ACOSIM

Application of co-simulation to support tests and operations

29 September 2020

Georgia Soulioti
Project Manager
georgia.soulioti@emtech.global

ACOSIM – Application of co-simulation to support tests and operations

Programmatic details

- ESA/ESTEC TRP project:
  - Project reference: AO/1-8777/17/NL/GLC
  - Project duration: 2018 -2020
  - Project budget: 600,000 EUR

- Consortium members:
  - Prime Contractor: EMTech Space P.C.
  - Sub-Contractors:

    Thales Alenia Space Italia S.p.A,

    TWT GmbH Science and Innovation,

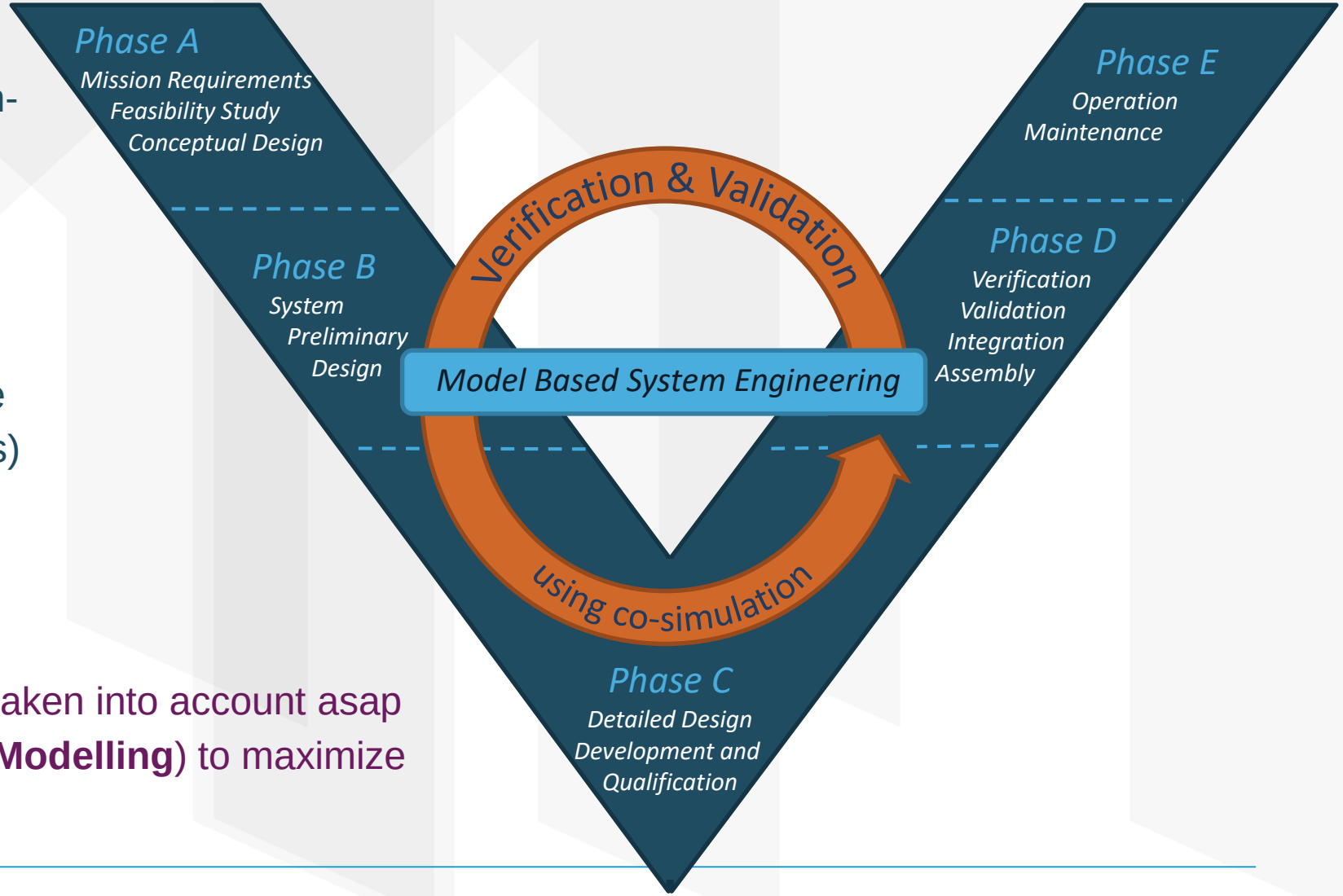
    Aarhus University

TWT GmbH
Science & Innovation

ACOSIM – Application of co-simulation to support tests and operations

High Level Objectives

- **FMI* and Co-Simulation**, as enabling technology for the System-Level simulation
- Improve the current **Verification, Validation and Operations** processes
- Promote **vertical reuse** (within one project between simulation facilities) as well as **horizontal reuse** (reuse from one project to another)

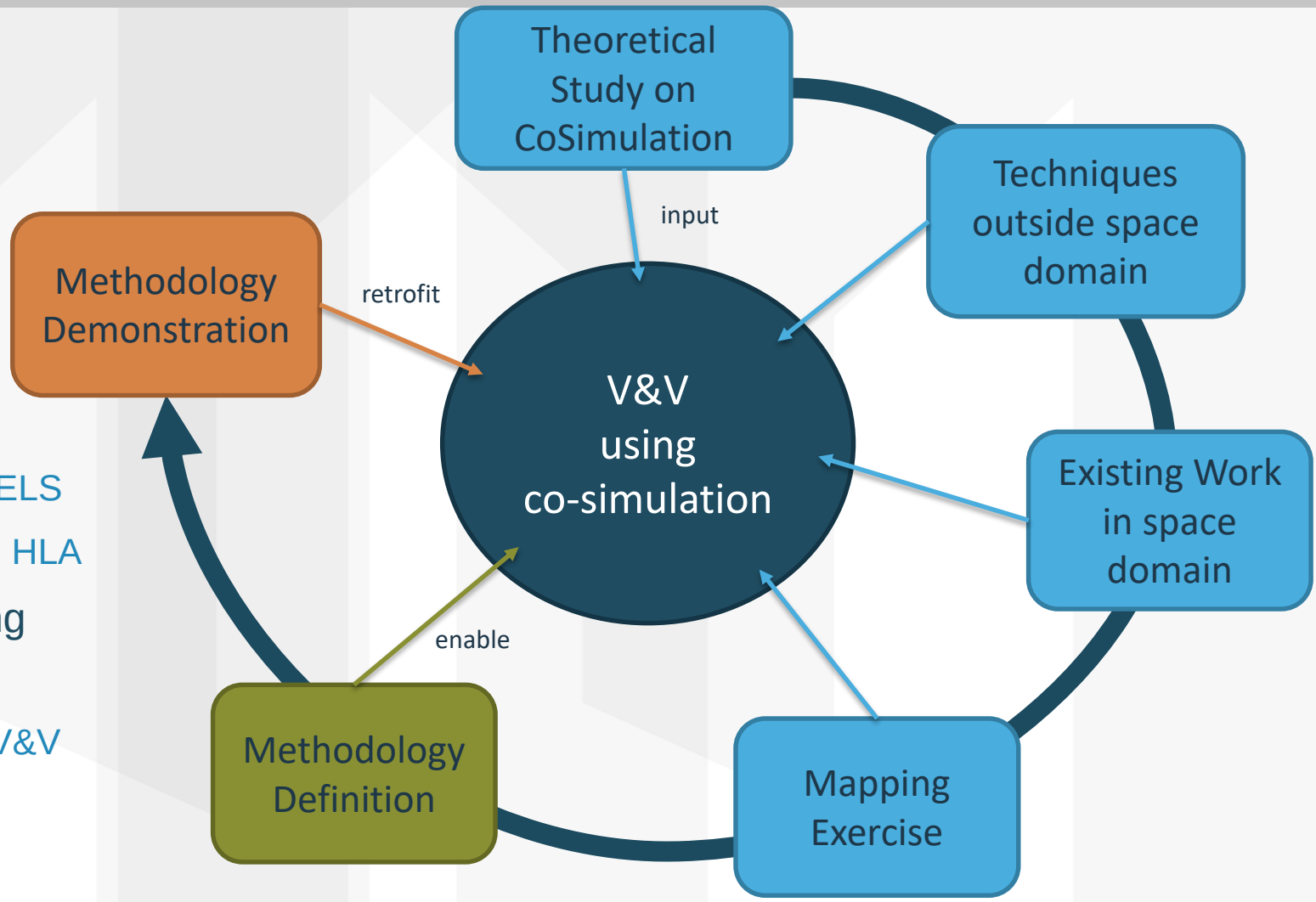


- Co-simulation aspects have to be taken into account asap (during MBSE and **System Level Modelling**) to maximize its benefits

*Functional Mock-up Interface
https://fmi-standard.org/

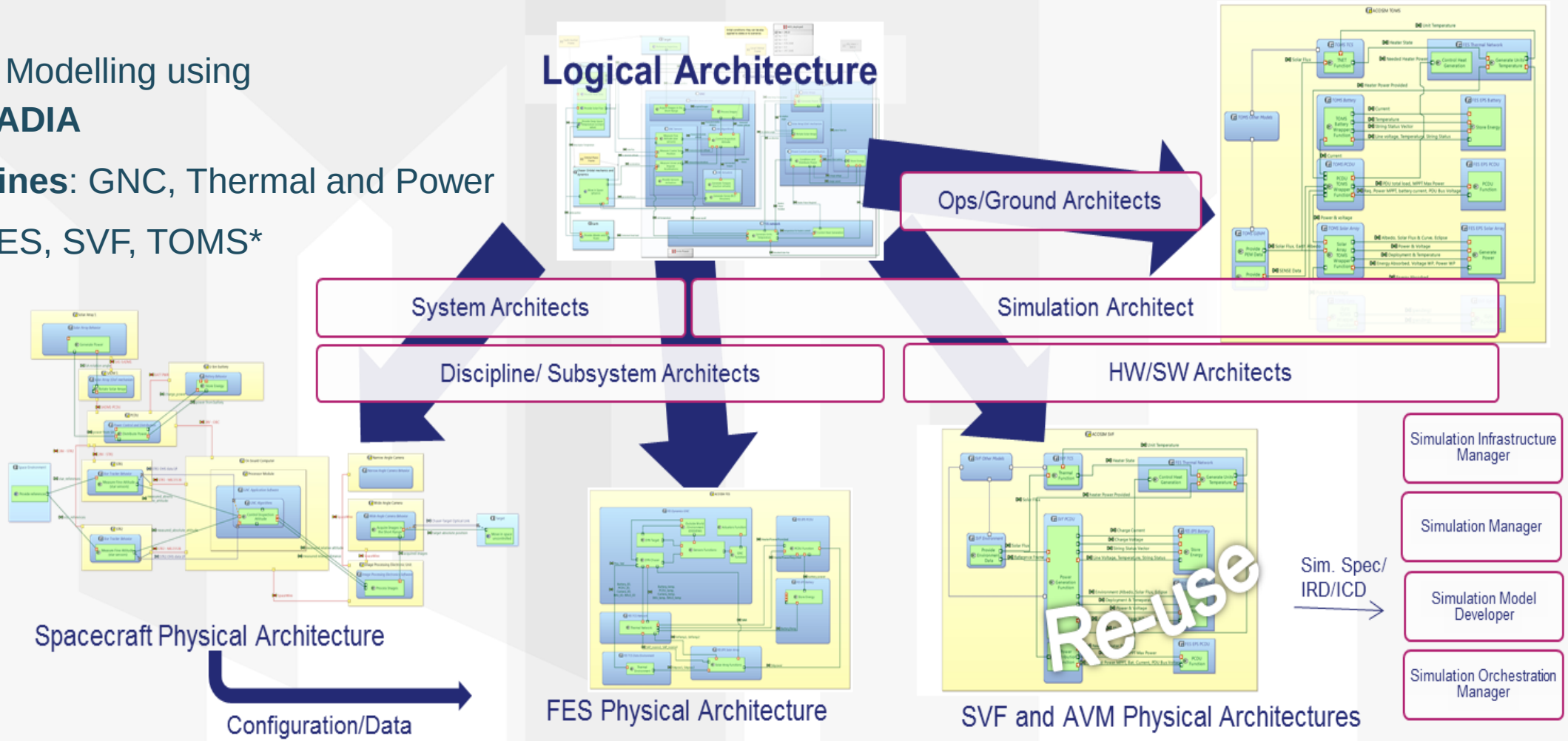
Project approach

- Study Co-Simulation outside the space domain
  - Functional Mockup Interface (FMI)
  - Automotive projects
- Space domain previous work
  - ECSS-ETM-10-21, ECSS-ETM-10-23,
  - VSD, FSS-MBSE, NMM, SVTLC, MARVELS
  - ARCADIA/Capella, SMP2, REFA, SSRA, HLA
- New Methodology definition for V&V using co-simulation
  - Design V&V, Software V&V, Operations V&V
- Methodology Demonstration
  - 3 Proof of Concepts (FES, SVF, TOMS)



MBSE approach

- System Level Modelling using **Capella/ARCADIA**
- Three **disciplines**: GNC, Thermal and Power
- Three **SSF**: FES, SVF, TOMS*



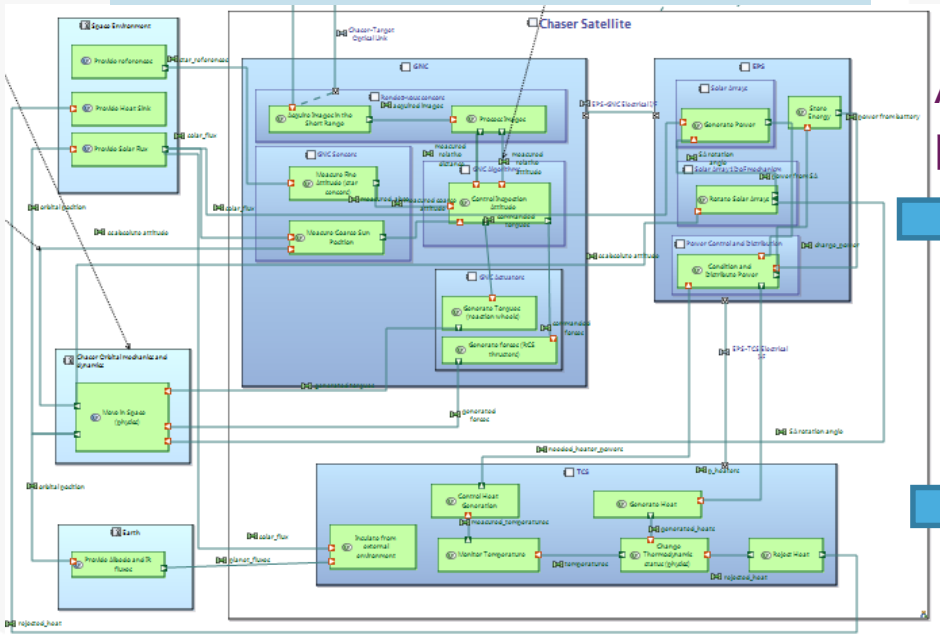
*Functional Engineering Simulator,
Software Validation Facility
Training, Operations and Maintenance Simulators

*Terms definition
ECSS-E-TM-10-21

MBSE approach

- Capella Design Analysis for Co-Simulation and Tracking with SADM (developed in NMM*)
  - Bridge the gap between System Modelling and System Repository
  - Track dependencies/changes → interfaces, models, simulation models, configuration files, test data etc.

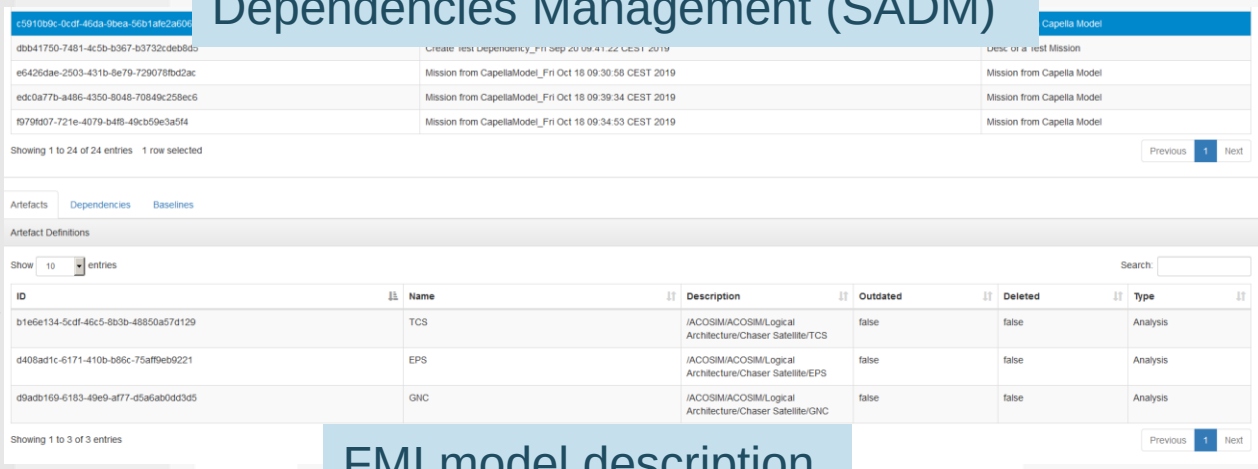
System Level Modelling (Capella)



Automated population

Template generation

Dependencies Management (SADM)



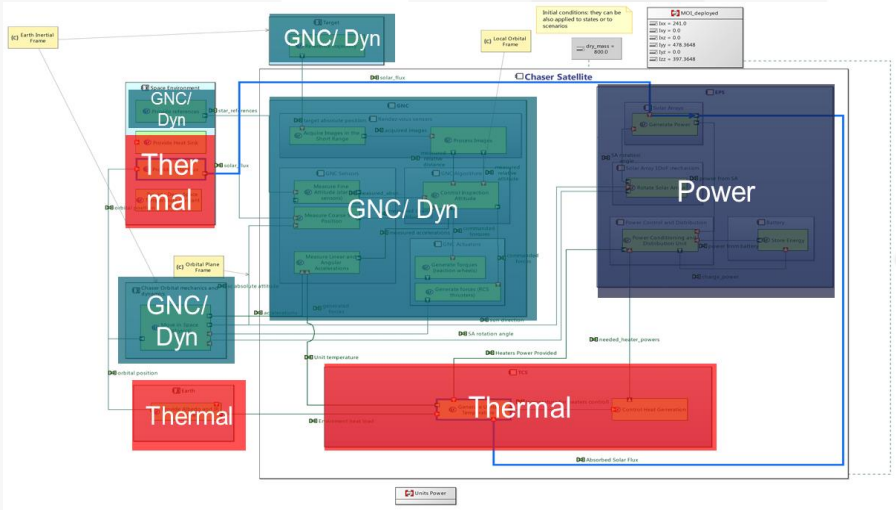
ID	Name	Description	Outdated	Deleted	Type
b1e6e134-5cdf-46c5-8b3b-48850a57d129	TCS	/ACOSIM/ACOSIM/Logical Architecture/Chaser Satellite/TCS	false	false	Analysis
d408ad1c-6171-410b-b86c-75aff9eb9221	EPS	/ACOSIM/ACOSIM/Logical Architecture/Chaser Satellite/EPS	false	false	Analysis
d9adb169-6183-49e9-af77-d5a6ab0dd3d5	GNC	/ACOSIM/ACOSIM/Logical Architecture/Chaser Satellite/GNC	false	false	Analysis

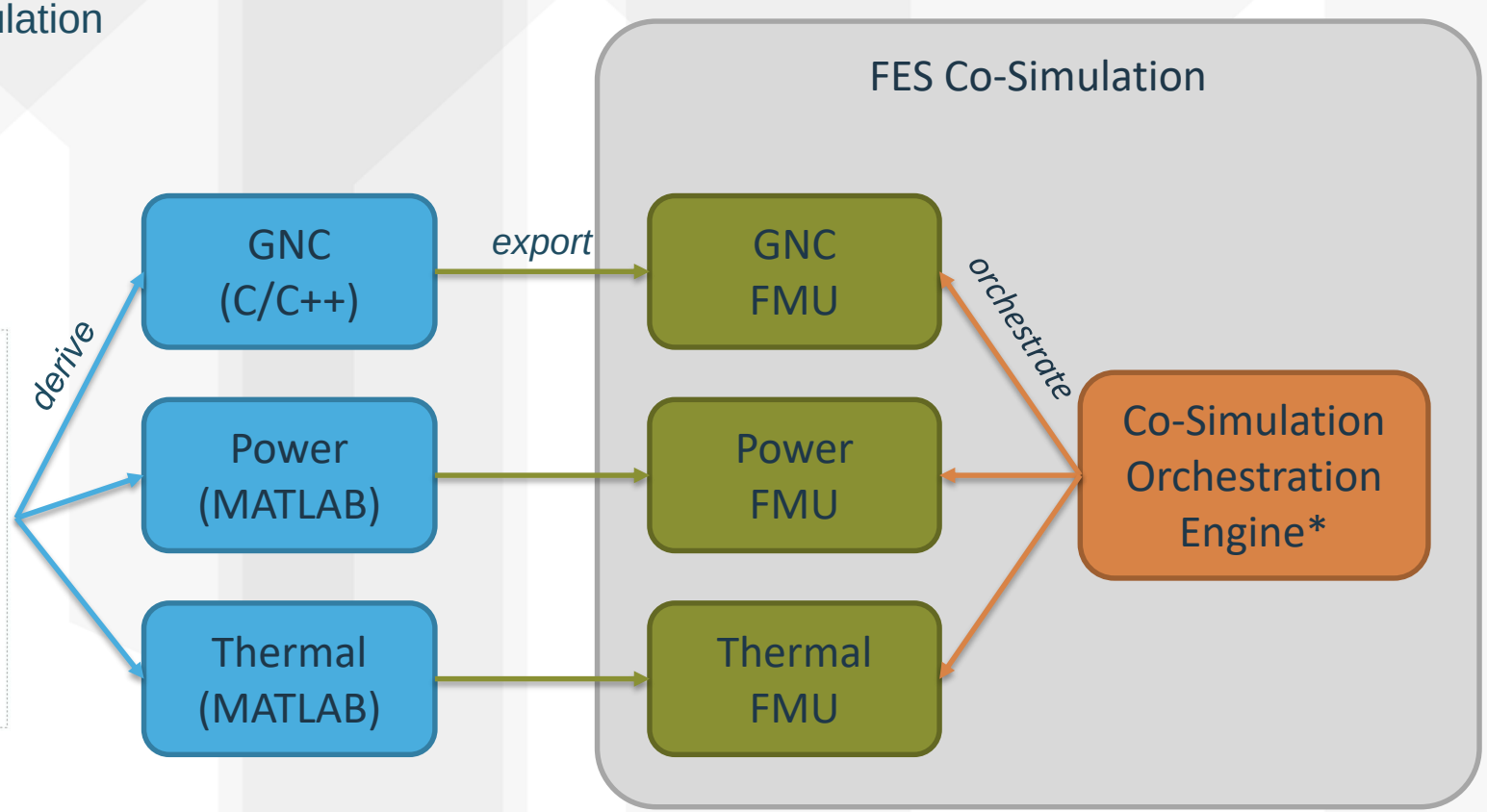
FMI model description

```
<?xml v
<fmiMo                                                    ...>
    <CoSimulation modelIdentifier="{{modelName}}"
                  canHandleVariableCommunicationStepSize="false" ...>
    </CoSimulation>
    <LogCategories><Category name="logAll" /> ... </LogCategories>
    <ModelVariables>{{#each variables}}{{#if fmi}}
      <ScalarVariable name="{{name}}"
                      valueReference="{{fmi.valueReference}}"
                      causality="{{fmi.causality}}"
                      variability="{{fmi.variability}}" >
        <{{fmi.descriptor}} {{#if input}}start="{{value}}"{{/if}}
                            {{#if parameter}}start="{{value}}"{{/if}} />
      </ScalarVariable>{{/if}}{{/each}}
    </ModelVariables>
    <ModelStructure> ... </ModelStructure>
</fmiModelDescription>
```

PoC 1: Co-Simulation in Functional Engineering Simulation

- Collaborative Functional Engineering Simulator
- GNC, Thermal & Power models co-simulation
- FMI based co-simulation orchestration

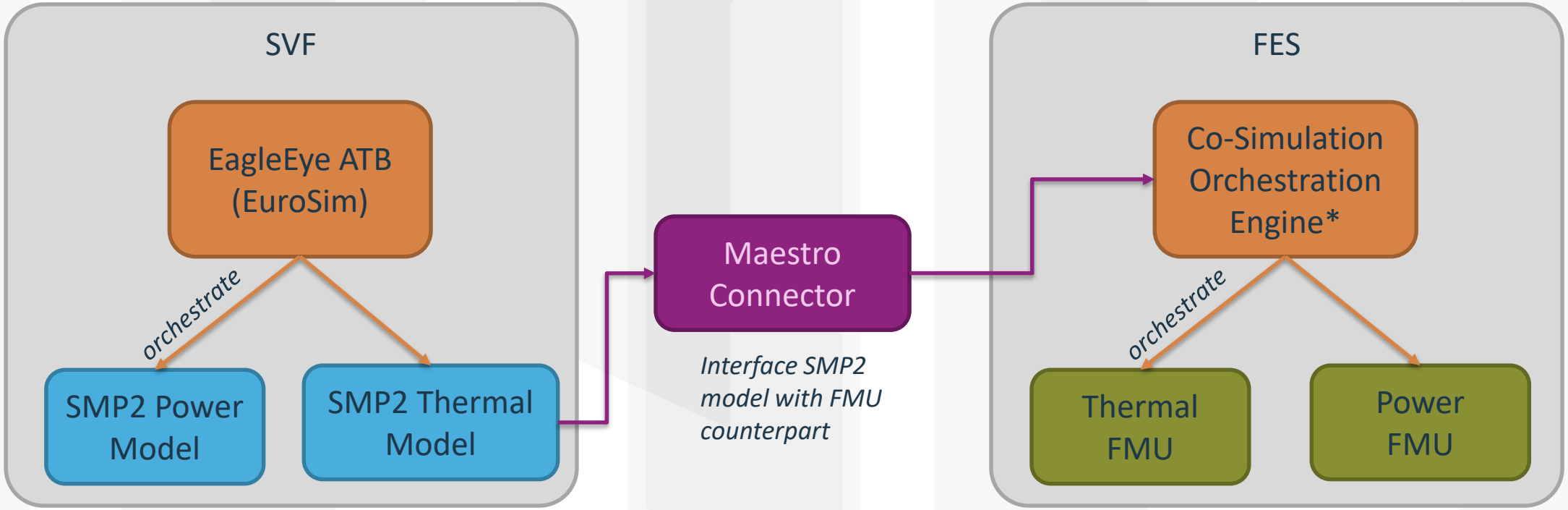




*developed in INTO-CPS (https://into-cps.org/)

PoC 2: FES – SVF co-simulation

- Collaborative Software Validation Facility
- Thermal & Power models co-simulation
- SMP2/FMI based co-simulation orchestration

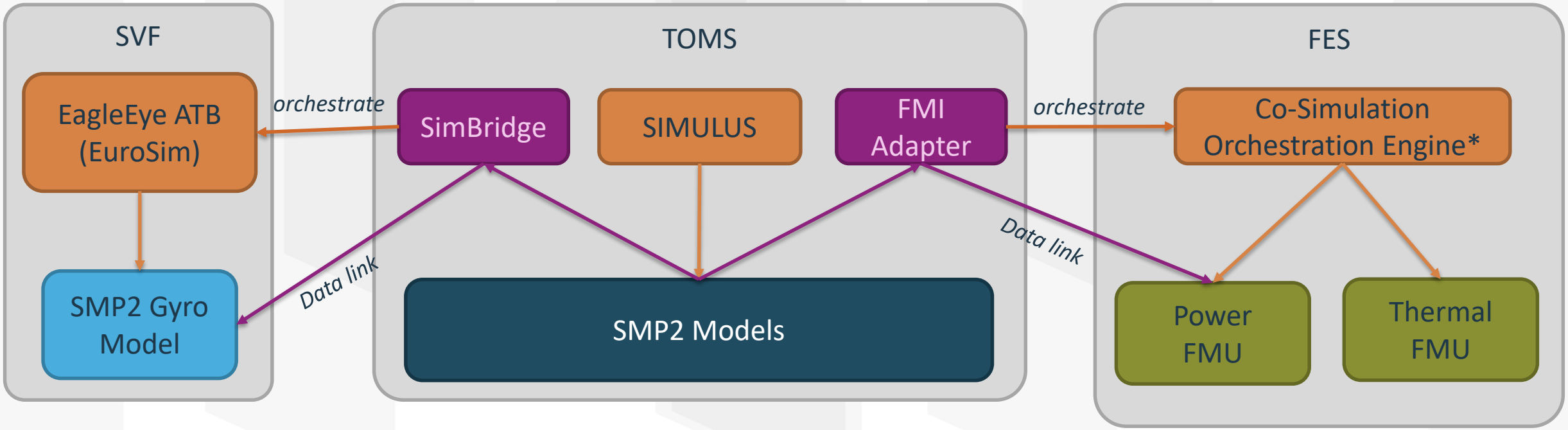


*developed in INTO-CPS (https://into-cps.org/)

ACOSIM – Application of co-simulation to support tests and operations

PoC 3: FES – SVF – TOMS co-simulation

- Collaborative Training, Operations and Maintenance Simulator
- Thermal, Power &Gyro models co-simulation
- SMP2/FMI based co-simulation orchestration



*developed in INTO-CPS (https://into-cps.org/)

Concluding remarks

- New **Verification & Validation Methodology using co-simulation**
- **FMI** standard in the space domain
- **MBSE** approach to enable co-simulation from early phases

- 3 PoCs developed
  - FES (GNC, Power & Thermal)
  - SVF – FES
  - TOMS – SVF – FES
- **Co-Simulation Software Enablers** developed:
  - Capella – SADM interface → system model dependencies' tracking
  - Maestro Connector → SMP2 – FMI Orchestrator interface
  - SimBridge for EuroSim → SIMULUS – EuroSim interface
  - FMI Adapter for SIMULUS → SIMULUS – FMI Orchestrator interface

Thank you for your attention!

“We are what we repeatedly do.
Excellence then, is not an act, but a habit.”
Aristotle

EMTECH
EXCEL MICRO TECHNOLOGIES

www.emtech.global

32 Korinthou Str. & S.Davaki, 14451, Athens, Greece
tel.: +30 2106528527 fax: +30 2106528717 em: info@emtech.global

HUBCAP

HUBCAP: An Online MBSE Collaboration Platform

Peter Gorm Larsen, Hugo Daniel Macedo**,** John Fitzgerald, Holger Pfeifer, Martin Benedict, Stefano Tonetta, Angelo Marguglio, Lorenzo Franco Sutton, Sergio Gusmeroli ,George Suciu Jr. and Prasad Talasila

PROJECT PARTNERS	Politecnico di Milano	KTH Royal Institute of Technology
Aarhus University	Controllab Products	Engineering Ingegneria Informatica
Fortiss GmbH	Verified Systems International	F6S Network Limited
Fundazione Bruno Kessler	Technology Transfer Systems	Unparallel Innovation
University "Lucian Blaga" of Sibiu	Newcastle University	BEIA Consult
Research Institutes of Sweden	Virtual Vehicle Research	Validas

Horizon 2020 Programme
Grant Agreement #872698

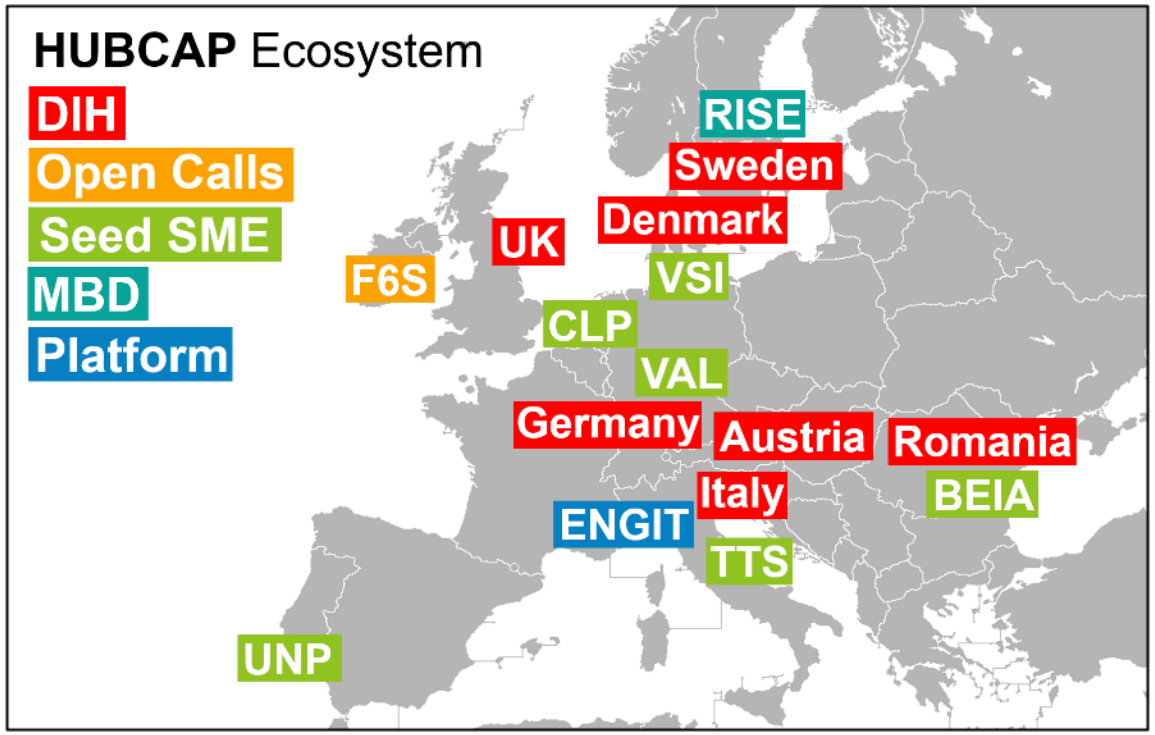
HUBCAP

ABOUT HUBCAP

- # Who we are

- **Innovation Action** co-financed by the European Commission, DT-ICT-01-2019 Smart Anything Everywhere initiative.
- **Coordinator** Aarhus University, Denmark
- **Project duration** January 2020 - December 2022, 36 months
- **Total EC contribution** EUR ~7.95M

- HUBCAP will provide a one-stop-shop for European SMEs wanting to join the Cyber-Physical Systems (CPS) revolution using Model-Based Design (MBD) techniques.
- **Vision** Lower barriers for SMEs to realize the potential of growing autonomy in CPS by accessing advanced model-based design (MBD) technology, providing training and guidance.



Horizon 2020 Programme
Grant Agreement #872698

HUBCAP

ABOUT HUBCAP

- **What we offer**

Network of DIHs:
- Inventory of service offerings
- Ecosystem building
- Cross-DIH collaboration
- Network sustainability

Open Calls
- Engage early-adopters
- 3 open call series

Seed SMEs
- Enabling quicker start for the platform
- Early-stage prototypical usage of HUBCAP
- Awareness-raising demonstrations

Model-Based Design:
- Populating the platform
- Enabling model-based services in sandbox
- Multi-user, validation and logging capabilities

Collaboration Platform:
- Cloud-enabled, based on DIHIWARE
- "Access to" and "Collaborate with":
  - Ecosystem
  - Community-building
  - Marketplace
  - **Sandbox**

Horizon 2020 Programme
Grant Agreement #872698

HUBCAP

HUBCAP OPEN CALLS

HUBCAP has a €3.2 million equity-free fund for SMEs to experiment and innovate with digital technologies

Call #1 Pull

Does your SME/midcap provide existing and marketable CPS & MBD tools and services? Integrate your asset in the HUBCAP platform and find potential new customers and collaborators in the subsequent open calls.

1000€
per SME

Call #2 Experiment

Is your SME/midcap looking to embrace digital innovation? Connect with a supplier from the HUBCAP platform and receive tailormade support and services to co-create and experiment with CPS & MBD tools.

30,000€ to **75,000€**
per consortium of 2 SMEs

Call #3 Innovate

Develop and implement highly innovative and challenging CPS & MBD experiments. Create new products and services and benefit from business and tecnical support from the HUBCAP experts for highest impact.

Up to **200,000€**
per consortium of 2-3 SMEs

Horizon 2020 Programme
Grant Agreement #872698

Non-EU/SMEs are also welcome to share their assets, but cannot apply to the OCs!

HUBCAP

HUBCAP Collaboration Platform

Model-Based Design of Cyber-Physical Systems: HUBCAP!

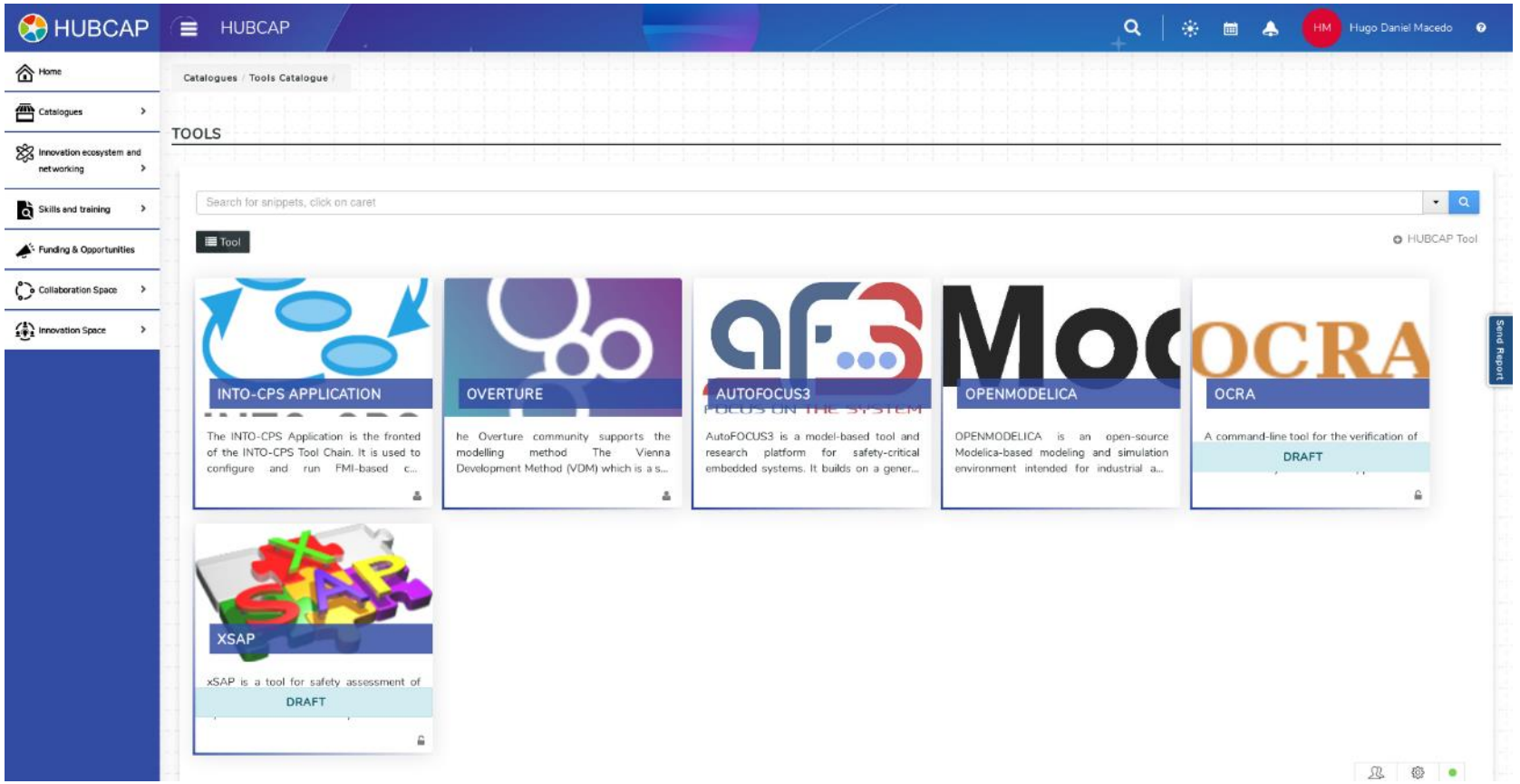
- Limit initial investment for newcomers (get an online sandbox capability, free to use)
- In particular SMEs typically closely collaborate/deliver to larger organisations (collaboration platform, pay as you go rather than licences per seat)
- Getting SMEs started with first projects using MBD (DIHs will support for these, but since they have different strengths get them to collaborate)
- Getting funding enabling investment (open calls)
- Can we also use this to start filling the collaboration platform (the seed SMEs + first open call round)

Horizon 2020 Programme
Grant Agreement #872698

HUBCAP

HUBCAP Collaboration Platform

The Tools Catalogue

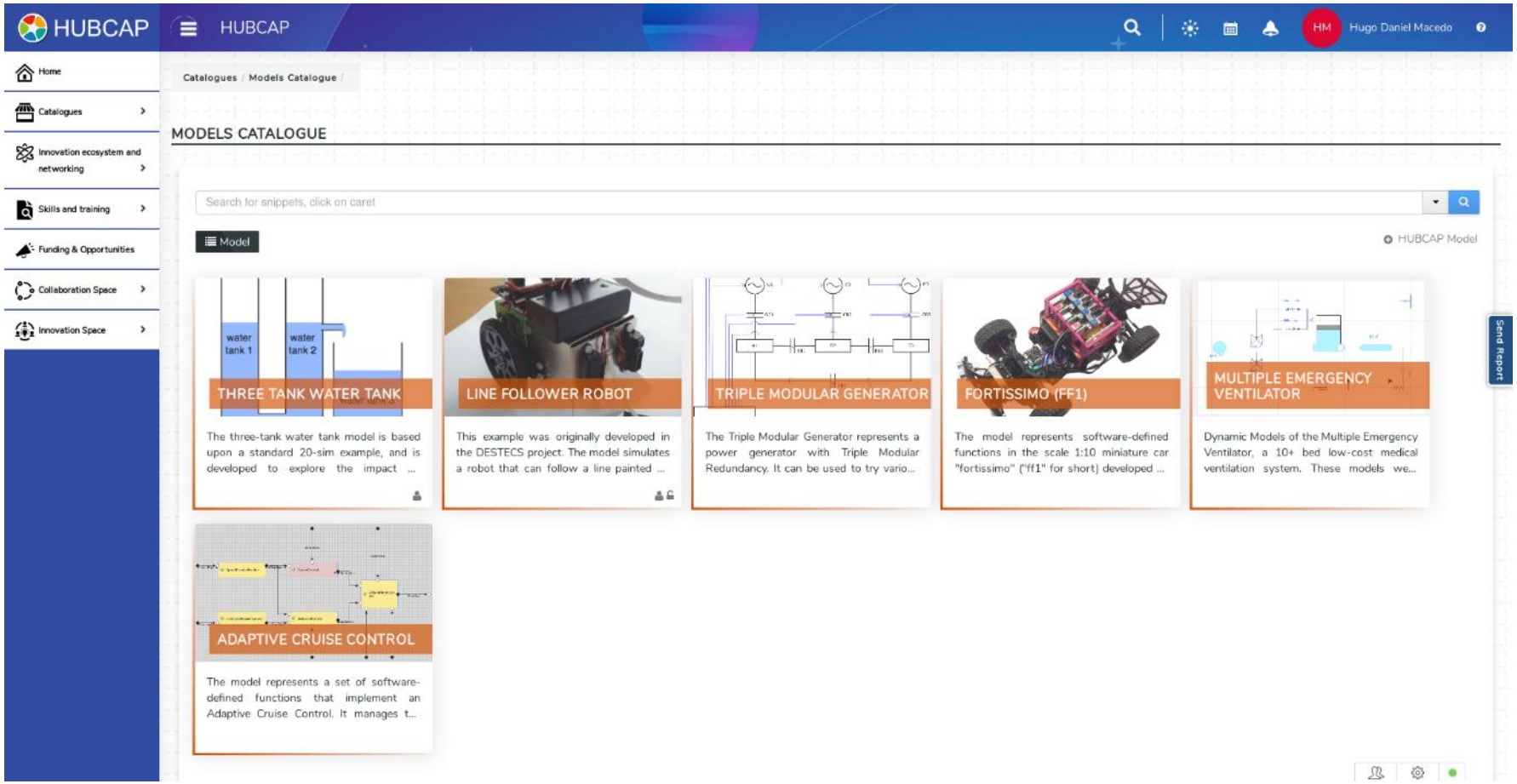


Horizon 2020 Programme
Grant Agreement #872698

HUBCAP

HUBCAP Collaboration Platform

The Models Catalogue



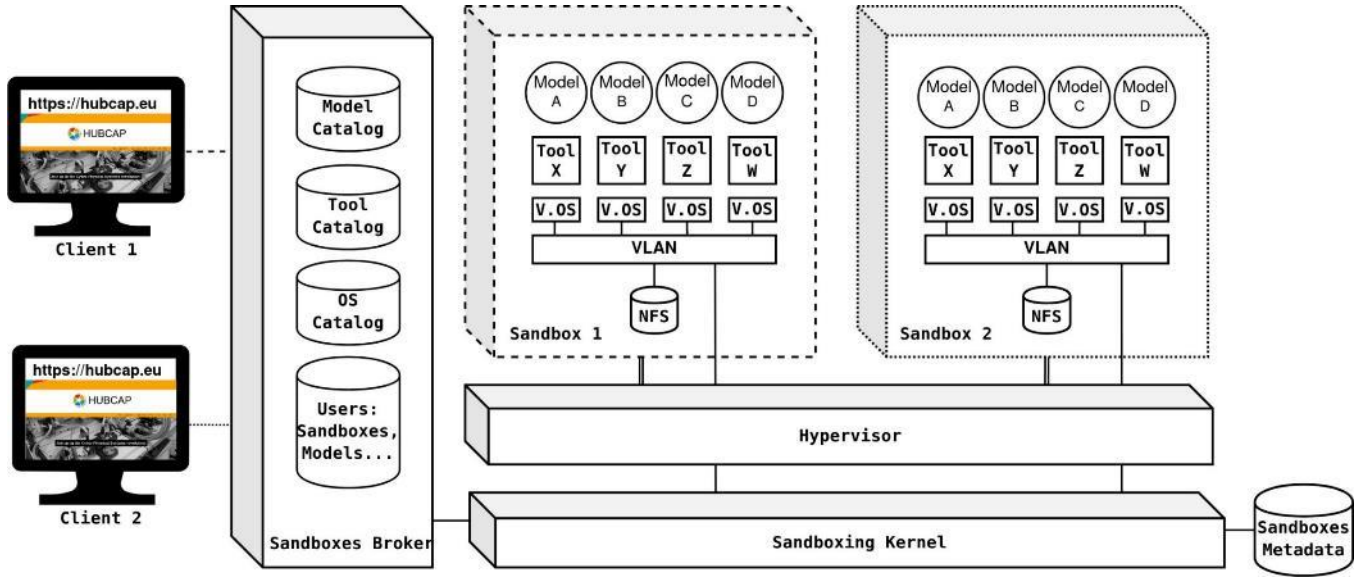
Horizon 2020 Programme
Grant Agreement #872698

HUBCAP

HUBCAP Collaboration Platform

The Sandbox

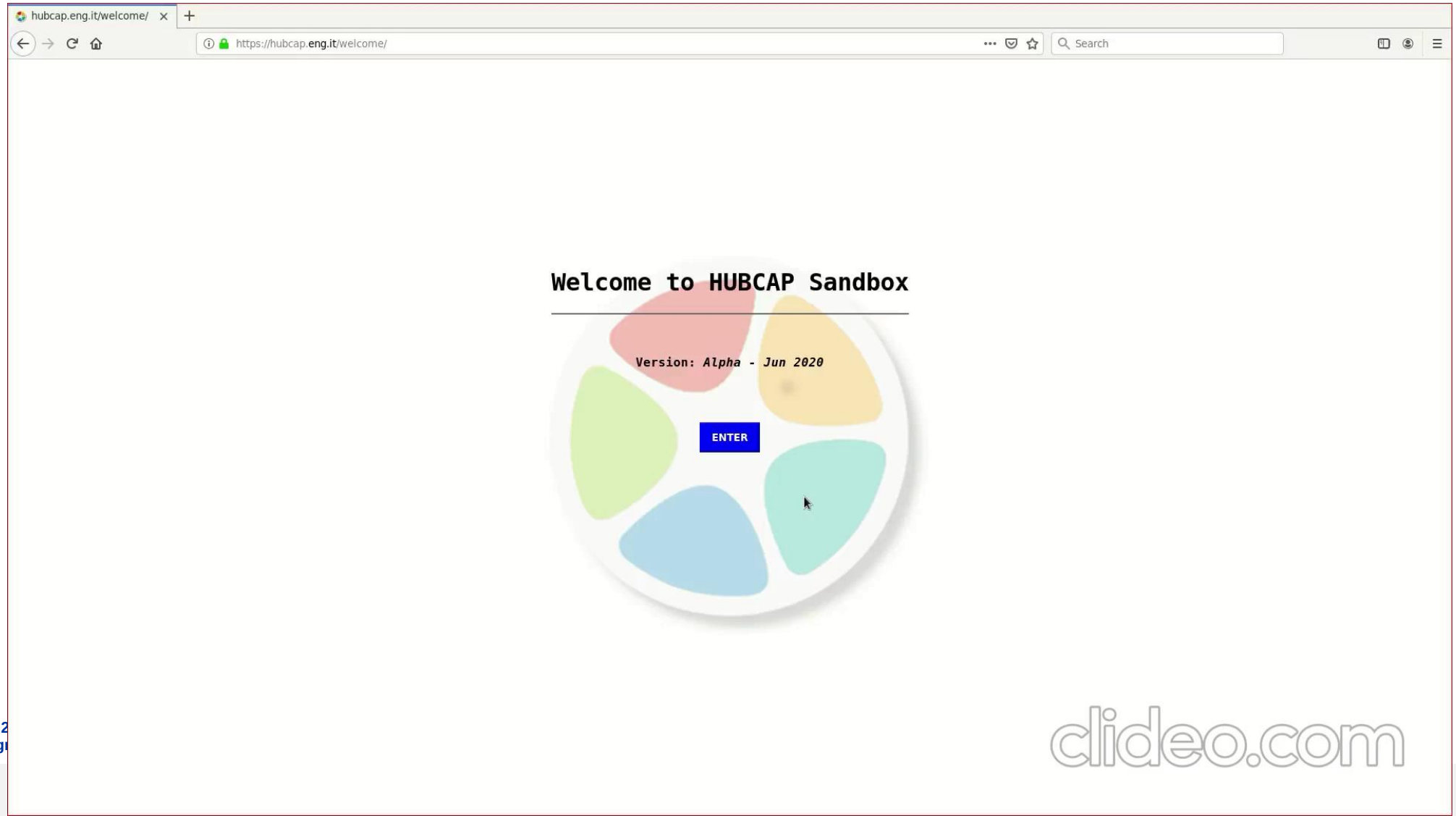
- Enables Interaction between:
  - Tool Providers
  - Users/SMEs
- Ready-to-use
- Pay-as-you-go



Horizon 2020 Programme
Grant Agreement #872698

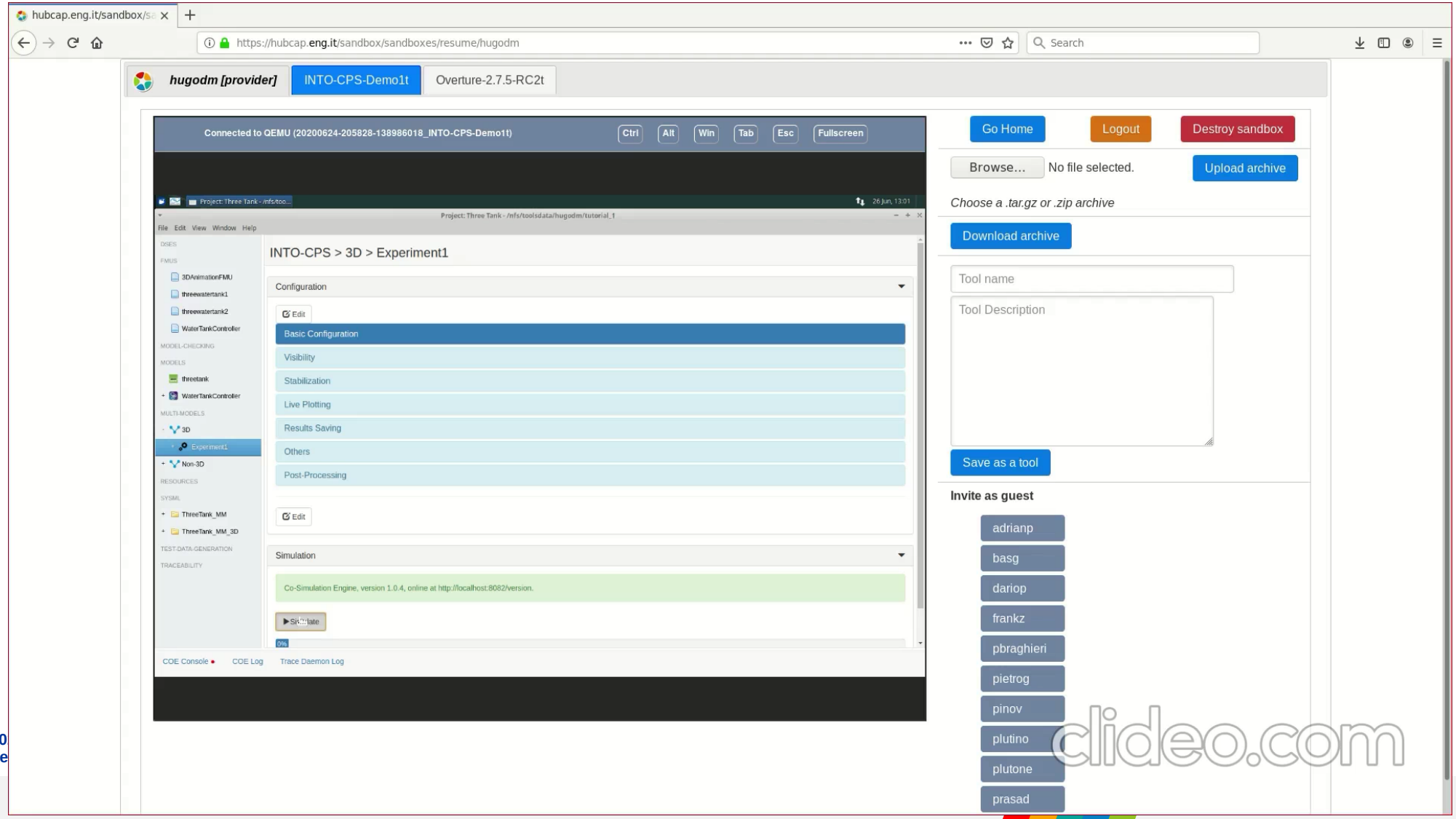
Demonstrating the Sandbox Setup

HUBCAP



The Sandbox Collaboration Possibilities

HUBCAP



Horizon 20
Grant Agre

HUBCAP Collaboration Platform

HUBCAP

Concluding Remarks

- HUBCAP Project
- Open Calls for EU SMEs providing or interesting in MBD of CPS
- A Cloud-Based Collaboration Platform for Model-Based Design of Cyber-Physical Systems

- Join us:
  - https://www.hubcap.eu/
  - https://twitter.com/hubcap_eu
  - https://www.linkedin.com/company/hubcap-eu/

Horizon 2020 Programme
Grant Agreement #872698