Grant Agreement: 644047

Integrated Tool chain for model-based design of CPSs

HUBCAP Collaboration Platform v3

Technical Note Number: D5.4

Version: 1.0

Type: Other

Date: December 2021

Public Document

HUBCAP (au.dk)

Editors:

Pietro Greco (ENGIT)

Giuseppe Veneziano (ENGIT)

Angelo Marguglio (ENGIT)

Contributors:

George Valentin Iordache (BEIA)

Reviewers:

Claudio Sassanelli (POLIMI)

Pietro Braghieri (FBK)

Consortium:

Aarhus University	AU	Newcastle University	UNEW
Fortiss GmbH	FOR	Virtual Vehicle Research Center	VV
Fundazione Bruno Kessler	FBK	KTH Royal Institute of Technology	KTH
University “Lucian Blaga” of Sibiu	ULBS	Engineering Ingegneria Informatica S.p.A.	ENGIT
Research Institutes of Sweden AB	RISE	F6S Network Limited	F6S
Politecnico di Milano	POLIMI	Unparallel Innovation	UNP
Controllab Products	CLP	BEIA Consult	BEIA
Verified Systems International GmbH	VSI	Validas	VAL
Technology Transfer Systems srl	TTS		

Document History

Ver.	Date	Author	Description
0.1	01-11- 2021	Angelo Marguglio, Pietro Greco, Giuseppe Veneziano	ToC and initial material
0.2	16-11-2021	Pietro Greco, Giuseppe Veneziano	Deliverable 2nd ToC and initial contributions
0.3	20-11-2021	Pietro Greco, Giuseppe Veneziano	Resolving reviewer's comments
0.4	30-11-2021	Angelo Marguglio, Giuseppe Veneziano	ENG Internal Review
0.5	01-12-2021	Pietro Greco, Giuseppe Veneziano	Refinement
0.6	05-122021	Angelo Marguglio, Pietro Greco, Giuseppe Veneziano	Document sent to peer Review
0.7	12-12-2021	George Valentin Iordache (BEIA)	Contribution for IPR
0.8	13-12-2021	Claudio Sassanelli (POLIMI), Pietro Braghieri (FBK)	Peer Review. Feedback received
0.9	22-12-2021	Angelo Marguglio, Pietro Greco, Giuseppe Veneziano	Resolving reviewer's comments ENG Internal Review
1.0	23-12-2021	AU-TEAM	Document ready for submission

List of Definitions (HUBCAP contextualized)

Term	Definition
Catalogue	Set of entries available in the Collaboration Portal describing a CPS tool or model
Collaboration Platform	Platform resulting from the combination of the *Collaboration Portal* and *Sandboxing Middleware*
Collaboration Portal	It is the entry point of the Collaboration Platform. It provides access to a set of functionalities and assets conceived to foster collaboration among project stakeholders.
Model	Archive containing files and directories implementing a CPS model usable inside a sandbox
Operating System	A minimal installation of a Linux or Windows OS ready-to-use inside a sandbox for installing a CPS tool
Repository	List of sandbox-instantiable operating systems, tools and models
Sandbox	Isolated set of running tools, operating systems and models featuring a dedicated local network and a shared storage
Sandbox Viewer	Web page through which it is possible to interact with all the sandbox components
Sandboxing Middleware	Provides a protected environment where CPS tools and models can be safely evaluated inside sandboxes
System Interactive Mode	Every day the HSM switches between two modes: interactive and batch. During the first one a HSM user can interact with a sandbox via the sandbox viewer.
Tool	CPS Software for Model Based Design which has been added to the Tools Repository

List of Acronyms

Acronym	Description
CPS	Cyber Physical Systems
CTA	Call to Action
DIH	Digital Innovation Hub
HCP	HUBCAP Collaboration Portal
HSM	HUBCAP Sandboxing Middleware
IPR	Intellectual Property Rights
KPI	Key Performance Indicator
LTS	Long Term Support
MBD	Model-based Design
OC	Open Call
OS	Operating System
OSP	One Session Passphrase
PC	Personal Computer
REST	REpresentational State Transfer
SBM	System Batch Mode
SIM	System Interactive Mode
SME	Small and Medium size Enterprise
UI	User Interface
UIS	User Interactive Session
VM	Virtual Machine

Abstract

This report is the accompanying document for deliverable *D5.4 HUBCAP Collaboration Platform Version 3*. The deliverable itself is the **HUBCAP Platform release for Month 24** (therefore of type 'OTHER'), deployed as an online tool available at:

https://hubcap-portal.eng.it/

The creation of an innovation ecosystem for MBD of CPSs and embedded systems, which is one of the main project's objectives, is supported by means of the HUBCAP Platform that acts as a one-stop-shop for accessing MBD competencies, technologies, best practices, methods, business and funding efforts have been made to opportunities.

The modular architecture of the Platform and its customization capabilities, next to a concrete adoption plan, are allowing the delivery of a specific HUBCAP tailored environment, based on the different system's modules and in line with the stakeholders needs and requirements.

Upon the previous releases (D5.3 HUBCAP Collaboration Platform v2, published in M18), specific customizations (e.g., spaces structure customization and catalogues refinements and new design) and new developments have been realized in order to reach the objectives and new requirements identified, and in line with the needs coming from final users (mainly SMEs among OCs winners). Therefore, the aim of this document is to provide an overview of the results and artefacts making the deliverable with a focus on the updates since the previous release.

In this document and release, attempts have been made to address the midterm **review report comments**. In particular:

- Chapter **2 Platform Overview: Diagram, General Description and Main Subsystems Interactions** presents a new diagram depicting the whole Platform and highlighting the main subsystems and their components. This diagram is commented describing components functionalities and the main interactions;
- Paragraph ***3.3.1* HSM Tools Provisioning** illustrates the requirements a tool has to satisfy for running in a sandbox and a new tool provisioning lifecycle that better delimits the resources usage for each tool;
- Paragraph **3.3.4 System Resources Control** shows the criteria adopted to avoid wasting resources and balance them among the Hubcap Sandboxing Middleware (HSM) users.

Many efforts have been done also to address the **HSM users' feedback**. In particular:

- Paragraph **3.3.2 Improved Integration between Collaboration Portal and HSM** shows the new mechanisms adopted to facilitate the connection between HSM Repositories and Portal Catalogue;

- Paragraph **3.3.5 Revised Web Interface** shows what implemented for improving usability, robustness and look and feel of the HSM UI;
- Paragraph **3.3.9 User Guides and Video Tutorials** illustrates the new form of the HSM User Manual that now is provided as WEB pages more comfortable, lightweight and easy to handle in respect to a monolithic PDF;
- Paragraph **3.3.6 HSM Extensions** presents the provisioning of a **licensed version of the Windows OS** into HSM and the extension of the duration of the interactive session.

In particular, the section 3.1 offers an insight into the stakeholder approach used to map a high-level user journey. This mapping exercise allows the determination of how well the system currently supports the existing pathways and touchpoints and where there may be areas of improvement to support potential updates.

Then a focus on the key updates delivered in the Collaboration Portal sets out the work completed to facilitate the user onboarding process and improve the user experience into the Platform (see Section 3.2).

Table of Contents

List of Figures

1 Introduction

This accompanying report to D5.4 HUBCAP Collaboration Platform v3, released at Month 24 of the HUBCAP project, reports the key updates carried out since the v2 release, highlighting the development carried out to incorporate a set of user requirements deriving from input and feedback provided by the HUBCAP partners in various ways.

The document starts with an overview of the Platform that aims at helping the reader understanding better the architectural approach behind the developed solution.

Then there is an overview of the methodology used to ensure valid and reliable results followed by introduction of the update and new public sections for the Collaboration Portal.

A specific focus on the new HSM advantages and new forms of inter-connection between the Collaboration Portal platform and the Sandbox environment are detailed in the following parts of this document.

The updated version of the HSM User Manual is also provided as an annex (the latest version always being available as an independent document as well).

2 Platform Overview: Diagram, General Description and Main Subsystems Interactions

The HUBCAP Collaboration Platform is composed by two main subsystems:

- **Collaboration Portal** (HCP): providing the HUBCAP users the access to a plethora of functionalities and resources conceived to foster collaboration among SMEs and DIHs;
- **Sandboxing Middleware** (HSM): offering a simple and dynamic solution allowing the HUBCAP Providers to bring their CPS assets (tools and models) on the HUBCAP Platform, and where the HUBCAP Consumer can try CPS assets easily with just a browser.

The following Figure 1 gives an overview of the whole Platform.

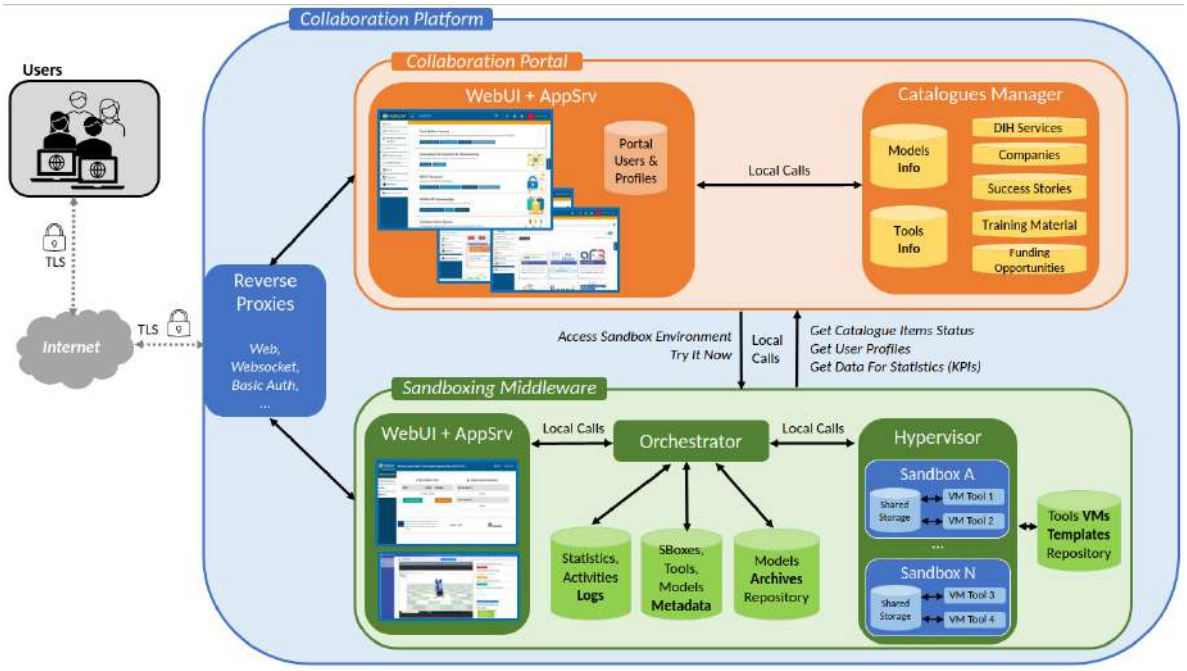


Figure 1 Overview of the HUBCAP Collaboration Platform with its components

The Platform main components are shortly described in the following paragraphs.

2.1 Reverse Proxies

This component is the main interface (frontend) between the Platform and the external public network (Internet). It is composed by a set of software (e.g. Apache, websockify and so on) which is responsible for implementing:

- **https** access to the entire Platform and **requests routing,**
- routing **security rules**,

- **basic authentication** for the HSM, **(*)**
- **protocol adaptation** for the HSM.

(*) As described in the Deliverable D5.2 (sections*: Integration between the DIHIWARE Platform and the Sandboxing Middleware* and *Security Aspects - d. Two-factors authentication*) users accessing the HSM must authenticate first on the HCP and only then they will be able to receive a One Session Token to use as password for the Apache Reverse Proxy Basic Authentication.

2.2 Collaboration Portal main components

WebUI + AppSrv is a web application responsible for managing:

- Platform Users registration, permissions, profiles,
- Workspace structure,
- Collaboration capabilities.

Catalogues Manager is a backend application responsible for managing:

- Tools Catalogue,
- Models Catalogue,
- Services Catalogues,
- DIHs/Companies Catalogue,
- Guidelines Catalogue,
- Experiments Catalogue (WIP).

2.3 Sandboxing Middleware: basic concepts and main components

2.3.1 Sandboxing Middleware basic concepts recap

As defined in Deliverable 5.2, a **sandbox** is a set of **virtual machines** (*VMs*) connected through a dedicated and **isolated network** (*Sandbox Isolated Network*) through which they can interact with each other (e.g., via RESTful calls). Moreover, the sandbox VMs can exchange data using also a dedicated, private, and **shared storage** (*Sandbox Shared Storage*) where common files are stored. A graphical representation of a sandbox is presented in Figure 2.

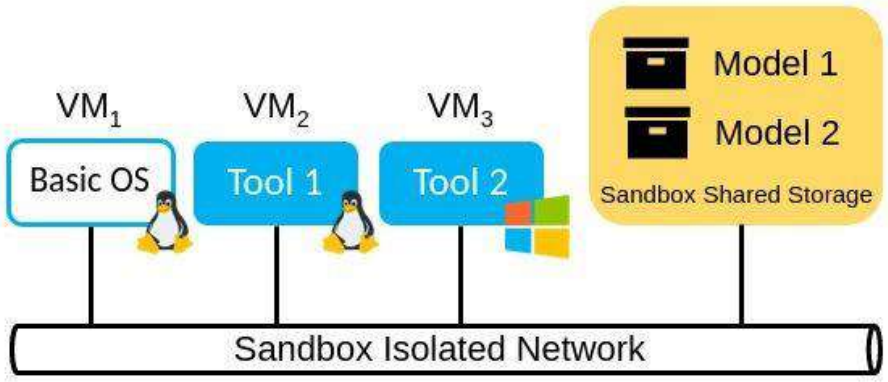


Figure 2 A Sandbox with a basic OS and two Tools. On the right the Sandbox Shared Storage

In the HUBCAP sandbox implementation:

- each VM can either contain a basic, ready-to-use **operating system** (Linux or Windows) or one of such OSes previously customized by installing on it a **CPS tool**;
- each VM has access to a shared storage as a **directory** where end-users can upload/download files from/to their PC and where directories and files constituting a **CPS model** are extracted.

Distinct instances of the same *operating system*, *tool* and *model* can be used simultaneously in **many distinct sandboxes**.

2.3.2 Sandboxing Middleware main components

Orchestrator is responsible for managing:

- the **life cycle** of **multiple sandboxes** running simultaneously,
- the **metadata** of the entities involved (tools, models, running sandboxes, and so on) through its own database,
- the **Portal interactions** need to collect and manage information related to the Platform **Users** and **Catalogues,**
- the **logs** related to users and system activity,
- the **CPS model archives** uploaded from HUBCAP Providers (constituting the **HSM Models Repository**).

Hypervisor, relying on Kernel Virtual Machines **(KVM**), is responsible for managing:

- the **CPS tools low-level implementation** as VMs (constituting the **HSM Tools Repository**),
- the **isolated network** of each sandbox,

- the **shared storage** of each sandbox.

WebUI + AppSrv is a web application responsible for managing:

- a **WEB user interface** to access and interact with HSM using a simple HTML5-compliant browser,
- the **internal calls** to the Orchestrator in order to execute the low-level actions needed to satisfy the end-user requests.

2.4 Subsystems Interactions

The **interactions** between Collaboration Portal and Sandboxing Middleware occur as follows:

- **Sandbox Environment** functionality (portal side) allows users to submit new requests to access the HSM, as shown in the following
- Figure 3.

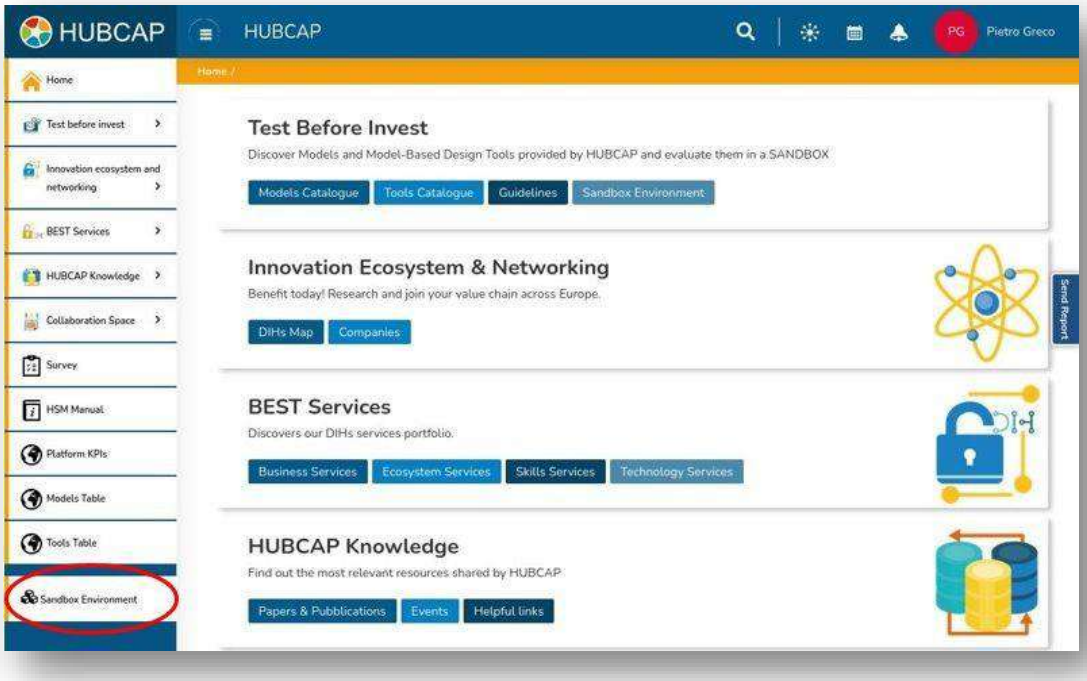


Figure 3 Sandbox Environment button available in the Collaboration Portal home page and useful to access the Sandboxing Middleware

The Collaboration Portal invokes a **HSM endpoint** which processes the user information and allows to **switch to the HSM UI** enabling the features corresponding to the user profile. Obviously if the user profile does not have adequate permissions, the access is denied.

Try It Now functionality (portal side) allows to bring the user **directly** from a tool or model details page of the Portal Catalogues to the Sandboxing Middleware, as depicted in Figure 4.

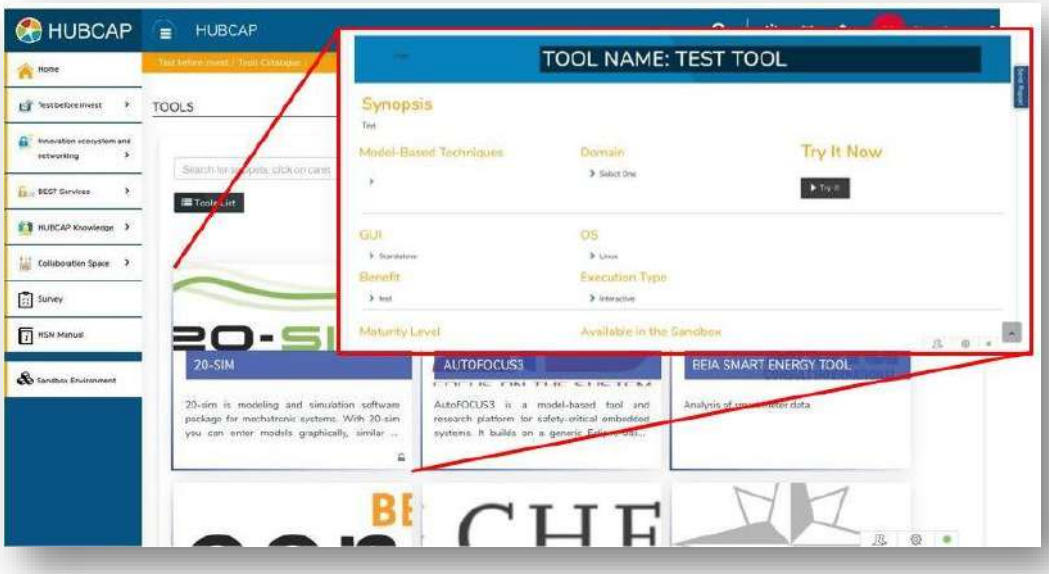


Figure 4 Detail of the Try It Now section available in a tool details page

The Collaboration Portal invokes a **HSM endpoint** which processes the user information and **automatically composes a ready-to-launch sandbox** with the item (tool or model) of their choice:

- **Data For Statistics Calculations Retrieving** (HSM side): the HSM implements the business logic needed to compute the HUBCAP KPIs for both Sandboxing Middleware and Collaboration Portal. While data for the HSM are already available, those for the Portal need to be collected. To do that the HSM periodically queries the Portal to obtain and process them all together;
- **User Profiles Retrieving** (HSM side): sometimes during the execution of its backend tasks, the HSM needs to know the profile of a user and then queries the Portal for that;
- **Catalogue Items Status Retrieving** (HSM side): sometimes during the execution of its backend tasks, the HSM needs to know the status (e.g., published or not) of a tool or a model in the Portal Catalogues and then queries the Portal for that.

3 HUBCAP Collaboration Platform: Key Updates and Features Delivered in Version 3

3.1 User Journey and Features

The HUBCAP Platform development and customization goes hand in hand with the adoption plan of the Platform and this synergism aims to map out a strategy to optimize and improve the Platform evolution process in order to address the key challenges of the HUBCAP Ecosystem.

For the previous release we started to work on the design of the HUBCAP workspace story map shown in Figure 5, with the aim to build a shared vision of the digital workspace within their beneficiaries[1].

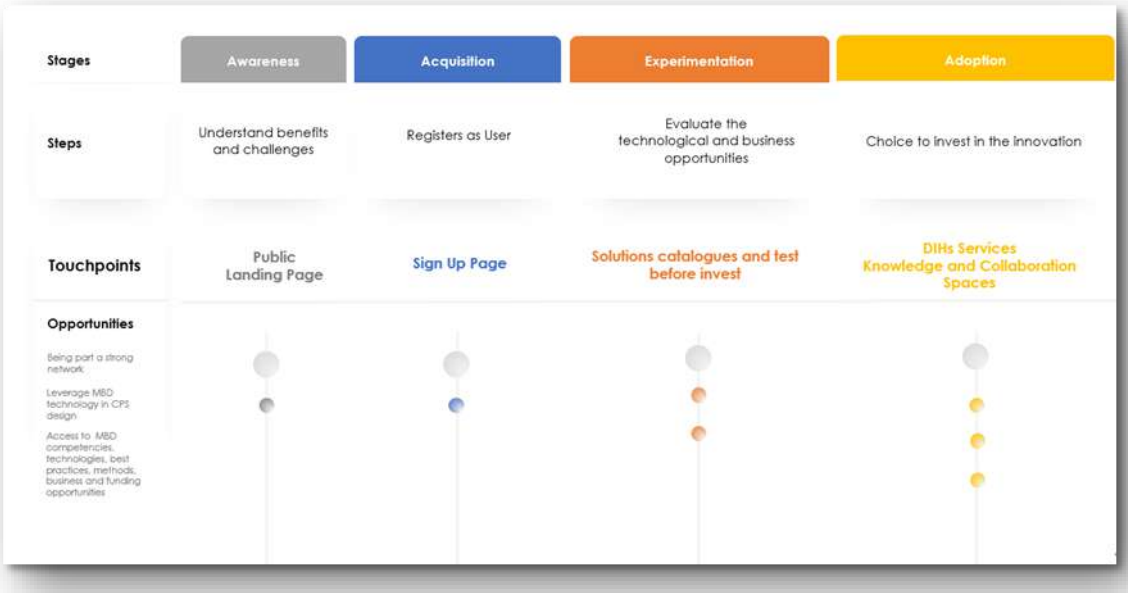


Figure 5 HUBCAP workspace story map

Thanks to this map, the attention has been focused on how user can navigate through the system from beginning to the end to achieve the desired business goal and, in order to get the platform management right. Efforts have been made to bridge technology with the business need of our stakeholders.

Once completed the high-level user journey, the work continued with the analysis of the steps (Figure 6) to make sure the delivery of the right value at the right time. For each stage of the journey, the focus was placed on the touchpoints and on how users can navigate across them as they move through the journey. Then, the opportunities of delivering of a specific service at every user step was deeply analysed. Moreover, using user experience data it was possible to map it with the specific touchpoints, and identify the improvements that will have the biggest impact on the user and his overall

[1] D5.4 HUBCAP Collaboration Platform v2

experience.

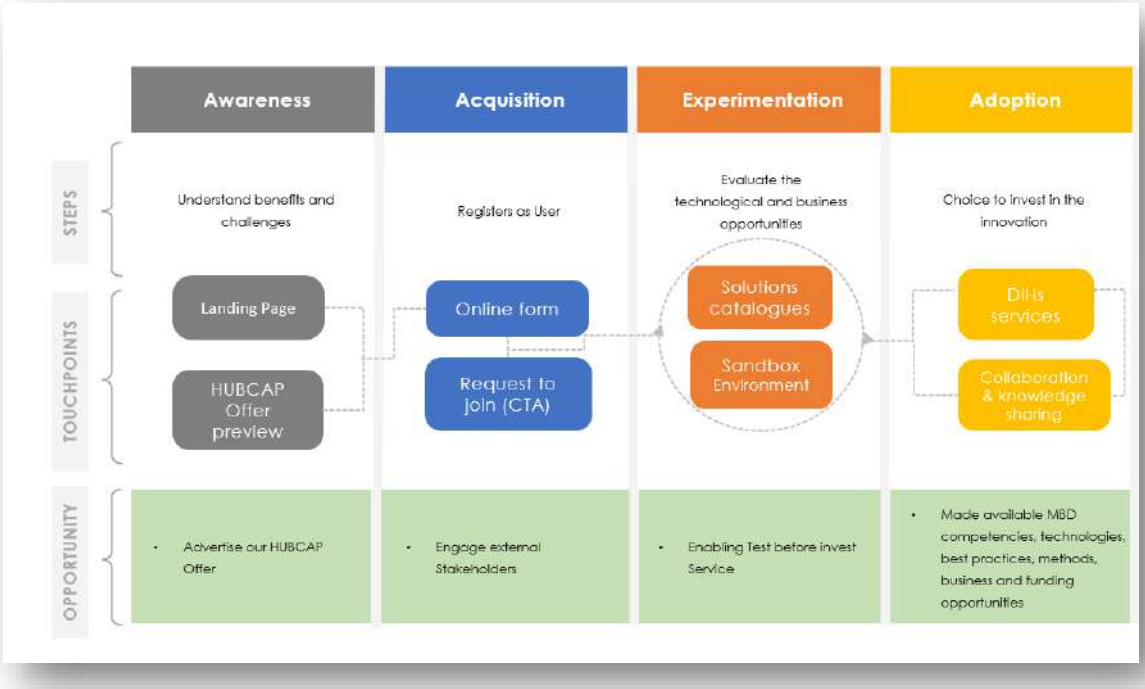


Figure 6 Journey Analysis

For this V3 release we have turned our attention on the first two stages of the journey (left out from the previous V2 release), closely related to the necessity, raised by the Consortium, to engage into the HUBCAP Platform more and more external stakeholders (DIHs, Technology providers and Consumers). Those stakeholders need to understand the full potential achieved by joining the HUBCAP Ecosystem and by an active participation in the Platform (Awareness); this awareness must be turn into the will to register as User (Acquisition). To satisfy those needs, a Public Landing Page has been implemented and released (see Section 3.2.1).

The stage of the journey that requires a technological focus and a wide variety of new features (new compared to those previously released) and improvements which will allow our final users the experimentation with new digital technologies – tools and models – to understand new opportunities and return on investments, is the Experimentation stage. The HUBCAP Sandboxing Middleware and all the new technological advances (detailed in Section 3.3) represent the technical work that have been completed to improve the experience at this step.

3.2 HUBCAP Collaboration Portal

Using a Stakeholder Requirements approach, the HUBCAP Consortium encourages comments, surveys and other feedback loop-oriented exercise to gain useful and relevant insights that guide the Platform development and customization work and facilitate the user onboarding process.

Regarding the Collaboration portal following the main updates are listed:

- Portal catalogues updates (Tools, Models, Services and Guidelines): some structural changes have been made with the addition of the new fields and the revision of some of the catalogues' variables;
- Experiments Catalogue design: a new structure and layout have been created for the Experiment entity and it will be made available when we have the first experiments results;
- Public section of the Platform: a dedicated Landing page has been designed and released as explained in the HUBCAP Public Landing Page section.

3.2.1 HUBCAP Public Landing Page

In order to create a relationship between the HUBCAP community and external new potential stakeholders, we have designed and implemented a public landing page as shown in the Figure 7, Figure 8, Figure 9, Figure 10, and Figure 11.

This new page highlights the value of the HUBCAP offer conveyed and offered through the platform, and lead our visitors to respond to our call to action (CTA) sending a request for join the Platform (via a dedicated form shown in the Figure 12), and so as to be a part of the widening HUBCAP Ecosystem.

In particular the landing page is composed by are six core elements:

- The main headline with a very short description of the HUBCAP Platform selling proposition.
- The Mission section that, supporting the headline, aims to describe specific benefits along with features.
- The Community Section aiming at giving an overview of the HUBCAB ecosystem mainly composed by the DIHs Ecosystem and Experts on MBD in CPSs.
- The Expertise Section containing a representative collection of models and tools available and ready to be experimented into the platform.
- The Service Section provides a representative picture of the HUBCAP DIHs Offer.
- The Request to join form that is the main call-to-action (CTA) of the page designed to persuade our visitors to join the platform.

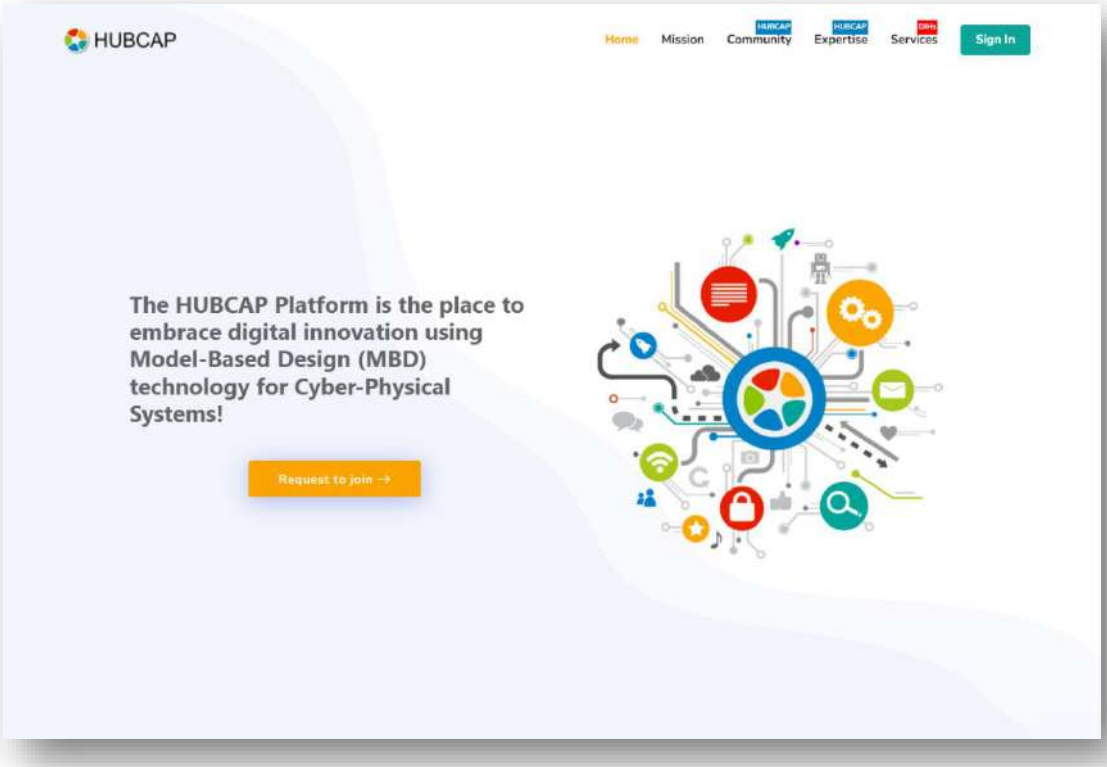


Figure 7 HUBCAP Platform Landing page - Header Section

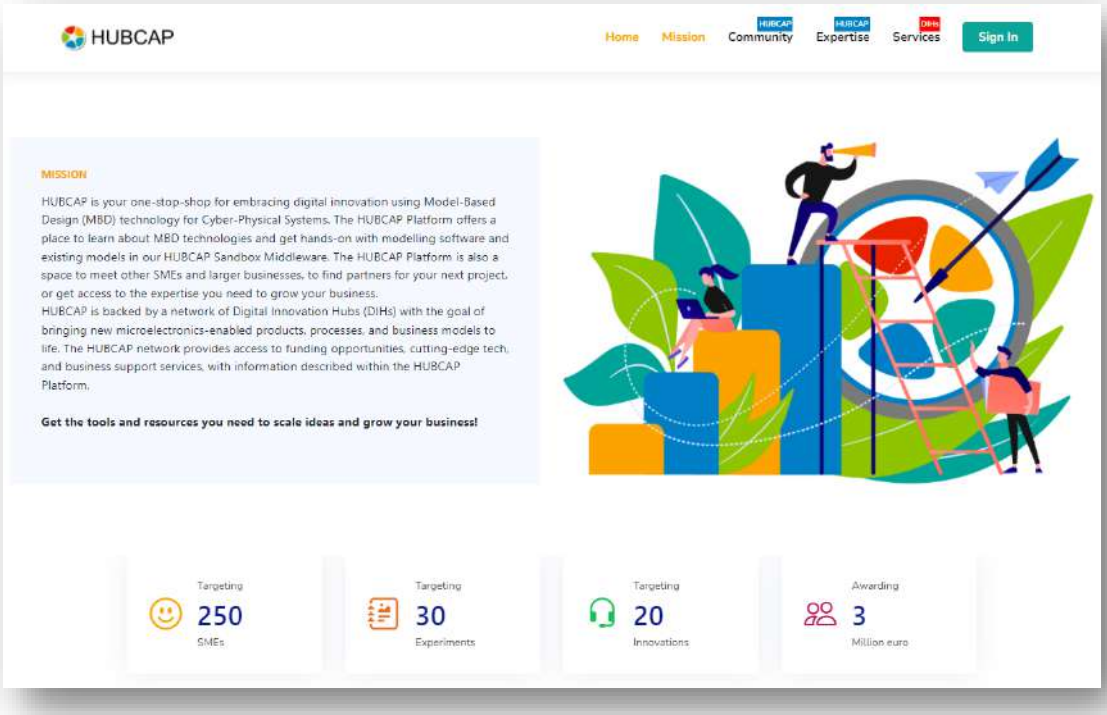


Figure 8 HUBCAP Platform Landing page - Mission section

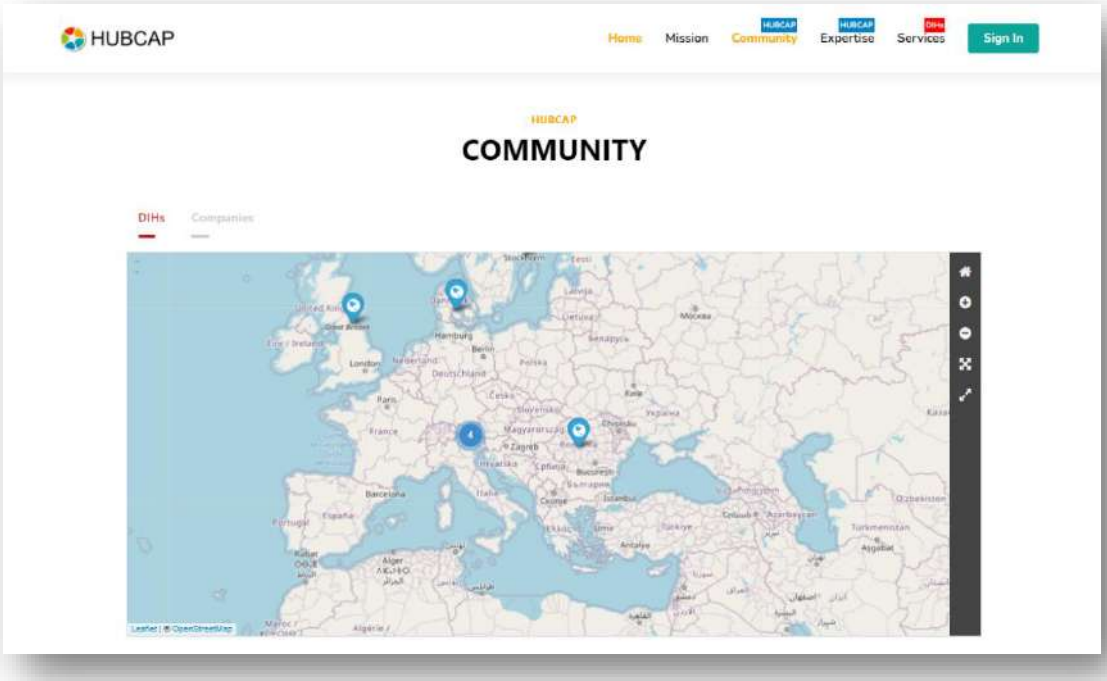


Figure 9 HUBCAP Platform landing page - Community section

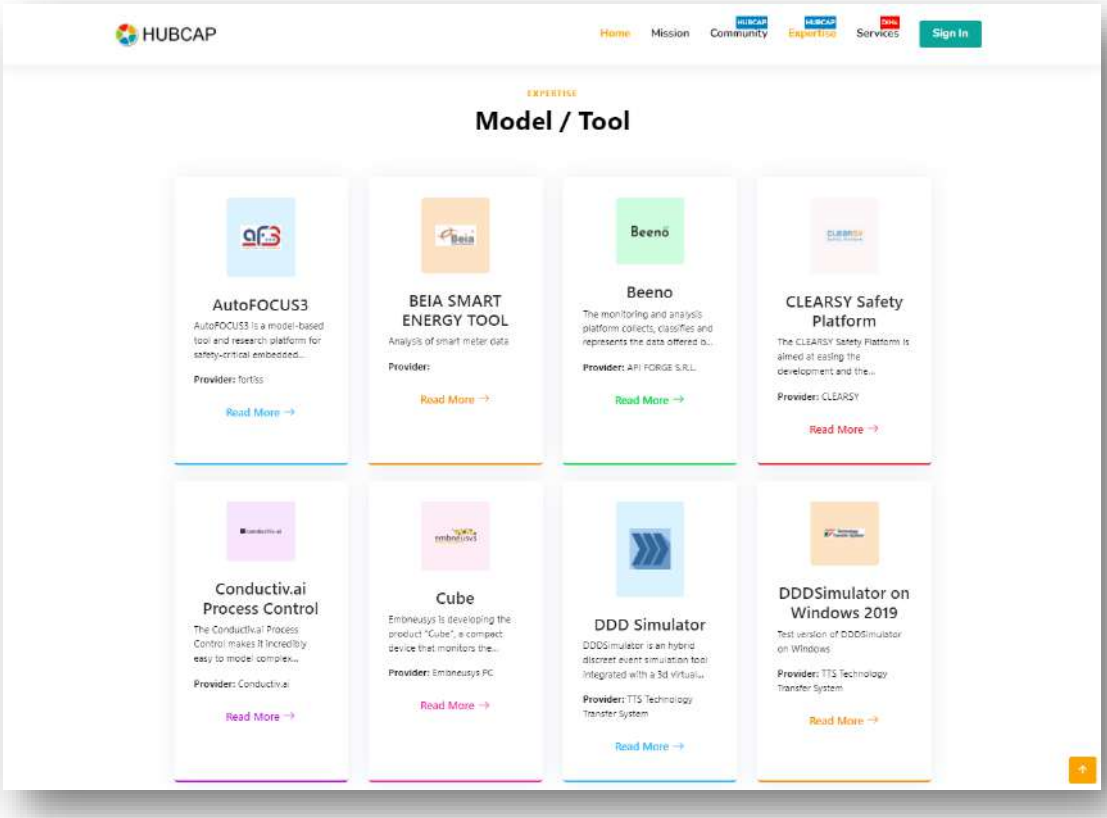


Figure 10 HUBCAP Platform Landing page - Expertise section

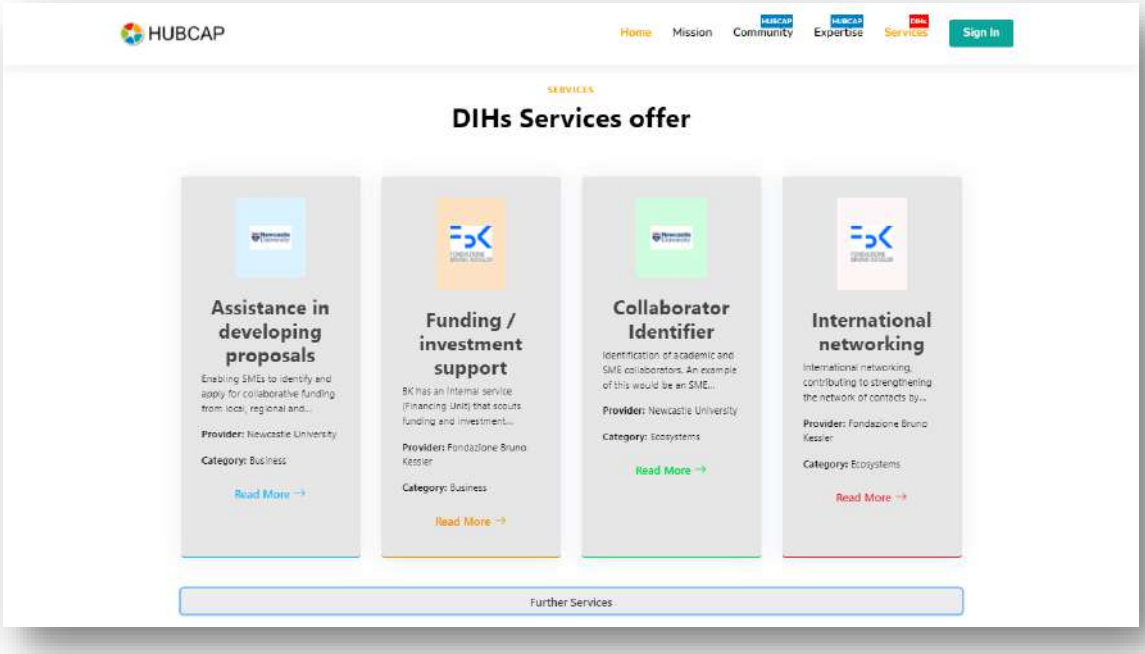


Figure 11 HUBCAP Platform Landing page - Services section

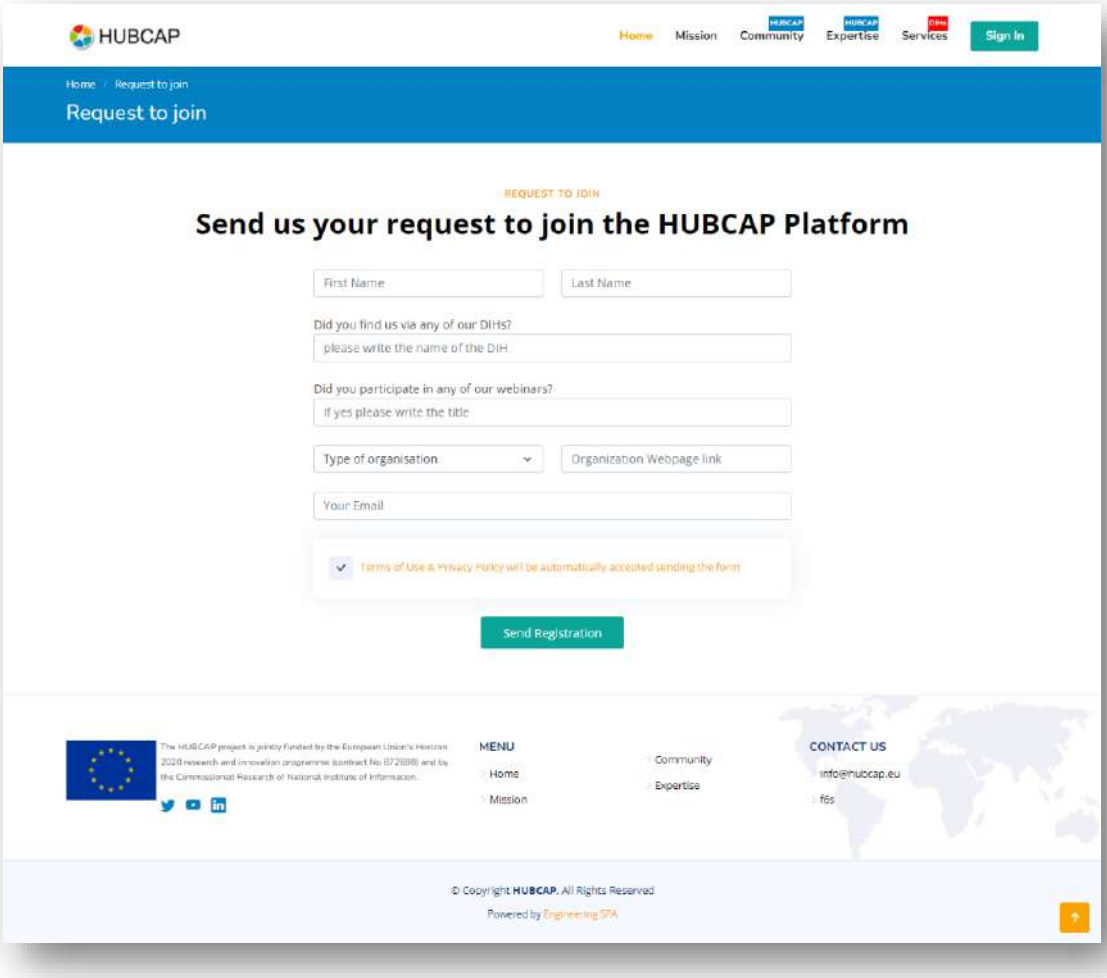


Figure 12 HUBCAP Platform - Request to join

3.3 HUBCAP Sandboxing Middleware

The goals of this third release of the HSM have been tuned by re-collecting and analysing the **feedback** arrived from many different sources (Project Coordinator suggestions, mails from partners using the HSM, needs manifested by the OCs Winners and so on).

From that analysis emerged **three main aspects** which the current implementation has been focused on and here shortly listed with the corresponding areas of development (described in more detail in next paragraphs):

1. **Optimization:**
    a. New Tools Provisioning Lifecycle,
    b. System Resources Control,
2. **Usability:**

a. Revised Web User Interface,

b. Improved Integration between Collaboration Portal and HSM,

3. **Extension:**

a. System Interactive Mode,

b. Licenced Windows.

A lot of effort has also been put into other more general aspects, such as:

- **Security**,
- **KPIs**,
- **User Guides and Video Tutorials**.

3.3.1 HSM Tools Provisioning

3.3.1.1 HSM Tools Requirements

In general, a wide range of CPS tools can be installed and run on the HSM, which is based on Linux KVM virtual machines whose UI (graphical or textual) is made accessible via a regular browser.

This design choice allows to bring to the Sandboxing Middleware many of the tools designed to run on physical desktop computers.

However, tools requiring some special peripherical or hardware device in order to work appropriately (USB stick, graphical processors, …) might encounter some difficulty to run or might not run at all inside a HSM sandbox. Nonetheless, adopting some precautions or tweaks, in many cases they can be installed onto the HSM and used for the experiments.

Such a tool might require a provider to adapt it to a virtual environment (for example by replacing a hardware dongle licence key with a “software” key) or tuning the experiments (for example using simpler 3D models).

The **main requirements** to install and run a tool in the HSM follow:

- the tool must be **installable** and **runnable on a VM**; below those available in the HSM (see Table 1),

Available Operating Systems	vCPU [#]	vRAM [GB]	Min vDisk Usage [GB]	Max vDisk Available [GB]
Windows - Server 2019 Desktop Edition	4	8	16	50
Linux Desktop - Ubuntu 18.04 LTS - Ubuntu 20.04 LTS - CentOS 7 XFCE	2	4	5	50
Linux Terminal - CentOS 7	1	1	2.5	50

Table 1 Specifications for the operating system base virtual machines offered by the HSM

- the tool should also **work without specific, physical hardware dependencies**,
- the tool should only **rely on libraries whose licences allow their execution on cloud** environments,
- the tool should **not rely on special purpose OSes** (e.g., real-time OSes).

3.3.1.2 New Tools Provisioning Lifecycle

Release 3 of the HUBCAP Sandboxing Middleware features a new, well-defined and **optimized** tools provisioning lifecycle that aims to:

- **simplify** the tools installation and maintenance process,
- **prevent** HSM resources waste.

For **each tool** - identified by its name - the HSM now keeps at maximum **two VMs**, corresponding to two versions: production and development.

- The **production version** is to be considered a *stable* version of the tool that other HUBCAP users can try (public),
- The **development version** is to be considered a work in progress version only visible to its owner (private).

3.3.1.2.1 Description

The state diagram shown in Figure 13 illustrates the new mechanism (see online HSM user guide for further details).

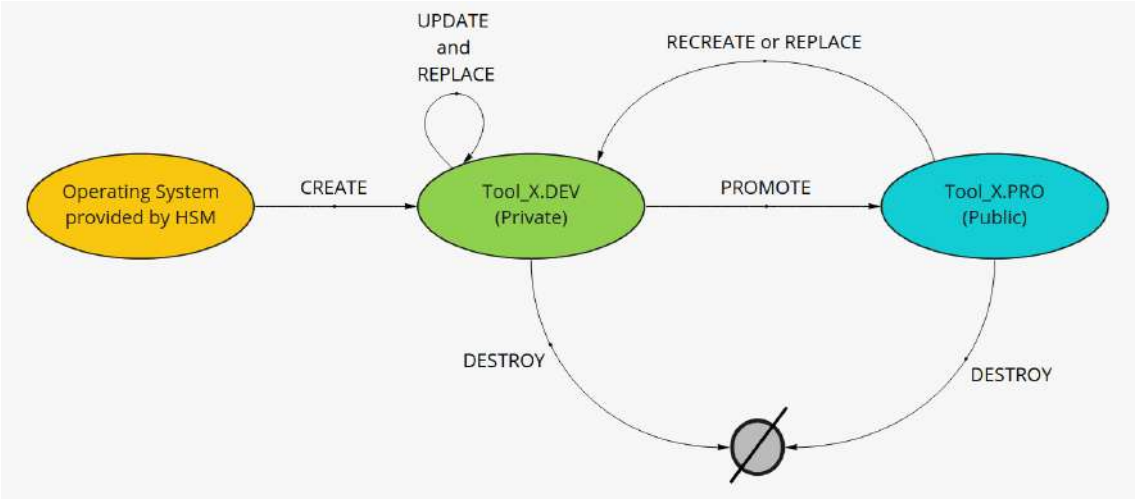


Figure 13 State diagram illustrating the new tools provisioning lifecycle

When HUBCAP Providers want to make a new CPS tool available in the HSM, they:

1 - start a sandbox with an instance of a **base OS VM,**

2 - customise this VM by **installing on it** their CPS software,

3 - save the VM **creating a new development VM** for the tool.

At that point, the Providers can either:

4.a - **update/replace** the development version as many times as they want until a satisfying release is obtained, or

4.b - **promote** it to production version, in which case a new independent copy of the development VM is created and made public.

Moreover, the Provider can:

5 - **destroy** a development version no longer needed,

6 - **recreate/replace** a development version starting from the current production one and from there build a new release of the tool.

3.3.1.2.2 Benefits

This new mechanism brings many benefits to the users and to the system. The most important of them are listed below:

- The development version of a tool - on which the provider can perform any customization, development and testing activities - remains **decoupled** from the production one which can still be used **without interferences** by other HSM users.

- The development version of a tool can be modified by its owner and the **changes saved on the same VM** (whilst in the previous version they had to save a new VM and delete the old one).
- The number of VMs **for a specific tool** is now kept under control (being at maximum two, development and production) avoiding obsolete, forgotten VMs wasting disk space.

3.3.2 Improved Integration between Collaboration Portal and HSM

Each HUBCAP provider can create and own more distinct tools inside HSM (each one identified by its unique name and having its own VM).

The reason for which a tool VM is created in the HSM lies in the Portal Catalogues (e.g., the tool is needed to try a new model, the tool is an innovative one, ….).

So, to each HSM tool must correspond at least one public entry in those catalogues and that, in a certain way, legitimates the system resources usage for the tool VM.

In order to allow this association and to avoid having unnecessary tool VMs, the optimised provision lifecycle takes advantage of the Try It Now links connecting Portal Catalogue entries to HSM VMs.

In particular, for each HSM tool **not linked** to any public portal catalogue entry, its provider periodically receives warning messages (pop-up, emails, …) as reminder to set the Try It Now link.

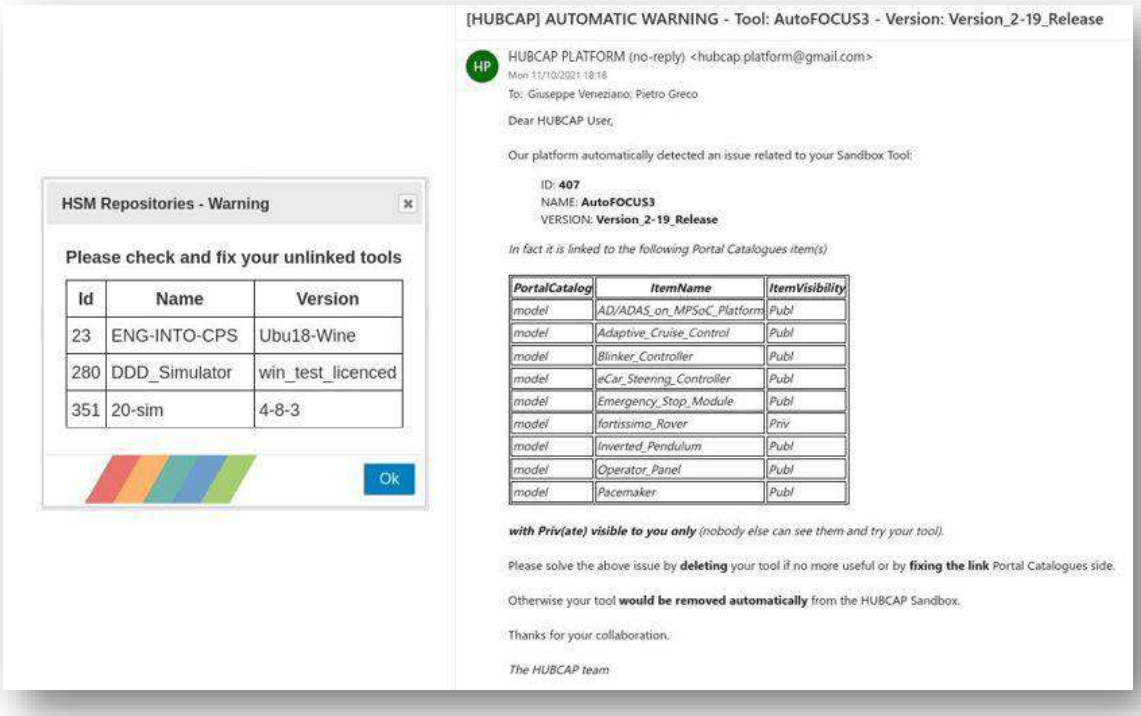


Figure 14 Warning emails and dialogs sent to inform the user about unlinked VMs

3.3.3 HSM Features vs Profiles and Roles – Revised Table

The following table outlines the main HSM functionalities updated to the third release and correlated to the users' profiles and roles for which they are intended.

Feature	Owner Role		Guest Role
	Provider Profile	Consumer Profile	Whatever Profile
Consecutive SIMs	**3**	**1**	-
Access to remote viewer	X	X	X
Upload Archive	X	X	-
Download Archive	X	X	-
Invite Guests	X	X	-
Destroy Sandbox	X	X	-
Select Tool	X	X	-
Select Model	X	X	-
Select Operating System	X	-	-
Save New Development Tool from OS	X	-	-
Update Development Tool	X (their own)	-	-
Promote Development to Production Tool	X (their own)		
Recreate Development from Production Tool	X (their own)		
Change Tool Visibility	X (their own)		
Upload New Model	X	-	-
Delete Repository Item	X (their own)	-	-

Table 2 List of features offered by the HSM along with combinations of profile and roles they are intended for

The **number of consecutive SIMs** represents - with some degree of approximation - the **maximum number of days across which the Sandbox is preserved.** When a user has a profile with this parameter greater than 1, they can resume working the following day on the same sandbox instance from the status left the day before.

3.3.4 System Resources Control

Many checks are implemented in the HSM to maintain the system **clean** and **usable by the highest number of users**.

In particular:

- Each user can only **own one sandbox at a time** but can be **guest of many sandboxes** if invited to them by the corresponding owners.
- In **composing a sandbox**, a user can add at most:
    - ***α*** virtual machines - no matter if instances of tools or OSes - of which only one Windows-based,
    - ***β*** models, without any duplicate,

  (where ***α*** and ***β*** can be tuned at system level).
- In case there were **not enough system resources** to fulfil a new sandbox instantiation request, the user is informed through a pop-up message.
- In case the number of **Windows-based VMs simultaneously running** were already the maximum legitimated by the available Windows licence**,** the system prevents the instantiation of new sandboxes containing further Windows-based VMs.

3.3.5 Revised Web Interface

A lot of effort has also been put into enhancing the **usability** of the HSM web user interface, aspect considered very important for the success of the project.

The main sandbox web UI is now more compact and cleaner as shown in the Figure 15.

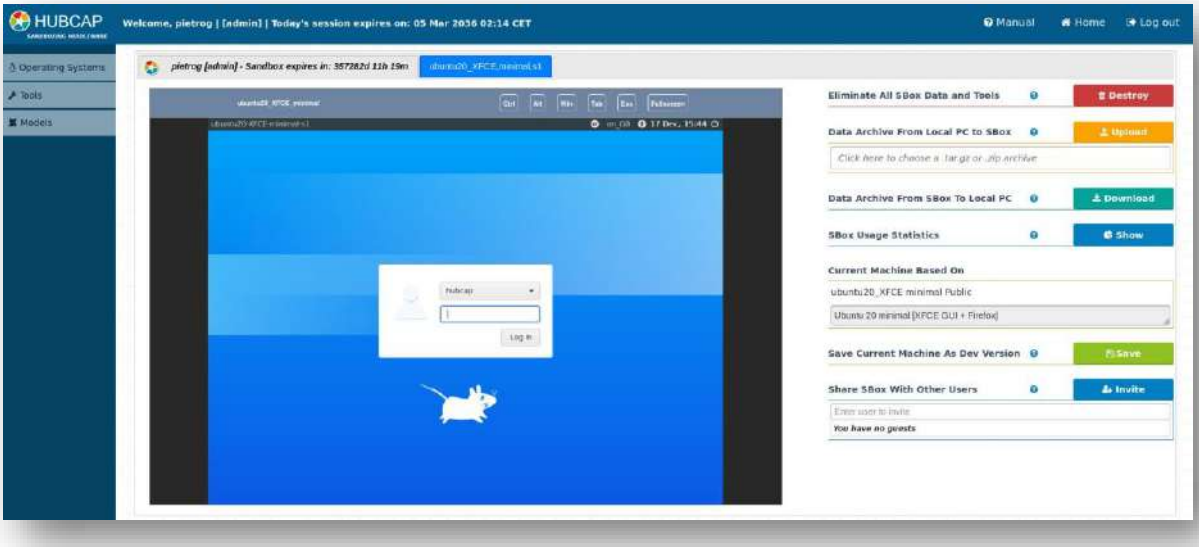


Figure 15 Sandbox web UI

3.3.5.1 Revised Sandbox Viewer Control Panel

The Sandbox Viewer Control Panel - important set of UI controls to interact with a running sandbox - has been graphically revised as shown in the Figure 16 below.

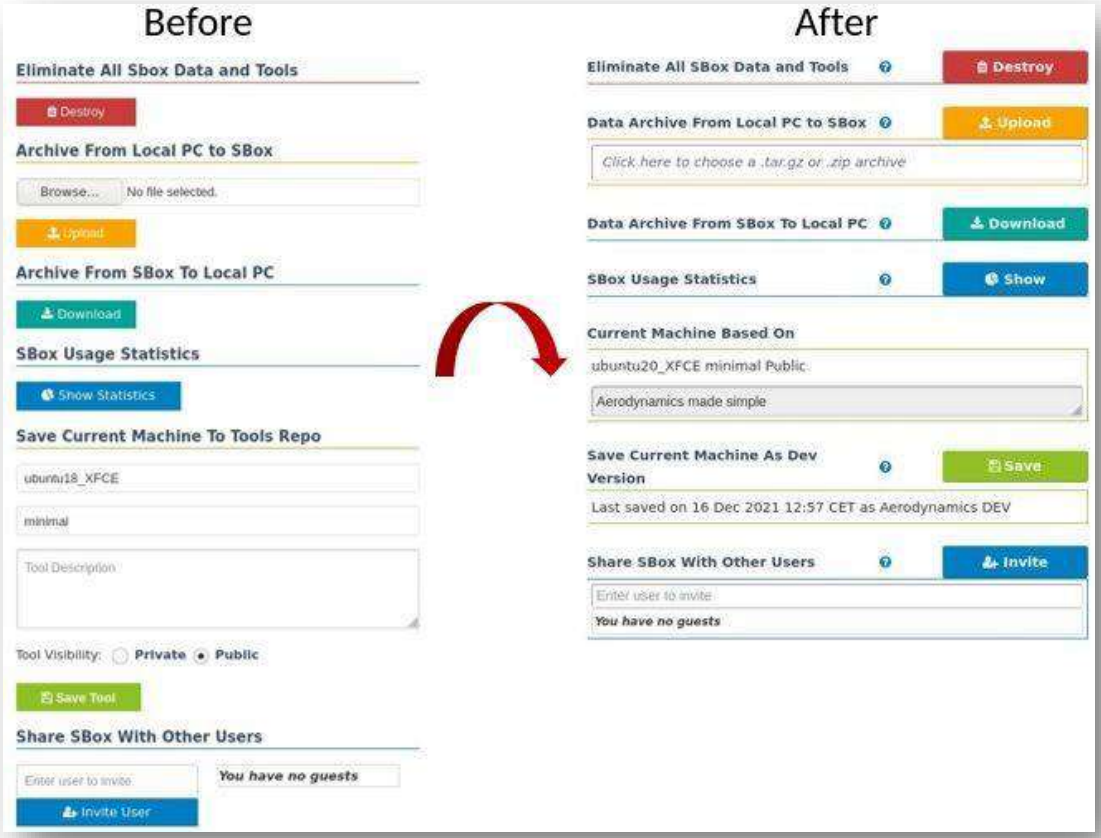


Figure 16 Control Panel before and after the restyling

As it can be noticed, the restyling work consisted of:

- Reallocation of the buttons to the right, reorganization of "*Save Current Machine To Tools Repo*" and "*Share SBox With Other Users*" sections: (*i*) **improved graphical clarity** and **coherence**, thus contributing to cleanliness and reducing the risk of distracting the user; (*ii*) **saved vertical page space,** which allowed to enrich the panel with additional information about currently selected VM (name, version, visibility, description and **last save**),
- "Outset" and "Inset" border effects on the buttons and form fields respectively: **made it clearer** they are UI controls the user can interact with,
- Custom archive upload section: **made it easier** to use the *upload archive to sandbox* function.

Therefore, the changes are not merely aesthetical but also functional and have consequentially been applied coherently to all the other instances of the same UI controls (buttons, form fields, etc...) throughout the web application.

3.3.5.2 *Updated Look & Feel*

Other changes to the UI have been targeted to **optimise accessibility** and **graphical coherence** aspects, and include – as shown in Figure 17: an updated look and feel according to the new theme defined for the Collaboration Portal, a new HSM logo, and a revised session information string. From the picture it can be noticed that:

- the background of the top bar and left menu have been changed (now solid colours, the same used in the Collaboration Portal)
- the logo now includes a “Sandboxing Middleware” subtitle moved from the session information string
- the session information string (highlighted in red) is therefore now shorter, thus improving experience on smaller screens

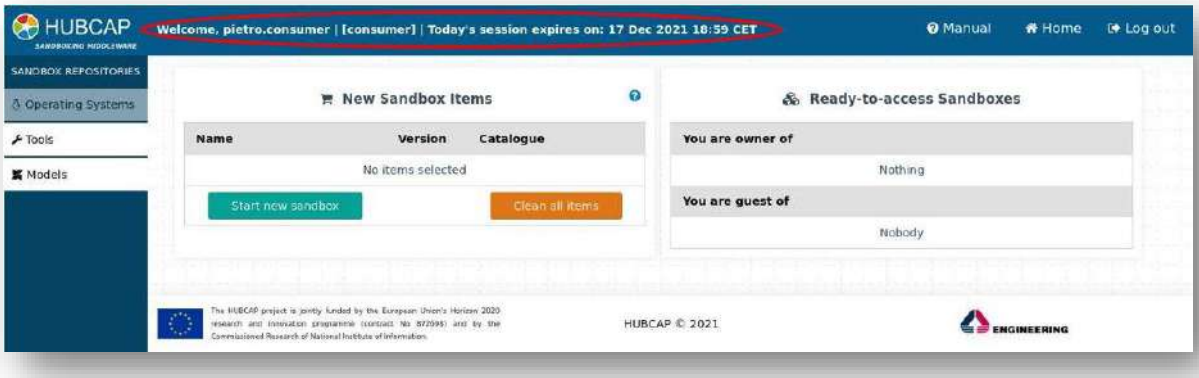


Figure 17 HSM home page featuring updated L&F, logo and session information string

3.3.5.3 *Improved Data Entry – Form Data Retention Mechanism*

To provide users with a **better experience** making the processes of saving or promoting a tool and uploading models **user-friendlier, faster** and **more robust**, a **form data retention mechanism** has been implemented. Now, when a user fills in and submits a form and an error occurs, the form field values previously entered are preserved, thus relieving the user from re-entering them again from scratch. An example is shown in Figure 18. Here, it can be noticed that the form now includes in the top area information about the error that has just occurred, and that the values previously entered have been preserved to be amended by the user.

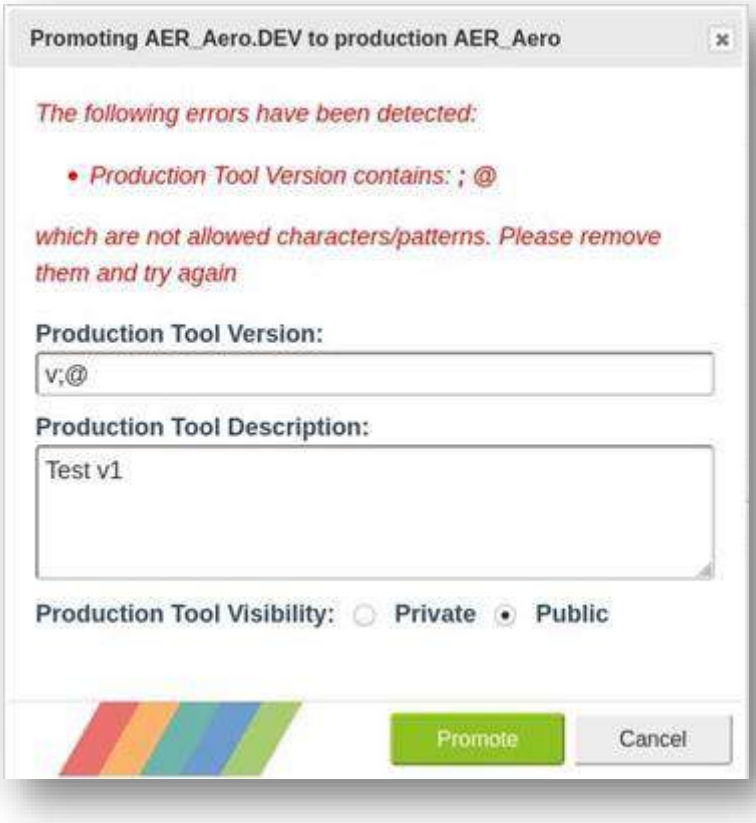


Figure 18 Development VM promotion form showing fields retained after error

3.3.5.4 Confirmation Dialogs

In conjunction to the implementation of the new tools provisioning lifecycle, the HSM UI has also been equipped with a series of confirmation dialogs ensuring that **users are always aware of the consequences of their actions**. Confirmation is asked during tool saving or promotion, and in particular:

- for **tool metadata** entered in save or promote forms
- whenever an existing **development** or **production version** of a tool is going to be **overwritten**

Asking for these confirmations is made possible by a set of **new backend functionalities** able to fetch additional information about tools in repository and user actions within a sandbox. Figure 19 shows the confirmation prompt for a development tool being saved.

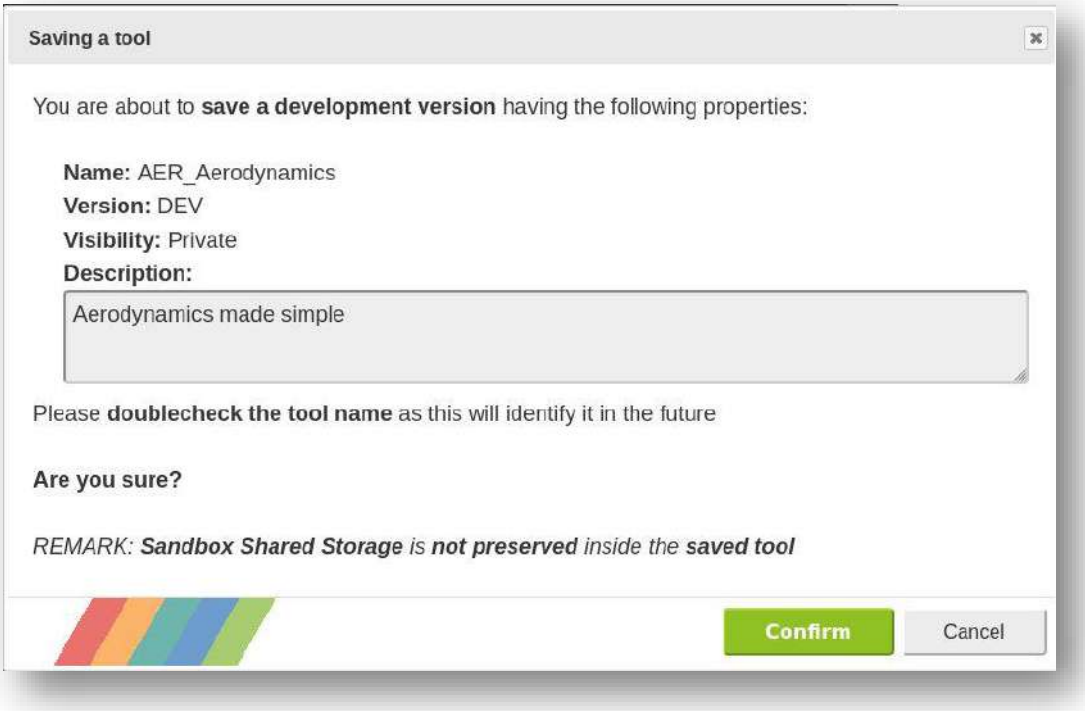


Figure 19 Tool saving: metadata confirmation dialog

Figure 20 shows the confirmation prompt for the promotion of a development tool to production.

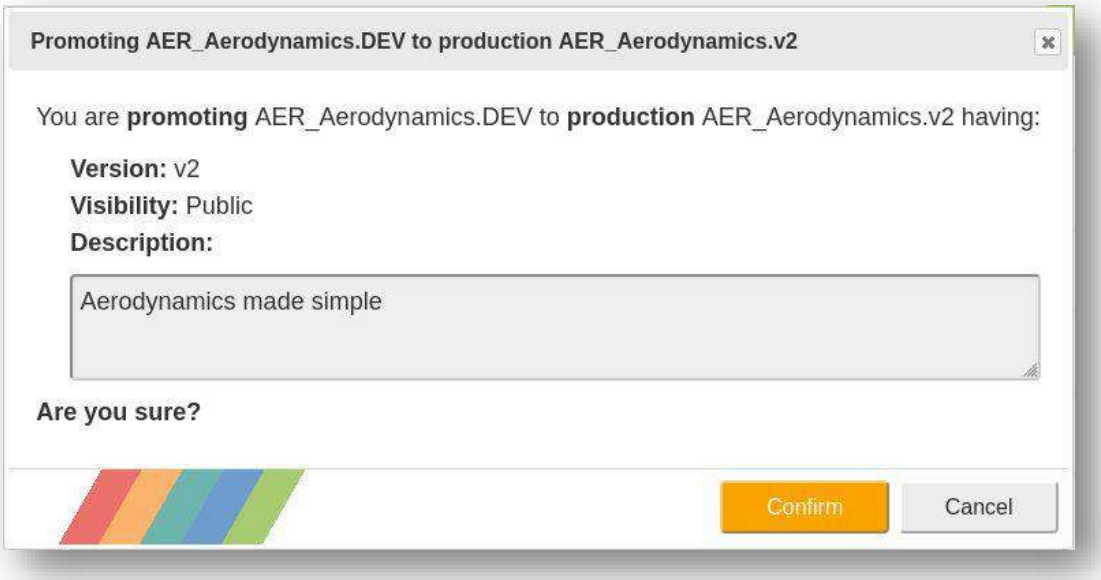


Figure 20 Tool promotion: metadata confirmation dialog

Figure 21 shows the confirmation prompt for the replacement/overwrite of an existing development version of a tool.

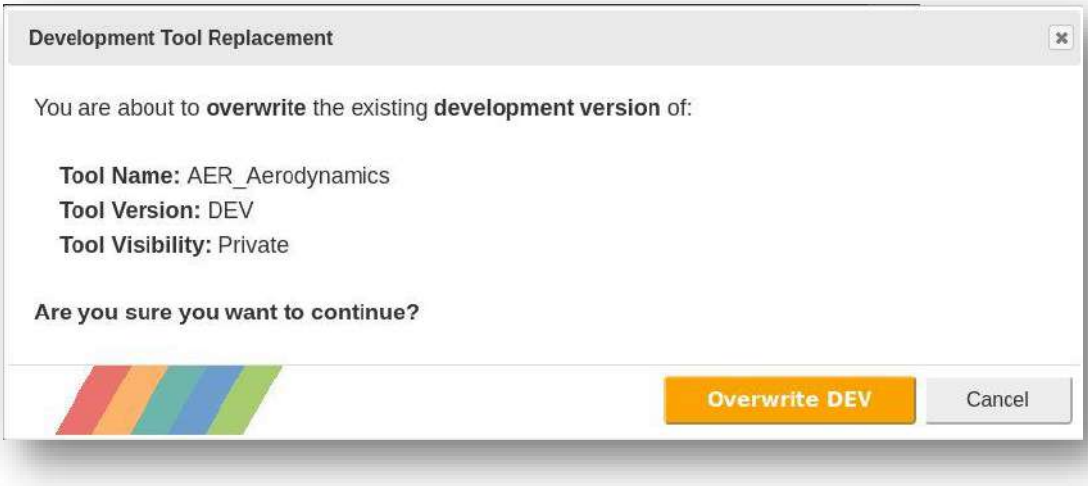


Figure 21 Tool saving: existing development version overwrite confirmation

Figure 22 shows the confirmation prompt for the promotion of a development version of a tool overwriting the existing production version of the same tool.

Figure 22 Tool promotion: existing development version overwrite confirmation

3.3.6 HSM Extensions

3.3.6.1 Timeslot for Accessing the HSM

The daily duration of the interactive web interface of the HSM (SIM) has been extended till **10 hours** (previously this duration was 8 hours) to get more comfortable the CPS tools experimentation inside a sandbox.

3.3.6.2 Repositories

3.3.6.2.1 Licenced Windows

After some research aiming to identify the Windows edition with the most suitable licencing policy to the HSM, the choice fell on **Windows Server 2019.** This edition comes with a desktop GUI and first tests carried out by some partners have already produced positive feedback.

Complementarily and as mentioned earlier, a new mechanism also ensures that the Windows Licence **constraints are enforced** (e.g., maximum number of Windows machines simultaneously running).

With a licenced version of Windows available, an even **wider range of tools can now be brought to the Platform**.

3.3.6.2.2 New Operating System

Upon OC winner request a new operating system VM – Ubuntu 20.04 LTS - has been added to the repository.

In preparing new operating system VMs attention is always paid to removing all those packages not strictly necessary, thus obtaining a VM with a **low disk usage footprint** and **faster to start up, save and promote**.

Moreover, the Linux-based operating systems offered by the HSM are all LTS (**Long Term Support**) as this assures HUBCAP providers to always be able to add the **latest security updates** in their CPS tool installations.

3.3.7 Security

3.3.7.1 Security Assessments

In developing the HSM some security aspects have been ulteriorly refined and consequentially the TLS configuration rating increased as proved by **Qualys SSL Labs** (https://www.ssllabs.com/ssltest/) and shown in Figure 23.

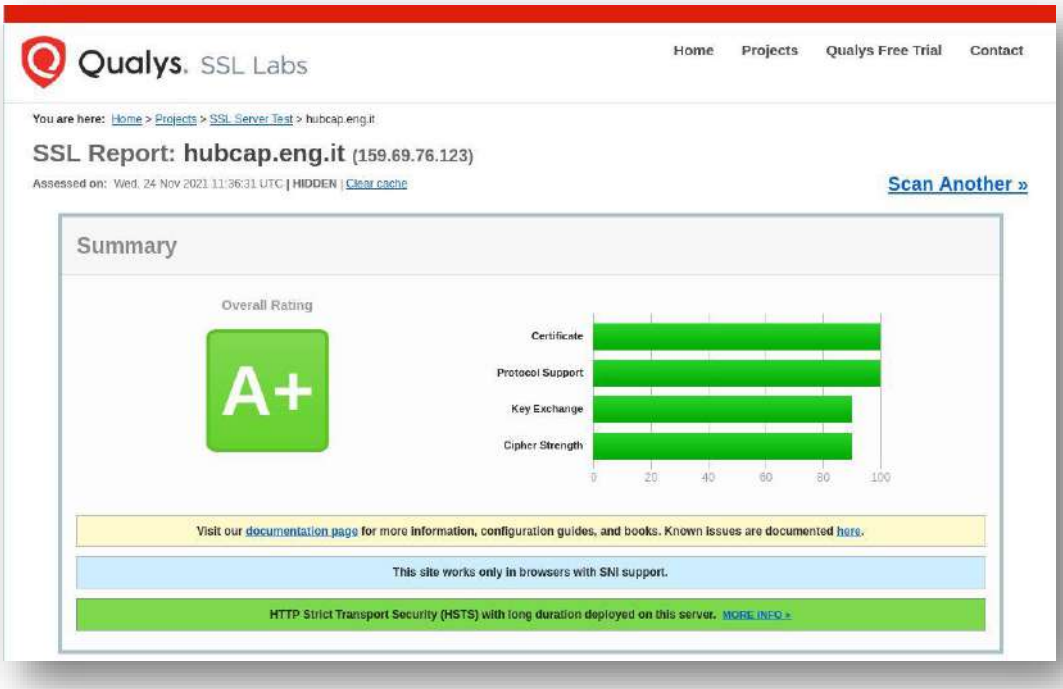


Figure 23 Qualys SSL Labs report showing A+ rating for hubcap.eng.it configuration

Furthermore, the **Vienna Development Method** (Aarhus University) has been used to specify and analyse – security wise - the interactions among tools, models and sandboxes in different scenarios.

3.3.7.2 Data Entry: Dangerous Characters / Patterns Removal

To **prevent a range of injection attacks**, the system does not accept some characters/patterns for tools and models metadata, and in general for information entered by the user. A **series of checks** is carried out, both client and server side, to **detect** and **inform** the user about the existence of such characters. In case of existence of such characters, the user is prevented from going ahead. Also, it is worth noticing that being the checks also carried out client-side, **server load is reduced**. Figure 24 shows a dialog specifying in which fields of the input form dangerous characters were detected and what they are.

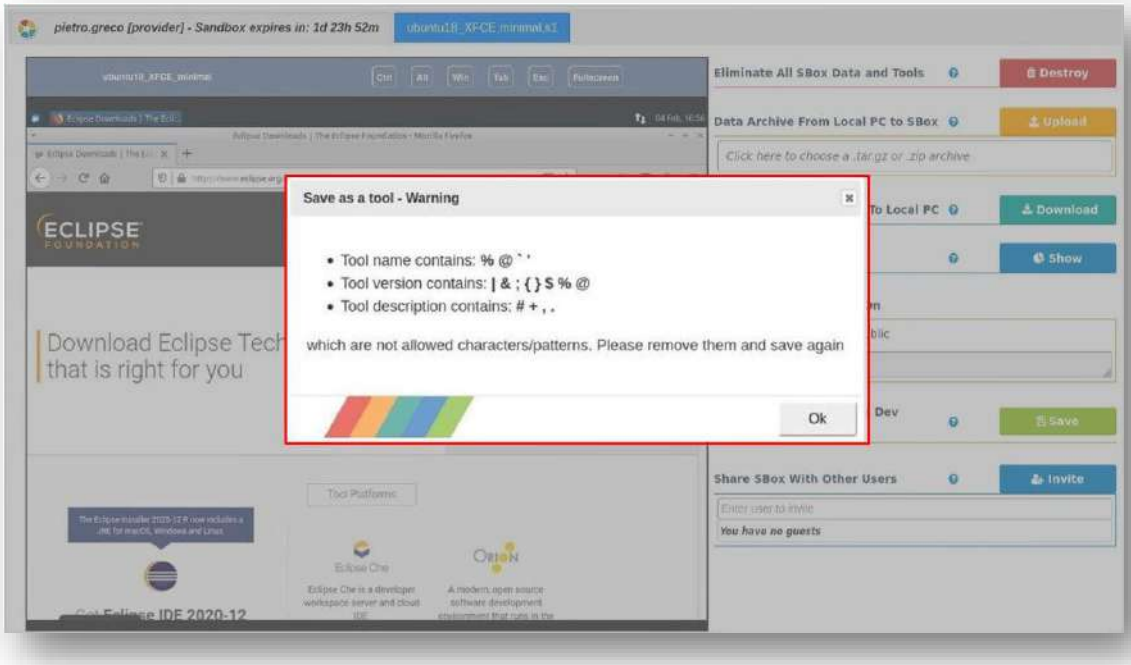


Figure 24 Alert about prohibited characters existence in data entered in save form

3.3.8 KPIs Calculation System

During the period covered by this report **improvements** have also been made to the KPIs calculation system to allow to compute **new KPIs for both the Collaboration Portal and HSM**.

Moreover, the KPIs reports made available online through the Collaboration Portal since the previous release have also been enriched by some interactive charts able to increase the readability of the results. Figure 25 shows an example of interactive chart for the “HSM Users Activities Trend” report. The legend on the right shows all the datasets available for visualization. By clicking on a specific legend item, it is possible to toggle

the visibility of the corresponding dataset. The labels of the datasets that have been hidden will appear crossed out.

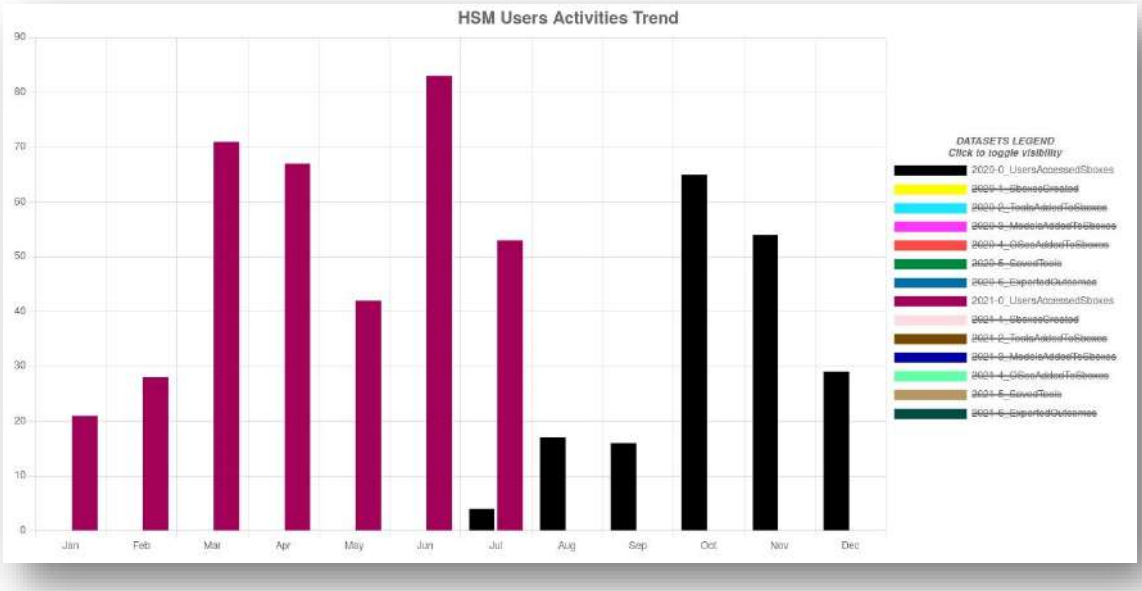


Figure 25 HUBCAP Platform KPI

3.3.9 User Guides and Video Tutorials

The **HSM user guide** has always been kept up to date and enriched since the initial versions of the HUBCAP Platform. Now it is provided online as **WEB pages**, thus being **more comfortable**, **lightweight**, and **easy to handle** in respect to a monolithic PDF. Also, the users can now receive updates earlier too.

Furthermore, links to specific sections of the online user guide have been properly added throughout the HSM web application user interface, **making it easier for users to reach the instructions they need when they need them**. Figure 26 shows an example of such help buttons in the Sandbox Control Panel. By clicking on one of them, the corresponding user manual section is opened in a different tab.

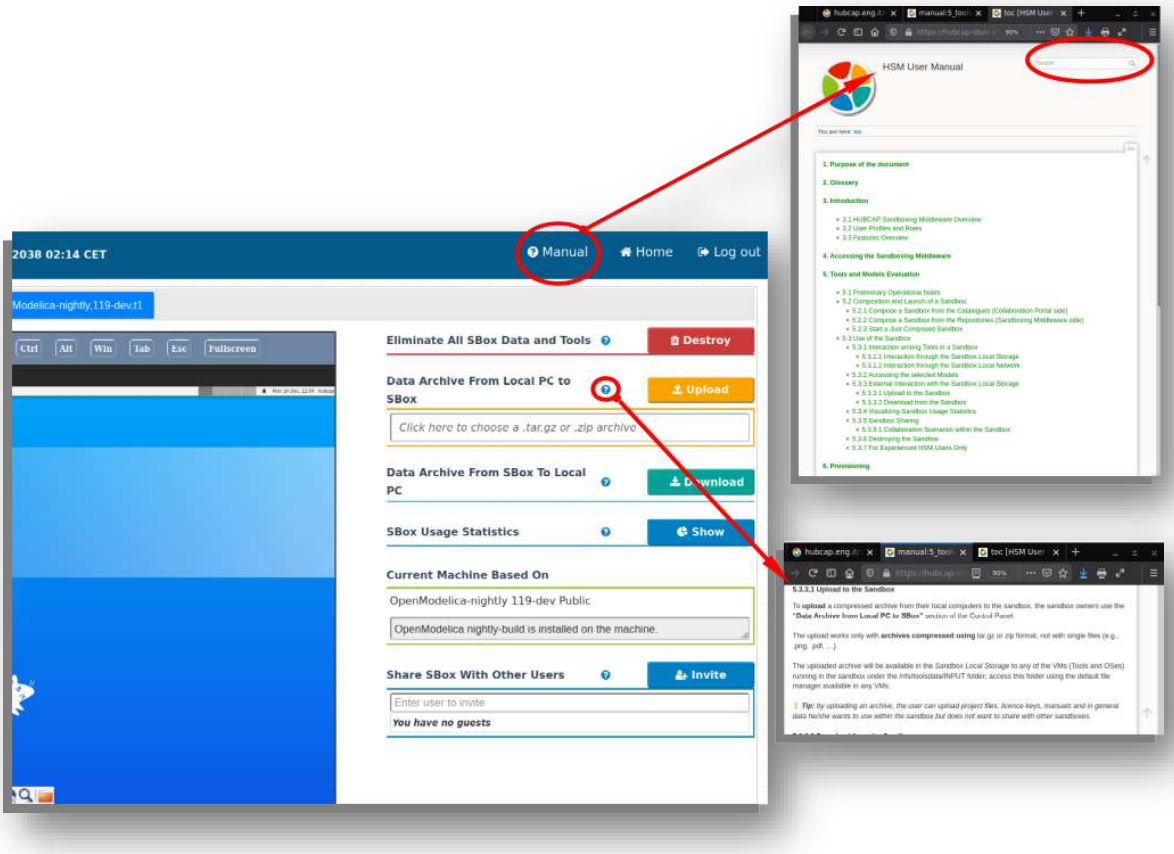


Figure 26 Example of HSM User Guide section on help button

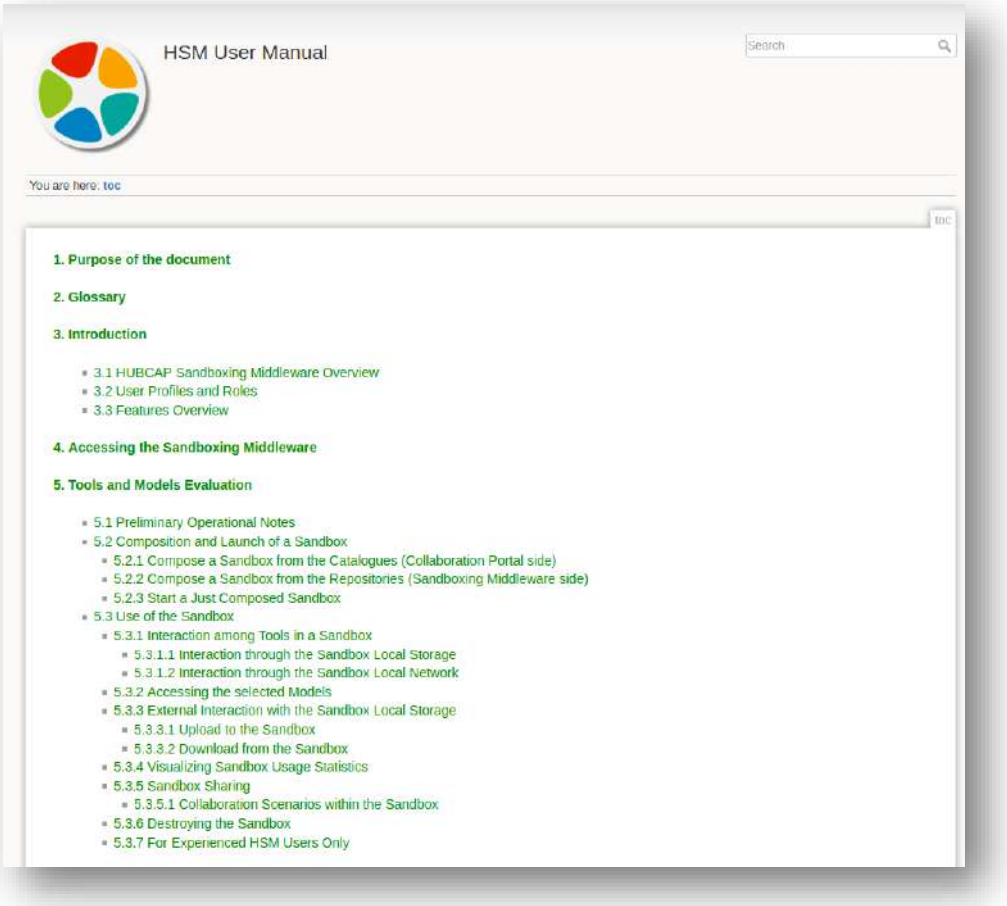


Figure 27 Start page for the online web version of the HSM User Manual

In any case for completeness, a copy of the latest manual is included in this document as Annex 2 – HSM User Manual.

In addition to this, a quick overview of the main features (including the new ones) has been illustrated by the following **video tutorials** made available to the HUBCAP Collaboration Platform users through various distribution channels (Portal Guidelines Section, HUBCAP SVN, YouTube):

- **HSM Tour in 15 minutes** (https://youtu.be/UwCMKHVFMUo)

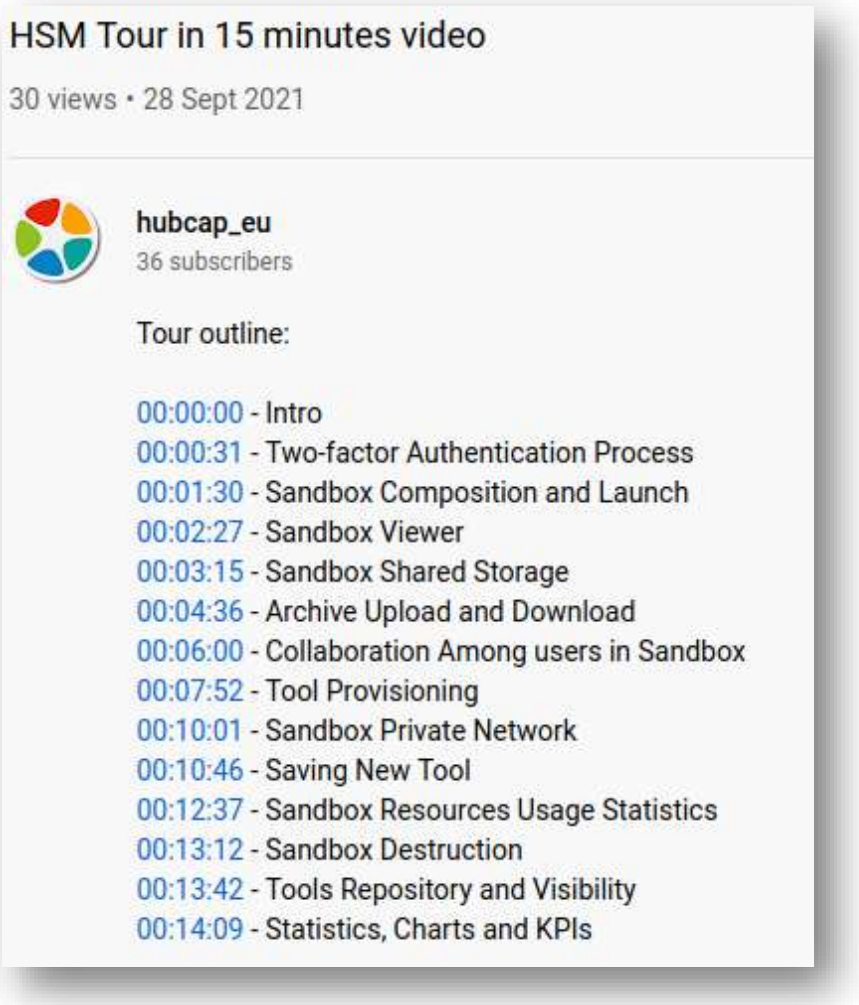


Figure 28 Tour video "chapters"

- **A 15-minute tour inside the HSM RC3** (https://youtu.be/BAsHFarfY-A)

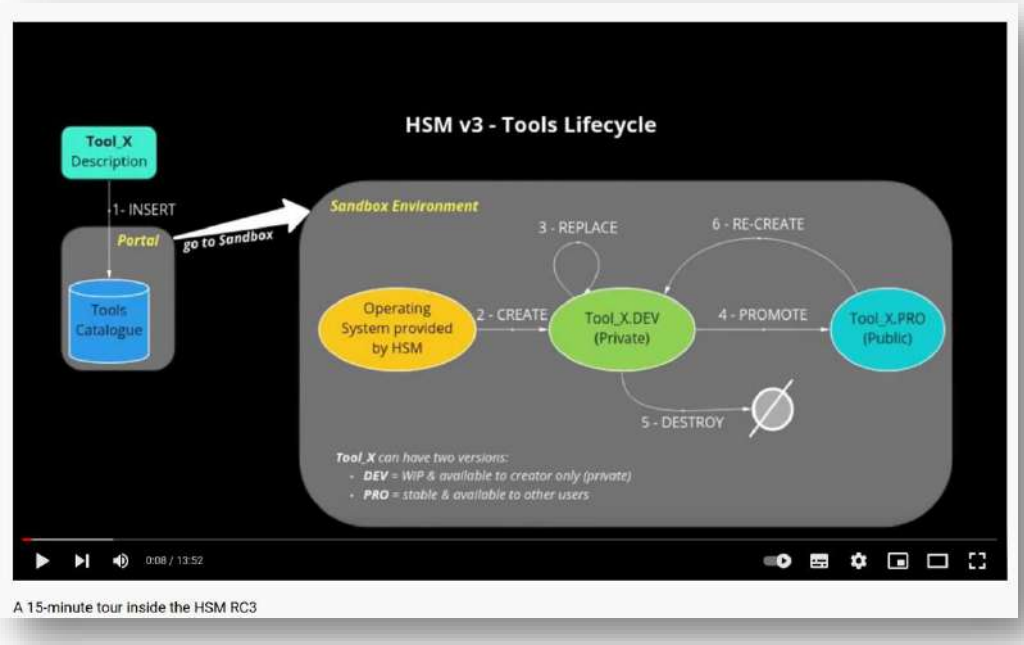


Figure 29 First sequence of the video, showing a state diagram for the new Tools Lifecyle

4 Access Rights for Use inside the HUBCAP Platform and Intellectual Property Rights

The preservation of Intellectual Property Rights (**IPR**) of the HUBCAP assets, in particular tools and models, it is a very important topic that should be tackled from both a **contractual perspective** and a **technological support** one.

Some of the major aspects covered by the IPR related to the **tools** inside the HUBCAP Platform are briefly indicated below:

- **Confidentiality**: each Platform User will treat information from other Platform Users as confidential and not disclose it to Third Parties.
- **Ownership of Knowledge**: it is owned by the Platform User who carried out the work generating the knowledge or by those whose behalf such work was carried out.
- **Access Rights**: Platform Users grant to each of the other Platform Users royalty-free access right to knowledge generated in the project to the extent needed to successfully perform the project.

All IPRs created or developed by participating in HSM must be clear and fairly easy to be followed. For this even a certain **contract** can be established between the Platform Users. They are important because both the HSM and the tool are confidential and can be accessed only by certain Platform Users.

The Platform Users and Clients must consider both the intellectual property rights related to the usage of the HUBCAP Platform and also of the tools that are provided by the platform.

On the other hand, the HUBCAP Sandboxing Middleware (HSM) offers several **technical features** to support the IPR. In the Deliverable 5.3 this topic has been described in detail (***§1.2 Tools IPR protection***), but its main aspects are recapped here:

- **Only tool owners can re-save their tools**. A provider **cannot save a customized, new version of a tool** provisioned **by other providers,** meaning that:
    - Tools unlocked with **product keys** won't be cloned
    - Some **licence constraints** will be respected
    - **Proprietary configurations** will be prevented from being shared
- The **providers** can set their tools visibility in the HSM Tools Repository to either **private** or **public.**
    - **Public tools** are visible in the repository to all the HSM users
    - **Private tools** are visible only to their owner/creator
    - **Private tools** can be used by **HSM users other than the tool owner**, but only if they are invited as **guests** by the private tool owner.
      In such a way, the selected guests will be able to **collaborate** with the tool owner and under their supervision on a private tool not visible to them directly.
- The tools providers have the **full control over the HSM VM** on which they install their tools. Therefore, they can exploit all the VM OS features (e.g., setting permissions to access folders, restricting the tool execution to unprivileged users, and so on) and/or their tools distinctive protection to ensure tools IPR.

In the Annex 1 - IPR BEIA Use Case there is a description of a Use Case related to a provider and HUBCAP partner.

5 Conclusion

This project is an opportunity to provide a cloud-based platform to underpin the ecosystem and enable collaboration through servitization of MBD tools.

This objective was tackled by analysing the available practical experiences already performed by the HUBCAP initial seed SME partner and DIHs network and taking into account comments and feedback coming from the Open Call winners who were the first Platform end users.

There are still open issues which will be addressed in future releases, together with some HSM refinements. In particular:

- Portal Search and Filter Capabilities improvements,
- Portal User Experience enhancement,
- Identification of specific customer types (personas) to create distinctive user experience maps able to generate insights and action plans for the system improvements

The HUBCAP Platform could benefit of the joint efforts of different Consortium members in tackling these challenges starting to work on that for next releases.

Annex 1 - IPR BEIA Use Case

Related to the Intellectual Property Rights, Beia will make the Smart Energy Tool available within the HUBCAP Sandboxing Middleware, and shall grant non-exclusive, non-transferable rights and licenses to the other Parties (i.e., platform users) for the execution of their tool. These rights will be limited for the duration of the HUBCAP Project and for the exclusive use of research in the Project.
However, the Parties concerned may decide to agree otherwise and grant such access rights against payment of fees, especially in the case where the “exchanges” are unbalanced. Access Rights to the application “Needed” for the execution of the Smart Energy Tool under the HUBCAP Project shall be granted on a royalty-free basis.
The possible users that are registered in the HUBCAP Platform are able to access the Beia Smart Energy Tool through a certain user and password provided by Beia automatically through the Web interface of the Smart Energy Tool (see Figure 30). Whilst the sandboxing protects the tool consumers by guaranteeing a protected way to access and safely run software of interest, tool provider’s IPR for a specific tool running in a Sandbox can be controlled by means of the functionalities described in section 4.

In this way, interested clients can test the tools on the HUBCAP Platform without actually buying them and in accordance with the IPR

Further enforcing respect for BEIA’s IPR, the Beia Smart Energy Tool offers some pre-existing characteristics for the possible users to test its functionalities.

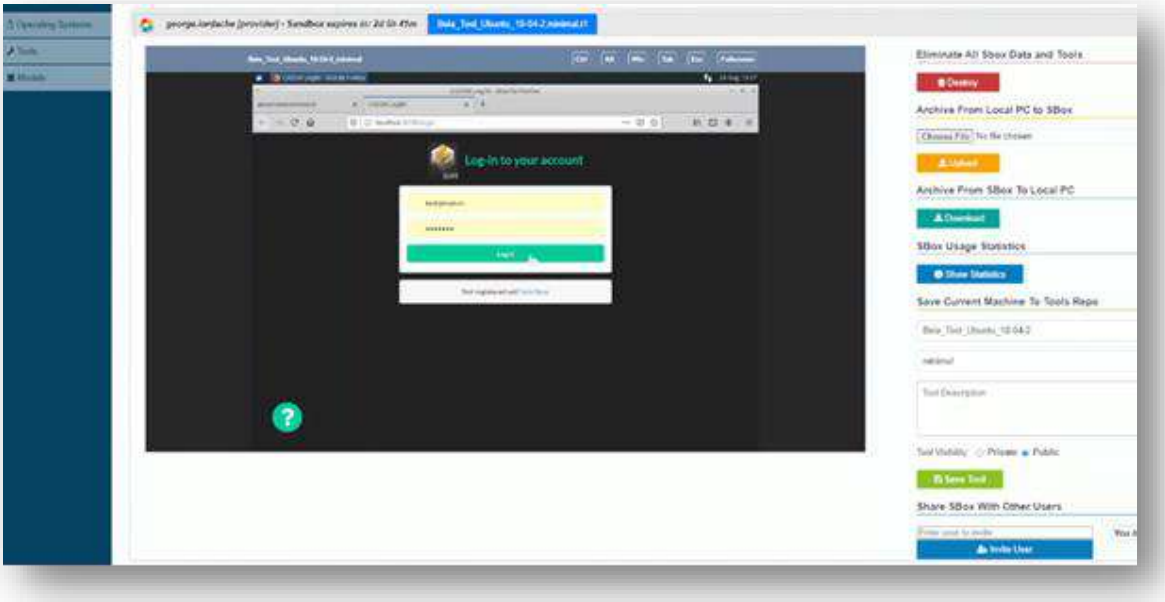


Figure 30 Web UI with already existing user and password to the Beia Smart Energy Tool

Figure 31 Pre-existing scenarios in the Smart Energy Tool

In particular, Beia offers limited features to its Smart Energy Tool by using reduced data functionalities, and any user that wants to get access for more functionalities should negotiate these intellectual property rights with Beia Consult International.

Access Rights for Use outside the HUBCAP Platform

The access rights to the final version of the Smart Energy Tool may be granted on fair and reasonable conditions defined in a contract, which shall be negotiated outside the Project.

Any Access Rights granted expressly exclude any rights to sublicense unless expressly stated otherwise.

Annex 2 – HSM User Manual

HUBCAP Sandboxing Middleware

User Guide

Version 1.8
Sandboxing Middleware v3 (Updated to 2021-12-23)

Table of Contents

Document History

Version	Date	Author(s)	Description
V0.8	2020-07-27	Pietro Greco, Giuseppe Veneziano	
V0.9	2020-08-27	Pietro Greco, Giuseppe Veneziano	Replaced old images, added new images, extended tools provisioning paragraph
v1	2020-09-26	Pietro Greco, Giuseppe Veneziano	Updated §3.3. Feature overview table for Sandbox
v1.1	2021-01-28	Pietro Greco, Giuseppe Veneziano	Updated glossary (“OSes -> “Operating Systems”), modified paragraph on role of temp password in §4. picture of home page with full cart now replaces cart-only image. Added note on selected Models availability within the Sandbox Shared Storage in §5.1. Added notes
v1.2	2021-02-04	Pietro Greco, Giuseppe Veneziano	
v1.3	2021-06-14	Pietro Greco, Giuseppe Veneziano	Updated log in process description, included references to additional conditions for User Sessions Expiration and corresponding changes to UI, added note on one-session-only policy, updated images
V1.4	2021-06-25	Pietro Greco, Giuseppe Veneziano	Added chapter on KPIs
v1.5	2021-07-23	Pietro Greco	Added note on new two pop-ups dialogs and associated checks. The first dialog informs the user about invalid characters entered in the save as a tool form. The second one, always shown during the saving of a tool, asks the user to confirm the entered tool name, version and visibility. Also updated the pictures for the new theme and changes to UI.
v1.6	2021-10-11	Pietro Greco	Updated some images to reflect the fact that now Tool description is shown in Sandbox Viewer. Added step 15 in Tool Provisioning procedure to inform users that they should use the Try It Now function (establishing the link)
v1.7	2021-11-08	Pietro Greco, Giuseppe Veneziano	Updated tools provisioning section to consider the new tools lifecycle available since RC3. Already existing content regarding Tools Provisioning has been rearranged
v1.8	2021-11-19	Pietro Greco, Giuseppe Veneziano	Various enhancements to the chapters in order to shorten and simplify the overall user guide

1. Purpose of the document

The HUBCAP Collaboration Platform is composed of two main sub-systems:

- a Collaboration Portal and
- a Sandboxing Middleware.

The purpose of this document is to describe how to use the functionalities offered by the **HUBCAP Sandboxing Middleware** (hereafter ***HSM***). However, given the integration between the two subsystems, throughout the text the Collaboration Portal will be referred to as: portal, portal side, (portal) Catalogues.

Videos illustrating some of the HSM functionalities presented in this guide are available in the guidelines section of the Collaboration Portal and in the project's YouTube channel

2. Glossary

Term	Description
Sandbox	Isolated set of running tools, operating systems and models featuring a dedicated local network and a shared storage
Sandbox Local Network	A TCP/IP Network available to all the tools and operating systems in a Sandbox. Each sandbox has its own network.
Sandbox Local Storage	A folder shared by all the tools and operating systems in a Sandbox. Each sandbox has its own storage.
Sandboxing Middleware	Provides a protected environment where CPS tools and models can be safely evaluated inside sandboxes
One Session Password (OSP)	A temporary password sent by the system to the user who requested access to the Sandboxing Middleware
Sandbox Viewer	Web page through which it is possible to interact with all the sandbox components
Remote Viewer	The section of the Sandbox Viewer allowing the users to access remotely to the desktop or terminal interfaces of tools and OSes running in a sandbox

System Interactive Mode (SIM)	Every day the HSM switches between two modes: interactive and batch. During the first one a HSM user can interact with a sandbox via the sandbox viewer.
Operating System	A minimal installation of a Linux or Windows OS ready-to-use inside a sandbox for installing a CPS tool
Tool	CPS Software for Model Based Design which has been added to the Tools Repository
Model	Archive containing files and directories implementing a CPS model usable inside a sandbox
Repository	List of sandbox-instantiable operating systems, tools and models
Catalogue	Set of entries available in the Collaboration Portal describing a CPS tool or model
Collaboration Portal	It is the entry point of the Collaboration Platform. It provides access to a set of functionalities and assets conceived to foster collaboration among project stakeholders.
Collaboration Platform	Platform resulting from the combination of the *Collaboration Portal* and *Sandboxing Middleware*

3. Introduction

3.1 HUBCAP Sandboxing Middleware Overview

The HUBCAP Sandboxing Middleware (**HSM**) provides an environment where several sandboxes can be executed concurrently without interfering with each other.

It is mainly composed of:

1. **Software Orchestrator:** needed to manage the environment and make it operational.
2. **Repositories:** containing tools, models, operating systems used as templates to create new running instances.
3. **Sandboxes:** each sandbox is a set of running tools, operating systems (OSes) and/or models connected through a virtual, private and isolated network; the sandbox tools and OSes also share a dedicated storage (Figure 1).

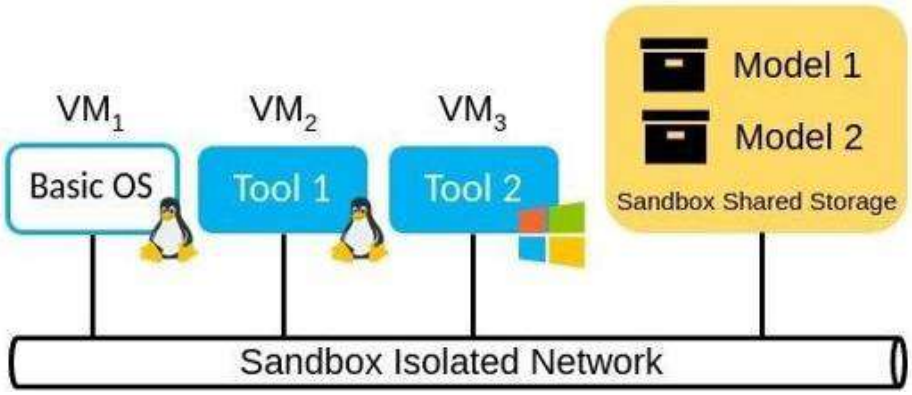


Figure 1 - Structure of a Sandbox Instance

Each sandbox is **instantiated dynamically** by a platform user by picking up a set of items from the repositories:

- Operating Systems
- Tools
- Models

Different users can instantiate different sandboxes that can later be shared with other users.

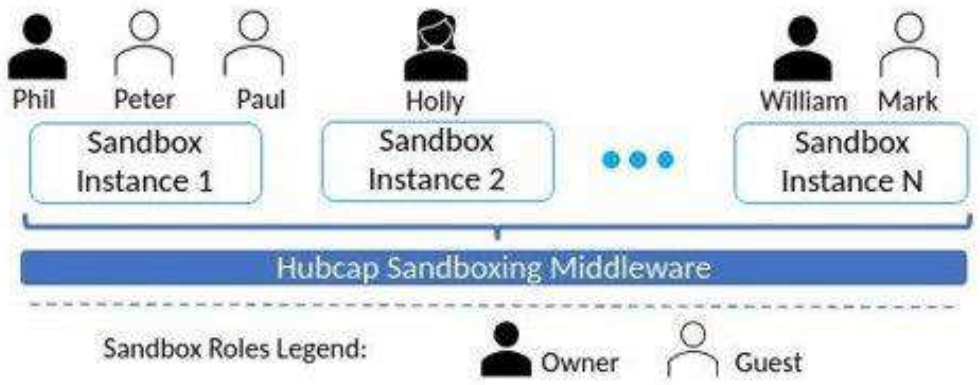


Figure 2 - Several sandboxes instantiated by different users running on the Hubcap Sandboxing Middleware

3.2 User Profiles and Roles

Each HSM user is characterized by a **profile** and one or more **roles**.

Profiles

A **profile** determines to which **functionalities of the Sandboxing Middleware** a Collaboration Platform user can access. One specific profile must be pre-assigned by the Platform administrator to each user in order to **allow the access to the HSM**.

Currently the following profiles have been implemented:

- **Provider:** can
  - instantiate sandboxes selecting operating systems, tools and models already available in the HSM repositories,
  - install a CPS tool on an operating system provided by the HSM,
  - save a tool to the HSM Tools Repository,
  - upload a model to the HSM Models Repository,
  - delete tools or models they have previously added to the HSM Repositories.
- **Consumer:** can instantiate sandboxes just selecting tools and models already available in the HSM Repositories.
- **Null:** cannot access the HSM.

Roles

A user logged in to the HSM can access to more sandboxes and **for each sandbox a specific role is assigned** to him/her. Each **role** defines to which **functionalities of a specific sandbox** a user can access.

Currently the following roles have been implemented:

- **Owner**: is a HSM user that **instantiates a new sandbox**. As an owner, they can:
    - destroy their own sandbox,
    - share it with other HSM users (who become their guests)
    - upload or download local archives to/from the sandbox.
- **Guest**: is a HSM user invited to access one or more sandboxes which they are not the owner of. All the guests of the same sandbox can collaborate with each other and with the sandbox owner sharing screen, mouse and keyboard of each tool or operating system within the sandbox. A guest cannot upload or download archives, destroy or share the host sandbox.

So, a Collaboration Platform user

- has **one HSM profile** (provider, consumer, null)

and, if they can access the HSM, they

- can be **owner** of **only one** sandbox instance at a time,
- can be **guest** of **many** sandbox's owners.

3.3 Features Overview

The following table outlines the main functionalities made available by the HSM as well as the combinations of users' profiles and roles for which they are intended.

Feature	Owner Role		Guest Role
	Provider Profile	Consumer Profile	Whatever Profile
Consecutive SIMs	**3**	**1**	-
Access to remote viewer	X	X	X
Upload Archive	X	X	-
Download Archive	X	X	-
Invite Guests	X	X	-
Destroy Sandbox	X	X	-
Select Tool	X	X	-
Select Model	X	X	-
Select Operating System	X	-	-
Save New Development Tool from OS	X	-	-
Update Development Tool	X (their own)	-	-
Promote Development to Production Tool	X (their own)		
Recreate Development from Production Tool	X (their own)		
Change Tool Visibility	X (their own)		
Upload New Model	X	-	-
Delete Repository Item	X (their own)	-	-

The **number of consecutive SIMs** represents - with some degree of approximation - the **maximum number of days across which the Sandbox is preserved.** When a user has a profile with this parameter greater than 1, they can resume working the next day on the same sandbox instance from the status left the day before.

4. Accessing the Sandboxing Middleware

To access the Sandboxing Middleware, the users first have to log in the Collaboration Portal home page at the URL https://hubcap-portal.eng.it/ and then click on “Sandbox Environment” button in the left sidebar:

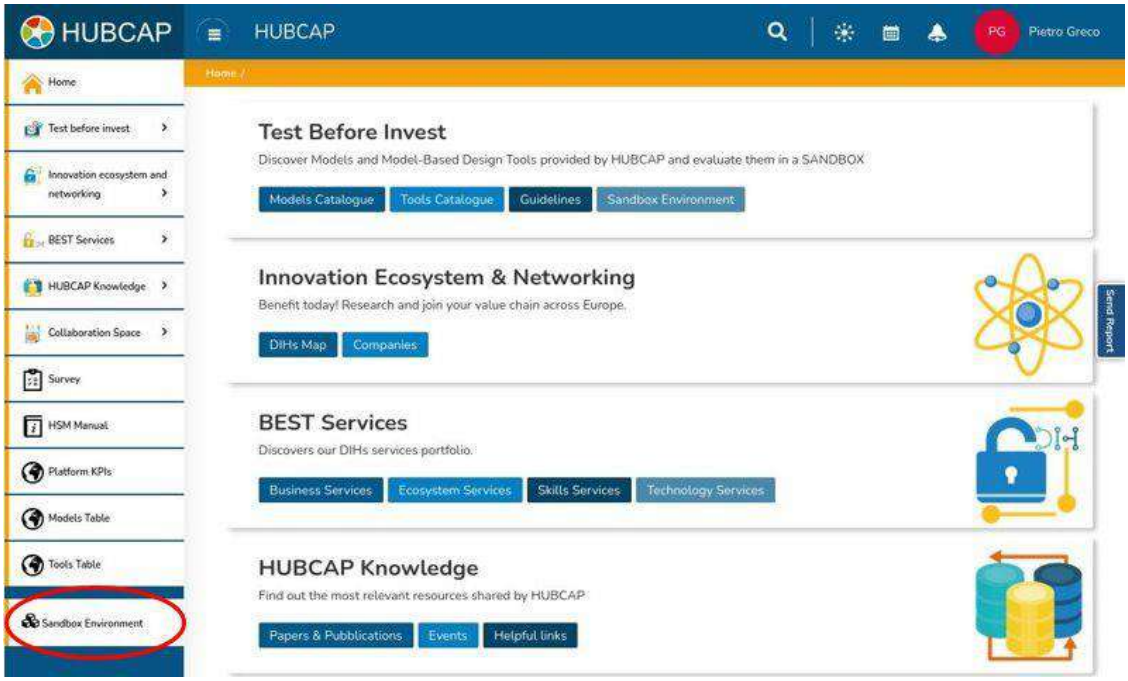


Figure 3 - Collaboration Portal Main Sidebar Menu

Currently there are **two modes of operation** for the HSM:

- **System Interactive Mode**: daily time slot within which users **can log in to** and use the middleware interactively
- **System Batch Mode**: entered when the *Interactive Mode* is over. The users **can no longer log in**, but sandboxes instantiated during the Interactive Mode will keep on running.

If the **Batch Mode is on**, a dialog will inform the users that temporary they cannot access the HSM.

If the **Interactive Mode is on**, a dialog will say whether a new **One Session Password** (hereafter also **OSP** - a temporary password to access the HSM) has been sent to the user’s email address or the one previously received is still valid.

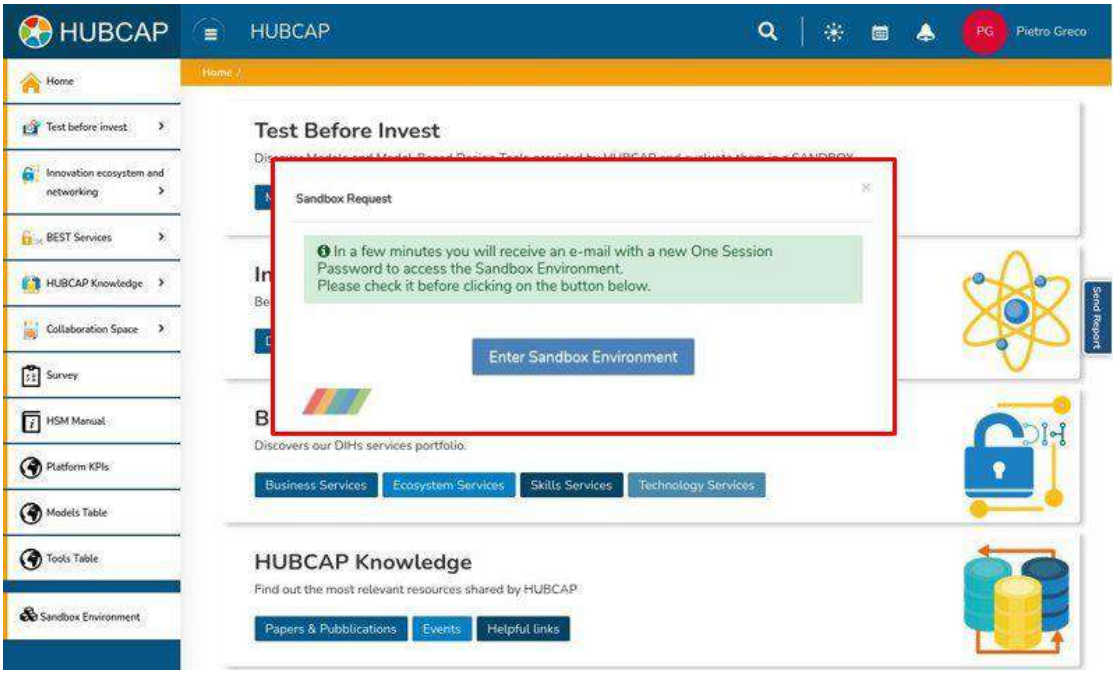


Figure 4 - Collaboration Portal showing dialog informing user that a new OSP has been sent to their email address

At that point, by clicking on “Enter Sandbox Environment” dialog button, the system will open the HSM welcome page in another tab.

In the HSM welcome page a dialog pops-up allowing the user to enter the credentials (Username and OSP) received by email:

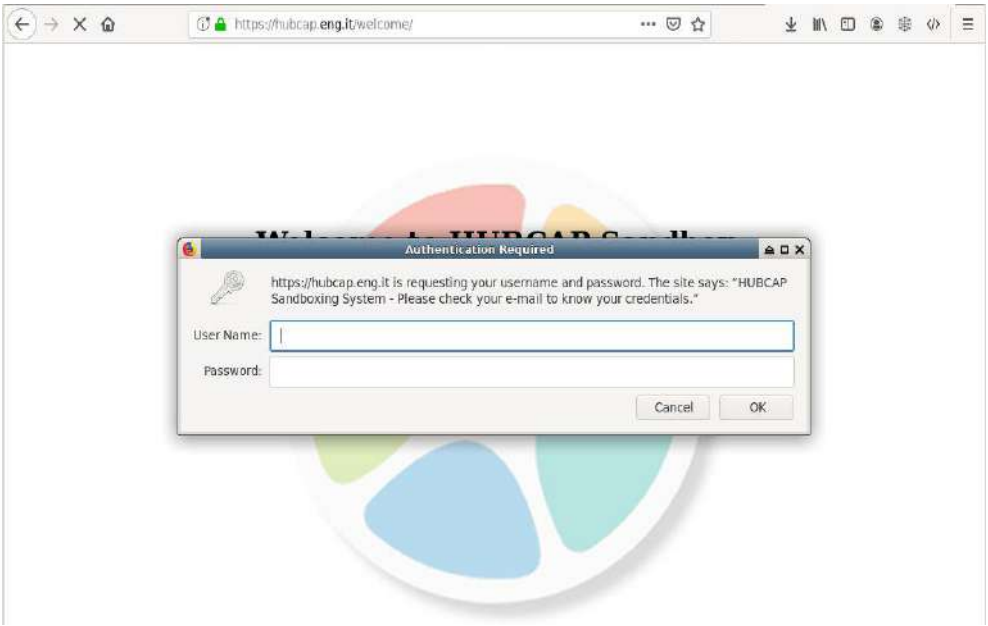


Figure 5 - Sandboxing Middleware Welcome Page showing the login form

Note: *some browsers (e.g., Chrome) could block the Sandboxing Middleware welcome page pop-up, in this case please change the browser configuration to*

accept it

After a successful authentication, the HSM home page will be displayed:

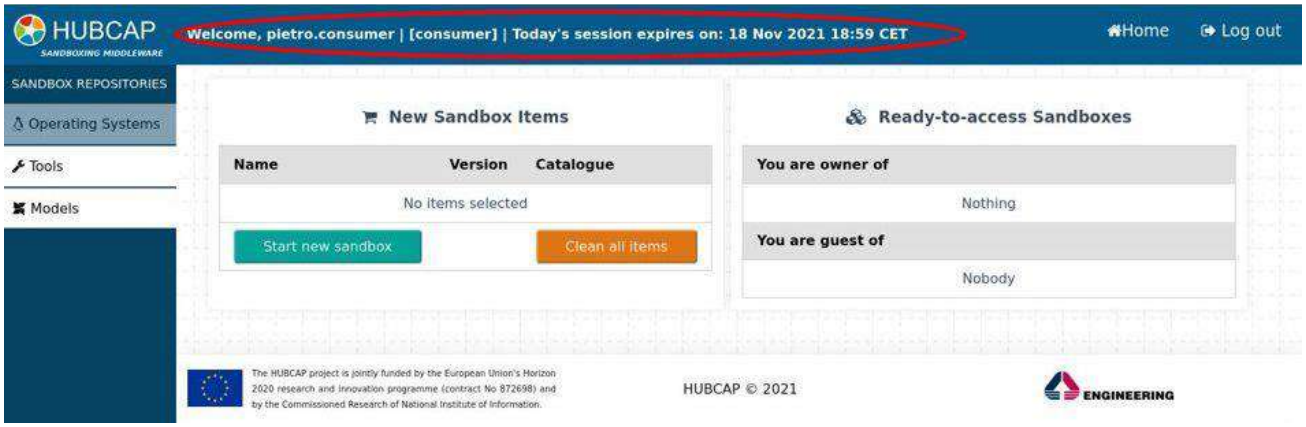


Figure 6 - Sandboxing Middleware Home Page

The One Session Password and thus the corresponding user session are only valid for a predetermined period of time, which is shown in the upper bar in the figure above.

Moreover, the **OSP expires**:

- when the user clicks on “Logout”
- at the end of the *daily timeslot* (the **System Interactive Mode**)
- it has been about 10 minutes since a HSM tab browser closure
- it has been about 10 minutes since a browser closure
- the user remains idle on the HSM web user interface for more than about 15 minutes

__Note:__ after about 15 minutes of inactivity, the HSM __informs the user__ about the __incoming session invalidation__ through a pop-up dialog. At that point, by clicking on either the “Close” or “Ok” button, the user will be able to __reset the inactivity detection__ mechanism and continue to use the middleware.

During the System Interactive Mode, if the users log out or the session is automatically invalidated (end of daily time slot or inactivity), they will be able to access the HSM again from the Collaboration Portal as described at the beginning of this chapter.

__Note:__ if __the user does not click on Logout__ but instead only __closes the HSM tab__ or __the browser__, the session will remain active for about 10 minutes. If it was the browser that was closed, the user will not be able to access again until the session expires after 10 minutes (security reasons).

The following sections describe the capabilities offered by the HSM for the evaluation of CPS tools and models.

5. Tools and Models Evaluation

This chapter describes how to carry out evaluation experiments with tools and models **already available** in the HSM Repositories, so it is oriented to both:

- the **consumer users** and
- the **provider users using other providers' tools/models.**

In particular, the following paragraphs describe how to:

- **Compose and launch a sandbox** by selecting CPS tools and/or models from the HSM Repositories
- **Use the Sandbox**
  - Make the tools running in a sandbox interact with each other
  - Interact with the sandbox from the user's local computer in a secure and controlled way

5.1 Preliminary Operational Notes

A set of checks is implemented in the HSM to maintain the system **clean** and **usable by the highest number of users**.
In particular:

- Each user can only **own one sandbox at a time** but can be **guest of many sandboxes** if invited to them by the corresponding owners.
- In **composing a sandbox**, a user can add at most:
  - α virtual machines - no matter if instances of tools or OSes - of which only one Windows-based
  - β models, without any duplicate
- In case there were **not enough system resources** to fulfil a new sandbox instantiation request, the user is informed through a pop-up message
- In case the number of **Windows-based VMs simultaneously running** were already the maximum legitimated by the available Windows licence**,** the system prevents the instantiation of new sandboxes containing further Windows-based VMs.

5.2 Composition and Launch of a Sandbox

Before launching a sandbox, it is necessary to compose it by selecting tools and/or models.

5.2.1 Compose a Sandbox from the Catalogues (Collaboration Portal side)

This is the **easiest way** to instantiate a simple sandbox in order to evaluate a tool and/or a model.

It is possible to select a tool or a model to test **directly from the HUBCAP Collaboration Portal** thanks to the **Try It Now** functionality (if enabled by the item provider).

To do so the user browses the tools or models Catalogues to locate the item they are interested in, click on the item card and click on the “Try It” button available in the item details page (again, available only if enabled by the provider):

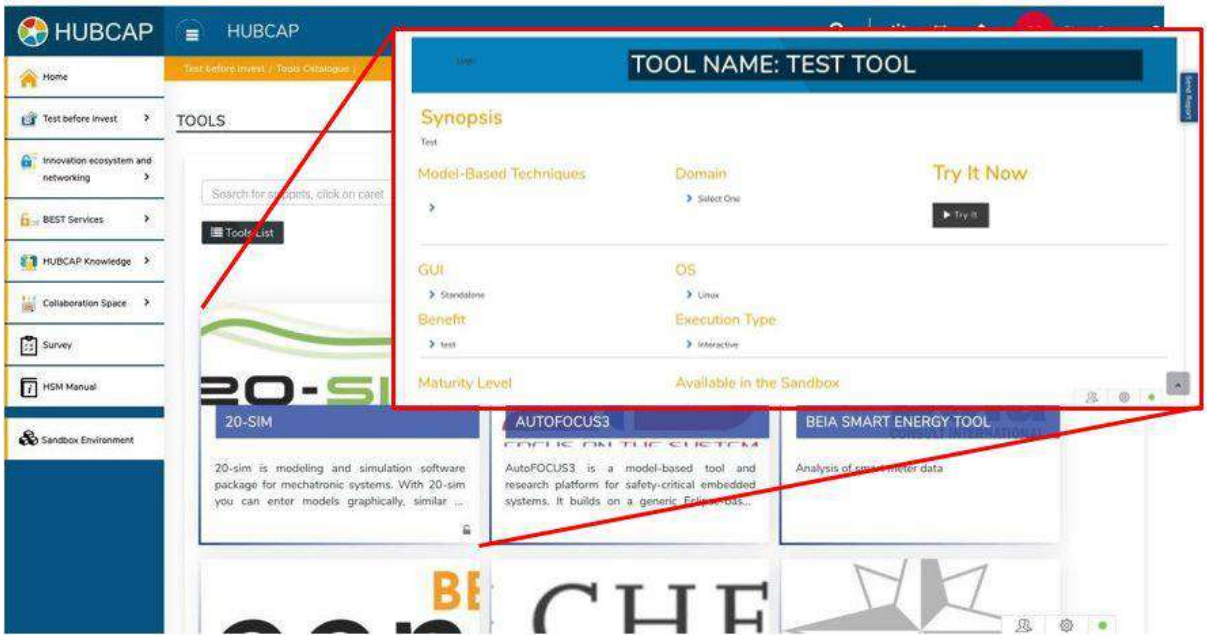


Figure 7 - Tools Catalogue portal side and tool details page with Try It Now section

At that point, after the usual authentication HSM side, the user will find (HSM side) a sandbox pre-composed with the selected item. In case of a model, the sandbox will also contain a tool useful to test it.

5.2.2 Compose a Sandbox from the Repositories (Sandboxing Middleware side)

This modality allows the user to instantiate a sandbox with a more **sophisticated composition** (more tools, more models).

After logging in to the HSM, the users can compose their sandbox by selecting **tools and/or models** from the HSM Repositories - accessible from the left sidebar in the HSM home page.

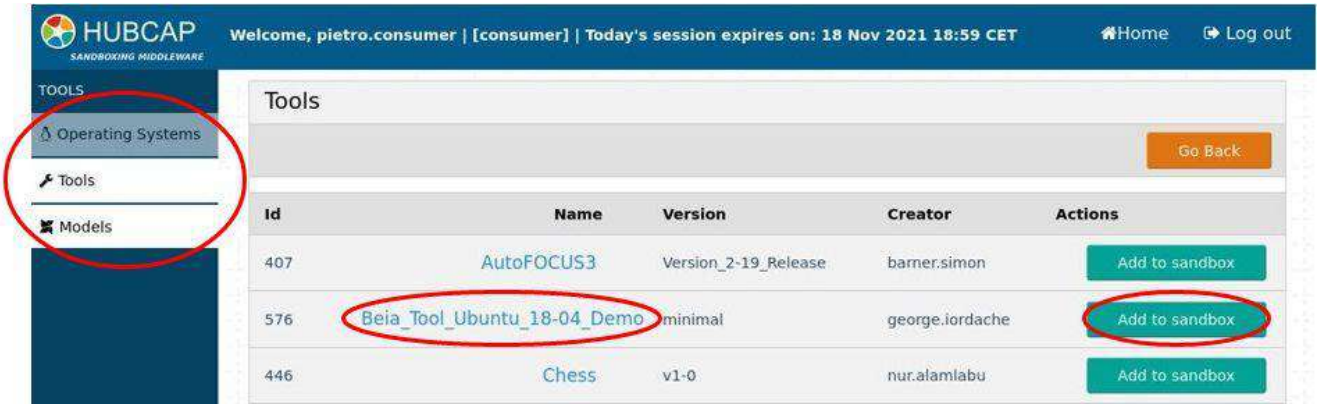


Figure 8 - HSM Tools Repository from where tools can be selected through the Add to sandbox button. Same applies to Models Repository.

It is also possible to view the details of an item by clicking on the **item name.**
A recap of the tools and models added to the sandbox is available on the home page under the "New Sandbox Items" section (Figure 9):

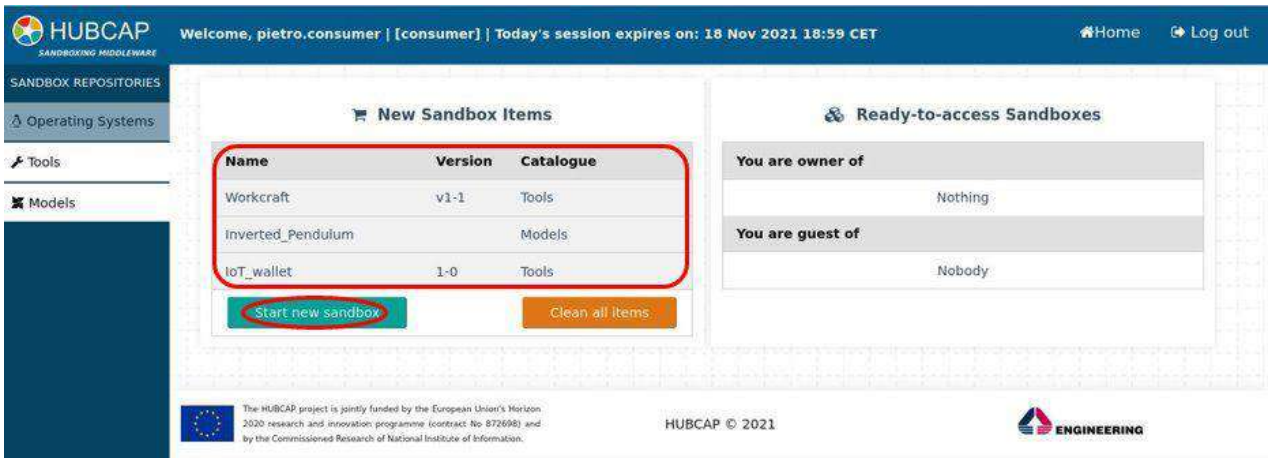


Figure 9 – Home page featuring a cart (New Sandbox Items section) with two Tools and one Model.

In case the users wanted to recompose their sandbox, they can click on “Clean all items” to reset the cart.

***Note:** The selected models, as stated later in §5.3.2, will be available to any tools or operating system VMs running in the Sandbox through the `/nfs/toolsdata/<username>` folder*

5.2.3 Start a Just Composed Sandbox

No matter from where the sandbox has been composed (from the **Portal Catalogues** or from the **HSM Repositories**), it can be **instantiated** and **started** by clicking on the “Start new sandbox” button in the home page (Figure 14).

*Note: It is possible to own **only one** Sandbox per time. If the "Start new Sandbox" button is **disabled**, you are already owner of a running sandbox. In that case, you can access your existing sandbox by clicking on the corresponding button in the "You are owner of" section of the HSM Home Page*

5.3 Use of the Sandbox

Once the sandbox instantiation process is complete, the Sandbox Viewer will be shown (Figure 10):

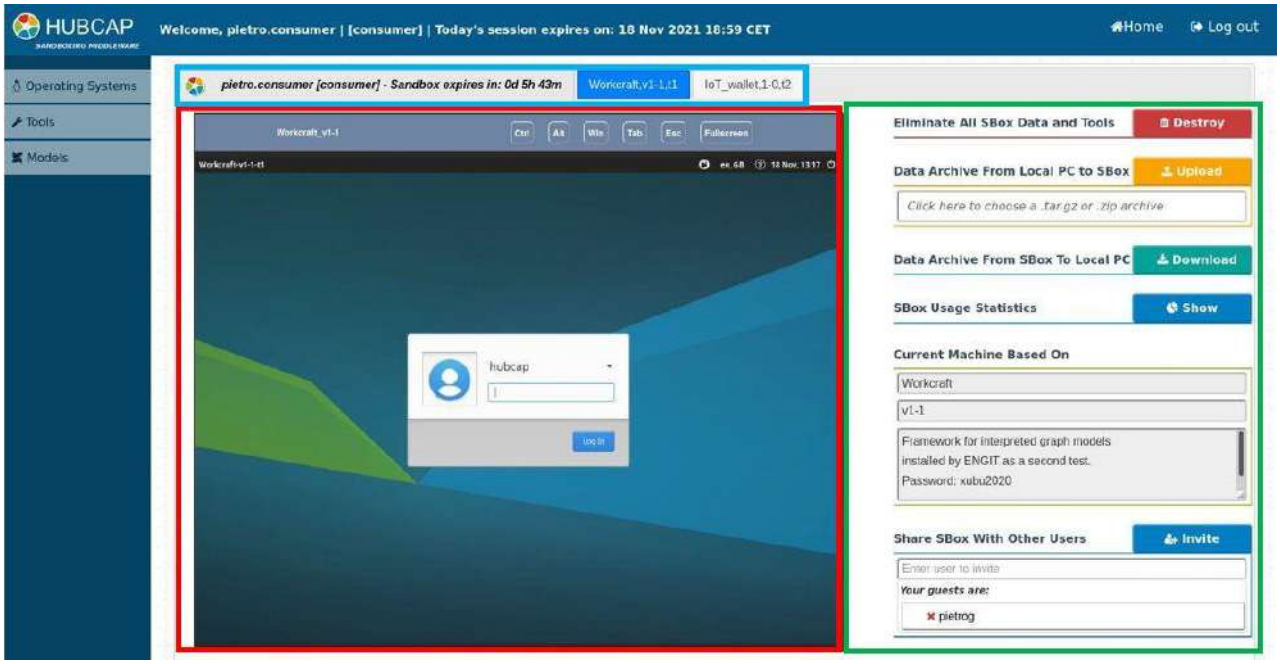


Figure 10 - Sandbox Viewer with its three main areas highlighted.

The **Sandbox Viewer** is composed of three principal areas:

- Remote Viewer (red area)
- Sandbox Upper Bar (blue area)
- Control Panel (green area)

The **Remote Viewer** provides the user with access to the user interface of the operating system on which the Tool has been installed. It also features a set of buttons (Ctrl, Alt, Win, Tab, Esc) - some of which toggle buttons (Ctrl, Alt, Win) - that can be used to send special combinations of keys to the operating system. In addition, the Fullscreen button allows the user to switch to Fullscreen mode.

*Tip: once Fullscreen mode is on, for a better user experience, you might want to **change the screen resolution** using the specific utilities provided by each tool*

operating system running in the sandbox.

***Note:** the tool operating system asks for a **password,** which by default is hubcap. If the tool provider has changed it, the modified one could be found in the tool description - appearing in the control panel.*

The **Sandbox Upper Bar** shows on the left some information about the session and on the right gives the possibility to switch from one tool to another one through a set of clickable tabs.

The session information section shows – among the other – **the Sandbox expiration time.** Indeed, every sandbox has a lifetime after which it *is automatically destroyed,* and which depends on the **number of consecutive System Interactive sessions (SIMs)** associated with the specific user profile (see table in section 3.3 for further information). **One hour before the sandbox expiration**, the HSM sends to the owner a **reminder email** advising them to save any unsaved data.

While the sandbox is alive and during a System Interactive Mode, the user is free to leave the Sandbox Viewer to access it again later. The **correct way** to do that is by clicking on "**Home**" or "**Log out**", both available at the top right of the page.

In the **first case** the user gets access to the **HSM home page**, from which they can immediately:

- Reopen the Sandbox Viewer for their own Sandbox (clicking on the button under "Ready-to-access Sandboxes" >> "You are owner of" section), or
- Access any other sandboxes shared by other users with them (see §5.3.5 - Sandbox Sharing)

In the **second case**, since the **logout invalidates the session**/One Session Password, before getting access to the HSM home page again, it will be necessary to request a new One Session Password from the Collaboration Portal (see chapter 4 – Accessing the HSM).

Finally, the **Control Panel** - on the right of the Sandbox Viewer - gives access to a set of functionalities - described on what follows - available depending on the combination of role and profile assigned to the user.

5.3.1 Interaction among Tools in a Sandbox

Different tools running within the same sandbox can interact with each other through:

1. the **Sandbox Local Storage**, which is a folder they **share** (accessible from any tools under `/nfs/toolsdata`), or
2. the **Sandbox Local Network,** referring to each other via their hostnames or IP addresses.

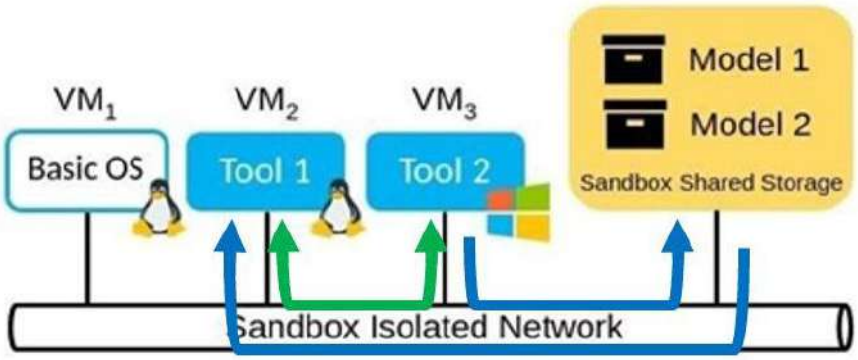


Figure 11 - The Sandbox Isolated Network and Storage allow the tools of the Sandbox to interact with each other.

5.3.1.1 Interaction through the Sandbox Local Storage

Files added to the `/nfs/toolsdata` shared folder can be accessed from any tools through the default File Manager offered by the operating system on which they are installed (Figure 12).

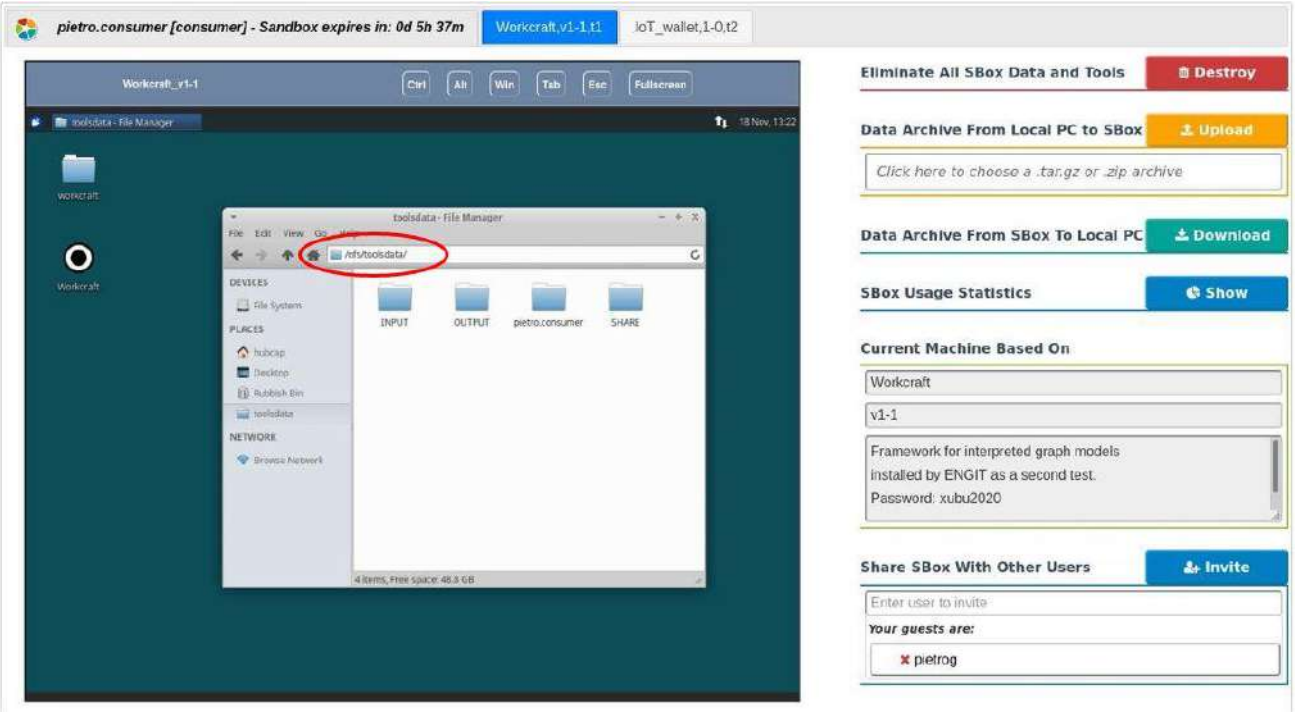


Figure 12 - File manager of operating system running inside the sandbox opened on the Sandbox Local Storage (/nfs/toolsdata)

Note: *The Sandbox Shared Storage is dedicated* ***only*** *to the tool/OSes running in a specific sandbox and* ***cannot be accessed from other sandboxes****.*

5.3.1.2 Interaction through the Sandbox Local Network

The tools can also interact through the **Sandbox Local Network** referring to each other via their hostnames or IP addresses.

To get the hostname or the IP address of a tool instance the user can open, from it, a terminal and use the following commands:

OS Information	Linux	Windows
Hostname	`hostname`	`ipconfig /all`
IP address	`hostname -I`	

Note: *The Sandbox Local Network is dedicated only to the tool/OSes running in a specific sandbox and* ***cannot be accessed from other sandboxes****.*

5.3.2 Accessing the selected Models

The models selected and added to the Sandbox during its composition are available in the **Sandbox Local Storage** under `/nfs/toolsdata/<username>`. This folder, being

under `/nfs/toolsdata`, is accessible from any tools of the same sandbox.

5.3.3 External Interaction with the Sandbox Local Storage

Note: *This and the following paragraphs describe those functionalities available to users with* ***owner role*** *(those who have instantiated the sandbox) regardless of the Consumer or Provider* ***profile****.*

5.3.3.1 Upload to the Sandbox

To **upload** a compressed archive from their local computers to the sandbox, the s*andbox owners* use the **"Data Archive from Local PC to SBox"** section of the Control Panel.
The upload works only with **archives compressed using** tar.gz or zip format, not with single files (e.g., .png, .pdf, ...)

The uploaded archive will be available in the *Sandbox Local Storage* to any of the VMs (Tools and OSes) running in the sandbox under the `/nfs/toolsdata/INPUT` folder; access this folder using the default file manager available in any VMs.

Tip: *by uploading an archive, the user can upload project files, licence keys, manuals and in general data he/she wants to use within the sandbox but does not want to share with other sandboxes.*

5.3.3.2 Download from the Sandbox

The sandbox owner can **download** files from the sandbox to their local computer (CPS Software output, experiment results, reports, etc.) by adding them to the `/nfs/toolsdata/OUTPUT` folder and then clicking on the "Download" button available alongside **"Data Archive from SBox to Local PC"** in the Control Panel. The user's browser will open a **download dialog** from which an automatically compressed archive containing all the files of the OUTPUT folder can be downloaded.

5.3.4 Visualizing Sandbox Usage Statistics

By clicking on "Show" alongside **"SBox Usage Statistics"** in the Control Panel the user visualises, in a pop-up dialog and for each Tool and for the Shared Storage, information about the resources they have been consuming:

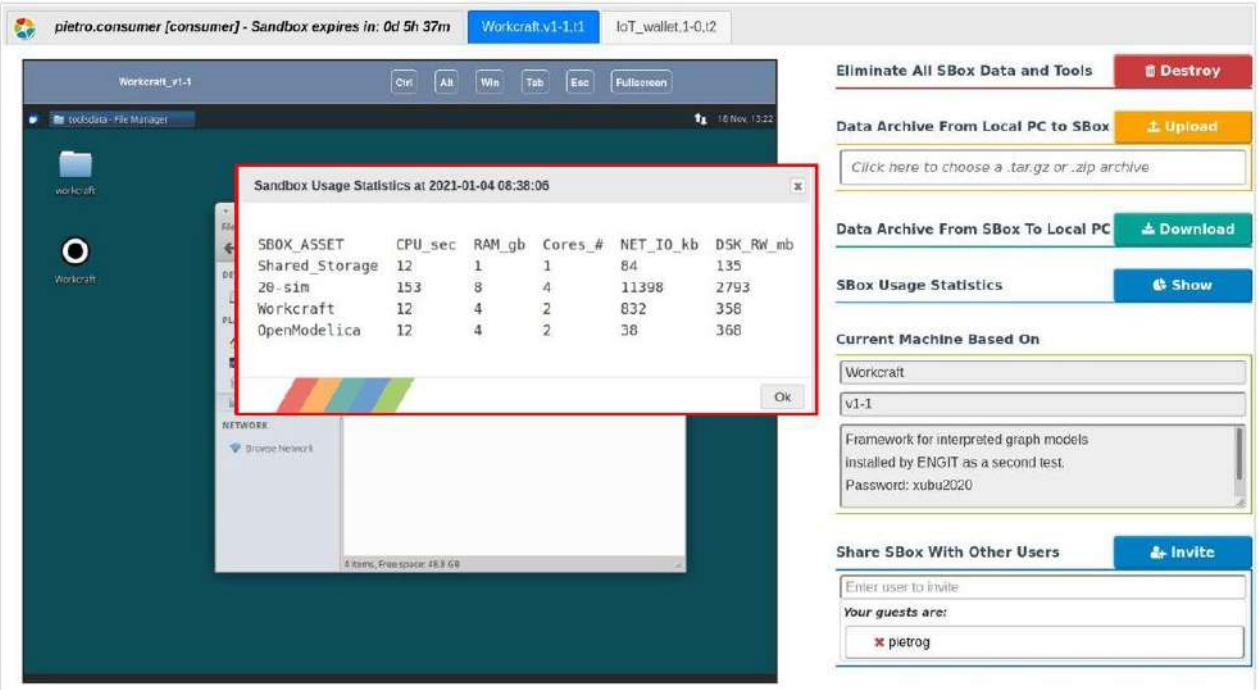


Figure 13 - After clicking on the Show Statistics button, a dialog will show the resources the sandbox items have been consuming

A final report on resource consumption will also be shown after the destruction of the sandbox in the acknowledgement message.

5.3.5 Sandbox Sharing

The owner of a sandbox can share it with other users in order to collaborate with them in real-time interacting with the tools running inside the sandbox.

To share the sandbox with a specific user, the sandbox owner uses the **"Share SBox with Other Users"** section of the Control Panel.

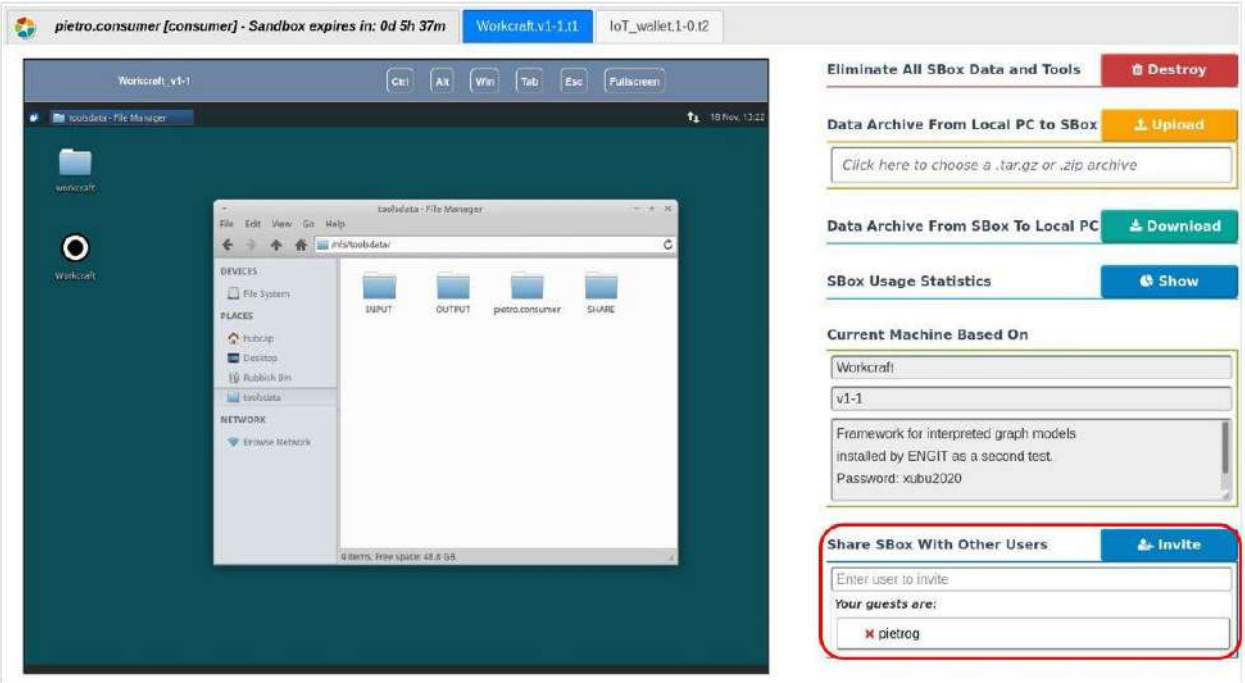


Figure 14 - After clicking on the Show Statistics button, a dialog will show the resources the sandbox items have been consuming

The sandbox owner enters the candidate guest's username (the autocomplete search bar will help) and clicks on the "Invite" button; another button corresponding to the just selected guest will appear under the search bar.

To stop sharing the sandbox with a specific user, the sandbox's owner clicks on the button labelled with the guest's name available in the Sandbox Viewer in the "Your guests are" section.

On the other hand, the **guest user** (the invited user) will see in their HSM home page (inside the "Ready-to-access Sandboxes" section, "You are guest of" subsection) a **new button** labelled with the name of the **host user** (the owner of the sandbox inviting them) (Figure 15)

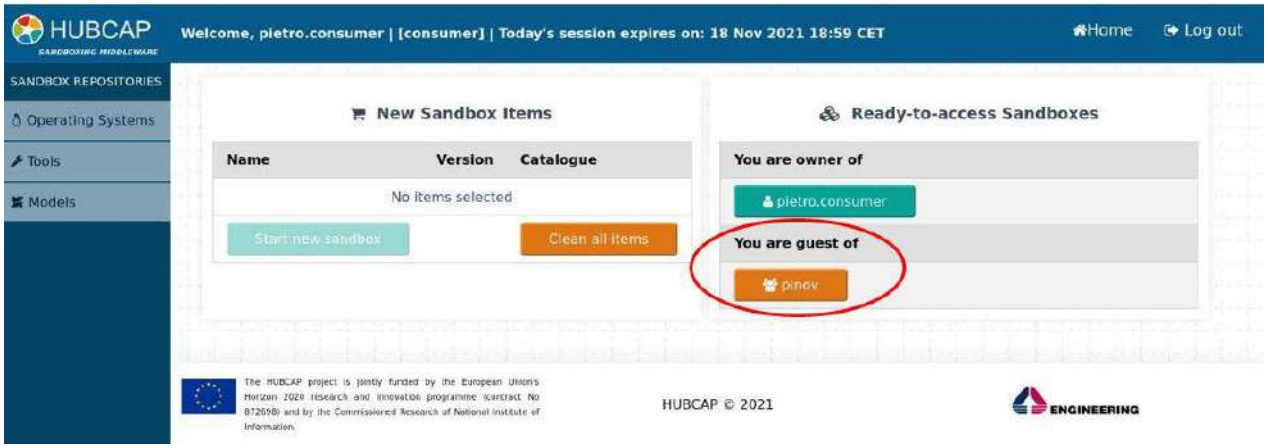


Figure 15 - Ready-to-access Sandboxes section showing the sandbox owned by another user.

By clicking on that button, the guest will see in their Sandbox Viewer the host sandbox and will be able to use the keyboard and screen shared with the owner (and possibly with other guests of the same sandbox)

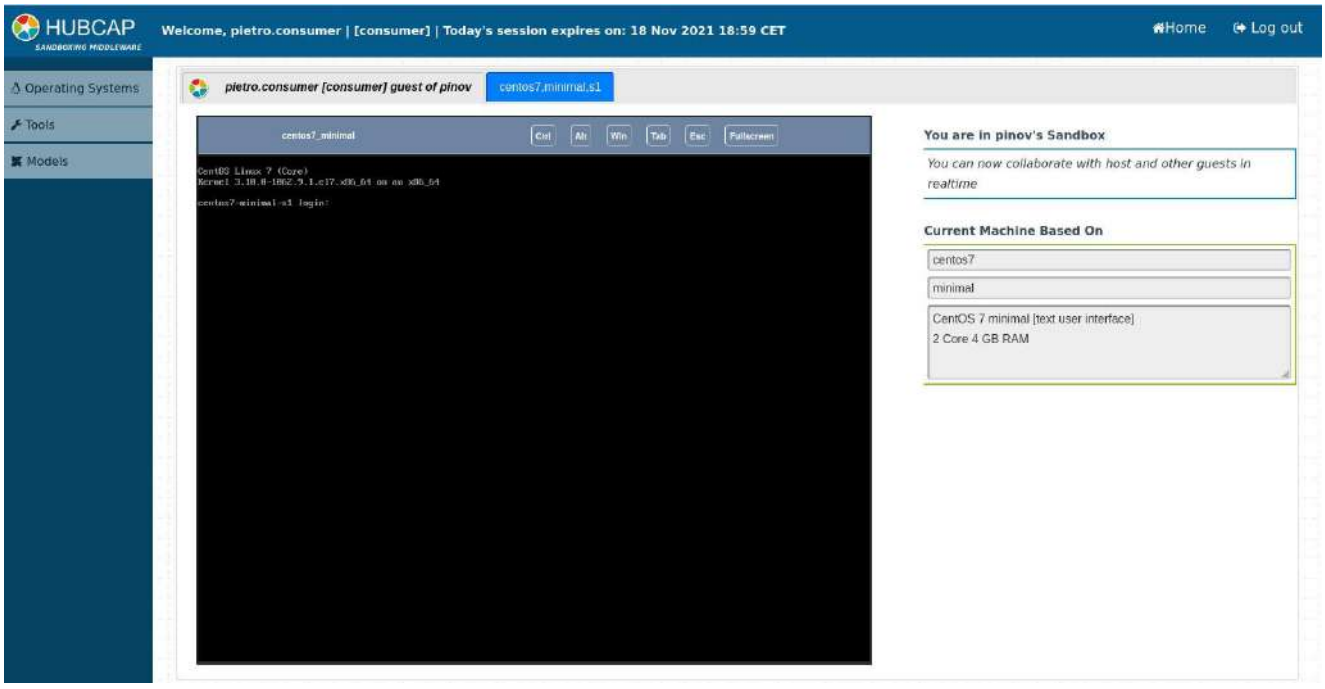


Figure 16 - Ready-to-access Sandboxes section showing the sandbox owned by another user.

5.3.5.1 Collaboration Scenarios within the Sandbox

Multiple users connected to the **same sandbox** can work simultaneously on the **different tools running in the sandbox.**

Furthermore, the users connected to the sandbox can also access the **same tool**, sharing its screen; **only one virtual keyboard** and **one virtual mouse** are **shared** for collaboration

among all the users interacting with the same tool instance.

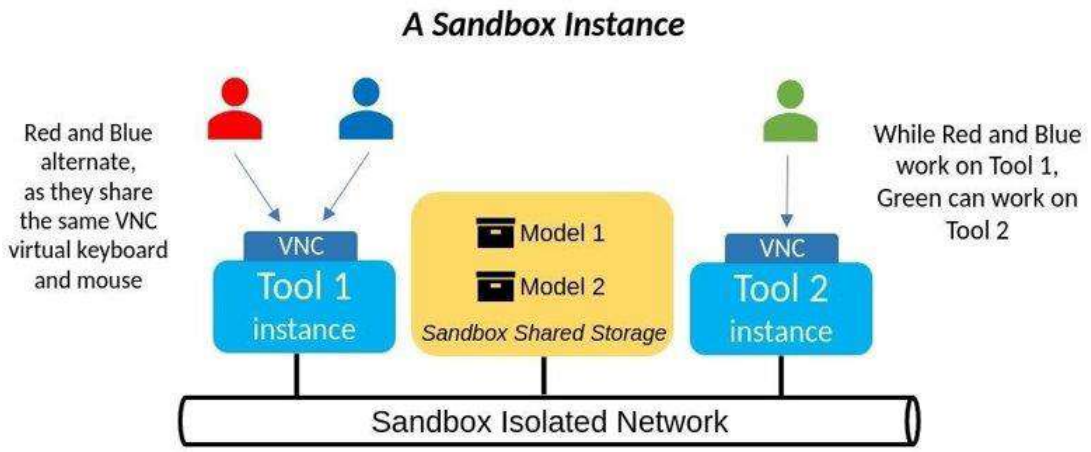


Figure 17 - Typical collaboration scenario within the Sandbox.

***Note:** If the sandbox contains sandbox **owner's private tools**, guests will be able to interact with them until the sandbox is destroyed.*

5.3.6 Destroying the Sandbox

To destroy the sandbox and all its content click on "Destroy". Guest users will be disconnected.

***Warning:** files and any kind of data available in the sandbox (composing tools and Local Storage) are deleted with the destruction of the Sandbox and **are not recoverable**. Be careful!*

***Note:** users who do not need the sandbox anymore should always destroy it.*

Upon sandbox destruction the HSM shows a report on resources consumption:

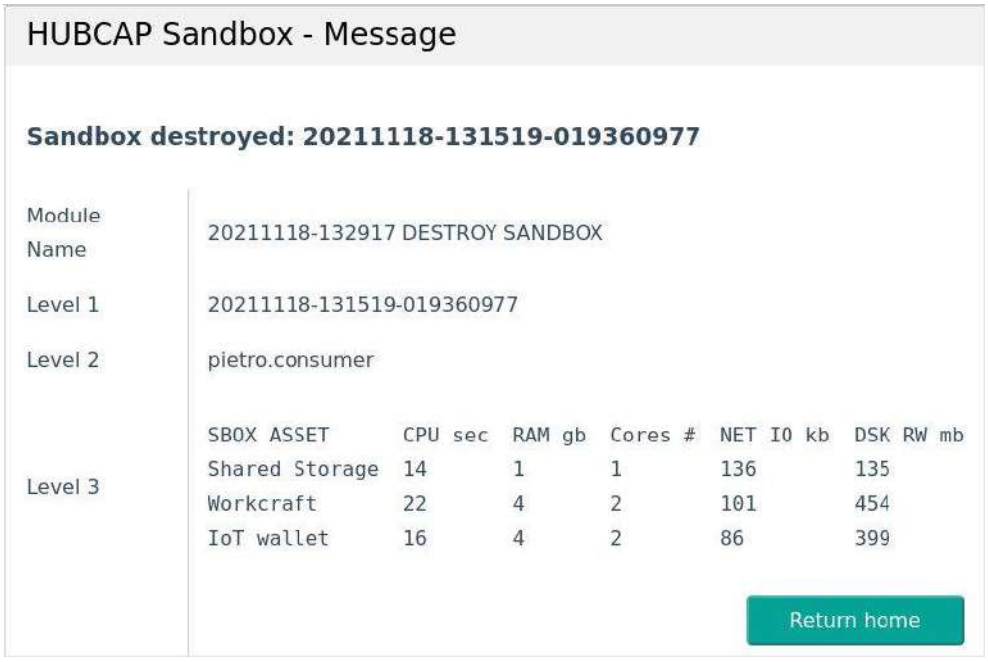


Figure 18 – Sandbox destruction acknowledgement message containing a report on the resources consumed

5.3.7 For Experienced HSM Users Only

While composing a sandbox, the user can select a tool multiple times. Multiple instances of it will run simultaneously in the Sandbox.

Note for Providers: *This is true also for OSes but not for the development version of tools.*

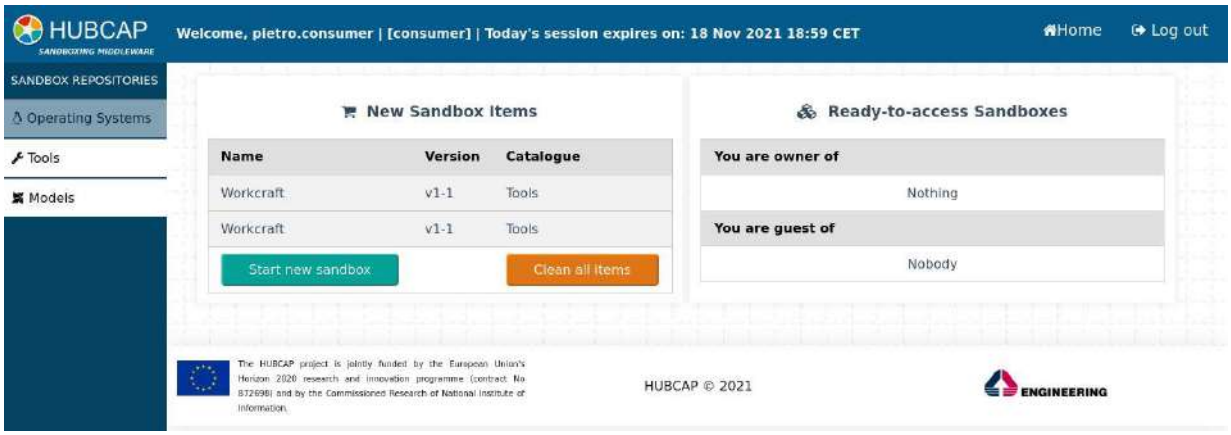


Figure 19 - Same production tool selected twice.

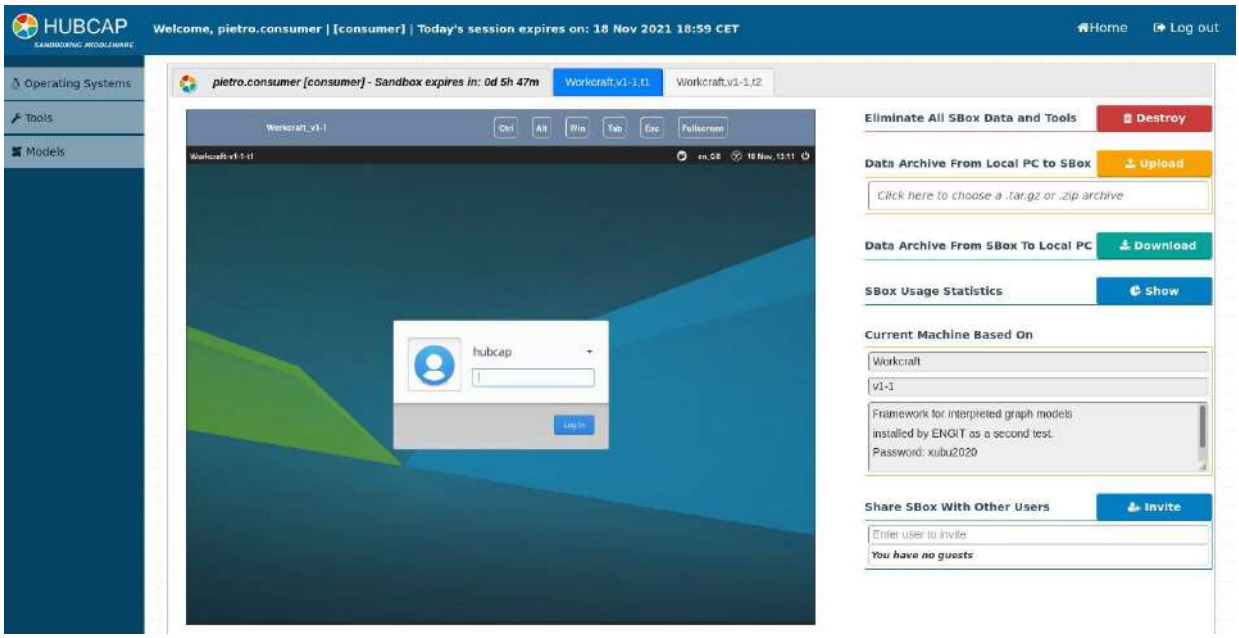


Figure 20 – Two instances of the same production tool running in the sandbox.

6. Provisioning

The **basic functionalities** illustrated in the previous chapter are available to **all the HSM users**, whereas those illustrated in this chapter are available to the **HSM providers only**. In fact, they are intended for **bringing new *tools* and *models*** to the HSM Repositories.

Warning:** Before going on, the providers **are required to know** the basic functionalities illustrated in chapter **5. Tools and Models Evaluation

6.1 Tools Provisioning

6.1.1 Tools Requirements

In general, a wide range of CPS tools can be installed and run on the HSM. However, tools requiring some special peripherical or hardware device in order to work appropriately (USB pendrive, graphical processors, …) might encounter some difficulty to run or might not run at all inside a HSM sandbox. Nonetheless, adopting some precautions or tweaks, in many cases they can be installed onto the HSM and used for the experiments.
Such a tool might require a provider to adapt it to a virtual environment (for example by replacing a hardware dongle licence key with a “software” key) or tuning the experiments (for example using simpler 3D models).
That said, the **main requirements** to install and run a tool in the HSM are summarised here:

- The tool must be **installable** and **runnable on a VM**; below those available in the HSM:

HSM Available Operating Systems	vCPU [#]	vRAM [GB]	vDisk [GB]
Windows: -Server 2019 Desktop Edition	4	8	16
Linux Desktop -Ubuntu 18.04 LTS -Ubuntu 20.04 LTS -CentOS 7 XFCE	2	4	5
Linux Terminal	1	1	2.5

-CentOS 7			

Table - Specifications for the operating system base virtual machines offered by the HSM

- The tool should also **work without specific, physical hardware dependencies**
- The tool should only **rely on libraries whose licences allow their execution on cloud** environments
- The tool should **not rely on special purpose OSes** (e.g., a real-time OSes).

6.1.2 Basic Concepts: Production and Development Versions, Tool Visibility

The **name** assigned to a tool when it is first created in the HSM will **identify it uniquely.**

Warning:** a **different name** is interpreted by the HSM as a **different tool.

For **each tool,** the HSM will keep at maximum **two VMs** corresponding to two tool versions: **production** and **development.**
In particular:

- **production (version) VM** allows the tool creators to provide the other HUBCAP users with a *stable version* that they can try - also directly from Portal Catalogue (**Try It Now** functionality) - and this version remains **decoupled** from the development one.
- **development (version) VM** will be used to perform any customization, development and testing activities, **without interfering** with the possible usage of a production version already provided and accessible to the HSM users.

At any moment, it is possible that either the development or the production version exists or also **both**, although this last case should be considered **temporary**.
For any tool, the conventional and automatically fixed string "**DEV**" will identify the **development version**, whereas the providers will be able to use **any string** for the **production version** but "DEV".
To each tool stored in the HSM Tools Repository is associated a **visibility** value; in particular

1. a **"private"** visibility means that the tool will be shown in the HSM Tools Repository only to the provider who has created it;
2. a **"public"** visibility means that the tool will be shown to all the users of the middleware accessing the HSM Tools Repository.

6.1.3 Main Tool Provisioning Flow: An Overview

The next paragraph (§6.1.4) will describe in more detail the installation and management process of a new CPS tool in the HSM as depicted by the following diagram:

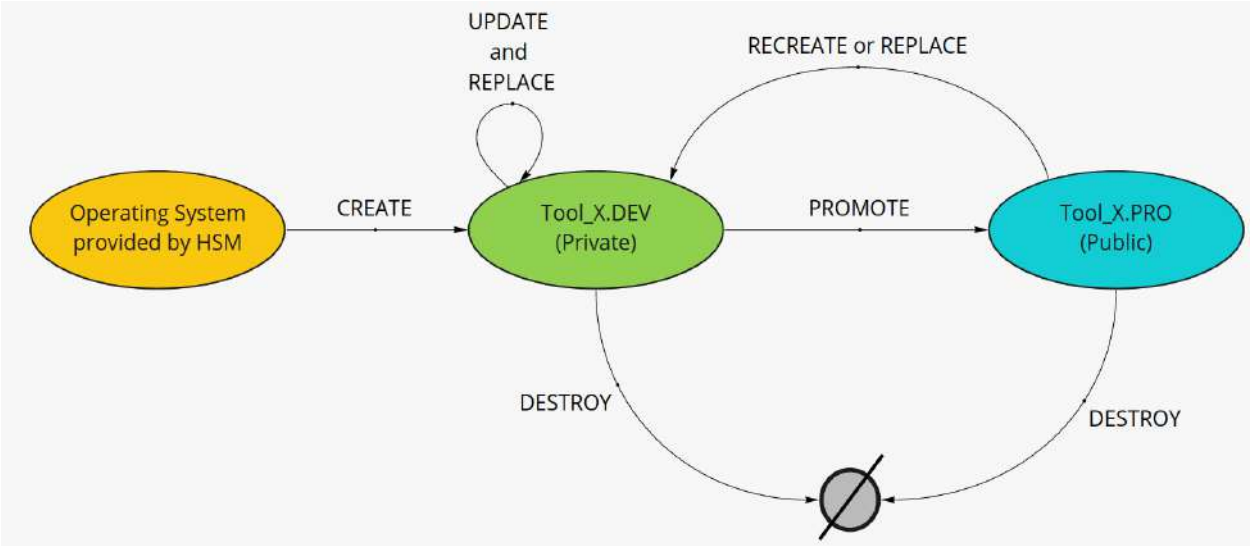


Figure 21 – Two instances of the same production tool running in the sandbox.

and summarized in the following macro-steps:

A. **Create** an entry for the new tool in the Collaboration Portal Tools Catalogue.
B. **Create** a development VM for the new tool by using an empty operating system provided by the HSM itself and starting to install the new tool on it.
C. **Link** the tool development VM to the corresponding Collaboration Portal Tools Catalogue entry created at the initial step A.
D. **Update and replace** the tool development VM until a production version of the new tool is ready.
E. **Promote** the development version (private) of the tool to production (public) thus making it available to the HUBCAP platform users.
F. **Destroy** development versions no longer needed.

The provider will also be able to:

G. Recreate a development version starting from the production one when the development cycle of a new release of the tool has to begin, resuming the macro-flow from macro-step D

Important note: *during a* ***promotion*** *(macro-step E), the* ***Portal Catalogues entry*** *which the* ***development version*** *had been* ***linked to*** *(macro-step C.) will be* ***re-linked automatically*** *to the* ***production version****.*

6.1.4 Installation Process

This paragraph illustrates how to provision new CPS Software starting from an **empty**

operating system selected from the HSM Operating Systems Repository. A similar procedure applies when the providers want to modify **their own tools** already saved to the HSM Tools Repository (macro-step G). In case it **were not possible to complete** a new tool **installation** in a **single working session**, the provider can save the work as a first development VM that can be later re-instantiated to **resume the installation.**

6.1.4.1 - Create a Catalogue Entry Portal Side for the New Tool

Before beginning the installation of the tool in the HSM, the providers have to **describe it** by publishing a corresponding entry in the **Collaboration Portal Tools Catalogue.** The HSM implementation of the tool (initially the development version VM) will have to be linked to this catalogue entry.

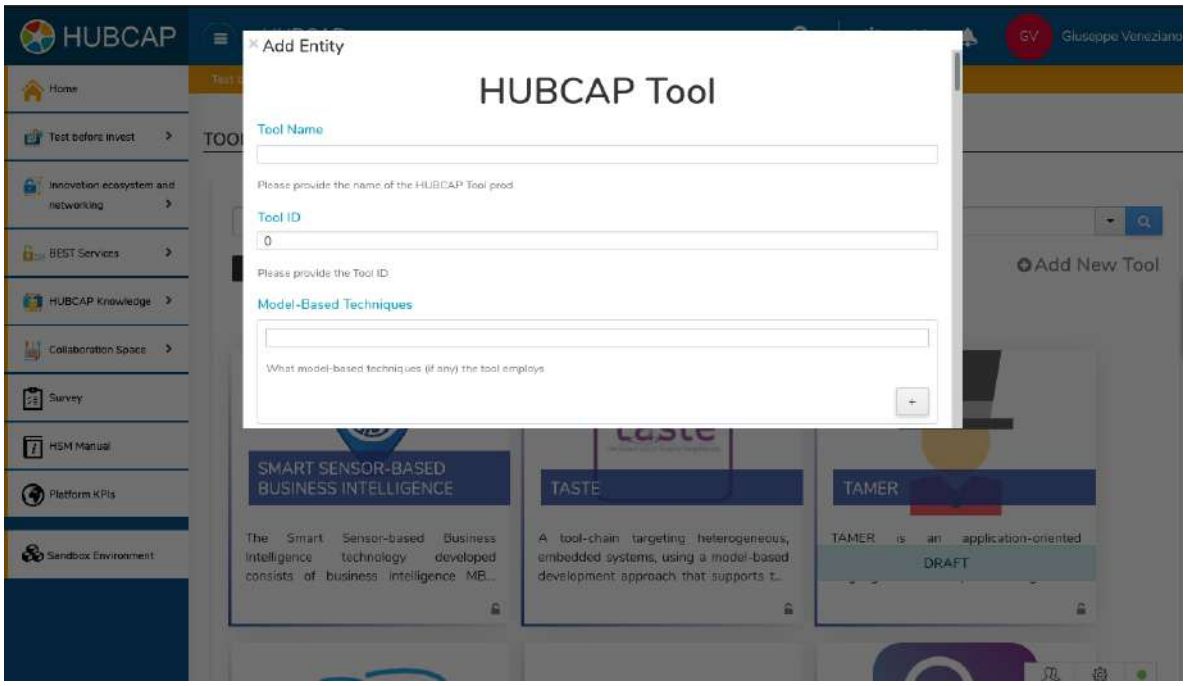


Figure 22 – Tool addition form available Collaboration Portal side and useful to describe a CPS tool

6.1.4.2 - Install the new tool VM

The providers can leverage all the functionalities described in the “Tools and Models Evaluation" chapter 5. So, for instance, they might:

- use the **upload archive** functionality to upload installation scripts, licence keys or manuals from their local PC directly into the base operating system VM within a sandbox,

- access the Internet from this OS VM to download other useful material (e.g., tool dependencies, manuals, ...),
- invite other users to support the installation
- and more

Warning: *in installing a tool the provider must pay attention not to store installation data in the* ***NFS shared folder*** *(Sandbox Shared Storage) as this will be automatically destroyed with the destruction of the sandbox.*

Note: *the following steps will describe the installation process* ***pretending*** *that* ***Eclipse IDE*** *is a* ***CPS tool****.*

6.1.4.2.1. Base Operating System Selection

As first step the provider *selects* an operating system from the Operating Systems Repository (Home Page -> Left Sidebar -> Operating Systems) (Figure 23) and starts the sandbox. The CPS software will be installed on top of this operating system VM.

Figure 23 - Operating Systems Repository

6.1.4.2.2. Tool Installation

The provider accesses the OS by entering the **default login credentials** (user: ***hubcap*** and password: ***hubcap***) (Figure 24):

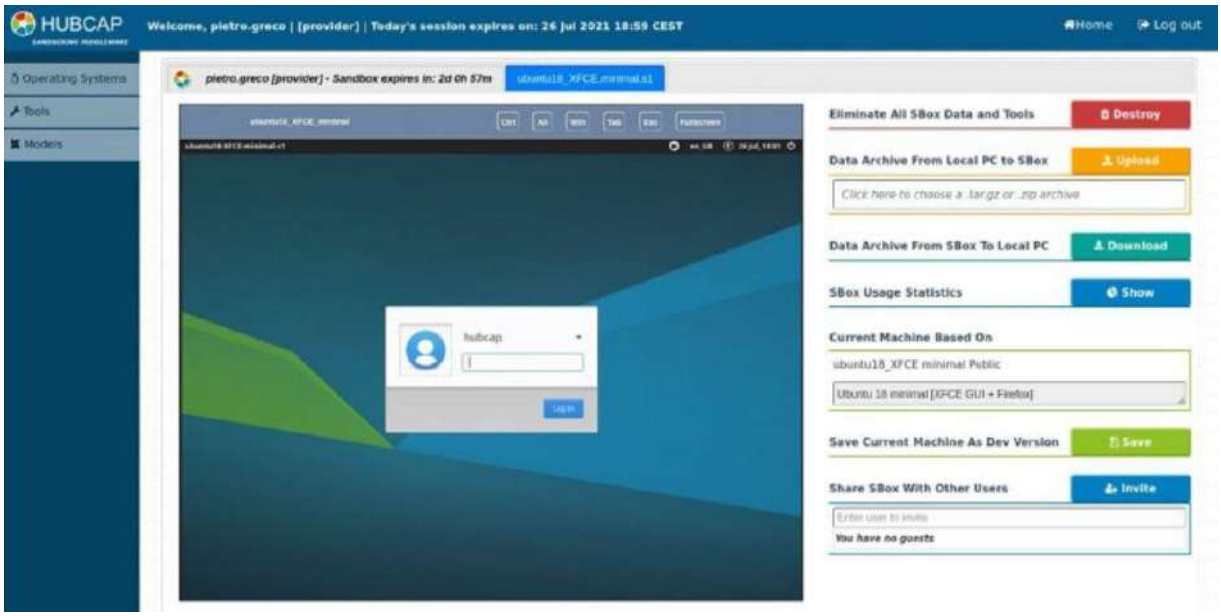


Figure 24 –Tool Operating System showing the login form

The provider **accesses the Internet from within the o*perating system* VM** to download the Eclipse installer and the required dependencies (Figure 25):

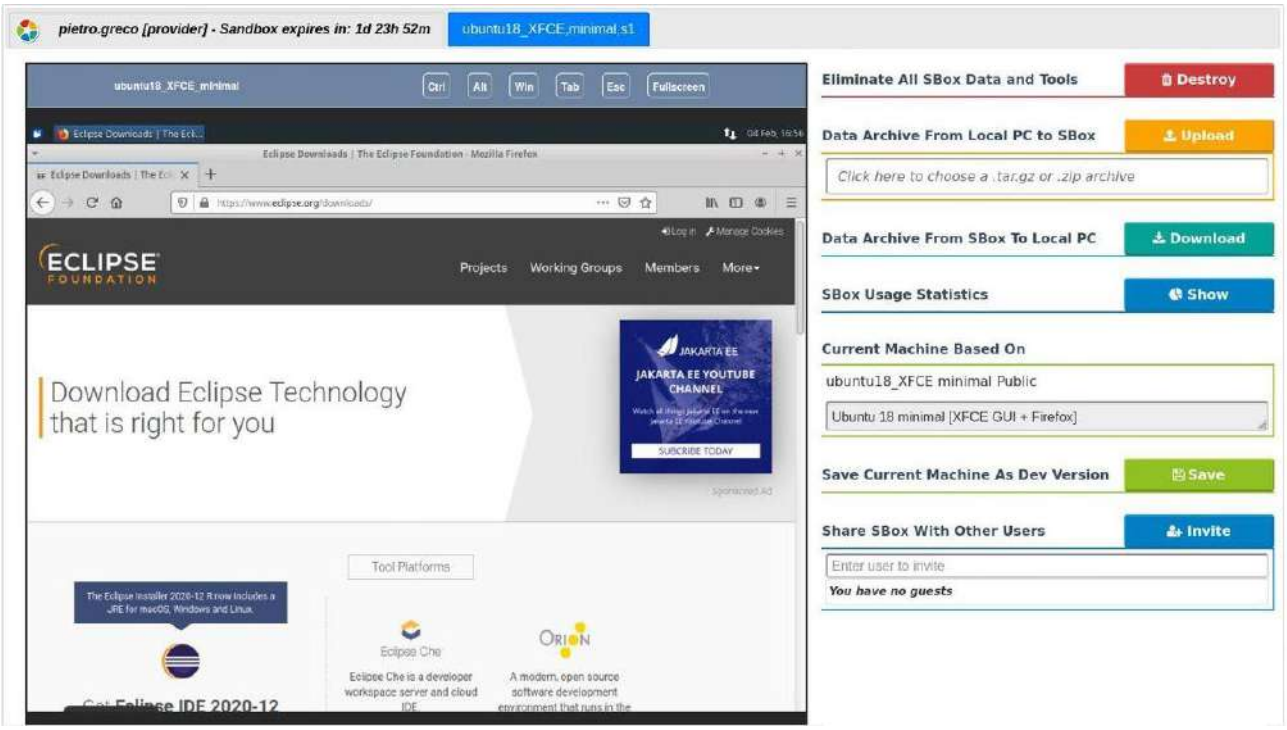


Figure 25 - Browser open on an operating system VM running inside the sandbox. The Eclipse download page is shown.

The provider installs the dependencies and Eclipse (Figure 26):

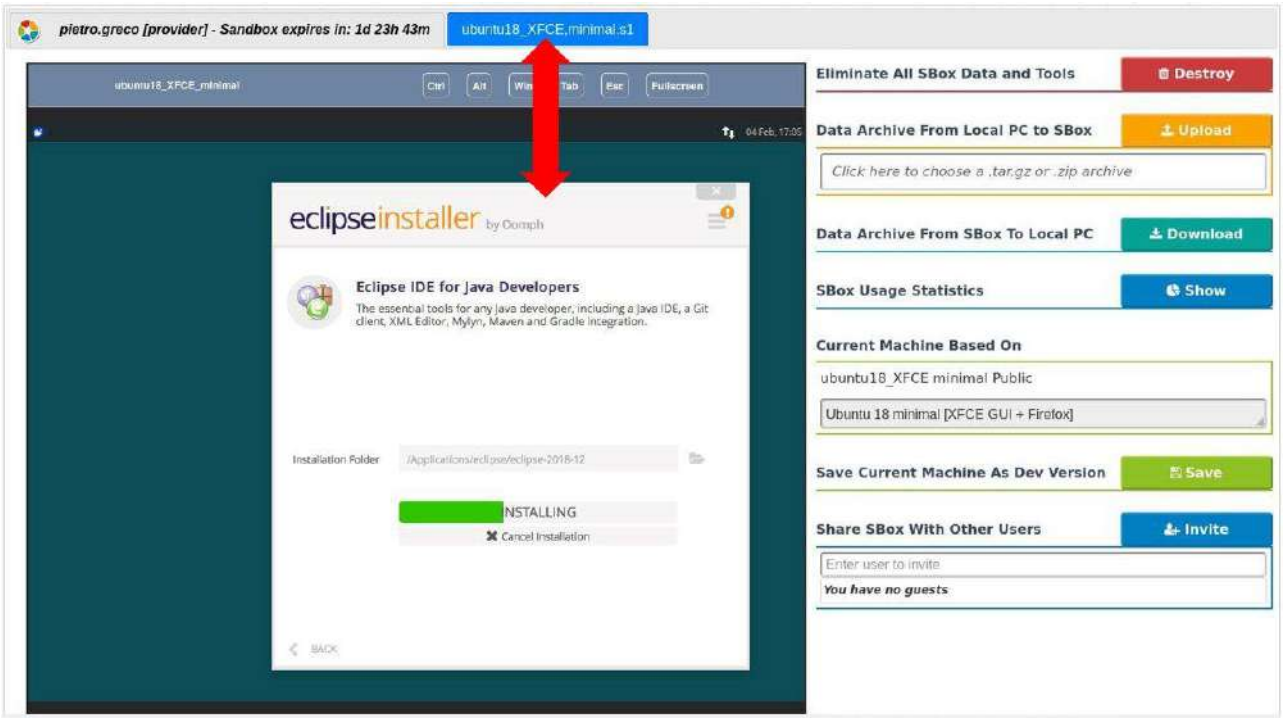


Figure 26 - Sample software being installed on the selected operating system

***Note:** On each Operating System VM a provider should install only one tool.*

The provider **configures** and **tests** the installed tool (Figure 27):

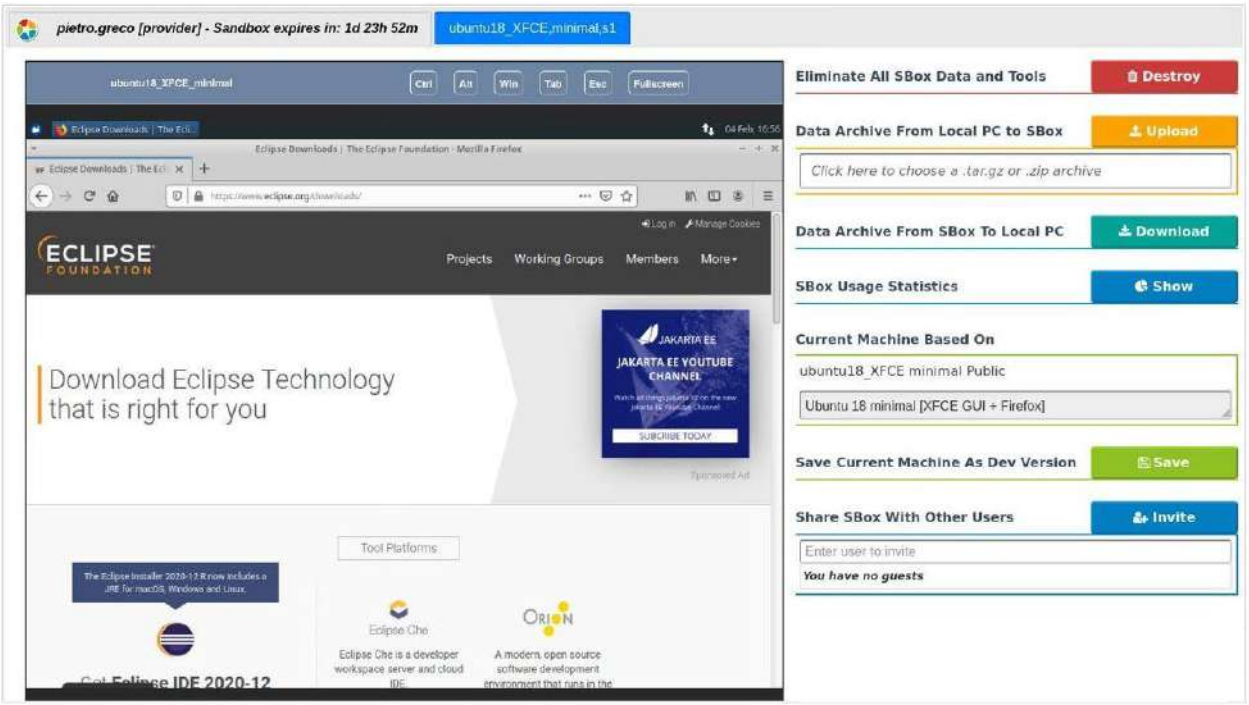


Figure 27 - Eclipse installed and ready to be tested.

6.1.4.2.3 Development Tool Saving

The provider **saves the new tool development version** VM

The provider clicks on Save and enters the **name** of the tool and a **description**. The **version** and **visibility** are automatically fixed by the HSM to "***DEV***" and "***Private***" respectively.

***Tip:** The provider should add the tool operating system **password** as first line of the description*

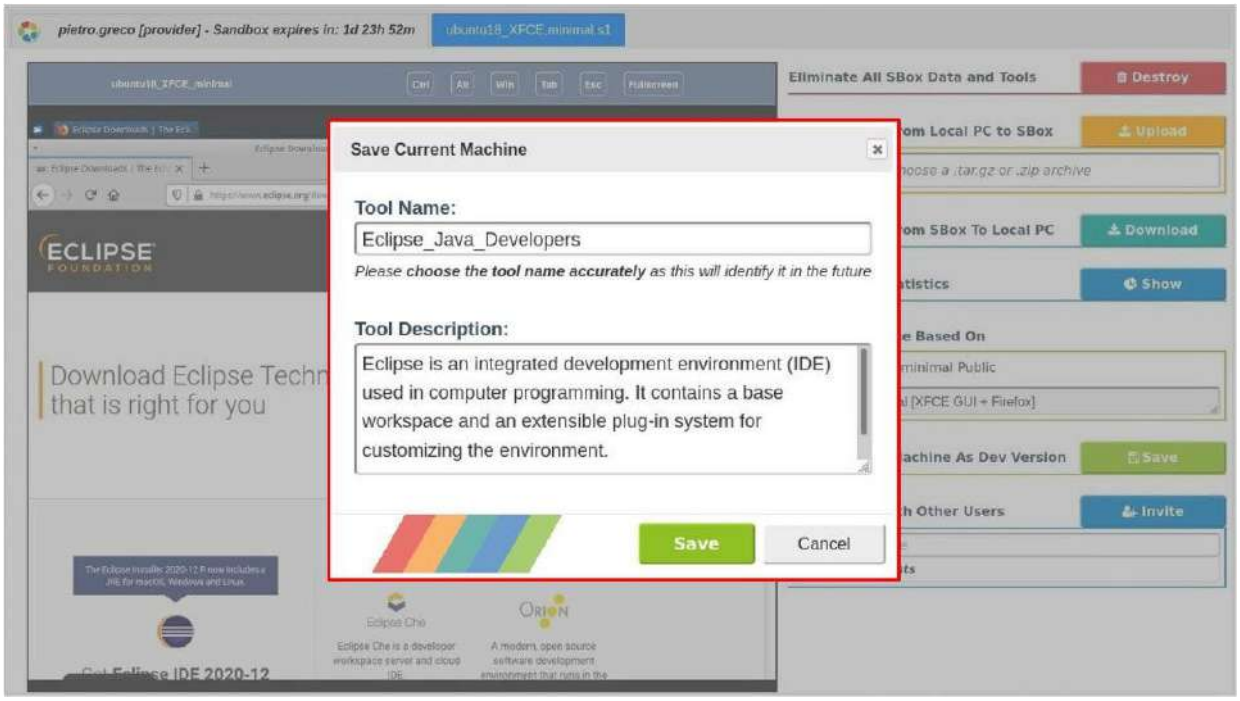


Figure 28 - Save tool pop-up form

The provider then confirms the information entered to **save and add the tool to the HSM Tools Repository**.

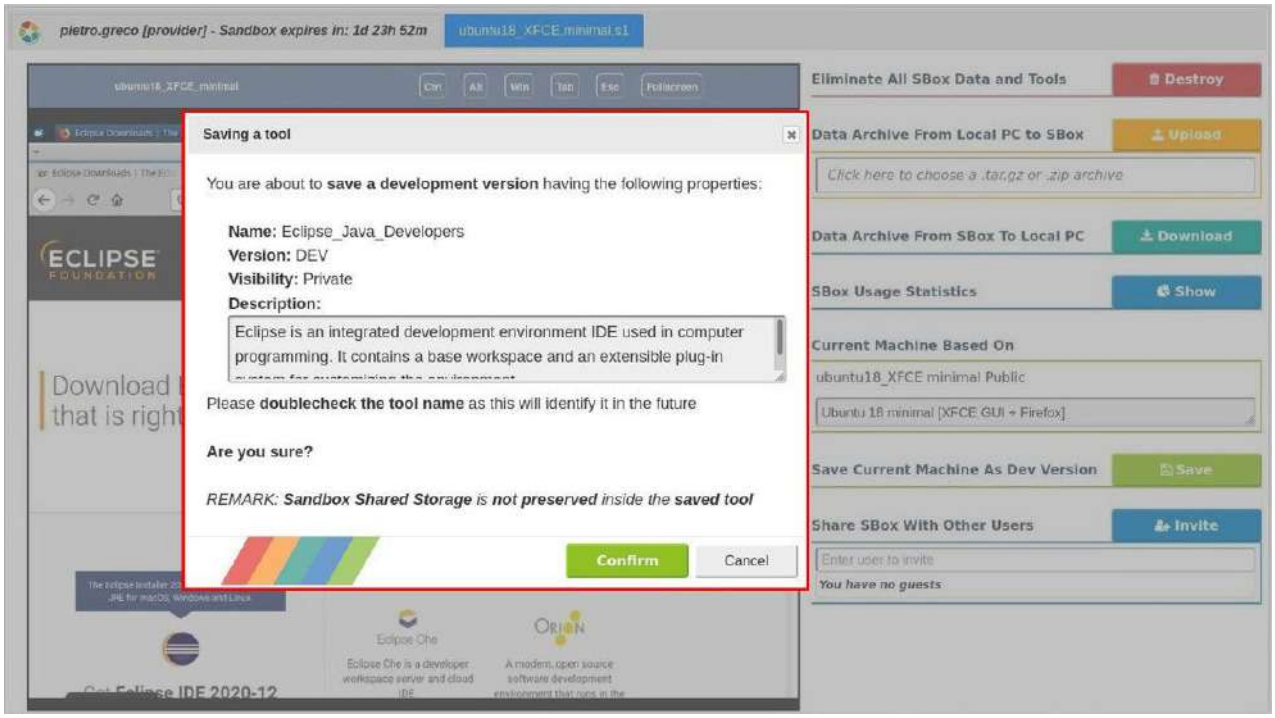


Figure 29 – Save tool confirmation dialog

In case of success, the provider is shown this message:

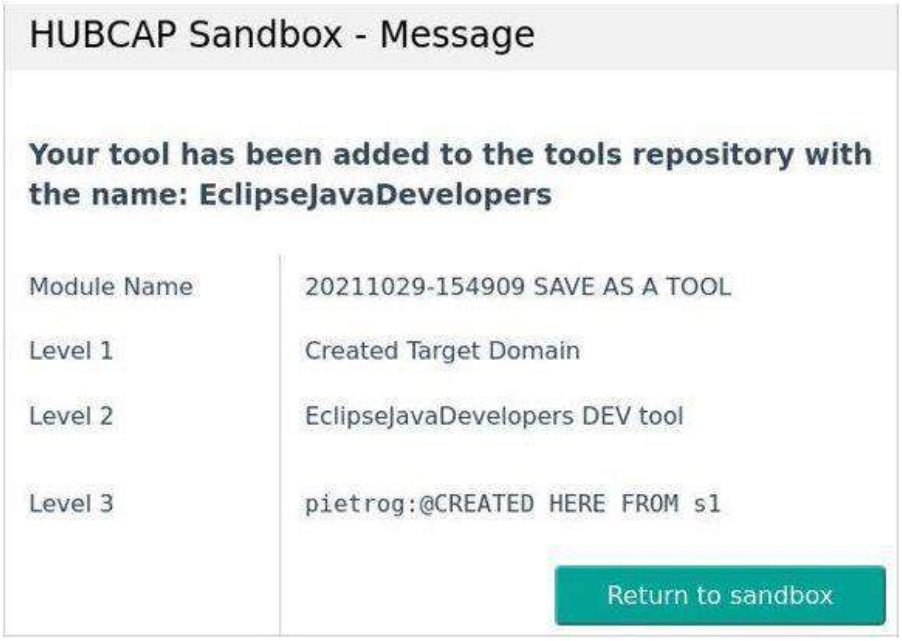


Figure 30 – Tool saved acknowledgement message

6.1.4.2.4 Development Tool Resaving

After saving the tool, the sandbox is **not automatically destroyed** and the HSM gives access to it again, allowing the provider to **continue the installation/customization**. The new changes can be **saved repeatedly** many times overwriting every time the previous development version.

When no longer needed the provider can **destroy the sandbox** by clicking on "Destroy".

Warning: *Destroying the sandbox without having saved the tool will result in an unrecoverable loss of unsaved installed data.*

6.1.4.2.5 The Saved Development Tool

The saved tool is now available in the HSM Tools Repository **as a development version**.

Development versions are **private** and therefore **not visible to the other HSM users** visiting the HSM Tools Repository.

However, if the tool creator launches a sandbox containing instances of their development (*private*) tools, they **can invite other users** (as guests of this sandbox) to use these private tools under their supervision.

6.1.4.3. Link the Tool Development version to Portal Catalogue Entry

After having saved a development tool in the HSM Tools Repository, the providers have

to link it to the Collaboration Portal by using the "***Try It Now"* feature** – available Collaboration Portal side.

The ***"Try it Now"*** functionality allows the providers to bind the **full description** of a tool - saved in the Portal Catalogue (**see §6.1.4.1 above**) - to its **implementation** - saved in the HSM Tools Repository.

When the "***Try it Now***" link refers to a **production tool,** this can be **started in a new sandbox** easily **from the Portal Tools Catalogue.**

On the other hand, when the "***Try It Now***" link is associated to a **development tool**, it allows the **users** browsing the Portal Catalogue to know the **tool provider is working** in HSM to create a **sandbox-ready tool implementation:**

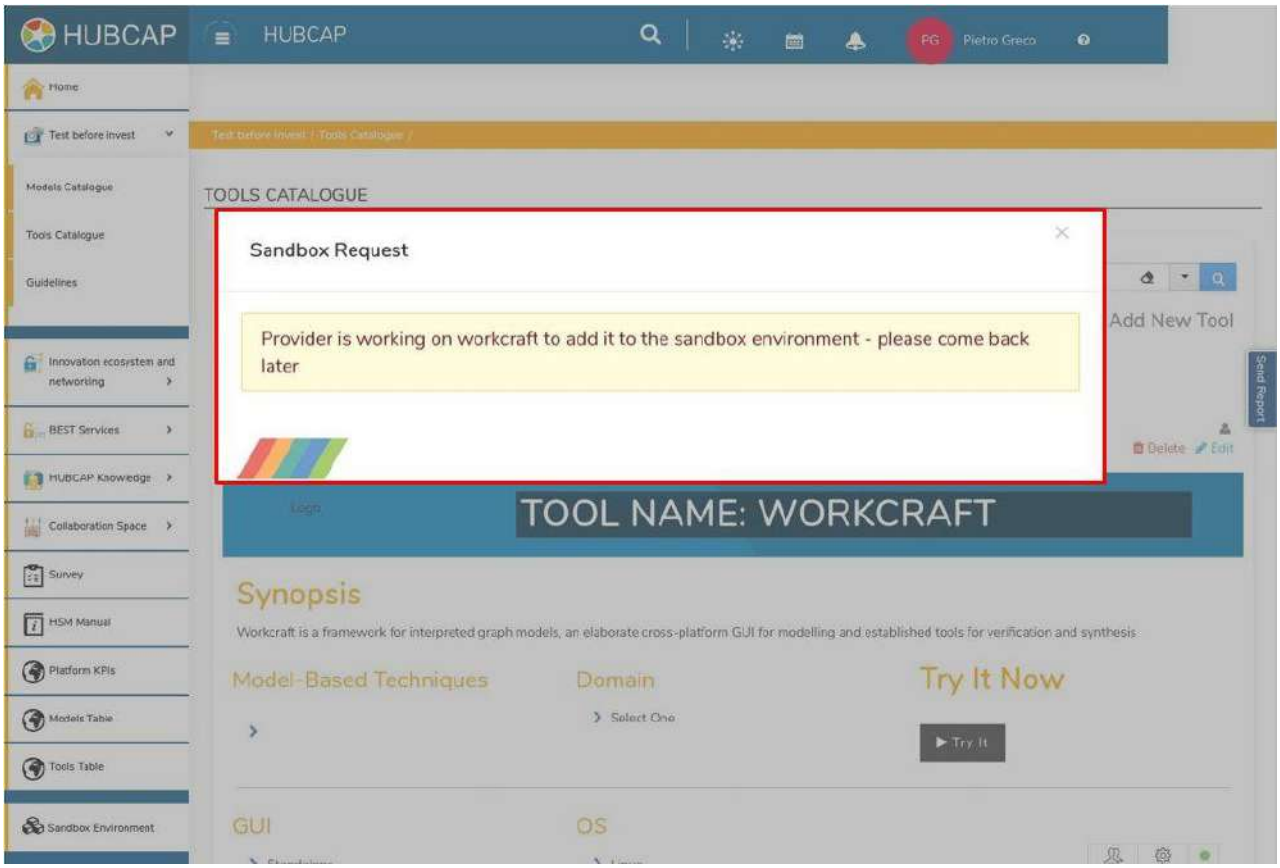


Figure 31 – Dialog informing users that the selected tool is work in progress

Moreover, if the **first development version** of a tool saved in the HSM Tools Repository is immediately linked to the Portal Catalogue, the **providers** do **not have to worry** about **updating this link manually** in case of update and replacement of the development versions or even promotion to production – as the **HSM** will take care of **preserving the**

link for them **automatically**.

Some more operational details about how to activate the "***Try It Now" function*** can be found in **§6.4 below**.

Note: *the providers of* ***tools not associated to the Collaboration Portal*** *via the "Try It Now" feature will periodically receive detailed* ***warning messages*** *about the* ***missing links****.*

6.1.4.4. Update and Replace the Tool Development VM

The providers can update the development version of a tool - overwriting the existing one - as many times as they want.

To do so it is sufficient to instantiate the development version from the HSM Tools Repository in a new Sandbox, customise it and save it again.

6.1.4.5. Promote the Tool from Development to Production version

When the installation, configuration and testing of a tool **development version** have been completed, the providers **could already promote it** to **production version**.

However, since this operation makes the tool **public** and then **available to all the HUBCAP users** (either via the "***Try It Now***" Collaboration Portal functionality or by selecting it directly from the HSM Tools Repository) the providers, **before promoting, are responsible for** implementing a few measures needed, for example, to:

- make the **tool OS secure** and **locally protected**,
- **facilitate the tool usage** by other HSM users and **avoid possible misuse**,
- **reduce** as far as possible the **VM storage footprint**
- ...

In **operational terms,** the providers should pay attention to things like these:

- create a **tool-dedicated system account** and set its permissions as restricted as possible,
- remove or protect **sensitive data** that might have been stored in the OS during the installation,
- add a **desktop shortcut** to access and launch the tool easily,
- leave inside the OS a **quick tool guide** easy to find,

- set a preferred **screen resolution**,
- delete any **temporary files**, applications **cache** (e.g., packages manager local copies of the installed software) not needed for the evaluation experiments,
- …

After these measures have been implemented, the providers **can promote** their tool from the private development version to the public production one, by following the next steps:

- open the HSM Tools Repository
- search the development version of their tool to promote
- click on the corresponding “Promote” button

Figure 32 – Promote button available in the HSM Tools Repository alongside the tool to promote

- set the production tool attributes (**version**, **description** and **visibility**) by using the promotion dialog:

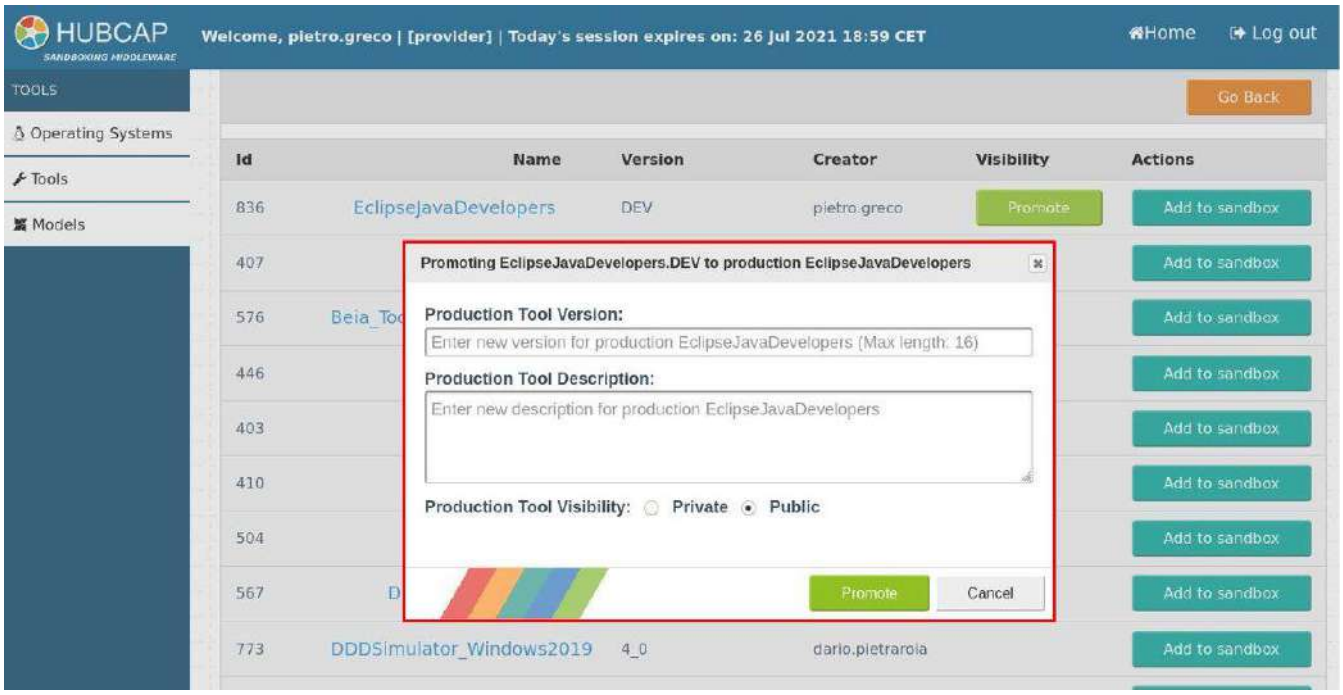


Figure 33 – Tool promotion dialog asking for production version, description and visibility

Notes

1. *the **version** cannot be "**DEV**" and cannot exceed 16 characters*
2. *the **visibility** must be "**public**" to allow other HSM users to experiment with the tool*

During the promotion operation the tool **development machine** is **copied:**

- **creating** a **new production version** (if none exists)

or

- **overwriting** the **latest production version** already existing.

In both cases the **pre-existing links** to the Collaboration Portal Catalogues **are preserved.**

6.1.4.6. Destroy the Development Version

The provider should delete the just promoted development version if it is no longer necessary. It will be possible to recreate it later starting from the latest saved production version.

6.1.5 For Experienced HSM Users Only

Notes

Dangerous characters/Patterns: *the system, for security reasons, **does not accept some characters/patterns** for tool name, version and description. If the user enters some of such characters, the system shows a pop-up dialog listing the not allowed characters entered alongside each interested field. **The user must remove these characters to continue.***

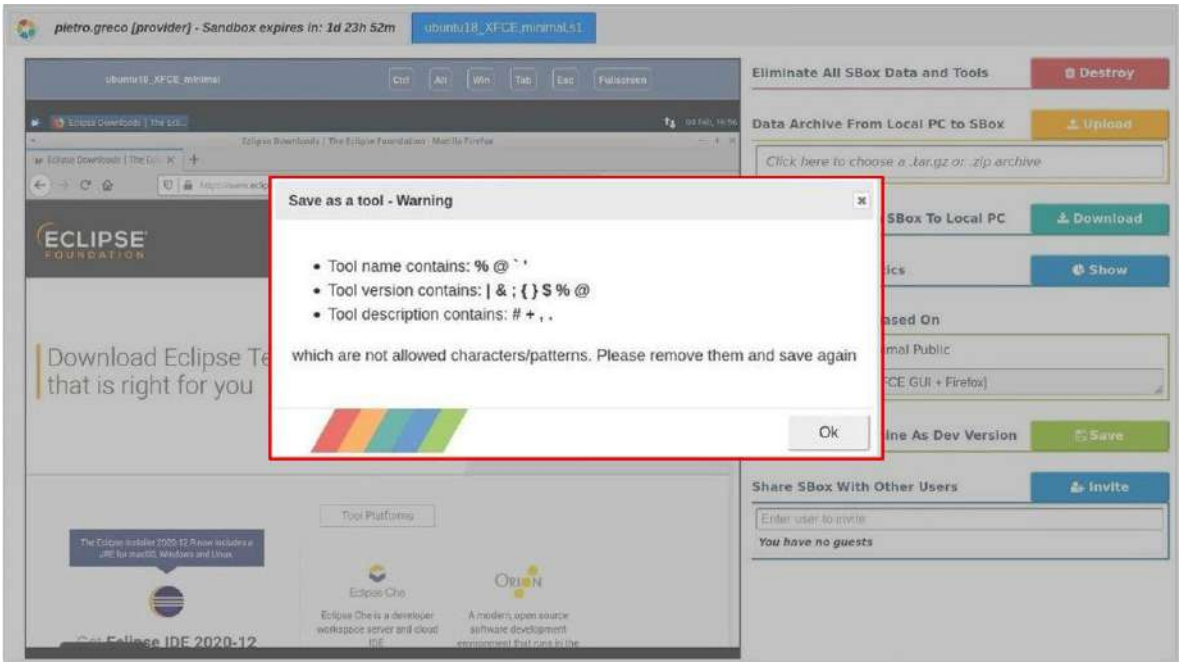


Figure 34 – Dialog informing user about prohibited characters existence in data entered in save form

Advanced Tip: *the above instructions have described the installation process of a single tool starting from a single OS VM. The HSM also enables to carry out, in a single working session,* ***the installation of many tools "simultaneously"****. The providers instantiate a sandbox with as many OS VMs as the tools to provision, customise them and save their resulting tools.*

6.2 Models Provisioning

In addition to provisioning a *tool*, a provider can also add a model to the Models Repository. A model is an archive (.tar.gz or .zip) containing files (e.g., project files, tutorials, manuals ...) and folders.

To add a new model, the provider accesses the Models Repository from the home page and clicks on "Upload New Model" (Figure 35):

Figure 35 - Models Repository

then they are shown the following form (Figure 36):

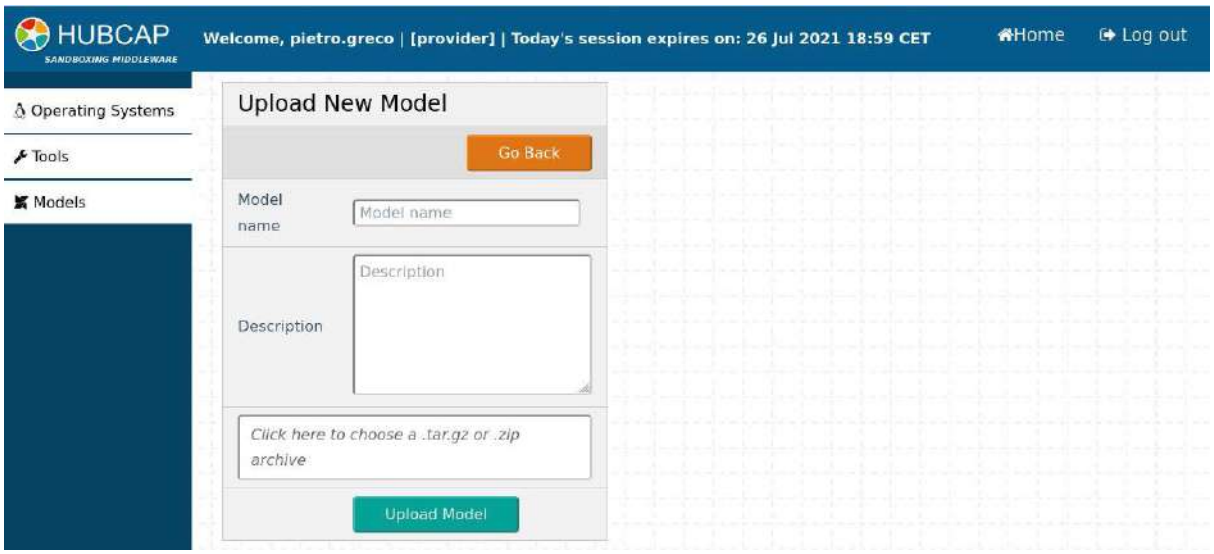


Figure 36 - Upload New Model form

They enter model name, description, select the archive from their local computer and finally click on “Upload Model”. The model is now available in the Models Repository

and accessible to the other users.

6.3 Repository Management

6.3.1 Destroying Items

From a repository, the user clicks on the item name to access the details page, then clicks on “Destroy” to destroy the item. The user can only destroy those tools and models he/she has previously provided to the HSM.

Figure 37 – By clicking on the item name from a HSM repository users get access to the item details page

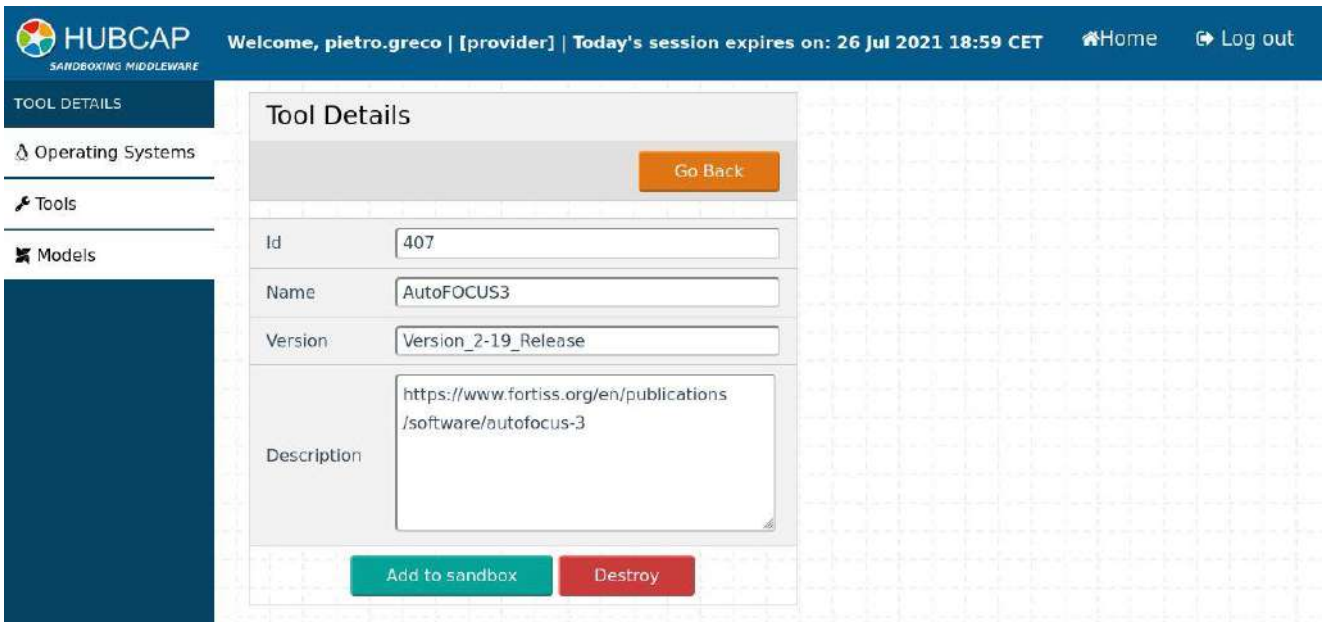


Figure 38 – Tool details page where further functionalities are available

6.3.2 Tool Promotion

A development version of a tool considered stable can be promoted to production by clicking on the corresponding “Promote” button available alongside it in the Tools repository.

Figure 39 – Promote button available in the HSM Tools Repository alongside the tool to promote

More details about how to use this functionality have been described in the previous ***§6.1.4.5. - Promote the Tool from Development to Production version.***

However, it is worthy to remind here that in promoting a development version, a copy of it is created and will become the new production version. **The existing production version, if any, will be overwritten**. In this case, if the overwritten production version was already linked to the Collaboration Portal Catalogues, the provider **will not need to update the link by hand** since the HSM will preserve the HSM Tool ID and the related links.

Tip: *Do not forget to delete the just copied development version if you do not need it anymore. It will be possible to recreate it by instantiating the production version in a Sandbox and resaving.*

6.3.3 Changing Tools Visibility

A provider can change the visibility settings of their production tools from the HSM Tools repository by clicking on the desired state: “Private” or “Public" (Figure 40):

Figure 40 – HSM Tools Repository: toggle button to change tool visibility.

6.4 Enabling the Try It Now feature (Portal Side)

After having provisioned a new Tool or a Model, it is possible to enable the *Try It Now* feature (portal side) for it. The *Try It Now* function allows providers to establish a shortcut between the Collaboration Portal Catalogues and Sandboxing Middleware. Enabling it means activating a *Try It Now* section with a *Try It* button in the tool/model

detail page (portal side) (Figure 41). The button, if clicked, makes the Sandbox Cart (HSM side) be automatically populated.

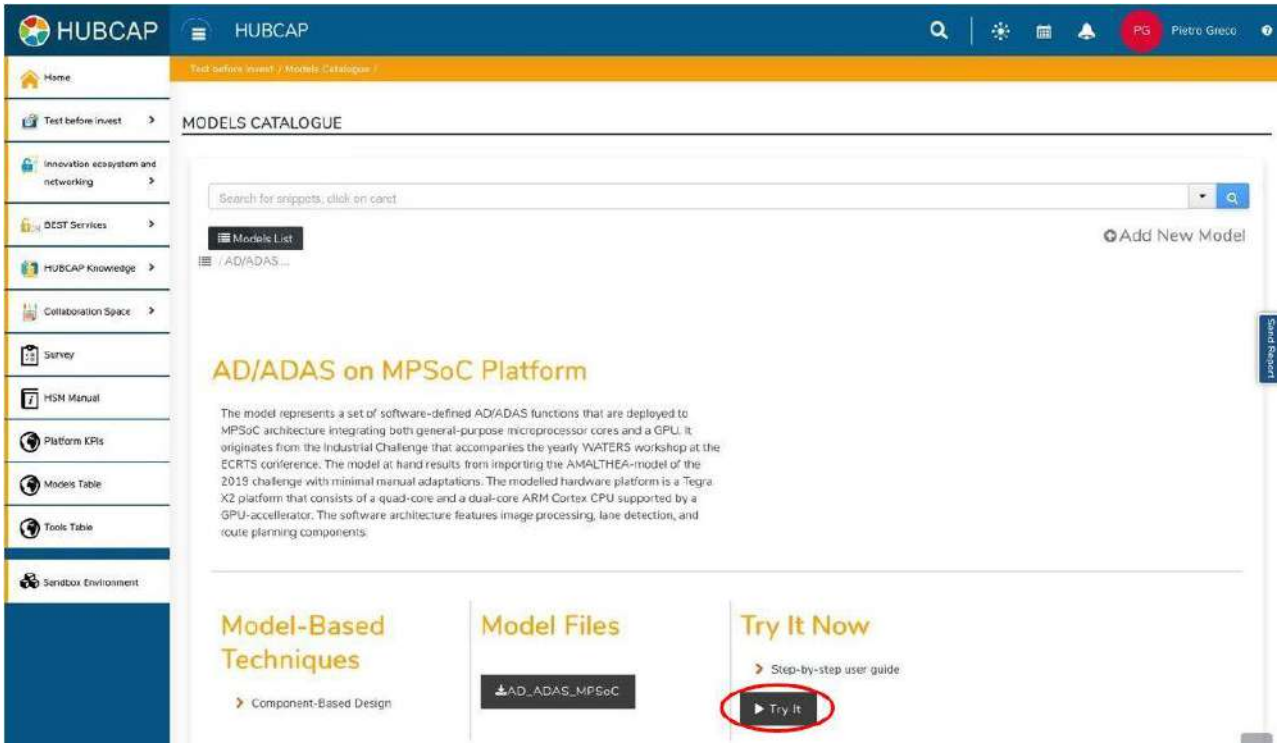


Figure 41 - Try It Now section with Try It Button

6.4.1. For Models

This feature can be enabled for Models by the **providers** by:

1. Creating or selecting, in the Models Catalogue portal side, the model entry for which the function should be enabled
2. Adding the following information to the details of that model through the create/edit Model form (Figure 42):
    a. the ID of the **model** uploaded to the HSM,
    b. the ID of the **tool** already available in HSM and **able to process the model**,
    c. a step-by-step **user guide** which explains how to use the model with the associated tool inside a same sandbox.

Note: *Tool and Model IDs are shown in the HSM Repositories UI.*

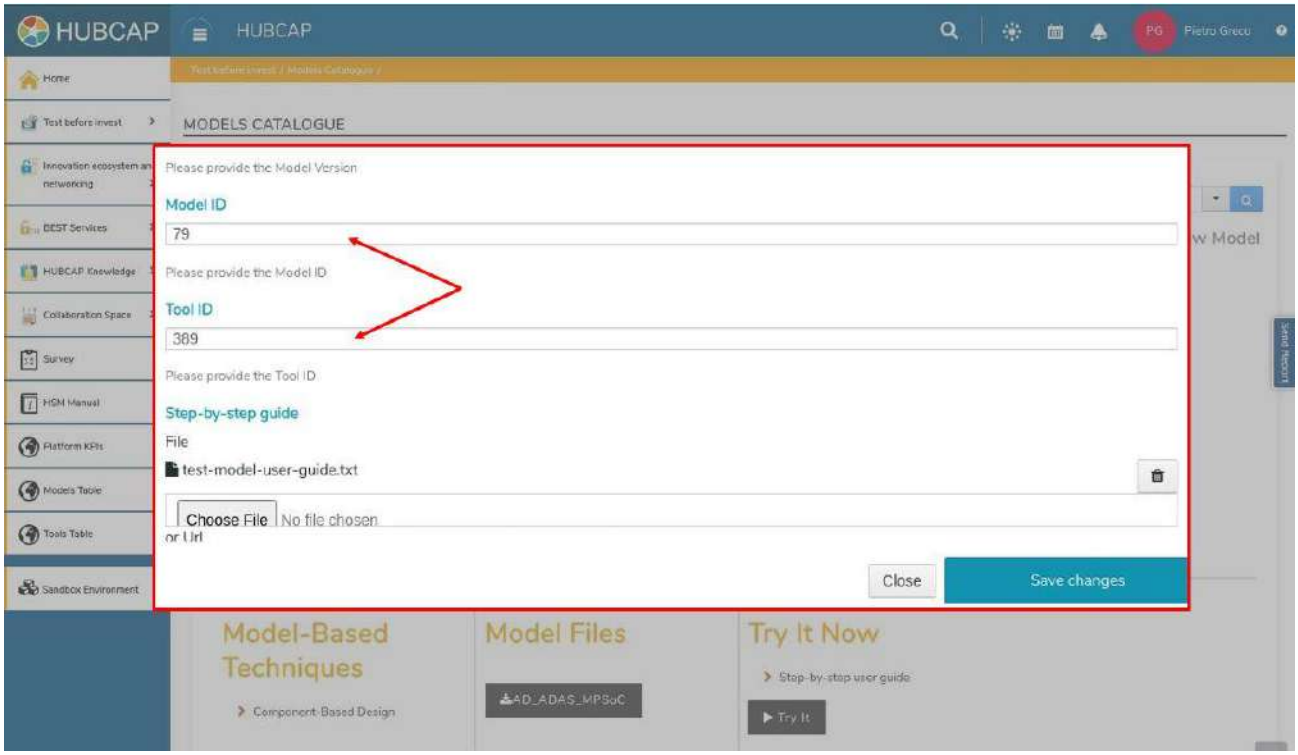


Figure 42 - Model edit dialog showing the information to enter to enable the Try it Now feature

All the three above mentioned fields are mandatory and have to be filled in to allow the user to see the "Try it Now" section (Figure 43).

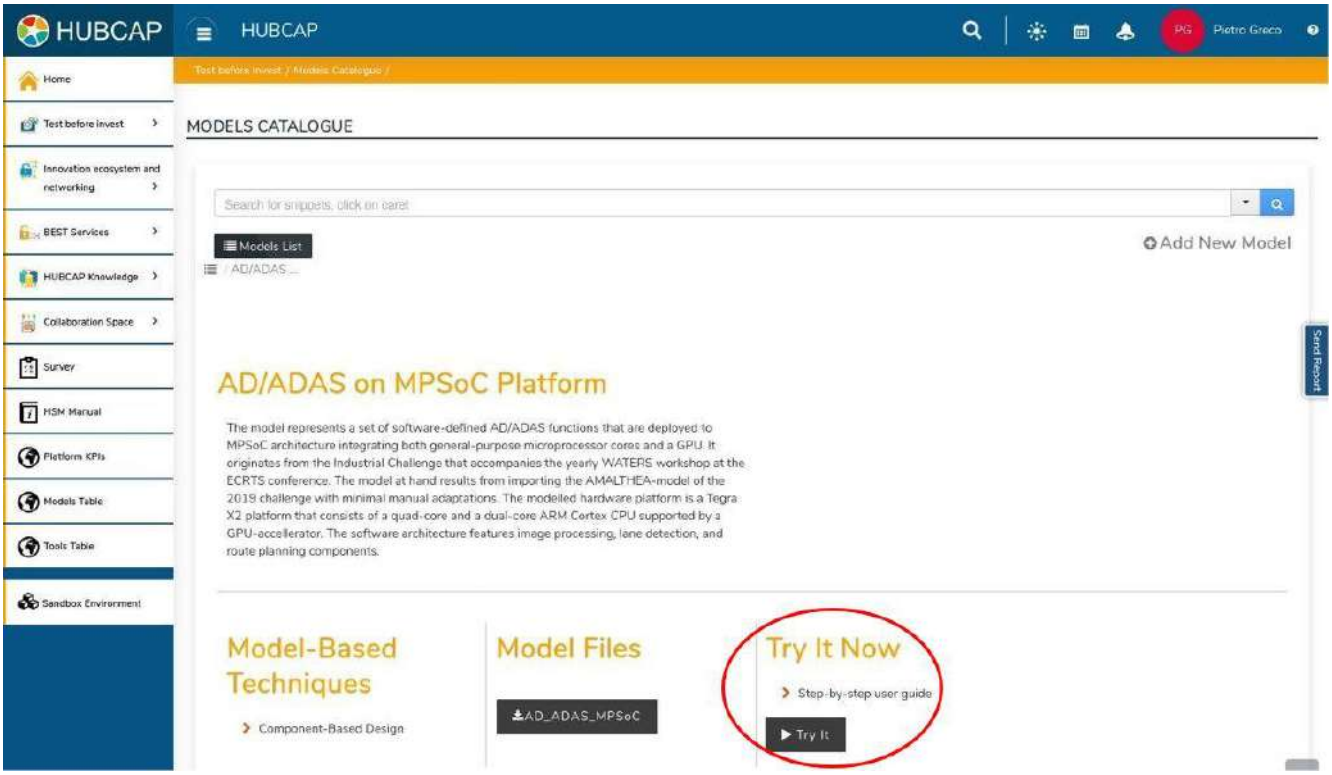


Figure 43 - Model details page with Try it Now section

Clicking on the “Try It” button, the HUBCAP user (after the usual HSM authentication) will find the sandbox cart automatically filled with both the model selected from the Models Catalogue and the tool pre-set for it by the model provider. Clicking on the **“Step-by-step user guide"** link, the user guide will be opened separately for an easy consultation during the model-and-tool sandbox usage.

6.4.2. For Tools

The same function is also available for Tools. In this case only the Tool ID has to be added to the details of the tool in the Tools Catalogue Collaboration Portal side to enable the functionality (Figure 44).

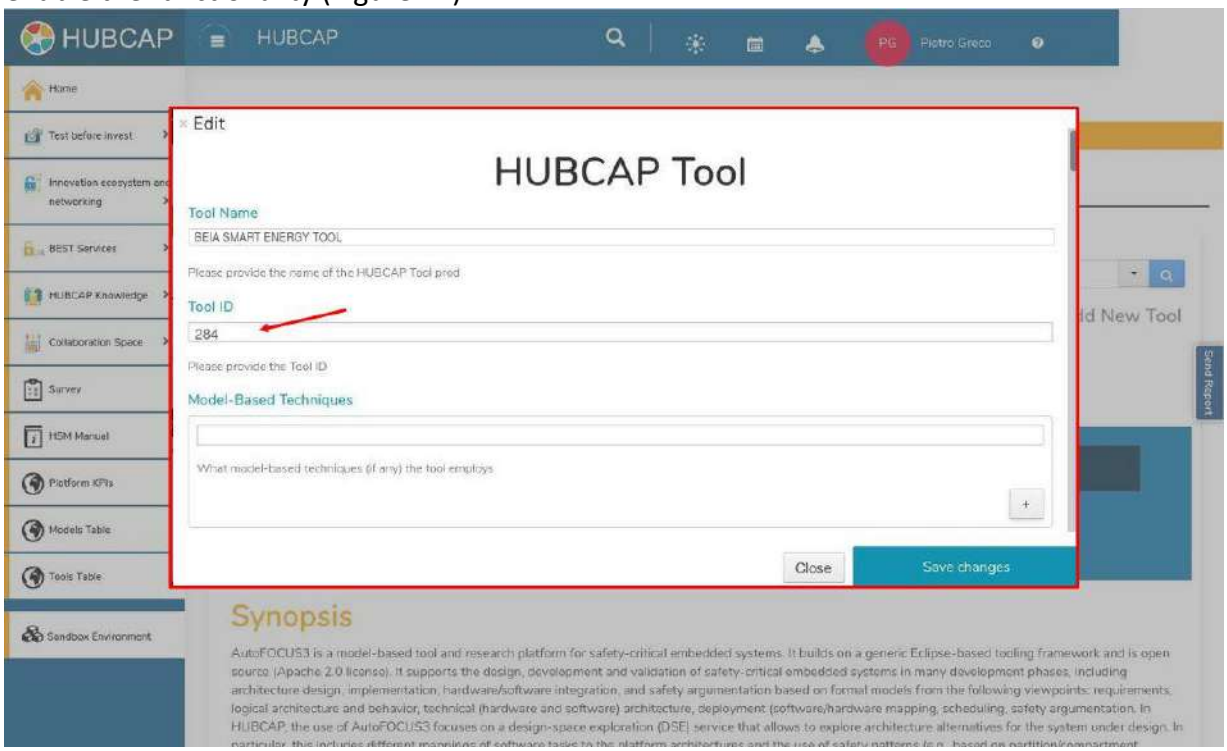


Figure 44 - Tool Create/Edit Form available in the Tools Catalogue Collaboration Portal side

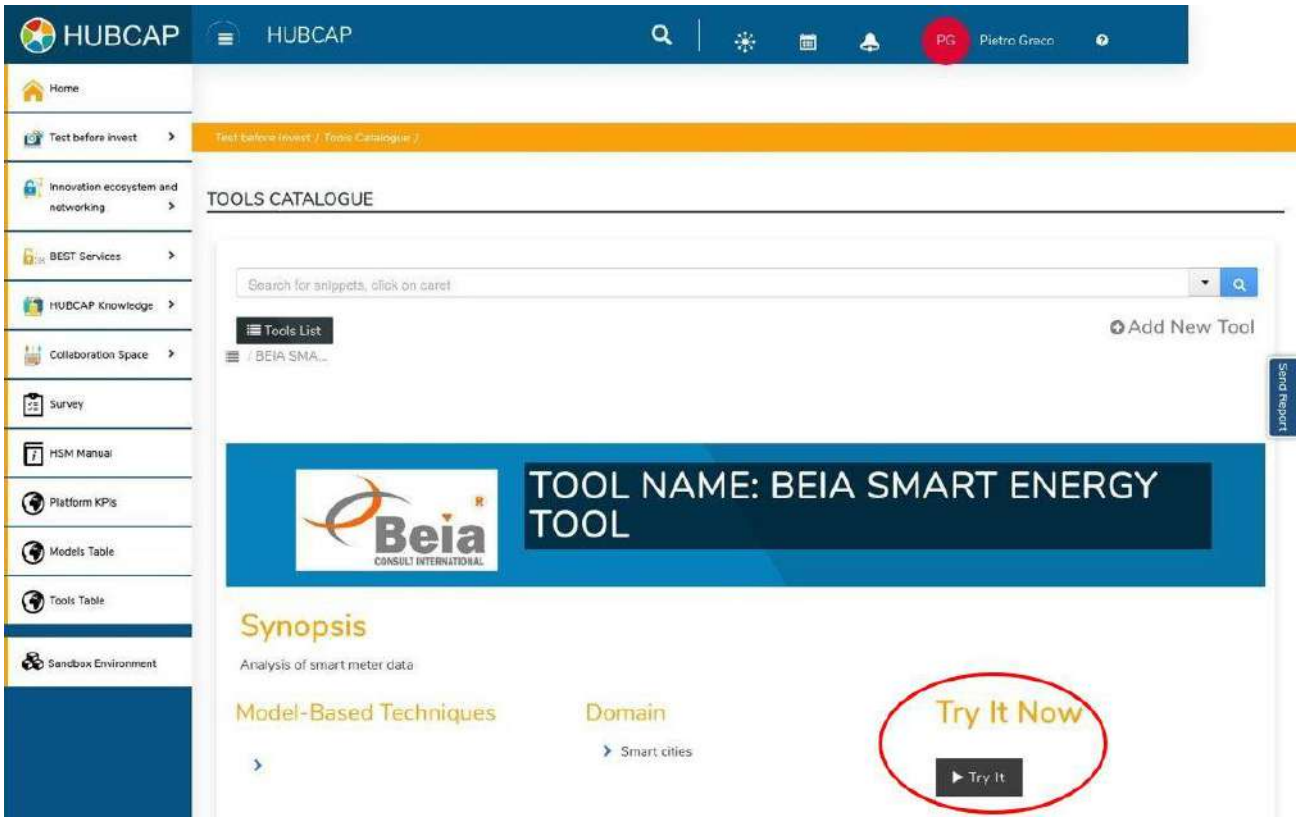
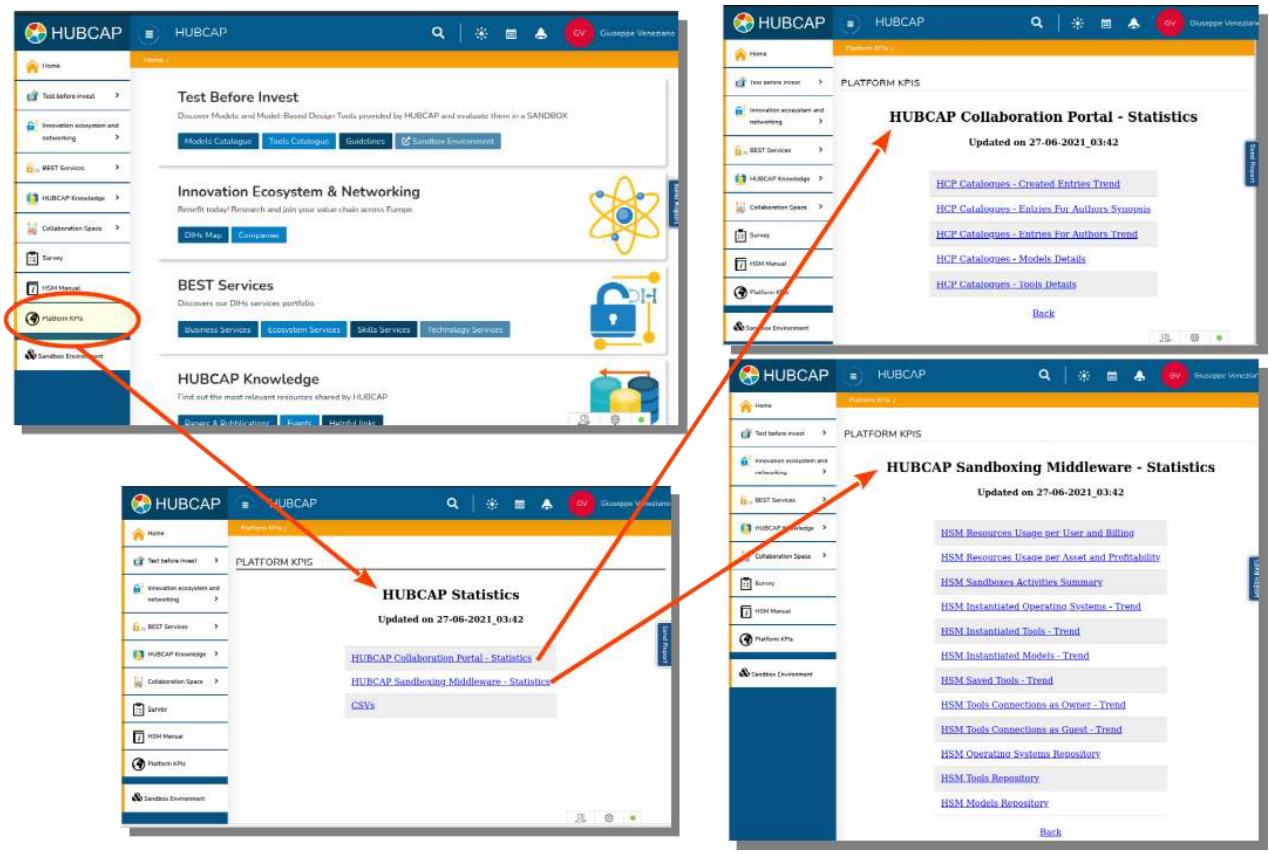


Figure 45 - Tool details page with active Try It Now section

In this case, clicking on the "Try It" button, the end user will find the sandbox cart automatically filled with only the tool.

7. KPIs

KPIs for the HUBCAP Collaboration Platform are available through the **Collaboration Portal (HCP)** by clicking on the "Platform KPIs" button in the sidebar menu:



From there a first menu will give access to:

- Statistics for the HUBCAP Collaboration Portal
- Statistics for the HUBCAP Sandboxing Middleware
- Downloadable CSV files for all the statistics

The statistics for the Collaboration Portal and Sandboxing Middleware are in turn split into categories. Moreover, for some of the reports **charts** are also available.

7.1 HUBCAP Collaboration Portal KPIs - Details

7.1.1 HCP - Created Entries Trend

HCP Catalogues - Created Entries Trend

Updated on 25-06-2021_12:14

Back

Show 50 entries Search:

Catalogue	Year	Created	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
hubcapmodel	2020	25	0	0	0	0	7	4	0	5	1	5	1	2
hubcapmodel	2021	48	0	0	0	0	9	39	0	0	0	0	0	0
hubcapmodel	Total	73												
hubcaptool	2020	15	0	0	0	0	6	4	4	1	0	0	0	0
hubcaptool	2021	15	0	1	4	2	6	2	0	0	0	0	0	0
hubcaptool	Total	30												

Showing 1 to 6 of 6 entries Previous 1 Next

Back

Figure 46 - For each catalogue, the number of entries created each month; Yearly results are also shown.

7.1.2 HCP - Entries for Authors Synopsis

HCP Catalogues - Entries For Authors Synopsis

Updated on 25-06-2021_12:14

Back

Show 10 entries Search:

Author	Models	Tools	Total
A. Robert Robert Manolea	0	1	1
Adrian Pop	18	2	20
Alberto Bombardelli	19	1	20
All Authors	73	30	103
All Authors 2020	25	15	40
All Authors 2021	48	15	63
Amos Smith	0	1	1
Andrea Micheli	2	0	2
Barner Simon	6	0	6
Bas Gunnink	0	2	2

Showing 1 to 10 of 29 entries Previous 1 2 3 Next

Back

Figure 47 - For each author (provider user) the number of entries created in each catalogue: models or tools (with total)

7.1.3 HCP - Entries for Authors Trend

HCP Catalogues - Entries For Authors Trend

Updated on 25-06-2021_12:14

Back

Show 10 entries Search:

Author	2021 Entries	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
A. Robert Robert Manolea	1	0	0	1	0	0	0	0	0	0	0	0	0
Adrian Pop	16	0	0	0	0	0	16	0	0	0	0	0	0
Alberto Bombardelli	14	0	0	0	0	5	9	0	0	0	0	0	0
All Authors	63	0	1	4	2	15	41	0	0	0	0	0	0
Amos Smith	1	0	0	1	0	0	0	0	0	0	0	0	0
Barner Simon	6	0	0	0	0	4	2	0	0	0	0	0	0
Georgios Foroglou	1	0	0	0	1	0	0	0	0	0	0	0	0
Grigore Stamatescu	1	0	0	1	0	0	0	0	0	0	0	0	0
Hugo Daniel Macedo	3	0	0	0	0	2	1	0	0	0	0	0	0
Mikel PÃ©rez	1	0	1	0	0	0	0	0	0	0	0	0	0

Showing 1 to 10 of 16 entries Previous 1 2 Next

Figure 48 - For each author (provider user) the overall number of catalogue entries created each month, with yearly total.

7.1.4 HCP – Models Details

HCP Catalogues - Models Details

Updated on 25-06-2021_12:14

Back

Show 10 entries Search:

Num	Model Name	Model Vers	Author	Creation Date	TIN_Tool	TIN_Model
1	AD/ADAS on MPSoC Platform		Simon Barner	20200804-122648	AutoFOCUS3	ADAS_on_MPSoC_Platform
2	Adaptive Cruise Control	2020-06	Simon Barner	20200603-155058	AutoFOCUS3	Adaptive_Cruise_Control
3	Adder		Alberto Bombardelli	20210609-131019	-	-
4	Air Traffic Control		Alberto Bombardelli	20200901-085026	OCRA	Air_Traffic_Control
5	Automatic Train Control		Prasad Talasila	20210604-135825	-	-
6	Automotive Turn Indicator	V1.0	Dr JÃ¶rg Brauer	20201026-110622	-	-
7	Autonomous Vehicle - Bicycle Model		Hugo Daniel Macedo	20210601-081127	-	-
8	Autopilot		Prasad Talasila	20210604-133650	-	-
9	BatterySensor		Alberto Bombardelli	20210609-132330	COMPASS_Tool	BatterySensor
10	Blinker Controller	2021-05	Barner Simon	20210521-101751	AutoFOCUS3	Blinker_Controller

Showing 1 to 10 of 73 entries Previous 1 2 3 4 5 … 8 Next

Back

Figure 49 - For each model of in the Models Catalogue: name, version, author, creation date and references to actual HSM Tool and Model for the Try It Now feature (TIN_Tool and TIN_Model)

7.1.5 HCP – Tools Details

HCP Catalogues - Tools Details

Updated on 25-06-2021_12:14

Back

Show 10 entries Search:

Num	Tool Name	Tool Vers	Author	Creation Date	TIN_Tool
1	20-sim	4.8.2	Bas Gunnink	20200624-122639	-
2	AutoFOCUS3	2.17	Simon Barner	20200526-145338	-
3	Beeno	v1.0.0-rc	A. Robert Robert Manolea	20210309-162643	-
4	BEIA SMART ENERGY TOOL		George Suciu	20200708-121434	-
5	CHESS	1.0	Stefano Tonetta	20200821-115538	-
6	COMPASS	3.1	Nur Alam Labu	20210430-164344	-
7	Cube	2.3	Georgios Foroglou	20210415-135643	-
8	DDD Simulator	4.0	Dario Pietraroia	20200707-082405	-
9	Developair		Mikel PÃ©rez	20210225-105545	-
10	Evitado System Simulator	1.3	Amos Smith	20210310-135247	Evitado_System_Simulator

Showing 1 to 10 of 30 entries Previous 1 2 3 Next

Back

Figure 50 - For each tool of the Tools Catalogue: name, version, author, creation date and reference to actual HSM Tool for the Try It Now feature

7.1.6 HCP – Users Accesses Trend

HCP Users Accesses Trend

Updated on 07-07-2021_15:56

Back

Show 50 entries Search:

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2020	0	0	0	0	0	27	17	14	27	66	43	36
2021	57	35	108	90	76	103	24	0	0	0	0	0

Showing 1 to 2 of 2 entries Previous 1 Next

Back

Figure 51 - For each year and month, the number of accesses to the Hubcap Collaboration Portal

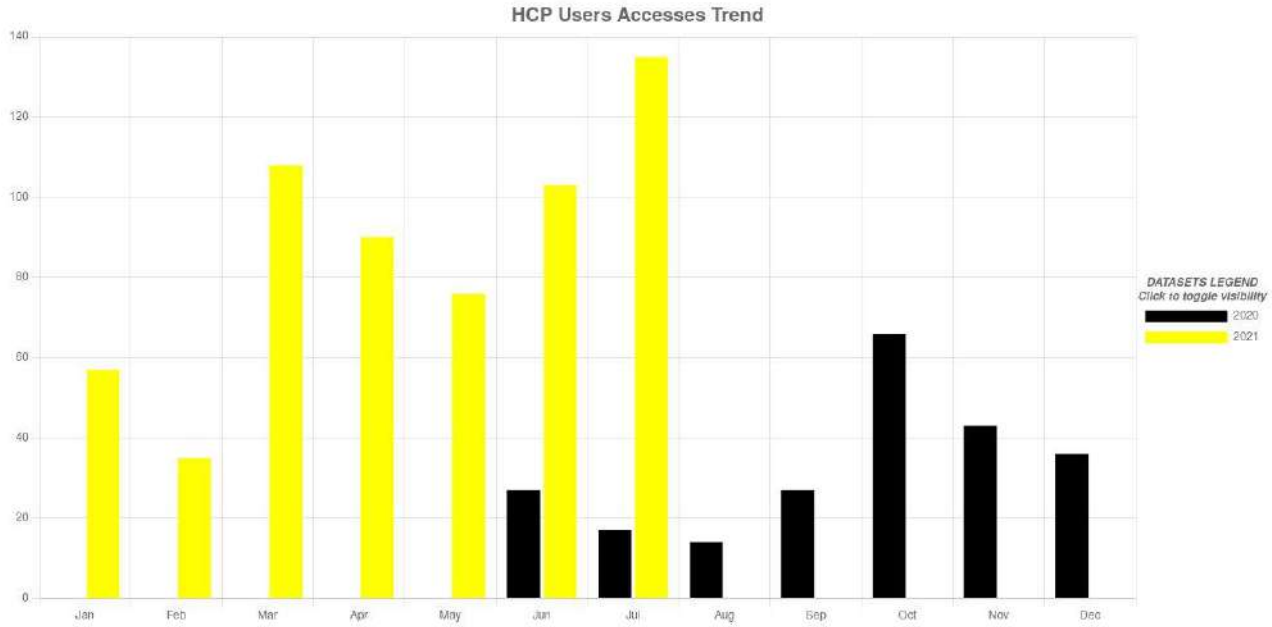


Figure 52 - For HCP Users Accesses Trend report a chart is also available.

7.2 HUBCAP Sandboxing Middleware KPIs - Details

7.2.1 HSM – Resources Usage per User and Billing

HSM Resources Usage per User and Billing

Updated on 25-06-2021_12:14

Back

Show 10 entries Search:

Resources Usage per User - Year 2021	CPU time [secs]	Network I/O [KB]	Storage R/W [MB]	Bill [€]
alberto.bombardelli	814	396389	1995	6.77
alexandru.vulpe	755	408700	2038	6.88
amos.smith	2260	1291385	8387	23.56
b.gunnink	810	407907	2643	7.53
barner.simon	135	2928	1641	1.81
daniel.craciunean	644	4021117	6043	46.90
dario.pietraroia	153998	1268725	3167	169.85
frank.zeyda	7846	4255285	16463	66.86
frank.zeyda2	306	252638	2064	4.90
george.iordache	7072	2170475	21968	50.74

Showing 1 to 10 of 24 entries Previous 1 2 3 Next

Back

Figure 53 - For each user the overall amount of resources (CPU time, Network traffic in KB, Read/Written MB from/to the Sandbox Shared Storage) used by their sandboxes and a hypothesis of bill computed using sample fares

7.2.2 HSM – Resources Usage per Asset and Profitability

HSM Resources Usage per Asset and Profitability

Updated on 25-06-2021_12:14

Back

Show 10 entries Search:

Resources Usage per Asset - Year 2021	CPU time [secs]	Network I/O [KB]	Storage R/W [MB]	Bill [€]
OS - centos7	92	69478	745	1.53
OS - centos7_XFCE	5465	4884368	12669	66.98
OS - ubuntu18_XFCE	16859	748277	22606	46.95
ST - Shared_Storage	27228	33010280	125613	482.94
TO - Air_Traffic_Control_Tool	812	145690	4323	6.59
TO - AutoFOCUS	420	8675	1738	2.24
TO - AutoFOCUS3	5303	23659	5207	10.75
TO - Beia___Tool_Ubuntu_18_04	1310	8416	2816	4.21
TO - Beia__Tool_Ubuntu_18_04	1	2	0	0.00
TO - Beia_Tool	2725	210589	5305	10.14

Showing 1 to 10 of 56 entries Previous 1 2 3 4 5 6 Next

Back

Figure 54 - For each sandbox asset (OS: Operating System, ST: Shared Storage, TO: Tool) the amount of resources (CPU time, Network traffic in KB, Read/Written MB from/to the Sandbox Shared Storage) they have consumed and a hypothesis of bill/profit computed using sample fares.

7.2.3 HSM – Sandboxes Activities Summary

HSM Sandboxes Activities Summary

Updated on 25-06-2021_12:14

Back

Show 10 entries Search:

HSM_Activities_Summary	Year_2021	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
a) # of Instantiated Sandboxes	316	30	41	77	47	40	81	0	0	0	0	0	0
b) # of OSes Instantiated in SBoxes	87	7	14	24	14	14	14	0	0	0	0	0	0
c) # of Tools Instantiated in SBoxes	278	30	31	61	39	33	84	0	0	0	0	0	0
d) # of Models Instantiated in SBoxes	86	6	8	13	25	15	19	0	0	0	0	0	0
e) # of Tools Saved to HSM Repository	93	10	7	21	20	9	26	0	0	0	0	0	0
f) # of SBox Owners Tools Connections	689	65	73	159	120	90	182	0	0	0	0	0	0
g) # of SBox Guests Tools Connections	22	0	2	1	4	12	3	0	0	0	0	0	0
h) # of Archives Downloded from SBoxes	11	1	2	3	1	3	1	0	0	0	0	0	0
i) # of Archives Uploaded to SBoxes	38	6	1	14	8	8	1	0	0	0	0	0	0

Showing 1 to 9 of 9 entries Previous 1 Next

Back

Figure 55 - For each month and with yearly total, a summary of activities involving sandboxes.

7.2.4 HSM – Instantiated Operating Systems – Trend

HSM Instantiated Operating Systems - Trend

Updated on 25-06-2021_12:14

Back

Show 50 entries Search:

OSes Instantiated in SBoxes	Year_2021	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
centos7	4	0	0	0	1	2	1	0	0	0	0	0	0
centos7_minimal1s	1	1	0	0	0	0	0	0	0	0	0	0	0
centos7_XFCE	12	0	1	8	0	1	2	0	0	0	0	0	0
ubuntu18_XFCE	63	0	12	16	13	11	11	0	0	0	0	0	0
ubuntu18_xfce1s	3	3	0	0	0	0	0	0	0	0	0	0	0
Win10_Minimal1s	3	3	0	0	0	0	0	0	0	0	0	0	0
windows	1	0	1	0	0	0	0	0	0	0	0	0	0

Showing 1 to 7 of 7 entries Previous 1 Next

Back

Figure 56 - For each Operating System, the number of times it has been instantiated in sandboxes, for each month and with yearly total.

7.2.5 HSM – Instantiated Tools – Trend

HSM Instantiated Tools - Trend

Updated on 25-06-2021_12:14

Back

Show 10 entries Search:

Tools Instantiated in SBoxes	Year_2021	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
20-sim	2	0	2	0	0	0	0	0	0	0	0	0	0
20-sim_4_8_3_win10_minimal_demo1t	6	3	3	0	0	0	0	0	0	0	0	0	0
20-sim_4_8_3_win10_minimal_demo_test1t	1	1	0	0	0	0	0	0	0	0	0	0	0
20-sim_4_8_3_win10_minimal_demo_test_21t	1	1	0	0	0	0	0	0	0	0	0	0	0
Air_Traffic_Control_Tool	10	0	0	0	4	2	4	0	0	0	0	0	0
AutoFOCUS	3	0	0	1	0	2	0	0	0	0	0	0	0
AutoFOCUS3	11	0	0	0	0	4	7	0	0	0	0	0	0
AutoFOCUS3_DesignSpaceExploration_Qual1t	2	2	0	0	0	0	0	0	0	0	0	0	0
AutoFOCUS3_DesignSpaceExploration_Qual2t	3	3	0	0	0	0	0	0	0	0	0	0	0
AutoFOCUS3_FF12t	1	1	0	0	0	0	0	0	0	0	0	0	0

Showing 1 to 10 of 73 entries Previous 1 2 3 4 5 … 8 Next

Back

Figure 57 - For each Tool, the number of times it has been instantiated in sandboxes for each month and with yearly total.

7.2.6 HSM – Instantiated Models – Trend

HSM Instantiated Models - Trend

Updated on 25-06-2021_12:14

Back

Show 10 entries Search:

Models Instantiated in SBoxes	Year_2021	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adaptive_Cruise_Control.tar.gz	2	0	0	0	0	0	2	0	0	0	0	0	0
ADAS_on_MPSoC_Platform.tar.gz	7	0	0	0	0	2	5	0	0	0	0	0	0
Air_Traffic_Control.zip	1	0	0	0	1	0	0	0	0	0	0	0	0
Automatic_Train_Control.zip	1	0	0	0	0	0	1	0	0	0	0	0	0
Blinker_Controller.tar.gz	1	0	0	0	0	1	0	0	0	0	0	0	0
CitiSim.zip	4	2	0	0	0	2	0	0	0	0	0	0	0
Dual_Channel.zip	5	0	0	0	1	0	4	0	0	0	0	0	0
Ferryman.tar.gz	6	0	0	0	1	0	5	0	0	0	0	0	0
IntoCPS_Tut_1.tar.gz	2	2	0	0	0	0	0	0	0	0	0	0	0
Inverted_Pendulum.zip	1	0	1	0	0	0	0	0	0	0	0	0	0

Showing 1 to 10 of 25 entries Previous 1 2 3 Next

Back

Figure 58 - For each Model, the number of times it has been instantiated in sandboxes, for each month and with yearly total.

7.2.7 HSM – Saved Tools – Trend

HSM Saved Tools - Trend

Updated on 25-06-2021_12:14

Back

Show 10 entries Search:

Tools Saved to HSM Repository	Year_2021	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
20-sim_4.8.3_tool	1	0	1	0	0	0	0	0	0	0	0	0	0
20-sim_4_8_3_win10_minimal_demo_test_2_tool	1	1	0	0	0	0	0	0	0	0	0	0	0
20-sim_4_8_3_win10_minimal_demo_test_tool	1	1	0	0	0	0	0	0	0	0	0	0	0
Air_Traffic_Control_Tool_v0.1_tool	1	0	0	0	1	0	0	0	0	0	0	0	0
AutoFOCUS3_DesignSpaceExploration_Qual_tool	1	1	0	0	0	0	0	0	0	0	0	0	0
AutoFOCUS3_Version_2.19_Release_tool	1	0	0	0	0	1	0	0	0	0	0	0	0
Beia___Tool_Ubuntu_18_04_minimal_tool	1	0	0	0	0	0	1	0	0	0	0	0	0
Beia__Tool_Ubuntu_18_04_minimal_tool	1	0	0	0	0	0	1	0	0	0	0	0	0
Beia_Tool_minimal_tool	1	0	0	0	1	0	0	0	0	0	0	0	0
Beia_Tool_U_18_04_minimal_tool	1	0	0	0	0	0	1	0	0	0	0	0	0

Showing 1 to 10 of 85 entries Previous 1 2 3 4 5 … 9 Next

Back

Figure 59 - For each Tool, the number of times it has been saved, for each month and with yearly total.

7.2.8 HSM – Tools Connections as Owner – Trend

HSM Tools Connections as Owner - Trend

Updated on 25-06-2021_12:14

Back

Show 10 entries Search:

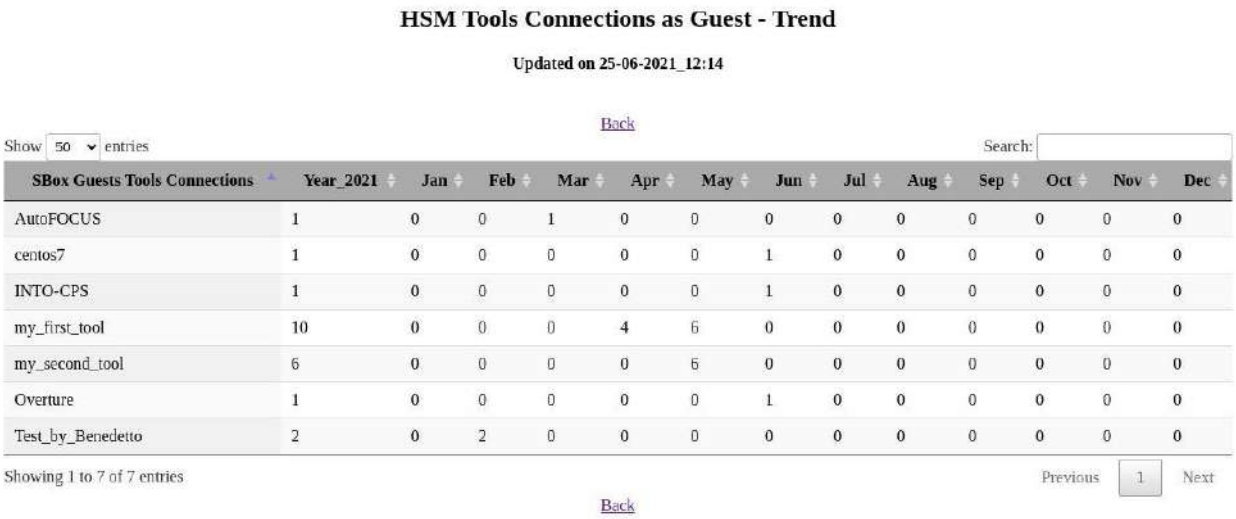
SBox Owners Tools Connections	Year_2021	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
20-sim	6	0	6	0	0	0	0	0	0	0	0	0	0
20-sim_4_8_3_win10_minimal_demo1t	8	5	3	0	0	0	0	0	0	0	0	0	0
20-sim_4_8_3_win10_minimal_demo_test1t	1	1	0	0	0	0	0	0	0	0	0	0	0
20-sim_4_8_3_win10_minimal_demo_test_21t	1	1	0	0	0	0	0	0	0	0	0	0	0
Air_Traffic_Control_Tool	15	0	0	0	7	2	6	0	0	0	0	0	0
AutoFOCUS	3	0	0	1	0	2	0	0	0	0	0	0	0
AutoFOCUS3	16	0	0	0	0	6	10	0	0	0	0	0	0
AutoFOCUS3_DesignSpaceExploration_Qual1t	4	4	0	0	0	0	0	0	0	0	0	0	0
AutoFOCUS3_DesignSpaceExploration_Qual2t	6	6	0	0	0	0	0	0	0	0	0	0	0
AutoFOCUS3_FF12t	1	1	0	0	0	0	0	0	0	0	0	0	0

Showing 1 to 10 of 79 entries Previous 1 2 3 4 5 … 8 Next

Back

Figure 60 - For each Tool, the number of times sandbox owners have established remote desktop connections to it, for each month and with yearly total.

7.2.9 HSM – Tools Connections as Guest – Trend



HSM Tools Connections as Guest - Trend

Updated on 25-06-2021_12:14

Back

Show 50 entries Search:

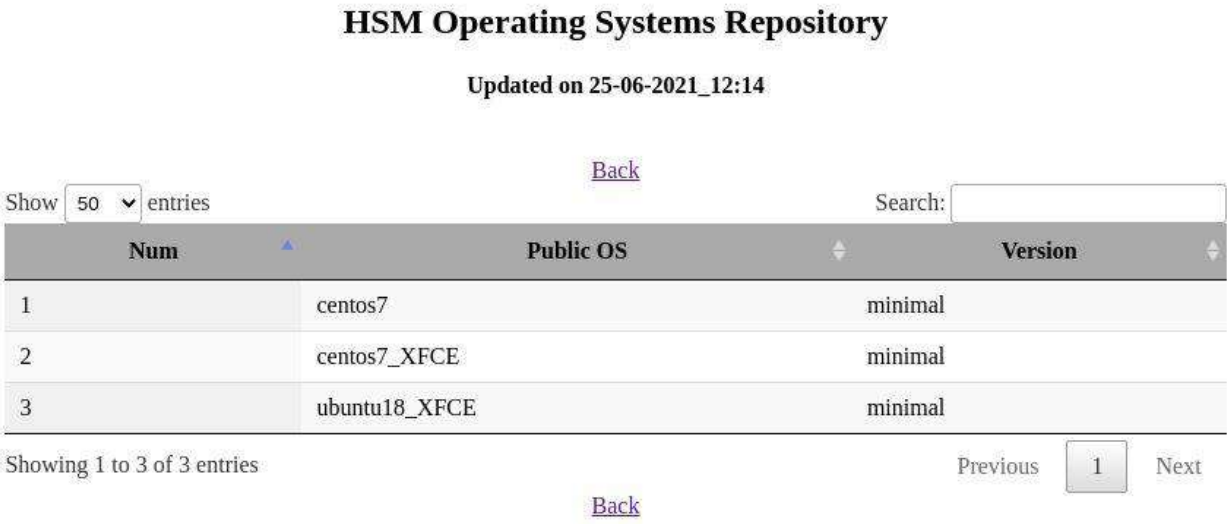
SBox Guests Tools Connections	Year_2021	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
AutoFOCUS	1	0	0	1	0	0	0	0	0	0	0	0	0
centos7	1	0	0	0	0	0	1	0	0	0	0	0	0
INTO-CPS	1	0	0	0	0	0	1	0	0	0	0	0	0
my_first_tool	10	0	0	0	4	6	0	0	0	0	0	0	0
my_second_tool	6	0	0	0	0	6	0	0	0	0	0	0	0
Overture	1	0	0	0	0	0	1	0	0	0	0	0	0
Test_by_Benedetto	2	0	2	0	0	0	0	0	0	0	0	0	0

Showing 1 to 7 of 7 entries Previous 1 Next

Back

Figure 61 - For each Tool, the number of times sandbox guests have established remote desktop connections to it, for each month and with yearly total.

7.2.10 HSM – Operating Systems Repository



HSM Operating Systems Repository

Updated on 25-06-2021_12:14

Back

Show 50 entries Search:

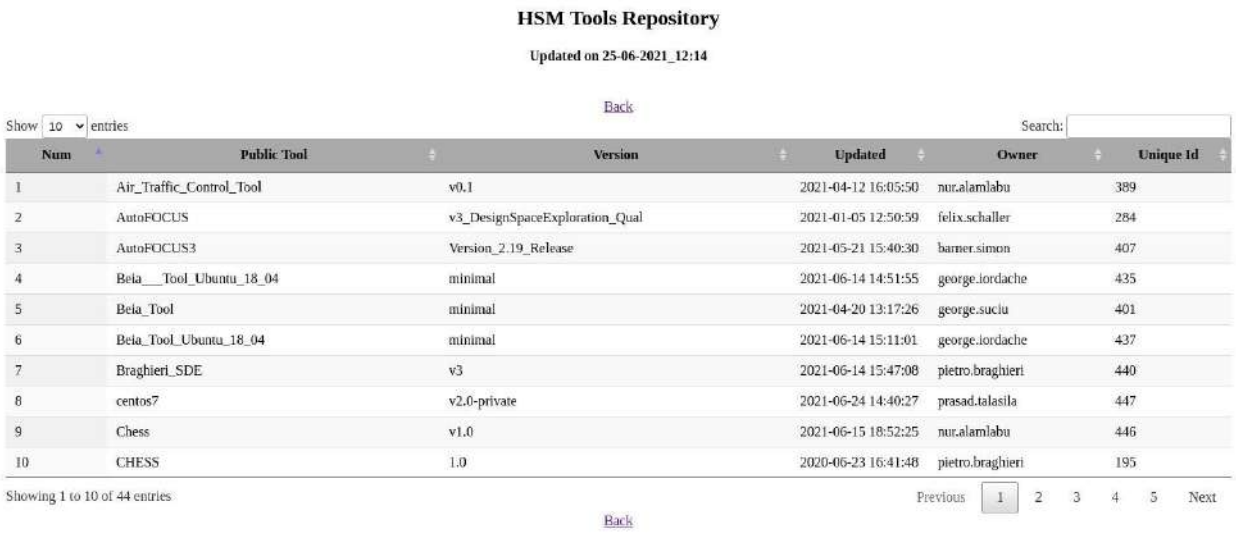
Num	Public OS	Version
1	centos7	minimal
2	centos7_XFCE	minimal
3	ubuntu18_XFCE	minimal

Showing 1 to 3 of 3 entries Previous 1 Next

Back

Figure 62 - List of Operating Systems available in the corresponding repository.

7.2.11 HSM – Tools Repository



HSM Tools Repository

Updated on 25-06-2021_12:14

Back

Show 10 entries Search:

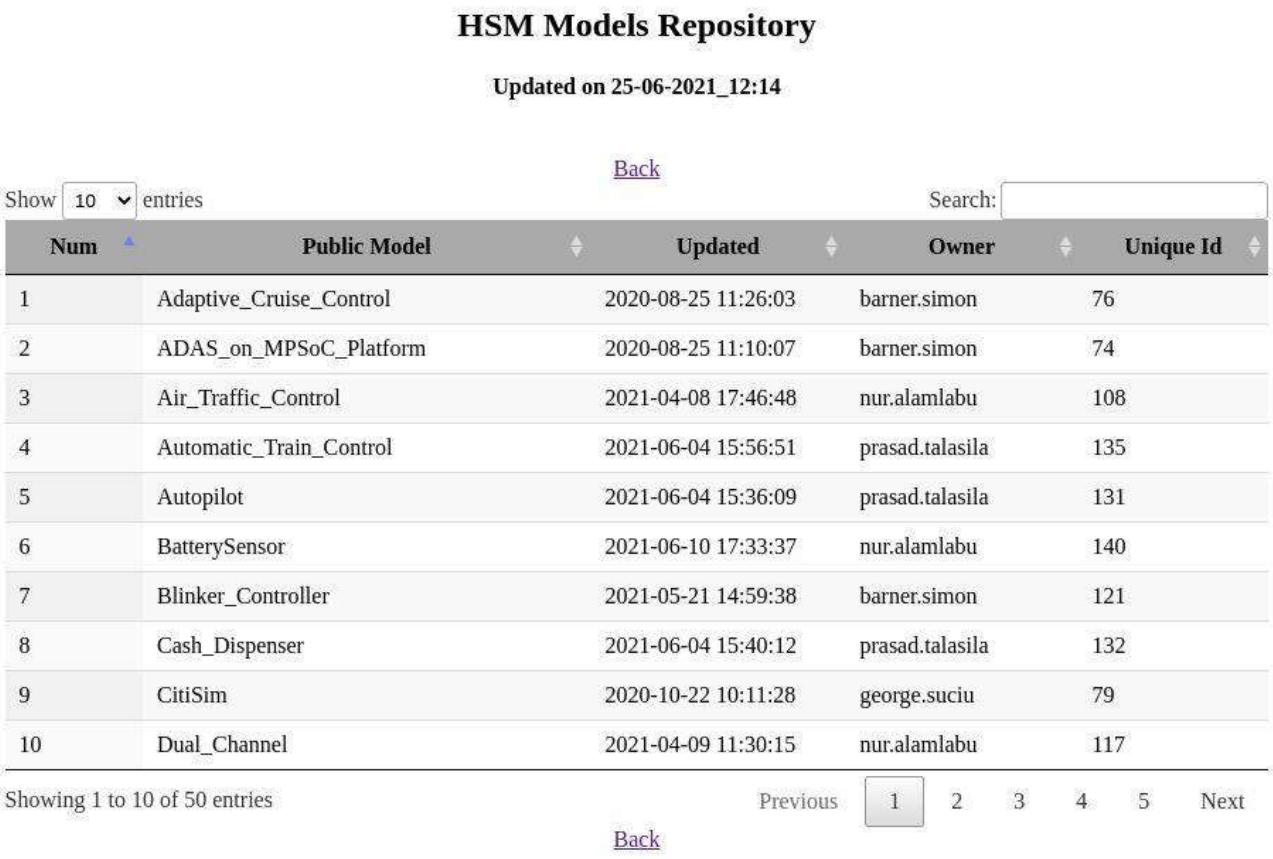
Num	Public Tool	Version	Updated	Owner	Unique Id
1	Air_Traffic_Control_Tool	v0.1	2021-04-12 16:05:50	nur.alamlabu	389
2	AutoFOCUS	v3_DesignSpaceExploration_Qual	2021-01-05 12:50:59	felix.schaller	284
3	AutoFOCUS3	Version_2.19_Release	2021-05-21 15:40:30	barner.simon	407
4	Beia___Tool_Ubuntu_18_04	minimal	2021-06-14 14:51:55	george.iordache	435
5	Beia_Tool	minimal	2021-04-20 13:17:26	george.suciu	401
6	Beia_Tool_Ubuntu_18_04	minimal	2021-06-14 15:11:01	george.iordache	437
7	Braghieri_SDE	v3	2021-06-14 15:47:08	pietro.braghieri	440
8	centos7	v2.0-private	2021-06-24 14:40:27	prasad.talasila	447
9	Chess	v1.0	2021-06-15 18:52:25	nur.alamlabu	446
10	CHESS	1.0	2020-06-23 16:41:48	pietro.braghieri	195

Showing 1 to 10 of 44 entries Previous 1 2 3 4 5 Next

Back

Figure 63 - List of Tools available in the corresponding repository with details: version, creation datetime, owner and unique id in HSM.

7.2.12 HSM – Models Repository



HSM Models Repository

Updated on 25-06-2021_12:14

Back

Show 10 entries Search:

Num	Public Model	Updated	Owner	Unique Id
1	Adaptive_Cruise_Control	2020-08-25 11:26:03	barner.simon	76
2	ADAS_on_MPSoC_Platform	2020-08-25 11:10:07	barner.simon	74
3	Air_Traffic_Control	2021-04-08 17:46:48	nur.alamlabu	108
4	Automatic_Train_Control	2021-06-04 15:56:51	prasad.talasila	135
5	Autopilot	2021-06-04 15:36:09	prasad.talasila	131
6	BatterySensor	2021-06-10 17:33:37	nur.alamlabu	140
7	Blinker_Controller	2021-05-21 14:59:38	barner.simon	121
8	Cash_Dispenser	2021-06-04 15:40:12	prasad.talasila	132
9	CitiSim	2020-10-22 10:11:28	george.suciu	79
10	Dual_Channel	2021-04-09 11:30:15	nur.alamlabu	117

Showing 1 to 10 of 50 entries Previous 1 2 3 4 5 Next

Back

Figure 64 - List of Models available in the corresponding repository with details: creation datetime, owner and unique id in HSM.

7.2.13 HSM – Users Activities Trend

HSM Users Activities Trend

Updated on 07-07-2021_12:33

Back

Show 50 entries Search:

Year	Activities	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2020	0_UsersAccessedSboxes	0	0	0	0	0	0	4	17	16	68	54	29
2020	1_SboxesCreated	0	0	0	0	0	0	3	10	16	30	35	13
2020	2_ToolsAddedToSboxes	0	0	0	0	0	0	4	10	11	23	41	12
2020	3_ModelsAddedToSboxes	0	0	0	0	0	0	0	4	1	0	1	0
2020	4_OSesAddedToSboxes	0	0	0	0	0	0	1	1	7	11	2	2
2020	5_SavedTools	0	0	0	0	0	0	0	5	6	6	8	8
2020	6_ExportedOutcomes	0	0	0	0	0	0	0	1	1	4	13	2
2021	0_UsersAccessedSboxes	21	28	71	67	42	83	4	0	0	0	0	0
2021	1_SboxesCreated	30	41	77	47	40	82	6	0	0	0	0	0
2021	2_ToolsAddedToSboxes	30	31	61	39	33	86	6	0	0	0	0	0
2021	3_ModelsAddedToSboxes	6	8	13	25	15	19	0	0	0	0	0	0
2021	4_OSesAddedToSboxes	7	14	24	14	14	14	2	0	0	0	0	0
2021	5_SavedTools	10	7	21	20	9	26	0	0	0	0	0	0
2021	6_ExportedOutcomes	1	2	3	1	3	3	0	0	0	0	0	0

Showing 1 to 14 of 14 entries Previous 1 Next

Back

Figure 65 - For each year and month, the number of occurrences for the main HSM user activities

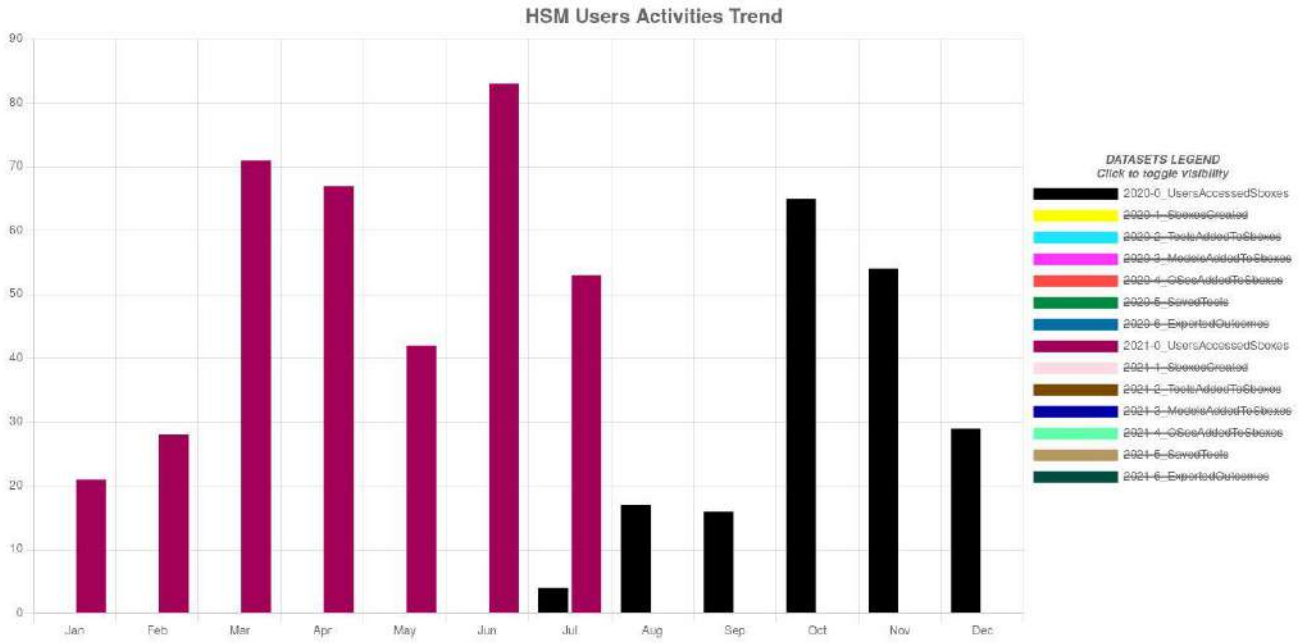


Figure 66 – For HSM Users Activities Trend report a chart is also available. By clicking on the datasets in the legend it is possible to show/hide them.