

# Flight Testing and Telemetry at Patuxent River: Past, Present, and Future

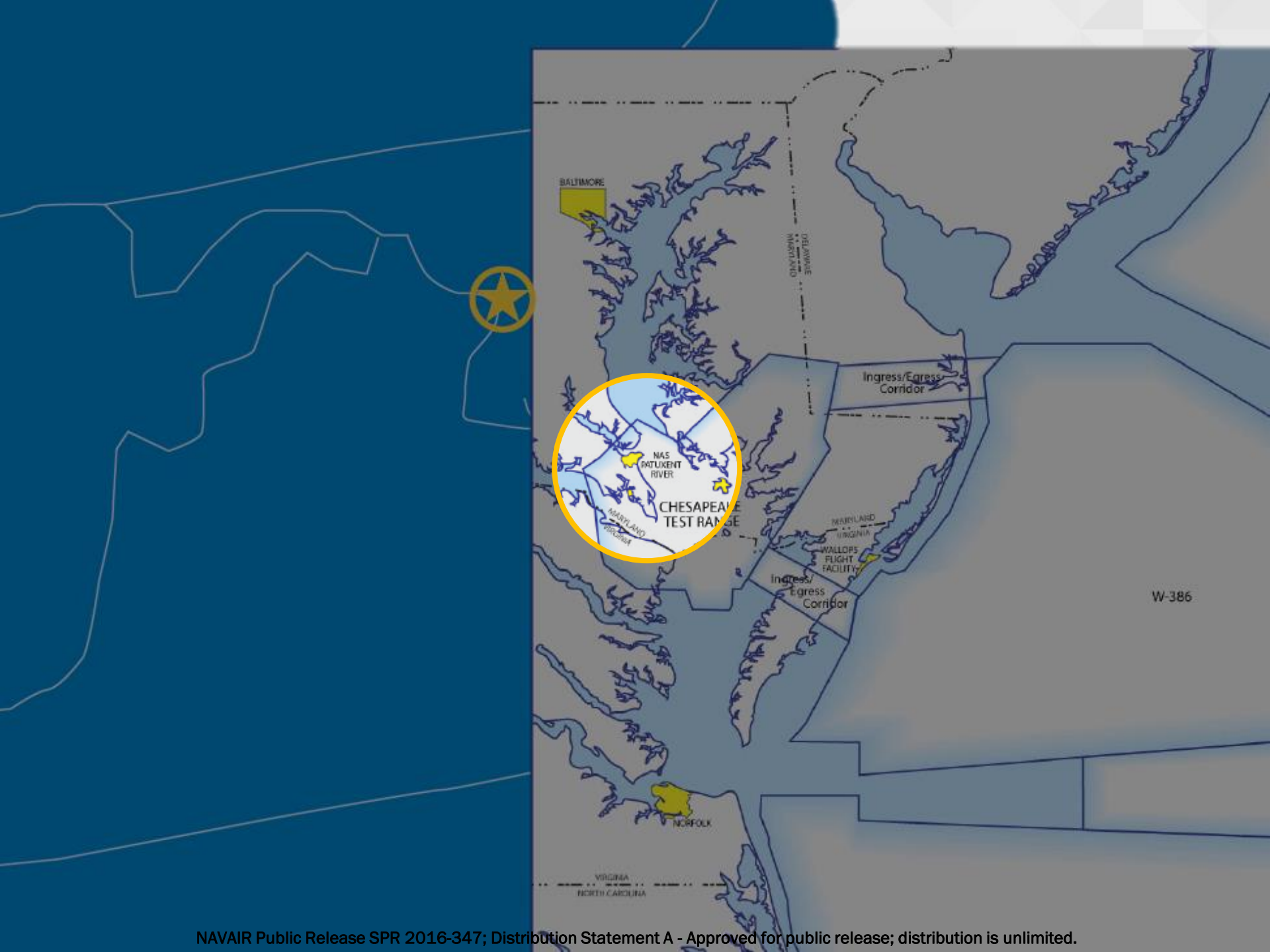
Rob Vargo  
Director, Atlantic Test Ranges  
Patuxent River, Maryland



LAKEHURST, NJ

PATUXENT RIVER, MD

ORLANDO, FL



BALTIMORE

NAS PATUXENT RIVER

CHESAPEAKE TEST RANGE

Ingress/Egress Corridor

MARYLAND

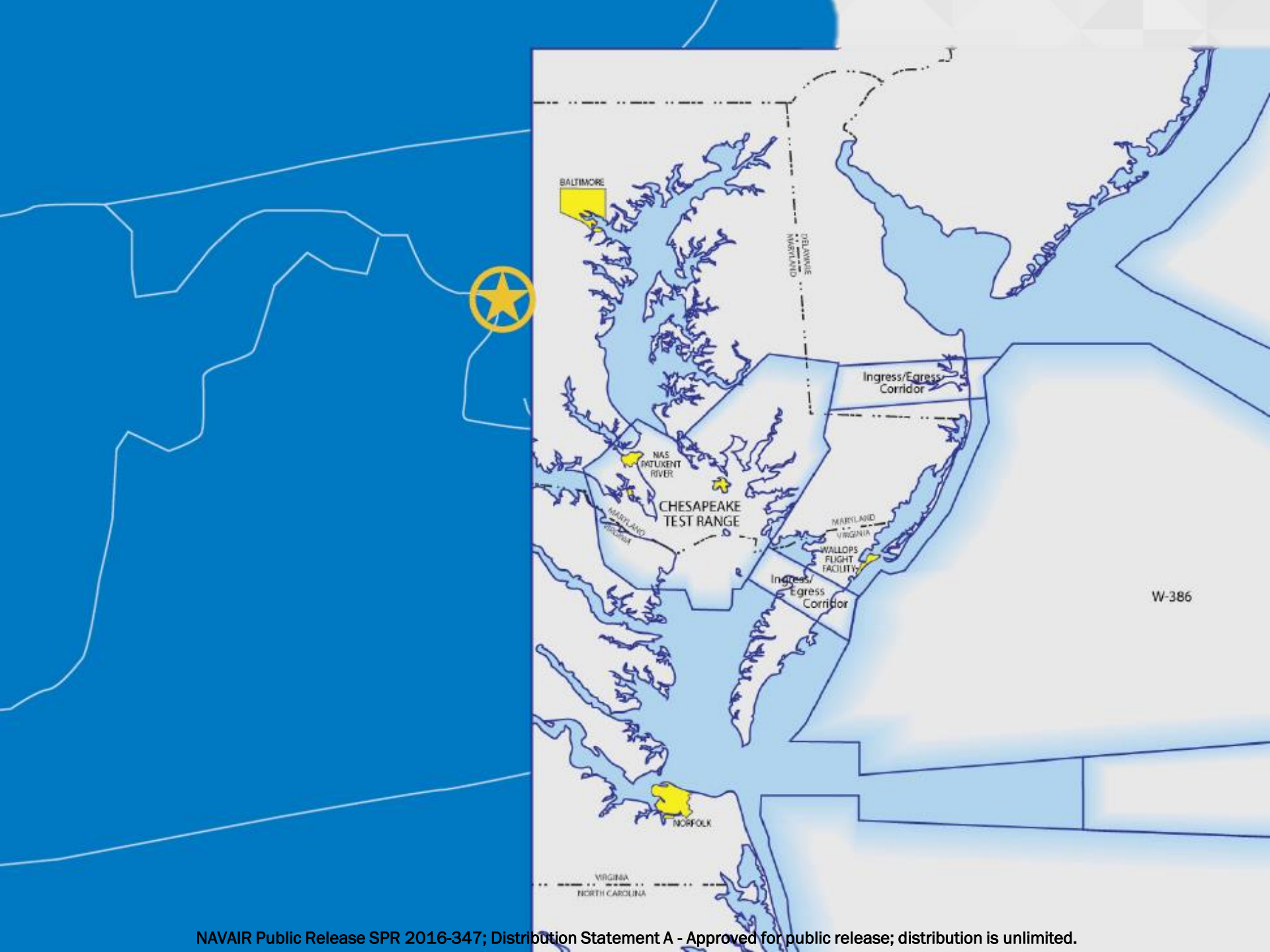
WALLOPS FLIGHT FACILITY

Ingress/Egress Corridor

NORFOLK

VIRGINIA  
NORTH CAROLINA

W-386



BALTIMORE

MARYLAND  
MARYLAND

Ingress/Egress  
Corridor

NAS  
PATUXENT  
RIVER

CHESAPEAKE  
TEST RANGE

MARYLAND  
VIRGINIA

WALLOPS  
FLIGHT  
FACILITY

Ingress/  
Egress  
Corridor

W-386

NORFOLK

VIRGINIA  
NORTH CAROLINA

# NAS Patuxent River

## *A Brief History*



**April 1, 1943**

NAS PAX Commissioned

**1945**

Naval Air  
Test Center  
established



**1958**

U.S. Navy Test Pilot  
School established

**1992**

Reorganized as the  
Naval Air Warfare Center Aircraft Division  
(implemented BRAC 1991 decision)

- Consolidated research and development facilities (Warminster PA & Trenton NJ) with existing test and evaluation mission
- Relocated Naval Air Systems Command HQ and acquisition offices from Northern Virginia (1997)

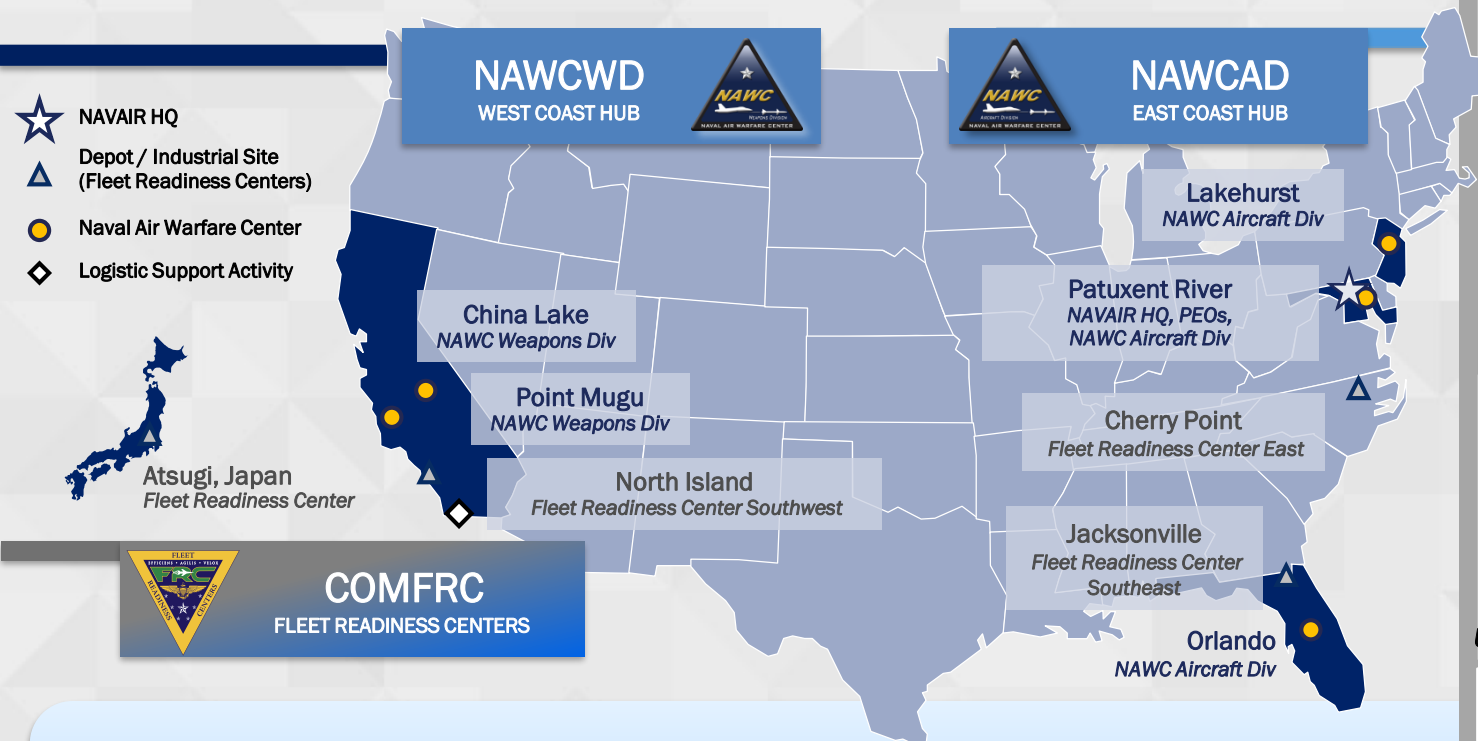
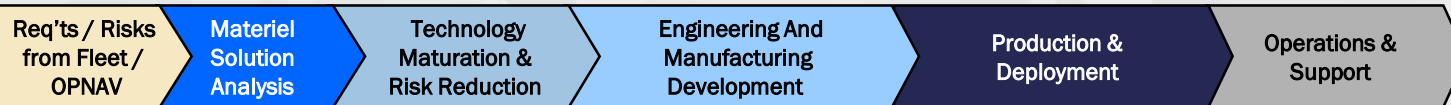
**2003**

Regionalization:  
Naval District Washington (NDW)  
Commander Navy Installations  
Command (CNIC)



# NAVAIR snapshot

## Full Life-cycle Management



**26,221**  
Civilians

**1,657**  
Military

**9,050\***  
Contractors

\* The CSS number reflects that of FY14, other numbers reflect FY15

## Products



Tactical Aircraft



Air ASW, Assault & Special Mission



Unmanned Aircraft & Strike Weapons



Common Systems / Mission Systems / Training / ALRE

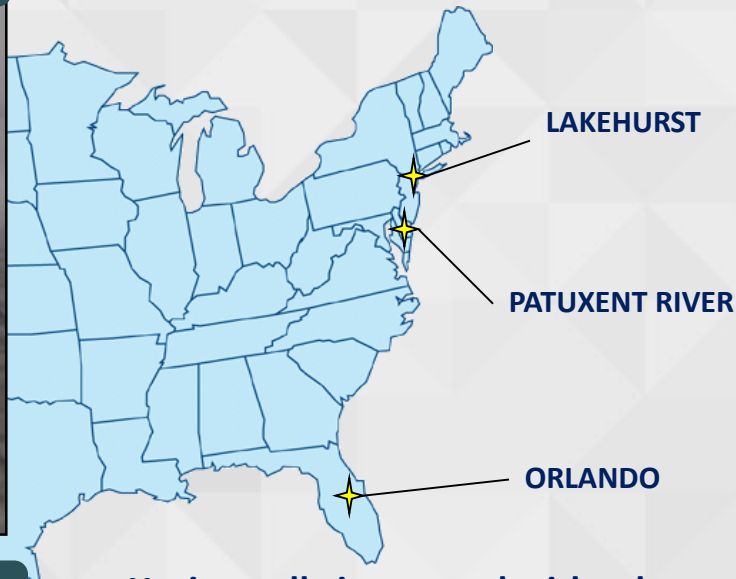
# Naval Air Warfare Center Aircraft Division

## AIRCRAFT SYSTEMS



- AIR VEHICLES
- PROPULSION & POWER
- AVIONICS & SENSORS
- CREW SYSTEMS
- SUPPORT SYSTEMS
- LAUNCH & RECOVERY

## Major Sites



- **Horizontally integrated with other Warfare Centers and National Labs**
- **Warfare Centers shaped by BRAC (Indianapolis, Trenton, Warminster closed & consolidated at Pax)**
- **The only combined Air/Ship/Shore C4I and Interoperability DT&E activity**

## Value Proposition

- **Mission...**the Navy's principal RDAT&E, engineering and fleet support activity for naval aircraft, engines, avionics, support systems and ship/shore/air integration.
- **Workforce:** 13,000 engineers, flight test engineers, scientists, RDATE professionals. Navy's intellectual capital works here.
- **National Ranges and Labs:** Integrated, unique, MRTFB invested, joint facilities, and not duplicated by industry.
- **Customer:** PEO/PMA, but strong history in Joint, Inter-Service, Inter-Agency, FMS and Industry collaborative.
- **Business Model:** Navy Working Capital Fund (NWCF) supply and demand model incentivizes cost consciousness.
- **Flag Officer** with Command responsibilities (NAWCAD) and Technical Authority (Air 4.0).

## TRAINING SYSTEMS



- HUMAN PERFORMANCE / SIMULATOR SYSTEMS

**NAWCAD Pax: The Busiest Test Center in the World**

# Unique RDT&E capabilities

Propulsion & Power



Surface Air Interoperability Lab



ACETEF



Atlantic Test Range  
(Dynamic RCS Testing)



North Engineering Center



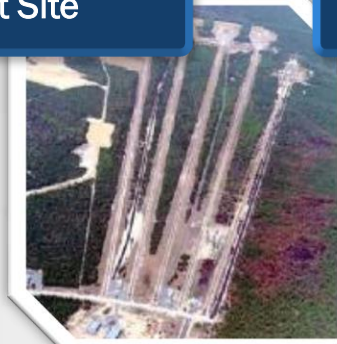
Electromagnetic Pulse Simulator



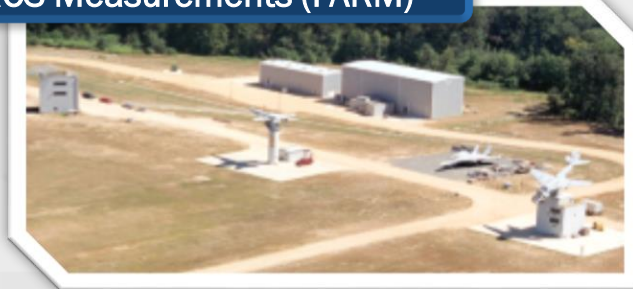
South Engineering Building



Jet Car Test Site



Facilities for Antennas & RCS Measurements (FARM)

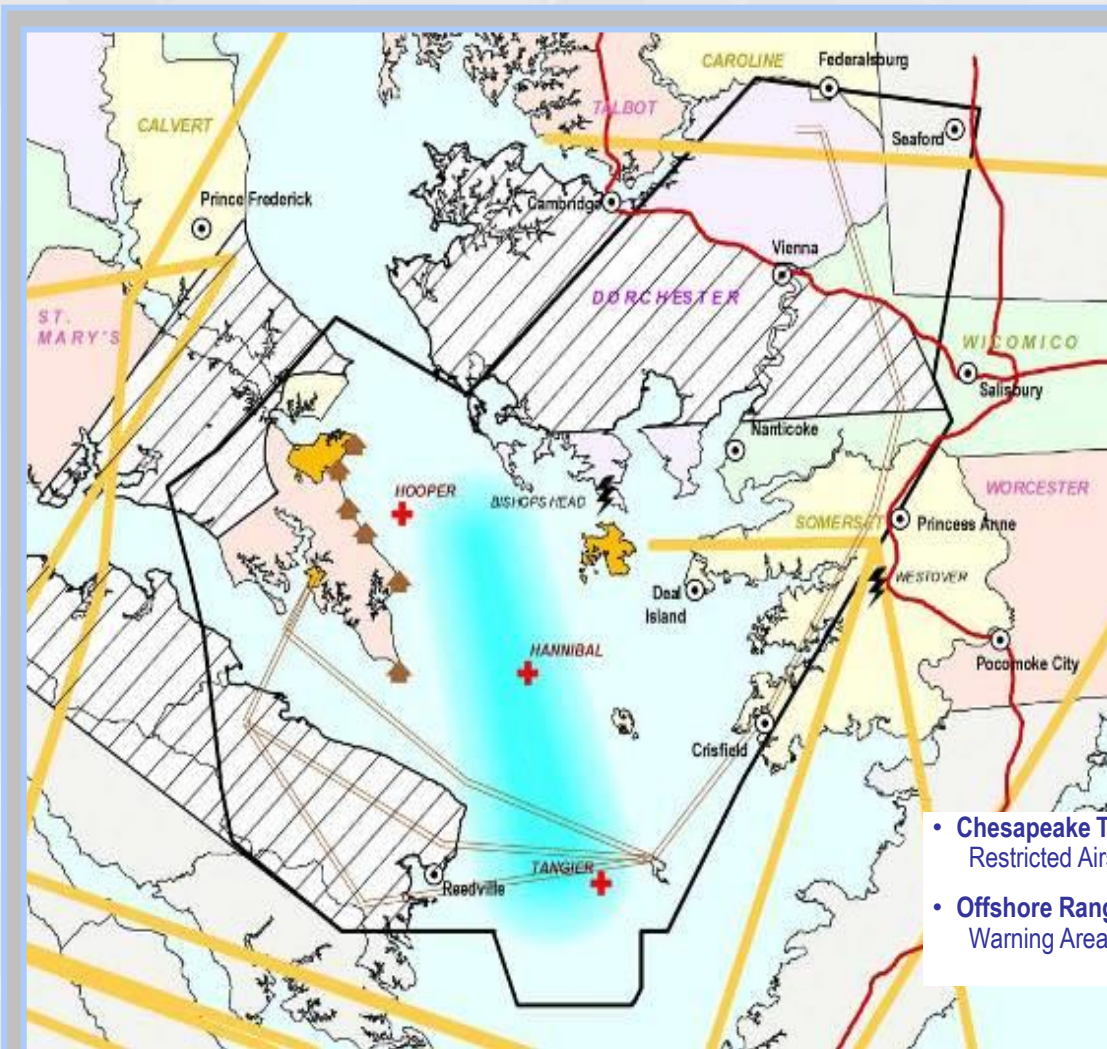




# Atlantic Test Range



# Patuxent River Complex



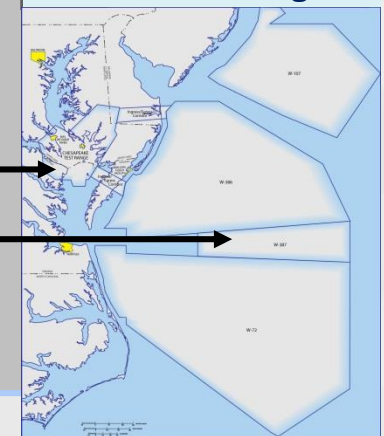
## NAS PAX River Assets

- Chesapeake Test Range
- Supersonic Corridor
- UAV Routes
- Helicopter Operating Areas
- Military Training Routes also used by
  - Andrews AFB
  - Dover AFB
  - Delaware ANG
  - DC ANG
  - Other military

## Expanded Air Space

- Chesapeake Test Range Restricted Airspace
- Offshore Ranges Warning Areas

## Atlantic Test Ranges



**HOW DO WE TEST?**

# Past flight testing



Envelope expansion at  
prime contractor site



Follow-on testing at  
MRTFB range

# Traditional test programs

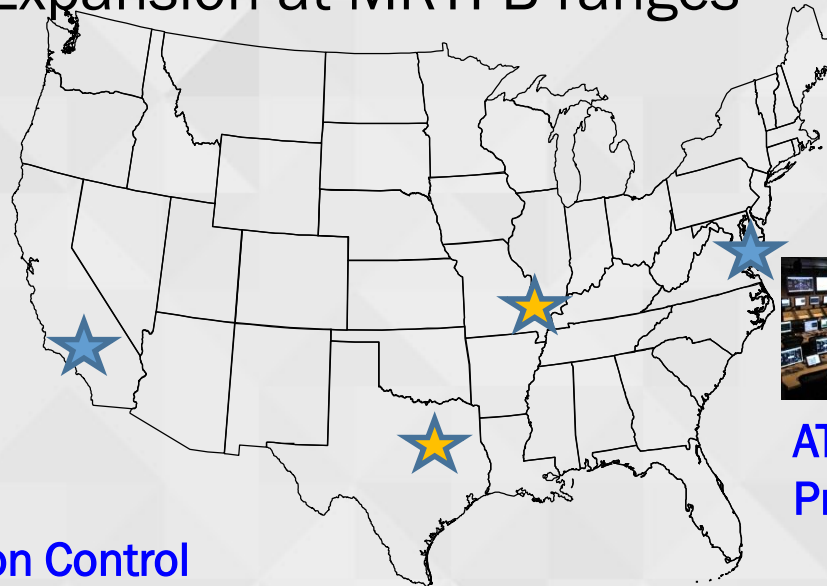
- Initial Airworthiness at Contractor site



- Envelope Expansion at MRTFB ranges



**EAFB: Ridley Mission Control**



**ATR: Real-Time Telemetry Processing Systems (RTPS)**

# Taking the range to the test

- Initial testing at contractor site, migration to MRTFB range
- MRTFB range supplies TM equipment and manpower



**MRTFB Range Equipment at Contractor Site**

# Taking the range to the test

## Mobile Real-Time Telemetry Processing Systems (RTPS)



**12 Person Dedicated Equipment**



**10-15 Person**

**Uses Portable equipment (Shell)**



**24 Person Dedicated Equipment**



**Short Bus -6 Person Uses Portable Equipment**

# Taking the range to the test

## Mobile Telemetry Acquisition Systems



Four 8' L&S Band  
Two 10' L,S&C Band



Two 6' Mobile Telemetry  
Acquisition Vehicles (MTAV)



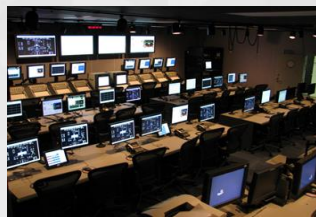
4 Portable Antennas for  
Shipboard use.



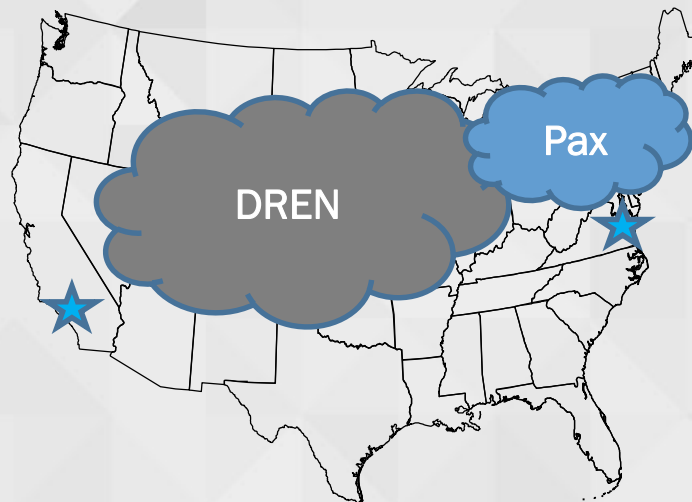
# Distributed testing

in a networked environment

- Testing is performed at contractor and MRTFB sites based on program requirements
- DREN connectivity for contractor and government sites to share data in both real-time and post flight.



Auxiliary  
Control Room



Primary Test Team

# Mission area focused RDT&E

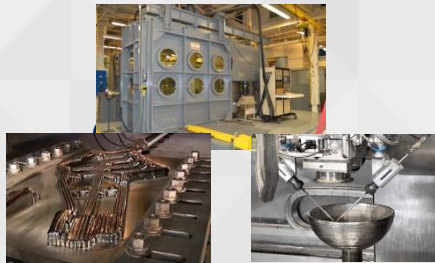
## Mission Areas

- Anti-Submarine Warfare (ASW)
- Anti-Surface Warfare (ASuW)
- Electromagnetic Warfare (EMW)
- Air Warfare (AW)
- Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR)

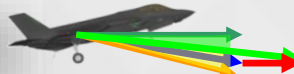
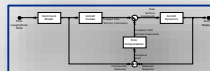


## Enabling Transformational Change through Innovation

- Advanced Control and Displays for Future Carrier Aircraft Approach and Recovery – (Magic Carpet +++)
- Airwing Manned/Unmanned Integration
- Additive Manufacturing/Advance Repairs
- Big Data Analytics/Digital Thread
- Precision Timing – Atom Interferometry



Dynamic Inversion CLAWs  
 • Flight Path Rate Command  
 • Flight Path Command  
 • Stick in center = Ref Flight Path



Optimized HUD Displays  
 • Ship-Referenced Symbology  
 • Glideslope / Lineup Cues  
 • Tailored by Control Mode

# Integrated Capabilities to Support Program Requirements



System Integration Labs



S&T Facility



Simulation Facility



Installed System Test Facility

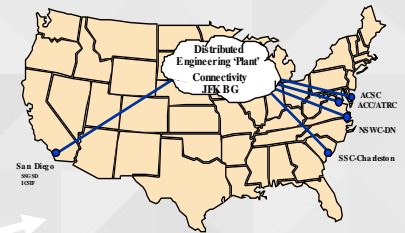


Open Air Range

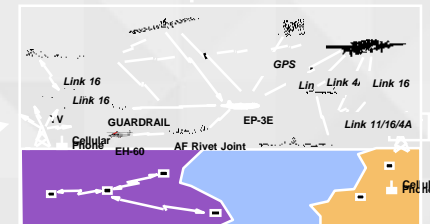


Hardware-in-the-loop

Common Simulation & Stimulation Environment



Participant in DEP



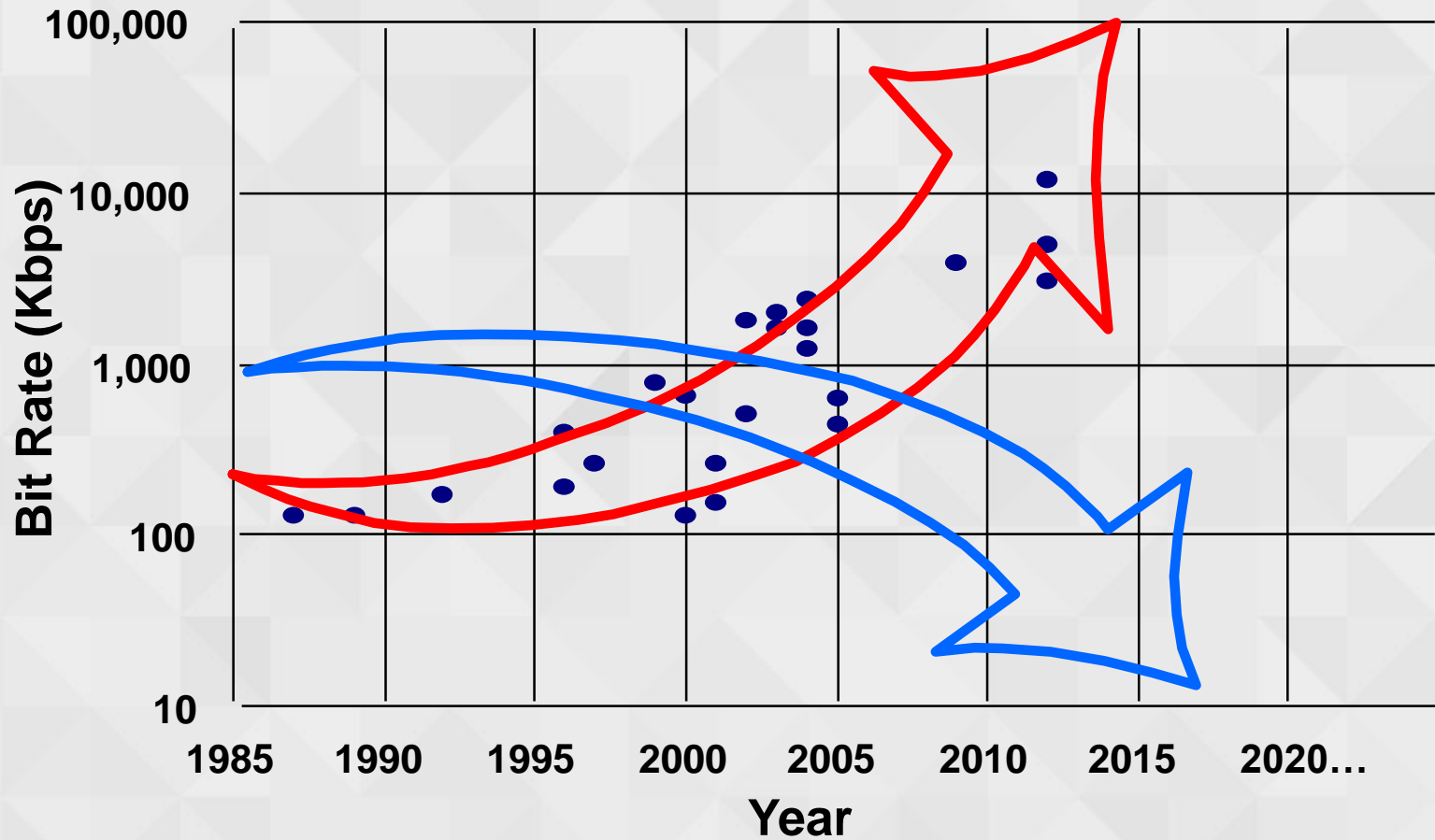
Joint Service and Fleet Battle Experiments

**To support Research and Development, Acquisition, Test and Evaluation and Training for NCW capabilities such as:**

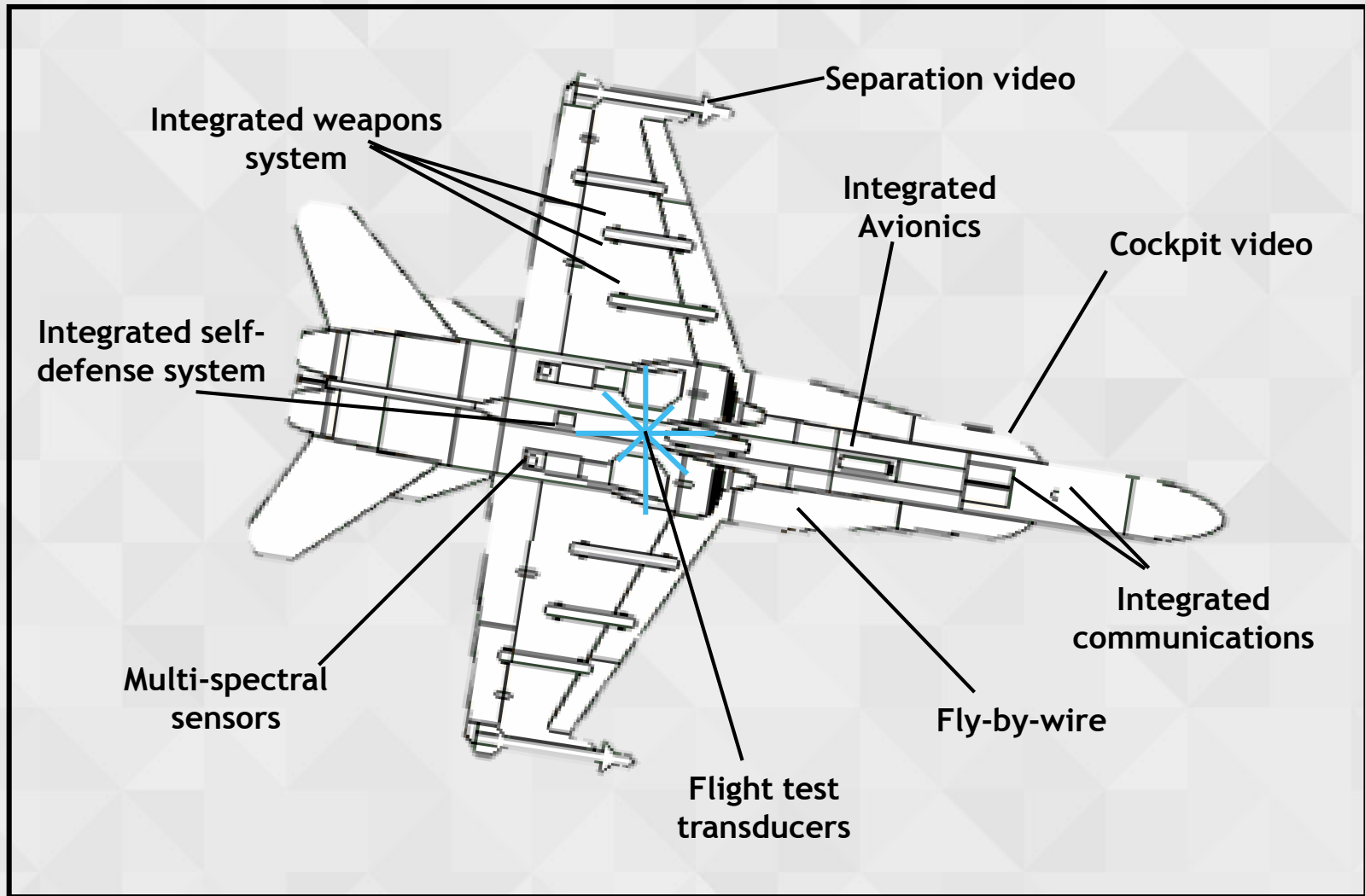
- C4ISR
- Combat Identification
- Third Party Targeting
- SoS Integration

**SPECTRUM**

# Spectrum congestion driven by DEMAND



# How telemetry is used

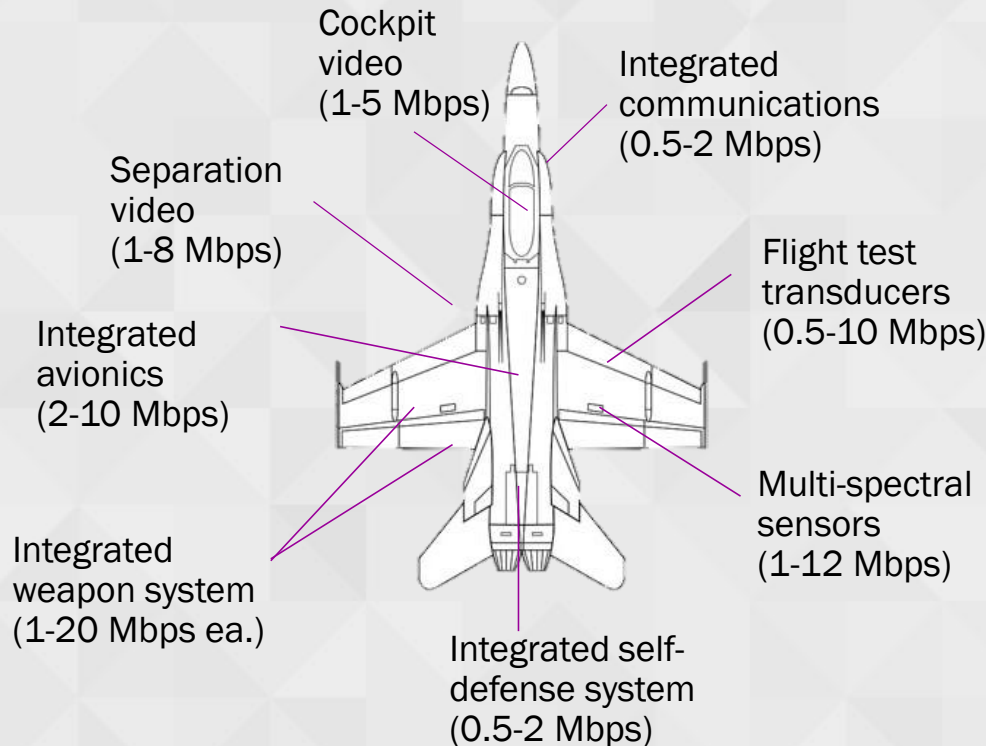


Source: *Telemetry Band Augmentation: A Critical Need for Flight Test*, presented to SETE 2005 (T. Chalfant)

NAVAIR Public Release SPR 2016-347; Distribution Statement A - Approved for public release; distribution is unlimited.

# What drives demand for spectrum in test?

## Increased System Complexity



## • Larger Footprints

- 4-on-4 test flights (more systems per test)
- Much faster weapons systems
- Geographic separation not as effective as it used to be

## • Demand for Shorter Acquisition Cycles

- More concurrent testing
- More real-time analysis

## • Increased System-of-Systems Test Complexity

- “Five Futures”  
(EW, UAV, NCO/W, DE, Hypersonics)
- Integrated fleet
- Future Combat Systems
- “Swarming” UAVs

**HOW IS IT CHANGING?**







# The RF spectrum – in general

The Government is allocated exclusive use of a very small portion of the spectrum. The remainder is controlled either by the Federal Communications Commission FCC (representing private sector use) or mutually between the FCC and National Telecommunication and Information Agency (NTIA) (Federal government)

Of the 0 – 30 GHz allocated.....“beachfront property”



- **Government**/Federal has exclusive use of 7%
- **Non-Government**/Federal has 30%
- And the remainder, 63% is shared

Of the 0 – 300 GHz allocated...



- **Government**/Federal has exclusive use of 1.4%
- **Non-Government**/Federal has exclusive use of 5.5%
- And the remainder, 93.1% is shared

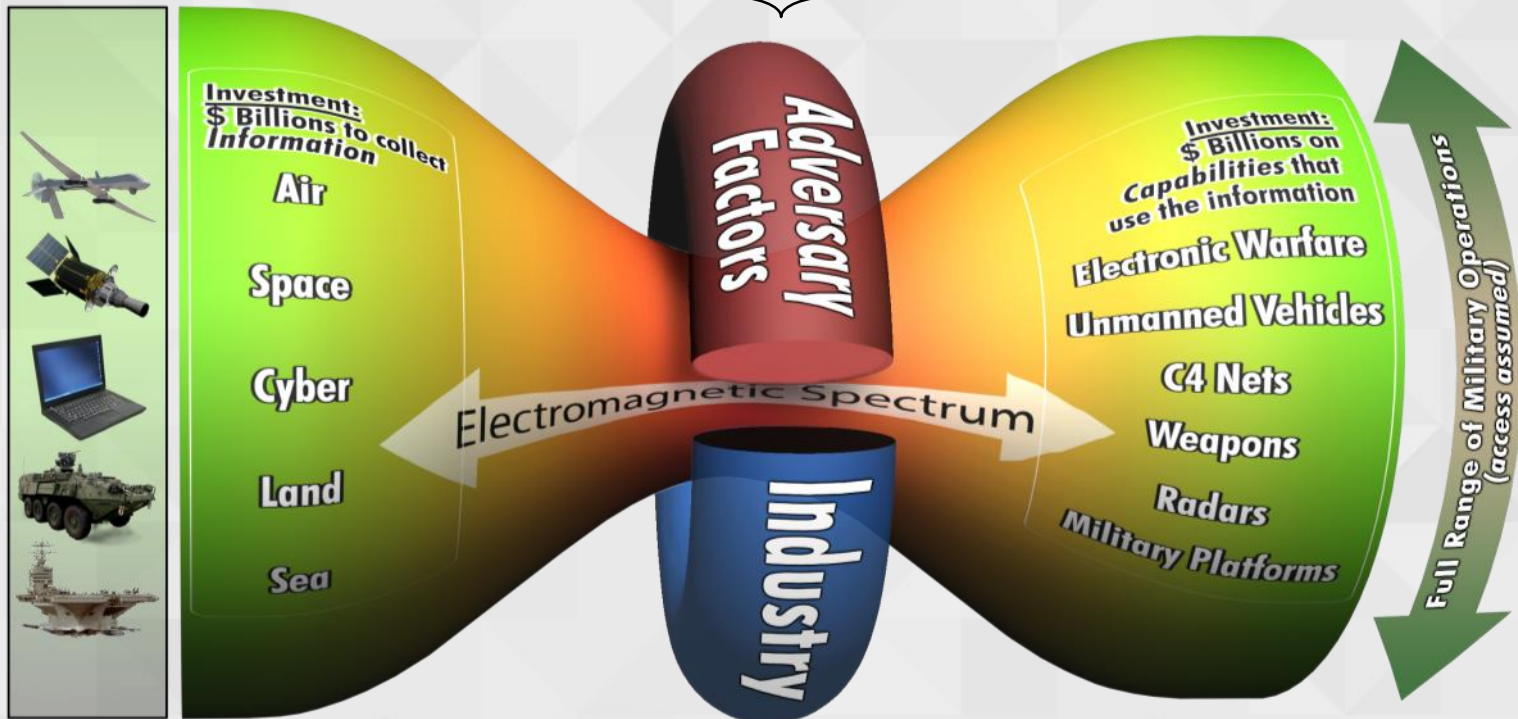


Lots of spectrum above 30 GHz that requires innovation

**SO WHAT IS THE PROBLEM  
AND WHAT DO WE DO?**

# Why this matters: DoD operational implications

- Directed Energy (EMP, HPM, laser)
- Digital RF Memory
- Weaponized COTS
- GPS jammers
- MMW
- Proliferation
- Advanced C2 nets



- Broadband technologies
- IEEE Standards
- Speed/Throughput/ Streaming Content
- Economic Growth
- Jobs Creation

**The foundation upon which DoD builds weapons systems is changing; DoD efforts to recognize and to build to a new foundation are critical to national security**

# Game-changing technologies

## Adaptive EW



## Autonomy



## Hypersonics



## Cyber Security



# Dynamic, Flexible, Cognitive, Mutable Ops

## CHALLENGE TO INDUSTRY

Dynamic, Flexible, Cognitive systems that select operating frequencies allowed by policy & locally free from use  
When the environment changes, system adapts frequencies to avoid interference across with all users

### UNITED STATES FREQUENCY ALLOCATIONS THE RADIO SPECTRUM

**RADIO SERVICES COLOR LEGEND**

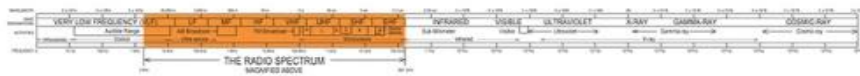
AERIAL TELEVISION	FIXED	INDUSTRIAL, SCIENTIFIC, AND MEDICAL (ISM)
AERIAL MOBILE (SATELLITE)	INDUSTRIAL MOBILE	NAVIGATIONAL MOBILE (SATELLITE)
AERIAL NAVIGATION	LAND MOBILE (SATELLITE)	NAVIGATION (SATELLITE)
AIRTEL	MARITIME MOBILE	NAVIGATION SATELLITE
AIRTEL SATELLITE	MARITIME MOBILE (SATELLITE)	NAVIGATION SATELLITE
FIXED	MARITIME MOBILE (SATELLITE)	NAVIGATION SATELLITE
FIXED SATELLITE	MARITIME MOBILE (SATELLITE)	NAVIGATION SATELLITE
FIXED MOBILE	MARITIME MOBILE (SATELLITE)	NAVIGATION SATELLITE
FIXED MOBILE SATELLITE	MARITIME MOBILE (SATELLITE)	NAVIGATION SATELLITE
FIXED MOBILE SATELLITE	MARITIME MOBILE (SATELLITE)	NAVIGATION SATELLITE
FIXED MOBILE SATELLITE	MARITIME MOBILE (SATELLITE)	NAVIGATION SATELLITE
FIXED MOBILE SATELLITE	MARITIME MOBILE (SATELLITE)	NAVIGATION SATELLITE

**ACTIVITY CODE**

GOVERNMENT EXCLUSIVE	GOVERNMENT NON-GOVERNMENT SHARED
NON-GOVERNMENT EXCLUSIVE	

**ALLOCATION USAGE DESIGNATION**

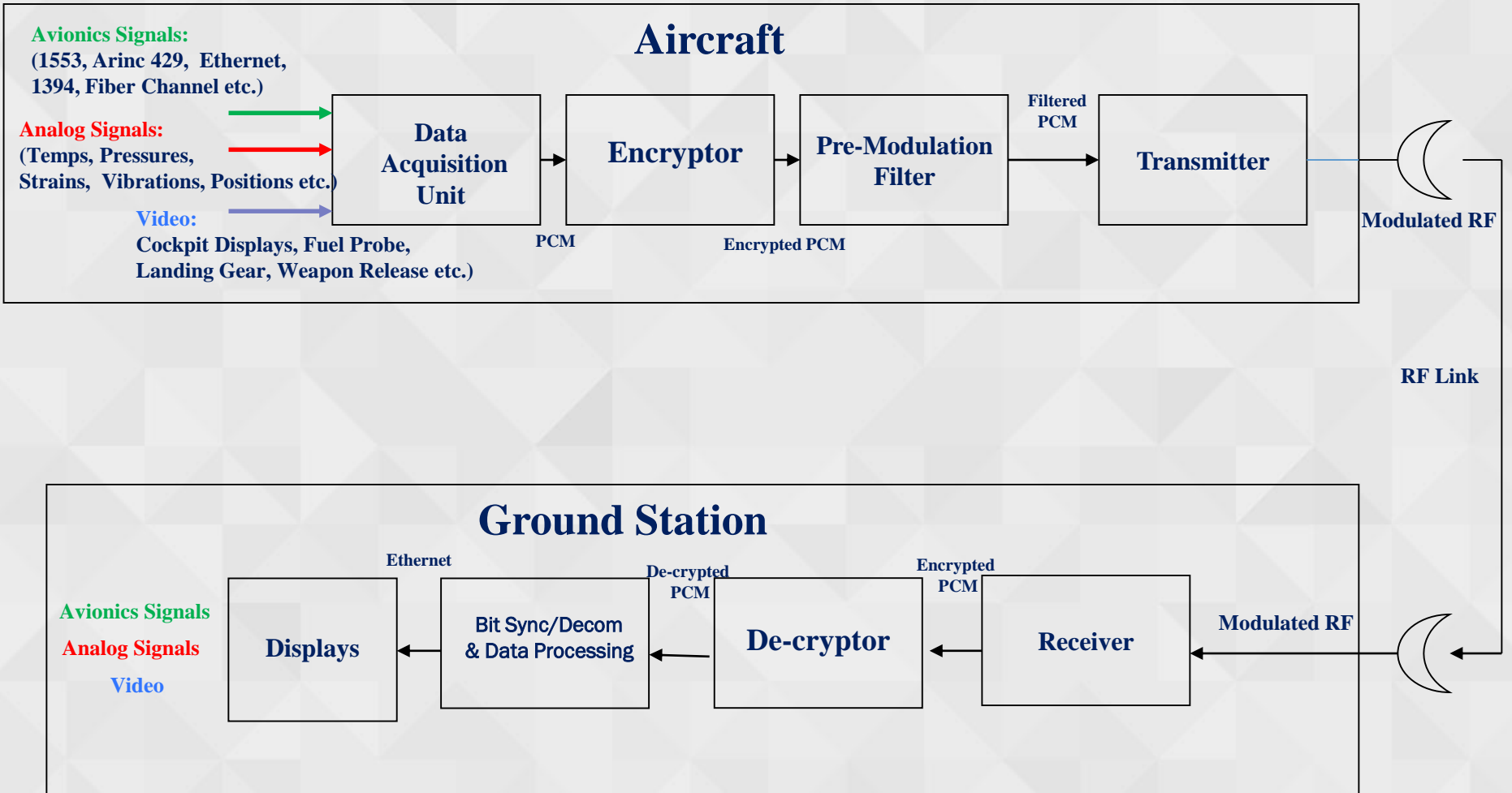
SERVICE	EXAMPLE	DESCRIPTION
Primary	Radio	Exclusive
Secondary	Mobile	For Captain and Senior Crew Members



# AIRCRAFT INSTRUMENTATION



# Typical TM System



# Aircraft to ground station telemetry

Telemetry (TM) is the remote monitoring of sensors. The data received provides a near real-time picture of what is occurring on the aircraft.



Aircraft left planning link spring displacement sensor on the main landing gear.

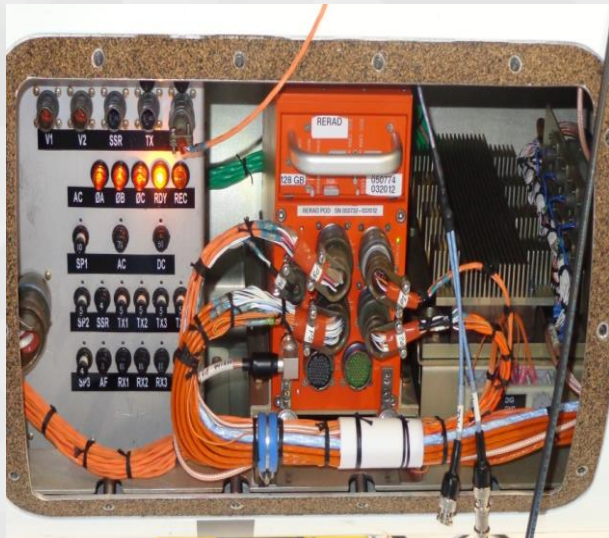


Ground station display of displacement as -1.208 in.

# TM receive/record & re-radiation pod



- Pod Capable of Receiving/Recording & Re-Transmitting (4) PCM Streams
- Capable of L,S,& C Band Operations
- Re-Purpose production cockpit controls (No Aircraft Modifications)



# Transmitter Impact (Current/Future)

## Current State

L Band



S Band



C Band



L/S Band



S/C Band



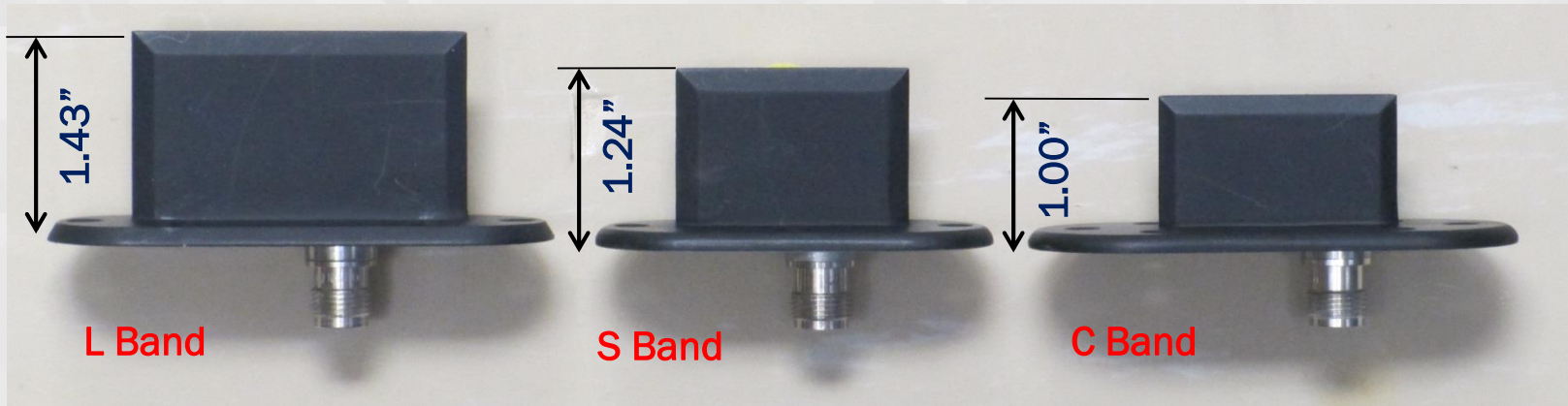
## Future State



L/S/C Band

# Antenna Impact (Current/Future)

## Current State



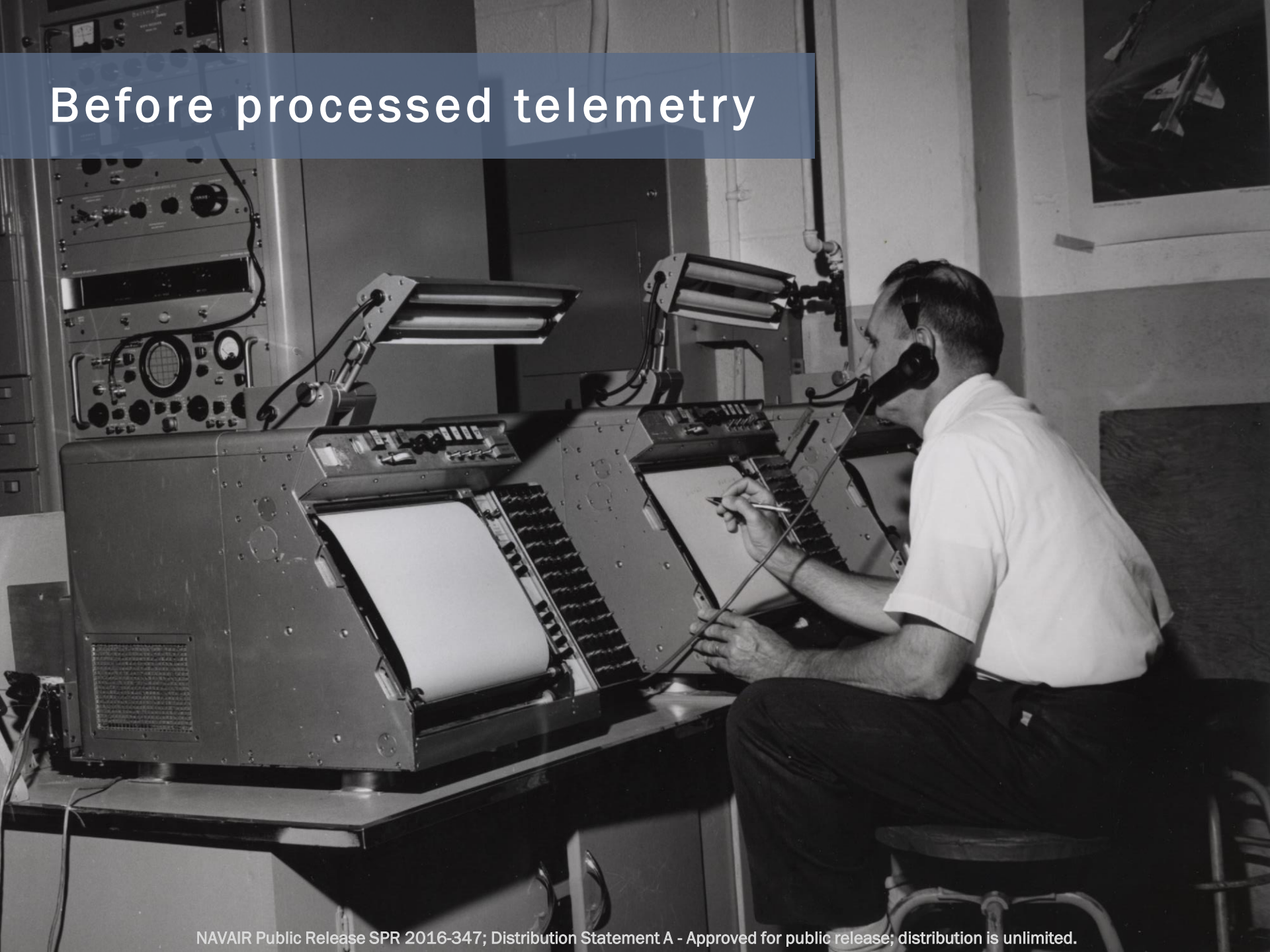
Multiband  
(L/S/C)

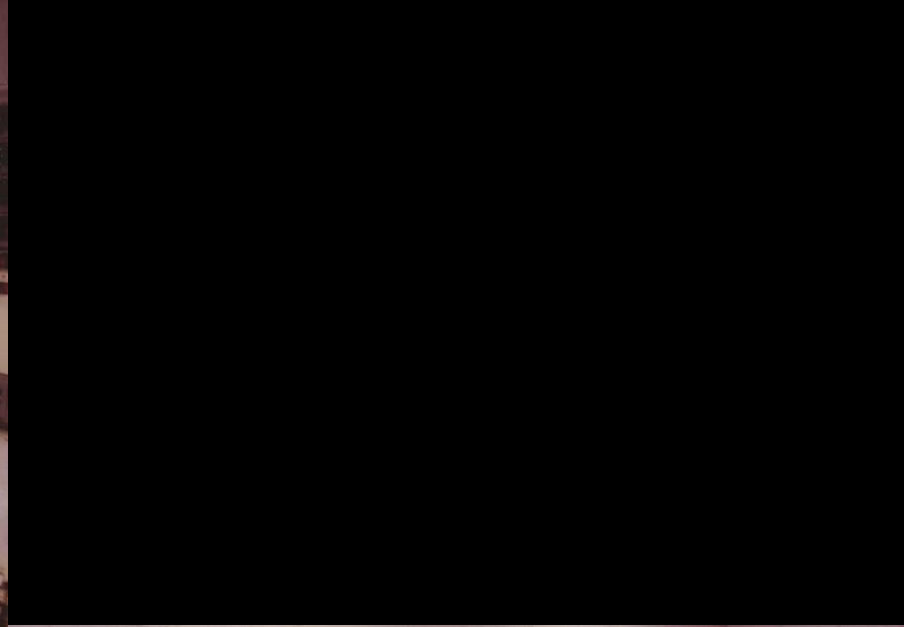


## Future State

# RANGE SYSTEMS

Before processed telemetry





**RTPS I & II (1973-1988)**  
2 rooms



# RTPS III (1987-2004)

8 rooms



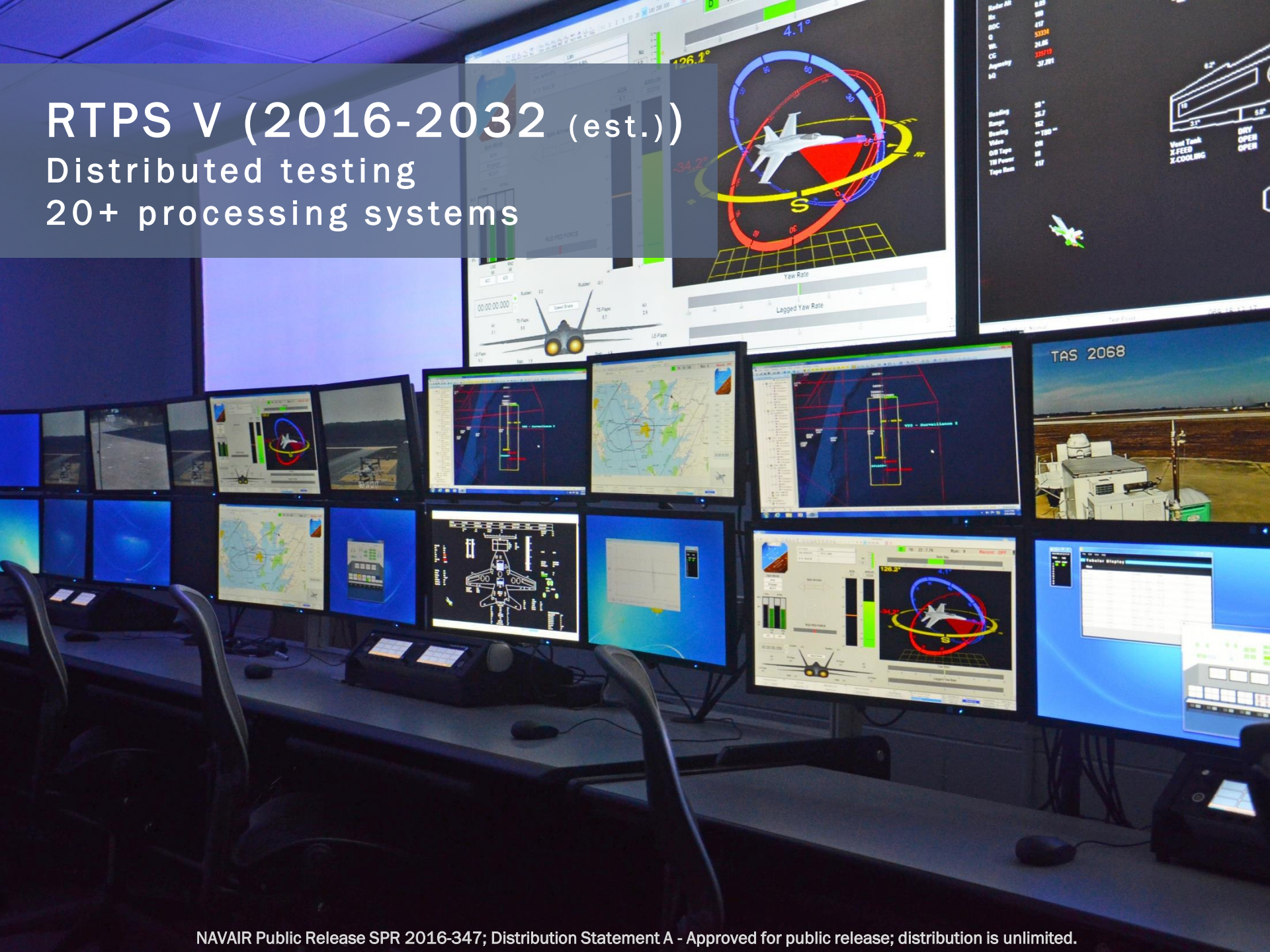


16:00:45

**RTPS IV (2002-2018 (est.))**  
10 rooms, 6 remote systems

# RTPS V (2016-2032 (est.))

Distributed testing  
20+ processing systems



# Distributed flight testing

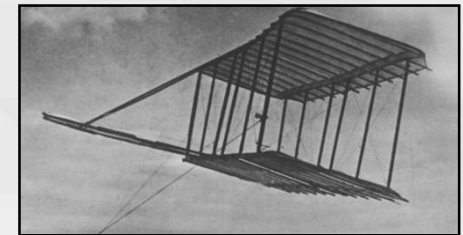
## Future UAS Testing – Multiple Sites Monitoring in Real-time



Software Integration Lab  
at Government Site



Software Integration Lab  
at Contractor Site



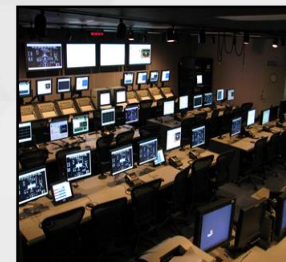
Auxiliary Test Team  
at Contractor Site



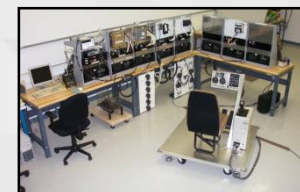
Hardware-in-the-Loop  
Contractor Site



UAS Control  
Station(s)



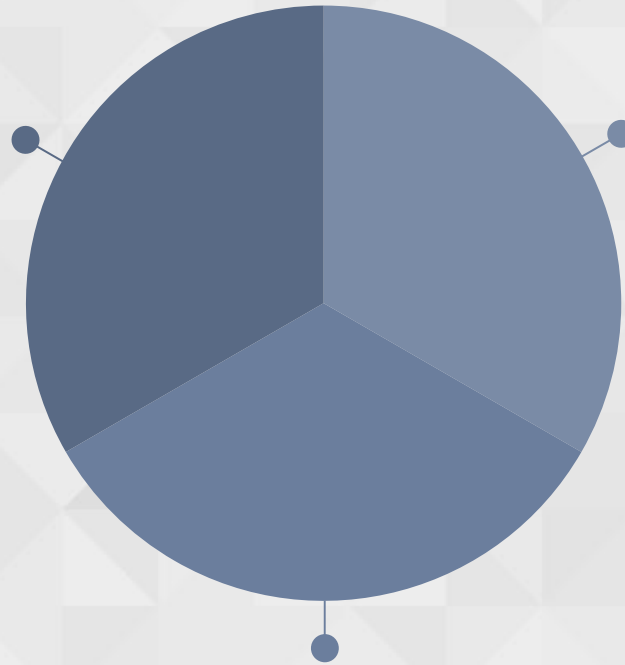
Primary Test  
Team at MRTFB  
Site



Hardware-in-the-Loop  
Government Site

# AREAS NEEDING INNOVATION

Sharing spectrum  
technologies



Aviation TM at  
higher frequencies

Onboard sensor,  
data processing,  
LVC technologies

AND FINALLY,

WHY WE DO WHAT WE DO,

AND

WHY IT IS THE  
GREATEST PLACE TO WORK

# X-47B first carrier-based arrested landing



**THANK YOU**

**QUESTIONS?**