National Aeronautics and Space Administration

Orion Flight Test Architecture
Benefits of MBSE Approach

PM Challenge 2012

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OVERVIEW

- Exploration Flight Test 1 (EFT-1) is an unmanned first orbital flight test of the Multi Purpose Crew Vehicle (MPCV)
- Mission's purpose is to:
  - Test Orion's ascent, on-orbit and entry capabilities
  - Monitor critical activities
  - Provide ground control in support of contingency scenarios
- Requires development of a large scale end-to-end information system network architecture
- To effectively communicate the scope of the end-to-end system a model-based system engineering approach was chosen

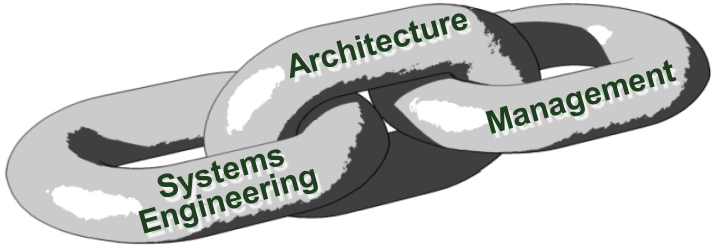
ADVANTAGES OF AN ARCHITECTURE

- Provides a linkage between the technical and programmatic aspects of the system. It describes:
  - The system's components, relationships, interfaces, etc. (technical architecture)
  - Why the system looks the way it does – driven by design principle, stakeholder constraints/concerns, results of trades

- Provides an approach that helps the team
  - Understand the important aspects of the system, where each component fits, and how trades in one area impact other areas
  - Better communicate the resulting system and how it addresses stakeholder concerns and constraints
  - Maintains the record of the analysis and decisions that have been made (why we got here, and what conditions would trigger a re-evaluation)
  - Maintain the integrity of the system through the trade-offs and design process

PURPOSE OF EFT-1 NETWORK ARCHITECTURE

- Addresses why the end-to-end information system is the way it is and how the understanding of the system is to be sustained
  - It underlies the system's ability to meet flight test objectives, concepts of operation and satisfy stakeholders needs
  - Defines the design and what is to be built and how
- The EFT-1 network architecture is the integration of multiple, widely distributed, NASA and LM ground system assets
  - Potentially unwieldy and complex without use of the right approach
  - Making the need for an effective architecting effort essential
- Methodology used to develop architecture allows us to manage:
  - Technical baseline
  - Risks
  - Costs
  - PPBE activities

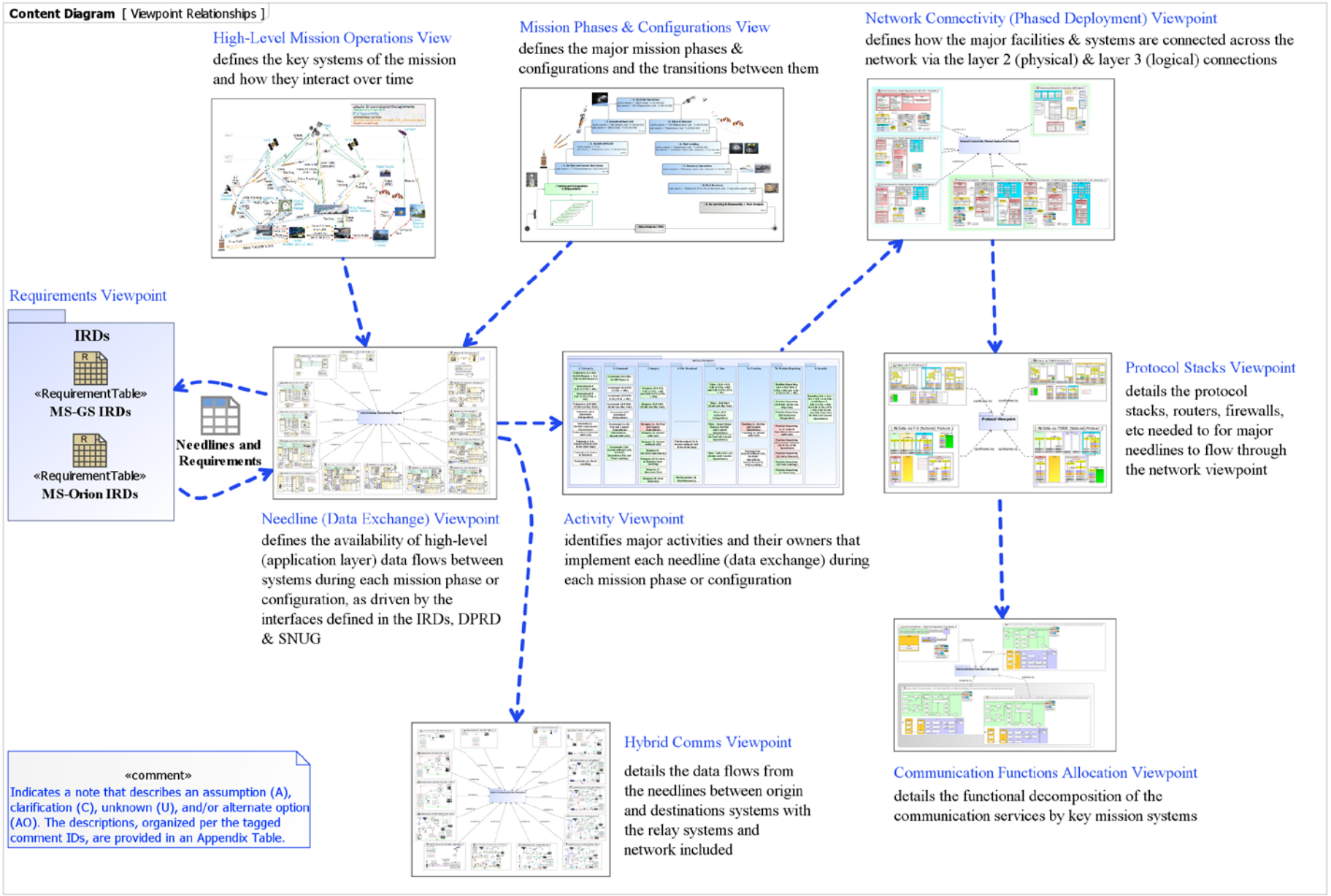


SCOPE OF EFT-1 ARCHITECTURE

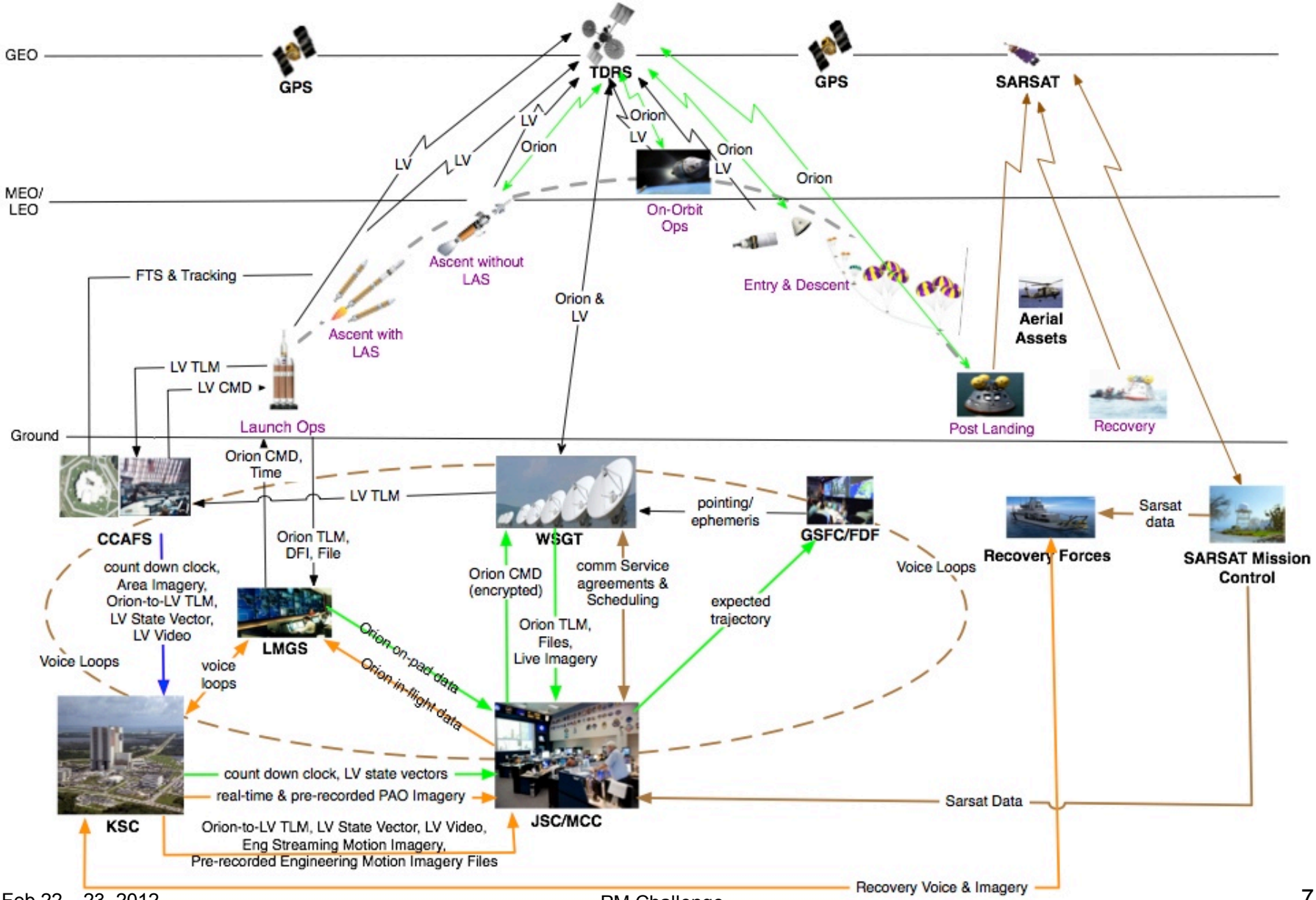
- Cross-system integration of hardware/software intensive systems responsible for generation, processing, archiving and dissemination of test and operational data (cmd, tlm, voice, video, vehicle position, time sync, etc.)

- The architecture and end-to-end information system is designed to support
  - Development
  - Test operations
  - Mission operations
  - Post flight data analysis

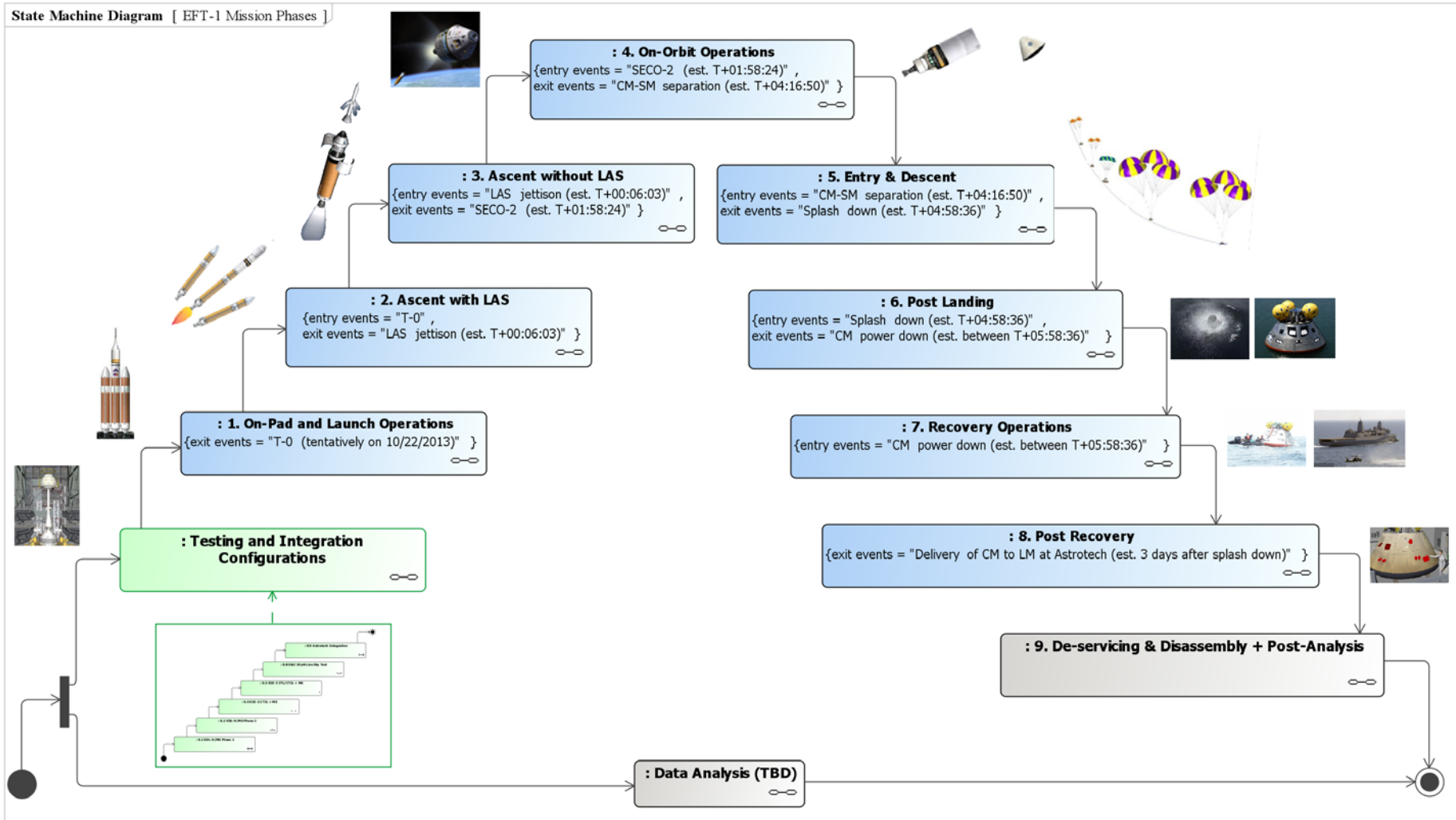
ARCHITECTURE STRUCTURE



EFT-1 HIGH-LEVEL MISSION VIEW



COVERS ALL MISSION PHASES

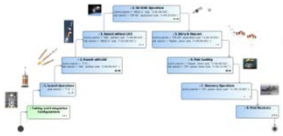


CUSTOM VIEWS OF MODELED ARCHITECTURE

OV-1

high-level arch. overview

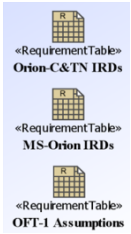
Mission Config's & Phases



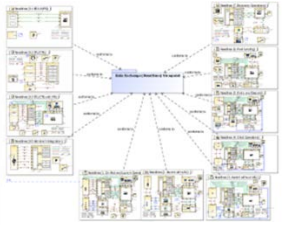
arch. evolution over ti

data X'es only w/ sources & sinks

IRDs



Needlines



Hybrid Comms

reqt's

data X'es w/ sources, sinks, & relays

ops

system connectivity over networks

for data i from origin to destination

of comms services

Examples of Additional Viewpoints

Stakeholders & Concerns

Parametrics

Behaviors

Trades

In actuality there can be as many or as few views into the modeled architecture (that resides inside the 3D shape) as deemed necessary to satisfactorily address the specified concerns of the customer stakeholders.

REDUCES DOCUMENT ENGINEERING

- Much of the EFT-1 architecture is defined in technical products scattered throughout various areas of expertise
- The E2E data architecture serves as centralized source of the integrated information
  - Captures salient features which allow us to…
    - address questions which arise directly from core stakeholder's concerns
    - derive which viewpoints must be created and presented
- Capture and then re-project out the architecture description to stakeholders in a way that they can consume
  - Model the architecture in one place and begin to explore via multiple types of viewpoints
  - Each type of viewpoint is tailored to different stakeholders & their concerns, but draws from the same architecture description model
- Transfers time and efforts away from PowerPoint and document engineering back to integrated design via formal model-based engineering techniques

BENEFITS

- Reduces document engineering
- Enforces system engineering rigor
- Supports management in PPBE activities and decision making
- Reusable for various system configurations (EFT-1, AA-2, Orion 2, etc.)
- Provides an integrated design centric approach
- Informs cross-system interface development
- Enables ability to identify gaps
- Facilitates functional requirement development
- Supports various levels of design definition
- Enables system-level trade analysis responsive to defined Figures of Merit

LESSONS LEARNED

- Using terminology "Model-Based System Engineering (MBSE)" causes confusion
  - Do not use this terminology for OFT-1
  - Emphasizing activity as…"system engineering using a modeling approach" more effective in gaining acceptance across the organization
- Take the time to understand what you need to communicate
  - Clearly understand stakeholder needs
  - Plan how best to utilize the model in support of your specific system engineering needs
  - Some courses note that up front planning isn't an important step
    - Strongly disagree – upfront planning essential
- Approach requires discipline experts using the tool to perform their system engineering functions
  - It's not about just using a tool and drawing elaborate PowerPoint pictures