FITMAN Future Internet Enablers for the Sensing Enterprise: A FIWARE Approach & Industrial Trialing

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Abstract

Future Internet technologies (BigData, Cloud Computing, Mobile Web Apps, etc.) offer manufacturing industries the possibility to engage in a digital transformation leveraging advanced business processes. Furthermore, IoT technologies are enabling technologies for new Smart Manufacturing solutions. The FITMAN project, Future Internet Technologies for Manufacturing Industries, is working on the development of Generic and Specific Enablers (GE, SE) that are the essential components of 3 reference platforms (smart, digital and virtual factory). The paper will discuss and present the enablers and architectures implemented by the enterprises for providing advanced and innovative services based on Future Internet technologies. The paper will also present the high-level features that are leveraged by the FITMAN reference platforms and the associated GEs/SEs to develop new business processes. The paper will show how these enablers and high-level features represent a solid and flexible technical foundation for communities of developers and practitioners to develop digital business processes in an open & programmable internet, through concrete industry-led trials.

1. Introduction to the Sensing Enterprise and the FITMAN project

Over the last few years, an increasing effort has been put in place to enable enterprises to develop further business capabilities relying on Internet and IT enablers. From its description of the Digital Business Community (DBI) Position Paper on Orientations for H2020 published in 2011, the Sensing Enterprise refers to an enterprise anticipating future decisions by using multi-dimensional information captured through physical and virtual objects and providing added-value information to enhance its global context awareness. That is to say, the enterprise will not only capture selective information from the environment (physical, virtual and social), but it will also integrate decentralised intelligence into its decision-making process. The Sensing Enterprise denotes a specific set of characteristics of a Digital Enterprise, and combines the vision of the Internet of Everything (IoE), Big Data Analytics, and Next Generation Collaboration, with the evolution of enterprises as a business and policy concern on the one hand, and with the technical evolution of enterprise systems from architecture to specific processes and components on the other.

Current factories are nowadays going through a transformation that should respond to major megatrends taking place worldwide. As an industrial renaissance takes hold in Europe, advanced manufacturing (which provides over

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20% of Europe's jobs and generates 67% of its exports) is being transformed in multiple ways leverage by the ICT very relevant role. To address these challenges, future enterprises are developing new capabilities in their three dimensions smarter, digital and virtual factories. These advanced business capabilities can be achieved providing improved technologies for interoperability, connectivity, mobility and intelligence, which make enterprises smarter, more agile, mobile and collaborative. Future Internet technologies present enterprises with a new instrument to implement highly efficient advanced services that leverage a digital transformation[1][2][3][4][5].

However, the Sensing Enterprise is not only the vision of the DBI community for the H2020, since relevant European companies are working towards the digital transformation in very important European Research projects such as FITMAN, OSMOSE, FUTUREENTERPRISE, MSEE or ComVantage; promoting new forms of enterprises, business transformation, and new/enhanced product/service development.

The paper brings an insight into the OS enablers and architectures (Reference Platforms) that have been developed in the Future Internet Phase 2 Use Case project FITMAN (Future Internet Manufacturing Technologies). The paper provides a clear understanding about how the FITMAN Future Internet (FI) modular components will allow the development of added-value services and applications on the top of EDA-SOA architectures in the Sensing Enterprise concept.

The document also presents the industry-led trials implementing FITMAN OS components related to the smart-IoT services, digital information management and collaboration. The usability of FI enablers facilitate the development of advance services and applications in the manufacturing sector, leveraging the smart, digital and virtual domains in the companies towards the Sensing Enterprise.

2. FITMAN Future Internet Enablers and Reference Platforms

FITMAN aims to test and assess the suitability, openness and flexibility of FIWARE OSS components (GEs) to meet the needs of European Manufacturing Industries in the domains of Smart, Digital and Virtual Factories of the Future. Additionally, FITMAN provides 15 specific components for manufacturing (SEs), which customise FIWARE for the Manufacturing Business Processes, and complement FIWARE enablers in those domains. These OS components enable several advanced functionalities related to shopfloor data collection, complex realtime event processing, secure event management, collaborative 3D web visualization and synchronisation, 3D data storage, unstructured data analysis, semantic analysis, collaborative assets and business processes management, etc.

FITMAN also provides three Reference Platforms that conceptually describe the interconnection between the FIWARE and FITMAN enablers (GEs, SEs) on a specific Factory of the Future domain: Smart, Digital and Virtual Factories. In other words, user-friendly guideline for fast FIWARE OS components "assembly" in the different domain applications.

The Smart Factory platform is focused on the collection and processing of realtime data collection for shop floor operations, directly related to IoT technologies. It uses sensors and monitoring systems (Kinect sensor, RFID sensors, etc.) deployed in the production lines and services/applications for sending messages or warnings. It aims to manage both tangible assets (energy, productivity, throughput, and wastes) and intangible assets (customer sentiments, workforce wellness, comfort and safety) to obtain more competitive and productive manufacturing environment. As a result, more efficient knowledge-management strategies will be implemented, achieving the intelligent and smart factory.

The Digital Factory Platform aims to provide advanced data visualisation in order to connect people to the huge amount of information available. It faces the challenge of improve the time-to product and time-to-market of products

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[1] FInES Cluster, Position Paper on Orientations for FP8: A European Innovation Partnership for Catalysing the Competitiveness of European Enterprises, 18 March 2011.
[2] G. Santucci, C. Martinez, D. Vlad-Câlcic. The Sensing Enterprise. August 2012
[3] FInES Cluster, Embarking on New Orientations Towards Horizon 2020, 30 June 2013.
[4] What "Digital" / What "Smart" for Advanced Manufacturing? K4I Forum Debate, European Parliament. May 2015
[5] More information in the Digital Business Community: http://www.dbi-community.eu/

and services, managing more efficiently the product life-cycle information using intelligent knowledge flows and providing the services and tools to make easier the cooperation between the different systems, such as ERP, MRP II, social networks, testing system, etc.

The Virtual Factory Platform is oriented to cross-enterprise collaboration through the tangible and intangible assets management. It aims to obtain collaboration models and platforms, in order to manage the activities that demand multi-partners interaction based on product-centric collaboration space. Accordingly, the virtual factory experimentation sites could be located in the collaborative private servers and networks where partners share information about their needs and tenders. A common component in most of virtual experimentation sites is SQL Server for enterprise-level data storage.

As a summary, the FITMAN FI enablers and architectures will provide the following main functionalities:

- Physical-Digital service synchronisation.
- Real-time dynamic event processing.
- Connecting People to Information.
- Advanced and secure (3D) data visualisation capabilities.
- Cross-enterprise collaboration & interoperability.

As can be seen from the functionalities and capabilities offered by the previous modular components and architectures, the FITMAN enablers will facilitate the easy, fast and efficient development of smart, digital and virtual services and apps based on Future Internet technologies. This is fully aligned with the Sensing Enterprise concept, which leverages the integration of enterprise systems with IoT platforms and ecosystems, the incorporation of smart objects and associated technologies into business contexts and practices, and effective information management practices that move enterprises from big data, access to information, cloud, and business intelligence.

3. FITMAN Industrial Trialing

FITMAN offers the availability of generic & specific OSS software components organised in a modular architecture for digital business process development in an open & programmable internet. Furthermore, FITMAN implements 55 innovative business processes in 10 industry-led use case trials based on the FI enablers and architectures previously described. In the following section, how the FITMAN trials develop advanced services and apps through the implementation of the modular components will be shown, facilitating smart-IoT services, digital information management and collaboration in the framework of the Sensing Enterprise.

Concerning the business objectives of the manufacturing companies to perform the digital transformation process, FITMAN trials are mainly oriented to reducing production costs, reducing time to market, increasing production capacity and increasing the usefulness of information. FITMAN trials supports the transition towards self-organising production capabilities that leverage far more adaptive advanced manufacturing production sites. Specifically, the FITMAN SMEs will benefit from the movement towards more responsive and energy efficient production sites that can respond more effectively to production requirements and can better plan production processes based on capacity available.

TRW trial (automotive supplier – Tier 1) aims to develop a new generation of worker-centric safety management system in order to reduce the accident and incidents in the production workplace through workers' empowerment. The use case of TRW is focused on monitoring and evaluation of the risk that can affect to the blue-collar workers on the production lines, in order to provide effective prevention strategies. Thus, the trial specially demands the functionalities of the real-time detection through Kinect sensors, as well as continuous data processing for events creation and corrective actions performance. TRW trial supports the introduction and acceptance of IoT technologies in the manufacturing industry, providing the necessary balance between security concerns and privacy concerns. The implementation of monitoring technologies supports the innovative human-in-theloop model, getting a participative approach for the workers' empowerment solution.

Whirlpool trial (white goods sector) provides solutions for real-time decision support systems. It is characterized by an underutilization of the data gathered in the production line and thus an unexploited benefit in terms of speed of reaction and effectiveness of decision taken by the factory staff. The trial instantiation is mainly focused on reducing quality defects due to operation going out of control by preventing as much as possible machine interruption. This can be achieved enabling the decision maker with a mobile device and a system able to gather all the basic events

happening along the production line through RFID sensors, filtering them applying a selective algorithm and deliver enriched information about the event through the mobile device.

Piacenza trial (textile sector) is focused on both cloud manufacturing and enhanced production monitoring, in order to provide manufacturing as a service business model. The trial handle the production capacity forecasts, leading to the publication of forecast data on the cloud and hence sharing the production resources. The real time monitoring of the shopfloor production is supported by the usage of smart tags (RFID enabling technology), so the monitoring of the order status will be automated and each order in production will be connected with the right machinery. In this way, the solution provides an updated data to feed cloud computing by adequate monitoring and capacity estimation instruments. Consulgal (construction sector) aims to provide a solution for collaborative workspace and effective decision-making. The major focus is the automation of the concrete handling procedure with a well-defined information management system, supported by RFID technologies for the tracking and monitoring of the concrete samples and dams. Consulgal trial aims to provide a more collaborative participation between the stakeholders and support effective decision making with almost realtime data from shopfloor with contextual information. AgustaWestland (aeronautics sector) is oriented to the workforce support and production tracking in aeronautics. During final assembly line and maintenance operations the Foreign Object Damage (FOD) -any possible damage attributed to a foreign object that is not part of the vehicle or any foreign object itself that may or may not degrade- avoidance is very relevant and strictly related to the correct management of tools. To prevent and avoid FOD risk and improve efficiencies to be sure all tools have been removed from the Helicopter, maintenance and manufacturing teams have dedicated strict tool control procedures and use of dedicated training courses and different instruments for their tracing and checking too, such as toolbox, tagged tools. For as question of safety at the end of the activity, all the tools must be stored in the referring box. AgustaWestland trial aims to give further support to the technicians during daily activities in the final assembly line using the support of new instruments in order to facilitate the tracking of the tools.

4. Conclusion

FITMAN is a cost-effective, modular and open approach to develop advanced applications and services in the framework of the Sensing Enterprise for the manufacturing domain. Through IoT services, digital information management and collaboration capabilities, the FITMAN SEs and reference architectures will make easier, faster and more efficient the development and implementation of innovative smart, digital and virtual services.

The evidence of the FITMAN approach is shown on the trials, where digital business process have been developed in an open & programmable internet, demonstrating:

- Real-time data detection through sensors and “smart” objects, as well as continuous data processing for events creation in order to support effective decision making with contextual information;
- Digital information management, advanced visualization of the users’ information, feasibility of the cloud in the manufacturing domain, and trends forecasting through social networks; and
- More collaborative participation between the stakeholders in the value chain, through enterprise networking platforms, and tangible and intangible assets management.

Nevertheless, the impact of the Sensing Enterprise is expected to go deeper and wider: new business processes, new value chains, new notions of business assets (mainly intangible ones), new relationships, balance of power and control between people and objects in enterprises and enterprise networks. Importantly, people, data, process and objects will become collaborating and possibly competing partners in an enterprise environment; the interactions between people, their digital representations, and objects will be a key issue. These future challenges will be strongly leveraged by the Future Internet technologies (BigData, Cloud Computing, Mobile Web Apps, etc.), and supported and facilitated by the FITMAN enablers and reference platforms.

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