Road 4 FAME

A Roadmap for Future Architectures and Services for Manufacturing

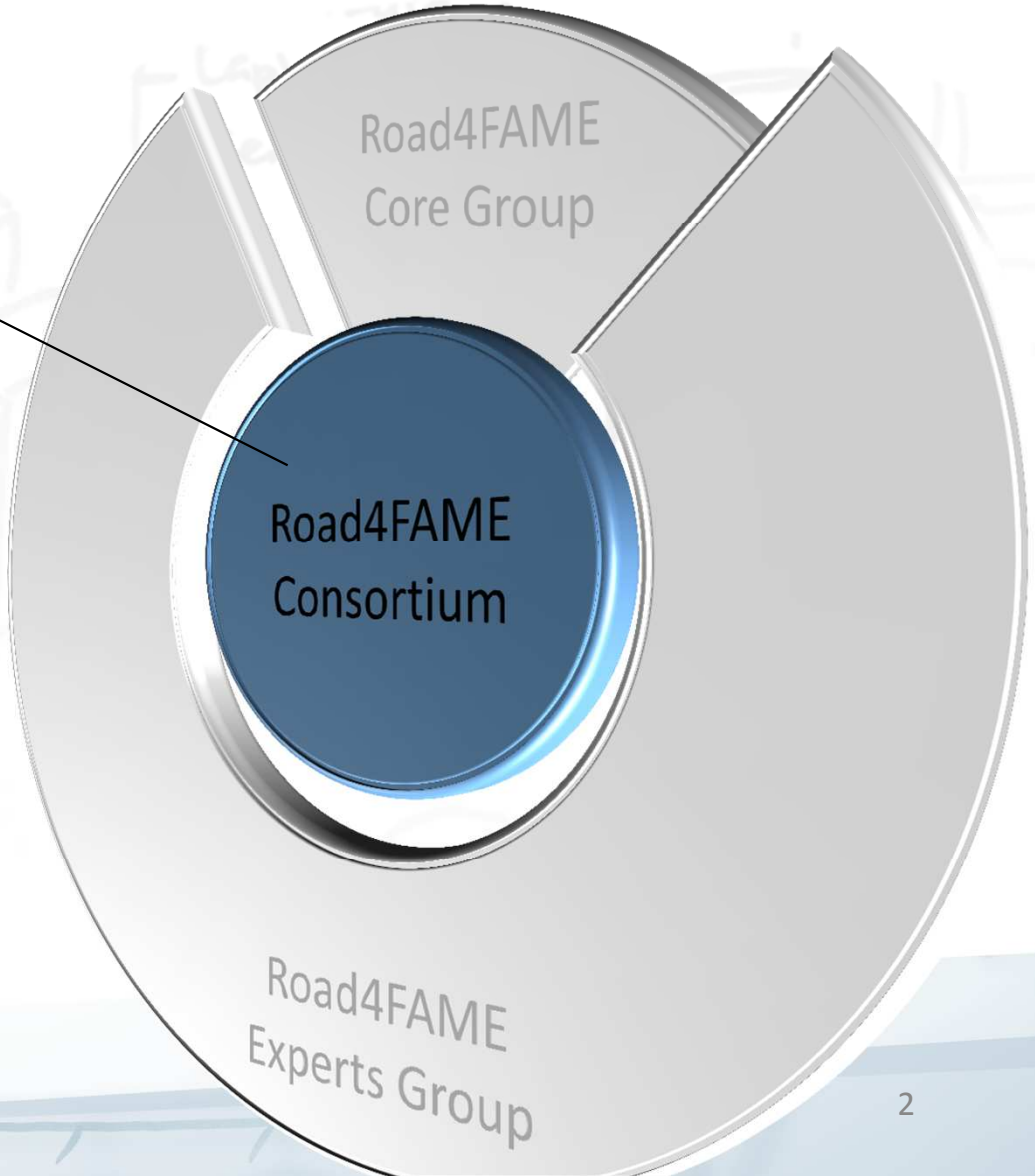
Dr. Nicky Athanassopoulou

Digital Technologies for Manufacturing Innovation: Embracing Industry 4.0

Nottingham, November 30th, 2015

Road4FAME in a nutshell

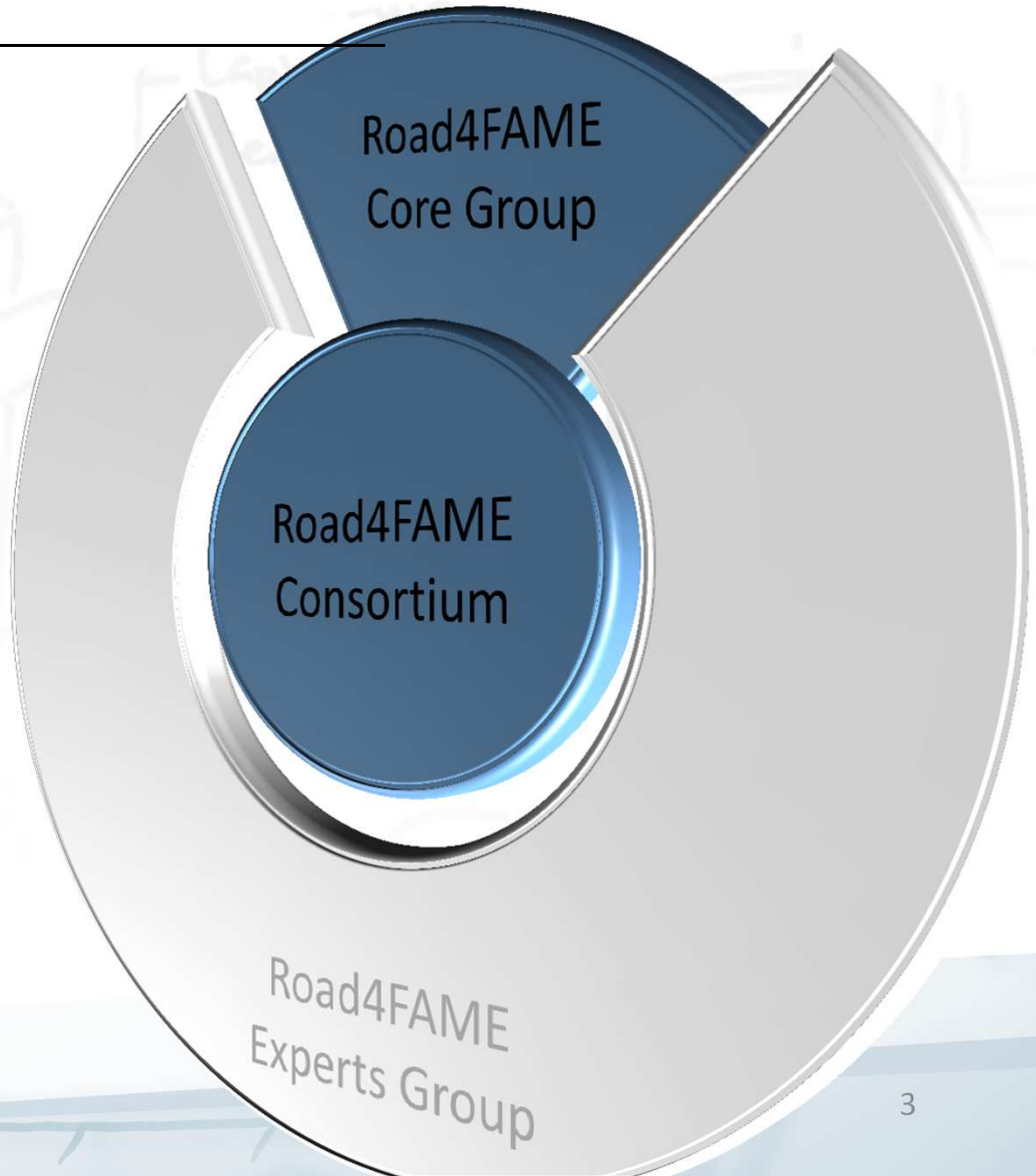
Roadmapping and technology transfer experts and manufacturing IT experts

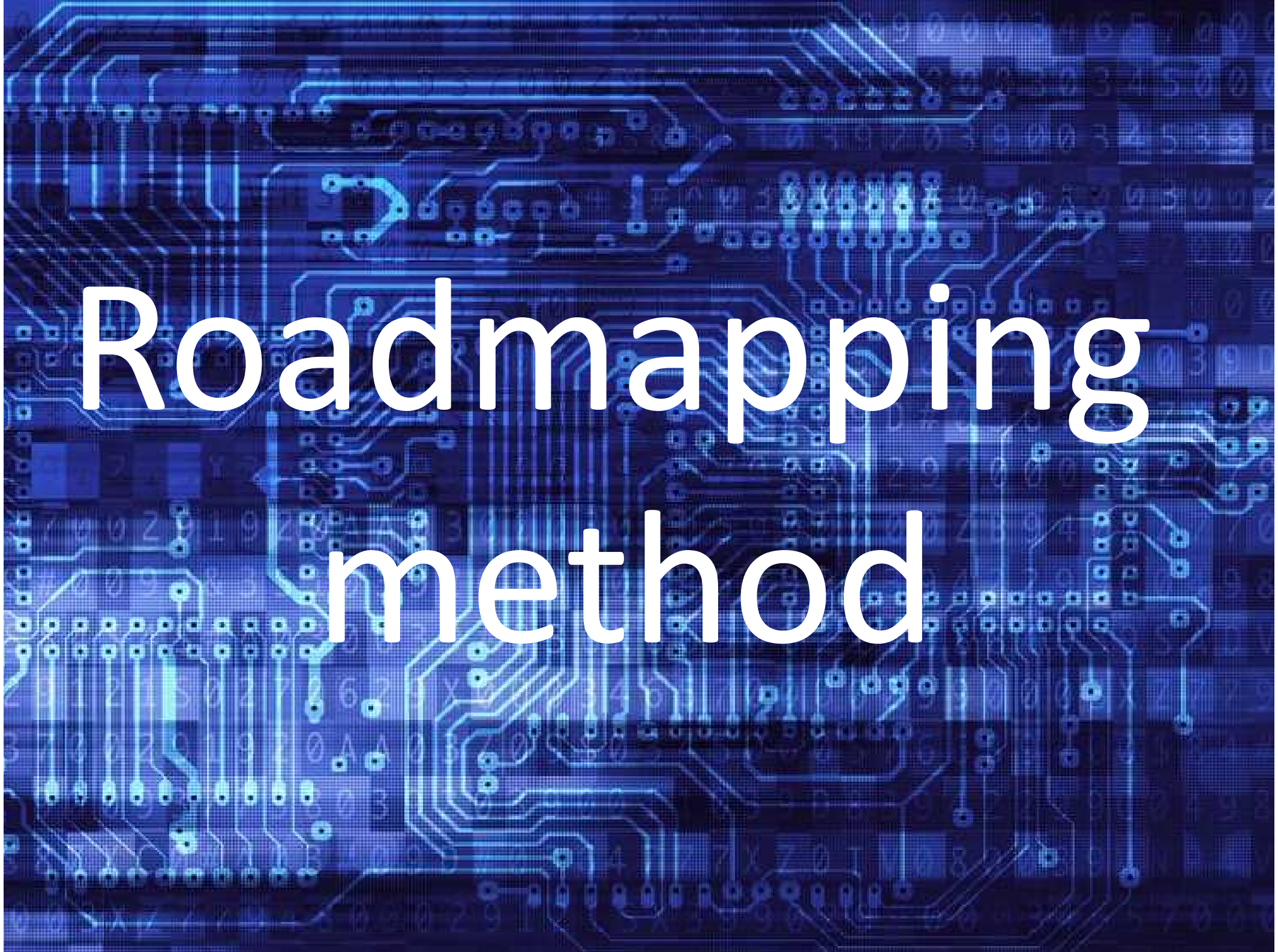


Road4FAME in a nutshell

Selected experts and representatives from industry and the FoF roadmapping ecosystem for:

- Strategic advice
- Link to expertise
- Validation of project results
- Multiplicators for project results




Roadmapping
method

Methodology

Literature Review of **over 30** public documents and roadmaps)
e than 30 expert consultations / interviews from Industry and academia
Content Review with **10** specialists from the Expert Panel
4 iterations of the roadmap architecture

op with **15 experts** to review, assess and prioritise **the IT Capabilities** required and **Underpinnning Research**
57 Required Research and resources shortlis

119 Trends, Drivers and Needs identified
57 Required Research and resources
4 Working Scenario descriptions

2nd workshop with **18 experts** to assess and prioritise T
eds, generate the 1st roadmap and recomm

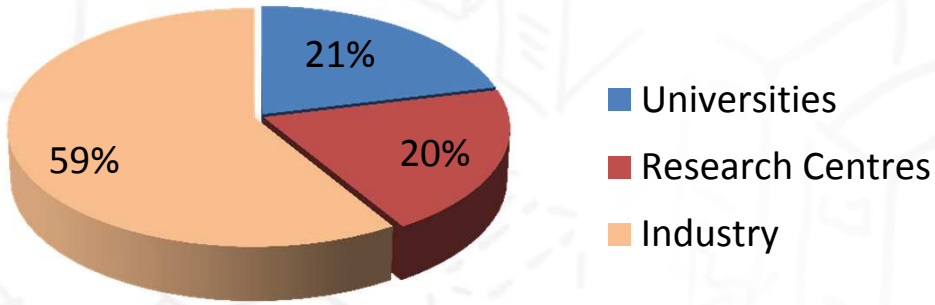
58 Trends, Drivers and Needs
6 Business Models
39 ICT Solutions
57 Required Research and resources

orkshop with **45 experts** generate the final roa
and recommendations

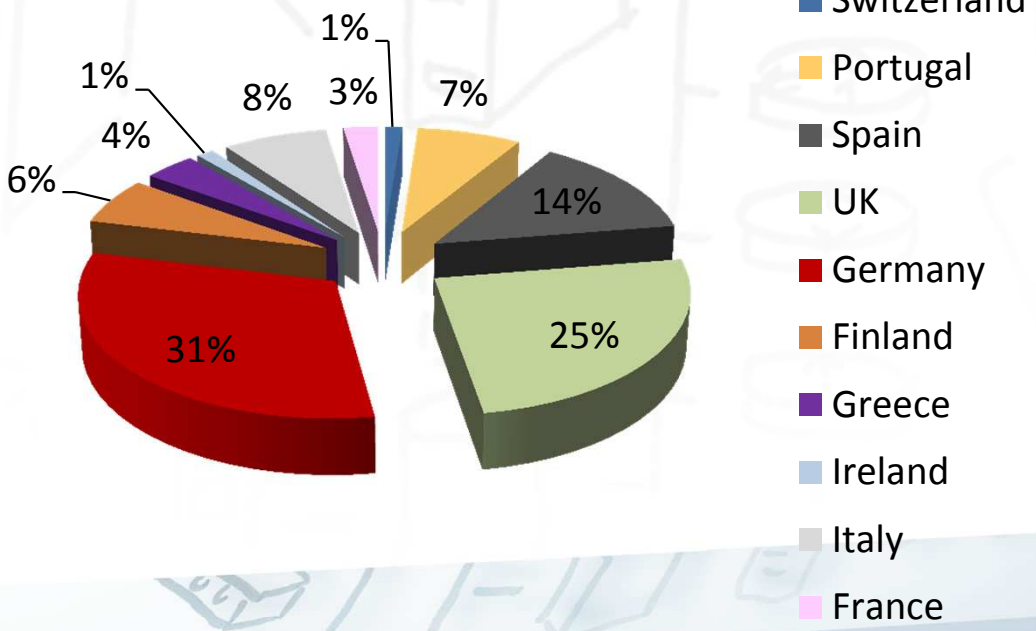
th workshop with **15 experts** to assess relevan
business models and innovation recommendatio

Methodology

Participation per type of organisation



Participation per EU Country



Roadmap for ICT Architectures and Services in Manufacturing

Road 4 FAME

time

Short-Term	Medium-Term	Long-Term
2018	2021	2025

Manufacturing Needs

- Flexible manufacturing
- Supply-chain flexibility; attain highest levels of flexibility at the plant level and the upstream supply chain
- Cost reductions by improvements in business processes and in particular production processes
- Monitoring and Decision Making for Performance Optimisation
- Integration of human worker in manufacturing process; Increasing hybrid cross-over products/ embedded IT and integrated services

ICT Solutions

- Flexible production equipment and interconnections
- Supply chain visibility and decision assistance
- Problem and context – centric display of only crucial information to the users
- Security protection solutions for collaborative networks
- Product & service co-design with customer
- Open data and system integration platform
- Joint cognitive systems (machine learning/ complex decision making)
- Engineering platform for design/ operations continuum
- Big data analysis and use for quality control
- Customer and demand data gathering and analysis
- IT-OT convergence: integrated architecture PLM-MES-ERP

Enablers: Interoperability & Standards, Establishing of Demonstrators, Incorporation of psychology into ICT research, Applied, multidisciplinary research with large scale industrial collaboration, Supporting Education in the field of CPS

Future vision

- High volume "mass customization";
- High levels of automation;
- Short reconfiguration cycles;
- IT literate workers;
- Context-relevant information supported by decision support and self-learning systems

Recommendations

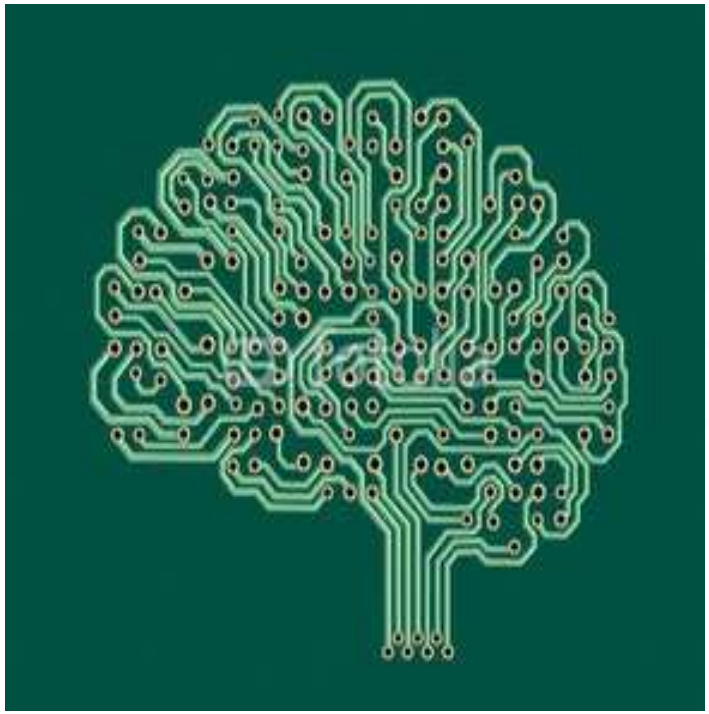
- Reference Architectures / Open Architectures
- System and Information Integration Architectures
- Data Capture, Storage and Analysis
- Data and Information Visualisation
- Security
- Confidentiality
- Flexible and Adaptable Manufacturing
- New or Improved low-cost, miniaturized smart sensors
- CPPS - Cyber-Physical Production Systems
- New Algorithms
- Modelling

ICT Solutions

Top ICT Solutions

Road 4 FAME

- **Flexible production equipment** and interconnections
- **Supply chain visibility** and decision assistance/ **ICT platform** for advanced **supply chain decision support**
- Problem and **context-centric display** of only crucial information to the users
- **Security** solutions for collaborative networks
- Product and service **co-design** with customer
- **Open data and system integration platform** for unstructured data environment
- Joint **Cognitive Systems** for decision support (machine learning/ complex decision making)
- **Engineering Platform** for design/operations continuum
- **Big data** analysis and use for **quality** control
- Customer and **demand data gathering** for analysis
- IT-OT convergence: **integrated architecture PLM-MES-ERP**



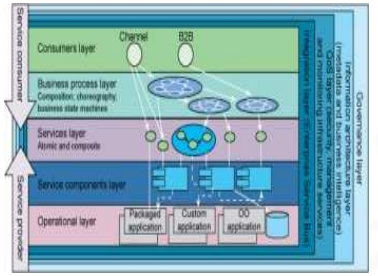
Recommendations

Recommendations – ICT Architectures/Services

Road 4 FAME

Reference Architectures / Open Architectures

Many projects have generated reference architectures. These could be transformed into open architectures, which can be either implemented or further developed or adapted by other projects to improve them further.

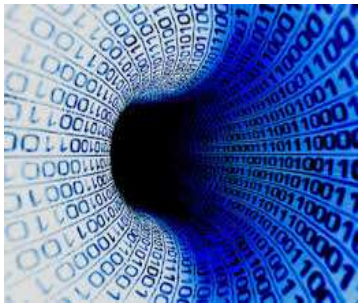


System and Information Integration Architectures

System and Information Integration Architectures are becoming increasingly important due to the growing heterogeneity, amount of information and system components available and they need to be developed to cope with this challenge.

Data Capture, Storage and Analysis

Technology to capture, store and analyze data is advancing from a technical standpoint, but specifically from a methodical and legal side further developments are needed to enable efficient sensible data and information handling, enabling business models and innovation, while protecting individuals and companies.



Recommendations – ICT Architectures/Services

Road 4 FAME

Data and Information Visualisation

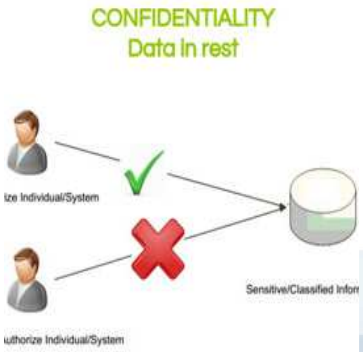
Visualisation techniques and specifically context-aware responsive visualization of data which is a major pre-condition for efficient decision support systems. Human-centric adaptive interfaces and context-centric display of only crucial information to enhance usability.

Security

Research in security strategy, protocols and tools for companies and standards to protect the networked and distributed manufacturing systems would be necessary to ensure balance between security cost and benefits to an organization.

Confidentiality

Confidentiality and know-how protection throughout the network of increasingly larger interconnected networks is essential. Therefore technological evolution of authorization, authentication and encryption mechanisms, as well as the establishment of trust among network participants, to cope with this scenario is recommended.



Recommendations - ICT Infrastructures

Flexible and Adaptable Manufacturing

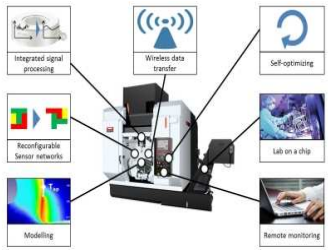
Self-adapting, resilient and reconfigurable manufacturing environments need to be facilitated by standardization of intra- and inter-machine communication. Wireless technologies, context awareness, human-interaction and self-learning (e.g. for production configuration) mechanisms, etc. can significantly contribute to efficiency improvements of the (re-) configuration, ramp-up, and optimisation

New or Improved low-cost, miniaturized smart sensors

Sensors need to become cheaper, smarter, smaller and more energy efficient, to enable new applications that until now were not possible or viable enough due to technological and economic restraints.

CPPS - Cyber-Physical Production Systems

CP(P)S concepts need to be further evaluated and implemented. Certain standards such as self-description, integration/interface, intercommunication and orchestration need to be developed for on platform and system level.

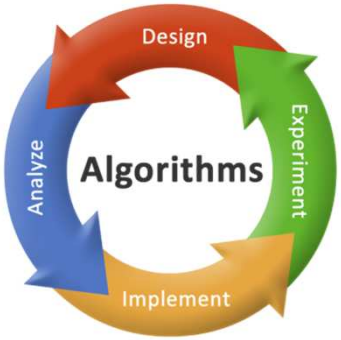


Recommendations – Other Technologies

Road 4 FAME

New Algorithms

The development of easy to use algorithms for analysis, and real time prediction needs to both address various manufacturing enterprises and also be time and resource efficient and cost effective, especially for SMEs. It also has to incorporate knowledge from other domains, where necessary. Furthermore, the algorithms should be able to be executed in a distributed manner to ensure their applicability in manufacturing environments.



Modelling

The development of smarter and better information and domain models can provide not only design details but also greater predictive capacity in order to reduce physical prototyping needs or construction of pilot plants. Simulations, virtual reality, tacit knowledge modelling and User eXperience (UX) of mathematical modelling potentially supports problem solving, decision support and rapid prototyping.

Enablers

- **Interoperability** and **Standards**
- Establishment of **Demonstrators**
- Incorporation of **psychology** into **ICT research**
- Applied**, multidisciplinary research** with large scale **industrial collaboration**
- Supporting **Education** in the field of **CPS**

Thank you