Capella on the field: Model-based system engineering use cases

EclipseCon Europe 2014
Ludwigsburg, October 29th, 2014

Christophe Gatti (Thales Corporate Engineering)
Matthieu Helleboid (Thales Corporate Engineering)
Collective intelligence for a safer world

Whenever critical decisions need to be made, Thales has a role to play.
In all its markets — aerospace, space, ground transportation, defence and security — Thales solutions help customers to make the right decisions at the right time and act accordingly.

World-class technology, the combined expertise of 65,000 employees and operations in 56 countries have made Thales a key player in keeping the public safe and secure, guarding vital infrastructure and protecting the national security interests of countries around the globe.

A balanced revenue structure

Defence 55%  Civil 45%

Revenues in 2012

€14.2 billion euros

Shareholders

(at 31 May 2013)

French State 27%

Dassault Aviation 26%

Float 47%
of which employees 3%

Employees

65,000 (workforce under management at 31 Dec. 2012)

Global presence

56 countries

Research and development

2.5 billion euros (approx. 20% of revenues)
Dual markets
Military & Civil

AEROSPACE

SPACE

GROUND TRANSPORTATION

DEFENCE

SECURITY

TRUSTED PARTNER FOR A SAFER WORLD
Thales: A Wide Spectrum of Complex Systems

N°1 worldwide
- Payloads for telecom satellites
- Air Traffic Management
- Sonars
- Security for interbank transactions

N°2 worldwide
- Rail signalling systems
- In-flight entertainment and connectivity
- Military tactical radiocommunications

N°3 worldwide
- Avionics
- Civil satellites
- Surface radars

€14 billion in revenues

This document is not to be reproduced, modified, adapted, published, translated in any material form in whole or in part nor disclosed to any third party without the prior written permission of Thales. © THALES 2014 – All rights reserved.
Need for an Engineering Transformation

- Systems are more complex
- COTS are inadequate / Tool-vendors
- Do more... cheaper and faster, with more constraints

Better quality of developed systems: Integration, seamlessness, consistency, traceability
- Early validation
- Better productivity of engineering activities
- Collaborative engineering
- Best practice & know-how capitalization

Market

Model-Based Systems Engineering
Model-Based Engineering Method for Architectural Design

Capella

Graphical Modelling Workbench supporting Arcadia
How to improve quality, productivity, agility and flexibility of overall engineering?
How to improve quality, productivity, agility and flexibility of overall engineering?

- Eco-system wide collaboration
  - A single architecture reference
How to improve quality, productivity, agility and flexibility of overall engineering?

- Eco-system wide collaboration
  - A single architecture reference

- Complexity mastering
  - Multi-level engineering
  - Separation of concerns
Arcadia: MBSE Scalable and Adaptable Method

How to improve quality, productivity, agility and flexibility of overall engineering?

- Eco-system wide collaboration
  - A single architecture reference

- Complexity mastering
  - Multi-level engineering
  - Separation of concerns

- Concurrent engineering
  - Integrated specialty engineering
  - Early validation
  - Trade-off analysis

ViewPoints etc.
- Product Line
- Human Factors
- Performance
- Security
- Safety

Evaluation Rules

Solution Architecture
How to improve quality, productivity, agility and flexibility of overall engineering?

- Eco-system wide collaboration
  - A single architecture reference

- Complexity mastering
  - Multi-level engineering
  - Separation of concerns

- Concurrent engineering
  - Integrated specialty engineering
  - Early validation
  - Trade-off analysis

- Mastering transitions
  - Information refinement
  - Consistency maintenance
  - Multi-level impact analysis
Guidance
[Embedded methodological browser]

Complexity management
[Abstraction via computed information]

Productivity tools
[Automated transitions and diagram creation accelerators]

Model Analysis & Navigation
[Model validation, semantic browser]

Multi-criteria analysis
[Viewpoints and management framework]
Capella: Embedded Methodological Guidance

Overview of SAR

Define Stakeholder Needs and Environment
- Capture and consolidate operational needs from stakeholders
- Define what the users of the system have to accomplish
- Identify entities, actors, roles, capabilities, activities, concepts

System Analysis

Formalize System Requirements
- Identify the boundary of the system, consolidate requirements
- Define what the system has to accomplish for the users
- Model functional behaviours and dynamic behaviour

Logical Architecture

Develop System Logical Architecture
- See the system as a whole: define how the system will work
- Perform a root-cause analysis
- Perform a threat-and-attack analysis

Develop System Physical Architecture
- How the system will be developed and built
- Software vs. hardware allocation, specification of interfaces, deployment configurations, trade-off analysis

Physical Architecture

Formalize Component Requirements
- Manage the interface and integration strategy:
  - What is expected from each designer / sub-contractor
  - Specify requirements and interfaces of all configuration items

EPBS

Introduction | Operational Analysis | System Analysis | Logical Architecture | Physical Architecture | EPBS

EPBS

Transition from Logical Functions
- Perform an automated translation of Logical Functions
- Create Traceability Matrix

Define Physical Functions, Describe Functional Exchanges
- Create a new Functional Behaviour diagram
- Create a new Functional Data Flow Block diagram
- Create a new Functional Scenario

Define Physical Components and Actors, Manage Deployment
- Perform an automated translation of Logical Actors
- Perform an automated translation of Logical Components

Create a new Physical Component Breakdown diagram
- Create a new Physical Architecture diagram

Allocate Physical Functions to Physical Components
- Delegate Logical Interfaces and create Physical Interfaces

Execute Physical Scenarios

Communication with Ship
- Determine Position and fleet Aircraft
- Route Aircraft towards Alerts Ship
- Drop time hop
- Manage Rescue Mission
- Consolidated tracks

Acquire radar tracks
- Acquire radar image
- Acquire PLR image

Acquire Search Zone
- Access Situation
- Monitor Search Zone
- Acquire radar track
- Acquire radar image
- Acquire PLR image

Acquire Search Zone
- Access Situation
- Monitor Search Zone
- Acquire radar track
- Acquire radar image
- Acquire PLR image
Concretely

Capella

Feedback and use cases...
Use Case 1:

Managing System Design Complexity
**Context**

- Issues in the latest phases of operational validation
- Very good design documents, but in silos

**MBSE usage**

- 1 man month to reverse a first level of detail in a model, based on existing documents
- **First time overall views have been available**
  - Good support for discussion
  - Visualization of transverse functional chains
- Still **insufficient to solve low-level issues**: Same MBSE approach should have been used with subsystems
Managing System Design Complexity

275 Functions (230 Leaves)

578 Functional Exchanges between leaf functions

5 levels of decomposition
Contextual Diagrams: Low-level internals, high-level neighborhood
How to analyze transverse topics?
How to have transverse overviews?

Challenge: Build and maintain simplified views
Computed Diagrams: High-level Functions, Low-level Exchanges
Managing System Design Complexity

MODEL

VIEW

Children of F21 and F22 not displayed

Ports on F21 and F22 are graphically computed
Managing System Design Complexity

MODEL

VIEW

Children of F2 not displayed

Ports on F2 are graphically computed
Managing System Design Complexity

Children of F1 and F2 not displayed

Ports on F1 and F2 are graphically computed
Managing System Design Complexity

Tag-based simplification mechanism

Computed graphical simplifications free engineers from tedious and error-prone maintenance of abstraction levels
Managing System Design Complexity: Global Overview

End-to-end visualization of Functional Chains
Lots of Other Different Use Cases

And more to come!
Use Case 4:

Model-driven IVV
Requirements are clarified with Functional Chains

Test Procedures are linked to Functional Chains
IVV Strategy: Requested Versions / Developed Versions

Define operational content expected for each project milestone

Deduce functional content and components to be delivered

Define components versions and content

This document is not to be reproduced, modified, adapted, published, translated in any material form in whole or in part nor disclosed to any third party without the prior written permission of Thales.
Red: Delayed, missing
Grey: expected in further version
Release management viewpoint:
Automated visualization of versions
Developed Version 1
Available elements in BLUE
Developed Version 2
Available elements in CYAN
Developed Versions 1 & 2
Common available elements in GREY
Compare Planned vs Developed versions
Description of System Architecture

Implementation of the ISO/IEC 42010 Std

MBE Workbench

System description

Complete system description

Co-engineering

Core Viewpoints

Coupled Viewpoints

Decoupled Viewpoints

Transition bridge

Upstream Engineering Workbench

Performance Engineering

Bridge

Performance Engineering

MDE Runtime Env.

Bridge

Safety Engineering

Downstream Engineering Workbench

Code Generation

(e.g. UML, DSLs, etc.)

MBE Runtime Environment

Abstraction Level 1 viewpoint

Abstraction Level 2 viewpoint

Abstraction Level 3 viewpoint

Abstraction Level 4 viewpoint

Abstraction Level 5 viewpoint

Perfo. VP

Safety VP

Cost VP
Instantiation of MBE Workbenches with Kitalpha

MBE Workbench

« Classic » DSMLs

and its Viewpoints
for System Engineering

Kitalpha

OSSed in PolarSys

eclipse

TRN : 0001-0011317532  rev 001 - 19/06/2014
Thales Global Services / Template: 83150233-DOC-TGS-EN-002
Maturity Levels of Viewpoint Development

Development Aspects
- Data model
- User Interfaces
- Diagrams
- Services
- Validation rules
- Transformation rules
- Semantic browser
- Connectors
- Documentation
- Continuous integration
- ...

Manual Development
- Expertise of multiple tools
- Costly development (duration, errors...)
  - Unsystematic

Generators
- Productivity and quality improvement
  - Not integrated solution

DSL
- Abstraction of technical details
  - Integrated solution
  - Larger adoption

This document is not to be reproduced, modified, adapted, published, translated in any material form in whole or in part nor disclosed to any third party without the prior written permission of Thales. © THALES 2014 – All rights reserved.
Kitalpha: Development and Execution Environments

**Development**

**Architecture Framework Development**
- Description: AF DSL
- Generation: AF Generation
- Packaging: Architecture Framework

**Viewpoint Development**
- Description: Viewpoint DSL
- Generation: Viewpoint Generation
- Customization: Additional Development
- Packaging: Metamodels, User Interface, Diagram, Tools

**Execution**

**MBE workbench**
Kitalpha Viewpoint DSL: Example
Kitalpha Viewpoint DSL: Example

**Viewpoint** QualityAssessment {
  name: "QualityAssessment"
}

**Data** QualityAssessment.data

**UI** QualityAssessment.ui

**Diagrams** QualityAssessment.diagram

**Services** QualityAssessment.services

**Build** QualityAssessment.build

**Configuration** QualityAssessment.conf

**Generation configuration**

**Continuous integration**

**User interfaces**

```
User interfaces {WI
  QualityAssessment_QualityAssessment {
    label: "Quality Assessment"
    Container QualityAssessment_QualityAssessment_Section {
      Container QualityAssessment_QualityAssessment_AttributeGroup {
        label: "Quality Assessment Attributes"
        Field maturityLevelField label: "Maturity Level" type text,
        Field confidenceLevelField label: "Confidence Level" type text
      }
    }
  }
  QualityAssessment_QualityMeasure {
    label: "Quality Measure"
    Container QualityAssessment_QualityMeasure_Section {
      Container QualityAssessment_QualityMeasure_AttributeGroup {
        label: "Quality Measure Attributes"
        Field basedOnField label: "Based On" type multichoice
      }
    }
  }
}
```

**Services**

```
Services {
  QualityAssessment.rules {
    Rule Rule1 type Java
    Rule Rule2 type Java
  }
  QualityAssessment.services {
    Service MyService orchestrates Rule1 , Rule2
  }
}
```

**Diagrams**

```
Data {data
  QualityAssessment.data {
  }
}
```

TRN : 0001-0011317532  rev 001  -  19/06/2014
Thales Global Services / Template: 83150233-DOC-TGS-EN-002
import external "http://www.polarsys.org/kitalpha/ComponentSample"

Data ComponentSampleQualityAssessment.data {
  Class QualityAssessment {
    description: "Quality Assessment"
    icon: "QualityAssessment.png"
    extends ComponentSample.AbstractComponent
    superClass external ComponentSample.ComponentElement
    Attributes:
      maturityLevel type ecore.EString
      confidenceLevel type ecore.EEnumerator
        values ( "Not Assessed", Low, Medium, High )
      assessed type ecore.EBoolean
    Associations:
      basedOn refers [0,*] QualityAssessment
      context refers [0,*] external ComponentSample.ComponentElement
      measures contains [0,*] QualityMeasure
  }
  Class QualityMeasure {
    icon: "QualityMeasure.png"
    superClass external ComponentSample.ComponentElement
    Attributes:
      criterion type ecore.EString
      measureValue type ecore.EInt
  }
}
Kitalpha Viewpoint DSL: Example

MBE workbench

[Diagram of MBE workbench with various components and connections labeled.]
Video
Capella OSS Status

Phase 1:
Get OSSing competence & prepare environment

Phase 2:
OSSing MDE technical components & solutions

Phase 3:
OSSing Capella ➔ IP Review in progress

« Built upon »

Kitalpha
(incl. Sirius)

« Hosted by »

Clarity

« Hosted by »
PolarSys

Eclipse

EGF

Eclipse Generation Foundry

This document is not to be reproduced, modified, adopted, published, translated in any material form in whole or in part nor disclosed to any third party without the prior written permission of Thales. © THALES 2014 – All rights reserved.
Thank you for your attention!

Any Questions?

Capella Open Source Project
https://www.polarsys.org/projects/polarsys.capella

Contacts
Matthieu.helleboid@thalesgroup.com
Christophe.gatti@thalesgroup.com