Universal Synaptics

IFDIS – Expanding Role Across the DoD Maintenance Enterprise

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"Great Ideas"
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Presenter: Ken Anderson

The Problem:

- Maintenance of aircraft electronic Line Replaceable Units (LRUs) pose an ever increasing challenge
- Much of the challenge is related to intermittent faults which occur because of aging wiring and connections
- Intermittent problems manifest themselves as “bad actor” LRUs and repair shop No Fault Found (NFF) test results
- Intermittent faults are a growing problem in electronic equipment

Intermittent Faults:

Variety of intermittent fault causes

- Loose or corroded wire wrap
- Cracked solder joint
- Corroded connector contact
- Loose crimp connection
- Hairline crack in a printed circuit trace
- Broken wire
- Unsoldered joint
- Number of other phenomena, all very common in electronic equipment

These problems are becoming more severe in aging aircraft

Intermittent Faults:

Intermittent fault occurrences

- Consistent discontinuity (hard failure) is not difficult to detect
- Intermittent discontinuity is typically very short in duration, of low amplitude and is difficult to detect and isolate

Intermittence typically manifest itself during stress situations

- High G loading
- Thermal extremes
- Vibration
- Combination of stresses

Intermittent Faults:

Intermittence has many names

NFF – No Fault Found
ER – Erroneous Removal
NPF – No Problem Found
NDF – No Defect Found
NTF – No Trouble Found
CND – Can Not Duplicate
RETOK – Retest OK
NEOF – No Evidence of Failure
NTR – Nothing to Report
DCR – Disassemble Clean & Reassemble

Conventional Approach:

- Billions of dollars have been spent industry wide on conventional legacy test equipment
- All designed to detect hard failures, yet research has found that approximately 50% of the problem is intermittence
- Unable to detect momentary faults
- Tests or scans ONE circuit or function at a time
- Not capable of detecting intermittence

Conventional Results:

- “In one year false alarms and "cannot duplicate" conditions wasted more than 246,000 maintenance man hours, including aircraft downtime and logistics costs associated across just six aircraft platforms” *(NAVAIR Integrated Diagnostics & Automated Test Systems (IDATS) Laboratory)

- “The Department of Defense maintained 400 types of test systems and spent $50 Billion to buy and support these systems over a 12 year period” *(Government Accountability Office Study)

- NFF resulting from undetected intermittency is now one of the largest aircraft maintenance cost drivers for the Department of Defense – $2 Billion annually *(OSD ODASD (Maintenance))

Innovative Solution:

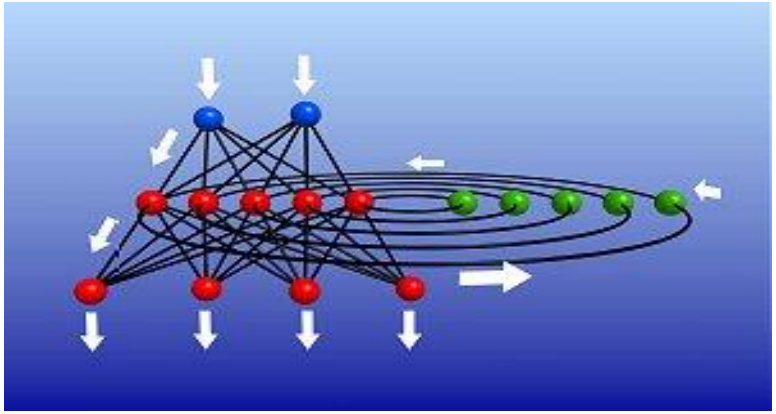
- Build a maintenance tool specifically designed to detect and isolate intermittent faults that cause NFF
- Repairing an intermittent circuit is not difficult
- The challenge is detecting and isolating the intermittence
- **The Intermittent Fault Detection & Isolation System (IFDIS) is the only proven solution!**
- Currently configured to test LRU chassis and aircraft wiring

IFDIS

- Intermittent Fault Detection & Isolation System (IFDIS) contains a patented hardware neural network analog diagnostic system specifically designed to detect and isolate intermittent faults in electronic equipment

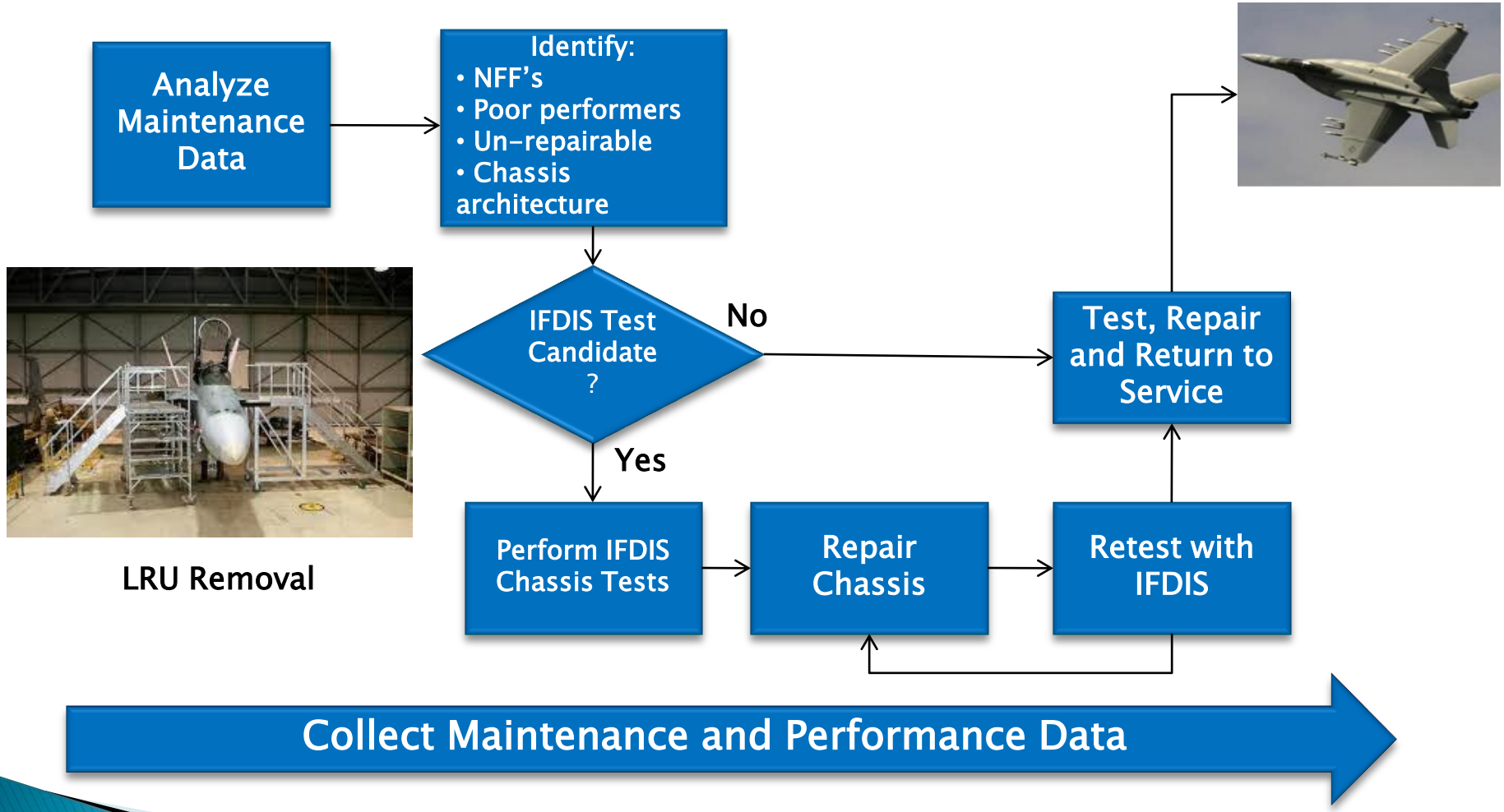
- Monitors **ALL** circuit paths individually, simultaneously and continuously, detecting any intermittent as short as 50 nanoseconds (0.00000005 seconds)

- The IFDIS also detects and isolates any open circuits, short circuits and incorrect wiring problems that may be present in the Unit Under Test (UUT)



IFDIS: Configuration

Identifying IFDIS Test Candidates



Case Study: MLPRF

- **F-16 AN/APG-68 Radar System Modular Low Power Radio Frequency (MLPRF) Line Replaceable Unit (LRU)**
- One of the poorest performing LRUs on the F-16
- Cracked ribbon cable solder joints
- Massive re-soldering program
- Shotgun approach to maintenance
- Had no means to detect intermittent circuits

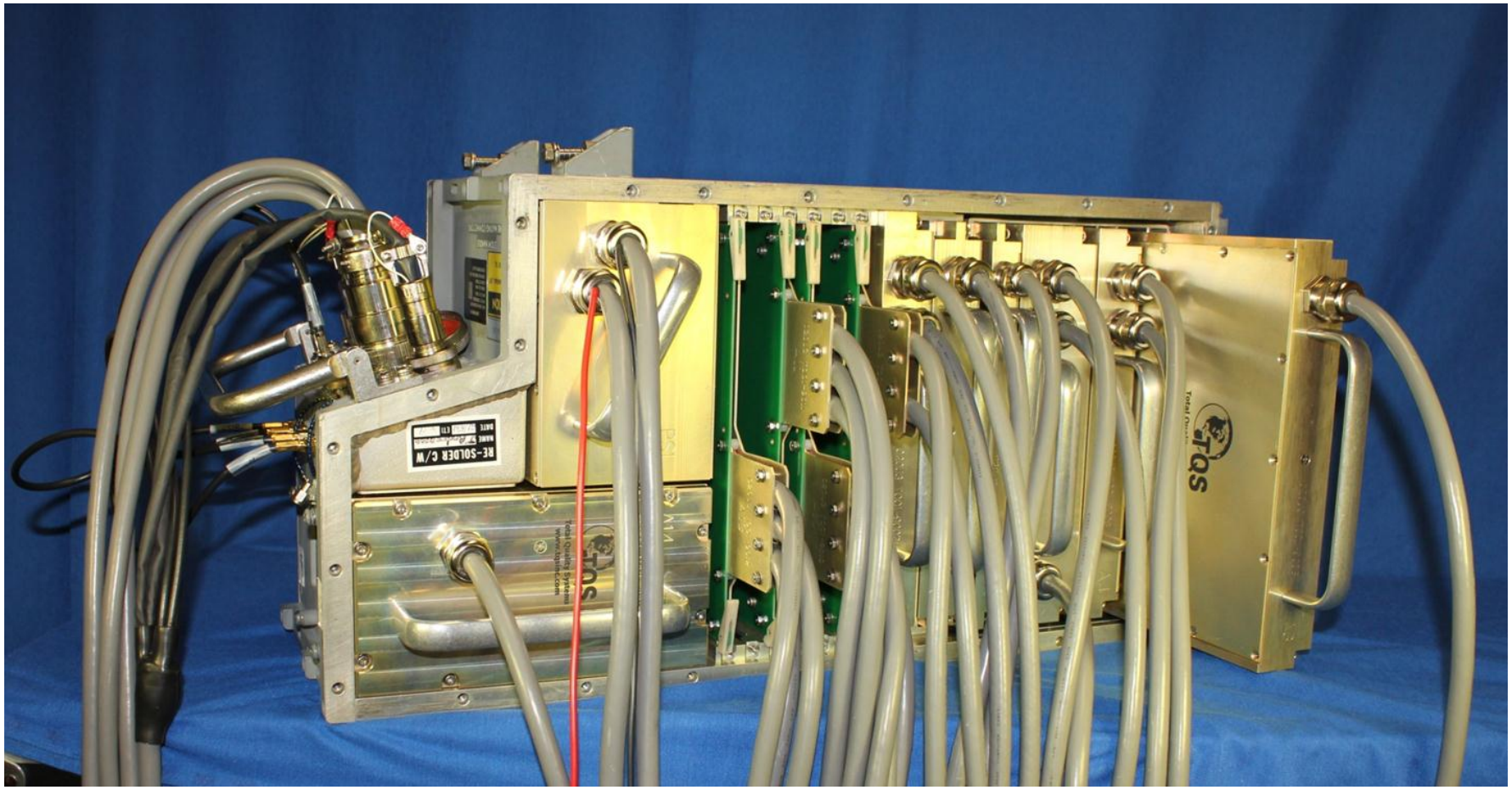
IFDIS: MLPRF Example Serial # 10435

Date	Depot Level LRU Repairs	Depot Level SRU Repairs
31-Jul-98	No Fault Found	None
22-Mar-00	Reseat Circuit Card Assemblies (CCAs)	None
30-Aug-00	No Fault Found	None
5-Dec-01	Replace Frequency Synthesizer	Replace Guide Pin
	Replace Low Noise Assembly	Replace IF Assembly
5-Apr-02	No Fault Found	None
13-Aug-02	Resolder Ribbon Cable	None
19-Mar-03	Replace Low Noise Assembly	Replace Receiver Protector and FET Amp
7-Oct-05	Replace Low Noise Assembly and Micro-Switch	Replace Receiver Protector and FET Amp
15-Aug-06	Replace Frequency Synthesizer	RTOK
1-Feb-07	Replace Sample Data Assembly	Adjust R57 & R7 (Expected 90 +/-3, Measured 93.46)
11-Apr-07	Reseat Reference Oscillator Assembly	None
27-Aug-09	**IFDIS Tested - 1 Open & 11 Intermittent Circuits**	

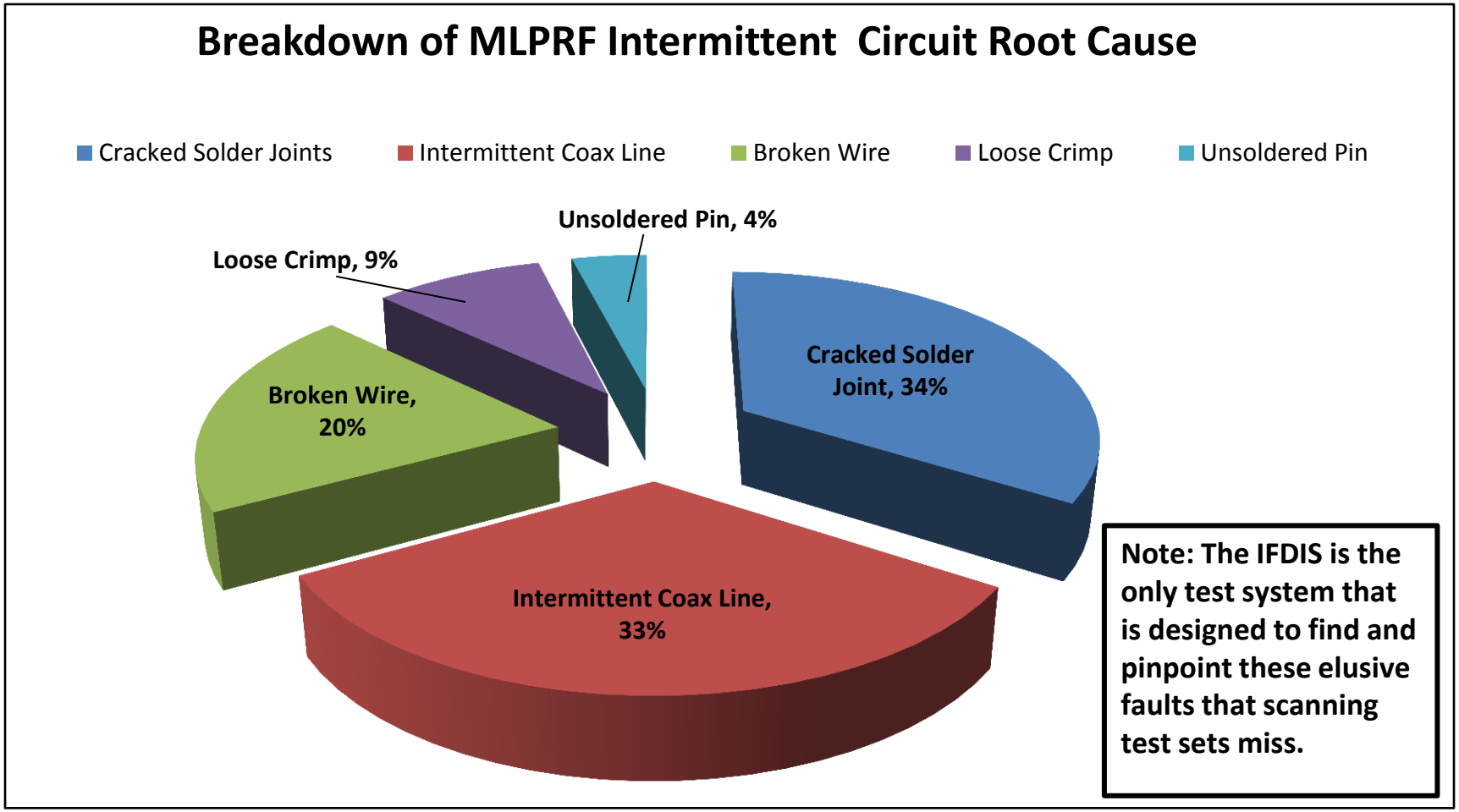
Ref Des	Repair Activity	Intermittent Circuits
A14	Low Noise Assembly - Replaced 3 Times	A14-28 to A13-114
A2	Frequency Synthesizer - Replaced 2 Times	A2A2-3 to Ground
A8	Sample Data Card - Replaced 1 Time	A8-97 to A6-57
A3	Reference Oscillator Assembly - Reseated 1 Time	A3-9 to A13-50 & A3-12 to A13-139

No Fault Found (NFF)
Quasi NFF Repair Activity

MLPRF: Interface Test Adaptor

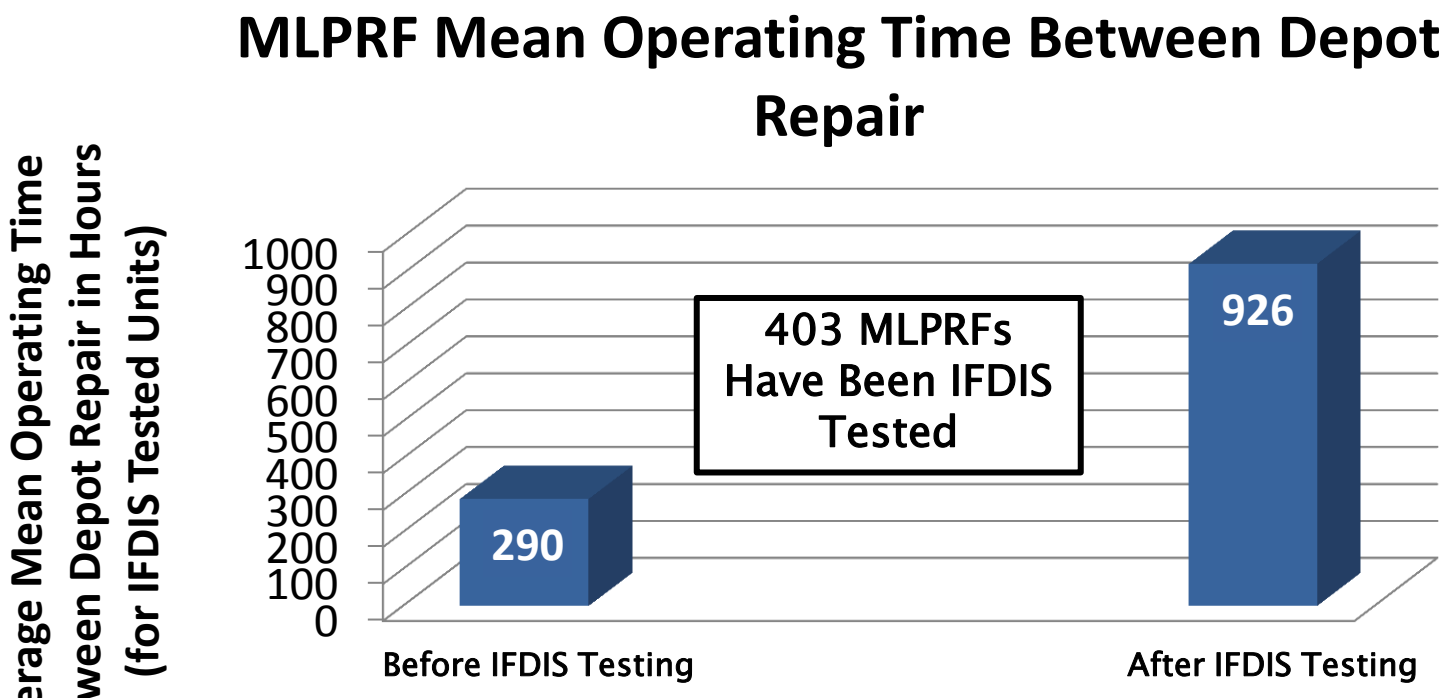


MLPRF: Results



Note: The IFDIS is the only test system that is designed to find and pinpoint these elusive faults that scanning test sets miss.

MLPRF: Results

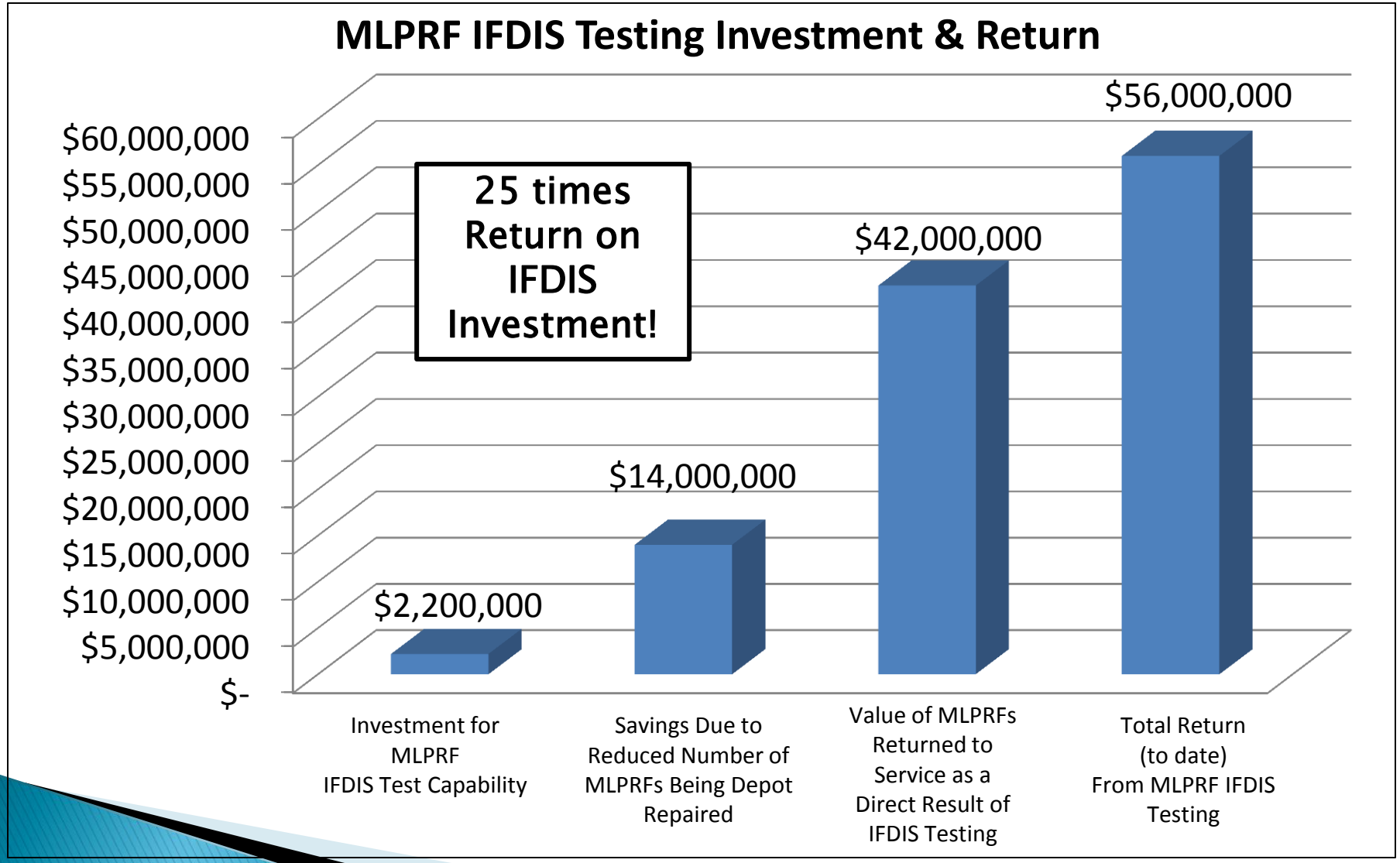


Reliability Tripled!

MLPRF: Results

	Before IFDIS Testing	IFDIS Test Date	After IFDIS Testing	
Serial Number	Average Hours Between Depot Repair		Average Hours Between Depot Repair	Increase in Average Hours Between Depot Repair
10074	182	8-Sep-08	1884	1702
11347	168	13-May-08	1267	1099
10849	59	2-Apr-09	941	882
10888	286	17-Sep-08	1132	846
11877	257	20-Apr-10	1010	753
10725	79	4-Jan-10	697	618
11437	72	4-Nov-09	622	550
11863	463	4-Nov-08	1008	545
11188	567	5-May-09	1102	535
11525	164	14-May-08	646	482
10386	157	23-Feb-09	611	453
11792	127	15-Oct-07	581	453
11732	70	28-Apr-09	477	407
11296	24	20-May-09	430	406
11267	317	28-Jul-08	713	396
11665	183	16-Nov-10	568	385
10752	707	20-Jul-09	1086	379

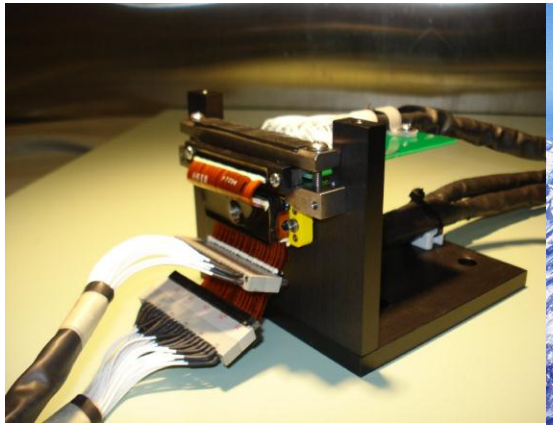
MLPRF: Results



IFDIS: Expanding Role

F-16 AN/APG-68 Radar System Azimuth Elevation (AZ/EL) Ribbon Cable

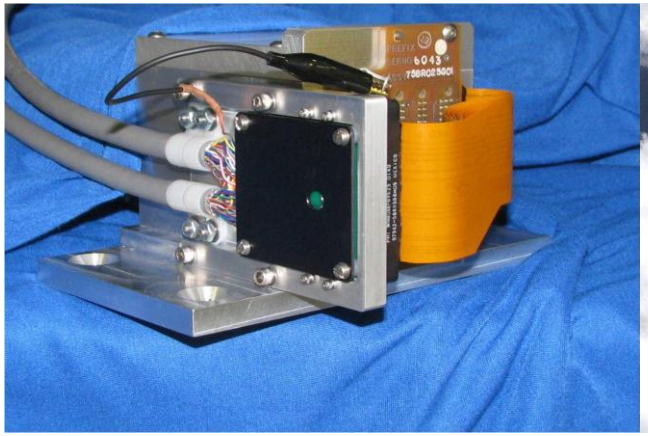
- Grounding F-16s
- Conventional scanning ONE circuit at a time test equipment unable to identify intermittent ribbon cables
- IFDIS detected and isolated intermittence in 76% of IFDIS tested AZ/EL ribbon cables
- IFDIS testing is now preventing functional ribbon cables from being discarded and intermittent ribbon cables from being installed on F-16 aircraft



IFDIS: Expanding Role

F-16 AN/APG-68 Radar System Digibus Matrix Plate Assembly Ribbon Cable

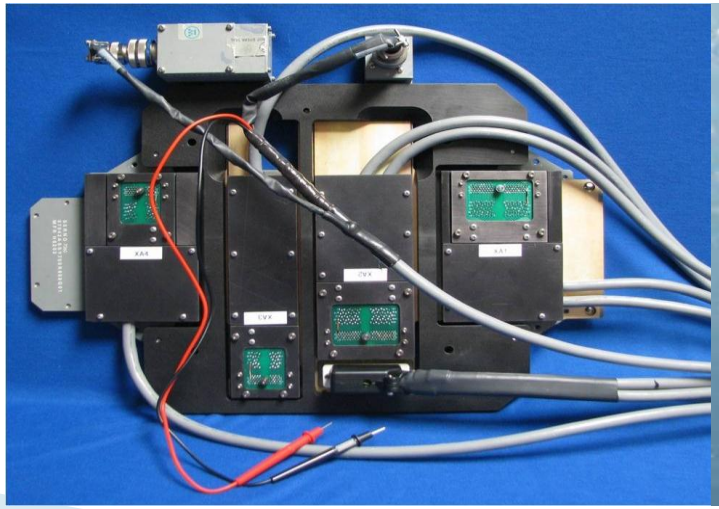
- High on-aircraft failure rate and high NFF rate at the depot
- Conventional scanning ONE circuit at a time ATE unable to identify or isolate intermittent faults
- Ribbon Cable replaced 44% of the time (speculative replacements)
- IFDIS testing used to discriminate good vs. bad Digibus Matrix Plate Assembly Ribbon Cables



IFDIS: Expanding Role

F-16 AN/APG-68 Radar System Mechanically Scanned Array Back Plane

- High replacement cost of back plane assembly
- IFDIS testing utilized to identify intermittent circuits conventional serialized scanning ATE is unable to detect
- IFDIS now facilitating the test and accurate repair of the back plane assembly enhancing long term supportability of the F-16 Radar System



IFDIS: Expanding Role

F-16 AN/APG-68 Radar System Antenna Line Replaceable Unit (LRU)

- High depot repair costs
- Conventional testing unable to detect and isolate intermittent circuits, improve availability or reduce NFF costs
- IFDIS is now simplifying the test and repair process of the Antenna, improving reliability and reducing depot costs

IFDIS: Expanding Role

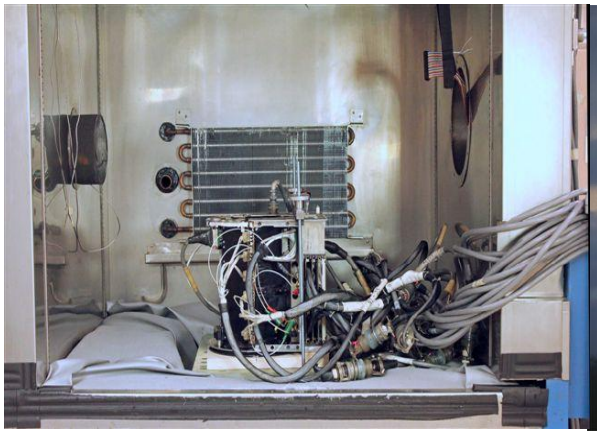
EA-6B Prowler Intercommunication System (AIC-45) Weapon Replaceable Assembly (WRA)

- High Mission Incapable (MICAP) rates
- High NFF / CND rates
- Conventional test equipment unable to identify intermittent issues or improve reliability
- IFDIS identified and isolated one or more intermittent circuits in **83%** of the AIC-45's tested

IFDIS: Expanding Role

F/A-18 Hornet Generator Convertor Unit (GCU) Weapon Replaceable Assembly (WRA)

- Second highest WRA degrader in the NAVAIR inventory
- Conventional scanning ONE circuit at a time test equipment unable to identify intermittent issues
- IFDIS detected and isolated one or more intermittent circuits in **80%** of GCU's IFDIS tested – ALL GCUs had been certified Ready for Install (RFI) before IFDIS testing



IFDIS: Expanding Role

CH-47 Chinook Wiring Harnesses

- High NFF rates, costly to support and sustain
- Conventional ONE circuit at a time wire testers unable to identify and isolate intermittent wiring problems, reduce NFF or improve reliability
- IFDIS (portable) is detecting and isolating intermittent wiring that cause NFF and drive high sustainment costs

IFDIS: What's Next?

F-16
Central Air Data Computer (CADC)

C-130
AN/APQ-122
Radar System

UH-60
"Top 10 Degraders" Program

Patriot Missile Systems

IFDIS: Utility

- The IFDIS approach is **simple, highly cost effective** and **extremely successful** in filling the intermittent / NFF testing void

- The IFDIS approach is platform neutral and can be used to test a wide variety of LRUs, WRAs and wiring harnesses in the DoD inventory that suffer from NFF

IFDIS: Great Idea!

- Quickly detect, isolate and repair intermittent circuits that conventional ATE is incapable of detecting
- Root cause fault identification of NFF is now finally possible
- Advanced all lines all the time monitoring capability is producing a paradigm shift in the avionics testing industry
- Substantially improve availability and mission readiness by more than doubling reliability
- Significantly reduce NFF and remediate bad actor LRUs
- Dramatically reduce the $2B annual DoD NFF costs through rapid adoption and deployment of IFDIS across the DoD Maintenance Enterprise

IFDIS: Questions?