

## 4 Refinement of the Flspace Conceptual Architecture and Operational Model

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Since the last deliverable of WP200 in Mo 6 of the project, implementation of Flspace modules as well as initial Apps has commenced. During this processes, as well as in frequent interactions and meetings of the development team, the conceptual architecture and the operational model of Flspace have been scrutinized. This lead on the one hand to a confirmation of the viability of several of the conceptual design choices that have been taken (and which were in parts the outcomes of the previous Phase I projects). On the other hand, some adjustments on the Flspace operational model have been made in order to address technical issues that were faced when implementing the conceptual architecture; e.g., to better address security, privacy and trust concerns. Section 4.1 thus provides an update of the Flspace operational model, including an updated example and set of roles and tasks.

In addition, based on the operational model presented in the previous deliverable, we have achieved a common understanding of what constitutes a Flspace App, leading to a clear classification of the software components that are developed as part of ST451 (“Initial Apps”). This better understanding is summarized in Section 4.2

### 4.1 Flspace Operational Model

The Flspace platform is built as an extensible SaaS cloud offering that can be extended by means of two key extension mechanisms (see Figure 1):

- **Extension Mechanism 1: Addition of functionality through Apps:** Apps will provide value added services and wrapped software capabilities; Flspace Apps thus aggregate capabilities in a reusable fashion such as to become attractive for many users. They will be offered through a dedicated App store. For example, such Apps could offer features such as spraying advice, bad weather alerts, pricing proposals, exception reporting and decision support, shipment status, meat transparency information, or augmented reality product information.
- **Extension Mechanism 2: Configuration through collaborative workflows:** Flspace allows Apps to be composed along collaborative workflows and mashed-up into personalized dashboards for users. In addition, Flspace can be configured to allow flexible integration of data sources of users and linking those data sources to Apps along collaborative workflows. As an example, one could envision that a meat transparency information App is composed with an augmented reality product information App through a collaborative workflow involving meat producers, shippers and retailers.

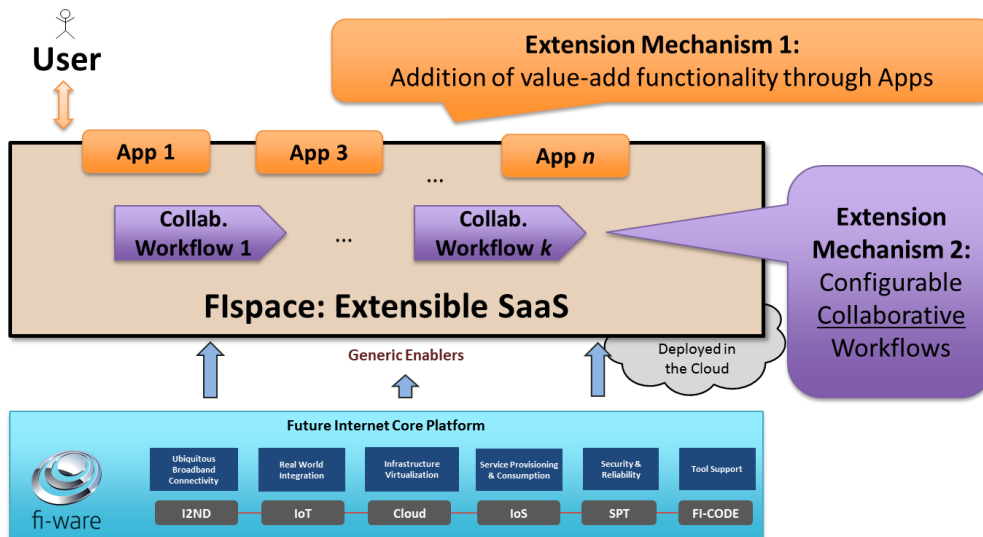


Figure 1: Flspace as Extensible SaaS Platform

It should be noted that different from typical smartphone Apps (see Figure 2). Flspace Apps will not be built towards a given (and possibly fixed) programming interface (API). Rather, one key aspect of Flspace Apps is that *they* will declare what input data or events they *require*. In this regards, the Flspace App model is much closer to the software (Web) service or the component based software-engineering model, where reusable features are offered through interfaces defined by the service/components, and interested parties can select and mashup those services/components into more complex service compositions<sup>2</sup>.

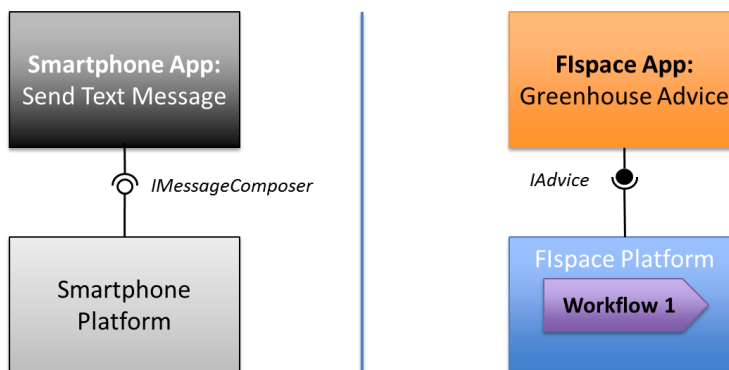


Figure 2: Smartphone App Model vs. Flspace App Model

Given the business setting in which the Flspace solutions will be employed, three major types of stakeholders are involved in the overall value chain: **Business Users**, **Business Architects** and **App Developers**. Their roles are detailed in the following subsections.

<sup>2</sup> E.g., see E. Di Nitto, C. Ghezzi, A. Metzger, M. P. Papazoglou, and K. Pohl, "A journey to highly dynamic, self-adaptive service-based applications," *Autom. Softw. Eng.*, vol. 15, no. 3-4, pp. 313–341, 2008.

### 4.1.1 Business User

Business Users are the actual (industry) users (supply chain actors) of the collaboration services and Apps provided by Flspace. Those users will be supported in their daily business activities, with special focus on their interaction and collaboration with business partners. Examples of those users include farmers, shippers, freight forwarders, cargo carrying airlines, and regulatory agencies.

Business users cooperate with other businesses and even technology (such as sensors or actuators) to execute some collaboration process supported by a configuration/mash-up of a variety of Apps that are linked together by an instantiated model of the business workflow (instantiated from a generic business process model). Main features of such a business process model are that it is artefact-centric and event-driven. As a very simple example we may look at a spraying advice from an advisor for a farmer based on sensor information. The business cooperation for getting an advice is then concerned with a farmer, an advisory service and a sensor gateway (for connecting to the sensors and obtaining measurements). Business users may want to use a similar business process several times, for the same crop at different points in time, for different crops with different sensor gateways and, last but not least, for different advisors. If the business model is generic (reference model), configurable and instantiable and if Apps and interfaces that are used to support the information needs of such a business process are using standard API's and standardized content of messages exchanged then such an approach truly provides an efficient strategy towards setting up and supporting business collaborations.

The below table provides a more detailed and extensive explanation of the activities that the role Business User is envisioned to perform with respect to the Flspace platform. **Boldface** text marks the Flspace modules which are employed resp. relevant for the activities described.

Table 2: Activities of Business User

Activity	Involved Flspace Modules
<p>Registration &amp; User Profile Maintenance through <b>User Front-End (&amp; SPT)</b></p> <ul style="list-style-type: none"> <li>• Register &amp; Log-In to Flspace</li> <li>• Create &amp; Maintain User Profile (individual / organizational unit / company level):                             <ul style="list-style-type: none"> <li>○ Select / define role</li> <li>○ Provide basic profile information</li> </ul> </li> <li>• Personalize Cockpit (appearance, basic notification &amp; communication settings)</li> </ul>	<p><b>Front-End</b></p> <ul style="list-style-type: none"> <li>• Registration &amp; Log-in Process</li> <li>• User Profile Management</li> <li>• Personalization Features</li> </ul> <p><b>Security (indirect, integrated in Front-End)</b></p> <ul style="list-style-type: none"> <li>• Secure Log-In &amp; Usage</li> <li>• Access management</li> </ul>
<p>Find &amp; Manage Business Partners through <b>User Front-End</b></p> <ul style="list-style-type: none"> <li>• Find business partners (known &amp; unknown)</li> </ul>	<p><b>Front-End</b></p> <ul style="list-style-type: none"> <li>• Search for public user profiles</li> <li>• Basic Contact Management</li> <li>• Basic networking &amp; collab. fea-</li> </ul>

Activity	Involved Flspace Modules
<ul style="list-style-type: none"> <li>○ Via public user profiles</li> <li>○ Via offered business services</li> <li>● Manage your business contacts                             <ul style="list-style-type: none"> <li>○ Maintain contact data</li> <li>○ Seamless communication via social networking &amp; collab. features</li> </ul> </li> <li>● Manage business partners                             <ul style="list-style-type: none"> <li>○ Set-up &amp; manage contracts</li> <li>○ Rate partners (public + private)</li> </ul> </li> <li>● Create Business Communities (for e.g. areas of interest, establishing networks, ...)</li> </ul>	<p>tures</p> <ul style="list-style-type: none"> <li>● Formation of communities</li> </ul> <p><b>SPT</b> (indirect)</p> <ul style="list-style-type: none"> <li>● Information Security</li> <li>● Access management</li> </ul>
<p>Get &amp; customize pre-configured Apps for Business Activities (from <b>App Store</b>)</p> <ul style="list-style-type: none"> <li>● Find &amp; get need Apps                             <ul style="list-style-type: none"> <li>○ Pre-configured by Business Architects</li> <li>○ Apps that do not need configuration by business architect (such as weather App, time of day App, etc.)</li> </ul> </li> <li>● Customize for individual needs (only 'personal configuration', such as user name, appearance, etc.)</li> </ul>	<p><b>Front-End</b></p> <ul style="list-style-type: none"> <li>● Personalization &amp; Configuration for Apps (selection, personal appearance, look &amp; feel)</li> <li>● Access Apps (consume Apps via UIs that are provided in Front-End)</li> </ul> <p><b>App Store</b></p> <ul style="list-style-type: none"> <li>● Use pre-configured Apps / customized solution provided by associated Business Architects of User organization</li> </ul>
<p><b>Use Apps &amp; Flspace Platform Features</b> for conducting daily business, incl.:</p> <ul style="list-style-type: none"> <li>● Define specific notification &amp; communication settings for business activities</li> <li>● Use collaboration features for specific business activities and transactions</li> <li>● Continuously manage business partners</li> </ul>	<p><b>Front-End</b></p> <ul style="list-style-type: none"> <li>● Access to Apps (UIs integrated in Front-End)</li> <li>● Personalization &amp; Configuration Features</li> <li>● Embedded social networking &amp; collaboration features (basic + advanced)</li> <li>● Access to statistics on App Usage, Business Partner Information, etc.</li> </ul> <p><b>App Store</b></p> <ul style="list-style-type: none"> <li>● Payment of App / Platform usage</li> </ul>

### 4.1.2 Business Architect

Business Architects are the experts (internal or external to the User organization of the supply chain actor) that are in charge of configuring Flspace for their individual business needs. Particularly they will define customized collaborative workflows and connect those workflows with Flspace Apps and backend systems.

The functionality to be provided to users depends on the availability of defined and configured business processes or workflows which represent the business information needs and in which these workflows are connected to the appropriate Apps, backend systems, and IoT devices. Business architects, as , are in charge of developing and configuring these workflows in Flspace. In particular they will define customized collaborative workflows and connect those workflows with Flspace Apps and backend systems.

The role of Business Architects is to ensure reusability along a number of lines. A farmer for instance may use almost the same business process collaboration for the same crop over time and fore different crops and resources without further assistance provided that the instantiation mechanisms allow the same business process model (BPM) to be instantiated for these differing situations. Similarly the same BPM can be instantiated by other farmers who enter into similar co-operations for their own crops.

Table 3: Activities of Business Architect

Activity	Involved Flspace Modules
<p>Find &amp; get relevant Apps</p> <ul style="list-style-type: none"> <li>• Search / browse <b>App Store</b></li> <li>• Investigate for suitability                             <ul style="list-style-type: none"> <li>○ Features &amp; functionality</li> <li>○ Interfaces, Data Structures</li> <li>○ Options for configuration, extension, re-sue</li> <li>○ Pricing &amp; payment models</li> </ul> </li> <li>• Purchase relevant Apps (for company / org. unit / individuals)</li> </ul>	<p><b>App Store</b></p> <ul style="list-style-type: none"> <li>• App Search &amp; Discovery facilities</li> <li>• Investigation Support for Consumers (features + pricing models) and for Developers (technical details)</li> <li>• App Purchase Support</li> <li>• Ratings of Apps by Flspace Community</li> </ul>
<p>Create customized Solution</p> <ul style="list-style-type: none"> <li>• Use <b>B2B Core</b> to design desired Workflow for Users                             <ul style="list-style-type: none"> <li>○ Sequence / Process of Apps</li> <li>○ Data models and relevant systems</li> <li>○ Interaction &amp; collaboration with business partners</li> </ul> </li> <li>• Configure / extend / define data structures and technical workflow for <b>B2B Core</b> to integrate Apps                             <ul style="list-style-type: none"> <li>○ Configure / extend Collaboration Artifacts + Event Rules (or define new / additional ones)</li> <li>○ Configure / extend selected apps (hide / rename data fields, resp. add additional functionality)</li> <li>○ Orchestrate Apps into desired workflow: define /</li> </ul> </li> </ul>	<p><b>B2B Core's Authoring Tools</b> (encompasses various tools for business architects)</p> <ul style="list-style-type: none"> <li>• Configuration / Extension for Collaboration Artifacts &amp; Event Handling Rules</li> <li>• Customization of Apps (configuration, extension)</li> <li>• Mash-Up &amp; Orchestration of Apps</li> </ul> <p><b>System &amp; Data Integration</b></p> <ul style="list-style-type: none"> <li>• Tool-supported techniques for connecting business systems (legacy &amp; standard systems, ...)</li> <li>• Tool-supported techniques for connecting external systems &amp; services (e.g. IoT-enabled sensor system, 3<sup>rd</sup>-party services)</li> <li>• Data mediation &amp; integration facilities</li> </ul>

Activity	Involved Flspace Modules
<p>'mash-up' execution sequence &amp; technical interaction models</p> <ul style="list-style-type: none"> <li>• Use <b>System and Data Integration</b> facilities to connect relevant systems ('legacy' systems and external systems &amp; services), as well as Apps to be able to integrate them into the customized workflow                             <ul style="list-style-type: none"> <li>○ Define &amp; create connectors between Flspace Apps and Flspace platform</li> <li>○ Define &amp; create connectors between existing / legacy systems and Flspace platform</li> <li>○ Define 'data mediators' to transform / mediate data from legacy systems</li> </ul> </li> </ul>	
<p>Provide customized solution to Users</p> <ul style="list-style-type: none"> <li>• Provision to relevant Users by making the customized solution accessible in the personal <b>User Front-End</b> of relevant Users</li> <li>• Pre-configure for Users: Access Rights, setting for notifications + communication (<b>SPT</b>)</li> <li>• Configure pricing &amp; payment models (for company / org. unit / individual level) with the support of the <b>App Store's</b> revenue sharing facilities</li> </ul>	<p><b>Front-End</b></p> <ul style="list-style-type: none"> <li>• Personalization &amp; Configuration for individual Users</li> </ul> <p><b>SPT (via Front-End)</b></p> <ul style="list-style-type: none"> <li>• Configuration (Access Rights, Notification &amp; Comm. Settings)</li> </ul> <p><b>App Store</b></p> <ul style="list-style-type: none"> <li>• Selecting payment options / model</li> </ul>

### 4.1.3 App Developer

App Developers are the actual software and system providers who offer “packaged” / componentized solutions and applications in form of Apps.

The concept of the extensible SaaS delivery model offers opportunities for App developers who know about particular generic business situations for which they have an idea for an App to support such generic business situations. The offering to be provided differs from the concept often found in current Apps (Android and iOS). Specifically, Flspace Apps are characterized by the following specifics:

- The functionality of the App is described in the context of a “reference” business process model (in contrast to current Apps that provide isolated and generic functionality);
- The *required* interfaces and contents of the inputs (in particular also semantically) and APIs are described. These inputs are to be provided by the platform in order to

allow the App to run properly (in a sense this reverses the typical direction found in current Apps). See the elaborations that follow below.

Table 4: Activities of App Developer

Activity	Involved Flspace Modules
<p>(optional) Find existing Apps to build upon</p> <ul style="list-style-type: none"> <li>• Search / browse <b>App Store</b></li> <li>• Investigate for suitability &amp; re-usability               <ul style="list-style-type: none"> <li>○ Features &amp; functionality</li> <li>○ Interfaces, Data Structures</li> <li>○ Options for configuration, extension, re-use</li> <li>○ Pricing models, terms &amp; conditions for re-use</li> </ul> </li> </ul>	<p><b>App Store</b></p> <ul style="list-style-type: none"> <li>• App Search &amp; Discovery facilities</li> <li>• Support for Detailed Investigation (features, functionality, technical details, pricing models, terms &amp; condition for re-use)</li> <li>• App Purchase Support for re-use</li> <li>• Ratings of Apps by Flspace Community</li> </ul>
<p>Develop App</p> <ul style="list-style-type: none"> <li>• Using <b>Software Development Toolkit</b> to develop an App to comply with the Flspace operational model and in particular:               <ul style="list-style-type: none"> <li>○ <b>UI Framework &amp; Technology</b></li> <li>○ Technical Interfaces &amp; Interaction Protocols</li> <li>○ Usage of <b>security, privacy, and trust</b> technologies</li> </ul> </li> <li>• Define provided interface (including functions that can be called and data/events required by App)</li> </ul>	<p><b>Software Development Toolkit</b></p> <ul style="list-style-type: none"> <li>• Compliance with Flspace operational model and frameworks (UI technology, technical interfaces &amp; interaction protocols, security techniques)</li> <li>• Link with libraries required to connect to Flspace Cloud Service Bus (<b>Operating Environment</b>) and <b>SPT</b> mechanisms</li> </ul>
<p>Publish new App in <b>App Store</b>, incl.</p> <ul style="list-style-type: none"> <li>• Creation of App Description (required / provided interfaces)</li> <li>• Configure / define pricing models, usage terms &amp; conditions</li> <li>• Conduct Flspace App Publication Process</li> </ul>	<p><b>App Store</b></p> <ul style="list-style-type: none"> <li>• Publication Process for Apps</li> <li>• Configuration / definition of pricing models, usage terms &amp; conditions</li> <li>• ‘Compliance’ Check (does App follow operational model and framework constraints?)</li> </ul>

#### 4.1.4 Illustration of the Operational Model – The “Greenhouse” Scenario

To provide a rather concrete illustration of the Flspace operational model, we refer to one of the trial scenarios developed in the project. More specifically, we use the “Advice Request” scenario of the “Greenhouse Management & Control” trial (for more details,

please refer to deliverable D400.10<sup>3</sup>). The (industry) User of the FIspace configuration for that trial will be a Farmer that would like to be provided with spraying advice in case there is a deviation from expected environmental conditions. Environmental conditions are provided by a Greenhouse Management System, which links to a sensor network in the green house in order to measure the environmental conditions. In addition, the Greenhouse Management System can be used to control the green house (e.g., execute concrete spraying actions).

Figure 3 below shows the key elements of how FIspace would be used for that trial and how each of the above three stakeholders (Users, App Developers, and Business Architects) participate.

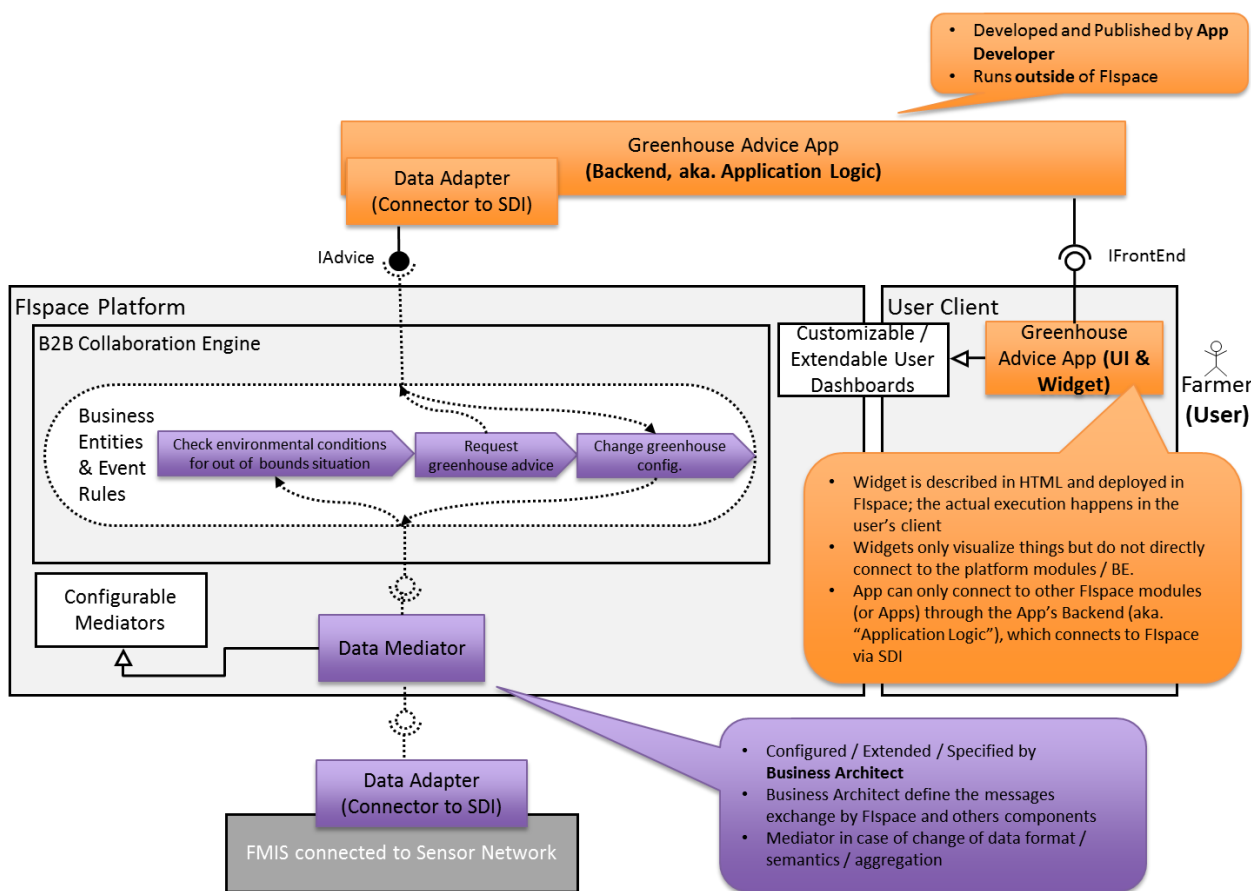


Figure 3: Illustration of FIspace Operational Model

First, the App Developer offers a packaged expert system that provides spraying advice based on a list of specific environmental conditions. As can be seen, similar to a Web Service, the App would announce (through the *IAdvice* interface) that it can be called “getAdvice()” and that it requires EnvData (in a specific format) as input. In order to visualize the spraying advice and solicit confirmation from the user (in this case the farmer), the App provides a dedicated widget which is deployed through a set of stand-

<sup>3</sup> Please note that – for illustrative purposes and sake of conciseness -- this scenario is a simplified and slightly modified version from the initial one introduced in Section 2.2 of deliverable D200.1 and the detailed one depicted as part of the trial in WP400.



ard APIs (in this case *IFrontEnd*) by the platform (note that for this second type of functionality, the App model is closer to the smartphone App model).

Now that the App has been defined and implemented, a Business Architect can search (using the store and marketplace) the App and can start setting up a collaborative workflow involving this App.

To this end, the Business Architect needs to define a collaborative workflow that reflects the stages in checking the need for advice, soliciting advice and executing the advice. Note that this workflow includes the description of the business processes stages and data, as well as event rules that react on and aggregate events. The Business Architect then connects this workflow with a) the App that provides the advice, and b) the backend system that delivers the environmental data based on which the need for an advice is computed. The Business Architect is supported by the platform (i.e., by authoring tools and configurable components) to define collaborative workflows, as well as to define connectors and mediators to channel the data into the platform and thus ultimately to the App.

It should be noted that, although not discussed above for reasons of conciseness, all interactions between Flspace platform components will commence through the Cloud Service Bus (CSB), which is part of the Flspace Operating Environment. The CSB is based on overlay technology, and each component and module will connect with a respective agent to the overall Flspace overlay. This approach allows flexibility, federation and consistency of the platform operations and thus makes the overall operational model agnostic to the actual deployment of the platform modules.

For security reasons, all Apps connect to the Flspace through the System-and-Data-Integration module (SDI). ***Note that this marks a significant change from the operational model that has been described as part of deliverable D200.2.***

Concerning module and App deployment, it should be noted that for instance, the App Logic could be hosted by the App provider, by some third-party cloud provider, or even within the same Cloud that hosts the Flspace platform modules. In addition, not all Apps have to come with App Logic that needs to be hosted. Very simple Apps, which for instance merely visualize events or data, may only provide widgets that directly plug into the Flspace platform user front-end.

As a final important design consideration, it should be noted that if an App needs to connect to a backend system at the side of the App provider (for instance the expert system mentioned in the above example), it should not do this through the B2B Collaboration Engine and System and Data Integration. This would violate the Operational Model of Flspace, as Apps should be built as “self-contained” software capabilities and should be independently built by App Developers without the need for interacting with Business Architects. As it is the Business Architects that do the configuration of data connectors and mediators of the platform, it would not be a Flspace compliant design if an App would require such wiring to work. The System and Data Integration module is intended to support the connection with legacy systems and existing services not built towards the Flspace App model.

## 4.2 Differentiation of Initial Apps

It should be noted that operational model described above defines Apps that will be offered in the Flspace Store.

As part of the analysis carried out in ST451 (and reported in deliverable D400.7), the above operational model has led to a refinement of the software initially planned to be developed in ST451. Specifically, we identified that ST451 will deliver two kinds of software “components”:

- **Apps in the Flspace Store**
  - Product Information Service App (PInf-App)
  - Logistics Planning App (LPA)
  - Real-time Business SLA Management App (BizSLAM)
- **Services of the Flspace Platform**
  - Business Profile Service (BPS)
  - Marketplace Operations Service (MOS)

Therefore the Business Profile App (BPA) and Marketplace Operations App (MOA) will hereafter be labelled or mentioned as Business Profile Service (BPS) and Marketplace Operations Service (MOS). In general, this refinement of software “components” does not affect the development work that is being done inside ST451. The only difference is that those services will become an integral part of platform (during one of the forthcoming releases) and thus will be part of all Flspace instances, whereas the three remaining Apps are downloaded from the Flspace store and integrated into customer-specific solutions on demand, i.e., by a Business Architect.