The Future of Quality in a Model Based Systems Engineering (MBSE) World

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Agenda

- Introduction
- MBSE/SysML Background
- OSMA MBMA
- Promise of MBSE
- Summary and next steps

Introduction

- **Various pockets of MBSE effort have been consolidated around the agency.**
- **MBMA within NASA is emerging**
  - NASA OSMA MBMA Program
  - MBMA WS#1 last year
  - MBMA WS#2 coming
  - MIAMI MBMA piloting
- **Deal with product assurance not other SMA areas (ie institutional safety)**
- **Large range of possible Use Cases**
- **Although modeling is defined more broadly, this presentation will reference the Systems Modeling Language (SysML)**

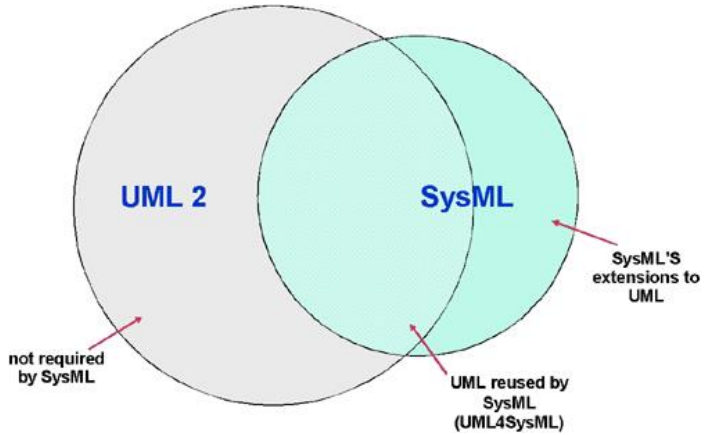
Background MBSE/SysML

- **The Systems Modeling Language (SysML) is a general-purpose descriptive modeling language for systems engineering applications.**

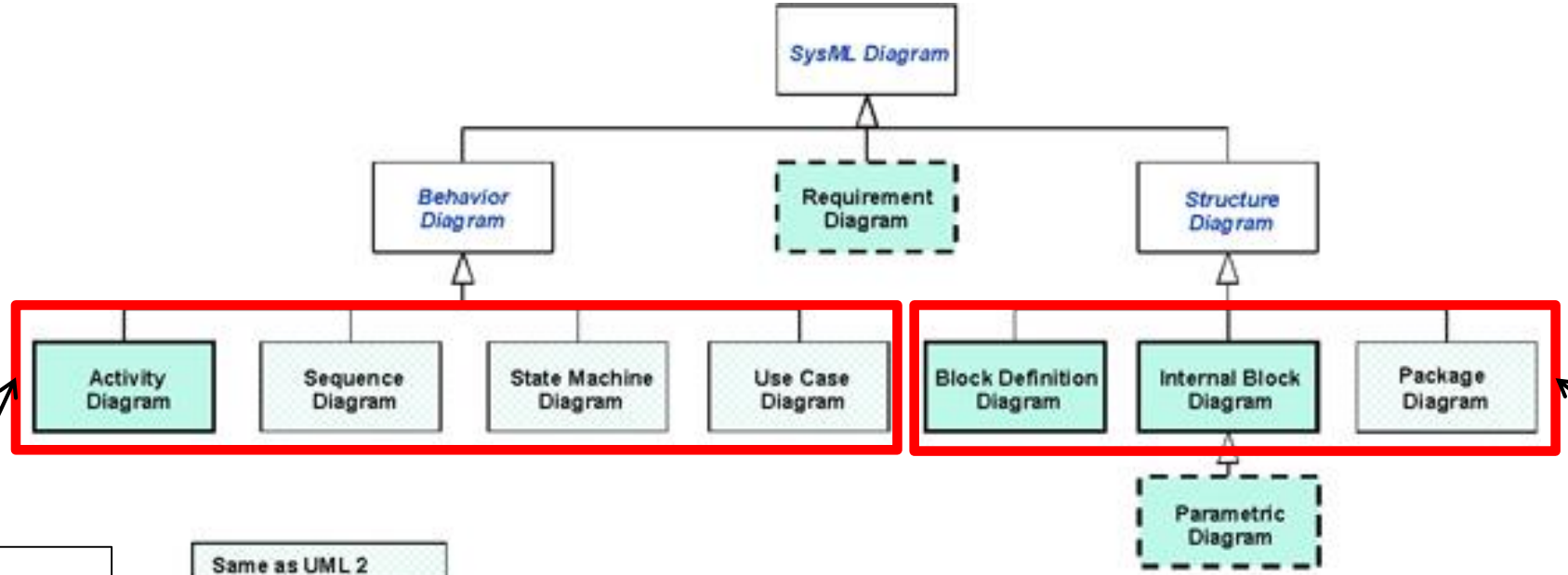
- **An extension of a subset of the Unified Modeling Language (UML).**

- **UML developed for the software industry in the 1990's**
  - accepted by the International Organization for Standardization (ISO) as industry standard for modeling software-intensive systems.

- **Managed by the Object Management Group**
  - http://www.omg.org/
  - http://www.omgsysml.org/



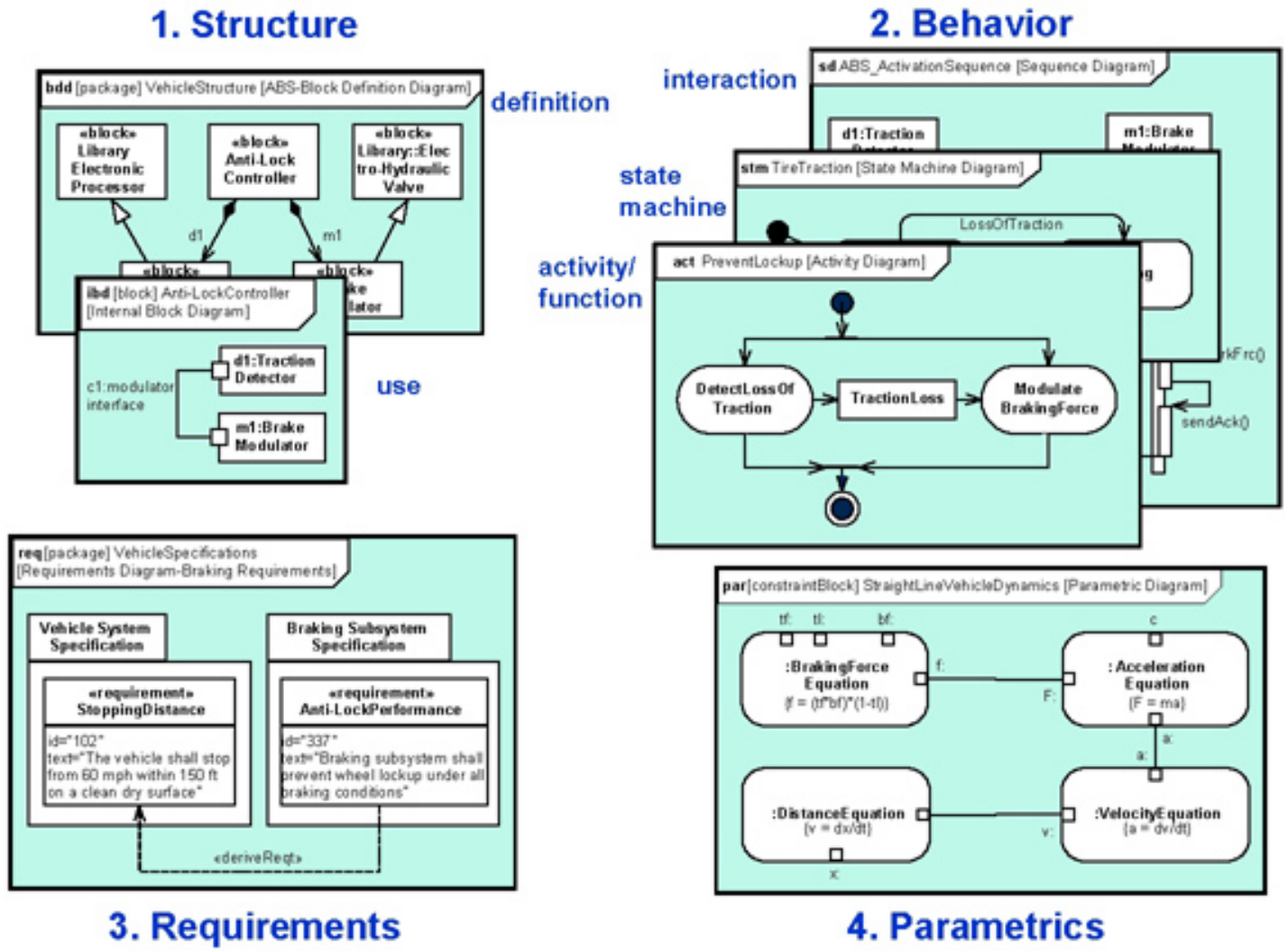
SysML has nine types of diagrams



Behavioral:
- Activities
- Information Flow

Structural:
- Structure
- Data

The four pillars of SysML



Note that the Package and Use Case diagrams are not shown in this example, but are respectively part of the structure and behavior pillars

OSMA MBMA

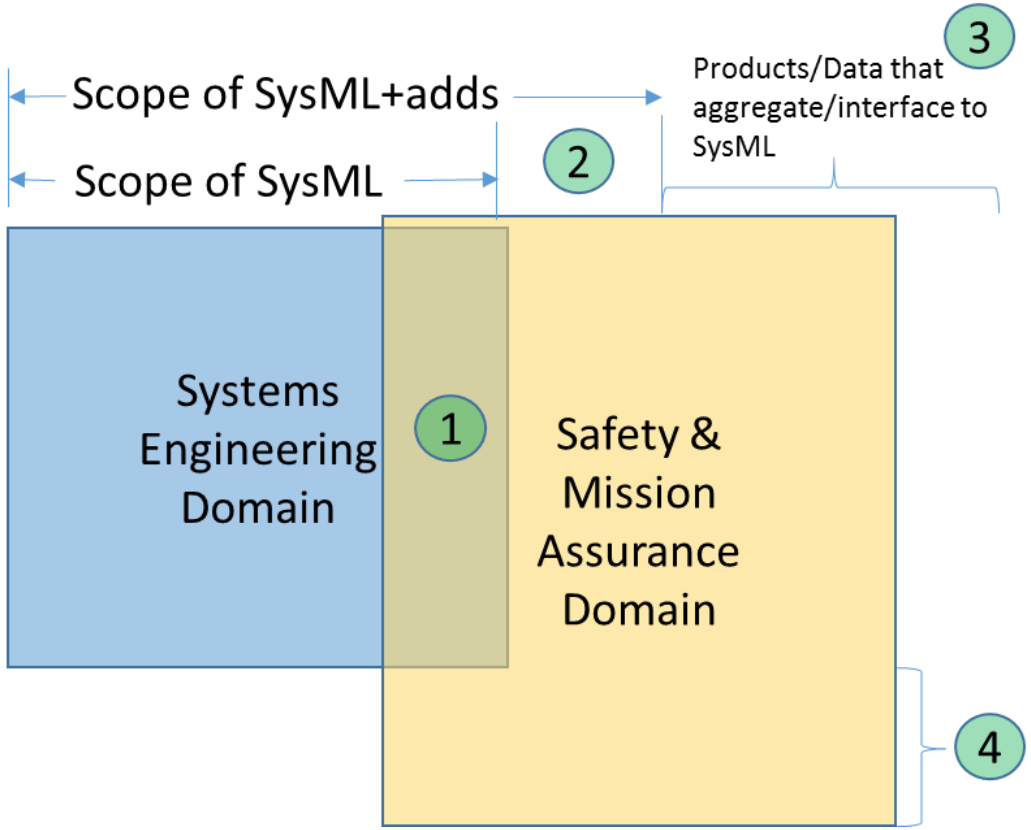
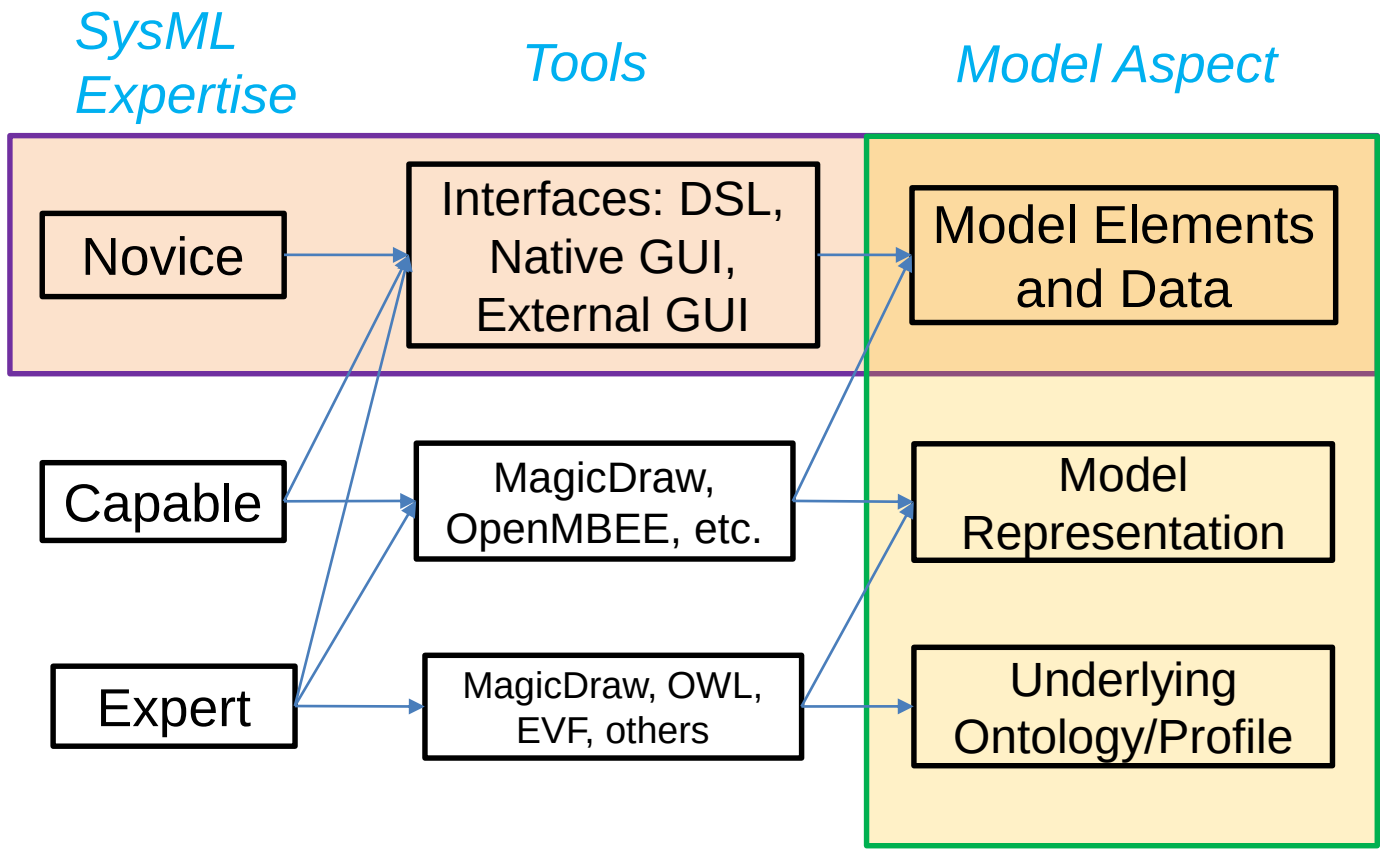


*Illustration of some key relationships between Systems Engineering, SysML and S&MA. 1) There is a lot of commonality between the two discipline areas and many of the nomenclature is the same. 2) "vanilla" SysML (that which one gets out of the box) enables extensions and indeed some are required to support additional SE domain activities, this extension, or add-in, process also will enable SysML to be extended to cover key S&MA domain activities, 3) Much of what OSMA needs is beyond the **breadth** of SysML and will require interfaces or interface tools to exchange products or data, 4) Much of what OSMA needs is beyond the **depth** of SysML and will require interfaces or interface tools to exchange products or data.*

NASA OSMA MBMA: Main Thrusts for FY19

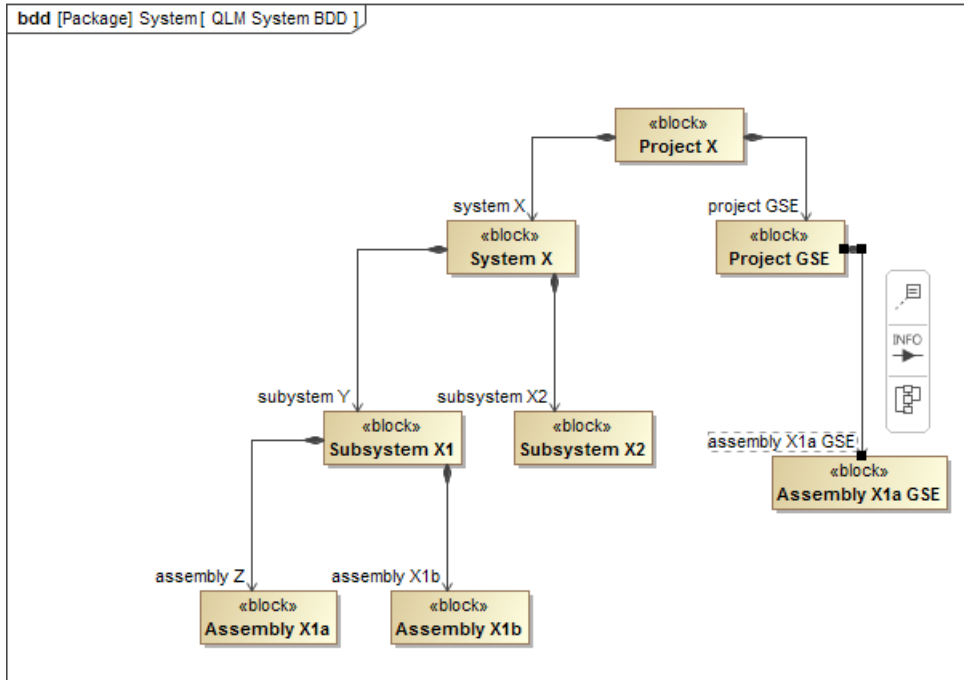
Thrust 2: S&MA non-expert interaction with SysML



Thrust 1: S&MA representation in SysML

System Structure Representation (see MBSE)

- **Walkthrough a simple example to illustrate key elements**



A simplified Project Hierarchy (bread and butter of Systems Engineers)

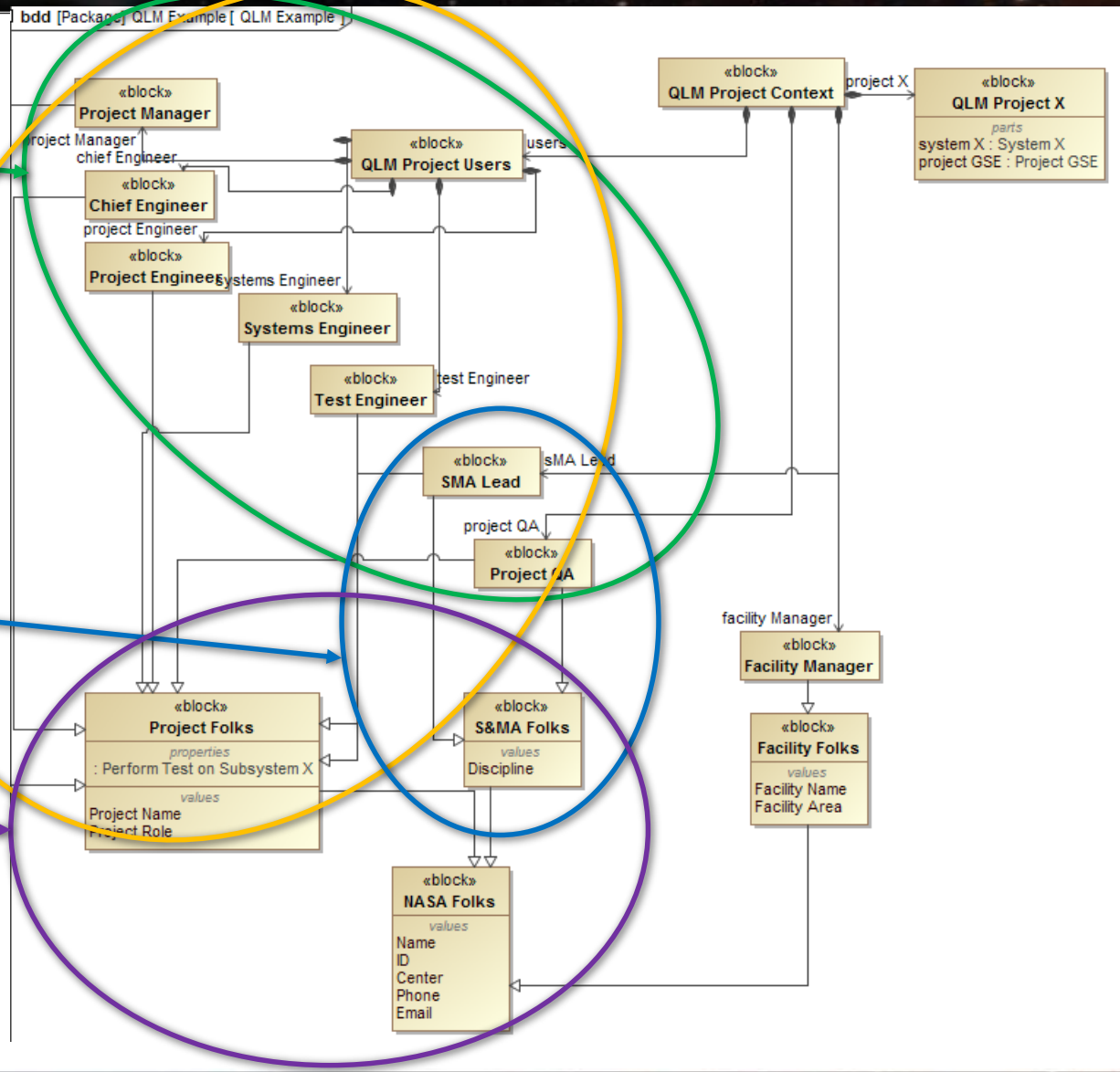
Another Example of Structure (and Inheritance)

A Project team *is composed* of these members. They are all part of the QLM Project Users

A Project team *inherits* some properties from being a member of Project Folks (eg. Project Role)

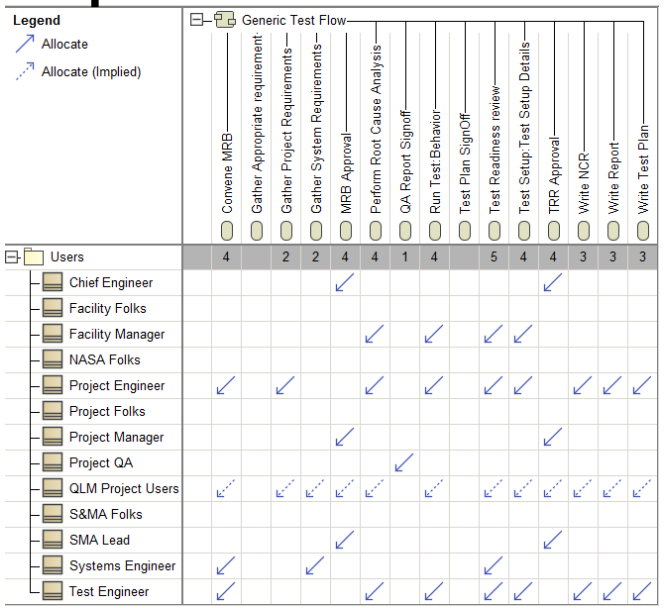
A Project SMA/QA team also *inherits* some properties from being a member of S&MA Folks (eg. Discipline)

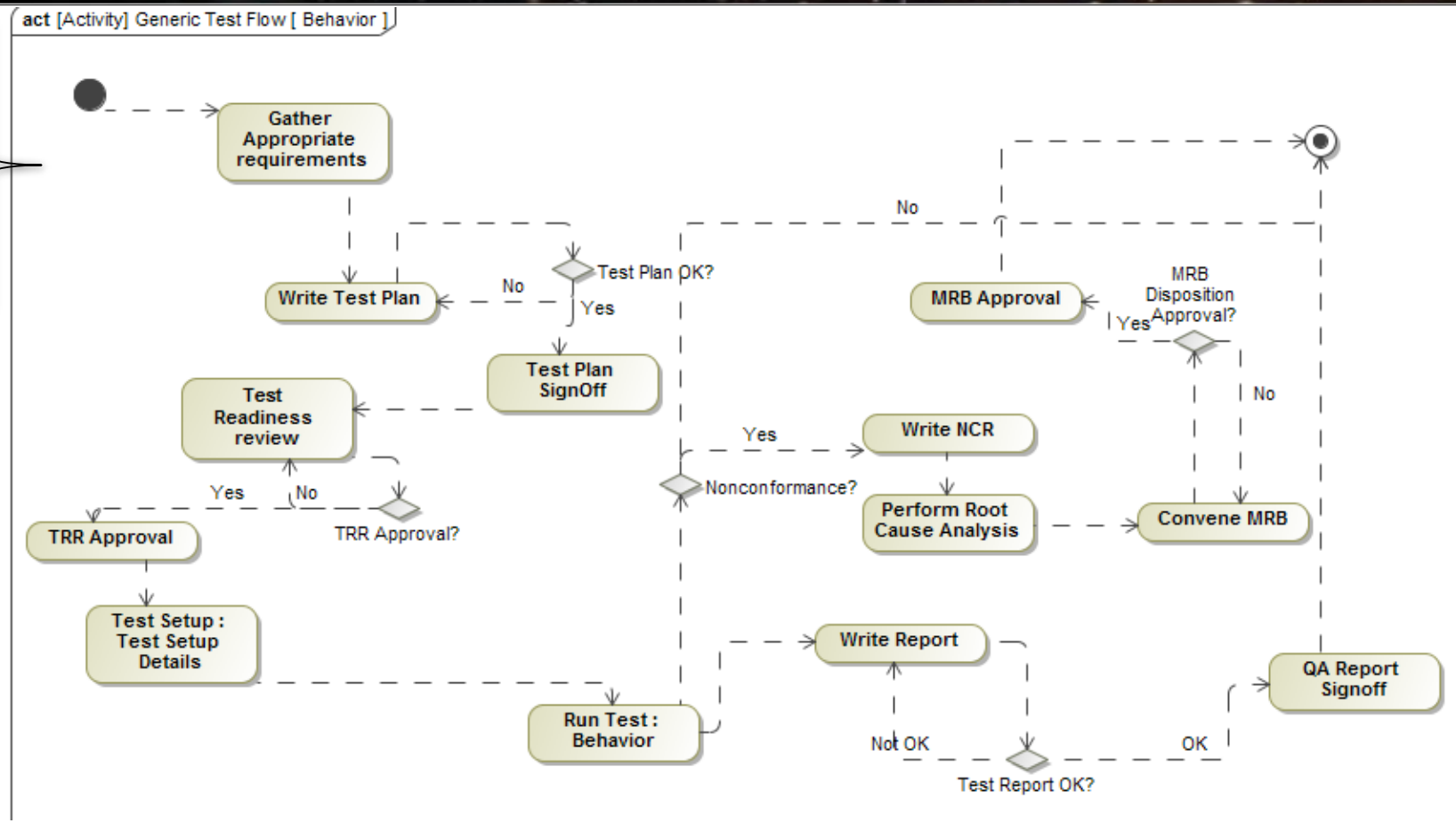
Both Project Folks and S&MA Folks i*nherit* some properties from being a member of NASA Folks (eg. Name, ID)



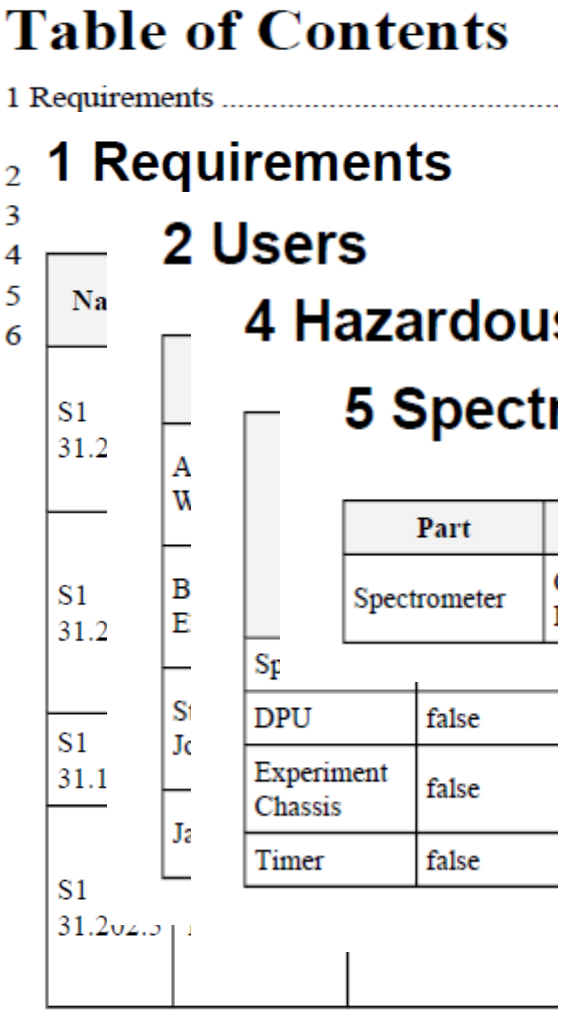
Example of Behavior: Simplified Generic Test Flow

- Note the flow is human readable
- It captures Decision points
- It can capture both information and control flow
- SysML also enables us to explicitly assign/manage responsibilities:





Scripts to generate editable documents



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5 Na

6 4 Hazardou

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S1 31.2

S1 31.2

S1 31.1

S1 31.2

A W

B E

S J

J

Part

Spectrometer

Sp

DPU	false
Experiment Chassis	false
Timer	false

6 Risk Analysis

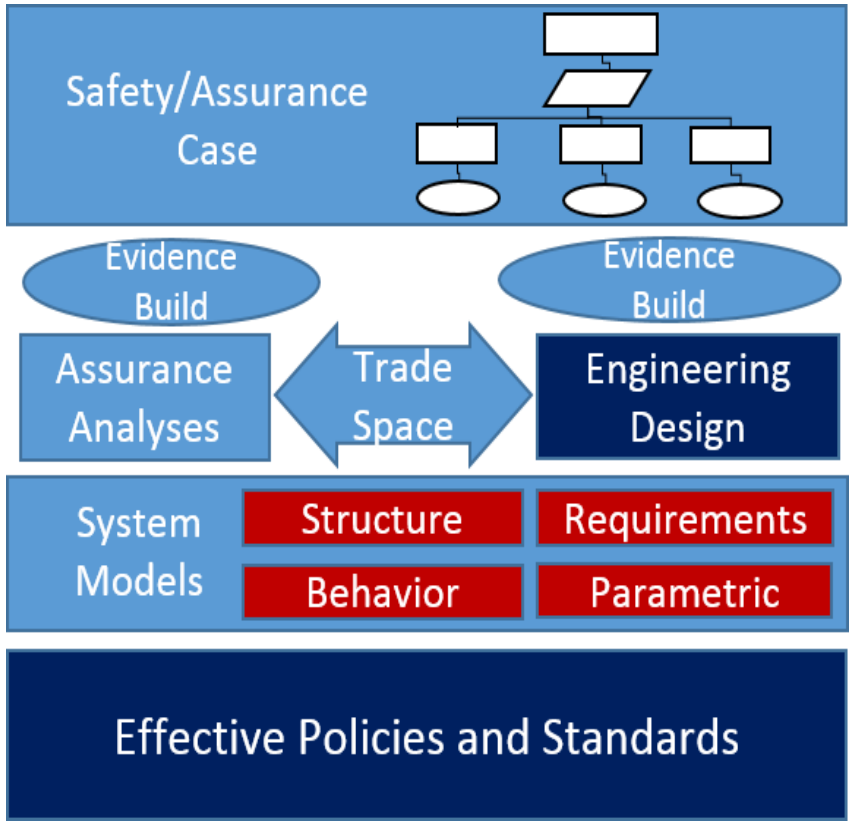
Table 7. Risks

Risk	Likelihood	Consequence	Risk Description	Risk Statement	Handling Action and Projected Outcome	Risk Handling Approach	Comments
36.319-007	4	2	GLN-MAC "Soft Reboot" inflight No Root Cause yet found on 36.245 Figueroa & 36.311 UG Green	Given that the unresolved GLN-MAC (or LN- 200) "soft reboot" that occurred on the 36.245 Figueroa & 36.311 UG Green mission, there is potential that a similar reboot could occur in flight leading to S-19L Loss of attitude reference in BGS leading to FTS activation on the vehicle (during guidance)	The AIB is actively investigating the GLN-MAC IMU failure. An open branch in the Fault Tree includes the LN-200, which is the primary attitude sensor in the S-19L BGS.	watch	
36.319-008	2	3	Crydom Relay Failure Ionic Contamination Susceptibility and	Given that Crydom Relay in the Shutter Door Control Box is susceptible to ionic contamination, there is potential that the component will not function as designed, leading to loss of planned inflight events (shutter door open and close).	Continue the investigation with the Galeazzi door NCR. Additional screening test (voltage scintillation tests) was completed on a replacement Shutter Door Control Box regarding the Crydom relays to detect contamination.	accept	Replacement Shutter Door Control Box tested acceptable for flight. Ionic contamination has positively occurred on 1 analyzed relay. Additional design with these relays are under scrutiny as possible implication in other subsystem inflight failures.

Promise of MBSE

- **Easier access to current, complete information.**
  - Black box and white box modeling, etc.
- **Focus on intuition not drudgery. Correct by construction.**
  - Eg. Click to make arrow is better than creating …
  - Scripts to evaluate documents and models.
- **Create multiple, relevant views and viewpoints.**
  - Pre-canned or customizable.
  - Use Case
  - Table: Allocations of Actions/Behaviors to Users
  - Diagram (ad): Process flow and decisions
  - Follow the model to a Procedure (links to other stuff in the QA Report Signoff activity)

OSMA MBMA: Future State



- **Explore integration of Safety Cases**
- **Define and explore integration of MBMA into system and analysis models**
- **Populate initial models from available data/pilots**
- **Define and begin development of relevant queries, analyses, etc.**
- **Explore and prototype view/viewpoints and MBMA dashboard**

Summary and Next Steps

- **Key Points:**
  - Easier access to current, complete information. Black box and white box modeling, etc.
  - Focus on intuition not drudgery. Correct by construction. Scripts to evaluate documents and models.
  - Create multiple, relevant views and viewpoints. Pre-canned or customizable.
- **Additional Notes**
  - A number of resources enabling viewing/interacting with the SysML model without knowing SysML
  - Very few actual toolsmiths are actually necessary
    - But, we need to capture (model) the SME general knowledge
    - Upcoming MBMA Workshop to capture Use Cases
      - May 7-8, 2019 at The Ohio Aerospace Institute just outside of NASA GRC in Cleveland, OH
      - We will have some experts there to capture SME knowledge in form of Use Cases
  - Lots of progress and opportunities to collaborate
  - Number of Efforts and Resources
    - MBSE CoP
    - MIAMI
    - MBMA CoP

Peering into the Future

- **Visionary stuff**
  - Thrust 1: Integrating S&MA into the model
    - Tests automatically have a post-test inspection inserted
    - Usage templates
    - Customization
    - More
  - Thrust 2: Lowering barrier to interaction
    - Views, Viewpoints, Portals
    - Updates and changes
    - Tracking
    - Customization
    - more

Future reviews: Same intent, better insight

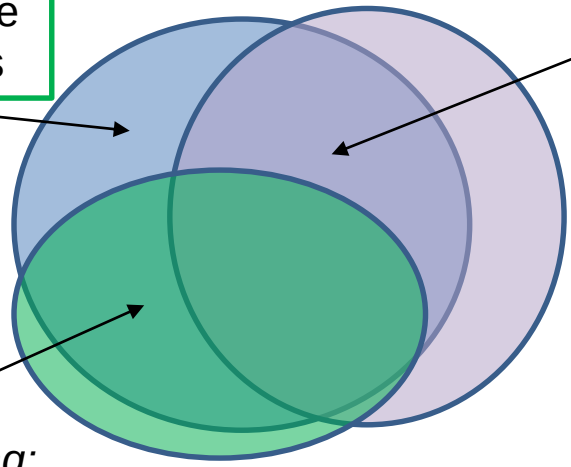
TODAY

Existing Reviews:
Policies, Practices,
Data used

FUTURE
Model-Based Reviews

Human Insight and Intuition:
Ability to examine, multiple viewpoints, multiple levels

easy Automation:
Existence,
Numerics,



Machine Reasoning:
Much can be done
Better with well-defined ontology

- **Let humans do what they do best: Intuition, Discovery, Insight, Reasoning (human)**
- **Let computers do what they do best: Numerics, Tree traversal, Consistent application of methods, Reasoning (machine)**