



Armstrong Flight Research Center (AFRC)

Partnership Opportunities with AFRC for Wireless Systems Flight Testing

PWST Workshop 2015

Presenter: Richard Hang

12/14 – 12/16, 2015, Orlando, Florida

Presenter: Richard Hang, Chief of the Sensors and Systems Development Branch.

Company: NASA Armstrong Flight Research Center

Location: Southern California, Mojave Desert , Edwards Air Force Base

Why I am here:

- To bring the AFRC flight test capabilities to the Wireless Community and open up opportunities for aerospace applicable wireless systems testing and validating through flight at AFRC
- To seek opportunities for partnerships in wireless sensor technology development and/or flight testing
- To broaden my horizon about wireless technologies and applications
- To find out what wireless sensors available that are applicable to our flight test instrumentation needs.

Armstrong Mission

Advancing 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



X-29



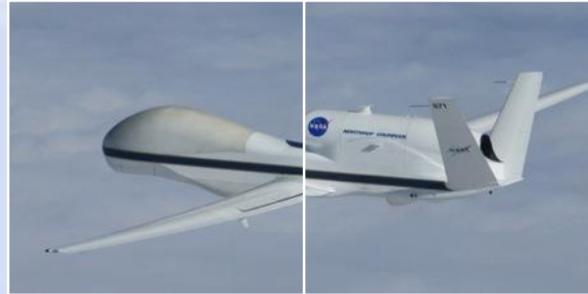
Armstrong Capabilities in Atmospheric Flight Research and tests

- Flight Test operations
 - *Back shops (Fabrication, sensors calibration and environmental testing)*
- Engineering expertise
 - *Various aircraft types*
 - *Avionics systems*
 - *Instrumentation systems*
 - *One of the kind system engineering/development (Fiber Optic Sensing System (FOSS))*
- Flight Safety and Risk Management
- Flight Project and Mission Management
- Variety of Experimental/Testbed Aircraft
- Airborne Science Platforms (SOFIA, DC-8, ER2)
- Various UAS Sizes and Capabilities
- Full Range Capability for Supporting Flight Tests
- Aircraft Test Facilities
 - Flight Load Lab
 - Flight Simulations

Testbed Aircraft



**King Air
B200**



**Global Hawk
RQ-4**



**Ikhana
Predator B**



**SOFIA
747SP**



**Mentor
T-34**



**Dragon Lady
ER-2**



**Eagle
F-15**



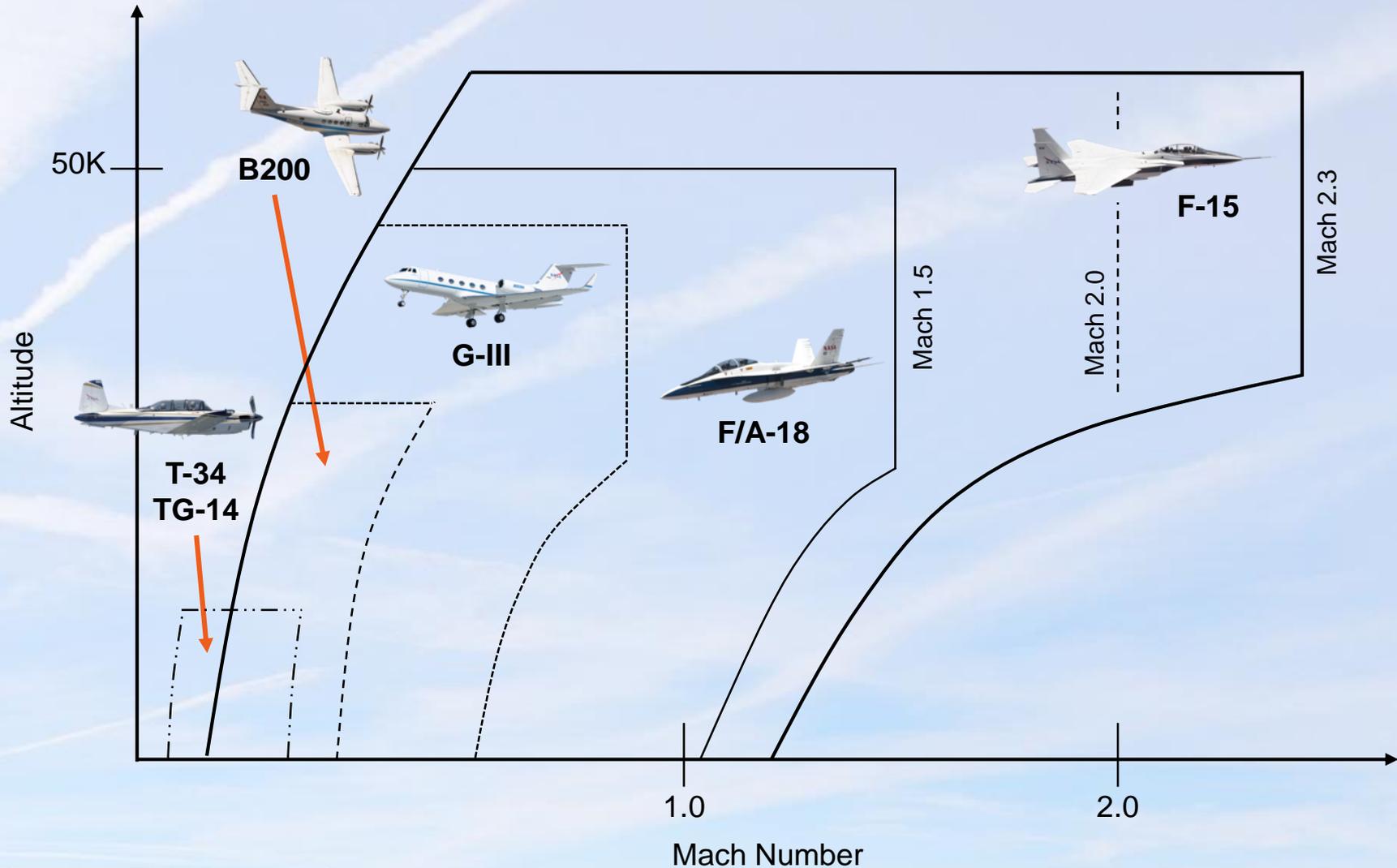
**Hornet
F/A-18**



**Gulfstream
G-III**

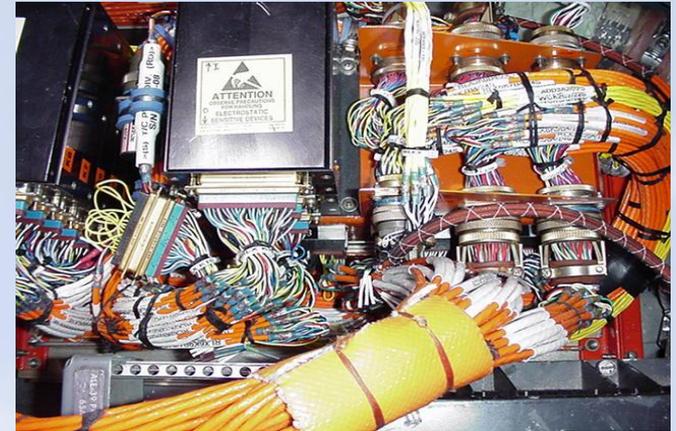
NASA AFRC Flight Research Envelope

Support Aircraft and Test Range Requirements



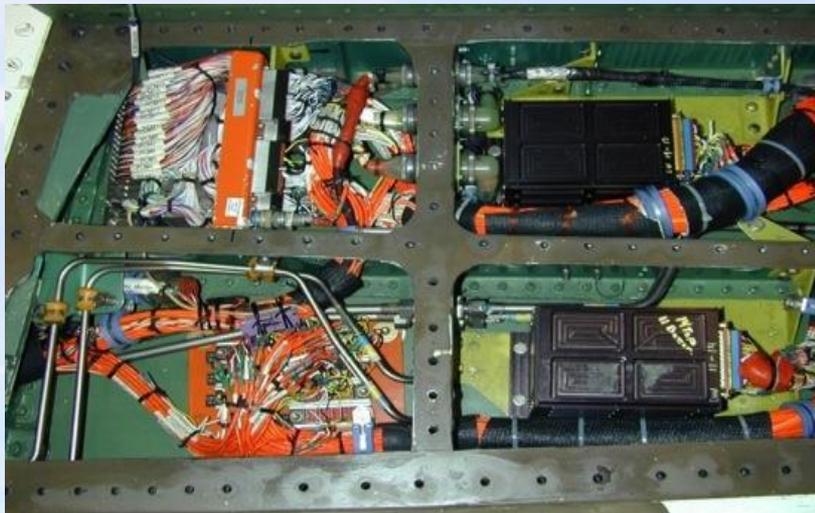
Flight Instrumentation Capabilities

- Design Instrumentation Systems for Ground & Flight tests:
 - › Data Acquisition Development
 - › Custom Circuit Board Design (one of the kind)
 - › Sensor selection, installation and calibration
 - › Fiber Optic Sensing System (FOSS)
 - › Power Distribution Systems Design
 - › Real-time embedded data processing systems
 - › Satellite Communication Applications
 - › Data Telemetry (PCM, IP-over-TM)
- Support Instrumentation-Related Activities On All Flight Platforms including aircraft wiring, integration and V&V process
- Process flight data using a variety of tools (COTS (ODE) and/or custom (FDAS))



Issues with Conventional Instrumentation

- Additional weight by cables/wires
- Must penetrate aircraft structure for wire routing
- Requires longer aircraft down time even for small add-on sensors
- Requires extensive aircraft wiring labored
- Requires extensive, costly engineering
- Not convenient for quick add-ons



Wireless Solutions

- **Benefits**
 - › Reduced cost, integration schedule, aircraft weight and engineering time
 - › Allows quick addition of sensors without extensive wiring modifications
 - › Avoids additional penetrations of aircraft structure (bulkhead, firewall, etc.)
 - › Can be used for moving parts (engines blades, landing gears, etc..)
 - › Allows remote sensing/measurement in inaccessible or dangerous places

- **Wireless sensors/systems Types needed:**
 - › Pressure
 - › Temperature
 - › Strain
 - › Fuel flow
 - › Acceleration (low and high frequency)
 - › Acoustic
 - › Video camera
 - › Torque
 - › Position
 - › Others?

Wireless Solutions Cont'd

- **Subjected to the following constraints/requirements**

- › High altitude operation (60k feet)
- › Extreme temperature condition (-60 to 160 degree F, operational)
- › High g vibration (depending on where the sensor is used it can be up to 22 grms)
- › Meeting defined EMI/EMC standards
- › Powering methodology
- › RF Range & Spectrum (L, C bands, ISM band)
- › Data security – encryption protocols
- › Data rate capabilities (up to 10000sps)
- › Number of channels per system (the higher number the better)
- › Low power requirement
- › Data communication connection types (P2P or P2MP)
- › Miniaturization (as small as possible)
- › Multiplexing Capability
- › Data fusion capability
- › Others

SBIR Proposals

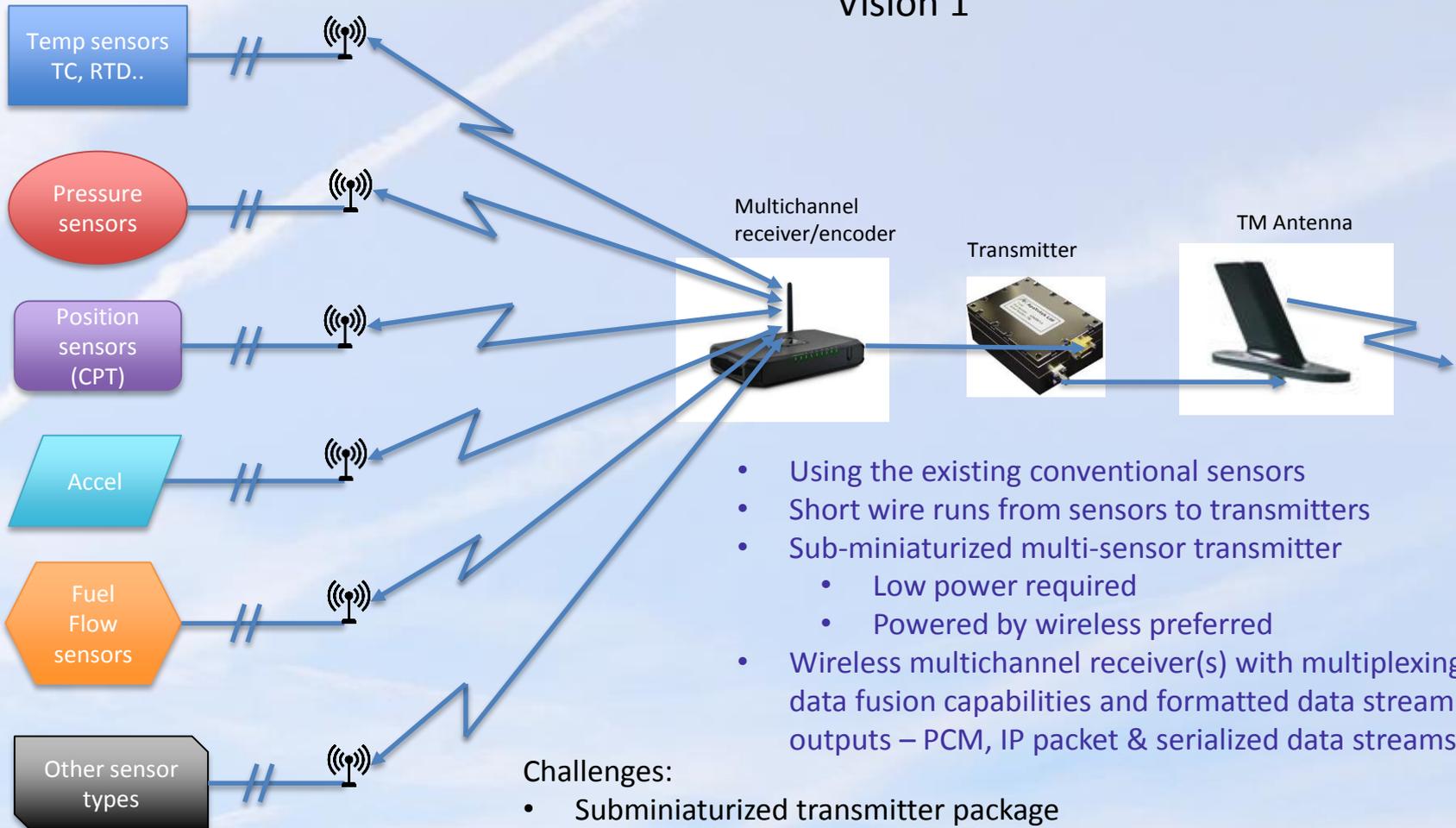
- NASA has Small Business Innovation Research (SBIR) and Technology Transfer (STTR) solicitation annually
 - › Visit SBIR website: www.sbir.nasa.gov for more information
 - › AFRC SBIR POC: Mark Davis, (661) 276-2241, mark.c.davis@nasa.gov
- There are two phase I SBIR proposals regarding wireless sensor technology currently active at AFRC for 2015:
 - › High Sensitivity Semiconductor Sensor Skins for Multi-Axis Surface Pressure Characterization (from NanoSonic, Inc.)
 - › Wireless Sensor Network for Flight Test (from Invocon)

Wireless Power and Data Communication Technologies

- › Power and data transmitting from the inside of the pressurized aircraft cabin or cockpit to outside and vice versa wirelessly (through wall propagating, non-intruding technology) with high data rate and/or high power efficiency.
 - » Applicable to metallic and non-metallic materials
- › Power and data transmitting along the aircraft surface/structure with high power efficiency and/or high data rate.
 - » Applicable to metallic and non-metallic materials
- › General wireless power technology, such as magnetic field radiation for instrumentation systems/sensors
- › Wireless data communication technologies using RF, laser, light, etc...

AFRC Vision of Active Wireless Systems for Flight Test

Vision 1

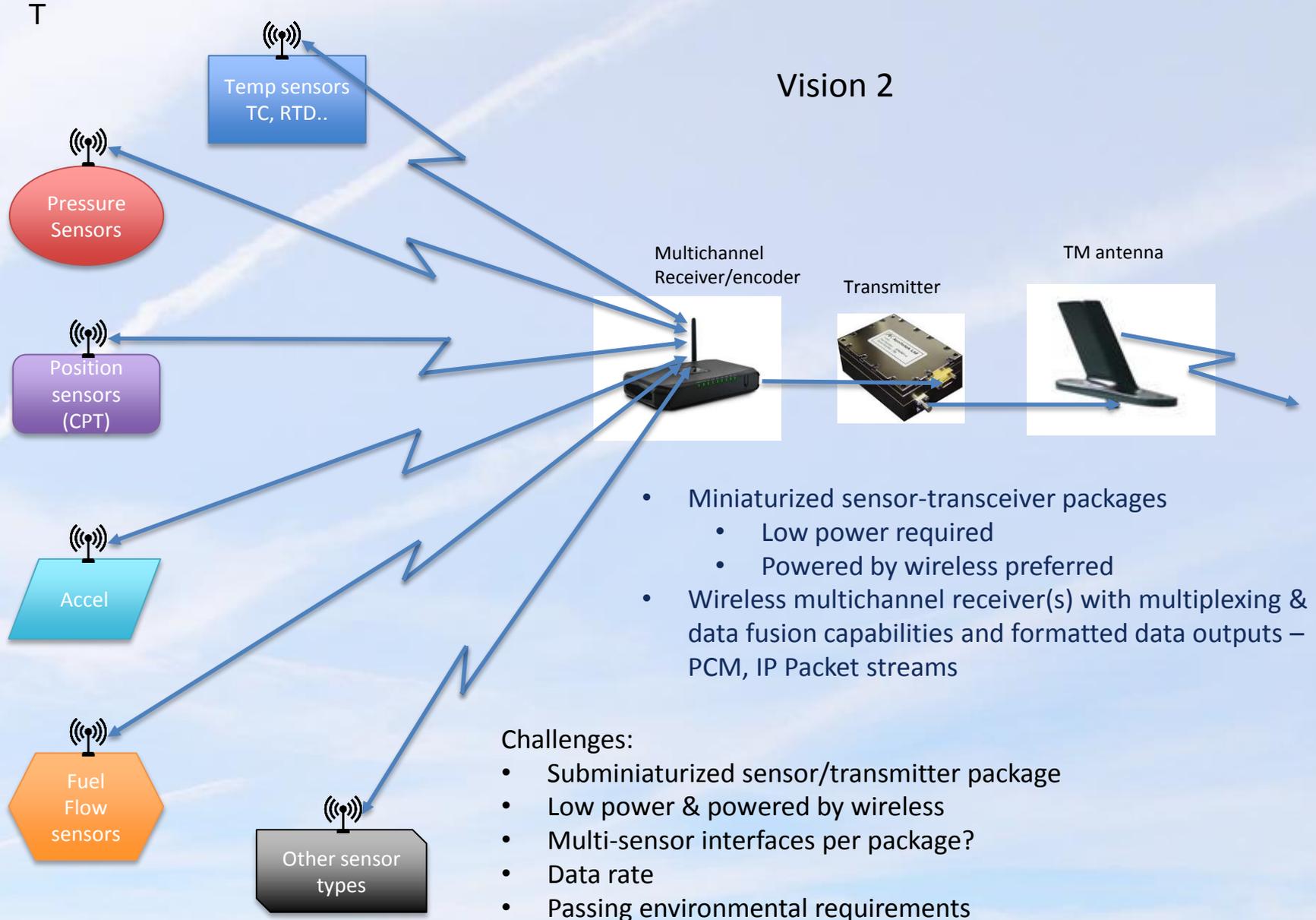


- Using the existing conventional sensors
- Short wire runs from sensors to transmitters
- Sub-miniaturized multi-sensor transmitter
 - Low power required
 - Powered by wireless preferred
- Wireless multichannel receiver(s) with multiplexing & data fusion capabilities and formatted data stream outputs – PCM, IP packet & serialized data streams

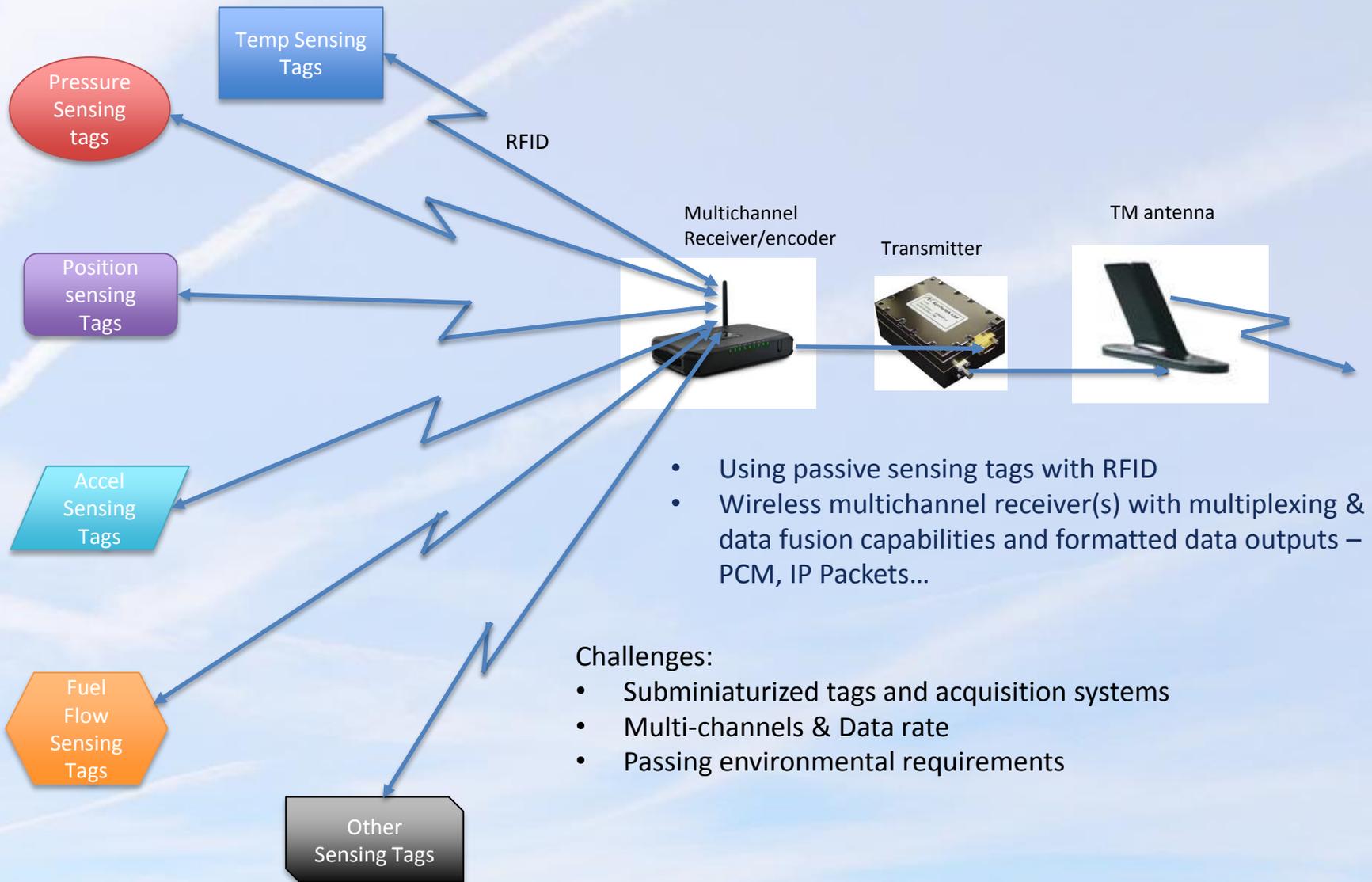
Challenges:

- Subminiaturized transmitter package
- Low power & powered by wireless
- Multi-sensor interface and serialization for transmitting
- Number of channels and data rate
- Passing environmental requirements

AFRC Vision of Active Wireless Systems for Flight Test



Passive Wireless Sensors for Flight Test



Information on Partnership and Collaboration with AFRC

- NASA capabilities including assets, facilities and staff are available in certain circumstances to support external organizations.
- NASA missions have priority, but all Centers are encouraged to support on an as available basis in particular if the proposed activity is in alignment with NASA's core competencies
- Wireless flight instrumentation has been and continues to be of interest to the NASA Armstrong Flight Research Center.
- The process includes the following parts:
 - Solidify the requirements for the overall activity
 - Estimate the resources required to complete the activity
 - Capture the requirements at a top level and the cost estimate for the agreement between NASA AFRC and the customer organization. [uses the authority granted to NASA in the Space Act of 1958]. It is organized into two parts: those parts that are the responsibilities of AFRC and those responsibilities of the customer.
 - 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 NASA Armstrong's Advanced Planning and Partnerships Office.

- There are two types of documents that are generated:
 - › One is a Memorandum of Agreement (executed under NASA's Space Act Authority) that 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.
 - › The other types of documents are project specific documents that are typically put in place for an efficient, safe and timely flight experiment such as: Project Plans, Schedules, Objective and Requirements Document (ORD), etc. Usually the Project Office that will be responsible for managing the execution of the activity would 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, often the scope is increased or decreased to fit what is financially possible for the customer.

Information on Partnership and Collaboration with AFRC

- On a Reimbursable basis, NASA AFRC can provide the full spectrum of involvement. 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.
- By Reimbursable we mean that the customer would shoulder the entire cost of the effort to include all AFRC labor and non-labor costs.
- NASA Armstrong's Advanced Planning and Partnerships is Armstrong's principal POC for external partnerships and collaboration.
- Here is POC info:
 - › Mr. John Del Frate
 - › Director, Advanced Planning and Partnerships Office
 - › 661-276-3704
 - › John.h.delfrate@nasa.gov

Information on Partnership and Collaboration with AFRC

- There are two Center approvals for taking on Reimbursable work.
 - › The Tactical Management Board (TMB) determines if this is the sort of work that is a good match for AFRC competencies and strategic plan.
 - › The Project Management Board (PMB) determines if the Center has the right resources in the right time frame to carry out the activity. The PMB also determines what the final cost estimate will be. After this approval, we have the green light to sign the Space Act Agreement (the MOU).

- All Reimbursable work is done on a “cost” basis. It is not performed on a “fixed price” basis. If it costs less, funds would be returned. If it costs more, then more funds would have to be collected before the effort can continue.

Conclusion:

- AFRC has a broad flight test capability that is suitable for flight testing of any wireless sensor suite. We are here to offer the flight test capabilities to you if you are looking for a good means to further your wireless sensor technology.
- AFRC is focusing on in-house passive and active wireless sensor development for flight test applications, and interested in partnership opportunities with the Wireless Community.