



A semantically-enhanced marketplace of interoperable platform-as-a-service offerings for the deployment and migration of business applications of SMEs

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### Dissemination Level

X	PU	Public
	PP	Restricted to other programme participants (including the Commission Services)
	RE	Restricted to a group specified by the consortium (including the Commission Services)
	CO	Confidential, only for members of the consortium (including the Commission Services)

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## Executive Summary

This document is a summary of the project activities and results. For a detailed look into the project the deliverables should be consulted.

### 1. A description of the main S&T results/foregrounds

PaaSport Marketplace is a platform that resolves the data and application portability issues that exist in the Cloud PaaS market through a flexible and efficient deployment and migration approach, for the benefit of cloud application developers and PaaS providers. This single, interoperable marketplace removes the semantic interoperability barriers and enables the unified access to different PaaS offerings, facilitates cross-platform deployment and allows Cloud PaaS vendors to benefit.

PaaSport Marketplace allows developers to be independent from a single vendor and be able to switch between different platforms that they can discover through a single marketplace. By using the PaaS paradigm, developers can enhance their development and deployment process, while developers using PaaSport can be helped to save time and reduce the cost of deployment and migrating from one provider to the other. Developers also benefit by the requirement elicitation through the definition of application requirements that are used in order to find the recommended PaaS offerings.

For developers, the added value offered by PaaSport is provided by the following:

- Easy to use portability and monitoring libraries to develop and monitor portable PaaS services (e.g., web services, databases)
- A marketplace to search for suitable PaaS offerings across industry leading and EU-based cloud providers based on the application, resource and offering requirements.
- The marketplace hosts offerings for the following 8 cloud providers: **OpenShift, Heroku, CloudFoundry, IBM BlueMix, AWS Beanstalk, Apache Stratos, Stackato and CloudControl**

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- Ranked results of PaaS offerings that match user requirements which allow users to easily select the offerings that satisfy best their needs
- Real-time, scalable and elastic application monitoring and SLA violation notification service

PaaS providers, and especially the start-ups and SMEs, can also benefit from using PaaSport Marketplace as they are offered with a marketplace that they can join and add their product in order attract more customers to their platform. PaaS providers can use the extended model of PaaSport in order to define all characteristics of their PaaS offering; from infrastructural parameters to defining all the services that are supported by each PaaS. Overall, PaaSport Marketplace can help European Cloud PaaS vendors to increase their competitiveness by providing feedback for improving their offerings and promoting interoperability and standards in the PaaS segment.

Demonstration of the platform usage is also available on the videos of the platform that are available on the project YouTube channel<sup>1</sup>. The integrated PaaSport marketplace is publicly available at <http://demo.paasport-project.eu>.

The welcome, login and registration pages (depicted in Figure 1) provide to the interested user information about PaaSport marketplace and also about the project, and include the links for the login and registration forms.

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<sup>1</sup> <https://www.youtube.com/watch?v=XFtOovy7PQY&list=PLmFdeo622zqgV7pVEW10Cbv7w8ljasuGo>

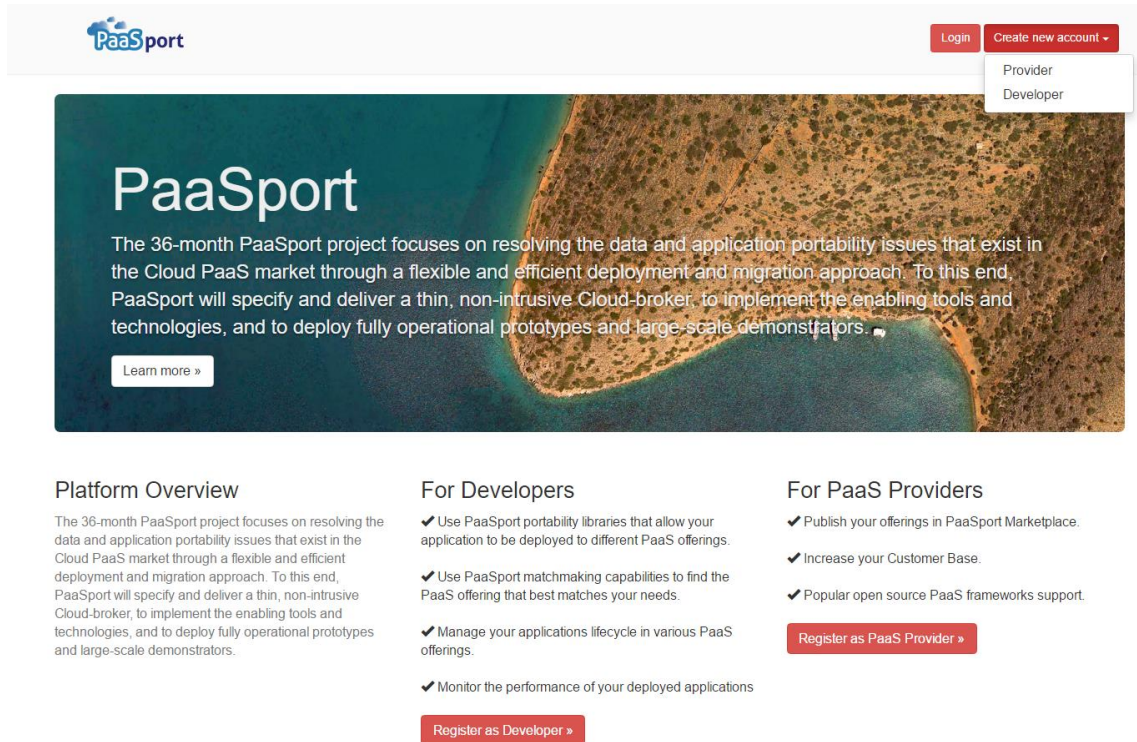


Figure 1: PaaSport Marketplace welcome page

In the next paragraphs, the main S&T results and foregrounds are presented.

### PaaSport Requirements Analysis

A review of the state-of-the-art and the market shareholder expectations related to Cloud Computing interoperability was conducted. This report was focused on the needs from members of the participating Software SMEs Associations, providing a prioritized list of requirements that will be addressed by PaaSport. An **online survey** was conducted in which 146 Cloud-related companies participated where their target groups are mainly SMEs and business customers. The participating companies come from Germany, Turkey, Sweden, Italy, Greece, Latvia, Belgium, Australia and Cyprus. Based on these findings, the PaaSport Reference Architecture has been designed. The findings of this analysis are presented in D1.1.

### PaaSport Reference Architecture

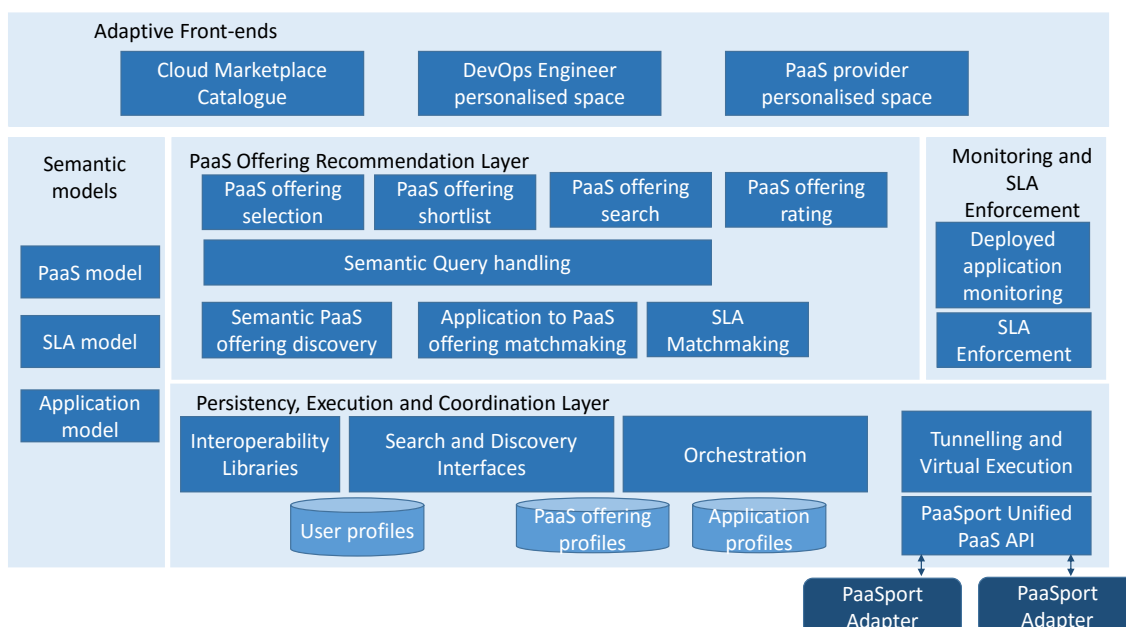
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The PaaSport Reference Architecture addresses the requirements that have been included in the prioritised list and constitutes the blueprint of the PaaSport Marketplace Infrastructure. PaaSport Marketplace constitutes a thin, non-intrusive broker that mediates between PaaS offerings and PaaS users. It relies on open standards and introduces a scalable, reusable, modular, extendable and transferable approach for facilitating the deployment and execution of resource intensive business services on top of semantically-enhanced Cloud PaaS offerings. PaaSport Reference architecture was consolidated in PaaSport D1.2 and it is illustrated in Figure .

Figure 2: High-level view of the PaaSport Marketplace Architecture

PaaSport Marketplace comprises of the following five layers:

- The **PaaSport Semantic Models** that serve as the conceptual and modelling pillars of the marketplace infrastructure, for the annotation of the registered PaaS offerings and the deployed applications profiles;
- The **PaaS Offering Recommendation Layer** that implements the core functionalities offered by the PaaSport Marketplace Infrastructure, such as PaaS offering discovery,



recommendation and rating;

- The **Monitoring and SLA Enforcement Layer** that realizes the monitoring of the deployed business applications and the corresponding Service Level agreement;

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- The **Persistency, Execution and Coordination Layer** that puts in place the technical infrastructure, e.g. repositories, on top of which the PaaSport marketplace is built. It also includes the PaaSport Unified PaaS API that is a common API exploited in order to uniformly interact with the heterogeneous PaaS offerings and, in addition, it realizes the lifecycle management of the deployed applications.
- The **Adaptive Front-ends** that support seamless interaction between the users and the PaaSport functionalities, through a set of configurable utilities that are adapted to the user's context;

### **PaaSport Semantic Models**

PaaSport Semantic models (described in D1.3) provide the necessary concepts and attributes for the definition of the semantic profiles of the available Cloud PaaS offerings, the applications to be deployed through the proposed Cloud marketplace and the SLAs to be established between the offerings' providers and the applications owners. In particular, the following semantic models have been developed:

- the **PaaSport Platform as a Service model** that facilitates the semantic description of the available Cloud PaaS offerings in terms of functionalities, resources and business characteristics offered;
- the **PaaSport Application model** that enables the semantic description of the application to be deployed on a PaaS offering through the PaaSport marketplace, in terms of functionalities, resource and business characteristics requirements; and
- the **PaaSport SLA Model** that enables the structured descriptions of the service-level agreements provided and supported by the registered PaaS offerings.

### **PaaS Offering Recommendation Layer**

In PaaSport, the PaaS Offering Recommendation Layer (described in D2.2 and D2.3) is responsible of filtering and recommending the best suitable PaaS Offerings. Based on the PaaSport Cloud-broker Architecture specification, PaaS Offering Recommendation Layer includes eight main sub-components. The sub-components are as follows:



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- PaaS Offering Search
- Semantic Query Handling,
- Semantic PaaS Offering Discovery
- Application to PaaS Offering Matchmaking
- PaaS Offering Shortlist
- PaaS Offering Selection
- SLA Matchmaking
- PaaS Offering Rating

In order for the user to obtain the desired results, the PaaS offering recommendation layer interacts with PaaSport semantic models discussed and with the Persistence, Execution and Coordination Layer via the search and discovery interfaces.

### **PaaSport Recommendation Algorithm and Model**

The Recommendation Layer of the PaaSport Reference Architecture involves the development of algorithms and software for supporting the selection of the most appropriate PaaS offering that best matches the requirements of the application a developer wants to deploy. Under this context, the PaaSport recommendation algorithms and models are aimed at providing the necessary semantic layer on top of the offering and application model descriptions, solving interoperability issues and improving the quality of the recommendations. To this end, standard vocabularies and ontology languages are used for capturing the structural and semantic characteristics of the various entities involved in the PaaSport domain, whereas the underlying conceptual models facilitate the use of lightweight reasoning during the matchmaking process.

A **semantic matchmaking algorithm** (described in D2.1) has been developed in the context of PaaSport to support the selection and scoring of persistently stores PaaS offerings with respect to cloud application models provided as input. The algorithm consists of two parts:

- the matchmaking part, where the functional parameters of the application profile are taken into account to rule out inconsistent offerings, and

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- the ranking part, where the non-functional parameters of the application profile are taken into account to score offerings and rank them according to this score.

A proof-of-concept SPARQL-based implementation of the algorithm and the Java API that can be used to integrate the framework in existing architectures were developed.

Considering the algorithm-specific requirements, we have met the following requirements:

- The matchmaking and recommendation algorithm is efficient and scalable, since its complexity is linear to the number of instances and the number of parameters.
- The matchmaking and recommendation algorithm is easily extensible. Actually, when the semantic model is extended with new offering instances, concepts and parameters, the algorithm does not change at all, because the algorithm is agnostic to domain specific concepts and parameters.

A novel **SLA policy model** (described in D3.1) has been introduced which is utilized for agreement between a PaaS offering and a service consumer who intends to deploy his/her application. The main contributions of this model can be summarized as follows:

- The PaaSport metrics meta-model presented is PaaS provider agnostic and compatible to PaaSport semantic models.
- The PaaSport SLA management model considers the available metrics from both the application level and the PaaS providers API.
- PaaSport broker leverage the presented SLA policy model, which extends the WS-Agreement schema, in order to monitor not only the SLA between the PaaS provider and the service consumer but also the service consumer custom requirements.

### **Monitoring and SLA Enforcement Layer**

This Layer (described in D3.2 and D3.3), which is responsible to monitor the deployed business applications and the corresponding Service Level agreement, includes the following core components:

- **PaaS Offering Management component:** It provides the functionalities to manage both the semantic profiles of PaaS offering models and PaaS offerings, and enables the filtering of PaaS offerings based on custom filters. It is a mechanism for easy and transparent access to PaaSport repositories. Furthermore, PaaSport approach allows

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the reuse of PaaS offering models by various PaaS providers for the creation of multiple, interoperable, PaaS offerings.

- **Application Lifecycle Management (ALM) component:** This mechanism enables the creation, deployment, undeployment, deletion and search of applications. We implicitly define the Application Lifecycle which resides in the core of the PaaSport system. The PaaSport ALM component guarantees that applications strictly follow the defined application lifecycle and they are always in a consistent state.
- **PaaSport Monitoring System:** It comprises an automated and portable monitoring stack capable of supporting interoperable collection of PaaS application metrics, so as to provide end-users' with portable Monitoring-as-a-Service.
- **SLA Violation Detection and Alerting Service:** On top of the PaaSport monitoring system we design and implement the PaaSport SLA Violation Detection and Alerting Component which is an easily extendable system responsible for real-time detection of SLA violations and alerting.

All the functionalities of the developed components are easily accessible through well-defined REST APIs, and are utilized by PaaSport components or external services.

### **Persistency, Execution and Coordination Layer**

**Persistence layer** (described in D4.2 and D4.3) responsibility is to conceptualize the repositories and the interfaces needed by mechanisms that are part of PaaSport marketplace on all PaaSport Layers. The components responsible for persistence are the specific repositories that store the semantic descriptions of the advertised PaaS offerings, the deployed application, and the users of the PaaSport Marketplace. Apart from the dedicated repositories, the persistence layer includes appropriate interfaces for creation and management of data entities. These interfaces are available to be used by other PaaSport layers that need access to the repositories and are called Search and Discovery Interfaces.

**Execution layer** (described in D4.2 and D4.3) is responsible for the cross-platform deployment and management of application. This layer includes components utilizing

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specific functionalities, namely the PaaSport Unified Cloud API, a set of corresponding PaaSport Adapters, the interoperability/portability libraries (hereinafter PaaSport SPI approach), and the Tunnelling and Virtual Execution Component.

A **PaaSport Unified PaaS API** (described in D4.1) has been implemented. Specifically, this API allows the deployment, management and migration of applications transparently to the user and independent of the specificities of a PaaS offering, by building upon and extending CAMP and the Cloud4SOA APIs. The PaaSport Dynamic Configuration Interface that boosts the portability of applications deployed to the cloud has also been defined. This model is used as the base for the PaaSport Unified Cloud API, a REST API that attempts to provide interoperability by encapsulating common functionalities offered by the PaaS offerings API. Also, the PaaSport Dynamic Configuration Interface (PaaSport SPI) is defined along with the approach that allows the portability of applications.

The PaaSport Unified Cloud API has been implemented based on the analysis of PaaS providers' APIs and the elaboration of third-party initiatives related to PaaS interaction. This API relies on some commonly identified entities related to PaaS offerings and on the support of CRUD methods (Create Retrieve Update Delete) for these entities. PaaSport Adapters rely on the interface of PaaSport Unified Cloud API in order to support the unified interaction between PaaSport and PaaS platforms. Tunnelling and virtual execution component uses PaaSport Unified Cloud API methods in order to encapsulate proper deployment and management through PaaSport, as deployment and management methods differ among PaaS offerings. A Message-oriented middleware (MOM) has also been used in order to allow the asynchronous operation of calls to PaaS offerings that are time consuming. In addition to this interaction, Interoperability/Portability Libraries have been developed as part of the execution layer. These libraries should be used when developing the application that will be deployed to PaaS offerings supported by PaaSport.

**Coordination layer** (described in D5.1) includes services that are provided to other components of the overall architecture, including the REST interface utilized by the User Interface (UI) and provides an additional and clear conceptual delineation between persistence and execution functions. The coordination components provide mechanisms for

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orchestrating applications' lifecycle management and PaaS offerings management. Through lifecycle management, we refer to the ability of managing the state of a PaaS offering or an application throughout their lifespan, while PaaS offering management refers to the management semantic profiles of the PaaS offerings. The functionalities offered are implemented in the orchestration component that consists of three subcomponents, the Application Lifecycle Management (ALM), the PaaS Offering Management and the UI Landing Point.

### **Adaptive Front-ends**

The PaaS Offering provider as well as the software engineers accesses the PaaSport broker and marketplace using the User Interface (UI). The UI can be considered as the promotion of the marketplace. The UI constitutes the topmost layer of the reference architecture and supports the access of the users to the marketplace functionalities. According to the particular preferences of different kind of users, e.g. DevOps engineers or PaaS providers, the UI provides configurable components adapted to the user's profile and context.

Non-technical, the UI (described in D5.2) has been designed to be user-friendly, pleasant and functional. The usability is increased for the end-user by providing an UI usable on different devices as on conventional computers, laptops or tablets. From a technical point of view, there exist the following requirements. Having the performance in mind, the resulting user interface needs to be designed in order to need as less server load as possible. To ensure compatibility the data supply of the UI should agree with the one provided by the server.

The UI consists of three parts. The first one, the common front-end components, describes the common front-end viewable of service developers as well as of PaaS providers. It provides a catalogue component as well as the user management widget.

- Cloud Market Place Catalogue component: Search and Discovery interfaces provided by the Persistency, Execution and Coordination Layer

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- User Management Widget: User profiles databases provided by the Persistency, Execution and Coordination Layer

The next two parts are dedicated to the different user groups in the marketplace. A Software SMEs needs access to other services as the PaaS providers. The adaptive front-end is offering a personalized space for each of them.

- Application Semantic Profile Management Widget for DevOps Engineer: Search and Discovery interfaces provided by the Persistency, Execution, and Coordination layer, application models
- Application Monitoring Widget: Deployed application monitoring component and SLA Monitoring component provided by the Monitoring and SLA enforcement layer
- Search PaaS Offerings Widget: Interaction with the PaaS offering shortlisting, PaaS offering search and PaaS offering selection provided by the PaaS Offering recommendation layer
- PaaS Rating Widget: Offers a user interface for the rating of PaaS providers
- Application Migration Widget: tunnelling, virtual execution and application lifecycle management component provided by the Persistency, Execution, and Coordination Layer
- SLA Matchmaking Widget: displays the SLA terms and matchmaking terms with the help of the SLA enforcement component provided by Monitoring Layer as well as the SLA matchmaking component provided by the PaaS offering recommendation layer and the application profiles repository supplied by the Persistency, Execution and Coordination layer
- Application Lifecycle Management Widget: A front-end for the application life-cycle management component provided by the Persistency, Execution, and Coordination layer
- Account Information Widget: Provides consolidated charges to the DevOps Engineer, account information can be added and edited by interacting with the PaaSport Unified PaaS API from the Persistency, Execution, and Coordination layer.

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- PaaS Offerings Management Widget: Deliver a list of PaaS offerings as well as forms to manage PaaS offerings including the PaaS provider information stemming from PaaS offerings and profiles repository out of the Persistency, Execution, and Coordination layer and from the offering search out of the PaaS offering recommendation layer.
- PaaS Offering Semantic Profile Widget: Creates list of PaaS offerings descriptions and form to create and edit PaaS offerings descriptions with the help of PaaS offerings profiles repository included in the Persistency, Execution and Coordination layer as well as with the help of the PaaS model stemming from the semantic models layer.

The PaaSport marketplace UI is a client application in a web browser.

### **Integration & Testing**

The integration (described in D5.3) is based on the Spring framework according to the power of this framework itself and the high number of extensions available. Furthermore, the open project structure gives the recommended possibility to extend the Spring framework in order to fit perfect into the PaaSport framework. The project is organized with the help of Apache Software project Maven in combination with Jenkins to handle the build system and SonarQube for quality assurance. Software and documents are shared in a common way using the open source tool Git as well as Nexus. Continuous integration during the developing process is ensured with the help of the Jenkins framework.

The testing plan includes unit tests as well as integration tests. The unit testing belongs to every artefact developer and is performed before the integration of the artefact in the marketplace. For integration tests several main functionalities of the marketplace were identified with the help of the deliverable D1.2. The PaaSport marketplace includes bug tracking by distinguishing between user support by Bugzilla and internal issue tracked with the help of Git bug tracker.

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A release plan for the PaaSport marketplace has also been prepared. It is orientated on the Git branching model and contains a first release and a final one. The particular artefacts are handled as separate features of full marketplace.

The PaaSport development is a continuous process which contains all required discrete steps that re-assure quality during the entire lifetime of the project. It could be argued that this process is realized in a virtual circle that contains the following functional components: a) Source-Code-Versioning/Management, b) Continuous Integration, c) Quality Assurance, d) Persistent Storage of built (a.k.a. artefacts) and e) Issue/Bug Tracking.

Each part of the circle is supported by mature tools that are setup and interoperate smoothly. More specifically these tools are: a) Git for Source Versioning, b) Jenkins for Continuous Integration, c) Sonar for quality assurance, d) nexus for artefact-management and e) OpenProject for Issue Tracking.

### **PaaSport Demonstrators**

The first deployment of PaaSport Marketplace has been deployed by SingularLogic and is hosted in Ubitech premises. This deployment was used since the first release of PaaSport Marketplace was available and has been used as a demo server that allowed the project consortium to test and user the platform for evaluation, training, or even dissemination activities. This deployment also allowed Ubitech to utilize some internal PaaS offerings and execute the specified demonstration scenarios. The second deployment is the one managed CAS and is used for performing CAS demonstration scenarios and also it is used as a marketplace for BiTMI members. The third deployment is a testbed used by TBV and it has been used for testing the marketplace in terms of adaptation and extensibility, allowing the investigation of exploitation capabilities in the Turkish market. The PaaSport Demonstrators are described in D6.2.

### **PaaSport Platform Technological Readiness Level**

With the completion of the PaaSport project, the developed PaaSport Platform features a Technical Readiness Level of 7 (TRL 7) based on the technology maturity assessment table



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provided by the EU H2020 Work Programme<sup>2</sup>. This means that the developed PaaSport Platform has been demonstrated in both relevant and operational environments with the system prototype available online and accessible from the PaaSport website (<http://demo.paasport-project.eu/>). In addition to this, the PaaSport Platform adheres to the **DIN-SPEC standardization efforts** for unified and portable cloud application management (DIN SPEC 91337). Specifically, the DIN (Deutsches Institut für Normung) is the German Institute for Standardization. DIN and PaaSport consortium have been working together for the past few months to develop, deliver, and make available to the market a specification for Application Management Interface for Cloud Platforms. This is the first IT innovation to be standardized and published by DIN at the international level. The standard and publishable materials will be provided in 2017 in English targeting international users. The package comes in two parts: 1. Normative and 2. Informative. The Normative part is a written document of 24-30 pages (subject to the final format by DIN) and the Informative part is the downloadable zip file including standardized APIs. The "DIN SPEC 91337 - Unified Application Management Interface for Cloud Application Platforms" is expected to be released in 2017.

## Conclusion

The PaaSport Platform is currently in its second release (v0.2-beta) with SME association members and other invitees able to request access, test the platform free-of-charge<sup>3</sup> and provide critical feedback to the consortium. Feedback from early adopters allows the consortium to assess and confirm the platform's overall quality and performance. Feedback is collected via direct interactions (e.g., after demonstrations), the PaaSport support email channel ([support@paasport-project.eu](mailto:support@paasport-project.eu)) and the PaaSport issue tracking service (<https://github.com/ubitech/paasport/issues>) for bug reporting and feature requests.

## 2. Training material and activities

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<sup>2</sup> [http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016\\_2017/annexes/h2020-wp1617-annex-g-trl\\_en.pdf](http://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2016_2017/annexes/h2020-wp1617-annex-g-trl_en.pdf)

<sup>3</sup> This refers to PaaSport charges and NOT cloud infrastructural usage charges which depend solely on cloud service provider pricing policies

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PaaSport has prepared training material to introduce the stakeholders into PaaS and PaaS brokerage and educate the target groups of the project in the utilization. With this training material produced the SME associations have carried out training activities as workshops, seminars and other type of events.

### **Training material**

Training is among the most important tasks associated with the preparation of the PaaSport exploitation. Primarily, this is due to the fact that the PaaSport platform cannot be usable unless associations are trained on how to use them. Furthermore, the more the management of the associations knows and understands about the platform, the better they can plan for their sustainability and wider use. Overall, PaaSport acknowledged training as a complementary asset that can substantially contribute to the evaluation of the offer and the success of the PaaSport platform deployment beyond the end of the project. Therefore, the PaaSport consortium has created an overall disciplined methodology for training the various SME associations and their members, which the RTD performers and the associations will accordingly adapt to the particular needs of each association. The training methodology of PaaSport includes the broader identification of the target audiences, as well as of the overall training topics and schedule, the overall training session management, and the development of baseline training material.

The consortium agreed to use an online training platform ([training.paasport-project.eu](http://training.paasport-project.eu)) for the upload and distribution of shared training material. This training platform will become the first attempt for participating SME associations to organize training on PaaS interoperability as a whole and on the PaaSport platform itself.

The target audience of the training comprises employees working within an organization having a specific role in the PaaSport scenario. The organization roles that we will consider are the following:

- PaaS users: SME who wants to deploy his/her application on a PaaS offering or wishes to switch PaaS providers.

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- PaaS providers i.e. are businesses that have set up a Cloud PaaS system which makes available more than one PaaS offerings. PaaS providers sell the usage of their PaaS offerings following different business and pricing models.
- PaaSport Broker: An organisation assigned to the operation, maintenance, and management of the PaaSport cloud broker and marketplace system as well as the training of the PaaS users and PaaS providers. It could be the association itself or an external organisation responsible for individual task on behalf of an association.
- PaaSport Contributor: An enterprise (e.g. an Independent Software Vendor) that develops and sells enabling technologies for interoperability between PaaS offerings, e.g. in the form of PaaSport adapters

This deliverable describes an updated version of the PaaSport training framework. It presents the material to be used and adapted for the training sessions and also material that could be developed beyond the end of the project.

This training approach will be a key issue to promote the use of the PaaSport platform and to encourage the exploitation and sustainability of this approach. It will also help to achieve an overall learning about Cloud Computing and PaaS interoperability issues for associations as well as for their members. The participating associations will be able to develop qualified training services.

### **Training activities**

During the course of the project several training activities were carried out by the ICT associations. The ICT associations have extensive experience in promotion and extra-occupational IT education. In conjunction with PaaSport workshops, training sessions were organized and have taken place, targeting at the participating SMEs Associations and their SME members

In particular activities were aimed at the engineers of the members of the participating European software SMEs Associations, focusing on the introduction and the adoption of the project results in their everyday activities. Also the workshops were addressing the need of

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decision makers and ICT managers of the diverse organizations. The engineers of the European Software SMEs and SME Cloud vendors were trained in the utilization of the PaaSport Marketplace in all aspects. The decision makers were instructed in the utility of PaaSport to optimize their processes and organizations. The education events have taken place in Latvia, Turkey, Sweden and Germany.

#### **LIKTA**

The PaasPort training session took place in Riga on August 25<sup>th</sup>, 2016. Participants from ICT companies – LIKTA member organisations – were introduced to PaasPort solution and possible benefits. Informal discussion has been held after the training session to obtain additional feedback from the participants and clarify most interesting topics for the second (planned) workshop.

#### **TVB**

The workshop of TBV took place 10.10.2016 at the Istanbul Technical University – ARI Teknokent. The workshop has done great impact on the participants that created more enthusiasm and interest. Through the questions we received from the audience that took more than an hour to reply all questions which have enabled us to have a dialogue based presentation rather than a monologue and most importantly, audience has received prompt explanation about their ideas and questions. The Training Workshop has helped us to manage, evaluate and achieve many things at the same time such as: Disseminating the platform and the project to the specific and targeted group, receive feedback, analyse and consider their expectations, disseminating our foundation, gather targeted group of people together to create a network and find potential partners/users for the finalized product.

#### **GCM**

The workshop by GCM took place at Hotell Jörgen Kock, Malmö, Sweden on May 17th 2016-05-17 supported by UCY.

#### **BITMi**

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The workshop by Bundesverband IT-Mittelstand e.V. was supported by CAS Software AG and took place at GRÜN Software Hub, Pascalstr. 6, 52076 Aachen on 28.10.2017. The workshop started with an introduction into Cloud Computing. The layer model of Cloud Computing was explained. The differences between IaaS, PaaS and SaaS were on a deeper level explained. Current developments and future technologies but also challenges like standardization, interoperability, portability and vendor-lockin were highlighted. The argumentation was supported with market data. The participants were in particular interested to get to know more on stack management in the Cloud on a technical level. Then the focus was set on Platform as a Service and the advantages compared with conventional on-premise software development illustrated. This led to the discussion with the participants about the topic, what do "ME's and independent software vendors expect of Cloud Computing and software coding in the Cloud. In course of the discussion several needs crystallized. The ISV or SaaS companies want to focus on their business and need technologies, which make it easier to optimize their profit allocation. The companies want to maintain their freedom to choose between different suppliers. The enterprises are also critical on data protection and security driven by the requirements of the end customers. In Germany many ISV are delivering products and services to industrial companies, which are obliged to protect their data and trade secrets. Data protection and security are in this sense order qualifiers. This discussion was connected to the PaaSport project in the next phase of the workshop. The PaaSport concept, vision and objectives were introduced and the five main results (adaptive front-ends, semantic models ...) were presented to the audience. A more detailed explanation of the PaaSport architecture followed this introduction. The particular achievement of the current support for already 8 PaaS providers was presented. Within the participants questions were formulated with regards to the benefits of the PaaSport market place for potential users. The discussion revolved around interactive PaaS catalogue, the rating service and the matchmaking. Also the participants considered the business model of the PaaSport marketplace. They considered the incentives for SaaS / ISV – companies to participate in the PaaSport marketplace relative stronger than those of the PaaS providers, but of course the decision of the SaaS to get into PaaSport depend on the variety of PaaS providers hosted in PaaSport. The next phase of the workshop was more technical orientated and more directed to developers. The ontology, parameters, core technology and functional requirements of PaaSport was drafted. The

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audience was interested in the options to adapt and optimize PaaSport to their needs. There are several options. For example before deployment the PaaSport user has to provide credentials for each PaaS offering that wishes to deploy an application. Or a PaaSport user can create an application request that describes the required services of the application. Based on the user input PaaS offerings are filtered and user can select a PaaS offering for deployment. The session ended with practical exercises on the PaaSport website. The participants applied the learned knowledge in using the deployment, migration, rating and matchmaking services. After a final discussion and summary the workshop was closed. The participants expressed a positive attitude towards. They could imagine using PaaSport in case a critical mass of PaaS providers were deployed on the platform.

### **3. Market Analysis, IPR Model and Exploitation Plan**

The exploitation activities were carried out by the consortium members within the PaaSport project, between December 2013 and November 2016. It includes all the activities for the exploitation of the project results to the benefit of the SME economy.

All the partners were responsible to get involved in the exploitation activities. The following list of elements was analyzed:

- Results of the PaaSport project
- Market conditions for Cloud Computing, PaaS and PaaS brokerage
- Costs
- TRL
- Standardization
- Customer value propositions, exploitation perspectives and commercialization options
- Intellectual property rights
- Commercialization opportunities

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The exploitation strategy integrates the view of the consortium members regarding exploitation of project results and outcomes. The associations as the owner of the IPR have agreed on a consensual approach for exploitation on ground of the consortium agreement but also on ground on a shared opinion to support the European SME economy. The associations anticipate in the first step a national / regional commercialization strategy. On this solid ground European wide or global commercialization approaches have later on better chances to be successful. The associations are intending to cooperate later on and realize the best solution for the SME economy.

The associations based their exploitation and commercialization strategy on the customer value propositions generated by PaaSport. The customer value propositions identified by the associations are making use of the results of the PaaSport projects. They see the PaaSport capability for migration as a chance for their memberships to avoid customer lock in. This gives the companies the ability to select PaaS providers according to their criteria not limited by a coerced situation based on the legacy of former decisions. While this is a core value proposition given by PaaSport to memberships of the associations the PaaSport approach goes beyond this and offers with the marketplace, rating service, matchmaking further value propositions enhancing the power of PaaSport for the SME memberships. While the core benefits are shared by all participants the associations recognize particular value propositions based on their structure, membership, location and direction. For example Game Co-op Malmö's members are game developments SMEs producing computer games (including video games, VR games, mobile games. For the game developers, as specified above, enabling peer networks for exchange of experience on PaaS migration is of special value. Bundesverband IT-Mittelstand with members being part of industrial value chains are attracted by the management and administration capabilities of PaaSport. LIKTA is considering opportunities in introducing additional related services like training and unified service desk. TVB see the matchmaking service as particular valuable. The consortium has investigated business model creation to facilitate and accelerate the building of the PaaSport market place. The consortium will start the business development with local, regional, national level and later extend to European and global level. The association partners are agreeing to support each other to generate maximum benefit for

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the SME. Every association has drafted its own commercialization approach based on a cost analysis made by the consortium.

The long term perspectives of PaaSport seems promising. PaaSport is a sustainable solution. With the completion of the PaaSport project, the developed PaaSport Platform features a Technical Readiness Level of 7 (TRL 7) based on the technology maturity assessment table provided by the EU H2020 Work Programme. One of the crucial aspects regarding the platform's sustainability is openness. Openness is a functional characteristic according to which any potential adopted can contribute to the extension of the code-base. PaaSPort was built with the openness in mind from the very beginning as far as technical readiness is concerned. However, extensibility is more robust when it relies on tangible standards. To this end, the consortium undertook the responsibility to propose a normative standard in the DIN standardization body.