Increasing Reliability
with Wireless Instrumentation Systems
from
Space Shuttle
to
'Fly-By-Wireless'

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New Technology Transitions have always caused concern…

1930's	Vacuum-driven instruments; early aircraft radios; vacuum-controlled autopilots; 14 volt DC systems; HF radio
1940 's	DC electrical autopilots; 28 volt DC systems; VHF radio; electrical cockpit instruments; 115VAC electrical autopilots; vacuum tube controls; LORAN; radio direction finders and altimeters; hydraulic flight control; jet propulsion
1950's	Solid state (transistor logic) controls; airborne computers for G&N and weapon system control; stability augmentation; UHF radio; TACAN; MLS
1960's	Integrated circuits; fly-by-wire (Mercury, Gemini, Apollo); digital flight control (Apollo)
1970's	Redundant data bus flight control (Shuttle; USAF 680J project); CRT displays
1980's	Liquid crystal displays; Global Positioning System (GPS); auto-land
1990's	Photonics; GPS attitude control; **Standalone wireless instrumentation sensor networks for Space Applications**
2000's	**Wireless Zones in Spacecraft, Wireless Sensor Networks in Critical Applications, Wireless Flight Control, Long Range active/passive RFID sensors, and…**

New System Engineering to accommodate "Fly-by-Wireless"

Aerospace Vehicle Structures Need to be Reliable and we so Need Reliable Sensor Systems

Structural Health Monitoring

1. Get to Know the
   - Structure
   - Environments
   - Operations
   - Failure Modes/Hazards
   - Materials
   - Vehicle System
2. Demonstrate ability to measure the phenomenon with current technology and models in operational scenarios to understand the impact of limitations.
3. Develop system options to conquer the limitations of current technology to get what you need.

Structural Health Monitoring Systems

1. Develop the System Requirements through prototyping and test.
   - Structure
   - Environments
   - Operations
   - Failure Modes/Hazards
   - Materials and components
   - Vehicle Systems Interfaces
   - **Manufacturing & Critical Skills**
   - **Monitoring System Reliability**
2. Demonstrate ability to measure the phenomenon **with prototype system** and get the results in time to use it.
3. Generate **Integrated Models of System** & demo advantages over current technology to improve reliability.

Vision: "Fly-by-Wireless" Aerospace Vehicles where RF is Commonplace

- **Robust Low-Power/High Data Rate RF Communication Systems** must be developed to NOT INTERFERE or BE SUSCEPTIBLE to other systems on the aircraft/spacecraft.

- **A "Toolbox"** of Wireless real-time, delayed access, and ground use only systems must be in place to make use of for entire life cycle.

- **System Engineering** involving all systems to include <u>modular wireless electronics</u> packages in the original designs and upgrades:

  1. Smart, very low power, jam-resistant RF networks with adaptable RF system operating frequencies and modes, RF relays nodes, and even Long-range Passive RFID Sensor-Tags.

  2. Structural RF pass-throughs, imbedded sensors, wave guides, coatings, imbedded sensors, highly redundant sensors and data acquisition/storage nodes.

  3. Micro-power scavenge, remote power, rechargeable systems.

  4. More functions improving interaction with ground systems.

  5. System and Structural Design Process Changes.