746th Test Squadron

Innovate, Execute, Excel

U.S. AIR FORCE

Testing of the GPS SAASM End-to-End Functionality On Operational Weapons Platforms Without the Availability of the Signal in Space

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Integrity - Service - Excellence - Agility

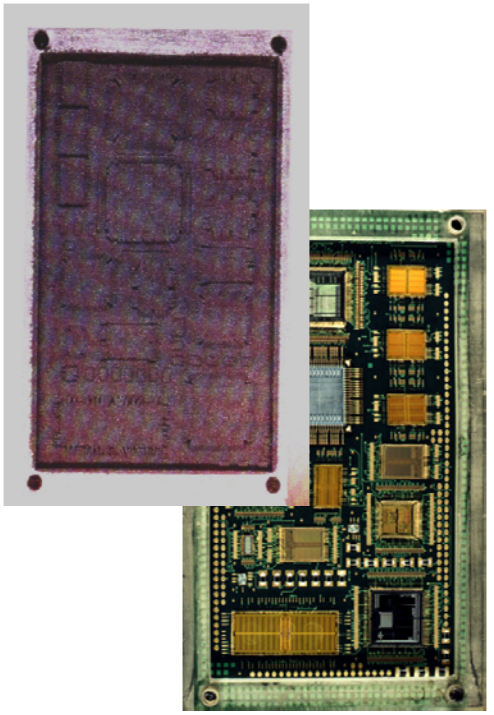
UNCLASSIFIED

Overview

- Background SAASM
  - What is SAASM
  - Status of Implementation
  - Test Capability Shortfall
  - Proposed Solution
- SAASM-ISER Test Set up
  - Concept
  - Components
  - Test Strategy
- Demo on Army HIMARS and Navy P-3
- SAASM-ISER Phase II Interfaces
- Benefits to the User
- Recap
- Questions

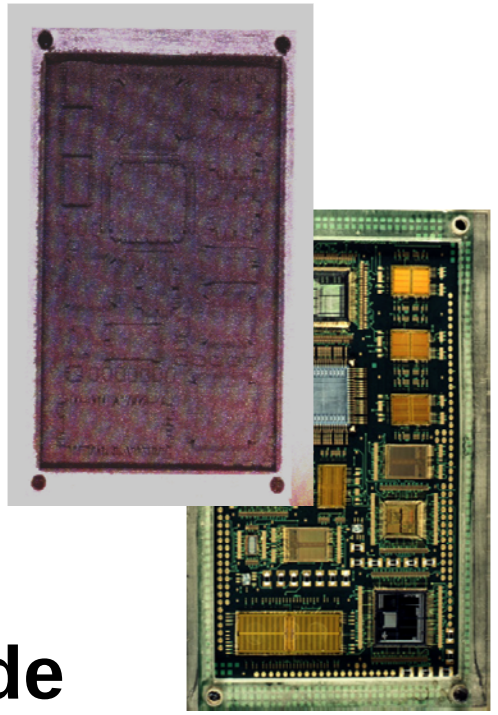
What is SAASM GPS?

- **New generation GPS Security Architecture**
  - **Extended functions**
  - **Black (unclassified) Keys**
  - **Over the Air Rekey (OTAR)**
  - **Anti-tamper design**
  - **Direct Y enabler**



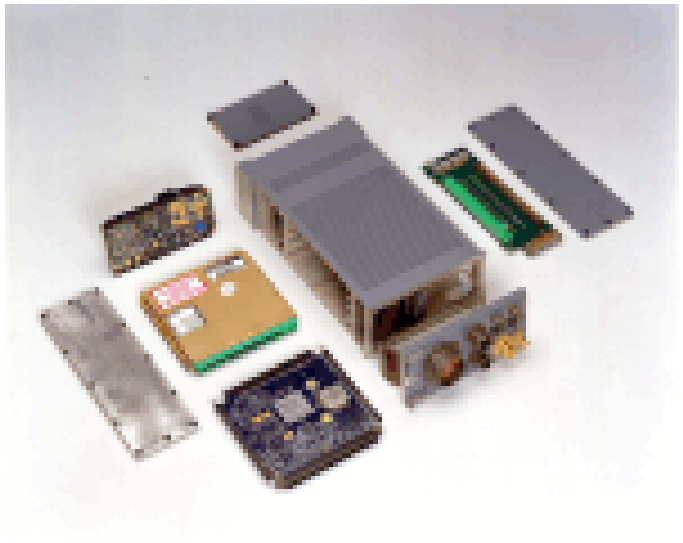
SAASM GPS

- **What does the User Get ?**
  - **Same Accuracy Performance**
  - **More Secure Military Ops**
  - **Simplified handling**
  - **More Capability**
  - **Over the Air Rekey**



- **Signal in Space (SIS) awaiting Master Control Segment upgrade**
  - **User and Space Segment ready**

SAASM Integrated Status



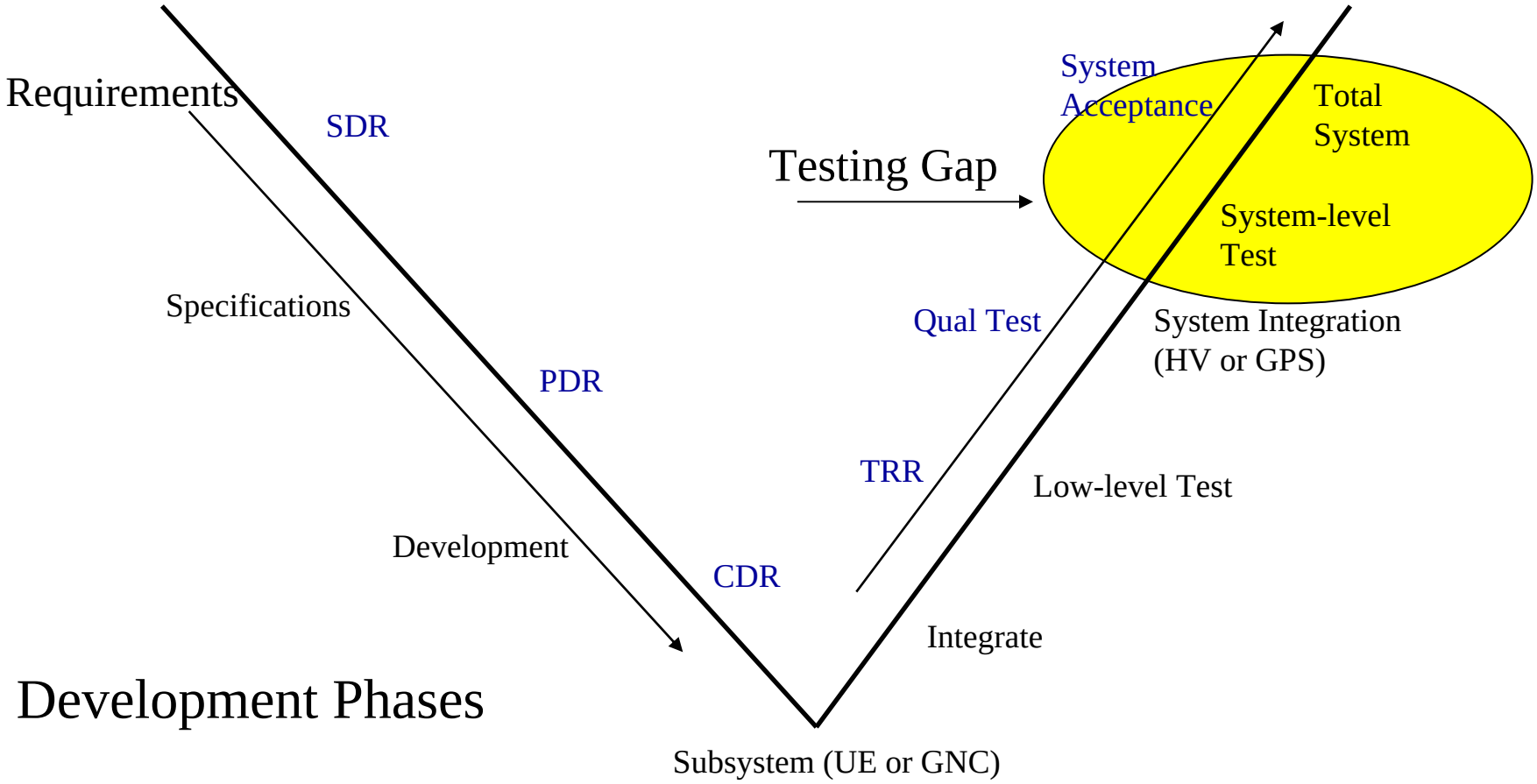
- Cards developed
- Integrated into box
- Integrated into systems
- Systems going operational
- SIS not available yet

Testing Gap

- **GPS SAASM cards are tested at the chip level, receivers are tested at the box level**
- **However, fully integrated system level testing was not being accomplished**
- **So, there is a Testing Gap of full functionality at the integrated system level**

Systems Engineering from Mission Need to Operational Part

- **MNS / ORD / CDD**



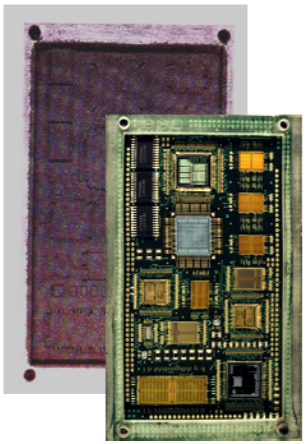
Lessons Learned

- **Most acquisition programs begin test phase with high level of confidence and optimism in the expected outcome, but…**

- **In practice most every test program experiences unanticipated ‘glitches’ that require correction**

SAASM Testing

CARD ✓



BOX ✓

?

INTEGRATED SYSTEM

Problem

- **Platforms that use SAASM-based receivers cannot be tested easily at the system level**
  - **On-orbit signals are not yet available**
  - **Hard for operational platform to come to lab**
  - **Anechoic chamber testing is very costly**

Wait for SIS ?

- **Even with SIS a gap in test capability exists**
  - **Can't expect full functionality testing from SIS**
  - **Difficult to control scenarios during tests**
  - **Repeatable scenarios probably not available**
  - **Anomaly resolutions; lack the ability to duplicate specific conditions and signals**
- **Needed:**
  - **Capability to test before & after going operational**
  - **Ability to simulate and control all the SIS scenarios**
  - **Mobility to travel to the test platform**
  - **Connectivity - easy interface with various platforms**

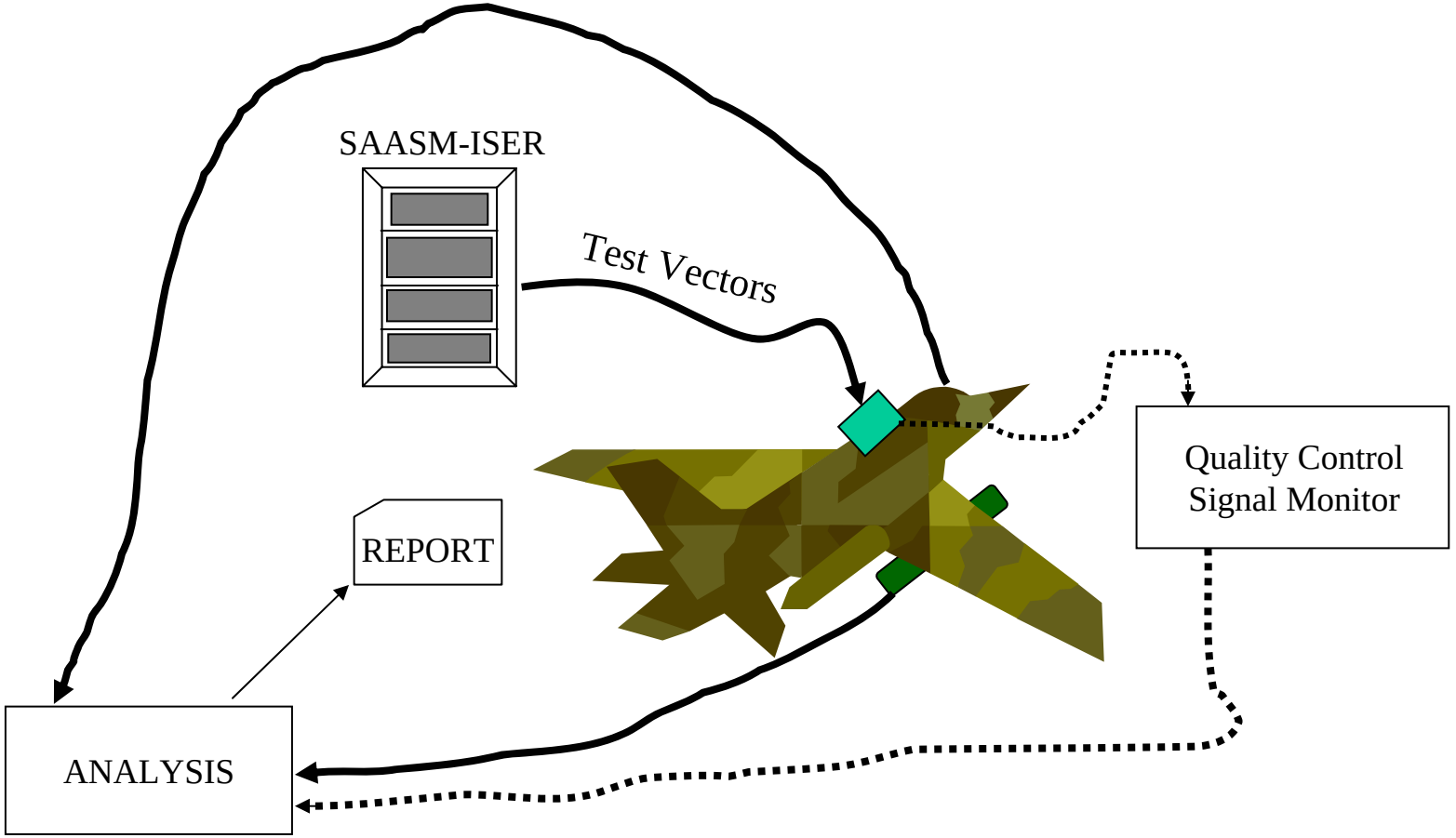
746 TS Developed Solution

- **SAASM Integrated System Evaluator and Reporter - (SAASM-ISER)**
  - **Configure a precision GPS signal simulator to generate and exercise the extended functions on the SAASM-equipped platform**
  - **Make it a mobile test capability that can travel to the user's location; palletize and van equipped**
    - **Little to no down time on operational asset**
  - **Allow user's platform systems to be run unaltered in their operational configuration – antenna hood**

Phase I SAASM-ISER Components

- **RF Hood (FRPA), GPS Simulator with PC NavTEL, Test Van**

SAASM-ISER Concept



Test Strategy and Approach

- **SAASM scenarios and data collection requirements are coordinated with customer**
  - **Determine best scenarios, sequence, and data collection sources for SAASM-ISER tests**
    - **Scenarios are a subset of SAASM test vectors**
  - **Synchronize scenarios to platform test location**
    - **Consistent with INS geo-position and time**
  - **Test the hood for RF leakage prior to tests**
    - **Add shielding if necessary**
  - **Collect preplanned Data to include:**
    - **GPS State, Code Track, PVT, FOM, C/N_0**

HIMARS Initial Demonstration

- **Demonstrated first SAASM-ISER proof of concept and basic capabilities on the Army's High Mobility Artillery Rocket System (HIMARS) in 2005**
- **Desired test vectors successfully accomplished on a fully integrated and operational weapon system**

HIMARS GMLRS

Antenna Hood

GPS Simulated signal scenarios are fed to test platform's GPS antenna and adjacent antenna tied to quality control monitor system to ensure signal integrity

Hood Mounted over 2 GPS Antennas

SAASM-ISER Test Van

- **Fully Equipped:**
  - **Elec Power Systems**
  - **Rack Tie-Downs**
  - **Dual Air Conditioning**
  - **Insulated**
  - **Climate Controlled**

Laptop Monitors,

DAGR

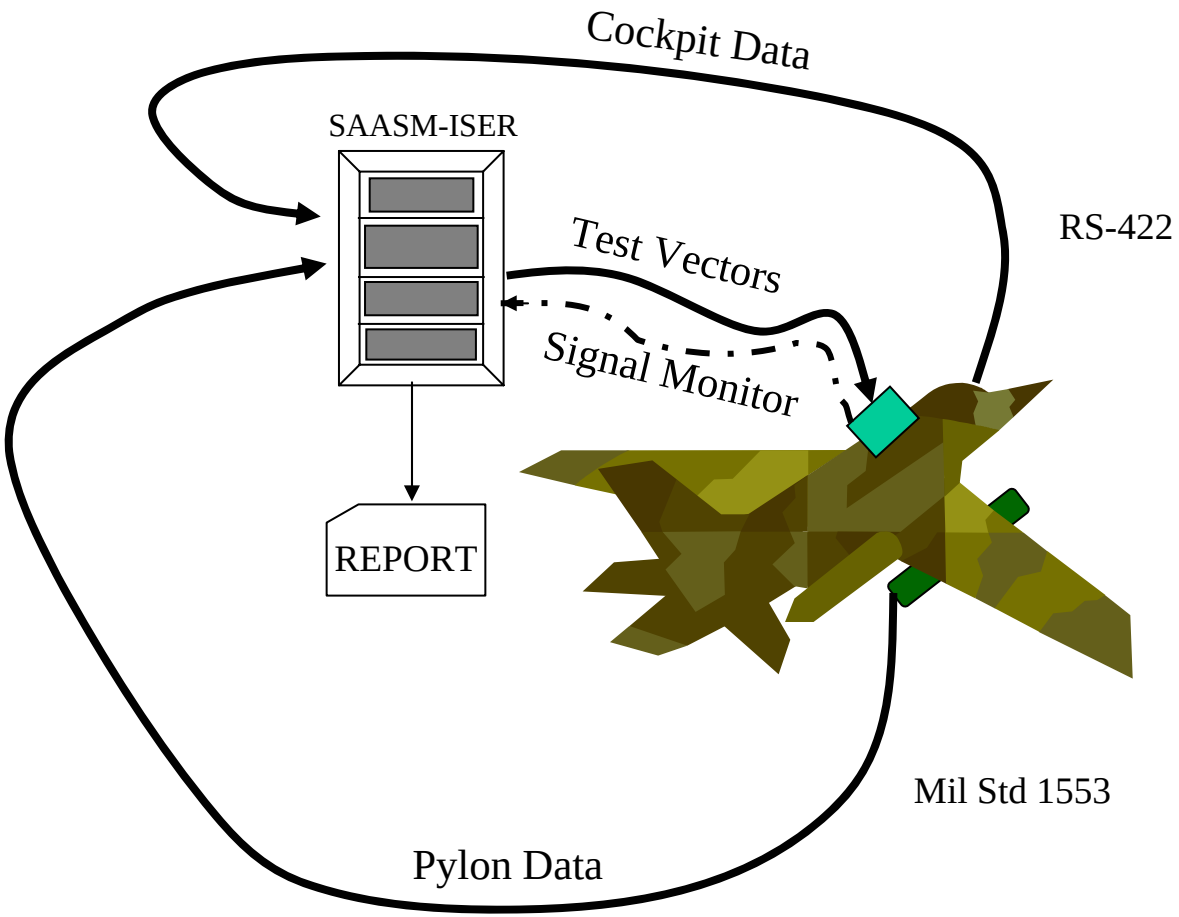
Signal quality and baseline monitor

Simulator

Navy P-3 Checkout

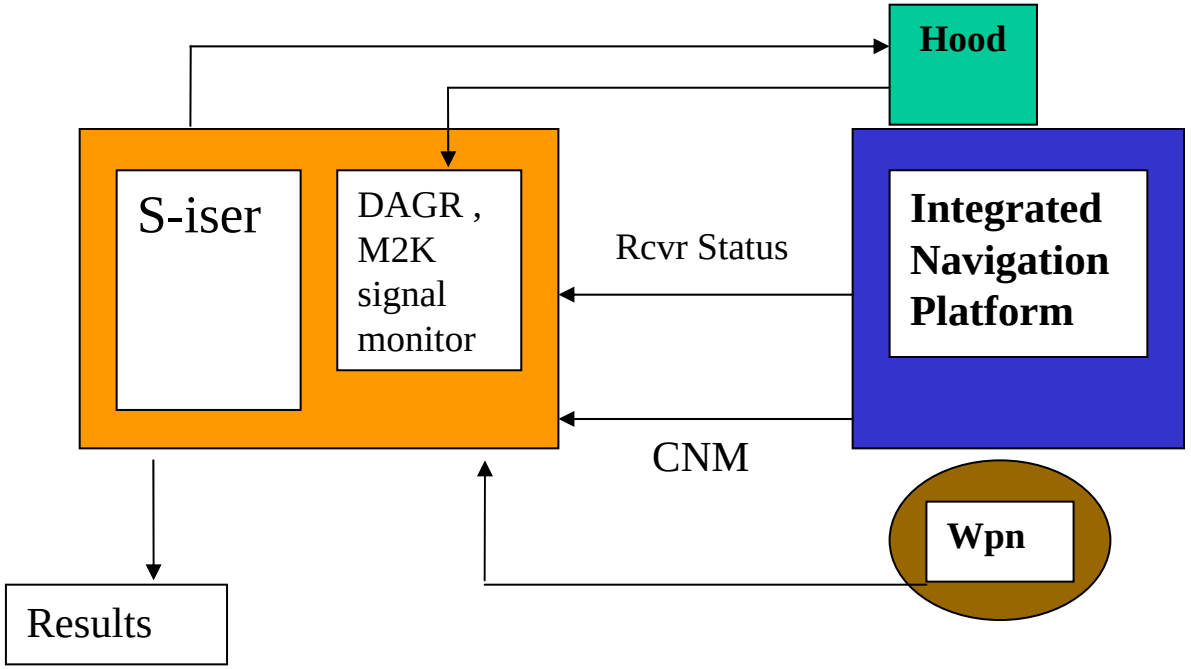
Performed SAASM and GPS RAIM tests on operational P-3 using SAASM-ISER

Phase II SAASM-ISER Concept



SAASM-ISER Block Diagram

- **RF feed into platform antenna(s)**
- **RS-422, Mil-Std-1553, CDU data monitoring**



SAASM-ISER

- Assessment methods:
  - Real-time assessment via cockpit displays
  - Data collected from receiver RS 422 Instrumentation Port
  - Data collected from platform Mil-Std 1553 bus
- Verifies integrated navigation system functionality of unaltered platform and weapon interface

What are the Benefits

- **Overall Benefits to the Warfighter are:**
  - **Reduces risk by substantiating technical performance prior to verifying system readiness**
  - **Resolves integrated system deficiencies early**
  - **Provides cost effective, short duration testing**
  - **Mobile - Can be performed on an operational platform at home station**
  - **Leverages 746 TS expertise in SAASM lab testing**
  - **Provides a means of anomaly resolution if needed**

Recap

- **SAASM- Integrated System Evaluator & Reporter**
  - **Fills a gap in the government's ability to perform end-to-end tests integrated SAASM systems**
  - **Provides for functional checkout of GPS SAASM extended functions on fully integrated weapons platform at low cost on home station**
  - **Provides means to duplicate/investigate anomalies**
- **SAASM-ISER Implemented on:**
  - **Army HIMARS**
  - **Navy P-3**
- **Follow on aircraft are in planning phase**

Questions?

Backup Slides

- Test Strategy
- HIMARS 3 Tier System
- Two FRPAs in Test
- Baseline Monitor
- SAASM-ISER Spirent, PC NavTEL
- Hood Detail
- Interface Cards

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HIMARS Weapon System

- **CONSISTS OF THREE SYSTEMS INTEGRATED**
  - **Fire control system**
  - **Position / Navigation system (GPS / INS)**
  - **Launcher Weapon system (GPS / INS)**

Baseline Monitor

- **Baseline SAASM monitor ensures the quality of the signal and the scenario being used for the unit under test.**

- **Baseline monitor antenna mounted next to platform's antenna. Feeds monitor SAASM receiver (DAGR)**

SAASM-ISER Components

- GPS Satellite Simulator
  - Spirent STR 4760
  - Multi Channel GPS L1/L2, CA, P(Y) code
  - Generates GPS simulations
  - Certified by GPS JPO according to the Enhanced Validation Test Plan
- PC NavTEL
  - Provides real-time bus control, monitoring, communications and display of simulation
  - Exercises various models and test scenarios
  - Communicates with Spirent over a General Purpose Interface Bus (GPIB) interface

SAASM-ISER Components

- **FRPA RF Hoods**
  - **Metal Enclosure & RF Absorbent interior**
  - **Includes internally mounted FRPA radiator to provide simulated RF SAASM GPS signals**
  - **Signal is received by UUT antenna and separate monitor FRPA under the antenna hood;**

  1) **System-Under-Test antenna**
  2) **Baseline FRPA connected to DAGR**
     - **Provides baseline monitoring and quality control for signal integrity of SAASM-ISER scenarios**

SAASM-ISER Interfaces

- Interface Cards:
  - Mil-Std-1553
    - Common SAASM Interface Change Notice
  - RS-422
    - IP for ICD-GPS-150 type messages
  - Weapon Interface
    - Mil-Std 1760 connector

SAASM-ISER (Phase II)

- Software module communications development
  - RS-422 (Instrumentation Port data)
  - Mil-Std-1553
    - Common SAASM ICN (IFC-SJICWG-001) Provides "common" SAASM interface data to Smart Mil-Std-1760 Weapons
- Test and Validate
  - Conduct phase II tests on proxy system
    - MAGR2000-GS or SAASM-EGI in lab testing
  - Conduct analysis
- Work with platforms on special requirements