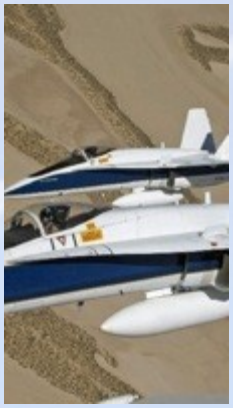
National Aeronautics and Space Administration








Armstrong Flight Research Center

Wireless Development Plans and Needs

PWST Workshop 2019

Presenter: Richard Hang

October 16th, 2019

Ottawa, Canada

Agenda

- **Purpose:** Bring Wireless Technologies to Armstrong
- **Introduction:** Armstrong Flight Research Center (AFRC)
- **Let us help you**: Many flight test platforms to test your systems on
- **Help us**: Reduce challenges and increase capabilities for flight test
- **Conclusion:**

Purpose of this Presentation

- Bring wireless sensing technologies to Armstrong Flight Research Center (AFRC) for flight instrumentation applications.
- Share AFRC's wireless sensing concepts in addressing some of the issues associated with the conventional instrumentation methodology for flight test.
- Share AFRC's wireless development approaches as well as technical challenges in wireless technologies for flight instrumentation that we need to overcome.
- Seek collaboration/partnership opportunities with the wireless communities in developing of wireless systems for flight test applications.

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Armstrong Flight Research Center

Edwards AFB, California, main campus:

- Year-round flying weather
- 301,000 acres remote area
- Varied topography
- 350 testable days per year
- Extensive range airspace
- 29,000 feet of concrete runways
- 68 miles of lakebed runways
- Supersonic corridor
- U.S. Air Force Alliance

Armstrong Mission

To advance technology and science through flight

1. Perform flight research and technology integration to revolutionize aviation and pioneer aerospace technology
2. Validate space exploration concepts
3. Conduct airborne remote sensing and science observations

Ikhana MQ-9 Predator B Unmanned Aircraft System

Stratospheric Observatory for Infrared Astronomy (SOFIA)

X-56 Multi-Utility Technology Testbed

Armstrong Vision

To separate the real from the imagined through flight

Space Shuttle Approach and Landing Tests

Lunar Landing Research Vehicle

Hypersonic test

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AFRC – Current Testbed/Platform Aircraft

King Air
B200

Global Hawk

SOFIA
747SP

Airborne
Science
DC-8

Mentor
T-34

Dragon Lady
ER-2

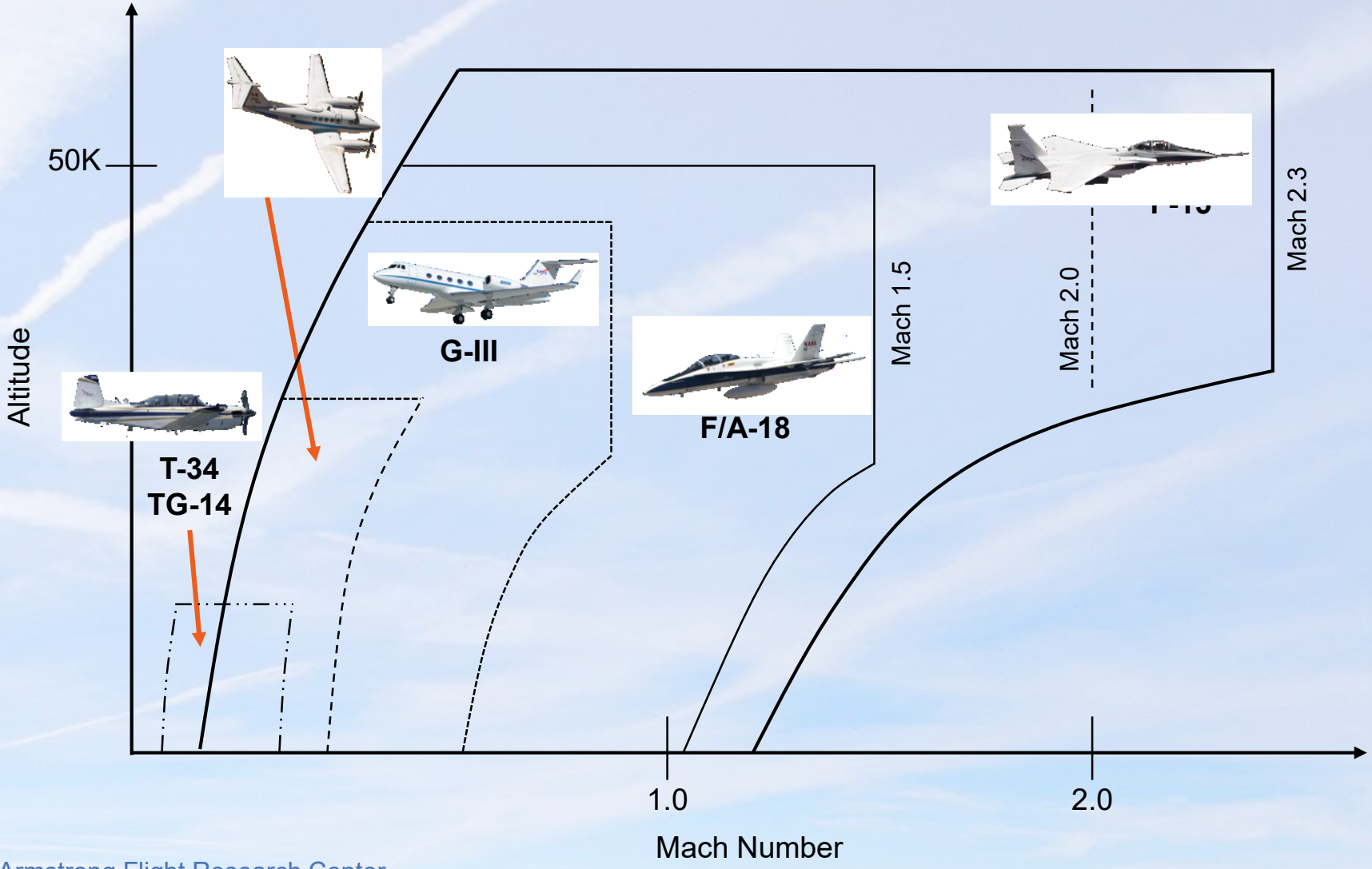
Eagle
F-15

Hornet
F/A-18

Gulfstream
G-III

NASA AFRC Flight Research Envelope

Support Aircraft and Test Range Requirements



AFRC - Flight Test Services

Full Flight Test Operations:

- Engineering expertise
- Flight research technologies
- Flight projects and mission management
- Flight safety and risk management
- **Flight instrumentation systems for data collection**
- **Airworthiness process**
- Variety of experimental aircraft (UAV, Airborne Science Platforms, supersonic fighter jets, subsonic aircraft, etc.)
- **Aircraft wiring and integration**
- Verification and validation and combined systems test
- Flight test range.
- Control room
- Telemetry
- Flight simulations
- **Back shop fabrication**
- Data services

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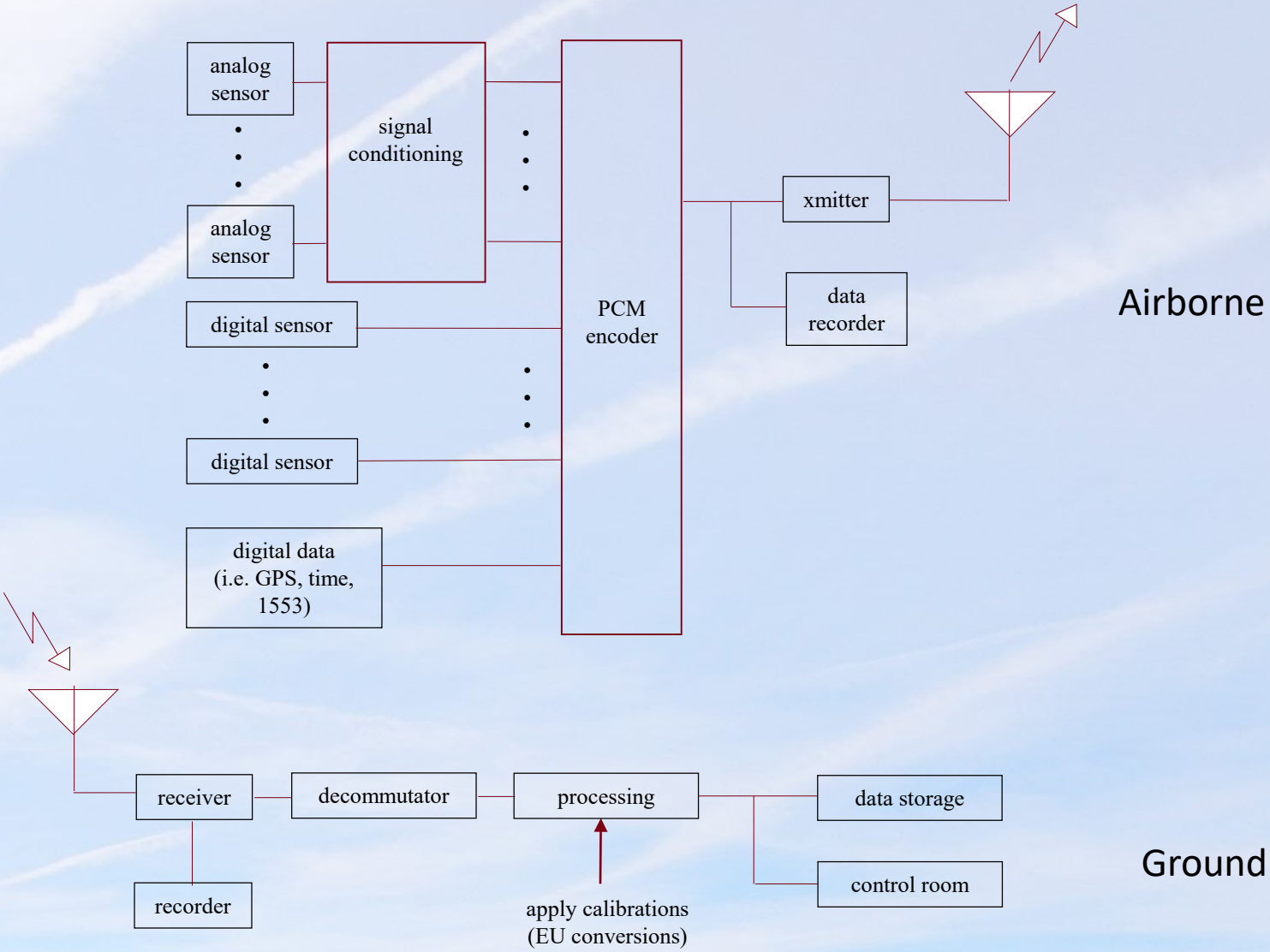
Conventional Instrumentation System Overview



Issues with Conventional Instrumentation

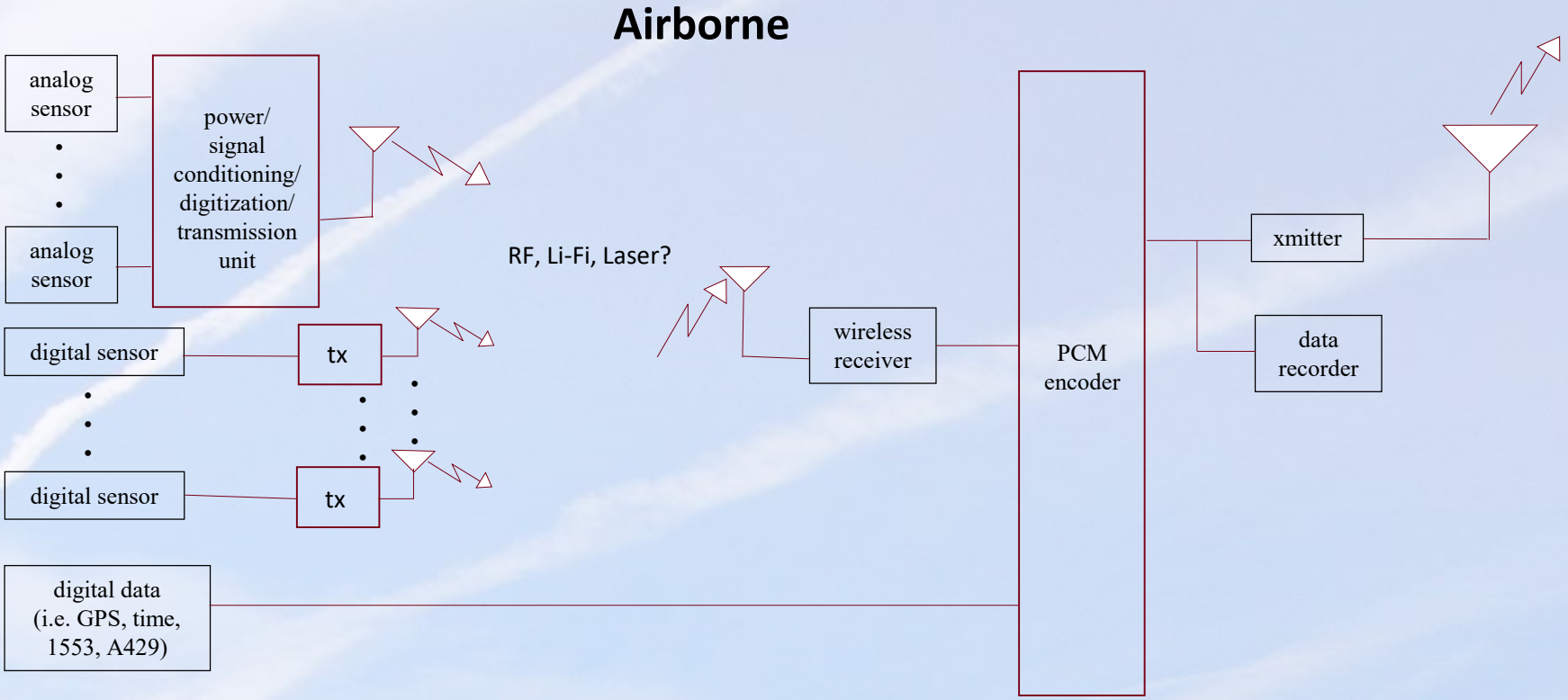
- Additional weight (wires, connectors, brackets, mounting plates…)
- Must penetrate aircraft structure for wire routing
- Long aircraft down time
- Extensive wiring labor
- Extensive and costly engineering due to complexity
- Not convenient for quick add-ons

Wireless solutions are needed to mitigate these issues.

Requirements for Future Wireless Sensing Solutions

- Receivers and accompanying software that interface to existing PCM flight encoders
- Smart, miniaturized, and low-power transceivers for flight applications
- Evaluate appropriate protocols for reliable wireless operations in flight environment.
- Power source, signal conditioning, and digitizing modules integrated to collect multi-channel analog signals with wireless transmitting and receiving capabilities
- Suitable energy harvesting technologies for flight test instrumentation
- Compatibility with standalone passive wireless sensors (PWS) and interrogators

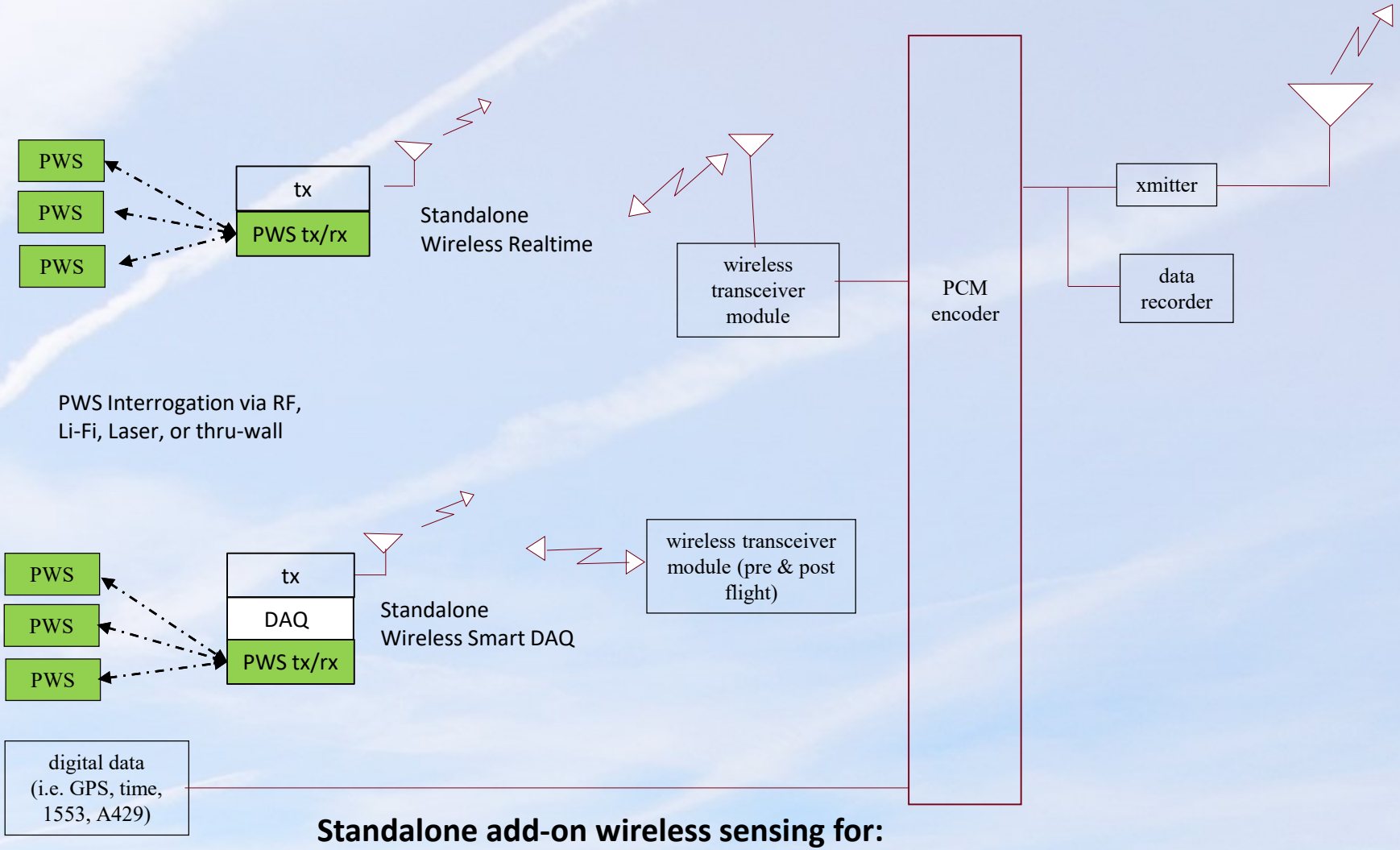
AFRC Potential Wireless Solution - Using Conventional Sensors and Equipment



Challenges:

- **EMI/EMC, multi-path, bandwidth and aircraft metal skin penetration issues.**
- **Airworthiness**
- **Synchronization and timing**

Potential Passive Wireless Sensor Solutions



Standalone add-on wireless sensing for:

- **Structure health monitoring**
- **Environments monitoring**
- **System troubleshooting**

Overall Challenges

- Wireless sensing systems should provide equivalent signal conditioning capabilities, i.e., reference junction, excitation current/voltage, bridge completion and signal amplification.
- Limited channel count due to requirement of small form-factor.
- Synchronization and timing between multiple wireless sensor units.
- Meeting EMI & EMC characterization and limitations due to pre-existing flight system operations.
- Providing adequate power for the wireless transceivers.
- Handling the multi-path signals at the receivers.
- Signal penetration and attenuation issues due to the metal aircraft structure.

Wireless Sensors for Landing Gears, Engines & General Measurements

- **Discrete sensor types:** Accelerometer, Position, Strain, Pressure, RPM, Temperature, Torque, Fuel flow and Level, etc.
- Work with miniaturized transceivers to make them wireless systems.
- **Wireless communication protocols** could be but not limited to: Wi-Fi, Bluetooth, RFID, Li-Fi, or laser.
- **Flat conformal antenna** is preferred.

How to get started on Flight Testing at AFRC

- **Contact AFRC's Advanced Planning and Partnerships Office**
  - Director: Tony Ginn
  - Phone number: 661.276.3530
  - Email: tony.e.ginn@nasa.gov

  - For SBIR (Small Business Innovation Research) info:
  - www.sbir.nasa.gov
  - A2.01 Subtopic: **Flight Test and Measurement Technologies**

  - Talk to me, Richard Hang, for initial help
  - Phone: 661.276.2090
  - Email: richard.hang-1@nasa.gov
- **What AFRC expects the customer to do:**
  - Solidify the requirements for the overall activity.
  - Estimate the resources required to complete the activity.
  - Contact AFRC Advanced Planning and Partnerships office. This office will provide more information and help you complete the partnerships and collaborations process.
  - Negotiate the final terms of the agreement to be signed by both parties.

Information on Partnership and Collaboration with AFRC

- The agreement process would be handled by AFRC's Advanced Planning and Partnerships Office.
- Two types of documents are generated:
  - A Memorandum of Agreement (executed under NASA's Space Act Authority) captures (at a high level) the scope of the activity, who will be responsible for what, a cost estimate, POC's intellectual property, liability, etc. Armstrong's Advanced Planning and Partnerships Office could take the lead in developing this document.
  - Project specific documents are typically put in place for an efficient, safe and timely flight experiment such as: Project Plans, Schedules, Objective and Requirements Document (ORD), etc. The Project Office will be responsible for managing the execution of the activity would usually lead in the development of these documents.
- NASA Armstrong resources to carry out the activity are estimated and a cost associated with that is developed.
- As part of the negotiation, the scope is often increased or decreased to fit customer's financial resources.
- AFRC can provide the full spectrum of involvement ona reimbursable basis. Our participation could range from support for a simple flight experiment/test with minimal involvement or full involvement to include collaboration on the technical development of wireless technology.
- Customer would reimburse AFRC for all costs including labor and non-labor costs.

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Conclusion

- **Talk to us:**
  - **Recommendations and Suggestions – How Passive Wireless can help us?**
  - **Your wireless products – How could we test your PWS system in flight?**
- **Partner with us**
- **Contract for our Flight Test Services**
  - **Flight Test your own wireless – possibly "Piggy-back" on other missions**
- **Consider submitting an SBIR proposal:**
  - **A2.01, Flight Test and Measurement Technologies.**
- **AFRC has the experience and capability to support the wireless communities with sensor validation through flight tests.**

Thank you!

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NASA Armstrong Flight Research Center
https://www.nasa.gov/centers/armstrong/capabilities