31st Annual INCOSE international symposium

virtual event

July 17 - 22, 2021

Model of Models Methodology: Reuse Your Architectural Data

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Outline

- Digital Engineering (DE)
- Models Based Systems Engineering (MBSE)
- MBSE Project Dataflow to Enable Digital Environment
- Model of Models Methodology (M.O.M.)
  - Justification
  - The Methodology
- Conclusion

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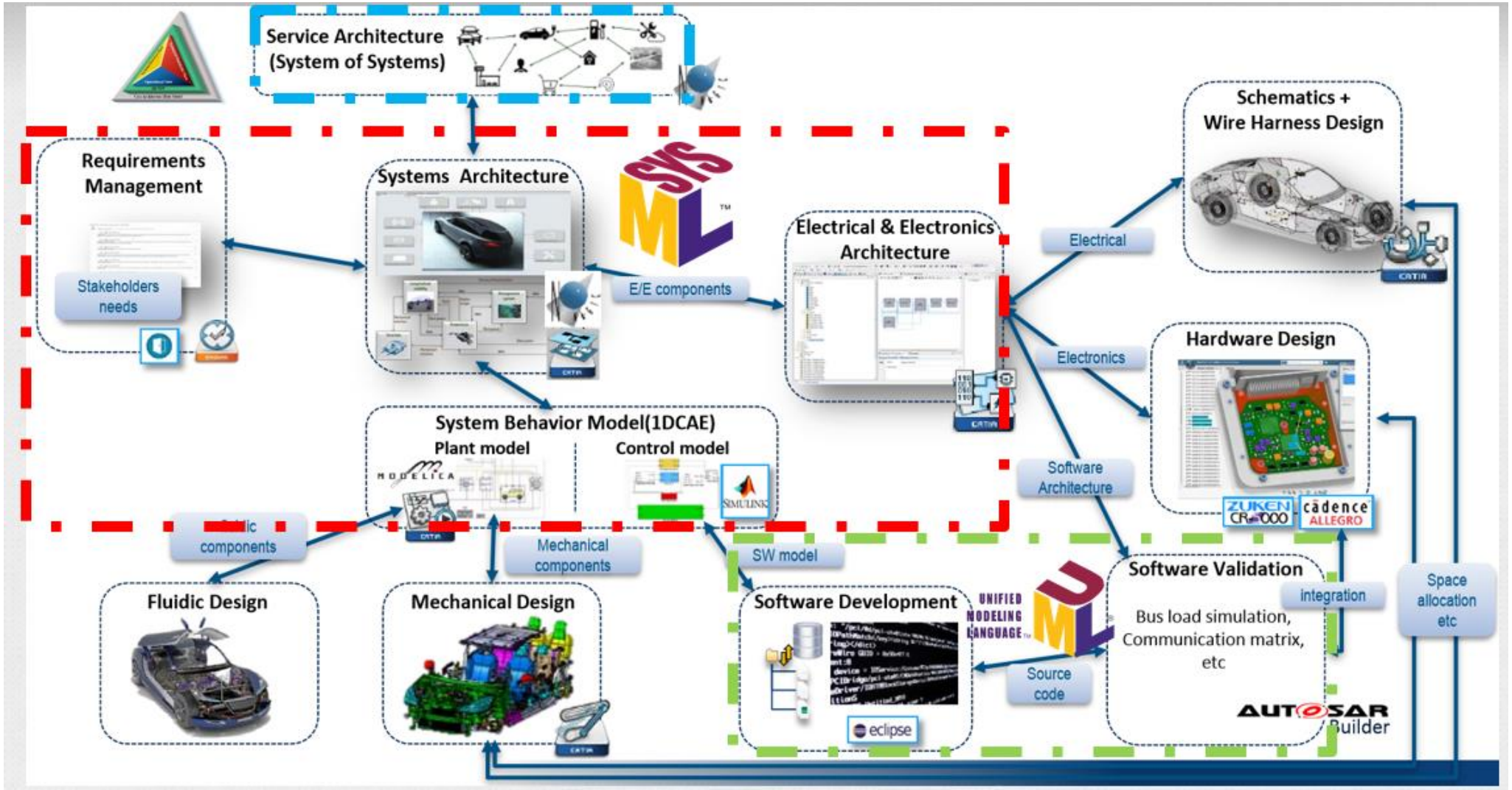
Digital Engineering (DE)

DE

- Digital Engineering (DE) Strategy
  - Informed Decision Making
  - Enhanced Communication
  - Increased Understanding
  - Increased Confidence
  - Increased Efficiency
- Processes
- Authoritative Source of Truth (ASOT)
- Digital Thread

Digital Enterprise



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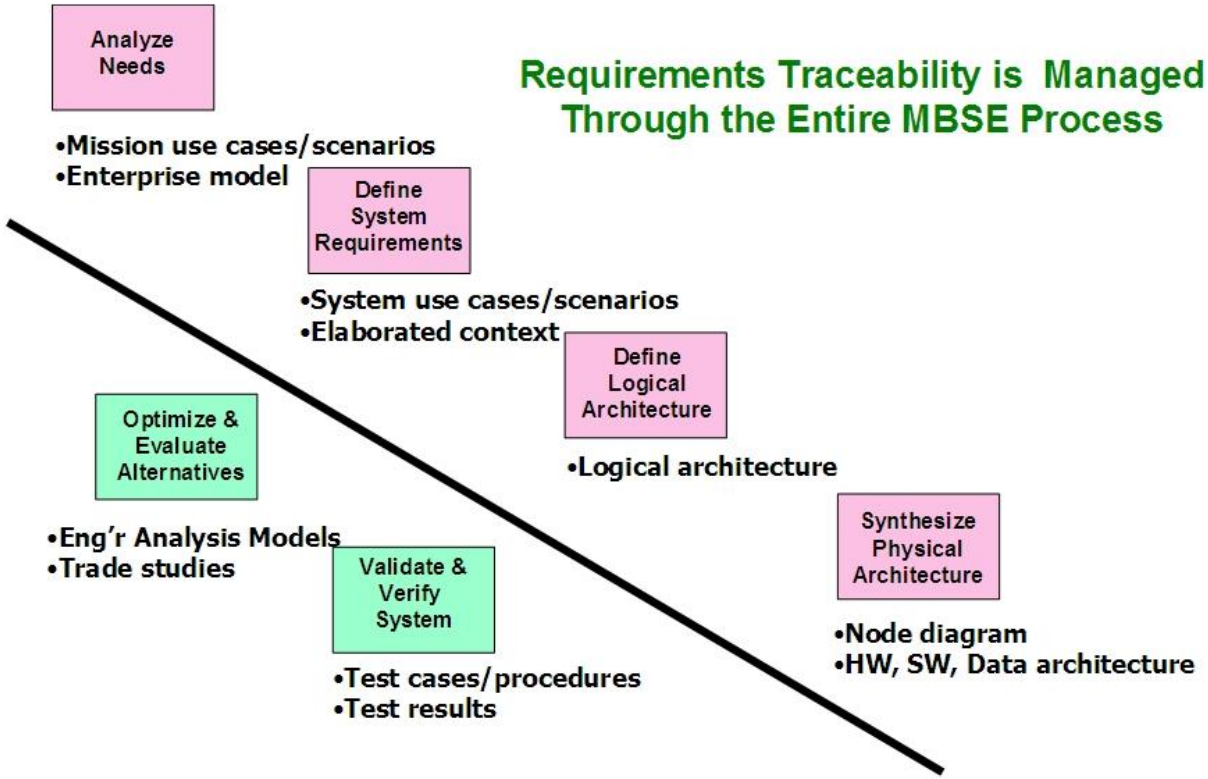
Models Based Systems Engineering (MBSE)

MBSE Pillars

- Language
- Tool
- Method
  - OOSEM
  - MTSI MBSE Process

OOSEM

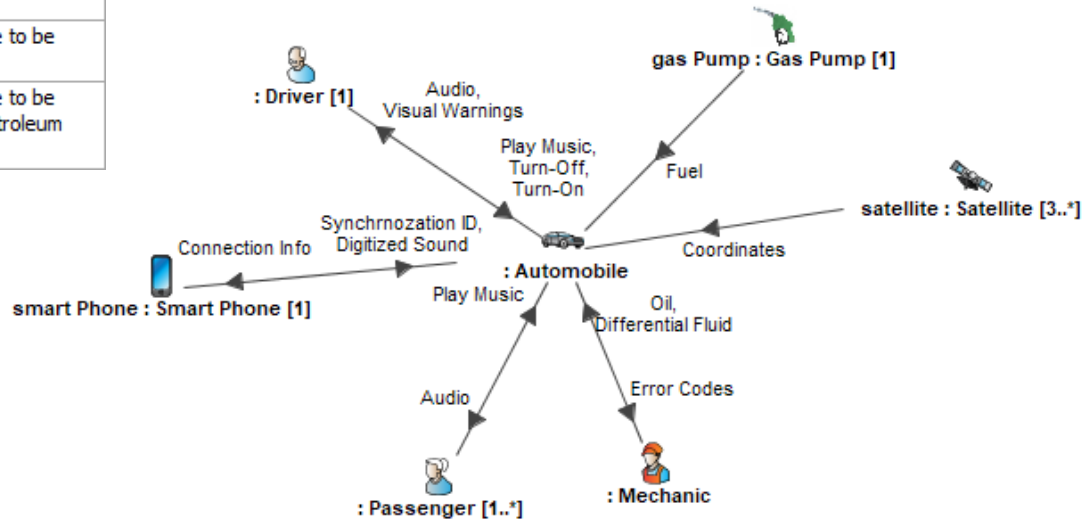
- Object Oriented Systems Engineering Method (OOSEM) built on the foundation of Object-Oriented software principles.
- **Promotes reusability and inheritance**
- **Supports Agility**
- Generic templates produced from which variants inherit

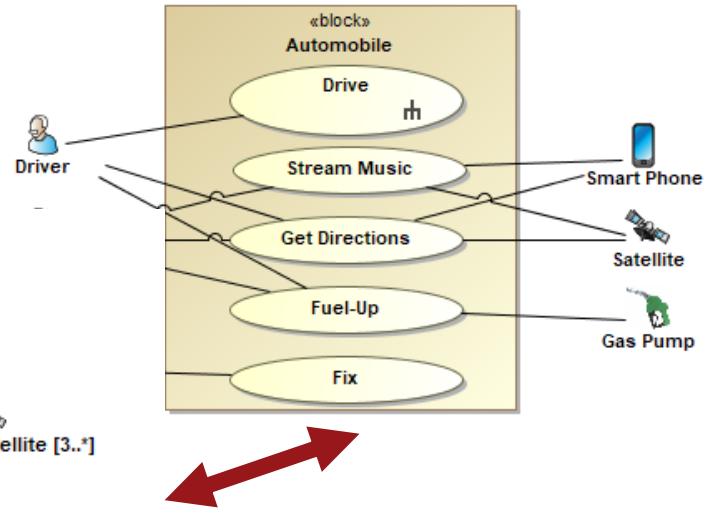


OOSEM - Conceptual Model

- High-level model that focuses on the business case for the system.
- Captures black-box on how the system will be used.
- Provides the criteria (requirements) on which the system as a whole will be evaluated.

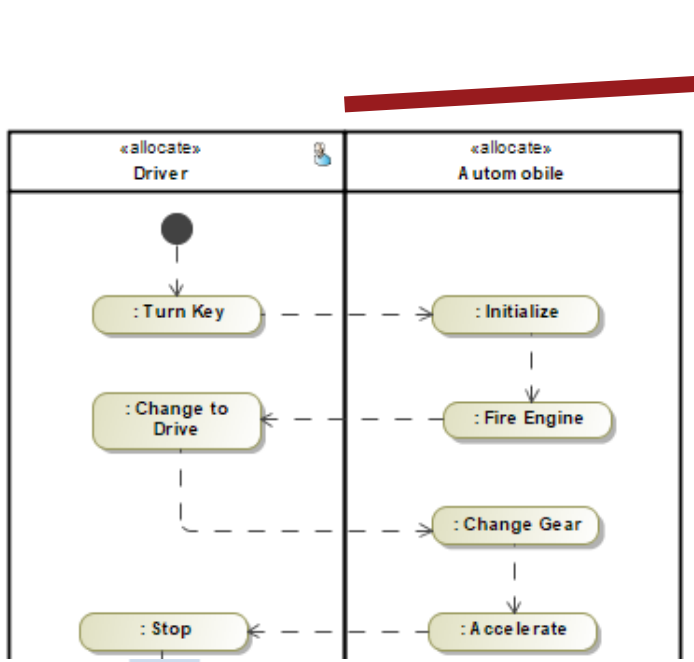
#	Name	Text
1	1 Drive	The car needs to be drivable.
2	2 Connectivity	The car needs to be able to connect to smart devices.
3	3 GPS	The car needs to know its location and be able to decide the fastest route to a target GPS location.
4	4 Fixable	The car needs to be able to be fixed by a mechanic.
5	5 Fillable	The car needs to be able to be fueled by a standard petroleum pump.



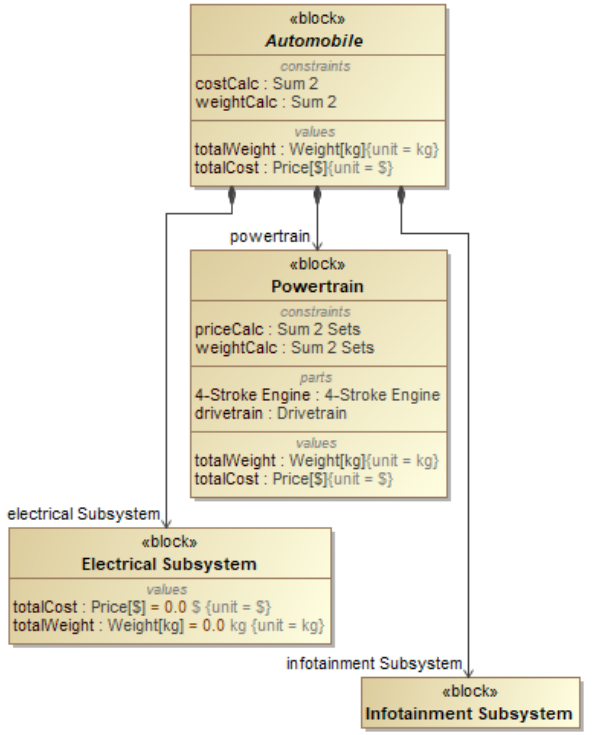


OOSEM - Logical Model

- The Logical Model is used to further define the system of interest.
- Produce a "**template**" that can be reused to produce variants.

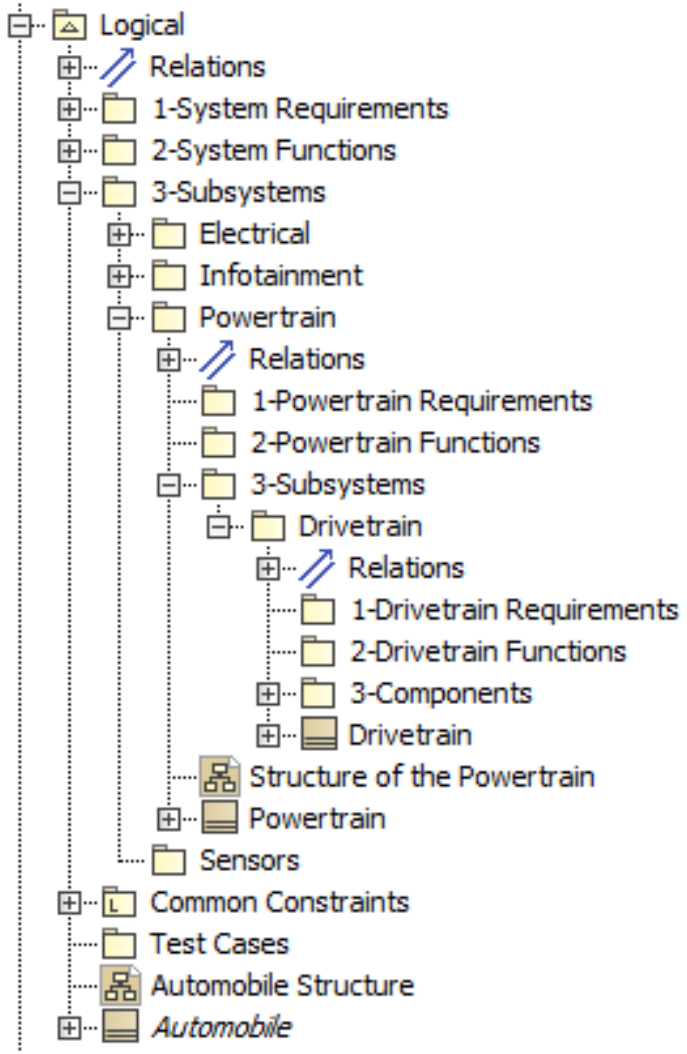


#	Name	Text	Derived From
1	6 Highway Gas Mileage	The car shall get 40 mpg on the highway in ideal conditions.	
2	7 Max Carrying Capacity	The car shall be capable of carrying over 2000 lbs.	
3	8 City Gas Mileage	The car shall get 20 mpg on city roads in ideal conditions.	
4	9 Manual Start	The car shall be able to be turned on by the driver.	1 Drive
5	10 Manual Stop	The car shall be able to be turned off by the driver.	1 Drive



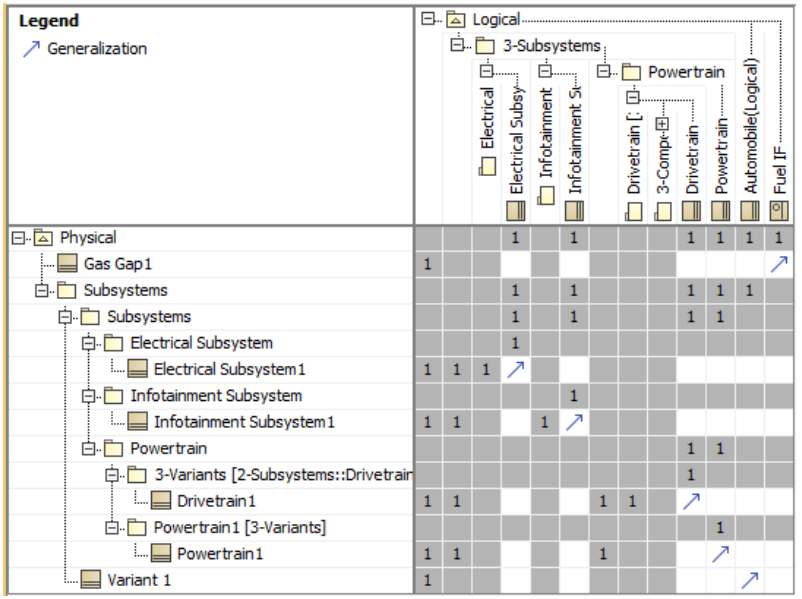
OOSEM - Logical Model Continued

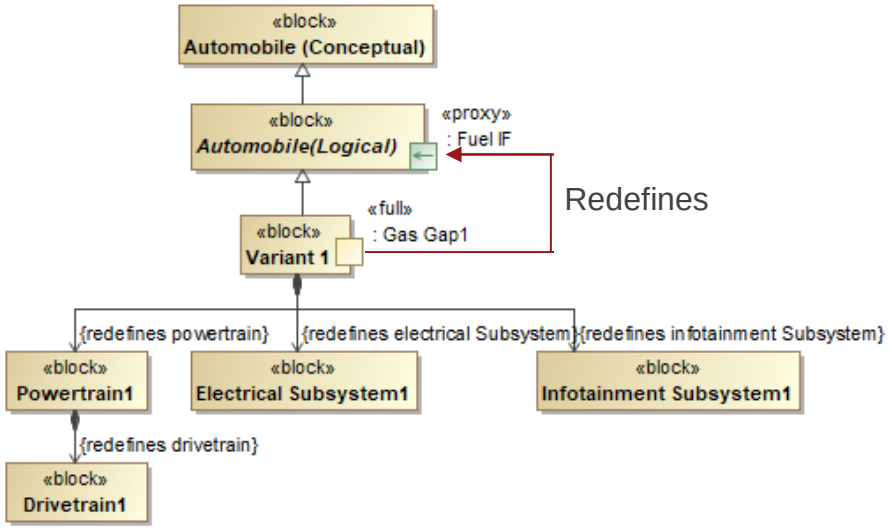
- Recursive Package Structure:
  - Ensures functions and requirements alongside structures
  - Helps with **model navigability and modularity**
  - Nested sections exportable to own projects.
  - **Improves agility**
  - Enables **divide-and-conquer**
  - **Decouples Model**



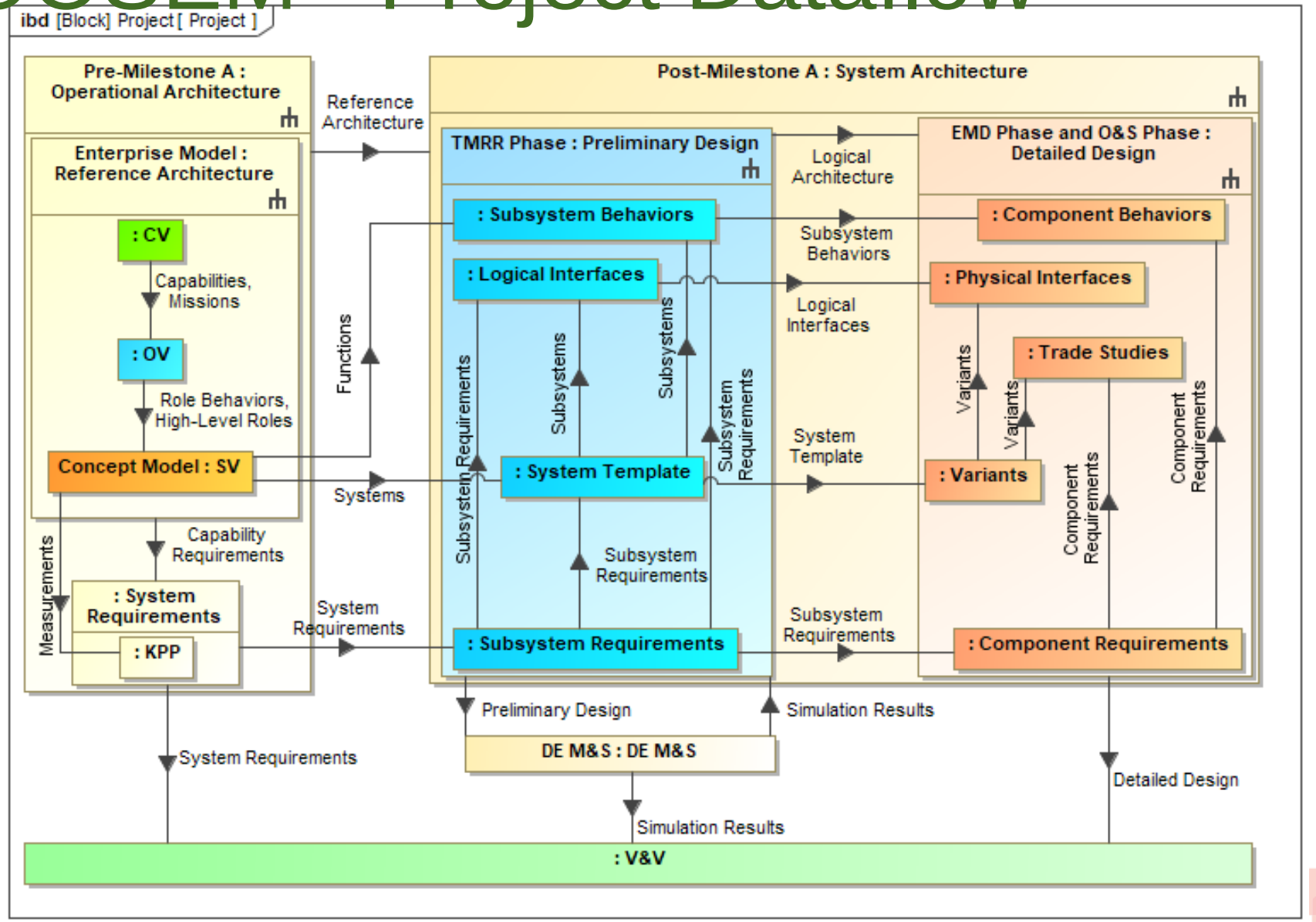
OOSEM - Physical

- Capture variants!
- Tedious process starting by creation of a physical system with physical subsystems inheriting from logical.
- The properties then get redefined where multiplicities and types for the variants are specified.
- Potentially could be sped up by MBPLE.





OOSEM - Project Dataflow

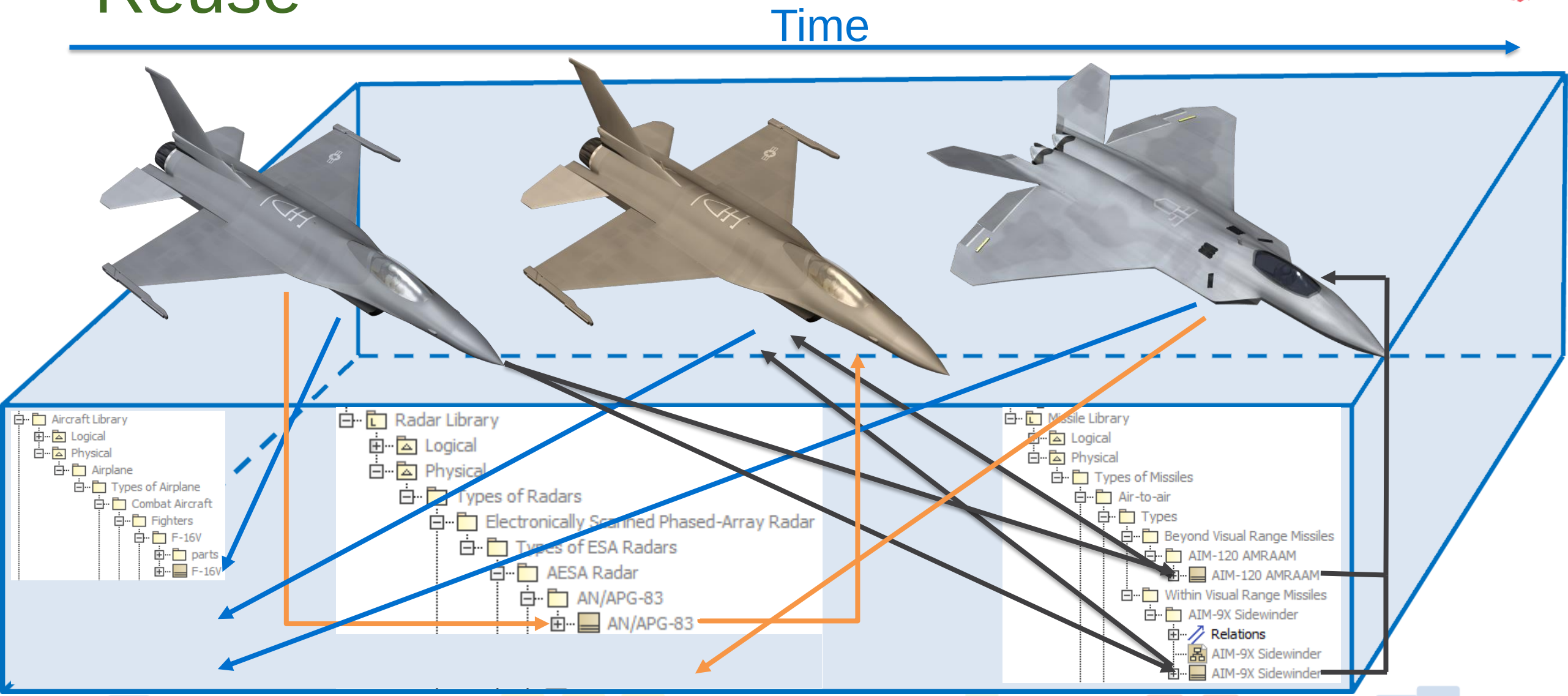


Legend

- Architecture Types
- Capability View
- Operational View
- Systems View
- V&V Environment
- Logical Model
- Physical Model

M.O.M. Methodology (The Goal)

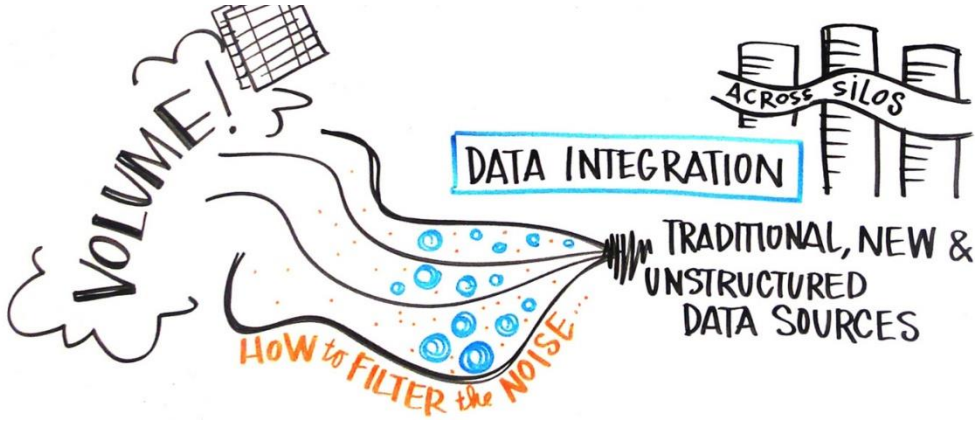
Reuse


Time
Aircraft Library
Logical
Physical
Airplane
Types of Airplane
Combat Aircraft
Fighters
F-16V
parts
F-16V
Radar Library
Logical
Physical
Types of Radars
Electronically Scanned Phased-Array Radar
Types of ESA Radars
AESA Radar
AN/APG-83
AN/APG-83
Missile Library
Logical
Physical
Types of Missiles
Air-to-air
Types
Beyond Visual Range Missiles
AIM-120 AMRAAM
AIM-120 AMRAAM
Within Visual Range Missiles
AIM-9X Sidewinder
Relations
AIM-9X Sidewinder
AIM-9X Sidewinder

The M.O.M. Methodology

How M.O.M. Differs

- In traditional MBSE, all information may captured in one monolithic model.
- Problem of team members not “staying-in-their-lane” arises where people often “assist” other teams overstepping bounds.
- Model management challenges due to model size increases (big data challenge).
  - increasing model load times
  - contributors overstepping
  - More difficult CM



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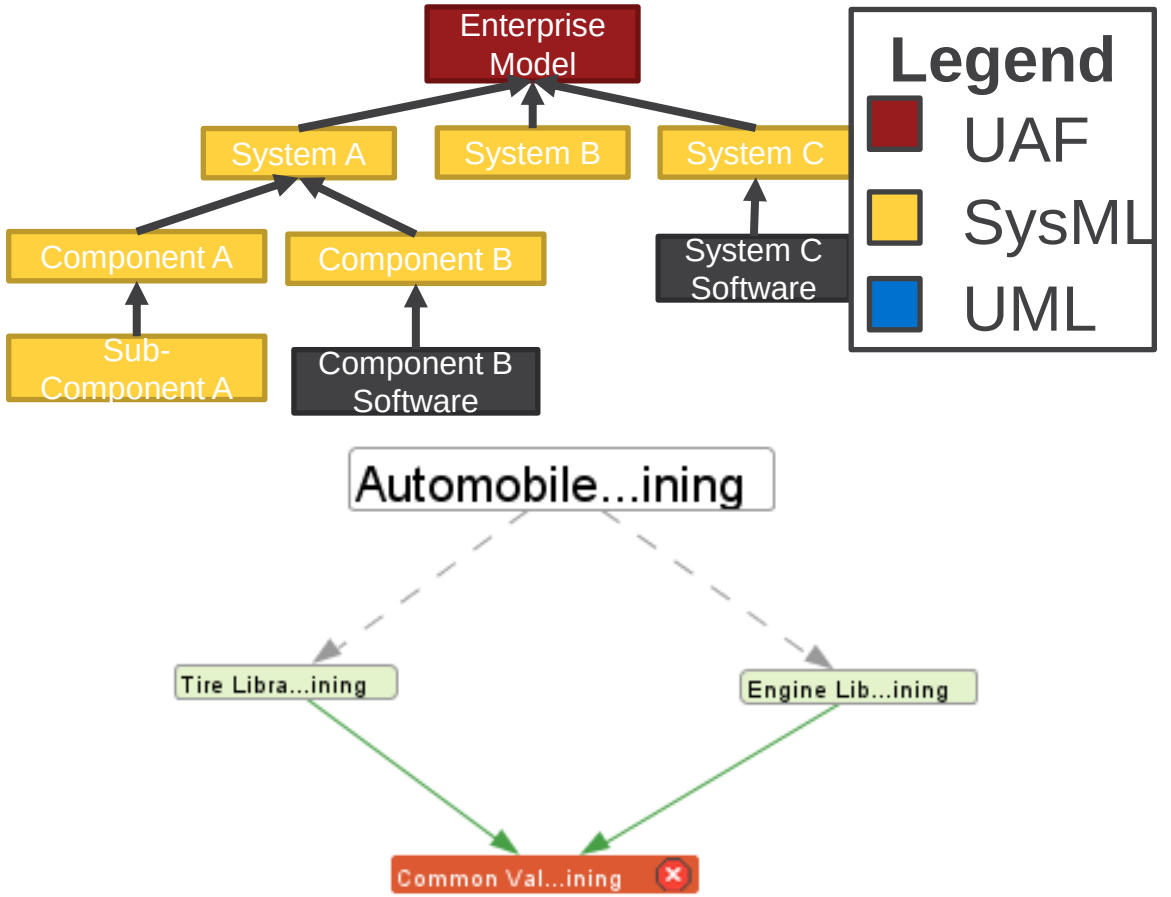
M.O.M. (The Facts)

- Many systems are becoming system-of-systems, and all enterprises are composed of systems.
- No one person builds a system from the system-of-systems level down to the resistor level.
- AHA! Point at which components are captured at black-box level.
- Variants of components are measured against one another to determine which one(s) best meets the needs of our system variant.
- Recursive operation all the way down to the component fabrication.

M.O.M. (The Solution)

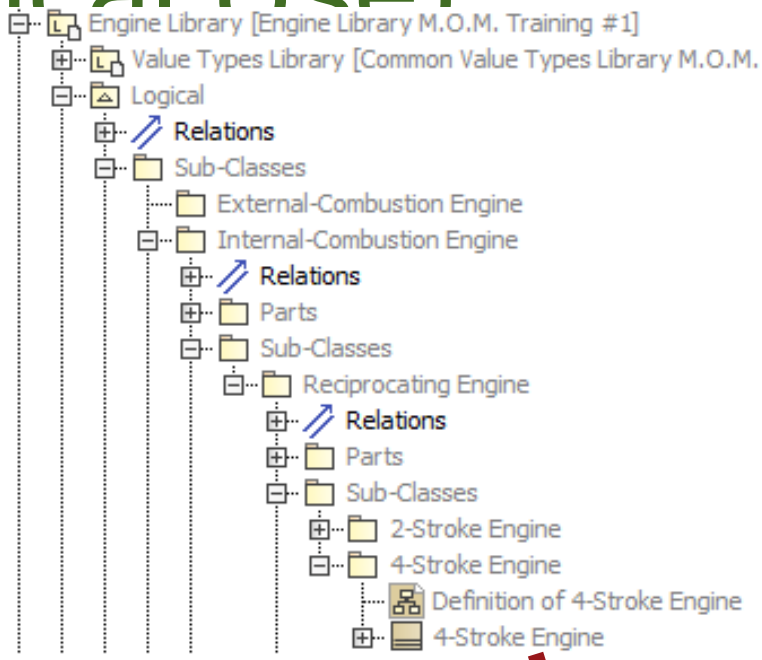
- Using modularity and OOSEM, create projects for each system and for components.
- Component treated as its own system
  - OOSEM process observed at the higher-level system supplying both a logical model of the component and its variants.
- These projects will use other projects to supply their components.
- Each “component” project will be managed by the teams that are responsible for them.
- Tree of used projects, where
  - Only elements directly used within the project will be loaded when the project is opened drastically reducing the memory usage.

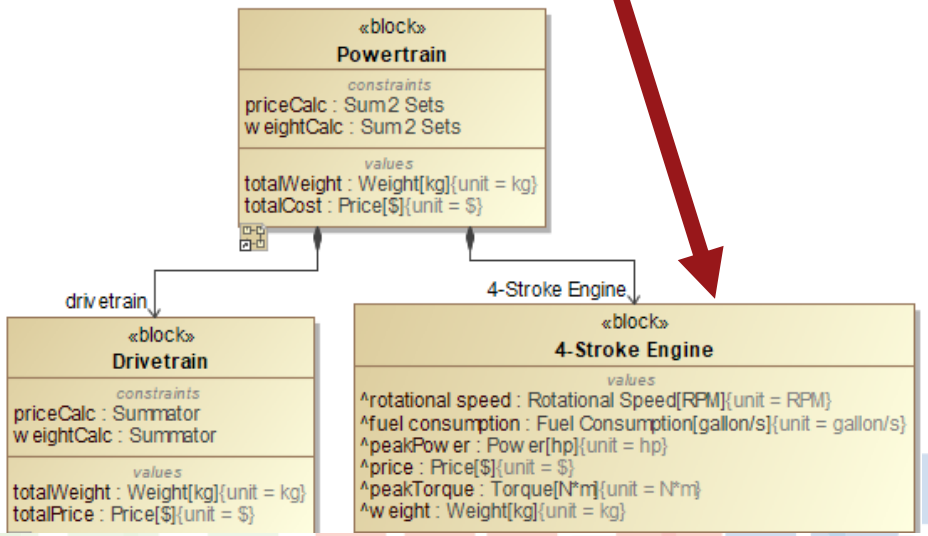


M.O.M. (The Solution Logical Use)

- Components defined in their respective models, with
  - Only as much detail as necessary
  - Component models then used in higher-level system models.

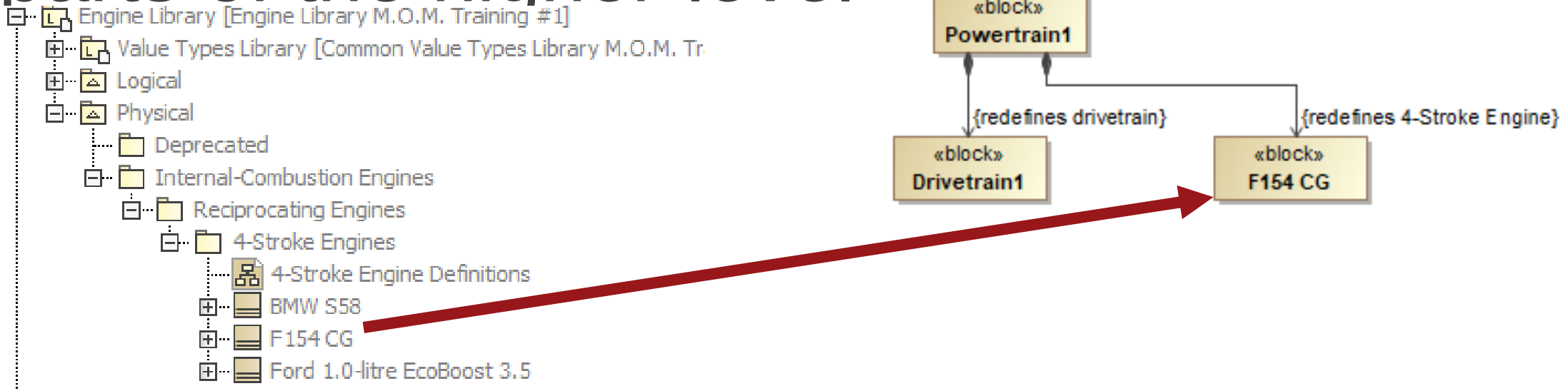
- The logical structures will be used to type parts in the logical portion of the higher-level system.





M.O.M. (The Solution – Variant Use)

- Component variants are used in the higher-level system models to type the parts of the higher-level subsystems



The Value Statement

1. **Reusability**
    1. One of the biggest advantages to MBSE is reuse
    2. Reuse prevents us paying for the same artifacts to be defined each time it is used
    3. Teams operate in parallel creating what's new and using what's baselined.

2. **Process**
    1. One of the biggest cripplers to MBSE is not using an established process on a program
    2. Often times, MBSE fails due to non-standardized tooling or non-standardized process in a program.

3. **Digital Thread**
    1. The M.O.M. process ensures the digital thread through inheritance across abstraction layers
    2. As such, one can "pull" the thread back to the origin point (e.g. the capability this system is supposed to exhibit)

4. **Modularity**
    1. Modularity enables complex problems to be broken down, solved, and baselined by the experts that solve them.
    2. Helps folks to "stay in their lane" and stop "assisting" others in tasks they are not assigned

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Importance of Tools

Importance of Tools

- The M.O.M. process should be tool-agnostic as it is SysML “pure”
- As libraries grow, the redefinition process can be time-consuming and tedious.
- Tools that enable automating some of this process are be increasingly more valuable.

Conclusion

1. Demand for DE and MBSE rapidly increasing
2. M.O.M. built on top of OOSEM with the primary objectives of:
    1. increasing reuse and modularity
    2. reducing time spent designing architecture
3. M.O.M. already in use and successful

Questions

- Email questions to:
  - joseph.mccreless@mtsi-va.com

- For more information about MTSI, please visit:

  www.mtsi-va.com

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