

**FORTISSIMO**

D2.5

Marketplace Best Practice Final Report

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Executive Summary

This document is Deliverable D2.5 “Marketplace Best Practice Final Report” from Work Package 2 (WP2) of the EU-funded Fortissimo project. The title of WP2 is “Core Service Requirements Capture and Infrastructure Development”. This document is an output from the WP2 task titled “Task 2.4 Architecture of Fortissimo Marketplace and HPC Cloud for sustainability”. The objective of this task is to capture and document the functionality and technologies required to operate a sustainable Marketplace. The document identifies these as being a Content Management System, a scalable delivery platform, a flexible architecture, identity management, security, flexible service integration, e-Commerce, accounting, billing and a helpdesk. Further this document offers recommendations for developing a Marketplace that cover choice of Content Management System, use of Cloud services for infrastructure, building trust, choice of e-Commerce solution and functionality to use, process automation, helpdesk operation and service integration.

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1 Introduction

This document is Deliverable D2.5 “Marketplace Best Practice Final Report” from Work Package 2 (WP2) of the EU-funded Fortissimo project [1]. The title of WP2 is “Core Service Requirements Capture and Infrastructure Development”. This document is an output from the WP 2 task “Task 2.4 Architecture of Fortissimo Marketplace and HPC Cloud for sustainability”. As stated in the Fortissimo project’s Description of Work,

“The objective of this task performed in a close collaboration with WP8, Sustainability, is to capture and document the functionality and technologies required to operate a sustainable Marketplace and HPC Cloud which meets the demanding needs of its users that are designed, developed, integrated and tested in Tasks 2.1, 2.2 and 2.3.”

The Description of Work (DoW), also states that this document (i.e. D2.5) is a public report that analyses the best practices for a sustainable HPC Cloud.

The principal objective of Fortissimo was to enable European manufacturing, particularly small to medium enterprises (SMEs), to benefit from the efficiency and competitive advantage inherent in the use of simulation. This was to be achieved through the provision of simulation services running on a cloud infrastructure making use of High Performance Computing systems. Fortissimo was to make advanced simulation accessible to industrial users, particularly SMEs, through the realisation of a “one-stop shop” where hardware, expertise, applications, visualisation and tools were to be easily available and affordable on a pay-per-use basis. Fortissimo was to be driven by end-user requirements where business-relevant application experiments were to be used to develop, test and demonstrate both the infrastructure and the “one-stop pay-per-use shop”.

Section 2 of this document summarises the sources of the requirements identified as necessary for a sustainable Marketplace. Section 3 identifies the key functionality and technologies that form the foundations for meeting these requirements. It describes each in turn and highlights, where appropriate, aspects of each that contribute to Marketplace sustainability. Section 4 provides some concluding remarks.

1.1 Acronyms and Abbreviations

Table 1: Common acronyms and abbreviations used in this document.

BPMN	Business Process and Modelling Notation
CAS	Central Authentication Service
CMS	Content Management System
DoW	Description of Work
Dx.y	Deliverable x.y
EU	European Union
HPC	High Performance Computing
ISV	Independent Software Vendor
MSx	Milestone X
PM	Project Month
SAGA	Simple API for Grid Applications
SME	Small to Medium-sized Enterprise
SSO	Single Sign-On
Tx.y	Task x.y
WP	Work Package

2 Marketplace Requirements

As stated previously, the purpose of WP 2 Task T2.4 was to

“to capture and document the functionality and technologies required to operate a sustainable Marketplace and HPC Cloud which meets the demanding needs of its users that are designed, developed, integrated and tested in Tasks 2.1, 2.2 and 2.3.”

To determine the necessary functionality and technologies for a sustainable Marketplace, the prime sources of requirements for WP 2 were:

- The WP 4, 5, 6 experiments where the partners involved covered the range of potential actors in the Fortissimo Marketplace.
- Fortissimo WP 8 “Exploitation and Sustainability”

The mechanism for WP 2 to collect requirements from Fortissimo experiment partners has been previously been documented in Fortissimo deliverable D2.4[3]. D2.4 also lists the high priority requirements for the Marketplace. The key business processes necessary to operate a sustainable Marketplace has been the primary mechanism by which WP 8 (in collaboration with other WPs) has defined its requirements for WP2. This resulted in the identification and specification of the following key sub-processes.

- User Application
- Member Application
- Add Member Services
- Matchmaking Services
- Service Purchase
- Service Delivery pay-per-use
- Service Delivery pre-pay

Moreover, the business model work of WP 8 identified that a key sustainability factor was to limit the costs involved in providing the necessary functionality to fulfil these requirements. For example, in the User Application process (see Figure 1) a person, the applicant, has decided to apply to become a Marketplace user. This application process involves the applicant completing an application form, reviewing and accepting the Terms and Conditions and then submitting their application. The Marketplace validates the application form and if the applicant is accepted then a User account is created. The applicant is then informed that their application has been accepted that the user is sent their account credentials. If an application is unsuccessful, the applicant is informed of this.

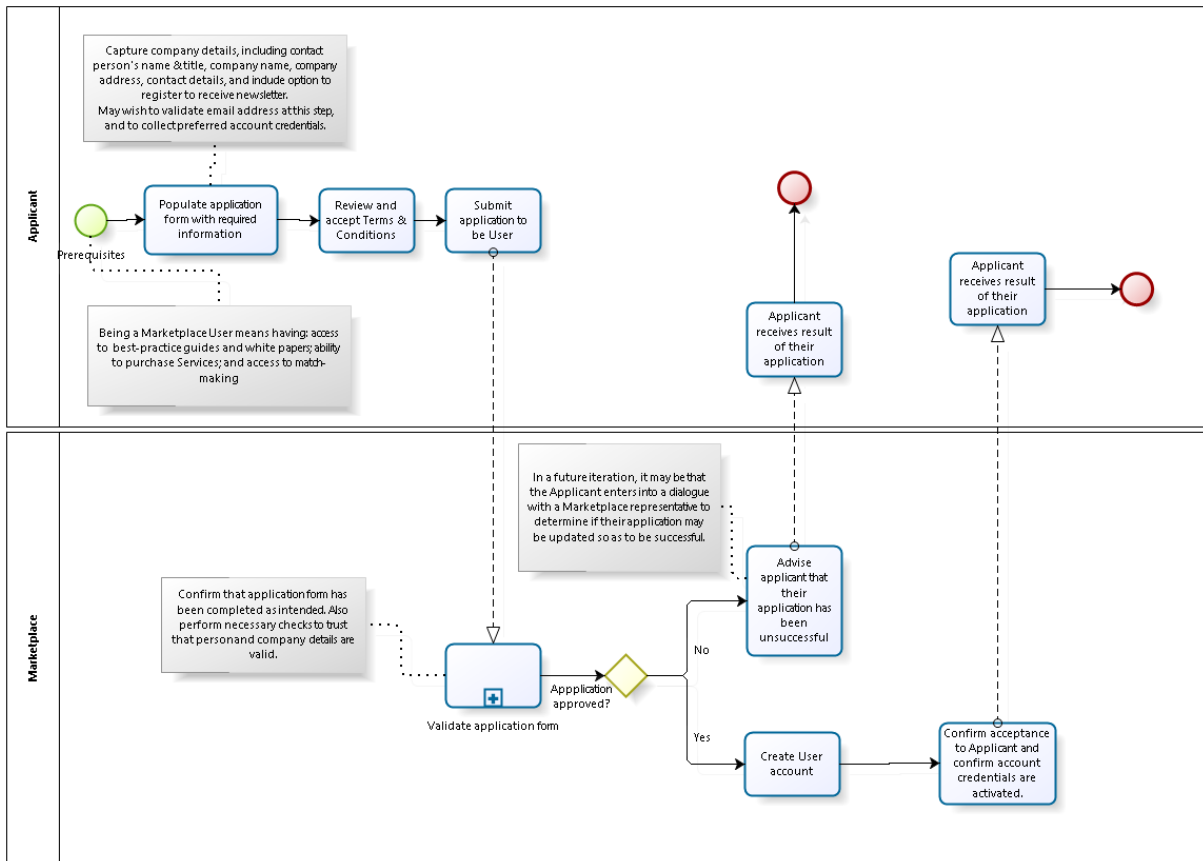


Figure 1: The User Application process notated in BPMN [8].

It was recognised that the operational costs of this process could be expensive if effort was required from Fortissimo staff to undertake aspects such as validation of application forms. To reduce these operational costs and hence make the Marketplace more sustainable it was agreed to automate this process as much as possible using modules available within the Drupal content Management system from which the final Marketplace was built. Hence the application validation solely comprises the user being sent a one-time activation link to confirm their email address. After confirming their email address a user account is automatically created and the user is sent their Marketplace account credentials. This all occurs with no intervention required from Fortissimo staff. Only when a User decides to buy then are more staff-intensive checks activated.

Given the above requirements sources and context, the remainder of this document describes the foundations, including technologies, that were identified and used by the project to create the final sustainable Marketplace, which satisfies the requirements.

3 Marketplace Foundations

This section describes some of the foundations, including key technologies, chosen to underpin the sustainable Marketplace so that it can meet its higher-level requirements. This section also shares general recommendations that have resulted from the development of the Marketplace.

3.1 Content Management System

As stated in the project’s Description of Work, Fortissimo is concerned with,

“making advanced simulation accessible to industrial users, particularly SMEs, through the creation of a ‘one-stop shop’, the Fortissimo Marketplace, where hardware, expertise, applications and visualisation and other tools are easily available and affordable on a pay-per-use basis;”

The Fortissimo Marketplace is a Web-based entity and clearly the choice of technology for hosting and delivering its content is of prime importance. A Content Management System (CMS) *“is a computer application that supports the creation and modification of digital content using a simple interface to abstract away low-level details unless required, usually supporting multiple users working in a collaborative environment”*[2]. As such a CMS is an obvious candidate technology for the Marketplace.

Initially the Fortissimo project chose a dual approach whereby the project Website and the Marketplace were two separate entities that were built using different CMS technologies. As the project progressed it became clear that this approach was not the most appropriate from a maintainability perspective and thus could not fit in with the sustainability goal.

The project Website was built using a proprietary CMS which meant the pool of expertise able to update and maintain the Web site was restricted to the CMS software provider themselves and a small number of staff who had been trained in it. Moreover, this proprietary CMS did not have the functionality to support the additional functionality required by the Marketplace.

The Marketplace was initially built using the Liferay platform [4]. This is an open-source technology that includes a CMS and various other functionality that could meet the requirements of the Marketplace. It was initially chosen by WP 2 due to its perceived flexibility and customisation capabilities. Following the release of the Marketplace v1.0 to Fortissimo WP 3 “Core Service Deployment and Facility Operation”, it became apparent however that Liferay was difficult for Fortissimo WP 3 to maintain and operate. Issues identified during development and testing of the Liferay-based Marketplace included difficulties in moving code, content and configurations between the Integration, Pre-Production and Production stages in the Marketplace development environment, the lack of documentation, the cost of training and support, the small, active developer community compared to other approaches meaning a lack of pre-existing plug-ins to meet desired requirements and thus requiring custom development by the Fortissimo team.

Moreover, the addition of some desired functionality (e.g. Single Sign-On) would be expensive if using Liferay. It also became apparent the open-source community around Liferay was small compared to other CMS and so access to expertise outside the project was limited.

The decision to use a single technology for both the project Website and the Marketplace was an easy one. The choice of CMS to use was more involved. After a survey of possible technologies, Drupal [5] was chosen because of its open source nature, ease of customisation, modularity, its large and active community and hence ease of access to 3rd party expertise outside the project.

Recommendation 1: To decrease your initial deployment costs, use a CMS with programming capabilities that has a large community of users and companies offering services to program and adapt it.

3.2 Delivery Platform

Originally when the project Website and Marketplace were two separate entities, the project Website was hosted at the University of Edinburgh under the URL www.fortissimo-project.eu, whilst the Marketplace was hosted at HLRS in the University of Stuttgart under the URL www.fortissimo-marketplace.com. At HLRS, this included a Liferay workflow environment comprising integration, pre-production and production stages to enable components and content to be developed in isolation from the publicly accessible Marketplace. This also required hosting, maintenance and support for source code version control, none of which were included with Liferay. This whole environment had to be built, maintained and operated.

When the decision was taken to have the project Website and Marketplace combined and using the same CMS platform, it was also agreed to use a specialist Drupal hosting provider, namely Acquia. Acquia “offers a secure platform-as-a-service cloud environment for the Drupal web content management system, advanced multi-site management, powerful developer tools, and software-as-a-service capabilities for personalization, content syndication, and more.”[6] This includes a workflow environment comprising Development, Staging (i.e. Pre-production) and Live (i.e. Production) that comes as standard along with source code version control hence removing the need for one of the WP 2 partners to build, maintain and host the equivalent. Moreover, Acquia also offers the ability to scale the underlying computational resources available to meet demand.

From a sustainability perspective using Acquia in this way will reduce the costs of operating the Marketplace in the future.

Recommendation 2: To decrease your initial deployment costs, use Cloud services and avoid having to create your own infrastructure.

3.3 Architecture

Given that the Fortissimo Marketplace, as stated in the Fortissimo project’s Description of Work, is a “‘one-stop shop’ ... where hardware, expertise, applications and visualisation and other tools are easily available and affordable on a pay-per-use basis”, it therefore requires an architecture that is flexible enough to support the addition of new content and requires minimal maintenance.

For the Liferay-based v1.0 of the Marketplace delivered by WP 2 at the end Year 2 of the project, the flexibility was achieved by using a building block approach whereby Liferay provided the core platform for display of the services (see Figure 2).

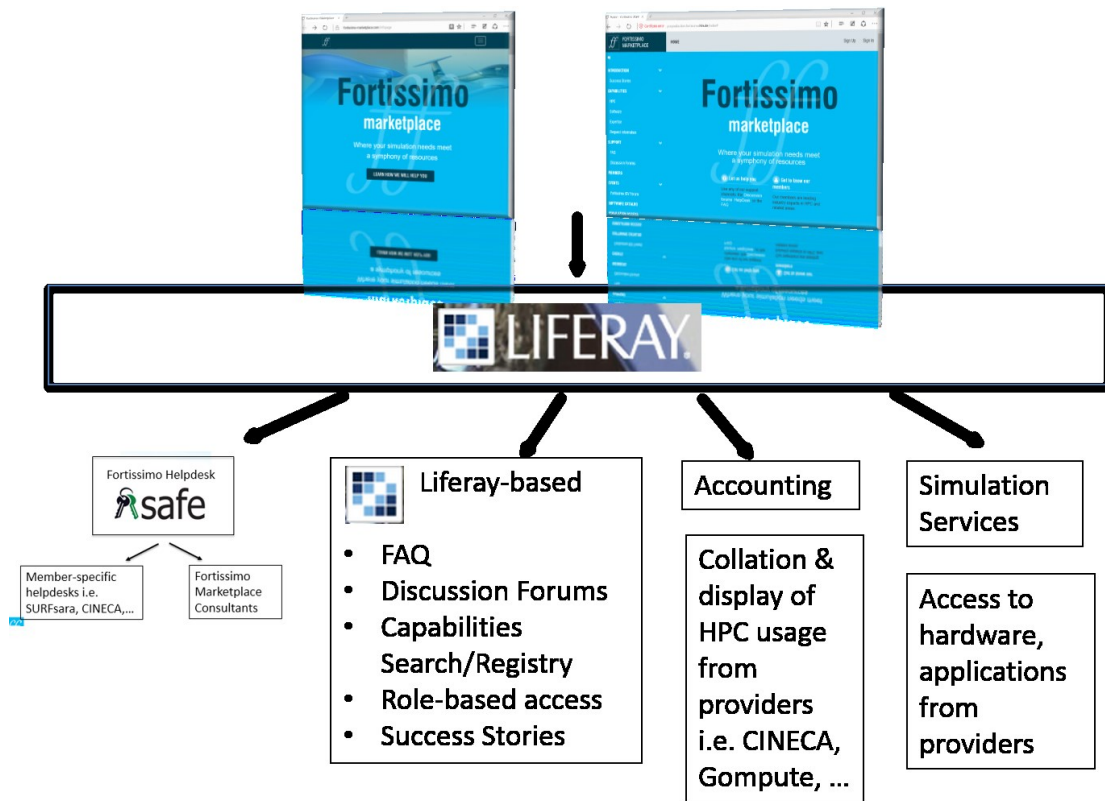


Figure 2: The architecture of V1.0 of the Fortissimo Marketplace. This is based around the use of Liferay.

With the replacement of Liferay by Drupal, this building block approach has been maintained whereby certain functionality can be delivered direct from Drupal whilst others (e.g. the SAFE helpdesk software, simulation software, etc.) are located at other sites and accessed via the Drupal installation (see Figure 3).

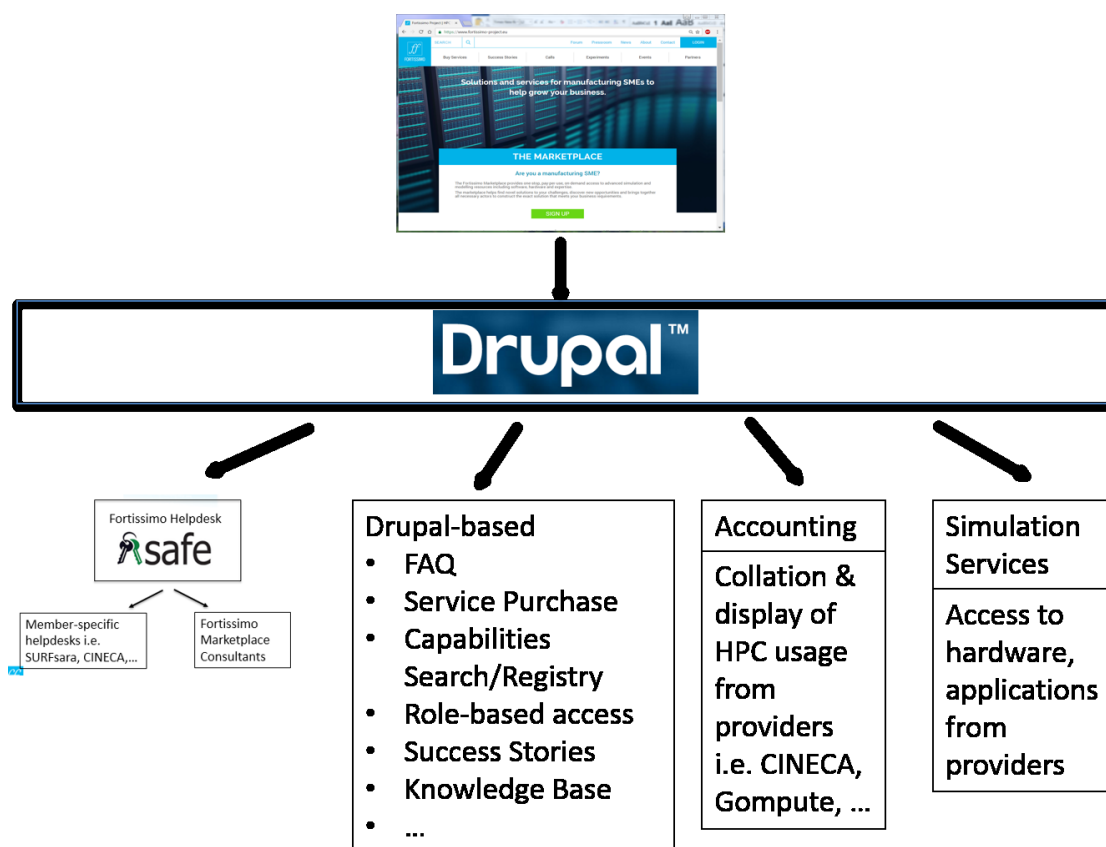


Figure 3: The architecture of V2.0 of the Marketplace. This is based around the use of Drupal.

This architecture allows flexibility in the nature of services that can be offered in the Marketplace. For example, WP8 wanted the Marketplace to offer different levels of membership: Gold and Platinum and hence enable the Marketplace to have different income streams. With Gold level membership, a service provider can have their service included in the services listing on the Marketplace but only as a click-through service, that is, the entry in the service listing includes a Web link for the user to access. If a user wants to use the service then it is the service provider that must deal with the service purchase, service delivery, resource usage accounting etc. With Platinum membership, a service provider can choose to exploit further Marketplace functionality in increasing combinations. For example, the provider could initially utilise the Single Sign-On capability so that a service user has the same credentials for accessing the service as they do for accessing the Marketplace. Next, they may decide to or allow the user to view their resource usage in the Marketplace and perhaps next they get the Marketplace to deal with resource usage accounting and billing.

Recommendation 3: Create a flexible and modular architecture that allows the integration of third party applications and services. This architecture must allow the deployment of application front-ends on your site.

3.4 Identity Management

The Fortissimo Marketplace provides a Web-based market for HPC suppliers and HPC customers to provide and consume services. This is fundamentally a distributed architecture – the services offered are from a broad range of organisations and have widely varying requirements e.g. consultancy requests as compared to job submission.

Identity management is central to the operation of this distributed marketplace – with many differing services being provided by various third parties via the main Website, the Identity management is the one consistent thread. In addition, the services for running the Marketplace itself require Identity management. For example:

- The Content management system requires Identity management to determine who owns and who can edit material and such like.
- Resource usage accounting requires Identity management to know where charges are to be made.
- The Helpdesk requires it to allow correct assignation to help with particular services, user identification and Helpdesk operation itself.

The identity data itself can be made available via a distributed directory service (e.g. LDAP).

In the Liferay-based V1.0 of the Marketplace, user entries were managed with Liferay tools and these entries were exported to an LDAP managed database. This LDAP database could then be used by other services for authentication and authorization, either directly or by exporting the attributes to other LDAP databases (e.g. for service providers) as shown in Figure 4.

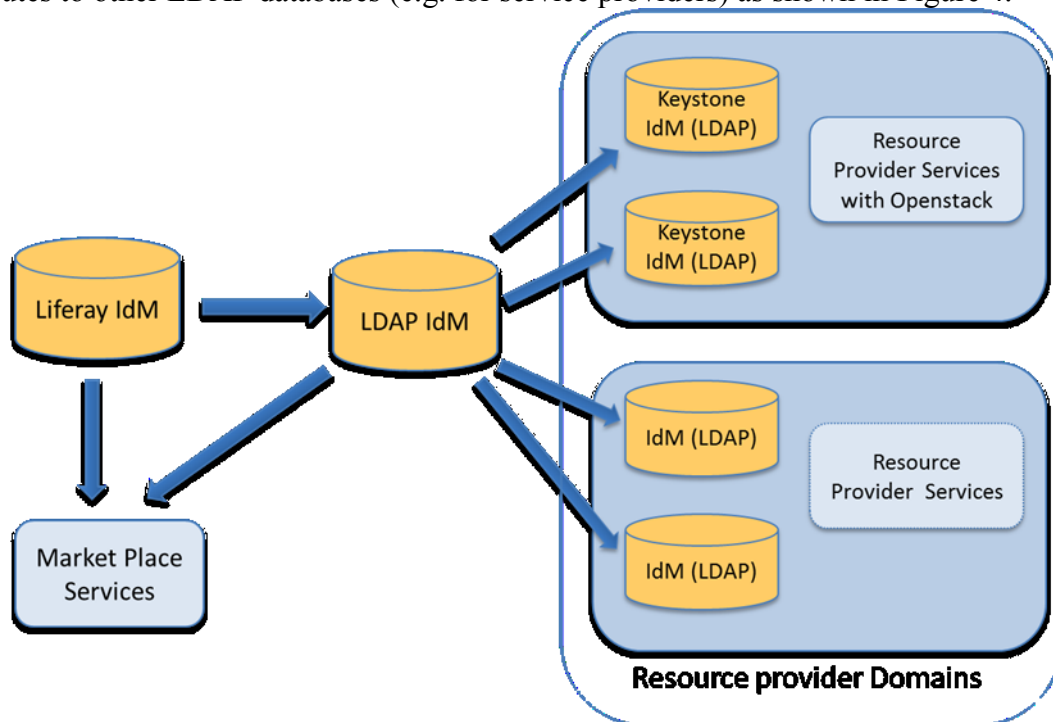


Figure 4: Fortissimo Marketplace Identity Management (IdM Infrastructure).

With the move to a Drupal CMS for the combined project Website and Marketplace, LDAP has been retained as the central store for user entries. The Fortissimo Marketplace Identity Management infrastructure has however been augmented by the addition of Single Sign-On (SSO) to enable a user to have the same credentials (username/password) for accessing the Marketplace and any services that are integrated with this SSO capability. This ensures ease of use and consistency since users can directly interact with such services using their marketplace credentials. SSO is provided by the Central Authentication Service (CAS) [7].

As shown in Figure 5, when a person registers with the Marketplace, their data is stored in the Fortissimo LDAP. (The screens the person uses to register with are actually hosted in Drupal as well.) The Marketplace, associated services and the CAS interrogate this LDAP for the user entries. It is the CAS that issues SSO tokens to enable the user to use the same credentials

across the participating services. This issuing and handling of the SSO tokens is hidden from the user.

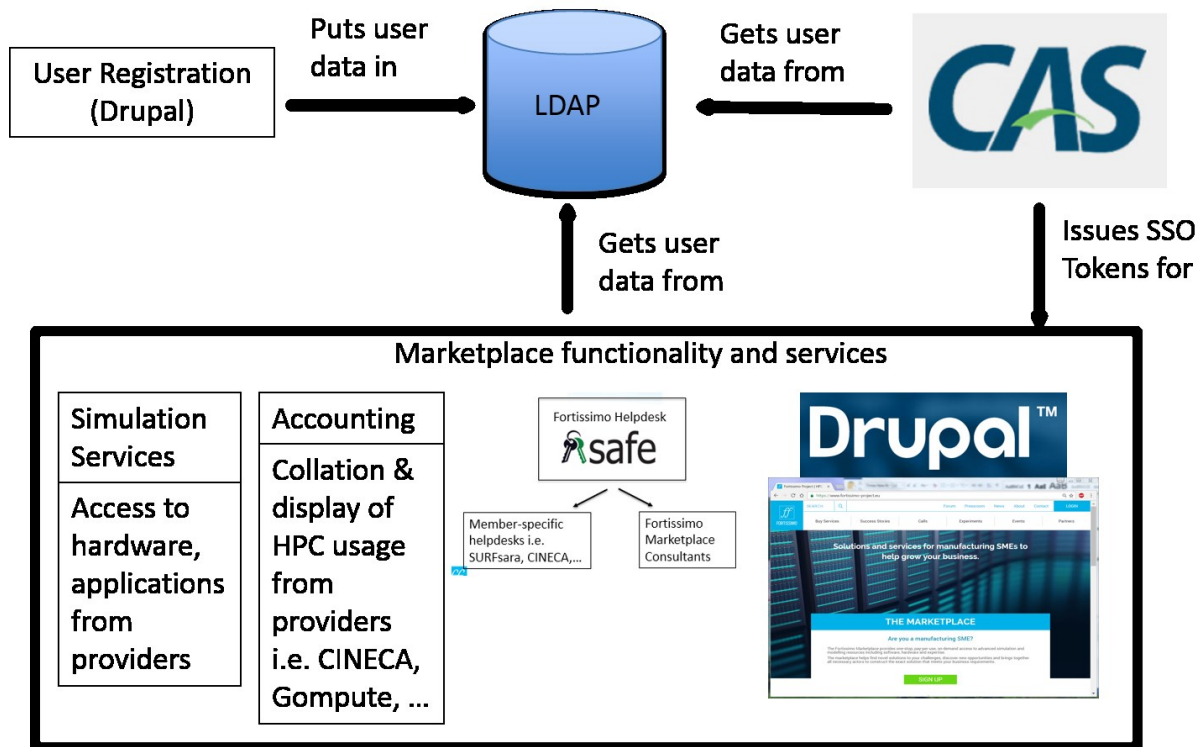


Figure 5: In the Drupal-based V2.0 of the Marketplace, the central LDAP database is still used to store user entries.

The CAS server and LDAP system are both hosted at HLRS.

The intention had always been for the Marketplace to provide SSO. In the Liferay-based Marketplace, the extent to which this could be easily supported was limited. The move to Drupal enabled the use of freely available modules that integrate CAS with Drupal in order to provide SSO.

Recommendation 4: Identity management is a key functionality for a Marketplace. Whilst it must be distributed, it must also be under the exclusive control of the Marketplace in order to create trust with your customers.

3.5 Security

During the requirements capture exercises amongst the Fortissimo partners, a commonly stated requirement from end-users and service providers was not surprisingly the need for security and in particular that confidential data and information are safe from potential competitors on the same platform. The following actions were taken to ensure this.

- Secured connections with HTTPS are used for any communication with the Marketplace to prevent other users and competitors from intercepting the communication between users and the Marketplace.
- Any attempt to establish an unsecure connection is immediately redirected to secure connections.
- To establish secure connections with HTTPS a certificate from a certification authority is required. A certificate is only issued if the certification authority approves the identity

of the Marketplace. The Fortissimo Marketplace has been issued with an official certificate from a certification authority that enables these secure connections to be established. This means a user can be sure that they are only sending data to the official Marketplace.

- User related data within the marketplace is protected with role based access control (e.g. for accounting data, orders etc.). A user can see only data related to their own orders (billing or accounting information) whilst a member (vendor) can see the information concerning their own service offers. Only the Marketplace operators have a wider access to this data in order to investigate any kind of problems that may arise.
- In the case of job submission by a user to a service provider resources, it is the service provider's security regime that applies. Services offered on the Marketplace have to display their terms and conditions. This allows a user to determine if the provider's security regime is sufficient for them before purchasing the service. It should be noted that the Marketplace Terms and Conditions state that if a user decides to purchase service through the Marketplace then the resulting legal contract is between the user and the service provider.

Recommendation 5: Official certification and secure communications are fundamental to building trust between the Marketplace and its users and to show that the Marketplace is treating seriously the need to handle user data securely and confidentially.

3.6 e-Commerce

With the experiences gained from the V1.0 Liferay-based Fortissimo Marketplace and the definition of the key business processes it became apparent that a further key technology for the Marketplace is e-commerce so that service providers can create and customize commercial services as well as handle billing and invoicing. In particular, it became apparent that the Add Member Services, Matchmaking Services and Service Purchase could benefit greatly from e-Commerce technologies. Further, because SMEs look for complete solutions (that may include HPC, applications and services in a single contract), this e-Commerce platform must allow customers to create specific packages. This package creation is from both sides, that is from service providers that wish to offer a complete packaged solution and from customers that want to create their own specific packaged solution comprising various services available in the Marketplace.

The latest Drupal-based version of the Marketplace therefore exploits the Ubercart e-Commerce module [9] to provide this. Ubercart is an open source module with a large, active development activity and a proven track record in commercial use. From a Marketplace sustainability perspective, it made complete sense to use this in preference to bespoke implementation where long-term support and maintainability -have cost implications. The sub-sections below describe where Ubercart has been used to implement the Add Member Service, Matchmaking and Service Purchase business processes and highlights areas where it has an impact on staff effort and hence Marketplace sustainability.

Recommendation 6: Use a flexible e-Commerce solution that allows service providers to jointly create jointly offers and packages and allows customers to create their own self-service added-value service that aggregates solutions from different providers into a single package.

3.6.1 Add Member Services

This business process is shown in Figure 6. It is concerned with the creation of a service offer by a Marketplace member (i.e. a service provider), the validation of this offer by the

Marketplace and finally its publication. Potentially, this process could be very staff-intensive, have high operational costs and hence adversely affect Marketplace sustainability. The Drupal Ubercart module has therefore been configured to automate as much of the process as possible in order to reduce the Fortissimo staff effort required. Also where possible and where it is sensible from a business relationship perspective, the member wishing to offer the service is tasked with completing necessary activities.

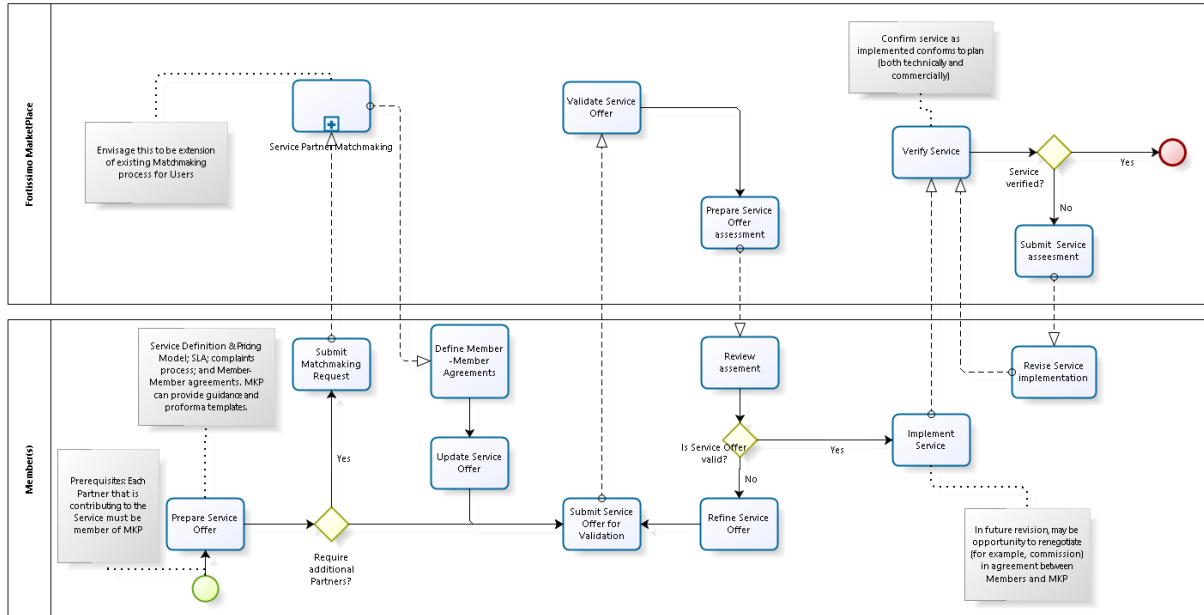


Figure 6: The Add Member service process notated in BPMN [8].

In the Marketplace, this process is implemented by means of a link on the member dashboard called “Sell Services” (see Figure 7). This presents the member with a Drupal template form they must complete to describe their proposed service. When completed the member clicks the “Submit” button whereupon a number of in-built automated content checks (e.g. number of characters in description, missing field checks) are executed. If one or more of the checks are not successful, the member is informed where the error is. If all the checks are successful the Marketplace Helpdesk is notified automatically that there is a new service offer that must be validated. Up until this point in the process no effort is required from Fortissimo staff. The next part of the process however involves the assigning of a Fortissimo Marketplace consultant who validates those aspects of the offer checking that have not been automated. The extent of this validation will determine the operational cost of this step. The Marketplace does provide guides to the members to help them create their offer. This in combination with the in-built content checks on the template form helps reduce potential member errors. Clearly the more this validation can be automated, the greater the reduction in Fortissimo staff and hence the better for Marketplace sustainability.

Recommendation 7: Where possible and sensible, automate processes as much possible to reduce staff costs and errors.

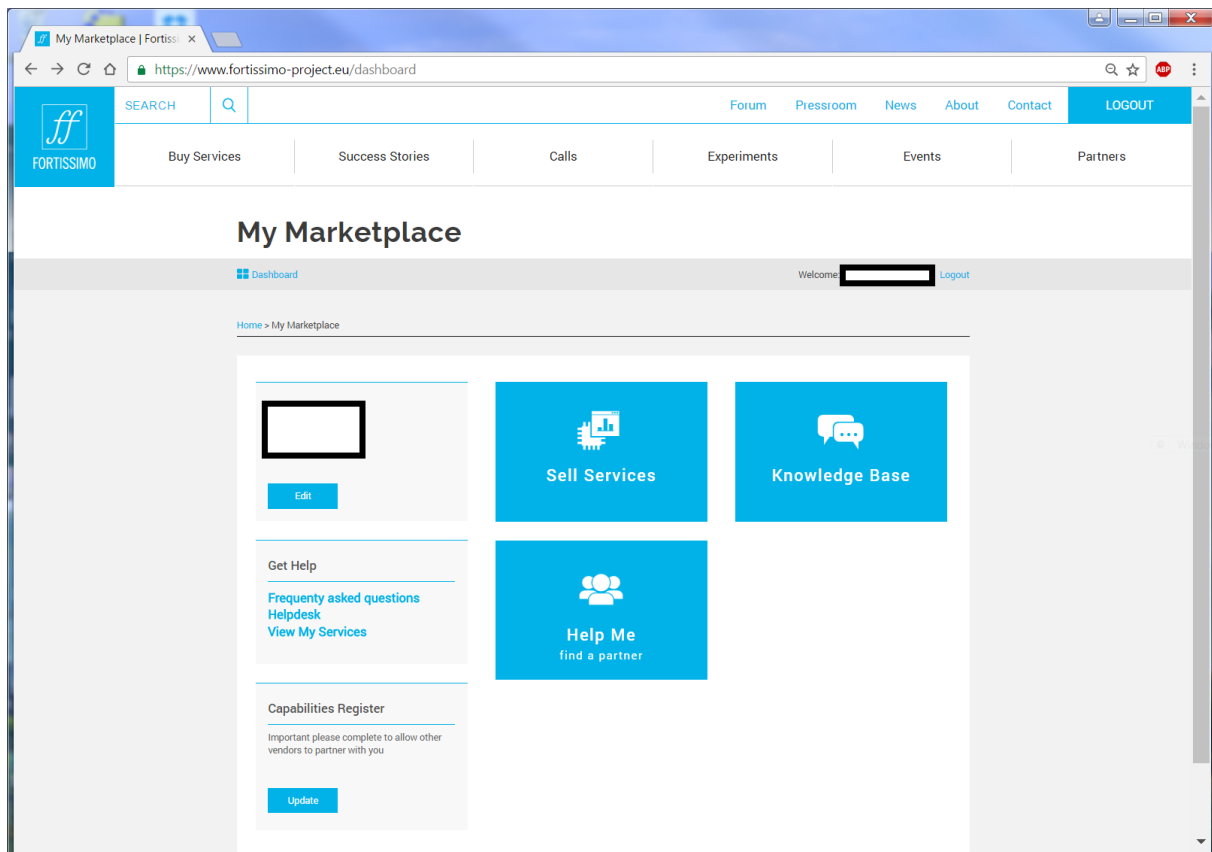


Figure 7: The dashboard presented to a Member after they login to the Marketplace.

3.6.2 Matchmaking Services

Within the Drupal-based Marketplace, the functionality to fulfil this business process is provided in three different ways, one of which, the “Buy Services” link (see Figure 8), is made possible through the use of the Ubercart module. This displays the list of service offers that have been added by members and so in effect provides the shop window of services that a user can purchase. Once a service has been approved (as explained in section 3.6.1 above) it automatically appears in this service listing without the need for further Fortissimo staff intervention.

From a user perspective in addition to the service listing, Ubercart provides the shopping cart functionality (see “View cart” below “My Marketplace” headline in Figure 8). This enables a user to add multiple services to their shopping cart and when they are ready proceed to the checkout to complete service purchase.

Recommendation 8: Easy to use search and a shopping cart are needed to aggregate services into a single commercial proposition.

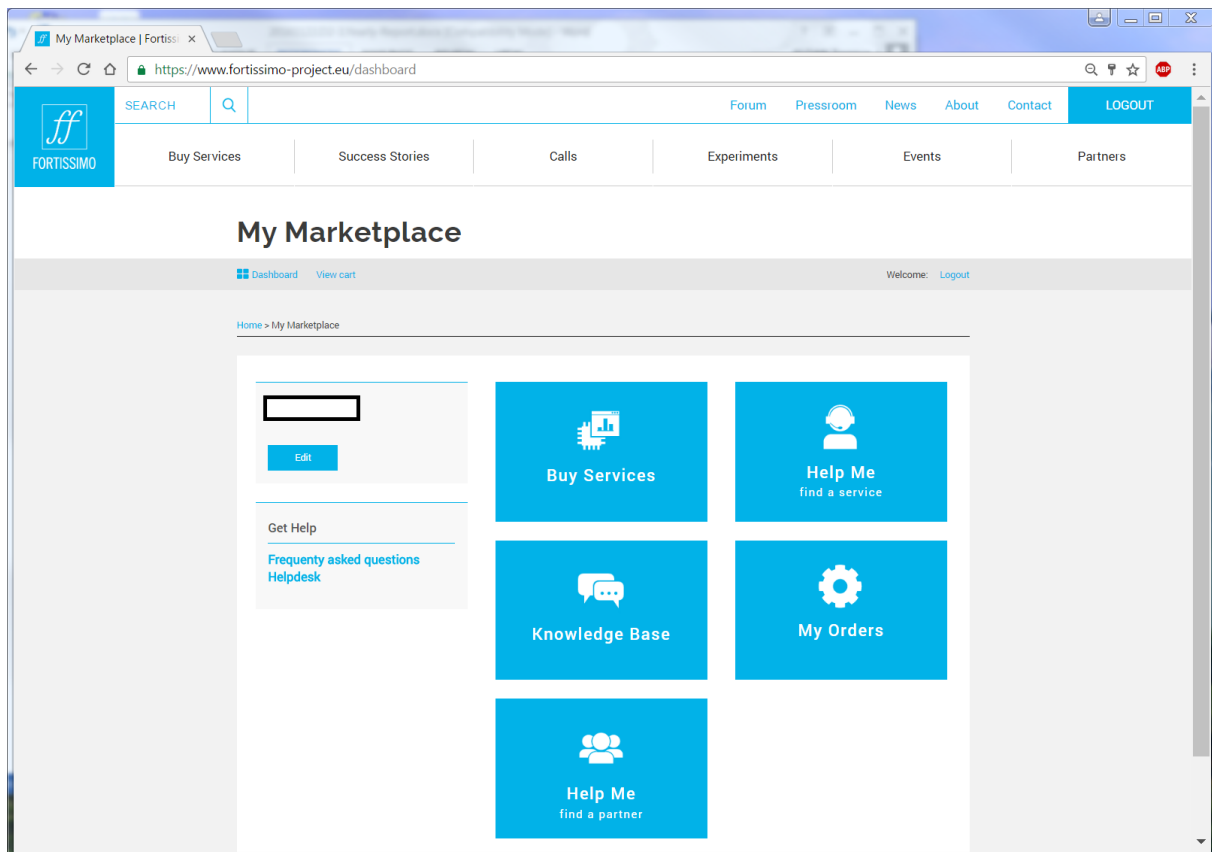


Figure 8: The dashboard presented to a User after they login to the Marketplace.

3.6.3 Service Purchase

Figure 9 shows the Service Purchase business process for the Marketplace. In this process a Marketplace user has decided to purchase a Service offered to them via the Matchmaking Process. The user, after reviewing and accepting the Terms & Conditions sends in a Purchase Order, including all the details about the way the Billing should be done. The Marketplace validates the Purchase Order and decides whether to decline or accept the order. It sends the outcome of the decision both to the Marketplace user and the service provider.

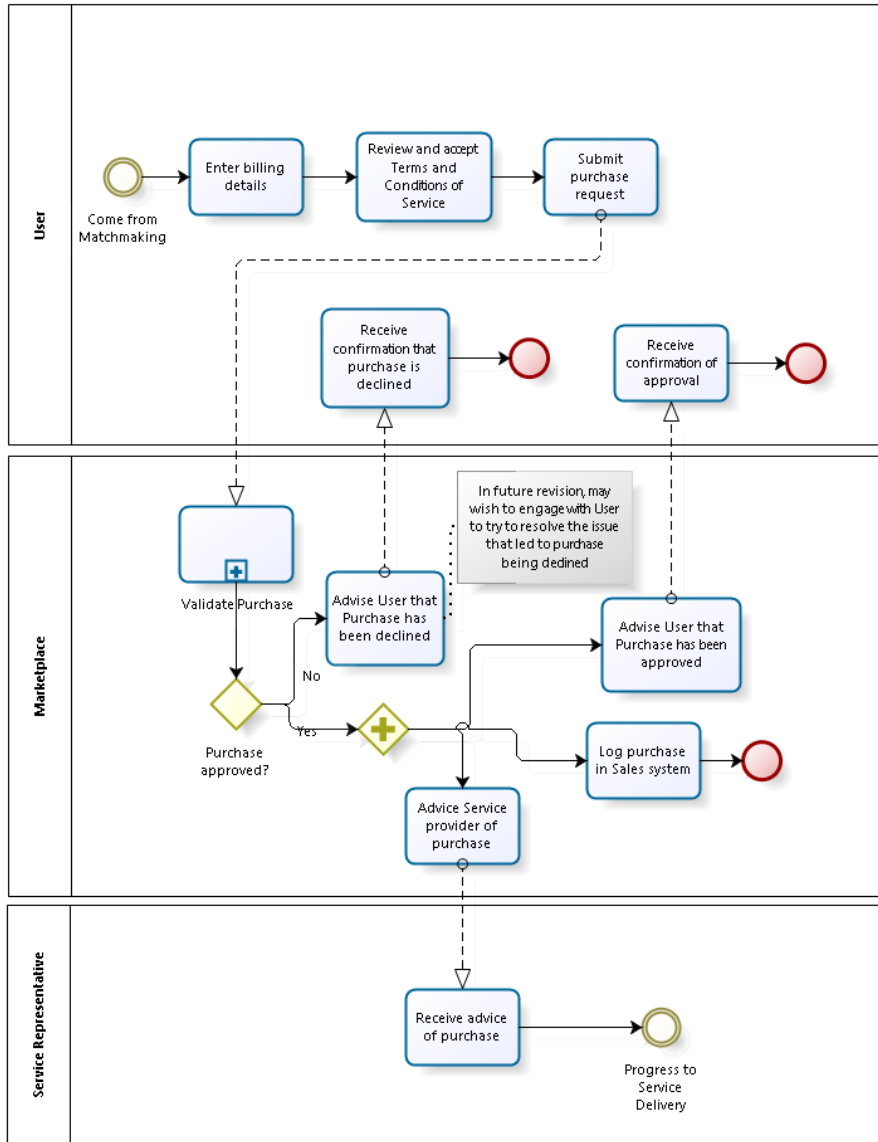


Figure 9: The service purchase process notated in BPMN [8].

In the latest version of the Marketplace, the implementation of the process uses the Drupal Ubercart e-Commerce module to provide some of the required functionality for the Service Purchase business process. For example, the service offer entry must contain a link to the Terms and Conditions of the service and the user must accept these before they can proceed with the purchase. It is the Ubercart module that enforces this. A further example is that once a user has submitted their order they can then review the status of their submitted orders and hence be informed if the purchase has been approved (see Figure 10). Again Ubercart allows automation of various aspects of the process hence reducing the effort required from Fortissimo staff and so improving Marketplace sustainability. However, note that not all aspects can necessarily be checked automatically and these may vary depending on the nature of the service. For example, full compliance with the Terms and Conditions of a provider is very likely to require further manual checks by the provider.

My order history

Date	Order #	Status	Products	Total
11/30/2016	231	Pending	10	€1.500

Figure 10: Review a submitted order

Looking to the future, Ubercart already provides integration with various payment mechanisms such as Paypal meaning there are further options for improving billing too with minimal effort.

Recommendation 9: Be flexible in applying process automation. The level of automation possible will vary across services as well as processes. One service provider's Terms and Conditions may require manual intervention for certain user verification/validation criteria whilst another's may not.

3.7 Accounting and Billing

After purchasing, the service has to be delivered. Platinum providers can use the Marketplace to deliver their services and so further functionality is needed. In particular, resource usage accounting must be included to allow customers to track the usage of their resources and for service providers to track usage of their offered services. Billing must also obviously be included so that service providers can get paid. These high end added-value services will also create additional income for the Marketplace since they are only available to service providers who purchase the more expensive platinum membership of Marketplace.

Since services can be diverse (from CPU-hours on-demand to consultant hours) in their billable characteristics, accounting and billing must support different entities, must accept direct submission of accounting records from providers and also provide Web interfaces for smaller service providers. This activity must be monitored and enforced to guarantee that the customer has up-to-date information at least once per day.

Fortissimo has developed its own accounting and billing system that supports this functionality. It has a JSON flexible accounting record, an authenticated REST service to submit information and a Web-based application for the customer to track their usage. Also, the Marketplace includes a powerful module to generate the bills using this service-provider information, aggregating records from different providers.

Recommendation 10: Accounting and billing systems are key modules to guarantee Marketplace sustainability. They must provide commonly used interfaces for providers to submit information and an easy-to-use interface for customers to view their usage of the services they have purchased.

3.8 Helpdesk

The definition of the key business processes reinforced the critical need, identified during requirements capture exercises with the Fortissimo experiment partners, for a suitably staffed Helpdesk. With the Marketplace aimed at both naïve and expert HPC users, HPC providers, software vendors, domain experts, etc., the range of possible queries is extensive. From a Marketplace sustainability perspective this is a worry.

To remedy this, Fortissimo adopted an approach whereby the Helpdesk operator will generally route a helpdesk query to the organisation best placed to answer it. For example, if the query concerns a particular service offering then the query will be routed to the member responsible for that service offering since that member will almost certainly be able to answer the query more quickly and effectively than the helpdesk operator. A further advantage of this approach is that if a query requires knowledge of a particular European language then the query can be routed to an appropriate Fortissimo partner.

The Fortissimo helpdesk early on agreed that the EPCC SAFE helpdesk software [10] would be used for submission and management of helpdesk queries. It was also agreed that this installation would be made available to Marketplace users and members so that they could track and submit their queries with it too.

SAFE is based upon Apache, Tomcat and MySQL technologies and is highly customisable. Within Fortissimo, the SAFE installation is located at the University of Edinburgh, however it has been configured to support SSO through CAS and hence utilises the Fortissimo Identity Management infrastructure described above (see section 3.4). This means that a Marketplace user or member can also directly access the SAFE using their Marketplace credentials via the “Helpdesk” link on the user dashboard (see Figure 8) and member dashboard (see Figure 7) respectively.

Looking to the future it is important that the Marketplace continues with this policy of wherever possible routing queries to relevant parties to ensure that the effort required to staff the Helpdesk does not impact upon the sustainability of the Marketplace. Moreover, to reduce the number of queries that reach the Helpdesk in the first place, the Marketplace must continue to adopt the approach of encouraging users and member to help themselves. This means regular review and update of the existing Marketplace Frequently Asked Questions (FAQ) as well as adding to the current list of user and member guides in the Marketplace Knowledge Base (see Figure 7 and Figure 8). These are obvious and well-proven techniques to encourage this desired user and member behaviour.

Recommendation 11: The Helpdesk is a key service for a successful HPC Marketplace. Due to the distributed nature of Marketplace services, it must have access to highly trained staff that can help customers both purchase and create offers and must have robust management software for tracking the status of queries. In addition, the Helpdesk must adopt techniques to encourage users to help themselves and so reduce the staffing overhead for dealing with queries.

3.9 Flexible Service Integration

For service providers who wish to sell their services on the Fortissimo Marketplace there are two levels of membership: Gold and Platinum. The extent to which a service can be integrated into the Marketplace depends on the membership level of the service provider. Platinum members have the most options available to them for service integration. Figure 11 shows the options for Gold and Platinum members as they are listed on the Marketplace at <https://www.fortissimo-project.eu/vendor-sign-up>.

Functionality		Gold	Platinum
Advertising	Inclusion in Capability Register	✓	✓
Resource Library	Best Practice Guide	✓	✓
Support	Helpdesk	✓	✓
	Marketplace Consultancy Support		✓
User Management	Resource usage monitoring		✓
	Accounting(user view)		✓
	Helpdesk		✓
Service Purchase	User buys service directly		✓
	Billing and Payments handled by MKP		✓
Service Front-end Development and Hosting	Front-end Development		✓
	Front-end Hosting		✓
Document Templates	Service Legal Agreements		✓
	Member-member Agreement		✓
After-sales Support	Customer satisfaction survey		✓
Fees (subject to VAT)		€1000 annual Membership Fee	€1000 annual Membership fee + 15% commission on sales

Figure 11: The functionality options available to service providers who purchase Gold and Platinum membership.

A service offered by a Platinum member need not adopt all these options, rather, a sub-set appropriate to the service can be chosen. This sub-set can vary across services if the member is offering more than one service in the Marketplace.

For example, a consultancy firm takes up platinum membership so that it can sell its expertise in the Marketplace. The firm creates an entry that appears in “Buy Services” on the Marketplace. The firm uses the Marketplace accounting and billing options so that they can provide their users with information on their usage of consultancy hours and also get the Marketplace to deal with the billing of these users on their behalf. This requires the firm to regularly submit to the Marketplace accounting system, resource usage by users. The

Marketplace deals with invoicing users, ensuring user payment and transfers funds to consultancy firm.

On the other hand, an HPC centre with Platinum membership may wish to offer a more fully integrated service, say to run simulation jobs. Again this can be offered to potential customers via an entry in the “Buy Services” link on the Marketplace. This simulation service allows a Marketplace user to use a Web front-end directly from the Marketplace. The link to the service front-end can appear on the User dashboard (see Figure 8) once a user’s purchase has been approved. The service uses the Single Sign-On and Identity Management infrastructure provided by the Marketplace to enable the user to interact with the service using their Marketplace credentials. The service user uses this front-end to submit simulations to the HPC centre facilities. The HPC centre regularly submits to the Marketplace accounting system, resource usage by service users. This allows their service users to view their usage of the service directly from their Marketplace User Dashboard (see Figure 8). The Marketplace also uses this accounting information to bill the service users on behalf of the HPC centre. Once again the Marketplace can deal with ensuring user payment and transfers of funds to the HPC centre.

A further point to note regarding service integration and job submission to HPC resources is that HPC providers typically employ different access mechanisms to their facilities. Whilst from a user perspective it would be better if all HPC providers adopted the same access approach, it was recognised early on in the life of the Fortissimo project that there are operational, legal and political reasons why this cannot occur. The Marketplace must therefore be flexible enough to allow HPC centres to offer services based on different access mechanisms. In some cases this may mean a service where a user employs the traditional SSH approach to directly log onto an HPC facility rather the Web front-end approach described above.

To overcome this constraint a number of HPC centres and software providers have experimented with building job submission functionality based on the SAGA [11] standard that can be used within a Web front-end accessible from the Marketplace. This involves the software service utilising the SAGA API for job submission calls to HPC facilities and the HPC facilities having an adapter that handles the translation of these SAGA calls into a format suitable for execution on the HPC platform Figure 12. Thus far these experiments appear to be a promising way to deal with this underlying heterogeneity at the HPC resource level.

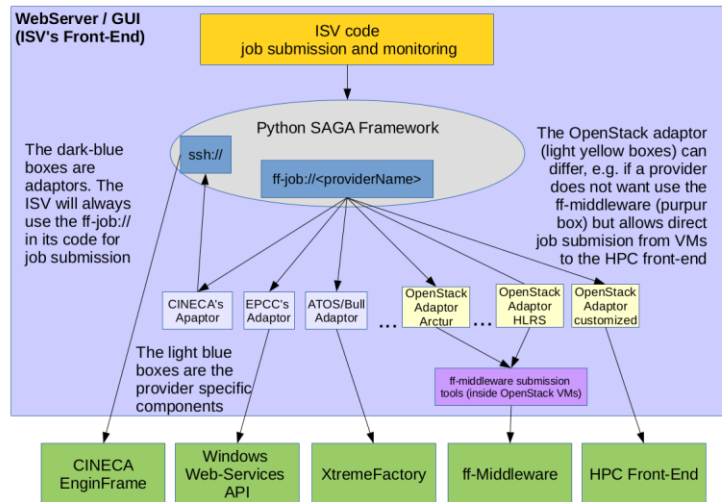


Figure 12: Using SAGA to overcome Fortissimo HPC heterogeneity.

Recommendation 12: HPC services are more than providing access to computation. A Marketplace must be flexible enough to allow differing levels of service integration that are appropriate to the service and the provider.

4 Concluding Remarks

This Deliverable has identified the key functionality and technologies required to provide the foundations for operating a sustainable Marketplace. These are:

- a customisable, open-source Content Management System with an active development community;
- a scalable delivery platform with appropriate provision for development and staging
- an architecture that supports flexibility of service provision;
- an Identity Management infrastructure that supports a distributed architecture and multiple applications;
- e-Commerce functionality to provide a shop window and service purchase;
- a flexible accounting and billing system;
- a Helpdesk that distributes queries appropriately; and finally
- support for differing levels of service integration.

Further, this Deliverable has also identified a number of general recommendations developing a Marketplace. These are listed here again in full in Table 2.

Table 2: Recommendations for a sustainable Marketplace

Number	Recommendation
1	To decrease your initial deployment costs, use a CMS with programming capabilities that has a large community of users and companies offering services to program and adapt it.
2	To decrease your initial deployment costs, use Cloud services and avoid having to create your own infrastructure.

3	Create a flexible and modular architecture that allows the integration of third party applications and services. This architecture must allow the deployment of application front-ends on your site.
4	Identity management is a key functionality for a Marketplace. Whilst it must be distributed, it must also be under the exclusive control of the Marketplace in order to create trust with your customers.
5	Official certification and secure communications are fundamental to building trust between the Marketplace and its users and to show that the Marketplace is treating seriously the need to handle user data securely and confidentially.
6	Use a flexible e-Commerce solution that allows service providers to jointly create jointly offers and packages and allows customers to create their own self-service added-value service that aggregates solutions from different providers into a single package.
7	Where possible and sensible, automate processes as much possible to reduce staff costs and errors.
8	Easy to use search and a shopping cart are needed to aggregate services into a single commercial proposition.
9	Be flexible in applying process automation. The level of automation possible will vary across services as well as processes. One service provider's Terms and Conditions may require manual intervention for certain user verification/validation criteria whilst another's may not.
10	Accounting and billing systems are key modules to guarantee Marketplace sustainability. They must provide commonly used interfaces for providers to submit information and an easy-to-use interface for customers to view their usage of the services they have purchased.
11	The Helpdesk is a key service for a successful HPC Marketplace. Due to the distributed nature of Marketplace services, it must have access to highly trained staff that can help customers both purchase and create offers and must have robust management software for tracking the status of queries. In addition, the Helpdesk must adopt techniques to encourage users to help themselves and so reduce the staffing overhead for dealing with queries.
12	HPC services are more than providing access to computation. A Marketplace must be flexible enough to allow differing levels of service integration that are appropriate to the service and the provider.

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