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Feasibility Assessment

WP 500

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The SmartAgriFood Project

The SmartAgriFood project is funded in the scope of the Future Internet Public Private Partnership Programme (FI-PPP), as part of the 7th Framework Programme of the European Commission. The key objective is to elaborate requirements that shall be fulfilled by a "Future Internet" to drastically improve the production and delivery of safe & healthy food.

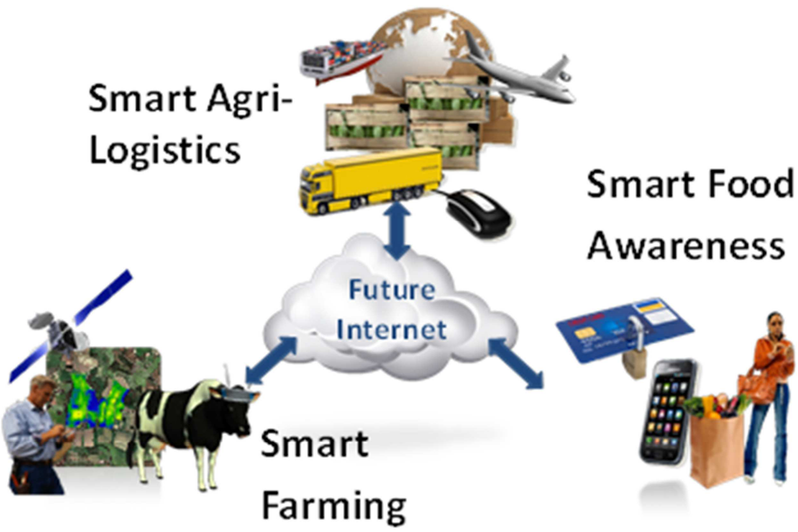
Project Summary

SmartAgriFood aims to boost application & use of Future Internet ICTs in agri-food sector by:

– Identifying and describing technical, functional and non-functional Future Internet specifications for experimentation in smart agri-food production as a whole system and in particular for smart farming, smart agri-logistics & smart food awareness,

– Identifying and developing smart agri-food-specific capabilities and conceptual prototypes, demonstrating critical technological solutions including the feasibility to further develop them in large scale experimentation and validation,

– Identifying and describing existing experimentation structures and start user community building, resulting in an implementation plan for the next phase in the framework of the FI PPP programme.



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Dissemination Level

PU	Public	X
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)	

Document Summary

This report presents the evaluation of the SmartAgriFood pilots from an integral technological point of view. The purposes are to outline the most appropriate scenarios for trial specifications in FI-PPP Phase II and to assess the feasibility of Generic Enablers to realise the trials. The report presents end-to-end scenarios for collaboration and information exchange across agri-food supply chain networks. It demonstrates how these scenarios can be realised according to the SmartAgriFood architecture. From this high level overview it zooms in to the technical architecture underlying the prototype realisation and the pilots in which details of the end-to-end scenario were tested. The testing aimed both at assessing the realisation and usability of the prototypes and at assessing the feasibility of the Core Platform and individual Generic Enablers. The test results are documented for each pilot, and for each pilot an outlook to the innovative potential of the Future Internet is presented. The prototypes were presented to farmers', logistics', and consumers' stakeholder forums. The most important requirements of the actors in the food supply chain are reliability and security. These issues are planned to have proper attention in Phase II. Key features of SmartAgriFood concepts will be demonstrated and verified in trials and large scale demonstration in FI-PPP Phase II which starts in 2013. These trials have been specified in close co-operation with the FI-PPP Phase I project FInest. The FInest and SmartAgriFood concepts and architectures were found complementary in the logistics stage of the supply chain. The joint Phase I experience of FInest and SmartAgriFood underlies the design of the cSpace platform on top of the Core Platform. The cSpace platform has been proposed and accepted for trials in FI-PPP Phase II. The trials will cover the following domains:

- Crop Protection Information Sharing
- Greenhouse Management & Control
- Fish Distribution and (Re-)Planning
- Fresh Fruit and Vegetables Quality Assurance
- Flowers and Plants Supply Chain Monitoring
- Meat Information Provenance
- Import and Export of Consumer Goods
- Tailored Information for Consumers

Abbreviations

AP	Access Point
B€	Billion Euro
B2B	Business to Business
B2C	Business to Consumer
BBC	British Broadcasting Corporation
CDI	Connected Devices Interface
CEP	Complex Event Processing
CU	Consumer Unit
CVS	Certification Validation Service
D	Deliverable
DB	Data Base
DSE	Domain Specific Enabler
EC	European Commission
EPC	Electronic Product Code
EPCIS	EPC Information Service
ESB	Enterprise Service Bus
EU	European Union
FAO	Food and Agriculture Organisation
FI	Future Internet
FI-PPP	Future Internet Public Private Partnership
FMIS	Farm Management Information System
FMS	Farm Management System
GDP	Gross Domestic Product
GE	Generic Enabler
GNSS	Global Navigation Satellite System
GRAI	Global Returnable Asset Identifier
GTIN	Global Trade Item Number
GTS	Global Traceability Standard
I2ND	Interface to Networks and Devices
ICT	Information and Communication Technology
ID	Identification
IdM	Identity Management
IoT	Internet of Things
IPv6	Internet Protocol version 6
LBS	Location-Based Services
LU	Logistics Unit
LVS	Logo Validation Service
M2M	Machine to Machine communication
NFC	Near Field Communication
P2P	Peer to Peer
PI	Parallel Internet
PInfS	Product Information Service
QoS	Quality of Service
QR code	Quick Response code
RFID	Radio Frequency IDentifiction
RIS	Reproducable Information Service
ROI	Return On Investment
SAF	SmartAgriFood
SIFT	Scale-Invariant Feature Transform
SME	Small or Medium-sized Enterprise
SSCC	Serial Shipping Container Code
SU	Shipping Unit
TU	Trade Unit
UAV	Unattended Vehicle
UK	United Kingdom
URI	Uniform Resource Identifier
UWB	Ultra Wide Band
VNDB	Virtual Network Data Base
VRA	Variable Rate Application
WWF	World Wildlife Fund
XML	Extensible Mark-up Language
XMPP	Extensible Messaging and Presence Protocol

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1 Introduction

This report presents the evaluation of the SmartAgriFood pilots from an integral technological point of view. It assesses the feasibility of the technical architecture as implemented in the conceptual prototypes used in the pilots, and the feasibility of the Core Platform to support applications in agriculture and food supply chains with Future Internet technologies.

The intended audience are ICT-architects, systems analysts, and software developers. The report presents end-to-end scenarios for collaboration and information exchange across agri-food supply chain networks. It demonstrates how these scenarios can be realised according to the SmartAgriFood architecture with four general services: the product information service, the business relations service, the certification service, and the identification service. From this high level overview it zooms in to the technical architecture underlying the prototype realisation and the pilots in which details of the end-to-end scenario were tested. The testing aimed both at assessing the realisation and usability of the prototypes and at assessing the feasibility of the Core Platform and individual Generic Enablers.

1.1 Project background

The SmartAgriFood project is part of the Future Internet Public-Private Partnership (FI-PPP) program[1] and addresses farming, agri-logistics and food awareness as use cases. Using a user-centred methodology, the use case specifications are developed with a particular focus on transparency and interoperability of data and knowledge across the food supply chain. For each of the use cases, two prototype applications have been developed, focussing on representative details of the end-to-end scenario. A set of Generic Enablers, representing all of the FI-WARE chapters have been applied in the prototype applications. The prototypes were tested in pilots with end users.

The project's strategic vision can be summarised as follows:

- A growing amount of useful data is available, but hardly shared in the agri-food sector.
- Future Internet extends the Internet with functionalities to handle and use shared data.
- The FI-WARE Core Platform (CP) defines and implements a set of basic functionalities.
- On top of the CP, SmartAgriFood offers collaboration and data sharing applications.
- It boosts the SME-driven economy and helps to resolve major societal food issues.

Key features of SmartAgriFood concepts will be demonstrated and verified in trials and large scale demonstration in FI-PPP Phase II which starts in 2013.

1.2 Purposes of the report

The SmartAgriFood project developed ICT architectures and conducted experiments with prototypes for Future Internet support to farmers, supply chain partners, and consumers of agri-food products. The present report documents the evaluation of the prototypes to assess the domains that could be connected to the Core Platform for large-scale trial in FI-PPP Phase II. The purposes are to outline the most appropriate scenarios for trial specifications and to assess the feasibility of Generic Enablers to realise the trials.

1 http://www.fi-ppp.eu/

1.3 Assessment method

The scope of the project was on testing applications in specific stages of the supply chain. For these specific stages, prototype applications have been developed with which the functionalities from a user's point of view and the feasibility of Generic Enablers from an ICT point of view have been assessed. In addition, Generic Enablers were tested in isolation, i.e. not in the context of a pilot implementation. The results of the assessments from the ICT point of view are documented in this report. The test results were reported by the pilot teams and integrated in the present report. Furthermore, the test results are reported in Generic Enabler evaluation templates, provided by the FI-WARE team. The completed FI-WARE evaluation templates are attached as appendices to this report.

Realisation of full farm-to-fork functionalities was out-of-scope for the present project. In order to validate the architectural concepts designed for realisation in FI-PPP Phase II, farm-to-fork scenarios have been specified from farmers', logistics', and consumers' viewpoints. Simulations of the scenarios have been realised, including the roles of the general SmartAgriFood services (Product Information Service, Business Relations service, Certification service, and Identification Service). Using these simulations the architectural concepts to be implemented in Phase II could be validated at the conceptual level.

1.4 Related documents

The present report focusses on technical feasibility of the overall SmartAgriFood ICT architecture and the Core Platform, to boost supply chain collaboration and real-time product information exchange in agriculture and food supply networks. It is closely related the following deliverables from the project, which describe the non-technical aspects and details of specific supply chain stages:

- D100.4 – Final Strategic Overview
- D200.4 - Smart Farming: Final Assessment Report
- D300.4 - Smart-Logistics Standardization Needs and Roadmap
- D400.4 - Smart Food Awareness: Final Assessment Report
- D500.3 - Specification on network elements and functions of Core Platform
- D500.4 - Specification on protocols between domain networks of stakeholders and Core Platform
- D500.5.2 - Second Release of SmartAgriFood Conceptual Prototypes
- D600.4 - Infrastructure Specifications for Large Scale Experimentation
- D700.1 - Overall Implementation Plan for Large Scale Experimentation

Figure 1-1 depicts the relations of these reports with the chapters of the present one.

1.5 Report structure

Chapter 2 presents an overview of the SmartAgriFood architecture. It opens with a summary of the strategic vision, then presents the farm-to-fork scenarios and the relation of the pilots to the overall scenario, and is concluded by the technical architecture of the prototype realisations. Chapter 3 shortly introduces each pilot and the test set-up, documents the test outcomes, and formulates a vision and recommendations for extending the pilot to Phase II, form an ICT perspective. Chapter 4 summarises the evaluation from the users' viewpoints. Chapter 5 consolidates the pilot evaluations for each FI-WARE Generic Enabler chapter. Chapter 6 presents a first specifications of large-scale trials, to be elaborated in the cSpace project in which the Phase I results of the SmartAgriFood and FInest projects will be merged [20].

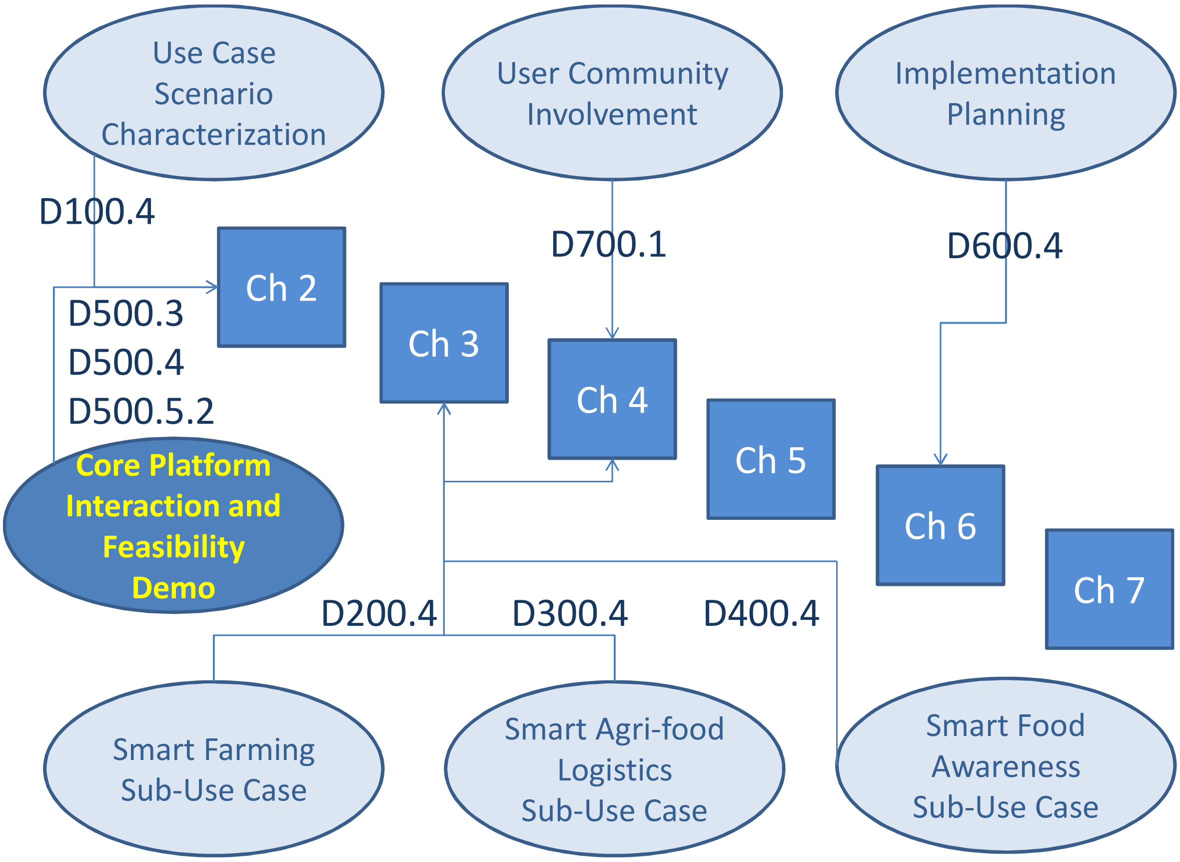

Figure 1-1: Relation between other documents and chapters of the present report.

2 Overview of SmartAgriFood

This deliverable of the SmartAgriFood project reports the feasibility of Future Internet technologies to enable innovations in agriculture and food supply chains. The present chapter introduces the context of the feasibility assessment. It starts with a presentation of the product vision and an overview of the farm-to-fork scenario, including a description of the high-level architecture. Subsequently it describes global scenario's, which have been simulated to validate the architectural principles. Next, it presents an overview of the pilots and the technical architecture of the conceptual prototypes, including the use of FI-WARE Generic Enablers.

2.1 Strategic vision

The purpose of the agri-food supply chain is to produce plant and animal products and to deliver the produce to consumers. Nowadays the realisation of agri-food products and specifically the operation of supply chains has become increasingly complex, due to great number and diversity of actors (smallholders, SME, multinationals, government agencies), the composition of food from a diversity of sources, the uncertainty and health risks associated with living and perishable materials, the dependency on external factors like weather and pests, and the continuous re-planning of activities due to these uncertainties. It is obvious that, given these complexities the information intensity and the millions of stakeholders involved, the Future Internet holds great promises for the agri-food sector (Figure 2-1).

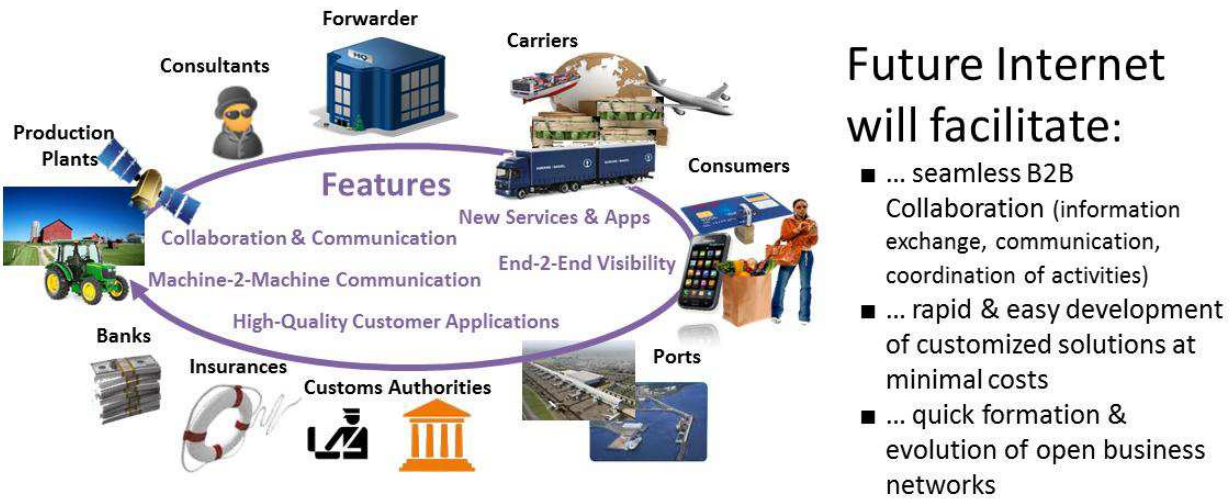

Figure 2-1: Agri-food business networks facilitated by the Future Internet

The SmartAgriFood software services build heavily on the functionalities provided by the FI-WARE Generic Enablers, as described in the deliverables D500.3 [11] and D500.4 [12]. As described in deliverable D100.4 [1], the SmartAgriFood services are to be elaborated for trials in the FI-PPP's second phase, in addition to services for more specific business functions, such as dynamic, on-line logistics planning and re-planning based on real-time information, and real-time exception detection and handling. Together with the general SmartAgriFood services, these services provide an open platform for the integration of additional, SME-provided services and legacy systems. They can be integrated in innovative agri-food applications, based on dynamic service composition by workflow controllers. By exploitation of the workflow controllers and the productivity-boosting functionalities offered by the FI-WARE Core Platform, the SmartAgriFood platform facilitates the availability of innovative software solutions for the agri-food sector and for the consumers of its produce. Figure 2-2 depicts this product vision and shows that the approach builds heavily on Generic Enablers in the FI-WARE Core Platform.

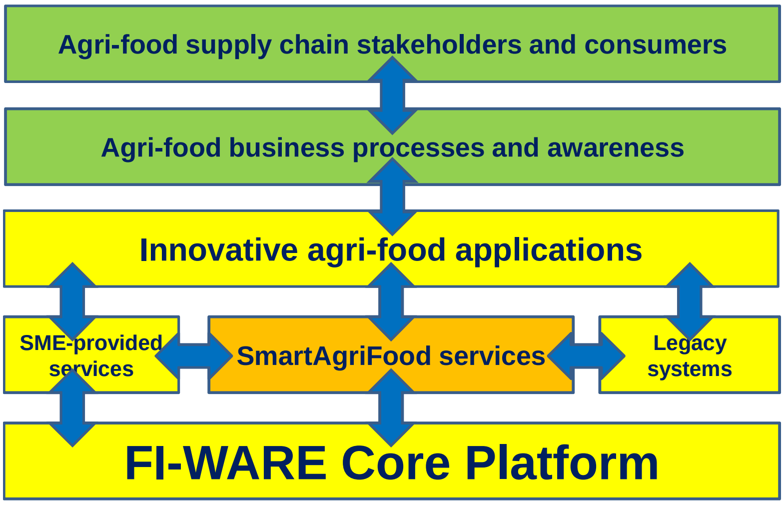

Figure 2-2: Summary of the SmartAgriFood product vision, building upon the FI-WARE Core Platform

The second as well as the third phase of the FI-PPP program offers the opportunity to take a next step in realising the envisaged SmartAgriFood architecture and to further mobilise the diverse stakeholders that have a serious interest in realising the SmartAgriFood vision. The main strengths of the envisaged solutions are in the adoption of the FI-WARE generic enablers and the promotion of the domain specific enablers supporting product information and business relations, and in the specific controllers for smart farming and tailored information for consumers, which are specifically related to agriculture and the overall food chain. Diverse aspects and business benefits are addressed that can come true based on specific agri-food functionalities like quality controlled logistics, quality based vendor Inventory Management, and tracking and tracing for rapid, high-precision, exception handling. On top of that, SmartAgriFood identified complementary expertise especially with respect to general logistics functionalities to realise real-time logistics support and re-planning. Collaboration on that has already started with the FI-PPP project FInest that specifically offers these complementary solutions and is therefore an ideal partner for future joint activities towards FI-PPP phase two and three. Hence, FInest and SmartAgriFood have already joined their efforts for developing a joint FI-WARE based platform for trials in the second phase of FI-PPP, called cSpace [20].

2.2 Overview of the farm-to-fork scenario

Figure 2-3 presents an example supply chain to be supported by the SmartAgriFood services. Tomatoes are grown in a greenhouse. The greenhouse climate is monitored and regulated by sensors and actuators connected with a farm management system (FMS). Along with the monitoring data, the production data, such as data about pesticide application, are recorded by the FMS. The farmer and a trader find each other through the internet and close a contract for delivery of the tomatoes. Before shipping the tomatoes, the farmer packs them in standard reusable Europool crates with electronically readable labels. The farmer registers the packaging event in a GS1 standard event repository (EPCIS). Through this registration, the production data of the particular lot are linked with the crate ID. The trader closes contracts with retailers and ships the crates to the retailers' distribution centres, where they are redistributed over shipments to the supermarkets. During these processes, all location changes and other events are registered in EPCIS event repositories, using the electronically readable crate labels. The trader monitors the location changes and can through the Internet of Things discover sensors (for temperature, humidity, shaking, etc.) in the environment of the tomatoes. The sensor data are used to forecast quality at point of sales, the result of which can be used to re-plan logistics or re-price the tomatoes. The consumer buying the tomatoes can be informed about the tomatoes history and forecasted quality, and can give feedback to the farmer. The farmer can follow the tomato on its way to the consumer and use this information, along with the feedback from consumers and supply chain partners, to optimize production processes and delivery schedules. In case of food safety hazards, e.g., the discovery of bacteria in production lots or laboratory analyses showing too high pesticide residue levels, all involved supply chain partners and even consumers who subscribed to this information, can immediately be notified with high precision.

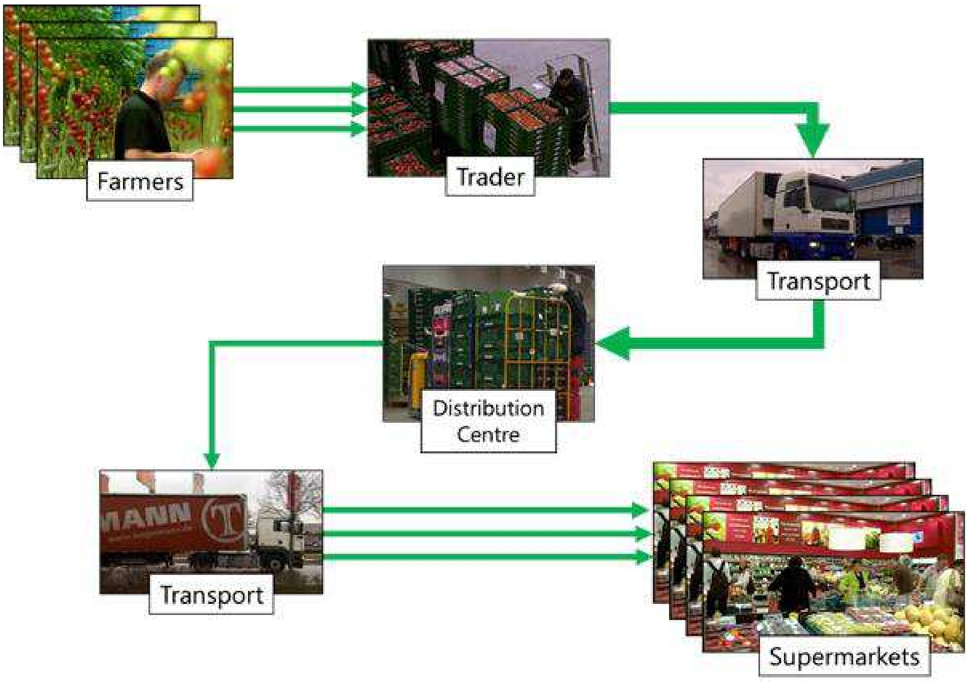

Figure 2-3: Overview of a typical agri-food supply chain

The specific issues for agri-food supply chains to be solved by the FI are (see Figure 2-4)

1. product information sharing between supply chain partners (e.g., farmers, logistics, and retail) mutually and with consumers, and
2. the collaboration, and associated with it, the discovery of new opportunities in the supply chain.

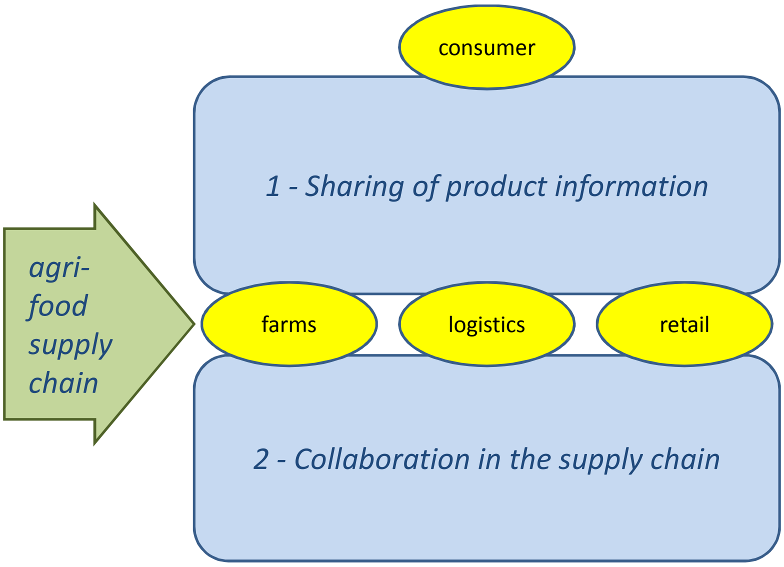

Figure 2-4: Main issues to be resolved by the Future Internet

According to the SmartAgriFood vision, the sharing of product information will not be realised by storing product information in large central repositories or by forwarding the information along the supply chain, but by opening the supply chain actor's private databases to trusted partners. When forwarding the products, the links between the data sources are recorded in event databases, using the GS1 standard solutions Object Naming Service (ONS) and Electronic Product Code Information Service (EPCIS). Products and product packages are identified by Global Trade Item Numbers (GTIN) recorded in electronically readable RFID or QR-code labels. In the SmartAgriFood architecture, the information sharing is enabled by the Product Information Service (Figure 2-5). The Product Information Service not only enables information forwarding, but also feedback from consumers to all supply chain partners, including direct feedback to farmers. All supply chain partners can use this information to tune product quality and delivery schedules to market demands, to an extent which is currently impossible.

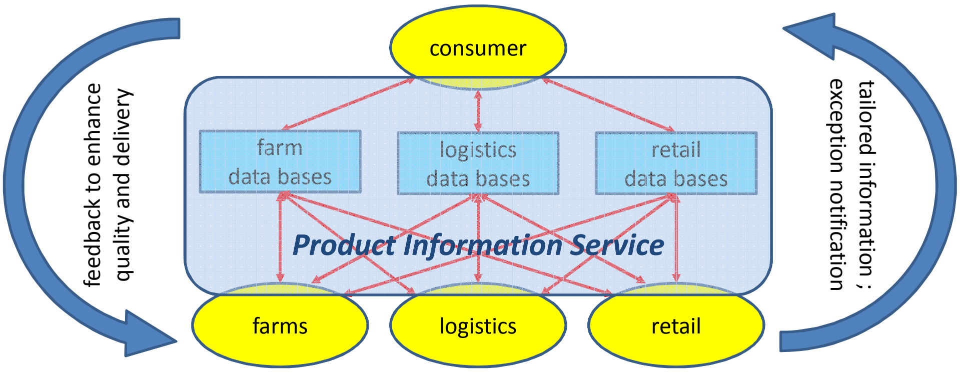

Figure 2-5: The Product Information Service, enabling data access from farm to fork vice versa

Supply chain collaboration requires specific attention in the agriculture and food sectors, because of the large numbers of smallholders and SME involved in production and logistics on the one hand, and the diversity of large food processing and retail multinationals, combined with a large number of SME in retail on the other hand. According to the SmartAgriFood architecture, the Business Relations Service enhances supply chain collaboration in particular for the smallholders and SME. This service supports the formation and operation of dynamic, complex, supply networks. It enables identification of potential partners, set up electronic contracts for new business service networks, real-time and on-time management of relationships based on the contracts and monitors the maintenance of service level agreements. The main features of the Business Relations Service are (1) visualisation of business services options, reducing the barriers for SME to participate in global business collaborations, (2) integration of on-line information about service level agreements, reducing the present overcharging due to lack of information, and (3) creation of trust-building feedback channels, enabling dialogues across the supply chain and customer-specific interventions.

The Product Information Service and the Business Relations Service are at the core of the SmartAgriFood architecture. These two basic services are to be supported by the Identification Service and the Certification Service, which are essential for building trust across supply networks where too many stakeholders are active in order to build trusted relations based on personal interactions.

- The Identification Service guarantees that electronic services which claim to be acting on behalf of a particular stakeholder indeed do so and accounts for the use of internet services.
- The Certification Services guarantees that information provided about stakeholders and products is trustworthy.

The four generic services are depicted is Figure 2-6. Together they extend the FI-WARE Core Platform with generic functionalities for realising innovative agri-food supply chain applications.

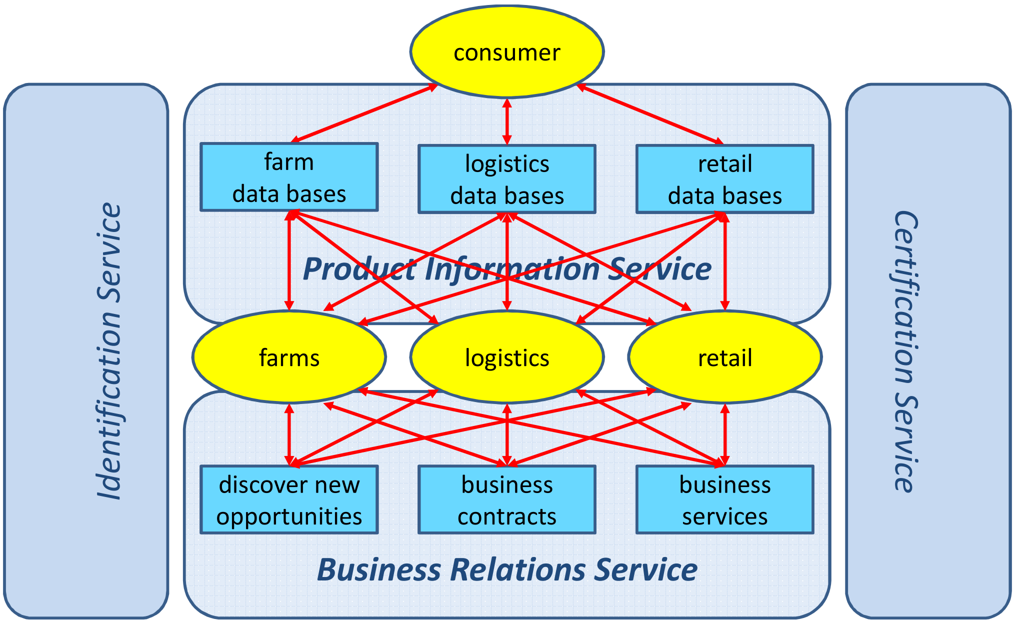

Figure 2-6: The four SmartAgriFood Domain Specific Enabler services

The generic services can be composed together with specific services for particular farming or logistics processes or consumer information, by specific controllers for each supply chain stage, with user interfaces tailored to the needs of the users in that specific stage. The architecture supporting the over-all farm-to-fork scenario is depicted as an Archimate model in Figure 2-7. The model shows the relationships between the services specific for each supply chain stage and the Domain Specific Enablers. Furthermore, it shows the role of the GS1 Object Naming Service (ONS) in identifying individual products and linking them to extended product information from farm and logistics databases, and the role of the EPCIS repositories in linking information through location changes and other events. The Identification Service is not included in this picture; it supports every single service in the SmartAgriFood ecosystem, while at the same time being part of the ecosystem.

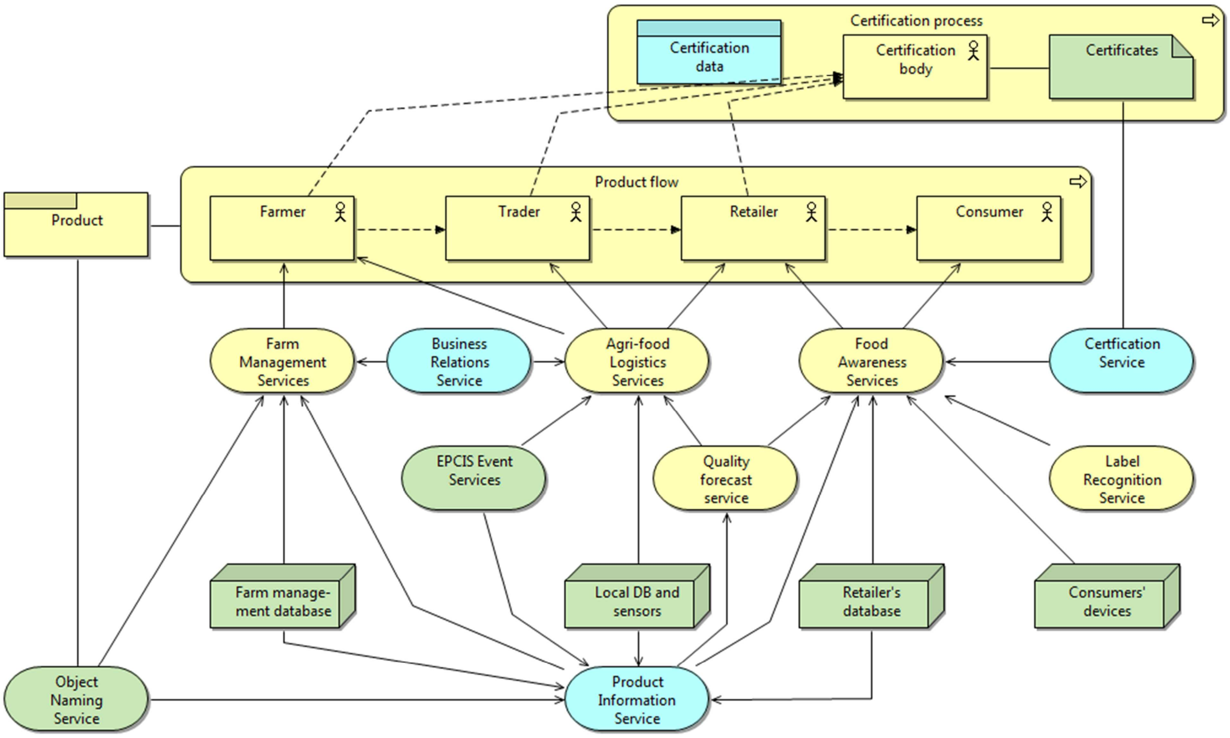

Figure 2-7: Archimate model of the SmartAgriFood architecture, supporting the farm-to-fork scenario

2.3 Simulation of the farm-to-fork scenario

The simulation of role of the Domain Specific Enablers in realistic scenarios is the first step in the technical feasibility assessment of the architecture and the concepts developed in the SmartAgriFood project. These simulations are performed with a tool developed by the University of Athens[2]. The tool is based on scenario representations in XML, the functioning of which can be visualised by the simulator. Simulation scenarios have been developed for the farm-to-fork scenario from three different viewpoints: the farmers' viewpoint, the traders' viewpoint, and the consumers' viewpoint. The present section describes the simulated scenarios. Downloadable XML-representations of the scenarios are available[3].

2.3.1 The farmers' perspective

Figure 2-8 depicts the simulated farmers' viewpoint scenario.

In the first step the farmer is authenticated by the Identification Service. This step has several purposes. First the identity of the farmer is verified, so that supply chain partners and service providers can trust that the farmer is the farmer indeed. Access to data is controlled through this authentication. Secondly, it makes the farmer's service subscriptions available for use in service composition by the smart farming controller. Furthermore, it enables billing for services used.

The smart farming services support the farmer in farm monitoring, decision making, and production processes, such as the application of pesticides. The smart farming services use the Future Internet technologies. The use case scenarios for the smart farming are described in detail in Chapter 3. In the present chapter we focus on supply chain interactions. It is important to note that all data recorded during the farming (production logs and observations about the produce) are recorded in the farming system and will not be forwarded along the supply chain.

When products are ready for delivery, the farming services call the Product Information Service to register the link of the data in the farming system with the GS1 Object Naming Service (ONS), and to receive a GTIN (Global Trade Item Number) for each production lot.

When the farmer is certified, e.g. for the use of some organic farming label, the famer may update the data underlying his certification.

When all has been set to bring the produce to the market, the farmer registers his offering with the Business Relations Service. Supply chain partners may, after authentication with the Identification Service, register their demand and when a match is found, the product data can be downloaded though the Product Information Service and the associated peer-to-peer business network. In this process the farmer has control of who has access to which data in his farming system, based on authentication by the Identification Service. After consulting the certification service to verify the farmer's claims about product and service quality, a contract is proposed to the supply chain partner. The Business Relations Service supports contract drafting and the entailing workflow composition. When both partners have agreed the service confirms the contract to both.

Assuming that the contract entails delivery in Europool crates, the farmer can package the produce, if required label the packaged products with the GTIN (in RFID or QR-code), and call the agri-food logistics service to register this event with the EPCIS service, which links the individual product or the product production lot GTIN to the crates' RFID labels.

The carrier scans the RFID labels when the crates are shipped and records the location change as an EPCIS event.

2 Download the simulator software: http://scan.di.uoa.gr/index.php/open-source-software

3 Download the scenario's:

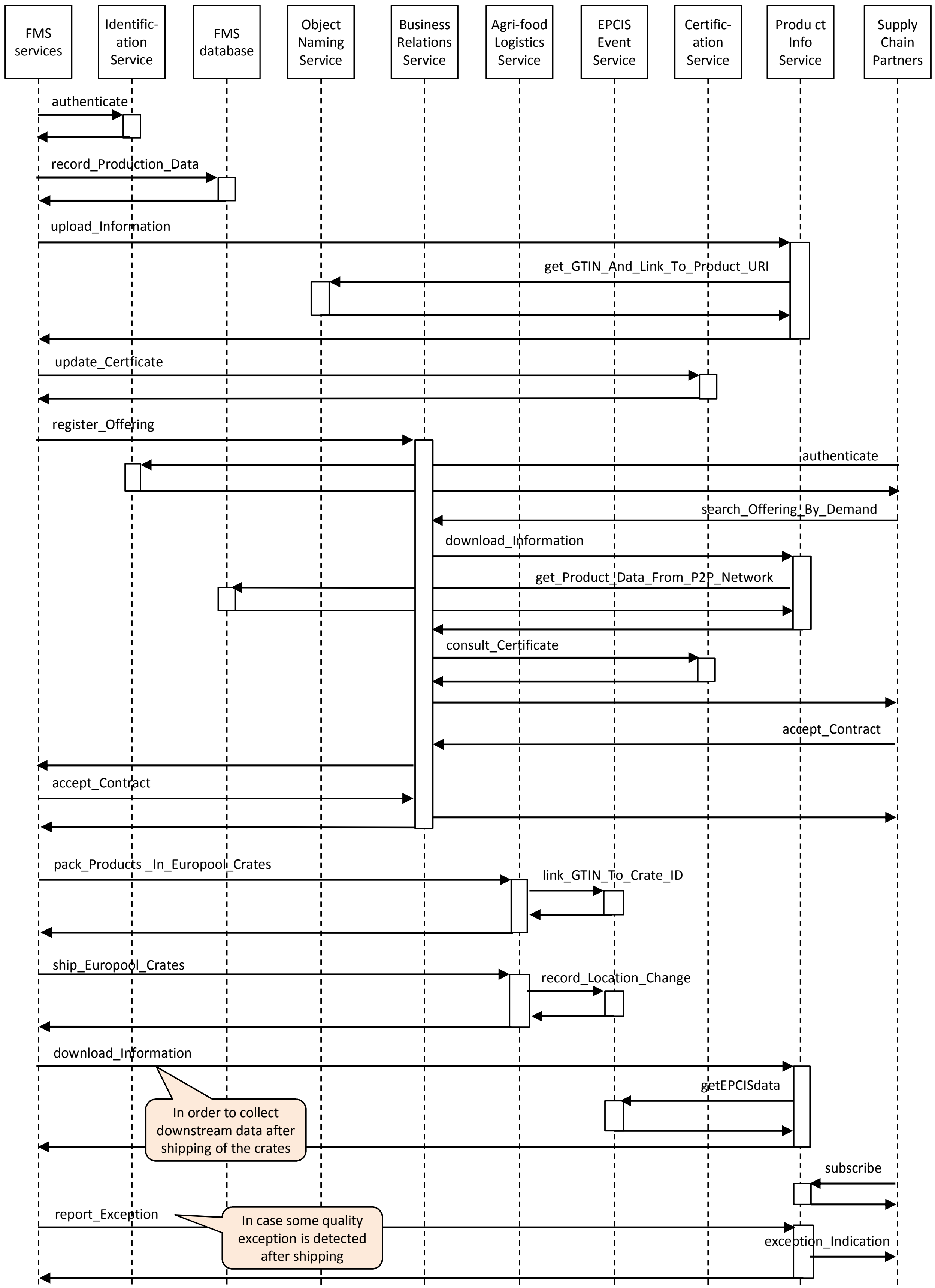

Figure 2-8: Example scenario for the Smart Farming sub-use case

When all subsequent location changes are recorded as EPCIS events, the farmer can follow his products downstream the supply chain and use this information to acquire data (through the Product Information Service and the peer-to-peer network) about quality degradation during transport, quality at point of sales, time of sales, lead times etc.

Supply chain partners can subscribe with the Product Information Service to any information to come available about the product or the production lot.

In case that the farmer or other parties become aware of health hazards, e.g., based on revealed contaminations of inputs or laboratory analyses which show unacceptable pesticide residue levels, they can report the exception to the Product Information Service. Involved supply chain partners can rapidly and with high precision be tracked through the EPCIS events. The Product Information Service will notify those partners and the subscribers about the exception.

2.3.2 The traders' perspective

Figure 2-8 depicts the simulated traders' viewpoint scenario.

Like all actors involved in the supply chain, traders and carriers authenticate with the Identification Service.

At every location change or repackaging of the products, the RFIDs or QR-codes are scanned and location changes are recorded with the EPCIS event service. This allows full tracking and tracing, beyond just delivering packages. Also the repackaging and, for instance, cutting, slicing and mixing of meat are recorded as events.

Quality management is an important issue is agri-food logistics. Large volumes of produce are wasted due to quality degradation before they reach the consumers. SmartAgriFood logistics services aim to exploit the Internet of Things for advanced quality management. Traders can monitor in real-time the environments where there goods reside, by discovering and reading the data on sensors present in those environments. The quality forecast service uses this information to estimate the future quality development. It collects basic data through the Product Information Service. Using the ONS the link to the farm and product data, such as the quality at shipping time, can be retrieved. Using the EPCIS event data, current and past locations can be found. Through the peer-to-peer network, the Product Information Service collects product data and sensors. Subsequently it reads the sensor data and delivers it to the quality forecast service, which presents the expected quality over time, dependent on expected environmental conditions.

Based on the quality forecast and logistics information, for instance when a truck is stuck in a traffic jam or is delayed due to defects, the trader can decide to re-plan the logistics and to find another outlet for the products. An interested retailer nearby the current location of the truck may be registered with the Business Information Service.

The trader can offer the goods through the Business Relations Service. When a nearby retailer has registered an interest in the particular product, the Business Relations Service can bring them together, present them with reputation data collected in the recommender system and propose a contract. The Business Relations Service assists in negotiating and closing the contract, handling the payments etc. The trader can then use the agri-food logistics services to redirect the trucks for delivery at the retailer, and schedule a new transport for the original delivery.

Finally, reusable packaging materials, such as Europool crates, must be returned, and cleaned after return. These location changes and other events are also recorded as EPCIS events. Thus the management of pools of reusable packaging materials can be optimized, based on precise knowledge of the location and status of each item.

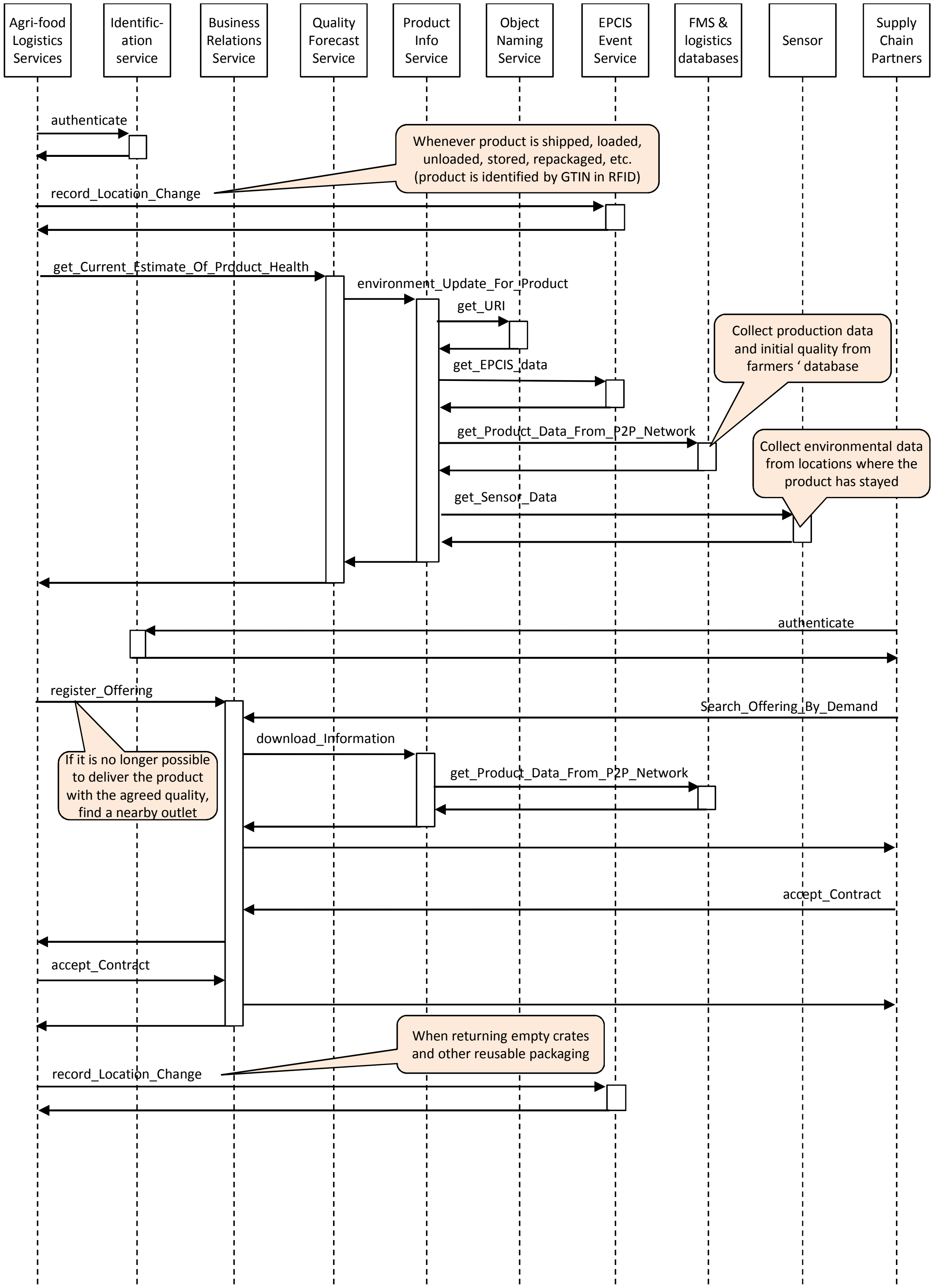

Figure 2-9: Example scenario for the smart agri-food logistics sub-use case

2.3.3 The consumers' perspective

The viewpoint of the consumer is somewhat different from that of the supply chain partners. The latter are primarily interested in a smooth business process, and product information is instrumental. From the consumers' perspective product information is the core issue. The modern consumer does not simply buy food, but he/she buys food and the information associated with it [Kinsey 2001. For instance: How will this product affect my health? Does it contain any allergens? How long can I keep it? Is it fair trade? Is it organic? What is the footprint? Were the animals treated well? Is child labour involved? How are woman's rights guaranteed? The main purpose of the Food Awareness scenario is not process optimization but information. Figure 2-10 depicts the scenario.

Unlike the firms in the supply chain, consumers do not necessarily authenticate. They may remain anonymous.

Consumers can ask the certification service for information about labels on products, such as organic or fair trade labels.

Products can be identified by the GTIN in the RFID or QR-code labels, which can be scanned by mobile devices. Based on the GTIN supply chain partners, including the retailers, can make product information available on the peer-to-peer network, accessible through the product information service. Examples of such product information could be a list of firms involved in the production and delivery, the origin of feedstuffs or other inputs used actual quantities of pesticides or antibiotics used for this product, actual food miles for this particular product, or allergen information. The data is delivered to the consumer's device by the Product Information Service and further processed by the food awareness services.

In order to check the reliability of the data and the products, consumers can consult the certification service. Using the GTIN, it can collect all certificates related to the product and the supply chain parties involved in its production and delivery.

The food awareness services enable the collection of ratings given to the product or supply chain parties by other consumers, through the Business Relations Server or through social media.

Consumers can also provide ratings. The Business Relations Service will inform the supply chain partners about the given ratings.

Furthermore, the consumers can provide feedback on individual products or product lots to the farmers, through the Product Information Service. Farmers can use this feedback to improve their production and delivery processes, or select different marketing channels. For instance, a consumer can ask: "Good tomatoes! I bought them from shop X. where else I buy them? Or could you have them delivered at home?"

The quality forecast service is available to consumers, for instance for variable best-before-dates.

Consumers can subscribe to updates on products they bought, using the GTIN. In case of health hazards or other exceptions, they will be notified through the Product Information Service.

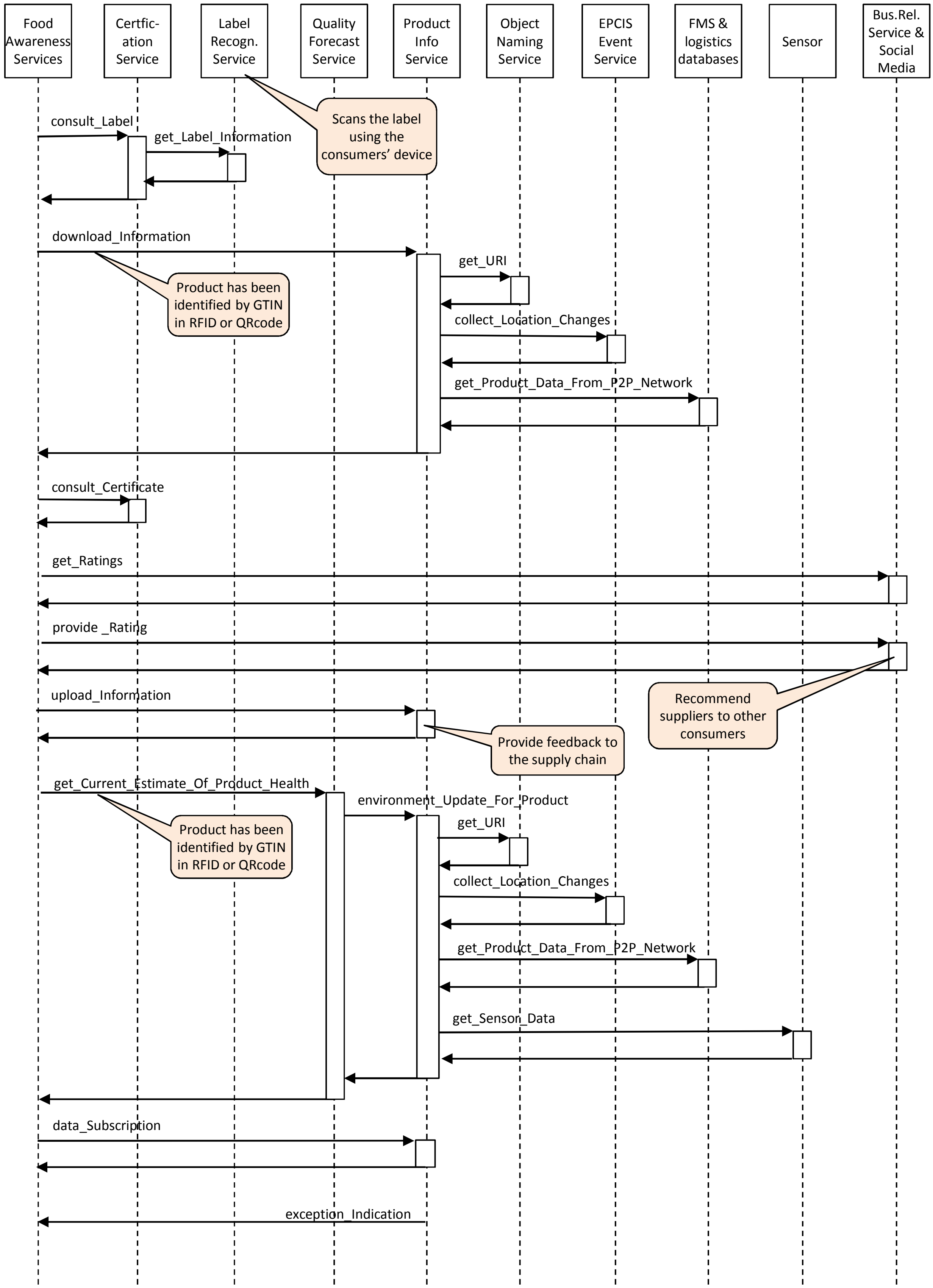

Figure 2-10: Example scenario for the smart food awareness sub-use case

2.4 Overview of the pilots and their relation to the farm-to-fork scenario

The scenarios presented in Section 2.3 demonstrate the use of the four generic SmartAgriFood services in information exchange and collaboration throughout agri-food supply chain networks. The demonstrations illustrate the feasibility of the SmartAgriFood concepts based on Future Internet technologies. Deliverable D500.3 [11] describes in detail which information is exchanged and how the four generic SmartAgriFood services can be realised on top of the FI-WARE Core Platform. Deliverable 500.4 specifies the interfaces of the generic services and the controllers for each of the supply chain stages.

In the context and the work plan of the project, full realization of these scenarios was not foreseen. The project focussed on pilots with conceptual prototypes to assess the feasibility of the Future Internet and the Generic Enablers in different stages or aspects of the supply chain, in use case related to farming, logistics, and food awareness. Figure 2-11 presents an overview of the pilots and relates them to the farm-to-fork scenario.

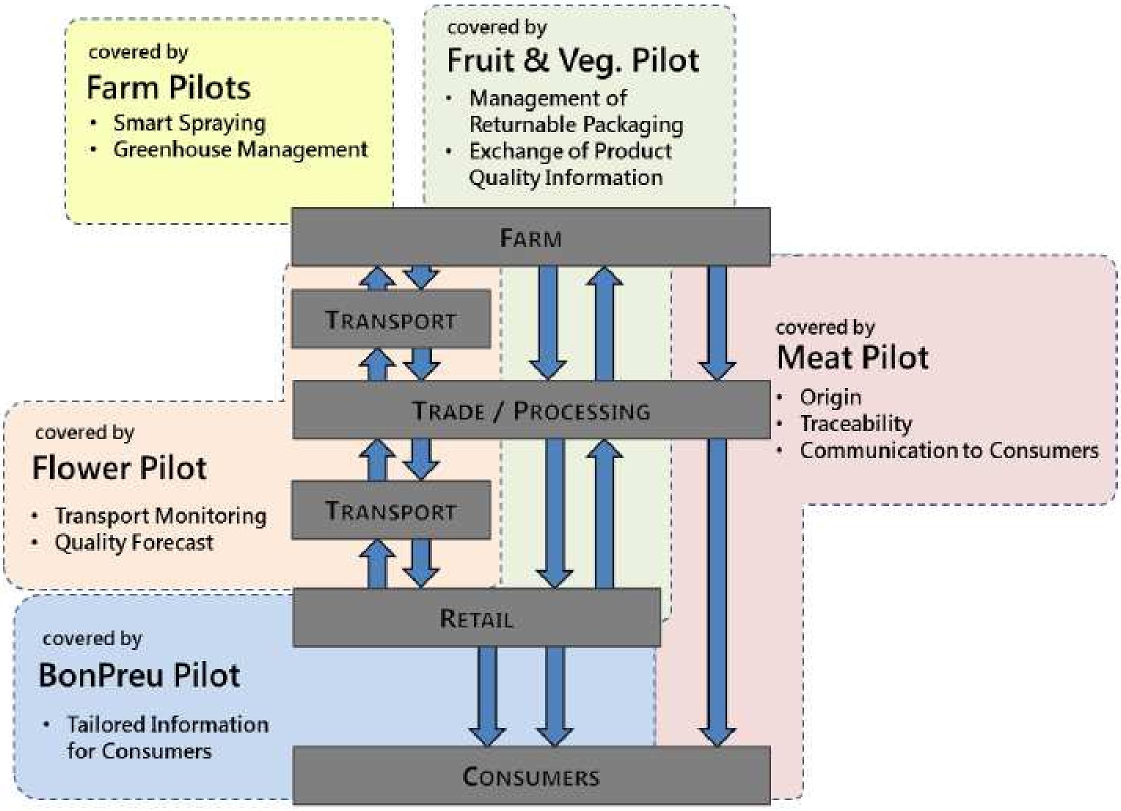

Figure 2-11: Relation of the SmartAgriFood pilots to the farm-to-fork scenario.

Together, the pilots cover a great part of the scenario's presented in Section 2.3. However none of the pilots covers a full farm-to-fork scenario or implements the generic SmartAgriFood services. The present project is a lead-up to the realization of such scenario's and generic services in the Phase II trials. The purpose of the current pilots is to assess the feasibility of Future Internet and the Generic enablers to realise innovations in the use cases of Smart Farming, Smart Agrifood Logistics, and Smart Food Awareness.

The following section is the last of this chapter. It presents the technical architecture underlying the conceptual prototypes applied in the pilots.

2.5 Technical architecture

In Section 2.2 of this document a technical overview of the farm-to-fork scenario is available. This description includes the description of the Generic SmartAgriFood Services, further explained in the deliverables D500.3 [11] and D500.4 [12] already submitted by the project. This chapter goes a step deeper, and focuses on the usage the end-to-end scenario makes of the Enablers, both the Domain Specific and the Generic ones, explaining how these are integrated into its technical architecture in the three subdomains that compose the food chain: Smart Farming, Smart Agri-food Logistics and Smart Food Awareness.

2.5.1 Overview of Domain Specific Enablers

The Domain Specific Enablers (DSE) are software modules with a concrete functionality for a specific domain. For example, a Data Analyser in a farm, gathering data from a sensor in a greenhouse, will be different from one installed in the venue of a retailer or a trader. Many different DSE have been developed within the systems of the three subdomains of the chain, and are described in Table 2-1. A further explanation of these modules can be found in the D200.2 [3], D200.3 [3], D300.2 [5], D300.3 [6], D400.2 [8], and D400.3 [9].

Table 2-1: Domain Specific Enablers per sub-domain

Sub-domain	Pilot	Name of the DSE	Functionality
Smart farming	Greenhouse management	Data Collector	Its main task is to transfer data to and from the Data Collector Database and the Raw Data Database, internal DDBB of the system.
		Data Analyser	It is mainly involved with the processing and analysis of different types of data and different types of context. It also checks periodically if some received values are not inside an expected range.
		Statistical Analyser	It processes an amount of data using mathematical and statistical functions. Its main operations include the analysis of the system's performance using data mining techniques as well as the identification of a malfunctioning farming machinery or sensor.
		Coordination module	This module receives input from the Data Analyser and the Statistical Analyser and has the "intelligence" to handle a situation. This especially useful in cases where two services may try to enforce conflicting actions.
		Execution module	It is used for actions that can be executed automatically inside a farm (e.g. open the windows start the ventilation system, initiate a firmware update, etc.).

Sub-domain	Pilot	Name of the DSE	Functionality
		Notifier module	It will be used to inform stakeholders (e.g. farmers, buyers, spraying contractors, agriculturists, etc.) about events of the existing system or it will send information about issues that may be of interest to them.
	Smart spraying	Service framework	Supports functionalities such as User Registration, Sign In, Service Registration, Searching and Subscribing to Services and Rating Services. It also supports information exchange and user interface embedding between the registered third party services.
Smart farming	Fruits and Vegetables (FFV)	Connected Device Handler	This domain specific enabler is in charge to manage the connections of the different de-vices and is implemented as an Enterprise Service Bus (ESB)
		Data Management	Module in charge to abstract the lower layer and composed by a NoSQL storage system in order to be able to manage heterogeneous information based on multiple data formats
		Request Handler	The responsibilities of this module are handling all requests about product related information. Directly connected to the Identity Management and Security module, it prevents the misuse and unintended disclosure of information
		Exception Propagation	Its main responsibility is propagating information caused by anomalies in products or processes
		User Notification	In charge to propagate manual notifications launched directly by users when irregularities are detected in the products
		Session Management	Closely connected with the Identity Management GE, it is responsible to manage both specific and anonymous sessions
		Ext. System Communication Handling	Module in charge to connect different systems involved in the FFV Pilot and manage connections among the different providers involved in the Pilot
	Plant and Flowers (PF)	Expert System - Prediction Web Service	The expert system predicts the quality decay of a plant of interest based on the history of its environment. With this,

Sub-domain	Pilot	Name of the DSE	Functionality
			higher levels of intelligence in food logistics information processing (cf. [14]) can be reached. The prediction functionality is realized as a web service, which communicates with the main dashboard application
		Event Platform	It is charge of gathering all the events sent by the different actors in the flower chain, mainly from sensors, as RFID readers
		Cloud Dashboard	Based on the cloud, this dashboard makes possible the management of the Event platform. It is the interface used by the stakeholder's employees, where they can find all the information related to a product
Smart Food Awareness	Tailored Information for Consumer (TIC)	SmartWebProxy	It is a high level model that allows a mobile device to carry out tasks that are necessary for the tailoring information process, in form of web technologies (HTML5, JavaScript) instead of having native applications.
		Logo Recognition	A picture/pattern recognition algorithm identifies the specific quality sign and compares it with available information on the Future Internet including the sign owner and the manufacture of the product.
	Tracing and Awareness in Meat supply chains (TTAM)	Server query cache	The fTRACE server handles large volumes of querying. It is vital to cache query requests to serve identical queries from the cache in the web server instead of making unnecessary database query
		B2C query module	It is a web service that generates HTML5 document from consumer query response to be sent to the user's mobile device

2.5.2 Application of Generic Enablers

The SmartAgriFood project has studied many of the GEs already released by FI-WARE, due to the diversity of functionalities developed by the different pilots along the food chain. Many other GEs were studied by us, although we only had their specification in the "High Level description document" provided by FI-WARE at the beginning of the Phase I. Some of these not yet released GEs are also very interesting for applications in agriculture and food supply chains. Chapter 6 elaborates on the envisaged use of the Generic Enablers during FI-PPP Phase II.

During Phase I, some GEs have been identified as useful for our developments and have been integrated into them, being used nowadays in our Proofs of Concept (PoC) and demos [D]. Others, although interesting for us, could not be integrated because of technical problems (documentation not in English, some functionalities not ready, problems accessing to them, etc.) [U] Finally, the functionalities of other studied GEs did not fit with the requirements of our project or were not consolidated enough to be used [E]. In Table 2-2 and Table 2-3 the current usage of the each GE per PoC can be found.

An evaluation of the GEs has been provided to the FI-WARE partners, using the templates provided by them. The filled-out evaluation templates are attached to this document as Appendices A and B.

Table 2-2: Levels of usage of a GE in a PoC

GE integrated in a Demo PoC:	D
GE taken into consideration in a design	U
GE studied and experimented with	E

Table 2-3: Utilization of each PoC of the released GEs

Cloud Chapter	Name	Greenhouse	Spraying	FFV	PF	TIC	TTAM
Allocation of VMs	IaaS Data Center Resource Management	D				D	E
Allocation of Object Storage	FI-WARE Implementation	U					
	IaaS Service Management - Claudia						
I2ND							
Cloud Proxy	Cloud Edge / Technicolor	D					
Data Chapter							
Complex Event Processing (CEP)	IBM Proactive Technology Online / IBM	E		D	D		
Publish/Subscribe Broker	SAMSON Broker / Telefonica	D		U	U	U	
Publish/Subscribe Broker	Context Awareness Platform / Telecom Italia						
BigData Analysis	SAMSON / Telefonica						
Compressed Domain Video Analysis	Codoan / Siemens						
Media-enhanced Query Broker	QueryBroker / Siemens						
Location	LOCS / Thales Alenia Space			U	U	U	
Semantic Application Support	- / ATOS						
Semantic Annotation	SANr / Telecom Italia						
Apps Chapter							
Service Description Repository	Service Description Repository / SAP	D					
Marketplace	Marketplace / SAP	U	D			U	
Composition Editor/Execution	Light Semantic Composition Editor - COMPEL/ ATOS						
Composition Editor/Execution	Mashup Factory / DT	D			U		
Composition Editor/Execution	Ericsson Composition Editor (ECE) / Ericsson						
Composition Editor/Execution	WireCloud / UPM						E
Mediator	Mediator_TI / Telecom Italia	D		U			
Mediator	SETHA2 / Thales						
IoT Chapter							
(Backend) Things Management GE	Things Management GE - TID/NEC	U	E		E	E	
(Backend) Device Management GE	N.A.	E	E		E		
(Gateway) Data Handling GE	CEP Mobile Manager/Orange,SOL-CEP/ATOS	E	E		E		
(Gateway) Protocol Adapter GE	ZPA / Telecom Italia	E	E		E		
(Gateway) Device Management GE	Ericsson Gateway / Ericsson		E		E		

Security Chapter							
Security Monitoring GE	Service Level SIEM (SLS) / ATOS; Attack Path Engine/Thales						
Identity Management	GCP / DT	U	D	D	E	D	
Identity Management	One-IDM / NSN						
Data Handling	PPL / SAP		E			D	
DB Anonymizer	DBA / SAP						
Secure Storage	SSS / Thales						
	TOTAL	**14**	**8**	**5**	**10**	**7**	**2**

3 Scenarios tested in the pilots

This chapter reports the results of testing the conceptual prototypes in the pilots. Each of the pilots and its roles in the farm-to-fork scenario are introduced. The test scenarios are described and the results are presented, with special attention to the feasibility of the Generic Enablers. Each section is concluded by an outlook to potential innovations and, when applicable, recommendations to enhance the Core Platform's functionalities.

3.1 Smart Spraying

The Smart Spraying Pilot targeted to investigate the requirements for Future Internet technologies from the point of view of Precision Agriculture and beyond. Precision spraying was chosen as an example case since it is an information intensive task, and is sensitive with regard to weather circumstances, timing, correct chemical dosing, food safety, and environmental impacts. Well controlled precision spraying with optimal timing and spraying setups is a complex and demanding task for a farmer. An extra challenge is to cope with the unexpected situations like weather change or machine breakdown during the spraying. When contracting spraying, the challenge is also to serve optimally customer farm's business targets and act correctly in sometimes unfamiliar fields.

The scope of the pilot was to tackle the complexity related to precision spraying operation management and diversity of farms with different business goals and resources.

The challenge is:

- Firstly, to create and provide farm/customer specific assisting services available for fluent task planning and execution, and
- Secondly, to enable the employment of the assisting services in an organized and user friendly way by the farmer or contractor, especially during the mobile work.

The aim is that results are applicable also to other farming tasks, their management, and execution support.

During the project we specified and developed using user-centric approach (D200.4 [4]) a Service Framework solution with tight integration with FI Global Customer Platform (GCP) identity management (IdM) and Marketplace Generic Enablers (GEs) (D200.3 [3], D500.5.2 [14]). The proposed solution enables tailored farm management system services where farmer has freedom to choose the most suitable service bundle and easily change the service provider. Global Customer Platform and Marketplace integration enables easy providing and purchasing of services and registering and taking them in use anywhere and anytime. In sudden or hazardous work situations, farmer is able to purchase and register services on-line to receive location and context aware assistance in real-time, e.g. to avoid environmental emissions. The system takes care of the complexity of inter-connecting several sub-services on behalf of the user. The automatic information exchange between loosely coupled services enables fluent information and work flow. Usability is improved by third party service User Interface exchange and embedding which gives impression of operating only one application.

3.1.1 Relation of the pilot to the farm-to-fork scenario

Related to the farm-to-fork scenario presented in Chapter 2 the Smart Spraying pilot per se resides in the farm end. In addition it provides crop and environment related information to the stakeholders in the food supply chain. The functionalities implemented in the Smart Spraying pilot are divided into the general service framework functions and the E-agriculturist functions (D200.3 [3], D500.5.2 [14]). The farm management services referred to in Figure 2-8 are a combination of these two building blocks. As a part of the E-agriculturist functions the farm data, the data collected from the farm operations, is stored into a third party data storage service apart from any of the assisting services.

As pointed out in D100.4 [1] the separation of farm data from applications brings benefits to the farmer and the whole food supply chain and the service ecosystem related to that as well. With standardized interfaces several from each other independent sub-services and applications of Farm Management System using the same data source are able to provide efficiently added value to the farmer. Also, farm data is able to be used by other stakeholders for many other purposes, like product information services in the context of the whole food chain.

3.1.2 Scenario's tested

The Smart Spraying and the FI enabled Smart Spraying service concept have been evaluated and tested during the project with tight interaction with developers, end users and other stakeholders. The process as well as the results is described in detail in D200.4 [4].

Based on the requirements for the Spraying Pilot [4] three essential FI Generic Enablers were identified: Global Customer Platform GCP IdM, Marketplace and Things Management (Figure 3.1.1). The GCP and the Marketplace GEs are tightly integrated into the Smart Spraying Service Framework architecture (D200.3 [3], D500.5.2 [14]). IoT GEs are needed in the context of automatic discovery and utilization of location aware sensors and sensor networks. The GCP IdM implementation is fully integrated. The Marketplace and the IoT GEs are handled at conceptual level.

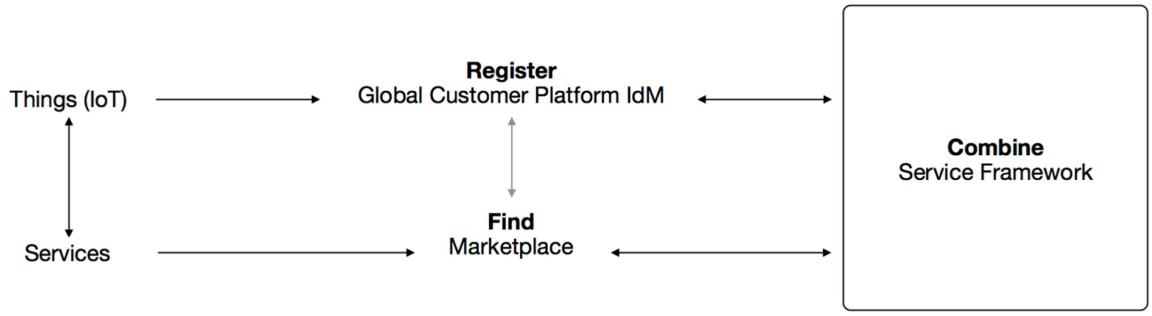

Figure 3-1: The Smart Spraying Service Framework relation to FI-WARE GEs

3.1.2.1 Scenario 1

A user licenses a smart spraying service framework implement and walks through the sign up process to register it.

Related GEs:

Global Customer Platform GCP IdM GE: A smart spraying service framework implement aims to use the GCP for IdM and session management operations. The priority is in sign up, sign in and session management as well as to provide the user easy-to-use customer self-care management tools.

3.1.2.2 Scenario 2

When a user signs up as a smart spraying service framework user, the services already registered into the GCP IdM become visible through integrated Globally Registered Services view. One of the core functionalities in the Smart Spraying service framework is to enable automatic data and functionality exchange between the framework registered services (D500.5.2 [14]). A user finds and licenses a disease pressure service (DPS) from an integrated marketplace. Usually a DPS algorithm needs weather information (either current or forecast) for the proper calculations as well as the information on performed actions on the field, for current and last year. The DPS automatically detects that the user has a GCP registered weather stations and a weather service with a license to use it also in third party services and suggests them as alternatives. The information on the farm operations is provided by the farm data storage service.

Related GEs:

Global Customer Platform GCP IdM GE: The globally registered services of a user become visible and accessible within the smart spraying service framework. The user's GCP registrations are queried using relevant REST API (D500.5.2 [14]).

Marketplace GE: The integrated marketplace enables the user to easily find, license and switch the e-agriculturist services needed. The services and the offering relevant to the smart spraying service framework implement are presented in a Market view. The contract and money sharing issues are taken care of by the SLA management and the revenue sharing and settlement systems, part of the applications and services ecosystem and delivery framework.

Things Management GE: IoT encapsulation in weather stations and weather station network makes it easier for a user and third party services to discover and access the location aware sensor data.

3.1.2.3 Scenario 3

A user has two weather stations in his/her fields. He/she needs to share the weather station data with minimum efforts with third party services. A user might also want to sell the current data to third parties to cover the expenses.

Related GEs:

Things Management GE: Gives a single point of contact to the user. IoT encapsulation in weather stations and weather station network makes it easier for a user and third party services to discover and access the location aware sensor data.

Marketplace GE: A weather station backend service is registered into a marketplace as an offering.

3.1.2.4 Scenario 4

A spraying contractor receives an order from his/her existing customer farm to take care of fungicide spraying in certain fields. To fit the new task in his/her work schedule and to carry out the work in correct time the contractor licenses a disease alarm service using an embedded marketplace in his mobile implement of the service framework (D200.3 [3], D500.5.2 [14]) to the customer farm's fields. Due to a trusted relationship the contractor has an access to the farmer's farm data service as well as other relevant services the farmer has registered into the Global Customer Platform. For the best disease pressure calculation outcome the contractor selects or the system suggests the most relevant weather station registered for the farmer's use in the GCP to be used in the calculations. After the set-up the contractor is able to follow the progress of disease status in the customer's fields to fit their treatment optimally to his/her own task schedule.

Related GEs:

Global Customer Platform GCP IdM GE: The globally registered services of a user become visible and accessible within the smart spraying service framework. The user's GCP registrations are queried using relevant REST API (D500.5.2 [14]).

Marketplace GE: The integrated marketplace enables the user to easily find, license and switch the e-agriculturist services needed. The services and the offering relevant to the smart spraying service framework implement are presented in a Market view. The contract and money sharing issues are taken care of by the SLA management and the revenue sharing and settlement systems, part of the applications and services ecosystem and delivery framework.

Things Management GE: IoT encapsulation in weather stations and weather station network makes it easier for a user and third party services to discover and access the location aware sensor data.

3.1.3 Test results

The overall user feedback related to the possibilities provided by the FI Generic Enablers in the context of the Smart Spraying pilot was positive.

As stated in D200.4 *"In conclusion of the end-user validations we may state that end-users were able to comprehend and get interested on services that could be opened to them via the FI technologies. In the earlier interaction with the end-users in 5 different countries the end-users expressed doubts and even somewhat pessimistic responses. When we presented a systematically defined concept and demonstrated a proposal for the user-interface and discussed it with the end-users they were much more positive towards the future possibilities.*

The end-users did see benefits of the proposed service and spraying concepts what regards to increasing effectiveness of work and reduction of workload, but in particular they found possibilities to develop the work, create learning and improve competences. ***These positive effects are due to the improved utilisation of information for understanding the complex agricultural phenomena of farming, and due to the possibilities to interact within the network of farmers, and even the wider communities of the entire food chain. Direct links to consumers was seen positive from business, safety and product quality point of view.***

Even though the overall response was quite positive there were issues that clearly need attention when the Smart farming concept is developed further. The most pressing issues were related to efficient management and processing of information, compatibility between different systems, reliability of information and security issues, and automatic input and registration of information." [4]

From the developer's point of view, as a GE user, the overall experience has been positive. The research and evaluation of GEs performed by reading (including product vision, architecture descriptions and open/open API specifications) as well as by concrete testing has indicated that the usage of the GEs in software development process supports developing new innovative architectures to bring ease of use, ad hoc service employment and real time assistance into the mobile work environment.

3.1.4 Innovations enabled by the Future Internet

The spraying pilot focuses on the external service level in the FMS Architecture (D200.3, figure 2-2) [3]. All the functionalities presented on the spraying pilot business process model (D200.2, chapter 2.4.5, figure 14) [2] are considered as loosely coupled interconnected services. The overall architectural decisions are based on service-oriented architecture (SOA) principles and methodologies.

Based on the value proposition and functional requirements [4] the smart spraying pilot introduces a service framework that provides innovative services not only to the farmers but to actors in the whole food chain. An implementation based on the framework architecture enables end users easily to find, licence, utilize and change the services to build meaningful and relevant farm service ecology.

The initial software requirements (derived from the business requirements and value proposition described in D200.4 [4]) behind the architectural decisions are:

- A service should support identity management like FI Global Customer Platform
- A service should support a FI Marketplace integration
- A service should support information exchange between any third party service when applicable
- A service should support any third party service user interface exchange and embedding when applicable

The functionalities implemented in the Smart Spraying Pilot are divided into two parts; namely, the general service framework functions and the E-agriculturist functions. Together with FI Generic Enablers the architecture and infrastructure of the general service framework functions provide IdM and marketplace services and enable information exchange and user interface embedding between registered services for enhanced scalability. The E-agriculturist functions as third party services enable, among other things, spraying setup functions and machine breakdown support.

The service framework forms tight integration with the identity management (GCP) and the marketplace. It uses the IdM service for sign up, log in and session management as well as to discover globally registered services of a user. The marketplace is used to find services. It also provides for example such service metadata as service rating. The services bought from the integrated marketplace are registered into the framework registry. Registration makes services visible to each other enabling information and functionality exchange between them.

Embedding complex third path services that require user interaction usually entails some initial decisions on hard coding the functionality into a solution. This way the functionalities that a solution offers become predefined. For more flexible and cost efficient service integration, the service framework implements an external service user interface exchange and embedding functionality.

The service framework together with employed FI generic enablers enables:

- registering of different IoT encapsulated farm machinery, devices and sensors automatically to farmer's use via FI Global Customer Platform (GCP) identity management (IdM)
- providing third party services to provide their applications in a Marketplace
- providing IoT encapsulated farm machinery, devices and sensors as services to possible customers in a Marketplace
- registering of different third party services to farmers use via FI GCP IdM
- separation of farm data from applications so that farm data can be used by all applications and services
- the farmer to purchase services in the Marketplace, and register and take them in use via FI GCP

The IoT encapsulation enables automatic discovery and utilization of location aware things like farm machinery, devices and sensors. When the service framework is accessed with the same credentials or the ones within the trusted credential pool the IoT encapsulated things become visible in the globally registered services enabling them to communicate automatically with any framework registered third party service that implements automatic information exchange interface. In addition, when an IoT compatible data providing sensor entity (weather station or weather station network as an example) is registered as an offering into the marketplace the owner of the entity can easily sell the data to other actors like service providers or neighbouring farmers.

When we think about the spraying event itself the wind speed data of the IoT compatible weather stations can be used to adjust the sprayer nozzle for the best spraying outcome. With the location awareness the sprayer can always connect to the nearest IoT encapsulated location aware weather station or the possible third party assisting service in the Cloud can make suggestions to the nozzle controlling system based on the location of the sprayer and the nearest weather station.

3.2 Greenhouse Management

The Greenhouse Management prototype is a Future Internet compliant framework which takes into account real data (e.g. weather data) from sensors and provides it to a Farm Management System (FMS) in order to make smart decisions regarding actions that need to be done and will eventually lead to the increase of the farm's productivity and product quality. Cloud-based services have access to the real data collected and produce results related to smart planning of farming actions. Notifications and alerts about the current situation and actions are forwarded to the farmer. In this way, a farmer achieves having a complete surveillance of his farm. The Greenhouse Management prototype has been implemented in order to fulfil a number of innovative concepts. In particular:

- Lower investment cost since the intelligence of the system is located in the cloud.
- Automatic communication of the system with any equipment using SOA.
- Storage of raw data and guaranteeing user-independence from any FMS.
- Service adaptation according to user preferences and end-device capabilities.
- One-stop market place facilitating the end-user in his everyday needs.
- Integration of domain specific services (e.g., advisory services).
- Learning schemes focusing on improving operations through exploitation of accumulated data

3.2.1 Relation of the pilot to the farm-to-fork scenario

The Greenhouse pilot is part of a larger ecosystem of pilots constituting the SAF prototyping environment. The Greenhouse pilot resides in the farm end and provides information regarding the status of the plantation as well as the growing of vegetables. Regarding the scenario presented in Section 2.2, modules implementing the greenhouse pilot interact through the following blocks:

- Sensor Data: Raw sensor data are extracted from the deployed sensors and stored both locally and in the cloud. These values are used in numerous ways; they provide valuable input for the deployed service while in parallel are used for tracking the production lifecycle of vegetables.
- FMS Database: The FMS database comprises the storage module of the FMS Controller. The database collects and stores the sensor values and other relevant production data after proper pre-processing.
- FMS Services: The term FMS Services encapsulates all functionalities offered by the various modules instantiating the Generic and Domain Specific enablers of the Smart Farming architecture. Thus, it can be instantiated by the FMS Controller, the FMS Enablers or the FI Intelligent Services.

3.2.2 Scenario's tested

The validity and viability of the concept has been verified by thorough testing in two deployed instances of the pilot. The first instance of the pilot has been deployed in an actual Greenhouse in Crete. The greenhouse is approximately 10000m^2, having an almost rectangular shape. The deployed nodes are equipped with 3 soil moisture, 3 temperature, 3 relative humidity, 1 CO_2 and 1 PH sensors. There is also a node outside the greenhouse equipped with a temperature sensor. The deployed wireless nodes send their measurements periodically to the gateway which is deployed on a commodity PC located at the farmer's office. The information is propagated to the university premises in Athens, where the FMS Controller is hosted. The processed information and the extracted knowledge are subsequently presented to the farmer via a web based portal, deployed on another server.

A second deployment of the pilot has been done locally in NKUA premises. The deployment facilitated on-the-spot testing, experimentation with new features as well as project dissemination and demonstration activities [17], [18].

More details regarding the internal design of the pilot, the employed GEs, the actual deployment and its technical requirements can be found in D200.3 [3], D200.4 [4], D500.5.1 [13] and D500.5.2 [14].

The following use cases were used in order to validate the system and its functionality:

- Internet connection management: Assess the self-healing capability of the cloud proxy in case of limited or no internet connectivity. The scenario assumes the existence of a network problem; in such case the cloud proxy should revert to local processing and resume normal operation as soon as the problem is restored.
- Service registration by service provider: A service provider registers a service through a dedicated web page in the portal (part of GE Evaluation Scenario 1)
- User service registration: A user registers to a service (part of GE Evaluation Scenario 1)
- User service consumption: The user starts consuming the service (part of GE Evaluation Scenario 1)
- Charging and billing: The user checks his billing information (part of GE Evaluation Scenario 1)
- Over-the-air firmware update: The farmer uses the portal in order to retrieve updates for the firmware used by his sensors. Installation and deployment is done with zero human intervention.
- Notification and alert management: The extracted sensor values are assessed and proper notification/alert is issued to the farmer. The notifications/alerts are emitted by an expert system, specifically designed for this purpose (part of GE Evaluation Scenario 2).

In the following, we provide additional details regarding the testing of the generic enablers integrated in the pilot.

3.2.2.1 GE Evaluation Scenario 1

A user provider logs in the platform and attempts to register a service. In order to do so, he exploits the dedicated user interface available and provides details about his service, company etc. In general, he provides all details required in order to perform proper indexing and storage of his service (key-words, charging profile etc.). The service description is formulated and transmitted in linked-USDL format. As soon as the farmer checks the marketplace in his end-user application he notices the existence of the new service and registers. Upon registration, the service is added to his application profile and he is able to access its functionalities. The usage of the service is constantly monitored; the application provider can validate the logs and based on the performed actions charge the user.

The following GEs are used in the context of this scenario:

- Repository GE: Through REST API calls we offer functionalities regarding uploading/accessing a service description in linked-USDL format. The GE offers the capability to upload the service description. Therefore we can upload USDLs to the repository and access all the available services information.
- Mediator GE: Acts as a medium between a web service and a web service client. Every time our service (or method of a service) is invoked, an event is logged. Afterwards we count the number of the events happening in a specified time frame and use it for charging the users.

3.2.2.2 GE Evaluation Scenario 2

The user has deployed the pilot in his Greenhouse. The devices constantly transmit information to the cloud which before storage is assessed by the Statistical Analyser. The latter, upon identification of a problematic situation, triggers a notification action which is in turn forwarded to the farmer through the appropriate communication channel.

The following GEs are used in the context of this scenario:

- Data Center Resource Management GE: We have used the graphical interface of the portal to create a Linux virtual machine in which we deploy the Statistical Analyser. Furthermore we have a dedicated VM in which the Publish/Subscribe Broker GE is running.
- Publish/Subscribe SAMSON Broker GE: This GE exposes its functionalities through REST API calls. We register a context with specific attributes to the Publish Subscribe Broker and query the attributes to get their values.
- Cloud Edge GE: This GE is used in the farmer's premises in order to facilitate the communication of the local system with the cloud infrastructure.

All scenarios have been evaluated in house by the NKUA development team, consisting of 3 programmers (2 junior and 1 senior). GE Evaluation Scenario 2 has also been evaluated by a single user, whose greenhouse we use for the actual deployment of the system. The first scenario has been evaluated on the standalone testing testbed during December 2012 and January 2013; the second has been under evaluation since mid-December 2012. The actual scenarios can be found in video format at [18].

3.2.3 Test results

From a user perspective the overall experience related to the inclusion of GEs in the pilot was positive. Additionally, we managed to achieve a seamless transition from the GE-less implementation to GE-full one without affecting user experience (e.g. Cloud Edge GE was incorporated in the pilot while it was deployed).

However, the testing process also revealed some problems related to a set of GEs we tried to exploit. For example, we were unable to perform a core integration of the Service Composition and Application Mash up GEs; thus we opted for a loose coupling. The Service Composition & Application Mashup GE has been integrated in the GUI frontend of the pilot. It can be used to provide graphic mash ups that exploit the capabilities of the widgets provided by the Mashup Factory. In the background, these widgets/services compose a new one in a service composition manner. Some additional problems are reported in the following:

Object Storage GE: We faced difficulties using the Authentication REST API. Specifically the authentication procedure needs clarification of the required parameters.

Things Management GE: We were unable to register a context entity. Additionally, it seems that the NSGI 9 interfaces for the broker were not provided (at the time of this writing).

A possible integration scenario using the latter GE has already been designed since it enabled incorporating a larger set of Generic Enablers. The sensor nodes located inside the greenhouse transmits measurements through the Cloud Edge GE, by means of NGSI 9/10 API calls, to the Things Management GE located in the cloud. The Publish Subscribe Samson Broker subscribes to the Sensors' context entities and every time they are updated, it gets notified. This information is stored inside the database and exploited for notifications and alerts.

3.2.4 Innovations enabled by the Future Internet

The Greenhouse Management Pilot is competing against existing Farm Management Information Systems (FMISs) and Control & Data Acquisition Systems (SCADAs). An FMIS is a system for collecting, processing, storing and disseminating data in addition to the smart control of individual farm operations to provide value-added functions in the operations of a farm. SCADA is an integrated solution consisting of a supervisory system that collects information and issues commands, remote terminal units connecting to sensors to collect their data and transfer them to the supervisory system, programmable logic controllers and an appropriate human-machine interface. The designed solution essentially combines these two while in parallel introduces significant novelties:

- Lower investments by use of cloud intelligence
- Plug and Play with IoT solutions
- Independent maintenance infrastructure
- Natural language processing
- Storage of raw data
- Dynamic device dependent service
- Marketplace for farming services
- Opinion mining
- Learning schemes
- Context aware networking
- Integration into the food supply chain
- Integration of existing infrastructure
- Yield measurement

Of course, in the limited timeframe of the project, only a subset of these features has been implemented and deployed in the real system. Despite this, we managed to -partially- quantify the added value introduced by these features is evident and we present it in the following:

- Open APIs enabling the integration of third party services; this means that virtually anybody can design, implement and provide a service. For example, regulator authorities can provide policy services to farmers (e.g. how organic tomatoes should be cultivated) while in parallel, scientists, exploiting the very same API can provide task scheduling services to farmers (e.g. detailed guide of cultivating cucumbers).
- Modular and cost-effective solution for the management of a Greenhouse; the actual financing of the solution is extremely low (especially when compared to current state-of-the-art systems). A low cost PC for local control, a commodity ADSL connection, sensors (e.g. 5 sensor boards for 10.000m^2 greenhouse) and an expert for the set up hardly reach the sum of 3000 euros. Moreover due to the design of the system and the exploitation of FI technologies, software maintenance is simple and fast since everything comes with a lifetime guarantee, thanks to the over-the-air software download

- Easy to install and configure; Installation, configuration and deployment takes approximately 5 hours (for a 10.000m^2 greenhouse)

Essentially, everything boils down to the fact that the design and implementation of the pilot offers a new business case; novel opportunities for economic growth throughout the value chain. In principle, a single person with a ground-shaking idea can implement it, advertise it through the framework and gain revenue upon deployment.

Last but not least, it should be pointed out that the pilot will be ported in its current form and be further extended in the context of the cSpace project [20].

3.2.5 Recommendations to enhance the generic enablers

Based on the hands-on experience gained so far with the experimentation and validation of the GEs we can concretely report regarding the extension of the Identity Management GE. From a developers' perspective the GE could be further extended by introducing a Java API together with the currently provided JavaScript one. Due to the applicability of Java, such an interface would facilitate integration efforts.

3.3 Fresh fruit and vegetables

Improvements in food networks are based on the responsibility of the food sector towards mankind in delivering food that is safe, affordable, readily available, and of the quality and diversity consumers expect. Assuring food safety and quality requires appropriate controls (e.g., on matching regulatory requirements on the use of pesticides, etc.) but also transparency and the support of trust through the provision of information and of guarantees for its trustworthiness. Additionally, the communication towards the consumer about the production of agricultural products is an important part of increasing awareness for food products.

The FFV pilot concentrates on the topics transparency and information exchange between agri-food enterprises which includes the management, tracking and tracing of the product and returnable packaging in order to enable the provision of product quality information from actors to actors in a supply network. It is based on a dual approach concentrating on the "management of product & information carrier" and the "provision of product quality information". Both scenarios are elaborated with European-wide acting business partners from the sector. The major challenge in this pilot is to communicate product quality information in a complex supply network with dynamically changing business relationships and temporary supply chains, which are formed and cancelled due to seasonal production and availability of products. The improvement of transparency on product quality and safety requires the linkage of hidden product quality information in distributed IT systems all over the supply network and its linkage to physical transport items handled in the distribution process.

3.3.1 Relation of the pilot to the "super scenario"

The pilot in general targets at the creation of a communication infrastructure from farm to retail without central coordination based on FI-WARE GEs. Based on this infrastructure the communication of product quality information has been discussed in order to improve trust in food safety measures and to support quality guarantees for traded products. The second scenario is the communication of exception notifications to ensure that unsafe or products from unreliable actors are detected on time and removed from the distribution process.

Following the train of thought presented in chapter 2 the pilot uses the following Services (see also Figure 2-11) to realise the previously discussed business scenarios.

The pilot's range includes all Agri-food companies and transport logistic processes from the farm gate to the retail supermarket. The involved actors collect and record tremendous amounts of product-related information related to traded items in their local databases. This includes farmers, who record their agricultural production and process characteristics in Farm Management Systems, as well as traders, who collect, aggregate and supplement information on product quality from their members (farmers) and laboratories managing their pre-harvest and post-harvest quality controls.

The management of dynamically changing business relationships is required as a starting point to manage information exchange between specific companies linked by the distribution process. The sum of business relationships between different stages describes a supply network with temporary supply chains. In order to improve information exchange even between short-term connected agri-food companies, the management of business relationships has to be supplemented by EPCIS events that describe the status of the distribution process between different companies from creating product batches by:

- inbound and outbound events, where product deliveries arrive or leave an agri-food company, as well as internal events, such as
- aggregation events, where smaller product batches, e.g. from different small farmers, are aggregated to a larger batch,
- disaggregation events, where large product batches, e.g. a truck load of a single product type is disaggregated to smaller batches which are delivered to many smaller retail supermarkets.

This EPCIS event management represents a logistic-centric representation of traceability that is required to enable the previously described business scenarios by identifying linked enterprises in the distribution process. The basic principle behind the Product Information exchange along the supply chain is the creation of a link between the physical transport unit (Trays, Crates, Pallets, Dollies) and Product Quality Information stored in local DBs in a way, that every actor handling a specific transport unit can access and provide information backwards and forward in the supply chain using the Product Information Service. The Business Relation Service is facilitated to manage access rights to information for specific business partners to protect the competitiveness of SMEs against Large enterprises. Figure 3-2 summarises the previous discussion and illustrates the integration of the FFV Pilot into the super scenario.

3.3.2 Scenarios tested

To validate the pilot three pilot instances have been installed in three locations in Germany. The first instance was installed 20km north of Bremen to simulate the functionalities of farm. An instance to simulate the Trader has been deployed on a server in Bremen. To present the solution to users the distributor instance was installed locally on a laptop. On top of that a so called rendezvous peer has been deployed in a data centre near Nuremberg.

The following scenarios were created to validate and test the functionalities of the pilot:

- Acquisition of data
- Provisioning of product related information
- Provisioning of tracking data
- Exception detection
- Propagation of exception
- Exception reporting

From this set of scenarios some were used for test and analysis of the capabilities of the provided GEs. These are presented in the next subsections.

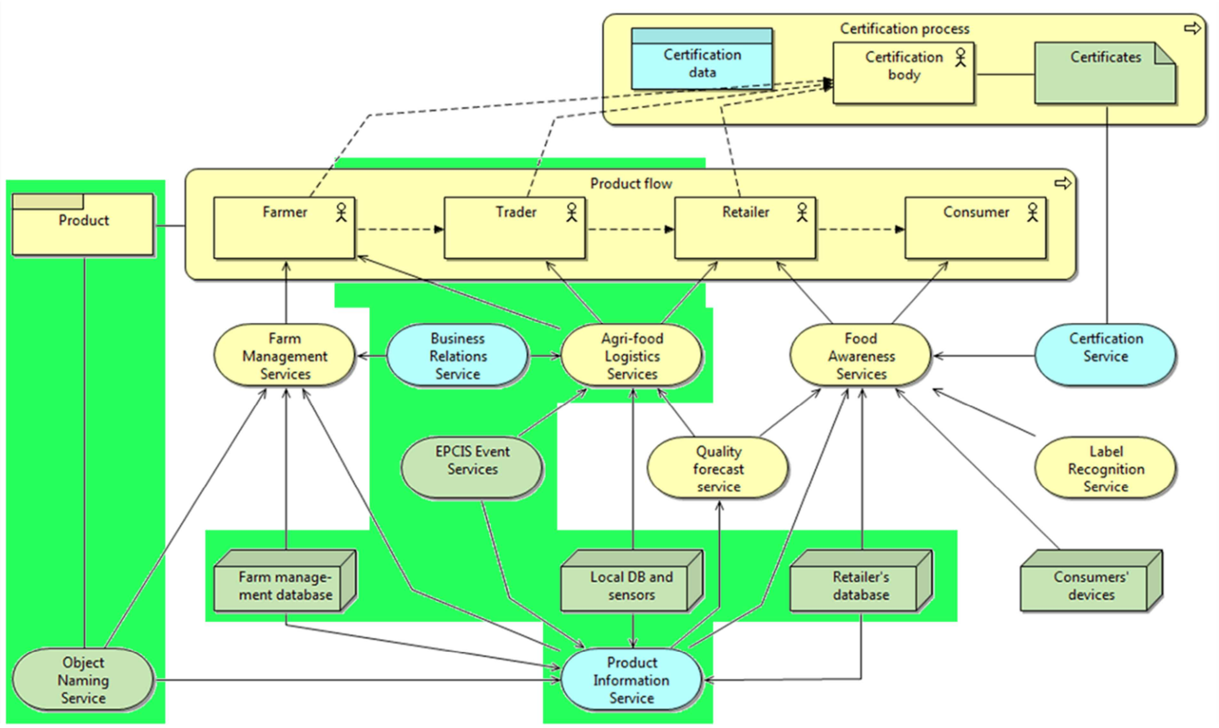

Figure 3-2: Integration of the FFV Pilot in the Super-scenario

3.3.2.1 Scenario 1 – Exception Detection

A trader of fresh fruits and vegetables sends a product sample to a laboratory to determine the pesticides load and possible contaminations of viruses and bacteria. The laboratory compiles the result of its analysis and sends these data electronically back to the trader. After the message is received by the FFV Pilot the event analyser module processes the data and validates it against the requirements of the law and the envisaged customer product. If the product is above the configured thresholds it raises an exception and informs the corresponding user inside the company.

CEP GE: The GE differentiates based on its configuration between laboratory data which should raise an exception and data which doesn’t require it.

3.3.2.2 Scenario 2 – Exception Reporting

Exception reporting is considered as a major requirement for improved food chain management. Exception reporting follows the term “If something went wrong, notify the decision making persons that are required to be notified”. Currently decision makers get the information on potential hazards to late or not at all, when the possibility is there for corrections in the process and to control the process in a way, which allows the removal of unsafe products.

To create an exception the user “A” logs into the web frontend and creates an exception for a given product by entering the GRAI of the corresponding box and the reason why the exception is raised. According to the flow of the product the exception is transmitted to other stakeholders who were or are in possession of the product.

The FFV instance of a different company receives this exception and notice the responsible user “B” about it, allowing him to withdraw the product.

Identity Management GE: The IdM GE was used to fetch the public certificate from the sending user “A” to validate the origin of the transmitted exception against the signature of the message.

3.3.3 Test results

Like the other pilots within the SAF project the overall experience was positive. From a developer point of view the provided web sessions and the training sessions supported the understanding of the capabilities of the GEs and their usage.

Identity Management GE: In the described scenario the IdM GE was mainly used to identify and authorise the user of the web interface against the backend system. These requirements were provided as expected and successfully integrated.

CEP GE: The authoring tool is designed to be as generic as possible which makes it too complex for domain end user. To address this, a domain specific authoring tool will be developed during phase two, tailoring the amount of information and capabilities to the users' need. Furthermore a wizard based tool will be developed to support the user by domain specific tasks.

3.3.4 Innovations enabled by the Future Internet

The innovation in the pilot concerns the way product information is communicated in a complex and dynamic network of agri-food enterprises of different stages and different e-readiness levels. Today, product information is communicated over traditional communication channels, which are decoupled from ERP systems in general. This requires tremendous efforts in manual extraction, processing and input from and into existing systems at every stage. Electronic data interchange has proven to be an efficient way of automating the communicating of transaction information; however it excludes dynamic product-related information. Extensive interface development for all suppliers and customers in the dynamic supply network would be necessary in order to establish the electronic exchange of product quality information between all involved parties in the supply network. The pilot prototype showed that the problem can be solved on a theoretical basis by local implementations of the SAF Local Servers hosting different GEs, Peer-to-Peer networking elements and developing a single interface to existing internal systems. The communication network creation between different SAF local servers and the standardisation of the communication between these servers (based on EPCIS messages) reduces the number of necessary interfaces independent from the size of the supply network always to one, the local one. The Local Server could also act as cloud-based solution for SMEs with no sophisticated IT infrastructure, which also solves the question how to involve SMEs with a low e-readiness level.

3.3.5 Recommendations to enhance the generic enablers

While using the IdM GE we missed the functionality of authentication via a certificate approach beside the username/password mechanism. On top of that, it would be very useful for the P2P communication to allow the validation and creation of signed or encrypted messages based on public/private certificates of the sending users to secure the message exchange. Although it was possible to attach public certificates on user accounts, this step should be further elaborated and automated.

The CEP GE is planned as a central tool for the processing of product related events; unfortunately the authoring tool was quite undocumented. Although the web seminars highly improved our understanding of this system, this should also be written down in tutorials (document and video).

Generally spoken it would support the development process if the FI-Ware project would offer Java implementation of clients to access the Generic Enablers. Furthermore we propose the implementation of an EPCIS generic enabler, which plays an essential role in this pilot, but also in the Flowers and Plants and Tracking, Tracing and Awareness in Meat supply chains pilots.

3.4 Flowers and Plants

The management of product quality is of vital importance in supply chains of fresh produce such as flowers and plants. The floricultural industry currently uses data loggers that record sensor data of quality conditions such as temperature and humidity. However, these data are only tracked afterwards and not in real time. The combination of new technologies for tracking and tracing (e.g. RFID), quality monitoring (e.g. wireless sensor networks) and internet connectivity (e.g. cloud computing and web services) enables real-time management of product quality in a supply chain context.

This pilot analyses and demonstrates the possibilities of Future Internet technologies for dynamic Quality Controlled Logistics in floricultural supply chains. In this approach, logistic processes throughout the supply chain are continuously monitored, planned and optimised based on real-time information of the relevant quality parameters (such as temperature, humidity, light, water).

The scope of the pilot is a supply chain from production to retail (Figure 3-3). The focal company is a Dutch trader with the role of supply chain orchestrator. Via this trader, also a grower, transporter and auction are involved. The pilot is leveraging the trader's logistic tracking system, which is based on the ultrahigh-frequency RFID tags that are attached to the complete pool of plant trolleys.

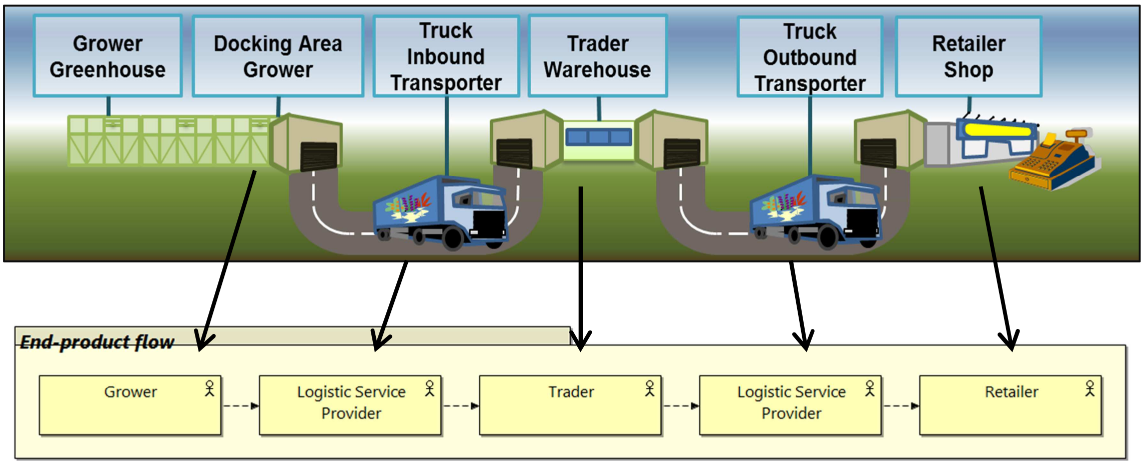

Figure 3-3: A specific supply chain was selected to represent the floricultural sector.

3.4.1 Relation of the pilot to the farm-to-fork scenario

The pilot "quality controlled logistics" aims at providing all supply chain stakeholders with information about the items their current logistic flow. This is a prerequisite for development of smarter logistic (re)scheduling services and shelf life projection services. Currently, the following services are provided to the users:

- Tracking and tracing service, which is used to present the location of items;
- Environment monitor service, which is used to present the environmental conditions (air humidity, temperature, luminance) at a specific item location;
- Product quality service, which is used to present the environmental conditions history and the current and projected quality of items;
- Exception notification service; which is used to present exception notifications of items for which quality standards can no longer be met.

In Figure 3-4 the current pilot development focus is presented in the context of the farm-to-fork scenario which was presented in Chapter 2. The farm-to-fork scenario identifies the complete agricultural supply chain from "farm to fork" and stakeholders associated with it, like presented in the upper boxes 'End product flow' and 'Other stakeholders'. The stakeholders that are currently within the scope of the pilot have an orange colour. All stakeholders are supported with functionality from the three boxes underneath it: "Front End", "Smart Agri-Food Core Functionality", and "Back End". Different functional services are identified that are distributed over the boxes. Domain Specific Services (yellowish green ovals) are identified that express functionality that is generic for the domain. In the Front End box we find the Identification Service that provides with end-user access and communication facilities. In the Back End box the Product Information Service is identified which realizes access to external data from e.g. event platforms, ERP systems or third party systems. In between of the front and back end boxes the Smart Agri-Food Core Functionality is visualised, including the business relations service and certification service. Here we find Smart Agri-Food specific services (blue ovals) like Agri-Food Logistics Services of which the quality controlled logistics pilot is part. Functionality that is developed within the pilot has a red colour.

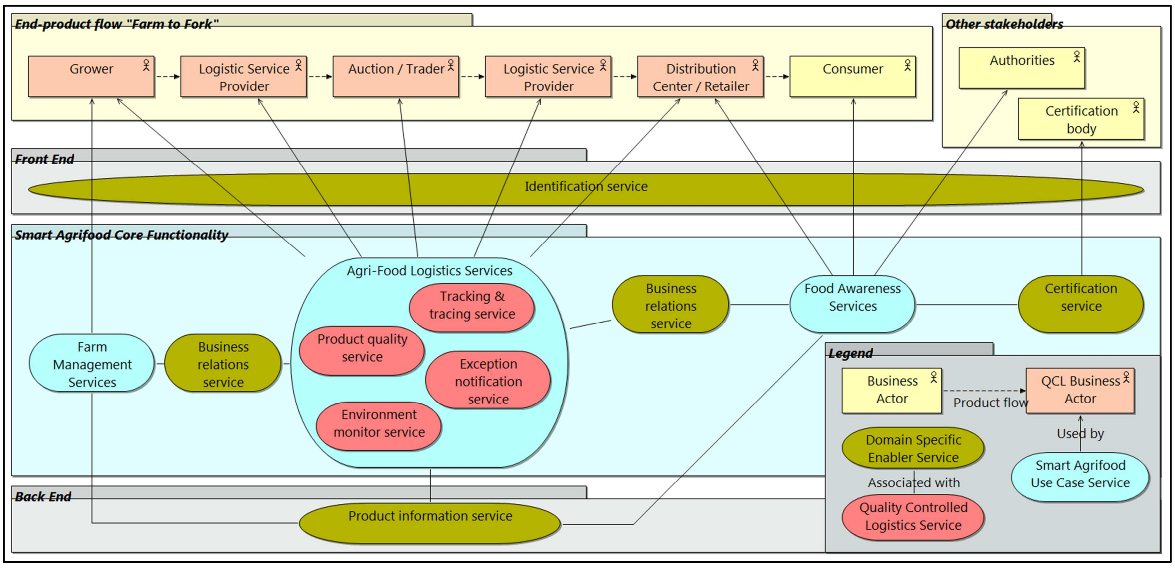

Figure 3-4: Current focus of pilot development in "quality controlled logistics".

3.4.2 Scenarios tested

Tests of the developed demonstration software are carried out with simulated data. The look, feel and information value of the demonstration application was thoroughly evaluated by stakeholders via an open discussion at the stakeholder meeting, supplemented by individual questionnaires. Actual testing of scenarios with implemented devices for tracking and tracing and condition sensors are anticipated to be carried out in the next phase of the pilot. For the contents and results of the stakeholder evaluation, please refer to deliverable D300.3 [6]. The test scenario's that were presented to the stakeholders are described below.

Simulated test data was sent via EPCIS messages to the Fosstrak EPCIS platform. The EPCIS messages contain tracking & tracing data in the format that is currently implemented in the Mieloo & Alexander RFID solution for the horticulture sector. The condition datasets are added to these EPCIS events with an Extension to the data model. From that point onwards the developed technical infrastructure and application functionality was used as described in deliverable D500.5.2 [14]. EPCIS messages of items with different characteristics and supply chain stages were sent to the platform to test the following business scenario:

- The supply chain contains items of different cultivars (*Orchid, Geranium, Hibiscus, Lavender, and Campanula*);

- The items reside at different locations in the supply chain (Grower Greenhouse, Grower Docking, Inbound Logistics Service Provider, Trader, Outbound Logistics Service Provider, Retailer);
- The items are subjected to different environmental conditions within and outside norms (*Temperature*, *Humidity*, *Luminance*);

For each item different events are simulated according to the scenarios described above and sent to the Event platform. The simulated data objects are presented in Figure 3-5. Quality projections are carried out for all items. How these data items are represented in the application is described in deliverable D500.5.2 [14]. The light red objects are derived from the event data on the event platform. The light green objects are derived from the red objects by the quality monitor application functionality.

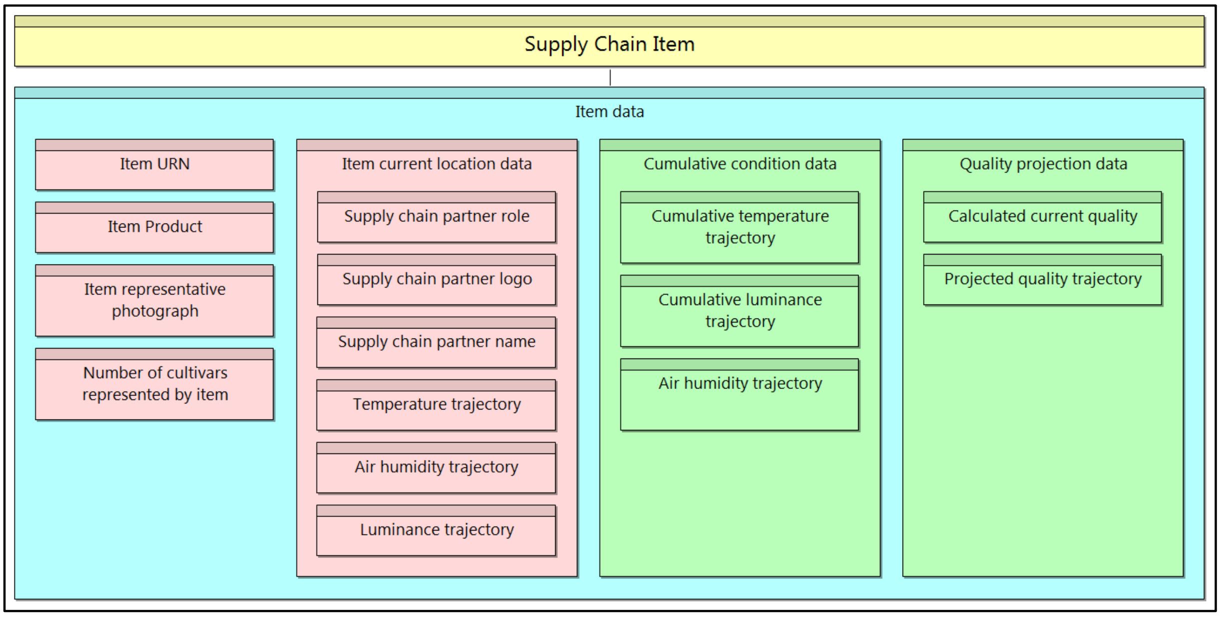

Figure 3-5: Item-associated simulated data objects

On a technical level, the suitability to use the Generic Enabler (GE) Complex Event Processing (CEP) in the quality projection expert system was thoroughly evaluated. The output of a temperature sensor was simulated. If the first recorded temperature is above a certain threshold an output file with all the collected temperatures is built, otherwise no action is taken.

With respect to the generic enablers the Complex Event Processing seems a promising candidate. A successful proof of concept was built for its integration as visualised in Figure 3-6. For this demonstration, the "file method" was used, following the instructions from the corresponding FI-WARE partner were followed. Namely, the configuration of the CEP Proton engine was described in a .JSON file. The SafTestScenario.TXT file was used to provide input data to the GE. The CEP component processed the data and responded with the TemperatureReport.TXT file as output.

3.4.3 Test results

The most important outcomes from a user's point of view are the following. From the stakeholder evaluation it has become clear that in reality the amount of items in the supply chain at any given moment in the high season runs into the millions. Therefore showing all data associated with these items would overwhelm the user. The focus should be on items that are aberrant. Also stakeholders would value personalized screens that reflect the information that is most important to them.

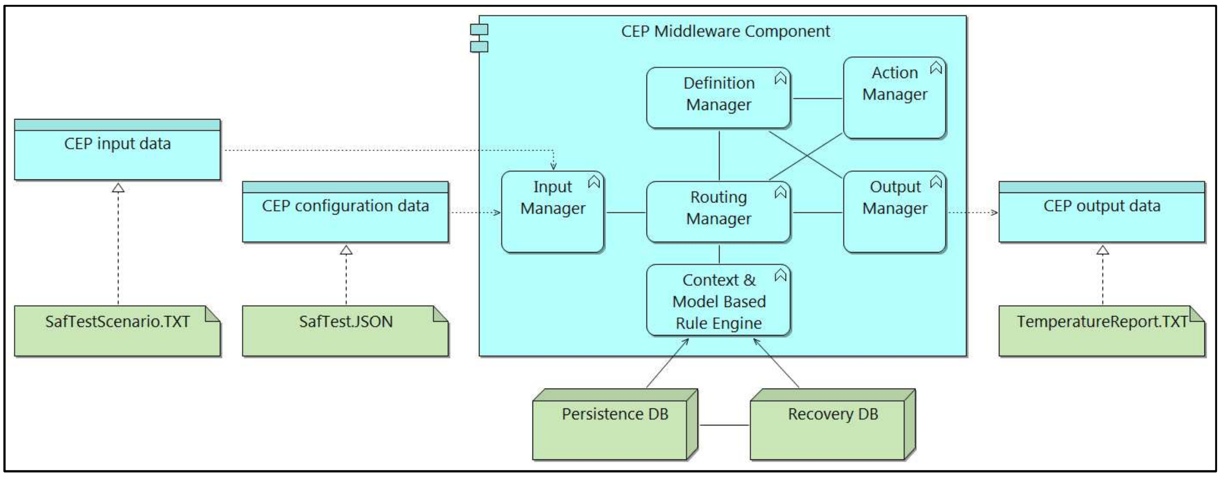

Figure 3-6: Test scenario for the Complex Event Processing GE

From the evaluation results can be concluded that the quality projection module needs improvement. In the current implementation, the underlying algorithm is developed for cut roses and extended to other potted plant cultivars, which is not realistic. Also, this algorithm gives an idea on the current quality of a cultivar based on temperature, but is neglects the other environmental conditions and does not provide in quality projection. The projection of the quality decay is now in fact dummy-functionality. The choice for this set-up was made to be able to test the idea of a quality module in the demonstration software and to check the response of chain stakeholders. However, to be able to provide valuable input for logistic (re)planning this functionality should be further developed into a mature quality projection module.

Additionally to the point described in the previous paragraph, the results from the anticipated quality module should be checked with reality on a regular basis. The quality assessment made by the system will be derived from the storage conditions of the products during their stay in the chain. However, other factors may be of influence. Therefore data on regular sample checks of the actual quality by experts should be used to calibrate the system. Ideas to use that input to make the system self-learning have been expressed by stakeholders and project staff.

During the work on CEP GE integration, several issues were detected. All problem descriptions were delivered to FI-WARE in a direct communication with the corresponding partner (IBM). We believe that improvements in these fields would significantly enhance the applicability of CEP GE not only in this pilot, but in other applications, as well. As it will be shown in the sequel, some of these issues have been recognized by FI-WARE, and there are concrete solutions planned for Release 2 of the CEP GE.

In the following the major issues are organized in two categories:

- Framework issues (generic about the whole CEP framework)
- Authoring tool issues (the web interface used to build the .json files describing CEP processes and networks).

Framework Issues

- <u>External infrastructure needed:</u> The currently available CEP GE framework does not permit direct pushing of data into CEP. This means that in order to communicate with CEP in a real life scenario, one needs an external infrastructure running (an application server with REST accessible web services, an accessible database, etc.). *The response from FI-WARE regarding this comment was positive; they have already implemented a REST service that allows one to push the input events to the CEP using REST POST.*

- <u>No structured input data is supported:</u> Only flat attributes are supported, which can cause inconveniences for the developers.
- <u>The guides contain only one practical example:</u> Currently there is only one practical example with FILE producers and consumers. More examples, covering different situations/scenarios, would significantly help in understanding the CEP functionality and the subsequent development.

Authoring Tool Issues

- <u>It is impossible to cancel a single element</u>: There is no cancel functionality for a single consumer, producer, etc. This might be quite annoying for the developers using the CEP GE, since the created events which are not needed cannot be eliminated from the web interface. Currently, this has to be done manually (e.g., in the .json file), since the system lets one cancel only an entire project. *FI-WARE informed us that this problem has been recognized, and it will be solved for Release 2.*
- <u>There is no “import” function</u>: If one has already created a .json file for a CEP project, it is impossible to load it in an existing Authoring instance. *FI-WARE response: This functionality will also be added in the next release.*
- <u>No import/export function for a single element:</u> There is no import/export functionality for single elements like consumers, producers etc., and this makes reusing the objects one has already created, even within a single Authoring tool instance, impossible. *The answer from FI-WARE regarding this issue is that no single element import has been implemented, but that an option for duplication of the existing elements to create a new one (in the same project) will be provided in Release 2.*
- <u>There is no debug tool:</u> When using the authoring tool no corresponding debug tool is available, so tests must be done at the prompt level. When a wrong element is detected, one only gets a warning message when saving the object.
- <u>There is no possibility to deploy directly from the authoring tool:</u> It would be nice to have the possibility of exporting the .json file in a correct directory. *FI-WARE Response: The next release is supposed to have this capability. In addition, Release 2 will have the option to run the engine, replace its definition file, and stop it using REST services, without the need to actually log into the testbed machine.*

3.4.4 Innovations enabled by the Future Internet

Tracking & tracing systems that make use of UHF RFID are not new, not even to this sector. Also the monitoring of environmental parameters to optimize the conditions of transport is something that is common to certain fresh industries. However, in the potted plant sector currently no systems are available that are able to project the quality development of plants based on the environmental conditions history. Combining that with the input of tracking and tracing systems to realize smart logistic (re)planning is a radical new approach to logistic management of potted plants. The in the pilot developed ideas and demonstration software serves as a basis for further development of this concept which can potentially lead to:

- a reduction of product waste;
- shorter lead times;
- better capacity utilisation;
- and better product end-quality for consumers.

But on a less ambitious scale the publishing and sharing environmental condition data associated with specific items in the supply chain is new too. This concept was enthusiastically embraced by the involved stakeholders, because it would make it much easier to track down what happened where and when received products are below quality thresholds.

The Complex Event Processing GE can help in identifying exception notifications. It has the potential to aid in the configuration of rules for complex event processing. It may provide support for the following application functions:

- generating exception notifications when:
  - environmental conditions are outside the norms for a specific cultivar;
  - the quality of a cultivar is outside the norms;
  - the expected quality of a cultivar is outside the norms within a certain period of time;
- easily updating CEP rules with improved cultivar quality decay models.

Important additional prerequisites to make the system work are:

- insight in the factors that influence quality decay of potted plants;
- access to expert evaluations of samples of the plants that reside in the supply chain;
- access to the initial quality of plants in the chain.

As one of the main advantages of the utilized CEP GE in comparison with the originally developed prediction service DSE, we see the facilitation of an easy and fast creation of various types of expert systems. While the original solution exhibited limited connection possibilities (e.g., via the WSDL agreement) and could be considered as cryptic for a non-expert, the utilization of CEP paves the way for exploiting the more advanced REST principles, while on the other side it enables (under the assumptions that some improvements of the GE, explained in the following section, are implemented) also the users without significant experience in software development to design an algorithm, and extend the functionalities according to their wishes.

3.4.5 Recommendations to enhance the generic enablers

In the next phase SmartAgriFood and FInest are combined to form the C-Space project. The software functionality from the pilot “quality controlled logistics” will then be modularized in the platform. In Figure 3-7 a conceptual design is presented of a possible way to integrate the pilot into the platform. In the start-up of the next phase definite choices have to be made, but for now this concept represents the ideas of the pilot team. A major benefit would be that generic functionality from the platform could be used, for example GUI customization and configuration functionality and functionality to assure security and privacy.

Based on the pilot outcomes user specific GUI’s should be developed, to realize management cockpits that match with the specific interests of the stakeholders. Customization and configuration tools on the platform may be used to develop these. That way the development of user specific GUI’s can also be carried out by non-technical professionals. This will improve the integration of the information from the system in the business processes of the users.

The scope of functionality offered by the quality module could be expanded to a broader audience. Next to input for logistics management, the quality development of plants in the chain could also be valuable to consumers and authorities. With some modifications consumers could be informed about the expected vase life of plants while they are still in the shop (possibly based on the home situation of the consumer like brightness and temperature of the room). For this purpose a Shelf Life Service could be developed. Also certain quality indicators could be selected that could inform authorities of the phyto-sanitary risks associated with certain batches of plants. This could be done by a Phyto-sanitary Risk Service, but for now that is out of scope.

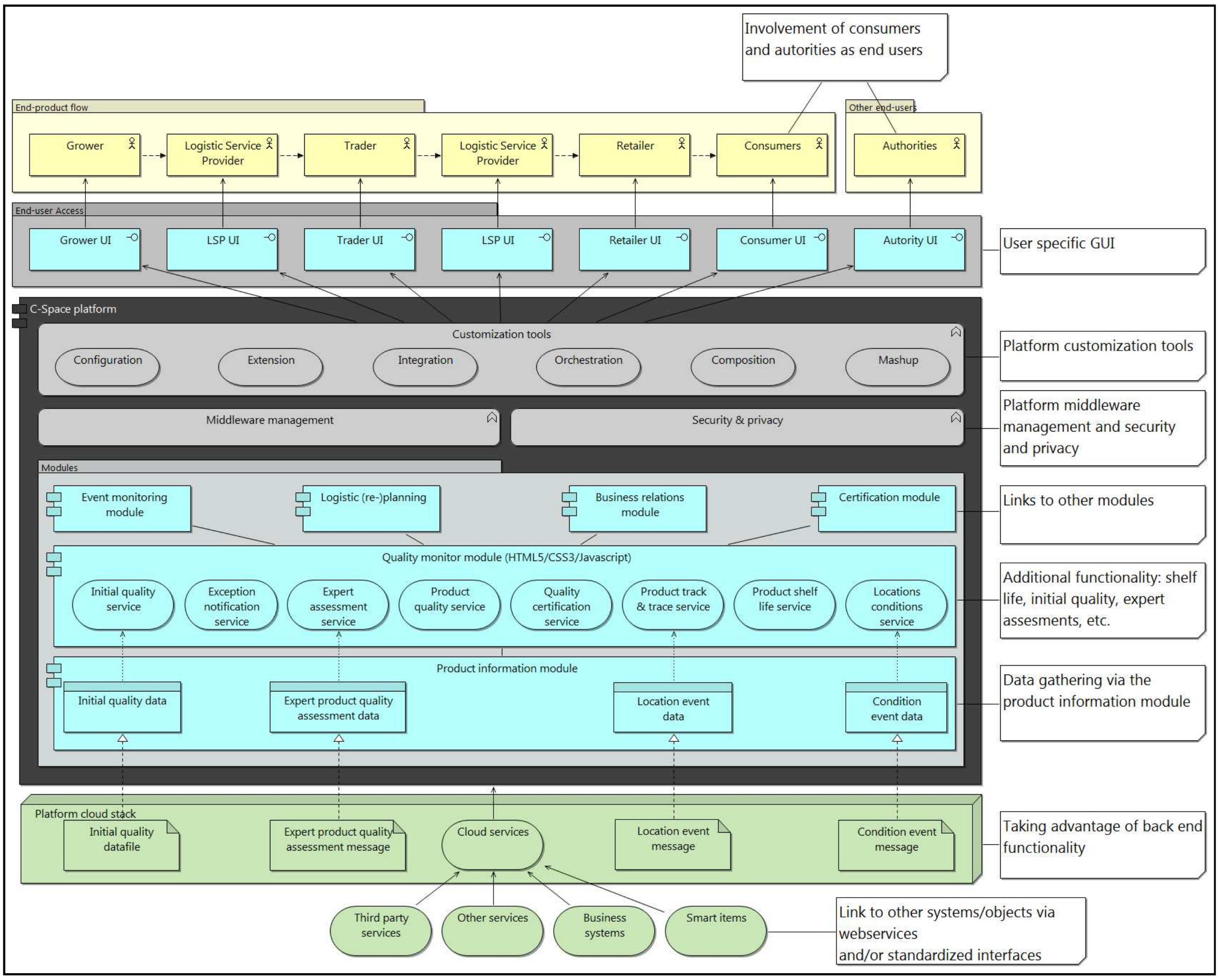

Figure 3-7: Plan for embedding the Quality Controlled Logistics functionality in the C-Space platform.

In the following phase the integration with other modules on the platform can be improved. For example links to advanced (re)planning modules which are developed in the FInest project. Within the quality module an additional (re-)planning service is envisioned to be developed for the detailed interaction with the (re-)planning module. Additionally, the integration with certification services may be valuable for the possible issuing of quality certificates to plants. Within the quality module a quality certification service could take care of this.

Additional to or improvement of existing functionality within the quality module it may be the development of an initial quality service: Functionality to record the initial quality (the quality of the cultivar after harvest) of items (e.g. trays with potted plants), further integration of the exception notification service (based on the CEP). Also, an expert assessment service should be developed so that the evaluations of experts can be accessed by the system and the quality assessments can be calibrated.

The communication to back end systems may be further improved. Ideas about this are developed in SmartAgriFood and FInest. In SAF a product information service is envisioned to take care of such functionality. In FInest extensive back end functionality on the platform will. In the next phase the quality module may reap the benefits of the combination of the ideas of both projects.

3.5 Tracking, Tracing and Awareness in Meat supply chains

This pilot concerns ensuring consumers, regulators and meat supply chain participants to have accurate information concerning where a meat product originated (production farm) and how it was affected by its distribution (quality assurance). The use of common components for smart distribution and consumption shall help consumers to obtain better information on the meat they purchase, and producers to better control the flow of their goods to the consumer.

From the technical perspective the TTAM pilot resembles the TIC pilot in that it enables consumers to request about product information using their smart devices (smartphones and tablets) during and after shopping process. It differs from the TIC pilot in a number of aspects. First, the TTAM pilot is about tracking, tracing and awareness of a more specific product - meat. In TTAM we aim to address the requirements of recent regulatory requirements (e.g. EU Reg. No. 1169/2011) and increase consumers trust in meat by providing trustworthy and certified information. Second the TTAM pilot covers the whole meat supply chain from farm to retail – in contrast the TIC pilot focuses on consumers' interaction with retailers. Particularly, we aim to demonstrate how to provide more information on the provenance of the meat (place of breeding, slaughter, deboning, etc.) and other attributes, such as recipes to improve consumers' awareness of the diverse attributes of meat.

For the TTAM experimentation, the focus was on beef. This meant that we excluded sausages, minced and diced meats, as well as pork, chicken and other types of meat. Also we restricted ourselves to packed beef. We focused on five groups of information, which are: general information, origin, quality, production and recipes. This is achieved by gathering traceability and transparency information from all partners of the supply chain in a centralized transparency database maintained by a third party. Instead of building a completely new system, the TTAM conceptual prototype builds on an existing application called fTRACE.

3.5.1 Relation of the pilot to the farm-to-fork scenario

The current fTRACE system (Figure 3-8) can serve as an output channel for any kind of traceability data combined with static product data. All gathered information in any contemporary repository can theoretically be called and displayed to the users.

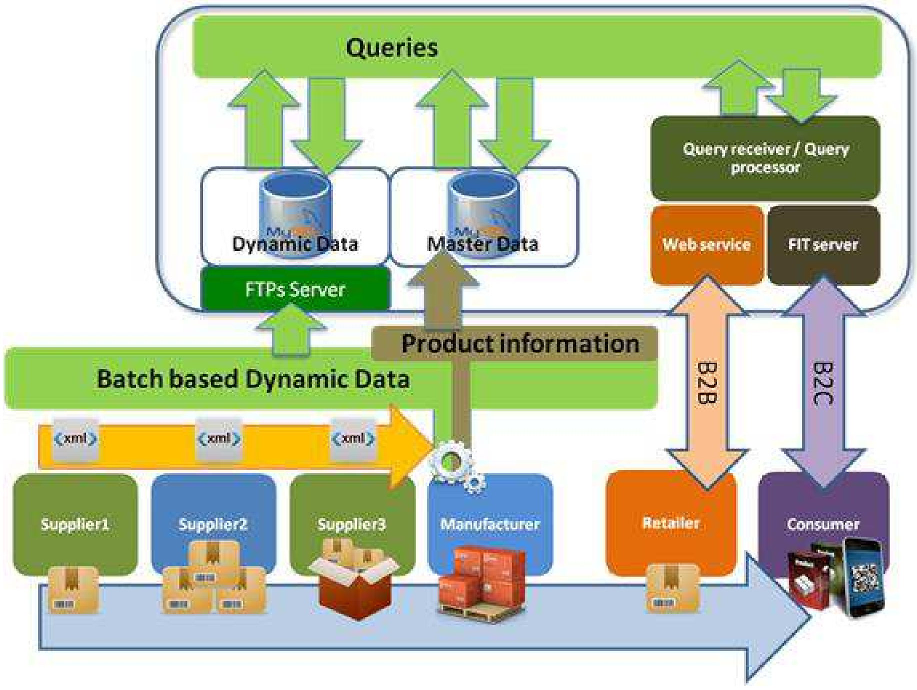

Figure 3-8: Current fTRACE System

All information which were delivered directly to the fTRACE server, are transported through a GS1 XML file. This XML file in turn bases on a traceability XSD file which contains all necessary definitions for a various amount of branch specific information (meat production, fisheries, fruit and vegetables, wood industry etc.). This XML file can be used to communicate traceability data to all stakeholders.

This was successfully tested with the TIC pilot. The XML file for a specific dataset was created for the usual fTRACE system for importing and displaying it to the users and also processed by the TIC pilot app[4].

The XML file can not only be used for delivering data to the fTRACE server, it can also be used for exchanging transportation-, transformation- or processing-information along the supply chain. Every supply chain participant adds his specific information to the XML file and hands it over to the next participant. The last supply chain participant adds his data and transfers the XML file to the fTRACE server.

3.5.2 Scenario's tested

In a first step a questionnaire in the meat sector was part of the preparation for the TTAM pilot. The questionnaire itself focuses on the attachment of labels during the meat production. These labels are intended for consumers and function as labels that are visible on the meat product throughout in the retail shop. By interviews with experts of the meat sector it was intended to get detailed insight in the source of the data on the labels of consumer meat products. Such insight is necessary to realize an improved information infrastructure in meat supply chains. The questionnaire therefore focused on two dimensions:

a) the way of data capturing, storing and providing on the one hand and
b) the data items (origin and approval numbers, reference numbers and best before dates) on the other hand.

Additionally the interviewed partners were asked about their estimation and prospective desires related to additional product information and the way how to share them in future.

In a second step of tests the new transparency system based on the existing and proven technology of the fTRACE transparency system and mobile app was expected to demonstrate the novel approach of TTAM in gathering, processing and presenting data from the meat chain. For the TTAM pilot is was so far very obvious to check whether consumers also like to scan food labels at a retail shop to get detailed information about the food item they are actually buying. The need and the applicability of such a modern transparency system in the meat sector had to be proved and discussed with end-users.

From this perspective the TTAM team expected a response of the supply chain and thus a validation of the actual system by testing a further developed and a to Spanish/ Catalan customers' requirements adapted fTRACE mobile app. It was demonstrated and explained entirely in Barcelona on January 28th 2013 in a common workshop with the TIC pilot of SAF to a well-known group of sixteen test-individuals. The volunteers were asked to experiment with the fTRACE app in Catalan tongue by using their own smartphones and scanning a physical dummy of a package of meat (see Figure 3-9).

[4] fTRACE output view: http://www.ftrace.de/de/de/product/0000000298/0000/GS/traceit

Figure 3-9: Testing the fTRACE app.

3.5.3 Test results

The results of the first test round were as follows. In most cases of the sent back questionnaires origin-related information come from physical intermediate labels, with which each meat cut needs to be labelled (for animal document) by regulation (EU) 1760/2000 or accompanying documents. Otherwise the information in the cases considered are received electronically (fax, email) but not as standardized data type, even if some of the companies use EANCOM 2002 data types for traceability data with their customers. But even in this case, all products additionally are carrying a product label with all origin and traceability data according to law.

The interviewees pointed out amongst others, that more detailed information regarding special biological races, feeding material, use of medicine, salmonella status, origin (other animal species but beef), location/name of farmer/producer, transport conditions, animal welfare, and the level of maturity from their point of view will become more important in the future. As long-term perspective there could (should) be a well-arranged and transparent platform for consumers that shows “who, when, what” established. Furthermore it would be preferable to achieve a regular exchange with existing data bases (e.g. national data bases registering movements of cattle based on regulation (EC) No. 1760/2000, internal data bases hosted by existing quality and food safety schemes such as “Qualität und Sicherheit”) and last but not least sharing information from the veterinary authorities. All interview partners considered that data exchange about a cloud/ web service will be the appropriate and forward-looking solution. As today´s key impediments the following aspects were mentioned:

- inadequate "technologization" upstream
- lack of standardization for integrated data exchange covering the whole chain “from farm to fork” or rather insufficient convenience e.g. for hanging carcasses so far
- different systems between farming and meat industry
- data exchange at present limited to one step up/one step down (based on regulation (EC) No. 178/2002
- no common and open approach („everyone cooks his own soup“)
- unbalanced cost-benefit ratio

In the second test round the probands were asked to document their practical knowledge from the test by answering nine short questions in a shared questionnaire. One of the most import questions was in what degree the Web app has allowed them to know more in detail and in an easy way about the meat. They should answer by evaluating their satisfaction from best with 10 points down to 1 point - the worst. The average points of those who were able to use their mobile device were 8.6 - meaning good to very good. Looking at Figure 3-10 one can see that this derives from the estimation between only the 4 top-ranks from quite good to excellent.

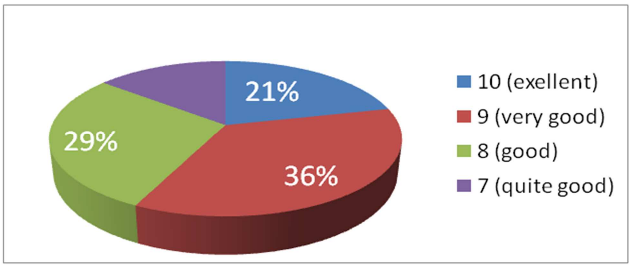

Figure 3-10: Consumers' satisfaction with detail and ease of information about the meat

Another the main message was that more than 80 per cent of the volunteers were not prepared to pay more money for added value in form of more information to the products they buy. No more payment for guaranteed meat! Only a few could imagine paying up to 10 per cent more for such a higher quality of information. Nobody could imagine paying perhaps 20 per cent or even 30 per cent more.

The conclusion of the results obtained by the volunteers during that testing in Barcelona is a positive one. Not only looking at the very few open issues which are at the same time also quite encouraging, they are all well-meant recommendations for further improvements. But not only have the single aspects themselves to be evaluated as successful. It is the whole workshop which resulted in a big success. The volunteers were happy to contribute to research and development therefore their judgements are honest and realistic. The recommendations and estimates made by the probands are valuable for the progress of SAF pilots. The positive evaluation by a group of real customers of the web-based services for transparency with fTRACE confirms the right attempt of stepping into the next phase with large-scale experimentation trials.

3.5.4 Innovations enabled by the Future Internet

In TTAM the following domain specific enablers are used / implemented:

1. 2D Barcode reader: Widely available 2D Barcode readers are the primary means of reading the 2D Barcode-encoded query from meat packages. The 2D Barcode contains also the address of the fTRACE server and thus the 2D Barcode reader and the default browser of the device together the inbuilt camera are used to send a query the fTRACE server.
2. Database: Relational data bases are used to store static and dynamic data. The large volume of dynamic data means the database needs to saleable.
3. Server query cache: The fTRACE server handles large volumes of querying. It is vital to cache query requests to serve identical queries from the cache in the web server instead of making unnecessary database query.
4. B2C query module: The B2C query module is a web service that generates HTML5 document from consumer query response to be sent to the user's mobile device.
5. B2B query module: The B2B query module is web service that generates XML document from business partner query response to be sent to the web server of the partner.

3.5.5 Recommendations to enhance the generic enablers

In the final release of fTRACE, an EPCIS (a global standard) enabler will be implemented. The application area of an implementation of EPCIS can however be used in many domains (logistics, faming, transparency system, warehouse management, to mention the few). We, therefore, would like to propose the EPCIS implementation that is being undertaken, as a generic enabler.

3.6 Tailored Information for Consumers

The TIC pilot focuses on allowing consumers to make purchase decisions considering comprehensive information about the products they can found in retail stores. Based on *Future Internet*, consumers can access information behind agri-food products, not all information available but only those attributes that mainly interest a particular consumer. Product attributes related with origin, food processing, environment, health, quality, safety and so on should be tracked and available in the *cloud*. With the TIC prototype, consumers can define a *consumer profile* where they specify the product attributes they are interested in. Then, thanks to scanning technology (QR) each consumer can get tailored information about the scanned product and also about logos on the product. A Web-based Application allows users to access product information by using any device with internet access and a camera while shopping or at home.

Figure 3-11 shows the architecture of the pilot and Figure 3-12 the operation steps followed by a consumer using the TIC Web app.

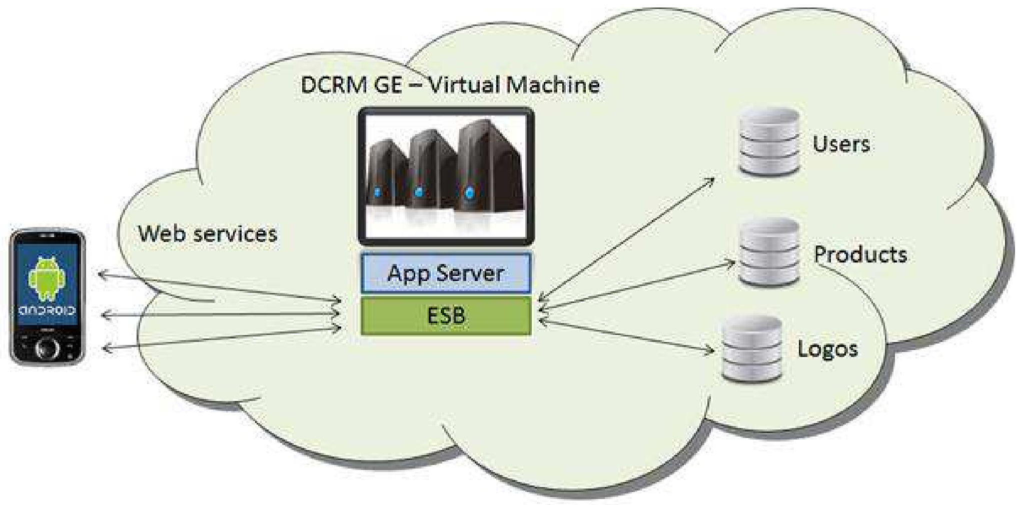

Figure 3-11: Architecture of the TIC pilot

Figure 3-12: Scheme of the Web app operation

The TIC pilot targets all mechanisms (e.g. applications, infrastructure, data and communication models) which enable consumers to request information of a specific product using their Smartphone before/during and after shopping; they only get product attributes according to their profiles. This requires an infrastructure for managing consumer profile data (taking into account security and privacy issues) and for managing product attributes.

The TIC pilot is mainly focused on the data management and provision to consumers. As described in deliverable D 400.2 [8] there are two main information dissemination approaches:

1) The push approach, which enables consumers getting asynchronous information from products at any time, even if they are out of the scope of the supermarket.

2) The pull approach where consumers get tailored information on request during their visit in the supermarket's facilities.

The Smart Food Awareness architecture supports both approaches. The first phase of the pilot specification is focused on the second approach, which is less invasive to costumers and is more straightforward, in terms of application compatibility among different mobile devices. Nevertheless, it is taken into consideration in the prototype design that the push communication approaches offers extended capabilities to the whole Smart Food Awareness scenario, so developments are prepared for it.

The data provision to the consumer is basically carried out by two ways:

• Providing tailored product information from selected products costumers will find in the supermarket.

• Showing hidden information from logos and signs which can be found in some products, usually processed products.

The generation of tailored information depends on the consumer profiles. This characteristic allows more accurate information matching in comparison with the generic and fixed information provision by current product labels.

Having tailored information after a matching process leverages privacy and security issues. As this information is supposed to be managed, in the future, by external entities in the form of GE, consumers, inside the TIC pilot, will be owners of all the tailored data they consume and produce. Consumers can also make use of anonymous profiles in the case they are not interested on permanently sharing their information with the supermarket, the service cloud and GEs behind.

3.6.1 Relation of the pilot to the farm-to-fork scenario

The TIC pilot accomplishes a key role within the SmartAgriFood farm-to-fork scenario, being the link between the food supply chain and the consumer. This role is twofold:

- Providing the product information to the consumer in a tailored way. The consumer only receives information he asked for or with an added value for him, i.e. indicating that a product has a nutritional composition not appropriated for him.
- Gathering the consumer's feedback into the food chain, providing to the stakeholders with valuable information about the acceptance of their products, which can be used to enhance them based on the end user preferences.

As explained in Section 3.1.3 of D500.4 [12], the TIC pilot interacts with the agri-logistics stakeholders of the chain to exchange information in a bidirectional way: product information from the grower to the retailer, and the consumer's feedback to the chain.

To make this exchange possible, the Tailored Information System (TIS), core of the pilot, mainly interacts with the Product Information Service, which is in charge of gathering the product information from the appropriate sources. The TIS also interacts with the Certification Service, which ensures the reliability of the certificates of supermarket products regarding product information reliability and provides a logo validation service that ensures a corrected and reliable use of the logos. Finally, by using the Business Relation Service (BRS), supermarkets can search for product providers and for offers and demands of different stakeholders, and also can use the feedback management function of the BRS to provide and receive ratings regarding their business services. A further elaborated explanation of these interactions can be found in deliverable D500.4 [12].

The two pilots developed for *Consumer Awareness* have been proved to integrate together. While the TTAM pilot main objective is to gather information of meat products through all supply chain stages. The TIC pilot focused on how to provide value chain information to consumers in a tailored, transparent, rigorous and clear way. The integration of the two pilots has been validated with the last workshop with consumers done in Bon Preu.

3.6.2 Scenario's tested

As detailed in D400.3 [9], the TIC pilot has been deployed in Bon Preu facilities located in Barcelona (Spain). A medium sized supermarket is located there and a room dedicated to consumers is found above the supermarket. This room is called *Consumers' Space* and it is used for consumer-retailer interaction in order to have feedback from its regular consumers about different subjects such as new products offered by the supermarket, cooking classes, master classes of nutrition, etc. It is a room with capacity for maximum 25 people with all the facilities for carrying out workshops, talks, cooking classes, and so on.

The deployment of the pilot in Bon Preu facilities has taken into account that it would be validated with the involvement of end-users (consumers) in a closed and realistic environment (Figure 3-13). Hence, the physical pilot deployment has covered three areas: (1) the "Consumers' Space", where initially (first iteration) an ESB redirected the requests to another ESB server located in Atos; (2) Atos facilities where the Tailored Information Server is located and received the information requests from Bon Preu ESB and accessed the database and collected the information required (Figure 3-14); (3) the access points (WiFi) installed in the supermarket to which consumers connected the Smartphone to access to the TIC Web App (Figure 3-15).

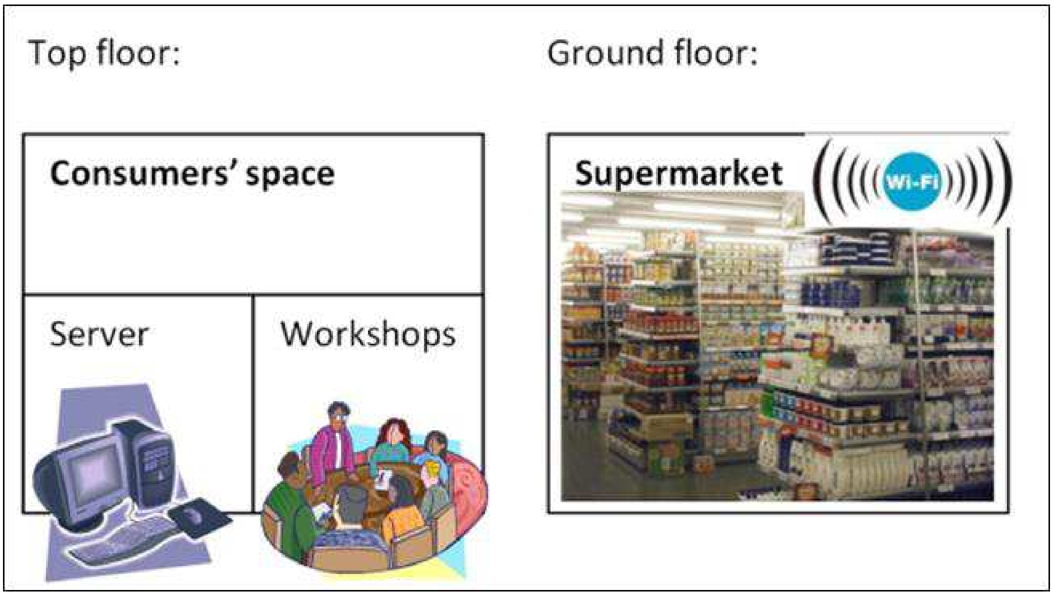

Figure 3-13: Pilot deployment in Bon Preu

Figure 3-14: ESB in Bon Preu

Figure 3-15: Wi-Fi connection in Bon Preu supermarket

In the second iteration, all the infrastructure side has been contained in the Data Center Resources Management GE; so all the requests are gathered by this single node which has been hosted in this GE.

For the first version of the pilot, any Generic Enabler was taken into account because any of them was ready so an adaption of the infrastructure had to be done. We deployed the application in the Bonpreu's facilities and a service layer in the ATOS facilities. There was a connection between them. Our main idea was to use the Data Centre Resource Management GE to upload the entire software infrastructure to the cloud, including databases, ESB, webserver, etc.

For the second iteration of the pilot, the DCRM GE was ready and we could start using it. We migrated the entire infrastructure to the cloud and the application was still working perfectly. Other GEs were taken into account. For the last iteration of the pilot, we integrated the Identity Management GE – GCP and the Data Handling GE.

<u>Steps followed for pilot implementation and validation: pilot test with consumers</u>

Feedback from end users (consumers) is a key point to assess viability and compliance with their expectations. For this, several *workshops* have been planned in the "Consumers' Space" in order to involve consumers in the TIC pilot. The objective of these workshops has been to involve a panel of 15-20 consumers in all the process of the TIC pilot: its conception, development and evaluation. For this, four workshops have been performed according to the pilot development steps.

Step 1: Conceptualisation of the prototype. Two workshops were performed to know consumers opinion about the future way of consumption (*first workshop*) and stipulating which product attributes consumers would like to know and how (*second workshop*).

Step 2: Pilot development and deployment. An infrastructure for managing consumer profile data and for managing product attributes was developed by using three *Generic Enablers*: *Data Centre Resource Management GE; Functional integration of Data Centre Resources Management GE and Data Handling GE.* The TIC pilot was deployed in *Bon Preu* facilities for testing.

Step 3: Pilot validation via workshops with consumers. The prototype has been tested in a closed and realistic environment where the panel of consumers used the TIC Web App to get tailored information about a lot of *smart* products (products with a QR code linked with a variety of attributes). Two workshops were performed coinciding with two iterations of the Web App, evaluating consumers' feedback from a technical and a user point of view.

3.6.3 Test results

The evaluation results of the TIC pilot with consumers where very satisfying. An evaluation from a technical and a conceptual point of view has been done using surveys that were filled by the consumers participating in the workshops.

Consumers were able to test two iterations of the TIC Web app. The first test allowed detecting some problems and improvements that were corrected for the second test. New functionalities were included to be tested in the 3rd workshop.

Figure 3-16 shows the results of the technical evaluation of each functionality of the pilot for the first and the second test with consumers.

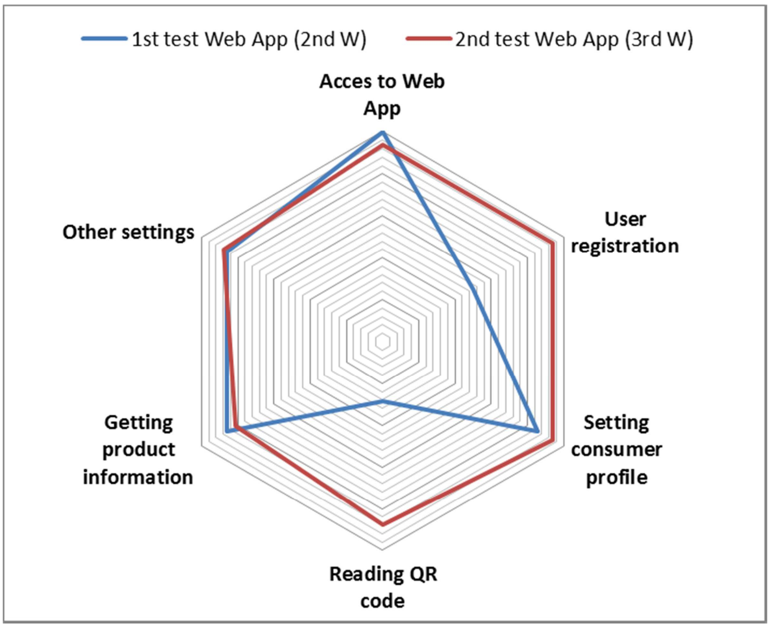

Figure 3-16: Comparison between first and second technical evaluation of the web app.

A global evaluation of the TIC Web app regarding conceptual value for consumers was done. Figure 3-17 shows the results of the two tests with consumers.

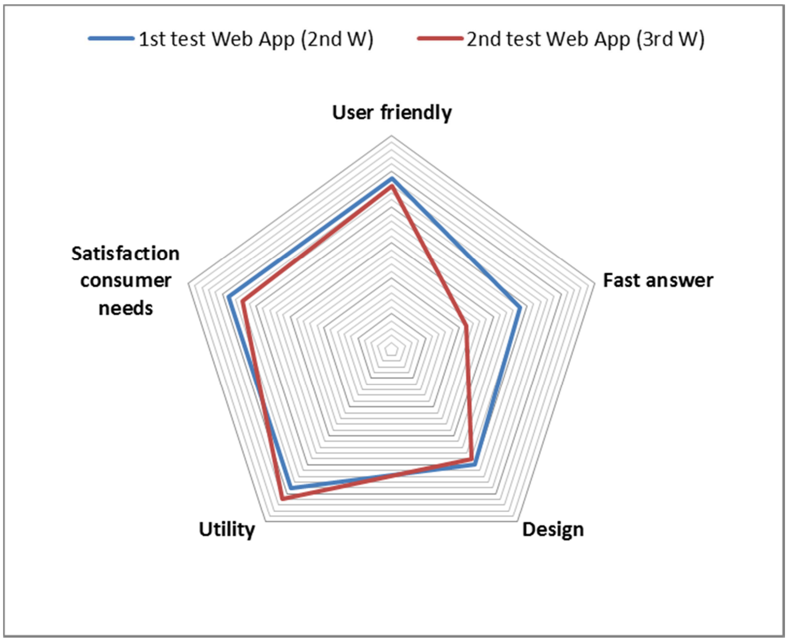

Figure 3-17: Comparison between first and second global evaluation of the web app.

As a conclusion, we can say that consumers participating in the process for pilot evaluation were very interested and motivated in the TIC pilot and are willing to use the TIC Web app.Figure 3-18 shows the percentage of the panel of consumers that would use the TIC Web app after the first and second tests. We can see a great increase).

Figure 3-18: Percentage of consumers who would use the web app while shopping

Regarding the utilized Generic Enablers mentioned above, the results are quite good. The Data Centre Resource Management GE has been really useful for us. The possibility of creating a new instance of a virtual machine and can administrate it was very useful to make the pilot's tests, to avoid the resources consumption of our servers and to decouple the pilot from a specific place such as Bonpreu's facilities or ATOS's.

The Identity Management GE provided the expected functionality to our needs. We could integrate it and combine the login page with the GE. It allowed us to avoid keeping he information related to the users in the used databases. The pilot does not keep the user's personal information, just the identifier and password, but in case that the supermarket would decide to keep this information, the GE could support this functionality without making any changes and this is an added value to its utilization.

The documentation of the Identity Management GE was not easy to understand. We had some troubles because most of the documentation provided by FIWARE was written in German. In the end, we could integrate it in a good way.

The Data Handling GE was used to describe the user's security policies. This functionality was very useful in order to let the supermarket access to determined information regarding the user's activities. However, it was quite difficult to use. There was a misunderstanding between the open specifications detailed in the FIWARE wiki and the functionalities provided in the implemented version of the Generic Enabler. We contacted the people responsible of the GE and they provided the requested functionality. Thanks to this, we could integrate partially the functionalities expected. The specifications show some functionality about keeping different user roles. This functionality would have been useful for us to keep the user's food preferences. We expect that for future versions we could use it this way.

Finally, it was planned to use the CDI GE to manage the capacities of the devices, in our case, to manage, for example, the camera of the mobile phone to recognize the QR code. The problem with this Generic Enabler was that there was not an implemented version for this first phase. We expect that, for phase II, this Generic Enabler will be ready and we will integrate it in the pilot.

3.6.4 Innovations enabled by the Future Internet

The TIC pilot can provide to consumers static and dynamic information of a product according to a profile where each consumer can choose which product attributes he/she want to know. So the application is adapted to each profile and range of information needs of consumers. The integration of the TTAM pilot with the TIC pilot means that the Web App is prepared for working with a real standardized tracking and tracing model. Besides, the logo recognition functionality improves awareness of logos and signs by providing the criteria that they must accomplish. Furthermore, the TIC pilot is based on an application Web that is accessible from any gadget with internet access and camera. Besides, the architecture makes use of Generic Enablers coming from FIWARE and thus validating their use in the Retail sector.

The pilot will provide a clear value for *consumers with better information* on origin, production method, quality, safety, nutrition, sustainability and other aspects of agri-food products; *retail companies*, by providing a *differentiation service* that will attract new customers, increase their satisfaction and fidelity; and for *producers*, with improvements in assuring that their *products reach consumers which are informed of all product attributes*. Communicating attributes of their products will add a clear value.

The Data Centre Resource Management Generic Enabler enables providing the application as a service for the user, so the cloud providers manage the infrastructure and platforms on which the application runs. This "on-demand software" business concept allows the user use the services or systems that needs exactly, avoiding extra costs and developments not related with its real purposes.

The Identity Management Generic Enabler provides essential feedback to the security of the organisation that grants access to resources in its information systems. It's also essential to the security of the individual who accesses these resources, particularly when they belong or relate to him/her (e.g. personal data such as medical preferences). This Generic Enabler does not offer a binary choice between full assurance and no assurance regarding the parties to an interaction. It offers a range of levels of assurance, as appropriate (e.g. low, medium or high). The rationale for selecting the level of assurance primarily includes its alignment with the level of risk carried by the interactions between the parties.

The TIC pilot architecture is ready for scalability and interoperability. As explained in D400.4 [10], with the paradigm of cloud computing embedded into the TIC pilot, scalability issues related to server availability, data and communication load, multitenancy, federation, are more of a factor from the economic point of view than for the technical domain. Cloud computing allows companies to easily upscale or downscale IT requirements as and when required.

The *Tailored Information System* has been developed for working with different item identifiers (barcode, QR, 2D barcodes, RFID...) and most of the functionalities developed in the pilot have been designed and implemented following the principles and methodologies of SOA architecture. This provides the added value of interoperable services, understood as small/medium software components which can be reused for different purposes.

In this first phase of the FI-PPP, one of the objectives to achieve was the study of the Generic Enablers, their comprehension and utilization the maximum way we could inside the pilots. For the second phase, a whole platform based on the Generic Enablers will be developed. The trials defined for this second phase will be based on this platform.

3.6.5 Recommendations to enhance the generic enablers

The next challenges and innovations foreseen in the scope of Tailored Information for Consumers pilot are mainly focused on the user’s shopping experience. Of course that technical innovations and the adoption of emerging technologies can improve the final experience of the user, but the points assessed in this scope are:

- Enhance the user experience in the supermarket and its involvement
- Integration with trustworthy authorities
- Add post-shopping process (payments, claims…)
- Integrate new technologies as NFC, augmented reality…
- Gather all supply chain information created by each stakeholder

Mainly, we expected one extra requirement which can enhance the functionality and interoperability of the Generic Enablers we’ve used in this pilot: with the growth of services exceeding predictions, cloud computing will gravitate even further into the enterprise with hybrid clouds, so the interoperability between clouds of different nature would be a requirement for future trends in this aspect.

4 Feedback from the community

4.1 Expected users' evaluation

In order to screen the users' expectations and opinions on actual development of the pilots and applications, during the whole project users were involved from different parts of the food chain who are not participating partners of the project. The aim always was to get more information from a broader community and get ideas for a broader scope than the actual descriptions and value propositions of the use cases on farming, logistics, and consumers' food awareness, and e.g. to identify the users' operational problems.

The feedbacks of these user involvements showed a large level of consistency at any stage of the project independently of the different countries – in relation to the applicability and the feasibility, the expectations or even the limitations and doubts emerged.

4.1.1 Before the pilots

In the very first stage of the project expected users' expectations and requirements already were collected. Based on the feedbacks, there were some demands and limitations which were universally mentioned.

It was generally agreed that two functions of the Future Internet could be very important:

- Ensuring the possibility that the services, equipment, devices, etc. should be available everywhere and they can operate their business processes remotely from anywhere - in addition it is necessary that the applications and devices should be integrated and standardized.
- Ensuring a higher privacy which guarantees for the protection of personal data.

It is very clear that the ensuring of safety and security of data and information is the essential element for the users. Most of the users are worried about the unauthorized use of their data and they require that the expected systems and applications should be safe. Therefore availability of databases should be regulated and controlled to guarantee the data security and protection. The most important requirement of the actors in the food supply chain is reliability and security.

Lower costs for implementing the new or advanced applications was also a priority, as currently the price of the technologies required is too high, particularly for smaller businesses.

According to this, in relation to applicability and feasibility, we could state that in the future those applications, functions or systems can be viable and will be implemented, which will have great benefit, or which are already applied even in some other crude format (manual or non-automatic), therefore they can be developed easily or in a cheaper way.

As most of the users do not have appropriate experience about using the Internet, by their opinion also important preconditions were the following:

- User-friendly applications and interfaces
- Improved filtering and systematic organization of the received, stored, sent or browsed data - even on demand by a predetermined profile

4.1.2 During development of the pilots

By ensuring the continuous discussion between the users and the pilot developers, users evaluated the pilots several times with respect to the technical solutions applied.

In general, in their opinion overall solutions could be useful and will be probably applied by the potential users, and most of them thought that the systems have a lot of functionalities that are useful for their life or business e.g. for an efficient management.

- Feedback information about collected/transmitted data by the different actors or services back to the farming processes was seen as very valuable and promising, since evaluation based on real data gives more reliable estimations for the different planning levels.
- It is possible to create new business when information is available using standard formats and interfaces.
- Ideas about how things should work were good by their opinion, but the technical solutions (e.g. cloud services) must be considered very carefully.

What did they think the potential hurdles of applicability are?

The farmers and end-users were and are worried about the costs of the investment. Users have to see benefits of services, functions and new methods, since usually aim is still to achieve cost efficiency.

Another issue that has been discussed was how the farmers and users are ensured that the data that come from the systems and stored in the cloud are accurate. Biggest question and worry was reliability of the functions and services of the pilot. Especially security issues were emphasized during the discussions. Confidence to the user supporting functions is based on reliability of the solutions in the future.

Figure 4-1 summarises the stakeholders' main concerns.

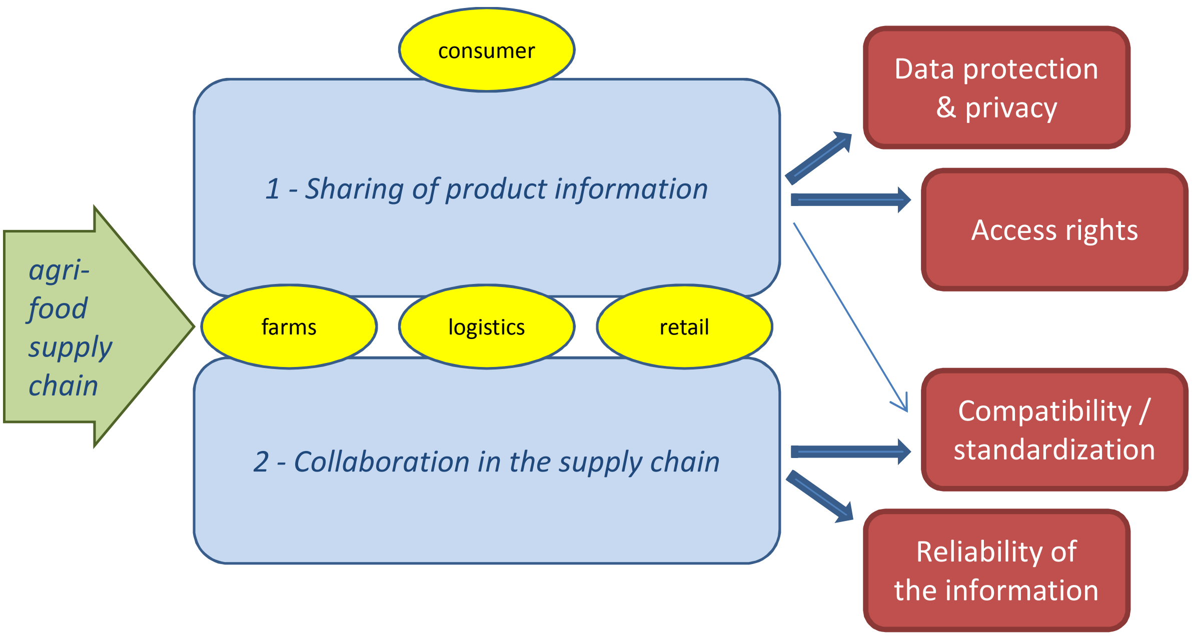

Figure 4-1: Main issues completed with users' key demands

What should the solution providers change or improve?

farmers:

- According to the discussions, change from the old operation model to new one depends on the benefits for all actors. Another way is the authorities impose rules on the farming and food sector (e.g. interface / data format legislative rules).
- Risk and fear of sharing information is that e.g. authorities of legislation use data only for seeking mistakes and faults. According to the discussions also authorities have to change standards of activities.
- If feedback information is available and benefits are shown for the all participants sharing of information was a supported idea.

logistics:

- The interoperability of systems or services was a key issue.

consumers:

- Getting retailers involved to the service widely from the EU area is a key challenge, as retail is a key partner in the pilots.
- Food chain actors might find information on consumer profiles useful, for instance in helping with new product development. However, more incentives must be communicated in order to increase their interest to get involved.
- Implementation only has realistic chance if at least 70-80% of a retailer network in a region or country accepts it simultaneously.

4.1.3 At the end of the project

In general the pilots and their value propositions were and are thought as applicable and useful solutions in the future. The technologies described in the pilots are potentially applicable and usable parallel in different solutions.

However, there are still some key issues and questions which are still opened, for all pilots and applications developed.

- The main resources to implement the systems or applications are still one of the capitals of the SMEs. A statement or estimation at least about the costs of the implementation would be useful.
- Information management (incl. production, sharing, controlling, pricing, ownership etc.) in the food chain and the cloud service is a big challenge, and should be addressed in more detail in the pilots and the whole project. Who defines and controls the reliability and correctness of information? Who is responsible for the information?
- The characteristics of the cloud service should be precise and defined in detail. Key questions that have to be considered are:
- What is the business case for managing this vast cloud service?
- How will the cloud be managed in practice?
- By whom and how will the cloud service as well as the cloud proxy be maintained, controlled and managed?

4.2 Stakeholders and users evaluation in pilots

The stakeholder evaluations took place at several different occasions within all three use cases with different key stakeholders of the pilot consortium.

4.2.1 Benefit to farmers

Economic aspects

The adoption of FI technologies will result in several benefits for the farmer with regard to the economic outcome of his enterprise. A more efficient use of fertilizer, seeds and pesticides will lead to lower costs and a higher production rate. The sales price of the farm product can be higher due to a higher quality of products (regional marketing, certification of the production process, better freshness) and due to a higher demand response. Better planning tools allow for less machine operations. Costs for energy and water can be saved by smart metering and dynamic tariffing. The use of cloud services will lower the costs for advisory and consultancy services and reduce in-office work hours. Finally, the capital investment for IT equipment can be lower, but the operating costs for cloud services are higher.

In order to quantify this economic benefit, a business case was analyzed. In both the smart spraying and the greenhouse pilots the project group was able to develop business models that could be found credible and acceptable by the end-users. Especially in the case of the smart spraying we were also able to articulate the concepts from the end user point of view and describe what the added value of the concept could be for farming.

Social aspects

The smart farming pilot developed around the arable farming demonstrated technical feasibility of those FI innovations and enablers developed in the FI programme. It appears also that it the Smart farming pilot could find support for FI-based farming concepts from the end-users so that the social feasibility could be demonstrated. The end-user feedback gained conveys the message that farmers are aware and concerned of the generic challenges of the food –chain, i.e. food safety, environment, ethical issues and cultural preferences, and that they see the possibilities of FI to tackle these challenges.

It was found that the smart farming work process focuses on optimising safety and environmental goals with regard to efficiency of farming.

Safety of the product (food safety) was considered especially with regard to pesticide residues. In order to monitor this optimization goal the actor needs to pay attention to his/her pesticide usage and that the usage fulfils the set rules and norms.

Environmental values were also considered. Wind drift was found one of the most important goals of optimisation that relates to accounting environmental values. The criterion is observing the wind direction and velocity wile spraying. Environmental values were also portrayed when considering the carbon footprint goal. The criterion to observe by the actors is that fuel consumption is kept under set carbon dioxide limits.

Connected to better control of food safety and environmental challenges also the possibilities to improve the quality of products and development of new products, and markets were considered. The increased transparency of the food chain was considered a possibility also to demonstrate the quality and develop high brand products.

Reduction in work load was not the most dominant issue that the end-users considered when discussing the perspectives of FI-based technologies. Of course some increase in effectiveness of work and saving of work effort was anticipated but these prospects were, probably, not the most motivating aspect of the new technology. The possibilities of the Future Internet based technologies were connected with developing the agricultural domain and work, and the possibilities to learn and develop new competencies. These aspects appeared to have high relevance for the end-users.

Improved networking was one of the most relevant functionalities that FI-basic technologies can provide for farmers. Information sharing for creating professional and situation awareness and possibly sharing of work seamlessly by sub-contracting within the network would support farmers to operate their everyday tasks and increase satisfaction towards their work.

Tailored services according to the user needs ensure the usefulness of the service framework for all users despite their educational background. The markets should be aware of the user needs in the present (and local) markets and react the need by providing appropriate services.

4.2.2 Logistics sector

The pilot results are evaluated by the stakeholders of both pilots. This evaluation has focussed on the conceptual and face validity of the designed pilot architectures and the developed prototypes. The stakeholder evaluation was setup systematically based on a structured questionnaire (see Appendix C), which comprises more parts: 1.) stakeholder objectives and requirements, 2) desired situation and process design, 3) system architecture, 4) prototype demonstration and 5) Impact and adoption.

In both pilots the stakeholders are very committed and evaluated the results very positively. More specifically, below some specific remarks are summarized.

Some highlights of the stakeholders' feedback in the PF pilot:

- The margins are currently extremely low due to the economic crisis, new inventions only have a chance to be adopted if the business case is undisputedly positive;
- Most respondents do seem to trust cloud-based solutions provided that authorization is covered. They also indicate that a chain wide platform would be suitable approach;
- The overall response to the demonstrated software was positive and enthusiastic; one stakeholder literally said "this exactly corresponds with what I had in mind myself but did not manage to put on paper";
- The expert system for quality prediction should be improved to make it suitable for practical usage e.g. by making the system self-learning;
- The involved parties all find the pilot project very interesting and like to continue or even increase their involvement in the pilot during the Phase 2 of the FI-PPP.

The FFV evaluation showed very positive tendencies from the key stakeholders, especially from partners in retail (EDEKA), trade organizations (Landgard, Pfalzmarkt) and RTI Pool Management. Euro Pool System tested the RTI management part of the prototype in their operative business environment which advanced towards the scope of phase 2 already.

However, two issues resulting from the evaluation discussions (which are not related to technical issues) relevant for the large-scale implementation remain unsolved at this point of the project:

- Payment and trade mechanisms of product- and process-related information in an environment, where large-scale companies are dominant in the market, and
- Rules for further usage of information provided by the Product Information Service.

These two issues have to be solved with a Code of Conduct-kind way, which has to be developed by the involved stakeholders in the sector. Such a compromising solution has to be supported by the project with ideas and functionalities which enable its implementation.

The results from the Pilot in Phase 1 were promising in different ways:

- Key stakeholders are discussing about information exchange and possible applications for future collaboration (already a discussion towards Phase 3 developed in the past month);
- The prototypes have been evaluated positively ;
- The most important point however is, that key stakeholders from different stages use the project as platform to discuss about the previously summarized organizational issues in a joined way, which is a major step into the direction of large-scale implementation;
- The flexibility of using different batch sizes (boxes, pallets, dollies) is one of most important requirement for successful implementation;
- RFID technology would tremendously reduce the effort of RTI scanning and increase the adoption potential, but it requires sectorial coverage of RFID technology;
- Exception reporting would have an enormous potential to help companies to investigate their supplies in case of food crises;
- The local server was rated as very good concept to extend the existing IT infrastructure of the interviewed stakeholders without large investments; however, for smaller enterprises with less IT infrastructure a cloud-based service could be helpful, especially focusing on farmers;

The stakeholders want to manage the access rights for their data on their own; it is not thinkable to leave the data at a neutral party for further distribution.

4.2.3 Consumers and the retail sector

During the whole project it was main objective to expose and analyse the feedback provided by the final user of the Smart Food Awareness sub-domain within the food chain, and also to evaluate the conclusions obtained during the project within the Retail sector. Workshops were realized for both the TIC and the TTAM pilot in order to obtain feedback of the consumer of the supermarket. These involved real consumers and most of them realized in a supermarket of Bon Preu, located in Barcelona, Spain.

After getting the feedback of both the supermarket customer and the food chain stakeholders, the received information was analysed. The conclusions are different for these food chain players:

- Consumers: along the three workshops in the supermarket the same group of people was involved in it, and these are their main conclusions:
    - There is a lack of information related to products for the costumer in the supermarket. And if the information is available it is difficult to understand it
    - Not all the currently provided information is useful or interesting for the consumer
    - The food awareness activity is useful and very interesting, and can help end-user to gather information that is interesting for them
    - But they disagree with raising the product price or paying any money to gather the tailored information
    - They are willing to start using a real market application with the same characteristics that the ones offered by the proofs of concept
    - They are receptive use the new technologies while shopping, and they prefer them to the classical supermarket communications, as SMS or old-fashion mailing.
- Food chain stakeholders:
    - There are many problems in the meat chain that hinder correct tracing and tracking of meat products nowadays
    - The project addresses those problems in the right way, and from a technical point of view it is possible to solve them

- The reliability of the tracking & tracing information, which can only evolve from an intense usage of such systems, therefore cannot be guaranteed by the project itself
- So it is necessary to better involve the stakeholders within the meat chain and a change of mind in the way these companies share their data is needed; and also from the side of the customers public stated requirements may support a development of increased transparency in food chains

After analysing the feedback of the consumer, a first requirement analysis and a costs benefit analysis of developing the proof of concept applications of pilots into real market software tools has been realized:

- The cost and revenues of these applications in a real market software tools have been estimated by simulation. The main conclusions are that a significant increment in the benefits for the retailers and supermarkets would be achieved. But not only these companies will enhance their working methodologies, and therefore their revenues, but also farmers, producers and food-processors that will be able to produce better products based on the feedback got from different sources, and the logistics companies, improving the transport and maintenance of the products in the food chain. These actors also can improve their businesses using all the gathered information. Not only looking at higher turnover by increased sales and distributions, at the same time each participant in the value chain would be able to realize benefits on ameliorating his purchases and procurements.
- The modifications that would be necessary to be done in the structure of the food chain would imply an environmental improvement in the transport of the food products. It will provide an improvement of the consumer awareness about any product information and how it can affect the environment. Therefore, a consumer would be more sensitized about environmental impacts and more aware of how to act in their consumption habits in order to reduce them.
- From a technical point of view, the improvements to be done in the applications and their deployment into the real market would be easy to be performed. Mainly due to the cloud oriented definition of the architecture of the backend of the applications, and the service oriented definition of their functionalities, what boost the addition or modification of new functionalities in the software solutions to be deployed. Also, the use of new technologies, as HTML5, enables a more easy and general access for a consumer using any kind of gadget with access to the internet, as computers, tablets, smartphones, etc.

All these conclusions envisage an optimistic future for the Food Awareness products in the next years, helping to improve the buying of more healthy and less environmental-injurious products by the consumer.

The first need to realise this vision is the development of a food chain environment, where all the involved players are connected and know each other. This idea has been further elaborated in the Phase II project called cSpace [20], where a collaborative space has been defined, not including B2B functionalities to ease the links between the stakeholders, but also a common data model, to improve the data exchange, and a market place where final users and SMEs can provide new applications with new functionalities and open new markets.

5 GE feasibility assessment

This chapter summarizes the results of the GE evaluation by FI-WARE chapter. Table 5-1 presents an overview of the coverage of required functionalities as assessed in Chapter 3 and Appendix A.

Table 5-1: Feasibility of GEs in the SmartAgriFood pilots by FI-WARE chapter

FI-WARE Chapter	Generic Enabler	Coverage	Pilot name
Cloud Hosting	Data Center Resource Management	*****	Greenhouse
		******	TIC
	Object Storage	**	Greenhouse
Data/Context Management	Complex Event Processing (CEP)	*****	Flowers and Plants
		****	FFV
	Publish/Subscribe SAMSON Broker	******	Greenhouse
Applications/Services Ecosystem and Delivery Framework	Repository	******	Greenhouse
	Marketplace	****	Spraying
	Service Composition & Application Mashup	****	Greenhouse
	Mediator	***	Greenhouse
IoT	Things Management	***	Spraying
		***	Greenhouse
Security	GCP IdM	******	Spraying
		******	FFV
		****	TIC
	Data Handling	****	TIC
I2ND	Cloud Edge	***	Greenhouse

The table shows that Generic Enablers from all FI-WARE chapters have been tested during the pilot evaluations. A more detailed overview of evaluation outcomes is presented in Appendix B. The following sections discuss, by FI-WARE chapter, the feasibility of the evaluated Generic Enablers for the SmartAgriFood applications.

5.1 Cloud Hosting

The *IaaS Data Center Resource Management GE* has been used in two pilots and it worked well.

The *Allocation of Object Storage GE* was part of the architecture designed for several prototypes. The specifications are perfect for our future experimentation, but due to inadequate documentation and authorization problems in the REST API we could not fully implement it in the current prototypes. We do foresee to apply it in the FI-PPP phase II trials.

5.2 Data/Context Management

The *Complex Event Processing (CEP)* GE's announced functionalities can be useful for many pilots. It is included in the architectures of all SmartAgriFood prototypes, but it could not be applied in the current project, due to unclear documentation and complexities in the rule specification and maintenance. The problems have been communicated with the GE owner and solutions to some of the problems are planned for release 2. We do plan for application of this GE in Phase II.

The *SAMSON Publish/Subscribe broker GE* has successfully been applied in the Greenhouse prototype. It runs in a virtual machine created with the IaaS Data Center Resource Management GE. It is used, for instance, to subscribe to sensor data in the Farm Management System, and the published data is used for notifications and alerts. The GE is foreseen to be applied in all pilots for Phase II.

The *Context Awareness Platform Publish/Subscribe Broker GE* could be of interest for Phase II. No links between CEP and this GE are available in Phase I. Phase II will cover links among different GEs. Apps can contact CEP directly (e.g. for speed improvement), but PubSub in between provides a standardized NGSI (OMA Next Generation Services Interface) interface [19]. XML and JSON bindings will be supported. No filtering is supported at the moment. We will have to re-evaluate it for Phase II.

The *Samson BigData Analysis GE* is seen as a candidate to be applied in the TIC pilot in Phase II. However, it has not been deeply evaluated in the current project.

Based on the original High Level Document we planned to apply the *Multimedia Analysis GE*, but the *Compressed Domain Video Analysis GE* as currently available is not feasible. It only highlights points of interest inside a video stream (e.g. a moving person) by returning the detected rectangle.

We also did not further analyse the *Media-enhanced Query broker GE*. It seems that it is not enhanced by multimedia features, but limited to multimedia files.

The *Location GE* is useful for tracking products during delivery. Device location updates can also be subscribed to. A weakness is the lack of a history view, it only says where you are not where you have been, but I guess the client needs to store that. The location info can be accessed via any web browser with the code shown on the catalogue page. The GE is foreseen to be used in Phase II.

Since no semantic technologies were actually applied in the project, we did not evaluate the involved GEs.

5.3 Internet of Things (IoT) Services Enablement

The *Things Management GE* is foreseen to be used in pilots in Phase II. We tested it for the Greenhouse pilot. Since NGSI 9 functionality is planned but not available in the testbed version, we did not proceed to implement it in the prototypes and could not assess the feasibility in practical situations.

5.4 Applications/Services Ecosystem and Delivery Framework

The *Repository GE* enables interaction with a repository where services information is stored in a USDL format. Its REST API allows easy upload and retrieve of services info. It is used currently in the Greenhouse pilot for the purposes of a services repository. It works well and is feasible for other pilots. It is foreseen to be applied in Phase II as a core component in the use of third-party services in Farm Management Systems and Consumer Information apps.

The *Marketplace GE* offers an integrated view with domain relevant offerings. The Marketplace integration is based on the two functional requirements derived from the value proposition of the SmartAgriFood Farm Management Systems vision: the framework enables review and purchasing of available services (access to services in the market) and enables building a meaningful farm service ecology (tailoring of user service bundle). The GE is foreseen to be applied in phase 2 for Farm Management and Consumer Information trials.

This *Mashup Factory GE* provides an easy way to compose multiple services into a more complex one and provides a graphical mash-up as a result. It is implemented in the Smart Greenhouse prototype. However, we were unable to perform a core integration of the Service Composition and Application Mash up GEs; thus we had to opt for a loose coupling. The Service Composition & Application Mashup GE has been integrated in the GUI frontend of the pilot. It can be used to provide graphic mash ups that exploit the capabilities of the widgets provided by the Mashup Factory. In the background, these widgets/services compose a new one in a service composition manner. The final evaluation is that the GE is feasible for application in Phase II.

The *Mediator GE* was used to expose services in the Smart greenhouse pilot, and to account for the use of the services. There were problems in the implementation and comments are forwarded to the GE owner, but we managed to get it working. Application of this GE will be reconsidered in Phase II.

5.5 Security

We considered the *One-IDM Identity Management GE*. This GE seemed to be promising for the identification of various subjects in our prototypes. However its current version which supports only JavaScript interfaces clash out with our goals since we need identification also in our Java modules.

The *GCP Identity Management GE* provides the core functionality of the identity management of the service framework including user registration and login, user service registration and session management. Also serves as access point to globally registered services. It is very useful for our purposes. However, some points can be improved, as reported in Chapter 2 and Appendix B.

The *Data Handling GE* enables data owners to attach privacy policies to the data, telling data consumers what to do with it. It was applied in the TIC pilot. The GE is very hard to understand and complex to use for a programmer. However, the implementation is pretty much complete and works satisfactory, so we recommend using it in all Phase 2 pilots. The “programmer-friendliness” can be improved in future releases.

5.6 Interface to Networks and Devices (I2ND)

The first release of the *Cloud Edge GE* has limited functionality. The resource monitoring and resource controller components are missing; there is no integration with the cloud. So what we get out of it the capability to download a bundle on the farmers’ pc, which contains a Linux distribution with our software preloaded on it, and this bundle to run isolated from everything else. We have used the Cloud Edge GE in order to deploy our local FMS software in an isolated environment inside the greenhouse pc. A Linux image is produced with the local FMS software running on it. This image is deployed through the provided client in the medium commodity pc installed inside the greenhouse. According to the technical roadmap, all features will be implemented in the second release, so future releases of the Cloud Edge GE can be used in the pilots.

6 Specification of Phase II trials

Phase II trials will be implemented in the cSpace project, which is a merger of FI-PPP Phase I projects SmartAgriFood and Finest [20]. cSpace focuses on the development, validation, and particularly the preparation for large-scale expansion of the cSpace concept in Phase 3 by leveraging results of Phase 1 projects and related Future Internet R&D projects.

The cSpace architecture comprises three main components: the cSpace platform, the trial applications, and the cross-domain apps. The latter provide general services to the trial applications. The trial applications and the cross-domain apps described in this chapter will be built on top of the cSpace platform, which will deliver support to collaboration in cross-organizational and cross-domain business networks, covering both technical and business model aspects [20]. The present chapter describes the trial specifications (Section 6.1) and the cross-domain apps (Section 6.2).

The cSpace project aims to use the Generic Enablers. Based on the Phase 1 projects FInest & SmartAgriFood as well as considering the latest results of the FI-WARE project, cSpace is carefully planning that usage. The latest planning of GE usage in the trial applications and is presented in the sections 6.1 (i.e. referencing the usage of GEs in the cSpace trials) and 6.2 (i.e. intended GE usage in the cross-domain apps). For planned GE usage in the cSpace platform, we refer to the cSpace proposal [20].

Acknowledgement

The ideas presented in this chapter are elaborated in co-operation with our cSpace colleagues from the FInest project. We thank our colleagues for their inputs. This refers in particular to the trials 3 (Fish Distribution and (Re-)Planning) and 7 (Import and Export of Consumer Goods).

6.1 Phase II trials in Agri-Food and Transport and Logistics

The eight use case trials that will be executed in cSpace, will demonstrate the large potential of Future Internet technology for enabling innovation and improvements in important business domains. They will showcase the progress over existing approaches that can be achieved through the use of Future Internet technologies, and the state-of-the-art made possible through the cSpace service and its Apps in the agri-food and transport and logistics domains. The trials will be executed within three related major clusters: Smart Food Production (Section 6.1.1), Intelligent Perishable Goods Logistics (Section 6.1.2) and Smart Distribution and Consumption (Section 6.1.3). These domain trials build upon, extend and integrate the use cases and proofs of concepts that were developed in Phase I of the FI PPP, in particular the outcomes of the FInest and SmartAgriFood use case projects. The following sections describe the trial specifications according to the cSpace proposal.

6.1.1 Smart Food Production

6.1.1.1 Trial 1: Crop Protection Information Sharing

Numerous actors contribute to the food on consumers' tables: suppliers of crop protection material, farmers growing crops, processors, and retailers. These actors have at present independent, mostly proprietary solutions to supply each other and the consumer with information. Transparency and fluid information transfer is lacking.

There is a great need for tracking and tracing information about inputs, including crop protection agents and the quality of food. This is relevant for consumers' food awareness and, in case of food emergencies, for a rapid response. Many sources of information are also required to support farmers in decision-making, for example on the application of plant disease agents. cSpace will connect actors along the agri-food supply chain, enhance licence agreement orchestration, and enable seamless creation of different tailored services for, and amongst, stakeholders.

The trial demonstrates the use of Future Internet technologies with functionalities to address social, business, and policy objectives (e.g., optimization of the use of plant protection agents), create environmental benefits, transparency, and food security. Protection of potatoes against *Phytophtera*, which requires at present approximately ten spraying actions, will be used as a first use case for this trial.

The Future Internet provides possibilities for real-time support for farmers (Figure 6-1).

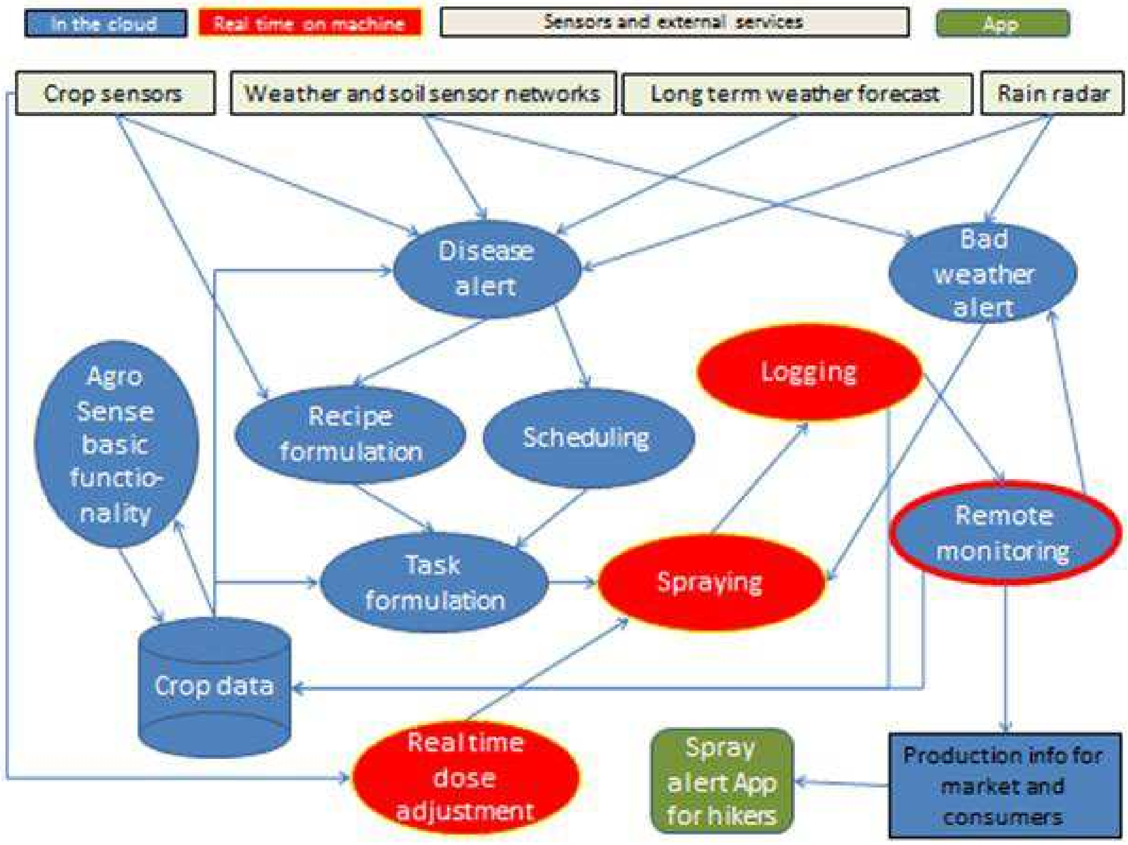

Figure 6-1: Layout Crop Protection Information Sharing Trial

Real-time weather information from sensors and rain radar will be made available and integrated in real-time, as will medium range weather forecast. *Phytophtera* development will be forecasted based on this information and data on cropping history and crop development. A disease warning will be generated should analysis indicate that this is necessary. Recipe formulation with the optimal type of crop protection agent, scheduling of the operation with respect to weather conditions and resource availability and task formulation will start as soon as a disease alert is given. The actual measured crop density is used for real-time dose adjustment based on parameters determined during recipe formulation. Actually applied dosages, sensor information and machine status will be logged and made available by IoT sensors. Sensor data will thus be available for real-time situational support as a service in the cloud, and may even be offered to the public, e.g., by providing information on recently treated fields for hikers with allergies in the form of a "Spray Alert for Hikers" App. Data from such remote monitoring can also be used for fault diagnostics and tracking and tracing purposes by authorised users.

Relevant Generic Enablers

IaaS Data Center Resource Management GE, Data Warehouse GE, Monitoring GE, Metering and Accounting GE, USDL Repository GE, Marketplace and Storage GE, USDL Registry GE, SLA Management GE, Revenue Settlement and Sharing GE, Security Monitoring GE, Identity Management GE, Privacy GE, Pub/Sub GE, Complex Event Processing GE, Big Data Analysis GE, Meta-Data Pre-processing GE, Location GE, Data and Content Management GE, Mobility Analysis GE, Real Time Recommendation GE, Opinion Mining GE, IoT Communication GE, IoT Resource Management GE, IoT Process Automation GE, IoT Data Handling GE

6.1.1.2 Trial 2: Greenhouse Management & Control

The greenhouse trial focuses on improving greenhouse management and control processes. The goals are a) provide affordable sophisticated applications and services to the farmers b) enable them to interact with other stakeholders along the food chain in a more efficient and transparent way, and c) provide the means to integrate any legacy systems they may have through the cSpace.

The layout of the trial is presented in Figure 6-2.

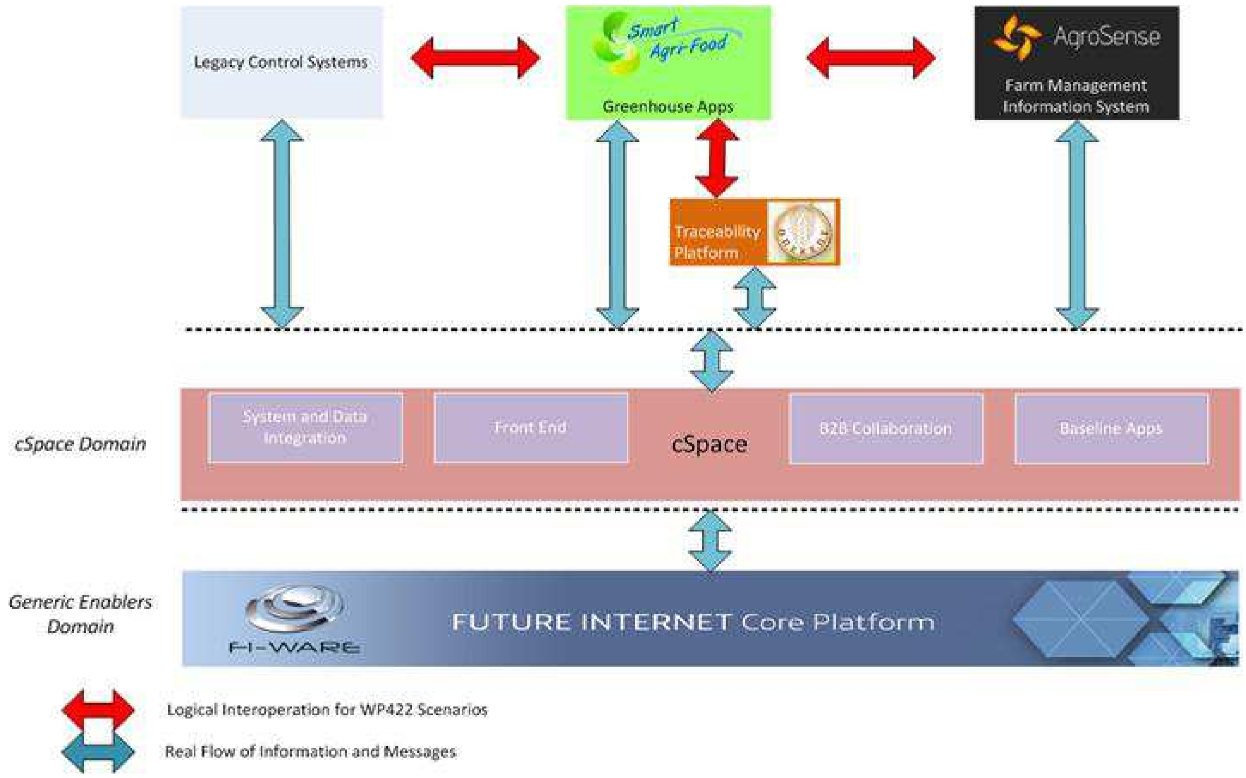

Figure 6-2: Layout Greenhouse Management & Control Trial

Farmers install locally in their greenhouses the required sensors (e.g., temperature, CO2, luminosity, relative humidity, etc.) and actuators, and possibly a low cost/capabilities proxy machine. The collected data, as well as the intelligent applications that may have access to these data, are located in the cloud. The intelligent applications will provide alerts and notifications to the farmers through a variety of devices allowing the farmer to improve his productivity. Moreover, the farmer, using cSpace, will have access to a market place of services and stakeholders with the same ease as a mobile user today for installing, using or deactivating services in a smartphone. This approach is expected to provide radical changes to the farm management market where today only monolithic, proprietary and usually expensive solutions for the farmers exist.

In the context of this trial we will provide the greenhouse and services (e.g., expert system for different vegetables) and the end-devices (boards with a number of sensors installed and wireless communication modules) that were developed in SmartAgriFood. These services will be ported into cSpace and additional services (e.g., task planning, inventory) will be developed. Moreover, software solutions to integrate a legacy greenhouse control system with cSpace and provide interoperation scenarios with the above mentioned services will be provided. This experiment will prove in practice how legacy systems can be integrated with cSpace to improve their operation. The results will lead to the future integration of other similar products from other companies with cSpace. Moreover, we will further test the integration capabilities offered by cSpace by implementing test scenarios that will be used in the Crop Protection Information Sharing trial.

Relevant Generic Enablers

Service Composition and Application Mashup GE, Repository GE, Data Center Resource Management GE, Pub/Sub SAMSON Broker GE, Cloud Edge GE, Mediator GE, Object Storage GE, IoT Resource Management GE, Identity Management GE, Gateway Data Handing GE, Protocol Adaptor GE, Gateway Device Management GE

6.1.2 Intelligent Perishable Goods Logistics

6.1.2.1 Trial 3: Fish Distribution and (Re-)Planning

This trial is concerned with the planning of logistics and transport activity in the fish industry, a crucial process for ensuring performance across the whole supply chain. The main challenges addressed are low predictability and late shipment booking cancellations, mostly due to lack of collaboration or access to information, affecting directly the resource and asset utilization of service suppliers. Furthermore, data quality at the planning phase is essential for enabling effective monitoring of transport execution.

The trial will be built on the export of fish from Norway (see Figure 6-3).

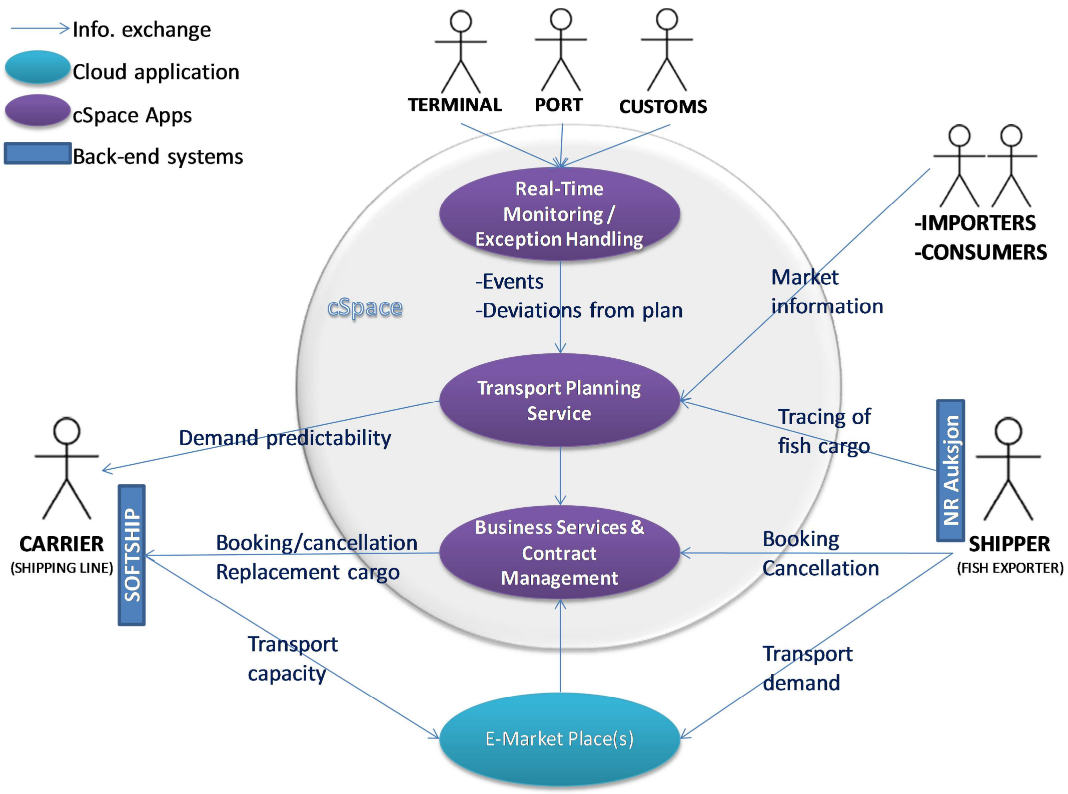

Figure 6-3: Layout Fish Distribution and (Re-)Planning Trial

Fish exporters produce fish continuously, sell it to retailers/wholesalers overseas, then contact a cargo agent for carrying out the logistics operations, including planning, booking/contracting of transport services, customs declarations, follow up, and tracking and tracing of cargo.

The trial will show-case the innovations of cSpace by addressing the following key activities in the supply chain:

- Distribution (re)scheduling: For the shipper, this includes finding a transport supplier, creating a shipment order, developing a transport execution plan, and rescheduling transport in case of deviation.
- Transport demand (re)planning: For the carrier, this includes demand planning/prediction, resource management and (re)planning of transport operation in case of deviations.
- Tracing of cargo: tracing of cargo at product level is essential for monitoring of transport, but also for detecting deviations at the planning phase (delayed cargo).

The trial will explore applications that can contribute to B2B collaboration for improving logistics operations, but also enabling open innovations. Two examples of test applications are:

- Improved Booking Reliability: improved upstream planning so that the carrier gets more visibility, more reliable booking, and early notification of changes. The trial will demonstrate how a better integration of the supply chain, in terms of information distribution and accessibility, can contribute to better planning and resource utilization.
- Handling of Late Cancellations: provide to the carrier quick access to online e-market place and ability to reschedule bookings, find replacement cargo or additional last minute cargo in a shorter time window compared to what today's IT network can offer. Combined with pricing policies that encourage early booking and dissuade late booking cancellations, this solution is believed to have a strong positive impact on capacity utilization as well as cost efficiency, especially for the short sea shipping spot market.

The scenarios will feature primarily the carrier (container shipping operator) and cargo owners (fish exporters) or, alternatively, cargo agents. They will represent real-life situations, business activities, or types of events, and show how cSpace enables them to interact more effectively to increase supply-chain efficiency.

Relevant Generic Enablers

Service Description Repository GE, Complex Event Processing GE, Marketplace GE, Application Store GE, Pub/Sub GE, Data/Context Management GE

6.1.2.2 Trial 4: Fresh Fruit and Vegetables Quality Assurance

This use case trial will look at (a) transparency along the chain (forward and backward) regarding food safety, food quality and transportation issues and at (b) deviations (transports, products) that affect the distribution process in general either deviations for the plan or other external events requiring re-planning. Based on transparency, focus is on the detection of the deviations and signalization to all concerned stakeholders in a complex business network environment in due time, so that corrective actions can be taken in a timely manner. Due to the complexity of food networks with its many SMEs and its need to dynamically rearrange supplier-customer relationships because of unreliability in supplies, past technology could not provide appropriate solutions to the transparency problem irrespective of many efforts in industry and research. The scope of the information and deviation management trial will demonstrate cSpace functionalities regarding:

- The exchange of product- and process-related information between agri-food enterprises in order to enable information flow (regular, on demand) along the supply chain network from farm to retail,

- Evaluation and monitoring of this information flow in order to identify deviations from pre-defined product and process schemes,
- Distribute exception messages regarding a potentially identified deviation within a process, or regarding a specific product, to other involved actors within the supply chain network. This includes, e.g., the signaling of an inadequate product quality status (based on, e.g., laboratory results, transport damage and other detected deficiencies that have an impact on food safety and quality) triggering a need for reactions by suppliers or customers such as, e.g., removal of products from the distribution process or recalls.

These core functionalities will be found in the “Product Quality Information” App (developed as part of this trial). The idea behind this App is to make sharing of reliable product- and process-related information within the food supply network much easier and enable agri-food companies to react to deviations in a timely way in order to reduce negative impacts and waste. The concept behind this App is based on results of the CuteLoop, Transparent_Food and SmartAgriFood projects and is developed and tested in the cSpace project together with a consortium of notable associated partners to determine if it meets their needs.

The trial is aligned to the fresh fruit and vegetables supply network, where short time to market, fast distribution and timely communication of deviations are of great importance in order to detect and remove unsafe products from the distribution process before they can harm consumers. Rapid detection of deviations is extremely important for agri-food enterprises as inadequate monitoring of quality in the past has had extremely negative impacts on their reputation and caused massive loss of trust in several companies. This trial brings together different business partners with different points of view on the fresh fruit and vegetable market (Figure 6-4).

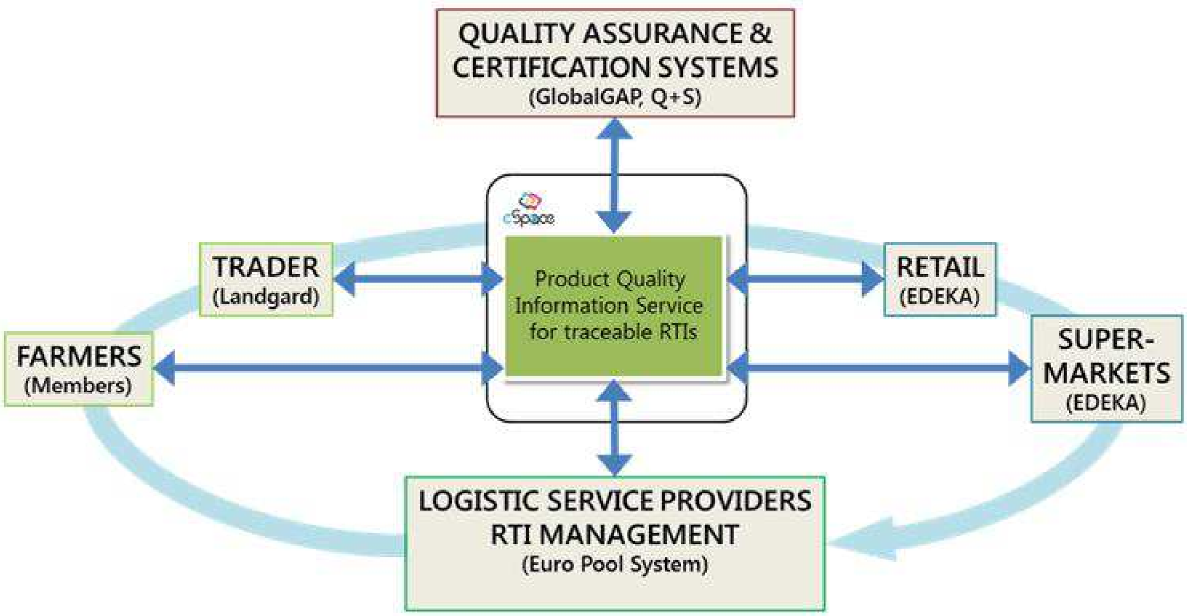

Figure 6-4: Layout Fresh Fruit and Vegetables Quality Assurance Trial

Relevant Generic Enablers

tion Store GE, Pub/Sub GE, Data/Context Management GE, Data Center Resource Management GE, Identification Management GE, Data Handling GE, IoT Communication GE, IoT Resource Management GE, IoT Process Automation GE, IoT Data Handling GE

6.1.2.3 Trial 5: Flowers and Plants Supply Chain Monitoring

This trial is concerned with monitoring transport and logistics processes and focuses on the tracking and tracing of shipments, assets and cargo, including quality conditions and simulated shelf life. The trial will demonstrate the continuous monitoring, control, planning and optimisation of business processes based on real-time information of real-world parameters. The experiment will test, in particular, dynamically updating rich virtual profiles of products, containers and shipments, providing multiple views for distinct purposes of usage; the combination of different types of sensor data; a timely and flexible availability of product and quality information to a variable network of downstream and upstream partners; and proactive control of distribution activities (i.e., triggering deviation management and planning).

The scope of the trial will demonstrate cSpace functionalities regarding:

- Cargo and Asset Quality Tracking ("intelligent cargo"): monitoring and control of quality status of the cargo and related assets and its relevance for customer's quality requests; communication of monitoring results to stakeholders;
- Shipment Tracking ("intelligent shipment"): monitoring and control of shipments from (primary) producers to end customers, and specification of its relevance for customer expectations;
- Lifecycle Information tracking on cargo characteristics along the supply chain: information collection and distribution along the whole chain ensuring correct information on the cargo accessible for any stakeholder involved in the products' lifecycle and especially consumers as the final customers.

The trial is aligned to the flowers and plants supply network (see Figure 6-5).

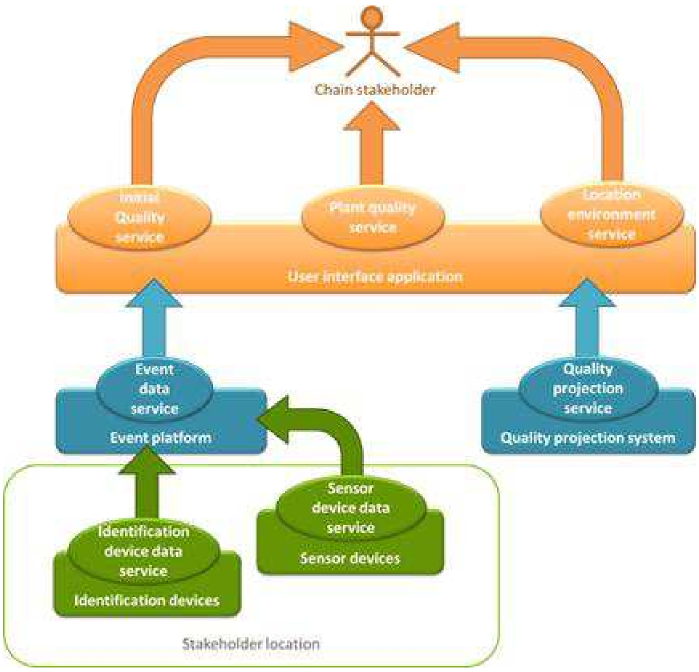

Figure 6-5: Layout Flowers and Plants Supply Chain Monitoring Trial

This sector is characterised by high uncertainty of both demand and supply. Supply uncertainty is high because product is vulnerable to decay, weather conditions, pests, traffic congestion and other uncontrollable factors. Further, demand uncertainty is high because of weather-dependent sales, changing consumer behaviour, and increasing global competition. This results in high variability of supply capabilities and demand requirements in terms of volume, time, service levels, quality and other product characteristics. As a consequence, the timely, error-free and flexible monitoring of products, assets and shipments is a key challenge in floricultural supply chains.

Relevant Generic Enablers

Big Data Analysis GE, SQL/Non-SQL Storage GE, Mediator GE, Composition Execution GE, Repository GE, Marketplace GE, USDL Tooling GE, Pub/Sub GE, Complex Event Processing GE, Identity Management GE, Security Monitoring GE, Data Handling GE, Security Storage GE

6.1.3 Smart Distribution and Consumption

6.1.3.1 Trial 6: Meat Information Provenance

This trial aims at providing reliable information about the meat supply chain for various stakeholders (from farm to fork and from fork to farm). These stakeholders are interested in different information. Stakeholders can make a profile of what kind of meat-related information they are interested in. Consumers are interested in the farm where the animals were raised, in health risks and in animal welfare. Other stakeholders require other information, e.g., slaughterhouses are interested in expected numbers of animals in the next time period, farmers in the price of meat, meat retailers (including supermarkets) are interested in the current location of the product in case of a food alert and the consequential need for recall, and, finally, the authorities require information according to legislative directives. All information should be reliable through certification.

Recently, experiments providing consumers with provenance information on smartphones have become successful. However, efficient, effective and tailored provision of meat transparency information to consumers still requires widespread support for adoption of standards. Standards facilitate access to data in order to enlarge the number of participant and reduce cost of implementation. Moreover, provision of meat transparency information is currently limited by the willingness to collaborate along the supply chain and the loss of information in the slaughtering process of large slaughterhouses. In this use case trial the basic infrastructure as presented in Figure 6-6 will be developed based on cSpace where specific apps on the topics mentioned can be implemented in the area of information delivery to consumers.

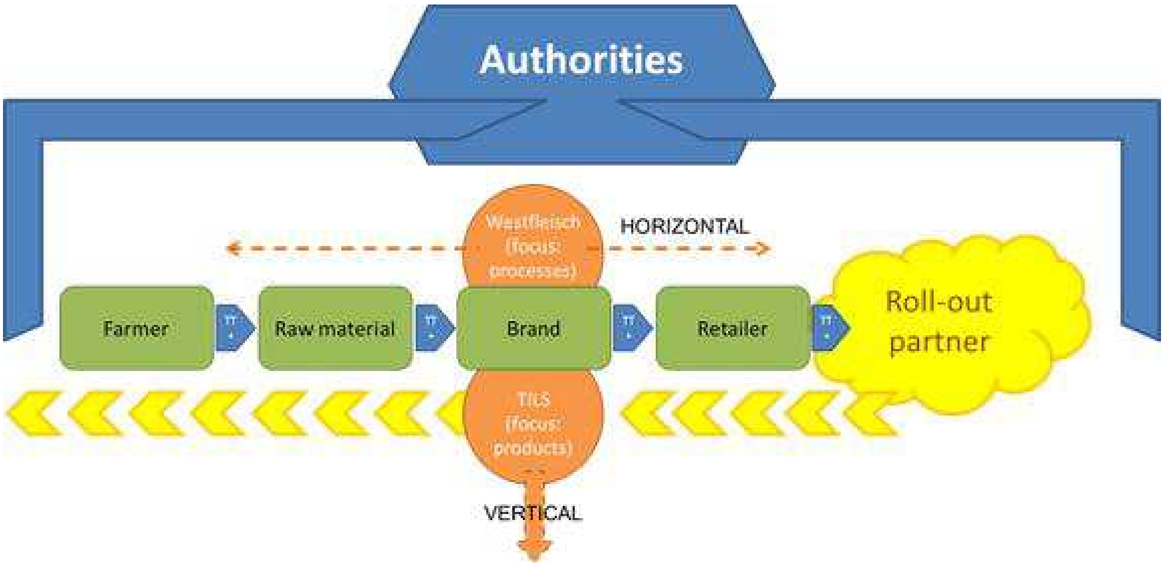

Figure 6-6: Layout Meat Information Provenance Trial

Relevant Generic Enablers

Service Description Repository GE, Complex Event Processing GE, Marketplace GE, Application Store GE, Pub/Sub GE, Data/Context Management GE, Data Center Resource Management GE, Identification Management GE, Data Handling GE, IoT Communication GE, IoT Resource Management GE, IoT Process Automation GE, IoT Data Handling GE

6.1.3.2 Trial 7: Import and Export of Consumer Goods

The import and export of consumer goods trial addresses multiple types of supply chains that can be differentiated by several dimensions; by the nature of the markets, by product ranges (white goods as well as brown goods) and also by sourcing types (production or trading).

A wide range of products and sourcing modes generates complexity on the supply side. The product range contains white goods as well as consumer electronics. Large home appliances, i.e., washing machines, dishwashers, refrigerators, freezers, dryers, TVs, are supplied by the production facilities of the company whereas small appliances are generally outsourced from more than 100 suppliers, 60% of which are located in China. On the other hand, production facilities are distributed in different cities and countries. Refrigerators and washing machines have more than one production plant in the supply network. In addition, all production plants have different production and material flexibility. In total, production deals with over thousand suppliers that are distributed mostly across Europe and Asia. Even though all products are assembly manufacturing products, inventory management strategies or monitoring requirements are different as well. Since consumer electronics have a relatively short product life, critical components/materials become rapidly obsolete. For instance, given the share of a display in the total material cost of a LED TV (around 60%) and given the supply lead times, the incentives in monitoring and managing material and work-in-process inventories needs to be more aggressive in consumer electronics than all white goods.

End-to-end collaborative supply chain planning, along with the enhanced visibility, is essential. Linking demand with supply throughout the entire supply chain is required for implementing tailor-made supply chain strategies in order to increase reliability and responsiveness to customer with a cost efficient and high quality manner. Only cSpace's approach to cloud-based collaboration services and Apps can lead to wide acceptance with a large number of small suppliers and dealers, as it significantly reduces the investment in such IT.

The transport chain planning and optimisation with effective and proactive deviation management is necessary to ensure on-time delivery in full and high on shelf availability at the destination with high customer satisfaction level. Re-planning should be triggered at the right time to prevent delays in the production process to prevent loss of sales, loss of company prestige, reliability and goodwill of customers.

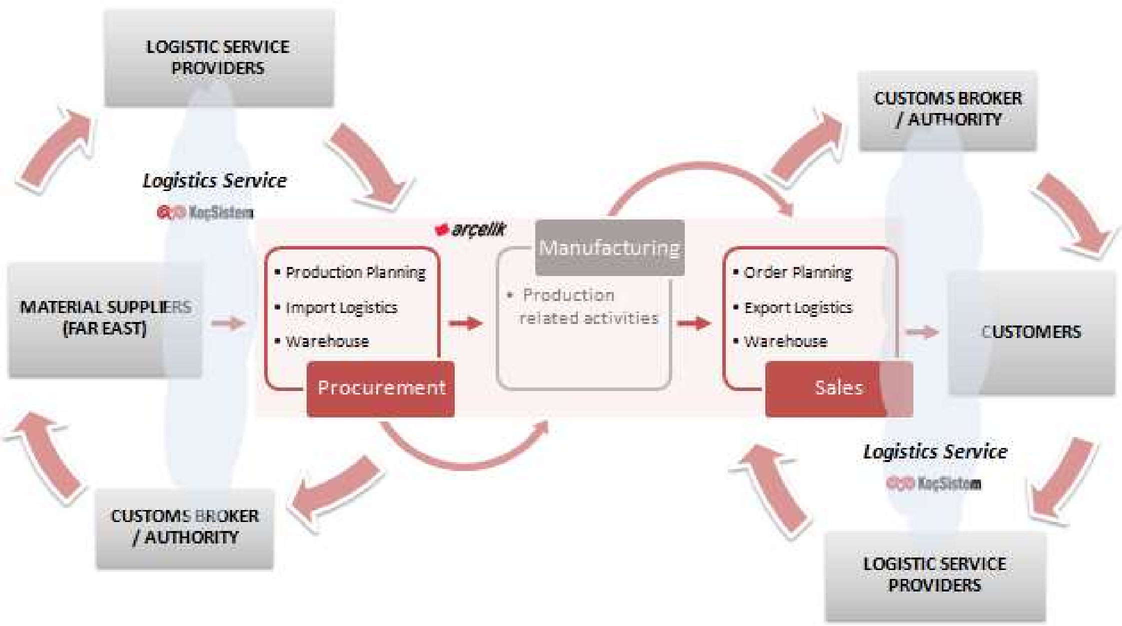

Figure 6-7: Layout Import and Export of Consumer Goods Trial

The layout of this trial is presented in Figure 6-7. In this trial the inbound transportation of raw materials from suppliers in the far-east to an ARCELIK facility will be managed, and after the delivery and consumption of materials, raw materials will be transformed into finished goods that in turn will be exported as consumer electronics goods to the UK. The trial includes operational planning of logistics activity, purchasing/planning of logistics operations and the execution of the transport activities focusing on inbound production logistics including deviation management. The trial can easily be scaled up to the total supply chain and also other supply chains in Phase 3.

Relevant Generic Enablers

Big Data Analysis GE, SQL/Non-SQL Storage GE, Mediator GE, Composition Execution GE, Repository GE, Marketplace GE, USDL Tooling GE, Pub/Sub GE, Complex Event Processing GE, Identity Management GE, Security Monitoring GE, Data Handling GE, Security Storage GE

6.1.3.3 Trial 8: Tailored Information for Consumers

This trial will demonstrate how Future Internet technologies will be able to improve food awareness among consumers. Agri-food products contain a lot of information, some of which is shown in the labelling of the product; other information is provided by certifications communicated through package logos (environmental footprint, quality or health related). The trial will showcase a novel App(s) that helps consumers (through using their personal, mobile device) to become more aware of the food they buy in the supermarket, and which they eat. The App(s) will support both pre-shopping and post-shopping activities and will enable customization in the way the information is presented. The scope of the Tailored Information for Consumers (TIC) trial concentrates on demonstrating cSpace functionalities by (see also Figure 6-8):

- Defining supermarket products and user profiles: Defining supporting tools for enabling supermarket operators to load product information into data bases.
- Implementing mechanisms for selection of products by matching products info with consumer profiles using personal preferences.
- Defining and creating mechanisms for sharing personalised profiles with other consumers, by the use of publish and search mechanisms.
- Supporting pre-shopping activities: user registration, user location and login, user profiles accessing and updating.
- Supporting post-shopping activities: alert notification and consumer feedback management (using the Business Service and Contract Management cSpace baseline app).

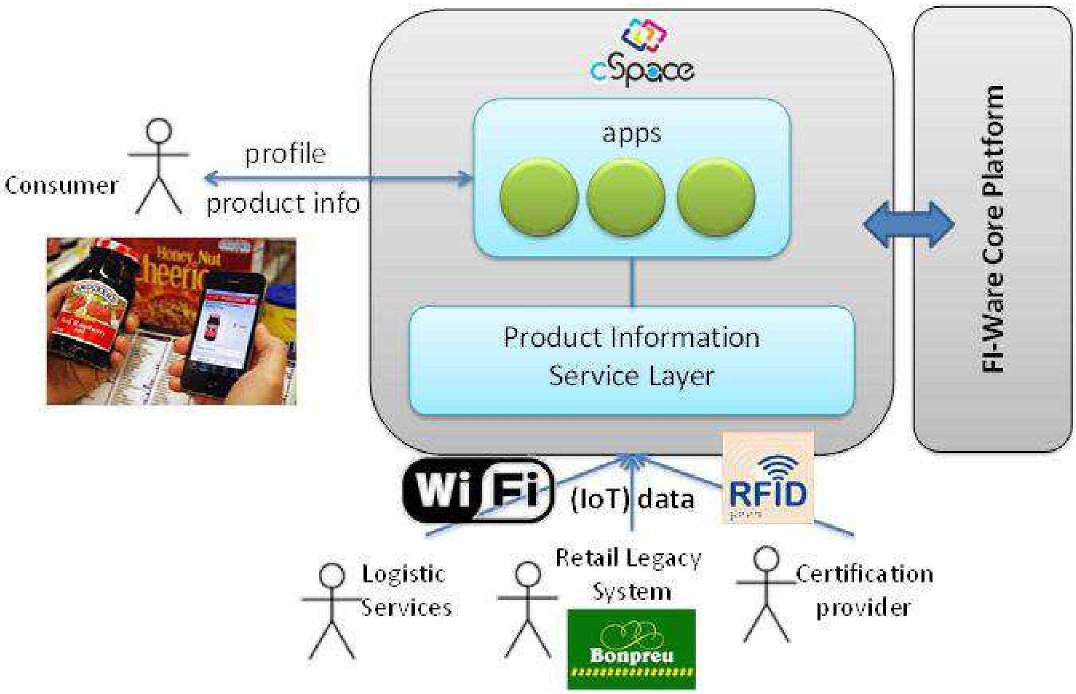

Figure 6-8: Layout Tailored Information for Consumers Trial

The App(s) that will be defined and implemented will consider:

- Facilitating consumer's registration and identification in the supermarket, taking advantage of location capabilities and contextual information.
- Creating an alert control system regarding food notifications and to provide critical information about food to the right group of consumers in a reliable way.
- Allowing for optimum information filtering representing tailored information in consumer's mobile devices.
- Creating facilities for enabling the consumer to provide and access information regarding products and the supermarket such as reviews and recommendations, and information from social media.
- *Relevant Generic Enablers*

Data Center Resource Management GE, Identification Management GE, Data Handling GE, Connected Device Interface GE

6.2 Value-added, cross-domain Apps

In addition to use-case-specific Apps (some of which have been introduced in Section 6.1), cSpace will deliver a set of cross-domain Apps that provide value-added business and domain capabilities by exploiting the features and capabilities of cSpace and the underlying Future Internet technology [20] .

As outcomes of Phase 1, four of those Apps have already been identified and designed, and thus will be introduced below to demonstrate the progress from the state-of-the-art that is made possible through cSpace [20].

6.2.1 "Business Services & Contract Management" App

From the business service perspective, service management deals with communication between stakeholders, customer relationships, enterprise resource planning, etc. Currently, establishing business relationships and contracts is a highly manual process in the agri-food and transport and logistics domains. As an example, a transport contract is a paper based document that is not generally available to the individuals who are responsible for executing the service agreed to in the contract. As a consequence, execution of paper-based contracts do not allow for automatic, real-time and accurate checks as to whether the Service Level Agreements (SLAs) of such contracts are being maintained, which results in billing problems among parties to a contract and after the fact verification of contract violations. In addition, the contracting process for complex business networks is currently a manual and time consuming process. The process includes partner identification and qualification, partner bid development and bidding, bid evaluation and tentative partner selection. Once a tentative partner has been selected a contract is negotiated and agreed between the contracting parties. All these steps, until the actual agreement among the parties, are typically executed by individuals interacting using email, phone calls, datasheets and/or text documents. There are only a few initiatives trying to automate the contracting process. However, these attempts are still far away from solving the high dependence on manual intervention.

In order to change the current situation for business services and contract management, the "Business Services & Contract Management" App will deliver novel facilities for (1) real-time and on-time management of business service relationships established via *electronic* contracts, (2) supporting the setup of new business service relationships and *electronic* contracts.

Building on the design and proof-of-concepts from Phase 1, the "Business Services & Contract Management" App will deliver novel semi-automated e-contracting services that provide digital facilities for managing service levels and establishing performance based contracts between collaboration partners, as well as connecting with service market places. This approach extends and adapts strategies and tools for dynamic management of electronic contracts for service-oriented systems.

Main features

- Visualization of business services options (service offers and demands), seamlessly integrating options from inside cSpace as well as from external marketplaces, thus providing (1) better visibility and potential to seek out new partners for collaborating without heavy manual intervention, (2) potential to reduce the barriers for market participation of SMEs in global business collaborations;
- Integration of electronic and online information about the service level agreements and objectives (SLA) into the execution of collaborative business services, thereby (1) governing business services execution according to contract terms, (2) reducing the amount of overcharging currently observed in industry due to the lack of online and real time information during business process execution.
- Creation and collection of feedback through the EFM (Enterprise Feedback Management) function, enabling organizations to establish a dialogue with employees, partners and customers regarding key issues and concerns, thus (1) facilitating correct understanding of feedback across an organization, promoting feedback initiatives, sharing results and being aware of the needs of stakeholders, (2) triggering customer-specific real-time interventions when required.

Relevant Generic Enablers

Service Description Repository GE (Apps & Services Chapter), Marketplace GE (Apps & Services Chapter), Object Storage GE (Cloud Chapter), Registry GE (Apps & Services Chapter).

6.2.2 "Logistics Planning" App

As business processes and their management are becoming more and more dynamic, the requirements towards near real-time planning support increase. Current solutions for transport and logistics planning can usually only be applied offline, as (1) current planning algorithms (striving for a global optimal solution) are very computation intensive and thus may prohibit their use in an online fashion, (2) the planning tools do not have direct and real-time access to data (such as contracts, SLAs, business processes) that would allow for such online planning.

The “Logistics Planning” App will address these shortcomings by providing real-time planning and re-planning facilities that augment existing transport and logistics planning solutions to exploit real-world, online event data and forecasting of future situations. The App will provide logistics planning functionality both for the logistics service clients and providers.

For the logistics service client, the App shall support the building of a transport chain plan based on the client’s demand and online available services, using the latest available information for service descriptions. For the provider, the App will enable the description of transport services that can be used by the clients, enable the connection to markets (through interconnecting with the “Business Services & Contract Management” App, see Section 6.2.1) to find demands that match the provided services, as well as for planning the use of subcontractors. For both client and provider, the App will have facilities for detailing the execution plans and for booking of the services. The app will also provide functionality for dynamic re-planning in case the execution of the original plans fails.

The App’s interfaces will be open and will allow the use of external systems, like order management, resource management, weather and traffic information, etc., for automatic updates of demand and service descriptions. These kinds of external services can be used to base the planning on up-to-date information on service availability, schedules and resource utilization. As mentioned above, the App will also make use of services provided by other cSpace Apps, like the “Business Services and Contract Management” App for using information on long-term contracts as well as spot-market services in the planning process, enabling establishment of contacts between both existing and new partners. The finished plans contains information on execution of the plans, including instructions for the logistics operations, event monitoring and reporting rules, and involved parties; the plans can be used as a base for collaboration objects for logistics operations in the cSpace collaboration core.

Main Features

- Support for generating transport chain plans (following GS1 Common Framework standards), using the descriptions of the demands and online logistics service descriptions;
- Facilities for the description of logistics services and logistics demands, both for use in the transport planner and for publishing on marketplaces.
- Open interfaces to enable the use of external systems, including order management, resource management, as well as systems for updating schedules based on weather and traffic data.
- Provide facilities for booking of services, directly based on the plan. The facilities may be used both by the logistics service clients and the providers.

Relevant Generic Enablers

Object Storage GE (Cloud Chapter), as well as indirect use of Generic Enablers for security and for interaction with legacy systems through cSpace core.

6.2.3 “Product Information Service (PInfS)” App

Existing solutions for product related information exchange and provisioning are mainly based on centralised approaches. Data is often governed centrally in combination with unique identification (e.g. barcodes, RFID) of related products. Mechanisms for the lookup of information sources have to rely on centrally stored data sources (e.g., centralised data warehousing) or handled in a decentralised approach that imposes constraints on combining information from different actors in a supply chain when a product changes ownership within the workflow. As a result, such solutions only enable the addition of information sources through a single authority.

These gaps are addressed by the "PInfS" App, which provides event-driven product information exchange between stakeholders within a supply chain. Product information includes all product-related data, such as quality certificates, sensor data and data requests. This will facilitate controlling information flow in complex supply networks, and, drastically reduce reaction times with respect to quality issues along the supply chain. The App can be personalized to provide to the individual business actor (1) communication infrastructures that fit a specific supply network, (2) basic technical environments that provides generic functionalities to reduce the complexity of business areas like logistics and quality management. In addition the App will support diverse identification schemes (used by different actors on different levels of packaging and transport), allow for the addition, deletion, replacement or extension of product information (i.e., content) that is exchanged within the supply chain/network, and, finally, enable the decentralised storage of product related information.

Main Features

- Easy and secure exchange of product related information between supply chain partners, both from a technical and business perspective, by avoiding centralised storage of information;
- Facilities for fine-grained access control over own product data by maintaining own data sources with adjusted access management;
- Provisioning of product information from trusted sources (certified by existing business relations from cSpace);
- Federation of decentralised product data sources to increase data availability.
- On-demand and real-time data access and update functionalities reducing duration and effort of data exchange;
- Enabling bidirectional communication through the supply chain.

Relevant Generic Enablers

GEs for IoT integration (IoT Chapter). Through the cSpace platform the App will indirectly use Generic Enablers for security and for interaction with legacy systems.

6.2.4 "Real-time Exception Detection and Handling" App

Existing solutions for real-time business process monitoring, such as Business Activity Monitoring (BAM), exploit real-time data to support dynamic decision making and optimization of business processes. Yet, BAM does not yet consider events generated by IoT devices and sensors, and it falls short of predicting imminent future problems, and thus lacks proactive management capabilities for addressing them. On the other hand, analytical approaches for business processes, such as Business Analytics (BA) and Business Intelligence (BI), address longer term aspects based on logs and historic data. Obviously, those approaches fall short of addressing deviations of individual business process instances in real-time.

These gaps are addressed by the "Real-time Exception Detection and Handling" App, building on the design and proof-of-concepts from Phase 1. Together with the underlying cSpace capabilities, it enables users to define constraints, observations and mitigation actions for business process instances. To this end, the App, exploiting core features of cSpace, continuously checks the compliance of these constraints to the actual situation and execution of business processes and thus can – in real-time – detect potential violations. In case of violations, pre-defined exception handlers allow an immediate reaction with short delay, with or without direct user intervention. The definition of constraints and exception handlers is supported by a set of rules, which can be defined by the user beforehand. Thereby, process monitoring, tracking and tracing can be adapted to the needs of particular end-users, and even to specific scenarios and tasks.

The cSpace B2B Collaboration Core provides the global knowledge base for all managed business processes and their execution as well as proactive event monitoring to detect situations of interest (like deviations, constraints violations and execute rules ahead of time if needed). While the cSpace B2B Collaboration Core provides generic mechanisms, more targeted solutions are required that address deviation detection and handling – a requirement identified for most of the trials in cSpace. This includes an oriented mechanism to configure and set-up the cSpace components needed, including System and Data Integration, connectivity capabilities within cSpace Operating Environment (such as the Enterprise Service Bus) and ubiquitous access via the Front-end for notifications about observations (deviations, situations of interests, Key Performance Indicators, etc.). This allows for multi-channel support (e.g., portal message, email, SMS or web service call), depending on user demands and urgency.

Main Features

- Adaption of business process monitoring and management to different end-user demands and scenarios, thereby allowing (1) definition observation of user-defined business process constraints, (2) execution of pre-defined exception handlers as immediate reaction to deviations and to mitigate deviations;
- Multi-channel and predictive notification distribution depending on urgency and user demands.

Relevant Generic Enablers

The “Real-time Exception Detection and Handling” App will use the GEs that are used and thus made accessible through the Real-time B2B Collaboration Core.

7 Conclusion

This report opened with an overview of the SmartAgriFood architecture for collaboration and information exchange across agri-food supply chain networks. The architecture builds on the FI-WARE Core Platform and comprises four generic services, as depicted in Figure 7-1: the Business Relations Service, the Product Information Service, the Certification Service and the Identification Service.

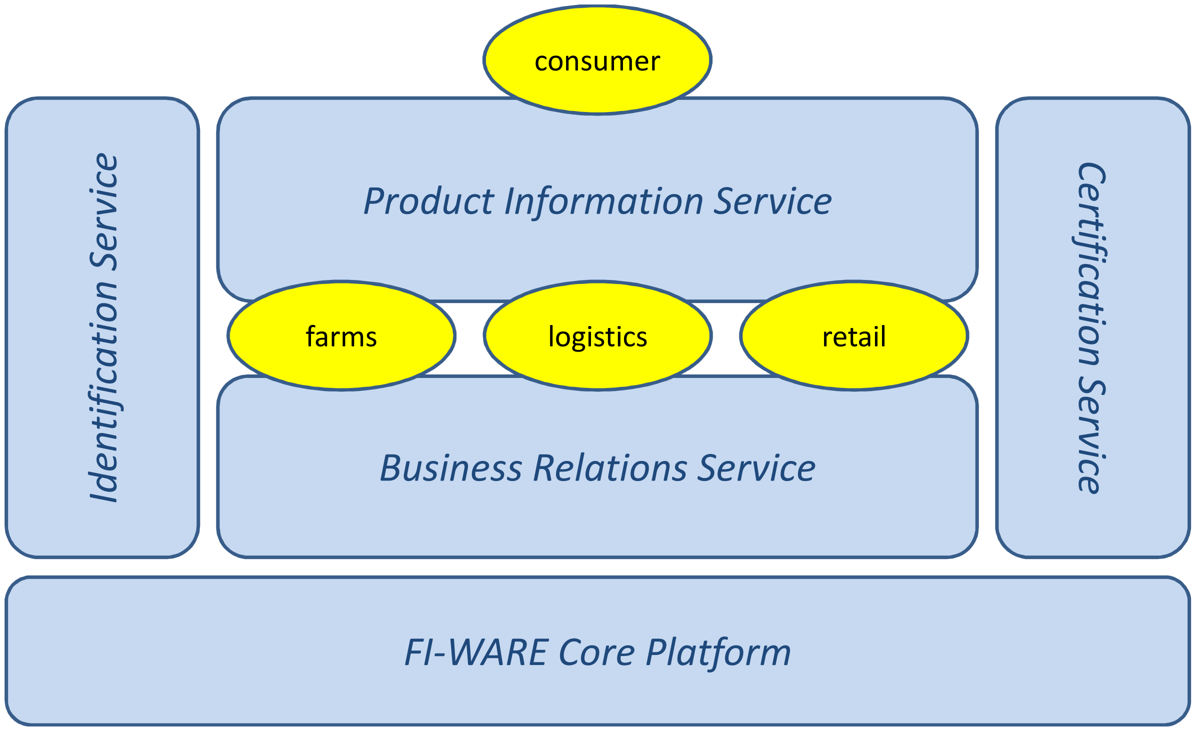

Figure 7-1: The four generic services in the SmartAgriFood architecture

Farm-to-fork scenarios have been designed to demonstrate the feasibility of the SmartAgriFood architecture to enhance business collaboration and product information exchange with these services, using GS1 standard concepts such as the Object Naming Service (ONS) and Electronic Product Code Information Services (EPCIS). Simulations of the designed scenarios have been built, which validate the feasibility of the architecture.

Specific aspects of the scenarios have been implemented in pilots, focussing on particular stages or aspects of the agri-food supply chain in farming, logistics, and food awareness for consumers. For the pilots conceptual prototypes were developed, in which the Core Platform's Generic Enablers were applied, thus providing an environment to test the feasibility of the Core Platform to enable Future Internet support to applications in agriculture and food supply networks.

Before integrating the Generic Enablers into the conceptual prototypes, they were tested in isolation. Some of the Generic Enablers envisaged to be part of the prototypes could not be incorporated because the implementation in the first release of the testbed did not provide sufficient functionalities or documentation. Most of the Generic Enablers could be incorporated and the experience of the implementation teams is largely positive. Details of the feasibility assessment of the Generic Enablers for the SmartAgriFood pilots are reported to the FI-WARE team, using the templates included in Appendices A and B of the present deliverable.

The general conclusion is that both the SmartAgriFood architecture and the Core Platform can greatly contribute to realise innovative applications to enhance business collaboration and product information exchange across agri-food supply networks, including exception detection and exception handling in case of food health hazards. The applications can enhance consumers' food awareness and enable direct feedback, from points of sales and consumers, to farmers, who can use this information to attune their product offerings and delivery schedules to market demands. This feedback does not only comprise consumer response, but also quality monitoring data based product virtualization and electronic sensing of location and environment in the Internet of Things.

Ensuring safety and security of data and information is the essential element for the users. Most of the users are worried about the unauthorized use of their data and they require that the expected systems and applications should be safe. Therefore availability of databases should be regulated and controlled to guarantee the data security and protection. The most important requirement of the actors in the food supply chain is reliability and security. These items have not been fully addressed in the current prototypes, but will have proper attention in the large-scale trials of Phase II.

The concepts developed and experience gained in the SmartAgriFood pilots were used to specify trials for FI-PPP Phase II. These trials have been specified in close co-operation with the Finest project. The Finest and SmartAgriFood concepts and architectures were found complementary in the logistics stage of the supply chain, with SmartAgriFood focussing on quality management and Finest focussing on real-time logistics planning.

Joint trials were specified and a joint application platform building upon the Core Platform was conceptualised. These specifications are at the core of the cSpace proposal for FI-PPP Phase II [20]. This project has been awarded and starts in April 2013. The trials cover the following domains:

- Crop Protection Information Sharing
- Greenhouse Management & Control
- Fish Distribution and (Re-)Planning
- Fresh Fruit and Vegetables Quality Assurance
- Flowers and Plants Supply Chain Monitoring
- Meat Information Provenance
- Import and Export of Consumer Goods
- Tailored Information for Consumers

Based on the feasibility analysis by the SmartAgriFood and Finest projects in Phase I, the cSpace platform to support the trials and the application of Generic Enablers to realise it could be drafted. An overview of the platform's components is described in the present report. The organization of trials and the architecture of the cSpace platform are specified in detail in deliverable D600.4 [15] and the cSpace proposal [20], respectively.

8 References

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9 Appendix A: FI-WARE GE Evaluation Template part 1

SmartAgriFood Validation _Template

This document describes the evaluation scenarios for the GE. Some questions can be answered for the project in general, see below. The other questions are answered in the subsequent document sections per scenario.

Question VC.1. When did the evaluation actually take place?

All evaluations took place in the last quarter of 2012 and the first quarter of 2013.

Question VC.4. How the communication channels did work for the scenario (if not scenario specific, please answer only once)

SmartAgriFood project partners participated in the training sessions and in the webinars for most of the Generic Enablers. In particular the webinars have been found very useful. Where problems arose with the actual testing or implementation of the Generic Enablers, project partners contacted the GE owners directly and have always been helped satisfactory.

Question VC.5. How much did the GE cover the requirements of your envisioned scenario? (Star-rating – one star = "no to little coverage", six stars="completely covered")

Pilot name	Scenario	Generic Enabler	Coverage
Smart Spraying	Sub-scenario Smart Spraying 1	GCP IdM	******
	Sub-scenario Smart Spraying 2	GCP IdM	******
		Marketplace	****
		Things Management GE	***
	Sub-scenario Smart Spraying 3	Marketplace	****
		Things Management GE	***
	Sub-scenario Smart Spraying 4	GCP IdM	******
		Marketplace	****
		Things Management GE	***
Smart Greenhouse	Sub-scenario 1	Repository	******
		Mediator	***
	Sub-scenario 2	Data Center Resource Management	*****
		Publish/Subscribe SAMSON Broker	******
		Cloud Edge	***
	GE's tested but not included in the scenario's	Service Composition & Application Mashup	****
		Object Storage	**
		Things Management GE	***
Fresh Fruit and Vegetables	Sub-scenario Exception Detection	CEP	****
	Sub-scenario Exception Reporting	GCP IdM	******
Plants and flowers	Sub-scenario: Generation of Alarms	Complex Event Processing (CEP)	*****
Smart Food Awareness (TIC and TTAM)	Sub-scenario Tailored Information for Consumer	Data Center Resource Management	******
		GCP IdM	****
		Data Handling	****

1 The Smart Spraying Scenario

The Smart Spraying Scenario targeted to investigate and demonstrate the requirements for Future Internet technologies from the point of view of Precision Agriculture and beyond. Precision spraying was chosen as an example case since it is an information intensive task, and is sensitive with regard to weather circumstances, timing, correct chemical dosing, food safety and environmental impacts. Well controlled precision spraying task with optimal timing and spraying setups is a complex and demanding task for a farmer. Extra challenge is to cope with the suddenly changed situations like change in weather or machine breakdown during the spraying. When contracting spraying, the challenge is also to serve optimally customer farm's business targets and act correctly in sometimes unfamiliar fields.

The scope of the scenario was to tackle the complexity related to precision spraying operation management and diversity of farms with different business goals and resource.

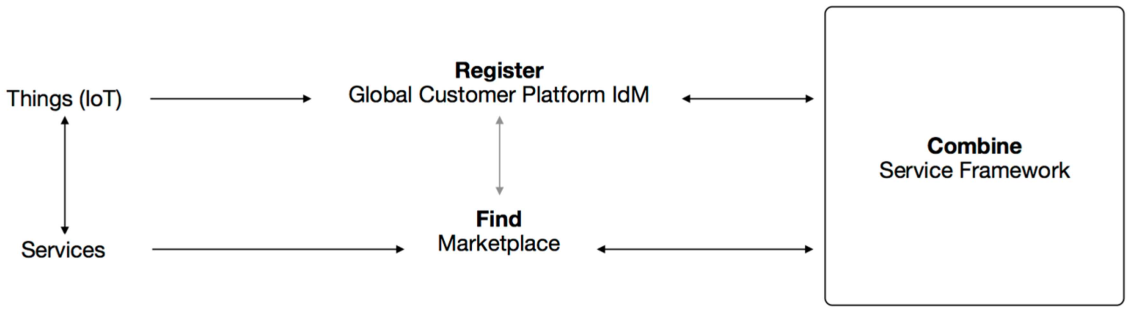
The challenge is:

- Firstly, to create and provide farm/customer specific assisting services available for fluent task planning and execution, and
- Secondly, to enable the employment of the assisting services in an organized and user friendly way by the farmer or contractor, especially during the mobile work.

The aim is that the results are applicable also to all other farming tasks, their management and execution support.

The Smart Spraying and the FI enabled Smart Spraying service concept have been evaluated and tested during the project with tight interaction with developers, end users and other stakeholders. The process as well as the results are described in detail in D200.4. The following four subscenarios are underlining the benefits and the innovations enabled by the FI-WARE.

Based on the requirements for the Spraying Scenario (D200.4) three essential FI Generic Enablers were identified: Global Customer Platform GCP IdM, Marketplace and Things Management (see figure below). The GCP and the Marketplace GEs are tightly integrated into the Smart Spraying Service Framework architecture (D200.3, D500.5.2). IoT GEs are needed in the context of automatic discovery and utilization of location aware sensors and sensor networks. The GCP IdM implementation is be fully integrated. The Marketplace and the IoT GEs are handled in conceptual level.



The Smart Spraying Service Framework relation to FI-WARE GEs

1.1 Sub-scenario Smart Spraying 1

User licenses a smart spraying service framework implement and walks through the sign up process to register it.

Related GEs:

- Global Customer Platform GCP IdM GE: A smart spraying service framework implement aims to use the GCP for IdM and session management operations. The priority is in sign up, sign in and session management as well as to provide the user easy-to-use customer self care management tools.

1.2 Sub-scenario Smart Spraying 2

When a user signs up as a smart spraying service framework implement user, the services already registered into the GCP IdM become visible through integrated Globally Registered Services view. One of the core functionalities in the Smart Spraying service framework is to enable automatic data and functionality exchange between the framework registered services (D500.5.2). A user finds and licenses a disease pressure service (DPS) from an integrated marketplace. Usually a DPS algorithm needs weather information (either nowcast or forecast) for the proper calculations as well as the information on performed actions on the field both current and the last year. The framework implement registered DPS automatically detects that the user has a GCP registered weather stations and a weather service with a license to use it also in third party services and suggests them as a one of the alternatives in GCP calculation. The information on the farm operations is provided by the farm data storage service.

Related GEs:

- Global Customer Platform GCP IdM GE: The globally registered services of a user become visible and accessible within the smart spraying service framework. The user’s GCP registrations are queried using relevant REST API (D500.5.2).
- Marketplace GE: The integrated marketplace enables the user to easily find, license and switch the e-agriculturist services needed. The services and the offering relevant to the smart spraying service framework implement are presented in a Market view. The contract and money sharing issues are taken care of the SLA management and the revenue sharing and settlement systems, part of the applications and services ecosystem and delivery framework.
- Things Management GE: IoT encapsulation in weather stations and weather station network makes it easier for a user and third party services to discover and access the local aware sensor data.

1.3 Sub-scenario Smart Spraying 3

A user has two weather stations in his/her fields. He/she needs to share the weather station data with minimum efforts with third party services. A user might also want to sell the nowcast data to third parties to cover the expenses.

Related GEs:

- Things Management GE: Gives a single point of contact to the user. IoT encapsulation in weather stations and weather station network makes it easier for a user and third party services to discover and access the local aware sensor data.
- Marketplace GE: A weather station backend service is registered into a marketplace as an offering.

1.4 Sub-scenario Smart Spraying 4

A spraying contractor receives an order from his/her existing customer farm to take care of fungicide spraying in certain fields. To fit the new task in his/her work schedule and to carry out the work in correct time the contractor licenses a disease alarm service using an embedded marketplace in his mobile implement of the service framework (D200.3, D500.5.2) to the customer farm’s fields. Due to a trusted relationship the contractor has an access to the farmer’s farm data service as well as other relevant services the farmer has registered into the Global Customer Platform. For the best disease pressure calculation outcome the contractor selects or the system suggests the most relevant weather station registered for the farmer’s use in the GCP to be used in the calculations. After the set-up the contractor is able to follow the progress of disease status in the customer’s fields to fit their treatment optimally to his/her own task schedule.

Related GEs:

- Global Customer Platform GCP IdM GE: The globally registered services of a user become visible and accessible within the smart spraying service framework. The user's GCP registrations are queried using relevant REST API (D500.5.2).
- Marketplace GE: The integrated marketplace enables the user to easily find, license and switch the e-agriculturist services needed. The services and the offering relevant to the smart spraying service framework implement are presented in a Market view. The contract and money sharing issues are taken care of the SLA management and the revenue sharing and settlement systems, part of the applications and services ecosystem and delivery framework.
- Things Management GE: IoT encapsulation in weather stations and weather station network makes it easier for a user and third party services to discover and access the local aware sensor data.

1.5 Test results Smart Spraying

Question VC.2. Who (role and skill of the person(s)) and how many people did the actual evaluation?

Two senior developers and one senior programmer.

Question VC.3. What went good, what went bad during the evaluation?

The overall user feedback related to the possibilities provided by the FI Generic Enablers in the context of the Smart Spraying scenario was positive.

As stated in D200.4 "*In conclusion of the end-user validations we may state that end-users were able to comprehend and get interested on services that could be opened to them via the FI technologies. In the earlier interaction with the end-users in 5 different countries the end-users expressed doubts and even somewhat pessimistic responses. When we presented a systematically defined concept and demonstrated a proposal for the user-interface and discussed it with the end-users they were much more positive towards the future possibilities.*

The end-users did see benefits of the proposed service and spraying concepts what regards to increasing effectiveness of work and reduction of workload, but in particular they found possibilities to develop the work, create learning and improve competences. ***These positive effects are due to the improved utilisation of information for understanding the complex agricultural phenomena of farming, and due to the possibilities to interact within the network of farmers, and even the wider communities of the entire food chain. Direct links to consumers was seen positive from business, safety and product quality point of view.***

Even though the overall response was quite positive there were issues that clearly need attention when the Smart farming concept is developed further. The most pressing issues were related to efficient management and processing of information, compatibility between different systems, reliability of information and security issues, and automatic input and registration of information."

From the developer's point of view, as a GE user, the overall experience has been positive. The research and evaluation of GEs performed by reading (including product vision, architecture descriptions and open/open API specifications) as well as by concrete testing has indicated that the usage of the GEs in software development process supports developing new innovative architectures to bring ease of use, ad hoc service employment and real time assistance into the mobile work environment.

Question VC.6. Please provide your (positive and negative) comments on GE usefulness

The functionalities implemented in the Smart Spraying Scenario are divided into two parts; namely, the general service framework functions and the E-agriculturist functions. Together with FI Generic Enablers the architecture and infrastructure of the general service framework functions provide IdM and marketplace services and enable information exchange and user interface embedding between registered services for enhanced scalability. The E-agriculturist functions as third party services enable, among other things, spraying setup functions and machine breakdown support.

The service framework forms tight integration with the identity management (GCP) and the marketplace. It uses the IdM service for sign up, log in and session management as well as to discover globally registered services of a user. The marketplace is used to find services. It also provides for example such service metadata as service rating. The services bought from the integrated marketplace are registered into the framework registry. Registration makes services visible to each other enabling information and functionality exchange between them.

Embedding complex third path services that require user interaction usually some initial decisions on hard coding the functionality into a solution is needed. This way the functionalities that a solution offers become predefined. For more flexible and cost efficient service integration, the service framework implements an external service user interface exchange and embedding functionality.

The service framework together with employed FI generic enablers enables:

- registering of different IoT encapsulated farm machinery, devices and sensors automatically to farmer's use via FI Global Customer Platform (GCP) identity management (IdM)
- providing third party services to provide their applications in a Marketplace
- providing IoT encapsulated farm machinery, devices and sensors as services to possible customers in a Marketplace
- registering of different third party services to farmers use via FI GCP IdM
- separation of farm data from applications so that farm data can be used by all applications and services
- the farmer to purchase services in the Marketplace, and register and take them in use via FI GCP

The IoT encapsulation enables automatic discovery and utilization of location aware things like farm machinery, devices and sensors. When the service framework is accessed with the same credentials or the ones within the trusted credential pool the IoT encapsulated things become visible in the globally registered services enabling them to communicate automatically with any framework registered third party service that implements automatic information exchange interface. In addition, when an IoT compatible data providing sensor entity (weather station or weather station network as an example) is registered as an offering into the marketplace the owner of the entity can easily sell the data to other actors like service providers or neighbouring farmers.

When we think about the spraying event itself the wind speed data of the IoT compatible weather stations can be used to adjust the sprayer nozzle for the best spraying outcome. With the location awareness the sprayer can always connect to the nearest IoT encapsulated location aware weather station or the possible third party assisting service in the Cloud can make suggestions to the nozzle controlling system based on the location of the sprayer and the nearest weather station.

2 Smart Greenhouse Management Scenario

The Greenhouse Management prototype is a Future Internet compliant framework which takes into account real data (e.g. weather data) from sensors and provides it to a Farm Management System (FMS) in order to take smart decisions regarding actions that need to be done and will eventually lead to the increase of the farm's productivity and product quality. Cloud-based services have access to the real data collected and produce results related to smart planning of farming actions. Notifications and alerts about the current situation and actions are forwarded to the farmer. In this way, a farmer achieves having a complete surveillance of his farm. The Greenhouse Management prototype has been implemented in order to fulfil a number of innovative concepts. In particular:

- Lower investment cost since the intelligence of the system is located in the cloud.
- Automatic communication of the system with any equipment using SOA.
- Storage of raw data and guaranteeing user-independence from any FMS.
- Service adaptation according to user preferences and end-device capabilities.
- One-stop market place facilitating the end-user in his everyday needs.
- Integration of domain specific services (e.g., advisory services).
- Learning schemes focusing on improving operations through exploitation of accumulated data

The Greenhouse scenario is part of a larger ecosystem of scenarios constituting the SAF prototyping environment. The Greenhouse scenario resides in the farm end and provides information regarding the status of the plantation as well as the growing of vegetables. Modules implementing the greenhouse scenario interact through the following blocks:

- Sensor Data: Raw sensor data are extracted from the deployed sensors and stored both locally and in the cloud. These values are used in numerous ways; they provide valuable input for the deployed service while in parallel are used for tracking the production life-cycle of vegetables.
- FMS Database: The FMS database comprises the storage module of the FMS Controller. The database collects and stores the sensor values and other relevant production data after proper pre-processing.
- FMS Services: The term FMS Services encapsulates all functionalities offered by the various modules instantiating the Generic and Domain Specific enablers of the Smart Farming architecture. Thus, it can be instantiated by the FMS Controller, the FMS Enablers or the FI Intelligent Services.

The validity and viability of the concept has been verified by thorough testing in two deployed instances of the scenario. The first instance of the scenario has been deployed in an actual Greenhouse in Crete. The greenhouse is approximately 10000m^2, having an almost rectangular shape. The deployed nodes are equipped with 3 soil moisture, 3 temperature, 3 relative humidity, 1 CO2 and 1 PH sensors. There is also a node outside the greenhouse equipped with a temperature sensor. The deployed wireless nodes send their measurements periodically to the gateway which is deployed on a commodity PC located at the farmer's office. The information is propagated to the university premises where the FMS Controller is hosted. The processed information and the extracted knowledge are subsequently presented to the farmer via a web based portal, deployed on another server.

A second deployment of the scenario has been done locally in NKUA premises. The following use cases were used in order to validate the system and its functionality:

- Internet connection management: Assess the self-healing capability of the cloud proxy in case of limited or no internet connectivity. The scenario assumes the existence of a network problem; in such case the cloud proxy should revert to local processing and resume normal operation as soon as the problem is restored.
- Service registration by service provider: A service provider registers a service through a dedicated web page in the portal (part of GE Evaluation Scenario 1)
- User service registration: A user registers to a service (part of GE Evaluation Scenario 1)
- User service consumption: The user starts consuming the service (part of GE Evaluation Scenario 1)
- Charging and billing: The user checks his billing information (part of GE Evaluation Scenario 1)

- Over-the-air firmware update: The farmer uses the portal in order to retrieve updates for the firmware used by his sensors. Installation and deployment is done with zero human intervention.
- Notification and alert management: The extracted sensor values are assessed and proper notification/alert is issued to the farmer. The notifications/alerts are emitted by an expert system, specifically designed for this purpose (part of GE Evaluation Scenario 2).

2.1 Smart Greenhouse Management Sub-scenario 1

A user provider logs in the platform and attempts to register a service. In order to do so, he exploits the dedicated user interface available and provides details about his service, company etc. In general, he provides all details required in order to perform proper indexing and storage of his service (key-words, charging profile etc.). The service description is formulated and transmitted in linked-USDL format. As soon as the farmer checks the marketplace in his end-user application he notices the existence of the new service and registers. Upon registration, the service is added to his application profile and he is able to access its functionalities. The usage of the service is constantly monitored; the application provider can validate the logs and based on the performed actions charge the user.

The following GEs are used in the context of this scenario:

- Repository GE: Through REST API calls we offer functionalities regarding uploading/accessing a service description in linked-USDL format. The GE offers the capability to upload the service description. Therefore we can upload USDLs to the repository and access all the available services information.
- Mediator GE: Acts as a medium between a web service and a web service client. Every time our service (or method of a service) is invoked, an event is logged. Afterwards we count the number of the events happening in a specified time frame and use it for charging the users.

2.1 Smart Greenhouse Management Sub-scenario 2

The user has deployed the scenario in his Greenhouse. The devices constantly transmit information to the cloud which before storage is assessed by the Statistical Analyser. The latter, upon identification of a problematic situation, triggers a notification action which is in turn forwarded to the farmer through the appropriate communication channel.

The following GEs are used in the context of this scenario:

- Data Center Resource Management GE: We have used the graphical interface of the portal to create a Linux virtual machine in which we deploy the Statistical Analyser. Furthermore we have a dedicated VM in which the Publish/Subscribe Broker GE is running.
- Publish/Subscribe SAMSON Broker GE: This GE exposes its functionalities through REST API calls. We register a context with specific attributes to the Publish Subscribe Broker and query the attributes to get their values.
- Cloud Edge GE: This GE is used in the farmer's premises in order to facilitate the communication of the local system with the cloud infrastructure.

2.2 Test results Smart Greenhouse Management

Question VC.2. Who (role and skill of the person(s)) and how many people did the actual evaluation?

All scenarios have been evaluated in house by the NKUA development team, consisting of 3 programmers (2 junior and 1 senior). GE Evaluation Scenario 2 has also been evaluated by a single user, whose greenhouse we use for the actual deployment of the system. The first scenario has been evaluated on the standalone testing testbed during December 2012 and January 2013; the second has been under evaluation since mid-December 2012. The actual scenarios can be found in video format at http://www.youtube.com/watch?v=dDq4RQYNiNs

Question VC.3. What went good, what went bad during the evaluation?

From a user perspective the overall experience related to the inclusion of GEs in the scenario was positive. Additionally, we managed to achieve a seamless transition from the GE-less implementation to GE-full one without affecting user experience (e.g. Cloud Edge GE was incorporated in the scenario while it was deployed).

However, the testing process also revealed some problems related to a set of GEs we tried to exploit. For example, we were unable to perform a core integration of the Service Composition and Application Mash up GEs; thus we opted for a loose coupling. The Service Composition & Application Mashup GE has been integrated in the GUI frontend of the scenario. It can be used to provide graphic mash ups that exploit the capabilities of the widgets provided by the Mashup Factory. In the background, these widgets/services compose a new one in a service composition manner.

Some additional problems are reported in the following:

Object Storage GE: We faced difficulties using the Authentication REST API. Specifically the authentication procedure needs clarification of the required parameters.

Things Management GE: We were unable to register a context entity. Additionally, it seems that the NSGI 9 interfaces for the broker were not provided (at the time of this writing).

A possible integration scenario using the last GE has already been designed since it enabled incorporating a larger set of Generic Enablers. The sensor nodes located inside the greenhouse transmits measurements through the Cloud Edge GE, by means of NGSI 9/10 API calls, to the Things Management GE located in the cloud. The Publish Subscribe Samson Broker subscribes to the Sensors' context entities and every time they are updated, it gets notified. This information is stored inside the database and exploited for notifications and alerts.

Question VC.6. Please provide your (positive and negative) comments on GE usefulness

The Greenhouse Management Scenario is competing against existing Farm Management Information Systems (FMISs) and Control & Data Acquisition Systems (SCADAs). An FMIS is a system for collecting, processing, storing and disseminating data in addition to the smart control of individual farm operations to provide value-added functions in the operations of a farm. SCADA is an integrated solution consisting of a supervisory system that collects information and issues commands, remote terminal units connecting to sensors to collect their data and transfer them to the supervisory system, programmable logic controllers and an appropriate human-machine interface. The designed solution essentially combines these two while in parallel introduces significant novelties:

- Lower investments by use of cloud intelligence
- Plug and Play with IoT solutions
- Independent maintenance infrastructure
- Natural language processing
- Storage of raw data
- Dynamic device dependent service
- Marketplace for farming services
- Opinion mining
- Learning schemes
- Context aware networking
- Integration into the food supply chain
- Integration of existing infrastructure
- Yield measurement
-
- Of course, in the limited timeframe of the project, only a subset of these features has been implemented and deployed in the real system. Despite this, we managed to -partially- quantify the added value introduced by these features is evident and we present it in the following:
- Open APIs enabling the integration of third party services; this means that virtually anybody can design, implement and provide a service. For example, regulator authorities can provide policy services to farmers (e.g. how organic tomatoes should be cultivated) while in parallel, scientists, exploiting the very same API can provide task scheduling services to farmers (e.g. detailed guide of cultivating cucumbers).
- Modular and cost-effective solution for the management of a Greenhouse; the actual financing of the solution is extremely low (especially when compared to current state-of-the-art systems). A

low cost PC for local control, a commodity ADSL connection, sensors (e.g. 5 sensor boards for 10.000m^2 greenhouse) and an expert for the set up hardly reach the sum of 3000 euros. Moreover due to the design of the system and the exploitation of FI technologies, software maintenance is simple and fast since everything comes with a lifetime guarantee, thanks to the over-the-air software download
- Easy to install and configure; Installation, configuration and deployment takes approximately 5 hours (for a 10.000m^2 greenhouse)

Essentially, everything boils down to the fact that the design and implementation of the scenario offers a new business case; novel opportunities for economic growth throughout the value chain. In principle, a single person with a ground-shaking idea can implement it, advertise it through the framework and gain revenue upon deployment.

Last but not least, it should be pointed out that the scenario will be ported in its current form and be further extended in the context of the cSpace project.

2.2.1 Recommendations to enhance the generic enablers

- Based on the hands-on experience gained so far with the experimentation and validation of the GEs we can concretely report regarding the extension of the Identity Management GE. From a developers' perspective the GE could be further extended by introducing a Java API together with the currently provided JavaScript one. Due to the applicability of Java, such an interface would facilitate integration efforts.

3 Smart fresh fruit and vegetables scenario

Improvements in food networks are based on the responsibility of the food sector towards mankind in delivering food that is safe, affordable, readily available, and of the quality and diversity consumers expect. Assuring food safety and quality requires appropriate controls (e.g., on matching regulatory requirements on the use of pesticides, etc.) but also transparency and the support of trust through the provision of information and of guarantees for its trustworthiness. Additionally, the communication towards the consumer about the production of agricultural products is an important part of increasing awareness for food products.

These high level improvements can be described as two aims, **increasing efficiency in food logistics** and **ensuring food quality and food safety**, which the scenario is regarding.

Increasing efficiency in food logistics:

- Tracking and tracing of products and shipments in order to enable better planning of resources and better enabling of product withdrawal and recall,
- Monitoring of transport processes and conditions by capturing data from transport processes in order to identify critical situations and enable pro-active handling of transports,
- Forecasting of negative influences on product quality in order to enable better distribution of supplies.

Ensuring food quality and food safety:

- Provision of product quality information for specific product batches in order to proof compliance with different legal and private requirements,
- Capturing and provision of process information in order to maintain product quality and reduce negative influences leading to spoilage,
- Gapless tracking and tracing between agricultural production and the point of sale or even beyond in order to identify the path of potentially unsafe products.

The FFV scenario concentrates on the topics transparency and information exchange between agri-food enterprises which includes the management, tracking and tracing of the product and returnable packaging in order to enable the provision of product quality information from actors to actors in a supply network. It is based on a dual approach concentrating on the “management of product & information carrier” and the “provision of product quality information”. Both use cases are elaborated with European-wide acting business partners from the sector.

To validate the scenario three scenario instances have been installed in three locations in Germany. The first instance was installed 20km north of Bremen to simulate the functionalities of farm. An instance to simulate the Trader has been deployed on a server in Bremen. To present the solution to users the distributor instance was installed locally on a laptop. On top of that a so called rendezvous peer has been deployed in a data centre near Nuremberg.

The following scenarios were created to validate and test the functionalities of the scenario:

- Acquisition of data
- Provisioning of product related information
- Provisioning of tracking data
- Exception detection
- Propagation of exception
- Exception reporting

From this set of scenarios some were used for test and analysis of the capabilities of the provided GEs. These are presented in the next subchapters.

1.1 Sub-scenario Exception Detection

A trader of fresh fruits and vegetables sends a product sample to a laboratory to determine the pesticides load and possible contaminations of viruses and bacteria. The laboratory compiles the result of its analysis and sends these data electronically back to the trader. After the message is received by the FFV Scenario the event analyser module processes the data and validates it against the requirements of the law and the envisaged customer product. If the product is above the configured thresholds it raises an exception and informs the corresponding user inside the company.

CEP GE: The GE differentiate based on its configuration between laboratory data which should raise an exception and data which doesn't require it.

1.2 Sub-scenario Exception Reporting

Exception reporting is considered as a major requirement for improved food chain management. Exception reporting follows the term "If something went wrong, notify the decision making persons that are required to be notified". Currently decision makers get the information on potential hazards to late or not at all, when the possibility is there for corrections in the process and to control the process in a way, which allows the removal of unsafe products.

To create an exception the user "A" logs into the web frontend and creates an exception for a given product by entering the GRAI of the corresponding box and the reason why the exception is raised. According to the flow of the product the exception is transmitted to other stakeholders which were or are in possession of the product.

The FFV instance of a different company receives this exception and notice the responsible user "B" about it, allowing him to withdraw the product.

Identity Management GE: The IdM GE was used to fetch the public certificate from the sending user "A" to validate the origin of the transmitted exception against the signature of the message.

1.3 Test results Smart Fresh Fruit and Vegetables

Question VC.2. Who (role and skill of the person(s)) and how many people did the actual evaluation?

Two senior developers and two supply chain researchers.

Question VC.3. What went good, what went bad during the evaluation?

Like the other scenarios within the SAF project the overall experience was positive. From a developer point of view the provided web sessions and the training sessions supported the understanding of the capabilities of the GEs and their usage.

Identity Management GE: In the described scenario the IdM GE was mainly used to identify and authorise the user of the web interface against the backend system. These requirements were provided as expected and successfully integrated.

CEP GE: The authoring tool is designed to be as generic as possible which makes it too complex for domain end user. To address this, a domain specific authoring tool will be developed during phase two, tailoring the amount of information and capabilities to the users' need. Furthermore a wizard based tool will be developed to support the user by domain specific tasks.

Question VC.6. Please provide your (positive and negative) comments on GE usefulness

While using the IdM GE we missed the functionality of authentication via a certificate approach beside the username/password mechanism. On top of that, it would be very useful for the P2P communication to allow the validation and creation of signed or encrypted messages based on public/private certificates of the sending users to secure the message exchange. Although it was possible to attach public certificates on user accounts, this step should be further elaborated and automated.

The CEP GE is planned as a central tool for the processing of product related events, unfortunately the authoring tool was quite undocumented. Although the web seminars highly improved our understanding of this system, this should also be written down in tutorials (document and video).

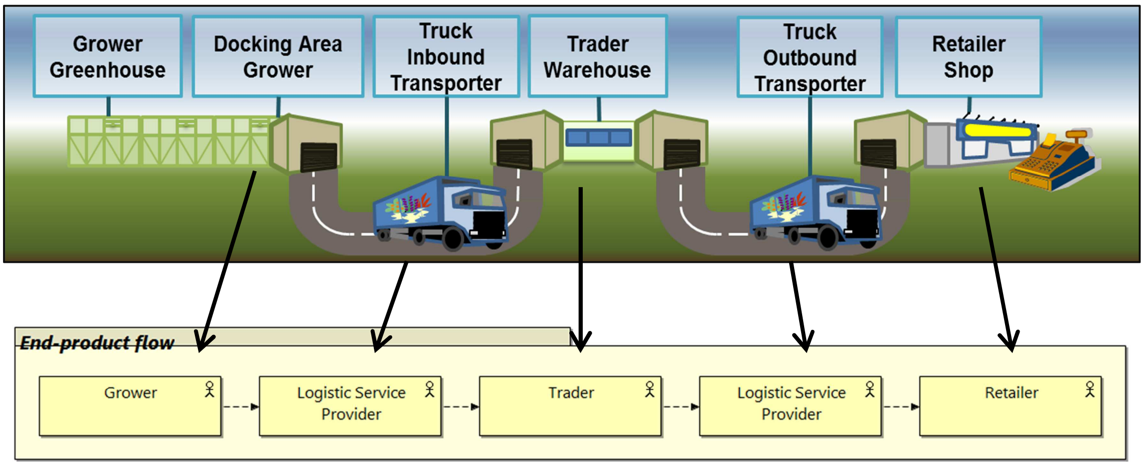
Generally spoken it would support the development process if the FI-Ware project would offer Java implementation of clients to access the Generic Enablers. Furthermore we propose the implementation of an EPCIS generic enabler, which plays an essential role in this scenario, but also in the quality managed logistics and tracking and tracing of meat scenarios.

4 Smart quality managed logistics scenario

The management of product quality is of vital importance in supply chains of fresh produce such as flowers and plants. The floricultural industry currently uses data loggers that record sensor data of quality conditions such as temperature and humidity. However, these data are only tracked afterwards and not in real time. The combination of new technologies for tracking and tracing (e.g. RFID), quality monitoring (e.g. wireless sensor networks) and internet connectivity (e.g. cloud computing and web services) enables real-time management of product quality in a supply chain context.

This scenario analyses and demonstrates the possibilities of Future Internet technologies for dynamic Quality Controlled Logistics in floricultural supply chains. In this approach, logistic processes throughout the supply chain are continuously monitored, planned and optimised based on real-time information of the relevant quality parameters (such as temperature, humidity, light, water).

The scope of the scenario is a supply chain from production to retail (see figure below). The focal company is a Dutch trader with the role of supply chain orchestrator. Via this trader, also a grower, transporter and auction are involved. The scenario is leveraging the trader's logistic tracking system, which is based on the ultrahigh-frequency RFID tags that are attached to the complete pool of plant trolleys.



A specific supply chain was selected to represent the floricultural sector.

The "quality controlled logistics" scenario aims at providing all chain stakeholders that are described before with information about the items that are currently in their logistic flow through the supply chain. This is a prerequisite for development of smarter logistic (re)scheduling services and shelf life projection services. These are anticipated to be developed in following phases. Currently, the following services are provided to the users:

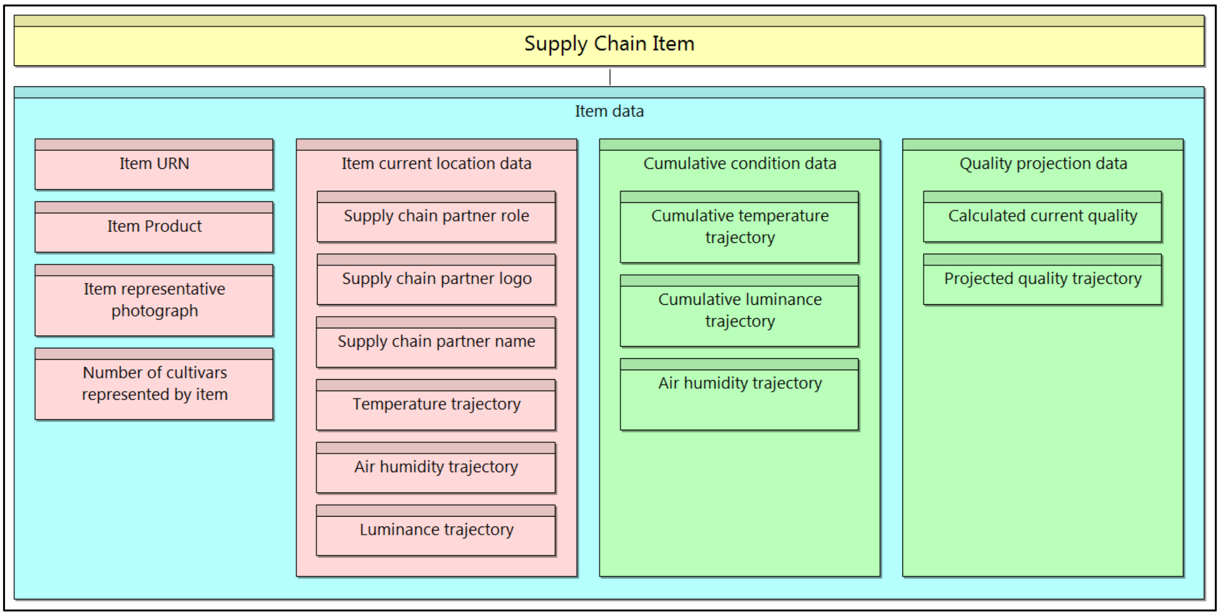
- Tracking and tracing service, which is used to present the location of items;
- Environment monitor service, which is used to present the environmental conditions (air humidity, temperature, luminance) at a specific item location;
- Product quality service, which is used to present the environmental conditions history and the current and projected quality of items;
- Exception notification service; which is used to present exception notifications of items.

Tests of the developed demonstration software are carried out with simulated data. The look, feel and information value of the demonstration application was thoroughly evaluated by stakeholders via an open discussion at the stakeholder meeting, supplemented by individual questionnaires. Actual testing of scenarios with implemented devices for tracking and tracing and condition sensors are anticipated to be carried out in the next phase of the scenarioThe test scenario's that were presented to the stakeholders are described below.

Simulated test data was sent via EPCIS messages to the Fosstrak EPCIS platform. The EPCIS messages contain tracking & tracing data in the format that is currently implemented in the Mieloo & Alexander RFID solution for the horticulture sector. The condition datasets are added to this EPCIS events with an Extension to the data model. From that point onwards the developed technical infrastructure and application functionality was used as described in deliverable D500.5.2. EPCIS messages of items with different characteristics and supply chain stages were sent to the platform to test the following business scenarios:

- The supply chain contains items of different cultivars (*Orchid, Geranium, Hibiscus, Lavender and Campanula*);
- The items reside at different locations in the supply chain (Grower Greenhouse, Grower Docking, Inbound Logistics Service Provider, Trader, Outbound Logistics Service Provider, Retailer);
- The items are subjected to different environmental conditions within and outside norms (*Temperature, Humidity, Luminance*);

For each item different events are simulated according to the scenarios described above and sent to the Event platform. The simulated data objects are presented in the figure below. Quality projections are carried out for all items. How these data items are represented in the application is described in deliverable D500.5.2. The light red objects are derived from the event data on the event platform. The light green objects are derived from the red objects by the quality monitor application functionality.



Item-associated simulated data objects

On a technical level, the suitability to use the Generic Enabler (GE) Complex Event Processing (CEP) in the quality projection expert system was thoroughly evaluated. The output of a temperature sensor was simulated. If the first recorded temperature is above a certain threshold an output file with all the collected temperatures is built, otherwise no action is taken.

1.4 Test results

Question VC.2. Who (role and skill of the person(s)) and how many people did the actual evaluation?

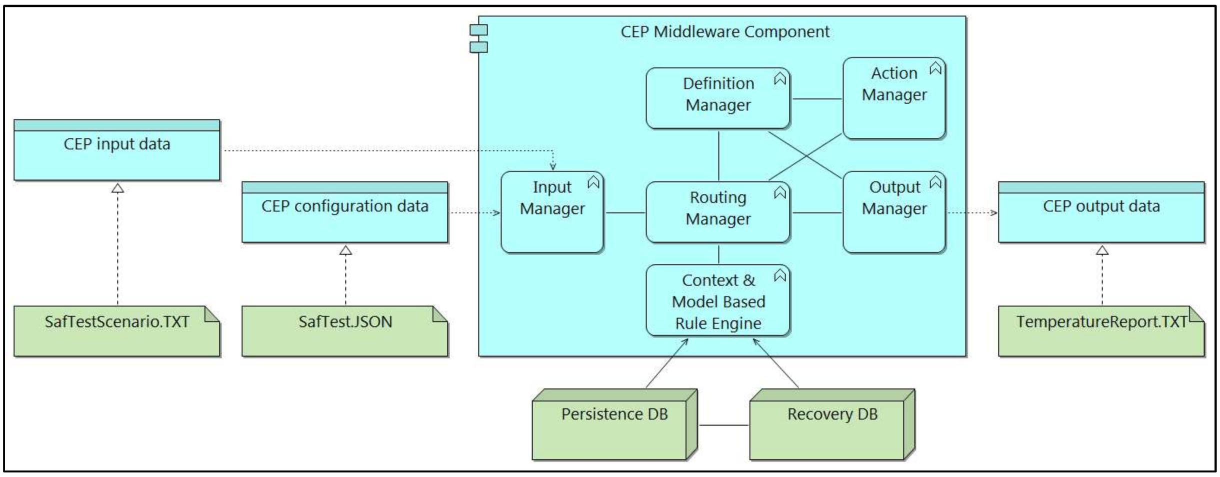
Software developers from the project and from the involved SMEs

Question VC.3. What went good, what went bad during the evaluation? (free text)

The most important outcomes from a user's point of view are the following. From the stakeholder evaluation it has become clear that in reality the amount of items in the supply chain at any given moment in the high season runs into the millions. Therefore showing all data associated with these items would overwhelm the user. The focus should be on items that are aberrant. Also stakeholders would value personalized screens that reflect the information that is most important to them.

From the evaluation results can be concluded that the quality projection module needs improvement. In the current implementation, the underlying algorithm is developed for cut roses and extended to other potted plant cultivars, which is not realistic. Also, this algorithm gives an idea on the current quality of a cultivar based on temperature, but is neglects the other environmental conditions and does not provide in quality projection. The projection of the quality decay is now in fact dummy-functionality. The choice for this set-up was made to be able to test the idea of a quality module in the demonstration software and to check the response of chain stakeholders. However, to be able to provide valuable input for logistic (re)planning this functionality should be further developed into a mature quality projection module.

Additionally to the point described in the previous paragraph, the results from the anticipated quality module should be checked with reality on a regular basis. The quality assessment made by the system will be derived from the storage conditions of the products during their stay in the chain. However, other factors may be of influence. Therefore data on regular sample checks of the actual quality by experts should be used to calibrate the system. Ideas to use that input to make the system self-learning have been expressed by stakeholders and project staff.



Test scenario for the Complex Event Processing GE

With respect to the generic enablers the Complex Event Processing GE from the FI-WARE Catalogue Version 1 seems to be a promising candidate.

In the test scenario for CEP, generation of alarms was examined. A successful proof of concept was built for the integration of CEP as visualised in the figure above. The alarms of interest were defined based on predefined thresholds for the environmental parameters (temperature, humidity, and luminosity). The previously developed expert system (cf. D300.3, D500.5.1) was enhanced for this purpose by utilizing the CEP. The test was performed by the software developers in the pilot.

In order to test the CEP GE, the method based on building the .json examples files, recommended by the corresponding FI-WARE partner, was utilized, and the dedicated testbed instance provided to the SmartAgriFood project from FI-WARE, was exploited. The configuration of the CEP Proton engine was described in a .JSON file. The SafTestScenario.TXT file was used to provide input data to the GE. The CEP component processed the data and responded with the TemperatureReport.TXT file as output.

The implemented functionality provides the pilots with a possibility to design reactions to environmental sensor measurements. For illustrative purposes, only the basic threshold alarms were generated by creating the appropriate input files, and receiving answers in the corresponding output files. The tests were conducted by the developers, however, earlier feedback from the end-users confirmed the importance of having such alarms.

It should be remarked, that the test results were positive also in terms of extending the threshold based rules, with a more complex rule engine. In other words, more sophisticated alarms, based, e.g., on the combination or correlation of various measurements, can be easily incorporated. This will be of interest for the further work in this pilot in FI-PPP Phase 2.

Further, for the developers, it was encouraging to realize that the expert system, developed as a domain specific enabler (DSE) for this pilot and implemented as a prediction web-service, can in principle be completely substituted by an appropriate utilization of the CEP GE. Namely, CEP GE is ready to be used also as a web service, and the developed prediction algorithms can be easily placed on top of this GE. The final realization of this idea is planned for Phase 2 and the result will be a compact expert system module, which will be easily extendable.

Question VC.6. Please provide your (positive and negative) comments on GE usefulness

Tracking & tracing systems that make use of UHF RFID are not new, not even to this sector. Also the monitoring of environmental parameters to optimize the conditions of transport is something that is common to certain fresh industries. However, in the potted plant sector currently no systems are available that are able to project the quality development of plants based on the environmental conditions history. Combining that with the input of tracking and tracing systems to realize smart logistic (re)planning is a radical new approach to logistic management of potted plants. The in the scenario developed ideas and demonstration software serves as a basis for further development of this concept which can potentially lead to:

- a reduction of product waste;
- shorter lead times;
- better capacity utilisation;
- and better product end-quality for consumers.

But on a less ambitious scale the publishing and sharing environmental condition data associated with specific items in the supply chain is new too. This concept was enthusiastically embraced by the involved stakeholders, because it would make it much more easy to track down what happened where and when received products are below quality thresholds.

The Complex Event Processing GE can help in identifying exception notifications. It has the potential to aid in the configuration of rules for complex event processing. It may provide support for the following application functions:

- generating exception notifications when:
  - environmental conditions are outside the norms for a specific cultivar;
  - the quality of a cultivar is outside the norms;
  - the expected quality of a cultivar is outside the norms within a certain period of time;
- easily updating CEP rules with improved cultivar quality decay models.

Important additional prerequisites to make the system work are:

- insight in the factors that influence quality decay of potted plants;
- access to expert evaluations of samples of the plants that reside in the supply chain;
- access to the initial quality of plants in the chain.

Additional to or improvement of existing functionality within the quality module itself may be the development of an initial quality service: Functionality to record the initial quality (the quality of the cultivar after harvest) of items (eg trays with potted plants), further integration of the exception notification service (based on the CEP). Also, an expert assessment service should be developed so that the evaluations of experts can be accessed by the system and the quality assessments can be calibrated.

The communication to back end systems may be further improved. Ideas about this are developed in Smart AgriFood and FI-NEST. In SAF a product information service is envisioned to take care of such functionality. In FI-NEST extensive back end functionality on the platform will. In the next phase the quality module may reap the benefits of the combination of the ideas of both projects.

During the work on CEP GE integration, several issues were detected, as well. All problem descriptions were delivered to FI-WARE in a direct communication with the corresponding partner (IBM). We believe that improvements in these fields would significantly enhance the applicability of CEP GE not only in this pilot, but in other applications, as well. As it will be shown in the sequel, some of these issues have been recognized by FI-WARE, and there are concrete solutions planned for Release 2 of the CEP GE.

In the sequel the major issues are organized in two categories:

- "Framework" (generic about the whole CEP framework)
- "Authoring tool" (the web interface used to build the .json files describing CEP processes and networks).

Framework Issues

- **External infrastructure needed:** The currently available CEP GE framework does not permit direct pushing of data into CEP. This means that in order to communicate with CEP in a real life scenario, one needs an external infrastructure running (an application server with REST accessible web services, an accessible database, etc.). *The response from FI-WARE regarding this comment was positive; they have already implemented a REST service that allows one to push the input events to the CEP using REST POST.*
- **No structured input data is supported:** Only flat attributes are supported, which can cause inconveniences for the developers.
- **The guides contain only one practical example:** Currently there is only one practical example with FILE producers and consumers. More examples, covering different situations/scenarios, would significantly help in understanding the CEP functionality and the subsequent development.

Authoring Tool Issues

- **It is impossible to cancel a single element:** There is no cancel functionality for a single consumer, producer, etc. This might be quite annoying for the developers using the CEP GE, since the created events which are not needed cannot be eliminated from the web interface. Currently, this has to be done manually (e.g., in the .json file), since the system lets one cancel only an entire project. *FI-WARE informed us that this problem has been recognized, and it will be solved for Release 2.*
- **There is no "import" function**: If one has already created a .json file for a CEP project, it is impossible to load it in an existing Authoring instance. *FI-WARE response: This functionality will also be added in the next release.*
- **No import/export function for a single element:** There is no import/export functionality for single elements like consumers, producers etc., and this makes reusing the objects one has already created, even within a single Authoring tool instance, impossible. *The answer from FI-WARE regarding this issue is that no single element import has been implemented, but that an option for duplication of the existing elements to create a new one (in the same project) will be provided in Release 2.*
- **There is no debug tool:** When using the authoring tool no corresponding debug tool is available, so tests must be done at the prompt level. When a wrong element is detected, one only gets a warning message when saving the object.
- **There is no possibility to deploy directly from the authoring tool:** It would be nice to have the possibility of exporting the .json file in a correct directory. *FI-WARE Response: The next release is supposed to have this capability. In addition, Release 2 will have the option to run the engine, replace its definition file, and stop it using REST services, without the need to actually log into the testbed machine.*

5 Tracking, Tracing and Awareness in Meat supply chains scenario

This scenario concerns ensuring consumers, regulators and meat supply chain participants to have accurate information concerning where a meat product originated (production farm) and how it was affected by its distribution (quality assurance). The use of common components for smart distribution and consumption shall help consumers to obtain better information on the meat they purchase, and producers to better control the flow of their goods to the consumer.

For the TTAM experimentation, the focus was mainly on beef. This meant that we excluded sausages, minced and diced meats, as well as pork, chicken and other types of meat. Also we restricted ourselves to packed beef. We focused on five groups of information, which are: general information, origin, quality, production and recipes. This is achieved by gathering traceability and transparency information from all partners of the supply chain in a centralized transparency database maintained by a third party. Instead of building a completely new system, the TTAM conceptual prototype builds on an existing application called fTRACE.

Question VC.2. Who (role and skill of the person(s)) and how many people did the actual evaluation?

Question VC.3. What went good, what went bad during the evaluation? (free text)

Currently, no generic enablers are actually implemented. The following will be considered in Phase 2.

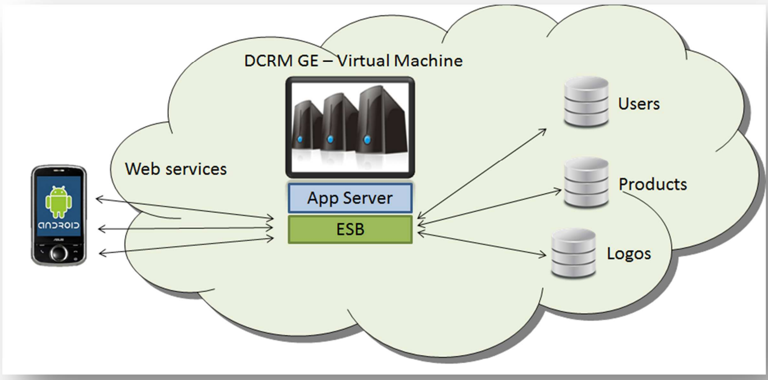
GE category	GE
Application/services frameworks	Application Mashup – Wirecloud
Data/Context management	Publish/Subscribe Context Broker
	Complex Event Processing (CEP)
Security	Identity Management – GCP
Cloud hosting	IaaS Data Center Resource Management

Question VC.6. Please provide your (positive and negative) comments on GE usefulness

In the final release of fTRACE, however, an EPCIS (a global standard) enabler will be implemented. The application area of an implementation of EPCIS can however be used in many domains (logistics, faming, transparency system, warehouse management, to mention the few). We, therefore, would like to propose the EPCIS implementation that is being undertaken, as a generic enabler.

6 Tailored Information for Consumers scenario

The TIC scenario focuses on allowing consumer to take purchase decisions considering comprehensive information about the products they can found in retail stores. Based on *future internet*, consumers can access to information behind agri-food products, and not to all regardless information available but only to those attributes that mainly interest each particular consumer. Product attributes related with origin, food processing, environment, health, quality, safety and so on should be tracked and available in the *cloud*. With the TIC scenario, consumers can define a *consumer profile* where they can specify in which product attributes are they interested in. Then, thanks to scanning technology (QR) each consumer can get tailored information about the scanned product and also about logos on the product. A Web-based Application allows users accessing to product information by using any gadget with internet access and a camera while doing their shopping or once at home. The following figure shows the architecture of the scenario and the operation steps followed by a consumer using the TIC Web app.



Architecture of the TIC scenario

Scheme of the Web app operation

The TIC scenario targets all the mechanisms (e.g. applications, infrastructure, data and communication models) that enable consumers to request information of a specific product using their Smartphone before/during and after their shopping process; so they only get the right product attributes of their interest according to their consumer shopping profile. This requires an infrastructure for managing consumer profile data (taking into account security and privacy issues) and for managing product attributes.

In order to match the consumer's interests, users can create a dynamic consumer profile in order to know what information they are interested in. Hence, the generation of tailored infor-mation depends on these profiles so this characteristic allows more accurate information matching in comparison with the generic and fixed information provision of products' labels.

Having tailored information after a matching process leverages privacy and security issues. As this information is supposed to be managed, in the future, by external entities in the form of GE; consumers, inside the TIC scenario, will be owners of all the tailored data they consume and produce. Consumers can also make use of anonymous profiles in the case they are not inter-ested on permanently sharing their information with the supermarket, the service cloud and GEs behind.

The TIC scenario accomplishes a key role within the SmartAgriFood super scenario, being the link between the food chain and the final user, the consumer. This role is twofold:

- Providing the product information to the consumer in a tailored way. The consumer only receives information he asked for or with an added value for him, i.e. indicating that a product has a nutritional composition not appropriated for him.
- Gathering the consumer's feedback into the food chain, providing to the stakeholders a valuable information about the acceptance of their products, which can be used to enhance them based on the end user preferences.

As detailed in D400.3, the TIC scenario has been deployed in Bon Preu facilities located in Barcelona (Spain). A medium size supermarket is located there and a room dedicated to consumers is found above the supermarket. This room is called *Consumers' Space* and it is used for consumer-retailer interaction in order to have feedback from its regular consumers about different subjects such as new products offered by the supermarket, cooking classes, master classes of nutrition, etc. It is a room with capacity for maximum 25 people with all the facilities for carrying out workshops, talks, cooking classes, and so on.

6.1.1 Sub-scenario Tailored Information for Consumer

Consumers publish their personal preferences & interests about several food aspects, and using the supermarket application the customer can retrieve personalized information about the shop's products via its mobile phone or pc browser.

The relation with FI-WARE's GE is as follows:

For the registration in the application, the login/logout operations and the whole session management we make use of the Identity Management GCP Generic Enabler.

For the management of users' personal data we use the Data Handling GE. Users define their privacy preferences via the mobile app (in natural language); the user data is also stored in the GE; the service provider, in our case Bon Preu's Supermarket, had previously defined their privacy policy; the systems transforms both privacy policies into a valid XACML+PPL format. When Bon Preu wants to use users' data the application calls the GE; it does the matching between both policies and grants or denies Bon Preu access to the data depending on the result of the matching.

For the server hosting we used the Data Centre Resources Management GE. This Generic Enabler has been very useful for the development of the pilot. We could create as many virtual machines as we needed in a fast way and manage them as we wanted. The relation experimented between the FI-WARE crew and us has been quite good. They answered all the questions that presented to us quickly and helped us every time we had problems with the Generic Enabler. The webinars done by FI-WARE were very useful to get in touch with the GE and to learn how to configure it.

Generic Enablers:

- Data Centre Resource Management GE;
- Functional integration of Data Centre Resources Management GE and
- Data Handling GE.

6.1.2 Test results

Question VC.2. Who (role and skill of the person(s)) and how many people did the actual evaluation?

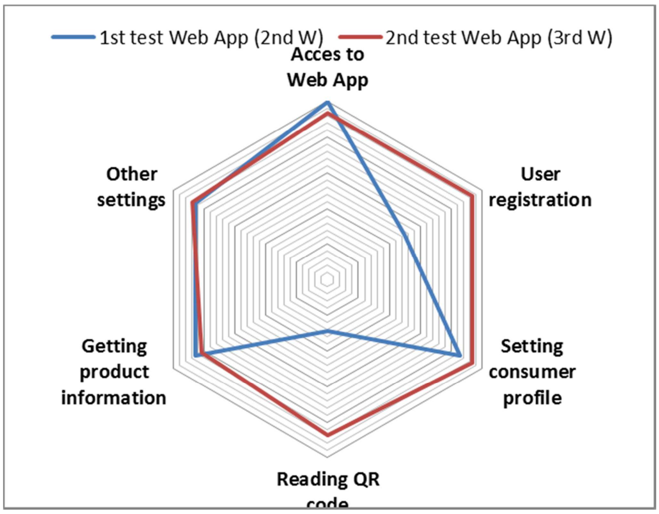
The TIC scenario was deployed in *Bon Preu* facilities for testing. The prototype has been tested in a closed and realistic environment where the panel of consumers used the TIC Web App to get tailored information about a lot of *smart* products (products with a QR code linked with a variety of attributes). Two workshops were performed coinciding with two iterations of the Web App, evaluating consumers' feedback from a technical and a user point of view.

Consumers were able to test two iterations of the TIC Web app. The first test allowed detecting some problems and improvements that were corrected for the second test. New functionalities were included to be tested in the 3rd workshop.

Question VC.3. What went good, what went bad during the evaluation? (free text)

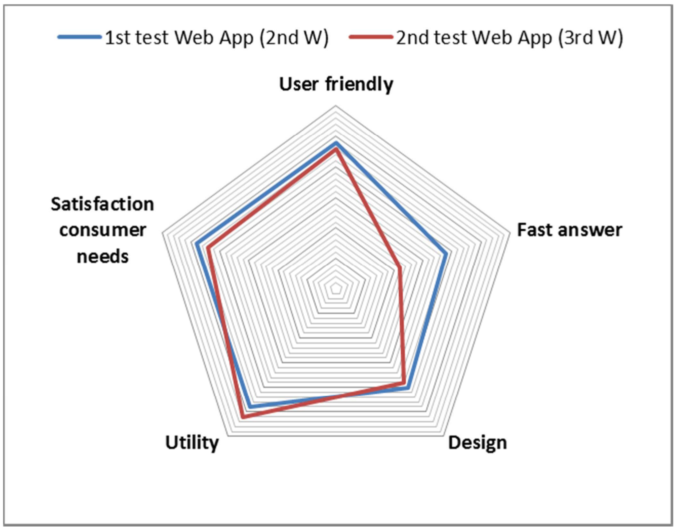
The evaluation results of the TIC scenario with consumers where very satisfying. An evaluation from a technical and a conceptual point of view has been done using surveys that were filled by the consumers participating in the workshops.

The figure below shows the results of the technical evaluation of each functionality of the scenario for the first and the second test with consumers.



Comparison between first and second technical evaluation of the web app.

A global evaluation of the TIC Web app regarding conceptual value for consumers was done. The following figure shows the results of the two tests with consumers.



Comparison between first and second global evaluation of the web app.

As a conclusion, we can say that consumers participating in the process for scenario evaluation were very interested and motivated in the TIC scenario and are willing to use the TIC Web app.

2nd test

1st test

Percentage of consumers that would use the web app while shopping

For the second iteration of the scenario, the DCRM GE was ready and we could start using it. We migrated the entire infrastructure to the cloud and the application was still working perfectly. Other GEs were taken into account. For the last iteration of the scenario, we integrated the Identity Management GE – GCP and the Data Handling GE. These Generic Enablers took us some time in the integration. The documentation of the Identity Management GE was not easy to understand. We had some troubles because most of the documentation provided by FIWARE was written in German. In the end, we could integrate it in a good way.

The Data Handling GE was quite difficult to use too. There was a misunderstanding between the open specifications detailed in the FIWARE wiki and the functionalities provided in the implemented version of the Generic Enabler. We contacted the people responsible of the GE and they provided the requested functionality. Thanks to this, we could integrate partially the functionalities expected.

Finally, it was planned to use the CDI GE to manage the capacities of the devices, in our case, to manage, for example, the camera of the mobile phone to recognize the QR code. The problem with this Generic Enabler was that there was not an implemented version for this first phase. We expect that, for phase II, this Generic Enabler will be ready and we will integrate it in the scenario.

Regarding the utilized Generic Enablers mentioned above, the results are quite good. The Data Centre Resource Management GE has been really useful for us. The possibility of creating a new instance of a virtual machine and can administrate it was very useful to make the scenario's tests, to avoid the resources consumption of our servers and to decouple the scenario from an specific place such as Bon Preu's facilities or ATOS's.

The Identity Management GE provided the expected functionality to our needs. We could integrate it and combine the login page with the GE. It allowed us to avoid keeping he information related to the users in the used databases. The scenario does not keep the user's personal information, just the identifier and password, but in case that the supermarket would decide to keep this information, the GE could support this functionality without making any changes and this is an added value to its utilization.

Finally, the Data Handling GE was used to describe the user's security policies. This functionality was very useful in order to let the supermarket access to determined information regarding the user's activities. The specifications show some functionality about keeping different user roles. This functionality would have been useful for us to keep the user's food preferences. We expect that for future versions we could use it this way.

Question VC.6. Please provide your (positive and negative) comments on GE usefulness

The TIC scenario can provide to consumers static and dynamic information of a product according to a profile where each consumer can choose which product attributes he/she want to know. So the application is adapted to each profile and range of information needs of consumers. The integration of the TTAM scenario with the TIC scenario means that the Web App is prepared for working with a real standardized tracking and tracing model. Besides, the logo recognition functionality improves awareness of logos and signs by providing the criteria that they must accomplish. Furthermore, the TIC scenario is based on an application Web that is accessible from any gadget with internet access and camera. Besides, the architecture makes use of Generic Enablers coming from FIWARE and thus validating their use in the Retail sector.

The scenario will provide a clear value for *consumers with better information* on origin, production method, quality, safety, nutrition, sustainability and other aspects of agri-food products; *retail companies*, by providing a *differentiation service* that will attract new customers, increase their satisfaction and fidelity; and for *producers*, with improvements in assuring that their *products reach consumers which are informed of all product attributes*. Communicating attributes of their products will add a clear value.

The Data Centre Resource Management Generic Enabler enables providing the application as a service for the user, so the cloud providers manage the infrastructure and platforms on which the application runs.

This "on-demand software" business concept allows the user use the services or systems that needs exactly, avoiding extra costs and developments not related with its real purposes.

The Identity Management Generic Enabler provides essential feedback to the security of the organisation that grants access to resources in its information systems. It's also essential to the security of the individual who accesses these resources, particularly when they belong or relate to him/her (e.g. personal data such as medical preferences). This Generic Enabler does not offer a binary choice between full assurance and no assurance regarding the parties to an interaction. It offers a range of levels of assurance, as appropriate (e.g. low, medium or high). The rationale for selecting the level of assurance primarily includes its alignment with the level of risk carried by the interactions between the parties.

In this first phase, one of the objectives to achieve was the study of the Generic Enablers, their comprehension and utilization the maximum way we could inside the scenarios. For the second phase, a whole platform based on the Generic Enablers will be developed. The trials defined for this second phase will be based on this platform. The figure below shows most of the Generic Enablers we are willing to use during phase 2.

FI-WARE chapter	Generic Enabler
Application/Services Ecosystem and Delivery Framework	- Repository GE - Marketplace GE - Registry GE - Store GE - Mediator GE - Service Composition GE - Application Mashup GE
Cloud Hosting	- Iaas Data Centre Resource Management - Cloud Edge GE - Object Storage GE
Data/Context Management	- Big Data GE - PubSub GE - CEP GE - Location GE - Meta-data pre-processing
Interfaces to the Network and Devices	- CDI GE
Internet of Things	- Communication GE - Resource Management GE - Gateway Data Handling GE - Protocol Adapter GE - Device Management GE
Security	- Monitoring GE - Identity Management GE - Security storage GE

10 Appendix B: FI-WARE GE Evaluation Template part 2

SMARTAGRIFOOD	Question GE.1. Is the provided documentation clear enough in order to understand the features you used and their implementation ? (Star-Rating)	Question GE.2. Is the GE open specification complete with respect to what you would expect from the component? (Star-rating)	Question GE.3. If your score in question GE.2 is less equal than three, please briefly describe what you expected vs. what you got out of the description (e.g. missing functionality, API details imprecise documentation)	Question GE.4. To what degree is the GE implementation complete with respect to what declared in the GE open specification? (Star-rating)	Question GE.5. What is desirable to have more/better in the GE implementation ? What parts of the GE suited your demand?	Question GE.6. Did you introduce customizations and use-case specific example data? (Y/N)	Question GE.7. If yes, what amount, which parts of the platform, etc.	Question GE.8. How difficult was it to integrate the GE in your application? ("Not Applicable" and Star-rating)	Question GE.9. If your score in question GE.8 is less equal than three (and not NA), please briefly describe the difficulty encountered (e.g. technical, documentation, communication)	Question GE.10. How do you consider this GE's global quality to be acceptable? (Yes/No)	Question GE.11. Would you recommend the GE? (Star rating – one star = "definitively not", six stars="Definitively yes")	Question GE.12. Which API/ were mainly used/considered for the validation?	Question GE.13. How deep did you analyze the GE? (Levels orderd by granularity, if you select more fine grained ones, the "upper" levels are included. Levels: PV - Product vision; ML - Materializing; AD – ArchitectureDescription; OS - Open Specification; WB - visited the Webinar/education session or got 1:1 training from GE owner; OAS - OpenAPI Specification)	Question GE.14. Overall comments? Please give recommendations for future use and improvements or positive aspects of the GE.	actual D/E/U
D															
Allocation of VMs (see note 2)	****	*****	Our expectations have been covered. We hava had some problems with the connectivity and the firewall filters.	*****	The generic enabler suited all our demands.	YES	We deployed our application and the related databases in the virtual machine provided by the GE.	NA	The webinar helped us a lot to configure the enviroment and the virtual machine. It was really good to understand the funcionality of the GE.	YES	*****	NA	OAS - OpenAPI Specificati	The GE is quite good and covers all our expectations.	D
Cloud Proxy (see note 3)	**	**	There is a mismatch between the features described in the open specification and the first release.	***	The SPM and VES are useful but would like to have the other components as well. I believe that future releases will be far more useful			****		Yes	****		OS	Nice to have but future versions will be more useful. According to the technical roadmap, all features will be implemented in the second release, so yes i believe that being much more "rich" in features it will fit real nice to the smart farming scenario/sub use.	D
Composition Editor/Execution	****	****		****	We have used the **Mashup Factory** which creates composite services in the backend.	NO		****		Yes	******	Graphic interaction only	OS	Interesting GE with various capabilities	D
Publish/Subscribe Broker (see note 5)	*****	*****		*****		NO		****	We have developed a scenario where the **SAMSON** broker pub/sub GE receives data and other applications query its contexts	Yes	******	NGSI9/NGSI10	OAS	Very helpful implementation	D
Service Description Repository	******	******		******		NO		******		Yes	******	REST APIs	OAS	Very helpful for storing services descriptions	D
E															
(Backend) Device Management GE															
(Gateway) Device Management GE															
BigData Analysis															
Composition Editor/Execution															

Location													AD – ArchitectureDescription	Useful for tracking all products during delivery. Device location updates can also be subscribed to. No history view, only says where you are not where you have been, but I guess the client needs to store that. The location info can be accessed via any web browser with the code shown on the catalogue page.	E
Publish/Subscribe Broker															
U															
(Backend) Things Management GE	***	**	Dummy configuration management component, and no NGSI 9 functionality, at the testbed instance at least.	***		No		We didn't procede to integrate it, only tested it.		Yes	***	NGSI 10	OAS		U
Allocation of Object Storage (see note 2)	****	**	Missing details in how to use the REST APIs	*****		NO		*	Problems in using the REST api are found. There is no clear documentation about the parameters to be used. We used only the portal functionality to create objects.	Yes	****	Rest API	OAS	This GE seems to be very useful ; More detailed documentation is needed though.	U
Data Handling	**	**	API is lacking explanation; Information from the different documentation available (wikis, etc) is not coherent as in some places you find information which is contradicted in the others. Example, the use of the downstream component	****	For the purpose of the GE, the implementation is pretty much complete. Maybe a tool to help programmers understands and create the privacy policies would be nice but that is, I believe, out of the scope of the GE	YES	Bon preu customers' personal profile/informatio n would be managed through the GE	**	First of all and as stated before, the documentation was quite confusing. Also, the process to fully understand the XACLM+PPL standards from scrach was very hard.	YES	****	??? The RESTful one from the wiki…..was there another?	OAS - OpenAPI Specification	Good and useful GE. Hard to develop the XACML part. Should be considered inside the FFV pilot for Phase 2.	D
DB Anonymizer													WB - visited the Webinar/education session or got 1:1 training		
Identity Management	*****	***	This GE offers only a javascript API. Java API is mostly needed .	****		NO		*	Not integrated	Yes	*****		OAS	Useful GE for Web applications only however	U

Marketplace													WB - visited the Webinar/education session or got 1:1 training from GE owner	Future implementation for spraying. Integrated view with domain relevant offerings. The Marketplace integration is based on the two functional requirements derived from the value proposition of the spraying pilot: the spraying UC service framework enables review and purchasing of available services (access to services in the market) and enables building meaningful farm service ecology (tailoring of user service bundle).	U
Media-enhanced Query Broker													AD – ArchitectureDescription	Allows the federated meta data querying of different multimedia storage systems (e.g. Flickr, YouTube, Custom Implementations) It seems to me that its not enhanced by multimedia features, but limited to multimedia files	E
Mediator	***	****		***	More clear mediator interfaces to use in proxies that we create.	NO		*	The server exposed wrong certificates,documentation was not too helpful too .	Yes	***	Wsdl that the mediator exposes for a specific WebService	OAS		D
Security Monitoring GE													WB - visited the Webinar/education session or got 1:1 training from GE owner		
Complex Event Processing (CEP)	**	**	The documentation doesn't provide a clear way of how to build a complete event handling process ;It focuses mainly on the architecture .	****	Easier way to create customized events and rules.	NO		*	It was not integrated due to imprecise documentation	Yes	***		OS	Needs better documentation however its capabilities seem to be very useful in event processing	U
Identity Management GCP IdM	*****	******	The Java API is not clear enough. Things like authentication should be explained and how to manage it too. Credential management among several services (and/ or clouds) to provide a uniform way of identification beyond particular environments	******	GCP IdM is suitable for our needs as a whole. As a matter of fact the GE provides more than expected (like adding extra parameters for a service). There should be some way to delete created users. A more decentralized way of authenticating identities. Ability to handle Public/Private Keypairs/Certificates	YES	We have developed a module to integrate the GE within the login module of our pilot.	*****	The documentation was quite difficult to understand and it took much time to start working properly with the GE. The received support was not the expected. The terminology used in the API documentation is not always clear. For example service id might be ambiquous since there are two options that in GCP admin panel.	Yes	******	Most of the REST APIs provided by the GE	PV, OS, OAS, Private documentation provided by the project	Suites well for IdM operations required by the UC. It should be improved to use in back-end Java applications	D

Compressed Domain Video Analysis	AD – ArchitectureDescription	This GE has absolute nothing to do with the Multimedia Analysis GE presented in the Product Vision. It only highlights POI inside a Videostream (e.g. a moving person) by returning the detected rectangle. I can see no usage for the FFV and TIC pilot	E
Object Storage	WB - visited the Webinar/education session or got 1:1 training from GE owner	-We have difficulties in using the Authentication REST API. Specifically ,the authentication procedure needs clarification of the parameters that are used. -We would like to see a live full example with the REST API : authentication and creating a container with some data.	E