Airbus Fly-By-Wire Computers A320 – A350

Ying Chin (Bob) Yeh, Ph. D., IEEE Fellow
Technical Fellow
Flight Controls Systems
Boeing Commercial Airplanes

IEEE ComSoc Technical Committee on Communication Quality & Reliability

Emerging Technology Reliability Roundtable

Stevenson, WA, USA, May 9, 2016

Non-technical / Administrative Data Only. Not subject to EAR or ITAR Export Regulations
Airbus (and French) Organizations for Airbus FBW Computers

- **Research**
  In 1970, French government modeled SRI International and MIT DraperLabs to create LAAS CNRS research institute for Computing System Technology, with a workforce of 750. A sub-group, Informatique critique (dependable computing), has been the main research arm for Airbus FC, consisting of ~20 Ph.D researchers. This group is the computer architect for A320 FBW Computers.

- **Platform Design**
  After A320, Airbus creates EYY group to MAKE FBW Computers and being responsible for FBW Computers, Warning Electronics, and Maintenance.
Airbus Fly-By-Wire Computers
Design Philosophy

• Active-Standby control of an actuator for a control surface with multiple actuators, other actuators in By-Pass Mode

• Active-Passive control of an actuator among Flight Control Computer channels: upon detecting loss of an active computer channel commands, the passive computer will become active

• Self Monitor computer channel, with Command Lane and Monitor Lane
An example of Airbus FBW COM/MON-based Monitoring
Evolution of Airbus FBW Computers

- **A320** (Architect: LAAS, Platforms: Thompson CSF and Sfena, now Thales)
  - Dual-Dual ELAC (Elevator & Aileron): Thompson CSF, Motorola 68010 based
  - Triple-Dual SEC (Spoiler & Elevator): Sfena Aerospatiale, Intel 80186 based

- **A330/340** (Platform: Airbus EYY)
  - Triple-Dual PRIM (Elevator, Aileron, Spoiler), Intel 80386 based
    - Auto-coded SW design with Assembler in COM and PL/M in MON
  - Dual-Dual SEC (Elevator, Inboard Aileron, Spoiler), Intel 80286 based
    - Hand-coded SW design with Assembler in COM and Pascal in MON

- **A340-500/600** (Platform: Airbus EYY)
  - Triple-Dual PRIM, Intel 486 DX4 (32 MHz)
  - Triple-Dual SEC, DSP Sharc (40 MHz)

- **A380** (Platform: Airbus EYY)
  - Triple-Dual PRIM, Power PC 755 (66 MHz – 98 MHz), Auto-coded COM & Hand-coded MON
  - Triple-Dual SEC, DSP Sharc (40 MHz), Auto-coded COM & Hand-coded MON

- **A350** (same triple-dual channel as A380, Processors updates unknown)
A340 FBW Architecture
A380 Flight Controls Architecture

AILERONS
- O/B
- M
- I/B
- P2, P3
- S3, S1, S2
- B

SPOILERS
- S1, S2, S3
- P1, P2, P3
- S1, S2, S3

AILERONS
- I/B
- M
- O/B
- P2, P3
- S3, S1, S2
- B

SPOILERS
- S1, S2, S3
- P1, P2, P3
- S1, S2, S3

28VDCless 28VDC1
- S1, S3

ELEVATORS
- O/B
- I/B
- P1, P2, P3
- S1, S2, S3
- B

28VDCless 28VDC1
- S1, S3

ELEVATORS
- I/B
- O/B
- P2, P3, P1
- S2, S3, S1
- B

GREEN hydraulic system

YELLOW hydraulic system

Electrical Motor

Conventional hydraulic servocontrol

EHA, Electro Hydrostatic Actuator

EBHA, Electrical Backup Hydraulic Actuator

P1 P2 P3 Prim and Sec Flight Control Computers
S1 S2 S3 Command unit: unit A, unit B
B BCM ultimate backup control

Pedals Feel and Trim Unit

Rudder
- P1 S1 B
- P2 S2
- P1 S1 B
- P3 S3

Vertical Stabilizer
- E1 AC power
- E2 AC power
- E3 AC power
A350 FBW Architecture
Ultimate Back-Up

- **A320**
  Mechanical linkage to THS & rudder

- **A330/340**
  Ditto, plus Back-up Yaw Damping to improve Dutch Roll damping

- **A340-600**
  Ditto, Rudder becomes fully electrical (see next sheet, BPS and BCM), analog BCM

- **A380**
  Ditto, for Yaw control plus BPS + Analog BCM to power:
  - Electrical pitch back-up (elevator) linked to side-stick
  - Electrical roll back-up (ailerons) linked to side-stick
  - Pitch Trim (Trim Hand Wheel is replaced by Switches)

  (note: FC System Architecture contains 2H/2E and Electrical RAT supply EHA and EBHA in case of total engine flame-out)

- **A350**
  Ditto, with digital BCM as depicted next sheet
A350 FC Backup System

- An Electrical Backup System (EBS) controls the aircraft in the case of the failure of:
  - All the PRIMs and all SECs, or
  - The Electrical power supply of the PRIMs and the SECs

- The EBS is totally segregated from the normal flight control system and has:
  1. A Backup Power Supply (BPS)
     The BPS is an electrical generator that is activated in the case of computer or electrical generation failure. The yellow hydraulic supplies the BPS.
  2. A Backup Control Module (BCM)
     The BCM controls and monitors:
     - The inboard aileron
     - The elevators
     - The rudder

- The direct control laws apply whenever the EBS is active, with the following features:
  - Pitch motion damping
  - Yaw damping
  - Direct roll
Airbus 350 FBW Computers: Normal Electronic Signal and Ultimate Back-up Control Module (BCM)
Airbus 380 Data Communication: FC and IMA

non essential functions (warning, maintenance, ...) located on shared resources

Essential data network
-old technology
-Separated from ADCN