# Data Bus

- It provides a medium for the exchange of data and information between various

  Avionics subsystems

- Integration of Avionics subsystems in military or civil aircraft and spacecraft.

# TYPES OF PROTOCOLS

**Command/Response** :**Centralized Control Method**

**Token Passing** : **Decentralized Control Method**

**CSMA/CA** : **Random Access Method**

# Topology

**How the systems are interconnected in a particular fashion**

**LINEAR NETWORK**

- **Linear Cable**
- **All the systems are connected in across the Cable**

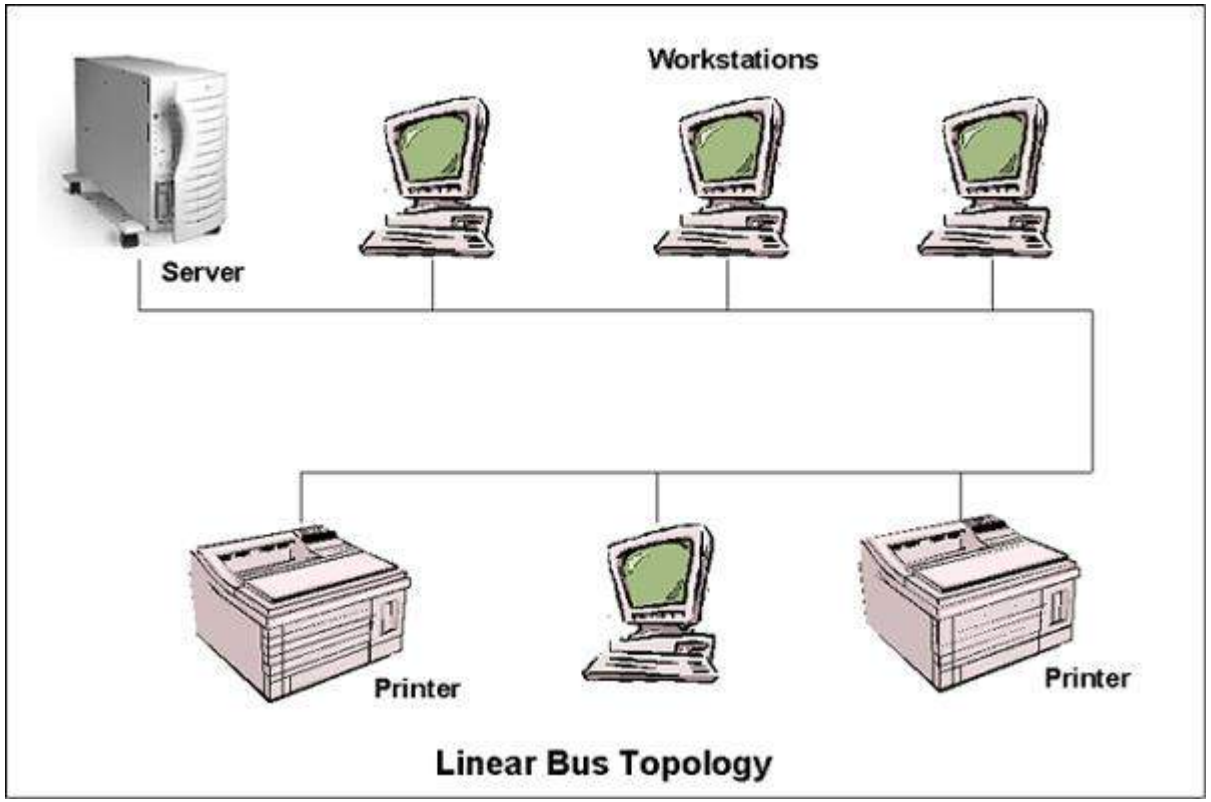
**RING NETWORK**

- **Point to Point interconnection**
- **Datas flow through the next system from previous system**

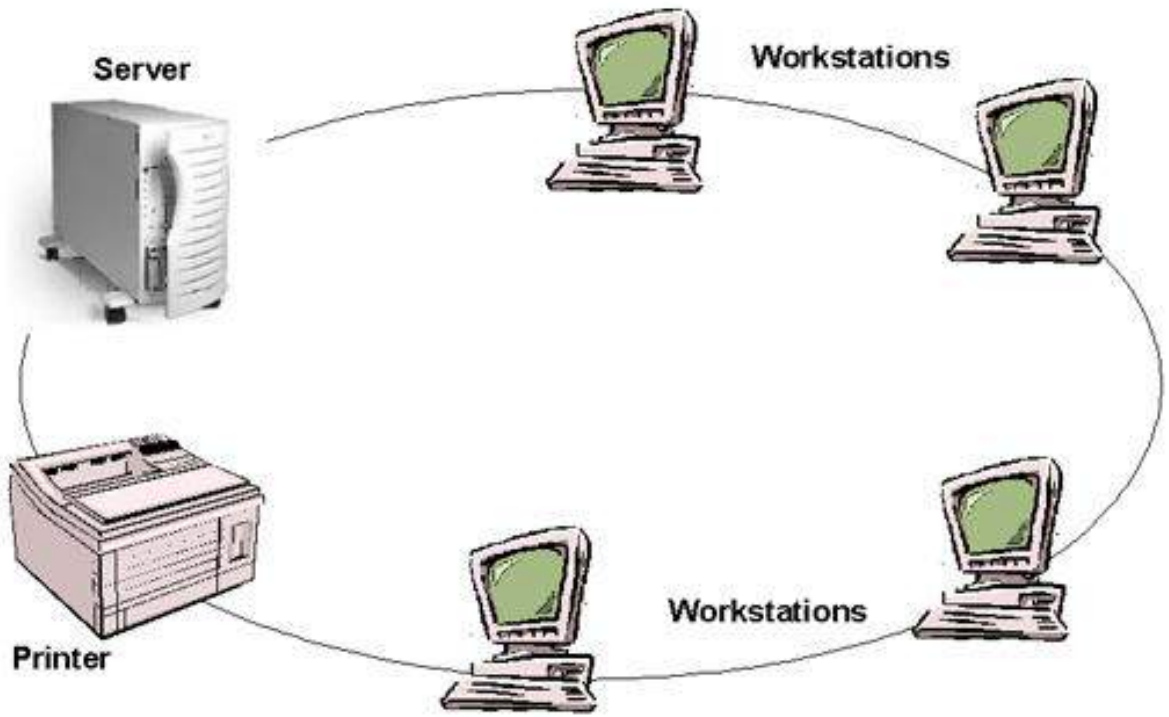
**SWITCHED NETWORK**

- **Similar to telephone network**
- **Provides communications paths between terminals**

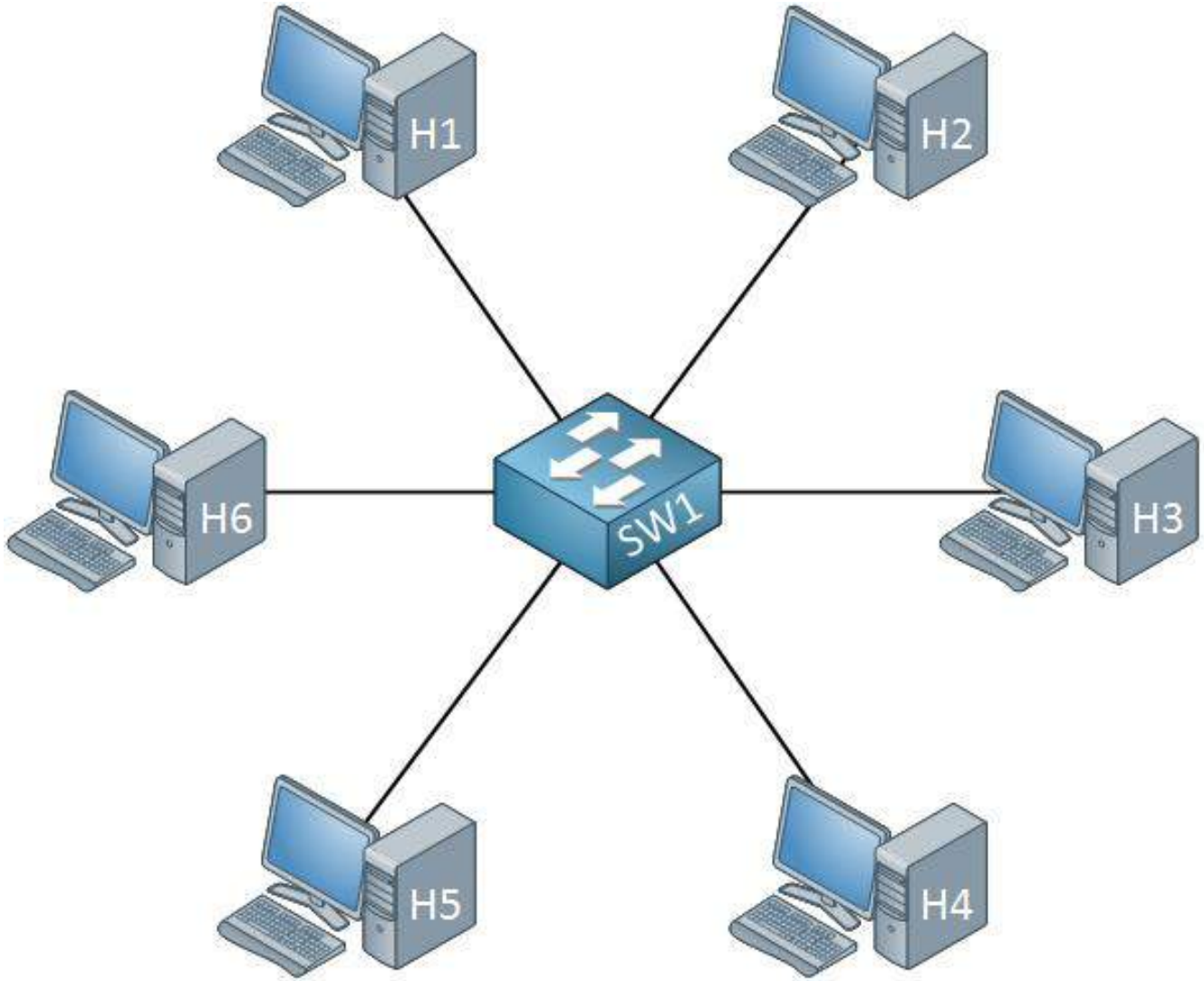
# Linear



# Ring



# Switched



# MIL-STD 1553B

- Developed at Wright Patterson Air Force  Base in 1970s
- Published First Version 1553A in 1975
- Introduced in service on F-15 Program
- Published Second version 1553B in 1978

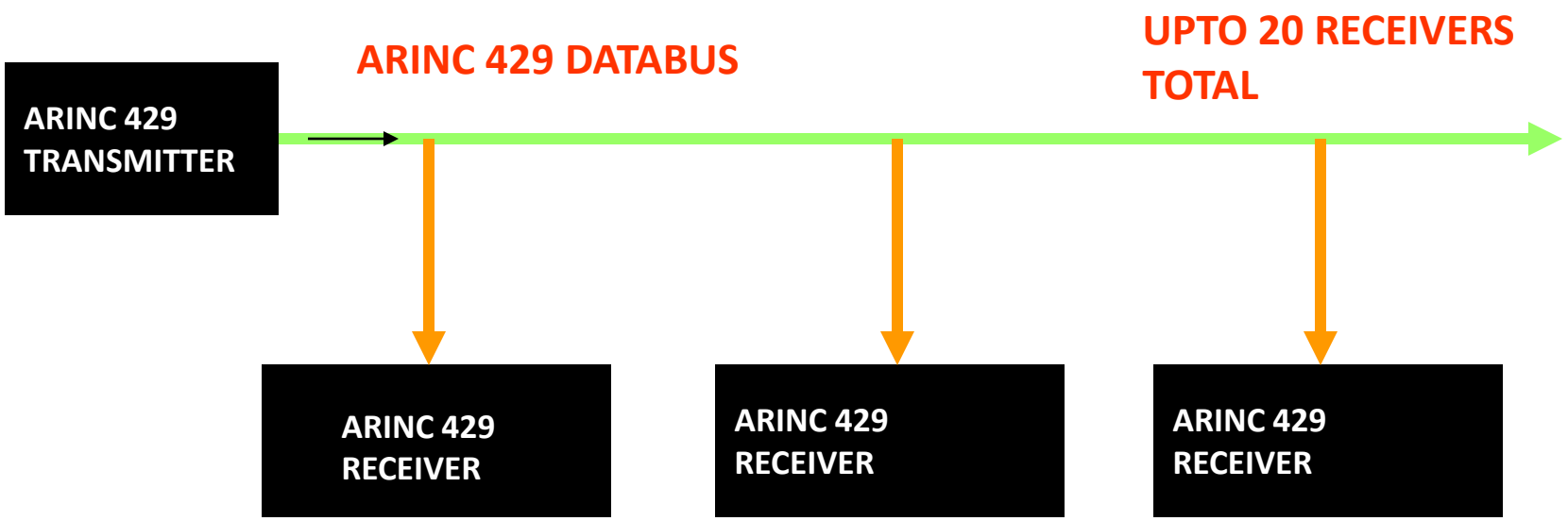
- **MIL-STD-1553**, ***Command / Response Aircraft Internal Time Division Multiplex Data Bus***, **is a Military standard which has become one of the basic tools being used today for integration of Avionics subsystems**

- **This standard describes the method of communication and the electrical interface requirements for the subsystems connected in the data bus**

# SPECIFICATION OVERVIEW

| | |
|---|---|
| Data Rate | 1 Mbps |
| Word Length | 20 Bits |
| Message Length | 32 Word Strings(maximum) |
| Data Bits per Word | 16 Bits |
| Transmission Technique | Half - Duplex |
| Encoding | Manchester II Bi-phase |
| Protocol | Command Response |
| Transmission Mode | Voltage Mode |

# ARINC 429


ARINC 429 DATABUS
UPTO 20 RECEIVERS TOTAL
ARINC 429 TRANSMITTER
ARINC 429 RECEIVER
ARINC 429 RECEIVER
ARINC 429 RECEIVER

# ARNIC 629

**1977 => Boeing began to work on “DATAC” project**

**1977 - 85 => DATAC Emerged as ARINC 629**

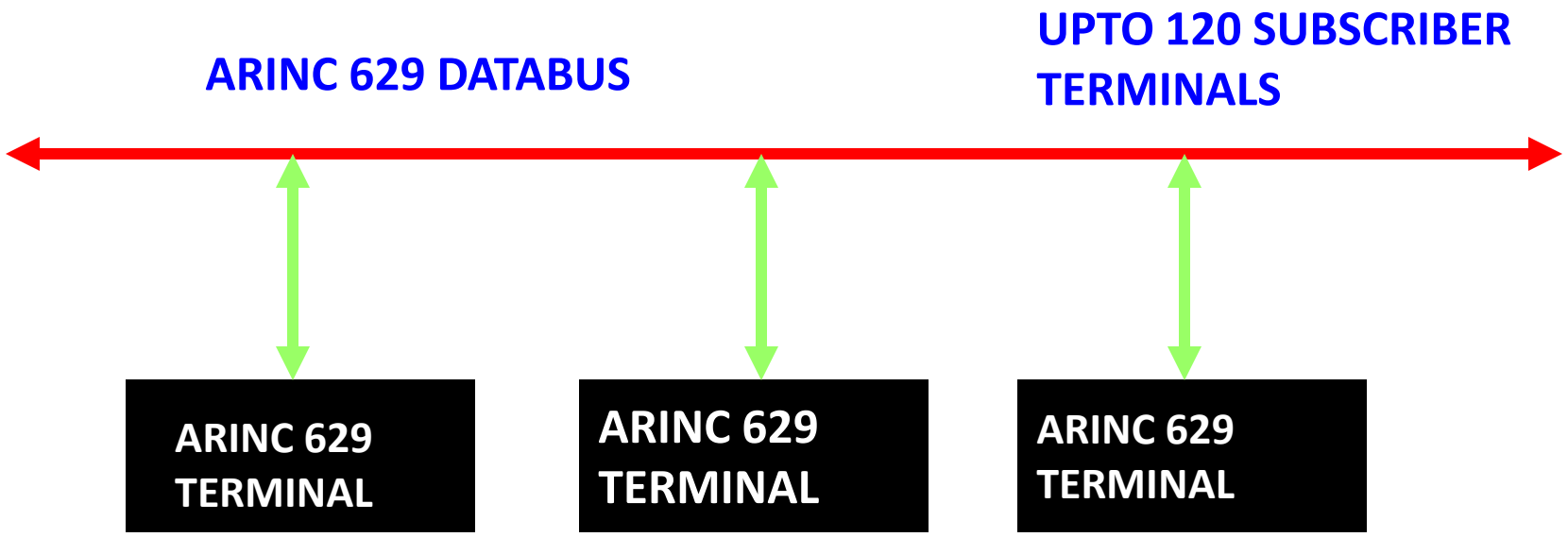
**1989 => ARINC 629 was adopted by AEEC**

**1990 => ARINC 629 was first implemented in BOEING-777**

# SPECIFICATION OVERVIEW

| | |
|---|---|
| Data Rate | 2 Mbps |
| Word Length | 20 Bits |
| Message Length | 31 Word Strings(maximum) |
| Data Bits per Word | 16 Bits |
| Transmission Technique | Half - Duplex |
| Encoding | Manchester II Bi-phase |
| Protocol | Carrier Sense Multiple Access Collision avoidance |
| Transmission Mode | Voltage Mode,Current Mode, Fiber Optic Mode |

# ARNIC 629 ARCHITECTURE



# AFDX [ARNIC 664]

- **Avionics Fully Duplex Switched Ethernet** is an advanced Protocol Standard to interconnect avionics subsystems
  - It can accommodate future system bandwidth demands
  - Increase flexibility in Avionics design
  - Reduce aircraft wire counts, thus lowering aircraft weight and cost

- Since the Ethernet is a switched architecture rather than a point-point link, aircraft designers can create redundant sub networks

- Faults can be isolated and analysed without impacting the system as a whole

- ARINC 429 data bus may still be used but the main Avionics data pipe will be Ethernet (AFDX) of 100 Mbps

# HSDB

- Used in F-22 Advanced tactical fighter
- Generic version SAE Aerospace Standard 4074.1
- 50 Mbps- linear bus
- for optical medium implementation – star topology
- HSDB uses distributed control in which each terminal is permitted to transmit only when it receives the token frame.

# SCI

- IEEE –STD-1596-1992
- SCI is an interconnect system for both backplane and LAN usage.
- It is a system of rings and switches in its basic format
- Operates at 1 Gbps
- Electrical links upto 30m and optical links upto several kms.
- Same Bandwidth as today's 155Mbits/sec ATM links , 32 times that of today's fiber optic channel and 800 times that of Ethernet.

## Signaling Rate

1553B - 1Mbps

Ethernet(AFDX) - 100Mbps

ARINC 429 - 100Kbps or 12-14.5Kbps

ARINC 629 - 2Mbps

# MIL-STD 1553

# WHY OPTICAL FIBER?

- Though 1553B is used in various modern aircraft, it is recognised that buses operate in extremly severe environment like
- EMI from intersystem and intrasystem
- Lightning
- Electrostatic discharge
- High Altitude Electromagnetic pulse

- Fiber-optic version of 1553B
- It also operates at the rate of 1Mbps
- It also have the same 20 bit word and three words such as command word, status word and data word
- stronger immunity to radiation-induced electromagnetic interference

# CAN BUS

- Controller Area Network (CAN) is the network Established among microcontrollers.

- Carrier-sense multiple access with collision avoidance (CSMA/CA) Protocol

- Two wire high speed network system which was firstly Established to overcome the problems (wire harness,Communication) faced in automobiles.

- Linked up to 2032 devices(assuming one node with one identifier) on a single network.

- CAN offers high speed communication up to 1 Mbps, thus allowing real time control.

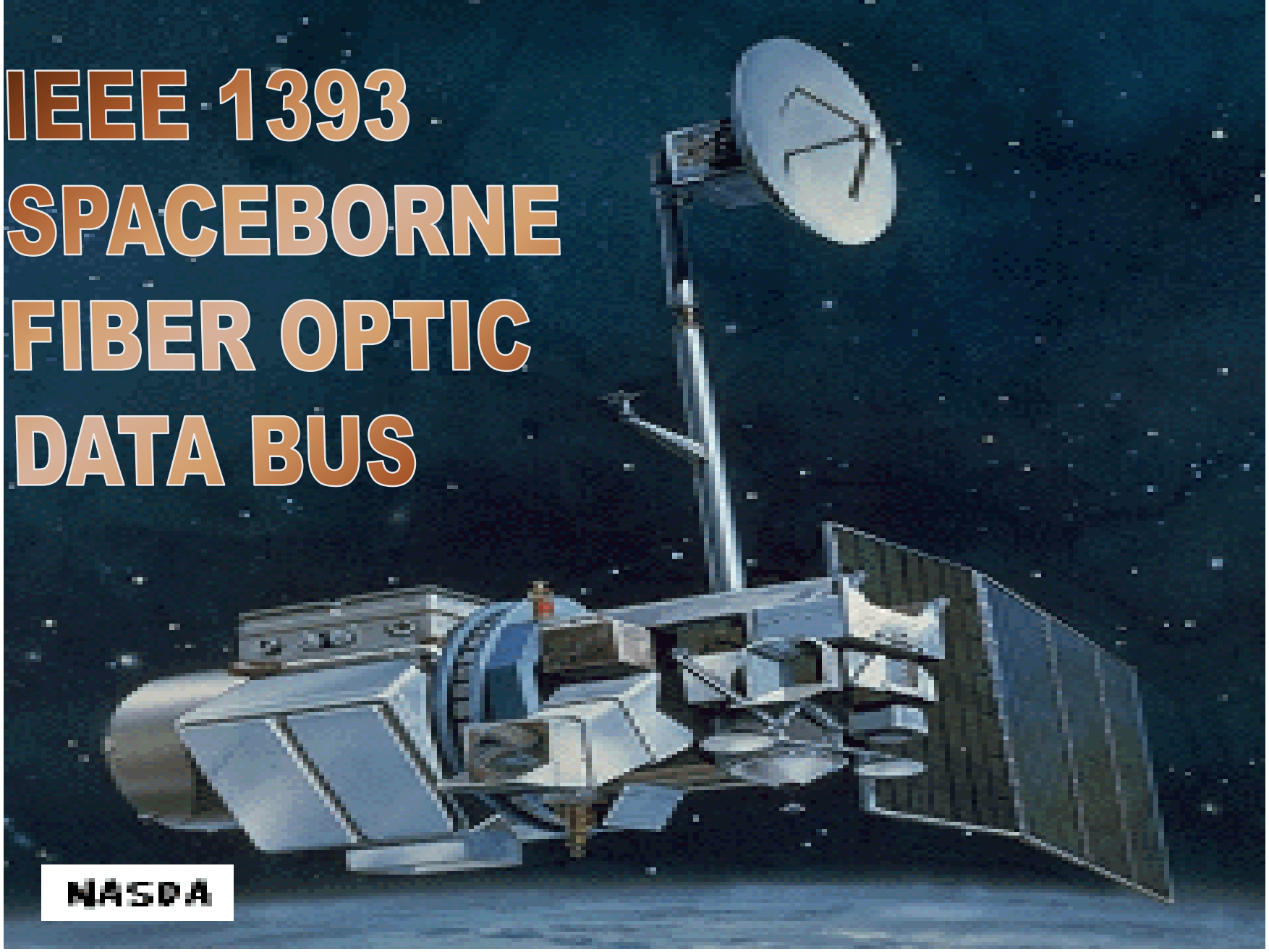
# Digibus

• Originally **Ginabus (G**estion des **I**nformations **N**umeriques **A**eroportees – Airborne Digital Data Management)

• Designed jointly by Electronique Serge Dassault (ESD) and Avions Marcel Dassault- Breguet Aviation (AMD-BA) and SAGEM between 1973 and 76

• Digibus is now standard for all branches of French Military.


DATA BUSES
IN
SPACE APPLICATIONS


IEEE 1393
SPACEBORNE
FIBER OPTIC
DATA BUS
NASDA

# MDM DATA BUS

- Serial point to point communication

Between space shuttle payload general support computer and various subsystems

- MDM interface consists of a serial data bus and three discretes (Message in, Message out and word)

- Discrete contains the timing , direction and No. of words on the serial data bus

# AVIONICS ARCHITECTURE

# AVIONICS SYSTEM ARCHITECTURE

- Establishing the basic architecture is the first and the most fundamental challenge faced by the designer

- The architecture must conform to the overall aircraft mission and design while ensuring that the avionics system meets its performance requirements

- These architectures rely on the data buses for intra and intersystem communications

- The optimum architecture can only be selected after a series of exhaustive design tradeoffs that address the evaluation factors

# AVIONICS ARCHITECTURE

**First Generation Architecture ( 1940's –1950's)**

- Disjoint or Independent Architecture ( MiG-21)
- Centralized Architecture (F-111)

**Second Generation Architecture ( 1960's –1970's)**

- Federated Architecture (F-16 A/B)
- Distributed Architecture (DAIS)
- Hierarchical Architecture (F-16 C/D, EAP)

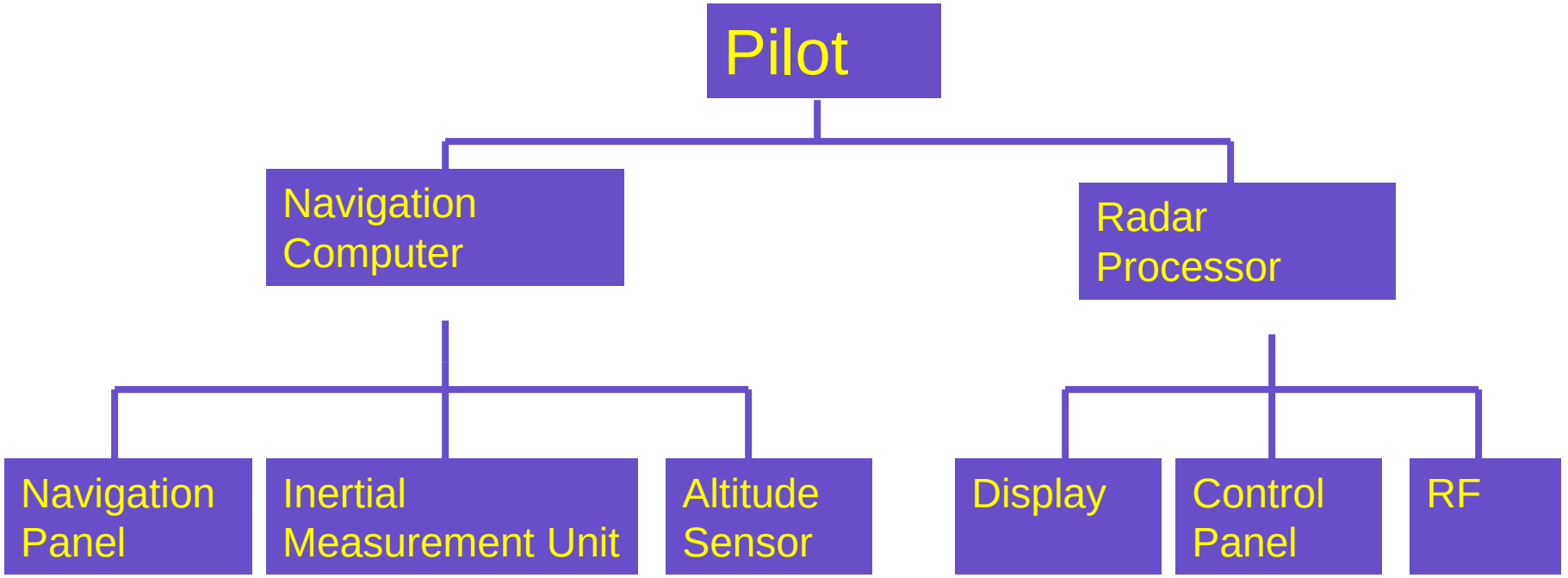
**Third Generation Architecture ( 1980's –1990's)**

- Pave Pillar Architecture ( F-22)

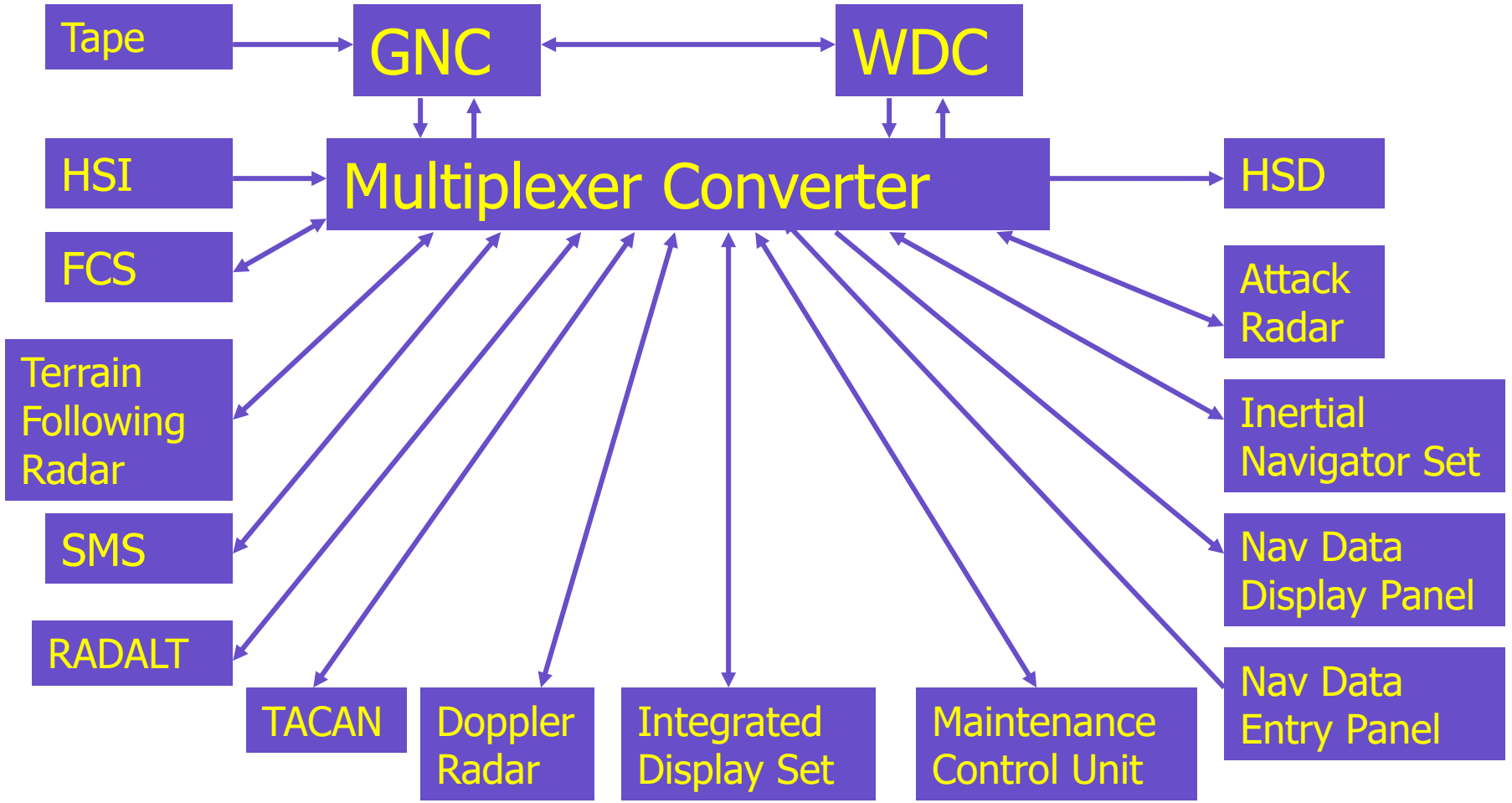
**Fourth Generation Architecture (Post 2005)**

- Pave Pace Architecture- JSF
- Open System Architecture

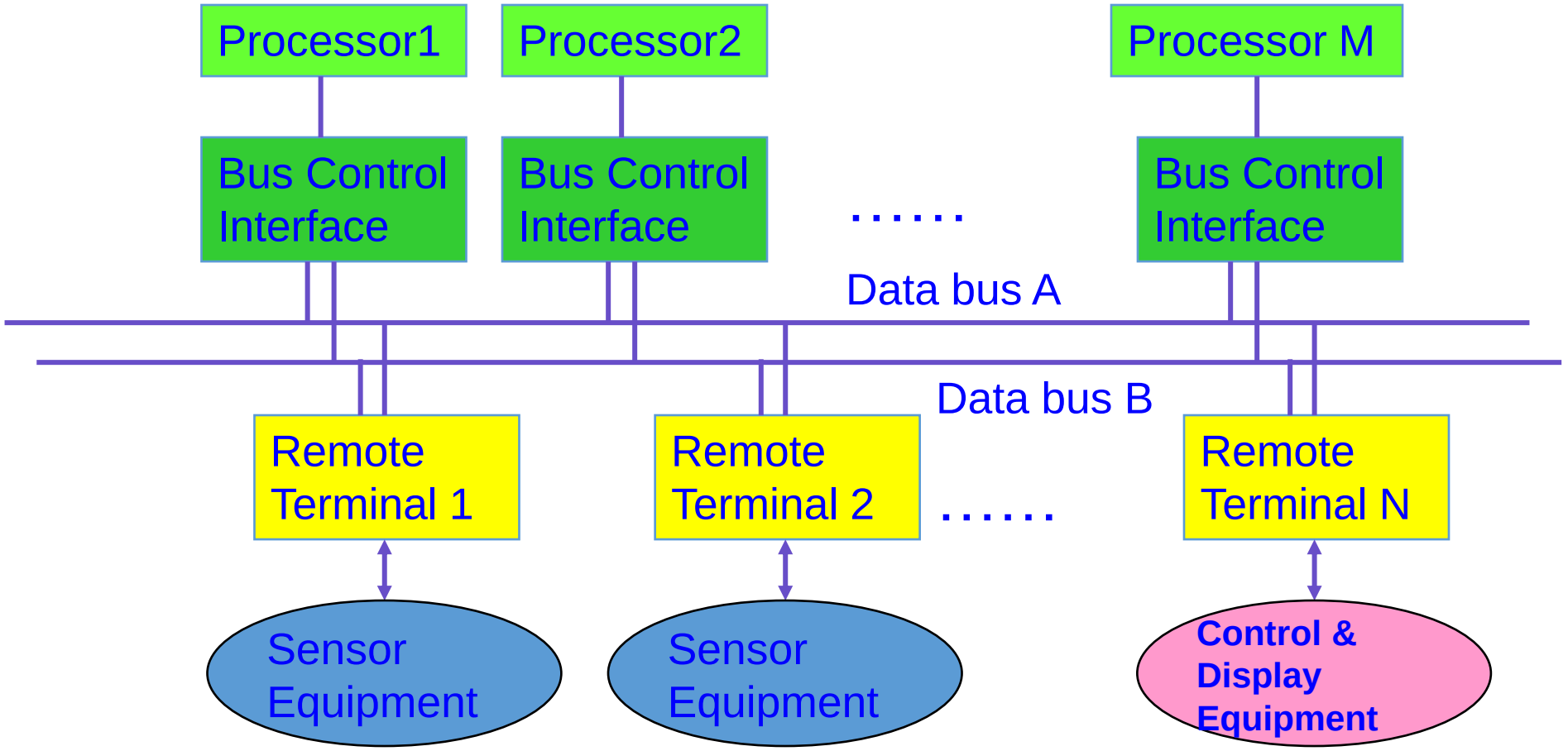
# FGA - DISJOINT ARCHITECTURE



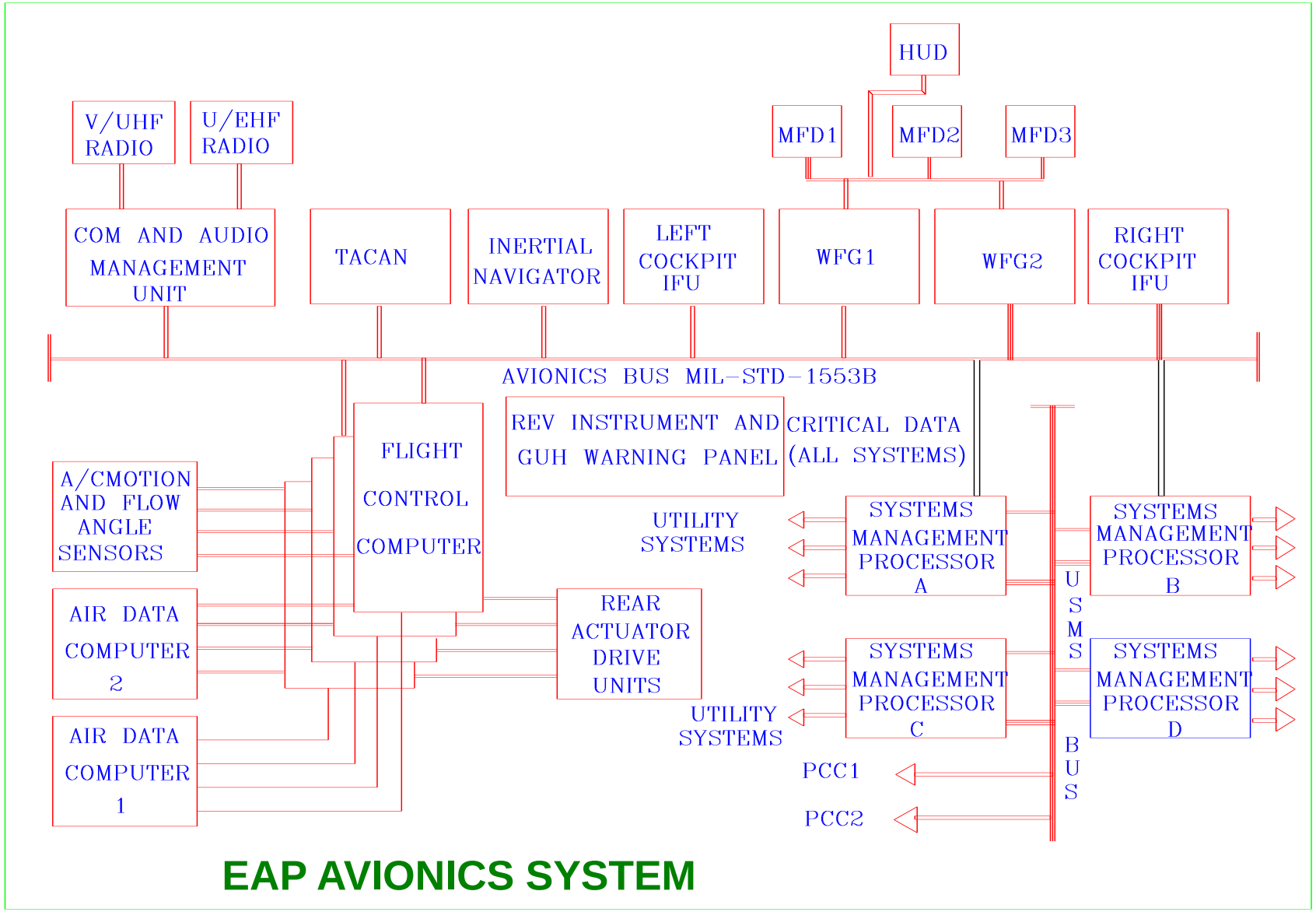
# FGA - CENTRALIZED ARCHITECTURE



# SGA - DAIS HARDWARE ARCHITECTURE

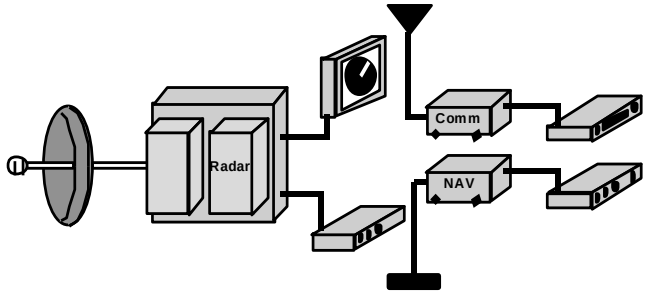


# SGA - HIERARCHICAL SYSTEM

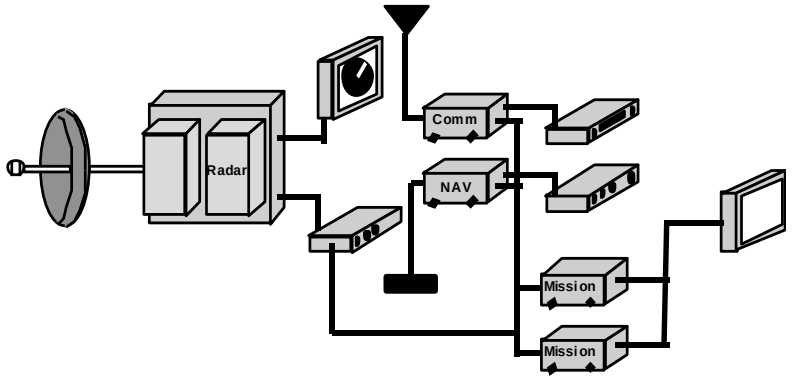



## EAP AVIONICS SYSTEM

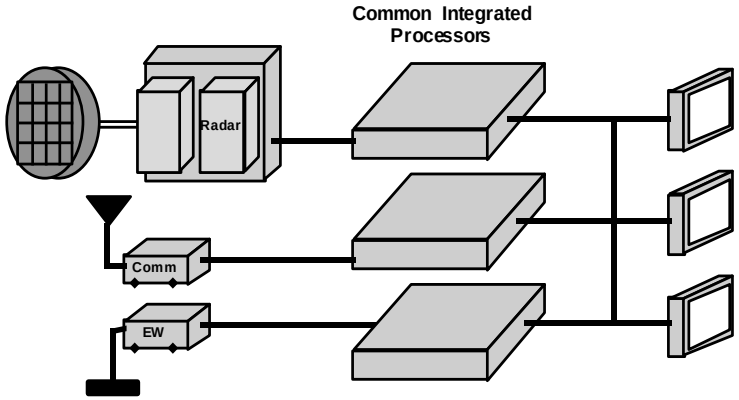
# AVIONICS SYSTEM EVOLUTION



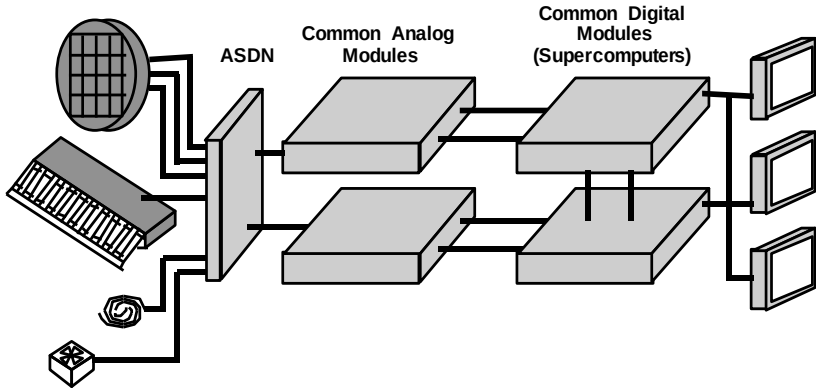

**Independent Avionics**
**(40's - 50's)**




**Federated Avionics**
**(60's - 70's)**




**Integrated Avionics**
**(80's - 90's)**




**Advanced Integrated Avionics**
**(Post 2000)**

# KEY OBSERVATIONS

## AVIONICS ARCHITECTURAL EVOLUTION

- Increased Digitization of Functions
- Increased sharing and modularization of functions
- Integration/ sharing concepts increased to the skin of the aircraft
- Functionality has increasingly obtained through software
- Complex hardware architecture modules
- Complex software modules
- Increased network complexity and speed

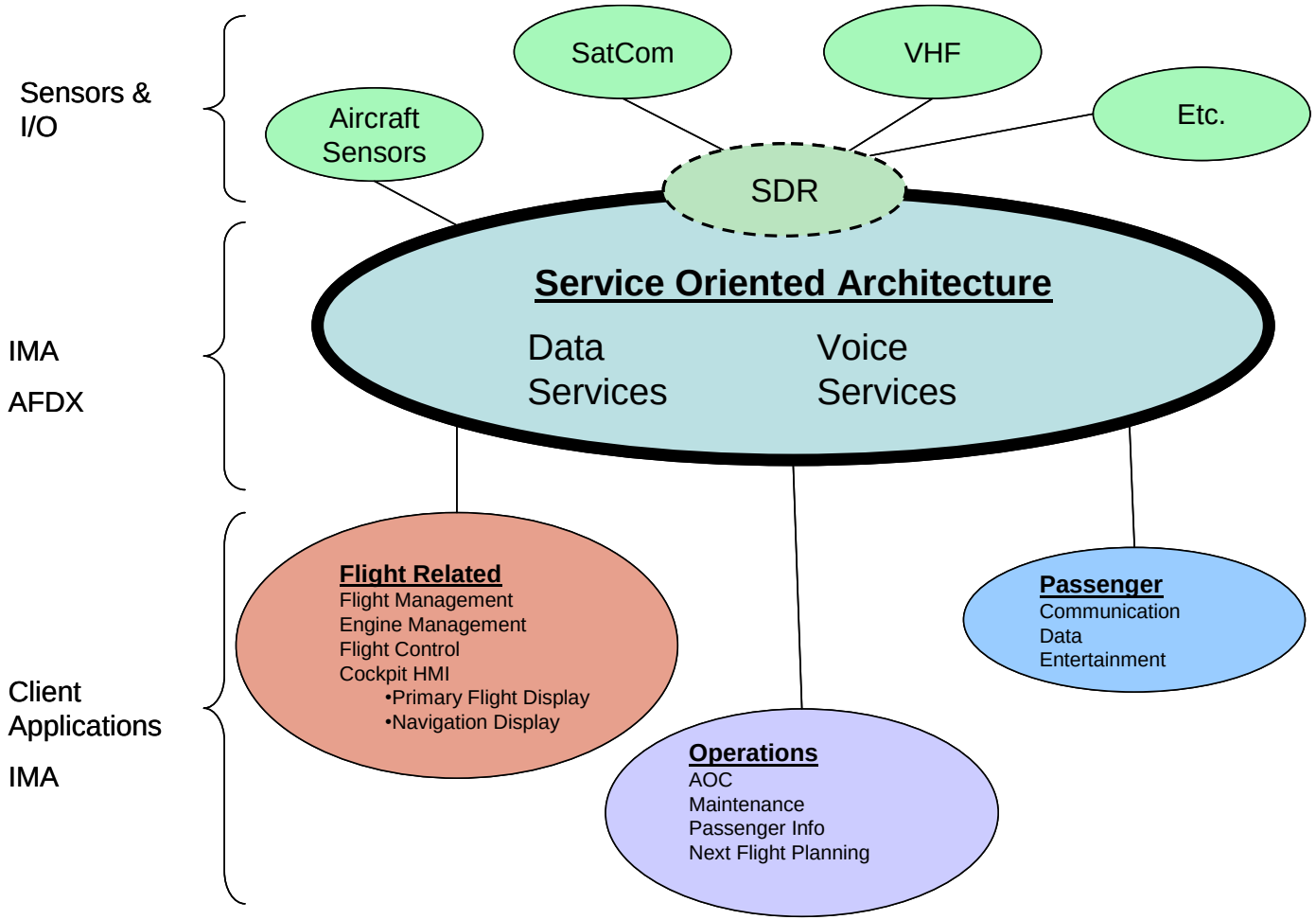
# Current avionics

- **Many Line Replaceable Units (LRU)**
  - Communication systems – multiple VHF radios, HF, satellite, etc
  - Similarly for navigation and surveillance
- **Multimode units will reduce unit count**
  - Multimode navigation system already
  - Multimode communications systems are expected
- **Integration of communication, navigation and surveillance data only takes place in the cockpit HMI and is performed by the pilot at the moment**
  - New architectures will enable closer information integration

# New aircraft architectures

- Boeing and Airbus have adopted new network-based approach to interconnection on their new aircraft – **B787 and A380**
  - Enabled through Integrated Modular Avionics (IMA)
- Flexible Application Environment
  - Data is shared more widely with a range of applications
  - Sensors provide data for use by a wide range of applications
- Service-oriented architecture (SOA)
  - Enables integration with current systems in a phased approach without any major architectural changes

# Future Avionics Architecture



# Thank You