Ecosystem for COllaborative Manufacturing PrOceSses – Intra- and Interfactory Integration and AutomaTION
(Grant Agreement No 723145)

D8.1 Pilot plans on the Shopfloors and preparation actions I

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Nadir Raimondo (ISMB)	2018-02-08	Minor modifications. Proposition to place table 6 in a separate chapter.

Index:

1 Executive Summary

The present document is a deliverable of the COMPOSITION project, that is funded by the European Commission's Horizon 2020 Research and Innovation programme, reporting the results of the activities carried out by WP8. The aim of COMPOSITION is to create a digital automation framework (the COMPOSITION IIMS) that optimizes the manufacturing processes by exploiting existing data, knowledge and tools to increase productivity and dynamically adapt to changing market requirements. This is achieved through the connection of supply chain (inter-factory) data and services among enterprises and the connection of value chain (intra-factory) data within a factory, so that it can meaningfully support decision-making. More specifically the developments of COMPOSITION will be demonstrated and validated to five multi-sided pilots. The first pilot, from the biomedical device domain (Boston Scientific Ltd - BSL), focuses on the integrated information management system in a multisided manufacturing process (intra-factory). The second pilot from the lift manufacturing industry (KLEEMANN - KLE) concentrates on intra-factory procedures and on interaction between different companies using the COMPOSITION ecosystem with the agent-based marketplace for collaboration (inter-factory). The third pilot from the recycling industry (ELDIA) focuses on the reduction of the amount of waste that is disposed at the Sanitary Landfill (inter-factory). The fourth pilot from the industrial manufacturing software domain (ATLANTIS - ATL), focuses on the supply chain/Inter-factory cases and will deploy COMPOSITION for software upgrade and deployment. The last pilot from the IT and Telecommunications sector (NEXTWORKS – NXW), serves as a technology and service provider in both the value chain and the supply chain use cases, specifically for factory premises and production line monitoring and management.

This deliverable provides a methodology for planning and preparing the pilots' sites for the use case implementation. The methodology is comprised of four stages: 1. Factory Acceptance Testing, 2. Site Acceptance Testing, 3. Deployment and Commissioning and 4. Operation and Maintenance. COMPOSITION components, their usage and implementation per use case are described in detail. Finally, a concluding overall framework for pilot plans on the shopfloor and preparation actions is presented. This framework is common for all pilots and combines the developed components with each use case.

Deliverable *"D8.1 Pilot plans on the Shopfloor and preparation actions I"* documents the actions that should be taken for preparing the shopfloor before the deployment of COMPOSITION tools. D8.1 will be further developed through an iterative approach, and results of it will be presented in the second version of D8.1 i.e. *"D8.2 Pilot plans on the Shopfloor and preparation actions II"* (M30).

2 Abbreviations and Acronyms

Table 1: Abbreviations and acronyms used in the deliverable

Acronym	Definition
AMS	Agent Management Service
AMQP	Advanced Message Queuing Protocol
BMS	Building Management Systems
CSO	Chief Sales Officer
DoA	Description of Action
DSS	Decision Support System
FAT	Factory Acceptance Testing
HMI	Human Machine Interfaces
IIMS	Integrated Information Management System
JWS	JSON Web Signature
LS	Learning Service
PCB	Printed Circuit Board
PCBAs	Printed Circuit Board Assemblies
RTLS	Real Time Location System
SAT	Site Acceptance Testing
SPD	Solder Paste Deposit
SPI	Solder Paste Inspection
UC(s)	Use Case(s)

3 Introduction

3.1 Purpose, context and scope of this deliverable

The purpose of this deliverable is to provide a systematic methodology for the planning and preparation actions that should be taken for the implementation of the use cases. This document focuses on the preparation of the COMPOSITION platform (components, tools, services, interfaces) and installation of infrastructures to the shopfloor. The document will be updated in *“D8.2 Pilot plans on the Shopfloor and preparation actions II”*, due in M30.

D8.1 describes the usage of COMPOSITION platform components that are necessary for the successful implementation of the use cases (Boston Scientific, KLEEMANN, ELDIA, ATLANTIS and Nextworks) at the five pilot sites. The five pilots and their involvement in COMPOSITION are described in section 6.

3.2 Content and structure of this deliverable

The deliverable is structured as follows:

Section 4, includes details of the methodology regarding the planning of implementation on the shopfloors, the time scheduling and the evaluation of the pilots. In section 5, the architecture components and its usage and implementation are described. Section 6 includes details of the value chain (intra-factory) scenarios and supply chain (inter-factory) scenarios. Section 7 concludes the deliverable by presenting a framework of pilot plans on the shopfloor and preparation actions.

4 Methodology for Planning the Deployment on the Shopfloors

4.1 Shopfloor areas for the deployment of the use cases

The use cases shall be linked to specific shopfloor areas, according to specifications and user needs taking into account the ongoing needs of the project (for example UC prioritization). The end users shall provide figures that show the highlighted areas where the use cases will be deployed. They should also provide information about the industrial infrastructure for the deployment.

4.2 Planning of implementation

The purpose of this section is to describe the planning methodology towards the deployment of the COMPOSITION system at the pilot sites, in order to better understand the scenarios and use cases that were developed based on the end-user's needs and requirements documented in "*D2.1 Industrial use cases for an Integrated Information Management System"* and "*D2.2. Initial requirements specification".* The main objective is to enhance and enrich the pilots' shopfloor environments by integrating the key enabling technologies and developed components.

4.2.1 Methodology

This section describes the processes that will be followed in order to utilize the COMPOSITION tools and components into operation at the end users' shopfloors. The key stages towards implementation are identified below.

- **Stage 1 Design of components – Preparatory actions (Factory Acceptance Testing, FAT)**

  Factory Acceptance Testing is used to make sure that the system performs as expected. It verifies the correct operation of the system and formally approves it. FAT makes sure that certain steps are met. It is a customized process for checking the system and its functions and includes 5 steps i.e. Planning, Performing Test Activities, Gathering Test Results, Identifying and Correcting Issues (if necessary) and Sign-off (see Figure 1). The first step, planning, is related to the definition and documentation of the tests to be performed, test criteria, protocols, tools needed along with specifications for variances and acceptability. Roles and responsibilities of the involved personnel should also be defined. In step 2, the involved stakeholders (end users' personnel and technical partners), collaborate in order to perform tests based on the planned requirements, specifications and agreements. Results and outcomes are gathered and measured to determine whether objectives and criteria of tests have been met (step 3). According to pre-determined criteria, step 4 identifies the faults, failures, errors and hazards that may occur. Any unresolved issue, is addressed for acceptance. This process may require re-testing. Finally, the involved stakeholders sign-off on the acceptance of equipment/systems (step 5). Factory acceptance tests are performed by the end users along with the technical partners.

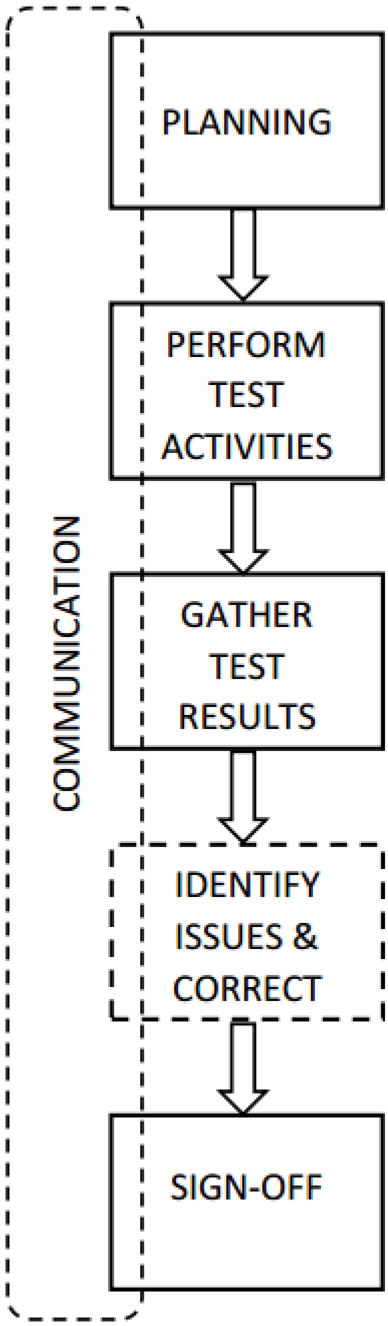

Figure 1: Factory Acceptance Testing

- **Stage 2 Set-up at the shopfloors (Site Acceptance Testing, SAT)**

  Site Acceptance Testing is used to show that the system is working as expected in its operational environment. More specifically, it makes sure that the COMPOSITION IIMS is adequately tested at the end user's facility and performs according to the end user's expectations and specifications. The tests also show whether the system interacts properly with all other systems at the site. The installation is performed by the technology providers in close collaboration with the end-user. The basic infrastructure and the equipment installation at the final position is done by end-user personnel according to health and safety regulations and in compliance with the regulation for commissioning equipment to shopfloor with specific industry pilot plants. The installation is performed either by local presence of the technology providers or remotely through the appropriate tools for accessing the infrastructures and the servers that will be used for COMPOSITION project. A user preparation plan should also be designed comprised by two parts. The first part, "user recruiting plan" describes the key messages that are delivered to the users and any incentives intended to promote participation in the pilot. The second part "user training plan" describes the training during the pilot covering topics such as the description of the UC, the expected results and a brief description of the COMPOSITION IIMS.

- **Stage 3 Deployment and Commissioning**

  In this stage, all required equipment (sensors, cables, gateways etc), software and connections, are installed. After the installation phase, the equipment is tested in a standalone environment including wireless and cabled connections. The developed software is deployed to the end users' facilities after successful testing. The end user performs the tests and any bugs found are reported to the technical partners.

- **Stage 4 Operation and Maintenance**

  Operation and maintenance includes information related to the ongoing operation and periodic maintenance required for each of the use case components and technologies.

The four stages of pilot planning on the shopfloor are presented below in Figure 2. To ensure successful pilot planning and testing, effective communication is important throughout the stages, setting clear expectations and clarifying roles and responsibilities before each stage is to be performed.

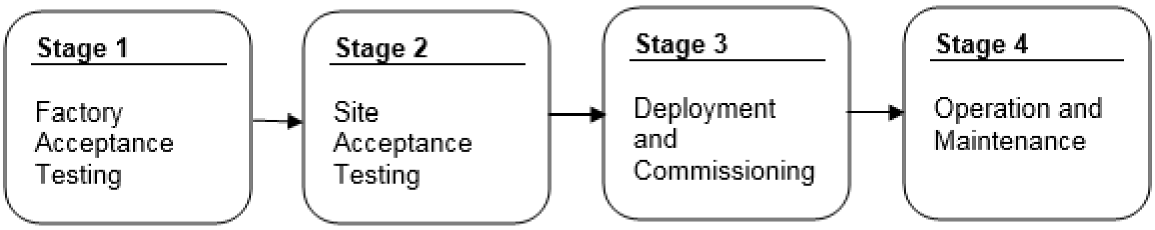

Figure 2: The four stages of pilot planning on the shopfloor

4.2.2 Implementation activities

In this section, the activities performed before and during the deployment and operation of the COMPOSITION platform shall be described. The activities should be identified by the implementation team (pilot partners, technical partners, research partners) in every stage of the pilot planning and for every use case. Some examples are given in the table below.

Table 2: Activities and aspects description

No.	Activity/Aspect description	Input / Comments
1	Logical, sequential and efficient coordination of activities	
2	Develop clear deployment specifications	
3	Edit an implementation report	
4	Other	

4.2.3 Time scheduling for each use case

A Gantt diagram of the implementation stages of the use cases should be provided in the beginning of each use case pilot. The Gantt diagram illustrates the project time schedule, the relationships between the use case stages and the current status. An example is given below.

Table 3: Gantt diagram UC scheduling

Use Case Stages	M18	M19	M20	M21	M22	M23	M..(n)	M36
UC- (Company) - (Number), e.g. UC-BSL-1								
Design-Preparation (FAT)								
Set up (SAT)								
Deployment - Commissioning								
Operation - Maintenance								

4.2.4 Evaluation of pilot studies

In line with *"D8.7 Evaluation Framework"*, quantitative and qualitative data will be gathered through a combination of questionnaires, interviews, telco's and workshops. In addition to D8.7, the pilot studies will be evaluated considering multiple criteria that will be defined during the implementation phase. Evaluation criteria could be classified into categories such as energy consumption, process viability, health and safety issues, cost efficiency etc. (see table below).

Table 4: Evaluation of pilot studies

No.	Evaluation category	Input / Comments
1	Energy consumption	
2	Process viability	
3	Health and safety issues	
4	Cost efficiency	
5	Other	

5 Components and their Application in COMPOSITION Use Cases

5.1 User workshop and scenarios

Two user workshops were conducted at the BSL and KLEEMANN premises. These workshops included tours on the facilities, for the latter also a tour at ELDIA. The participants discussed relevant scenarios and developed value chain and supply chain use cases.

The workshops and developed use cases are described in detail in deliverable "*D2.1 Industrial Use Cases for an Integrated Information Management System"*.

5.2 COMPOSITION components

COMPOSITION components are documented in brief below. Detailed descriptions are available in *"D2.3 The COMPOSITION architecture specification I"*. The diagram below shows the dependencies between COMPOSITION components.

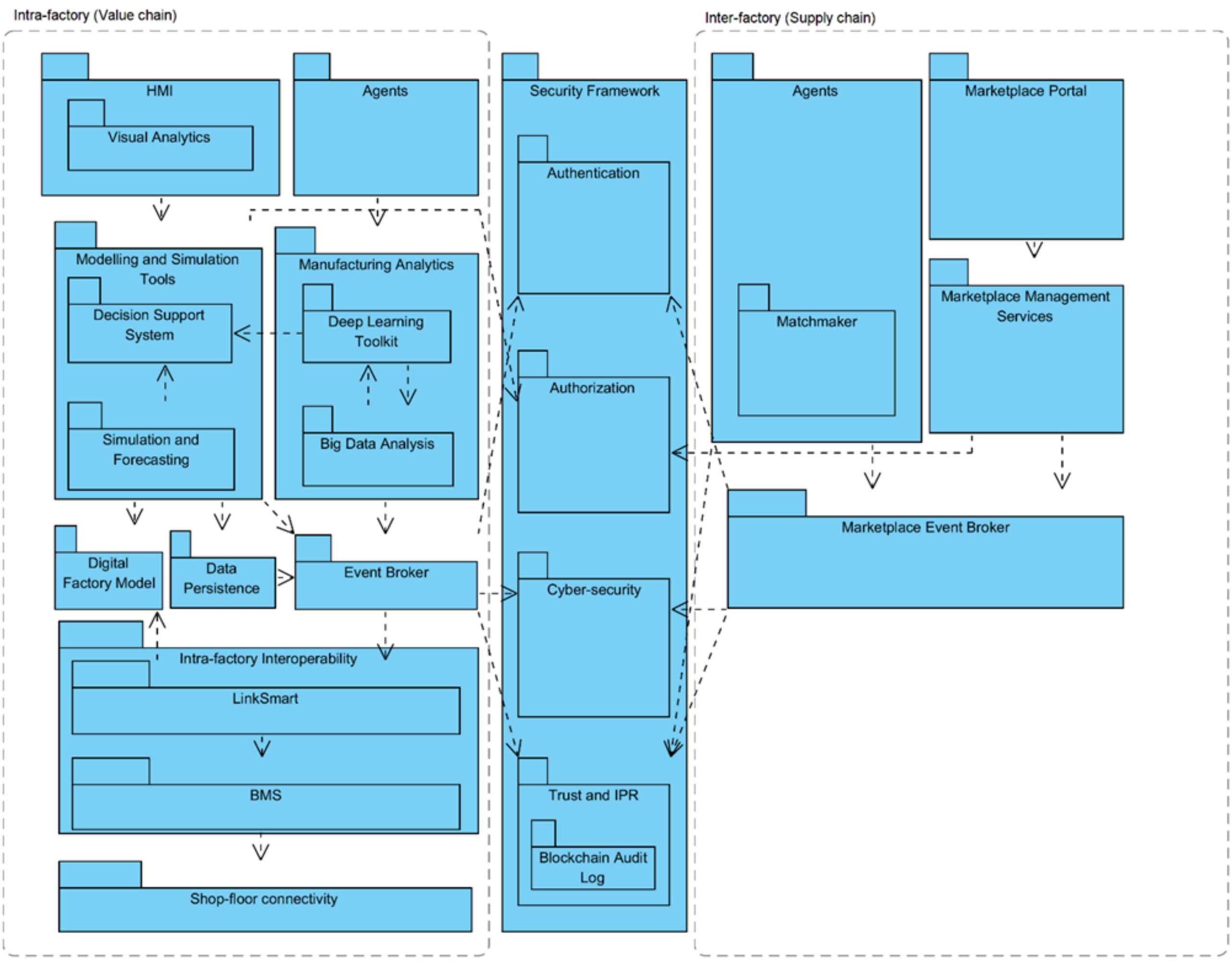

Figure 3: High-level functional view of COMPOSITION architecture

Agent Marketplace

The COMPOSITION Agent Marketplace is the container of the COMPOSITION agents. Agents within the Marketplace may implement market-specific services (such as the white pages or the MatchMaker), or they can act on behalf of industry stakeholders participating in the Marketplace. Required communication infrastructure is provided by a suitable message broker (namely the Marketplace Event Broker), which provides message delivery services to all other components through a well-known, publish-subscribe, interaction paradigm. It exists a well-defined set of messages, in JSON format, that define the different communications between interacting agents.

As stated in deliverable D2.3, there are two main categories of agents that can be defined a priori, depending on the kind of provided services:

- Marketplace agents
- Stakeholder agents.

The former category groups all the agents providing services that are crucial for the marketplace to operate. In COMPOSITION the most important one is the Agent Management Service (AMS). According to FIPA specifications[1] an AMS is a mandatory component of every agent platform, and only one AMS should exist in every platform. It offers the white pages service to other agents on the platform by maintaining a directory of the agent identifiers currently active.

The latter complementary category, groups agents developed and deployed by the marketplace stakeholders to take part in supply chain formation rounds.

The role of the AMS is crucial for the correct functioning of the whole marketplace. Prior to any operations, any agent must register itself to the AMS in order to get a valid unique identifier that will be used in all future transactions.

The AMS interacts with:

- RabbitMQ broker, in order to exchange messages with other agents using AMQP as transport protocol
- MatchMaker, in order to update the list of all the agents currently active on the marketplace, as well as with the services they offer. Moreover, requestor agents do not directly communicate with the MatchMaker but, they rely on the AMS for retrieving the list of suppliers that might be interested or capable to reply a certain offer
- Requestor and Supplier agents, so that they can get their unique identifier. Requestor agents retrieve the list of the suppliers possibly interested in a certain bidding process by calling a specific AMS's API. In order to update their status on the marketplace, requestor and supplier agents always need to inject this information to the AMS.

Security Framework

The COMPOSITION Security Framework is composed of the following components and model most of which have been reported in *"D4.1 Design of the Security Framework I"*. An updated version, *"D4.2 Design of the Security Framework II"* due in M18, will include updates, new components and the description of a Reputation Model to be applied within COMPOSITION. The following is a brief description of current foreseen components:

- **Authentication – Keycloak:** Component responsible for providing the authentication mechanisms for users, applications, services and devices. Supports the following standard authentication protocols:
    - OAuth 2.0: Industry-standard protocol for authorization. Makes heavy use of the JSON Web Token (JWT) set of standards
    - Open ID Connect (OIDC): Authentication protocol based on OAuth 2.0. Unlike OAuth 2.0 OIDC is an authentication and authorization protocol
    - SAML 2.0: Authentication protocol similar to OIDC, but older, that relies on the exchange of XML documents between the authentication server and the application.

  It also supports most common social networks which allows delegating authentication to a semi-trusted and respected entity where the user already has an account. Most common social networks are supported, like Google, Facebook, Twitter, Github, LinkedIn, Microsoft and StackOverflow

  For more information related to this component refer to section 4.1 in *"D4.1 Design of the Security Framework I"*.

- **Authorization – EPICA:** Component responsible for providing authorization mechanisms to COMPOSITION architecture. It´s a component based on XACML v3.0 that provides an attribute-based access control mechanism. It provides the means to define authorization policies used to protect

[1] http://www.fipa.org/specs/fipa00023/SC00023K.pdf

resources; any request to access a protected resource will first be evaluated against the defined policies and the evaluation result will be enforced depending on the outcome.

For more information related to this component refer to *"D4.1 Design of the Security Framework I"* - Section 4.2.

- **Message Broker Auth-Authz Service – RAAS:** Component responsible for providing authentication and authorization to COMPOSITION Message Broker (RabbitMQ) overriding built-in mechanisms. The usage of this service allows the use of centralized Authentication and Authorization COMPOSITION components described before.

  For more information related to this component refer to *"D4.1 Design of the Security Framework I"* - Section 4.3.

- **XL-SIEM: XL-SIEM** (Cross-Layer SIEM) provides the capabilities of a Security Information and Event Management (SIEM) solution with the advantage of being able of handling large volumes of data and raise security alerts from a business perspective thanks to the analysis and event processing in a Storm cluster. The main XL-SIEM functionalities can be summarized in the following points:
  - Real-time collection and analysis of security events
  - Prioritization, filtering and normalization of the data gathered from different sources
  - Consolidation and correlation of the security events to carry out a risk assessment and generation of alarms and reports.

  XL-SIEM makes use of components called Cyber-Agents responsible for catching security events and transmit them to XL -SIEM to be analysed. They are installed on the systems that need to be secured and their configuration may differ from one installation to another depending on the events to be monitored.
  For more information related to this component refer to "D4.1 Design of the Security Framework I" - Section 4.4.

- **Blockchain PKI:** Component responsible for providing access to public keys needed for validating the signature of flowing messages in COMPOSITION.

  This component will be described in detail on *"D4.2 Design of the Security Framework II"* due in M18.

- **Reputation Model:** Model developed in COMPOSITION for the trustworthiness of information exchanged in the manufacturing ecosystem based on the context of data

  This model will also be described in *"D4.2 Design of the Security Framework II"*.

Big Data Analytics

The Big Data Analytics developed in COMPOSITION project is detailed in *"D5.1 Big data mining and analytics tools I"*. The Big Data Analytics service is provided by the LinkSmart® Learning Service (LS). The LS is a Stream Mining service that provides means to manage real-time data for several proposes. In the first place, the LS provides a set of tools that collects, annotates, filters, aggregates, or caches the real-time data incoming from the production facilities. This set of tools facilitates the possibility to build applications on top of real-time data. Secondly, the LS provides a set of APIs to manage the real-time data lifecycle for continuous learning. Thirdly, the LS can process the live data to provide complex analysis creating real-time results for alerting or informing about important conditions in the factory, that may be not be seen at first glance. Finally, the LS will adapt to production needs during the production process. In the pilots, the LS will be responsible for collecting live data coming from the broker for fusion, aggregation, annotation and redistribution to several other components.

BlockChain Connector

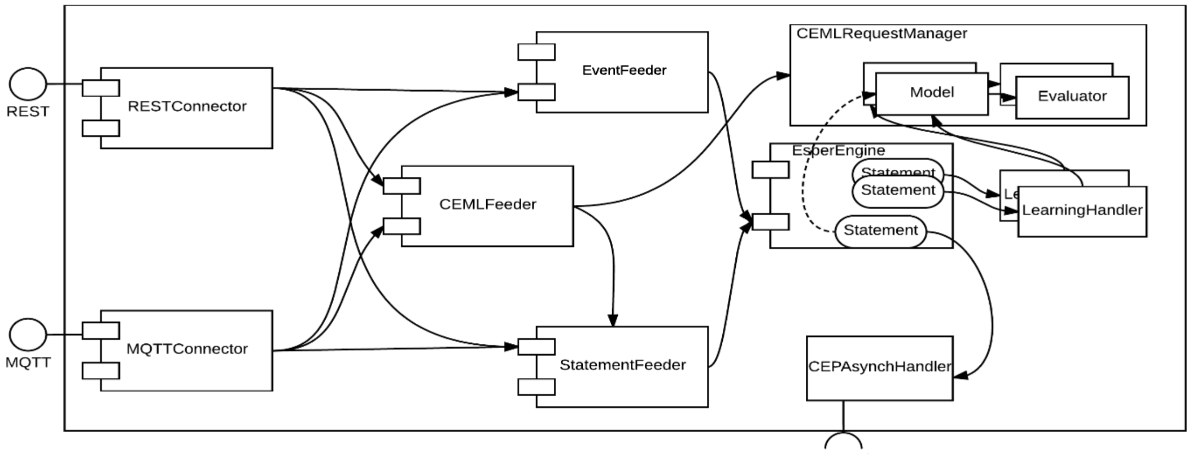

Figure 4: Big data analytics component

COMPOSITION will use blockchain technology to provide a log of transactions that will ensure the integrity and non-repudiation of messages, e.g. agent negotiation and contracts in the marketplace or material/shipment tracking in the factory. The blockchain connector is the component that interfaces COMPOSITION, implements the COMPOSITION specific functionality and interacts with a blockchain implementation. Multichain, an open source product implementing the Bitcoin protocol with some additions, has been selected as the blockchain implementation. Multichain is relatively easy to configure and deploy, not dependent on an underlying “currency” to function, very versatile and free to use as deployed by COMPOSITION. The blockchain connector can work off a specific exchange in the Rabbit MQ event broker using the shovel plugin described in *“D6.1 Real-Time Event Broker I”*, where all events sent to this exchange are automatically forwarded to the regular exchange, while also being processed by the blockchain connector. The exact integration with the broker is still under development. The means of verification against the chain is also under development.

Commissioning System

The role of the Commissioning System is to configure sensor setup, e.g. PLC register mappings and hardware and software identifiers, when deploying the COMPOSITION IIMS, re-configuring or installing new sensors. The information about the deployed equipment is stored in the Digital Factory Model instance for the factory and will have to be distributed to the involved components by the Commissioning System.

Deep Learning Toolkit

Machine learning is the branch of computer science concerned with the development of algorithms and techniques to allow systems to learn from training and previous experiences without task-specific programming. As algorithms are evolving, their time efficiency and resources consumption is progressively decreasing and the number of possible fields in which machine learning is applicable is becoming almost endless.

The Deep Learning toolkit represents a point of intelligence aggregation in the COMPOSITION ecosystem providing predictions and forecasts about relevant indicators, such as predictive maintenance and raw material market prices estimations. The Artificial Neural Networks are the base of the toolkit prediction approach. The computational models of these networks are inspired by the biological neurons in an animal brain. They are comprised of a large number of highly interconnected processing elements (neurons), typically organized in layers, linked together to solve specific problems.

The real power over Artificial Neural Networks will not be achieved by withholding intellectual proprieties over algorithms or frameworks, that in fact are released open source and progressively updated by the community, but this true power over prediction accuracy dwells in the data ownership.

Regarding the development and deployment of the toolkit, it is worth mentioning that the aim is not to create a Swiss knife tool for every application, but a tailored solution that fits a complex ecosystem from its roots to its leaves. After outlining these scenarios, it is easy to understand why the Deep Learning Toolkit will have as many declinations as the use cases in which it will be deployed, working at both intra-factory and inter-factory levels. Each solution will be specifically developed for the actions required and will be based on historical data availability.

During the training activity of the networks, the most appropriate models are selected and configured for optimal predictions about each use case. This process consists in iterating multiple times through the input dataset. During each training step, the optimal parameters are determined for a given combination of model hyper-parameters, by minimizing prediction error over the training set. The success rate of predictions is drastically dependent of the amount of data provided by the end-user partners in each of the scenarios. In fact, there is a linear dependency between the model complexity and the amount of data required: the deeper and more complex the model, the larger a training set is required.

The Deep Learning Toolkit is going to be deployed in an already trained form continuously refining its training by analysing small batches of live data.

Intrafactory Interoperability Layer

In COMPOSITION intra-factory use cases there is a need of a centralized approach to integrate data from multiple sources and support flexible components integration. These tasks are carried out by the Intrafactory Interoperability Layer, which has three main functions:

- to grant a data agnostic layer to exchange heterogeneous contents through common interfaces
- to secure the messaging system using the services provided by the COMPOSITION security framework
- to ensure the conformity between communications among interconnected components.

Real-time communications are managed by the RabbitMQ message broker, a high-scalable implementation of the lightweight TCP/IP-based MQTT protocol. The SSL cryptographic protocol and Keycloak virtual layer have been adopted to provide authentication, authorization and to secure the broker connections. Moreover, all the exchanged messages are signed with the JSON Web Signature (JWS) to demonstrate the authenticity of the sender and to ensure data integrity.

The LinkSmart© Service Catalog allows seeking information about services that are authorized to communicate through the Intrafactory Interoperability Layer. The catalog provides a JSON-based RESTful API to access service information like publication topics and JWS public keys.

Furthermore, the Building Management System (BMS) provides a seamless interconnection among all the heterogeneous physical sensors systems in the factory and the software modules in the upper layer (data processing, decision support, etc.). This component gathers data read from the sensors, installed in the local environment and interconnected through different field buses and protocols, and organizes it into a uniform Data Model. The RabbitMQ broker mediates communication between the BMS and the other components of the COMPOSITION environment.

This component provides a model for interconnecting the COMPOSITION ecosystem in the intra-factory scenario. It also ensures the conformity between communications among interconnected components.

Manufacturing Decision Support System

The Decision Support System is the component used to connect all other subsystems with the HMI(s) providing a common way of communication with the user. Initially Decision Support System will aggregate data from all sources (like factory models, sensorial data) in order to provide human readable KPI’s that reflect the performance of the underline manufacturing process. DSS system also translates predictions from the Deep Learning Toolkit and forecasts from the simulation toolkit in order to produce the required response strategies concerning the predictive maintenance. DSS based on a dynamic rule engine produces the necessary work orders and addresses them to the suitable personnel. Based on historical data, it gives the necessary context for maintenance activities. For that, it keeps track of the performed maintenance task(s) and informs the COMPOSITION system through the MQTT protocol. On the top of that, DSS provides support for several REST services to provide a programming interface to existing systems when this is required.

It should be also noted that the DSS system is deployed as docker image file and can be deployed as part of the COMPOSITION ecosystem.

Market Event Broker

The Market Event Broker is the instance of the message broker used in the COMPOSITION Marketplace (see deliverable D6.1). It interacts with most components and is the hub through which marketplace agents communicate. However, this is through the standard AMQP protocol and needs no special configuration or development of the broker itself. The broker is tightly integrated with the security framework, which provides identity and access management for all brokers in the COMPOSITION system (federated or clustered).

MatchMaker

The Matchmaker is one of the core components of the COMPOSITION Marketplace. This component aims to match requestor and supplier agents participating in the Marketplace based on different selection criteria. Furthermore, the Matchmaker component is used by agents in order to match requests and offers between the agents. The Matchmaker's functionality is exclusively depended on the Collaborative Manufacturing Services Ontology. The Matchmaker infers new knowledge by applying rules on the knowledge which is stored in the Ontology.

The Ruled-based Matchmaker has been developed in Java and it is offered through RESTful web services. A set of rules (Jena rules) has been created to support matchmaking between services (requested & offered). Also supports offer and request matching based on price, quantity, delivery time and company ranking.

Internally, the Matchmaker component offers a complete semantic framework to the Marketplace. An Ontology store is used in order to store the Ontology's individuals. An Ontology Querying Engine which applies SPARQL queries to Ontology story is offered through RESTful web services. The Marketplace agents are able to read or store individuals to Ontology Store by using this comment. The Ruled-based Matchmaker is the third component.

The Matchmaker will be used in pilot cases related to bidding processes, raw material provision and searching for solutions inside the Marketplace.

A Docker image for the Matchmaker component which contains the complete semantic framework of the Marketplace has been created and deployed in the COMPOSITION Inter-factory Portainer in order to be ready for usage by the agents.

Real-Time Multi-Protocol Event Broker

The Real-Time Multi-Protocol Event Broker is an instance of the message broker used in the COMPOSITION factory IIMS (see D6.1). As the hub for all message-based communication, it interacts with most components in the IIMS. However, this is through the standard MQTT protocol and needs no special configuration or development. The broker is tightly integrated with the security framework, which provides identity and access management for all brokers in COMPOSITION system (federated or clustered).

Requestor Agent

The Requestor Agent is the agent exploited by a factory to request the execution of an existing supply chain or to initiate a new supply chain. Due to the dynamics of exchanges pursued in COMPOSITION, there is no actual distinction between the two processes, i.e., for any supply need a new chain is formed and a new execution of the chain is triggered. The Requestor Agent may act according to several negotiation protocols, which can possibly be supported by only a subset of the agents active on a specific marketplace instance.

Simulation and forecasting tool

The Simulation and Forecasting Tool component is part of the high-level platform of the COMPOSITION, Integrated Information Management System. The main purpose of the Simulation and Forecasting Tool is to simulate process models and provide forecasts of events whose actual outcomes have not yet been observed.

Its main interactions are Digital Factory Model, Data persistence storage, Decision Support System (DSS) and Visual Analytics tool. The Simulation and forecasting tool provides predictions by applying a wide variety of algorithms. DSS will be use the produced data in order to suggest solutions and actions.

A first analysis of pilot site data related to BSL, KLE and ELDIA use cases has been completed. Algorithms related to Descriptive statistics, linear regression analysis, Markov models, Genetic algorithms for optimization and Correlation heatmaps have been developed in Python programming language and applied to related data and use cases. The first results have been evaluated.

More precisely, for KLEEMANN Maintenance decision support use case a Probabilities of Future Faults (PoFF) algorithm has been developed. A Tonnage-Route Genetic Algorithm (T-RGA) has been implemented for ELDIA use case. Algorithms such as Correlation Heatmaps in Real Time, Linear Trend Profile (LTP), Deviation Scores (DS) and Local Outlier Factor (LOF) has been applied and tested for BSL Predictive Maintenance pilot case.

Supplier Agent

The Supplier Agent is the counterpart of the Requestor Agent in the COMPOSITION marketplace. It is usually adopted by actual suppliers to respond to supply requests coming from other stakeholders in the marketplace. Factories transforming goods typically employ at least one Requestor Agent to get prime goods and one supplier agent to sell intermediate products to other factories.

5.3 Use cases and component usage and implementation

In order to assess the use cases and their connection to the COMPOSITION platform, all partners should provide information related to the usage of components, the restrictions/prerequisites and the feasibility of each component used at the specific use case.

In order to analyse and describe the impact of each component on each of the UCs, an assessment framework is proposed (see following table). The first and second columns refer to the use case and component respectively. The component usage (third column) can be: 1) direct, when the UC uses this component, 2) indirect, when the UC uses this component through another component and 3) no usage, when the UC does not use the component at all. The fourth column describes the required effort from a scale of 1 to 5 and shows how difficult it is to incorporate the component to the use case. The 1 to 5 value is related to the complexity of the component integration to the infrastructure of the shopfloor and not to person months. The fifth column refers to the restrictions and barriers identified. The last column refers to the prerequisites of each component.

Table 5: Use cases and component usage and implementation

Use Case	Component name	Component usage	Effort Required (1-5)	Restrictions	Prerequisites
UC-KLE 1	Manufacturing Decision Support System	Direct	2	Interoperability, Data format	WiFi
	Intrafactory Interoperability Layer	Indirect	4	Not known	-
	Simulation and forecasting tool	From DSS	1	Historical and live data	-
	Deep Learning Toolkit	Indirect	2	At the moment, no useful historical data have been collected to properly train and deploy the component	Live and historical sensor data
UC-KLE 2	Simulation and forecasting tool	From DSS	1	Historical data or data from DSS	-
	Intrafactory Interoperability Layer	Indirect	4	None known	-
UC-KLE 3	Simulation and forecasting tool	From DSS	1	Historical and live data	-
	Deep Learning Toolkit	Indirect	2	At the moment, no useful historical data have been collected to properly train and	Live and historical sensor data

Use Case	Component name	Component usage	Effort Required (1-5)	Restrictions	Prerequisites
				deploy the component	
	Intrafactory Interoperability Layer	Indirect	4	None known	-
UC-KLE 4	Matchmaker	Agents UI	1	Messages by agents	
	Simulation and forecasting tool	Agents UI	1	Fill level sensor data	-
	Agent Marketplace	Direct	3	Data format, communication protocols	RabbitMQ broker, MySQL database, Security framework
	Requestor Agent	Direct	2	Data format, communication protocols	Marketplace infrastructure
	Supplier Agent	Direct	2	Data format, communication protocols	Marketplace infrastructure
	Deep Learning Toolkit	Indirect	2	At the moment, no useful historical data have been collected to properly train and deploy the component	Live and historical sensor data
UC-KLE 7	Matchmaker	Agents UI	1	Messages by agents	
UC-ELDIA-1	Agent Marketplace	Direct	3	Data format, communication protocols	RabbitMQ broker, MySQL database, Security framework
	Requestor Agent	Direct	2	Data format, communication protocols	Marketplace infrastructure
	Supplier Agent	Direct	2	Data format, communication protocols	Marketplace infrastructure
	Matchmaker	Agents UI	1	Messages by agents	
	Simulation and forecasting tool	Agents UI	1	Fill level sensor data	-

Use Case	Component name	Component usage	Effort Required (1-5)	Restrictions	Prerequisites
	Deep Learning Toolkit	Indirect	2	At the moment, no useful historical data have been collected to properly train and deploy the component	Live and historical sensor data
UC-BSL-2	Simulation and forecasting tool	From DSS	1	Historical and live data	-
	Deep Learning Toolkit	Indirect	2	None known	Live and historical sensor data
	Intrafactory Interoperability Layer	Indirect	4	None known	-
	Manufacturing Decision support	Direct	2	Interoperability , Data format	WIFI, docker host
UC-BSL-5	Intrafactory Interoperability Layer	Indirect	4	None known	-
	Manufacturing Decision support	Direct	3	Data format	Docker host with connectivity
UC-BSL-3	Intrafactory Interoperability Layer	Indirect	4	None known	-
	Manufacturing Decision support	Direct	2	Interoperability , Data format	WIFI, docker host
UC-BSL-7	Intrafactory Interoperability Layer	Indirect	4	None known	-
UC-BSL-4	Intrafactory Interoperability Layer	Indirect	4	None known	-
UC-ATL-2	Matchmaker	Agents UI	1	Messages by agents	
UC-ATL-3	Matchmaker	Agents UI	1	Messages by agents	
UC-NXW-1	BMS	Direct	2	Interoperability, Field protocols, Data format	Field protocol support
	Manufacturing analysis	Direct	2	Interoperability, Data format	Data format

Use Case	Component name	Component usage	Effort Required (1-5)	Restrictions	Prerequisites
	Modelling and simulation tools	Indirect	2	Interoperability, Data format, Big data storage	Data format, big data storage
	Event broker	Indirect	2	Data format	Connection with the broker
	Agent	Direct	4	Matchmaking, Data format	Matchmaking algorithm
	Marketplace services	Indirect	2	Matchmaking	Service providers

6 Preparation Actions for the Implementation of Use Cases

Preparation actions are broken into two parts i.e. value chain scenarios and supply chain scenarios. Figure 5 presents the hierarchy of the value chain and supply chain scenarios, which is a proposition of the first review of COMPOSITION that has been conducted by the European Commission. In the preparation actions, the following two deliverables will be utilized to assist the implementation of the UCs : 1) *"D7.4 Test, installation and operation plan template I"* which provides a preliminary test, installation and operation plan for each of the defined use cases and *"D7.6 On site Readiness Assessment of Use Cases based on Existing Sensor Infrastructure I",* which assesses the readiness of the COMPOSITION industrial use case sites for potential integration of wired and wireless sensors.

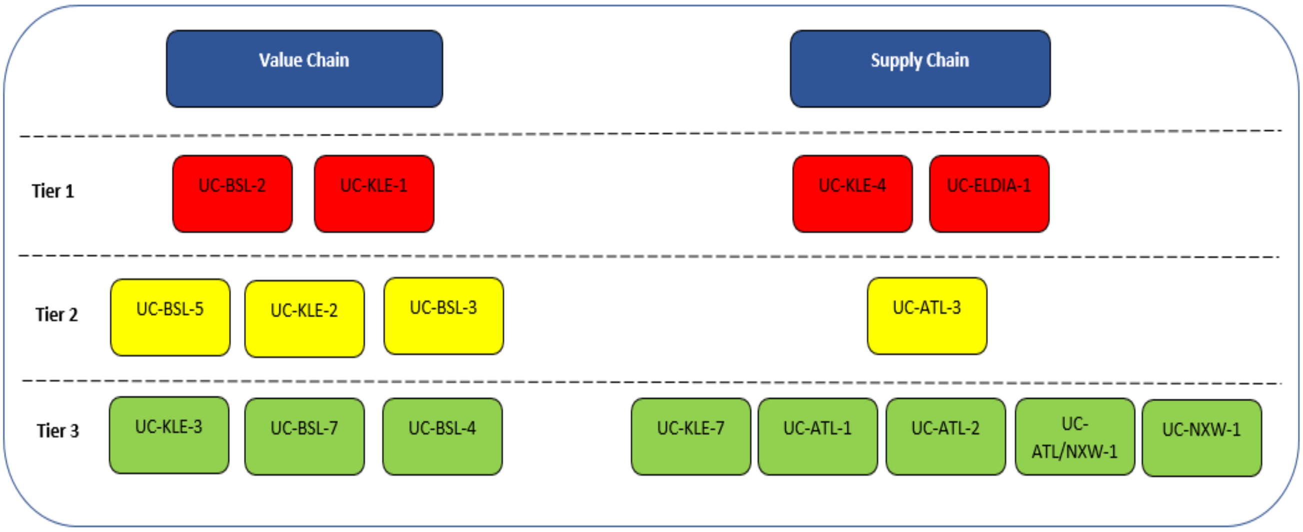

Figure 5: Hierarchy of value chain and supply chain UCs

For each use case detailed in the following section, the description includes four subsections: the components and technologies used, the involved actors and their responsibilities, the risks of conducting the pilot and the success criteria and metrics. Since the security framework and it´s components are horizontal, they are involved in all use cases and hence they are described only in the first intra-factory and inter-factory use case.

Before discussing the UCs, the five pilots and their involvement in COMPOSITION are described below.

Boston Scientific Ltd

Boston Scientific is one of the largest medical device companies in the world with over 23,000 employees worldwide. Boston Scientific Limited (BSL) in Clonmel, Ireland is the largest in terms of Value of Production in the Boston Scientific network of plants. BSL will run the Value Chain/Intra-factory pilot in the COMPOSITION project. The BSL pilot will implement specific elements of the COMPOSITION solution to realise the future Front End solution for implantable Printed Circuit Board Assemblies (PCBAs).

KLEEMANN

KLEEMANN operates both in the field of manufacturing and trading of complete lift systems. The head offices are based in Kilkis, Northern Greece, with offices and subsidiaries in 15 territories serving more than 100 countries worldwide. The range of products includes domestic and commercial lift systems, as well as car parking and multi-storey building lift systems. In COMPOSITION, KLEEMANN will be involved in the Value Chain/Intra-Factory Pilot, where two departments will participate; the maintenance department will be responsible for UC-KLE 1 and UC-KLE 3 and the piston-cylinder unit will be responsible for UC-KLE 2. For the Supply Chain/Inter-factory Pilot, which will be deployed at the KLEEMANN plant in Kilkis and part of it jointly at ELDIA's recycling facilities in Thessaloniki, two departments will be involved; the maintenance department and the purchasing department will be responsible for UC-KLE 4. The purchasing department will also be responsible for UC-KLE 7.

ELDIA

ELDIA is the largest waste management company in Northern Greece and one of the leading dealers of recycled materials in Greece. ELDIA offers services providing solutions to solid waste management and disposal issues of industrial and commercial enterprises, local government, or organizations of the broader public sector. ELDIA undertakes the screening of all commercial and industrial waste in order to recover materials (paper, wood, plastics, metal, pallets, and glass) and promote the recycling industries. The principle under which ELDIA operates and handles waste is in line with what COMPOSITION will apply at the latest stages of the ecosystem development. The ELDIA pilot aims to remove all reusable material from the waste stream and to reduce the amount of waste that is disposed of at the Sanitary Landfill. Parts of the Supply Chain/Inter-factory Pilot will be deployed jointly at the KLEEMANN plant in Kilkis and at ELDIA's recycling facilities in Thessaloniki.

ATLANTIS

ATLANTIS Engineering is an SME whose main activities include the support of daily production activities in different factories with simple and advanced manufacturing systems, the organisation and computerisation of maintenance departments, the customised maintenance consulting and training, and asset life cycle optimisation. ATLANTIS has long standing experience in the industrial manufacturing domain. The expertise of the company is mainly in decision support for the management and optimisation of production activities and assets' life-cycle, in the design, interconnection and implementation of models and protocols for the manufacturing sector, and in the streamlining of the various maintenance related processes (predictive, condition-based, and reactive). Parts of the Supply Chain/Inter-factory Pilot will be deployed by ATLANTIS for software upgrade and deployment.

Nextworks

Nextworks, located in Pisa, Italy, is an SME operating in the IT and Telecommunications sectors. Nextworks has long-term experience and proven skills in the frameworks of IoT, wireless, access and transport networks, digital video encoding and transport, control and automation, design and development of complex software systems on both traditional and embedded platforms. The role of Nextworks is two-fold: as a pilot in the Supply Chain / intra-factory domain, and as technology and service provider in both the value chain and the supply chain use cases, specifically for factory premises and production line monitoring and management. These services will be provided based on information collected both from the field (production line and BMS), and where possible from other stakeholders' ERP systems. Decisional processes inside the production line will also be supported, enhancing their functionality using professional analysis tools offered by the COMPOSITION marketplace.

6.1 Value Chain (intra-factory) scenarios

6.1.1 Tier 1 Use Cases: Very high overall priority

6.1.1.1 UC-BSL-2 Predictive Maintenance

Use of sensors that can 'listen' and monitor performance (temperature, vibrations, power consumption) on and near fans (blowers) in reflow ovens. The 'signature data' from these can give early indication that a fan will fail in the near future. This will then be communicated to relevant personnel via email and displayed on large visualization screens in the factory. This early warning enables preventative maintenance to be scheduled which can result in significant savings both in terms of disruption to production and avoiding loss of materials.

Figure 6: Position of sensors in BSL reflow oven

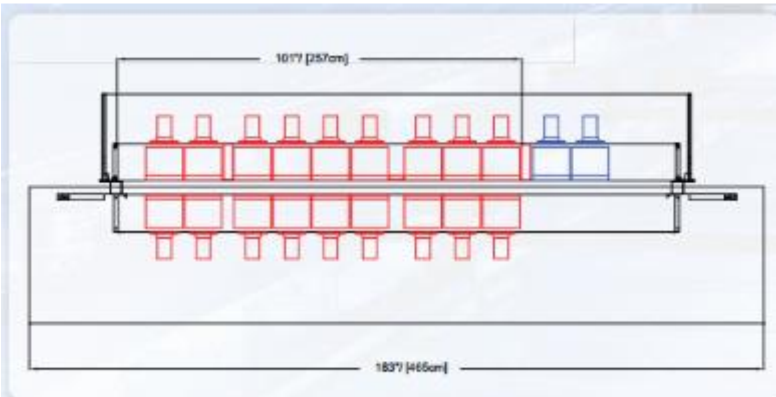

Figure 7: Layout of fans (blowers) in reflow oven

6.1.1.1.1 Components and technologies used

- Security Framework:

  Authentication – Keycloak: provides authentication mechanisms

  Authorization – EPICA: provides authorization mechanisms

  Message Broker Auth-Authz Service – RAAS: enable authentication and authorization to message broker (RabbitMQ)

  XL-SIEM and Cyber-Agents: catch and analyze security events

- The Deep Learning Toolkit component is expected to distribute the latest prediction about the next expected failure of the oven blower machine, based on the continuous input stream of sensors data streams. In specific, data from BLS and the Brady oven re-flower has been used for creating the first lab scale set-up. Once deployed, it will process live data streams provided by the Big Data Analytics component, producing meaningful predictions and updating them whenever enough information is processed and a new one is available.

- The Intrafactory Interoperability Layer provides extraction of live data from ovens' sensors making them available to other components involved in this use case.

- The Digital Factory Model will be used in order to model static and dynamic data related to this use case.

- The Simulation and forecasting tool will provide predictions about future malfunctions.

- Decision Support System

  Assess information from multiple sources to issue alerts or alarms when necessary. It is interacting with information providing components on the background and it visualises results to the users with different data access authorisation levels.

- Real-Time Multi-Protocol Event Broker

  Publish/subscribe-based communication of sensor data and predictions between components. It is indirectly used by the participating components.

6.1.1.1.2 Actors involved and responsibilities

TNI-UCC supply the expertise and hardware for the wired and wireless sensors, mainly using commercially available parts but examining existing and emerging technology, their capabilities, inter-operability with existing infrastructure, etc. into consideration. For the 1st generation any wireless sensors used will be battery or mains powered. TNI-UCC is investigating technologies such as energy harvesting to develop power management solutions to self-power the sensors and eliminate battery replacement in 2nd generation design (or at least extend battery life significantly).

The data is fed to FIT & ATL who develop the DSS to enable predictive maintenance regimes also using data from existing infrastructure (e.g. power consumption of individual fans).

A visualisation screen will then be used to notify BSL’s Process Technician’s and Technician Supervisor’s about fan performance and impending fan failures.

6.1.1.1.3 Risks for conducting the pilot

One of the risks associated with UC-BSL-2 is people solely relying on the COMPOSITION IIMS. If people rely on the system completely and the system performs poorly, this may lead to motors completely failing, the oven going down causing production to stop. This would increase non-recoverable product and production downtime. Also, available sensorial data may not be sufficient for predictive algorithms to provide an acceptable prediction. Another risk could be the inadequate definition of response strategies. Finally, users may not be willing to use the COMPOSITION tools.

6.1.1.1.4 Success criteria and metrics

There is currently no reliable way to detect the failure of a motor. Motors are usually replaced if a technician notices that the temperature does not stabilize or if they hear a high-pitched noise when they walk past the oven. Replacing the motor too late may lead to the part failing and stopping the production process. Replacing the motor too early means the useful lifetime is reduced and the total cost of owner ship increases. This use case would allow for the detection of the optimum process performance and provide instant notification to relevant personnel. This would prevent the manufacturing process from being disrupted, reduce scrap and reduce the cost/efforts of maintenance. The potential cost of non-recoverable oven alarm resulting in non-conforming product being scrapped is estimated as $32K. Other success criteria include the stability and reliability of the system, the intuitive and user friendly HMIs and finally the outcomes of predictive maintenance that result in time/cost savings.

6.1.1.2 UC-KLE-1 Maintenance Decision Support

In UC-KLE 1, the goal of the COMPOSITION system is to identify/forecast problems in the machines and then to inform the Maintenance Manager, making proper suggestions and work orders for machine maintenance. The sensors will be installed on the motors inside and outside the Bossi Machine (Figure 8, Figure 9, Figure 10).

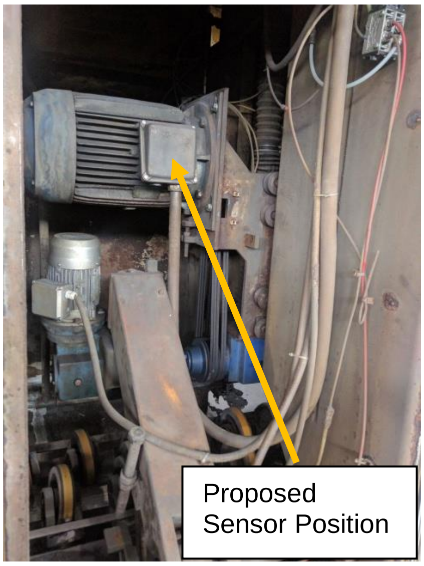

Figure 8: Proposed sensor position inside Bossi Motor

Figure 9: Proposed sensor position outside Bossi Motor

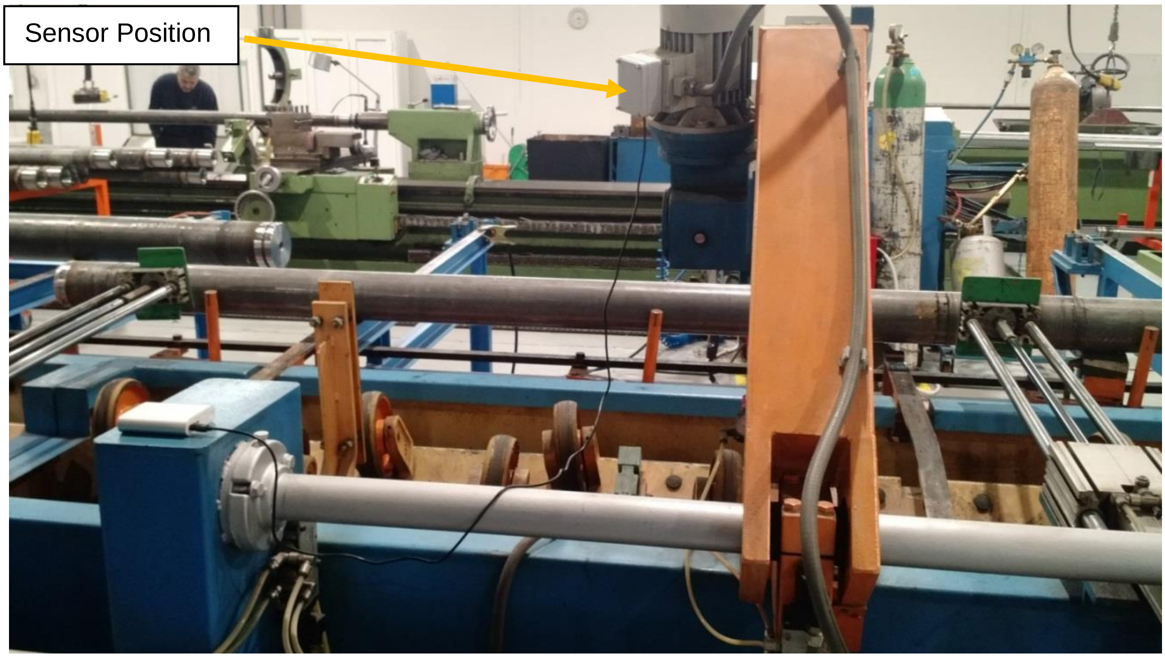

Figure 10: Actual sensor position outside Bossi Motor

6.1.1.2.1 Components and technologies used

- Security Framework (same as UC-BSL-2, see 6.1.1.1.1)
- The Digital Factory Model will be used in order to model static and dynamic data related to this use case
- The Simulation and forecasting tool will provide predictions about future malfunctions
- Intrafactory Interoperability Layer
- Vibration sensors will be added at Bossi machine. Figure 10 shows the actual sensor position of the first test
- When deployed, the Deep Learning Toolkit component will distribute the latest prediction about the next expected failure of a Bossi machine, based on the continuous input of sensors' data stream provided by the Big Data Analytics component. Given that, at the moment, no useful historical data have been collected for a proper component training the deployment will be documented in the next iteration of this deliverable
- Real-Time Multi-Protocol Event Broker

  Publish/subscribe-based communication of sensor data and predictions between components. It is indirectly used by the participating components.
- Decision Support System

  Import data from CMMS, sensors and COMPOSITION components. Export data to other systems and visualise information to users.

6.1.1.2.2 Actors involved and responsibilities

The actors that will be involved in this UC are technicians (electrical, electronic, mechanical, and hydraulic), the maintenance planner and the maintenance manager.

6.1.1.2.3 Risks for conducting the pilot

The risks associated with UC-KLE 1 are the lack of qualified personnel, inadequate or difficult user interface, poor performance of the COMPOSITION system, changes in maintenance timetable. Also, connectivity issues may affect the speed of data acquisition. Another potential risk is if not all users are logged into the system. If triggers of preventive maintenance schedule are not well defined and if HMIs are not well received by personnel, problems may be caused when implementing the pilot.

6.1.1.2.4 Success criteria and metrics

Success criteria for this UC are the minimization of downtimes, the proper notifications to responsible persons, the reduction of mean time to repair and the use of system results to reduction of break down time.

6.1.2 Tier 2 Use Cases: High overall priority

6.1.2.1 UC-BSL-5 Equipment Monitoring and Line Visualisation

This use case will provide real-time monitoring of equipment performance on the PCBA line in a visual format. It will show live and relevant information on the equipment (Equipment name, status (red, green, yellow), BSL equipment ID), products on the line (actual and target), and flow of the PCBA's visually through the lines on a 'factory map' on a big visualization screen. This will be done by manipulating existing data from BSL machine/systems. It will be displayed on large visualization screens where logged-in users can retrieve the history and performance of the equipment, previous failure modes, production and production compared to build plans. Comments can be entered and retrieved from the system. Persons that have login for the 'Equipment monitoring and line visualization system' will have the option to 'subscribe' to equipment and will receive updates to this equipment. Alerts will then be sent out to relevant personnel when a machine changes status. This line visualization screen will also be used to display aspects of UC-BSL-2 (Predictive Maintenance) and UC-BSL-3 (Component tracking).

6.1.2.1.1 Components and technologies used

- Security Framework (same as UC-BSL-2, see 6.1.1.1.1)
- The Digital Factory Model will be used in order to model static data and BSL processes related to this use case
- Intrafactory Interoperability Layer
- Decision Support System

  BSL exposes data from lighthouses to DSS and the latter combines them to visualise the health status of the machines in an intuitive HMI
- RealTime MultiProtocol Event Broker

  Publish/subscribe-based communication of sensor data and predictions between components. It is indirectly used by the participating components.

6.1.2.1.2 Actors involved and responsibilities

Equipment Monitoring and Line Visualization would be used by a range of people on the BSL factory floor. Product builders, area supervisors, quality engineers, lean engineers, process owners would be interested in using the system to keep track of equipment issues/status's.

6.1.2.1.3 Risks for conducting the pilot

Risks for UC-BSL-5 include false alarms of equipment status, inadequate or over-complicated user interface and late notification to relevant personnel. Also, BSL data may not be available in time in the agreed format. Connectivity issues is another risk that affects performance. Finally, KPIs may not be easily understood by the personnel.

6.1.2.1.4 Success criteria and metrics

There is currently no way to reliably track equipment up-/downtime and the production hour's lost due to equipment issues. This system will reduce equipment downtime as a result of instant notification to relevant personnel leading to increased output/efficiency. It has the potential to aid as a planning tool for new investments based on historical data about up-/downtime. BSL will implement this onto the PCBA front end, and if successful it has the potential to run across all production lines.

Potential success criteria include the success of the system in providing the health status of the equipment, the user friendly and usable HMIs and the use of system results to facilitate the supervisors in their everyday tasks.

6.1.2.2 UC-KLE-2 Delayed Process Step

In this UC, COMPOSITION will perform forecasts for delayed process steps that lead to production bottlenecks. A first set of productivity data has been sent to CERTH and is being analysed.

6.1.2.2.1 Components and technologies used

- Security Framework (same as UC-BSL-2, see 6.1.1.1.1)
- The Digital Factory Model will be used in order to model static and dynamic data related to this use case
- The Simulation and forecasting tool will provide predictions about future steps.

6.1.2.2.2 Actors involved and responsibilities

The actors that will be involved in this UC are the production manager, the production supervisor and technical partners.

6.1.2.2.3 Risks for conducting the pilot

The risks of UC-KLE 2 are the false alarms for bottlenecks, the possibility of wrong suggestions for handling bottlenecks, the late notification to the production manager and possible changes in production schedule.

6.1.2.2.4 Success criteria and metrics

In this UC, success criteria are related to correct notifications to the production manager of possible bottlenecks, adjustments of production process to counteract bottlenecks and improvements in productivity.

6.1.2.3 UC-BSL-3 Component Tracking

6.1.2.3.1 Components and technologies used

Use of wireless sensors that can be attached to component reels, fixtures, jigs, sub-assembly trays, etc. so their location can be determined within a factory. The direct (material value) losses and indirect (time lost in production) losses in a factory can be considerable if such assets cannot be found quickly.

As per the predictive maintenance use case TNI-UCC supply the expertise and hardware for the wireless sensors using commercially available parts but examining existing and emerging technologies, their capabilities, inter-operability with existing infrastructure, etc. into consideration. For the 1st generation any wireless sensors used will be battery powered. TNI-UCC is investigating technologies such as energy harvesting to develop power management solutions to self-power the sensors and eliminate battery replacement in 2nd generation design (or at least extend battery life significantly).

Based on studies to date as described in *“D7.6 On-Site Readiness Assessment of Use Cases Based on Existing Sensor Infrastructure I”* the partners have decided to focus on two technologies for RTLS (real-time location system)

(i) BLE Bluetooth low energy

(ii) UWB (ultra-wide band) with integrated IMU (inertial motion unit)

The initial plan is that the sensors are used for short-term tracking of components within a given area in the production floor. They are embedded in re-usable trays and frequently used. In each case the tray is ‘married’ to a batch of components for the period (<2 weeks) and then re-set.

Figure 11: Examples of Trays to Track

- Security Framework (same as UC-BSL-2, see 6.1.1.1.1)
- The Digital Factory Model will be used to model static data and BSL processes related to this use case
- Intrafactory Interoperability Layer
- Decision Support System

  Visualisation of events and provision of notifications to the suitable personnel.

6.1.2.3.2 Actors involved and responsibilities

TNI-UCC is working closely with BSL to make decisions on technologies selected, infrastructure required in lab and then production environment, scalability needs, etc. Whilst initially a stand-alone system the vision is for the data to be visualized and captured in the COMPOSITION IIMS, particularly as part of UC-BSL-5 Equipment Monitoring and Line Visualisation. The goal of this system is to give product builders, material handlers and quality engineer's constant access to the location of containers/subassemblies which have deviated from their normal production path.

6.1.2.3.3 Risks for conducting the pilot

The risks associated with UC-BSL-3 are inadequate or over-complicated user interface, poor performance of the COMPOSITION system and late/inadequate notification to relevant personnel. Connectivity issues that affect asset tracking and failure of tracking valuable material are also considered as potential risks.

6.1.2.3.4 Success criteria and metrics

The use of the asset tracking platform reduces losses. Material worth an estimated $50.000 to 100.000 is unaccounted for every year, and approximately 14.5 manufacturing days lost per year awaiting replacement material. The target for this use case is to get a 50% reduction in both cost and time associated with the loss of components.

6.1.3 Tier 3 Use Cases: Medium overall priority

6.1.3.1 UC-KLE-3 Scrap Metal and Recyclable Waste Transportation

In this UC the purpose is to optimize the collection of scrap metal and recyclable waste through the early (real-time) notification of bin and container fill levels and the suggestion of optimal routes within the factory.

6.1.3.1.1 Components and technologies used

- Security Framework (same as UC-BSL-2, see 6.1.1.1.1)
- The Digital Factory Model will be used to model static and dynamic data related to this use case
- The Simulation and forecasting tool will provide suggestions related to the optimal route for waste transportation
- Fill level sensors will be used in KLE bins for bins' monitoring
- When deployed the Deep Learning Toolkit component will distribute the latest prediction about the fill level of waste material in a bin/container, in order to allow for optimization of the collection of scrap

metal. The prediction will be based on dataflow from one or more bin-mounted sensors. Given that, at the moment, no useful historical data have been collected for a proper component training, the deployment will be documented in the next iteration of this deliverable.

- Real-Time Multi-Protocol Event Broker

  Publish/subscribe-based communication

6.1.3.1.2 Actors involved and responsibilities

The actor involved in this UC is the worker who drives the forklift and empties the bins into the containers.

6.1.3.1.3 Risks for conducting the pilot

Risks associated with this UC are the false monitoring of fill levels of scrap metal and recyclable waste and the wrong suggestion of routes.

6.1.3.1.4 Success criteria and metrics

The success criteria identified in this UC are the minimization of transport time and costs through the proposition of optimal routes for collecting bins.

Figure 12: Proposed sensor position in recycling bins

6.1.3.2 UC-BSL-7 Automatic long-term tracking of high value materials for physical security

This use case will use the same technology as that developed for UC-BSL-3 but will take into account the fact that the asset being tracked will have a greater variety of operational environments, on average will be 'dormant' for long periods and the sensor will be 'married' to the asset for a longer period. This has significant implications for power management solution that will be devised. Lessons learnt from UC-BSL3 will be incorporated into the design.

6.1.3.2.1 Components and technologies used

- Security Framework (same as UC-BSL-2, see 6.1.1.1.1)
- Intrafactory Interoperability Layer
- Real-Time Multi-Protocol Event Broker

  Publish/subscribe-based communication of sensor data.
- Blockchain Connector

The blockchain connector will (possibly) be to provide distributed trust in the tracking log.

6.1.3.2.2 Actors involved and responsibilities

As for UC-BSL-3 TNI-UCC is working closely with BSL to make decisions on technologies selected, infrastructure required in lab and then production environment, scalability needs, etc. Whilst initially a stand-alone system the vision is for the data to be visualized and captured in the COMPOSITION IIMS, particularly as part of UC-BSL-5 Equipment Monitoring and Line Visualisation. The goal of this system is to give product builders, material handlers and quality engineer's constant access to the location of high value equipment/material.

6.1.3.2.3 Risks for conducting the pilot

The risks associated with UC-BSL-7 are inadequate or difficult user interface, poor performance of the COMPOSITION system and late/inadequate notification to relevant personnel.

6.1.3.2.4 Success criteria and metrics

This use case is similar to UC-BSL-3. It aims to reduce the cost and effort associated with the loss of material.

6.1.3.3 UC-BSL-4 Automatic Solder Paste Touch Up

Currently during Solder Paste Inspection (SPI) if a Solder Paste Deposit (SPD) on a Printed Circuit Board (PCB) fails because of low volume, the machine shows which pad failed. The product builder will then add solder paste to the pad and the PCB will be re-inspected. This process continues until the SPI gives a passing result.

The aim of this use case to have a rejected PCB to be automatically re-directed to the dispense system. The dispense system would then automatically dispense the correct amount of paste onto the relevant pad location. The challenge for COMPOSITION is to provide communication between the SPI and the dispense system. The SPI does export an XML file but the dispense system is not configured to receive this file. COMPOSITION should create an intermediate step between both machines for automatic data conversion.

6.1.3.3.1 Components and technologies used

- Security-Framework (same as UC-BSL-2, see 6.1.1.1.1)
- Real-Time Multi-Protocol Event Broker

  Publish/subscribe-based communication of sensor data.
- Intrafactory Interoperability Layer

6.1.3.3.2 Actors involved and responsibilities

This use case aims to be a completely automated process. The only systems involved should be the SPI, the dispense system and a maintenance engineer.

6.1.3.3.3 Risks for conducting the pilot

The risk for UC-BSL-4 is that the system performs poorly and does not top up the correct pad by the appropriate amount. This would cause the PCB to fail numerous times, causing delay in production or scrap.

6.1.3.3.4 Success criteria and metrics

The success of UC-BSL-4 would be based on the reduction cost/effort in manual labour associated with manually taking this PCB off the line and touching it up.

6.2 Supply Chain (inter-factory) scenarios

6.2.1 Tier 1 Use Cases: Very high overall priority

6.2.1.1 UC-KLE-4 Scrap metal collection process and bidding process

The goal of UC-KLE 4 is the automated notification that the scrap metal container is full. This will lead to the optimization of the transportation of scrap metal and the selection of the best offer from the bidders. In Figure 13, the proposed position of the sensor that will be installed is shown. The actual position of the sensor in the first testing is shown in Figure 14.

Figure 13: Proposed sensor position in scrap metal container

Figure 14: Actual sensor position in scrap metal container

6.2.1.1.1 Components and technologies used

- Security Framework:

  Authentication – Keycloak: provides authentication mechanisms

  Authorization – EPICA: provides authorization mechanisms

  Message Broker Auth-Authz Service – RAAS: enable authentication and authorization to message broker (RabbitMQ)

  XL-SIEM and Cyber-Agents: catch and analyze security events

  Blockchain PKI: enable public key sharing for message signature validation:

  Reputation Model

- The purpose of the Deep Learning Toolkit component in this use case will be twofold:

  The component will distribute the latest prediction about the fill level of waste material within a bin/container, in order to allow for optimization of timing and logistics of collections as well as improve any related commercial aspect.

  The component will distribute the latest prediction about the price per ton at which specific commercial partners are likely to accept to buy/sell scrap metal within fixed timeframe in the future.

  These information in the formed of predictions will be intended to support the agents intelligence in order to improve the decision system that is in charge of accept/emit commercial offers about scrap metal.

  Given that, at the moment, no useful historical data have been collected for a proper component training the deployment will be documented in the next iteration of this deliverable.

- COMPOSITION Marketplace Agents are necessary to guarantee the correct information flow between the different companies' agents, both Requestor and Supplier.
- Requestor and Supplier agents are required for negotiations and notifications between the different parties involved in any transaction.
- The Matchmaker and Collaborative Manufacturing Services Ontology will be used to match KLE agent with waste management companies' agents. Moreover, they will evaluate the available offers and will match the KLE request with the best one.
- The Simulation and forecasting tool will provide live predictions related to fill level of bin.
- Fill level sensors will be used in KLE bins for bin monitoring
- Real-Time Multi-Protocol Event Broker

  Publish/subscribe-based communication of fill level sensor data.

- Market Event Broker

  The marketplace agents will communicate via the broker using the agent protocol.

6.2.1.1.2 Actors involved and responsibilities

The involved actors in UC-KLE 4 are waste management companies, the maintenance manager and the purchasing manager.

The COMPOSITION Marketplace sends a notification to KLE about the fill level of the scrap metal bins, setting the requirement about the bidding process. The bidding process starts autonomously (it is started by KLE Requestor agent), and waste management companies are alerted, through their agent (Supplier agent) in the COMPOSITION Marketplace. After offers have been evaluated, the most suitable candidates are presented by the Requestor agent to the maintenance and purchasing manager who, in turn, will decide the best candidate and approve it. All the waste management companies are notified by the COMPOSITION system about the outcome of the bidding process.

6.2.1.1.3 Risks for conducting the pilot

Identified risks for conducting the pilot are the notification of the selected company only, the absence of pick-up notification, the overlapping of the selected date with another pick-up process, the late notification for pickup date, late payments and late pick up.

6.2.1.1.4 Success criteria and metrics

The success criteria identified in this UC are the notification of all selected and not selected companies, the automatic proposition of the best offer, on-time payments, improvements in reaction time, reduction of operational costs.

6.2.1.2 UC-ELDIA-1 Fill-level Notification – Contractual wood and recyclable materials management

The goal of UC-ELDIA-1 is to receive an automatic notification about the container fill level, in order to optimize its logistics services and improve the wood and recyclable materials management.

6.2.1.2.1 Components and technologies used

- Security Framework (same as UC-KLE-4, see 6.2.1.1.1)
- Like for UC-KLE-4, the Deep Learning Toolkit will distribute the latest prediction about the wood and recyclable materials within a bin/container, in order to allow for optimization of timing and logistics of collections as well as improve any related commercial aspect. Given that, at the moment, no useful historical data have been collected for a proper component training the deployment will be documented in the next iteration of this deliverable
- COMPOSITION Marketplace Agents are necessary to guarantee the correct information flow between the different companies' agents, both Requestor and Supplier
- Requestor and Supplier agents are required in order to allow negotiations and notifications between the different parties involved in any transaction
- Fill level sensors will be used in KLE bins for bins' monitoring
- The Simulation and forecasting tool will apply a generic algorithm which minimize the number of routes for ELDIA
- Real-Time Multi-Protocol Event Broker

  Publish/subscribe-based communication of fill level sensor data
- Market Event Broker

  The marketplace agents will communicate via the broker using the agent protocol and data sharing between KLE and ELDIA will be set up using the broker and the integrated security framework.

6.2.1.2.2 Actors involved and responsibilities

Notification of fill level is sent from KLEEMAN to ELDIA using the Marketplace. This involves the use of the agents (Requestor and Supplier) to ensure a correct information flow and the participation of ELDIA's Logistics Manager, Driver and Accounting department.

6.2.1.2.3 Risks for conducting the pilot

Identified risks in this use case include the absence of pick-up notification, late notification for pickup date, late pick up and thus late payments.

6.2.1.2.4 Success criteria and metrics

Success criteria are related to automatic proposition of optimal pick up, on-time payments, improvements in reaction time and reduction of operational costs.

6.2.2 Tier 2 Use Cases: High overall priority

6.2.2.1 UC-ATL-3 Searching for recommended solutions

The goal of UC-ATL 3 is to allow potential buyers to search within the COMPOSITION ecosystem for recommended solutions/suggestions for their needs/inquiries. The demand side will trust the recommendations coming for an ecosystem with built-in trust, safety and verification mechanisms.

6.2.2.1.1 Components and technologies used

- Security Framework (same as UC-KLE-4, see 6.2.1.1.1)
- The Matchmaker and Collaborative Manufacturing Services Ontology will be used in order to match customers with available solutions
- Marketplace Ontology
- Requestor
- Supplier
- Marketplace

6.2.2.1.2 Actors involved and responsibilities

The involved actors are potential customers' purchase department and/or technical/IT team members. From the suppliers side, the Sales Engineer, as well as the Technical Support Engineer are involved.

6.2.2.1.3 Risks for conducting the pilot

There is not enough data for the system to generate recommendations.

Buyers do not use the system that much.

COMPOSITION fails to be considered a trusted environment.

6.2.2.1.4 Success criteria and metrics

The system generates recommendations for all inquiries.

COMPOSITION is perceived as a trusted advisor for both buyers and sellers.

The system is stable and fast (generates recommendations within a few minutes, after all information of demand side are provided as input).

6.2.3 Tier 3 Use Cases: Medium overall priority

6.2.3.1 UC-KLE-7 Ordering raw materials

The goal of this UC is to automate the supply chain processes in order to get high quality raw materials on the best price, delivered on time and to establish good customer-supplier relationship.

6.2.3.1.1 Components and technologies used

- Security Framework (same as UC-KLE-4, see 6.2.1.1.1)
- The Matchmaker and Collaborative Manufacturing Services Ontology will be used in order to match customers with available raw material providers
- Market Event Broker

  The marketplace agents will communicate via the broker using the agent protocol.

6.2.3.1.2 Actors involved and responsibilities

The actors involved in this UC are the purchasing manager and the raw material suppliers.

6.2.3.1.3 Risks for conducting the pilot

The risks associated to UC-KLE-7 are delivery of the wrong raw materials, the delayed delivery and the offering of poor quality of raw materials.

6.2.3.1.4 Success criteria and metrics

The success criteria for this UC are related to on-time delivery of the right raw materials, the automated order placement of high quality materials at the best price and the reduction of supply chain costs.

6.2.3.2 UC-ATL-1 Selling software/consultancy

The goal of UC-ATL 1 is to allow software/consultancy providers to offer their products and services and to describe their features to potential buyers. Potential clients have a need and request software solutions via the ecosystem, which matches them with suitable providers.

6.2.3.2.1 Components and technologies used

- Security-Framework (same as UC-KLE-4, see 6.2.1.1.1)
- Marketplace Ontology
- Matchmaker
- Requestor
- Supplier
- Marketplace.

6.2.3.2.2 Actors involved and responsibilities

From the demand/buyer side members of the respective supply and technical departments are involved. From the provider's side actors involved may be the following: Chief Sales Officer, Chief Marketing Officer, Digital Marketing Manager, Sales Engineer, Technical Support Manager.

6.2.3.2.3 Risks for conducting the pilot

Insufficient data from demand and supply sides are available to enable the matchmaking.

System is unstable.

6.2.3.2.4 Success criteria and metrics

The Matchmaker provides suitable results.

The marketplace is stable and safe.

The marketplace is perceived as stable and safe by the users.

6.2.3.3 UC-ATL-2 Searching for solutions

Customers look for software solutions and/or solution providers in the ecosystem. Customers select solution providers based on information they can easily find in the ecosystem. This approach may get them in touch with less-known providers and in turn increases the chances of the latter for increasing sales.

6.2.3.3.1 Components and technologies used

- Security Framework (same as UC-KLE-4, see 6.2.1.1.1)
- The Matchmaker and Collaborative Manufacturing Services Ontology will be used in order to match customers with available solutions
- Marketplace Ontology
- Matchmaker
- Requestor

- Supplier
- Marketplace

6.2.3.3.2 Actors involved and responsibilities

From the potential customers who want to find solutions the involved actor is the department responsible for supplies and orders, with the support of the respective/relevant technical department. From the providers side the actors are the CSO and Sales Engineer who want to increase sales and the Technical Support Manager who wants to facilitate the provision of services.

6.2.3.3.3 Risks for conducting the pilot

Insufficient data from demand and supply sides are available to enable the matchmaking.
System is unstable.

6.2.3.3.4 Success criteria and metrics

Matchmaker provides suitable results.

The marketplace is stable and safe.

The marketplace is perceived as stable and safe by the users.

6.2.3.4 UC-ATL/NXW-1 Integrate external product into own solution

Solution providers often want to build solutions that use some devices, hence develop interfaces to devices and systems which can be integrated into solutions. The developed solution is built according to COMPOSITION standards – a service based on data internal to customer premises. The developed solution is “COMPOSITION compatible” which means an external application for example can use the “COMPOSITION compatible” service output through the interface, thus facilitating integration and interoperability.

6.2.3.4.1 Components and technologies used

- Security Framework (same as UC-KLE-4, see 6.2.1.1.1)
- Real-Time Multi-Protocol Event Broker

  The broker will likely be an integration point for the external product.
- Market Event Broker

  The broker will likely be an integration point for the external product.

6.2.3.4.2 Actors involved and responsibilities

Solution providers want to develop products/services compatible to the COMPOSITION interface standards. Actors internal to the COMPOSITION ecosystem provide the solutions and specify the interface standards. Actors external to the ecosystem develop compatible solutions, may involve their CSO, Chief Technical Officer, Technical Support Manager, Technical Support Engineer to make sure that the external application complies with the COMPOSITION interface and that it can use the information exposed from the internally available services.

6.2.3.4.3 Risks for conducting the pilot

The definition of “COMPOSITION compatible” is unclear.
Standards selected are not widely accepted by the industry.

6.2.3.4.4 Success criteria and metrics

The developed solution is “COMPOSITION compatible”. Which means an external application for example can use the internal service output through the interface.

Standards selected are mostly open and widely accepted and used by the manufacturing industrial sector.

6.2.3.5 UC-NXW-1 Decision support over marketplace

The use case aims to show how to get more specific software tools from the marketplace, in order to refine the decision support process for the configuration of production machines.

6.2.3.5.1 Components and technologies used

- Security Framework (same as UC-KLE-4, see 6.2.1.1.1)
- Manufacturing analysis
- Modelling and simulation tools
- Event broker
- Agent
- Marketplace services

Composition components used are the Intra-factory interoperability layer and the BMS in order to collect the data from the shopfloor. Then, the data are sent to the upper layers (Manufacturing analysis and Modelling and simulation tools) in order to be processed. The Marketplace Event broker will be in charge of connecting the communications from all those components to the Agent and the Marketplace services. After purchasing the requested tool from the Marketplace, it will act in place of the Decision Support System.

External components

- BMS: The Building Management System which continuously collects data from the environment
- Analysis tool: External software tool that can analyse the data coming from the factory, in order to support the decision process.

6.2.3.5.2 Actors involved and responsibilities

The following actors are involved:

Worker: A Worker is an individual who controls its machine settings to configure it correctly for the assigned task.

Purchasing manager: The Purchasing manager is responsible for the final selection of the analysis tool.

6.2.3.5.3 Risks for conducting the pilot

Identified risks for conducting the pilot are to use a tool with worse performances than the integrated COMPOSITION DSS, the absence of real benefits in terms of product quality, a slow response-time of the tool for configuration insights.

6.2.3.5.4 Success criteria and metrics

The success criteria are to get high quality products in terms of the expected size, quality and shape, reducing the value chain costs by accelerating and improving the manufacturing process.

7 Conclusion

This deliverable provides a methodology for planning the deployment of COMPOSITION on the shopfloor. It describes how, when and by whom pilot planning is going to take place. Each use case has been analysed regarding the components used, the involved actors, the associated risks and the success criteria. This pilot planning and preparation actions combined with the results derived from the *"D8.7 Evaluation Framework"* will be provided in *"D8.2 Pilot plans on the Shopfloors and preparation actions II"* (M30). An overall concluding framework of pilot planning on the shopfloors and preparation actions is presented below.

Table 6: Pilot plans on the shopfloor and preparation actions framework

Value Chain Use Cases						
Use Case	**Use Case Stages**	**Components & technologies**	**Actors**	**Risks**	**Success criteria & metrics**	**Time scheduling**
UC-BSL-2	1.Design-Preparation	1.Simulation and forecasting tool 2.Deep Learning Toolkit 3.Intrafactory Interoperability Layer 4.Manufacturing Decision support 5. Real Time Multi Protocol Event Broker	1.TNI-UCC 2.FIT 3.ISMB 4.BSL	1.Poor performance of the Composition system 2.Available sensorial data are not sufficient for predictive algorithms to provide a good enough prediction. 3.Response strategies are not well defined. 4.Users are not willing to use the COMPOSITION tools.	1. Detection of the optimum process performance 2. Instant notification to relevant personnel 3. Prevent the manufacturing process from being disrupted 4. Reduce scrap 5. Reduce the cost/efforts of maintenance 6. The system is stable and reliable. 7.HMIs are intuitive and user friendly. 8.Results on predictive maintenance result to time/cost savings.	
UC-KLE-1	1.Design-Preparation	1.Manufacturing Decision Support System 2.Intrafactory Interoperability Layer 3.Simulation and forecasting tool 4.Deep Learning Toolkit	1.Maintenance planner 2.Maintenance manager 3.Research partners 4.Technical partners	1.Lack of qualified personnel 2.Poor performance of the COMPOSITION system 3.Inadequate or difficult user interface,	1.Downtime minimization 2.Proper notifications sent to responsible persons 3.Reduce mean time to repair 4. Use of system results to	January 2018 (First tests of sensors have been performed by CERTH and KLEEMANN at KLEEMANN's shopfloor)

		5.Real Time Multi Protocol Event Broker		4. Changes in maintenance timetable 5.Connectivity issues affect the speed of data acquisition. 6.Not all users are logged into the system. 7.Triggers of Preventive maintenance schedule are not well defined. 8.HMIs are not well received by personnel.	reduction of break down time	
UC-BSL-5	1.Design-Preparation	1.Real Time Multi Protocol Event Broker 2.Manufacturing Decision Support System 3. Intrafactory Interoperability Layer		1. False alarms of equipment status 2. Inadequate or difficult user interface 3. Late notification to relevant personnel 4.BSL data are not made available in time in the agreed format. 5.Connectivity issues affect performance. 6.KPIs are not easily understood by the personnel.	1. Provides method to track up-/downtime which is not currently available 2. Reduce equipment downtime as a result of instant notification to relevant personnel 3. Increased output/efficiency 4. Provides an planning tool for new investments based on historical data 5.System succeeds in providing the health status of the equipment. 6.HMI is user friendly and usable. 7.Use of system results to facilitation of the supervisors everyday tasks.	
UC-KLE-2	1.Design-Preparation	1.Simulation and forecasting tool	1.Production manager	1.False alarms for bottlenecks 2.Possibility of wrong	1.Right notifications to the production manager for	Not yet defined

		2.Intrafactory Interoperability Layer	2.Production supervisor 3.Research partners 4.Technical partners	suggestions for erasing bottlenecks 3.Late notification to the production manager 4.Possible changes in production schedule	possible bottlenecks 2.Adjustments of production process to erase bottlenecks 3.Improvements in productivity	
UC-BSL-3	1.Design-Preparation	1.Intrafactory Interoperability Layer 2.Manufacturing Decision support	1.TNI-UCC 2.BSL	1. Inadequate or difficult user interface 2. Poor performance of the COMPOSITION system 3. Late/ inadequate notification to relevant personnel.	1. Reduction in cost associated with the loss of components 2. Reduction in time/effort associated with loss of components 3. Connectivity issues affect asset tracking. 4.Asset tracking platform fails to track valuable material.	
UC-KLE-3	1.Design-Preparation	1.Simulation and forecasting tool 2.Deep Learning Toolkit 3.Intrafactory Interoperability Layer 4. Real Time Multi Protocol Event Broker	1.Worker 2.Research partners 3.Technical partners	1.False monitoring of fill levels of scrap metal and recyclable waste bins 2.Wrong suggestion of routes.	1.Minimization of transport time and costs	Start: 01/06/2018 End:01/07/2018
UC-BSL-7	1.Design-Preparation	1.Real Time Multi Protocol Event Broker 2.Blockchain Connector 3.Intrafactory Interoperability Layer	1.TNI-UCC 2.BSL	1. Inadequate or difficult user interface 2. Poor performance of the COMPOSITION system 3. Late/ inadequate notification to relevant personnel.	1. Reduction in cost associated with the loss of components 2. Reduction in time/effort associated with loss of components	

UC-BSL-4	1.Design-Preparation	1.Real Time Multi Protocol Event Broker 2.Intrafactory Interoperability Layer		1. Poor performance of the COMPOSITION system 2. Inadequate or difficult user interface	1. Reduction cost/effort in manual labour.	
Supply Chain Use Cases						
UC-KLE-4	1.Design-Preparation	1.Matchmaker 2.Simulation and forecasting tool 3.Agent Marketplace 4.Requester Agent 5.Supplier Agent 6.Deep Learning Toolkit 7.Real Time Multi Protocol Event Broker 8.Market Event Broker	1.Waste management companies 2.Maintenance manager 3.Purchasing manager.	1.Notification of the selected company only 2.Absence of pick-up notification 3.Overlapping of the selected date with another pick-up process 4.Late notification for pickup date 5.Llate payments 6.Late pick up	1.Notification of all selected and not selected companies 2.Automatic proposition of the best offer 3.On-time payments 4.Improvements in reaction time 5.Reduction of operational costs	January 2018 (First tests of sensors have been performed by CERTH and KLEEMANN at KLEEMANN's shopfloor)
UC-ELDIA-1	1.Design-Preparation	1.Real Time Multi Protocol Event Broker 2.Market Event Broker	1.Logistics manager, 2.Driver, 3.Accounting department	1.Absence of pick-up notification 2.Late notification for pickup date 3.Llate payments 4.Late pick up	1.Automatic proposition of optimal pick up 2.On-time payments 3.Improvements in reaction time 4.Reduction of operational costs	Scheduled for February 2018
UC-ATL-3	1.Design-Preparation	1.Matchmaker 2.Marketplace Ontology 3.Requester 4.Supplier 5.Marketplace	1. Purchasing department 2. Sales Engineer 3. Technical Support Engineer.	1. Not enough data to generate recommendations. 2. Buyers don't use the system. 3. COMPOSITION not considered as a trusted environment	1. System generates recommendations. 2. COMPOSITION is perceived as a trusted advisor. 3. The system is stable and fast.	Start: 01/05/2018 End:01/10/2018
UC-KLE-7	1.Design-Preparation	1.Matchmaker 2.Market Event Broker	1.Purchasing manager 2.Raw material suppliers	1.Wrong raw materials delivery 2.Delayed delivery	1.On-time delivery of the right raw materials 2.Automated order placement of high	Not yet defined

				3.Proposition of bad quality raw materials	quality materials on the best price 3. Reduction of supply chain costs	
UC-ATL-1	1.Design-Preparation	1.Marketplace Ontology 2.Matchmaker 3.Requester 4.Supplier 5.Marketplace	1. Purchasing department 2. Chief Sales Officer 3. Chief Marketing Officer 4. Digital Marketing Manager 5. Sales Engineer 6. Technical Support Manager	1. Not enough data. 2. System is unstable.	1. Matchmaker provides suitable results. 2. Marketplace is stable and safe. 3. Marketplace is perceived as stable and safe by the users.	Start: 01/08/2018 End:01/12/2018
UC-ATL-2	1.Design-Preparation	1.Marketplace Ontology 2.Matchmaker 3.Requester 4.Supplier 5.Marketplace	1. Purchasing department 2. Chief Sales Officer 3. Sales Engineer 4. Technical Support Manager	1. Not enough data. 2. System is unstable.	1. Matchmaker provides suitable results. 2. Marketplace is stable and safe. 3. Marketplace is perceived as stable and safe by the users.	Start: 01/08/2018 End:01/12/2018
UC-ATL/NXW-1	1.Design-Preparation	1.Real Time Multi Protocol Event Broker 2.Market Event Broker	1. Solution provider 2. CSO 3. CTO 4. Technical Support Manager 5. Technical Support Engineer 6. External application provider	1. “COMPOSITION compatible” is unclear. 2. Standards selected are not widely accepted by the industry.	1. Developed solutions are “COMPOSITION compatible”. 2. Standards selected are mostly open and widely accepted and used by the manufacturing industrial sector.	Start: 01/08/2018 End:01/12/2018
UC-NXW-1	1.Design-Preparation	1.BMS 2.Manufacturing analysis 3.Modelling and simulation tools 4.Event broker 5.Agent	1.BMS 2.Worker 3.Purchasing manager 4.Analysis tool	1.Worse performances 2. Absence of real benefits in terms of product quality 3.Slow response-time of the tool	1.To get high quality products in terms of the expected size, quality and shape 2.Reducing the value chain costs by accelerating and refining the	Not yet defined

		6.Marketplace services			manufacturing process.	

8 List of Figures and Tables

8.1 Figures

8.2 Tables

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