ACCELERATING INNOVATION

Universal Synaptics

CTMA ANNUAL PARTNERS AND INTEGRATED PROJECT MEETING 2017

# Intermittent Fault Detection & Isolation Reduces NFF and Enables Cost Effective Readiness


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NCMS NATIONAL CENTER FOR MANUFACTURING SCIENCES

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# No Fault Found

- **No Fault Found (NFF) is an annual multi-billion dollar non-value added expense to the DoD**
  - Intermittent discontinuity resulting in NFF is now recognized by the Department of Defense (DoD) as an operational readiness degrader and life-cycle cost driver
  - DoD estimates that 3 out of 4 (75%) of DoD weapons systems have undetected intermittent faults that manifest as operational failures
  - NFF costs the Department of Defense (DoD) between $2B - $10B annually (Source: Office of the Secretary of Defense (OSD) Maintenance, CTMA Partners Meeting)

- **Universal Synaptics**
  - Over 20 years experience in NFF remediation and solutions
  - Focus on improved diagnostics capability to address intermittent faults in Line Replaceable Units (LRUs) / Weapon Replaceable Assemblies (WRAs) and Electrical Wiring Interconnect Systems (EWIS) which have been conclusively linked as a significant contributor to NFF
  - Deployed intermittent fault detection capability has demonstrated significant reductions in NFF, improved availability and cost savings

**Intermittent Fault Detection & Isolation = Cost Effective Readiness**

# The Problem

- **Aircraft electronic LRUs test "No Fault Found" (NFF) approximately 50% of the time**
  - Box malfunctions intermittently during flight, but tests good during subsequent ground testing
  - Intermittent activity also categorized as RTOK, CND, NTF, NEOF or even "gremlins"
  - Intermittent discontinuity is also a significant problem in electronic wiring interconnect systems

- **Intermittent faults are mechanical in nature**
  - Failures are in wiring, solder joints, wire wraps, connectors, via's etc.
  - Modern components are more reliable and capable – intermittent discontinuity between components is a growing concern and becoming a major cost driver

**No Fault Found costs the DoD between $2 and $10 Billion annually**

# Conventional Approach

- **Functional ATE and Continuity testers cannot detect and isolate intermittent faults that cause NFF**
  - Test only one function at a time
  - Test only one circuit at a time, even when connected to multiple circuits
  - Digital averaging, scanning and sampling masks and or misses the intermittent faults – a testing "blind spot" or "testing void" exists
  - LRUs are not tested in an operational environment which is when the failures occur, EWIS is also tested in static environment
  - Only designed to find functional failures and failed components and circuit opens and shorts
  - Intermittent faults that cause NFF do not follow specific failure patterns

**Conventional Approach = Conventional Results**

# Conventional Approach

- **Digital Multi-Meters** (DMMs) take sample readings and, over a specific period, average them before presenting them to the user's display. Most DMMs will be sampling at a rate of once per millisecond; so even if a high ohmic reading was detected on one or even a few of the reads, over a thousand readings they would be averaged into insignificance. This digital averaging renders DMMs incapable of detecting ohmic intermittent faults of Category 3 or shorter (Category 3 as per the DoD MIL-PRF 32516 definition: 501 microseconds to 5 milliseconds). Most conventional wiring continuity testers have a DMM as their underlying testing technology and while a continuity tester may be physically connected to many lines, it is still only testing one line-at-a-time. Therefore any intermittence occurring on a line not actively being tested is missed.

# Mx & Supply Impact

- **Tools provided to maintainers are not sufficient:**
  - Just because an LRU passes BIT or ATE tests multiple times in a row, does NOT mean there isn't a lurking problem in the unit
  - BIT and ATE testing does not check all circuits or functional paths in an LRU, including all connection paths to SRUs simultaneously
  - Conventional ATE does not test in an operationally relevant environment
  - Conventional ATE is incapable of detecting short duration intermittent faults that cause NFF

- **Flight Line "Blacklisting" of LRUs makes an expensive supply problem worse**
  - Creates availability issues / unnecessary acquisition
  - Masks the real problem / drives "swaptronics"
  - Recirculates "bad actors" to other military units, thus perpetuating the problem

**An Innovative Solution is Needed to Solve This Problem**

# Operational Impact

- **High MICAP rates**
  - Missions are canceled or postponed
  - Readiness is negatively impacted
- **High NFF / RTOK / CND rates**
  - Wasted O / I / D-level maintenance resources and supply man-hours
  - Wasted time on supply documentation, transportation and troubleshooting
- **Supply chain becomes more expensive and less responsive**
  - Each LRU sent to the depot for a non-fix, unnecessarily wastes Combat and Support Commands millions of dollars each year
  - High availability (even a 100% production fill rate) does not equal high reliability or weapon system readiness

**The DoD Mx Enterprise is large, global, complex and costly**
**Change is required to reduce NFF & improve operational availability**

# Intermittent Faults / NFF

- **The Testing Problem:** Intermittence occurs randomly in time, place, amplitude and duration. The very nature of the failure mode suggests that the ability to detect and isolate the intermittence root cause is based on test detection COVERAGE and SENSITIVITY rather than conventional parametric methods concentrating on ohmic measurement accuracy.

- Simply put, you can't detect an intermittent event until it occurs, and then you have a very limited opportunity to capture it on the specific circuit when it does occur. Using any reasonable scientific approach to solve the problem of catching intermittents on the ground, you need to have 100% coverage and phenomenal testing speed.

- In other words, the proper equipment for the task must be able to test all of the failing system's lines, all of the time, in a simultaneous and continuous fashion. Conventional test equipment can not do this.

**"DoD maintained 400 types of test systems and spent $50B to buy and support these systems over a 12 year period" – GAO.**
**None of these test systems are solving the NFF problem**

# Intermittent Fault / NFF Solution

- **The Testing Solution:** To address all the testing limitations mentioned, the Intermittent Fault Detector™ (IFD™) was specifically developed to detect and isolate intermittence.
- It uses patented super sensitive analog neural network detection technology on the front end and digital reporting and data processing technology on the back end, and it does it all in an efficient, parallel circuitry manner.
- The IFD™ consistently detects all intermittent events on all circuits in a UUT, simultaneously, with ohmic glitch durations as short as 50 nanoseconds. The number of simultaneous test points is scalable from 128 to over 30,000 test points.
- Two major product lines were developed to deploy the IFD™ technology to the DoD & Industry.

# Universal Synaptics NFF Solutions

Voyager Intermittent Fault Detector™ (VIFD™) and the Intermittent Fault Detection & Isolation System™ (IFDIS™)

- Advanced all lines all the time circuit monitoring
- Proven technology that reduces NFF and improves system availability while reducing cost
- TRL 9 solutions

Intermittent Fault Detection & Isolation System™ (IFDIS™)

"Our equipment shows signs of wear and tear, we can't be complacent about our competitive advantage."
**– General Joseph Dunford, USMC,**
**Chairman of the Joint Chiefs of Staff**

# DoD Solution

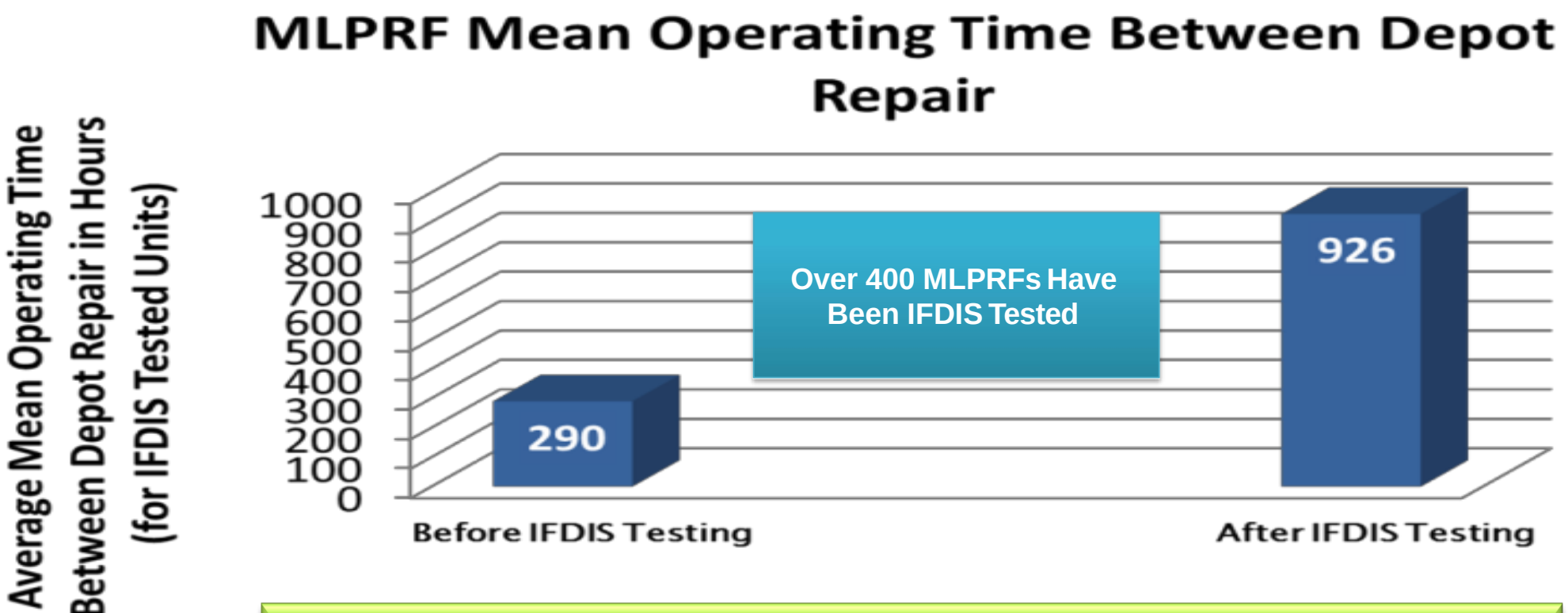
- Office of the Secretary of Defense established the Joint Intermittence Testing (JIT) Working Integrated Product Team (WIPT) in 2012 – Joint Service effort to address the intermittent testing void
- DoD released Military Performance Specification (MIL-PRF) in March 2015, MIL-PRF 32516 *"Electronic Test Equipment, Intermittent Fault Detection & Isolation"*
- JIT Industry Week (04 – 07 Jan 2016), Universal Synaptics IFD technology passed all JIT Intermittent Fault Emulator (IFE) tests in compliance with MIL-PRF 32516
- Universal Synaptics has proven solutions that detect and isolate intermittent faults down to 50ns
  *TRL 9 technology solutions

**"Ladies & Gentlemen, we are out of money, we have to think" – Winston Churchill**

# IFDIS & Voyager Proven Results

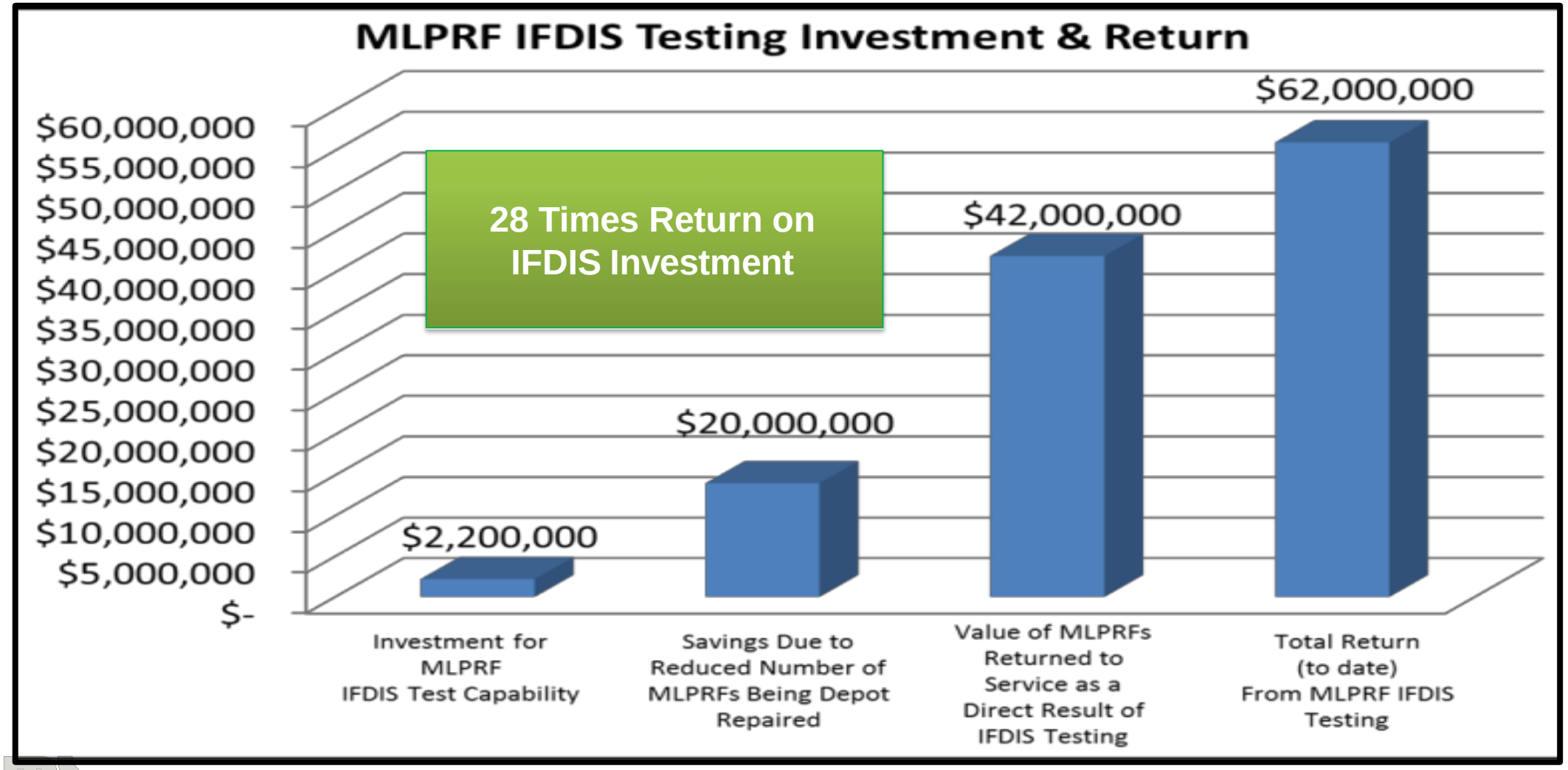
- F-16 Fighting Falcon
- F/A-18 Hornet & Super Hornet
- EA-6B Prowler
- UH-60 Blackhawk Helicopter
- AH-64 Apache Helicopter
- CH-47 Chinook Helicopter
- C-130J Super Hercules
- Eurofighter Typhoon
- Tornado GR4
- M1A1 Abrams
- Boeing 757 & Airbus A320

# Proven Results




**MLPRF Availability Tripled!**

# Proven Results



# Proven Results

- F/A-18 GCU: Results to date:

"Collaboration, innovation and forward thinking were key words used to describe the amazing work taking place across the FRC landscape in support of the Naval Aviation Enterprise Vision.

At FRC West, Sailors teamed with artisans to interdict repairs for Generator Control Units—or GCUs—using the Intermittent Fault Detection and Isolation System. This resulted in the GCU time on wing to more than double, providing what was a top ten degrader asset, to be readily available for longer periods of time in support of flight operations."

Rear Adm Zarkowski

Commander FRCs

USN

# Technology Partners

U.S. AIR FORCE

OGDEN ALC

NAVAL AIR SYSTEMS COMMAND

FLEET READINESS CENTER SOUTHWEST FRC

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COMMERCIAL TECHNOLOGIES for MAINTENANCE ACTIVITIES CTMA

Derco Aerospace Inc. A Sikorsky Aerospace Services Company

MINISTRY OF DEFENCE

AUSTRALIAN ROYAL AIR FORCE

Copernicus Technology Ltd

indra

SAMSUNG

"Create the Future" Contest – "Top 100 Finalist" 2015

Best of State, Applied Science & Technology Category – Winner 2014

DoD Maintenance Symposium, "Great Ideas" Competition – Winner 2010 & 2012, "Top 5 Finalist" 2014

CTMA Symposium, OSD MX Technology Challenge – "Top 5 Finalist" 2012 & 2013

# Conclusion

- Undetected intermittent faults are a systemic issue – a multi-billion dollar NFF problem exists
- Advanced Intermittent Fault Detector™ (IFD™) diagnostic solutions are available to detect and isolate intermittent faults in compliance with DoD MIL-PRF 32516 that cause NFF
- Intermittent fault detection and isolation capability has proven to reduce NFF, reduce life cycle costs, reduce MICAPs and improve operational availability
- IFDIS™ & Voyager™ are proven solutions and are making a positive impact today that can be utilized on any platform

**It's Time to Stop Admiring the Problem**

# Questions?

Universal Synaptics

*The Wright Brothers of No Fault Found*

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