Dassault Aviation feedbacks on its military and civil IMA applications

Thierry Cornilleau
ARTIST2 meeting on Integrated Modular Avionics
November 12-13, 2007, Roma (Italy)
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MDPU
IMA in military aircrafts
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

ASAAC Phase 0

ASAAC Phase I

ASAAC Phase II Stage 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:

- Aircraft 2x115V ac and 28V dc
- Air cooling
- External connectors
MDPU software architecture

APPLICATION

API
- Appl. Context mngt
- Appl. tasks mngt
- Time mngt
- Error mngt
- Standardized communication
- File mngt

OS Interface
- Process/task scheduling
- Memory mngt
- on-module time mngt
- on-module communication

Posix OS

BOARD SUPPORT PACKAGE

Hardware

Configuration blueprints
- Configuration/Reconfiguration
- Module + Rack Implementation & Debug
- Synchronization
- Initialization
- Built-In-Tests

APPLICATION

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Posix OS

BOARD SUPPORT PACKAGE

Hardware
Module generic architecture

Modular internal architecture

generic core
dedicated mezzanine

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

MDPU backplane bus (SCI)
Module packaging

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

Backplane connector

Aircraft I/O connector
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 MDPU
  - weight: -25%
  - volume: -50%
  - power: -60%

Rafale F1

Rafale F2/F3
**MDPU benefits (2/3)**

- **Logistic support simplified:**
  - 2\textsuperscript{nd} 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 2\textsuperscript{nd} 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
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


1st flight on M2000-9
Falcon2000 EX certification
Operational on M2000-9
Falcon900 EX certification
Operational on Rafale
1st flight on Rafale
F7X certification

EASy

MDPU
Key points
Key points (1/4)

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

Control of Interfaces !!
Key points (2/4)

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

  **Federated architecture**
  **Modular Architecture**
  **DO297 model**

Diagram:
- System integrator
- Equipment Supplier
- IMA platform
- Component
- Appli.

Direction Générale Technique

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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

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

"Early Validation"
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 ?