 Rationale

- Core requirements identified as being consistent requirements throughout a test series
- Core requirements would be used in each test model

- # Relation Map To Show Traceability



- Can generate views that show the complete traceability through all tests within a test series

Future Model Validation