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A Strategy for Implementation of Integrated Vehicle Health Management (IVHM) into the Space Shuttle Program

The objective of Integrated Vehicle Health Management (IVHM), also referred to as Integrated Vehicle Health Monitoring depending whether or not the system is "active" or "passive" in nature, is to reduce planned ground processing, streamline problem troubleshooting (unplanned ground processing), enhance visibility into systems operation and improve overall vehicle safety. The "integrated" piece of IVHM describes the integrated communication between flight and ground components. The flight side of IVHM is essentially an evolution of a traditional vehicle instrumentation system, which consists of sensors (pressure, temperature, voltage, strain, accelerometers, discretes, etc.); wiring; signal conditioning devices; multiplexing devices and recording devices. IVHM takes it a step further by providing capabilities to process data versus merely recording data. This allows for on-board trend analysis to enunciate system degradation as well as control of in-flight systems checkout. The ground side of IVHM consists of more integrated and automated ground support equipment for more efficient system servicing and checkout. While incorporation of an IVHM architecture into a new vehicle is a complex process in itself, implementation of IVHM into the Space Shuttle Program must deal with additional considerations such as not impacting the flight manifest, cost/payback, Military and Commercial Off-The-Shelf (MOTS/COTS) evaluations and hardware installation decisions. Before commitments are made on specific approaches it has been proposed that at least two flight experiments be packaged as technology demonstrations. The specific purpose of these NASA/Kennedy Space Center led IVHM HEDS Technology Demonstrations (HTDs) are to demonstrate competing modern, off-the-shelf sensing technologies in an operational environment to make informed design decisions for the eventual Orbiter upgrade IVHM. Technologies to be demonstrated include: micro electromechanical sensing (MEMS) for hazardous gas detection and cryogenic distribution system vacuum jacketed line pressure sensing, Bragg-Grating fiber optic sensing systems for hazardous gas detection and structural strain/temperature determination, thermal flow meter leak detection, Hall Effect current sensing, accelerometers for pump vibration sensing, VME bus architecture, flash card memory and neural networks. It is planned to fly two HTDs on the same Orbiter on successive flights with incorporation of additional sensors between flights.