

# Air Vehicle Prognostics & Health Management

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**Abstract**— Affordability in both acquisition and support is a key objective of the Joint Strike Fighter (JSF) Program. The concept of Autonomic Logistics, or the automation of previously labor-intensive, routine tasks, has been identified as the enabler of a streamlined Support Concept. JSF Prognostics & Health Management (PHM) is a comprehensive system for detecting and isolating failures as well as predicting remaining useful life for critical components. The PHM system is a hierarchical distribution of data collection and information management elements, both on-board and off-board, that make maximum use of conventional failure symptom-detecting techniques combined with advanced software modeling to achieve excellent failure detection and isolation with zero false alarms. The information processed and managed on-board the aircraft enhances the pilot's knowledge of his remaining capabilities in the event of malfunction and, at the same time, triggers the Autonomic Logistics processes by relaying failure information to the ground. The use of on-board processing resources coupled with the Autonomic Logistics System provides operations and support cost savings over legacy aircraft while providing the Warfighter with superb system management capabilities.

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### 1. INTRODUCTION

To achieve the benefits of a streamlined Support Concept, the JSF PHM system needs to provide comprehensive failure detection and fault isolation to a single component, with a near-zero false alarm rate. This same system collects and processes performance information on critical components to enable prediction of remaining useful life for those components.

Figure 1 below shows PHM in the context of operational use.

### 2. GENERAL APPROACH

PHM is a system function that touches every element of the Weapon System in some way since, broadly speaking, PHM

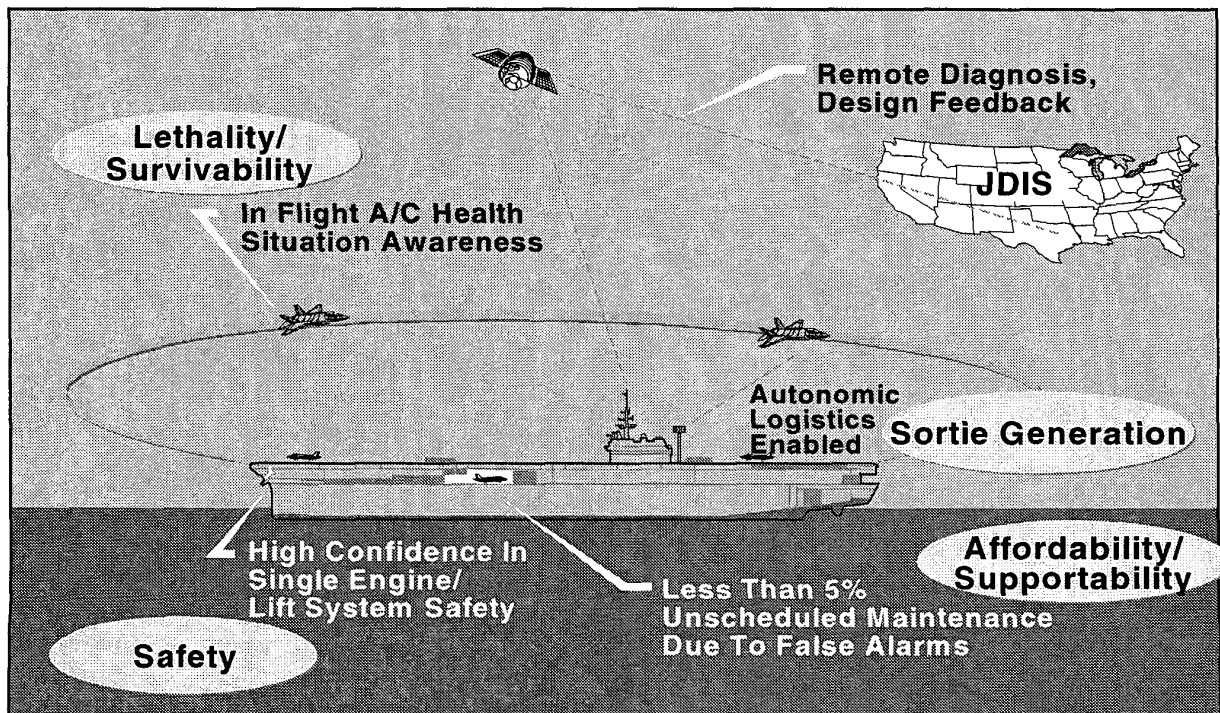


Figure 1 PHM Operations

includes every method used to assess the health of the systems elements beginning with the manufacturing process and continuing through all levels and elements of operations, support, and training.

The general approach for PHM is to design for excellent diagnostics, supplement the diagnostics with reasoning to enhance failure detection and isolation, and selectively acquire performance data for equipment to predict remaining life. The fundamental requirements for PHM are to:

- Provide system health status to enable pilot alerts, reconfiguration, graceful degradation, and system capability assessment in the event of failure.
- Detect and isolate failures and report failure information to trigger the Autonomic Logistics process to effect maintenance.
- Collect and analyze component performance data to predict remaining life of selected components for the purpose of enhancing safety and better maintenance and spares planning.

### 3. OVERALL STRATEGY FOR PHM

- Develop a system architecture illustrated in Figure 2 to include an Air Vehicle level management function and Area PHM managers in each of the primary control areas: Mission Systems, VMS/Subsystems, and Propulsion with other stand-alone management functions as necessary.
- Make use of traditional BIT approaches beyond the level of legacy systems at subsystem and component levels.

- Supplement BIT, using control and feedback data to feed real-time equipment models to enhance failure detection and fault isolation at the Area Manager and Air Vehicle levels. These real-time models will be selected based on effectiveness and efficiency.
- Acquire and analyze performance data for selected components and trend this performance data to predict remaining life of components. The bulk of the trending of information will be accomplished in the JDIS system; however, the Area Managers and the Air Vehicle Manager functions will be responsible for data acquisition, data compression, and delivery to JDIS.

The approach to PHM development is methodical and evolutionary, taking advantage of strides in technology while keeping the basic architecture and design solutions as simple as practical.

**Barry Ferrell** is the Joint Strike Fighter Team Lead for PHM for Lockheed Martin. He has provided overall team direction in requirements derivation, architectural concept, technology investigations, and design approach. Prior to this assignment on the JSF program, he was the Lockheed Martin Tactical Aircraft Lead for Diagnostics & Health Management on the F-22 Program. He has a BSEE from the University of Texas.

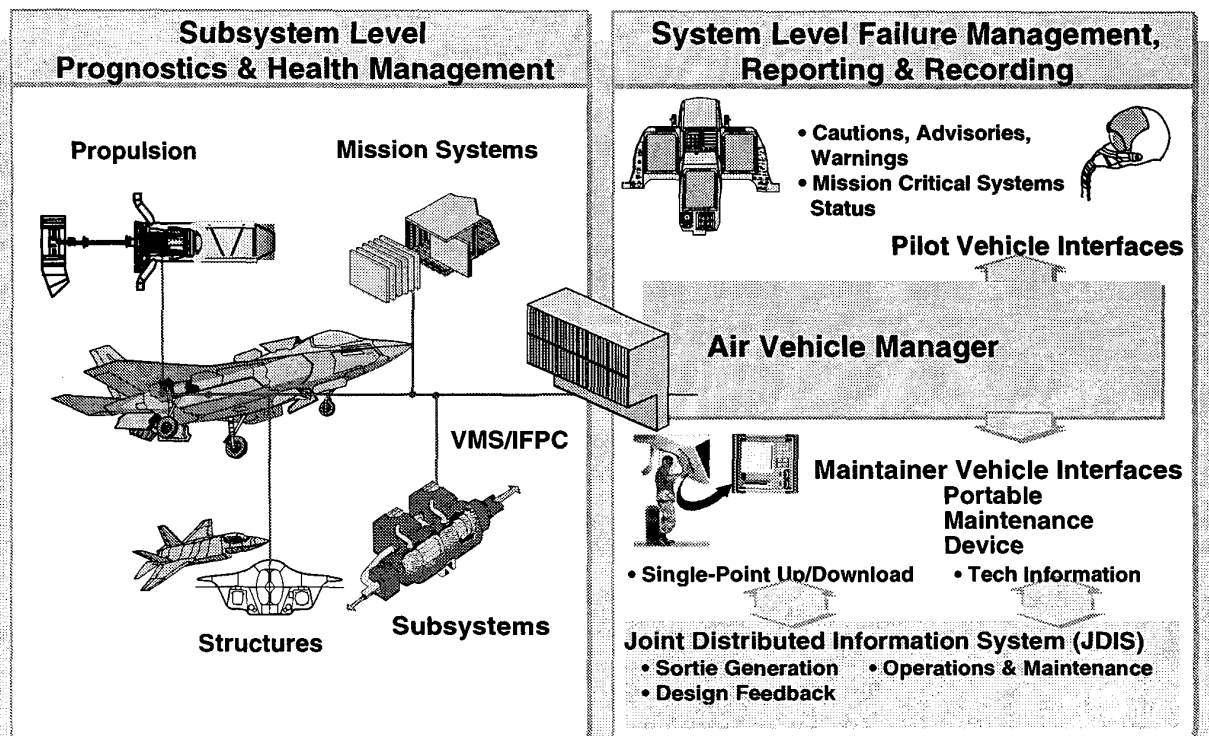


Figure 2 PHM System Architecture