Connected Smart Factories
Workshop Report

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1. Introduction

The Connected Smart Factories Workshop (26th – 27th September 2018) was organised alongside the IEEE-IS2018 conference in Madeira. The workshop brought together industrial representatives from the digital manufacturing and IoT domain, along with the researchers from the areas of smart manufacturing, enterprise information systems, IoT, cloud computing, big data, standardisation, process engineering, business modelling and FIWARE. The aim of the workshop was to analyse and discuss the ongoing developments in the broad area of Connected Smart Factories.

The workshop was supported by 4 European funded projects (COMPOSITION[1], DIGICOR[2], NIMBLE[3] and vf-OS[4]) with a focus on different aspects of smart manufacturing, and with the common vision to contribute towards a Connected Smart Factory platform in Europe.

The workshop program was composed of 19 presentations organised into the 4 thematic sessions.

1. Enabling Collaborations (Matchmaking, Automated Negotiations, Process Orchestration)
2. Smart Tools (Digital Manufacturing, Smart Factory, IoT)
3. Big Data Management (Interoperability, Analytics)
4. Business Modelling (Ecosystem Strategies, Simulations)

The workshop was attended by 38 participants, who actively contributed towards the discussions during each of the presentation. The summary of the discussions is provided in the following sections.

2. Enabling Collaborations

Within this thematic area the presentations focused on Automated Negotiations and Trust, Matchmaking, Process Orchestration and the role of Marketplaces.

Automated Negotiations and Trust: *how do you set the trust values in new collaborations?*

Understanding the links among business process and Multi-Sided platforms are critical to automate the negotiation phase. For new collaborations the trust is generally based on the partner profile. More profile information helps to determine how trustworthy partner is. There can be several places from where the profile can be populated and also validated. Later, the trust values can be gathered from past interactions and transaction monitoring – more data generates better trust values.

Matchmaking: *What are the expected benefits of automated match-making mechanisms?*

Team formation and collaborations enable SMEs to jointly respond to the needs coming from OEMs. The benefits of automated matchmaking include: reduced time and cost to perform partner selection and related tasks, broaden access to supplier market, increased number of bids against open tenders and improved manufacturing capacity utilisation.

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[1] https://www.composition-project.eu/
[2] https://www.digicor-project.eu/
[3] https://www.nimble-project.org/
[4] http://www.vf-os.eu/

Process Orchestration: *What key features of a process design and execution environment can effectively support agile collaborations in digital manufacturing platforms?*

A shared (web-based) process environment can support effective collaborations by interlinking and executing distributed activities in a reliable and transparent way. The key attributes for such a process environment include: support for distributed and parallel process design, two way communication between physical and virtual world to synchronise physical world activities with different activities/tasks in the process, real-time monitoring and alerting of process status, role-based access to processes, interoperability/standardisation of the data-exchange as well as security and privacy of information being processed through the process environment.

Marketplace: *how to ensure integrity of data and (agent) behaviours in electronic marketplaces?*

With the increasing number of electronic marketplaces, there is a need to develop trust models and governance mechanisms that ensure integrity of exchanged data as well as governance of the software agents that operate in the marketplace. For example, a rogue software agent can participate in multiple auctions e.g. to create artificial price hike or to damage the business transaction. The governance mechanisms can impose policies to control certain behaviours and the intelligent decision making of agents in the negotiation processes. This also includes the mechanisms for some kind of traceability on how decisions have been reached. Thus, the topic of governance is quite hot and open at the moment. While emphasising on the mechanisms for structured interactions and conflict resolution, the digital platform developers/owners also need to pay attention to the governance and trust-building mechanisms. Recent advancements in this area include the use of Blockchain for reputation models and to govern B2B interactions and transactions.

3. Smart Tools

Within this thematic area the presentations focused on Smart Manufacturing and Control, Enterprise Integration, IoT Tools for Smart Factories and SDKs for Smart Factories.

Smart Manufacturing: *what are the key focus areas for smart manufacturing tools?*

There are extensive efforts on the data front, where new approaches are being devised to allow aggregated and meaningful data to be presented to the smart manufacturing tools and services. Standardisation is also a key area where there is increasing traction on some standards, such as OPC-UA for bringing shop-floor data to higher level services. However, the implementation of smart factory tools often overlooks the use of standards. This fact endangers the iinteroperability among platforms hampering the creation of a healthy ecosystem where large platforms offer services to other platforms.

Enterprise Integration: *Why enterprise integration is relevant to the smart manufacturing domain?*

The future of manufacturing is about Connected Smart Factories where intra-factory (value chain) and inter-factory (supply chain) need to be aligned to deliver products and services on time. When integrating data from the shop-floor into a central information management system, BPMN based business process models can be used to connect shop-floor data with relevant systems in a smart way.

SDK for Smart Factories: *How the SDK can be presented to the users?*

The SDK can be offered to the users as a bundled set of libraries or as an integral part of a visual tool such as process environment (in the vf-OS project), where the process designer is used for visual composition of different services in an application.

IoT Toolkit: *How to address the lack of test datasets required to develop and test IoT applications?*

An example is the vf-OS IO Toolkit that facilitates driver development by using a drag and drop approach. However, the lack of relevant data for testing and training is a real problem faced by the developers. A way around this problem is to work with reference and/or generated datasets e.g. International Data Spaces (https://www.internationaldataspaces.org/) offers valuable resources here. The developed solutions can be tested through automated testing and benchmarking techniques.

Planning Tools for Complex Supply Chains: *How a planning tool can help in distributed Supply Chains?*

Big companies are transferring the coordination of tender processes to Risk Sharing Partners e.g. Airbus has selected a small number of RSPs from the Tier 1 suppliers list to manage the supply chain downstream. In such situations the planning tools (e.g. tender facilitator) plays a crucial role to conduct the overall process, allocate partners to components and subcomponents as well as planning and scheduling of procurement processes.

4. Big Data Management

Within this thematic area the presentations focused on the techniques for big data management in digital platforms.

Data Management: *What problems are critical for the big data management platform?*

The critical issues for managing big data include: establishing trust in the storage and processing aspects of data management, preserving data integrity, only sharing data with trusted entities, clarifying point of truth for distributed datasets, managing ownership of data throughout the value chain and ensuring seamless access for application and services

Data Harmonization: *How can manufacturing companies, with limited technical knowledgebase, acquire relevant tools to manage their data?*

The lack of relevant standards for harmonising different data formats is one of the issues that hinders the wider adoption of digital manufacturing platforms. This is also the issue for establishing interoperability between different platforms. UBL (Universal Business Language), DOM.ONTO or eCl@ss are interesting initiatives that provide ontologies to be applied in this field. In the case of manufacturing and IoT devices there is a lack of ontologies making it very difficult to provide data maps. One recommendation is to consult relevant experts. Another alternative is through crowdsourcing techniques, where more data-maps contribute towards richer reference models.

Data Analytics: *What analytic techniques are needed or currently sought for?*

Digital platforms handle and manage a lot of data, not much of it is used for market exploitation. Statistical models are quite underrated these days, although they are good enough for most analytic scenarios. Artificial Intelligence based analytic techniques are getting a lot of attention these days. In essence, AI techniques kick-in or augment statistical analysis when there is uncertainty. At the end, complex analytics should be easier to maintain and user friendly.

5. Business Modelling

Within this thematic area the presentations focused on Simulations for Business Modelling and the development of ecosystem around digital platforms.

Business Model Simulations: *Can simulations be used to evaluate business models?*

Simulation is an interesting approach to analyse the viability of new business models. The starting point for a new simulation will be determined by different KPIs and dynamic market conditions., which are carefully analysed before being fed into the simulation. Simulations can also be used to evaluate existing business models. The simulation of market factors alongside the performance KPIs of the platform allows us to be more realistic about what we could expect from current business models. From a platform owner perspective simulation also helps us to determine the minimum number of users we need to meet the operation cost of our platform. Moreover, when the simulation uses the market size (number of manufacturers and suppliers) of our use cases, we can see whether there could be revenue indeed or whether the operation cost has to be minimised according to the target market.

Ecosystem: How do you foster ecosystem growth?

Digital platforms are driven by the ecosystem of service providers and consumers. Building an ecosystem requires adequate emphasis on barriers and enablers. Barriers include awareness (of benefits, trust etc), slow rate of technology acceptance, interoperability and propension to change. Enablers include better knowledge of the domain, access to interoperable tools and services, partnerships and new business opportunities.

6. Discussion

The workshop concluded with a round table discussion focusing on the following topics:

Intelligent Agents vs Intelligent Services: All project discussed in the workshop had a common feature i.e. the use of intelligent agents to automate human tasks. In not so distant past, intelligent agents were being replaced by intelligent services. While theoretically they are different concepts, technologically they are quite similar except for their communication interfaces. In the past it was thought that intelligent agents were already doomed because their communication interfaces were not that practical in contrast to intelligent services. However, now in all the projects discussed in the workshop, intelligent agents are present up front. The hypothesis is that intelligent agents, as a technology, have reached a sufficient maturity level to be seriously considered for robust, real-time, highly critical systems – such as the ones being developed in the ongoing European projects.

Business and Governance Challenges: Platform owners define the business rules based on the well-established business protocols from specific domains. These rules are often well known to the platform users or made visible at registration and transaction phases. However, governance rules and policies are often less visible. Governance is about setting out rules of engagement and operations. DESCA (http://www.desca-2020.eu/) is an example of governance rules used to manage the complex interdependency and collaboration needs in the distributed EU projects. In addition to collaboration, another key focus area for governance is data. For example, the data governance models of IDS provide the control mechanism towards data ownership and access.

Impact of FoF-11-2016 projects on Connected Smart Factories: A furniture manufacturing platform instance is starting to emerge out of the NIMBLE project. The vf-OS project is leading to a start-up focusing on the smart IoT applications, data harmonization and analytics. The COMPOSITION project contributes with scientific impacts in the field of agent-based marketplaces. Furthermore, the pilot partner Boston Scientific is planning to roll out the tracking system that is developed within the COMPOSITION project. Finally, the DIGICOR platform is being rolled out to SME communities in the aerospace and automotive sectors by the two partner SME clusters.