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JSF
JOINT STRIKE FIGHTER
the next generation strike fighter



JOINT STRIKE FIGHTER PHM VISION

Joint Strike Fighter Program Office

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VISION

**BE THE MODEL ACQUISITION PROGRAM FOR JOINT
SERVICE AND INTERNATIONAL COOPERATION**

DEVELOP AND PRODUCE A FAMILY OF **AFFORDABLE
MULTI-MISSION FIGHTER AIRCRAFT USING MATURED/
DEMONSTRATED 21ST CENTURY TECHNOLOGY AND
SUSTAIN IT WORLDWIDE**



Prognostics and Health Management

- **Why Did We Choose This Technology?**
 - **Enable Autonomic Logistics**
 - **Enhance Flight Safety**
 - **Single Engine Aircraft, Must Have Dual Engine Reliability**
 - **Increase Sortie Generation Rate**
 - **Eliminate False Alarms**
 - **Eliminate CND's and RTOK's**
 - **Reduce Life Cycle Costs**
 - **Maximize PHM Benefit from Limited Specialized Sensors**
 - **Take Max Advantage of the “Smart” Digital Aircraft**

Natural Evolution of Legacy Diagnostic Capabilities Coupled with the Added Functions, Capabilities, and Benefits offered by New Technologies



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
- **Prognostics** – actual material condition assessment which includes predicting and determining the useful life and performance life remaining of components by modeling fault progression
- **Health Management** – is the capability to make intelligent, informed, appropriate decisions about maintenance and logistics actions based on diagnostics/prognostics information, available resources and operational demand.

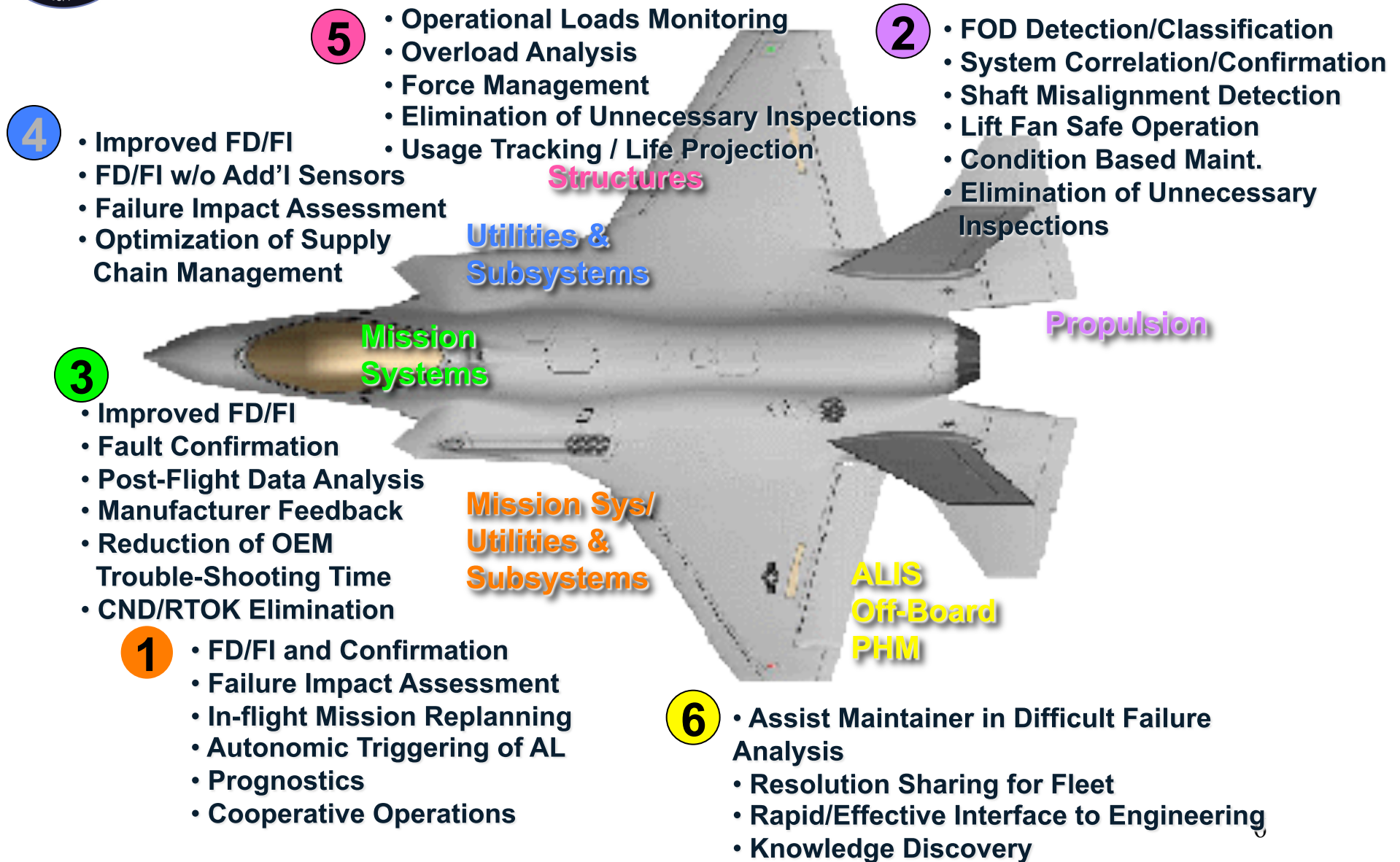


PHM Constituent Functions and Processes

- **Fault Detection**
- **Fault Isolation**
- **Advanced Diagnostics**
- **Predictive Prognostics**
- **Useful Life Remaining, Time-to-Failure Predictions**
- **Component Life Tracking**
- **Performance Degradation Trending**
- **Warranty Guarantee Tracking - Enabling New Business Practices**
- **Health Reporting**
 - Only tells pilot what **NEEDS** to be known immediately
 - Informs Maintenance of the rest
- **Aids in Decision Making & Resource Management**
- **Fault Accommodation**
- **Information Fusion and Reasoners**
- **Information Management**
 - Right Info to Right People at Right Time

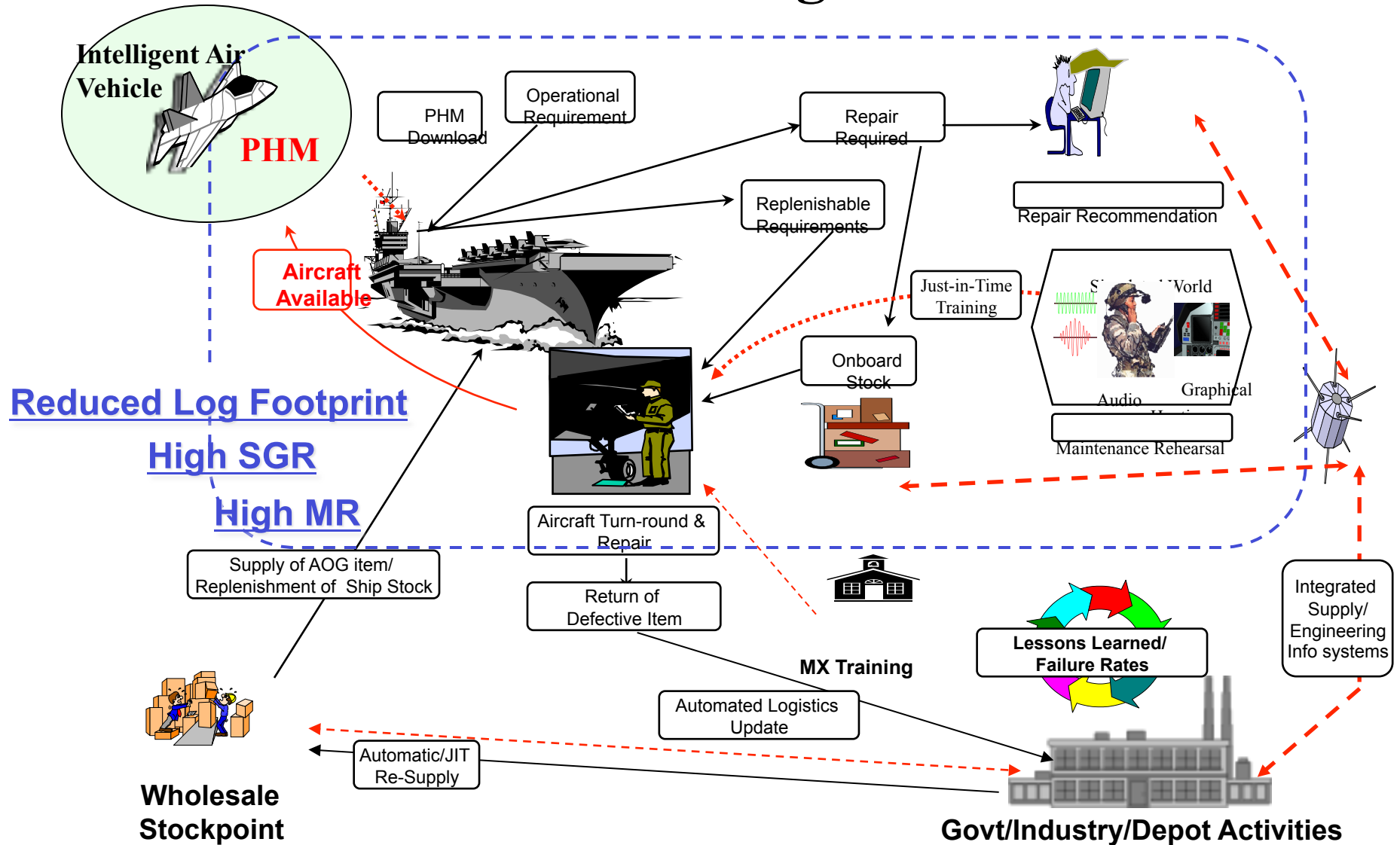


JSF CDP AVPHM/JDIS Demos Provided Substantiation of Weapon System PHM



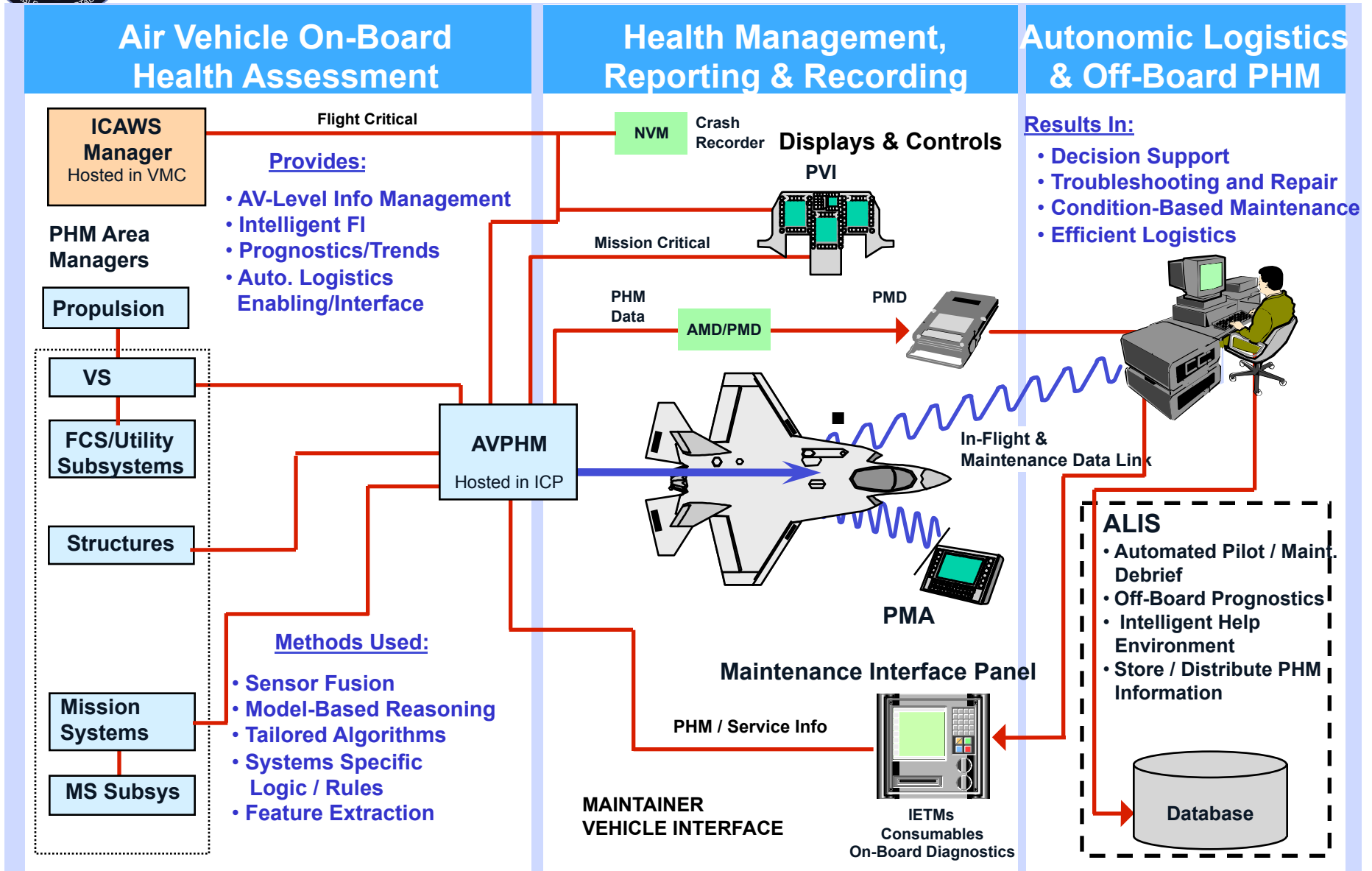


PHM Is the Air Vehicle Enabler of the Autonomic Logistics Structure





PHM Architecture and Enabling Technologies

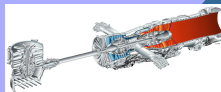
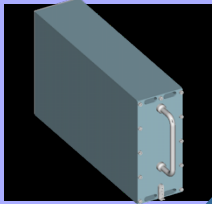
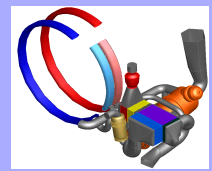




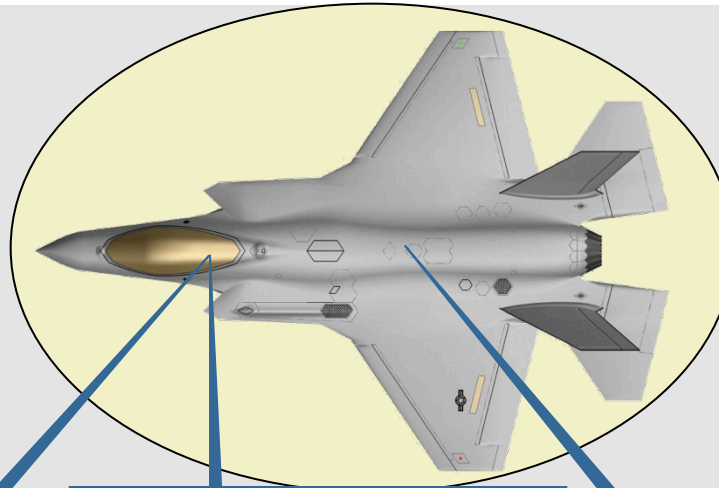
Air System PHM IPT Products

VS/MS PHM SEIT

- Optimal Diagnostic / BIT Capabilities for Subsystem IPT's

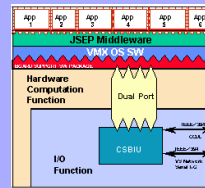


- Diagnostics / BIT
- IPT's / supplier teams achieve the best and most cost effective coverage
- Pertinent data acquisition at sensor, component and sub-system levels.
- Requirements, top level design, use cases, verification.



VS/MS/AF PHM Area Managers (products)

- Enhanced diagnostics, System models, Corroboration, Correlation, and Information fusion
- Prognosis Collect data, Compute life usage Predict time to failure



Off-board PHM (product)



- Prognosis models,
- Failure resolution algorithms
- Diagnostic Tools

Air Vehicle PHM (product)



- Health management Report Remaining Functionality
- Information broker for on- and off-board users
- High-level service requirements for data reduction, file management



Advanced Techniques Are Applied to JSF Weapon System PHM Solution

Performance Monitoring / Trending:

PTMS (IPP, Filters, Reservoirs, Coalescer, etc.)
Hydraulic System (Pumps, Filter, Reservoirs, Accumulators)
Fuel System (Pumps, Valves, Heat Exchanger)
Weapon Bay Door Drive (Pump Speed & Swashplate Angle)
Rotary Actuators, EHAs
Weapon Racks
OBIGGS Filter

Auto Calibration / Gain Trending:

Radar
Displays
Fuel Probes
Stick & Throttle

Enhanced Sensor Technologies:

Engine - FOD Detection, Oil Debris,
Oil Condition, Blade Tip Monitoring,
Vibration Monitoring
SDLF - FOD Detection, Oil Debris,
Oil Condition, Shaft Alignment / Torque,
Clutch Wear / Vibration
Brake Temperature
Landing Gear (Strut Servicing, 'Smart Tire')

Operational Loads/Usage Monitoring:

Structures, Landing / Arresting Gear
Gun, EPS Starter/Generator
CSMU (Write Cycles)

Off-Board Technologies:

Diagnostic Tools
Intelligent Help
Prognosis Models

Cross-Comparison (Redundancy Management):

Flight Controls (VMC, Inceptors, EHAs, Sensors)
EPS (Degraded modes, Emergency Power)
Fuel Probes

Capacity Trending:

28 & 270 volt Batteries
Cryo Cooling Capacity
ESA (loss of Elements)
OBIGGS / OBOGS
HIPPA Recharge Rate

Information Management:

Model-Based Reasoning, Trending,
Pattern Recognition (Enhanced
Diagnostics, Fault Isolation)

Automated Testing:

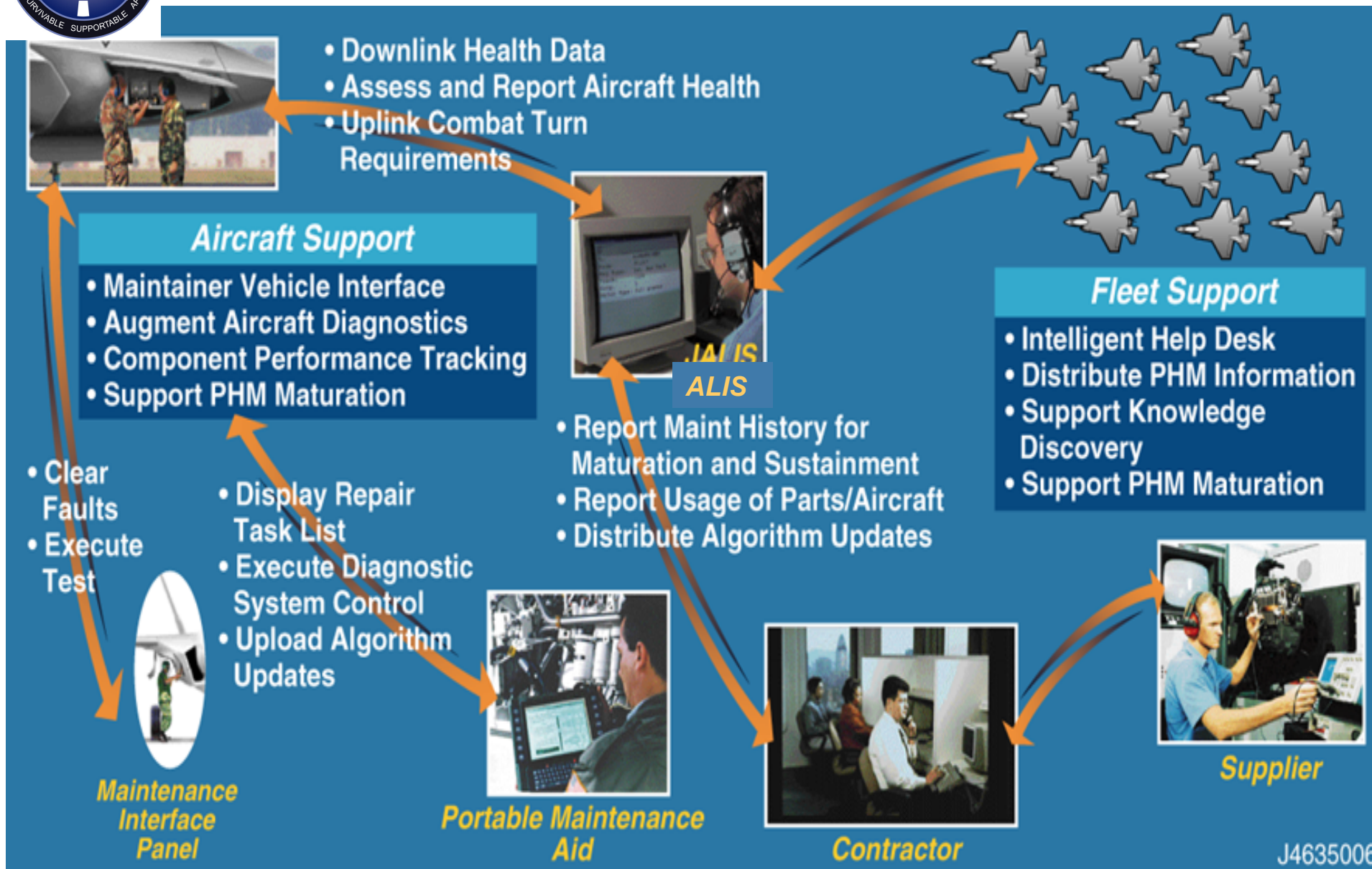
WBDD Actuator Backlash
External Fuel Tanks
RIOs, VSP Software
Nose Wheel Steering Friction Collar
CSMU (Periodic Read/Write Testing)
Aircraft Wiring



PHM Is an Integral Part of Every Facet and Subsystem of the Weapon System



Off-Board PHM Overview



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AUTONOMIC LOGISTICS SYSTEM TECHNICAL SOLUTION

INTEGRATED SUPPORT

- Design Data → Direct to → Support Information
- Failure Prediction → Remove Unit Before Failure



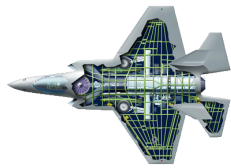
TECHNOLOGICALLY-ENABLED MAINTAINER



FLIGHT OPERATIONS

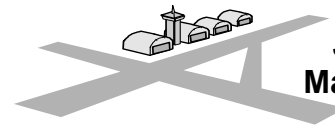
- Integration for Optimal Mission Performance
- High Sortie Generation Rate
- Low Logistics Footprint

AUTONOMIC LOGISTICS INFORMATION SYSTEM



INTELLIGENT AIR VEHICLE

- Prognostics & Health Management
- Design for Supportability
- High Reliability & Maintainability



Joint Aircrew & Maintainer Training

INTEGRATED TRAINING

- Common, Joint Pilot/Maintainer Training
- Modular, Flexible Training
- Embedded Training

PHM Enables the Integrated JSF AL System - Affordable, Supportable, Survivable, & Lethal



Summary

- **PHM Is the Key Enable for the Autonomic Logistics Vision**
- **Technology is Now NOT the Limiting Factor**
 - **And It will Only Improve With Time**
- **All Elements Are Coming Together To Enable Our Visions of Advanced Diagnostics, Prognostics and Real Health Management**
- **Must Implement and Apply Smartly and Wisely to Maximize Affordability Benefits**
- **PHM Must Be a Critical Element in all System Design Trades to Achieve Envisioned Reduction in Total Ownership Cost**

Successful PHM Implementation Is Achievable and Critical to JSF Program Goals