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HUBCAP

HUBCAP Collaboration Platform Prototype

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Abstract

This report is the accompanying document for deliverable *D5.1 HUBCUP Collaboration Platform Prototype version 1*. While the deliverable itself is the platform prototype (available at http://hubcap-portal.eng.it), deployed as an online tool at Month 6 and is, therefore, a deliverable of type 'Other', this document aims to provide an overview of the results and artefacts making the deliverable and highlighting the main features. In particular, it provides the description of the platform, also detailing the baseline needs, principles and design choices behind this first prototype version of the Platform, along with a description of the services offered and the actual ways users can utilise them.

In order to establish an ecosystem of pan-European stakeholders in the domain of MBD for CPS and Embedded Systems, the HUBCAP project implements an Innovation and Collaboration platform. This HUBCAP platform provides a common virtual environment to access (Models and Tools) as well as offers test-before-invest 'sandboxes'. Users will be able to test and experiment with assets in a secure and trusted environment. The HUBCAP platform helps build and promote an ecosystem of asset providers and users.

The HUBCAP Collaboration Platform is based on the DIHIWARE, a solution developed by the MIDIH H2020 EU project (http://midih.eu/) and currently in use in many ecosystems in Europe. The DIHIWARE offers a complete collaboration environment inspired by Enterprise Social Software. It supports both "Access to" and "Collaborate with" services, providing companies access to the latest knowledge, expertise and technology during their digital transformation paths toward piloting, testing and experimenting with new digital technologies.

The knowledge-driven services, complemented by the collaborative and innovation side of the Platform, will create a virtual environment where providers and consumers of digital technologies are not just matching assets and needs, but they are collaborating together towards joint innovations. This environment will be the core on top of which specific customizations (environment customization, catalogue designing and dedicated user journey) will be realized based on the specific needs of the HUBCAP project.

The design and implementation of a sandboxing middleware of the HUBCAP collaboration platform will constitute the main enhancements of the platform.

Contents

1 Introduction

This document describes the HUBCAP Collaboration Platform developed in the scope of the HUBCAP project to foster the collaboration among HUBCAP DIHs. The platform is using modern IT solutions and methodologies developed in previous innovation initiatives as the core on top of which specific customizations (environment customization, catalogue designing and dedicated user journey) have been made while others are planned to be done.

The Platform is intended to be an IT integrated platform to support both the “Access to” and “Collaborate with” services of the HUBCAP ecosystem, easing the understanding and the adoption of digital innovations by providing easy access to the latest digital innovations and offering experimentation facilities.

The main goals of the platform will be achieved through the three main systems constituting the overall environment and that are described in the following chapters. The first two are the Knowledge Management System (Section 3) and the Catalogue management system (Section 4). They are the core of the DIHWARE platform and are available for the HUBCAP Ecosystem in this version of the platform. They will be further customized and updated throughout the project based on the specific needs of such CPS Ecosystem. The last is the Sandbox System (Section 5), which is under development but with an existing working implementation ready for demonstration.

2 Overview and Architecture of the Collaboration Platform

The HUBCAP Collaboration Platform is an integrated environment made of three main systems: Knowledge Management System (KMS), Catalogues Management System (CMS), and Sandboxing System. Each system provides a specific function and complements the functionality of other two systems.

The KMS and the CMS together constitute the DIHWARE Platform. The KMS will be the main entry point for users and enables open collaboration, online community building and management and access to knowledge. The CMS provides functionalities related to both the back-end management, structure and storage of the catalogues as well as for the front-end (integrated within the KMS environment) allowing users to interact with them (e.g. view, filter and select). The Sandbox (currently under development), will provide a dynamic environment for testing and experimenting with the HUBCAP tools.

The high-level decomposition is shown in Figure 1 and each system (including its core technologies and functionalities) is described in more detail in the following sub-sections.

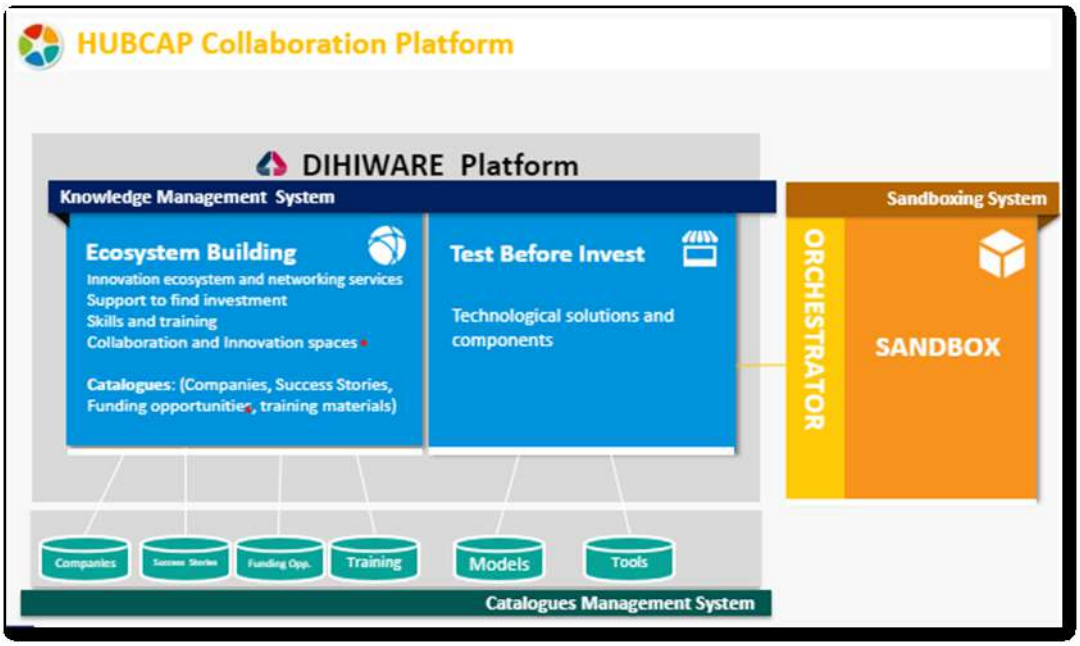


Figure 1 HUBCAP Platform architecture

3 The Knowledge Management System

The KMS is the main subsystem, offering tools for social activity, collaboration and innovation. KMS links Users, Processes, Resources and acts a powerful knowledge hub. To this end most community members will access only to this module as the main entry point to the platform albeit also interacting with all other modules of the platform.

The suite of integrated and interconnected solutions of the platform aims to support efficiency, visibility and collaboration processes. The Collaboration Platform, in fact, enables and supports the development, integration and delivery of knowledge sharing and collaboration services based on social networking, collective intelligence, collaboration, sharing, transparency and self-empowerment.

The final aim of any collaborative platform is to support knowledge sharing in a multi-actor scenario. To this extend, the developed Collaboration Platform involves primitives for human socio-business activities and collaboration, including idea management, open innovation and cross-enterprise social networks. In particular the DIHIWARE Collaboration Platform aims to realize a one-stop-shop for industrial partners to access technology and knowledge in a market that enables collaborative processes.

KMS offers two kinds of services - "Access to" and "Collaborate with". The “Access to” services will enable users to gather information about skills, technological and business matters (Competencies, Technology, Industrial Experiments, Knowledge, and Market). The “Collaborate with” services will enable dynamic interactions and collaborative creative processes among users (Open Innovation and Social Networking). These services will be complemented by cross functionalities supporting the general mode of operation, such as Searching Functionalities, Multi-lingual support, Guide for content creation, Workflow monitoring and support.

The services portfolio offered by the HUBCAP ecosystem will be refined during the project in order to provide additional features. For the first platform release, the attention has been focused on the following groups of services:

- **Ecosystem Building:** Facilitate the brokering role of the HUBCAP hub which will allow the mapping of the innovation ecosystem, the understanding of stakeholders needs and the highlighting of new opportunities.:
    - *Innovation ecosystem and networking* space will help companies contact other companies of their value chain, innovators, or early clients that want to test solutions. The group of functions enabling the building of Innovation ecosystem and networking are a catalogue of Users and Companies, the Events Matchmaking application, a Success Stories Catalogue and list of interesting events.
    - *Support to find investment* will contain a catalogue of funding opportunities enabling the access to financial institutions and investors, thus supporting the use of Invest EU and other relevant financing mechanisms.
    - Skills and training will provide a set of training, boot-camps, traineeships to the members of hubcap ecosystem.

- Collaboration and Innovation spaces will enable the collaboration among research and innovation actors enabling the exchange of their digital transformation journeys in order to accelerate the learning process.

- **Test before Invest:** The HUBCAP provider will use this space to provide access to the catalogues of models and tools for sandbox-based experimentation and testing.

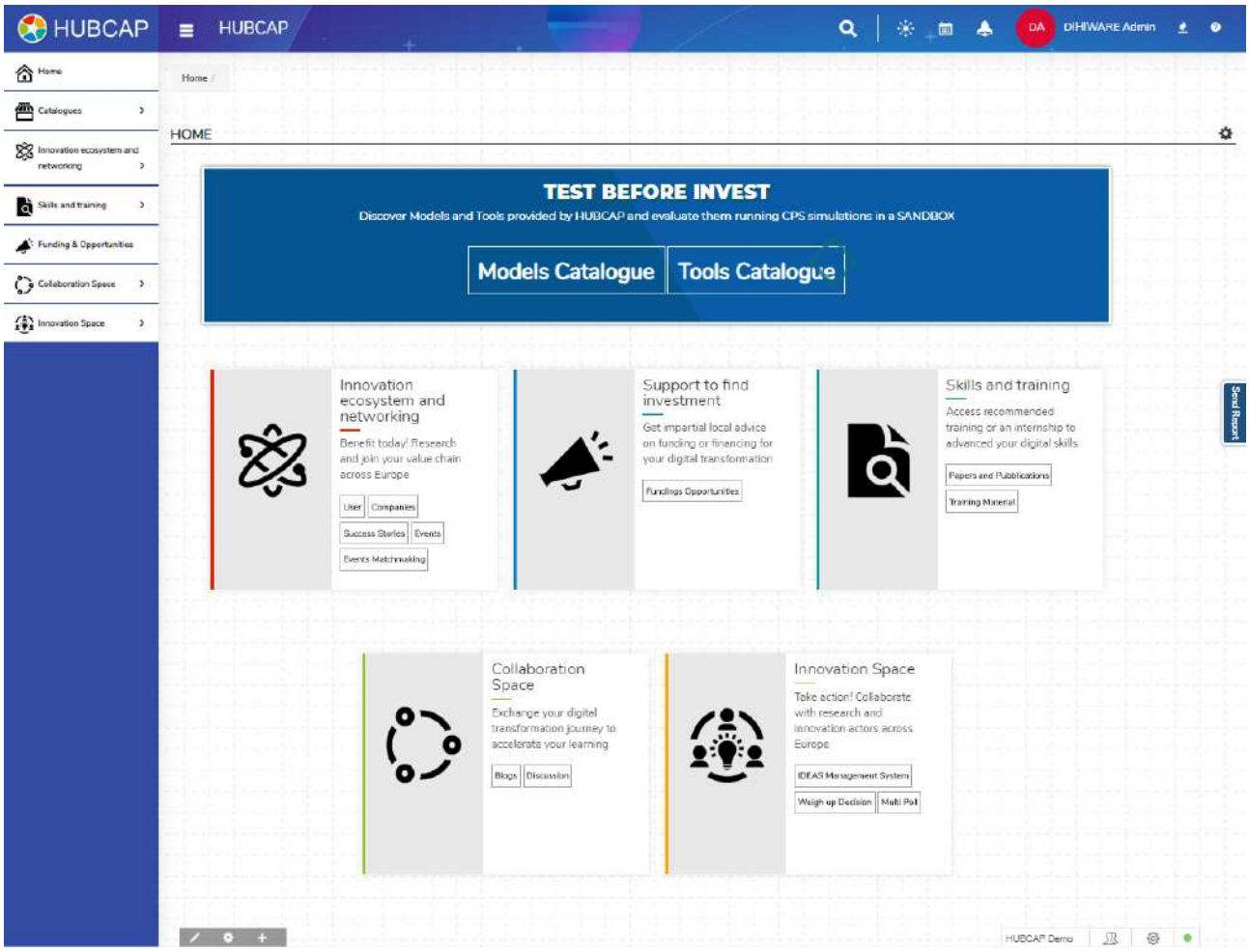


Figure 2 HUBCAP Platform - landing page

3.1 Background components and technologies

The Knowledge Management System is built on top of the existing OPENESS Collaboration and Content Management Platform developed by ENGIT. This Liferay[1] platform provides a built-in web content management system allowing users to build websites and portals as an assembly of themes, pages, portlets/gadgets and a common navigation.

Additionally, OPENNESS follows the principles of Open Innovation, Collective Intelligence, Enterprise Social Software. The platform enables the development, integration and delivery of

[1] http://www.liferay.com/

services and collaborative environments based on models of social networking and collective intelligence and provides in SaaS mode (Software-as-a-Service) features and services such as management and development of the community, knowledge management and collective experience and applications, enabling collaborative working and social analytics.

The **Identity Management** (IdM) is a KeyRock FIWARE Generic Enabler that covers a number of aspects involving users' access to networks, services and applications, including secure and private authentication from users to devices, networks and services, authorization & trust management, user profile management, privacy-preserving disposition of personal data, Single Sign-On (SSO) to service domains and Identity Federation towards applications. The Identity Manager (IdM) is the central component that provides a bridge at connectivity-level and application-level. For end users, the IdM provides a convenient solution for registering with applications since it gives them a means to re-use attributes like address, email or others, thus allowing an easy and convenient management of profile information.

Universal Search (integrated in OPENNESS), provides interactive search by inserting filters on the search bar. The users can search for specific words by simply entering the search terms to see content containing all the specified words in any order. They can find resources by person, title and content, and benefit from suggestions shown in real-time in the search box when typing the query. Furthermore, it also shows a set of tips to enrich the query that take into account the user's activities in the community.

4 The Catalogues Management System

The Catalogue Management System acts as a new way of managing information where the use of taxonomies and the power of metadata enable the organization of product and services and their dynamic modelling and visualization.

The system offers a single access point for users leveraging on already existing information in different organisations by creating a federation of catalogues for a scalable system (data blending).

In HUBCAP a strong integration work among service providers and IT platform providers has been carried out in order to implement a first version of the identified catalogues (models and tools catalogues) in line with the HUBCAP future value proposition. In particular the identification of the services (models and tools) key details and related fields specifications by the Providers allowed the IT platform provider (ENG) to build the catalogues that will be described in further detail in D6.1 (The Initial HUBCAP Models) and D6.2 (The Initial HUBCAP Model-Based Services).

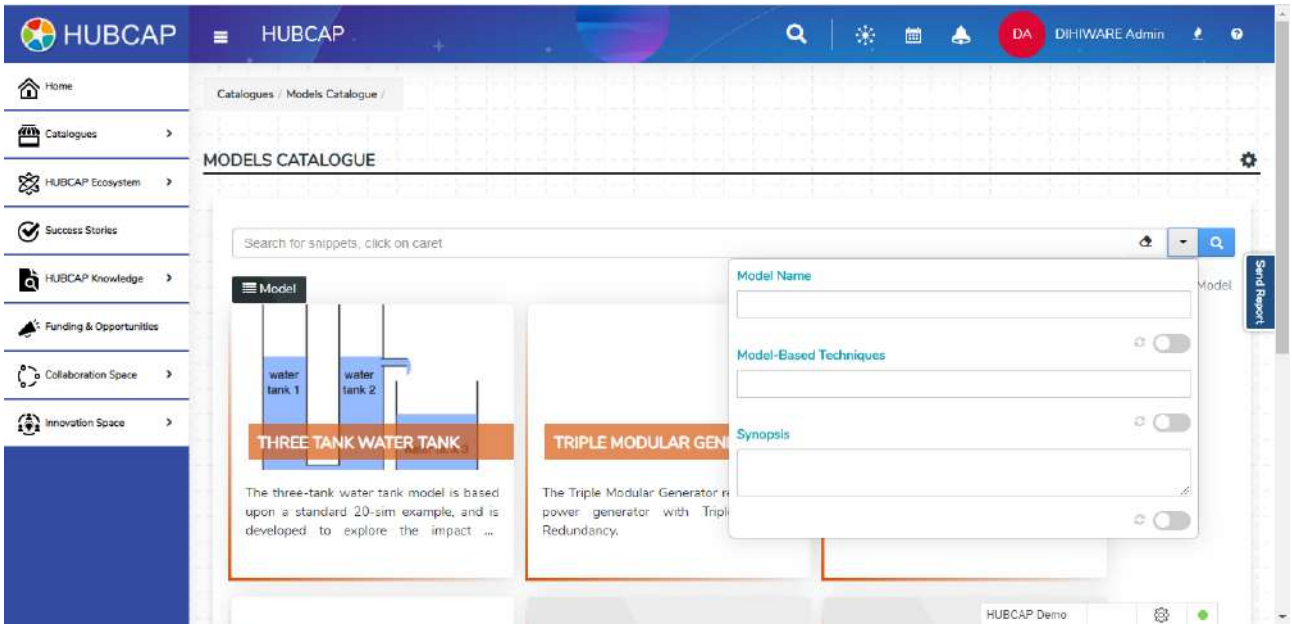


Figure 3 Services Catalogues visualization and filters

4.1 Background components and technologies

The Catalogue Management System relies on DYMER – that stands for *DYnamic Information ModElling & Rendering – which is a WCM (Web Content Management) made by Engineering.*

It consists in two main components: Dymer-Core and Dymer-Viewer.

Dymer-Core is based on micro-service architectural style with an approach to developing a single application as a suite of small services, each running in its own process and communicating with lightweight mechanisms using HTTP/REST protocols alongside JSON (JavaScript Object Notation).

Each micro-service is born with a specific role and among the main ones we can identify three:

- *Service-Model* allows dynamic modelling of data and metadata inherent to the products and services offered.
- *Service-Template* allows the generation of graphic templates that can be used in the display of products and services using logic-less templates
- *Service-Entities* manage the storage and use of the product and services.

These micro-services are developed using the Express.js web application framework (for Node.js), released as free and open-source software under the MIT License. It is designed for building web applications and APIs.

The information is stored in a NoSql Dabatase (MongoDB - www.mongodb.com) which provides high performance, high availability, and automatic scaling. Service-Entities use Elasticsearch (www.elastic.co). When a user enters a query using a form, the submitted data is saved as jsonObject in Elasticsearch. Any file uploads (e.g. text, PDF, image) are saved in MongoDB with the use of GridFS.[2]

Interaction with the Dymer-Core takes place through the Dymer-Viewer that is a fast, small, and feature-rich JavaScript library. Thanks to that library it is possible to interact with the platform facilitating the user in the use of data by offering a single search point and displaying the results in special graphic templates.

[2] https://docs.mongodb.com/manual/core/gridfs/

5 The Sandboxing System

The **Sandboxing System** (currently under development) will provide an environment where several sandboxes can be executed concurrently without interfering with each other. Each **Sandbox** is instantiated dynamically by a platform user picking up a set of entities from the following catalogues:

1. Operating Systems
2. Tools
3. Models

From the implementation point of view, both Operating Systems and Tools are customized Virtual Machines whereas Models are compressed archives containing an arbitrary set of directories and files.

An **Operating System** is a minimal installation of an official OS (Linux or Windows) with few, not invasive customizations making it ready-to-use inside a Sandbox.

A **Tool** (VM) is built by the HUBCAP tool providers **directly on the Sandboxing System** by using and customizing an OS (VM) selected from the OSes Catalogue. The Tool VM customized and ready-to-use with the new tool will be saved in the Tools Catalogue.

One or more **Tools** VMs can be picked up by a regular user from the Tools Catalogue and included in a new sandbox along with some predefined **Models** picked up from the Models Catalogue.

The archive of each model included in a sandbox will be unpacked and made available to all tools running in the same sandbox via a shared network file systems (NFS).

User interface

The only client program a user needs for accessing and using the Sandboxing System is a simple web browser. The current work-in-progress implementation has a very simple web interface which is currently enough for following the sandbox facility development.

In the following pages we show some screenshots illustrating briefly the path a HUBCAP tool provider could follow for creating a new Tool VM.

Figure 4 HUBCAP Sandbox Welcome Page

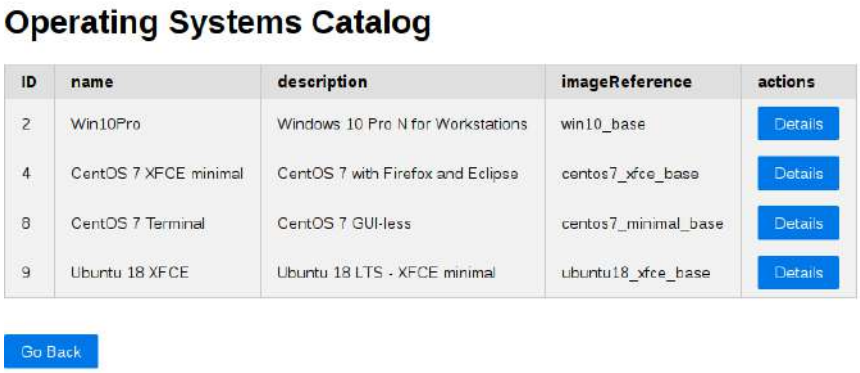


Figure 5 Operating Systems from where picking up the basic VM for installing a tool

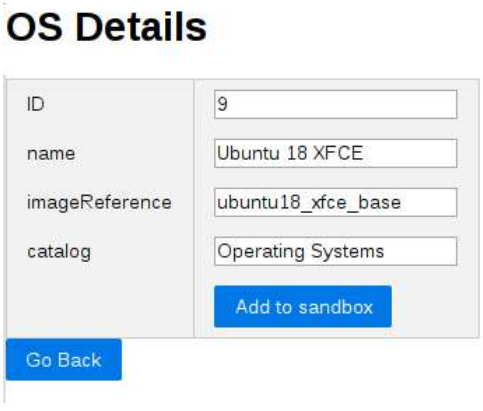


Figure 6 Form the details form the provider can get some information about the OS and add it to a new sandbox

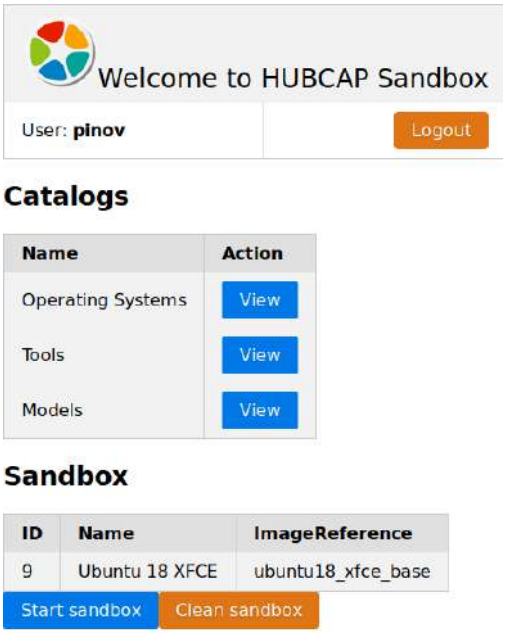


Figure 7 Sandbox configuration after the previous choice; then clicking the start button one can get it run.

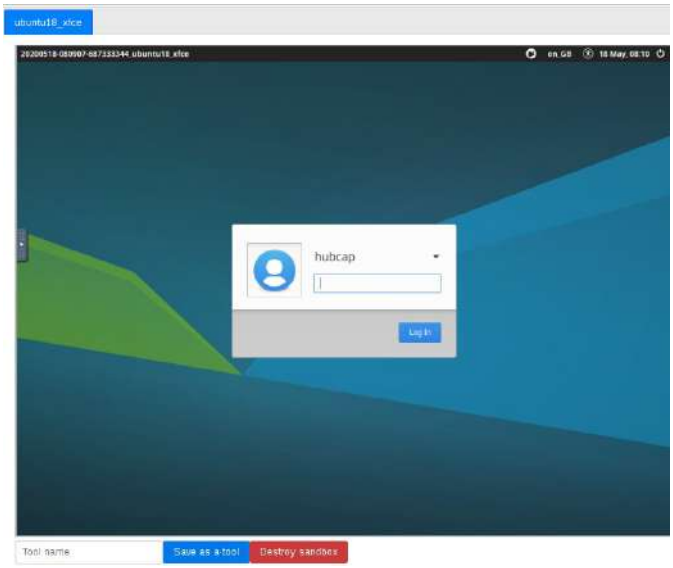


Figure 8 Sandbox ready to be used. After few seconds the new sandbox is ready to be used; the OS login form appears in the browser and one can log in with a default username and password.

The minimal desktop OS has its own browser and access to the Internet for downloading all the necessary software for the tool installation. Moreover, the default sudoer user (hubcap) can install packages and configure the system as required for supporting the tool execution. In these examples the Workcraft open source tools are downloaded from the official site and installed on the Linux OS VM.

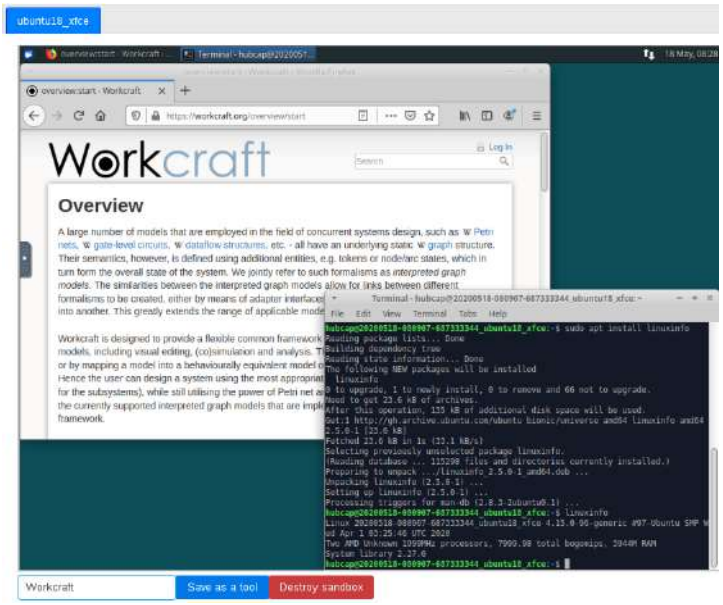


Figure 9 Minimal desktop OS: Desktop environment, browser and terminal.

When the HUBCAP tool provider is finished with all the operating system customizations (e.g. tool installation, default password changing, new non-privileged user adding, etc.) they can save the running VM as a tool, feeding the Tools Catalogue.

Tools Catalog

ID	name	description	actions	
14	openmodelica_eng		Details	Delete
25	dddmodeleditor		Details	Delete
64	IntoCPS_Tut1_Win10		Details	Delete
96	IntoCPS_Ubu18		Details	Delete
102	Workcraft	framework for interpreted graph models	Details	Delete

Go Back

Figure 10 Tools Catalogue

A regular user can choose the new tool, add it in a new Sandbox and use it.

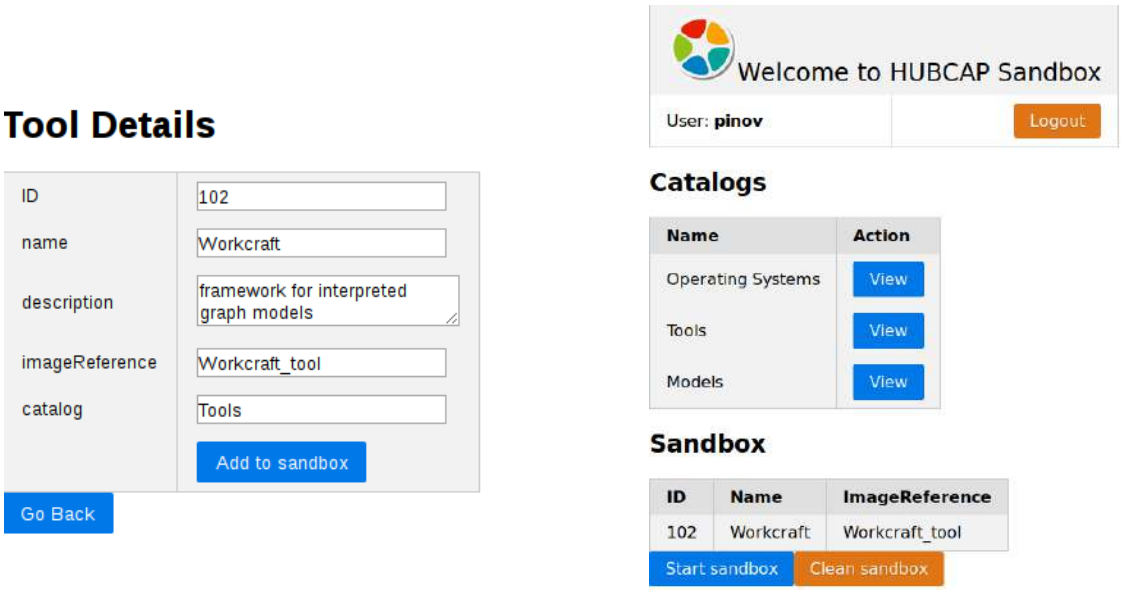
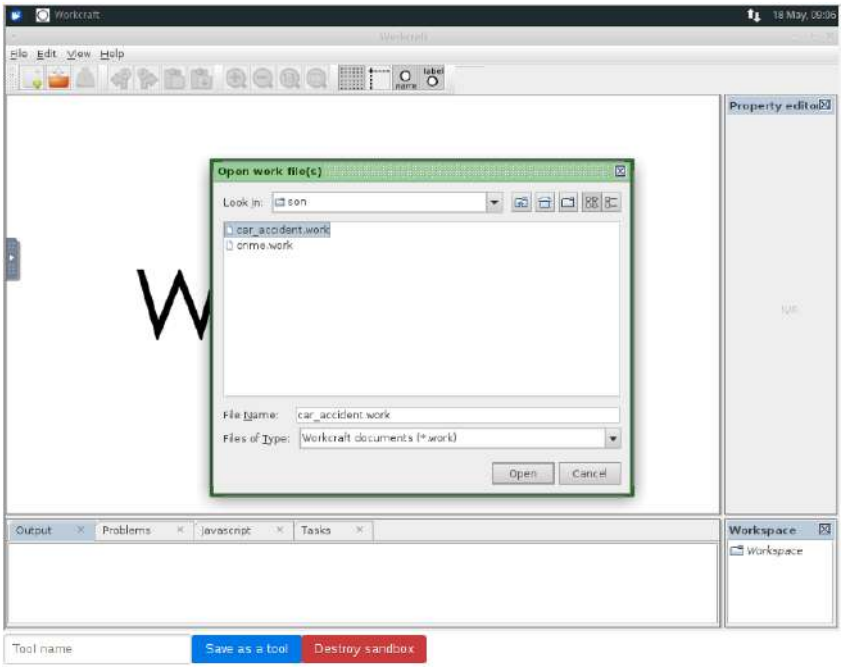


Figure 11 Interface screenshots for a regular user.



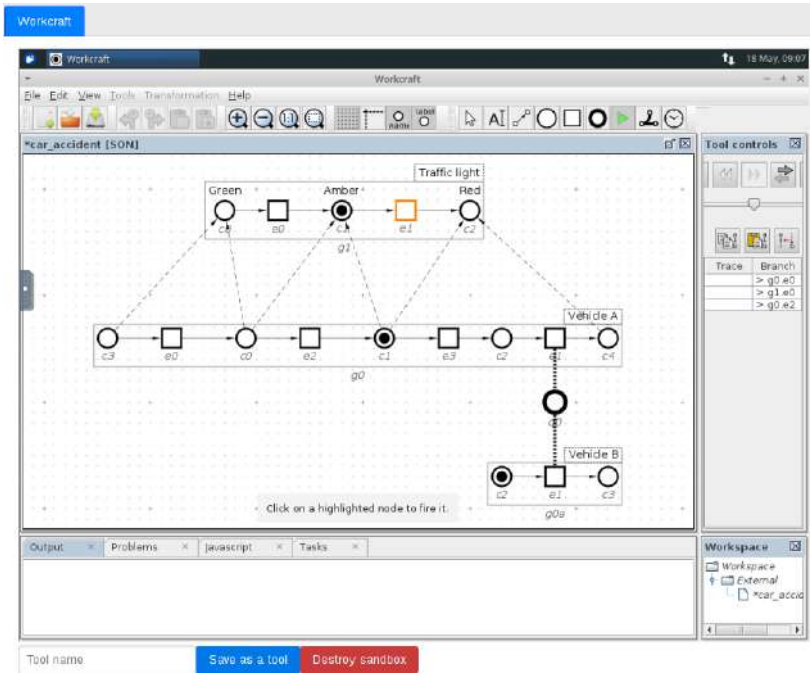


Figure 12 Workcraft tool running in a newly created Sandbox

5.1 Technology Details

Each sandbox is implemented as an isolated set of virtual machines based on **Kernel Virtual Machine** (KVM, https://www.linux-kvm.org). KVM allows to bind a **VNC server** to each VM in order to "export" the VM UI (graphical or textual). When a sandbox is instantiated:

- some VMs will be created and started (these VMs will run the CPS Tools selected by the platform user);
- a KVM virtual subnet will be created for connecting the sandbox's VMs to eachother;
- a dedicated NFS storage is created and attached to the sandbox's subnet allowing data sharing among the sandbox's VMs themselves.

Obviously, no interaction is permitted between the VMs belonging to different sandboxes.

WebSockify (https://github.com/novnc/websockify) is a "protocol adapter" allowing to reach a VNC server (that uses the RFB protocol https://tools.ietf.org/html/rfc6143) via a WebSocket connection. Moreover, *it is possible to configure WebSockify to connect to different hosts and ports based on an **opaque token*** making the connections safer (https://github.com/novnc/websockify/wiki/token-based-target-selection). We use this feature, even if it is a bit more difficult to manage.

noVNC (https://github.com/novnc/noVNC) is a web client - running in an HTML5 compliant browser - that is in charge of managing the interactions between a user and a remote screen of a Tool VM.

Apache Httpd Web Server (http://httpd.apache.org/) is the sandboxes point of access. It provides an HTTPS secure channel between the web browser and the Sandboxing System and it acts also as a WebSocket Reverse 2.5.

The **Sandbox Orchestrator** will be in charge of:

- managing the life cycle of multiple sandboxes and
- interfacing to the Knowledge Management System for collecting the assets needed to instantiate a sandbox.

The sandbox orchestrator is a prototype created by ENGIT living autonomously in a development environment.

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List of Abbreviations

DIH	Digital Innovation Hub
CMS	Catalogues Management System
HTTP	HyperText Transfer Protocol
IdM	Identity Management
JSON	JavaScript Object Notation
KMS	Knowledge Management System
REST	Representational State Transfer
SSO	Single Sign On