IVHM for the 3rd Generation RLV Program – Technology Development

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Integrated Vehicle Health Management
Project Objectives:
Develop and integrate the technologies which can provide a continuous, intelligent, and adaptive health state of a vehicle and use this information to improve safety and reduce costs of operations.

Technology Objectives:

- Develop, validate, and transfer next generation IVHM technologies to near term industry and government reusable launch systems.

- Focus NASA on the next generation and highly advanced sensor and software technologies

- Validate IVHM systems engineering design process for future programs
Global Civil Aviation

Revolutionary Technology Leaps

Access to Space

Reduce Accident Rates, 10x

Increase System Throughput, 3x

Reduce Cost of Air Travel by 50%

Reduce Emissions, 5x

Reduce Noise, 4x

IVHM Objectives

- Safety
- Reliability
- Mission Assurance
- Reduced Maintenance Costs
- Efficient Vehicle Turn-Around

IVHM Methodologies

- Sensor Technology
- Information Technology
- Communication Technology

Integrated Vehicle Health Management

IVHM Support of NASA Pillars and Goals
Collect, process, and integrate information about the health of a launch system including the vehicle, subsystems, components, sensors, and ground support systems to make informed decisions and take appropriate actions to ensure the success of a mission.

- Anomaly detection and isolation
- Recovery/Reconfiguration
- Component degradation detection

The Union of Advanced Hardware and Software - Providing higher reliability, with greater robustness, at lower costs

Integrated Vehicle Health Management

IVHM
Propulsion IVHM
GRC and MSFC

Avionics IVHM
MSFC

CPU

Health Node

Health Node

Systems Engineering and Integration IVHM
ARC

Structures IVHM
LaRC

Ground IVHM
KSC

Integrated Vehicle Health Management

Core Technologies (ARC)
Information Technologies
Sensors
Communications

Power IVHM
GRC

Thermal Protection Systems IVHM
ARC

IVHM Elements
Integrated Vehicle Health Management

IVHM Level II Roadmap
## Major Milestones

Commit to flight configuration Decisions

## Key Tasks

- **Component/Subsystem Demo**
- **Integrated Demo**
- **Flight Demo**
- **Foundation Technologies**
- **Companion System Definition**

### Integrated Vehicle Health Management (IVHM) Roadmap

<table>
<thead>
<tr>
<th>Year</th>
<th>Description</th>
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<tbody>
<tr>
<td>2000</td>
<td>Design Hdbk</td>
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<tr>
<td>2001</td>
<td>Cost/Benefit Simulations</td>
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<tr>
<td>2002</td>
<td>Informed Maintenance Demos</td>
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<tr>
<td>2003</td>
<td>Wireless Structure IVHM Concept</td>
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<tr>
<td>2004</td>
<td>Wireless Propulsion IVHM Concept</td>
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<tr>
<td>2005</td>
<td>PMAD IVHM Prototype</td>
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</tbody>
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- **Structures IVHM**: Tunable Laser Source and Fiber Optic Component
- **Propulsion IVHM**: Ground Demonstration of RLV IVHM Components and Systems
- **Power IVHM**: Algorithms and Diagnostics for Power Management and Distribution
- **Adaptive intelligent TPS IVHM**: Architectures and Defect Detection Standards
- **Avionics IVHM**: Prototype IVHM Software On Smart Wireless Networks
- **Ground IVHM**: Vehicle Servicing, Check Out, and Informed Maintenance
- **IVHM SE&I**: Design Handbook

**Virtual IVHM Testbed and Integrated Subsystem Demonstrations**

**Electrical Power Health Management**

**Structures Health Mgt**

**Future Pathfinder IVHM Flight Experiments**

**SSME Health Management and IVHM Data and Flight Exp. on STS**

**IVHM Subsystem Support and Interfaces**

- **PHM**: Propulsion IVHM
- **PMIVHM**: Power Mgmt IVHM
- **SMH**: Structures IVHM
- **TMH**: TPS IVHM
- **SE&I**: IVHM Crew Safety
- **GHM**: Ground IVHM
- **AHM**: Avionics IVHM
- **Crew Crew and Safety**

**Integrated Vehicle Health Management**

**IVHM Roadmap**
Advice

- Scope - Develop a university and university sponsored research institute team to act as a peer review for project and program strategies and tactical planning
- Initial discussions held with a few universities. Others to follow.
- Continue to leverage activities of the IVHM National Team to survey and gain access to the best ideas from universities.

Collaboration

- Scope - Universities identified as contributors in IVHM Projects:
  - Smart, Self Healing Sensory Systems
  - Self Learning, Self Correcting Propulsion Systems
  - Structures IVHM

The project office is seeking new partnerships with the academic community.
Integrated Vehicle Health Management

ARC Is Coordinating IVHM For Space Transportation