Case Study: Custom Enhancement of MBSE Tools for Easier and More Accurate Use of a Large Transport Network Architecture

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Transport
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NSW

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Overview

- Introduction
- Tool Development for the TfNSW Context
- MBSE Tool Enablers
- General Types of Enhancements
  - Data Exchange and Distribution
  - Standardisation of Diagrams and Structure
  - Validation of model and anomaly detection
- Conclusion

Introduction

- Projects are becoming increasingly complex
- Architecture Tools are axiomatic to the success of projects
  - Such as CORE, Magic Draw, Integrity Modeller…
    - However, tools out of the box may not always provide all of the desired functionality
      - Unrealistic to expect them to be able to meet all possible contexts
      - Customise Tools to specific application environments, such as TfNSW, provides improved usability and acceptability by new users
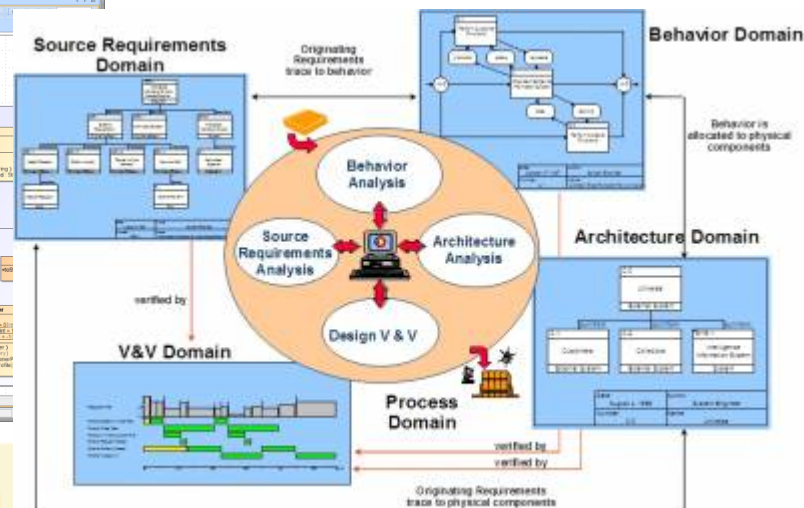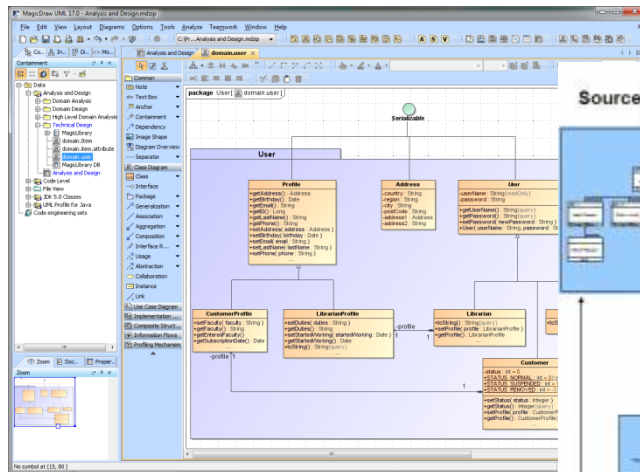
Tool Development for the TfNSW Context

- UOW SMART is working with the ASA Systems Engineering Process Network and Standards Section to apply Model Based Systems Engineering (MBSE) to meet the needs of TfNSW for High Level Planning Capability across the organisation. This includes:
  - Asset Standards Stewardship,
  - Standards Management,
  - Support for Competency Frameworks and
  - General Knowledge Management needs.
- ASA also needs to get a mature organisation to use this new approach
- The work described here uses Magic Draw
  - Previously chosen by ASA as the preferred tool.
- TfNSW has ~A$60+B of projects under consideration

MBSE Tool Enablers

- Typed Object-Oriented Database
  - Enables identification of what an object is
    - Better selection of objects to apply – inherit attributes for better characterisation etc, enables easier application of automated routines

- Use of SysML
  - Standardises the set of types that are found as model develops
  - Formalises relationships that are found
  - Constrains the language used
    - Makes for easier identification of elements

- Architecture Frameworks
  - Populated content indicates the maturity and content of the available information
    - See next slide

AF Indicators of Content
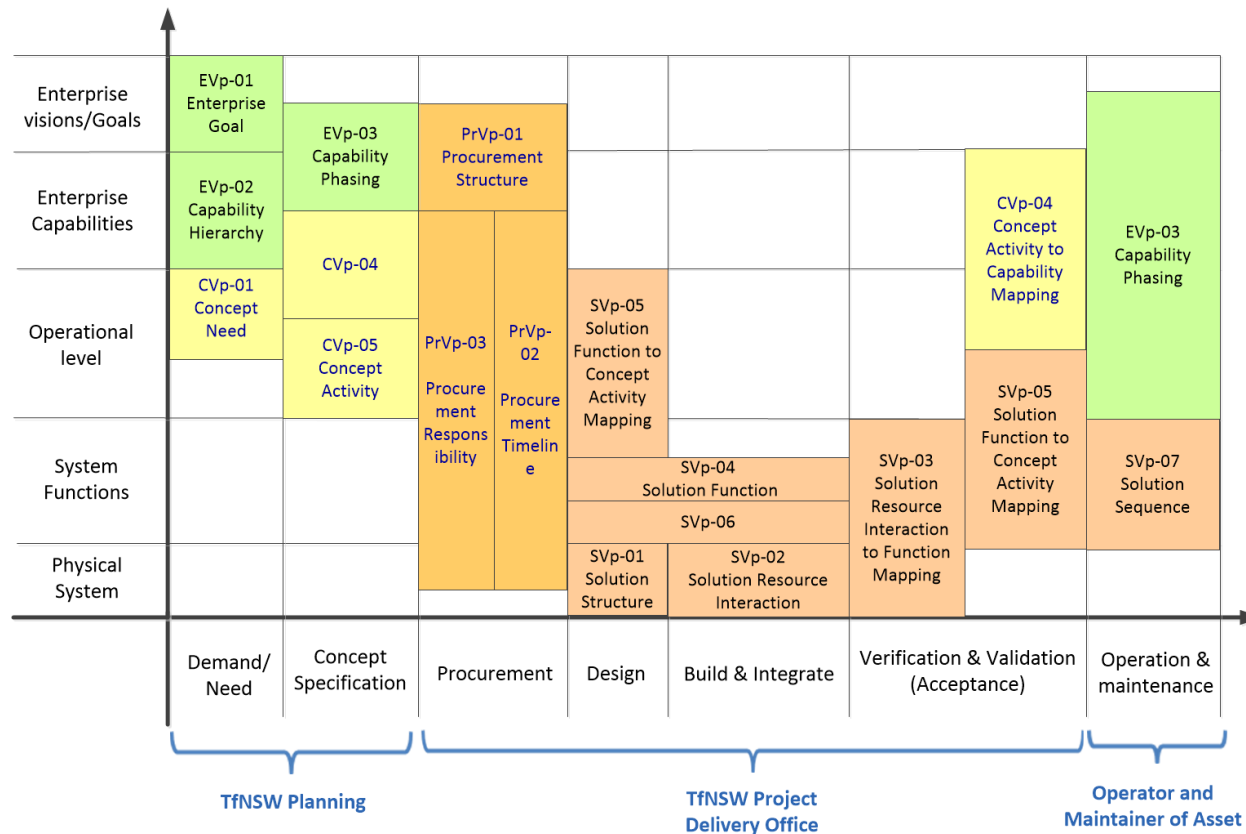
Shirvani F., Efatmaneshnik M., & Campbell P. 2014 *"An Architecture Framework Modification Supporting the Acquisition Stakeholders"* Proceedings of the Systems Engineering and Test Evaluation Conference 2014.

Overview of MBSE Environment Enhancement Types

- Distribution of data and information
  - The ability to obtain data from other sources and propagate it forward
- Standardisation of Diagrams and Structure
  - Usability functions that reduce effort and increase consistency
- Validation of the model and anomaly detection
  - Feedback functions that improve the quality of the data

Distribution of Data and Information

- Customised DOORS Exchange
  - Existing tools enable transfer but often require manual manipulation
  - Automate manipulation
    - reduce effort
    - ensure greater tool integration
- HTML Export
  - Generate a generic model representation that can be published
    - Fully navigable
    - Maintains existing web presence
- Generic Excel Import
  - Built for compatibility with existing tools
    - Can be an alternate path from other tools (such as DOORS)
    - Was a trial to establish the ability to manipulate Magic Draw
  - Imports from previously used structures
  - Establishes relationships to existing data where possible

# Standardisation of Diagrams and Structure

- Diagram Formatter
  - Structures diagram data to meet ASA defined standards
    - Generates consistency between users and contributors
    - Moves, colours, & resizes content
- Replication detection and merger
  - Ensures robustness when multiple users develop parts of the framework
    - Essential for stakeholder engagement
  - Identifies and merges repeated content
- Automated data integration
  - Easier to generate new content and then integrate once approved
  - Tool takes content developed externally and places into the formal model area
  - Ensures model structure is maintained

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Validation of the Model and Anomaly Detection(1)

- Orphan detection
    - Elements can be created that are no longer in any diagrams
        - Difficult to find orphans manually
    - Moves unrepresented elements into "orphanage"
        - Human then can decide the element's fate – see later slide

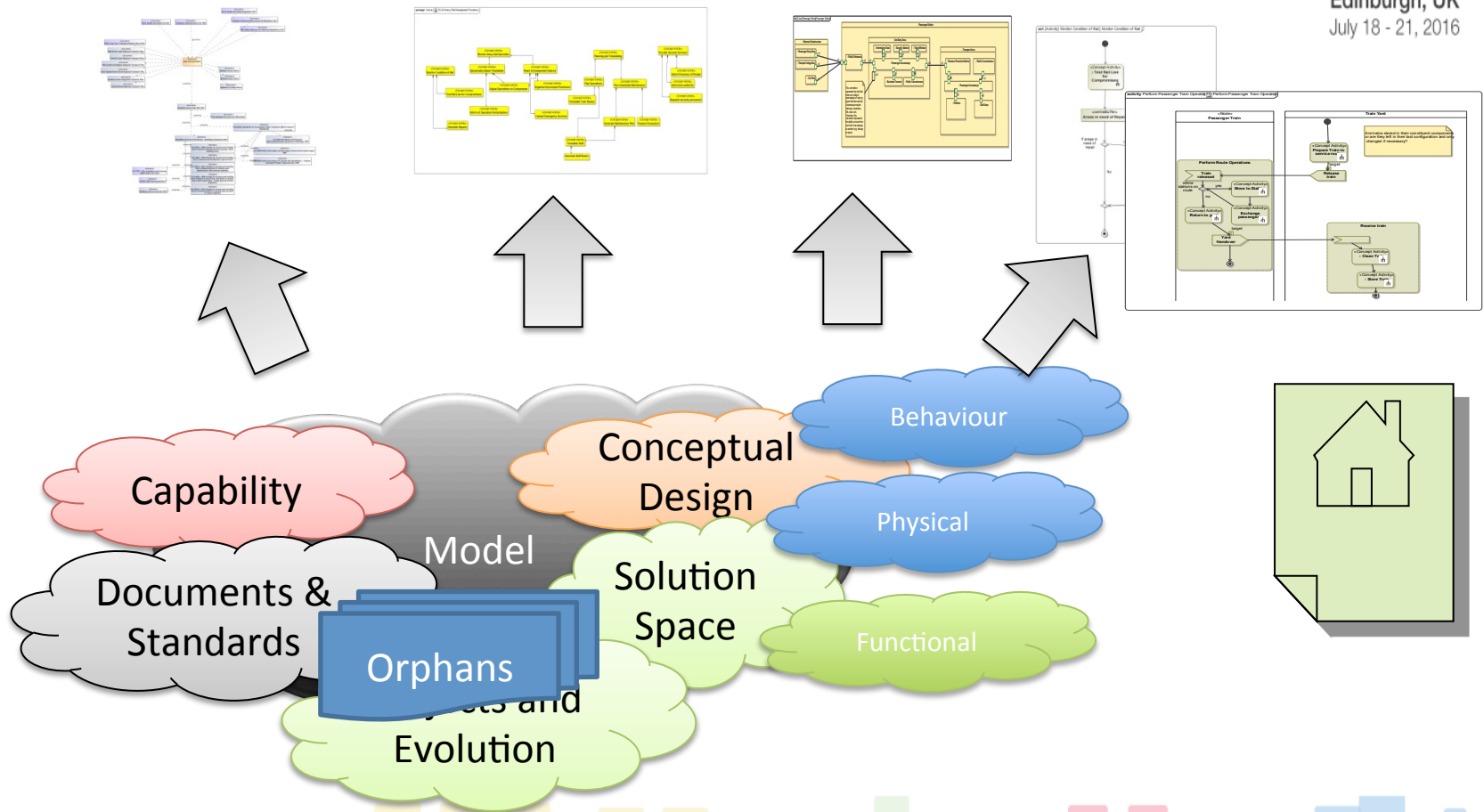# Validation of the Model and Anomaly Detection (2)
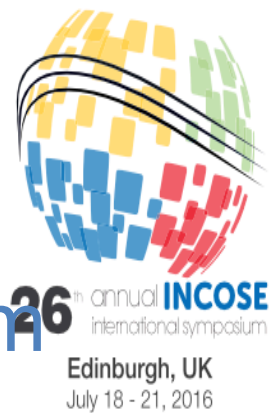
- Auto-change Propagation and Diagram Update
  - Determination of rules, search for additional entries, sub-diagram identification, diagram content update, testing

- Requirement Text Validation
  - Examines text in requirements to see if they meet best practice – see later slide

- Content Validation
  - Rule-based examination of elements to ensure they meet predefined criteria

Orphan Detection

Capability

Documents & Standards

Model

Behaviour

Conceptual Design

Physical

Solution Space

Orphans

Functional

Evolution
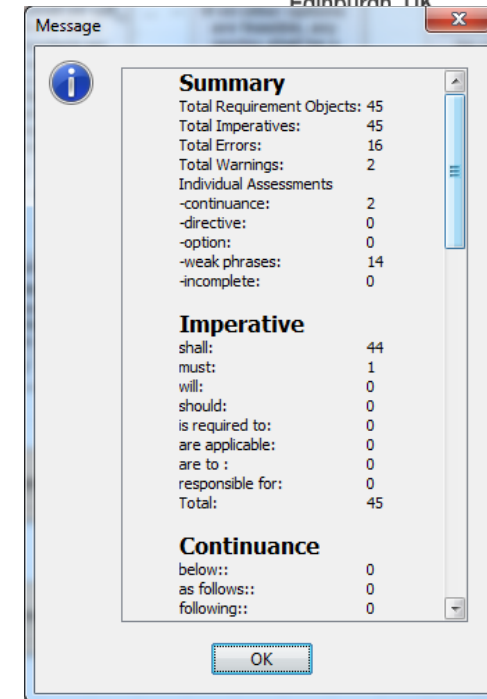
Development of Requirements Assessment Tool

- An expansion to Magic Draw that assesses Requirement statements
  - Based on ARM from NASA and similar research undertaken at UniSA
- Requirement Assessment Algorithm
  - Model Database is searched for requirements and each requirement is tested
  - Tests are a check against words that are commonly associated with problems in requirements
  - Generates a summary report and highlights errant elements

Message
Summary
Total Requirement Objects: 45
Total Imperatives: 45
Total Errors: 16
Total Warnings: 2
Individual Assessments
-continuance: 2
-directive: 0
-option: 0
-weak phrases: 14
-incomplete: 0
Imperative
shall: 44
must: 1
will: 0
should: 0
is required to: 0
are applicable: 0
are to : 0
responsible for: 0
Total: 45
Continuance
below:: 0
as follows:: 0
following:: 0
OK

Continuity Issue Detection

- Checks that an object is correctly connected within the model
- Rules are applied to an object's relationships to ascertain that a relationship exists that:
  - Links to the correct type of object
  - With the right label
  - In the right direction
- Rules often list alternatives for flexibility
  - E.g. a concept activity can be derived from a needed capability or be a sub-activity
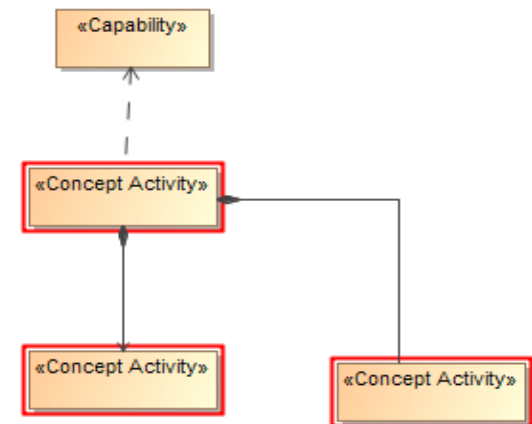
Automated Diagram Update

- Aims to align an existing diagram with content that has been generated elsewhere
  - Assumes a tree structure in the diagram
    - Commonly used by ASA in diagram development
- Application of graph theory to derive the rules applied to generate the diagram:
  - Stereotypes used to indicates what to display
    - Both elements and relationships
  - Bounds of the diagram determined based on tree structure
    - Determines root and depth to identify typical content

Diagram Update Routine

- Searches the database for content:
  - Of the same stereotypes
  - Linked with common relationships
  - Maintains current tree depth
- Examines other diagrams for sub-trees
  - Prevent sub-diagrams being inserted
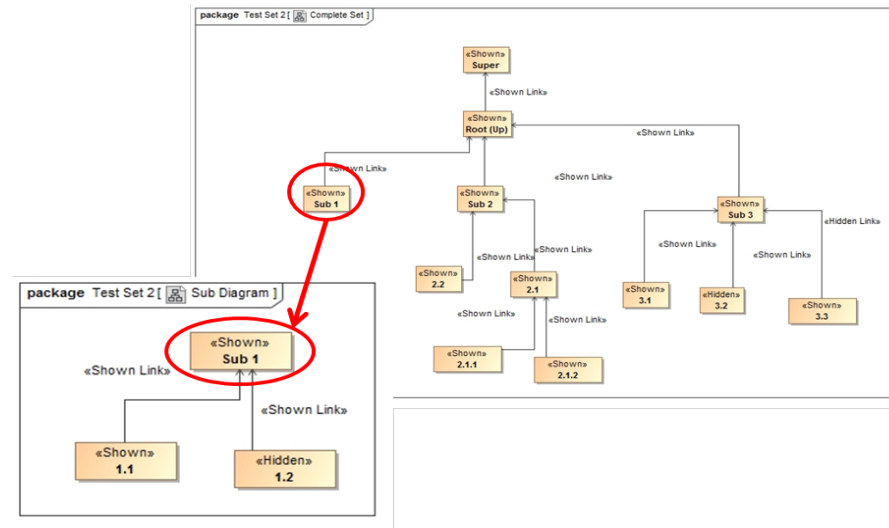
Conclusion

- This presentation has given a number of examples of tool enhancements
  - These have been customised to meet ASA best practice and their preferences
- These enhancements result in:
  - Better usability and readability,
  - Better knowledge management and
  - Improved accuracy and confidence in the model
- Also, this has addressed many reservations that have previously limited stakeholder acceptance and/or uptake
  - Effort required to develop and maintain the information
  - Benefits from that effort

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