Dynamic Business Collaboration in Supply Chains with Future Internet technologies: Acceleration of SME-driven App Development

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Abstract: The European Future Internet Initiative, called FIWARE, targets in its final and third phase at acceleration of Small and Medium sized Enterprises (SME). The 'FInish' accelerator provides grants for realisation of intelligent systems and specifically business to business (B2B) oriented apps for supply chains of perishable products such as food and flowers. In general, new ways to facilitate seamless B2B collaboration in complex supply chains and networks are searched for. This shall provide benefits for diverse actors as well as directly or indirectly deliver benefits for consumers. The available grants will be available to software developing entrepreneurs and SMEs that are making use of Future Internet and IoT related technological enablers as well as develop solutions that are realising innovations for dynamic business collaboration to ease and speed-up the collaboration set-up as well as facilitate participation in new regional, horizontal, and vertical collaboration at minimal costs.

1. Introduction

The supply of fresh food products is of vital importance to feed Europe in a healthy way, while Europe has also an important role in feeding the world. At the same time, food products and other perishables such as flowers impose very challenging demands on the management of its supply chains. Due to the high perishability, quality conditions including temperature has to be controlled from farm to fork, order-to-delivery lead-times are very short (while volumes are high) and supply chains have to deal with unpredictable variations in quality and quantity of supply [1.]. Consequently, planning, control and processing systems need to be very flexible, enabling last minutes changes and re-allocations, but also proactively enabling early warning and preventive control [2.]. Furthermore, in the past years numerous food calamities have required massive product recalls, e.g. the E. coli outbreak and the horse meat scandal. As a result there is a clear need for high-speed, high precision methods for product recalls and highly transparent product tracing approaches [3.]. Future Internet based solutions are offering the potential to provide a new dimension of information and added value services to the consumer as well as to facilitate the communication between B2B networks and consumers as the very final customer [4.].

Nevertheless, complexity of current solutions is too high and jeopardizes the development and operation of affordable solutions. As a result, there is a mismatch between state of information technology (IT) in agri-food and high and increasing need for intelligent solutions that combine interoperability with flexibility and that are both sector-specific and suitable for SMEs [5., 6.]. An additional complexity from an IoT perspective is that sensed objects are very dynamic by nature, especially because of its perishability, while at the same time network coverage is often still limited e.g. in rural areas. As a consequence, IoT applications are mainly limited in scope and focus on specific subparts of the agri-food supply chain [1.].

This paper is outlining key challenges for business collaboration in supply chains of perishable products and opportunities to meet these challenges with Future Internet technologies. Chapter 2 is summarising key challenges that need to be taken into account when aiming at the realisation of solutions for such a dynamic SME driven business sector. These challenges are currently addressed by a multidisciplinary group with representatives from agri-food producers, supply-chain actors and service providers as well as from industry, research and academia. The dimension of enabling technologies is outlined in chapter 3, highlighting the potentials of a homogeneous SaaS Platform for business collaboration. However, this platform needs to be considered as a specific enabler that facilitates the realisation of a composite to combine low-level IoT up to complex legacy systems having a clear conceptual approach towards app support business processes. This is further detailed in chapter 4.

This open innovation environment is offering software developers to contribute to the ecosystem. On top of that, chapter 5 is presenting the acceleration scheme that is currently offering some 80 Mio Euros of grants for entrepreneurs and SME type software developing organisations. This is also highlighting additional opportunities beyond the domain of agri-food. Finally, chapter 6 is concluding the paper with a short outlook towards the next milestones in the FIWARE acceleration scheme.

2. Perishable Products – A dynamic SME-driven Business Sector

2.1 Key Characteristics of the Business Sector

Coordination of business collaboration is generally based on agreed business processes, defined procedures, assigned responsibilities, planned schedules and a communication infrastructure that is providing decision relevant knowledge and event data helping to process situations from simple to complex nature. In dynamic supply chains of perishables it is of key importance that such an environment is fed the timely, relevant and reliable information from IoT. Therefore, it needs to be based on a symbiotic interaction among the real/physical, digital, and virtual world [8.].

Collaboration requires certain agreements and preparation between actors and struggles with an immediate change of interacting parties. Ad-hoc collaboration of unknown business parties needs to be considered as quite limited and could be just supported to that degree of generalisation that can be predefined as valid definitions and potential agreements that are accepted by diverse collaborating partners. Therefore, it is of high importance to target at the definition of general procedures and

business process capabilities (e.g. ordering, quality inspection, packaging, shipping of goods, and (dis-)aggregation), while specifically the following characteristics of the business sector handling perishables need to be taken into account:

- Large amount of small business actors as producers, service and logistic providers
- Dynamically changing, seasonal and weather dependent collaboration
- Limited possibility to forecast available amounts of produce
- Short-term perishability of produce and impact of transport and storage conditions
- High demands on sustainability for being able to feed over 7 bn. individuals
- Health risks due to contaminated, allergen containing and deteriorated food
- Limited reactions times to react on hazardous situation, due to the short time period from delivery to consumption
- Complex network structures of actors producing, processing and handling food that highly complicate the traceability of food items

These characteristics have a direct impact on the realisation of solutions that are incorporating Information and Communication Technologies (ICT). On top of that, the current state of the art of ICT in the agri-food logistics is characterized by large amounts of available data, but there is a poor level of integration, and the support for intelligent use of these data is insufficient. The complexity of current solutions is too high and jeopardizes the development and operation of affordable solutions. As a result, the adoption of internet for basic information services is high, but the use for more advanced functionalities is limited. [5., 6.].

2.2 Technological Challenges

The integrated usage of technologies is asking for standardised communication protocols and semantics. There are diverse initiatives active to elaborate approaches on different levels of abstraction. When considering ICT & IoT support for business collaboration in agri-food and specifically in agri-food logistics, it can be structured in accordance to the required features to control business processes at different players.

As an IoT related enabling layer, real-time virtualisation needs to translate the presence of physical objects into the virtual world. This asks for an acquisition of the object characteristics incorporating a unique identification as well as assigning contextual information. Moreover, beyond the position of the physical object, also information and/or knowledge is needed about its ambience, the processes and actors handling the object. From an IoT perspective, especially the latter imposes additional challenges, since information about an extended context could require the need to interface with different systems at device level, while even this might not be feasible, if related interfaces are missing. For this reason, a connectivity layer needs to be taken into account that is able to assure a timely, reliable, secure and flexible data communication in relation to the virtual representation of the object. Finally, information about the object and its context can be used for making intelligent solutions that are enabling the control of processes and subsequent workflows.

Basic requirements that are formulated in such scenarios are addressing a functional dimension especially with respect to identification, monitoring and decision support. However, as soon as a perspective of an open collaboration in business networks is added, technological solutions need also to assure satisfaction of

diverse non-functional requirements. Technological features need to be secure, guaranteeing privacy and trust, being scalable, allowing the required performance and finally taking into account the end-user's expectations with respect to usability and costs.

Therefore, a software developer needs to take into account a larger dimension when aiming at the delivery of a separate feature that is far beyond the separate fulfilment of an individual need of a business actor. Therefore, especially a larger dimension of collaboration beyond the usage of an individual device requires an amount of features that cannot be realised by the individual developer when aiming at the realisation of ICT that supports the collaboration in open business networks.

3. FIWARE Future Internet Technologies

3.1 Enabling Technologies – The Big Picture

As stated by the Future Internet Assembly [9.], the "today's Internet was designed in the 1970s for purposes that bear little resemblance to current and foreseen usage scenarios". Therefore, initiatives on the Future of the Internet were started all over the world and specifically in the US (GENI, 2013; FIND, 2013). The European initiative was specifically kicked off in the beginning of 2008 while a fast growing community was assembling with dedicated conferences enabling a joint work on e.g. architectures, IoT, service offer, trust & identity as well as on the relation of an FI to the socio-economics. Finally, born out of several groups and members from research, academia and industry a public private partnership was realised. Since then, the so called FIWARE [6.] was equipped with a public funding of some 300 Mio Euros to realise a new dimension of Internet related enabling technologies to push the realisation of innovations as well as to increase the employment opportunities for software developers.

The basic idea was to develop and provide so called "Generic Enablers" (GEs) that are representing applications/ services of a general nature and being applicable by multi-sectorial solutions within a Future Internet. For being able to test and validate those GEs from a multi-sectorial perspective, so called use case projects were initiated to elaborate on the needs of different sectors (i.e. food chain, transport and logistics, environment, media content, energy, personal mobility, utility provision and citizen safety) as well as to test and validate the enablers. This new dimension and size of collaboration and coordination in a European RTD programme was further complemented with the realisation of an acceleration initiative that started in September 2014.

Some 16 accelerators were established that are also addressing different sectors like agri-food, transport, manufacturing, health, energy, smart-cities, multi-media and gaming. Within the domain of agri-food, especially the four accelerators FInish, Fractals, SmartAgriFood 2 and SpeedUpEurope are active to specifically provide grants to app developers that are making use of Generic Enablers. On top of that, those accelerators are pushing the development of apps that are making use of the FIspace platform, targeting at a support of seamless B2B collaboration.

3.2 FIspace – A Homogeneous SaaS Platform

From the very beginning in FIWARE, a multi-disciplinary initiative joined its forces to push the innovation in agri-food related business networks. The sector-specific challenges as well as the technological barriers were carefully analysed and served as reference when targeting at design of a Software-as-a-Service (SaaS) Platform. The so called FIspace platform is currently being developed, enabling seamless, efficient, and effective business collaboration across organizational boundaries. It represents and integrated and extensible collaboration service together with an initial set of domain applications, thereby establishing the standard for supporting and optimizing inter-organizational business collaboration in global transport, logistics, and agri-food business [7.]. On top of that, FIspace represents a homogeneous platform with an overall architecture that facilitates the establishment of ecosystems with business benefits for both stakeholders from industrial sectors as well as the ICT industry.

- ***Business end-users*** can register as an organisation in the FIspace platform, enabling them to add different users (employees of their organisations) as well as to establish links to their (potential) business partners. Software application can be received via the app store. Moreover, the B2B collaboration core is used to define and control workflows, while external systems can be interfaced via the system & data integration module.
- ***ICT developers*** need not to reinvent the wheel. They can build upon the underlying FIspace platform features and can fully concentrate on the development of their software application. After uploading their app in the FIspace store, instances of a software application running at different users as well as interfacing different apps can be coordinated via the B2B core, helping to define and control workflows. Especially the coordinated combination of different apps via allowing a work/ information flow between them enables a new potential of solution development. Hence, an app developer can elaborate a feature that would make use of information and functionality offered by apps provided by other developers.

The development is not limited to a specific kind of software application. It could be a very focused software with few features, while it could also include more complex features and operations. Also the underlying technology or data storage approach is not specifically limited. There is also no limitation to specific hardware devices.

However, for being able to finally upload an app in the store and integrate it in the FIspace front-end, the app is handled as a W3C compliant widget. Moreover, it should be noted that different from typical smartphone Apps, FIspace Apps will not be built towards a given (and possibly fixed) programming interface (API). Rather, one key aspect of FIspace Apps is that they will declare what input data or events they require. In this regards, the FIspace App model is much closer to the software (Web) service or the component based software-engineering model, where reusable features are offered through interfaces defined by the service/components, and interested parties can select and mashup those services/components into more complex service compositions

Further details about the different modules of the FIspace platform are available via the FIspace website [7.] and FIspace Wiki (http://dev.fispace.eu/doc/wiki/Home).

4. IoT enabled Apps for B2B Collaboration

Development of FIspace included the realisation of initial apps that are used for the test of the overall platform and for validation of the business context. Those initial apps are split in a front and back-end, while the front-end represents the app in the overall FIspace platform front-end as a W3C conformant widget. The architectural design of the back-end shall be driven by the solution context, instead of following too restrictive requirements. It can be based on central processing and storage capabilities and distributing those features in accordance to process or user requirements, while the trials are also involving different IoT enabled capabilities like:

- Distributed monitoring of environmental conditions in greenhouses to enable the control in relation to the produce
- Unique identification of objects based on barcode and QR code at retailers to enable user profile based provision of information
- Virtualisation of product quality in floricultural supply chains, especially based on RFID and wireless sensor networks, to monitor up-to-date quality information including ambient conditions (e.g. temperature and humidity), prediction of remaining shelve life, and early warning in case of (expected) deviations;
- Tracking of fish and meet to enable the traceability of objects along the chain

Moreover, those IoT enabled scenarios were combined with the potentials of the integrated event processing engine to allow an integrated design of simple and up to complex control patterns.

Software developers can connect their software applications (i.e. the backend) via the system and data integration module with the platform. This ability of the FIspace platform enables the combined and synergetic usage of different apps or different instances of the same app as well as of different apps via the platform, while to increase a similar look and feel, each app will provide access to its frontend via the overall FIspace front end. As an underlying paradigm of the FIspace platform, it is to enable the dynamic mash-up of apps. A central business collaboration module is enabling the design and control of workflows as well as the usage of capabilities provided by different apps.

Therefore, the more apps are available via the FIspace app store, the more capabilities will be registered and offered. As soon as a critical mass of apps is available, the design of workflows including different business processes will be facilitated. Business related functionalities can be reused and composed in a flexible approach. On top of that, app developers can reduce complexity of their apps by systematically considering available features and concentrate on specific features. This can help to reduce the amount of errors in single applications, increase the speed of realising solutions as well as decrease the costs and risks for both app developers and business end-users.

5. Acceleration for SMEs

As outlined before, the FInish accelerator will support ecosystems of agri-food and supply chains/networks, aiming to bring together:

- Business needs of technology end-user communities represented by actors like farmers, traders, retail and supply chain service providers with
- Creative ideas & technological opportunities of SME type software developers.

Generally, the FInish accelerator is searching for solutions that can be used by numerous users, like producer groups and/or virtual/extended enterprises. This can take into account the business collaboration in networks from different perspectives, taking into account potentials for vertical, horizontal, regional as well as dynamic collaboration in networks that are active either in a local environment or in an international setting. Therefore, the underlying idea is to allow complex networks involving actors directly from the food and flowers supply chain as well as actors from farming, logistics and transport providers, food manufacturing, retail and finally consumers to take and advantage of the developed apps.

The FInish accelerator started in the beginning of September 2014. The acceleration process is based on two individual open calls for applications. Within each call it is envisaged to fund at least some 20 apps that are tested and validated by real end-users from the agri-food chain. Especially the relevance for real world business processes is considered as key success factor to assure a successful commercialisation of the supported developments. On top of that, the entrepreneurs will keep the full intellectual property rights and their shares. Due to the public resources involved, the accelerator itself specifically supports the realisation, while not limiting the commercial exploitation. This will reduce the financial and technical risks for entrepreneurs as well as open a real business opportunity to be followed up after successfully finalising the development.

The first open call will be published in October/November 2014, followed by the second call in spring 2015. Moreover, it is planned to realise competitions in combination with large trade fairs, to push the realisation of apps as well as to provide prizes at events inviting the business community to facilitate the access to potential business end-users.

Moreover, the FInish accelerator joins its forces with the other 15 accelerators to provide appropriate support and generate synergies as the programme is open all over Europe. This means that entrepreneurs from all over Europe will be enabled to benefit from those 80 Mio Euros that are provided by the 16. From now on, interested parties can directly access more information from FIWARE and FInish [10., 11.].

6. Conclusions

The paper was presenting key challenges for business collaboration in supply chains of perishable products and the opportunities to meet these challenges with Future Internet technologies. It specifically introduced the FInish accelerator of the European Future Internet Initiative, which provides a unique opportunity for both software developing SMEs and web-entrepreneurs as well as end-users from the business sector of perishable food and flowers. Grants for realising innovative solutions are available that are making use of FIspace and/or FIWARE as well as allowing the exploitation of IoT technologies. FInish specifically encourages the development of

solutions that are offering a high potential for commercialisation in the agri-food chain, once the solution is developed.

The business sector was outlined, highlighting the characteristics of the business domain and related technological challenges. The sector represents an excellent environment for exploitation of so called 'Future Internet' technologies that are being developed and available for full usage in both experimental and business settings.

The FIspace platform as one FIWARE enabler is used to support the development of apps and to achieve a critical mass of features presenting capabilities that are available for selective usage, facilitating mash-up of solutions, integrating IoT technologies and satisfying needs of B2B collaboration.

The FInish accelerator is currently preparing the selection of the first proposals for innovative apps and will promote the usage of FIWARE in close collaboration of the accelerator community, organising and attending a large amount of events, offering to discuss diverse ideas for app development.

The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement number 623 857.

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