NASA SBIR 2006 Phase I Solicitation

X2.01  Integrated Systems Health Management

Lead Center: ARC

Participating Center(s): GRC, JPL, JSC, MSFC

In order to increase the safety and effectiveness of future spacecraft and launch vehicles, innovative health management technologies are required throughout the system lifecycle including design, development, test, validation, integration, operation, maintenance, and disposition. Traditional means of supporting vehicle health, such as invasive inspections, are extremely limited in their utility for exploration missions. Other solutions, such as ground-based monitoring of telemetry data, become less useful as communication delays or bottlenecks increase. Under these circumstances, autonomous and automated solutions to systems health management provide the best means of increasing crew safety and mission success probability for future space exploration missions.

Another significant concern is the high cost of ground and mission operations. Future ground operations will require quick and efficient turnaround and processing of spacecraft for launch. In addition, new mission operations concepts must be developed to provide appropriate levels of safety and mission success factors while reducing support staff.

Proposals should be responsive to the overall goals and objectives of NASA's Constellation and Lunar Precursor and Robotic Programs. Proposals may address specific vehicle health management capabilities required for exploration system elements (crewed spacecraft, launch systems, habitats, rovers, etc.). In addition, projects may focus on one or more relevant subsystems such as propulsion, structures, thermal protection systems, power, avionics, life support, and communications. Proposals that involve the use of existing NASA health management testbeds (power, propulsion, systems integration, life support, diagnostics, networking, etc.) for technology validation are strongly encouraged.

Specific technical areas of interest related to integrated systems health management include the following:

- Methods and tools to enable concurrent design of system function and health management systems. These methods and tools should provide a means to optimize health management system design at the functional level to decide on failure detection methods, sensor types and locations, and identify additional functionality to safeguard against failures before costly design decisions have been made.
• Health monitoring and management technologies for increased situational awareness of system health, safety, and margins. Of special interest are innovative methods for sensor validation, robust state estimation, and model-based methods for fault isolation. Proposals should focus on data analysis and interpretation rather than development of new sensors.

• Data-driven methods for detection of failure precursors and recognition of anomalous patterns in large data sets. A specific emphasis is on methods that utilize propulsion system data sets.

• Concepts for advanced built-in-tests for spacecraft avionics that reduce or eliminate the need for extensive functional verification. Methods for reducing or disambiguating false alarms on built-in-tests are also of interest.

• Methods for robust control of critical components, subsystems, and systems and robust execution of critical sequences during flight. Of special interest are robust recovery methods and innovative approaches to functional redundancy for the purpose of enhancing safety, availability, and maintainability.

• Prognostic techniques able to anticipate system degradation and enable further improvements in mission success probability, operational effectiveness, and automated recovery of function. Proposals in this area should focus on systems and components commonly found in spacecraft.

• Human-system integration methods that are capable of summarizing sensor readings, presenting system status, assessing spacecraft capability and mission readiness, and proposing corrective actions in a manner that does not exceed the capacity of human understanding, especially in high-risk situations requiring rapid human response. Innovative ways for the health management system to convey a wealth of information quickly and effectively are desired.