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TABLE OF CONTENTS

EXECUTIVE SUMMARY

In traditional models of manufacturing, the information flow from product design, over production processes, to the manufactured product has been strictly unidirectional. The production equipment "blindly" executes tasks that have no direct relationship to the concepts that are present in the original design models and the product is used with little or no feedback concerning product use patterns. In order to enhance the manufacturability of products and at the same time the flexibility of both factory production systems and modern products, both effective configurability and feedback to design and production is required to assure their highest efficiency.

The SAFIRE project has developed new and innovative technologies to enable Reconfiguration as a Service for dynamic smart factory systems and manufactured smart products that take advantage of cloud-based services and computing power to continually optimise the performance of manufacturing systems and products with respect to key performance characteristics including throughput, power consumption, utilisation, maintenance and other factors.

A key objective of the project was to develop cloud-based analytics and reconfiguration capabilities that extend the operating systems of smart factories with: 1) both reactive and predictive reconfiguration for production systems; 2) flexible run-time reconfiguration decisions during production rather than pre-planned at production planning time; 3) real-time reconfiguration decisions for optimisation of performance and real-time production functions. The advanced analytics and reconfiguration capabilities are based on innovations in shared situational awareness and mastering the big data challenges associated with sensor, smart objects and process data from manufacturing and smart product systems. Underpinning all of the newly developed components is an advanced framework for ensuring security, privacy & trust that is capable of integrating with existing manufacturing security infrastructures.

This final report provides an overview of the SAFIRE project technologies, the manufacturing business scenarios where they have been applied and demonstrated, and the information needed for actors in the European manufacturing sector to get started and to exploit the project technologies that have been made publicly available.

1. SAFIRE PROJECT OVERVIEW

Manufacturing of products has become increasingly complex and requires greater flexibility due to an increased diversity of product use and product portfolios, customer demand for more customised products and shorter time-to-market requirements. To face these challenges, there is a need for, on the one hand, adaptive and smart manufacturing systems and products with features for intelligent reconfiguration of production processes & products and, on the other hand, for feedback from product use to production and design stages. In order to improve the manufacturability and reconfigurability of products, the product designers need to have more information about how the product use affects the life cycle of a product and how the design of the product affects the production processes. Currently, product use and product production activities are often separated, which is leading to low efficiency and high costs for both users and manufacturers, especially for those acting at the global market. Some of these required optimisations can be carried out by adjusting control and others require the reconfiguration of products.

The SAFIRE project targeted two related technology challenges for smart factories that present new opportunities for improving production, products and services:

1. Interconnected Systems of Production Systems (SoPS) within smart manufacturing environments, where individual production systems and the SoPS as a whole, have hardware and software requirements to be addressed to achieve specific business objectives, such as scheduling, power consumption, throughput, and maintenance.

2. Connected Product Networks (CPNs) where networked smart products collect data, can be adapted in the field, and can deliver extended services to customers through optimisation of smart product performance parameters and customisation of products to environments, usage patterns and other dynamic factors.

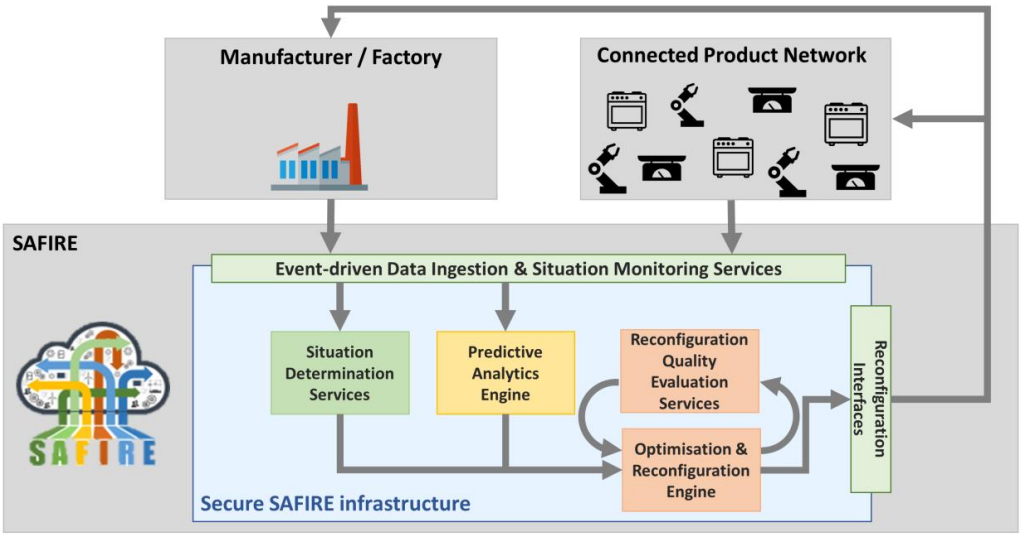

Figure 1: SAFIRE Overview

A key objective of the project was to develop cloud-based analytics and reconfiguration capabilities with both reactive and predictive reconfiguration for both production systems and smart products, flexible run-time reconfiguration decisions during production rather than pre-planned at production planning time, real-time reconfiguration decisions for optimisation of performance, and real-time production and product functions. The advanced analytics and reconfiguration capabilities enable manufacturers to master the big data challenges associated with manufacturing (sensor and process data), enterprise data and smart product data to provide advanced analytics to address production system behaviour forecasting and to establish optimisation methods that are integrated in the design and product chain.

The project has delivered big data analytic capabilities that meet real-time requirements so that dynamic run-time reconfiguration decisions are made during production time rather than pre-planned at production planning time. The project allows both SoPS clients with limited resources to leverage the smart services running in the cloud to perform complex optimisation algorithms on their behalf to maintain and improve performance of SoPS within a dynamic production environment, as well as data from CPNs to be analysed using cloud resource, to drive smart product optimisation decisions. By performing reconfiguration in the cloud, continuous optimisation of the system can be achieved that enables far better reconfiguration control and accuracy than if performed in either a pre-planned or online manner.

The objectives of the project were to develop a new methodology for reconfiguration and optimisation of products and factories based on predictive big data analytics, while exploiting new innovations in security, privacy & trust and situational awareness. The methodology addresses technical and organisational issues for extension and introduction of such novel big data based situational aware tools/services for reconfiguration and optimisation of factories / products. The SAFIRE methods and tools have been brought from Technology Readiness Level (TRL) 4 – technology validated in the lab – in the first year of the project to TRL 6 – technology demonstrated in industrially relevant environments – as the project was completed at the end of year three.

Benefits to the three manufacturing companies in the project in terms of reducing time to market in building new and / or upgrading existing products and machines/equipment as well as services around their products as different manufacturability, environmental and final product mass customisation aspects have been validated through three large demonstrators in industrially relevant environments. The approach allows for considerable improvements in knowledge sharing across product design, manufacturing and product-service life-cycle, as well as new and better product-service offerings addressing customer needs. As the three industrial manufacturing companies in the consortium are highly representative of typical manufacturing companies, similar improvements can be expected for other actors in the manufacturing sector thereby strengthening the global competitiveness of European manufacturing companies.

2. SAFIRE SOLUTION

2.1 SAFIRE PLATFORM

SAFIRE provides a solution that gathers data streams from the products/machines and their contexts to proactively make recommendations leading to the enhancement of the product performance, or the optimisation and reconfiguration of the production processes. These data streams provide important insights into the specific requirements for the factory infrastructure and configuration, and new opportunities for the improvement of products/machines, which implicitly has an enormous impact on the user or operator satisfaction by improving the experience of the product/machine.

SAFIRE has been implemented following the general architectural model shown in Figure 2.

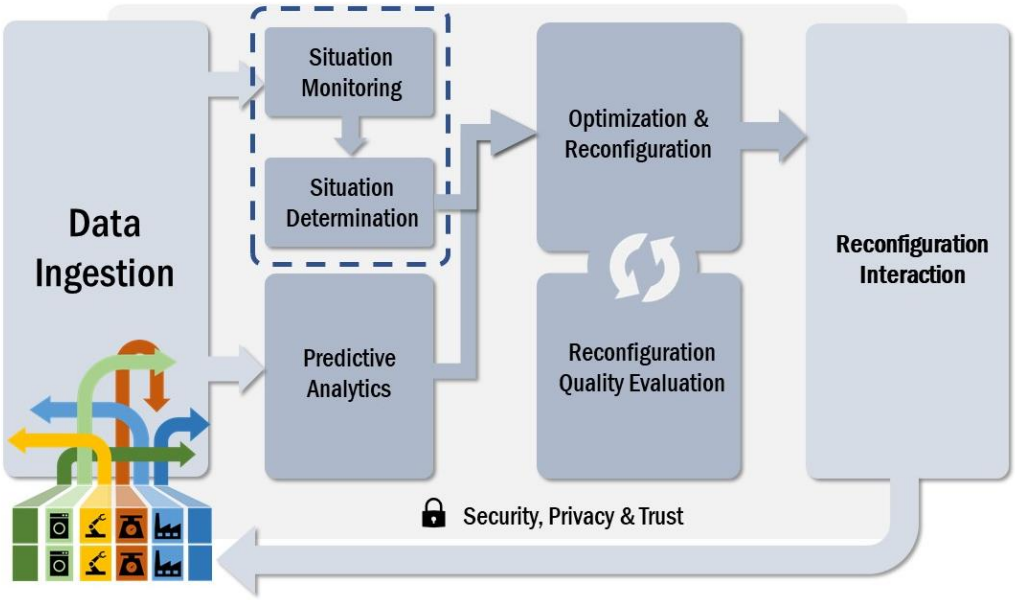

Figure 2: Main components of SAFIRE

The Data Ingestion services are the entry point of data into the system, with this data then being delivered to the Situational Determination Services (composed by Situation Monitoring and Situation Determination) and also the Predictive Analytics Services, with all of these components having been designed to support the Security, Privacy & Trust framework within the platform.

2.2 SAFIRE COMPONENTS

The key advances and innovations made possible by the technology components that comprise the SAFIRE solution shown in Figure 2 are summarised below.

SAFIRE Data Ingestion
Provides the ability to ingest data from external systems transparently into the SAFIRE platform using well-established protocols including MQTT, OPC-UA, JSON and others that are either de-jure or de-facto industry standards. The accompanying component

methodology involves identifying data to be ingested, modelling the data using NiFi templates, and then integrating the Data Ingestion component within the industrial environment. This results in a Service that is able to collect data from external systems and push data into the SAFIRE platform.

SAFIRE Predictive Analytics
Provides the ability to execute advanced analytics in real time, store huge amounts of data collected from industrial environments, and includes established web visualisation tools to easily query and visualise the stored data. The accompanying component methodology involves identifying the data to be analysed and then configuring the predictive analytics components, and integrating these case-specific analyses within the Predictive Analytics service. The component provides Services for real-time prediction of system operation (e.g. performance, maintenance, process, behaviour, etc.).

SAFIRE Situation Awareness
Provides facilities for the observation of changes in context under which a system (smart product, production equipment, factory system) is operating, that then generates data that is used to support reconfiguration / optimisation of systems. It is based on an ontological approach. The accompanying methodology involves identifying assets to be monitored, modelling of the Situations, and integrating these case-specific models within the Situation Awareness Services. The component provides a set of Services that monitor systems for changing context, identifying / extracting situations in real-time, and providing identified situations for determining new optimisations and potential reconfigurations.

SAFIRE Optimisation Engine
Provides scalable and high quality reconfigurations of industrial systems / manufacturing processes, while ensuring predictable upper bounds on execution time of optimisation algorithms, and supports fully configurable objective functions to address a wide range of optimisation challenges and industrial scenarios. The accompanying methodology involves modelling of the scenario to be optimised using the Factory Description Language (FDL) and configuring the metrics API. The component provides a set of Services for automatic configuration of objective function, and delivery of the Reconfiguration & Optimisation Engine results.

SAFIRE Security Framework
Provides an Industrial Internet Consortium IIoT Security Framework compliant set of tools for defining, visualising, and enforcing security policies within the SAFIRE platform, and is able to be integrated within existing industrial security infrastructures in manufacturing. The accompanying methodology involves identifying assets to be protected, security objectives and requirements, defining security policies for data and systems, and utilising security guidance provided for administrators. The framework includes a set of Services for centralised security policy administration, distributed security policy enforcement, protection of Data at Rest (DAR), and protection of Data in Transit (DIT) for the SAFIRE platform.

In summary, the SAFIRE project has delivered the following for the European manufacturing sector:

- Methodology for reconfiguration and optimisation of products and factories that addresses the technical and organisational issues for extension and introduction of SAFIRE, while emphasising security, privacy & trust.
- Set of tools and services to support predictive big data analytics, dynamic reconfiguration and optimisation, and situational awareness technologies that satisfy industrial security requirements.
- Cloud-based secure infrastructure add-on for an existing product, production system or smart factory operating system following the embedded systems paradigm so that all of the SAFIRE components can be tailored to specific systems.

The project innovations have been provided as open source technologies for European industry, and are accompanied by available commercial services from each of the technology development partners (ATB, IKERLAN, University of York, The Open Group) to support actors in the manufacturing domain in the adoption of the project technologies as an add-on for smart products, production systems, or next generation factory operating system enabling them to be transformed to include new capabilities for dynamic real-time reconfiguration and optimisation.

3. BUSINESS CASES

All of the work within the SAFIRE project has been driven by industrial requirements coming from commercial organisations representing different sectors of Europe's manufacturing industry. In particular, the project included industrial partners Electrolux, ONA and OAS whose interests were focused respectively on manufactured mass volume smart products, specialised production systems, and factory operations management. Each of the industrial scenarios where SAFIRE innovations have been applied is referred to as a Business Case (BC).

The gains in performance delivered by the SAFIRE technologies for each of the industrial BC partners are commercially sensitive as disclosure would reveal insights into new commercial directions and competitive advantages the BC partners will have in offering new products and services in some months' time. However, some examples in general terms of the improvements BC partners have demonstrated and quantified include substantial reduction in energy usage through optimised reconfigurations, higher utilisation levels, reduced production times, production that auto adapts in real-time by detecting small variations in components, and other improvements. The improvements quantified are at double digit percentage levels, which indicate the open source project technologies are capable of delivering substantial impacts for European manufacturers.

An overview of each BC and the industrial project outcomes from the perspectives of the industrial manufacturing partners in the project are provided in the following sections.

3.1 ELECTROLUX

Overview

Every product tells a different story: there are as many ways of using a product as there are users. In the field of home appliances, this is mainly manifested in the selection of functions (washing cycle, cooking recipe, etc.), or process parameters (e.g. spin speed, temperature), and in the way users interact with the user interface.

The SAFIRE solution enables analysis of data of embedded controllers of products in a cloud platform to obtain important data and valuable information that will meaningfully improve the experience of the customers. In that way, the cloud services implemented in the platform, capture data from the appliances which can be exploited, not only to improve the design and manufacturing processes, but also to embed new features in the working product if they improve the experience of the user. But, SAFIRE goes further by gathering data of the context and extracting behavioural patterns of the user that can lead to a more optimised operation of the appliances. An example is the identification of the ideal time frame to carry out a defrosting cycle, when the appliance is traditionally not used, but keeping the adequate temperature for food preservation.

The Electrolux Business Case focused on demonstrating the validity of SAFIRE in the real-time "Personalisation" and the "Adaptive operation" of a smart kitchen product. In particular, Electrolux has demonstrated and undertaken assessments of the SAFIRE technologies in three different scenarios:

- **Scenario 1:** Improvement of devices' performance based on the feedback obtained from the user.
- **Scenario 2:** Improvement of devices' performance based on historical data containing information about usage of the appliance, incidents occurred, maintenance actions, etc.
- **Scenario 3:** Adaptive control of devices based on a specific situational patterns identified by SAFIRE system.

Industrial Outcomes

SAFIRE has been a research project with a disruptive proposition inside Electrolux for two main reasons:

- From the customer point of view it has introduced the concept of feature personalisation powered by an extra feature dimension of context awareness. This is definitely something completely new for the domestic appliance market
- From the factory point of view it has introduced the concept of manufacturing completed c/o the final user's home with all the possible implications (e.g. after sale service). This is not similar to product firmware/software upgrades, like OTA, it is a completely new concept where, in principle, there are as many products as clients.

The introduction of disruptive concepts in companies like Electrolux, with a large number of products manufactured every year (60+ million), must always be carefully considered because any technical problem that produces a "recall from the field" puts the health of the company at risk. However Electrolux can say that SAFIRE has paved the way towards new directions. The natural development process forecast that this new technology will be further evaluated within the Advanced Development Department before it enters the Product Development phase.

For Electrolux, SAFIRE has made it possible to study, deepen understanding, and test new technologies, solutions, business models, thereby reducing the uncertainties and in the end, reducing the risks. In this perspective SAFIRE has reached its target. In the next two years the results of these innovations will be seen in new products that delight the customers of Electrolux with greater personalisation and the introduction of a new model for interacting with customers and products in the field.

3.2 ONA

Overview

ONA is a manufacturer of Electrical Discharge Machining (EDM) solutions, highly specialised in large, custom and automated EDM machines and installations. As part of the digital transformation of the company, ONA focuses on the research of advanced services for connected machines. A cloud platform (*ONA Smart Connect*) is being deployed with the dual aim of improving ONA customer´s processes and ONA products and services performance.

Advanced data analytics and dynamic situational models are the SAFIRE technologies explored in the context of adaptive machining and smart EDM.

Research activities in this field try to increase the machine capabilities to adapt to changes with respect to pre-planned operations. When manufacturing a component, the relevant manufacturing data are monitored and registered to identify anomalies, or to advance deviations from a target pattern. It has been a matter of important research to apply machine-learning-based technologies in SAFIRE to anticipate unexpected events, or to generate new process sensors that can add valuable information to the signature part concept and the machine condition fingerprint.

The last developments in ONA EDM solutions increase the manufacturing options for a job. Apart from having many machine sizes and configuration options, some specific machining modes in the ONA Smart CNC open a potential for process optimisation. That is the case of eco modes for saving consumables and energy, or the management of urgent jobs, for instance. It is expected that Optimisation and Reconfiguration modules in SAFIRE will assist ONA customers to select the optimal EDM manufacturing way in their EDM workshops.

Finally, the SAFIRE add-on concept was also an opportunity to test the interoperability service of the ONA Smart Connect platform.

Industrial Outcomes

The work carried out has enabled ONA to evaluate several critical issues in the Machine Tool Industry with a focus on developing advanced services for connected machines. No roadblocks were discovered when applying SAFIRE to address specialised EDM domain-specific requirements, so the demonstration can be considered sufficiently representative of the general Machine Tool sector because EDM process used to be not as well-known as other conventional machining processes.

Nowadays, a major challenge in the Machine Tool Industry, and also for ONA, is to shift from the scenario of being a machine provider to a new one in which the focus should be the overall process

efficiency of the customers and to change the relationship with them in order to be a manufacturing solution partner. The key points in this approach are to find a new position in the value chain and to propose innovative revenue business models taking advantage of Connected Product Networks (CPNs).

Top digital services based on CPNs require some degree of an underpinning platform concept. It is not easy to forecast who will operate such future platforms. Industry players (machinery manufacturers), automation players (machinery integrators) and IT players (industry 4.0 platform provider, cloud service/data analytics provider, etc.) are taking positions in the market and there is some kind of "platforms battle" underway.

Among the potential paid promising services are track and trace concept, quality management, remote service, product condition monitoring, online support, monitoring and analysis of operations data, … First class business support focusing on increasing the efficiency of the customer processes and its transparency enabled by SAFIRE technologies could be the most valuable services. That is the case of the provision of support for manufacturing decisions, to discover new insights (based on manufacturing data analytics), to maximize asset uptime and OEE, to optimize manufacturing process, and to improve the energy efficiency,

The proprietary CNC technology developed by ONA is considered a valuable "ICT" asset in the CPNs structure and in the deployment of data driven services based on connected machines. It is a core component with a privileged position in the manufacturing data generation.

As part of the digital transformation process of the company, ONA is actively involved in developing new digital services based on connected products (machines). The *ONA Smart Connect* cloud-based platform is a key component of this strategy. In this context, the demonstration activities in the project has shown that the SAFIRE platform add-on concept can be integrated with ONA's OSC open architecture, in order to extend the current functionality with secure data analytics and optimisation services.

3.3 OAS

Overview

OAS AG is an innovative middle-sized company with a rich experience in weighing technology and industrial plant construction all over Europe. The objective of OAS was to demonstrate the use of SAFIRE to optimise production processes and preventive maintenance activities, managed by OAS' proNTo control system, using reconfiguration based on the analysis of data gathered from the equipment and other systems.

ProNTo is a high performance process visualisation system for SCADA and, at the same time, a control system for the process and production control level (MES). It is optimised for the control and administration of batch-oriented processes and it is particularly suitable for weighing solutions.

OAS validated the SAFIRE technologies in one of their customer's installations. The plant was continuously observed by the SAFIRE platform to identify usage patterns. These patterns were used for achieving optimal re-configuration parameters for a production process, as well as the baseline for advanced preventive maintenance based on analytics.

In addition, OAS intends to use information gathered from its customers to monitor the performance of their control systems. This will be used as feedback to OAS design process to improve design of new control systems.

The SAFIRE technologies will extend the overall OAS portfolio and increases the innovativeness of OAS through the addition of solutions for challenges related to Industry 4.0 (i.e. vast amount of data to process, needs for additional sensors for data acquisition and product control, connectivity demands, etc.). The SAFIRE technology with its big data analysis, situational awareness and optimisation features comes, therefore, at an excellent time for a market entry with a very high potential.

Industrial Outcomes

The prototype application using SAFIRE technologies was developed in an iterative way, with each iteration having a feedback round focussing on the production installations and the technical perspective of OAS as provider of the proNTo system. Based on this feedback, the application was improved and extended step-by-step, making it more user-friendly.

The future work required from OAS is to make the approach easily adjustable and customisable to the production installations of other plant facilities, by also taking into account different constraints of the respective production installations of the other companies (e.g.

different situation regarding shared resources between production lines, or different rules about which type of production can be produced on which production line).

In addition, what needs to be explored in the future is how far the functionality of the production scheduling support application utilising all of the SAFIRE components can be fully integrated with the proNTo system, by integrating the user interfaces, and possibly also transferring the suggested optimised production reconfigurations directly into proNTo.

4. GETTING STARTED

4.1 SAFIRE METHODOLOGY

In the complex domain of manufacturing, information about products, machines and processes can be crucial for the future improvement and achievement of innovation, covering the ever-increasing needs of the customers while maintaining low costs and time to market. SAFIRE aims to enhance the process of information management and (re)use and offer a medium for advanced big data analysis and situation-based process optimisation, that is easy to adapt in the manufacturing environment, and suitable for different business concepts. Towards this aim, the SAFIRE platform is composed by four service modules, namely the:

- Predictive Analytics (PA) component
- Situation Determination (SD) component
- Optimisation Engine (OE)
- Security Framework (SPT)

An informational dashboard is also part of the SAFIRE solution allowing the platform administrators to monitor the operation of the components during their operation while embedded within industrial environments.

The challenge in creating the SAFIRE platform was in the difficulty in integrating the different functionalities into one platform able to be used as a plugin in any industrial environment, requiring only simple configuration and set-up for individual scenarios. Figure 3 illustrates the structure of the methodology followed to adapt and integrate the SAFIRE services into the platform for a single smart product or manufacturing system, referred to as a Business Case (BC). (The specific BC examples where SAFIRE was applied in the project are described earlier in Section 3.)

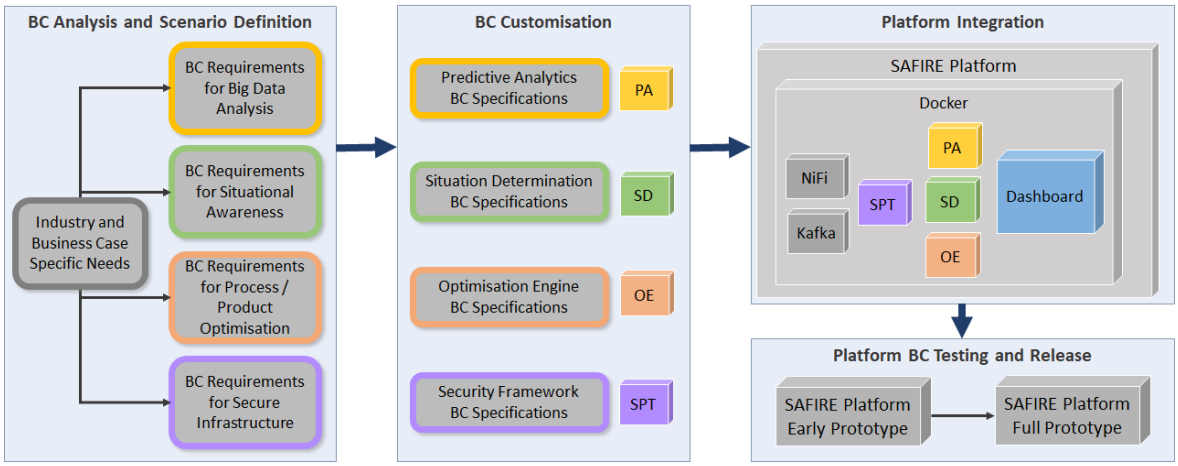

Figure 3: Structure of the SAFIRE Platform Methodology

As shown in Figure 3, the methodology followed for the SAFIRE platform is structured into four main steps:

BC Analysis and Scenario Definition

The first step in the SAFIRE methodology includes the research and analysis of the requirements that should be covered by the SAFIRE platform. Industrial and business goals, customer expectations and needs, as well as particularities of the selected business cases have to be collected, analysed and structured so as to lead to specifications for the platform to be developed. During this step, potential actors of the system to be enhanced by applying SAFIRE technologies could be revealed, leading likely to more clear or specialised requirements. Additionally, the specific requirements for the main features delivered by the project, namely big data analysis, situational awareness, process optimisation and security in operation, should be identified. Those requirements should be compared and combined with those collected for the industry/business, to lead later on in the shaping of specifications, as well as to a more detailed scenario concept.

This step requires close cooperation of the industry experts with SAFIRE experts and potential end users. As a practical example of an operation belonging to this step, for the development of the SAFIRE solution, the definition of the BC-specific scenarios (e.g. concept, actors, workflows, etc.) from the business case experts in cooperation with the development partners could be mentioned.

BC Customisation

As a second step to the SAFIRE methodology, the customisation of the different services based on the selected BC scenarios follows. The specifications, which have been already derived from the process in the previous step are being reviewed, if necessary, and decisions for the adjustment of the data models, the data exchange formats/files and the legacy connection modules will be made.

Regarding the current development of the SAFIRE solution, an operation of this step is the definition of the situation models, and the data exchange formats to be communicated between the SAFIRE modules and the legacy systems (e.g. xls files, string JSON formats, etc.).

Platform Integration

As part of this step, the individual services are being connected to work together using the full prototype of the integrated platform, and exchanging data and pushing their results to the common communication channel (e.g. Kafka). Additionally, the integrated services are being adjusted (e.g. change input data source) to interact with the BC systems. Modifications can be made to the individual modules, as well as to the integrated part, in case any BC, or scenario parameter should be adjusted (e.g. data exchange rate or amount of data traffic allowed). Part of this step is also the description of the integration process to document that can also be used as user manuals.

This step might reveal the necessity of additional services or modules to assist in the legacy system integration or in the observation of the platform operation. For this development of the platform, the SAFIRE dashboard was introduced to monitor the SAFIRE service-status for each of the components.

The result of this step is a fully functional packaged (e.g. using Docker) modules that are able to accept and process the selected data including those coming directly from the BC infrastructure.

Platform Testing and Release

This final step of the SAFIRE methodology includes the testing of the integrated platform, as well the release of the final version. The first release of the platform is being validated in the industrial environment, and the operation of the whole system is being observed using the SAFIRE dashboard. The tests might reveal conflicts with the legacy systems (e.g. discrepancy in the security policies, or connection issues due to the configured data exchange options), or with the internal communication of the modules in real environments (e.g. delay in result production of a module due to hardware limitations). Those conflicts will be adjusted to the final version of the platform (in case those require platform adjustments), or during the installation process (in case those are due to configuration options).

The steps mentioned above describe the common methodology to create and apply the generic SAFIRE solution within a typical BC scenario. The next sections describe the detailed information that is available for each of the individual components and associated methodologies for the customisation of each of the SAFIRE services (Predictive Analytics, Situation Determination, Optimisation Engine and Security Framework), as well as how to access the open source technologies.

4.2 PUBLIC REPORTS AND SAFIRE TECHNOLOGIES

Getting familiar with SAFIRE technologies described in Section 2 is straightforward. The best approach is to start with the reports describing the integrated SAFIRE solution beginning with the SAFIRE Concept, followed by the SAFIRE Integrated Methodology, and then the SAFIRE Integrated Cloud Analysis and Reconfiguration Platform. These will provide a good overview of the SAFIRE capabilities, along with how to set-up, customise, and deploy SAFIRE technologies for a particular manufacturing system, factory processes or smart product.

Further reports describe each of the SAFIRE components and their associated methodologies in more detail, with each being targeted for specific discipline and skill set experts within manufacturing organisations. All of the SAFIRE components are available in open source and all of the public reports are available on the project website (www.SAFIRE-Factories.org) and are listed below with their respective links for downloading.

Integrated SAFIRE Solution

- SAFIRE Concept
- SAFIRE Integrated Methodology
- SAFIRE Integrated Cloud Analysis and Reconfiguration Platform
- SAFIRE GitLab Open Source Repository

SAFIRE Component details: Predictive Analytics

- Specification of Predictive Analytics Platform
- Prototype of Predictive Analytics Platform

Situation Determination Component Details

- Specification of Situational Awareness Services
- Prototype of Situational Awareness Services

Optimisation Engine Component Details

- Specification of Dynamic and Predictable Reconfiguration and Optimisation Engine
- Prototype of Dynamic and Predictable Reconfiguration and Optimisation Engine

Security, Privacy and Trust Component Details

- Specification of Security, Privacy and Trust Framework
- Prototype of Security, Privacy and Trust Framework

In addition to the final deliverables, earlier public deliverables from the project are available at the CORDIS site for the SAFIRE project hosted by the European Commission. However, the final versions of the reports available from the above links are recommended for anyone wanting to become familiar with the project technologies.

5. INFORMATIONAL MATERIALS

During the operation of the project informational materials describing the SAFIRE solution were prepared and are available on the project website including a brochure describing the SAFIRE platform and components, newsletters, and 16 peer-reviewed technical papers, journal articles and book chapters that were presented at international conferences and published by leading scientific journals.

In the final months of the projects each of the BC partners have prepared videos describing their industrial demonstrators where SAFIRE technologies were deployed

and the future benefits the technologies will have on their respective businesses. These are a quick way to get an introduction to the project technologies, how they are applied within typical manufacturing organisations, and the kind of business benefits to be expected.

All of this and much more information is available by visiting the project website at:

www.SAFIRE-Factories.org