Grant Agreement: 872698

Digital innovation HUBs and CollAborative Platform for Cyber-Physical Systems

HUBCAP

Fourth Version of HUBCAP Contents

Technical Note Number: D6.5
Version: 1.0
Date: March 2022
Public Document

https://www.hubcap.eu/

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Document History

Ver.	Date	Author	Description
0.1	08/02/2022	Nur Alam Labu	Initial structure
0.2	14/02/2022	Stefano Tonetta	Revised structure
0.3	17/02/2022	Alberto Debiasi	Added contents on guidelines
0.4	18/02/2022	Gerhard Benedikt Weiss	Added contents on OC support
0.5	28/02/2022	Hugo Daniel Macedo	Added contents on training
0.6	04/03/2022	Stefano Tonetta	Revised abstract and introduction
0.7	07/03/2022	Román Bastidas Santacruz	Added contents on quality assurance
1.0	02/03/2022	Stefano Tonetta	Editorial fixes
1.1	11/03/2022	Hugo Daniel Macedo	Revision fixes
1.2	21/03/22	Mark Jackson	Revision fixes

Abstract

The **HUBCAP Collaborative Platform** provides **catalogues of models and tools** for trial experiments with Model-Based Design (MBD) technology to design and develop innovative Cyber-Physical Systems (CPS) solutions with the support of MBD.

The HUBCAP platform is already operational and contains more than fifty tools and more than ninety models. The platform is therefore rich of contents to allow SME getting started with MBD tools and techniques. However, the large amount of information may be a blocking issue for new adopters of MBD solutions.

The purpose of Task 6.5 is to lower the barrier for new adopters by proving guidelines, ensuring the quality and usability of the platform's contents, and giving direct support to the users and in particular to the winners of the Open Calls (OC). In this document, we report on the activity and material developed by the partners for this purpose, and in particular on the quality checking of the assets in the platform and on the mind maps as visual to present tools and models that guide the users to find the right MBD techniques/tools. D6.5 is an intermediate report of the activity of T6.5. A follow-up deliverable (D6.6) will complete the overview at the end of the task.

D6.5 is a document of **type "OTHER"**, given by the actual enhancement of the platform's contents. These can be browsed by accessing the platform. This document summarizes T6.5 contributions.

List of Abbreviations

API	Application Programming Interface
CCA	Common Cause Analysis
CLI	Command Line Interface
CMS	Catalogues Management System
COE	Co-simulation Orchestration Engine
CPU	Central Processing Unit
DIH	Digital Innovation Hub
DMA	Direct Memory Access
DSE	Design Space Exploration
FMEA	Failure Modes and Effects Analysis
FMI	Functional Mock-up Interface
FMU	Functional Mock-up Unit
FTA	Fault Tree Analysis
GPU	Graphics Processing Unit
GUI	Graphical User Interface
HSM	HUBCAP Sandboxing Middleware
HTTP	HyperText Transfer Protocol
IDE	Integrated Development Environment
IdM	Identity Management
JSON	JavaScript Object Notation
KMS	Knowledge Management System
MBD	Model-Based Design
MBT	Model Based Testing
MCS	Minimal Cut Sets
OSLC	Open Services for Lifecycle Collaboration
RBAC	Role-Based Access Protocol
RCP	Rich Client Platform
REST	Representational State Transfer
SAT	Boolean Satisfiability Problem
SMT	SAT Modulo Theories
SME	Small and Medium-sized Enterprises
SSO	Single Sign On
SSP	System Structure and Parametrization
SysML	Systems Modeling Language
TFPG	Timed Failure Propagation Graphs
TRL	Technology Readiness Level
UML	Unified Modeling Language
UAV	Unmanned Aerial Vehicle
VDM	Vienna Development Method
VM	Virtual Machine
VNC	Virtual Network Computing

Contents

1. Introduction

Model-Based Design (MBD) is a method to address the design of complex systems with models. It prescribes the use of models throughout the development process in order to represent system structure and behaviours, providing a basis for machine-assisted analysis of system properties, and supporting design decisions through processes of refinement into implementation. The purpose is 1) to **reduce the complexity** of design **by abstraction**; 2) to **ensure the quality** of the system **by rigorous analysis** of its properties; 3) to **reduce the cost** of the development **by detecting issues** in the **early** phases of the development. MBD is quite standard in software engineering and is becoming more and more relevant in systems engineering, where it must integrate methods for control engineering and safety engineering.

MBD appears largely to be applied in domains such as aerospace where the return on investment can take decades. By contrast, SMEs require considerable flexibility to change processes to adopt MBD and may lack in-house expertise. In addition, the selection, procurement, training and deployment costs for some methods and tools can be discouragingly high. In general, it is difficult for SMEs to invest in acquiring the necessary background for example because of the high license fees from commercial vendors of MBD assets.

The **HUBCAP Collaborative Platform** lowers such barriers by providing **catalogues of models** and MBD tools for trial experiments to design and develop innovative CPS solutions with the support of MBD technology. D6.5 consists of a third version of the platform's contents and, in particular, the guidelines for new adopters of MBD. This document summarizes the contents of the catalogue for the reviewer's convenience, and reports on additional T6.5 activities to support the platform's users.

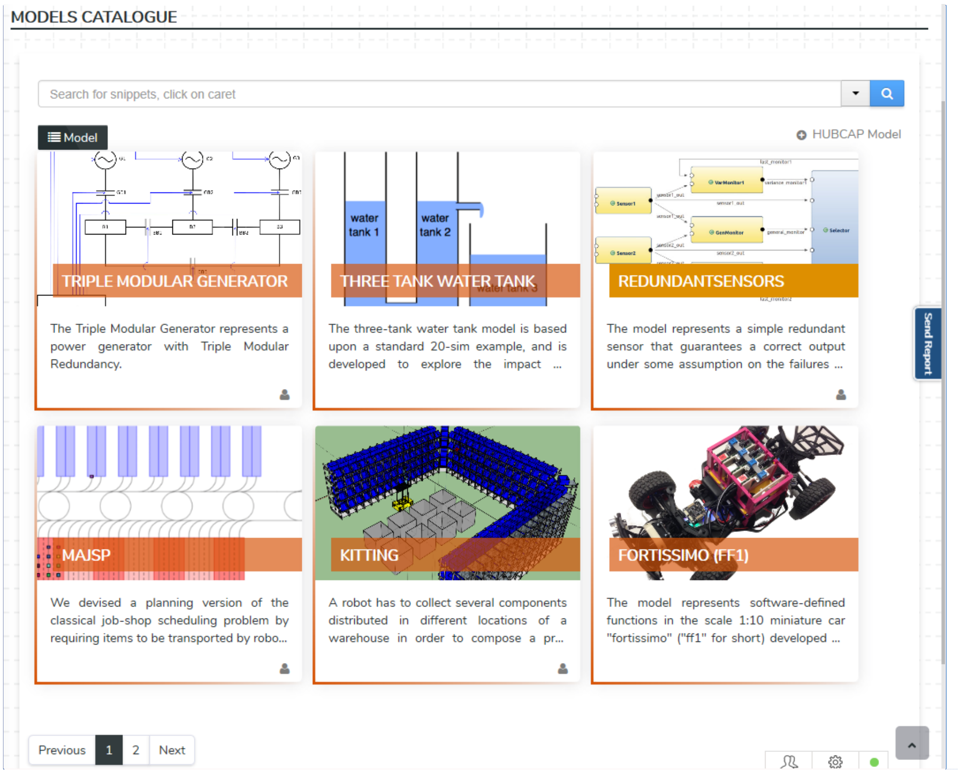

Figure 1: Screenshot of the models catalogue.

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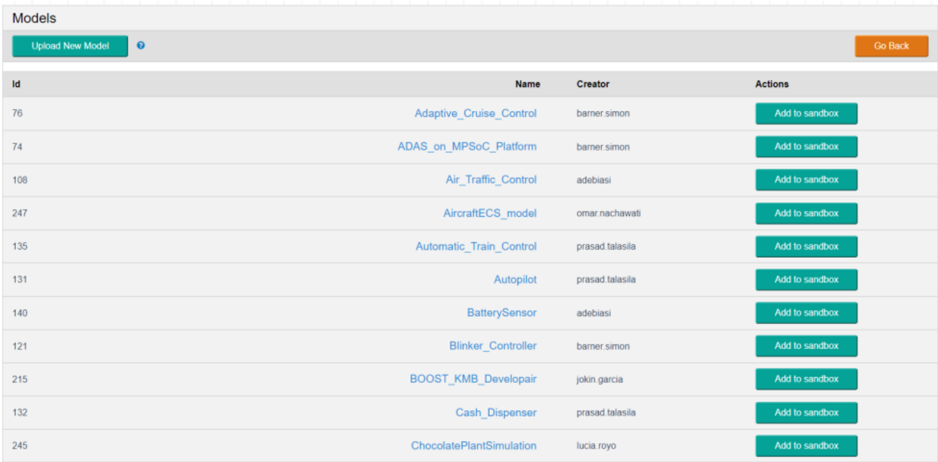
2. Summary of current HUBCAP contents

In the previous deliverables, we described the models and tools that were initially uploaded and how they are linked to the sandbox environment through the "Try It Now" features. These contents have been continuously updated, also contributed to by the SME winners of the open call. The number of models in the platform is indeed contributing to the KPIs of the HUBCAP project. We summarize here the status of models and tools.

The models cover various application domains including control engineering, electrical engineering, automotive, and avionics. The model catalogue currently has more than ninety models, almost all of which have been connected to the sandbox environment (Figure 2~~Figure 2~~).



Models

Upload New Model

Go Back

Id	Name	Creator	Actions
76	Adaptive_Cruise_Control	barner.simon	Add to sandbox
74	ADAS_on_MPSoC_Platform	barner.simon	Add to sandbox
108	Air_Traffic_Control	adebiasi	Add to sandbox
247	AircraftECS_model	omar.nachawati	Add to sandbox
135	Automatic_Train_Control	prasad.talasila	Add to sandbox
131	Autopilot	prasad.talasila	Add to sandbox
140	BatterySensor	adebiasi	Add to sandbox
121	Blinker_Controller	barner.simon	Add to sandbox
215	BOOST_KMB_Developair	jokin.garcia	Add to sandbox
132	Cash_Dispenser	prasad.talasila	Add to sandbox
245	ChocolatePlantSimulation	lucia.royo	Add to sandbox

Figure 2: The sandbox environment.

At present, the tool catalogue (Figure 3) has more than fifty tools and most of them have been connected to the sandbox environment. The sandbox can be launched directly from the tools catalogue with the "Try It Now" feature. These tools are provided by the HUBCAP partners, SMEs partners, and they are uploaded, installed, and tested inside the HUBCAP Collaborative Platform sandbox to constitute the contents of the catalogue of tools.

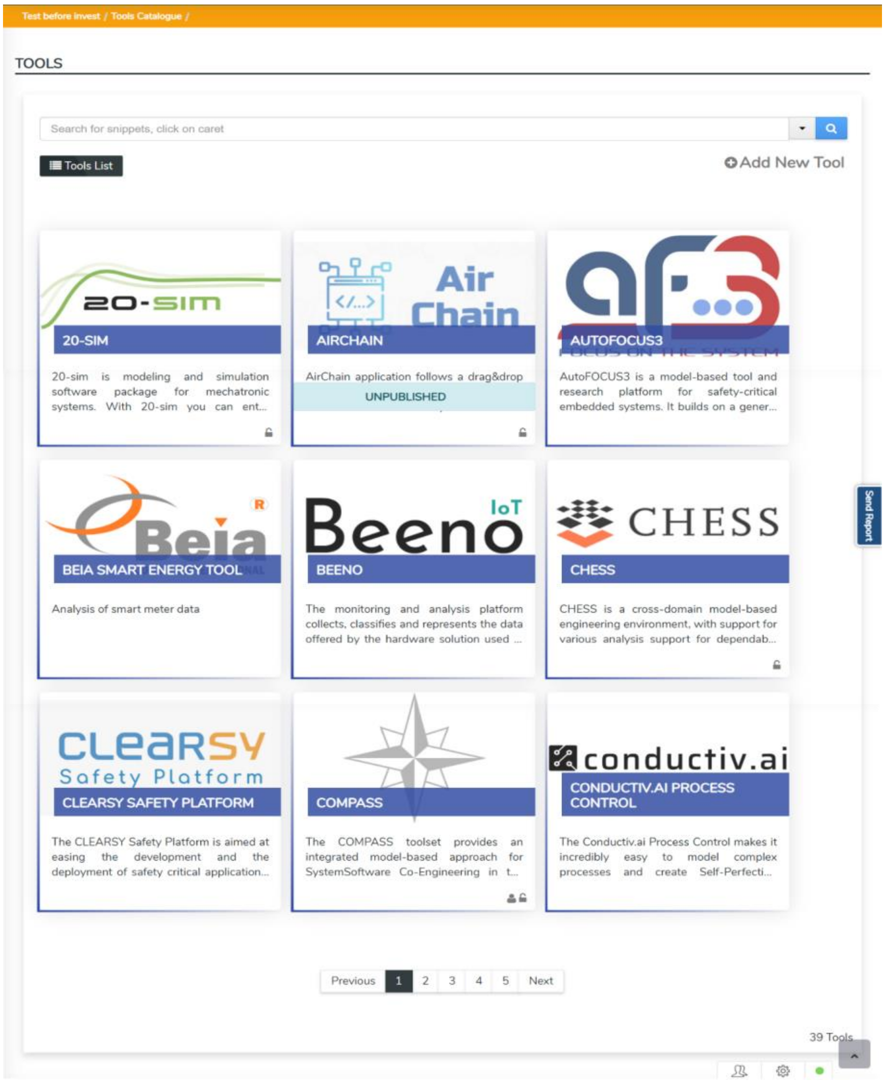


Figure 3: The Tools catalogue.

3. Guidelines

3.1. Videos

The guidelines related to the HUBCAP platform are provided in video format[1]. The available videos cover the following topics:

- HUBCAP Sandbox Environment:
  - Login and Sandbox creation.
  - Run model-based design tool.
  - Add a tool to the repository.
  - Add a model to the repository.
  - Share the Sandbox with other users.
- Ferryman Model Evaluation in the HUBCAP Sandbox Environment.
  - Using the "try-it-now" feature from the HUBCAP platform.
- RT-TESTER MBT tool experiment in the HUBCAP Sandbox Environment
  - Using the "try-it-now" feature from the HUBCAP platform.
- HUBCAP Platform.
  - Contents of the HUBCAP platform.
- OCLS Service Provider for MBD Analysis.
- Servitization of certifying model checking.
- Beia Smart Energy Tool.
- Simulating a 20-sim model in the sandbox.
- Manufacturing Process Simulation in a Hybrid Cloud Setup.

3.2. Mind maps

Each tool provider is working on the creation of mind maps. In this context, the mind map is a graphical visualization that describes the techniques supported by each target tool. For example, Figure 4~~Figure 4~~ depicts the mind map of the CHESS tool. On the left side of the visualization, a textual area summarizes the features of the target tool.

[1] Videos are accessible at this YouTube playlist.

Figure 4: Mindmap related to the CHESS tool.

All the mind maps are created by the same template customized for the HUBCAP project. Up to now, the mind maps are located in the private repository of the project. The mind maps will be the content of the HUBCAP wiki.

3.3. Navigation tree

To ease the access of information, the main wiki page will be enriched with a navigation tree. In this context, the navigation tree is an interactive visualization that connects together the key entities of the HUBCAP platform that are: the tools, the models, the techniques, and the application domains. The entities are structured as a tree. Figure 5~~Figure 5~~ shows a proposal of navigation tree partially populated. The levels (from left to right) that compose the tree are:

- Level 0: root node. The model-based design domain.
- Level 1: families of techniques (e.g., Model Checking).
- Level 2: specific techniques (e.g., Deadlock Checking).
- Level 3: model-based design tools (e.g., COMPASS).
- Level 4: models (e.g., SmartGrid).

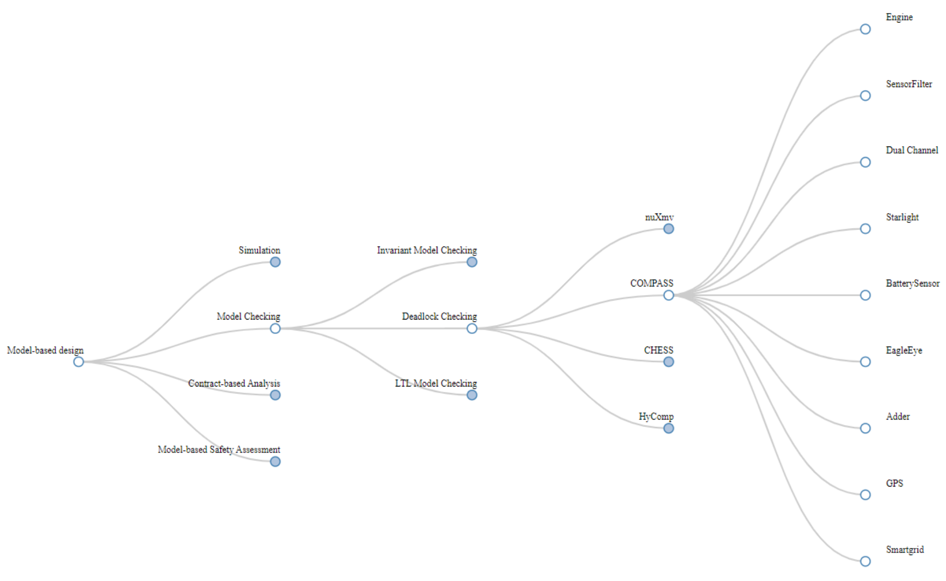


Figure 5: Navigation tree. From techniques to models.

An alternative candidate structure of the tree starts from the application domains:

- Level 0: root node. The model-based design domain.
- Level 1: application domains
- Level 2: models
- Level 3: model-based design tools.
- Level 4: families of techniques.
- Level 5: specific techniques.

The user interacts with the navigation tree with the following events:

- Click on the node circular shape => its child nodes are expanded/collapsed.
- Move the mouse over the node label => the description associated to the node appears.
- Click on the node label => the web page associated to the node is open.

4. Quality checking of assets on the platform

The HUBCAP platform divides its assets into catalogues, one for Models and one for Tools. Each one provides general information about the different assets and their providers, information that is furnished according to specific templates present in the catalogues. In order to ensure a standard level of quality for the information of the assets present in the platform, a quality checking process for both catalogues was proposed and implemented.

The proposal and implementation of this quality checking process was divided into four main steps: Identification of Model and Tool requirements, Generation of a quality checklist based on the requirements, Generation of a short manual on how to perform the quality check of the catalogues by a reviewer, and Execution of the QA revision. The process is summarized in the following workflow diagram.

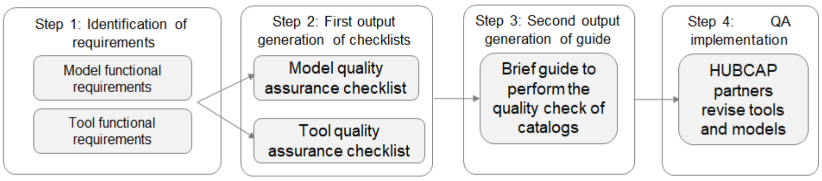


Figure 6. Workflow diagram of the generation of the Quality Assurance process

The first step consisted in the identification of the requirements that are needed to be checked for each asset. The input to identify these relevant items were the Model and Tool requirements present in the Deliverable 5.2, as well as the items asked in the templates that are displayed on the uploaded process of a new asset. These templates contain every item of information that must be provided by an asset provider. The second step of the process was the deliverable of the checklists, both structured in the items retrieved from the mentioned inputs. The Model quality assurance checklist and the Tool quality assurance checklist contains all the items identified in the first step as "needed to be checked". The quality assurance process was intended to be conducted by an **asset reviewer,** the role of the person in charge of conducting the quality assurance process, and that was established among all the HUBCAP partners involved in the Task 6.5.

The third step of the process consisted in writing a brief manual with the instructions to use the checklists correctly, sent to each asset reviewer via email. Finally, once the checklists and the instructions on how to use them were well established, the asset reviewers were able to start the implementation of the quality assurance, identified as the step four of the process.

Due to logistics and time restrictions, it was decided to conduct the quality assurance process **manually**. Nevertheless, a proposal of automation of the process was made. The automated process would imply the involvement of resources to develop it online in the platform. For this reason it is still under evaluation. The proposed solution will be described later in this document.

After evaluating the inputs, a checklist to conduct the process manually was proposed, the chosen format was an Excel file structured in five columns: Item, Description, Instructions, Answers, and Comments as indicated in the Figure 7~~Figure 7~~. The exact same format was used for the Tool checklist.

Model Name:	(Write model's name in this cell)			
Item	**Description**	**Instructions**	**Answer**	**Comments**
Model Name	Is the name correctly indicated?	If it is correct, indicate it in the "Answer" column. If not, please indicate it and make a comment on the issue	Yes	
Modelling languages or model types (ODE, DAE, FEM, etc.) utilized	Is any Modelling language or type indicated?	If it is correct, indicate it in the "Answer" column. If not, and it's required, please indicate it and make a comment on the issue.	No	
Model-based analysis technique implemented (simulation, model checking, safety analysis, etc.).	Is any Model-Based Technique indicated?	If it is correct, indicate it in the "Answer" column. If not, and it's required, please indicate it and make a comment on the issue		
Model Version	Is the model version provided?	If it is correct, indicate it in the "Answer" column. If not, please indicate it and make a comment on the issue		
Model ID	Is the model ID provided?	If it is correct, indicate it in the "Answer" column. If not, please indicate it and make a comment on the issue		
Tool ID	Is the tool ID provided?	If it is correct, indicate it in the "Answer" column. If not, please indicate it and make a comment on the issue		

Figure 7. Model checklist format

Broadly defined, the instructions given to the asset reviewers were to check in the platform the correctness or absence of the information for each item and report it in the checklist choosing the adequate option in the fourth column. Then the reviewer had to write in the last column all the possible comments regarding anomalous items. The only possible options in the fourth column were "yes" highlighted on green, and "no" highlighted on red, making it easier to identify the items that must be corrected for the provider.

At the point of review, the Model catalogue counted around 72 models and the Tool catalogue counted around 28 tools. The tools and models were divided equally between the HUBCAP partners present on the Task 6.5, the task leader assigned the same number of models and tools to be checked for each one as shown in the following table.

Table 1. Table of the model and tool assignment for each partner

Partner	Number of Models	Number of tools
AU	9	3
UNEW	9	3
FOR	9	3
VV	9	3
ULBS	9	3
RISE	9	3
FBK	9	5
POLIMI	9	5

Nine models and three tools were assigned to each partner (aside from FBK and POLIMI who received five tools each). The task leader sent the checklists and the instructions to be completed according to the assigned assets. Then, the task partners had a certain period of time to complete the quality assurance process, and once completed were updated to the SVN Platform.

One of the last actions inside the implementation of the quality assurance process (step four), that is still ongoing, is the contact of each asset provider to modify the items that are needed to be corrected or in which it is needed to provide further information. Initially, it was proposed that each asset reviewer was going to be in charge of contacting the providers of their assigned assets. However, later it was decided to concentrate the communications on the task leader to offer a seamless communication with the tools and models providers. Lastly, it was also proposed to initially address the correction of critical items. To this end, the conduction of a priority analysis on the current data was suggested. The final goal of this is to identify which of the items require to be addressed first, and which of them can be corrected over time.

With the final goal to structure the QA process and to create a path to the improvement of the platform's quality, the items considered to be relevant to be addressed were identified through an analysis of the complete set of data gathered from the platform.

First, the items that were less correctly reported were identified for both types of digital assets i.e., Tools and Models. The identification of these items was done by considering the number of digital assets reported each item correctly as shown in Figure 8~~Figure 8~~ and Figure 9~~Figure 9~~.

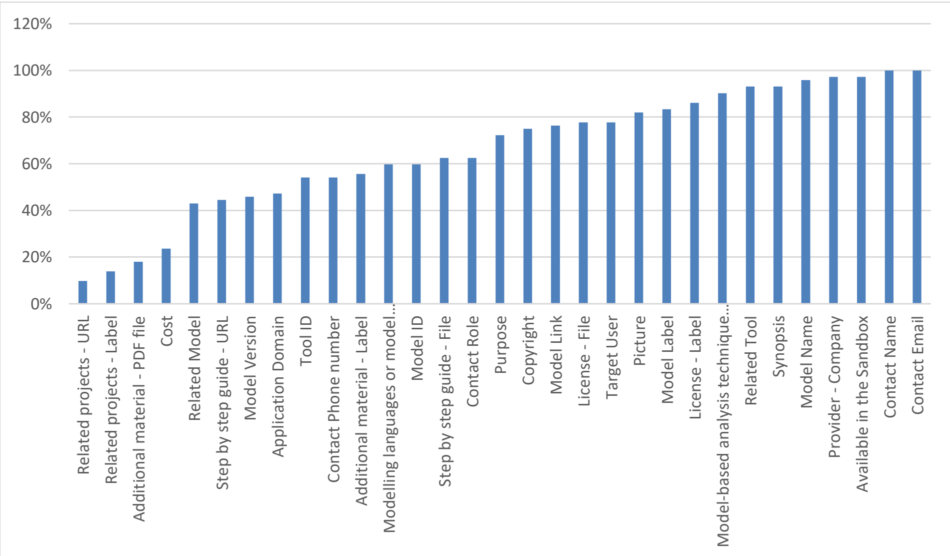


Figure 8. Percentage of Models with accurate information classified by items of the platform

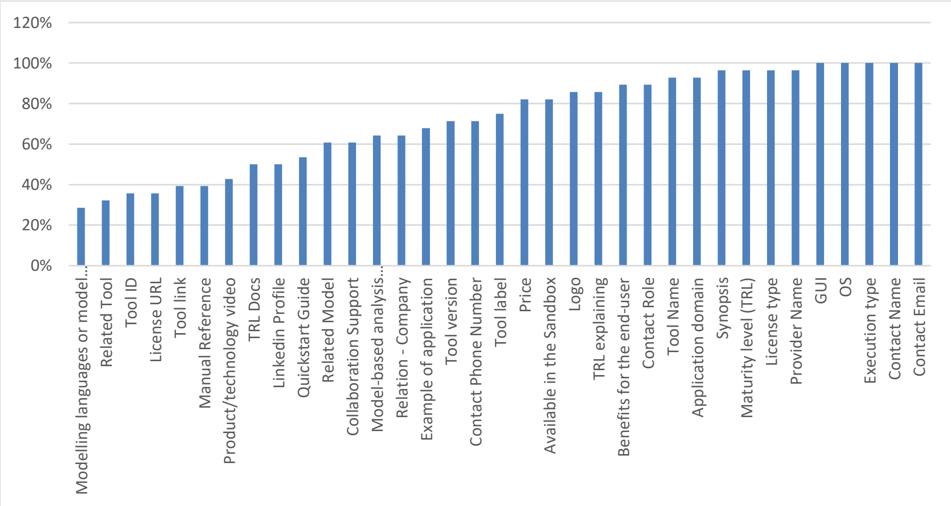


Figure 9. Percentage of Tools with accurate information classified by items of the platform

The second step will consist in the analysis of the assets that have the highest amount of missing or incorrect information in the platform. This with the intention to motivate the completion of the information with higher effort to the asset providers that have low percentage of completion. In addition, it is intended to define with the HUBCAP consortium, the items that are highly relevant to be reported correctly in the platform and start addressing them through direct communications with the asset providers.

Further steps

The development and implementation of a new "**Revision mode**" in the HUBCAP Platform was discussed in different meetings with the consortium. The aim of the new revision mode was on one hand to add the feature of **notifying directly** to the asset provider when an information is missing or wrong. On the other hand, to automate the process of quality assurance, developing a new interface available for the reviewer that will permit him or her to conduct the process in a simpler, faster, and more efficient way. However, the Engineering partners highlighted the complexity of the implementation of this alternative, and the fact that an important portion of time and effort will be needed to develop and implement this idea.

In regard to the future steps of the task, the decision about how to continue checking the new entries of models and tools added to the platform is still under discussion.

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5. Support to OC winners

5.1. Training sessions

Open call winners were offered a mandatory, one-time, workshop, providing training about the platform and sandbox to OC 1 winners. There were four workshops in total. One for each of the open calls: 1.1, 1.2, 1.3 and 1.4. The training sessions were hosted online and participants were able to follow presentations and interact with the speakers and organizers in an informal way. A substantial part of the session was directed at instructing how to access the platform, troubleshoot problems, and train how to deploy/upload the OC winners' asset contribution.

Various materials were prepared for the training sessions, including presentations, preparation forms, etc. For the specific task of deployment/uploading of OC winners' assets, in addition to those materials, we adopted an hands-on approach, that became fully developed in the last two editions (OC1.3 to OC1.4), consisting of an interactive session, where a speaker would share a screen with the platform interface and show the required actions needed to perform each step in the process of deploying/uploading an example asset into the platform. The participants were given time to repeat the steps of the instructor at each step and thus accomplish the task at hand, for instance to fill metadata about their asset offering in the HUBCAP portal catalogues and/or prepare sandboxes for their assets. In all the events we were able to wait for all the participants declaring an intention to accomplish the step during the online session, proceeding only with the demonstration of and move to the next step when all the participants declared the completion of the task or mentioned they intended to deploy their assets on their own at a posterior stage.

In the training sessions, OC winners' were made aware of the platform user manuals and the several video guidelines provided as reference for the tasks to accomplish, specially relevant to the participants wishing to deploy their assets at a later stage. Troubleshooting of access and other issues were executed during the session and the contacts of key partners were provided in case the participants would find issues or need help after the workshop. In the later sessions participants were asked to use a support contact instead.

5.2. First level support for OC winners' questions and issues

As described in section 5.1 the training session is a one-time workshop for OC 1 winners. To support OC1 winners in case of technical problems (typical troubleshoot) or questions after the workshop it was defined in the amendment that VV takes care about this activity based on the experience with the seed SME's from WP3. Thus, a support e-mail address (help@hubcap.eu) has been created which is mirrored to gerhard-benedikt.weiss@v2c2.at as single point of contact.

From February 2021 up to now (February 2022) around 110 e-mails were received concerning support issues (counting received e-mails to both addresses). Moreover, many e-mails have been sent actively asking the SMEs to provide some information or to remind to finish the integration of their asset. Thus, the e-mail communication can be sorted into the following support activities:

a) troubleshoot e-mails
b) reminder to finish the integration
c) gathering information about the needed operating systems
d) HSM cleaning

a) Several e-mails are about missing the credentials to login in the platform or no permission to access the sandbox environment. Credentials with permission to access the sandbox are provided only to participants in the workshop, but it turned out that in many cases these participants were not the actual employees who are supposed to do the integration of the asset in the sandbox environment. After discussing this issue in the WPL NM meeting the vetting process to get permission for the sandbox has been opened by a mandatory watching list of tutorial videos as described in section 3.1.
Typical troubleshooting was that platform user couldn't find certain items on the portal or had problems filling out the catalogue (like what is the tool ID, is a url link mandatory, …). Two users shut down the costumed VM in the sandbox, so it got inaccessible. Other reported issues are that user with sandbox permission couldn't access the sandbox anymore. In most cases the reason was that the user tried to access the environment during the batch mode (maintenance mode). Some OC winners asked what to do since their asset is a web-based application. A workaround has been defended for those providers: automate at startup the launch of the browser with the given URL of the application when the system starts and user logs-in.
b) The workshop for the OC1.1 and OC 1.2 winners did not have a hands-on session. Thus, reminders were sent out by VV to start or finish the integration of their asset.
c) Since it was unclear how many windows licenses are needed a survey for the OC1.1 and OC1.2 winners was started by ENGIT and VV to identify the operating systems landscape. The survey result is depicted in Figure 10~~Figure 10~~:

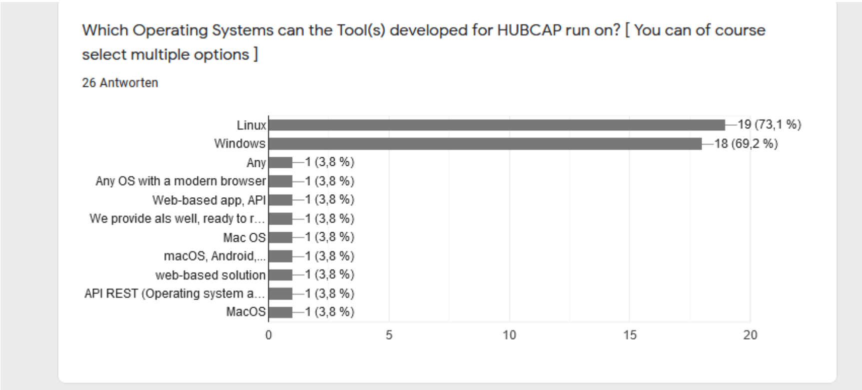

Figure 10: Survey about the needed OS

Further analysis of the feedback showed the following:

- 26 of 34 OC winners responded to the survey
- 18 providers quoted that their application runs in Windows, but only 6 (23%) quoted that their tool is Windows only
- 5 providers have a web-based application

Based on that ENGIT contacted Microsoft and finally a (licensed) Windows Sever 2019 has been add in the HSM OSes repository.

Before installing the Windows server, it was necessary to do a clean up of the HSM repository in order to unlock resources. An analysis of the tools repository showed that a few OC winners saved several VM's. Since it was not clear which VM's are the actual contribution and which are test images, VV contacted those providers to make sure each OC winners provides a single image of their asset

6. Summary

This document reports on the deliverable D6.5, which consists of the fourth version of contents that populate the models and tools catalogue on the HUBCAP platform. These contents count now almost 150 assets among models and tools. In this document we focused on the enhancement of the platform with guidelines to lower the barrier for new adopters of MBD, on the activities to improve the contents' quality, and on the support given to the users of the platform. This is a partial status report on the activities of T6.5. In the next deliverable D6.6, we will conclude with the final status of this task.