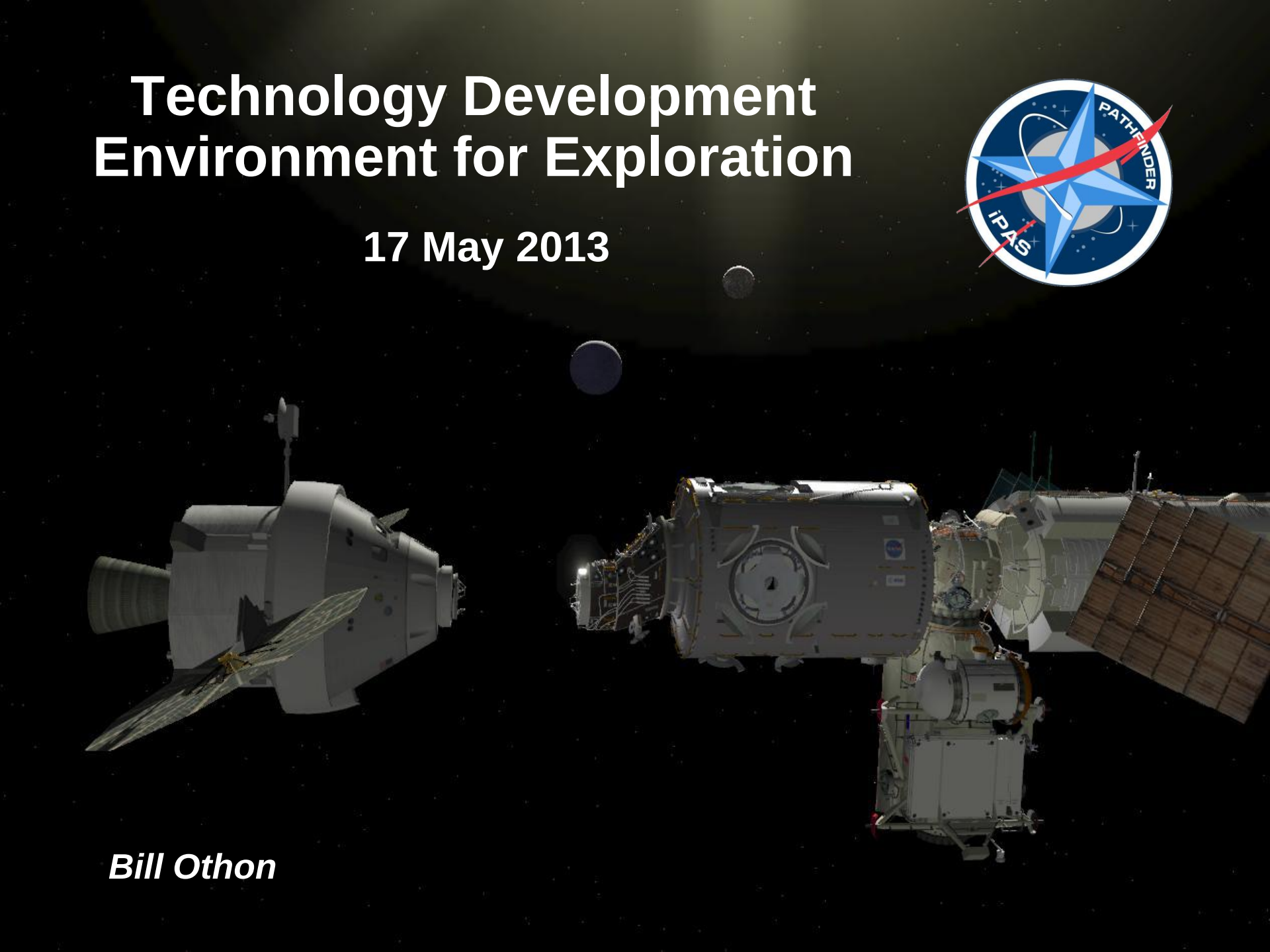
Technology Development Environment for Exploration

17 May 2013



Bill Othon

Thanks for the Invitation

- AIAA Symposium is a good Progress Marker
  - What has been done since last year?
- Thanks to the MBSE team
  - Linda Bromley/JSC
  - Lui Wang/JSC
  - Shira Okon/Tietronics
  - Michel Izygon/Tietronics
  - Chatwin Landsdown/JSC
  - Howard Wagner/JSC
- Thanks to new Practitioners
  - Luis Vasquez
  - Rod Robinson
  - Denise Varga
  - David Fletcher

Challenge for MBSE Practitioners

- Interest in Model Based Methods increasing
  - Metric: students signing up for SysML class
  - More engineers are exposed to object-analysis and data architectures
- Still a perception problem with Managers
  - Not seen as a value (no ROI)
  - Adds costly infrastructure and time
  - Not in line with our new “agile” world
- Problem of getting Jedi-Trained in MBSE
  - Can’t demonstrate value without training
    - Methods and tools
  - Can’t train while you are busy building

Key: Link between Models and Products

- Projects are established to create useful products
- Models must be shown to relate directly to successfully producing products
- Then, Project Managers will care
- Examples
  - Models describe systems (communication)
  - Models enable analysis (performance)
  - Models create products (development and test)
  - Models support operations (product use)

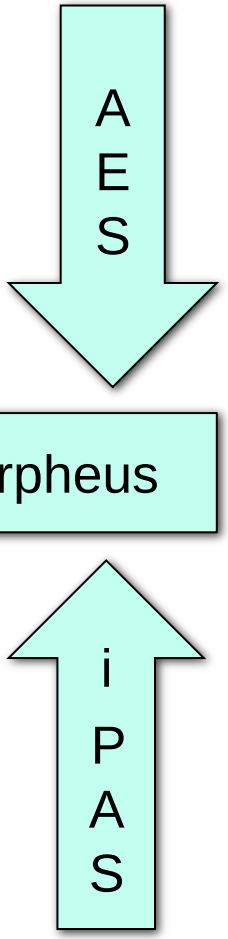
Must make a connection between Model and Product as soon as possible.

Strategies to Gain Buy-In

- Bottoms-up: Engage Discipline Leads
  - Models must be used in the course of product creation
  - Engineers can use models for their work
- When engineers use MBSE, the models are more aligned with the product
  - Too often, MBSE is more of a *reflection* of the product
- Relate the model to the product as early as possible
  - Tighten the iterative loop between model development and system development/test
  - Validate the model as early and continuously as possible

Different Approaches to Specification

PROJECT FORMULATION	• Requirements • Functions/Capabilities • Functional Flow Block Diagrams • Early Project Formulation
PROJECT EXECUTION	• Cost • Schedule • Resources • Risk Management
PRODUCT DEVELOPMENT	• System Engineering and Integration • System Development • Subsystem Development



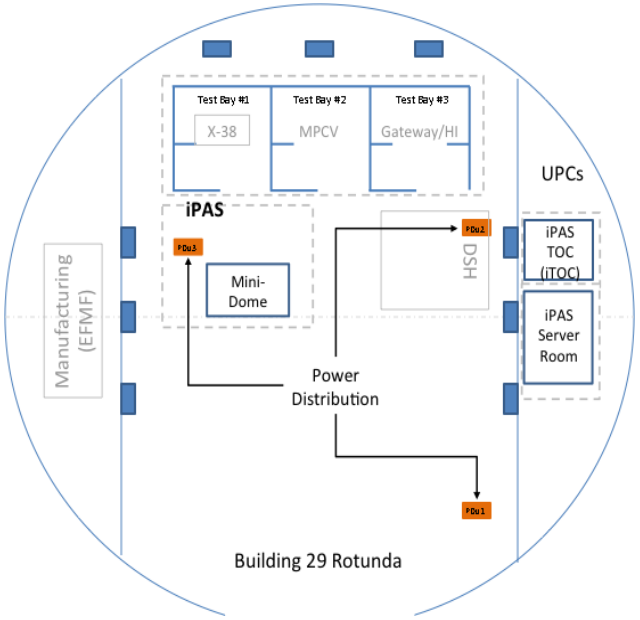
iPAS – Environment for Integration

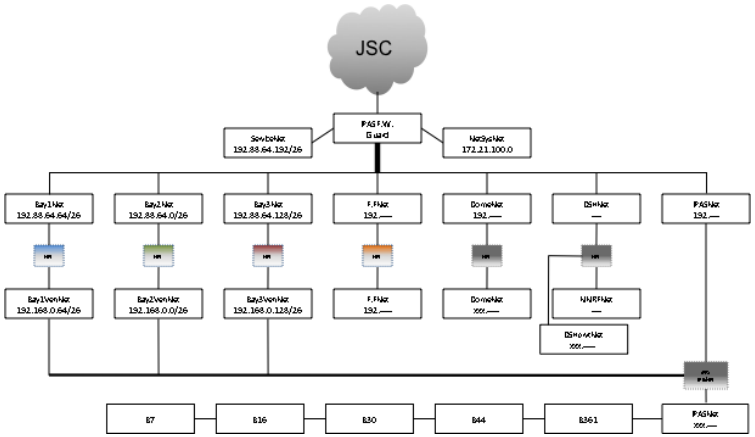
- Promote Integration of Technology and Engineers
  - Pathfinder team (includes EA, MOD, SF, other centers)
  - Focus on “building things”, inline with NASA/JSC mission
- Three elements of iPAS
  - The Iron Bird: Mission Systems (Vehicle, Operations)
    - Support the development of a *common avionics, hardware, software, and operations architecture* that can be applied over various missions
  - The Iron Nest: Testbed Systems
    - Provide a *common testbed framework* that supports integrated hardware/software testing for a variety of applications
  - The Process: Improving SE&I techniques and assessments
- Real-world Environment to Learn MBSE
  - Models developed to describe system
  - Models related to hardware on the floor

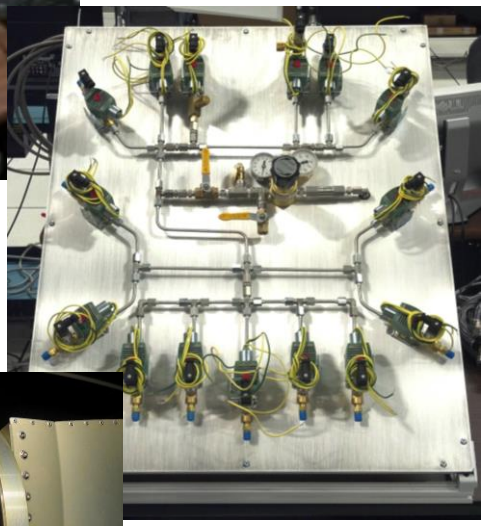
iPAS – Environment for Integration

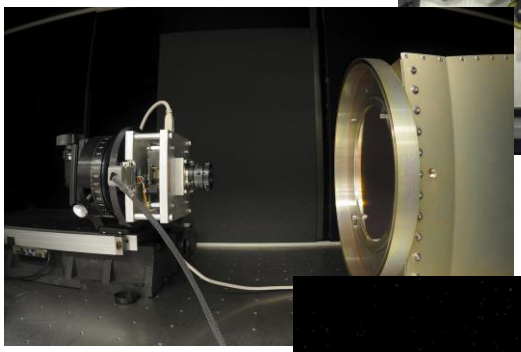
- Promote Integration of Technology and Engineers
  - Pathfinder team (includes EA, MOD, SF, other
  - Focus on “building things”, inline with NASA/J
- Three elements of iPAS
  - The Iron Bird: Mission Systems (Vehicle,
    - Support the development of a *common av* *and operations architecture* that can be applied over
    - issions
  - est: Testbed Systems
    - a *common testbed framework* that supports integrated
    - e/software testing for a variety of applications
  - s: Improving SE&I techniques and assessments
- Real World Environment to Learn MBSE
  - Models developed to describe system
  - Models related to hardware on the floor

iPAS – Integrating People and Products





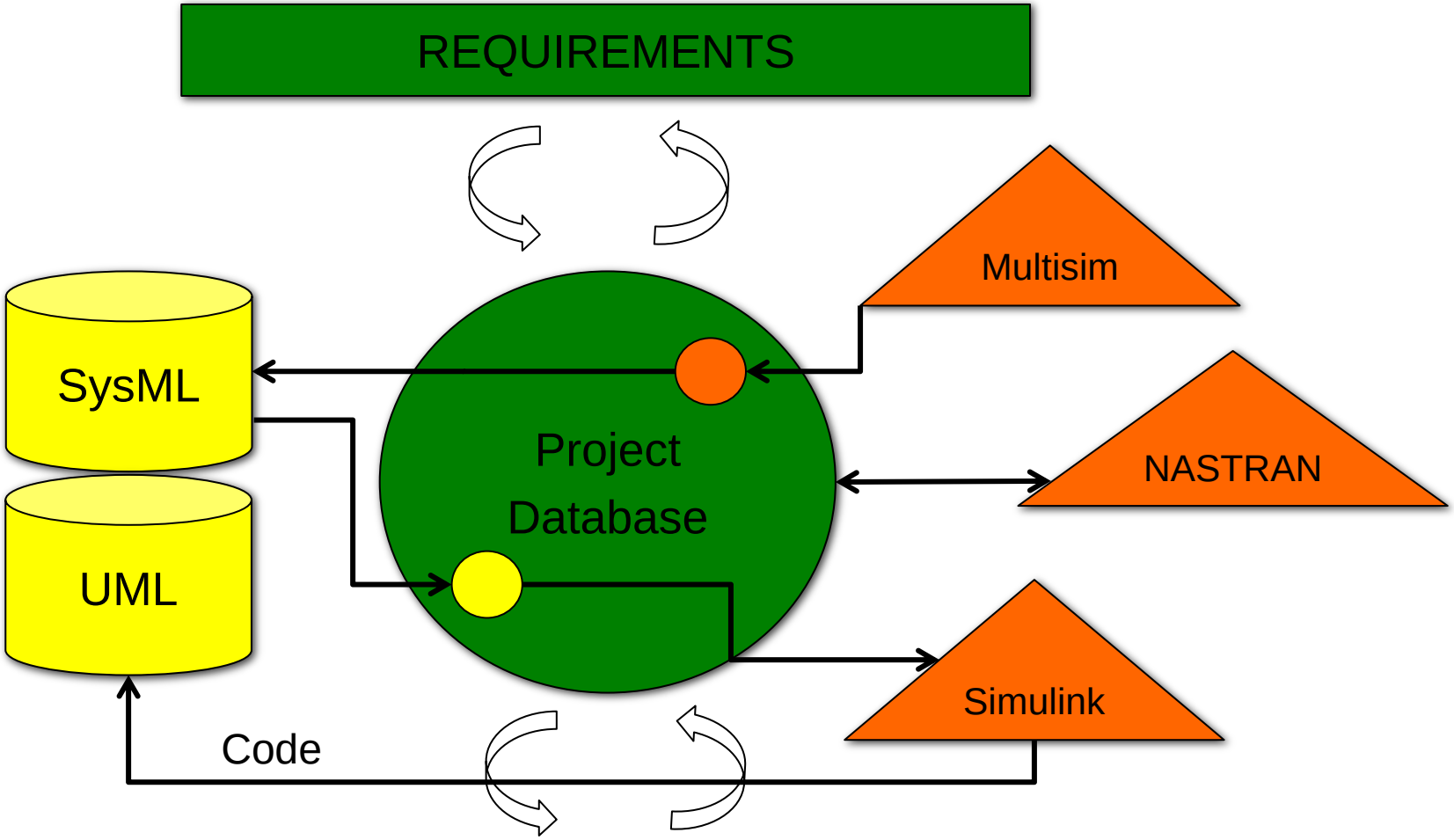




Supporting Technologies

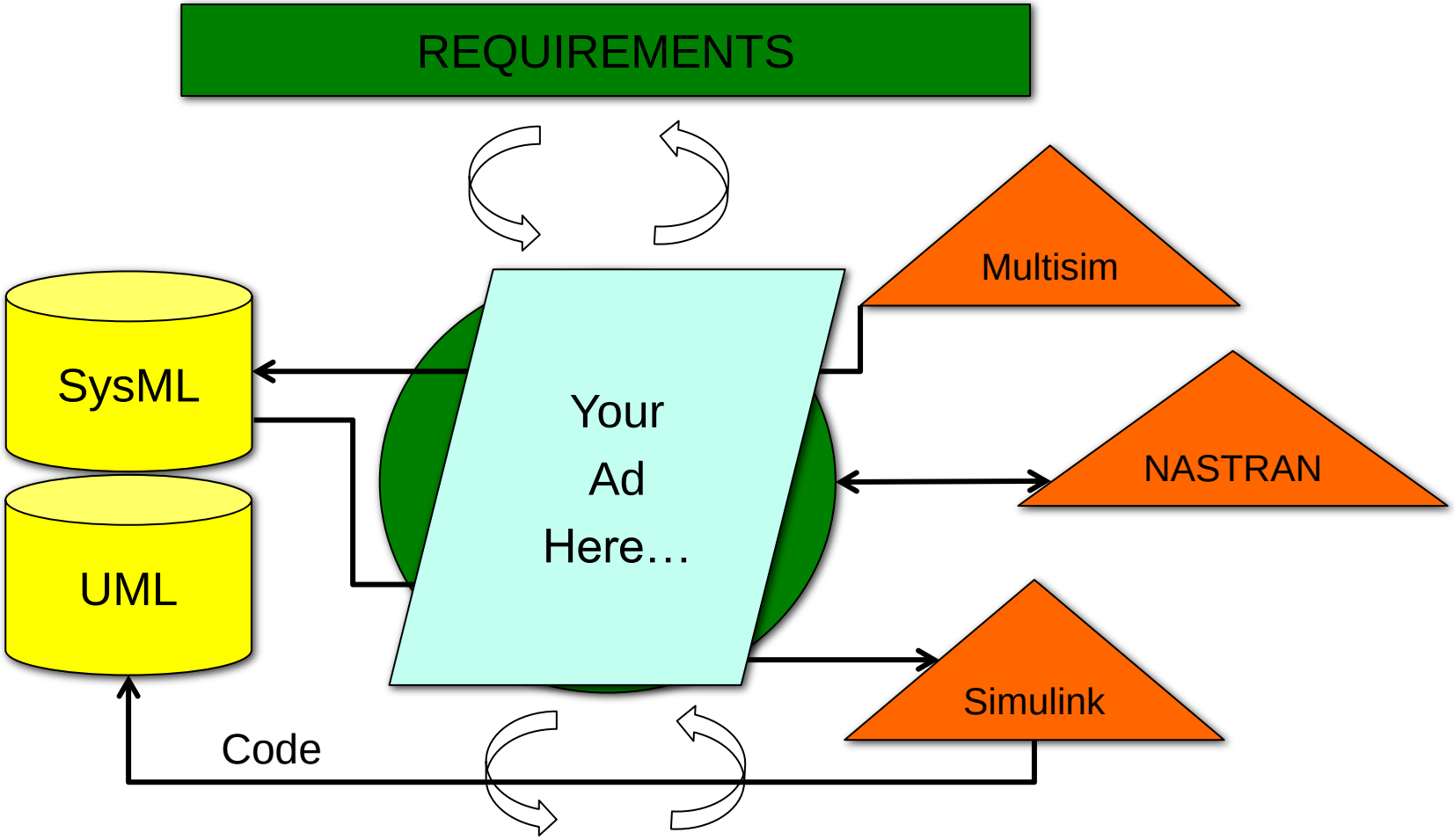
- Model Based Engineering
  - Analysis tools that support design and development
- Model Based System Engineering
  - Environment that supports analysis of multi-discipline integration
- Model Application
  - Requirements and sizing: Mission Planning
  - Design and Development: Describe systems
  - Analysis: Generate inputs files for analysis tools
  - Test: Generate test procedures for iPAS
  - Operations: Deliver product to crew/operators

Data Architecture



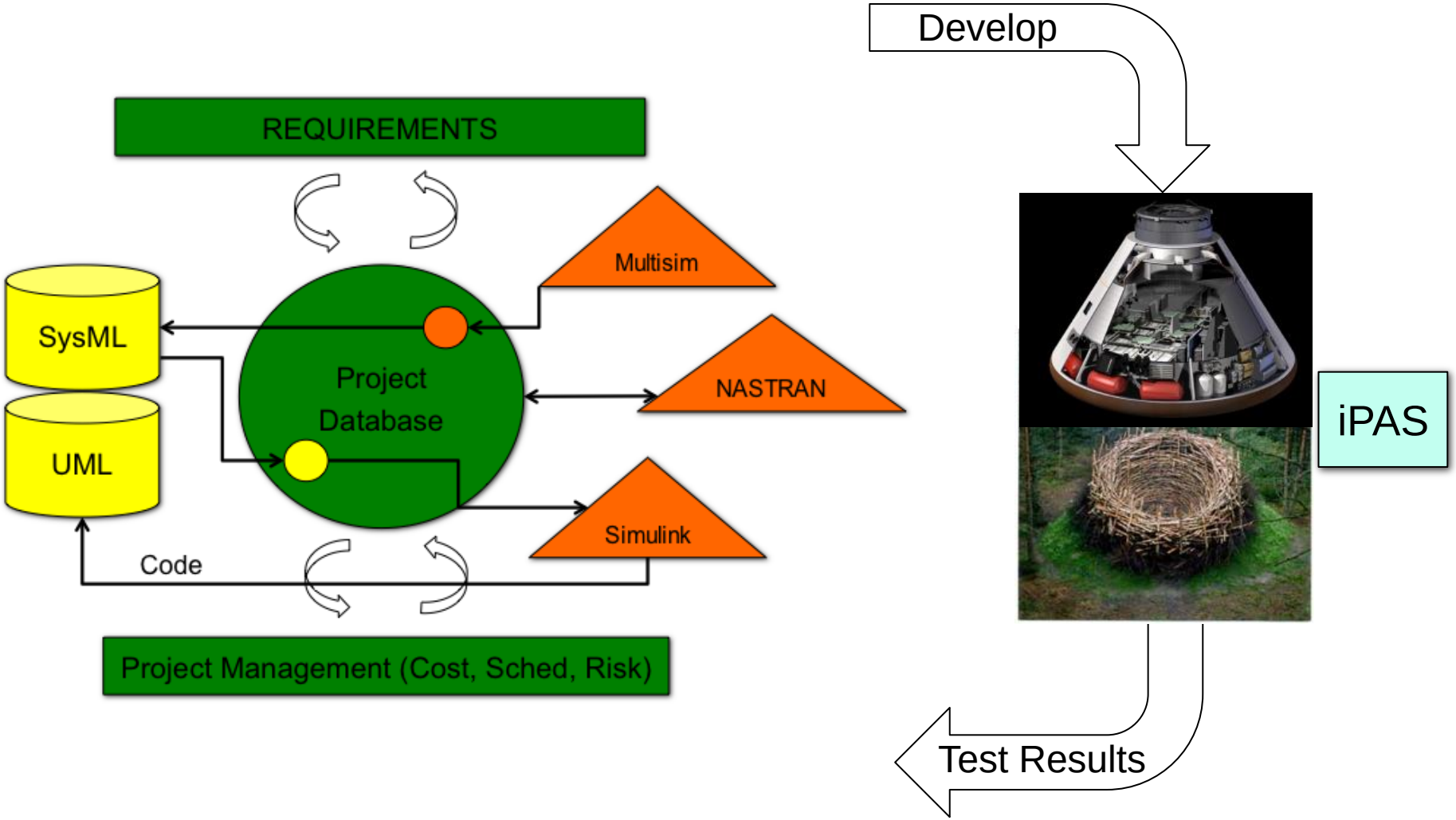
What's in the Middle?

Data Architecture



What's in the Middle?

Product Development and Test



Establish iterative loop between Models and Products!

Pilot Project: Power System in iPAS

- High Power Distribution Unit (HPDU)
- Integrated with other vehicle elements in iPAS
- Plan
  - Model existing design in iPAS (reverse engineer)
  - Link models to analysis tools (Multi-sim)
  - Link models to products (source code, telemetry)
  - Link models to test (ATML, mREST)
- Strategy
  - Perform operations manually first
    - Understand what are the important attributes
  - Then, automate products from models

Key Players

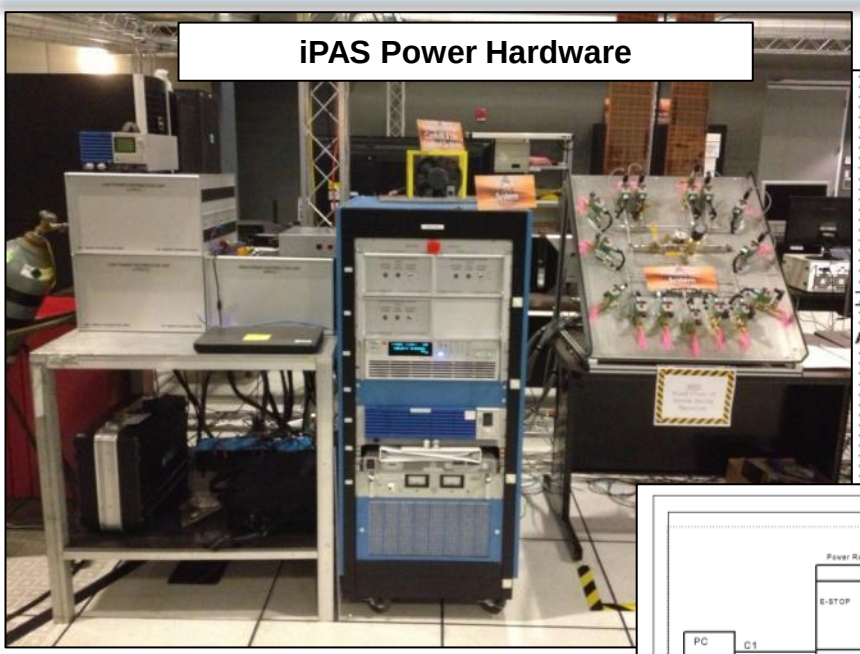
- Power Engineer: Lydia Davis/EP
  - Technical discipline (young, energetic, optimistic)
- MBSE Mentor: Shira Okon/Tietronics
  - Knowledgeable
- Test Orchestration: Pat McCartney/METECS and Chatwin Landsdown/EV
- Collaborators
  - Lui Wang, Michel Izygon, Bill Othon

Technical Products

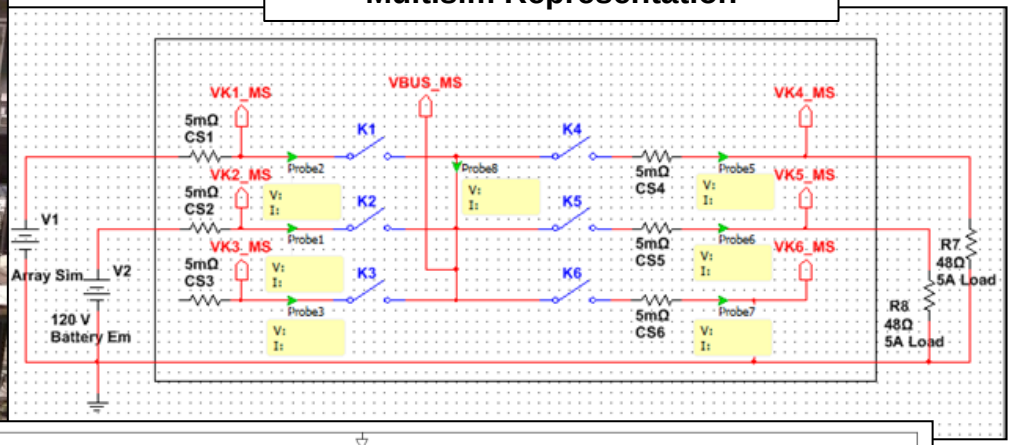
- Design Specification
  - Describe product through models
  - Replace “locked” information (PDF, PPT)
- Analysis support
  - Tie models to Power Analysis (Multisim)
- Software Products
  - Tie models to code and ICDs
- Test Specification
  - Tie models to Test Execution products
- Operational products
  - Tie models to Telemetry and Commands
  - Consider using models for crew interfaces

Power System Specification

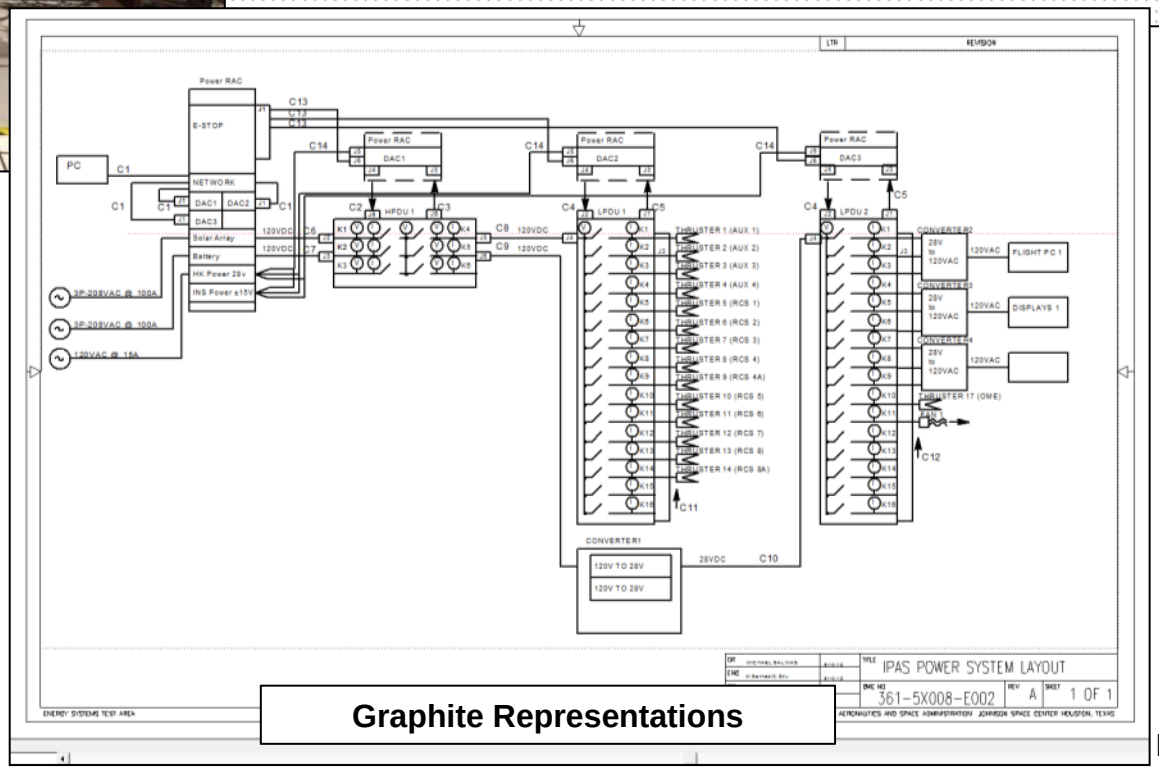
iPAS Power Hardware



Multisim Representation

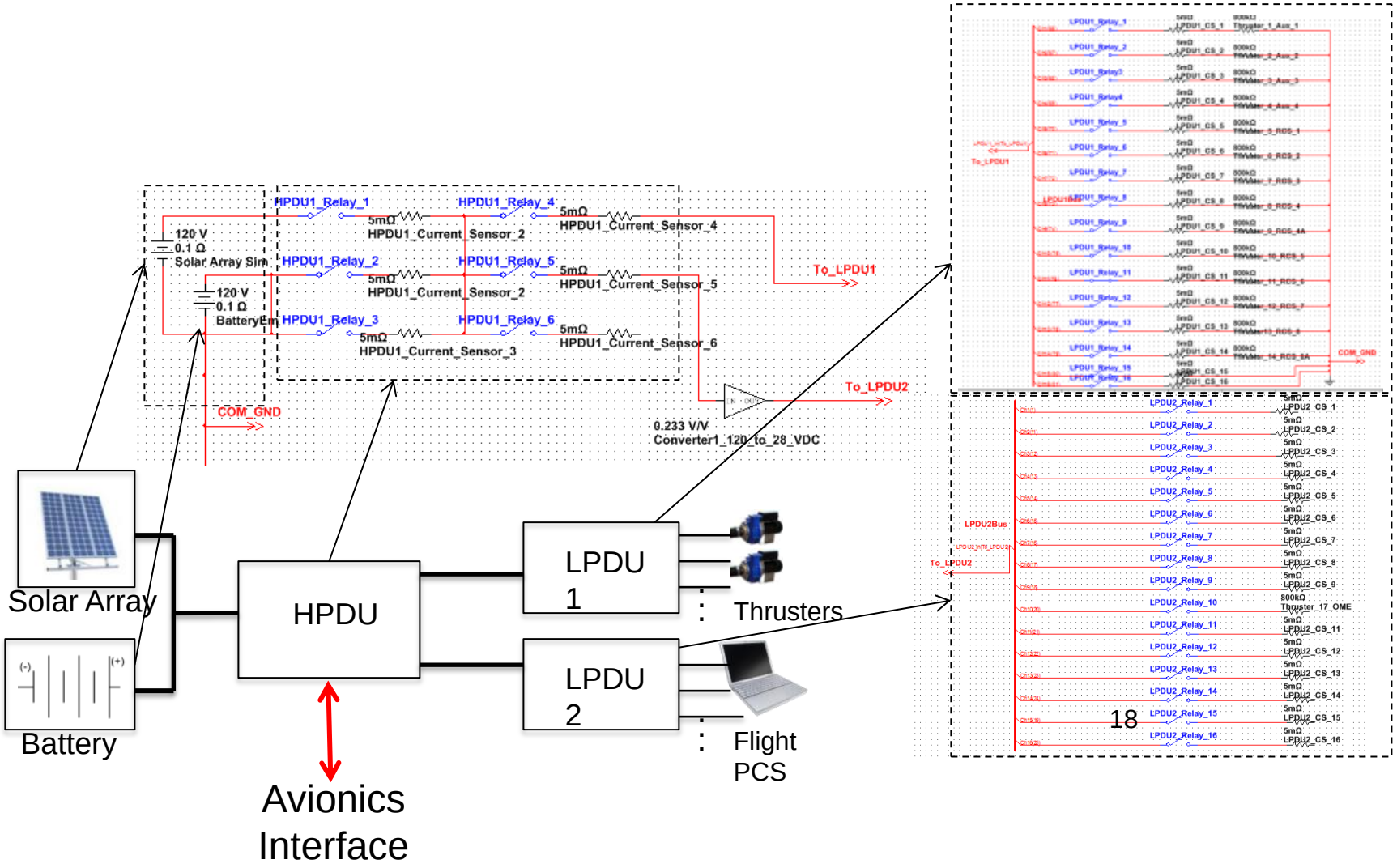


Existing Representations

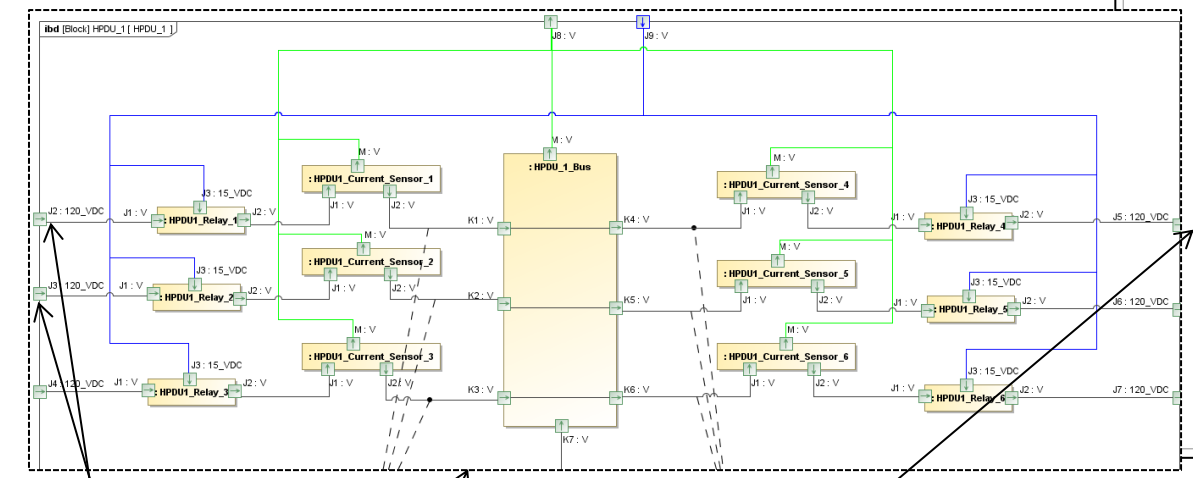


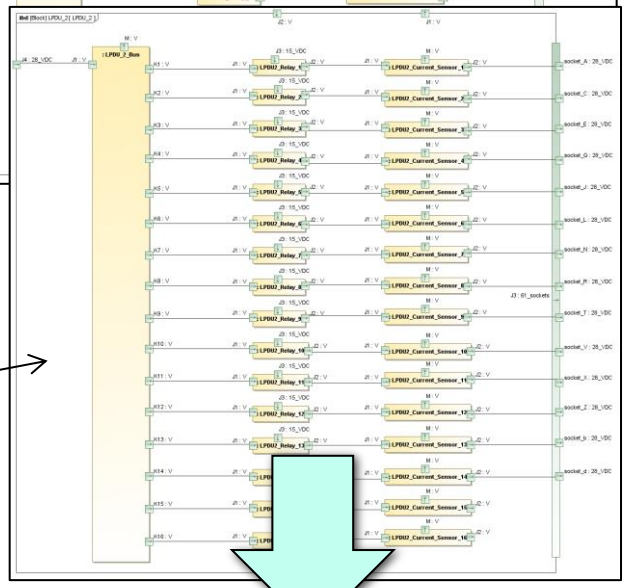
Graphite Representations

iPAS Power System in MultiSim



Same Model in SysML





Solar Array

Battery

HPDU

LPDU 1

LPDU 2

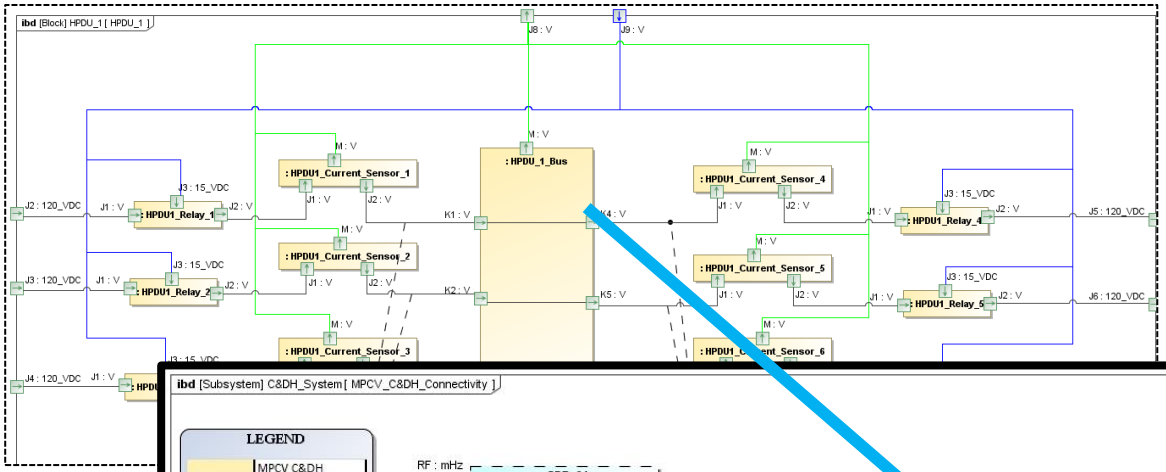
Thrusters

Flight PCS

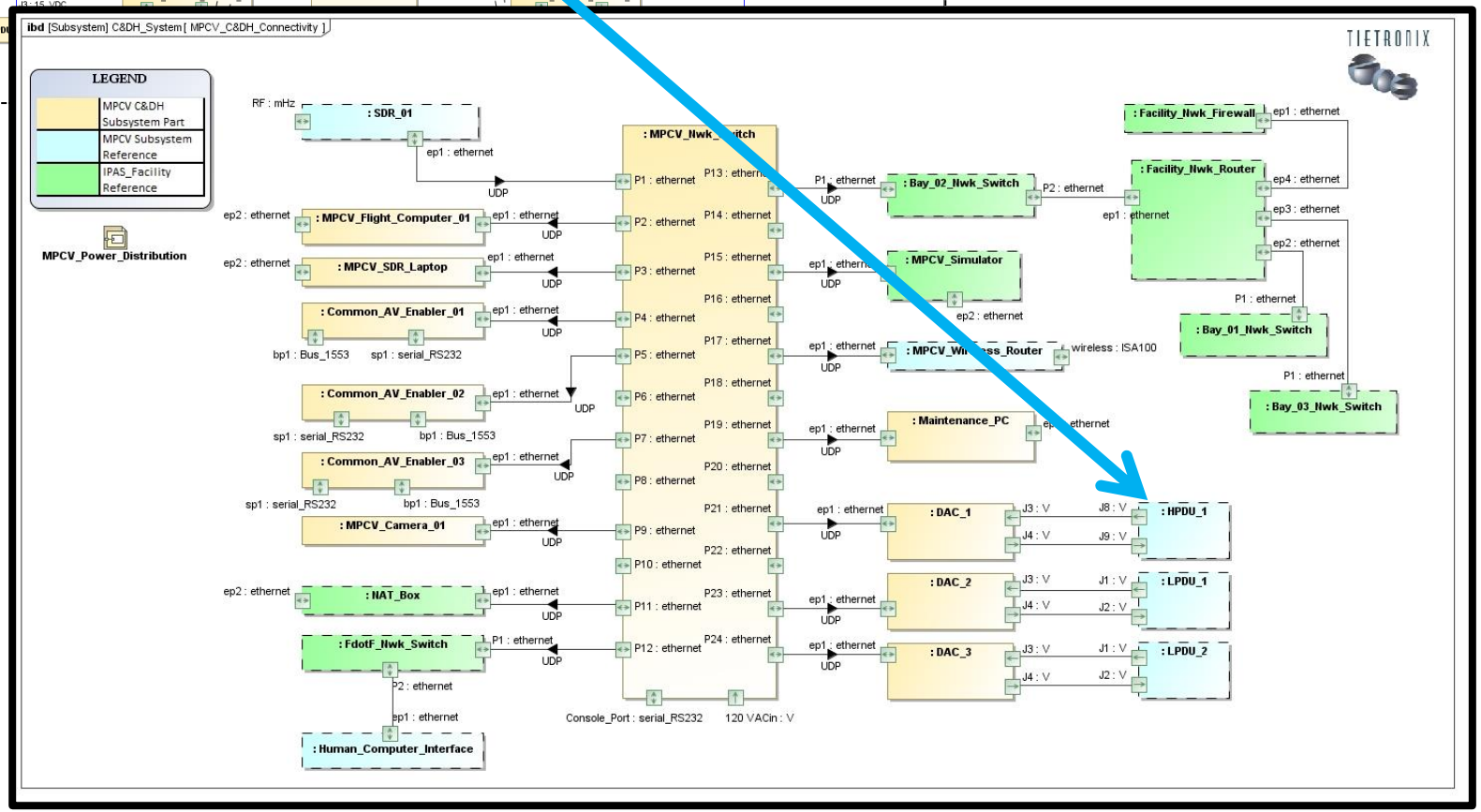
Avionics Interface

MultiSim Input File

Power System in Avionics Architecture

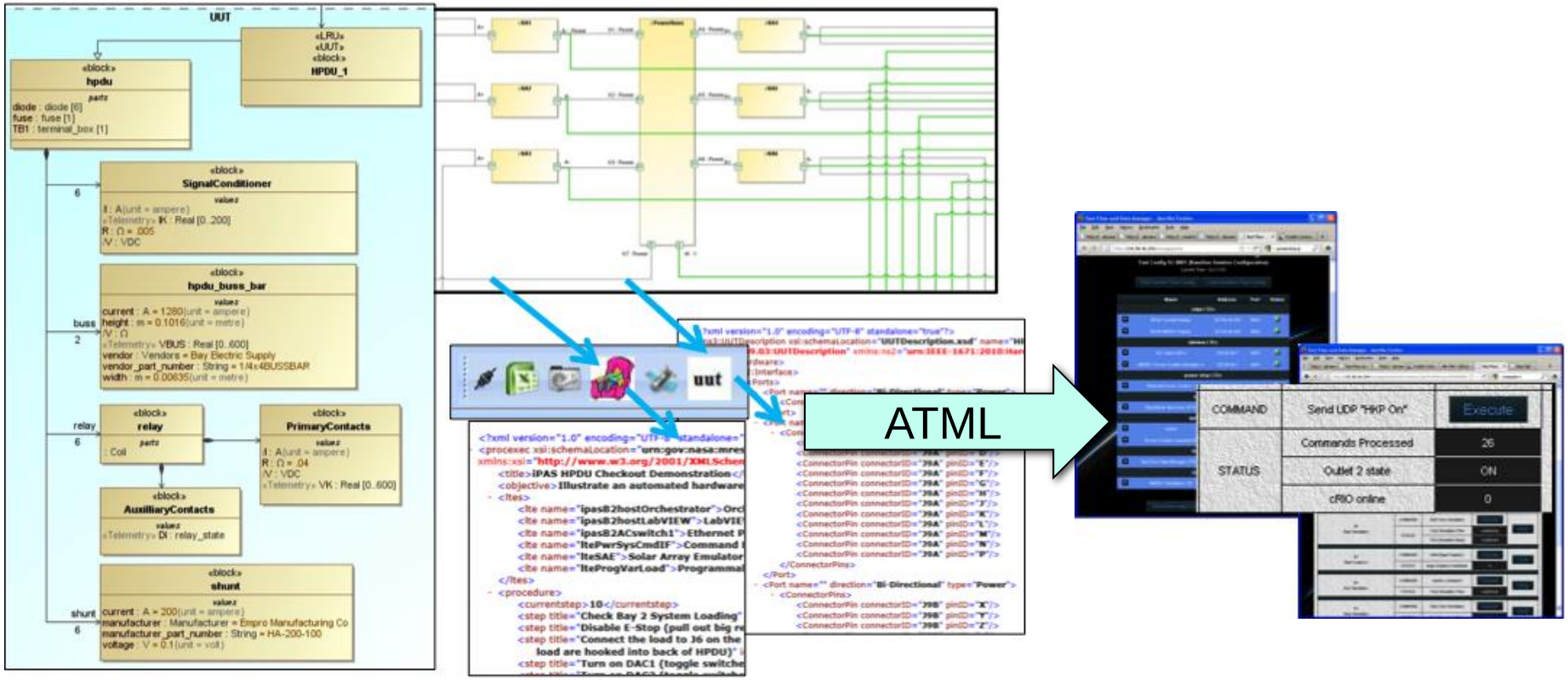


Integration Across Technical Disciplines

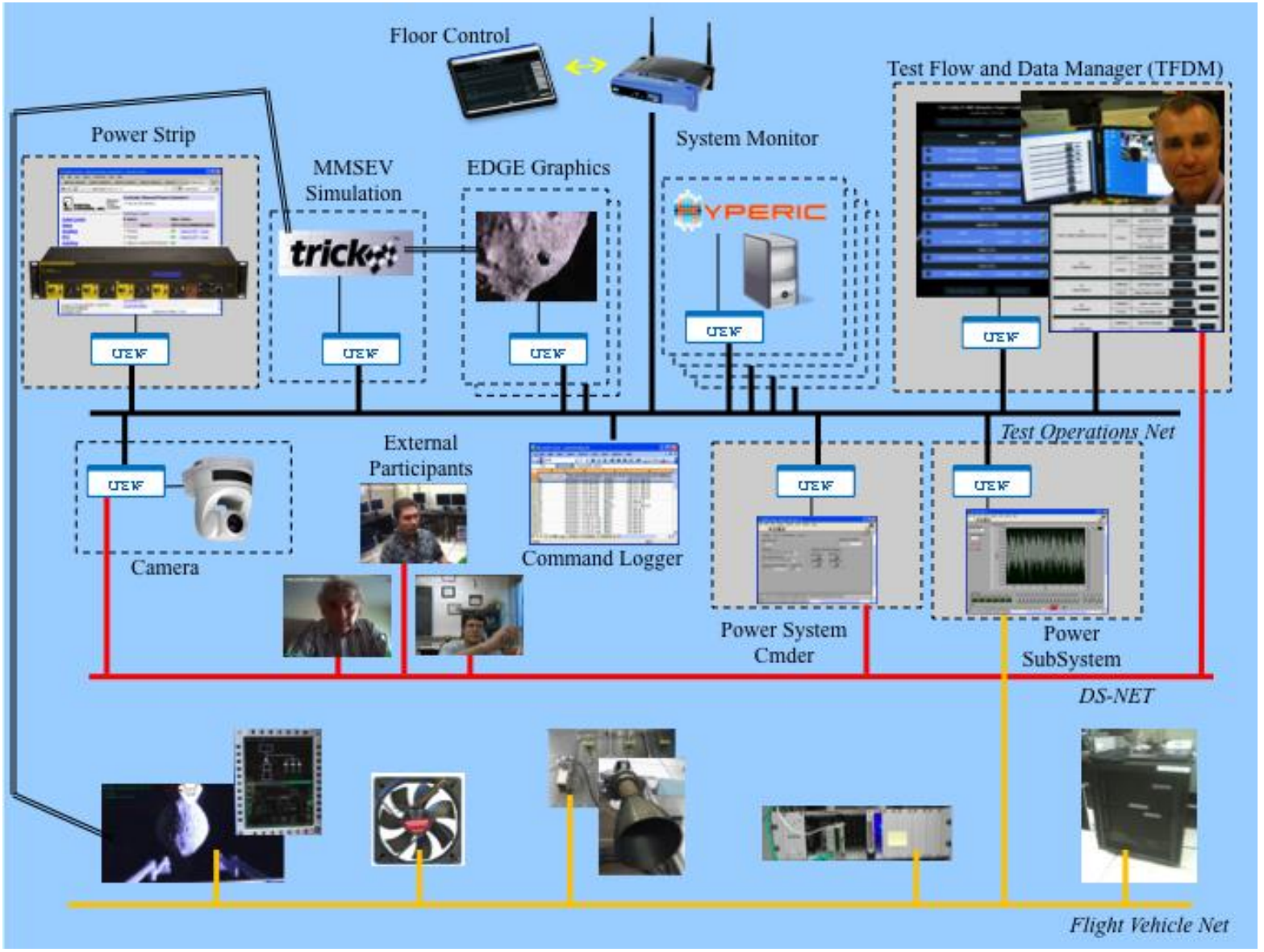


Support for Integration and Test

- Convert model specification into Test Configuration and Execution script
  - ATML to mREST



Test Automation through mREST

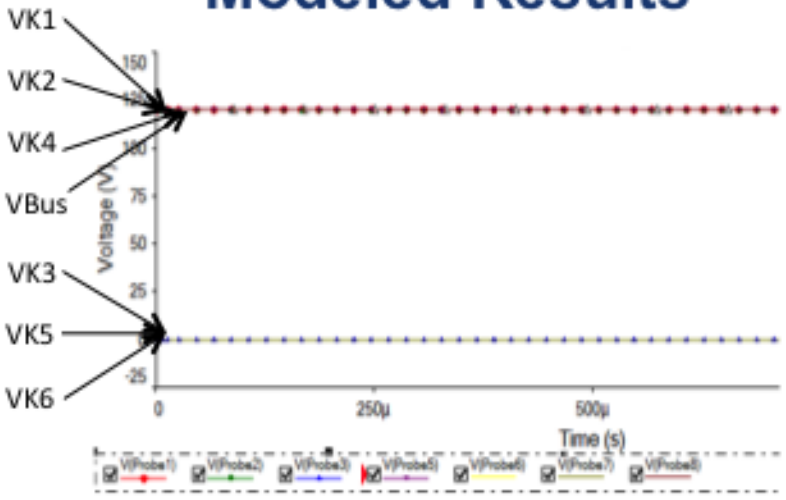


Test Demonstration in iPAS

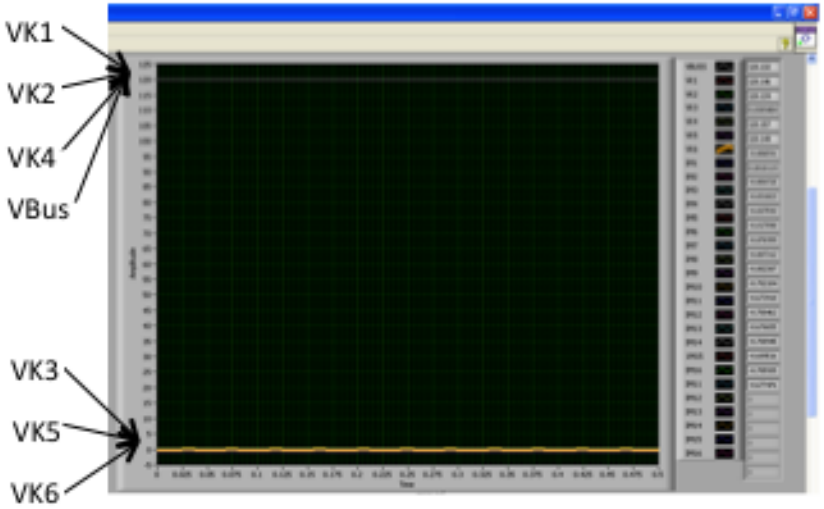
Expected Results

Channel	State	Voltage	Value	Current	Value
K1	Off	VK1	120	IK1	0
K2	On	VK2	120	IK2	0
K3	Off	VK3	0	IK3	0
K4	On	VK4	120	IK4	0
K5	Off	VK5	0	IK5	0
K6	Off	VK6	0	IK6	0
Vbus		VBUS	120		

Modeled Results



Actual Results



Data provided by Lydia Davis/EP

JSC SysML Users Group

- Thursday, Noon-1pm
- Just two months in
- Key topics
  - Review of model development (new developers)
  - Model exchange
    - File control and configuration management
    - Deployment of “packages” and “libraries”
    - Integrating existing models into project databases
  - Plug-in Development
    - Identifying attributes for parsing
    - Generating products (mass table, telemetry list)
    - Model search and analysis (JSC, Ames)

Thanks

- Questions?