HUMAN EXPLORATION SPACECRAFT TESTBED FOR INTEGRATION AND ADVANCEMENT

HESTIA Integration and Test
Bill Othon/EG
Development Focus

• Capabilities driven
  • Identify gaps, develop new technologies
  • Mature through ground-test (bridge TRL gap)
  • Ensure technology can be integrated into systems
    • And with humans and operations (human centered design)

• Exploration Focused
  • NASA is strategizing ultimate goals and architectures
  • Environment needs to be open to trades

• Resource constrained
  • Leverage existing capabilities, and advance them
  • Engage centers and commercial partners
  • *Intentionally* design an environment for collaboration
Three Elements of Test

• One: The Articles Under Test
  • Use ground-based test to mature technology
  • Reduce risk for future missions

• Types of Articles
  • Flight hardware
  • Path-to-flight hardware
  • Emulators
  • Simulators
  • Data
  • Humans

• Fidelity selection
  • Based on availability
  • Based on research need
  • Based on resources
Three Elements of Test

• The Testbed (Infrastructure for Testing)
  • Data networks between systems
  • Environment Chambers
  • Test Execution software
  • Data collection and analysis
  • Library of applications (App Store)

• The Integration Process
  • Manage complexity (Model Based Engineering)
  • Domain tools (MATLAB, Multisim)
  • Integrated Performance Analysis (Trick, GUNNS)
  • Train a team to support integration and test

Train development team through active integration and test
iPAS: Enabling Integration Across Projects

iPAS Services [TEMPLATE]
- Test Operations support
- Closed-loop Simulation (Trick/ER)
- Data collection and archival
- Multi-center Software Library
- Network services
  - Within iPAS
  - Across JSC
  - Across NASA
- Infrastructure
  - Space
  - Power
  - Data
iPAS Testbed Template: Empty
iPAS Testbed Template: Orion AA2

Vehicle
- Ground Station
- SIGI
- PDU
- Comp

Testbed
- Whiteboard
- TOC
- EDGE
- DEV2
- DEV1
- SIMHOST
- PPS

Testbed Services
- Test Orchestration
- 3D Graphics
- Simulation & Library

Data Analysis
- 1553 Bus Analyzer
- Wireshark
- Oscilloscope
- Time Reference
- CFS Library
Several Types of Missions

Asteroid Encounter (2011)

Waypoint (2012)

Asteroid Redirect (2013)

Phobos Orbit (2014)

Mars Surface (2015)

ER products: Sim, Graphics, Domes
Co-location When Feasible

Avionics
- Processors
- Networks
- Wireless
- Comm

GN&C
- ALHAT
- Crew Piloting
- On-board Trajectory Planning

Core Flight SW
- Framework
- Apps Store
- GNC Apps
- Hardware Apps

Delay Tolerant Net
- Mission Evaluation
- DTN on Radio
- DTN on Computer

Advanced Modular Power
- Power Systems
- Integration with avionics in DSH

Habitat
- Avionics
- Crew Displays
- Vehicle Health
JSC Lab Integration via Fiber (iPASNet)

B16 – GNC/Dome
- Star Tracker
- Star Field
- Cockpits
- Dome

B30 – Mission Ops
- MCC emulator
- SNRF interface
- Telemetry and commanding

B44 – Comm
- Channel simulator
- TDRSS
- Comm architecture

B7 - ECLSS/HESTIA
- Chambers
- PLS lab

B361 – ISRU/Power
- Interface to power systems
Multi-center Integration

Ames
- AMO
- Data Architecture

Armstrong
- DFI for AA2

JPL - PTL
- Deep Space Network
- DTN
- Comm standards

Goddard
- Core Flight SW
- Comm
- Interface Specs (EDS)

Glenn
- AMPS
- Engineering observation during test

Langley
- Avionics

KSC – LCC
- Launch Control emulator
- On-pad Vehicle Communication

MSFC - HOSC
- Multiple Control Center activities
- ECLSS Lab
Example: Mars Surface Mission (HESTIA)

- Multi-vehicle surface operations
  - Habitat: Maintain Life Support
  - ISRU: Create Commodities
  - Rover: Commodities Transfer

- Mission Scenario: Oxygen creation, storage, and transfer
HESTIA: Mars Surface Scenario

FY15 GOAL: Perform initial demonstration of HESTIA Vehicle Integration

Cross-discipline Team
- EC: ECLSS
- EP: ISRU and Power
- ER: Modeling and Simulation
- EG: GN&C
- iPAS: SE&I

Identify Products (articles under test)

Define Scenario (support analysis)

Apply SE&I and Test
Coordination Among Teams

- Lay support infrastructure
- Coordinate product delivery
- Prepare for integration opportunity
- Align test with schedule, not the other way around
Refinement Through Execution

How do you demonstrate Efficiencies? Through Repeated Application

Execute Test

Capture Results, Analyze and Repeat

Human Dimension to Test
- Trained Team
  - Opportunity to Learn
- Agile Environment
  - Preserve Success
  - Apply to other projects
- Regular Test Rhythm
  - Within one project
  - Across different projects

How do you demonstrate Efficiencies? Through Repeated Application
Value of Cross-Discipline Integration

• Identify commonalities across disciplines
  • “Clean water”: Propulsion vs. ECLSS
  • Discuss water cleaning techniques
  • Common hardware (valves, pumps)

Sources of Water on Mars

- EP: Water from regolith
- EC: Water from condensate
- EP: Water from fuel cells
- EC: Water from urine

Notional
End of Presentation

• Questions