NASA GRC MBSE IMPLEMENTATION STATUS

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AGENDA

- GRC MBSE Adoption Timeline
- Forums Advancing GRC MBSE Adoption
- GRC MBSE Project History
- GRC MBSE Adoption Challenges
- Future Initiatives

TIMELINE

2007
- Concept brought to GRC

2009
- NASA SEWG Started MBSE Study

2010
- PTC Training on SysML
- GRC Working Group (WG) kick-off

2011
- NoMagic Architecture Framework Training
- GRC WG perform MSBE Tool Trade

2012
- InterCAX 101/201 Training
- GRC Practitioner's Forum kick-off

2013
- Internal MBSE Overview Training
- GRC WG developed MBSE Roadmap

2014
- Internal Hands-On Training

2015
- Internal MBSE 1-day Hands-on Training
- InterCAX 101/201 Training
- InterCAX 891 Training

2016
- GRC WG developed MBSE Quick Kickstart document

MBSE WORKING GROUP PURPOSE

Improve practice of systems engineering at GRC by:

- Increasing Center's understanding and utilization of MBSE
- Improving MBSE capabilities within Systems Engineering Division
- Maintaining awareness of MBSE's application across the center and agency

MBSE PRACTITIONER'S FORUM PURPOSE

Collaborative setting for Modelers to:

- Exchange ideas
- Discuss challenges
- Keep skills fresh with training sessions

SAMPLING OF PROJECTS CURRENTLY APPLYING MBSE AT GRC

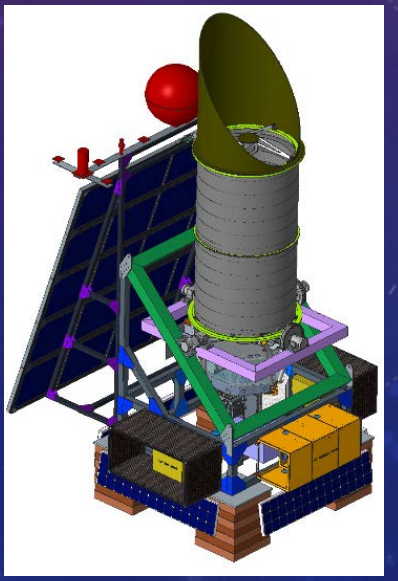
GRC Mission/Project	MBSE Partner Center	Architecture	ConOps	Requirements	Interfaces	Structural and Behavioral	Tool Integration	Trade Studies	V & V
integrated Power, Avionics, and Software Lab	JSC	X		X	X	X			
Space Communication and Navigation	JPL, GSFC	X	X		X		X	X	
Asteroid Robotic Redirect Mission	JPL	X	X	X	X	X	X		X
Space Launch System	MSFC	X		X		X			
NESC ESD V&V Plan Assessment	JPL, KSC			X					X
Advanced Modular Power Systems	JSC					X			
Gondola for High Altitude Planetary Science	GSFC, MSFC	X	X	X	X		X		X

SAFFIRE-I, -II, AND –III PROJECT

- Project Overview:
  - Class D experiment for Spacecraft Fire Safety Demonstration Project, SAFFIRE-1 launching in March 2016
  - Each Saffire flight unit has same configuration, with different samples
- Model used to:
  - Provide training opportunity at GRC
  - Convert Saffire design and configuration data to a system model
  - Represent
    - Physical architecture, Interfaces
    - Use cases, experiment operation
    - Requirements
- Utilized and extended custom requirements stereotypes to capture project-specific verification methods

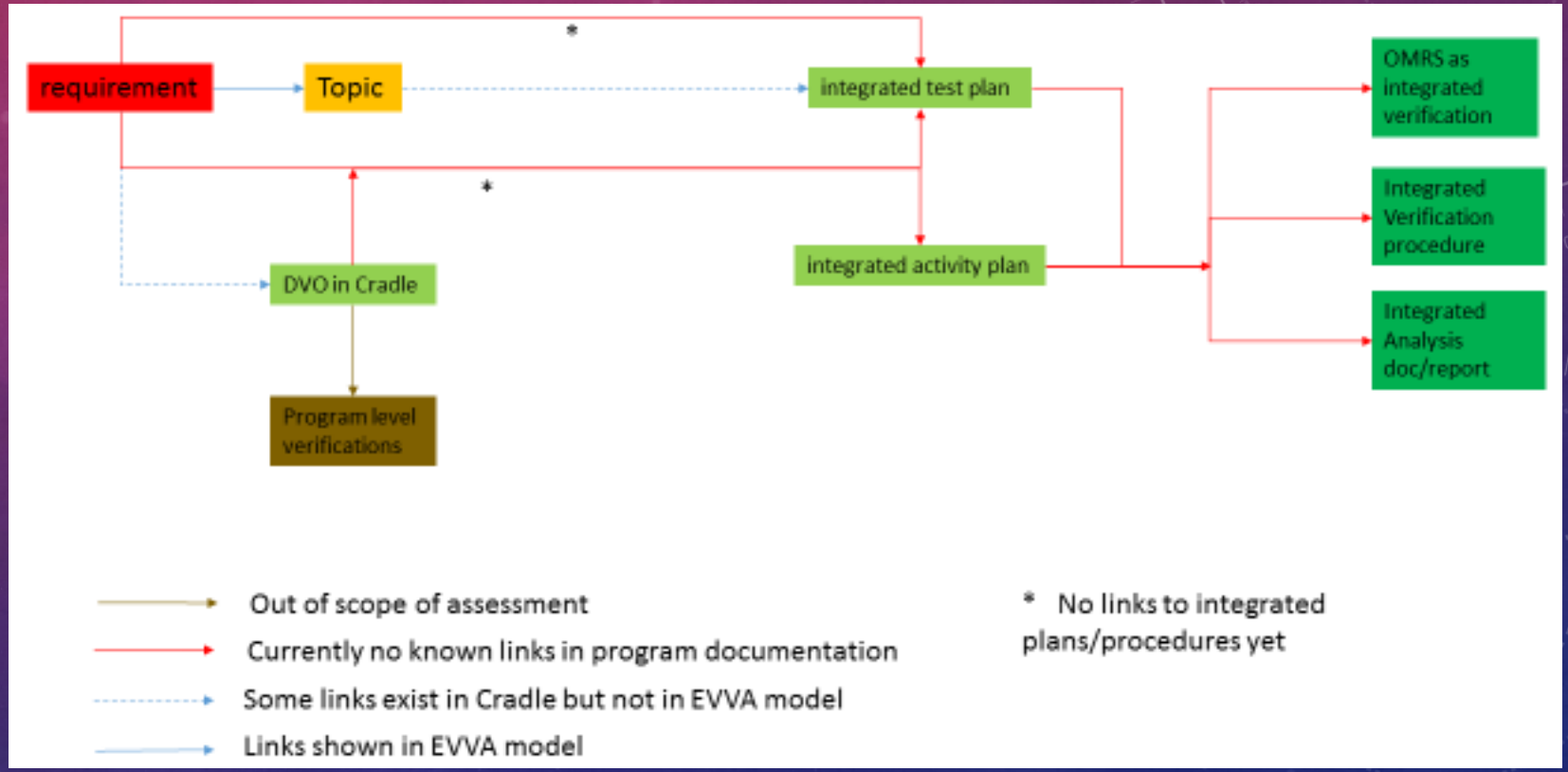
GONDOLA FOR HIGH ALTITUDE PLANETARY SCIENCE

- Modeling Objectives:
  - Model requirements and allocate to subsystems and components
  - Tie requirements to verifications
  - Generate Use Cases to define mission scenarios
  - Manage interfaces
  - Maintain and manage Master Equipment List and Power Equipment List
  - Integrate with simulations for pointing control system and science target availability at various launch sites over varying launch dates and mission durations
- Top Technical Challenges:
  - Design to allowable mass for a SuperPressure balloon on a 100-day mission
  - Achieve <1 arcsecond pointing accuracy and stability
  - Design to be refurbishable within a year for next flight at a cost of <20% of original development
  - Protect equipment while waiting for recovery in harsh environments such as Antarctica
- Organizational Challenge:
  - Develop platform elements at 4 different NASA locations – MSFC, GSFC, GRC, WFF



NESC EXPLORATION SYSTEMS DEVELOPMENT (ESD) V&V PLAN ASSESSMENT

- MBSE training opportunity offered by NESC, led by JPL
- Purpose: Assess ESD cross-program V&V planning and implementation
- Model used to:
  - Integrate V&V data from various sources
  - Establish formal relationships between integrated data
  - Illuminate gaps or coverage between plans
- GRC Focus:
  - Modeling associated with “Integrated Abort” topic
  - Architecting model results reporting process

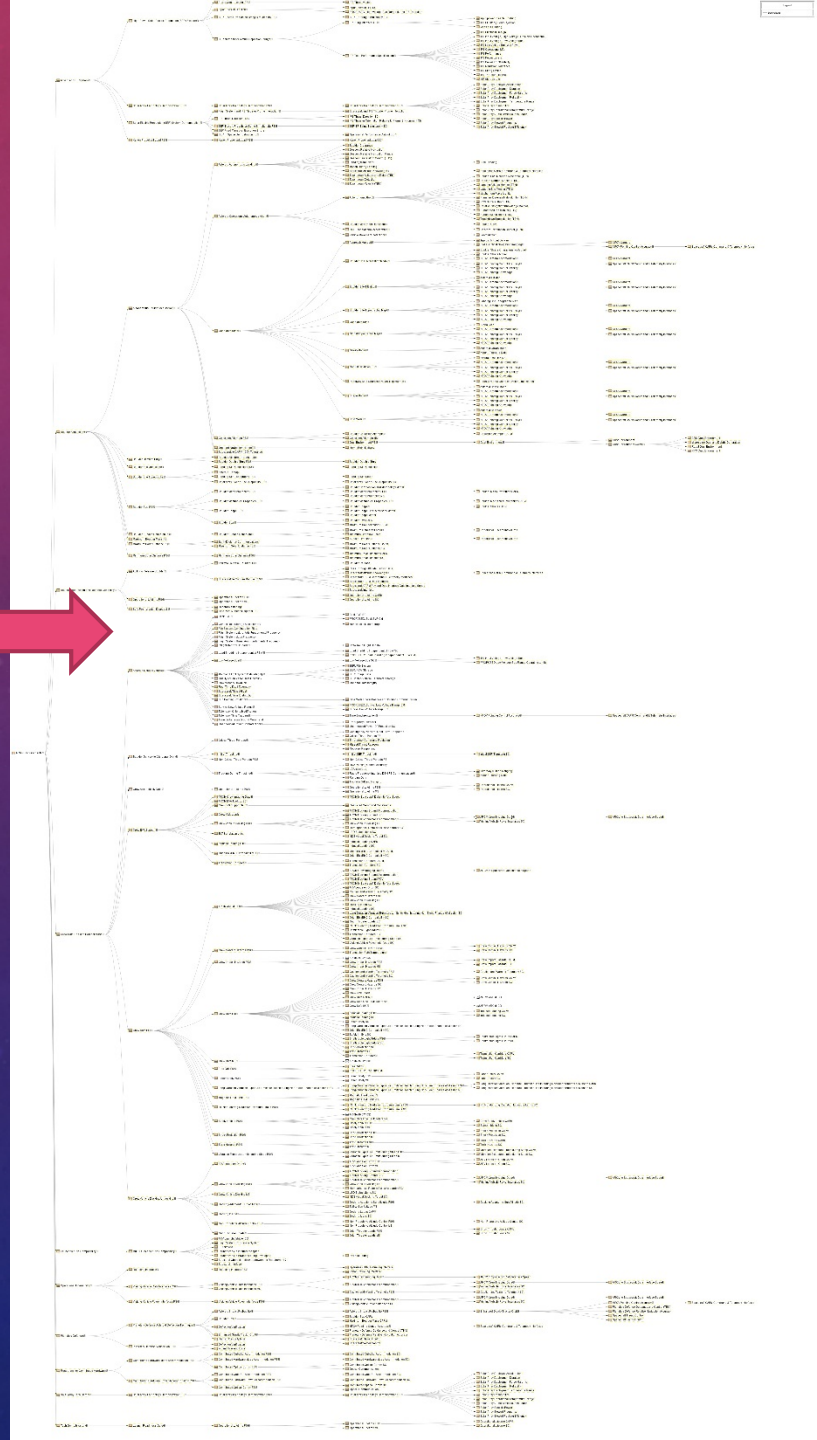


ASTEROID ROBOTIC REDIRECT MISSION

GRC Participation:

- Concept of Operations Modeling
  - Spacecraft function definition
  - Lead for two mission phase concept models
- Requirements Modeling
  - Relating requirements to
    - Satisfying functions (from ConOps) and project elements
    - Allocated project elements
  - Link Government-Furnished Equipment requirements with spacecraft requirements
- Product Breakdown Structure to subsystem level

Other ARMM Modeling: Project System ConOps, WBS, project personnel, interfaces…



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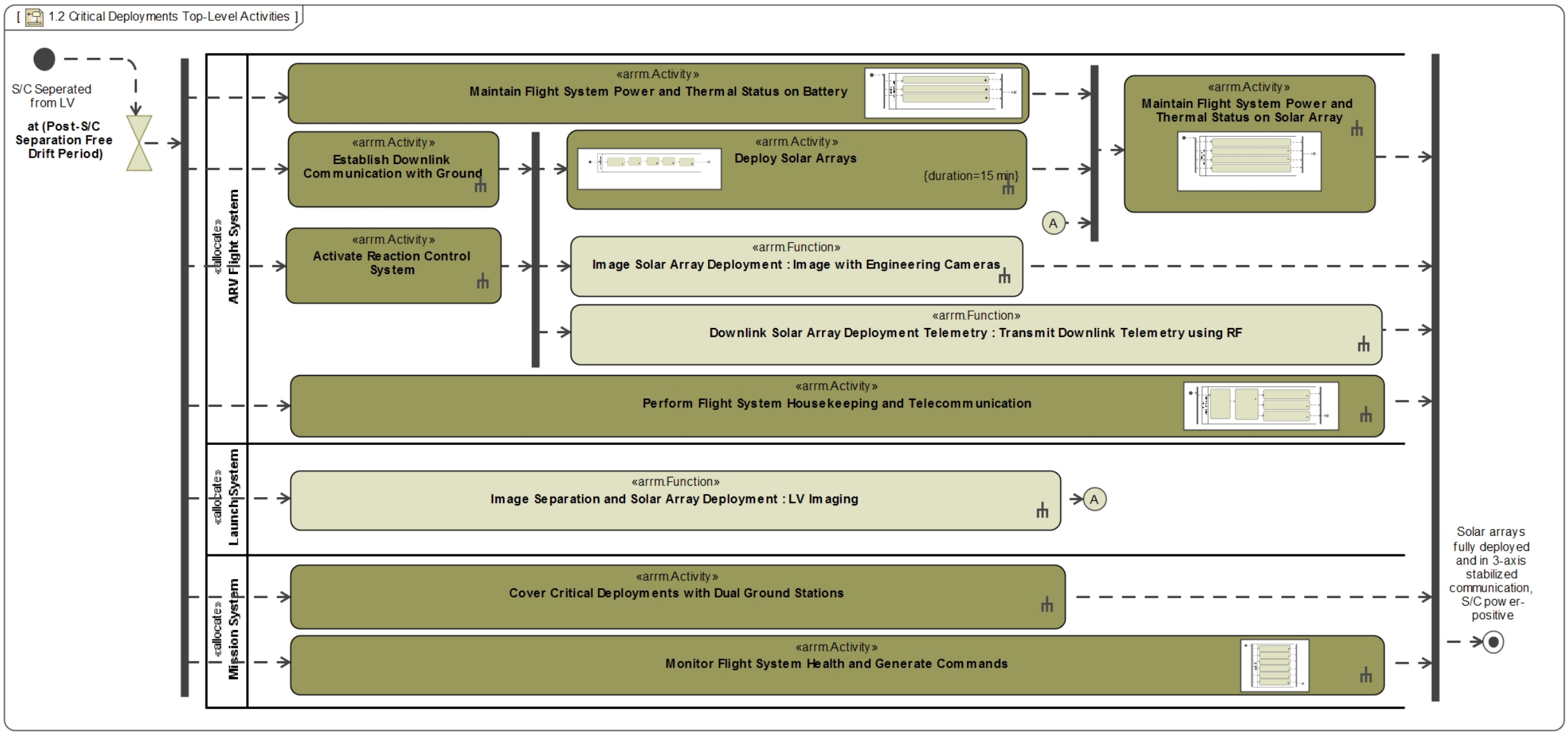

ASTEROID ROBOTIC REDIRECT MISSION

Benefits

- Requirements validation through ConOps
- Shared model facilitates communication across team
- Enhanced ability to track deliverable progress
- Mentorship by more experienced modelers

Challenges

Cross-center access of model (VPN)

Huge size of model (>150 MB)

Larger modeling team

+ Modeling tool instability

= Slow tool interface

Occasional loss of work

Long download/commit times (>20 min)

GRC MBSE ADOPTION CHALLENGES

- Significant investment required to become effective MBSE practitioner
  - Projects budgets are tight and are unable to devote money (in development time or resources) for SE to learn
  - Learning how to read SysML effectively
  - Jumping from basic tool knowledge to modeling to satisfy SE deliverables
  - Applying best practices often requires failing a few times, first
- Collaboration in a multi-center modeling effort
  - Model storage so all SE team members can access efficiently
  - Model access so all domain team members can access effectively
- Resources
  - More experienced modelers often do not have availability to mentor less experienced or capture lessons learned
  - Contracted modeling support can be expensive

FUTURE MBSE ASPIRATIONS AT GRC

- Facilitate stakeholder access to model
  - Setting up an OpenMBEE instance (web interface to model viewpoints)
- Expand outside of the architectural models
  - Integrate SysML with other tools, for simulation
- Expand support to Practitioners
  - Continue to expand the GRC plug-in tool capabilities
  - Capture best practices and share knowledge: more “kickstarters”
- Increase percentage of new projects using MBSE as a baseline