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# Integration of Requirements Management and Architectural Modeling

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- Not a presentation focusing on requirements or requirements management...

*....but will touch on why requirements are important.*

- Not a presentation focusing on architecture methods and notation...

*....but will mention some of them by way of example.*

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This is a presentation on how combining architecture models with requirements can be effective for.....

- Enhancing communication with customers, development team, and subcontractors, thereby reducing the chances of misinterpretation of data and concepts.
- Smoother integration of components and systems (SoSE).....fewer surprises.
- Verify that systems being built perform to specification

# ***What are Requirements?***

*(They are the TO-DO List of the Project Team)*

- List of the goals and objectives of the business
- List of what the users need
- List of what the system must do to satisfy user and business needs
- List of what components must be built
- List of what each component must do, and how components will interact

# The Role of Requirements

- Come to an agreement with the customer and users on what the system should do
- Give system developers a better understanding of the system
- Delimit the system
- Provide basis for planning technical iterations
- Provide basis for performing system tests (Verification)
- Provide a basis for acceptance (Validation)



# Are textual requirements enough.....

....to effectively and efficiently build,  
integrate and deploy a system or System of  
Systems?

**Formal**  
File Edit  
Standard v  
ID  
UR-356  
UR-357  
UR-484  
UR-3  
**2 User Types**  
UR-4 This section describes the  
UR-5 **2.1 Nationalities**  
UR-6 The car will be used in the Europe, Australia & New Zealand.  
UR-552 Telelogic is purchasing a file:///C:/DOORS Projects  
UR-644 Brand management and su  
UR-780 will be contract http://www.m  
UR-9 **2.2 Target**  
UR-10 The car will be range.  
UR-11 **3 Require**  
UR-12 This section co  
UR-13 **3.1 Capabi**  
UR-14 **3.1.1 Carry**  
UR-547 The car shall bi  
UR-746 The car shall bi

**2 Testing Specs**  
8 **2.1 Capability Tests**  
9 **2.1.1 Carrying Capacity**  
10 Driving, safety and road tests will be conducted by a test vehicle.  
11 ft. 5 in. in height.  
13 Road test will be conducted utilizing four average size and level of comfort provided by the top 40% of cars produced.  
17 Driving, safety and road tests will be conducted utilizing standard footwear.

ID	Description	0.00	3080.00	3080.00	0.00	3080.00
1.1	<b>1.1.1 Engine block</b>	0.00	3080.00	3080.00	0.00	3080.00
1.2	<b>1.1.2 Pistons</b>	0.00	880.00	880.00	0.00	880.00
1.3	<b>1.1.3 Crank shaft</b>	0.00	2400.00	2400.00	0.00	2400.00
2	<b>1.2 Body equipment manufacture</b>	0.00	15000.00	15000.00	0.00	15000.00
2.1	<b>1.2.1 Internal</b>	0.00	4000.00	4000.00	0.00	4000.00
2.2	<b>1.2.2 External</b>	0.00			0.00	3000.00
3	<b>1.3 Gear box manufacture</b>	0.00			0.00	3360.00
3.1	<b>1.3.1 Casing</b>	0.00			0.00	1200.00
3.2	<b>1.3.2 Internal gearing</b>	0.00			0.00	840.00
4	<b>1.4 Clutch assembly</b>	0.00			0.00	0.00
4.1	<b>1.4.1 Clutch plates</b>	0.00			0.00	0.00
4.2	<b>1.4.2 Clutch springs</b>	0.00			0.00	0.00
5	<b>1.5 Electrical equipment manufacture</b>	0.00			0.00	0.00
5.1	<b>1.5.1 Distributor</b>	0.00			0.00	0.00
5.2	<b>1.5.2 Plugs</b>	0.00			0.00	0.00
5.3	<b>1.5.3 Points</b>	0.00			0.00	0.00
6	<b>1.6 Entertainment System</b>	0.00			0.00	0.00
6.1	<b>1.6.1 Sound System</b>	0.00			0.00	0.00

**San Diego CHAPTER**

**INCOSE Region II Fall Mini-Conference**

**Formal module '/Passenger Car/**

ID	User requirements for passenger
UR-356	<b>1 Introduction</b>
UR-357	These are the initial user r
UR-484	<u>All requirements ©200</u>
UR-3	This module contains the
UR-3	commercially available by
UR-3	<b>2 User Ty</b>
UR-4	This section de
UR-5	<b>2.1 Nation</b>
UR-6	The car will be
UR-552	Europe, Austra
UR-644	<a href="file:///C:/DOOQ">file:///C:/DOOQ</a>
UR-780	Telelogic is pur
UR-780	Brand manager
UR-9	will be contract
UR-10	<a href="http://www.m">http://www.m</a>
UR-11	<b>2.2 Target</b>
UR-12	The car will be
UR-13	range.
UR-14	<b>3 Require</b>
UR-547	This section co
UR-746	<b>3.1 Cap:</b>
UR-746	<b>3.1.1 Ca</b>
UR-746	The car she
UR-746	The car she

**Formal module '/Passenger Car/Test Requirements' current 0.0 - DOORS**

ID	Testing specifications for passenger car
4	<b>1 Introduction</b>
5	These are the initial test specifications t
6	passenger motor vehicle.
	This module contains the test specification
	commercially available by 1 October 2004

**Formal module '/LifeCycle Demo/MS Project Car plan' current 0.4 - DOORS**

WBS	6. from microsoft project	Actual Cost	Baseline Cost	Cost	BCWP	BCWS
0	<b>1 CAR</b>	35000.00	48880.00	48880.00	15000.00	2032
1	<b>1.1 Power train manufacture</b>	0.00	12960.00	12960.00	0.00	1296
1.1	<b>1.1.1 Engine block</b>	0.00	3080.00	3080.00	0.00	3080
1.1.1	<b>1.1.1.1 Pistons</b>	0.00	880.00	880.00	0.00	880.
		00.00	2400.00	2400.00	0.00	2400
		000.00	15000.00	15000.00	0.00	15000
		00.00	4000.00	4000.00	0.00	4000
		00.00	3000.00	3000.00	0.00	3000
		40.00	6240.00	6240.00	0.00	3360
		00.00	1200.00	1200.00	0.00	1200
		60.00	1960.00	1960.00	0.00	840.
		80.00	5280.00	5280.00	0.00	0.00
		0.00	880.00	880.00	0.00	0.00
		00.00	2200.00	2200.00	0.00	0.00
		80.00	4880.00	4880.00	0.00	0.00
		0.00	600.00	600.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00
		0.00	0.00	0.00	0.00	0.00

• What are we building?

• Are there subsystems?

• If there are subsystems, how do the integrate?

• How do we create a Work Breakdown Stucture (WBS)?

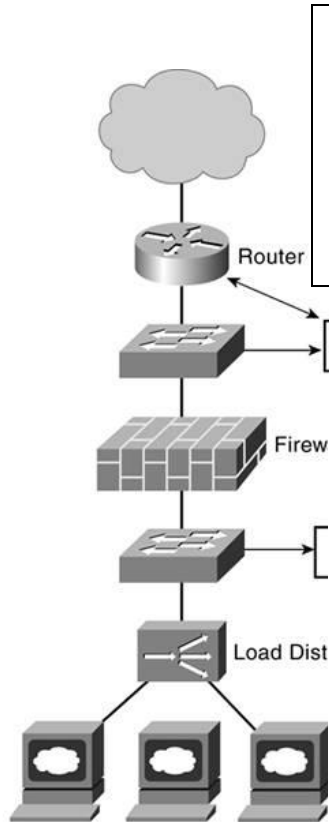
• At what level do we test?

**Text requirements leave a lot of unanswered questions, especially in the area of systems integration and test.**

30 **2.1.4 Ease of Access**

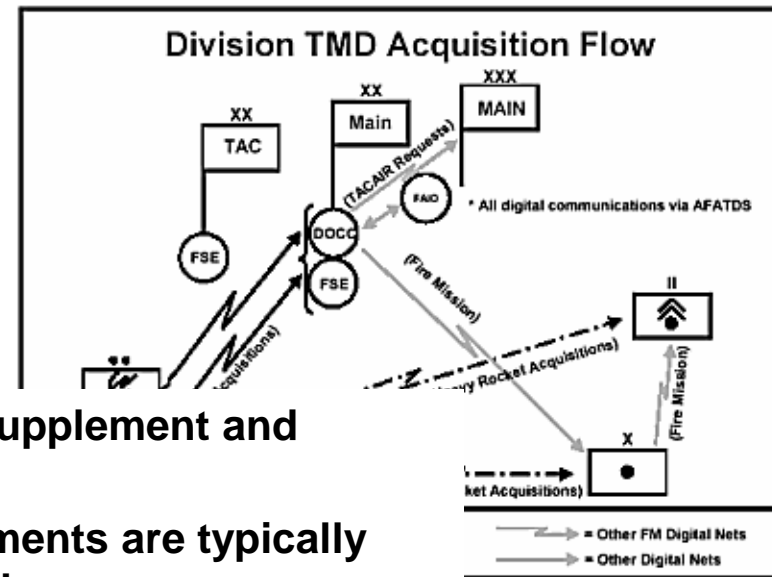
31 Driving tests will be conducted utilizing standard footwear.

# The Model is **not** the Requirement



- What are the goals of the system?
- What are the user needs?

- Textual requirements supplement and explain the models
- non-functional requirements are typically not captured in a model
  - Performance
  - Safety
  - Ease-of-use
  - Time lines
  - Etc...
- a graphical model is generally insufficient as a contractual basis.



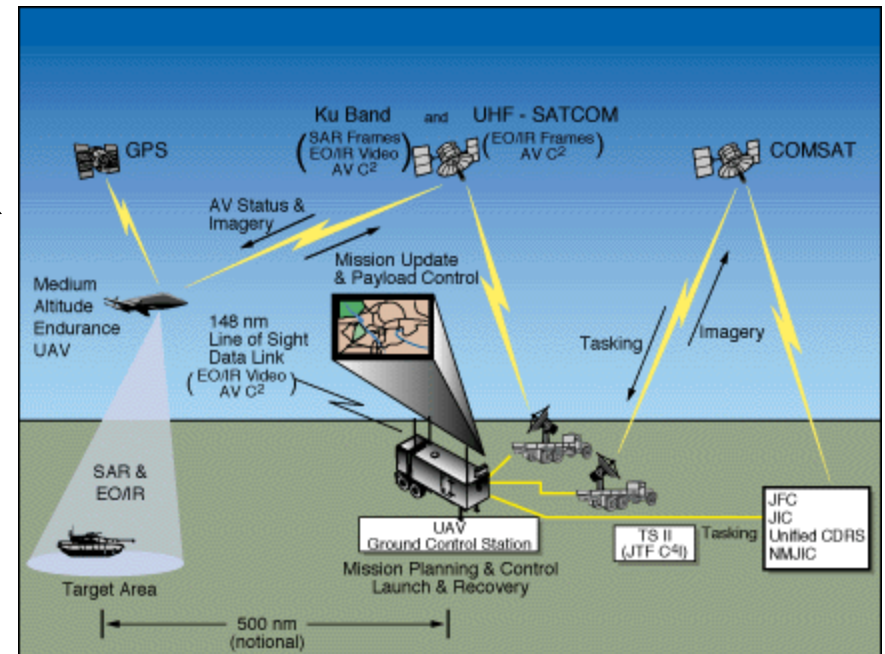


# Now we can see the Big picture...

Requirements Document



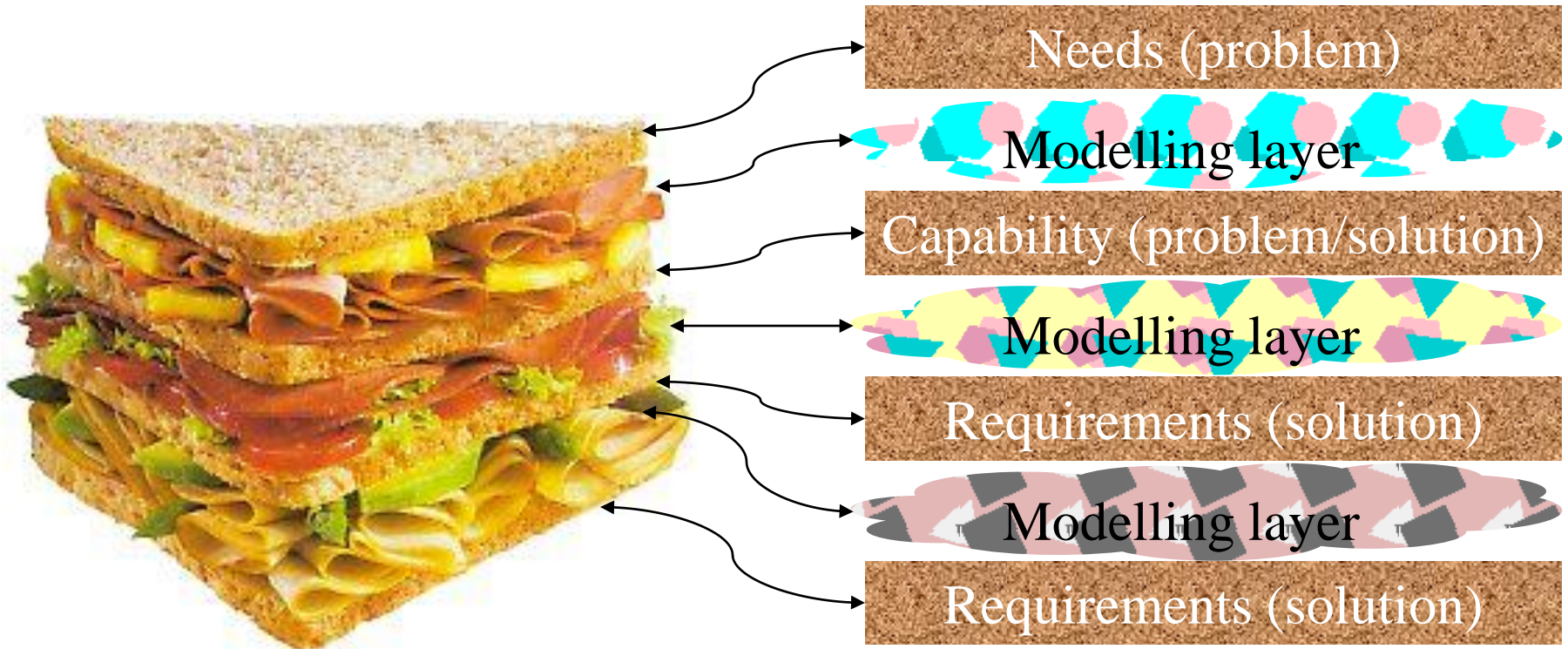
- We know what we are building.
- There are subsystems.
- We understand high level integration.
- Rough idea of Work Breakdown Structure (WBS).
- Rough idea of test.



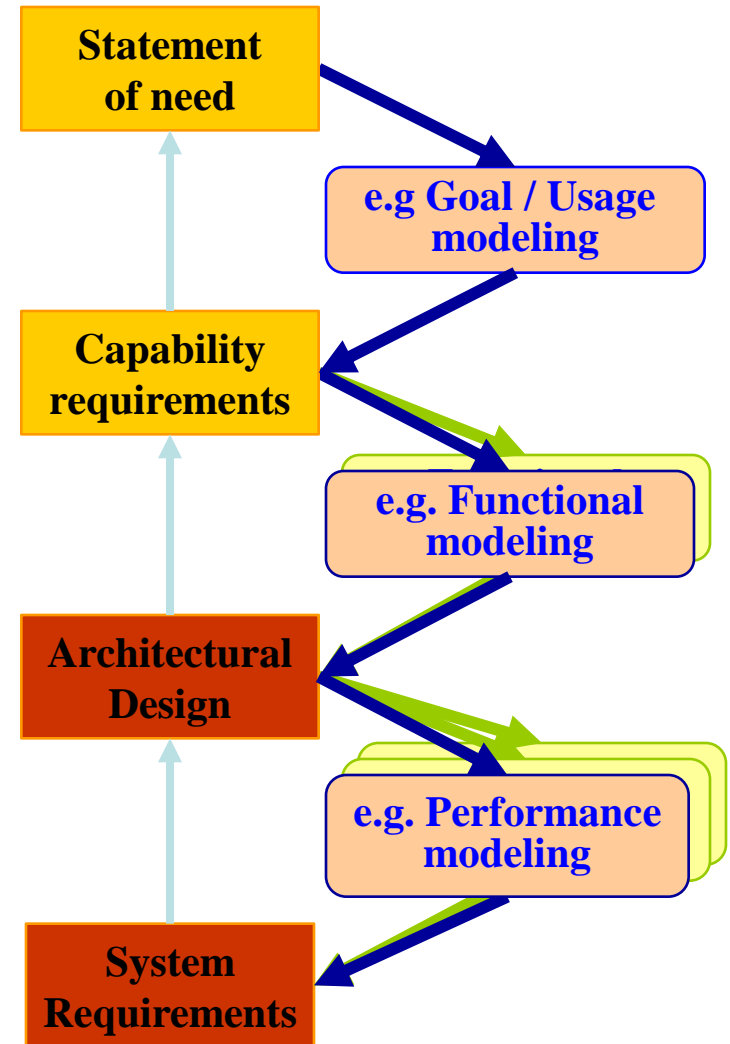
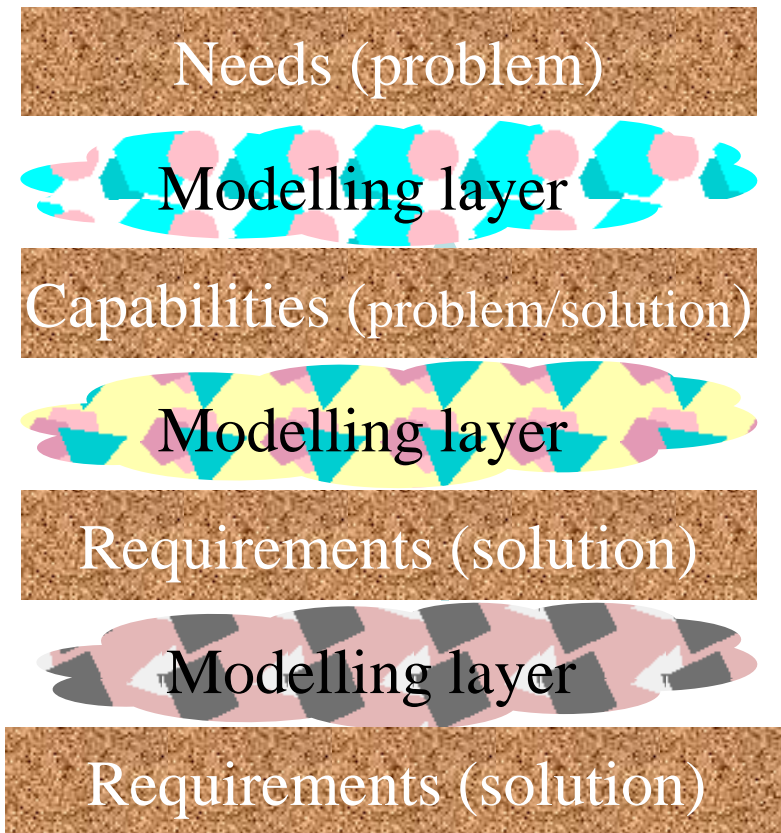
# Managing Complexity – Divide and Conquer

Relating Requirements  
To  
Systems of Systems Engineering (SoSE),  
Systems Engineering

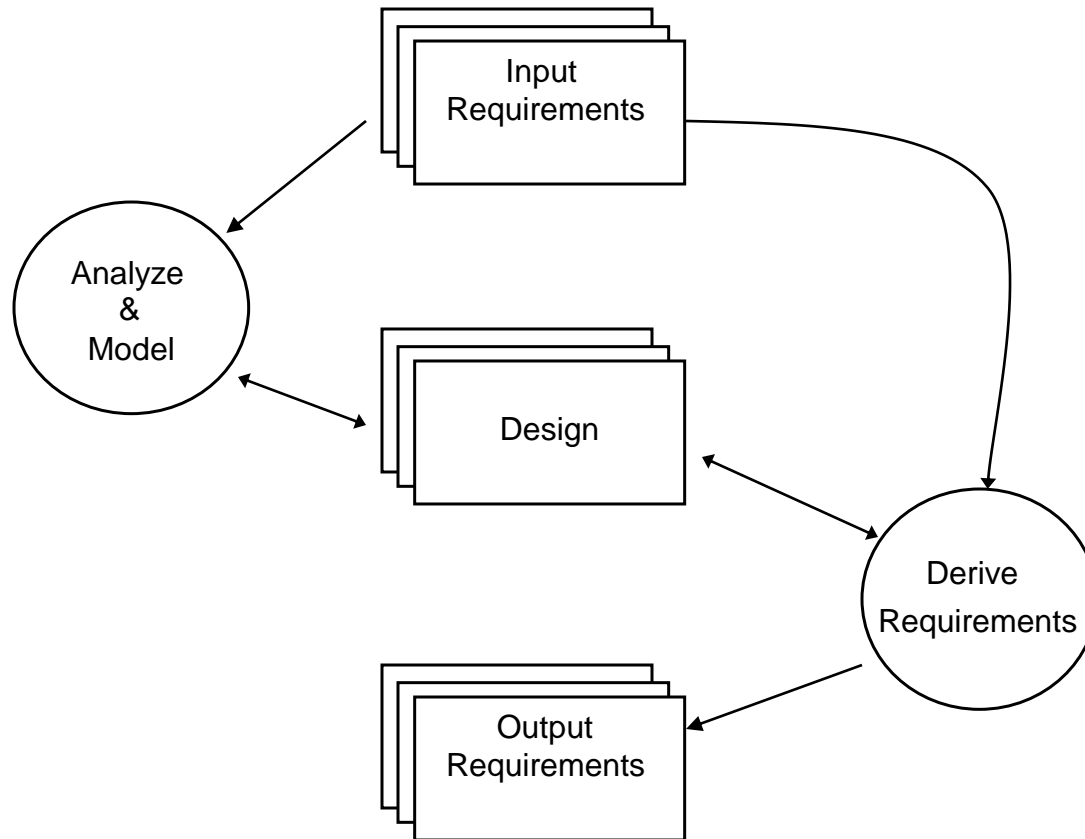
# Capability Driven, Architecture Centric, Model Based Club Sandwich



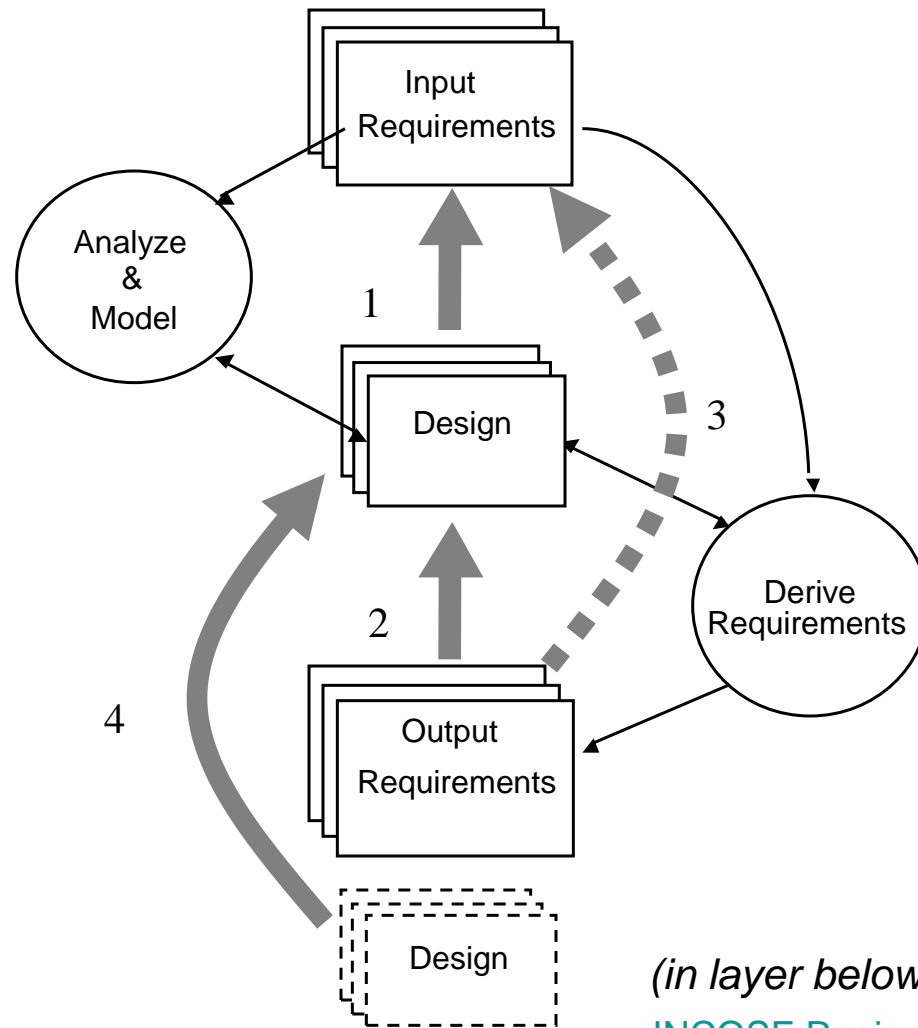
# Models Bridge Layers of Requirements



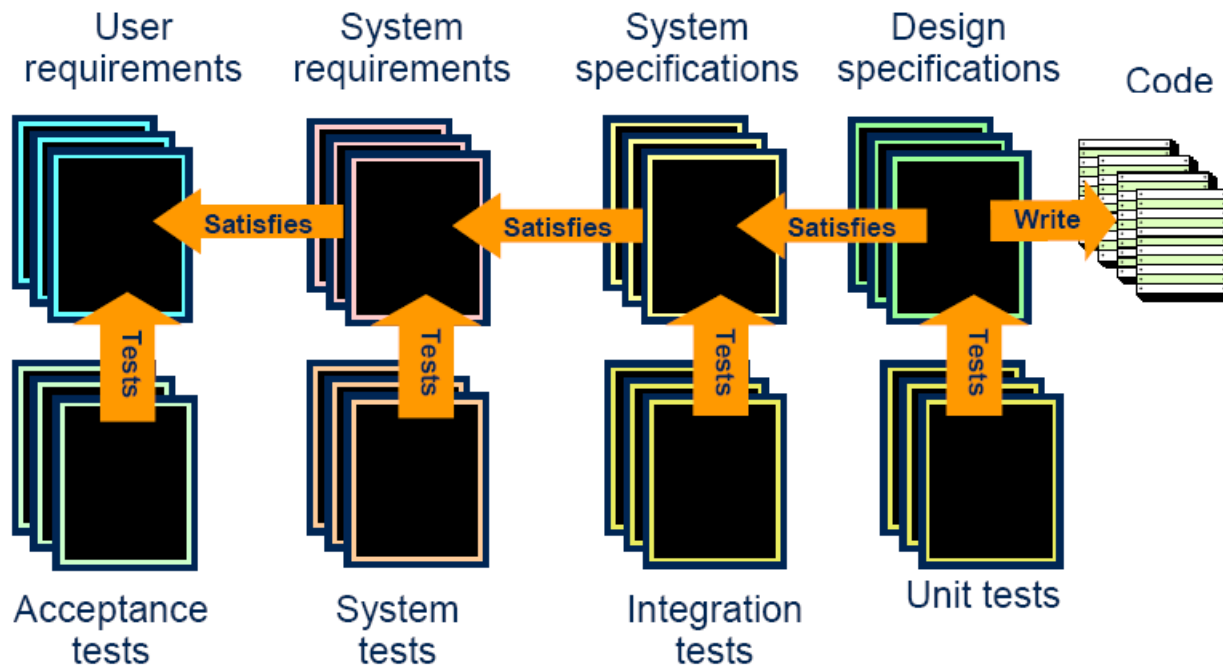
# Basic Process for Systems Engineering



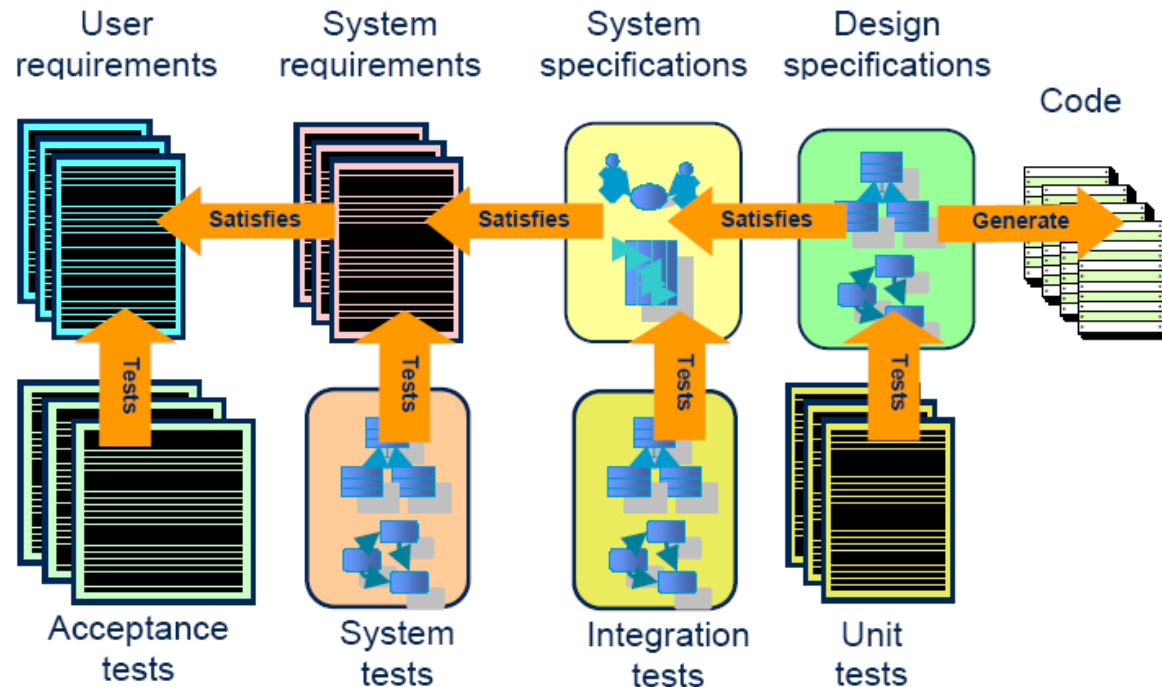
# Basic Process for Systems Engineering Showing Traceability



In traditional requirements management, documents are produced, and relationships between elements of those documents are established, as outlined below:



Modeling has been shown to be an essential part of project development, aiding in the visualization and clarification of requirements and assuring their robustness and structural integrity.



A natural flow is established from those setting the original requirements to those developing and launching the final product,



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# Integrating Requirements Management and Architectural Modeling

Examples:

**D**epartment of **D**efense **A**rchitectural **F**ramework - (**DoDAF**)

**S**ystem **M**odeling **L**anguage – **SysML**

**S**imulation for Requirements Verification

# What is DoDAF

## (Department of Defense Architecture Framework)?

- ***“The DoDAF version 1.0 defines a common approach for DoD architecture description, development, presentation and integration for both warfighting operations and business processes. The DoDAF is intended to ensure that architecture descriptions can be compared and related across organizational and mission area boundaries, including joint multi-national boundaries and DoD warfighting and business domains.”***
  - Excerpt from memo from John P. Stenbit, CIO, Department of Defense, February 2004.

• DoDAF supersedes C4ISR Architecture Framework

# Interoperability Is Key To Successful Military Operations

- Breakdown in communications leads to:
  - ‘Friendly fire’ incidents
  - Lack of co-ordination of units
- ‘Net-Centric Operations and Warfare’ is the solution
  - Effective communications between forces
  - Compatible technologies
  - Interoperable systems
- Requires a standard way to describe systems and their interfaces
  - So that ‘touch points’ can be checked for compatibility before the system is developed
  - Helps when new capabilities are ‘grafted’ onto existing systems

# DodAF – OV-2 Operational Node Connectivity

Formal module '/Sample/MFCS' current 0.0 - DOORS

File Edit View Insert Link Analysis Table Tools User Help

Standard view All levels

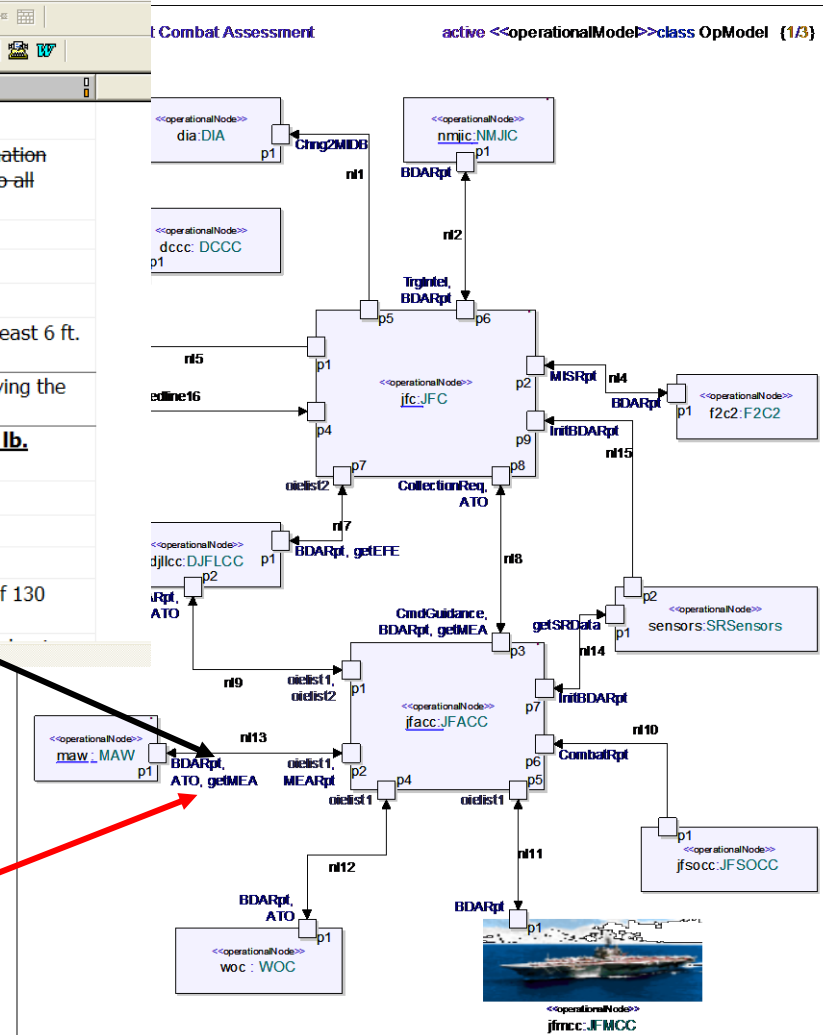
ID	Missile Fire Control System
req-1	<b>1 System Interface definitions</b>
req-2	The system shall receive radar messages containing Target Tracking information (Position, Heading, Height, Speed, Identification Friend or Foe (IFF) code fro all tracks from the radar system.
req-3	The system shall assign a track ID to each track. a change
req-24	<b>1.1 Signal Definitions</b>
req-25	<b>1.1.1 Subsystem Interfaces</b>
req-26	• Driving, safety and road tests will be conducted by a test driver at least 6 ft. 5 in. in height.
req-27	• Road test will be conducted utilizing four average size adults satisfying the level of comfort provided by the top 40% of cars produced in 2000.
req-28	• Driving, safety and road tests will <u>be conducted utilizing a 240 lb. weight in the luggage</u> compartment.
req-29	<b>1.1.2 Signal Field Defintion</b>
req-30	<b>1.1.2.1 Speed &amp; Acceleration</b>
req-31	<b>1.1.2.1.1 Signal Timing specs</b>
req-32	A radar gun will be utilized to determine the vehicle can maintain a speed of 130 mph on a flat, straight road with minimal wind conditions.

OIEs – show interfaces between operational nodes

Can be linked to

Interface Description Reqs.

Information Exchanges

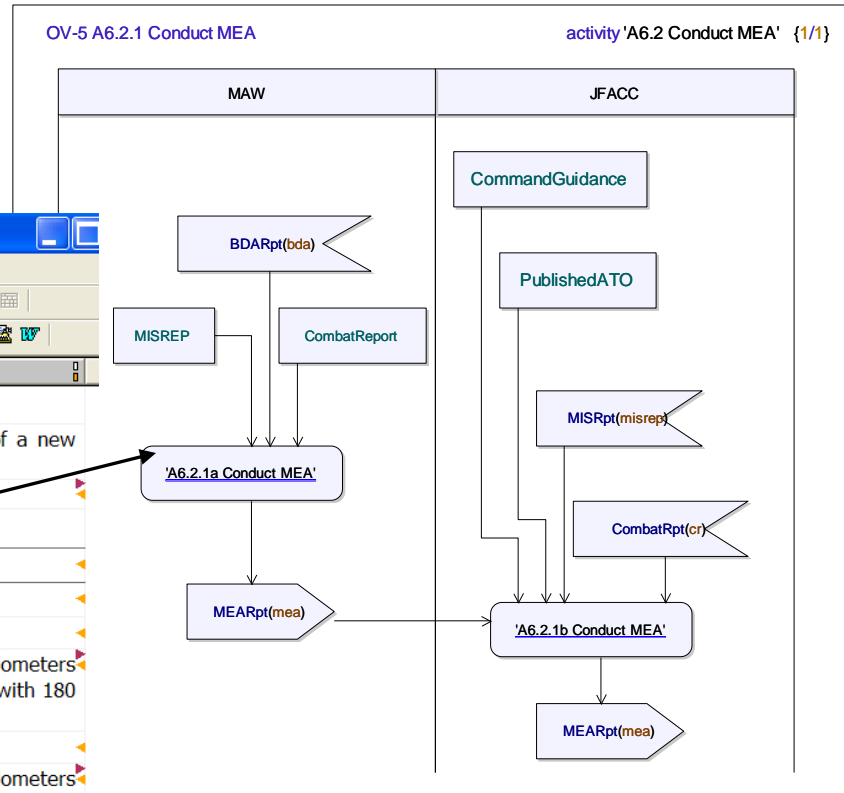


# DodAF – OV-5 Operational Activity

OV-5 decomposition of activity per  
Op\_Node

links to  
Functional Requirements

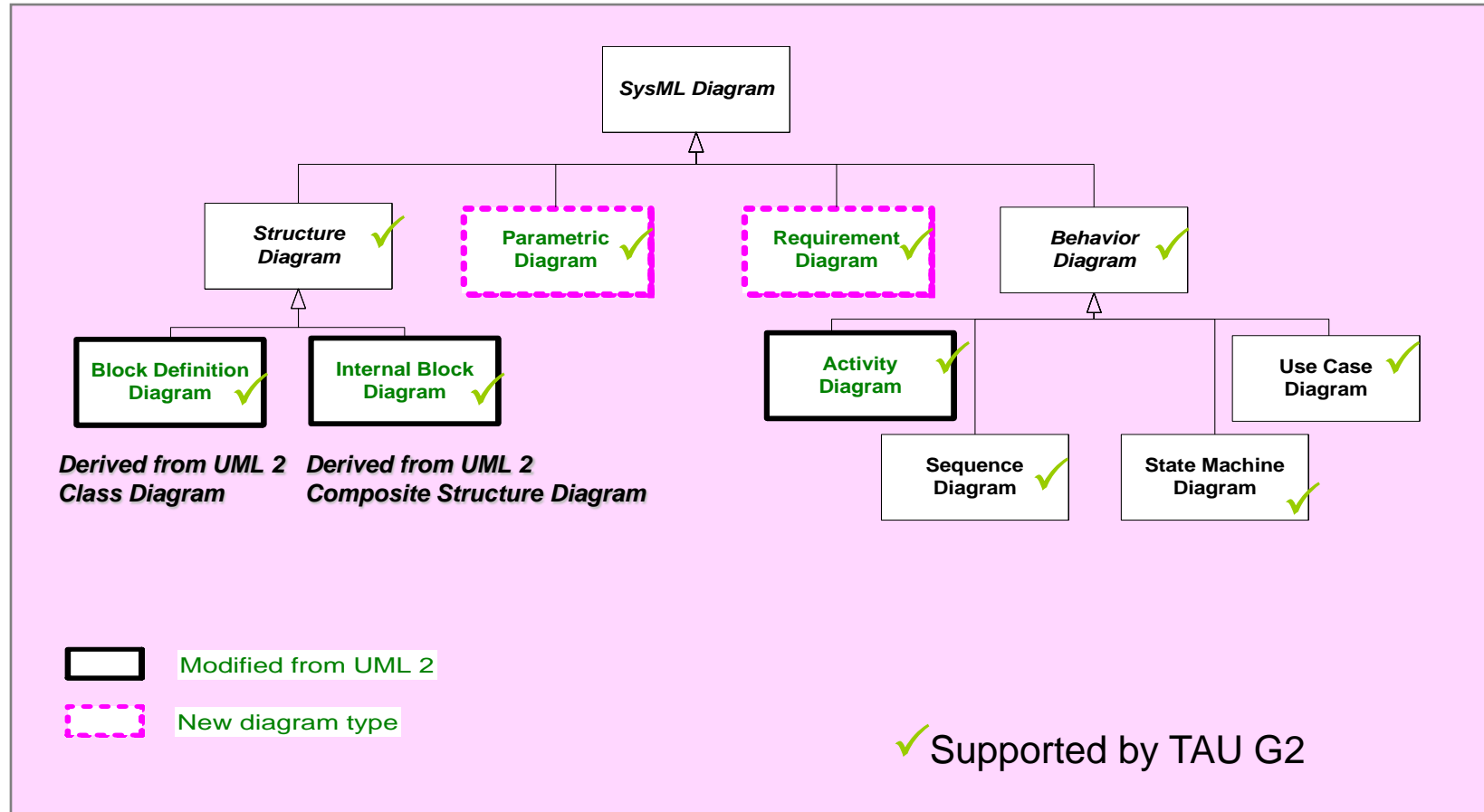
Formal module '/LifeCycle Demo/System Requirements' current 0.0 - DOORS	
File Edit View Insert Link Analysis Table Tools User Help	
Basic view All levels	
Object Identifier	2. System requirements for passenger car
SR-146	<b>1 MAWW Functions</b>
SR-145	These are the functional system requirements for the development of a new passenger motor vehicle as derived from the user requirements.
SR-147	The car will have a world wide market.
SR-1	<b>2 Functional Requirements</b>
SR-2	<b>2.1 Monitor trajectory</b>
SR-3	<b>2.1.1 Move Radar</b>
SR-4	<b>2.1.1.1 Move forwards</b>
SR-5	The car shall be able to move forwards at all speeds from 0 to 200 kilometers per hour on standard flat roads with winds of 0 kilometers per hour, with 180 BHP.
SR-6	<b>2.1.1.2 Move backwards</b>
SR-7	The car shall be able to move backwards to a maximum speed of 20 Kilometers per hour on standard flat roads with winds of 0 kilometers per hour, with 180 BHP.



# What is SysML (System Modeling Language)?

- **Systems Modeling Language (SysML)** - an extension of the UML for systems engineering applications. SysML supports the specification, analysis, design, verification and validation of a broad range of systems and systems-of-systems. These systems may include hardware, software, information, processes, personnel, and facilities.
  - SysML is an open source project that is organized and supported by representatives from the SysML Partners, an informal association of industry leaders, tool vendors, government agencies and professional organizations.

# SysML Diagram Taxonomy

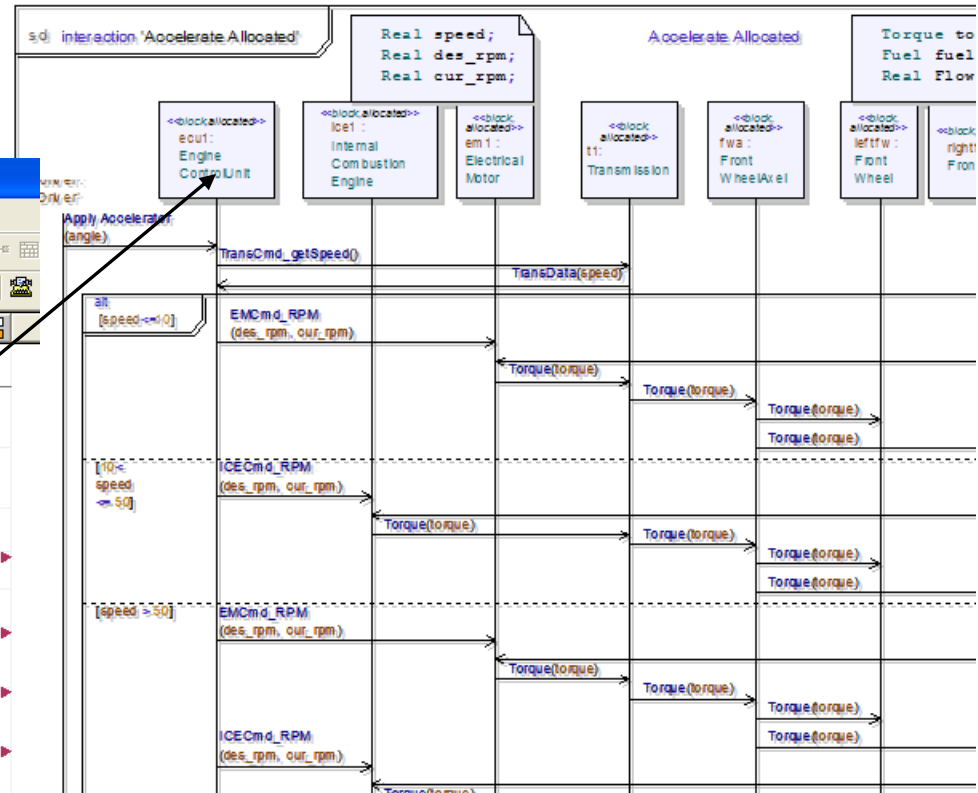


# SysML – Sequence Diagram

- Shows control and data flow
- Useful for analyzing key system scenarios and response threads.

Can be linked to  
Test specifications to verify sequence

Formal module 'Passenger Car/Test Requirements' current 0.0 - DOORS	
File Edit View Insert Link Analysis Table Tools User Help	
Standard view All levels Right align column	
ID	Testing specifications for passenger car
4	<b>1 Test specifications</b>
5	These are the initial test specifications for the development of a new passenger motor vehicle.
6	This module contains the test specifications for a new car to be commercially available by 1 October 2004.
8	<b>2 Testing Specs</b>
9	<b>2.1 Capability Tests</b>
10	<b>2.1.1 Carrying Capacity</b>
11	Driving, safety and road tests will be conducted by a test driver at least 6 ft. 5 in. in height.
13	Road test will be conducted utilizing four average size adults satisfying the level of comfort provided by the top 40% of cars produced in 2000.
17	Driving, safety and road tests will be conducted utilizing a 240 lb. weight in the luggage compartment.
18	<b>2.1.2 Movement</b>
19	<b>2.1.2.1 Speed &amp; Acceleration</b>
20	<b>2.1.2.1.1 Forwards</b>
21	A radar gun will be utilized to determine the vehicle can maintain a speed

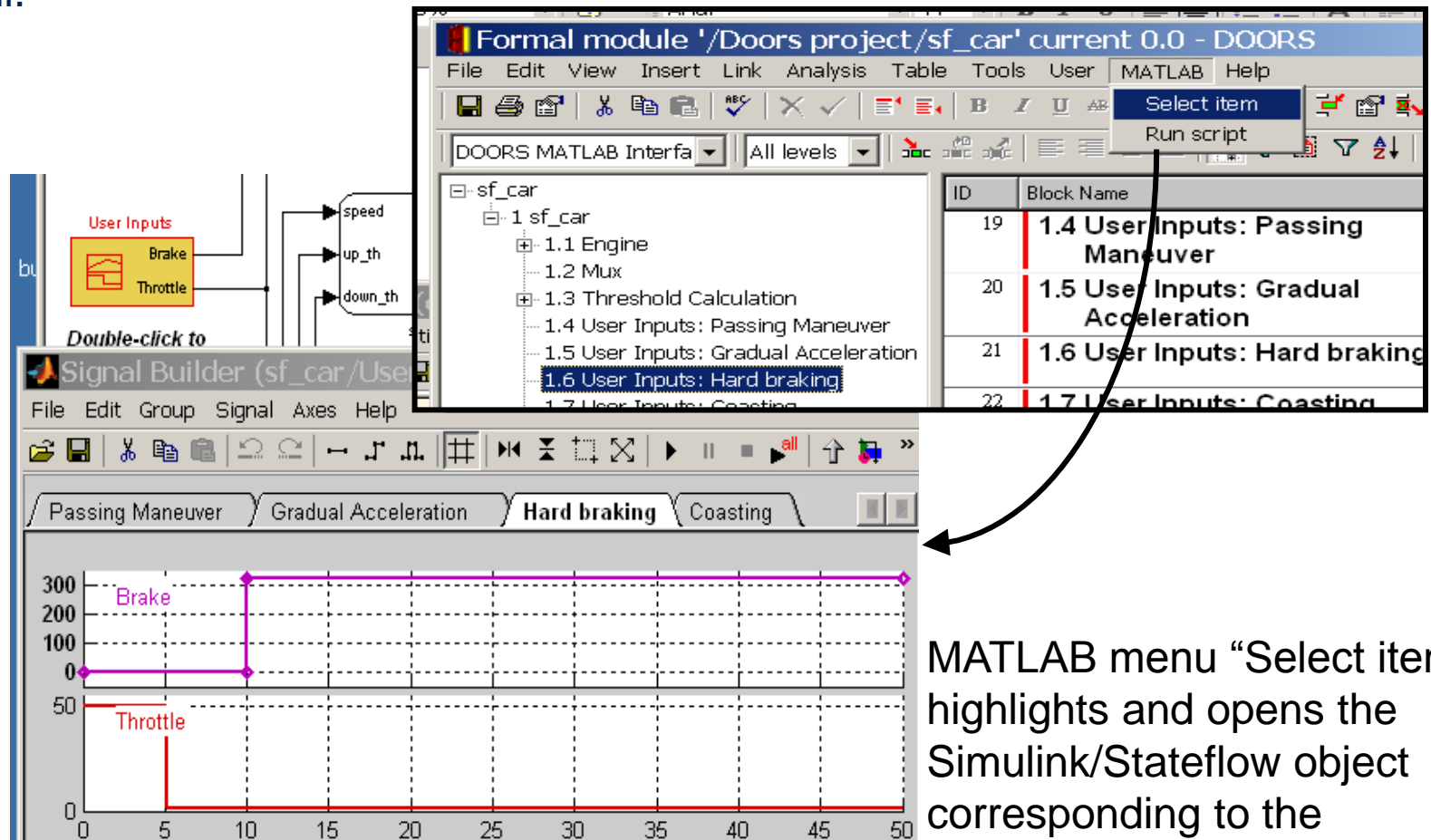




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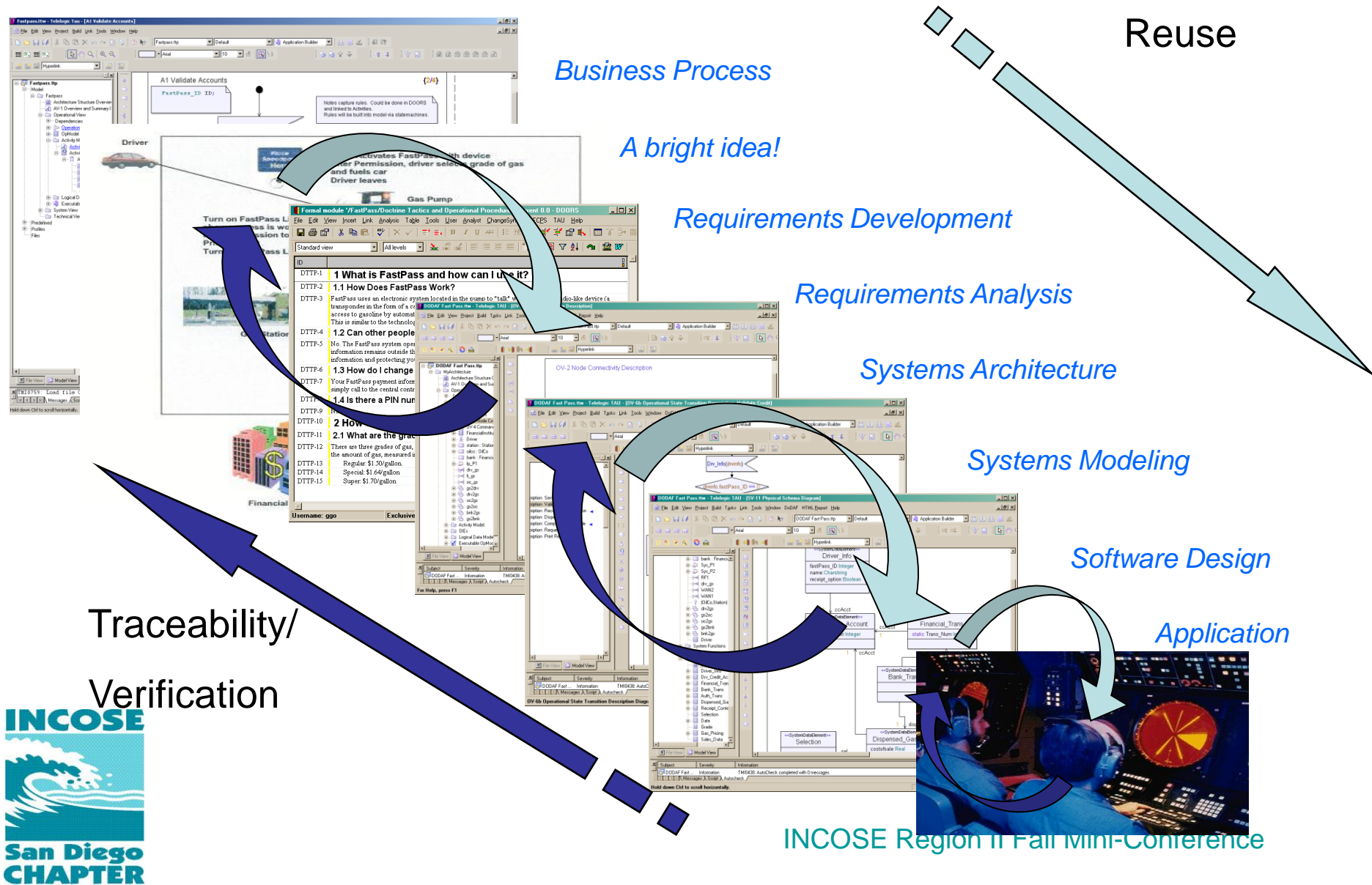
# Requirements Verification and Validation using MatLab for Algorithmic Simulation

- MATLAB is well suited for complex algorithm development. The elements derived from the MathWorks suite of tools are linked back to the requirements as well.



MATLAB menu “Select item” highlights and opens the Simulink/Stateflow object corresponding to the selected row.

# Integrate Throughout the Lifecycle



# Tool Support for Integration of Requirements and Architecture Models

Telelogic – DOORS, System Architect, Tau, Rhapsody  
(fully integrated)

IBM/Rational – Requisite Pro, Rose, RSA

UGS - SLATE, Teamcenter for Requirements

Others – Visio, Excel, Word...”roll your own” etc.

## Summary:

- **Text requirements can leave a lot of unanswered questions, especially in the area of systems integration and test.**
- **The Model is *not* the Requirement**

### **Benefits of an integrated approach:**

- Aids communication with customers, development team, and subcontractors, thereby reducing the chances of misinterpretation of data and concepts.
- Smoother integration of components and systems (SoSE).....fewer surprises.
- Requirements validation and verification can be achieved through links to simulation in the modeling environment.

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# Questions