29th Annual INCOSE international symposium

Orlando, FL, USA

July 20 - 25, 2019

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Exploring the Test and Evaluation Space using Model Based Conceptual Design (MBCD) Techniques

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Overview

- Introduction / Motivation
- Description of Approach
- Illustrative Example
- Conclusions / Next Steps

Introduction / Motivation

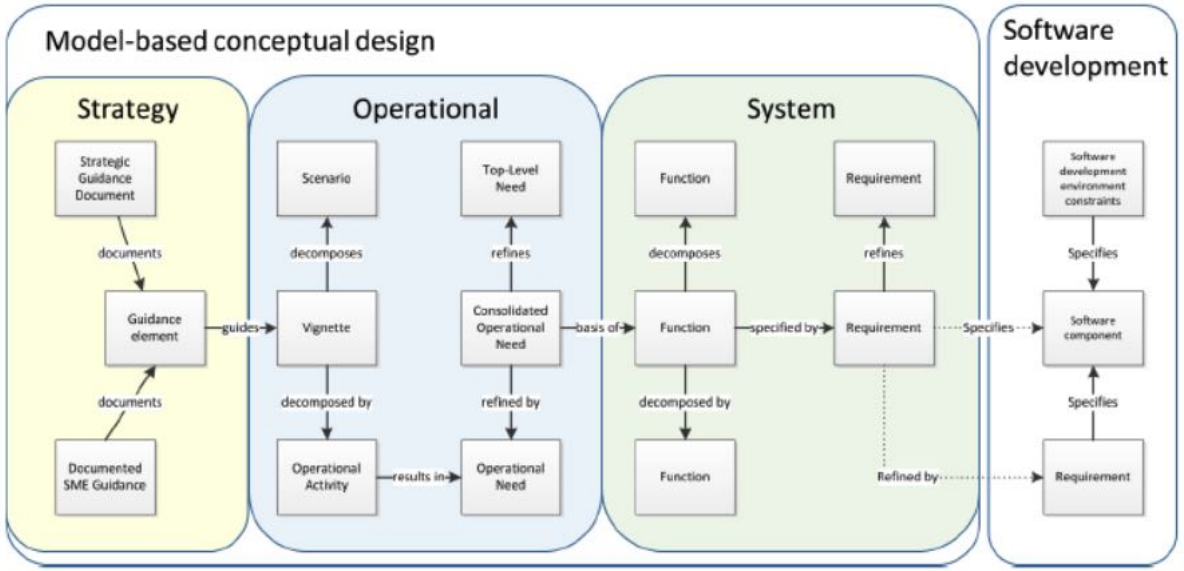
- During the initial concept development phase, Model Based Conceptual Design (MBCD) techniques may be used to assist the customer and other stakeholders develop a greater understanding of the system concept
- This approach does not provide significant focus on the Test and Evaluation (T&E) space, or identify where the T&E space is would be affected with a change in requirements.
- Our hypothesis is that decision makers would equally gain insight into the T&E considerations as well as system space considerations using MBCD techniques

Description of Five-Segment Approach

- The first defines how MBCD is used for system concept development and discusses the relevant artifacts, actors, and information
- The second describes the proposed T&E extension to the MBCD technique
- The third segment describes the linkage between the test domain and the other MBCD domains
- The fourth segment offers additional considerations to evaluate the entire system model
- The last segment offers an approach to evaluate the new linkages and to visualize the insight gained when one domain causes changes to the other domains

First Segment: MBCD Usage

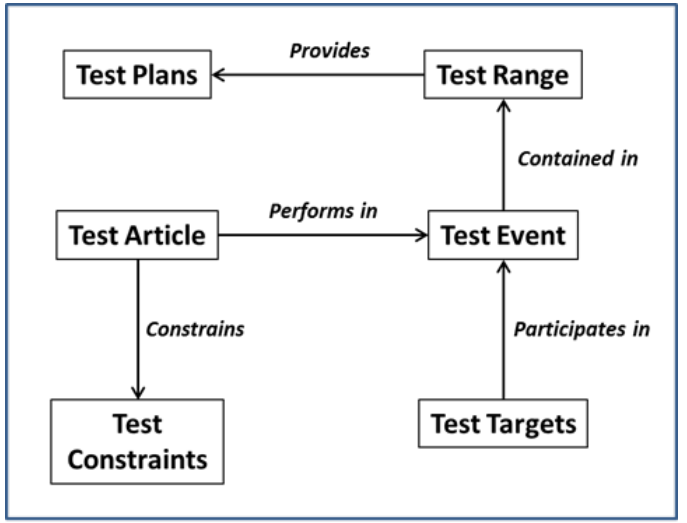
- MBCD is used to structure and link information about the understanding of a problem to possible solutions
- This level of insight can assist the decision makers to address the right problem and assist the developers to focus on the right solution set



Representation of MBCD approach

Second Segment: T&E Extension

- Extend the MBCD methodology to address the T&E domain
- Include information elements for:
  - Activities needed to test the requirements and functions
  - Trace the tests to the requirements
  - Include the system components to be tested
- Proposed elements of the test domain include: test plans, test ranges, test events, test articles, test targets, and test constraints



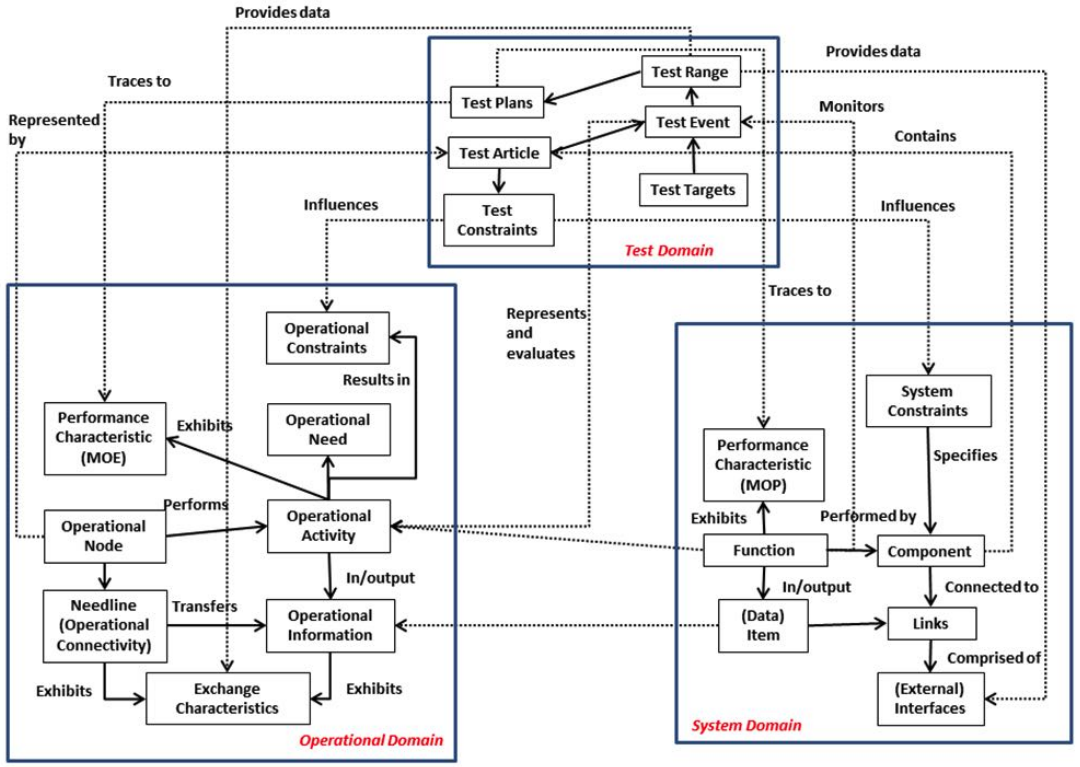
Test Domain

Schema is developed based on literature and experience to categorize information types

Third segment: Test domain linkage to existing MBCD domains

- The strategic domain (enterprise context) focuses on the guidance
- The operational domain focuses on mission tasks, operational environment, and service requirements
- The system domain focuses on functions needed to address the mission, as well as the specific components that perform the functions

Third segment: Test domain linkage to existing MBCD domains



- Augment the existing MBCD schema (operational and system domain) with the test domain
- Based on experience and literature to map the information elements

Third segment: Test domain linkage to existing MBCD domains

		Operational Domain								System Domain							Test Domain					
		Operational Constraints	Operational Need	Operational Activity	Operational Information	Exchange Characteristics	Performance Characteristic (MOE)	Operational Node	Needline (Operational Connectivity)	System Constraints	Component	Links	(External) Interfaces	Performance Characteristic (MOP)	Function	(Data) Item	Test Plans	Test Article	Test Constraints	Test Range	Test Event	Test Targets
Operational Domain	Operational Constraints																					
	Operational Need														1							
	Operational Activity	1	1				1															
	Operational Information					1																
	Exchange Characteristics																					
	Performance Characteristic (MOE)																					
	Operational Node			1					1									1				
	Needline (Operational Connectivity)				1	1																
System Domain	System Constraints										1											
	Component											1						1				
	Links												1									
	(External) Interfaces																					
	Performance Characteristic (MOP)																					
	Function			1							1			1		1					1	
	(Data) Item				1							1										
Test Domain	Test Plans						1							1								
	Test Article																		1		1	
	Test Constraints	1								1												
	Test Range												1				1					
	Test Event				1															1		
	Test Targets																				1	

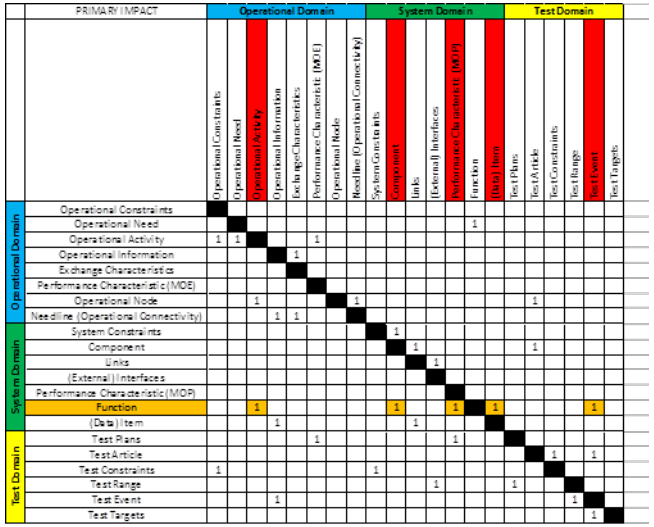
Convert the schema to an interdependency matrix (interfaces correspond to a “1” in the matrix

Fourth segment: Evaluation of the new linkage

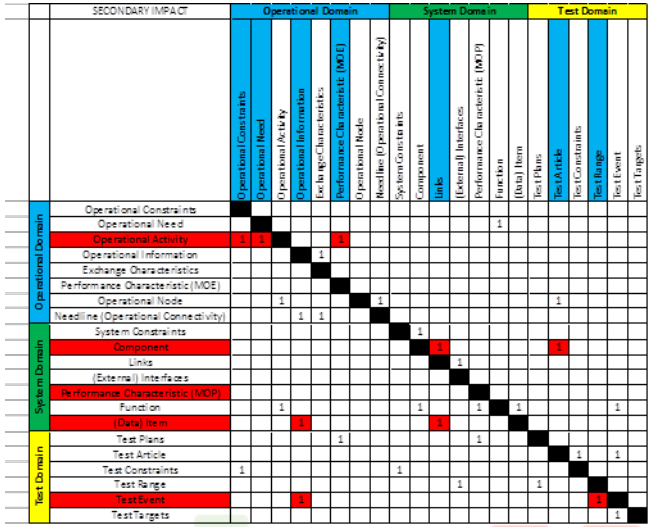
- Evaluate how the rest of the overall descriptive model is affected when one domain element is changed
- Changes may be viewed from different perspectives:
  - The decision makers may view changes to the model as a change in capability or fielding date, which may affect their investment strategy
  - Developers may view changes to the model as changing their delivery dates or scheduling of efforts
  - Analysts may view changes to the model as updating their assessment of the system capability, which then may affect the decision maker's insight of the system's capability
  - Testers may view changes to the model that may affect their existing testing capabilities or future testing capabilities that need to be developed

Fifth segment: Impacts of the changes

- Once the MBCD model has been modified, evaluate the model to ensure that the MBCD concepts are still valid
- Ensure the decision makers and other actors gain insight into the problem when changes to one domain are introduced



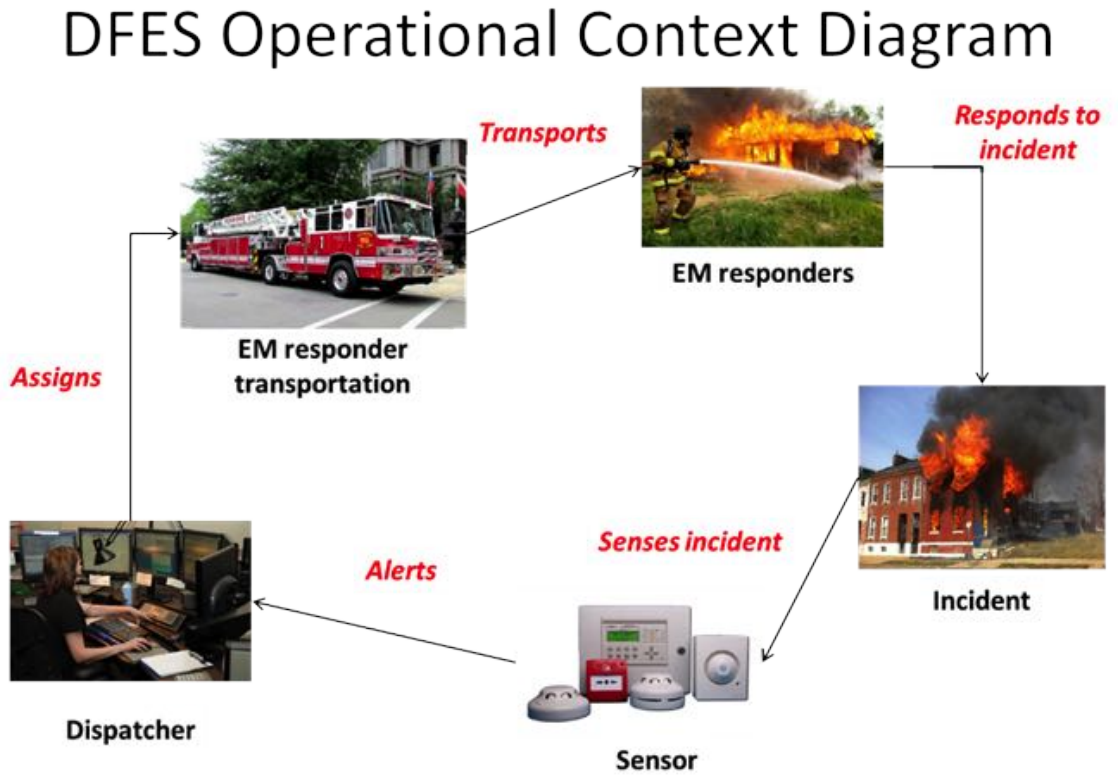
Changes to functions can affect the 3 domains



Which in turn can affect other functions

Illustrative Example

- We leverage and simplify an existing example that uses MBCD to evaluate fire and emergency services
- This example was developed for the Department of Fire and Emergency Services (DFES) of the Government of Western Australia



Illustrative Example

- The operational domain is defined by the DFES mission to detect, analyze, and respond to emergencies and incidents

Functions	Test Objective	Test Element
Sense smoke / incident	Determine if incident is properly detected	Sensors, fire source, facility environment
Send alert	Determine if alert is sent timely	Communications (transmitter and receiver), communications environment
Confirm incident / select action	Determine if response is correctly determined	Dispatcher, displays, dispatcher environment
Dispatch response units	Determine if dispatch is correctly executed	Response units, transportation environment
Respond to incident	Determine if response is adequately executed	Responders, fire source, facility response environment

Functions	Systems	Actors
Sense smoke / incident	Sensor	Fire service personnel
Send alert	Telephone / radio	Rescue coordinators
Confirm incident / select action	Data terminal	
Dispatch response units	Tanker, pumps, hoses	
Respond to incident	Transport vehicle	

Conclusions / Next Steps

- This offers a modification to the existing MBCD process to incorporate the test domain
- Ensure that the testing community and capabilities are considered during initial concept development phase
- Identify an example project that this approach could be applied to
- Collect data at significant milestones and confirm hypothesis that adding testing into the MBCD process could provide significant insight into the initial conceptual design phase

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