

CAPELLA AS A VECTOR OF INTEROPERABILITY BETWEEN PRACTICES

Capella Days – 18/11/2025

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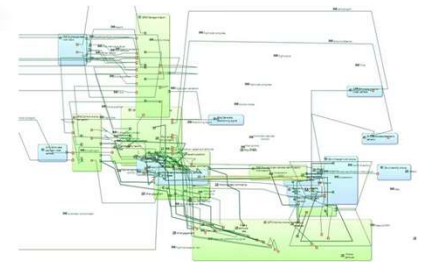
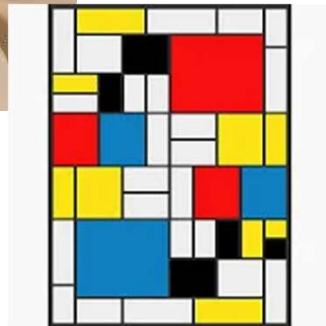
 **Capella**
Open Source MBSE Solution

Capgemini 



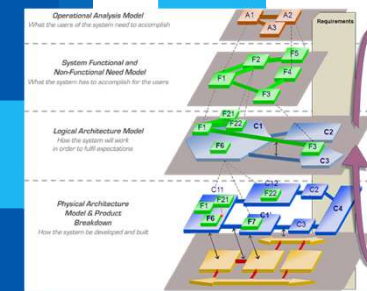
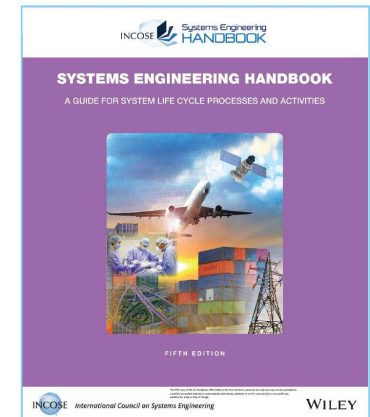
CAPELLA ?

CAPELLA, an artist's tool for drawing Box and Arrows ?



AGENDA

1. Capgemini Systems Engineering & Architecture
2. Systems Engineering practice ?
3. Interoperability with other practices
 1. Project Management
 2. Safety
 3. Product Line Engineering
 4. Frugal Platform
4. Conclusion and way forward
5. Q&A

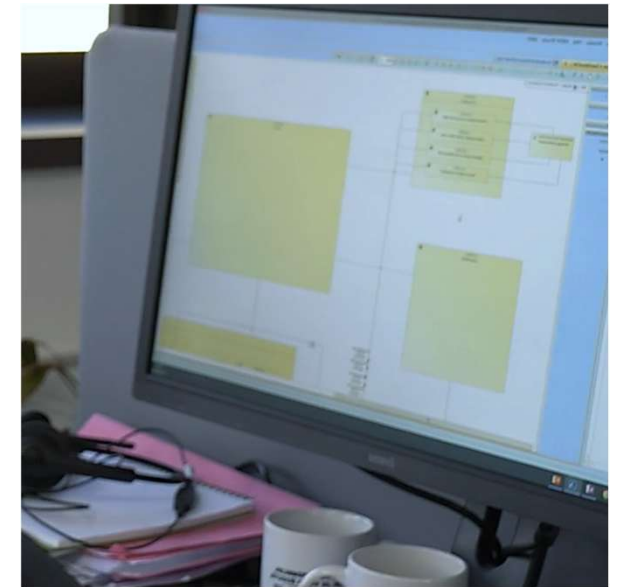


1 SYSTEMS ENGINEERING AND ARCHITECTURE



CAPGEMINI ENGINEERING

- SEA Team - Systems Engineering & Architecture
- Multi-industries & multi-clients
- SE Activities (including MBSE with ARCADIA/CAPELLA)
- Research & Innovation project « ECSE »
Efficient and Connected Systems Engineering



An End-To-End SE/MBSE vision with Capgemini Engineering



SE SETUP

Addressing « MBSE pilots », Capgemini Systems Engineering Expertise Center SETUP **MBSE process, methods and tools**, define **Roadmap** with MBSE pilots based on a cross-fertilization approach.

SE DEPLOYMENT

Addressing « MBSE pilots », Capgemini Systems Engineering Expertise Center DEPLOY MBSE best-in-class practices by **Training & Coaching** based on a cross-fertilization approach.

SE OPERATION

Addressing « Architects and Systems Designers », Capgemini architects and designers teams are designing Systems, Products, Manufacturing or Services by **operating MBSE in their day-to-day design** work.

Examples: ADAS, Connectivity, Train, Power Plant, Industrial Systems, Avionic satellite systems, ATAs, aircraft, car, ...



MBSE
Experts



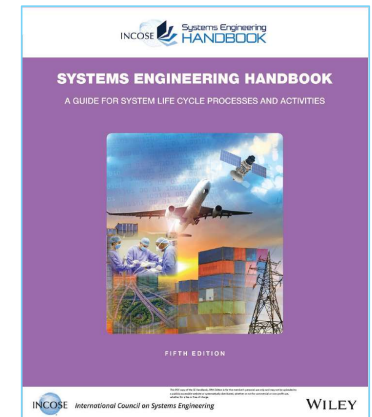
MBSE
practitioners



A cross-fertilization history for SE & MBSE



2 SYSTEMS ENGINEERING PRACTICE ?

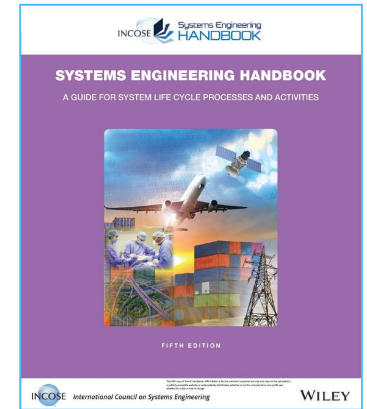


SYSTEMS ENGINEERING PRACTICE ?

Definition (INCOSE Handbook) :

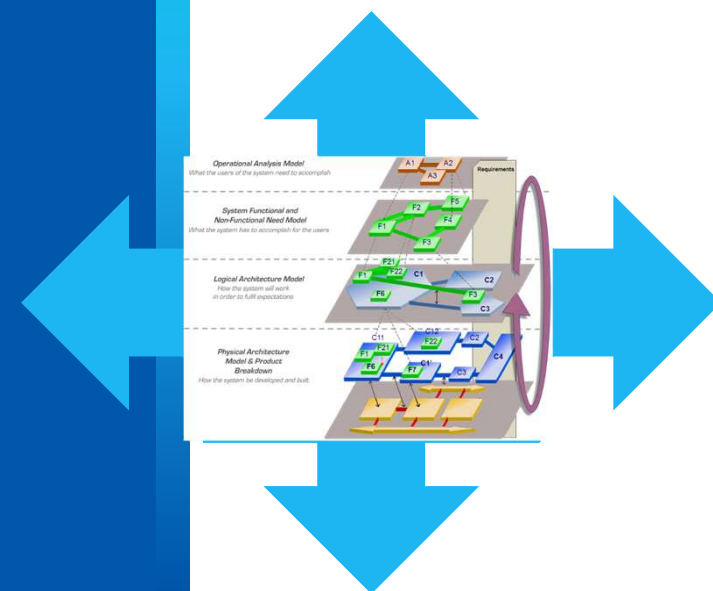
As defined by the INCOSE organization, the "Systems Engineering" practice is :

“A *transdisciplinary* and *integrative* approach to enable the *successful realization* of engineered systems.”



1. SE is a solution to the need « build the right system »
2. MBSE is a solution for a more efficient SE
3. CAPELLA is a solution for MBSE

3 INTEROPERABILITY WITH OTHER PRACTICES

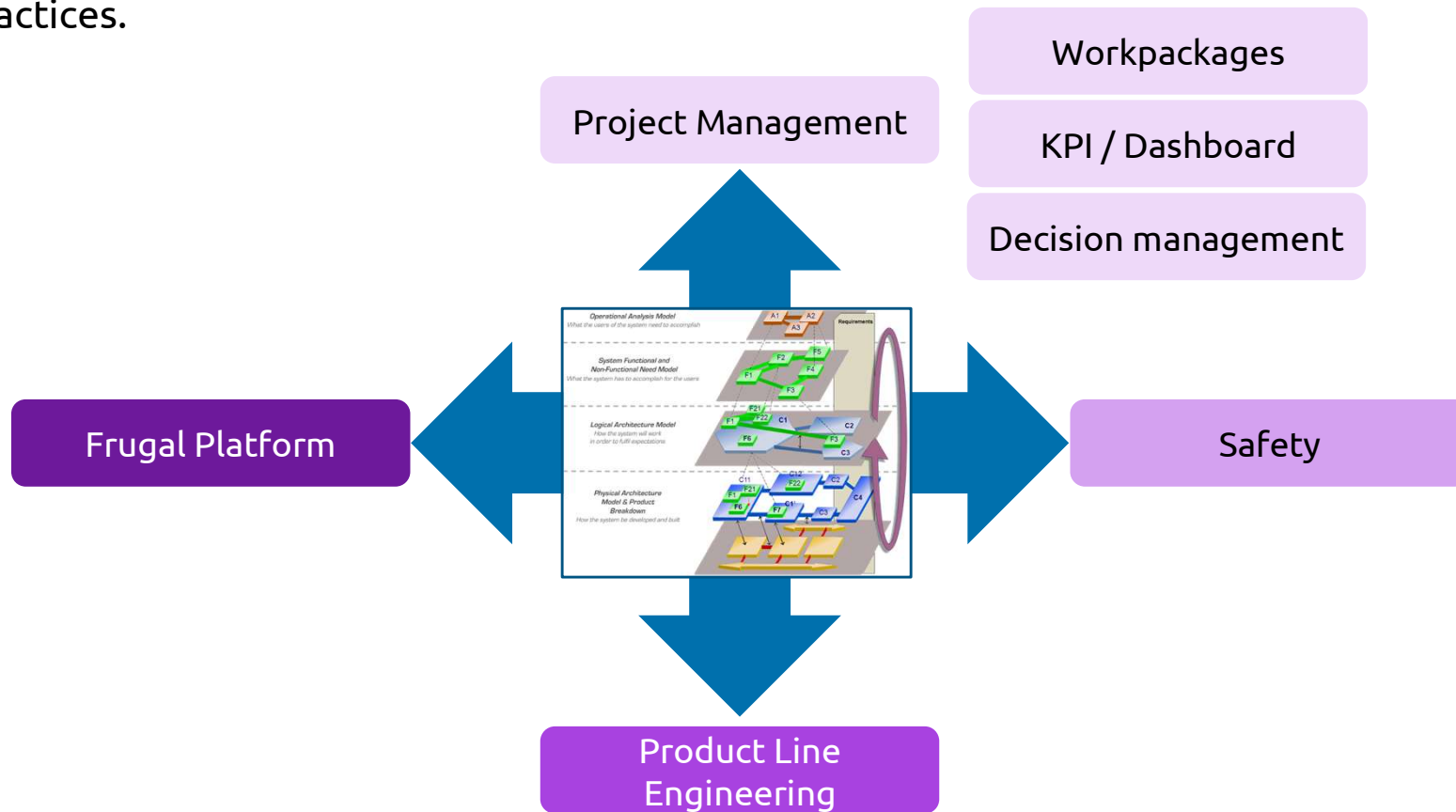




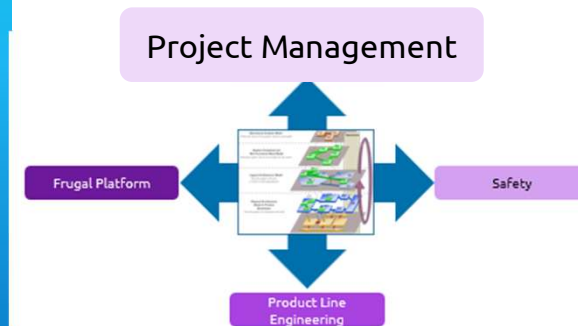
CAPELLA AS A VECTOR OF INTEROPERABILITY BETWEEN OTHER PRACTICES

Objectives :

Share several features added to CAPELLA during CAPGEMINI projects to highlight MBSE activities with other practices.



3.1 INTEROPERABILITY WITH PROJECT MANAGEMENT



PROJECT MANAGEMENT / ALLOCATION TO WORKPACKAGES

ALLOCATION TO WORKPACKAGES

OBJECTIVE

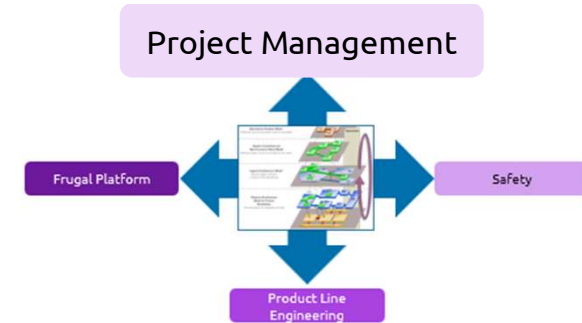
Allow the allocation of Capella objects (functions, logical or physical components, ...) to workpackages of the project to manage work sharing into a project or a consortium. [PVMT, DS]

CONTEXT / WHY ?

- Project with many enterprises or suppliers (consortium, ...)
- Avoid to adapt the **system** breakdowns (FBS, PBS, ...) to the breakdowns of the **project** (OBS, WBS, ...)

HOW / SOLUTION ?

- All CAPELLA functions are no more Green !



				Identifiant	Fonctions	Allocations Sous-Système (modèle)					
0	1	2	3			Mob	Rech	Sup	Comm	Voie	Mnt
H	16			FL_H160.0	Stocker l'énergie		X				
H	17			FL_H170.0	Produire de l'énergie		X				
I	1			FL_I10.0	Localiser le mobile			X			
I	2			FL_I20.0	Surveiller l'activité du conducteur	X					

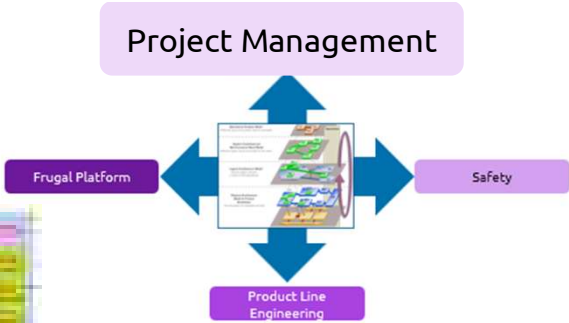
				Identifiant	Fonctions	Lots contributeurs							
0	1	2	3			Lot 2 Plateform	Lot 3 Energie	Lot 4 Archi EE	Lot 5 Cabine Conducteur	Lot 6 Cabine voyageur	Lot 7 Supervisi	Lot 8 Infra Voie	Lot 9 Référenc
H	16			FL_H160.0	Stocker l'énergie		1	X					
H	17			FL_H170.0	Produire de l'énergie		1						
I	1			FL_I10.0	Localiser le mobile						1		
I	2			FL_I20.0	Surveiller l'activité du conducteur			1	X				

PROJECT MANAGEMENT / ALLOCATION TO WORKPACKAGES

ALLOCATION TO WORKPACKAGES

SOLUTION IN CAPELLA

- Allocation of functions through an Excel file
- Import into Capella
- Update of attributes defined by PVMT addon
- Update of colors on diagrams by Diagram Styler addon



■	Lot 1 : Architecture système	■	Lot 7 : Système de supervision
■	Lot 2 : Plateforme SAFE	■	Lot 8 : Infrastructure voie
■	Lot 3 : Gestion de l'énergie	■	Lot 9 : Référentiel
■	Lot 4 : Architecture E/E	■	Lot 10 : Démonstrateur
■	Lot 5 : Cabine Conducteur	■	Lot 11 : Soutien Logistique
■	Lot 6 : Cabine voyageurs		

				Identifiant	Fonctions	Répartition Système	Lots contributeurs										
0	1	2	3				Lot 2	Lot 3	Lot 4	Lot 5	Lot 6	Lot 7	Lot 8	Lot 9	Lot 10	Lot 11	
							Plateform	Energie	Archi	Cabine	Cabine	Supervisi	Infra	Référenti	Démonstrat	SLI	
A				FS_A00.0	Transporter les utilisateurs et le chargement	Système	X		X	X	X						
A	1			FS_A10.0	Transporter les passagers	Système	X		X	X	X						
A	2			FS_A20.0	Transporter le chargement	Système	X				X						
B				FS_B00.0	Protéger les utilisateurs, Draisie et le chargement	Système	X	X	X	X	X	X					X
C				FS_C00.0	Assurer un environnement approprié aux utilisateurs et au chargement	Système	X		X	X	X	X					
C	1			FS_C10.0	Assurer le confort aux utilisateurs	Système	X		X	X	X						
C	2			FS_C20.0	Renouveler l'air du mobile et des infrastructures	Système					X						
C	3			FS_C30.0	Stocker le chargement	Système					X						

PROJECT MANAGEMENT / DASHBOARD

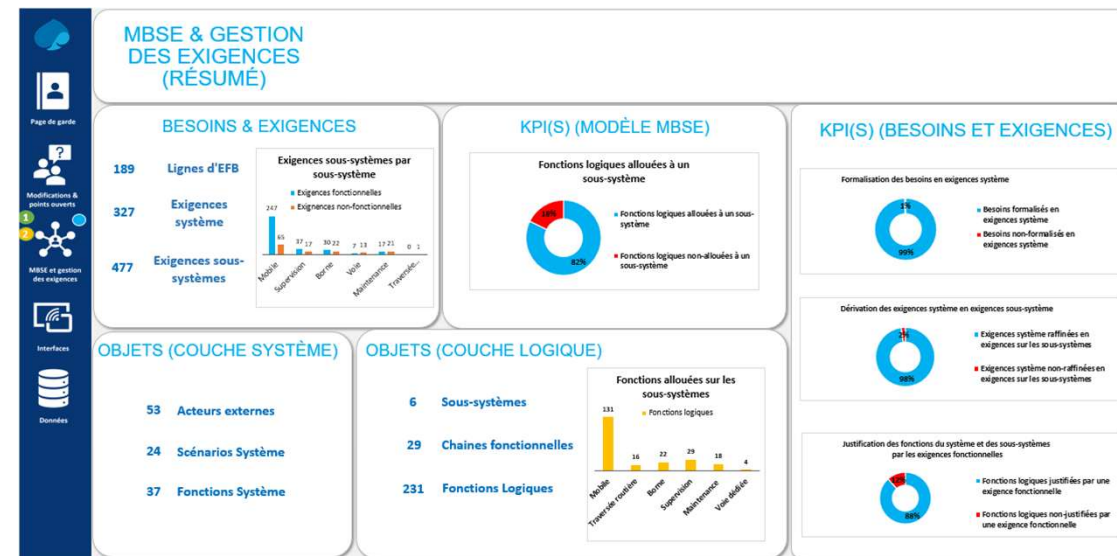
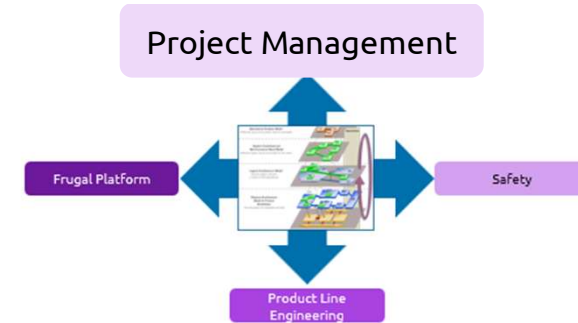
DASHBOARD

OBJECTIVE

Allow a communication about the quality, completeness and health of the MBSE model according to definition of KPIs and dashboard.
[Python4Capella]

CONTEXT / WHY ?

- Followup of the development of a MBSE model
- Check how the MBSE model bring value to the system design and the control of the project

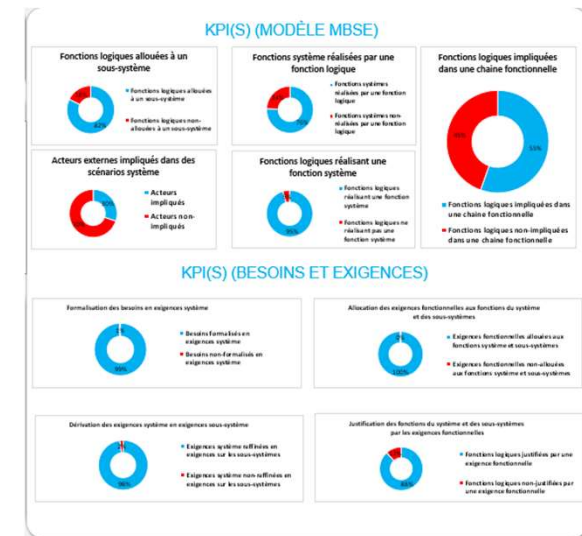
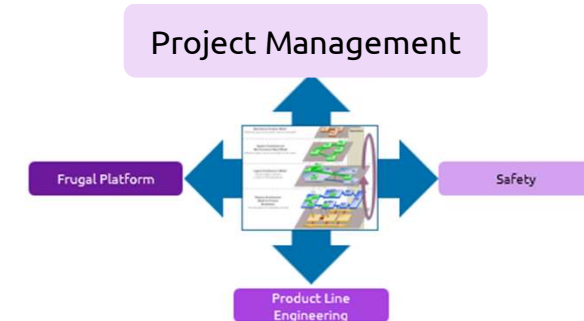
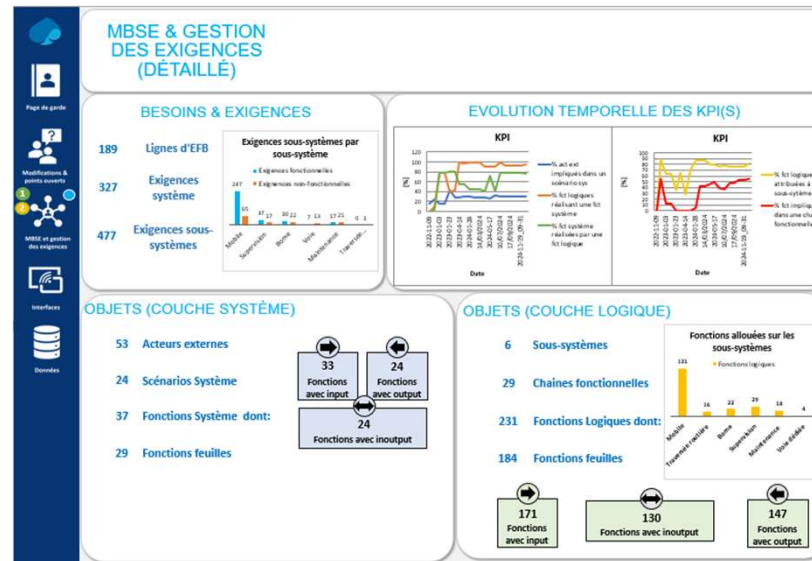


PROJECT MANAGEMENT / DASHBOARD

DASHBOARD

SOLUTION IN CAPELLA

- Extracts of data and properties with Python4Capella
- Layout of dashboard into Excel



PROJECT MANAGEMENT / DECISION MANAGEMENT

DECISION MANAGEMENT

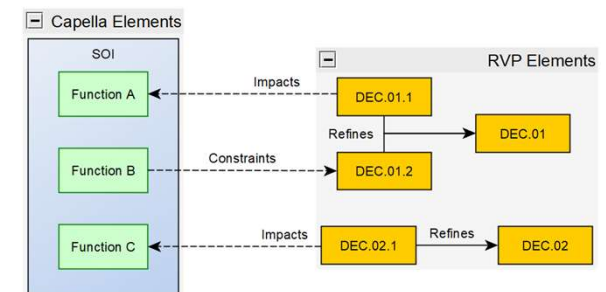
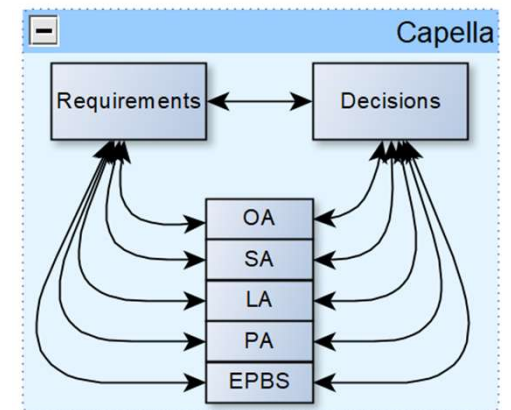
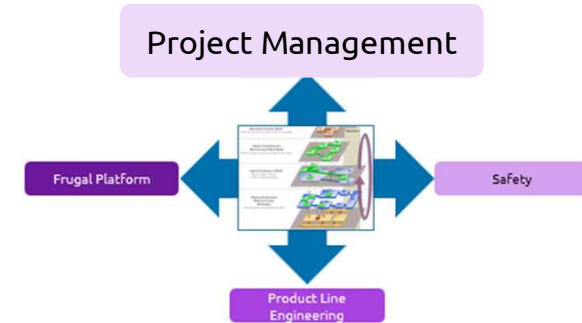
OBJECTIVE

Explainability of the design by tracing engineering elements back to a decision. Making the design more transparent and understandable for all stakeholders.

Allow the modelization of a network of decisions linked to any other Capella objects. Support the impact analysis on systems engineering data when the project shall modify a decision.

CONTEXT / WHY ?

- Decisions are the drivers of projects, engineering and architecture

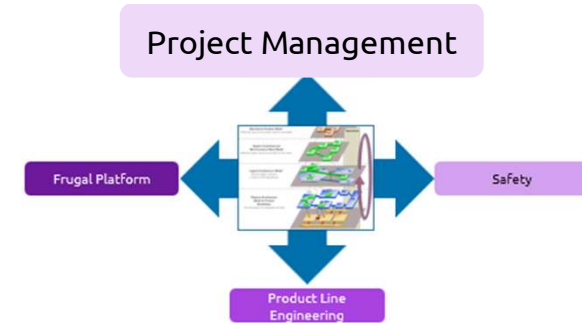
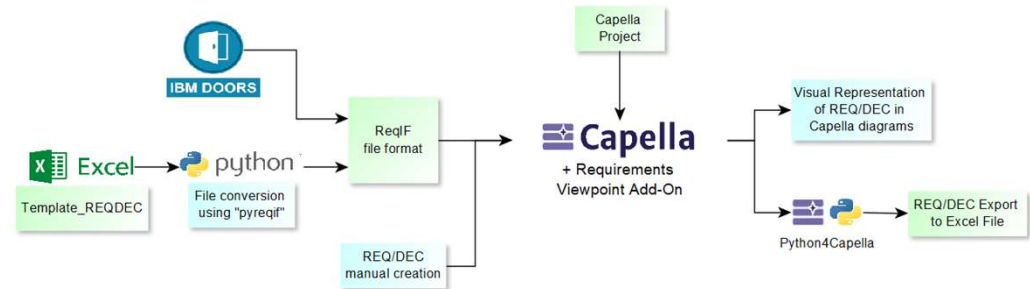


PROJECT MANAGEMENT / DECISION MANAGEMENT

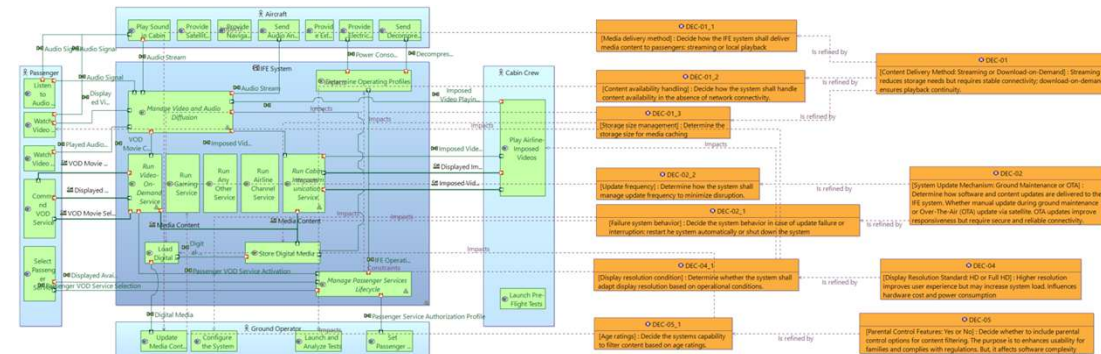
DECISION MANAGEMENT

SOLUTION IN CAPELLA

- Use of Requirement objets as Decision
- Links decisions together
- Links some decisions to Capella object
- Extract by Python4Capella to Excel

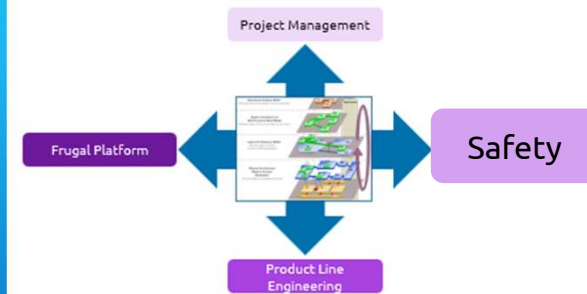


POC: IN-FLIGHT ENTERTAINMENT SYSTEM IN CAPELLA



Network of decisions. Some decisions linked to Capella objets.

3.2 INTEROPERABILITY WITH SAFETY ANALYSIS



SAFETY / INPUTS FOR SAFETY ANALYSIS

INPUTS FOR SAFETY ANALYSIS

OBJECTIVE

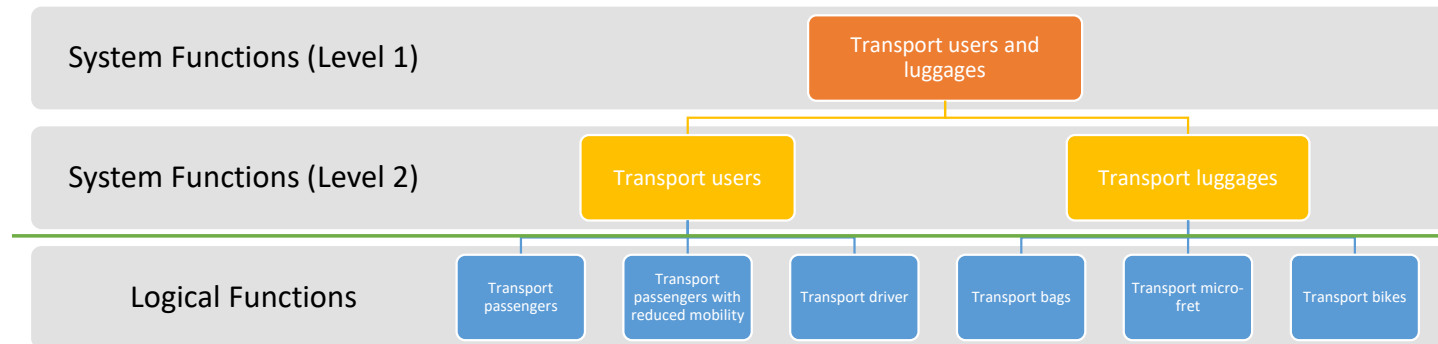
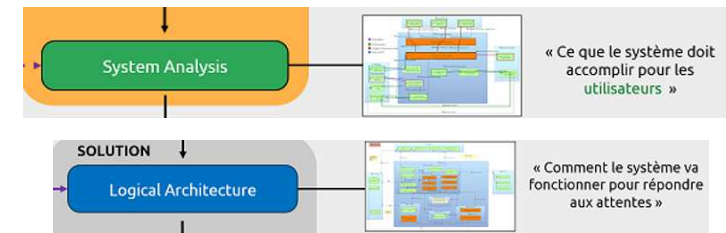
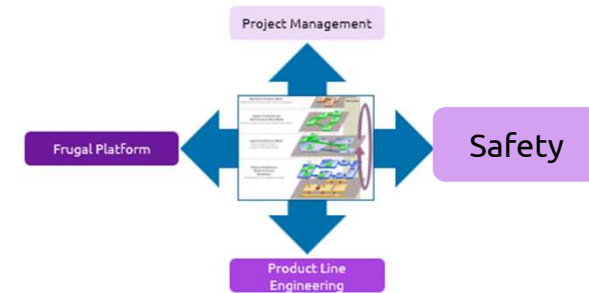
Allow a structured export of functions from Capella layers into a Functional Breakdown Structure into an Excel file, reused by a safety team to run Preliminary Risk Analysis to identify safety related functions and add new safety requirements.

CONTEXT / WHY ?

- Continuity between SE/MBSE and Safety

HOW / SOLUTION ?

- Extract the hierarchy of functions into a Functional Breakdown Structure (FBS)
- Functions come from Systems Analysis and Logical Architecture layers
- Done with Python4Capella



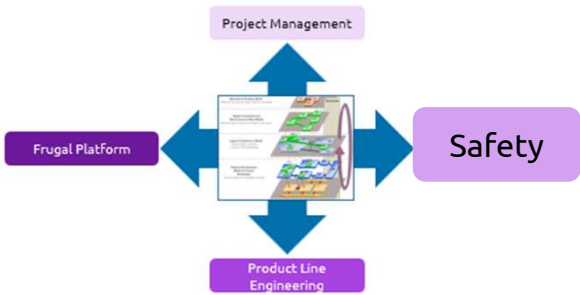
SAFETY / INPUTS FOR SAFETY ANALYSIS

INPUTS FOR SAFETY ANALYSIS

SOLUTION IN CAPELLA

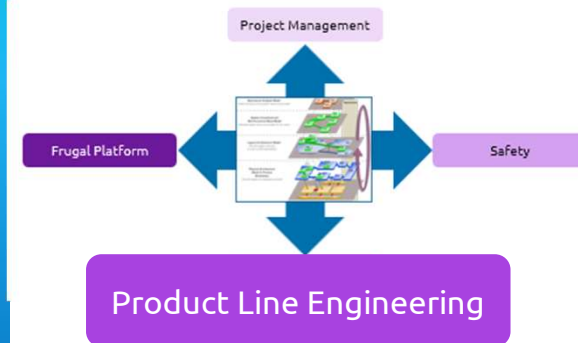
- Python4Capella to explore layers of MBSE model
- Generate a structured functional breakdown into several sheets of Excel
 - One external functional breakdown (blackbox) from System Analysis layer
 - One internal functional breakdown (whitebox) from Logical layer

	A	B	C	D	E	F	G	H	I	J	K
					Identifiant	Fonction	Description	Lot 2 Plateforme	Lot 3 Energie	Lot 4 Archi	Lot 5 Cabine conduite
5											
6	A				FS_A00.0	Transporter les utilisateurs et le chargement		x		x	x
7	A		1		FS_A10.0	Transporter les utilisateurs		x			
8	A		2		FS_A20.0	Transporter le chargement		x			
9	B				FS_B00.0	Protéger les utilisateurs, Draisys et le chargement		x	x	x	x
10	C				FS_C00.0	Assurer un environnement approprié aux utilisateurs et au chargement					x
11	C		1		FS_C10.0	Assurer le confort aux utilisateurs		x		x	x
12	C		2		FS_C20.0	Renouveler l'air du mobile					
13	C		4		FS_C40.0	Fournir une billetterie				x	
14	D				FS_D00.0	Assurer un accès des utilisateurs et du chargement au système Draisys		x	x	x	x
15	E				FS_E00.0	Assurer les états de déplacement du mobile	Situation du mobile Draisys lors de son déplacement	x	x	x	x
16	E		1		FS_E10.0	Fournir une force d'accélération		x	x	x	x
17	E		2		FS_E20.0	Assurer le démarrage du mobile		x	x	x	x



					Identifiant	Fonction	ID de la fonction système mère	Nom de la fonction système mère
D		5			FL_D50.0	Sécuriser les accès au système Draisys	FS_D00.0	Assurer un accès des utilisateurs et du chargement au système Draisys
D		5	1		FL_D51.0	Sécuriser les accès entre le mobile et le quai	FS_D00.0	Assurer un accès des utilisateurs et du chargement au système Draisys
D		5	1	1	FL_D51.1	Sécuriser les accès des passagers PMR entre le mobile et le quai	FS_D00.0	Assurer un accès des utilisateurs et du chargement au système Draisys
D		5	1	2	FL_D51.2	Sécuriser les accès des passagers non PMR entre le mobile et le quai	FS_D00.0	Assurer un accès des utilisateurs et du chargement au système Draisys
D		5	1	3	FL_D51.3	Sécuriser les accès du personnel entre le mobile et le quai	FS_D00.0	Assurer un accès des utilisateurs et du chargement au système Draisys
D		5	2		FL_D52.0	Sécuriser les accès entre le mobile et la voie	FS_D00.0	Assurer un accès des utilisateurs et du chargement au système Draisys

3.3 INTEROPERABILITY WITH PRODUCT LINE ENGINEERING



PLE / PRODUCT LINE ENGINEERING BASICS

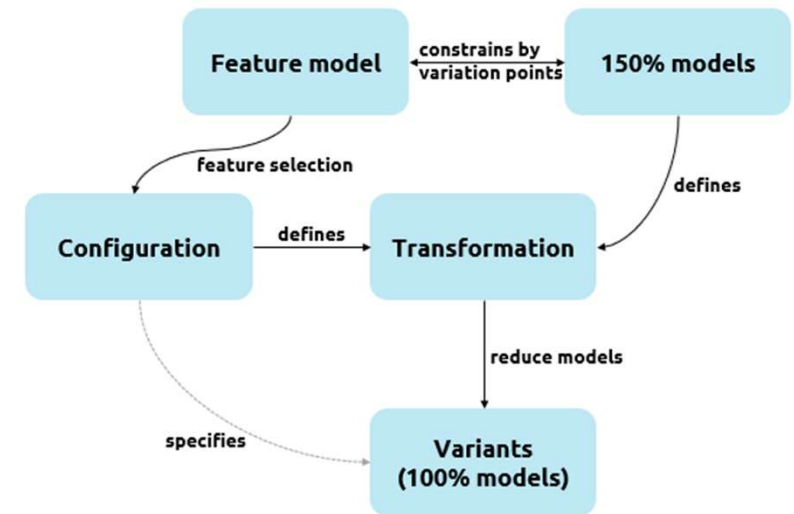
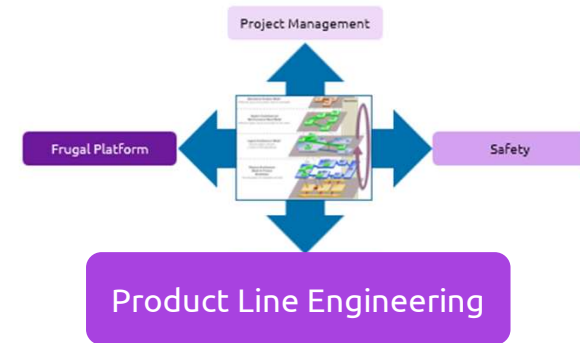
PRODUCT LINE ENGINEERING BASICS

OBJECTIVE

Product Line Engineering basics : allow the definition of a variability model and the identification of Capella objects that are specific to each variant. Support the reduction of a 150% multi-variants model into a 100% model of a selected variant.

CONTEXT / WHY ?

- Enhance efficiency

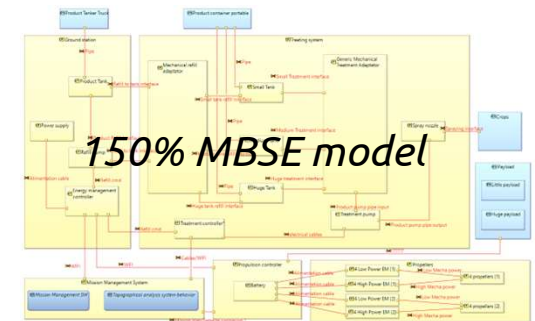
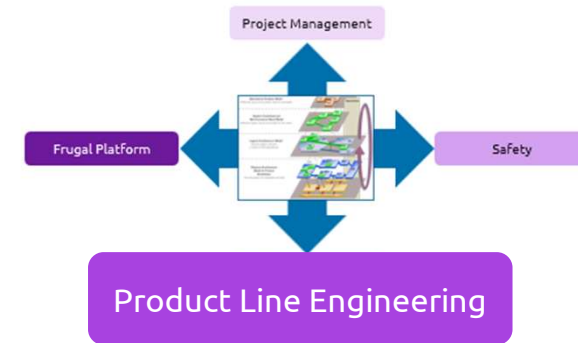


PLE / PRODUCT LINE ENGINEERING BASICS

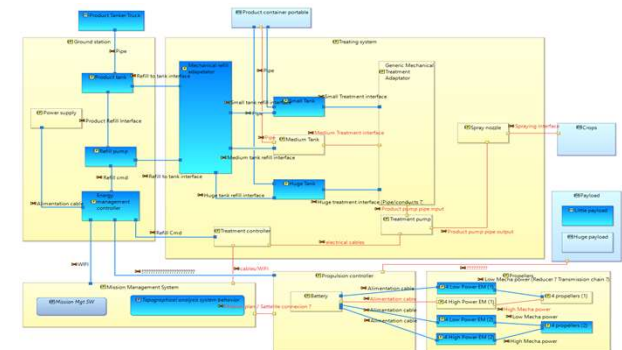
PRODUCT LINE ENGINEERING BASICS

SOLUTION IN CAPELLA

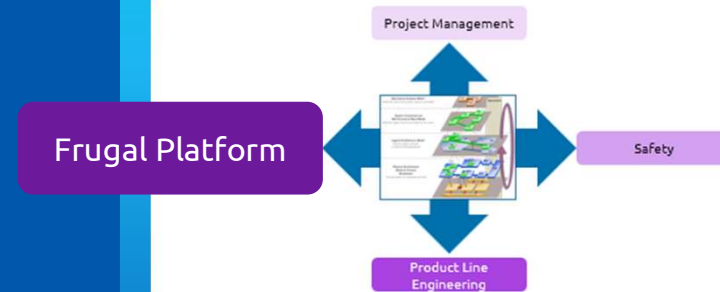
- Python4Capella, PVMT, DS, Excel
- Create a **background color** in the model for **unselected features**.
- The **colored elements** will be **removed** to obtain the **variant specific model**.



150% MBSE model with highlight of unused elements for a 100% MBSE model of a variant



3.4 INTEROPERABILITY INSIDE FRUGAL PLATFORM



PLATFORM / FRUGAL SYSTEMS ENGINEERING PLATFORM

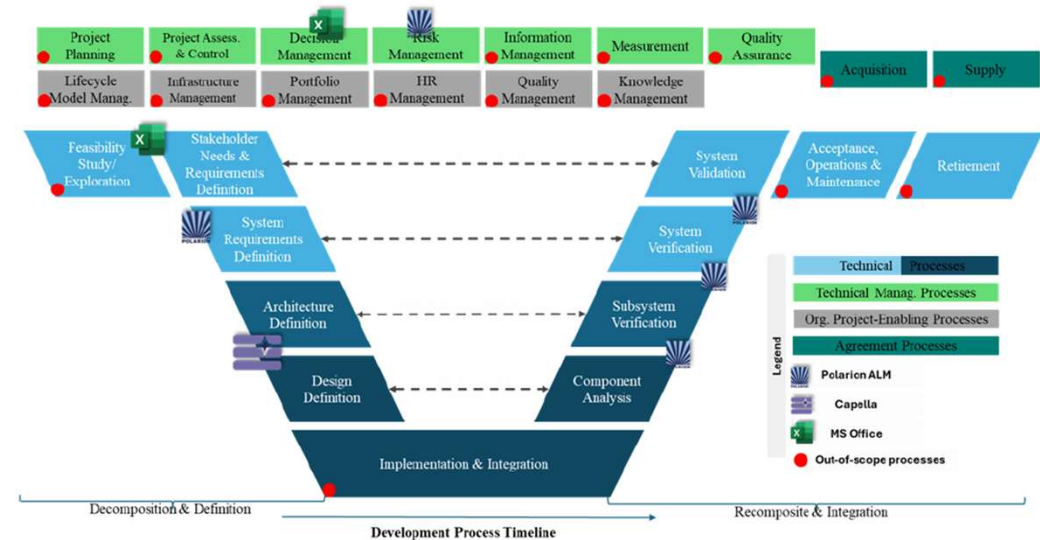
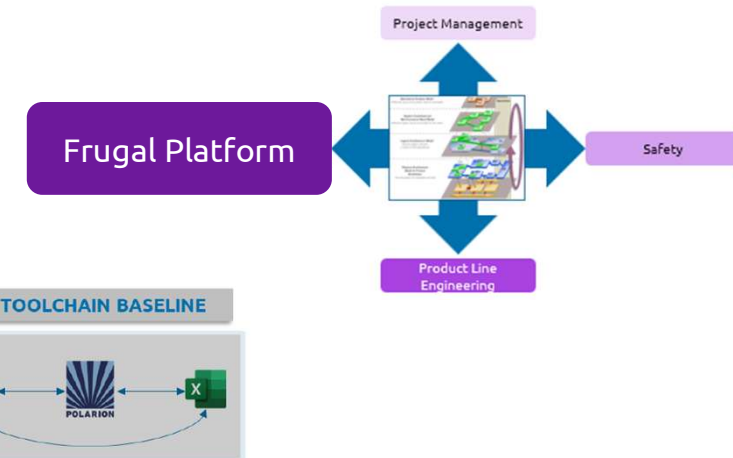
FRUGAL SYSTEMS ENGINEERING PLATFORM

OBJECTIVE

The objective of the frugal SE platform is to embed SE artefacts of a SE referential for a project.

CONTEXT / WHY ?

- How can frugality enhance SE efficiency ?
- Expected efficiency will allow to start to deploy SE/MBSE on a project with limited obstacles caused by the deployment of tools.

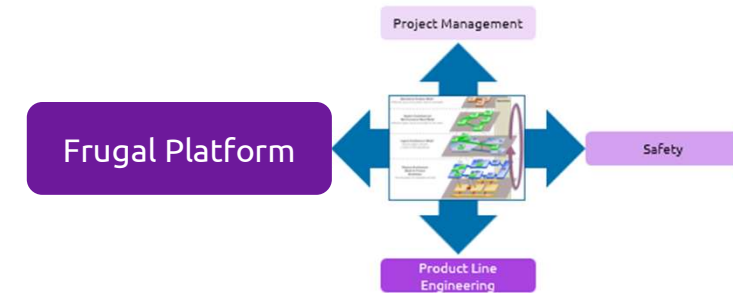
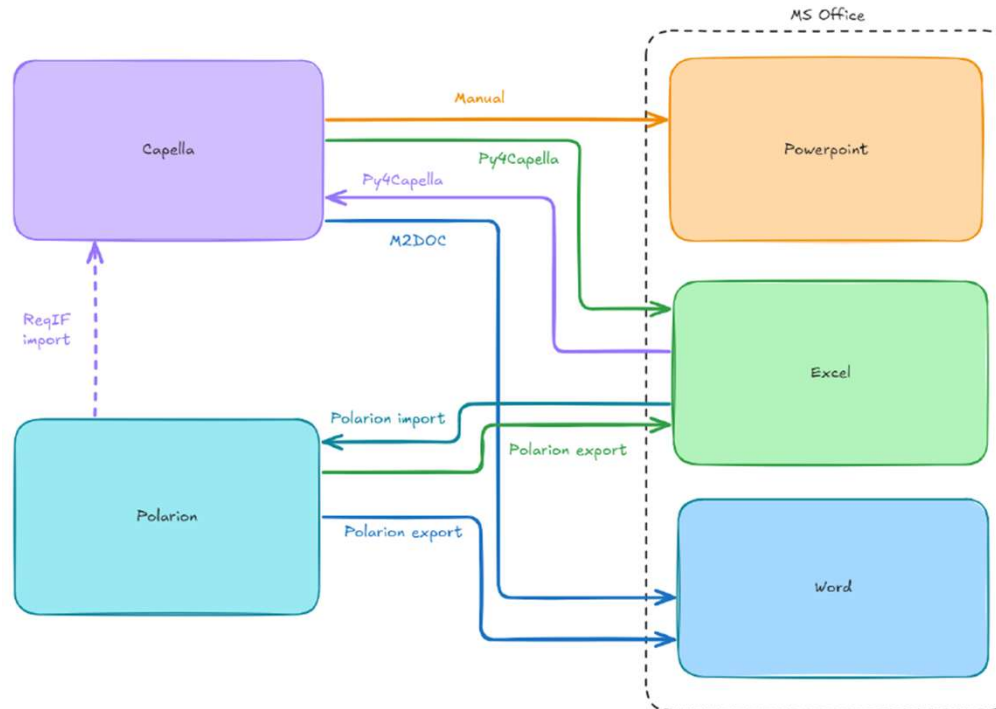


PLATFORM / FRUGAL SYSTEMS ENGINEERING PLATFORM

FRUGAL SYSTEMS ENGINEERING PLATFORM

SOLUTION IN CAPELLA

- ReqIF import
- Python for Capella
- M2doc



4

CONCLUSION AND WAY FORWARD



CAPELLA AS A VECTOR OF INTEROPERABILITY BETWEEN PRACTICES CONCLUSION AND WAY FORWARD

CONCLUSION

- MBSE is a mean for SE.
 - SE is a mean to design the right system.
- MBSE models are means to support the multidisciplinary approach drumbeated by SE
- MBSE can generate input for other practices

WAY FORWARD

- Extend PLE feature on other ARCADIA layers and concepts
- Extend coverage of SE processes by the frugal platform (tradeoffs, change management, cybersecurity, ...)
- Deploy and enhance those features on more multi-industries and multi-projects

Make it real.

5 Q&A



Make
it
real.

Capgemini 