Experimenting the Open Source MBSE Solution Capella: the Industrials' Viewpoint

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Arcadia, Capella and Clarity
Arcadia, a model based engineering method

What the users of the system need to accomplish

What the system has to accomplish for the users

How the system will work to fulfill expectations

How the system will be developed and built
Early validation: specialities know-how confronted to Architecture

Multi-viewpoint trade-off analysis (see ISO 42010 standard)
Mastering Complexity through multiple abstraction levels

Maintaining consistency across engineering phases

System Engineering

Sub-Systems Engineering

Software/Hardware Engineering
What is Clarity about?

→ Open sourcing a field proven systems engineering methodology and the world wide deployed workbench tooling it.

→ Pursuing and sharing innovation.
Who is Clarity?
AREVA involvement in Clarity: Feed-back after first year activities
Engineering, Procurement and Commissioning of nuclear energy facilities

- Fuel Cycle: enriching of uranium, fuel assemblies, treatment of nuclear fuel...
- Nuclear Power Plants (NPP): EPR™, ASTRID, new models, installed base...
Adopting Systems Engineering approach

An EPR™ Nuclear Power Plant

- ~ 300 strongly coupled systems

- 1 system may be ~ 100 SSC

- 1 empty Steam Generator weight = 1 A380 weight

- ~ 18 000 sensors and actuators

- ~ 300 I&C cabinets (centralized I&C)

Complexity
Evaluate adaptability of this MBSE tooled-method to AREVA engineering
- Not (only) software intensive systems
- A lot of efforts in justification of design
- Strong existing engineering cultures

Boost SE transformation
- Make the SE approach accessible and visible

Take advantage of a collaborative environment
- THALES having brought the tooled-approach to a high maturity level
- Sharing with other industrial partners involved
Why a MBSE tool?

Why a tool?

- **Consistency between architecting results / engineering deliverables**
- **Common formalism between architects**
- **Engineering steps are embedded in the tool**
- **Possibility to perform automatic trade-off analysis**
Why a MBSE tool?

Why a tool?
- Consistency between engineering deliverables
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Why a tool?

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Why a MBSE tool?

- **Why a tool?**
  - Consistency between engineering deliverables
  - Common and synthetic formalism between architects
  - Engineering steps are embedded in the tool
  - **Possibility to perform automatic trade-off analysis and early evaluation (TBE)**

- **Architects must deal with potentially contradictory constraints:**
  - Safety
  - Performances
  - Complexity of internal interfaces
  - Cost, subcontracting
  - ...  

- **Architecture = finding the most acceptable compromise**

  ➔ **Viewpoints** (advanced feature not yet explored, requires development)
 AREVA involvement in Clarity Year 1 actions

First year goals: evaluate the suitability of Arcadia & Capella to AREVA engineering practices and our learning curve

AREVA engineering activities addressed in 2015:
- Core design and transient analysis
- Fluid systems design
- Primary components design
- Handling equipment design
- I&C specifications
- I&C Architecture
- Human Factors engineering

- a rather wide spectrum

5 « official » pilot cases, with different levels of investigation:
- *** ASTRID Fuel Handling System
- ** EPR™ Extra Borating System
- ** NPP Overall I&C Architecture
- * PWR Advanced Control
- * NPP Human System Interface
The suitability of Arcadia & Capella has been evaluated and validated from a technical point of view

- Organizational and Financial suitability remain to be assessed
- Estimation of the ROI of MBSE

Arcadia method shall be tailored to AREVA engineering practices before foreseeing a wider deployment

- Current practices, but also future ones (e.g. ISO 15288 reference)

In order to increase ROI of MBSE, Capella tool needs to be coupled with data management tools
Additional expected benefits to be further tested in the context of R&D project:

- Arcadia & Capella as a support for early V&V of system design
- Support for comparison of alternative designs
- Coupling with simulations to support architecture trade-offs
- Automatic verification of design criteria
- More engineering work and much less paper work
- Better support for knowledge transfer
- ...

Suitability of Arcadia & Capella to the engineering of nuclear energy installations
26 November 2015 - p.23
A 4-steps approach to derisking MBSE with Capella in Airbus D&S
**3 Evaluation Process**

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### Step 1
**Capella/Arcadia Initiation**

- Training some engineering people:
  - Methods & tools
  - SoS & System architecture
  - Software
  - Avionics

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### Step 2
**Uses cases**

- Define the use cases and the objectives for each of them
- Tests the Capella functionalities and identify:
  - the advantages wrt current practices
  - the lacks of the tools

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### Step 3
**Internal communication**

- Formalize the result of the use cases
- Communicate to:
  - the management
  - relevant technical team

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### Next step
**Operational evaluation**

- Start with an operational project in a multi-user context
- Identify the pre-requisite for using the tool
- Define the Capella perimeter
- Facilitate adoption
« Main use case 1 » - CONOPS for military system

Space military system (project in progress)
Phase B CAPELLA/ARCADIA.
Assessment of CAPELLA in order to support the Operational Concept Document development
Compare the MEGA/NAF approach with CAPELLA Approach
[study case over]

Lunar lander Demonstrator (Project over)
Medium project / Phase C
Domains: Safety, Functional Analysis, Budget
[Study case for functionalities testing]

Large System in phase C
Development of the Avionics definition file. This study addresses the SA, LA et PA
Compare the MEGA/NAF & Rhapsody/SYSML approach with CAPELLA Approach for avionics
[study case over]
Goal:
- Generate a CONOPS on a Military project with short delay (8 weeks)

Why:
- Compare Capella/Arcadia with MEGA/NAF

How:
- 90 operational architecture diagrams done with Capella and included in the CONOPS delivery
  - Diagrams shall be included manually into the document
  - Capella cover the useful NAF views
  - Steep learning curve counter-balanced by improved efficiency
Goal:
- Propose to use Capella for avionics architecture

Why:
- Need for a new tool
- Optimise the current methodology (requirements centric)

How:
- Pilot case to convince stakeholders with Capella capacities regarding Avionics needs
  » Choose a use case known by avionics teams
  » 2 demonstration axis: telemetry sub-system and control of an engine valves
Step 2
Uses cases

- Avionics Launcher
Goal:
Propose to use Capella for avionics architecture

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Capella/Arcadia concepts well adapted to avionics discipline
Capella is user friendly with useful functionalities

Step 2
Uses cases

Step 3
Internal communication

Next step
Operational evaluation

Avionics Launcher

• Results presented to the avionics team and to the management
  Very positive feedback from the team

• Potential use for other avionics projects
• Find the right place of Capella in avionics context
5 mandatory topics for the new launcher project:

- Interface, synchronisation with the requirements management (Doors)
- Multi-user
- Interface with MEGA, Rhapsody (SysML), Matlab / Simulink, Open Modelica, Open Alterica.....

But Also:

- Interface management
- HTML site generation
- Data management
- Model continuity
- Configuration management
Very high interest on Capella/Arcadia mainly for avionics

An opportunity on new projects to be confirmed

To go further: How Capella can help on:
- Verification & Validation (IVV)
- Safety engineering
Come and meet us at Obeo booth!

- [http://www.clarity-se.org/](http://www.clarity-se.org/)
- [https://www.polarsys.org/capella](https://www.polarsys.org/capella)
- Follow us:
  - @capella_arcadia
  - Capella Modelling Workbench

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