Requirements Based Testing and MBSE in Defence

WiSEB:Widening Systems Engineering Borders

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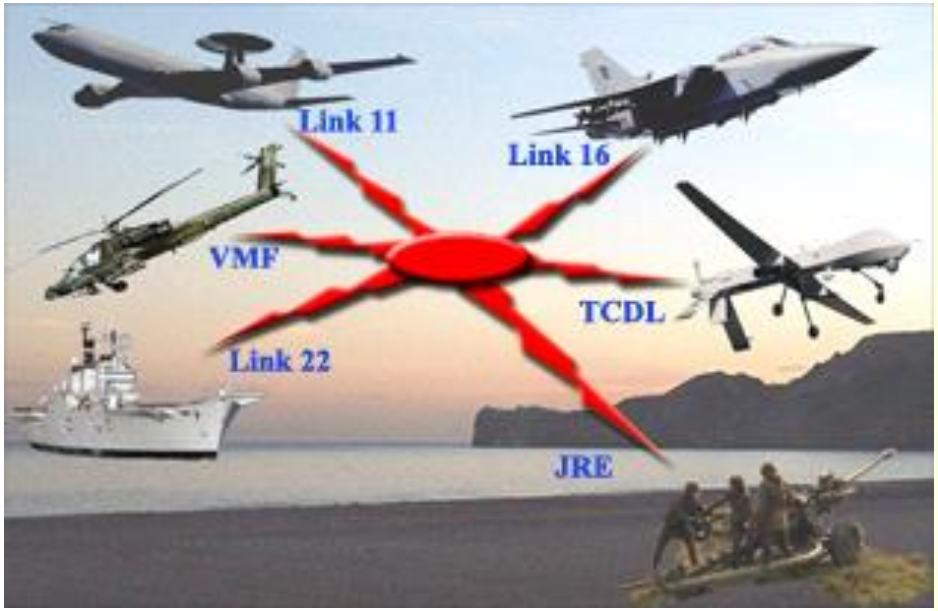
Tactical Data Links

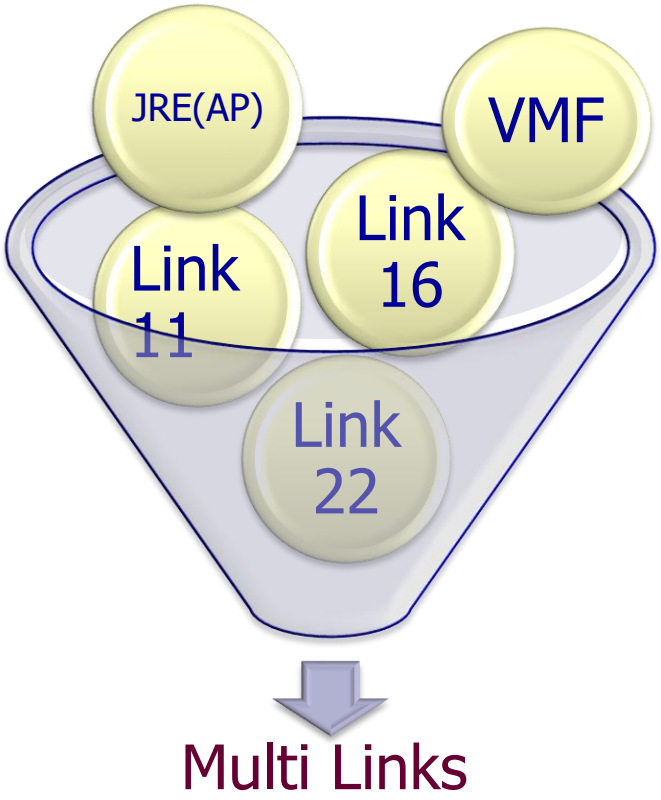
- Encrypted
- Secure
- Message Transfer mechanism
- Multiple Links
- Multiple Bearers
  - V/UHF
  - HF
  - SatCom



The Problem

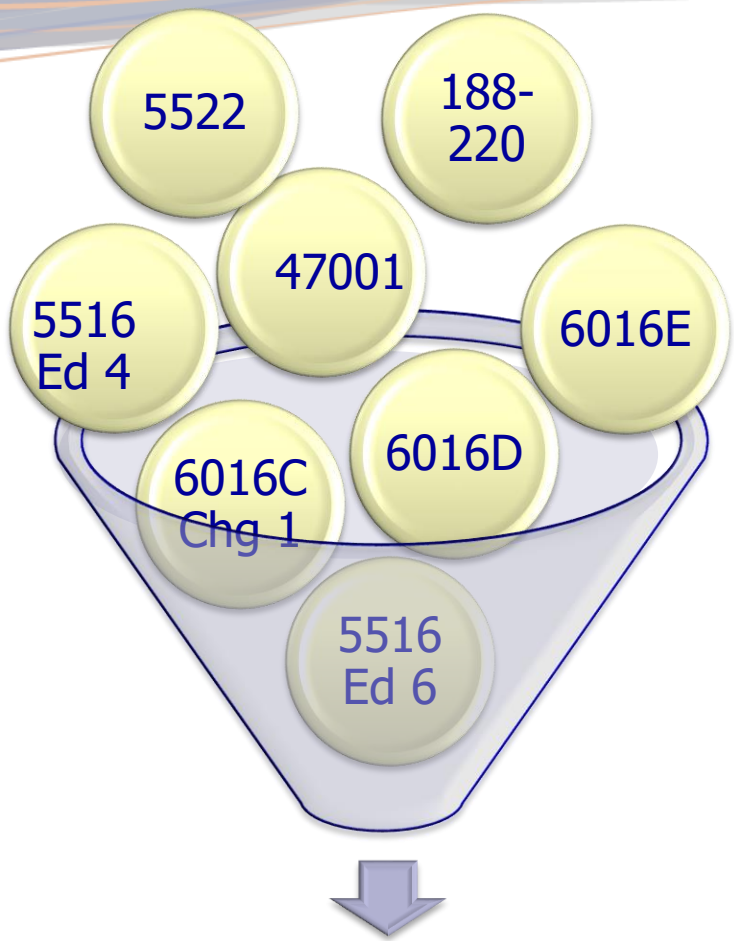
- Multiple Data Links
- Multiple evolving Standards for each Link
- Multiple Platforms
  - Differing National Interests
- Multiple interfaces between Links
- Complexity
- Deliver the capability to the Operator to execute his mission
- Interoperability

Multiple Data Links



- *VMF – Variable Message Format*
- *JRE(AP)-The Joint Range Extension Applications Protocol*

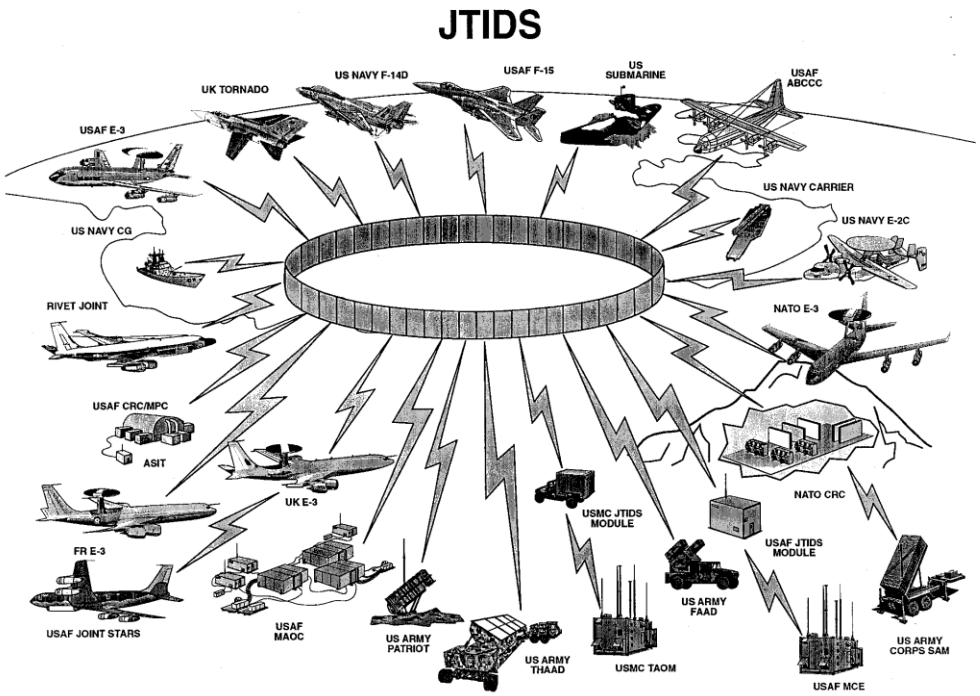
Multiple Standards



Multiple Platforms

- Multiple platform and domain types

The Joint Tactical Information Distribution System (*JTIDS*) is an L band Distributed Time Division Multiple Access (DTDMA) network radio system used by the United States armed forces and their allies to support data communications needs, principally in the air and missile defence community.



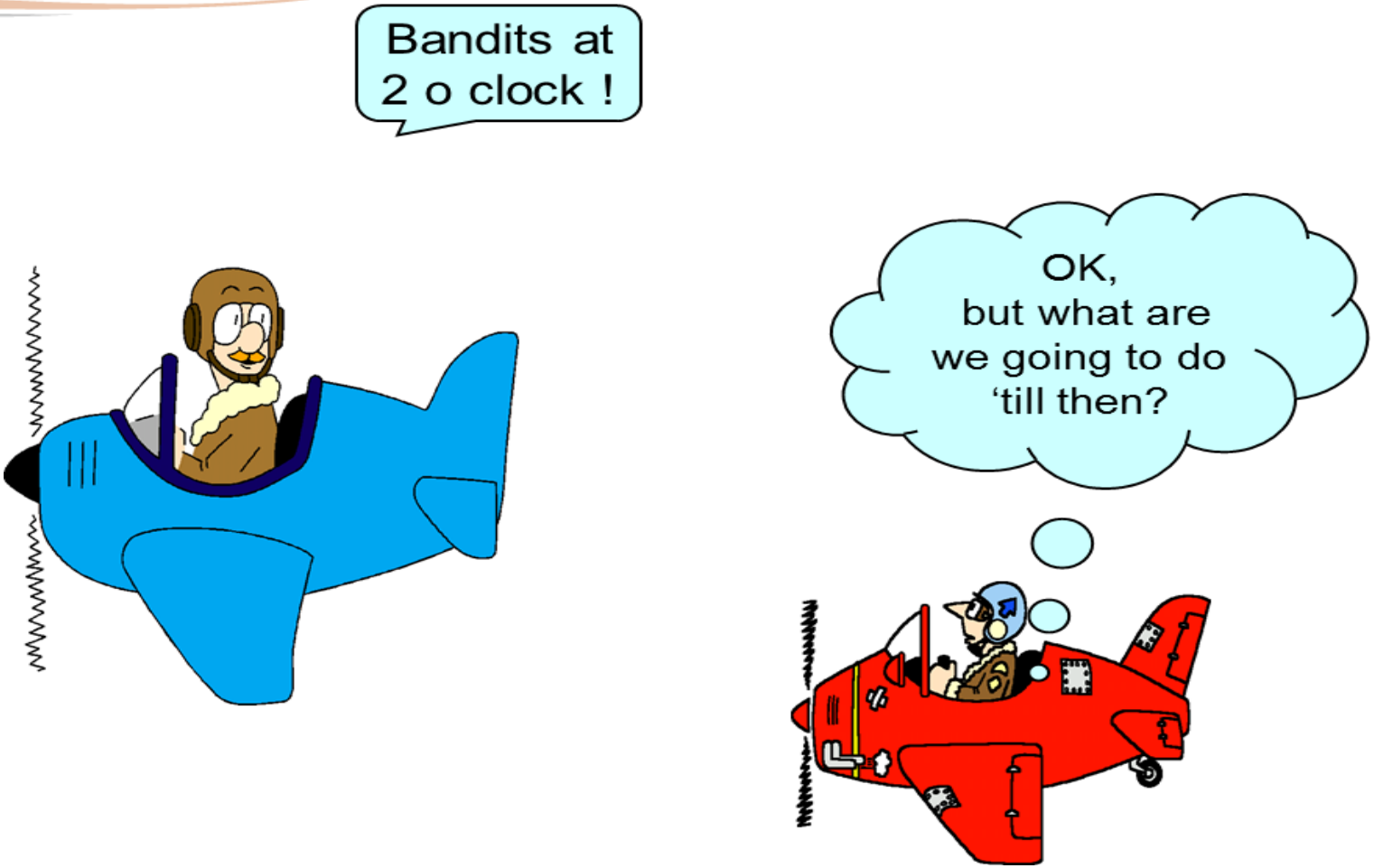
Multiple Physical Solutions

- Multiple Hardware & Software Implementations

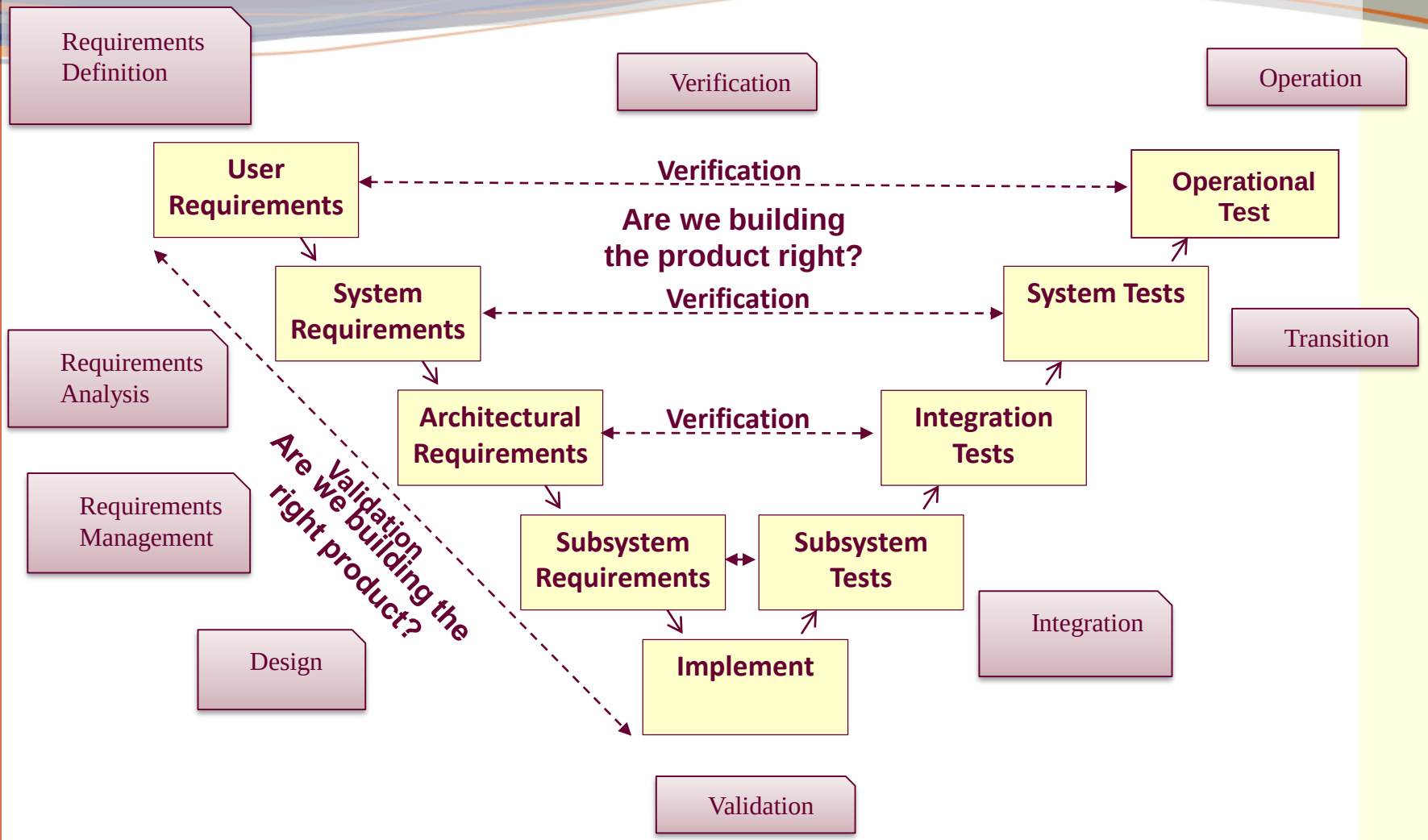
Requirements Based Testing and Interoperability

- Interoperability in exchange of information between TDL equipped platforms is operationally essential.
- Identification of capability gaps through implementation analysis support operational work arounds.
- Implementation against common standards improves interoperability.
- Testing against defined standards critical.

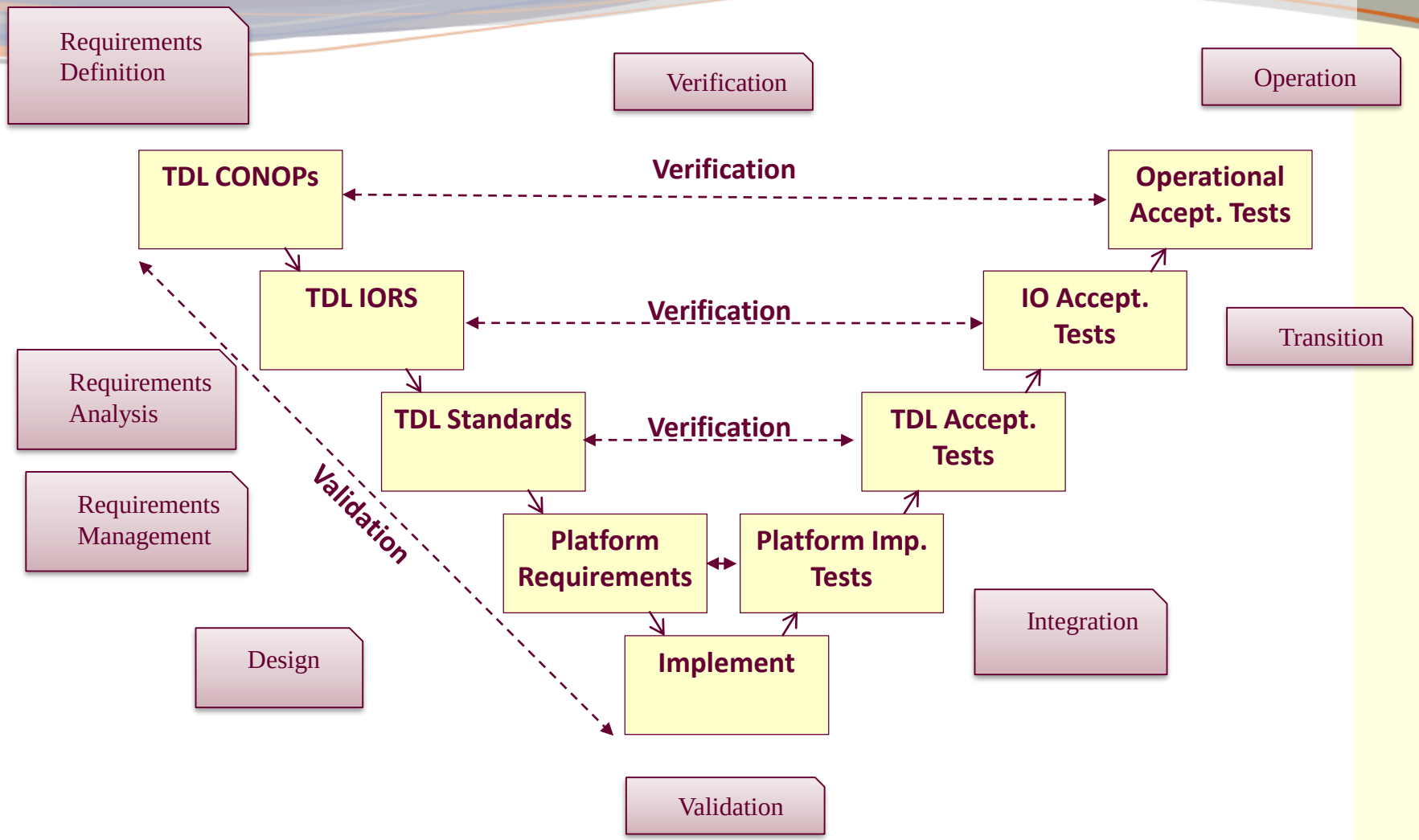
Interoperability Issue??



Systems Engineering V - Model



Systems Engineering V – Model - TDL



Applying SE to TDL

- Requirements
  - Establish clear, concise and unambiguous requirements
  - Generally requirements are defined within the TDL standards and are often ambiguous
    - Multiple requirements
    - Complex terminology
    - Abbreviations

Model Based Systems Engineering (MBSE)

- Apply MBSE techniques to reduce ambiguity and clarify functionality
  - Systems Modelling Language (SysML)
  - Unified Modelling Language (UML)
  - Simulation
  - Integration to Requirements
  - Integration to Testing

Model Based Systems Engineering (MBSE)

" An approach to realising successful systems that is driven by a model that represents a coherent and consistent set of representations that reflect multiple viewpoints of the system"

(Holt & Perry – SysML for Systems Engineers)

Validation and Verification

- Validation
  - Has the right product been built?
  - Validation Process (ISO/IEC 15288:2015)

The purpose of the Validation Process is to provide objective evidence that the services provided by a system when in use comply with stakeholders requirements, achieving its intended use in its operational environment

Validation and Verification

- Verification
  - Has the product been built right?
  - Verification Process (ISO/IEC 15288:2015)

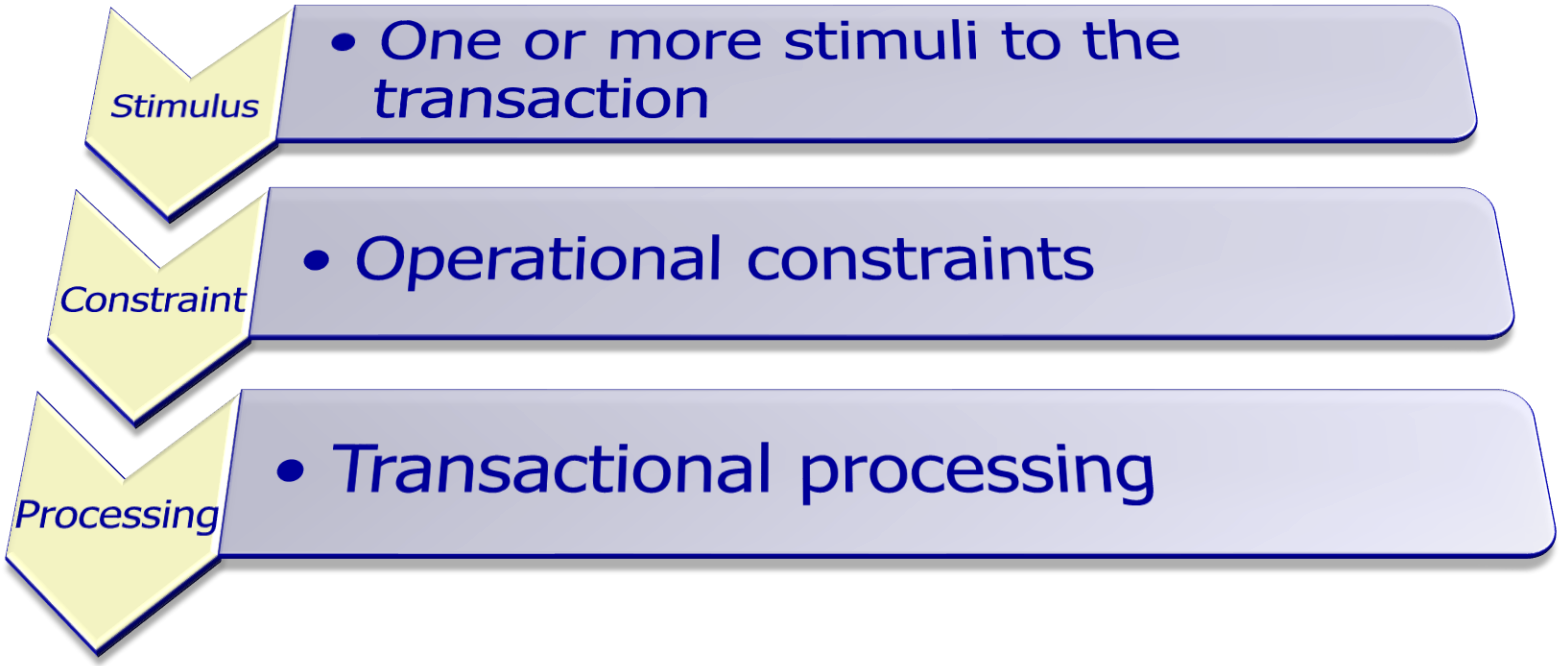
The purpose of the Verification is to confirm that the specified design requirements are fulfilled by the system.

Strategy for TDL's

- Capture and manage TDL Standards (Requirements) in industry standard requirements management database
- Perform Validation of standards by applying MBSE (modelling the standard)
- Enable Verification by utilizing the MBSE outputs to produce test cases against the modelled standard.

Transactional Standards

- Transactional standards better suited to MBSE



MBSE for TDL

Requirements Management

Requirements Analysis

TDL IORs

TDL Stds

Imported Source Documents

Derives

TDL Reqts

Reqts Mgmt Tool

Validation

Links

Requirements Definition

Validates

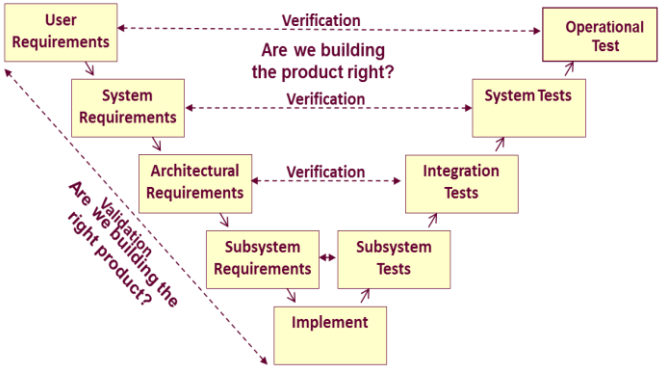
Validates

Validation

Validation

Validates

Dynamic UML Model



Validates

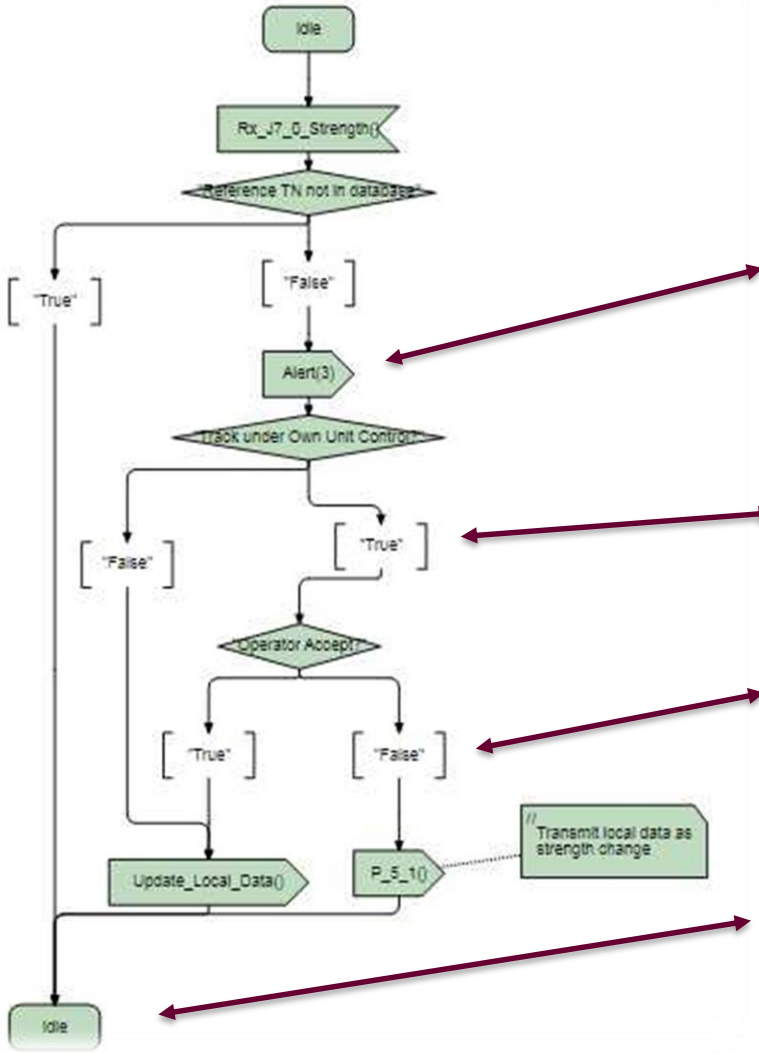
Verification

TDL Test Cases (Generic)

Issues with Requirements

P.5.3.3.1 The host system shall alert (cat 3) the operator to the reception of a Strength Change message indicating a change from locally held data for a track. If the track is under the control of own unit, the host system shall provide the capability for the operator to accept or reject the change. If the change is rejected, the host system shall stimulate Transaction P.5.1, C2 Preparation for Transmission of Strength Change, to cause transmission of the local data and perform no further processing of this transaction

Resolving Requirements - Clarification



The host system shall alert (cat 3) the operator to the reception of a Strength Change message indicating a change from locally held data for a track.

If the track is under the control of own unit, the host system shall provide the capability for the operator to accept or reject the change.

If the change is rejected, the host system shall stimulate Transaction P.5.1, C2 Preparation for Transmission of Strength Change, to cause transmission of the local data

and perform no further processing of this transaction

Test Cases

- Test cases written against model defined by standard

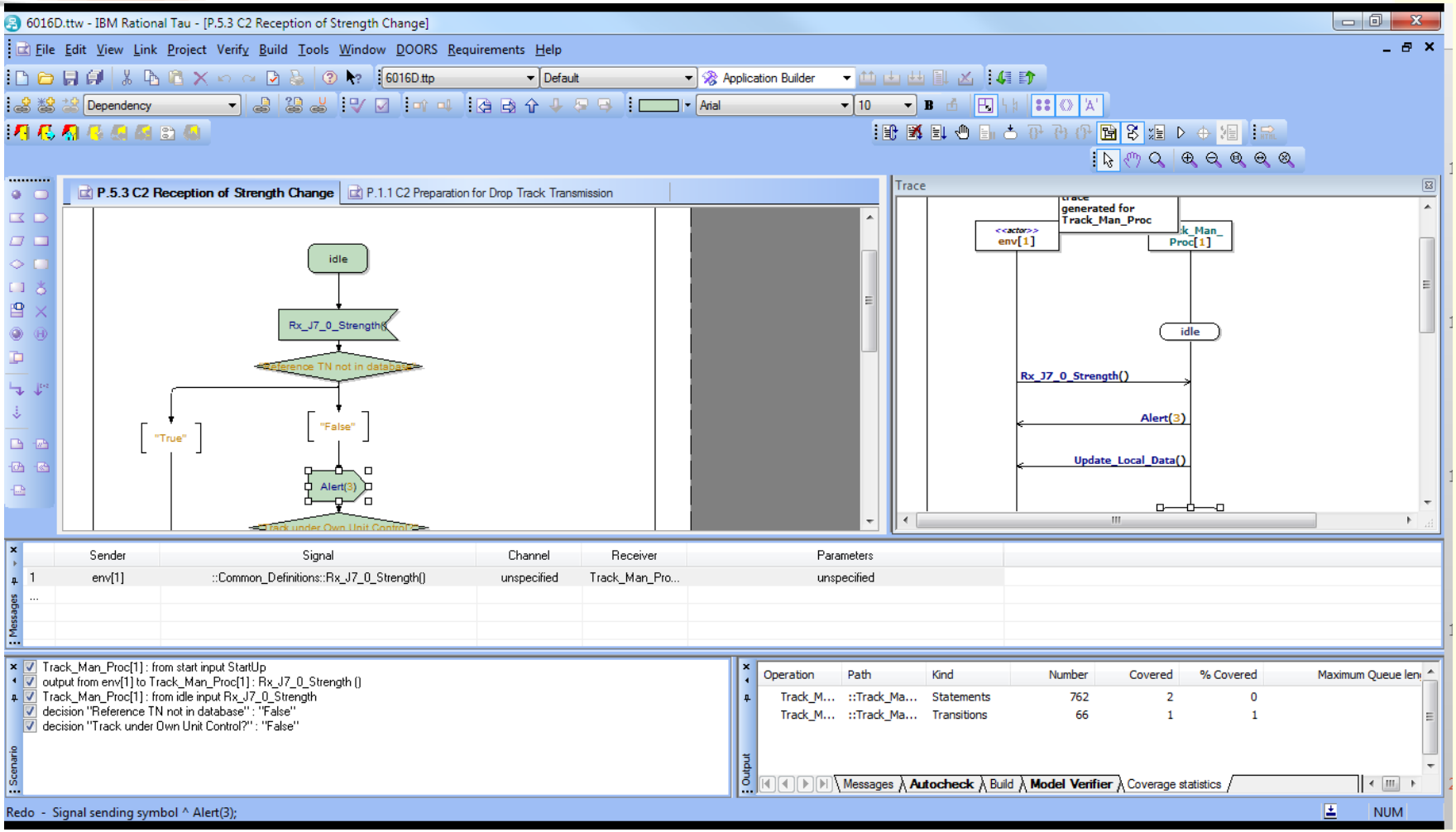
The host system shall alert (cat 3) the operator to the reception of a Strength Change message indicating a change from locally held data for a track.

1.2	Receipt of a J7.0 Track Management message, message use 5 (Receive Strength Change Data) for Track JU#3 TN [_____].	Category 3 Alert. Routine Alert: The Host System shall display the alert of a strength change message until the operator acknowledges it or the condition causing the alert no longer applies. The condition causing the alert shall be removed by whichever occurs first of remedial action by the operator or automatic change of system conditions. Host system provides the capability for the operator to accept or reject the change.
1.3	Operator rejects the Strength Change.	Host system stimulates Transaction P.5.1, C^2 Preparation for Transmission of a Strength Change, to cause transmission of the local data and perform no further processing of the transaction.

If the track is under the control of own unit, the host system shall provide the capability for the operator to accept or reject the change.

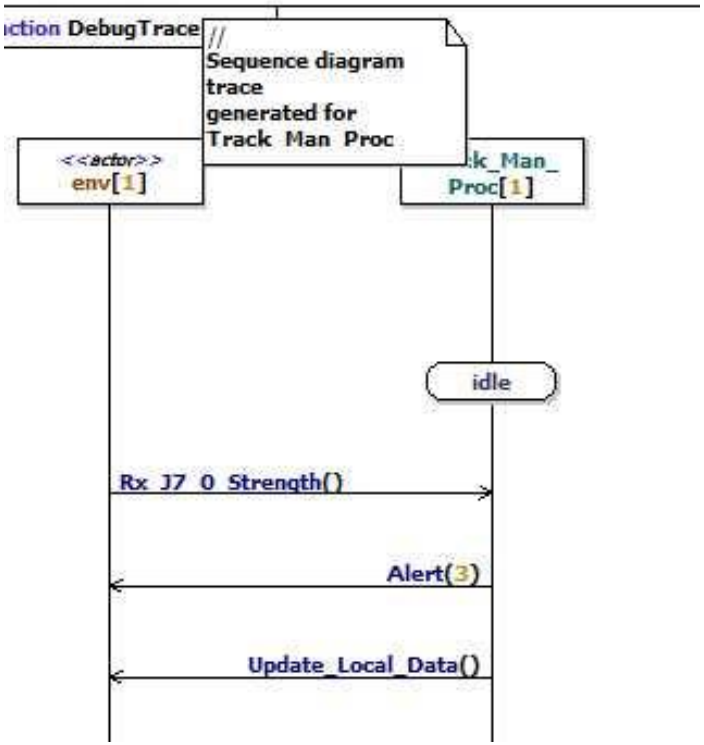
If the change is rejected, the host system shall stimulate Transaction P.5.1, C2 Preparation for Transmission of Strength Change, to cause transmission of the local data

Simulation

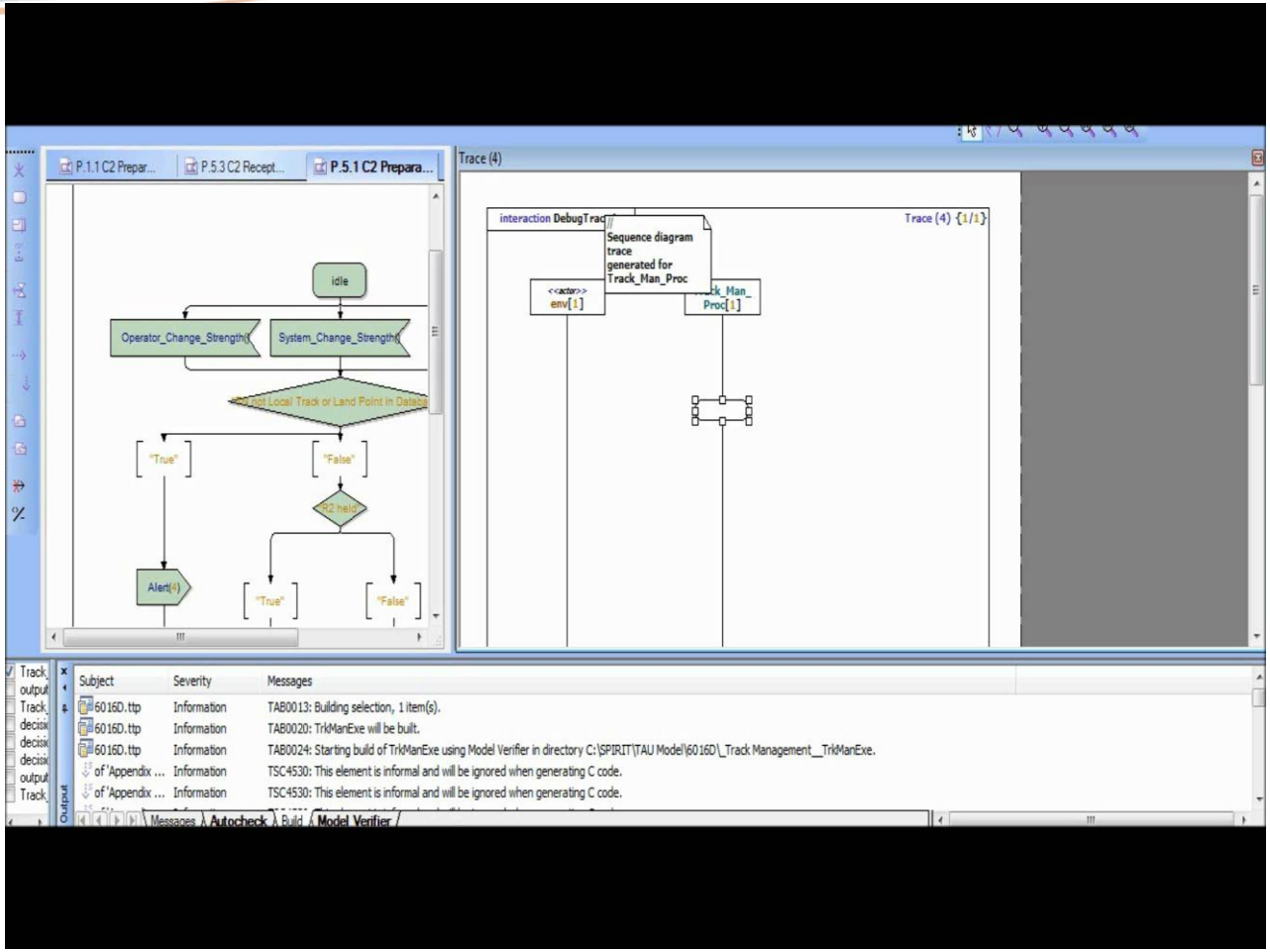

6016D.ttw - IBM Rational Tau - [P.5.3 C2 Reception of Strength Change]
File Edit View Link Project Verify Build Tools Window DOORS Requirements Help
P.5.3 C2 Reception of Strength Change
P.1.1 C2 Preparation for Drop Track Transmission
idle
Rx_J7_0_Strength()
"True"
"False"
Alert(3)
Trace
env[1]
idle
Rx_J7_0_Strength()
Alert(3)
Update_Local_Data()
Sender
Signal
Channel
Receiver
Parameters
env[1]
::Common_Definitions::Rx_J7_0_Strength()
unspecified
Track_Man_Pro...
Track_Man_Proc[1] : from start input StartUp
output from env[1] to Track_Man_Proc[1] : Rx_J7_0_Strength ()
Track_Man_Proc[1] : from idle input Rx_J7_0_Strength
decision "Reference TN not in database" : "False"
decision "Track under Own Unit Control?" : "False"
Operation
Path
Kind
Number
Covered
% Covered
Track_M...
::Track_Ma...
Statements
762
2
0
Transitions
66
1
1
Messages
Autocheck
Build
Model Verifier
Coverage statistics
Redo - Signal sending symbol ^ Alert(3);
NUM

Model Coverage

Operation	Path	Kind	Number	Covered	% Covered	Maximum Queue len
Track_M...	::Track_Ma...	Statements	762	2	0	
Track_M...	::Track_Ma...	Transitions	66	1	1	



Dynamic Execution of Model



Examples of issues

- Dynamic execution of the model revealed an issue with the handover of a controlled unit. This has been seen first hand operationally.
- Validation of the standard through modelling highlighted an error in the standard related to track number accountancy for Land Ground Points.
- Numerous examples of orphan transaction stimuli.

Summary

- The use of modelling to provide both static and dynamic visualisation of the transactional processing defined by the standards reduces ambiguity and therefore misinterpretation.
- The availability of predefined test cases written against the standard and validated by the modelling is appreciated by Industry as acceptance criteria.
- Association and traceability of requirements to models valuable for change management and impact analysis.

Progress

- Tool migration – SysML modelling
- New functionality for Standards Management
  - Configuration Management
- New functionality to manage platform deviations from the standard – Deviation Editor
- Progression from specific test cases to test rationales.
  - Inclusion of test rationales within platform test creation.

Questions and Discussion