vf-OS: virtual factory Operating System

WP10: Impact

D10.4a: Workshops Reports (M26) - Vs: 1.0

Deliverable Lead and Editor: João Sarraipa, UNINOVA

Contributing Partners: ICE, UPV, KBZ, IKERLAN

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Status: Consortium Approved

Short Abstract

This deliverable report two major workshops conducted in the period till M26. Both were designed orientated towards main scientific and research outcomes supported with some technology available during this phase. The second reported workshop was also designed to explore possible synergies with similar projects and to analyse the results achieved so far. Different collaborations and initiatives resulted from such workshops.

Grant Agreement: 723710

Document Status

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History

See Annex A.

Status

This deliverable is subject to final acceptance by the European Commission.

Further Information

www.vf-OS.eu

Disclaimer

Project Partners:

Executive Summary

The activities within the vf-OS project, as in other similar projects, benefit from the public awareness and debate with other specialists. That was a strong motivation behind the design of public workshops within the vf-OS project development with reports at middle and end of the project duration.

The present report, D10.4a – Workshop Reports, is the first of those two documents and reports the two workshops where vf-OS was presented and debated with specialists and other project leaders. From that sequence of events, the present report aims at documenting the materials presented, the dynamic of the workshops, the debate, and the outcomes. These activities come from the document of work; “Importantly, vf-OS commits to organise and lead two major workshops and will coordinate with other related projects to achieve this. One workshop in the middle of the project will identify current achievements and be orientated towards scientific/research/technology outcomes.” In this case two workshops where already organised with different audiences.

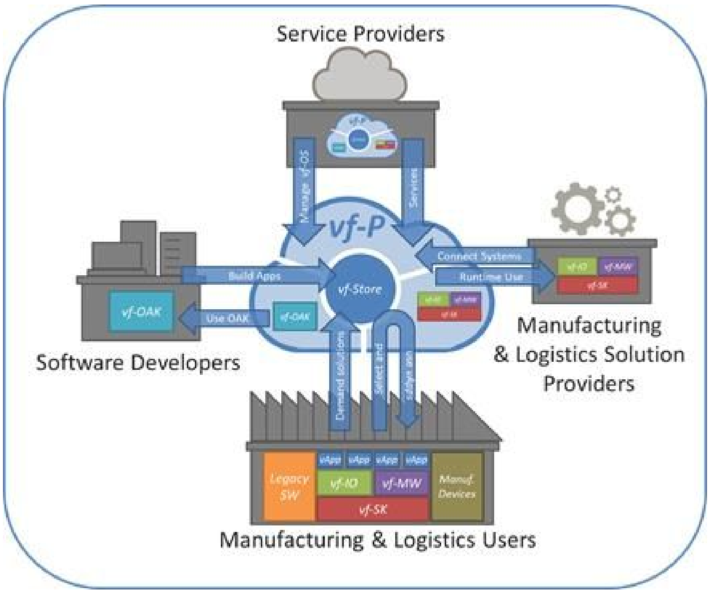
The hereby reported workshops were performed at the I-ESA 2018 conference and the other at the Intelligent Systems, IS 2018, conference.

Table of Contents

0 Introduction

0.1 vf-OS Project Overview

vf-OS – virtual factory Open Operating System – is a project funded by the H2020 Framework Programme of the European Commission under Grant Agreement 723710 and conducted in the period October 2016 until August 2019. It engages 14 partners (Users, Technology Providers, Consultants and Research Institutes) from 7 countries with a total budget of circa 7.5M€. Further information can be found at www.vf-OS.eu.



The World is facing the fourth industrial revolution based on ICT, specifically architectures and services, as key innovation drivers for manufacturing companies. Traditional factories will increasingly be transformed into smart digital manufacturing environments but currently, the full potential of ICT in manufacturing is far from being fully exploited. Factories are complex systems of systems and there is a need to develop a platform on which future manufacturing applications can be built. Examples of platforms exist in some industrial sectors but there is a lack of cross cutting platforms based on open standards for creating an ecosystem for cooperative innovation. Innovative open platforms to attract talent from solution developers and to provide accessible manufacturing smart applications to European SMEs are examples of the kind of solutions being sought.

The goal of vf-OS is to develop an Open Operating System for Virtual Factories composed of a kernel, application programming interface, and middleware specifically designed for the factory of the future. An Open Applications Development Kit (OAK) will be provided to software developers for deploying Manufacturing Smart Applications for industrial users, using the vf-OS Manufacturing Applications Store all operated through a Virtual Factory Platform.

The Virtual Factory Platform is an economical multi-sided market platform with the aim of creating value by enabling interactions between four customer groups:

- **Software Developers (independent or within individual manufacturers)** which will build Manufacturing Apps either through innovation or from manufacturing user demand
- **Manufacturing and Logistic Users** which will explore the marketplace for already created solutions, ready to be run on the vf-OS
- **Manufacturing and Logistics Solutions Providers** which will provide ICT interfaces and manufacturing connections
- **Service Providers (vf-OS innovators and third parties)** will make available services (hosting, storage, connected cloud services, etc.) including those based on developed solutions

The Virtual Factory Platform will provide a range of services to the connected factory of the future to integrate better manufacturing and logistics processes. Manufacturing Applications Store will be open to software developers who, using the free Open Applications Development Kit provided, will be able to quickly develop and deploy smart applications to enable and optimise communication and collaboration among supply networks of all manufacturing sectors in all the manufacturing stages and logistic processes.

vf-OS aims to become the reference system software for managing factory related computer hardware and software resources and providing common services for factory computational programs. This operating system will be the component of the system software in a real factory system where all factory application programs will run.

0.2 Deliverable Purpose and Scope

The purpose of this document “D10.4a Workshop Reports” is to present the public discussions that were performed while developing the workshops. The scope of the document comprises presenting the key points of the presentations at the workshops and the activities developed.

0.3 Target Audience

The target audience of this document are the members of the project that can find the summary of what was presented at the vf-OS workshops. At the same time this document enables all other attendants of the workshop to have a document with the presentations and indications about the workshop’s execution. Finally, this document promotes awareness of the project by informing about both workshops organised in the scope of the vf-OS project.

0.4 Deliverable Context

The context of the present deliverable includes the reporting of both workshops:

- Workshop at I-ESA 2018 conference
- Workshop at Intelligent Systems 2018 conference

0.5 Document Structure

This deliverable is broken down into the following sections:

- **Section 1:** **Smart Services and Business Impact of Enterprise Interoperability @ I-ESA2018:** This section provides the summary of the workshop hosted at the I-ESA’2018 conference
- **Section 2:** **Connected Smart Factories Workshop Report at IEEE-IS2018:** This section provides the summary of the workshop hosted at the IEEE-IS2018 conference

- **Annexes:**
    - **Annex A:** History
    - **Annex B:** References
    - **Annex C:** I-ESA’18 Call for Workshops Proposals

- **Annex D:** I-ESA'18 vf-OS Workshop Proposal
- **Annex E:** I-ESA'18 vf-OS Workshop Call for Papers
- **Annex F:** I-ESA'18 Workshops Programme
- **Annex G:** I-ESA'18 vf-OS Workshop Papers
- **Annex H:** I-ESA'18 vf-OS Workshop Presentations
- **Annex I:** I-ESA'18 vf-OS Workshop Pictures
- **Annex J:** IS'18 vf-OS Workshop Details
- **Annex K:** IS'18 vf-OS Connected Factories Workshop Notes
- **Annex L:** IS'18 vf-OS Workshops presentations
- **Annex M:** IS'18 vf-OS Photos

0.6 Document Status

This document is listed in the Description of Action as "public" since it has it reports public events and material presented to a wide audience.

0.7 Document Dependencies

This document has no dependency to other documents and will have implications in further versions.

0.8 Glossary and Abbreviations

A definition of common terms related to vf-OS, as well as a list of abbreviations, is available in the supplementary and separate document "vf-OS Glossary and Abbreviations".

Further information can be found at http://www.vf-OS.eu/glossary.

0.9 External Annexes and Supporting Documents

The annexes do exist and are reported in the Table of Contents and in the Document structure 0.4.1.

0.10 Reading Notes

The present document reports the activity shaped in the DoA as "The vf-OS project will organise and participate in workshops at industrial conferences or during some of their internal meetings. vf-OS will both identify the most relevant conferences in the area (T10.1: Dissemination strategy and plan) and propose 'minor' workshops to be held during these events. Importantly, vf-OS commits to organise and lead two major workshops and will coordinate with other related projects to achieve this. The vf-OS project will organise and participate in workshops at industrial conferences or during some of their internal meetings. vf-OS will both identify the most relevant conferences in the area (T10.1: Dissemination strategy and plan) and propose 'minor' workshops to be held during these events. Importantly, vf-OS commits to organise and lead two major workshops and will coordinate with other related projects to achieve this."

Uninova is responsible to organise such actions and all partners participate in the scientific workshops specially the RTD partners while the Industrial partners attend those workshops for the industrial community. Supporting documents and information can be found in Annexes at the end of this document.

1 Smart Services and Business Impact of Enterprise Interoperability @ I-ESA2018

The I-ESA Workshop was performed with the Scientific community attending the I-ESA conference 2018. The workshop was mainly based on the scientific papers (see them at Annex G:) and it was organised answering to the call for workshops presented at Annex C:. In the following the rationale and the main features related to the organised the workshop and finally some conclusions about it are presented.

1.1 Workshop Rationale

Today's economic environment is being shaped by profound transformations as the world is facing the fourth industrial revolution based on ICT. This trend has impact in promoting specifically architectures and services, as key innovation drivers for manufacturing companies. The devices and processes in traditional factories will increasingly be transformed into smart digital manufacturing environments using new strategies and new processing flows using the flow of knowledge associated with the emerging trend of exponential technologies. Currently, however, there is a lack of capacity to fully implement the potential for ICT in systems and there is a need to develop a platform on which future manufacturing applications can be built.

European companies, especially the SMEs present needs around ICT solutions that are far from being satisfied at affordable costs and lack opportunities to deploy solutions on time to market. Some of the constraints SMEs are facing can be summarised in:

- The integration overheads for ICT that should be reduced
- The need to provide mobile devices that are intuitive, to provide traceability from cradle to grave through the supply chain and to facilitate monitoring, optimisation, and predictive maintenance to enhance availability and productivity.

1.2 Smart Services vf-OS

Manufacturing companies have, so far, been implementing point-solutions, each bringing a specific feature or fixing a specific identified need. Resulting from this approach is a highly heterogeneous manufacturing IT landscape. While these IT landscapes are already costly to administer, further addition of capabilities becomes even more costly because they must be fitted into the heterogeneous IT landscape already existing. There is a need for a homogeneous manufacturing IT landscape offering manufacturing IT solutions to support manufacturing companies, especially SMEs, in successfully responding to the challenge to be flexible and offer highly customised products, and without daunting implementation costs, thereby maintaining and boosting their competitiveness locally and in the increasingly globalised markets they participate in.

As an answer to these needs, an H2020 European project called "Virtual Factory Open Operating System" (vf-OS) funded under the topic FoF-11-2016 "Digital Automation" subtopic "Collaborative Manufacturing and Logistics", started in October 2016 with a duration of three years. The aim of the Smart Services and Business Impact of Enterprise Interoperability workshop at the I-ESA conference is to demonstrate the research undertaken with the project during its first year. Therefore, vf-OS as organiser of a workshop related to this topic invited submission of related works, see the call for papers at Annex D:.

1.3 The six vf-OS aspects presented at the workshop

The following listed aspects relates to the six presented papers, which texts and presentations can be seen at Annex G: and Annex H::

- “vf-OS Architecture” describes the vf-OS software architecture. Information and requirements of the real world are included in the structural planning of the complex software system.
- “Enablers Framework: Developing Applications using FIWARE” proposes the Enablers Framework, a component of the vf-OS project that acts as a bridge between applications and enablers, granting programmers an easy access to the services they need.
- “vf-OS IO Toolkit” describes the 10 Toolkit, which provides tools for OnPremise facilitation of the access to manufacturing devices and existing business software, while also facilitating the interaction with the rest of the vf-OS infrastructure.
- “Data Management Component for Virtual Factories Systems” envisages the vf-OS middleware platform and the Data Management Component for covering the issues related to data handling, pre-processing, extracting, and data flows management for Virtual Factories.
- “An Open Environment for Development of Manufacturing Applications on vf-OS” describes a novel environment that was envisioned for providing software developers with an advanced editor with syntax highlighting, providing a large set of artefacts and libraries including standard connectors and extension points, debuggers, and tools to optimise the performance of developed vApps.
- “A Novel Approach to Software Development in the Microservice Environment of vf-OS” describes the vf-OS approach consisting of Docker-based microservices, orchestrated through common REST services with special attention given to the challenge of running resources OnPremise versus purely InCloud.

1.4 Conclusions

The most important aspects were covered during the first year of the vf-OS project development. Those aspects were continuously and consistently being addressed by the technical developers at the vf-OS consortium. They present a variety of solutions for the identified problems presenting in the first section. The workshop served the aims to present those developments to the community, providing a space for debate for both: the project partners and the community, and capture comments and contributions from the workshop attendees. It is aimed to present further developments at the next workshop with next stage evolution of the work currently being performed at vf-OS Project. To find more about the atmosphere of I-ESA workshop a set of related pictures are available at Annex I:. Because of this workshop a cooperation with NIST of USA was established where the specific outcomes from it will be reported in WP10 as a dissemination activity.

2 Connected Smart Factories Workshop @ IEEE-IS2018

The Connected Smart Factories Workshop (26th – 27th September 2018) was organised alongside the IEEE-IS2018 conference in Madeira conducted and reported by Usman Wajid from the Information Catalyst and Marc Jentsch from the Fraunhofer FIT Institute. 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, which details about its challenges and features are presented in the next sections:

- Enabling Collaborations (Matchmaking, Automated Negotiations, Process Orchestration)
- Smart Tools (Digital Manufacturing, Smart Factory, IoT)
- Big Data Management (Interoperability, Analytics)
- 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. Further information about the workshop program and its details is reported in Annex J:. Some notes reporting the main discussed topics are presented at Annex K:.

2.1 Enabling Collaborations

Within this thematic area the presentations (Annex L:) 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?

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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

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.

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.

2.2 Smart Tools

Within this thematic area the presentations (Annex L:) 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 interoperability 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 (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 eg, 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.

2.3 Big Data Management

Within this thematic area the presentations (Annex L:) 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 Harmonisation: 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. 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.

2.4 Business Modelling

Within this thematic area the presentations (Annex L:) 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. Annex L: provides more detailed information about different presentations performed in the vf-OS workshop.

2.5 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 (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 harmonisation 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. Annex M: illustrates this workshop atmosphere with some pictures.

*The authors would like to thank the following workshop chairs for their contributions: Violeta Damjanovic- Behrendt (SRFG), Wernher Behrendt (SRFG), Gash Bhullar (C2K), Eduardo Saiz (IKER), Carlos Agostinho (KBZ).

Annex A: History

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<tr><th colspan="2">Document History</th></tr>
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V0.2:
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V0.3:
Input inserted related to section2 2
V0.4:
Input inserted related to sections 1 and others</td></tr>
<tr><td>Contributions</td><td>UPV:
Raul Poler – Document Structure and 1st Workshop contents
UNINOVA
Joao Sarraipa – Main Editor
Fernando Ferreira – Document Structure; Sections 1
Elsa Jesus - Other sections
ICE
Usman Wajid – Workshop #2 related contents
Oscar Garcia – Internal review
IKERLAIN
Eduardo Saiz – Input related to Workshop #2
KBZ
Carlos Agostinho – Workshop #2 notes</td></tr>
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Annex B: References

There are no external references in this document.

Annex C: I-ESA’18 Call for Workshops Proposals

This annex presents the I-ESA’18 Conference Call for Papers, Call for Workshops Proposals and Call for Doctoral Symposium.

9th international I-ESA conference 2018

i-ESA 2018

Call for Papers

March 22nd -23rd

Pre-conference:
March 19th - 21st

Smart Services and Business Impact of Enterprise Interoperability

We invite papers for the 9th I-ESA conference on INTEROPERABILITY for ENTERPRISE SYSTEMS and APPLICATIONS. IESA attracts researchers, technologists and scientists from around the world to discuss latest developments in Enterprise Interoperability. Join us for technological breakthroughs, outstanding solutions and setting new standards in Interoperability. Be part of the world's leading community of Interoperability and hand in your paper now.

www.i-esa.org

The programme includes research paper presentations, prominent international keynote speakers, a Doctoral Symposium as well as pre-conference workshops. Best Paper awards will be given. Other notable papers will be published in renowned journals while all accepted papers will be released in the conference proceedings.

Scope "Interoperability" has been defined by INTEROP-VLab as "The ability of an enterprise system or application to interact with others at a low cost in a flexible approach". Being able to interoperate in collaborations is a step further for enterprises to react flexibly and efficient to market demands, building up consistent and fundamental internal structures and competences and being adaptive in a highly competitive market.

Topics

- Business Interoperability
- Future Internet and Digital Data Space
- Services for Enterprise Interoperability and Digital Twins
- Privacy, Security and blockchain in Enterprise Interoperability

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- Interoperability in Industry 4.0
- Interoperability in Industrial Automation
- Platforms and infrastructures for Enterprise Interoperability

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- Enterprise Modelling for Enterprise Interoperability
- Ontology and Semantics for Enterprise Interoperability
- Architectures and Frameworks for Interoperability
- Interoperability Application Scenarios
- Standards for Interoperability
- Education on Enterprise Interoperability

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(Bremen Univer. BIBA)

Vice-Chair
Prof. Raul Poler
(Univer. Politècnica Valencia (ES))

Best Paper Award

Most Innovative Solution Award

Key Dates

Conference *March 22nd to March 23rd, 2018*

Early bird discount* full paper submission due:	September 15th, 2017
Full paper submission deadline:	September 30th, 2017
Author notification due:	November 15th, 2017
Camera-ready copies due:	December 15th, 2017

Workshops *March 20th to March 21st, 2018*

Early-Bird discount* proposals submission due:	October 15th, 2017
Deadline for proposals:	November 4th, 2017
Acceptance notification due:	November 16th, 2017
Deadline for papers:	January 31st, 2018
Camera-ready copies due:	April 30th, 2018

Doctoral Symposium *March 19th, 2018*

Paper submission deadline:	November 30th, 2017
Author notification due:	December 15th, 2017

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Registration Fees

	Early Bird	Regular (from Jan 16th 2018)
Conference & Workshop	530€	680€
Conference	450€	600€
Workshop	150€	300€

Students

	Early Bird	Regular (from Jan 16th 2018)
Conference & Workshop	430€	530€
Conference	350€	450€
Workshop	50€	150€

*** There will be an extra 15% discount of registration fees if a conference paper is submitted before September 15th 2017 and finally accepted for the conference or if a workshop proposal is submitted before October 15th 2017 and finally accepted for the workshops.**

Venue The conference will be held at the Fraunhofer Institute for Production Systems and Design Technology, which conducts applied research and development across the whole process spectrum of manufacturing industry. It is located in Germany's famous capital **Berlin**, well known for its memorials, rivers, lifestyle, and creative-scene, but even more so for the amount of entrepreneurship and progress that is taking place in the ever growing city of innovation. Being a place of both historical significance and modernity makes up the unique feeling Berlin has today.

A conference of

InterOP - VLab DFI

Local organizer

Fraunhofer IPK

Annex D: I-ESA'18 vf-OS Workshop Proposal

This annex presents the Workshop proposal prepared at vf-OS Project and sent to the I-ESA'18 organisers.

I-ESA 2018

CALL FOR WORKSHOP PROPOSALS

I-ESA 2018 invites proposals for workshops to be held in conjunction with the main conference. The workshops are focused-on recent research and industry issues. The workshop topics are very close to those of the conference, but should be more oriented on project results. The particular goal is to facilitate an active exchange between the speakers and the audience in order to encourage further research and to publish the discussion outcomes in the proceedings. Workshops should also provide opportunities to promote the results of past or present International, European and national research projects in order to facilitate the exploitation of these results.

Suggested workshop topics (other relevant topic proposals would be welcomed):

- Funded collaborative projects (international, national or European),
- Application domains of Enterprise Interoperability research (Product Life Cycle Management and product-service integration, Industry 4.0, risk management, e-health, Smart Cities etc.),
- Research in Next Generation Enterprise Modelling: Semantic interoperability models for configurable manufacturing systems
- Design of Integrated Enterprise Models for industry use (case based team workshop)
- BigData interoperability and Cloud technologies
- Standardisation for sustainable interoperable systems , standards management, open standards

Important dates for the workshops

- Workshop proposals: **November 4 , 2017**
- Acceptance notification due: **November 16 , 2017**
- Workshop deadline for draft papers: **December 15, 2017**
- Workshop content publication: **January 19, 2018**
- Final daft papers due **March 6, 2018**
- Workshops **March 20 – 21, 2018**
- Publication of Proceedings **June 20, 2018**

Please send your proposal by e-mail to the Workshop Chair ws-chair@i-esa.org

<table>
<tr><th colspan="2">Template to describe a Workshop proposal (2-3 pages)
I-ESA 2018</th></tr>
<tr><td>1. Workshop title</td><td>Virtual Factory Operating System</td></tr>
<tr><td>2. Information about the organiser (s)

Please include name and contact details of each organizer, and indicate his/her relevant background and area of interest.</td><td>Name: Poler
First name: Raul
Organisation: Universitat Politècnica de València
Sector activity: Research & Education
Country: Spain
Email: rpoler@cigip.upv.es
Phone number: +34629046988
Research interests and areas of expertise: Enterprise Modelling, Collaborative Networks, Supply Chain Management, Knowledge Management, Production Planning and Control, Decision Support Systems, Evolutionary Algorithms.

Name: Gonçalves
First name: Ricardo
Organisation: UNINOVA
Sector activity: Research & Education
Country: Portugal
Email: rg@uninova.pt
Phone number: +351212948300
Research interests and areas of expertise: Data Acquisition Systems, Architectures for Systems Integration, and Complex Systems Interoperability.</td></tr>
<tr><td>3. Objective of the workshop, goals, content and topics covered</td><td>Virtual Factory Open Operating System (vf-OS) is a H2020 project funded under the topic FoF-11-2016 "Digital Automation" subtopic “Collaborative Manufacturing and Logistics” started in October 2016, 3 year of duration. The objective of this workshop is to show the research performed in the project during its first year and to contrast with the research performed in other H2020 projects, academia and industry.

vf-OS goal will offer a manufacturing orientated cloud platform, supporting a multi-sided market ecosystem that provides a range of services for the connected factory of the future, allowing manufacturing companies to develop and integrate better manufacturing and logistics processes including the building of vf-OS applications on top of its vf-OS platform.

Topics covered:
- Cloud Manufacturing
- Enterprise Apps
- Cloud Computing
- Interoperability
- Data Analytics
- Operating System Virtualisation
- Multi-sided Platforms
- Virtual Factory Data and Connect
- Internet of Things
- Virtual Factory Middleware</td></tr>
</table>

4. Format (draft) *Number of speaker s/ papers, invited presentations or panels, discussions, debates, Other methods to encourage communication and consensus?* *Half-day or full day?*	Number of speakers: 6 Presentations duration: 30 minutes each Discussions and debates duration: 30 minutes Total duration of the workshop: 3,5 hours Half-day
5. Publicity *How will the WS be advertised?*	At the vf-OS project Website, Facebook and Linkedin sites as well as Through the Connected Factory CSA
6. Audience *How many participants are expected and what is their background?*	30 participants Business processes modellers, software architects, software analysts, software developers
7. Workshop call for papers (tentative) *with the proposed members of the Program Committee. Workshop organisers have to set up a peer review of the proposed papers*	*Members of the Program Committee: Stuart Campbell, Raul Poler, Ricardo Gonçalves, Eduardo Saiz, Nejib Moalla, Raquel Almeida* **Call for Workshop Papers** **Workshop:** **Cloud Collaborative Manufacturing Networks** ***Workshop Chairs*** • **Raul Poler, Ricardo Gonçalves** You are cordially invited to participate to the Workshop ***"Virtual Factory Operating System"*** in the **International Conference on Interoperability for Enterprise Systems and Applications I-ESA 2018**. Since several years, I-ESA is the major event regarding Enterprise Interoperability and the official conference of Virtual Laboratory for Enterprise Interoperability (INTEROP-VLab) with the sponsorship of the International Federation for Information Processing (IFIP). Accepted and presented papers will be published by ISTE Publications UK. ***Objectives*** Virtual Factory Open Operating System (vf-OS) is a H2020 project funded under the topic FoF-11-2016 "Digital Automation" subtopic "Collaborative Manufacturing and Logistics" started in October 2016, 3 year of duration. The objective of this workshop is to show the research performed in the project during its first year and to contrast with the research performed in other H2020 projects, academia and industry. ***Topics*** Cloud Manufacturing, Enterprise Apps, Cloud Computing, Interoperability, Data Analytics, Operating System Virtualisation, Multi-sided Platforms, Virtual Factory Data and Connect, Internet of Things, Virtual Factory Middleware. ***Paper Submission*** Papers must be in English, describes original work and must follow the ISTE guidelines for authors. Paper length should be 6 pages for a full paper and 4 pages for a short paper. The selection of the paper will be performed based on the abstract and not on the full paper.

	Authors should submit their contributions by email to the Workshop Chairs: rpoler@cigip.upv.es, Stuart.Campbell@informationcatalyst.com, rg@uninova.pt ***Key Dates*** **15th December 2017** First draft paper submission 19th January 2018 Notification of acceptance 6th March 2018 Final draft paper submission 20th, 21st March 2018 I-ESA 2018 Workshops 30th April 2018 Camera-ready 20th June 2018 Publication of Proceedings Please, consider that **at least one author per paper must register** to the Workshops by **January 15th, 2018**. If none of the authors is registered, the paper will not be included in the workshop programme and in the proceedings. ***Further Information about this Workshop*** Enquiries to: Raul Poler (rpoler@cigip.upv.es) ***Further Information about Conference*** Website: www.i-esa.org

Please note that Workshop papers must be **no longer than <u>6 pages</u>**.

Annex E: I-ESA'18 vf-OS Workshop Call for Papers

This annex shows the vf-OS Workshop Call for Papers in the frame of the I-ESA'18 Conference.

Call for Workshop Papers

Workshop:

Virtual Factory Operating System

Workshop Chairs

- **Raul Poler, Ricardo Gonçalves**

You are cordially invited to participate to the Workshop ***"Virtual Factory Operating System"*** in the **International Conference on Interoperability for Enterprise Systems and Applications I-ESA 2018**. Since several years, I-ESA is the major event regarding Enterprise Interoperability and the official conference of Virtual Laboratory for Enterprise Interoperability (INTEROP-VLab) with the sponsorship of the International Federation for Information Processing (IFIP).

Accepted and presented papers will be published by ISTE Publications UK.

Objectives

Virtual Factory Open Operating System (vf-OS) is a H2020 project funded under the topic FoF-11-2016 "Digital Automation" subtopic "Collaborative Manufacturing and Logistics" started in October 2016, 3 year of duration. The objective of this workshop is to show the research performed in the project during its first year and to contrast with the research performed in other H2020 projects, academia and industry.

Topics

Cloud Manufacturing, Enterprise Apps, Cloud Computing, Interoperability, Data Analytics, Operating System Virtualisation, Multi-sided Platforms, Virtual Factory Data and Connect, Internet of Things, Virtual Factory Middleware.

Paper Submission

Papers must be in English, describes original work and must follow the ISTE guidelines for authors. Paper length should be 6 pages for a full paper and 4 pages for a short paper. The selection of the paper will be performed based on the abstract and not on the full paper.

Authors should submit their contributions by email to the Workshop Chairs:
rpoler@cigip.upv.es, rg@uninova.pt

Key Dates

15th December 2017	First draft paper submission
19th January 2018	Notification of acceptance
6th March 2018	Final draft paper submission
20th, 21st March 2018	I-ESA 2018 Workshops
30th April 2018	Camera-ready
20th June 2018	Publication of Proceedings

Please, consider that **at least one author per paper must register** to the Workshops by **January 15th, 2018**. If none of the authors is registered, the paper will not be included in the workshop programme and in the proceedings.

Further Information about this Workshop
Enquiries to: Raul Poler (rpoler@cigip.upv.es)

Further Information about Conference
Website: www.i-esa.org

Annex F: I-ESA'18 Workshops Programme

This annex provides the I-ESA'18 Workshops Programme, including the vf-OS Workshop with code A3 and scheduled by Wednesday, March 21st 9:00 to 13:00.

I-ESA 2018 (9TH INTERNATIONAL CONFERENCE)

INTEROPERABILITY FOR ENTERPRISE SYSTEMS AND APPLICATIONS

Smart Services and Business Impact of Enterprise Interoperability

I-ESA 2018
The International Conference on Interoperability for Enterprise Systems and Applications
Smart Services and Business Impact of Enterprise Interoperability

BERLIN, Germany
Pre-Conference:
19th March 2018 (Doctoral Symposium)
20th - 21st March 2018 (Workshops)
Conference: 22nd – 23rd March 2018

I-ESA 2018 Workshop Programme

Workshop A1	**From Embedded Intelligence to Directed Manufacturing Decision Support**
Organisers	Bob Young and Gash Bhullar
Papers and authors	Exploiting embedded intelligence in manufacturing decision support *Paul Goodal, Heinz Lugo, Richard Sharpe, Kate Van-Lopik, Sarogini Pease, Andrew West and Bob Young* Test of Industrial IoT – Open the Blackbox *Frank-Walter Jaekel and Jan Torka* Intelligent Decision Support Systems in Supply Chains: requirements identification *Eduardo Saiz, Raul Poler and Beatriz Andres* A Total Solution Providers' perspective on Embedded Intelligence in Manufacturing Decision Support Systems *Gash Bhullar*

Workshop A2	**Business impact of applications of Enterprise Interoperability**
Organiser	Frank-Walter Jaekel
Papers and authors	Enterprise Interoperability Management and Artifacts *Frank-Walter Jaekel* Challenges for adaptable energy-efficient production processes *Marc Allan Redecker, Alena V. Fedotova, Kay Burow, Quan Deng, Marco Franke, Zied Ghrairi and Klaus-Dieter Thoben* Interoperability Requirements for Adaptive Production System-of-Systems *Georg Weichhart and Alexander Egyed* Platforms for the Industrial Internet of Things: Enhancing Business Models through Interoperability *Soto Setzke, Nocolas Scheidl, Tobias Riasanow, Markus Böhm, and Helmut Krcmar*

Workshop A3	**Virtual Factory Operating System (vf-OS)**
Organisers	Raul Poler and Ricardo Gonçalves
Papers and authors	Vf-OS Architecture *Danny Pape, Tobias Hinz, Oscar Garcia Perales, Francisco Fraile, José Luis Flores and Oscar J. Rubio* Enablers Framework: an approach to develop applications using FIWARE *Pedro Corista, Joao Giao, Joao Sarraipa, Raquel Almeida, Oscar G. Perales and Néjib Moalla* Vf-OS Toolkit *Victor Anaya, Nejib Moalla, Ludo Stellingwerff, José Luis Flores and Francisco Fraile* Data management component for Virtual Factories Systems *Artem A. Nazarenko, Joao Giao, Joao Sarraipa, Oscar J. Saiz, Oscar G. Perales and Ricardo Jardim-Gonçalves* An Open Environment for Development of Manufacturing Applications on vf-OS *Carlos Coutinho, Luís Lopes, Vítor Viana, Danny Pape, Gerrit Klasen, Bastianvon Halem, Ludo Stellingwerff and Andries Stam* A novel approach to software development in the microservice environment of vf-OS *Luís Manteigas da Cunha, Ludo Stellingwerff and Andries Stam Almende BV*

Workshop A4	**Corporate Standardisation Management**
Organisers	Kai Jakobs and Martin Zelm
Papers and authors	Standardization: A multi priority approach *Eitan Naveh* Why Interoperability R&D Needs to be Driven by Agile Integration Standards? *Nenad Ivezic* Managing IT Standardization in Government Towards a Descriptive Reference *Dian Balta* Review: What are Strategies for and Benefits of effective IT Standardization in Government? *Dian Balta* Licensing terms for IoT standard-setting: Do we need “end-user” or “licence for all” concepts? *Matt Heckman*

Workshop B1/B2	**Industrial big data platforms enabling enterprise interoperability for smart services** (Full day workshop)
Organisers	Marten van Sinderen and Sergio Gusmeroli
Papers and authors	Semantic interoperability for the Internet-of-Things: performance analysis of JSON for Linked Data *João Moreira, Marten van Sinderen, Luís Ferreira Pires and Patricia Dockhorn Costa* FIWARE for INDUSTRY: a data-driven Reference Architecture *Stefano de Panfilis, Ernoe Kovacs, Sergio Gusmeroli, Jorge Rodriguez and Jesus Benedicto* European Big Data Value Association Smart Manufacturing Industry position paper *Anibal Reñones, Davide Dalle Carbonare and Sergio Gusmeroli* Big data platform architecture for synchromodal transport *Prince Singh and Marten van Sinderen* Contextual Data Analytics for Multivariate Anomaly Detection: an Industrial Use Case *Nenad Stojanovic. Pierluigi Petrali, Marko Dinic and Claudio Turrin* Fault Prediction in Aerospace Product Manufacturing: development of a model-based Big Data analytics service *Anna Maria Crespino, Marianna Lezzi, Carla Di Biccari and Mariangela Lazoi* A SAREF extension for semantic interoperability in the Industry and Manufacturing domain *Laura M. Daniele Matthijs Punter, Raúl García Castro, María Poveda and Alba Fernandez* Towards BIM-centred big data platform to support digital transformation of the AEC industry *Yvar Bosdriesz, Marten van Sinderen, Maria Iacob and Pieter Verkroost* Developing, Deploying and Experimenting with Industrial Big Data Platforms for Smart Furniture Product-Service Design *Fenareti Lampathaki, Evmorfia Biliri, Ariadni Michalitsi-Psarrou, Angelos Arvanitakis, Javier Martin, Fernando Gigante, Vicente Sales and Maria Jose Nuñez* IoT Service-Based Machine: a data integration infrastructure for IoT applications *Helder Oliveira Gomes Filho, José Gonçalves Pereira Filho and João Luiz Rebelo Moreira* RS4IoT - A Recommender System for IoT *Caio Martins Barbosa, Roberta Lima Gomes, José Gonçalves P. Filho and João Luiz Rebelo Moreira*

Workshop B3	**Predictive Maintenance in Industry 4.0: Methodologies, tools and interoperable applications**
Organisers	Gregoris Mentzas, Karl Hribernik, Klaus-Dieter Thoben, Dimitris Kiritsis and Ali Mousavi
Papers s and author	Maintenance planning support tool based on condition monitoring with semantic modelling of systems and their healthy/deteriorated signature *Alice Reina, Gökan May, Eva Coscia, Sang-Je Cho, Jacopo Cassina and Dimitris Kiritsis* A Morphological and Process-based Model for Digital Assisted Maintenance *Klaudia Kovacs, Fazel Ansari, Claudio Geisert, Eckart Uhlmann, Robert Glawar and Wilfried Sihn* The ProaSense Platform for Predictive Maintenance in Automotive Lighting Equipment Industry *Alexandros Bousdekis, Babis Magoutas, Dimitris Apostolou, Gregoris Mentzas and Primoz Puhar* Standards as critical means of integration of advanced maintenance approaches to production systems *Yves Keraron* How to use sensor data for predictive maintenance of a complex transportation asset *Bernd Bredehorst, Olaf Peters, Jeroen Versteeg, Markus Neuhaus and Carl Hans* On-board Model-of-signals approach for condition monitoring in automatic machines *Matteo Barbieri, Alessandro Bosso, Christian Conficoni, Matteo Sartini, Roberto Diversi and Andrea Tilli* Predictive maintenance framework: Implementation of local and cloud processing for multi-stage prediction of CNC machines health *Panagiotis Aivaliotis, Konstantinos Georgoulias, Raffaele Ricatto and Michele Surico* DRIFT Data-Driven Failure Mode, Effects, and Criticality Analysis (FMECA) Tool *Davide Zanardi and Manuele Barbieri* SERENA: Versatile plug-and-play platform enabling remote predictive maintenance *Sotirios Makris, Nikolaos Nikolakis, Konstantinos Dimoulas, Apostolos Papavasileiou and Massimo Ippolito* Approach for real-time predictive maintenance based on complex event processing *Klaus-Dieter Thoben, Abderrahim Ait-Alla, Marco Franke, Karl-A Hribernik, Michael Lütjen and Michael Freitag*

Workshop B4	**Industry 4.0 Qualification - Higher Education for the Era of Industry 4.0**
Organisers	Moritz von Stietencron, Gabriele Monteliscani and Gualtiero Fantoni
Papers and authors	Evaluation of Industry 4.0 Technology Applications *Moritz von Stietencron, Bjørnar Henriksen, Carl Christian Røstad, Karl Hribernik, Klaus-Dieter Thoben* A software application enhancing the workforce skills and competencies within Industry 4.0 *Enrico G. Caldarola, Gianfranco E. Modoni* Improving the efficiency of industrial processes with a plug and play IOT data acquisition platform *Daniele Mazzei, Gabriele Montelisciani, Giacomo Baldi, Andrea Baù, Gualtiero Fantoni* Knowledge transfer from students to companies: understanding industry 4.0 readiness levels

	Leonello Trivelli, Simona Pira, Gualtiero Fantoni and Andrea Bonaccorsi Going beyond technology: Can organizational foresight maturity reinforce Industry 4.0 uptake among SMEs? Anna Sacio-Szymańska, Anna Kononiuk, Stefanie Ollenburg, Gualtiero Fantoni
Workshop C2	**Modelling & Simulation to design Advanced Manufacturing System**
Organisers	Guy Doumeingts, Carlos Agostinho, Gregory Zacharewicz, Yves Ducq and Amir Pirayesh
Papers and authors	Developing an Enterprise Modelling Ontology *David Chen* Model Driven Requirements Elicitation for Manufacturing System Development *Amir Pirayesh, Guy Doumeingts, João Sousa, Carlos Agostinho, Cristiano Fertuzinhos* A Comprehensive Architecture to Integrate Modelling and Simulation Solutions in Cyber Physical Production Systems *Carlos Agostinho, Jose. Ferreira, Sudeep Ghimire, Grégory Zacharewicz, Guy Doumeingts* Modelling and Simulation of Decision Systems *Raul Poler, Beatriz Andres, Guy Doumeingts, Amir Pirayesh*

Workshop C3	**Method and Tools to support the development of Product Service System**
Organisers,	Guy Doumeingts, Sergio Gusmeroli, *Amir Pirayesh* and Giuditta Pezzotta
Papers and authors	Identify new PSS Concepts: The Product Service Concept Tree tool; *Guiditta Pezzotta, Fabiana Pirola, Roberto Sala, Antonio Margarito, Paulo Pina, Rui Neves-Silva* Product Service System (PSS) Innovation Process; *Amir Pirayesh, Guy Doumeingts, Marco Seregni, Maria Jose Núñez Ariño, Carl Hans* Technological and Organisational Pathways towards 2030 Product-Service Factories of the future *Chris Decubber, Sergio Gusmeroli, Domenico Rotondi, Luis Usatorre, Michele Sesana, Fenareti Lampathaki, Mike Freitag, Guy Doumeingts* *A Circular Engineering and Product Service Systems in the Machine Tool Sector: The PSYMBIOSYS approach* *Nerea Sopelana, Lara Gonzalez, Rikardo Minguez, Andoni Laskurain, Oscar Lazaro*

Workshop C4	**Interoperability for Crisis Management: Increasing Resilience of Smart Cities (ICRIM 2018)**
Organisers	Antonio de Nicola and Frederick Benaben
papers and authors	Assessment of Climate Change-Related Risks and Vulnerabilities in Cities and Urban Environments *Jingquan Xie* Semantic interoperability of Early Warning Systems: a systematic literature review *João Moreira, Luís Ferreira Pires and Marten van Sinderen* Towards Semantic Generation of Geolocalized Models of Risk *Alex Coletti, Antonio de Nicola, Antonio di Pietro, Maurizio Pollino, Vittorio Rosato, Giordano Vicoli, Maria Luisa Villani* An Ontology-based Operational Emergency Response System for Interoperability in a Crisis Situation: POLARISC *Linda Elmhadhbi, Mohamed-Hedi Karray and Bernard Archimède* Analysing Interoperability in a Non-Functional Requirements Ecosystem to Support Crisis Management Response *Nicolas Daclin, Behrang Moradi, Vincent Chapurlat*

Tuesday, March 20th

	Room	
08:00 AM	Foyer	Reception
08:45 AM	001	Opening

	Track A Room 360	Track B Room 307	Track C Room S_105
09:00 AM 10:30-11:00 AM Break Foyer	A1: From Embedded Intelligence to Directed Manufacturing Decision Support *R. Young, G. Bhullar*	B1: Industrial big data platforms enabling enterprise interoperability for smart services, (Full day) *M. vSinderen, S. Gusmeroli*	
1:00 PM	Testing area	Lunch	
2:00 PM 4:00-4:30 PM Break Foyer End: 6 PM	A2: Business impact of applications of Enterprise Interoperability *F-W. Jaekel*	B2: Industrial big data platforms enabling enterprise interoperability for smart services, (Full day) *M. vSinderen, S. Gusmeroli*	C2: Modelling & Simulation to design Advanced Manufacturing System *G. Doumeingts et al*

Wednesday, March 21st

	Track A Room 360	Track B Room 307	Track C Room S_105
09:00 AM 10:30-11:00 AM Break Foyer	A3: Virtual Factory Operating System, *R. Poler, R. Goncalves*	B3: Predictive Maintenance in Industry 4.0: Methodologies, tools and interoperable applications *G. Mentzas et al*	C3: Method and Tools to support the development of Product Service System *G. Doumeingts et al*
1:00 PM	Testing area	Lunch	
2:00 PM 4:00-4:30 PM Break Foyer End: 6 PM	A4 : Corporate standardisation management *K. Jakobs, M. Zelm*	B4: Industry 4.0 Qualification - Higher Education for the Era of Industry 4.0 *M. vStietencron et al*	C4: Interoperability for Crisis Management: Increasing Resilience of Smart Cities *A. de Nicola, F. Benaben*

Annex G: I-ESA’18 vf-OS Workshop Papers

This annex provides the authors version of the 6 papers presented at I-ESA’18 vf-OS Workshop. All received papers were reviewed by two reviewers who provides feedback to the papers authors to improve it.

1

Virtual Factory Operating System

World is facing the fourth industrial revolution based on ICT, specifically architectures and services, as key innovation drivers for manufacturing companies. Traditional factories will increasingly be transformed into smart digital manufacturing environments. Currently, however, the full potential for ICT in manufacturing is far from being fully exploited. Factories are complex systems of systems and there is a need to develop a platform on which future manufacturing applications can be built.

European SMEs’ needs around ICT solutions are far off to be satisfied at affordable cost and time, some are: to reduce integration overheads for ICT, to provide mobile devices that are intuitive, to provide traceability from cradle to grave through the supply chain and to facilitate monitoring, optimisation and predictive maintenance to enhance availability and productivity.

Over the last decades, manufacturing companies have been implementing point-solutions, each bringing a specific feature or fixing a specific issue. Resulting from this approach is a highly heterogeneous manufacturing IT landscape. While these IT landscapes are already costly to administer, further addition of capabilities becomes even more costly because they have to be fitted into the heterogeneous IT landscape already existing. There is a need for homogeneous manufacturing IT landscape offering manufacturing IT solutions, to support manufacturing companies, especially SMEs, for successfully responding to the challenge to be flexible and offer highly customized products, and without daunting implementation costs, thereby maintaining and boosting their competitiveness locally and in the increasingly globalized markets they participate in.

Chapter written by Raul POLER and Ricardo JARDIM-GONÇALVES

As an answer to these needs a H2020 European project called "Virtual Factory Open Operating System" (vf-OS) funded under the topic FoF-11-2016 "Digital Automation" subtopic “Collaborative Manufacturing and Logistics” started in October 2016 with 3 year of duration. The aim of this workshop was to show the research performed in the project during its first year. Six papers have been presented at the vf-OS workshop:

“vf-OS Architecture”: This paper describes the vf-OS software architecture. Information and requirements of the real world are included in the structural planning of the complex software system.

“Enablers Framework: an approach to develop applications using FIWARE”: This paper proposes the Enablers Framework, a component of vf-OS project that acts as a bridge between applications and enablers, granting programmers an easy access to the services they need.

“vf-OS IO Toolkit”: This paper describes the IO Toolkit, which provides tools for on-premises facilitating the access to manufacturing devices and existing business software, while also facilitating the interaction with the rest of the vf-OS infrastructure.

“Data Management Component for Virtual Factories Systems”: This paper envisages the vf-OS middleware platform and the Data Management Component for covering the issues related to data handling, pre-processing, extracting, and data flows management for Virtual Factories.

“An Open Environment for Development of Manufacturing Applications on vf-OS”: This paper describes a novel environment that was envisioned for providing to software developers an advanced editor with syntax highlighting, providing a large set of artifacts and libraries including standard connectors and extension points, debuggers, and tools to optimise the performance of developed Apps.

“A novel approach to software development in the microservice environment of vf-OS”: This paper described the vf-OS approach consisting on "Docker"-based microservices, orchestrated through common REST services with special attention given to the challenge of running resources OnPremise versus purely InCloud.

"Virtual Factory Operating System" workshop chairs kindly acknowledge all the members of the program committee. In particular, they thank Stuart Campbell, Eduardo Saiz, Nejib Moalla and Raquel Almeida for their support in the scientific success of the event. The research leading to the results presented in this workshop papers has received funding from the European Union H2020 Program under grant agreement No. 723710 "Virtual Factory Open Operating System" (vf-OS).

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1

vf-OS Architecture

This paper discusses the software planning of the Industry 4.0 project vf-OS. Information and requirements of the real world are included in the structural planning of the complex software system. The waterfall model is used, in which several phases of the planning build on each other. Starting with the system architecture, the individual components are defined in vf-OS and the individual connections to each other and to the outside world are specified. The application of various technical solutions is also dealt with in this phase. Based on this, the functional and technical specifications were drawn up, which describe the internal processes in more detail and also define the communication level. In today's industry 4.0 the emphasis is on security, since sensitive data in particular must be protected and the risk of abuse has increased as a result of the connection of industrial processes to the Internet. In order to minimize or avert these dangers, vf-OS has developed a concept for security and privacy that lists the main sources of danger and their solutions.

1.1. Global Architecture Definition

vf-OS is using a Service Oriented Architecture (SOA) approach in which the different vf-OS components implement individual functionalities and thus the composition of all these inter-related components form the complete vf-OS architecture to ground the vf-OS ecosystem. In order to apply this approach, all components implement and publish a REST interface allowing the exchange of data (primarily) with the messaging bus to be implemented within the project. vf-OS will support Event Driven SOA features so that the different components can decide their interaction pattern and react to internal and external events. Following this approach,

Chapter written by Danny PAPE, Tobias HINZ, Oscar GARCIA PERALES, Francisco FRAILE, José Luis FLORES, and Oscar J. RUBIO the components of vf-OS can behave either as services or as event producers and consumers.

The diagram in Figure 1 provides an overview of the high-level architecture of vf-OS and provides a formal split of functional components. This diagram classifies the components based on their role to vf-OS (design, runtime, etc.) and its relationship with external resources. The "Kernel box", situated at top-left of the diagram, indicates that all the components marked with the same color can be deployed within the vf-OS Kernel when vf-OS is installed as an OnPremise solution.

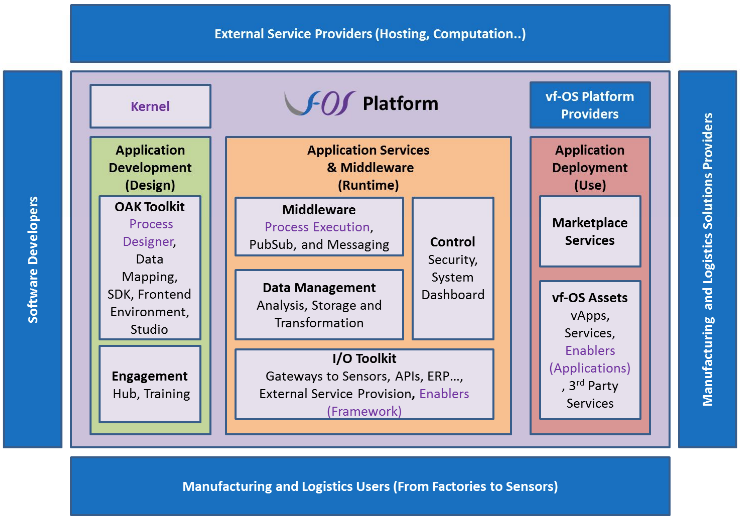

Figure 1. *vf-OS Global Architecture Definition*

Thus, the architectural building blocks are the following:

– Environment Block: The vf-OS Platform acts as an executing environment of vf-OS architecture. It acts as a container, which includes all other components.

– Application Development Block aka design time comprises the different vf-OS components that will be used for the development of vf-OS Manufacturing Assets/vApps.

– Application Services & Middleware Block aka Runtime includes the vf-OS components that will be used by the Assets/vApps, when they are requesting vf-OS resources.

– Application-Deployment Block includes all vf-OS components that will be taken into consideration when the vf-OS environment is going to be in use.

vf-OS Assets are the different elements that are executed within, or interacts with, the vf-OS ecosystem. Intrinsically speaking, a vApp (a Manufacturing Smart Application) is the first example of what a vf-OS Asset can be, but it is not the only one. As such, a vf-OS Asset consist of several Solution Building Blocks (SBB). In summary, the Solution Building Blocks are prioritized as follows:
FIWARE Enablers > Specific Enablers > Open Source Solutions > Existing Solutions > New Development.

1.2. Functional Specification

The functional specification describes how the vf-OS platform works from the perspective of the user. More specifically, for every component, the functional specifications contain a description of the functionality and behavior from the perspective of the user, the sequence of actions taking place during the execution of the component to satisfy its functionality and the mockups of the user interfaces that support the interactions with different vf-OS users.

The behavior and functionality of the components is described using story maps [PAT 14]. Story maps organize user stories for software development in a matrix, following the user workflow from left to right and the user priority from top to bottom. This visualization helps users and developers to build a common understanding on the behavior of the component and the expected functionality of the different software releases. User stories capture the functionality that needs to be developed with enough granularity to identify inconsistencies or overlapping of functionalities between components. The same methodology is applied to the pilot applications. This provides an effective feedback mechanism to from the pilots to the individual components.

The story maps are linked to UML sequence diagrams used to depict the interactions between components and to UI mockups that describe the interaction with users. This way, every activity in the story map sequence has a high level description of the interaction with external components and/or users.

Finally, the models used in the component and the inner interactions of the component are described using UML class diagrams and a detailed component architecture diagram to enrich the high-level description provided in the global architecture definition.

1.3. Technical Specification

The technical specification is the primary document detailing the communication amongst vf-OS components. It defines and describes the API endpoints and data models to be transferred in vf-OS. Therefore, it takes into account the knowledge of the Functional Specification and builds the foundation for development efforts.

The target group of the technical specification are developers who need to build software that interacts with vf-OS components. To ease this approach the outfacing interfaces of each component are accessible in a RESTful manner [RIC 08]. An online documentation tool has been used to do this where each vf-OS component describes its endpoints and data models. This approach keeps the documentation flexible and update-able for later use during the development or if there need to be changes in a later phase.

To provide all information needed by the developer each API endpoint is separated into three parts:

– Description: API endpoints are introduced with a short description to show the purpose of the related endpoint.

– Request: contains the endpoint URI and the necessary parameters (information and data) to be transmitted to the endpoint component for a successful response

– Response: describes both cases of responses (success and error). In case of success, it describes the expected data and the corresponding standardized HTTP status code (e.g. HTTP/1.1 200 OK), in case of an error a description is returned including a HTTP status code (e.g. HTTP/1.1 404 Not Found).

1.4. Holistic Security and Privacy Concept

The main aim of the vf-OS infrastructure is to provide a set of information services enabling industrial processes. From the security point of view, protecting industrial processes is very challenging, due to the high economic incentives for hackers to interfere with them (e.g. stop, corrupt, spy). This has resulted in a rising wave of cyber-attacks (e.g. denial of service, ransomware, espionage) targeting industrial services. Therefore, the vf-OS infrastructure must be adequately protected before it is deployed in production. This is not a trivial task, since vf-OS is composed of a variety of inter-related components and services that may expose large attack surfaces.

Hence, guaranteeing continuous and appropriate availability, integrity and confidentiality (AIC) levels along the whole vf-OS infrastructure calls for a solid, holistic security and privacy model. This model elicits know-how from reference software development life cycles, applicable regulations (General Data Protection Regulations), key industrial IT standards (mainly ISA-62443) and recommendations from top-class security institutions (e.g. NSA, NIST). The objectives pursued are to minimize attack surfaces, maintain security risks at acceptable levels and keep security threats at bay, while minimizing the negative impact of security measures on the functionality and performance of vf-OS services.

– Mainly inspired by SELinux , NSA's Open Source Security Enhanced Linux, the vf-OS holistic security model integrates five simple, ruling principles:

– The security component shall act as a security proxy, intercepting, authenticating and authorizing all actions on the platform in order to guarantee the protection of the vf-OS resources.

– Following the example of Marketplaces such as Google Play or iOS Store, every external software development shall be provided as an Asset so that they can be examined and controlled in a uniform manner.

– Most security processes (credentials exchange, tokenisation, cryptographic verifications) are automated and transparent, but there may be humans in the loop. Particularly, the process of vApp installation will typically involve granting vApp access permissions (to resources) by the administrator(s) of the vf-OS Platform instance. These access permission policies are managed by using a central console.

– There is sandboxing by default. Any access (to a resource) that it is not explicitly permitted, because it has been authorised, is prohibited.

– Authorisation policies follow a mixed system based on Role-Based Access Control (RBAC) and Attribute-Based Access Control (ABAC) called RABAC model. This will be addressed by means of XACML, and can be extended to support ABAC as well.

The holistic security model envisioned above translates into a vf-OS security component, whose architecture is defined by the following components:

– A Primary Security Component: Comprised of a Security Command Center that concentrates the majority of security processes (authentication, authorization, and continuous security monitoring), an Installer Broker Service, to download and install vf-OS asset, an Identity Service to provide authentication, and an authorization Service to provide global security policies. This component is the main target for cyber-attacks and represents the largest attack surface.

– Marketplace Identity Manager, located in the vf-OS Marketplace, it is intended as the dependable source of applications, externals packages, components etc.

– Marketplace PKI, located in the vf-OS Marketplace, it carries out the creation, delivery, and renewal of digital certificates for vf-OS in order to guarantee the authenticity and authorship of the vf-OS Assets.

– OAK Studio/Toolkit. It includes a set of tools for assessing the security of any development following a Software Development Life Cycle.

– Engagement Hub. It is responsible for providing required security information to the OAK Studio. This service is focused on providing check lists, threats lists, etc.

1.5. Conclusions

This paper describes the overall architecture and the specifications of vf-OS which are needed for the subsequent programming work. It ensures that the selected vf-OS technologies fit the requirements and that interfaces for all vf-OS software components are defined. Important security and privacy issues are promoted to their own focused task as they are cross-cutting concerns which largely need to be fulfilled by all vf-OS software components but of course they will be integrated with the overall specification stack. With the following completed core phases of software planning, the programming work of the individual components can begin.

– Architecture to define relations and data streams between vf-OS components and excluding APIs.

– Functional specification to define and prioritize functionalities depending on the requirements analysis

– Technical specification to define the access rules of each component.

– Holistic Privacy and Security Concept to prevent the system for misuse.

1.6. Acknowledgements

The research leading to these results has received funding from the European Union H2020 Program under grant agreement No. 723710

1.7. References

[JAL 12] Jalote, P., *An integrated approach to software engineering*, Springer Science & Business Media, 2012.

[PAT 14] Patton, J., Economy, P., *User story mapping: discover the whole story, build the right product.* "O'Reilly Media, Inc.", 2014.

[RIC 08] Richardson, L., Ruby, S., *RESTful web services.* "O'Reilly Media, Inc.", 2008.

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Enablers Framework: an approach to develop applications using FIWARE

Industry is moving towards smart systems and automation, which leads modern factories to demand a set of tools capable of sustaining their needs. Generic and specifics sets of enablers, are emerging as core industry 4.0 components, as they provide the software services that factories of the future require. Although enablers can be at the FoF foundation, a system able to integrate them together in an interoperable way does not exist. To integrate the several enablers with their matching applications, it is necessary to create an adaptable system able to overcome this gap. This article proposes the Enablers Framework, a component of vf-OS project that acts as a bridge between applications and enablers, granting programmers an easy access to the services they need. This framework will thus open the possibility to several business opportunities to arise, since the integration of such versatile components is an alternative to the heterogeneous components used in the industrial panorama.

1.1. Introduction

The World is facing the fourth industrial revolution[1] based on ICT, specifically architectures and services, as key innovation drivers for manufacturing companies. Traditional factories will increasingly be transformed into smart digital manufacturing environments but currently, the full potential of ICT in manufacturing is far from being fully exploited. Factories are complex systems of systems and there is a need to develop a platform on which future manufacturing applications can be built. Examples of platforms exist in some industrial sectors but

Chapter written by Pedro CORISTA, Joao GIAO, Joao SARRAIPA, Oscar GARCIA PERALES and Nejib MOALLA

there is a lack of cross cutting platforms based on open standards for creating an ecosystem for cooperative innovation. The approaches that have been used in industry rely on point to point solutions that compete, by providing new specific features or fixing specific issues. Using these solutions result on having a highly heterogeneous industrial IT panorama, where each factory may have similar solutions with different architectures and programming languages. Having such heterogeneous solutions create problems on adapting current solutions from an existing factory to another, as a specific solution is developed to a specific end. There is the need for a homogeneous solution that allows to support the needs from manufacturing companies and fill current approaches' gaps, vf-OS (virtual factory Operating System) aims to be that solution. The goal of the vf-OS project is to develop an Open Operating System for Virtual Factories, responsible for managing factory related computer hardware and software resources and providing common services for factory computational programs. This system will be the component in a real factory system where all factory application programs will run. To fulfill this objective, the system must have a component which follows kernel's principles and logic. A kernel is a component that acts as a resource manager by taking care of the various programs that are running concurrently in the system [MAU 2008]. As seen in [GAR 2010] one of Kernel's functions is to interface all the applications, granting the bridge between them and the resources they need. Following this concept, vf-OS has a component called Enablers Framework (EF) that interfaces the applications (vApps) and the services they require. Such a component allows to integrate the necessary tools, without the user needing to experience the associated installation complexity. This paper proposes a definition for the EF. The first section highlights the EF's purpose and its role as a wrapper, it also explains and details its main components. The second section is related to the business opportunities that EF provides, considering software developers, manufacturing users and ICT providers.

1.2. Enablers Framework

EF is the component that acts as a bridge between service providers and service consumers. There already exist approaches to work with FIWARE, that allow to integrate enablers with applications, as seen in [COL 2015], EF aims to provide support for enabler integration and also installing and managing instances of an enabler. To understand the overall functionality of EF's, it was necessary to define what are the service providers for the applications that consume them (vApps).

The service providers were chosen from the set of solutions adopted from the FIWARE project [FIW 2018 a] and are classified as generic enablers (GE) or specific enablers (SE). GE can be found at [FIW 2018 b] and provide functionalities that ease the connection to the Internet of Things (IoT) technologies and devices, process data and media in real-time at large scale, perform Big Data analytics or incorporate advanced features for the interaction with users. SE can be found at [FIT 2018] and provide functionalities, which are more specific to the manufacturing domains such as manufacturing assets virtualization, collaborative manufacturing asset management, 3D scanning and virtualization, social data analysis, etc. Using the functionalities of the several GE and SE, a programmer can have a high range of tools that can act as core software components, while designing the vApps. How EF integrates the existing enablers is explained in the next sections.

1.2.1. EF as a bridge

The EF component, provides a solution for integration, exposition of and uniform access to functionalities of the different enablers in a single service-based component. The enablers, specifically GE and SE, can expose heterogeneous sets of service interfaces that could be used by vApp developers posing a need to understand and implement them. EF component acts as a wrapper engine for the different enablers and the vApps consume its services. Such an approach presents high interoperability advantages, as any enabler can be accessed through the platform, and integrated in any developed application. The developer doesn't have to worry about the enablers installation process in the target machine, as the EF oversees its whole process. This way he can focus on the development process, saving time and resources. The first step to use an enabler is to register it through EF's interface. From that moment on, the user can create an instance of the enabler and use it. The instantiation process allows users to choose whether the enabler instance is public or private.

The instance creation and installation are processed by creating a Docker container from an enabler image, as seen in [MER 2014]. To run an enabler on a personal computer or public server it is necessary to have access to its virtual instance. The Docker solution allows to instantiate enablers, following an approach similar to the one done in [STU 2015] for microservices, presenting an alternative to actual Virtual Machines (VM). Docker is a platform that lets the user run an application in an isolated environment meaning that it is possible to run multiple containers at the same time on the same host. Using such approach, it allows any enabler to be packaged into isolated containers with necessary code, runtime environment, system tools, system libraries and settings bundled all together. This strategy can lead towards the realization of efficient, lightweight, self-contained software packages and guarantees that software always runs the same way, regardless of where it is deployed. A Docker based approach secures the enablers instantiation, granting that all enablers can be installed, thus contributing to the integration process.

1.2.2. Component functionalities

After an instance is created, a user can access the enabler he needs through the EF. The access to each enabler is granted by following an approach analogous to proxy communication. Whenever an application needs a service it communicates with the framework, that contacts the corresponding enabler, performing the necessary re-quest and delivering its result to the vApp. The communication between the applications and the framework can be made using Messaging and Pub/Sub components, all through the Process Execution. Between the applications and EF exists a Process Executor that orchestrates what the application will need. Communication between enablers and the framework is performed using IoT protocols such as REST and NGSI. To perform the enablers integration, EF uses two main modules: Request Handler (RH) and Enabler Registry Lookup Services (ERLS) (see Figure 1).

The RH abstracts and implements all necessary functionalities for translating requests to/from vApps and enablers that are served by the EF. The internal components of this module parse the requests and create a suitable communication channel for accessing the functionalities of the enablers and build necessary response messages, based on the result of the function invocation. This module uses the technical details of the enablers from the ERLS and relies on suitable proxies to invoke the method requested by vApp. ERLS abstracts all the data models corresponding to registrations details and provides functionalities for performing Create, Read, Upgrade and Delete (CRUD) operations on them. This module is also responsible for providing service details of the enabler to the RH.

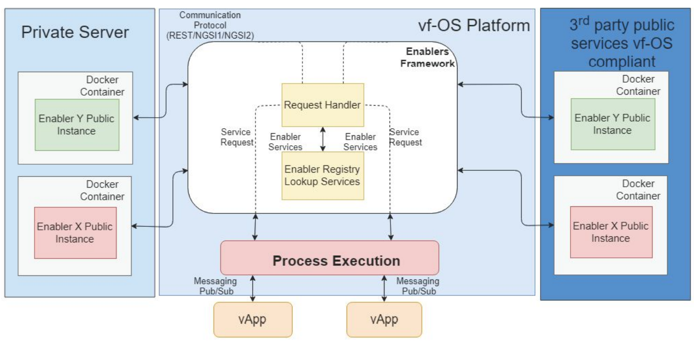

Fig. 1. Enablers integration using Enablers Framework

The two presented modules interactions grant the enablers integration. After receiving a service request from an application, the RH contacts ERLS to verify if such enabler is registered in the framework. Upon verifying it, ERLS informs RH about the target enabler's services, this information is then used to exchange information between the framework and the enabler. The framework informs then the vApp on the service's response or delivers an error if the target enabler or service are unreachable.

1.3. Implementation Scenario

This section provides a scenario that explains how the vApps can consume the enabler's services they need. The implementation scenario uses the EF's components presented in section 2.2, along with the Process Enabler (PE) (figure 2). The PE is a tool used to orchestrate the diffProerent tasks that a vApp will carry out. When developing a vApp (Design Time), the Process Designer (the designer side of the Process Enabler) will be used to define the different sub-tasks (e.g. call an analytics algorithm) and/or sub-processes (e.g. persist data in the storage) that will be necessary for executing the vApp, and assign the necessary EF libraries to achieve integration. This process model, in the form of a BPMN, will be then incorporated to the vApp source code so vf-OS is able to execute the different process steps. Thus, the cess Designer will contact the vf- OS Marketplace, vf-Store, to access the definition and the services of the different assets that the vApp developer wants to make use of. These assets could indeed be an enabler which offers certain services and then, this enabler will be accessed through the EF at runtime. At runtime, when the vApp is being executed, the vf-OS Platform will call the Process Execution (PEX) PE. This way, any vApp will be executed following the same pattern. Then, the PEX will open the BPMN definition of the vApp and orchestrate the calls to the different assets specified in this definition. When it is time to call the services offered by an enabler, regardless if its GE, SE or vf-OS Enabler, the PEX will call the EF that will be on charge of relaying the call to the enabler specified. Then, when the enabler replies, the EF will take its response, pack it and send it to the PEX so the response packet can continue its route in the BPMN flow of the vApp.

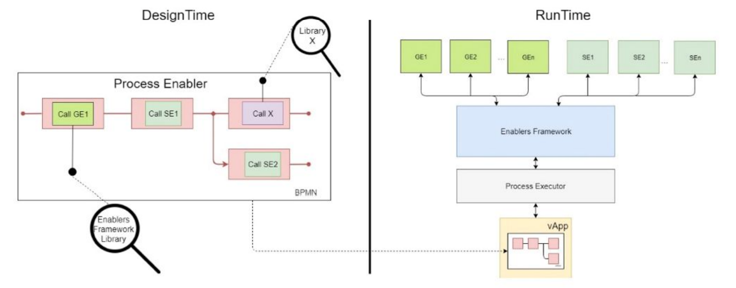

Fig. 1. Application scenario

1.4. Business opportunities

vf-OS aims to become a business multi-side platform enabling value by creating interactions between external producers and consumers. This approach provides an open, participative infrastructure for these interactions and sets governance conditions for them. Its main goal is to make producers' and consumers' information available to each other, in a timely, accurate and transparent way, diminishing their information asymmetry, and making the digital exchange of products and services a better interaction experience for both. The EF and its underlying enablers are a significant part of the added value of vf-OS, which business value relates to: 1) End user enablers that could be directly utilised in the development of vApps (design time), or solely to facilitate an easy plug and play of other resources (CPS, APIs etc.); 2) Scalable Services through enablers that can provide services, which vApps or other components can consume; 3) The vf-OS Ecosystem where the EF as the bridge between service providers and consumers facilitates their integration with the vf-OS platform and its associated services.

Being developed under FIWARE guidelines Enablers must follow an open source approach, but this doesn't exactly mean that the enabler services execution through the EF should be taken for free. On top of this free approach, enablers developers could sell support contracts on top of enablers deployment for continuous maintenance, specially customization. Thus, it is expected that all these transactions occur through vf-OS Store, being the platform the main sponsor of the marketing and selling activities of all its vApps and enablers specific services.

1.5. Conclusions and future work

Modern industry demands new tools capable of providing resources to its needs. Generic and specific enablers provide the services that factories of the future require. This article presented a framework, part of the vf-OS project, able to integrate enablers with the applications, acting as a bridge between them. By relying on a Docker-based approach the framework provides several instances of the desired enabler, without the user having to pass through its installation process. The enabler can then be accessed through the framework, that provides the means to access the enabler's services. The orchestration of the services can be achieved through Process Enabler, that assigns the necessary tasks which the application will carry out. The PE will then generate a BPMN which will be integrated in the vApp to execute the defined tasks. The integration of the enablers implies new business opportunities as it opens new business opportunities for its customer segments directly. Additionally, enablers can be used directly in shop floors for easy establishment of IoT connections, or indirectly by enrichment of the vApps functionalities.

1.6. Acknowledgements

The research leading to these results has received funding from the European Union H2020 Program under grant agreement No. 723710 "Virtual Factory Open Operating System" (vf-OS).

1.7. References

[MAU 2008] W. Mauerer, Linux ® Kernel Architecture. 2008.

[GAR 2010] Justin Garrison, "What is the Linux Kernel and What Does It Do?," 2010.

[COL 2015] S. Di Cola, C. Tran, K. Lau, A. Celesti, and M. F. B, "A Heterogeneous Approach for Developing Applications with FIWARE GEs," Eur. Conf. Serv. cloud Comput., vol. 2, pp. 65–79, 2015.

[FIW 2018 a] FIWARE, "FIWARE Project." [Online]. Available: https://forge.fiware.org/projects/fiware/. [Accessed: 4-Jan-2018].

[FIW 2018 b] FIWARE, "Generic Enablers." [Online]. Available: https://catalogue.fiware.org/enablers. [Accessed: 4-Jan-2018].

[FIT 2018] FITMAN, "FITMAN Manufactoring Enablers," 2013. [Online]. Available: http://catalogue.fitman.atosresearch.eu/catalogue.fitman.atosresearch.eu/enablers.html. [Accessed: 8-Jan-2018].

[MER 2014] D. Merkel, "Docker: lightweight Linux containers for consistent development and deployment," Linux J, p. 239, 2014.

[STU 2015] J. Stubbs, "Distributed Systems of Microservices Using Docker and Serfnode," 2015.

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vf-OS IO Toolkit

The growing variety of programming languages in software engineering feeds the permanent need of interoperability enablers between IT solutions. In agile and integrated software development, it is vital to ensure the communication between existing IT system and new ones. In addition, the connected smart factories paradigm extends the perimeter of enterprise information system to cover the direct integration of sensors and machines. vf-OS is an H2020 European project aimed at providing a development environment with an integrated, virtual view on manufacturing processes. Within vf-OS, the IO Toolkit provides tools for on-premises facilitating the access to manufacturing devices and existing business software, while also facilitating the interaction with the rest of the vf-OS infrastructure. As such it allows developers to build secure and controlled gateways into the factories, as part of the capability set for their applications.

1.1. Introduction

The World is facing the fourth industrial revolution based on ICT, specifically architectures and services, as key innovation drivers for manufacturing companies. Factories are complex systems of systems and there is a need to develop a platform on which future manufacturing applications can be built.

vf-OS, virtual factory Open Operating System, is an Open Operating System for Virtual Factories composed of a kernel, application programming interface, and middleware specifically designed for the factory of the future. The purpose is to attract talent from solution developers and to provide accessible manufacturing smart applications to European SMEs.

Chapter written by Víctor ANAYA, Nejib MOALLA, Ludo STELLINGWERFF, José Luis FLORES and Francisco FRAILE

Enterprise interoperability [JAK 12] remains the common research umbrella for software-oriented initiatives aiming to provide development frameworks and toolkits. To ensure engineering efficiency, structured interoperability methodologies are requested to improve the sustainability of software-oriented initiatives and solutions.

1.2. vf-OS IO Toolkit

The IO Toolkit is the development framework provided by vf-OS to Manufacturing and Service Providers wanting to generate new device drivers and API Connectors with the purpose to widen the range of shop floor devices and line of business systems that can be connected to applications developed for the vf-OS platform (called vApps).

Any new developed device driver or API connector (generically called IO Component) can be published to the Marketplace (see top-right part of Fig 1).

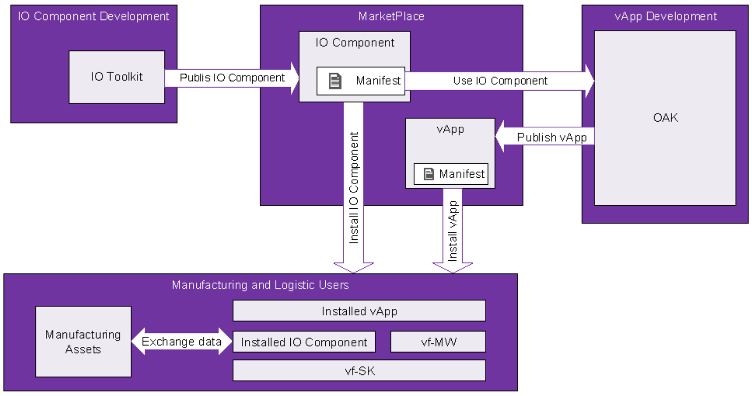

Fig 1 *IO Toolkit Positioning*

If a vApp uses a specific IO Component, then the Manifest file of the vApp describes this dependency, so that users can be informed before installing the vApp. Software Developers can thus develop functionalities that interact with any manufacturing asset that is connected to vf-OS via an IO Component.

1.3. IO Components

An IO component is a generic term to refer to Device Drivers or API connectors. A Device Drivers a kind of IO component that interacts with physical industrial devices to integrate sensors' data and send commands to devices. An example is a driver for consuming data from devices supporting the OPC UA protocol. In the other hand, API Connectors are IO components that interact with legacy software in factories (such as ERPs, databases or tailored ICT solutions).

The common structure followed by every IO component is shown in the next layered schema:

Fig 2. *I/O components functionalities*

1.3.1. Top Interfaces

Top interfaces are the interfaces that any IO component must implement to be vf-OS compliant. Those interfaces, bootstrapped by the IO toolkit provide mechanism to invoke and consume data and functionality provided by drivers and APIS. The different interfaces are:

– REST API Server Composition: providing specific REST APIs that new drivers and API connectors must follow to be called by the vf-OS platform components.

– Messaging endpoints: providing drivers and connectors ways to interact with the vf-OS Messaging component when sending and receiving new messages.

– Pub/Sub endpoints: providing ways to interact with the vf-OS Pub/Sub component, providing triggers, events and subscription functionalities.

– Metadata template composition: to generate a metadata template file used by vApp developers.

– Registration endpoints: providing functionality to drivers and API connectors to be registered themselves in the Platform and the Marketplace.

– Logging endpoints: to register logs that will be consume by the System Dashboard and the Marketplace.

1.3.2. Logic

The IO Toolkit will provide a set of functionalities available when developing the internal logic of a driver or API connector. Every new driver and component will have available a set of libraries when developing its internal logic. Those libraries are functionally aggregated as:

– Internal Storage: to connect and query the internal databases used to store configuration and operational data, both relational and non-relational databases.

– Key-value store: to access key-value stores to manage associative key-value pairs.

– Edge computing: to process sensor data as close to the data source as possible, instead of processing raw sensor data in the cloud.

– API Access Control: for authentication and security, which can be used alone or in combination to issue credentials and control access.

– API Lifecycle management: The IO Toolkit must provide API lifecycle management tools (prototype, publish, deprecate, and block).

1.3.3. Bottom Interfaces

Bottom interfaces are the proprietary interfaces part of well-known communication standards used by devices and business applications in manufacturing companies.

The IO Toolkit will provide out of the box the bottom interfaces (Table 1).

Table 1. Drivers and API connectors to be supported by vf-OS platform (extract)

Protocol	Description
OPC UA	OPC UA is a machine to machine communication protocol for industrial automation developed by the OPC Foundation.
MQTT	ISO standard (ISO/IEC PRF 20922) publish-subscribe-based "lightweight" messaging protocol for use on top of the TCP/IP protocol.

Modbus	Ethernet serial communication protocol extensively used in SCADA .
GPIO	Generic hardware interface integrated in single board computers (eg Raspberry Pi) widely used in fast prototyping.
MTConnect	Protocol to exchange data between industrial network components.
MS Excel	Spreadsheets are widely used in SMEs to build simple data analysis and reporting applications.
STEP	STEP a file format used in CAD to work with 3D models. The STEP file format is widely used in the design of mechanical parts and is supported by the most popular CAD Software tools.
ODBC	Standard API to access database management systems.
OData	REST protocol to build API Connectors with leading business software applications and systems (eg IBM WebSphere, Microsoft Dynamics CRM, Acumatica ERP, SAP ERP).
SAP ERP	OData-based API Connector
NAV ERP	Microsoft Dynamics NAV is an ERP system developed by Microsoft

1.3.4. IO Toolkit Security

The IO Toolkit Security incorporates a mapped set of security requirements and a documented unit testing plan in security for the development of new vf-OS IO Components. This set of security requirements are based on the recommendations of the most relevant and authoritative organizations in the field of security such as SysAdmin Audit, Networking and Security Institute (SANS), OpenWeb Application Security Project, or National Institute of Standards and Technology.

Based on these recommendations, the requirements are created and provided as a set of checklists. These will require concrete specifications of aspects such as the use of the corresponding libraries for implementing OpenID [OPE 17] for fulfilling the holistic authentication and authorization model of vf-OS (XACML [OAS 17]) or the specification of valid time periods of sessions, error management, or memory management policies.

Finally, the IO Toolkit Security will provide endpoints for the vf-OS Security Command Centre REST APIs (Identity Service, Policy Administration, and Continuous Security Monitoring).

1.4. Containerization

The vf-OS platform technical infrastructure [VFO 17] is based on microservices, and Docker [DOC 17] is the core technology used with that purpose.

Developed drivers and API connectors will be deployed by the vf-OS marketplace as Docker containers. The benefits that Docker provides the IO Toolkit

Execution Services are a Standardised API for connecting various services, the possibility to port applications to different environments and adapt to several deployment patterns, and several security features such as signed containers, through the Docker Trust feature.

1.5. Conclusions

The vf-OS IO Toolkit is the core component in the vf-OS platform providing the functionality to consume and interact with physical device drivers and existing business software solution. The IO Toolkit will provide a containerisation solution to run drivers and API connects as microservices in the context of the vf-OS technical architecture. The driver could be run in a specific webserver on a docker machine providing very flexible deployment alternatives. The IO toolkit will provide a catalog of driver and connector templates that will empower developers on the development of new Device drivers and API connectors on the vf-OS Platform. The IO Toolkit will provide a convenient development documentation, along with a standard versioning scheme for the Toolkit and the produced components. Finally, vf-OS requires new drivers and connectors to be properly validated. With that purpose, the IO Toolkit will provide a testing framework to check the compliance of the IO component development.

1.6. Acknowledgements

The research leading to these results has received funding from the European Union H2020 Program under grant agreement No. 723710 "Virtual Factory Open Operating System" (vf-OS).

1.7. References

[JAK 12] P. JAKOLE, P., *An integrated approach to software engineering*, Springer Science & Business Media, 2012.

[OPE 17] OPENID., *OpenID Specifications* http://openid.net/developers/specs/. [Accessed 30 10 2017].

[OAS 17] OASIS., *eXtensible Access Control Markup Language (XACML) Version 3.0* http://docs.oasis-open.org/xacml/3.0/xacml-3.0-core-spec-os-en.html. [Accessed 30 10 2017].

[VFO 17] vf-OS consortium, *D11.5: Technical Set Up and Quality Toolset v1.2*, 2017.

[DOC 17] Docker Inc., *Docker* https://www.docker.com/. [Accessed 30 10 2017].

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Data Management Component for Virtual Factories Systems

The vf-OS project aims to develop a middleware platform for the virtual factory of the future. The vf-OS is composed of several modules providing interoperability mechanisms for systems to exchange real-time data. Moreover, it enables the managing of data flows, transforming data, providing open API's to ease integration process. The proposed Data Management Component (DMC) intends to cover the issues related to data handling, pre-processing, extracting, and data flows management for Virtual Factories. It integrates four subcomponents: a data infrastructure middleware element that handles the data communications; a data storage mechanism able to work with high loads and triples; a semantic and mapping function to establish model information integration; and an analytical module composed by machine learning and prediction mechanisms to enable knowledge extraction from the vast amount of data generated by the associated virtual factory system.

1.1. Introduction

Modern Internet of Things (IoT) and Cyber-Physical Systems developed to cover needs of manufacturing domain are facing with difficulties related not only to amounts data generated which need to be properly stored, transmitted and delivered on demand, but also with challenges of structuring and analysing data in order to create additional value. The vf-OS project tightly related to concepts of IoT and CPS aiming at provision of an open platform for Virtual Factory (VF) and collaborative environment for different entities on different levels of manufacturing process. vf-OS ecosystem will also inherit the problem of handling enormous ascending and

Chapter written by Artem A. NAZARENKO, Joao GIAO, Joao SARRAIPA, Oscar J. SAIZ, Oscar GARCIA PERALES and Ricardo JARDIM-GONÇALVES

descending data flows. Some of these challenges are covered by other vf-OS platform components, where one of them is responsible for data connection (I/O functionality) and data movement which comes from its corresponding middleware module. However, before data are absorbed or consumed by applications, they need to be mapped from input to output type – this will be facilitated via semantic harmonisation and transformation techniques. Finally, for data consumption analytics interfaces provided by the infrastructure must scale to extract relevant data subsets according to user's expectations in the simplest possible way. To access the data, the proposed component also includes all the elements required for data stream management: reading, cleaning, storing, indexing, enrichment, search & retrieval, fusion, maintenance, and correspondence of open APIs. This data infrastructure will serve analytic and decision-making services to the Virtual Factory Open Operating System.

1.2. Virtual Factory Data and Connect

The focus of the proposed DMC [n.1] is on providing a set of semi-independent but related services taking the inputs of a variety data at large scale, with different characteristics such as transmission speed, etc., and providing set of nontrivial analytic operators. It is composed by four subcomponents: the Data Infrastructure Middleware; the Data Storage; the Data Harmonisation; and the Data Analytics. The Data Infrastructure Middleware provides the core access that utilise Data Storage functions for permanent and cross application access. Data Harmonisation provides transformation services, based on semantics, and is particularly connected to the first subcomponent for data connectivity. All these four will be supported by the Data Analytics.

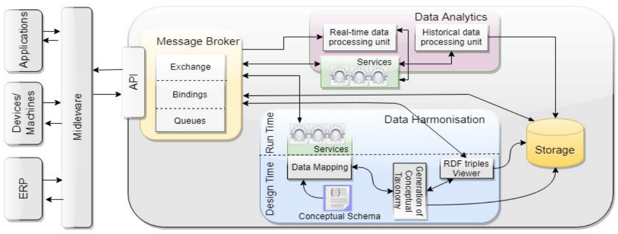

Figure N.1 – DMC architecture

1.2.1. Data Infrastructure Middleware

This component specifies and implements a data bus that will support the other subcomponents and the overall vf-OS application for data storage, transformation, and analytic operations. The data infrastructure will contain adapters in order to aggregate data from various enterprise information sources including: machines, hardware sensors (which might include high-precision camera data, accelerometers, vibration, and temperature sensors), software sensors from Enterprise Resource Planner (ERP) systems and external business context data, etc. and take use of other vf-OS activities. Since sensorial data typically generates large amounts of micro measurements, the supporting data infrastructure needs to provide a high throughput technology pipeline for acquisition, pre-processing and aggregation of collected data [VFO 17].

At the early stage two main concepts for middleware were considered REST and message-oriented (AMQP). Talking about advantages and disadvantages, first to be mentioned is that REST has synchronous nature and AMQP broker implies rather asynchronous processing, for instance, message might be requested right after it has been published in the queue or later, as it is kept until being consumed. REST has an advantage that the web-kind behaviour can be transmitted to its resources. In some cases, when direct communication client-server is not possible, REST approach will be completely useless, while AMQP allows ignoring mutual awareness between exchange parties. Another clear advantage considering IoT domain is that AMQP supports both point-to-point as well as publish/subscribe patterns, while REST implies only point-to-point connection. Considering two ways of implementation with broker or broker-less, the first one was chosen due its characteristics extremely relevant for vf-OS: history logging, traceability, message queuing and reordering.

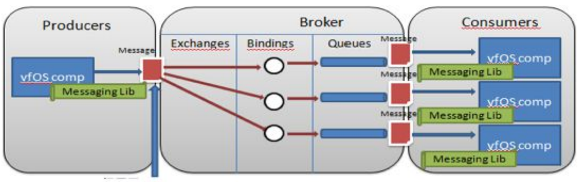

Figure N.2. – Messaging model for vf-OS components using RabbitMQ broker

To implement the abovementioned functionality message-oriented approach or middleware was selected: the AMQP protocol implemented by RabbitMQ message broker. According to the definition provided by designer of AMQP architecture [OHA 07] it is: "a binary wire protocol and well-defined set of behaviours for transmitting application messages between systems using a combination of store-and-forward, publish-and-subscribe, and other techniques." It is based on four basic definitions: (i) **Message** – basic unit of transmitted data, the main part of which is not interpreted by the server (only headers are processed). (ii) **Exchange point** – delivery service for messages, all messages are sent into this point to be then distributed into different queues [n.2]. There are three main types of exchange points: **Direct Exchange** – sending a message directly at a single queue, **Topic Exchange** – producing the copies of the message and sending to all clients, **Headers Exchange** – checking all headers on matching with query predicates from interested clients. (iii) **Queue** – here the messages are being kept, until the client request. (iv) **Bindings** – deliver necessary information about routing, in different types of exchange it is provided by different entities.

Main components represented on [n.2] are as follows message broker (RabbitMQ) deployed on the server side implementing the AMQP protocol for message exchange and on the client side both message producers as well as message consumers. The client side is only responsible for creating or requiring messages and also adding some headers with relevant information about type of exchange and target node/nodes the rest is being performed by broker. A Publish-subscribe middleware will help to implement Event Driven Architecture (EDA) and is fully compatible with major industry standards (i.e. JBI, SCA, BPEL or WSDL).

1.2.2. Data Storage

This component implements the storage services for vf-OS assets. It supports three major dimensions of "Big Data" when dealing with intensive streaming data, namely: Volume (scale of data being processed), Velocity (data transmission speed and optimized reaction time), and Variety (supporting heterogeneous types of data). It implements a scalable data storage system, capable of handling real-time sensor data and events, based on an underlying infrastructure that transparently absorbs very large amounts of data, as well as other types of non-real-time heterogeneous data. The vf-OS Platform has different needs of Data Storage, e.g., sensor data, events, alarms, time series, maps, models, data files, log files and structured data. Each of them has its own requirements in terms of velocity of storage and querying, volume and updateability of the data, consistency, availability, partition tolerance, and other dimensions. So, it is not possible to think of a solution based on a single storage system. Here is where *polyglot persistence* comes into play.

In 2006, Neal Ford coined the term "polyglot programming"[1], to express the idea that applications should be written in a mix of languages to take advantage of the fact that different languages are suitable for tackling different problems. The same

[1] http://nealford.com/memeagora/2006/12/05/Polyglot_Programming.html

concept can be applied to databases; thus applications utilize different databases using each for what they are best at to achieve an end goal. This is called polyglot persistence[2]. vf-OS storage is based on this polyglot persistence paradigm. So, following this paradigm, four different storage services are provided: 1) Relational data - to store relational data from vApps as well as other relational information of the vf-OS Platform itself.; 2) Time Series data - to allow storage and querying time series data 3) Document-Oriented data - to store, retrieve and manage document-oriented information, also known as semi-structured data; 4) RDF data - to store and query subject-predicate-object triples.

1.2.3. Data Harmonisation

Data Harmonisation aims at (i) extracting more information from incoming data and (ii) preparing the data in a form/schema suitable for other vf-OS components and vf-OS Assets. It will enable semantic enrichment with background knowledge and data mining on real-time streams, received through the Messaging component. The data enrichment objective is to generate from the observed data additional derived attributes/features, either using external background knowledge or internal relationships within data. This could include the use of external ontologies, statistical properties, (models) of data and/or temporal characteristics of data. The key aim is to encode functional transformations of data to help the data (pre-)processing as long as the vApp needs it; as an example, by carrying out analytic techniques of T5.4 to detect non-linear and other nontrivial patterns within the data (otherwise non-detectable by traditional analytic techniques).

Issues related to data extraction from heterogeneous sources with further transformation of them are solved by so called Extract-Transform-Load (ETL) Systems. The main goal of ETL systems is to make data more useful for further processing and analytics. This might be achieved through linking data and creating triples or semantic triples, which can be described as a statement of the subject-predicate-object form. ETL workflow consists of three main phases, as it follows from the definition: extraction, transformation and load. According to [BAN 14], data extraction aims at getting data from the source, which can be presented in form of flat file or data base source. Transformation is a process of “cleaning” data or bringing them to the form corresponding to the scheme, including some actions such as: normalization, filtering, etc. And the last stage is loading them to the data storage.

Since vf-OS is oriented towards the software developers wanting to develop vApps for the Manufacturing Industry, it is expected that the ETLs would be part of the execution of a vApp. However, vf-OS follows a different approach: instead of

[2] https://martinfowler.com/bliki/PolyglotPersistence.html

programming the ETLs directly in the source code of the vApp, the ETLs will be programmed as independent services and, thus, deployed as standalone services that could be re-used by other vApps and launch several instances of the same service if deemed necessary. As such, the Data Harmonisation is divided in two components: one for design-time, the Data Mapping, and another for run-time, the Data Transformation. Thus, the ETLs will be "programmed" under the Data Mapping component and deployed as these standalone services and executed within the vApp as part of the Data Transformation component.

1.2.4. Data Analytics

This sub-component covers the creation of building blocks for off-line analytical processing of inputs coming from the Manufacturing environment. This will include machine learning algorithms supporting supervised and unsupervised scenarios. The core of the analytic algorithms will be based on the combination of the modern statistical-machine-learning linear-algebra based algorithms (e.g. SVM, CRF, LDA, Mixture-Models) and traditional data-mining algorithms (e.g. decision trees and rules, k-means, association rules). This will cover typical classification and segmentation scenarios for enriched representations coming from semantic based ontological descriptions to capture nonlinearities in data. The key research innovation will be provided by using "multi-level" analysis on the top of more traditional machine learning algorithms simultaneously observing the data on multiple aggregation levels [VFO 17].

In a factory there will be two different types of analytics tasks to be performed: those ones depending on historical data sources, e.g. readings of sensors for a given period of time in the past, and those ones that need to be calculated on real-time as they will be involved in triggering alarms conducting to time (or spend) critical actions. As such, two different modules will be integrated into the Data Analytics component focusing each of them in these two, although complementary, areas. Similarly, to the Data Harmonisation, the Data Analytics will be composed of analytics libraries so that the vf-OS user, i.e. the developer of vApps, would be able to re-use the existing analytics libraries that will be provided by vf-OS. This means that there will be a set of libraries each of which covering complementary functionality. There will be libraries for the various analytics approaches as for modelling and training like Random Forest predictors, which will be built on top of a SOTA analytics tool [H2O 18] that offers an API to access to such different algorithms.

1.3. Conclusions and future work

Current research work represents the DMC as the part of vf-OS project's being performed within Horizon 2020 initiative. The proposed solution being developed to satisfy both basic as well as more complex needs of VF's in managing data flows. This includes organisation of data exchange based on Message Oriented Middleware, extracting, transforming and representing data with Data Harmonisation and Data Analytics subcomponents and storage of heterogeneous data both in terms of content and format. Important requirements for VF's such as vast amount of data being produced as well as consumed, scalability and adaptability of infrastructure, need to cope with different data in terms of formats, origin, heterogeneity and distributiveness of data sources are also considered. The main efforts are directed towards providing a scalable, open-source, modular platform for developing various industrial applications within a shared VF ecosystem. Resulting component, in fact an independent platform, will be able to solve relevant issues related to quick and agile deployment of smart applications through enabling of necessary tools and software modules around data flows handling. Further work will contain implementation of DMC within vf-OS for different manufacturing scenarios. However, DMC can be also used as an independent component being integrated with already exciting solutions and thus offering the wide range of possible implementations as a part of other systems and solutions.

1.4. Acknowledgements

The research leading to these results has received funding from the European Union H2020 Program under grant agreement No. 723710 "Virtual Factory Open Operating System" (vf-OS).

1.5. References

[VFO 17] Virtual Factory Open Operating System – Technical Annex (2017).

[OHA 07] O'Hara, J.: Toward a Commodity Enterprise Middleware. ACM queue, 48-55 (2007).

[BAN 14] Bansal, S.K.: Towards a Semantic Extract-Transform-Load (ETL) framework for Big Data Integration. IEEE International Congress on Big Data, 522-529 (2014).

[H2O 18] H2O.ai. Accessed from: https://www.h2o.ai, last accessed 2018/01/29.

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An Open Environment for Development of Manufacturing Applications on vf-OS

Developing a project aimed at providing an Operating System to a manufacturing system requires having a suite of tools that can specify, develop, build and distribute the applications that will be at the heart of this manufacturing system. These applications shall be able to receive stimuli from and to provide actuation over the manufacturing assets, combining this virtualised manufacturing system with the power of the novel ICT resources, enablers and state-of-the-art techniques for development and building of systems and applications that have been used in industry, which involve WYSIWYG editors with syntax highlighting, SDKs which provide a large set of artefacts and libraries including standard connectors and extension points, but also debuggers, tools to optimise the performance and make the best use of the latest technology. Additionally, innovative methodologies for development promote strong involvement of the development community and the developers' engagement. This paper describes a novel environment that was envisioned for this purpose, involved in the scope of the H2020 European Project vf-OS.

1.1. Introduction

The upcoming of the new industrial revolution "Industrie 4.0" [IND 18] presents a new paradigm for the development of manufacturing services, tightly aligned with the most advanced ICT innovations. At the very heart of this development are new techniques that promote the collection of data from multiple sensors and sources of

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Chapter written by Carlos COUTINHO, Luís LOPES, Vítor VIANA, Danny PAPE, Gerrit KLASEN, Bastian von HALEM, Oscar GARCIA PERALES, Ludo STELLINGWERFF and Andries STAM

input information and the ability to infer knowledge from it (Internet of Things – IoT), and virtualisation of the manufacturing assets. The new smart digital manufacturing environments will allow the development of applications that are able to interact with the virtual factory assets, receiving inputs and actuating on the real factory systems. This will allow them to benefit from the advances in the methodologies and development of software applications that traditionally were not applicable to the manufacturing domain, with multi-purposed agile dashboards and frontends that deal with accessibility and that are more responsive and provide more valuable information. New methodologies which include agile techniques, the use of popular and proven development frameworks, the support of development communities that provide manpower for testing and for innovative ideas, suggestions and bug corrections. Additionally, the development of applications shall be more pleasant, with a set of tools like IDEs and editors with code syntax highlighting, debuggers, drag and drop features, integration with version control, issue trackers and other mechanisms that engage and motivate the developer into the creation of applications, a set of libraries accessible through the development SDK that will provide access to innovative features such as new enablers, dependencies analysis, dashboards and especially the connection to the internet and to a whole new level of ICT assets.

The developers will be able to produce "What You See Is What You Get" (WYSIWYG) applications that use frontend elements commonly used on web-based applications, based on the latest technologies and best-practices of the market.

The H2020 project vf-OS [VFO 18] proposes to create an operating system targeted to the manufacturing business. This naturally involves the development of mechanisms that interact with the real factory assets, enablers for connecting to internet and web features, and an environment that fosters the development of applications for the manufacturing business. The vf-OS development framework is named virtual factory Open Application development Kit (OAK) [VFO 17]. It is composed by a set of libraries, assets and tools which are described next.

1.2. vf-OAK SDK

The vf-OAK Software Development Kit (SDK) is a centralised environment for the development of applications and, generically, for the centralised access of the vf-OS assets and functionalities. The SDK itself will not have a user interface per se, instead, it will be accessed as a set of APIs to access the main development resources. That way, the SDK will be able to provide to the vf-OAK Studio (see section 1.3) and to other Application/Development components the resources and services that they require.

The vf-OAK SDK comprises an extensive fully-documented API framework that provides to developers the means to easily generate applications (vApps) and services. It also includes the development of a service API which offers methods to access functionalities of all technical components in the vf-OS environment that the service developers need, such as the easy integration of data from the Cloud-based information infrastructure and the storage of service-specific data within the Cloud.

The basis for the development of the SDK is to provide a component or framework of elements that foster and improve the development of solutions and vApps for vf-OS. The idea is to be able to help a developer to create vApps with this framework such that the SDK will provide what needs to be included in the vApp, and then other OAK components will be responsible for defining behaviours, process flows and other application definitions, in a user-friendly interface, based on Frontend customised elements, that aims to promote and foster the development.

Particularly speaking, the SDK is divided into several parts considering the components that are to be connected: The SDK core is responsible for handling and exporting the communication layer between the OAK Studio or other components for actions e.g., publish/subscribe, messages, or security. The SDK for vApps has a process interpreter which can transform the results from the Process Designer tool (XML files) to JavaScript language. And the SDK for the I/O Toolkit accesses the real manufacturing devices, sensors and other mechanisms via the vf-IO interfaces.

1.3. vf-OAK Studio

The vf-OAK Studio provides an Integrated Development Environment (IDE) with a Graphical User Interface (GUI) for users that want to develop vApps for the vf-OS platform. It also provides all the necessary tools and means for developing a vApp, and supports the application deployment on end user devices, and its publication in multiple Marketplaces. Besides including tools for code development, with editors that include features like Business Process Management Notation (BPMN), syntax highlighting and drag-and-drop, debugging and analysis of the developed code, the vf-OAK Studio includes the interfaces for Process Designer, Frontend Composer, and provides access to the vf-Store marketplace.

The vApp creation starts by setting the necessary configuration which includes dependencies, marketplaces and permissions that are going to be used by the vApp. Then the vf-OAK Studio provides a working space composed by a Process Designer (see section 1.4) and a list of services and processes available in the vf-Store marketplace which are specified during the project configuration.

The implementation of vApps will be based on the composition of pre-built blocks, where the developer can select an available process/service from the marketplace, and drag-and-drop it as a block to the Process Designer. Each block can be configured by the user. If a process or service needed by the user is not available in the list, the user can create and develop a new customised block. The logic for the implementation of this custom block can be done using or composing other blocks or code. When finished, the custom block can be saved it locally, so it can be used on the vApp, or deployed to one or more marketplaces, so that other developers can make use of it.

The vf-OAK Studio also includes a Frontend composer (see section 1.5) which manages the user interfaces used by the vApp. From this tool, the user can use the available templates, e.g., default login page, or create new ones. This User Interface (UI) composer also supports logic implementation used by the UI, e.g., filters the received data and shows the results or gets the inputs entered by the user.

1.4. Process Designer

vf-OS will use a Process Designer for complementing the development of the vApps. The Process Designer is responsible for allowing users to model multiple manufacturing workflows for orchestrating the various assets available within a collaborative framework. The tool will be an online workspace supporting a BPMN-like model and will be usable by vApps whenever process design and orchestration is appropriate.

The Process Designer will be a visual online reactive canvas, allowing the developer to pull in existing models from a library representing the virtualised manufacturing assets and all the elements which will be necessary for the correct development of a vApp. These elements can be any of the vf-OS Assets: Generic FIWARE Enablers (Application, Services, e.g., single-sign-on (SSO), but also Specification/Methodology), Manufacturing Enablers (Applications, Services and Specification/Methodology), vf-OS Services (e.g., Transformation), vf-OS Component (e.g., Process Engine [VFOa 18]), and of course, other vApps.

Each asset may support additional properties that can be defined. The defined workflow can include other sub-workflows and be saved and versioned within the Data Storage as BPMN-model definitions. This will allow a developer to design an *ad hoc* workflow that will model and shape the desired vApp. Examples of vApps could be the execution of a specific business process or the integration both intra-plant and cross-company data exchange processes. These services, which will be orchestrated at runtime, will be augmented with additional information needed to define the required processes.

The vf-OS Process Designer will be a web-based BPMN tool accessible through the vf-OS OAK. It will take advantage of cutting-edge web technologies. The foundations of the Process Designer will make use of an open source BPMN modeller framework such as BPMN-IO, which is a rendering toolkit and web modeller for BPMN. It allows easy creation of BPMN2.0 diagrams using a web based modelling library which can be extended to add the functionality for vf-OS.

The toolbox inside the Process Designer will offer vf-OS manufacturing assets (Services) that are available from the vf-Store. From this repository, a process designer can then select and drag from the Toolbox onto the design canvas to begin modelling a process. It will contain all the standard BPMN modelling elements, such as Parallel or Exclusive Gateways, Processes, and many others needed to create a BPMN diagram.

1.5. Frontend

The Frontend Environment is part of vf-OAK and builds a library of graphical elements that are optionally linked to simple functionalities. These elements are cross-platform compatible and they serve as a help for developers to quickly and safely create consistent looking vApps. The libraries from the Frontend Environment are integrated into the vf-OAK Studio, and can be used directly, by using the elements in the shape of classes. By using the Frontend Environment, the developers can choose between the following repositories:

– UI Element Repository contains single UI elements following the style guide of vf-OS that can be used during vApp development. Particular attention was paid to the corporate holistic layout of vf-OS for branding purposes;

– UI Template Repository provides compositions of UI elements from the UI Element Repository. Each template appears as a single UI element but is composed of several UI predefined elements. A lightweight example of a UI template is a login form, which is composed of a grid, textbox, password-textbox, and action buttons;

– Behaviour Repository contains several default behaviours for activities, which are related to UI interactions. Those behaviours are easy to integrate and applicable for e.g., forms, downloads, registration, and notifications;

– Behaviour Template Repository provides a composition of several behaviour templates. A single behaviour template consists of lined-up behaviours that are processed synchronously. Lined-up behaviours ease the use of handling events and support developers with additional default events;

– Holistic Template Repository provides holistic templates that unite UI templates and behaviour templates. Those templates follow the style guide and include logic to handle user interactions automatically.

Furthermore, in vf-OS, the Frontend Environment is used both in design and at runtime. In design time the developer can choose elements from the library and can integrate them in their vApps with help of the vf-Studio. But in runtime, demanded user interactions can call simple functionalities from public vf-OS interfaces, such as the analytics component, or the vf-SDK.

1.6. System Dashboard

The vf-OS System Dashboard is a runtime, central dashboard and task manager, aimed at monitoring, warning, configuring, and adapting system resources. As such, it provides information on the runtime behaviour of the vf-Apps, useful for both the end user and the developers of the apps.

The primary component of the dashboard is a web-based user interface, in which the status of all user accessible vf-OS components and deployed assets can be monitored and controlled.

Behind this UI, a controller service is provided which aims to collect the required information for the dashboard and which contacts the execution services for the starting and stopping of vf-Apps and their dependencies.

A notification service is also part of the dashboard, allowing the user (and/or developer) to be informed of off-nominal issues or other triggers. The Notification Engine stores and manages notifications, and applies several external messaging mechanisms (e.g., email, messaging, notification icon) to warn users of such issues.

1.7. Developers Engagement Hub

To complement the actions of development, creation, debugging and integration, the modern methodologies for supporting the development advocate that as good or better than having a great development team is to have an active and engaged community of users, partners, customers and developers that contribute to the success of the projects.

Hence, the team proposed the inclusion of a centralised hub which has the purpose of gathering and promoting the contact, interaction, collaboration and discussion of interested stakeholders. These communities often help with their requirements, their suggestions and ideas, but also greatly with their own development or testing of the developed vApps. This is the largely successful philosophy around Open Source, but to be able to do this in a correct way, these communities need to be correctly biased and engaged to the developing project. The vf-OAK suite therefore includes a platform that has as sole purpose the capitalisation of the developing project, providing mechanisms that promote a clear and straightforward description of what is being developed, and its surrounding concepts, methodologies, requirements, and as much more information as possible.

The vf-OS Developers Engagement Hub will promote the dissemination of the developed code and its evolution using source code control (e.g., Git repositories), and tools which will mostly deal with dissemination and communication (collaboration), which may include wikis, templates, tutorials, multimedia, forums, mechanisms for capturing and describing new features and bugs (issue trackers), management tools, and many others which may support the development and make it simpler like business and continuous integration, connections to larger ERP and CRM tools, statistics and other tools which may both facilitate the development, its documentation and dissemination.

1.8. 2 Conclusion

The purpose of the H2020 vf-OS European Project is to provide manufacturing businesses with an open Operating System that will allow them to – similarly to what happens in a regular computer – create, develop, build and load applications that span and cover the whole manufacturing operations and processes, enabling the capture of the business knowledge and promoting its analysis and potential to achieve greater value.

1.9. Acknowledgements

The research leading to these results has received funding from the European Union H2020 Program under grant agreement No. 723710 "Virtual Factory Open Operating System" (vf-OS).

1.10. References

[IND 18] Industrie 4.0 Homepage, http://www.plattform-i40.de/I40/Navigation/EN/Industrie40/ WhatIsIndustrie40/what-is-industrie40.html, last accessed 2018/01/10.

[VFO 18] vf-OS Homepage, http://vf-os.eu, last accessed 2018/01/10.

[VFO 17] vf-OS Consortium, D2.1 Global Architecture Definition (2017).

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A novel approach to software development in the microservice environment of vf-OS

Within the vf-OS project, a common approach is taken for the deployment of computing resources and data models. As such vf-OS represents a modern approach to the software middleware layer, specifically aimed at the manufacturing domain. The approach consists of "Docker"-based microservices, orchestrated through common REST services. Because of the domain, special attention is given to the challenge of running resources OnPremise versus purely InCloud, and the challenges of letting such heterogeneous environments work together. As this environment poses challenges for the development process of applications, a novel approach to the development of such applications is needed. In this paper, this approach is described. During the vf-OS project, experience will be obtained, validating this approach.

1.1. Introduction

The World is facing the fourth industrial revolution based on ICT, specifically architectures and services, as key innovation drivers for manufacturing companies. Factories are complex systems of systems and there is a need to develop a platform on which future manufacturing applications can be built.

vf-OS, virtual factory Open Operating System, is an Open Operating System for Virtual Factories composed of a kernel, application programming interface, and

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Chapter written by Luís MANTEIGAS DA CUNHA, Ludo STELLINGWERFF and Andries STAM

middleware specifically designed for the factory of the future. The purpose is to attract talent from solution developers and to provide accessible manufacturing smart applications to European SMEs.

vf-OS offers a manufacturing oriented cloud platform, supporting a multi-sided market ecosystem that provides a range of services for the connected factory of the future, allowing manufacturing companies to develop and integrate better manufacturing and logistics processes. [VFO 18]

Due to the highly distributed microservices architecture used in vf-OS, such an environment poses some challenges for the software development process which will produce the assets. This paper describes the approach taken to handle these challenges and describes how this can be evaluated over the lifetime of the project.

1.2. vf-OS platform

The design of the vf-OS platform environment is formed based on the requirements set out in the public requirements document D1.5. [VFR 18] It provides the environment in which vf-OS assets are installed, run and accessed. These assets encompass services, tools and applications. In the case of end-user visible applications, these are called vApps. Such assets interact with each other through web-technologies, such as REST-services, web-based GUIs and modern message busses. See Figure 1.1.

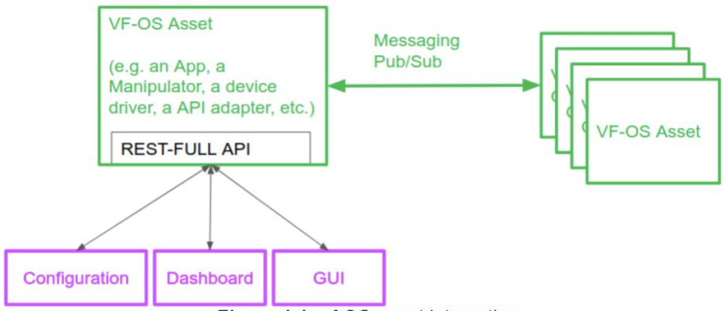

Figure 1.1. *vf-OS asset interaction*

The platform allows the assets to run both InCloud or OnPremise. This heterogeneous model is the result of the specific requirements for the manufacturing domain. In most use-cases there is data produced within the factories and through the legacy systems of the end-users. This data can be used within cloud applications.

This introduces quite stringent security challenges, to allow the users to control their data dissemination. Similarly it requires security measures to prevent undesired access to machinery and other local resources. The manufacturing domain poses several unique privacy and control issues, especially due to the inter-corporate interactions. The relationship between a factory, its subcontractors and its customers is complex, with many contracts on liability, guarantees, services and time constraints.

Within vf-OS this is solved by introducing a model where there are multiple vf-OS platform instances, with a strict inter-platform communication model. One of the implementation options for this model is shown in Figure 1.2. It shows a factory, which will run a platform instance locally, which will communicate with a cloud platform instance, through a controlled proxy asset. The customer application will then run in the cloud platform and only get very controlled access to the data from the factory's premises. The SCC component in the platform is the Security Contact Center, part of the security model of vf-OS.

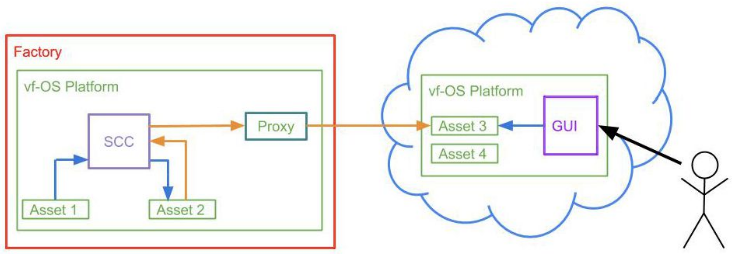

Figure 1.2. *vf-OS inter platform communication*

The vf-OS assets will have a standardized structure and packaging format. The basic executable entity will be based on Docker images. [DOC 17] This Docker image will be enveloped in a wrapper structure, containing metadata, like access rules, dependency information and security signatures. The assets will be storable in the vf-OS Marketplace and can be bought and deployed into the Execution environment, provided by the Platform.

This distributed environment makes it harder to create consistent, coherent applications, especially with regard to debugging, versioning and other software life-cycle aspects. An important part of the goals of the vf-OS project is aimed at providing an answer to these challenges.

1.3. Development approach

The vApp development is the most visible asset development process, as facilitating this process is the stated goal of the project. But the development of the other assets within the vf-OS environment is very similar. It is therefore a good approach to use a single development model for both application development and for the development of other assets. This means that different types of developers will interact with the development model, requiring some flexibility in supporting tools and building blocks.

To tackle this challenge of building consistent, coherent applications within the highly distributed environment of vf-OS, a integrated development environment has been chosen. This environment is called the vf-OS Studio. As all parts of the vf-OS project, it will be available as a set of assets, forming an IDE-like application. An overview of the building blocks of the studio is given in figure 1.3.

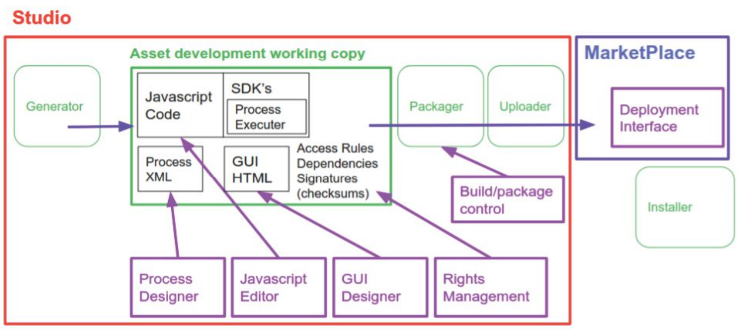

Figure 1.3. *vf-OS Studio components*

As can be seen, the main assets are Javascript-based services. Each service will run in its own docker container, providing some generic APIs for system interacting. For example, each asset will provide data for the vf-OS Dashboard. Similarly each asset exposes an API for interacting with the Execution environment. Assets may choose to also carry a web-based GUI, in the form of containing a web server. (e.g. an NGINX host [NGI 18]) Several SDKs and JavaScript libraries are provided by the project for interacting with other assets. Examples of such libraries are the publish/subscribe mechanism, the messaging framework and access to storage facilities.

To support the distribution and marketing of the developed vApps, the project offers a MarketPlace. This MarketPlace has several tasks in the software development process: a) a marketing and sales channel; b) a services registry; and c) hosting of the assets for deployment. Because of the single development model, incorporating this marketplace, these tasks all contribute to the ease of developing vApps.

External services can be represented in the single development model as well, by encapsulating them into vf-OS Assets. For this purpose the project provides a support module, called the External Services Provisioning framework.

1.4. Conclusions

We have explained a solution to a particularly interesting problem, arising from the manufacturing domain and the micro-services architecture which vf-OS employs to handle the domain. The described approach of standardized packaging, marketing, deployment and interaction between micro-services, is quite novel. Future steps are evaluating this approach, using the projects intermediate releases, use-cases and experimentation. The results of this evaluation will be reported in similar publications.

1.5. Acknowledgment

This paper presents work developed in the scope of the project vf-OS. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 723710. 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.

1.6. References

[DOC 17] DOCKER INC., "Docker – Build, Ship, and Run Any App, Anywhere", https://www.docker.com, 2017

[VFO 18] VF-OS CONSORTIUM, "vf-OS | virtual factory Operating System", http://www.vf-os.eu/, 2018

[NGI 18] NGINX INC., "NGINX | High Performance Load Balancer, Web Server, & Reverse Proxy", https://www.nginx.com/, 2018

[VFR 18] VF-OS CONSORTIUM, *D1.5: Requirements Specification (M6), Version 1.0.1, 2017*, http://www.vf-os.eu/results, 2018

8 I-ESA 18

[VFOa 18] http://158.42.105.151/mediawiki/index.php/Process_Engine, last accessed 2018/01/10.

Annex H: I-ESA’18 vf-OS Workshop Presentations

This annex provides the slides used by the speakers at the I-ESA’18 vf-OS Workshop, starting with an introduction to the vf-OS Project and following with the 6 papers presentations.

The title of the Workshop was “Smart Services and Business Impact of Enterprise Interoperability”

vf-OS Aspiration

Software Operating System Environment	*vf-OS* Equivalent
Kernel Processor, Memory, Internal Bus	**Virtual Factory System Kernel** Framework, Enablers
I/O Interfaces, Device Drivers, Peripherals	**Virtual Factory I/O** Device Drivers, APIs, Security
File and Data Handling Interfaces	**Virtual Factory Middleware** Data Infrastructure, Storage, Harmonisation, Analytics
SDK Application Development, System Monitor	**Open Applications Development Kit** System Dashboard, Frontend Environment, Studio, Developer Engagement Hub
Applications ERPs, CRMs, MESs, WMs	**vApps** Collaboration in real-time, monitoring

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vf-OS Some initial concepts

Term	*vf-OS* Definition
vApp	Manufacturing Smart Applications (vApps) developed in the three pilots act as the experimental base of the vf-OS Platform
Enabler	An Enabler is a third-party application that encompasses certain stand-alone functionality that has been already developed, ie within FIWARE, or developed by vf-OS
vf-OS Asset	A vf-OS Asset is compound of Enablers, Drivers, APIs, External Services and vApps

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vf-OS virtual factory Operating System

Application

vf-OS Use cases

Pilot A – Manufacturing & Logistics/Automation:

- **Goal:** To build a set of Smart Applications (vApps), integrated into vf-OS, for the advanced management of spare-parts in the automation production equipment sector

Pilot B – Manufacturing Assembly/Collaboration:

- **Goal:** To accelerate and maintain collaboration channels between a network of collaborative SMEs in two complementary business domains: plastic and metal

Pilot C – Construction/Industrialization:

- **Goal:** To facilitate the documentation management of a construction site by assimilating to an industrial factory where workers manufacture, assembly goods, operate machines, and carry out tasks processing products

Exploit and Sustain

Sustainable business model based on the use of the *vf-P*, *vf-Store,* and other vf-OS components

- **Open Access:** *vf-OS* and all its components will be by default open source
- **Sustainable Marketplace and Store**: *vf-OS* will take advantage of the great success of the mobile apps business model
- **Start-up Company:** Provide a sustainability model including the establishment of a start-up company to exploit data and data services

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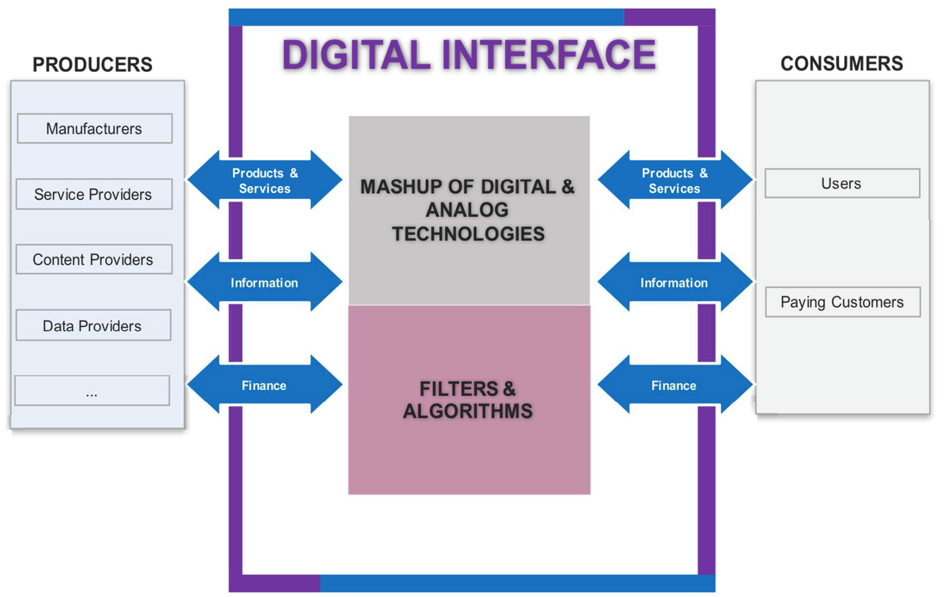
Multi-Sided Platform



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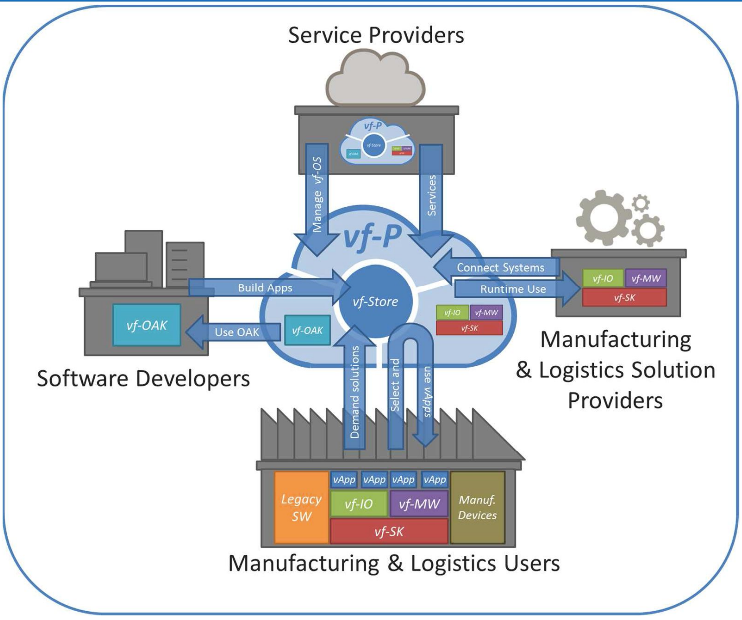
vf-OS Overview



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vf-OS Partnership

ID	Participant organisation name	Country	Nature
1 (CO)	Information Catalyst for Enterprise Ltd	UK	SME
2	Ikerlan SCL	Spain	Technological Center
3	UNINOVA - Instituto de Desenvolvimento de Novas Tecnologias	Portugal	Research
4	Universitat Politècnica de València	Spain	University
5	Caixa Mágica Software, S.A.	Portugal	SME
6	Université Lumière Lyon 2	France	University
7	Ascora GmbH	Germany	SME
8	Almende B.V.	The Netherlands	SME
9	Mondragón Assembly	Spain	SME
10	Via Solis UAB	Lithuania	SME
11	Consulgal - Engenharia e Gestao S.A.	Portugal	Large enterprise
12	Knowledgebiz, Lda	Portugal	SME
13	Applications Plastiques du Rhone SAS	France	SME
14	Tardy SAS	France	SME

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http://vf-os.eu
https://www.youtube.com/channel/UCN-5AXqIaXjXItq8jJuoW1w
https://www.linkedin.com/in/vf-os-project/
https://www.facebook.com/vfoseuropeanproject/
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723710.
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11

virtual factory Operating System

Architecture

Authors: Danny Pape, Tobias Hinz, Oscar Garcia Perales, Francisco Fraile, José Luis Flores and Oscar J. Rubio

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Agenda

- Global Architecture Definition
- Functional Specification
- Technical Specification
- Holistic Security and Privacy Concept

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Global Architecture Definition

- Service Oriented Architecture
- REST Interfaces
- Event Driven SOA features
- TOGAF oriented

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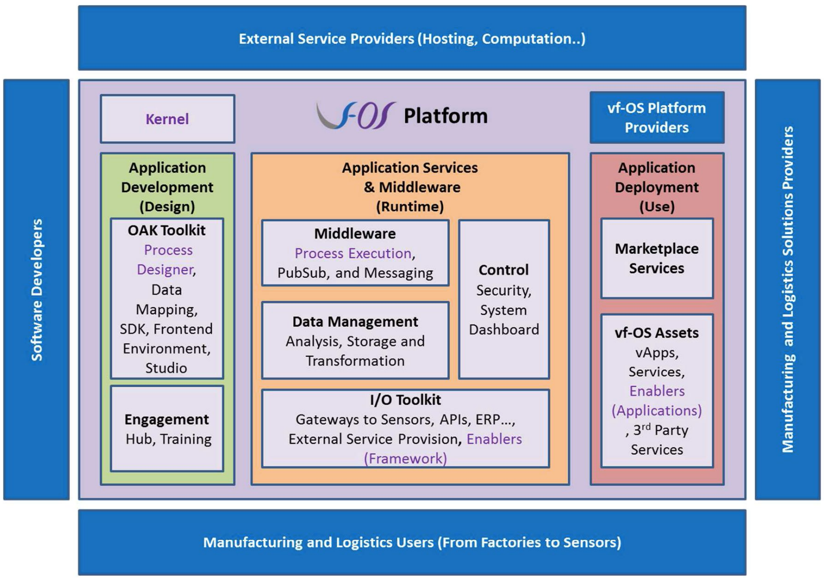
High Level Architecture



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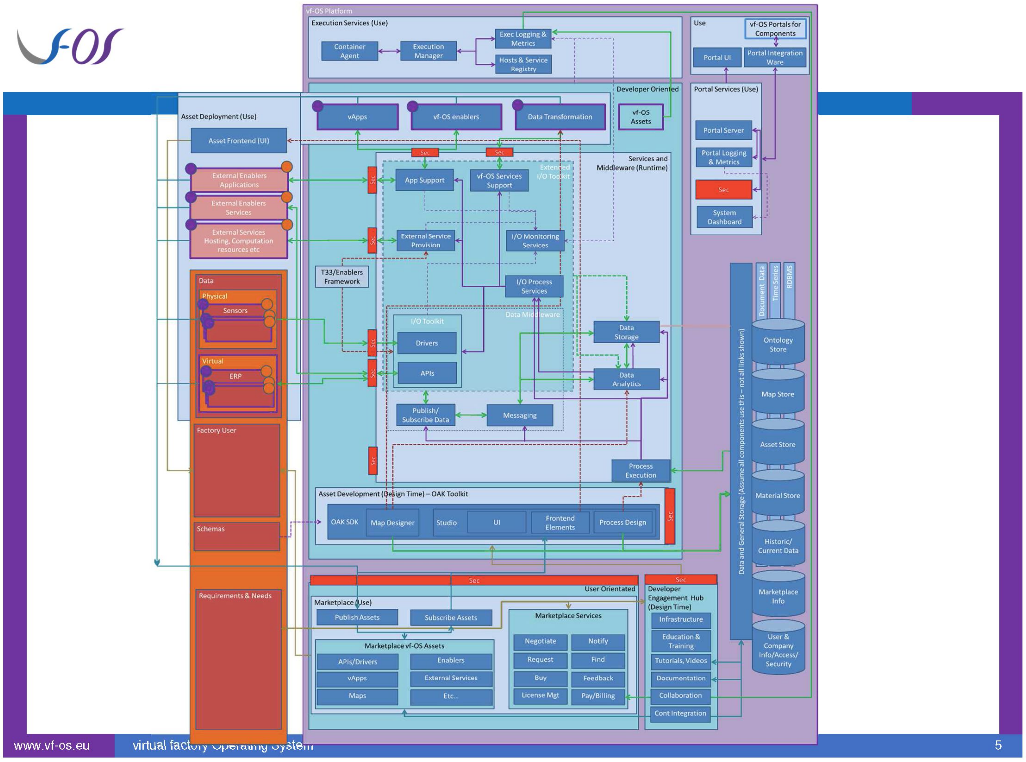

Architecture Building Blocks

- Environment Block
  - vf-OS Platform as a Container
- Application Development Block
  - vf-OS design time components
- Application Services & Middleware Block
  - vf-OS runtime components
- Application Deployment Block
  - vf-OS Microservices (Docker)

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Solution Building Block

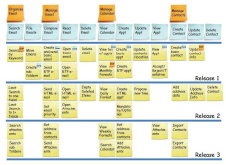
- vf-OS Assets
  - Generic Enablers (FIWARE)
  - Specific Enablers (FITMAN)
  - vApps
  - External Services
  - I/O Connectors
    - Software
    - Hardware

Functional Specification

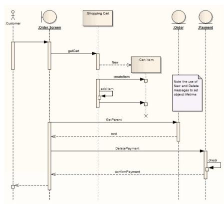
- User requirement evaluation
- Convert requirements to functionalities
- Prioritize functionalities
- Analyse functionality behaviour

Functional Specification Roadmap

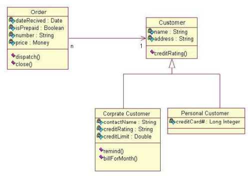
- Story maps
  - User workflow (left to right)
  - Priority (top to bottom)



- UML Sequence Diagrams
  - Depict interactions between components
  - Developing workflows in UI mock-ups



- UML Class Diagrams
  - Focus on component interactions



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Technical Specification

- API endpoint definitions
  - RESTful interfaces
- Data model definitions
  - That are relevant for communication between components
- Living online documentation (Slate)
  - Inclusive Code Repository and Continuous Integration

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API Endpoint composition

- Endpoint Description
- Request Information
  - how to use this endpoint
  - URL: POST /v1/paymentnotifications (example)
  - Table of required and non-required parameters
- Response Information
  - Return value
  - http status code

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Holistic Security and Privacy Concept

- Cyber Attack Protection
- vf-OS considers
  - IT Standards (mainly ISA-62443)
  - General Data Protection Regulations (GDPR)
  - Recommendations of top-class security institutions (e.g. NIST, NSA)

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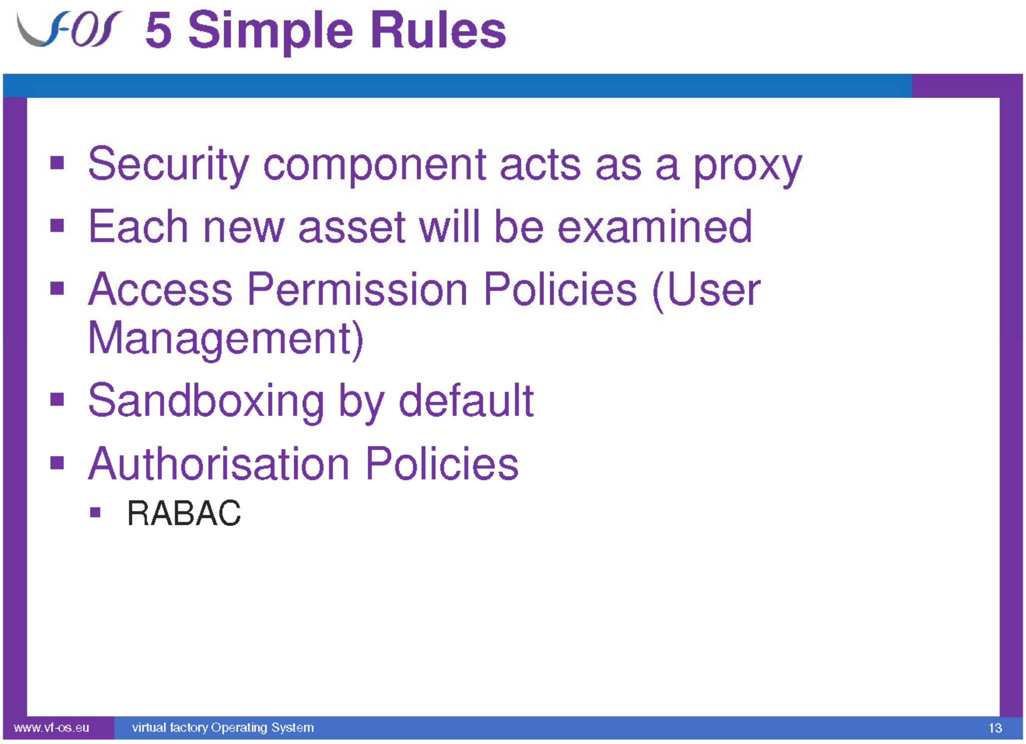
5 Simple Rules
Security component acts as a proxy
Each new asset will be examined
Access Permission Policies (User Management)
Sandboxing by default
Authorisation Policies
RABAC
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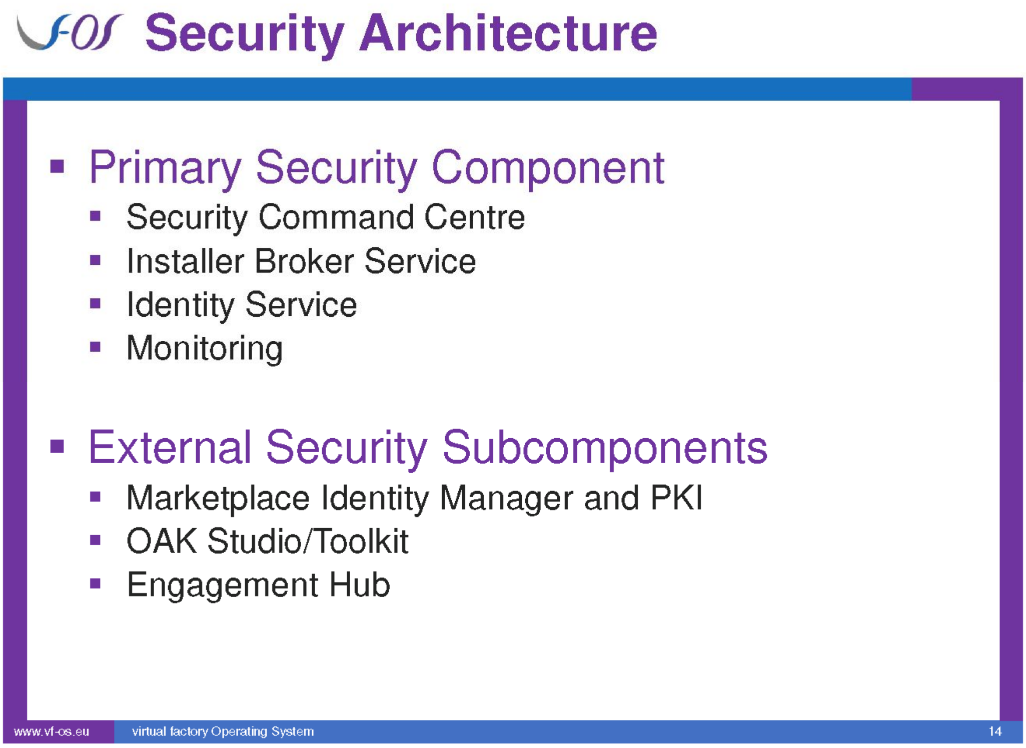
Security Architecture
Primary Security Component
Security Command Centre
Installer Broker Service
Identity Service
Monitoring
External Security Subcomponents
Marketplace Identity Manager and PKI
OAK Studio/Toolkit
Engagement Hub
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Questions?
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Enablers Framework: an approach to develop applications using FIWARE

Joao Sarraipa

UNINOVA

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Current Industrial Panorama

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vf-OS project

Objectives:

Provide a standard solution for the Industrial Panorama

Manage factory related computer hardware and software resources

Provide and integrate common services for factory computational programs

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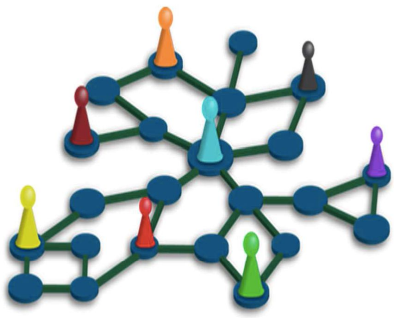
Enablers Framework



Main Role

Act as a bridge between service providers and service consumers.

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Enablers as Service Providers

Why to use them ?

Enablers offer reusable and shared modules, which include protocols and interfaces for operation and communication, able to cover several usage areas among different sectors.

Coverage Areas

Cloud Hosting

Data context/management

Internet of things

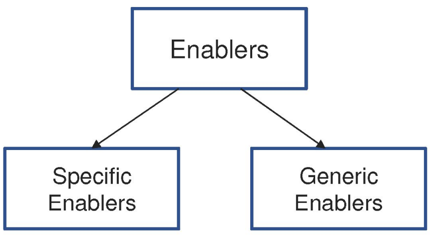
Applications, Services and Data Delivery

Security

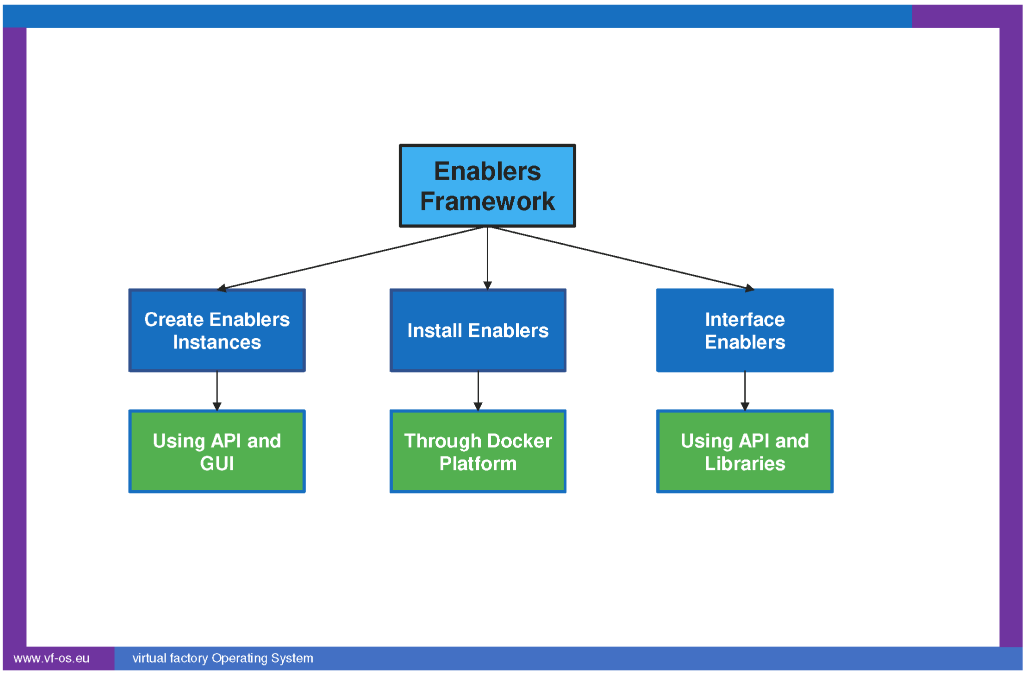
Interface with Networks and Devices(I2ND) Architecture

Advanced Web-based User Interface

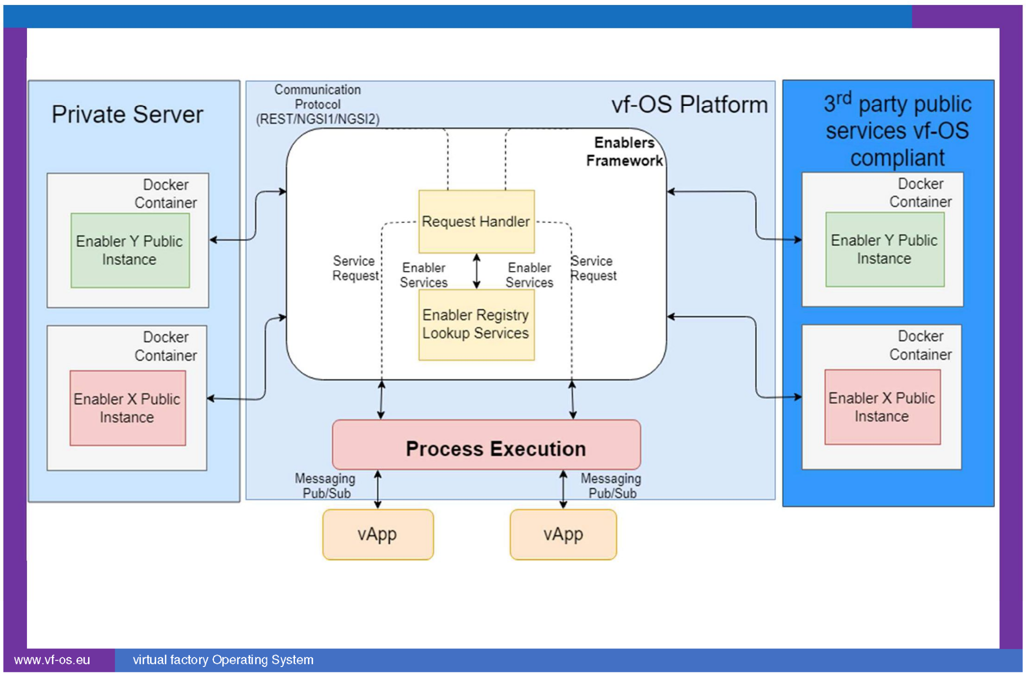
Factory Service Providers



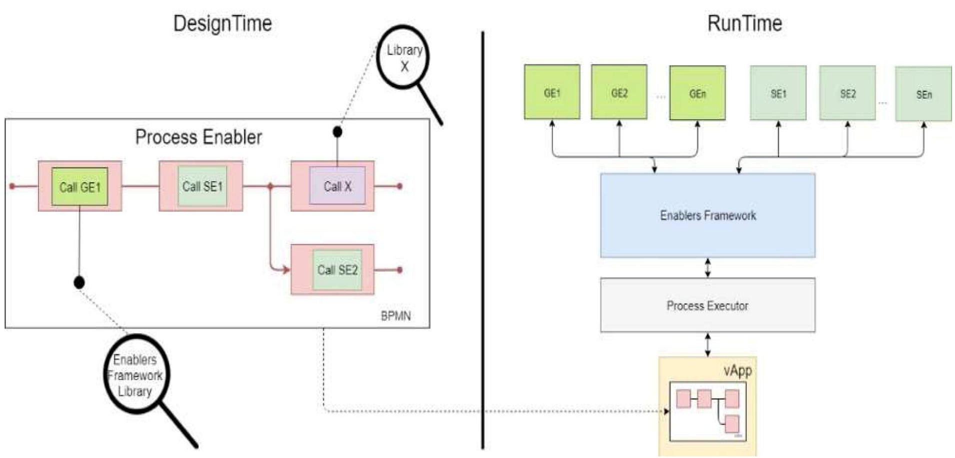
Enablers Framework as a Bridge



Components Functionalities



Implementation Scenario



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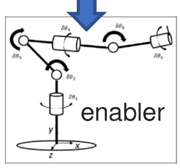
Enablers Framework Business Opportunities

- Facilitate enablers creation to be utilised in the **development of vApps or to facilitate plug and play of other resources.**
- **Interface the access to Enablers services** to be consumed by vApps and other components
- Contribute to vf-OS Ecosystem and act as the **bridge between service providers and consumers**

To teach karate

App developed

Define Control robot movements



enabler

E.g. Robot Producer

To be used in academic teaching

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Conclusions

FIWARE

- *FIWARE is an **open** sustainable ecosystem, built around **public**, **royalty-free** and **implementation-driven software standards**. We make and **share open source technology for smart solutions.***

vf-OS

- The proposed Enablers Framework, intends to integrate **enablers with the applications, acting as a bridge between them**.
  - **Acting as an approach to develop applications using FIWARE**
- It relies on a **Docker-based approach to provide (if needed) several instances of the enablers**, without the user having to pass through its installation process.
- The enabler can then be **accessed through the EF API**
- The **orchestration** of the services can be achieved through the **Process Enabler**, which generates a **BPMN to be integrated in the vApp to execute the defined tasks**.

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The End

Questions?

Joao Sarraipa
jfss@uninova.pt

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vf-OS IO Toolkit

2018-03-21

Victor Anaya, Nejib Moalla, Ludo Stellingwerff, José Luis Flores and Francisco Fraile

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Index

- Motivation
- Drivers and API connectors in vf-OS – the IO component
- A perspective from app developers
- A perspective from manufacturing and logistic users
- A perspective from drivers and API connector developers
- Security concerns
- Conclusions

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vf-OS Motivation

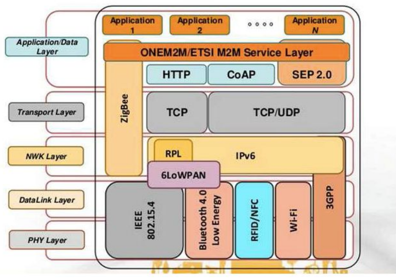
- vf-OS is an operating system that will permit applications to use existing manufacturing resources (devices and business applications)

vf-OS Context of manufacturing apps(devices)

- Wide range of existing devices in manufacturing

  Temperature
  Humidity
  Speed
  Pressure
  Flow Rate
  Speed
  etc

- Many protocols



Context of manufacturing apps(legacy)

- Siloed legacy system.

SAP SharePoint Microsoft Dynamics NAV ORACLE AUTODESK AUTOCAD

- Any with specific languages, APIs and environments to develop

COM objects DLL JAR / RMI REST C/C++ XML

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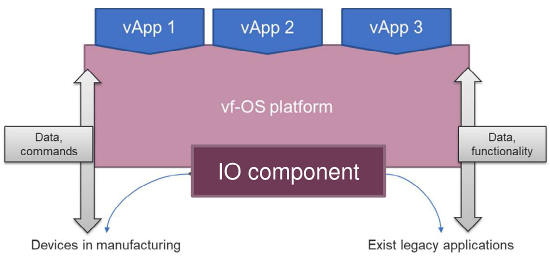
vf-OS input and output

- Provide tools to **app developers** for:
- Developing apps abstracting from complexity of different protocols
- Developing apps that coexist and profit from existing business applications



Input / Output (IO) Component

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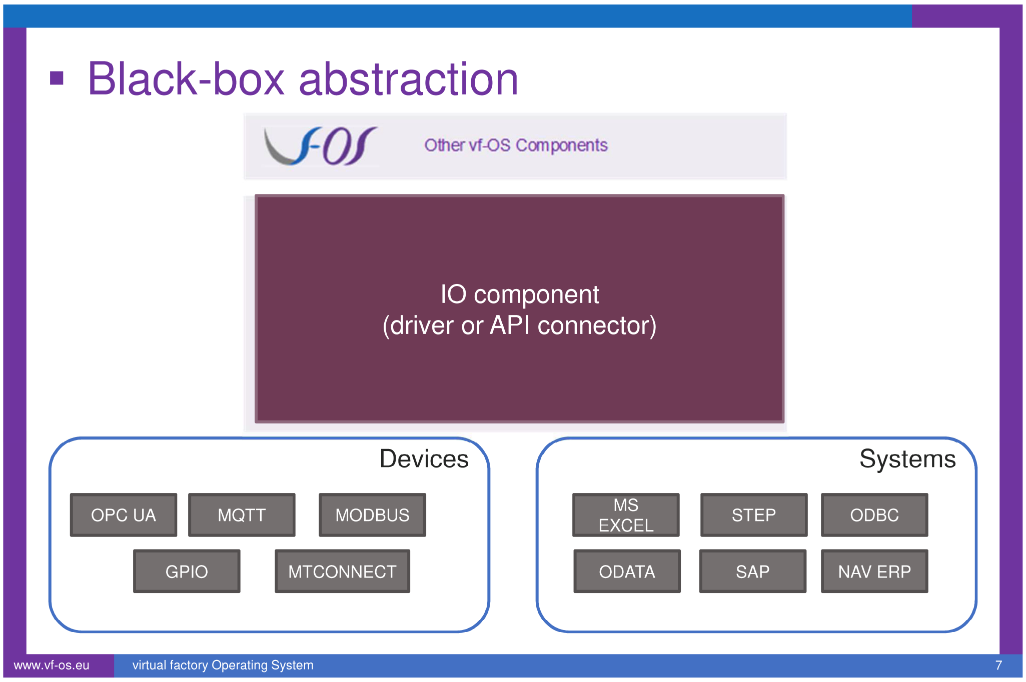
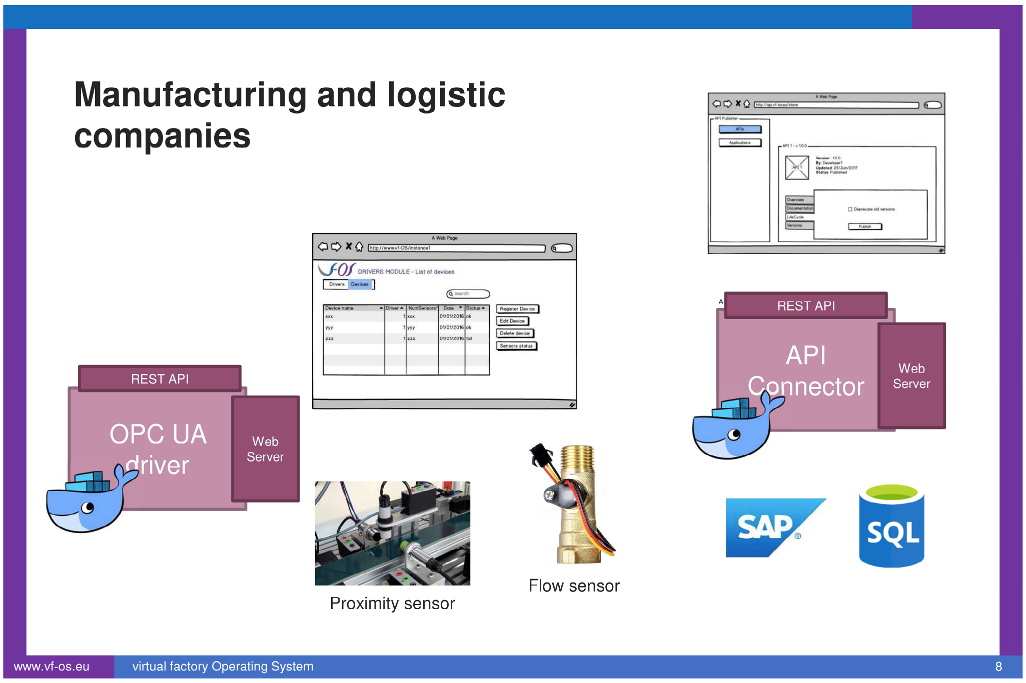
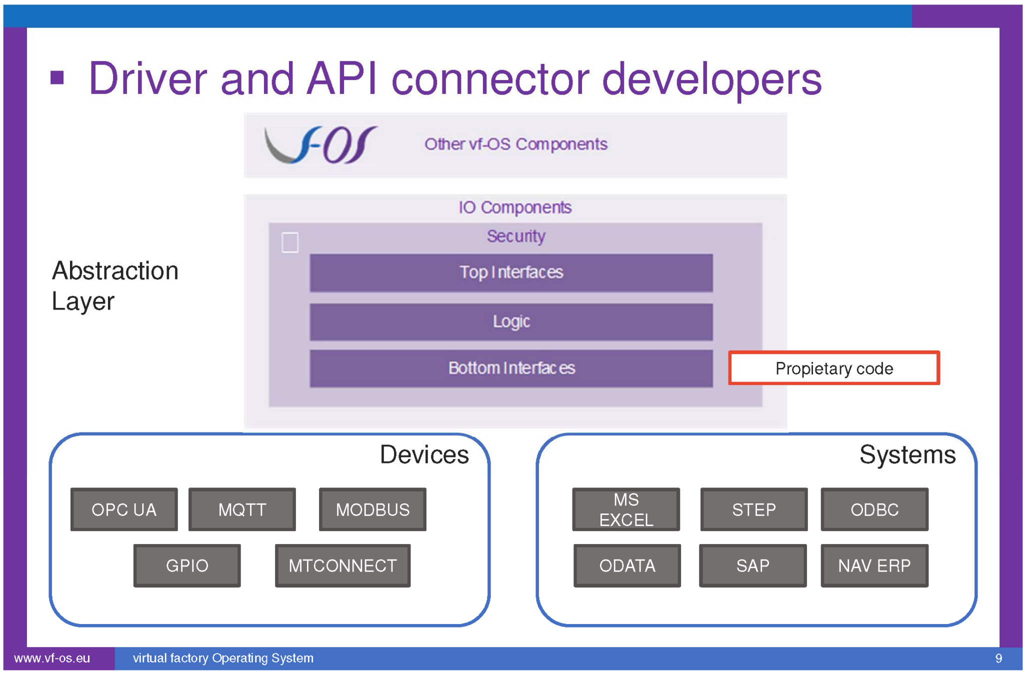
Solution - vf-OS IO component



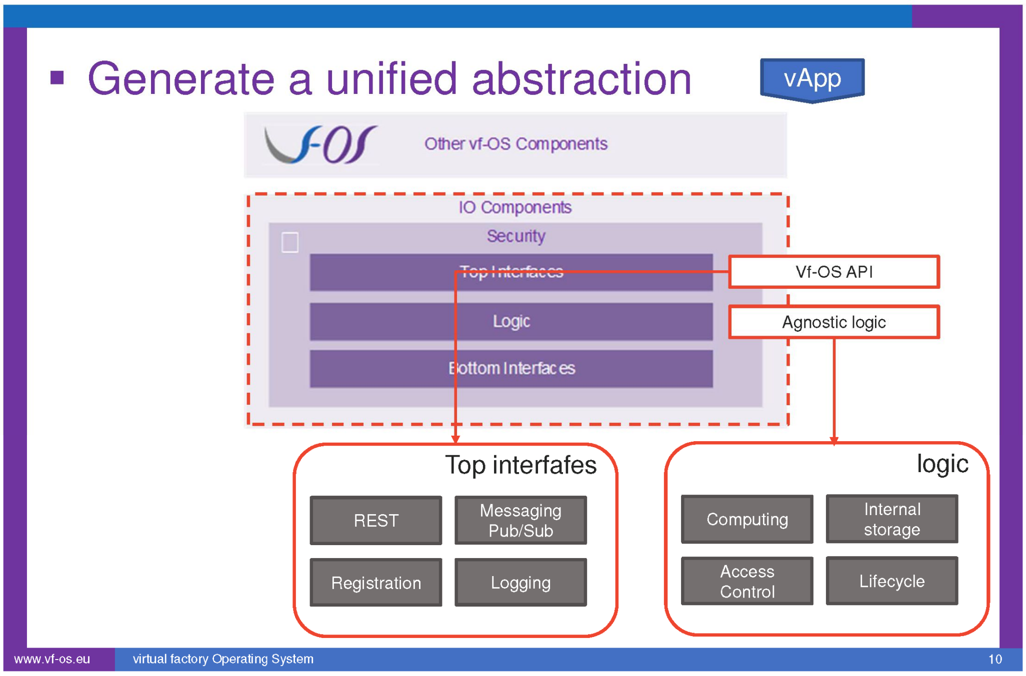
Using drivers and API connectors



Developing new IO components

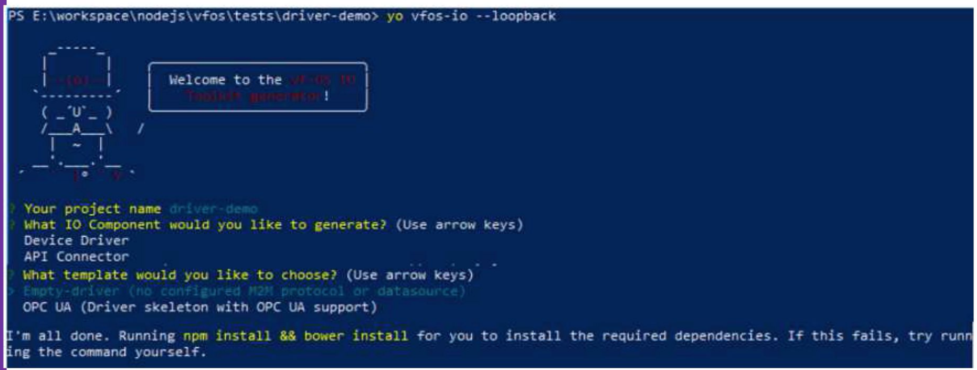


Solution - vf-OS IO component



IO Toolkit

- Command-line prompt tool to generate skeleton of IO components.



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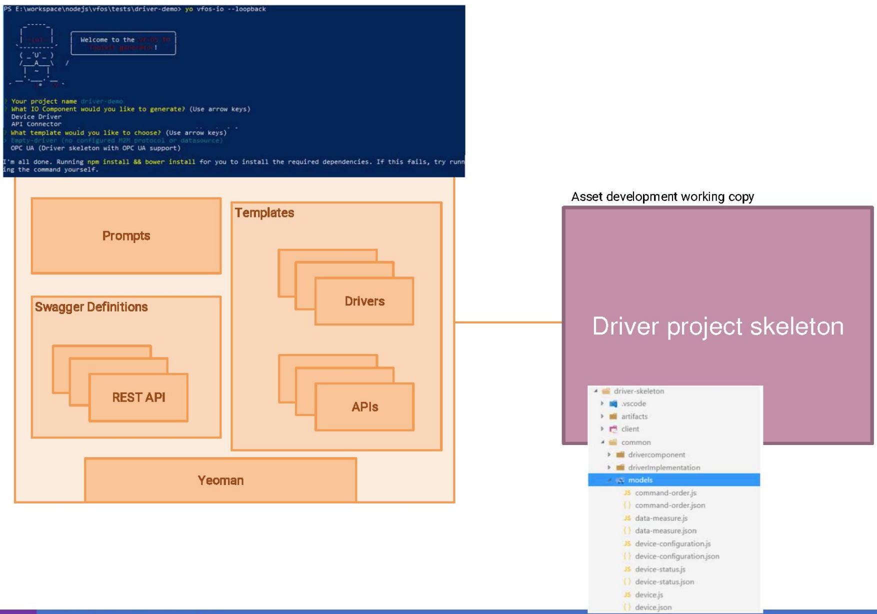
IO toolkit generator



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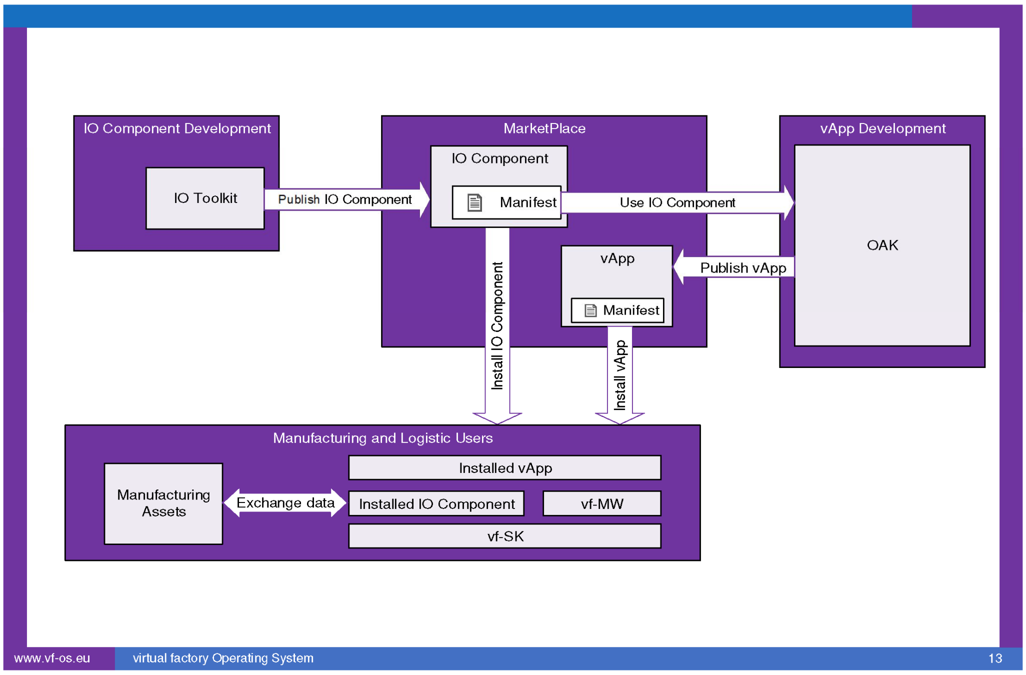
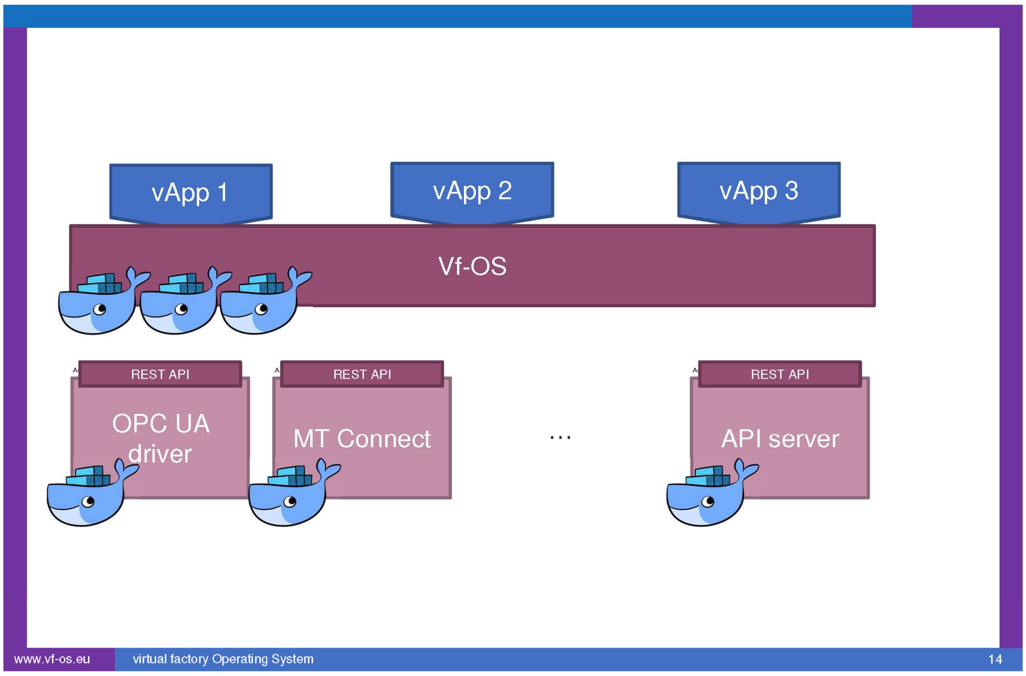
IO components on the marketplace



Deployment example



vf-OS Security Concerns

- External services
  - REST alignment with OWASP

OWASP
Open Web Application Security Project

- Internal services
  - ISA 99/IEC 62443 secure network architecture, service encapsulation

IEC | IEC 62443 Security Standard for Industry

- Asset development
  - ISA 99 / IEC 62443 component development, digital signatures
- Privacy and Personal information
  - Security Control Centre, cryptographic recommendations

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vf-OS Conclusions

- **IO component** is the component in charge of **wrapping** and **integrating** devices and legacy applications in vf-OS apps
- **IO components** are self-hosted, secured, server-based, **docker components**.
- Out of the box vf-OS plans to provide up to 20 drivers / API connectors
- IO toolkit is the easy-to-use tool to extend vf-OS with new IO capabilities

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Thanks you
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Data Management Component for Virtual Factories Systems

Joao Giao

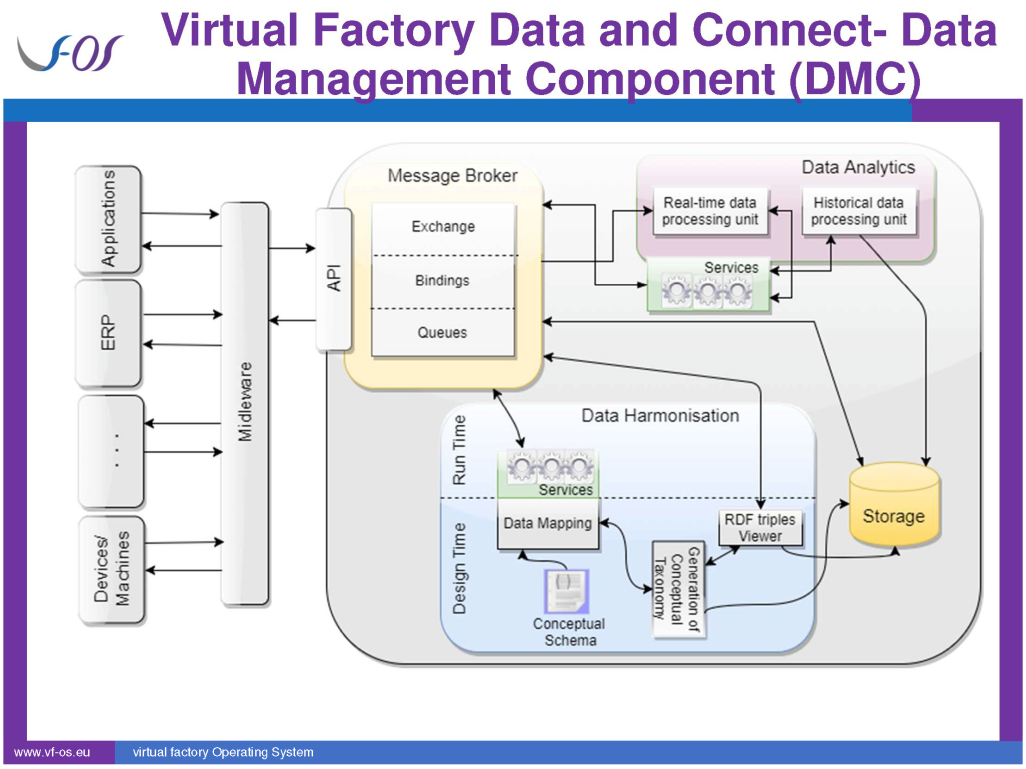
UNINOVA

Data Management Component Objectives

The *vf-OS* applications will consume and produce tremendous amounts of data

Objectives:

- Handle all vf-OS communication;
- Data storage capable of storing all vf-OS data;
- Harmonise vf-OS data;
- Analytic methods for enrichment, analysis and data interpretation.


Virtual Factory Data and Connect- Data Management Component (DMC)
Applications
ERP
. . .
Devices/ Machines
Midleware
API
Message Broker
Exchange
Bindings
Queues
Data Analytics
Real-time data processing unit
Historical data processing unit
Services
Data Harmonisation
Run Time
Design Time
Services
Data Mapping
RDF triples Viewer
Generation of Conceptual Taxonomy
Conceptual Schema
Storage
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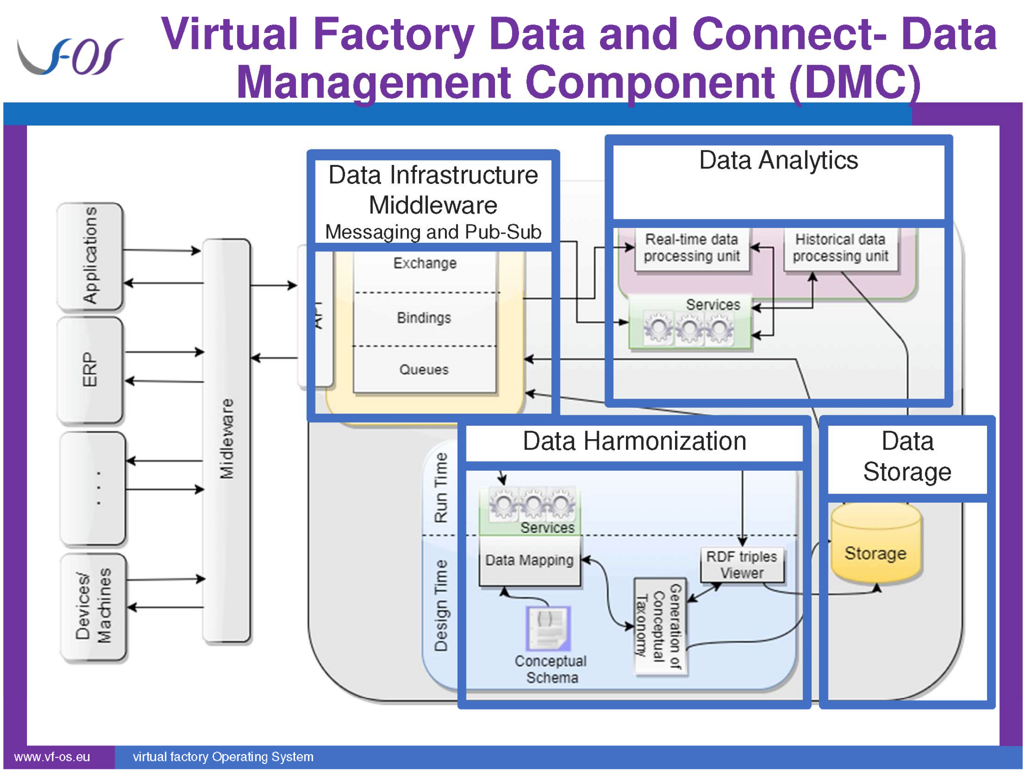
Virtual Factory Data and Connect- Data Management Component (DMC)
Applications
ERP
. . .
Devices/ Machines
Midleware
Data Infrastructure Middleware
Messaging and Pub-Sub
Exchange
Bindings
Queues
Data Analytics
Real-time data processing unit
Historical data processing unit
Services
Data Harmonization
Run Time
Design Time
Services
Data Mapping
RDF triples Viewer
Generation of Conceptual Taxonomy
Conceptual Schema
Data Storage
Storage
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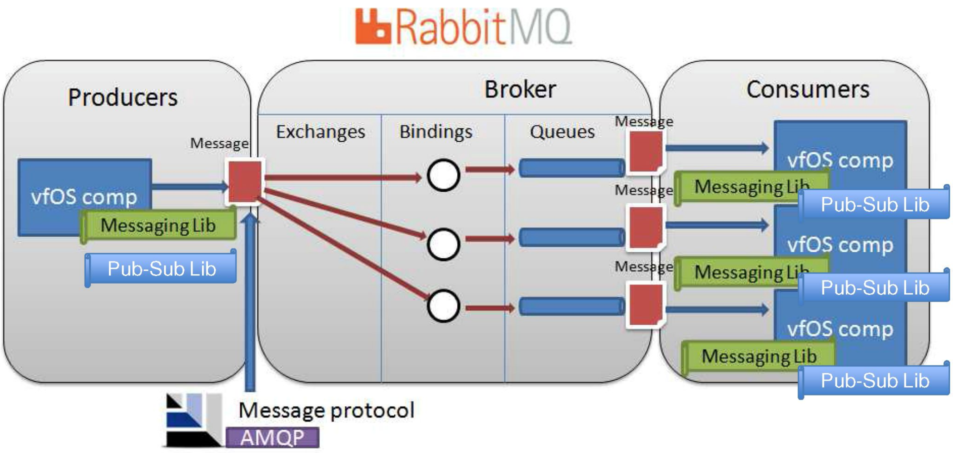
Data Infrastructure Middleware

Data Infrastructure Middleware relies on Message Oriented approach based on RabbitMQ using the AMQP protocol.
Develop the message and publish/subscribe components



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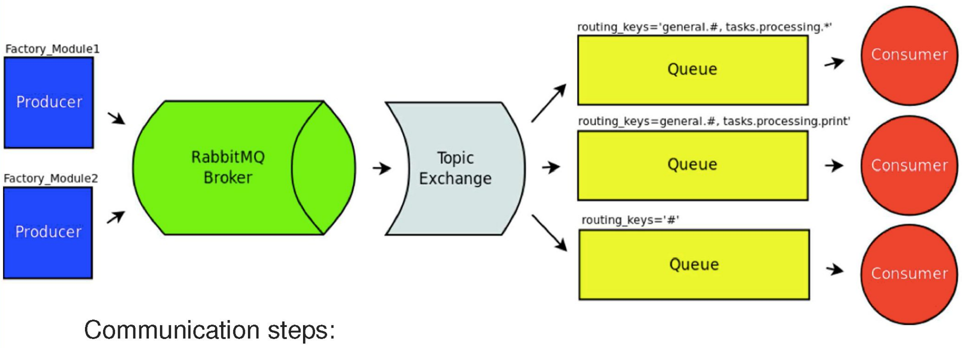
General representation of Data Infrastructure Middleware

Producer-Consumer Model for vf-OS



Communication steps:
1) Producer sends one message to one exchange and to one or more queues (with routingKeys);
2) Broker redirects the message to designed exchange;
3) The queues that are linked to the routingKeys will receive the message;
4) Consumers that are listening to specific queue get the message.

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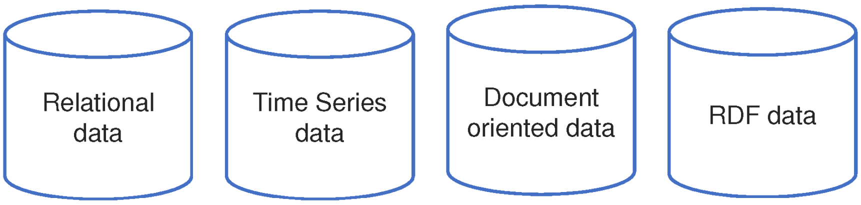
Data Storage

Data Storage has to provide storing services for heterogeneous data from heterogeneous sources



vf-OS usage:

- Relational data - relational data from vApps as well as other relational information of the vf-OS Platform itself;
- Time Series data - to allow storage and querying time series data. E.g: Sensor data
- Document-Oriented data - to store, retrieve and manage document-oriented information, also known as semi-structured data;
- RDF data - to store and query subject-predicate-object triples to be used in the conceptualization taxonomy (Data Harmonization module).

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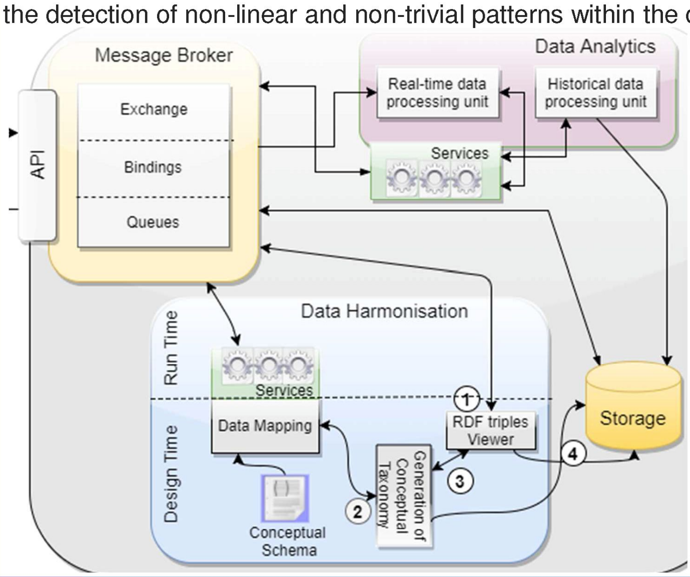
Data Harmonisation

Data Harmonisation has to provide taxonomy connections for vf-OS data, through the detection of non-linear and non-trivial patterns within the data



Design time:

1. Receive vf-OS data
2. Data arrangement
3. Link the data concepts
4. Store data concept connection for future use

Run:

1. Use pre-stored data relations to link vApps' data

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Data Analytics

Data Analytics has to provide analytical processing for sensor data.

Types of Data to be considered:

- Real-time data (alarms, critical actions);
- Historical Data (stored data for a certain period).

Types of algorithms to be used:

- Machine learning algorithms;
- Traditional data-mining algorithms (e.g. decision trees and rules, k-means, association rules).

In development

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Conclusions

- The Data Management Component, to be develop during the vf-OS' WP5, intends to manage data flows for vf-OS platforms.

Message Oriented Middleware	Data Harmonisation and Data Analytics	Data Storage
Data communication management	Transforming and representing data	Store vf-OS data

Main Goals

Scalability	Adaptability

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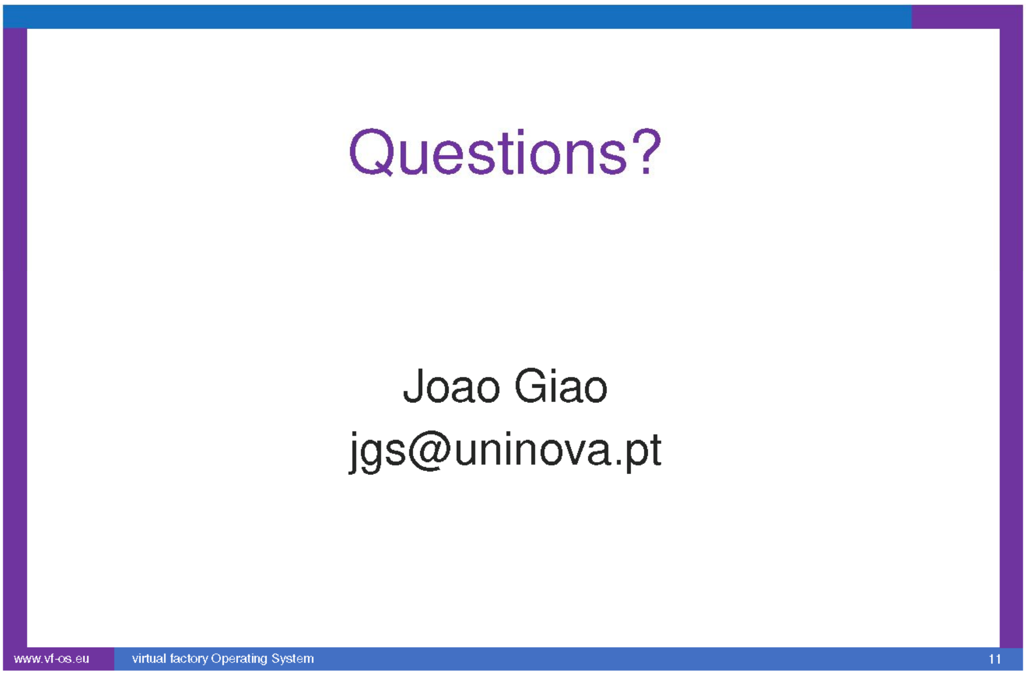
The End


Questions?
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jgs@uninova.pt
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ASCORA
Almende
ICE Information Catalyst
Carlos Coutinho
Luís Lopes
Vítor Viana
Danny Pape
Gerrit Klase
Bastian von Halem
Óscar Garcia
Ludo Stellingwerff
Andries Stam
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2018-03-21 – Berlin, Germany
Carlos Coutinho
CEO
Caixa Mágica Software
i-ESA 2018
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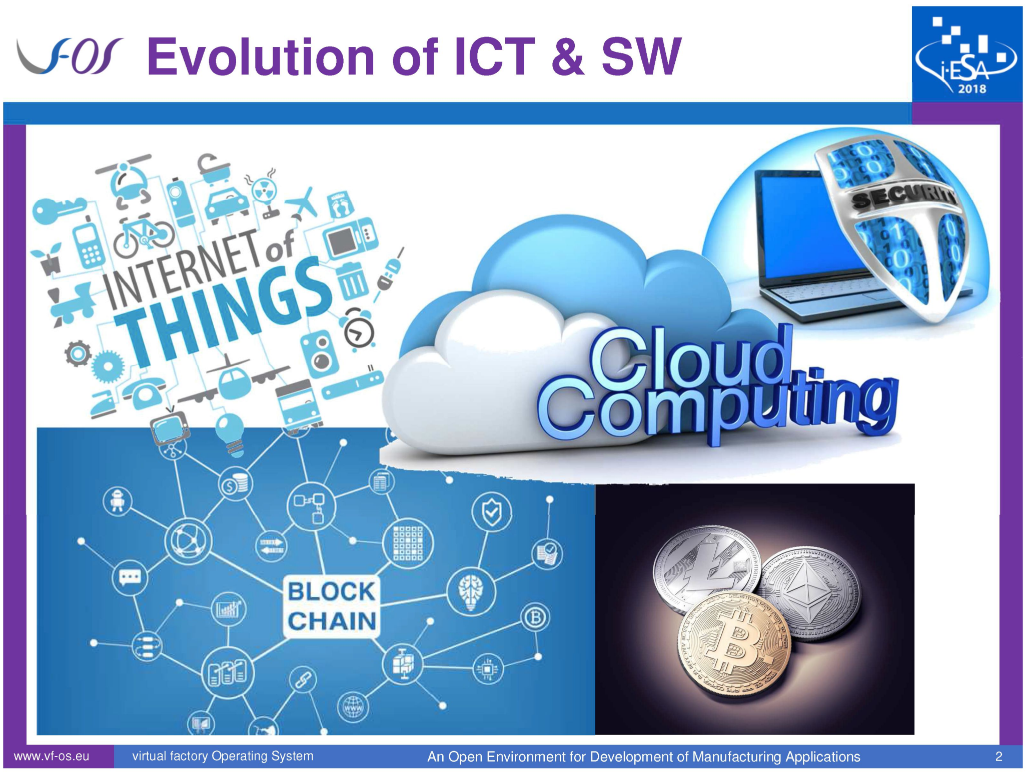
Evolution of ICT & SW
i-ESA 2018
INTERNET of THINGS
SECURITY
Cloud Computing
BLOCK CHAIN
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2


Industrie 4.0
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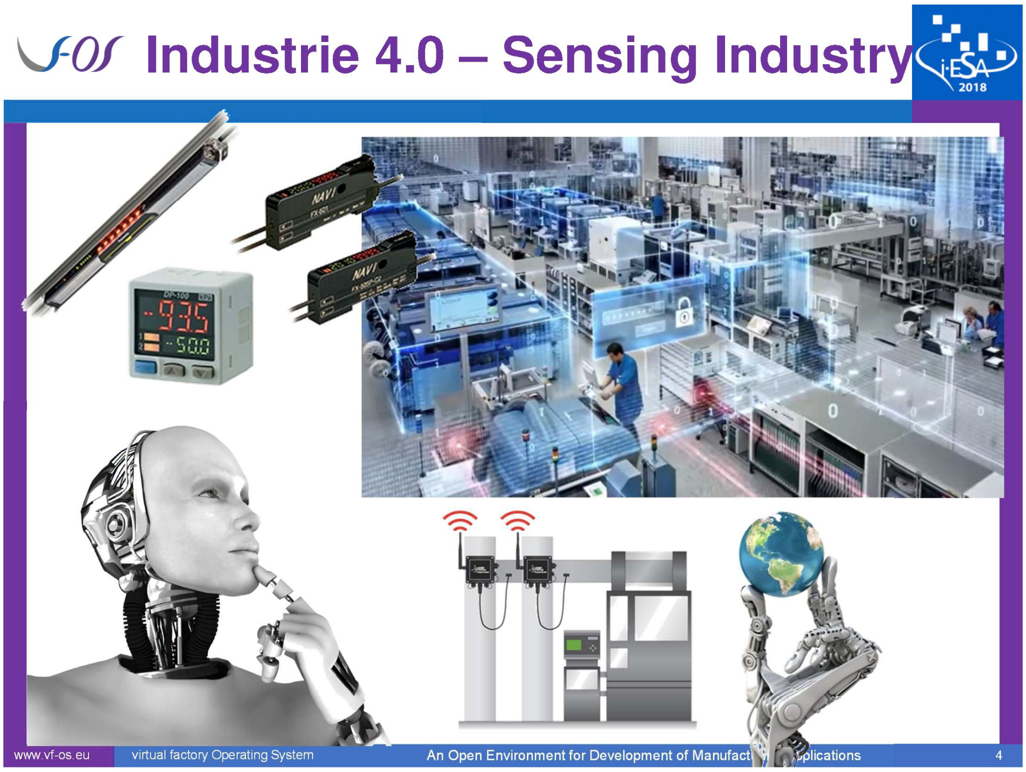
virtual factory Operating System
3


Industrie 4.0 – Sensing Industry
i-ESA 2018
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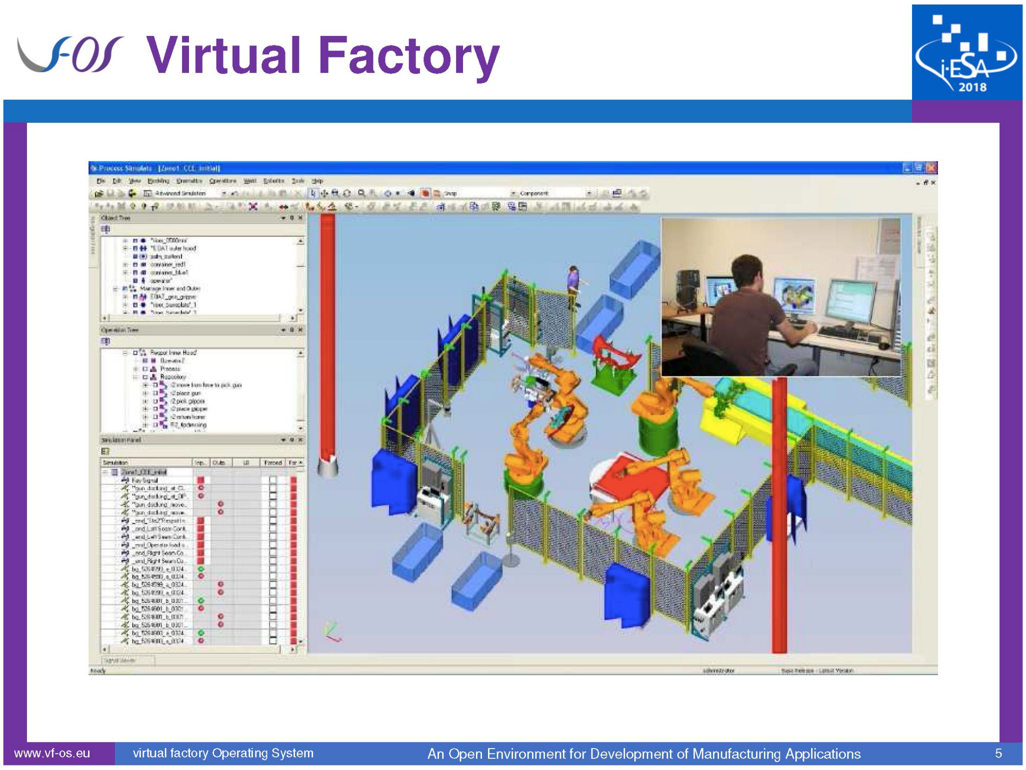
Virtual Factory
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Traditional Operating Systems
2018
User
Application
Operating System
Hardware
Caixa Mágica
Software
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6


Industrie 4.0 Operating System
User
Application
Operating System
Hardware
FIWARE
vApp
i-ESA 2018
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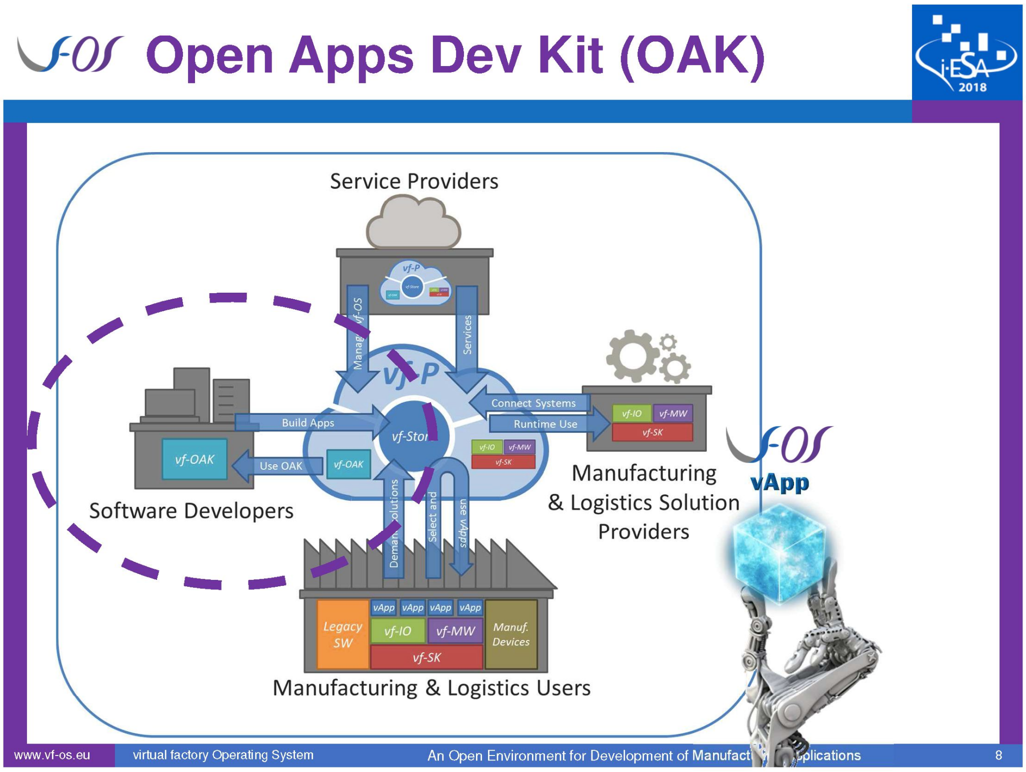
virtual factory Operating System
An Open Environment for Development of Manufact... ...plications
7


Open Apps Dev Kit (OAK)
i-ESA 2018
Service Providers
Services
Build Apps
Use OAK
vf-OAK
Software Developers
Connect Systems
Runtime Use
vf-IO
vf-MW
vf-SK
Manufacturing
& Logistics Solution
Providers
vApp
Legacy SW
Manuf. Devices
Manufacturing & Logistics Users
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8


Open Apps Dev Kit (OAK)
i-ESA 2018
SDK
OPEN SOURCE
vApp
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9


OAK Software Development Kit
i-ESA 2018
FIWARE
ingenico
SDK
WebApp
Tablet
Gaming Console
Mobile Device
Smart Phone
Connected Car
Connected Appliance
API
Websites
Enterprise Apps
Partners
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OAK SDK

- Concentrator for vf-OS resources
- Aggregator of APIs
- Tools & Procedures
- vApp Build and Deploy Libraries
- EFFRA coordination of WG-05 for SDKs

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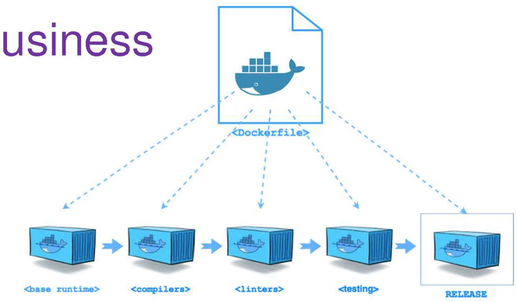
OAK SDK

- Abstraction of the Factory
- Abstraction of the Business
- Distributed Building
- Container isolation
- Interoperability between different systems



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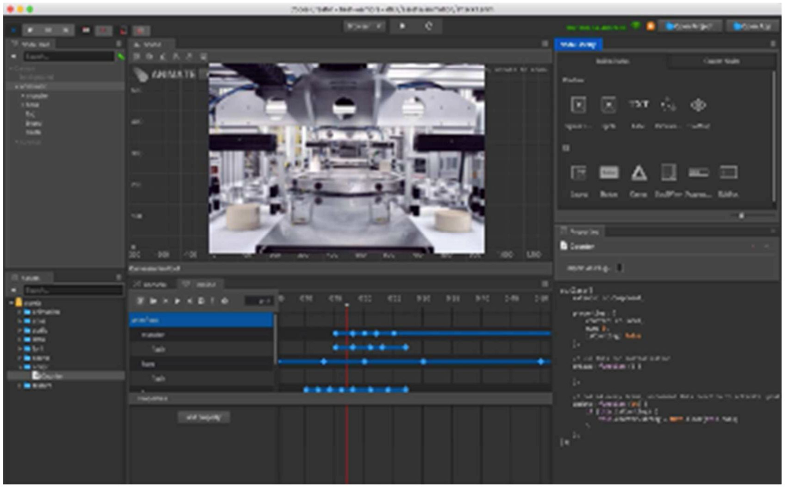
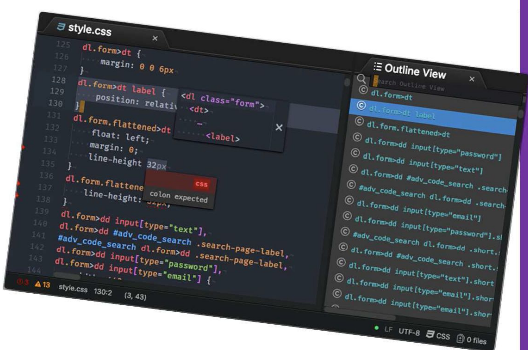
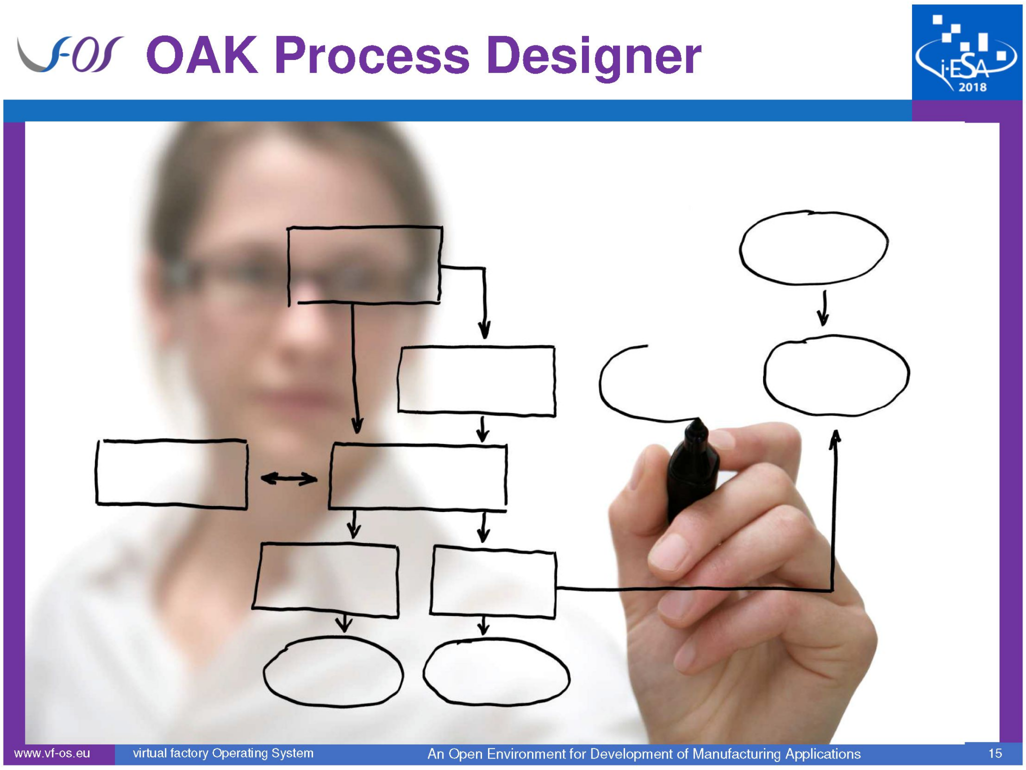
OAK Studio



OAK Studio

- Web-based GUI of the SDK
- Container-Targeted
- Full-featured IDE
  - Syntax Highlighting
  - Drag & Drop
  - Debug
  - …
- Code Editor & Build Interface





vf-OS OAK Process Designer
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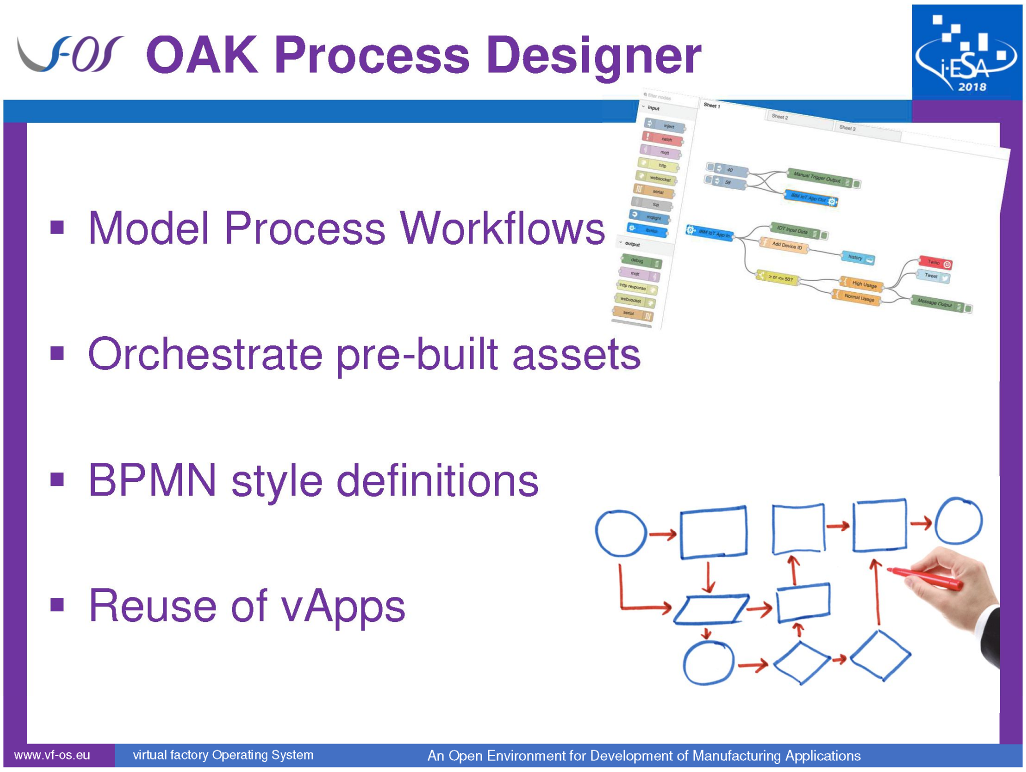

vf-OS OAK Process Designer
i-ESA 2018
Model Process Workflows
Orchestrate pre-built assets
BPMN style definitions
Reuse of vApps
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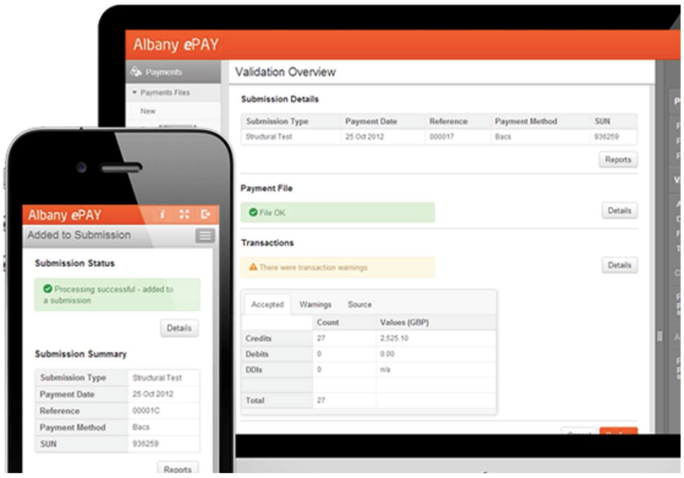
OAK Front End



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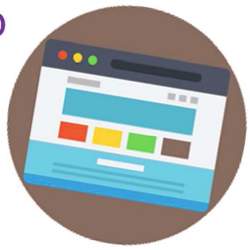
Front End Editor

- Allows simplified input of abstraction layers
- How-tos and auto-complete guides
- Based on Angular and Bootstrap
- Consumable and integratable
- MicroService of the vf-OAK studio



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Front End Editor

- Input:
  - Configuration (languages, etc.)
  - XML / HTML-alike styling for the structure

- Output:
  - Clickable prototype
  - Generates code for further usage

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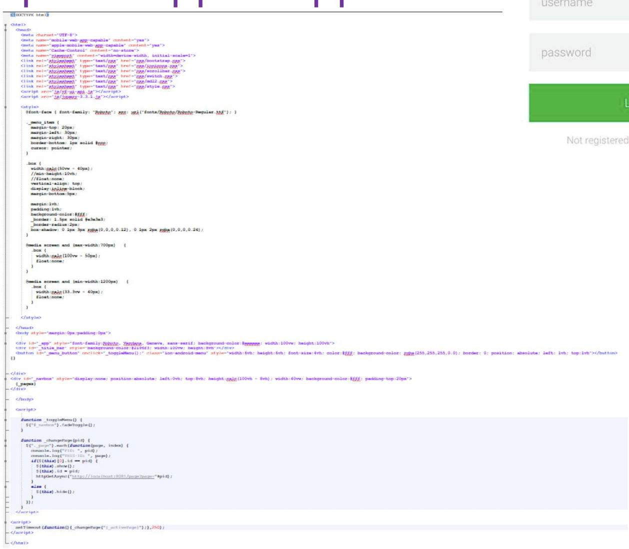
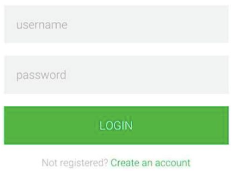
Front End Editor

- Example: <app></app> =





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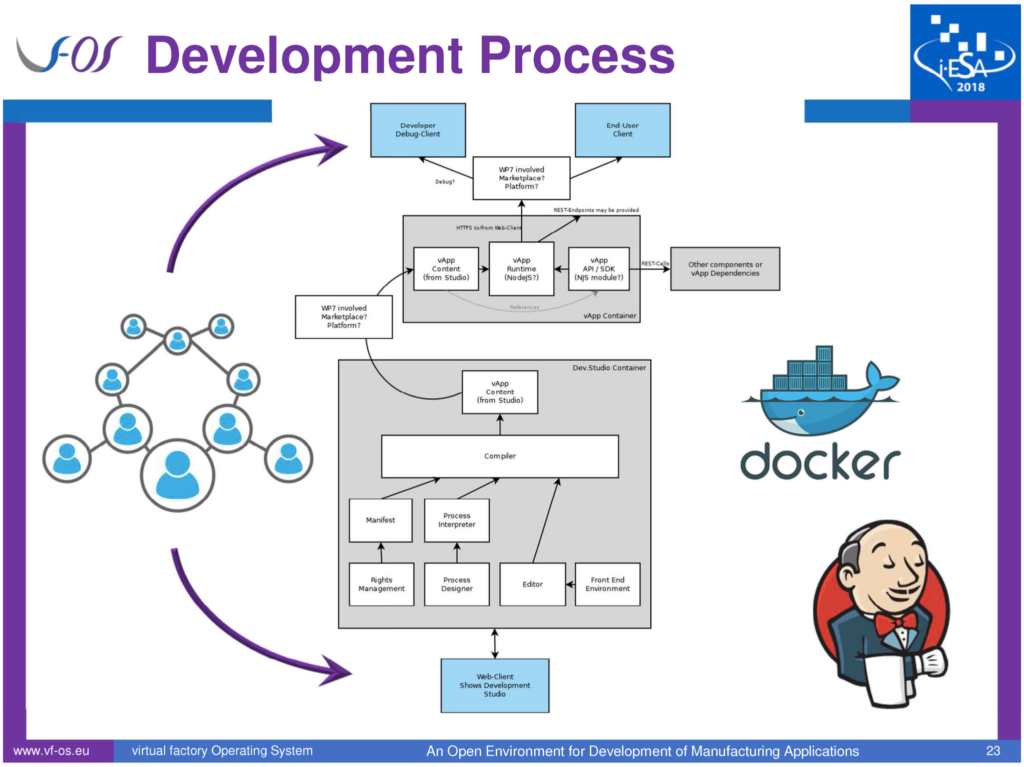
System Dashboards

OAK Dashboards

- Command & Control environment
- Central Dashboard
- Task Manager
- Provides information about runtime vApps


Development Process
i-ESA 2018
Developer Debug-Client
End-User Client
WP7 involved Marketplace? Platform?
Debug?
REST-Endpoints may be provided
HTTPS to/from Web-Client
vApp Content (from Studio)
vApp Runtime (NodeJS?)
vApp API / SDK (NJS module?)
REST-Calls
Other components or vApp Dependencies
References
vApp Container
WP7 involved Marketplace? Platform?
Dev.Studio Container
vApp Content (from Studio)
Compiler
Manifest
Process Interpreter
Rights Management
Process Designer
Editor
Front End Environment
Web-Client Shows Development Studio
docker
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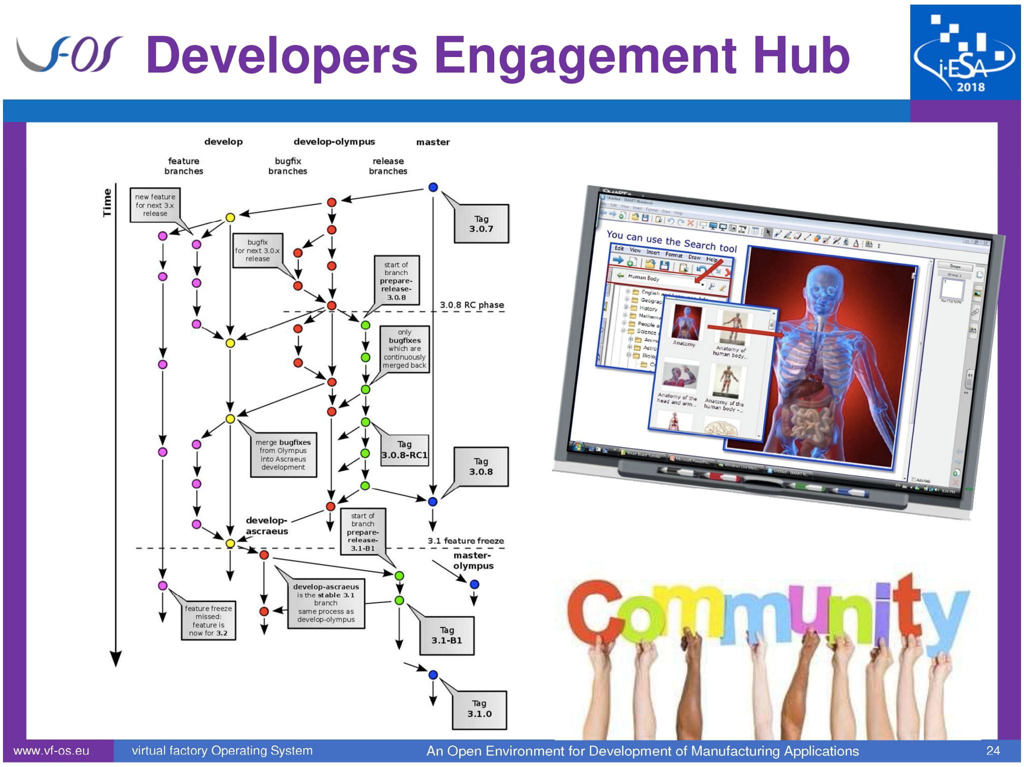
Developers Engagement Hub
i-ESA 2018
develop
develop-olympus
master
feature branches
bugfix branches
release branches
Time
new feature for next 3.x release
bugfix for next 3.0.x release
Tag 3.0.7
start of branch prepare-release-3.0.8
3.0.8 RC phase
only bugfixes which are continuously merged back
merge bugfixes from Olympus into Ascraeus development
Tag 3.0.8-RC1
Tag 3.0.8
develop-ascraeus
start of branch prepare-release-3.1-B1
3.1 feature freeze
master-olympus
develop-ascraeus is the stable 3.1 branch same process as develop-olympus
feature freeze missed: feature is now for 3.2
Tag 3.1-B1
Tag 3.1.0
You can use the Search tool
Community
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Developers Engagement Hub

- Share Code & Development
- Disseminate the vf-Apps
- Promote Reuse
- Promote Development
- Engage Community

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Developers Engagement Hub

- Community Building tools
- Open Source Git Repositories
- Multiple projects and Sub-projects
- Container Technology
- Continuous Integration
- Project Management

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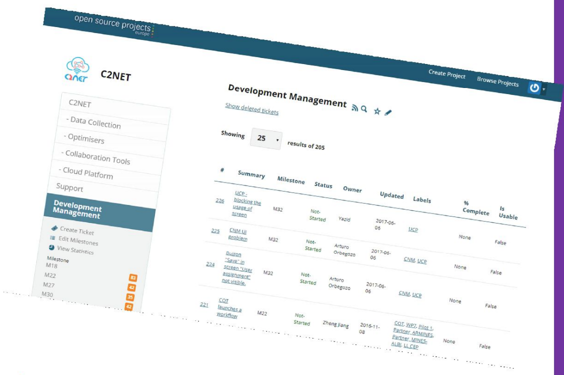
vf-OS Developers Engagement Hub

- Dissemination:
  - Wikis
  - Blogs
  - Forums, etc.
  - Multimedia
- Collaboration:
  - Issue-trackers per Topic
  - Chats
  - Social Networks
  - Gamification



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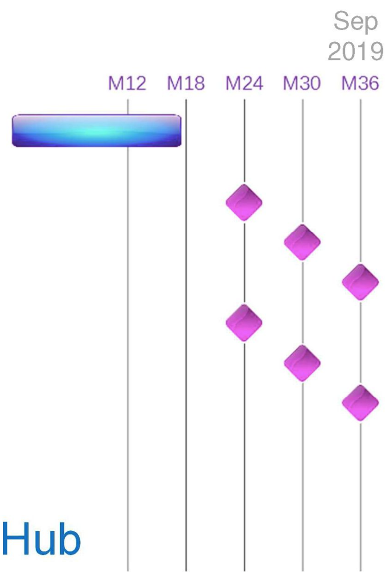
vf-OS OAK Development Timeline

- OAK SDK
- OAK Studio
- Process Designer
- Front End
- System Dashboards
- Developers Engagement Hub



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Questions ?
2018
Carlos Coutinho
CEO / R&D Manager
carlos.coutinho@caixamagica.pt
www.caixamagica.pt
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virtual factory Operating System

vf-OS Workshops Berlin, Germany - 21th March 2018

A novel approach to software development in the microservice environment of vf-OS

almende
ORGANIZING NETWORKS

Luís Manteigas da Cunha, Ludo Stellingwerff and Andries Stam

www.vf-os.eu virtual factory Operating System 1

Presentation

- Introduction
- vf-OS platform
- Development approach
- Conclusions
- Questions

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Introduction

vf-OS

- It is an Open Operating System for Virtual Factories
- Offers a manufacturing oriented cloud platform
- Supports a multi-sided market ecosystem that provides services for the connected factory of the future
- Allows manufacturing companies to develop and integrate better manufacturing and logistics processes

vf-OS is composed of

- Kernel
- Application programming interface
- Middleware specifically designed for the factory of the future

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Introduction

Challenge

Due to the highly distributed microservices architecture used in vf-OS, such an environment poses some challenges for the software development process which will produce the assets

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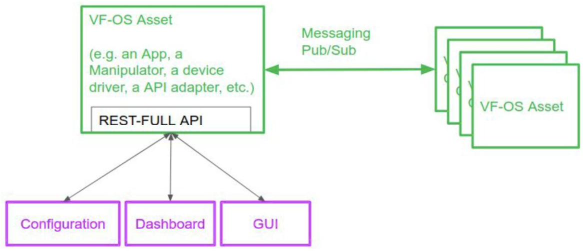
vf-OS platform

Assets encompass

- Services
- Tools
- Applications



Assets interact with each other through web-technologies

- REST-services
- Web-based GUIs
- Modern message busses

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vf-OS platform

The platform allows the assets to run both InCloud or OnPremise

Data might be produced within the factories and it can be used within cloud applications

Security challenges

- To allow the users to control their data dissemination
- Requires security measures to prevent undesired access to machinery and other local resources

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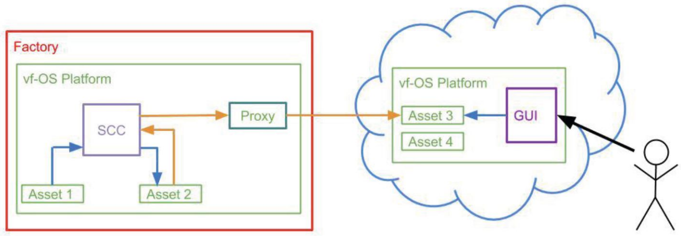
vf-OS platform

An implementation option:



Locally platforms can communicate with a cloud platform through a controlled proxy asset.

The customer application will then run in the cloud platform and only get very controlled access to the data from the factory's premises

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vf-OS platform

vf-OS assets

- Standardized structure and packaging format
- The executable entity will be based on Docker images
- Images will be enveloped in a wrapper structure, containing metadata, like access rules, dependency information and security signatures.
- The assets will be storable in the vf-OS Marketplace and can be bought and deployed into the Execution environment, provided by the Platform

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vf-OS platform

Problem
This distributed environment makes it harder to create consistent, coherent applications, especially with regard to debugging, versioning and other software life-cycle aspects.

Goal
An important part of the goals of the vf-OS project is aimed at providing an answer to these challenges.

Development approach

vApp is the end-user application as an asset.

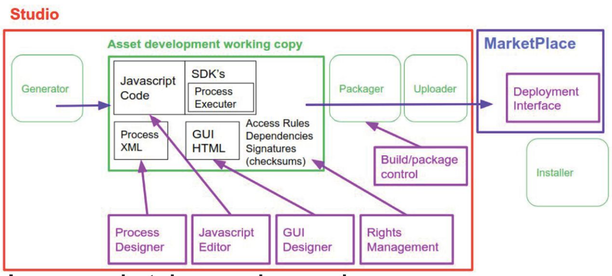
The **vApp development** is the most visible asset development process.

But the development of the other assets within the vf-OS environment is very similar.

It is therefore a good approach to use a **single development model** for both application development and for the development of other assets.

Development approach

vf-OS Studio



- IDE-like application
- The main assets are Javascript-based services
- Several SDKs and Javascript libraries are provided for interacting with other assets
  - Pub/Sub mechanisms, messaging framework and access to storage facilities
- Each service will run in its own docker container

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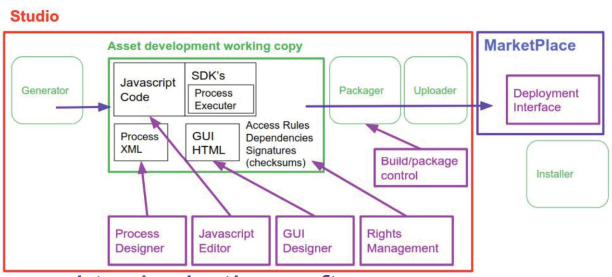
Development approach

MarketPlace



The MarketPlace has several tasks in the software development process:

- A marketing and sales channel
- A services registry
- Hosting of the assets for deployment

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Development approach

External services

External services can be represented in the single development model as well, by encapsulating them into vf-OS Assets.

For this purpose the project provides a support module, called the **External Services Provisioning framework**.

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Conclusions

- The core challenge is software development in such a microservices environment, with the added challenge of security in such a distributed environment
- The solution is to have such an integrated studio, including external services and a proxy model for security.
- The novelness lies in the web-based tooling (e.g.: Eclipse CHE) combined with modern containerization (Docker), Microservices and an OS-like middleware for messaging

Future steps are evaluating this approach, using the projects intermediate releases, use-cases and experimentation.
The results of this evaluation will be reported in similar publications.

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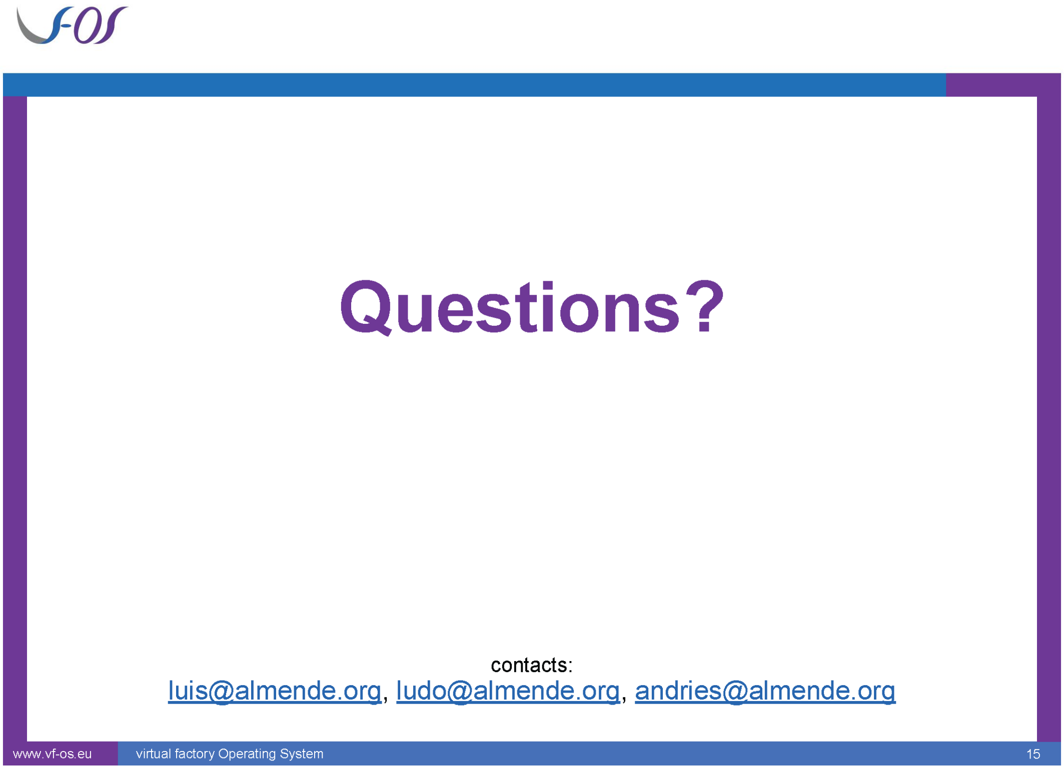
Questions?
contacts:
luis@almende.org, ludo@almende.org, andries@almende.org
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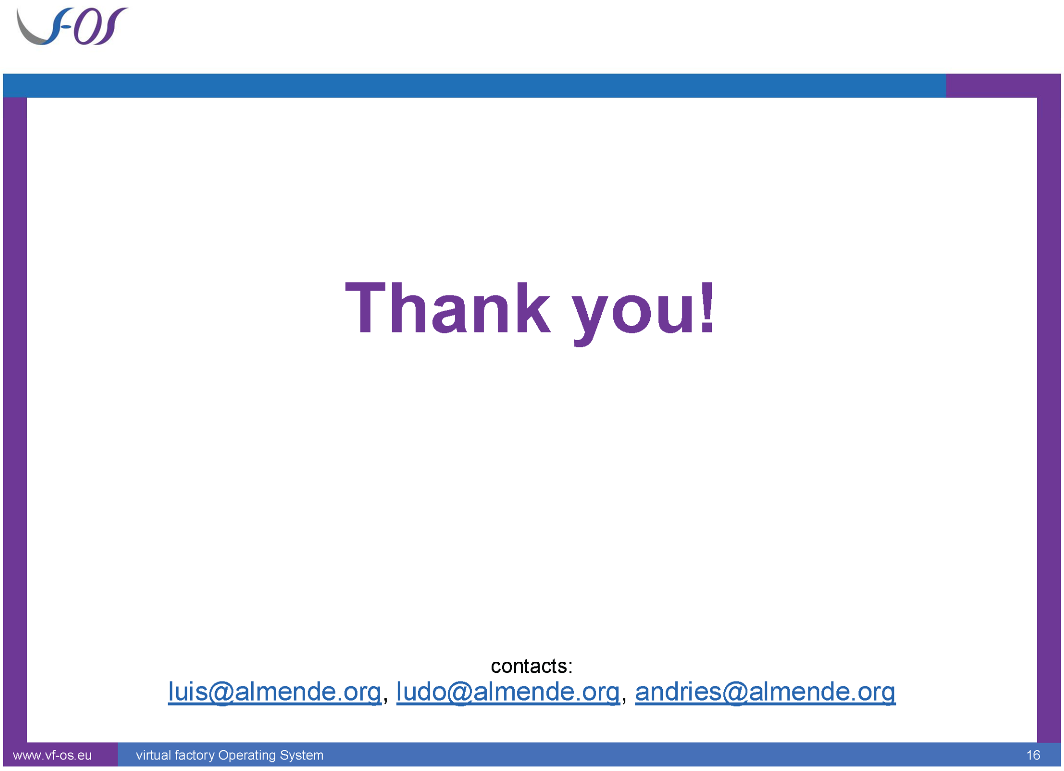
Thank you!
contacts:
luis@almende.org, ludo@almende.org, andries@almende.org
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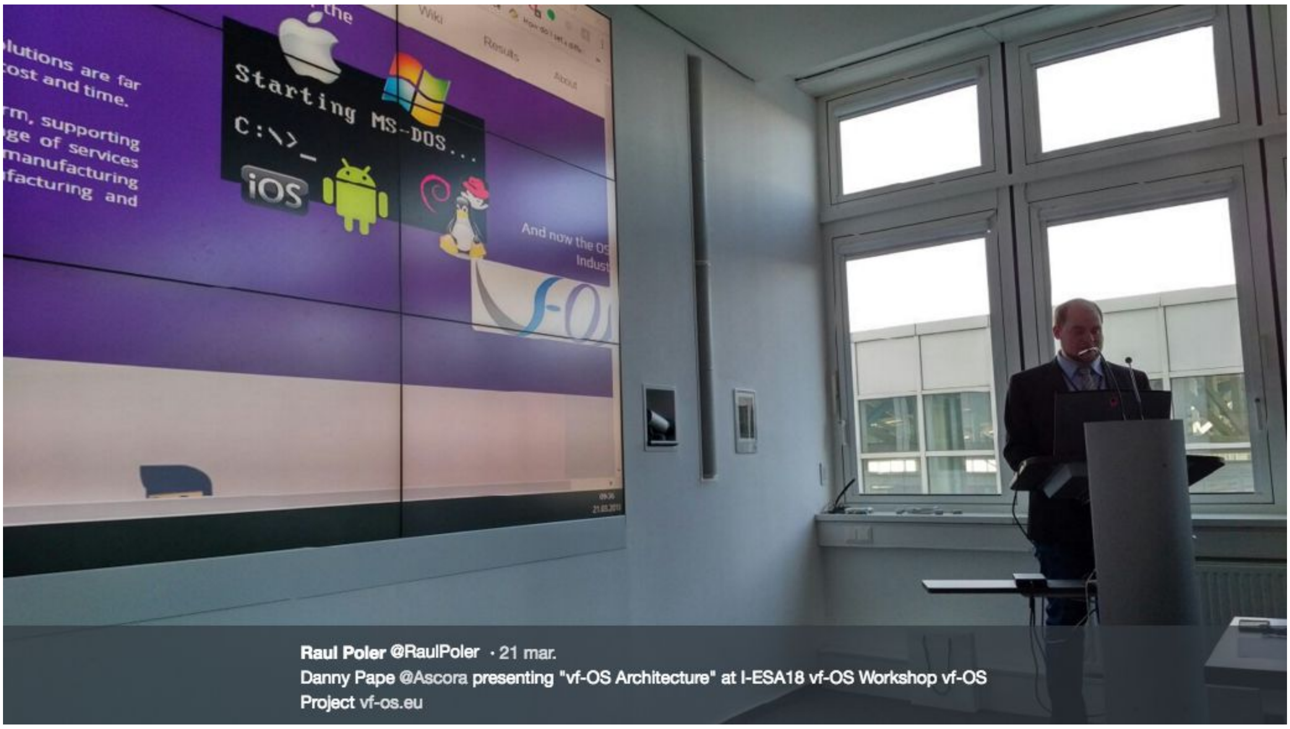
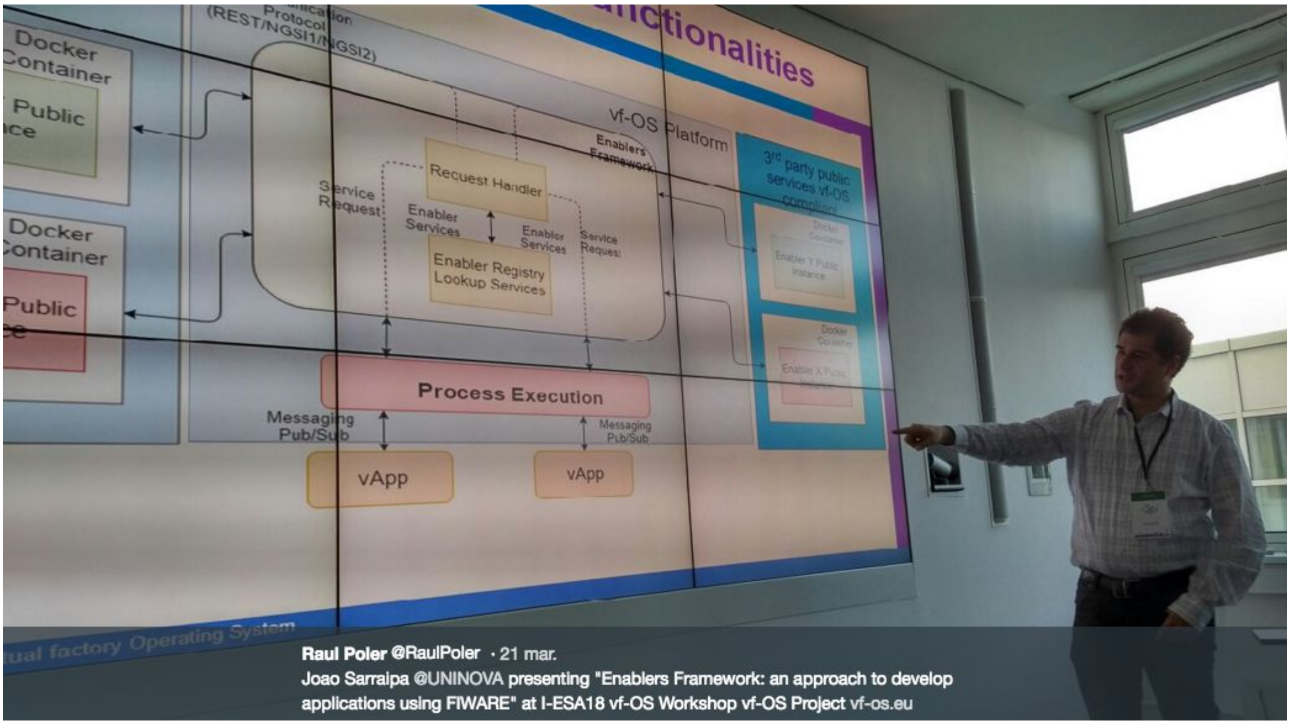
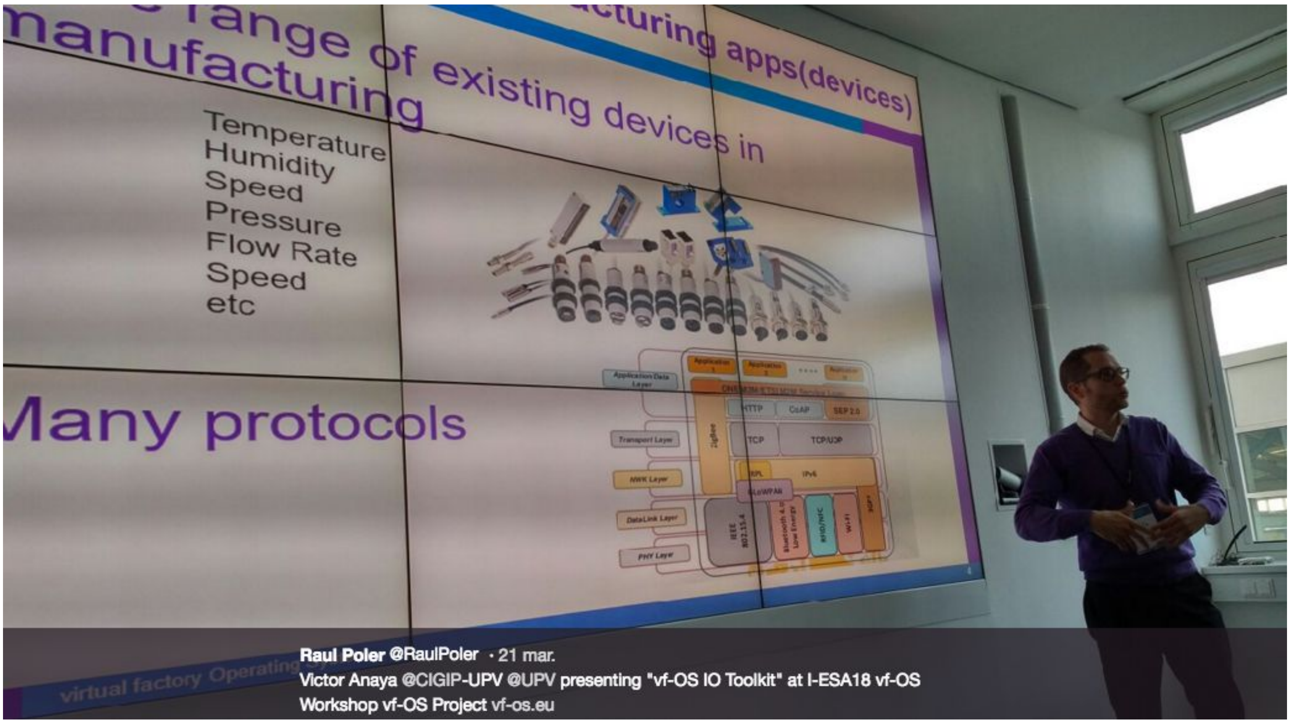
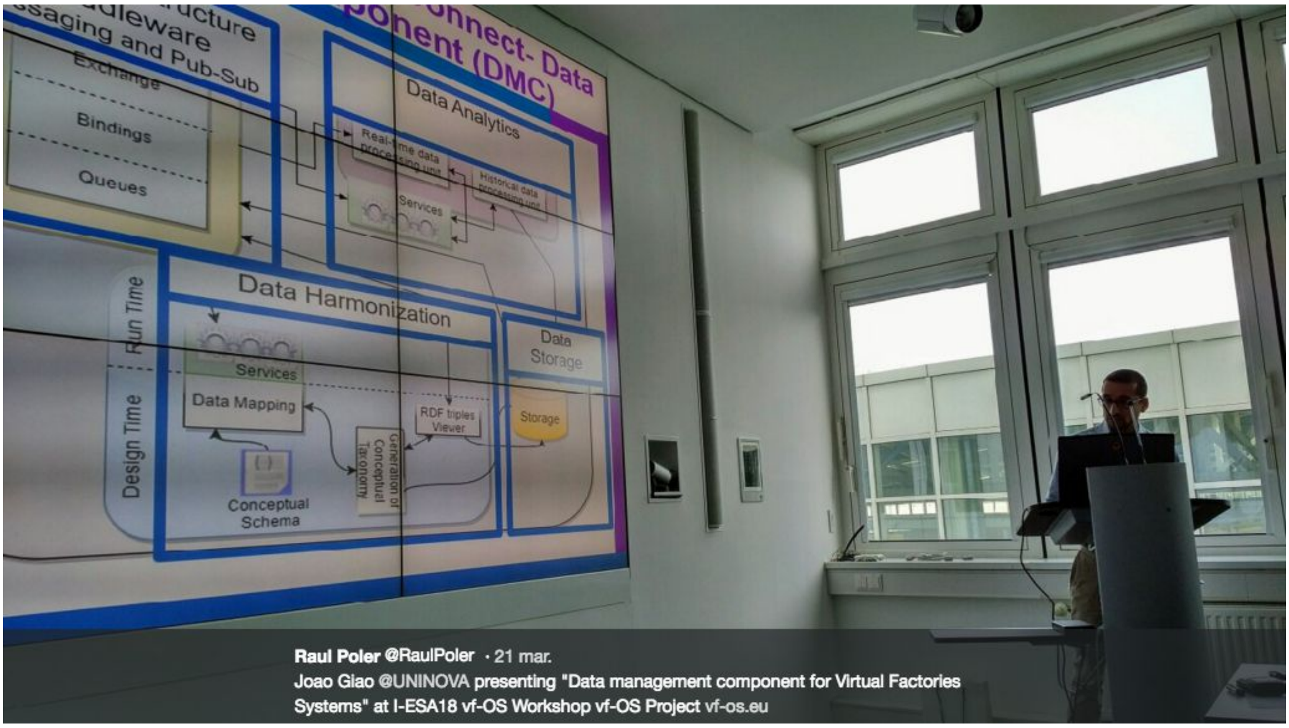
Annex I: I-ESA'18 vf-OS Workshop Pictures

This annex illustrates the I-ESA'18 vf-OS Workshop with some pictures: the workshop opening, the workshop attendees and the papers presentation starting.


Starting MS-DOS...
C:\>_
iOS
And now the OS
Raul Poler @RaulPoler · 21 mar.
Danny Pape @Ascora presenting "vf-OS Architecture" at I-ESA18 vf-OS Workshop vf-OS Project vf-os.eu


Docker Container
Docker Container
vf-OS Platform
Request Handler
Service Request
Enabler Services
Enabler Registry Lookup Services
Process Execution
Messaging Pub/Sub
vApp
vApp
Raul Poler @RaulPoler · 21 mar.
Joao Sarraipa @UNINOVA presenting "Enablers Framework: an approach to develop applications using FIWARE" at I-ESA18 vf-OS Workshop vf-OS Project vf-os.eu


manufacturing
existing devices in
apps(devices)
Temperature
Humidity
Speed
Pressure
Flow Rate
Speed
etc
Many protocols
Raul Poler @RaulPoler · 21 mar.
Victor Anaya @CIGIP-UPV @UPV presenting "vf-OS IO Toolkit" at I-ESA18 vf-OS Workshop vf-OS Project vf-os.eu


Data Analytics
Bindings
Queues
Services
Data Harmonization
Run Time
Design Time
Services
Data Mapping
RDF triples Viewer
Data Storage
Storage
Conceptual Schema
Raul Poler @RaulPoler · 21 mar.
Joao Giao @UNINOVA presenting "Data management component for Virtual Factories Systems" at I-ESA18 vf-OS Workshop vf-OS Project vf-os.eu


HINGS
BLOCK
CHAIN
Cloud
Computing
ctory Operating System
An Open Environment for Development of Manufacturing Applications
Raul Poler @RaulPoler · 21 mar.
Carlos Coutinho @LinuxCM presenting "An Open Environment for Development of Manufacturing Applications on vf-OS" at I-ESA18 vf-OS Workshop vf-OS Project vf-os.eu


SCC
Proxy
Asset 2
GUI
ns can communicate with a cloud platform
olled proxy asset.
application will then run in the cloud platform
ry controlled access to the data from the
ses
Raul Poler @RaulPoler · 21 mar.
Luís Manteigas da Cunha @AlmendeBV presenting "A novel approach to software development in the Applications on vf-OS" at I-ESA18 vf-OS Workshop vf-OS Project vf-os.eu

Annex J: IS'18 vf-OS Workshop Details

Annex K: IS'18 vf-OS Connected Factories Workshop Notes

Agenda 1st DAY
11:00 – Introduction to Connected Smart Factories Workshop – Usman Wajid (Information Catalyst, UK)
11:15 – Enabling Collaborations (Chair: Violeta Damjanovic-Behrendt)

- Automated Negotiations and Trust in the NIMBLE platform (Violeta Damjanovic Behrendt, Salzburg Research, Austria)
  - Links among Federated business process and Multi-Sided platforms. Collaborations to be explored in order to match challenges
  - Multi-sided platform approach in NIMBLE (vf-OS WP9)
  - Automated negotiation -> Which are the main added values comparing the current business process solutions provided by commercial solutions (e.g ERPs)?
  - Registration in the platform to collaborate
- Tender Decomposition & Matchmaking in the DIGICOR platform (Grigory Pishchulov, University of Manchester, UK)
  - Team formation and collaboration mainly among SMEs to respond needs coming from big sectors like the Aerospace
  - Call for tenders -> How to manage common interests of several partners in the same tender parts or components that include these parts? -> What are the rules for doing it in these cases?
  - Call for Tenders -> Who is responsible for managing the platform (the final user (Airbus), tier 1, a third party, …
- Process Orchestration in the vf-OS platform (Oscar Garcia, Information Catalyst, UK)
  - Why do you use of code generation instead of BPMN engines?
  - How is the connection of tasks with the organisation structure (deparments, staff,)?
- Marketplaces in the COMPOSITION platform (Giuseppe Pacelli, Instituto Superiore Mario Boella, Italy)
  - Agent-Based marketplace approach of COMPOSITION (useful for vf-OS WP7 -> vf-Store?)
  - Agent Management System with requester and supplier agents (something useful for ASC?)
  - Security infrastructure (to discuss among ASC, IKERLAN and …)
  - Blockchain -> something to consider in the vf-OS component vf-Store?
  - Clear possibilities of collaboration -> Approaches for ZDMP?
  - What kind of intelligence do agents have in the negotiation? They are some policies associated to the agents
  - Use of reputation model that could be used for DIGICOR (possibility)
  - Are there some kind of traceability of the decision making process? Now there is a log of the process

12:45 – Lunch Break
14:00 – Smart Tools (Chair: Gash Bhullar)

- Smart Monitoring and Control in the DIGICOR platform (Gash Bhullar, SMECluster, UK)
  - Aerospace and Automotive sectors
  - Core platform to offer services to other platforms (eg SME cluster platform)

  - Third party applications connectivity (link to vf-OS External services connection component vf-OS WP5?)
  - OPC-UA compliant for Smart monitoring
  - Production monitoring, IoT Server (COMAU), and Kanban tool
  - Open source implementation of OPC-UA
  - Interoperability among platforms
- Enterprise Integration in the COMPOSITION platform (Marc Jentsch, Fraunhofer FIT, Germany)
  - Intra Factory & Inter Factory
  - Use Cases: Predictive maintenance in a polishing machine (performance improvement), Fill level notification in scrap container (logistics improvement), Equipment monitoring and Line Visualisation (monitoring the full shopfloor processes) & Component tracking (avoid component lost)
  - BPMN used in the third use case
  - RFID Tags for components location?
- SmartFactory SDK of vf-OS (Carlos Coutinho, Caixa Mágica, Portugal)
  - Differences among SDK and IDE -> Studio as the front end of the SDK
  - Reference implementation of the SDK with the idea of being used in other projects
  - Are DIGICOR, NIMBLE & COMPOSITION interesting in SDK?
- IO Toolkitof vfOS (Victor Anaya, Universitat Politècnica de València, Spain)
  - Drivers development using vf-OS approach IO Toolkit (interesting for DIGICOR?)
  - Drag and drop approach
  - Possibility to collaborate in this field with DIGICOR?
- Planning in a distributed supply Chain (Xabier Rakotomamonjy, AIRBUS, France)
  - Coordination transferred from Airbus to Risk Sharing Partners (1st Tier supplier list restricted to a small number of RSP).
  - Offer preparation and management (connected to the Tender presentation of DIGICOR)
  - What is the role of the Tender facilitator? Conducting the process, allocation of partners to components and subcomponents, planning & scheduling, … What is the level of automation?

General discussion

- Problems to test IO Toolkit in real manufacturing scenarios
- How to create a SDK to be used in other projects?
- What is the role of the Tender facilitator?
- How to manage by contract the use of data belonging to different companies? Use of security approaches (command centre in vf-OS)
- Data sharing and privacy as the main barrier for collaboration

15:45 – Coffee Break

16:15 – FIWARE Solutions and Demos (Chair: Carlos Agostinho)

- vf-OS Enablers Framework (João Sarraipa, UNINOVA, Portugal)
  - Enablers including User Interface or not? Current vf-OS position is that an enabler should not include an user interface (it will provide by other vf-OS components. Gash raises a different opinion.
- FIWARE for Industry and OPC UA architecture: an industrial use case (Claudio Palasciano, POLIMI, Italy)
  - CPS-ized production system
- The use of FIWARE enablers in SMECluster portal (Gash Bhullar, SMECluster, UK)
  - Some kind of collaboration among DIGICOR (SMECluster) and vf-OS?

18:00 – End of First Day
Agenda 2nd DAY
11:00 – Business Modelling (Chair: Eduardo Saiz)

- Business Models for Multi-Sided Platforms (Cesar Marin, Information Catalyst, UK)
  - Morphological box for Business models definition (Check it WP9 for potential application)
  - Tender costs improvement as the main revenue generated
  - Currently, only a fix scenario is evaluated -> Focus on DIGICOR profits
- Business Model Simulations for a Smart Factory Platform (Raúl Poler, Universitat Politècnica de València, Spain)
  - Starting with the vf-OS Stakeholders -> Marketplace -> Different approach than in DIGICOR
  - Considering different scenarios
  - Business Model -> How to start with the calculations? Surveys with stakeholders …
  - Not platform functionalities improvements are modeled in the future
  - Simulation tool as a Stakeholders engagement tool
  - Investors interest (tool to convince)
  - Validation the model with some real cases
  - To discuss the use of the simulation toosl by DAEDALUS/NIMBLE, …
- Case Study from L4MS an Open Platform for innovation in Logistic-OPIL (Angelo Margulo, Engineering, Italy)
  - Productivity but also flexibility
  - Stakeholders: Mid-Caps, Competences centres, Business developers, Technologies suppliers
  - Application experiments
  - Open Platform and a Marketplace -> What kind of business models are defined for going to the market?
  - Business developers for helping to open new business
  - Go the market not only to the companies that demand this kind of services
- Technology platforms and ecosystems, who drives the success? The case of the DAEDALUS platform (Andrea Barni, SUPSI-ISTePS, Switzerland)
  - IEC61499 Standard
  - vf-OS Technology suppliers -> Marketplace. Could be shared with vf-OS marketplace (vf-Store): control software, APIs, drivers, ….?
  - IBM App Store -> Big coincidence with vf-Apps approach
  - DEADALUS Competence Centre
  - Individual Business Models and Business Plans. Are there some Joint Business Models?

General questions

- Multi-side platform – Roles of different stakeholders and benefits for them
- How complicated is to apply this tool to other projects? Customisation, experts software developers, licensing
- What about the figures? Different scenarios implies different outcomes (prediction) How to control the evolution of real figures when the product is introduced in the market
- What is the business model to exploit the platform (commercialisation, product development, support, …? Only individual-joint exploitation, Key project partner, Start-up, …
- How about data security and privacy? Some especial contract, technologies involved, …

12:45 – Lunch Break

14:00 – Big Data Management (Chair: Marc Jentsch)

- The Use of Deep Learning techniques in the COMPOSITION platform (Paolo Vergori, Instituto Superiore Mario Boella, Italy)
  - Artificial Neural Networks in Industry 4.0 -> Deep Learning
  - BSL Use Case: Predictive maintenance (2 ovens) -> dataset with 625.000, 350.000 samples, 60 sensors, ..
  - Interesting for prediction vApp? (MASS) (WP8) -> To sent presentation to Asier and Juan
  - Successful tests in Laboratory -> Ready to go with real validation
  - ELDIA: Agent-based marketplace estimation (4 raw materials markets)
- Product and Service Catalogue Management in the NIMBLE platform (Wernher Behrendt, Salzburg Research, Germany)
  - Enable the federation of B2B Platforms
  - Product Catalogue: UBL/DOM.ONTO/eCl@ss Ontologies
- - IoT Data Harmonisation in vf-OS (Oscar Garcia, Information Catalyst, UK)
  - Data Manufacturing Maps, Data formats
  - Who can provide the semantic maps? Recommendation for something from the companies with the required knowledge
  - How about crowsourcing? As much maps contributions the reference model will be richer
  - Have you done some statistics?
  - How often have to do these maps?

15:45 – Coffee Break

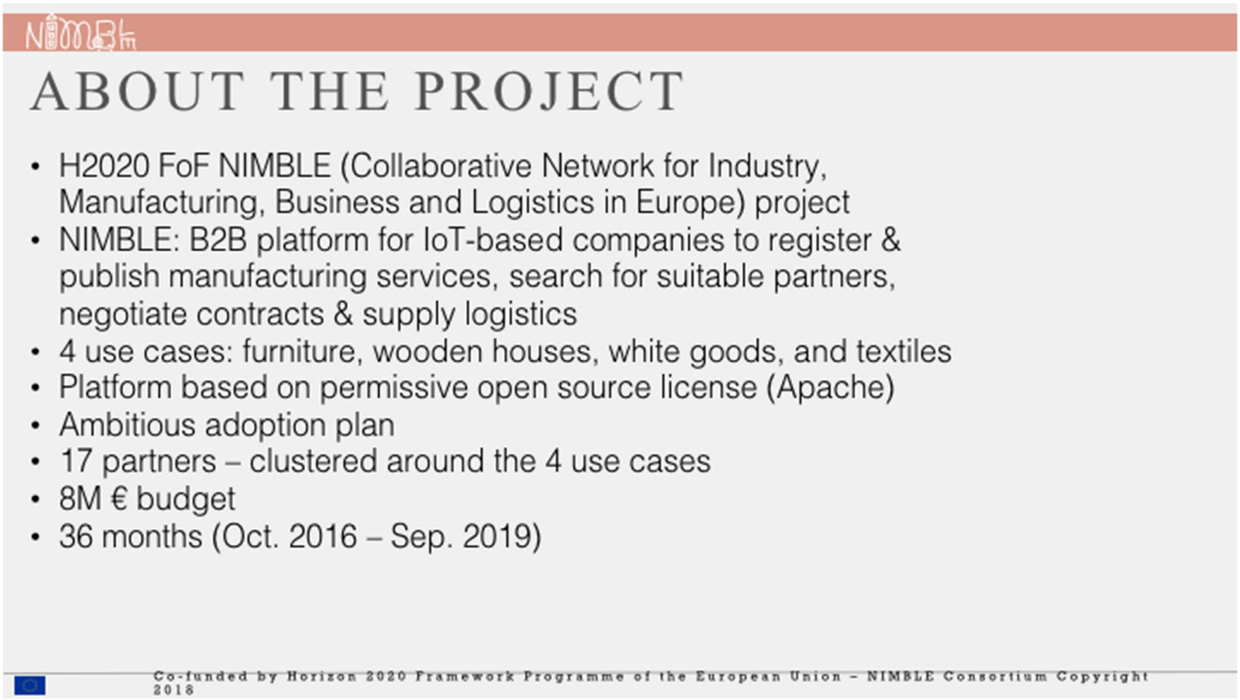
16:15 – Round Table Discussion (Chair: Usman Wajid)

- Challenges for Connected Smart Factories
  - Start ups: Governance procedures -> High percentage of communality
  - Availability of guidelines to support its definition
- Impact of FIWARE on Connected Smart Factories
  - vf-OS Enablers Framework -> To be used in DIGICOR
- Analysis of automation and digitalisation in the manufacturing value chain
  -
- Common goals and collaboration opportunities
  -

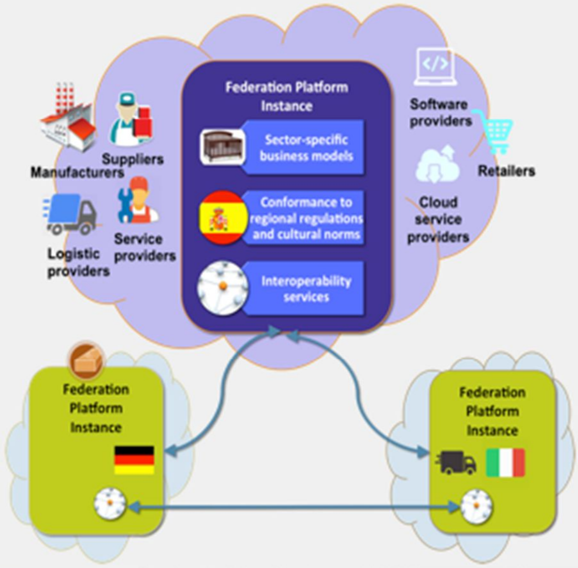
18:00 – End of Second Day

Annex L: IS’18 vf-OS Workshops presentations

This section presents the different presentations performed in the vf-OS workshop organised during the Intelligent Systems 2018 conference at Madeira, Portugal.



CONCEPT OF WORK



- Multi-Sided Platform (MSP)
- Federated cloud-based businesses
- Reduced search costs and shared transaction costs among participants
- Collaborative business processes
- Cybersecurity risks and possible harm to MSP participants

NIMBLE platform	• Core functionality (registration of users and comp.; catalogue pub.;	• All GUIs functioning	• Support for different platform instances (federation services)
Tools	• Search functionality • Simple negotiation	• Semantic search • Agent-based negotiation	• Advanced negotiation • Customizable business workflows
Security	• User authentication, Role-based AC	• Context-based AC; Sec. dashboard	• Trust and reputation
Industry connectivity	• Data channels for remote monitoring	• Support for additional standards, e.g. oneM2M	
Tool store	• Third party APIs	• Testing environment	
Infrastructure	• Infrastructure services running	• Centralized logging and monitor	• Advanced infrastructure diagnostics
Use cases Integration	• Partial	• Access from the 3rd party apps	• Integration of extern. adopters
Developers support	• Basic documentation	• More detailed documentation	• Extensive documentation
Community support	• Early adopters programme for companies and platform providers	• Access to testing version • Subscription to platform	• Subscription to federated platforms

NIMBLE

FUNCTIONALITIES TO BE AUTOMATED

- Release 3 (July 2018) functionality: https://www.youtube.com/watch?v=T-eVQDlhijM
- reviewing negotiation processes for inefficiencies & reinventing business models, strategies and platform technological capabilities

NIMBLE functionalities to be automated

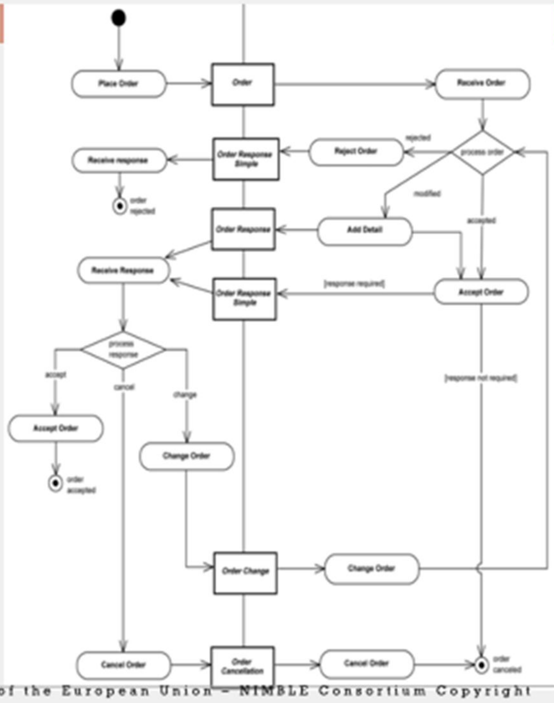
1. Negotiation of order placement and execution
2. Negotiation of supply chain and logistics processes
3. Negotiation and collaboration through data channels
4. Trust negotiation

NIMBLE

AUTOMATED NEGOTIATION OF ORDER PLACEMENT AND EXECUTION

- UBL order process
- Current functionalities of the platform:

1. inventory management
2. order placement
3. order routing



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NIMBLE

AUTOMATED NEGOTIATION OF ORDER PLACEMENT AND EXECUTION

- *Challenge 1*: the ability of the platform to track and verify products at any stage - in design, development, production, in shipment and possibly - at customer sites

- Visualization on the location, status and environment of assets using the **IoT + Computer Vision + data analytics** applications
- **Sensors & smart cameras** embedded in production machines, logistics facilities, vehicles, raw materials and products themselves to enable tracking and monitoring conditions in real time, as well as the speed and timeliness of shipment. They contribute to the product quality and (early) defect elimination
- **Data analytics** contribute to inventory replenishment and the requirements of customer's demand for specific products

-> NIMBLE data channels !!!

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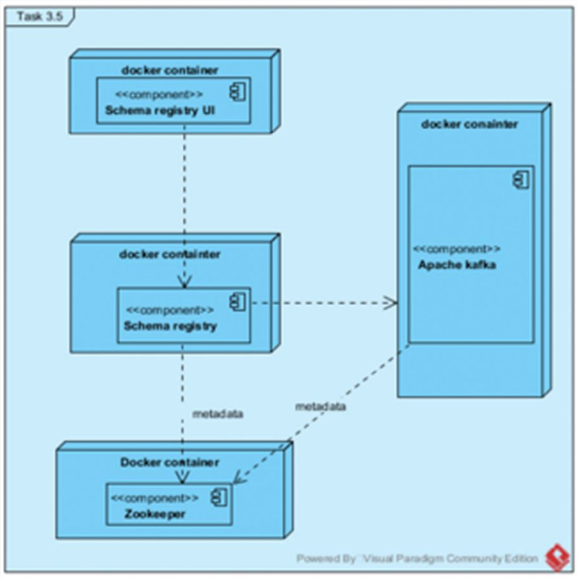
NIMBLE

AUTOMATED NEGOTIATION OF ORDER PLACEMENT AND EXECUTION

- NIMBLE data channels
- see Release 3, from 24:50: https://www.youtube.com/watch?v=T-eVQDlhijM

- Apache Kafka (open source messaging infrastructure & streaming platform)
- Zookeeper (service for maintaining configuration information, naming, providing distributed synchronization and group services)
- Schema Registry (metadata service registry)



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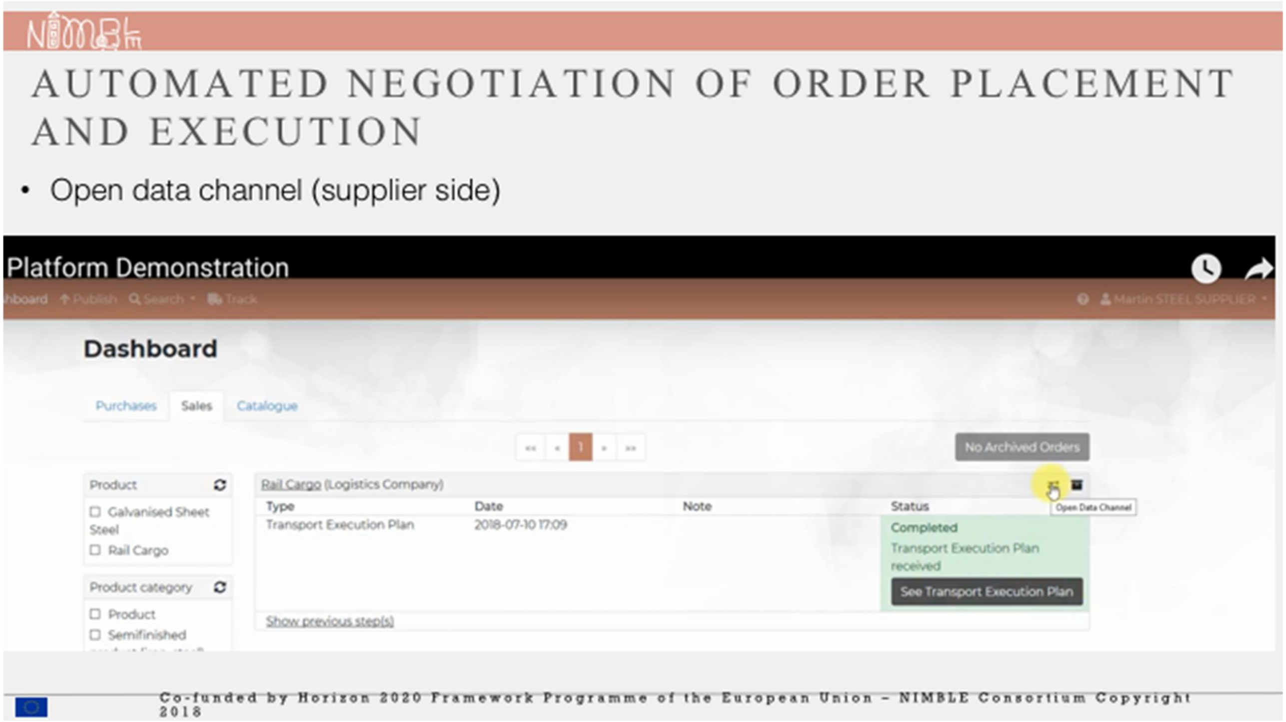
AUTOMATED NEGOTIATION OF ORDER PLACEMENT AND EXECUTION
• Open data channel (supplier side)
Platform Demonstration
Dashboard
Purchases
Sales
Catalogue
No Archived Orders
Product
Galvanised Sheet Steel
Rail Cargo
Product category
Product
Semifinished
Rail Cargo (Logistics Company)
Type
Date
Note
Status
Transport Execution Plan
2018-07-10 17:09
Completed
Transport Execution Plan received
See Transport Execution Plan
Open Data Channel
Show previous step(s)
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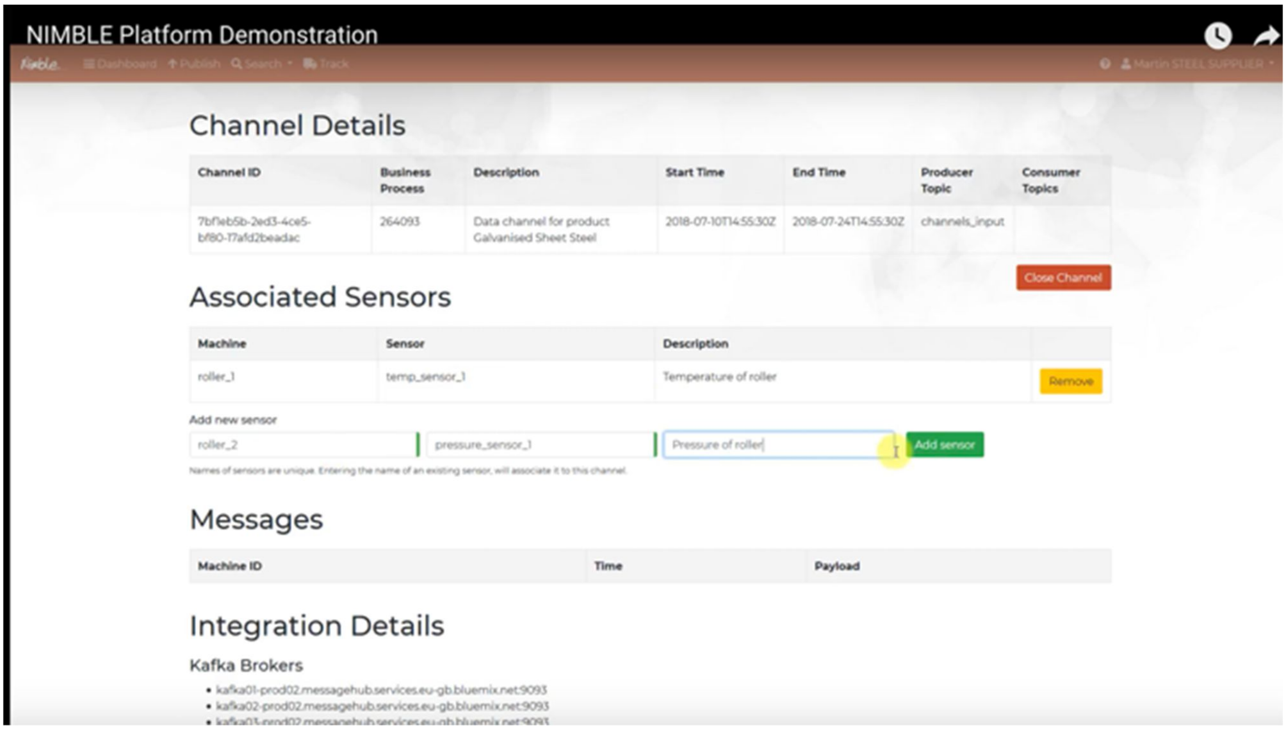
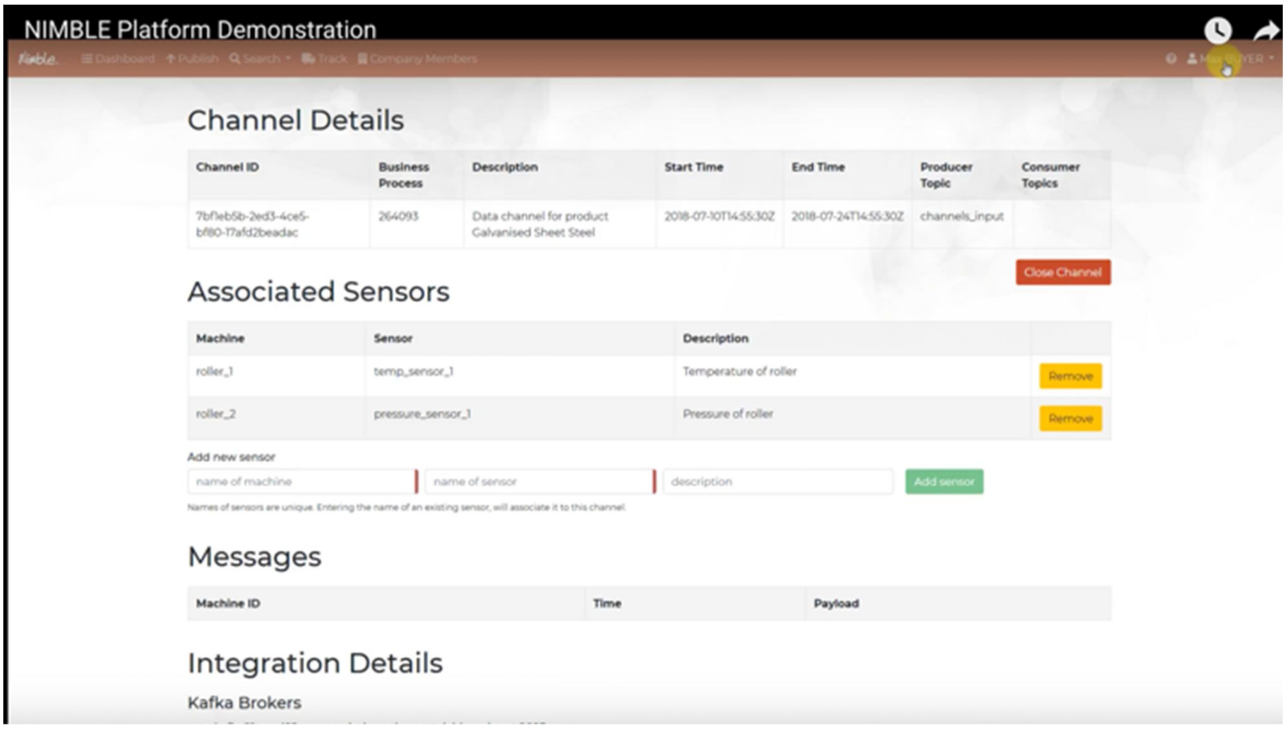
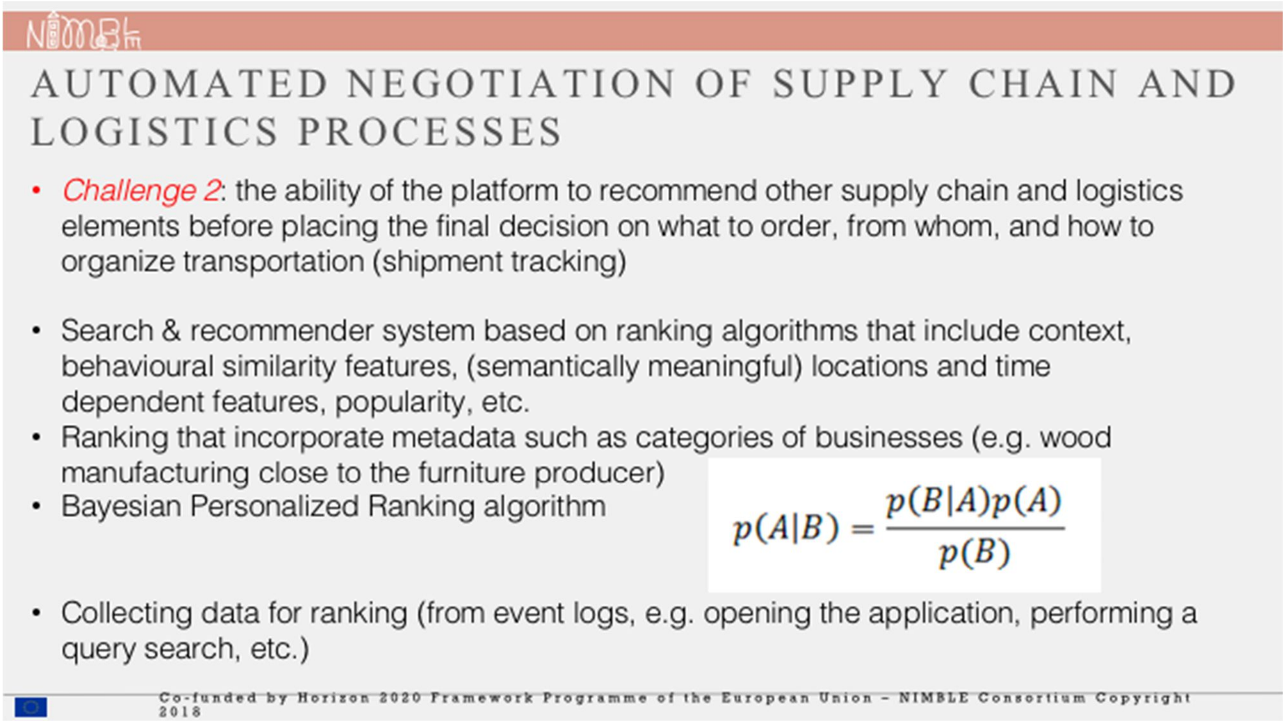

NIMBLE Platform Demonstration
Channel Details
Channel ID
Business Process
Description
Start Time
End Time
Producer Topic
Consumer Topics
7bf1eb5b-2ed3-4ce5-bf80-17afd2beadac
264093
Data channel for product Galvanised Sheet Steel
2018-07-10T14:55:30Z
2018-07-24T14:55:30Z
channels_input
Close Channel
Associated Sensors
Machine
Sensor
Description
roller_1
temp_sensor_1
Temperature of roller
Remove
Add new sensor
roller_2
pressure_sensor_1
Pressure of roller
Add sensor
Messages
Machine ID
Time
Payload
Integration Details
Kafka Brokers
kafka01-prod02.messagehub.services.eu-gb.bluemix.net:9093
kafka02-prod02.messagehub.services.eu-gb.bluemix.net:9093


NIMBLE Platform Demonstration
Channel Details
Channel ID
Business Process
Description
Start Time
End Time
Producer Topic
Consumer Topics
7bf1eb5b-2ed3-4ce5-bf80-17afd2beadac
264093
Data channel for product Galvanised Sheet Steel
2018-07-10T14:55:30Z
2018-07-24T14:55:30Z
channels_input
Close Channel
Associated Sensors
Machine
Sensor
Description
roller_1
temp_sensor_1
Temperature of roller
Remove
roller_2
pressure_sensor_1
Pressure of roller
Remove
Add new sensor
Add sensor
Messages
Machine ID
Time
Payload
Integration Details
Kafka Brokers


AUTOMATED NEGOTIATION OF SUPPLY CHAIN AND LOGISTICS PROCESSES
Challenge 2: the ability of the platform to recommend other supply chain and logistics elements before placing the final decision on what to order, from whom, and how to organize transportation (shipment tracking)
Search & recommender system based on ranking algorithms that include context, behavioural similarity features, (semantically meaningful) locations and time dependent features, popularity, etc.
Ranking that incorporate metadata such as categories of businesses (e.g. wood manufacturing close to the furniture producer)
Bayesian Personalized Ranking algorithm
$p(A|B) = \frac{p(B|A)p(A)}{p(B)}$
Collecting data for ranking (from event logs, e.g. opening the application, performing a query search, etc.)
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NIMBLE

AUTOMATED NEGOTIATION OF SUPPLY CHAIN AND LOGISTICS PROCESSES

Some examples of data to be used for NIMBLE ranking algorithms:

Distance between the buyer and the seller

Properties of the seller

- How popular/ highly rated is the company?

Properties of the buyer

- How many times has the buyer checked in here? When? Behavior (liked/disliked the seller or any seller's product in the past)

Time of the day

- Is the company open right now? How popular is the company?

Properties of the company's social network

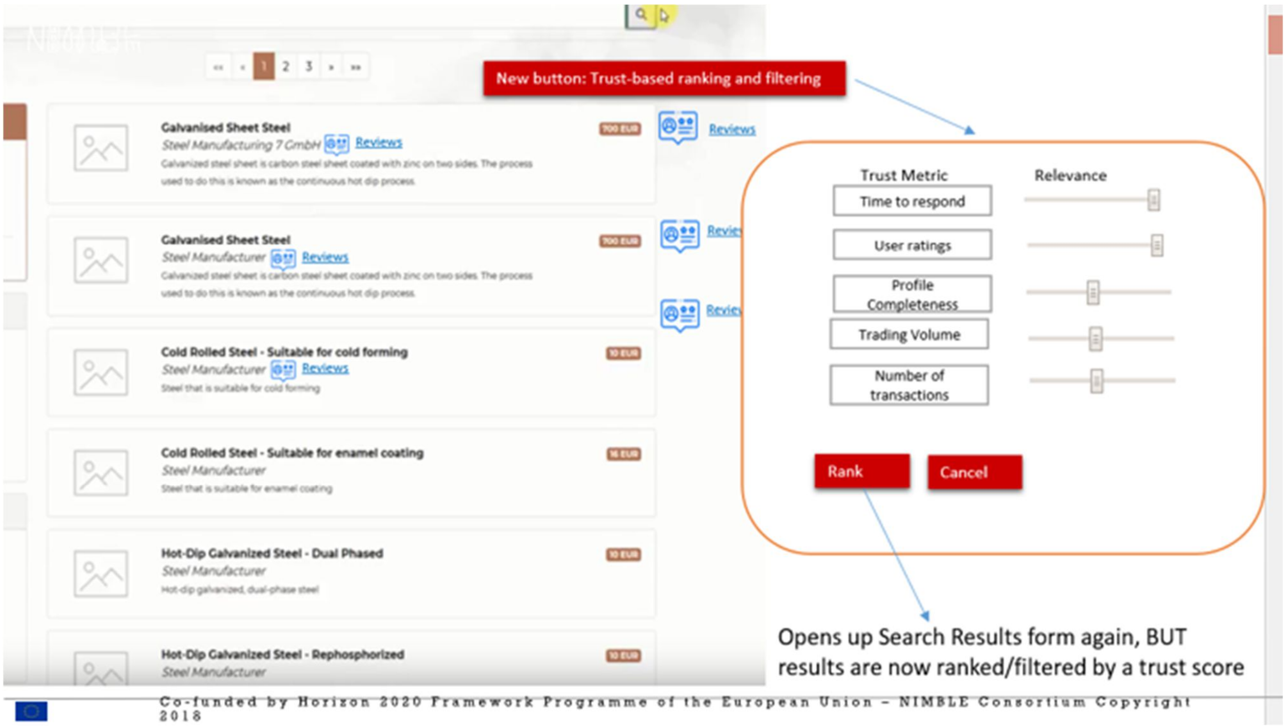
NIMBLE

AUTOMATED NEGOTIATION OF SUPPLY CHAIN AND LOGISTICS PROCESSES

- *Challenge 3*: the ability of the platform to trace supply chain and logistics using blockchain
- **The digital ownership certificate** - the blockchain stores an ownership relation by storing physical properties of the asset, e.g. a serial number, the wallet of the owner …
- **Tracking down assets and assembly in the supply chain** – for each transaction, the blockchain can provide information on the involved parties, the timestamps, notifications about the execution of various steps …
- **Trusted devices** - have a cryptographic identity and should be resistant to misuse. They can be used to automatically update the tracking information in case of a goods delivery.

AUTOMATED TRUST NEGOTIATION

- *Challenge 4*: the ability of the platform to create and use trust and reputation features of business entities for search and recommendation
- Collecting ranking data (explicit ranking (could be influenced by social trends), implicit ranking (what events occurred between the users?)), user behaviour/taste …
- Model training phase – with various levels of “personalization”, from fully personalized (based on personal taste/needs) to the most popular content (non-personalized content)
- Filtering based on similarity measurements (between items, between users…)
- Model evaluation phase – e.g. implementing the Mean Average Precision in the trust system



CONCLUSION

- *Challenge 1*: NIMBLE Data Channels for tracking and verifying products at any stage, at manufacturer side - in design, development, production
- *Challenge 2*: NIMBLE supply chain and logistics recommender service - what to order, from whom, and how to organize transportation
- *Challenge 3*: NIMBLE blockchain-based tracing and tracking service
- *Challenge 4*: NIMBLE automated trust-based search and negotiation

THANK YOU FOR YOUR ATTENTION

Violeta Damjanovic-Behrendt
Senior Researcher
Salzburg Research, Austria
E-Mail:
violeta.damjanovic@salzburgresearch.at

Salzburg Research Forschungsgesellschaft m.b.H.
Internet of Things / Industrial Internet
Jakob-Haringer Strasse 5/II
5020 Salzburg
Austria

JOIN THE PLATFORM:

HTTPS://NIMBLE-PLATFORM.SALZBURGRESEARCH.AT/NIMBLE/FRONTEND/

Tender decomposition and matchmaking in the DIGICOR platform

Grigory Pishchulov, Sonia Cisneros-Cabrera, Pedro Sampaio, Zixu Liu, Sophia Kununka, Nikolay Mehandjiev

University of Manchester, UK
St. Petersburg State University, Russia

Connected Smart Factories Workshop
9th international Conference on Intelligent Systems, 25-27 September 2018, Madeira

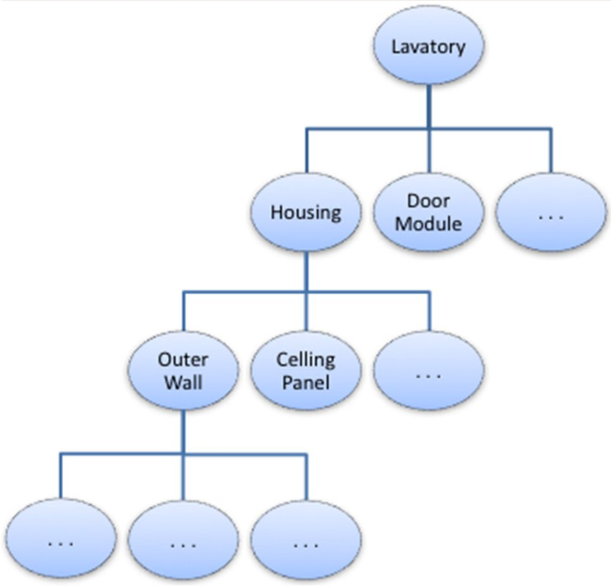
Agenda

1. Introduction
2. Call for tenders
3. Tender decomposition
4. Matchmaking
5. Conclusion

Introduction

Matchmaking

Demand

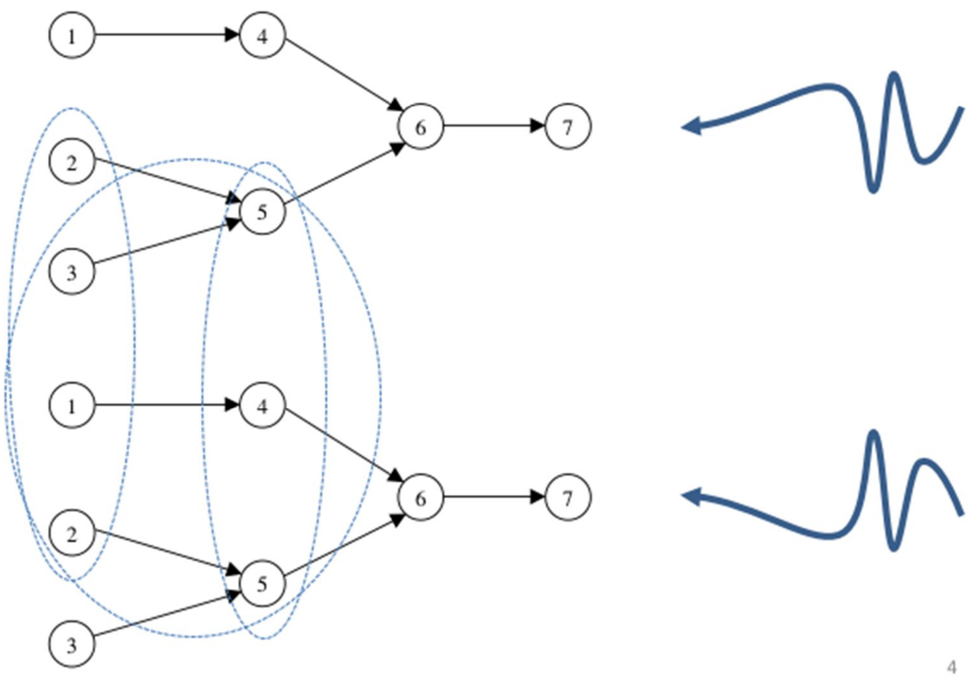


Supply

Company	Product	Capabilities	. . .
Company 1	Lavatories	Make	
Company 2	Lavatories	Design, Manage	
Company 3	Door Modules	Make, Deliver	
Company 4	Housing	Design, Make	
Company 5	Outer Walls	Make, Deliver	
Company 6	Outer Walls	Design, Manage	
Company 7	Outer Walls	Deliver	
Company 8	Celling Panels	Design, Deliver	
Company 9	Celling Panels	Design, Make	
Company 10	Celling Panels	Make, Manage	
....	....	....	

3

Introduction



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Artwork: Majumder and Srinivasan (2008)

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The University of Manchester

Call for tenders (CfT)

1. **Target item**
   » ontology
2. **Associated goals**
   » design
   » make
   » deliver
3. **Capabilities required**
   » certification
   » min. turnover
   » min. number of employees
4. **Capabilities desired**
   » industry branch, technology, materials, target regions

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Agenda

1. Introduction
2. Call for tenders
3. Tender decomposition
4. Matchmaking
5. Conclusion

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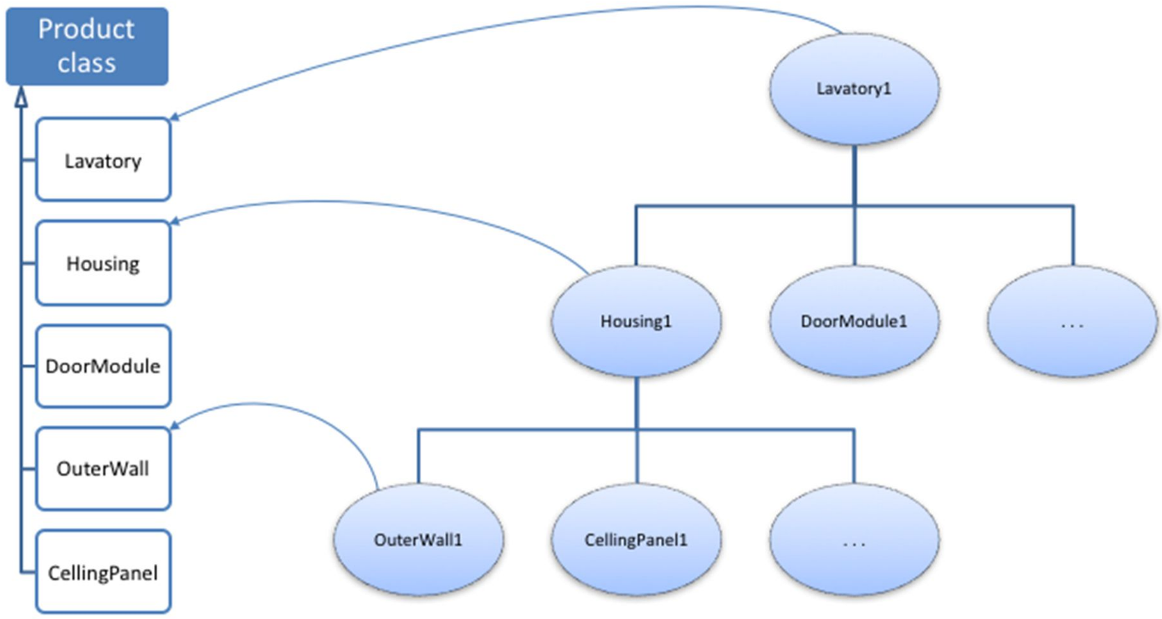
Tender decomposition: items



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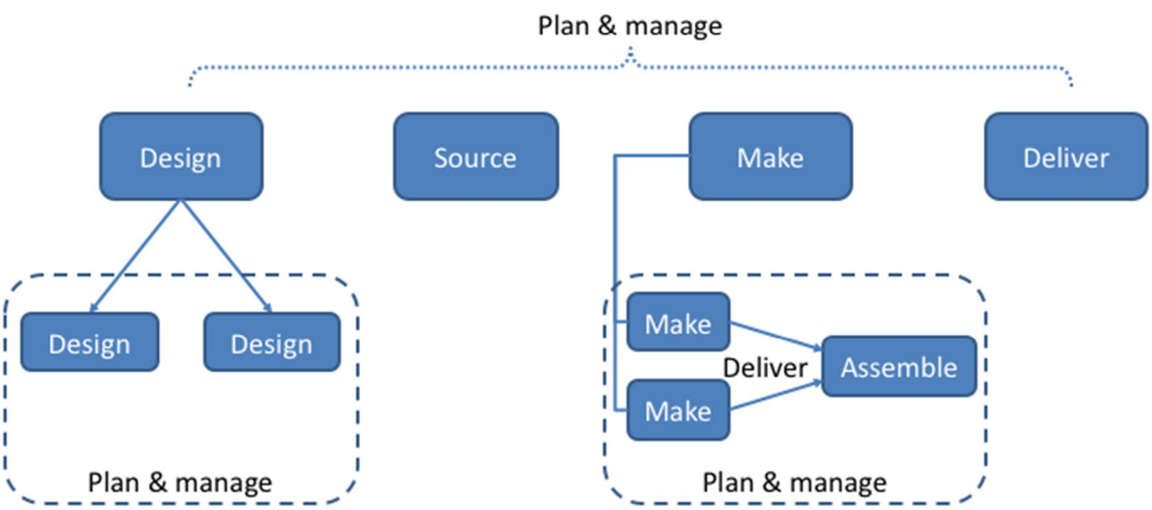
Tender decomposition: goals



8

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Tender decomposition

1. **Item decomposition**
   - » stepwise BOM explosion → generate all rooted subtrees
   - » each time, decompose a subset of items into sub-items
   - » add sub-items to the list of items → a new decomposition
   - » put decomposition in the queue
2. **Goal decomposition**
   - » each item may have several associated goals
   - » some goals may be decomposed, and some remain as is
   - » multiple goal decompositions per item decomposition

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Agenda

1. Introduction
2. Call for tenders
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Matchmaking

Criteria

1. **Inclusion criteria**
   » apply at the company level
   » exclude individual companies from search
2. **Grouping criteria**
   » apply at the team level
   » check eligibility of composed teams
3. **Evaluation criteria**
   » apply to individual companies within a team
   » apply to the team as a whole

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Matchmaking

Criteria

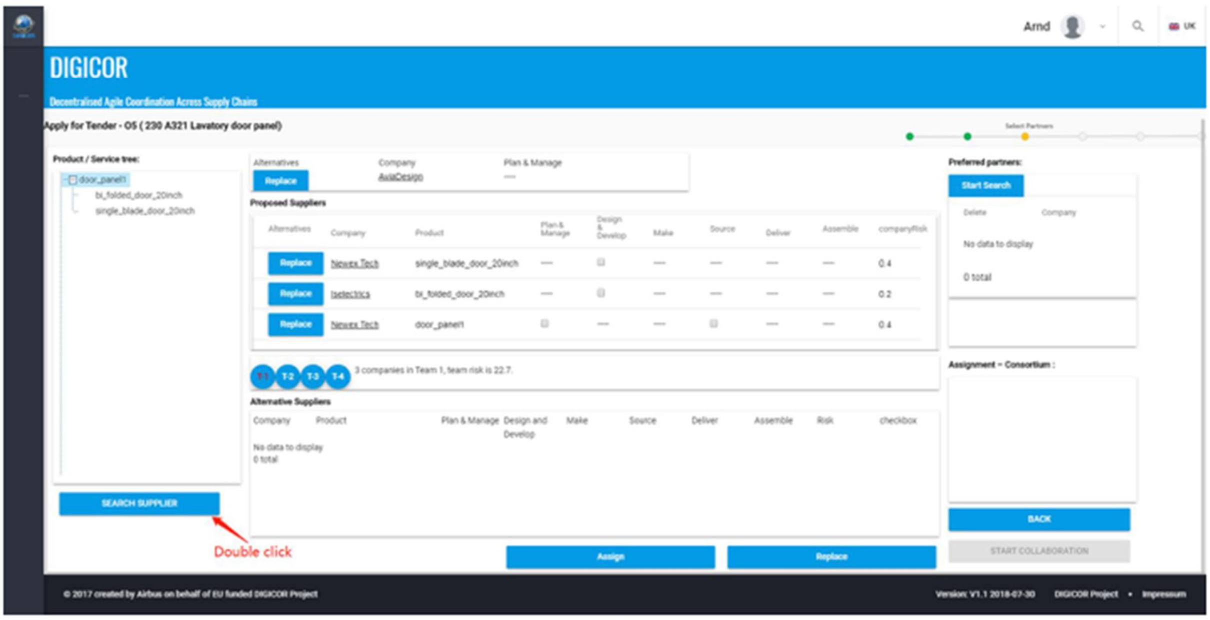
	Inclusion	Grouping	Evaluation
Item–goal capabilities	X		X
Annual turnover		X	
No. of employees		X	
Certification		X	X
Industry branch classification			X
Materials			X
Technology			X
Preferred contract types			X
Target regions			X
Locations			XXX

Matchmaking

Evaluation criteria → team risk

- **Company-level**
  - » item–goal capability: exact instance, product class, other instance?
  - » certificates: how well does the company cover CfT requirements?
  - » low coverage → high risk
  - » similarly: industry branch classifications, technology, materials, preferred contract types, target regions
- **Team-level**
  - » number of companies: increases team risk
  - » manufacturing locations: proximity of partners to each other reduces team risk

Example



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Conclusion

- **Outcomes**
  - » tender decomposition and matchmaking algorithm
  - » decomposition of items and goals, any product complexity
  - » team composition and evaluation subject to multiple criteria
  - » same algorithm for replacement of team members, CfT announce
- **To do**
  - » user evaluations
    - functionality and UI
    - matchmaking criteria

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www.digicor-project.eu

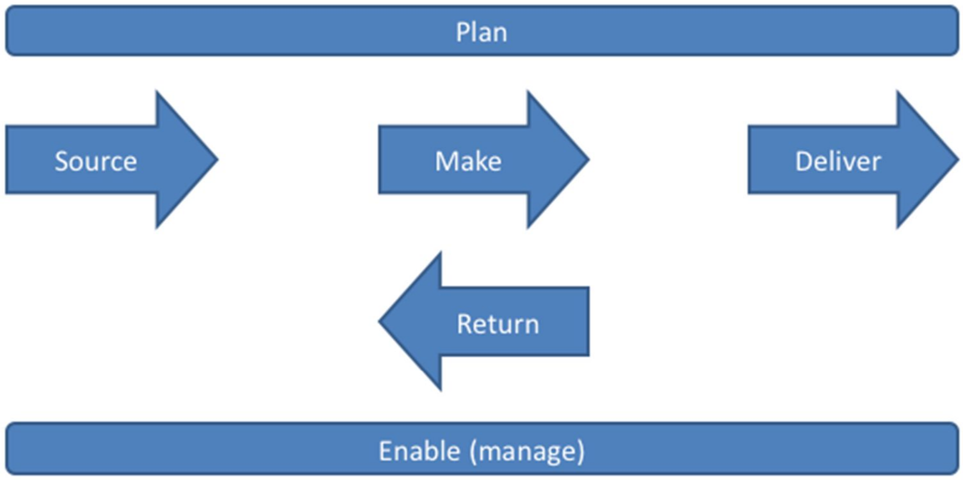
Thank you for your attention!

Your opinion matters to us

16

APPENDIX

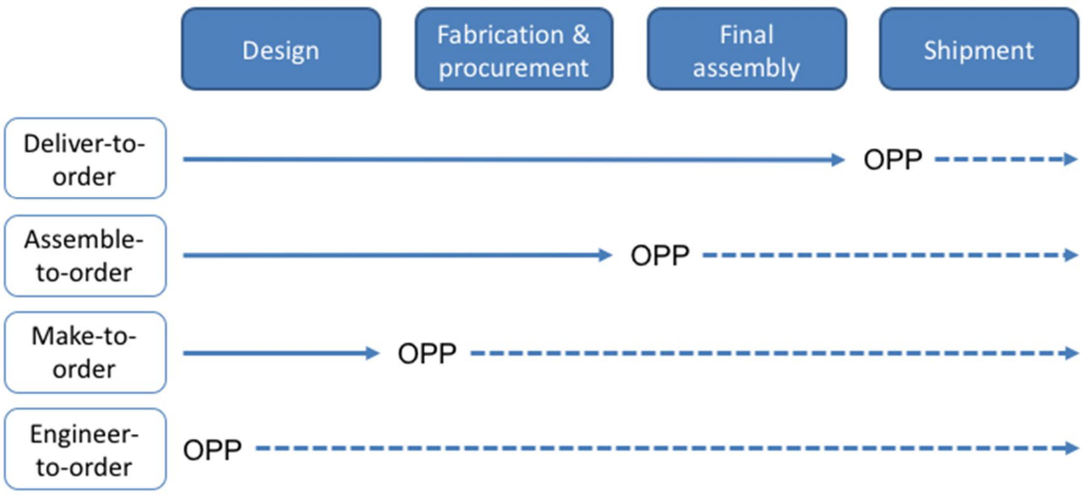
SCOR model:



17

Source: APICS (2017)

Product delivery strategies:



18

Source: Olhager (2003)

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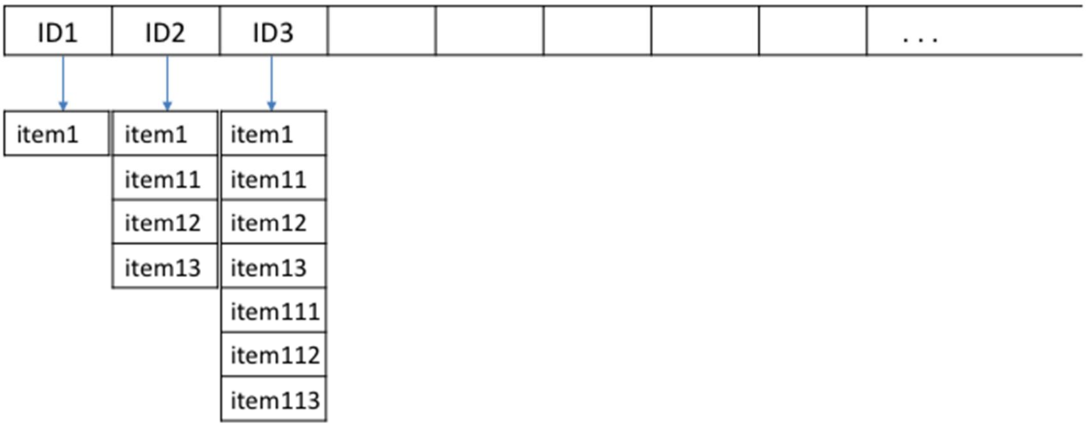
Tender decomposition

Item decomposition: list of lists



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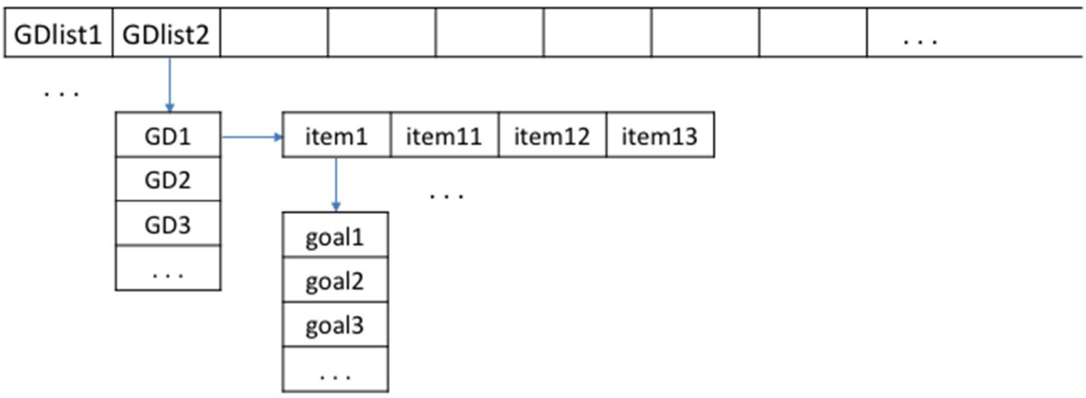
Tender decomposition

Goal decomposition: list of lists of lists of lists



20

Tender decomposition

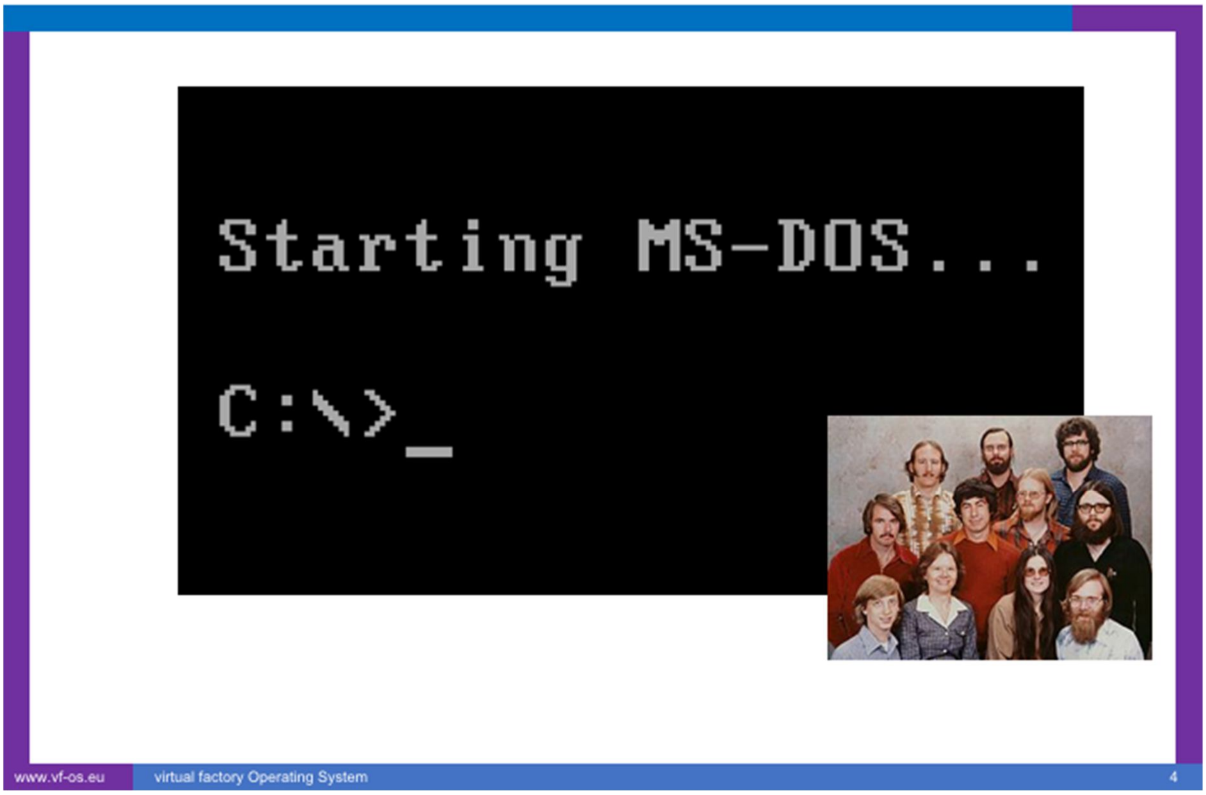
3. **Preventing combinatorial explosion**
   - » one-step look ahead
   - » do not decompose an item if:
     - none of platform members can fulfil a goal for a sub-item,
     - even after having the sub-item decomposed
   - » "can fulfil an item–goal" = can fulfil the goal for:
     - exactly this item, or its class, or any item from that class
4. **Speeding up**
   - » whitelisting item–goals that can be fulfilled
   - » blacklisting item–goals that can't
   - » blacklisting item–goals due to blacklisted children


virtual factory Operating System
Process Orchestration in the vf-OS Platform
2018-09-26 – Funchal, Portugal
Oscar Garcia Perales
Operations Director, Information Catalyst (ICE)
ICE Information Catalyst
www.vf-os.eu
virtual factory Operating System
1

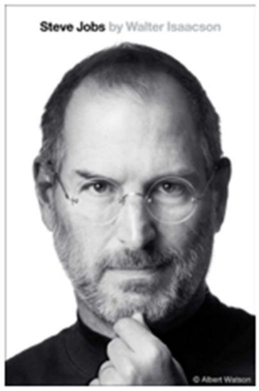

virtual factory Operating System
But before getting to the meat…
www.vf-os.eu
virtual factory Operating System
2

virtual factory Operating System

The Ages of the OS: DOS



The Ages of the OS: iOS



www.vf-os.eu virtual factory Operating System 5

…and now: vf-OS

virtual factory Operating System

www.vf-os.eu virtual factory Operating System 6

vf-OS Ambition

If you want to create an Android application you require an SDK with java programming and an Android Marketplace to exploit it

If you want to create an iOS application you require an iOS SDK with the swift language and the Apple App Store to exploit

If you want to create a vf-OS application you require the vf-OAK and utilise the vf-OS Platform to exploit it

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vf-OS Aspiration

Software Operating System Environment	*vf-OS* Equivalent
Kernel Processor, Memory, Internal Bus	**Virtual Factory System Kernel** Framework, Enablers
I/O Interfaces, Device Drivers, Peripherals	**Virtual Factory I/O** Device Drivers, APIs, Security
File and Data Handling Interfaces	**Virtual Factory Middleware** Data Infrastructure, Storage, Harmonisation, Analytics
SDK Application Development, System Monitor	**Open Applications Development Kit** System Dashboard, Frontend Environment, Studio, Developer Engagement Hub
Applications ERPs, CRMs, MESs, WMs	**vApps** Collaboration in real-time, monitoring

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virtual factory Operating System

Integrated Technical Story

Introduction

Objective within vf-OS:

- Provide an environment for developers to create vApps

What is needed for building a vApp?

- **Runtime Environment**:
  Place to execute a vApp and access components and services
- **OAK Development**:
  Tools to design and develop vApps
- **Data Management**:
  Components that deal with data, eg store, analyse, ETL, etc
- **I/O Toolkit**:
  Components to access machines & software, and security
- **Process Designer and Enablers :**
  Components to design internal workflows of a vApp and provide additional functionality from FI-WARE

vf-OS vApps and how they are developed

What is a vApp?

- Applications specially developed for solving particular industrial needs.

How are they developed?

- Re-use existing libraries
- Developing new functionality
- Assembly of these functionalities
- Executing the vApp
- Routing messages
- Monitoring performance
- Storing intermediary and final results

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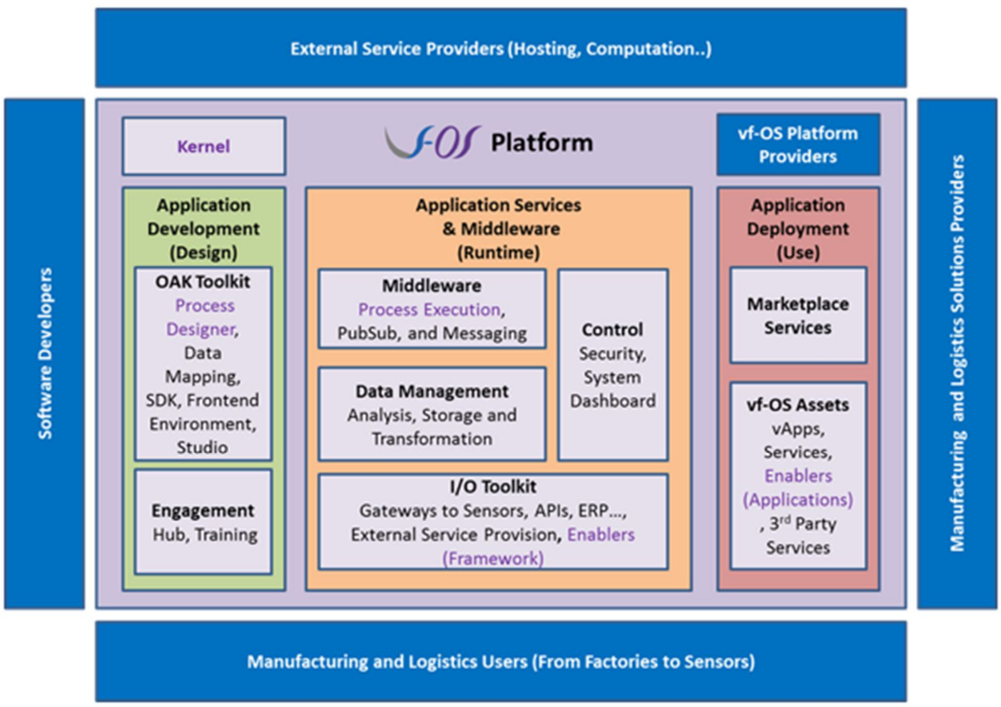
vf-OS High Level Architecture



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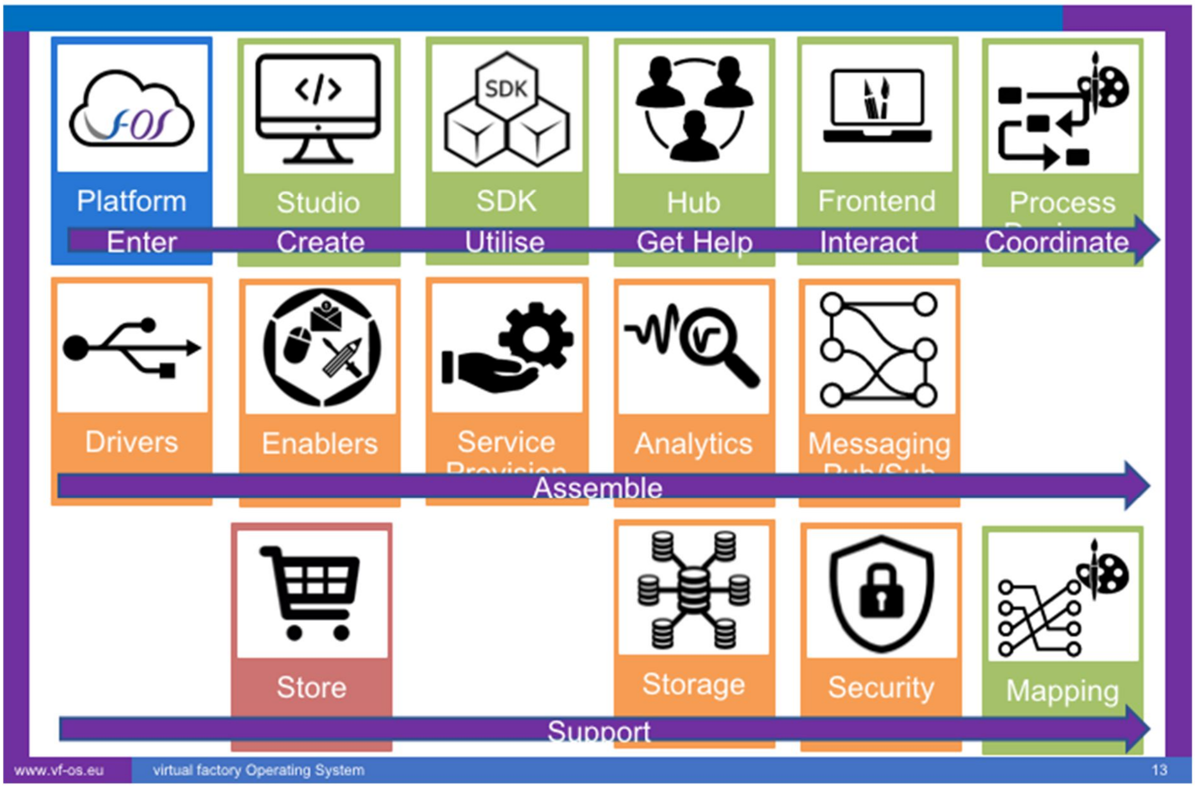
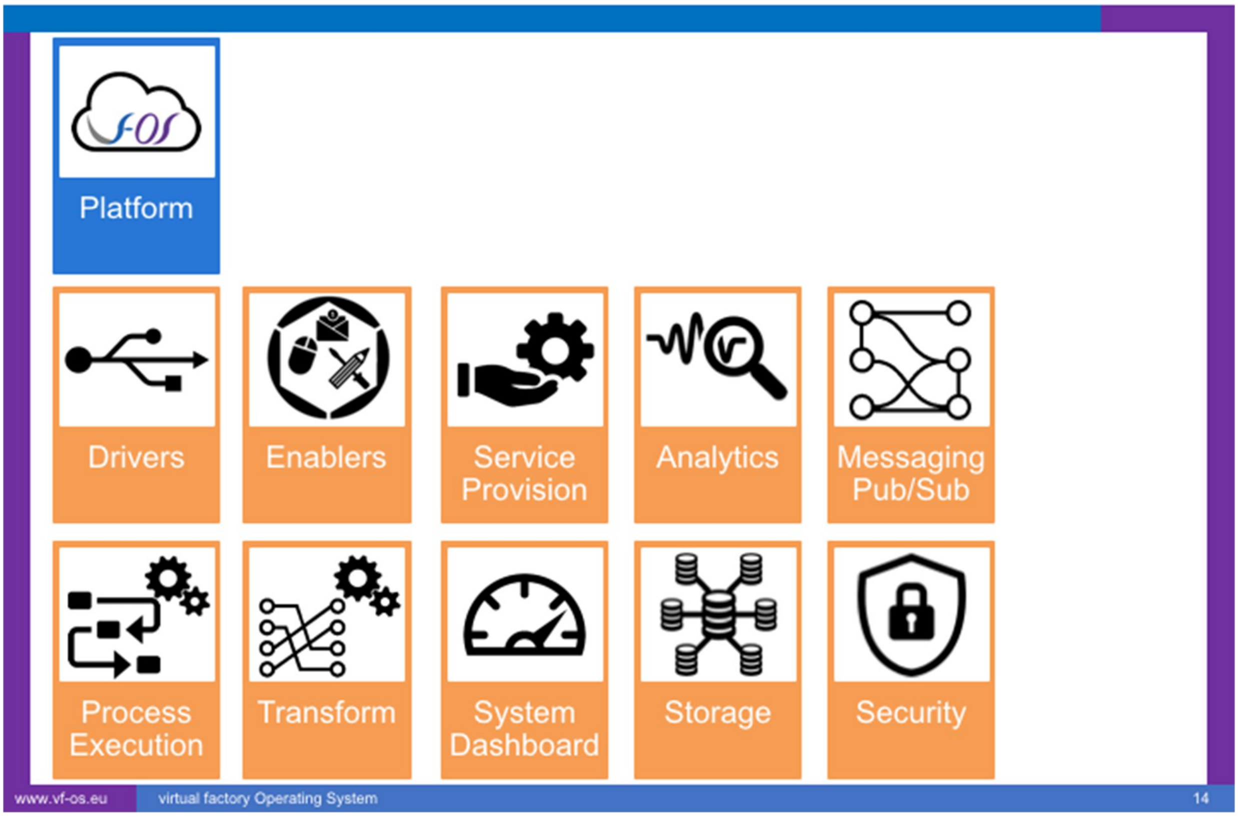
Typical Process – Design Time



Typical Process – Run Time




virtual factory Operating System
Process Orchestration in the vf-OS Platform
2018-09-26 – Funchal, Portugal
Oscar Garcia Perales
Operations Director, Information Catalyst (ICE)
ICE
Information Catalyst
www.vf-os.eu
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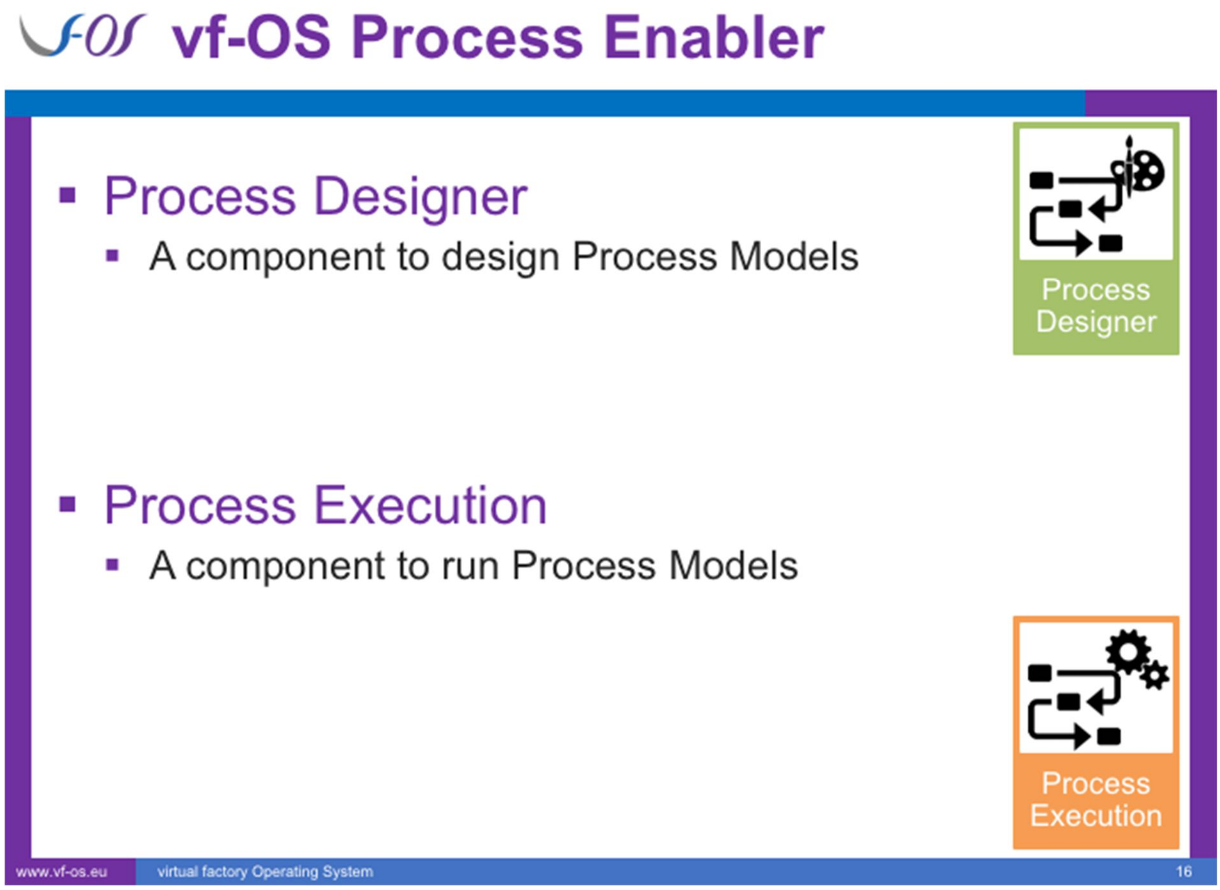
15


vf-OS Process Enabler
Process Designer
A component to design Process Models
Process Designer
Process Execution
A component to run Process Models
Process Execution
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virtual factory Operating System
16

vf-OS Process Enabler

- Process Designer
  - A component to design Process Models, but…
  - What if a vApp can be seen as a process model, then…
  - **Component to help designing/developing a vApp**
- Process Execution
  - A component to run Process Models, but…
  - What if source code can be linked to the Model
  - What if source code can be generated based on a BPMN process model, then…
  - **The Execution helps the developer in constructing source code**

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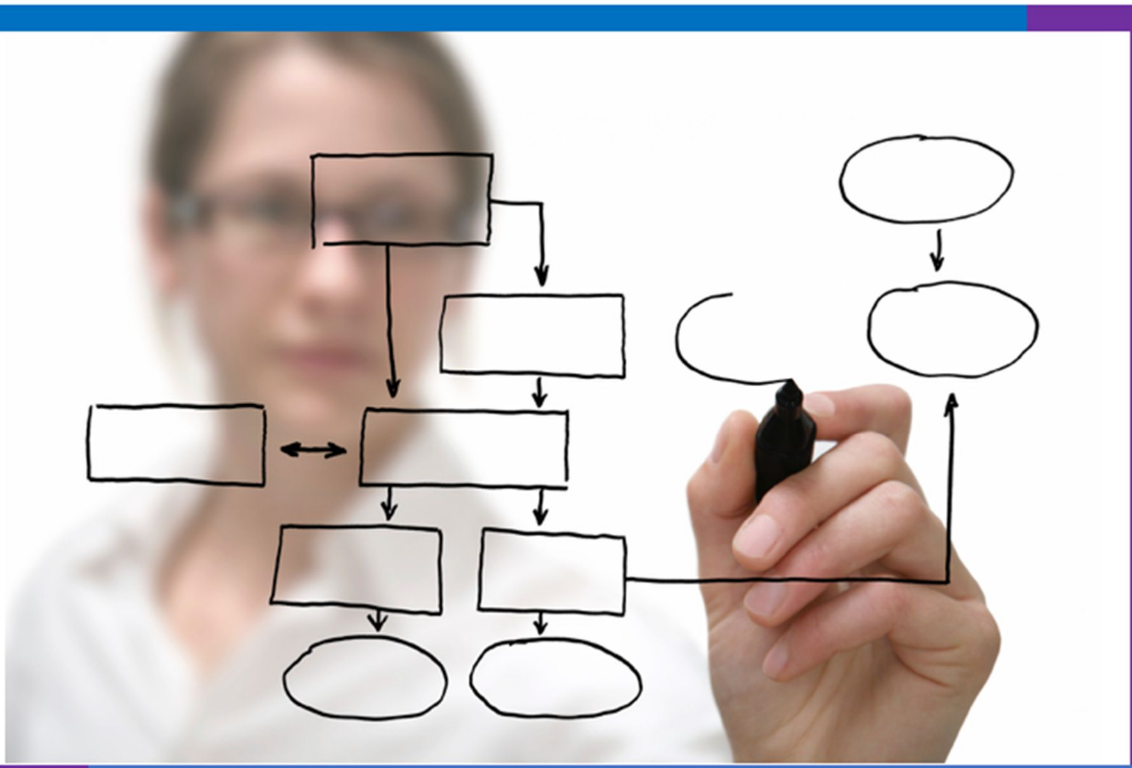
vf-OS Process Designer



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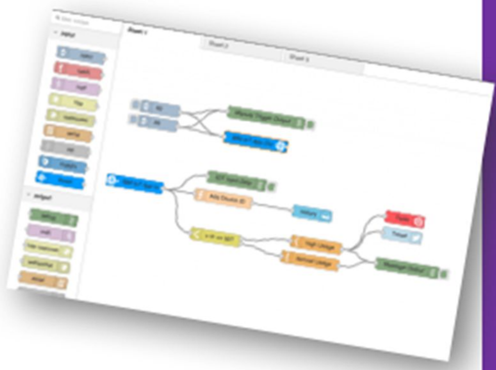
vf-OS Process Designer

Process Designer

- Model Process Workflows
- Orchestrate pre-built assets
- Based on BPMN style definitions
- Reuse of vf-OS Assets



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Interpreting BPMN when developing vApps

Process Designer

- In BPMN world, interaction with external services is described visually by Service Tasks
- Each Service Task is a rounded box in a diagram
- Inspection of service task definition to generate the corresponding call
- Parameters for the calls are accessed through:
  - Set those parameters in the message start
  - Manually typing the parameter values when the Service Task is dropped
  - Supply them through an incoming script task outputs
  - Let them flow from an incoming service task outputs

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Let's build a vApp
(as far as possible!)

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Justification

Business need:

- Create vApp capable of triggering alarms when a Tabber Stringer machine sensor hits a given value

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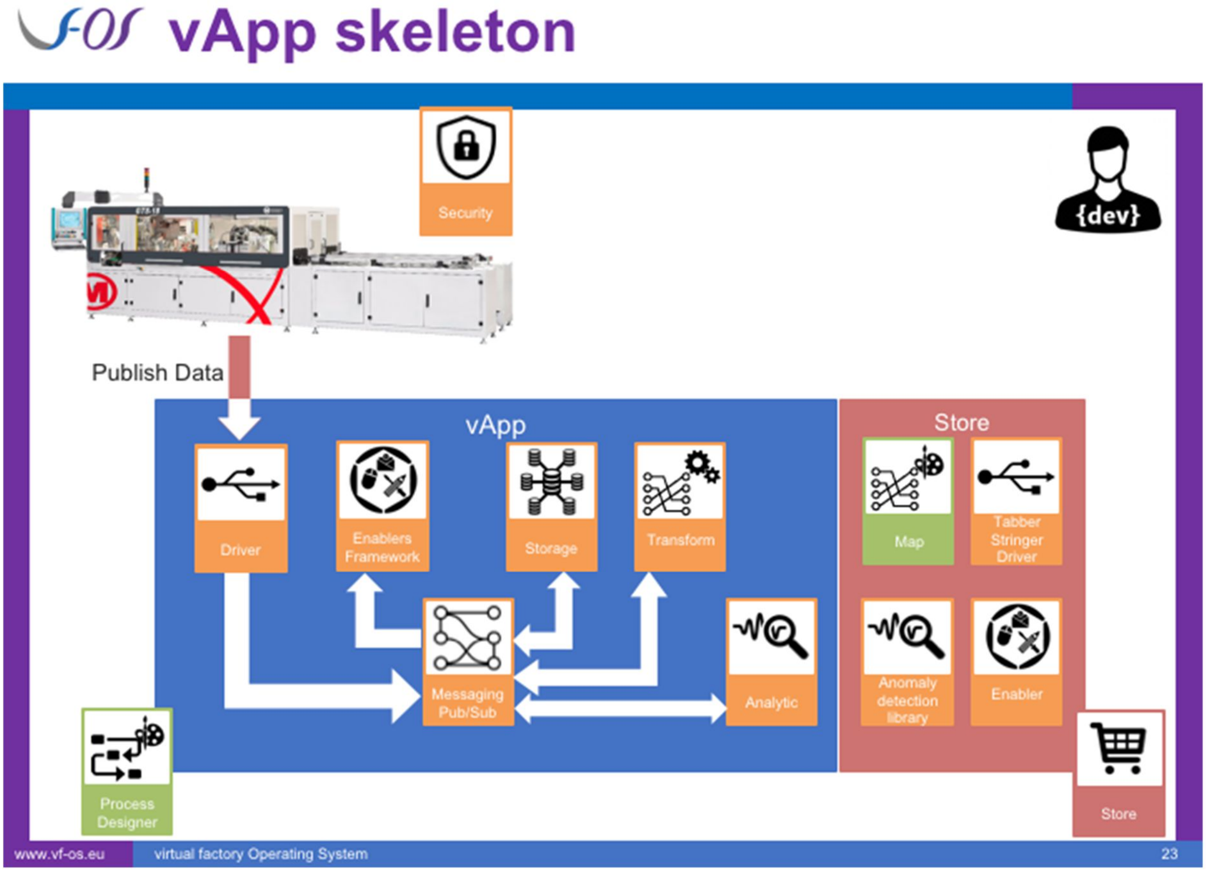
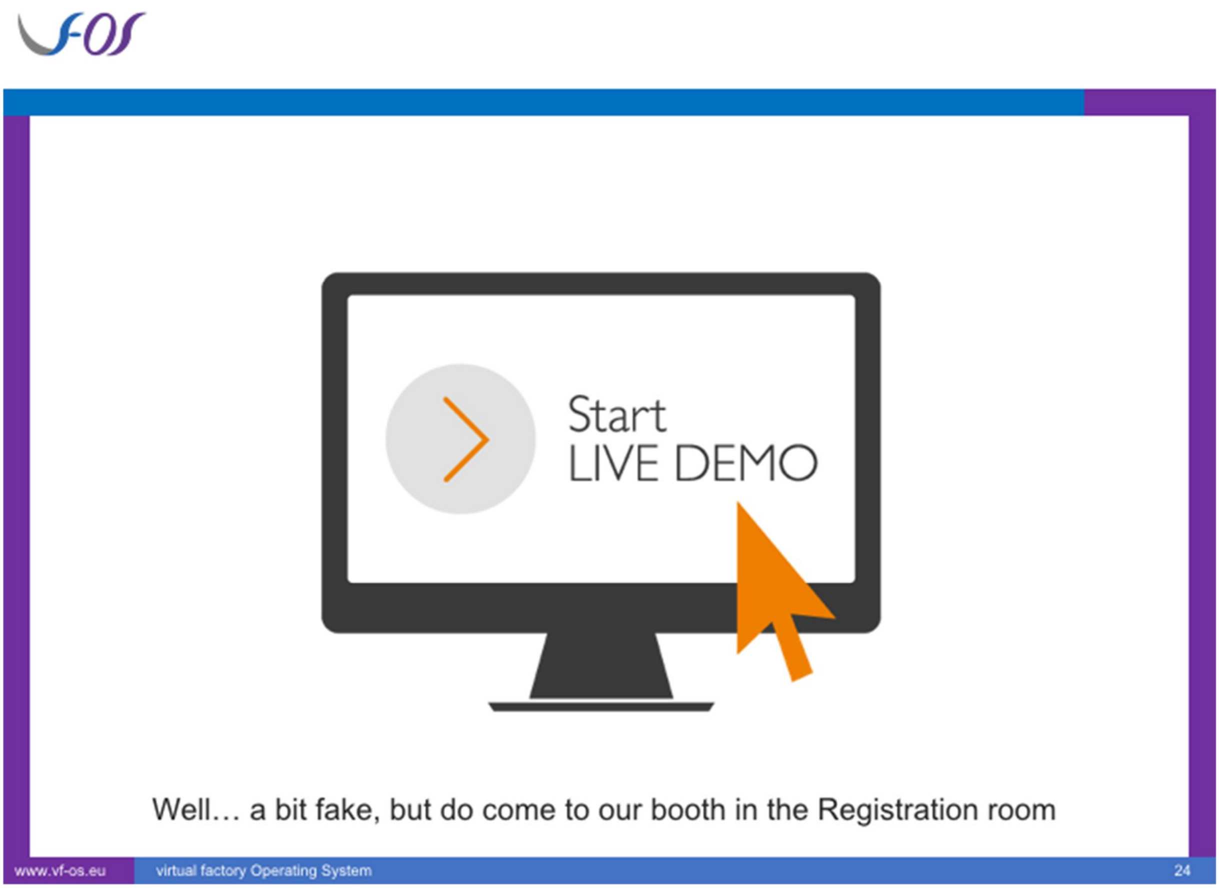
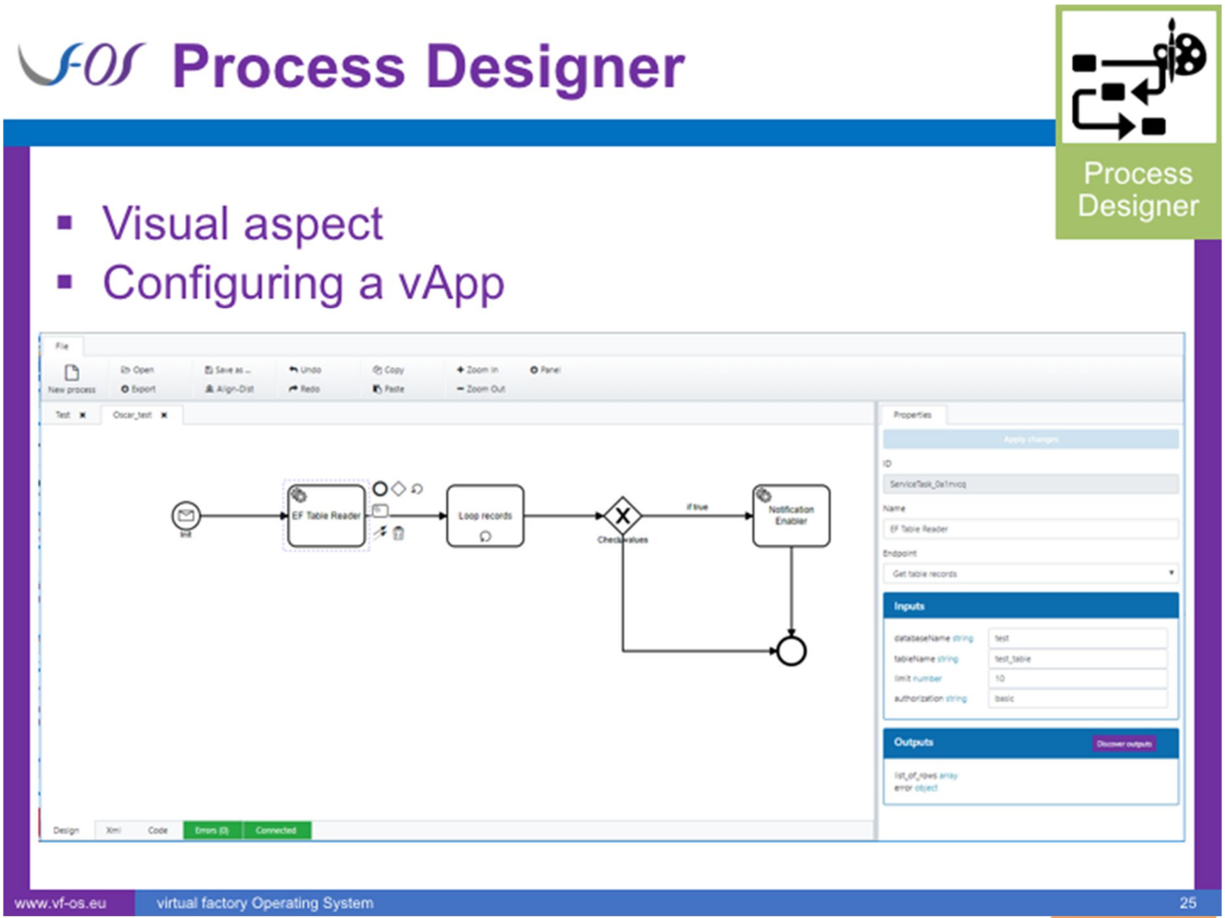
vAppskeleton






Process Designer
Process Designer
Visual aspect
Configuring a vApp
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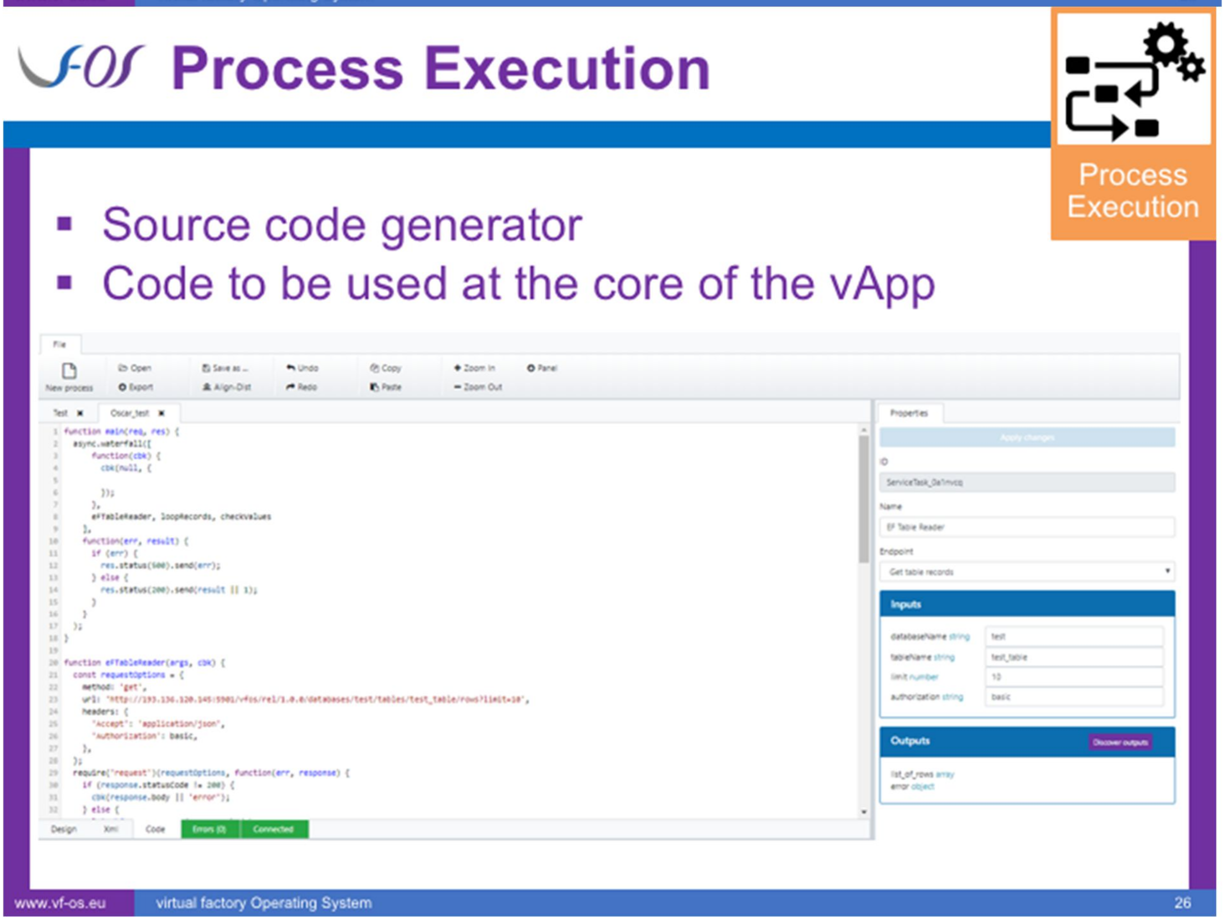
Process Execution
Process Execution
Source code generator
Code to be used at the core of the vApp
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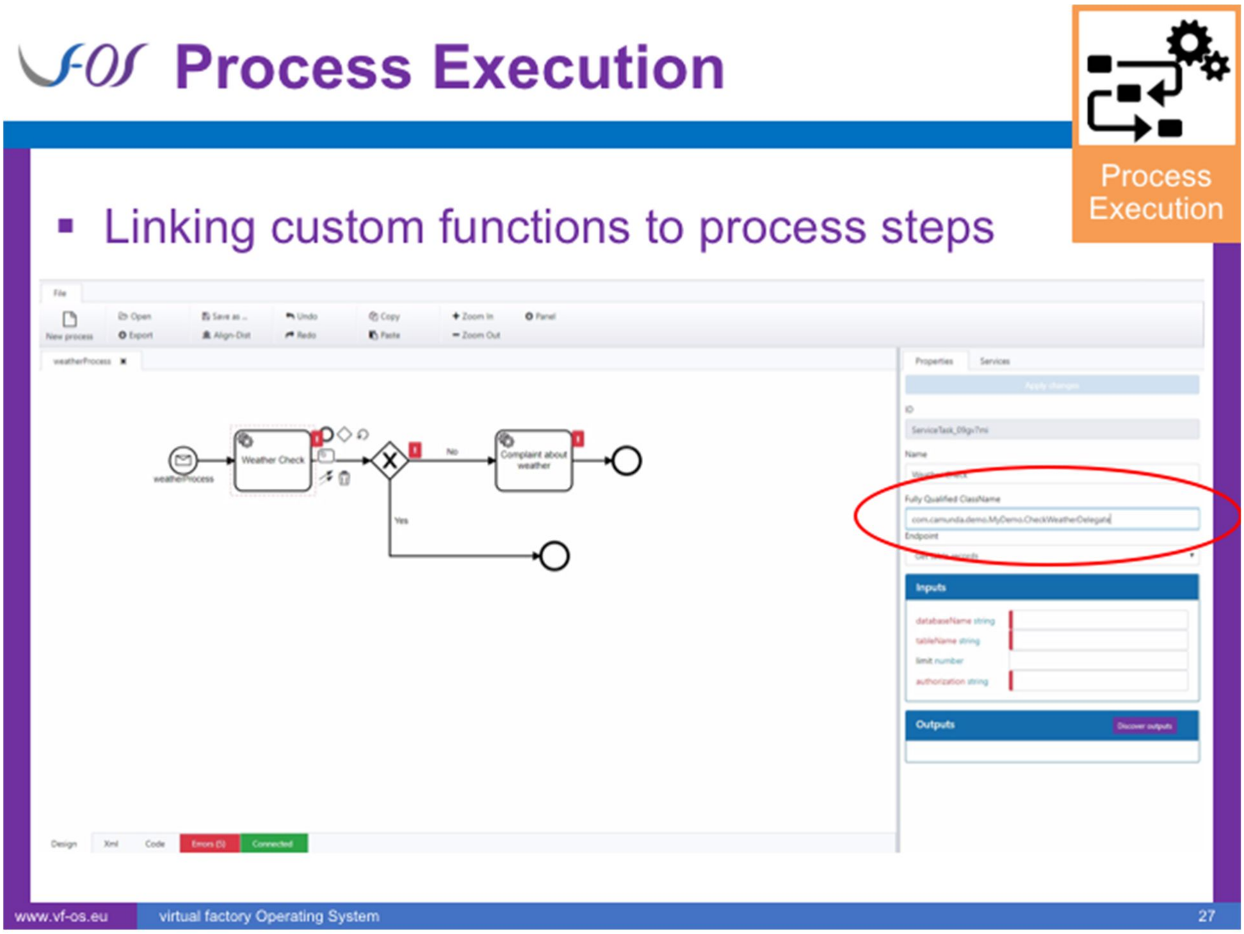
26


Process Execution
Process Execution
Linking custom functions to process steps
Weather Check
Complaint about weather
No
Yes
Properties
Services
Fully Qualified ClassName
Inputs
Outputs
Design
Xml
Code
Connected
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27


Questions?
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28

Partnership

ID	Participant organisation name	Country	Nature
1 (CO)	Information Catalyst for Enterprise Ltd	UK	SME
2	Ikerlan SCL	Spain	Technological Center
3	UNINOVA - Instituto de Desenvolvimento de Novas Tecnologias	Portugal	Research
4	Universitat Politècnica de València	Spain	University
5	Caixa Mágica Software, S.A.	Portugal	SME
6	Université Lumière Lyon 2	France	University
7	Ascora GmbH	Germany	SME
8	Almende B.V.	The Netherlands	SME
9	Mondragón Assembly	Spain	SME
10			
11	Consulgal - Engenharia e Gestao S.A.	Portugal	Large enterprise
12	Knowledgebiz, Lda	Portugal	SME
13	Applications Plastiques du Rhone SAS	France	SME
14	Tardy SAS	France	SME

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Contact us

http://vf-os.eu

https://www.youtube.com/channel/UCN-5AXqlaXjXltq8jJuoW1w

https://www.linkedin.com/in/vf-os-project/

https://www.facebook.com/vfoseuropeanproject/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723710.

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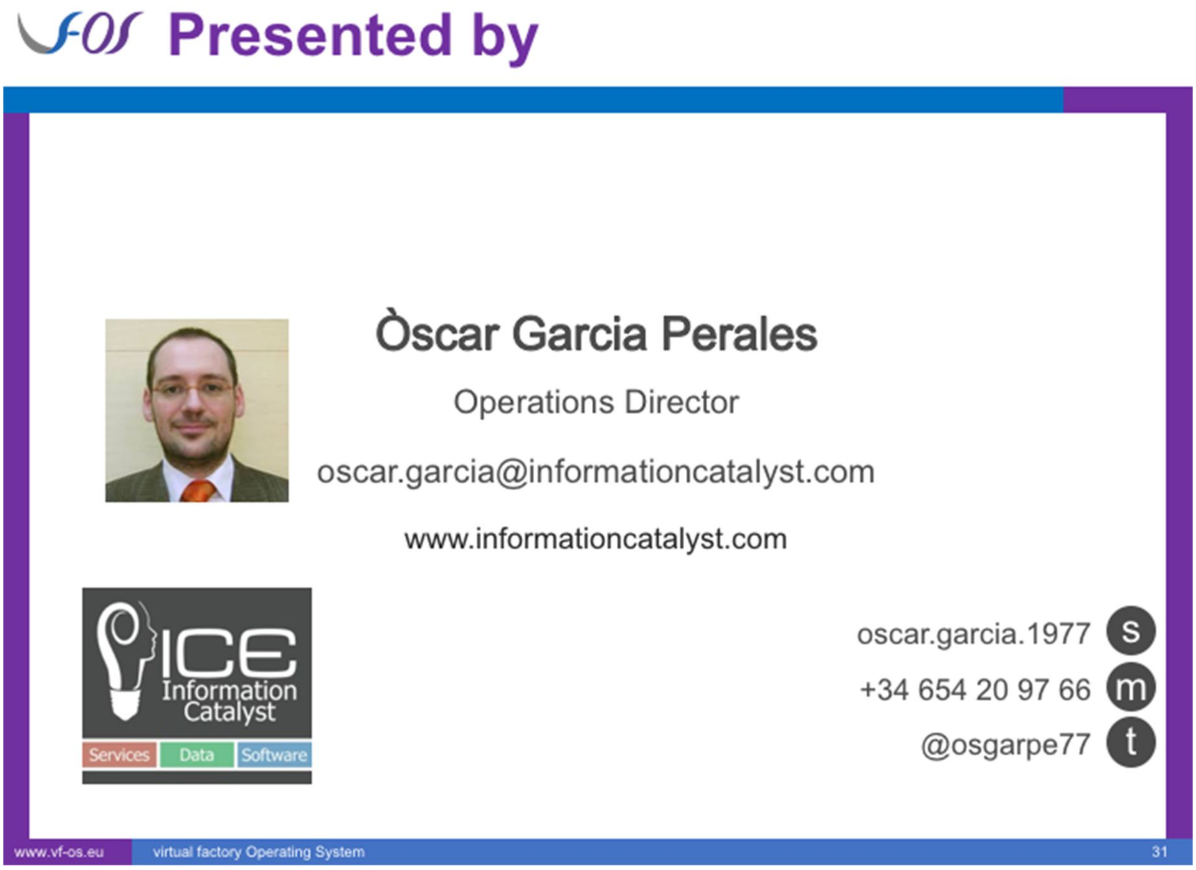
Presented by
Òscar Garcia Perales
Operations Director
oscar.garcia@informationcatalyst.com
www.informationcatalyst.com
ICE Information Catalyst
Services Data Software
oscar.garcia.1977
+34 654 20 97 66
@osgarpe77
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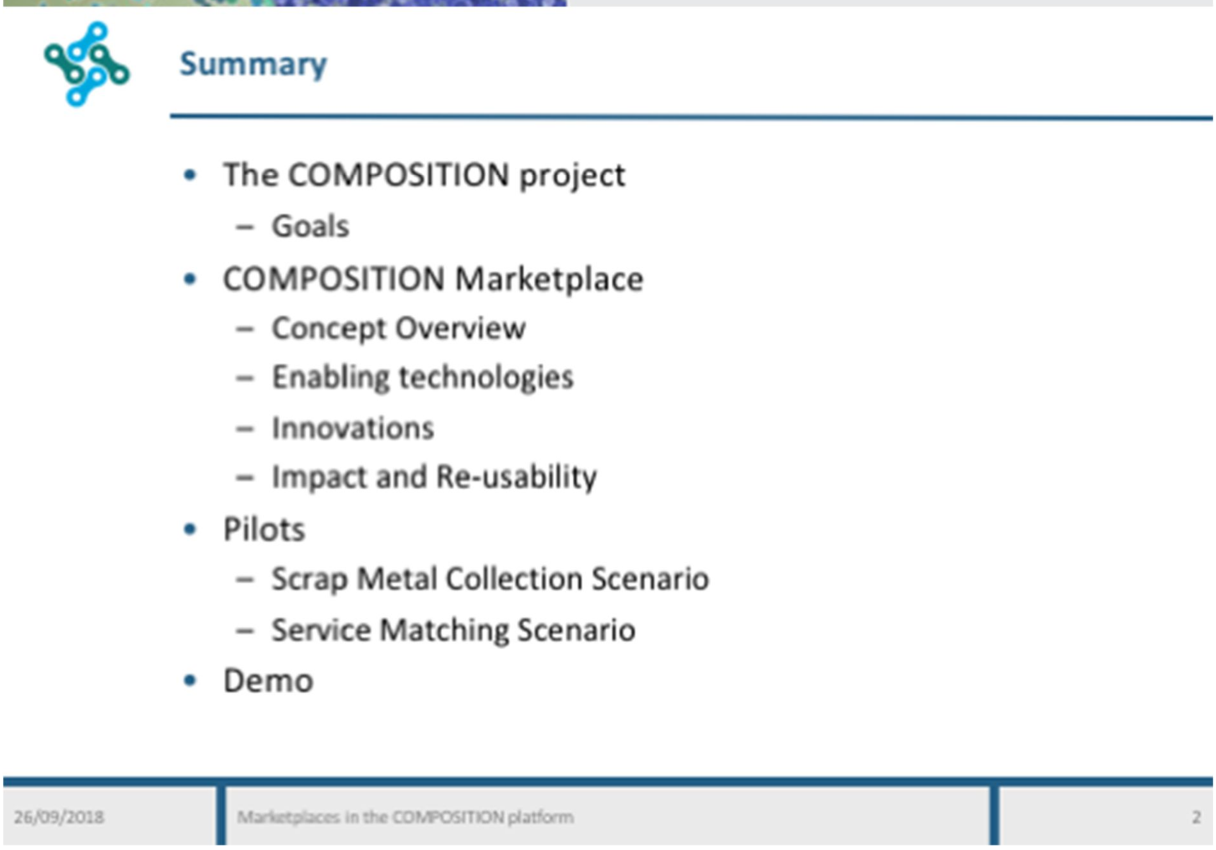
31


IEEE
Ecosystem for Collaborative Manufacturing Processes – Intra- and Interfactory Integration and Automation
Marketplaces in the COMPOSITION platform
Giuseppe Pacelli
pacelli@ismb.it
Istituto Superiore Mario Boella
Co-funded by the European Union
COMPOSITION


Summary
• The COMPOSITION project
– Goals
• COMPOSITION Marketplace
– Concept Overview
– Enabling technologies
– Innovations
– Impact and Re-usability
• Pilots
– Scrap Metal Collection Scenario
– Service Matching Scenario
• Demo
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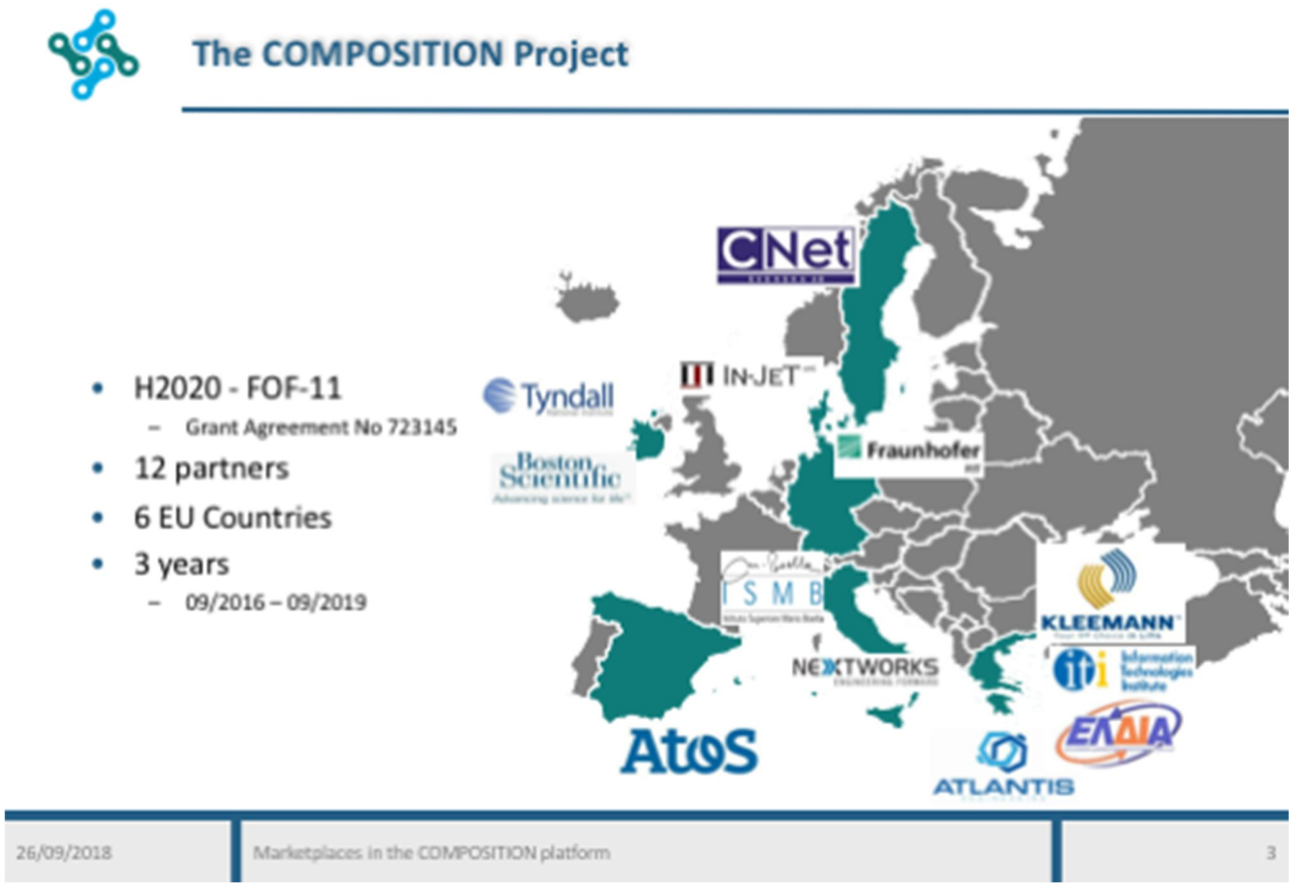
The COMPOSITION Project
H2020 - FOF-11
Grant Agreement No 723145
12 partners
6 EU Countries
3 years
09/2016 – 09/2019
CNet
IN-JET
Tyndall
Boston Scientific
Fraunhofer
ISMB
KLEEMANN
NEXTWORKS
iti Information Technologies Institute
ΕΛΔΙΑ
Atos
ATLANTIS
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Goals
Create a (semi-)automatic ecosystem, incorporating and inter-linking both the Supply and the Value Chains
CNet
IN-JET
Tyndall
Boston Scientific
Fraunhofer
ISMB
KLEEMANN
NEXTWORKS
iti Information Technologies Institute
ΕΛΔΙΑ
Atos
ATLANTIS
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Challenges

Value Chain

- Unveil and make usable knowledge "embedded" in the factory shop-floor
- Exploit data, at all levels
  - Shop floor
  - SCADA/MES
  - ERP
- Enhance response latency to changing market requirements

Supply Chain

- Define an ecosystem of connected and interoperable factories
- Allow for quick and seamless supply chain formation / reconfiguration
- Open new business opportunities

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COMPOSITION Marketplace

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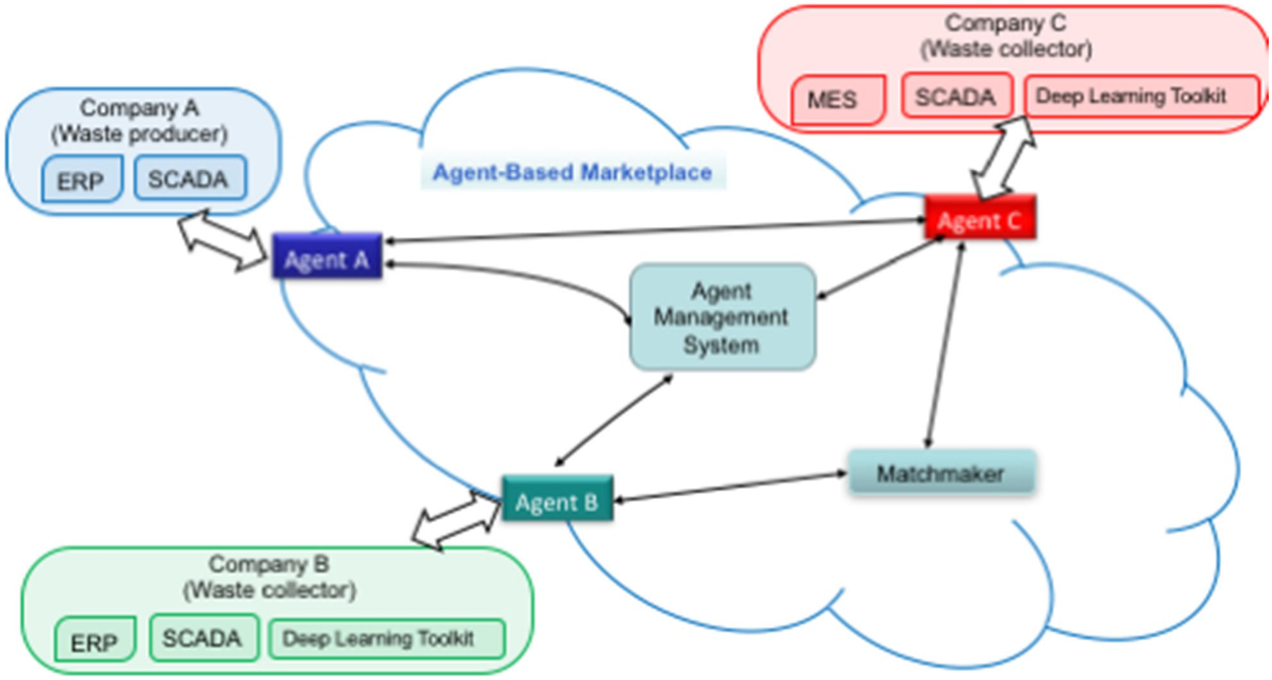
Concept Overview



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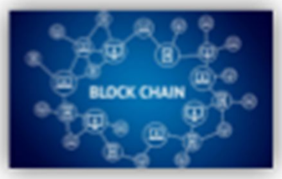
Marketplace enabling technology

- **Multi Agent System**
  - Agent Management System, White Pages Service
  - Requester and Supplier Agents
  - Composition eXchange Language
- **Security infrastructure**
  - Access Control
  - Channel encryption (TLS)
  - RBAC for agents

- **Blockchain**
  - Non-repudiation
  - Audit trail
  - Message Provenance & Trust
  - Material traceability



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Innovations

- Extension of the "Agent-container" definition
  - *" An agent container is a set of intelligent agents interacting through the same, shared broker (can be a cluster) and referring to shared platform services such as the Directory Facilitator and the Agent Management System."* In COMPOSITION a more advanced version of such an agent, namely the MatchMaker, operating based on ontology models is adopted.

- Open and closed marketplaces
  - *" A COMPOSITION Open Marketplace is a COMPOSITION Marketplace open to any stakeholder having valid COMPOSITION credentials".*
  - *"A COMPOSITION Closed Marketplace is a COMPOSITION Marketplace owned by one stakeholder and typically offered to a trusted subset of other COMPOSITION stakeholders."*

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Impact and Reusability

- Improved responsiveness to dynamic market demands
- Improved collaborative extra logistical chains

- Composition eXchange Language easily extendable to cover different scenarios
- Several negotiation protocol could be easily supported and added through simple software modules

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Pilots

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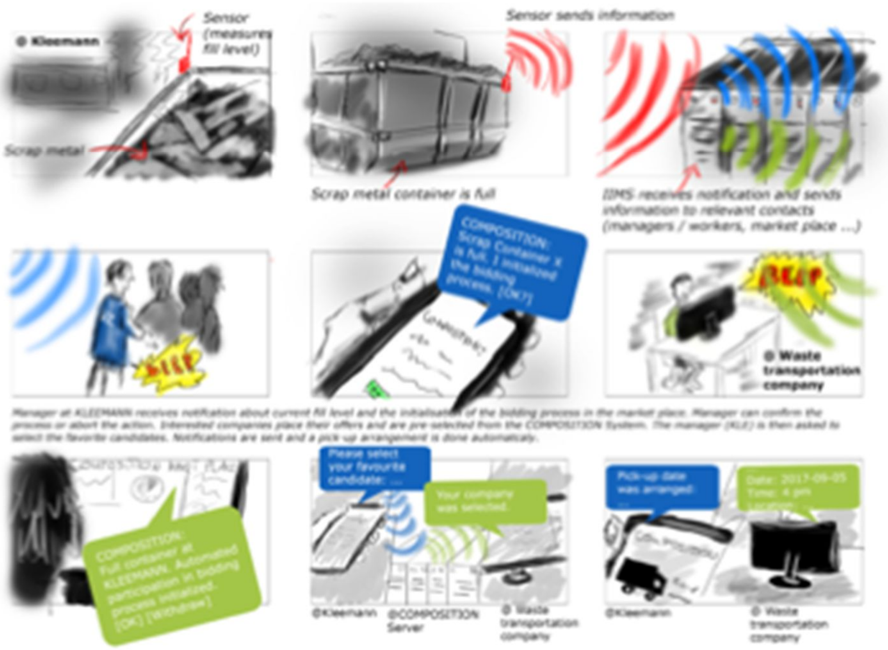
Pilots – KLEEMAN

KLEEMANN

- Supply chain formation / adaptation



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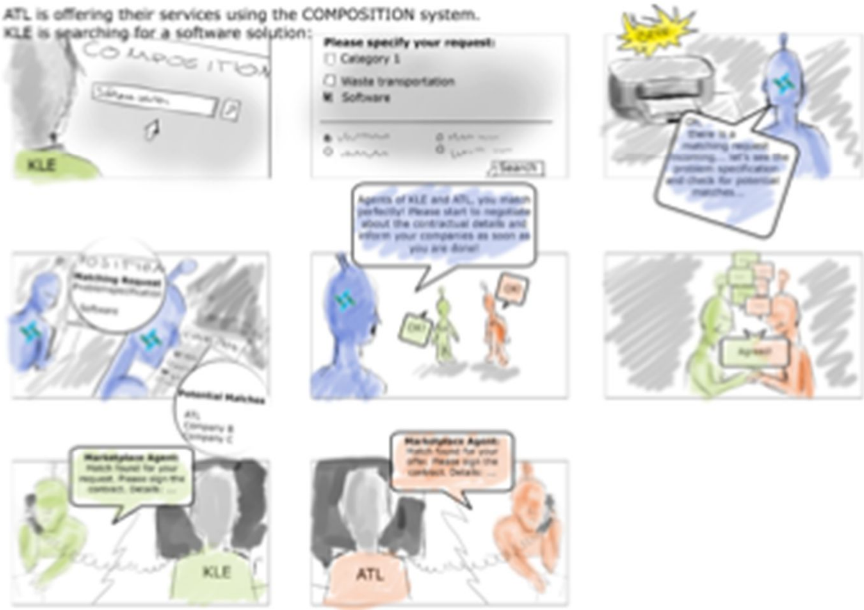
Pilots – ATLANTIS

ATLANTIS

- Service / need matching
- Pre-negotiation



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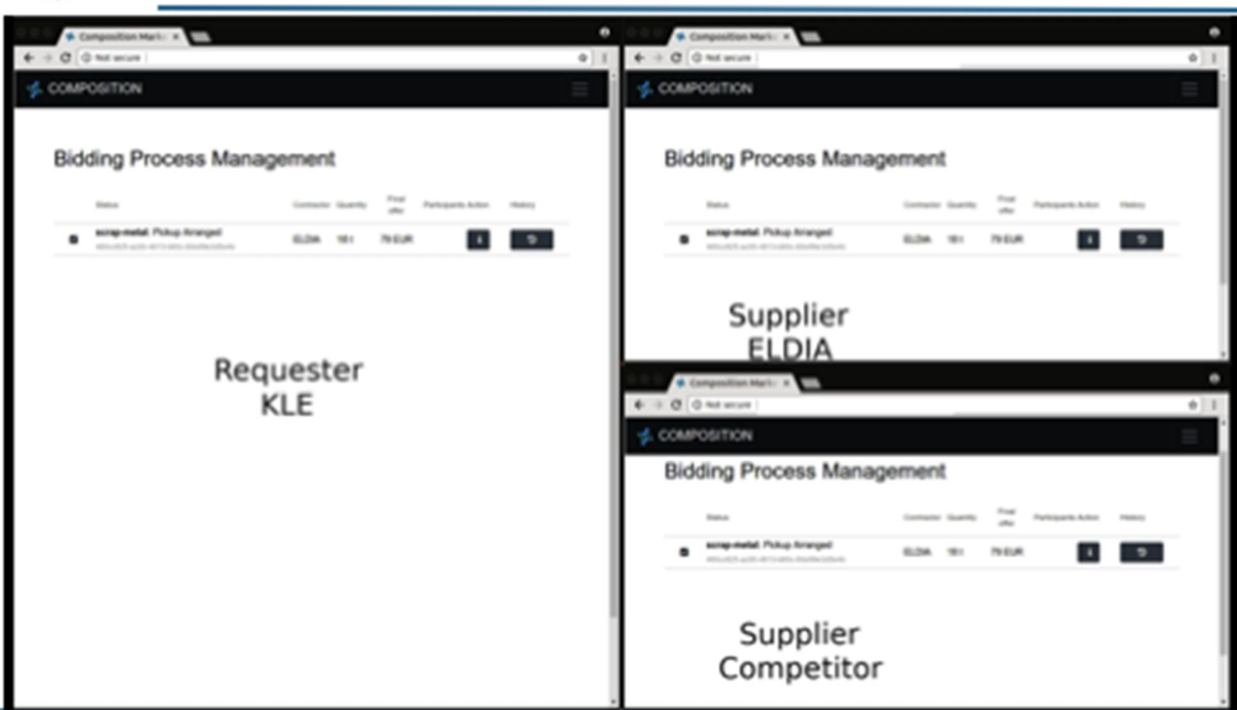
Demo



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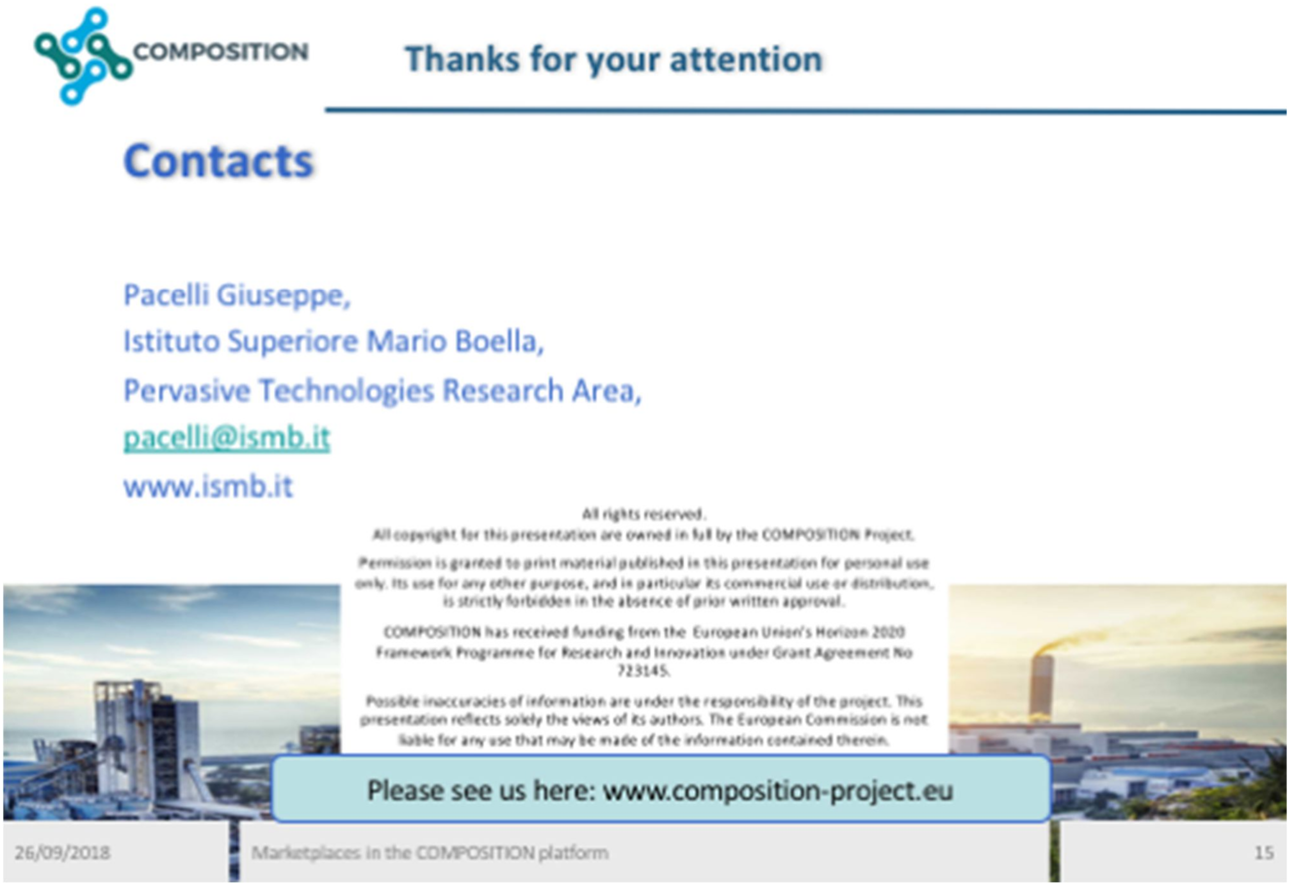
COMPOSITION
Thanks for your attention
Contacts
Pacelli Giuseppe,
Istituto Superiore Mario Boella,
Pervasive Technologies Research Area,
pacelli@ismb.it
www.ismb.it
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Please see us here: www.composition-project.eu
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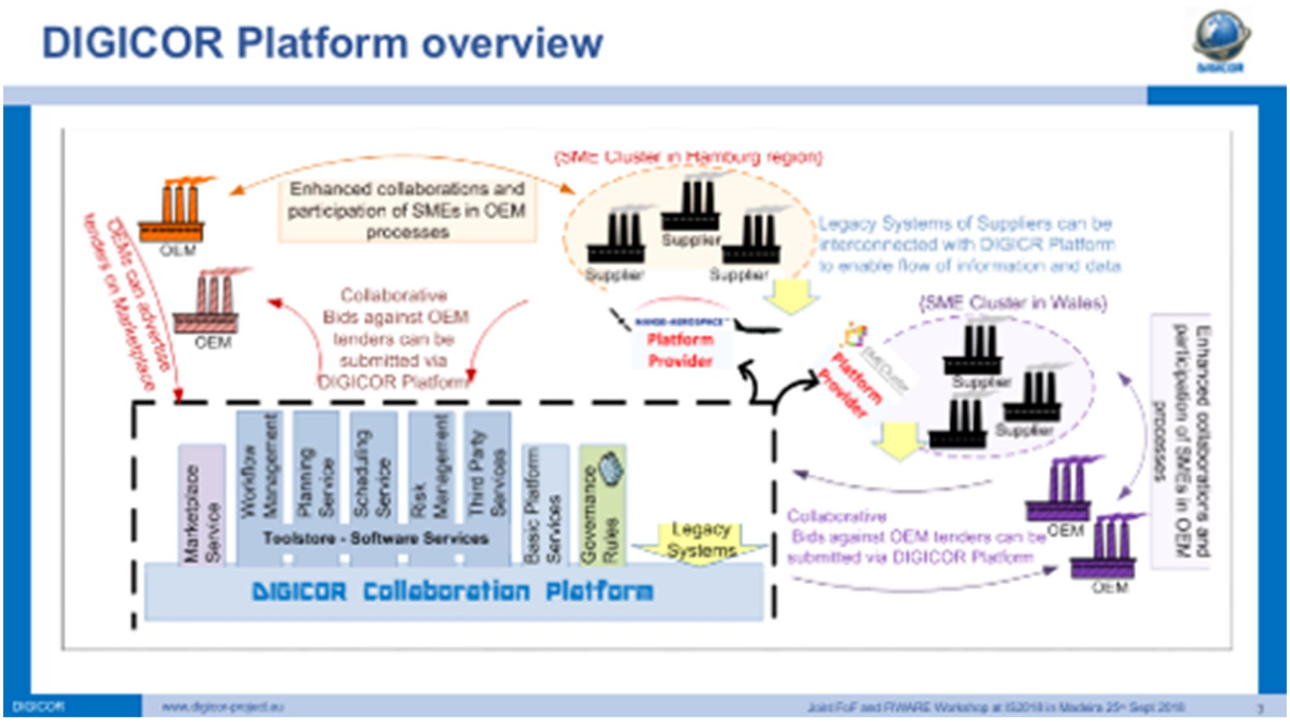
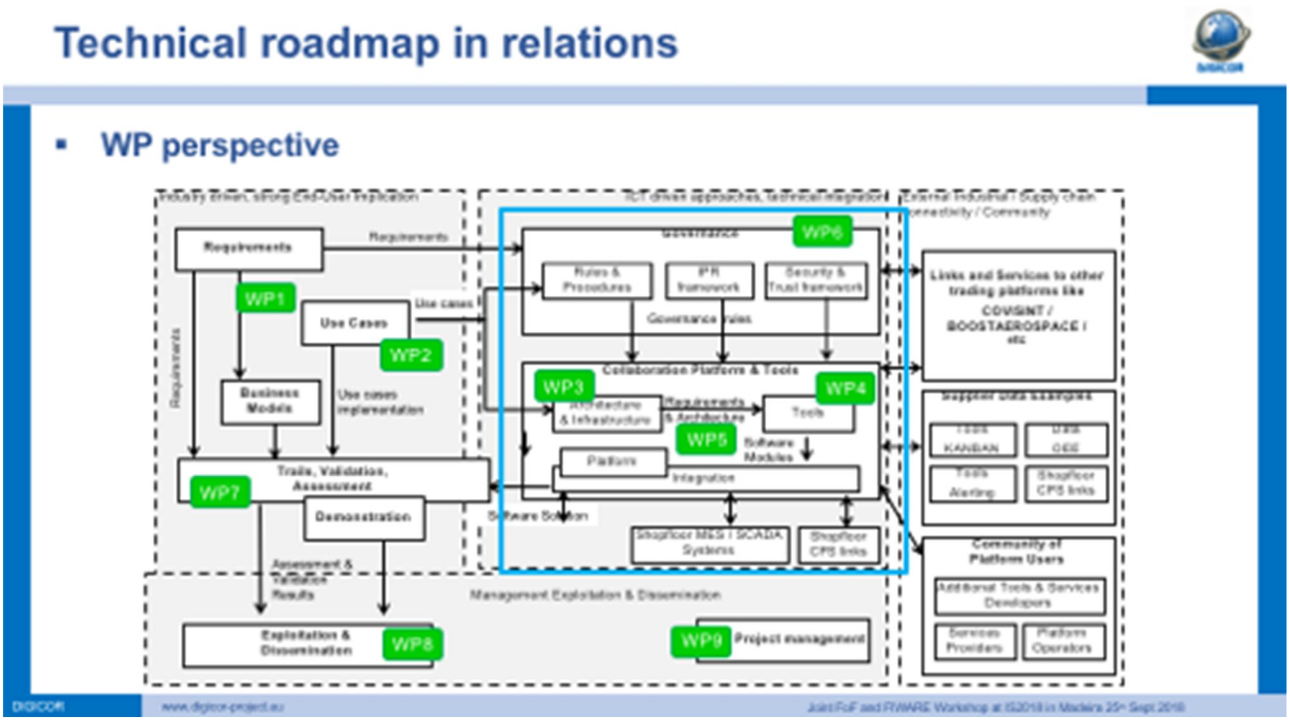
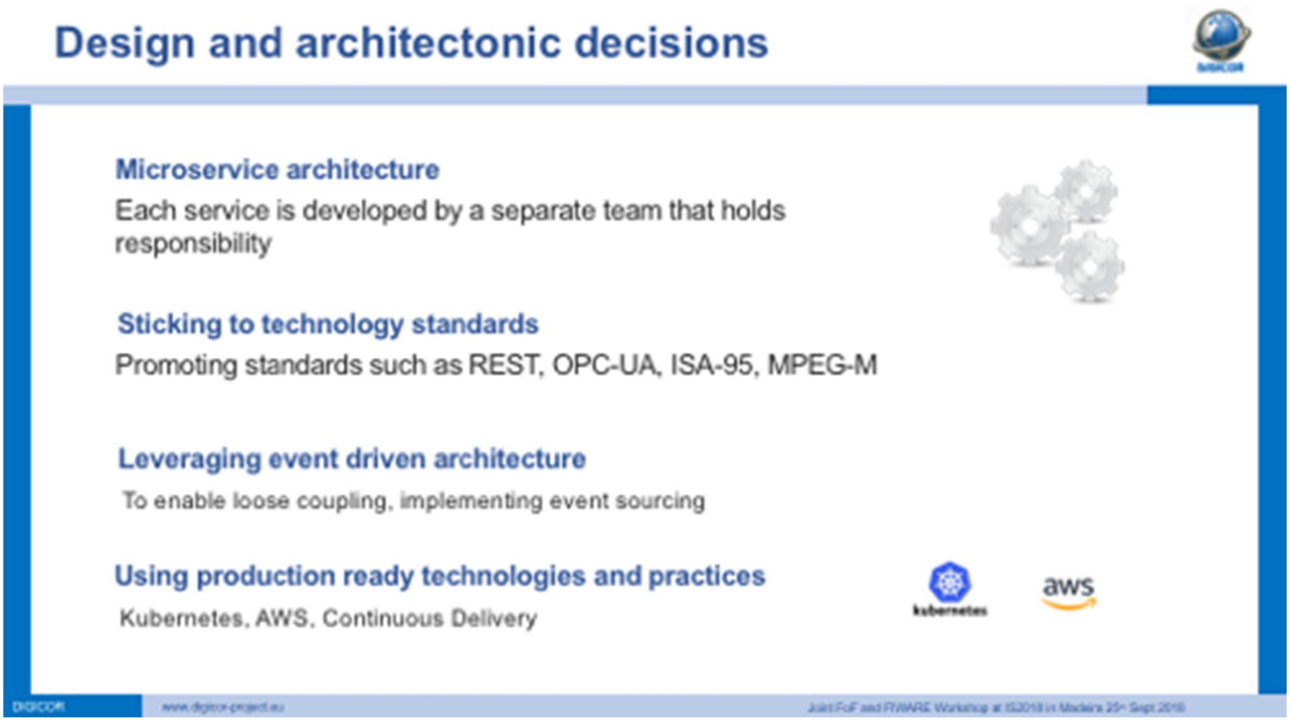
Decentralized Agile Coordination Across Supply Networks
DIGICOR
Smart Monitoring and Control in the Digicor Platform
26th – 27th September 2018, Madeira
Gash Bhullar, Control 2K Limited

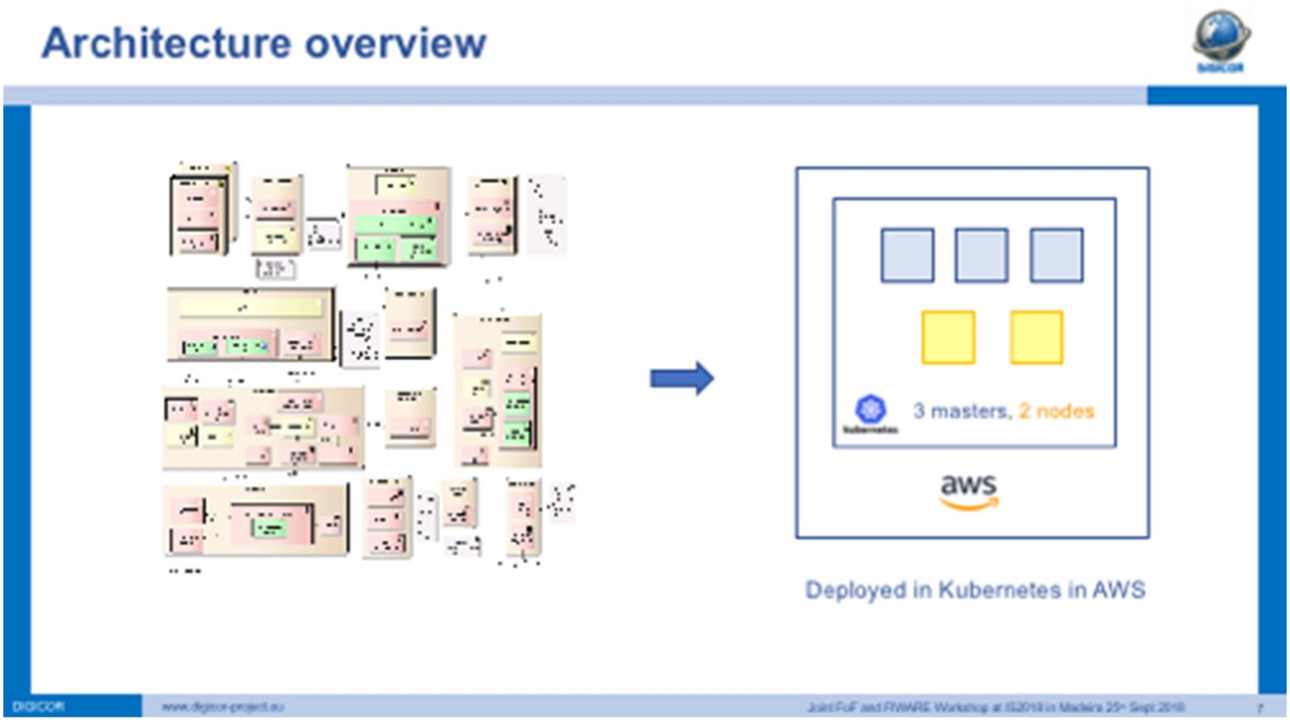

Introduction
Featuring Mid-term Review Slides from Digicor Technical Roadmap
Presented on 19th April 2018 in Prague by Filip Jiru, Certicon
Platform Overview
Goals and Challenges
Road map overview
Factory Connectivity and Smart Monitoring
Concluding remarks


DIGICOR Platform overview
(SME Cluster in Hamburg region)
Enhanced collaborations and participation of SMEs in OEM processes
OLM
OEM
OEMs can advertise tenders on Marketplace
Supplier
Legacy Systems of Suppliers can be interconnected with DIGICOR Platform to enable flow of information and data
Collaborative Bids against OEM tenders can be submitted via DIGICOR Platform
Platform Provider
(SME Cluster in Wales)
Enhanced collaborations and participation of SMEs in OEM processes
Marketplace Service
Workflow Management
Planning Service
Scheduling Service
Risk Management
Third Party Services
Toolstore - Software Services
Basic Platform Services
Governance Rules
Legacy Systems
DIGICOR Collaboration Platform
Collaborative Bids against OEM tenders can be submitted via DIGICOR Platform
DIGICOR
www.digicor-project.eu


Technical roadmap in relations
WP perspective
Requirements
WP1
Use Cases
WP2
Business Models
Use cases implementation
Trails, Validation, Assessment
WP7
Demonstration
Governance
WP6
Rules & Procedures
IPR framework
Security & Trust framework
Governance rules
Collaboration Platform & Tools
WP3
WP4
Tools
WP5
Software Modules
Platform
Integration
Software Solution
Links and Services to other trading platforms like COVISINT / BOOSTAEROSPACE / etc
KANBAN
Community of Platform Users
Exploitation & Dissemination
WP8
WP9
Project management
Management Exploitation & Dissemination
DIGICOR
www.digicor-project.eu

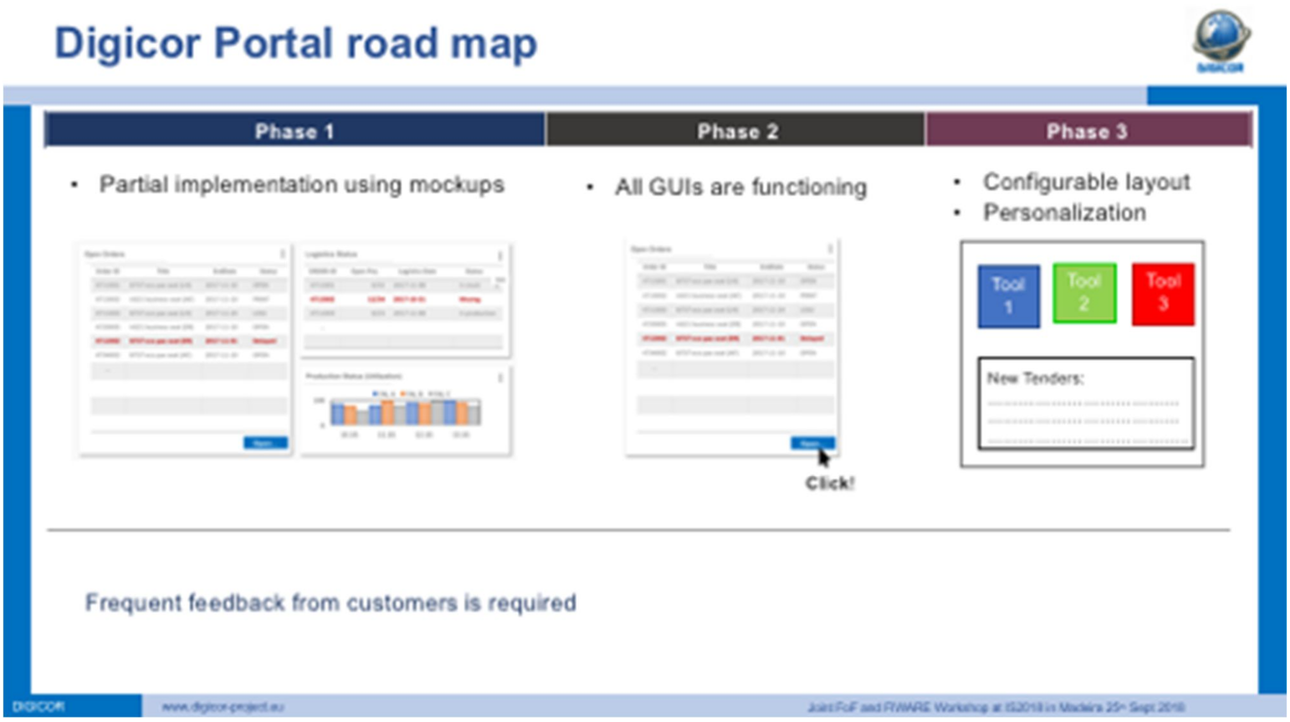

Goals and Challenges
The DIGICOR goal:
To provide extensible secure collaborative platform including communication with factories
Challenges:
• Third party tools vs. security
• Innovative Industry 4.0 approaches vs. readiness of companies
• Research project aiming to production
• Several distinct use cases
• Distributed development team
• Unknown target deployment
Good design decisions are critical

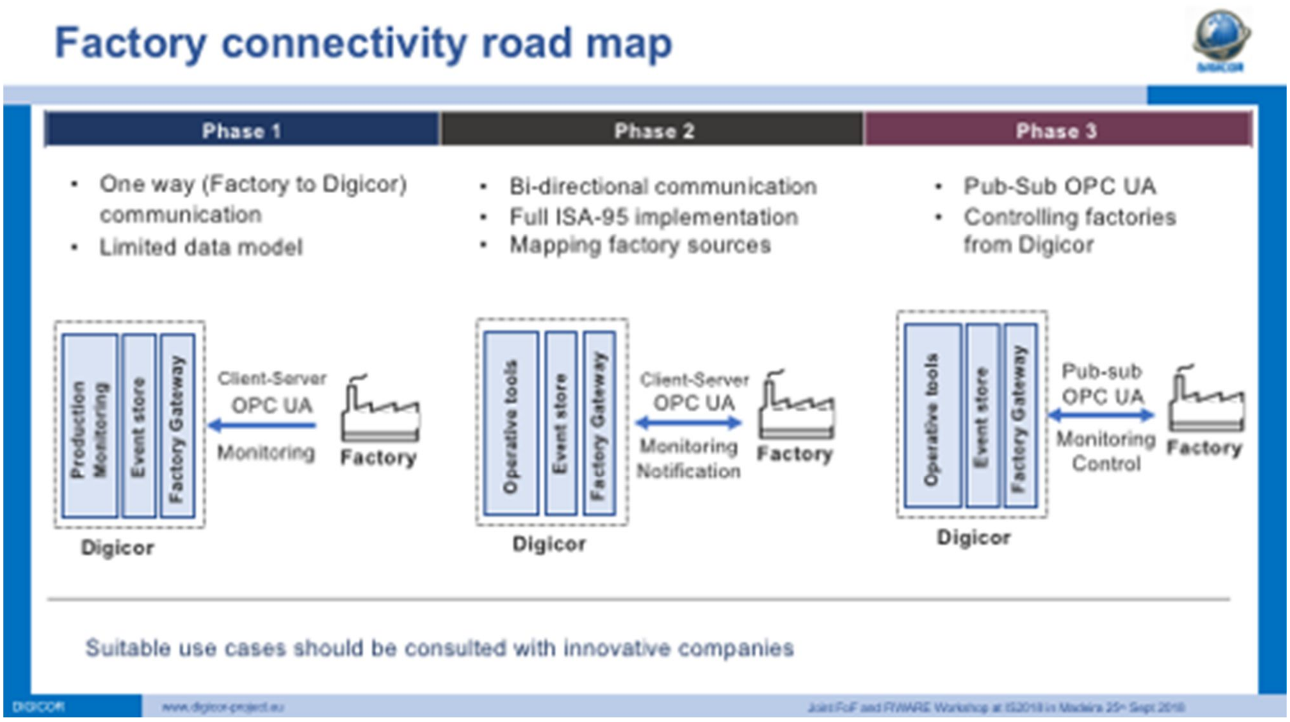

Design and architectonic decisions
Microservice architecture
Each service is developed by a separate team that holds responsibility
Sticking to technology standards
Promoting standards such as REST, OPC-UA, ISA-95, MPEG-M
Leveraging event driven architecture
To enable loose coupling, implementing event sourcing
Using production ready technologies and practices
Kubernetes, AWS, Continuous Delivery
kubernetes
aws

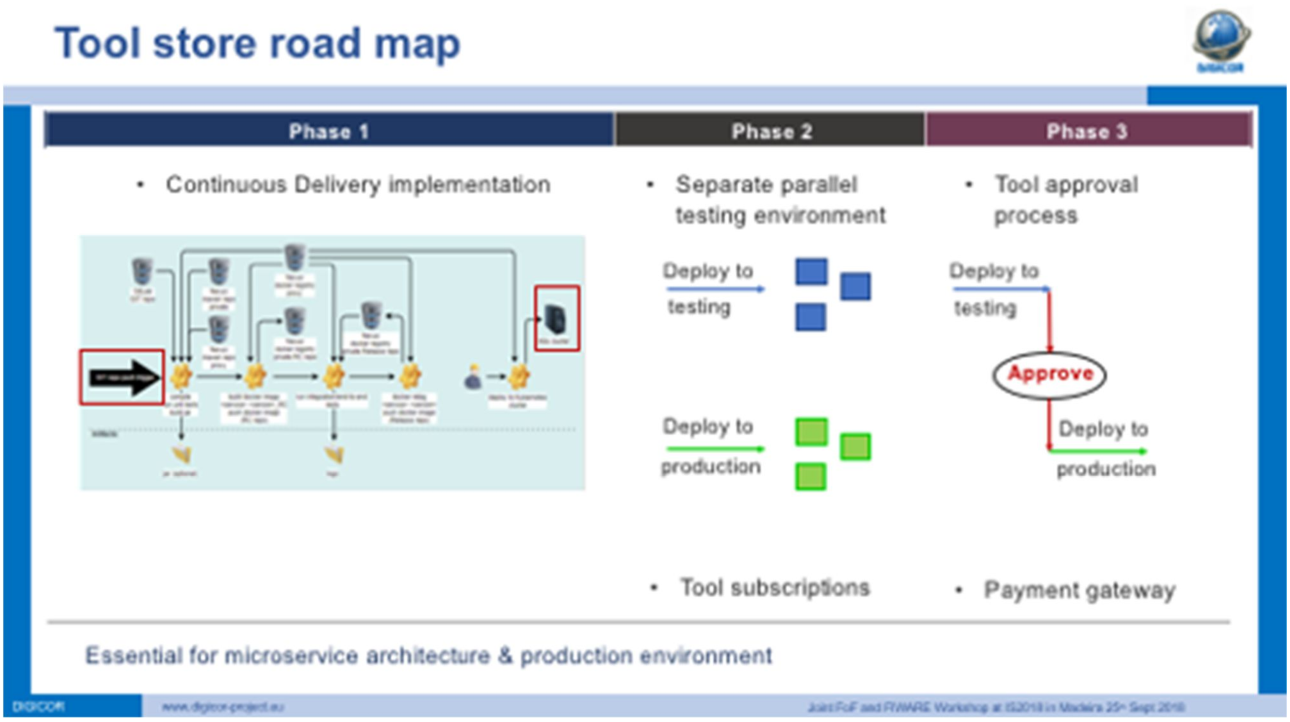


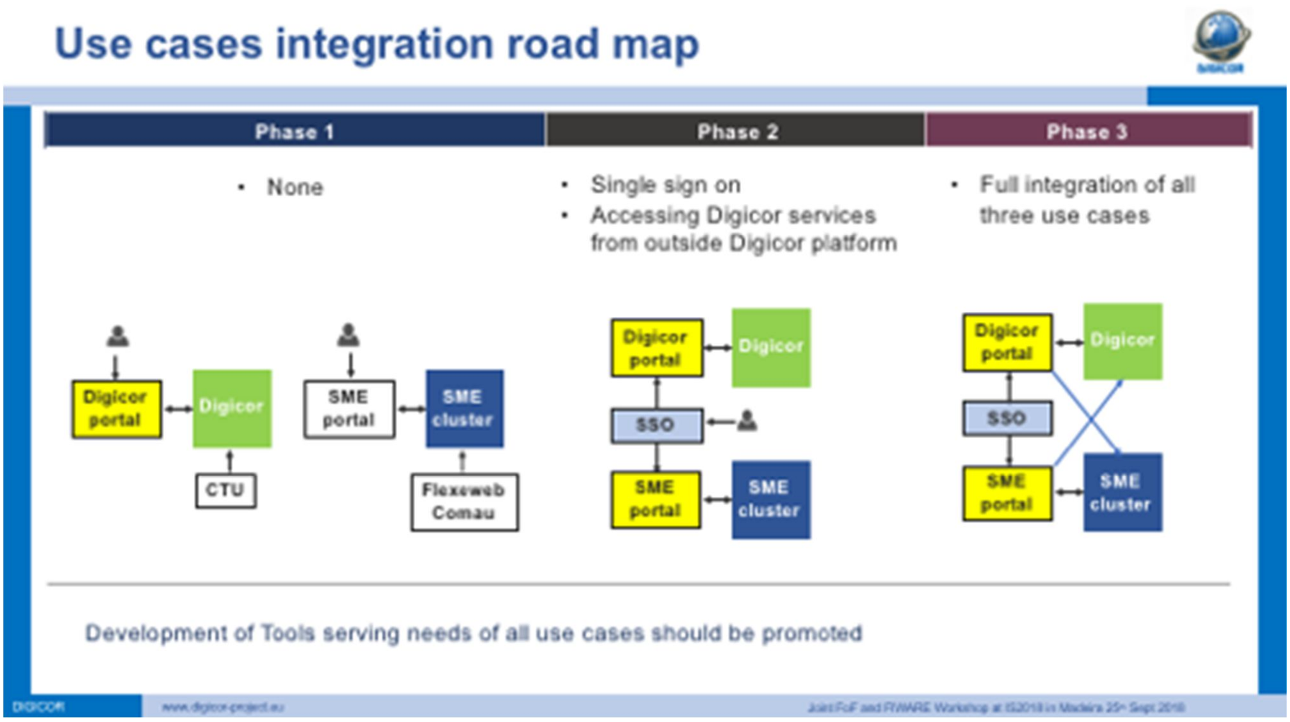
Technical road map overview

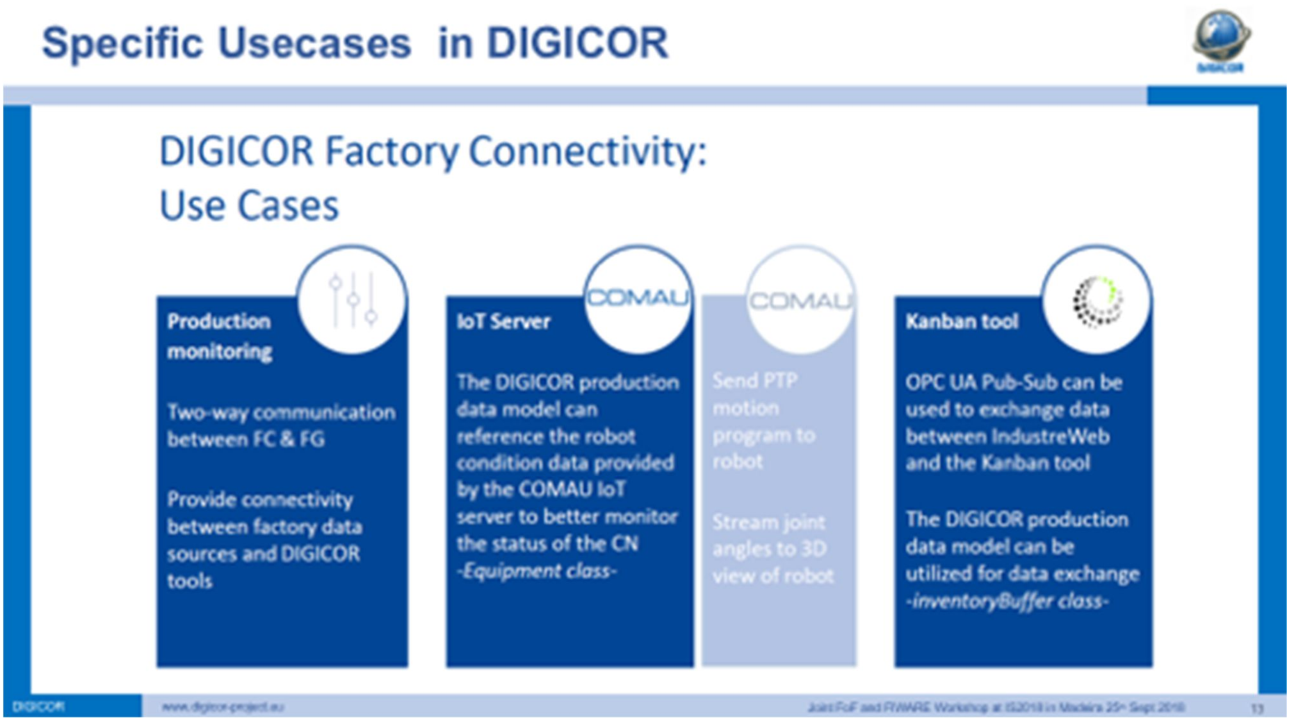
Component	Phase 1 (1st release)	Phase 2 (2nd release)	Phase 3 (3rd release)
Digicor Portal	• Partial implementation	• All GUIs functioning	• Configurable layout • Personalization
Tools	• Partial functionality	• All reference tools working	• Advanced algorithms
Security	• User authentication	• Complete access control	• Full data security
Factory connectivity	• One way (Factory-> Digicor) • Limited data model	• Two way communication • ISA-95 implementation	• Pub-Sub OPC UA • Controlling factories from Digicor
Tool store	• CD implementation	• Testing environment • Tool subscription	• Tool approval process • Payment gateway
Infrastructure	• Infrastructure services in place and running	• Centralized logging and monitoring	• Advanced Infrastructure diagnostic
Use cases Integration	• None	• Single sign on • Accessing Digicor services from outside Digicor platform	• Full integration of all three use cases
Developers Support	• Service template • Basic documentation	• More detailed documentation	• Extensive documentation available online
Community support	• Guided presentations	• Access to testing version	• Subscription to Portal

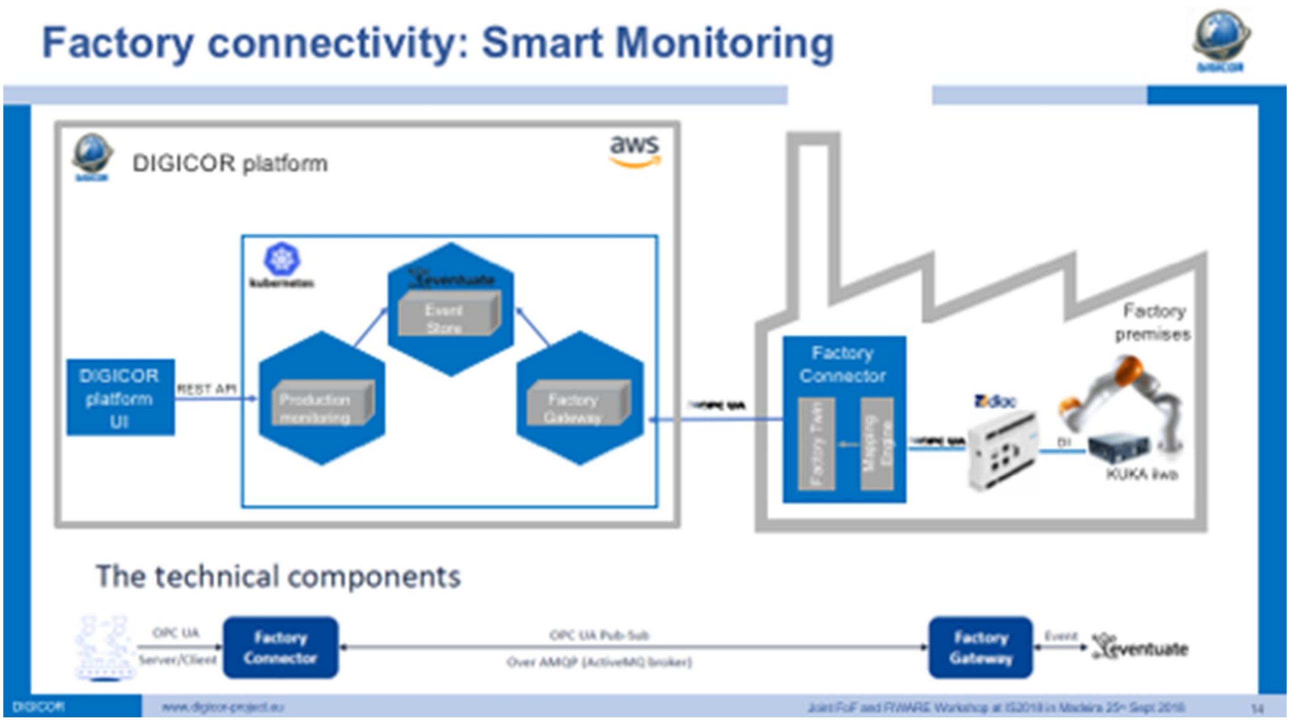

Digicor Portal road map
Phase 1
Phase 2
Phase 3
Partial implementation using mockups
All GUIs are functioning
Configurable layout
Personalization
Tool 1
Tool 2
Tool 3
New Tenders:
Click!
Frequent feedback from customers is required


Factory connectivity road map
Phase 1
Phase 2
Phase 3
One way (Factory to Digicor) communication
Limited data model
Bi-directional communication
Full ISA-95 implementation
Mapping factory sources
Pub-Sub OPC UA
Controlling factories from Digicor
Production Monitoring
Event store
Factory Gateway
Client-Server OPC UA
Monitoring
Factory
Digicor
Operative tools
Event store
Factory Gateway
Client-Server OPC UA
Monitoring Notification
Factory
Digicor
Operative tools
Event store
Factory Gateway
Pub-sub OPC UA
Monitoring Control
Factory
Digicor
Suitable use cases should be consulted with innovative companies


Tool store road map
Phase 1
Phase 2
Phase 3
Continuous Delivery implementation
Separate parallel testing environment
Tool approval process
Deploy to testing
Deploy to production
Deploy to testing
Approve
Deploy to production
Tool subscriptions
Payment gateway
Essential for microservice architecture & production environment

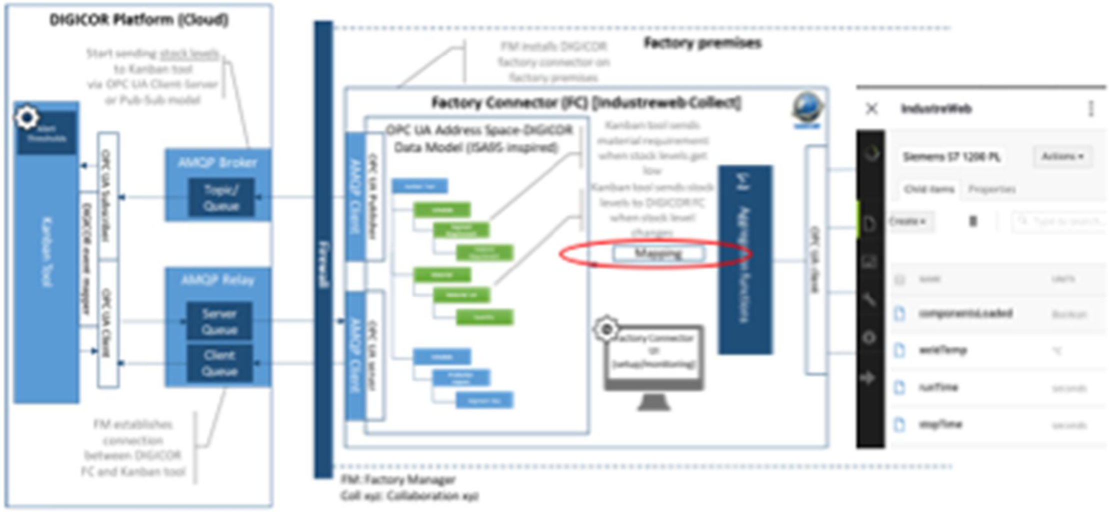

Use cases integration road map
Phase 1
Phase 2
Phase 3
None
Single sign on
Accessing Digicor services from outside Digicor platform
Full integration of all three use cases
Digicor portal
Digicor
CTU
SME portal
SME cluster
Flexeweb Comau
SSO
Development of Tools serving needs of all use cases should be promoted


Specific Usecases in DIGICOR
DIGICOR Factory Connectivity:
Use Cases
Production monitoring
Two-way communication between FC & FG
Provide connectivity between factory data sources and DIGICOR tools
IoT Server
COMAU
The DIGICOR production data model can reference the robot condition data provided by the COMAU IoT server to better monitor the status of the CN
-Equipment class-
COMAU
Send PTP motion program to robot
Stream joint angles to 3D view of robot
Kanban tool
OPC UA Pub-Sub can be used to exchange data between IndustreWeb and the Kanban tool
The DIGICOR production data model can be utilized for data exchange
-inventoryBuffer class-


Factory connectivity: Smart Monitoring
DIGICOR platform
aws
DIGICOR platform UI
REST API
Production monitoring
Event Store
Factory Gateway
Factory premises
Factory Connector
KUKA iiwa
The technical components
OPC UA Server/Client
Factory Connector
OPC UA Pub-Sub
Over AMQP (ActiveMQ broker)
Factory Gateway
Event
eventuate

Factory Node Data Model

- Mapping of Data Tree in IW to OPC UA Data Model



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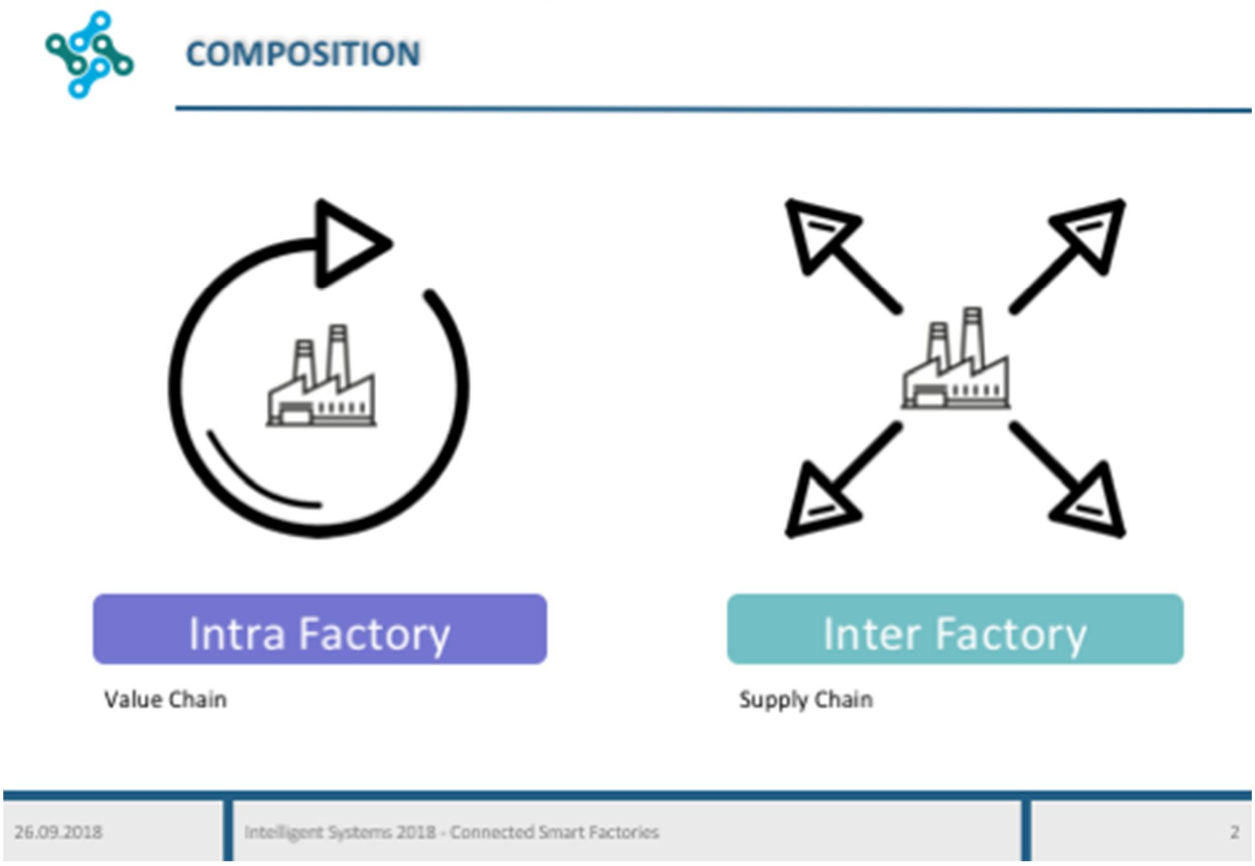
Conclusion

- Continuous need to have seamless connectivity to Enterprise Data
- Digicor like many other platform still needs a Digital Backbone to allow aggregated data to be presented to applications and services
- Infrastructure needs to be secure for company data but open for security enabled services

Thank you for your attention !

DIGICOR www.digicor-project.eu Joint FoF and FIWARE Workshop at IS2018 in Madeira 25th Sept 2018


COMPOSITION - Ecosystem for Collaborative Manufacturing Processes – Intra- and Interfactory Integration and Automation
IoT Applied to Factories of the Future
Marc Jentsch
Fraunhofer FIT
Co-funded by the European Union
COMPOSITION


COMPOSITION
Intra Factory
Value Chain
Inter Factory
Supply Chain
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2

Introduction of Pilot Partners

Boston Scientific

- Medical Device Manufacturer
- Optimization of Internal Processes

KLEEMANN

- Lift Manufacturer
- Optimization of Waste Processes

ΕΛΔΙΑ

- Recycling Company
- Customer Relationship with Kleemann

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Use Cases

Tier	Use Case
Tier 1	UC-BSL-2 Predictive maintenance
	UC-KLE-1 Maintenance decision support
	UC-KLE-4 Scrap metal collection and bidding process
	UC-ELDIA-1 Fill-level notification – Contractual wood and recyclable materials management
Tier 2	UC-BSL-5 Equipment monitoring and line visualization
	UC-KLE-2 Delayed process step
	UC-BSL-3 Component tracking
	UC-ATL-3 Searching for recommended solutions
Tier 3	UC-KLE-3 Scrap metal and recyclable waste transportation
	UC-BSL-7 Automatic long term tracking of high value materials for physical security
	UC-BSL-4 Automatic solder paste touch up
	UC-KLE-7 Ordering raw materials
	UC-ATL-1 Selling software/consultancy
	UC-ATL-2 Searching for solutions
	UC-ATL/NXW-1 Integrate external product into own solution
	UC-NXW-1 Decision support over marketplace

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UC-KLE-1 Maintenance Decision Support

- Forecast Motor Breakdowns of Polishing Machine

Challenge Technology Application

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UC-KLE-1 Maintenance Decision Support

- Combine Historial Breakdown Data with Vibration Sensor Data
- Vibration 0.038 m/s² data at 1.344 kHz (3 axes)

Figure 21: Bossi Motor (internal)

Figure 22: Bossi Motors (external)

Challenge Technology Application

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UC-KLE-1 Maintenance Decision Support

Challenge Technology Application

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UC-ELDIA-1: Fill-level Notification

KLEEMANN

Fill-level

Send Trucks

ΕΛΔΙΑ

Challenge Technology Application

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UC-ELDIA-1: Fill-level Notification
Sx1272mbas Lora communication module attached on the mcu PCB, Antenna HRLV-MaxSonar EZ (MB1043) Ultrasonic Sensor and a 4 AA Battery Pack
LoRa gateway access to Ethernet and power within 100m radius from the bins
Sensor Position
Challenge
Technology
Application
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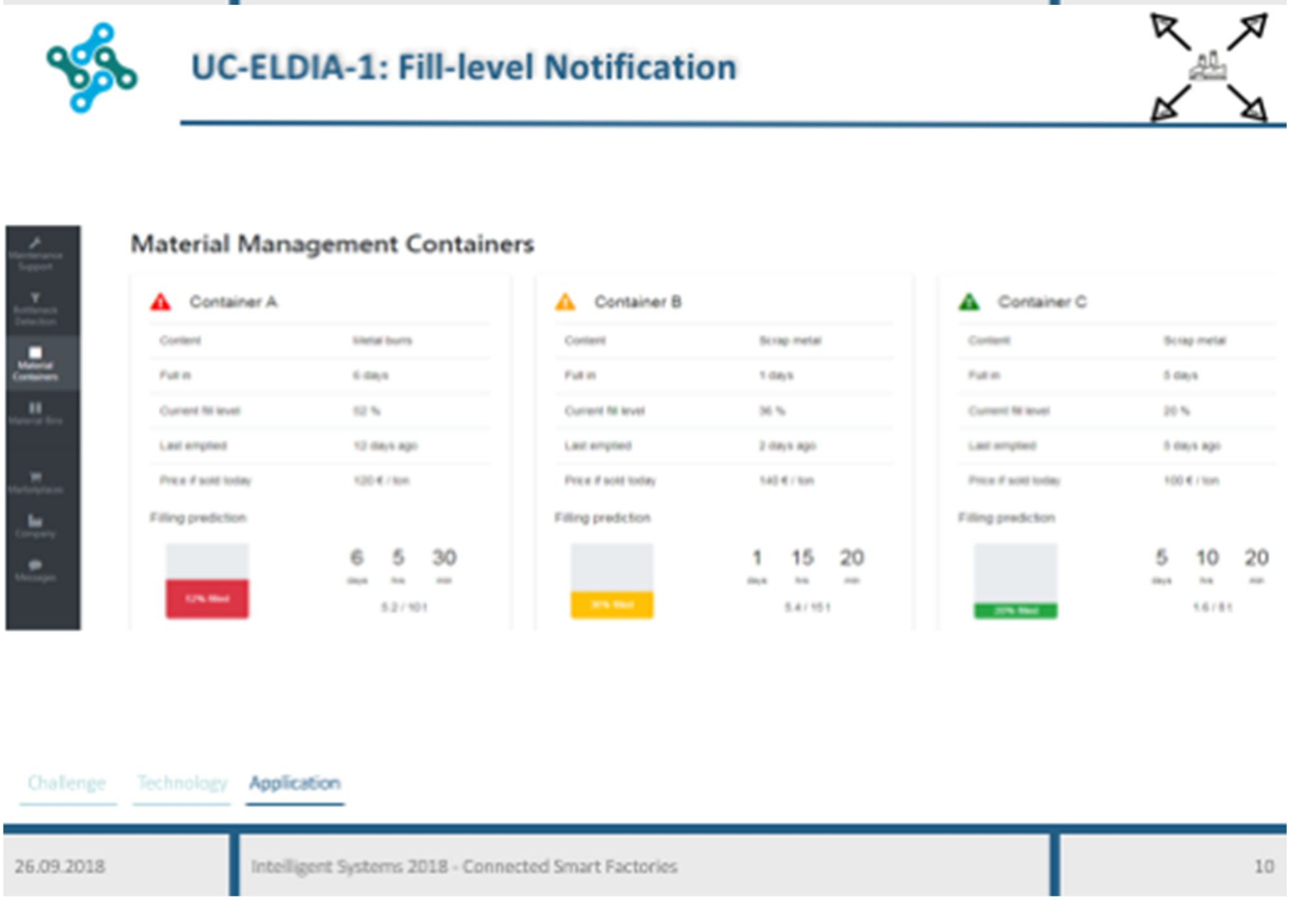
UC-ELDIA-1: Fill-level Notification
Material Management Containers
Container A
Container B
Container C
6 5 30
1 15 20
5 10 20
Challenge
Technology
Application
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10

UC-BSL-5 Equipment Monitoring and Line Visualisation

- Real time visualisation of production line's efficiency
  - Representation of Involved Equipment
  - Light Tower Equipment Status
  - Actual Production
  - Target Production

20/20	12/20	10/20	3/20	2/20	1/20	0/20
Laser	DEK	SPI	Mount	2D	Reflow	3D

Challenge Technology Application

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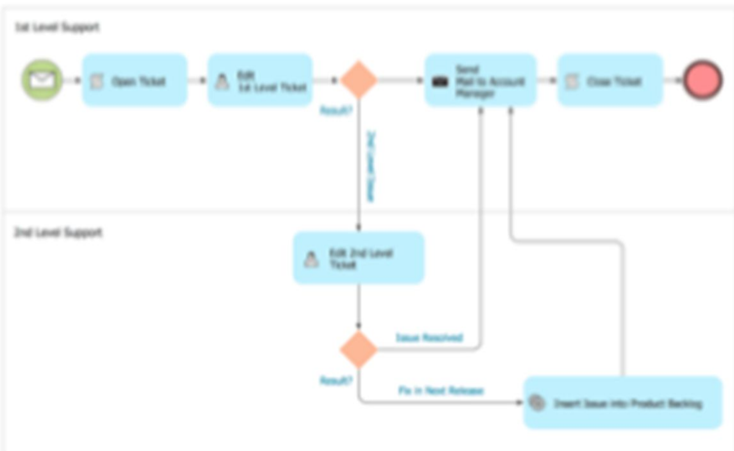
UC-BSL-5 Equipment Monitoring and Line Visualisation

- BPMN: Business Process Model and Notation
  - Graphical Notation for Specifying Business Processes
  - Available Software Tools to Execute Logic behind a BPMN Model



Challenge Technology Application

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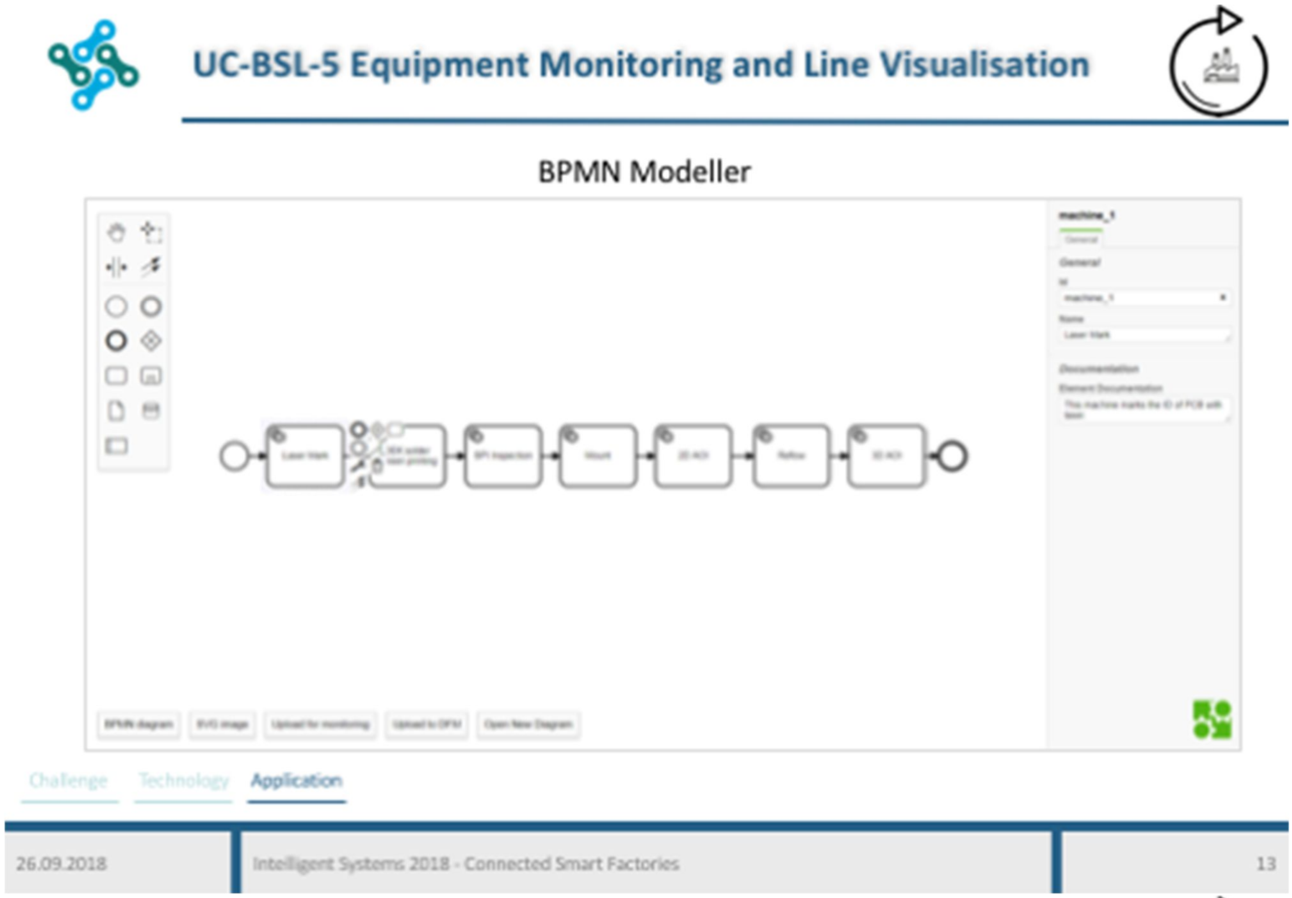
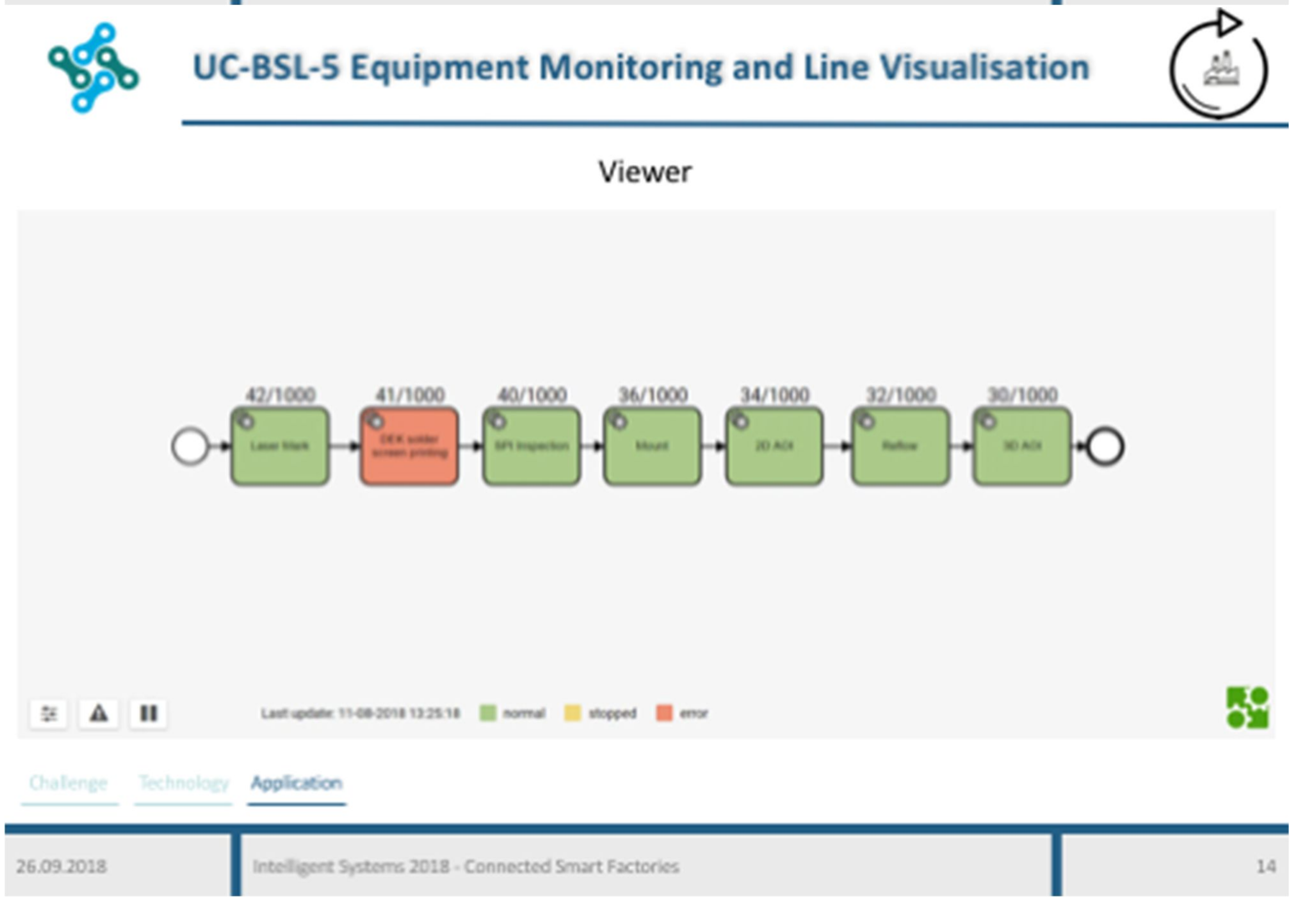

UC-BSL-5 Equipment Monitoring and Line Visualisation
BPMN Modeller
Challenge
Technology
Application
26.09.2018
Intelligent Systems 2018 - Connected Smart Factories
13


UC-BSL-5 Equipment Monitoring and Line Visualisation
Viewer
42/1000
41/1000
40/1000
36/1000
34/1000
32/1000
30/1000
normal
stopped
error
Challenge
Technology
Application
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14

UC-BSL-5 Equipment Monitoring

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UC-BSL-3 Component Tracking

- Pieces of Equipment get lost

Challenge Technology Application

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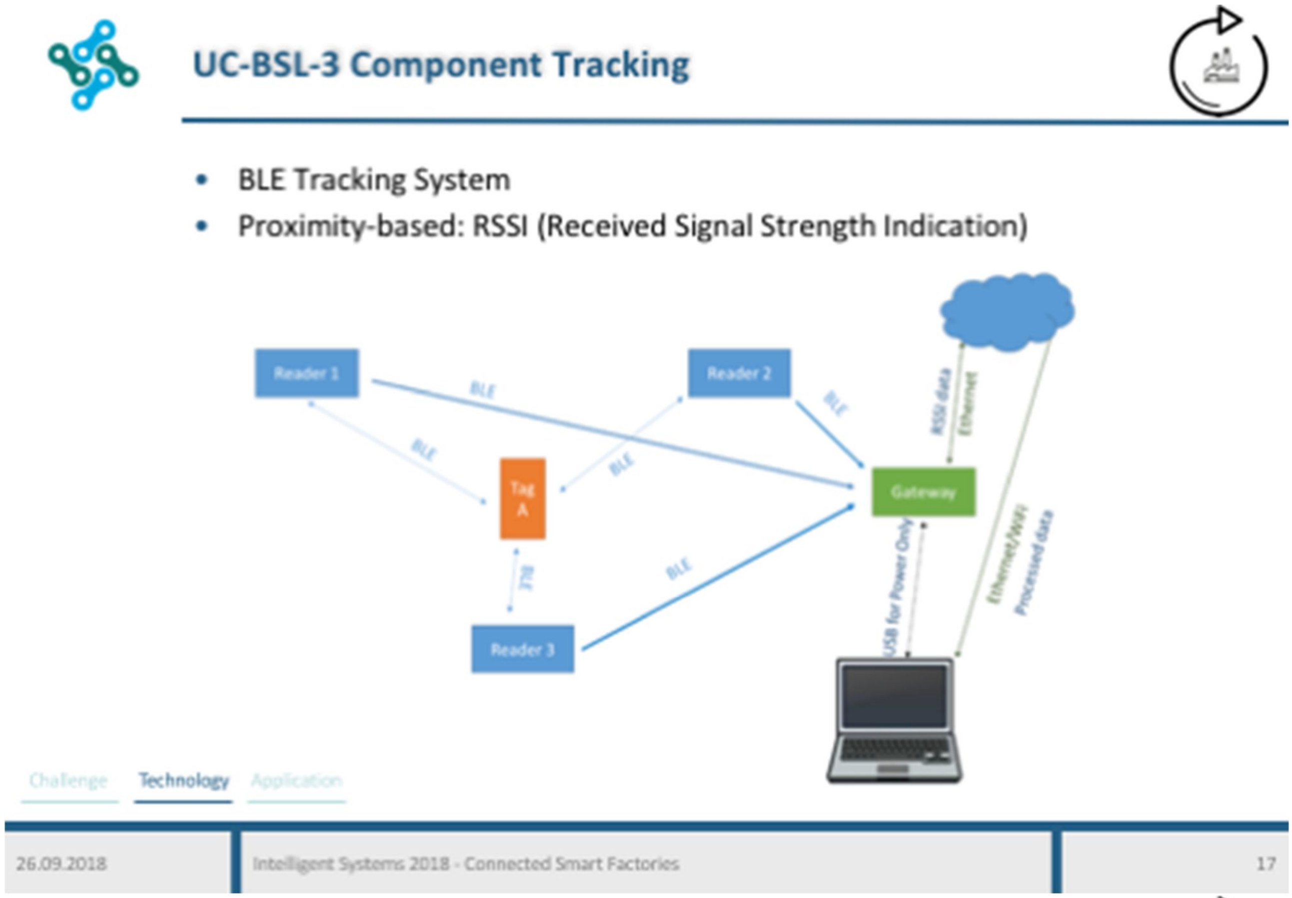
UC-BSL-3 Component Tracking
• BLE Tracking System
• Proximity-based: RSSI (Received Signal Strength Indication)
Reader 1
Reader 2
Reader 3
Tag A
Gateway
BLE
RSSI data
Ethernet
USB for Power Only
Ethernet/WiFi
Processed data
Challenge
Technology
Application
26.09.2018
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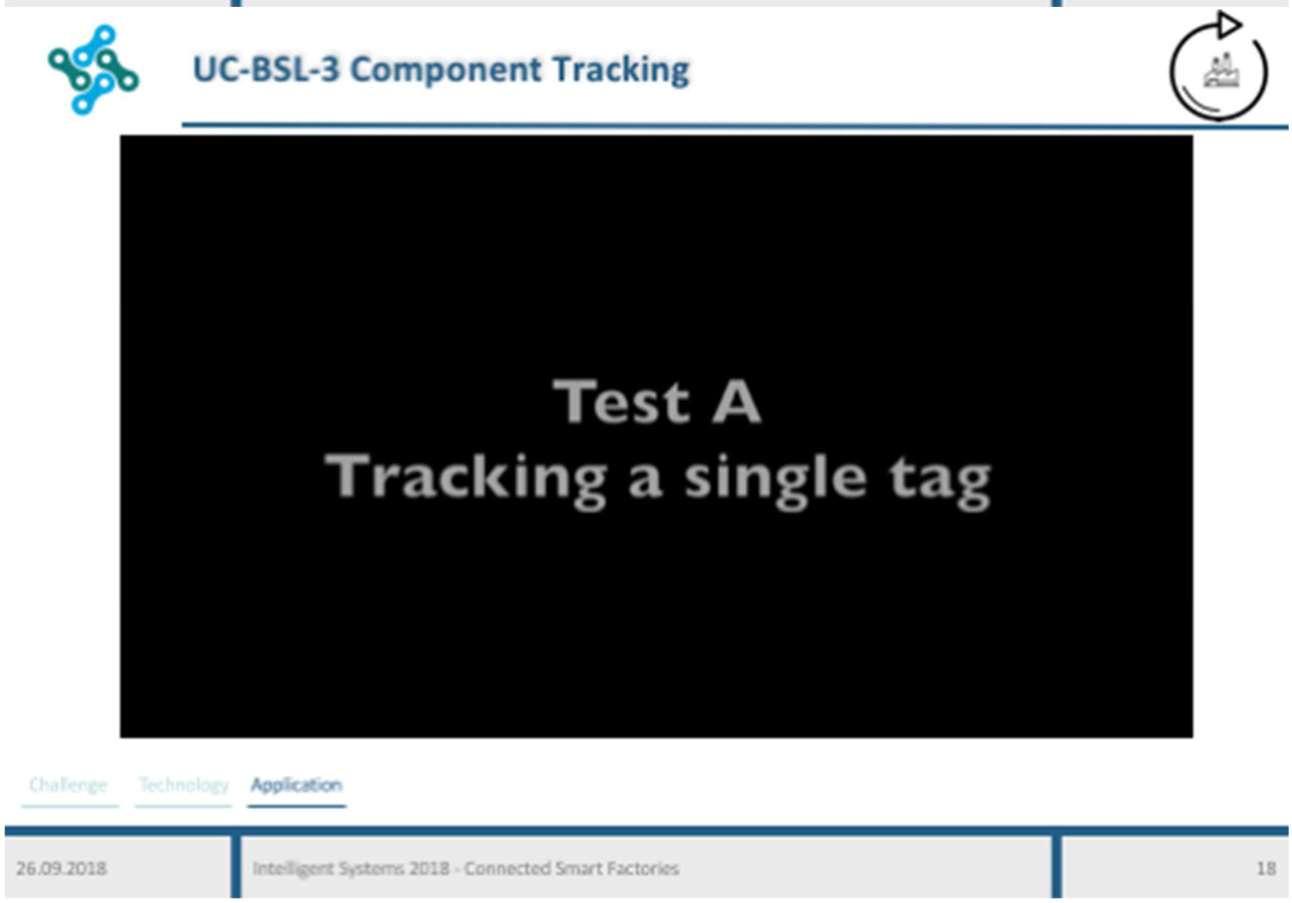
17


UC-BSL-3 Component Tracking
Test A
Tracking a single tag
Challenge
Technology
Application
26.09.2018
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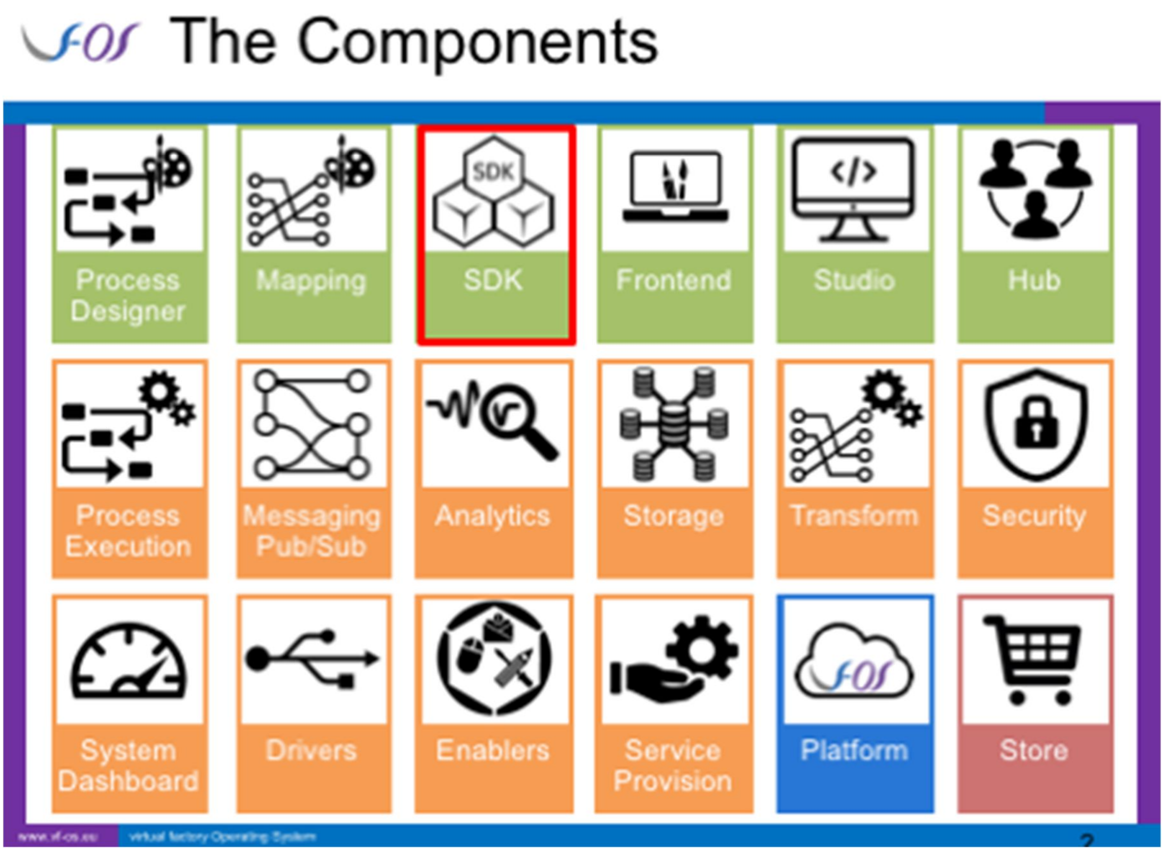
18

COMPOSITION

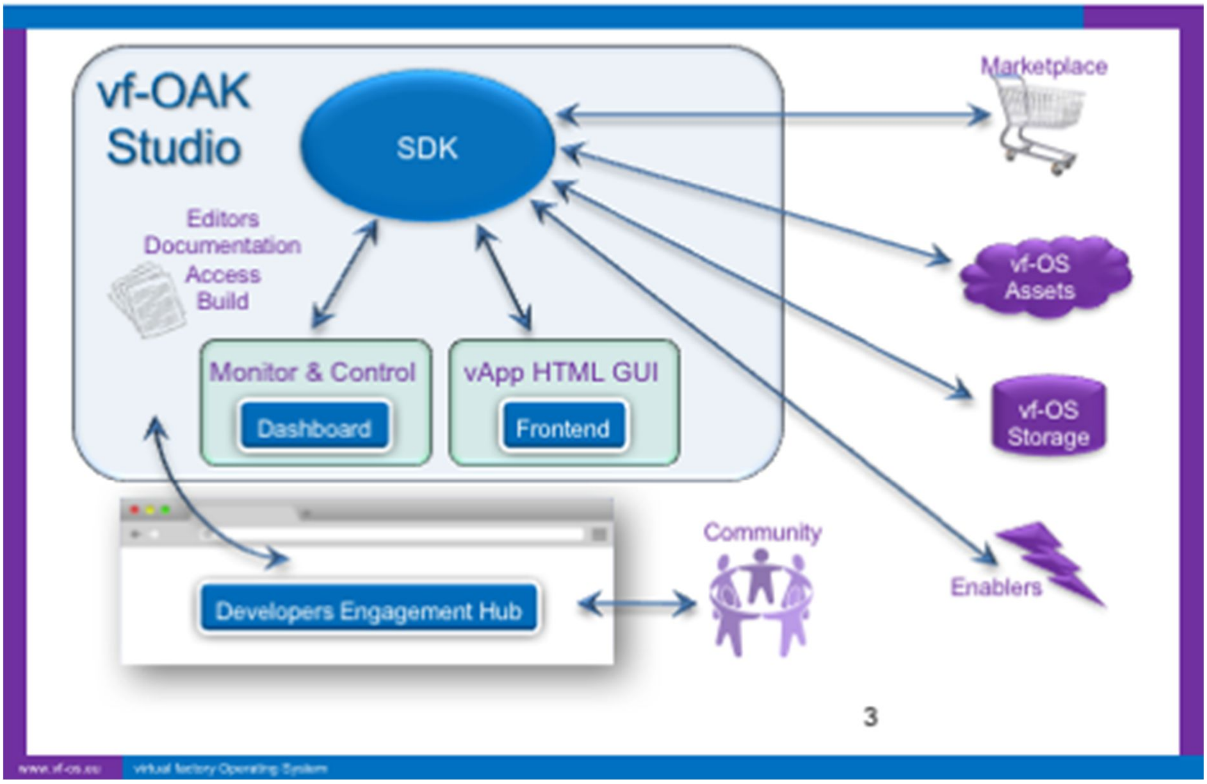
Thanks for your attention

COMPOSITION has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement No 723145.

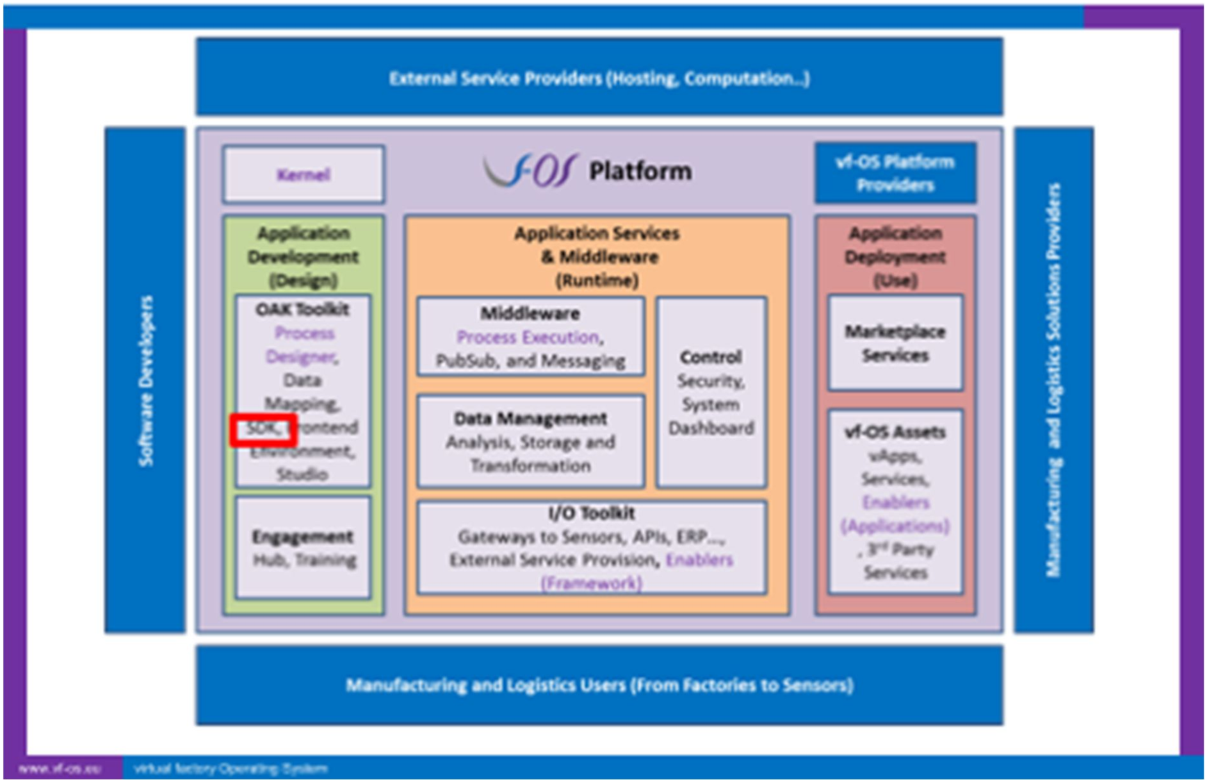

virtual factory Operating System
vf-OAK Software Development Kit (SDK)
Carlos Coutinho
CEO
Caixa Mágica

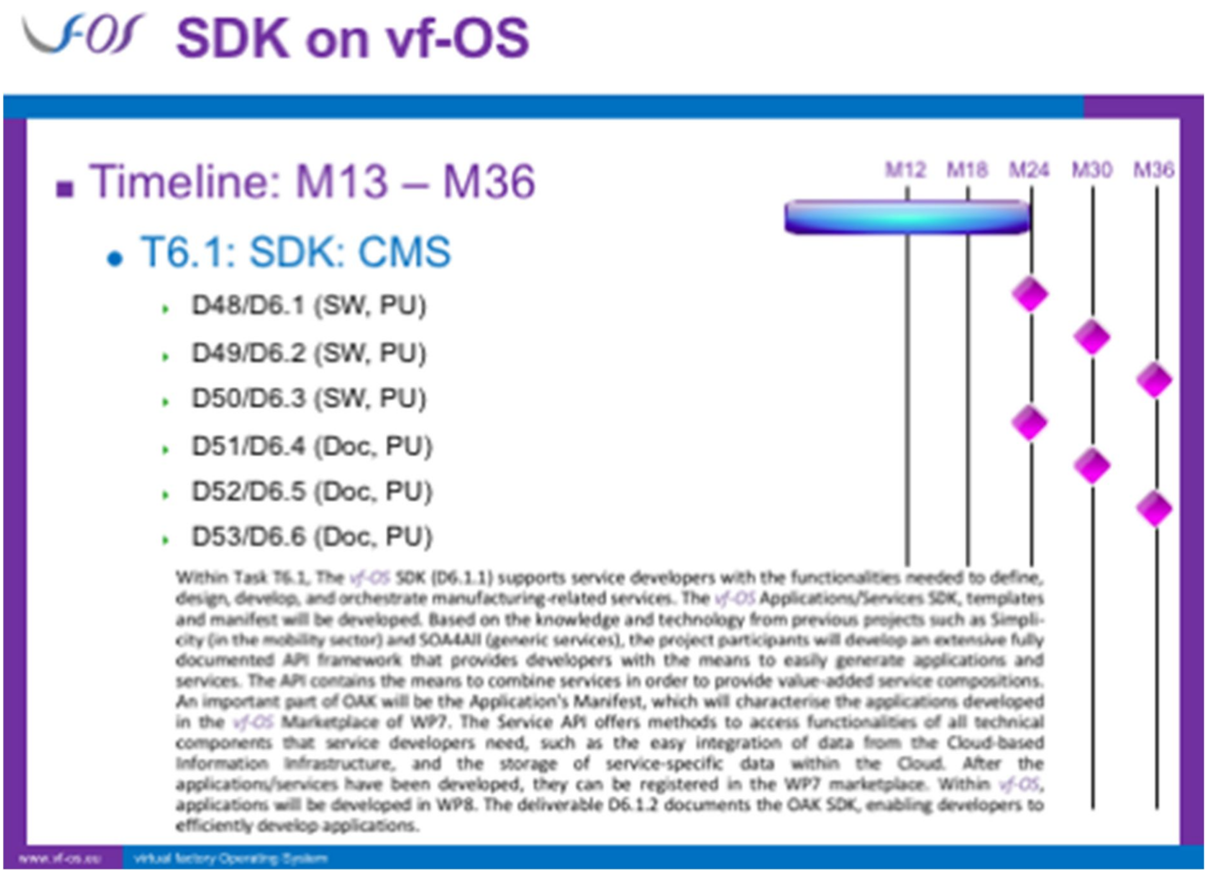

The Components
Process Designer
Mapping
SDK
Frontend
Studio
Hub
Process Execution
Messaging Pub/Sub
Analytics
Storage
Transform
Security
System Dashboard
Drivers
Enablers
Service Provision
Platform
Store

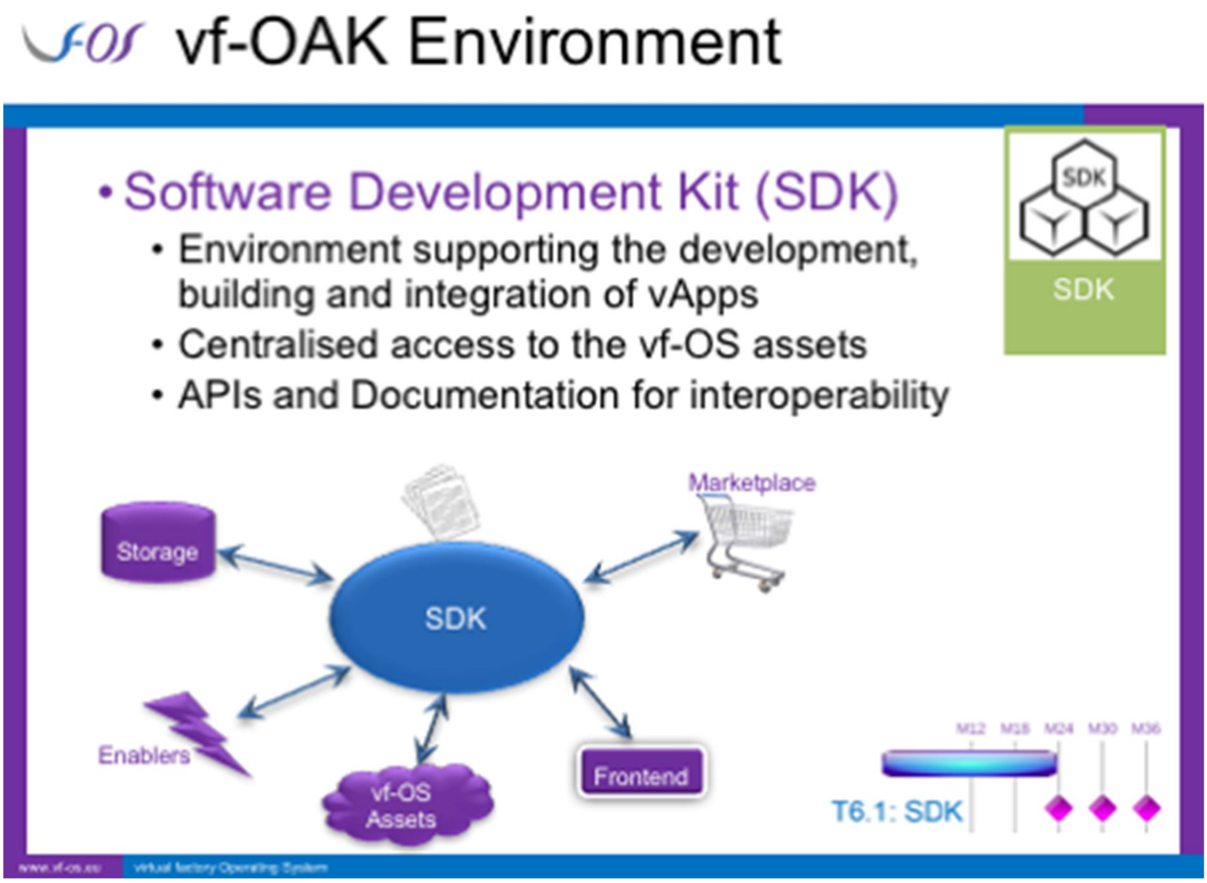
vf-OAK Diagram

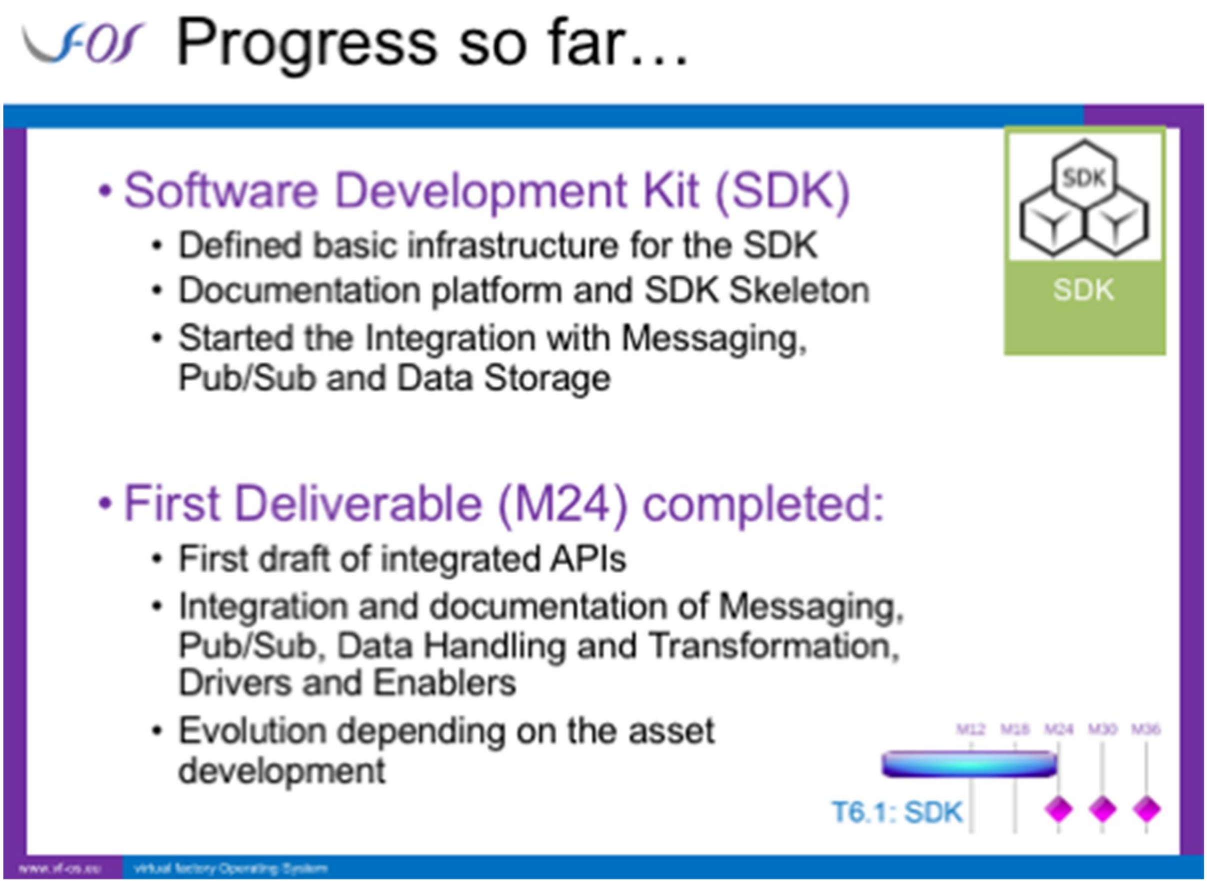


High-Level Architecture




SDK on vf-OS
Timeline: M13 – M36
T6.1: SDK: CMS
D48/D6.1 (SW, PU)
D49/D6.2 (SW, PU)
D50/D6.3 (SW, PU)
D51/D6.4 (Doc, PU)
D52/D6.5 (Doc, PU)
D53/D6.6 (Doc, PU)
M12
M18
M24
M30
M36
Within Task T6.1, The vf-OS SDK (D6.1.1) supports service developers with the functionalities needed to define, design, develop, and orchestrate manufacturing-related services. The vf-OS Applications/Services SDK, templates and manifest will be developed. Based on the knowledge and technology from previous projects such as Simpli-city (in the mobility sector) and SOA4All (generic services), the project participants will develop an extensive fully documented API framework that provides developers with the means to easily generate applications and services. The API contains the means to combine services in order to provide value-added service compositions. An important part of OAK will be the Application's Manifest, which will characterise the applications developed in the vf-OS Marketplace of WP7. The Service API offers methods to access functionalities of all technical components that service developers need, such as the easy integration of data from the Cloud-based Information Infrastructure, and the storage of service-specific data within the Cloud. After the applications/services have been developed, they can be registered in the WP7 marketplace. Within vf-OS, applications will be developed in WP8. The deliverable D6.1.2 documents the OAK SDK, enabling developers to efficiently develop applications.


vf-OAK Environment
Software Development Kit (SDK)
Environment supporting the development, building and integration of vApps
Centralised access to the vf-OS assets
APIs and Documentation for interoperability
SDK
SDK
Storage
Marketplace
SDK
Enablers
vf-OS Assets
Frontend
T6.1: SDK


Progress so far…
Software Development Kit (SDK)
Defined basic infrastructure for the SDK
Documentation platform and SDK Skeleton
Started the Integration with Messaging, Pub/Sub and Data Storage
SDK
SDK
First Deliverable (M24) completed:
First draft of integrated APIs
Integration and documentation of Messaging, Pub/Sub, Data Handling and Transformation, Drivers and Enablers
Evolution depending on the asset development
M12 M18 M24 M30 M36
T6.1: SDK

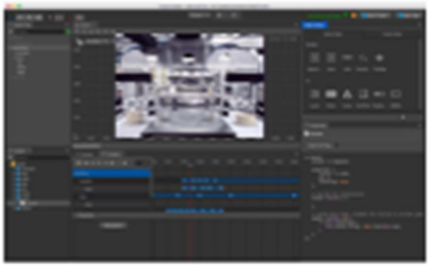

WG DA-05 Status
The WG-05 already performed one teleconf meeting
Participants
Carlos Coutinho, Vítor Viana
Usman Wajid
Chris Deccubber
Carlos Agostinho, Ricardo Gonçalves
Raquel Melo
Contacts have already been going (May/June) to have a follow-up meeting
Chris and perhaps Sergio Gusmeroli will provide additional partners working on SDKs, even if not part of EFFRA
Gash Bhullar showed interest in participating
It was decided to postpone until after the summer holidays
The meeting will take place in the following weeks

WG DA-05 Status

- Topics
  - Scope and known projects that could contribute
    - vf-OS
    - Digicor
    - EFFRA: Connected Factories
    - FIWARE – SDK
    - Fitman (FIWARE)
  - State of the art on SDKs
    - Generic enabler to access all functionality of a context
    - How to make different APIs available?
    - Flutter, Ionic and similar multi-platform development SDKs
    - Create a cross-platform environment
    - Interoperability and open-access documentation and sources
  - Possibility for developing a reference implementation
  - Possibility to publish research paper

WG Scope

- Objective:
  - To propose and define an environment Software Development Kit (SDK) for developing applications to the manufacturing area
- To define the SDK standards:
  - Current vision of the SDKs
  - Future SDK vision
  - Projects involved
  - New vision
    - Multi-platform
    - Raise the SDK level to Model?
  - Associated tools
    - YEOMAN: Templates of SDK, version and dependencies
    - SWAGGER: Documentation
    - NPM: Version Control system and manage dependencies



vf-OS WG Scope

- Objectives:
  - Create new standards
  - Create a reference implementation
  - Define a common approach on all FoF projects
    - A problem is the time frame for the vf-OS project
    - Will it be possible to develop anything at all?
    - Clarify with Chris the target of the EFFRA WGs
    - Is it just to define a roadmap for the future?
    - Or a common approach for future projects?
    - Definition of frameworks that gather projects
    - Define a Meta-SDK that would have access to other SDKs resources

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vf-OS WG Scope

- Actions:
  - Propose and Define SDK
    - This needs to be manageable and credible considering the project timeframes
  - Data Model
    - Define generic use-cases and requirements (interoperability?)
  - API
  - Exchange Formats
  - Define a standard set of tools for creating new SDKs
  - Define a common/reference platform for SDKs
  - Is this applicable only to manufacturing?
    - How can we include other parties outside EFFRA?
    - Added-value goes a lot beyond manufacturing projects

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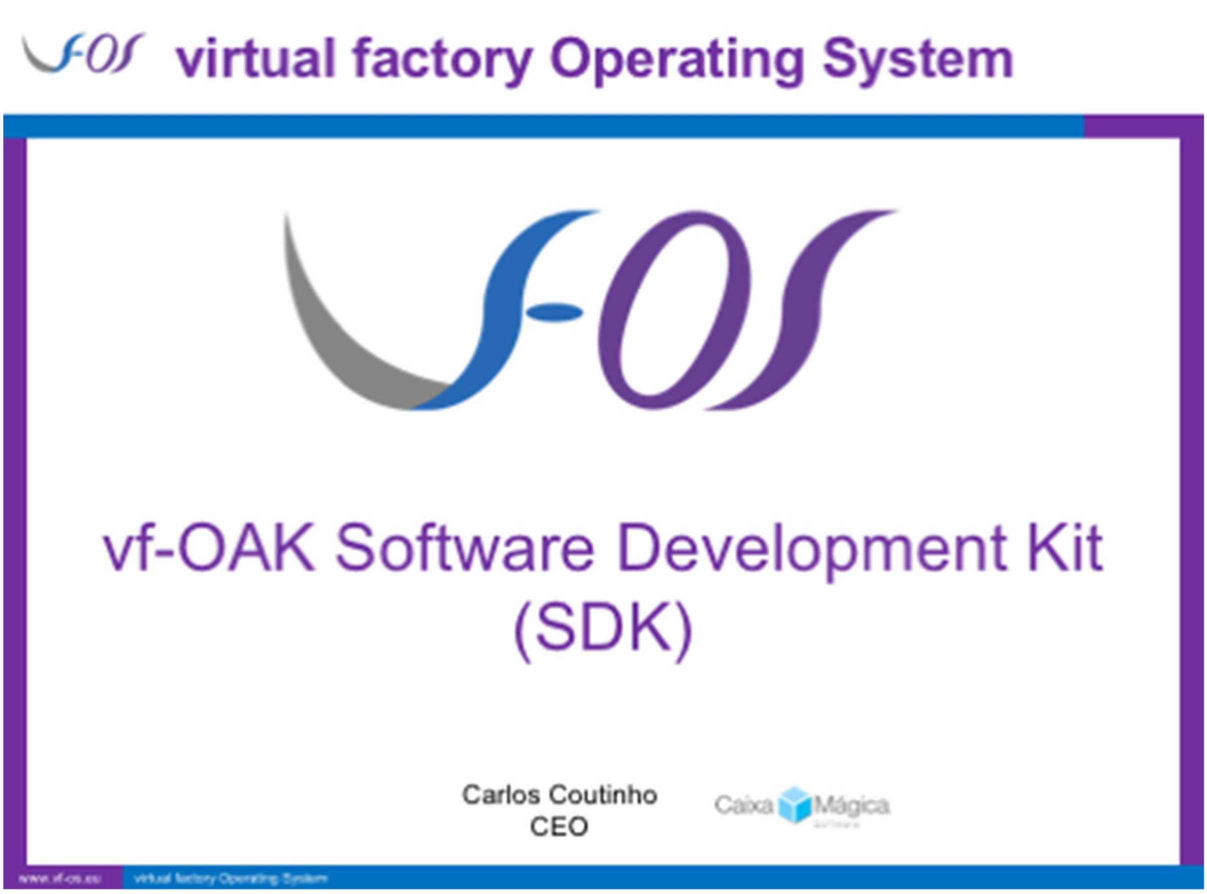
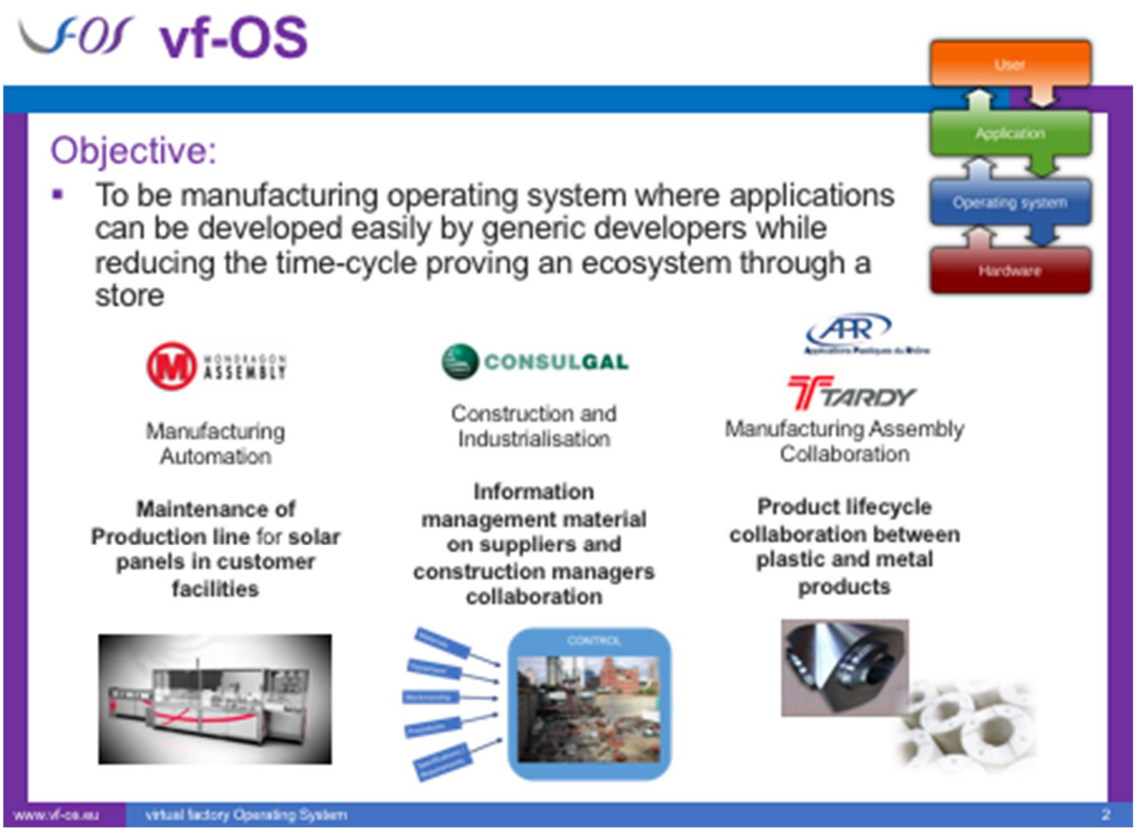

virtual factory Operating System
vf-OAK Software Development Kit
(SDK)
Carlos Coutinho
CEO
Caixa Mágica


virtual factory Operating System
IO Toolkit of vf-OS
IS2018 workshop
Víctor Anaya
Universitat Politécnica de Valencia
www.vf-os.eu
virtual factory Operating System
1


vf-OS
User
Application
Operating system
Hardware
Objective:
To be manufacturing operating system where applications can be developed easily by generic developers while reducing the time-cycle proving an ecosystem through a store
MONDRAGON ASSEMBLY
Manufacturing Automation
Maintenance of Production line for solar panels in customer facilities
CONSULGAL
Construction and Industrialisation
Information management material on suppliers and construction managers collaboration
CONTROL
APR
TARDY
Manufacturing Assembly Collaboration
Product lifecycle collaboration between plastic and metal products
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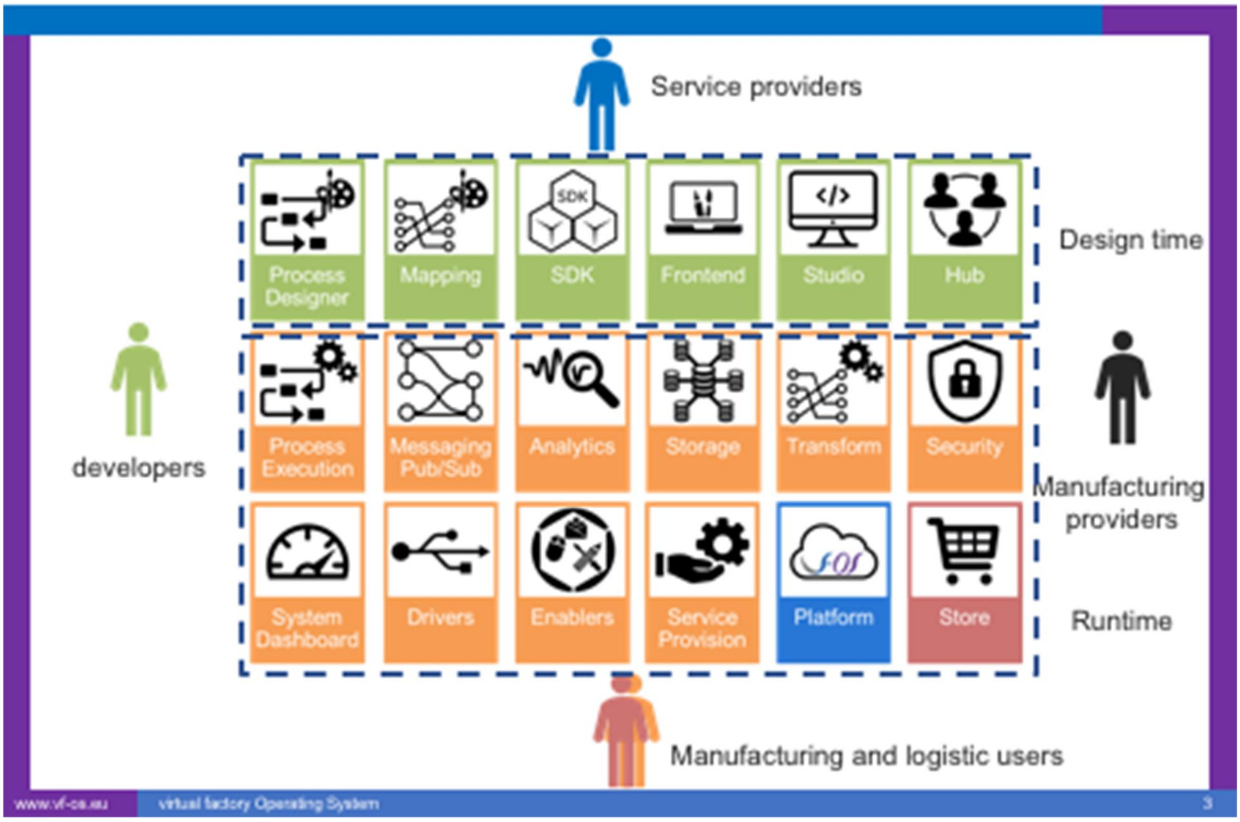
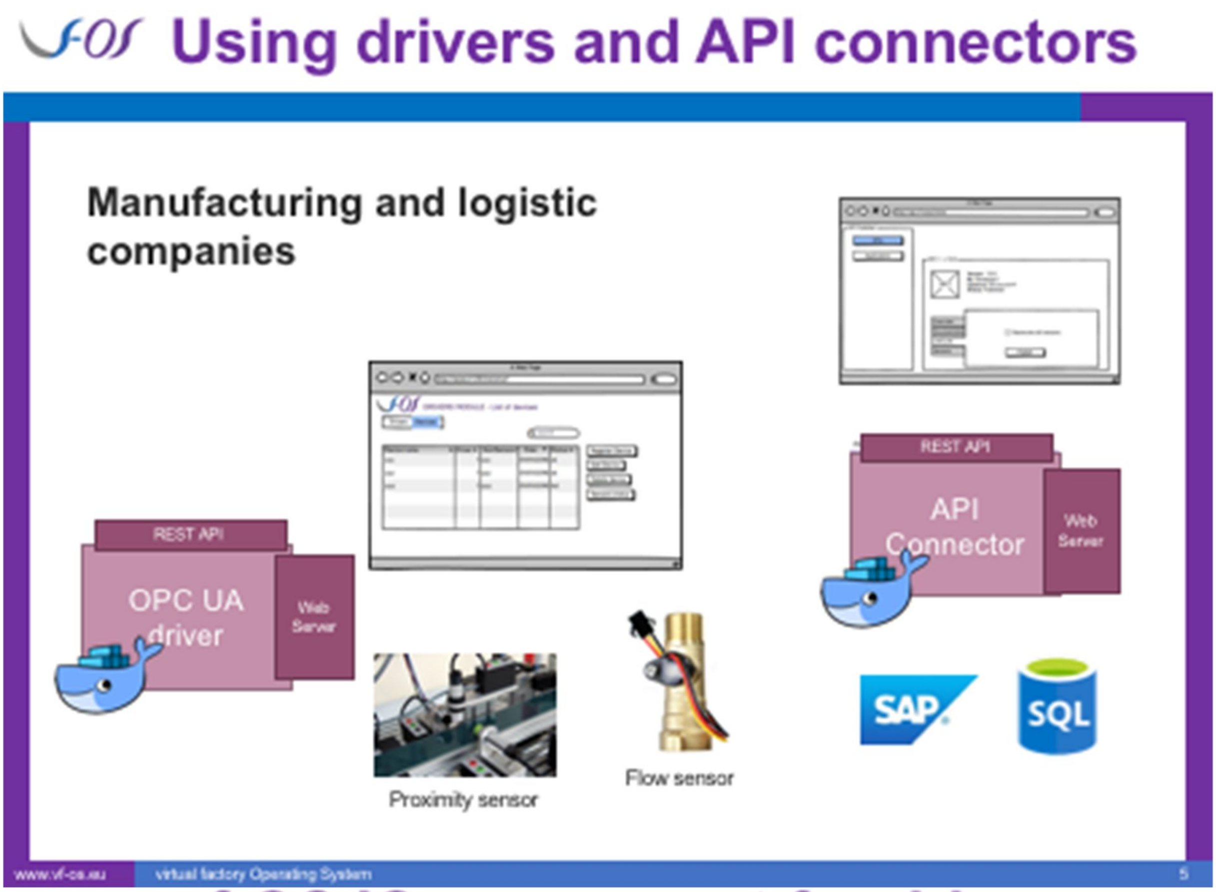
vf-OS ecosystem



vf-OS IO component Goal


Using drivers and API connectors
Manufacturing and logistic companies
REST API
OPC UA driver
Web Server
REST API
API Connector
Web Server
Proximity sensor
Flow sensor
SAP
SQL
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virtual factory Operating System
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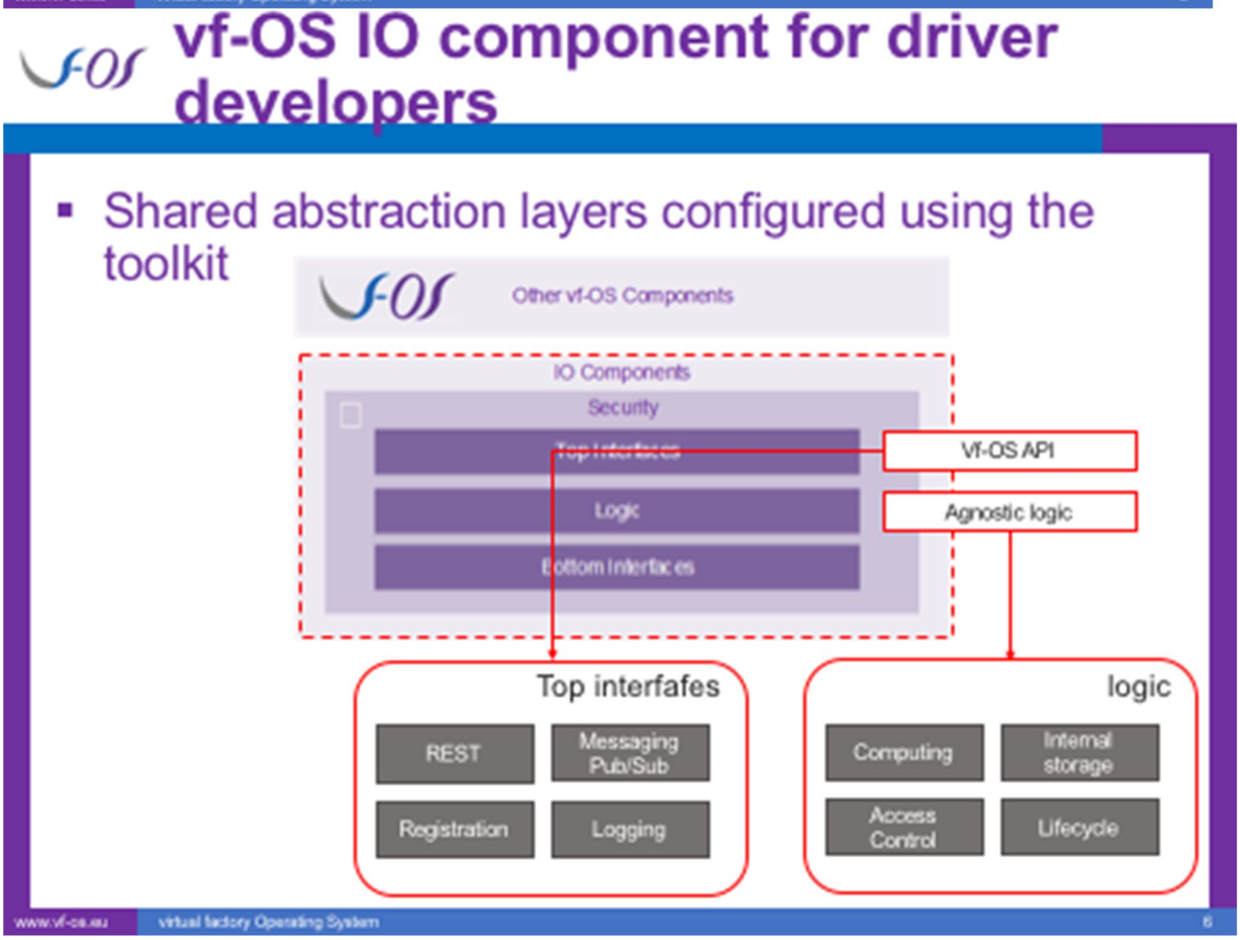
vf-OS IO component for driver developers
Shared abstraction layers configured using the toolkit
Other vf-OS Components
IO Components
Security
Top interfaces
Logic
Bottom Interfaces
Vf-OS API
Agnostic logic
Top interfafes
REST
Messaging Pub/Sub
Registration
Logging
logic
Computing
Internal storage
Access Control
Lifecycle
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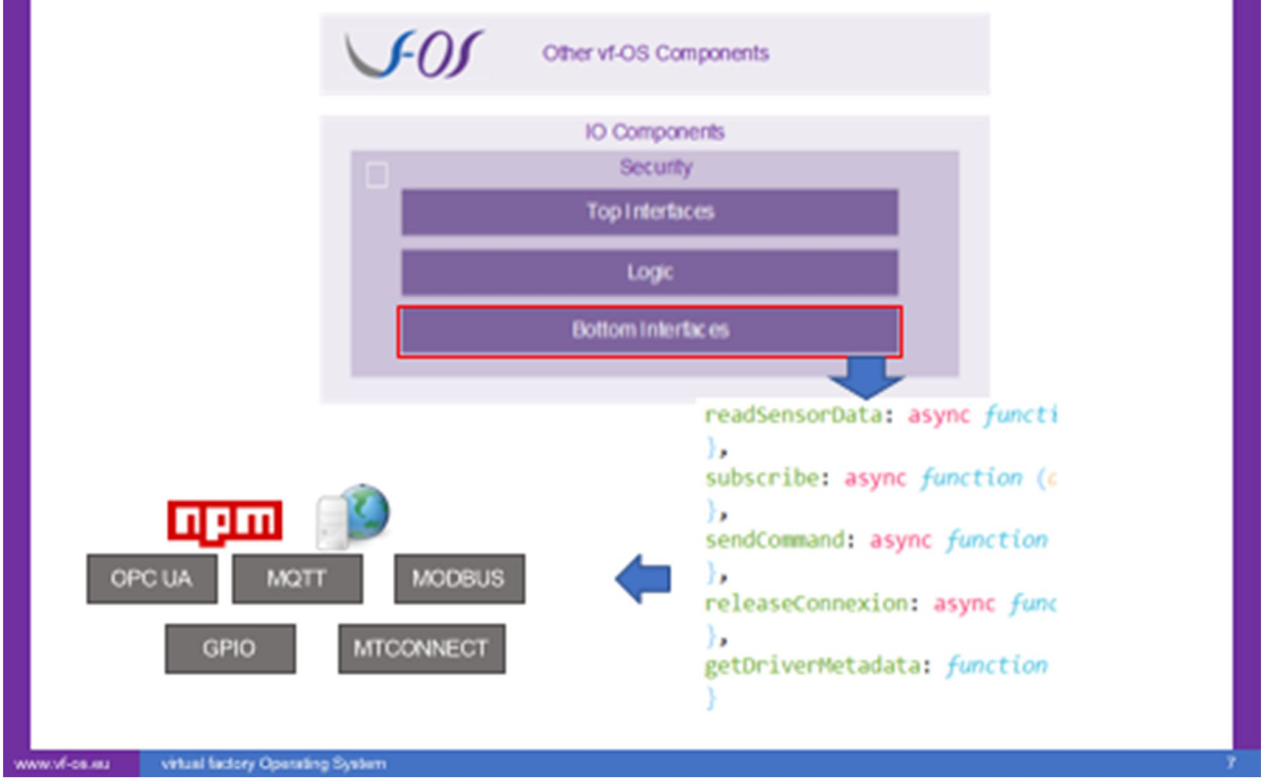
vf-OS IO component for driver developers



A case study: Failure Manager

Business need:

- Create vApp capable of triggering alarms when a Tabber Stringer gets an error propagating it to two different partners to improve the maintenance service

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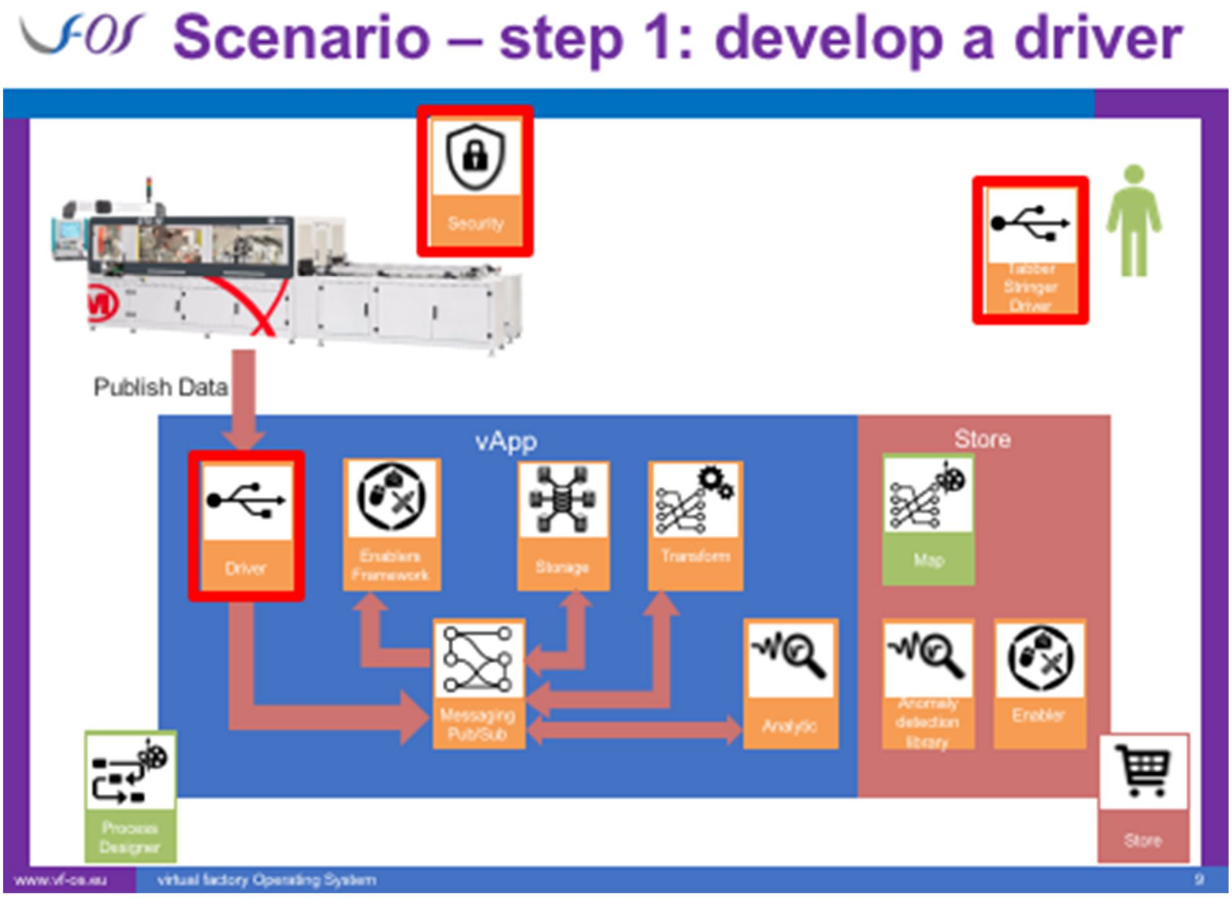
Scenario – step 1: develop a driver
Security
Tabber Stringer Driver
Publish Data
vApp
Store
Driver
Enablers Framework
Storage
Transform
Map
Messaging Pub/Sub
Analytic
Anomaly detection library
Enabler
Process Designer
Store
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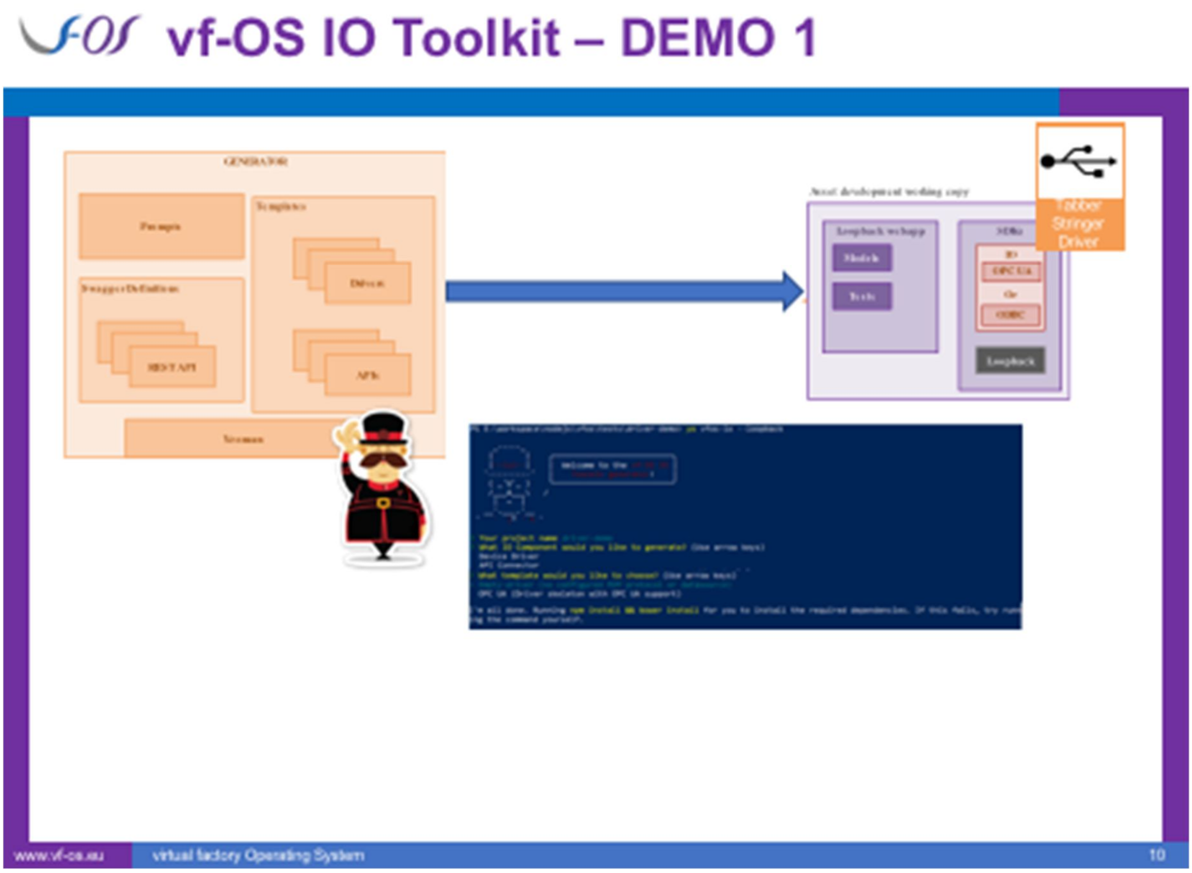
9


vf-OS IO Toolkit – DEMO 1
Tabber Stringer Driver
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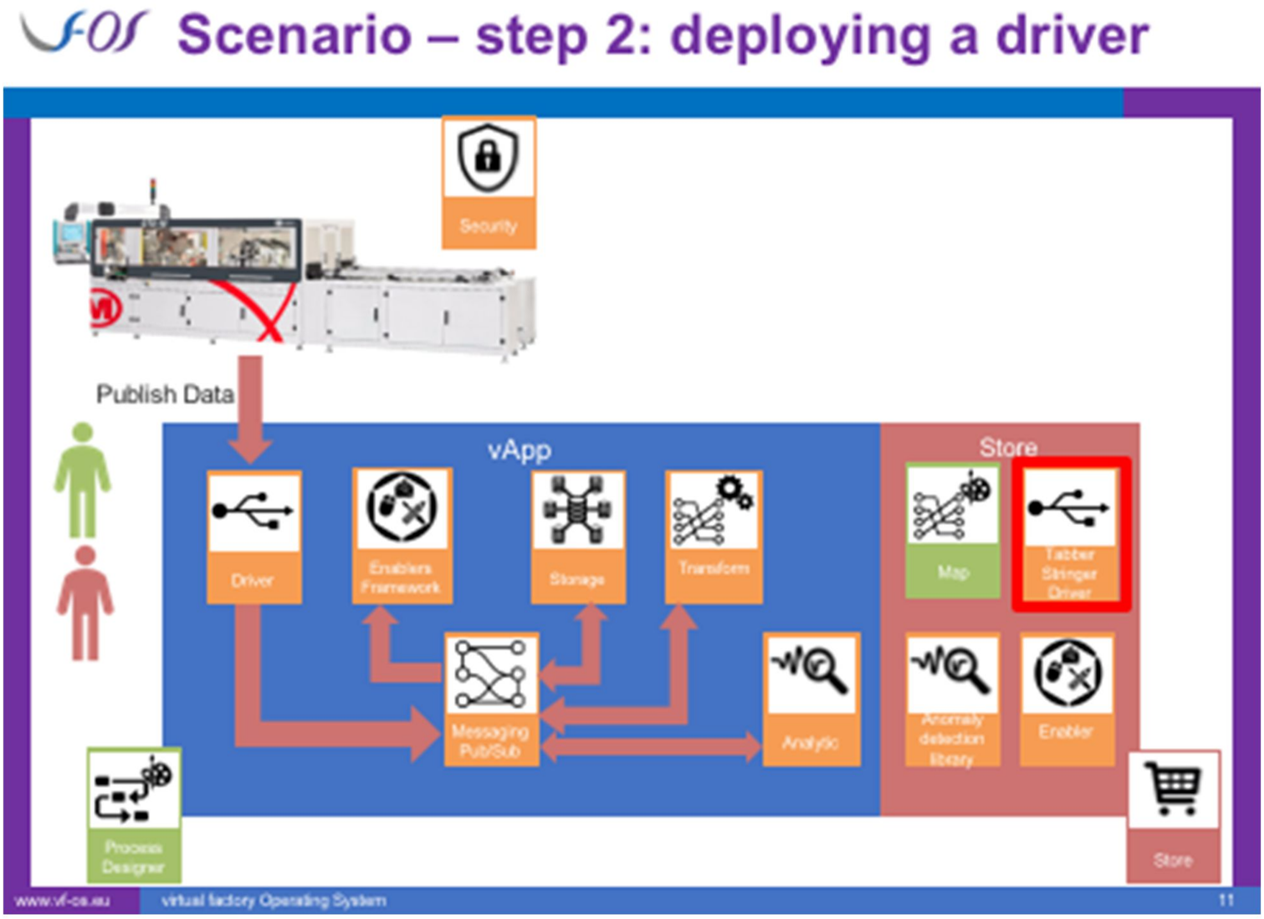
Scenario – step 2: deploying a driver
Security
Publish Data
vApp
Store
Driver
Enablers Framework
Storage
Transform
Map
Tabber Stringer Driver
Messaging Pub/Sub
Analytic
Anomaly detection library
Enabler
Process Designer
Store
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11


vf-OS IO deployment – DEMO 2
Devices
List of Devices
Id
Name
d1
Device1
BACK
Register Device
Device ID
Name
Proprietary Parameters
resourcePath
Devices
BACK
Data from device: d1 and sensor: s1
Value: 2 Degrees
TimeStamp: 2018-09-13T15:39:39.655Z
Status: Good
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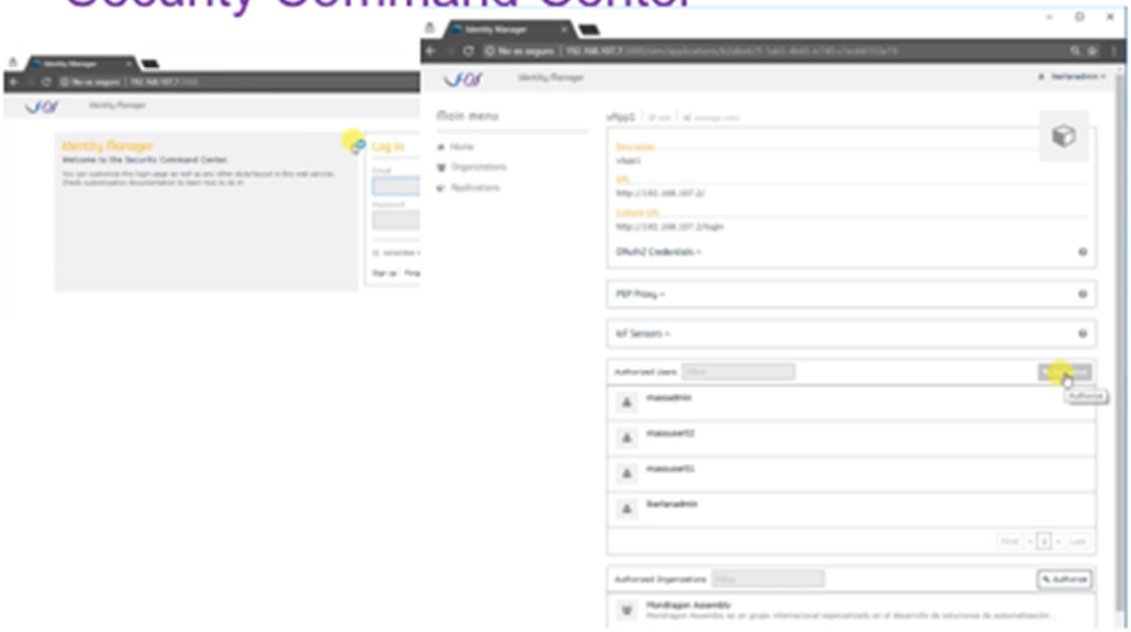
virtual factory Operating System
12

vf-OS Security

- Security Command Center



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vf-OS Conclusions

- vf-IO component is a framework to make easy to code or bring existing drivers to vf-OS
- Provides a code generator for vf-OS drivers and API connectors developers
- Allows the pre-configuration of drivers before deployment
- Provides a Driver and API deployment and configuration tools (web)

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virtual factory Operating System
Thanks you
vanaya@cigip.upv.es
Victor Anaya, Nejib Moalla, Ludo Stellingwerff, José Luis Flores and Francisco Fraile
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15

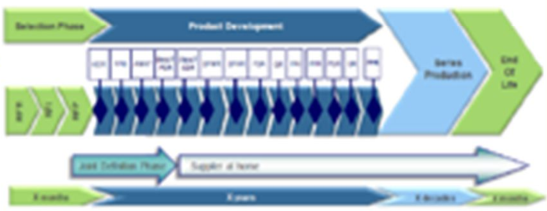
Planning in a distributed supply chain

2018-09-26 IEEE-IS

Xavier Rakotomamonjy
AIRBUS

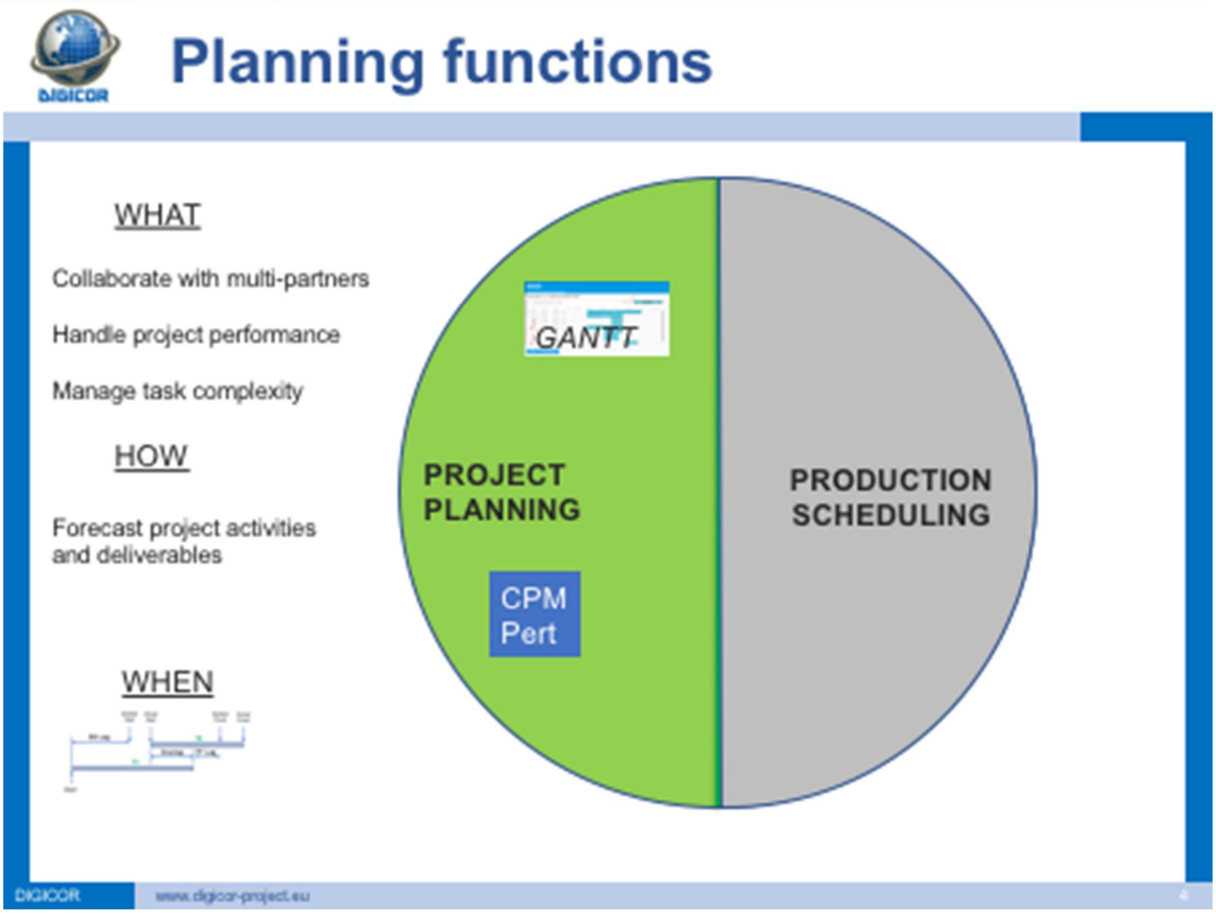
Challenges & needs

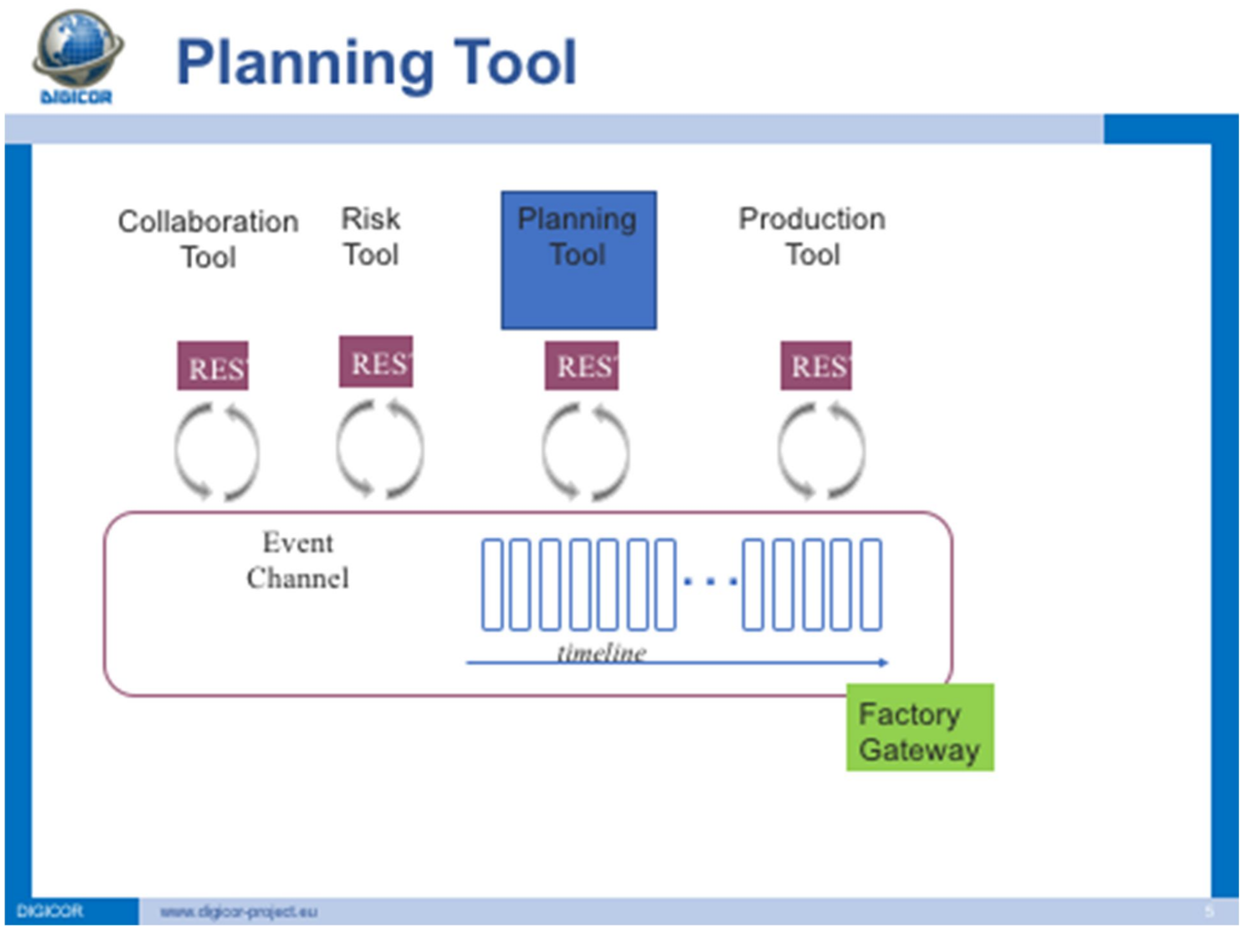
Supply Chain Criticality

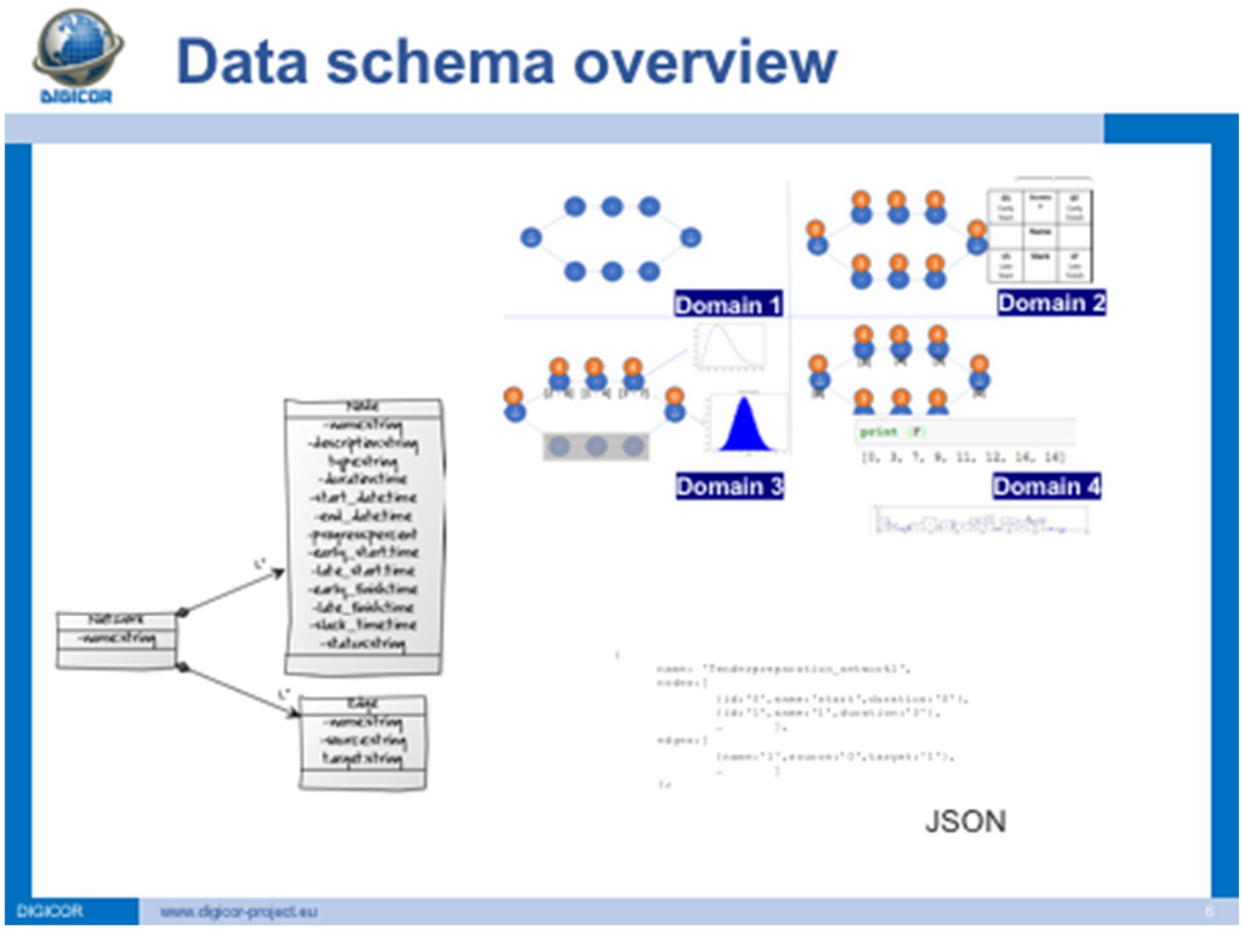


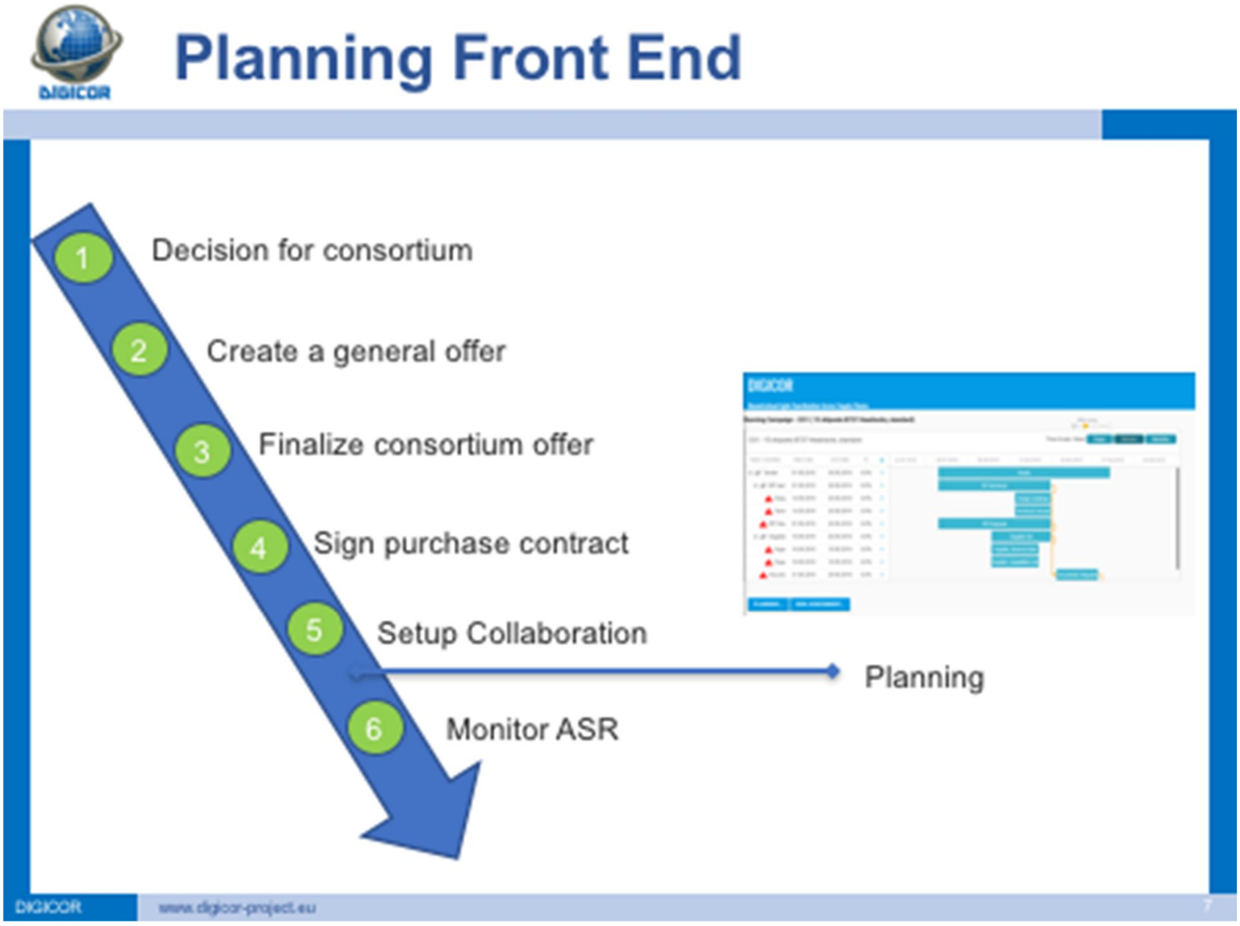
- Production ramp-up at Airbus need huge capacity increase at supplier side too
- Coordination is transferred from Airbus to Risk Sharing Partners (RSP)
- 1st Tier suppliers list is restricted to a small number of large RSP capable to fulfil the requirements
- Suppliers in aerospace sector have to fulfil complex requirements along the project life cycle


DIGICOR
Offer preparation & collaboration phase
Step 1: OEM set a new call to product with the associated dimension (production volume, quality, time constraints...)
Step 2: Several SME responds to the call by creating a join offer
Step 3: OEM make a trade-off between different offers by assessing several properties of the tender (consistency, availability, history..)
Step 4: Start collaboration
Tender Facilitator
Offer Preparation Process
DIGICOR
www.digicor-project.eu


DIGICOR
Planning functions
WHAT
Collaborate with multi-partners
Handle project performance
Manage task complexity
HOW
Forecast project activities and deliverables
WHEN
GANTT
PROJECT PLANNING
CPM Pert
PRODUCTION SCHEDULING
DIGICOR
www.digicor-project.eu


Planning Tool
Collaboration Tool
Risk Tool
Planning Tool
Production Tool
REST
REST
REST
REST
Event Channel
timeline
Factory Gateway
DIGICOR
www.digicor-project.eu


Data schema overview
Domain 1
Domain 2
Domain 3
Domain 4
Network
Node
Edge
JSON
DIGICOR
www.digicor-project.eu


Planning Front End
1 Decision for consortium
2 Create a general offer
3 Finalize consortium offer
4 Sign purchase contract
5 Setup Collaboration
Planning
6 Monitor ASR
DIGICOR
DIGICOR
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Decentralized Agile Coordination Across Supply Networks
DIGICOR
DIGICOR
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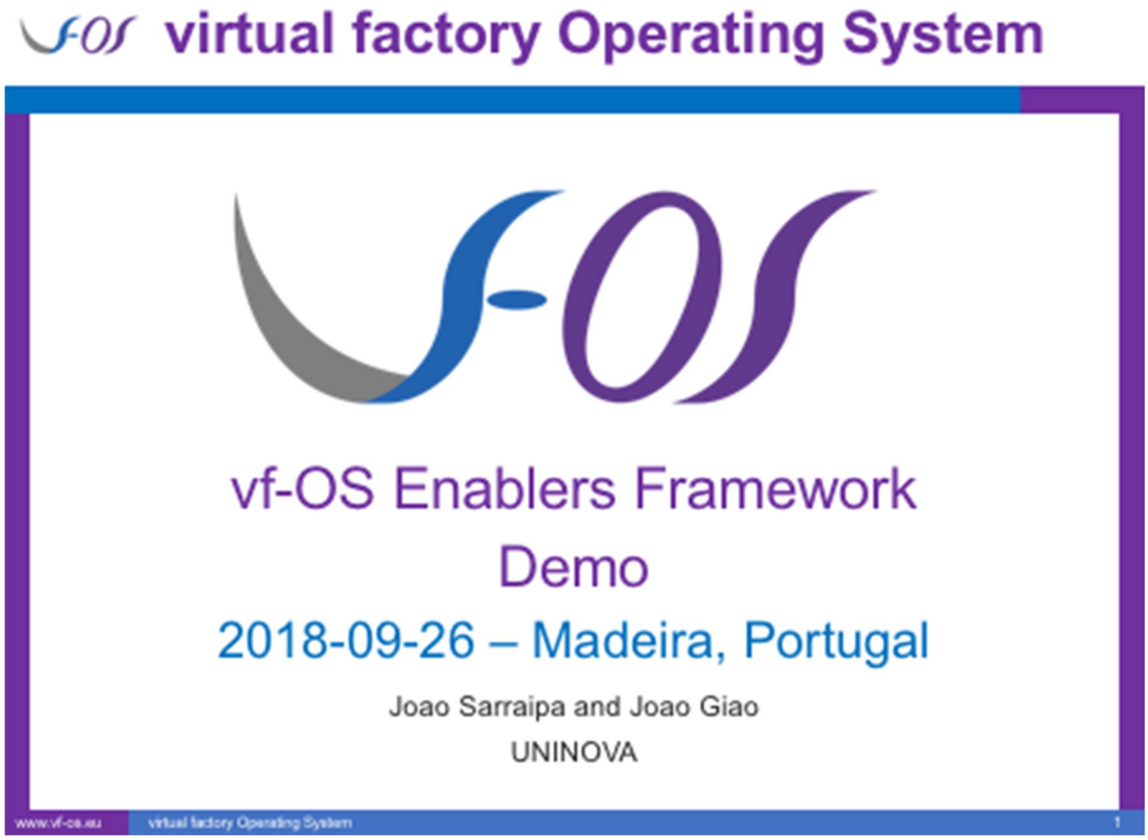
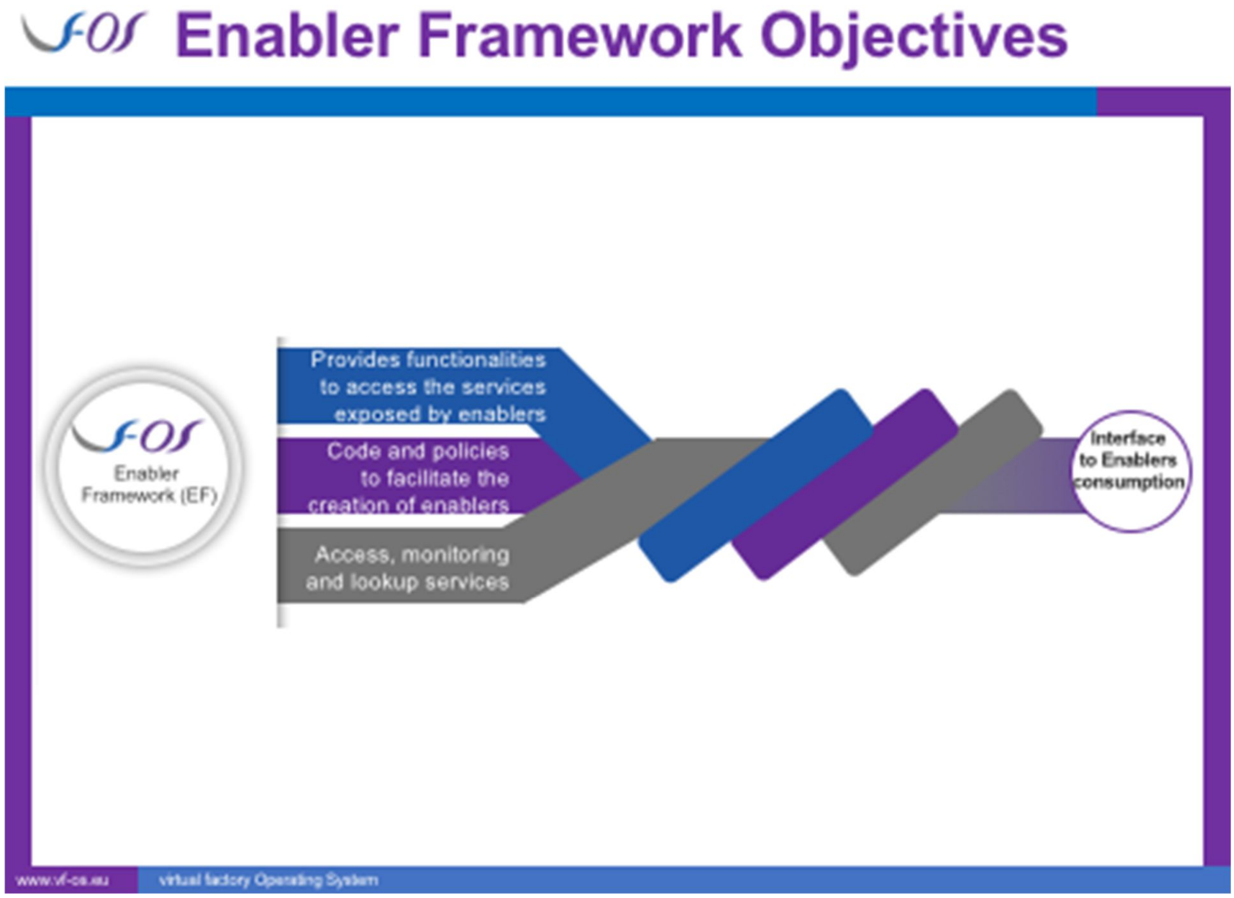
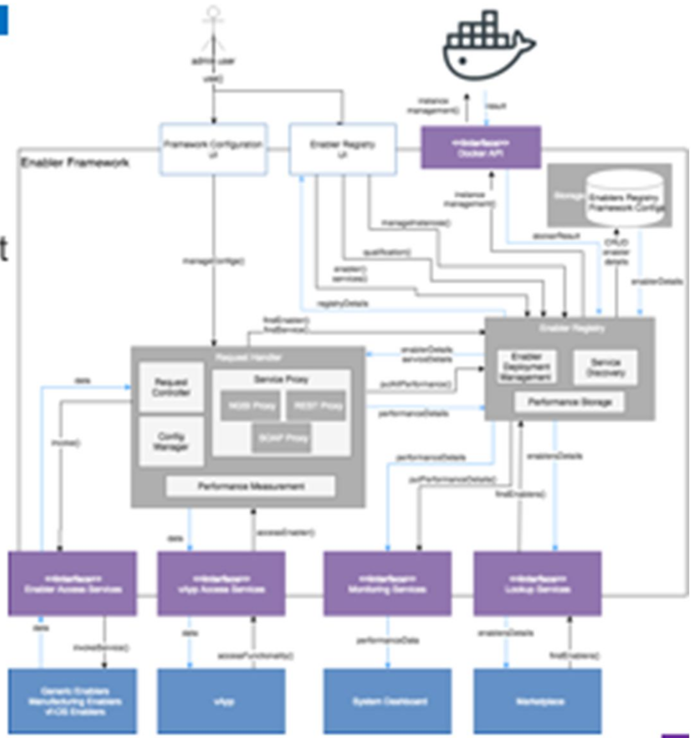

virtual factory Operating System
vf-OS Enablers Framework
Demo
2018-09-26 – Madeira, Portugal
Joao Sarraipa and Joao Giao
UNINOVA
www.vf-os.eu
virtual factory Operating System
1


Enabler Framework Objectives
Enabler Framework (EF)
Provides functionalities to access the services exposed by enablers
Code and policies to facilitate the creation of enablers
Access, monitoring and lookup services
Interface to Enablers consumption
www.vf-os.eu
virtual factory Operating System

Enablers Framework Architecture

- Request Handler
  - Service Proxy
  - Access Services for Enablers and vApps
  - Performance Measurement
- Enabler Registry
  - CRUD functionality
  - Monitoring & Lookup Services
- User Interface:
  - Enablers Framework Configuration;
  - Enabler Registry



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Enablers Framework Added Value

- Software reusability
  - Generic and Manufacturing Enablers (FIWARE and FITMAN Projects)
  - vf-OS Specific Enablers
- Uniformization
  - Docker based approach to install and use instances of Enablers
- Integration
  - accessing enablers services through a common API independently its protocol – NGSI1/2; REST
- Accountability
  - Technical performance and log registration features

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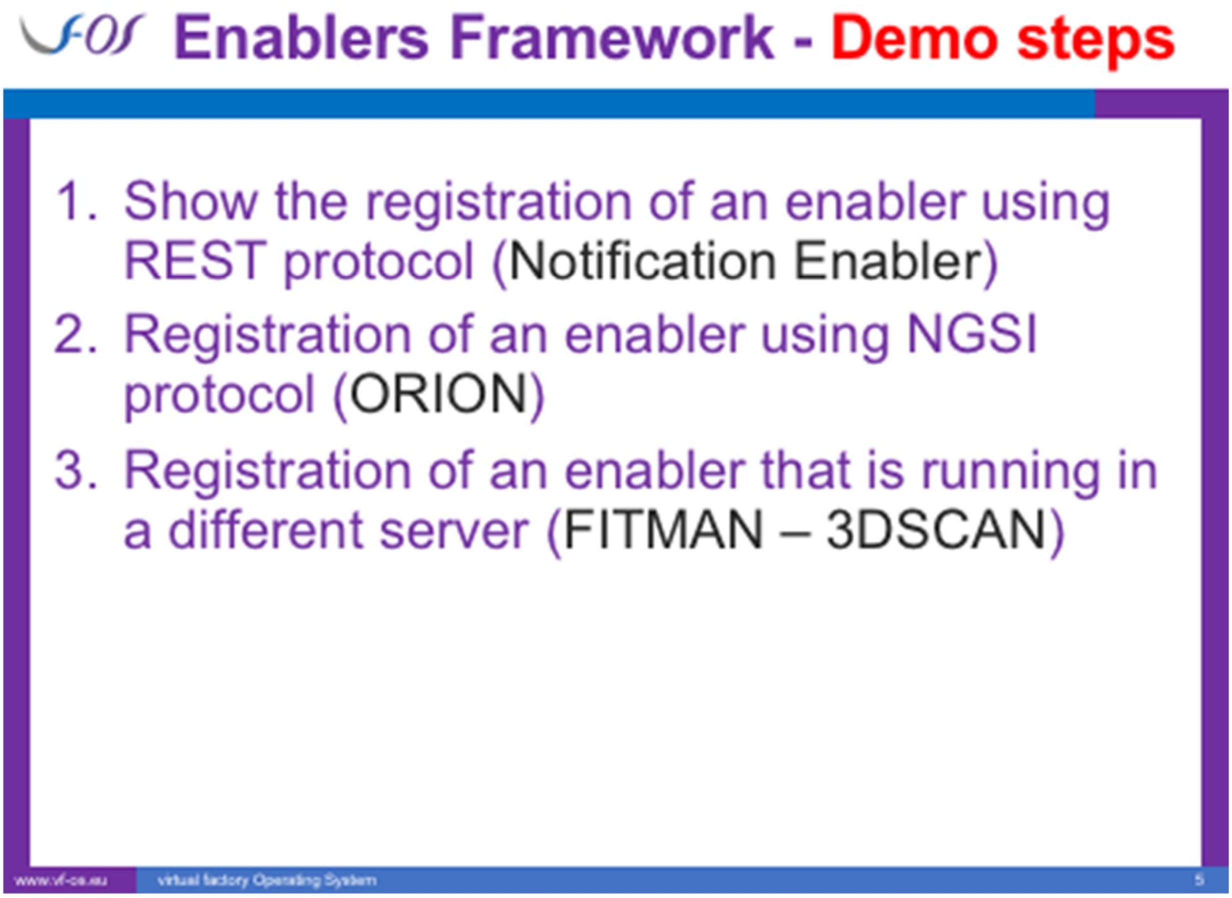
Enablers Framework - Demo steps
1. Show the registration of an enabler using REST protocol (Notification Enabler)
2. Registration of an enabler using NGSI protocol (ORION)
3. Registration of an enabler that is running in a different server (FITMAN – 3DSCAN)
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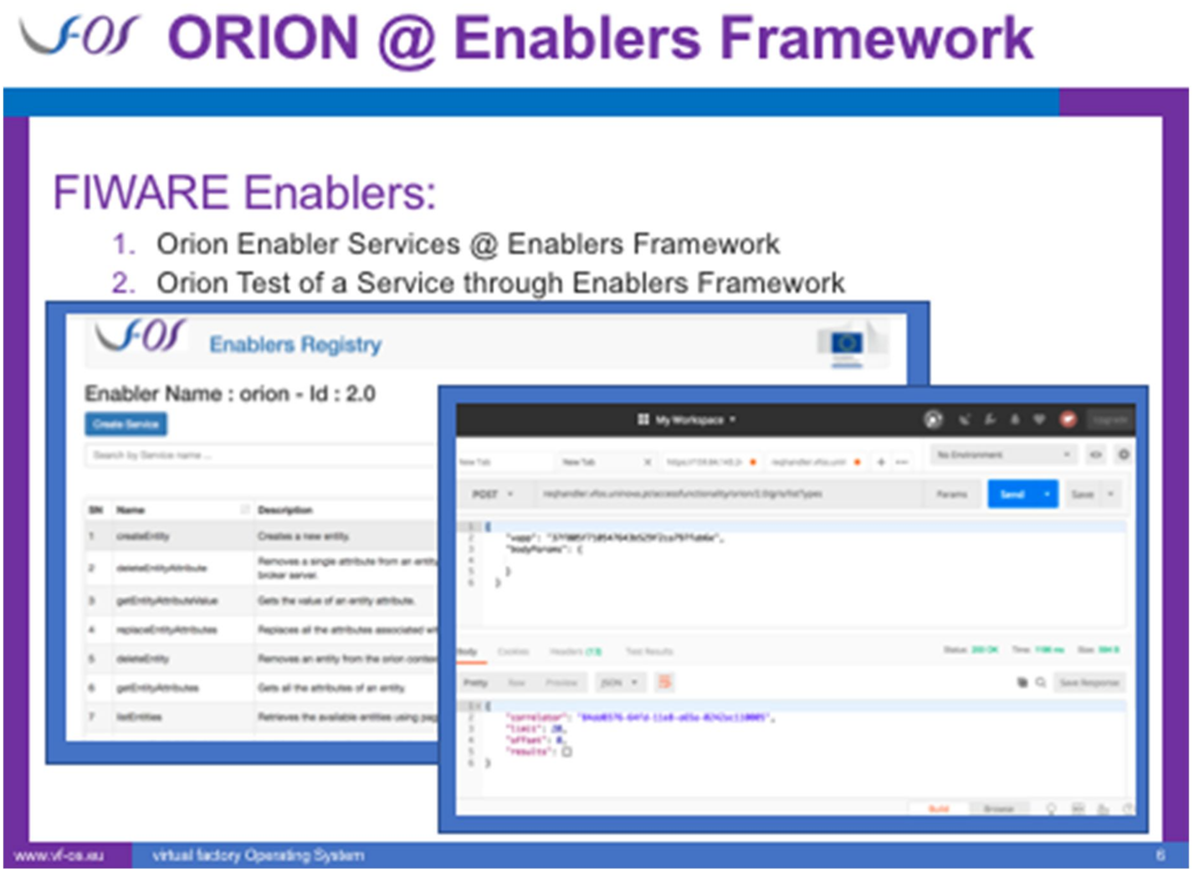
ORION @ Enablers Framework
FIWARE Enablers:
1. Orion Enabler Services @ Enablers Framework
2. Orion Test of a Service through Enablers Framework
Enablers Registry
Enabler Name : orion - Id : 2.0
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Enablers Framework Metrics

Enablers Registry

SN	vApp	Framework ExecTime	Enabler ExecTime	Status	Error Message	Request Size	Response Size
1	37f805f710547	36782	7737	Success		514	272
2	37f805f710547	38257	8177	Success		516	274
3	37f805f710547	30946	0	Error	JSON data does not correspond to Schema.	516	504
4	37f805f710547	31154	0	Error	JSON data does not correspond to Schema.	516	504
5	37f805f710547	56678	0	Error	JSON data does not correspond to Schema.	516	504
6	37f805f710547	19093	5838	Success		516	274
7	37f805f710547	30504	7663	Success		514	272
8	37f805f710547	96687	73137	Success		512	268

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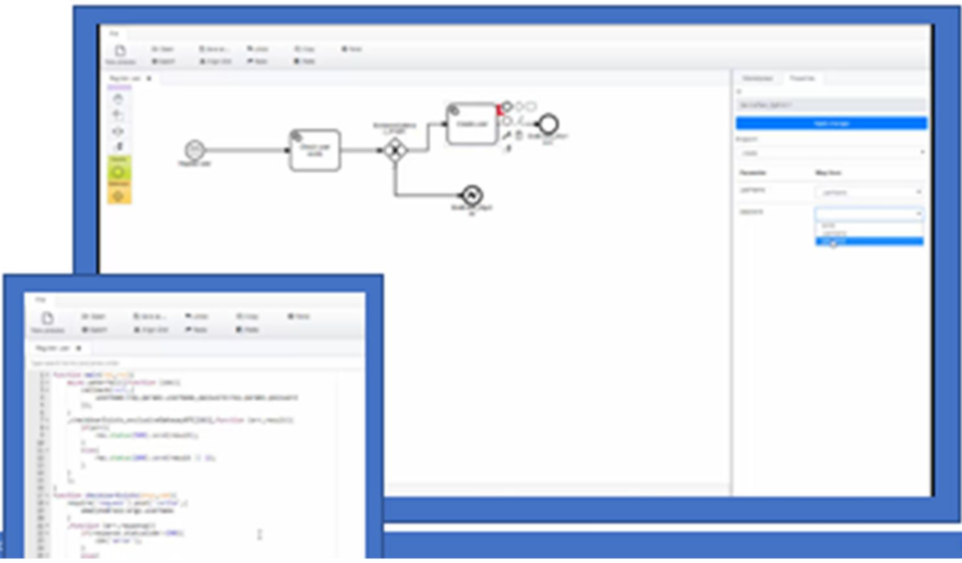
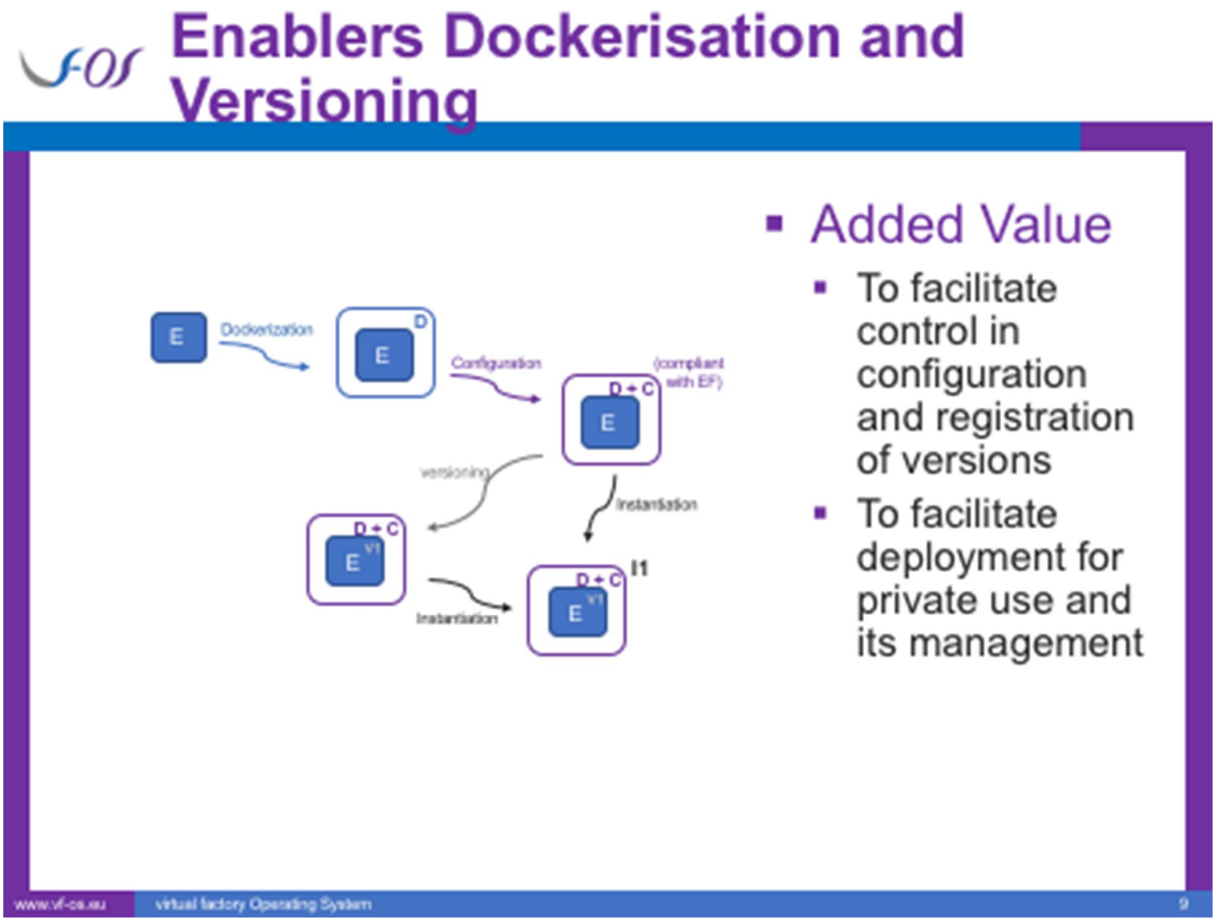
Enablers Framework Integration

Integration with the Process Designer:

- Generate NodeJS code to develop a vApp using enablers services schema provided by Enablers Framework



www.vf-os.eu virtual fa 8


Enablers Dockerisation and Versioning
Added Value
To facilitate control in configuration and registration of versions
To facilitate deployment for private use and its management
E
Dockerization
D
Configuration
(compliant with EF)
D + C
versioning
Instantiation
V1
I1
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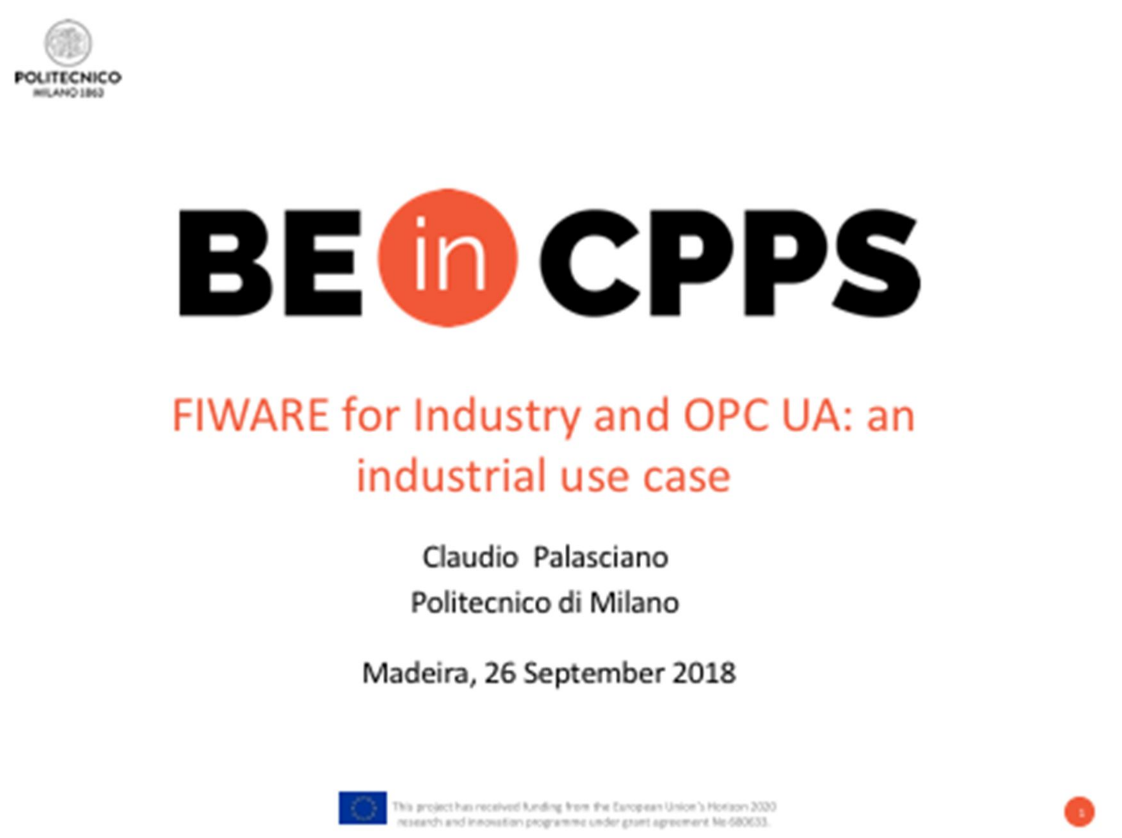
9


POLITECNICO MILANO 1863
BE in CPPS
FIWARE for Industry and OPC UA: an industrial use case
Claudio Palasciano
Politecnico di Milano
Madeira, 26 September 2018
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680633.
1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Who I am
BE in CPPS
PLANT Cockpit
fabbrica intelligente
INTELLIMECH
Industrial Technologies 2014
BEinCPPS project : Business Experiments in Cyber Physical Production Systems
PLANTCockpit project: Production Logistics and Sustainability Cockpit
EMC2-Factory project: The Eco-Factory: cleaner and resource-efficient production in manufacturing
Sust.Manufacturing/ Cluster Fabbrica Intelligente: Smart monitoring and planning, virtual production systems
Intellimech /Kilometro Rosso project: eco-factory per l'industria del futuro, 2014
IECON 2013 /APMS 2014 conferences special sessions: Emerging solutions for eco-factories
Industrial Technology 2014 Conference on nanotechnologies, biotechnology, advanced materials and new production technologies
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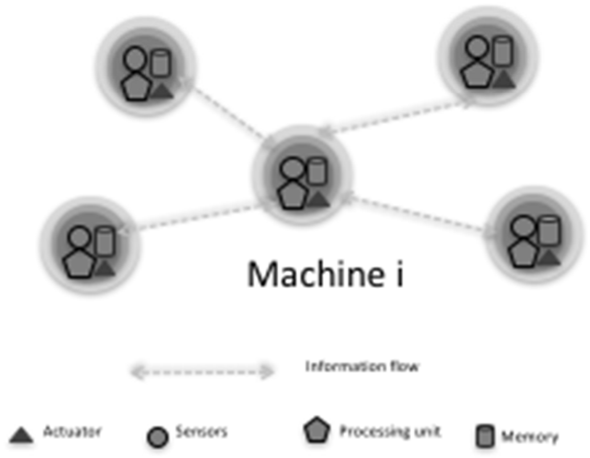
CPS-ized machine line



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CPS-ized line control

State of the Art

- **Trend:** reduce the idle time of machines in favor of stand-by states
- **Main focus**: single machine
  - Statistical models (inter-arrival times, processing time)
  - Local information
  - Production line quite unexplored

CPS-ized production line

- **Focus:** exploit potential of ICT enablers (information processing and M2M communication)
- **How:**
  - Real time information (digital twin)
  - Shared information among machines
  - Each machine decides in real-time their specific energy behavior based on the digital twins of all machines.

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Interoperable OPC UA standard

OPC UA (*): standard architecture at application layer for connection of an automation cell with the factory level, integrating machinery and workstations.

OPC FOUNDATION

OPC UA CHARACTERISTICS

- Flexible client-server approach
- Interoperable communication at industrial automation level
- Object-oriented 'address space' modeling (data model + methods)
- Semantically enhanced variables: struct type may include identifier, name, description

(*) https://opcfoundation.org/about/opc-technologies/opc-ua/}

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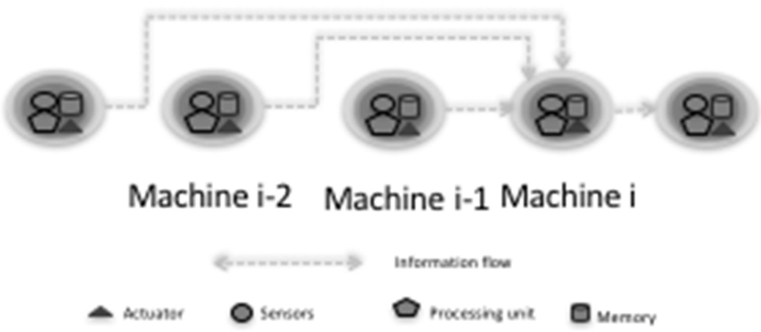
Energy saving serial line control



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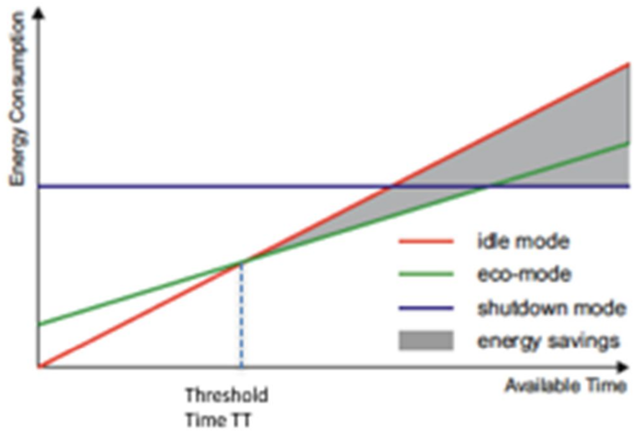
Energy breakdown



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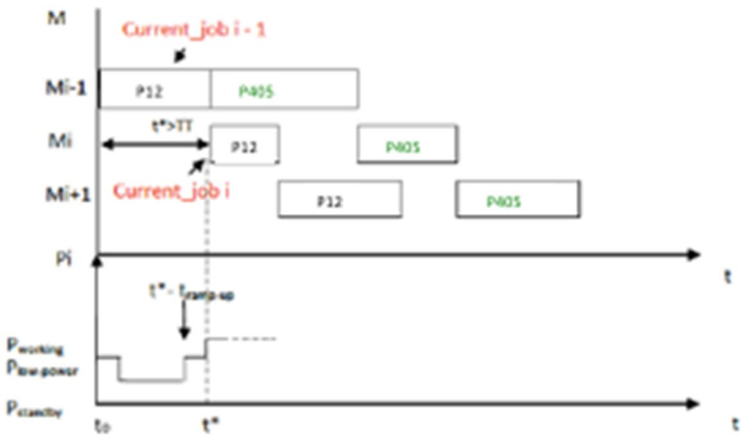
Heuristic Energy Control Policy

Time available t* >=TT (threshold time)



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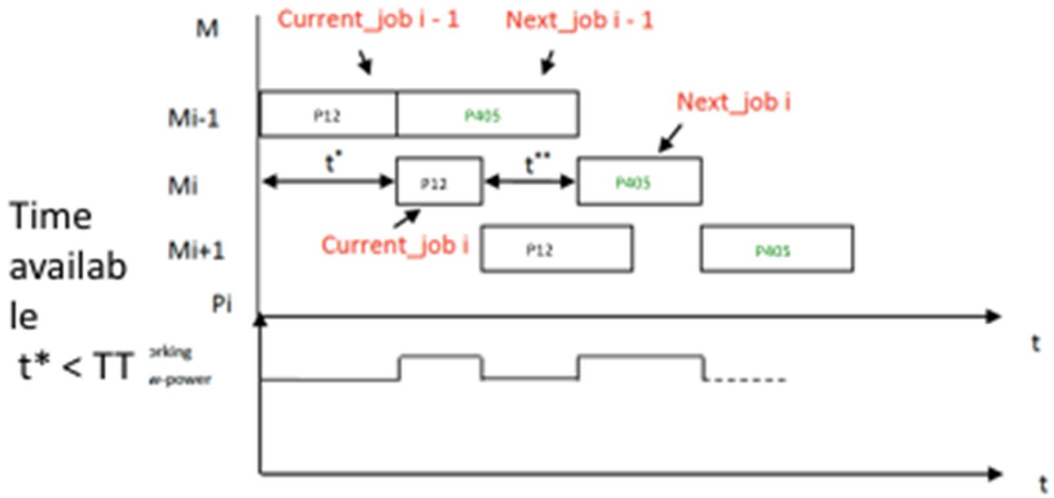
Limit of proposed policy



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Machine digital twin

Variable	Description and unit
$i = 1..N$	machine identifier
bufferObject[i]	part/job identifier
PT[i]	processing time of machine i (exogenous)
TT[i]	time threshold for activating stand-by in i (exogenous)
cjObject[i]	identifier of current job of machine i
cjExpectedExitTime[i]	expected exit time from i of job cjObject[i]

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Industry 4.0 Lab in POLIMI

7 machine modules and 1 robot (8 stations)

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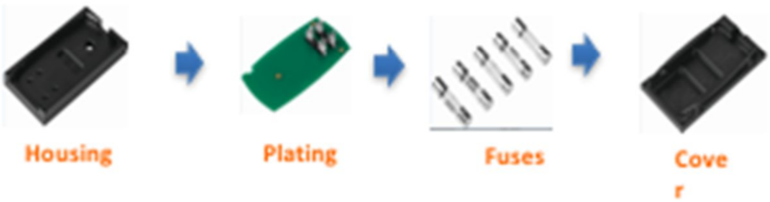
Product assembly mock-up

The main task is to produce simplified smartphone or remote control



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Scenario: energy aware control

Autonomous energy aware control

- Line stations share digital twins

- Drill station automatically defines its status vs.:
    - Its Buffer status
    - Magazine station State + TimeLeft for Operation of previous station

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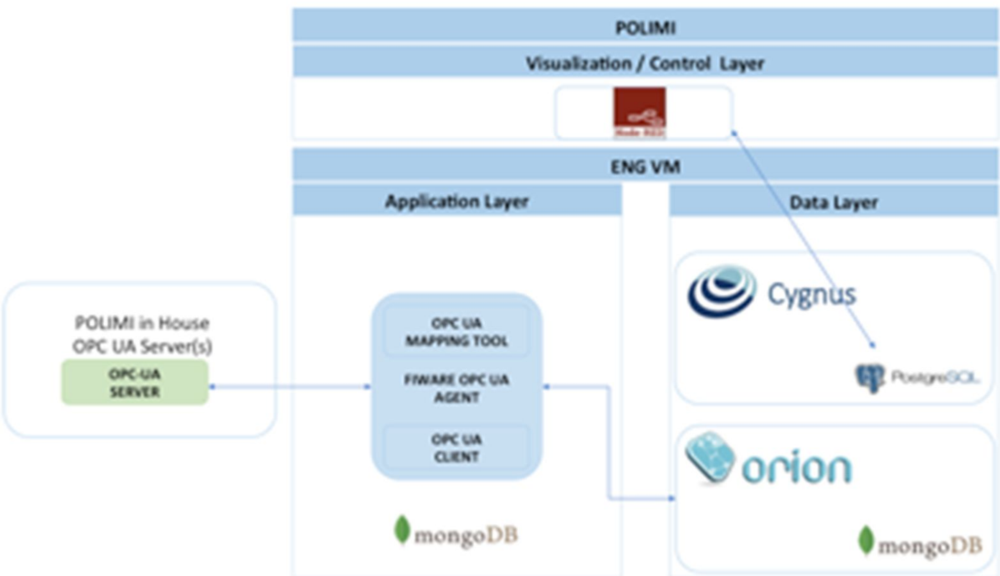
Architecture



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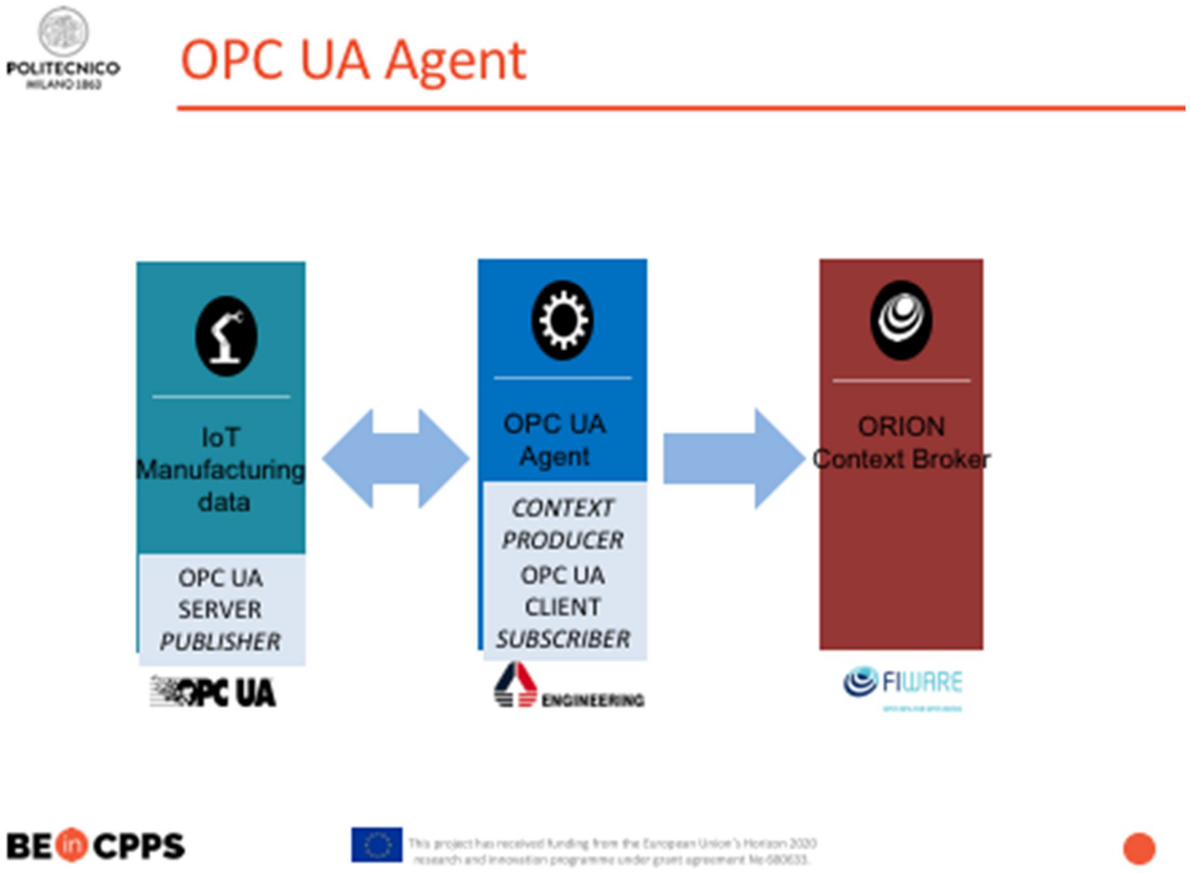
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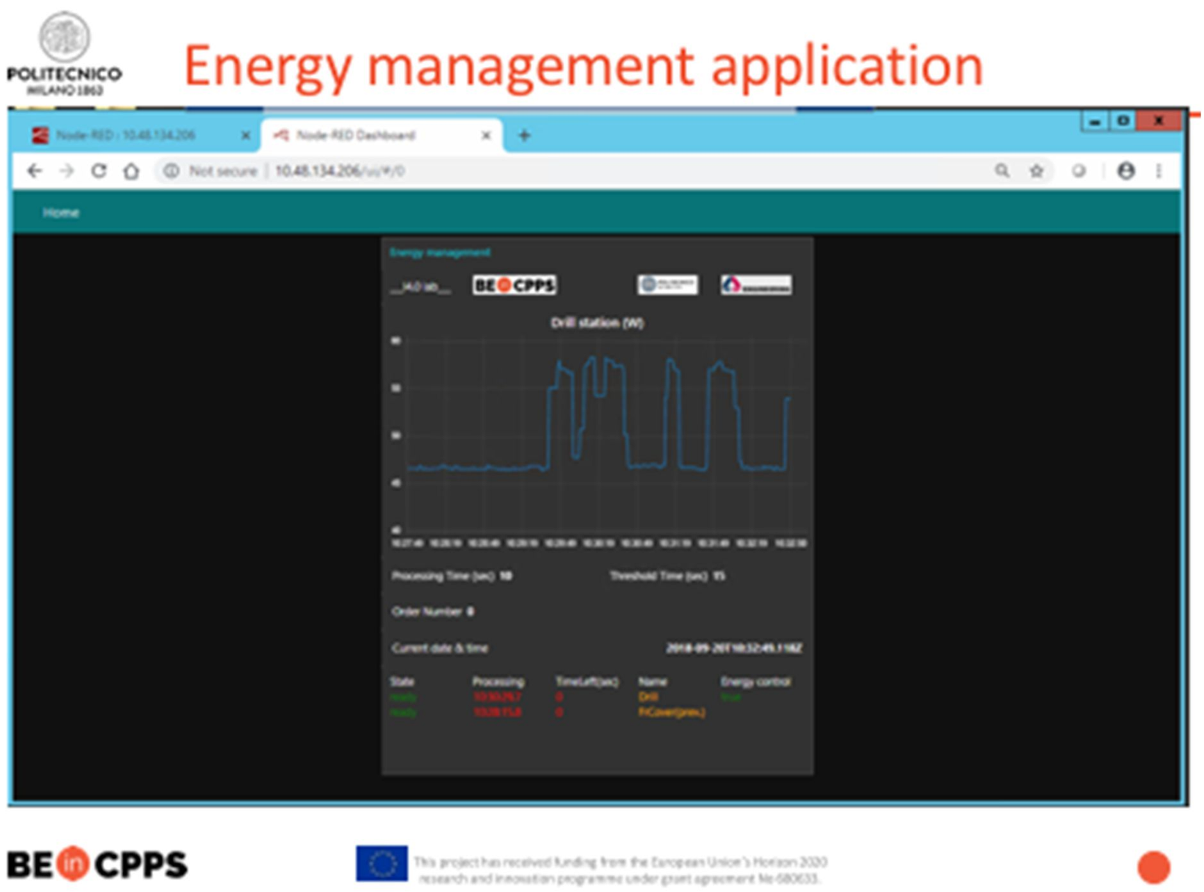
OPC UA Agent
IoT Manufacturing data
OPC UA SERVER
PUBLISHER
OPC UA
OPC UA Agent
CONTEXT PRODUCER
OPC UA CLIENT
SUBSCRIBER
ENGINEERING
ORION Context Broker
FIWARE
BE in CPPS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Energy management application
Node-RED Dashboard
Home
BE in CPPS
Drill station (W)
BE in CPPS

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Thank you very much

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OPC UA Agent

- The OPC UA Agent enables capturing data from OPC UA devices on the shopfloor and provides them to the upper levels of a FIWARE-based system. Therefore, the main focus of this component is on the communication from field devices implementing an OPC UA server to FIWARE, allowing the communication to the FIWARE Orion Context Broker.
- The agent for the southbound side registers itself to monitor the OPC UA variables (as OPC UA client), whereas for the northbound side it is a context producer in order to send context data to Orion Context Broker.

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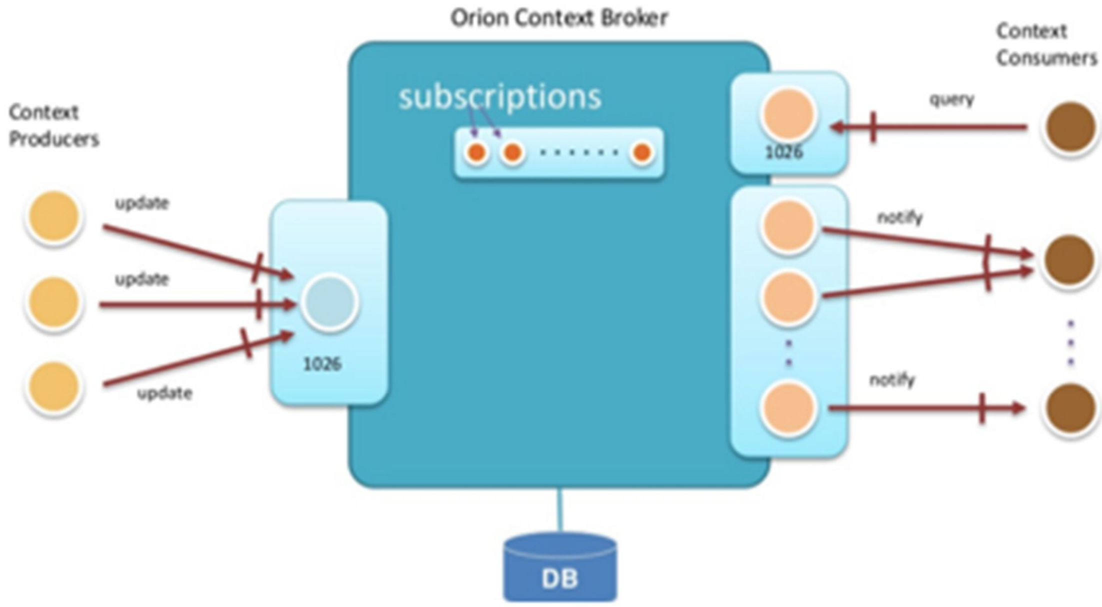
ORION Context Broker



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ORION Context Broker

- Orion Context Broker allows to manage context information: persists last observation about context data, handles subscriptions in order to notify context consumers abouth changes.
- OPC UA Agent represents the Context Provider
- Cygnus represents the Context Consumer

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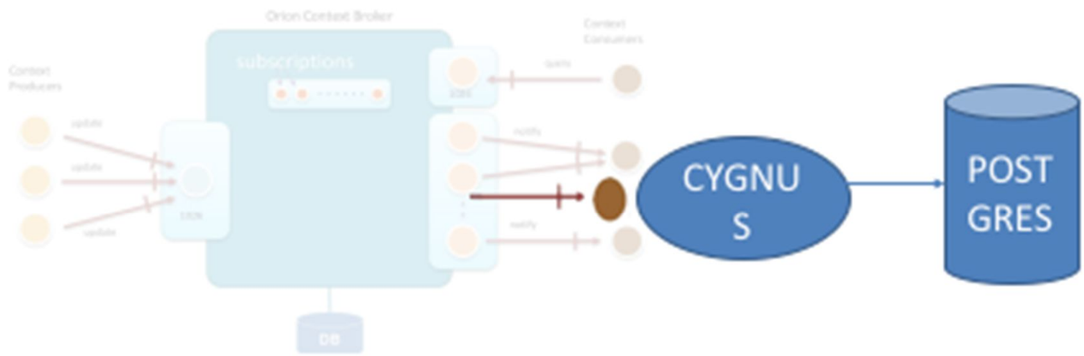
CYGNUS



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CYGNUS

- Cygnus is a connector, based on Apache Flume, in charge of persisting certain sources of data in certain configured third-party storages, creating a historical view of such data.
- Cygnus gets notifications from OCB (previously subscribed) and with a custom sink writes context data on Postgres db using custom tables (*SensorsLog* and *OperationLog*)

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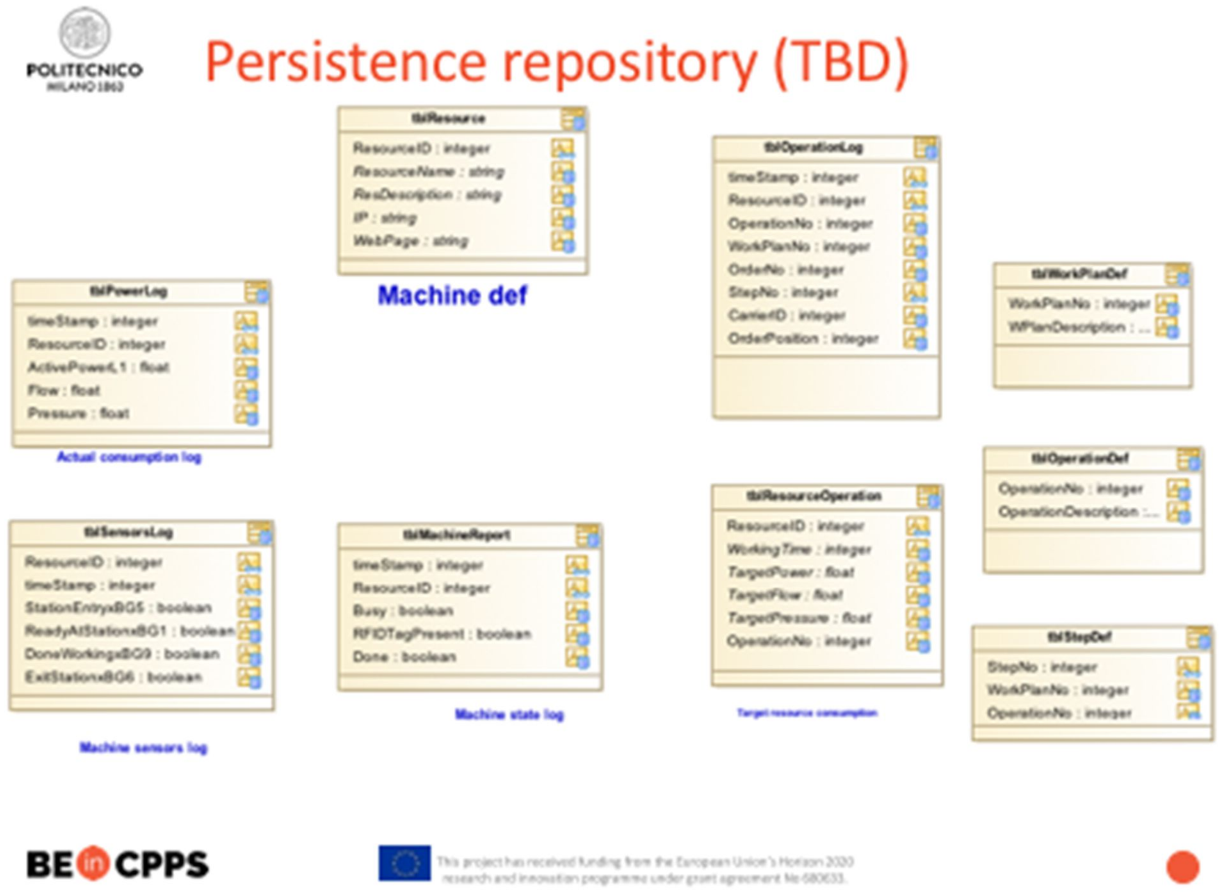
POLITECNICO MILANO 1863
Persistence repository (TBD)
tblResource
ResourceID : integer
ResourceName : string
ResDescription : string
IP : string
WebPage : string
Machine def
tblOperationLog
timeStamp : integer
ResourceID : integer
OperationNo : integer
WorkPlanNo : integer
OrderNo : integer
StepNo : integer
CarrierID : integer
OrderPosition : integer
tblWorkPlanDef
WorkPlanNo : integer
WPlanDescription : ...
tblPowerLog
timeStamp : integer
ResourceID : integer
ActivePower1,1 : float
Flow : float
Pressure : float
Actual consumption log
tblOperationDef
OperationNo : integer
OperationDescription : ...
tblResourceOperation
ResourceID : integer
WorkingTime : integer
TargetPower : float
TargetFlow : float
TargetPressure : float
OperationNo : integer
Target resource consumption
tblSensorsLog
ResourceID : integer
timeStamp : integer
StationEntryxBG5 : boolean
ReadyAtStationxBG1 : boolean
DoneWorkingxBG9 : boolean
ExitStationxBG6 : boolean
Machine sensors log
tblMachineReport
timeStamp : integer
ResourceID : integer
Busy : boolean
RFIDTagPresent : boolean
Done : boolean
Machine state log
tblStepDef
StepNo : integer
WorkPlanNo : integer
OperationNo : integer
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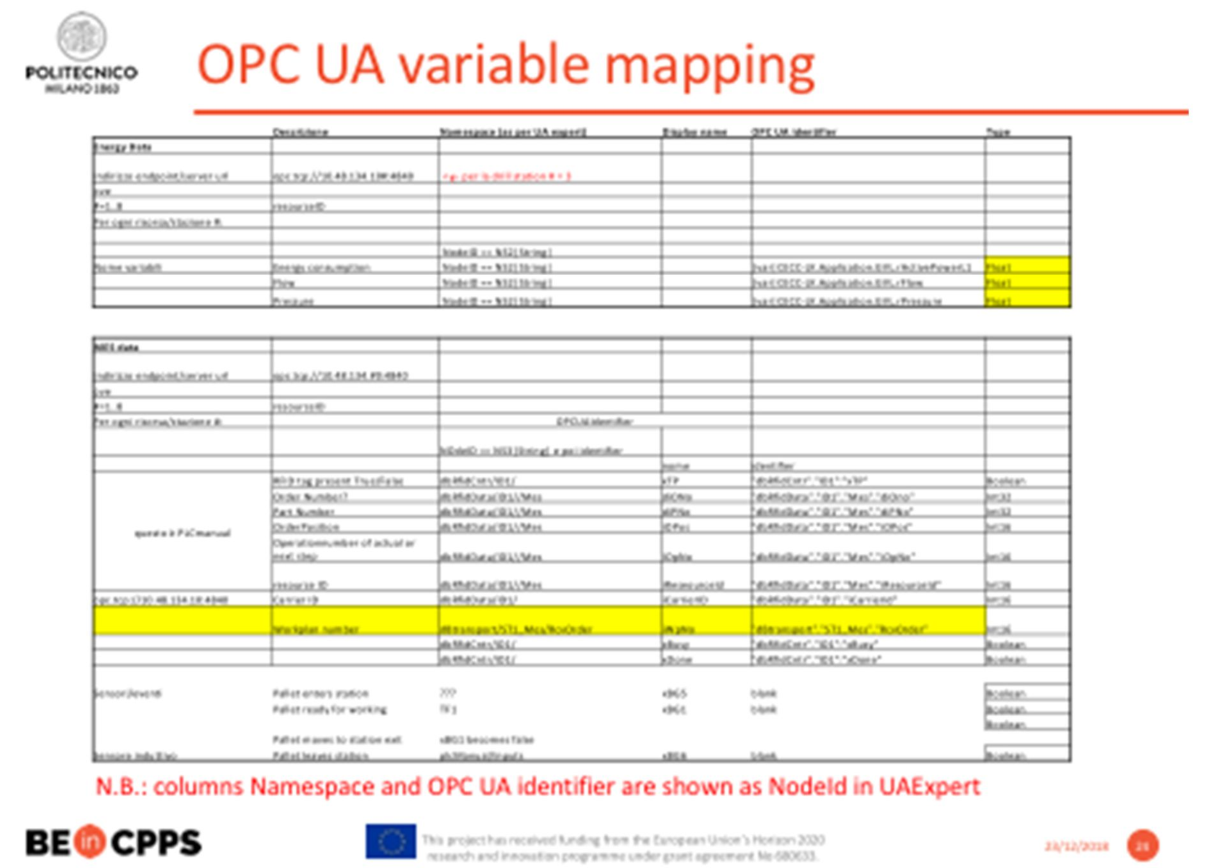
POLITECNICO MILANO 1863
OPC UA variable mapping
N.B.: columns Namespace and OPC UA identifier are shown as NodeId in UAExpert
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Current data collection in Access DB

Monitoring minimum frequency = 1 sec

- FestoDB contains MES data tables on production orders and machines
- FestoEnergyDB contains data tables on energy consumption (tblPower#) and compressed air consumption (tblSensors#) where # (1..86400) is the update frequency in seconds

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Possible functionalities

Real-time and off-line stats visualization

- Resource monitoring about processing state of the line, energy compressed air consumption (actual/target), energy consumption per order/cycle/product
- Statistics about orders and machines (lead time, throughput, machine utilization, bottlenecks…)
- Operational conditions and warnings (machine error states energy consumption peaks, substained actual/target delta, etc) for maintenance support

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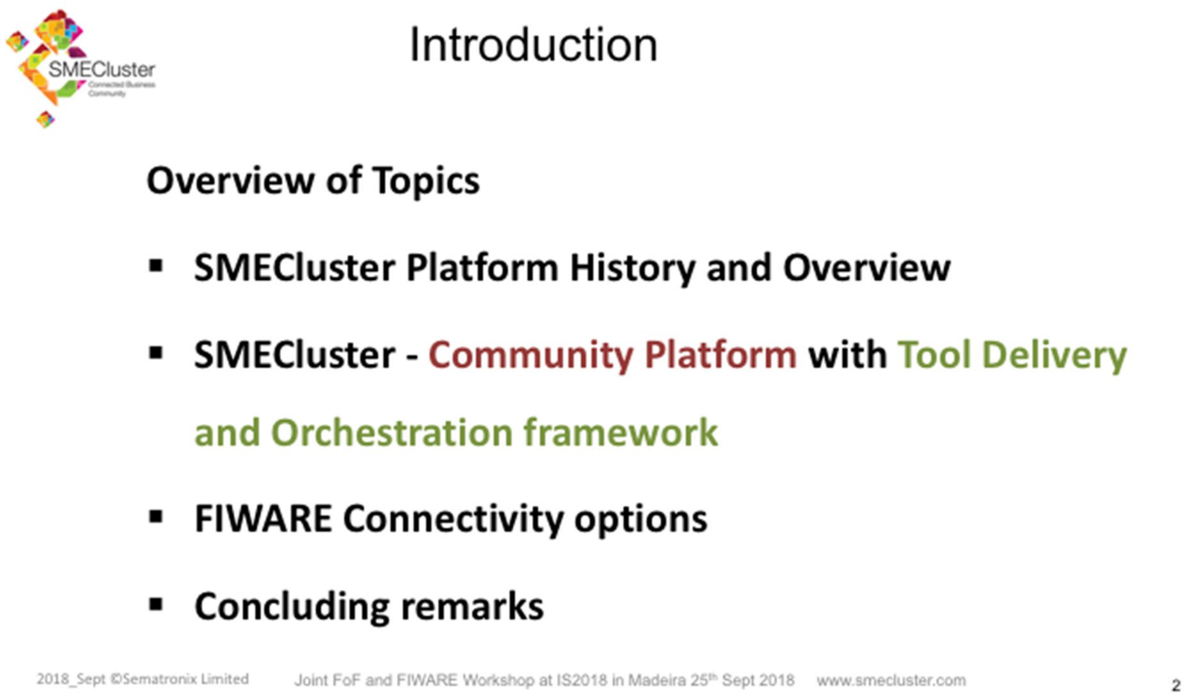
Decentralized Agile Coordination Across Supply Networks
SMECluster
DIGICOR
• The use of FIWARE Enablers in SMECluster Portal
• 26th – 27th September 2018, Madeira
• Gash Bhullar, Control 2K Limited


SMECluster
Introduction
Overview of Topics
▪ SMECluster Platform History and Overview
▪ SMECluster - Community Platform with Tool Delivery and Orchestration framework
▪ FIWARE Connectivity options
▪ Concluding remarks
2018_Sept ©Sematronix Limited
Joint FoF and FIWARE Workshop at IS2018 in Madeira 25th Sept 2018
www.smecluster.com
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SMECluster
Project Contributing to the development of
www.smecluster.com
SYNERGY - Supporting Highly Adaptive Network Enterprise Collaboration Through semantically enabled knowledge services
https://cordis.europa.eu/project/rcn/85320_en.html
CADIC - Cross-Organisational Assessment and Development of Intellectual Capital. Focus on providing an infrastructure open and extensible innovation for B2B environment, where Intellectual Capital (IC) can flow to the mutual benefit of all concerned
http://www.cadic-europe.org
CREMA – Provides an Everything as a Service model
http://www.crema-project.eu/
DIGICOR - The DIGICOR project develops novel collaboration concepts and implements an integrated platform that significantly reduce the burden to setup production networks and collaboration between SMEs
http://www.digicor-project.eu/
FLEXINET SERVICES
Intelligent Systems Configuration Services for Flexible Dynamic Global Production Networks
http://www.flexinet-fof.eu/Pages/FlexHome.aspx
FITMAN
http://www.fitman-fi.eu/
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www.smecluster.com
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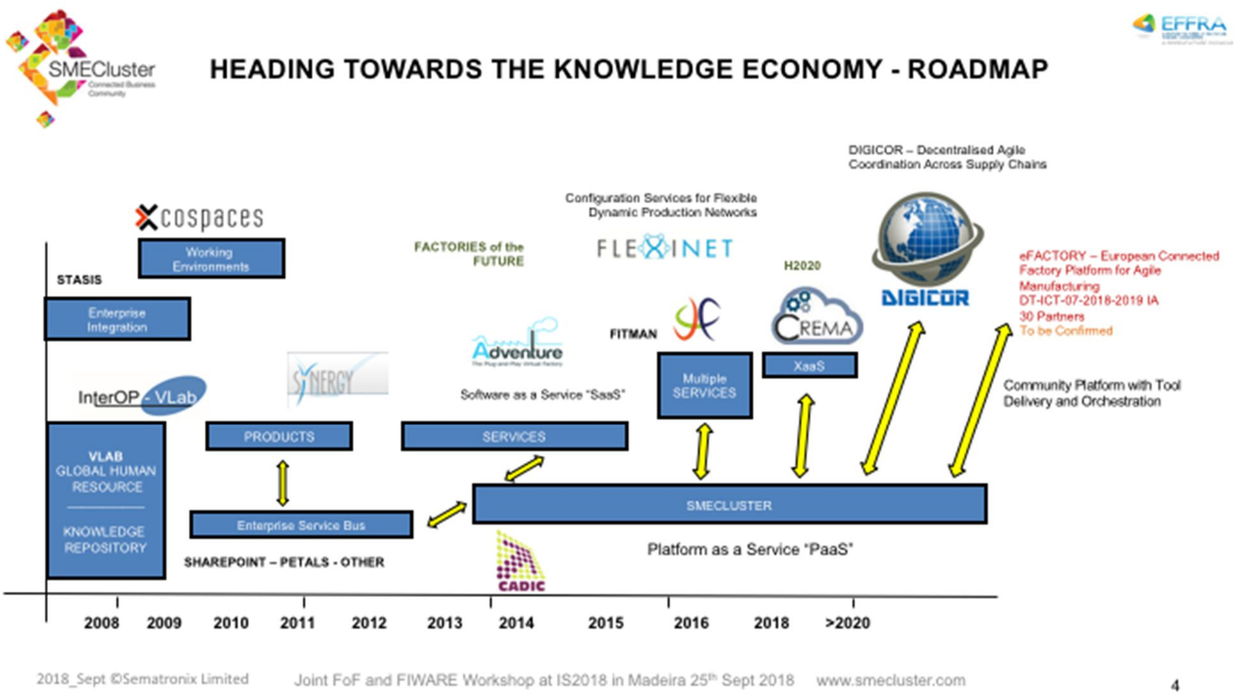
SMECluster
EFFRA
HEADING TOWARDS THE KNOWLEDGE ECONOMY - ROADMAP
DIGICOR – Decentralised Agile Coordination Across Supply Chains
Configuration Services for Flexible Dynamic Production Networks
cospaces
Working Environments
STASIS
Enterprise Integration
FACTORIES of the FUTURE
FLEXINET
H2020
DIGICOR
eFACTORY – European Connected Factory Platform for Agile Manufacturing
DT-ICT-07-2018-2019 IA
30 Partners
To be Confirmed
InterOP - VLab
SYNERGY
Adventure
FITMAN
CREMA
Software as a Service "SaaS"
Multiple SERVICES
XaaS
Community Platform with Tool Delivery and Orchestration
VLAB
GLOBAL HUMAN RESOURCE
KNOWLEDGE REPOSITORY
PRODUCTS
SERVICES
Enterprise Service Bus
SMECLUSTER
SHAREPOINT – PETALS - OTHER
Platform as a Service "PaaS"
CADIC
2008
2009
2010
2011
2012
2013
2014
2015
2016
2018
>2020
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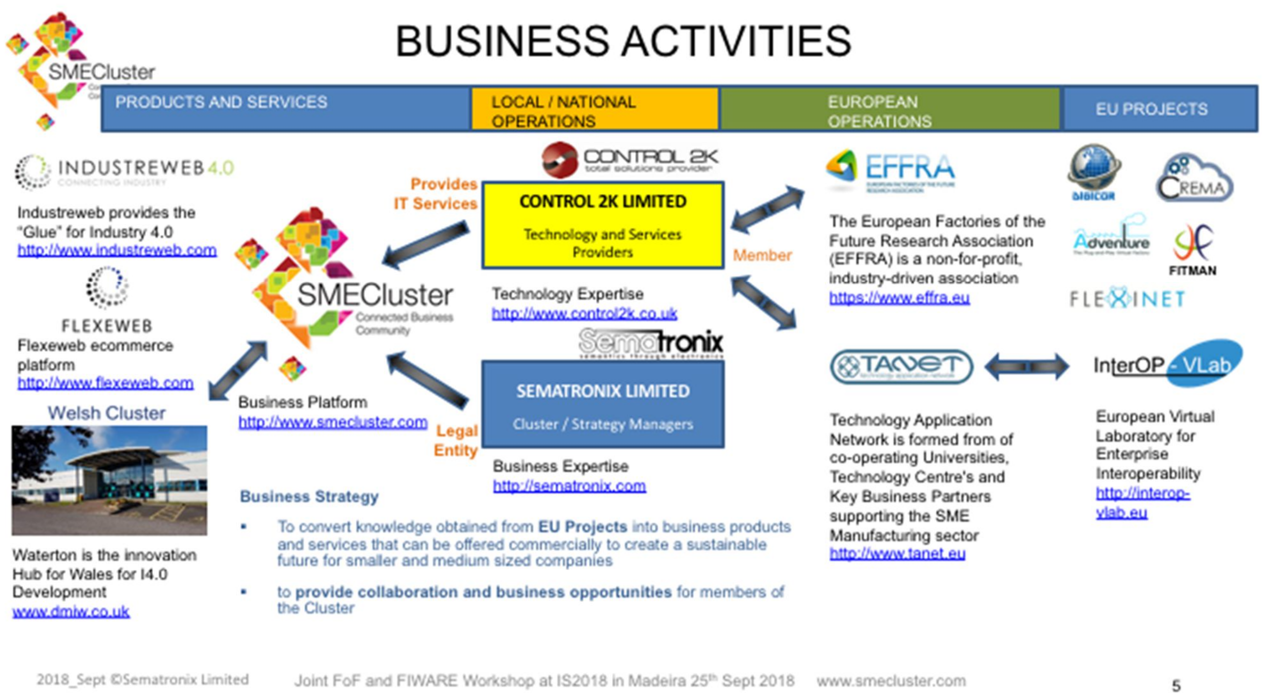

BUSINESS ACTIVITIES
SMECluster
PRODUCTS AND SERVICES
LOCAL / NATIONAL OPERATIONS
EUROPEAN OPERATIONS
EU PROJECTS
INDUSTREWEB4.0
Industreweb provides the "Glue" for Industry 4.0
http://www.industreweb.com
FLEXEWEB
Flexeweb ecommerce platform
http://www.flexeweb.com
Welsh Cluster
Waterton is the innovation Hub for Wales for I4.0 Development
www.dmiw.co.uk
Provides IT Services
SMECluster
Connected Business Community
Business Platform
http://www.smecluster.com
Legal Entity
CONTROL 2K
CONTROL 2K LIMITED
Technology and Services Providers
Technology Expertise
http://www.control2k.co.uk
Sematronix
SEMATRONIX LIMITED
Cluster / Strategy Managers
Business Expertise
http://sematronix.com
Member
Business Strategy
To convert knowledge obtained from EU Projects into business products and services that can be offered commercially to create a sustainable future for smaller and medium sized companies
to provide collaboration and business opportunities for members of the Cluster
EFFRA
The European Factories of the Future Research Association (EFFRA) is a non-for-profit, industry-driven association
https://www.effra.eu
TANET
Technology Application Network is formed from of co-operating Universities, Technology Centre's and Key Business Partners supporting the SME Manufacturing sector
http://www.tanet.eu
CREMA
Adventure
FITMAN
FLEXINET
InterOP - VLab
European Virtual Laboratory for Enterprise Interoperability
http://interop-vlab.eu
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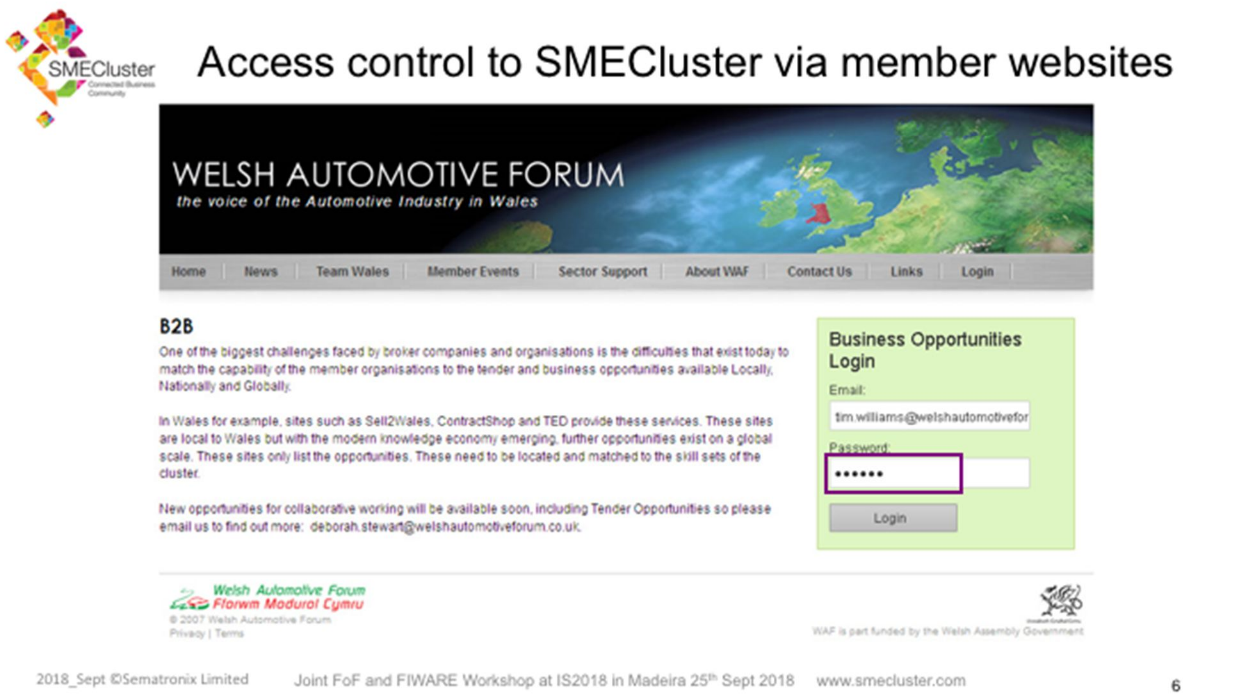

SMECluster
Access control to SMECluster via member websites
WELSH AUTOMOTIVE FORUM
the voice of the Automotive Industry in Wales
Home
News
Team Wales
Member Events
Sector Support
About WAF
Contact Us
Links
Login
B2B
One of the biggest challenges faced by broker companies and organisations is the difficulties that exist today to match the capability of the member organisations to the tender and business opportunities available Locally, Nationally and Globally.
In Wales for example, sites such as Sell2Wales, ContractShop and TED provide these services. These sites are local to Wales but with the modern knowledge economy emerging, further opportunities exist on a global scale. These sites only list the opportunities. These need to be located and matched to the skill sets of the cluster.
New opportunities for collaborative working will be available soon, including Tender Opportunities so please email us to find out more: deborah.stewart@welshautomotiveforum.co.uk
Business Opportunities Login
Email:
tim.williams@welshautomotivefor
Password:
••••••
Login
Welsh Automotive Forum
Fforwm Modurol Cymru
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Community Benefits / Pitfalls of Clustering

Benefits
- Access to more opportunities
- More flexibility to win business
- More effective use of resources
- Knowledge sharing
- Build up business to strengthen stand alone
- Easier to find / develop supply-chain 'hot spot'
- Greater networking / prospects pipelines

Pitfalls
- Commitment / Time
- Fear of structure – Understanding / lack of explanation
- Fear of subcontracting – Contractual Interaction
- Losing status / pecking order
- Ownership and liability not understood
- Lack of preparation to work collaboratively

Master Vendor with Subcontractors
Most common true definition of collaborative tendering
Used by the Public Sector

- Easiest structure for engagement for SME's to be successful
- One contractual engagement with buying organisation
- Fear of 'subby bashing' (Sub-contractor)
- Contractual structure is poorly understood / carried out

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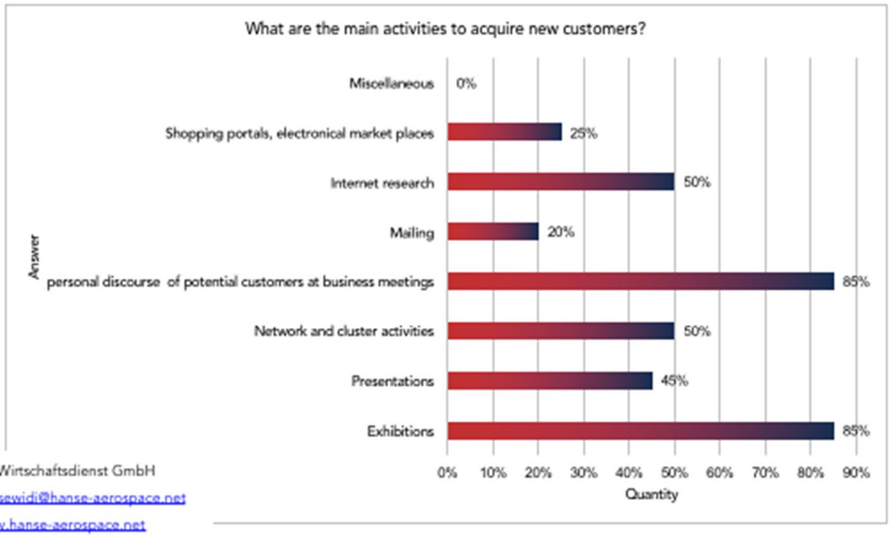
Survey for SME in the DIGICOR-Project



Hanse-Aerospace Wirtschaftsdienst GmbH
E-Mail: hansewidi@hanse-aerospace.net
Internet: www.hanse-aerospace.net

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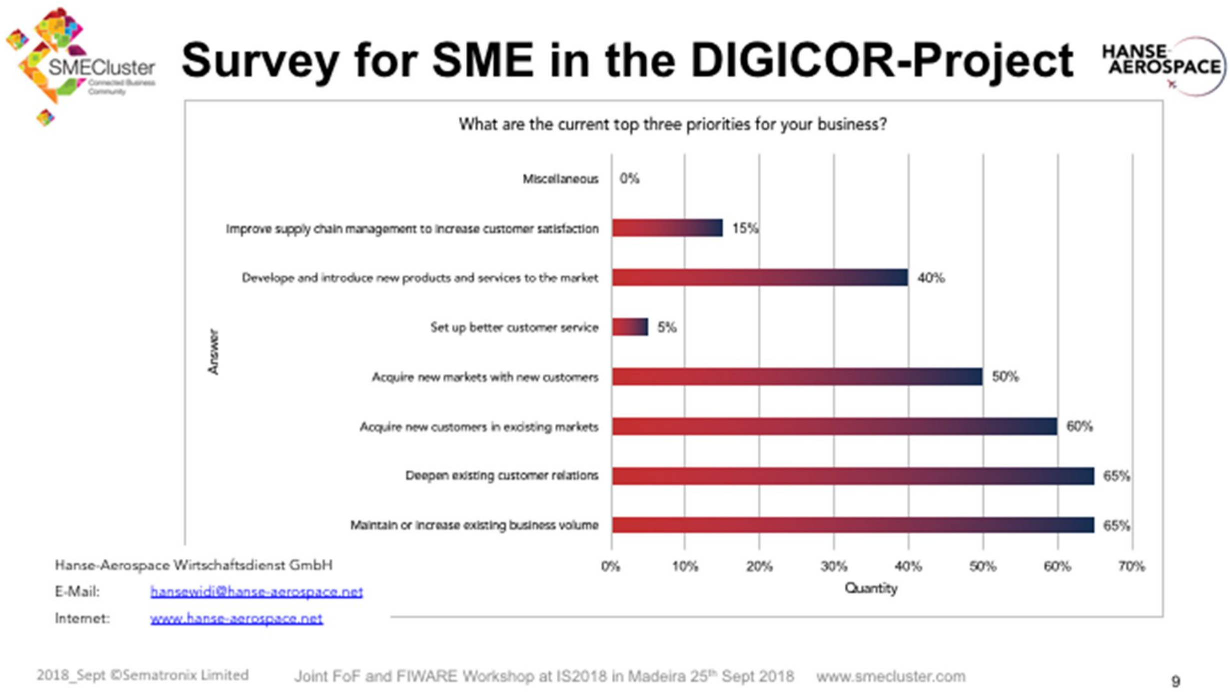
SMECluster
Survey for SME in the DIGICOR-Project
HANSE AEROSPACE
What are the current top three priorities for your business?
Miscellaneous 0%
Improve supply chain management to increase customer satisfaction 15%
Develope and introduce new products and services to the market 40%
Set up better customer service 5%
Acquire new markets with new customers 50%
Acquire new customers in excisting markets 60%
Deepen existing customer relations 65%
Maintain or increase existing business volume 65%
Answer
0% 10% 20% 30% 40% 50% 60% 70%
Quantity
Hanse-Aerospace Wirtschaftsdienst GmbH
E-Mail: hansewidi@hanse-aerospace.net
Internet: www.hanse-aerospace.net
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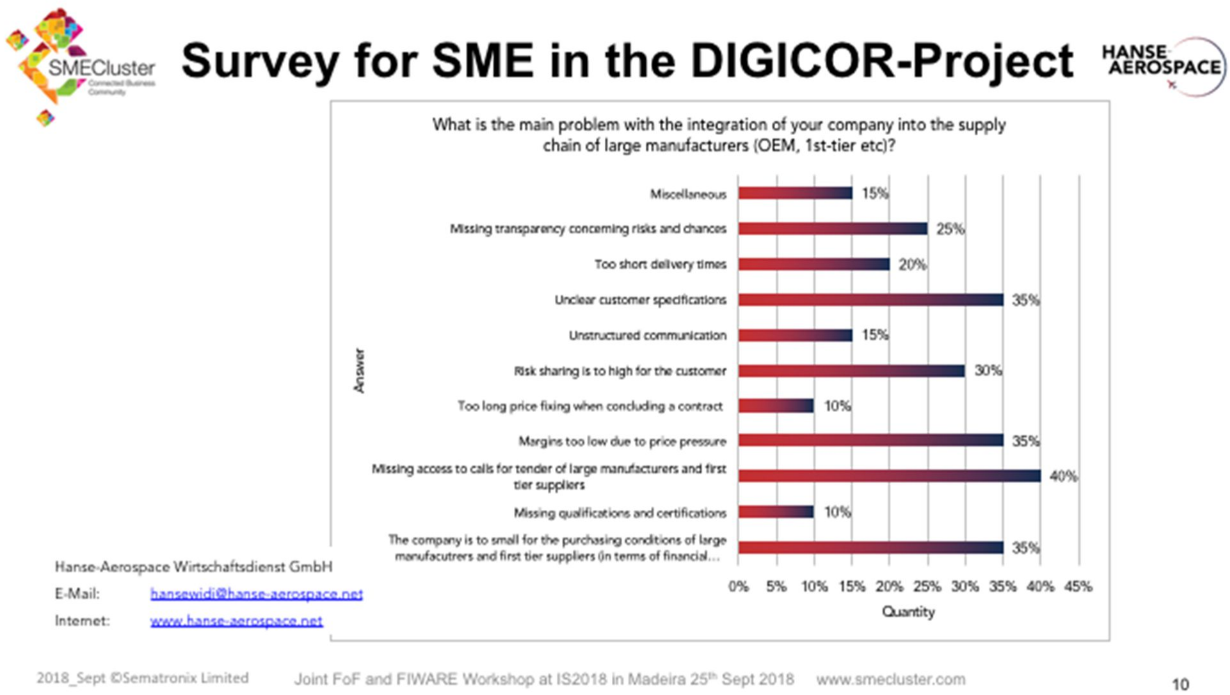
SMECluster
Survey for SME in the DIGICOR-Project
HANSE AEROSPACE
What is the main problem with the integration of your company into the supply chain of large manufacturers (OEM, 1st-tier etc)?
Miscellaneous 15%
Missing transparency concerning risks and chances 25%
Too short delivery times 20%
Unclear customer specifications 35%
Unstructured communication 15%
Risk sharing is to high for the customer 30%
Too long price fixing when concluding a contract 10%
Margins too low due to price pressure 35%
Missing access to calls for tender of large manufacturers and first tier suppliers 40%
Missing qualifications and certifications 10%
The company is to small for the purchasing conditions of large manufacutrers and first tier suppliers (in terms of financial... 35%
Answer
0% 5% 10% 15% 20% 25% 30% 35% 40% 45%
Quantity
Hanse-Aerospace Wirtschaftsdienst GmbH
E-Mail: hansewidi@hanse-aerospace.net
Internet: www.hanse-aerospace.net
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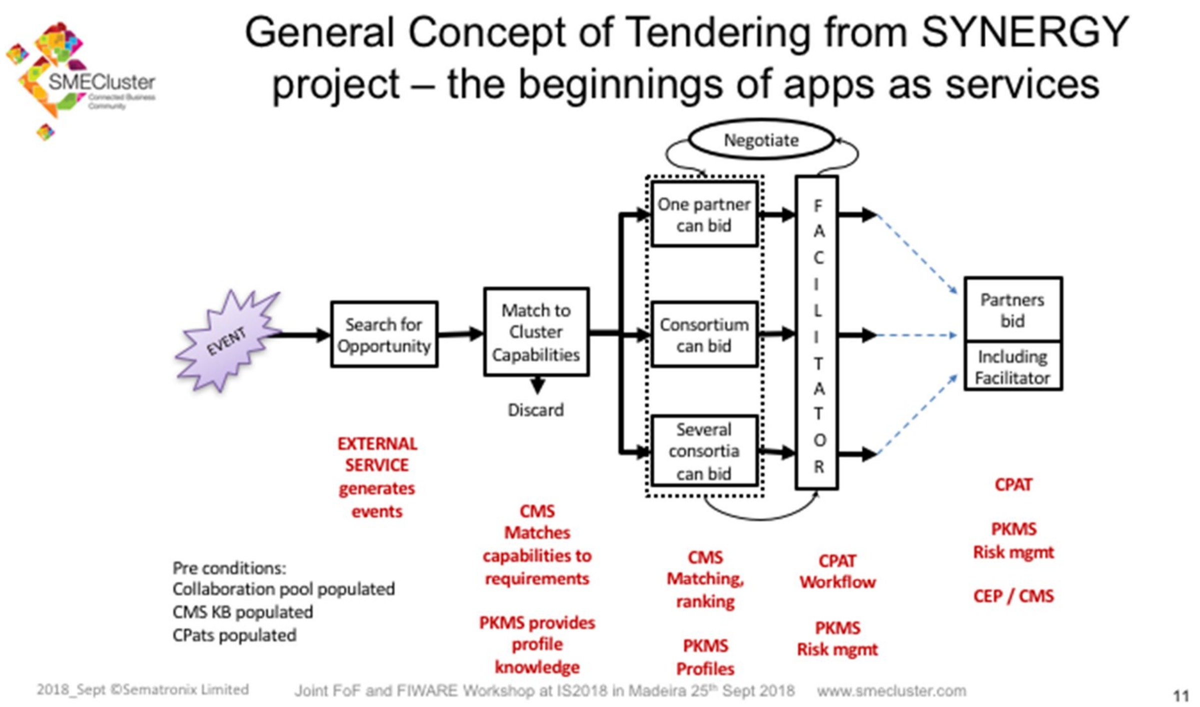
General Concept of Tendering from SYNERGY project – the beginnings of apps as services
SMECluster
Negotiate
EVENT
Search for Opportunity
Match to Cluster Capabilities
Discard
One partner can bid
Consortium can bid
Several consortia can bid
FACILITATOR
Partners bid
Including Facilitator
EXTERNAL SERVICE generates events
CMS Matches capabilities to requirements
PKMS provides profile knowledge
CMS Matching, ranking
PKMS Profiles
CPAT Workflow
PKMS Risk mgmt
CPAT
PKMS Risk mgmt
CEP / CMS
Pre conditions:
Collaboration pool populated
CMS KB populated
CPats populated
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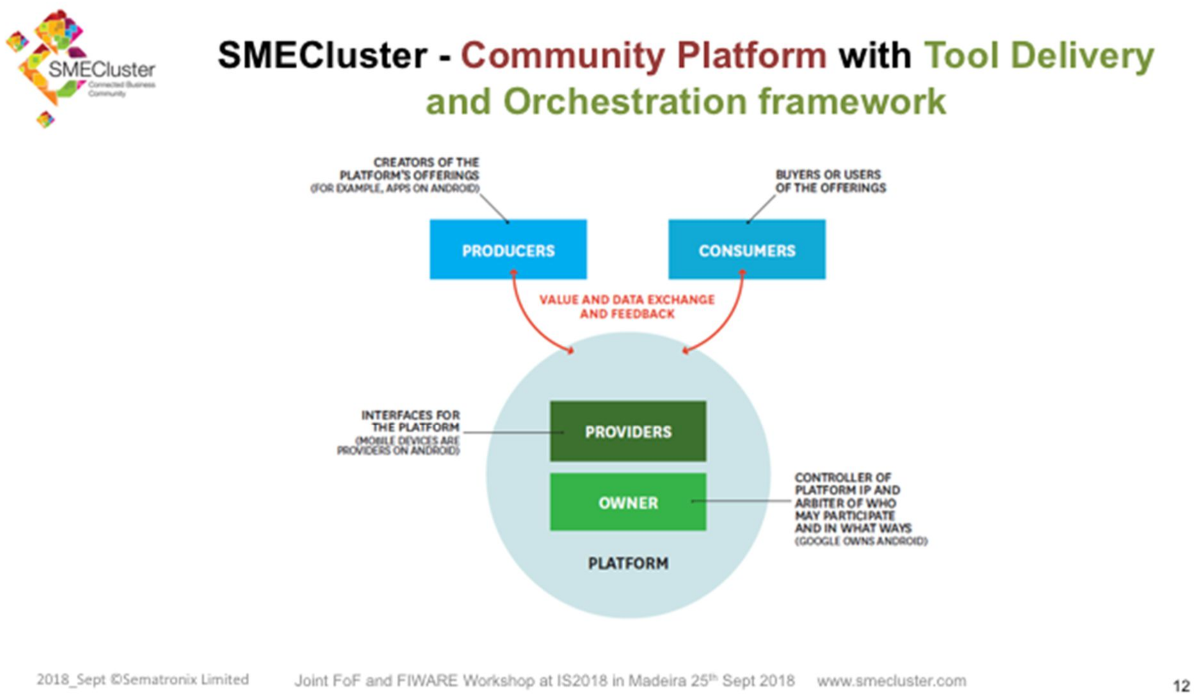
SMECluster - Community Platform with Tool Delivery and Orchestration framework
SMECluster
CREATORS OF THE PLATFORM'S OFFERINGS (FOR EXAMPLE, APPS ON ANDROID)
BUYERS OR USERS OF THE OFFERINGS
PRODUCERS
CONSUMERS
VALUE AND DATA EXCHANGE AND FEEDBACK
INTERFACES FOR THE PLATFORM (MOBILE DEVICES ARE PROVIDERS ON ANDROID)
PROVIDERS
OWNER
CONTROLLER OF PLATFORM IP AND ARBITER OF WHO MAY PARTICIPATE AND IN WHAT WAYS (GOOGLE OWNS ANDROID)
PLATFORM
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SMECluster

FITMAN

FITMAN
– THE FIWARE PROJECT FOR MANUFACTURING

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SMECluster

Trial Focus

8

TANET technology application network

Business Opportunity
&
SME Network
Matching

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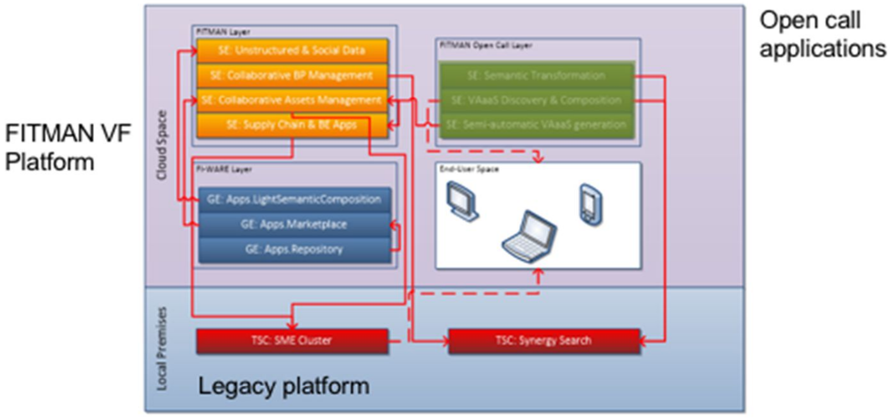
FITMAN Platform in TANET Trial

- Call for Tender Opportunities (BS.1)



Represent assets of a company to support facilitators in creating clusters to complete tenders.

GE / SE's Used in Smart and Virtual

FIWARE for Industry Open Source Components tested and Used in ALL TANet Trials:

Data Collection – SDC
IoT Protocols – ZPA
IoT Gateway Handling – CEP
Zigbee Data – ZPA
… Many others Tested

Specific Enablers:
Coll. Assets Management – CAM
Supply Chain and Bus. Ecosys. Apps – SCApp
Coll. Business Process Management – CBPM
Data Interop. Platform Services - DIPS
Management of Virtual Assets – MoVa
Generation & Trans. of Virt. Assets – GeToVA

New SE's used

- AK 3 (MoVA) - Using as a complement/possible replacement for CAM

- AK 24 (GeToVA) - Use to automate the import of suppliers into SMECluster

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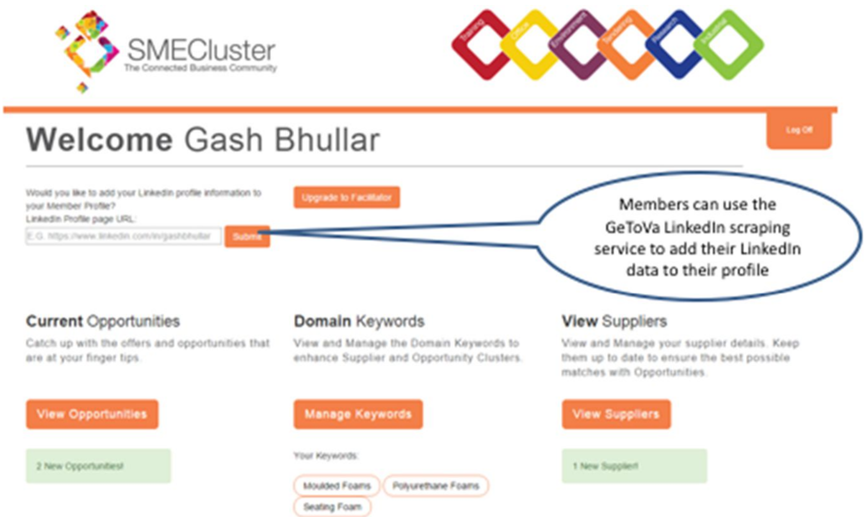

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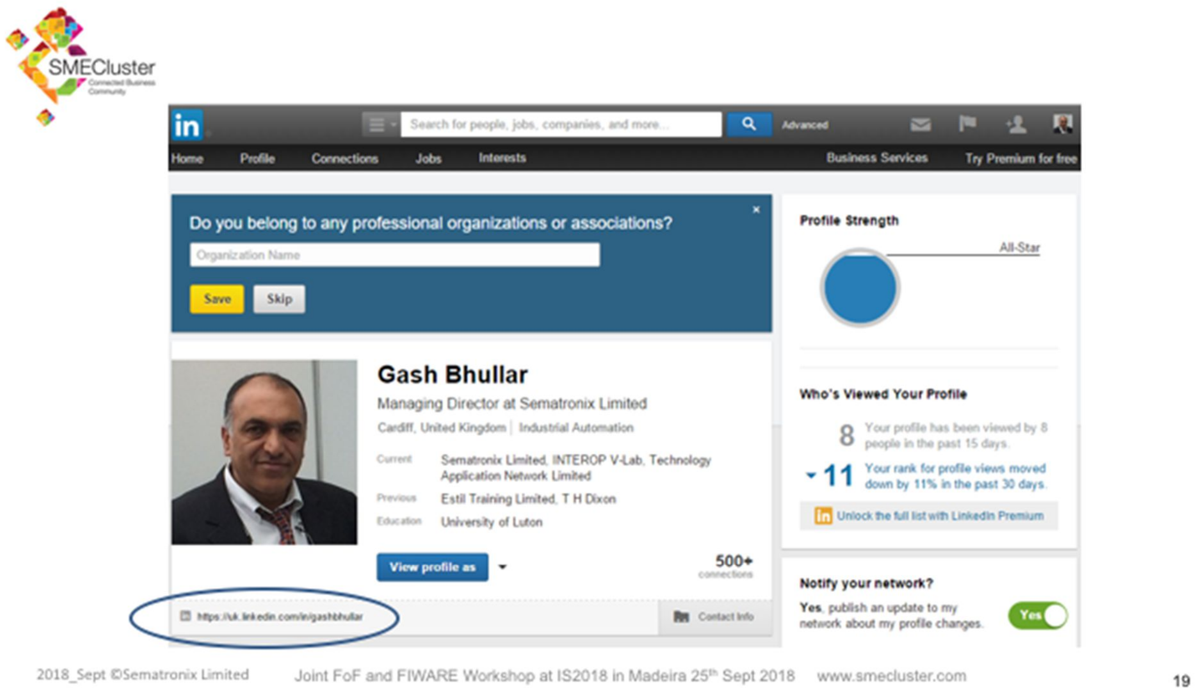
SMECluster
Home
Profile
Connections
Jobs
Interests
Business Services
Try Premium for free
Do you belong to any professional organizations or associations?
Save
Skip
Profile Strength
All-Star
Gash Bhullar
Managing Director at Sematronix Limited
Cardiff, United Kingdom | Industrial Automation
Current Sematronix Limited, INTEROP V-Lab, Technology Application Network Limited
Previous Estil Training Limited, T H Dixon
Education University of Luton
View profile as
500+ connections
https://uk.linkedin.com/in/gashbhullar
Contact Info
Who's Viewed Your Profile
8 Your profile has been viewed by 8 people in the past 15 days.
11 Your rank for profile views moved down by 11% in the past 30 days.
Unlock the full list with LinkedIn Premium
Notify your network?
Yes, publish an update to my network about my profile changes.
Yes
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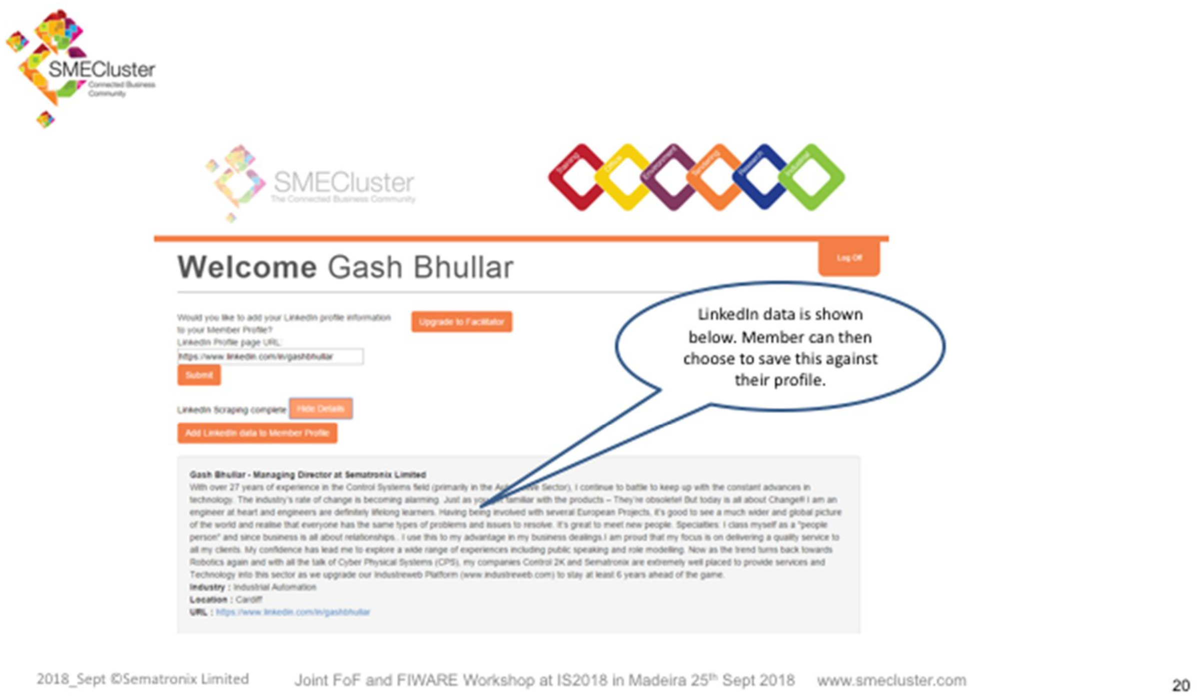
SMECluster
Welcome Gash Bhullar
LinkedIn data is shown below. Member can then choose to save this against their profile.
Gash Bhullar - Managing Director at Sematronix Limited
Industry : Industrial Automation
Location : Cardiff
URL : https://www.linkedin.com/in/gashbhullar
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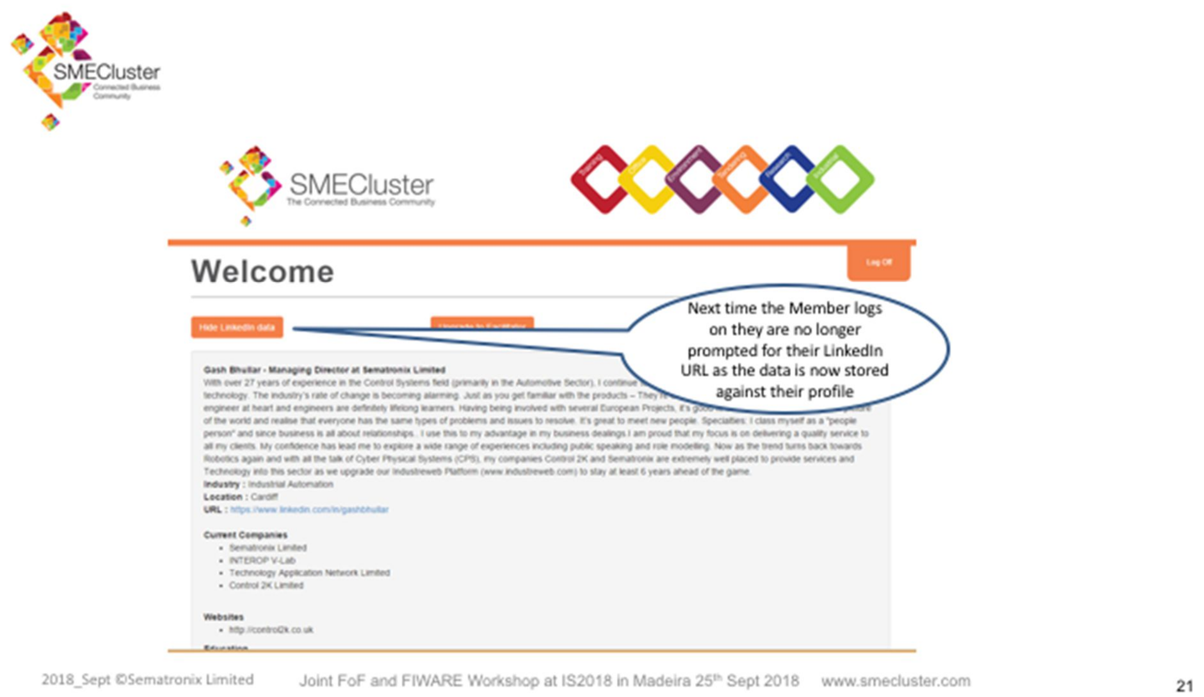
SMECluster
Welcome
Log Off
Hide LinkedIn data
Next time the Member logs on they are no longer prompted for their LinkedIn URL as the data is now stored against their profile
Gash Bhullar - Managing Director at Sematronix Limited
Industry : Industrial Automation
Location : Cardiff
URL : https://www.linkedin.com/in/gashbhullar
Current Companies
Sematronix Limited
INTEROP V-Lab
Technology Application Network Limited
Control 2K Limited
Websites
http://control2k.co.uk
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21


SMECluster
View Suppliers - 60
Suppliers can be searched using the box provided.
Back
Create new Supplier
Supplier
A2B Plastics Ltd
Supplier details and Domain Keywords imported from MoVA
Accelero Digital Solutions Ltd
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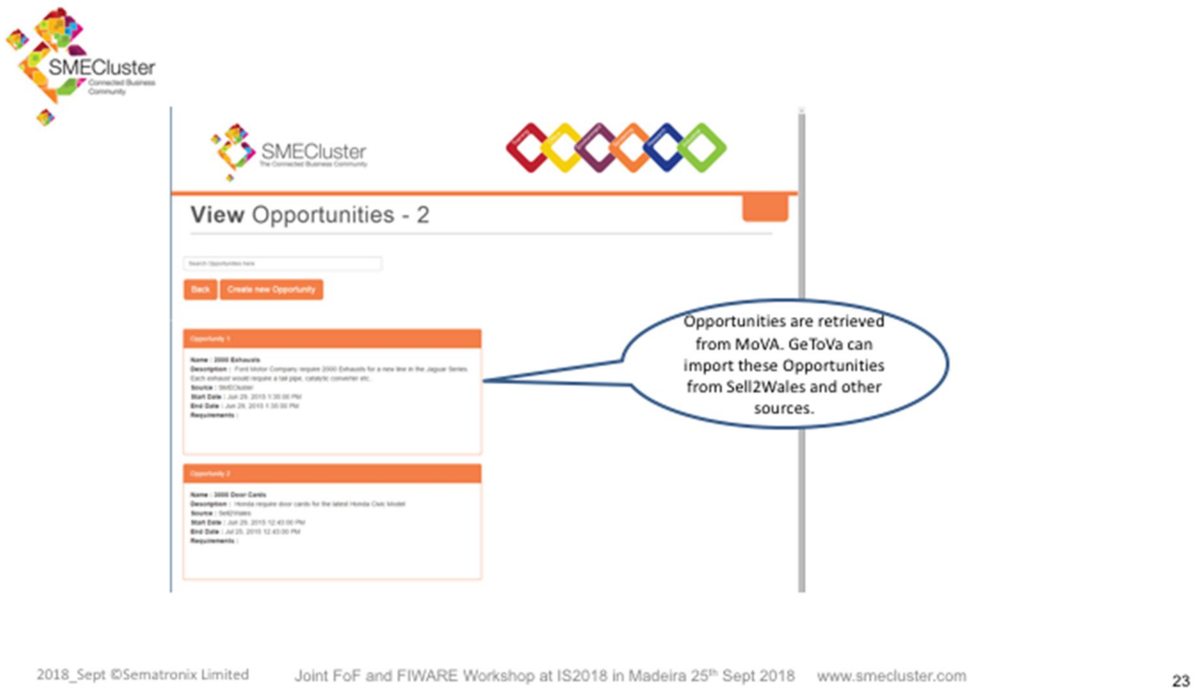
SMECluster
View Opportunities - 2
Back
Create new Opportunity
Opportunities are retrieved from MoVA. GeToVa can import these Opportunities from Sell2Wales and other sources.
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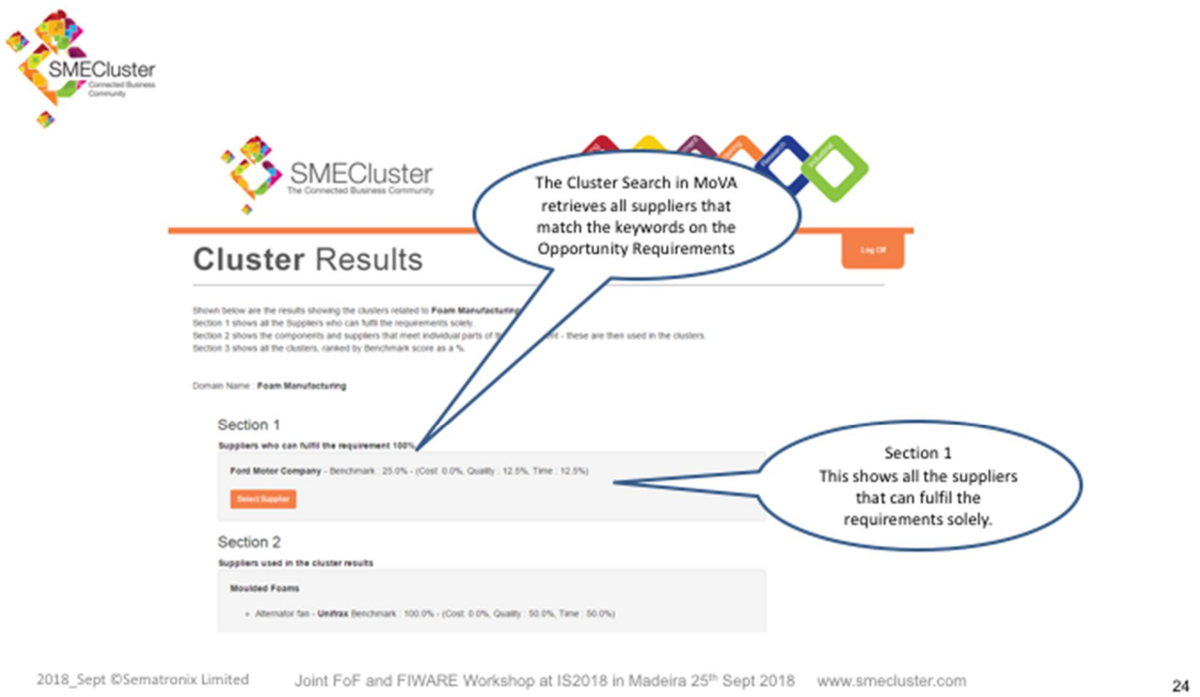
SMECluster
The Connected Business Community
Cluster Results
The Cluster Search in MoVA retrieves all suppliers that match the keywords on the Opportunity Requirements
Section 1
Suppliers who can fulfil the requirement 100%
Ford Motor Company
Select Supplier
Section 1
This shows all the suppliers that can fulfil the requirements solely.
Section 2
Suppliers used in the cluster results
Moulded Foams
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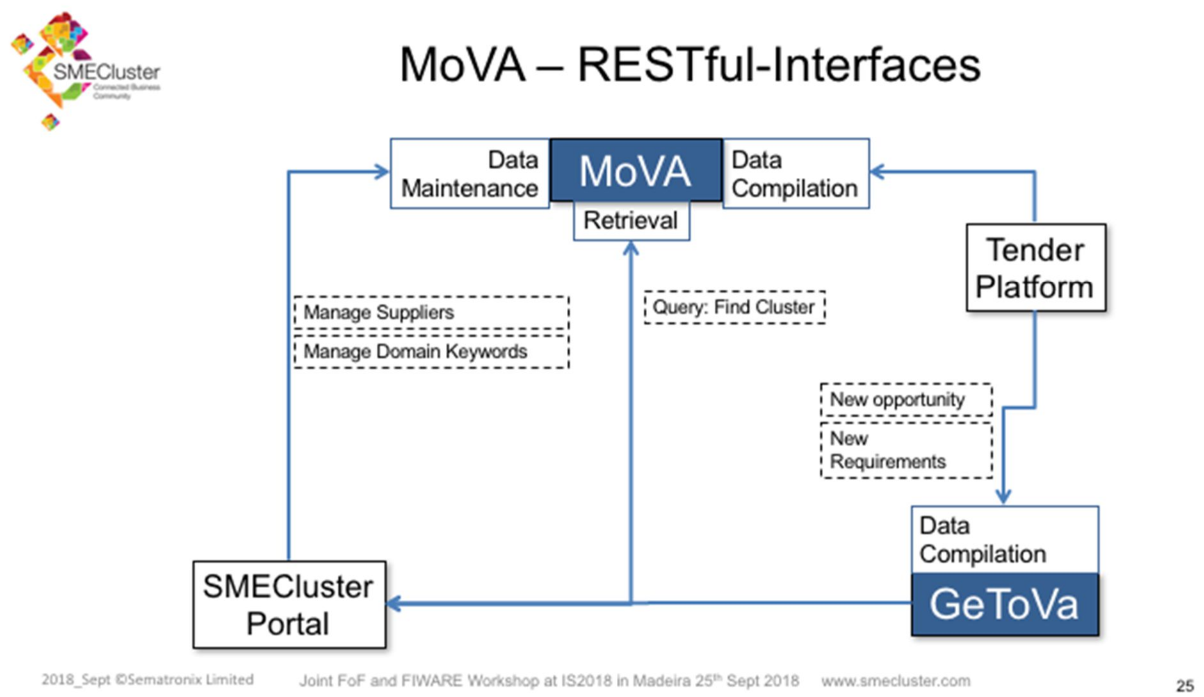
SMECluster
MoVA – RESTful-Interfaces
Data Maintenance
MoVA
Data Compilation
Retrieval
Tender Platform
Manage Suppliers
Manage Domain Keywords
Query: Find Cluster
New opportunity
New Requirements
Data Compilation
GeToVa
SMECluster Portal
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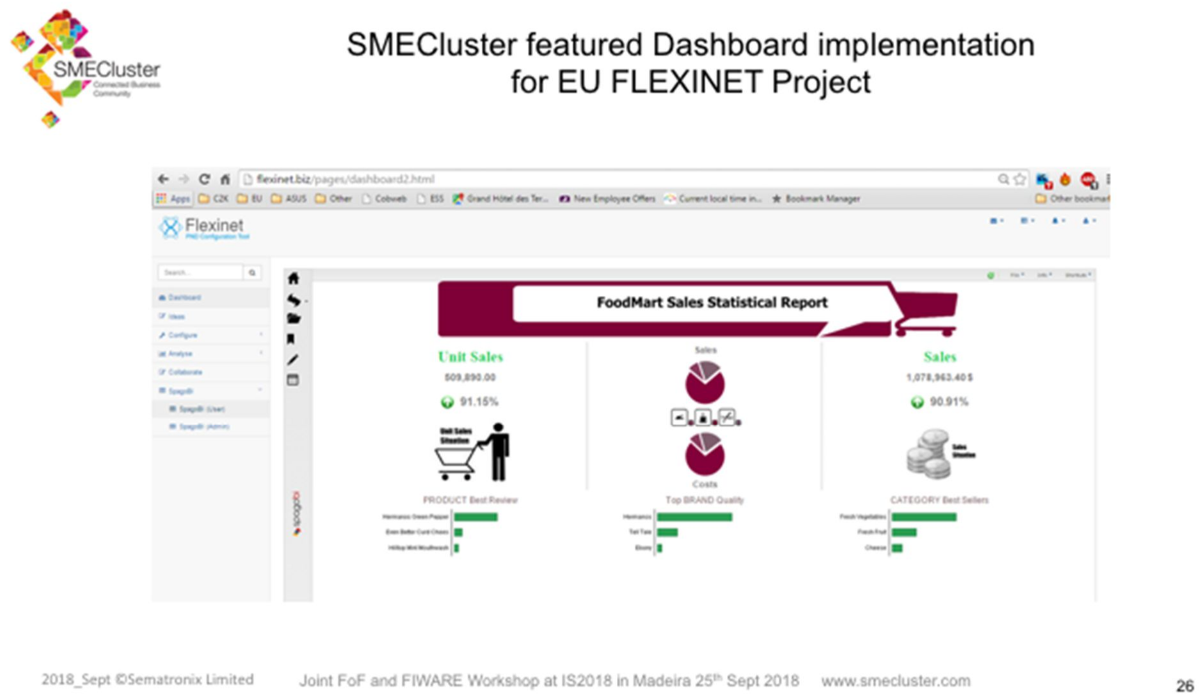
SMECluster
SMECluster featured Dashboard implementation for EU FLEXINET Project
Flexinet
FoodMart Sales Statistical Report
Unit Sales
Sales
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26

SMECluster Additional Tool Delivery and Orchestration framework for other providers – MindSphere

- With MindConnect MindSphere provides multiple, varied and easy-to-implement connectivity solutions to onboard a wide range of assets (Siemens and 3rd-party) in both brown- and greenfield:
- Focusing on brownfield installations, dedicated IoT Connectors like MindConnect Nano and MindConnect IoT2040, which provide plug and play connection of Siemens and 3rd party products thanks to communication via open standards like OPC UA
- MindConnect embedded agents in Siemens industrial products like SIMATIC and SINUMERIK focusing on greenfield projects
- For every further product, including 3rd-party, MindConnect LIB, which enables self programming of connectivity modules by interacting with the MindSphere southbound APIs

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Example APIs @ MindSphere

Timeseries (+Methods)

Use Timeseries APIs to read, write and edit Timeseries values from storage
- Aggregated Timeseries (M4)
- Min/Max Values
- Modify Timeseries

Trend Prediction

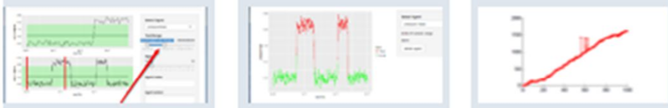
Use Trend Prediction APIs to create predictions based on one aspect

Anomaly Detection

Use Anomaly API to detect correlation analysis of two aspects

Outlier Detection

Use Outlier Detection API to detect failures through e.g. Gradient Check



Enable not only data visualization but also data analytics:
Implement application for data visualization and analyze data for dependencies, like energy consumption and production information

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FML Technology Enabler plan

In terms of the Virtual trial, the previous tables give an idea of how the SMECluster Platform will be expanded:

- Making platform and service maintenance faster, and more cost effective, and more reliable, since less custom code is used;
- Making the service offering more flexible and adaptable to technology developments, since evolving technology embedded in GE and SE instances will provide access seamlessly.
- Continue adding new features to support development of “Middleware” for manufacturing data collection services.
- Provide a reselling service for the FITMAN / FIWARE Enablers

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The potential home of FML Technology

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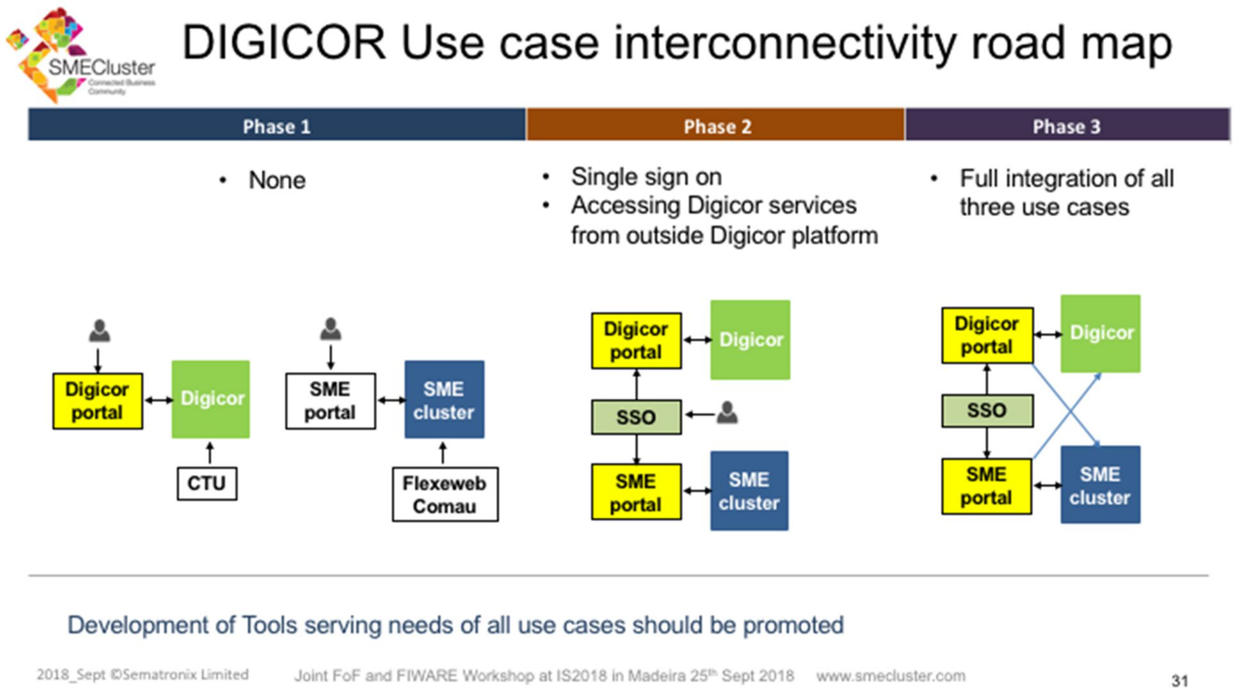
SMECluster
DIGICOR Use case interconnectivity road map
Phase 1
Phase 2
Phase 3
• None
• Single sign on
• Accessing Digicor services from outside Digicor platform
• Full integration of all three use cases
Digicor portal
Digicor
CTU
SME portal
SME cluster
Flexeweb Comau
Digicor portal
Digicor
SSO
SME portal
SME cluster
Digicor portal
Digicor
SSO
SME portal
SME cluster
Development of Tools serving needs of all use cases should be promoted
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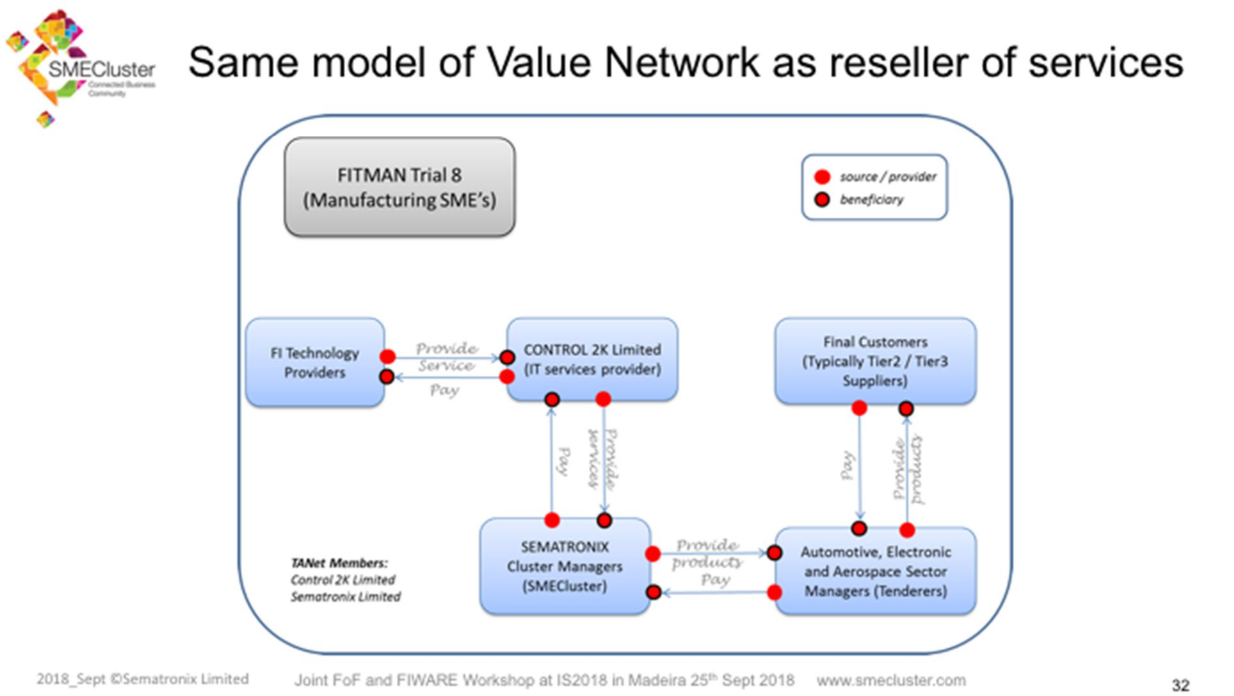
SMECluster
Same model of Value Network as reseller of services
FITMAN Trial 8 (Manufacturing SME's)
source / provider
beneficiary
FI Technology Providers
Provide Service
Pay
CONTROL 2K Limited (IT services provider)
Final Customers (Typically Tier2 / Tier3 Suppliers)
Pay
Provide services
Pay
Provide products
SEMATRONIX Cluster Managers (SMECluster)
Provide products
Pay
Automotive, Electronic and Aerospace Sector Managers (Tenderers)
TANet Members:
Control 2K Limited
Sematronix Limited
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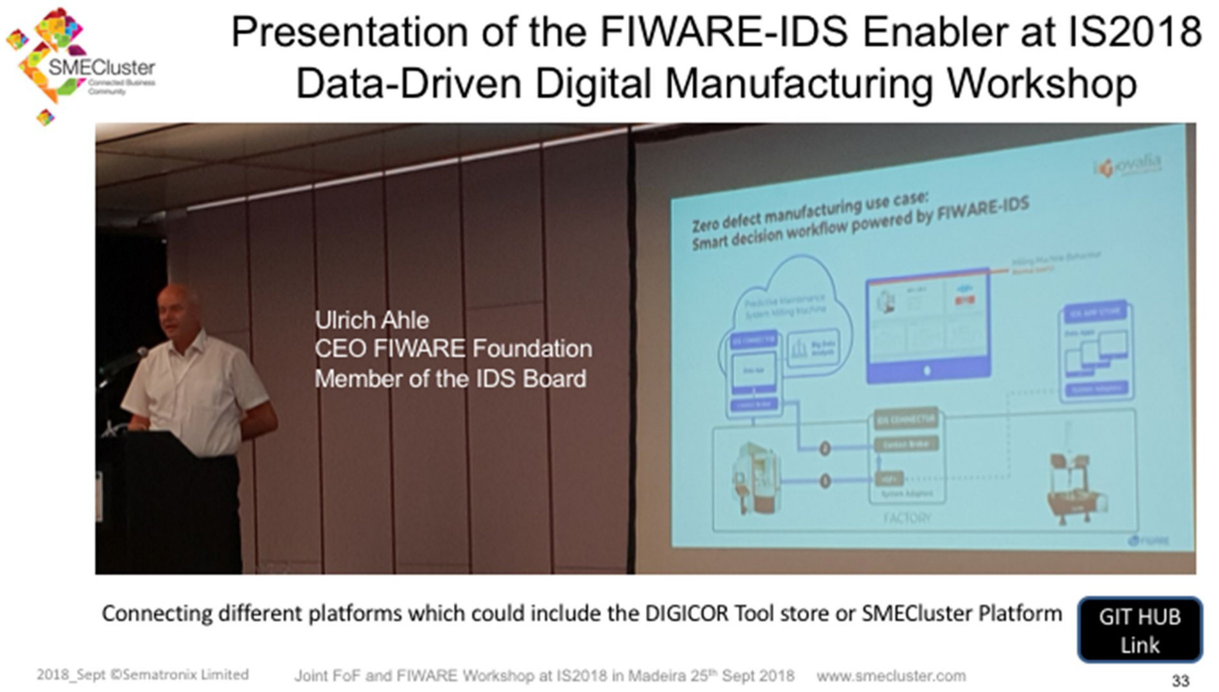
SMECluster
Presentation of the FIWARE-IDS Enabler at IS2018
Data-Driven Digital Manufacturing Workshop
Zero defect manufacturing use case:
Smart decision workflow powered by FIWARE-IDS
Ulrich Ahle
CEO FIWARE Foundation
Member of the IDS Board
Connecting different platforms which could include the DIGICOR Tool store or SMECluster Platform
GIT HUB Link
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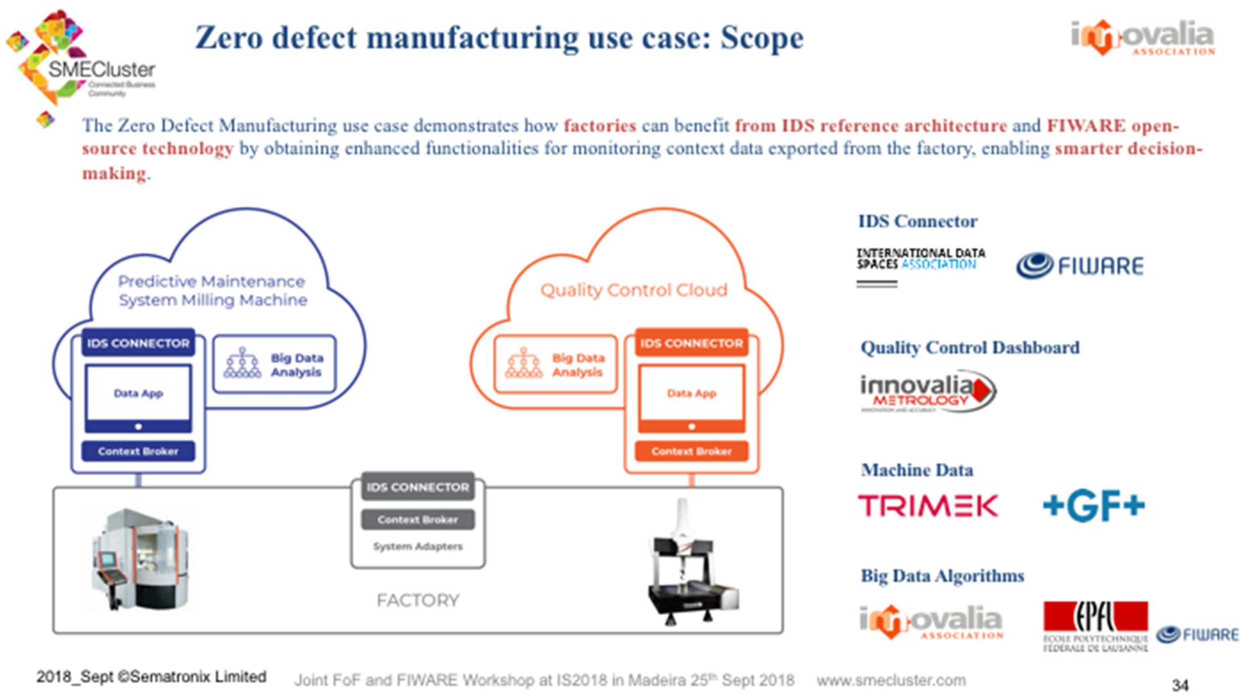
SMECluster
Zero defect manufacturing use case: Scope
innovalia ASSOCIATION
The Zero Defect Manufacturing use case demonstrates how factories can benefit from IDS reference architecture and FIWARE open-source technology by obtaining enhanced functionalities for monitoring context data exported from the factory, enabling smarter decision-making.
Predictive Maintenance System Milling Machine
IDS CONNECTOR
Data App
Context Broker
Big Data Analysis
Quality Control Cloud
Big Data Analysis
IDS CONNECTOR
Data App
Context Broker
IDS CONNECTOR
Context Broker
System Adapters
FACTORY
IDS Connector
INTERNATIONAL DATA SPACES ASSOCIATION
FIWARE
Quality Control Dashboard
innovalia METROLOGY
Machine Data
TRIMEK
+GF+
Big Data Algorithms
innovalia ASSOCIATION
EPFL
FIWARE
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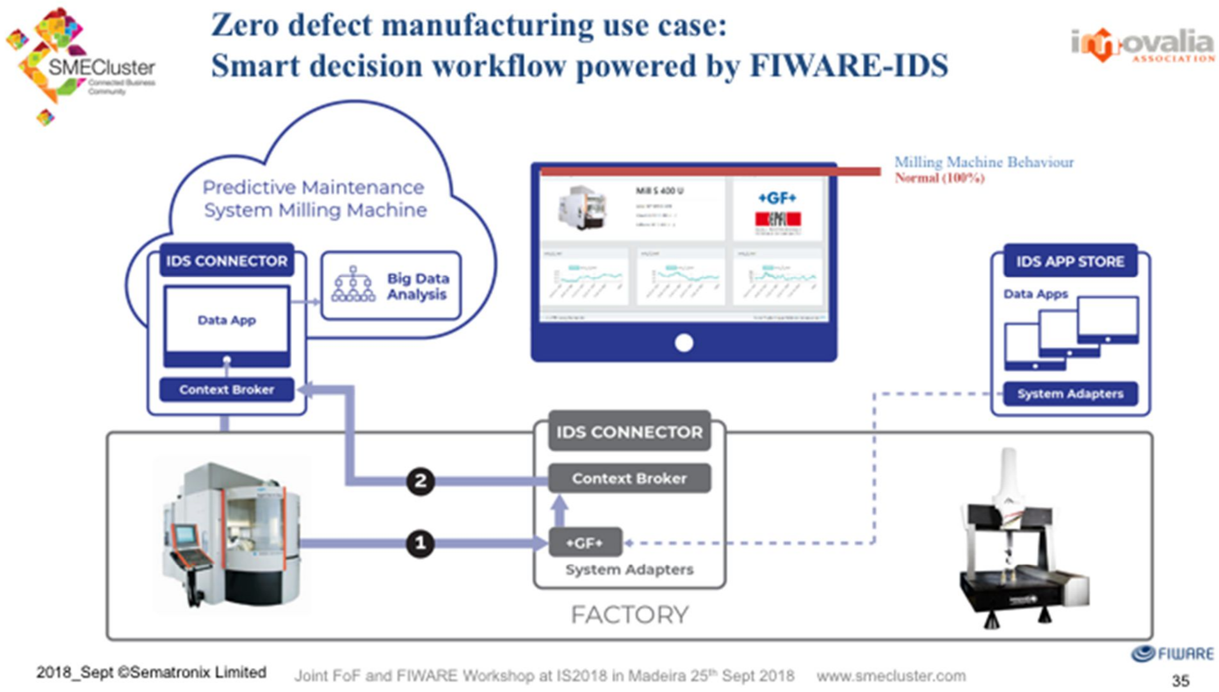
Zero defect manufacturing use case:
Smart decision workflow powered by FIWARE-IDS
Predictive Maintenance System Milling Machine
IDS CONNECTOR
Data App
Context Broker
Big Data Analysis
Milling Machine Behaviour
Normal (100%)
IDS APP STORE
Data Apps
System Adapters
IDS CONNECTOR
Context Broker
+GF+
System Adapters
FACTORY
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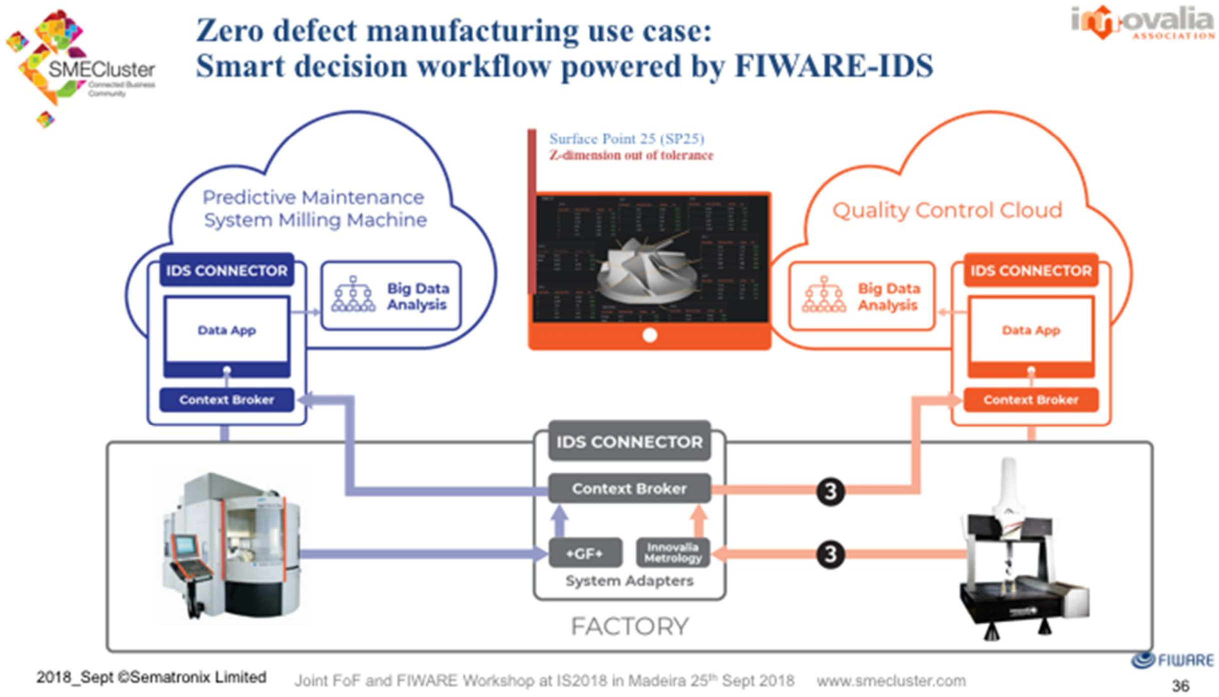
FIWARE
35


Zero defect manufacturing use case:
Smart decision workflow powered by FIWARE-IDS
Predictive Maintenance System Milling Machine
IDS CONNECTOR
Data App
Context Broker
Big Data Analysis
Surface Point 25 (SP25)
Z-dimension out of tolerance
Quality Control Cloud
Big Data Analysis
IDS CONNECTOR
Data App
Context Broker
IDS CONNECTOR
Context Broker
+GF+
Innovalia Metrology
System Adapters
FACTORY
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www.smecluster.com
FIWARE
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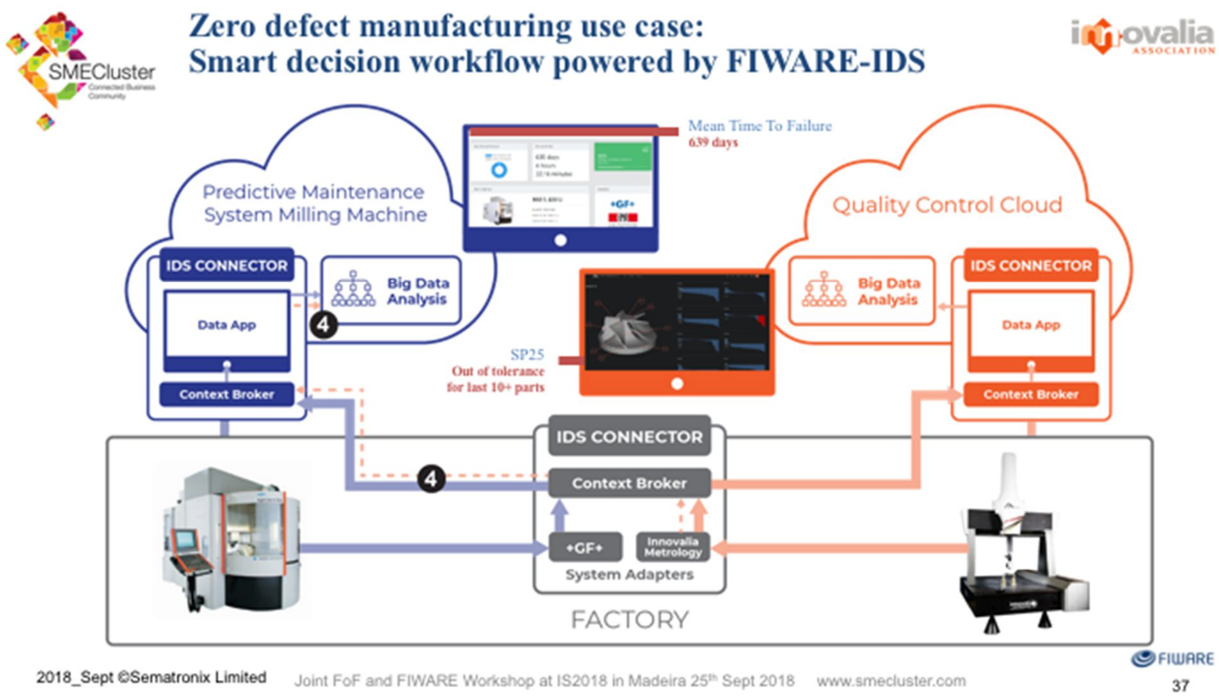
Zero defect manufacturing use case:
Smart decision workflow powered by FIWARE-IDS
SMECluster
innovalia ASSOCIATION
Predictive Maintenance System Milling Machine
Mean Time To Failure
639 days
Quality Control Cloud
IDS CONNECTOR
Data App
Context Broker
Big Data Analysis
4
SP25
Out of tolerance for last 10+ parts
IDS CONNECTOR
Context Broker
+GF+
Innovalia Metrology
System Adapters
FACTORY
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www.smecluster.com
FIWARE
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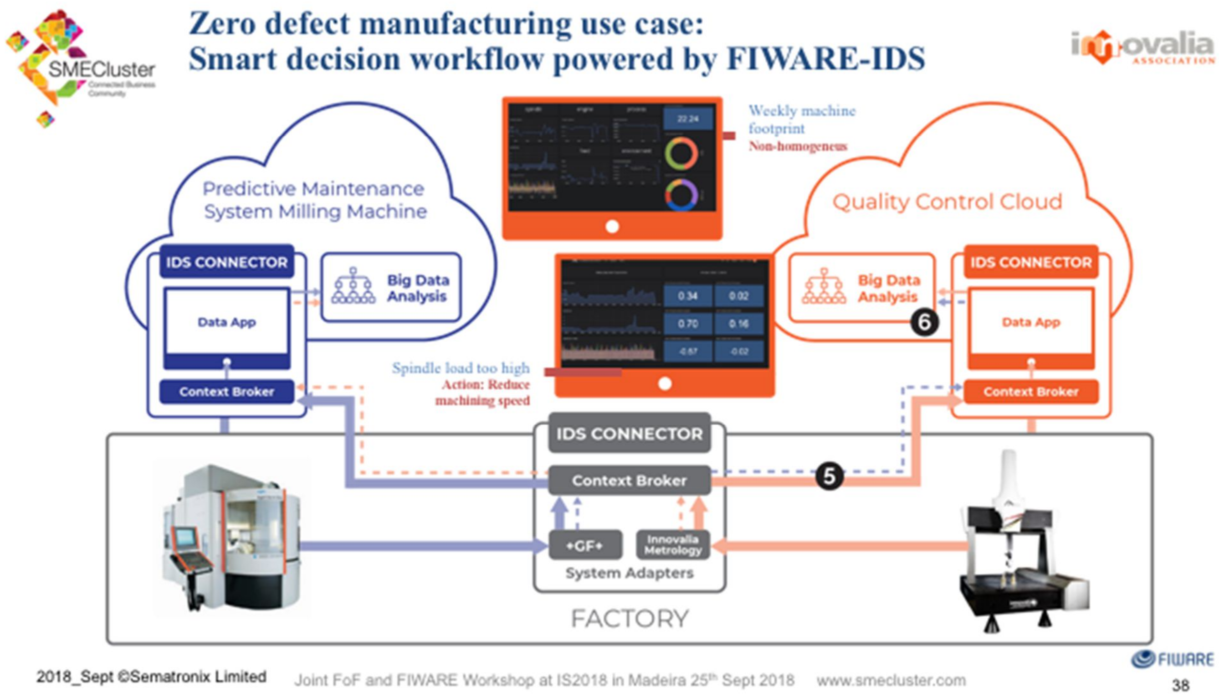
Zero defect manufacturing use case:
Smart decision workflow powered by FIWARE-IDS
SMECluster
innovalia ASSOCIATION
Weekly machine footprint
Non-homogeneus
Predictive Maintenance System Milling Machine
Quality Control Cloud
IDS CONNECTOR
Data App
Context Broker
Big Data Analysis
6
Spindle load too high
Action: Reduce machining speed
IDS CONNECTOR
Context Broker
5
+GF+
Innovalia Metrology
System Adapters
FACTORY
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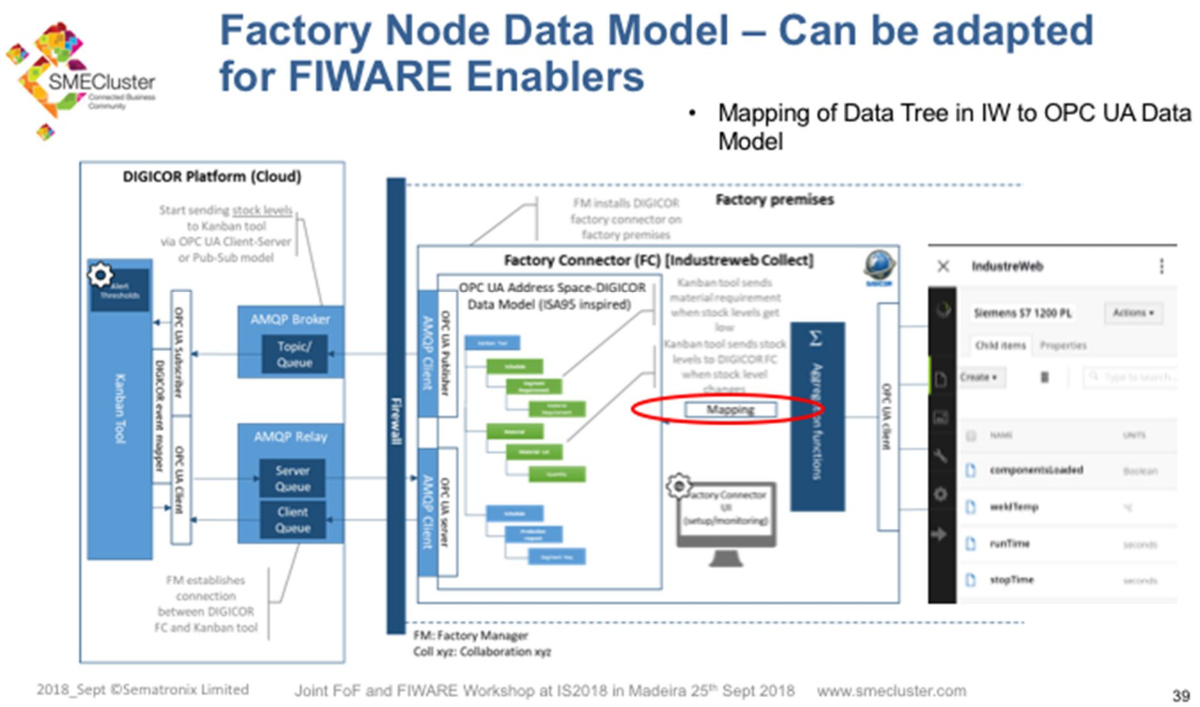
SMECluster
Factory Node Data Model – Can be adapted for FIWARE Enablers
Mapping of Data Tree in IW to OPC UA Data Model
DIGICOR Platform (Cloud)
Start sending stock levels to Kanban tool via OPC UA Client-Server or Pub-Sub model
Kanban Tool
OPC UA Subscriber
DIGICOR event mapper
OPC UA Client
AMQP Broker
Topic/ Queue
AMQP Relay
Server Queue
Client Queue
FM establishes connection between DIGICOR FC and Kanban tool
Firewall
FM installs DIGICOR factory connector on factory premises
Factory premises
Factory Connector (FC) [Industreweb Collect]
OPC UA Address Space-DIGICOR Data Model (ISA95 inspired)
AMQP Client
OPC UA Publisher
OPC UA server
Kanban tool sends material requirement when stock levels get low
Kanban tool sends stock levels to DIGICOR FC when stock level changes
Mapping
Aggregation functions
OPC UA client
Factory Connector UI (setup/monitoring)
IndustreWeb
Siemens S7 1200 PL
Actions
Child items
Properties
Create
componentsLoaded
weldTemp
runTime
stopTime
FM: Factory Manager
Coll xyz: Collaboration xyz
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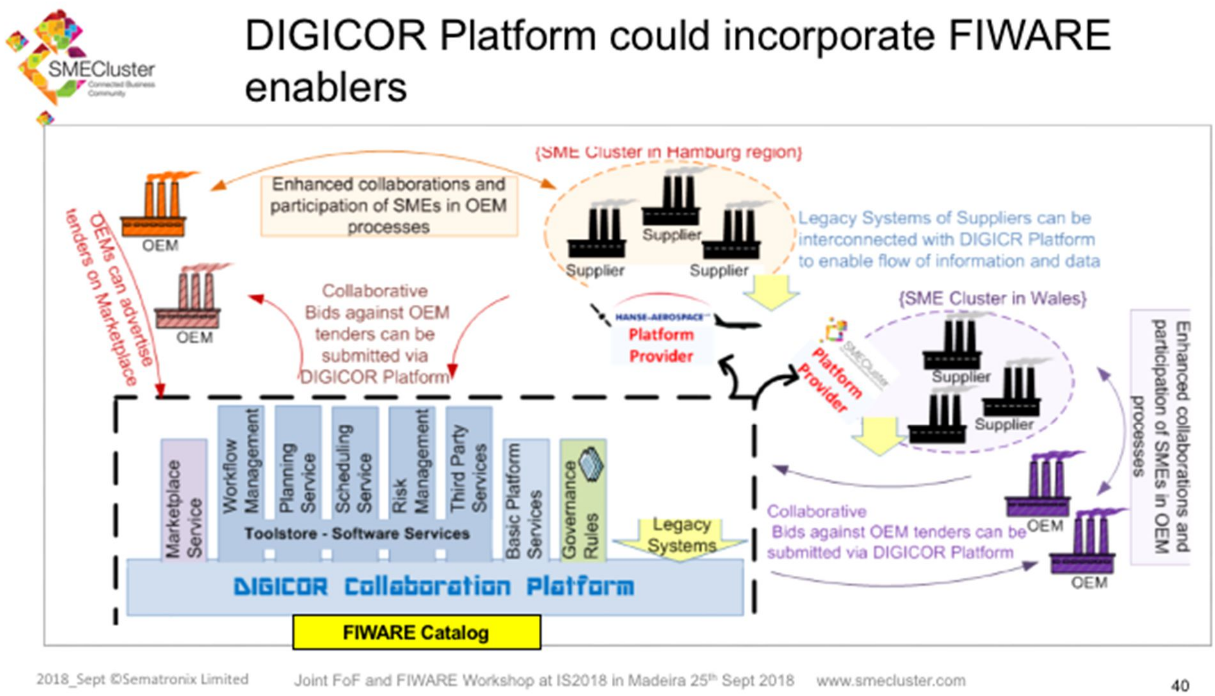
SMECluster
DIGICOR Platform could incorporate FIWARE enablers
{SME Cluster in Hamburg region}
Enhanced collaborations and participation of SMEs in OEM processes
OEM
OEMs can advertise tenders on Marketplace
Collaborative Bids against OEM tenders can be submitted via DIGICOR Platform
Supplier
Legacy Systems of Suppliers can be interconnected with DIGICR Platform to enable flow of information and data
{SME Cluster in Wales}
HANSE-AEROSPACE
Platform Provider
Marketplace Service
Workflow Management
Planning Service
Scheduling Service
Risk Management
Third Party Services
Basic Platform Services
Governance Rules
Toolstore - Software Services
Legacy Systems
DIGICOR Collaboration Platform
FIWARE Catalog
Collaborative Bids against OEM tenders can be submitted via DIGICOR Platform
Enhanced collaborations and participation of SMEs in OEM processes
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"Thank You"

Gurbaksh Bhullar
www.smecluster.com

Sematronix Limited
Control 2K Limited
Technology Application Network Limited
Waterton Technology Centre, Bridgend. South Wales. CF31 3WT. UK.

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Decentralized Agile Coordination Across Supply Networks

DIGICOR

(Simulation of) Business models for a multi-sided platform

Dr. Cesar Marin, Senior Computer Scientist
Information Catalyst (UK)

DIGICOR www.digicor-project.eu

Contents

- Introduction
- Business models
- Simulation
- Concluding remarks

DIGICOR www.digicor-project.eu 2


DIGICOR
Introduction
• What is DIGICOR about?
Technology platform, tools & services that allow the creation and operation of collaborative networks across the value chain
Strategic Collaborations
DIGICOR collaboration platform provides vital communication and decision support services to companies, particularly SMEs, allowing them to plan and control collaborative production and supply networks.
Marketplace and Toolstore
DIGICOR marketplace provides match making functionalities, allowing SMEs to find and interact with suitable partners. The primary function of the Marketplace is to facilitate the contracting of business with potential suppliers.
Governance Framework
DIGICOR governance framework and procedures sets out the terms of collaboration and rules of doing business on the DIGICOR platform. The framework allows SMEs to collaborate and exchange information in a trustworthy environment.
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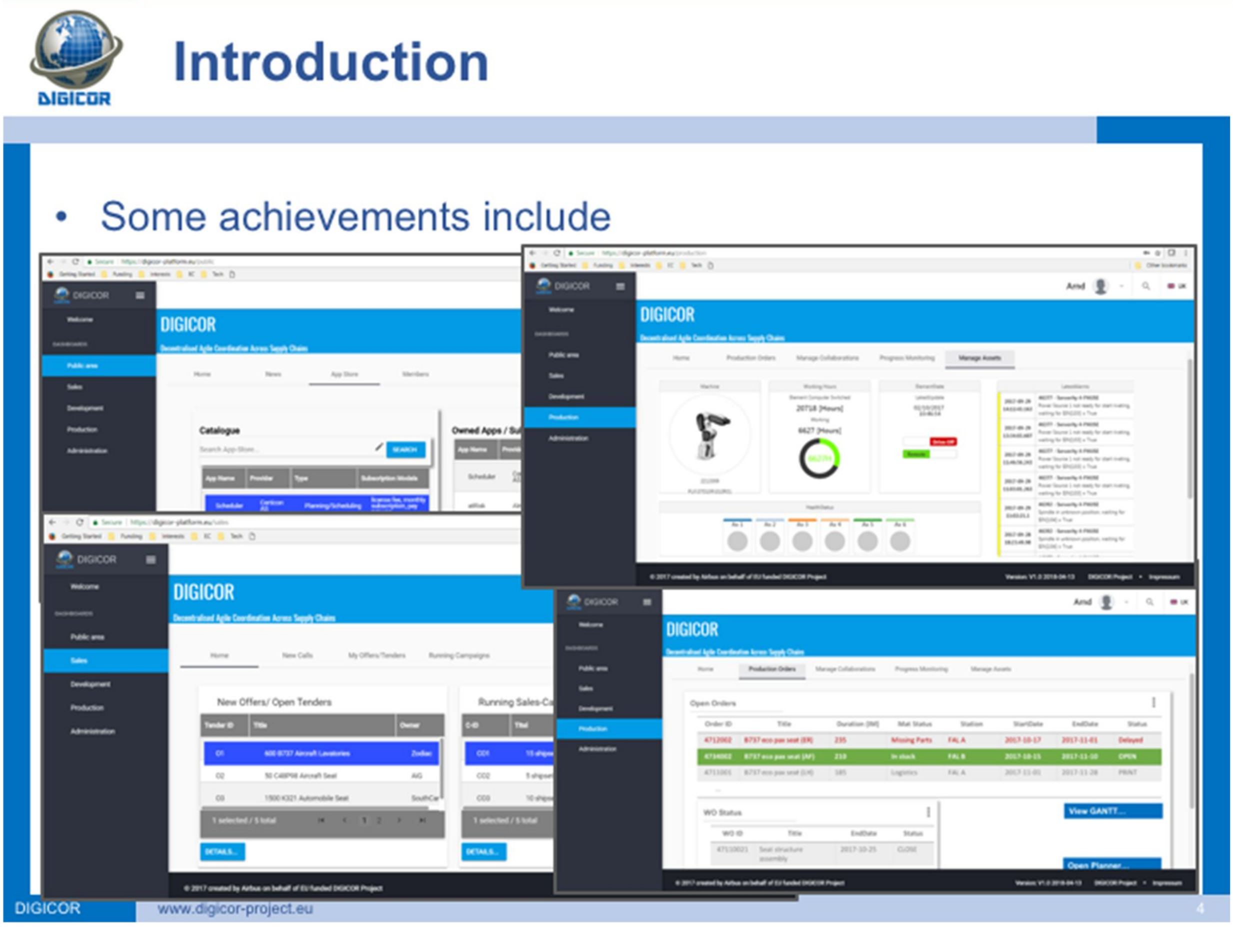
DIGICOR
Introduction
• Some achievements include
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Introduction

- How do we exploit these results?
  - DIGICOR as a whole?
  - Each component/tool exploited individually?

  - Business models were created with *some* insight information
  - … and then what?

- Simulation of DIGICOR in a dynamic market environment

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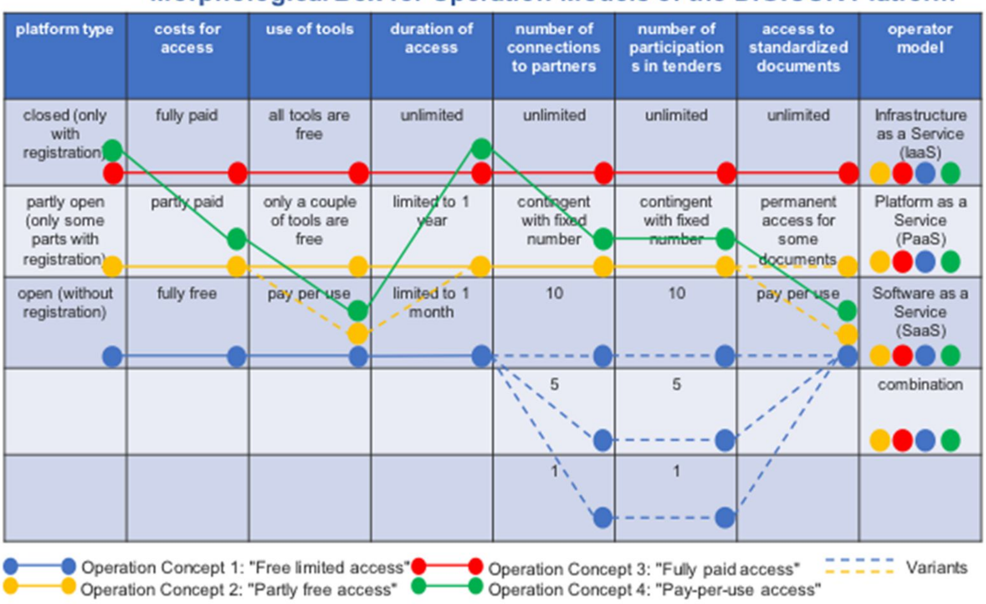
Business models

- DIGICOR business models (so far)

Morphological Box for Operation Models of the DIGICOR Platform



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Business models

- DIGICOR business models (so far) + costing

Morphological Box for Operation Models of the DIGICOR Platform

platform type	costs for access	use of tools	duration of access	number of connections	number of participation	access to standardized	operator model

Cost Calculation for Operation of the DIGICOR Platform (1st DRAFT)

		Service Concept 1: Free limited access	Service Concept 2: Partly free access	Service Concept 3: Fully paid access	Service Concept 4: Pay-per-use access
Personnel Costs (HAW)					
project leader	25% of full time	-25.000,00 €	-25.000,00 €	-25.000,00 €	-25.000,00 €
students		-6.000,00 €	-6.000,00 €	-6.000,00 €	-6.000,00 €
Technical Development (CER, SGL ?)					
hosting DIGICOR-platform		-12.000,00 €	-12.000,00 €	-12.000,00 €	-12.000,00 €
development of functions and interfaces		-48.000,00 €	-48.000,00 €	-48.000,00 €	-48.000,00 €
maintenance / updates / support	5% of costs for techn. devel.	-3.000,00 €	-3.000,00 €	-3.000,00 €	-3.000,00 €
other technical costs		-1.200,00 €	-1.200,00 €	-1.200,00 €	-1.200,00 €
payment systems for apps and functions		-1.200,00 €	-1.200,00 €	-1.200,00 €	-1.200,00 €
Marketing and Travel					
trade fairs		-3.000,00 €	-3.000,00 €	-3.000,00 €	-3.000,00 €
travel costs		-6.000,00 €	-6.000,00 €	-6.000,00 €	-6.000,00 €
marketing material		-2.400,00 €	-2.400,00 €	-2.400,00 €	-2.400,00 €
Costs total		**-107.800,00 €**	**-107.800,00 €**	**-107.800,00 €**	**-107.800,00 €**
funding?	50.000 € for 6 month	50.000,00 €	50.000,00 €	50.000,00 €	50.000,00 €
user fees for the platform	600 € per user yearly (50 users)		15.000,00 €	30.000,00 €	15.000,00 €
advertisements	10 per month á 300 €	36.000,00 €	36.000,00 €	36.000,00 €	36.000,00 €
sales for specific functions and apps	5% of order volume (500.000 € per year)	25.000,00 €	25.000,00 €	25.000,00 €	25.000,00 €
Income total		**111.000,00 €**	**126.000,00 €**	**141.000,00 €**	**126.000,00 €**
Costs total		-107.800,00 €	-107.800,00 €	-107.800,00 €	-107.800,00 €
profit / loss (-)		**3.200,00 €**	**18.200,00 €**	**33.200,00 €**	**18.200,00 €**

Operation Concept 1: "Free limited access"
Operation Concept 2: "Partly free access"
Operation Concept 3: "Fully paid access"
Operation Concept 4: "Pay-per-use access"
Variants

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Simulation

- "All models are wrong…"
- "…but some are useful" – (George Box, 1978)
  - We are looking for a business model simulation that provides insight into the potential revenue of DIGICOR outcomes
- Other works in the area:
  - (Ahrweiler, 2017) – Agent-based simulation for science, technology, and innovation policy
  - (Evans et al., 2017) – Business model innovation for sustainability: towards a unified perspective for creation of sustainable business models
  - (Lieder et al., 2017) – Towards circular economy implementation: an agent-based simulation approach for business model changes

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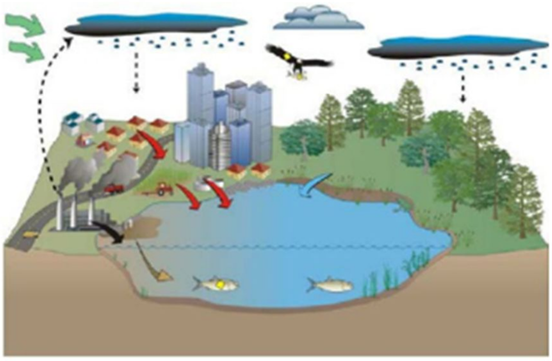
Simulation

- For our simulations we consider the following:
  - Factories need supplies
  - SMEs look for factories interested in their products

  - Factories decide to try DIGICOR platform with a given probability
  - SMEs enter DIGICOR with a given probability IF the factory they are interested in is ALREADY using DIGICOR

  - Once inside DIGICOR they all behave as part of a natural ecosystem



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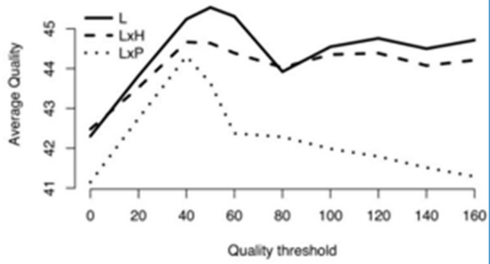
Simulation

- For our simulations we consider the following:
  - Inside DIGICOR, factories open calls for tender
  - SMEs bid to participate in tenders

  - Factories have an expected quality of their suppliers
  - SMEs supply products with a quality



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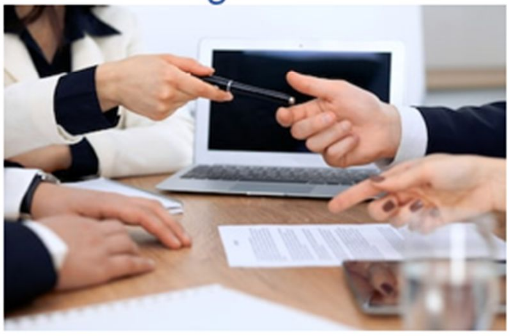
Simulation

- For our simulations we consider the following:
  - It can take days to complete a tender and days to find one
  - When a tender is completed, a contract is formed and manufacturing starts



  - Contracts increase happiness, no contracts decrease happiness
  - Low happiness make a factory or SME leave DIGICOR which reduces their probability of re-entry

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Simulation

- For our simulations we consider the following:
  - DIGICOR platform has an operation cost
  - Membership type has a fee

Morphological Box for Operation Models of the DIGICOR Platform

platform type	costs for access	use of tools	duration of access	number of connections to partners	number of participations in tenders	access to standardized documents	operator model
closed (only with registration)	fully paid	all tools are free	unlimited	unlimited	unlimited	unlimited	Infrastructure as a Service (IaaS)
partly open (only some parts with registration)	partly paid	only a couple of tools are free	limited to 1 year	contingent with fixed number	contingent with fixed number	permanent access for some documents	Platform as a Service (PaaS)
open (without registration)	fully free	pay per use	limited to 1 month	10	10	pay per use	Software as a Service (SaaS)
				5	5		combination
				1	1		

Operation Concept 1: "Free limited access" — Operation Concept 2: "Partly free access" — Operation Concept 3: "Fully paid access" — Operation Concept 4: "Pay-per-use access" — Variants

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Concluding remarks

- What is left to be done
  - Current simulation considers calls for tenders but other tools are also being developed in DIGICOR
  - Tools to include in the next version: risk analysis, planning tool, manufacturing monitoring, …
  - How will these tool impact the collaboration process?

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Concluding remarks

- What will we do with the simulation?
  - Produce and analyse simulations of business models for each use case
  - Produce and analyse simulation of DIGICOR as a whole and for individual tools
  - Final output for exploitation and as scientific publication

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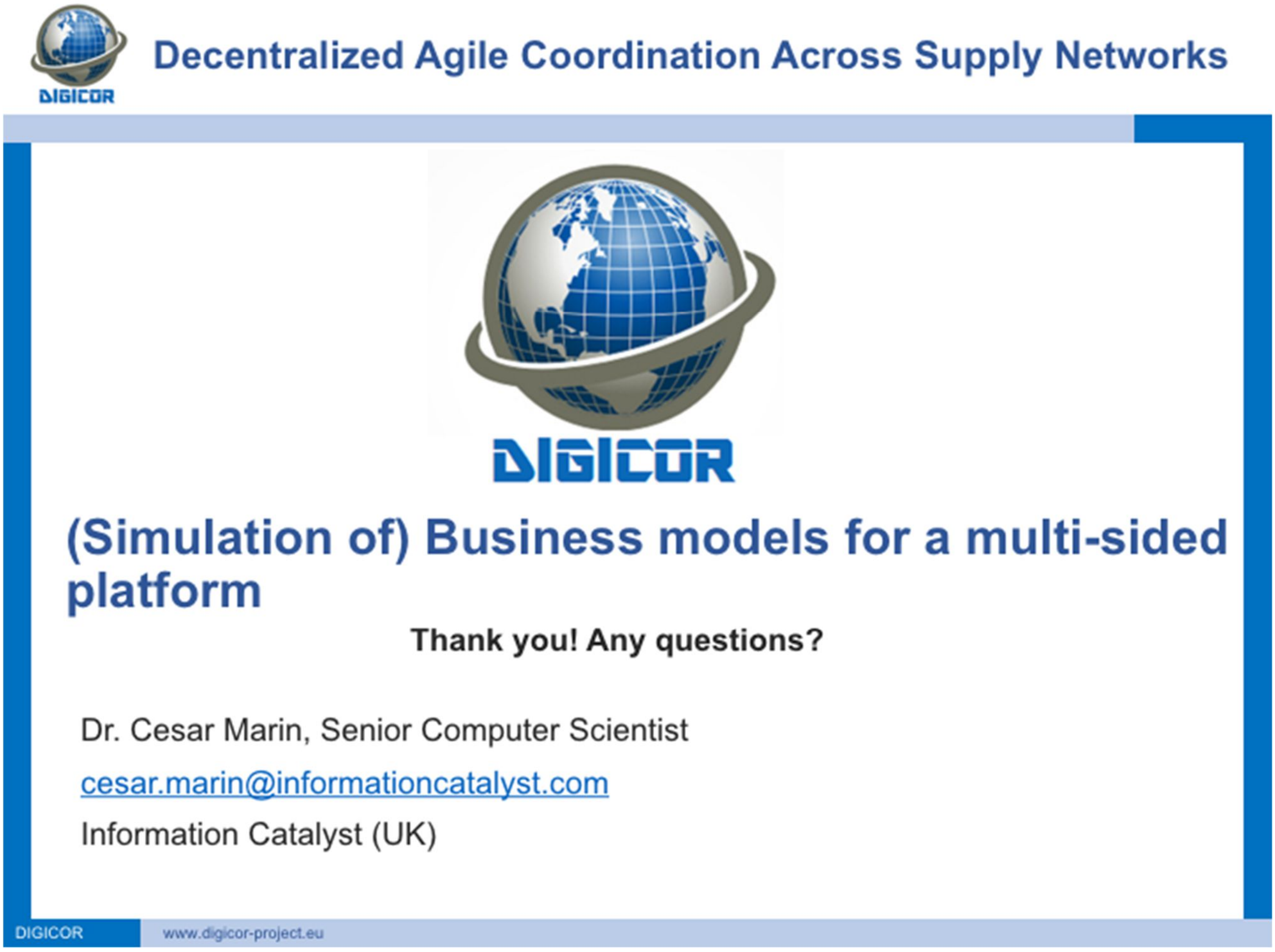
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Decentralized Agile Coordination Across Supply Networks
DIGICOR
(Simulation of) Business models for a multi-sided platform
Thank you! Any questions?
Dr. Cesar Marin, Senior Computer Scientist
cesar.marin@informationcatalyst.com
Information Catalyst (UK)
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Technology & Engineering Management Society
Business Model Simulation for a Smart Factory Platform
Joint FoF and FIWARE Workshop
9th international Conference on Intelligent Systems 2018
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Research Centre on Production Management and Engineering
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virtual factory Operating System
An Open Operating System for Virtual Factories
European SMEs needs around Manufacturing ICT solutions are far from being satisfied in an affordable way in terms of cost and time.
vf-OS offers a manufacturing orientated cloud platform, supporting a multi-sided market ecosystem that provides a range of services for the connected factory of the future, allowing manufacturing companies to develop and integrate better manufacturing and logistics processes.
Cloud Manufacturing
Enterprise Apps
Cloud Computing
Interoperability
Data Analytics
Operating System Virtualisation
Multi-sided Platforms
Virtual Factory Data and Connect
Internet of Things
Virtual Factory Middleware
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723710
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The vf-OS
Marketplace
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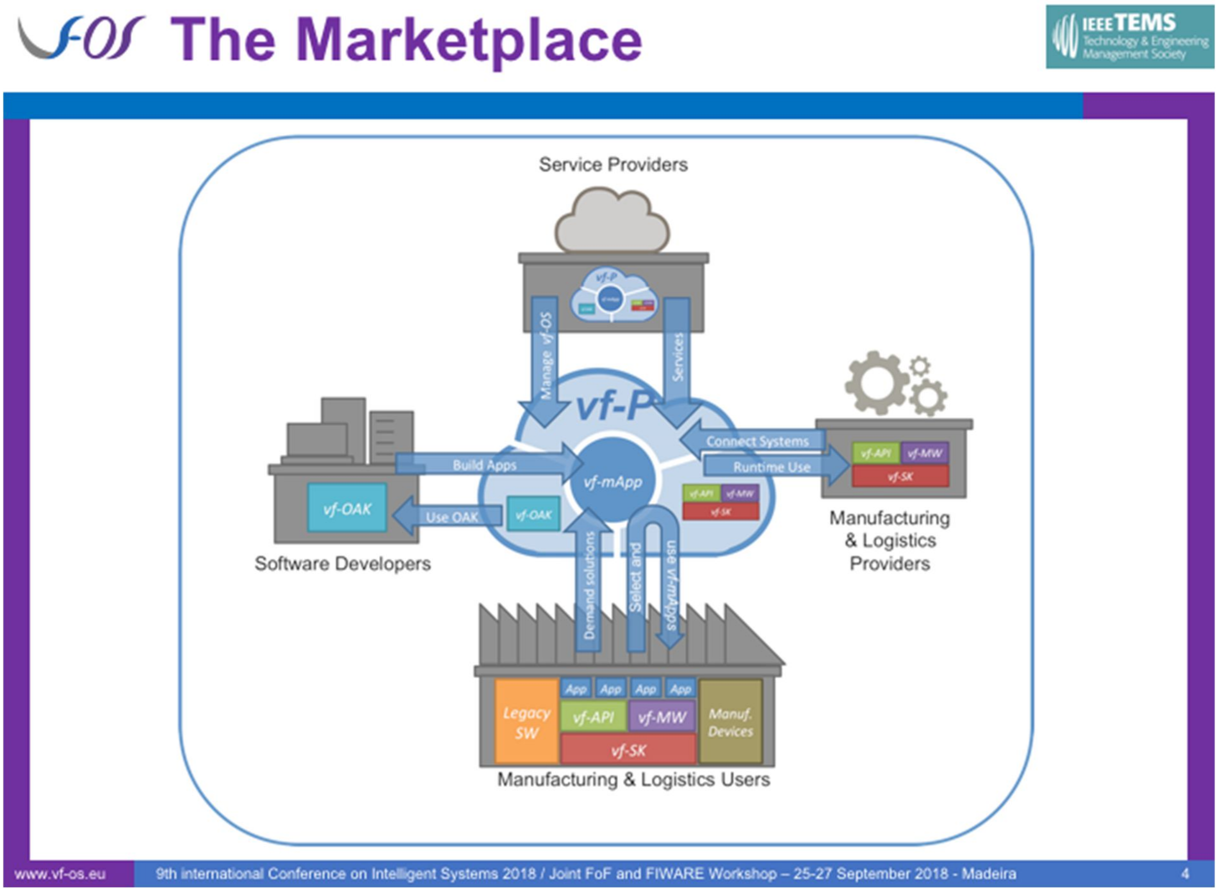
The Marketplace
Service Providers
Manage vf-OS
Services
vf-P
Connect Systems
Runtime Use
Build Apps
vf-mApp
vf-OAK
Use OAK
Software Developers
Manufacturing
& Logistics
Providers
vf-API
vf-MW
vf-SK
Demand solutions
Select and
use vf-mApps
App
Legacy
SW
Manuf.
Devices
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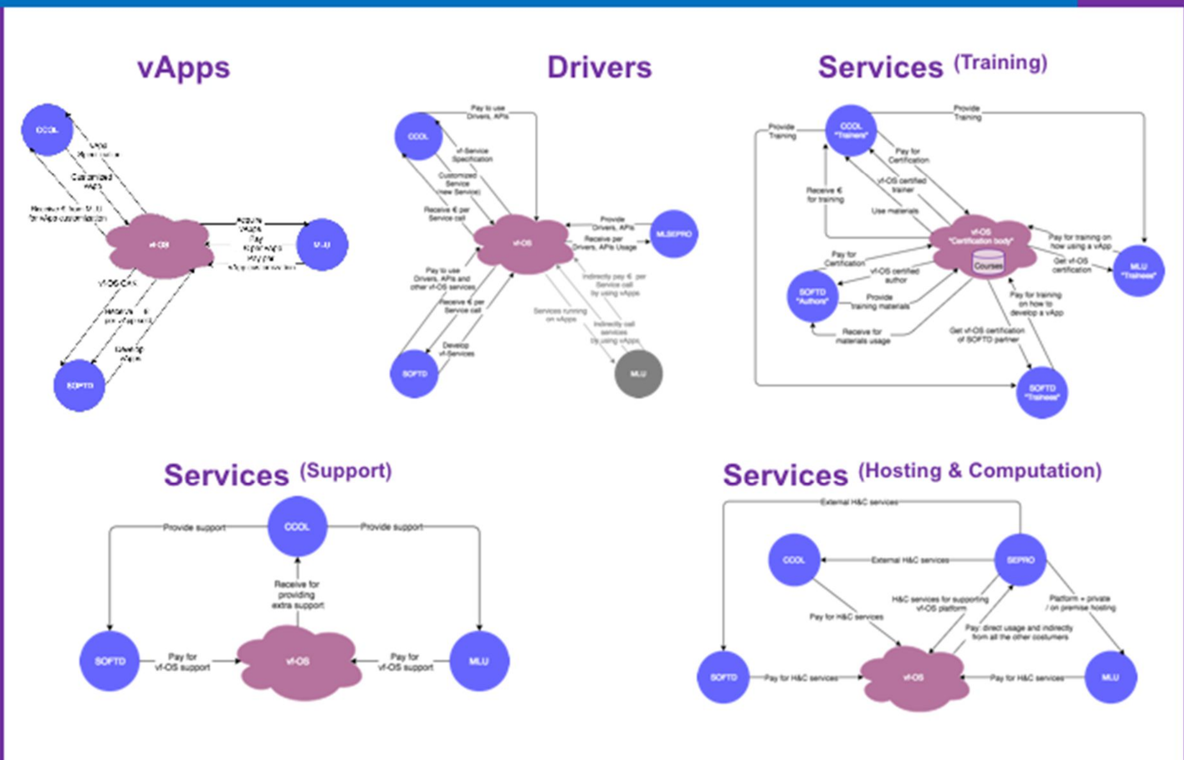
The Business Model

Transactional Graphs

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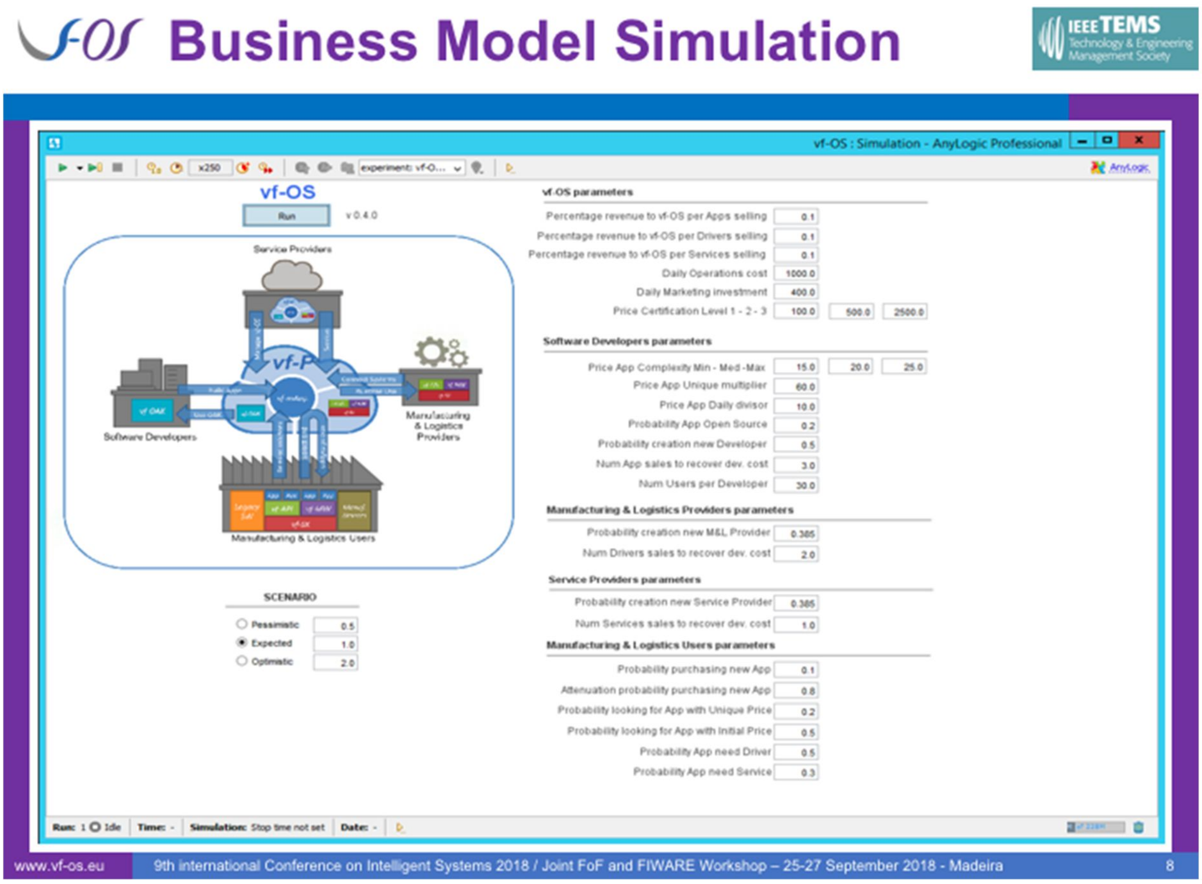
Business Model Simulation
vf-OS : Simulation - AnyLogic Professional
vf-OS
Run
v 0.4.0
Service Providers
Software Developers
Manufacturing & Logistics Providers
Manufacturing & Logistics Users
SCENARIO
Pessimistic 0.5
Expected 1.0
Optimistic 2.0
vf-OS parameters
Percentage revenue to vf-OS per Apps selling 0.1
Percentage revenue to vf-OS per Drivers selling 0.1
Percentage revenue to vf-OS per Services selling 0.1
Daily Operations cost 1000.0
Daily Marketing investment 400.0
Price Certification Level 1 - 2 - 3 100.0 500.0 2500.0
Software Developers parameters
Price App Complexity Min - Med -Max 15.0 20.0 25.0
Price App Unique multiplier 60.0
Price App Daily divisor 10.0
Probability App Open Source 0.2
Probability creation new Developer 0.5
Num App sales to recover dev. cost 3.0
Num Users per Developer 30.0
Manufacturing & Logistics Providers parameters
Probability creation new M&L Provider 0.385
Num Drivers sales to recover dev. cost 2.0
Service Providers parameters
Probability creation new Service Provider 0.385
Num Services sales to recover dev. cost 1.0
Manufacturing & Logistics Users parameters
Probability purchasing new App 0.1
Attenuation probability purchasing new App 0.8
Probability looking for App with Unique Price 0.2
Probability looking for App with Initial Price 0.5
Probability App need Driver 0.5
Probability App need Service 0.3
Run: 1 Idle Time: - Simulation: Stop time not set Date: -
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Pricing model

appComplexity simulates different types pf Apps, range from 1 (simplest) to 10 (most complex)

appComplexity	1	2	3	4	5	6	7	8	9	10
appComplexityF	0,17	0,64	1,41	2,47	3,82	5,45	7,35	9,53	11,99	14,71
appUniquePrice (min)	120,00	462,34	1.017,69	1.781,30	2.749,88	3.920,97	5.292,56	6.862,99	8.630,81	10.594,77
appInitialPrice (min)	2,00	7,71	16,96	29,69	45,83	65,35	88,21	114,38	143,85	176,58
appDailyPrice (min)	0,20	0,77	1,70	2,97	4,58	6,53	8,82	11,44	14,38	17,66
appUniquePrice (max)	250,00	963,20	2.120,19	3.711,03	5.728,92	8.168,69	11.026,17	14.297,89	17.980,85	22.072,43
appInitialPrice (max)	4,17	16,05	35,34	61,85	95,48	136,14	183,77	238,30	299,68	367,87
appDailyPrice (max)	0,42	1,61	3,53	6,19	9,55	13,61	18,38	23,83	29,97	36,79

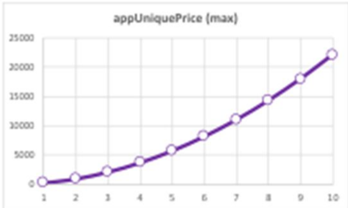
Parameters

priceComplexity (min)	15
priceComplexity (max)	25
priceLevel (min)	0,8
priceLevel (max)	1,2
multUniquePrice	60
divDailyPrice	10

priceLevel simulates different level of prices for each Developer, range from 0.8 to 1.2

Formulas

appUniquePrice = appComplexityF * priceComplexity * priceLevel * multUniquePrice
appInitialPrice = appComplexityF * priceComplexity * priceLevel
appDailyPrice = appComplexityF * priceComplexity * priceLevel / divDailyPrice



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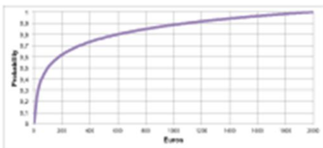
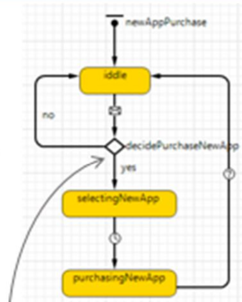
M&L Users modelling

- New M&L Users interested in buying vApps, Drivers and Services: *Mk: daily investment in marketing*

$$P(U) = \frac{Ln(\frac{Mk}{\alpha})}{\beta} * \varepsilon$$

$\alpha = 5$
$\beta = 6$





$$P_n(pA) = P_{n-1}(pA) * \prod_{i}^{nA} fAtt$$

Prob. purchase a new vApp with attenuation

- Selection of vApps among the offered in the marketplace:

$$Min\{wUp * Up_i + wIp * Ip_i + wDp * Dp_i + wCl * (3 - Cl_j)\}$$

wUp: weight unique price = 0.75
wIp: weight initial price = 0.15
wDp: weight daily price = 0.60
wCl: weight certification level = 0.25

Similar procedure for Drivers and Services selection, with:
P(nD): probability vApp needs Driver
P(nS): probability vApp needs Service

$i \in \{I \subset C\}$ *vApps, C → conditions (complexity level, unique price/daily price, initial price*
$j \in \{J\}$ *Software Developers*

...

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Software Developers modelling

- New Software Developers interested in developing vApps:

$$P(SD) = \begin{cases} P_o(SD)\,, if\ \dfrac{nUsers}{nSofDev} \geq nUpSD \\ 0\,, if\ \dfrac{nUsers}{nSofDev} < nUpSD \end{cases}$$

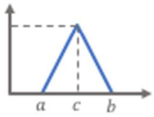
Number of Users per Software Developer

$$\overline{P(dA)} = \begin{cases} P(dA) * \partial\,, if\ revApps \leq 0 \\ P(dA) * \varphi\,, if\ revApps > 0 \end{cases}$$

Prob. develop a new vApp

$$\partial = \frac{1}{2} \quad \varphi = \frac{3}{2}$$

- Increase of Certification Level: $P(iCL) = triangular(0, 0.05, 0.1)$
- Probability Unique Price: $P(uPr) = triangular(0, 0.1, 0.2)$
- Probability Initial Price: $P(iPr) = triangular(0, 0.5, 1)$
- Price Complexity: $pComp = triangular(pCmin, pCmed, pCMax)$
- Price Level: $pLev = triangular(0.8, 1\,, 1.2)$



Similar modelling for M&L Providers and Service Providers (with some differences)

...

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Scenario value (Ɛ) impact

- Probability of new M&L Users : $P(U) = \dfrac{Ln(\frac{Mk}{\alpha})}{\beta} * \varepsilon$
- Probability M&L Users buying vApps: $P_o(pA) = P_o(pA) * \varepsilon$
  $fAtt = fAtt * \varepsilon$
- Probability M&L Users buying Services: $P(nS) = P_o(nS) * \varepsilon$
- Probability Soft. Dev. buying Services: $P(bS) = P_o(bS) * \varepsilon$
- Probability M&L Prov. buying Services: $P(bS) = P_o(bS) * \varepsilon$

$$\mathcal{E} = \begin{cases} 0.5\ if\ pessimistic \\ 1.0\ if\ expected \\ 2{,}0\ if\ optimistic \end{cases}$$

Default values, used for the presented analysis, can be changed in the simulation form.

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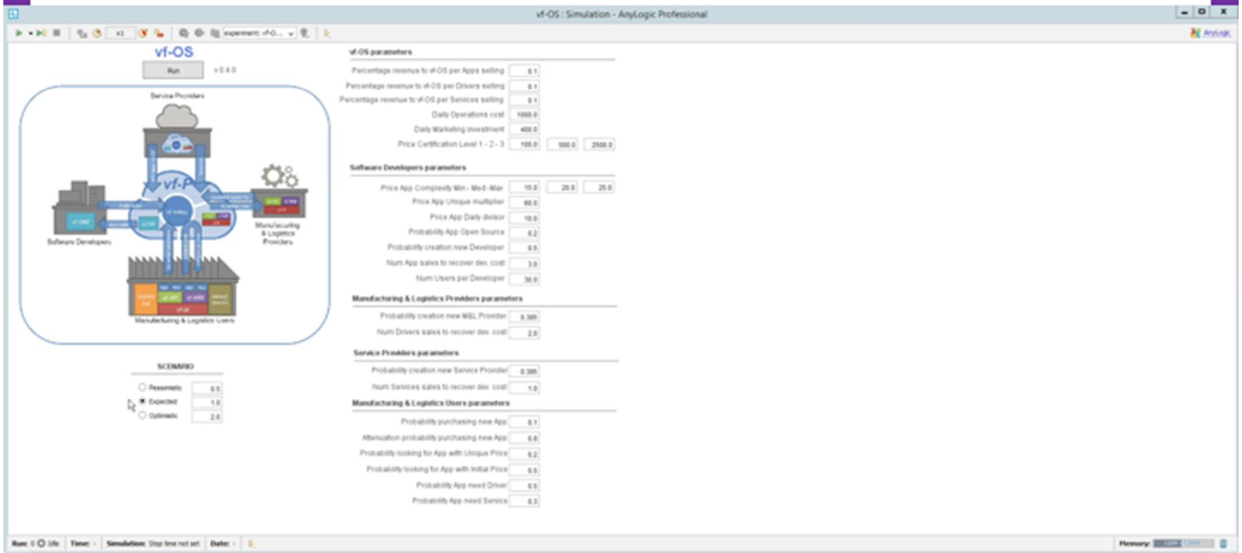

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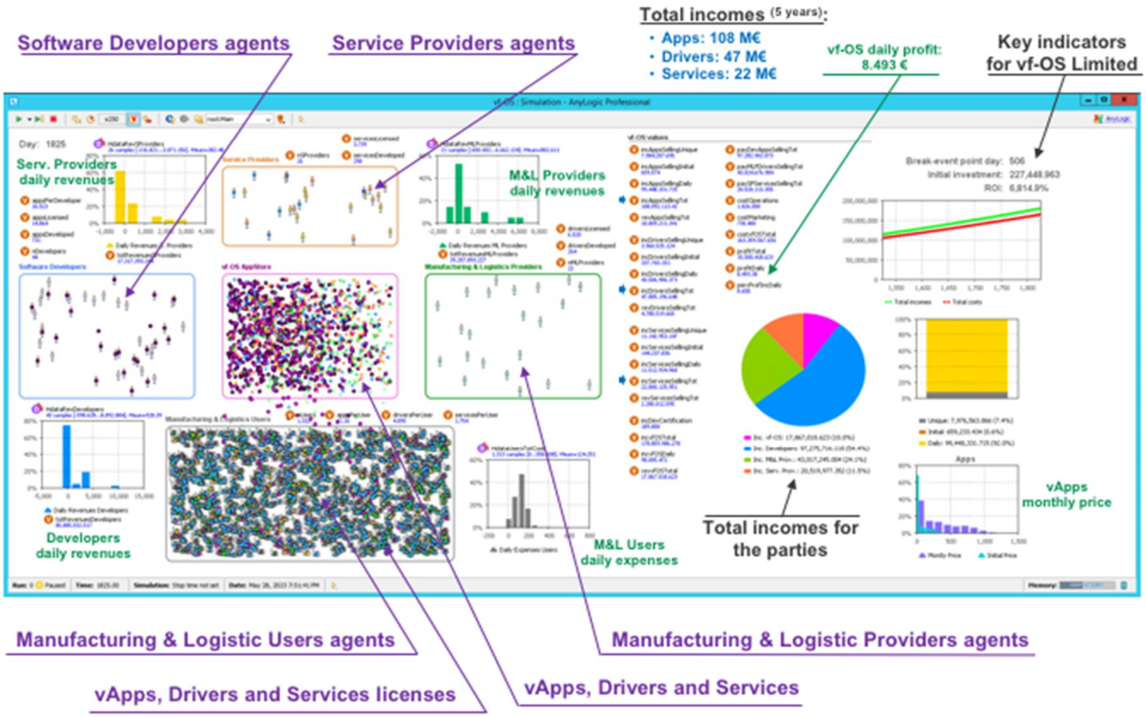

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Business Model Evaluation

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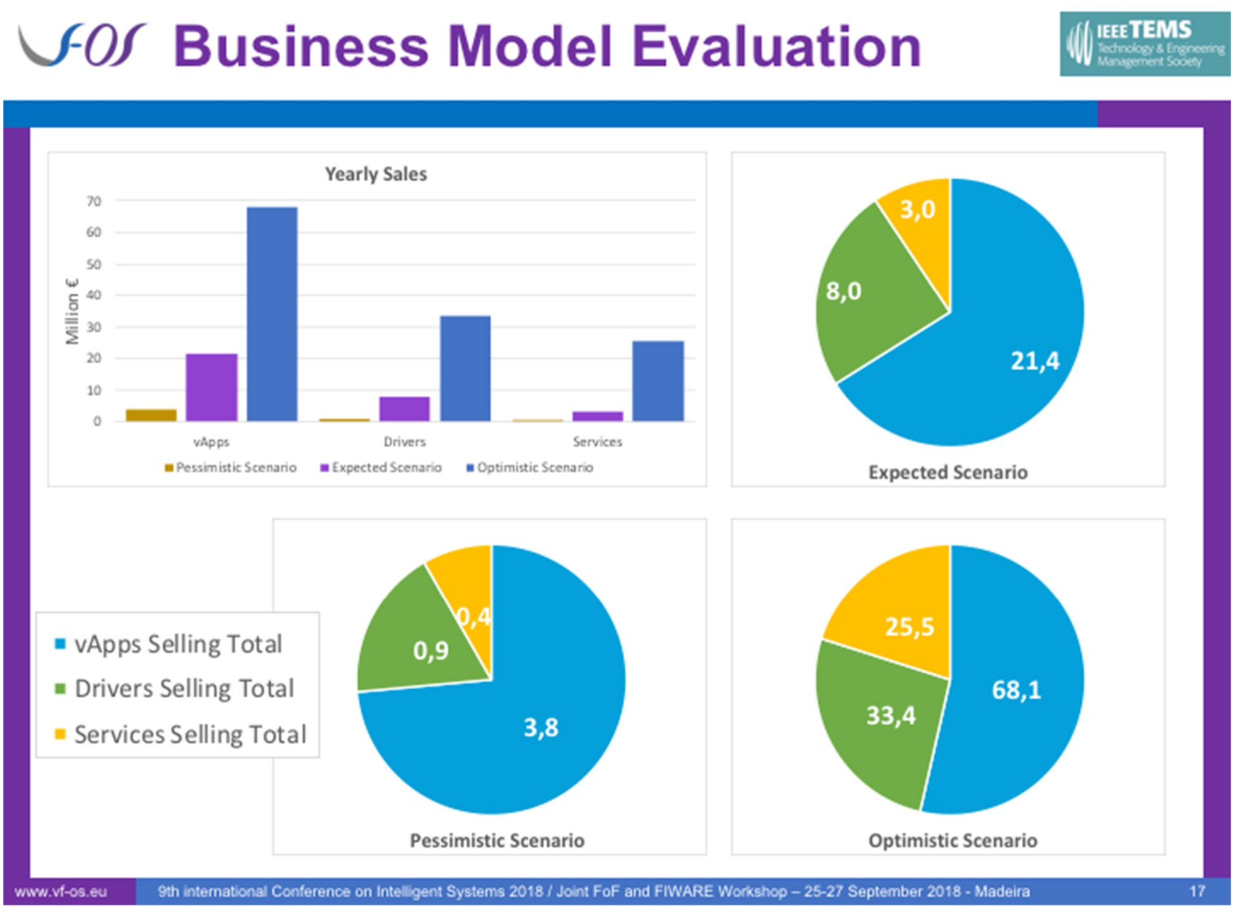
Business Model Evaluation
IEEE TEMS Technology & Engineering Management Society
Yearly Sales
Million €
vApps
Drivers
Services
Pessimistic Scenario
Expected Scenario
Optimistic Scenario
3,0
8,0
21,4
Expected Scenario
vApps Selling Total
Drivers Selling Total
Services Selling Total
0,4
0,9
3,8
Pessimistic Scenario
25,5
33,4
68,1
Optimistic Scenario
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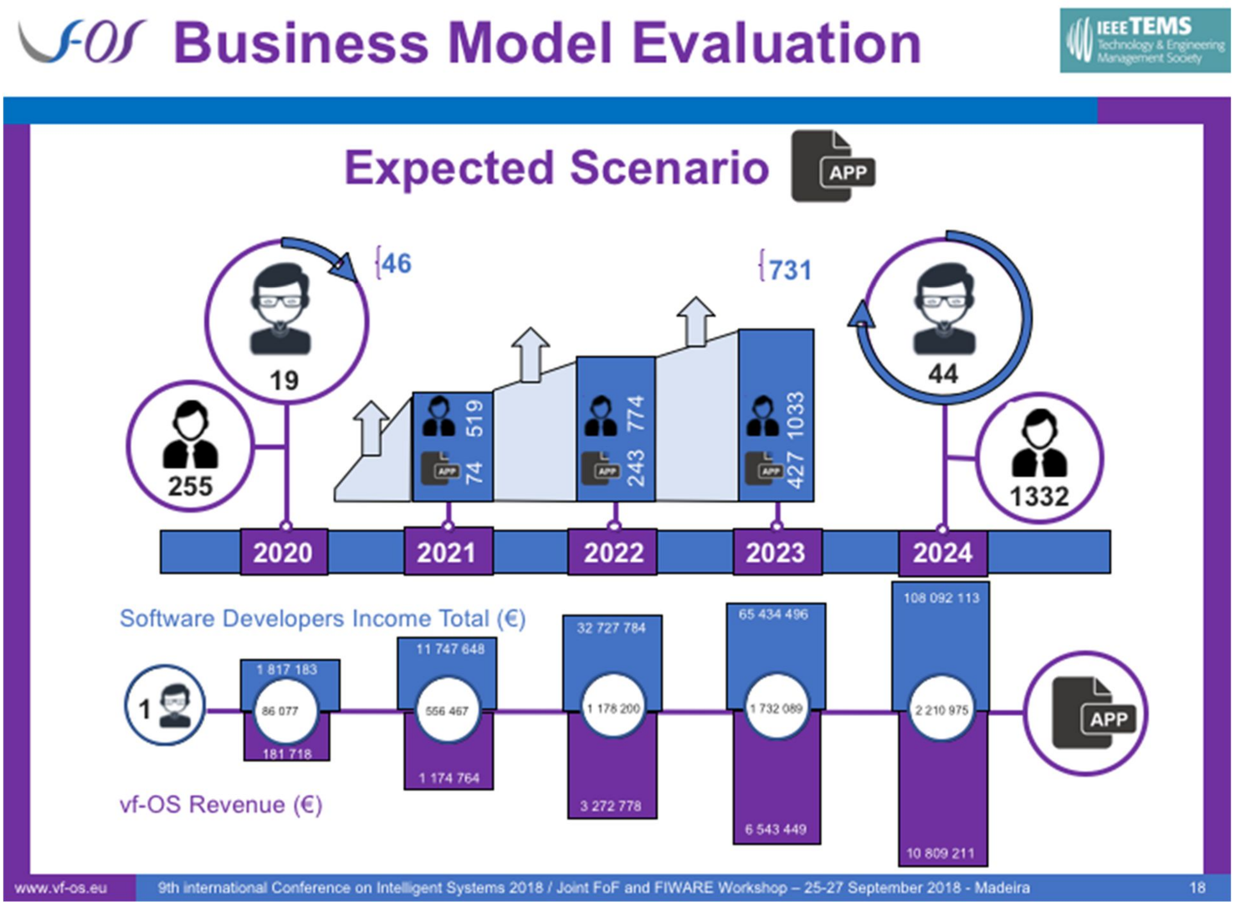
Business Model Evaluation
IEEE TEMS Technology & Engineering Management Society
Expected Scenario
APP
46
731
19
255
519
74
774
243
1033
427
44
1332
2020
2021
2022
2023
2024
Software Developers Income Total (€)
1 817 183
86 077
181 718
11 747 648
556 467
1 174 764
32 727 784
1 178 200
3 272 778
65 434 496
1 732 089
6 543 449
108 092 113
2 210 975
10 809 211
vf-OS Revenue (€)
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Conclusions

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Conclusions

Simulation conclusions (figures after 5 years):

- vf-OS is affordable for Buyers:
  - M&L Users pay 124 € per day (average) per 11 vApps, 4.8 vDrivers and 1.7 vServices (average)
- vf-OS Marketplace is attractive for Sellers:
  - vf-OS Limited profit is around 8.500 € per day
  - Software Developers revenues are around 930 € per day (average)
  - M&L Providers revenues are around 800 € per day (average)
  - Service Providers revenues are around 380 € per day (average)
    - Note that Software Developers, M&L Providers and Service Providers could not be focused in vf-OS
- vf-OS Limited is viable:
  - Initial investment is around 230 K€
  - Break-event-point is around 17 months

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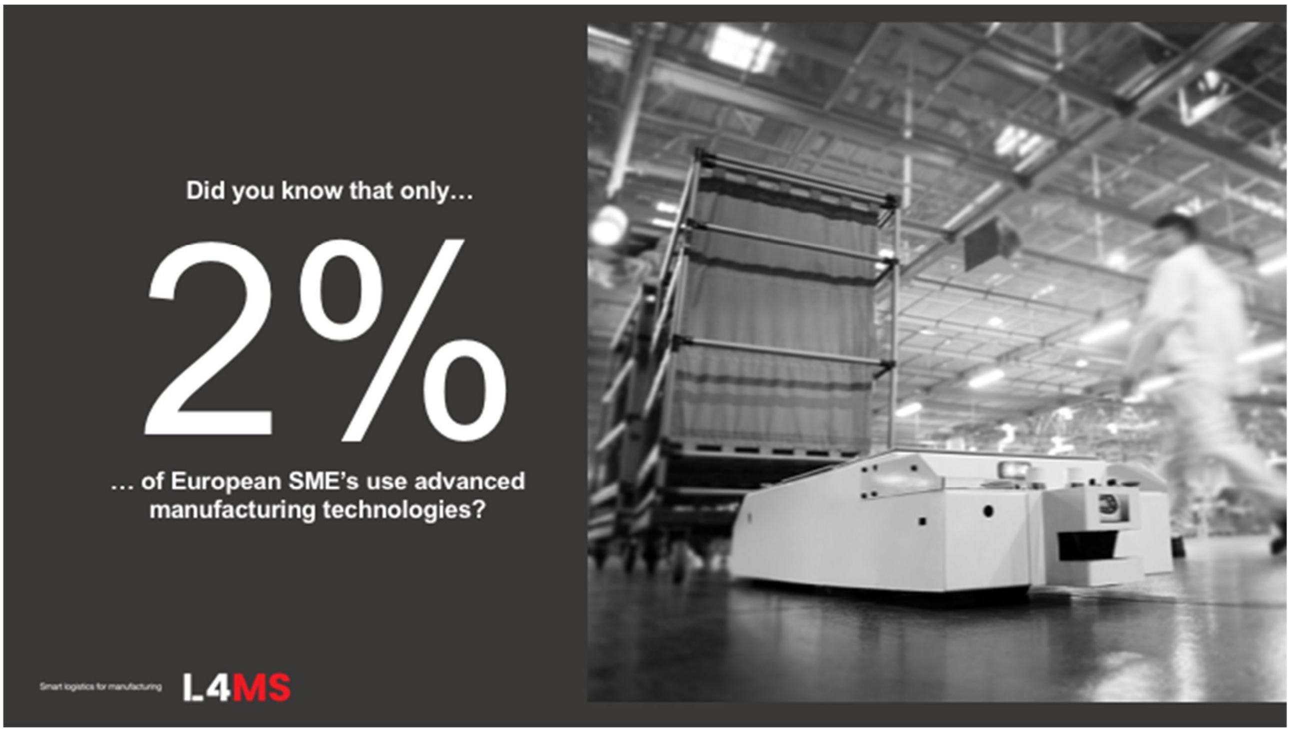
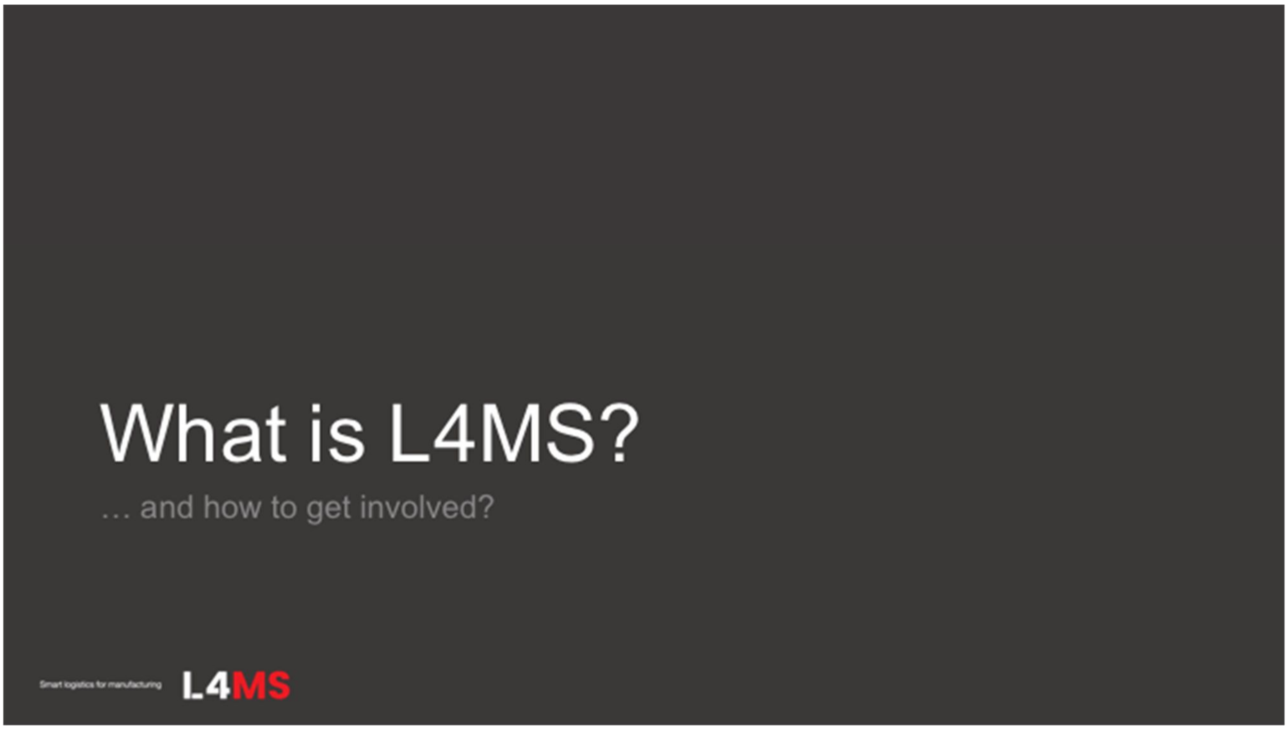
L4MS Open Call:
Opportunities for co-creation with OPIL
Angelo Marguglio (ENGINEERING)
Head of Smart Industry and Agrifood Unit
Smart logistics for manufacturing
L4MS
ENGINEERING

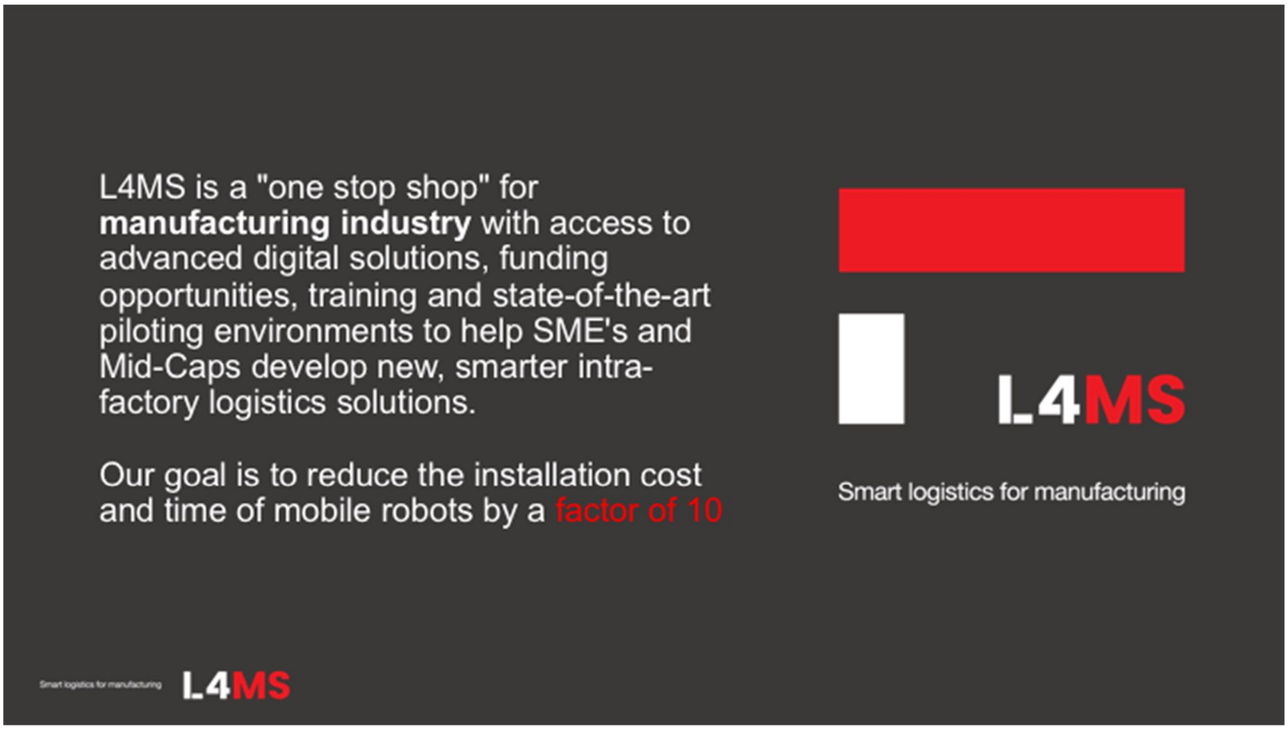

Did you know that only…
2%
… of European SME's use advanced manufacturing technologies?
Smart logistics for manufacturing
L4MS


Outdated intra-factory logistics are troubling European SMEs
• Innovations and new technological applications require
• Strategic thinking
• Simulation & planning
• Re-skilling
• Access to finance
• Resources that most SMEs don't have
Logistics account for up to 50% of total manufacturing costs
Smart logistics for manufacturing
L4MS

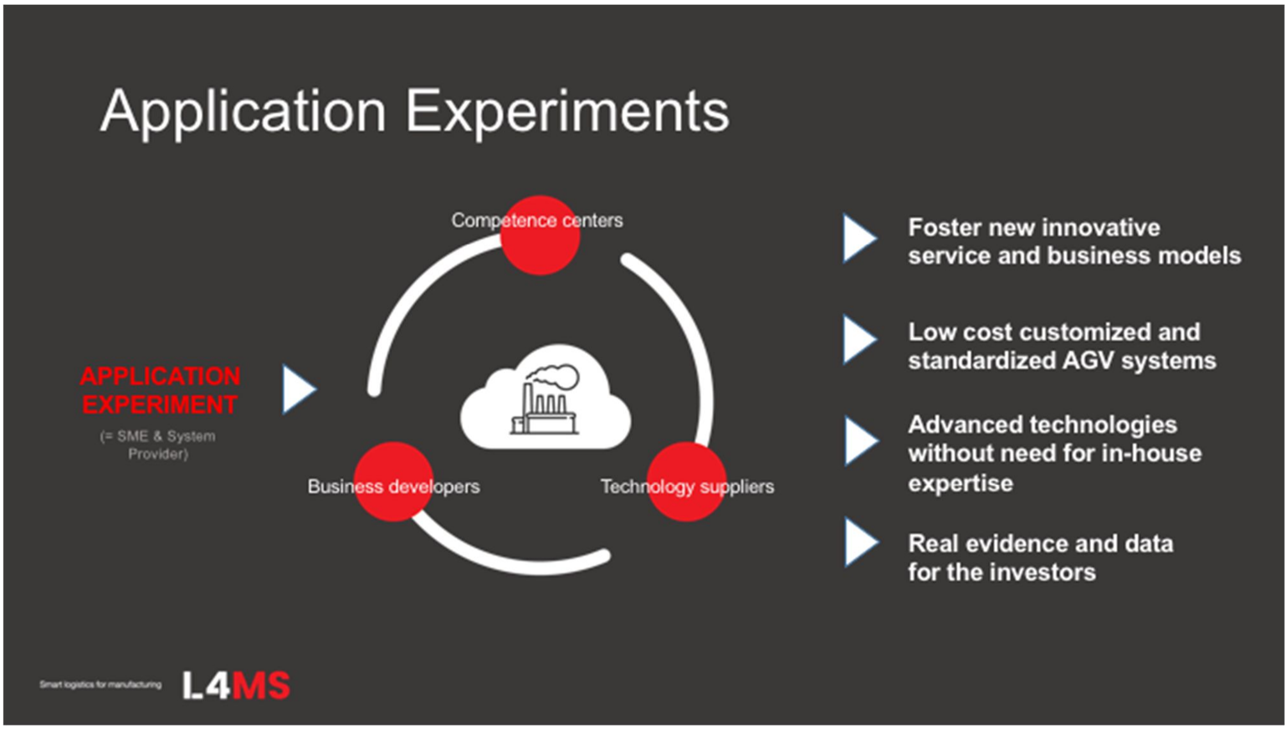

Logistics account almost half of total manufacturing cost of an item*
PRODUCTIVITY CHALLENGE
FLEXIBILITY CHALLENGE
*Material Handling Industry of America, (1999) Annual Report 1998-1999, Charlotte, North Carolina
Smart logistics for manufacturing
L4MS

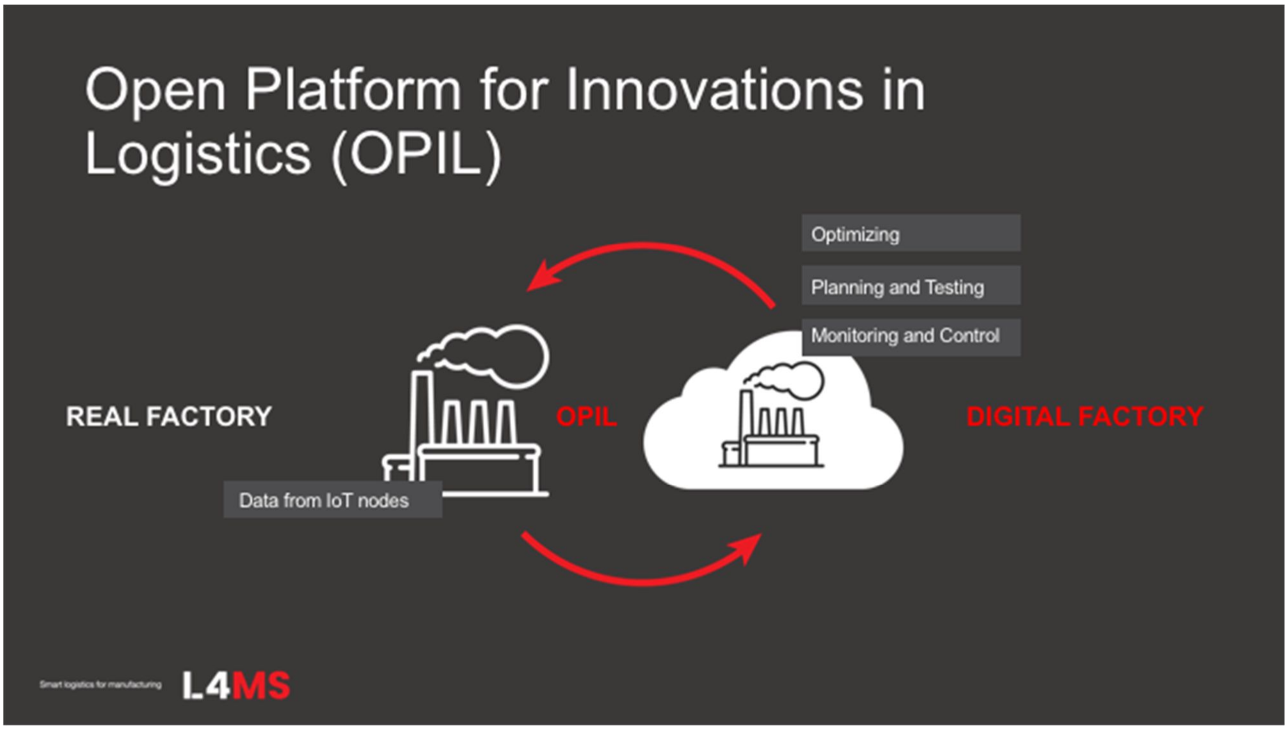

Shorter production cycles, individualization & customization require *flexibility*
PRODUCTIVITY CHALLENGE
FLEXIBILITY CHALLENGE
L4MS

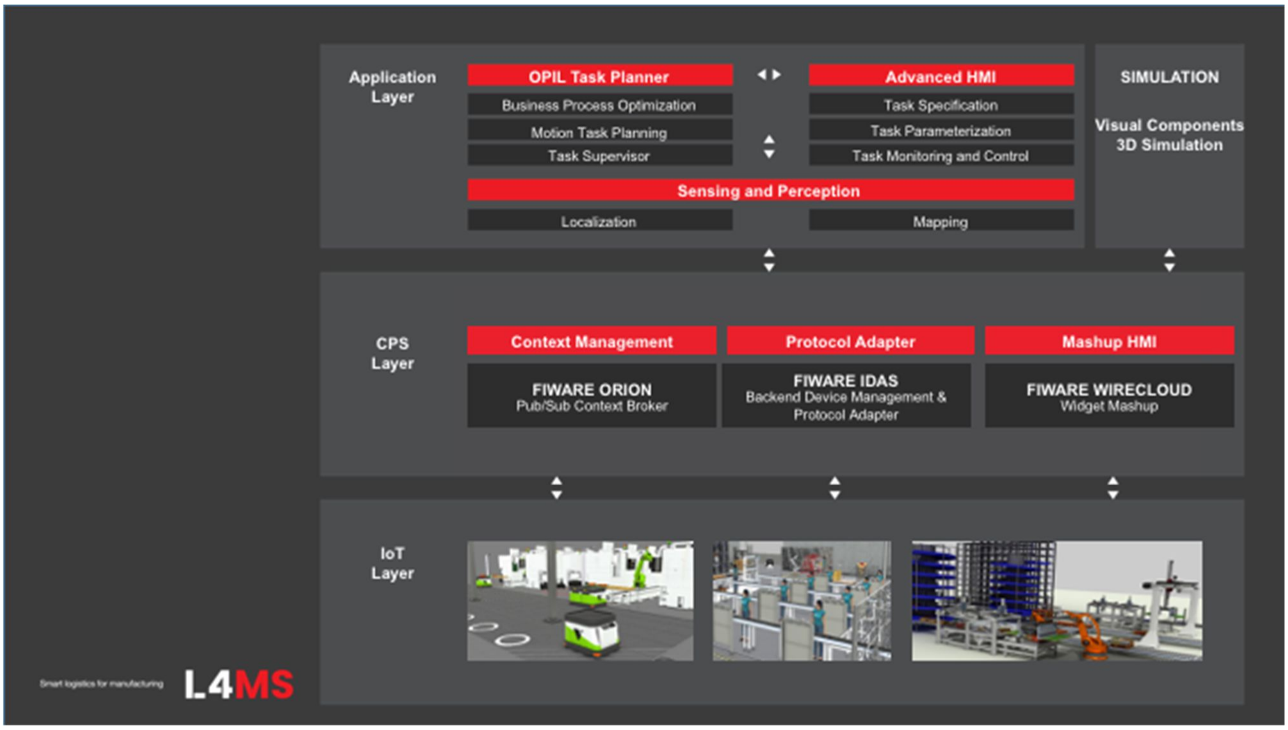

What is L4MS?
… and how to get involved?
L4MS

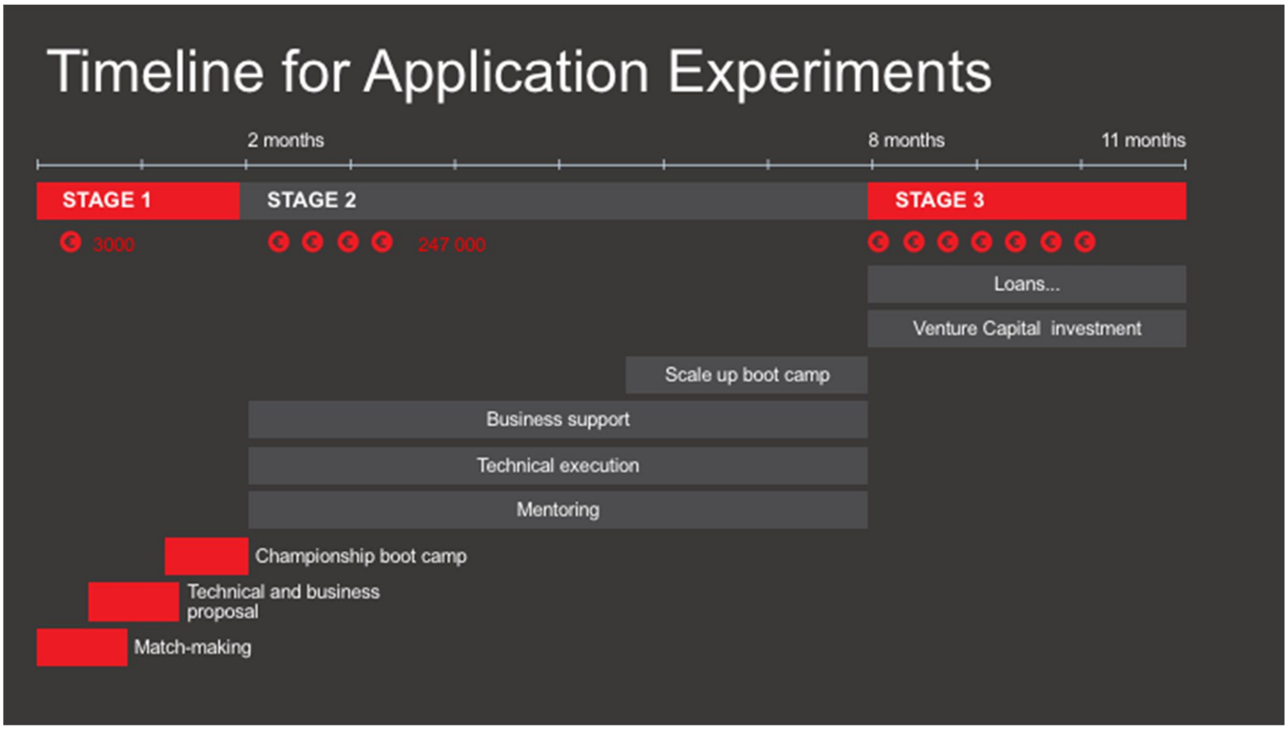

L4MS is a "one stop shop" for **manufacturing industry** with access to advanced digital solutions, funding opportunities, training and state-of-the-art piloting environments to help SME's and Mid-Caps develop new, smarter intra-factory logistics solutions.
Our goal is to reduce the installation cost and time of mobile robots by a factor of 10
L4MS
Smart logistics for manufacturing
L4MS

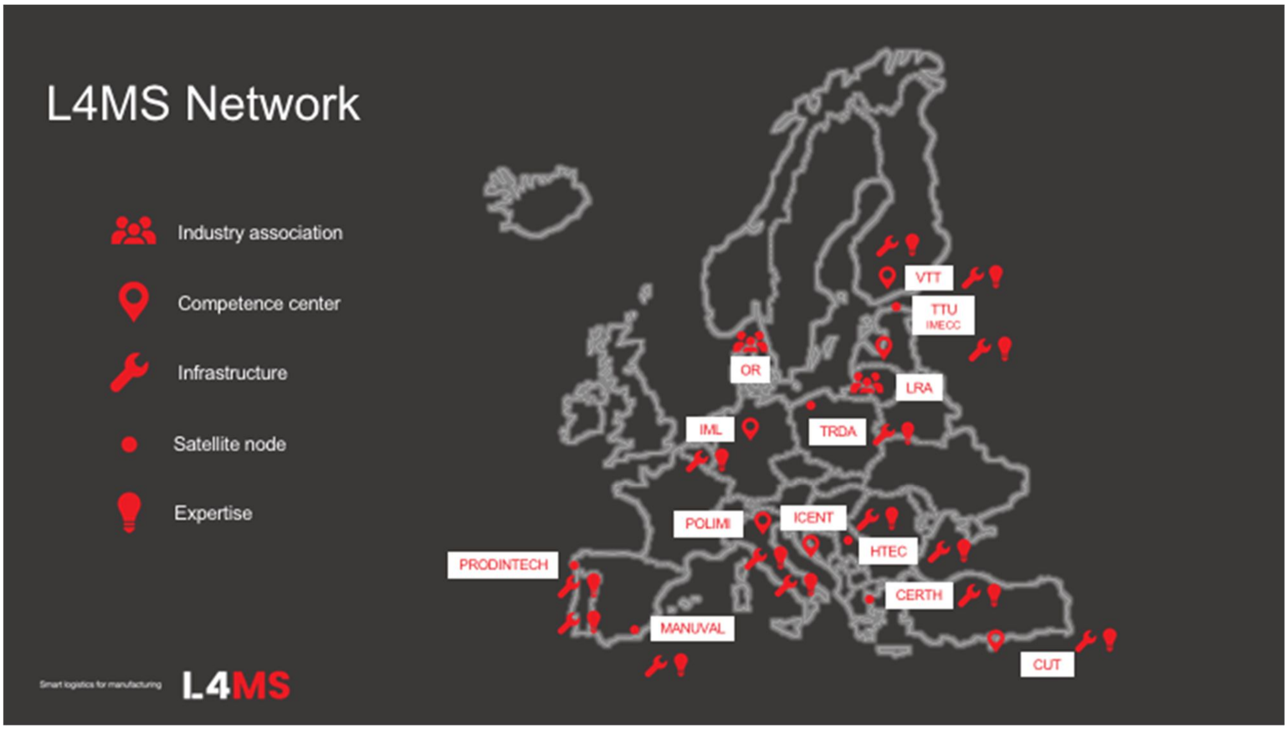

L4MS Marketplace: One-stop-shop for logistics
SME
Mid-Cap
Competence centers
Business developers
Technology suppliers
TECHNOLOGY
FINANCE
BUSINESS MENTORING
TRAINING
L4MS


Application Experiments
Competence centers
APPLICATION EXPERIMENT
(= SME & System Provider)
Business developers
Technology suppliers
Foster new innovative service and business models
Low cost customized and standardized AGV systems
Advanced technologies without need for in-house expertise
Real evidence and data for the investors
L4MS


Open Platform for Innovations in Logistics (OPIL)
Optimizing
Planning and Testing
Monitoring and Control
REAL FACTORY
OPIL
DIGITAL FACTORY
Data from IoT nodes
L4MS


Application Layer
OPIL Task Planner
Business Process Optimization
Motion Task Planning
Task Supervisor
Advanced HMI
Task Specification
Task Parameterization
Task Monitoring and Control
Sensing and Perception
Localization
Mapping
SIMULATION
Visual Components 3D Simulation
CPS Layer
Context Management
FIWARE ORION
Pub/Sub Context Broker
Protocol Adapter
FIWARE IDAS
Backend Device Management & Protocol Adapter
Mashup HMI
FIWARE WIRECLOUD
Widget Mashup
IoT Layer
L4MS

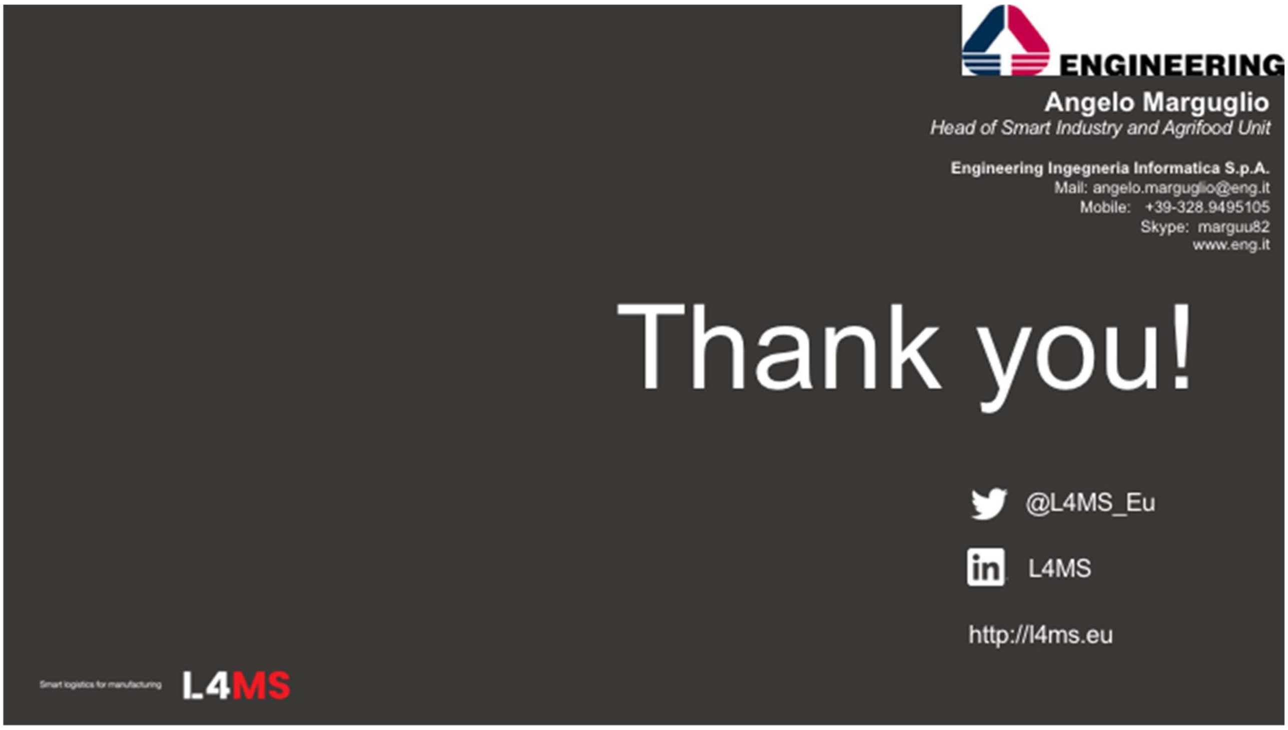

Timeline for Application Experiments
2 months
8 months
11 months
STAGE 1
STAGE 2
STAGE 3
3000
247 000
Loans...
Venture Capital investment
Scale up boot camp
Business support
Technical execution
Mentoring
Championship boot camp
Technical and business proposal
Match-making


L4MS Network
Industry association
Competence center
Infrastructure
Satellite node
Expertise
VTT
TTU
IMECC
OR
LRA
IML
TRDA
POLIMI
ICENT
HTEC
PRODINTECH
CERTH
MANUVAL
CUT
L4MS


What L4MS offers
Matchmaking with system integrators, mobile robots manufactures & SME's
Funding up to €250,000
State-of-the-art test environment within your region
Business developers for innovative business and service models
Technology expert for adopting latest logistics automation solutions
Training to re-skill workers at your door step
Finance for scaling up the new business and service models
L4MS


Apply now!
Submit applications at l4ms.eu
Sep - 30th Nov 2018
Smart logistics for manufacturing
L4MS


L4MS network
LITHUANIAN ROBOTICS ASSOCIATION
IMECC
ODENSE ROBOTICS
POWERED BY DEVELOPING FYN
VTT
Project Coordinator
Engino
ENT
POLITECNICO MILANO 1863
Fraunhofer IML
European Dynamics
Cyprus University of Technology
PBN
FundingBox
VISUAL COMPONENTS
ENGINEERING
MOBILE WORLD CAPITAL BARCELONA
KINE
ASTI
Hermia Business Development
muraplast
HORIZON 2020
H2020 Innovation Action - This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 767642
Smart logistics for manufacturing
L4MS


ENGINEERING
Angelo Marguglio
Head of Smart Industry and Agrifood Unit
Engineering Ingegneria Informatica S.p.A.
Mail: angelo.marguglio@eng.it
Mobile: +39-328.9495105
Skype: marguu82
www.eng.it
Thank you!
@L4MS_Eu
L4MS
http://l4ms.eu
L4MS

Technology platforms and ecosystems, who drives the success? The case of the DAEDALUS platform

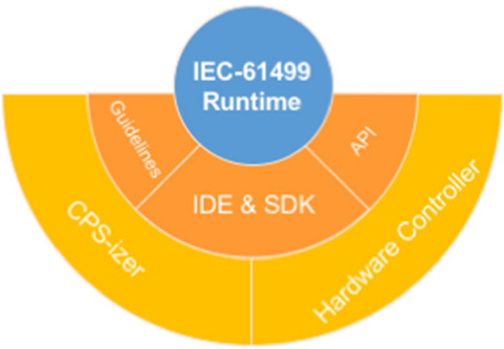
Andrea Barni – SUPSI

andrea.barni@supsi.ch

26 Sept. 2018, Madeira

The components of the DAEDALUS platform

- Platform products/services rich, developed on the top of IEC 61499
- Runtime + SW development supporting elements
- Reference Hardware & Software implementations

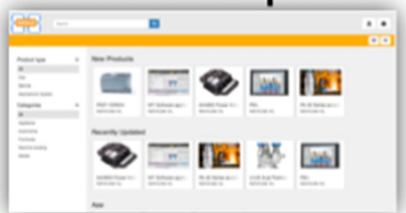


2

Marketplace: the access to platform value

DAEDALUS fosters the creation of an **ecosystem** that relies on the **IEC 61499** where the stakeholders of the automation domain are able to exchange **new forms of value**.

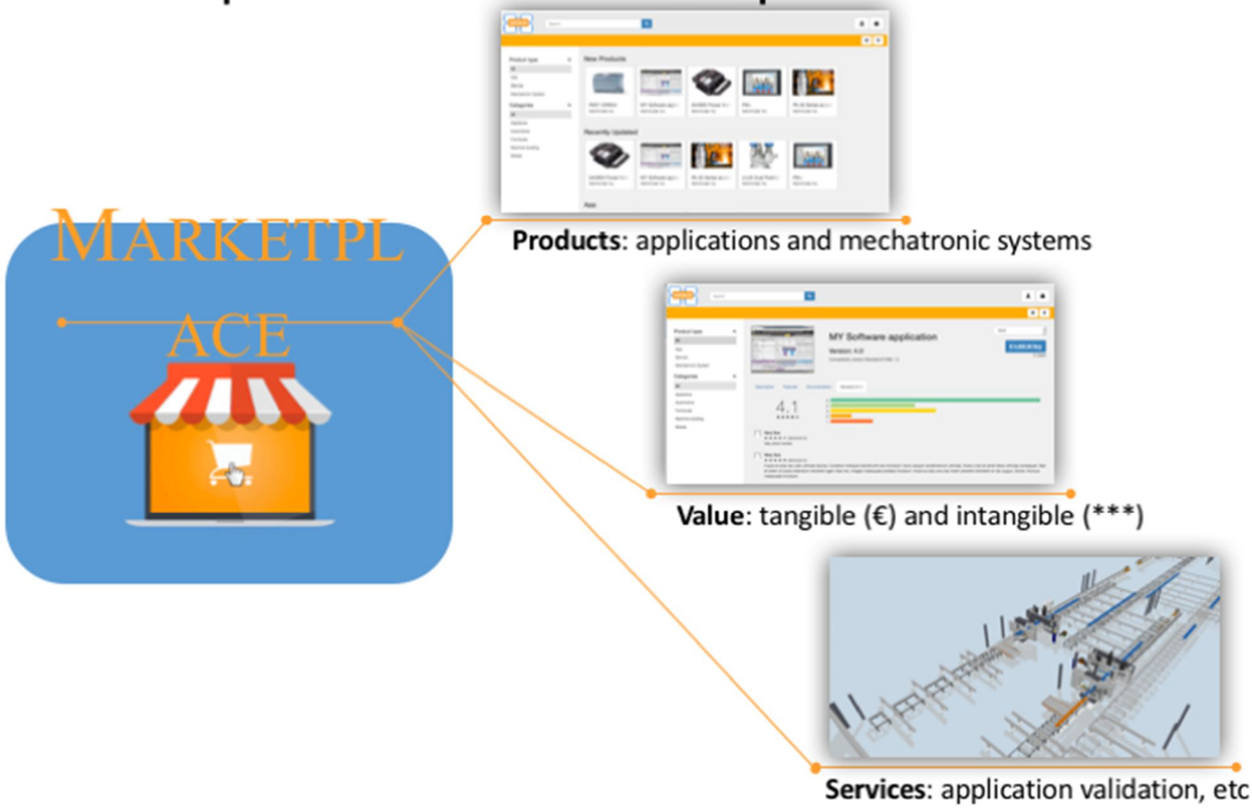
Marketplace: the access to platform value



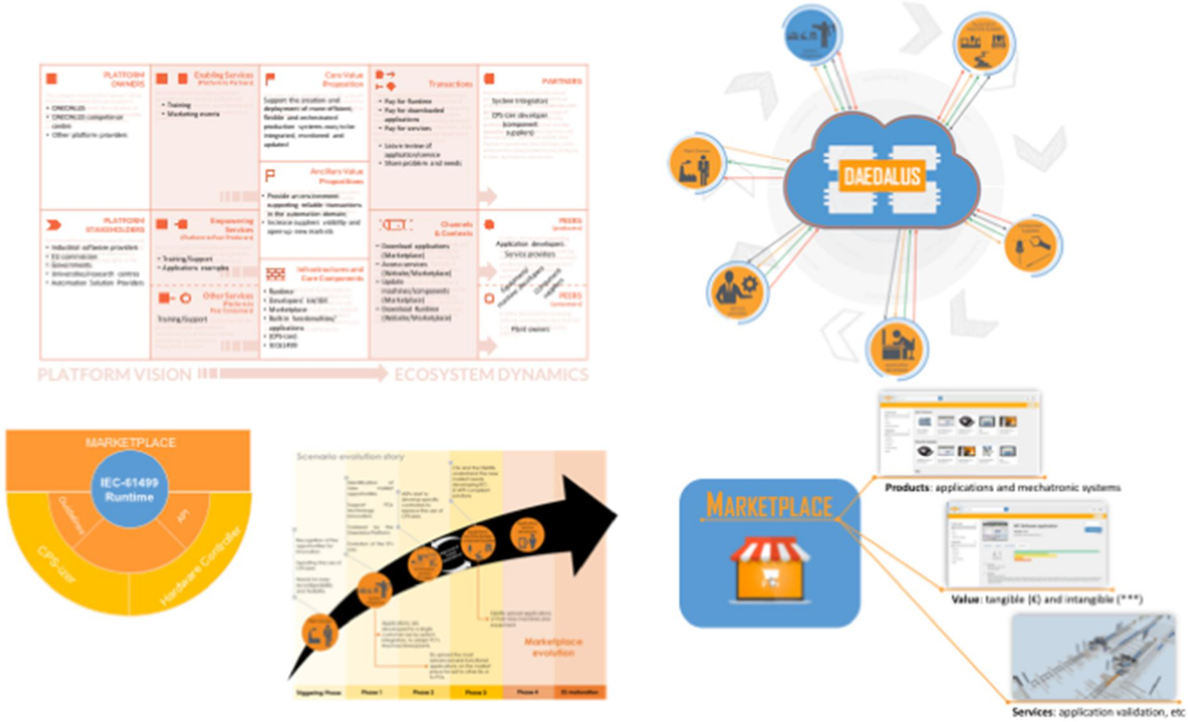
Products: applications and mechatronic systems

Marketplace: the access to platform value

Marketplace: the access to platform value



Is it enough to foster ecosystem growth?



From stakeholders to complementors

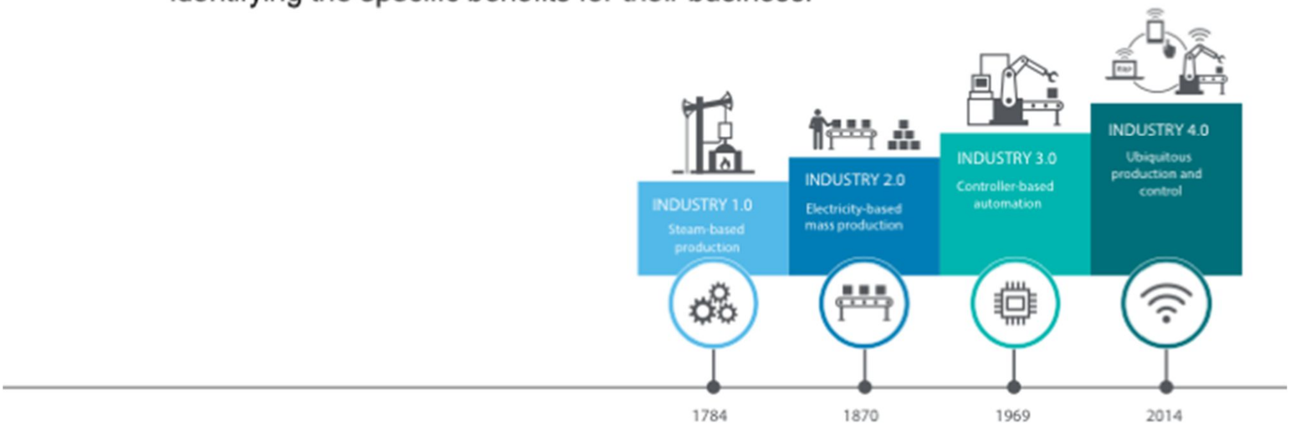
"A complementor is a company/organisation which directly sell a product or service (or services) that complements the product or service of another company/organisation, by adding value to mutual customers"

Brandenburger and Nalebuff

Is it enough to foster ecosystem growth?

The evolution of the automation value network towards DAEDALUS is strictly dependant by two factors:

1. **technology acceptance:** ability to make evidence of the improved efficiency and effectiveness of the work processes by means of IEC61499 adoption;
2. **propension to change:** ability to gradually guide companies in analysing and identifying the specific benefits for their business.



Is it enough to foster ecosystem growth?

The evolution of the automation value network towards DAEDALUS is strictly dependant by two factors:

1. **technology acceptance:** ability to make evidence of the improved efficiency and effectiveness of the work processes by means of IEC61499 adoption;
2. **propension to change:** ability to gradually guide companies in analysing and identifying the specific benefits for their business.
3. **Partnership:** ability to make the ecosystem living by incorporating business partners able to support ecosystem growth.

From App Store history
When IBM and SAP got involved, they began building apps specifically geared towards enterprise customers. Customers could access these apps from a vetted App Store, which also was appealing to IT. The Cisco deal gave IT faster on-boarding of Apple devices on networks running Cisco equipment (which most enterprises use).

1- Fostering technology acceptance

A common effort, led by the DAEDALUS Competence Centre, passing by activities aiming at:

- gain **visibility** at European level;
- provide **standard-based reliability**;
- **involve** interested **target groups**;
- **demonstrate** technology **effectiveness** through reference use cases.

European Competence Centre IEC-61499

CEN CENELEC

2- Encouraging propensity to change

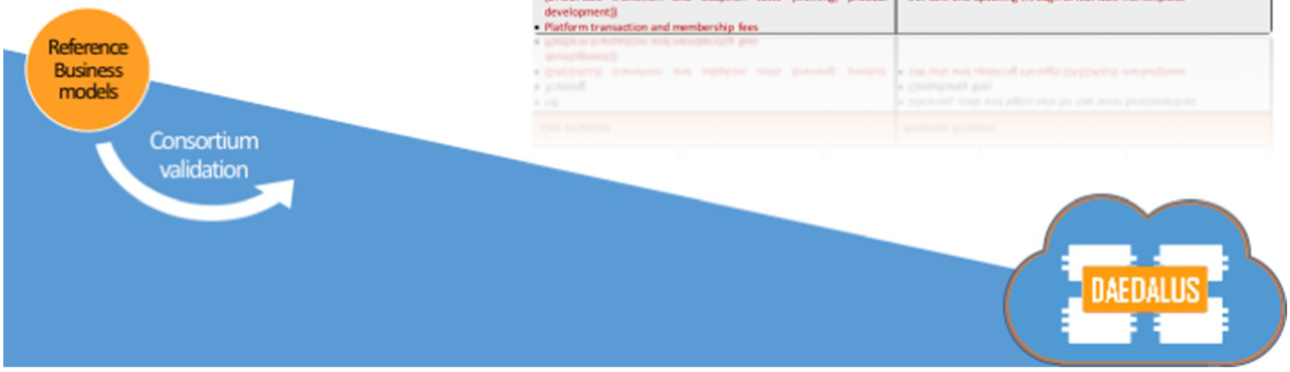
1. Development of a structured **process** guiding companies in **understanding the impact** of shifting towards a platform based technology;

2. Development of the **instruments** required to support the analysis.

Encouraging propensity to change: approach

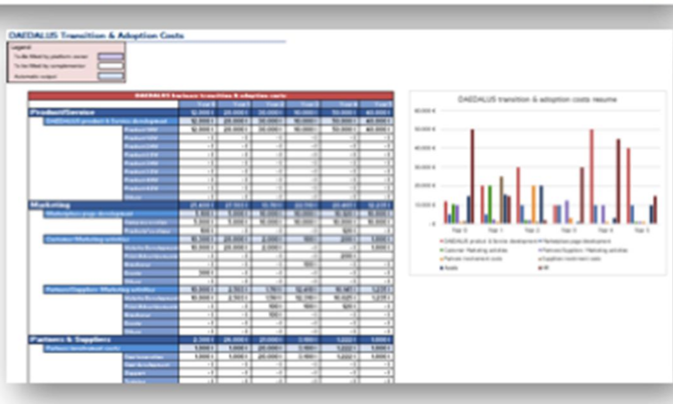
Development of **reference business models** contemplating the impact of integrating DAEDALUS technologies in complementors' one, and **validation by consortium partners**.

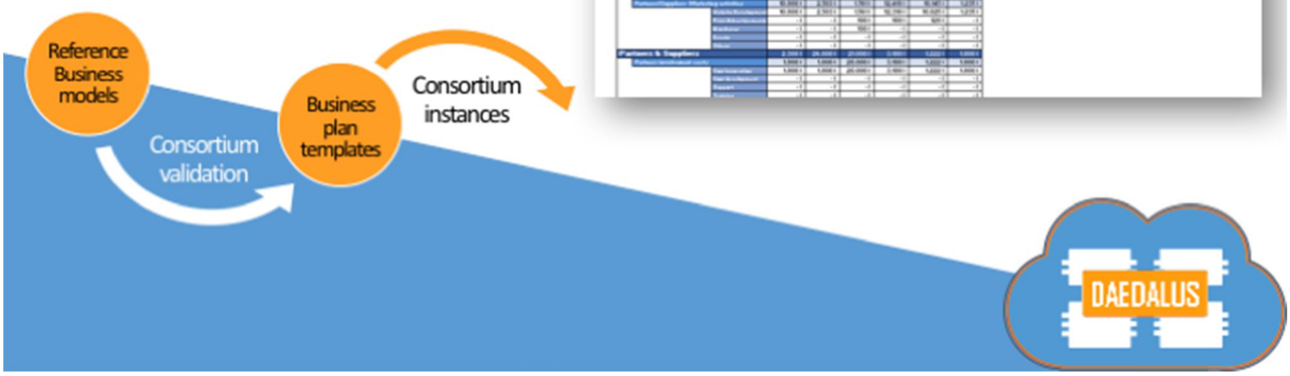
<table>
<tr><th>Key partners</th><th>Key Activities</th><th>Value Propositions</th><th>Customer relationship</th><th>Customer Segments</th></tr>
<tr><td rowspan="3">• ~~Automation Solution Providers~~
• Equipment & Machine Builders
• Components Suppliers
• CPS-izers producers
• (Third-party application developers)
• DAEDALUS platform</td><td>• Consultancy (design, RFP, implementation & ramp-up)
• After-sales services
• Training and Documentation
• Ongoing support
• SW development
• Legacy based systems update</td><td rowspan="3">Starting from customers' needs and existent legacy-based systems, design and implement a complete, turnkey and functional automation systems, increasing functionalities and performances through advanced application and SW, supporting also RFP and long-term services</td><td>• Direct assistance
• DAEDALUS Community</td><td rowspan="3">• Plant Owners
• Other SIs</td></tr>
<tr><th>Key Resources</th><th>Channels</th></tr>
<tr><td>• HR
• Experience and previous projects
• DAEDALUS technologies
• Developed SW</td><td>• Direct channels
• Automation solution providers
• Digital marketplace</td></tr>
<tr><th colspan="2">Cost structure</th><th colspan="3">Revenue Streams</th></tr>
<tr><td colspan="2">• HR
• Training
• (DAEDALUS transition and adoption costs (training, product development))
• Platform transaction and membership fees</td><td colspan="3">• Libraries, code and logics sale for low level functionalities
• Consultancy fees
• SW sale and updating through DAEDALUS marketplace</td></tr>
</table>



Encouraging propensity to change: approach

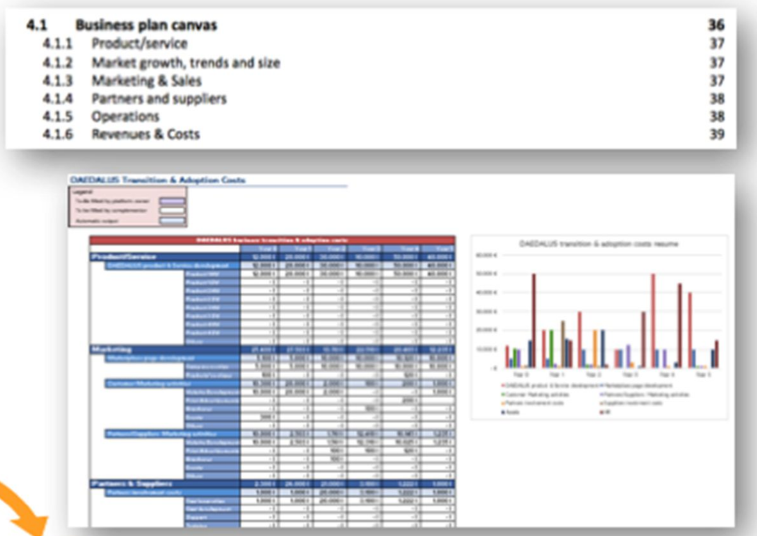
Development of **instruments** supporting the **preparation of business plans** contemplating the adoption of DAEDALUS technologies. **Qualitative** (supported interview) **+ quantitative approach** (spreadsheet).





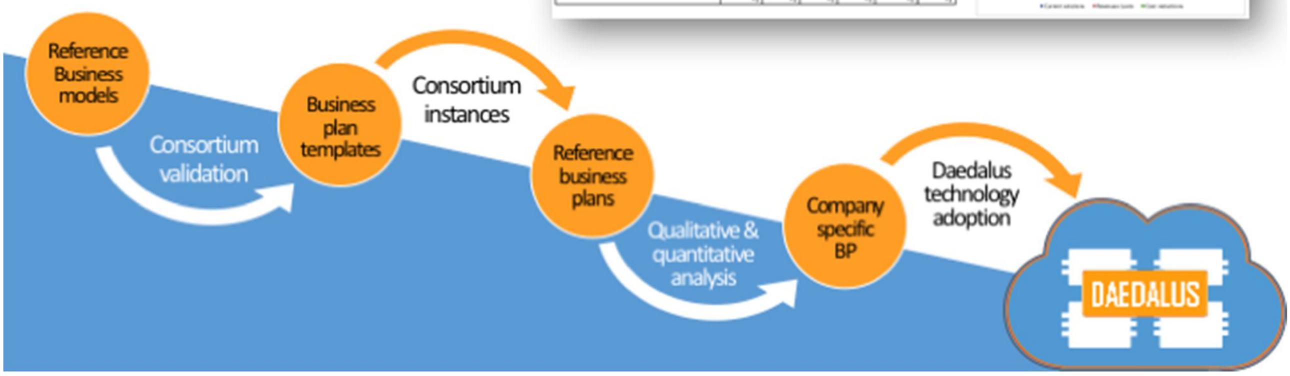
Encouraging propensity to change: approach

Development of a set of **reference business plan** implementations (at least one per complementor) **to support companies external to the consortium** in understanding benefits & changes in their business.



Encouraging propensity to change: approach

Use of the developed instruments to **analyse** the **specific impact** of Daedalus technologies' on external organisations and pave the way for the **transition towards platform integration**.



DAEDALUS

Distributed control and simulation platform to support an ecosystem of digital automation developers

Thank you for the attention

Andrea Barni
University of Applied Science of Southern Switzerland (SUPSI)
andrea.barni@supsi.ch

17

Agenda

- Why deep learning for factory of the future?
- The COMPOSITION's challenge
  - UC-BSL-2 Predictive maintenance
  - UC-ELDIA-1 – Contractual goods and recyclable materials management
- Deep Learning approach in Composition
  - intra-factory scenario
  - inter-factory scenario
- Future work

27/09/2018 COMPOSITION @IS2018 2

Why deep learning for factory of the future?

- Prolific environment
  - large amount of potential data available
  - tangible results achievable in finite time span
  - potential market exploitation
- Overcoming current state of the art
  - outperforming statistical models
  - continuous learning for adapting to dynamic production environment
  - transferrable results in terms of research (not in terms of models or dataset)
- Strong correlation to upcoming existing technologies
  - improving of matchmaking results, supporting decision systems

27/09/2018 COMPOSITION @IS2018 3

Deep Learning approach in Composition

- Deep learning toolkit
  - twofold application as both intra and inter-factory intelligent tool
  - intra-factory data analysis for predictive maintenance
  - inter-factory agent-based marketplace market estimation
- Continuous learning
  - triggered by inter-factory agents and learning framework
- Fits in a comprehensive ecosystem

27/09/2018 COMPOSITION @IS2018 4

The COMPOSITION's challenge - UC-BSL-2 Predictive maintenance

BSL: predictive maintenance on production equipment

- 2 analyzed reflow ovens
- very complex dataset with ~625.000, ~350.000 samples
  - 60 sensors readings in 20 zones
  - 5 newly sensors linearly independent
- few reported failures (~<<20) over recorded timeframe
- very demanding in terms of accuracy
  - tentative for ~2.5h of timeframe
  - more realistically ~5minutes of timeframe

27/09/2018 COMPOSITION @IS2018 5

The COMPOSITION's challenge - UC-ELDIA-1 – Contractual goods and recyclable materials management

ELDIA: agent-based marketplace estimation

- 4 analyzed raw materials markets
- very small dataset with few samples
  - recorded started in 2016 only
- less than 50 reported values
- very demanding in terms of prediction
- steady prices recorded before
- very little contextual data to the analyzed market

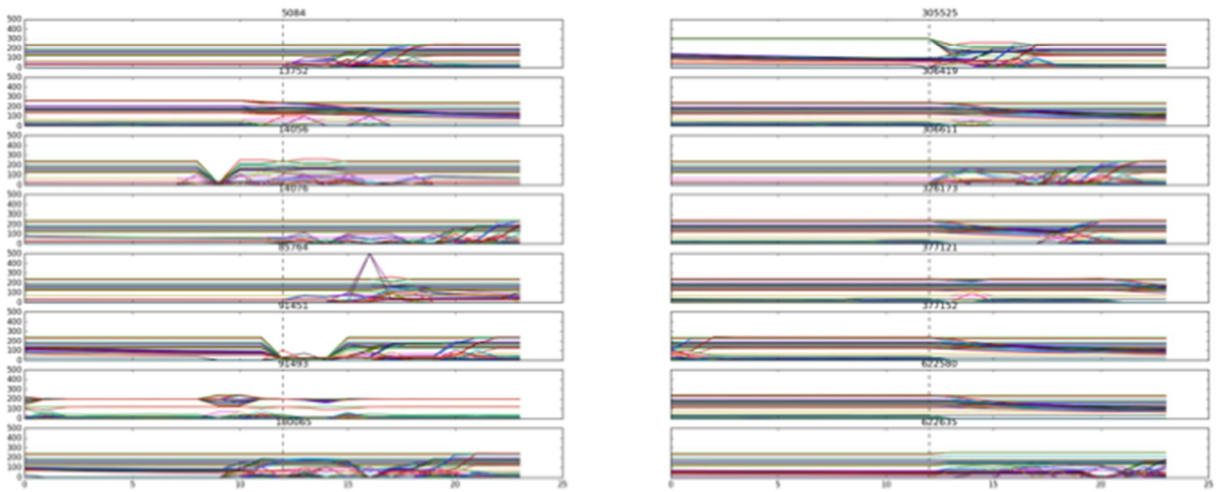
27/09/2018 COMPOSITION @IS2018 6

Deep Learning approach in Composition – intra-factory scenario

- Intra-factory data analysis for **predictive maintenance** from heterogeneous sources
  - data analysis of existing machinery, forming the **historical dataset**
  - **newly** deployed sensors for acquiring more information
- High risk challenge:
  - work with an **incomplete dataset** with no historical information on new measured parameters
  - have **unbalanced classes** in a nearly real-time environment
- Dichotomy of solution:
  - deploy **untrained ANNs** and rely on theoretical convergence forgetting the historical data
  - **balance the classes** and propagate new parameters backwards

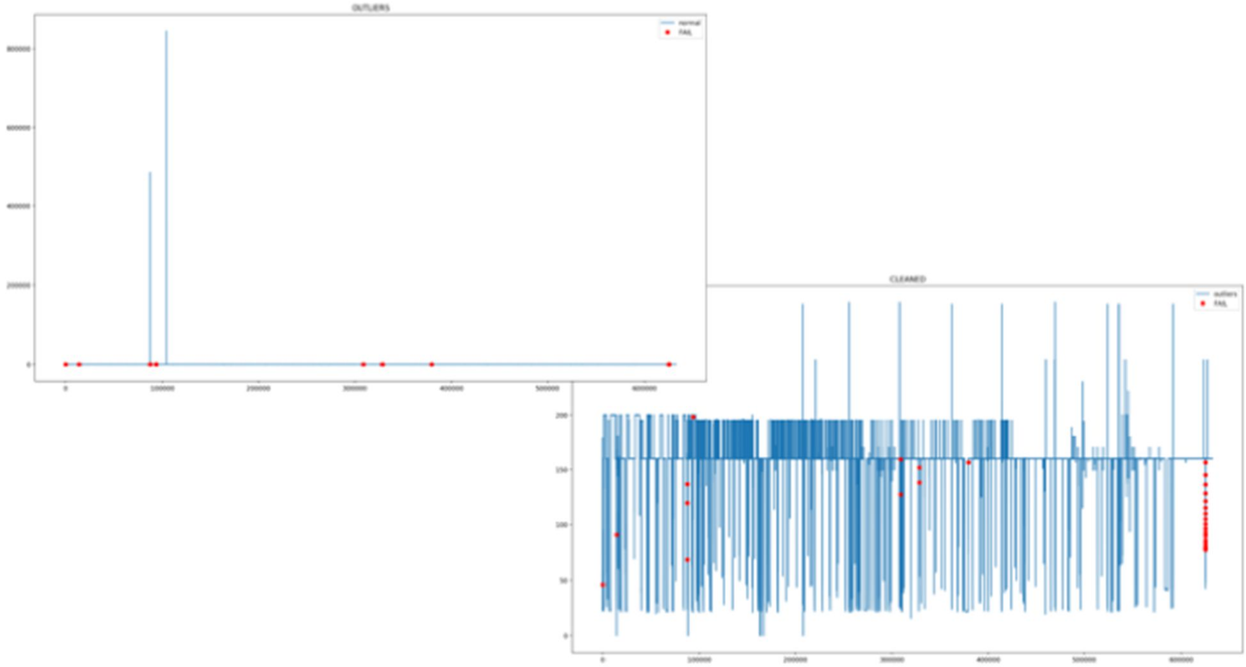
27/09/2018 COMPOSITION @IS2018 7

DLT – intrafactory – historical dataset



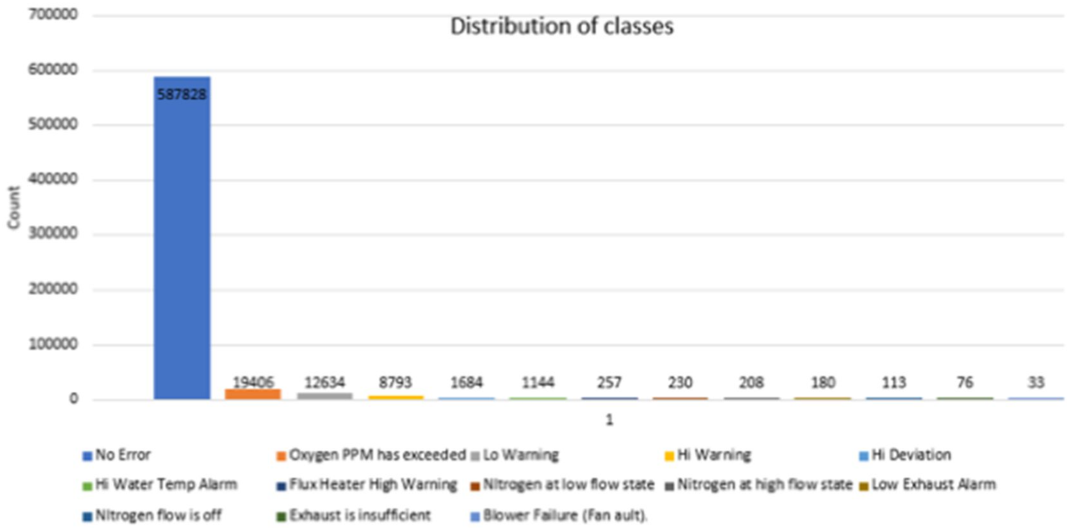
27/09/2018 COMPOSITION @IS2018 8

DLT – intrafactory – outliers and cleaned data



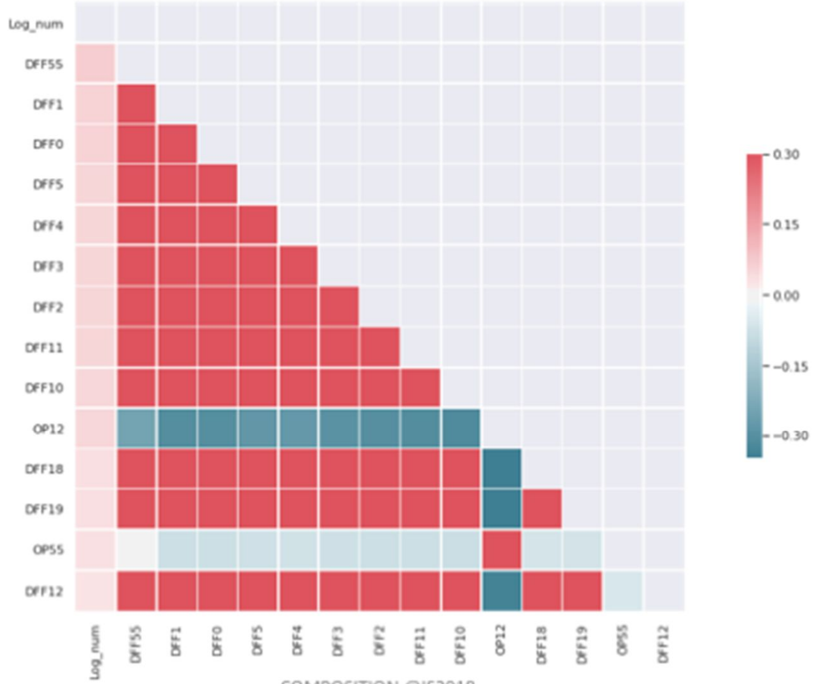
27/09/2018 COMPOSITION @IS2018 9

DLT – intrafactory – dataset creation



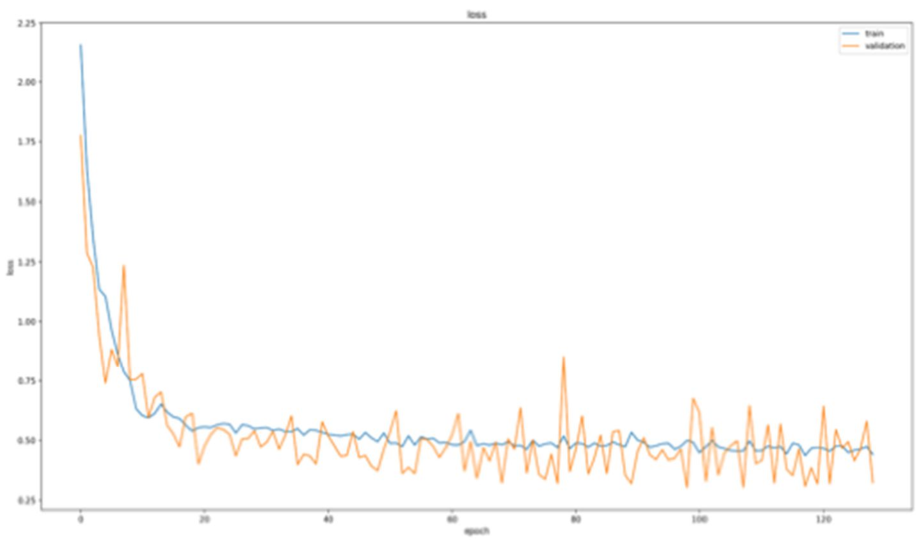
27/09/2018 COMPOSITION @IS2018 10

DLT – intrafactory – correlation matrix



27/09/2018 COMPOSITION @IS2018 11

DLT – intrafactory – loss function



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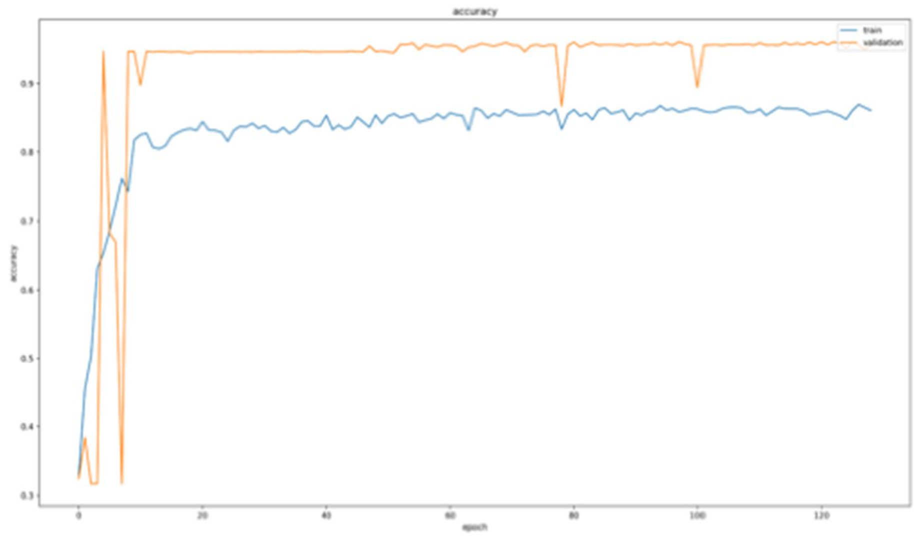
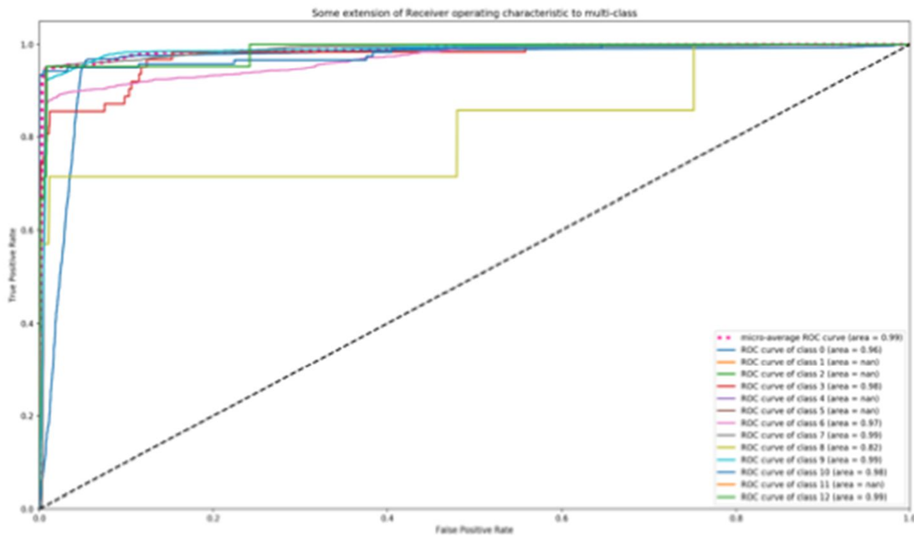
DLT – intrafactory – accuracy



27/09/2018 COMPOSITION @IS2018 13

DLT – intrafactory – ROC function



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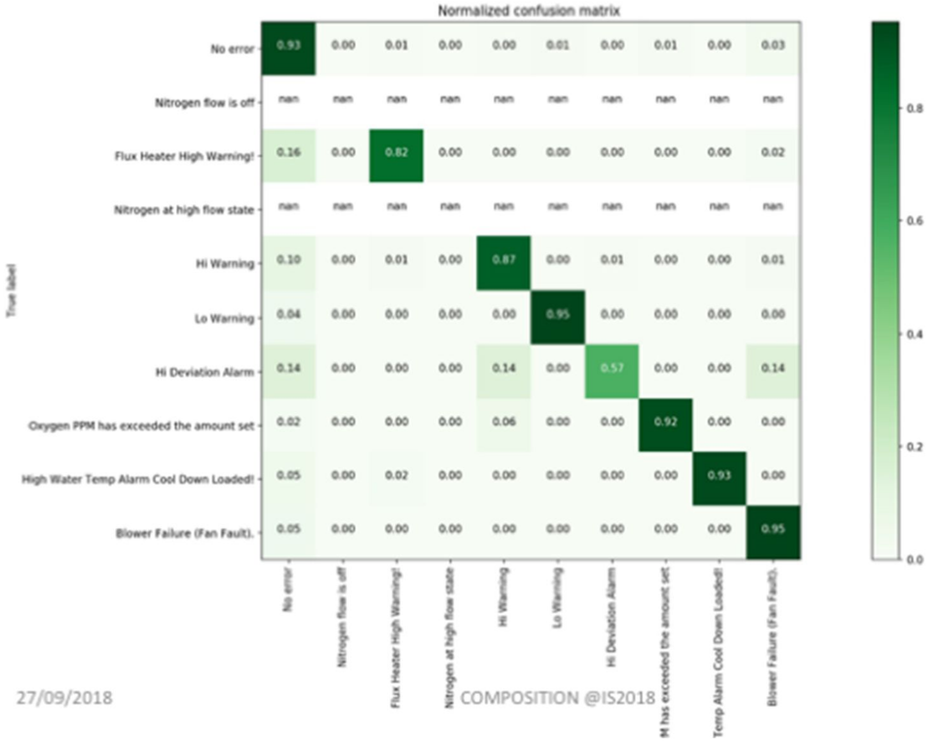
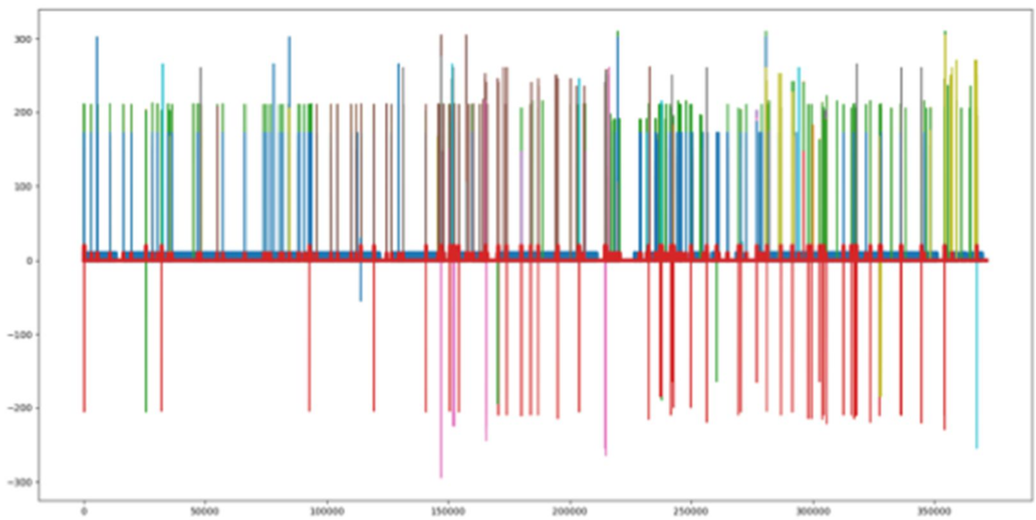
DLT – intrafactory – confusion matrix



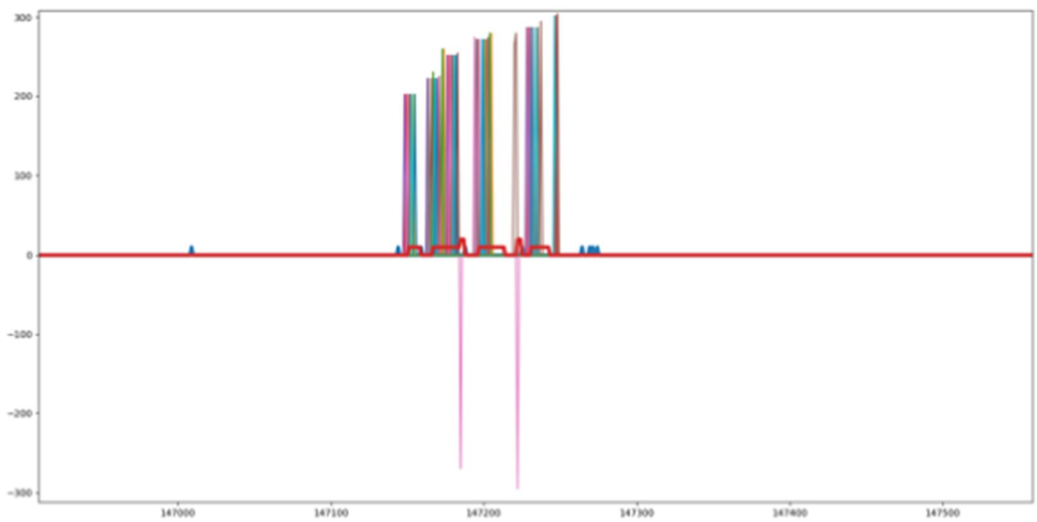
27/09/2018 COMPOSITION @IS2018 15

DLT – intrafactory – training dataset [2013-2017]

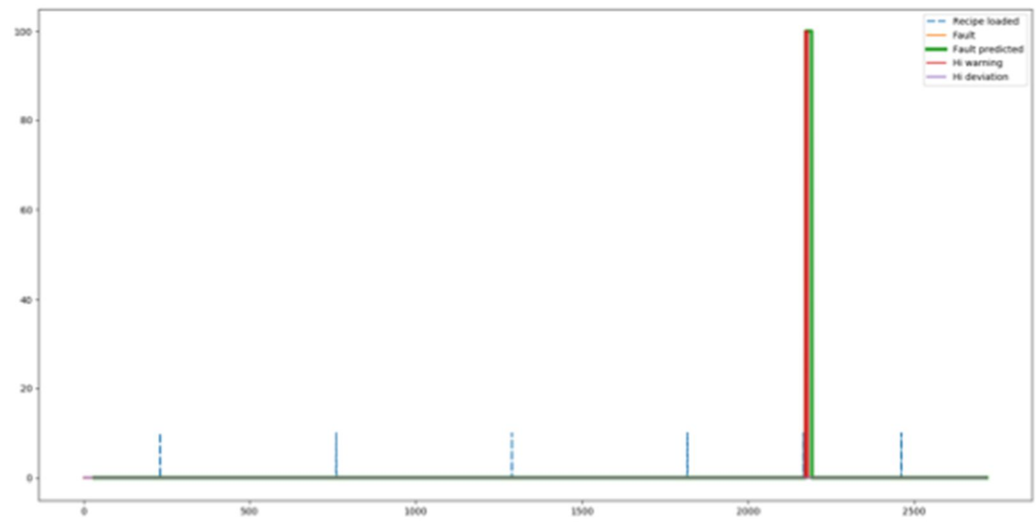


27/09/2018 COMPOSITION @IS2018 16

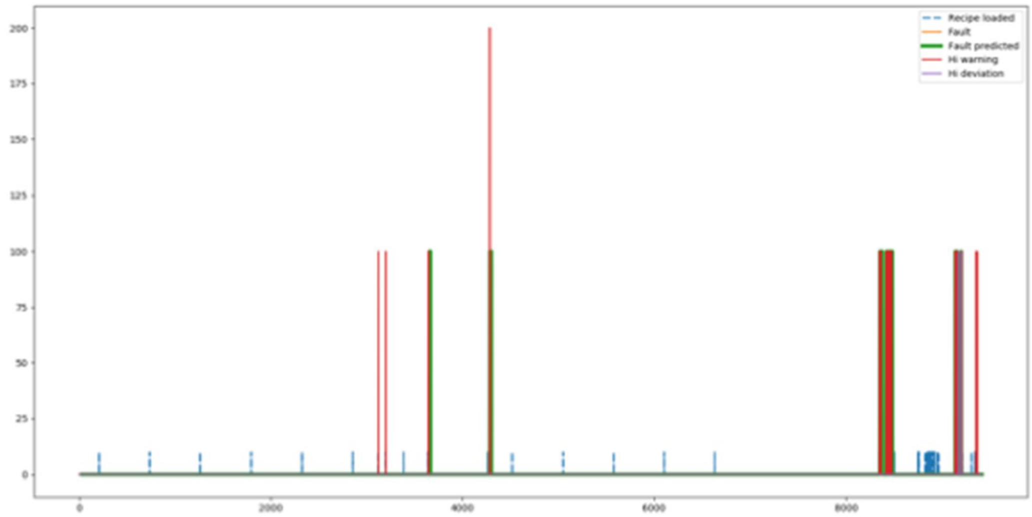
DLT – intrafactory – zoomed training dataset



DLT – intrafactory – test dataset – trial 2

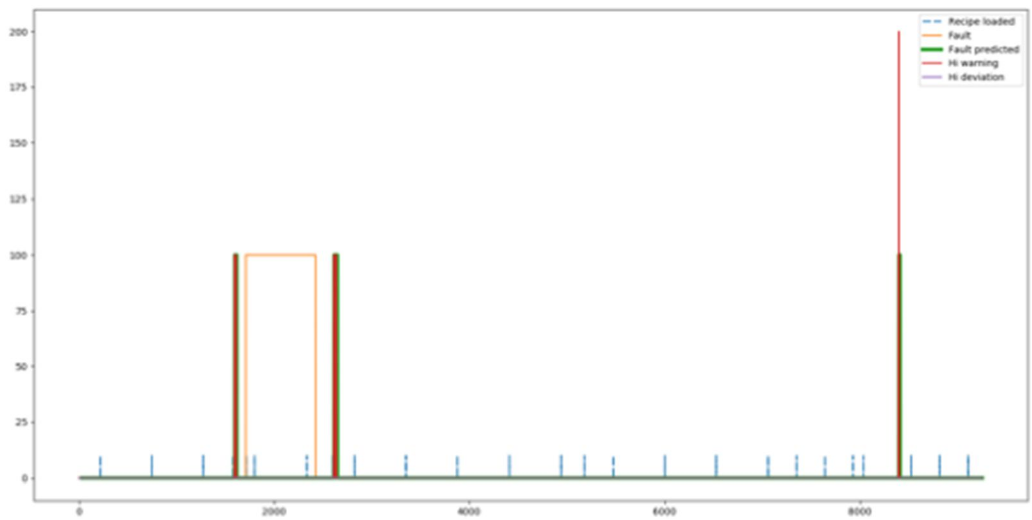


DLT – intrafactory – test dataset – trial 3



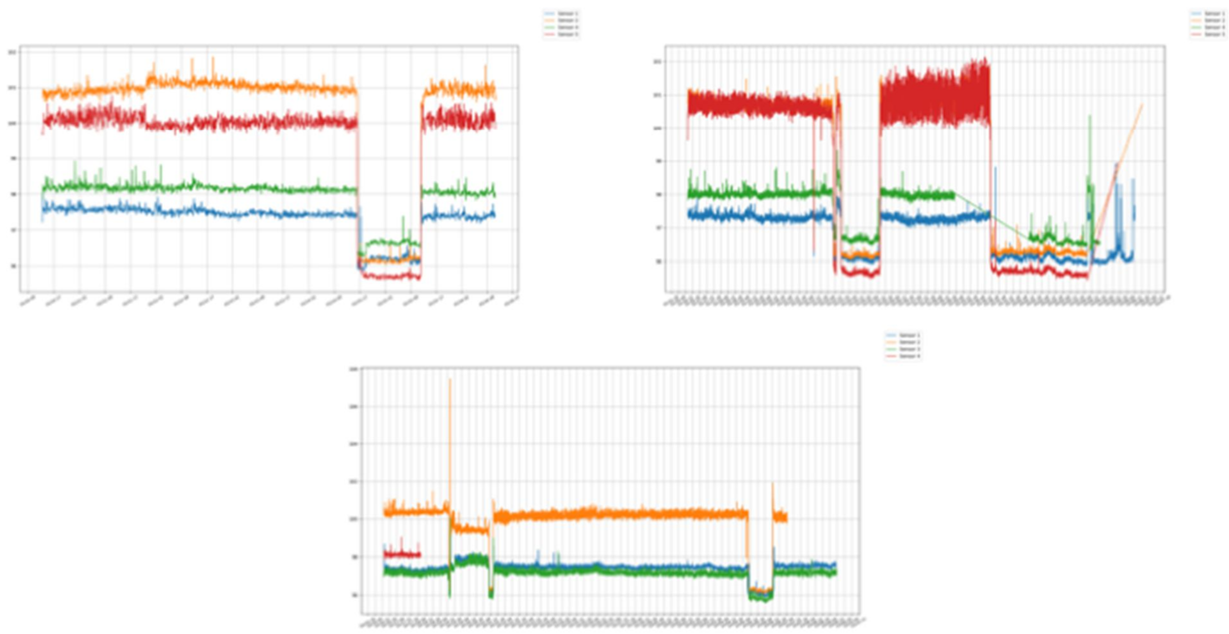
27/09/2018 COMPOSITION @IS2018 19

DLT – intrafactory – test dataset – trial 4



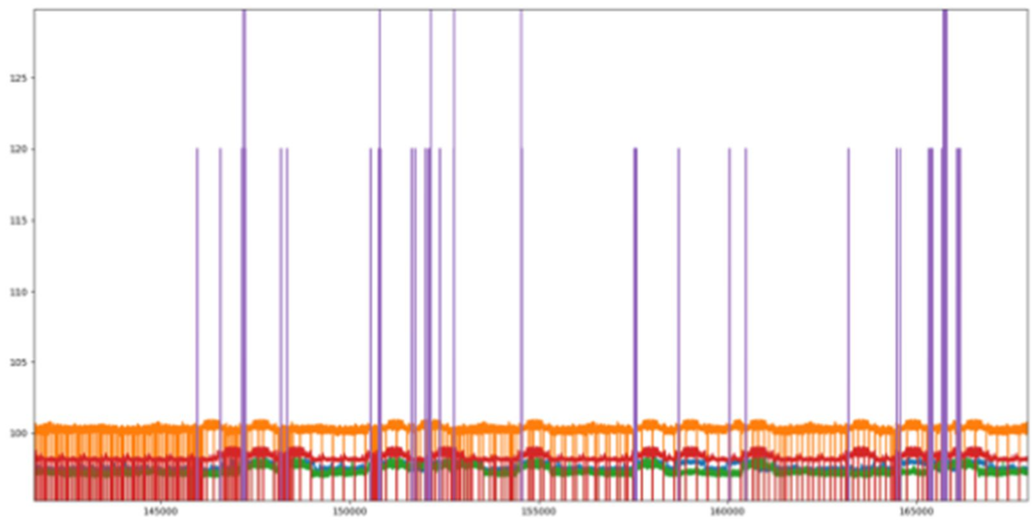
27/09/2018 COMPOSITION @IS2018 20

DLT – intrafactory – newly deployed acoustic sensors



27/09/2018 COMPOSITION @IS2018 21

DLT – intrafactory – zoomed training dataset with audio [2013-2017]



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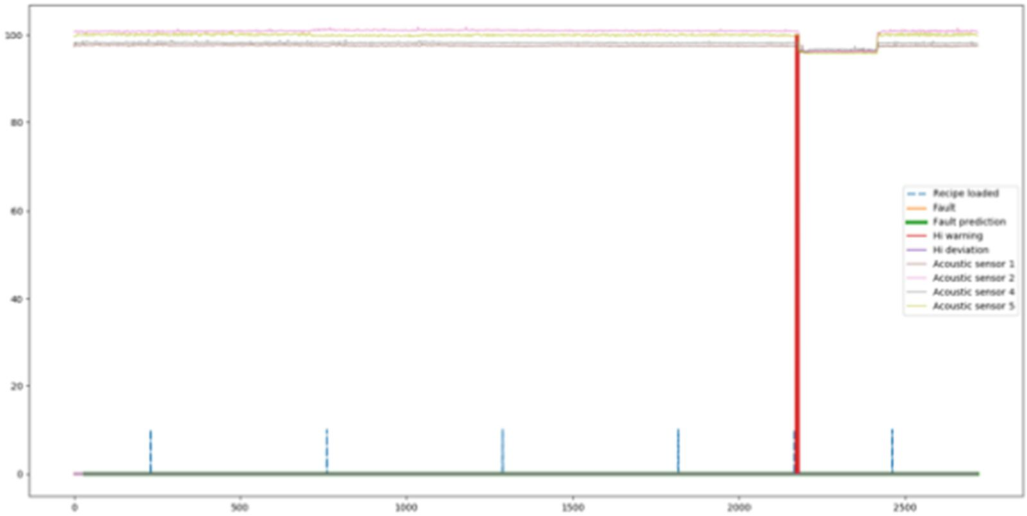
DLT – intrafactory – predictions on test dataset with audio, look ahead 1 sample – trial 2



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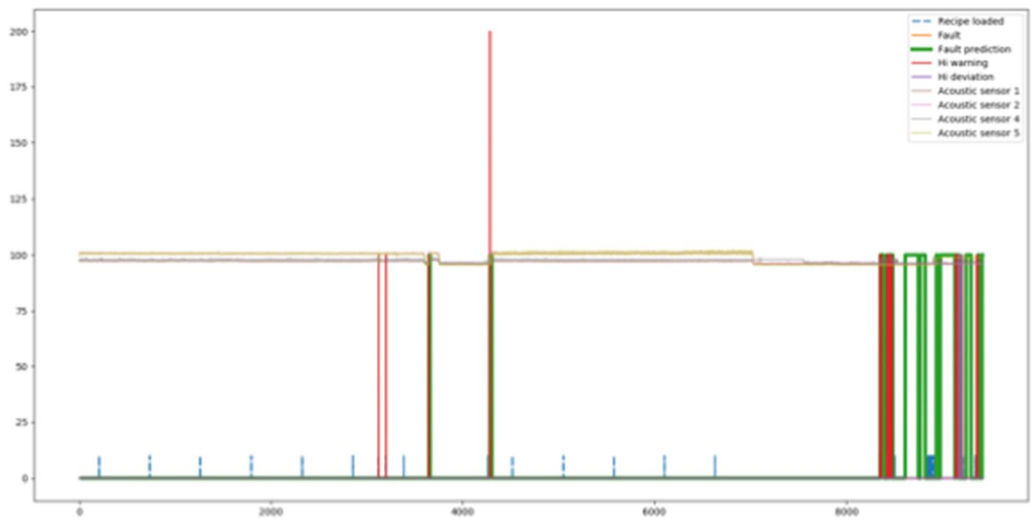
DLT – intrafactory – predictions on test dataset with audio, look ahead 1 sample – trial 3



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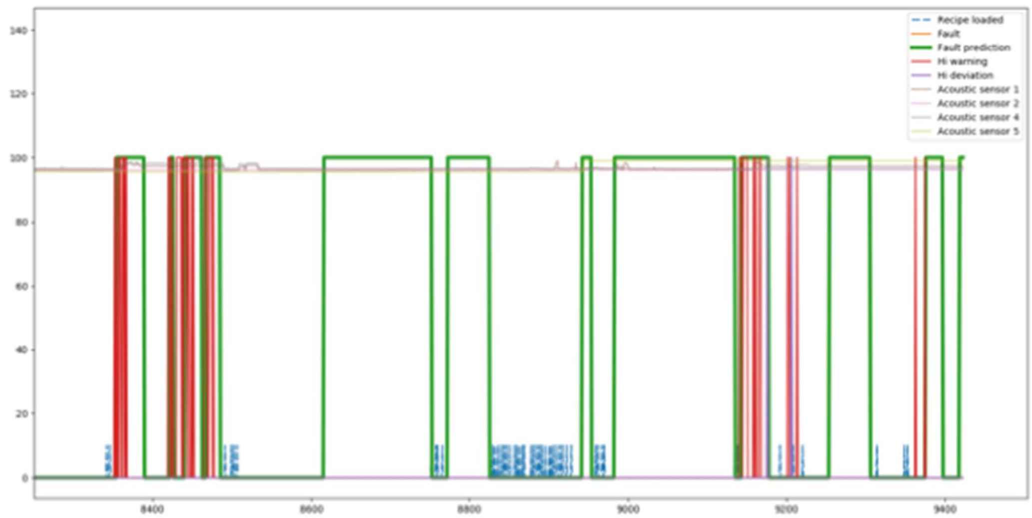
DLT – intrafactory – predictions on test dataset with audio, look ahead 1 sample – trial 3 zoomed



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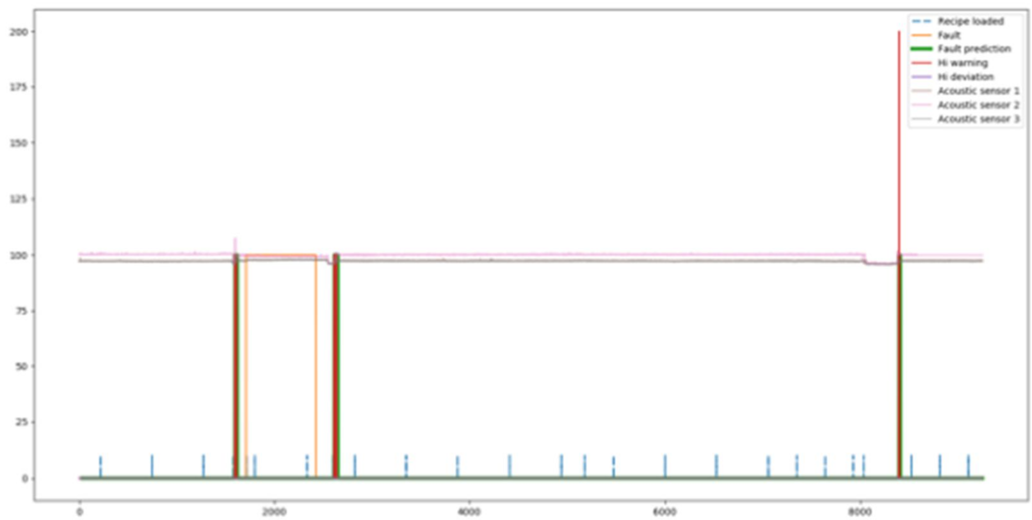
DLT – intrafactory – predictions on test dataset with audio, look ahead 1 sample – trial 4



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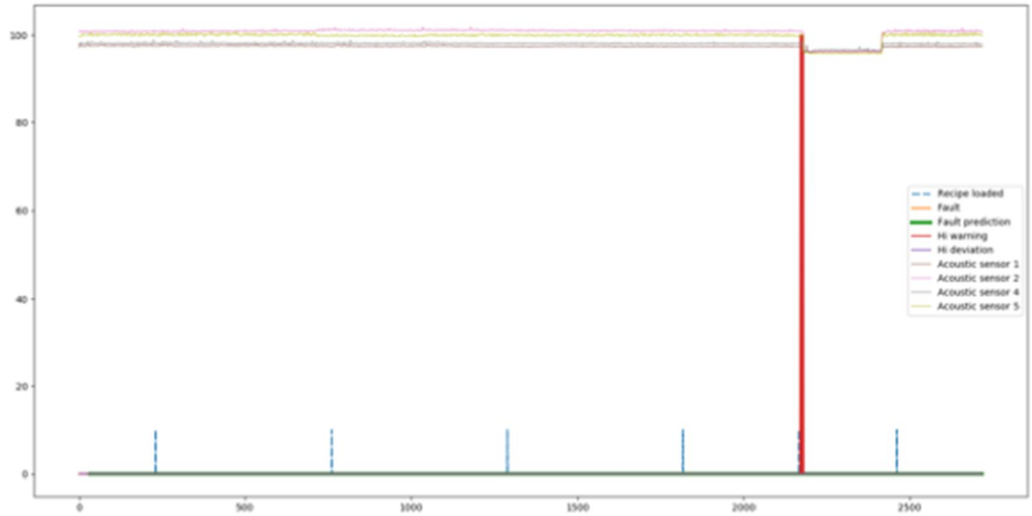
DLT – intrafactory – predictions on test dataset with audio, look ahead 16 samples - trial 2



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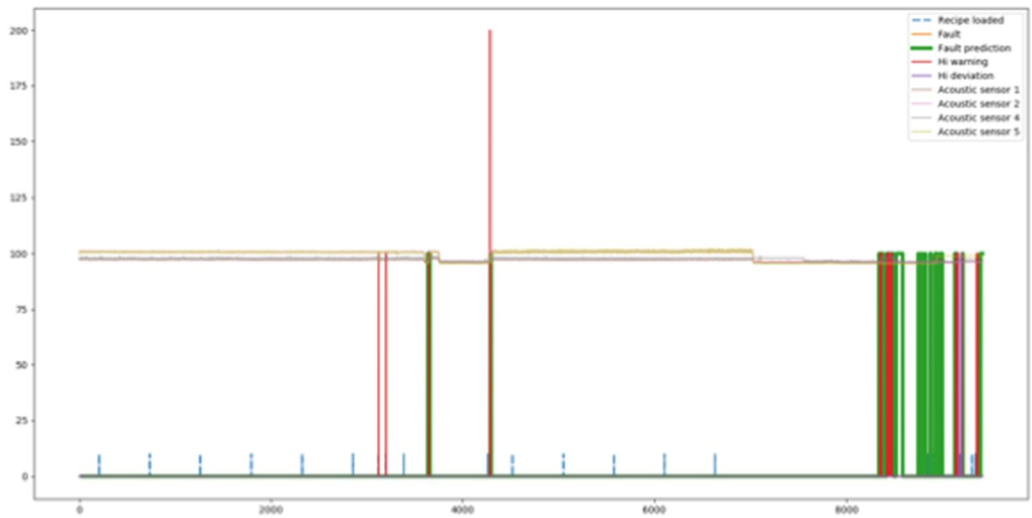
DLT – intrafactory – predictions on test dataset with audio, look ahead 16 samples – trial 3



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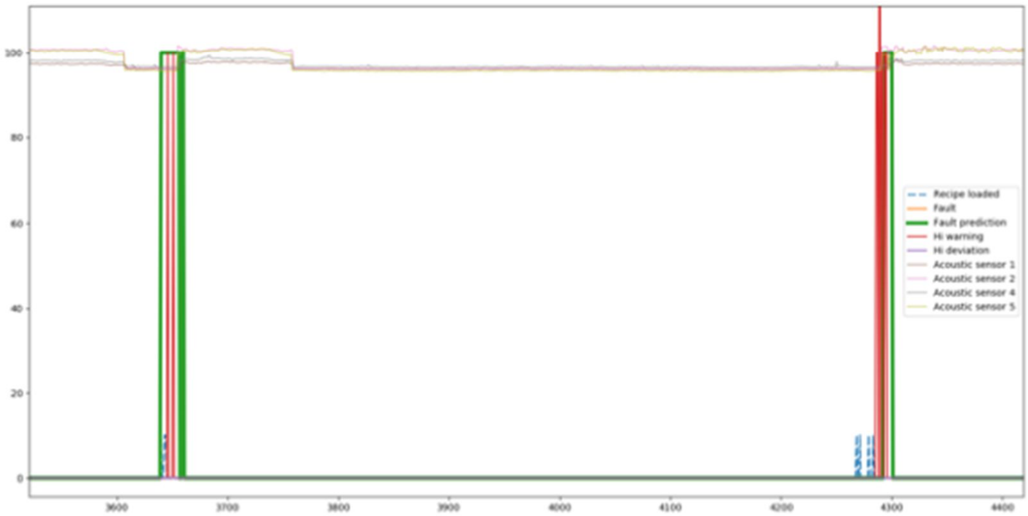
DLT – intrafactory – predictions on test dataset with audio, look ahead 16 samples – trial 3 zoomed



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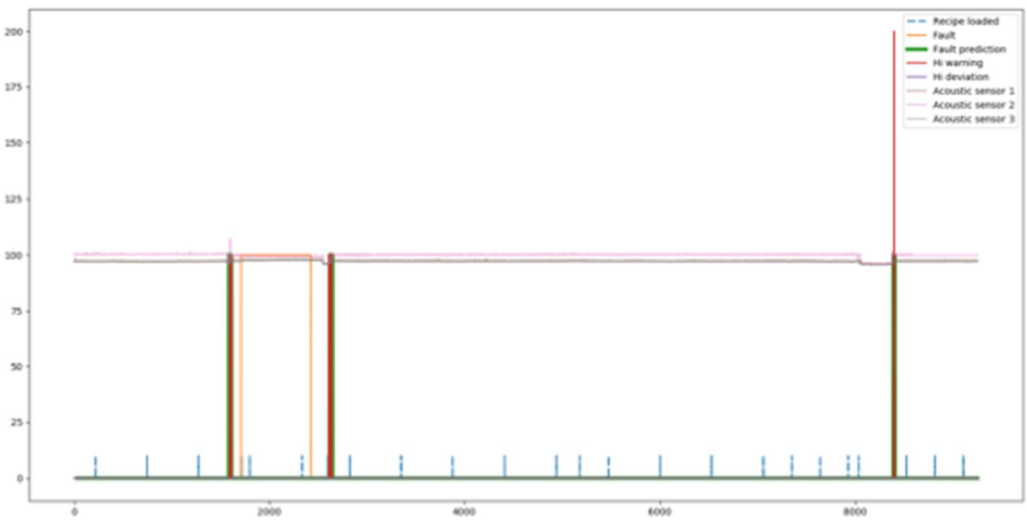
DLT – intrafactory – predictions on test dataset with audio, look ahead 16 samples – trial 4



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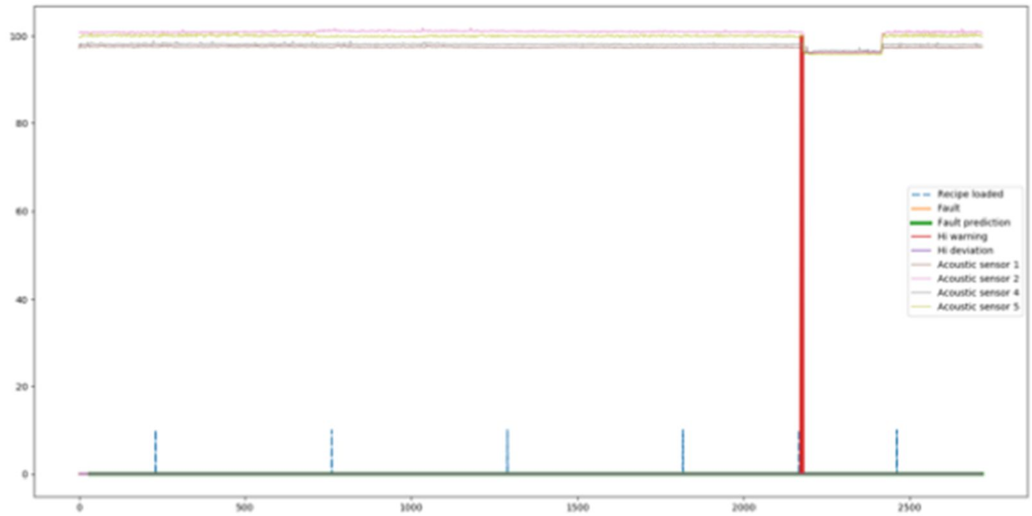
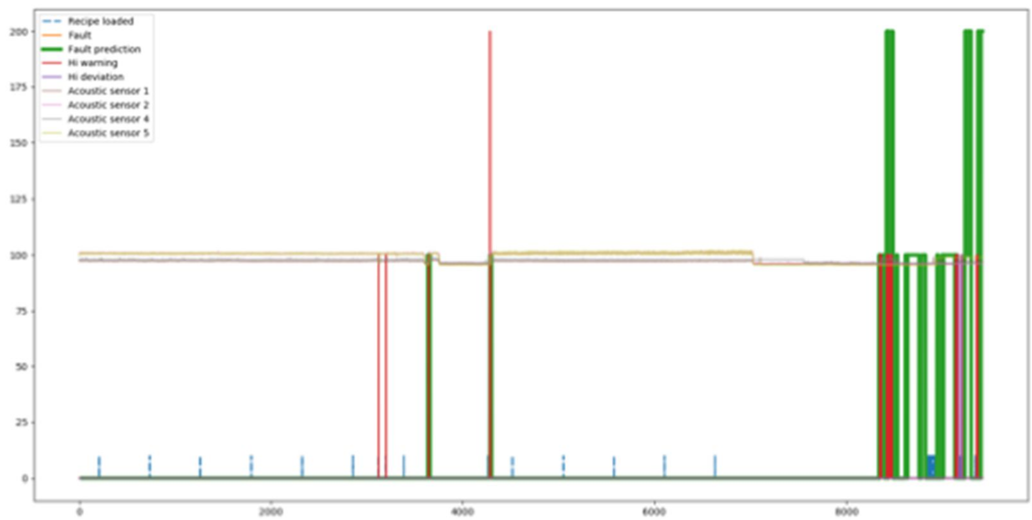
DLT – intrafactory – predictions on test dataset with audio, look ahead 16 samples weighted – trial 2



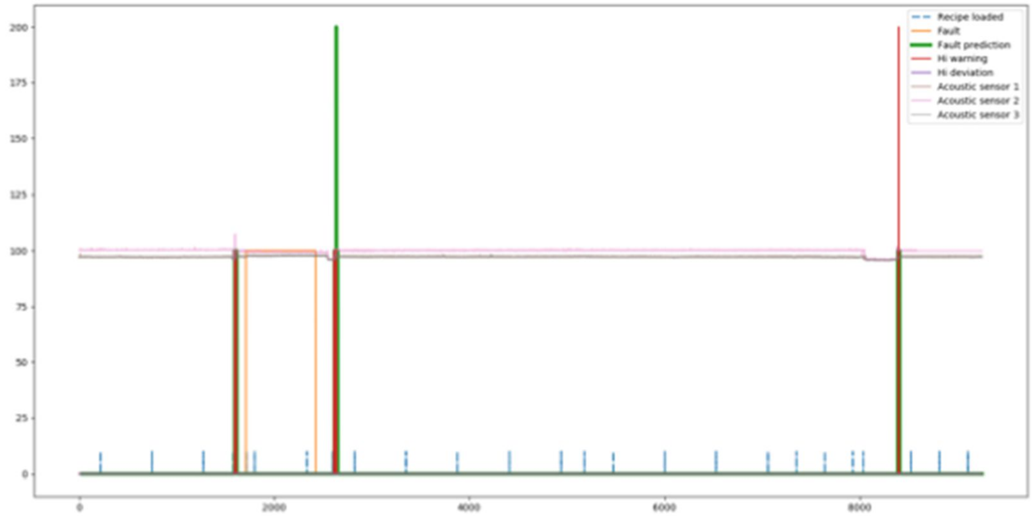
27/09/2018 COMPOSITION @IS2018 31

DLT – intrafactory – predictions on test dataset with audio, look ahead 16 samples weighted – trial 3



27/09/2018 COMPOSITION @IS2018 32

DLT – intrafactory – predictions on test dataset with audio, look ahead 16 samples weighted – trial 4



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Deep Learning approach in Composition – inter-factory scenario (I)

- Provide intelligence to the agents that form the agent-based marketplace
  - marketplace parameters estimation
    - historical data
    - matchmaking policies
    - learned transaction
- Continuous learning
  - triggered by inter-factory agents and learning framework

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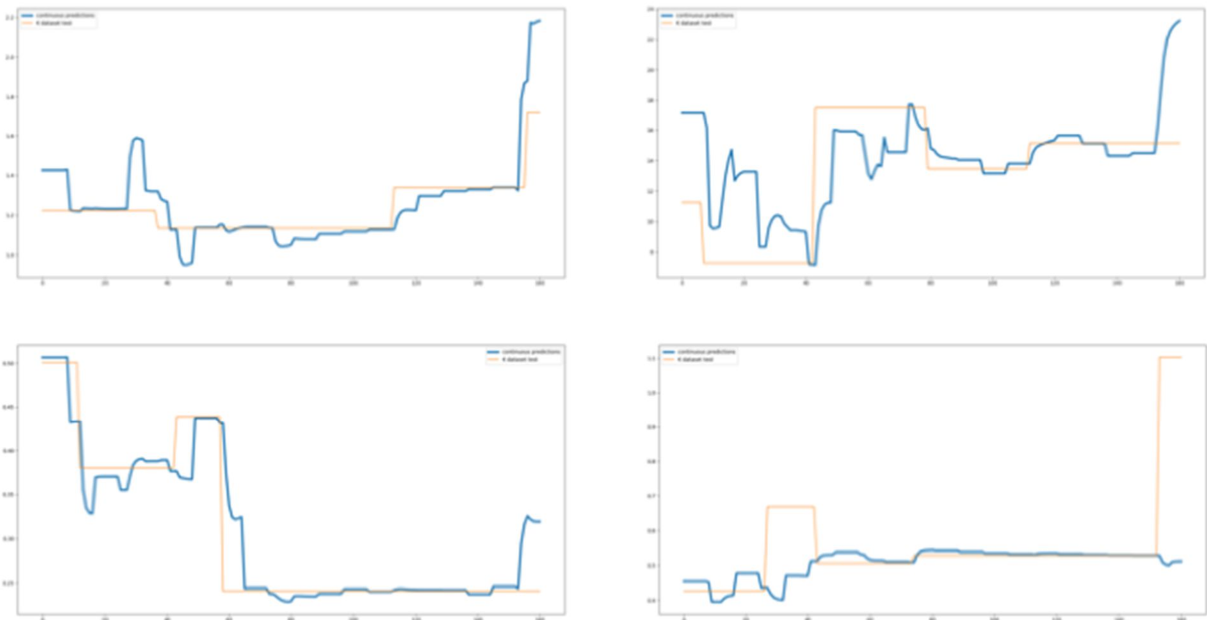
Deep Learning approach in Composition – inter-factory scenario (II)

27/09/2018 COMPOSITION @IS2018 35

Deep Learning approach in Composition – intra-factory scenario (III)



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Future work (I)

- Experiment novel ANNs topologies
- More datasets to be evaluated alongside contextual markets information
- Enhance connection with matchmaking for extending the available information to be evaluated, consolidating the accuracy and improving reliability
- Extend current ontologies for supporting a broader range of possibly market correlated information, coming from heterogeneous sources (e.g. factors that influence stock market)

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Future work (II)

Other challenges might be faced in different use cases by the DLT, based on different requirements:

UC-KLE-1: polishing machine predictive maintenance

- existing historical dataset with few recorded parameters
- no reported failures

UC-KLE-4: agent-based marketplace intelligence

- round trip time calculation and estimation by statistical models in simulation and forecasting tools
- bin fill level estimation with new deployed sensors

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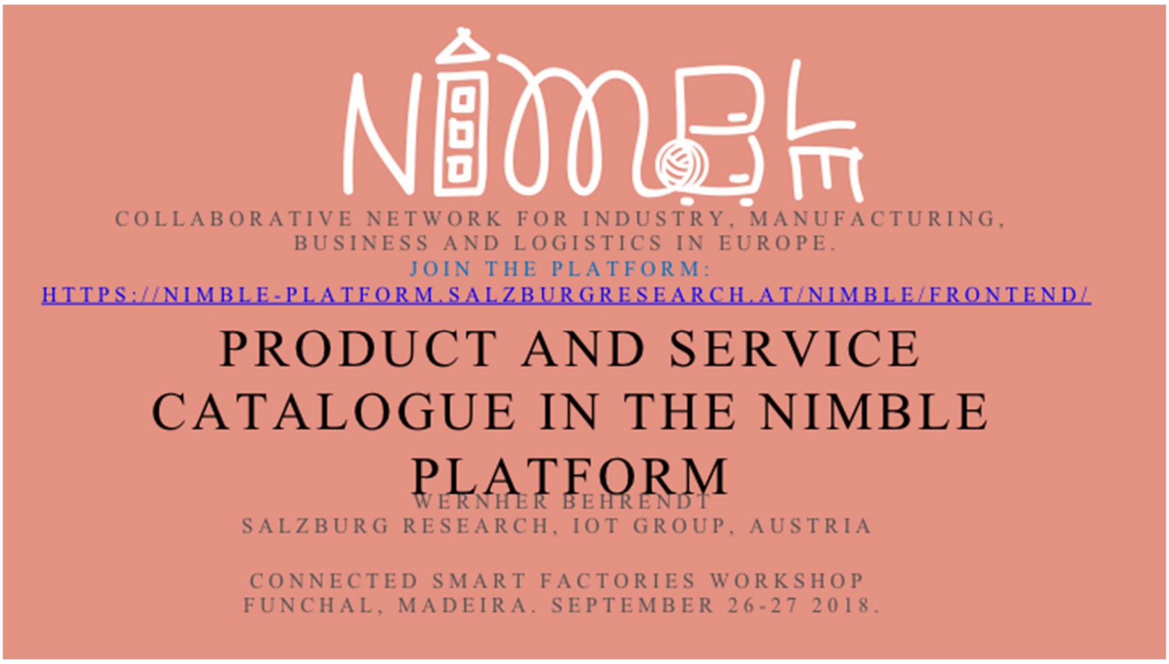
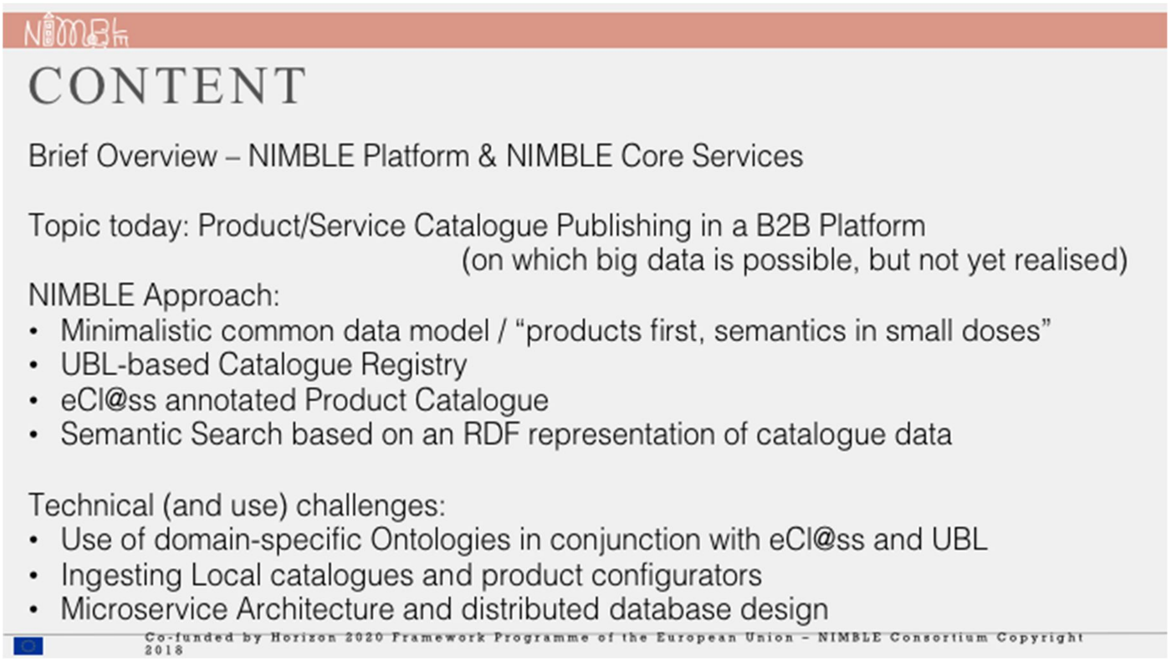
COMPOSITION

Thanks for your attention

COMPOSITION has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement No 723145.


COLLABORATIVE NETWORK FOR INDUSTRY, MANUFACTURING, BUSINESS AND LOGISTICS IN EUROPE.
JOIN THE PLATFORM:
HTTPS://NIMBLE-PLATFORM.SALZBURGRESEARCH.AT/NIMBLE/FRONTEND/
PRODUCT AND SERVICE CATALOGUE IN THE NIMBLE PLATFORM
WERNHER BEHRENDT
SALZBURG RESEARCH, IOT GROUP, AUSTRIA
CONNECTED SMART FACTORIES WORKSHOP
FUNCHAL, MADEIRA. SEPTEMBER 26-27 2018.


CONTENT
Brief Overview – NIMBLE Platform & NIMBLE Core Services
Topic today: Product/Service Catalogue Publishing in a B2B Platform
(on which big data is possible, but not yet realised)
NIMBLE Approach:
• Minimalistic common data model / “products first, semantics in small doses”
• UBL-based Catalogue Registry
• eCl@ss annotated Product Catalogue
• Semantic Search based on an RDF representation of catalogue data
Technical (and use) challenges:
• Use of domain-specific Ontologies in conjunction with eCl@ss and UBL
• Ingesting Local catalogues and product configurators
• Microservice Architecture and distributed database design
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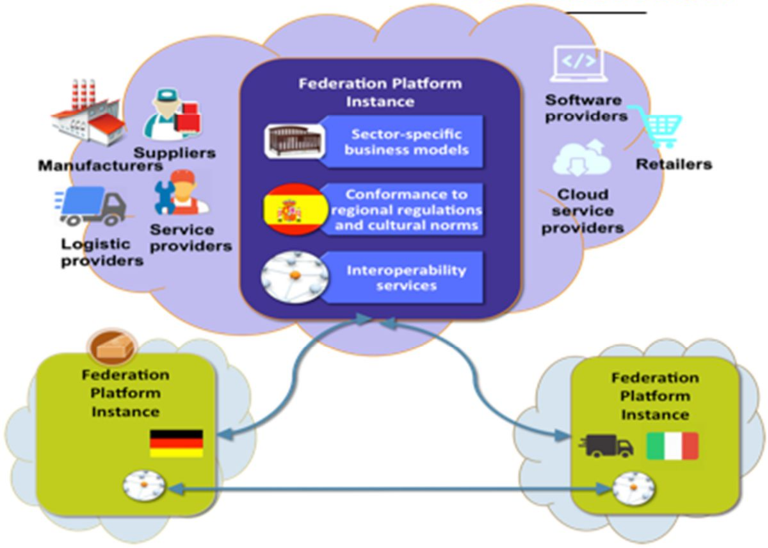
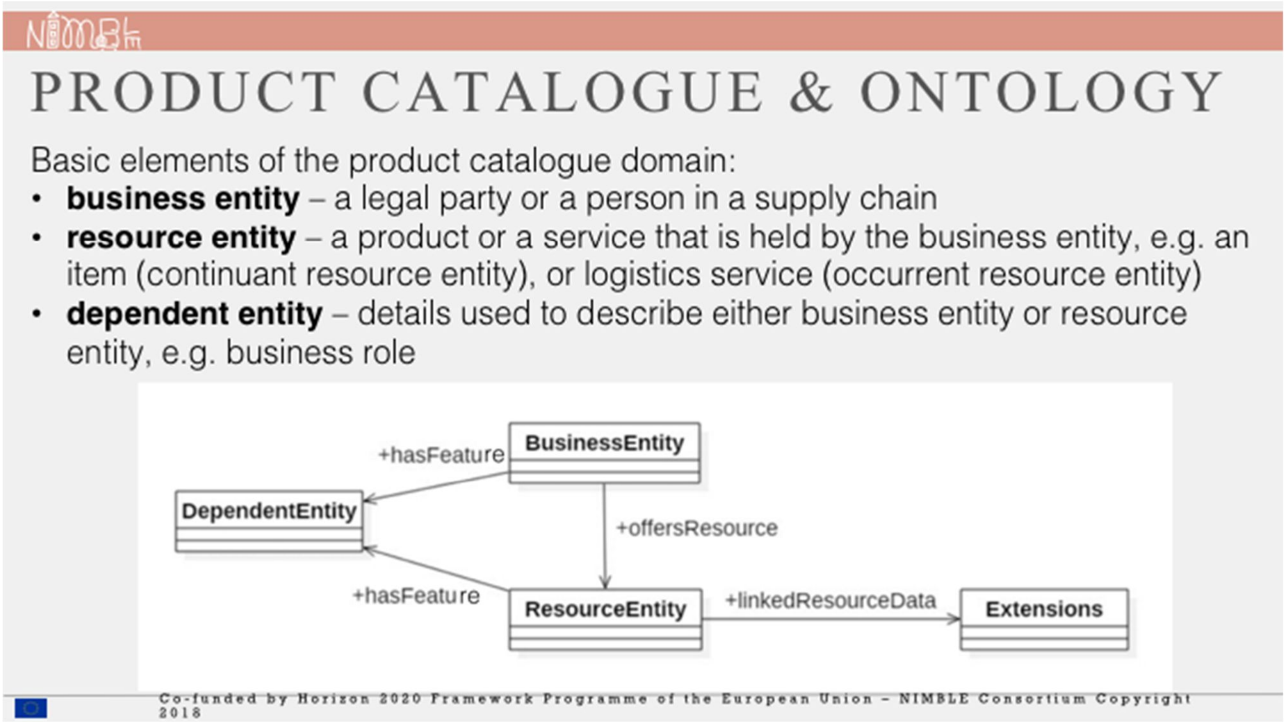
NIMBLE MAIN IDEA - FEDERATION



- Multi-Sided Platform
- Federated cloud-based businesses
- Reduced transaction costs among participants
- Collaborative business processes
- Core Business services
- Permissive open source
- Enable „Platform as a medium sized business“

CORE BUSINESS SERVICES

- Registration of users / companies (+ role management)
- Uploading and **management of product catalogues** (+ semantic annotations)
- Semantic Search based on **UBL, eCl@ss, and domain ontologies**
- Finding B2B partners and negotiating contracts that establish supply chains
- Execute business processes compliant with UBL (or design specific ones)
- Share production data via a platform-enabled data channel management system
- Use an open API to connect 3rd party services for use by participants


NIMBLE
PRODUCT CATALOGUE & ONTOLOGY
Basic elements of the product catalogue domain:
• business entity – a legal party or a person in a supply chain
• resource entity – a product or a service that is held by the business entity, e.g. an item (continuant resource entity), or logistics service (occurrent resource entity)
• dependent entity – details used to describe either business entity or resource entity, e.g. business role
BusinessEntity
+hasFeature
DependentEntity
+offersResource
+hasFeature
ResourceEntity
+linkedResourceData
Extensions
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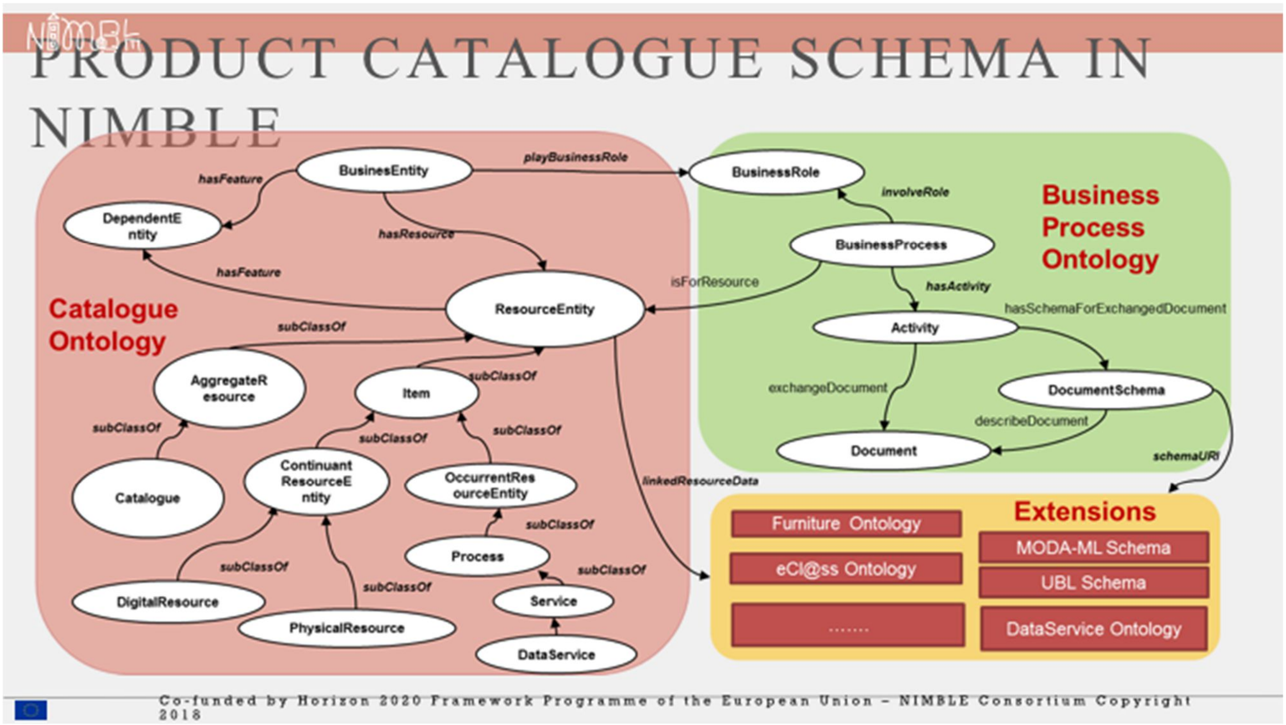
NIMBLE
PRODUCT CATALOGUE SCHEMA IN NIMBLE
Catalogue Ontology
BusinesEntity
playBusinessRole
hasFeature
DependentEntity
hasResource
hasFeature
ResourceEntity
subClassOf
AggregateResource
Item
subClassOf
subClassOf
subClassOf
subClassOf
Catalogue
ContinuantResourceEntity
OccurrentResourceEntity
subClassOf
Process
subClassOf
subClassOf
subClassOf
DigitalResource
PhysicalResource
Service
DataService
linkedResourceData
Business Process Ontology
BusinessRole
involveRole
BusinessProcess
isForResource
hasActivity
Activity
hasSchemaForExchangedDocument
exchangeDocument
DocumentSchema
describeDocument
Document
schemaURI
Extensions
Furniture Ontology
eCl@ss Ontology
....
MODA-ML Schema
UBL Schema
DataService Ontology
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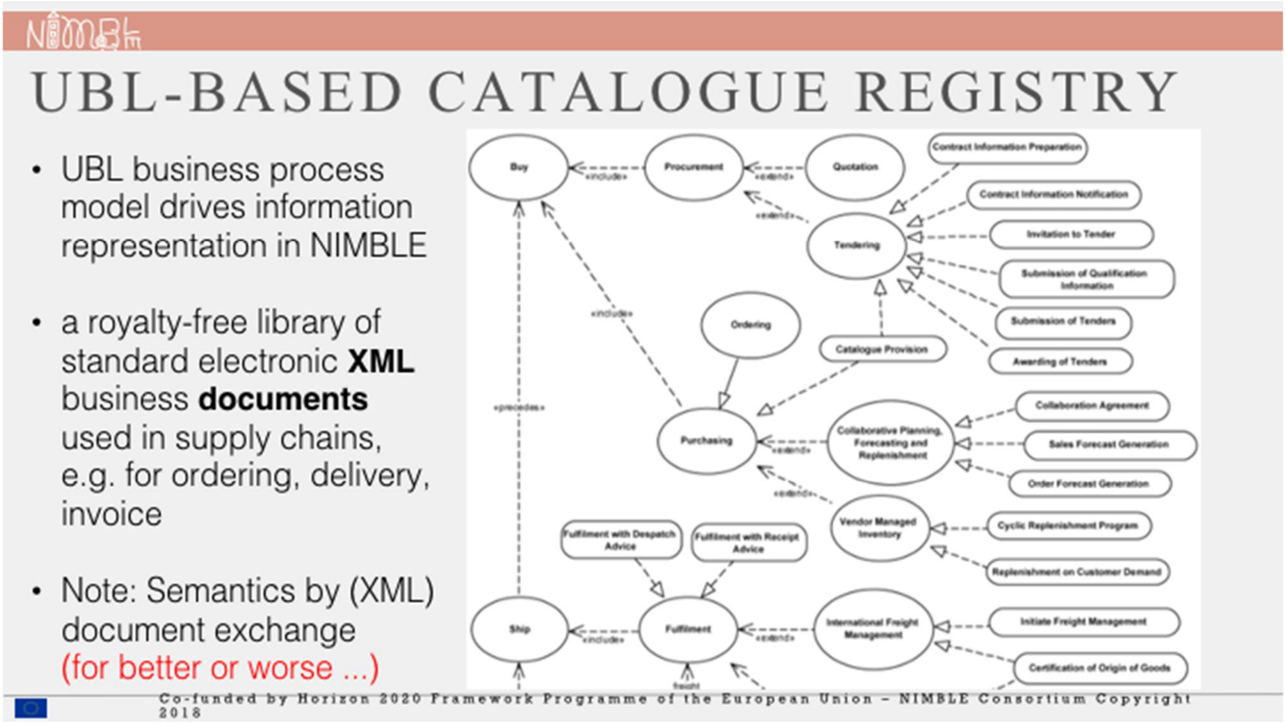
NIMBLE
UBL-BASED CATALOGUE REGISTRY
• UBL business process model drives information representation in NIMBLE
• a royalty-free library of standard electronic **XML** business **documents** used in supply chains, e.g. for ordering, delivery, invoice
• Note: Semantics by (XML) document exchange (for better or worse ...)
Buy
Procurement
Quotation
Contract Information Preparation
Contract Information Notification
Tendering
Invitation to Tender
Submission of Qualification Information
Submission of Tenders
Awarding of Tenders
Ordering
Catalogue Provision
Purchasing
Collaborative Planning, Forecasting and Replenishment
Collaboration Agreement
Sales Forecast Generation
Order Forecast Generation
Vendor Managed Inventory
Cyclic Replenishment Program
Replenishment on Customer Demand
Fulfilment with Despatch Advice
Fulfilment with Receipt Advice
Ship
Fulfilment
International Freight Management
Initiate Freight Management
Certification of Origin of Goods
«include»
«extend»
«precedes»
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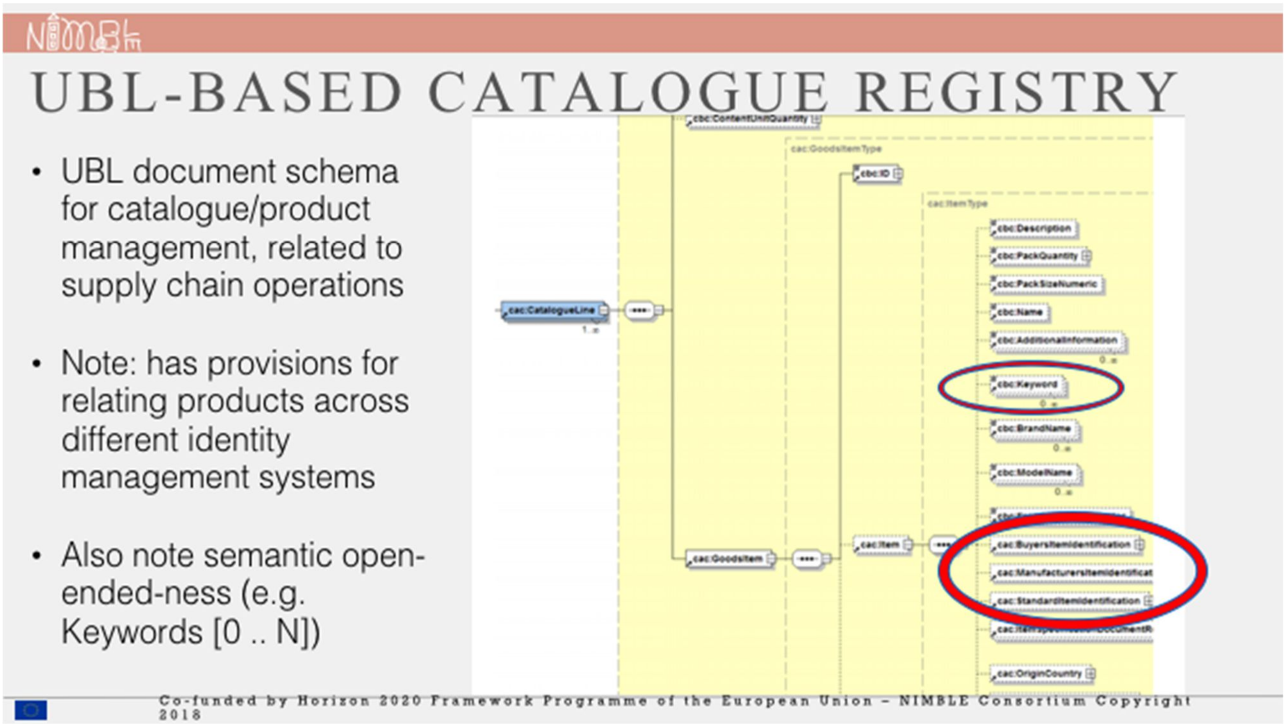
NIMBLE
UBL-BASED CATALOGUE REGISTRY
• UBL document schema for catalogue/product management, related to supply chain operations
• Note: has provisions for relating products across different identity management systems
• Also note semantic open-ended-ness (e.g. Keywords [0 .. N])
cbc:ContentUnitQuantity
cac:GoodsItemType
cbc:ID
cac:ItemType
cbc:Description
cbc:PackQuantity
cbc:PackSizeNumeric
cbc:Name
cbc:AdditionalInformation
cbc:Keyword
cbc:BrandName
cbc:ModelName
cac:CatalogueLine
cac:GoodsItem
cac:Item
cac:BuyersItemIdentification
cac:StandardItemIdentification
cac:OriginCountry
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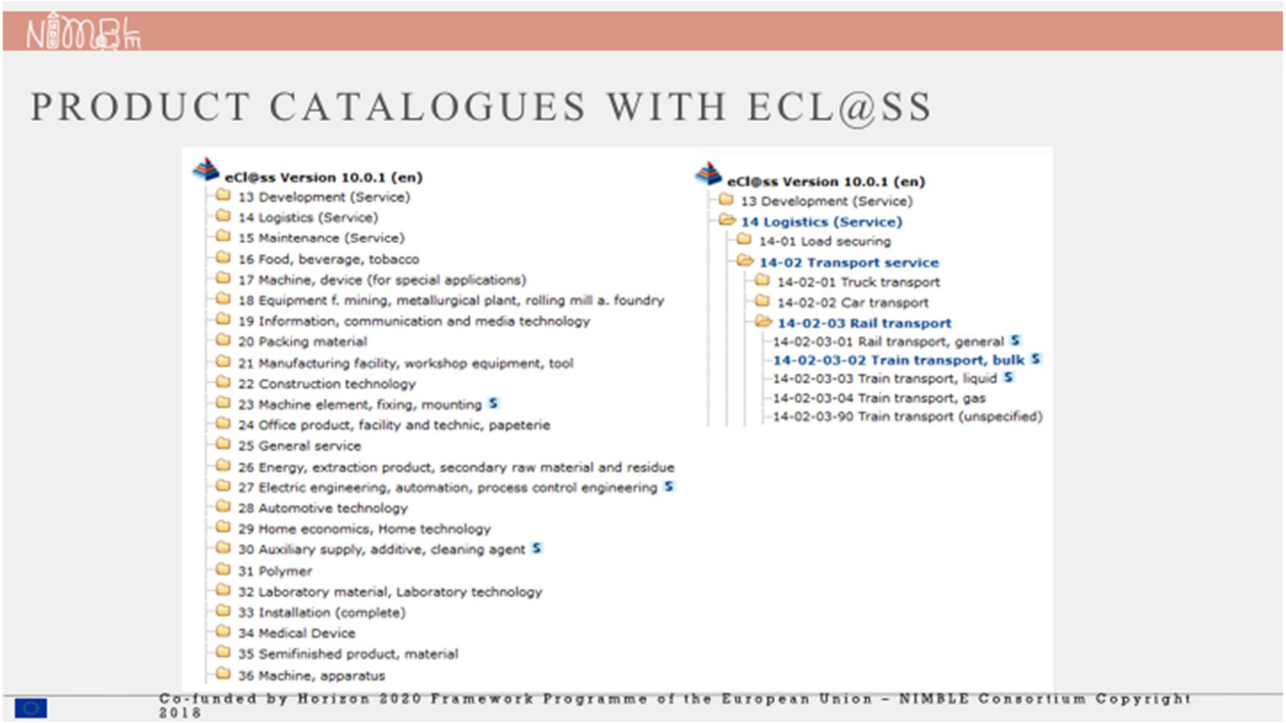
NIMBLE
PRODUCT CATALOGUES WITH ECL@SS
eCl@ss Version 10.0.1 (en)
13 Development (Service)
14 Logistics (Service)
15 Maintenance (Service)
16 Food, beverage, tobacco
17 Machine, device (for special applications)
18 Equipment f. mining, metallurgical plant, rolling mill a. foundry
19 Information, communication and media technology
20 Packing material
21 Manufacturing facility, workshop equipment, tool
22 Construction technology
23 Machine element, fixing, mounting
24 Office product, facility and technic, papeterie
25 General service
26 Energy, extraction product, secondary raw material and residue
27 Electric engineering, automation, process control engineering
28 Automotive technology
29 Home economics, Home technology
30 Auxiliary supply, additive, cleaning agent
31 Polymer
32 Laboratory material, Laboratory technology
33 Installation (complete)
34 Medical Device
35 Semifinished product, material
36 Machine, apparatus
eCl@ss Version 10.0.1 (en)
13 Development (Service)
14 Logistics (Service)
14-01 Load securing
14-02 Transport service
14-02-01 Truck transport
14-02-02 Car transport
14-02-03 Rail transport
14-02-03-01 Rail transport, general
14-02-03-02 Train transport, bulk
14-02-03-03 Train transport, liquid
14-02-03-04 Train transport, gas
14-02-03-90 Train transport (unspecified)
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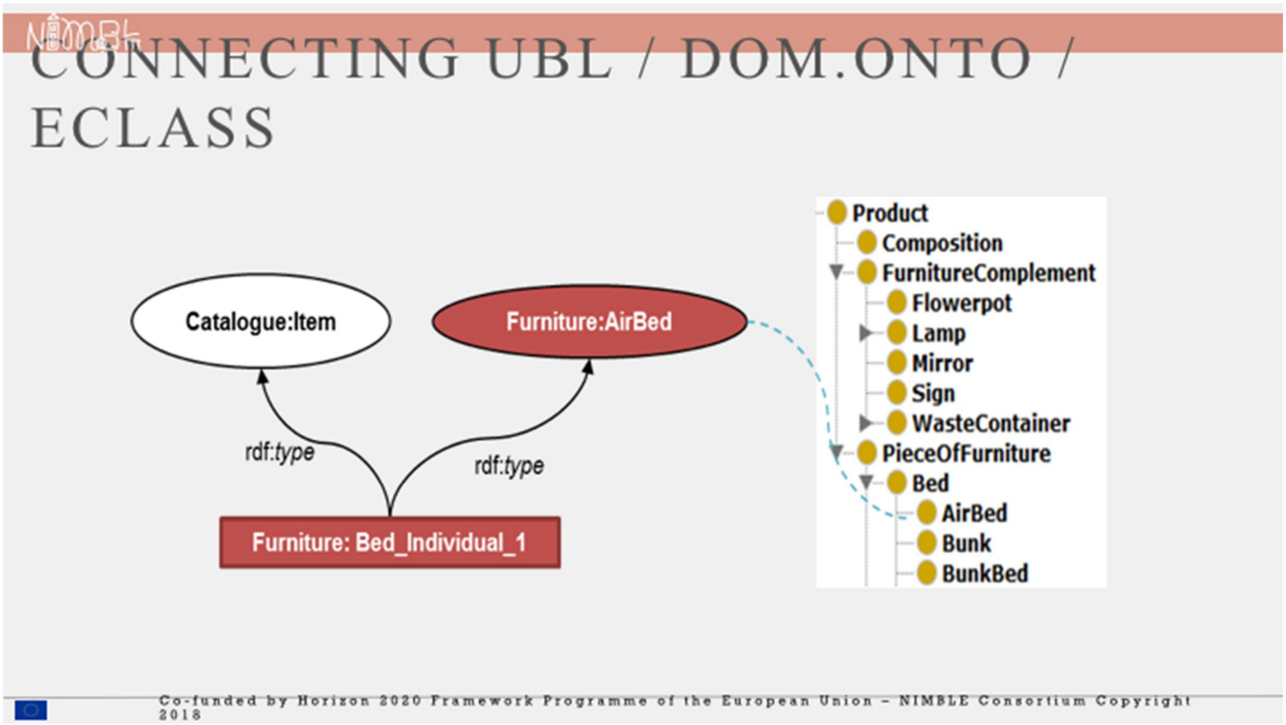
NIMBLE
CONNECTING UBL / DOM.ONTO / ECLASS
Catalogue:Item
Furniture:AirBed
rdf:type
rdf:type
Furniture: Bed_Individual_1
Product
Composition
FurnitureComplement
Flowerpot
Lamp
Mirror
Sign
WasteContainer
PieceOfFurniture
Bed
AirBed
Bunk
BunkBed
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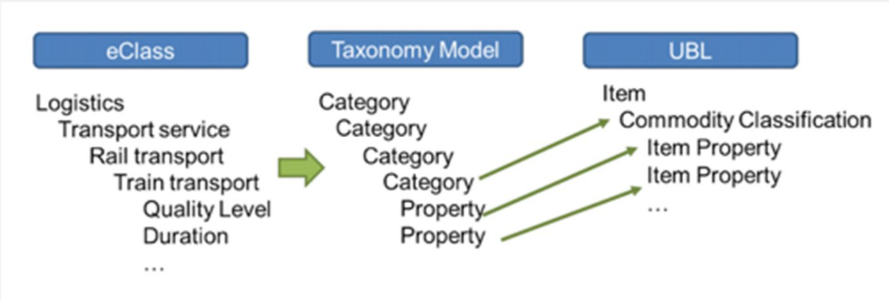
INTEGRATION OF ECLASS INTO UBL



Note that without eCl@ss, UBL would be semantically empty for catalogues

A GENERAL MODELLING ISSUE: SEPARATION OF CONCERNS

UBL describes many Business Processes

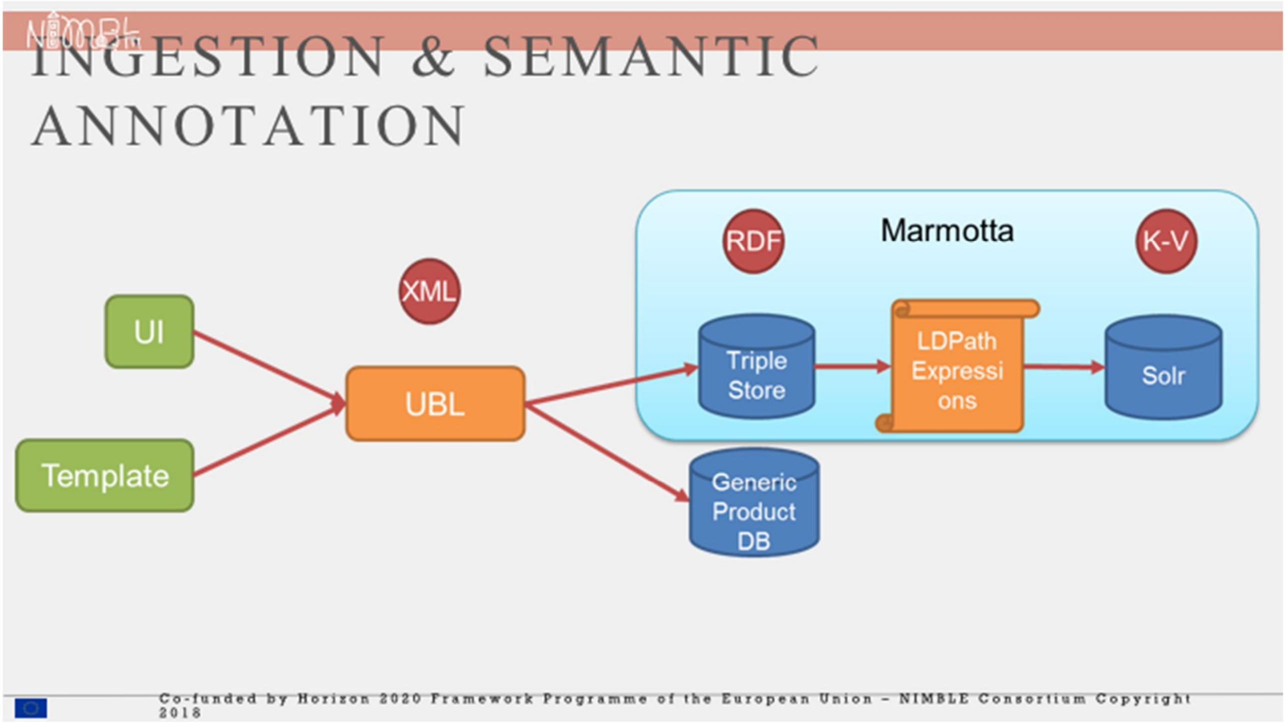
UBL says little about Products

Eclass gives us a vocabulary for distinguishing products and (logistics) services

Eclass says little about business processes

Semantic Models (aka „domain ontologies“) of specific fields try to do „a bit of both“

This leads to “semantic entropy“ (i.e. ambiguities of all sorts) when you merge ontologies


INGESTION & SEMANTIC ANNOTATION
Marmotta
RDF
K-V
XML
UI
Template
UBL
Triple Store
LDPath Expressions
Solr
Generic Product DB
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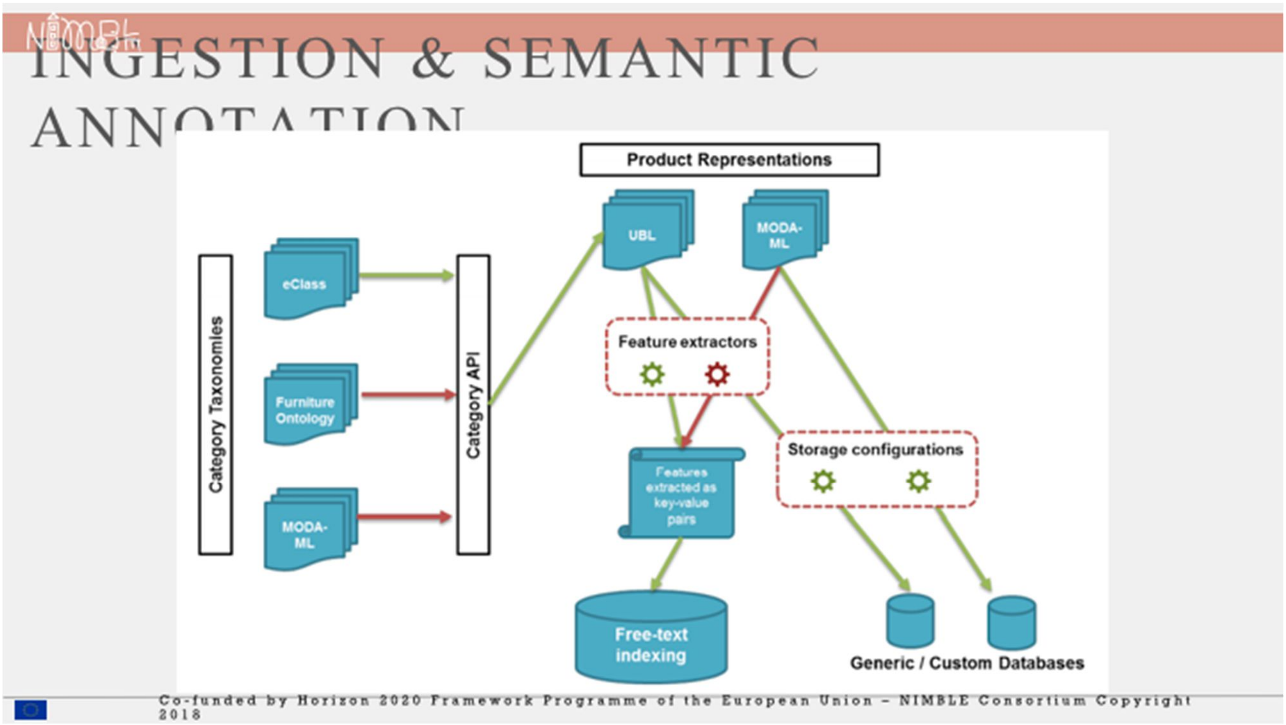
INGESTION & SEMANTIC ANNOTATION
Product Representations
Category Taxonomies
eClass
Furniture Ontology
MODA-ML
Category API
UBL
MODA-ML
Feature extractors
Features extracted as key-value pairs
Storage configurations
Free-text indexing
Generic / Custom Databases
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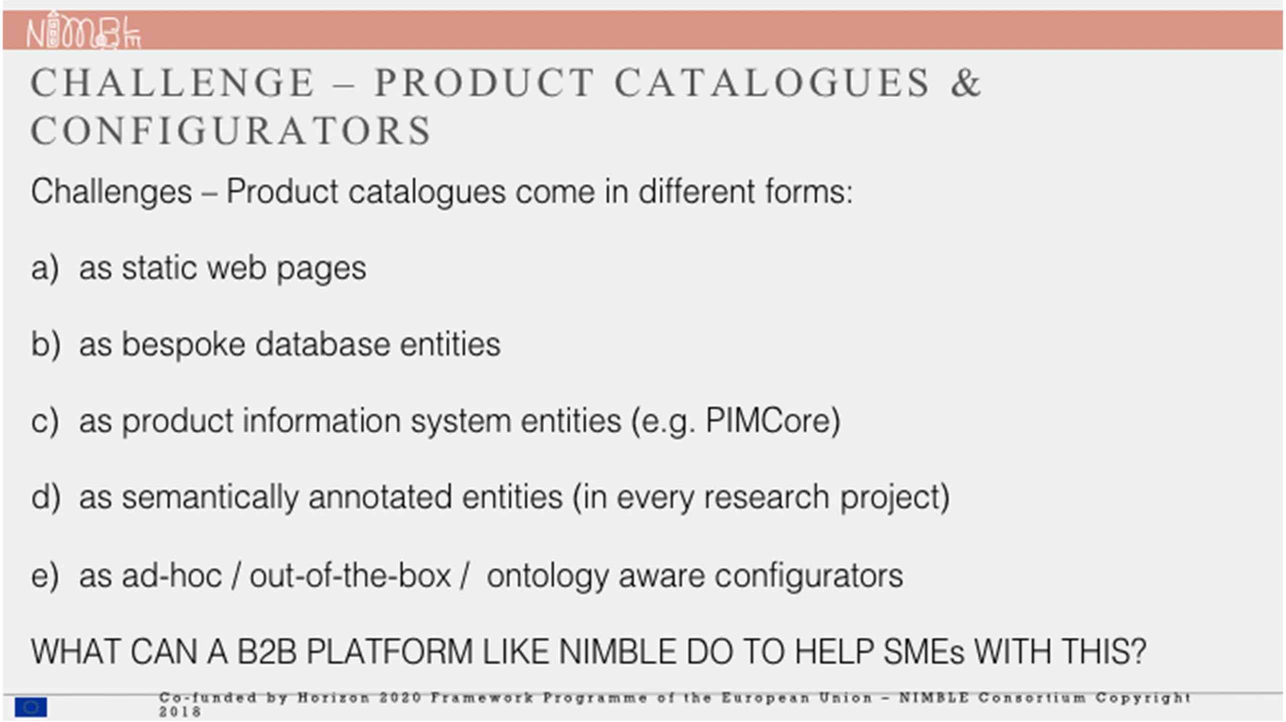
CHALLENGE – PRODUCT CATALOGUES & CONFIGURATORS
Challenges – Product catalogues come in different forms:
a) as static web pages
b) as bespoke database entities
c) as product information system entities (e.g. PIMCore)
d) as semantically annotated entities (in every research project)
e) as ad-hoc / out-of-the-box / ontology aware configurators
WHAT CAN A B2B PLATFORM LIKE NIMBLE DO TO HELP SMEs WITH THIS?
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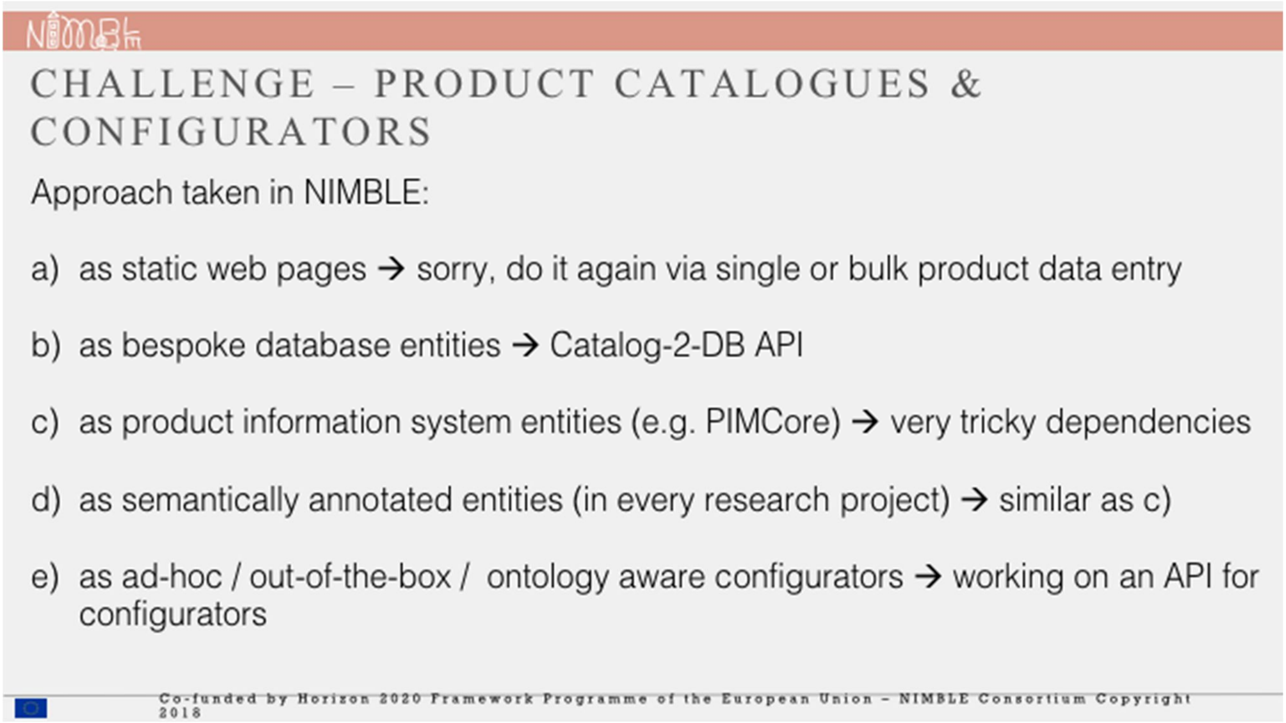
CHALLENGE – PRODUCT CATALOGUES & CONFIGURATORS
Approach taken in NIMBLE:
a) as static web pages → sorry, do it again via single or bulk product data entry
b) as bespoke database entities → Catalog-2-DB API
c) as product information system entities (e.g. PIMCore) → very tricky dependencies
d) as semantically annotated entities (in every research project) → similar as c)
e) as ad-hoc / out-of-the-box / ontology aware configurators → working on an API for configurators
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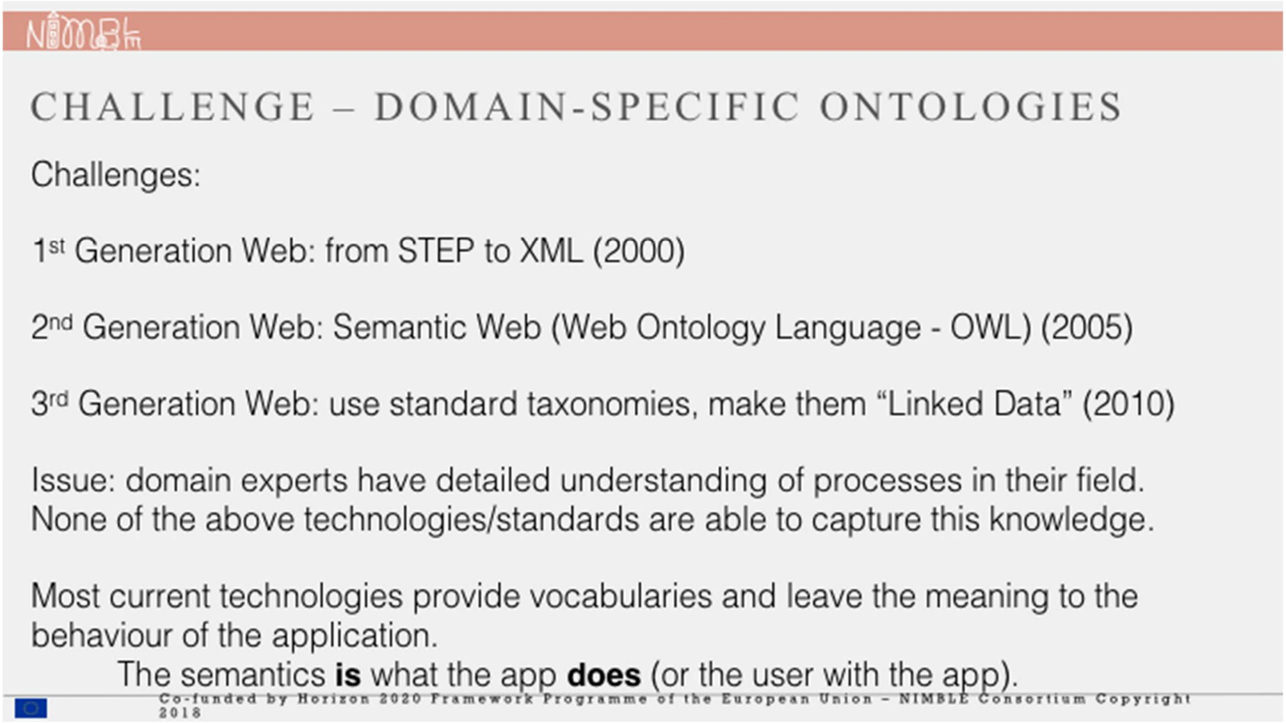
CHALLENGE – DOMAIN-SPECIFIC ONTOLOGIES
Challenges:
1st Generation Web: from STEP to XML (2000)
2nd Generation Web: Semantic Web (Web Ontology Language - OWL) (2005)
3rd Generation Web: use standard taxonomies, make them “Linked Data” (2010)
Issue: domain experts have detailed understanding of processes in their field.
None of the above technologies/standards are able to capture this knowledge.
Most current technologies provide vocabularies and leave the meaning to the
behaviour of the application.
The semantics is what the app does (or the user with the app).
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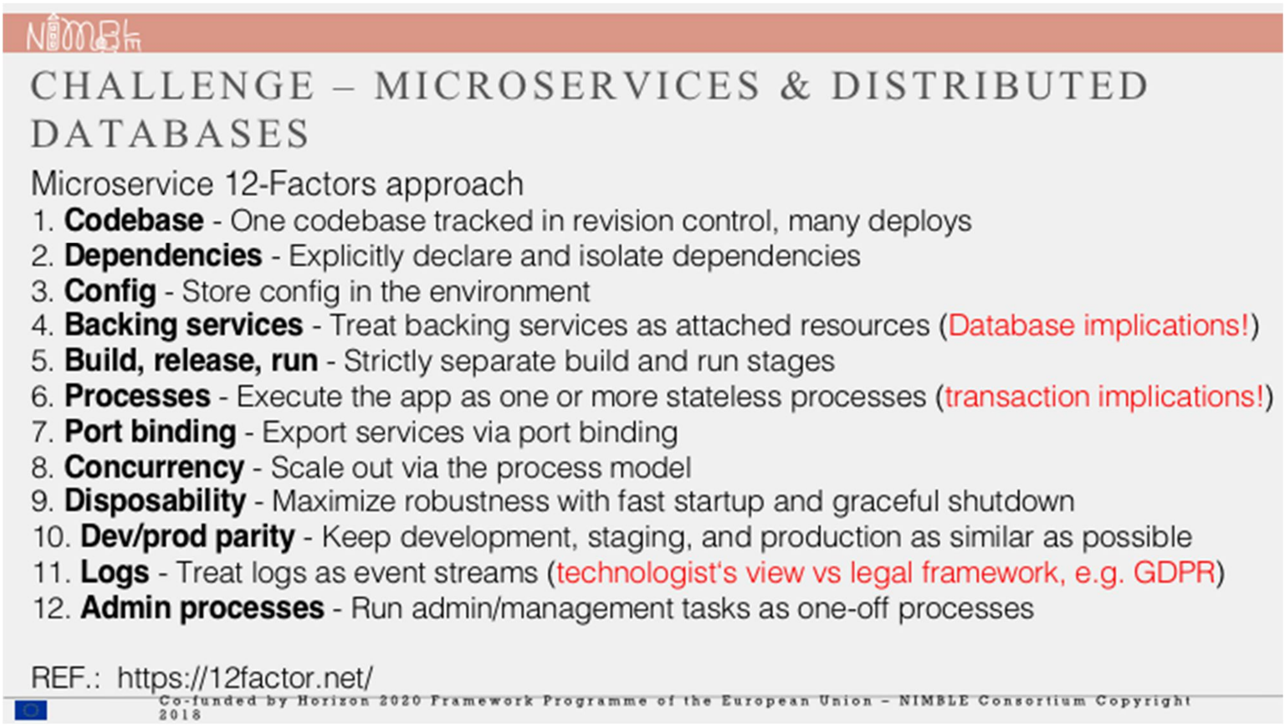
CHALLENGE – MICROSERVICES & DISTRIBUTED DATABASES
Microservice 12-Factors approach
1. Codebase - One codebase tracked in revision control, many deploys
2. Dependencies - Explicitly declare and isolate dependencies
3. Config - Store config in the environment
4. Backing services - Treat backing services as attached resources (Database implications!)
5. Build, release, run - Strictly separate build and run stages
6. Processes - Execute the app as one or more stateless processes (transaction implications!)
7. Port binding - Export services via port binding
8. Concurrency - Scale out via the process model
9. Disposability - Maximize robustness with fast startup and graceful shutdown
10. Dev/prod parity - Keep development, staging, and production as similar as possible
11. Logs - Treat logs as event streams (technologist's view vs legal framework, e.g. GDPR)
12. Admin processes - Run admin/management tasks as one-off processes
REF.: https://12factor.net/
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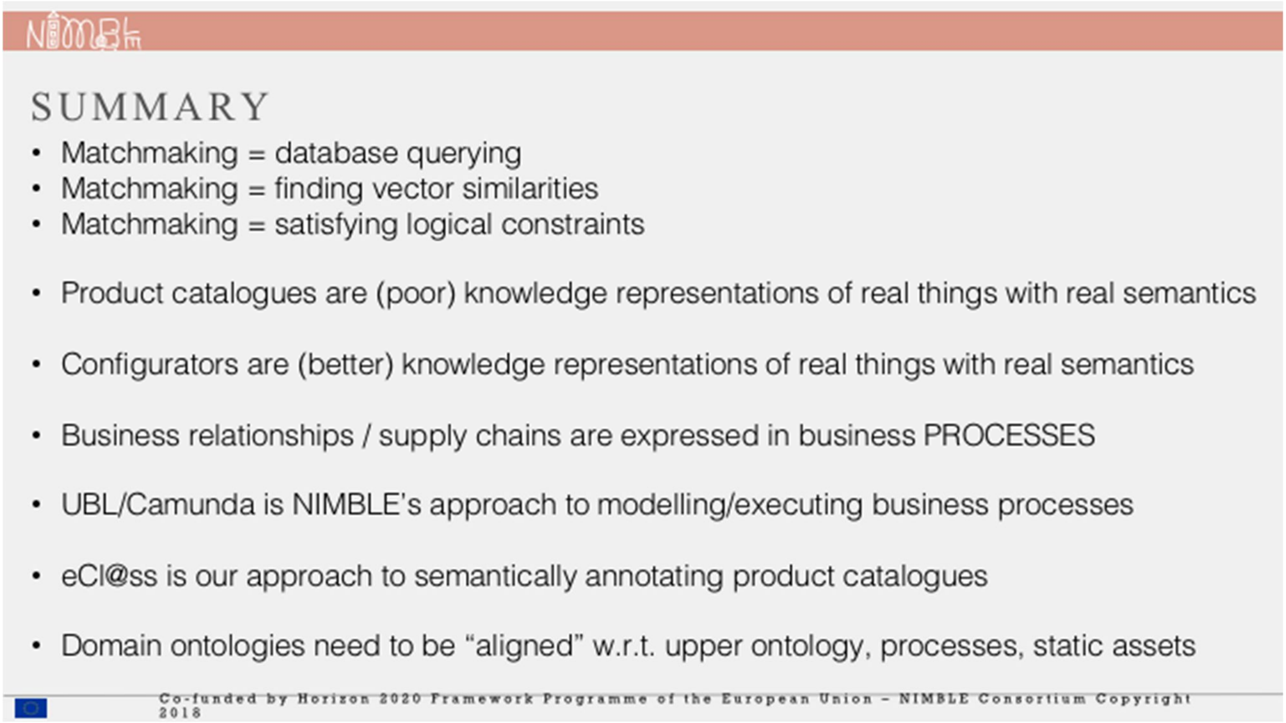
SUMMARY
• Matchmaking = database querying
• Matchmaking = finding vector similarities
• Matchmaking = satisfying logical constraints
• Product catalogues are (poor) knowledge representations of real things with real semantics
• Configurators are (better) knowledge representations of real things with real semantics
• Business relationships / supply chains are expressed in business PROCESSES
• UBL/Camunda is NIMBLE's approach to modelling/executing business processes
• eCl@ss is our approach to semantically annotating product catalogues
• Domain ontologies need to be "aligned" w.r.t. upper ontology, processes, static assets
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THANK YOU FOR YOUR ATTENTION
Wernher Behrendt
Senior Researcher
Salzburg Research, Austria
E-Mail:
wernher.behrendt@salzburgresearch.at
Salzburg Research Forschungsgesellschaft m.b.H.
Internet of Things / Industrial Internet
Jakob-Haringer Strasse 5/II
5020 Salzburg
Austria

NIMBLE

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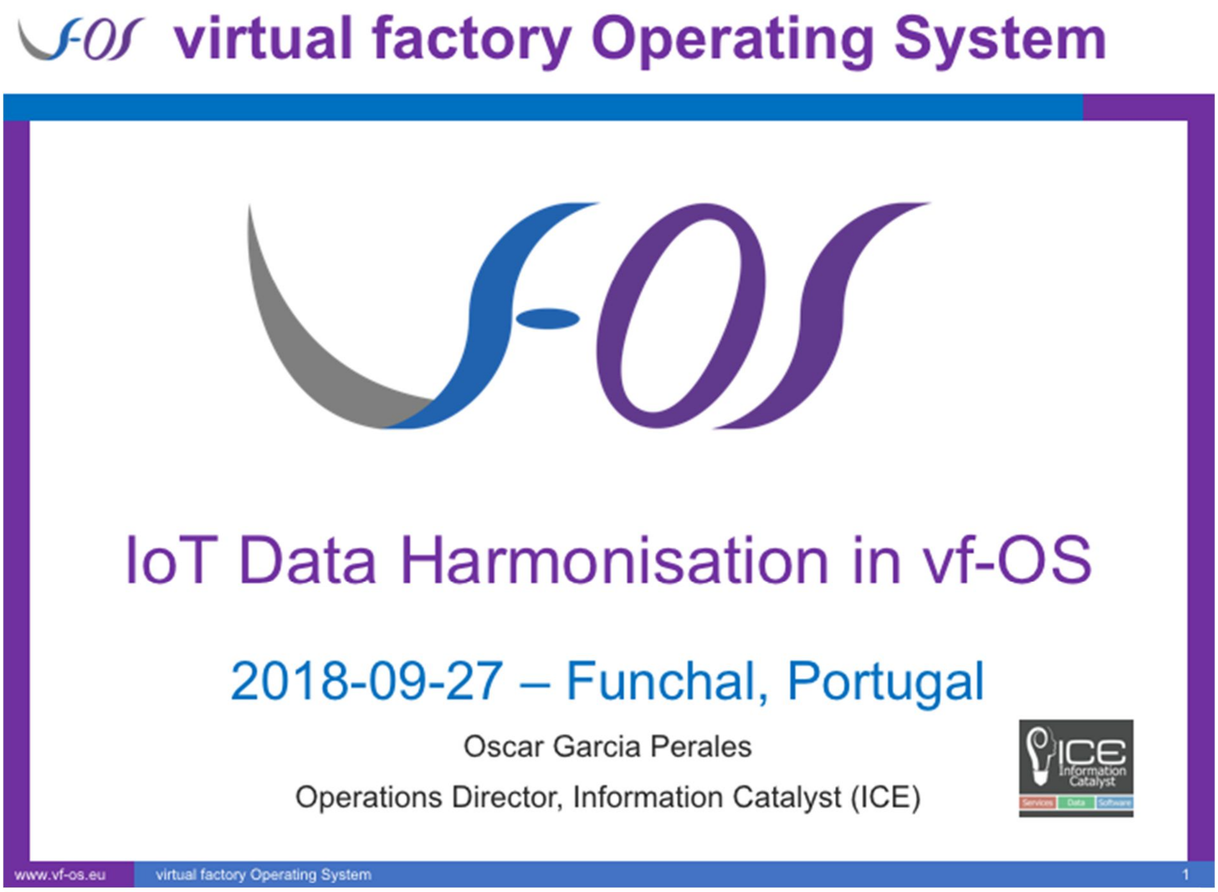
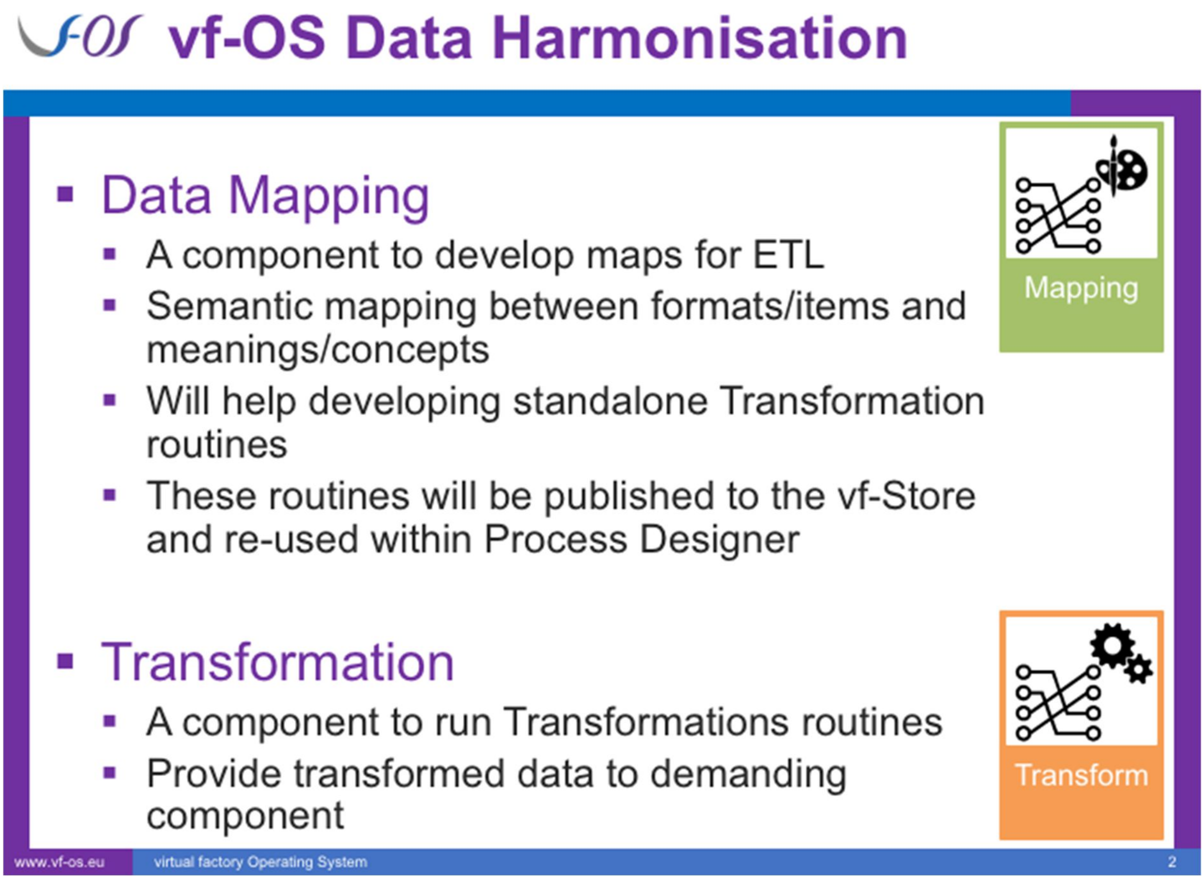
HTTPS://WWW.NIMBLE-PROJECT.ORG/PLATFORM


virtual factory Operating System
IoT Data Harmonisation in vf-OS
2018-09-27 – Funchal, Portugal
Oscar Garcia Perales
Operations Director, Information Catalyst (ICE)
ICE
Information Catalyst
Services
Data
Software
www.vf-os.eu
virtual factory Operating System
1


vf-OS Data Harmonisation
Data Mapping
A component to develop maps for ETL
Semantic mapping between formats/items and meanings/concepts
Will help developing standalone Transformation routines
These routines will be published to the vf-Store and re-used within Process Designer
Mapping
Transformation
A component to run Transformations routines
Provide transformed data to demanding component
Transform
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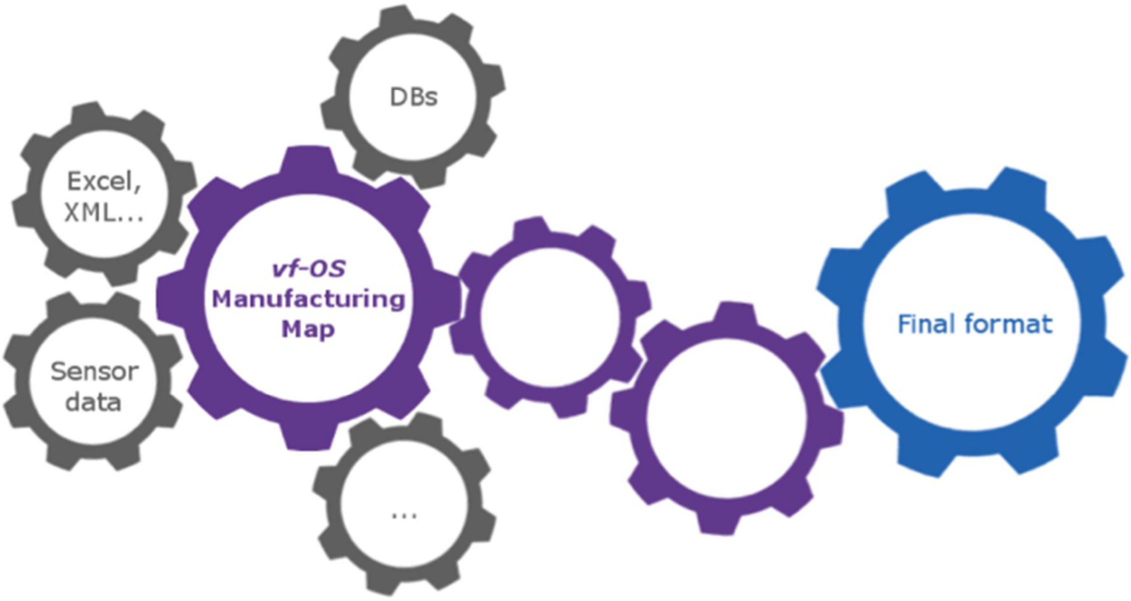
virtual factory Operating System
2

vf-OS Data Harmonisation



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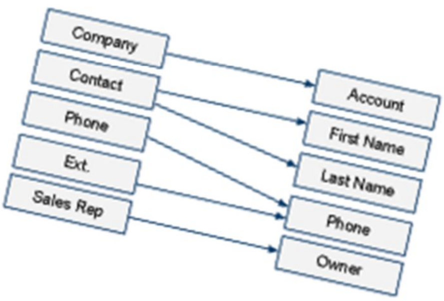
vf-OS Data Harmonisation

- vf-OS Data Model
- Syntactic and Semantic integration
- Crowdsourcing for better mapping suggestions
- Self-executable libraries



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vf-OS Data Model

- Main idea:
  - To provide clues to the user establish the mappings
  - Focused in connecting concepts/terms without any taxonomic structure
  - Conceptual structure with relations that relates concepts independently the why or the properties associated to such connections
- Future Actions:
  - Work in relate concepts potentially be mapped
  - Will require (re)adjusts as far as we use it to confirm it works perfectly to our purpose

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IoT devices Data Harmonisation

- In IoT world, sensors and devices are continuously spitting data each of them in their own format
- Each sensor will require an specific Transformation routine
- Similar sensors may share similar data formats
- vf-OS Manufacturing Maps can be:
  - Published in the vf-Store, so they can be sold (shared) with other representatives of the community
  - Derived from the knowledge of the crowd
  - Deployed as self-executable libraries for re-use at vApp development phase
  - Parametrized by providing any Pub/Sub topic, Messaging channels or persistent storages

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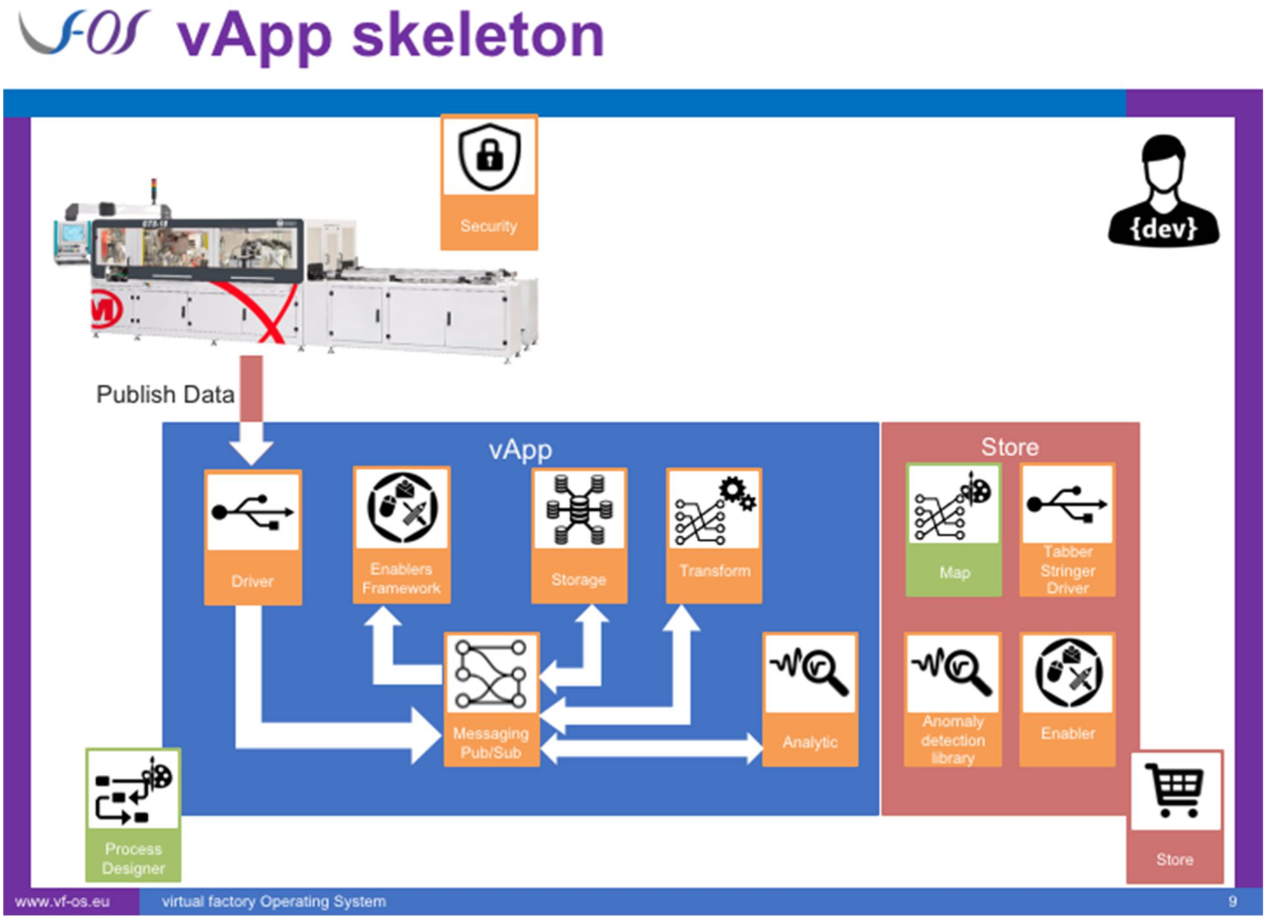
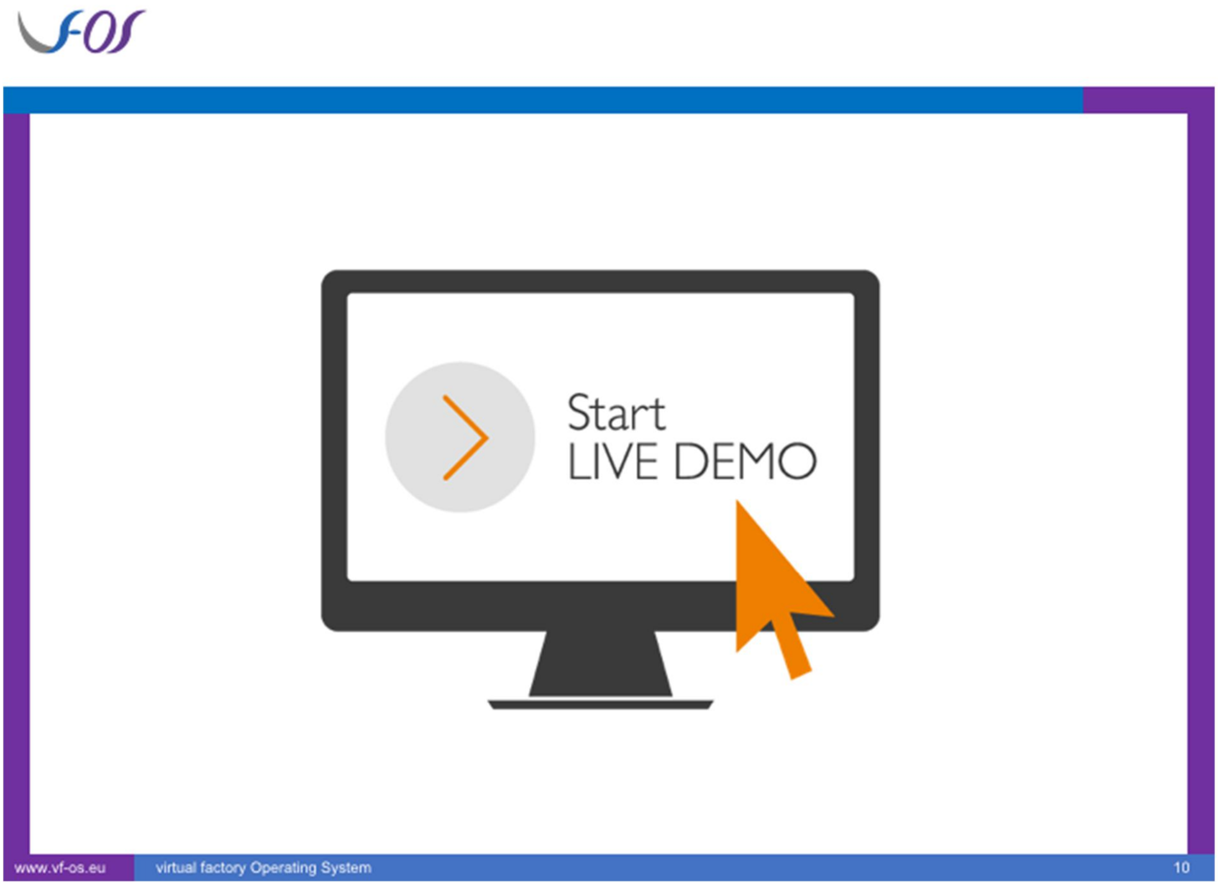
Let's build a *part of a* vApp

Business need:

- Create vApp capable of triggering alarms when a Tabber Stringer machine sensor hits a given value


vApp skeleton
Security
{dev}
Publish Data
vApp
Driver
Enablers Framework
Storage
Transform
Messaging Pub/Sub
Analytic
Store
Map
Tabber Stringer Driver
Anomaly detection library
Enabler
Process Designer
Store
www.vf-os.eu
virtual factory Operating System
9


Start
LIVE DEMO
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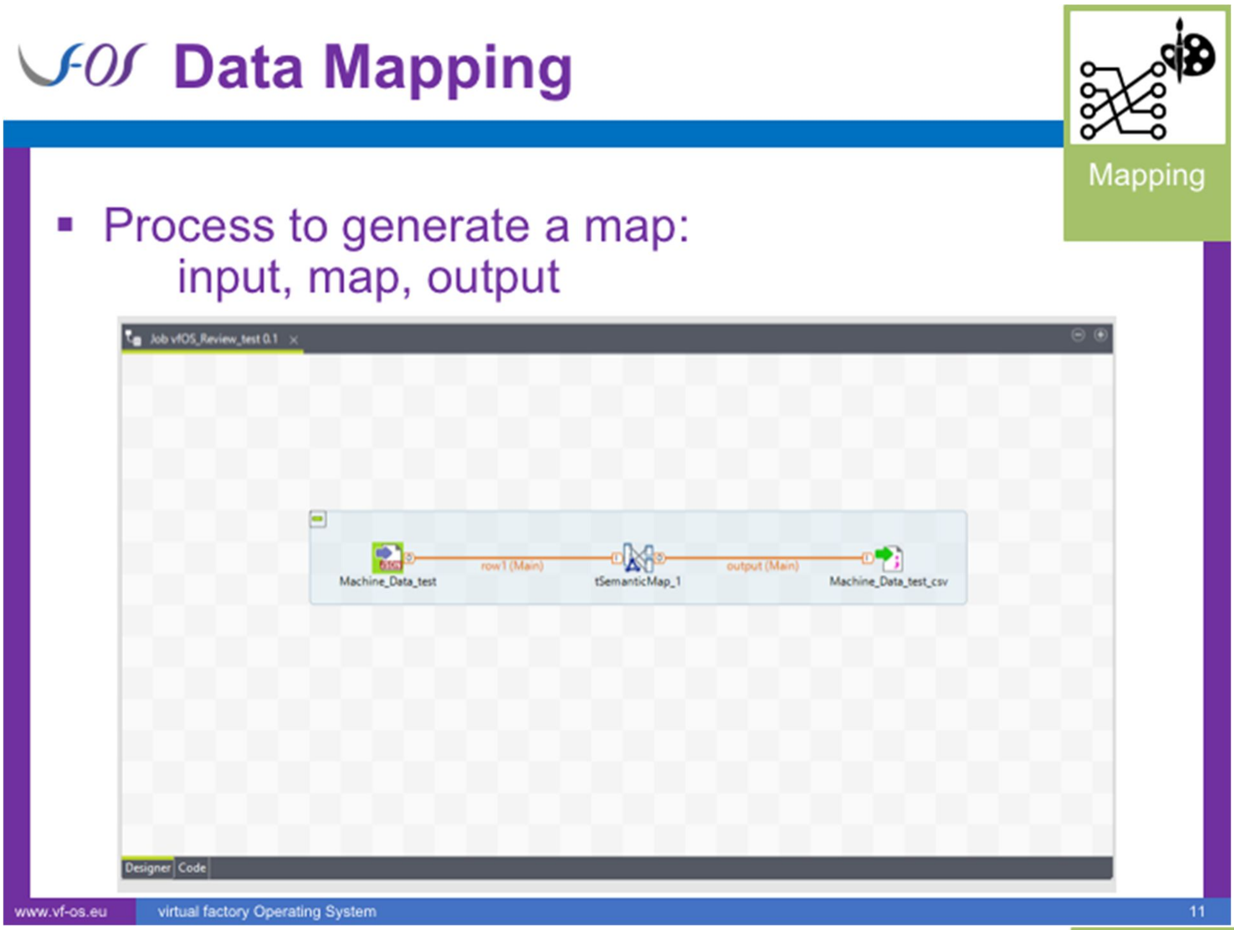
virtual factory Operating System
10


Data Mapping
Mapping
Process to generate a map:
input, map, output
Job vfOS_Review_test 0.1
Machine_Data_test
row1 (Main)
tSemanticMap_1
output (Main)
Machine_Data_test_csv
Designer
Code
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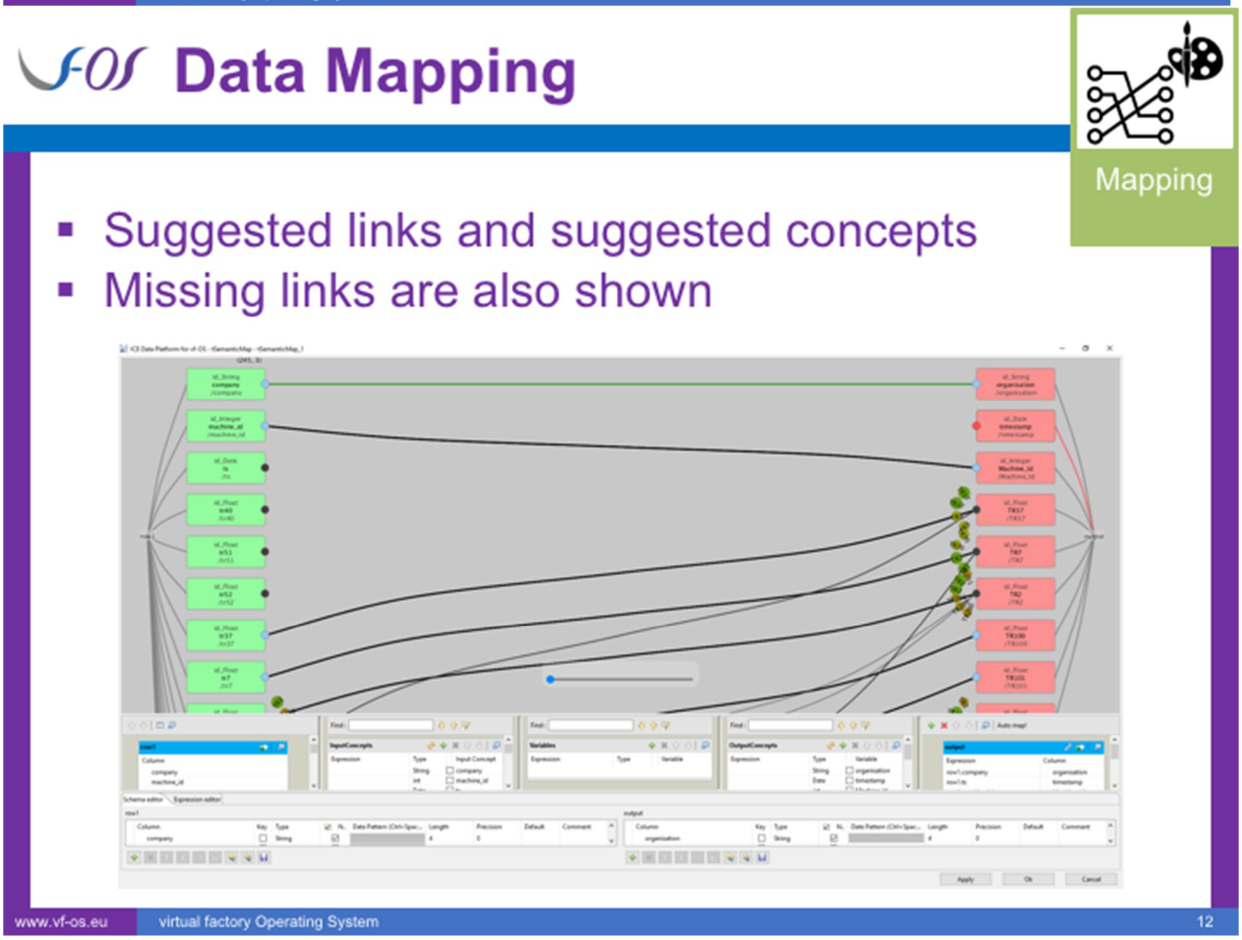
11


Data Mapping
Mapping
Suggested links and suggested concepts
Missing links are also shown
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12

Questions?

Presented by

Annex M: IS'18 vf-OS Photos


vf-OS

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