

Analysis and Visualization Tools for V&V

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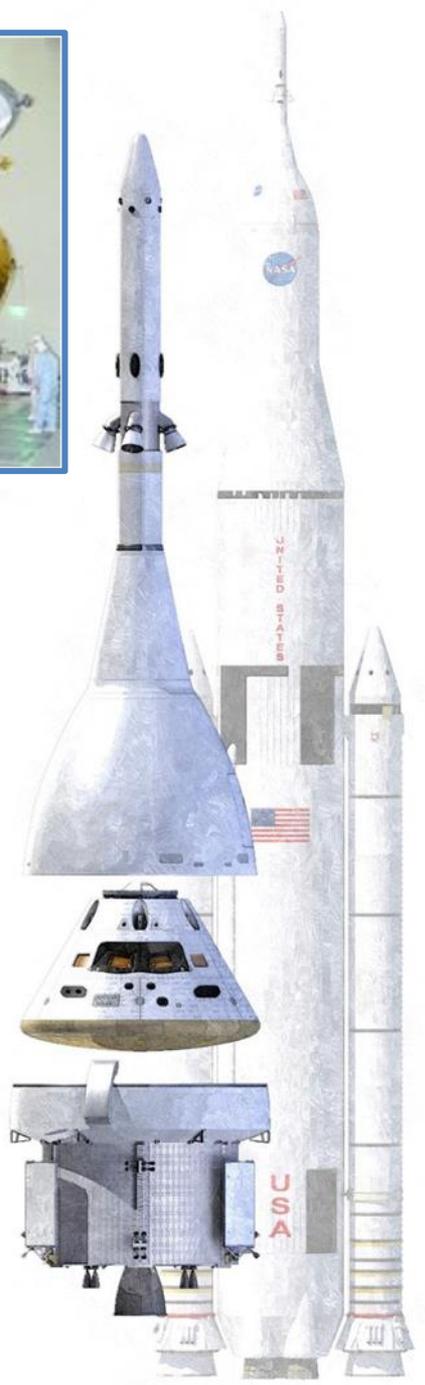
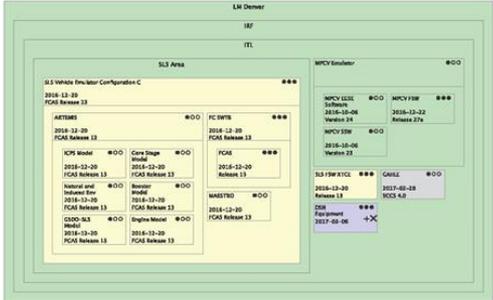


Figure A.15. Configuration: 2017-03-06 to 2017-03-10



A.4. Test Activity: Orion-NEN&SN Pre-Compat and Hardline-Only Test to MCC

Table A.4. Orion-NEN&SN Pre-Compat and Hardline-Only Test to MCC Description

Start	End	ISP	Source
2017-04-10	2017-04-14	SpaceComm_04	LM-ORN-0430 Test Windows rev 5 - chart 5
Tested In			
LM Denver . IIRF . ITL			
Might Verify			

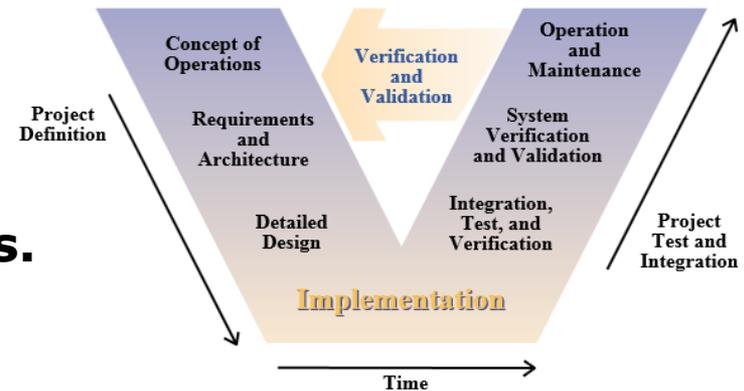




Definition of Verification & Validation

(Use and Terms Vary)

- ◆ **Verification - Act of reviewing, inspecting or testing, in order to establish and document that a product, service or system meets technical standards.**
 - “Does the product do the thing right”
- ◆ **Validation - Confirming that a product or service meets the needs of its users.**
 - “Does the system do the right thing”
- ◆ **Ensures a product, service, or system meets requirements and specifications and that it fulfills its intended purpose.**
- ◆ **V&V in this context is defined as a systems function.**





Systems Analysis - The Paradigm Shift

Current State

Top Down
Document-centric
Closed

Tight Integration



Future of SE

Bottoms-up

Legacy+New
Model-centric
Varied-lifeSpan
Open

System of Systems





Model Based Systems Engineering

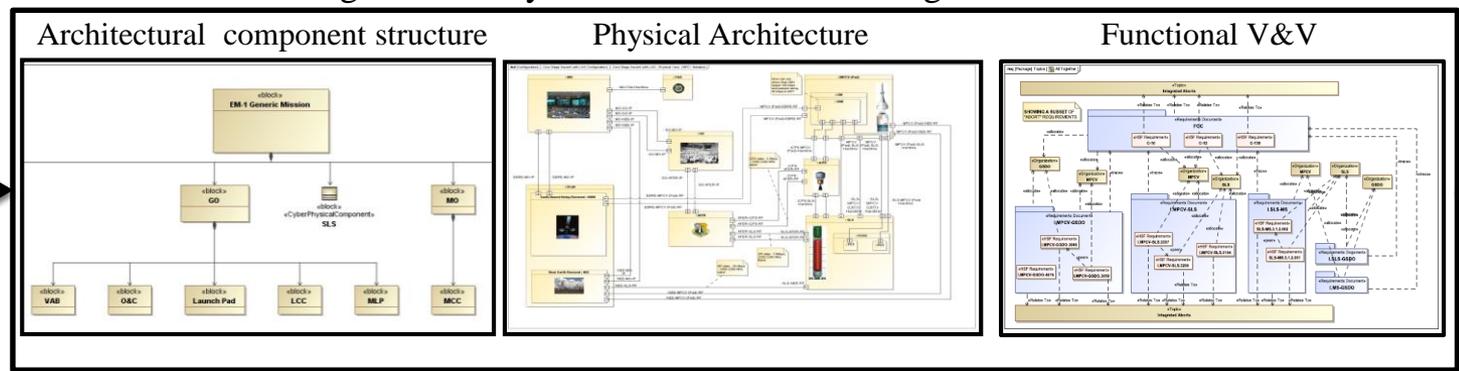
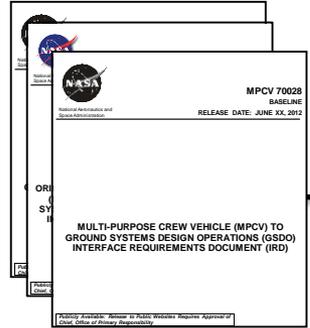
- ◆ **Model-Based Systems Engineering (MBSE) - formalized application using modeling to perform systems engineering functions:**
 - Requirements Development
 - Design
 - Analysis
 - **Verification and Validation**

- ◆ **Approach**
 - Facilitates understanding important aspects of the system and their inter-relationships.

 - Captures technical content then feeds information back to engineers so they may more clearly understand the implications of decisions.

Applying Advanced Methodologies to Ensure SE Rigor

Moving Towards Systems Architecture & Single Source of Truth



Increases Efficiency of V&V Systems Analysis

Document Issues/Concerns

ID	Issue/Concern	Severity	Status
1	Document ID: 70028-001-001	High	Open
2	Document ID: 70028-001-002	Medium	Open
3	Document ID: 70028-001-003	Low	Open
4	Document ID: 70028-001-004	High	Open
5	Document ID: 70028-001-005	Medium	Open
6	Document ID: 70028-001-006	Low	Open
7	Document ID: 70028-001-007	High	Open
8	Document ID: 70028-001-008	Medium	Open
9	Document ID: 70028-001-009	Low	Open
10	Document ID: 70028-001-010	High	Open
11	Document ID: 70028-001-011	Medium	Open
12	Document ID: 70028-001-012	Low	Open
13	Document ID: 70028-001-013	High	Open
14	Document ID: 70028-001-014	Medium	Open
15	Document ID: 70028-001-015	Low	Open
16	Document ID: 70028-001-016	High	Open
17	Document ID: 70028-001-017	Medium	Open
18	Document ID: 70028-001-018	Low	Open
19	Document ID: 70028-001-019	High	Open
20	Document ID: 70028-001-020	Medium	Open

Perform analysis

Analysis feedback

Enables Functional/ Parametric Analysis & Design

Perform functional analysis

Perform parametric analysis

Analysis feedback



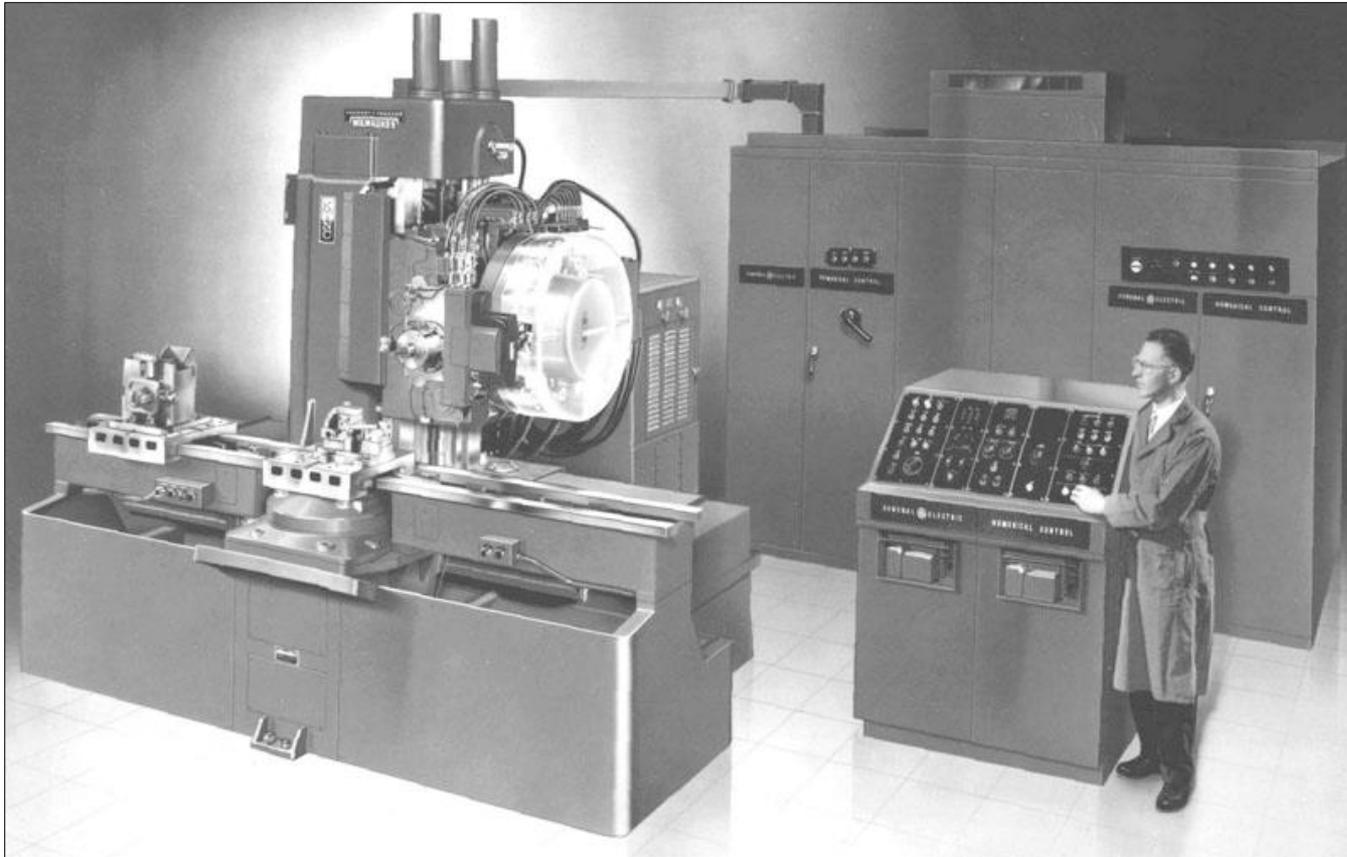
Emphasis is on Analysis

**Modeling patterns
support analysis**

**System assessed
in layers**

**Reporting of gaps
and conflicts**

**Repeatable &
rigorous**





Test Configuration Analysis

- ◆ **MBSE supports integration of widely distributed V&V information into cohesive, integrated views.**

Integrated Analysis

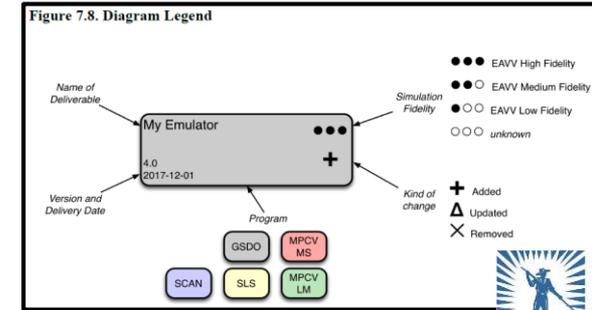
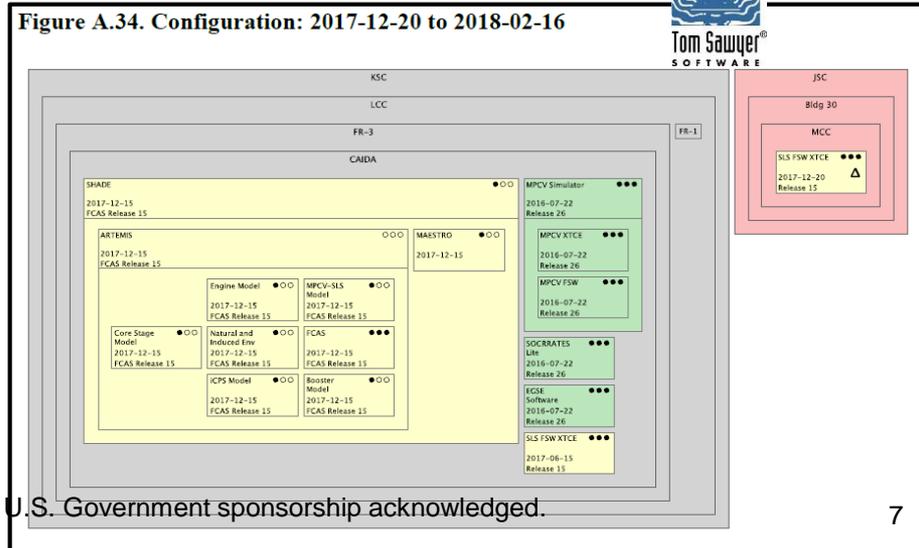
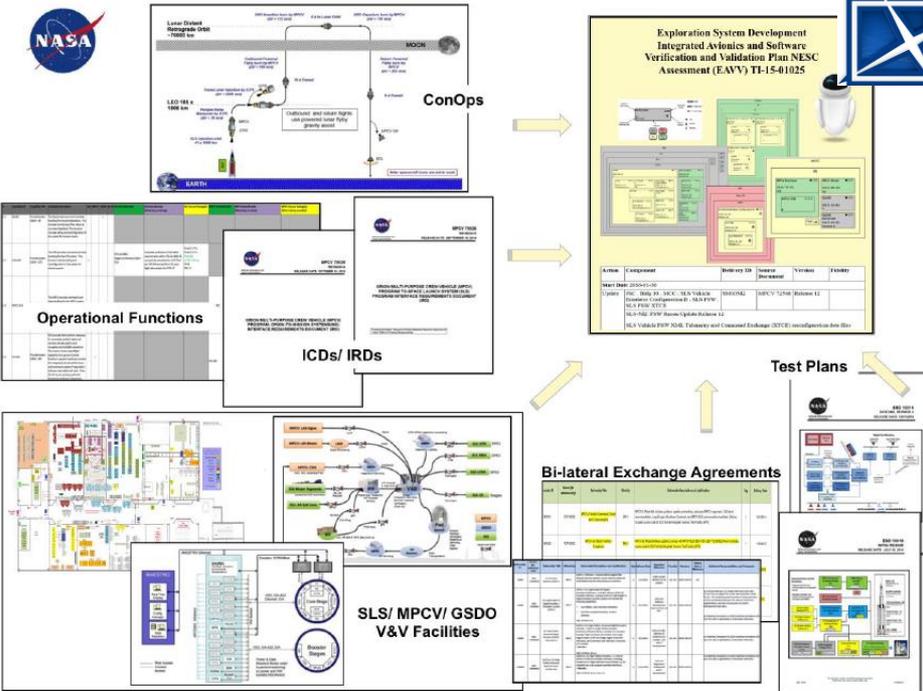


Figure A.34. Configuration: 2017-12-20 to 2018-02-16



MagicDraw

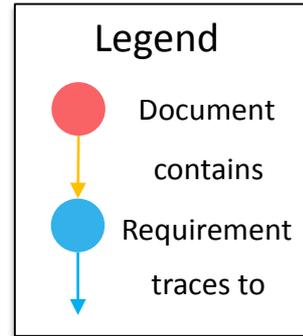


Document Driven Design



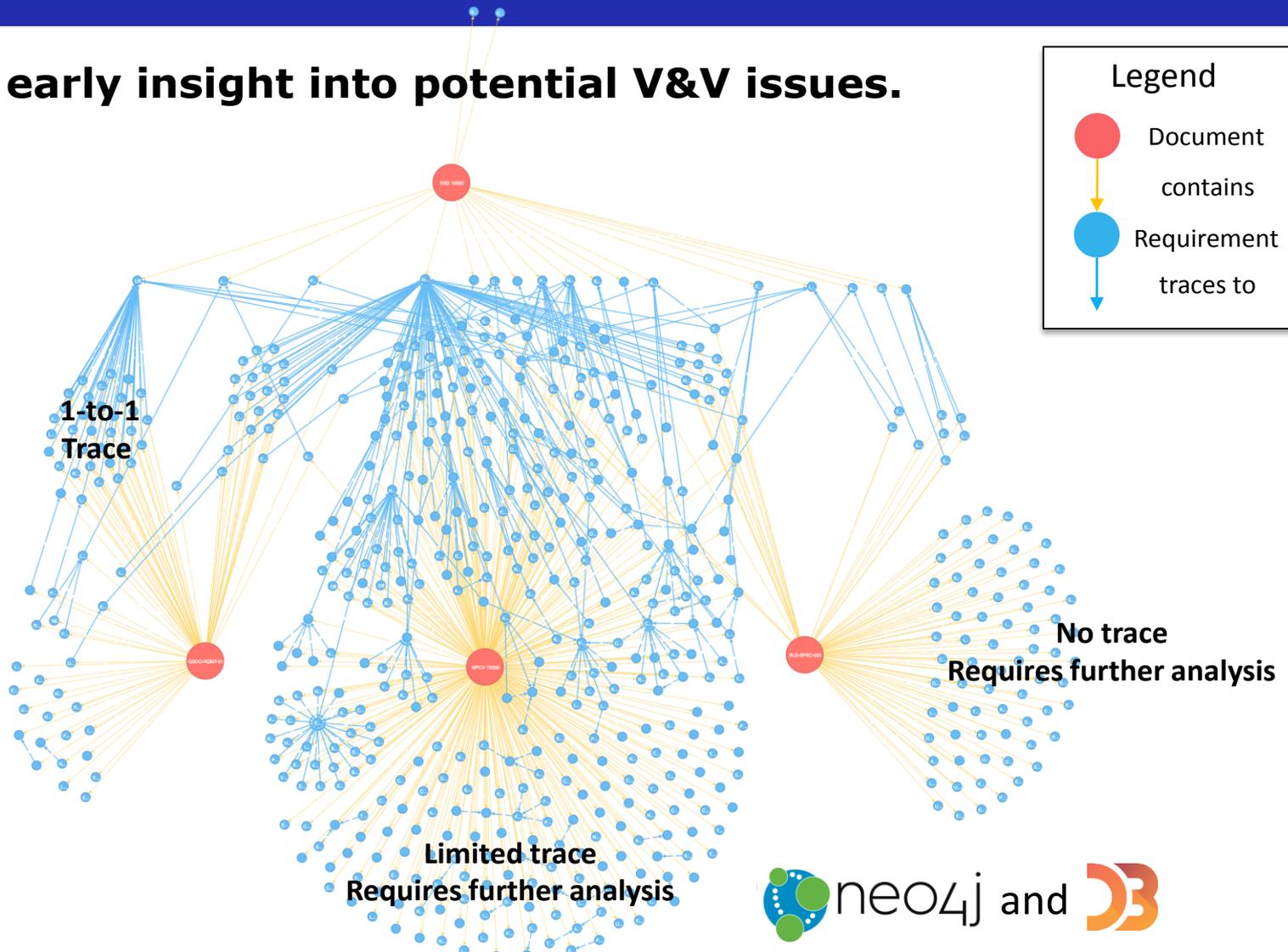
Traceability Analysis

◆ Provides early insight into potential V&V issues.



Level 2

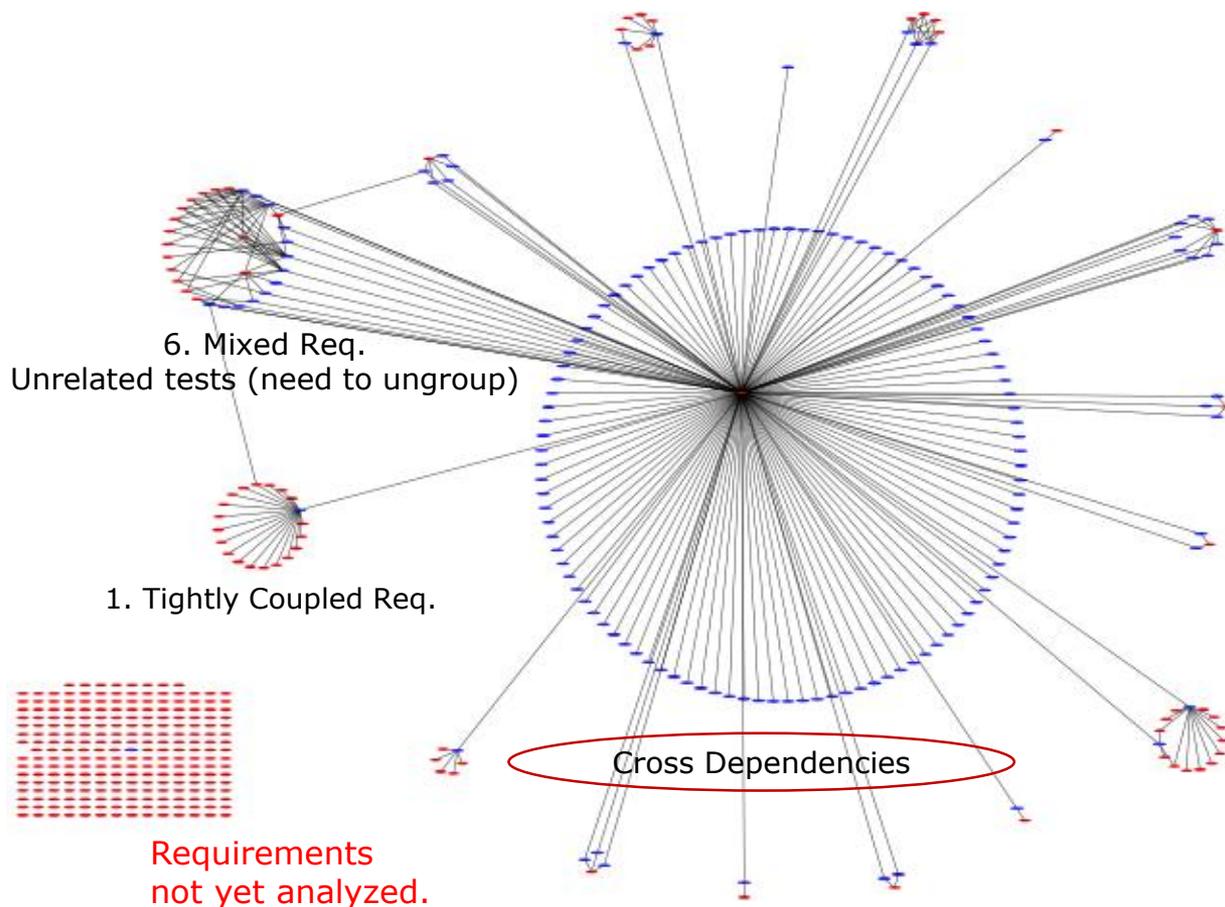
Level 3





Partitioning Analysis

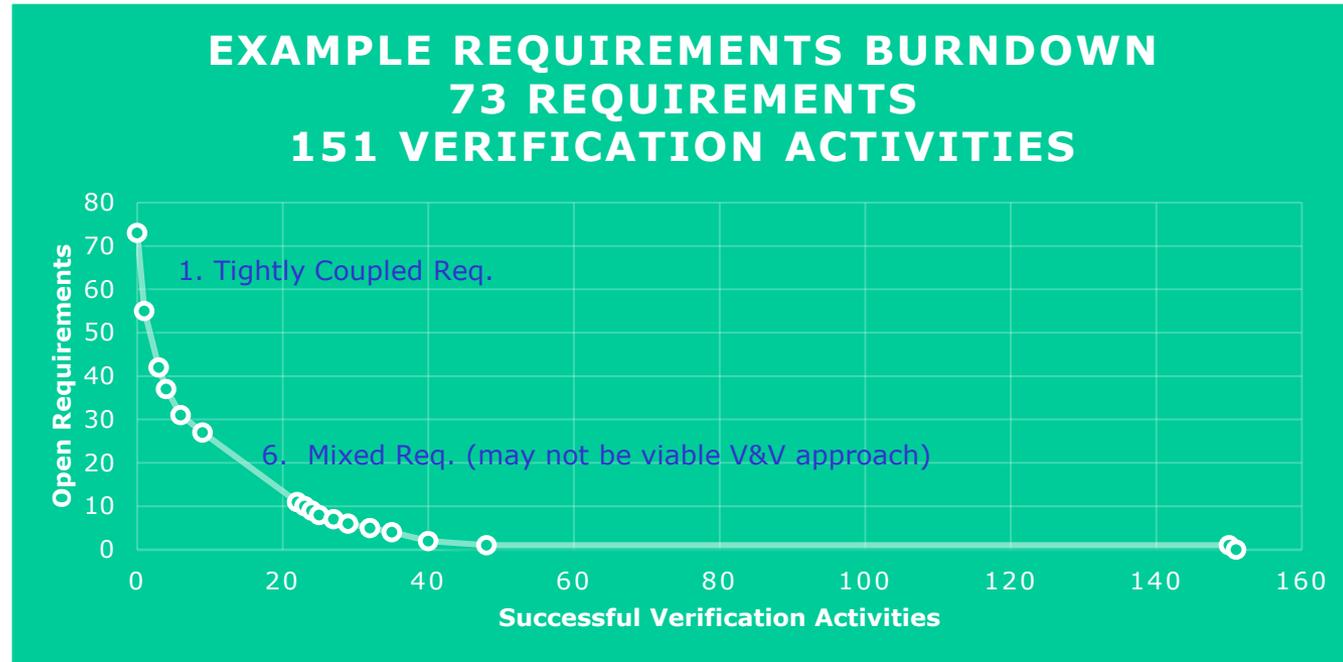
- Requirements and verification activities may be partitioned into groups.
 - Based on verification activities mapped to requirements
- Performing all verification activities in a group, may close most or all of requirements in that group.
 - Cross-group dependencies remain





Clustering Informs Verification Order

Group	Reqs	VAs	Req per VA
1	19	1	19.000
2	13	2	6.500
3	5	1	5.000
4	6	2	3.000
5	4	3	1.333
6	16	13	1.231
7	1	1	1.000
8	1	1	1.000
9	1	1	1.000
10	1	2	0.500
11	1	2	0.500
12	1	3	0.333
13	1	3	0.333
14	1	5	0.200
15	1	8	0.125
16	1	102	0.010
17	0	1	0.000
Totals	73	151	



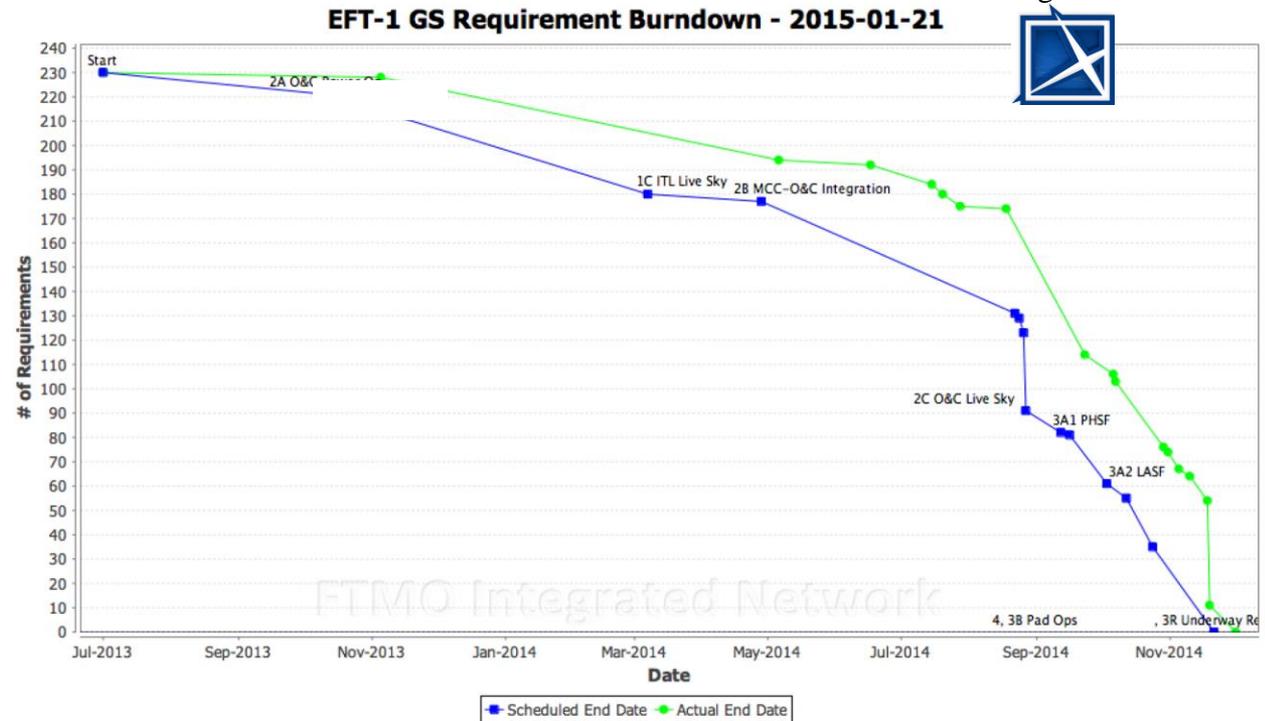
- **Possible to do highest payoff verification activities first**
- **Reduce risk early**
- **In absence of any other constraints, suggests order to perform verification activities**



Rigorous & Repeatable Analysis Throughout Program Lifecycle

Table 8.1. Validation of Launch Commit Criteria

	Operational Functionality	Ver	Val	Requirements Allocated	Source	Build	Method	Procedure	Proc Owner	Concurrence Date	
1	Countdown MET Clock			58.00173	MCC Annex	GSB 1C ITL to MCC - E2E-03 (External)	Demonstration	ORN-T-AV-0562 (O'Hagan)	Arain, Imran	2014-05-06	
2				EFT-1-FO-609775	EFT-1-FO Vol II	GSB 2A O&C (Internal)	Inspection	Inspection Report (Lisa Wild)		2014-09-23	
3				EFT-1-LR-610709	EFT-1-LR Vol I	GSB 2A O&C (Internal)	Inspection	PRD Inspection Reports (Olivia Fuentes)		2014-07-20	
4				I.MS-GS.1170	I.MS-GS	GSB 1C ITL to MCC - E2E-03 (External)	Demonstration	ORN-T-AV-0562 (O'Hagan)	Arain, Imran	2014-05-06	
5				I.MS-GS.1171	I.MS-GS	GSB 1C ITL to MCC - E2E-03 (External)	Demonstration	ORN-T-AV-0562 (O'Hagan)	Arain, Imran	2014-05-06	
6				VS-009A	Validation Statements	GSB 3B On-Pad Operations (External)					
7	Forwarded IP Stream			58.00059							
8				GDS.0100							
9				GDS.0101							
10				GDS.0102							
11				I.MS-GS.3013							
12				I.MS-GS.3016							
13	IF.LMGS.MS.0003										
14	VS-007A										
15	VS-007B										
16	Meteorological Observation Data			58.00101							
17				EFT-1-LR-610406							
18				EFT-1-LR-610605(j2)							
19	EFT-1-LR-610616(o2)										
				Legend:	Closed						





V&V Analysis Takeaways

- ◆ **Provides systematic approach for structuring V&V planning.**
- ◆ **Partitions V&V work into separable groups—difficult to do by hand.**
- ◆ **Intended to be a support tool for V&V Systems Engineering—does not replace human assessment.**



Challenges

- ◆ **Managers remain unclear of benefits.**
 - Mitigation: 1) Control scope, 2) Deliver quality products, 3) Show incremental progress

- ◆ **Paradigm shift: Difficult to move away from comfort zone of PowerPoint and Visio.**
 - Mitigation: 1) Focus on stakeholders, 2) Respond to content updates quickly

- ◆ **Creating viewpoints that look like what stakeholders are used to seeing...similar paradigm shift.**
 - Mitigation: 1) Prototype viewpoints early

- ◆ **Simultaneous infrastructure and product development.**
 - Mitigation: 1) Incremental agile, "scrum", development process



Key Messages

- ◆ Documents have been main conveyers of information as authoritative source of information for requirements, architecture, plans, analyses, tradeoff studies, etc.
- ◆ But connections in documents is hard to establish. Implicit and known only by their producers. Changes need to be manually propagated.
- ◆ Modeling allows for more accurate, reliable and automated domain analysis.
- ◆ Modeling patterns support analysis, and analyses is represented in the model (explains purpose of analysis and identifies results).
- ◆ Over four years of application has shown information models are typically much better at providing integrated, holistic view of the system being analyzed than documents only, but the word “only” is key.
- ◆ There will always be a mix of models and documents. Some technical content is suited for documents, while other information more naturally suited for models.

Multiple Implementations Enabled Creation of Lean, Capable Tool Set