

Fly-By-Wireless: Session 1
Wednesday 03/04/09

Fly-By-Wireless: Mission, Goals and Roadmap
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1. Vision

To minimize cables, connectors and promote increased use of MEMS and Nano Technology across the aerospace industry by providing reliable, lower cost modular and higher performance alternatives for a vehicle/program's life-cycle

2. Mission

Provide advocacy for its members and foster the advancement and increased use of MEMS (carbon filtering application) and Nano Technology toward the expansion of the FBW market;

Be the world's catalyst for the Fly-by-Wireless industry to bring breakthrough (disruptive) technologies to the aerospace and space sectors by ensuring aerospace qualification, reliability, lower cost and added-value; and

By setting a global direction, create opportunities for the flexible collaboration and conduct strategic research and development so as to yield a significant return on investment for all FBW industry partners.

- Not eliminating wires; simplifying the system. Start from the beginning at the systems level. Spend more time, do your homework at the systems level.

We don't currently have functional standards, everyone is just doing it their own way. We have to see that some standards should be developed and followed in a universal way – cost effective, economically efficient

When we talk about wireless, we talk about interference. So many accidents result from this. If you want to use FBW technologies, there are a lot of commercial solutions out there for communications – but not for aerospace. We have different challenges, which is what we are here to work on. We need to identify the challenges/issues and find appropriate solutions. Reliability is also a major issue.

The main thing for a data acquisition system is to collect data AND have real-time processing capability. Sensors – different scenarios (high altitude, dust, icing, moisture) affect sensors. Need to be interconnected with all areas to find solutions – also, materials.

Communications systems – there are so many within the aircraft already; interference is a major issue. To avoid this, some technology addresses this through the use of coatings,

different coatings. Different types of sensors are required for icing, moisture environments.

Less-wire and wireless alternatives are sought through CANEUS championing FBW concept. Navigation systems, pitch-angle measurements using video; sending signals through the wireless requires a lot of bandwidth, requiring in turn a lot of compression. Overall objective is to reduce the wires, because we cannot eliminate immediately; optical is another option because it saves space, weight, transfers multiple channels – less weight, area, volume. We need to find a solution through a compromise/balance among less wire, wireless, and optical.

We are talking about both devices and systems – everything is currently very bulky. There is an attitude of “if it works, don’t fix it” concerning the legacy systems (especially mechanical) – devices and subsystems need to be considered from the top, systems-level itself and addresses weight and volume.

Model concepts – if something fails, we can immediately replace it easily and cost-effectively.

Mass reduction is a key area as well.

Here at CANEUS, we need to identify the needs, review state of the art; match users with providers; generate a specific project plan; folding this plan into the envisioned strategic CANEUS FBW portfolio/strategic plan. CANEUS provides a common ground for people to come to the middle and see who is doing what, what problems are being encountered, efficiently.

FBW is divided into 4 subsystems with several associated potential project topics:

1. DAQ Micro-Miniaturization
2. Sensor Tags - Passive Sensor Tags – no need for using any power – suppose you want to use a lot of sensors in health monitoring system – easier to use.
3. Structural Health Monitoring Systems – passive sensor tags, micro/nano systems to reduce power consumption, volume, and weight

If you want to do something, reduce the number of wires. Maintenance of wires is difficult, FBW solves this issue.

Partnerships between/among companies – because it reduces cost, time associated with developing system (developing whole system vs. developing only a part).

Emphasis on systems-design approach to project/technology development.

Technology Alternatives to Cables and Connectors:

- Standalone Wireless DAQ and active sensor tags
- No-power RFID and passive sensor tags – direct access to sensors with no battery or cables at a short distance
- Robust/adaptive radios adjust characteristics to optimize RF communications
- Lightweight coatings/shieldings for EMI/EMC and avoid RF Interference
- Flight test instrumentation

*When finding different frequencies, we need to ensure that these are not interfering with existing frequencies being used

Key Advantages of FBW Approach:

- older aircraft have old wires and connectors, fail, and take a long time to fix
- Direct costs – with wireless, the cost can be estimated upfront; not so with wires
- Price of copper – right now, very expensive – avoid this and save money
- Cost of change – when wires are designed and need to be changed, difficult and expensive – not so with FBW
- Along the same lines, the cost of late changes
- Cost of vehicle resources – a lot of weight associated with cables/connectors
- Cost of flexibility – same as cost of changes and late changes
- Performance – upgrading is difficult in a cable system
- Physical restrictions – structural barriers limit access and connections to vehicle resources
- New composite structures – demand more testing and health monitoring than legacy structures

FBW Workshop – June 8 – 12, 2009 Montreal, Quebec, Canada

<http://www.polymtl.ca/en>

- manned, unmanned, space, flight test, ground support, human/robotic systems, infrastructure changes, application/tech links to other industries

Fly-By-Wireless: Session 2

Wednesday 03/04/09

Dr. Ali Abedi, University of Maine, Orono

Passive Wireless Sensor Tags

UMaine – Hybrid wireless

- small form factor, no battery, operate wirelessly in a reliable fashion as a part of the whole system, signal noise isn't an issue, can operate in noisy environments because it operates below the noise, not detectible = no jamming, codes allow us to place thousands of sensors in a small area, ping one of them, and not have any of the others interfere
- worried about antenna design because UMaine doesn't have expertise – working with Johnson Space Center
- problem: most of the common thinking is that people develop sensors, some develop radios and then they attach them. Here it is different in that it is developing an integrated approach

Sandia – Passive wireless

- surface acoustic wave acts as radio, sensor acts as payload

ASR&D Corp – application considerations

- STTR, SBIR programs to develop passive sensors
- Liquid sensitive sensors – tank filling, operates at any temperature
- Hydrogen leak detection capability
- Humidity sensor
- Sensor tag like Sandia with already qualified sensors, avoid requalification – looking for end users to validate technology development under SBIR Ph. I

UCF - Orthogonal Frequency Coded Surface Acoustic Wave Passive Remote Sensing and Tags

- problems maintaining orthogonality with loss of synchronicity – working on alternate coating techniques

Univ of Minnesota – Wireless sensor technologies utilizing high speed wireless telemetry, energy harvesting, and MEMs – part of an NSF-funded consortium

- can go extremely fast, ultrasound

NASA Langley Research Center – Rapid Surface Acoustic Wave (SAW) Sensor Development Tools

- looking at small sensors – identified applications like thermal acoustic testing of large structures with accelerometers – don't want to waste the time to wire it up, interested in wireless sensor tags
- applications in all sorts of aerostructures – want to eventually do active testing
- want smallest possible sensors to put into platform without causing problems and having minimal impact

Challenges, opportunities:

- Coding and modulation – focus on reliability (definable, measurable reliability)
- Wireless device design/fabrication – RF side of the story
- Sensor device design/fabrication – promoting joint design with device fabrication, or modular design
- Interrogator system design and implementation
- Modeling and analysis of wireless channel, sensor/wireless device, end-to-end system performance – need to make sure the whole system is going to work in the worst possible scenario
- Antennas – common need for good, special use antennas
- Knowing the end-users' actual needs – we don't know what to build
- Which frequency band should be used?
- Problem – distance and passive wireless – what you send has to be enough to power it, and get return
- Delamination of composite structures
- Goal of SAW device is hundreds of feet (bridge monitoring, etc) – currently capable of far less than that (under 15 feet)

Education, training in this industry is key – a workforce for the future needs to be in place that is capable of understanding, developing, installing these systems

NEEDS ASSESSMENT:

Boeing, EADS – very relevant:

- Health Monitoring Systems
- Passive sensors

Identifying a major gap – antennas

Wind turbine blades – tear themselves apart because of moisture – a humidity sensor could identify this before it flies off and damages something in the area.

Global Architecture vs. Developing a Wireless Sensing Capability – 2 different areas of FBW emerging in meeting discussion – those who are developing wireless sensor technologies think they might be a better fit in devices consortia

Boeing – open to anything that reduces weight:

- wherever we can reduce weight, we want to look there – have looked at non-essential systems to make them lighter; but when we go to systems that are critical or essential, we need to maintain the same reliability that the legacy system provides.
- Also concerned with portable electronic devices – blue tooth,
- Interested all the way up to 100 GHz

- Closing up the aperture is very important – don't want energy leak to antennas
- Air worthiness and reliability – have to answer to the FAA

Could we propose a project that addresses dual needs? – energy harvesting and damage indication and diagnosis is a need expressed in several areas – micrometeorite impact, acoustic emission monitors – detect delamination

Fly-By-Wireless: Session 2

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Non-Breakout session.

- Since there were not breakout sessions, everyone got together and tried to figure out where the device side of the business falls into place with the fly by wireless technologies.
 - It was stated that most people that are here are mainly working on the device side.
- Boeing made it clear that they are a potential end user, they are always looking for ways to reduce the weight and complications surrounding wiring there aircraft.
 - There has to be the reliability that there is with wired technologies.
 - Spurious noise, you can't have any unnecessary spurious noises in the environment.
 - Interest up to 100GHz
 - Maybe there is a place for a repeater for passive devices.
- There were some comments made about a potential project being to integrated passive/ wireless sensors to detect delaminating events.
- To follow up on the interest of a combined project, one person is going to take the lead, and follow up with all individuals evolved in the group effort.
 - And Idea to this respect is to have an ongoing web log of some sort and to have the facilitator "poke" those involved periodically in order to check on progress and to keep interest.

