Novel Approach for Overcoming Diagnostic Performance Limitations

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F/A/EA-18 Integrated Diagnostics

Boeing Defense, Space & Security - Global Services & Support

Accurate On-board Diagnostics Are Essential

- Many Avionic Weapon Replaceable Assemblies (WRAs) Cost In Excess Of $1,000,000 To Purchase.
- The Cost Charged To The Squadron's Operational Budget To Remove And Replace A WRA Is Significant Percentage Of The Purchase Price.
- Deployed Squadrons Must Be Able To Operate 24/7/365 With The Spare WRAs That They Are Allocated Locally.
- Recent Trends Toward Directed Two Level Maintenance Solutions Requires Accurate Organizational Level Diagnostics To Avoid Can-Not-Duplicates.
- When A Failure Cannot Be Isolated To A Single WRA The Ambiguity Group Must Be As Small As Possible.

Macro Diagnostic Dependencies

- Diagnostic solution planning for avionic systems establish hierarchical dependencies between:
  - Subsystem, System And Platform Diagnostic Elements
  - On-board And Off-board Organizational Diagnostic Elements
  - Organizational, Intermediate And Depot Maintenance Elements
- Each element contributes data to the subsequent elements thus creating information to establish an accurate and complete diagnostic solution
- When a diagnostic element cannot provide what is needed by the next level then diagnostic accuracy and completeness will be degraded unless an alternate source of the needed information can be established.

F-18 On-Board Diagnostic Environment

In a Federated System Architecture:

- Subsystems Have BIT And Testability Design Elements That Feed WRA Diagnostics
- WRA BIT And Testability Design Elements Feed System Or Aircraft Level Diagnostics
- Most Systems Report BIT Results To The Aircraft Level
- The Aircraft Processes BIT Data And Reports Failed WRAs To The Maintainers For Removal And Replacement

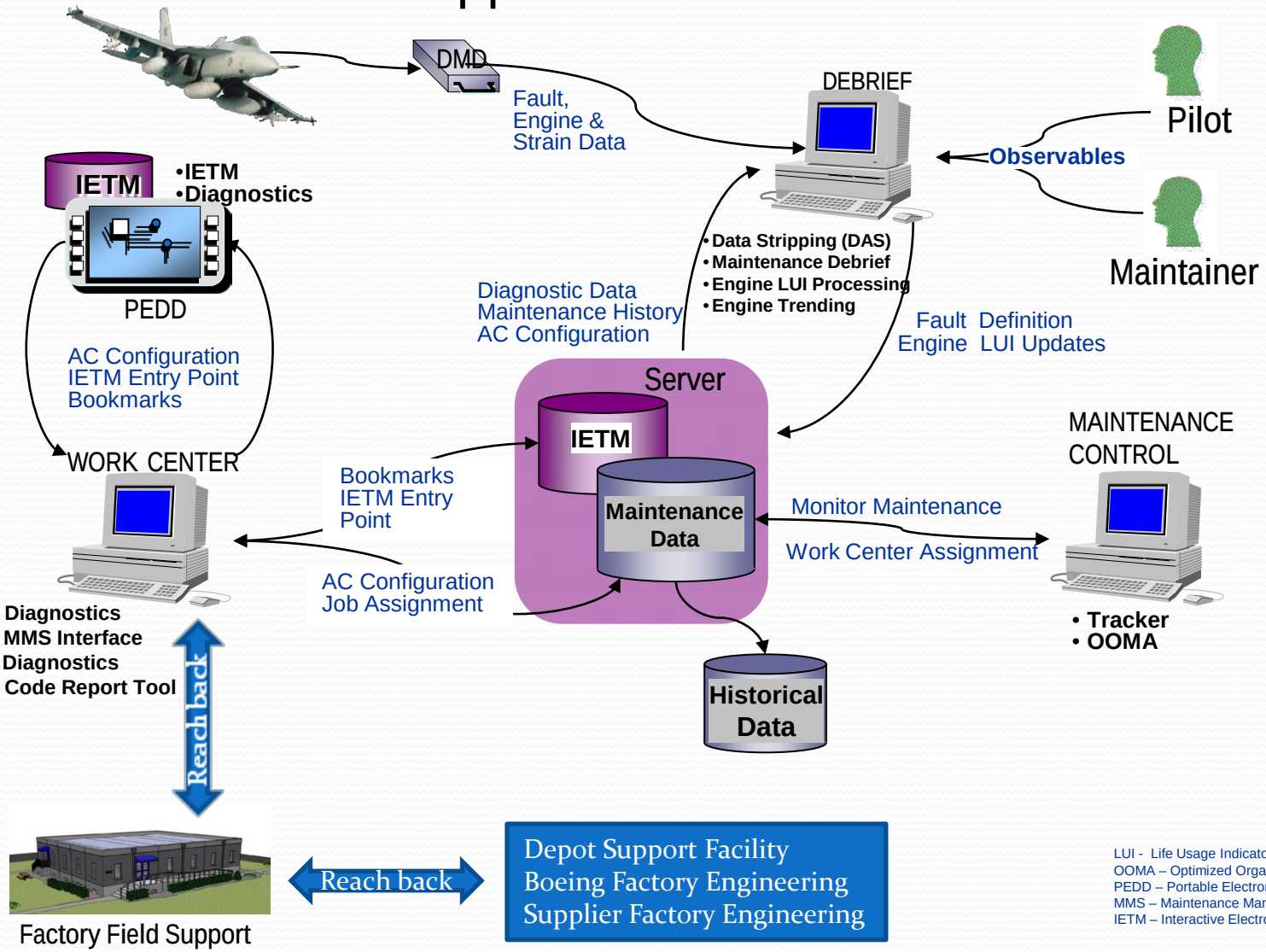
❖ *Aircraft Data Is Captured And Stored In A Digital Memory Device (DMD)*

Off-Board Organizational Diagnostic Resources

- Supplemental Off-Board Diagnostics
  - Flight Line Maintainer Experience and Expertise
  - Interactive Electronic Technical Manual (IETM)
    - IETMs provide technical guidance for the Flight Line Maintainer To Ensure Consistent Diagnostics
  - Organizational Level Support Equipment (SE)

- Other Available But Often Unused Resources
  - Aircraft Data Stored In The Digital Memory Device (DMD)
  - Historical Repair Data

Organizational Level Support Environment



LUI - Life Usage Indicator
OOMA – Optimized Organization Mx Activity
PEDD – Portable Electronic Data Device
MMS – Maintenance Management System
IETM – Interactive Electronic Technical Data

Description Of A Dysfunctional Diagnostic Solution

- A Major Existing Avionic System Was Transitioned From A Legacy Platform And Declared To Follow A Two Level (Organizational-To-Depot) Maintenance Approach.
  - The Decision Was Made To Save The Cost Of Establishing An I Level Facility.
  - Assumed That On-board Diagnostics Were Adequate To Meet Requirements.
- The On-Board Design Included Considerable Subsystem Diagnostics But WRA And System Level *Diagnostic Limitations* Resulted In Poor Isolation And Large Ambiguity Groups.
- Supplemental Off-Board Diagnostics Were Not Established To Compensate For The Poor On-Board Diagnostics Results.
- IETMs Directed Flight Line Maintainers To Remove and Replace The WRAs That The Aircraft Diagnostics Indicted.
  - Replacement Actions Often Resulted In The Same Repeated Failure Indications.
- This Led To A Shotgun Maintenance Approach Which Resulted In Even More Unnecessary WRA Replacements and Supply Chain Burden.

Money talks...but all mine ever says is good-bye

- A Significant Amount Of Unplanned Engineering Troubleshooting Was Required During Flight Test And OPEVAL To Resolve Failures That Were Hindering Progress On Completion Of Those Program Milestones.
- Squadron Budget Is Wasted By Replacing Good WRAs.
- With No Intermediate Maintenance Available to Screen Suspected Failed WRAs, Logistic Dollars Were Wasted Shipping Good WRAs Back To The Depot Maintenance Facility.
- Depot Testing Found Many Can-Not-Duplicates (CNDs) in the Returned WRAs. Depot Wasted Dollars Testing Good Boxes.
- An Increased Number Of Spare WRAs Were Purchased To Meet The Unplanned Demand.

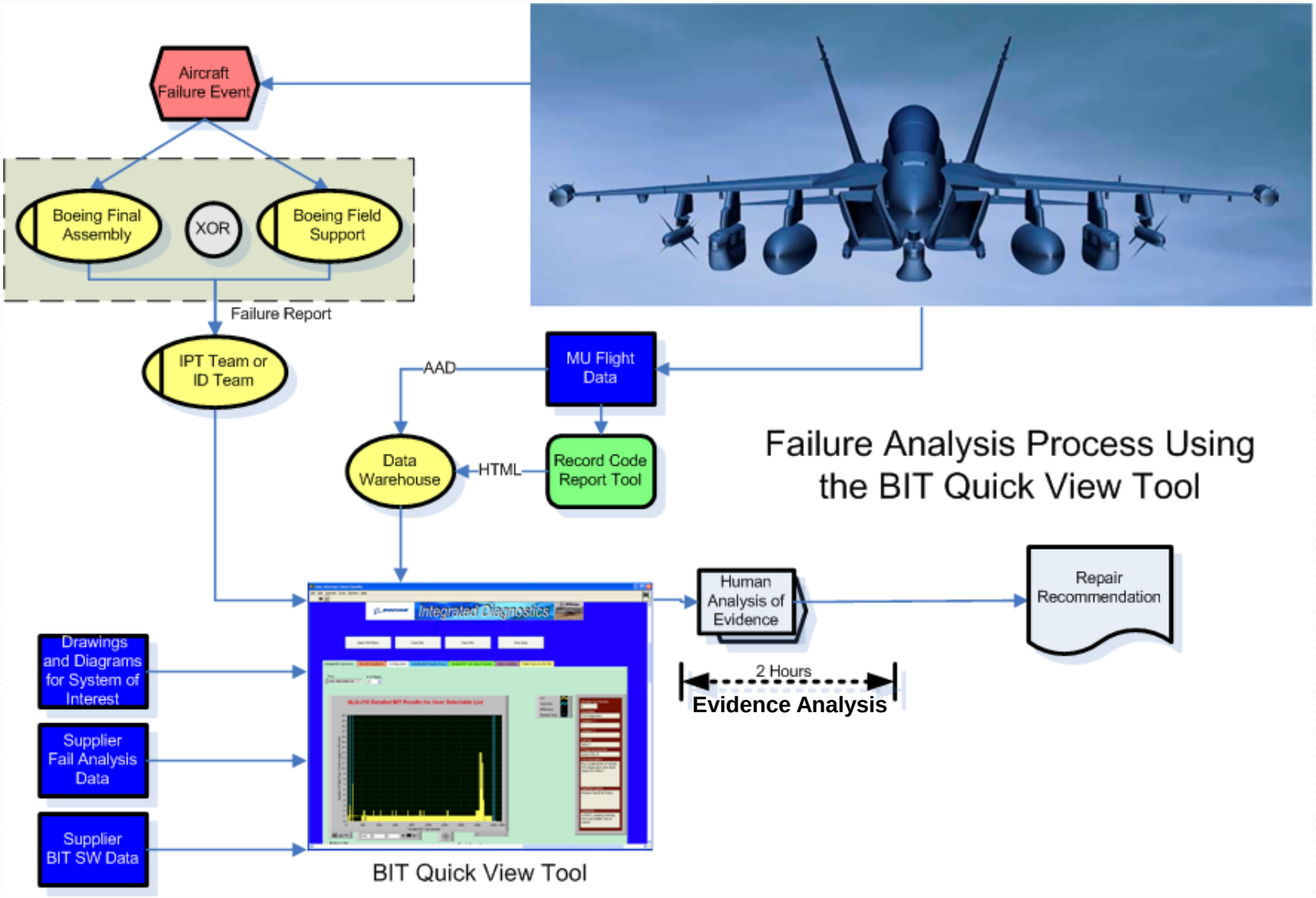
➡ Integrated Diagnostics Team Exploited Aircraft Flight Data To Troubleshoot Failures During Flight Test And OPEVAL.

We Initially Attempted to Implement A Manual Analysis Process

Manual Failure Analysis Process

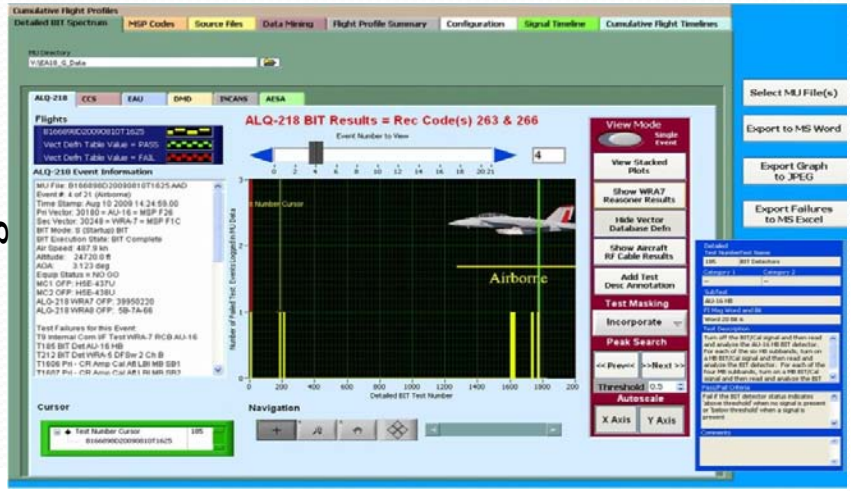
Aircraft Failure Event
MSP Code(s)
Boeing Final Assembly
XOR
Boeing Field Support
Failure Report
IPT Team or ID Team
Identify Failed System
Assign Analyst
Assemble Available Data
Drawings and Diagrams for System of Interest
Supplier BIT Data
MU Flight Data
Record Code Report Tool
Translation & Association
Aggregation & Documentation
Human Analysis of Evidence
Repair Recommendation
4 Hours
24 Hours
4 Hours
8 Hours
Data Collection
Data Translation & Association
Documenting the Evidence
Evidence Analysis

The Automated Process Made The Approach Feasible

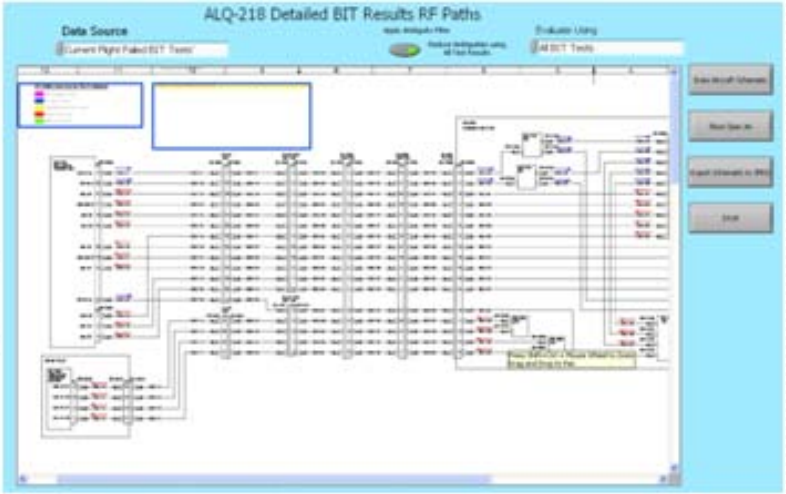


Aircraft Flight Data Clearly Summarized

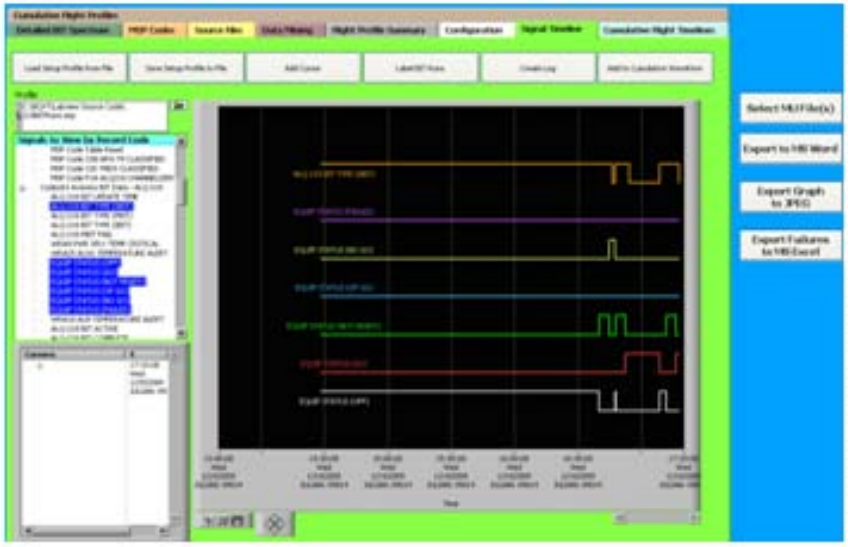
BIT Failure Histogram



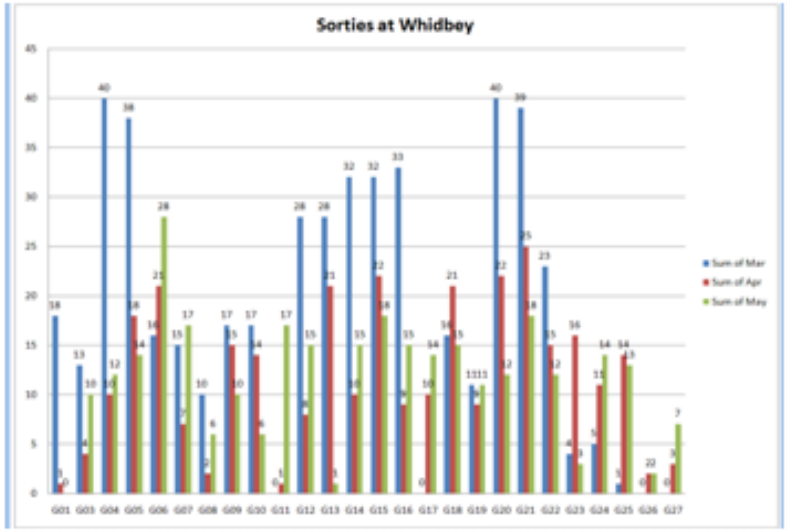
RF Cable Ambiguity Reduction



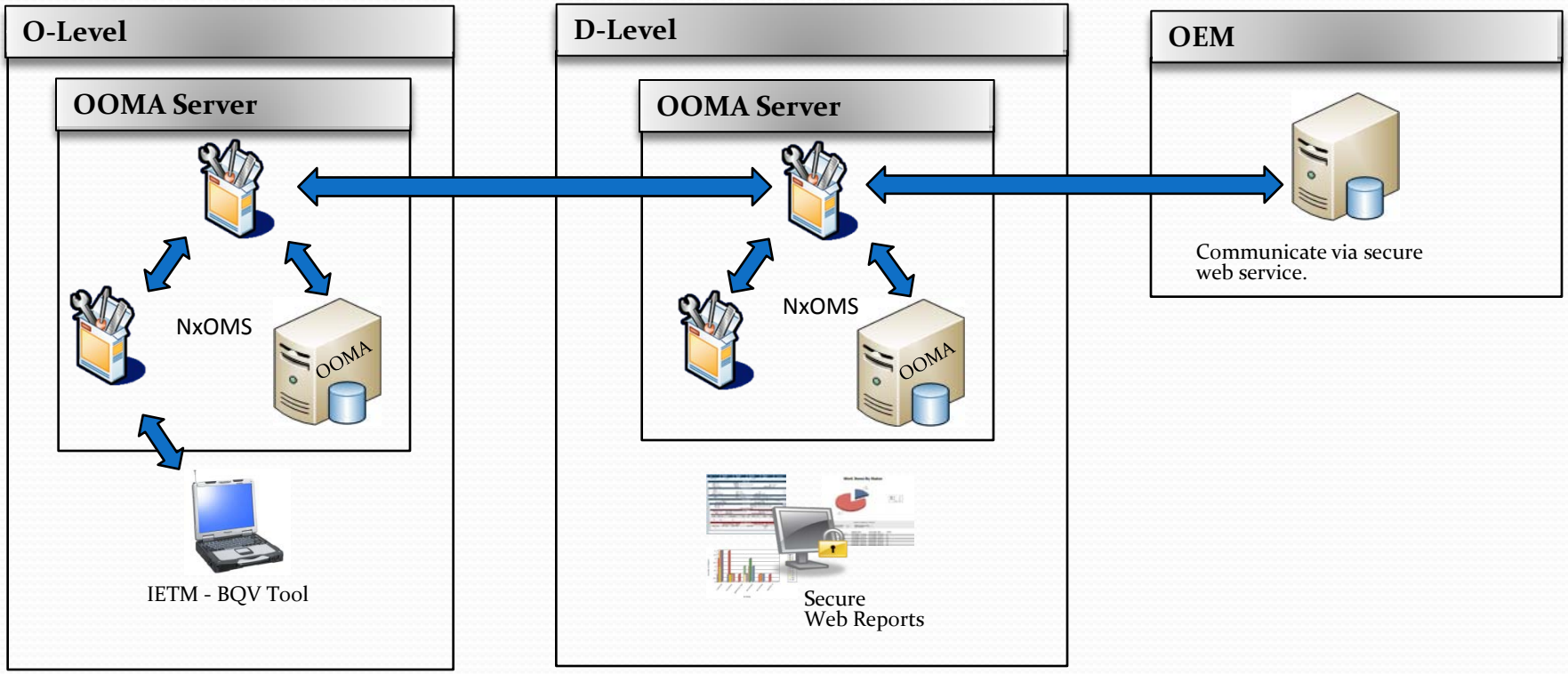
Signal Discrete Timeline



Historical Flight Data Mining Results



Data Flow Across Maintenance Levels



NXOMS – Next Generation Operations Management Software
BQV – BIT Quick View
IETM – Interactive Electronic Technical Data
OOMA – Optimized Organization Mx Activity

Program Cost Avoidance

- Significant Cost Avoidance Has Been Realized From Support Of STL Ramp Support And BIT Maturation Analysis.
  - Production Problems Are Handled By A Phone Call To Engineering Experts Who Analyze The Issue Using BQV And Suggest Maintenance Actions.
  - Process Has Resulted In Lean Support With Accurate Solutions Resulting In Lower Production Man-hours.
- Aircraft BIT Failure Reports Being Sent Back To The Supplier Have Resulted In Quicker Repairs Or Decision Making That Effect Repair Processes In House.
- BIT Maturation Data Collection Has Been Automated.