IEEE ISSE 2025
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Open Source MBSE at Scale

From Industry-Proven Tools to Web-Native SysML v2

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cedric.brun@obeosoft.com

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CEA - R&D Engineer
Asma.SMAOUI@cea.fr

CEA List | LAB FOR INTEGRATION OF SYSTEMS & TECHNOLOGIES

FROM RESEARCH TO INDUSTRY

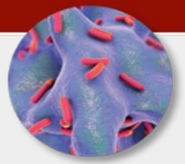
cea

1 Defence & national security

2 France's energy independence

3 Economic competitiveness of French industry

DRF
Fundamental research



DAM
Defence & Security

DEN
Nuclear & renewable energies

cea tech
Technological research for industry

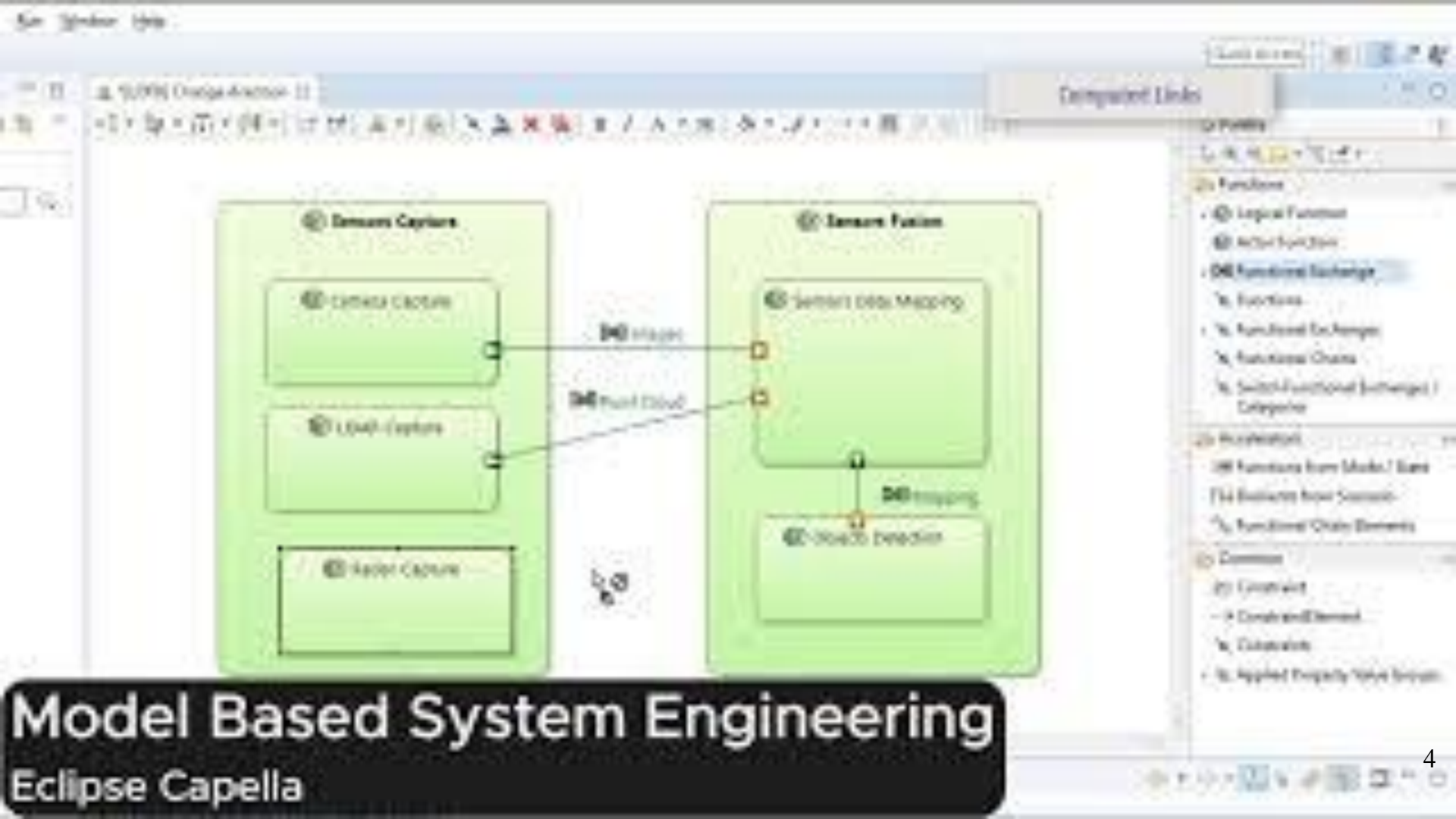
leti
Micro & nano-technologies

liten
New energy technologies

list
Smart digital systems

Obeo | Visual Tools for Designing Innovations

Energy | Transportation | Space & Defense
Manufacturing | Healthcare | Financial | Government


Sensors Capture
Camera Capture
Lidar Capture
Radar Capture
Sensors Fusion
Sensors Data Mapping
Mapping
Object Detection
Image
Point Cloud
Mapping
Model Based System Engineering
Eclipse Capella

the New Deal

SysML v2

Behavior

- Function-based
- State-based
- Sequence-based
- Use cases

Structure

- Decomposition
- Interconnection
- Classification

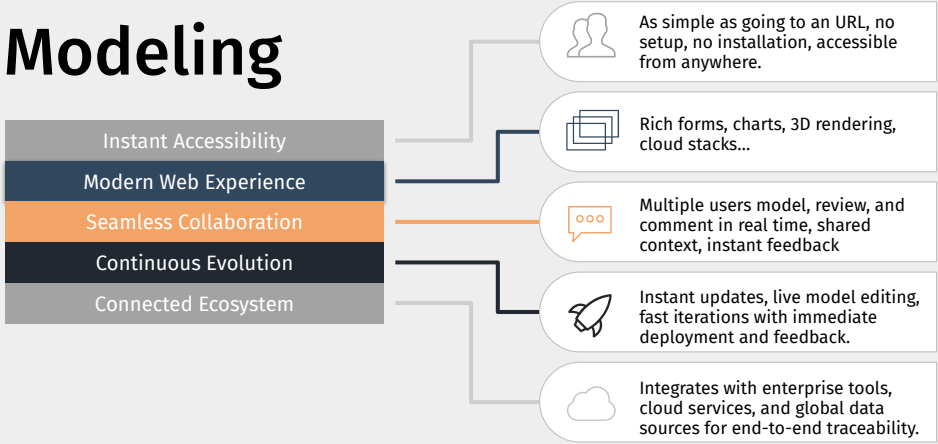
Analysis

- Analysis cases
- Expression language

Verification

- Verification cases

Web Based Modeling



Three promises :

Full interoperability (v2 & API)
Effortless adoption
Long-term sustainability

Adaptable Platform to build Domain Specific Tools

Eclipse Papyrus

UML based modeling
Simulation, code generation, analysis ...

cea

Eclipse Capella

Systems & Architecture engineering, definition, early validation

THALES

Interroperability

API, Import/Export
Transformation...

Representations

Define the graphical editors, forms, tables

Packaging

Deployment, installations and dependencies

Data Management

Schema, Concurrent access, Validation

System Engineering
Robotics
Safety
Simulation
Big Data
Business Process
Automotive
MicroControllers
Ontology
IOT
Cloud Computing
Software Development
Embedded
DevOps
Business Analysis
HealthCare
Risk Analysis
CyberSecurity
Enterprise Architecture
...

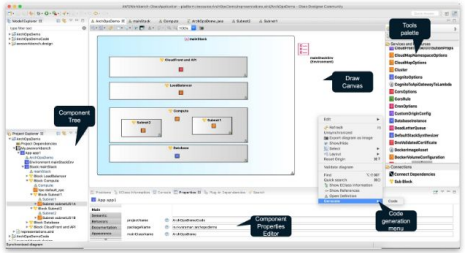
AWS Workbench

By RKVS Raman CLOUD COMPUTING SOFTWARE DEVELOPMENT DEVOPS

AWS Workbench is an ArchOps environment for designing and deploying AWS Infrastructure. It provides a "What You See Is What Is Deployed" (WYSIWID) view of infrastructure that improves cloud architecture design and deployment process.

Related links

- GitHub



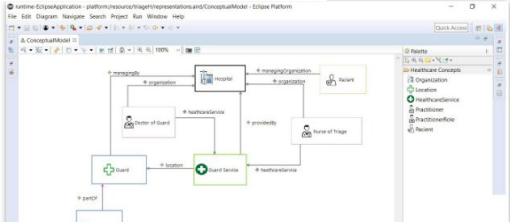
FHIR Designer

By Maria Cecilia Ariste HEALTHCARE

FHIR Designer is based on the open-source healthcare standard FHIR of HL7. It allows to design conceptual models of healthcare systems based on an international open source standard that defines resources of information for interoperatibily between heathcare systems.

Related links

- HL7 FHIR



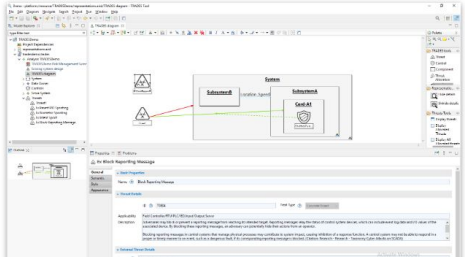
TRADES Tool

By Israel Aerospace Industries / ELTA Cyber Division RISK ANALYSIS CYBERSECURITY

A threat and risk assessment (TRA) tool for the design of engineered systems. TRADES Tool is an open-source design tool, implementing a risk-based, cybersecurity assessment methodology. The underlying model-based approach promotes establishing and maintaining the system's cybersecurity posture throughout the system life cycle.

Related links

- GitHub project



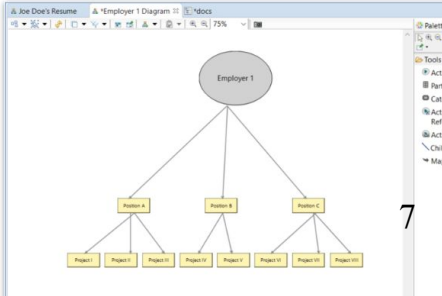
Nasdanika Vinci

By Nasdanika LLC SOFTWARE DEVELOPMENT

A Sirius-based tool for modeling and generation of web sites using diagram and tree representations.

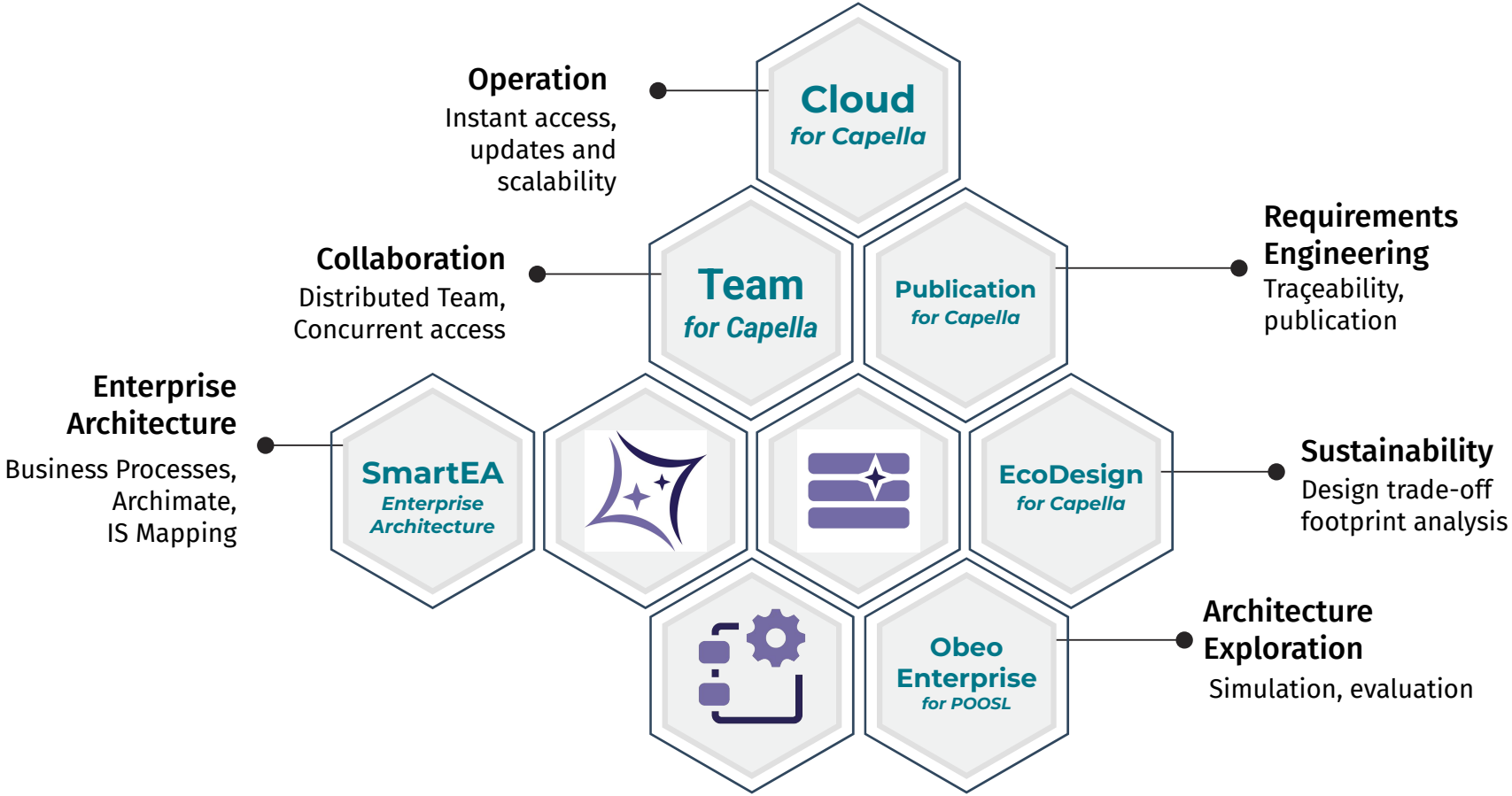
Related links

- Home page
- Get Started Guide
- Site created in Get Started guide

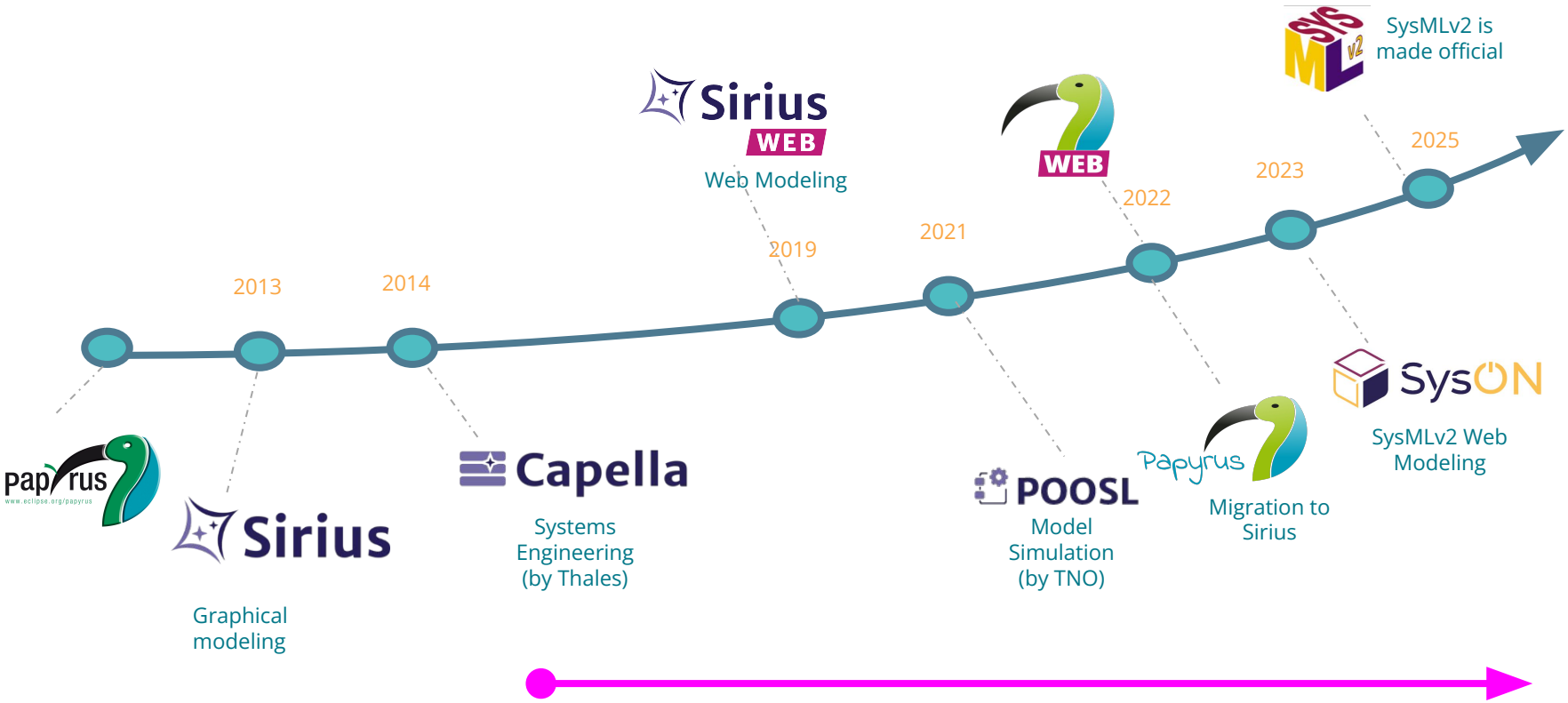


1000+ organizations are using Eclipse Capella worlwide

Enabling an EcoSystem of Capabilities



Ecosystem Development Takes Time



Eclipse Papyrus | Eclipse Papyrus

Complies with OMG standards

Code Generation

3rd generation languages
documentation
Json/Excel

Requirements

Modeling
Analysis

SW/HW Design

Structure
Behaviour

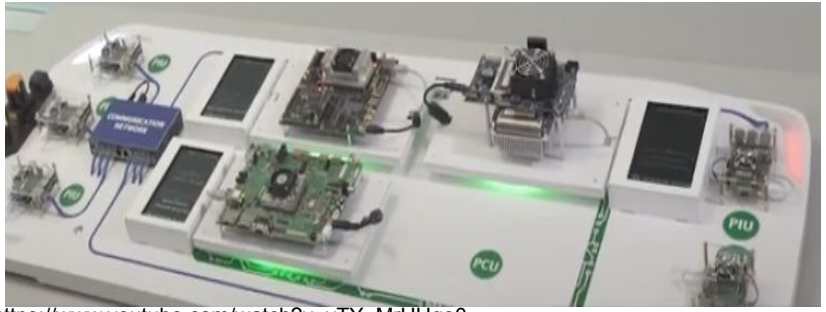
DSLs based on Papyrus

FACE

FUTURE ARCHITECTURE FOR AUTOMOTIVE COMPUTING ENVIRONMENT

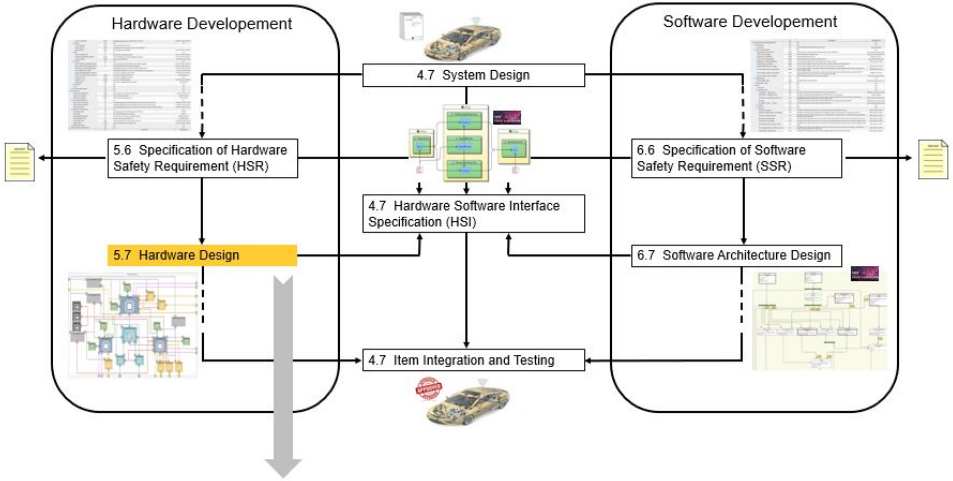
Need for a new **modular** and **centralized EE** architecture

- replace multiple **Hw** components by **Sw** components
- Enhance **safety**, **security** of EE



https://www.youtube.com/watch?v=yTY_MrHHqo0

- Requirement engineering
- ISO26262-related engineering
- Hardware engineering



runtime-New_configuration(6) - HardwareArchitecture/ImplentationHardwareArchitecture.di - FACE Designer

File Edit Navigate Search Papyrus Project Window Help

Model Explorer

- ProtocolHardwareArchitecture
  - <Package Import> MARTE_PrimitivesTypes
  - <Package Import> MeasurementUnits
  - <Package Import> GRM_BasicTypes
  - <Package Import> MARTE_DataTypes
  - <Package Import> BasicNFP_Types
  - <Package Import> TimeTypesLibrary
  - <Package Import> TimeLibrary
  - <Package Import> RS_Library
  - <Package Import> UML Primitive Types
  - Library
    - Functionnal Component
    - Protocol
    - Physical Component
      - Computing
      - Communication
      - Monitoring
      - Power
      - Memory
      - MISC
      - Connector
      - Control
  - Functional Models
    - Platform
    - PCU
    - PIU
  - Architectural Models
    - <p><span lang="EN-GB" style="line-height:
    - Platform
    - PCU
      - «HwComponent» Architectural PCU
      - «HwComponent» PCU Compute Board
      - «HwComponent» PCU Switch Board
      - «HwComponent» CSS Board
      - «HwComponent» CSSIF Board
    - PIU
      - «HwComponent» Architectural PIU
      - «HwComponent» PIU Compute Board
      - «HwComponent» PIU SDE Board
      - «Satisfy» <Abstraction> Satisfy7
      - «Satisfy» <Abstraction> Satisfy8
  - Real Component Models
- «ModelLibrary» EcorePrimitiveTypes

Outline

FACE_RequirementsModel.di | ImplentationHardwareArchitecture.di | HwNetworkLayer.css | HwPowerLayer.css

: PIU Power Supply P3 Domain
: PIU Power Supply P4 Do...
: TI TMP175
: Current Se...
: Micron MT...
: Cypress C...
: NXP S32K1105Q
: Renesas RH850/F1H Pr...
: Cypress C...
: PIU Power Supp...
: PIU Power Supply P...
: NXP TJA 1...
: TI TCAN10...
: TI TXB01...

Welcome | PIU Compute IP | Functionnal PIU | Architectural PIU Compute Board

Properties | Model Validation | Documentation | References

Layer Operator Top Layer

Layers | Advanced

Name: Top Layer

Description:

LayersExplorer

Diagram: PIU Compute IP

Container: org.eclipse.papyrus.infra.core.sasheditor.internal.SashWindowsContainer@3d3186e0

- Layer Operator Top Layer
  - Layer Power
  - Layer Network

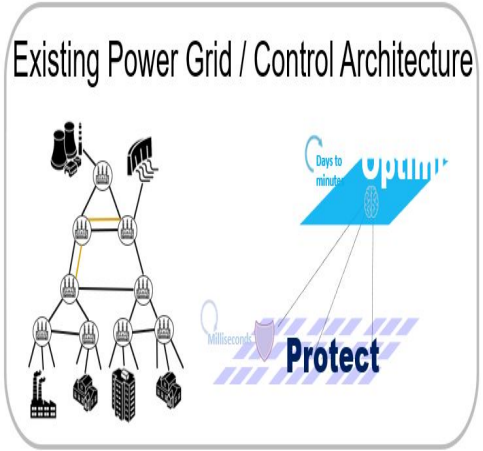
Palette

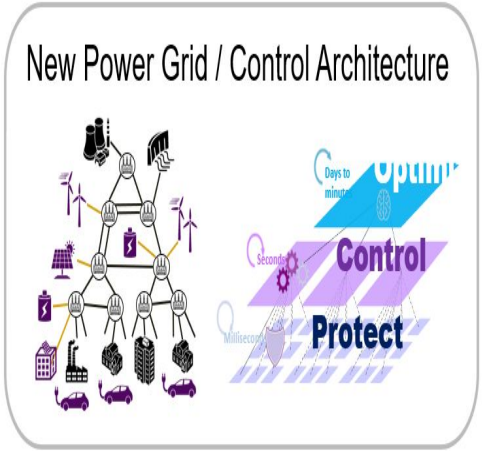
- Annotation
  - Comment
  - Constraint
  - Link
- Communication
- Computing
  - ASIC
  - BranchPredictor
  - ComputingResource
  - ISA
  - PLD
  - Processor
- Device
- Driver
- General
- Storage
  - Cache
  - Drive
  - DMA
  - Memory
  - MMU
  - RAM
  - ROM
  - StorageManager
- Timing
  - Clock
  - Timer
  - TimingResource

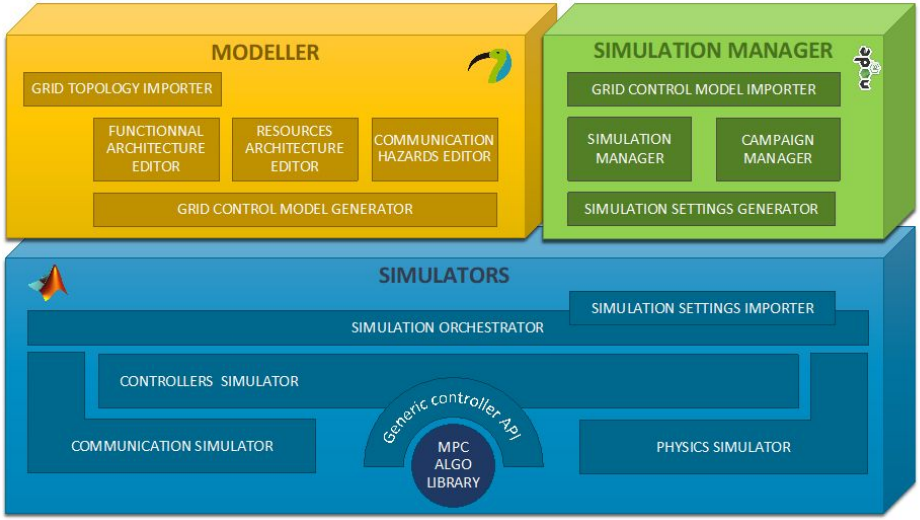
Hardware Design Engineering

NACRE

New Control Architecture for Power Grid







workspace-nacre - Multizone_5/Multizone_5.di - NACRE

File Edit Navigate Search Papyrus Project Run Window Help

Project Explorer | Model Explorer

- <Model> Multizone_5
  - <Package Import> MARTE_PrimitivesTypes
  - <Package Import> MeasurementUnits
  - <Package Import> GRM_BasicTypes
  - <Package Import> MARTE_DataTypes
  - <Package Import> BasicNFP_Types
  - <Package Import> TimeTypesLibrary
  - <Package Import> TimeLibrary
  - <Package Import> RS_Library
  - <Package Import> UML Primitive Types
  - <<CFA>> <Package> CFA
  - <<CRAS>> <Package> CRAS
    - <<CRA>> <Package> CRA1
    - <<CRA>> <Package> CRA2
      - <<CommunicationMedias>> <Packa
      - <<ComputingResources>> <Package
      - <<SoftwareResources>> <Package>
  - <<CFRAS>> <Package> CFRAS
    - <<CFRA>> <Package> CFRA1
    - <<CFRA>> <Package> CFRA2
- <<ModelLibrary>> <Package> MARTE_Library
- <<EPackage, ModelLibrary>> <Model> UML F
- <<ModelLibrary>> <Model> Ecore Primitive T

*Multizone_5.di | cea.nacre.design.di | VG_VTV_MLL_BLO_BEA.di | Decentralized_CRPT.di

Internationalization

- [ ] Private storage
- [x] Use internationalization

Language: fr_FR

General

Languages:

Name	Version
UML	2.5.0

Notation Views

filter

View	Context
CFAMainGridDiagram	CFA
CentralizedCRADiagram	CRA1
CFRADiagram	CFRA1
DecentralizedCRADiagram	CRA2

Create View

Welcome | CFAMainGridDiagram | CentralizedCRADiagram | DecentralizedCRADiagram | CFRADiagram

Properties | Model Validation | References | Documentation

Description	Element	Path	Type

AAS DSML

CanVAAs – Connected Assets iNteroperability framework Via AAS

Asset Administration Shell

Assets

FESTO

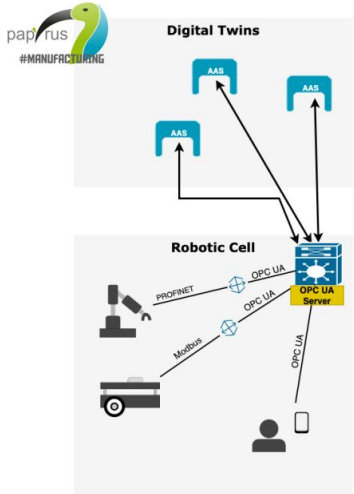
eit Manufacturing

Co-funded by the European Union

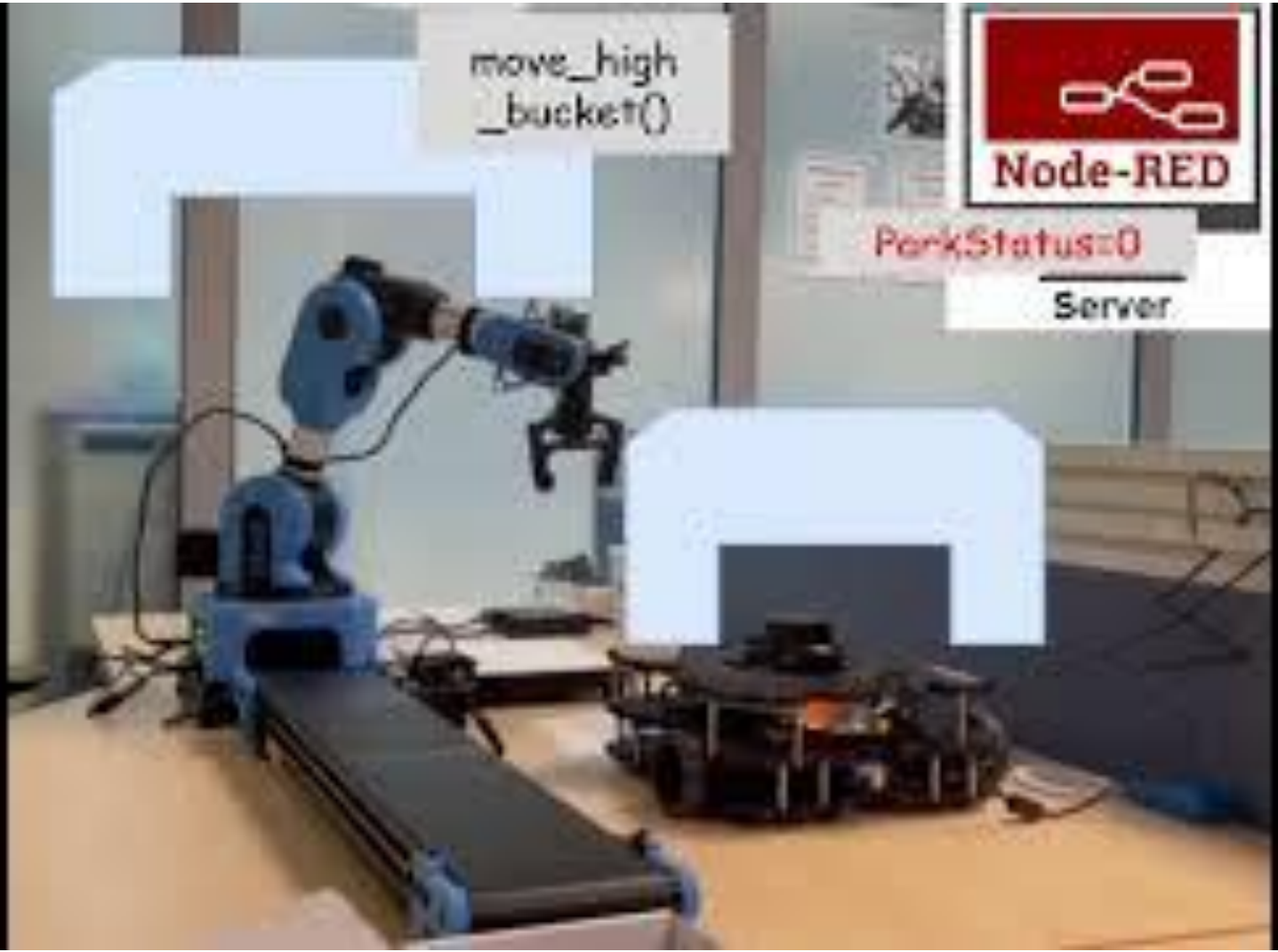
UC: Festo Didactic learning systems for Industry 4.0

- deploy the AAS standard on automatic guided vehicle platform (Industry 4.0 : Robotic domain)

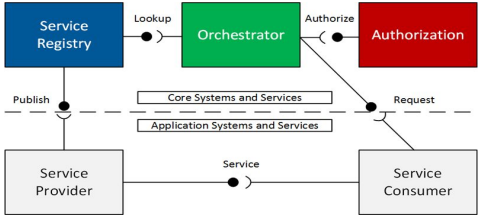
- **A Model Driven Tool providing:**
  - An Asset Administration Shells Modelling Environment
  - Asset Administration Shells automatic deployment to BaSyx
  - Digital Twins connectivity to physical assets using the OPC UA protocol

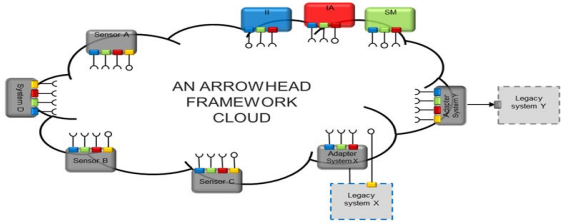


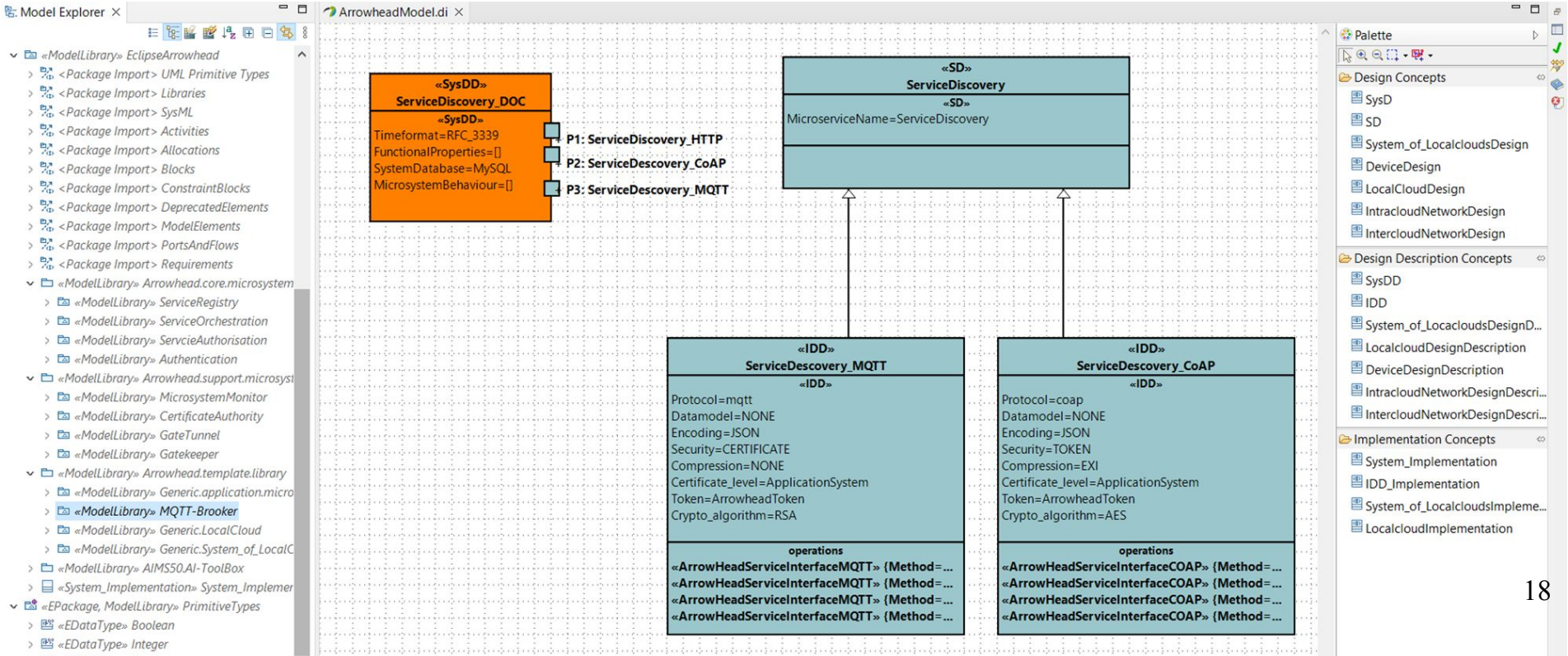
https://www.eclipse.org/papyrus/components/manufacturing/


move_high
_bucket()
Node-RED
PerkStatus=0
Server

SOA DSML


Service Registry
Lookup
Orchestrator
Authorize
Authorization
Publish
Core Systems and Services
Request
Application Systems and Services
Service Provider
Service
Service Consumer

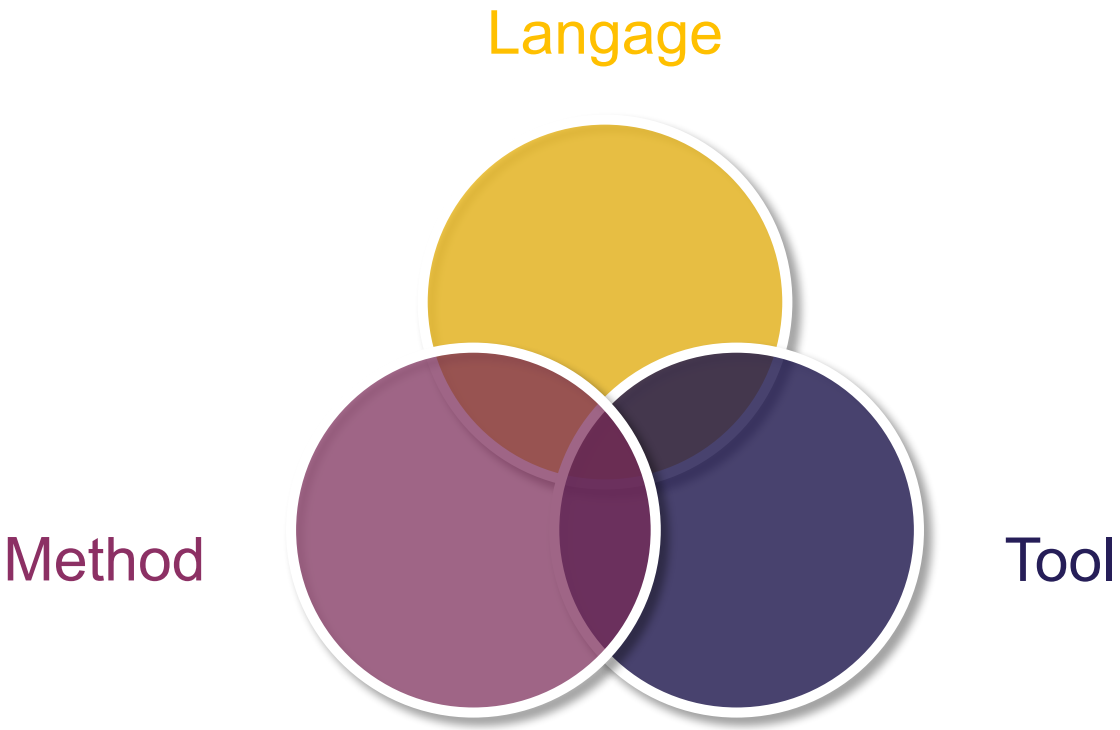

AN ARROWHEAD FRAMEWORK CLOUD
Sensor-A
Sensor-B
Sensor-C
Adapter System-X
Legacy system X
Legacy system Y


Model Explorer
«ModelLibrary» EclipseArrowhead
<Package Import> UML Primitive Types
<Package Import> Libraries
<Package Import> SysML
<Package Import> Activities
<Package Import> Allocations
<Package Import> Blocks
<Package Import> ConstraintBlocks
<Package Import> DeprecatedElements
<Package Import> ModelElements
<Package Import> PortsAndFlows
<Package Import> Requirements
«ModelLibrary» Arrowhead.core.microsystem
«ModelLibrary» ServiceRegistry
«ModelLibrary» ServiceOrchestration
«ModelLibrary» ServcieAuthorisation
«ModelLibrary» Authentication
«ModelLibrary» Arrowhead.support.microsyst
«ModelLibrary» MicrosystemMonitor
«ModelLibrary» CertificateAuthority
«ModelLibrary» GateTunnel
«ModelLibrary» Gatekeeper
«ModelLibrary» Arrowhead.template.library
«ModelLibrary» Generic.application.micro
«ModelLibrary» MQTT-Brooker
«ModelLibrary» Generic.LocalCloud
«ModelLibrary» Generic.System_of_LocalC
«ModelLibrary» AIMS50.AI-ToolBox
«System_Implementation» System_Implemen
«EPackage, ModelLibrary» PrimitiveTypes
«EDataType» Boolean
«EDataType» Integer
ArrowheadModel.di
«SysDD»
ServiceDiscovery_DOC
«SysDD»
Timeformat=RFC_3339
FunctionalProperties=[]
SystemDatabase=MySQL
MicrosystemBehaviour=[]
P1: ServiceDiscovery_HTTP
P2: ServiceDescovery_CoAP
P3: ServiceDescovery_MQTT
«SD»
ServiceDiscovery
«SD»
MicroserviceName=ServiceDiscovery
«IDD»
ServiceDescovery_MQTT
«IDD»
Protocol=mqtt
Datamodel=NONE
Encoding=JSON
Security=CERTIFICATE
Compression=NONE
Certificate_level=ApplicationSystem
Token=ArrowheadToken
Crypto_algorithm=RSA
operations
«ArrowHeadServiceInterfaceMQTT» {Method=...
«ArrowHeadServiceInterfaceMQTT» {Method=...
«ArrowHeadServiceInterfaceMQTT» {Method=...
«ArrowHeadServiceInterfaceMQTT» {Method=...
«IDD»
ServiceDescovery_CoAP
«IDD»
Protocol=coap
Datamodel=NONE
Encoding=JSON
Security=TOKEN
Compression=EXI
Certificate_level=ApplicationSystem
Token=ArrowheadToken
Crypto_algorithm=AES
operations
«ArrowHeadServiceInterfaceCOAP» {Method=...
«ArrowHeadServiceInterfaceCOAP» {Method=...
«ArrowHeadServiceInterfaceCOAP» {Method=...
«ArrowHeadServiceInterfaceCOAP» {Method=...
Palette
Design Concepts
SysD
SD
System_of_LocalcloudsDesign
DeviceDesign
LocalCloudDesign
IntracloudNetworkDesign
IntercloudNetworkDesign
Design Description Concepts
SysDD
IDD
System_of_LocacloudsDesignD...
LocalcloudDesignDescription
DeviceDesignDescription
IntracloudNetworkDesignDescri...
IntercloudNetworkDesignDescri...
Implementation Concepts
System_Implementation
IDD_Implementation
System_of_LocalcloudsImpleme...
LocalcloudImplementation

Key Challenges

- Deploy MBSE Tool in Industries
  - New Language → training cost
  - New Methodology → adopt and adaptation issues
  - New Tooling
    - Installation issue
    - Interoperability
    - UX Experience
    - Libraries for reuse

MBSE | Trio

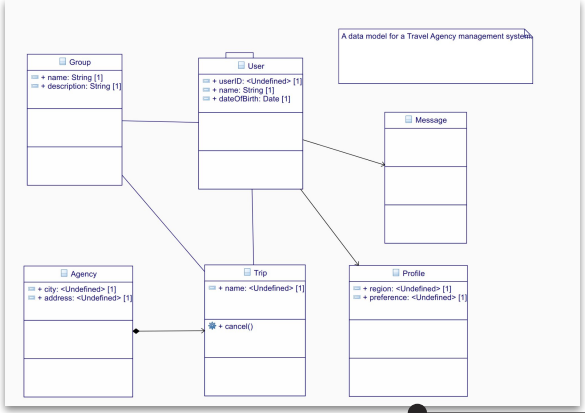


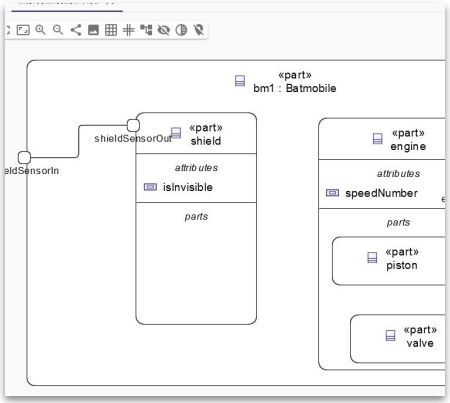
SysMLv2| The SysON project

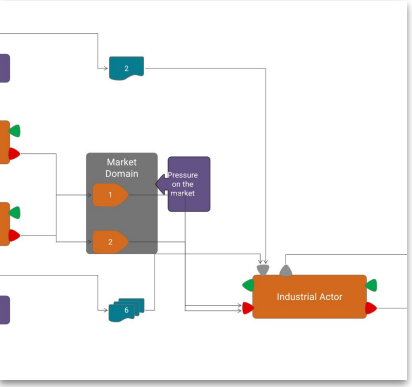
Foundation Project created in december 2023

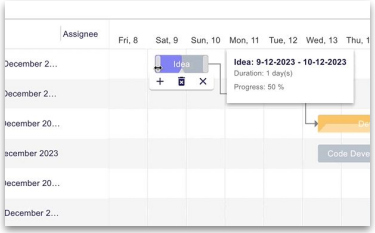
- Web based Tooling
- Graphical Modeling, tables, textual interrop
- Targets full conformance
- Releases every 8 weeks
- Extensible and adaptable : Foundation for building libraries of **domain specific ontologies**

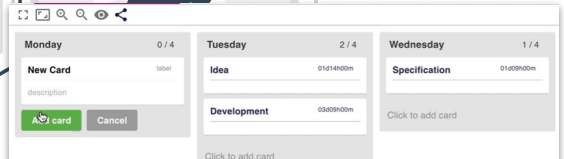
Viewing or authoring a SysML v2 model should be easily available to every Systems Engineers and beyond.

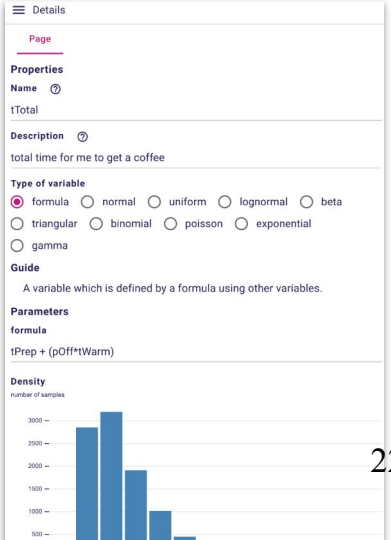

A data model for a Travel Agency management system
Group
+ name: String [1]
+ description: String [1]
User
+ userID: <Undefined> [1]
+ name: String [1]
+ dateOfBirth: Date [1]
Message
Agency
+ city: <Undefined> [1]
+ address: <Undefined> [1]
Trip
+ name: <Undefined> [1]
+ cancel()
Profile
+ region: <Undefined> [1]
+ preference: <Undefined> [1]


«part»
bm1 : Batmobile
shieldSensorOut
«part»
shield
attributes
isInvisible
parts
«part»
engine
attributes
speedNumber
parts
«part»
piston
«part»
valve

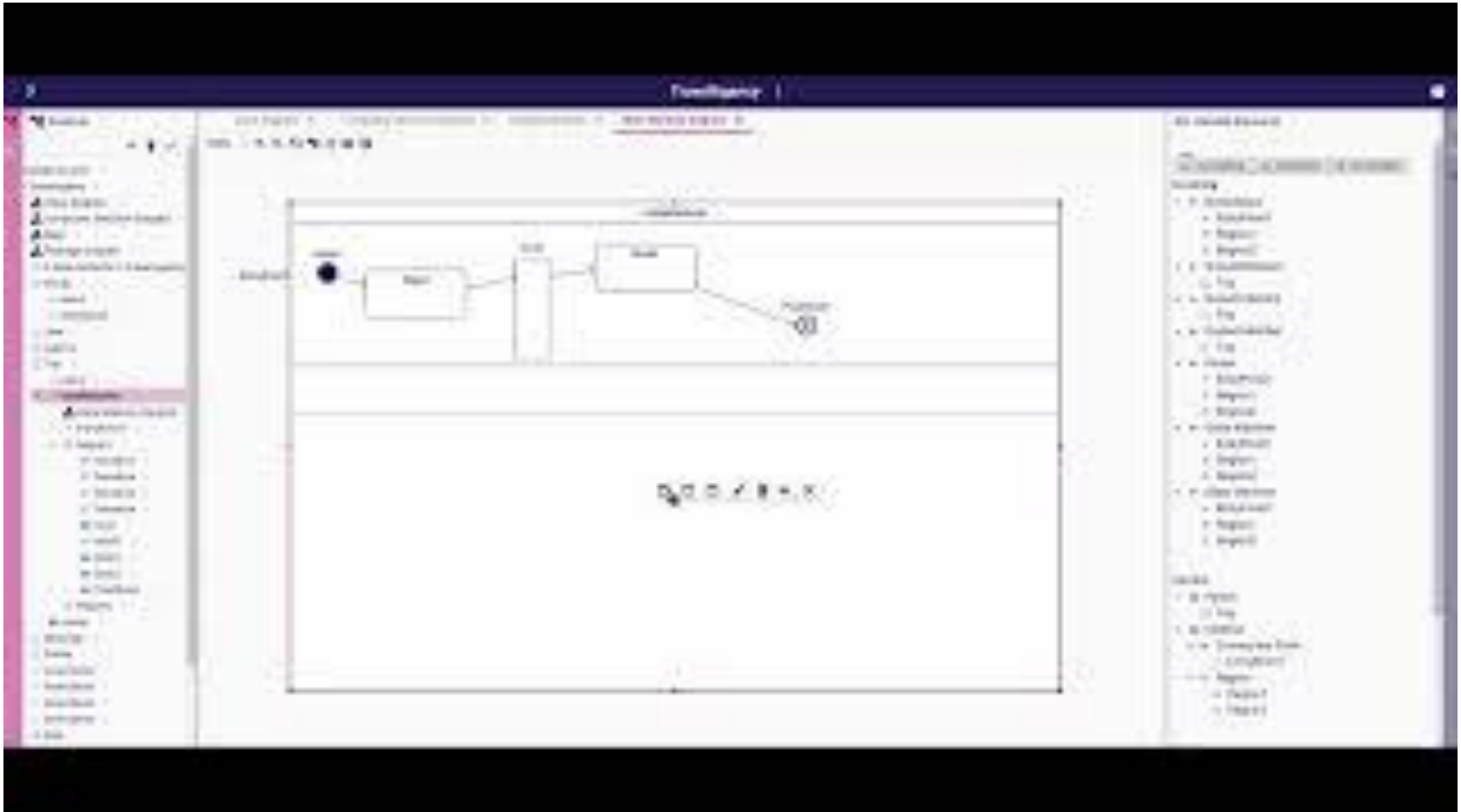

Market Domain
Pressure on the market
Industrial Actor


Assignee
Fri, 8
Sat, 9
Sun, 10
Mon, 11
Tue, 12
Wed, 13
Idea
Idea: 9-12-2023 - 10-12-2023
Duration: 1 day(s)
Progress: 50 %


Monday
0 / 4
New Card
description
Add card
Cancel
Tuesday
2 / 4
Idea
Development
Wednesday
1 / 4
Specification
Click to add card


Details
Page
Properties
Name
tTotal
Description
total time for me to get a coffee
Type of variable
formula
normal
uniform
lognormal
beta
triangular
binomial
poisson
exponential
gamma
Guide
A variable which is defined by a formula using other variables.
Parameters
formula
tPrep + (pOff*tWarm)
Density
number of samples

Web Modeling | Demo



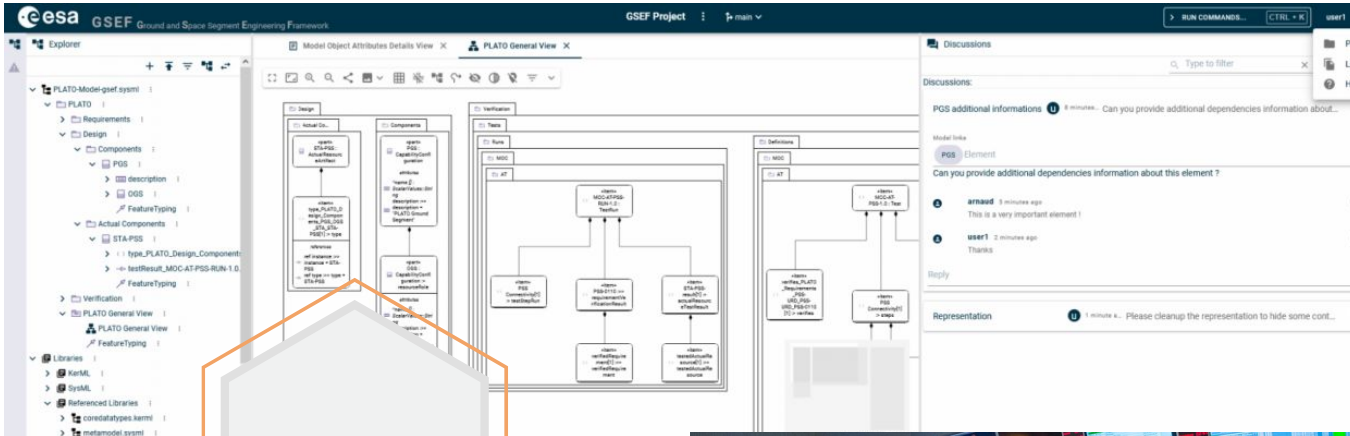
Your Tool

Leverage standards such as UML, SysML v2 or your plain metamodel.

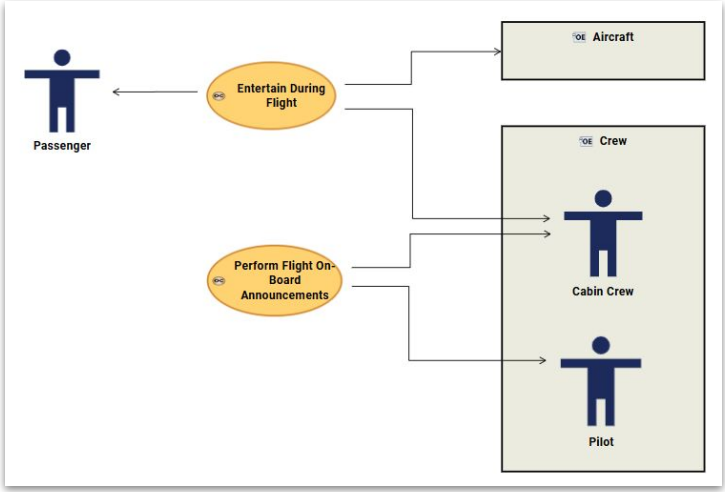
Ground and Space Segment Engineering Framework

Tailored **methodology support for the space domain**

- custom libraries
- editors
- process guidance

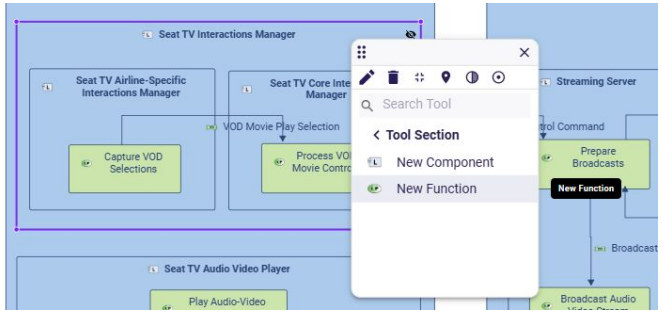


Extending SysON to support a Method : Arcadia experiment



Tailored **Arcadia/Capella support**

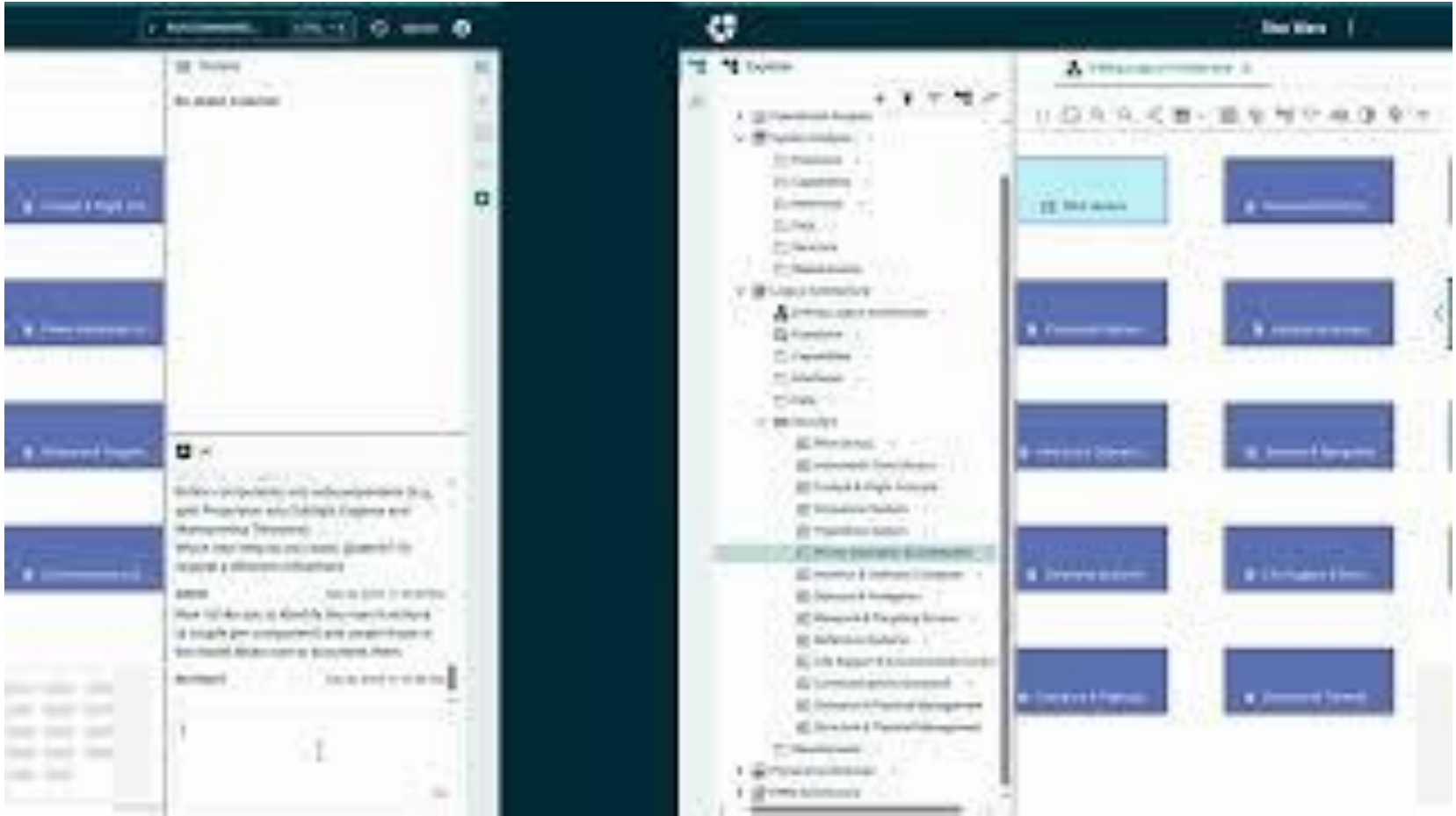
- custom libraries
- editors
- process guidance



SysON

Integration of the **Arcadia** Methodology

Agent Assisted Modeling| Demo



Software reaches its best when shared openly and evolved by collaborative communities.

Timing : **it's now**, SysMLv2 standard and Web technologies are making the vision practicable without a big bang

Platform: we **adapt the tool to the method and language**, not the other way around

Open Innovation leads to **durable solutions built on a rich resilient ecosystem**

https://mbse-syson.org/