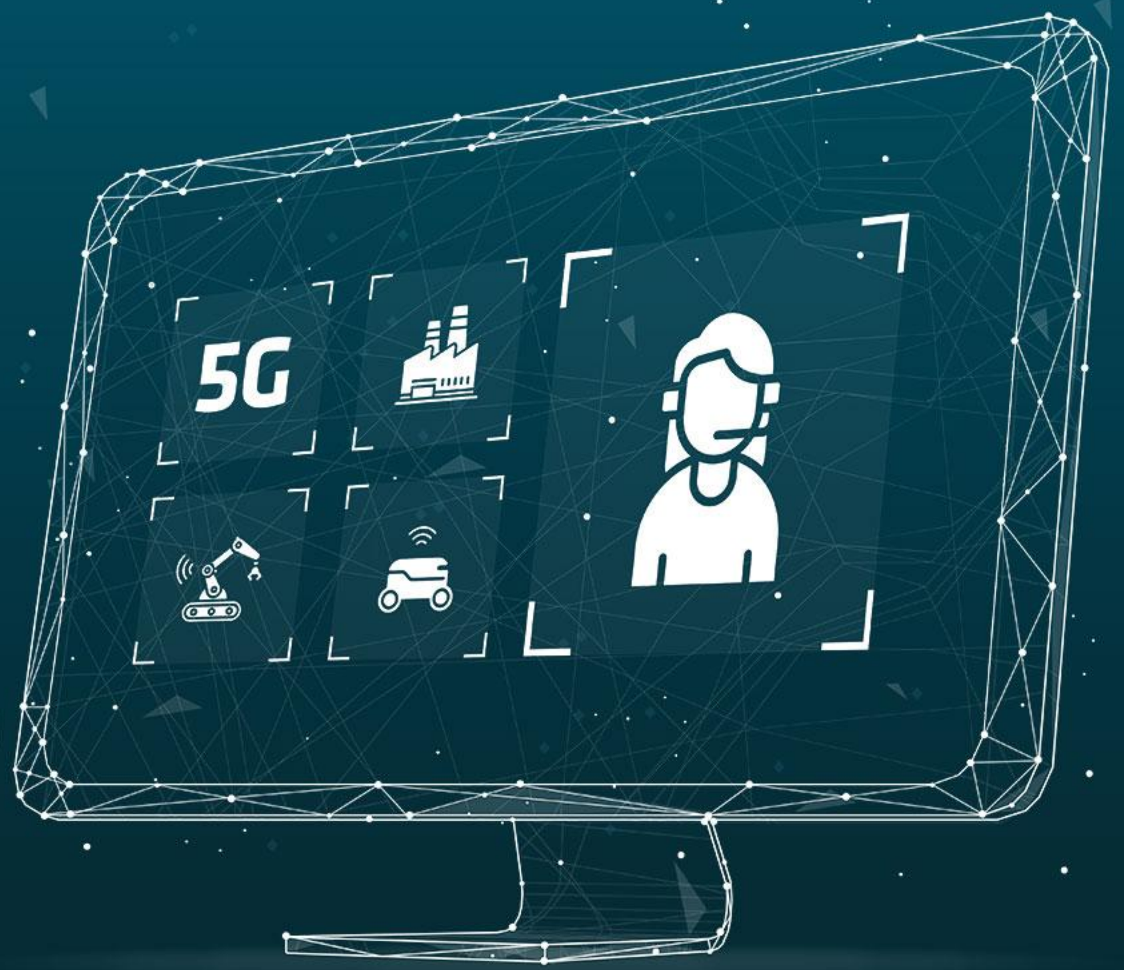
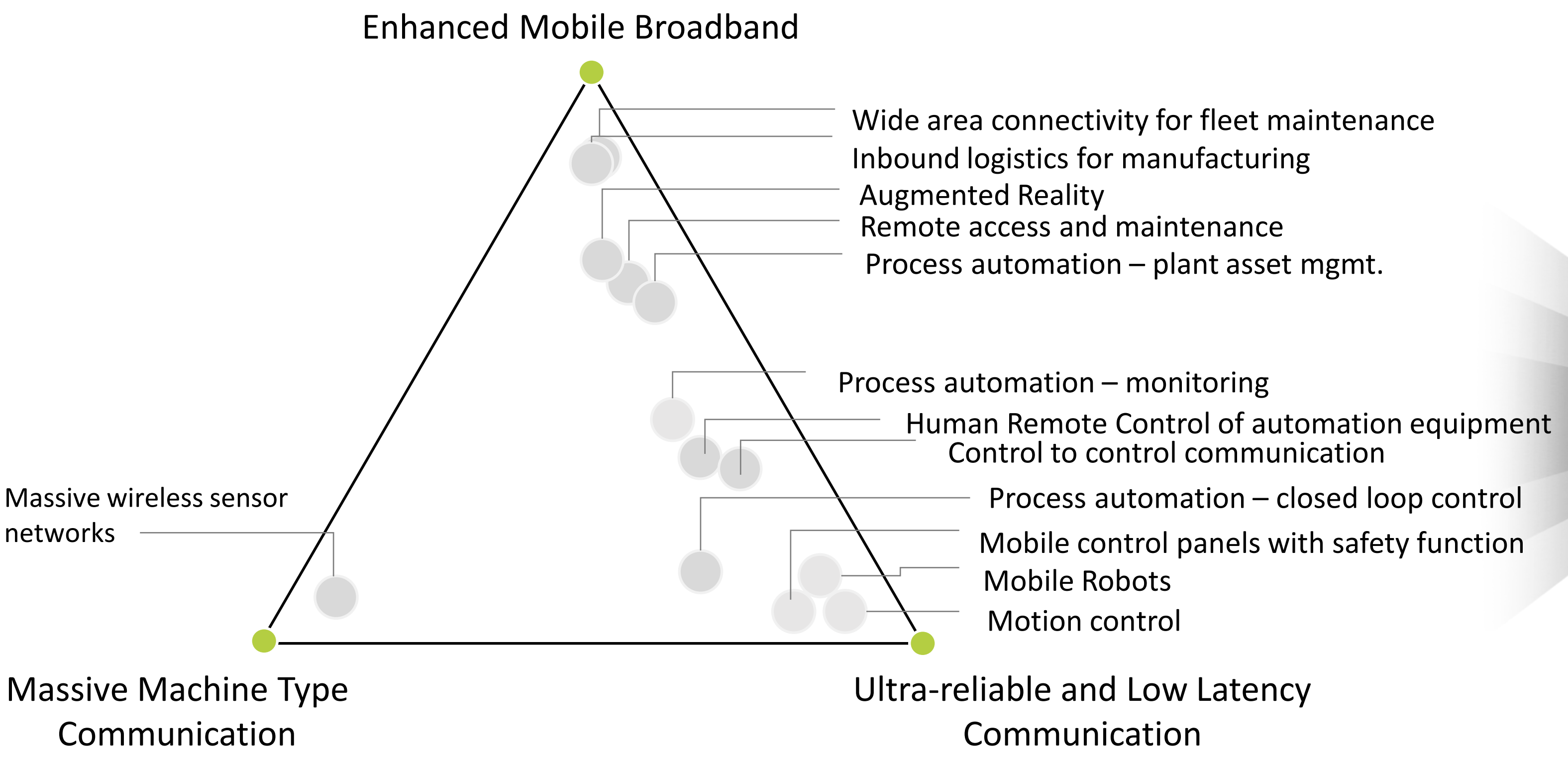
5G-ACIA Web Seminar

Industrial Requirements and the Evolution from 5G to 6G

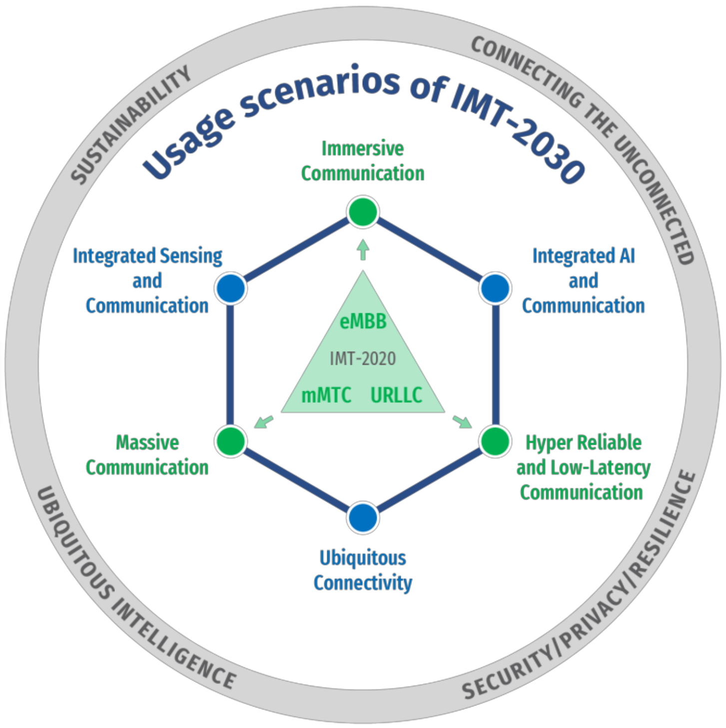


Michael Bahr

Industrial use cases – what is the next step?



5G Era



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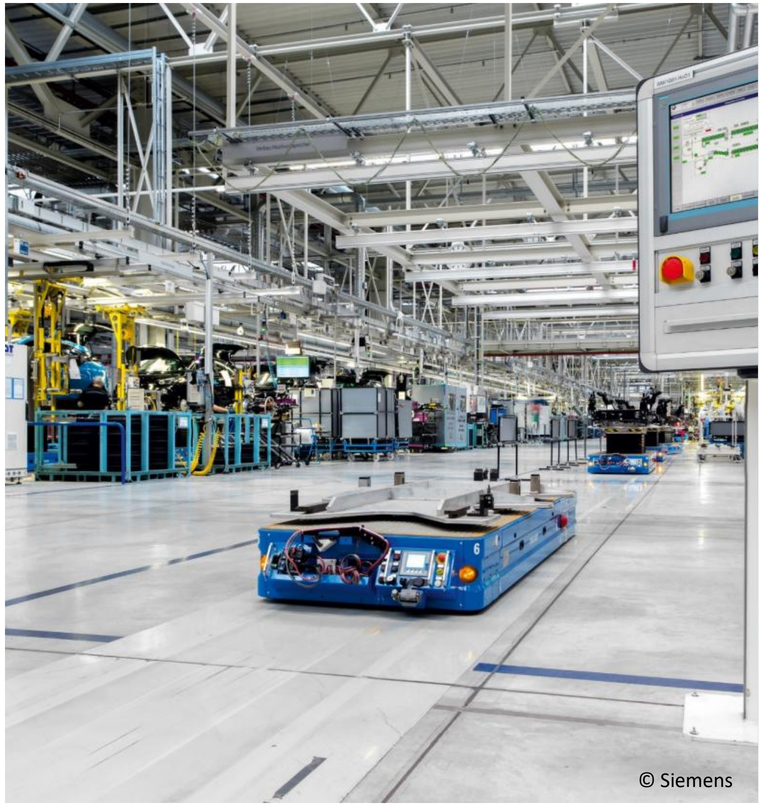
6G Era

Industrial 5G/6G Use Cases

Industrial 5G use cases are also applicable for 6G



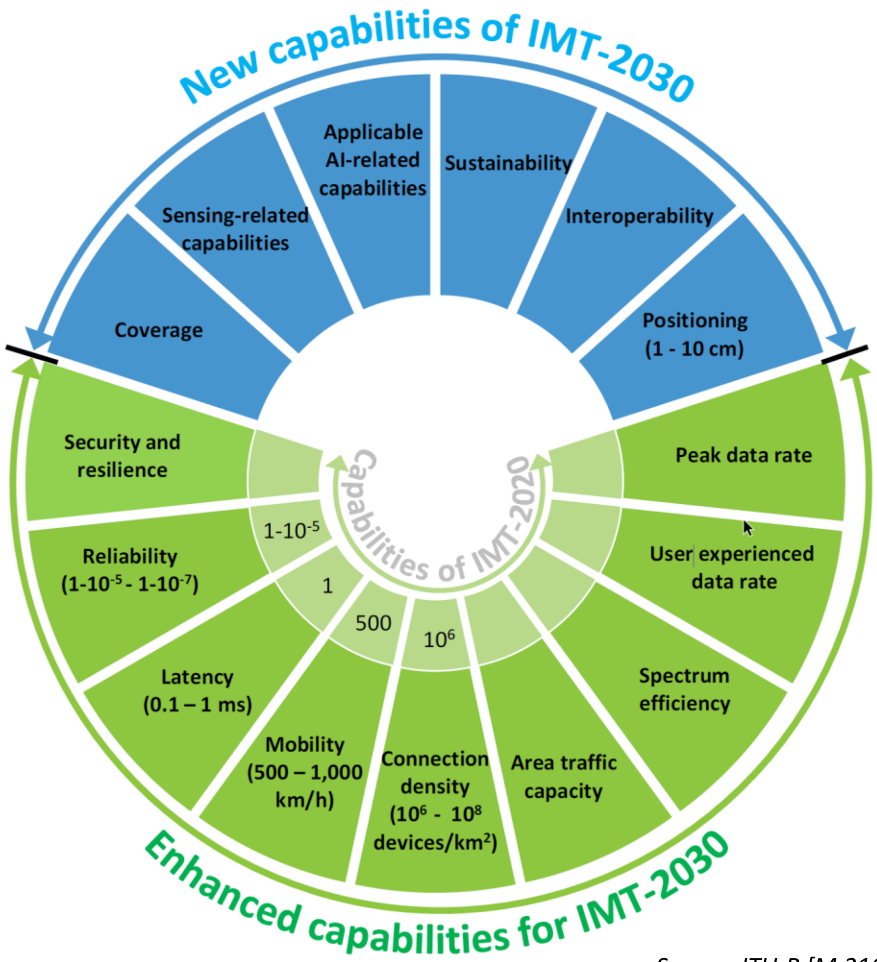
Flexible Modular Assembly Area
Communication of mobile assets (AGVs, mobile robots, …)

Industrial Automation
Wireless communication between PLCs and devices

Industry 4.0: Flexible Manufacturing
Dynamically configured production processes, mobility

Capabilities of IMT-2030

Hyper-Reliable Low-Latency Communication (HRLLC) in IMT-2030 [M.2160]



Source: ITU-R [M.2160]

Dependability is important:

- Interoperable integration into non-3GPP industrial communication networks
- High communication service availability/reliability.
- Meeting the latency limits.
- High operational reliability is more important than a very low latency KPI.
- Operate hundreds or thousands of industrial devices with dependable low latency communication in a factory hall.
- Dependable, scalable 1 ms latency would be great. ☺

The use case must work.

5G-ACIA 6G Consideration

Recommendation from Business Aspects

6G as evolution leverages ongoing and upcoming investments

- 6G has to be an evolution of 5G technology allowing 5G-based deployments to be upgraded with components of the next generation technology.
- It is of utmost importance to protect ongoing and upcoming investments and deployments of industrial users in 5G applications, devices, infrastructure, and spectrum (where applicable).
- Manufacturing and process industries require backwards compatible solutions, which is in line with the often long lifetimes of industrial equipment.

Life cycle matching between OT and ICT

- Mobile communication system is roughly progressing from one generation to the next every ten years, and its entire ecosystem (including research, standardization, commercialization of all technology components, etc.) are collaborating and self-adapting to reach this goal.
- In OT domain, the product life cycle is much longer than 10 years. Life cycle **mismatch** may result in different development speed, expectations, etc.

Ensuring an adequate evolution of 5G is very important – An evolution that meets the evolving challenging requirements of industrial automation, leverages OT investments in 5G technology, recognizes longer life cycles in the OT domain, and supports further sustainable development.

Dependability and Resilience

Performance Aspects

Background:

For mobile equipment data acquisition and control scenarios such as AGVs collaborating, multiple robots synchronized control, and integration of mobile networks in industrial time-sensitive networks, it is necessary to realize such advanced feature based on wireless network.

Ultra-accurate and stable synchronization

- Demanding production data acquisition, e.g. motion control with further improved and stable clock synchronization beyond 5G target and latency of ~1ms.
- Better scalability – URLLC/IIoT communication with demanding QoS for many concurrent communications.

Simplicity and Maintainability

Operational Aspects

Reduced complexity

- Simplified network management.
- Tailor-made functionality for industrial use cases.

Modularity and extensibility

- New operating models based on technology enablers, e.g. virtualization and softwarization.

Advanced exposure capability

- Evolve secure exposure of communication services at network level for monitoring, diagnosis, and standardized data and information exchange with industrial applications, e.g. data or knowledge exchange for external processing by AI.

Sustainability

Energy efficiency and facilitating factors for sustainability

Energy efficiency and green equipment connection

- Massive asset management and tracking demand with (very) low power consumption (e.g. passive or ambient powered).
- Achieve better energy efficiency for NPN (e.g. radio and relevant networking aspects).
- Energy efficient end devices (i.e. UEs).

Evolution from 5G to 6G

- New functionality via software updates, maintaining compatibility to 5G.

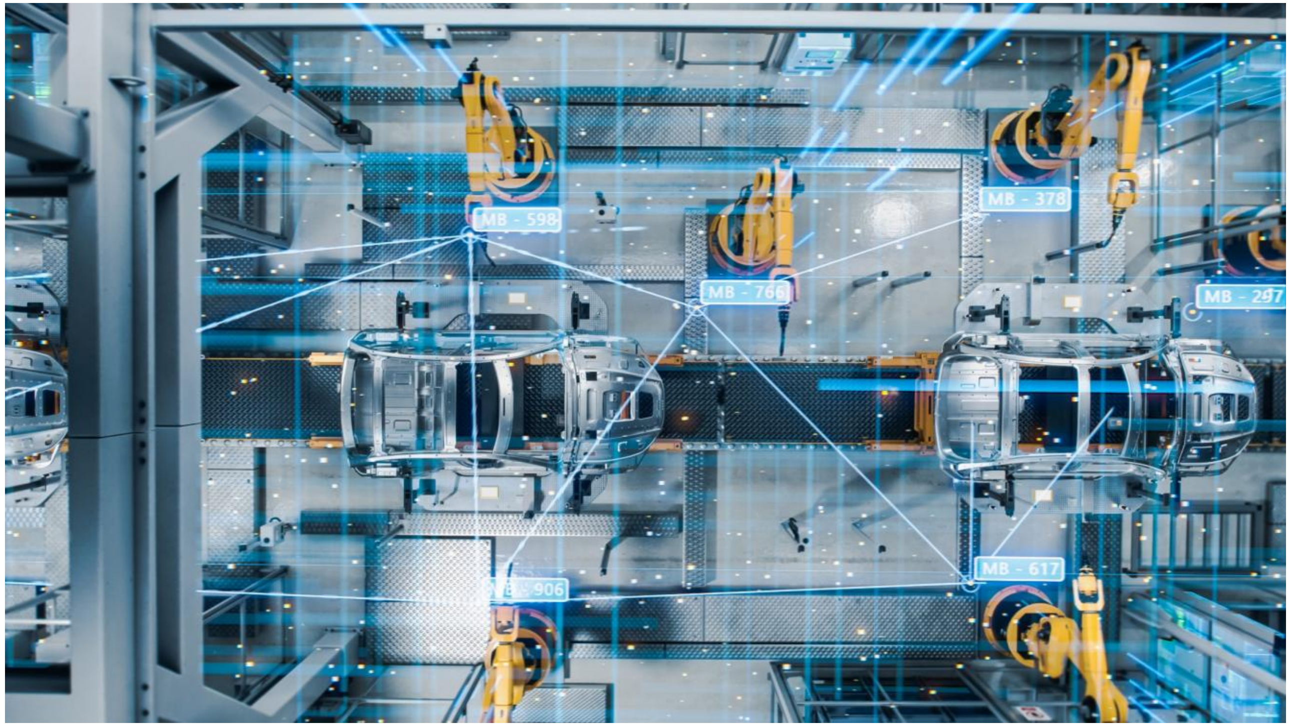
„Enablement"-Effect

- More efficient processes and more utilization of resources in different industrial domains to support a circular economy.

Non-Public Networks (NPNs)

5G features transition into 6G

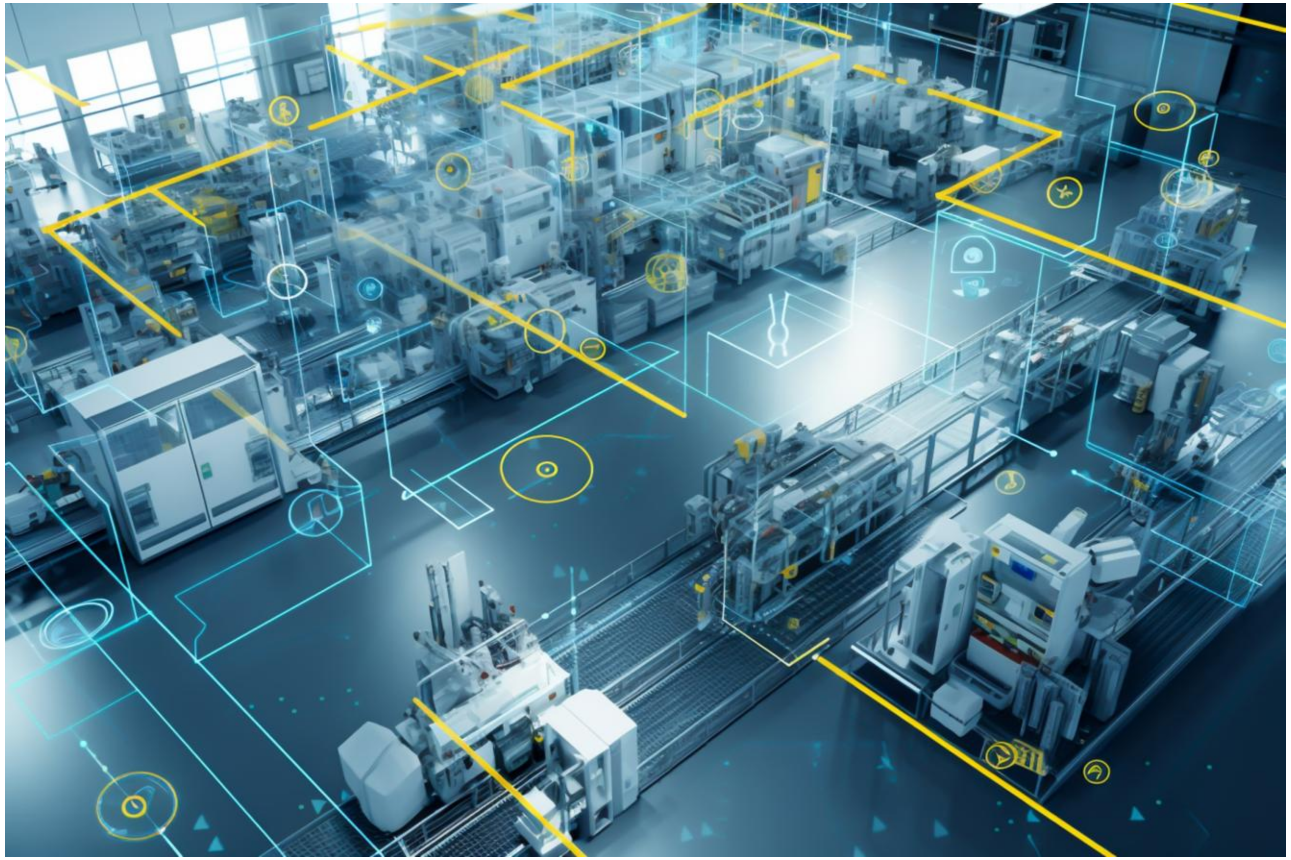
- NPN concept, both Standalone NPN and Public-Network Integrated NPN, will be brought from 5G to 6G.
- Standards must allow on-premises NPN deployments: NPN deployed on-premises of the industrial enterprise is needed to support typical industrial use cases.
- Simplification to deploy, configure and manage determinism & quality in NPN.
- Flexibility needed in O&M to support all NPN deployment types and operation models. (e.g. industrial enterprise has access to relevant networks management capabilities, NPN as-a-service data model).
- Privacy and Security need to be ensured in all NPN deployment types and operation models (network domains, external connections, third parties etc.).



Seamless Integration and Native Support of Industrial Communication Domains in NPN

5G features transition into 6G and may be enhanced

- Ability to build NPN that can further support several logically independent communication domains.
- Support for deterministic communication with standardized means.
- Industrial applications of various suppliers in different compute environments should be able to communicate with each other as they were in the same cloud.
- Feature complexity kept to level justified by the use cases (= economical feasibility).
- Integration of 6G wireless communication in non-3GPP industrial automation networks.
- Advanced exposure capability and well-defined interfaces.
- Further distributed autonomous network may bring new integration aspects.



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Liaison Statement to 3GPP (SP-241819)

Integrated Sensing and Communication (ISAC)

New capabilities triggering new use cases and requirements

Use the communication infrastructure as a sensor

New use cases and requirements

- Gesture recognition, vibration monitoring, and preventing hazards in industrial environments.
- Monitoring of stockpiles, optimizing flexible production flows.

Potential advantages:

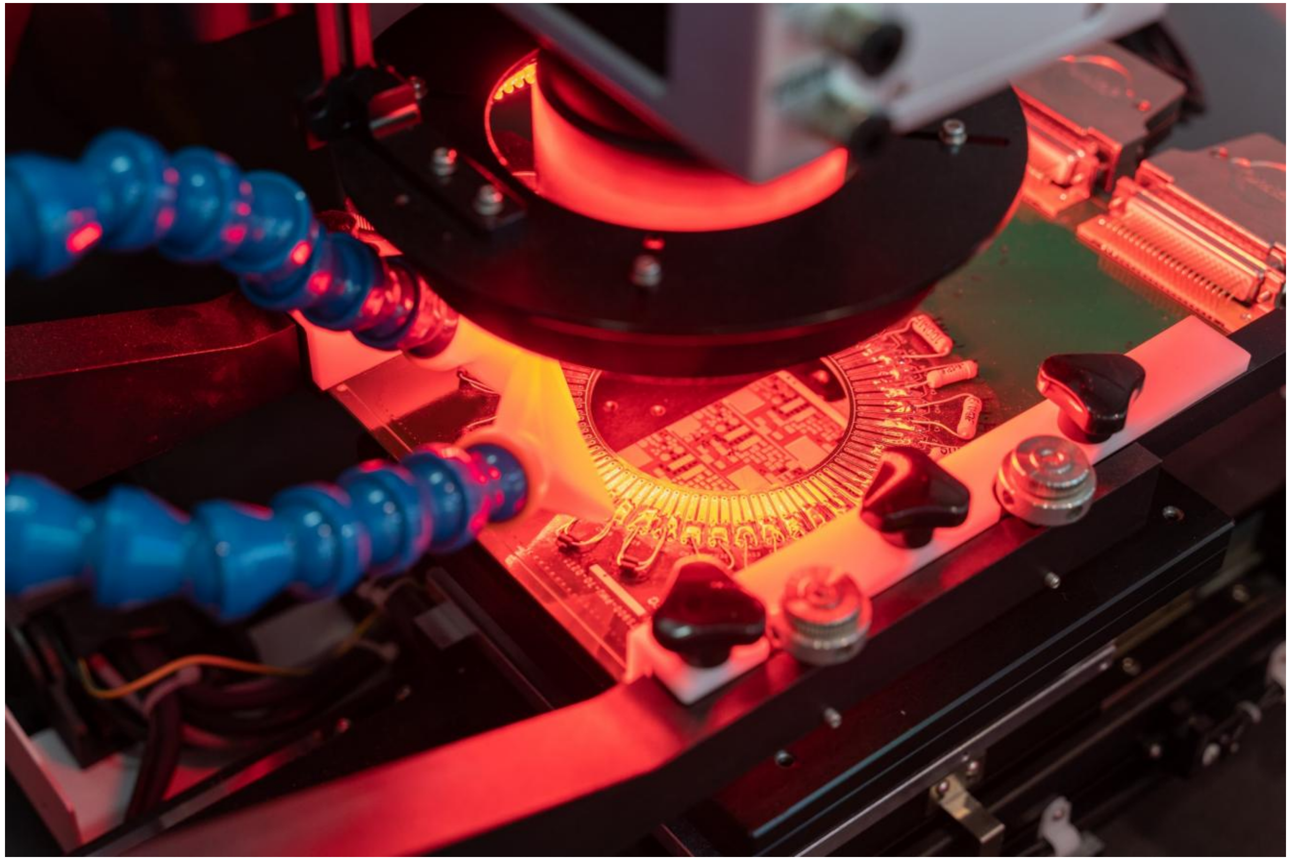
- Improved sensing accuracy and resolution through communication spectrum reuse and inter-cell interference coordination.
- Wireless, contactless sensing without dedicated sensors and suitable for harsh environments.
- Enhanced privacy compared to traditional sensors like cameras and microphones.
- A combination of multinode, multistatic and multimodality sensing achieves better sensing results by incorporating both 3GPP radio and authorized non-3GPP sensors.
- Unified, trusted environment for collecting and transferring sensing data.
- Sensing capability to enrich digital twin, enabler of industrial metaverse.

5G-ACIA Whitepaper LS to 3GPP S1-250071

Native Intelligence

New capabilities triggering new use cases and requirements

Utilization of AI and decentralized intelligence



Potential advantages:

- Native support of AI by 6G (e.g. data management, model distribution) as potential enabler for better adaptability to industrial scenarios.
- Handling of industrial data on-premises with support of efficient local training, data aggregation, etc.
- resolve customized network service provisioning for industrial use cases, e.g. with AI agents.
- Autonomous embodied agents within flexible manufacturing.

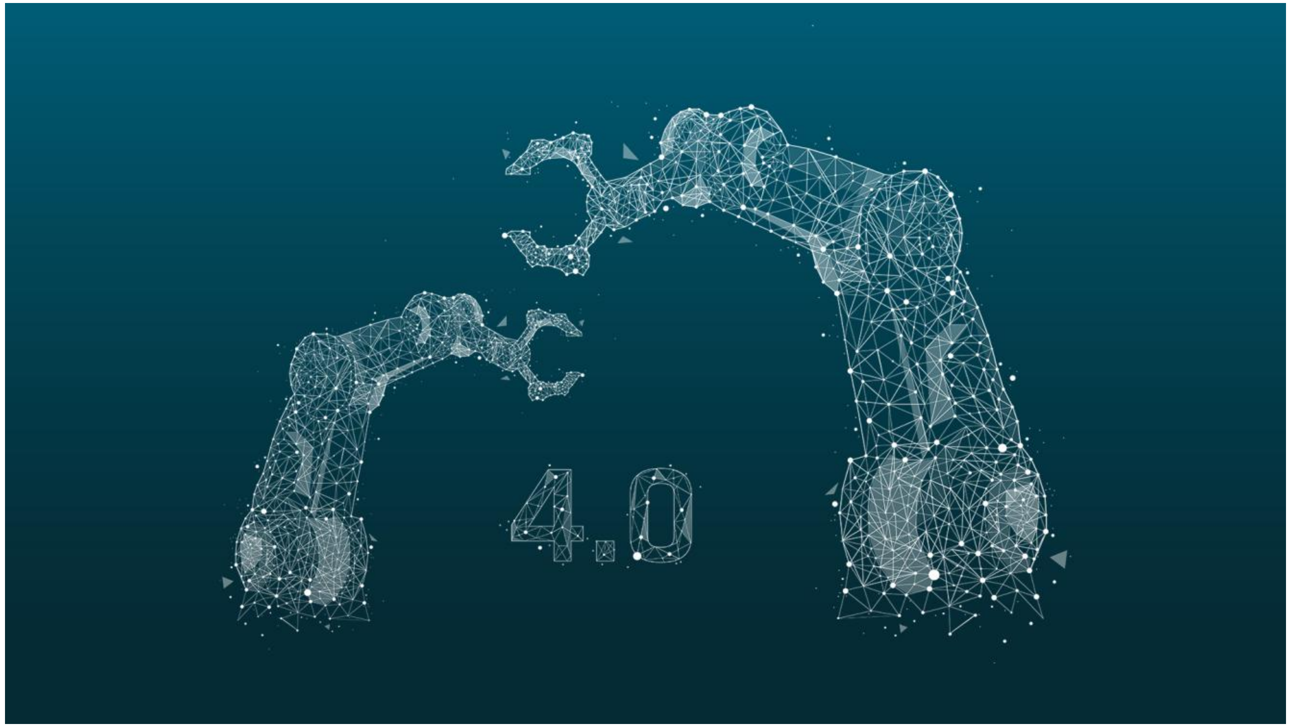
5G-ACIA will explore potential new use cases, functionalities, and requirements on native intelligence.

Realtime Digital Twin

New capabilities triggering new use cases and requirements

Support of Realtime Digital Twin

- Powerful communication system enables realtime digital twins allowing reduction of hardwiring / logic inside industrial systems to an environment outside of the system.
- Network Digital Twin



Potential advantages:

- Realtime data will support digital twins
- Realtime digital twin for efficient integration and operation
- Network digital twin enhanced O&M
- More harmonized environment to innovate faster
- More efficient interoperability and upgradability of industrial system over a long (+10 years) lifecycle

Key Messages

Industrial Requirements and the Evolution from 5G to 6G

Fundamental considerations:

- Industrial 5G use cases and requirements are still applicable for 6G.
- Protect ongoing investments by enabling a smooth evolution from 5G to 6G while meeting future demands.
  - → 6G architecture and services have to support this smooth evolution from 5G to 6G.
  - → Longevity and backward compatibility are important requirements.
- Industrial 6G has to be considered from the very beginning of 6G.
- Most relevant 5G IIoT features shall set the benchmark for 6G and maybe further discussed/enhanced in 6G, e.g. seamless integration with industrial domains, NPN, etc.

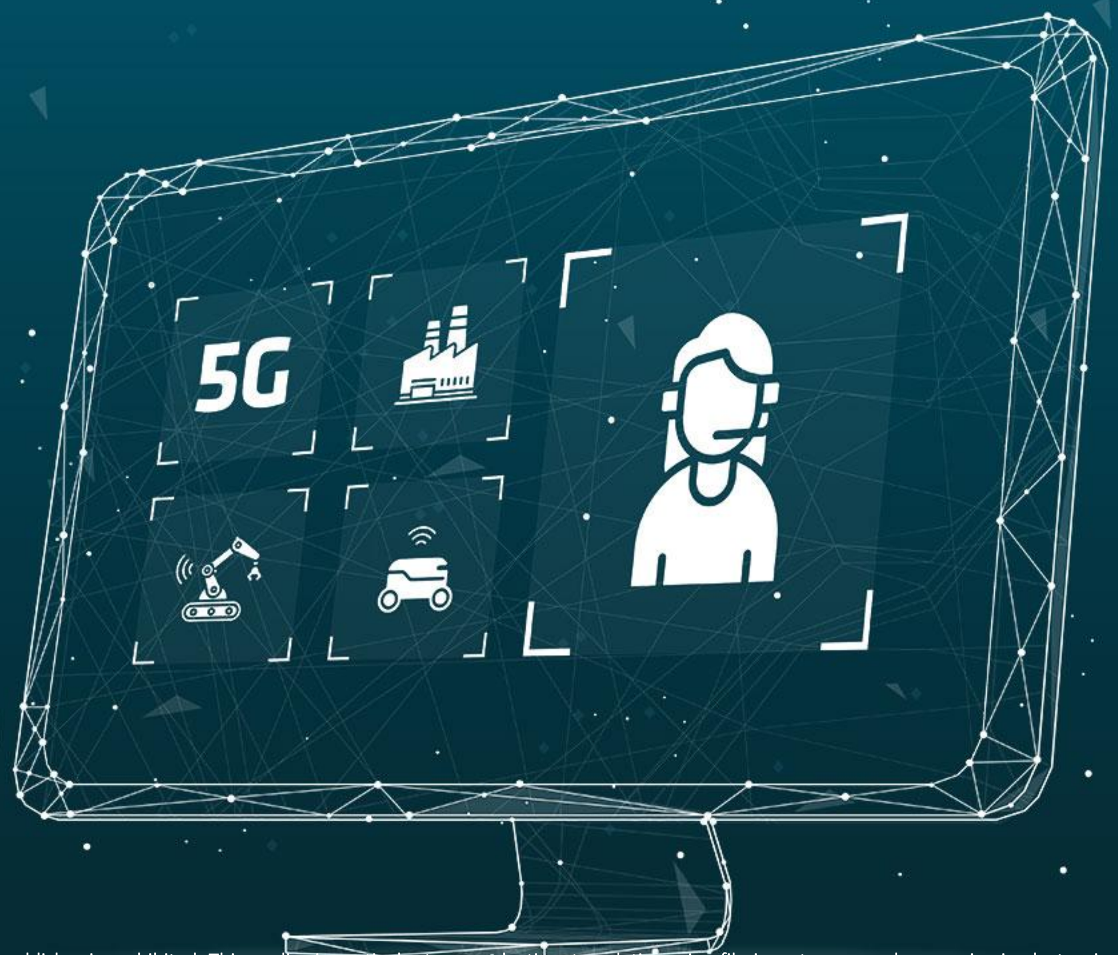
New thoughts brought by 6G:

- Overall, OT players value the following technical features: sustainability, dependability and resilience, and simplicity and maintainability.
- 6G new features like ISAC and AI exposure, agent technology, and native intelligence (based on ITU-R IMT2030 vision) will trigger new use cases and requirements for industrial IoT, e.g. (network) digital twin, industrial metaverse, etc.

The use case must work.

Thank you!

Michael Bahr (Siemens)
5G-ACIA WG1 Chair "Use Cases and Requirements"



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