

Open Architecture for naval Combat Direction System (CDS)

sea THE FUTURE

DCNS



MINISTÈRE DE LA DÉFENSE



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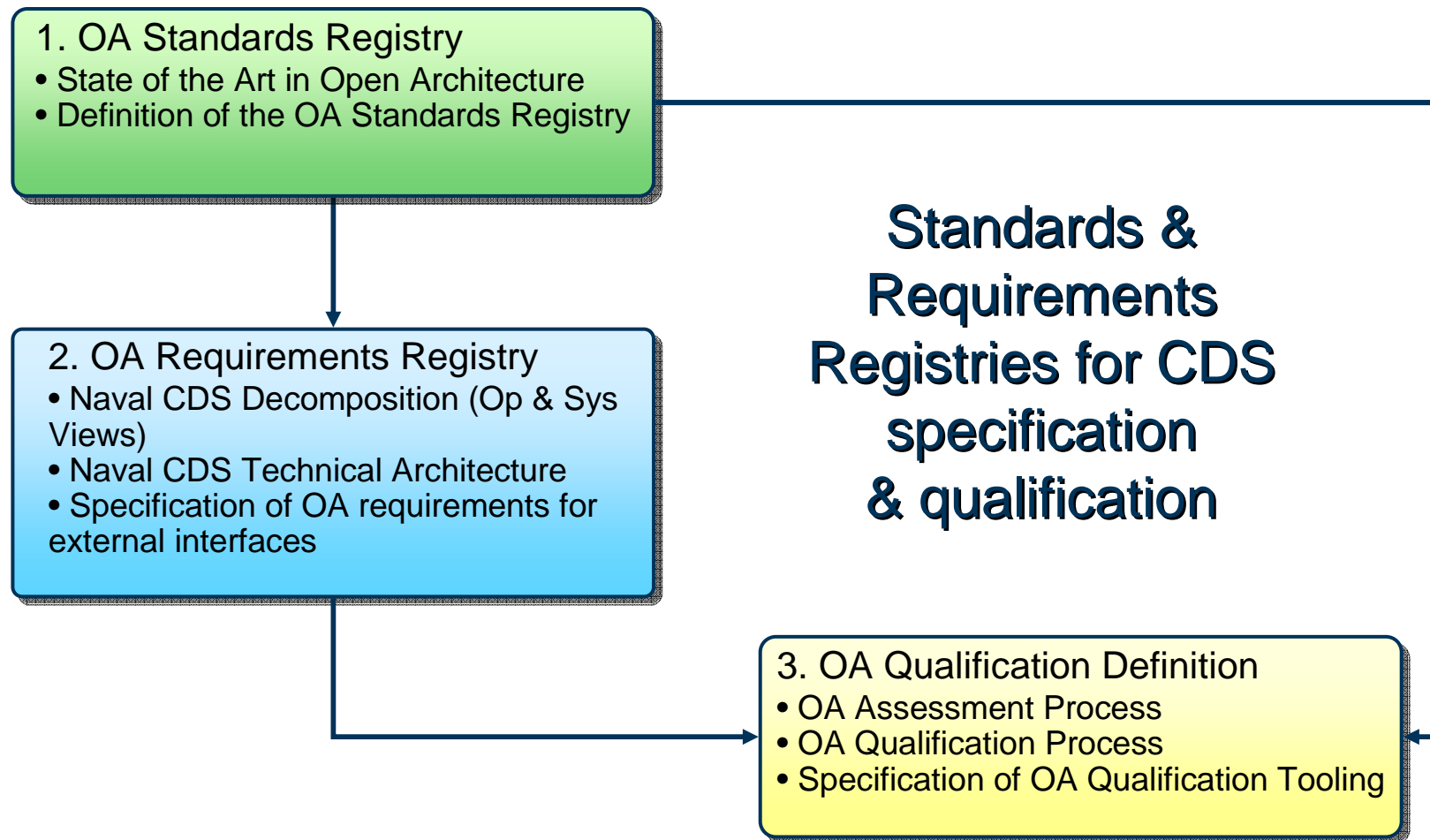
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OA French vision and approach

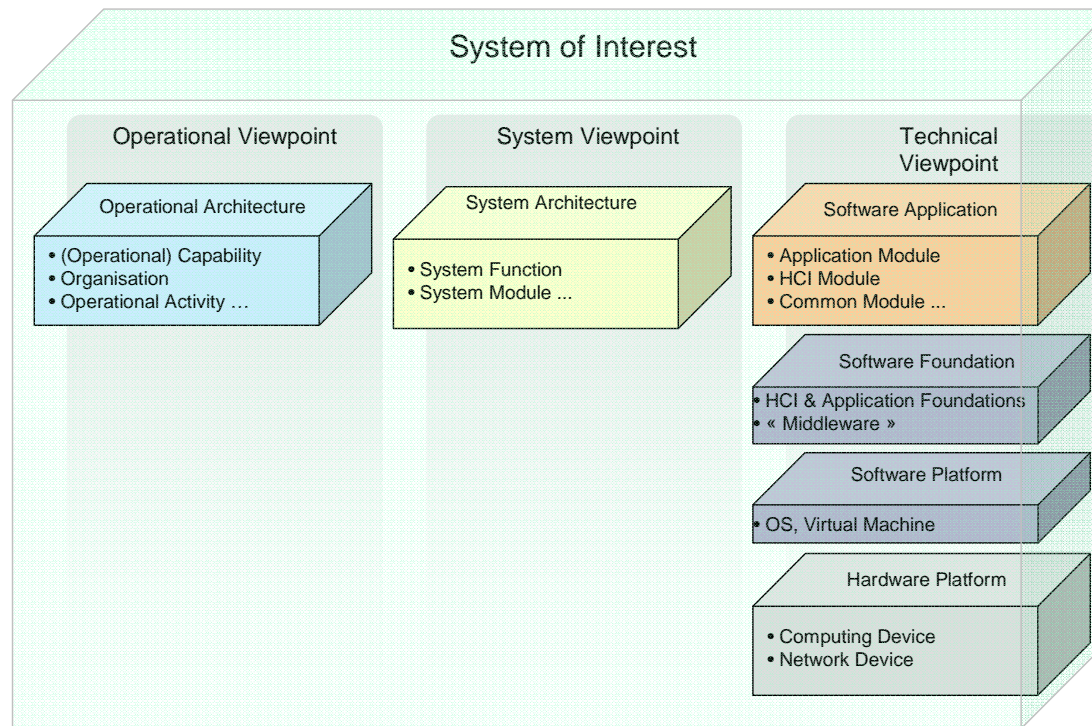
- **Strong expectation for modern CDS :**
 - **Reduce system total cost of ownership**
 - **Improve system flexibility / evolutivity to address operational needs evolutions and technology changes**
 - To maintain operational advantage and capability through whole system life cycle
 - To improve system maintainability
 - **Improve system interoperability with existing or future systems**
- **To do so an open architecture must be built on :**
 - **A modular architecture approach**
 - **Use of Open standard**

OA French vision and approach



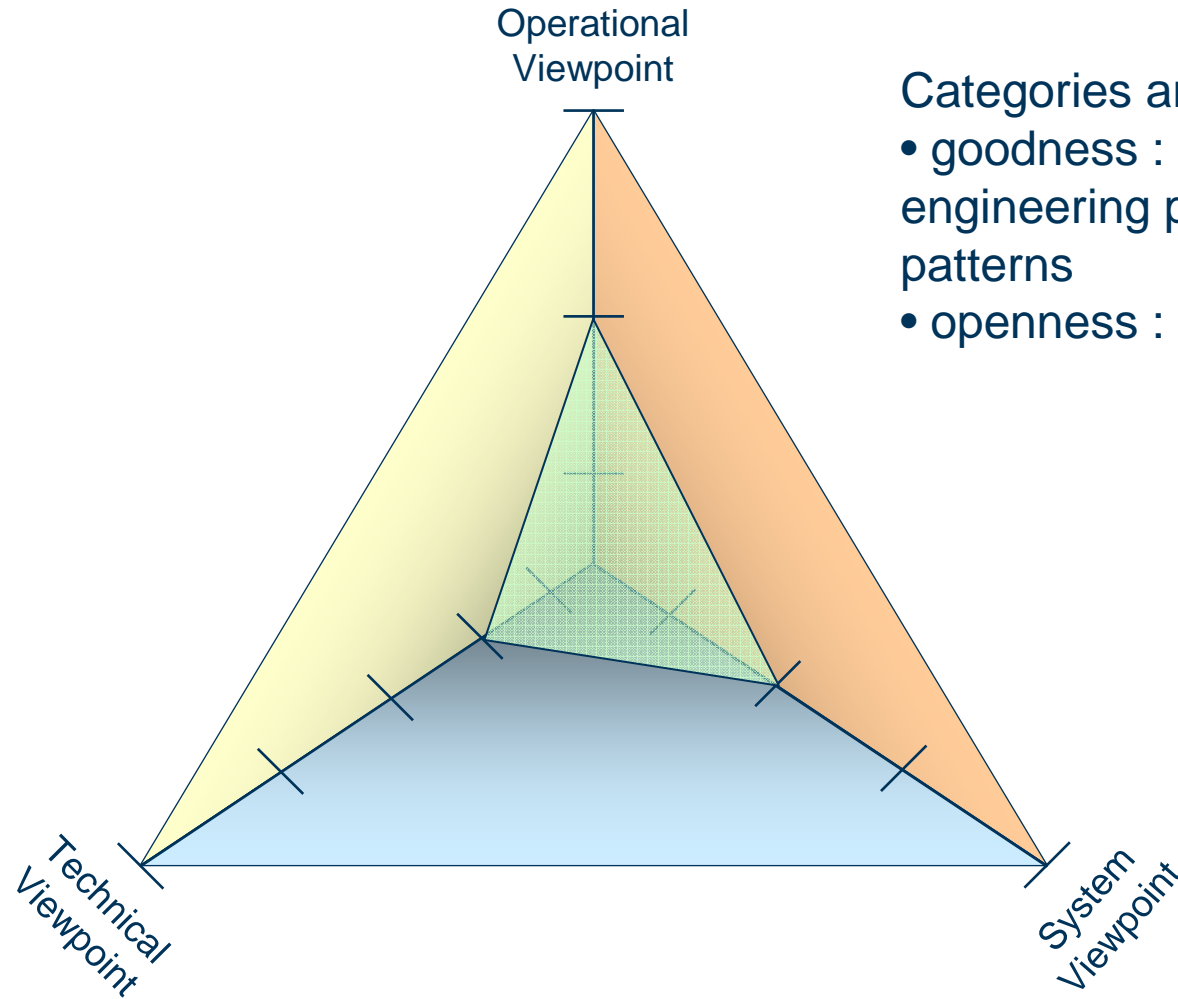
State of the Art

... in System Architecting and Engineering



- **Yet, current practices in Open Architecture do not address those different viewpoints:**
 - Some approaches only address a single viewpoint (e.g. US Navy OACE)
 - Other approaches define qualities (e.g. openness, interoperability, modularity, extensibility, ...) but without their characterisation in those viewpoints.

Innovative approach

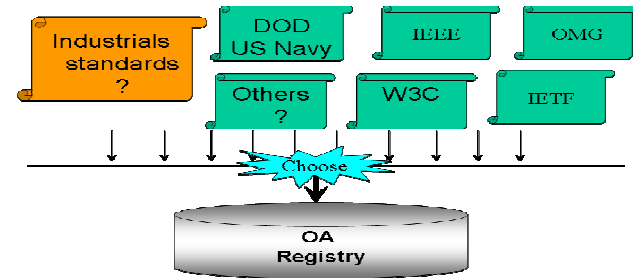


- Categories are defined by:
- goodness : architectural / engineering principles & patterns
 - openness : standards

OA Standards Registry

- **OA Standards Registry identifies :**

- **Recommended principles, patterns, standards and technologies**
- **According to :**
 - Their maturity (established, emerging)
 - Their diffusion (low, average, large)
 - The type of standard (de facto, de jure, open)
 - Supporting entity or Standardisation Organisation

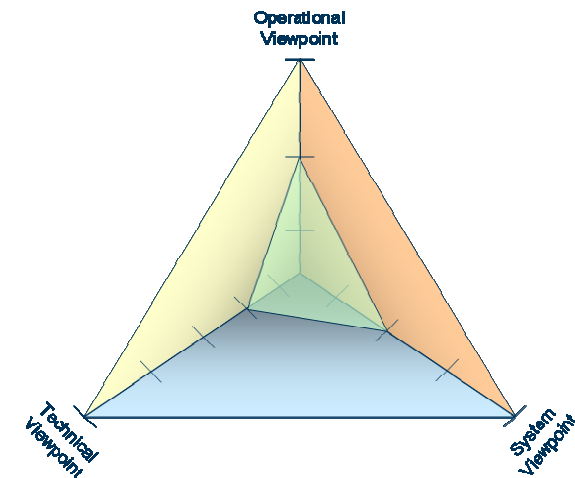


- **Registry addressing :**

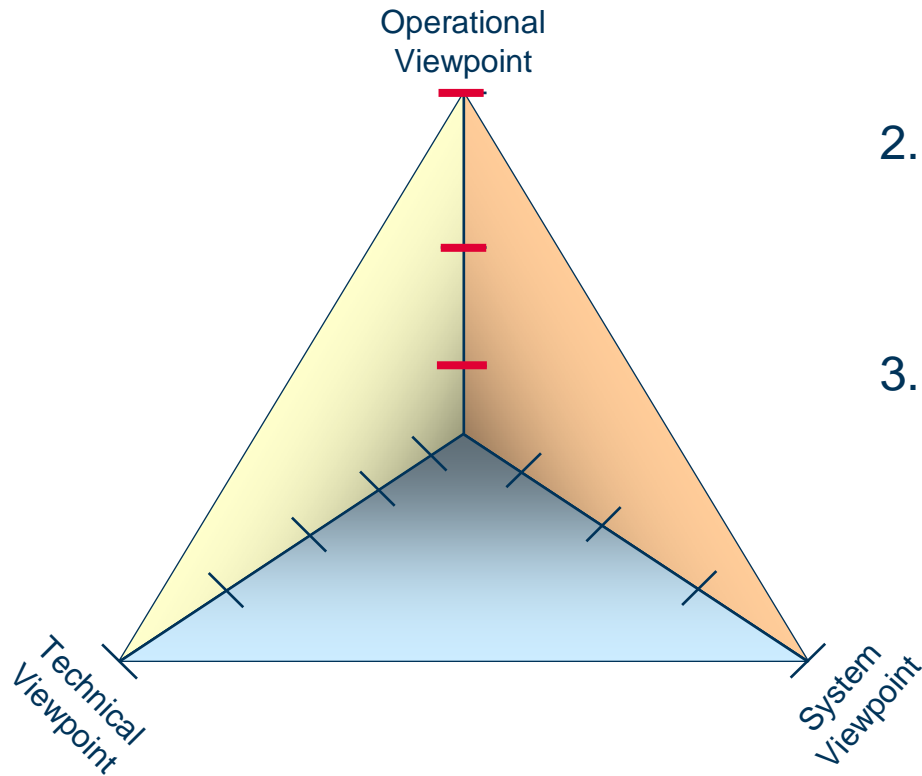
- **Operational, System and Technical viewpoints**
- **Different abstraction layers**
- **Both HCI and Application Server aspects**

- **Categories are defined by:**

- **Modularity : architectural / engineering principles & patterns**
- **Openness : standards**

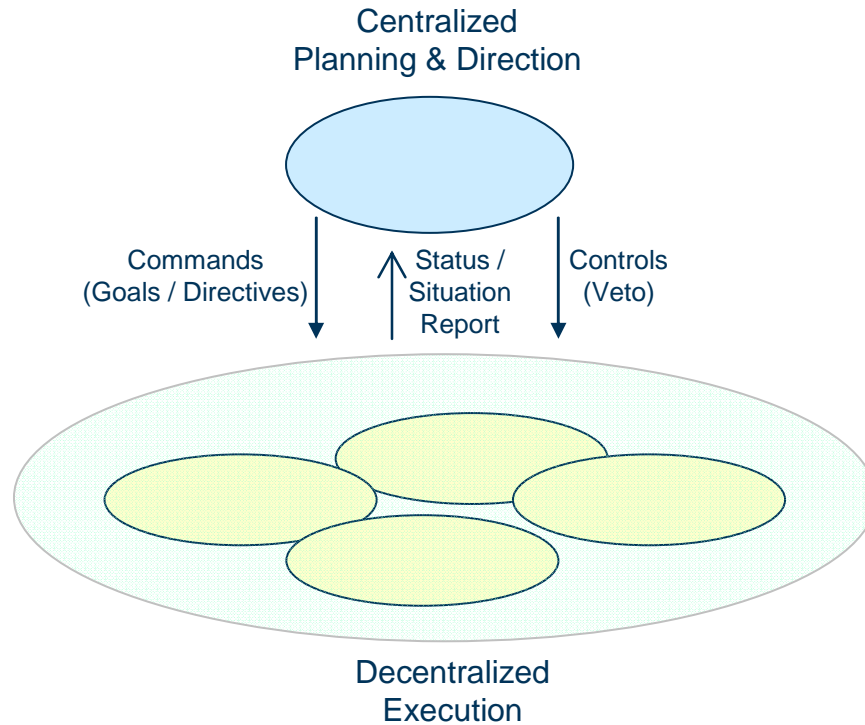


OA Standards Registry - Operational Viewpoint Categories

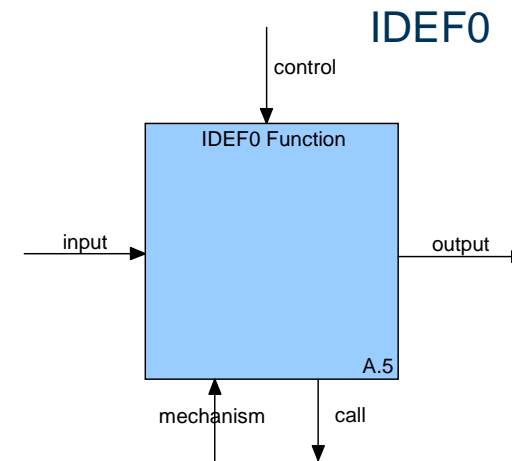


1. Insufficiently Formalized Operational Architecture
2. Formalized Operational Architecture
 - Architecture Framework
 - DoDAF / MODAF / NAF standard
3. Modular Operational Architecture
 - command & control vs. reporting

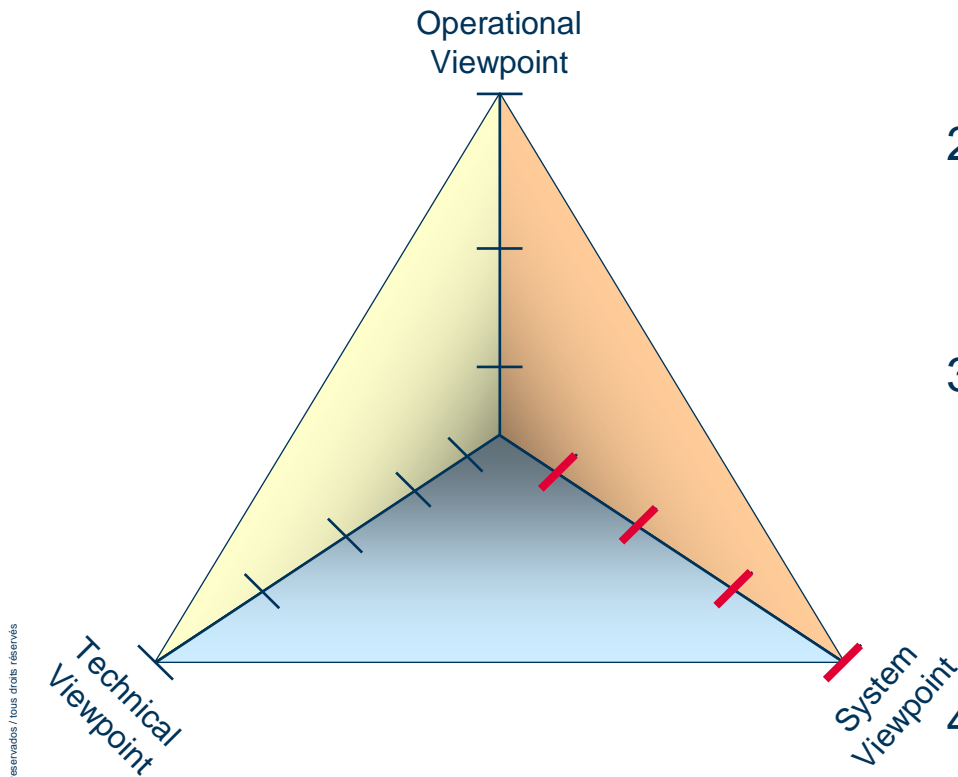
OA Standards Registry – Principles & Patterns



- SOA – Service Oriented Architecture: *request / reply* or *command / control* interaction
- DOA – Data Oriented Architecture: *publish / subscribe* interaction

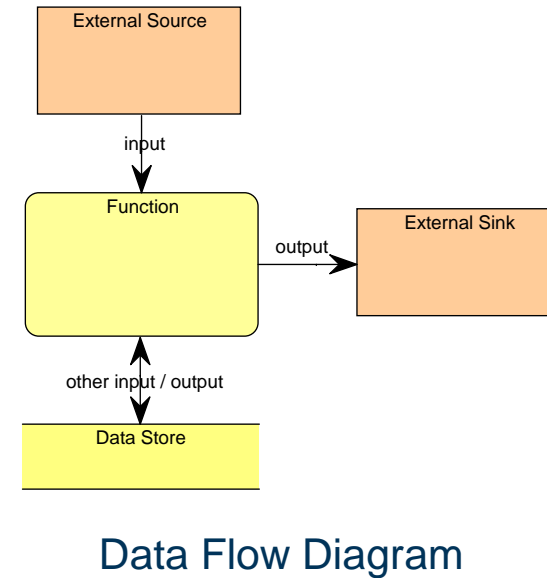
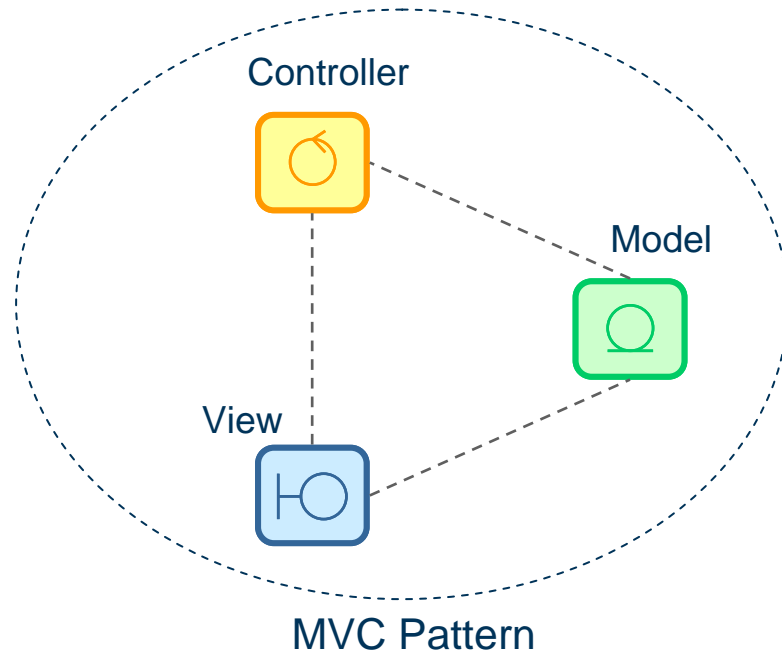


OA Standards Registry - System Viewpoint Categories



1. Insufficiently Formalized System Architecture
2. Formalized System Architecture
 - Architecture Framework
 - DoDAF / MODAF / NAF standard
3. Modular Computing System Architecture
 - SOA vs. DOA
 - computing function vs. data store (MVC Pattern)
4. Full Modular System Architecture
 - computing vs. HCI vs. gateway function (MVC Pattern)
 - standard interfaces

OA Standards Registry – Principles & Patterns



HCI function with:

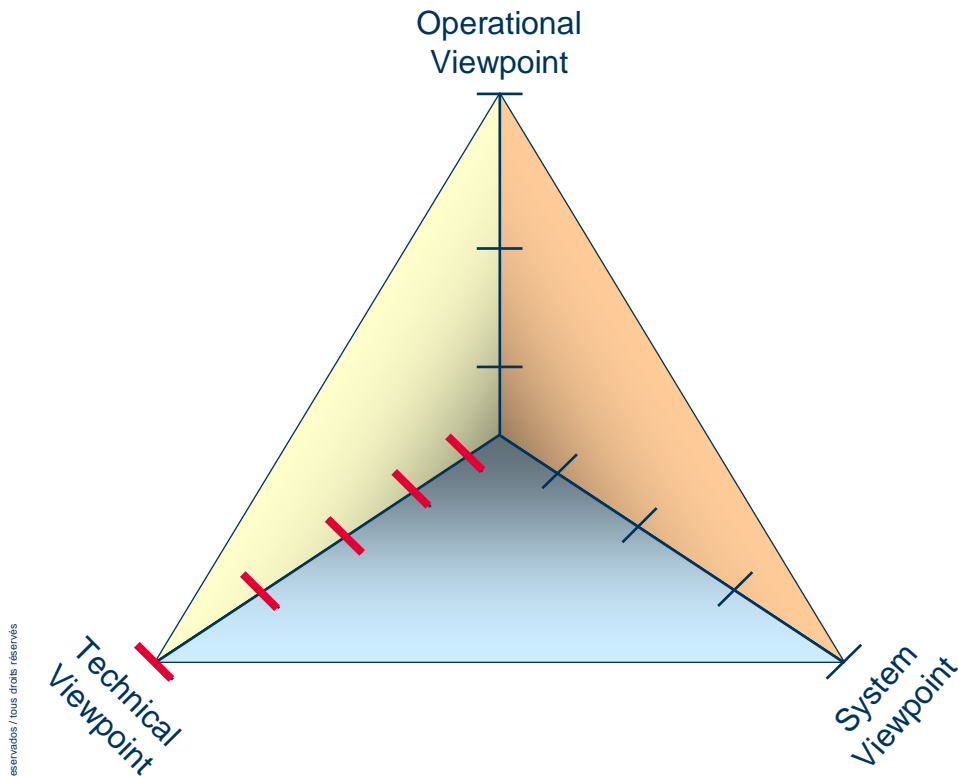
- elements to be visualized (function input) and controlled (function output).

Gateway – interface function with external system via:

- standard interfaces (if available) for conventional features
- specific interfaces for advanced features of a given equipment

Standard vs.
Modularity

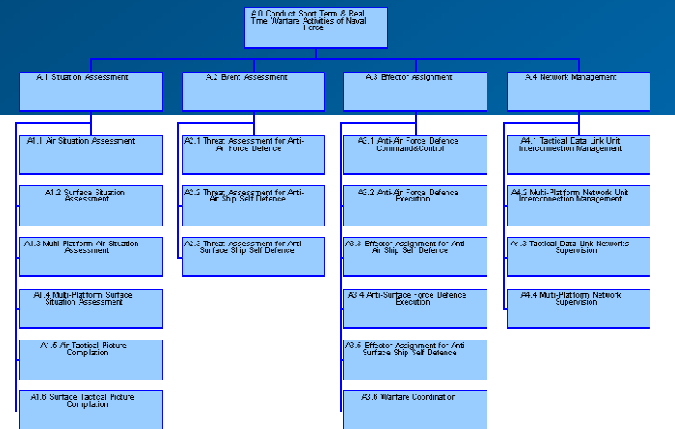
OA Standards Registry - Technical Viewpoint Categories



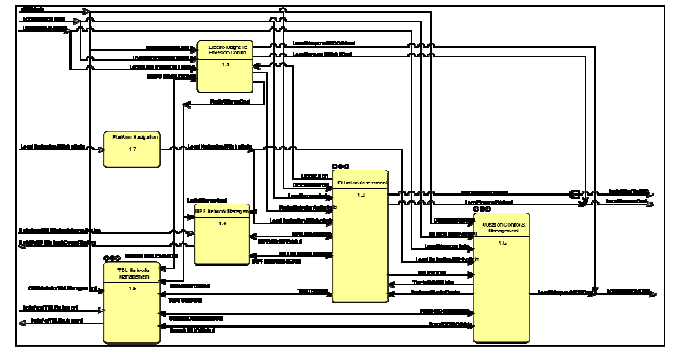
1. Legacy Technical Architecture
(~ OACE Hardware Adapter)
2. Layered Technical Architecture
(~ OACE Interface)
3. Open Technical Architecture
(~ OACE Standards)
4. Modular Technical Architecture
(~ OACE Common Functions)
 - Dependency Inversion
 - MVC Pattern
 - MDA
 - Component
 - AOP ...
5. Plug and Play Technical Architecture
 - Service Component
 - Plug-in = HCI part + Application part

OA Requirements Registry

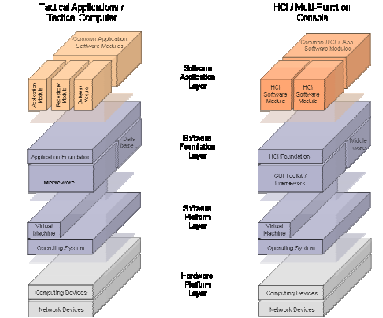
- Application of the Standards Registry to a Naval CDS :
 - Operational / System / Technical Decomposition
 - External Interfaces
- Identification and specification of openness supports
- Results
 - CDS Reference Architecture modelling
 - Openness support requirements



Operational Viewpoint



System Viewpoint



Technical Viewpoint

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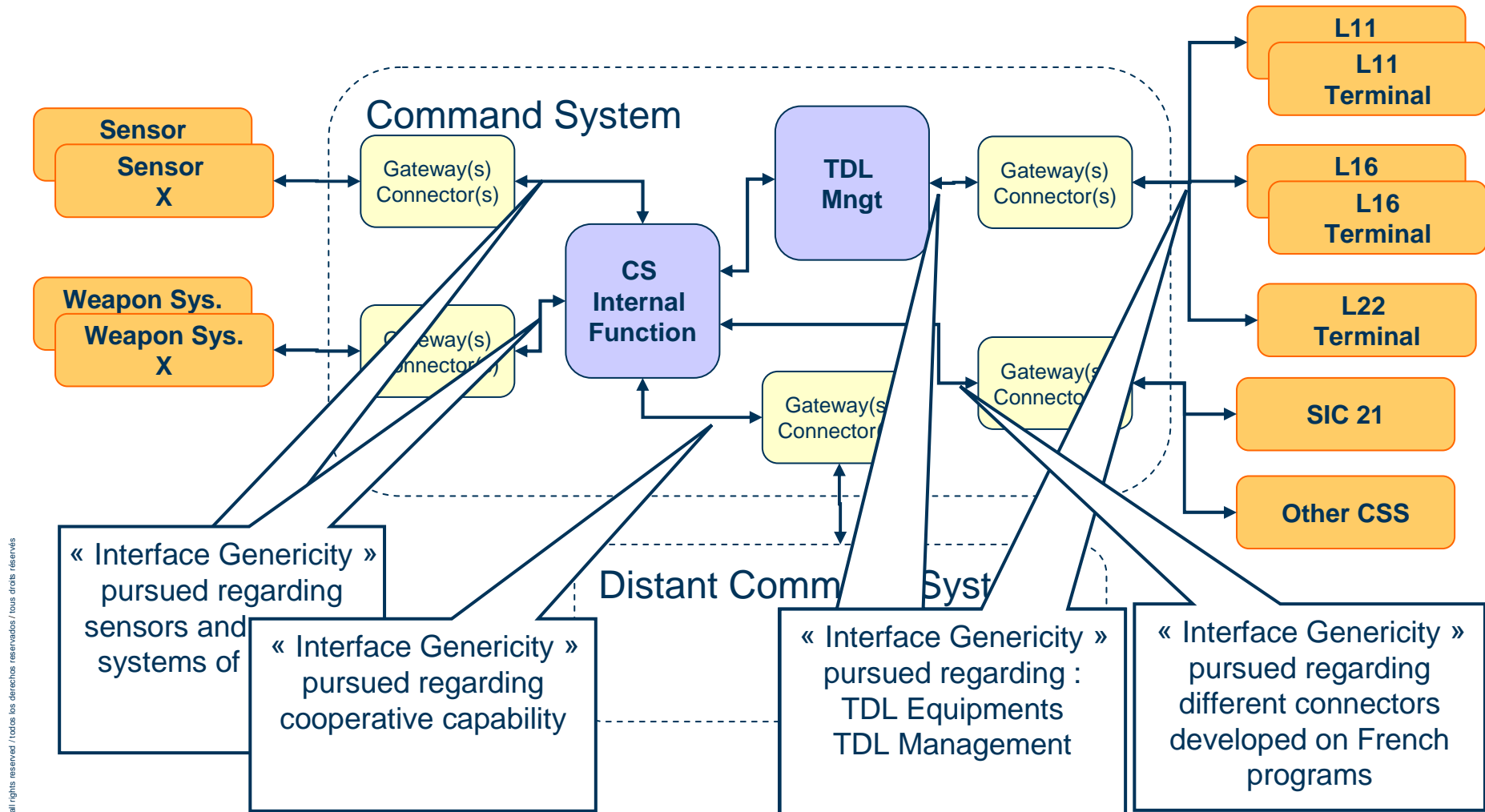
OA Requirements Registry - Naval CDS Decomposition

Scope and objectives

- **Capture future naval Command System architecture with :**
 - **Force Level Capabilities built on**
 - Multi-platform interconnexion
 - Cooperative situation awareness and engagement
 - **Decomposition addressing both operational and system viewpoints**
 - Based on a DoDAF / NAF sub-set of views
- **Enable the identification of openness supports especially regarding external interfaces**

OA Requirements Registry – External Interfaces

Approach overview



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OA Requirements Registry – External Interfaces

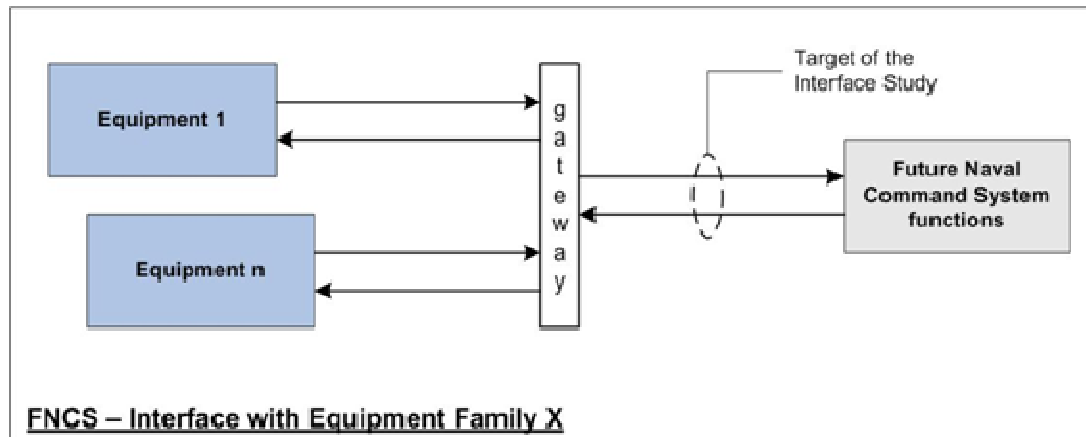
Approach overview

- **Openness Support are identified based on :**
 - a CS point of view
 - on external interfaces and related dataflows defined in CS decomposition
 - a set of unitary interfaces on which to applied SOLID Single Responsibility and Interface Segregation principles :
 - via Common / Specific Segregation pattern : Separation of the part (generic) common to different user/supplier modules from the parts specific to a given user/supplier module.
 - via Domain Partitioning pattern : Separation of interfaces corresponding to different domains (different functional domains, or functional domain vs quality of service).
- **Each openness support is characterized by :**
 - Requirements specifying applicable principles and patterns
 - A hierarchy between supports and related unitary interfaces
 - Associated unitary interfaces list

OA Requirements Registry – External Interfaces

Approach overview

- For each external interface :
 - Unitary interfaces are defined based on SOA and DOA patterns :
 - A CS point of view and related openness support
 - SOA : to distinguish C&C request and C&C reply interactions
 - DOA : as a native read and write segregation relying on data publication, data subscription and data query interaction
 - Each unitary interface is characterised by :
 - Requirements specifying applicable principles, patterns and open standards
 - Static and dynamic interface definition



OA Requirements Registry – External Interfaces

- **Support analysis based on the following sensors and effectors of interest :**

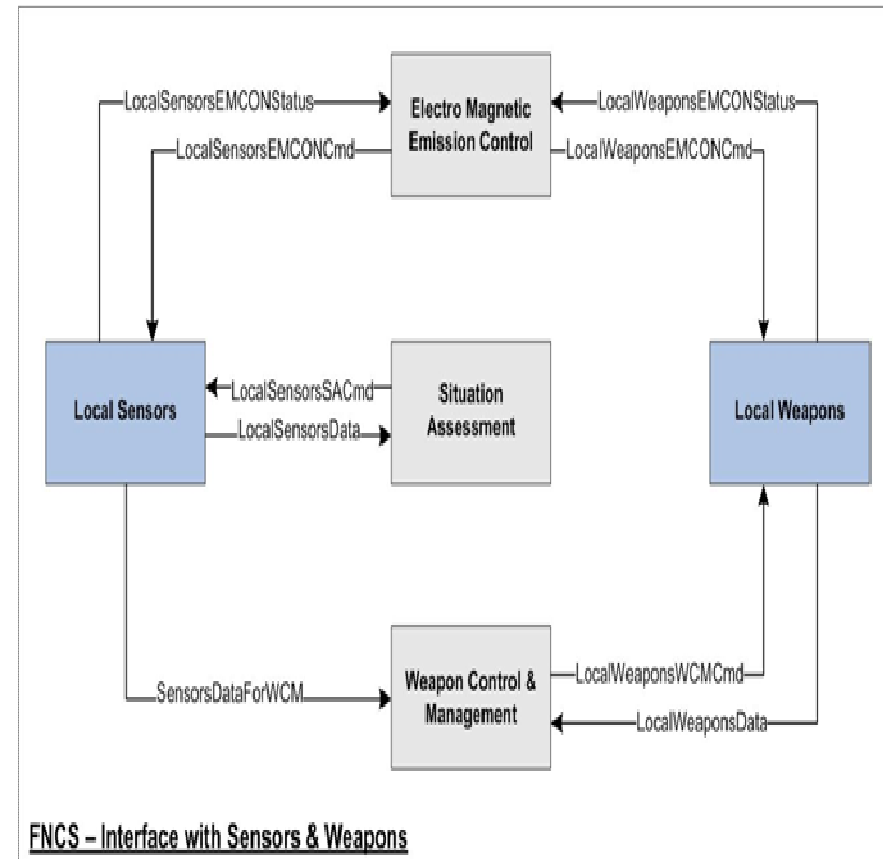
- SELESMAR and Scanter 2100 Navigation radars
- Scanter 4100 and 6002 2D Surv. Radar
- SMART-S and LRR-S1850 3D Surv. Radar
- EMPAR and Herakles MFR
- ASTER 15/30 and VL-MICA Anti-air missile weapon systems
- MM-40 block 2&3 Anti-ship missile weapon systems

- **Openness supports hierarchy retained :**

- **Sensors and Weapons**

- Sensors
 - › Radars
 - › Fire Control Systems
- Weapons
 - › Missile Weapon Systems

- **Work in progress to extend this approach to other types of sensor or weapon**



OA Requirements Registry – Sensors and weapon systems External Interface

Openness supports	C/S S		Interfaces (called OA)	DOA	SOA	Standards	
S_501 Sensors and Weapons	x	I_0010	Stop/Start own ship emissions		x		
		I_0030	Manage emission and firing areas		x		
		I_0060	Receive digital video	x			
		I_0130	Perform kill assessment request		x		
	S_502 Sensors	x	I_0040	Receive sensor plots	x		
			I_0050	Receive sensor tracks	x		
			I_0080	Manage extraction zones		x	
			I_0100	Control sensor states and modes		x	
	S_503 Radars	x	I_0020	Manage radar frequency usage		x	
			I_0070	Receive jamming interference reports from radar	x		
			I_0090	Perform radar measurement request		x	
	S_504 Fire Control Syst.	x	I_0120	Command target acquisition		x	
	S_505 Weapons	x	I_0110	Monitor weapon states and modes	x		
			I_0140	Set up engagement and firing policies		x	
			I_0170	Monitor engagement execution before kill assessment	x		
			I_0180	Give particular engagement and firing orders		x	
S_506 Missile Weapon Syst	x	I_0150	Assign Weapons to threats to engage		x		
		I_0160	Approve engagement plan		x		

OA Requirements Registry – Technical Architecture

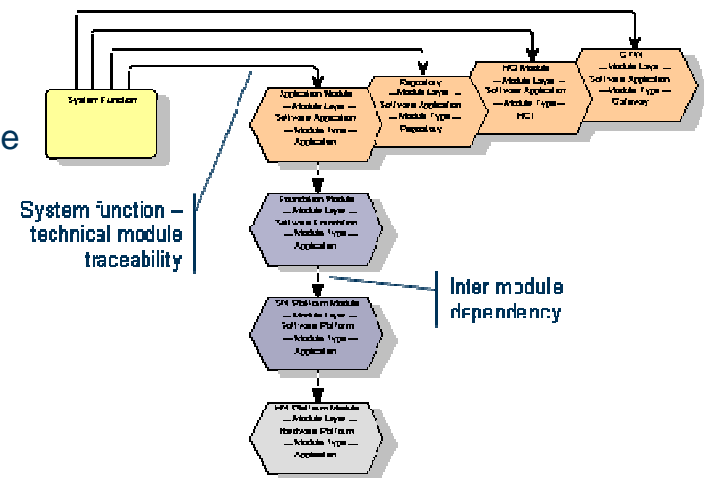
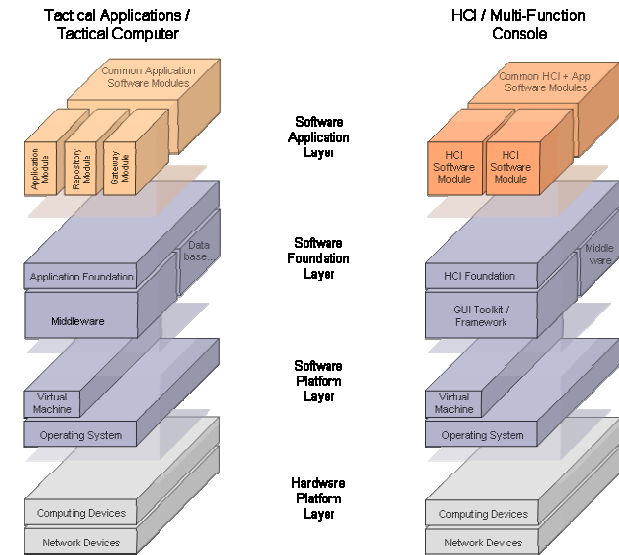
- Overall technical structure definition

- Identification of openness supports
- Possible aggregation

- Technical architecture modelling :

- Address the different abstraction layers
- Identifies :
 - “Applicative” modules typologies (application, gateway, repository, HCI)
 - Traceability between system functions and “applicative” modules
 - Typical technical decomposition for each “applicative” module
 - Dependency between technical modules

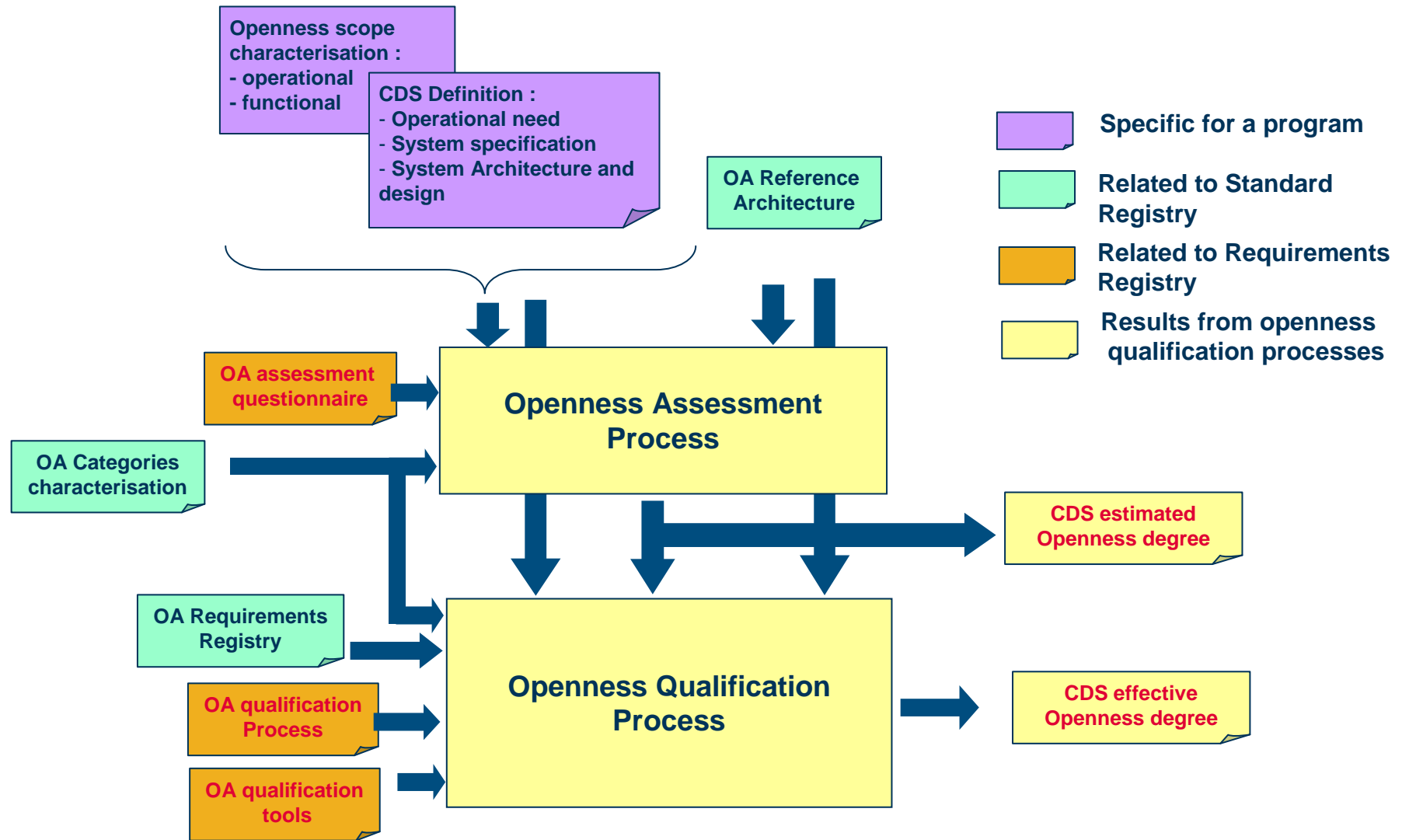
- Requirements for principles/patterns and standards to apply on openness supports



OA Qualification Definition

- **Definition of a process to check and qualify the degree of openness of a CDS in relation to the requirements baseline**
- **Two steps process:**
 - **Openness degree estimation based on a questionnaire**
 - **Openness degree verification based on IADT evaluation methods**

OA Qualification Definition - Processes



Perspectives

- **Work dissemination / promotion**
 - Standardisation organisation
 - Industries

- **On-going work**
 - Update of standard registry
 - Application of standard registry to a wider operational and system scope
 - Adaptation of the qualification process to operational CMS

Questions ?

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