D5.2 Final Management Report

Dissemination Level	
	PUBLIC

Partners:	TTS, DELCAM, HOLONIX, SUPSI, SmartFactoryKL, LMS, POLIMI
Authors:	TTS, SUPSI
Due Date:	
Version:	

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. EXECUTIVE SUMMARY

This deliverable represents the final version of the Pathfinder management report. A publishable summary, presented in chapter 3, is meant to briefly describe the logical structure of the whole roadmap and its main achievements. It starts with the explanation of the project context and objectives and describes how the different blocks of the roadmap tackle them.

Chapter 4 presents a summary of the objectives assigned to each work package in the context of the whole project Work-Plan, for the targeted reporting period. Chapter 5 addresses in detail all the achievements that have been met, task-by-task. Chapter 6 provides a list of the deliverables and milestones achieved during the period.

Chapter 7 focuses on the project management. Eventually chapter 8 introduces the plan for use and dissemination of foreground.

The last section, chapter 9, is the report of the societal implications.

2. DECLARATION BY THE SCIENTIFIC REPRESENTATIVE OF THE PC

I, as scientific representative of the coordinator of this project and in line with the obligations as stated in Article II.2.3 of the Grant Agreement declare that:

- The attached periodic report represents an accurate description of the work carried out in this project for this reporting period;
- The project (tick as appropriate):
  - ☑ has fully achieved its objectives and technical goals for the period;
  - ☐ has achieved most of its objectives and technical goals for the period with relatively minor deviations;
  - ☐ has failed to achieve critical objectives and/or is not at all on schedule.
- The public website is up to date.
  - ☑ is up to date;
  - ☐ Is not up to date;
- To my best knowledge, the financial statements which are being submitted as part of this report are in line with the actual work carried out and are consistent with the report on the resources used for the project (section XX) and if applicable with the certificate on financial statement.
- All beneficiaries, in particular non-profit public bodies, secondary and higher education establishments, research organisations and SMEs, have declared to have verified their legal status. Any changes have been reported under section 5 (Project Management) in accordance with Article II.3.f of the Grant Agreement.

Table 1: declaration by the scientific representative of the pc

Name of scientific representative of the Coordinator: Paolo Pedrazzoli

Date: 15/02/2015

Signature of scientific representative of the Coordinator.....

3. PUBLISHABLE SUMMARY

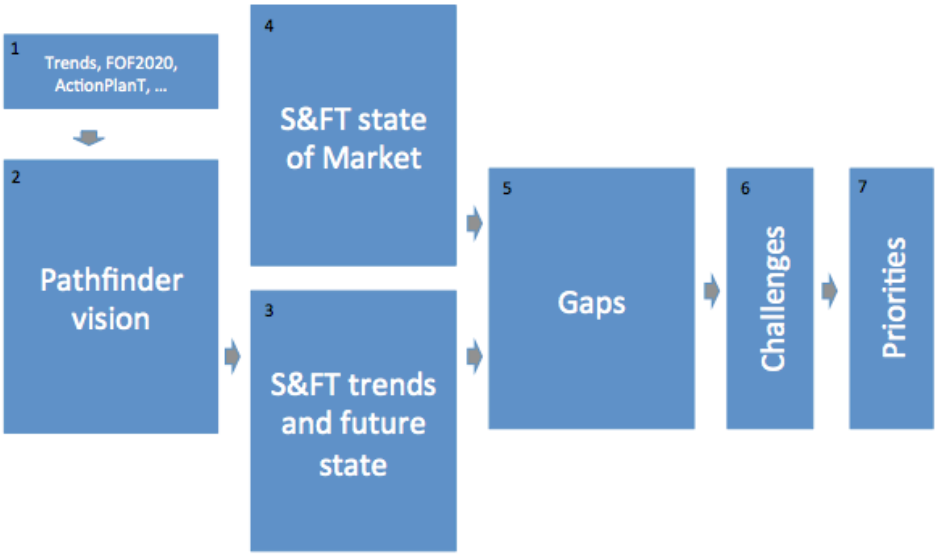
For a comprehensive publishable description of the road-mapping activity, please refer to http://www.pathfinderproject.eu/downloads/results/Pathfinder_WhitePaper1.pdf

European leadership and excellence in manufacturing are being significantly threatened by the huge economic crisis that hit the Western countries over the last years. More sustainable and efficient production systems able to keep pace with the market evolution are of paramount importance in the recovery plan aimed at innovating the European competitive landscape. An essential ingredient for a winning innovation path is a more aware and widespread use of ICT in manufacturing-related processes. ICT is indeed the cornerstone of economic growth. By the early 2000s, several economists found evidence to support a link between ICT investment and industrial productivity: the impact of information and communication technology is of paramount importance since an investment in such sector generates a bigger return to productivity growth than most other forms of capital investment.

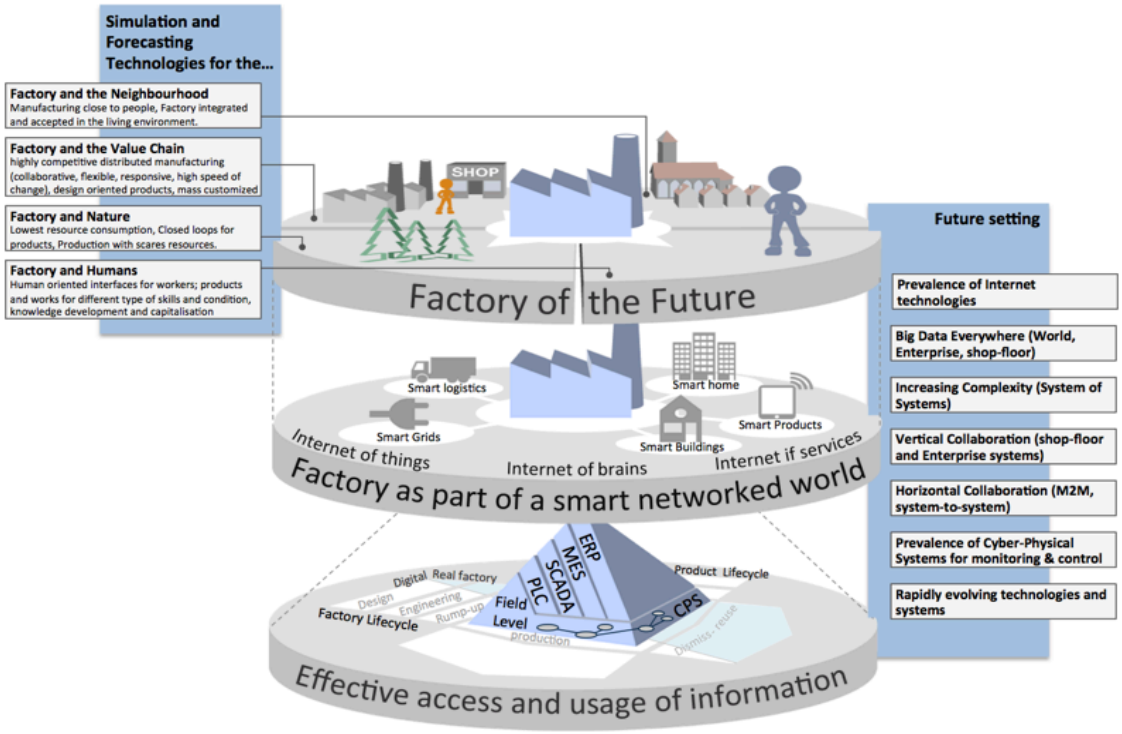
Europe has fallen behind the world leader in investment in ICT - the US - since 1991. The US increased its accumulated stock of ICT investment as a proportion of GDP from 9% in 1991 to 30% in 2010. Europe's ICT capital stock increased from 6-9% (near parity with the US) to around 20% over the same timeframe. The ICT investment disparity significantly affected Europe's relative productivity. From 2000-2010, annual US productivity growth accelerated to close to 2%. In Europe, annual productivity growth decelerated to around 1%.

Pathfinder investigates, in particular, the role of simulation and forecasting technologies (S&FT) as a lever to increase manufacturing performance and proposes the development of a roadmap capable to clearly point out key challenges for these technologies future development. Pathfinder is indeed intended to drive research and development activities in the Simulation and Forecasting Technologies arena, and, to this end, the roadmap must develop, through the analysis of current state of practice compared with the future state envisioned, a final list of research priorities to provide guidance for the key stake-holders. The process of roadmap building has been arranged into 7 logical blocks:

1. An analysis of trends, current road-mapping activities and national initiatives, set the basis for the definition of the pathfinder vision.
2. The Pathfinder vision has been developed in such a way to be consistent with current road-mapping efforts at national and international level (in order not to introduce a new vision on manufacturing itself, but to embrace existing activities).
3. From the vision, the current trends and future envisioned state of Simulation and Forecasting Technologies have been derived.
4. In parallel, the current state of market practice has been investigated.
5. By confronting the envisioned future state with the current state of market practice, the road-mapping activity has defined the related gaps. These can be considered as the missing link between what is currently available and the future envisioned manufacturing scenario.
6. Identified gaps, consolidated and grouped, are the main input for the identification of challenges that are expected to arise for the S&FT innovation need.
7. The identified challenges will be faced by addressing the research priorities identified by Pathfinder.



Pathfinder does not propose a new vision for manufacturing. The long-term direction embraced is consistent with the one anticipated within the "Factories of the Future Strategic Multi-Annual Roadmap" developed within EFFRA. The vision (described in detail in D2.2) has an essential role since it summarizes the main trends and expectations for the manufacturing of the future and brings into the reasoning the contextual factors that will have a reciprocal impact with the S&FT. The vision is built upon a three-layer structure as it is shown below



Once consolidated the vision, Pathfinder identifies, through experts consultation and through the analysis of current initiatives and roadmaps at national and European level, ***eight Research Areas***, meant to cluster the identified state of market, future state, gaps, and priorities.

RA1: Open and Cloud-based S&FT for High-performance Computing

RA2: Multi-disciplinary and Multi-domain Integrated S&FT

RA3: S&FT for Life-cycle Management

RA4: Multi-level S&FT Integration

RA5: S&FT for Real-Time Factory Controlling and Monitoring

RA6: Smart, Intelligent and Self-learning S&FT

RA7: Human-centred Simulation-based Learning & Training

RA8: Crowdsourcing-based S&FT

The identified gaps, resulting from the confrontation between the state of Market and the Future envisioned state, are a main input for the identification of challenges that, given the contextual factors, are expected to arise and to be faced by S&FT innovation. The identified gaps are:

- **G1.1** - Poor maturity level of use of cloud-computing in S&FT – RA;
- **G1.2** - Missing of multi-device and platform independent applications – RA
- **G2.1** - Missing of multi-disciplinary and multi-domain models - CMA
- **G2.2** - Lack of integration from different domain/discipline models - CMA
- **G2.3** - Few standards for multi domain models building & integration – CMA
- **G2.4** - No integration between tools – CMA
- **G3.1** - Poor modeling simulation of life-cycle issue – CMA
- **G3.2** - Limited modeling of product life cycle costs – CMA
- **G3.4** - De-manufacturing not completely assessed and only for specialized product type – RA
- **G4.1** - Shortage of multi-level S&FT models – CMA
- **G4.2** - Limited integration and interoperability across the process and product chain – CMA
- **G5.1** - Real-time data collection and synchronization barely used – CMA
- **G5.2** - Limited linkage to actual and real-time data – CMA
- **G5.3** - Poor maturity level of use of virtual factory models – CMA
- **G6.1** - Missing of self-optimizing and self-learning models – RA
- **G6.2** - Poor use of knowledge-based systems – CMA
- **G6.3** - Poor maturity level of use of smart objects – RA
- **G7.1** - Limited use on large-scale – RA
- **G7.2** - Lack of generic tools for human-centred simulation-based learning and training – CMA
- **G8.1** - Missing of crowd source-based framework for simulation and forecasting tool – RA
- **G8.2** - Lack of integration with social networks - RA

The afore mentioned analysis along with the continuous feedback process adopted within the Pathfinder network allowed to identify the following challenges:

S&FT and Digital Continuity - Digital Continuity refers to the ability to maintain the digital information available all along the factory life-cycle, despite changes in purpose and tools, allowing data (the oil that fuels manufacturing) to be enriched and used as needed for that specific phase (from design, through use and maintenance, till dismissal/re-design). This challenge addresses: Interoperable simulation and forecasting systems; Digital continuity across product and factory lifecycle of engineering information; seamless use and reuse of

engineering data; Reduce modelling effort; Modelling of complex problems; Multidisciplinary integrated modelling; Standardization.

S&FT and Scalability - Scalability refers to the ability of an application to function efficiently when its context is changed in size or volume. This challenge addresses: Step-by-step integration and adoption of S&FT; S&FT solution scalable on different devices and platforms; from on-premises software to cloud-based services;

S&FT and Synchronization of Digital and Real World - Synchronization of Digital and Real World refers to the convergence of physical world and virtual world, where the second must closely mirror the first and where the first generates an unprecedented volume of data to be taken care of by the latter. This challenge addresses: Self-adjustment of digital models triggered by smart objects (embedded intelligence – Cyber Physical System paradigm); Co-simulation in real-time; Multidisciplinary simulation models and tools, Handling of big-data.

S&FT and Advanced Human-Machine Interfaces – Advanced Human-Machine Interfaces (HMI) must provide transparent insights into the digital-virtual world and must allow to interact with S&FT in an intuitive and natural way. This challenge addresses: intuitive, mobile, context-sensitive and collaborative user-interfaces.

S&FT and Digital Consistency & Security - Digital Consistency & Security refers to the fact that data originating from and travelling along the factory lifecycle should be safe and shouldn't contradict each other. This is a significant challenge especially in the context of the digital continuity, vertical integration and horizontal integration, where distributed and heterogeneous data sources will be linked and made available in an open and interoperable manner. This challenge addresses: optimised provision of consistent data, data security and privacy.

S&FT, Data and Knowledge - This challenge addresses: Big Data and Data Analytics; Ontologies definition; Relevant knowledge capture and reuse, also for training and education

The use of S&FT is more advanced in those sectors where, historically, these tools have been considered as a fundamental element to support the product and process development. Based on an industrial survey, Pathfinder identified also the relevance and impact of the S&FT gaps and challenges in various sectors, to make a distinction between gaps pointing to functionalities and tools already existent but with a restricted application area, and novel features calling for research actions.

Europe must consolidate its strengths in the ICT sector and, as pointed out, further invest: EU is still world-leader in ICT for manufacturing and has a leadership position in the field of S&FT with big players like Siemens and Dassault. The use of ICT for manufacturing is widespread in several sectors and among large and small-medium enterprises. Nordic European countries score in the top 10 in terms of ICT readiness level evaluated globally by the World Economic Forum thus showing their commitment for developing their digital potential. The ground is mature enough to further rely on ICT advancements as a lever to increase productivity and competitiveness. Also, the strong knowledge base developed in European research institutes and the high quality training standards guaranteed by leading technical universities in the area of simulation, analytics and forecasting technologies are driving the growth of a skilled generation that will master successfully these technologies in the manufacturing arena.

Data is what fuels progress in manufacturing. The digitalisation of manufacturing processes generates a large amount of data that is not – yet – used to any real extent and offers broad opportunities for the future. The priorities acknowledged by Pathfinder clearly reflect the challenges and research area identified, as mentioned above, and focus on three main topics: I- Digital Continuity, where huge operational and economic benefits are expected through linking all the steps in the product life cycle digitally – form product design, production planning and engineering, production execution and services – and to create a full lifecycle data loop; II- Synchronization of

Digital and Real World, where the real world of production is accompanied by an equivalent in the digital world, so that products and production processes are simulated and optimized in detail before the real production is in place. The digital twin has the potential to monitor, adjust and optimize real processes, anticipate failures and thus to increase efficiency by orders of magnitude; III- Multidisciplinary integrated modelling and virtual validation of manufacturing equipment at design stage, and system-level simulation of mechatronic systems at production phase, prior to actual manufacturing, (thanks to integration of models from different domains) will ensure proper performance of equipment and processes.

3.1. List of partners

The abovementioned results have been achieved thanks to the coordinated efforts of the Pathfinder partners:

Partner	Website	Logo
Technology Transfer System srl	www.ttsnetwork.com	
Delcam PLC	www.delcam.com	
Holonix srl	www.holonix.it	
University of Applied Sciences of Southern Switzerland	www.dti.supsi.ch	
Technologie Initiative SmartFactory KL E.V.	www.smartfactory-kl.de	
University of Patras	www.lms.mech.upatras.gr	
Politecnico di Milano	http://www.polimi.it/en/	

Table 2: List of pathfinder partners

4. PROJECT OBJECTIVES FOR THE PERIOD

A summary of the objectives assigned to each work package in the whole project development is presented in the following table.

	Title	Objectives in short
WP1	**Framework and State of the art analysis**	• To set a reference context for Pathfinder. • To carry out an extensive analysis of the state-of-the art of the simulation and forecasting technologies, and identification of current challenges. • To take into account existing road-mapping activities and political drivers. • To involve main key players, industries and research initiatives. • To increase the understanding of how simulation and forecasting technologies can improve manufacturing performance and to develop an impact measuring tool.
WP2	**Vision for the future role of simulation and forecasting technologies**	• To build a vision of the future use and role of simulation and forecasting technologies, based on identified gaps. • To validate the vision.
WP3	**Roadmap for the next generation simulation and forecasting technologies**	• To identify technological challenges and drivers in line with the needs of the vision for the future of manufacturing.
WP4	**Communication and dissemination**	• To increase knowledge and awareness about the use and impacts of simulation and forecasting technologies by fostering a cross-sector dialogue involving both potential users, experts and technologies producers. • To communicate our project objectives and results through all relevant mediums to reach our target audience.
WP5	**Project management**	• Setting up and maintaining an infrastructure for project management, coordination and administration. • Setting up quality and risk management to achieve and maintain a high level of quality for all internal and external communications and deliverables. • Providing administrative and organizational support for the workshops and trainings. • Providing the information technology infrastructure for both internal and external users.

Table 3: list of the Pathfinder objectives for each period

5. WORK PROGRESS AND ACHIEVEMENTS DURING THE PERIOD

5.1. Work package 1 – Framework and state of the art analysis

This work package is meant to capture and critically analyse the state-of-the-art and related challenges in practice and theory related to the use of simulation and forecasting technologies (by involving main key players thanks to the partners' networks and to the exploitation of the industrial technology initiative SmartFactoryKL and of the RTD association EMIRAcle). Along with the collection of information from the field, an extensive analysis of existing roadmaps and political drivers will be carried out. Findings will be used as qualified inputs for the vision definition (WP2) and the roadmap development (WP3).

The analysis relies on the following sources:

- Existing roadmap initiatives in the ICT field that include also a part on simulation and forecasting technologies. Both industrial and research documents will be analysed.
- IT experts and industrial users
- Reports published by different manufacturing and ICT technology platform.
- Country reports able to provide an idea of the European landscape in terms of centres of excellence, regional clusters, existing eco systems and research initiatives.

Systematic capture and evaluation is supported by the development of a structured process that could integrate, in a coherent way, information coming from different sources, so to create the reference context of the project. At the same time, a timely dissemination of the state-of-the-art analysis is scheduled in order to reach the majority of the potential constituencies. An impact measuring tool is also developed in order to evaluate simulation and forecasting technologies impacts against expected requirements and drivers.

Task Name	Starts	Ends	Task Leader
T 1.1 Capturing and evaluating knowledge	1	6	LMS

Within Task 1.1 an extensive analysis of the state-of-the-art of the simulation and forecasting technologies has been carried out taking into consideration main key players, industries, research initiatives and commercial platforms. More in detail, the investigation included a systematic review of the existing literature, a market survey, and an examination of the past and current roadmaps on ICT-related topic.

Some preliminary activities have been done in order to structure in a proper way the analysis and to make sure that the information was functional to the next steps of the project. They can be summarized as follows:

- Definition of the scope of the analysis in order to better characterize the type of sources that needed to

be searched and analyzed;

- Definition of the methodology to follow for the analysis of each kind of source (literature, market tools, existent roadmaps)
- Definition of S&FT as relevant for the Pathfinder purposes

The literature review allowed the mapping of the various tools and technologies able to strategically support production-related activities during the product and production lifecycles. The investigation of the latest advancements for each tool has been used to clearly figure out the current state of development and future challenges that each technology will face. Moreover, the study identified the industrial applications of each tool and its specific importance for the industrial sector. Last, the commercial software tools available on the market have been identified. The following is a schematic representation of the results of this phase of analysis.

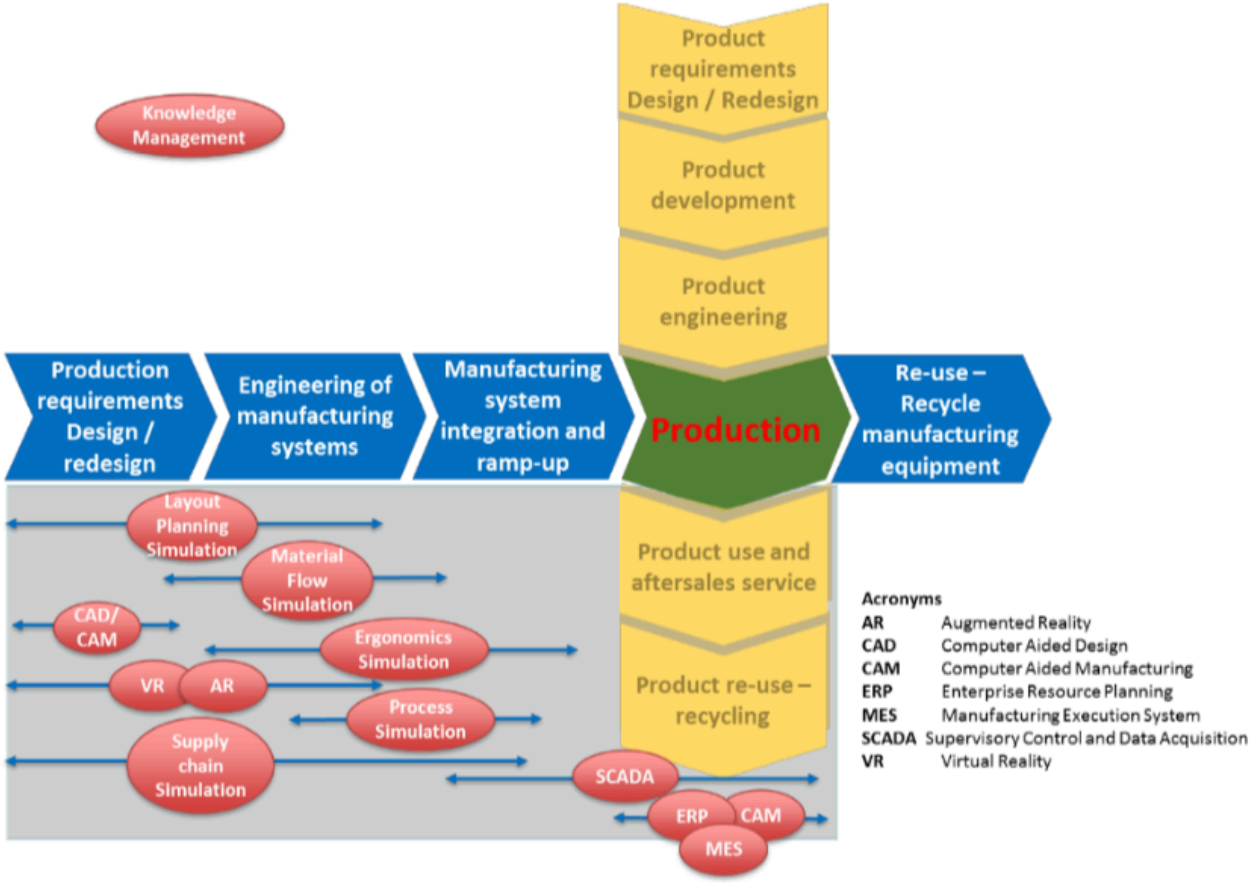


Figure 1: mapping of tools on production lifecycle

The next analysis was focused on the most recent roadmaps at the European level. Since no work specifically focused on the simulation and forecasting technology have been found, documents related to manufacturing and ICT for manufacturing have been considered the main reference. In the end, three roadmaps were chosen as the most interesting for the Pathfinder project:

- Factories of the future strategic multi-annual roadmap – Factories of the future 2020

(vision 7 march 2013);

- ICT for manufacturing – The ActionPlanT Roadmap for manufacturing 2.0;
- IMS202 – Roadmap on Sustainable Manufacturing, Energy Efficient Manufacturing and Technologies.

The analysis of the above-mentioned roadmaps led to the identification of research priorities related to simulation and forecasting technologies that have to be used as an input for the Pathfinder's roadmap since they depict research lines still active in the field of interest. A set of 21 research priorities was identified from the three documents. The topics were clustered relying on the nature of intervention they address and a total of 8 clusters were eventually defined. Below, the clusters and the related priorities are briefly presented:

- **Cluster 1: Open and Cloud-based S&FT for High-performance computing**

1. Exploit IaaS in cloud infrastructure for high-performance and complex simulation, forecasting and analytics;

   Facilitating SMEs to access high-performance and complex simulation, forecasting and analytics through a manufacturing app store;

- **Cluster 2: Multi-disciplinary and Multi-domain integrated S&FT**

2. Develop multidisciplinary models and tools for designing flexible and easily reconfigurable systems, integrating models from different domains able to monitor consumption of energy and other resources and prevent unforeseen and undesired reactive maintenance;
3. Development of closed loop simulation tools to be used in the design phase;
4. Use simulation for the sustainable supply chain design;

- **Cluster 3: S&FT for Life-cycle management**

5. Simulation tools for the de-manufacturing phase (dismantling, repairing and rebuilding);

- **Cluster 4: Multi-level S&FT integration**

6. Multi-level simulation applications that support usability at different levels aimed at providing different representations of relevant information (multi- level access features, aggregation of data with different granularity, zoom in and out functionalities);
7. Simulation tools enhancing data integration across the process chain;
8. Advanced visualization tools for better human understanding;

- **Cluster 5: S&FT for Real-Time factory controlling and monitoring**

9. Real-time data collection from all the factory resources and synchronization of real-world and virtual resources;
10. Knowledge-based and intelligent simulation tools able to assess performance at both factory level (energy consumption, productivity, production processes and quality) and supply chain level;

11. Performance assessment in real-time and predictive considering varying environmental conditions and phenomena;
12. Product-life cycle simulation tools that could support the decisional process providing KPIs
13. Integrating simulation tools with MES;
14. Real-time data collection from all the factory resources and synchronization of real world and virtual resources;
15. Developing digital mock ups of product and services in their environment to improve the control done by simulation tool;
16. Simulation tools used to guarantee production systems delivering “zero defect” parts;

- **Cluster 6: Smart, intelligent and Self-learning**

17. Self-learning systems to enable self-adaptation of simulation attributes from historical and real-time data;
18. Development of predictive data analytics techniques and forecasting capabilities to process the massive amount of data;

- **Cluster 7: Human-centred simulation-based learning & training**

19. Virtual and simulation environment for role game-based learning and training;
20. Tools to support the decision-making on the basis of worker capabilities;

- **Cluster 8: crowdsourcing-based S&FT**

21. Simulation tools interacting with social networks and HMI supporting the comparison between models and allowing a what-if analysis (interaction with customers);

Finally, a detailed analysis of the most adopted commercial simulation and forecasting software tools and suites offered by key vendors has been carried out pointing out the main functionalities.

The last activity carried out in Task 1.1 has been a summary of the key findings coming from the three sources of reference (literature, existing roadmaps and software solutions) paving the way for the definition of gaps that is developed in task 2.1.

Task Name	Starts	Ends	Task Leader
T 1.2 Involvement of experts and industrial players	**1**	**6**	**SFKL**

In this task several contacts have been activated with both industrial and institutional partners that work in this field and know how simulation and forecasting technologies can impact the manufacturing performances. Their expertise has been highly valuable for supporting the Pathfinder consortium in developing and validating the network. First, an Advisory Board group was created including nineteen members representing more than fifteen industries. They have been indispensable in shaping the whole process of development of the roadmap, from deriving gaps between the literature and its actual application on the market, and for draw the future challenges and research priorities that S&FT will face within the manufacturing arena. Other than the Advisory Board members, more than twenty other

contributors have been identified and have been invited at different Pathfinder workshops to discuss about the work achieved in different phases of the project and thus obtain their precious feedback. Other dissemination channels have been activated by the Pathfinder partners with EFFRA and I4MS.

Task Name	Starts	Ends	Task Leader
T 1.3 Reference context development and impact measuring tool	**3**	**8**	**SUPSI**

The main result achieved with this task is the development of the conceptual architecture that acts as the backbone of the Pathfinder's roadmap. Such architecture points out what are the main building blocks that influenced the roadmap development and the ones included in the roadmap itself. The final roadmap features the architecture presented in the scheme below.

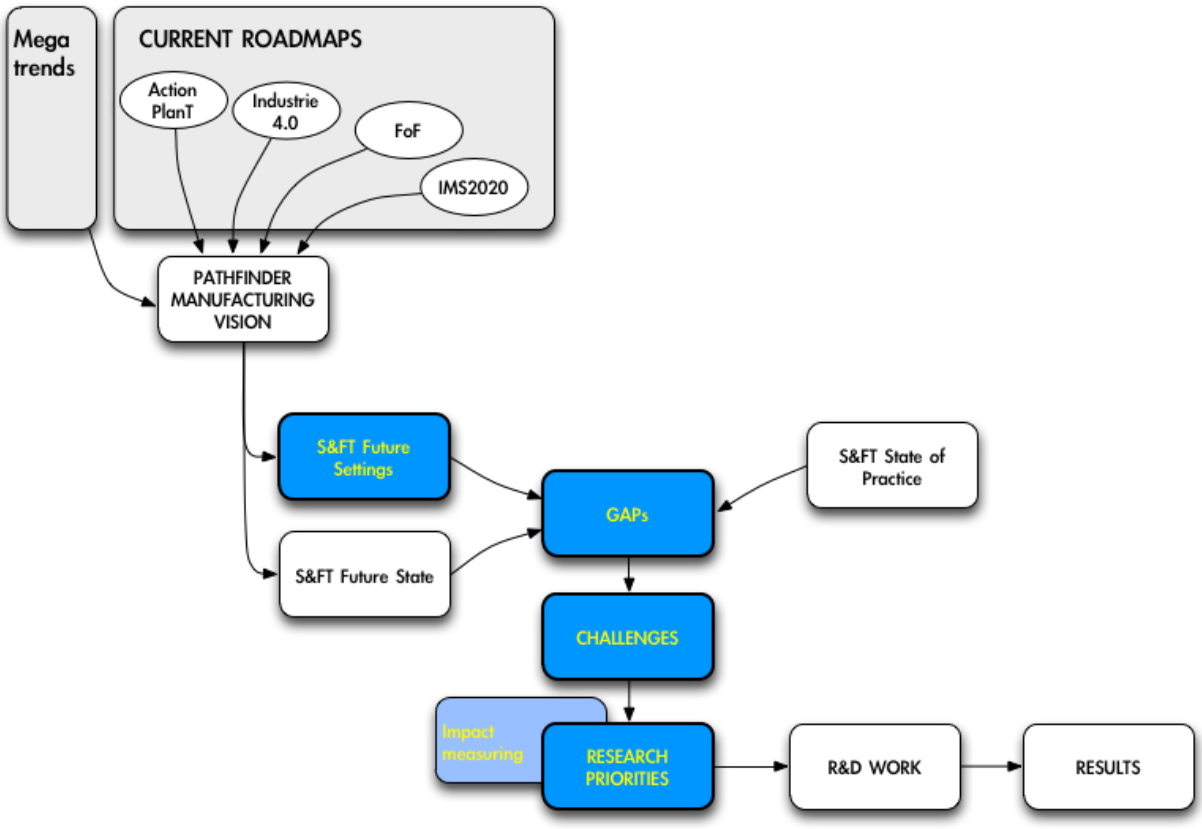


Figure 2: Pathfinder conceptual architecture

Along with this conceptual architecture, in this task a way to measure the impact of the identified research priorities has been introduced. More specifically, three types of impacts are thought to be relevant to drive the research priorities use. They are summarized as follows:

- Impact on Simulation and Forecasting Technologies challenges. The proposed impact assessment tool is a radar chart that shows how much each challenge is covered by a research priority. A four point scale is used to qualitatively assess the expected level of coverage of a challenge: 0- none; 1-low; 2-medium; 3- high. The assessment of the level of coverage on challenges was done with the support of experts. In the figure below a sample radar chart is shown considering a potential research priority:

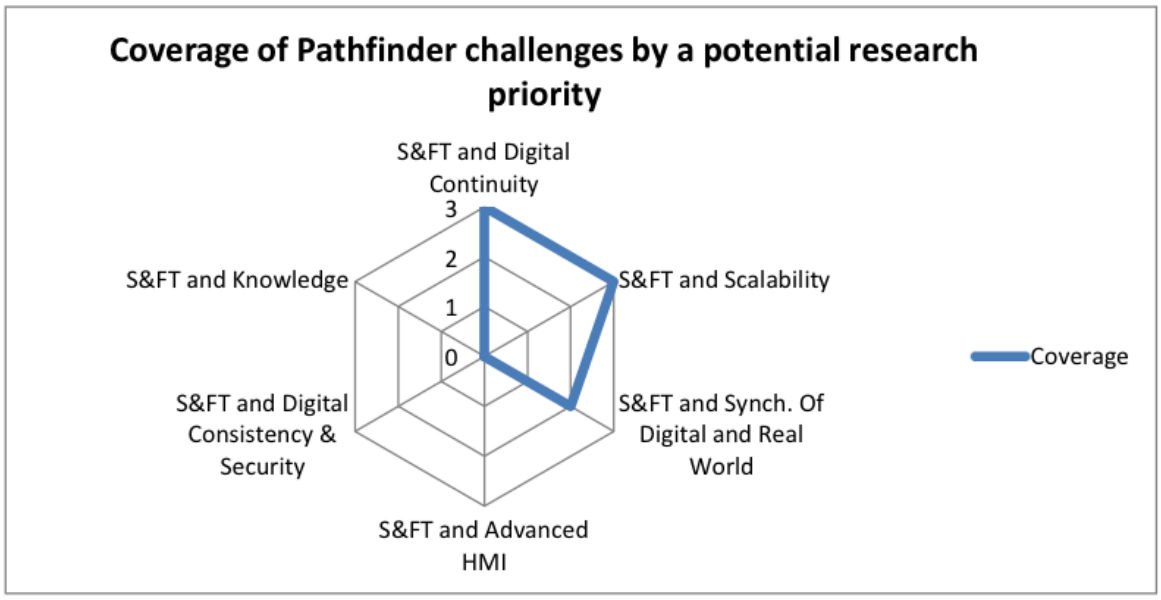


Figure 3: coverage of pathfinder challenges by a potential research priority

- Impact on the manufacturing performance dimensions. A list of dimensions influenced by Simulation and Forecasting Technology are first identified. Next, for each research priority it is suggested to qualitatively measure the impact on single dimensions and the impact on clusters of dimensions. In doing so, the core elements of future manufacturing depicted in the vision of the ActionPlanT roadmap were considered as an excellent reference to provide a meaningful link between the manufacturing vision and the more operative manufacturing performance that cam be referred to the core elements themselves. The table below presents the list of performance dimensions grouped according to the core elements of future manufacturing.

Core elements of future manufacturing	Performance dimensions
Seamless factory lifecycle management	Enhance utilization of resources/Information
	Enhance control/monitoring of machine parameters
	Enhance data integration
	Enhance data analysis
	Enhancing tools usability (i.e. visualization)
	Increase responsiveness of manufacturing process
Workers at the forefront	Increase people commitment
	Increase attractiveness work environment
Collaborative supply chain	Enhance data standardization
	Enhancing product customization
Agile manufacturing processes	Increase tools interoperability
	Increase value chain collaboration
	Empower interoperable de-centralized architecture
	Speed up introduction of new products/processes
	Enhancing capacity utilisation
	Supporting reuse/recycle of materials
Customers in-the-loop	Reduce emissions
	Decrease wastes
	Reduce energy consumption
	Decrease material usage

Figure 4: Manufacturing performance dimensions derived from the core elements of future manufacturing

In this way, a single research priority can be assessed on more operative performance dimensions and even on the core elements of future manufacturing by means of a badge-shaped scheme. As follows:

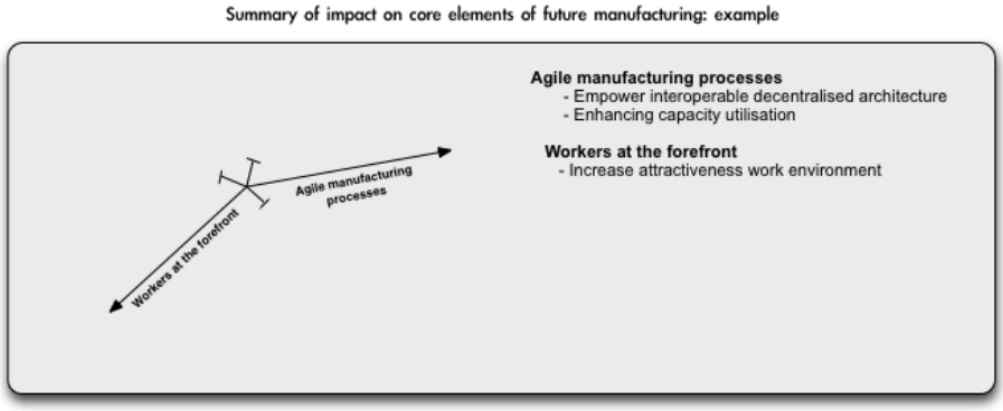


Figure 5: badge-shaped scheme representing a research priority impact upon the core elements of future manufacturing

- The involvement of experts in the process of ranking the identified research priorities. Their opinion in this regard was used to identify the most promising S&FT research topics.

5.2. *Work package 2 – Vision for the role of future simulation and forecasting technologies*

The aim of this work package is to build a vision of the future use and role of simulation and forecasting technologies taking into consideration the trends characterizing the manufacturing of the future. Whilst WP1 wants to identify the current progress of technologies and the corresponding challenges, WP2 tries to envision how the scenario will look like in the future. The identification of how to fill the gap between existing and future technologies is the objective of WP3. The vision will be heavily influenced by different environmental factors over which the control could be limited for manufacturing companies.

More in detail, the objectives of WP2 can be outlined as follows:

- Analysing current development and needs in order to identify possible gaps and areas that need to be further explored;
- Developing a vision for the future identifying possible scenarios defining future roles of simulation and forecasting technologies;
- Validating the vision with expert.

Task Name	Starts	Ends	Task Leader
T 2.1 Gaps identification	1	6	LMS

The specific aim of the task 2.1 regarding the “gaps identification” was to create a link among all the findings elaborated in WP1 of the Pathfinder’s project, identifying the main gaps that currently affect S&FT domain that should be possibly filled in further European research programs. To tackle this challenge, it was performed a comparison between the current state of the art of S&FT (studied in the previous tasks) and the clusters of research priorities (CRPs), in order to get a comprehensive understanding of what is reached so far and to assess the coverage of S&FT tools achieved towards the previous research priorities. The resulting list of technical and practical gaps is shown in the table below.

Gaps		Description
CRP1	**G1.1** - Poor maturity level of use of cloud-computing in S&FT; - RA	In S&FT there are only few vendors that offer powerful and entir cloud-based service. Although the research efforts and some ea adoptions, there is still a low commitment towards these technologies in S&FT.

	G1.2 - Missing of multi-device applications; - RA	At the moment almost all the tools analysed can be run only by a single device applications. Hence, the multi-device applications are missed.
CRP2	**G2.1** - Missing of multi-disciplinary and multi-domain models; - CMA	In S&FT there is a limited ability to use S&FT models in one domain/discipline that were created in a different domain/discipline. This statement leads the inability to integrate different domain/discipline models and this lack triggers the missing of multi-disciplinary and multi-domain models.
	G2.2 - Lack of integration from different domain/discipline models; - CMA	
	G2.3 - Few standards for multi domain models building & integration; - CMA	In the majority of the S&FT analyzed there are: no conventions or standards for common representation schemes to collectively manage different types of resources; no means of aggregating detailed data into a high-level model; and no common understanding or definition of the terms used by the different tools
	G2.4 - No integration between tools; - CMA	
CRP3	**G3.1** - Poor modelling simulation of life-cycle issue; - CMA	There are few S&FT models and tools that consider lifecycle issues. Lifecycle cost modelling is limited and often not complete assessed by the considered tools. Few tools support environmental analyses.
	G3.2 - Limited modelling of product life cycle costs; - CMA	
	G3.3 - Environmental issue are barely considered; - CMA	
	G3.4 - De-manufacturing not completely assessed and only for specialized product type; - RA	The main concerns, in this cluster, are about the de-manufacturing phase such as dismantling, repairing and rebuilding. However, this phase is barely considered and rarely complete assessed from the analysed tools.
CRP4	**G4.1** - Shortage of multi-level SF&T models; - CMA	The shortage of multi-level models triggers the limited integration and interoperability across the process and product chain. Despite the use of object-oriented models and the multiple interface and integration capacities, the digital continuity across level is still far

	G4.2 - Limited integration and interoperability across the process and product chain; - CMA	away to exist.
CRP5	**G5.1** - Real-time data collection barely used; - CMA	Some vendors offer the possibility to operate an accurate virtual production system to track real-time production. However, real-time data are barely collected and rarely have a linkage with actual data. This is due to the fact that data gathering is expensive and time consuming.
	G5.2 - Limited linkage to actual and real-time data; - CMA	
	G5.3 - Poor maturity level of use of virtual factory models; - CMA	Many researches and projects have been carried out towards virtual factory models. Nevertheless their application and their use seem to be still embryonic.
CRP6	**G6.1** - Missing of self-optimizing and self-learning models; - RA	Despite the recent advances in the S&FT field, the idea to have self-learning, intelligent and smart tools is still a faraway target.
	G6.2 - Poor use of knowledge-based systems; - CMA	Knowledge-based systems nevertheless are mature technologies, are barely used.
	G6.3 - Poor maturity level of use of smart objects utilization; - RA	A smart object is an object that can describe its own possible interactions. Despite their strong advantages these kinds of objects are not frequently used.
CRP7	**G7.1** - Limited use on large-scale; - RA	The large-scale use of these technologies is difficult because they are expensive and time consuming.
	G7.2 - Lack of generic tools for human-centred simulation-based learning and training; - CMA	The use of simulation-based learning and training is limited in specific S&FT domains such as military training and aeronautically training.
CRP8	**G8.1** - Missing of crowdsource-based framework for simulation ad forecasting tool; - RA	So far the crowdsource is mainly used in the design rather than in S&FT due to the fact that there is a lack of specific frameworks.
	G8.2 - Lack of integration with social networks; - RA	Although the use of social networking is an increasing trend, in S&FT the interaction with them is still missed.

Table 4: Gaps identified a mapped over the research areas

Task Name	Starts	Ends	Task Leader
T 2.2 Vision development	4	6	TTS

Thanks to the gaps identification, the objective of the task 2.2 was to draw future scenarios where next generation of simulation and forecasting technologies are a valid support for strengthening the manufacturing performance. Pathfinder does not propose a new vision for manufacturing. The long-term direction embraced is consistent with the one anticipated within the “Factories of the Future Strategic Multi- Annual Roadmap” developed within EFFRA. The vision has an essential role since it summarizes the main trends and expectations for the manufacturing of the future and brings into the reasoning the contextual factors that will have a reciprocal impact with the S&FT. The vision is built upon a three layers structure:

- The “highest level” expresses the long-term direction explained above. Four paradigms have been there identified as to guide the transformations of European Manufacturing:

  I - Factory and Nature -> green - sustainable production
  - Lowest resource consumption
  - Closed loops for products
  - Production and scares resources
  - Sustainability in materials and production processes

  II - Factory and the Neighbourhood -> production close to the worker and to the customer
  - Manufacturing close to people (in cities / metropolitan areas)
  - Factory integrated and accepted in the living environment

  III - Factories and the value chain -> collaborative production
  - Highly competitive distributed manufacturing (flexible, responsive, high speed of change)
  - Design oriented products, mass customized products
  - Integration of the product and process engineering

  IV - Factory and Humans -> human centred production
  - Human oriented interfaces for workers: process-oriented simulation and visualization
  - Products and work for different type of skilled an aged labour, education and training with IT-Support
  - Regional balance: work conditions in line with the way of life, flexible time- and wage-systems
  - Knowledge development, management and capitalization

- The high level vision afore introduced, that depicts the future relations among the factory, humans, neighbourhood and value chain, must be framed in a lower level vision capable to endow it. Pathfinder supports the foresight brought forward by the Industrie 4.0 Initiative, as a consistent framework for the actual fulfilment of the Factory Of the Future vision. Clear

trends, shaping the **future settings** for manufacturing, can be derived from Industrie 4.0 analysis:

- **Prevalence of Internet technologies** also at manufacturing level. Communication everywhere and every time, where future infrastructure will also support access to information without any specific installation / parameterization needs.

- **Prevalence of Cyber-Physical Systems for monitoring & controlling**. Powerful, autonomous microcomputers (embedded systems) increasingly wirelessly networked with each other along with the Internet allow the convergence of the physical world and the virtual world (cyberspace) in the form of Cyber-Physical Systems

- **Big Data Everywhere** (World, Enterprise, shop-floor). The availability of technologies able to efficiently gather and process large quantities of data and the increasing use of data-intensive technologies at every level of the factory will enable a faster and more insightful decision-making.

- **Increasing Complexity** (also System of Systems). Increasing functionality (e.g. coming from System of Systems, that is a collection of task-oriented systems that pool their resources and capabilities together to create a new, more complex system which offers more functionality and performance), increasing product customization, increasingly dynamic delivery requirements, increasing integration of different technical disciplines and organizations and the rapidly changing forms of cooperation between different companies make more and more complex the products and their associated manufacturing systems.

- **Vertical Collaboration** (shop-floor and Enterprise systems). End-to-end digital integration of actuator and sensor signals across different levels right up to the ERP level will allow the setting of IT configuration rules that make possible a case-by-case reconfiguration of the manufacturing structure that will not be fixed and predefined anymore.

- **Horizontal Collaboration** (system-to-system). New business strategies, value networks and business models will exploit a higher, IT-based integration through different stages of the value chain to deliver end- to-end solutions.

- **Rapidly evolving technologies and systems** (integration standards, no-vendor-lock, no monolithic systems, mobile system integration, etc.). The ever-rapidly-changing technological infrastructure will lead to the use of flexible and non-monolithic IT systems whose evolution is facilitated by the introduction of integration standards.

- The third level exploits the automation pyramid concept to describe the different systems levels of an overall automation solution. Pathfinder proposes an updated version of the pyramid representation, where the field level features CPS capable of articulated functions

(thus in contact with all the pyramid layers) while still a hierarchical structure is preserved. More over, the overall framework of the factory operation taking into account the factory and product life-cycle was defined.

The overall three layers vision proposed by Pathfinder is represented in the image above.

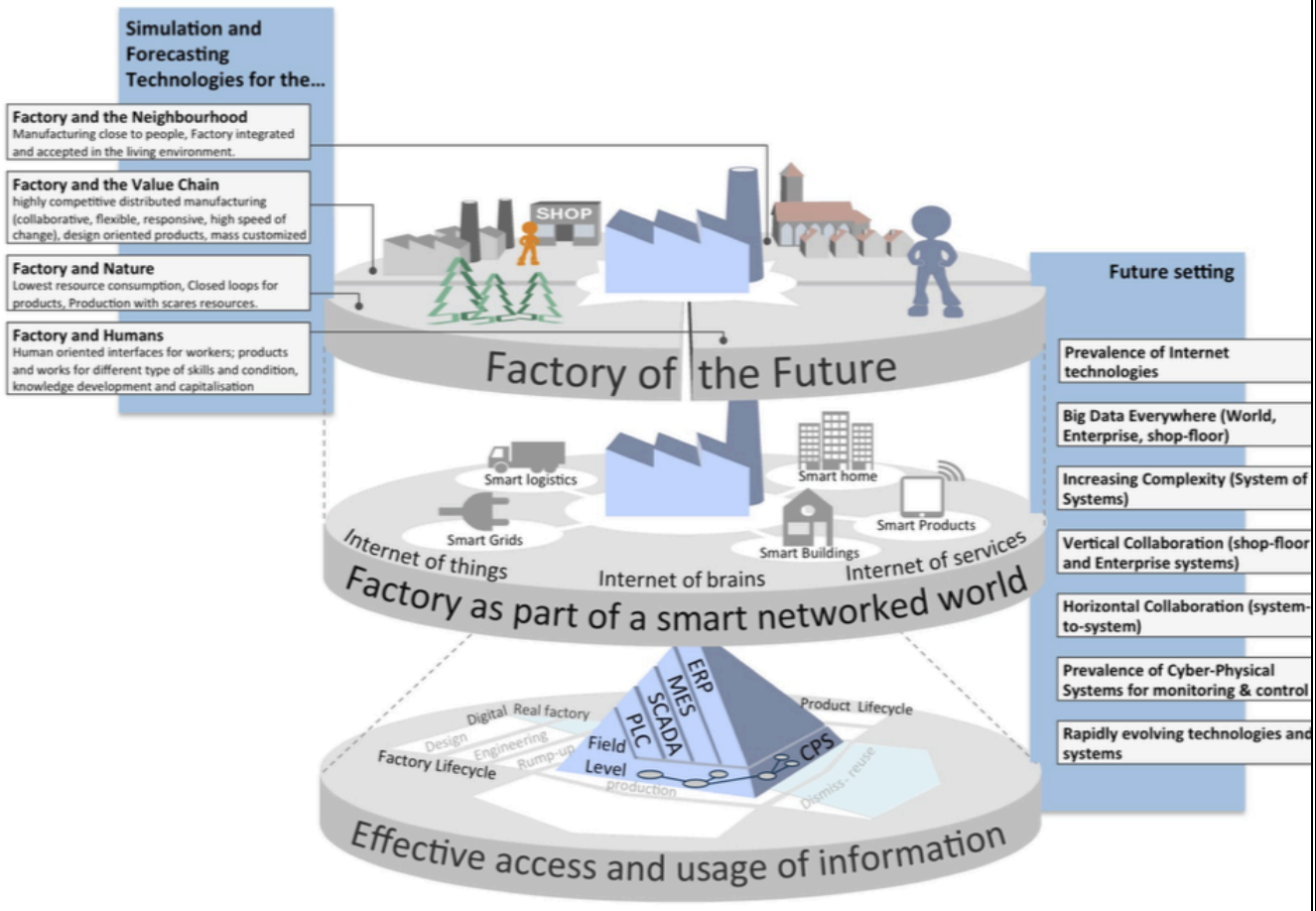


Figure 6: finalized three-layer pathfinder vision

The Pathfinder vision concept afore introduced, together with the gaps identified in D2.1, already points out some challenges that future Simulation and Forecasting Technologies (S&FT) will have to address, in order to empower the Factory of the future. Here below are listed the challenges that pathfinder acknowledges for the future role of S&FT into the future of manufacturing scenario.

S&FT and Digital Continuity - Digital Continuity refers to the ability to maintain the digital information available all along the factory life-cycle, despite changes in purpose and tools, allowing data to be enriched and used as needed for that specific phase. This challenge addresses: Interoperable simulation and forecasting systems; Digital continuity across product and factory lifecycle of engineering information; seamless use and reuse of engineering data; standardization.

S&FT and Scalability - Scalability refers to the ability of an application to function efficiently when its context is changed in size or volume. This challenge addresses: Step-by-step integration and

adoption of simulation and forecasting techs; S&FT solution scalable on different devices; SF&T that runs from single device to Cloud-based;

S&FT and Synchronization of Digital and Real World - Synchronization of Digital and Real World refers to the convergence of physical world and virtual world, where the second must closely mirror the first and where the first generates an unprecedented volume of data to be taken care of by the latter. This challenge addresses: Self-adjustment of digital models triggered by smart objects (embedded intelligence); Co- Simulation in Real-time; Handling of big-data.

S&FT and Advanced HMI - Human-machine interface refers to the study, planning, and design of the interaction between people and Simulation and Forecasting technologies. This challenge addresses: intuitive, mobile, context-sensitive, ergonomic, collaborative user-interfaces.

S&FT and Digital Consistency & Security - Digital Consistency & Security refers to the fact that data travelling along the factory lifecycle should be safe and shouldn't contradict each other. This is a significant challenge especially in the context of the updated pyramid model, based on CPS, where information is distributed. This challenge addresses: provision of consistent data, data safety and privacy.

S&FT and Knowledge - This challenge addresses: Relevant knowledge capture and reuse, also for training and education

Task Name	Starts	Ends	Task Leader
T 2.3 Vision validation	5	10	SFKL

In order to guarantee a proper validation of the Pathfinder results, an advisory board has been created to support the consortium. Contacts have been created since the beginning of the project and, within this task, their actual contribution has been asked in order to validate the Pathfinder vision. Firstly, a document containing the description of the vision has been sent via email to all the advisory board members. Thanks to their feedbacks it was possible to modify the vision and take into account the voice of numerous experts coming from different industrial sectors. The final validation of the vision was made in a workshop held in Brussels on the 6th of March 2014 in cooperation with the Pathfinder core group, the advisory board members and other invited experts. The final vision obtained is inspired by previous roadmapping activities as Industrie 4.0 and ActionPlanT.

5.3. Work package 3 – Roadmap for the next generation simulation and forecasting technologies

The main objective of this work package is the generation of a roadmap based on the vision developed in WP2, that could drive the research agenda of the next years for the development of innovative simulation and forecasting technologies.

More in detail, the objectives of WP3 can be outlined as follows:

- Identifying technological challenges and drivers in line with the needs of the vision for the future of manufacturing and define a set of priorities;
- Validating the identified research directions thorough industrial and IT experts involvement;
- Developing, with the support of experts, the reference document of the roadmap, envisioning the advances for simulation and forecasting technologies that could support the definition of further research streams in this area.

Task Name	Starts	Ends	Task Leader
T 3.1 Identification of challenges and priority topics	**5**	**12**	**SUPSI**
This task identifies how facing proper challenges will help to implement the innovation envisioned by the WP2. To tackle such a challenge the analysis was developed considering the individual country perspective and involvement towards the European manufacturing evolution and comparing their specific vision with the one proposed by the Pathfinder's project as far as references to S&FT were concerned. The study started with the consultation of experts involved in the Pathfinder project with the aim of acquiring knowledge and find the most suitable documents dealing with related manufacturing vision. After the skimming process the reports/roadmaps that were classified to be suitable to perform this vision-benchmarking objective were 10 out of the EU-28. After this research the analysis started with the representation of each document by specifying: • The aim and the scope of the document; • The actors/commitment; • The time horizon; • The simulation and forecasting technologies references; • A scheme that reflects the structure of the roadmap.			

For example, in the next scheme it is represented the roadmap called “Manufacturing 2020” developed by the Ireland’s policy advisory board for enterprise, science, technology and innovation.

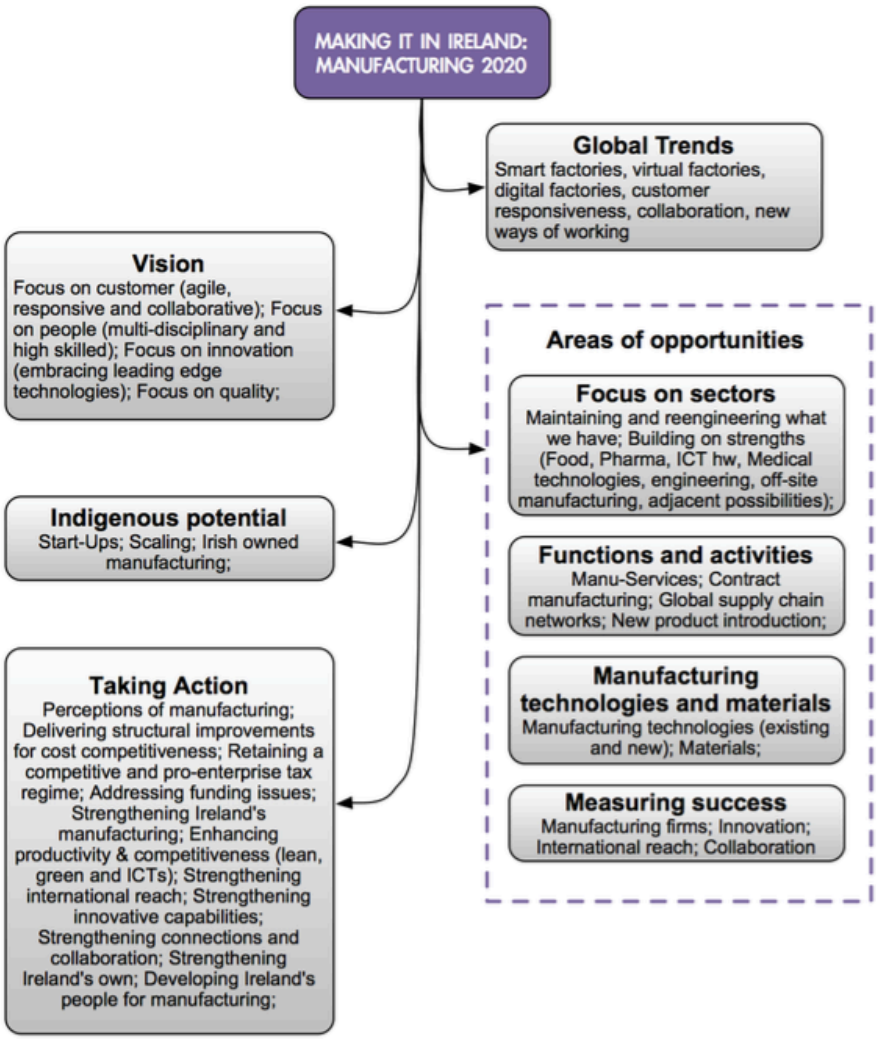


Figure 10: example of summarized scheme of the survey on the country reports study

The result of this study is a comparison between the Pathfinder research areas and the content of each analysed roadmaps. This allowed to draw inspiration from different perspectives and led to a conceptual harmonization and alignment of the roadmap.

The next step was the identification, always relying on experts suggestions, of the S&FT related associations/groups and centre of excellence that distinguish themselves for the quality of their research in this field.

The following figure represents the origin of the analysed S&FT related European associations.

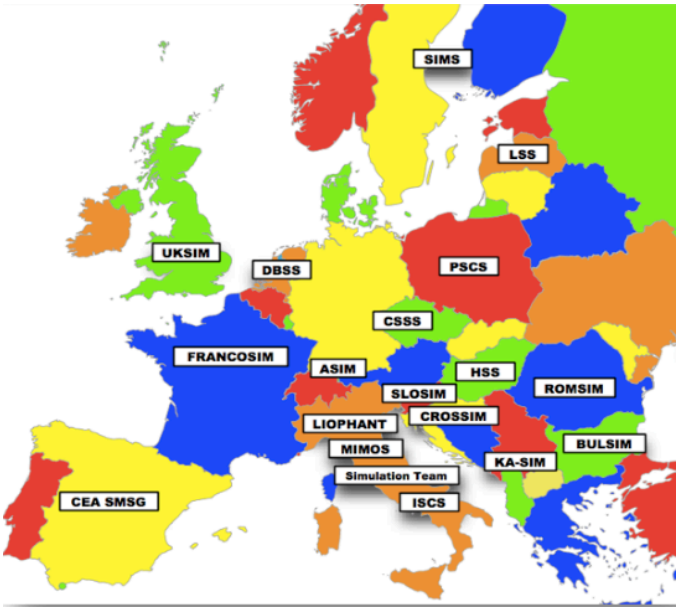


Figure 11: S&FT european associations

Instead, the next image maps the European centre of excellence discovered through the study.

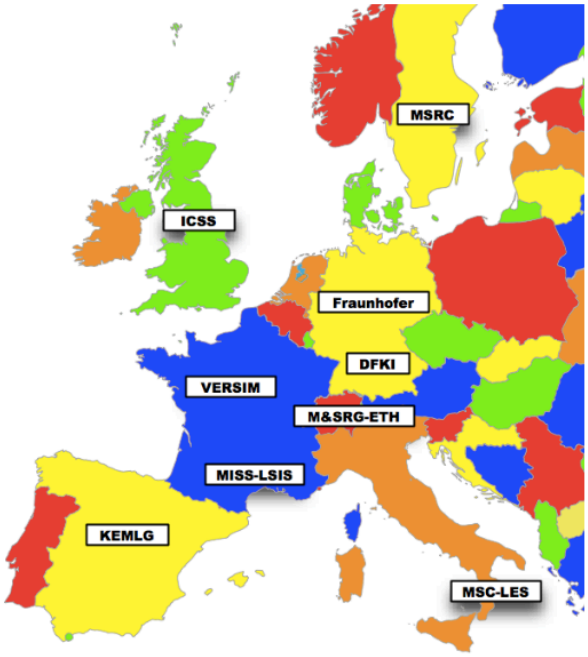


Figure 12: S&FT Eurooean center of excellence

This research contributed to figure out the actual scenario of S&FT network in Europe. Even in this case the competences of the analysed centres were mapped according to the research areas introduced in Pathfinder.

In conclusion, the study goes further with the analysis of the use of S&FT at the industrial sectorial level. A set of case studies in each sector is presented in order to provide an idea of best practices at the sectorial level as well as of excellent results achieved in a very specific context. Analysed sectors are:

- Aerospace & defence;
- Automotive;
- Engineering and Electronics;
- Chemicals;
- Pharmaceuticals;
- Metals and Food & Beverage.

This analysis is complementary to the previous one: the geographical focus is changed into a sectorial focus. In this case S&FT solutions developed and used in a restricted context can be identified and then considered for a possible transfer to other sectors. Best practices achieved in the S&FT were classified considering to what extent they cover the gaps identified in Pathfinder. The following chart shows for instance the S&FT gaps discovered in Pathfinder, which are covered by the automotive

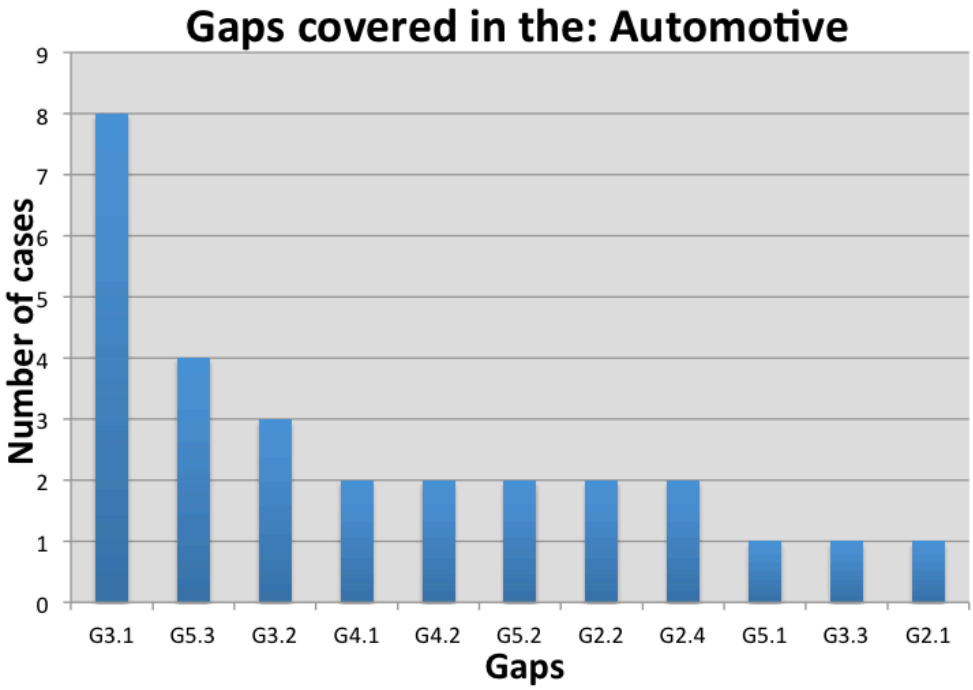


Figure 13: Pathfinder indentified gaps coverage of an analysed manufacturing sector

Task Name	Starts	Ends	Task Leader
T 3.2 Validation through industrial and IT experts	**10**	**18**	**SFKL**

With a similar approach to the one used in task 2.3 for the vision validation, the advisory board members have been involved also for the validation of the final version of the roadmap. The draft document has been sent to all the members asking them to provide their feedback. The whole process took a few weeks and several interactions between the advisory board members and the Pathfinder consortium. All the comments have been properly integrated in the roadmap and the final version has been presented during a workshop held on the 20th October 2014 in Brussels. Around 40 participants coming from different industrial and institutional sectors (the complete list is included in the roadmap document) were actively involved. This validation run in particular allowed the consolidation of the research priorities that were not been developed yet at the time the previous workshop had been held.

Task Name	Starts	Ends	Task Leader
T 3.3 Research roadmap	**10**	**18**	**TTS**

All the knowledge created in the previous activities was the fundamental input for this task. Here, the whole analysis and the vision developed so far, with the continuous feedbacks given by industrial experts, the advisory board, and other key players came into a final consistent document, which results in a set of research priorities. Such research priorities define where the future research policies must focus to address the challenges defined through the Pathfinder roadmap. Essentially, the process of roadmap building was arranged into 7 logical blocks:

1. An analysis of trends, current road-mapping activities and national initiatives, set the basis for the definition of the pathfinder vision.
2. The Pathfinder vision was developed in such a way to be consistent with current road-mapping efforts at national and international level (in order not to introduce a new vision on manufacturing itself, but to embrace existing activities).
3. From the vision, the current trends and future envisioned state of Simulation and Forecasting Technologies were derived.
4. In parallel, the current state of market practice was investigated.
5. By confronting the envisioned future state with the current state of market practice, the road-mapping activity defined the related gaps. These can be considered as the missing link between what is currently available and the future envisioned manufacturing scenario.
6. Identified gaps, consolidated and grouped, are the main input for the identification of challenges that are expected to arise for the S&FT innovation need.
7. The identified challenges will be faced by addressing the research priorities identified

by Pathfinder.

In the next figure the main logical structure of the roadmap starting from the vision and ending with the identification of the research priorities by the Pathfinder stakeholders is presented.

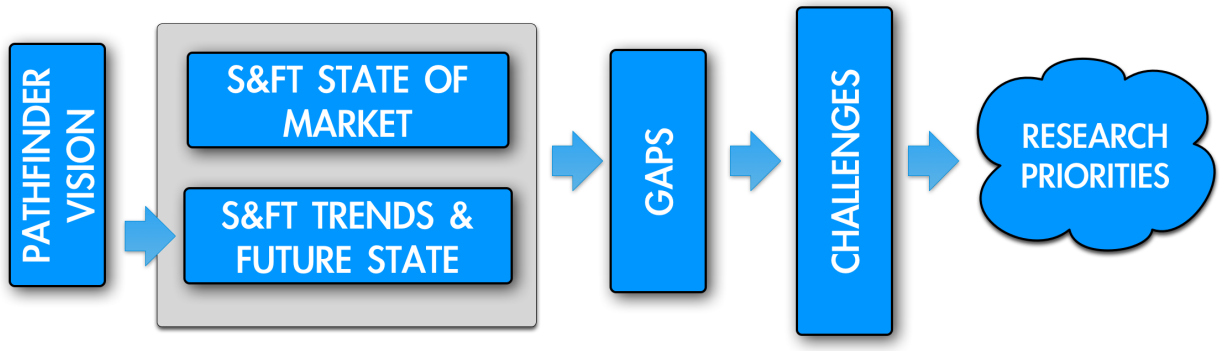


Figure 7: Pathfinder roadmap conceptual structure

As stated in the previous sections, Pathfinder identifies, through the consultation of the experts and through the analysis of current initiatives and roadmaps at national and European level, eight research areas, meant to cluster the identified state of market, future state, gaps, challenges and priorities that have been discussed before. They are the following:

- **RA1:** Open and Cloud-based S&FT for High-performance Computing RA2: Multi-disciplinary and Multi-domain Integrated S&FT
- **RA3:** S&FT for Life-cycle Management
- **RA4:** Multi-level S&FT Integration
- **RA5:** S&FT for Real-Time Factory Controlling and Monitoring
- **RA6:** Smart, Intelligent and Self-learning S&FT
- **RA7:** Human-centred Simulation-based Learning & Training
- **RA8:** Crowdsourcing-based S&FT

Furthermore, the identified gaps, derived by benchmarking the future state against the state of market over the research areas, were the main input for the identification of challenges that, given the contextual factors, are expected to arise and to be faced by S&FT innovation.

- **S&FT and Digital Continuity** - Digital Continuity refers to the ability to maintain the digital information available all along the factory life-cycle, despite changes in purpose and tools, allowing data (the oil that fuels manufacturing) to be enriched and used as needed for that specific phase (from design, through use and maintenance, till dismissal/re-design). This challenge addresses: Interoperable simulation and forecasting systems; Digital continuity across product and factory lifecycle of engineering information; seamless use and reuse of engineering data; Reduce modelling effort; Modelling of complex problems; Multidisciplinary integrated modelling; Standardization.
- **S&FT and Scalability** - Scalability refers to the ability of an application to function

efficiently when its context is changed in size or volume. This challenge addresses: Step-by-step integration and adoption of S&FT; S&FT solution scalable on different devices and platforms; from on-premises software to cloud- based services;

- **S&FT and Synchronization of Digital and Real World** - Synchronization of Digital and Real World refers to the convergence of physical world and virtual world, where the second must closely mirror the first and where the first generates an unprecedented volume of data to be taken care of by the latter. This challenge addresses: Self-adjustment of digital models triggered by smart objects (embedded intelligence – Cyber Physical System paradigm); Co-simulation in real-time; Multidisciplinary simulation models and tools, Handling of big-data.
- **S&FT and Advanced Human-Machine Interfaces** – Advanced Human-Machine Interfaces (HMI) must provide transparent insights into the digital-virtual world and must allow to interact with S&FT in an intuitive and natural way. This challenge addresses: intuitive, mobile, context-sensitive and collaborative user-interfaces.
- **S&FT and Digital Consistency & Security** - Digital Consistency & Security refers to the fact that data originating from and travelling along the factory lifecycle should be safe and shouldn't contradict each other. This is a significant challenge especially in the context of the digital continuity, vertical integration and horizontal integration, where distributed and heterogeneous data sources will be linked and made available in an open and interoperable manner. This challenge addresses: optimised provision of consistent data, data security and privacy.
- **S&FT, Data and Knowledge** - This challenge addresses: Big Data and Data Analytics; Ontologies definition; Relevant knowledge capture and reuse, also for training and education

Thanks to all the previous analysis it was possible to identify a set of 7 research priorities, which cover the challenges above mentioned and have a direct impact over the more operative performances, which constitute the core elements of future manufacturing.

RP1 - Integrated simulation and modelling tools, empowering digital continuity and real-world synchronization all along the factory life-cycle.

Simulation and modelling methods and tools are needed to support the whole lifecycle of production systems, integrating diverse simulation technologies and models from different domains and disciplines, since the early conceptual design phase, where the selection of production resources, production processes and the entire automation system are to be tackled. The information developed in this early phase is to be maintained all along the entire factory life-cycle, despite changes in purpose and tools, allowing data to be enriched, updated, synchronized with the real factory and used as needed in each specific phase.

RP2 – Scalable factory models, integrating real-time data acquisition, to support S&FT access and usability at different levels, from operators to managers

The development of collaborative simulation applications that support access and usability at different levels from operators to managers, with different objectives (economic performance,

logistics, operations, energy consumption, etc.) is of paramount importance to support the decision-making processes, activity planning and operation controlling. The development of integrated scalable factory models with multi-level access features, aggregation of data with different granularity, zoom in and out functionalities, and real-time data acquisition from all the factory resources (i.e. assets, machines, workers and objects) will be the key enabler. For real-time data acquisition, the connectivity concept offered by the CPS – cyber physical systems – paradigm should be exploited, as well as the potential given by cloud-based technologies)

RP3 – Simulation and Forecasting models for highly reconfigurable production.

Highly reconfigurable production means (lines or work-centres) and manufacturing networks are requested to accomplish dynamic production goals (in terms of production mix, time schedule and unplanned event management) to address the highly complex market landscape. That implies a huge complexity in the design, planning, and management tasks (considering also that operational performance parameters can vary time-wise, that flexible maintenance policies can be benefitted from, and that different configurations of the system can accomplish the same task). To this purpose, simulation tools must be able to model the production means (including involved human resources) and the manufacturing network behaviour and to update this model by acquiring data from the field (tools, inventories, logistics, etc.) through smart embedded devices, to provide process owners, operators and production plan managers with reliable predictive scenarios, to take informed decisions.

RP4 – IoT based Simulation and Forecasting Technologies towards reduced footprint manufacturing.

Efficient utilization of energy and resources, minimal environmental impact and complete awareness of how these factors are related to the product lifecycle, not only in the production phases, but all along the complete life-cycle till the disposal and re-cycling, require novel tools to design and simulate the product/process behaviour in different scenarios. Simulation tools, connected to the physical world according the Internet of Things paradigm, will continuously collect data to provide direction to the factory system to produce in more sustainable way products with reduced environmental footprint.

RP5 – Exploiting VR and AR technologies, empowered by cyber-physical systems, towards humans full potential realization, safety and work satisfaction.

The development of the factory environment will be accompanied by changing tasks and demands for the human working in that factory. As the most flexible entity in cyber-physical production systems, workers will be faced with a large variety of jobs ranging from specification and monitoring to verification of production strategies. Through technological support it is guaranteed that workers can realize their full potential and adopt the role of strategic decision-makers and flexible problem-solvers. A mediating interface between user and cyber-physical systems (CPS) must be created, through virtual and augmented reality, to simulate and interactively explore the behaviour of a CPS-based production system. Key enablers will be

mobile platforms, such as smartphones, tablets, and smart-glasses, which will be the most beneficial tools for interacting with CPSs.

RP6 – Knowledge enhanced digital factory models towards high quality interoperability among S&FT applications

An essential prerequisite for an interoperable use of simulation data and models is that they are firstly formalized and machine readable, secondly explicitly described which means formal semantics of all statements and thirdly at the right level of abstraction and suitable for the intended use. For the implementation of a semantic factory, where simulation data and models can be shared, combined and reused across simulation application and sector boundaries, various steps have to be addressed. These shall include, in particular, the reuse and sharing of digital factory models by raising the level of explicit semantics (e.g. by using ontologies), the support of intuitive modeling tools, the development of holistic factory models with relevant standardization activities, methods and mechanisms to increase the quality of data across the distributed factory in terms of accuracy, completion, currency and non-duplication as well as improvements of data mining, filtering and reasoning capabilities to better exploit digital simulation models in dynamic design, validation, optimization and decision making processes.

RP7 – Digital factory real-time synchronisation to tackle unexpected product and process re- configurations

Short-term planning decisions will obtain high priority within multifunctional, flexible and reconfigurable production environments. In such a case, a research focus must be transferred to the engaged interaction between the product lifecycle management, the real factory system as well as manufacturing execution and enterprise resource planning systems during the production process. In terms of a growing variety of products and unexpected incoming orders, short-term simulation methodologies uncover the unpredictable re-configurations within a high modular production system. It requires a continuously bidirectional data reconciliation between these systems and the digital and virtual world to get a direct insight for a current and required configuration of the production line. In addition replaceable production units by plug-and-play have to provide their own descriptions of model to create the required overall simulation models.

5.4. Work package 4 – Communication - Dissemination

WP4 is meant to increase knowledge and awareness about the use and impacts of simulation and forecasting technologies at EU manufacturing companies. The project consortium has been exceptionally active within key European and National events (e.g. ICT2013, Manufuture 2013, ASIM, SmartFactoryKL Innovation Day) and constantly monitors relevant events for Pathfinder dissemination. An effective link has been established with the I4MS initiative.

Detailed description of the activities carried out can be found at:

http://www.pathfinderproject.eu/index.asp

http://i4ms.eu/news/list_news.php

Task Name	Starts	Ends	Task Leader
T 4.1 Communication Plan Development	4	6	DELCAM

This task was achieved by answering to the following questions:

1. **Why do we want to disseminate?**
   Research and development is of great importance but the knowledge developed should not only remain at the universities, the RTD institutes or the (industrial) partners directly involved in the project. For improvement the knowledge, technology and roadmap developed should be distributed in all European countries.
   The specific aims of dissemination are:
   - To promote knowledge sharing;
   - To create greater public awareness;
   - To demonstrate the project outcomes;
   - To show the transparency of use of the EU funding.
2. **How do we want to disseminate?**
   - Dissemination for awareness: European Manufacturing Industry, European Commission, Advisory Board, Network of Experts were informed of the work of the Pathfinder project;
   - Dissemination for understanding: the involvement of experts and other useful contributors gave the possibility to draw in the best way the roadmap thanks to their continuous feedback;
   - Dissemination for action: the results of the Pathfinder roadmap have been disseminate to those people (EFFRA, I4MS, etc.) that are in a position to “influence” and “bring out change” within their organization so that they can benefit from Pathfinder achievements.
3. **What do we want to disseminate?**
   The following points were defined as important by the project partners:
   - The project’s publicity: the existence of pathfinder and the achievements during its development.
   - Current status of S&FT: informing the manufacturing industry in EU on state of the art of such technologies and findings from the examination of this current status at a technological level.
   - Future aspects: future scenarios for S&FT and the long-term vision.
4. **To whom we want to disseminate?**
   Developer of such technologies, user of such technologies, researcher and experts, organizations representing OEMs, political stakeholders;

Task Name	Starts	Ends	Task Leader
T 4.2 Execution of communication Plan	7	18	DELCAM

- **Branding**: Logo, PowerPoint templates and general project presentation have been developed and are in use.
- **Website**: A straightforward website with relevant sections has been developed and brought to the attention of the audience via the relevant channels like I4MS, EFFRA, DigitalAgenda, ComplexSystems.

Figure 15: pathfinder website

- **Partnering with I4MS-Gate**: I4MS-Gate is a FP7 CSA that aims at amplifying the findings of the road mapping activities PATHFINDER and Road4Fame and multiplying the innovation impact of more than 160 European ICT for manufacturing experiments planned in the I4MS programme via the seven earlier mentioned projects. At the moment I4MS-Gate has over 1400 relevant followers via LinkedIn and Twitter which are 1-to-1 now being updated with PATHFINDER outcomes and results.

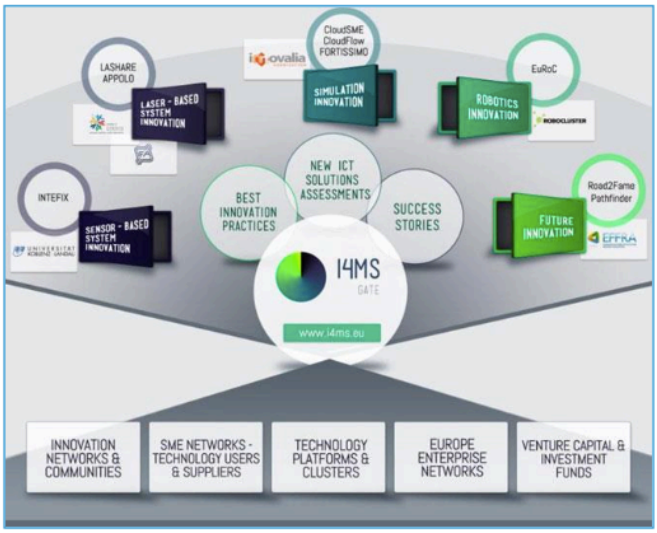
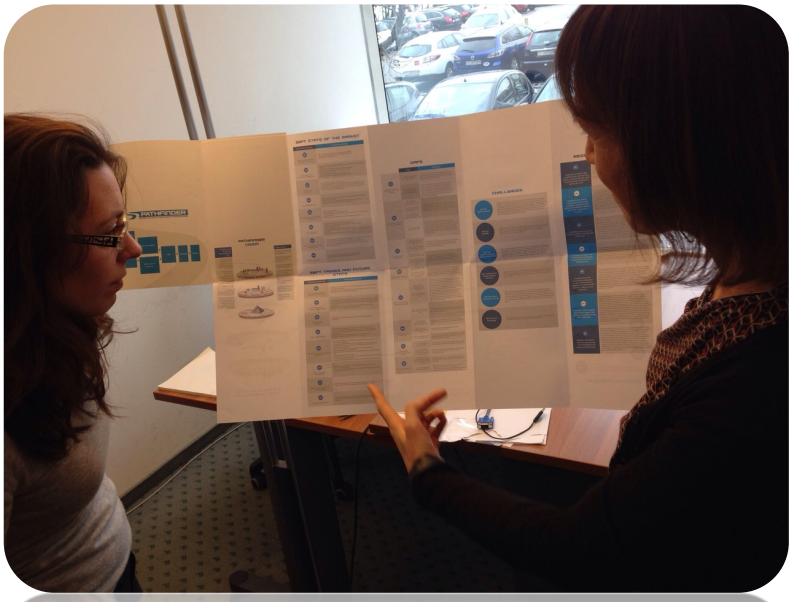


Figure 16: Pathfinder with I4MS-Gate

- **Roadmap Short Version:** a shorter version of the roadmap has been developed and shared across the Pathfinder's network in order to communicate in the best manner the main building blocks of the roadmap that have made possible to point out the research priorities for the next generation of simulation and forecasting technologies.



Task Name	Starts	Ends	Task Leader
T 4.3 Demonstration of SOA	7	18	SFKL

Based upon example applications of the Pathfinder consortium members, six case studies have been made to show the interested audience the possibilities (and limitations) of simulation and forecasting technologies. In each case study description the following items are described:

- Manufacturing scenario description
- Approach and results with simulation technologies
- Benefits for the company
- Key success factors

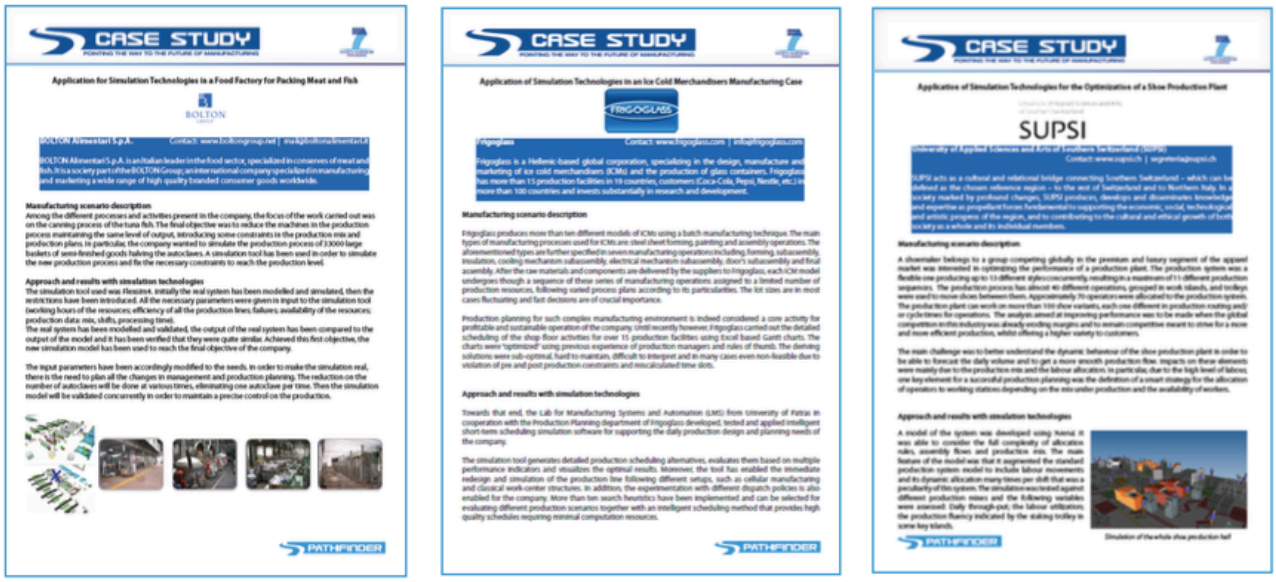


Figure 8: Analysed case studies

Furthermore, Visual demonstrations have been made available at the project website and at events. Another way would be also showing it 'live' within the SmartFactoryKL living lab.

Task Name	Starts	Ends	Task Leader
T 4.4 Articles / press releases	7	18	DELCAM

Through various channels such as the PATHFINDER website, the I4MS website, Twitter, press release with relevant information for the target audience, the knowledge created in Pathfinder has been disseminated.

- **Via the website**

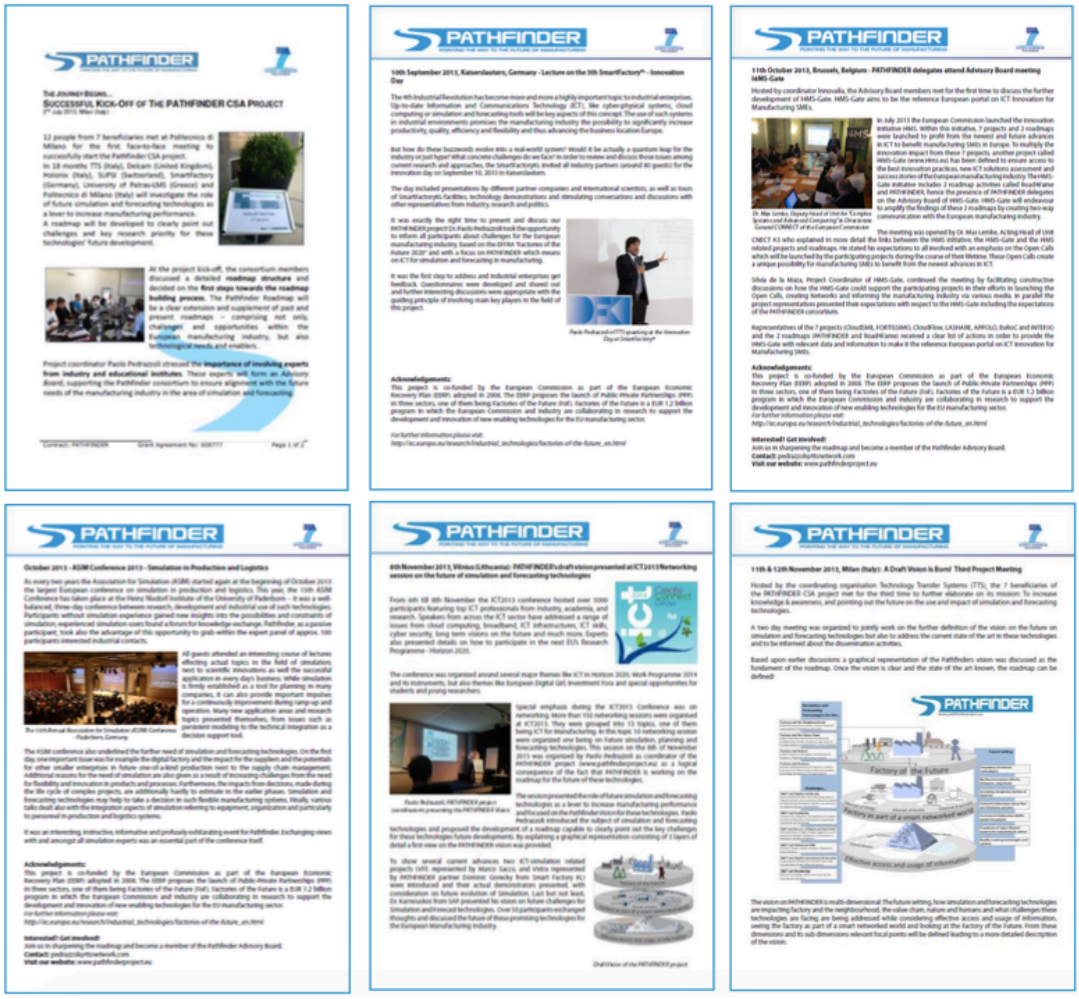


Figure 9: Articles and press realeses shared through the website

- **Via I4MS:** Via LinkedIn, I4MS has over 1400 'listeners'. Each message posted via this channel will reach this audience, which are actually the relevant stakeholders.

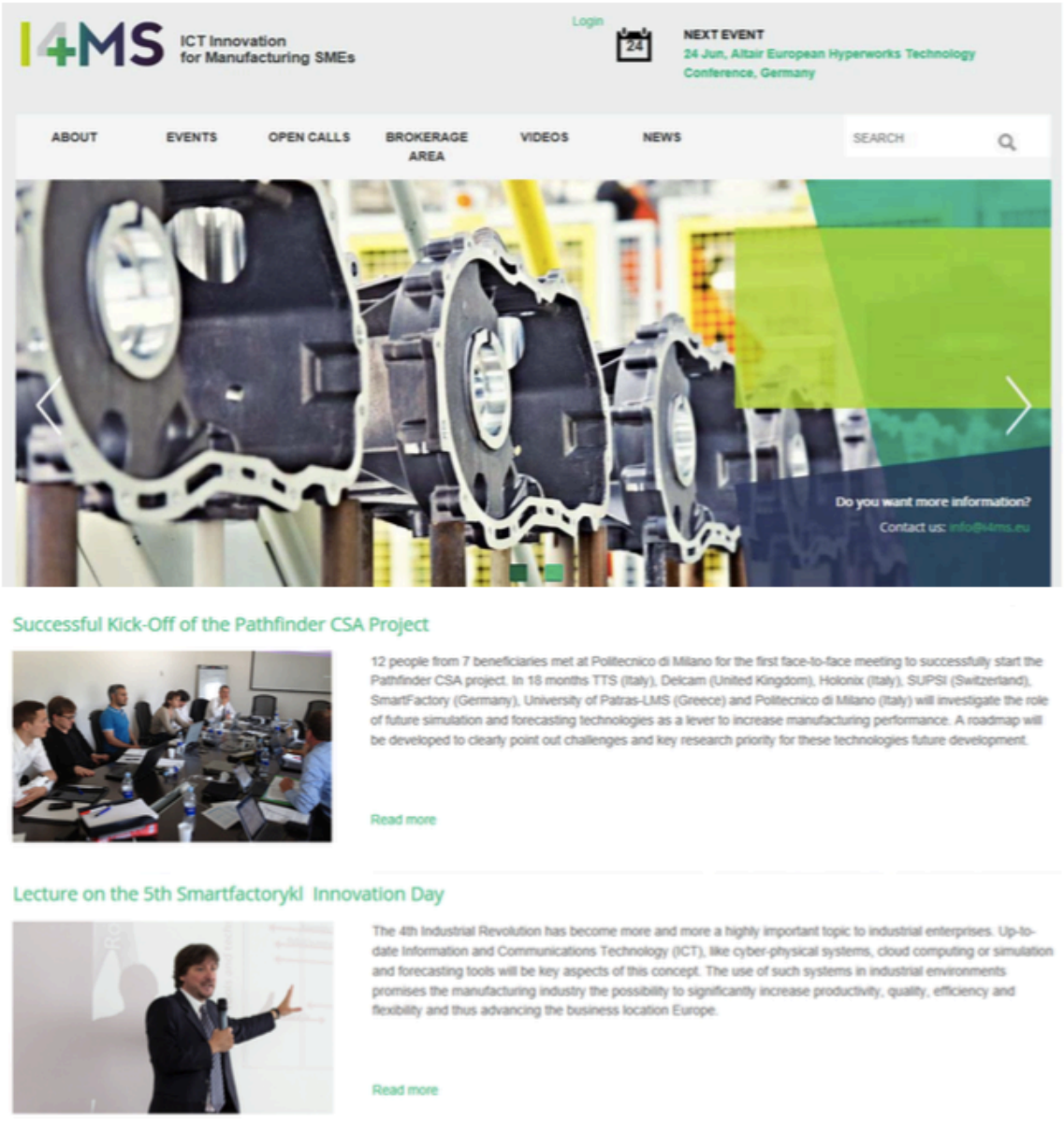


Figure 10: Pathfinder news on the I4MS portal

- **Via twitter:** Using the channels of @I4MS (399 followers), @DigitalAgenda (over 26900 followers), @Complex_Systems (443 followers) and @EFFRA (652 followers) – all relevant information is being disseminated via Twitter.

Figure 11: Pathfinder news on twitter

Task Name	Starts	Ends	Task Leader
T 4.5 Panels, Events, Workshop	7	18	SFKL

The aim of organising panels, events and workshops as part of the PATHFINDER dissemination/road mapping activities is to support and ensure an optimal dissemination of road mapping activities and results. A series of combined panels/events/workshops have been organised. Main events are presented in what follows.

- **Smart Factory Innovation Day**

Paolo Pedrazzoli of TTS speaking at the Innovation Day at SmartFactory^{KL}

September 2013
Kaiserslautern, Germany
80 participants

First announcement of Pathfinder roadmap activity on *SmartFactory*^{KL} - Innovation Day.

Content: The 4th Industrial Revolution in Germany has become more and more a highly important topic to industrial enterprises. Up-to-date Information and Communications Technology (ICT), like cyber-physical systems, cloud computing and as well simulation and forecasting tools will be key aspects of this concept.

Figure 12: Pathfinder presentation at the smart factory innovation day

- **ICT Conference Vilnius**

Paolo Pedrazzoli, PATHFINDER project coordinatorm presenting the PATHFINDER Vision

November 2013
Vilinius, Lithuania
40 participants
Diversified session about simulation activities within the European Sector

Content: Session 1 focuses on the challenges related to simulation, planning and forecasting technologies a relevant topic to the competitiveness of European factories of the future within the following line-up:

- Pathfinder project presentation
- "Working together" with questionnaire and worksheets
- Demonstration from the VISTRA simulation project
- Demonstration from the VFF simulation project
- Deep discussion about the vision on future use of Simulation and Forecasting technologies

Figure 13: Pathfinder presentation at the ICT conference at Vilnius

- **Advisory board workshop**: In March 2014, the Advisory board (20 experts including representative from the EC) and the PATHFINDER consortium discussed the seven elements which together form the work done and to be done within PATHFINDER. While be presented by the PATHFINDER members, the experts gave their views and vision on these as well.

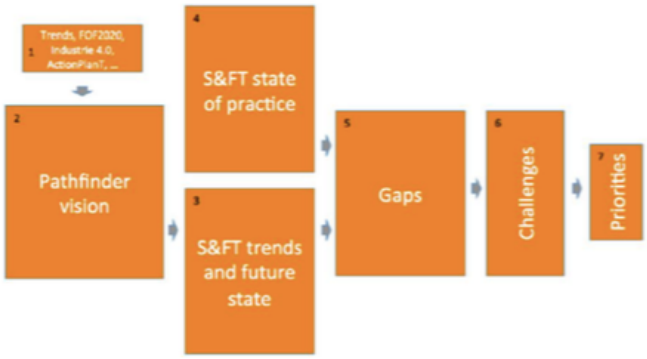


Figure 24: pathfinder conceptual framwork

- **Industrial Technologies 2014:** The PATHFINDER consortium was extremely pleased with the possibility to organize a workshop during Industrial Technologies 2014 (April 2014) being one of the main events in 2014 in the area of ICT/Manufacturing! There was a high demand/request for organizing these kind of workshops and it showed the importance of the subject as touched upon by the PATHFINDER CSA that this subject was selected. The workshop, whose organization was promoted by DG-Connect, focused on the challenges related to simulation and forecasting technologies as a relevant topic for the competitiveness of European Factories of the Future. The workshop brought together

relevant key players to provide input to the work-programme FoF-ICT under H2020. The workshop presenters came from the Pathfinder and Road4Fame CSAs advisory boards. 40 people attended it.

Figure 14: Industrial technologies 2014

- **20th ICE Conference - IEEE TMC Europe Conference:** held from 23-25 June 2014 in Bergamo, Italy. At the time of composing this report no information was available.

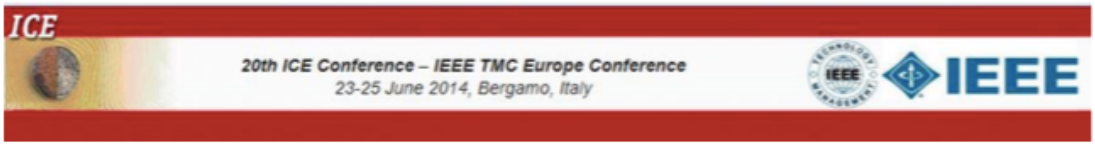


Figure 15: 20th ICE conference

- **Further event participations:**
  - October 2013: ASIM 2013 - Symposium Simulation Technique (ASIM SST) as the main conference of simulation applications in Germany, organized by the German speaking simulation association.
  - November 2013: SmartFactoryKL on SPS IPC Drives 2013 as Europe's leading exhibition for electric automation technology from around the world
  - March 2014: SmartFactoryKL on CeBit - world's largest and most international computer expo (cultivation of contacts within scientific community)
  - April 2014: SmartFactoryKL on Hannover Messe; world's biggest industrial fair with about 6,500 exhibitors and 250,000 visitors
  - May 2014: Symposium IT Factory Innovation: Lecture about Pathfinder elements "From Vision to Priorities"

Task Name	Starts	Ends	Task Leader
T 4.6 Network of Excellence	11	18	SFKL

The activities around the network of excellence started in the last months of the project with the aim of creating a legacy after the PATHFINDER lifetime.

The idea is to lead a European network of excellence for companies, research institutes, associations and individuals that have specialized in simulation and forecasting technologies. The goal is to bring companies with this field together with researchers from academia as well as with companies applying these technologies. In order to do so, two types of action have been activated:

- Active search for partners beyond the consortium by exploiting the partners' network :
    - o Advisory Board member within Pathfinder project
    - o The *SmartFactory*KL community, composed of members like companies, enterprises and institutions from industry and research which progress the work of the factory of the future with their support
    - o The EMIRAcle research network (LMS as partner)
    - o further networks of our consortium and any company, organization, association or individuals wishing to support the simulation network of excellence
    - o Potential partners should have suitable qualifications for participation and use of simulation
- Development of a sustainable and self-supporting network of excellence concept:
    - o for establishing a communication platform for a worldwide presence and visibility in form of a blog, website
    - o for offering a range of benefits, e.g. participation of annual network meetings or other annual events, seminars
    - o for offering access to early leading-edge research reports, evaluations, technologies and papers (from participating partners and associate partners)for group exchanges between industrial, academic or other groups

Task Name	Starts	Ends	Task Leader
T 4.7 Promotions on Public Fairs and Events	7	18	SFKL
Activities in this task have been carried out in close collaboration with the ones described in tasks 5 and 6 in order to exploit synergies. The main results have been presented in the previous description.			

5.5. Work package 5 – Project management

This work-package is meant to cover the overall legal, contractual, financial and administrative management of the project and to establish a reliable contact with the EC throughout the Project duration. Finally, this work-package will ensure that the work is carried out in a timely and cost effective manner and will supervise the preparation and the overall quality of deliverables.

Task Name	Starts	Ends	Task Leader
T 5.1 Project Management, Administration and support	**1**	**18**	**TTS**

The successful achievements of the Pathfinder project have been possible through constant efforts towards a thorough coordination among the Pathfinder key players. Indeed, the Advisory board and in general other contributors that are mentioned in the final roadmap's document extremely helped in shaping the Pathfinder vision. They have been invited to planned workshops and even involved in giving feedbacks about the daily advancements of the project in order to share their own experience, coming from different sectors of the manufacturing arena. Every suggestion has been discussed internally with the Pathfinder core group and added in the best possible manner into the roadmap. As a result, other than fulfil the standard contractual obligations, some logical additions needed to be made in order to address what the various workshops with the experts revealed. The common understanding of the project is even due to the established website that was designed and implemented so to provide both a communication channel as well as a management and control apparatus. The proper management of the project advancements led to spread the Pathfinder's vision among the partners, and as a result to get the final roadmap, which is structured by functional blocks that in turn have made possible to derive gaps, challenges and research priorities for the future role of S&FT in the manufacturing of the future. Such consolidated structure is clearly represented in the short roadmap version.

T 5.2 Quality Assurance and risk management	**1**	**18**	**SUPSI**

The continuous involvement of the partners in the project made possible to mitigate all the risks stated in the description of work. A brief explanation showing how the risk has been mitigated is reported here below.

1. State of the art analysis incomplete: the state of the art analysis was complete and compared against the S&FT trend and future state allowed to derive the gaps;
2. Reference context identification incomplete: the reference framework was consolidated by all the partners of the Pathfinder's project. It revealed to be the best one when the impact-measuring tool was built and the research priorities have been assessed upon it, so that the entire reference framework path was even quantitatively followable.
3. Stakeholders do not participate in the requested way to the workshop: the high number of stakeholders that have been involved in the project played a central role in shaping the roadmap development.
4. Vision inadequate: the three-layer approach adopted covered both more high-level aspects indispensable for demonstrating the S&FT potential on the manufacturing, and the operational once.
5. Stakeholders do not agree with topics: the continuous feedback process where the stakeholders were involved led to proactively change different aspects of the roadmap.
6. Target audience not interested: the analyzed trend of the website's session shows an increase of interest and knowledge share of S&FT.
7. Inadequate input from stakeholders: the discussed topics have been decided together during the workshops and the inadequate feedbacks have been explained.

8. The results do not reach the intended audience: as answer 6.
9. Underperforming partner: the know how of the partner have been re-distributed in case of missing knowledge in some aspects of the roadmap.
10. Disagreement among partners: not occurred.
11. Missing coordination and leadership: the experienced coordinator and the successful result of the roadmap clearly overtaken this point.

T 5.3 Workshop management	1	18	SUPSI

In the whole process of the Pathfinder's roadmap development many meetings and workshops have been organised. The first meeting was held in "Politecnico di Milano", the consortium members discussed a detailed roadmap structure and decided on the first step towards the roadmap building process. The project coordinator stressed the importance of involving experts from industry and educational institutes. Some other meetings have been organized internally afterwards in order to set up in the best way the roadmap. The second important workshop was done in march 2014. Here, after a presentation regarding the identified gaps and the draft challenges, it has been asked to the invited experts to point out opinions on the key trends concerning the elements presented during the workshop. Thus, more than one hour was spent discussing about the research areas identified and for the validation of the Pathfinder vision. In April another workshop was held in Athens, the suggestions and contributions of the previous workshop allowed to get the final figure and comparing the state of the market analysis against the future state of S&FT so to derive the final GAPS. In October 2014 another big workshop was organised with more than 40 participants, here the previous roadmapping steps came into the final figure and the more consolidated challenges and the research priorities were presented. A brainstorming session of around three hours with experts from different manufacturing sectors allowed to integrate other important parts in the roadmap's development. After this workshop, a meeting in Milan to coordinate the next steps among the partners meant for definitely finalizing the roadmap was done. Finally, the final review meeting confirmed that the logical structure of the roadmap given by the continuous contributions of industrial and institutional experts, and the resulting S&FT research priorities were aligned with the Manufacturing of the future.

T 5.4 Technical infrastructure for community interaction	1	18	TTS

For this purpose a website was designed and implemented so to provide both a communication channel as well as a management and control apparatus. It was constantly updated and every result deriving both from the workshops and from the internal discussions and advancements of the Pathfinder's project was immediately uploaded. All the files were available and downloadable so that the community involved in the project could see real-time the efforts spent in shaping the roadmap.

6. DELIVERABLES AND MILESTONES TABLES

Deliverable number	Deliverable name	WP	Lead beneficiary	Dissemination level	Nature	Delivery date from Annex I	Actual/Forecast delivery date	Status	Comments
D1.1	Framework and state of the art analysis	1	LMS	PU	R	6	6	Submitted	
D1.2	Reference Framework and impact measuring tool	1	SUPSI	PU	R	8	8	Submitted	
D2.1	Report on identified gaps	2	POLIMI	PU	R	6	6	Submitted	
D2.2	Draft Pathfinder Vision	2	TTS	PU	R	6	6	Submitted	
D2.3	Validated Pathfinder Vision	2	SmartFactory KL	PU	R	10	10	Submitted	

D3.2	Draft Roadmap	3	TTS	PU	R	12	12	Submitted	
D3.3	Final Pathfinder Roadmap with expert validation	3	TTS	PU	R	17	17	Submitted	
D4.1	Communication plan	4	DELCAM	PU	R	6	6	Submitted	
D4.2	Dissemination report v1	4	DELCAM	PU	R	12	12	Submitted	
D4.3	Roadmap short version glossary print	4	DELCAM	PU	R	18	18	Submitted	
D5.1	Periodic management report	5	TTS	PU	R	9	9	Submitted	
D5.2	Final management report	5	TTS	PU	R	18		Submitted	

Table 5: Table of deliverables

6.1.2. Milestones

Milestone number	Milestone name	WP	Lead beneficiary	Delivery date from Annex I	Achieved Yes/No	Actual/Forecast achievement date	Comments
MS1	FOFGate Portal specifications delivered	1	SUPSI	3	Yes	3	
MS2	Network of experts and industrial stakeholders in place (advisory board)	1	SUPSI	6	Yes	6	
MS3	Pathfinder vision developed	2	SmartFactoryKL	6	Yes	6	
MS4	Communication plan developed – key events list	4	DELCAM	6	Yes	6	
MS5	Roadmap structure	3	TTS	8	Yes	8	
MS6	Pathfinder vision validate	3	TTS	11	Yes	11	

MS7	Updated key events list	4	DELCAM	12	Yes	12	
MS8	Draft Recommendations for future research policies ready (including SWOT approach)	3	TTS	16	Yes	16	

Table 6: Table of the milestones

7. PROJECT MANAGEMENT

The Pathfinder project has been managed successfully, meeting all the objectives set for the reported period. Firstly the Coordinator played a central role in sharing the Pathfinder vision among the partners so that every task tackled demonstrates a visible impact over the 3-layer vision structure. Such impact has been clearly shown thanks to the “reference framework and impact measuring tools” developed within the project. The alignment of the project’s deadlines has been possible thanks to a transparent management and share of all the documents among the project partners. Nevertheless, the implementation of the Pathfinder’s website has been of primary importance for the involvement of the project stakeholders, for example the contributors who helped in shaping the roadmap development during the organized workshops could see their own contribution and give feedbacks. The Pathfinder network of experts, constituted by more than fifty contributors coming from renowned companies and institutions, participated successfully to different workshops for tailoring the on-going Pathfinder advancements.

7.1. Amendment request

During the development of the project a formal change has to be tackled within the consortium and it has been mandatory to request an amendment in date 07/11/2014 and modify the grant agreement. The modification is due to a third party, DELCAM BENELUX BV, which is linked to the following beneficiary: DELCAM PLC. This beneficiary may charge costs incurred by the above-mentioned third parties in carrying out the project, in accordance with the provisions of the grant agreement. The amendment has been approved in date 30 January 2015.

8. PLAN FOR USE AND DISSEMINATION OF FOREGROUND

During the 18 months of the project development many efforts have been dedicated to the dissemination procedures with the aim of involving and communicate in the best way the targeted audience. According to the fixed deadlines that are described in the various deliverables the dissemination has been done via multiple means, as for example the Pathfinder website (www.pathfinderproject.eu), I4MS and EFFRA portals, and the results have been presented in several occasions (e.g. ICT2013, Manufuture 2013, ASIM, SmartFactoryKL Innovation Day, etc.). The website has been updated on a regular base, indeed the trend of visits has been increased day after day, as it can be seen in the following figure.

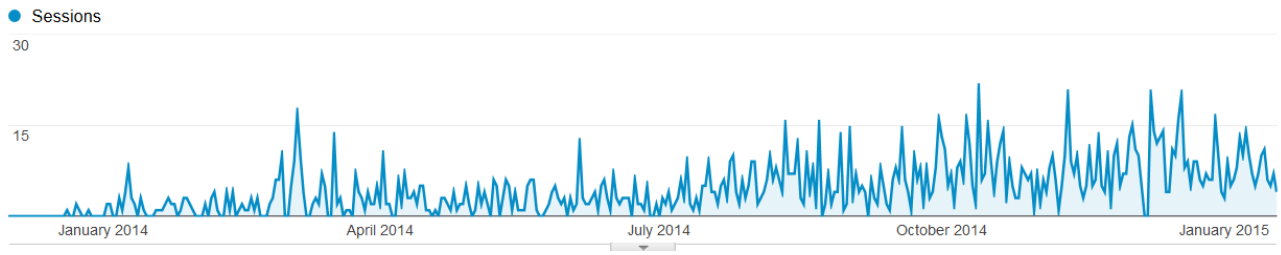


Figure 16: Increasing trend of the sessions on the Pathfinder website

This has been possible by adding S&FT materials resulted from the roadmap advancements, as for example the 35 case studies on S&FT gathered: 6 aerospace, 9 automotive, 3 chemicals, 7 engineering, 3 food, 4 metals, 3 pharma.

Furthermore, the visual demonstration (7 videos) offered another way of communication on how S&FT can enable to foresee different process within the manufacturing industry.

Figure 17: screenshot of the case studies section

8.1. Other main disseminations events

- **Smart Factory Innovation Day:** first announcement of Pathfinder roadmap activity on SmartFactoryKL – Innovation day at KaisersLautern, Germany in September 2013 with 80 participants.
- **ICT Conference Vilnius:** diversified session about simulation activities within the European sector at Villnius, Lithuania in November 2013 with 40 participants.
- **Advisory board workshop**: In March 2014, the Advisory board (20 experts including representative from the EC) and the PATHFINDER consortium discussed the seven elements which together form the work done and to be done within PATHFINDER. While be presented by the PATHFINDER members, the experts gave their views and vision on these as well.
- **Industrial Technologies 2014:** The PATHFINDER consortium was extremely pleased with the possibility to organize a workshop during Industrial Technologies 2014 (April 2014) being one of the main events in 2014 in the area of ICT/Manufacturing! There was a high demand/request for organizing these kind of workshops and it showed the importance of the subject as touched upon by the PATHFINDER CSA that this subject was selected. The workshop, whose organization was promoted by DG-Connect, focused on the challenges related to simulation and forecasting technologies as a relevant topic for the competitiveness of European Factories of the Future. The workshop brought together relevant key players to provide input to the work-programme FoF-ICT under H2020. The workshop presenters came from the Pathfinder and Road4Fame CSAs advisory boards. 40 people attended it.
- **20th ICE Conference - IEEE TMC Europe Conference:** held from 23-25 June 2014 in Bergamo, Italy. At the time of composing this report no information was available.
- **Advisory board workshop:** in October 2014, in Brussels has been organized a workshop and a brainstorming session where more than 40 participants (advisory board and experts) were involved in shaping the Pathfinder's roadmap.
- **Further event participations:**
    - October 2013: ASIM 2013 - Symposium Simulation Technique (ASIM SST) as the main conference of simulation applications in Germany, organized by the German speaking simulation association.
    - November 2013: SmartFactoryKL on SPS IPC Drives 2013 as Europe's leading exhibition for electric automation technology from around the world
    - March 2014: SmartFactoryKL on CeBit - world's largest and most international computer expo (cultivation of contacts within scientific community)
    - April 2014: SmartFactoryKL on Hannover Messe; world's biggest industrial fair with about 6,500 exhibitors and 250,000 visitors
    - May 2014: Symposium IT Factory Innovation: Lecture about Pathfinder elements "From Vision to Priorities"

8.2. Publications

P. Pedrazzoli, M. Cocco, D. Cerri, M. Taisch, D. Corti, M.Dal Lago, S.Terzi, “Simulation and forecasting technologies (S&FT): Gaps and challenges for their future role in manufacturing”, International ICE, 2014.

D. Mourtzis, M. Doukas, D. Bernidaki, “Simulation in Manufacturing: Review and Challenges”, Open Access Procedia CIRP, 8th International Conference on Digital Enterprise Technology – DET, (2014), Vol. 25, pp. 213-229, DOI: http://dx.doi.org/10.1016/j.procir.2014.10.032

9. REPORT ON SOCIETAL IMPLICATIONS

A General Information *(completed automatically when **Grant Agreement number** is entered.*

Grant Agreement Number:	608777
Title of Project:	Pathfinder
Name and Title of Coordinator:	Prof. Paolo Pedrazzoli

B Ethics

1. Did you have ethicists or others with specific experience of ethical issues involved in the project?	○	**Yes**
	◉	**No**

2. Please indicate whether your project involved any of the following issues (tick box) :	***YES***
INFORMED CONSENT	
• Did the project involve children?	NO
• Did the project involve patients or persons not able to give consent?	NO
• Did the project involve adult healthy volunteers?	NO
• Did the project involve Human Genetic Material?	NO
• Did the project involve Human biological samples?	NO
• Did the project involve Human data collection?	NO
RESEARCH ON HUMAN EMBRYO/FOETUS	
• Did the project involve Human Embryos?	NO
• Did the project involve Human Foetal Tissue / Cells?	NO
• Did the project involve Human Embryonic Stem Cells?	NO
PRIVACY	
• Did the project involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)	NO
• Did the project involve tracking the location or observation of people?	NO
RESEARCH ON ANIMALS	
• Did the project involve research on animals?	NO

• Were those animals transgenic small laboratory animals?	NO
• Were those animals transgenic farm animals?	NO
• Were those animals cloning farm animals?	NO
• Were those animals non-human primates?	NO
RESEARCH INVOLVING DEVELOPING COUNTRIES	
• Use of local resources (genetic, animal, plant etc)	NO
• Benefit to local community (capacity building ie access to healthcare, education etc)	NO
DUAL USE	
• Research having potential military / terrorist application	NO

C Workforce Statistics

3 Workforce statistics for the project: Please indicate in the table below the number of people who worked on the project (on a headcount basis).

Type of Position	Number of Women	Number of Men
Scientific Coordinator	0	1
Work package leader	1	3
Experienced researcher (i.e. PhD holders)	2	10
PhD Students	0	0
Other	0	4

4 How many additional researchers (in companies and universities) were recruited specifically for this project?	
Of which, indicate the number of men:	0
Of which, indicate the number of women:	0

D Gender Aspects

5	**Did you carry out specific Gender Equality Actions under the project** ?	⦿ ○	Yes No

6 Which of the following actions did you carry out and how effective were they?

	Not at all effective				Very effective
❑ Design and implement an equal opportunity policy	○	○	○	○	○
❑ Set targets to achieve a gender balance in the workforce	○	○	○	○	○
❑ Organise conferences and workshops on gender	○	○	○	○	○
❑ Actions to improve work-life balance	○	○	○	○	○

○ Other:

7 Was there a gender dimension associated with the research content – i.e. wherever people were the focus of the research as, for example, consumers, users, patients or in trials, was the issue of gender considered and addressed?

○ Yes- please specify

⦿ No

E Synergies with Science Education

8 Did your project involve working with students and/or school pupils (e.g. open days, participation in science festivals and events, prizes/competitions or joint projects)?

○ Yes- please specify

⦿ No

9 Did the project generate any science education material (e.g. kits, websites, explanatory booklets, DVDs)?

⦿ Yes – a website was developed in order to communicate main results during project development

○ No

F Interdisciplinarity

10 Which disciplines (see list below) are involved in your project?

⦿ Main discipline[1]:

○ Associated discipline[1]: ○ Associated discipline[1]:

G Engaging with Civil society and policy makers

11a	**Did your project engage with societal actors beyond the research**	○	Yes

[1] Insert number from list below (Frascati Manual)

community? *(if 'No', go to Question 14)*	⊙	No

11b If yes, did you engage with citizens (citizens' panels / juries) or organised civil society (NGOs, patients' groups etc.)?

- ○ No
- ○ Yes- in determining what research should be performed
- ○ Yes - in implementing the research
- ○ Yes, in communicating /disseminating / using the results of the project

11c In doing so, did your project involve actors whose role is mainly to organise the dialogue with citizens and organised civil society (e.g. professional mediator; communication company, science museums)?	○ ○	Yes No

12 Did you engage with government / public bodies or policy makers (including international organisations)

- ○ No
- ○ Yes- in framing the research agenda
- ○ Yes - in implementing the research agenda
- ○ Yes, in communicating /disseminating / using the results of the project

13a Will the project generate outputs (expertise or scientific advice) which could be used by policy makers?

- ⊙ Yes – as a **primary** objective (please indicate areas below- multiple answers possible)
- ○ Yes – as a **secondary** objective (please indicate areas below - multiple answer possible)
- ○ No

13b If Yes, in which fields?

Agriculture		Energy		Human rights	
Audiovisual and Media		Enlargement		Information Society	
Budget		Enterprise		Institutional affairs	
Competition		Environment		Internal Market	
Consumers		External Relations		Justice, freedom and security	
Culture		External Trade		Public Health	
Customs		Fisheries and Maritime Affairs		Regional Policy	
Development Economic and Monetary Affairs		Food Safety		Research and Innovation	✓
Education, Training, Youth		Foreign and Security Policy		Space	
Employment and Social Affairs		Fraud		Taxation	
		Humanitarian aid		Transport	

13c If Yes, at which level?

- ○ Local / regional levels
- ○ National level
- ◉ European level
- ○ International level

Table 7: Report on societal implications