Agenda (2/3)

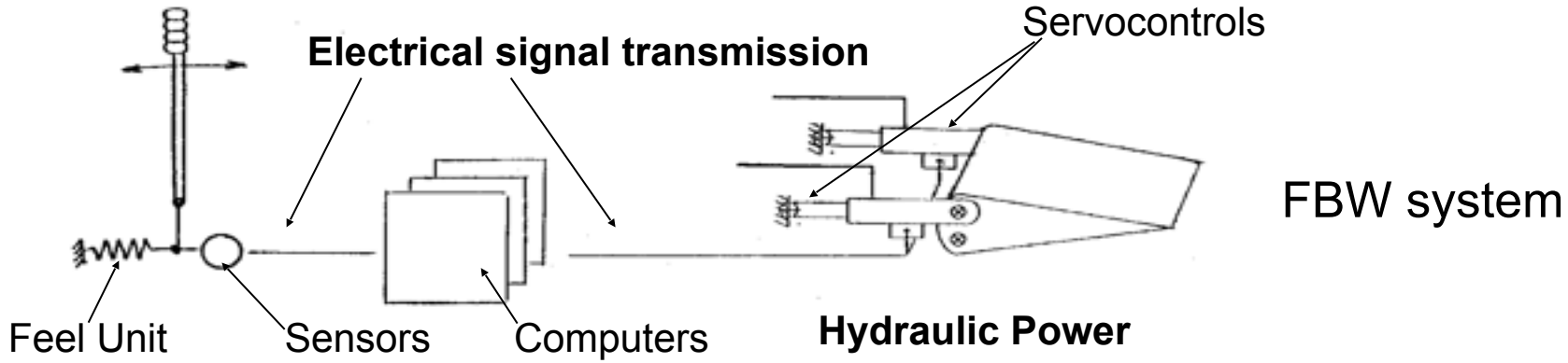
- Module 4 – Design requirements and Safety process
  - 4-1 Requirements
  - 4-2 Safety process
- Module 5 – Aircraft power systems
  - 5-1 Hydraulic power systems
  - 5-2 Electric power systems
- Module 6 – Aircraft Control systems Architectures
  - 6-1 Hydro Mechanical Systems
  - 6-2 Fly by wire systems
  - 6-3 Fly by wire systems new generation
  - 6-4 A320 FAL Visit

Outlines

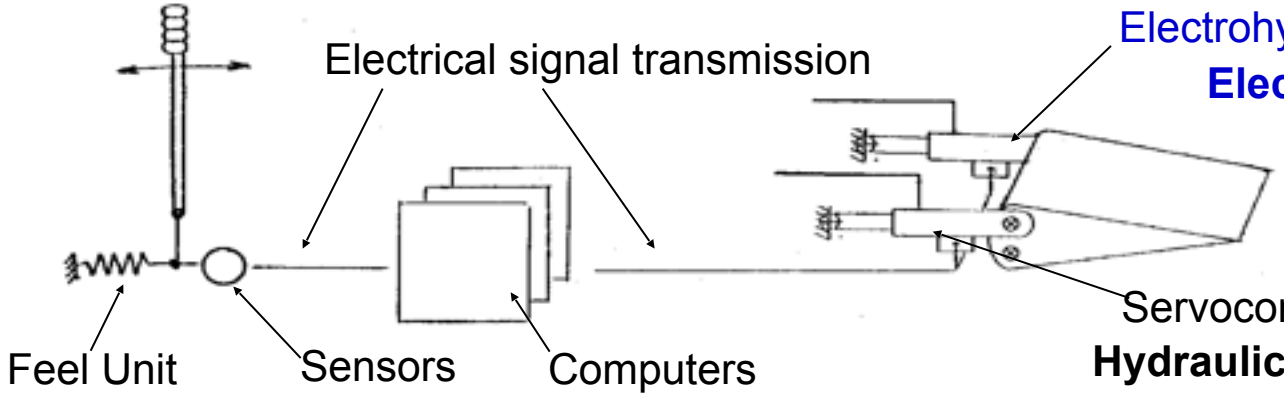
- Generals : Control surfaces & Cockpit controls
- Mechanical control systems (ATR)
- Hydromechanical control systems (A300/A310/B737 etc)
- First generation Fly by Wire systems (A320/A330/ A340/B777)
- New generation, hybrid power sources, full Fly By Wire systems (A380, others)
- Future trends, smart and more electric actuation

New generation, hybrid power sources, full FBW systems

- Airbus “More Electric” systems



FBW system



More Electric system

New generation, hybrid power sources, full FBW systems

- Airbus “More Electric” systems

Basic concept

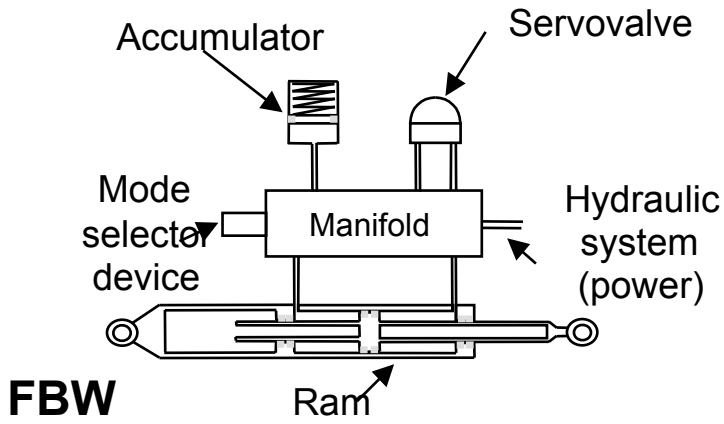
– Three independent power sources are required to make the complete loss of the flight control actuation system Extremely Improbable

– Large transport category airplanes are currently fitted with three independent hydraulic systems plus two independent electric systems, which makes a total of five independent power sources

– The basic idea is that one hydraulic system can be eliminated and replaced by a set of electrically powered actuators with no detrimental impact to the probability of loosing the flight control actuation system.

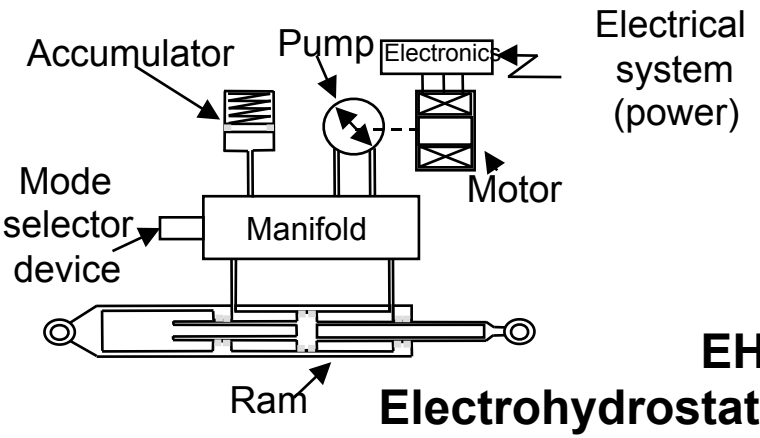
New generation, hybrid power sources, full FBW systems

- Key component, The Electrohydrostatic Actuator - EHA



FBW servocontrol

Servovalve replaced by an electric motor Pump

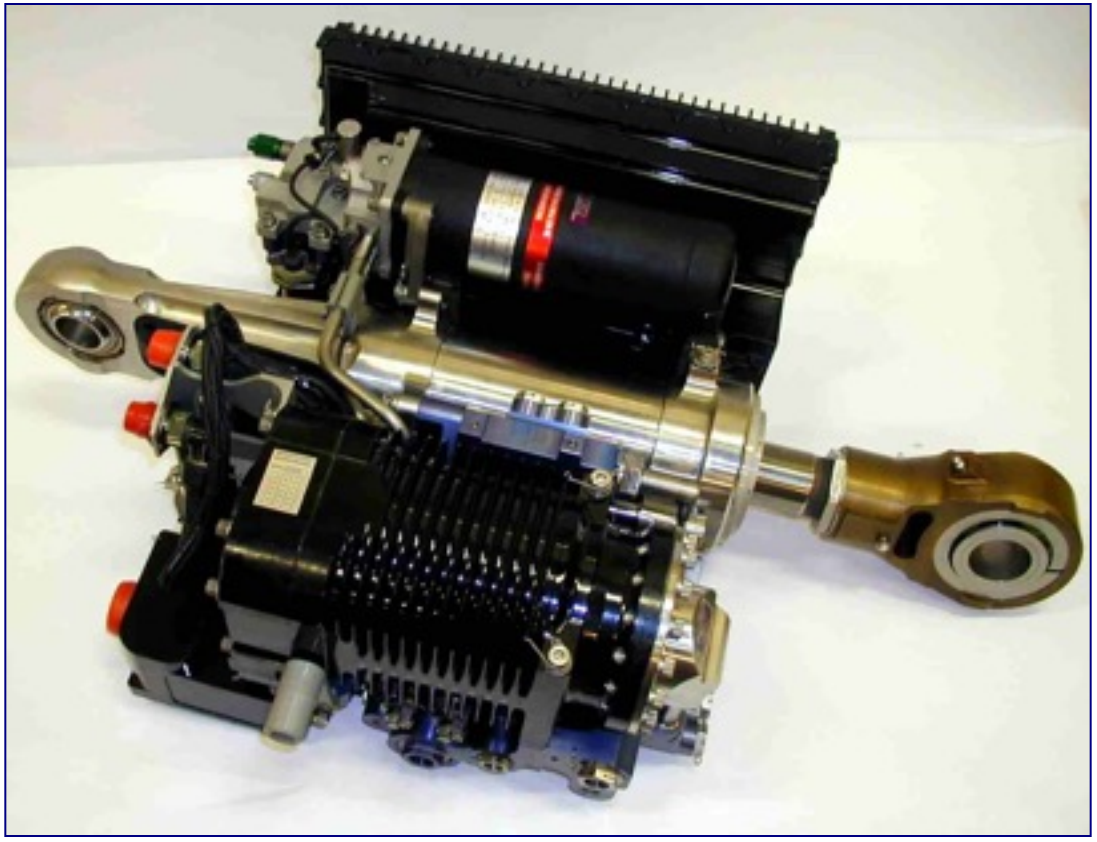


EHA Electrohydrostatic Actuator

A380 aileron EHA

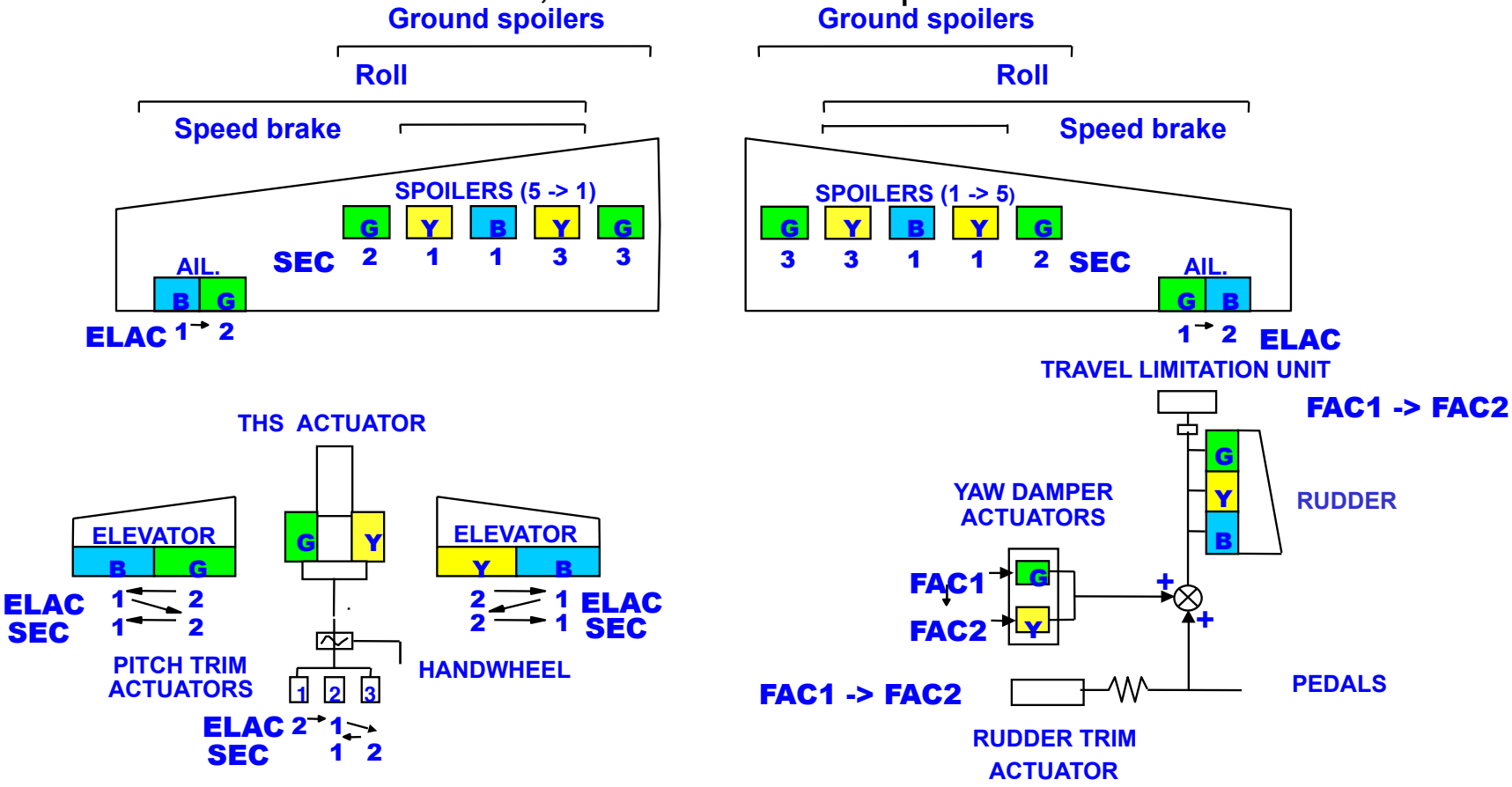
New generation, hybrid power sources, full FBW systems

- Key component, The Electrohydrostatic Actuator - EHA



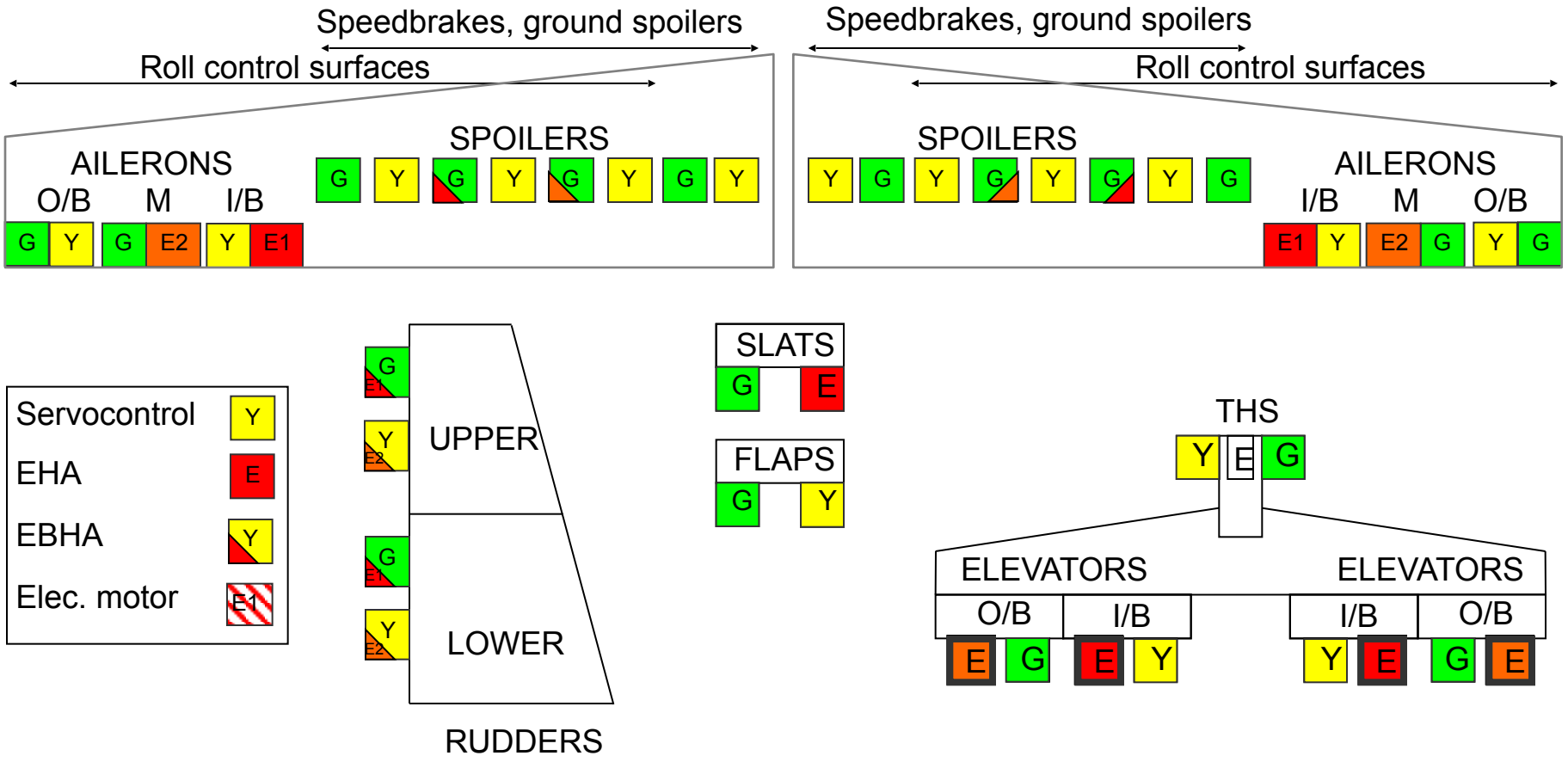
First generation Fly by Wire systems

A320 Power Source, Actuator and Computer Distribution



ELAC : Elevator and Aileron Computer **SEC** : Spoiler and Elevator computer **FAC** : Flight Augmentation Computer

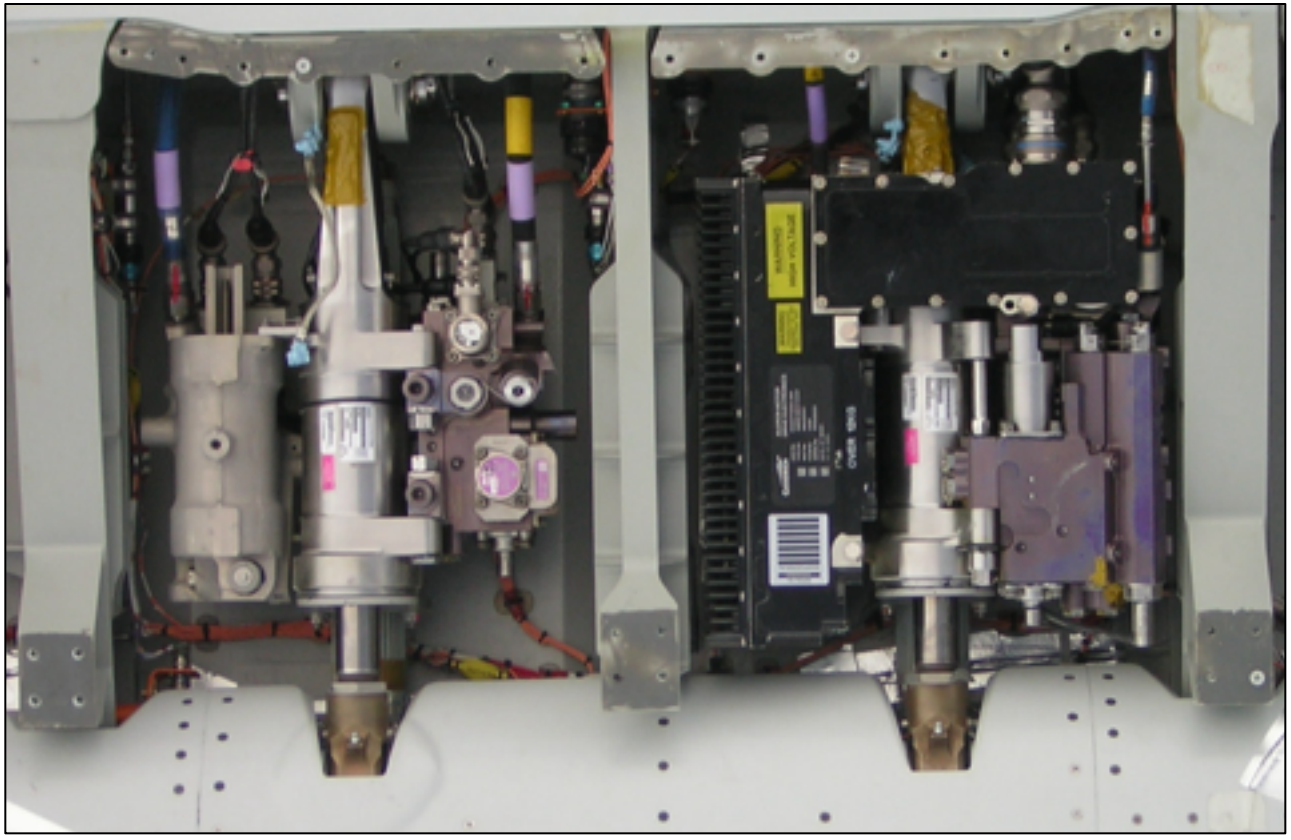
- A380 « 2H/2E » Power Source and Actuator Distribution



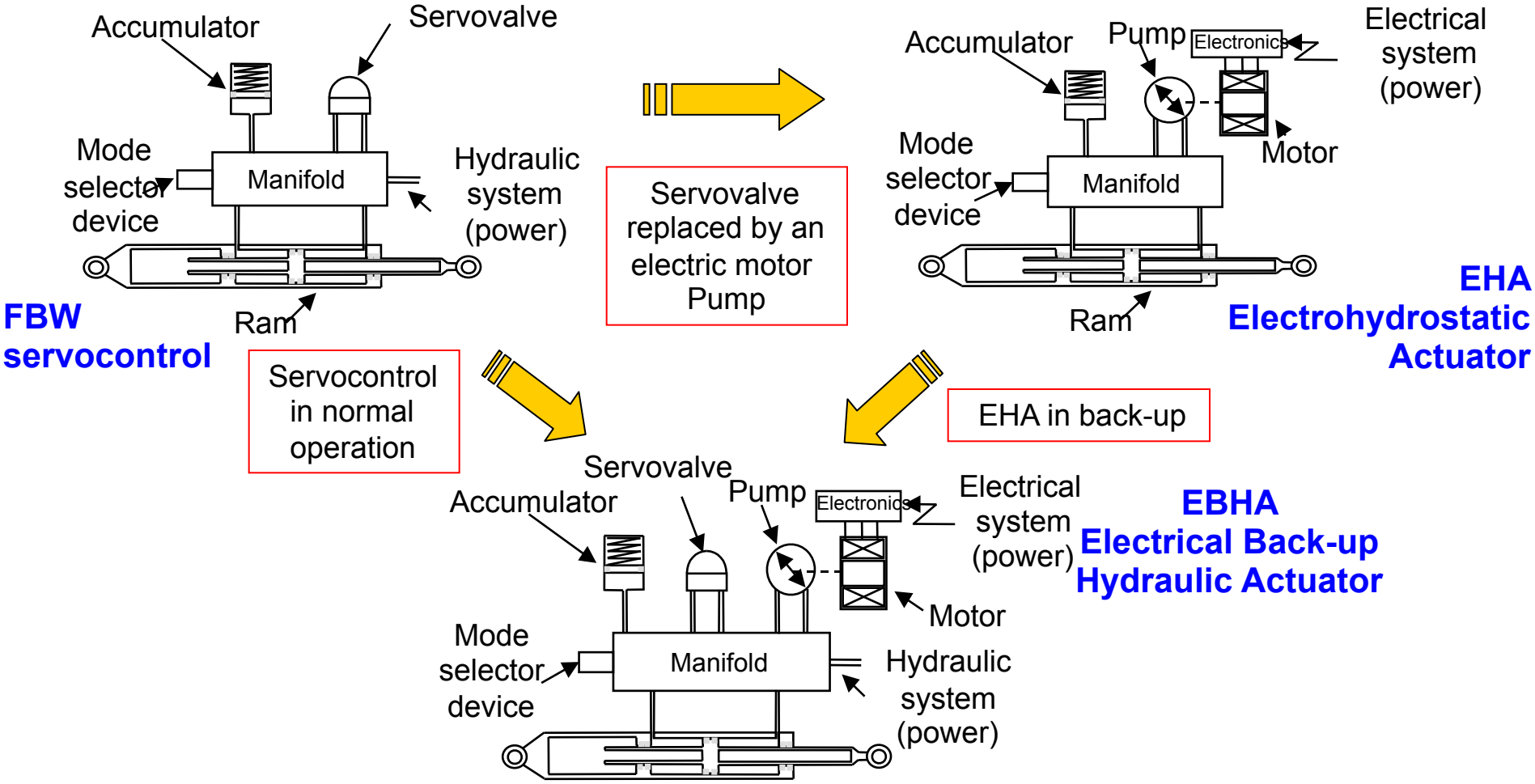
Electrically Powered Actuators in stand-by positions

New generation, hybrid power sources, full FBW systems

- EHA and servocontrol installation, A380 aileron

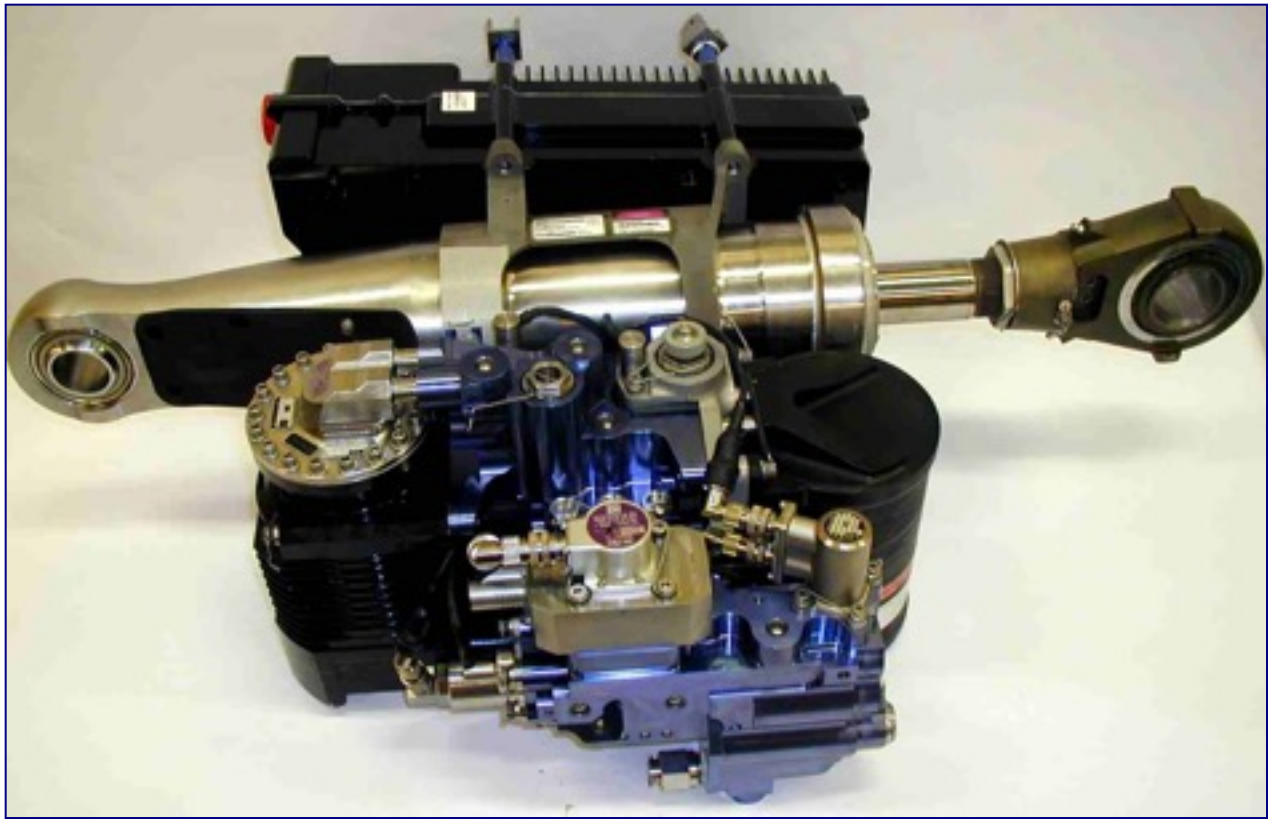


- Electrical Back-up Hydraulic Actuator - EBHA



New generation, hybrid power sources, full FBW systems

Electrical Back-up Hydraulic Actuator – EBHA, A380 rudder EBHA



New generation, hybrid power sources, full FBW systems

Electrical Back-up Control

New generation, hybrid power sources, full FBW systems

- Electrical Back-up Control

- The objective of the electrical back up is to achieve control and stability in case of temporary loss of all PRIM and SEC or of their electrical supply.

- The Back-up Control Module BCM becomes automatically operative in absence of inhibition signal from: PRIM1, PRIM3, SEC1 and SEC3.

- BCM is electrically powered by the BPS Back-up Power Supply

- The BCM is able to damp the dutch roll using internal yaw gyrometer and to stabilise the pitch axis using internal pitch gyrometer.

- When the BCM is activated, it controls all axes.

- It is impossible to activate the BCM axis per axis.

New generation, hybrid power sources, full FBW systems

•Overall benefits of the 2H / 2E arrangement

•Power source redundancy:
- •Increased number of power sources: 2 electrical systems replace 1 hydraulic system
- •Dissimilarity of power sources

•Survivability / robustness:
- •Make possible an efficient segregation of power distribution routes.
- •Electrical isolation of a part of the system easier/more efficient than hydraulic fuse
- •Reconfiguration in case of power generation failure more flexible

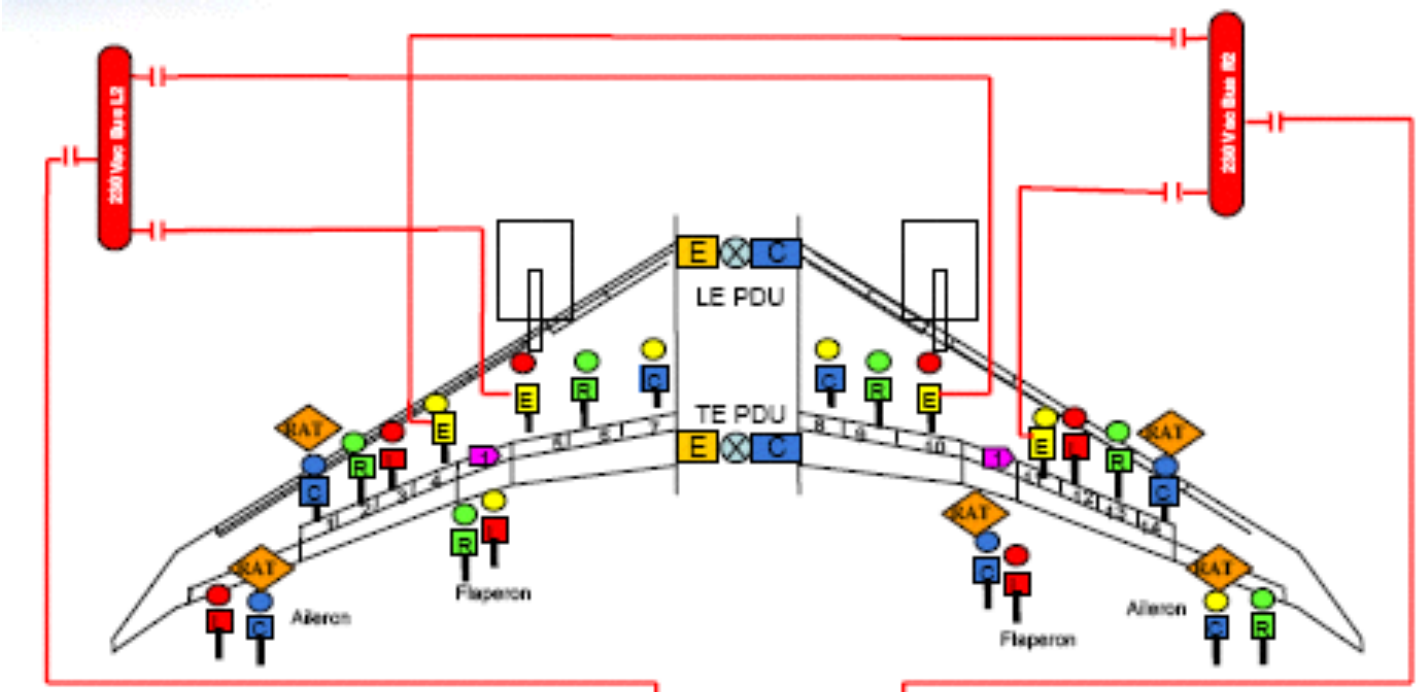
•Performance
- •Reduction of electrical power required: EHA efficiency better than EMP/servovalve
- •Weight saving.

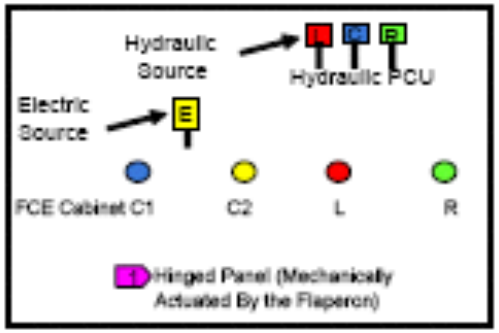
•Maintenance
- •Elimination of potential leakage sources

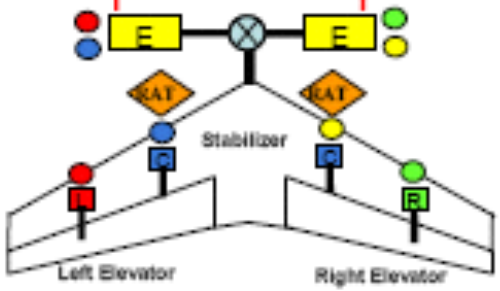
Actuation

- End of session
- Thank You!
- Any question?

- The B787 approach







2 EMA spoiler Pairs

Electric horizontal stabilizer actuator

A350 Flight Control Architecture