

5G in Smart Manufacturing

Future Requirements – What will need to be done

Vision from Network2020

Jyrki Huusko

Network2020 Expert Advisory Group
(VTT Technical Research Centre of Finland Ltd)

Based on the latest Network2020 Strategic Research and Innovation Agenda (SRIA)

Presentation Outline

- Trends driving the development
- Example of manufacturing use cases and technology enablers
- Thematic areas of SRIA related to Manufacturing Vertical
 - System Architecture
 - Edge Computing and Meta-Data
 - Radio Technologies and Signal Processing
 - Network and Service Security
- Conclusions

- The key trend influencing our future and manufacturing business is the need for ecological reconstruction
 - How do we respond to climate change
 - How to deal with dwindling availability of resources and excessive consumption
 - How to deal with waste-related problems
- Targeting for sustainable development, companies need to shift focus and develop products and technologies, including zero-waste and zero-emission technologies
 - Sustainable materials and circular economy
 - Advanced and optimized processes in manufacturing



- Advanced manufacturing capabilities and digitalization will help to overcome costly design complexities and enable facilitation of e.g. mass customization
- Novel communication technologies and digitalization as a tool for factories of future and manufacturing industry to achieve sustainability targets and enable digitalization
- Smart manufacturing and communication services can enable more distributed and decentralized production of physical goods.
- With real-time data, effective data monetization and digital automation of the manufacturing process, businesses will be able to shift focus towards generating higher revenues



- Industrial digital automation has created demand for development of standalone private networks with high reliability and high performance
 - Including requirements for bandwidth, latency, coverage, autonomicity (of management)
 - secure communications and data privacy
 - dynamicity and flexibility to arrange wireless communication e.g. for Industrial IoT, support for dealing with heterogeneity of systems
- In the manufacturing industry, robots are becoming both more autonomous and more cooperative. In the same time robot systems needs to be human-interfaced in “natural” way.
 - Human-machine interfaces
 - Machine-to-machine interfaces
- Industrial processes will be finely monitored in real time, enabling higher optimization levels and predictive maintenance, reducing costs and increasing productivity.



- Holographic type communications (HTC)
 - The holographic display needs to satisfy all visual cues for the human observation of any 3D object, such that it can appear as natural as possible
- Tactile Internet for remote operations (TIRO)
 - Tactile Internet is enabler the real-time control of remote infrastructure, creating a plethora of opportunities and opening new areas of applications within sectors such as Industry 4.0
- Industrial Internet of Things (IIoT) with cloudification
 - Industrial networks enabled by the Industrial Internet of Things are connecting back offices to factory floors and provide the integration from device level all the way through to enterprise business systems, resulting in the automatic operation and control of industrial processes without significant human intervention.



Example of manufacturing use cases and technology enablers

Time-critical process optimization

- Real-time communication between machines, processes,
- Real-time sensor data
- Extended Reality / Augmented Reality Applications (training maintenance)
- Haptic interactions between humans and machines
- Time Sensitive Networking support

Non time-critical process optimization

- Tracking objects and goods inside factory, IoT/positioning
- Non-realtime sensor data
- Data collection and storage/analysis for forecasting, controlling and designing processes
- Edge processing / AI

Remote control of factories/robots, digital twins of factories

- Security enablers for remote access
- Remote control and management of devices, high bandwidth and low latency
- Platform security, data collection for digital twin
- Remote AR/XR application support
- Remote Haptic control of devices
- Reliability

Seamless inter-/intra-enterprise communications

- End-to-end tracking of goods throughout the whole value chain
- Reliable and secure interconnection between premises
- Support for multi-domain and multi-tenant applications/services
- Edge-cloud continuum over multiple domains

Connected goods

- Collecting data from goods during whole lifecycle including the manufacturing process
- Privacy and security
- Wide-area connectivity to guarantee data availability
- Meta-data and semantic interoperability
- Edge-cloud continuum over multiple domains



System Architecture

- Trend is towards as a holistic system that combines the problem of data communication with that of distributed computing, transforming the existing infrastructure from the best effort connectivity to

*sustainable, greener **Intercompute system.***

- Softwarization of traditional monolithic communication system will boost the flexibility of communication and computing infrastructure use in manufacturing systems
 - For example in manufacturing process management and data collection capabilities
 - Enabling efficient edge computing capabilities for end-to-end tracking of goods and management of processes



Edge Computing and Meta-Data

- The trend is to move processing and data close to point where it is needed. Distribution and decentralization of services and resources related to manufacturing process without major restrictions caused by underlying networks
- How edge computing and semantic data interoperability should be arranged
 - Virtualisation of applications and functionalities
 - Containers and container orchestration
 - Distributed services and edge-cloud continuum
 - Edge, mobile edge computing and processing
 - Artificial Intelligence in edges of network (Edge AI)



Thematic areas of SRIA related to Manufacturing Vertical



Radio Technologies and Signal Processing

- New technological solutions are needed for wireless connectivity and radio technologies to support real-time and efficient connectivity of manufacturing systems
- Co-existence and interoperability of radio systems and spectrum usage in local (and e.g. neutral host) networks
 - Spectrum re-farming and reutilisation, as well as co-existence
- Support for massive IoT and Industrial IoT solutions
 - Random access for massive connections;
 - Wireless edge caching for further increased spectrum and energy efficiency.
 - New solutions and methods for IIoT and IoT communications utilising e.g. backscattering
- Advanced services for manufacturing and industrial use cases
 - Integrated positioning and sensing solutions, precise time synchronization
 - Support e.g. for extended reality and other high bandwidth services
 - Support for time sensitive networking over wireless
- Novel radio and communication systems
 - Millimetre wave systems
 - Terahertz communications including new materials (graphene)
 - Massive and ultra-massive MIMO including intelligent reflecting surface
 - Waveform, non-orthogonal multiple access and full-duplex
 - Enhanced modulation and coding



Thematic areas of SRIA related to Manufacturing Vertical



Network and Service Security

- Demand to provide trustworthy communication, data and connectivity platform for critical manufacturing environment
- Cybersecurity inbuild not add-on in system – Security by design
- Static security solutions do no longer apply, change towards a “Software Defined Security”
 - Slice integrity and isolation across multi-owned infrastructure segments
 - Programmability on the radio side also leads to new range of potential attacks
 - System-wide security,
 - Security as a service, security orchestration,
 - Distributed ledger technologies,
 - AI security,
 - Security monitoring of encrypted data,
 - Automated threat intelligence and prediction.



Thematic areas of SRIA related to Manufacturing Vertical



Other areas in research agenda having impact also to manufacturing vertical:

- Satellite communications especially connecting remote locations, positioning and earth / local environment monitoring
- Optical networks as a backbone for enterprise connectivity, demand of high bandwidth and reliable connectivity
- Novel approaches of nano-/bio-nano-things enabling new manufacturing paradigms and high accuracy monitoring of products and processes, communications and biodegradable materials



- Foundations of Networld2020 Strategic Research and Innovation Agenda (SRIA) are on solving global challenges from communication technology and its use cases point of view
- We have identified several technology trends and development targets relevant also for manufacturing industry
- Most imminent advances in technology can be found for supporting manufacturing industry needs on:
 - Support for real-time data processing, analysis and data delivery for industrial processes
 - End-to-End connectivity in enterprise level from production and supply lines to process control and management
 - Cybersecurity and trustworthiness of used communication and service infrastructure
 - New technology enablers to support efficient communication and enable advanced services, Industrial IoT, and human-machine interactions





NETworld Thank You



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