Modeling Requirements with MBSE

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Document Markings

About Me

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Software development lifecycle, software architecture principles & practices, systems engineering, MBSE, and threat modeling

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Definitions and Assumptions

Definitions and Assumptions:
Requirements

A description of the problem(s) that future systems should solve.

Business requirements:

High-level statements of the goals, objectives, or needs of an organization.

User requirements:

Mid-level statements of the needs of a particular stakeholder or group of stakeholders.

System requirements:

Usually detailed statements of capabilities, behavior, and information that the solution will need including detailed statements of the conditions under which the solution must remain effective, qualities that the solution must have, or constraints within which it must operate. System requirements include non-functional requirements, often called quality attributes or "ilities," such as security, usability, testability, and modifiability.

Definitions and Assumptions: *MBSE*

Model-based systems engineering is a formalized methodology that supports the requirements, design, analysis, verification, and validation associated with the development of complex systems.

Modeling Language: SysML

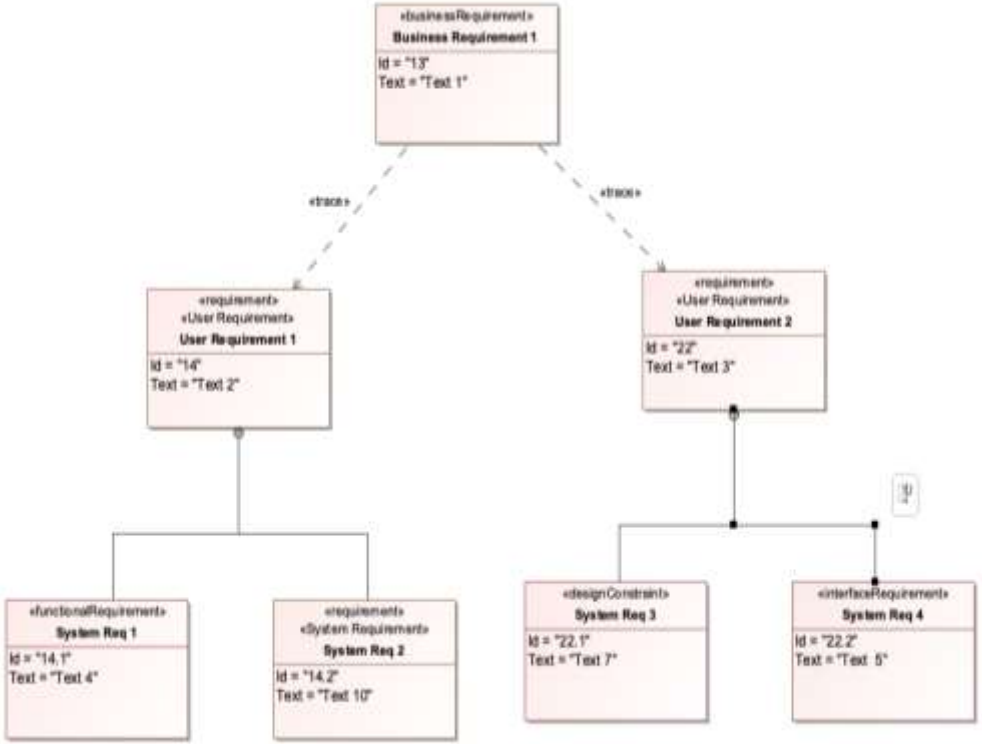
Modeling Environment: Digital modeling environment

Requirements in SysML

Requirements Mapping

- Business requirement → SysML *business requirement*
- User requirement → SysML generic *requirement* with *user requirement* stereotype
- System functional requirement → SysML generic *requirement* with *system requirement* stereotype or SysML *functional requirement* subclass
- System non-functional requirements → SysML *design constraint, usability requirement, performance requirement, interface requirement, physical requirement*

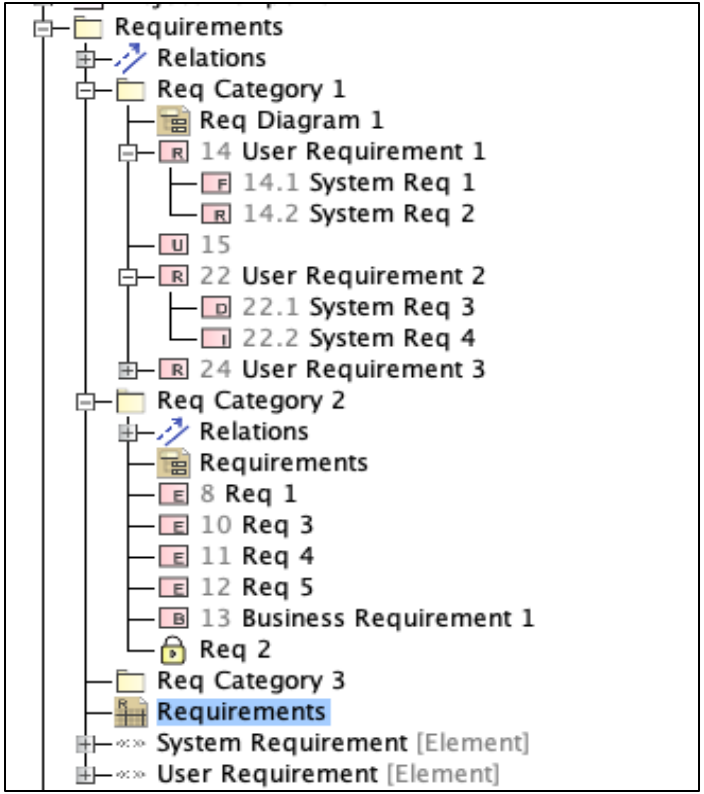
Requirements Mapping: ***Hierarchy***



Requirements in a Model

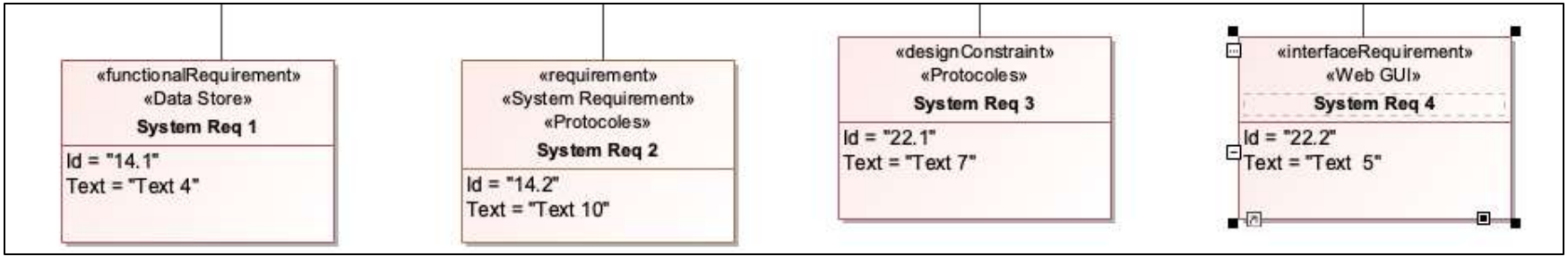
Organization and Initial Analysis: ***Categorization***

- Categories based on:
  - Type of requirements
  - Functionality
  - Part of a business process
  - Subsystems
  - Components
- Categories as Packages



Organization and Initial Analysis 2

- Categories as Custom Stereotypes



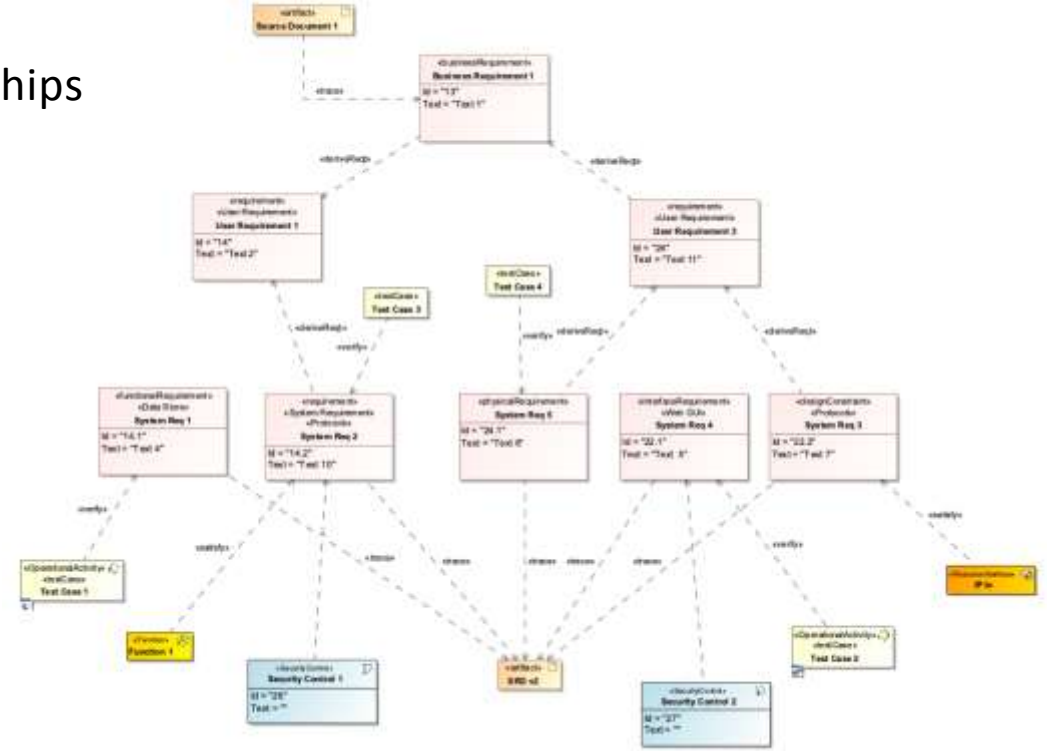
#	Name	Text	Applied Stereotype
1	14.1 System Req 1	Text 4	functionalRequirement [Class] Data Store [Element]
2	14.2 System Req 2	Text 10	Requirement [Class] System Requirement [Element] Protocoles [Element]
3	22.1 System Req 3	Text 7	designConstraint [Class] Protocoles [Element]
4	22.2 System Req 4	Text 5	interfaceRequirement [Class] Web GUI [Element]

Traceability and Relationships

- Requirement was published in the System Requirements Document (SRD) – ***Trace***
- Other requirements were derived from this requirement – ***Derive***
- Requirement was decomposed – ***Containment***
- Requirement refines any use case – ***Refine***
- Requirement was verified by a test case or test process – ***Verify***
- This requirement is the same as another requirement – ***Copy***
- Parts of the conceptual and/or solution architecture is satisfying the requirement – ***Satisfy***

Requirements Diagram

- Depict all elements and relationships directly related to a requirement
- Assist with the analysis



Requirements Table

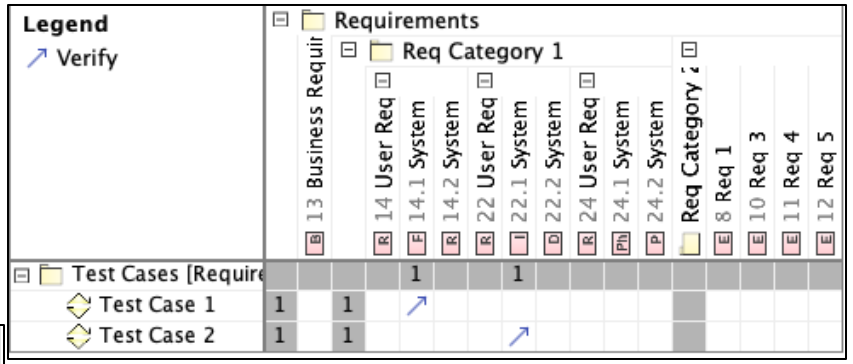
- Traditional and convenient way to look at the requirements
- Convenient and effective way to import the requirements by bulk

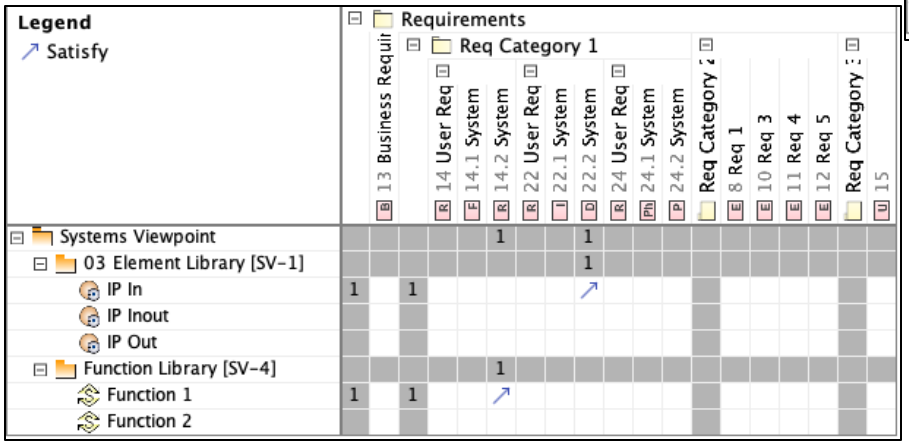
Id	Name	Text	Traced To	Satisfied By	Derived From	Verified By
	Business Capabilities					
32	32 Traveler Information Management	Text 3				
32.1	32.1 Traveler Profile Management	Text 4		Traveler Profile Management Ststem	32 Traveler Information Management	
32.2	32.2 Traveler History Management	Text 5			32 Traveler Information Management	Test Case 1
34	34 Communication Management	Text 6				
34.1	34.1 Mobile Communication Management	Text 7			34 Communication Management	
34.1.1	34.1.1 Mobile Communication Security	Text 8			34.1 Mobile Communication Management	
34.2	34.2 Optic Communication Management	Text 9			34 Communication Management	
34.2.1	34.2.1 Optic Communication Security	Text 12			34.2 Optic Communication Management	Test Case 2
35	35 Information Management	Text 13				
35.1	35.1 Information Lifecycle Management	Text 14			35 Information Management	
35.2	35.2 Information Organization	Text 15			35 Information Management	
36	36 Route Management	Text 16				
36.1	36.1 Route Analysis	Text 17			36 Route Management	
36.1.1	36.1.1 Statistical Analysis	Text 18	54 User Requirement 1		36.1 Route Analysis	
36.1.2	36.1.2 Route Visualization	Text 19	55 User Requirement 2		36.1 Route Analysis	
36.2	36.2 Route Planning	Text 20			36 Route Management	
37	37 Traffic Controls Information Management	Text 21				
38	38 Travel Condition Information Management	Text 22				
39	39 Traffic Controls Strategies Management and Optimization	Text 23				

- Requirements Analysis in a Model

Dependency Matrix

- To create and show the relationships:
  - Verify
  - Satisfy
  - Derive
  - Refine
  - Trace
  - Copy





Coverage Metric

- To evaluate a current state of the model
- Calculates statistics of how many requirements are covered with relationship
- Allows to monitor changes of a specific aspect of the model in time

#	Date	Scope	Requirements	Covered By Design Percentage	Covered By Design	Covered By Test Cases Percentage	Covered By Test Cases
1	2020.12.04 18.49	Requirements	15	26.6667	4	13.3333	2
2	2020.12.04 18.50	Requirements	15	33.3333	5	13.3333	2
3	2020.12.04 18.53	Requirements	15	26.6667	4	20	3

Dependency Map

- Put a specific requirement at the top of the tree
- Shows all or selected types of relationships for the requirement
- Shows multiple levels of the relationships
- Shows how the requirement relates to other domain

Find Errors:
Requirements Table

- Requirements can be derived only from higher level of requirements
- In the table, there is two errors

Can you find the errors?

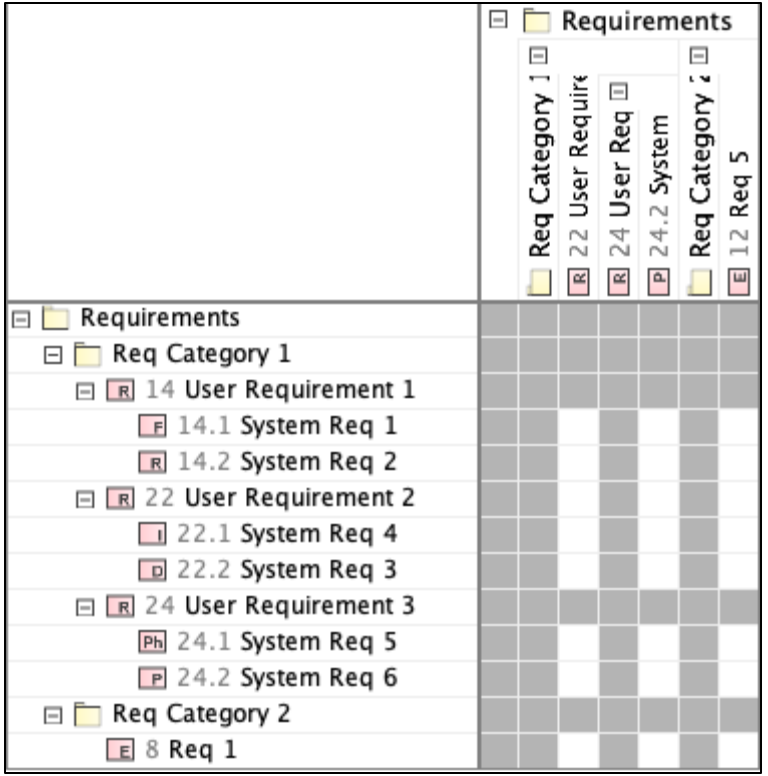
Business requirement cannot be derived from User requirement

#	△ Name	Text	Derived	Derived From
1	B 13 Business Requirement 1	Text 1	R 24 User Requirement 3	R 14 User Requirement 1
2	F 14.1 System Req 1	Text 4	R 14 User Requirement 1	
3	R 14.2 System Req 2	Text 10		R 14 User Requirement 1
4	I 22.1 System Req 4	Text 5		R 22 User Requirement 2
5	D 22.2 System Req 3	Text 7		R 24 User Requirement 3

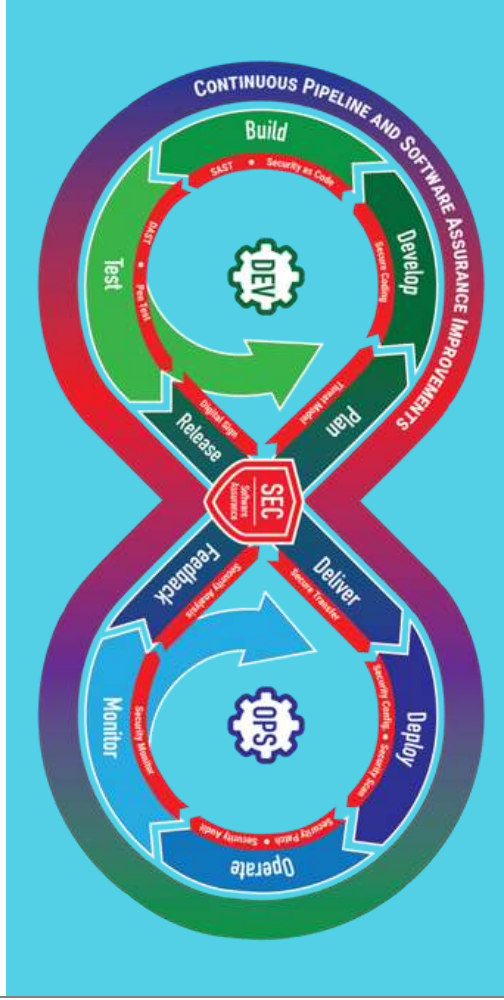
User requirement cannot be derived from System requirement

Find Gaps:
"Negative" Dependency Matrix

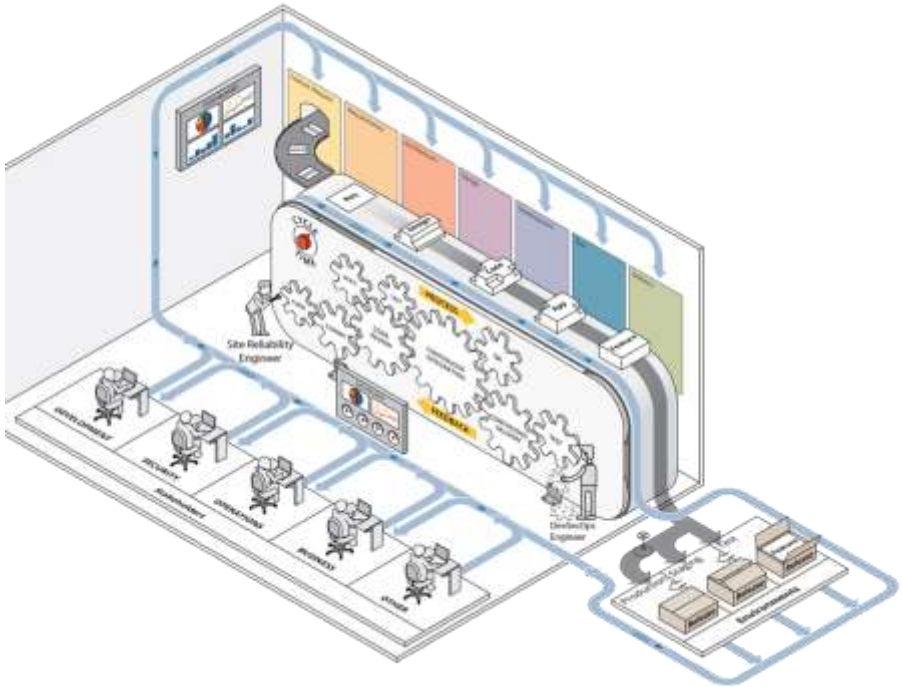
- To file a "negative" space – elements without the relationships



- Requirements in Real Model



DevSecOps Platform Independent Model (PIM)



- Is an authoritative reference to fully design and execute an integrated Agile and DevSecOps strategy in which all stakeholder needs are addressed
- Enables organizations to implement DevSecOps in a secure, safe, and sustainable way in order to fully reap the benefits of flexibility and speed available from implementing DevSecOps principles, practices, and tools
- Was developed to outline the activities necessary to consciously and predictably evolve the pipeline, while providing a formal approach and methodology to building a secure pipeline tailored to an organization's specific requirements.

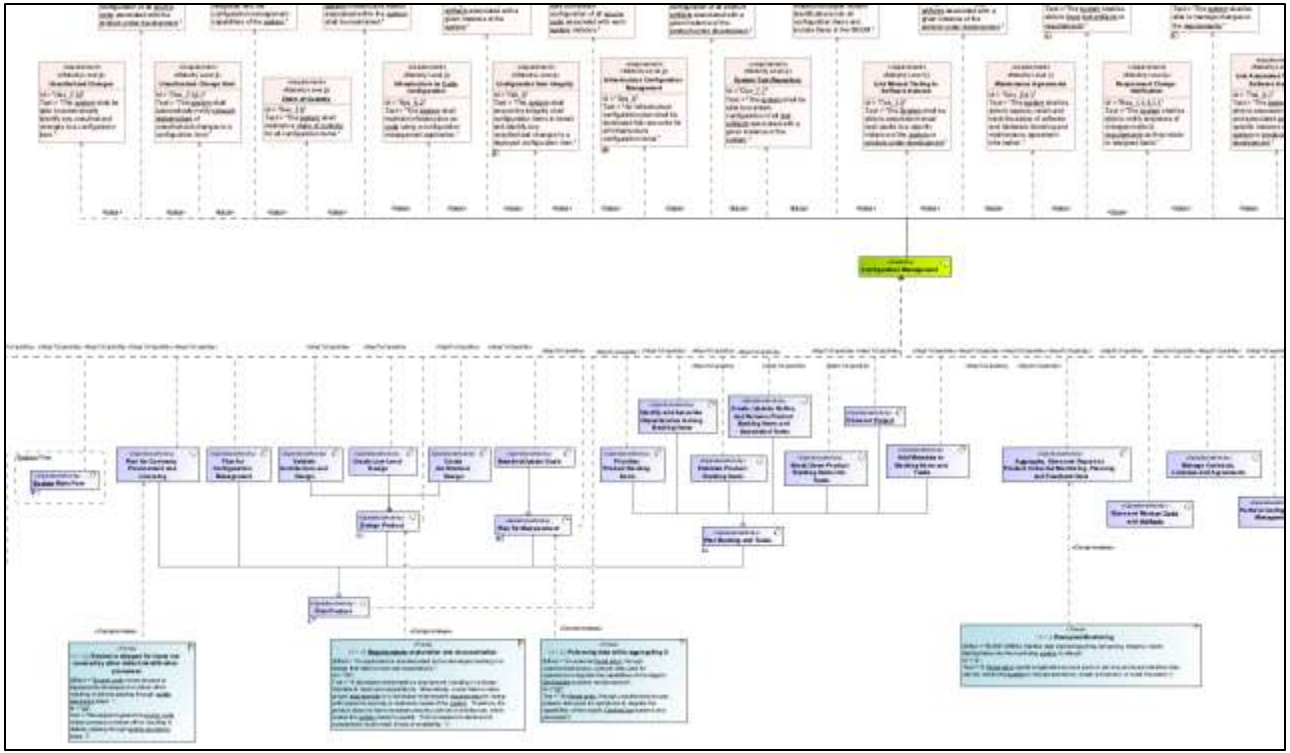
DevSecOps Capability/Strategic Viewpoint

A capability is a high-level concept that describes the ability of a system to achieve or perform a task or a mission

All requirements in the DevSecOps PIM were allocated to corresponding capabilities

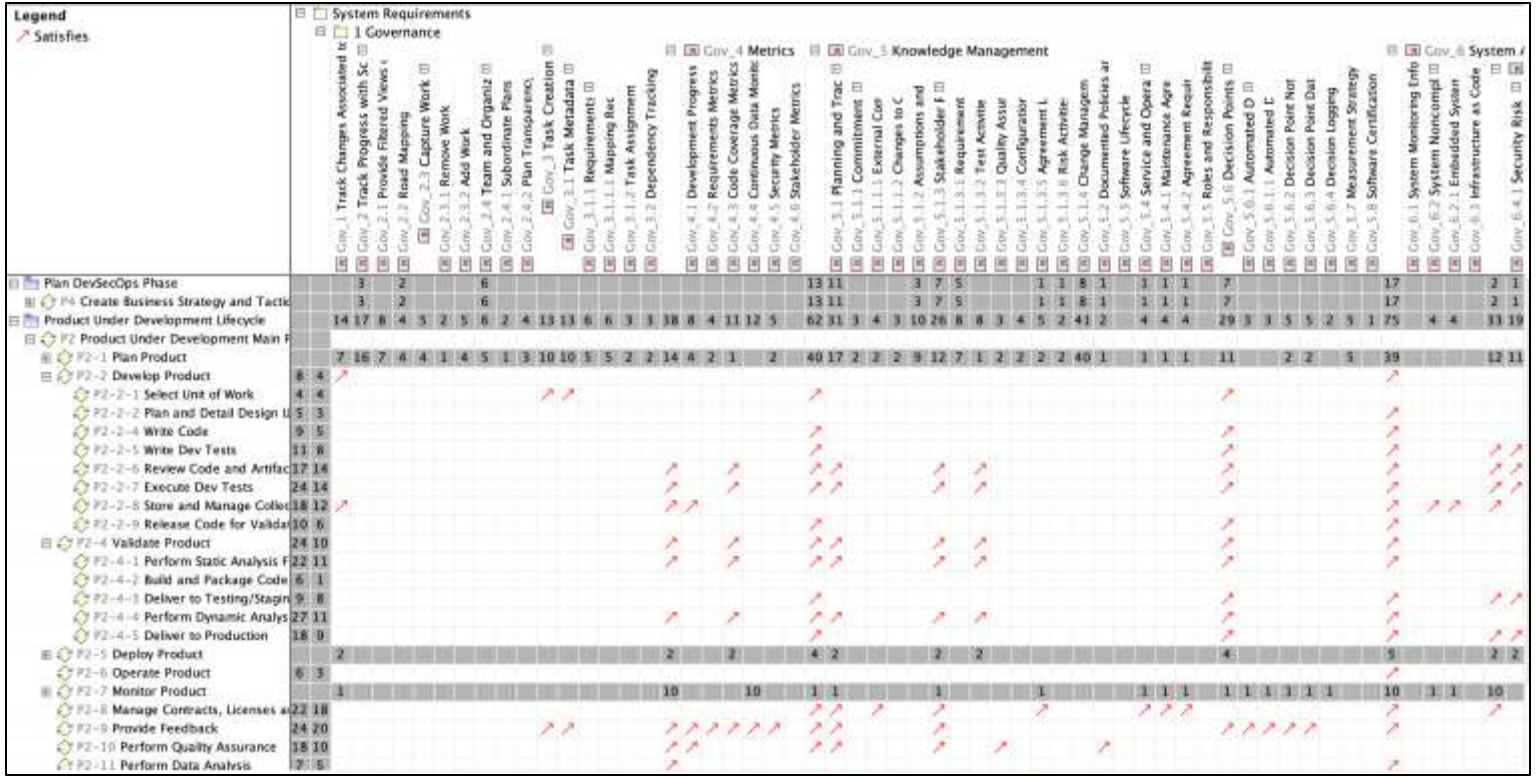
https://cmu-sei.github.io/DevSecOps-Model/

DevSecOps is a complex interconnected system



A Capability traced to Requirements

DevSecOps Requirements are Satisfied by Op. Activities



Questions