SELFSUSTAINED CROSS-BORDER CUSTOMIZED CYBERPHYSICAL SYSTEM EXPERIMENTS FOR CAPACITY BUILDING AMONG EUROPEAN STAKEHOLDERS

Research Innovation Action

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DELIVERABLE 5.2

First Version of SMART4ALL Technology Services Handbook

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Abstract

SMART4ALL introduces the concept of marketplace-as-a-service (MaaS) that acts as one-stop-smart-stop of SMART4ALL Digital Innovation Hub cluster for offering tools, services, platforms based mainly on open sources technologies as well as technology suppliers-adopter matchmaking capabilities customized to the four thematic pillars of the project (Digitized Transport, Digitized Agriculture, Digitized Environment, Digitized Anything). MaaS aims to act as an active enabler of knowledge and technology transfer, synergetic research and development as well as education in industry and industrial involvement in the academic education. At the same time, it will be the main and central point of publicity and continuous updates on the project's development and output to all interested collaborators. This will include advertising services (e.g. creation of infographics) for the experiments funded, which will be available through the SMART4ALL MaaS platform. In essence, the main role of the MaaS is to reduce the development effort (e.g., moving from idea to prototype) for stakeholders (startups/SMEs/mid-caps) that are doing businesses in one of the four SMART4ALL pillars. To this end, MaaS will include cloud services, related platforms, tools and middleware frameworks, and design service facilities mainly focusing on open-source technologies. Moreover, customized services, in later phases supported by AI based tools and algorithms, will be included in the MaaS e.g., personalized links to relevant events, customized web pages, and matchmaking (technology suppliers-technology receivers) activities.

History and Contributors

Ver	Date	Description	Contributors
00	09/12/2020	Document structure	BTU
01	06/01/2021	Draft of the deliverable	BTU, AVN, UoP
02/D	09/01/2021	Draft with input from all partners	AVN, UoP, BTU, PUT, RP, SEEU, DPN, FTN
03	11/01/2021	Internal peer review.	S&C, Red Pitaya
04/R	13/01/2021	Addresses peer review comments.	BTU
05/E	14/01/2021	Final preparations and submission.	BTU

Executive Summary

This document provides the Technology Services Handbook for the SMART4ALL marketplace. It is intended to give an up-to-date overview of the current state of the portal's development, explain the services realized and their use, and present already existing and usable artefacts.

After an introduction in Chapter 1, Chapter 2 gives an overview of the Marketplace as a Service concept and describes the goals as well as the services offered. In addition, the matchmaking service will be presented, which will make it easier to bring together providers and users of smart technology using artificial intelligence methods.

Chapter 3 contains the User Guide for the SMART4ALL Marketplace. After providing an introduction and a generic overview of the website, it describes how to use the specific components to achieve specific tasks. Furthermore, some technical notes and the legal terms of use are given.

The following Chapter 4 presents the services currently available in the marketplace and for each a short introduction, essential criteria and the goals which the corresponding service should support. The subsections are based on the tasks from WP5 and will be continuously extended during the project duration.

Section 5 summarizes and concludes the document and gives an outlook on the planned extensions for the next reporting period.

Abbreviations and Acronyms

Abbreviation	Explanation
AI	Artificial intelligence
API	Application Programming Interface
CLEC	Customized Low-Energy Computing
CPS	Cyber Physical System
CRUD	Create, Read, Update, Delete
DIH	Digital Innovation Hub
FTTE	Focused Technology Transfer Experiments
ICT	Information and Communications Technology
IoT	Internet of Things
KPI	Key Performance Indicator
KTE	Knowledge Transfer Experiment
LMS	Learning Management Platform
MaaS	Marketplace-as-a-Service
MVVM	Model-View-View-Model
PAE	Pathfinder Application Experiments
RDMS (or RDBMS)	Relational Database Management System
SME	Small and Medium Enterprise
TLS	Transport Layer Security
TRL	Technology Readiness Level

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INTRODUCTION

1.1 Purpose and Scope

The purpose of this document is to serve as a reference and a user guide for the SMART4ALL Marketplace. It will be updated continuously during the project duration and fixed versions will be released in Month 36 and 45.

Most important scope of the deliverable is the presentation and the detailed description of all services offered by the SMART4ALL Marketplace. It will present the basic services, the infrastructure as well as the first artifacts available in the Marketplace. For each section there will be an overview describing the criteria for selection and evaluation followed by the available services.

In the following chapter the concept and the basic features of the MaaS is shown. Chapter 3 gives a description of the user interface and a guide showing how to use the presented features. In the fourth chapter an overview of the specific artifacts that are available in the marketplace is presented. Chapter 5 concludes the document with a summary and an outlook for the next project period.

1.2 Approach

As this document will be updated continuously during the project duration by various partners providing input to the Marketplace, the structure chosen tries to reflect the responsibilities for the tasks in the project. The overall marketplace concept and the backend services as well as the user guide are presented in one chapter each, the artifacts, which have been and will be selected for presentation in the Marketplace are described in subsections of Chapter 4, divided according to the WP5 tasks.

1.3 Relation to other Work Packages and Deliverables

The relation of the Marketplace as a central part of WP5 the respective work package has a central role and clear interaction with all the rest SMART4ALL WPs. Specifically, apart from itself and rest of the WP5 Tasks, it received input from WPs 3, 6, and 7 in the form of funded projects' information and artefacts provided through the Marketplace and offers output to WPs 2, 4 and 8 as a critical pillar facilitation further promotion, outreach and advertising, sustainable business modes and impact monitoring.

2 MARKETPLACE AS A SERVICE (MAAS)

2.1 Basic MaaS Concept

SMART4ALL's concept regarding the proposed marketplace aims to transform the term *one-stop-shop* to *one-stop-smart-shop* through its proposal for a *Marketplace-as-a-Service (MaaS)*. Based on this concept MaaS aims to act as an active enabler of knowledge and technology transfer, synergetic research, and development as well as education in industry and industrial involvement in the academic education. At the same time, it will be the main and central point of publicity and continuous updates on the project's developments of any type and output to all interested collaborators. Through this idea, the main role of the MaaS is to reduce the development effort (e.g., moving from an idea to a competitive prototype) for stakeholders (startups/SMEs/mid-caps) that are doing businesses in one of the four SMART4ALL pillars (Digitized Transport, Digitized Agriculture, Digitized Environment, Digitized Anything). To this end, MaaS will include cloud services, related platforms, tools and middleware frameworks, and design service facilities mainly focusing on open-source technologies. Moreover, AI based customized services will be included in the MaaS e.g., personalized links to relevant events, customized web pages, and matchmaking (technology suppliers-technology receivers) activities.

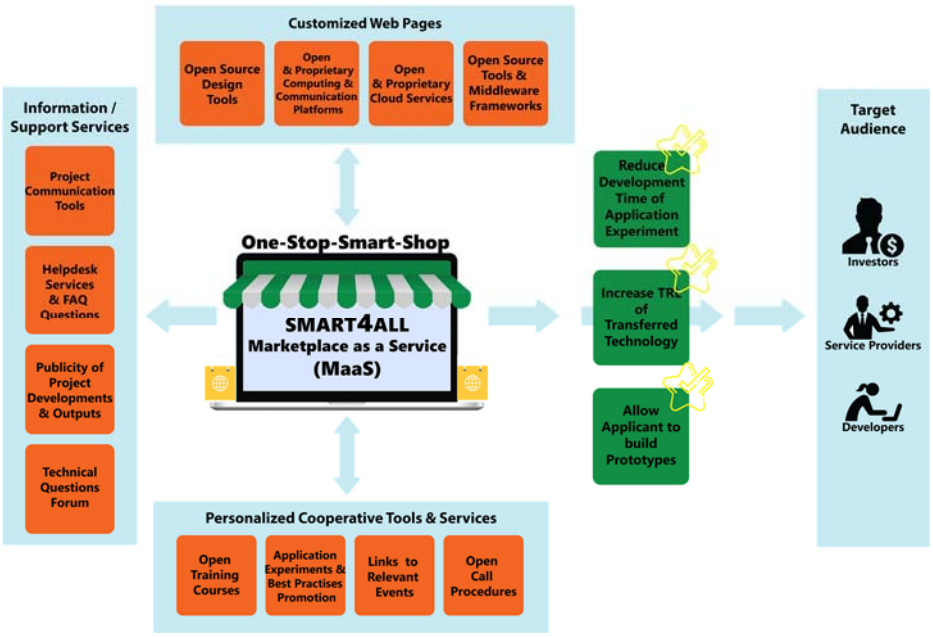

Figure 1. SMART4ALL Marketplace as a Service Concept

Concluding all and following the main concept of the SMART4ALL MaaS as depicted in the Figure 1, the developed and continuously expanding portal will offer a nexus of different and diverse artefacts, which will be tailor fitted to specific challenges/objectives posed by each registered user. The proposed artefacts will target specific KPIs as identified in the green blocks and thus satisfy the needs and requirements of a wide range of different and diverse types of target audiences. Specifically, we are confident that a wide audience is targeted comprised by technology providers, suppliers, funding agents and investors, innovation managers, business developers as well as policy makers.

To achieve the specific objectives a respective data model has already been defined and developed and adequate technologies have been identified as presented in D5.1. However, as the project progresses and more knowledge and experienced is gained, any kind of adjustment and modification may be required to make sure a sustainable, flexible, extendable, and expandable platform is offered.

2.2 Goals of the SMART4ALL Marketplace

The main goal of the proposed Marketplace as a Services (MaaS) is to serve experts and non-expert third-parties alike to access all the artefacts offered. A critical aspect will concern ICT technologies (open-source mainly) that will reduce the development time of an startup/SME/mid-cap that is doing business in one of the four SMART4ALL thematic areas. However, the proposed MaaS will promote more multifaceted goals, with AI based matchmaking and collaboration support comprising the most important of them, differencing SMART4ALL Marketplace from other relative efforts.

More specifically, SMART4ALL MaaS's goal will be to offer information for the CLEC CPS/IoT technologies of high interest to the end-user specifically targeting:

- Open and proprietary cloud services related to SMART4ALL technologies.
- Open and proprietary computing and communication platforms related to SMART4ALL technologies.
- Open-source tools and middleware frameworks related to SMART4ALL technologies.
- Open-source design tools related to SMART4ALL technologies.
- Training (model-based) open course related to SMART4ALL technologies.

SMART4ALL as a project and DIH target "Prepare for Growth" Services. To achieve this objective another novel goal of MaaS will be to focus on tools like open-source project and product management tools, tools for creating and maintaining business plans and financial tracking tools. In the same context, more traditional goals comprise by offering a "Helpdesk services and FAQ sections" and Active Forums for technical questions.

Through this complete set of capabilities and novel services and features, the final goal of the developed MaaS is to reduce the development time of PAEs, allow the applicant to build a prototype or increase the Technology readiness level (TRL) of the transferred technology with the least possible effort.

Yet another goal of increased added value will be to continuously and increasingly facilitate access to venture capitals able to invest in products and ideas that will comprise the outcome of SMART4ALL PAEs and not only. Both project's consortium structure and the supportive ecosystem around it (e.g. expressed through support letters) are a clear indication of this critical objective.

Finally, apart from offering access to wide range of artefacts or assets SMART4ALL's MaaS aims to actively form connections amongst a) SMEs and mid-caps that are interested in going digital to b) (Competence Centers) CCs and SMEs possessing CLEC CPS and the IoT competencies and experimentation resources and c) other auxiliary yet mandatory competencies (such as business) required to create results with a product/market fit. In this way, SMART4ALL DIH will be able to a) fosters customer-business-market oriented product development and b) harvests the fruits and at the same time feeds back smart specialization strategy.

2.3 Services offered by the MaaS

2.3.1 General Services

The SMART4ALL MaaS will offer various services (including training services) to third parties focusing mainly on open technologies. The Marketplace will be designed with specific places for each thematic pillar and will include a querying mechanism to facilitate the searching operations for expert and non-expert users. Apart from pure technical offerings, it will also include project and financial management tools and services as well as useful links to all relevant websites. To this end, MaaS will include cloud services, related platforms, tools and middleware frameworks, and design service facilities mainly focusing on open-source technologies. Moreover, AI based customized services will be included in the MaaS e.g., personalized links to relevant events, customized web pages, and matchmaking (technology supplier-to-technology receiver) activities. As part of the project, specific effort will be devoted by the SMART4ALL partners to evaluate the readiness of various open-source technologies and prepare useful application notes about the correct usage of these technologies in start-ups/SMEs/mid-cap companies.

2.3.2 Matchmaking Service

As the marketplace is meant to bring technology providers from academics and industry together with adopters one of the most important aspects of the SMART4ALL marketplace is the matchmaking service. Matchmaking allows to connect requests to offers. This means, that the registered MaaS users can ask for specific thematic connections which will be established with the matchmaking service. This is currently done by experts which have an excellent overview of the partner within the network in Europe and companies which can be potential partner for a specific request. In a later stage of the project, this matchmaking will be supported by AI in terms of algorithms which perform an even cognitive support by combining several parameters to find a match.

3 USERS GUIDE

3.1 Introduction

The first public release of the marketplace addresses particular functional and non – functional requirements as defined during the design time of the platform. In this section aims to service as a "how to" manual describing the available use case scenarios covered by the current version of the MaaS.

3.1.1 Accessing the Marketplace Portal

SMART4ALL portal can be accessed through the following URL: https://marketplace.smart4all-project.eu/. Access is given through secure http connection over TLS to guarantee the privacy and integrity of personal data such as the user credentials. Visiting the marketplace web portal is feasible through all the popular browsers (Google Chrome, Mozilla Firefox, Microsoft Edge, Safari, Opera) delivering the same user experience. Moreover, the design and the implementation of the page is fully responsive to various screen ratio and resolutions including mobile devices such as smartphones and tablets.

3.1.2 Artefacts browsing

The main landing page of the portal is depicted at Figure 2. The landing page presents two tiles for the two main services that the marketplace offers to the users. The artifacts repository and the match – making service.

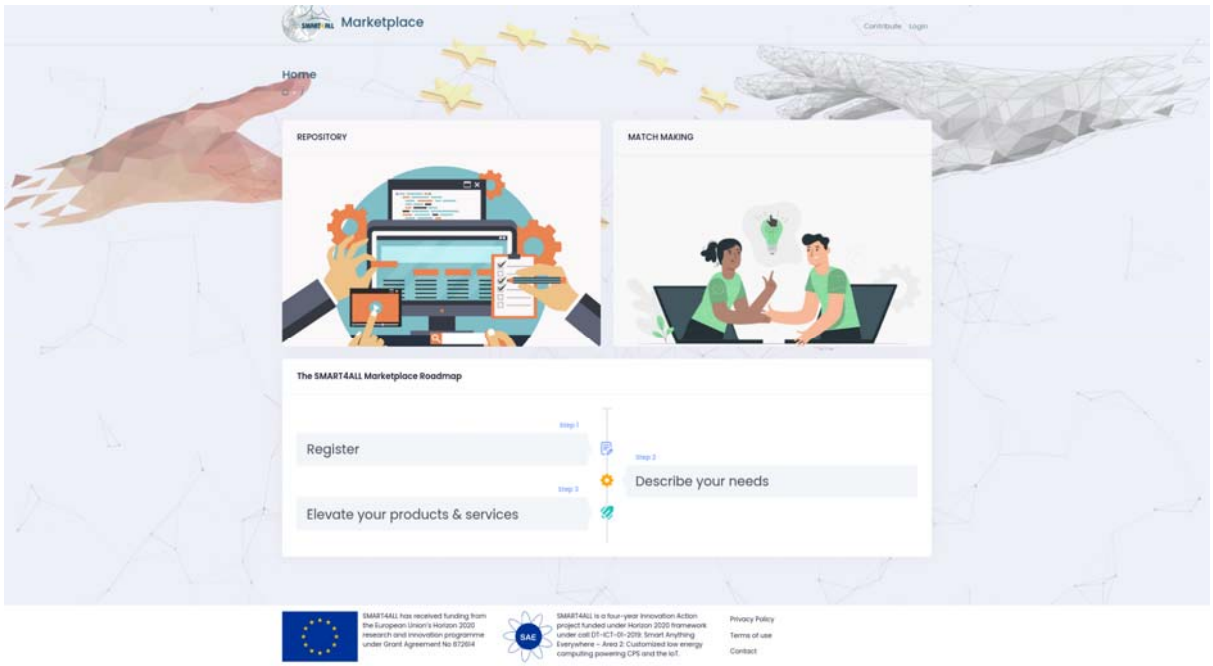

Figure 2. Marketplace Landing Page

A basic functionality such as browsing and searching the repository is given to the guests of the platform, but the full experience (accessing the artifacts, contributing artifacts) is given only to registered and authenticated users. Regarding the artifacts' repository, Figure 3 presents the view of the repository for the guests. As already described the guest can browse the repositories and search/filter according to his interests through the filtering toolbar. However, getting/accessing the artifacts is permitted only to authenticated user.

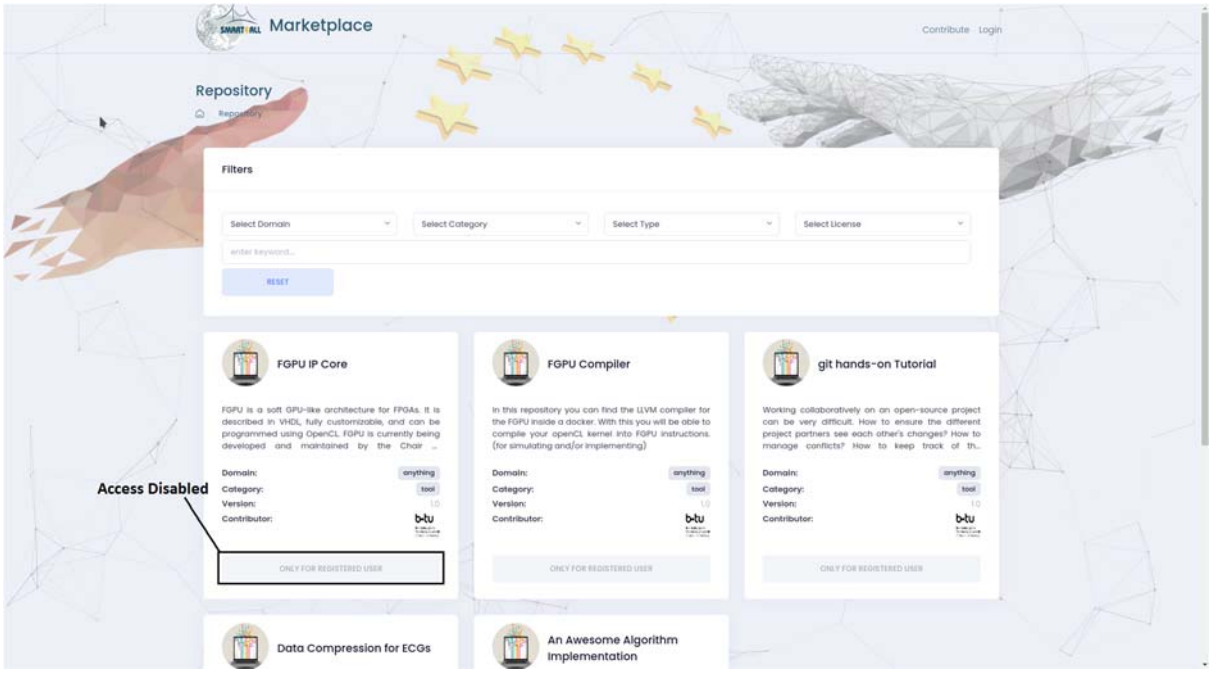

Figure 3. Marketplace Repository for guests

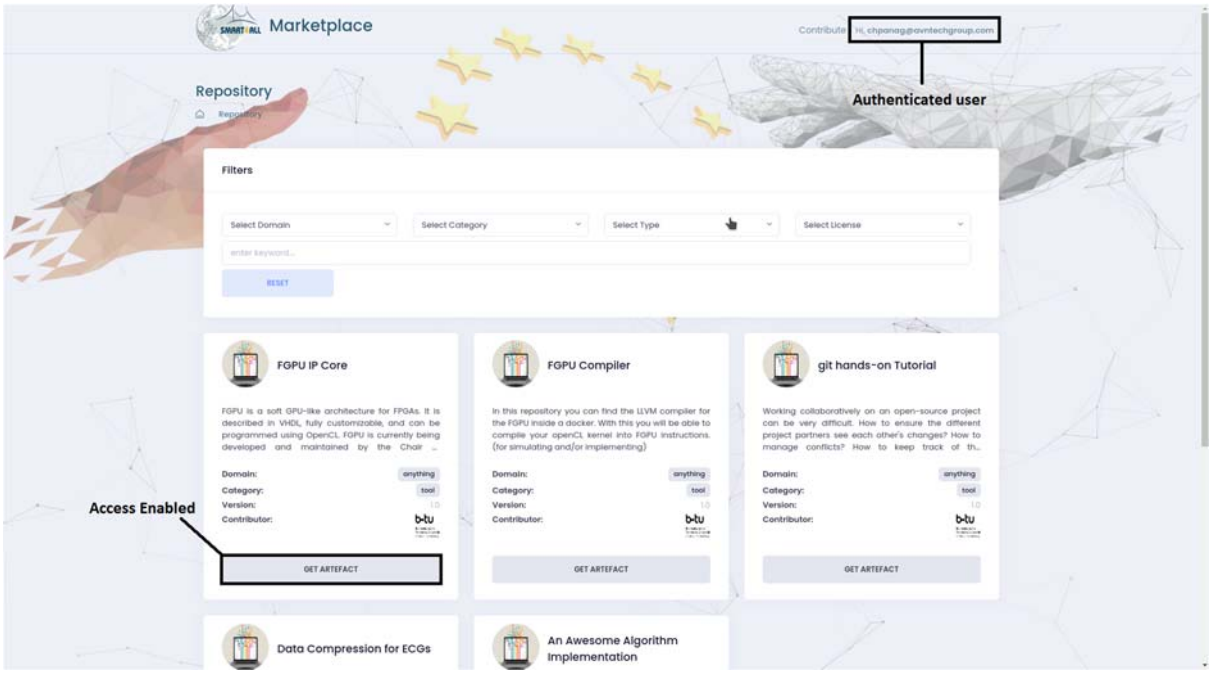

Figure 4. Marketplace Repository for authenticated users

The registration of a guest as a user of the platform is given through the registration process. The link for the user registration page is available on the Login page of the marketplace (Figure 5). More details on the authentication and registration services are given in section 4.1.1.

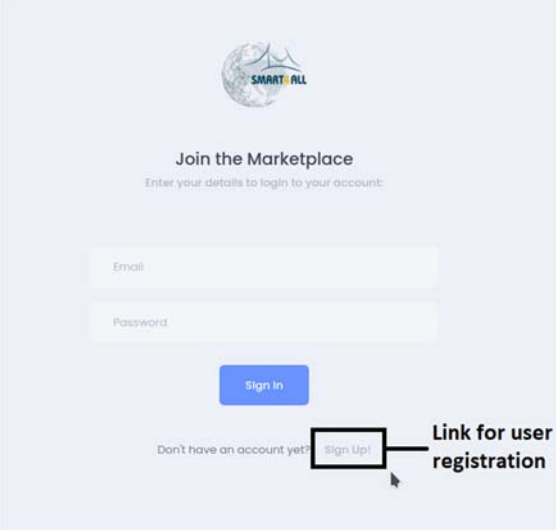

Figure 5. Registration Link available in the login page

3.1.3 Artefacts downloading

In order for a user to download/access an artefact he must be registered and logged in at the Marketplace. If the user is not registered. the Marketplace instructs the user to do so following a procedure described in the following sections. If the user is authenticated, the link for getting the artefact is activated. These two different views of an artefact are presented in Figure 6. The link "GET ARTEFACT" could serve a file to the user or direct him to an external page such as a GitHub repository or an event page, depending on the type of the artefact the user accesses. More technical details regarding the services behind this process are offered at sections 4.1.1 and 4.1.3.

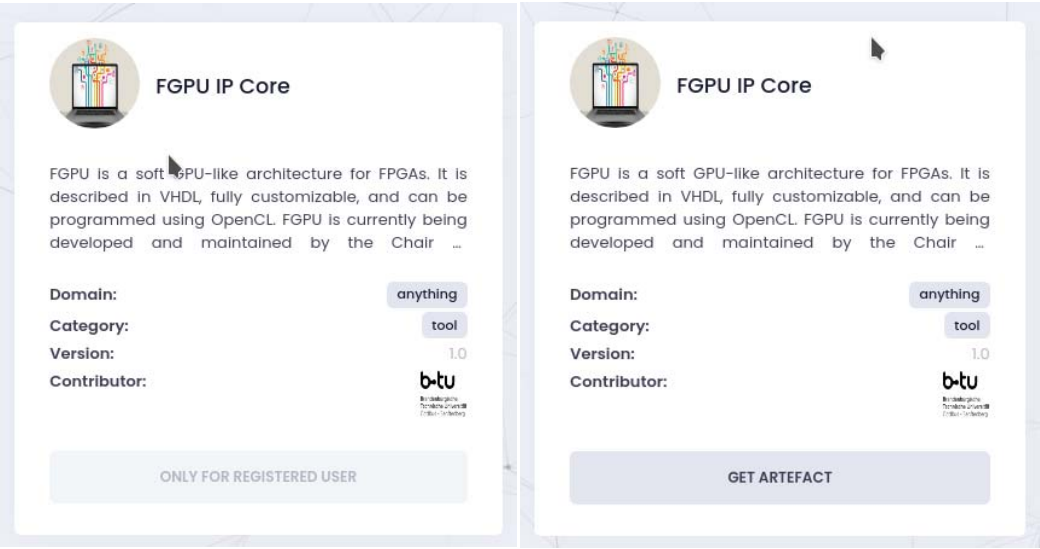

Figure 6. Views of artefact for guest and authenticated user

3.1.4 Artefacts uploading

If an authenticated user wishes to offer his own artefact to the marketplace this is delivered through the "Contribute" link placed in the header of the Marketplace page (Figure 7).

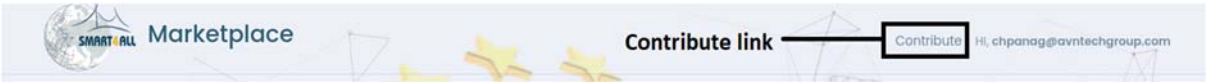

Figure 7. Artefact contribution Link

When the user presses the “Contribute” link he navigates to the artefact contribution page (Figure 8).

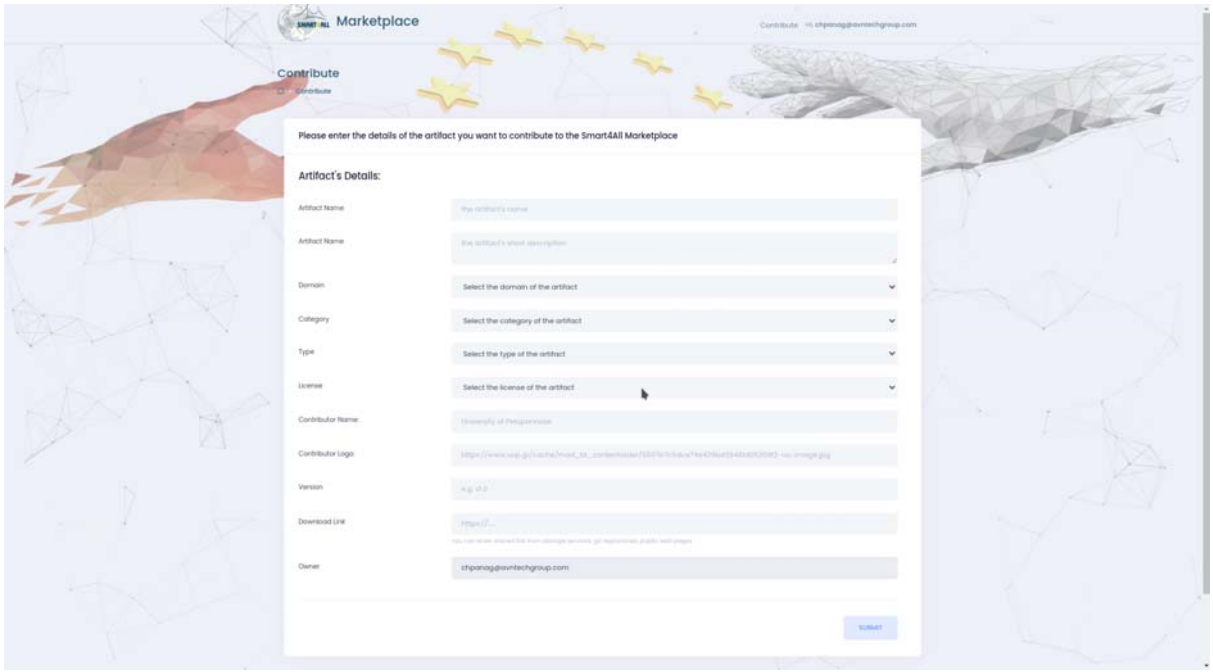

Figure 8. Artefact contribution Page. The artefact contribution process is described in more details at section 4.1.4

3.1.5 User registration process

The user registration process as already mentioned in many paragraphs of the current section is needed for joining the SMART4ALL Marketplace and getting access to its services. When a user tries to access these services (artefact access, artefact contribution) he is prompted to login. If he does not own a Marketplace account, then the sign-up process through a respective link is available as presented in Figure 5. This link serves to the guest the user registration page where respective information is requested. More technical details regarding this process are offered in Section 4.1.1.

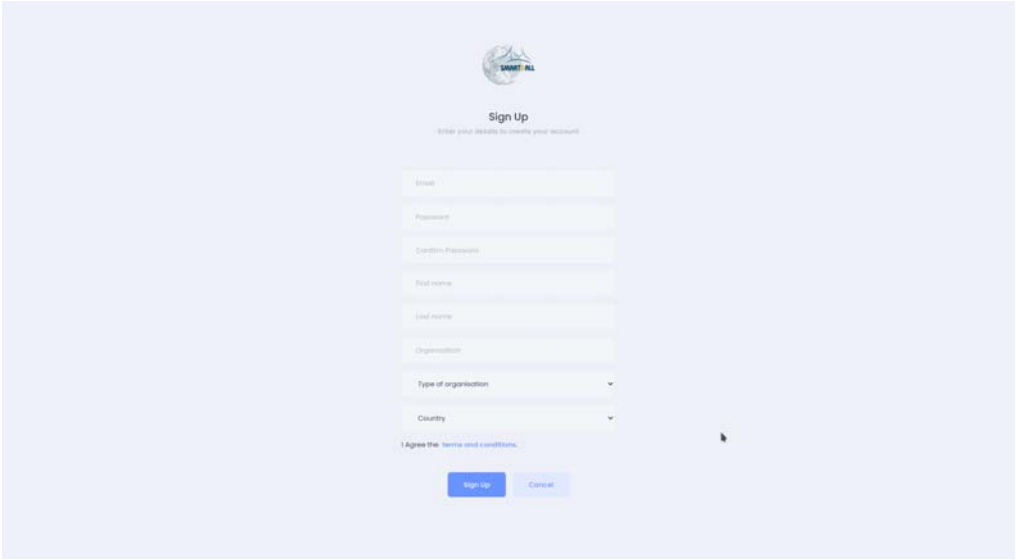

Figure 9. User Registration page

3.1.6 Active matchmaking process

As presented in Figure 2 , the second service available from the SMART4ALL Marketplace is the match – making service. By pressing the respective tile of the landing page, the user is directed to the match – making page (Figure 10).

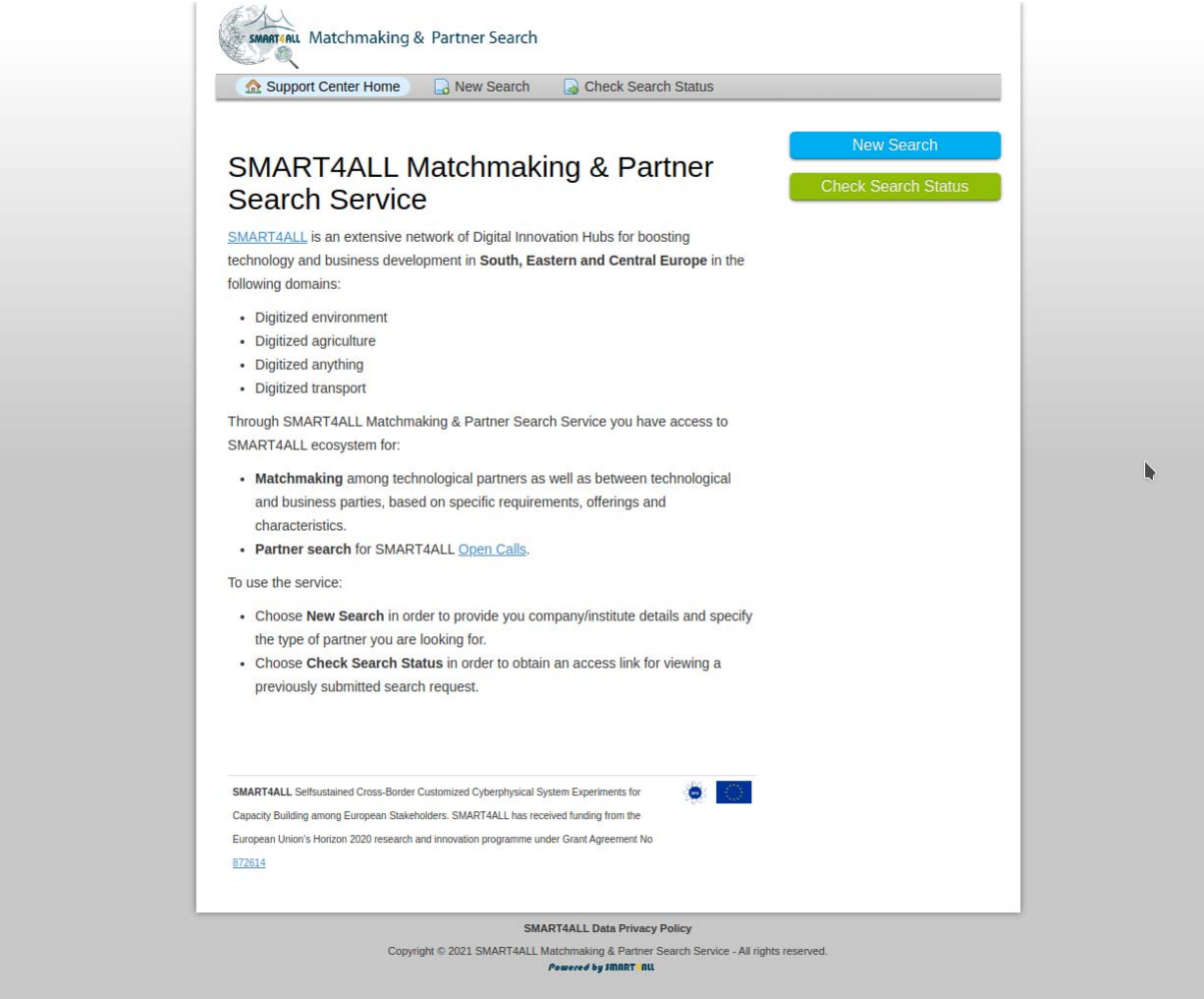

Figure 10. Match Making page

More technical details regarding this service at its current form are provided in the following sections as well as SMART4ALL deliverables D2.4 and D5.1.

3.1.7 Accessing Terms of Use and Privacy Policy

The use of the platform is subject to specific privacy policy and use of terms. The user must be aware of this framework in favor of transparency and data privacy. The texts that describe the privacy policy (Figure 12) and the use of terms of the platform are available in the footer of the Marketplace pages (Figure 11). Moreover, the sign-up page (Figure 9) requires that the user acknowledges the use of terms of the platform before registering.

Figure 11. Privacy Policy and Terms of use links in the footer of the platform

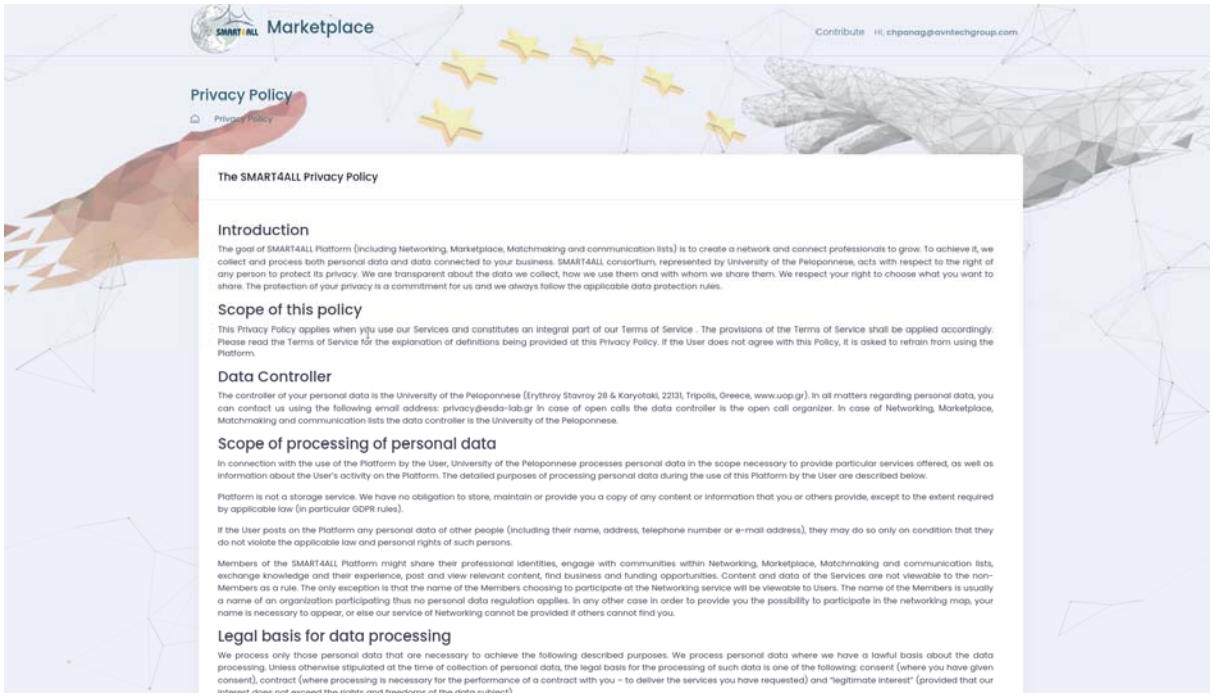

Figure 12. Privacy Policy page

More technical details regarding this service at its current form are provided in the following sections as well as SMART4ALL deliverables D1.3 regarding the data management plan.

3.2 Technical Notes

The Marketplace services have been based on the principles of microservices. During design time, the functionality of the system has been split into independent components. The requirements of these components and the isolation that microservices deliver through dockerization allowed us to use the most appropriate technologies for each component. The most fundamental services that comprise the Marketplace are presented in Figure 13.

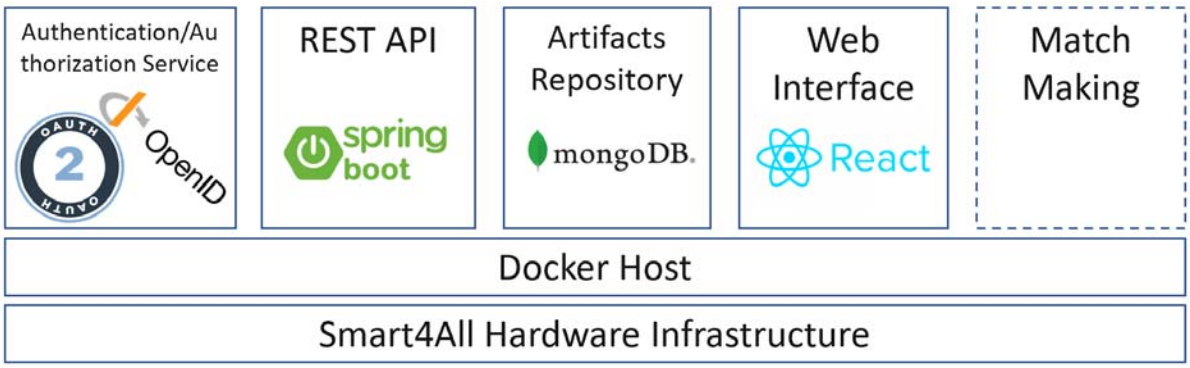

Figure 13. Markeplace Docker Services

In that sense, for the persistence of Marketplace data such user data, artifacts data, etc. NOSQL was selected and in particular the popular MongoDB. This architectural decision allowed us not to be strongly related to a database schema but to be free to update the structure of the documents that are collected and stored to the database if needed.

Another component of the marketplace is the server which is responsible to perform all the CRUD operations coming from the user interface. Such CRUD operations include the addition, update, delete of artifacts through POST/PUT/PATCH/DELETE REST requests. Additionally, the server component

connects to the database in order achieve the persistence of the objects. Other auxiliary activities such as auditing is also performed by the server component. All these features are managed very efficiently by the SPRING Framework that has dominant presence in the Java ecosystem.

Finally, the 3rd core component of the Marketplace system is the user interface. The user interface is implemented with HTML5 and CSS and based on the ReactJS JavaScript library. ReactJS allowed the design of the interface based on encapsulated components that manage their own state, and thus facilitate the composition of more complex and reactive UIs.

As it has been highlighted matchmaking comprises a cornerstone service of SMART4ALL and therefore of the proposed Marketplace. During the first phase of the project the respective service was based on a ticketing system clearly described in SMART4ALL deliverables D5.1 and D2.4, leveraging the local ecosystem of all SMART4ALL partners. This approach proved really useful aiming to promote collaborations, advertise the funding opportunities of SMART4ALL project while at the same time boost the SMART4ALL network extension.

Moving on to the second phase, Matchmaking is envisioned as a service facilitating the creation of partnerships and the building of collaborations among involved stakeholders through the integration with the Marketplace portal and all the artefacts and assets the Marketplace as a service aims to offer. In this context the respective service is developed as a web service and/or application, which is built under the Model-View-View-Model (MVVM).

Specifically, all the SMART4ALL network information aggregated is used to form a well-structured database following a detailed and versatile data model. The database, which supports the service, is developed on the MySQL RDMS framework and the front-end of the application is supported by the Python Flask framework. The data model utilized for storing the application data is presented in Figure 14.

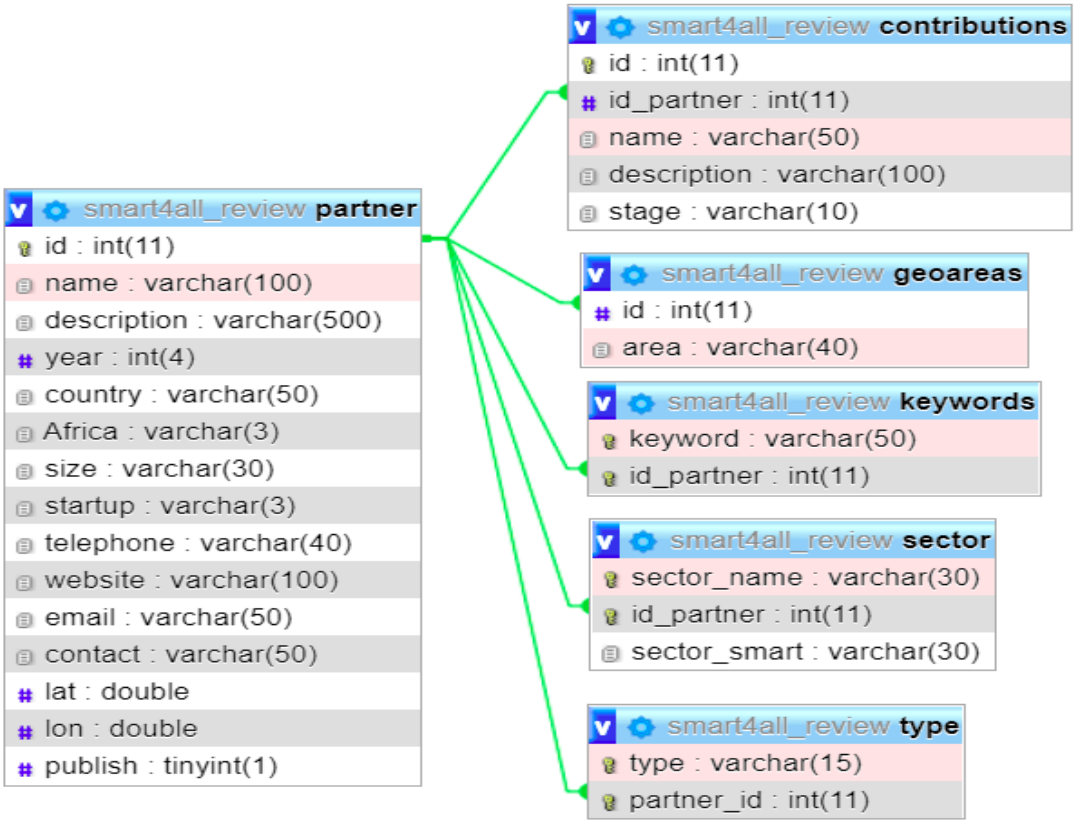

Figure 14. Matchmaking data model

As a standalone application, it allows the end user to view all the registered partners and filter them based on various keys, like name and country, as depicted in Figure 15. Finally, the users can use the export functionality and store the searched data in a readable format.

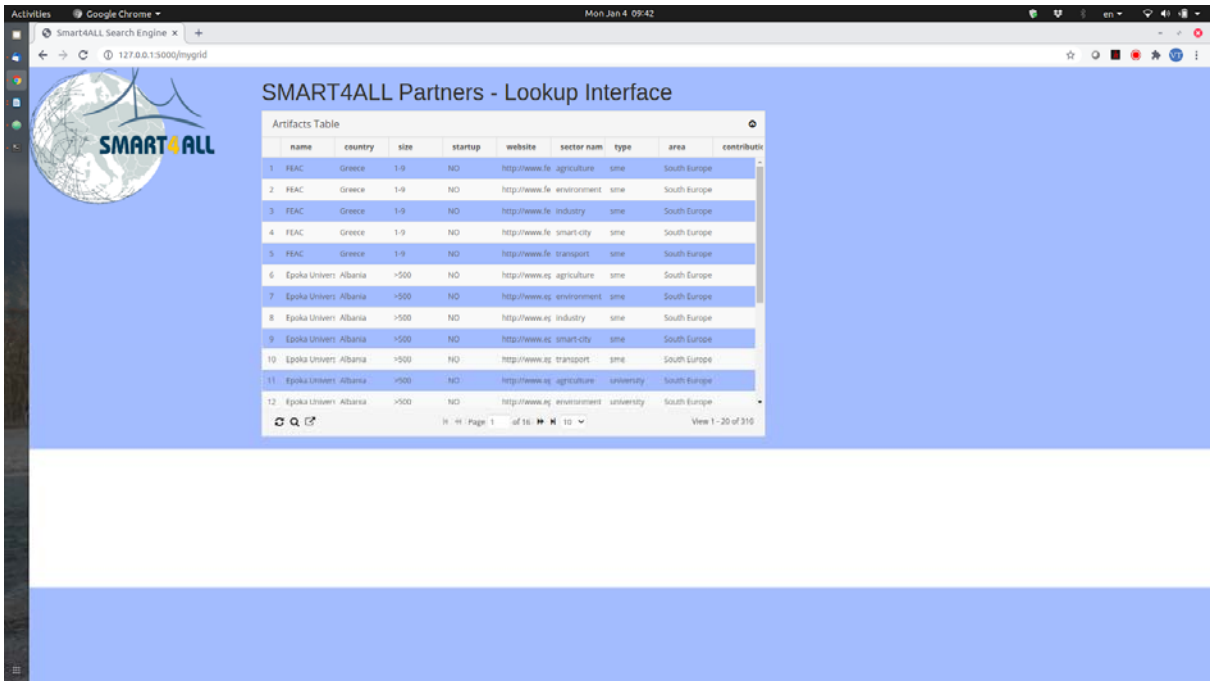

Figure 15. Matchmaking front-end web application

Additionally, the developed service offers a clearly defined APIs allowing the integration of the service with any 3rd part framework or infrastructure. Consequently, as a next step this service will be combined with all the different types of artefacts offered by the Marketplace as a service. This will allow the Market place to yield more information rich and multifaceted responses to any query posed by the registered users either being a SMART4ALL partner or to organizations outside the SMART4ALL consortium.

3.3 MaaS Terms of Use, Privacy Policy and Cookies Policy

As noted, the SMART4ALL MaaS platform is designed to act as an enabler of knowledge and technology transfer, synergetic research and development as well as education in industry and industrial involvement in the academic education. Therefore, it can be considered as multipurpose platform to facilitate technology pull and technology push services. Under this scenario, it is of paramount importance to clearly define the terms of use and the privacy policy of the MaaS platform. In parallel to this, the deliverable D1.3 (Data Management Plan) describes all the project activities to ensure that the MaaS data is managed in a FAIR (findable, accessible, interoperable and reusable) manner and in accordance to EU regulations.

Therefore, two separate documents have been prepared with the assistance of the legal department of UoP. The “Terms of Use” document (attached as Appendix B in D1.3) of the SMART4ALL Platform provides the guidelines of all SMART4ALL websites and Services (the latter includes software, networking, matchmaking, and the Marketplace) and the related “Privacy Policy” (attached as Appendix C in D1.3). It is important to mention that based on these two documents, the MaaS platformed have been enhanced (as mentioned in Section 3.1 and 3.2) with additional features (e.g., various consent forms) in order to be fully aligned with the rules and best practices as they described in these two documents as approved by UoP legal department and of course to be also aligned with EU regulations.

These documents where formatted and integrated in the Marketplace to be available to the users. The footer of the web interface includes the respective links for these two documents (Figure 16). Moreover, the user cannot register to the platform unless he accepts the terms of use.

Figure 16. Marketplace Footer

Finally, when a user visits the marketplace, he gets informed about the use of cookies by the platform and his consent is requested regarding any tracking data (Figure 17).

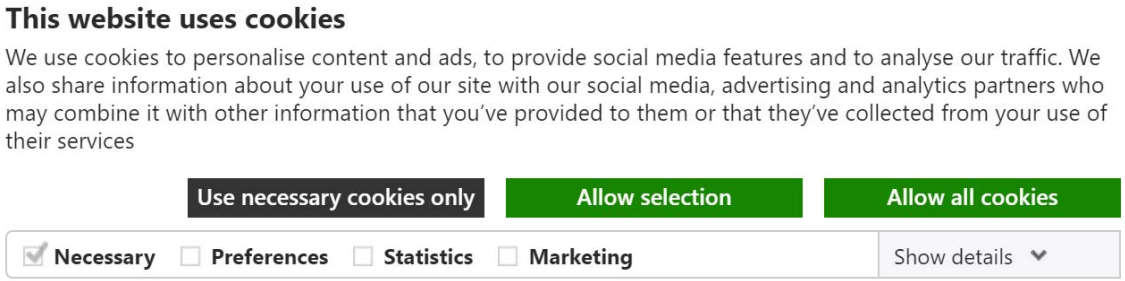

Figure 17. Cookies Consent

4 AVAILABLE SERVICES

4.1 Services offered by the Technology Portal (T5.2)

In this section details on the fundamental services delivered in the current version of the Marketplace are described.

4.1.1 User Registration and Authentication/Authorization

One of the required features that should be delivered with the first public release of the marketplace is the ability of the platform to authenticate the user of the platform and authorize him to perform specific actions. Authentication is performed through the login form depicted on Figure 18. In this form, the user enters his credentials and asks for authentication. The platform then validates the provided credentials and decides whether to grant permissions to the user or not. Permissions are distinguished in two specific user groups, users and administrators. Users are allowed to access details of each artifact, submit a new artifact, update an existing one. The administrators are able to list the existing users of the system but without having access to critical data such as their passwords. Moreover, administrators are able to screen the submissions of artifacts and accept them or not for publishing in the repository.

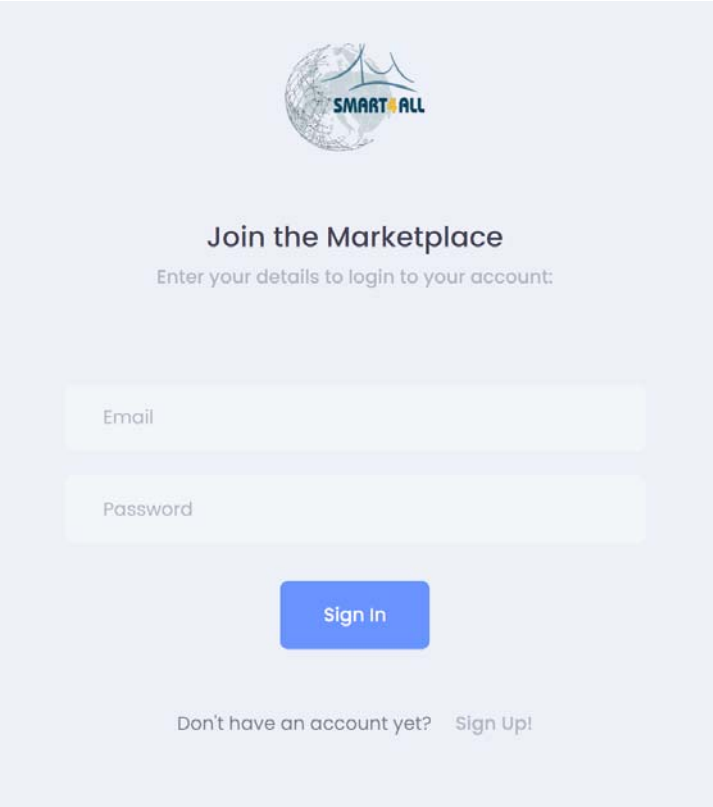

Figure 18. Marketplace login form

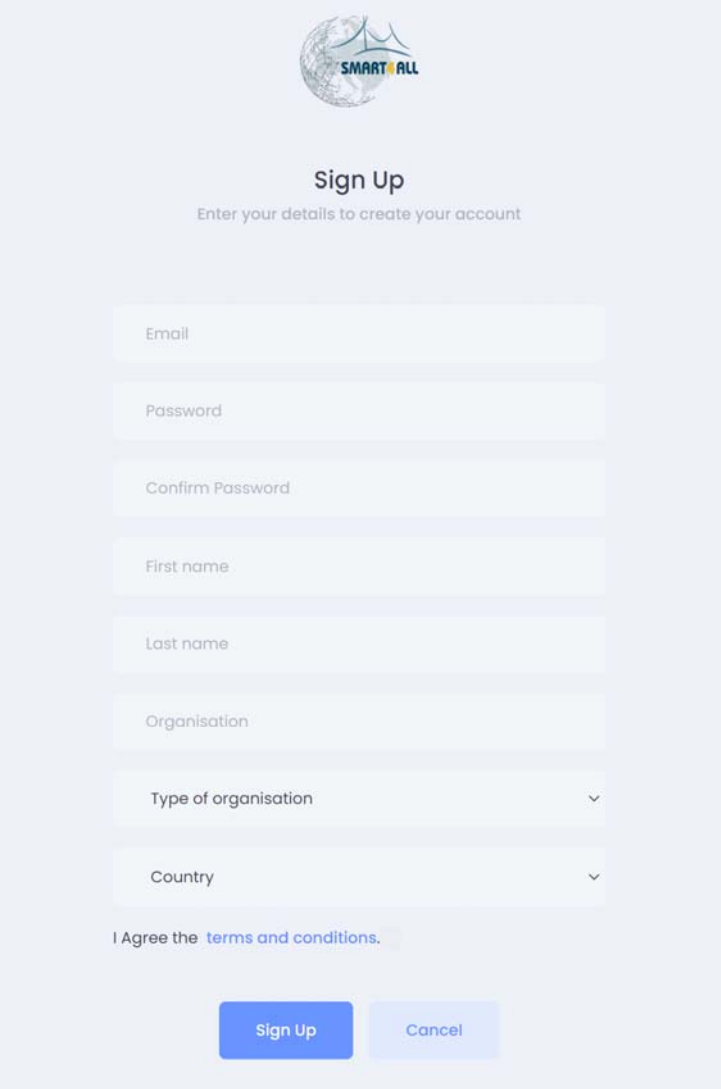

Figure 19. Marketplace User registration

In case the user is not yet registered to the Marketplace, the respective functionality is given through the registration form, shown in Figure 19. In this form, the guest is requested to enter some personal details such as email, password, first name, last name, organization name, type of organization, and country of origin.

Such critical information such as credentials and personal data of the users are transmitted encrypted over TLS from the browser to the server.

Of course, authentication is not needed for basic activities such the browsing of artifacts, accessing the policy terms, terms of use or contact pages.

4.1.2 User Management

The user that belongs to the administrators' group is permitted to access the users page where he may have a general overview of the registered users and their status (active, disabled, not confirmed). Of course, the credentials of the users are not possible to be presented as they are stored encrypted to the database. The administrator can enable or disable users. Deletion is not permitted in favor of data integrity.

4.1.3 Artifacts Repository

The artifacts repository is one of the most important functionalities that the Marketplace delivers to the public. This repository stores artifacts that the users may find useful in their organization and support them to elevate their expertise on a domain, improve the maturity of their product, find funding resources, discover new collaborations, etc. These artifacts are presented as a list of cards that present the basic information of each artifact in a user-friendly way. To improve the experience of the user and the functionality of the repository, searching and filtering capabilities are also supported through a set of filters that allow the user to focus on the artifacts of his interest. A view of the repository page is presented in Figure 20. The link for accessing/downloading the artifact's resources is available in the bottom left corner of each card only for the authenticated and authorized users.

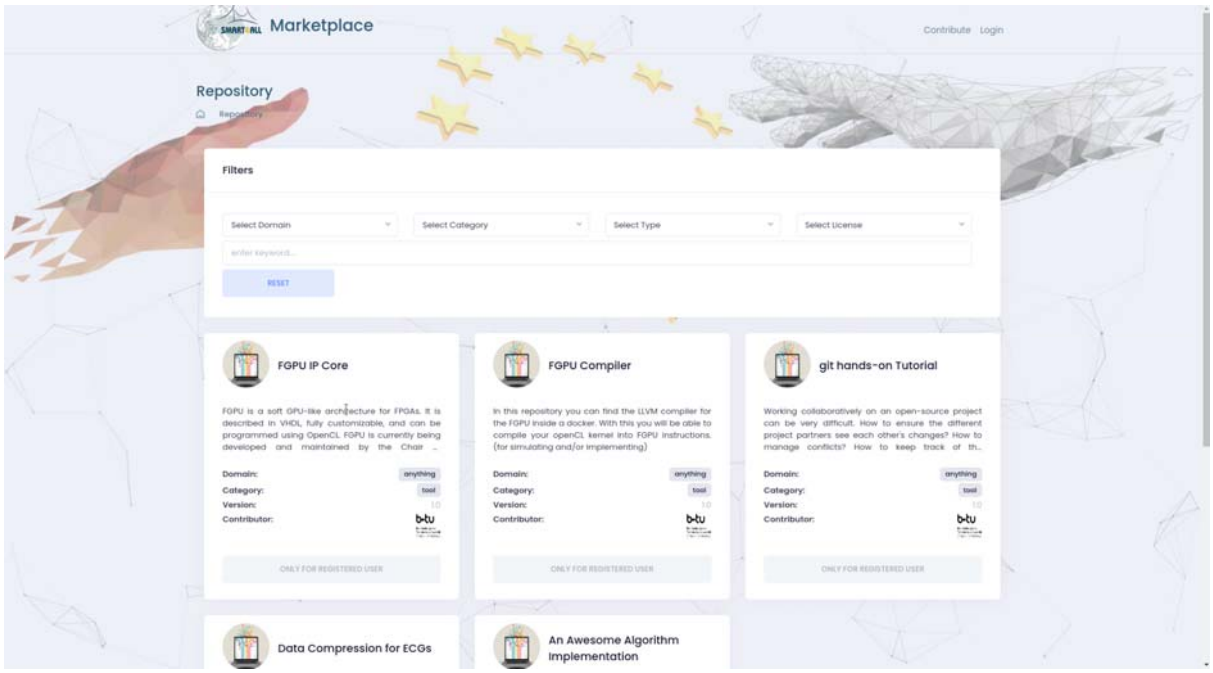

Figure 20. Marketplace Repository

4.1.4 Artifacts Submission Process

The artifacts submission process consists of two independent paths. The first path is performed by the user who accesses the contribution page and submits the required details for its artifact through a web form. This form is presented on Figure 21 and requests from the user to fill in the fields with the required information. The most important information that describes each artifact comprises of:

- Artifact's name
- Artifact's description
- Artifact's domain
- Artifact's category
- Artifact's Type
- Artifact's License
- Artifact's version
- Artifact's download link

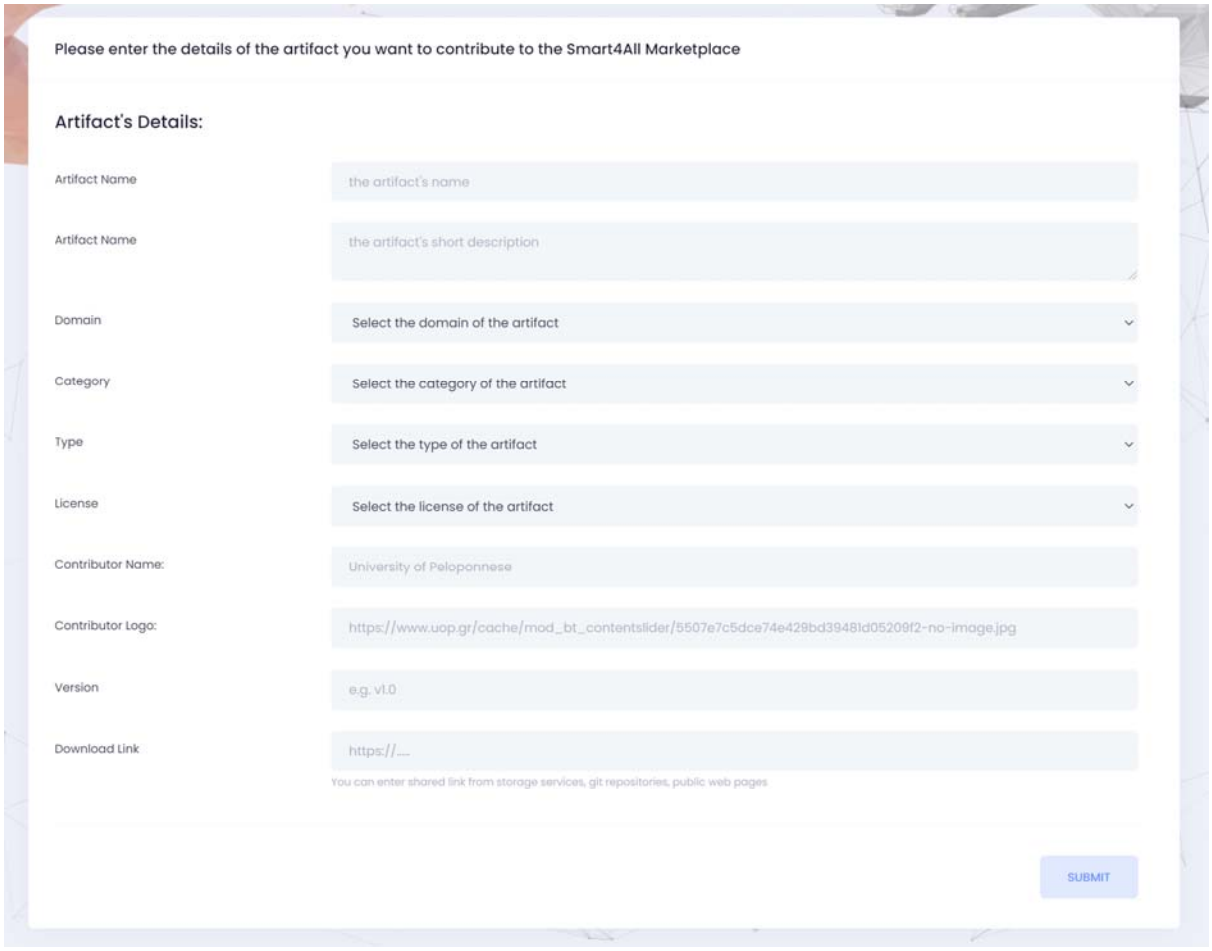

Figure 21. Artifact Submission Form

When the fields of the form are all filled the user submits the form. However, the artifact is not yet available through the repository. The permission for publishing a submitted artifact to the repository is given by the administrators of the Marketplace. The users that belong to the administrator's user group are performing a primary screening of each submission in order to reassure that the submission fits to the scope of the Marketplace. Since this is achieved, the status of the artifacts is updated to published and it becomes available to the users of the platform.

4.1.5 Preliminary Match – Making Service

The Match – Making service is the second fundamental service that is planned to be delivered through the Marketplace. In this first version, this is performed through an external link that navigates the user/guest of the platform to a 3rd party tool. However, the developments of the match – making services are still in progress in order to release a more sophisticated service based on Artificial Intelligence in the near future.

4.2 Cloud Services presented in the Marketplace (T5.3)

Cloud services are important tools for new smart technologies. In the SMART4ALL project they are necessary to use for creating the expected Marketplace facilities. Therefore, the main goal of Task 5.3 is the development and support of access to cloud services in the Marketplace in order to perform the SMART4ALL experiments with the prepared applications.

The performed work mainly consisted of the preparation and provision of a tutorial for both open and proprietary cloud services in the Marketplace, including the assessment of their features (advantages and potential disadvantages) of various mature open and proprietary cloud services related to the SMART4ALL technologies, and the preparation of sets of guidelines for the use of open and proprietary cloud services. Information sets on various selected open and proprietary cloud services are also prepared together with illustrative applications.

Among open cloud services the following were considered and analyzed: Nextcloud, OpenStack, CloudStack, Eucalyptus, OpenNebula, OpenShift (OKD). In addition, the following proprietary cloud services were analyzed: Amazon Web Services, Microsoft Azure, Google Cloud, IBM Cloud, Oracle Cloud.

Open cloud services are more flexible in the management and are more customizable with better and varied control panels. Users can have strong contribution to the software development. However, although the initial costs are lower than the license costs of the proprietary ones, there are some hidden costs of: installation, support, fixes, and upgrades. On the other hand, proprietary cloud services have some important benefits such as quality and stability.

As the result of the prepared analysis, the Nextcloud technology is recommended as the main Marketplace cloud service with the following facilities: an embedded application for on-line editing of office files, viewing PDF files without the need to download them (https://apps.nextcloud.com/apps/files_pdfviewer), a tool for analyzing data obtained from the GPS modules, a tool for visualizing transportation routes based on the collected coordinates (https://apps.nextcloud.com/apps/gpxedit, https://apps.nextcloud.com/apps/gpxpod). Moreover, the Marketplace should provide a possibility of performing calculations in the cloud using the whole SMART4ALL computing infrastructure.

4.3 Computing and Communication Platforms presented in the Marketplace (T5.4)

Our goal was to introduce already available hardware platforms to the SMART4ALL Marketplace that can be used by SMEs, startups and mid-caps to implement experiments or to develop products. As an expert on the field of embedded systems we focused on solutions that are already very popular and present in global markets and used by companies, startups, and universities for several years. Another very important aspect was to select platforms that are easy to use and great for fast prototyping in order to make it simple for users to implement experiments. We also compared price / performance efficiency and power consumption as well as connectivity, since nowadays these are very important factors especially due to the IoT era where systems are built of several devices that communicate together and are mostly accessed remotely.

Since our participation in Smart All is mainly focused on digitalization in the education area, we introduced several artifacts that are related to education, like FPGA, Python, C & MATLAB programming, signal processing, measurements, and control. Goal of this artifacts is to help universities that collaborate on SMART4ALL to get in touch with proper tools for practical experiments.

Examples of current contributions are as following:

Table 1 Hardware platforms currently available in the SMART4ALL Marketplace

1	Hardware	Raspberry Pi	https://www.raspberrypi.org/
2	Hardware	Arduino	https://www.arduino.cc/
3	Hardware	Red Pitaya	https://www.redpitaya.com/
4	Hardware	Hack RF	https://en.wikipedia.org/wiki/HackRF_One
5	Hardware	Groove sensors	http://wiki.seeedstudio.com/Grove_System/

Further artifacts we provided are related to the STEMlab platform and how it can be used in education.

4.4 Tools and Middleware presented in the Marketplace (T5.5)

This section of the SMART4ALL Marketplace offers ready-to-use solutions based on open SW and HW technologies that drives decision making for SMEs, startups and mid-caps. The Marketplace has been populated with various tools and Technologies related to SMART4ALL thematic areas that have been evaluated by using initially the various open-source tools and middleware frameworks related to SMART4ALL technologies.

After a clear evaluation, a set of mature tools and middleware frameworks have been uploaded in the SMART4ALL Marketplace. Currently the contribution is around dozens of items from this category and will continue to grow as the teams refine and update the lists.

In addition to simple listing the tools in the Marketplace, we are striving to prepare an application note for the selected tools and middleware frameworks that will have “a tutorial” approach to make things easier for SMEs, startups and mid-caps that would like to apply these tools and technologies.

Examples of current contributions are as following:

1. **Cropio** - Farm Management SaaS and Mobile App - https://cropio.com
2. **AgriOpenData – Platform for Farm Management** (https://www.agriopendata.it/)
3. **Zetta** (https://www.zettajs.org/) Zetta is a free API based IOT platform based on Node.js.

4. **OpenHAB** Framework (https://www.openhab.org/)
5. **DeviceHive** Framework (https://devicehive.com/ **)**
6. **Flutter** (http://flutterwireless.com/)
7. **Banana PI** (http://www.banana-pi.org/)
8. **ESP8266** (https://www.esp8266.com/)
9. **Orfeo Toolbox** (https://www.orfeo-toolbox.org/download/)

4.5 Design Tools and Services presented in the Marketplace (T5.6)

This section of the SMART4ALL Marketplace offers ready-to-use solutions based on open SW and HW technologies that drives decision making for SMEs/startups/mid-caps. The Marketplace will be populated with various tools and Technologies related to SMART4ALL thematic areas that have been evaluated by using initially the various open-source tools related to SMART4ALL technologies.

Currently the contribution contains a large number of items from this category and we will continue to grow as the teams refine and update the lists.

1. A list of alternatives from evaluation of proprietary open source cloud computing tools and platforms process of current contributions &
2. Comparative study of cloud computing platforms alternatives in an excel document can be found in the Smart4All Repository path below:

https://repository.smart4all-project.eu/f/10768

Current activities:

- Preparation of the tutorials about various Open-Source design tools further artifacts from different domains (e.g., hardware, software, systems)
- Preparation of artifacts from different domains and upload a set of mature design tools in Smart4All Marketplace
- Preparation of an application note for the selected design tools

After clear evaluation, a set of mature different types of open source tools will be uploaded in the SMART4ALL Marketplace. In addition to simple listing in the Marketplace, we are striving to prepare an application note for the selected tools and platforms that will have “a tutorial” approach to make things easier for SMEs/startups/mid-caps that would like to apply these tools and technologies.

Next steps:

Identify, analyze, collect, check artifacts and disseminate with UoP and other partners, the artifacts on the MaaS and upload them in Smart4All Marketplace.

4.6 Technology Training and Open Courses available in the Marketplace (T5.7)

In order to overcome security and access right issues with other Marketplace services, it has been decided to separate the course development server from the course delivery server. The development platform comprising 4 different Learning Management Platforms (LMS): Moodle, Canvas, edX and Big Blue Button has been deployed at the FTN server. There the project partners and external contributors will be able to test and deploy their courses. Once finalized the courses from arbitrary platforms will be exported to Moodle and then migrated to its final destination on the UoP server. The idea is to then have each course interfaced through a respective container at the MaaS. The process is illustrated in Figure 22.

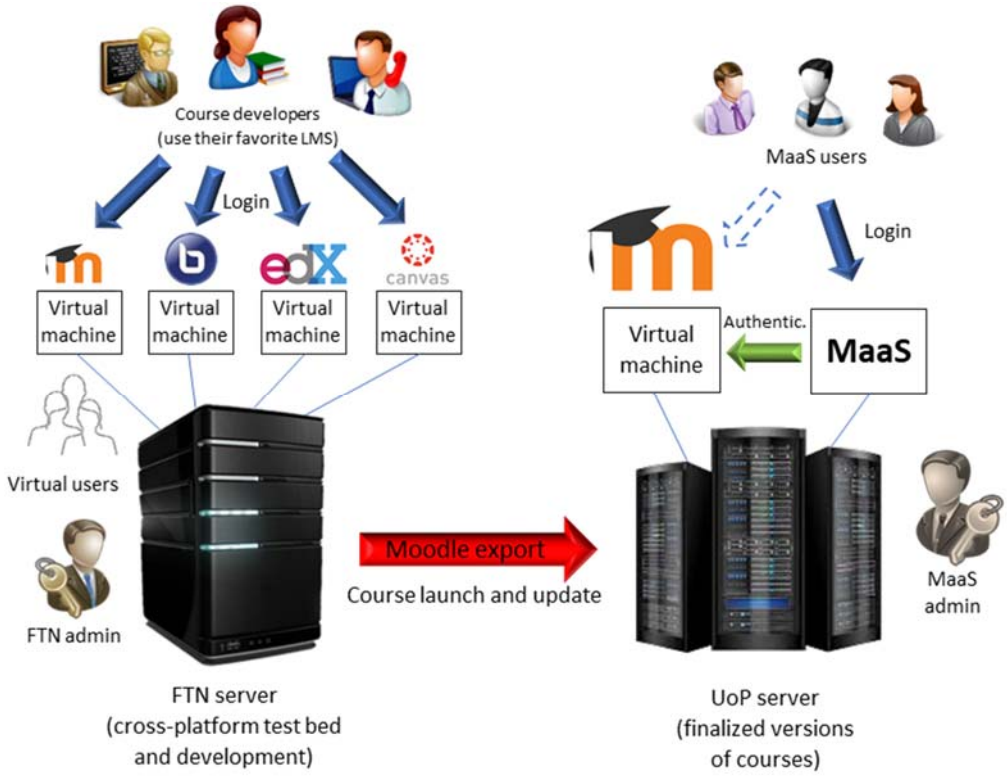

Figure 22. Development and deployment of the LMSes at the Marketplace

The development platform has been deployed at: http://www.smart4all.ftn.uns.ac.rs. The four LMS platforms feature no template. The final Moodle platform will feature the design and identity of the SMART4ALL project.

Access to various platforms after logging in is shown in Figure 23.

Figure 23. Screenshot of the development platform at the FTN server

The ongoing activities include the registration of contributors and liaising regarding the migration procedure between the FTN and the UoP platform.

5 CONCLUSION

5.1 Summary

This is the first version of the MaaS handbook which collects the current state of the provided services and an overview of the first methods and guidelines to use the service. The current status with the first artifacts show, that the environment of the MaaS is highly importnant for SME since the access to the several services needs to be cooridnated. This is done by a platform like the MaaS.

In the next steps, the number of artifacts will increase and the KTE, FTTE will contribute with their outcome as well to the portfolio of the MaaS.

5.2 Outlook

In the next steps, the number of artifacts will increase and the KTE, FTTE will contribute with their outcome as well to the portfolio of the MaaS. The use of the MaaS will be monitored and the offers will be optimized according to the needs of the SME.

5.3 Planned Extensions

A planned extension of the MaaS will be the usage of AI based algorithm for matchmaking but also for the interaction with the users. Under discussion is also a ChatBot service to guide the users to the MaaS.