

RMIVV Presentation

Capella days

www.thalesgroup.com



What kind of product are we talking about ?

▶ Equipments for airborne systems

▶ Several operational capabilities

- Tactical Reconnaissance
- Advanced Targeting

▶ High integrated technology and processing

- High resolution sensors
- High performance image processing
- Strongly constraint by Size Weight and Power (SWAP)

▶ Multi-disciplines engineering

- | | |
|---|--|
| <ul style="list-style-type: none"> • Optical • Hardware • Mechanical | <ul style="list-style-type: none"> • Thermician • Software • Firmware |
|---|--|



<https://www.thalesgroup.com/en/attack-recce-navigation>

Trends for Future products

More operational capabilities

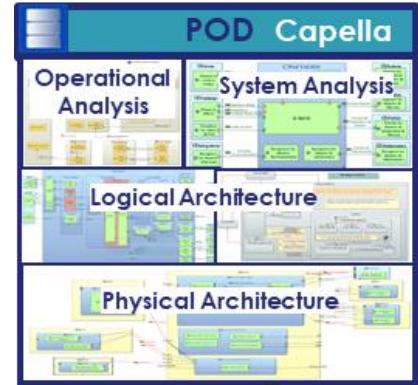
- Detection, reconnaissance, identification, localisation
- More sensors and more imaging channels
- More functionalities and coopération
- Introduction of embedded artificial intelligence

Several operational capabilities

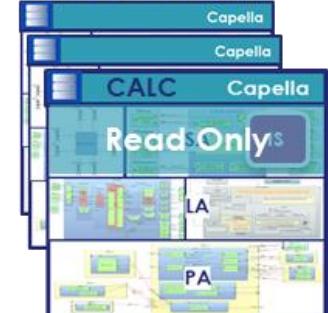
- Multiple sub-systems (sensing, processing, thermal dissipation, ...)
- Highly distributed embedded systems
 - ▶ More HW boards
 - ▶ More CPUs and image co-processors
 - ▶ More algorithms to allocate
 - ▶ But in the same range of SWAP ...
 - ▶ ... and strong expectations on competitiveness

MBSE becomes essential to master complexity

SYSTEM

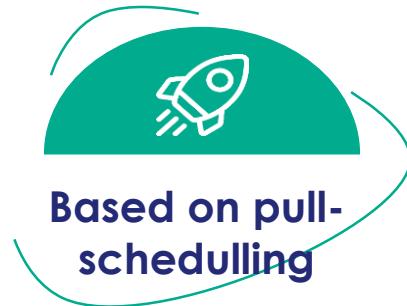


SUB-SYSTEMS



Engineering transformation to reach these challenges

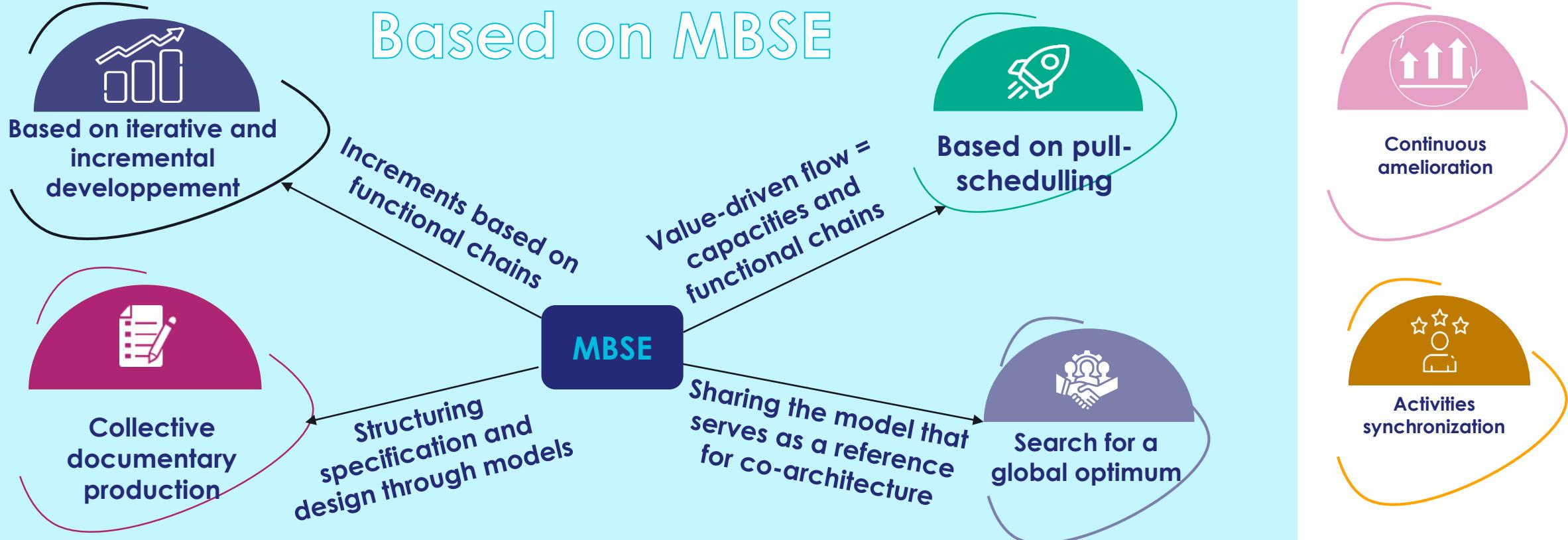
Promoting co-engineering activities



Engineering transformation to reach these challenges

Promoting co-engineering activities

Based on MBSE



IVV-Based incremental development

Capabilities and Functional chains drive the definition of the development increment content

IVV shall be implied early in the functional analysis to challenge functional scenarios

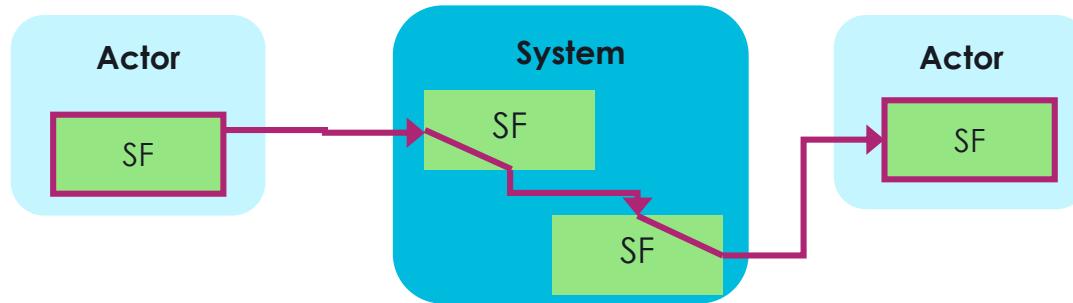
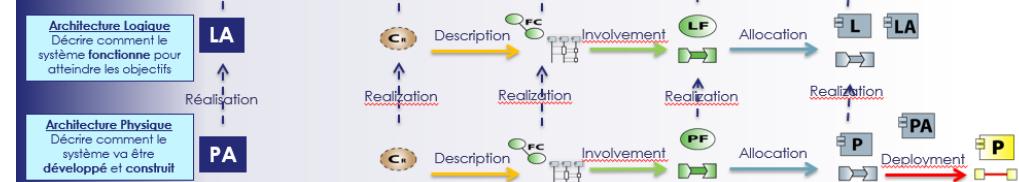
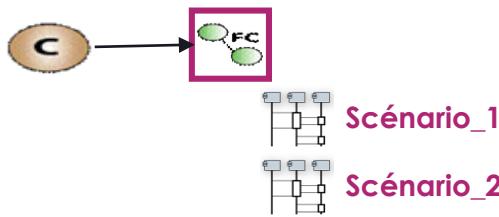
- ▶ An **increment** is a deliverable with content that brings value to the “customer” level (in the sense of the increment's consumer). It can be applied at system, subsystems and software levels
- ▶ Its definition is driven by the value analysis of **capabilities and functional chains** from System Analysis (SA)
- ▶ The granularity of the increment can be
 - One or several functional chains end-to-end
 - A subset of functional chains
- ▶ The IVV must have knowledge as soon as possible of the functional chains and associated functional scenarios
- ▶ System architect translates SA-level functional chains into logical and physical levels, and ensures traceability.
- ▶ IVV scenarios are developed by the IVV discipline on the basis of functional chains and operational scenarios.
- ▶ IVV contributes to the construction of development increments
- ▶ Functional chains and scenarios are refined at each engineering level; system and sub-system.

Increment definition based on components



Definition of functional chains at System Analysis level

NEEDS
Identification of Capabilities and Functional chains for releases



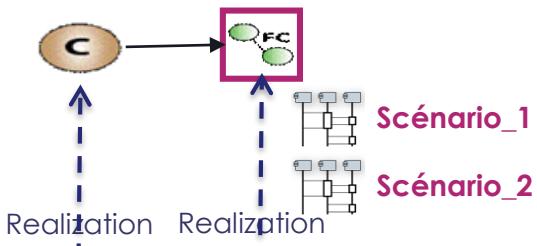
Increment definition based on components



Definition of functional chains at System Analysis level

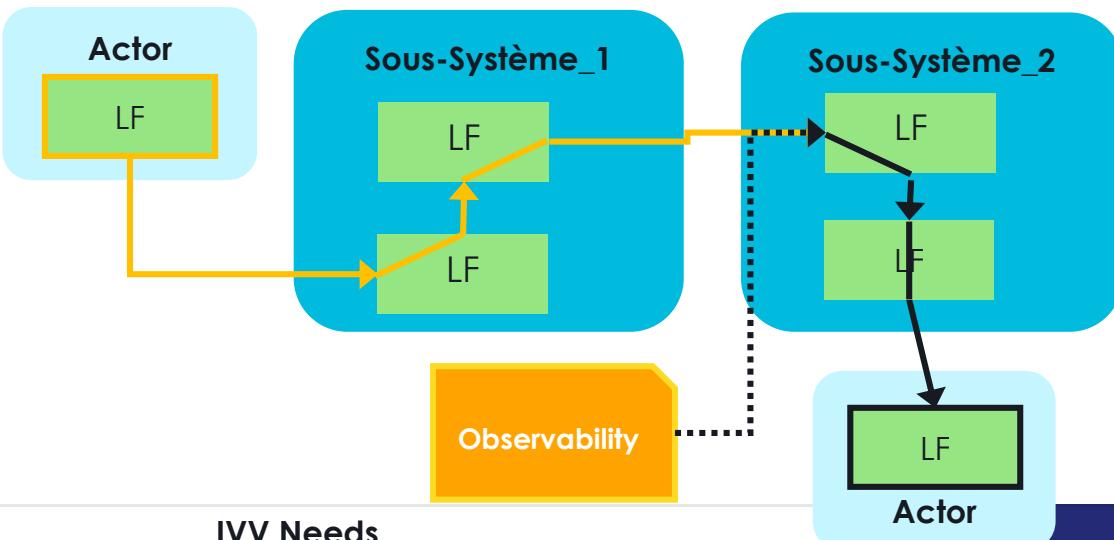
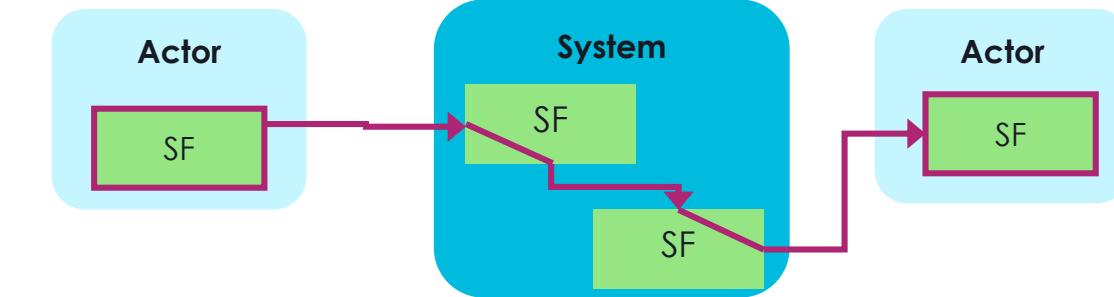
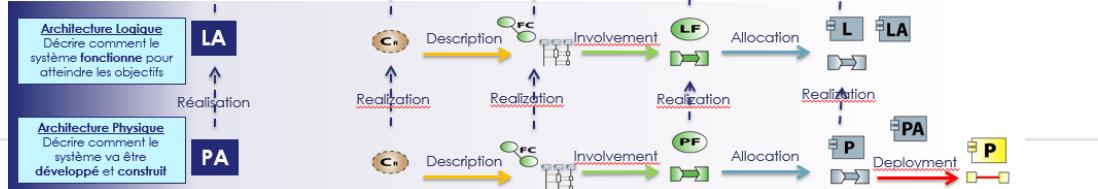
NEEDS

Identification of Capabilities and Functional chains for releases

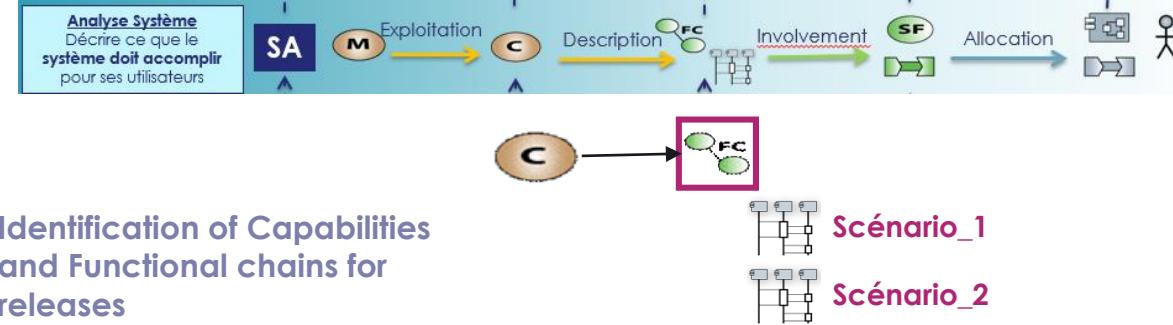


SOLUTION

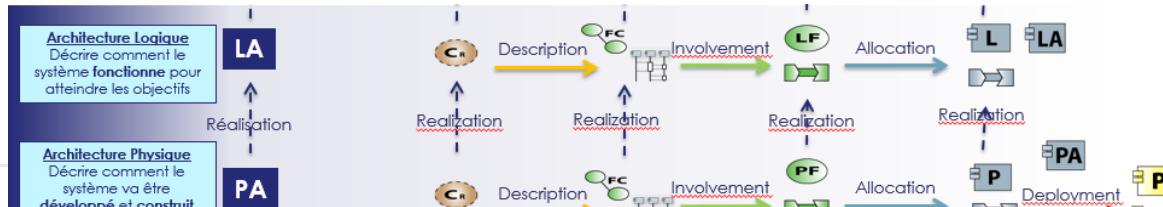
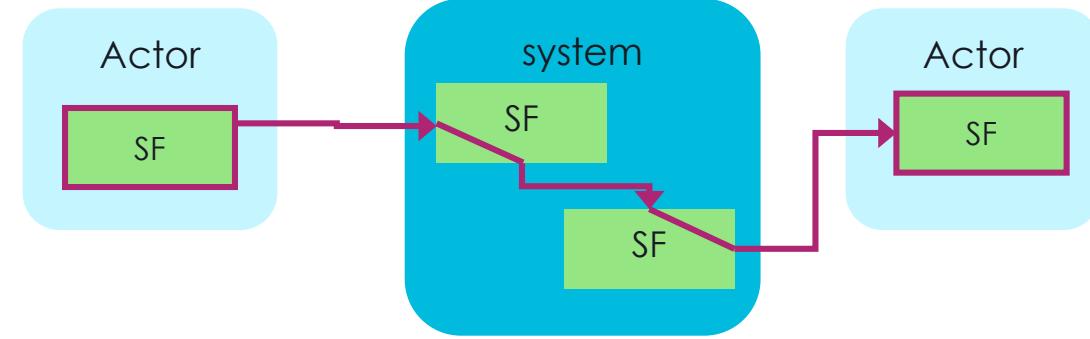
Identification of development increments to implement the releases



Increment definition by end-to-end FC refinement

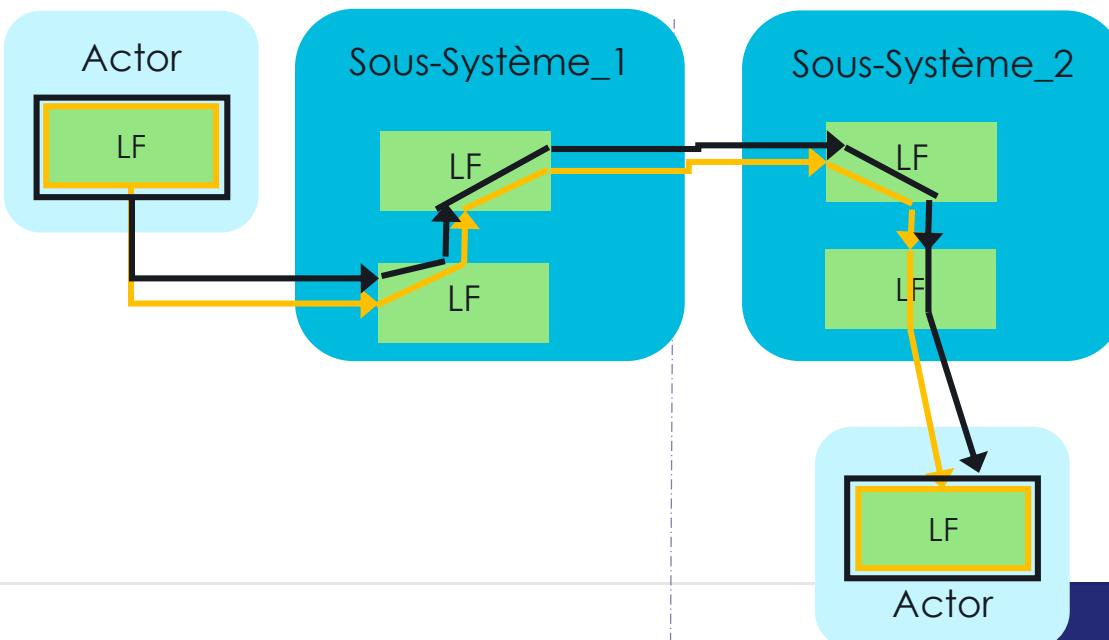
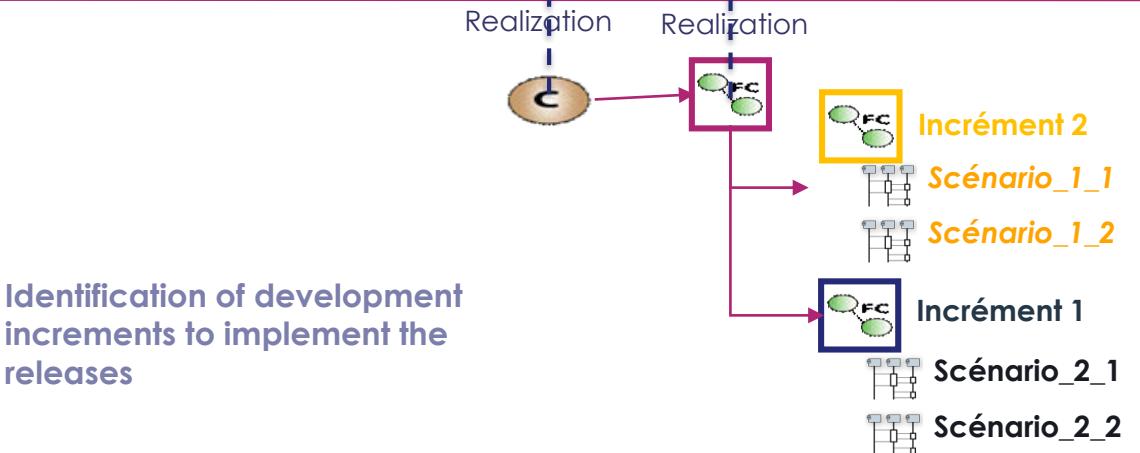
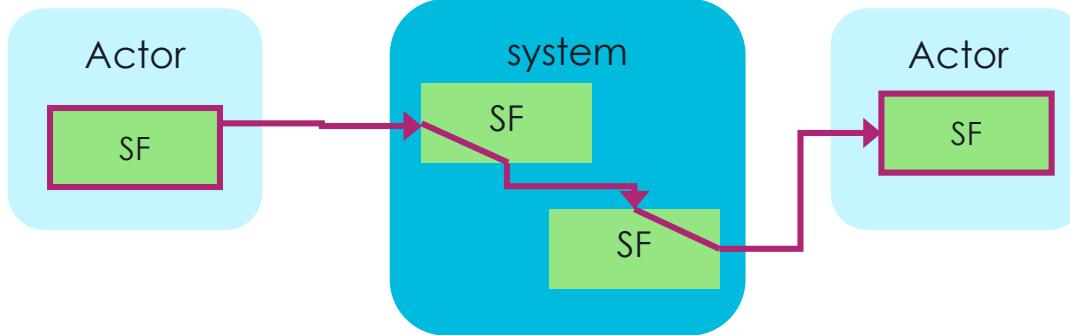
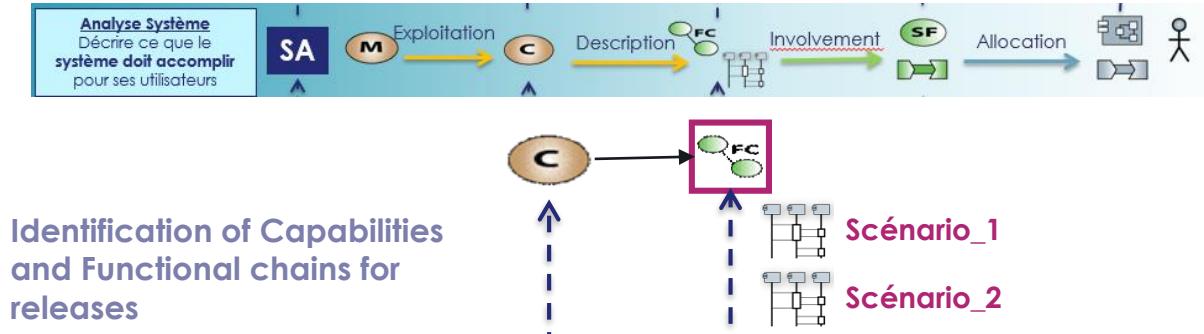


Identification of Capabilities and Functional chains for releases



INTRODUCTION

Increment definition by end-to-end FC refinement

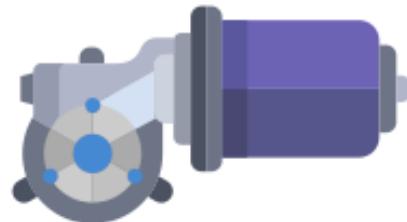


What is an increment ?



TIME →

INCREMENT 1



INCREMENT 2



INCREMENT 3



INCREMENT 4



How to define an increment ?

STEP 1

DEFINE WHAT IS **REQUIRED**

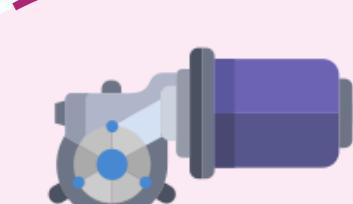
STEP 2

DEDUCT WHAT NEEDS TO BE **DEVELOPED**

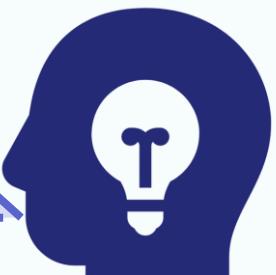
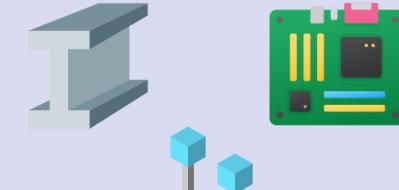
(TO MAKE WHAT IS **REQUIRED**)

EXAMPLE

« we want to create a car therefore we are **required** to make the engine »



« To make our car, we will **develop** these items... »



How to define an increment ?

STEP 1

REQUIRED

=

A NEED

STEP 2

DEVELOPED

=

A SOLUTION

How to define an increment ?

STEP 1

REQUIRED

=

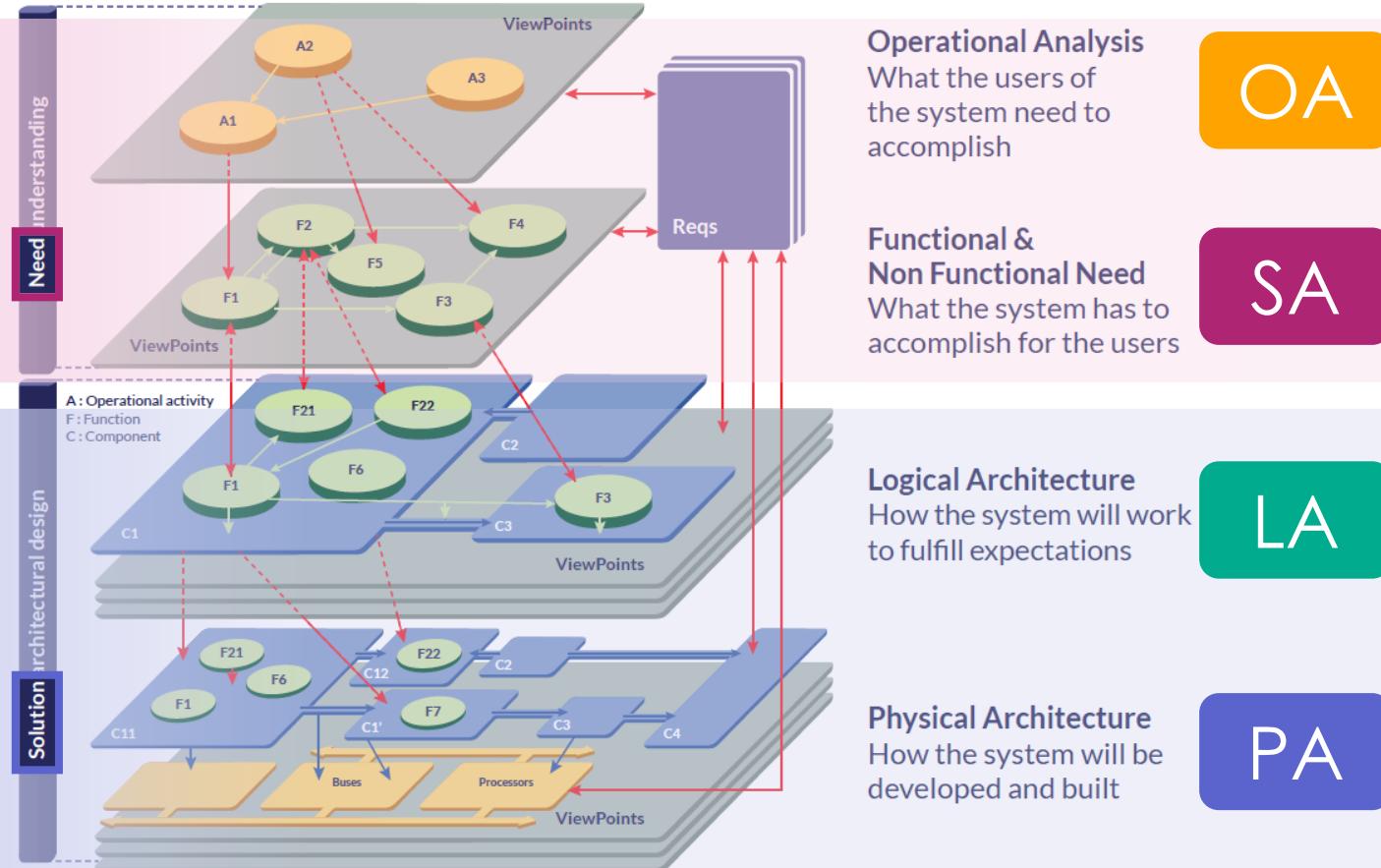
A NEED

STEP 2

DEVELOPED

=

A SOLUTION



3.

THE PROPOSED SOLUTION

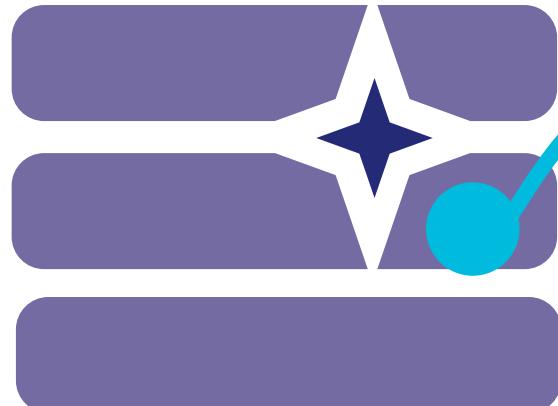
4. THE PLANNED PROCESS: PRACTICE



THE FACTS

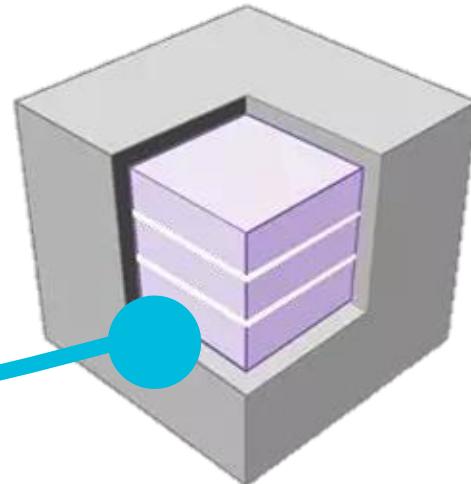
→ We have 2 processes

The creation of a model
in **Capella**



They **share** common
concepts
(Need/Solution)

The definition of **increments**



3.

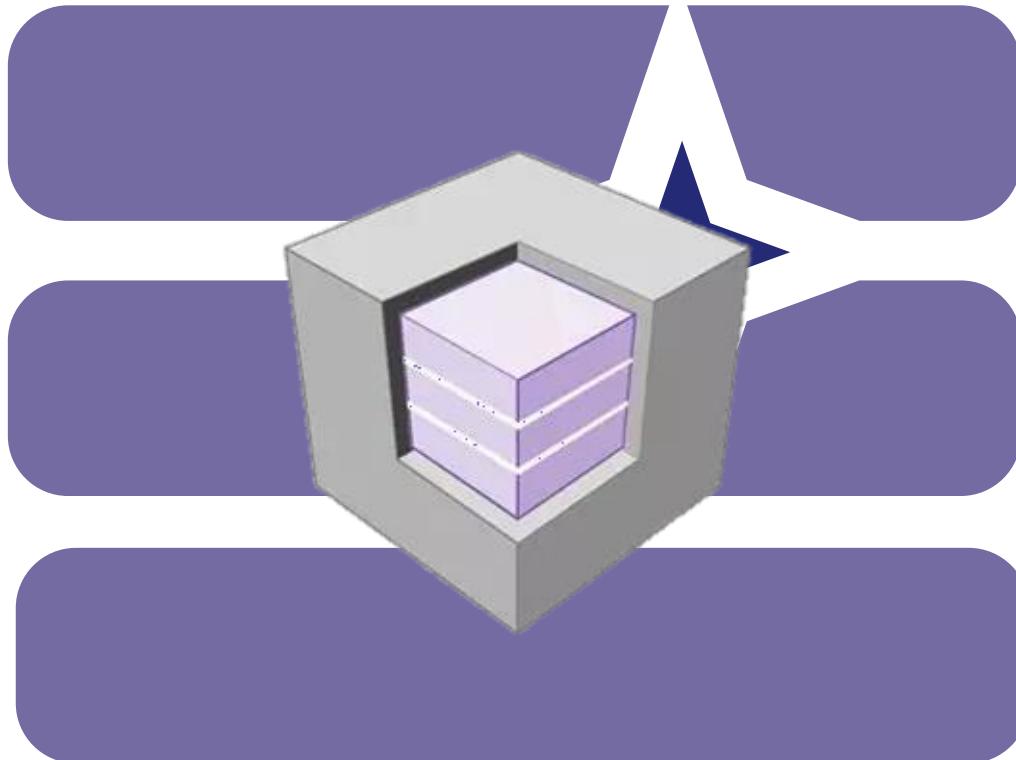
THE PROPOSED SOLUTION

4. THE PLANNED PROCESS: PRACTICE

Create the increments  Capella



THE IDEA



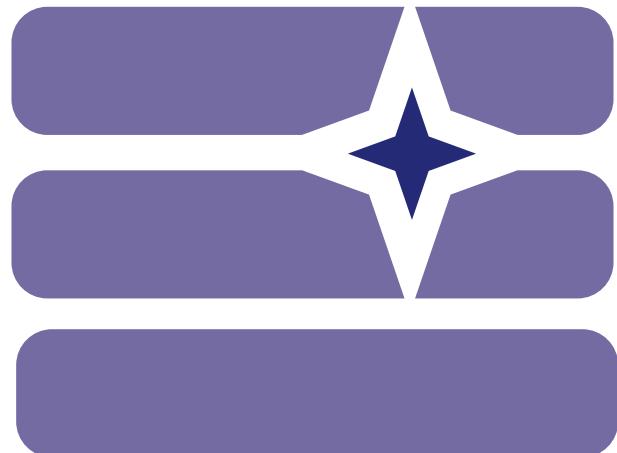
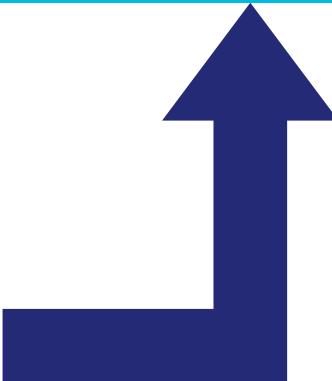
3.

THE PROPOSED SOLUTION

4. THE PLANNED PROCESS: PRACTICE



THE SOLUTION



3.

THE PROPOSED SOLUTION

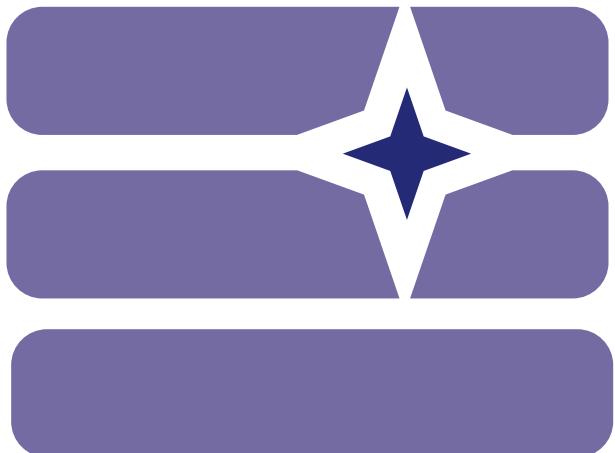
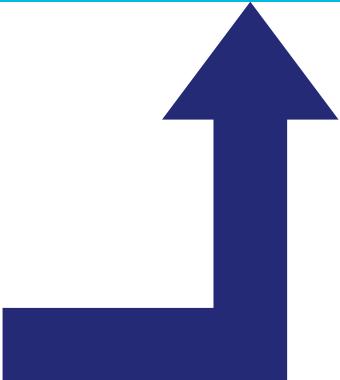
4. THE PLANNED PROCESS: PRACTICE



The Add-on

R elease M anagement and IVV

THE SOLUTION



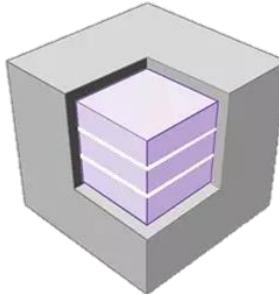
3. THE PROPOSED SOLUTION

4. THE PLANNED PROCESS : PRACTICE

The Add-on

R elease M anagement

Simplifies increment creation and management



STEP 1
REQUIRED

STEP 2
DEVELOPED

and

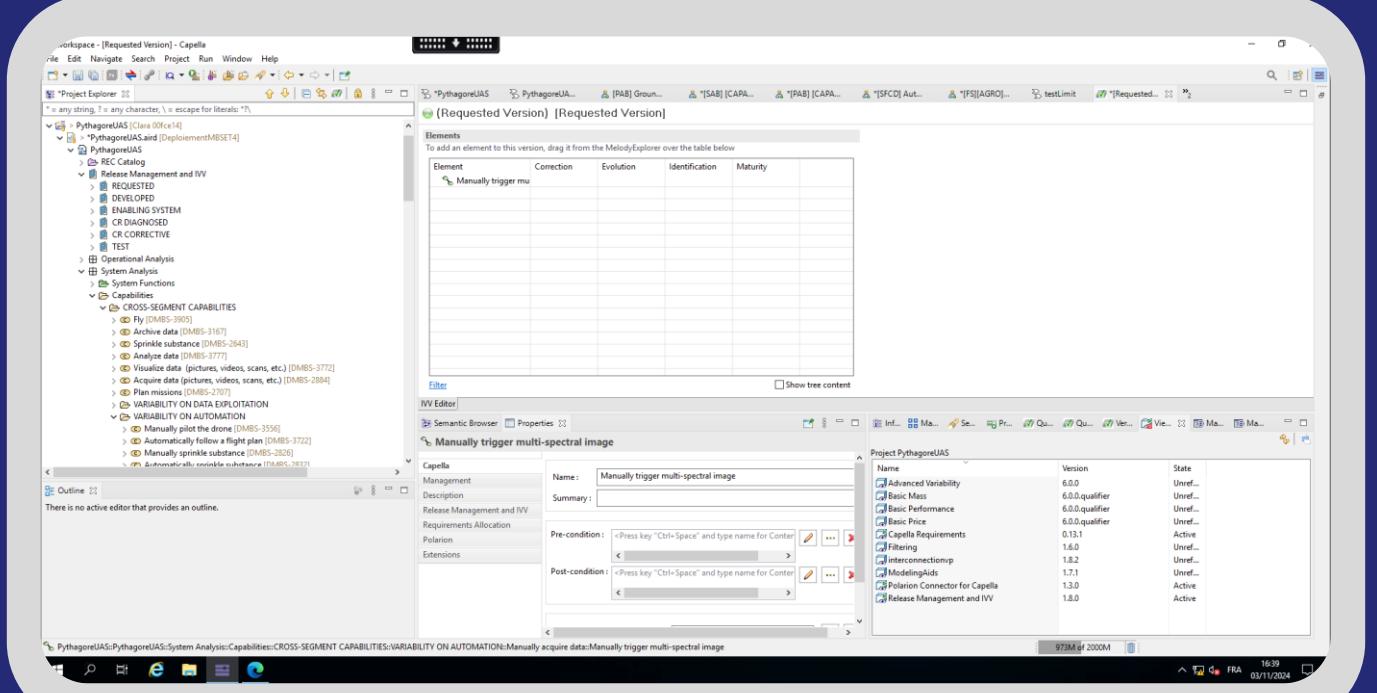
IVV

Provides the IVV manager with information to help him make decisions about testing



STEP 3
TESTABILITY

4. THE PLANNED PROCESS : PRACTICE



MY RECAP



THEORY

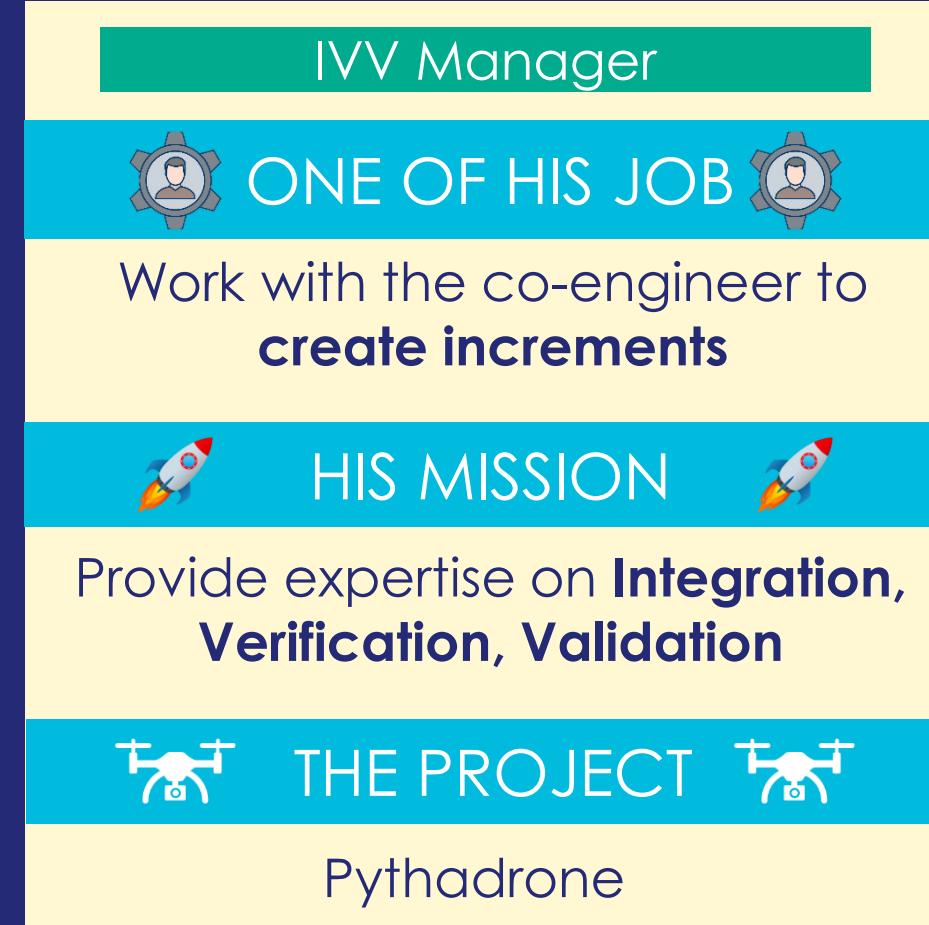
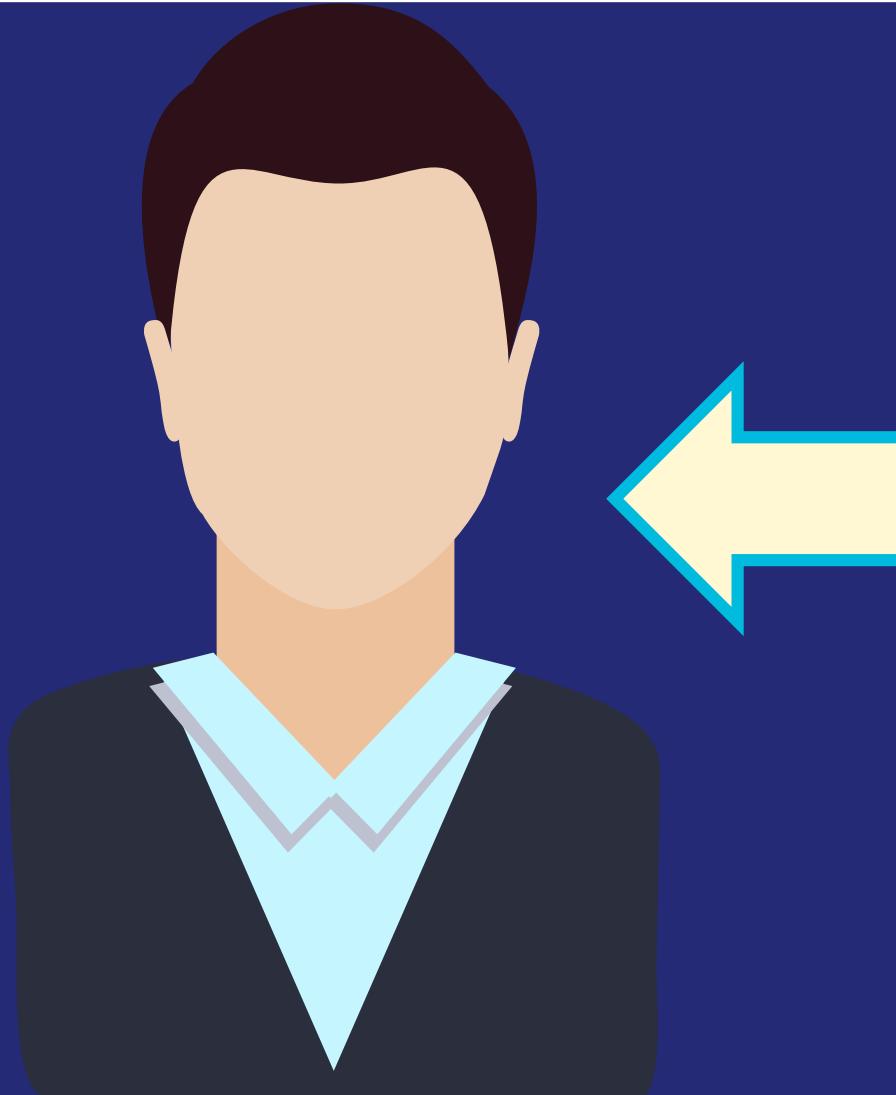
DEFINITION

STEP 1 Identify the **requested** elements

STEP 2 Deduce the **developed** elements

STEP 3 Evaluate the **testability**

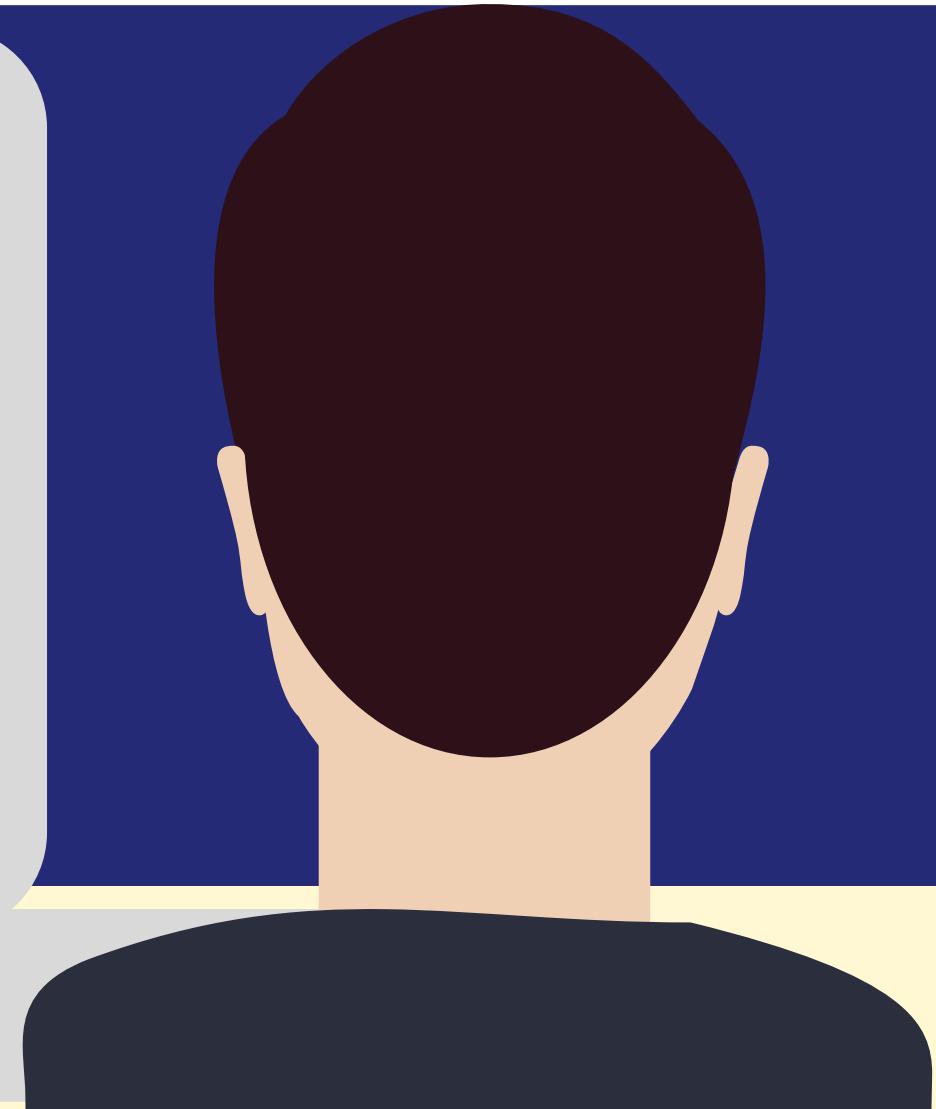
4. THE PLANNED PROCESS : PRACTICE



4. THE PLANNED PROCESS : PRACTICE

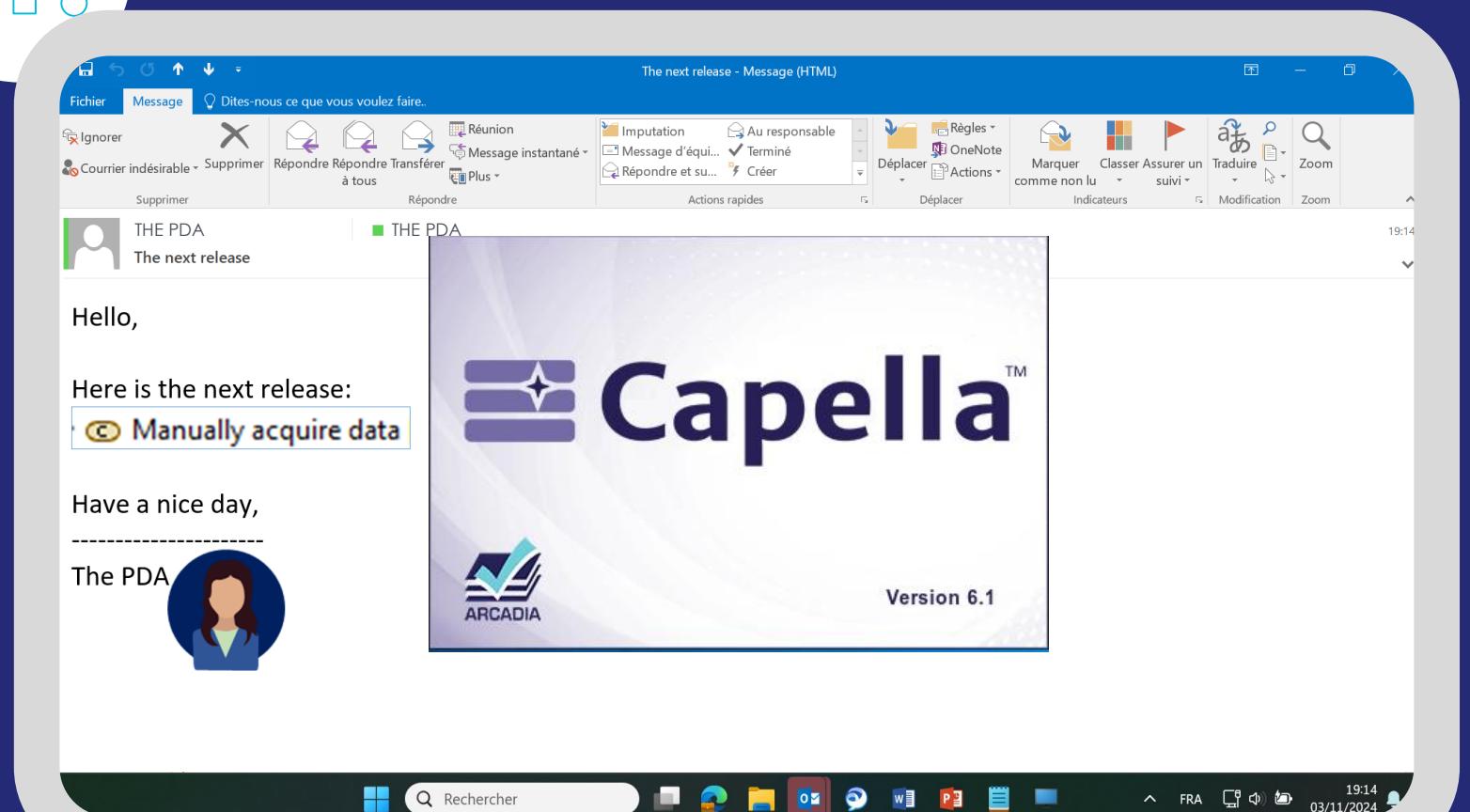


4. THE PLANNED PROCESS : PRACTICE



4. THE PLANNED PROCESS : PRACTICE

0.A. FIND THE RELEASE



MY RECAP



THEORY

STEP 0

DEFINITION

STEP 1

Identify the
requested
elements

STEP 2

Deduce the
developed
elements

STEP 3

Evaluate the
testability

PRACTICE



4.

THE PLANNED PROCESS : PRACTICE

0.A. IDENTIFY THE RELEASE

The screenshot shows the Capella tool interface with the following details:

- Project Explorer:** Shows a tree structure for "PythagoreUAS.aird [DeploymentMBSET4]". Under "PythagoreUAS", there are nodes for "REC Catalog", "Operational Analysis", "System Analysis", "System Functions", and "Capabilities". The "Capabilities" node is expanded, showing sub-categories like "CROSS-SEGMENT CAPABILITIES" and "VARIABILITY ON DATA EXPLOITATION".
- Workflow:** A vertical column on the right lists the workflow phases: "System Analysis", "Logical Architecture", "Physical Architecture", and "EPBS".
- System Analysis Phase:** Descriptions for the System Analysis phase include:
 - Identify the boundary of the system, consolidate requirements**
 - Define what the system has to accomplish for the users**
 - Model functional dataflows and dynamic behaviour**
- Logical Architecture Phase:** Descriptions for the Logical Architecture phase include:
 - Develop System Logical Architecture**
 - See the system as a white box**
 - Define how the system will work so as to fulfill expectations**
 - Perform a first trade-off analysis**
- Physical Architecture Phase:** Descriptions for the Physical Architecture phase include:
 - Develop System Physical Architecture**
 - How the system will be developed and built**
 - Software vs. hardware allocation, specification of interfaces, deployment configurations, trade-off analysis**
- EPBS Phase:** Descriptions for the EPBS phase include:
 - Formalize Component Requirements**
 - Manage industrial criteria and integration strategy: what is expected from each designer/sub-contractor**
 - Specify requirements and interfaces of all configuration items**
- Semantic browser:** A message at the bottom states "Semantic browser not available".
- Bottom status bar:** Shows "1457M of 2000M" and the file path "PythagoreUAS/PythagoreUAS.aird".

Okay, my capability is here.
In the semantic browser, i can see its
owned functional chains

MY RECAP



THEORY

STEP 0

DEFINITION

Identify the **requested** elements

STEP 1

Deduce the **developed** elements

STEP 2

Evaluate the **testability**

PRACTICE



4. THE PLANNED PROCESS : PRACTICE

1.A. VERIFY THE MODEL

The lines are filled, they should be empty!
This means that some of the realization links are missing.
I'll let the architect know and he will correct it.

FC	F	First	Occurrence	Provenance
avoidance	<ul style="list-style-type: none"> ↳ Manually control drone motion and orientation with obstacle avoidance 			
	<ul style="list-style-type: none"> ↳ Constitute obstacles ↳ Implement obstacle avoidance ↳ Manually control the drone trajectory ↳ Move and orient drone ↳ Process manual motion orders 	<ul style="list-style-type: none"> premier 3 0 3 0 1 dernier 4 0 1 	<ul style="list-style-type: none"> direct direct ↳ Manually control drone motion and orientation ↳ Manually control drone motion and orientation ↳ Manually control drone motion and orientation 	
	<ul style="list-style-type: none"> ↳ Manually trigger 3D image acquisition 			
	<ul style="list-style-type: none"> ↳ Is the object of study ↳ Scan ↳ Visualize, analyze and manually control the mission execution 	<ul style="list-style-type: none"> premier 5 0 3 0 11 	<ul style="list-style-type: none"> ↳ Acquire 3D image ↳ Acquire 3D image direct 	
	<ul style="list-style-type: none"> ↳ Manually trigger HD image acquisition 			
	<ul style="list-style-type: none"> ↳ Capture still images ↳ Is the object of study ↳ Visualize, analyze and manually control the mission execution 	<ul style="list-style-type: none"> 0 5 premier 5 0 11 	<ul style="list-style-type: none"> ↳ Acquire HD image ↳ Acquire HD image direct 	
	<ul style="list-style-type: none"> ↳ Manually trigger HD video acquisition 			
	<ul style="list-style-type: none"> ↳ Acquire video 			<ul style="list-style-type: none"> ↳ Acquire HD video

MY RECAP



THEORY

STEP 0

DEFINITION

Identify the **requested** elements

STEP 1



PRACTICE

B Verify that no **realization link** has been forgotten in the model

STEP 2

Deduce the **developed** elements



STEP 3

Evaluate the **testability**

4. THE PLANNED PROCESS : PRACTICE

0.B. ANALYSE THE MODEL

The screenshot shows the Capella software interface. On the left, the Project Explorer displays a tree structure of system components, including PythagoreUAS, REC Catalog, Operational Analysis, System Analysis, System Functions, and Capabilities. Under Capabilities, there are several functional chains: CROSS-SEGMENT CAPABILITIES (Fly, Archive data, Sprinkle substance, Analyze data, Visualize data, Acquire data, Plan mission), VARIABILITY ON DATA EXPLOITATION, VARIABILITY ON AUTOMATION (Manually pilot the drone, Automatically follow a flight plan, Manually sprinkle substance, Automatically sprinkle substance), and a segment-specific capability (Manually acquire data). On the right, the Workflow of PythagoreUAS is shown with four main steps: Operational Analysis, System Analysis, Logical Architecture, and Physical. Each step has associated documentation and requirements.

I notice that :

- Most of my functional chains are made up of functional **sub-chains**
- Functions are **in several functional chains**

I have already configured the rules

I want to start with the **SA** (System Analysis,

FC	F	Provenance
Acquire 3D image	Acquire 3D image	0 1 direct
Acquire HD image	Acquire HD image	0 1 direct
Acquire HD video	Acquire HD video	0 2 direct
Acquire HD video of moving element	Acquire HD video of moving element	0 2 direct
Acquire multi-spectral image	Acquire multi-spectral image	0 1 direct
Acquire thermal image	Acquire thermal image	0 1 direct
	Acquire 3D representation	premier 5 direct
	Is the object of study	premier 5 direct
	Capture still images	0 1 direct
	Is the object of study	premier 5 direct
	Acquire video	0 2 direct
	Is the object of study	premier 5 direct
	Acquire video	0 2 direct
	Is a target to follow	premier 1 direct
	Acquire multi-spectral image	0 1 direct
	Is the object of study	premier 5 direct

MY RECAP



THEORY

STEP 0

DEFINITION

RMIVV

RV
= Requested Version

Identify the requested elements

Deduce the developed elements

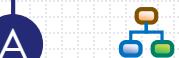
Evaluate the testability

PRACTICE

A Identify the release

B Verify that no realization link has been forgotten in the model

Analyze the model with :
Diagrams + Viatra Analysis Rules



Create and define the RV



Reminder
Layer: SA
Element : FC

4.

THE PLANNED PROCESS : PRACTICE

1.B. CREATE THE RV

My first increment is the **Functional Chain**:
Manually trigger HD video acquisition

Chaine	SousChaine	ChainNiveauSuperieur	Commentaire
Automatically control drone motion and orientation with obstacle avoidance	Compute drone attitude and altitude	Automatically control drone motion and orientation with obstacle avoidance	Lien de realisation manquant entre la SousChain
Automatically control drone motion and orientation with obstacle avoidance	Generate thrust	Automatically control drone motion and orientation with obstacle avoidance	Lien de realisation manquant entre la SousChain
Automatically trigger HD image acquisition	Acquire HD image	Automatically trigger HD image acquisition	Lien de realisation manquant entre la SousChain
Automatically trigger HD image acquisition	Acquire HD image	Automatically trigger HD image acquisition	Lien de realisation manquant entre la SousChain
Automatically trigger HD video acquisition	Acquire HD video	Automatically trigger HD video acquisition	Lien de realisation manquant entre la SousChain
Automatically trigger HD video acquisition	Acquire HD video	Automatically trigger HD video acquisition	Lien de realisation manquant entre la SousChain
Display 3D image in live	Acquire 3D image	Display 3D image in live	Lien de realisation manquant entre la SousChain
Display 3D image in live	Acquire 3D image	Display 3D image in live	Lien de realisation manquant entre la SousChain
Display acquired HD image in live	Acquire HD image	Display acquired HD image in live	Lien de realisation manquant entre la SousChain
Display acquired HD image in live	Acquire HD image	Display acquired HD image in live	Lien de realisation manquant entre la SousChain
Display acquired HD video in live	Acquire HD video	Display acquired HD video in live	Lien de realisation manquant entre la SousChain

MY RECAP



THEORY

STEP 0

DEFINITION

RMIVV

RV

=
Requested
Version

STEP 1

Identify the
requested
elements

A Identify the
release



PRACTICE

B Verify that no **realization link** has
been forgotten in the model



STEP 2

Deduce the
developed
elements

DV

=
Requested
Version

A Generate the
DV THEORIC



Reminder
Layer: LA & PA
Element : PC, PF, LC, LF

STEP 3

Evaluate the
testability

Reminder
Layer: SA
Element : FC



4.

THE PLANNED PROCESS : PRACTICE

2.A.

GENERATE THE DV THEORIC

JaysWorkspace - RV1 - Capella

File Navigate Search Project Run Window Help

*Project Explorer *PythagoreUAS *RV1

(Requested Version) RV1

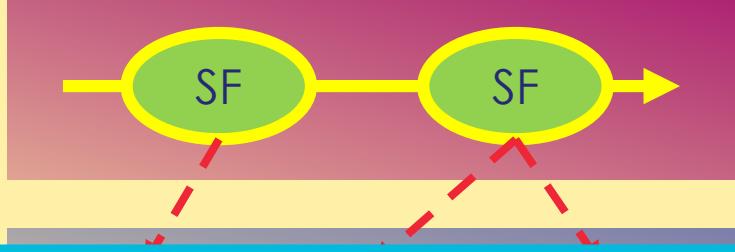
Elements

To add an element to this version, drag it from the MelodyExplorer over the table below

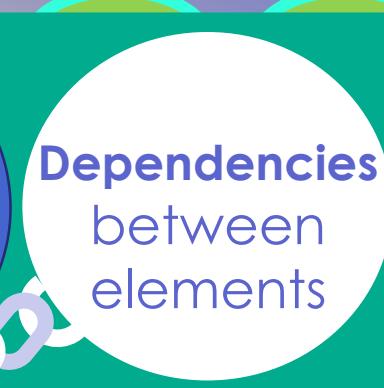
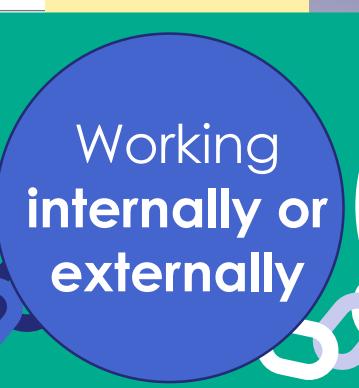
Element	Correction	Evolution	Identification	Maturity
Manually trigger HD				

How it works

RV



I have a problem 😞.
I can't test these functions at the same time.



MY RECAP



THEORY

STEP 0

DEFINITION

RMIVV

RV

=
Requested
Version

STEP 1

Identify the
requested
elements

STEP 2

Deduce the
developed
elements

STEP 3

Evaluate the
testability

PRACTICE

A Identify the
release



B Verify that no **realization link** has
been forgotten in the model



Analyze the model with :
Diagrams + Viatra Analysis Rules



Create and
define the **RV**



Reminder
Layer: SA
Element : FC

A Generate the
DV THEORIC



Reminder
Layer: LA & PA
Element : PC, PF, LC, LF

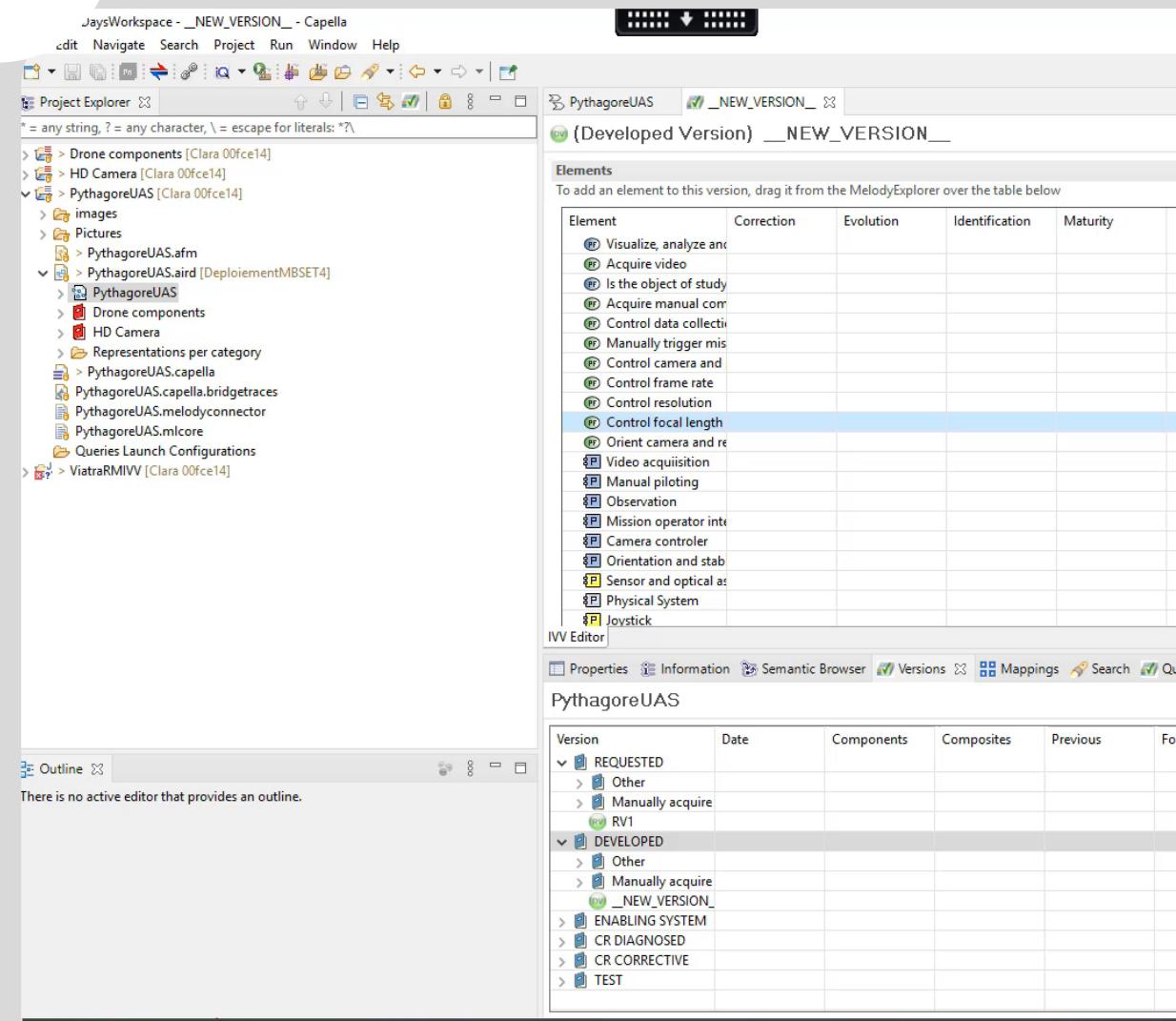
B Divide the
DV REEL



Reason:
Company
constraints

4. THE PLANNED PROCESS : PRACTICE

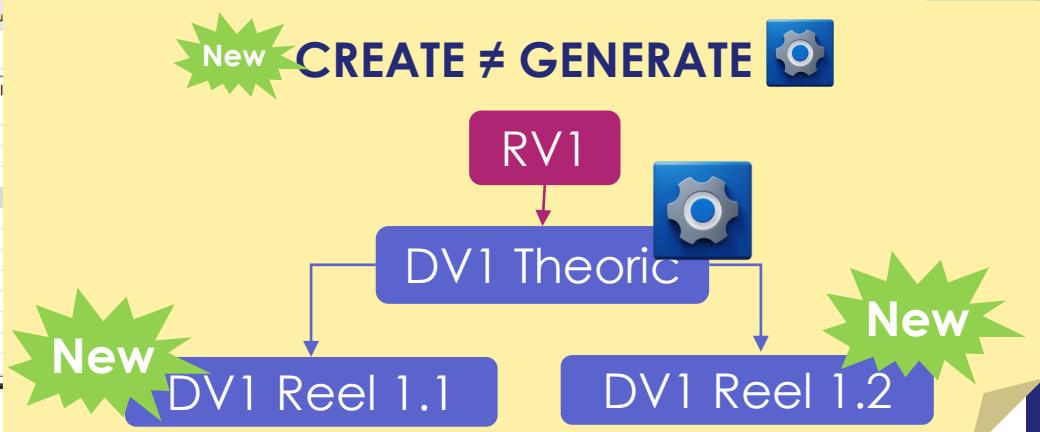
2.B. DIVIDE THE DV REEL



I need to analyze the elements in the Developed Version (DV) with :

- Mass Visualization View
- Semantic Browser
- Diagrams

I will **create** my first Developed Version (DV) Reel (my first reel increment)



4. THE PLANNED PROCESS : PRACTICE

2.B. DIVIDE THE DV REEL

The screenshot shows the Capella tool interface. The Project Explorer on the left lists various project components and files. The central area displays the 'Elements' table with columns for Element, Correction, Evolution, Identification, and Maturity. The bottom section shows the 'Versions' table, which lists different version states: REQUESTED, DEVELOPED, MANUALLY ACQUIRED, ENABLING SYSTEM, CR DIAGNOSED, and CR CORRECTIVE. A specific row for '_NEW_VERSION' is highlighted in blue.

Element	Correction	Evolution	Identification	Maturity
[P] Visualize, analyze and...				
[P] Acquire video				
[P] Is the object of study				
[P] Acquire manual com...				
[P] Control data collecti...				
[P] Manually trigger mis...				
[P] Control camera and...				
[P] Control frame rate				
[P] Control resolution				
[P] Control focal length				
[P] Orient camera and re...				
[P] Video acquisition				
[P] Manual piloting				
[P] Observation				
[P] Mission operator inte...				
[P] Camera controller				
[P] Orientation and stab...				
[P] Sensor and optical as...				
[P] Physical System				
[P] Joystick				
[P] Drone				
[P] Microcontroller				
[P] Tablet				
[P] Internal board				
[P] 2-axis gimbal				

Version	Date	Components	Composites	Previous	Following	Needs Predece...	Realised Versio...	Raised on	CR(s) Raised	Summary	Description
> REQUESTED											
< DEVELOPED											
> Other											
> Manually acquire											
> _NEW_VERSION											
> [Developed Versio...											
> ENABLING SYSTEM											
> CR DIAGNOSED											
> CR CORRECTIVE											

For better **organization**, I need to rename my versions. It is also possible to group them

4. THE PLANNED PROCESS : PRACTICE

2.B. DIVIDE THE DV REEL

The screenshot shows the PythagoreUAS software interface. The Project Explorer on the left lists various components and files, including Drone components, HD Camera, and PythagoreUAS. The main area displays the 'Elements' table under the 'DV1 Theoric' tab. The table has columns for Element, Correction, Evolution, Identification, and Maturity. Numerous items are listed, such as 'Visualize, analyze and', 'Acquire video', 'Is the object of study', etc. Below the table is the 'IV Editor' section with tabs for Properties, Inform, Semant, Mappings, Search, Query E..., Query R..., and Mass Vis... The 'DV1 Theoric' tab is selected. The 'Versions' tab at the bottom shows a table with columns for Version, Date, Components, Composites, Previous, Following, and Needs Pre. A large blue callout box on the right contains the text: 'After analysis, I have to divide my developed version DV1 into 3 parts: DV1 Reel 1.1, DV1 Reel 1.2, DV1 Reel 1.3.' Another blue callout box at the bottom right contains the text: 'Versions can be linked temporally. You can also enter the maturity of an element as a function of its version.'

MY RECAP



THEORY

STEP 0

DEFINITION

RMIVV

RV

=
Requested
Version

STEP 1

Identify the
requested
elements

STEP 2

Deduce the
developed
elements

STEP 3

Evaluate the
testability

ES

=
Enabling
System

PRACTICE

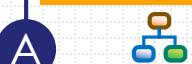
A Identify the
release



B Verify that no **realization link** has
been forgotten in the model



Analyze the model with :
Diagrams + Viatra Analysis Rules



Create and
define the **RV**



Reminder
Layer: SA
Element : FC

A Generate the
DV THEORIC



Reminder
Layer: LA & PA
Element : PC, PF, LC, LF

B Divide the
DV REEL



Reason:
Company
constraints

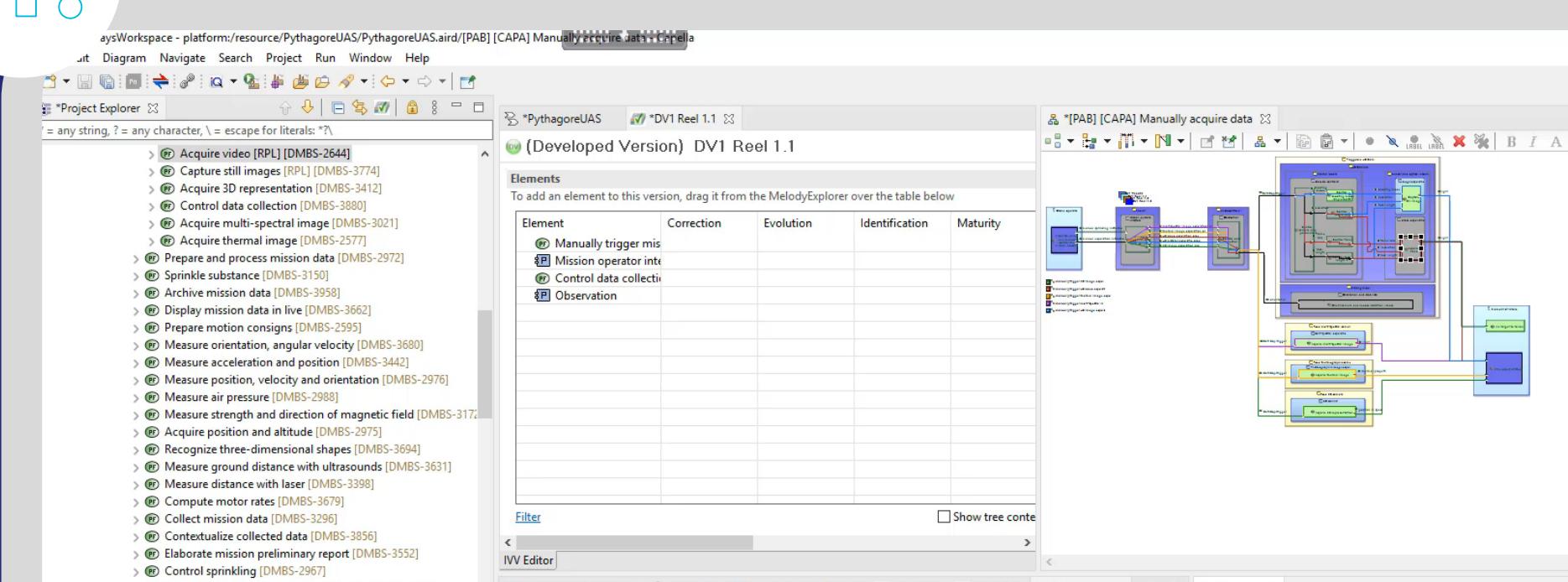
A Generate the
ES



Reminder:
need to simulate, plug
or already developed
to test this increment

4. THE PLANNED PROCESS : PRACTICE

3.A. GENERATE THE
ES



I need to generate an Enabling System (ES) per DV Reel. In the ES, we'll find the elements which have **links with the elements in the DV Reel**, and we'll **need to simulate, plug or already developed** to test this increment.



MY RECAP



THEORY

STEP 0

DEFINITION

RMIVV

RV

=
Requested
Version

Identify the
requested
elements

Deduce the
developed
elements

Evaluate the
testability

ES

=
Enabling
System

PRACTICE

A Identify the **release**

B Verify that no **realization link** has been forgotten in the model

Analyze the model with :
Diagrams + Viatra Analysis Rules

A



Create and define the **RV**

Reminder
Layer: SA
Element : FC

Generate the **DV THEORIC**

Reminder
Layer: LA & PA
Element : PC, PF, LC, LF

Divide the **DV REEL**

Reason:
Company constraints

C **Modify DV Reel** (if it's necessary)

Reason:
Project constraints

A Generate the **ES**

Reminder:
need to simulate, plug or already developed to test this increment

B Analyze the model with **tools**

Tolls:
Mass Visualization View,
Diagrams,
Semantic Browser, ...

5. CONCLUSION

Feedback from an IVV manager who tested the RMIVV add-on along with his process

Task Simplification:

- Information extracted from the model (time-saving)

Visualization:

- Diagram colorization (better visibility)
- Visual management, and temporal aspect

Definition and Sharing:

- Interest in co-engineering
- V-cycle integration

Export:

- Useful for data import into other tools