The ASAAC Phase II Program

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Presentation Overview

- The ASAAC Program
- ASAAC Phase II Program Objectives
- Top Level Requirements
- Architecture Concepts

  (Software, Common Functional Module, Communication/network, Packaging,System management)
- Standards

ASAAC Phase II Program

ASAAC Phase II Program Timescale

- **Stage 1 : Concept Refinement**
  - ASAAC Concept Refinement,
  - Demonstration Definition and Specification,
  - First Draft of Standards.

- **Stage 2 : Demonstrations**
  - Demonstration of ASAAC architecture,
  - Production of Final Draft Standards,
  - Validation of Standards.

ASAAC Phase II Program Organization

- An international program involving:
  - FRANCE,
  - GERMANY,
  - UNITED KINGDOM.
- SPAé (France) is the contracting agency on behalf of all three nations.
- The prime contractor is the DTAM GIE:
  - DTAM: Dassault Thomson Avionique Modulaire.
  - GIE: Groupement d'intérêt économique

ASAAC Industrial Partners

Nation	France	Germany	United Kingdom
National Contract Holders	DTAM* - GIE	DaimlerChrysler Aerospace	Marconi Electronic Systems
National Management Teams	DTAM - GIE	DEAT-JMT	IAWG - TMB
Industrial Members	Dassault- Aviation SEXTANT Avionique Thomson-CSF Detexis and Thomson-CSF Communications	DaimlerChrysler Aerospace ESG Elektroniksystem- und Logistik-GmbH	British Aerospace Military Aircraft and Aerostructures. Marconi Electronic Systems Smiths Industries

ASAAC Phase II Program Objectives and Architecture Requirements

ASAAC Phase II Objectives

To define and validate a set of Open Architecture Standards for Advanced Avionics Architecture (A3) applicable to new airplane and upgrade programs from 2005 and which supports :

- **The reduction of Life Cycle Cost of avionics systems,**
- **The improvement of operational performance,**
- **The improvement of mission performance.**

Top Level Architecture Requirements (1)

- Technology Transparency
- Interchangeability
- Buildability
- Modularity/configurability
- Reusability
- Growth Capability
- Maintainability
- Fault Tolerance

Top Level Architecture Requirements (2)

- Standardized Digital Computing Architecture implementing Data, Signal & Graphics multi-processing
- Application Functions
  - Sensors
    - Radar, EW, CNI, EO
  - Mission Management
  - Vehicle Management
  - Man Machine Interface

ASAAC Main Challenge

Conciliate the principle of Open Architecture

(ASAAC properties)

&

Performance Requirements

(Operational and Mission performances)

requested by the future avionics systems.

ASAAC Architecture has to satisfy these two types of requirements.

ASAAC Architecture
Software concept

Requirements on Software Architecture

- **Technology Transparency**
- **Modular**
- **Reconfigurable**
- **Reusable**

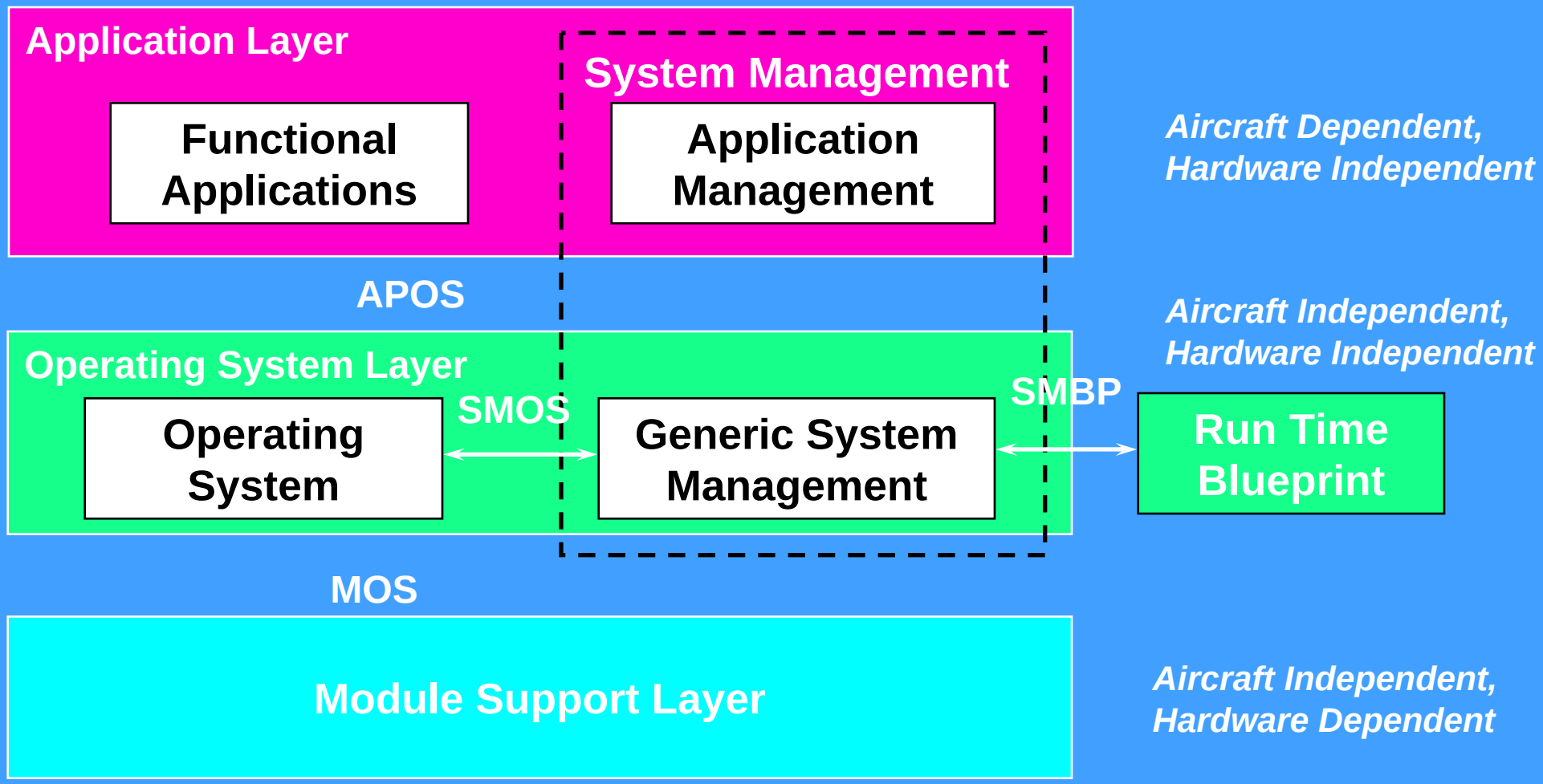
The software defines the system functionality: everything else in the architecture is subservient to this and is only included to improve support of the software.

Major Software Themes

- Software Virtual Machines
- Virtual Channels for communications
- Three layer software structure
- Blueprints for system definition and control

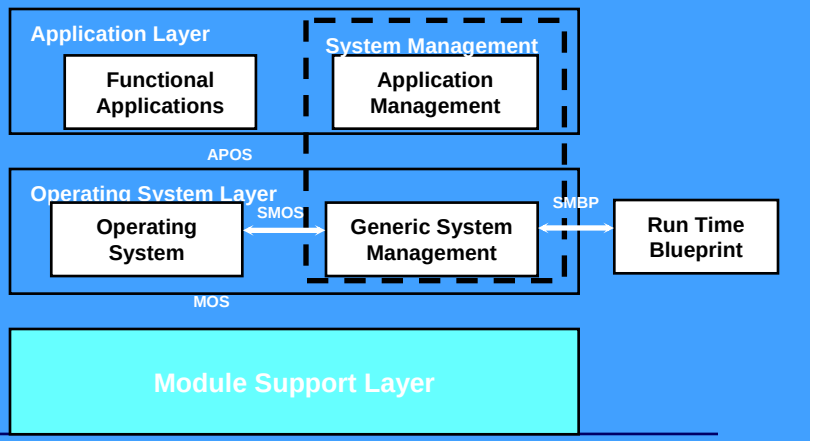
Tools and languages also considered

ASAAC Phase II - Software Model



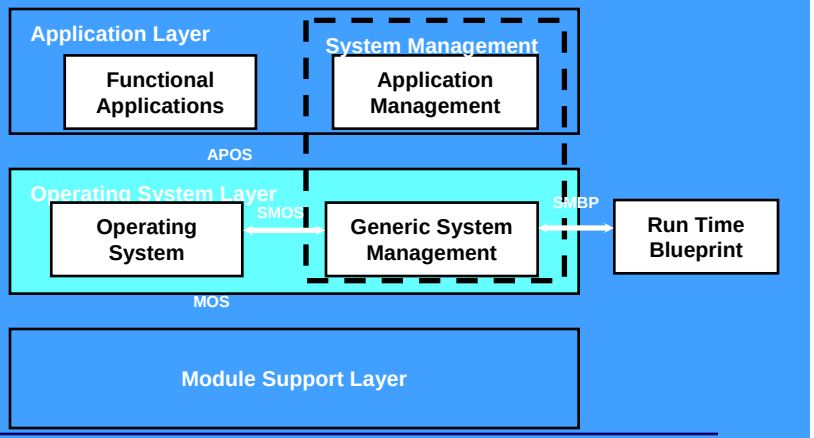
Module Support Layer

- Encapsulates the details of the underlying hardware.
- Provides access to low-level resources through the following services :
  - Memory,
  - Communications,
  - Timers,
  - Interrupts,
  - Built-In Test.
- Contains Boot Loader.



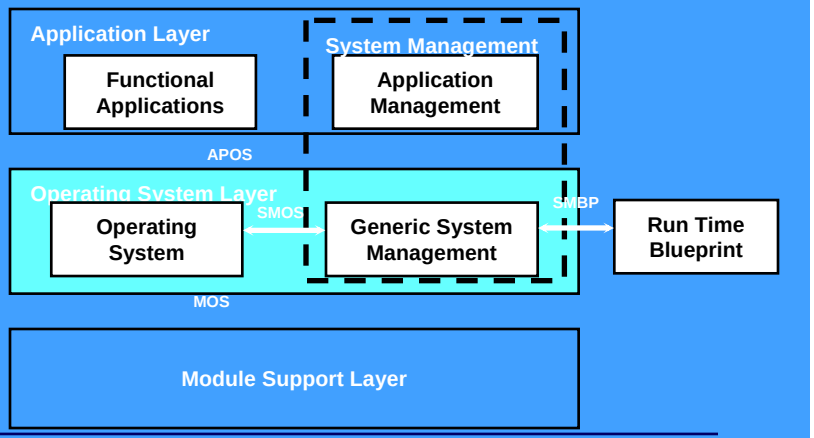
Operating System

- Two Functional Parts
  - Real-Time Operating System (RTOS) provides basic services
    - Threads services
    - Virtual memory services
    - Communications services
    - Synchronization services
    - Time services
  - Operating System Extensions (OSE) provide specific IMA services
    - GSM services
    - Virtual channel services



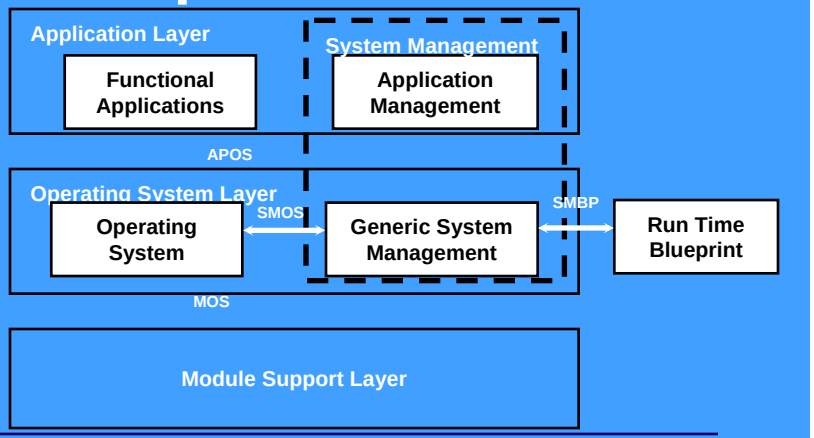
Generic System Management

- Manages system behavior using blueprints.
- Applies at distinct system hierarchy levels :
  - Aircraft
  - Integration Area
  - Resource level
- Four areas of responsibility :
  - Health Monitoring
  - Fault Management
  - Configuration Management
  - Security management



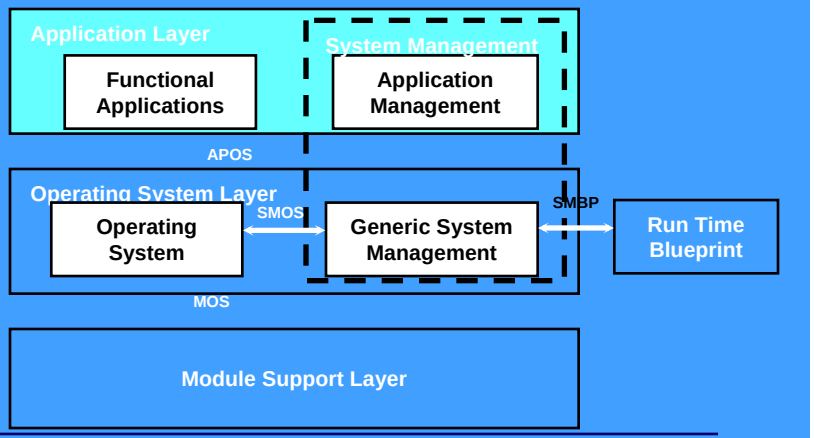
Blueprints

- Design Time Blueprint
  - Used during system design to match application resource requirements with resource capabilities to provide configurations
- Run-Time Blueprint
  - Tables of information used during run time by GSM to configure, control and change system operation

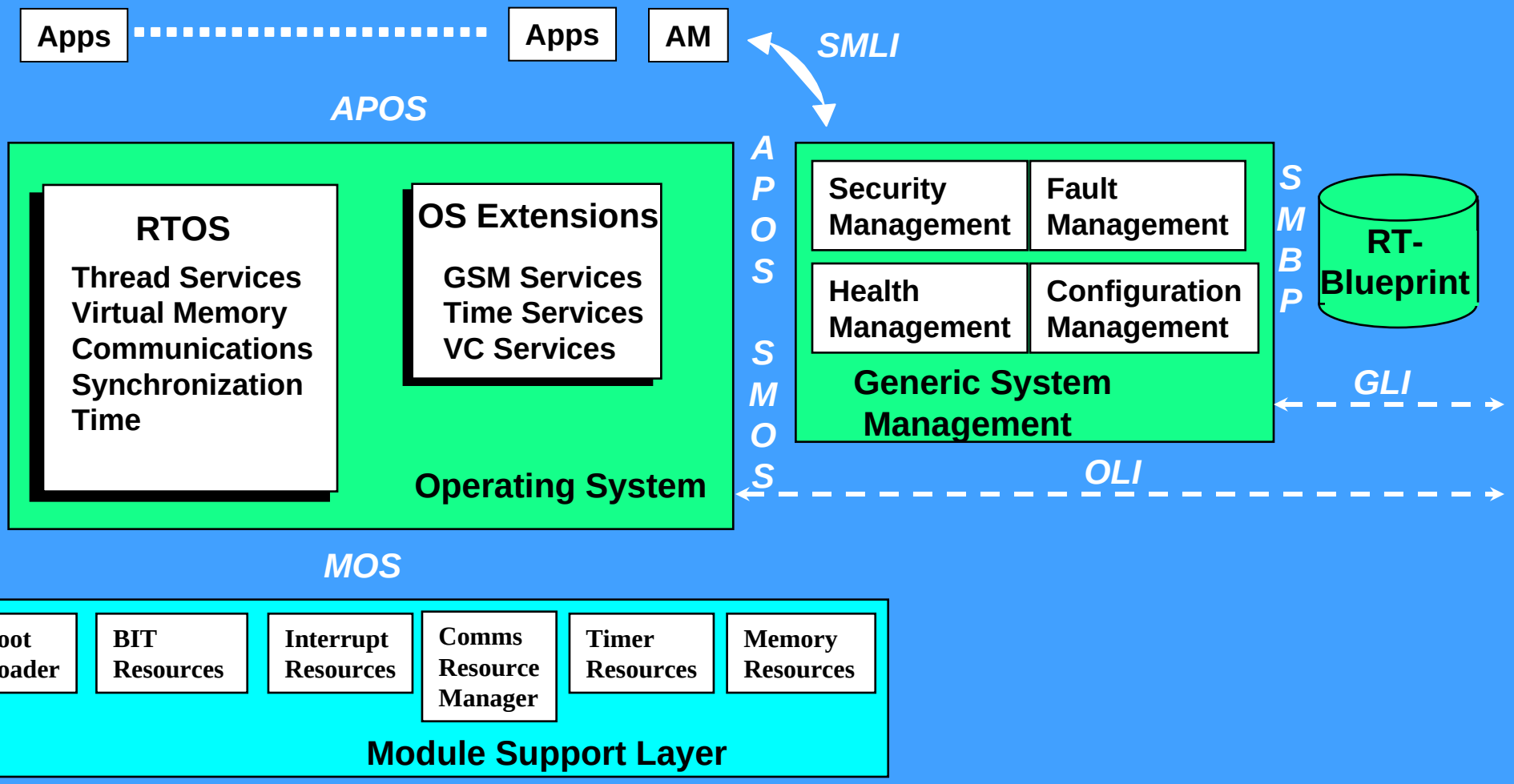


Application Layer

- Functional Applications
  - Relates to all functions that handle the processing of operational data.
  - Reuse between aircraft
- Application Management
  - Implements the mission/moding management tasks.
  - Specific to an aircraft
  - No special services - special Virtual Channels



Detailed Software Model



Software Model Interfaces (1)

- **APOS : Application / Operating System**

  Standard set of Application services; infrastructure independent

- **SMOS : System Management / Operating System**

  Set of services providing GSM with system control

- **SMBP : System Management / Blueprint**

  Set of services for GSM to access blueprint information

- **MOS : MSL / Operating System**

  Standard set of BIOS services independent of the hardware

Software Model Interfaces (2)

- **OLI : Operating System Logical Interface**
  - Standards for Virtual Channel information interchange
- **GLI : GSM Logical Interface**
  - System management control information exchanges
- **SMLI : System Management Logical Interface**
  - Information interchange between Apps Management and GSM

ASAAC Architecture
Common Functional Module concept

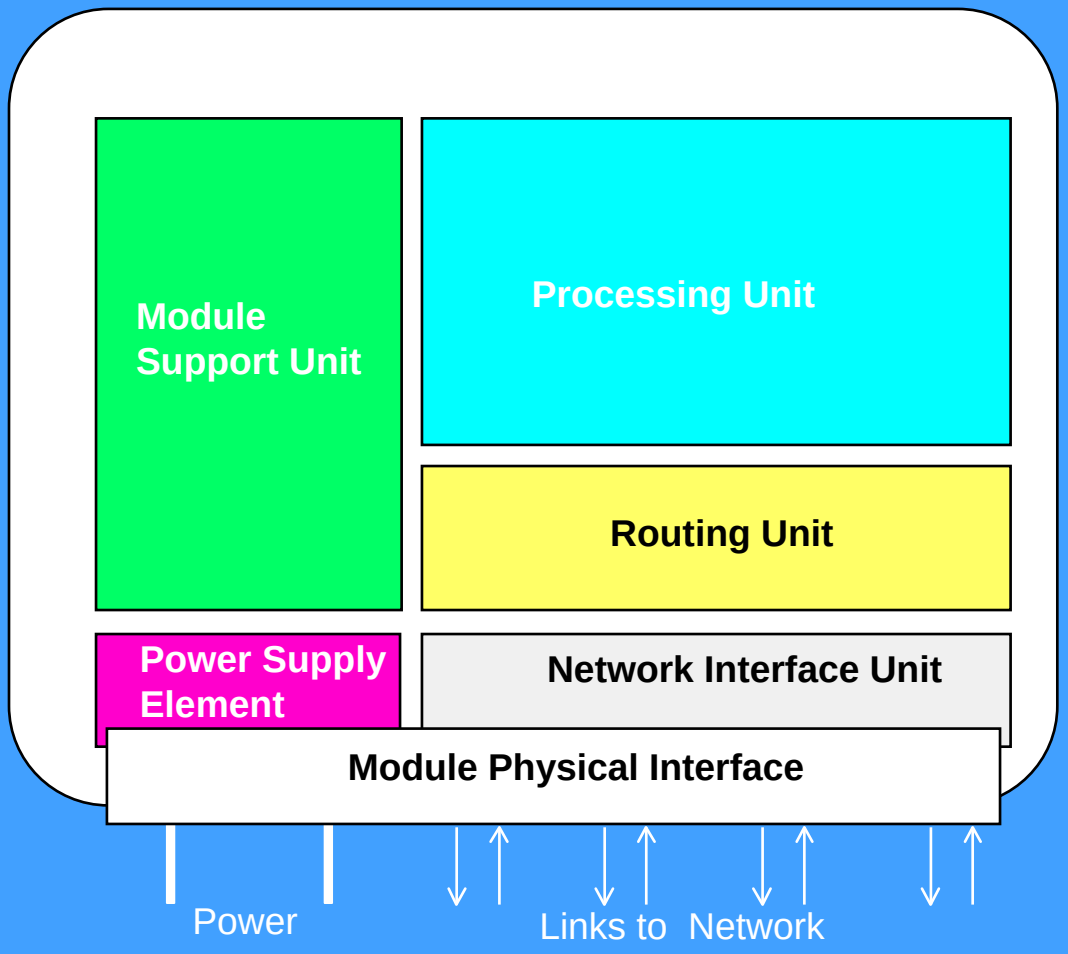
Requirements on CFMs

- Technology Transparency
- Interchangeability
- Buildability
- Modularity/system configurability
- Growth Capability
- Maintainability
- Fault Tolerance Support

Major CFM Themes

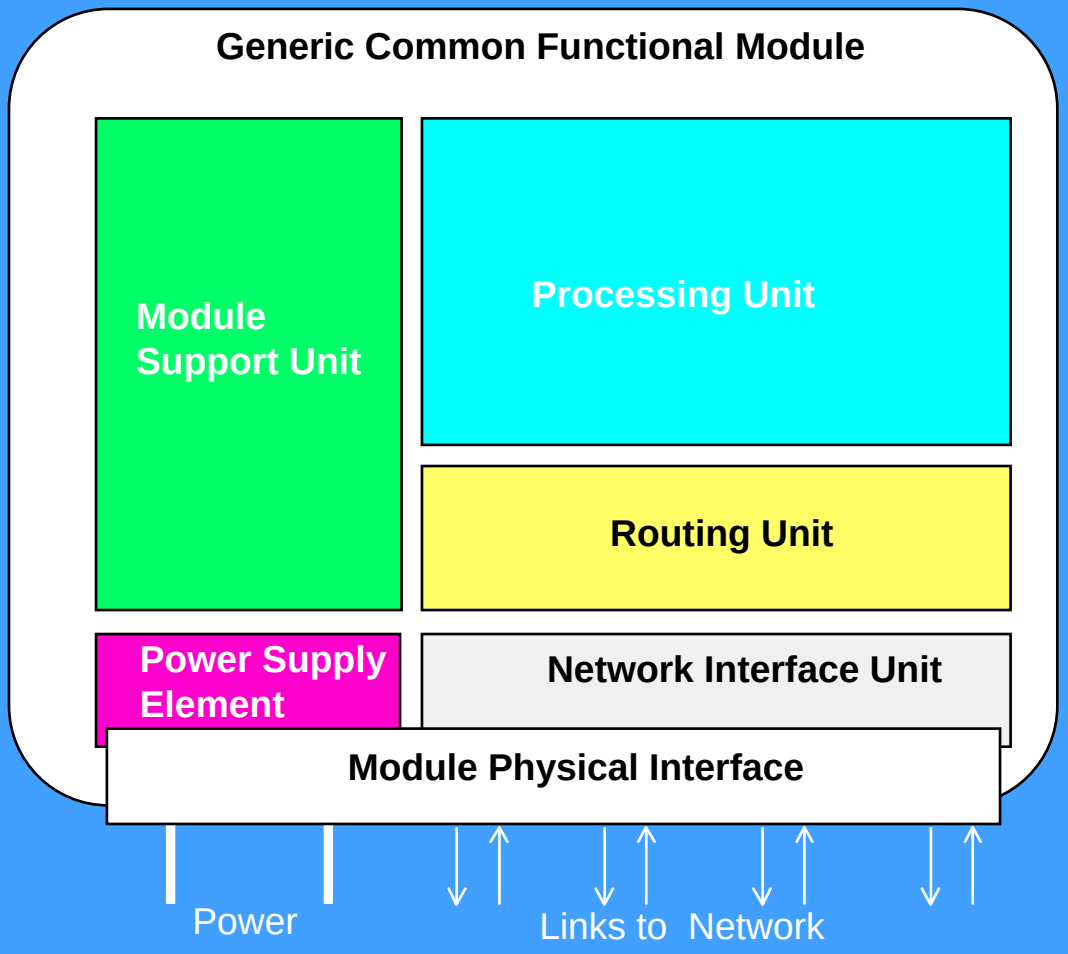
- Definition of generic common functional module
- Definition of common characteristics
- Small set of modules
- Mapping of software stack on CFMs

Generic Common Functional Module (1)



- Module Support Unit (MSU)
  - Control and monitoring of the module
  - Provides common functions (initialization, configuration, BIT, timers, status, debugging).
- Processing Unit (PU)
  - Specific processing functionality of a particular module type

Generic Common Functional Module (2)



- **Routing Unit (RU)**
  - Data distribution between on-module elements.
- **Power Supply Element (PSE)**
  - Transformation from standard backplane voltage to module specific voltages
- **Network Interface Unit (NIU)**
  - Interface to off-module network.

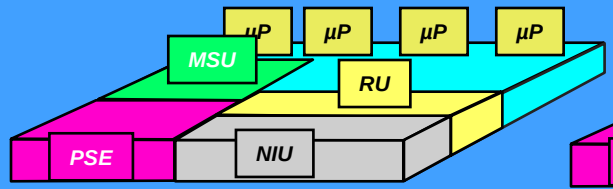
Common Characteristics

- Initialization / Boot Strap Loader
- Fault Management
  - BIT
  - Fault Log
- CFM Management
  - Control and Status
  - Embedded Information
- Absolute Local Time

Set of Common Functional Modules

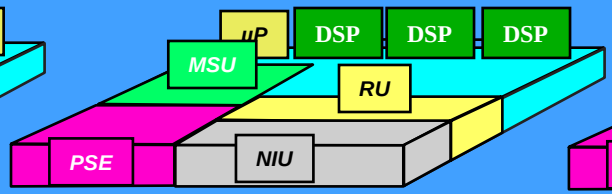
- Processing Modules
  - Data Processing Module
  - Signal Processing Module
  - Graphic Processing Module
- Support/Infrastructure Modules
  - Mass Memory Module
  - Power Conversion Module
  - Network Support Module

Processing CFMs



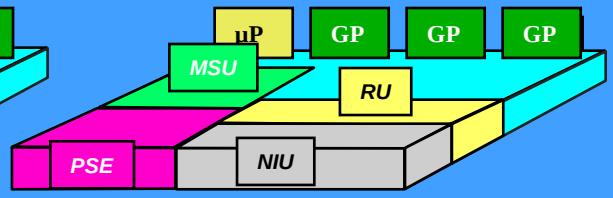
Data Processor
DPM

- Optimized for general data processing including branching
- Multiple, independent Processing Elements (PE)



Signal Processor
SPM

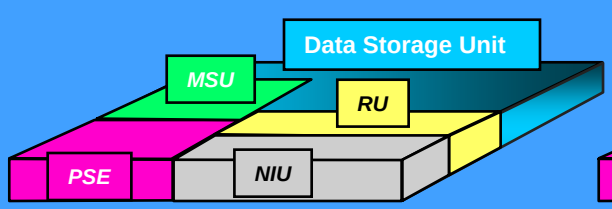
- Optimized for synchronous algorithmic and pipeline processing
- Multiple synchronized or independent PEs
- May utilize hardware dependencies for algorithm optimization



Graphics Processor
GPM

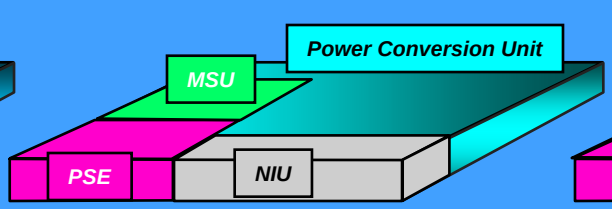
- Special resources included for graphics generation and manipulation

Infrastructure CFMs



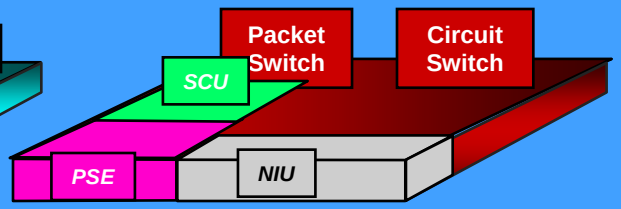
Mass Memory Module
MMM

- Mass non-volatile system memory
- Initialization manager
- Reference Clock



Power Conversion Module
PCM

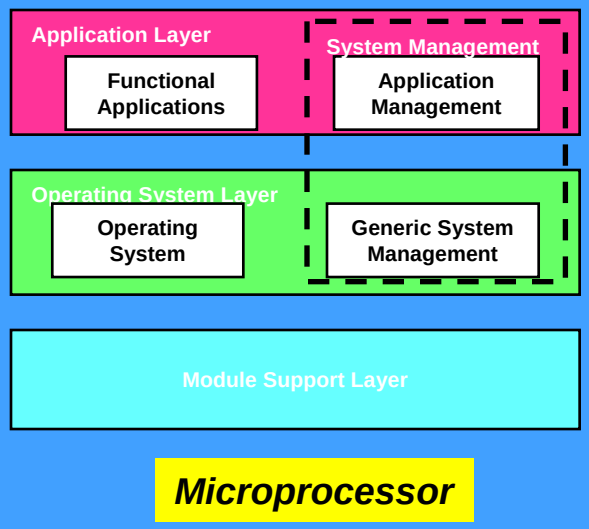
- Conversion from aircraft power to intermediate backplane voltage to modules
- Feeds to each module individually monitored and controlled
- Predefined initial outputs

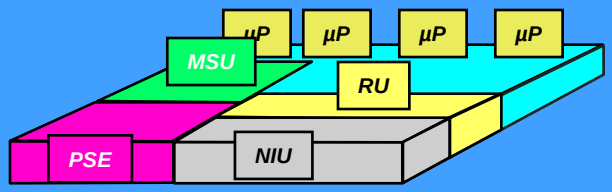


Network Support Module
NSM

- Provides flexible interconnection of modules
- Content dependent on network implementation
- Configuration loaded
- Reference Clock

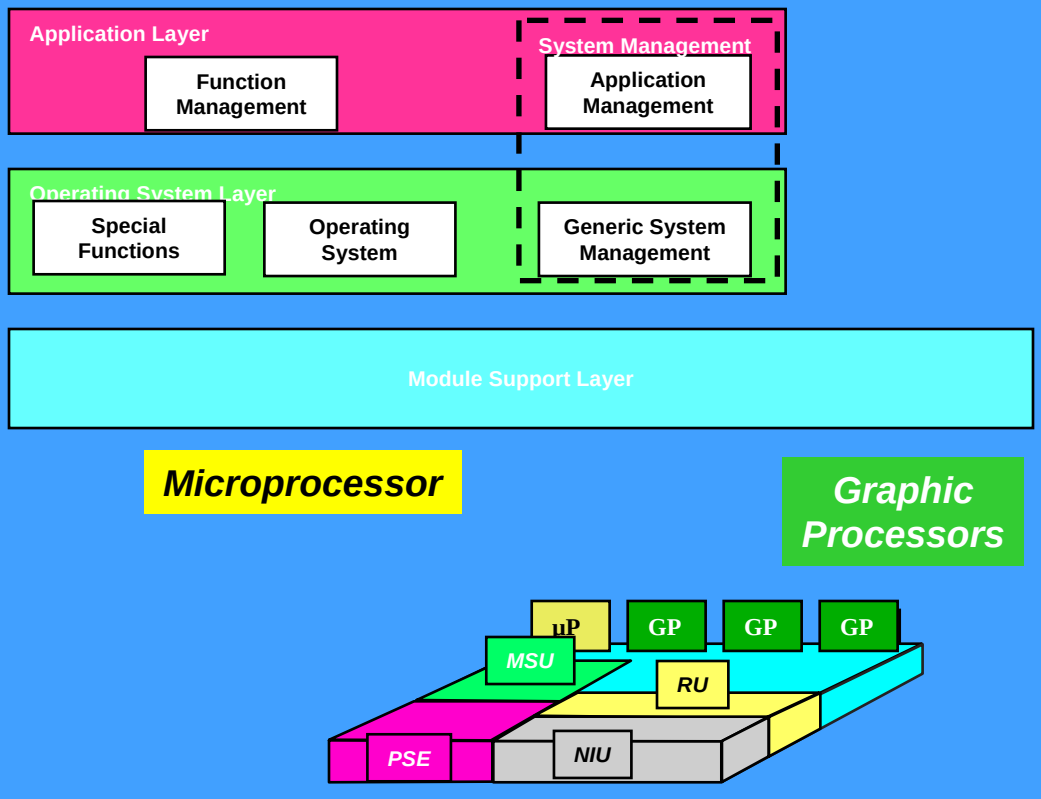
Mapping of Software Stack onto a DPM





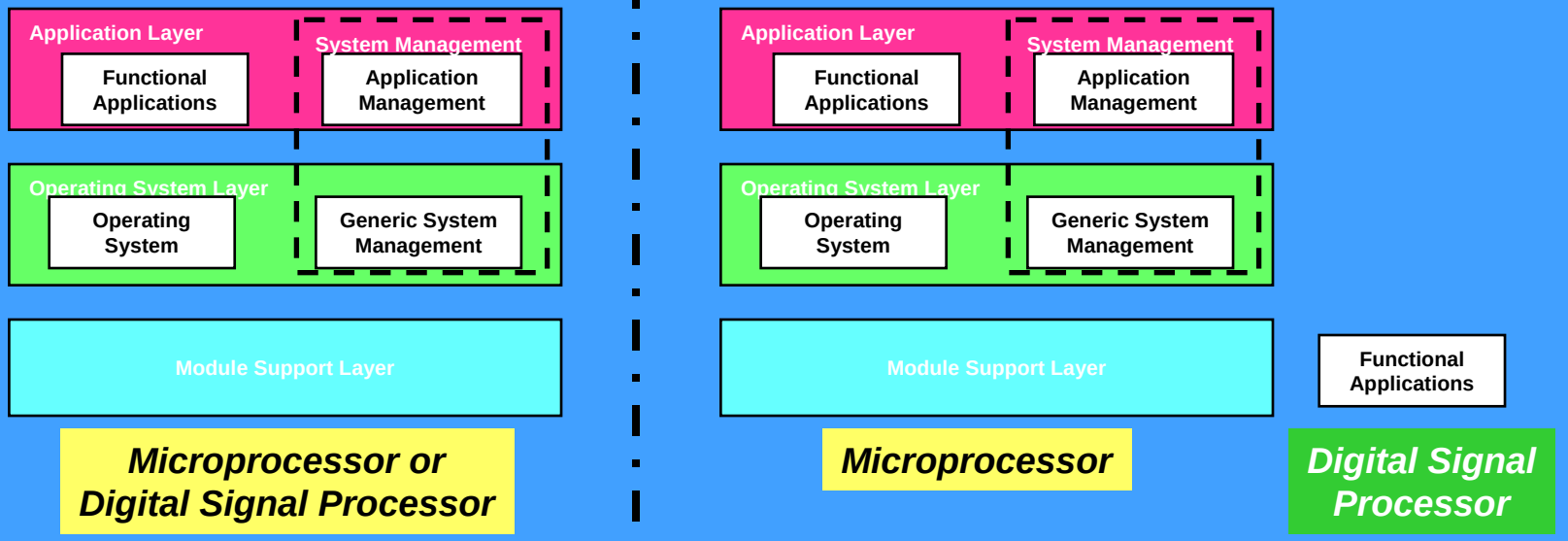
- Same stack on every processor
- Each processor is independent
- Module is seen as multiple processing elements

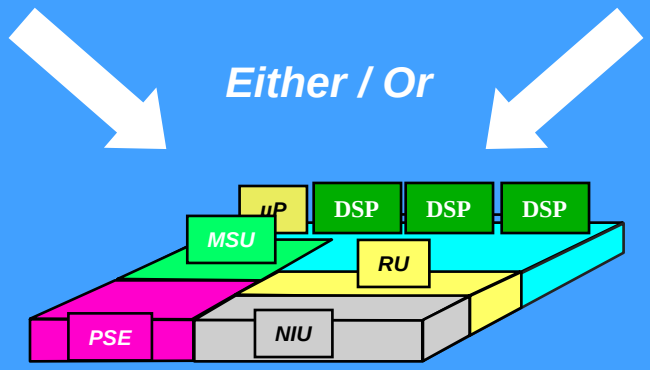
Mapping of Software Stack on a GPM



- Three layer stack on microprocessor
- Special services to access specialized hardware

Mapping of Software Stack on an SPM





ASAAC Architecture
Communication/Network concept

Requirements on Communications/Network

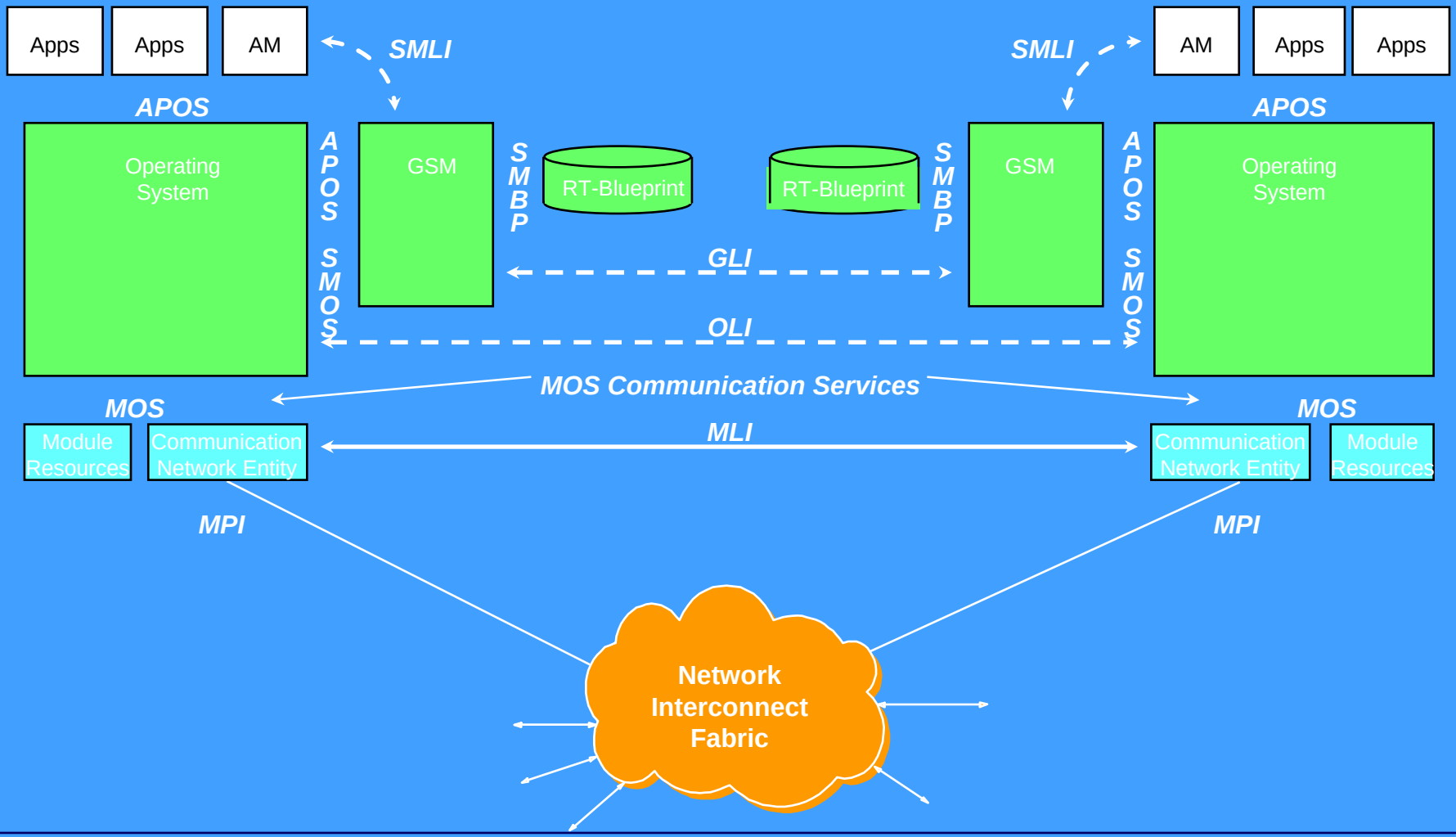
- Technology Transparency
- Growth Capability
  - System
  - Technology
- Maintainability
- Fault Tolerance

Major Communication/Network Themes

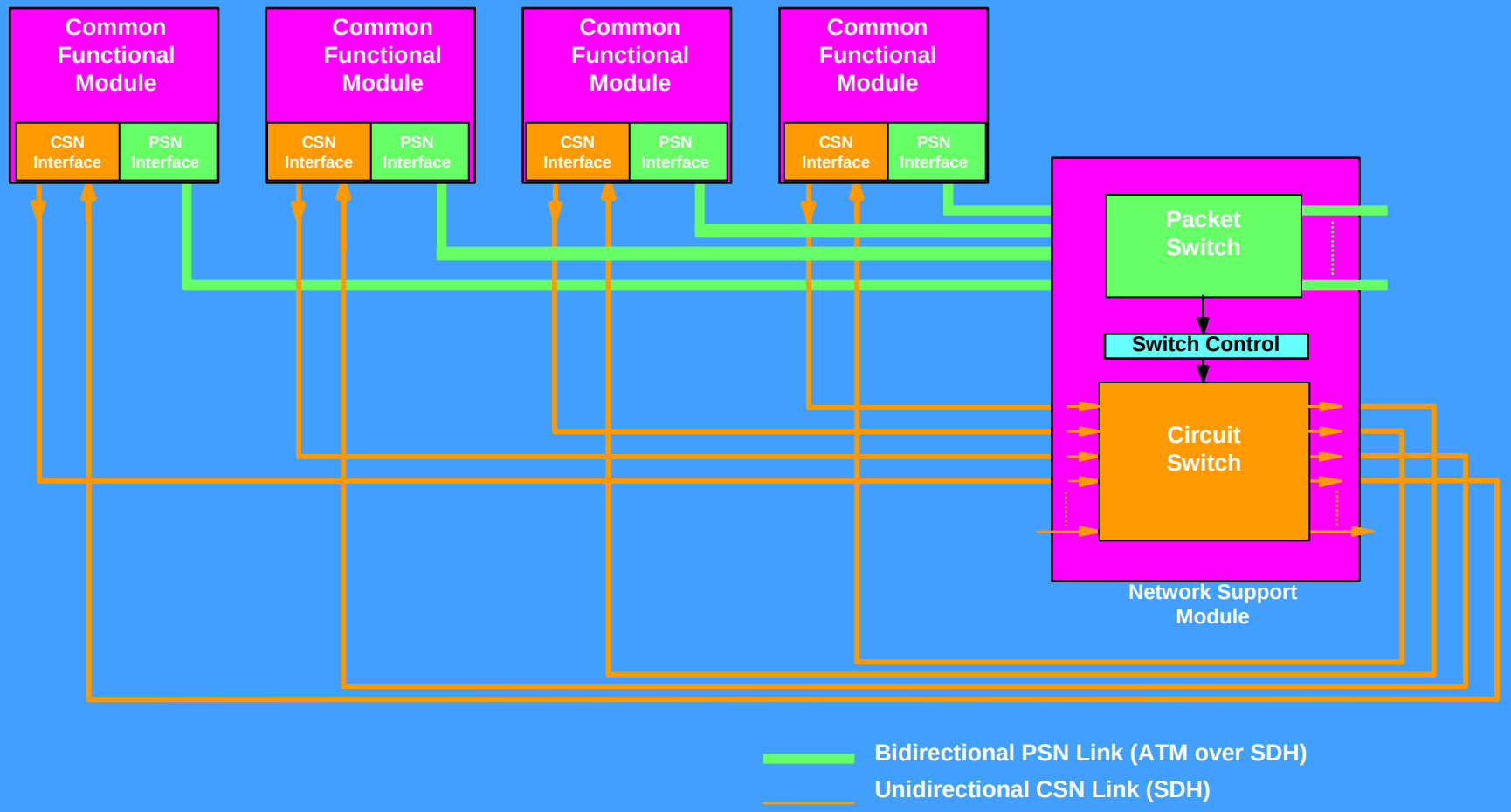
- Communication services the same for all scopes
  - Virtual Channels between Applications
  - Generic ports below OS
- Network technology transparent to software (MOS)
- Network technology transparent to infrastructure (MPI)
- Number of viable solutions for network implementation
- Module interoperability defined by MLI

Communications Model

Note: Italic Labels are Interfaces
Arrowed lines indicate Logical Interfaces (i.e. not software calls)



Baseline Network



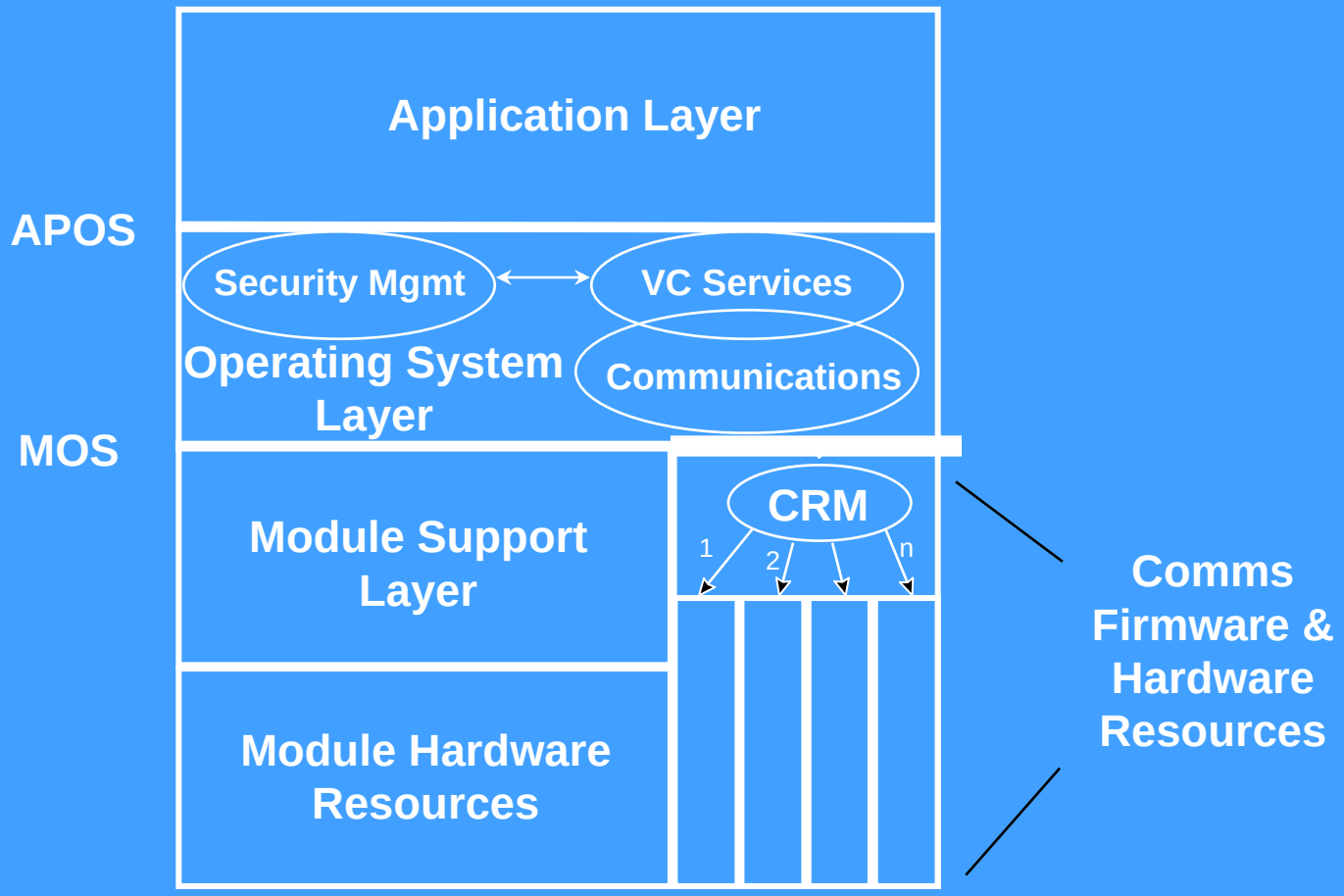
Baseline Network Characteristics

- Initial implementation envisaged to use
  - 622 Mbit/s ATM Packet Switched Network
  - 2.4 Gbit/s SDH Circuit Switched Network
  - Multiple interfaces of each for flexibility and redundancy
- Single Network View from Software
  - For Different Data Types
  - End-to-End
  - Covering all Communication Scopes
- Network Transparent to Software, NOT to System
  - Interfaces do not remove system dependencies

Possible Alternative Networks

- Replace SDH with Fibre Channel (FC) for Circuit Switched Network
- Use FC for both packet and circuit switched networks
  - Interchangeable interfaces
- Use SCI for both packet and circuit switched networks
- Integrate packet and circuit switched networks using FC or SCI

Communications Structure



Note: CRM = Communications Resource Manager

Backplane Interconnection

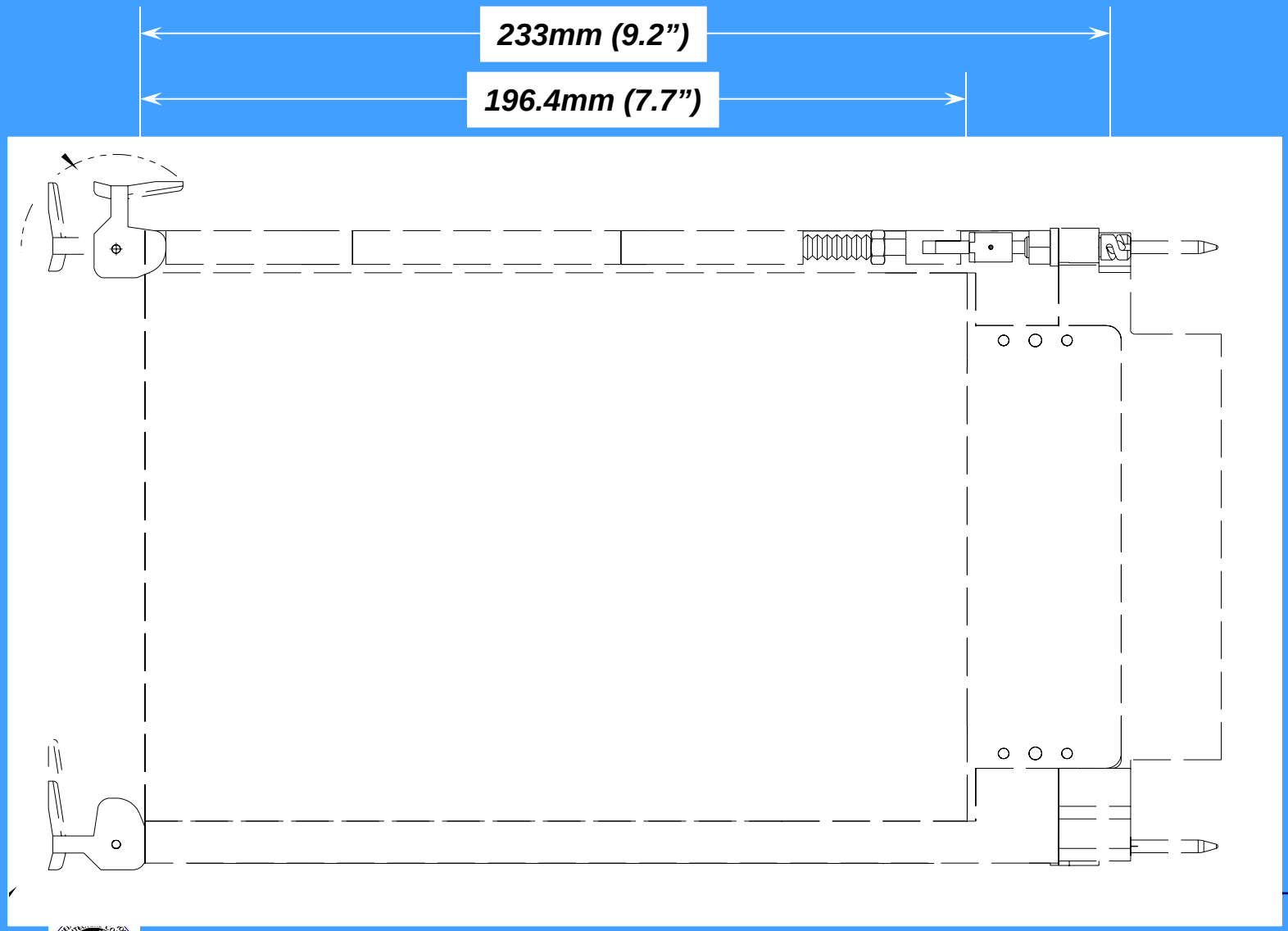
- All serial optical communication between modules
- Different technologies available
  - Guided optical fiber backplane using MT ferrule connectors
  - Free-space connectors with polymer waveguide backplane
  - Same connector shell; different inserts
- Electrical aspects
  - Power distribution from PCMs to other modules
  - Small signals for module location

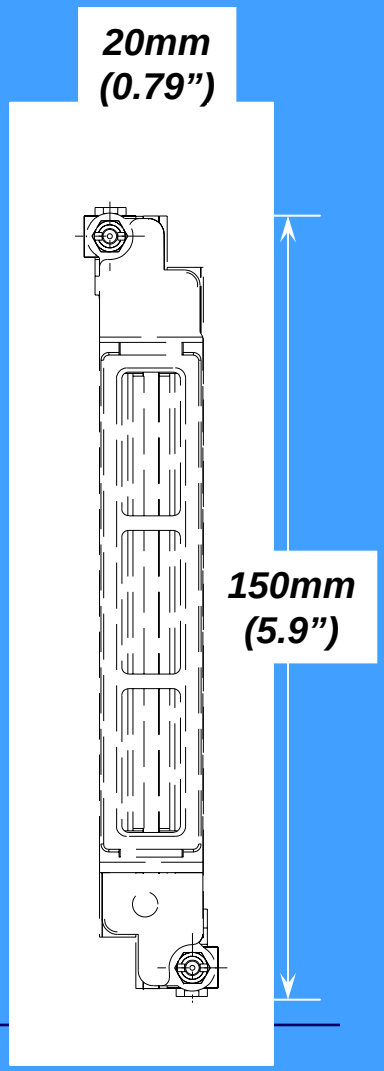
ASAAC Architecture
Packaging concept

Packaging Domains

- Mechanical handling
- Cooling
- Power supply distribution
- Electromagnetic Compatibility
- Interconnections

Mechanical Handling





Cooling

Two basic cooling techniques :

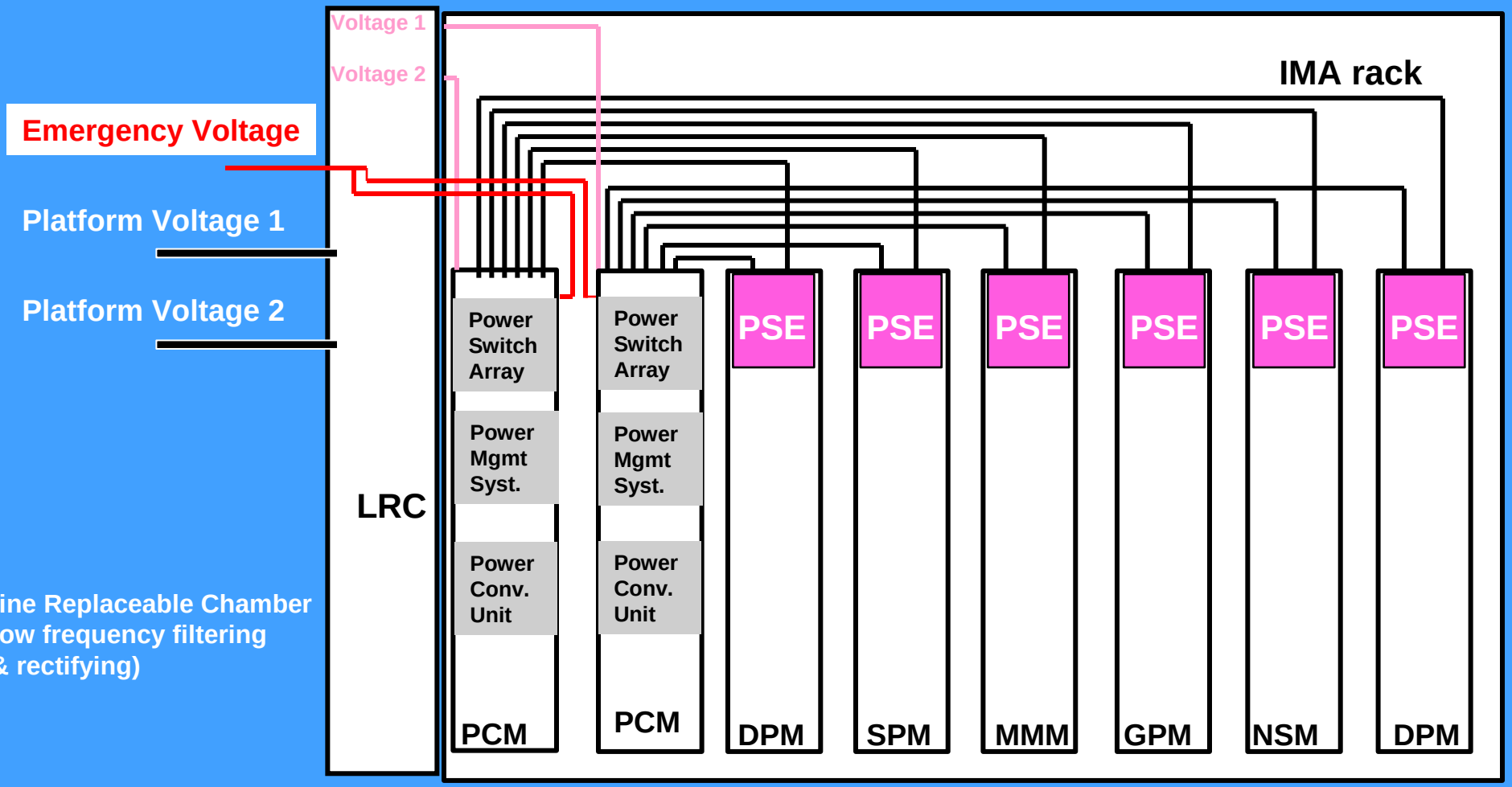
- Air Cooling
  - Direct Air Flow : Air flows through the center of the module
  - Air Flow Around: Air flows over the covers of the module
  - Air Flow Through: Air flows over the components in the module
- Conduction Cooling
  - Rack can have air or liquid cooling
  - Possible use of Heat Pipes in module

Choice dependent on aircraft requirements

Power Supply Distribution

- Two Stage Power Supply Architecture
  - Raw aircraft power to intermediate voltage by Power Conversion Module (PCM)
  - Intermediate to module specific voltages by Power Supply Element (PSE) in each CFM
  - « High » intermediate backplane voltage : 48 Vdc
- Distributed architecture
  - Separate feeds from each PCM to individual CFMs
  - Each CFM PSE consolidates independent inputs
  - Configurable essential and initialization PCM outputs
- Power management

Power Supply Distribution

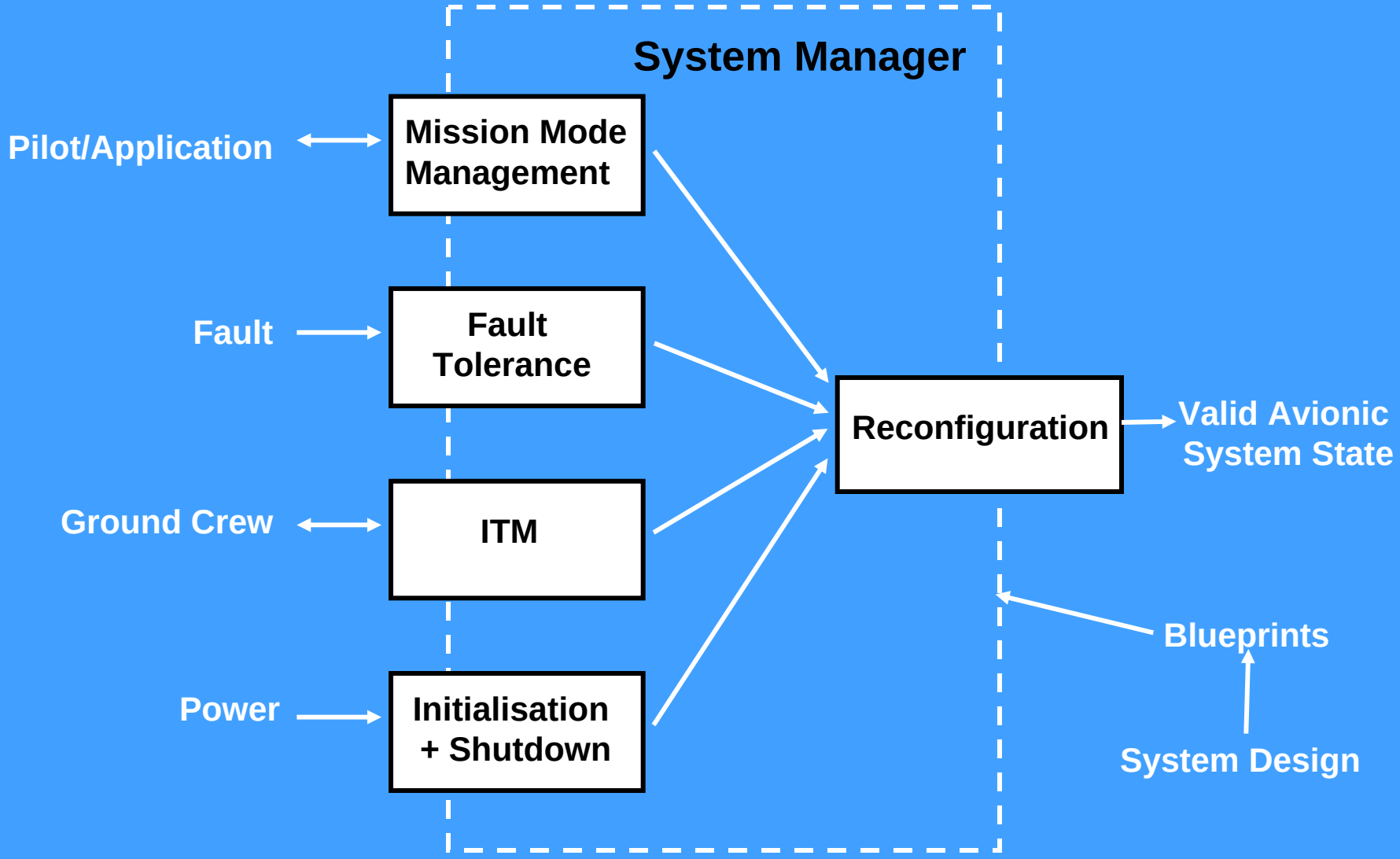


ASAAC Architecture
System Management concept

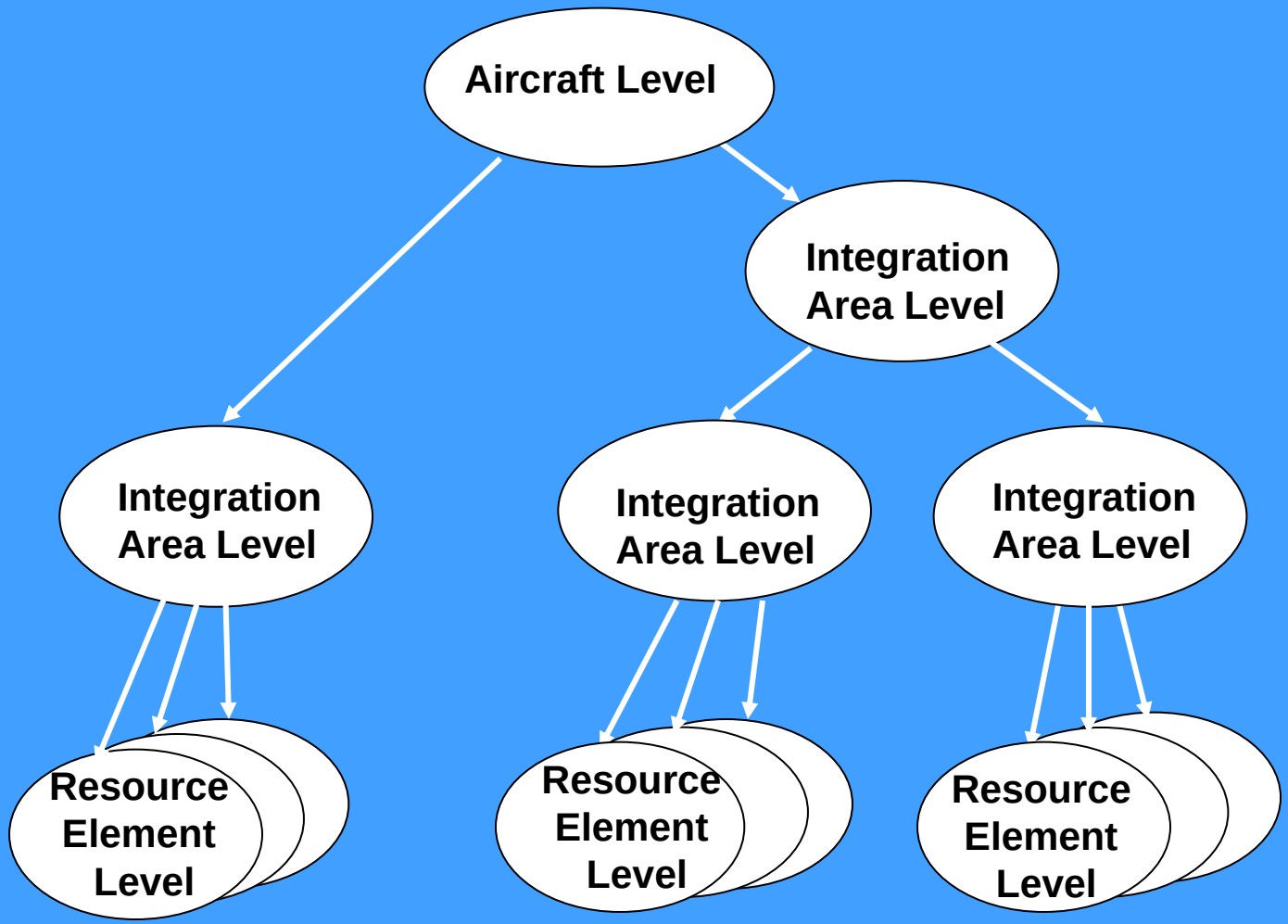
Major System Management Themes

- System Management Hierarchy
- Fault Management
- Time Reference
- Security
- Safety
- System Design (Blueprints)

System Management Operation



System Management Hierarchy



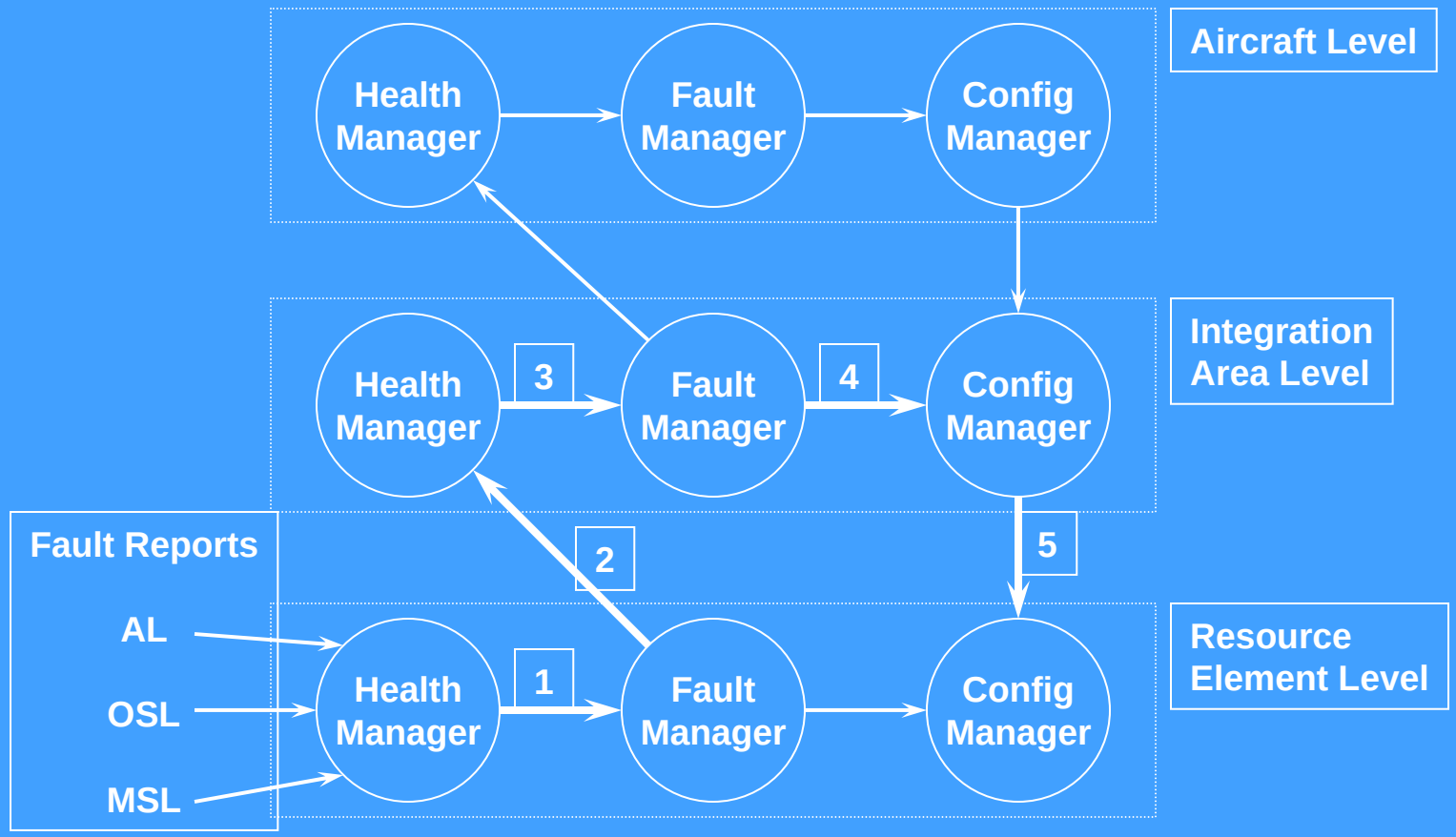
System Management Elements

- Health Monitor
  - Resource health determined BIT and Application reports
  - Provides information on potential faults to local FM
- Fault Manager
  - Determines action to be taken (based on blueprints)
  - May be local action or report to higher level for action
- Configuration Manager
  - Performs actions necessary to meet new configuration
- Security Manager
  - Controls access rights (input and output requests)

Fault Management Strategy

- Strategy defined for specific system requirements
- Use different sets of available techniques through standard services
- Supported by hardware and software routines
- Can use different strategies in different parts of the system

Fault Management Operation Example



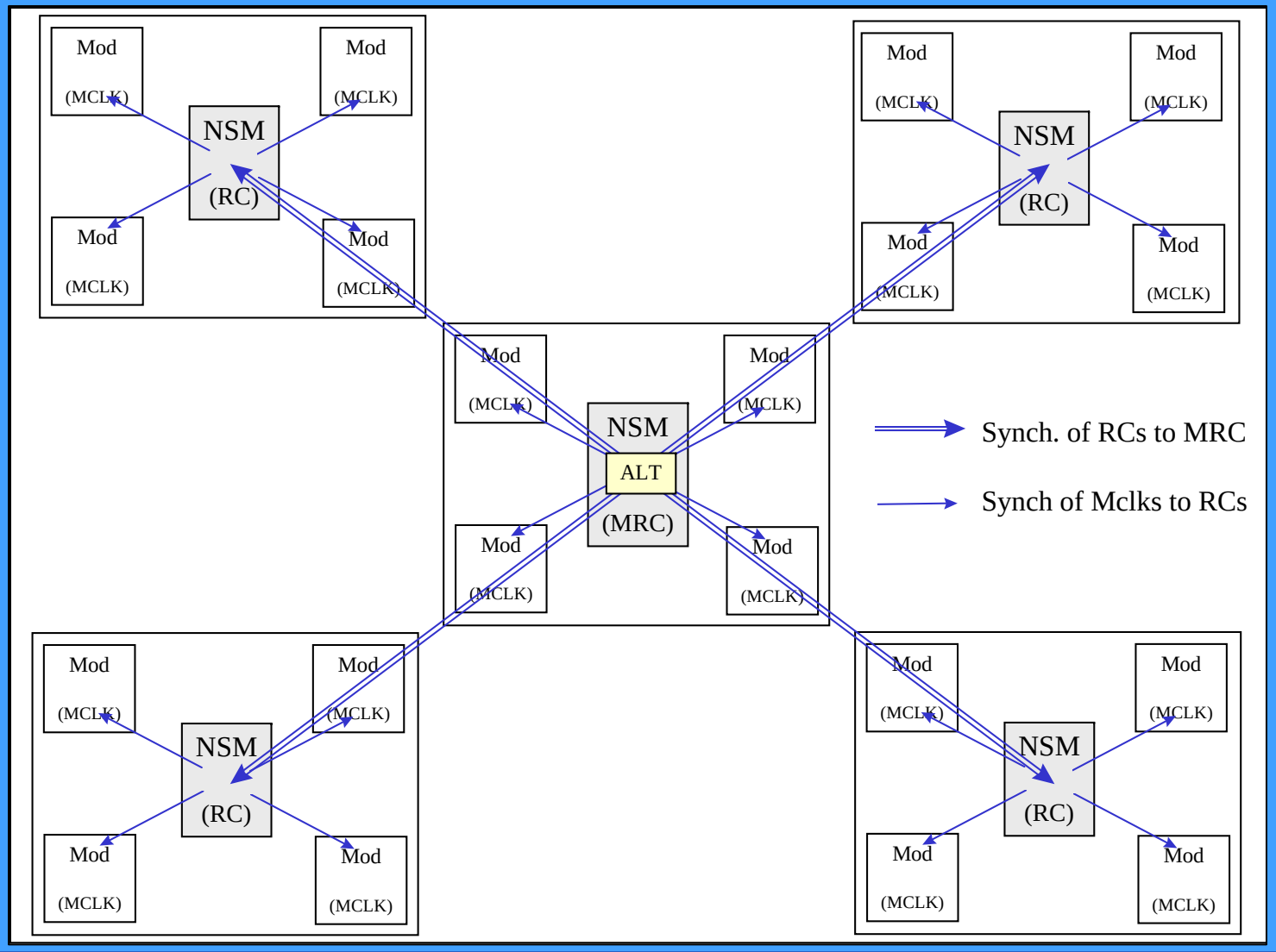
Initialization

- 3 stages
  - Generic
    - Always happens and is the same every time
    - Provides initial, limited capability (e.g. DPM, MMM and NSM)
    - Completed with Aircraft System Manager (ASM) in control
  - Selection
    - Full mission rôle initialization
    - Emergency/fast start up
    - Partial initialization for refuel/maintenance
  - Selection Specific
    - Reconfigurations to required capability

Provision of Time Reference

- Reference Clocks (RC) on MMMs and NSMs
- Single or group of RCs provide Master Reference
- Slave RCs can take over from MRC
- “External” Master Reference allowed
- Active Synchronization with Follow to damp errors
- Time distributed to Module Clocks on CFMs
  - Resolution
  - Accuracy
- System time: offset used to provide wall clock

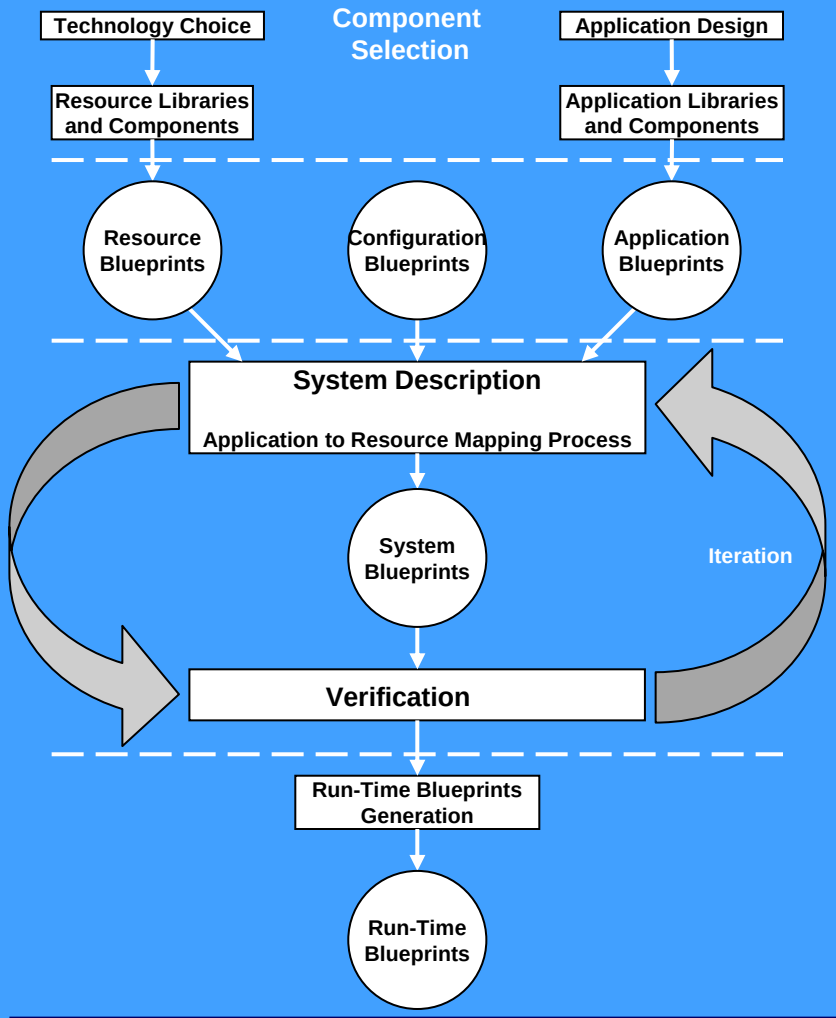
Time Distribution



Safety Considerations

- Different levels of integrity can be supported
- Modularity allows different approaches
  - No immediate spare: load on failure
  - Cold spare: code in a module but not initialized
  - Warm spare: code initialized in a module and receiving current status
  - Hot spare: master/slave relationship
  - Voting: Multi-lane cross-comparisons
- Certification a major issue
  - Common designs present common failure concerns
  - Desire for resources and software separately certificated

Blueprints in the Design Process



- Initial design begins with applications, resources and restrictions on how the first can be mapped on the second (configuration)
- Defining the system and assessing whether the correct properties are available results in the System Blueprints
- These are then condensed to provide the Run-Time Blueprints which are loaded into the system

Run-Time Blueprints

Describes the resource elements in terms of:

- Configurations
  - Hierarchical Application process mapping for each logical configuration
  - Communication infrastructure
- Resource initialization data
- Scheduling policy
- Security policy
- Fault handling policy
  - Action lists for each configuration upon event occurrence

ASAAC Architecture Proposed Standards

Architecture Elements (1)

Hardware elements:

- ASAAC Common Functional Modules
- Rack
- Backplane
- Line Replaceable Chambers
- Non-core equipment

Architecture Elements (2)

Software elements:

- Module Support Layer (considered as part of CFM)
- Operating System (in the OS Layer)
- Generic System Management (in the OS Layer)
- Run Time Blueprint (in the OS Layer)
- Functional Applications (in the Application Layer)
- Application Management (in the Application Layer)

Software Standards (1)

- **APOS : Application / Operating System**

  Standard set of Application services; infrastructure independent

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Software Standards (2)

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Hardware Standards

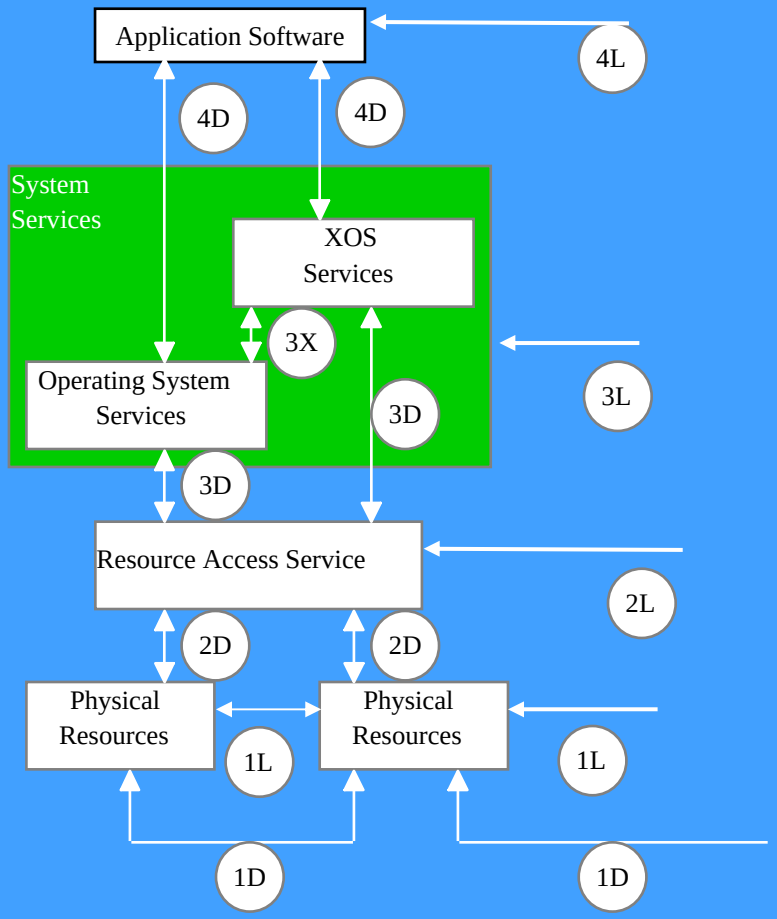
- **MLI - Module Logical Interface**
  Definition of inter-module network
- **MPI - Module Physical Interface**
  Defines mechanical outline, insertion and extraction device
- **CFM - Common Functional Module**
  The set of modules and their common characteristics
- **CFMSS - Common Functional Module System Support**
  CFM behavior for system events
- **GRS - Generic Rack Slot**
  Mechanical outline to receive modules
- **PSD - Power Supply Distribution**
  Characteristics of the two-stage supply

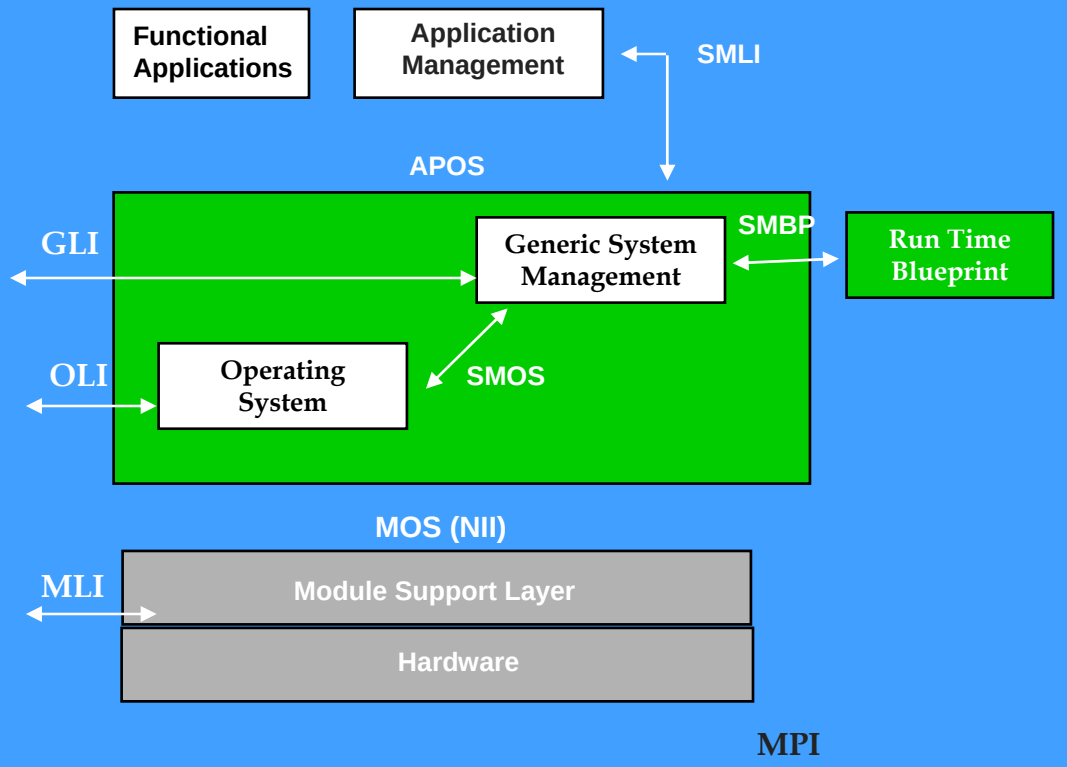
Matrix of Standards and Architecture Elements

Standard	CFM	IMA rack	Back-plane	LRC	Non-core	OS	GSM	RTBP	Func Apps	Apps Mgmt
APOS						X	X		X	X
MOS	X					X				
SMOS						X	X			
SMBP							X	X		
SMLI							X			X
OLI					X	X				
GLI					(X)		X			
MLI	X				X					
MPI	X		X							
CFM	X									
CFMSS	X				(X)					
GRS		X	X							
PSD	X			X						

(X) Not necessary unless element included in system management

ASAAC Comparison with GOA Architecture





ASAAC Phase II Stage 1 Conclusion

Standards

- Consistency between standards requires system viewpoint
  - Cannot define standards in isolation
- Standards defined into 2 parts :
  - Standards main body independent of technology
  - Slash sheets containing implementation dependent specifications
- Standards only useful if wide Industrial acceptance
- Implementation technology, however, will be the key for reuse

Program

- Set of agreed draft ASAAC standards defined
- Demonstration phase defined for validation
- Pull-through of concepts into near-term programs

The ASAAC Phase II Program

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