THALES

From initial investigations up to large-scale rollout of an MBSE method and its supporting workbench: the Thales experience

Jean-Luc Voirin, Stéphane Bonnet,
Véronique Normand, Daniel Exertier

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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

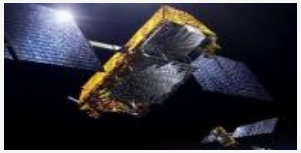
Rail signalling systems

In-flight entertainment
and connectivity

Military tactical
radiocommunications

N°3 worldwide

Avionics

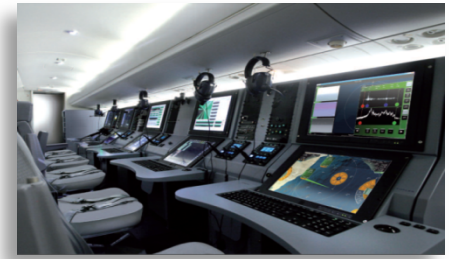


Civil satellites

Surface radars

€14 billion in revenues

Engineering Challenge: From Equipment to Global Solution Supplier



- More complex missions, more technical constraints, larger teams
- More reliability, versatility and added value
- Less time to market

The Thales Model-Based System Engineering Odyssey

2000 2002 2004 2006 2008 2010 2012 2014

Engineering Practices Transformation Plan

Pilot Deployments

ARCADIA Method Building

Short-Loop Validation & Adjustment

Real Operational Use

Early Experiments

UNIFIED MODELING LANGUAGE

Corporate Research Program

melody advance

Dedicated Tool Development

Commercial Tools Experiments

Capella Tool Open Sourcing

DoDAF

NatoAF

OMG SYSTEMS MODELING LANGUAGE SysML

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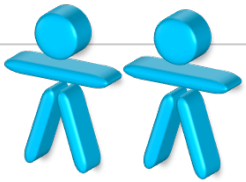
Success Enablers For Large-Scale MBSE Deployment

PEOPLE AND ORGANIZATION
DRIVERS AND FOUNDATION

People and Organization: Teaming

Skilled, profoundly motivated network of individuals teaming towards one single objective

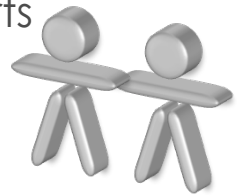


System and software architects

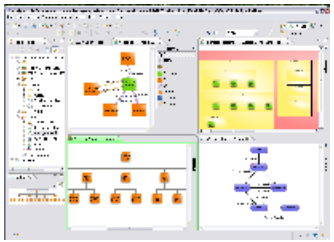
Method and modeling experts

Method and Tool building

Specialty engineers (safety, security, integration…)



Tool development experts



solve engineering issues and challenges

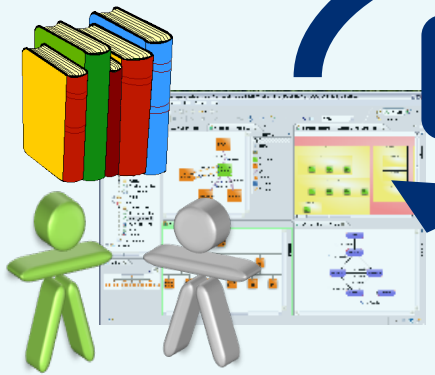
(blindly) apply modeling techniques, deploy tools

People and Organization: User-Driven

Validation in operational, real life context, real engineering data and teaming/sizing.

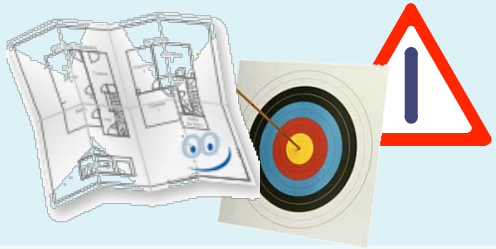
Advanced Research Teams

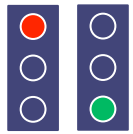
Common expert team:
- Method and modeling
- Tool development



Initial validation **6 months** max

Operational Units
Pilot projects





Operational Units
All projects

No concept promoted
if not submitted to this validation

Typ. **2 years** of incubation before end-user delivery

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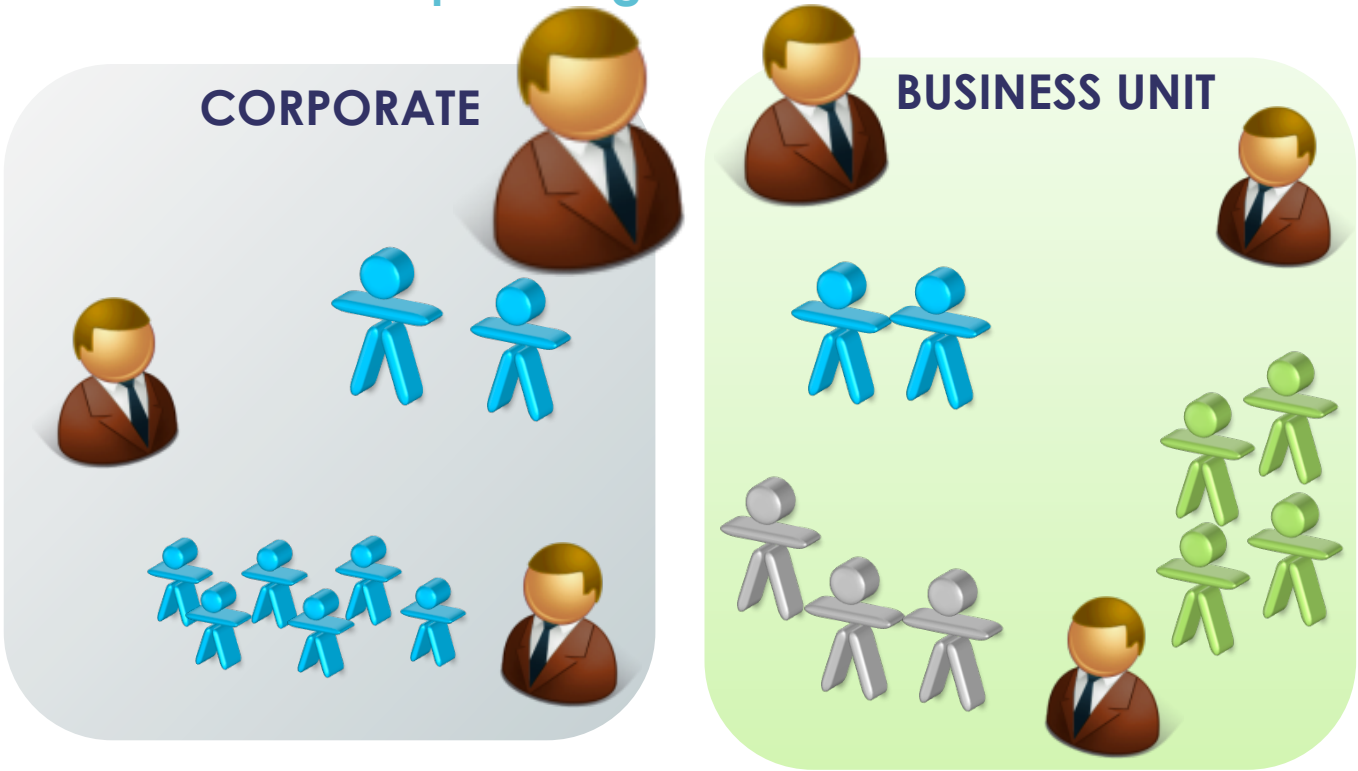
People and Organization: Management

Strong Support & Commitment of Top Management

- Engineering Transformation Managers,
- Technical Directors,
- Programme Directors,
- etc.



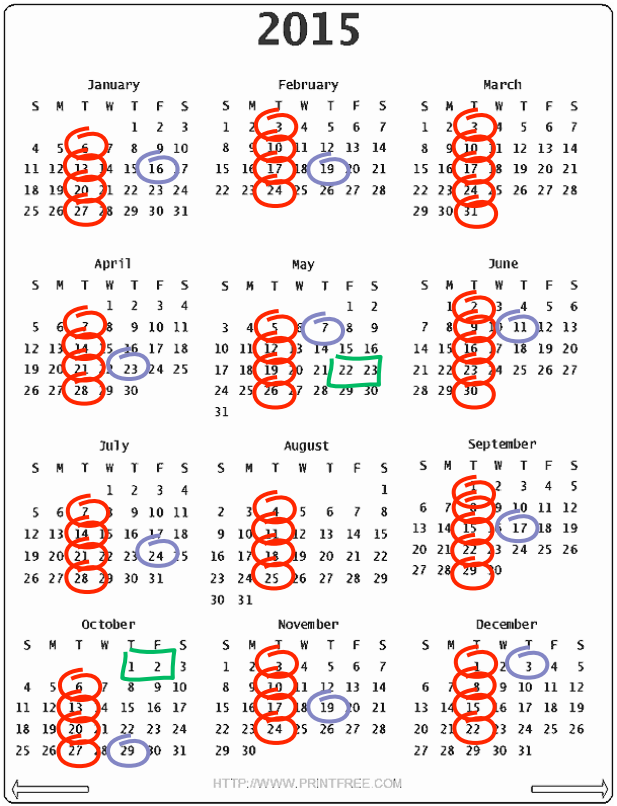
People and Organization: Community

A growing community of users sharing experiments, complementary tools and practices

- Weekly **tool user groups**
- Monthly **method user workshops**
- Bi-Yearly **Thales-wide symposiums**

Workgroups mixing business units, research labs and tool development team, e.g.

- To enrich the method and the tool

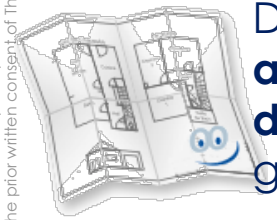


Drivers and Technical Foundation: Language

Targeting **system engineers**, NOT modeling experts

Concepts found in traditional **engineering documents**

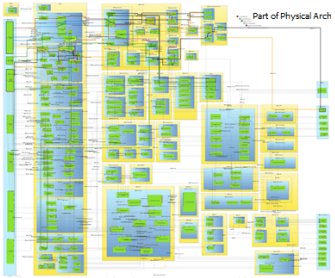
Suitable for **non-functional engineering** support



Dedicated to **architecture description**, NOT general purpose

Inspired by NAF/DoDAF, UML and SysML, BUT **simplifying and filtering**

Focused on **scalability** and **complexity management**



Drivers and Technical Foundation: Language

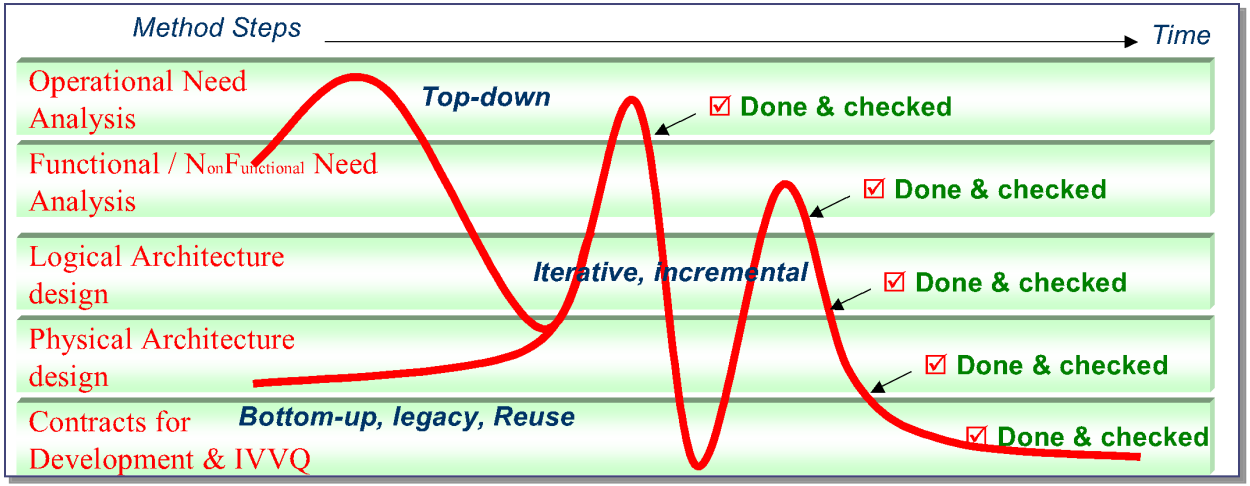
A language familiar to most users, efficiently supporting collaboration between stakeholders

Drivers and Technical Foundation: Method

Method applicable to different contexts

- No strongly enforced sequencing of activities
- Legacy reuse or brand new products, large or small projects
- **Customizable** and extensible to adapt to local constraints and specificities

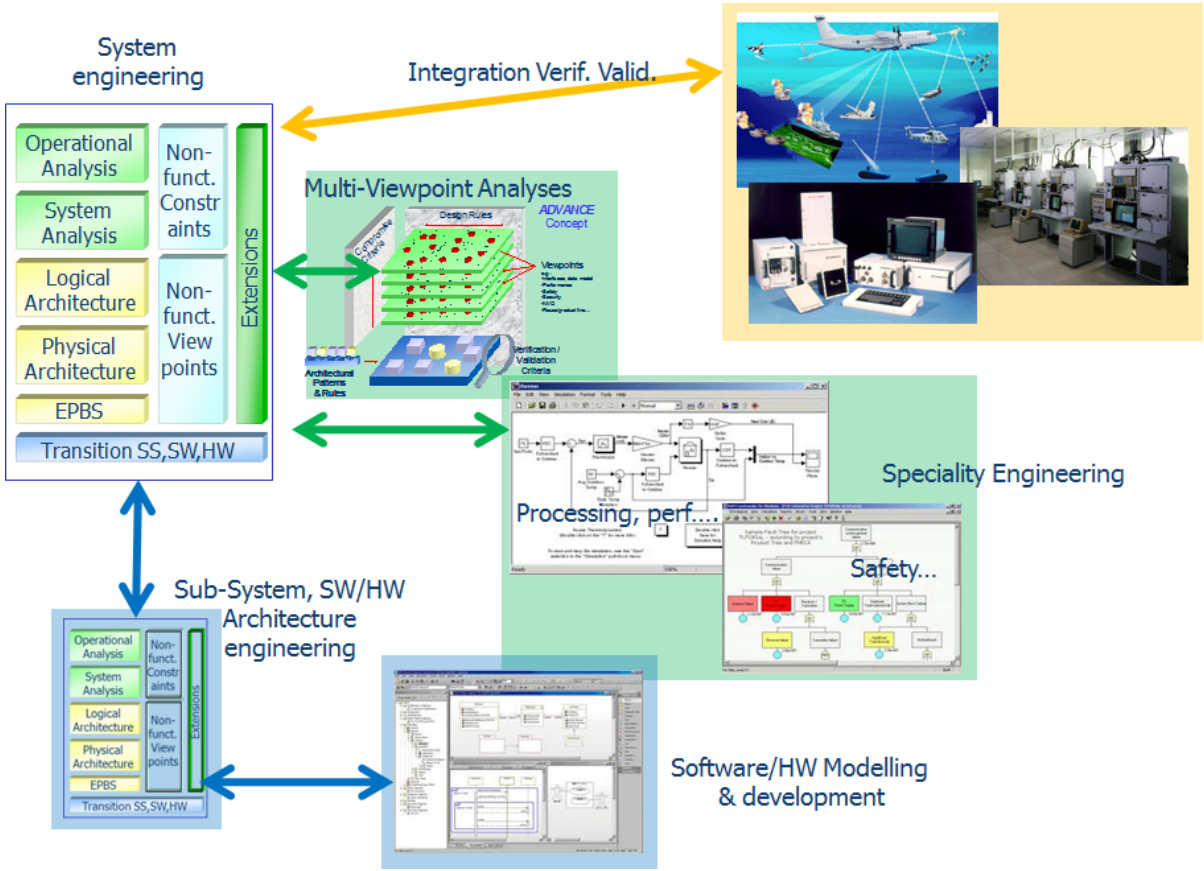
Compatible with most workflows (top-down bottom-up, iterative, legacy-based , mixed, etc.)



Drivers and Technical Foundation: Method

Comprehensive coverage of engineering and architecture design

- From requirements to integration and validation
- From complex system to equipment and subsystem, SW, HW
- From functional to non-functional constraints and engineering specialties

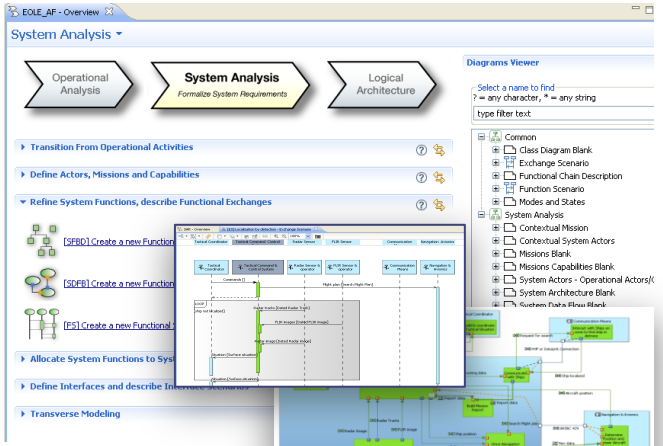


Drivers and Technical Foundation: Modeling Workbench

Field-proven workbench dealing with complexity and size

Extensibility
New diagrams, new layers, M2 extensions, Etc.

Edition Tools
Layered diagrams, Tables, Editors



Model Monitoring
Progress, metrics

Embedded Methodological Guide

Modularity & Reuse
Librairies, Patterns, Etc.

Iterative Transition Tools
Traceability, Generation

Model Analysis
Semantic browser, Model check, Etc.

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Drivers and Technical Foundation: Modeling Workbench

Open Source MBSE Solution
Demos on PolarSys Booth

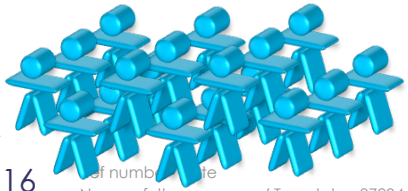
A Few Figures

Initial method & tool training — Less than **one week**

Method coaching — **One full –time** coach for several **tens of users**

Coaching effort on a new project — **One day to one week** initial workshop, then **one day meeting per month**, decreasing; full autonomy within less than one year usually

Size of models — **Hundreds to thousands** of functions/ components
(tens of thousands of model elements)



Current active users community — **Several hundreds users**, in most major Thales domains and countries
Hundreds of trainees per year now

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A Few Figures

Overall cost of definition/development

- Method, including language, dedicated focuses…
- Modeling Tools (including the three now open-sourced components: **Sirius**, **Kitalpha** and **Capella**)

  - > **100 (wo)men.years**

Example of return on investment at project-level:

- Reduction of defects raised at integration and validation time: typ. between **3 and 5 times less**
- Reduction of global project duration

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Use Case 1

MANAGING SYSTEM DESIGN COMPLEXITY

Managing System Design Complexity

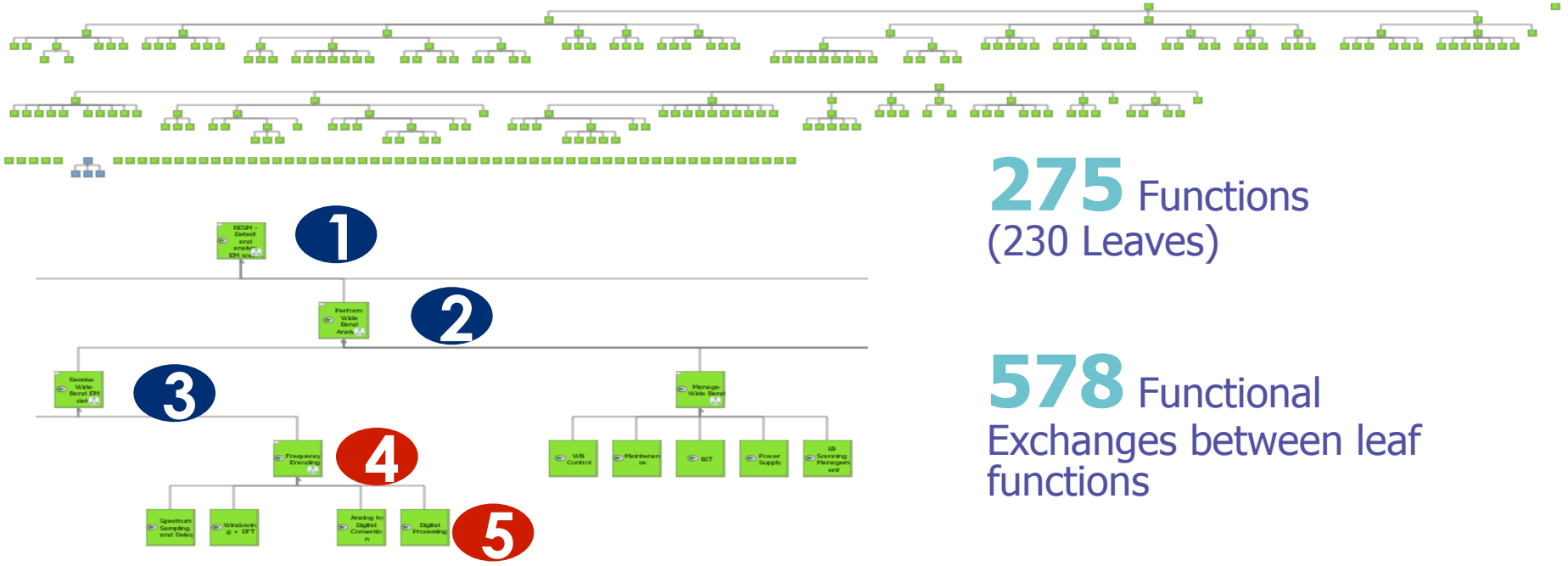
Context

- 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

Managing System Design Complexity



275 Functions
(230 Leaves)

578 Functional Exchanges between leaf functions

5 levels of decomposition

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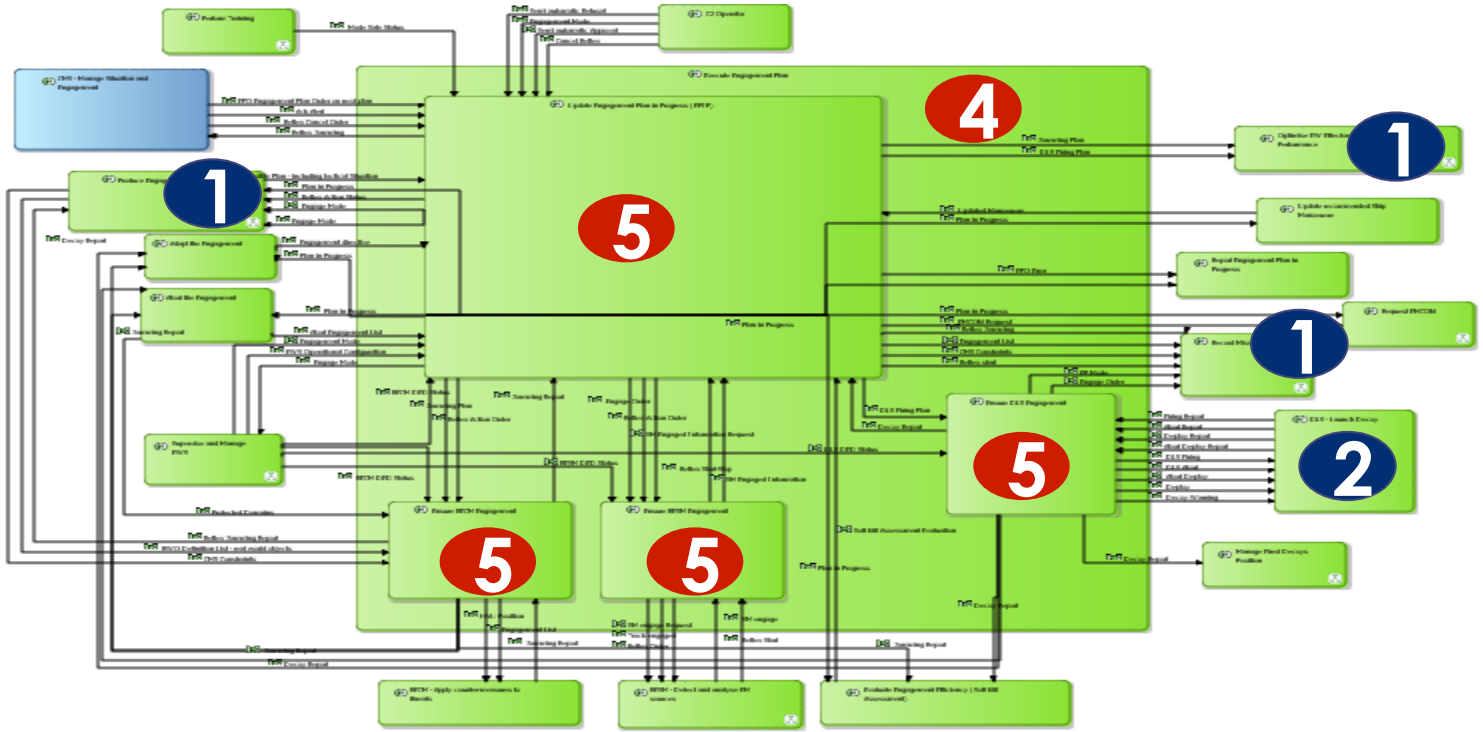
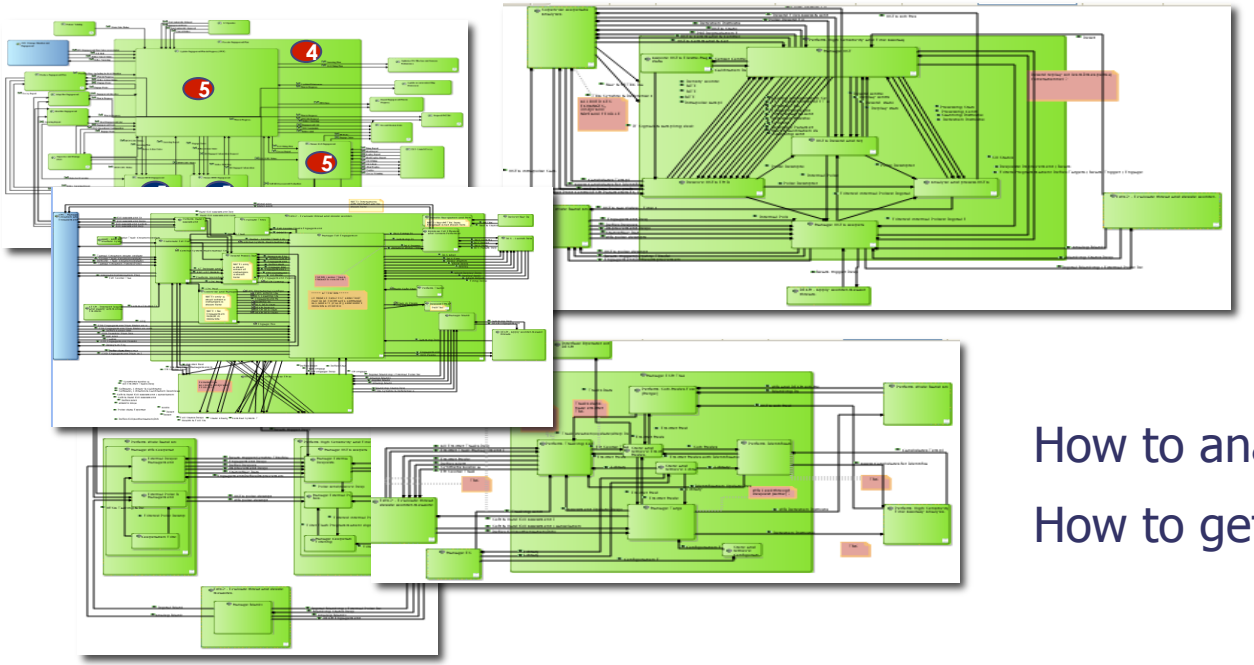
Managing System Design Complexity

Contextual Diagrams: Low-level internals, high-level neighboorhood



Managing System Design Complexity



X 40

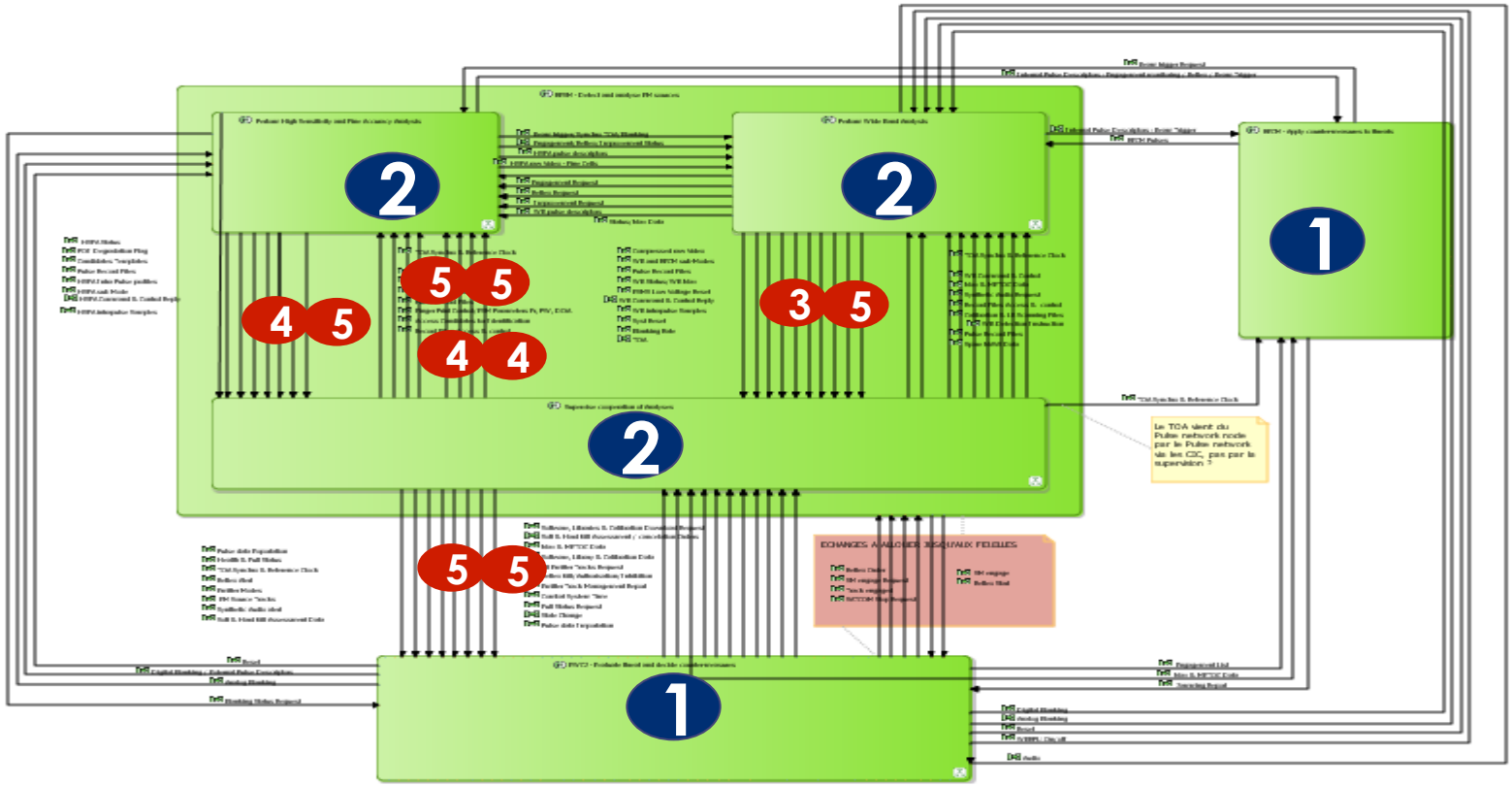
How to analyze transverse topics?

How to get transverse overviews?

Challenge: Build and maintain simplified views

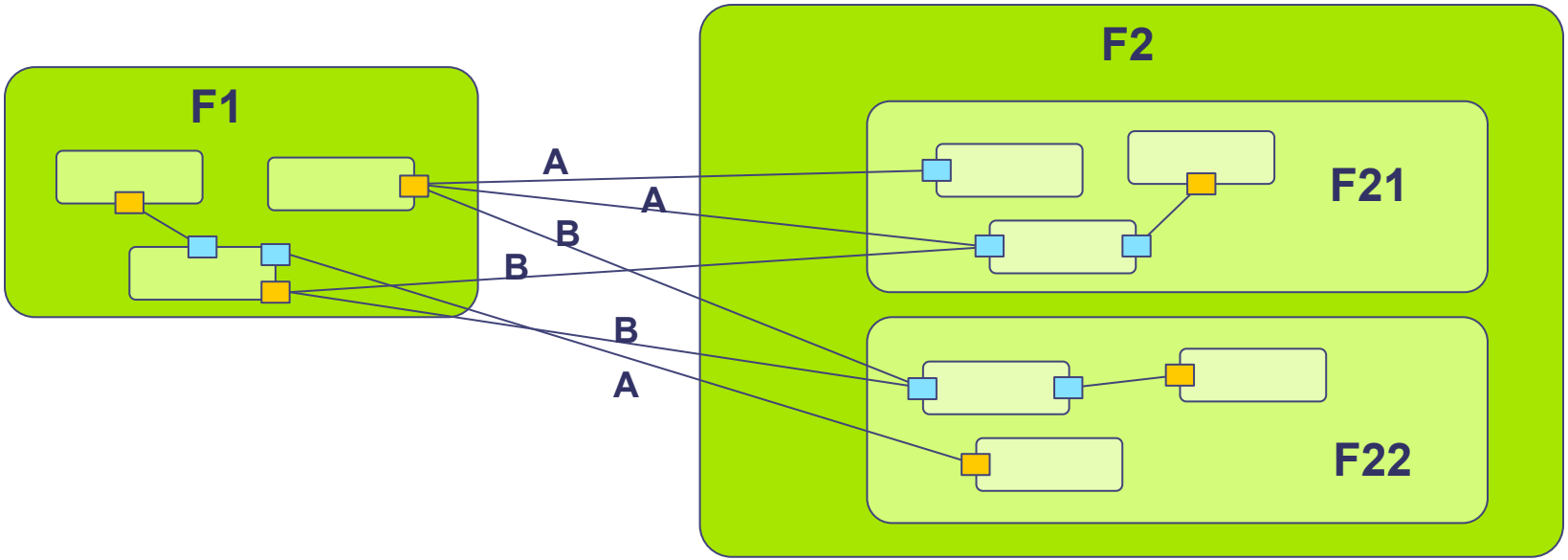
Managing System Design Complexity

Computed Diagrams: High-level Functions, Low-level Exchanges



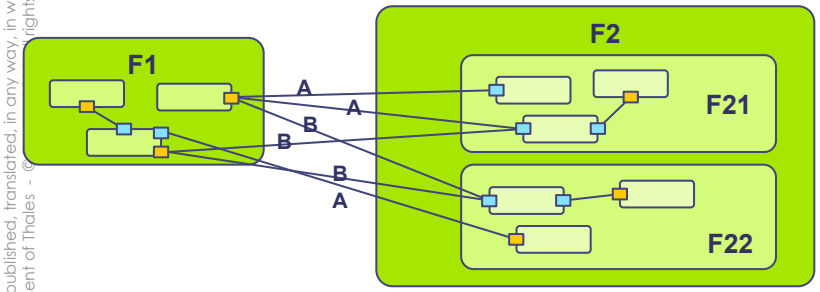
Managing System Design Complexity

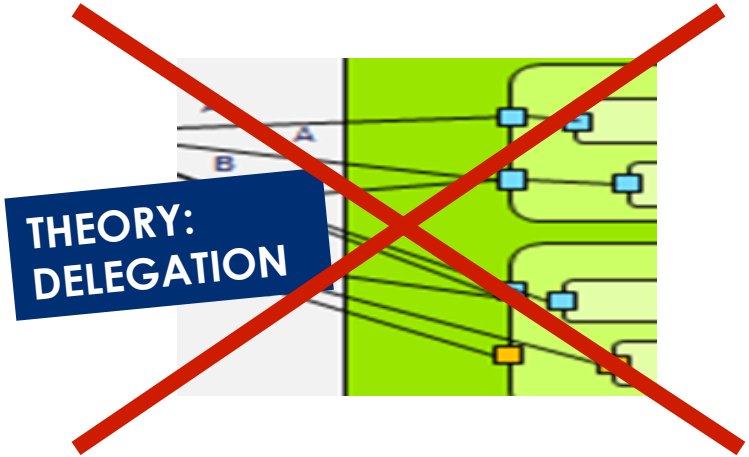
MODEL



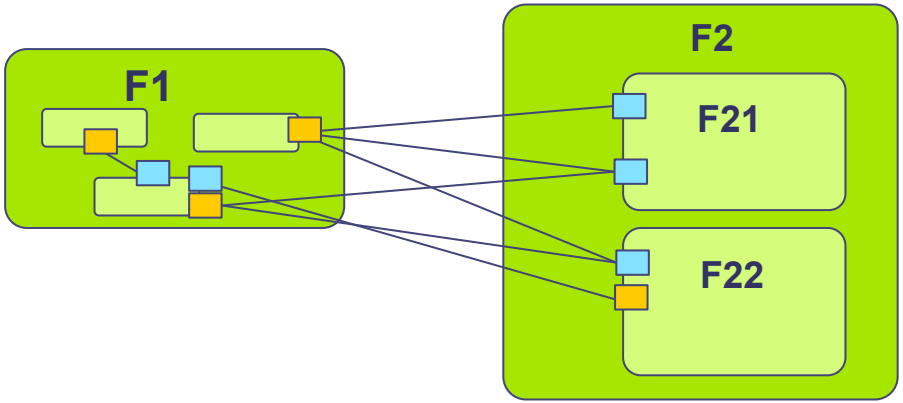
Managing System Design Complexity

MODEL





VIEW

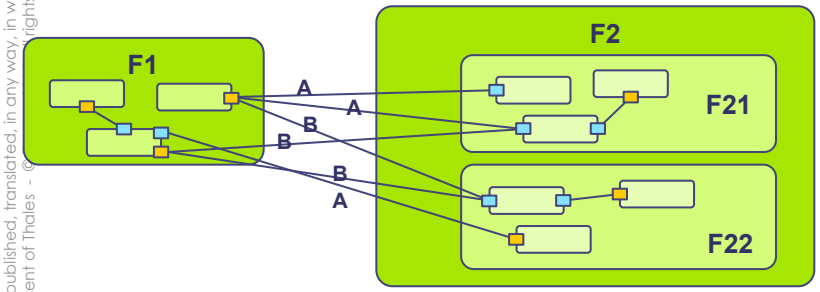


Children of F21 and F22 not displayed

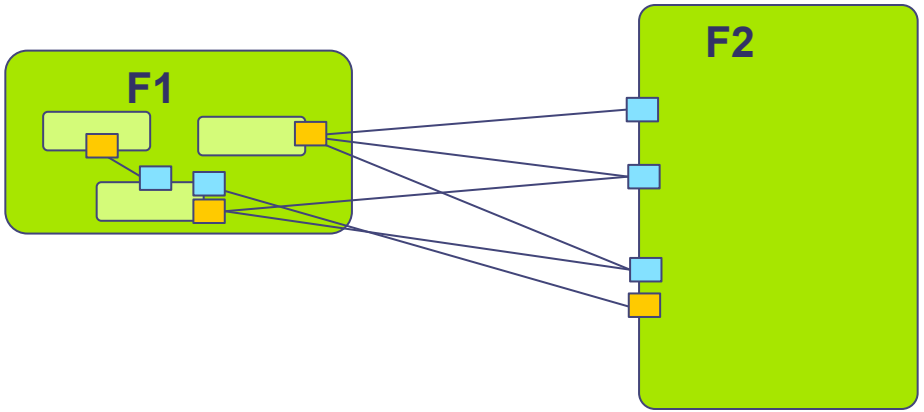
Ports on F21 and F22 are graphically computed

Managing System Design Complexity

MODEL



VIEW

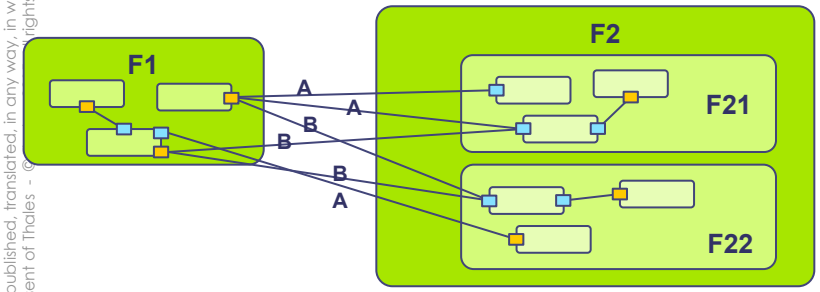


Children of F2 not displayed

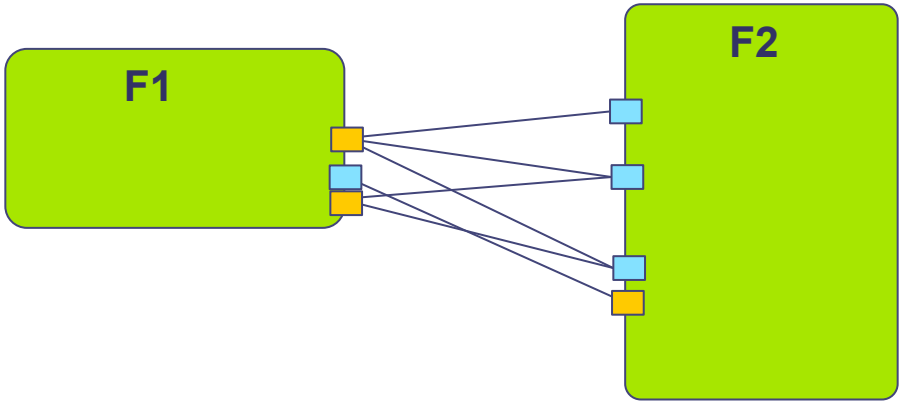
Ports on F2 are graphically computed

Managing System Design Complexity

MODEL



VIEW



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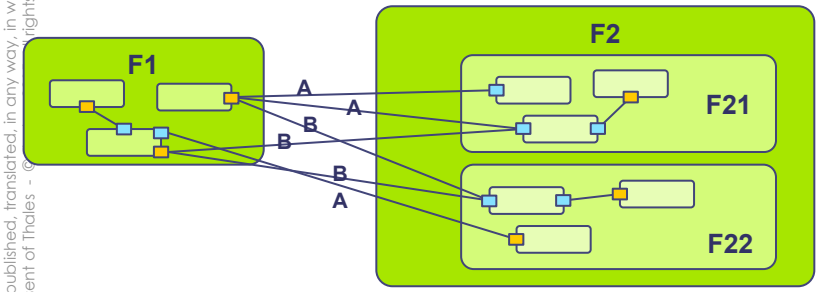
Ports on F1 and F2 are graphically computed

Managing System Design Complexity

MODEL



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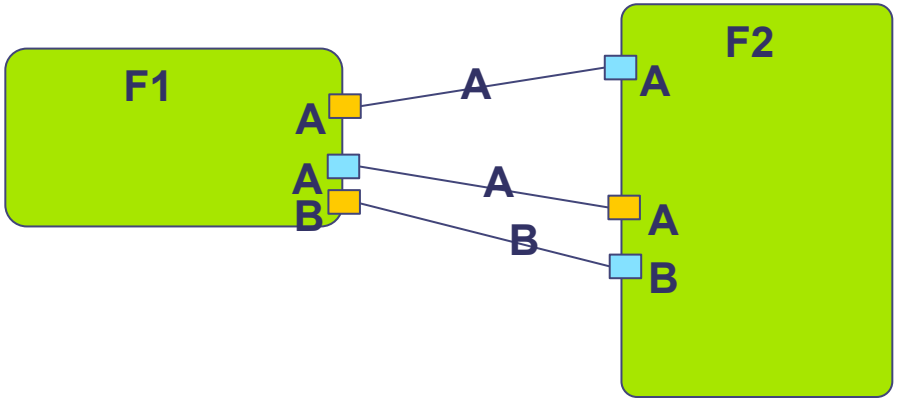
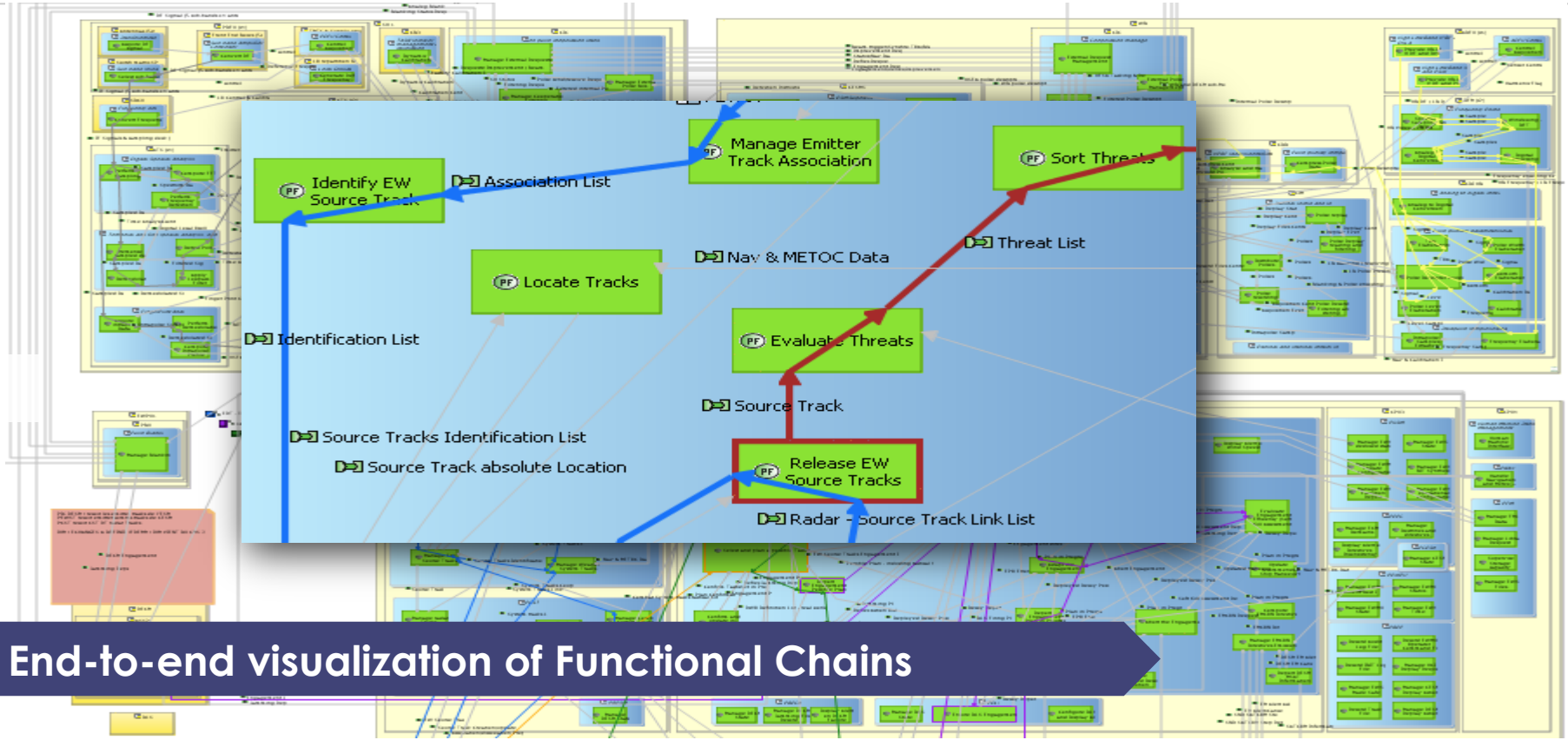


Tag-based simplification mechanism

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

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Use Case 2

MBSE-BASED MASTERING OF EVOLUTIONS

Use Case 2: MBSE-Based Mastering of Evolutions

Context

- Maritime Patrol Program delivered to the Customer
- New functionalities asked by the Customer

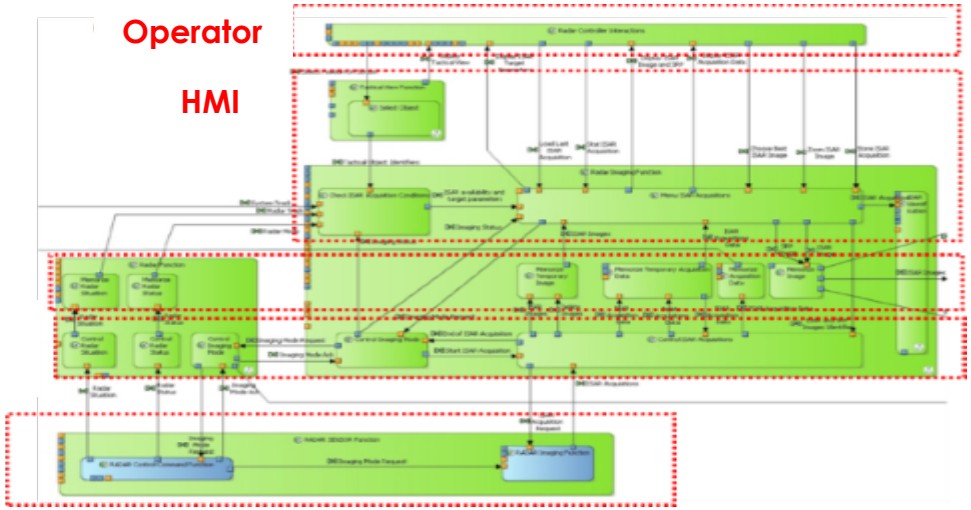
MBSE usage

- Up-to-date model of the delivered System available
- Modification of the model in order to:
  - **Estimate feasibility, cost and risks**
  - Drive developments and IVVQ
- **Product line** management

« HDPI » Model Representation

A regular reading pattern

- Multiple contributors modeling the same way
- Facilitates first access to diagrams
- Eases diagram review
- Allows quick inconsistency detection



Need Representation based on Delivered Solution

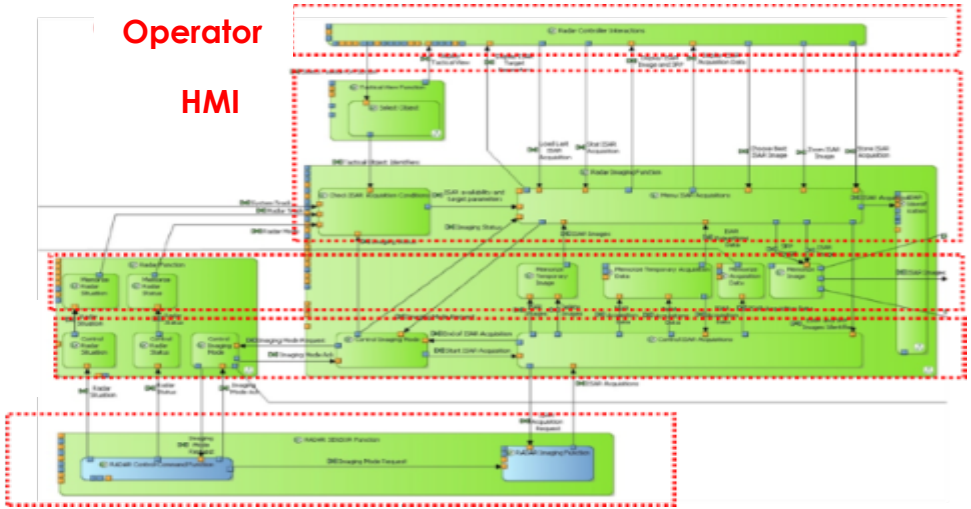
SSS: Need

PIDS: Reverse Engineering from Software Specification

DATA

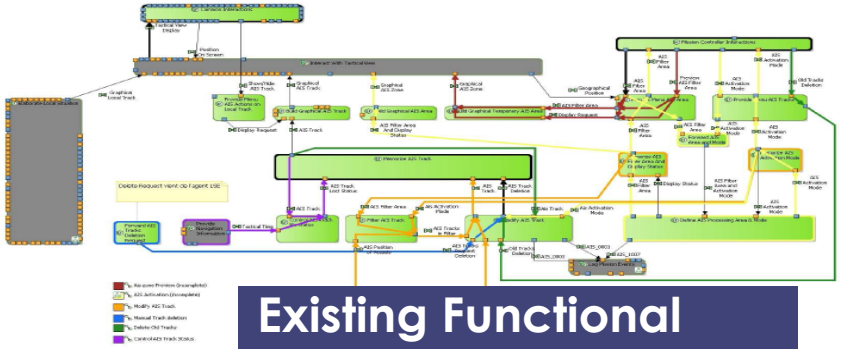
PROCESS/ INTERFACES

EQUIPMENT

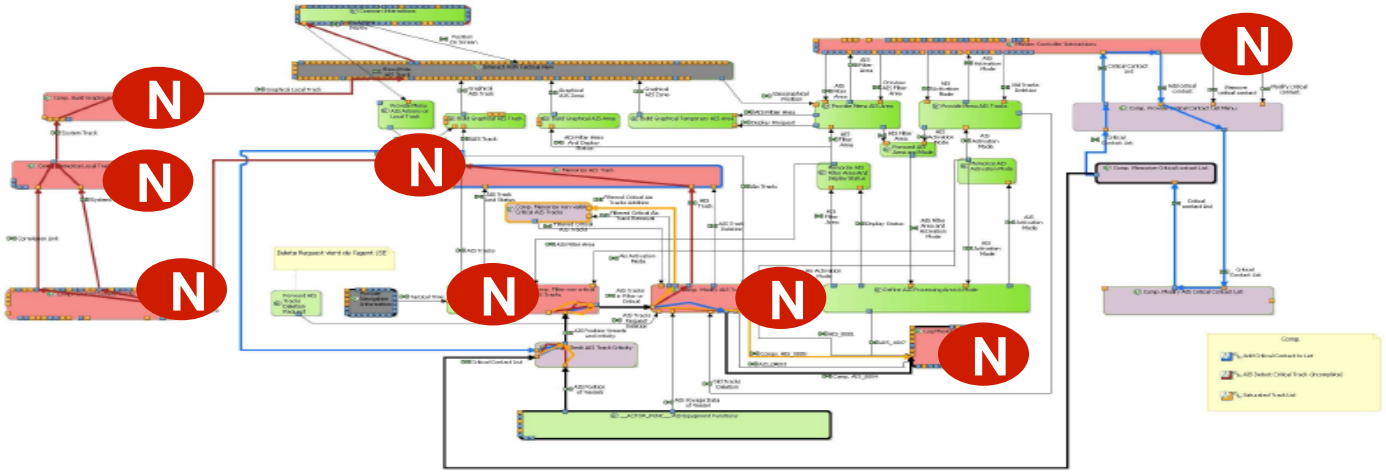


Managing Change: Feasibility and Risks

New Customer needs



Existing Functional Chains



N Impacted Functions

New Functional Chains

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Change Management: Cost Estimation

COST Analysis Viewpoint

Elementary work decomposition

- Panels
- External / Internal Interfaces
- Data Memorisation
- Processing Complexity

Capella Outputs (model export)

Computed Data: Estimated Cost

Fct 9	Panneaux OM ou	Interfaces internes	Interfaces externes	Memorisation: 1 si	Algo: Niveau 1=	Combinatoire	Fonctions chiffrées	Complexité Calculée	Implem TU retenue	AP	AQ	AR
	528	*1485*	*82*	*45*	*697*		238	13650			100%	
	800	1300	70	50	400		239	14843		New	77%	
Complexité	7	2	5	2	10	1	####			Reuse	15%	**0**
Totaux	**528**	**1485**	**82**	**45**	**697**	**234**	**238**	16009	139	COTS	8,4%	**9419**
[redacted]	1	3	0	0	5	1	1	69	69	New	100%	**69**
	0	3	0	0	1	1	1	20	20	New	100%	**20**
	0	4	0	1	0	1	1	18	18	New	100%	**18**
				0		0						
				0		0						
	3	15	0	0	2	2	1	101	10	New	100%	**101**
	0	11	0	1	0	1	1	32	32	New	100%	**32**
	2	8	0	0	4	2	1	96	96	New	100%	**96**
	2	8	0	0	2	2	1	70	70	New	100%	**70**
	0	2	0	0	2	1	1	30	30	New	100%	**30**
				0		0						
	4	9	0	0	0	1	1	57	57	New	100%	**57**
	0	5	0	0	0	0	1	10	10	New	100%	**10**
				0		0						
	0	4	0	0	0	0	1	14	14	New	100%	**14**
	0	9	0	1	0	1	1	31	31	New	100%	**31**
	2	3	0	0	0	0	1	20	20	New	100%	**20**
				0		0						
	0	6	0	1	0	1	1	17	17	New	100%	**17**
	0	6	0	1	0	1	1	17	17	New	100%	**17**
	0	8	0	1	0	1	1	23	23	Reuse	75%	**17**
	4	8	0	0	5	1	1	103	10	COTS	50%	**52**
	0	5	0	0	0	0	1	10	10	New	100%	**10**

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Use Case 3

MASTER MULTIPLE ENGINEERING LEVELS

Use Case 3: Multi-Level Engineering and Automated Transitions

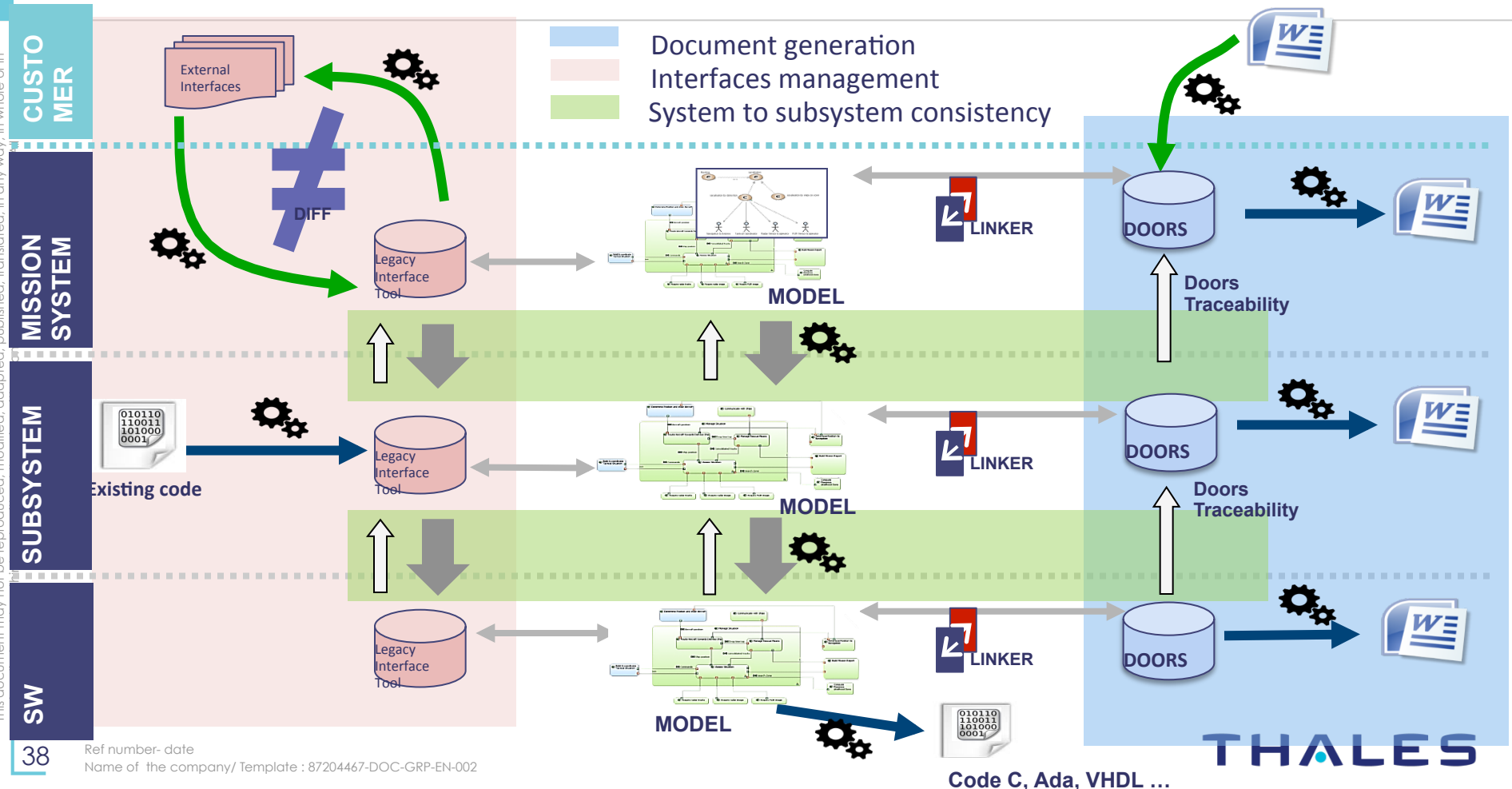
Context

- Complex systems with full Thales responsibility (from Mission System to SW Component)

MBSE usage

- Setup a global, **multi-level engineering approach**
- Joint effort with Thales Airborne Systems / Thales Corporate to **specify and develop an automated, iterative transition**
- Incubation on two projects. Now integrated in the product and used in other contexts

Multi-Level Engineering and Automated Transitions



Multi-Level Engineering and Automated Transitions

Operational Analysis

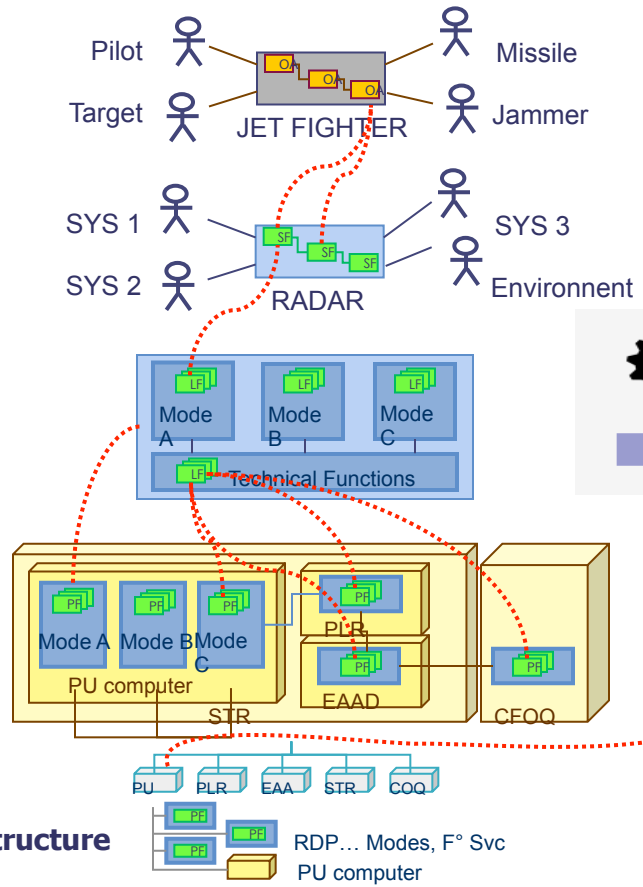
System Analysis

Logical Architecture

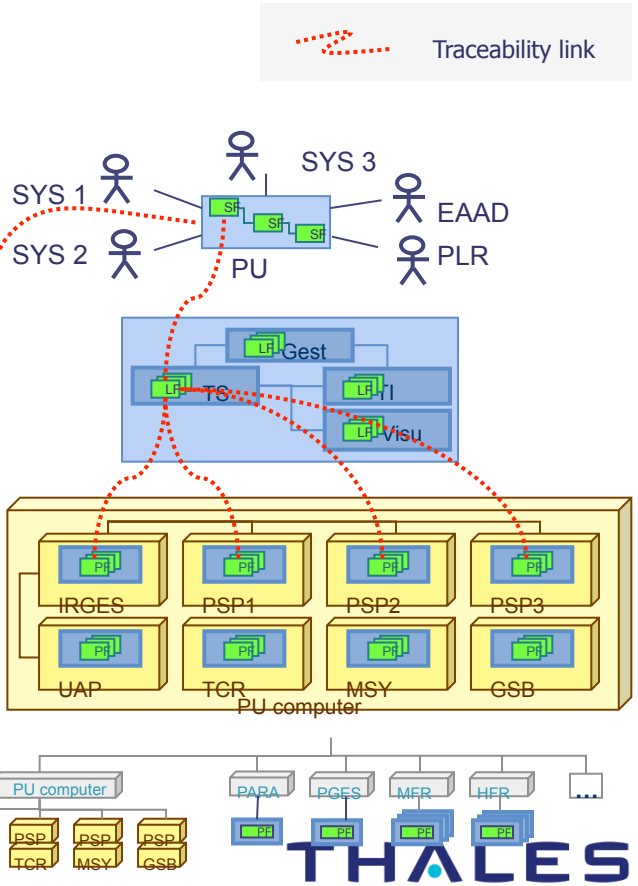
Physical Architecture

Product Breakdown Structure

Radar Engineering



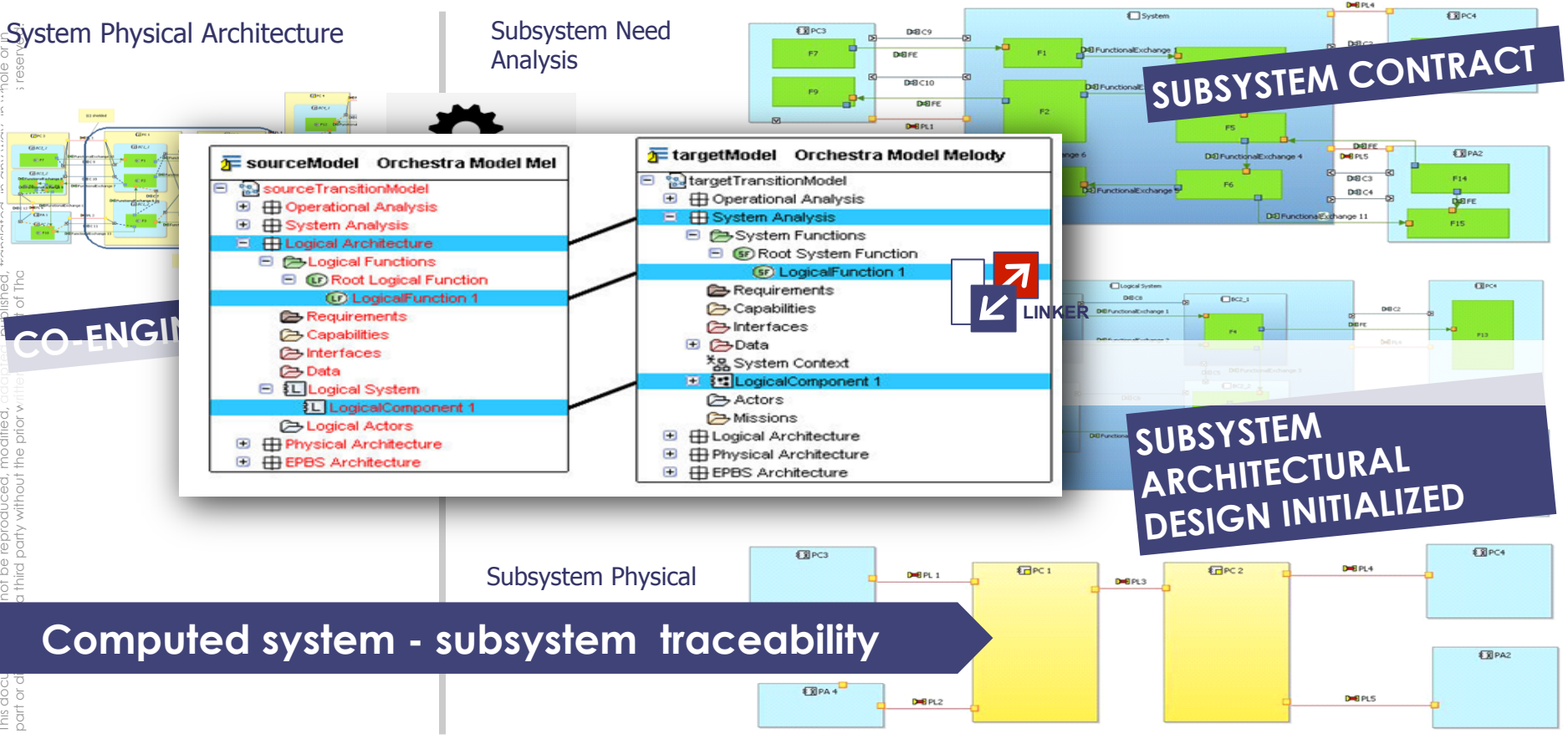
Processing Unit Engineering



Multi-Level Engineering and Automated Transitions

System Physical Architecture

Subsystem Need Analysis



Subsystem Physical

Computed system - subsystem traceability

THALES

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Implementing the MBSE Cultural Change: Organization, Coaching and Lessons Learned

5.4.1: Agile Systems Engineering

Stephane Bonnet, Jean-[illegible] Voirin, Veronique Normand, Daniel Exertier (Thales)

When	Tue 14, Jul 13:30-14:10
Where	Grand Ballroom C

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