Aircraft Wiring Reduction


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Topics – Fly by less wire

Flight Controls

- Remote electronics for actuation
- Communication to remote electronics
  - Wireless
  - Optical
  - Piggy back data on power wiring

Other systems excluding cabin

- Databus
- Centralised computing with remote data concentrators/distributions
  - Wireless
  - Optical
  - Piggy back data on power wiring
Topics – Fly by less wire

Cabin Systems

- Wireless passenger service unit
- Wireless emergency lighting system
- Wireless smoke detection systems
- Wireless IFE
- Wireless cabin management
- Wireless cabin intercom
Baseline Concept

Overview route concept FBW

Rudder Pedals
Cockpit Controls
Pedals
MCU 2
AECM 2
Mcu 1
AECM 1
Yellow=FADEC
Green=FCC 3
Blue=FCC 2
Red=FCC 1

Production breaks FCC 2+3 to rudder actuators
Production break FCC 1 to rudder actuator
System Installation Cockpit Bay looking forward
System Installation Centre fuselage bay looking forward
System Installation Aft Fuselage bay, Avionics & Electrical
Fly by less wire

Flight Controls

- Remote Electronics for actuation
  - Smart actuators are not new but their application to commercial transport has been limited in the past.
  - Trends that are driving the need for REM’s are More Electric and the use of data busses to reduce wiring from centralised systems.
  - Actuator loop closure is a function of the REM, this allows slower data links to be used between the REM and the main computing.
Fly by less wire

Flight Controls

- Data Links
  - Wireless could be used, advantage of reducing data wiring although power wiring is still needed. An REM for a typical hydraulic PCU would require between 10 and 30 watts depending on the types of solenoid valves being used.
  - HIRF, lightning and frequencies of operation are hurdles to be overcome for a safe and deterministic system.
  - Optical links provide huge bandwidth which is not really required, however, the integrity of the link in harsh HIRF/lightning environments is excellent although the actual electro-optical interfaces can still be an issue.
  - The possibility to use light as a power source for the REM’s would be an interesting development.
  - Electrically powered REM’s require power wiring, piggy backing data on that wiring would provide a less wire data-bus solution.
  - Data link integrity for wired systems will potentially need greater shielding when used with composite structures.
Fly by less wire

- **Other Systems**
  - Avionics, Inertial Reference, Air data, High Lift, Landing Gear, Nosewheel Steering, Brakes, Fuel, Environmental Control, Door’s etc.
  - All of the above systems today require many miles of wiring even in a small regional jet – reducing this wiring offers many benefits
    - Less weight
    - Less installation time
    - Less fault opportunities
    - Improved troubleshooting
    - Less volume
  - The concept of Highly Integrated Systems or Integrated Utilities offers the possibility to reduce this wiring
Present – Independent Systems

Autopilot

Gauging

Landing Gear

Brakes

Flap/Slats
Future – Integrated Systems Context Diagram
Proposed Architecture Concept

Display System

I/O Module

I/O Module

I/O Module

I/O Module

I/O Module
Future – Integrated Systems System Diagram
Fly by less wire

Remote interface unit

- This provides a significant wiring reduction due to the databus to the main computing platform.
- However, there is still considerable wiring required from these RIU’s to actual real world sensors, actuators etc.
- As an example, passenger doors have somewhere between 7 and 10 proximity sensors per door, cargo and avionics doors also have proximity sensors.
- Doors are spread throughout the fuselage, RIU’s get you closer to actual doors but there is still considerable wiring required from the RIU to the door sensors.
- What if we had RFID interfaced proximity sensors with there own built in power source that would allow self power between "C" checks??
Cabin Systems

- The next slides illustrate some of the problems that have to be overcome in commercial transport aircraft design.
GROWING MARKET | INCREASING DEMANDS

Passengers demand:
- Enhanced comfort
- More non-stop flights

Airlines demand:
- More fuel efficiency
- Lower maintenance costs
- Dependable Performance

CRJ705 Interior shown

And the CRJ1000 Jet delivers
In-flight entertainment systems (seatback IFE or PSU mounted IFE) are leading edge with passenger-friendly features.

Enhanced cabin air distribution system provides more uniform temperature throughout the cabin for increased passenger comfort.
Where do we put the systems and wires?

- Fuselage needs to be the smallest diameter possible to minimise weight and drag
- Passenger space needs to be as large as possible for comfort/capacity
- Cabin storage needs to be as large as possible, most travelers in the USA want to take a roller bag on board
- Cargo bays need to be as large as possible, extra revenue for the operator
- Where do we put the systems and there associated wiring
  - ECS, Hydraulic, Electrical, Passenger Services, Flight Controls, Avionics etc?
Fly by less wire

- **Cabin Systems**
  - Wireless passenger service unit
    - In-seat Passenger Control Units could be wirelessly interfaced to their respective Passenger Service Unit to control reading lights and attendant call functions. A key benefit is the ability to quickly reconfigure the cabin without all of the wiring reconfiguration hassles. Each PSU panel could be powered by the mounting rail system.
Fly by less wire

- **Cabin Systems**
  - Wireless emergency lighting system
    - Systems are being developed whereby the emergency lights, while hard-wired for power, are wirelessly activated.
  - Wireless smoke detection systems
    - Systems are being developed to remove data wires from the smoke detectors in lavatories & cargo compartments.
  - Wireless IFE
    - We all know what happened with this one on the B787, however, this is an approach that would offer significant benefits
      - Easy cabin reconfiguration
      - Significant reduction in wiring
      - Easy troubleshooting with easy LRU changes at the gate
Fly by less wire

- **Cabin Systems**
  - Wireless cabin management
    - Although these systems are currently data bussed with other cabin systems, there is opportunity to introduce additional redundancy with a wireless interface. Proposed systems are currently capable of supporting a wireless cabin LAN however no efforts have been made to wirelessly interface the other system controllers (ECS, water/waste, lighting, etc.) It would also be possible to broadcast single channel messaging to the Passenger Information Displays located in the PSU panels to display typical flight status, arriving/connecting gates and other info.

    - There is a great opportunity to interface this with the Wireless Passenger Service Units.
Fly by less wire

- **Cabin Systems**
  - Wireless cabin intercom
    - Today, airliners rely on a wired cabin handset for each flight attendant station - perhaps with a wireless system, attendants can be in constant contact with each other and the flight deck from anywhere in the cabin.
    - This is seen as both an efficiency gain and also a very effective safety improvement and most importantly, provides a better means of communication if a threat situation occurs.
Fly by less wire

- Caution
  - Just a word of caution. As has been evidenced in the past, less wires doesn't necessarily mean less weight or complexity. The main benefits are simpler installation and reconfiguration but at a potentially higher LRU cost.
  - The challenge is to provide “less wire” technology that has the following attributes:
    - Less initial cost (bill of materials)
    - Less weight
    - Less volume
    - Higher reliability
    - Easier troubleshooting
    - Easier re-configuration
    - Low spares cost
  - Which all lead to lower costs for the end user
  - Which leads to more people flying
  - Which ultimately leads to continued pay packets for commercial aerospace employee’s!!!!