Open Architecture for Naval Combat Direction System

Mr. Denis Janer and Mr. Chauk-Mean Proum
DCNS
BP 403 (Le Mourillon)
83055 Toulon cedex
FRANCE

denis.janer@dcnsgroup.com / chauk-mean.proum@dcnsgroup.com

ABSTRACT

France has adopted an "Open Architecture" approach for its Naval Combat Direction Systems (NCDS) in order to reduce the system's total cost of ownership, to improve the system flexibility and to ensure system interoperability with existing or future systems. DCNS has been contracted by DGA, French Ministry of Defence, to develop this approach by defining a global process to specify and qualify the openness level of its Naval CDS. This process is based on the modelling of a reference architecture using NAF views and the creation of a requirement repository for system and technical openness specification and qualification. This study aims to increase the standardization of Naval CDS, above all from system view point.

1.0 INTRODUCTION

France has adopted an "Open Architecture" approach for its Naval Combat Direction Systems (NCDS), the real-time part of the Combat Management System (CMS). Comforted by international state of the art and similar studies in other countries, French vision relies on an open architecture built on a modular architecture and the use of open standards.

Like for other nations, Open Architecture is deemed:

- to reduce the system's total cost of ownership
- to improve the system flexibility and evolutivity in order to face operational need evolutions and technology changes
- to ensure the system maintainability
- to ensure system interoperability with existing or future system

DCNS has been contracted by DGA, French Ministry of Defence, to develop this approach based on the following tasks:

- Standards Registry definition. This first task aims at:
  - identifying relevant state of the art principles and patterns for architecting and designing a CDS
  - identifying relevant standards
  - defining openness categories or levels and the appropriate selection of principles / patterns and standards for each openness category
- Requirements Registry definition. This task covers:
  - the functional and technical decomposition of a NCDS
  - the requirements definition of interfaces with external systems: sensors, effectors, TDL (Tactical Data Link) and CSS (Command Support System)
  - the requirements definition of interfaces related with Force Level Capabilities

- Openness Qualification definition. This task includes:
  - an Assessment Process definition
  - a Qualification Process definition
  - a Qualification Tooling specification

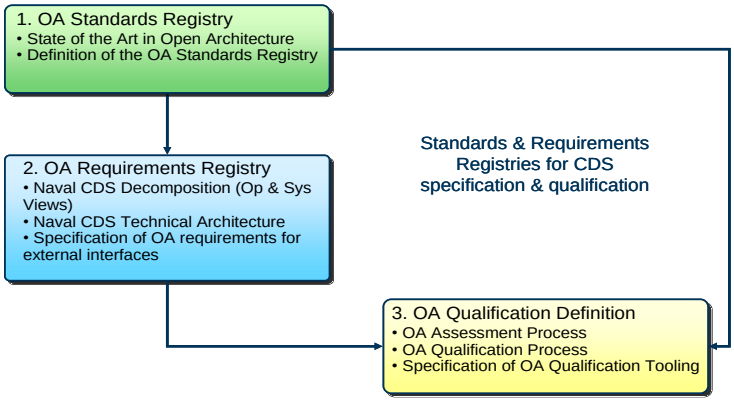


Figure 1: OA Study for naval CDS

This paper will present the objectives of OA Standard registry and openness category definition approach and will focus on the work done on NCDS decomposition, external interface and qualification process. As a conclusion, it will expose the perspectives and continuation of this program.

2.0 STANDARD REGISTRY AND OPENNESS CATEGORIES

Based on international OA state of the art and previous studies conducted by DGA and DCNS, the first step of the study was to identify:

- Architecture and design principles or patterns that should be recommended to contribute to architecture modularity aspects
- Standards and technologies that should be recommended for openness aspects

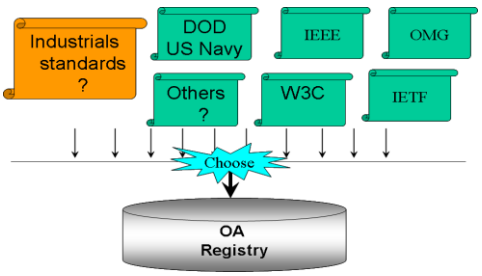


Figure 2: OA Standard registry

These recommendations are not limited to a technological viewpoint. They address operational, system and technical point of view through the different abstraction layers.

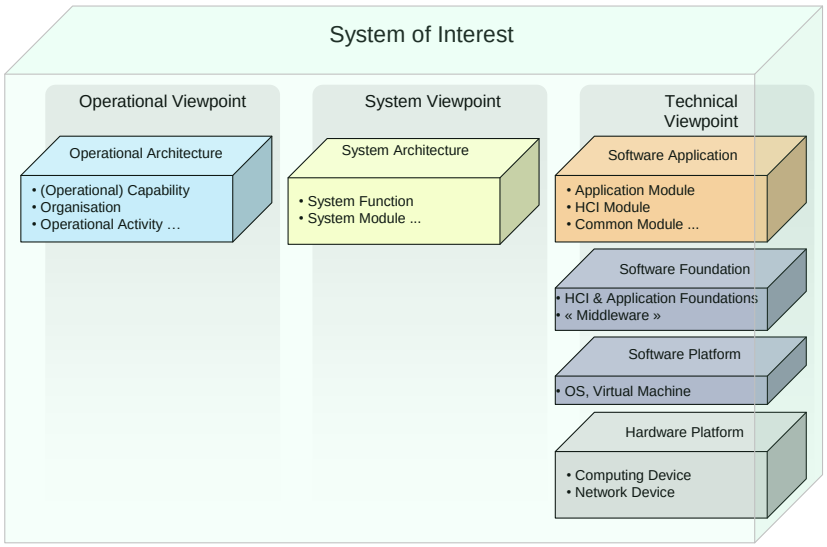


Figure 3: Viewpoints

For each point of view, both modularity and standardization have been considered:

- Operational viewpoint is necessary to capture
  - Mission or capabilities modularity and their future evolutions
  - Operational organisation and tasking variants
  - Capabilities interoperability needs
- System View point enables the translation from operational architecture and its modularity into system functional decomposition and deployment
- Technical viewpoint enables system to be build according to a layered technical architecture where application layer relies on software foundation, ensuring the independence of application modules from technologies

Standards and technologies are considered not only for their contribution to system openness but also for their maturity and their diffusion. This analysis and these set of recommendations make possible to define Openness categories for each point of view depending on modularity and openness/standard use objectives.

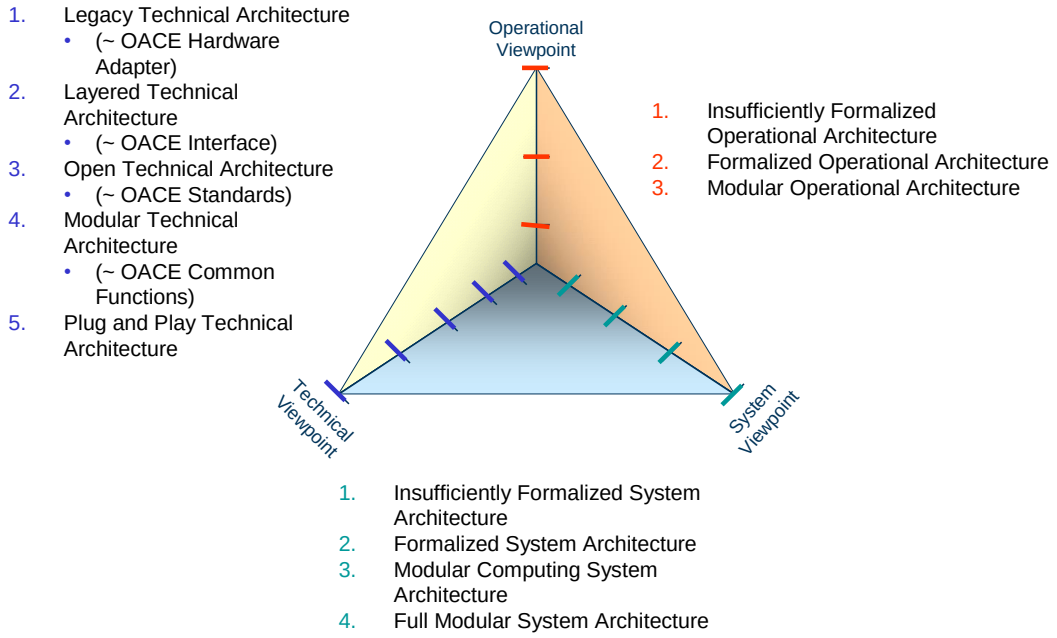


Figure 4: Openness categories definition

3.0 OA REQUIREMENTS REGISTRY

The second part of the study has been conducted to identify how and which elements of the standard registry have to be applied to a naval CDS. To do so, operational, system and technical architectures have been considered.

3.1 NCDS Modelling

A NCDS decomposition and modelling have been provided for these 3 viewpoints. Modelling has been made based on NAF formalism and a subset of NAF-views.

- Operational point of view : as previously seen for operational categories, the aim was to initiate a first operational modelling defining typical capabilities and operational activities (see figure 5). The perimeter of the study covers Anti Air Warfare, Anti Surface Warfare and Force Level capabilities (cooperative situation awareness, engagement on remote data).

- System point of view : functional decomposition is aiming especially at identifying openness supports related to external interfaces based on the system data flows and external interface definition (see figure 6).

- Technical point of view : the aims is to identify openness supports across the 4 layers model distinguishing different kind of application module (HCI, repository, gateway) and taking into account for each of them a typical technical decomposition capturing dependencies between technical modules across the 3 lowest layers (see figure 7).

The results of NCDS modelling is an identification of potential openness supports.

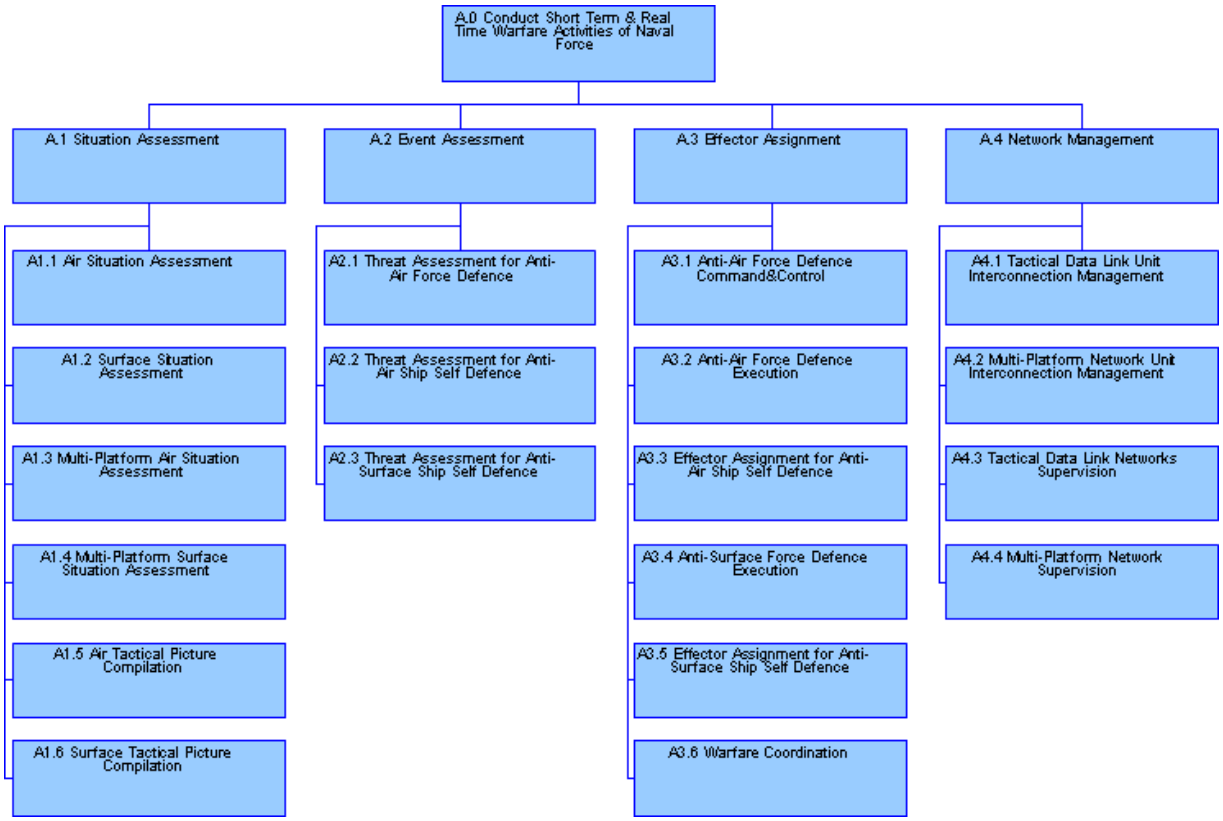
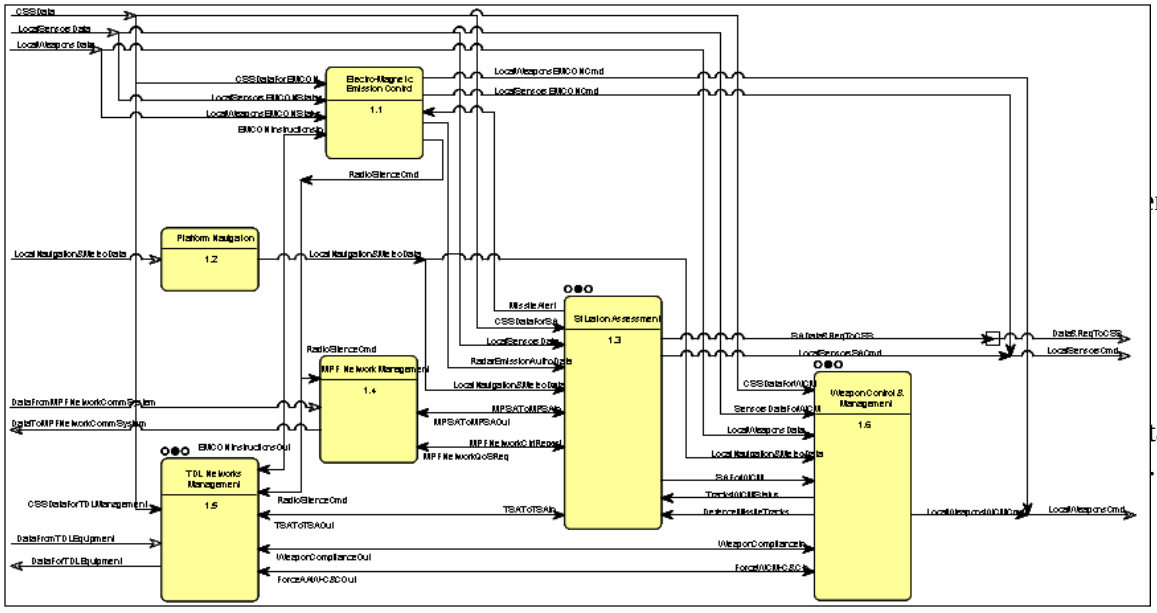


Figure 5: Operational view



ncies between

tandards to be

Figure 6: System view

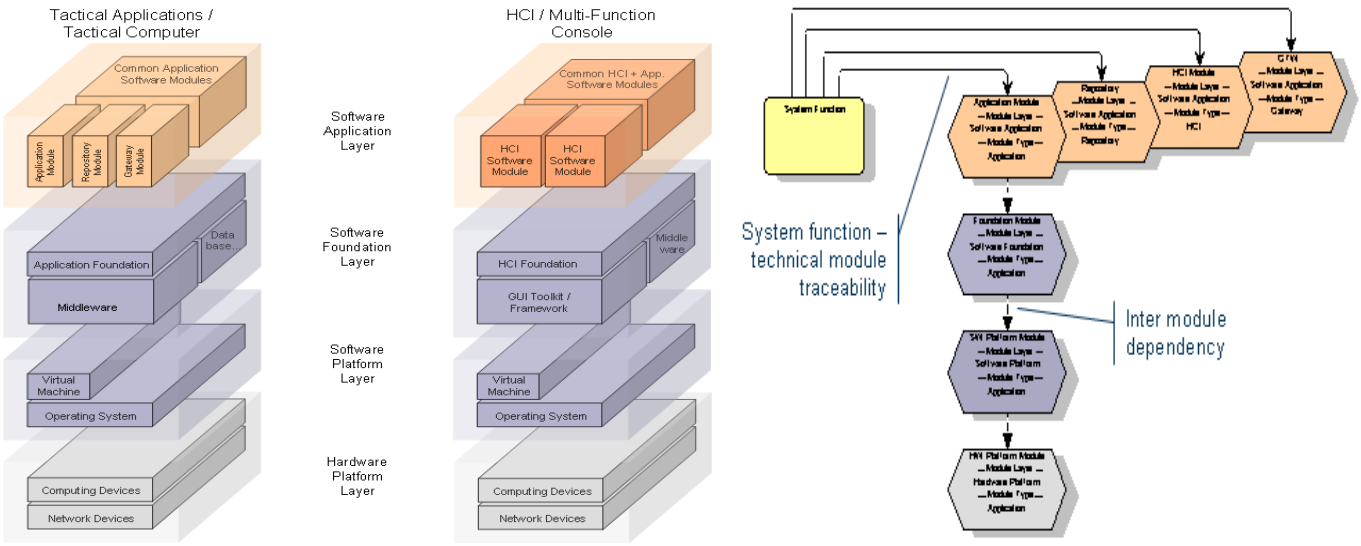


Figure 7: Technical views

3.2 External interfaces

The interfaces of a system form natural openness supports. This part of the study consisted in closely examining the flows exchanged between the functions of the NCDS reference architecture and the combat system equipment items in order to retain system exchanges presenting the most common features with respect to the diversity and variability of the equipment items.

Openness supports are then specified according to OA principles and forms an initial definition of unitary interface with a set of gateways that are designed to adapt these external interfaces to the specific nature of the equipment items. Gateway approach is fully compliant with gateway stereotype approach recommended for physical and software architecture, even despite interface normalization issues.

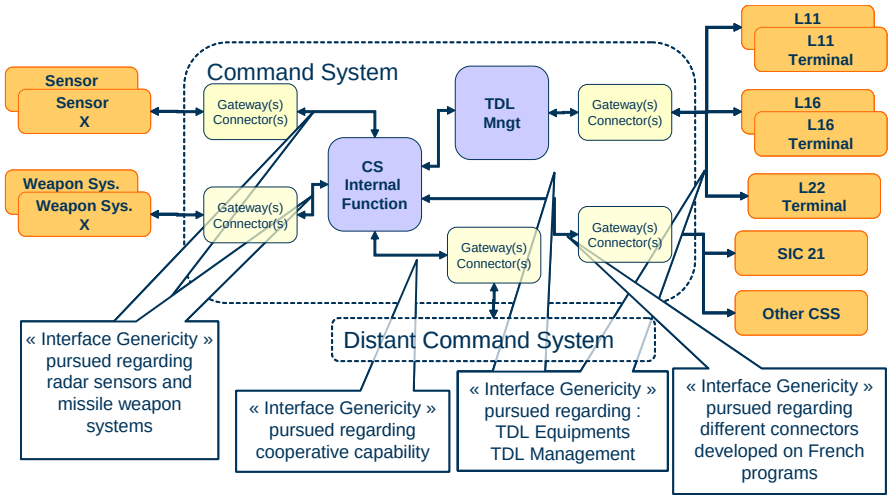


Figure 8: CDS External Interfaces candidate for genericity

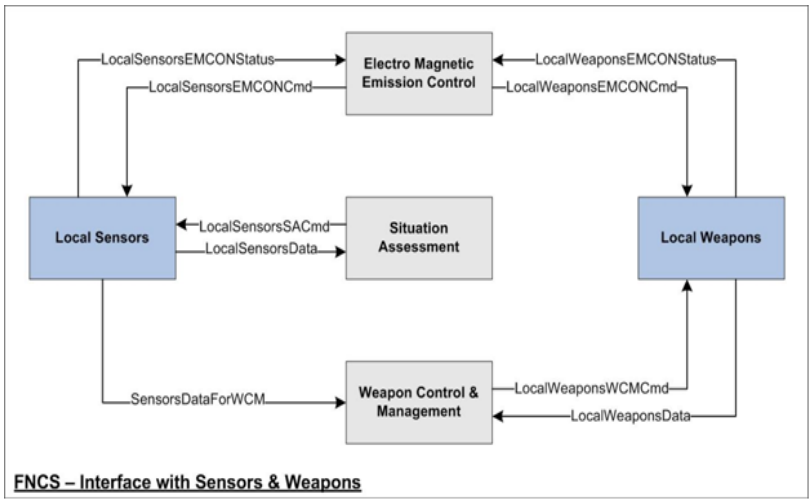


Figure 9: Sensors and Weapons Interfaces Modelling

Each openness support is characterized by requirements specifying applicable principles and patterns and associated unitary interfaces list. Each unitary interface is characterised by SOA or DOA pattern, static and dynamic definition and applicable principles and patterns.

Openness supports	C/S S		Interfaces (called OA)	DOA	SOA	Standards
S_501 Sensors and Weapons		I_0010	Stop/Start own ship emissions		x	
		I_0030	Manage emission and firing areas		x	
		I_0060	Receive digital video	x		
	x	I_0130	Perform kill assessment request		x	
S_502 Sensors		I_0040	Receive sensor plots	x		
		I_0050	Receive sensor tracks	x		
		I_0080	Manage extraction zones		x	
	x	I_0100	Control sensor states and modes		x	
S_503 Radars		I_0020	Manage radar frequency usage		x	
		I_0070	Receive jamming interference reports from radar	x		
	x	I_0090	Perform radar measurement request		x	
S_504 Fire Control Syst.	x	I_0120	Command target acquisition		x	

Figure 10: Interfaces Openness support example

4.0 QUALIFICATION PROCESS

The purpose of the qualification process is to check and qualify the degree of openness of a CDS in relation to the requirements baseline previously defined. This qualification process can form part of a contractual context in which the customer defines, in its requirement specification, a CDS openness objective in line with one of the categories defined in the normative baseline. The customer then validates, through the CDS definition, the applicable openness supports and their specifications based on the requirements baseline.

The result of this process must enable the effective attainment of an openness category according to each operational, system and technical viewpoint to be verified and provide information concerning the work that would need to be implemented to attain the higher category if this has not been reached.

The figure 11 presents the sequence of the steps to estimate and check the requirements.

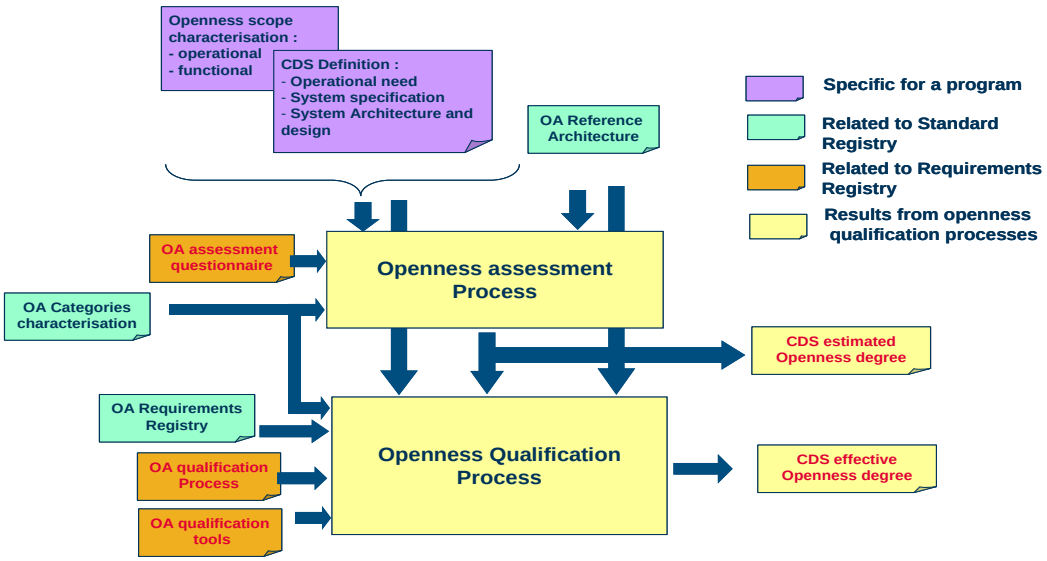


Figure 11: Openness Qualification process

The prerequisite to run the qualification process is to estimate the degree of openness attainable through an estimation process questionnaire. The estimation step represents an initial qualification step as it is used to:

- Identify the category estimated to be attainable according to each viewpoint
- Check the evidence provided in the responses to the questionnaire

The qualification process itself is executed by implementing the steps to check the coverage of the applicable requirements .

The figure 12 presents an overview of the tool chain upon which the process is based.

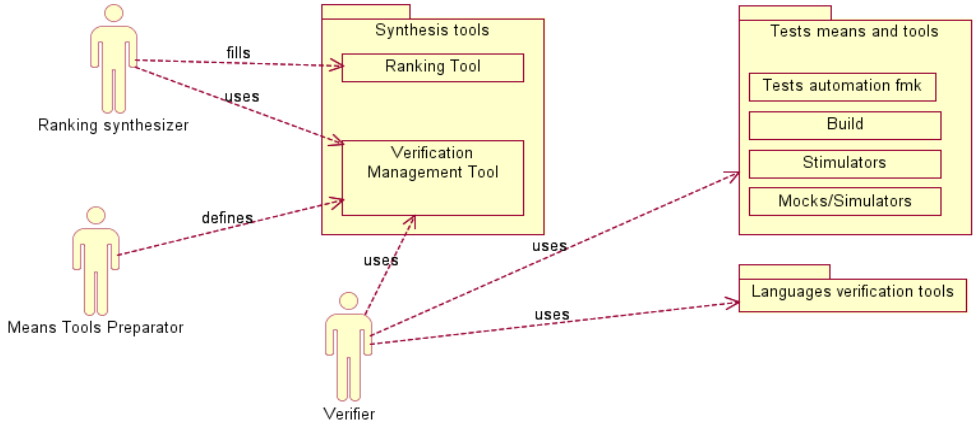


Figure 12: Tools chain

5.0 CONCLUSION

DCNS and DGA have developed an innovative open architecture approach for Naval CDS development addressing a full scope :

- An openness characterisation and categorisation not only for the technical viewpoint but also for the operational and system view points
- An Openness support specification based on set of recommended principles, patterns, standards and technologies
- An Openness assessment and qualification process

It provides a first reference Naval CDS architecture modelling addressing operational, system and technical point of view. The Openness categories definition could be applied in other domains and is not Naval specific.

This study has shown an insufficient standardization initiative from system view point. Except for Tactical Data Link, standardization remains mostly confined to technical aspects. OA standard registry, CDS modelling and external interfaces requirements form a first analyse that should support and contribute to NCDS interface standardization.

Work is still going on to update standard registry with some emerging new principles or standards and to extend OA standard registry recommendations and related requirements to a wider operational and functional scope.

6.0 REFERENCES

[1] IBM (2008). Open Architecture Technical Principles and Guidelines

[2] Open Architecture Computing Environment (OACE) Design Guidance V1.0

[3] Open Architecture Computing Environment Technologies and Standards V1.0