Evolution of Industry 4.0 Platforms within H2020 Projects and Current Issues

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Abstract

The H2020 framework of the European Union is eager to support research in the Industry 4.0 domain for the European manufacturers to gain a competitive advantage through better digitization. Originated by extremely costly and aged hardware besides the traditional approaches for management and knowledge/data transfer, a real need for improvement are perceived.

Many projects have been conducted in the last 10 years, and within the ZDMP (Zero-Defects-Manufacturing-Platform) Innovation Action the evolution of the predecessors toward the current approach are reviewed to identify potential constraints for other projects in the same research and innovation sector.

Still, EC (European Commission) reviewers stated that it is hard for external parties to understand the relation between these projects and the concept's evolution to reach the objective of innovation and digitization of manufacturing processes in the EU. This document depicts the most important concepts of H2020 platform projects in the manufacturing domain of Industry 4.0 in the last 10 years with examples focusing on CREMA, vf-OS, and ZDMP, to demonstrate which issues hindered dissemination of these platforms in the past and how the following projects are evolving to get a foothold in the market by 2022-2023.

Keywords 1

Zero Defects, Manufacturing Platform, Industry 4.0, H2020, CREMA, vf-OS, Evolution, Business Concepts, Data Privacy

1. Introduction

Industry 4.0 is revolutionizing the manufacturing industry based on the digitization of assets and processes as a key innovation driver for manufacturing companies. Factories are complex systems of other systems, and in many of the manufacturing industry, the digitization still did not happen.

The integration issues faced are manifold, machines often cost millions, therefore, hardware cannot simply be replaced when interfaces are missing, instead, proprietary interfaces have to be used. Also, additional sensors may have to be manually added to machines or products, taking time, effort and additional planning, posing as a business challenge for a platform that should reach the real-world business sector.

The basic technical challenge was to interface with the machines and planning systems in manufacturing companies and connect this to a platform to develop solutions on. The author's first experience with such a task was 2011 in the FP7(7th framework programme) EU project ADVENTURE (Adaptive Virtual Enterprise Manufacturing Environment), where a message bus, a global database and virtual machines composed the platform, and the access to machines was individually programmed (in a concept called "Gateways"). The technical concepts were lacking, but still, the concept sounded good enough to rework it for H2020.

Also, technical issues were in all of the projects either conceptually inherent to the proposal or brought to the projects as a matter of unfit implementation technologies, mismanagement, or lack of

Proceedings of the Workshops of I-ESA 2020, 17-11-2020, Tarbes, France
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experience of single partner companies. Research projects are sometimes like Frankenstein monsters, and when the proficiency with a particular technology is proclaimed by a partner company, but the conceptualization or implementation of it is lacking in certain areas, some vital parts of the platform might prove to hinder the whole project. Usually, risk management should come into play, but the management of large research projects is also a hard task where issues can arise.

Problems can occur in different areas, and the evolution of these different areas are analyzed in the following sections.

H2020 Research and innovation action CREMA (Cloud-based Rapid Elastic Manufacturing) was a 3-year EU funded project that aimed to create a platform, to facilitate the development of custom applications to the manufacturing sector. The concept was based on the low-level ADVENTURE project from the 7th framework programme, where the initial idea of providing a platform preconfigured for industry use was conceptually validated. Partner companies from the manufacturing sector showed interest, and therefore the need to drive this field of research was confirmed..

While CREMAs concepts stemmed from ADVENTURE, vf-OS (Virtual Factory Operating System) was launched a year before CREMA finished, and focused on taking the technical and business concepts further. Now ZDMP and eFactory are sister projects that started a year before vf-OS came to an end in December 2019.

2. Technical Concepts Evolution

CREMA did provide working solutions based on a messaging infrastructure, common Cloud storage for data and many more application-level tools and services. Processes and workflows could be represented in a BPMN editor called Process Designer, where steps could call services, and the virtual machines for these could be set up during runtime if necessary, and then the response would be taken on to the next steps.

This Process Designer was verbalized as “the programming language of CREMA”, to make clear that technical knowledge is still necessary to build technical solutions, as some partners were envisioning a programming-free technical solution - something not possible yet for some years. Also, the Process Designer did not make the design of solutions easier, it just enforced a model which works with the services and the marketplace of CREMA, which restricts the possibilities of programmers creating solutions. Also, it had implications on execution sequence and speed, as parallelization is very basic in BPMN-like structures and also limits programming paradigms. Still, it was possible to implement many processes and tasks and use any of the services in the Marketplace component.

CREMA lacked technically in many areas, but especially security, federation and data privacy, all extremely important aspects for industrial companies with confidential business data..

The project vf-OS proposed to improve many of these factors. vf-OS was intended to be an open operating system for virtual factories composed of a kernel, application programming interface, and middleware specifically designed for the factory of the future – concepts from computing systems were transposed on the digital infrastructure of manufacturing plants. Security and federation of components were planned across the other technical components and concepts to be developed in the research project.

Also, were CREMA did not endorse 3rd party support, in vf-OS, the integrated development editor (IDE), innovation hubs, better documentation and even more tools specifically designed to help 3rd party developers to create solutions on top of vf-OS, coined vApps.

While vf-OS was coming to an end, two more evolutions of the concept were planned: eFactory intends to focus on a business infrastructure route to combine the different kinds of Industry 4.0 projects and their solutions and marketplaces, while ZDMP is another more massive refinement of vf-OS, reinstated as an Innovation Action instead of a Research and Innovation Action using 30 partner companies (half partners are from the industry) to push the technology in the market. Technically though, ZDMP puts the focus on industrial-grade solutions (open source as much as possible), instead of custom-built systems, and adding specific components and tools to implement the Zero Defects paradigm.

3. Business Concepts Evolution

The concept of CREMA lacked in one major area – the exploitation would only work when the CREMA solutions would be supported by a company with a valid business model, to keep the servers running and sell a product to the manufacturing companies. The consortium already realized this from ADVENTURE but specifying direct exploitation through a legal entity within a proposal was a no-go in proposals to the European Commission at the time. Therefore, the coordinator decided that the exploitation deliverables within the project should put together the different factors needed for a business plan, to at least have the chance of combined exploitation if the plan was promising enough.

The business model, market analysis and dissemination towards a common legal entity was created within the project, but as the contract with the EU didn't foresee the creation of a legal entity, partners commitment was very limited and the experiment of creating a company within CREMA leading to supporting actors to lose interest, despite the coordinator intention of following the experiment. The concept was clear, and therefore the creation of a company at the end of the project was now envisioned in the vf-OS Description of Action (DoA). While the project was mostly focused on technology, collaboration with ZDMP was planned as the last year overlapped with the start of ZDMP, and the ZDMP DoA went much further in terms of common exploitation including a legal vehicle, as, by 2018, the EC adopted the necessity of this.

In ZDMP, a company would not be founded at the end of the project but instead within the first year of the 4-year-project (which was the last year of the vf-OS project), as at the end of the project funding period viability of this company did not matter anymore for the participants. Also, the DoA specified that the company to be founded would be applying as an equal partner and consortium member after its founding and would get redirected funding from the other involved partners, so that building a real company was now also in the hands of the ZDMP consortium..

Getting a critical mass of users is also a major issue for a platform. For CREMA, this was practically impossible. In terms of 3rd party application support, documentation was minimal, technical support was missing. In vf-OS, the case was much better. As mentioned above, vf-OS incorporated an IDE, innovation hubs, documentation and tools for 3rd party developers to create vApps for the integrated marketplace. Still, the motivation of 3rd party developers to test out the platform was nonexistent, as there were no customers in the vf-OS marketplace. The vf-OS DoA planned hackathons with a bit of price money, and those were conducted but still not more than a handful of 3rd party developers tried out the technology and were not excited.

In ZDMP this issue was attacked in manifold ways. The aforementioned business concept is realized as an internal drive to get a profitable marketplace for 3rd party developers and possibly some products generating visibility and is now anchored in the DoA. A second tenet is the 3rd party developer support, which was taken over from vf-OS, combined with the concept of open sub-calls. 3,200,000€ will be distributed for projects with up to 150,000€ each that use the technology created within ZDMP, registration for information as soon as it becomes available is possible on the ZDMP website [1]. Also, the marketplace enables the selling of 3rd party solutions towards customers directly within ZDMP under the reign of i4FS, which means that i4FS can get a provision of the sales the 3rd party developers make.

4. Current Challenges

Data privacy in the Cloud is hard. Technically, the main issue is that computing on encrypted data (i.e. using homomorphic encryption) is not technically viable to use in Cloud databases yet [3]. Therefore, to be able to query a database, data cannot be hidden from the database provider. The contents can be encrypted for data privacy reasons, but then no useful queries can be done with the information in the database, which is the main reason to put data into a database in the first place. Solutions currently are separation of data into secret and non-secret data, and either encrypting the secret data or store it in a trusted environment.

Storing data on-site vs. in a private or public Cloud so far is the only way to ensure that business secrets cannot be exploited by rivals, especially as trust in online systems has been eroding since it became clear that the intelligence services have been corrupting technology infrastructure worldwide,

which indicates that backdoors can be expected everywhere. Hard encryption and on-premise solutions, therefore, can be the only way forward to secure business secrets currently. Therefore, the only technical solutions can be seen in a separation of data into private (on-site), semi-private (Private Cloud) and pubic data (Public Cloud), as the aforementioned project's topic is not data security, neither primarily nor even secondarily.

Creating a business without a product is difficult. Creating a company in ZDMP is not a problem but creating a product for companies in the market is difficult. If it was easy, it would have been done without an H2020 project behind it. Having a promising product though is essential to get people invested in this company so effort and resources are put into it. Therefore, finding out how to create a sellable product from such an Innovation Project is one of the main tasks, as this product is not defined in the DoA. To prevent conflicts of interests by consortium members, a legal body with its employees needs to exist, so they can define a product (or multiple products or solutions) to sell, which might make market research and product definition necessary. If all of these steps have happened, a commercial uptake of the platform is viable.

Currently, the company is coined i4FS (Industry 4.0 Factory Solutions [2]) and at the time of writing (Jan 2020) consists of seven core companies from ZDMP and vf-OS. The main issue in this early stage even before the entry as a possible beneficiary of the ZDMP project is finding a business developer who has the qualifications and the motivation to drive this artificial company, that is even without a concrete product or business yet. This business developer also should not be directly involved with the consortium partners, not ask for much money and needs to be convincing the EC, which still has to approve the amendment inviting i4FS as a beneficiary.

5. Conclusions

The explained opinions demonstrate the issues that H2020 platform projects in the Industry 4.0 manufacturing domain are dealing within the last 10 years with examples focusing on CREMA, vf-OS and ZDMP, and the current challenges in terms of technical concepts and business concepts.

6. Acknowledgements

The research leading to these results received funding from the European Union H2020 Program under grant agreement No. 825631 “Zero Defect Manufacturing Platform (ZDMP)”. The content of this paper does not reflect the official opinion of the European Union. Responsibility for the information and views expressed in this paper lies entirely with the authors.

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