Advanced Range Data System (ARDS) Service Life Extension Program (SLEP)

"Ensuring GPS Based TSPI Remains a Viable T&E Range Instrumentation Asset"

By

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ARDS SLEP Background

- **The Advanced Range Data System (ARDS) is a GPS based TSPI instrumentation suite originally fielded in the early 1990's.**
  - Full Scale Engineering Development (FSED) and Low Rate Initial Production (LRIP).
- **Full Rate Production (FRP) hardware was fielded in 1997-1998.**
  - Total investment including all CTEIP and I&M funding from conception to FRP hardware was just over $500M.
- **The expected life span was 8-10 years.**
  - Production hardware was delivered with numerous components already deemed obsolete requiring immediate obsolete component replacement programs.
- **The initial effort to retrofit and upgrade the system in 1998-1999 alleviated the obsolete component issues present when the FRP hardware was delivered.**

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ARDS SLEP Background

- **Preparations for a new follow on CTEIP program called the Enhanced Range Applications Program (EnRAP) began in 2001.**
- **This program was targeted at providing significant enhancements and improvements to the existing ARDS hardware suite**
  - Improved performance and TSPI solution accuracy.
  - Significant component miniaturization.
  - More efficient data link system.
- **EnRAP hardware was supposed to be the next generation GPS TSPI hardware suite that would replace ARDS starting in 2007.**
  - Timed to be fielded at the end of the original 10 year expected service life of the ARDS full rate production hardware suite.
  - The contract was awarded in 2005.

ARDS SLEP Background

- **The EnRAP program started experiencing problems shortly after it began and was canceled in March 2006.**
- **The T&E ranges involved in the EnRAP program immediately initiated a Service Life Extension Program (SLEP) on the ARDS hardware suite.**
- **T&E ranges involved in the ARDS SLEP established the following objectives and goals.**
  - Replace the obsolete and soon to be obsolete components identified in the most cost efficient manner possible.
  - Develop form-fit-function replacements where possible.
  - If not form-fit-function, develop replacements that required the least amount of changes to the system overall (wiring harnesses, mounting rail, software mods, etc.).
  - Procure life time supply of parts identified as soon to be obsolete.

ARDS SLEP GOALS

- **Focus on replacing obsolete hardware with equivalent capabilities.**
  - Enhancements and improvement in performance not the primary goal.
  - Maintain current performance capabilities as a minimum.
  - Driven by what the available funding was allowed to be spent on.
- **Eliminate proprietary hardware and software wherever possible.**
- **Develop multiple sources of procurement for key components.**

ARDS SLEP Background

- **The ARDS SLEP began officially in FY07.**
  - The majority of the SLEP efforts are being executed through the Tri-Service GPS Sustainment Management Office (GPS SMO) out of the Naval Air Warfare Center Weapons Division, China Lake.
  - There are two key in-house obsolete component replacement efforts being executed by the 46th TW at Eglin AFB.
    - **Replacement for the Advanced Digital Interface Unit (ADIU)**
    - **Replacement for the Intelligent Flash Solid Sate Recorder (IFSSR)**
  - Key T&E ranges involved are China Lake, Pax River, Eglin AFB, Edwards AFB, and White Sands Missile Range (WSMR).
  - Also involved are two German T&E ranges that have the same hardware fielded and operational.

ARDS SLEP Background

- **The ARDS SLEP is divided up into several areas.**
  - Development of new hardware to replace obsolete hardware where no current off-the-shelf solution exists.
  - Life time buy of hardware that will soon be obsolete.
- **Develop multiple sources of procurement for key components.**
  - DLT – Modem and Power Amplifier
  - ADIU
  - IFSSR
  - Power Supplies – Red and Black
  - ARDS Pod Cable Harnesses
  - GPS Receiver

ARDS SLEP Components Involved

- **ARDS components being addressed in the current SLEP.**
  - Data Link Transceiver (including the modem and power amplifier).
    - **Procure new backwards compatible modems from DRS Defense Solutions.**
    - **Procure new replacement DLT power amplifiers from DRS Defense Solutions (developed by Aethercomm to a DRS specification).**
    - **Develop and procure a replacement DLT power amplifier to the current government owned SCD from Nanowave Technologies (the original manufacturer).**
    - **Take the government owned Multi-Service Target Control System (MSTCS) DLT and migrate it to a fully ARDS compatible DLT (form-fit-function).**
    - **Develop a new ARDS compatible miniaturized DLT for use in onboard installations in the JSF, F-22, UAV applications, etc.**

ARDS SLEP Components Involved

- **ARDS components being addressed in the current SLEP (Cont…).**
  - AC/DC Converter (DLT power supply).
    - **Procure more of the current power supplies from Technipower LLC (One of two original equipment manufactures).**
  - GPS receiver
    - **Procure the new form-fit-function replacement DRS Integrated GPS System (DIGS) receiver from DRS Defense Solutions to replace the obsolete Rockwell Collins GNP-10.**
    - **Develop two separate NovAtel commercial receiver solutions to replace the GNP-10.**
  - Advanced Digital Interface Unit (ADIU).
    - **Procure a new ADIU from DRS Defense Solutions.**
    - **Develop and manufacture a new government owned ADIU**

ARDS SLEP
Components Involved

- **ARDS components being addressed in the current SLEP (Cont…)**
  - Intelligent Flash Solid State Recorder (IFSSR)
    - **Procure a new IFSSR from DRS Defense Solutions.**
    - **Develop and manufacture a new government owned IFSSR.**
  - DC/DC Power Supply
    - **Develop a new DC/DC power supply.**
    - **Competed the development – awarded to Technipower (now Unipower) LLC.**
    - **Government developed a new updated equipment specification**
  - New Red, Black, and REM by-pass Cable Harnesses
    - **Develop a second source of procurement.**
  - ARDS Pod Tube Hangers – Forward, Center, and Aft

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ARDS SLEP
Current Progress

- **Replacement DLT power amplifier manufactured by Nanowave.**
  - Nanowave was the original manufacture of the Full Rate Production ARDS DLT power amplifier.
  - German T&E ranges, via the Tri-Service GPS SMO and FMS cases, funded the development of a replacement DLT power amplifier built to the same SCD as the original DLT power amplifier.
- **The initial requirement was for the procurement of 52 new DLT power amplifiers.**
  - Additional orders were placed bringing the total ordered to 105.
  - All 105 power amplifiers have been delivered and accepted.
- **The DD Form 1494 frequency approval process has been completed.**

ARDS SLEP
Current Progress

- **Replacement DLT power amplifier manufactured by Aethercomm and sold through DRS Defense Solutions.**
  - Developed by Aethercomm for DRS and designed to a new DRS proprietary specification.
  - The DD Form 1494 approval process has been completed.
- **Multi-Service Target Control System (MSTCS) DLT conversion effort.**
  - The MSTCS DLT was developed under a separate CTEIP program and was based on the ARDS DLT architecture.
  - The government owns the rights to the MSTCS DLT hardware and software design (modem and power amplifier)
  - Current ARDS SLEP activities include funding the conversion of the MSTCS DLT to operate as a fully compatible ARDS DLT.

ARDS SLEP
Current Progress

- **MSTCS DLT Conversion Effort (cont…)**
  - Conversion efforts include repackaging the converted MSTCS DLT into the ARDS form factor.
  - Delivery includes just the single modem CCA and a repackaged power amplifier.
  - Government engineers at the 46th TW at Eglin will perform the final assembly into ARDS modem and power amplifier housings – form factor.
  - Government is performing all the environmental stress screening, EMI/EMC, and shock/vibration testing in-house.

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ARDS SLEP
Current Progress

- **Miniaturized ARDS DLT development effort.**
  - The T&E ranges developed a miniaturized ARDS compatible DLT capability to instrument smaller test platforms several years back.
  - The “ARDS Lite” package utilized COTS FreeWave radios that were coupled to a special data link relay (FMIU) in order to work in the ARDS network.
    - **Obsolescence issues were present with this system as well.**
    - **Allowed only 1/3 of the RF throughput of a true ARDS DLT.**
    - **Utilized a truncated or compressed ARDS message format.**
    - **Required a dynamic translation of ARDS messages into their ARDS "Lite" equivalents (and vice versa) in real time.**

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ARDS SLEP
Current Progress

- **Miniaturized ARDS DLT development effort (Cont…).**
  - The current miniaturized ARDS DLT development effort took the existing ARDS “Lite” transceiver and replace it with a ARDS capable miniature DLT with most of the functionality of the current DLT
    - **Does not currently have a relay capability.**
    - **Utilizes F1 frequency only.**
    - **Encryption capability not currently present.**
  - The new miniaturized DLT development resulted in a small, low cost ARDS DLT.
    - **The baseline production hardware has been received and accepted by the government.**
    - **The DD Form 1494 frequency approval process is in work.**
  - Funded improvements to the baseline product include adding a link-less capability and a live monitor mode.

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ARDS SLEP
Current Progress

- **AC/DC Power Supply.**
  - Technipower LLC, formerly Transchem, was one of two original manufactures of the 96150400 AC/DC power supply.
    - The second manufacture Keltec, no longer manufactures this power supply.
  - CM approved AC/DC power supply for ARDS.
  - Source Control Drawing in the ARDS documentation package.
  - Originally thought to be obsolete and out of production.
  - This power supply is still a standard production line for Technipower in accordance with the government owned SCD.
  - All power supplies ordered have been delivered and accepted.

ARDS SLEP
Current Progress

- **GPS Receiver Replacement.**
  - Current GNP-10 GPS receiver manufactured by Rockwell Collins is obsolete and can no longer be procured.
  - Failed GNP-10 units sent in for repair are starting to be returned “Beyond Economical Repair” (BER).
  - No drop in replacement available from Rockwell Collins without extensive NRE ($5-6M).
  - DRS Defense Solutions developed a GNP-10 replacement for use on the P-5 program.
    - DRS Integrated GPS System (DIGS).
    - NRE was covered 100% by other DRS programs and internal R&D funding.
  - The T&E ranges were able to procure this new “form-fit-function” replacement GPS receiver without any NRE expenses.

ARDS SLEP
Current Progress

- **GPS Receiver Replacement (Cont…).**
  - TYBRIN initiated contract actions to procure DRS Defense Solutions new replacement DIGS GPS receiver.
    - Accuracy and performance problems were discovered during several rounds of low dynamic truck tests and flight tests conducted at Eglin.
    - Problems were also discovered during attempts to post process raw data from the DIGS.
  - DRS has made significant progress in resolving the problems identified.
  - Low dynamic flight testing on the redesigned DIGS receiver (new Kalman filter) has been completed.
  - High dynamic accuracy testing is tentatively scheduled for April 2011.

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ARDS SLEP
Current Progress

- **GPS Receiver Replacement (Cont…).**
  - Navy integration of the Novatel Synchronous Position, Attitude and Navigation (SPAN) SE GPS/INS receiver.
    - Worked with NovAtel to develop and evaluate a new NovAtel commercial receiver GPS/INS (LN-200) instrumentation package to replace the current GNP-10/LN-200 instrumentation package.
    - Designed for use in the new F/A-18 internal mount configuration.
    - Not designed for use in the ARDS pod.
    - Objective – achieve the same performance and TSPI accuracy as the current GNP-10/LN-200 configuration.
    - The new GPS/INS system has been tested and evaluated in ground tests (van), low dynamic flight testing (Baron prop plane), and high dynamic flight testing on the F/A-18.
    - Successful flight testing and TSPI accuracy testing has been completed.
    - Development of production internal mount configurations is underway.

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ARDS SLEP
Current Progress

- **GPS Receiver Replacement (Cont…).**
  - Air Force (Eglin) 46th TW Development and Integration of the Eglin NovAtel SPAN GPS Receiver (ENGR).
    - Worked with NovAtel to develop and evaluate a new Kinematic Carrier Phase capable NovAtel SPAN commercial GPS receiver coupled with the LN-200 Inertial Measurement Unit (IMU) instrumentation package to replace the current GNP-10/LN-200 TSPI instrumentation package.
    - Repackaged into a GNP-10 form factor - ARDS Pod configuration.
    - Objective – achieve the same Method I performance and TSPI accuracy as the current GNP-10/LN-200 configuration.
    - Outputs both GNP-10 format messages and NovAtel messages via USB or Ethernet – NovAtel messages used for the post processing.
    - Primary difference between the GNP-10 and ENGR is that the ENGR will accomplish Differential GPS (DGPS) via WASS corrections versus the RAJPO DGPS format.
    - Dynamic flight testing comparing the ENGR performance against the GNP-10 and other TSPI sources is underway now.

ARDS SLEP
Current Progress

- **ADIU and IFSSR development efforts.**
  - Two development efforts are underway for a replacement ADIU and IFSSR.
  - The 46th TW at Eglin AFB is developing a replacement ADIU and IFSSR in-house.
    - All hardware and software design will be owned by the government.
  - A major T&E range customer procured a follow-on DRS developed replacement for the ADIU and IFSSR as well.
    - Schedule requirements dictated that the replacements would be needed before the in-house government effort at Eglin would be completed.
    - Hardware and software for the DRS development will be proprietary to DRS.
    - All hardware ordered has been delivered.

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ARDS SLEP
Current Progress

- **ADIU and IFSSR development efforts (Cont…).**
  - The current ARDS hardware configuration utilizes a R^3 interface between the ADIU and DLT.
  - A new Synchronous Data Link Control (SDLC) interface has been developed to resolve problems with utilizing the Range Encryption Module (REM).
  - The new DRS developed ADIU will only work in the SDLC mode and is not backwards compatible with the R^3 interface.
    - The Navy does not currently plan to transition to the SDLC configuration.
  - The Eglin in-house developed ADIU (referred to as the EDIU) is backward compatible with the R^3 interface and will also work with the new SDLC interface.
    - The Air Force and Army have hard requirements to use the REM and are migrating to the SDLC configuration as a result.

ARDS SLEP
Current Progress

- **ADIU and IFSSR development efforts (Cont…).**
  - The new DRS IFSSR requires a new end cap be incorporated in the pod rail as well as installing a new battery holder in front of the DLT.
  - The Eglin in-house developed IFSSR (referred to as the EFSSR) is a form-fit-function drop in replacement and does not require the new end cap or the relocation of the batter holder.
  - The new Eglin EDIU and EFSSR hardware and software development is complete.
    - Qualification testing has been completed including environmental stress screening, vibration and shock, and EMI/EMC.
    - Certified Manufacturing has been placed on contract to build up 100 production units for both the EDIU and EFSSR.
    - Production deliveries are underway.

ARDS SLEP
Current Progress

- **Replacement DC/DC power supply.**
  - No form-fit-function drop in replacement was currently available.
  - A new DC/DC power supply equipment specification was created based on previous SCD's.
  - A limited open competition was conducted between previous power supply providers.
  - TYBRIN awarded a contract to Technipower LLC on 1 December 2008.
  - The government owns the full re-procurement data rights to the new design.
  - Delivery of 91 production power supplies is underway and will be completed by April 2011.

ARDS SLEP
Current Progress

- **ARDS Pod Cable Harnesses.**
  - The government qualified a new cable harness supplier to manufacture the current ARDS cable harness set.
  - The government now has two qualified sources to procure the ARDS Red, Black, and REM By-pass cable harnesses from.
  - The new cable harness supplier provides a significant cost savings while maintaining superior quality workmanship.
  - Modifications have been incorporated into the REM By-pass cable harness to allow it to be interchangeable with the R^3 configuration and the SDLC configuration.
    - Previously, the REM-By-pass cable had to be modified to work in the SDLC configuration and once modified, could no longer be used in the R^3 configuration.

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ARDS SLEP
Current Progress

- **New ARDS Pod Tube Hanger Configurations.**
  - The ARDS pod tubes currently have the 1,500 hour AIM-9 forward, center and aft hangers installed.
    - Poses significant problems when flown on the F/A-18.
    - Limited number of flight hours before they have to be inspected for stress and cracks.
    - Downtime for inspection is lengthy.
  - The Navy has decided to move to the new DRS proprietary P-5 TCTS forward hanger and government owned P4RC center and aft hanger configuration.
    - Allows significantly longer flight hours before inspections are required.
    - Allows replacement of the hanger shoe on the forward hanger without replacing the entire hanger band assembly

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ARDS SLEP
Current Progress

- **New ARDS Pod Tube Hanger Configurations (Cont…).**
  - The ARDS flight clearance for the new Navy hanger configuration has been approved, and all hanger retrofits have been completed.
  - The Army also incorporate the Navy hanger configuration since they have to support test operations with the F/A-18 as well as the F-15, F-16, and A-10.
    - Migrated to the hanger configuration that will support the most stringent requirements they have to meet – F/A-18 E/F wingtip.
  - The 46th TW is migrating to the P4RC forward, center, and aft hanger configuration.

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ARDS SLEP
Current Progress

- **New ARDS Pod Tube Hanger Configurations (Cont…).**
  - Edwards AFB (AFFTC) will stay with the 1500 hour configuration.
  - New Nomenclatures were established for the hanger configurations.
    - AN/ARQ-52B (V)17 Modified (AFFTC and UTTR configuration)
    - AN/ARQ-52C (V)17 New Navy and WSMR Configuration
    - AN/ARQ-52D (V)17 New Eglin Configuration
  - SEEK EAGLE fleet wide flight clearance approval in process for all three configurations for Air Force F-15, F-16, and A-10 aircraft.

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ARDS SLEP Issues

- **The major issue in the ARDS SLEP has been documentation, documentation, documentation!**
  - Incomplete documentation.
  - Missing documentation.
  - Documentation not procured.
    - Too many proprietary parts.
  - Undocumented hardware and software changes to the system.
  - Documentation not properly validated and verified.
  - Configuration Management and the documentation package was the responsibility of the SPO at Eglin that procured the ARDS hardware up until late 2002.
  - Responsibility for CM and all the documentation was transferred to the Tri-Service SMO in a formal transfer agreement.

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ARDS SLEP Issues

- **In preparation for the ARDS SLEP, the T&E ranges realized how poor the documentation package transferred from the acquisition SPO was.**
- **System performance specifications in general and descriptions of how the DLT (network interfaces) and ADIU operated and interfaced were virtually non-existent (two key components of the ARDS hardware suite).**
  - No documentation had been procured in many cases.
  - Documentation procured had been lost and was no longer available.
  - Many undocumented changes (from an ECP standpoint) had been made to the DLT and ADIU software.
    - **These components became proprietary to the OEM.**
  - Source Control Drawings for proprietary components had not been procured in in an effort to cut costs in the original acquisition.
  - Existing SCD's used in the SLEP were found to have glaring errors that should have been discovered in the initial validation/verification process.

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ARDS SLEP Lessons Learned

- **The original FSED & LRIP ARDS development produced a complete build to print Level III drawing package.**
  - All software source code was available.
  - All hardware drawings were available.
  - All system specifications were current and accurate.
  - Allowed for open competition for the full rate production hardware.
- **By the time Full Rate Production was completed, approximately 50% of the documentation package was no longer valid.**
  - Obsolete components encountered during production were engineered around without proper documentation.
  - Enhancements added toward the end of the production cycle (Option II on the contract) were incorporated with no documentation procured.
  - What started as a 100% government owned hardware and software system became a system where all the key components were proprietary.

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ARDS SLEP Lessons Learned

- **When originally procured and fielded, no thought was given to having to potentially sustain the system beyond its projected life expectancy.**
- **Emphasis was on buying more hardware and less documentation.**
- **Maintaining and properly archiving documentation from the initial development (FSED & LRIP) was not accomplished.**
  - Not available for ARDS SLEP use.
- **Proper validation/verification was not completed on the documentation package that was maintained.**
- **The lack of proper documentation has resulted in a tremendous amount of additional cost and time to develop suitable replacements for key subsystems during the ARDS SLEP.**

ARDS SLEP Conclusions

- **Failure of the EnRAP program resulted in having to keep the ARDS hardware suite operational long past its projected life expectancy.**
  - Planned operation after the SLEP is through 2017.
- **The ARDS hardware had a significant number of obsolete components.**
- **A large effort has been made to develop multiple sources of procurement for many key ARDS components.**
- **The government is working hard to reduce or eliminate proprietary components.**
  - Regain control and ownership of the hardware and software.
  - Allow for lower cost and quicker turnaround in future enhancements and obsolete component replacement efforts.
- **The ARDS documentation package was very incomplete complicating the ARDS SLEP greatly.**
- **Future CTEIP programs should focus more on ensuring the proper documentation is procured and reduce the amount of proprietary components.**