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TRANSFORMING THE DOD MAINTENANCE PARADIGM

ADDITIVE MANUFACTURING • Laser Coating Removal • JOINT INTERMITTENT TESTING • Item Unique Identification • CONDITION-BASED MAINTENANCE + • Expeditionary Fluid Analysis Capability

ONE MAN'S LEGACY ON DOD PLATFORMS—FROM NAVAIR PROGRAM MANAGER TO OSD DIRECTOR, ENTERPRISE MAINTENANCE TECHNOLOGY

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Universal Synaptics Technical Director Tony Iseminger provides training on the Portable Intermittent Fault Detector™ (PIFD) to a Navy Artisan. Photo courtesy of Universal Synaptics.

Dana Ellis, NCMS

JOINT INTERMITTENCE TESTING (JIT) WORKING GROUP

In September of 2012, the ODASD-MR, formerly, Maintenance Policy and Programs, formed and chartered the Condition Based Maintenance + (CBM+) JIT Working Integrated Project Team (WIPT). The team includes voluntary participants from the U.S. Air Force, U.S. Army, U.S. Navy, and other Defense Agencies working in close cooperation with industry. This group has been instrumental in shaping the strategic and tactical activities required to identify diagnostic equipment capable of detecting intermittent faults. Through the JIT WIPT collaboration, the Military Services concluded that Intermittent Fault Detection Equipment standardization is critical to address electronics component failures.

The JIT WIPT galvanized interest and support from the electronics maintenance community. It also sponsored and continues to update and refine the technical framework enabling further implementation of proven capabilities. Among other activities, the JIT WIPT classified and validated joint performance requirements for a Joint Service intermittent fault detection system, defined the minimum fault detection threshold requirements for the applicable wiring systems, component types, and system architectures. Additionally, the project team identified and validated test methods for ensuring specified minimum performance requirements for detecting and isolating intermittence are met according to the MIL-HDBK-527 proposed MIL-HDBK-454 Intermittent Fault Diagnosis Guideline.

The JIT WIPT continues to lead the charge in the electronics intermittence problem. It drives key implementation activities and originates and updates technical publications essential to maintain momentum and focus on intermittence issues. It also develops briefings and publishes technical reports to assist the Military Services as they develop intermittence solutions supportive of their operational environments.

Specification Effectiveness

The accomplishment that best illustrates the JIT WIPT's effectiveness in terms of technical competence, government and industry collaboration, and action orientation is the publication of MIL-PRF-32516 *Electronic Test Equipment, Intermittent Fault Detection and Isolation for Chassis and Backplane Conductive Paths* in March 2015. It formally recognized intermittence as a DOD-recognized

failure mode and addressed the intermittent fault capability gap. This specification defined the minimum performance requirements for equipment to detect and isolate nanosecond, microsecond, and millisecond conductive paths and intermittent faults. These can occur in all the hundreds to thousands of Line Replaceable Unit/Weapons Replaceable Assembly (LRU/WRA) chassis and backplane circuits and their wiring harnesses in the DOD's equipment. Prior to this publication, no specification or standard existed to remediate these intermittent fault problems.

JIT Effectiveness: Intermittent Fault Emulator (IFE)

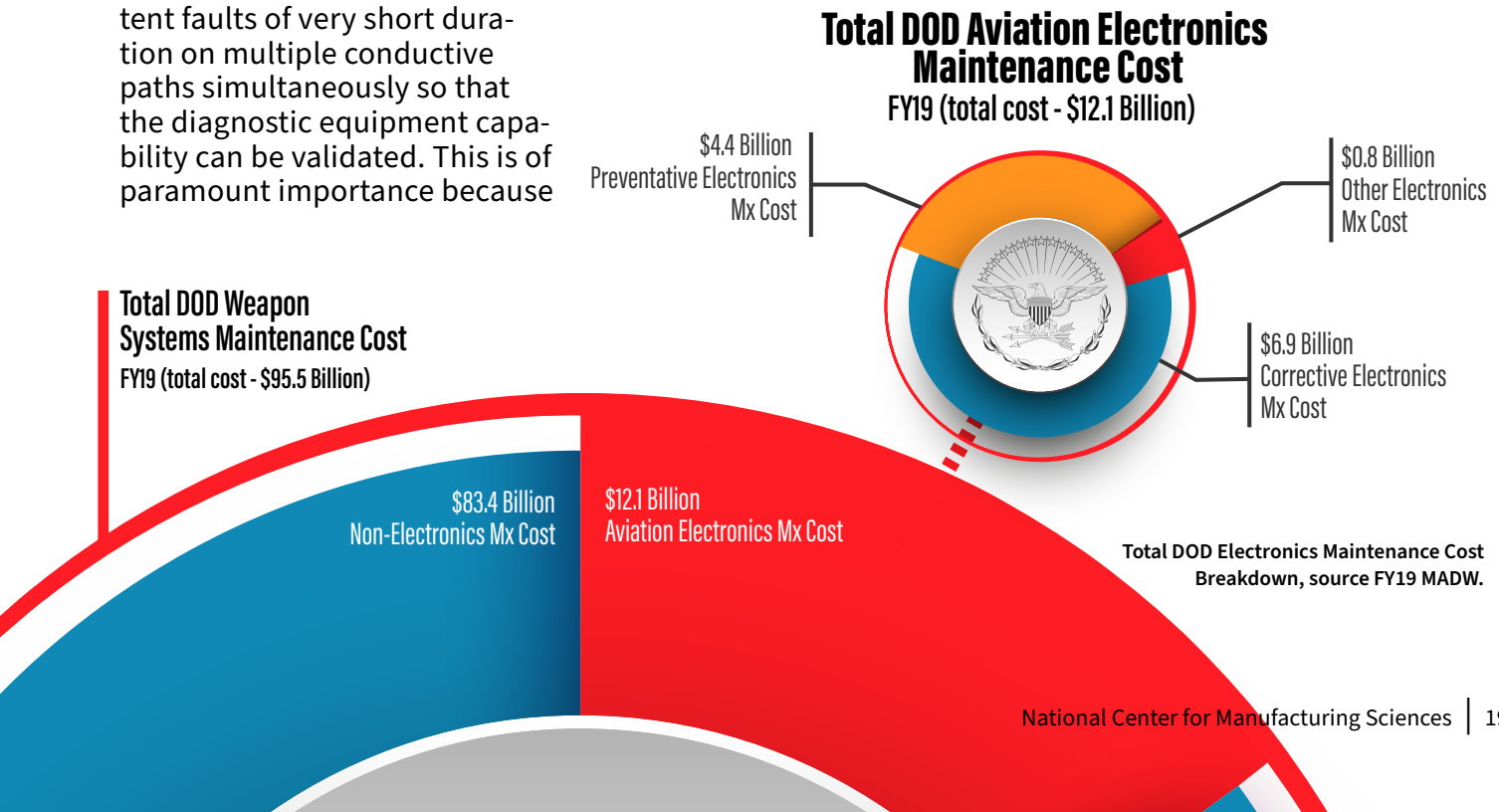
The JIT WIPT further demonstrated its highly effective technical competence, government and industry collaboration, and action orientation with the development of an IFE. The challenge is validating intermittent fault diagnostic equipment capability. The IFE can be programmed to emulate and isolate intermittent faults of very short duration on multiple conductive paths simultaneously so that the diagnostic equipment capability can be validated. This is of paramount importance because there is a significant amount of test equipment which purports to detect and isolate intermittent faults.

The JIT WIPT serves as an enterprise-wide technology insertion best practice. It has brought synergy and commonality to the required transformation of DOD's electronics maintenance capabilities to support today and tomorrow's electronics maintenance communities across DOD. By helping to define the intermittence problem at the appropriate levels within the DOD, and then continually setting the conditions to offer solutions tied to clear technical requirements, the JIT WIPT is instrumental in facilitating action to address intermittence-related readiness and cost drivers.

DOD maintenance operations sustain and restore weapon systems and materiel to inherent performance, safety, and reliability levels. Maintenance generates and sustains materiel readiness, ensuring weapon systems, equipment, and platforms are available to support training and exercises, and ultimately, to deploy in support of warfighter requirements to respond to any humanitarian or contingency situation. Roughly $95 billion of DOD's total FY19 expenditure was applied to maintenance activities and services with aircraft maintenance being the greatest expenditure at approximately $32 billion. Electronics maintenance, a leading driver of weapon systems non-availability, accounted for over $12 billion in FY19 maintenance costs.

The $3 Billion NFF Problem

Intermittent electronics failures continue to be a leading contributor to DOD's $3 billion annual No Fault Found (NFF) problem, unnecessarily consuming 25 percent of the electronics maintenance budget. Many aircraft maintenance



Total DOD Electronics Maintenance Cost Breakdown, source FY19 MADW.

issues are directly related to interconnectivity problems on the Electrical Wiring Interconnect System (EWIS), within electronic components, or assemblies. Intermittent faults are mechanical in nature and can include failures in solder joints, wiring, wire wraps, connectors, etc., which manifest as operational failures due to temperature, vibration, and other external environmental stimuli. Hard failures, where wiring issues are evident, are relatively routine to detect and repair. Major electrical issues and critical down-line failures may occur when an electrical fault appears only intermittently, on multiple conductive paths in short duration, under operational conditions (such as high G-force loading and extremes in temperature or stress, or vibrational states) that are difficult to replicate during ground testing and maintenance. The duration of these intermittent events can range from nanoseconds to seconds, and may oscillate repeatedly during an event or a single occurrence during a given testing session.

These circuit path disruptions often cause operationally evident functional failures/faults in LRU/WRA chassis and backplanes whose root cause(s) cannot be detected and isolated using conventional Automatic Test Equipment (ATE) and troubleshooting processes. Intermediate and depot maintenance actions, such as the reseating of a degraded connection, solder joint, etc., can temporarily cause the intermittent connection to function properly for days, or even weeks after, and may only manifest as a repeat operational failure after several months.

HAVING THE CAPABILITY TO MONITOR ALL CONDUCTIVE PATHS SIMULTANEOUSLY AND CONTINUOUSLY WHILE SIMULATING THE SPECIFIED TMS OPERATING ENVIRONMENT, WHILE NOT YET WIDELY AVAILABLE, HAS BEEN IDENTIFIED AS AN EXCELLENT OBJECTIVELY PROVEN SOLUTION.

This situation results in a revolving cycle for EWIS and the LRU/WRA removal, maintenance and testing resulting in NFF, and subsequent reinstall on aircraft. Additionally, considerable preventive and corrective DOD electronics maintenance costs are applied to this issue. Even while these resources are consumed, LRU/WRA and system wiring with intermittent faults become known as the Services' "bad actors" and are repeatedly sent to DOD and commercial repair facilities, but the current intermittent test equipment void prevents accurate problem diagnosis. In many instances, this leads to unnecessary condemnation of weapon systems components. One main symptom of an Intermittent Fault Failure (IFF) mode problem is a high rate of Cannot Duplicate (CND or A-799), NFF, No Trouble Found (NTF), and Re-test OK (RETOK) reported by the maintenance activities. Diagnostic equipment having the capability to monitor all conductive paths simultaneously and continuously while simulating the specified Type/Model/Series (TMS) operating environment, while not yet widely available, has been identified as an excellent objectively proven solution.

Intermittence, while persistent and pervasive, has gained traction and is emerging as an accepted failure mode within the DOD. It is characterized by decreasing reliability and time-on-wing (TOW) and has been conclusively identified as a major contributor to NFF costs and decreased materiel availability. The DOD now operates approximately 400 types of traditional diagnostic test systems valued at $50 billion. However, these test systems do not continuously and simultaneously test all conductive paths. They have very limited or no capability to detect and isolate intermittent faults or reduce NFF costs.

Innovating How to Resolve Intermittent Faults

The JIT WIPT has provided a forum for government, military and civilian professionals to collaborate on ideas and exchange information on how to resolve intermittent issues across many platforms through briefs, industry days, CTMA development, and outreach and technology transition activities. It provides unique opportunities for cross-Service exchange of ideas and programs which benefit decision-makers and the acquisition workforce. It helps bring

synergy and commonality to the transformation of our military weapon systems to support warfighter operations in today and tomorrow's battlefield.

The JIT WIPT forwarded a draft revision to the Joint Services Wiring Action Group (JSWAG) charter to add a new JIT Committee in August 2019. The new Committee has the following objectives:

- Advise and assist in the implementation of a DOD Intermittent Fault Detection (IFD) solution
- Leverage current and emerging IFD technology for demonstration, testing, and cost-benefit analysis
- Educate and inform program management, electronics, and (EWIS) maintenance community on IFD
- Define and validate joint performance requirements for a Joint Service IFD system
- Collect and analyze implementation and operational data on IFD systems currently in use
- Identify, define, and validate test methods for ensuring specified minimum performance requirements for detecting and isolating intermittence are met
- Leverage DOD's Maintenance and Availability Data Warehouse to assist in identification of intermittence-related readiness and cost drivers and recommend IFD opportunities
- Investigate and develop plans for integrating IFD with existing EWIS maintenance and repair diagnostics, and diagnostic equipment
- Investigate intermittence-driven EWIS unscheduled maintenance
- Develop recommendations and plans for decreasing intermittence-driven unscheduled maintenance and shifting to schedule-based IFD proactive maintenance
- Collaborate with industry and academia on innovative intermittence-driven NFF solutions and methods

The JSWAG Executive Steering Committee was receptive of the new JIT Committee and its objectives, but due to COVID-19 has not met since the new Committee was proposed. ◉