Dassault Aviation feedbacks on its military and civil IMA applications

Thierry Cornilleau

ARTIST2 meeting on Integrated Modular Avionics

November 12-13, 2007, Roma (Italy)

Contents

- *MDPU - IMA in military aircrafts*
- *EASy - IMA in Falcon business jets*
- *Key points*
- *Next challenges*
- *Conclusions*
- *Questions*

MDPU
IMA in military aircrafts

DASSAULT AVIATION

MDPU Objectives

MDPU = Modular Data Processing Unit

- *Offer growth potential*
- *Improve technological obsolescence management*
- *Third party developments*
- *Simplify the support*
- *Reduce recurring cost*

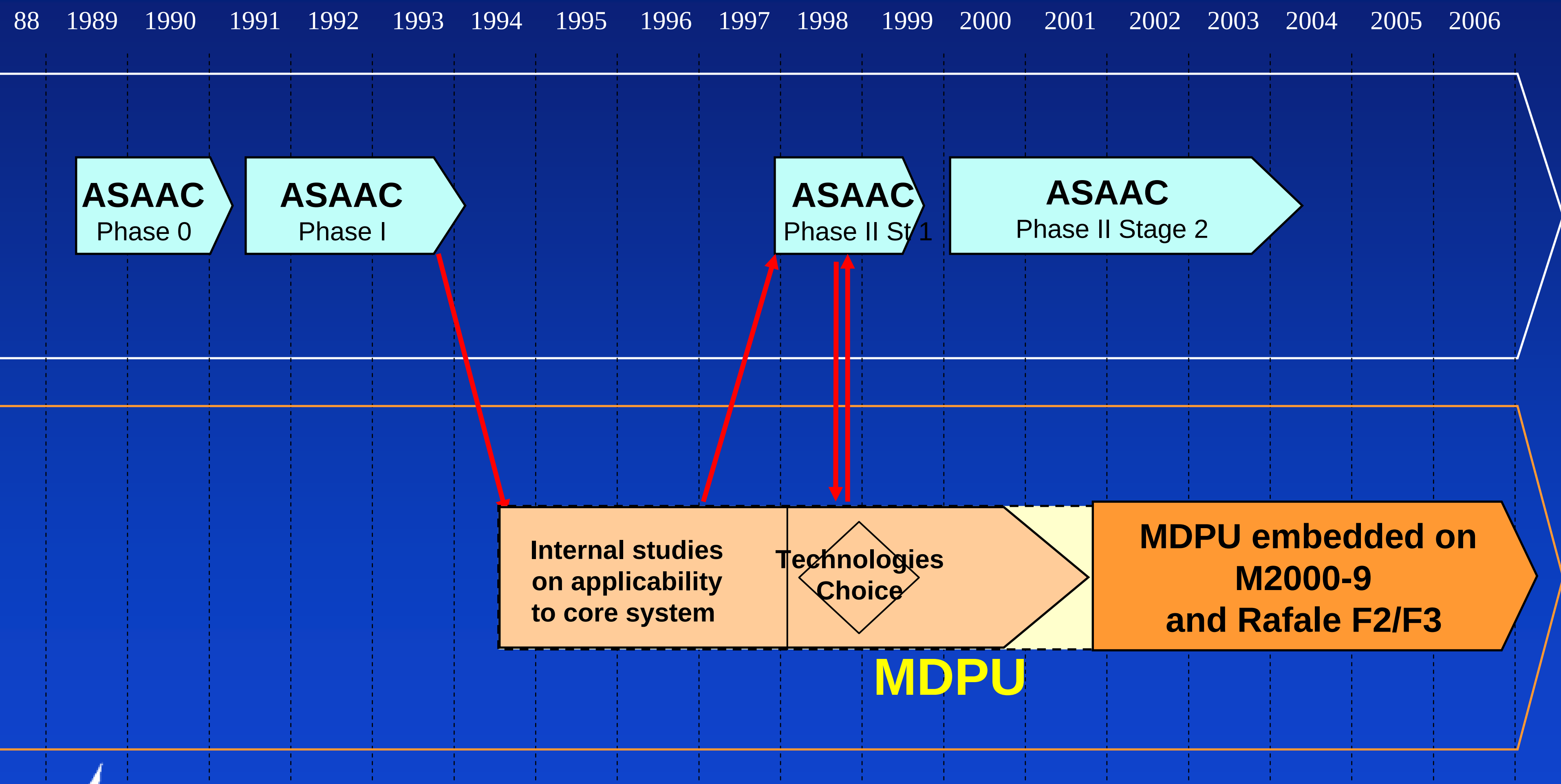
- *By providing HW and SW resources which are generic and configurable*

Implementation constraints

Implementation of ASAAC concepts taking into account :

- *Available technology in 1999*
- *Maturity of concepts (lessons learned from French studies)*
- *Application limited to A/C core system*
  - non critical functions: mission management, flight path management, map generation, MMI, data storage, …
  - critical interruptible functions: terrain following, …
- *Requirements to install MDPU into 2 existing aircrafts (Rafale et Mirage 2000)*

History



88
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
ASAAC Phase 0
ASAAC Phase I
ASAAC Phase II St 1
ASAAC Phase II Stage 2
Internal studies on applicability to core system
Technologies Choice
MDPU embedded on M2000-9 and Rafale F2/F3
MDPU

MDPU generic architecture

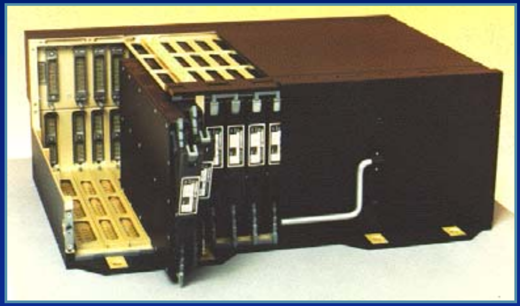
Elementary components:

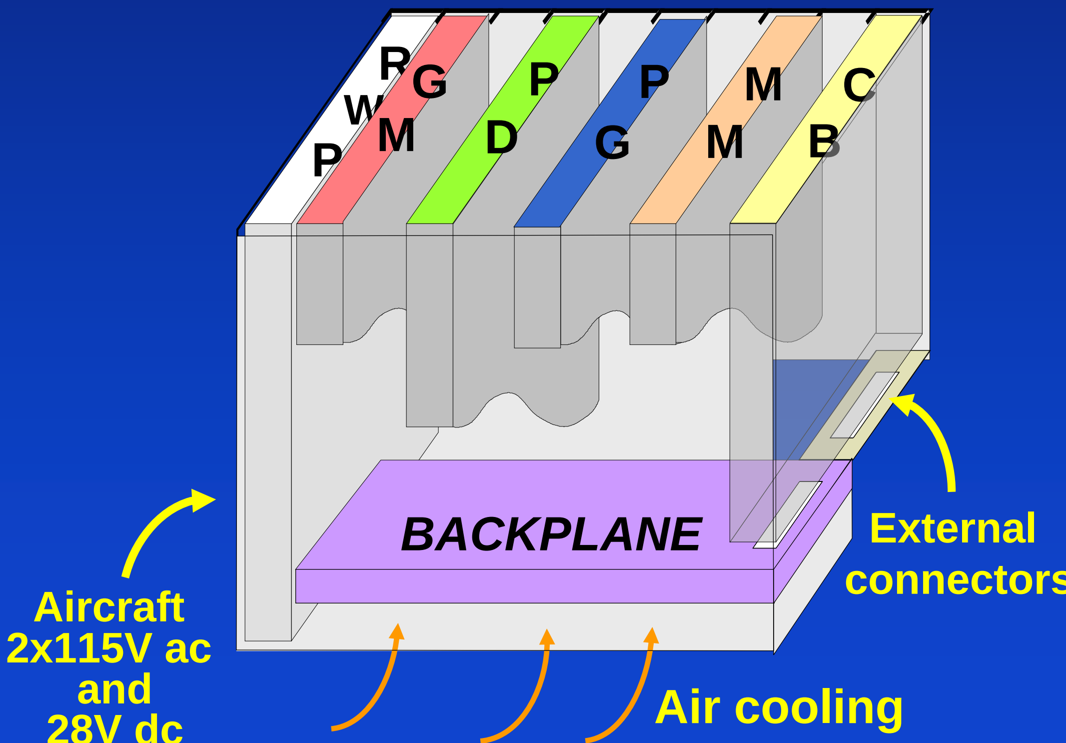
1 Rack : SCI backplane + 1 2xPWR supply + 18 slots

5 common functional modules:

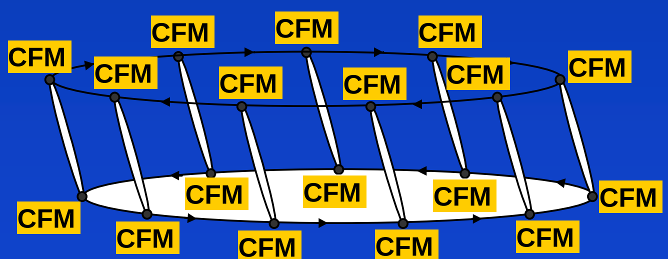
- DP Data Processing
- GP Graphic Processing
- BC Bus Coupling
- MM Mass Memory
- MG Map Generator

Dummy modules for spare slots



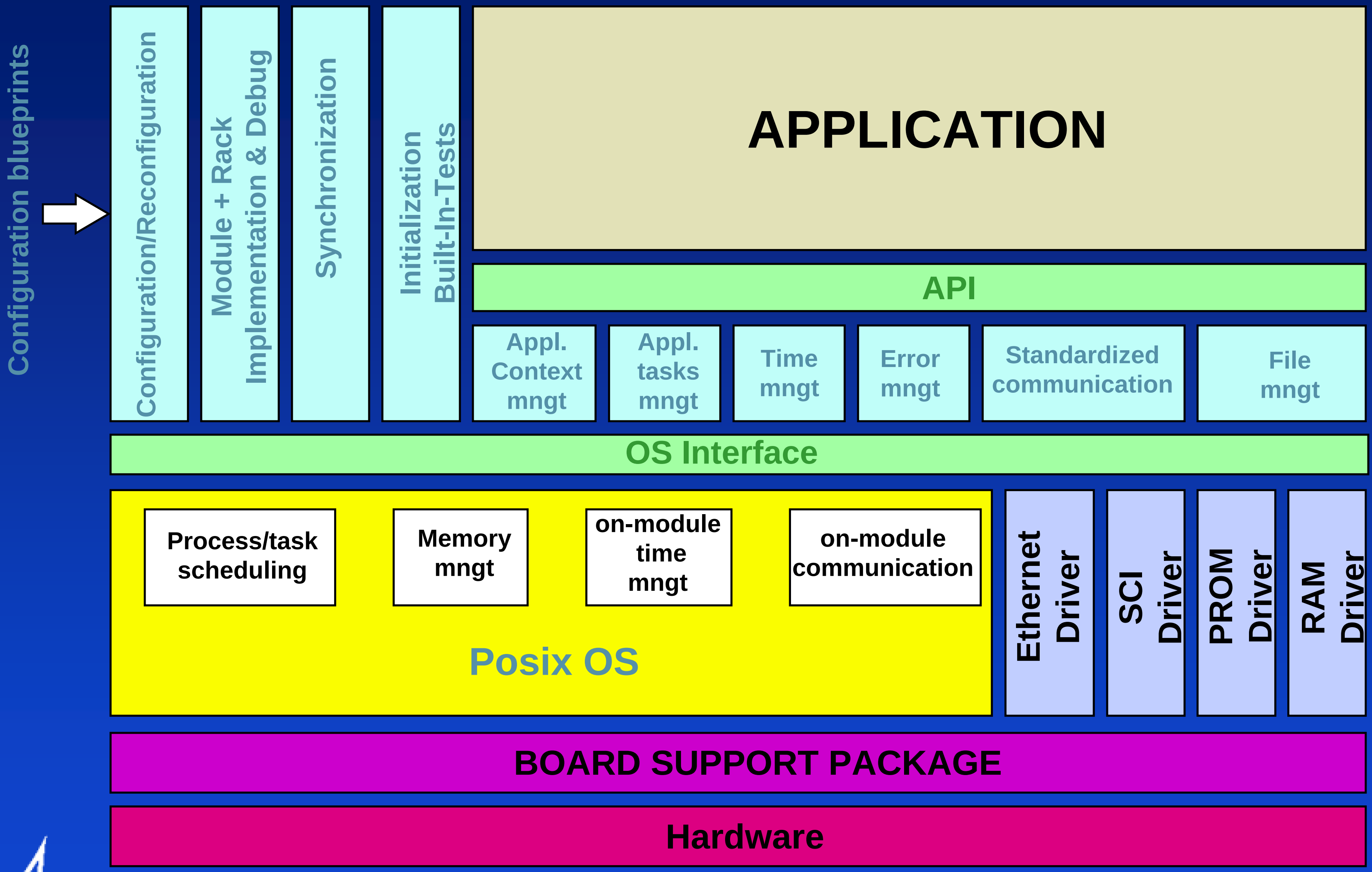


SCI backplane topology:



DASSAULT AVIATION

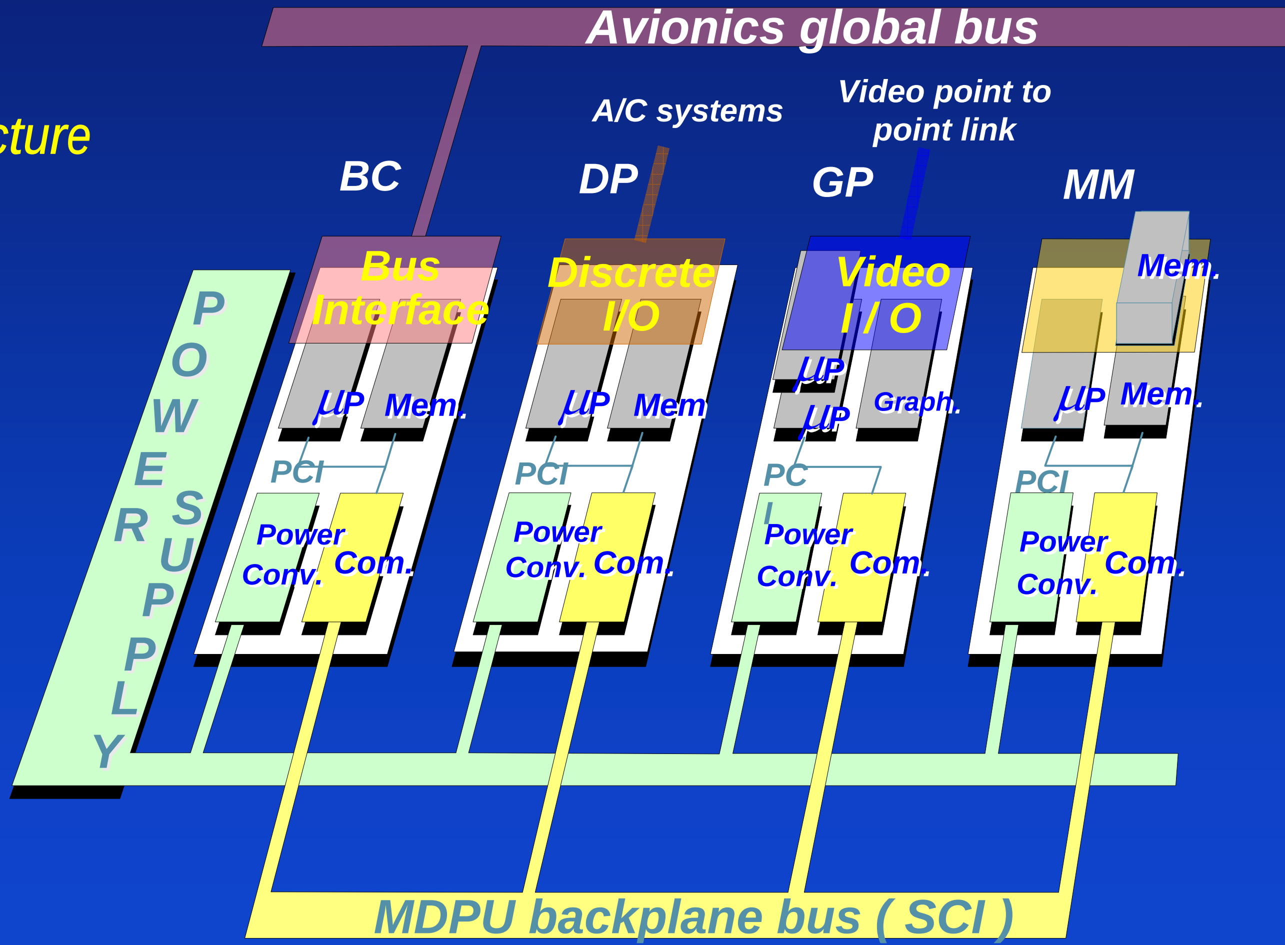
MDPU software architecture



Module generic architecture

Modular internal architecture

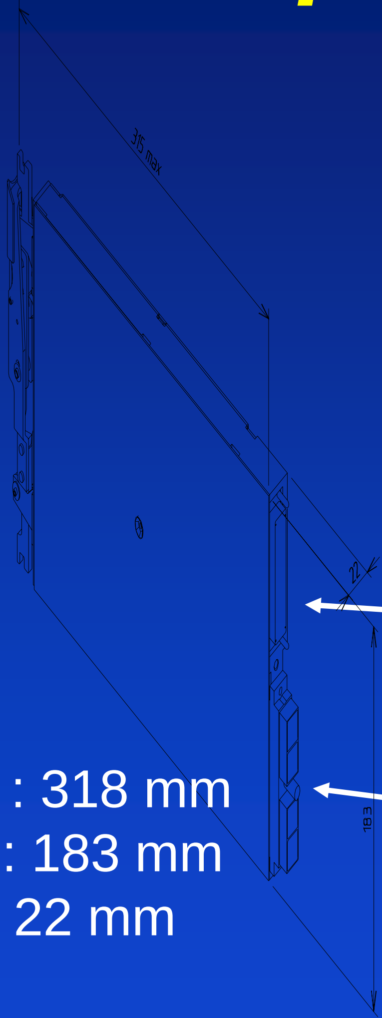
- generic core
- dedicated mezzanine



BC **: Bus Coupling**
DP **: Data Processing**
GP **: Graphic Processing**
MM **: Mass Memory**

DASSAULT AVIATION
Direction Générale Technique

Module packaging



Backplane connector

Aircraft I/O connector

Length : 318 mm
Height : 183 mm
Width : 22 mm

ASAAC heritage

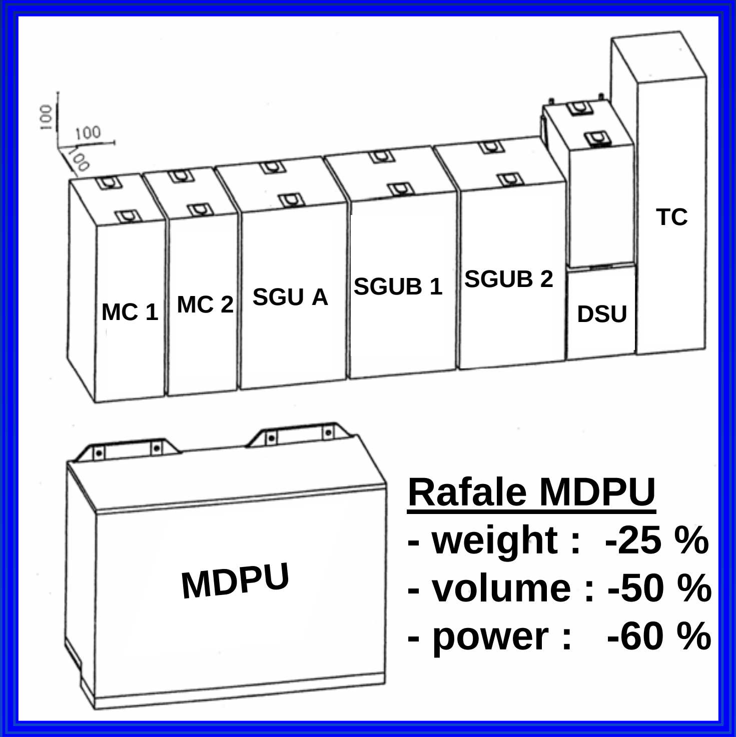
Following ASAAC concepts selected for MDPU

- Three layer software stack
  - to get a first level of HW independence
- Standardized communications
- Modular packaging (enclosure, extraction handle)
- Two stage power supply
- Air flow cooling

MDPU benefits (1/3)

- Reduced weight, volume and power consumption

Rafale example:



Rafale F1

Rafale F2/F3

MDPU benefits (2/3)

- Logistic support simplified:
  - 2nd level maintenance suppressed
  - LRM (Line Replaceable Module) Concept
  - Reduce drastically part numbers leading to less spares in Air Forces
- Growth capacity:
  - Available slots in the rack,
  - Moreover, for Rafale, provision to add a 2nd rack

MDPU benefits (3/3)

- Open architecture and standardised interfaces:
  - For making applications mapping easy on modules
  - Ability to add new functions : new applications on existing or new modules
  - Ease treatment of obsolescence by replacing well-interfaced components
- Same resources for two aircrafts with different functional perimeter
  - Amortize more easily non recurring costs and treatment of obsolescence

EASy Avionics
IMA in Falcon business jets

EASy

EASy = Enhanced Avionics System

IMA System based on Honeywell Primus Epic©

Architecture built with MAUs (Modular Avionics Unit)

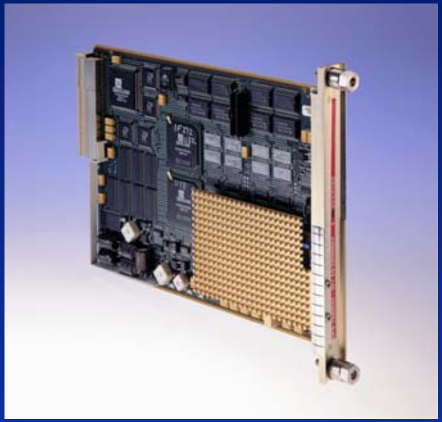
A MAU is a rack with a double backplane capable to host up to 20 modules

Covered functions:

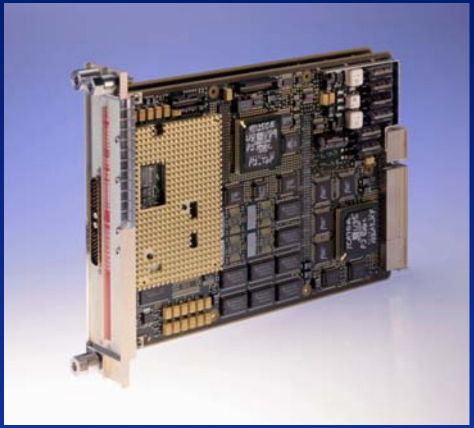
- Acquisition, processing/formatting, display of A/C systems
- Auto Pilot, Auto Throttle, Flight Management, Terrain Awareness Warning System, Electronic Checklist, Centralized Maintenance, Data storage functions.

MAU modules

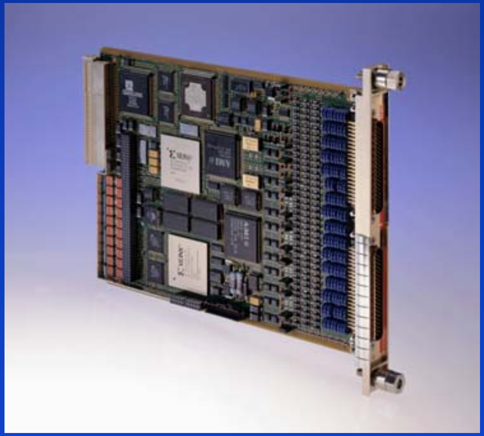
Power supply



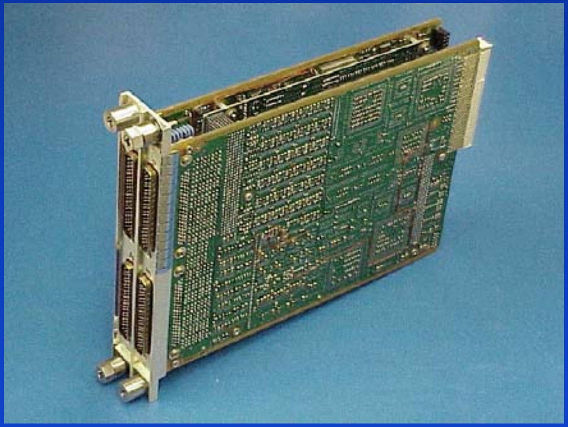
Processor



NIC + Processor



Control I/O

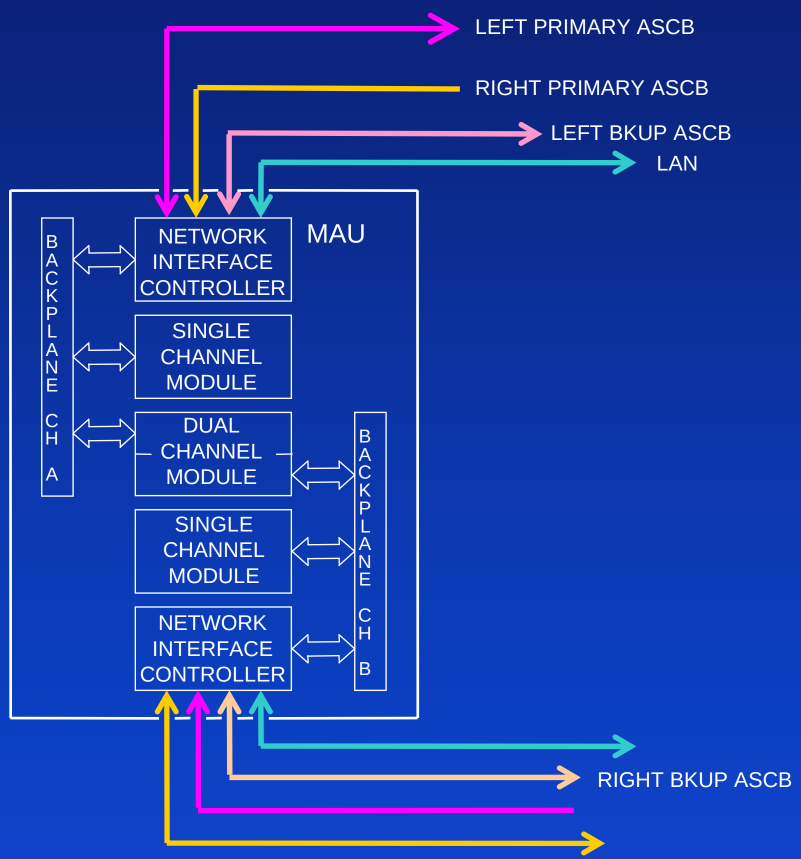


Dual Channel I/O

Module SW

- *Operating System common to several modules*
  - Near to ARINC 653 concepts
  - Coupling to HW through the PAL (Platform Abstraction Layer)
- *MAU Core functions linked to the OS*
  - Fault History Management
  - File System
  - Inter-modules communications
  - CORE Built-In-Test
  - Configuration Monitor System

Communications



MAU internal bus

- based on cPCI

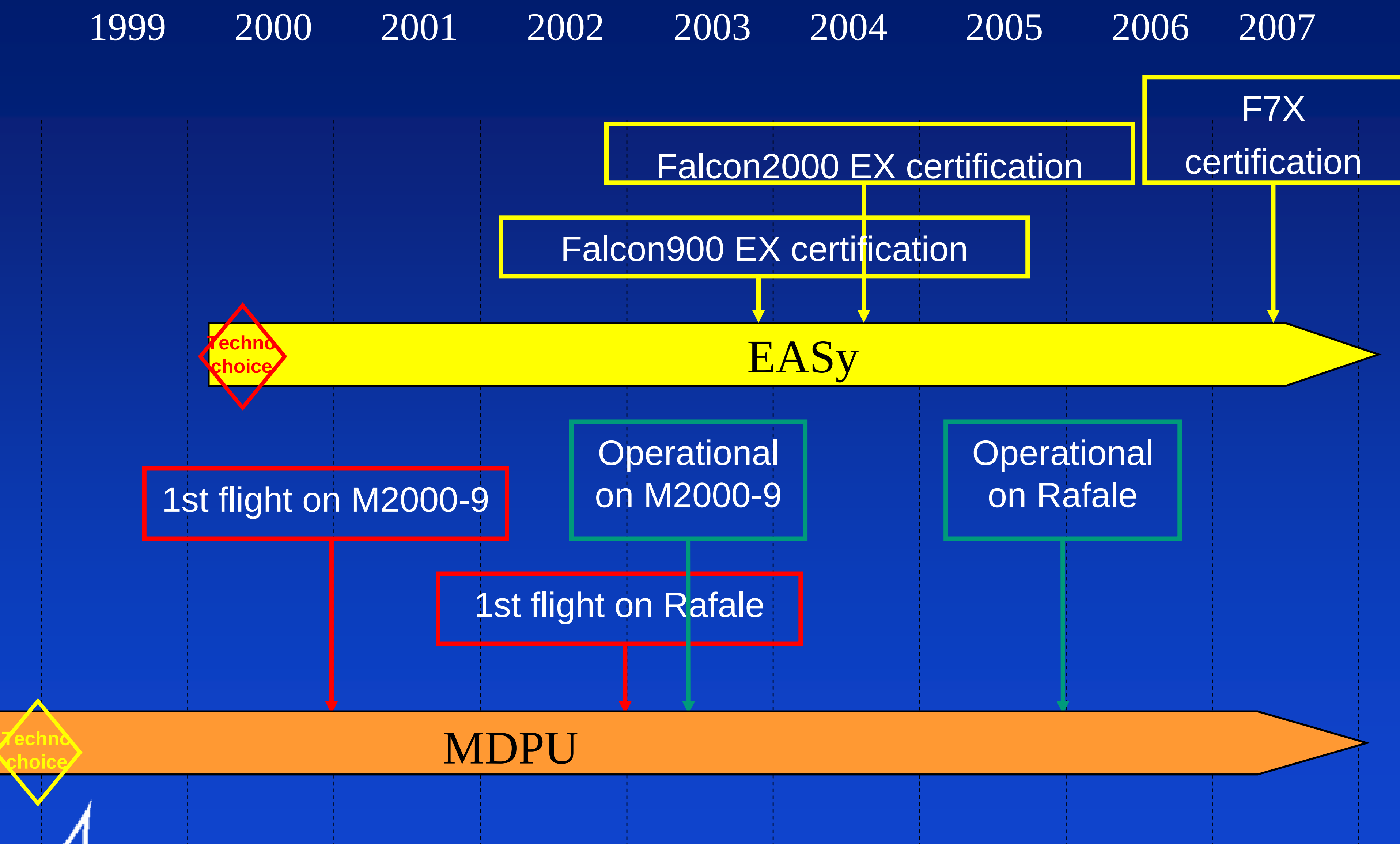
Aircraft bus

- redundant serial bus @ 10 MHz
- Flight critical and non-critical data (EFIS, AFCS, …)

Maintenance bus

- Ethernet

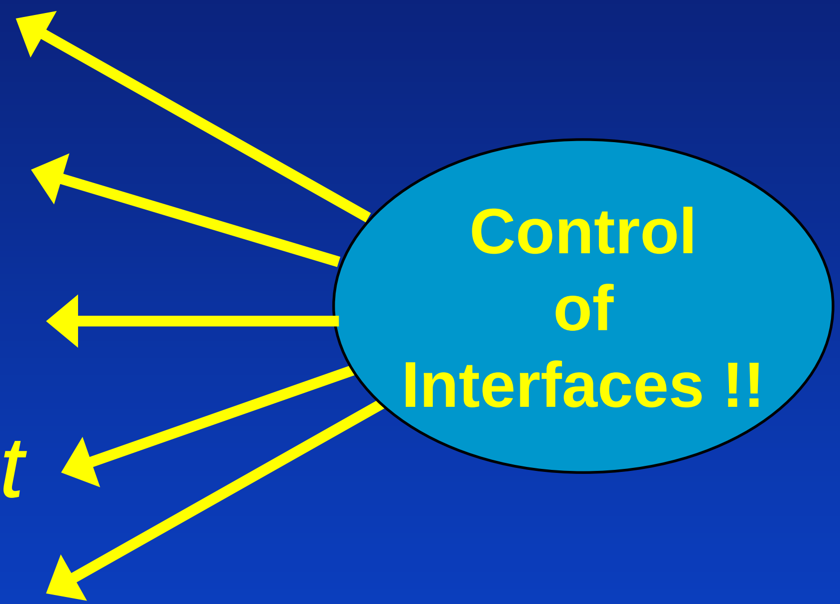
Schedule


1999
2000
2001
2002
2003
2004
2005
2006
2007
F7X certification
Falcon2000 EX certification
Falcon900 EX certification
Techno choice
EASy
Operational on M2000-9
Operational on Rafale
1st flight on M2000-9
1st flight on Rafale
Techno choice
MDPU

Key points

Key points (1/4)

- *Industrial work share*
- *Specifications*
- *Platform development*
- *Applications development*
- *Integration*



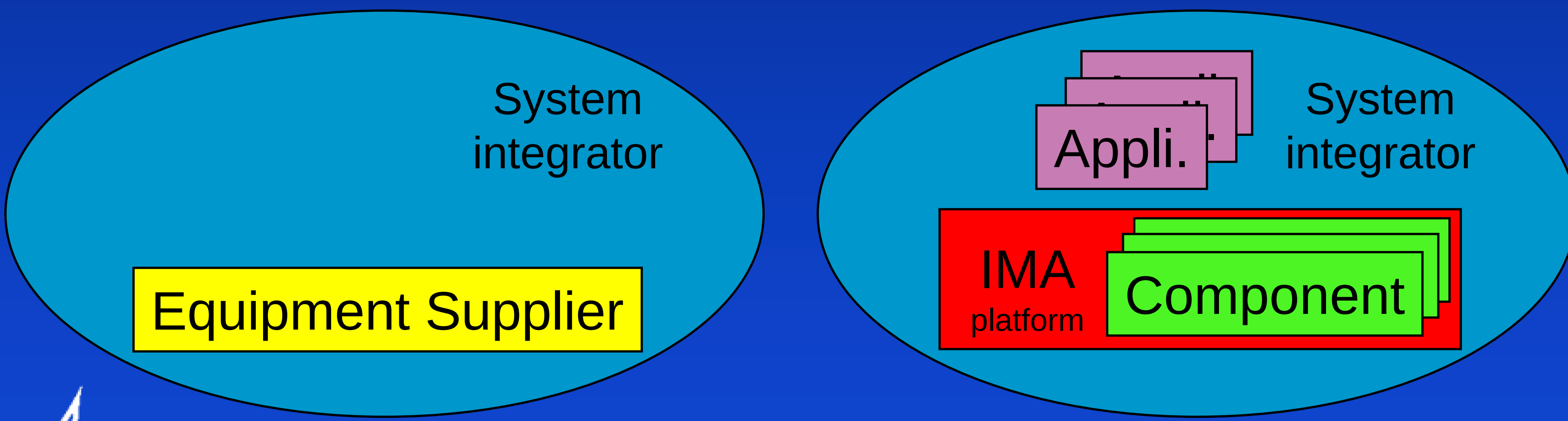
Key points (2/4)

- *Industrial work share*
  - Change in the competences and in the roles :

Federated architecture

Modular Architecture

DO297 model



Key points (3/4)

- *Specifications phase*
  - System engineering :
    - Top-down approach to specify components : Air systems, Core system, IMA platform, Applications
    - Explicit non functional requirements
  - Observability requirements
  - Inter-systems interactions
  - Modes change logic

→ "Early Validation"

- *IMA Platform development*
  - Use COTS components in their previously experimented usage domain

Key points (4/4)

- *Applications development*
  - HW / SW decoupling → *Reduction of development duration*
  - Rules to be put in place so that the applications behave independently from their localisation
- *Integration*
  - Spatial and temporal partitioning notably simplify trouble shooting issues (e.g. ARINC 653)
  - Clear separation between platform acceptance activities and applications integration ones
  - Application maximum sizing prediction

Next challenges
&
Conclusions

Next challenges (1/3)

Growth of third party involvement

- Open interface standards
  - Defined by a contract that can be fully specified and verified
  - Understandable, unambiguous, predictable, well shared, … by all stakeholders
- Data security
  - Integration of components for which degree of confidence is not known => implementation of MILS concepts
- Application reuse

Next challenges (2/3)

Enhancement of complexity control with

- Extended configuration capabilities
  - Cold and warm reconfigurations of an IMA subject to certification
- Component approach
  - Plug and Play, Contract-based, Reuse, …
- Early verification and validation
  - Predictable sizing, behavior, performance, …
- Incremental certification

Next challenges (3/3)

Assessment of new technologies

- Parallel processing resources (multicore, …)
- IT technologies in embedded world
- Asynchronous networks for deterministic applications

Convergence of solutions for all transport (automotive, train, aerospace) needs

- to avoid to reinvent the wheel

Conclusions

Successful IMA integrations in civil and military projects

Mirage 2000-9, Rafale, Falcon 2000Ex, 900Ex and F7X

Open architectures allow the main contractor to sub-contract suppliers in their domains of excellence while keeping the control of the system

Questions ?

DASSAULT AVIATION