412th Test Wing

War-Winning Capabilities … On Time, On Cost

Challenges and Opportunities for Testing of Autonomous Systems

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Chief, Performance & Flying Qualities

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Integrity - Service - Excellence

Agenda

- **412 TW/Edwards Overview**
- **T&E at 412 TW**
- **Ranges & Capabilities**
- **Current Autonomy Projects**
- **Future Autonomy Projects**
- **Autonomy Test Challenges**

Our Mission and Our Vision

Conduct Developmental Test and Evaluation of air, space, & cyber systems to provide timely, objective, and accurate information to decision makers

Tester of Choice…Today and Tomorrow

412 Test Wing Mission

- 412 Test Wing (part of Air Force Test Center)

  ❑ Plans, conducts, analyzes and reports on all flight and ground testing of aircraft, weapons systems, software and components as well as modeling and simulation for the US Air Force

  ❑ Core components: flying operations, maintenance and test engineering

  ❑ Test and evaluation mission areas

    o Airframe, propulsion, avionics (APA) in Test Engineering Group

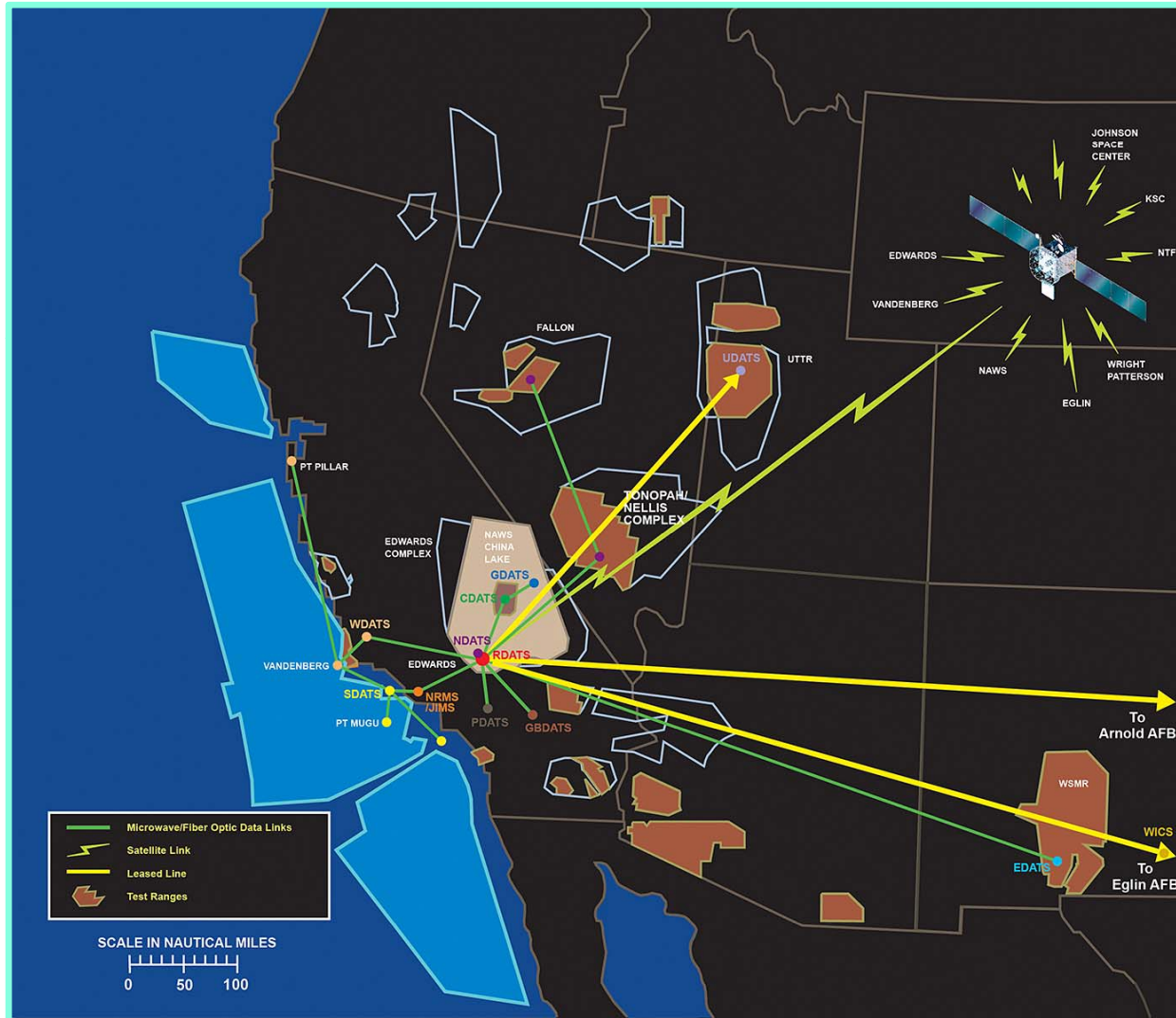   o Electronic warfare (EW) in the Electronic Warfare Group

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# BIG Mission… BIG Base!
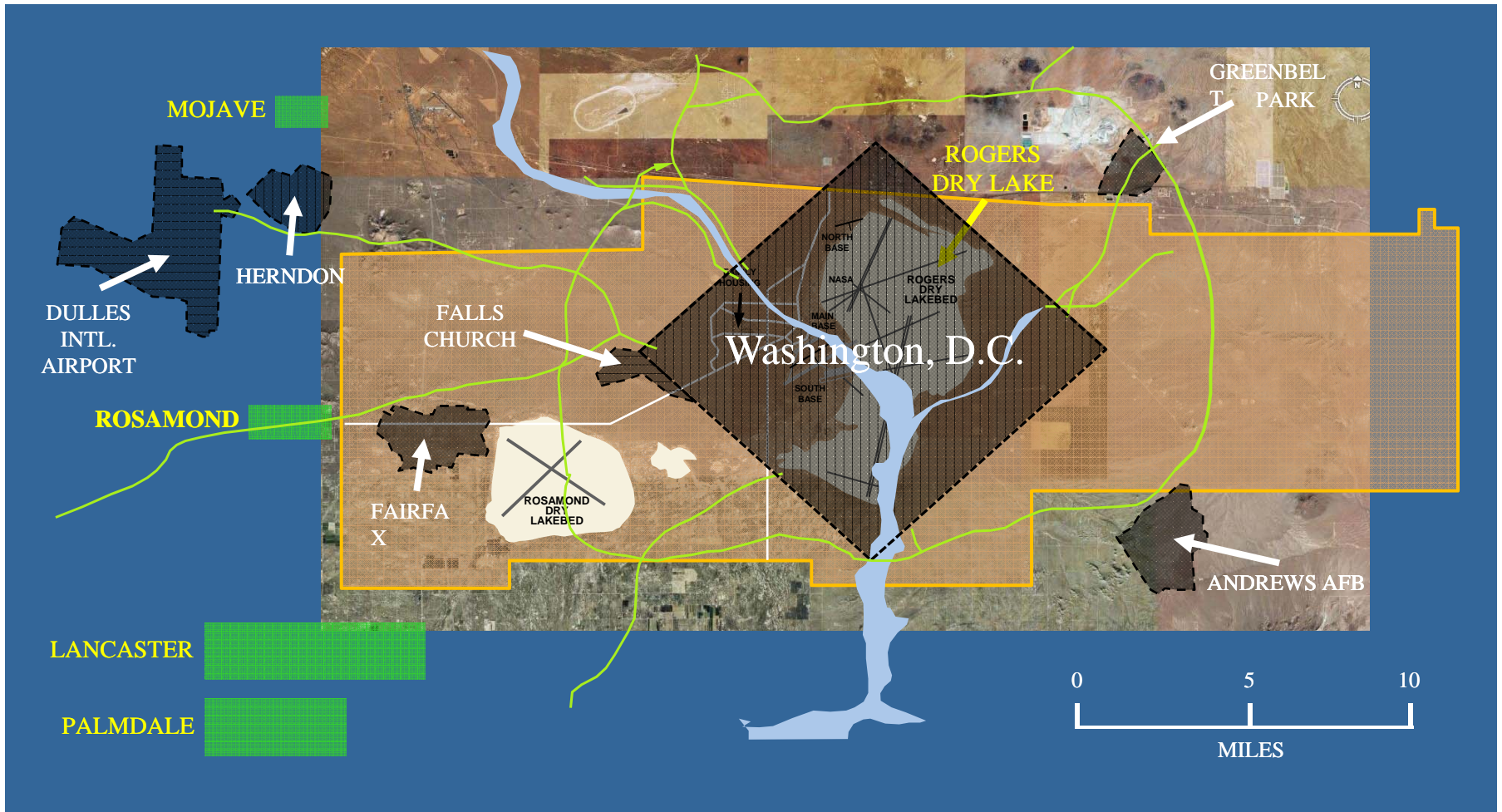
Test Range Network

Range Capabilities

- **Operate and Sustain Real-Time Systems**
  - ❑ **Mission Control Rooms**
  - ❑ **Data Acquisition and Transport Systems**
  - ❑ **Telemetry (TM) Systems**
  - ❑ **Encryption/Decryption Systems**
  - ❑ **Data Decom Systems**
  - ❑ **Air to Ground Communication Systems**
  - ❑ **Mobile Systems**

- **Sustain Range Instrumentation**
  - ❑ **PIRA targets and vehicles**
  - ❑ **TSPI Pods and Sensors**

- **Develop and Enhance Range Systems**
  - ❑ **Based on defined requirements perform software and hardware developments**

Mission Control Room

DoD Test Range Network

Mobile Systems


Telemetry Systems


TSPI ASSETS
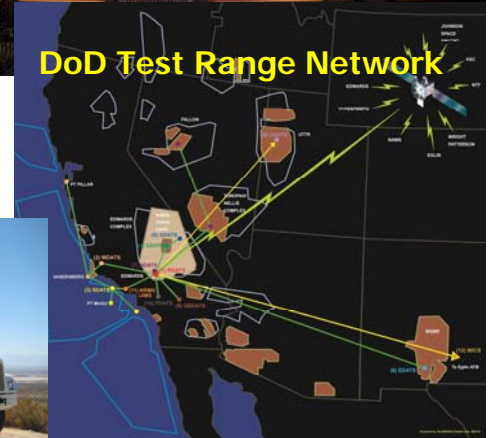
Instrumentation Capabilities

- **Operate and Sustain Instrumentation Systems**
  - ❑ **Perform pre and post flight checks and provide troubleshooting of instrumentation systems**
  - ❑ **Repair and replace data recorders, data acquisition systems, and sensors**
  - ❑ **Design instrumentation systems and components**

- **Development Engineering Requirements**
  - ❑ **Develop data validation tools**
  - ❑ **Support the development of Range Commander's Council standards**

Instrumentation Systems
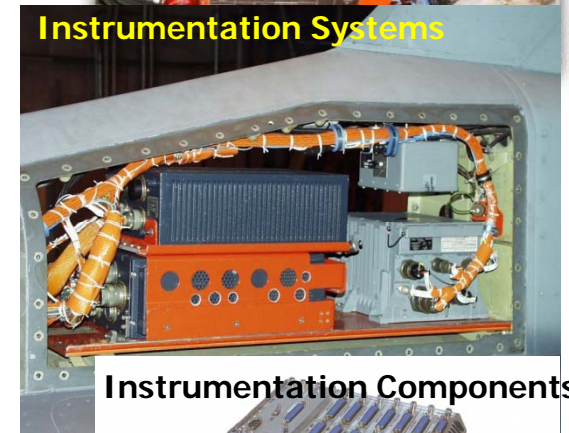
Instrumentation Components

IRIG Standards

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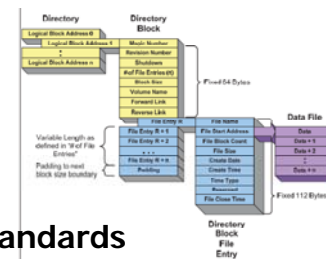
Test Engineering Capabilities

- **Test Discipline Support**
  - ❑ **Provide planning, conduct, analysis and evaluation support in the APA test engineering discipline**
  - ❑ **Provide data technician support and analysis in the areas of deficiency reporting for reliability and maintainability (R&M) testing**
  - ❑ **Provide Weapons munitions accounting and planning for weapons integration test activities**

- **Reporting Support**
  - ❑ **Provide technical editing support to ensure that the reports are readable, comply with appropriate policies, and meet timeliness requirements**

- **Data production**
  - ❑ **Develop, operate, and sustain data analysis and production capabilities for the CTFs**

Electronic Warfare Test Capabilities

- **Benefield Anechoic Facility (BAF)**
  - ❑ Plan, configure, and operate the BAF chamber systems and test environment
  - ❑ Operate and sustain the key BAF sub-systems to include simulators, stimulators, radar absorbing material | (RAM), and other test equipment

- **Integrated Facility for Avionics Systems Test (IFAST)**
  - ❑ Plan, configure and operate the hardware and software systems for a variety of hardware in the loop test facilities

- **Modeling and Simulation (M&S)**
  - ❑ Develop, operate and sustain hardware and software systems for manned cockpit simulators
  - ❑ Operate and maintain the computing resources needed for M&S capabilities

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Current Autonomy Projects

- **Currently no developmental testing Programs of Record**
- **Majority of work happening at lower TRL levels**
  - **AFRL**
  - **DARPA**
  - **Academia**
  - **sUAS**
- **Numerous projects ongoing that begin to touch at autonomous principles and systems**

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Projects "Touching" Autonomy

- AGCAS/ACAS/ICAS
- Sensor Data Fusion
- Hypersonic projects
- NASA-Armstrong Alliance
  - Autonomy Architecture Efforts
  - Collision Avoidance
  - sUAS test ranges
- Test Pilot School
  - Loyal Wingman
  - Vista F-16
  - Test Management Projects for AFRL & others

Future/Anticipated Projects

- **Currently no Programs of Record for Autonomous Systems**

- **Anticipate initial projects will be upgraded capabilities to existing subsystems within existing aircraft**

- **sUAS will likely be entrypoint for future programs of record for initial fully autonomous aircraft**

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What are We Doing to Prepare

- **TRMC UAST & OSD ATEVV Working Groups**
- **TRMC/GTRI Autonomy Range Study**
- **AFRL Autonomy Projects**
- **Johns Hopkins University Applied Research Lab**
  - TACE
  - Autonomy Development
- **412 TENG UAST Working Group**
- **NASA-Armstrong Alliance**
- **Ground Based Sense and Avoid System**
- **sUAS Test areas within Edwards Complex**
- **Efforts to get involved in upcoming programs**
  - We want to help and learn now!

Concerns for Testing Autonomy

- **What Does Autonomy Look Like?**
- **How do we test it Safely and Effectively?**
- **Airspace Deconfliction and Safety**
- **Range Resources Required**
- **Personnel Skills and Abilities Required**
- **How Much is Enough Testing**
- **How do we analyze autonomous systems**
- **How do we design systems for test**
- **AUTONOMY WILL BE DIFFERENT**
  - **We can't wait until it shows up to figure out testing**

Testing of Autonomy Thoughts

- **Run Time Assurance**
  - NASA EVAA designs
- **Licensure**
- **Safe & Effective Ranges**
  - TACE & Live Virtual Construct
  - Common Architectures
  - Design for Test
- **Paradigm Shift in how Testers think**
  - Lack of Repeatability
  - Can never be done – What is enough?
- **Continuum of Test**
- **Types of testers required**

QUESTIONS?

412TW