F-35 Joint Strike Fighter
Autonomic Logistics and
Prognostics & Health Management

Dr. Neal McCollom
JSF AutoLog PHM Integrator

23 October 2006

Cleared for public release under provisions of PIRA AER200408011 and AER200307014
F-35 JSF VISION

Be the model acquisition program for joint service and international cooperation

Develop and produce an **affordable** next generation strike fighter weapon system and sustain it worldwide
Prognostics and Health Management

What is it?

- **Enhanced Diagnostics** – the process of determining the state of a component to perform its function(s), high degree of fault detection and fault isolation capability with very low false alarm rate

- **Health Management** – the capability to make intelligent, informed, appropriate decisions about maintenance and logistics actions based on diagnostics/prognostics information, available resources and operational demand

- **Prognostics** – actual material condition assessment that includes predicting and determining the *useful life* and *performance life remaining* of components by modeling fault progression
**PHM Is Integrated Across the Air System**

**Air Vehicle On-Board Health Assessment**

- Fault Accommodation Status via ICAWS

**PHM Area Managers**
- Hosted in ICP and/or DMC

**Airframe**
- Mission Systems
- Vehicle Systems
- Propulsion PHAM

**Provides:**
- AV-Level Info Mgmt.
- Cross Correlation
- Intelligent FD/FI
- FA Mitigation
- Auto. Logistics

**Methods Used:**
- Sensor Fusion
- Model-Based Reasoning
- Sub-system Knowledge Bases
- Tailored Algorithms
- Systems Specific Logic/Rules
- Feature Extraction

**Air Vehicle/Support System Interface**

- Crash Data Recorder
- Portable Memory Device
- In-Flight Maint. Downlink

**Results In:**
- Decision Support
- Maintenance Planning
- Condition-Based Maint.
- Affordable Logistics

**ALGS & Off-Board PHM**

- Automated Pilot/Maintenance Debrief
- Off-Board Troubleshooting
- Off-Board Prognostics
- Trending
- Life Mgmt
- Fleet Mgmt
- Knowledge Discovery
- Store/Distribute PHM Information

**AV PHM Area Manager Hosted in ICP and/or DMC**

**Portable Maintenance Aid (PMA)**

**JTD, Consumables, Stores Off-Board Diagnostics (AFRS)**

**Displays and Controls**

**PHM Data**

**NVM**
Several hundred Prognostic Candidates have been identified and have been classified in three categories:

- **Category 1**: Well-Defined Understanding of the Physics of Failure with Historical Basis
  - Implementation

- **Category 2**: Defined Understanding of Physics of Failure with No Historical Basis
  - Gather data and refine algorithms over time

- **Category 3**: Suspected Relationship of Indicators with Physics of Failure with No Historical Basis or Proven Technology
  - Gather data for future data mining and possible algorithm development
Prognostic Candidates

- Actuator Leakage and Wear
- Engine
- Nitrogen Generator and Filter
- Landing Gear and Arresting Hook Structure fatigue life
- Oxygen Generator
- Power and Cooling Turbo Machine Life, Oil Condition, Oil Servicing and Filter Condition
- Heat Exchangers
- Generator Oil Level Hydraulic Filters, Pump, and Hydraulic Fluid Level
- Battery
- Rotary Actuator Wear
- Nose Wheel Stability
- Landing Gear Strut Pressure and Fluid Level
F-35 Joint Strike Fighter

Lightning II