TECHNOLOGY INSIGHTS

5G for digital industries

5G – the fifth generation of cellular communication technology – is a key enabler for the digitalization of industry. It is difficult to overstate the impact 5G will have on the industries with which ABB is involved. What are the value propositions of 5G and what is ABB doing to unlock them?

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With the megatrend of digitalization ramping up quickly, vertical industries are looking to improve competitiveness by a deeper integration of value networks, operations processes and production equipment. More than ever, automation systems are expected to enable flexibility, increase productivity and decrease operational risk for their owners. For automation vendors, this means extending focus from the automation of energy and material flows to the automation of information flows and digital processes – even between different vertical industries →01. 5G can address the needs of such a converged digital ecosystem.

What is 5G?

With the world depending ever more on connectivity and the exchange of data, the communications industry is moving to provide a completely new type of wireless network: 5G [1]. With, for example, the ability to serve many devices nearly simultaneously and even run different logical networks for autonomous driving, voice and industrial applications on one physical infrastructure, 5G is not just a faster 4G, it is a game-changer →02.

There are three key aspects of 5G performance, which will become available, in an incremental fashion, over the next few years →03:

- Enhanced mobile broadband (eMBB) increases bandwidth by an order of magnitude over 4G, targeting applications like high-definition (HD) video-streaming or augmented reality (AR) – not only in the consumer world but also the industrial domain. Public 5G coverage started up in 2019.
- Ultra-reliable low-latency communication (URLLC) reduces the achievable latency and enhances the reliability of communication. URLLC targets process- and safety-critical applications like closed-loop process and motion control, safe communication and autonomous logistics with automated guided vehicles (AGVs). URLLC may also be referred to as critical machine-time communication. Standardization for this aspect has been completed; commercial availability is expected in 2021/2022.
- Massive machine-type communication (mMTC) aims to increase the number of devices in a given area by orders of magnitude, primarily aimed at sensor applications with low data rates (compared to, for example, video) but high spatial density. This feature will be standardized last and is expected to become available by late 2023.

In practice, applications demand a combination of these performance features. A good example is the streaming of augmented-reality content, which requires both high bandwidth for content itself but also low latency to prevent motion lag – if the delay between head-motion and the AR image is too great, the technology becomes unusable in the field. Similarly, closed-loop control applications require both a high density of sensors and high reliability (but rather low data rates). These two examples also neatly encapsulate the scope of the two basic types of industrial 5G communication:

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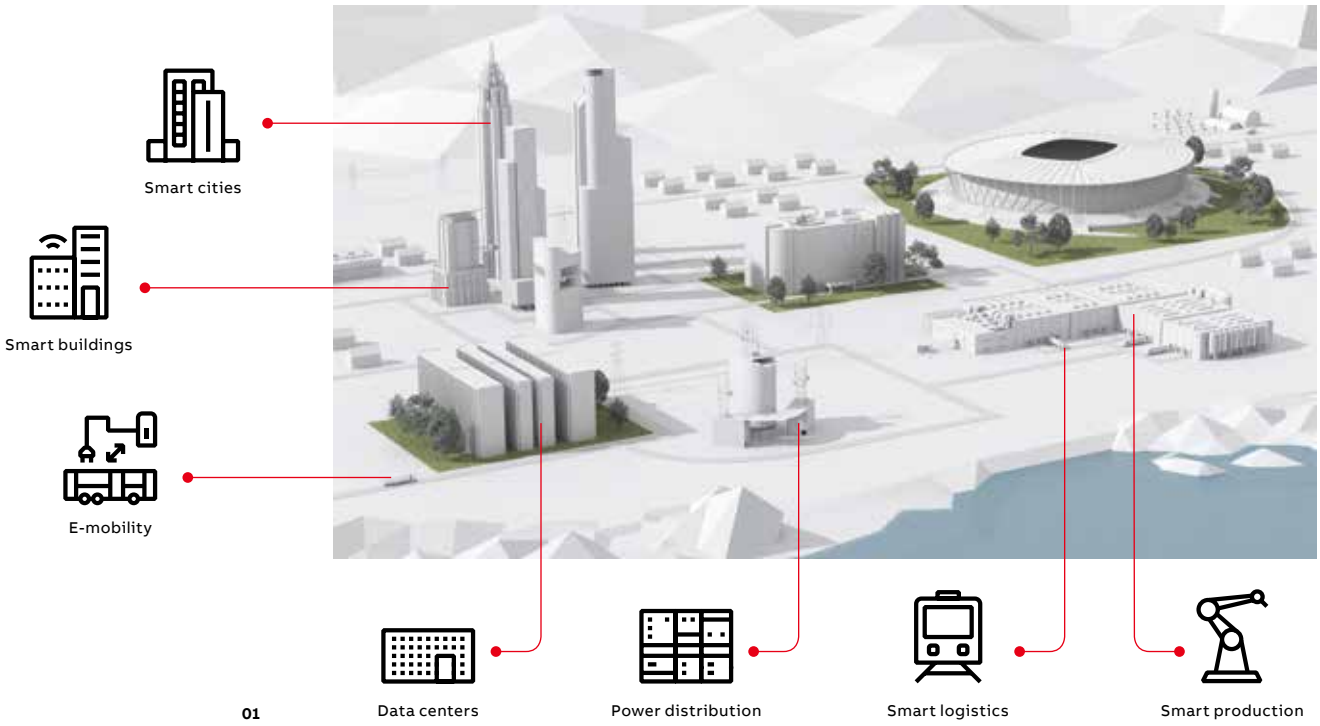

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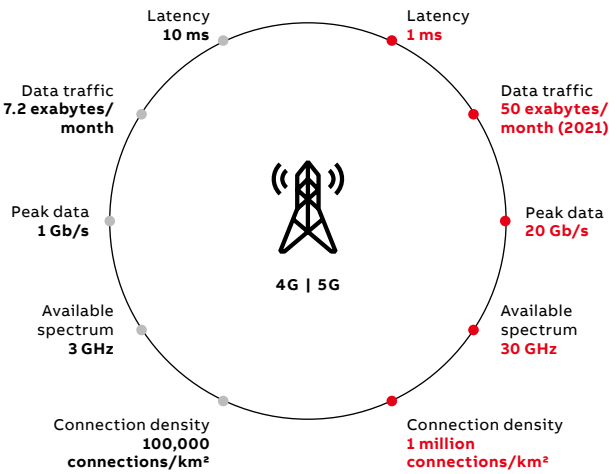

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Scalable, deterministic communication infrastructure

5G offers mechanisms for guaranteed delivery of data with bounded latency. While network resources are available, applications can easily be scaled because resource protection is built into the technology. Network performance, in turn, can be scaled by plugging in additional radio, fiber and computer resources where needed.

Network slicing

Network slicing enables multi-tenancy for networks. By subscribing to a network slice, time-critical applications can be run without having to invest in a dedicated infrastructure (eg, autonomous driving and autonomous plants could share a 5G network). Alternatively, a single private network can reliably segregate communications from office IT, process control, operations, hazard control, utilities and infrastructure, etc.

- Deterministic communication for the control of physical processes. This type of communication requires high reliability and low latency to close the loops of cyber-physical processes.
- Transactional communication to optimize and maintain the process and the process equipment. Here, a large number of diverse sensors may be connected.

Beyond the mere improvement of protocol performance described above, cellular ecosystems built on 5G technology offer a variety of features and innovations with benefits for automated industrial systems:

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01 Scope of connected verticals. 5G can address the needs of a converged digital ecosystem of verticals, from distributing power to automating smart cities.

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02 5G has a performance about ten times better than that of 4G.

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03 Key performance areas of 5G.
Communication latencies:
125 µs to the order of seconds.
Data rates:
kbps to gbps.
Coverage radius:
1 m to 1,000 km.
Device density:
1 to 1,000,000 devices/km².
Availability:
99 to 99.999 percent.

Universality
5G offers universally capable and configurable radio technology. Radio equipment can be configured to support a particular combination of determinism, bandwidth and number of network participants, depending on the available radio resources. No specialized radio technologies are needed anymore to cover the different types of automation applications, from motion control to process video.

Precision time synchronization
Besides low latency for control applications, wide-area precision time synchronization enables a wireless sequence of events (SoE) for critical processes where alarms and events from distributed equipment must be globally integrated into one chronological sequence.

Mobile edge computing
Signal processing and data analytics can be flexibly deployed as virtualized software functions in the proximity of the process, without having to burden (energy-constrained) sensors or process-critical equipment. This approach has several advantages: data can be fed back to the process with low latency (eg, to integrate product quality control) and no specialized computing equipment needs to be added on the premises. If a so-called private network is used, sensitive data does not even leave the corporate network, let alone be transferred to third-party data centers.

Low power and high density
5G offers low-power and low-data-rate protocol variants that exploit Narrow-Band IoT (NB-IoT) to support vastly increased device density (see mMTC). NB-IoT is a low-cost, low-power, wide-area radio network standard running on 200 kHz

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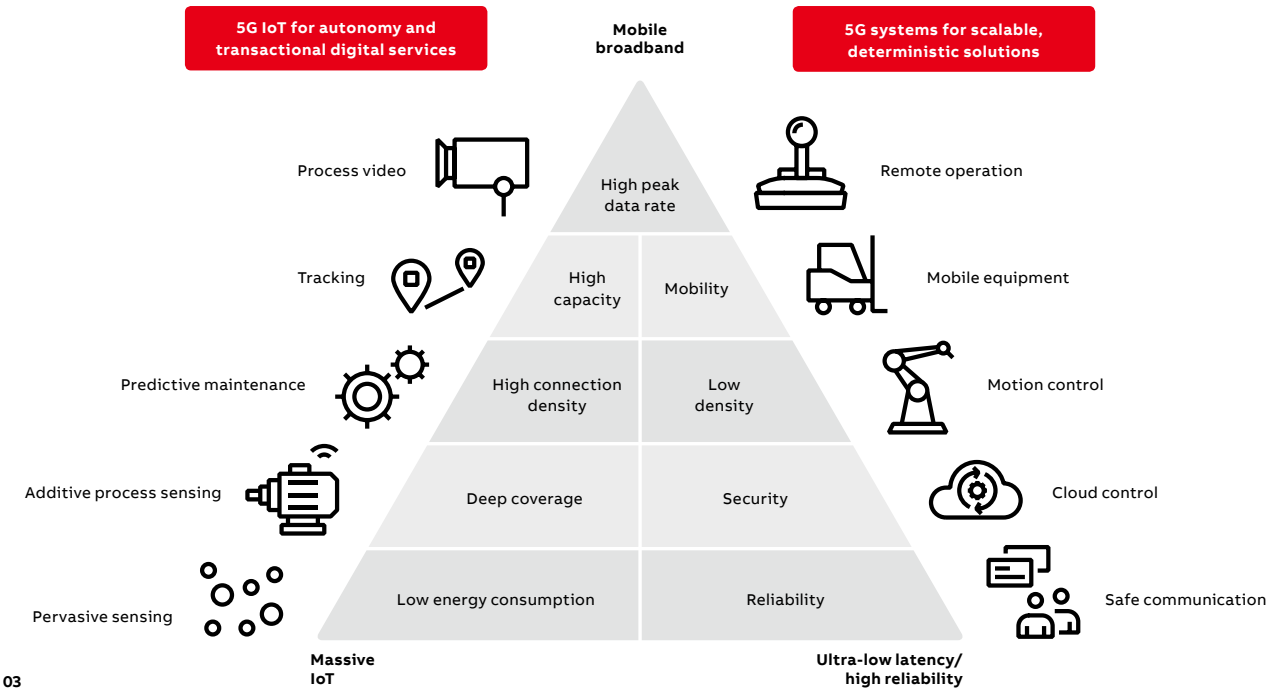
Added customer value is the main driver behind ABB's engagement in 5G.

that enables a wide range of cellular devices and services, focusing on indoor coverage, long battery life and high connection density. With transmission power in the mW range, NB-IoT allows the flexible location of even energy-autonomous sensors – without any regard for communication or power source, thus reducing both cost and installation time.

The value of 5G
As outlined above, 5G industrial applications can run concurrently over the same network infrastructure, contingent on the availability of adequate radio and network resources. These resources can be reconfigured in software to adapt to the changing mix of application needs in adaptive production systems.



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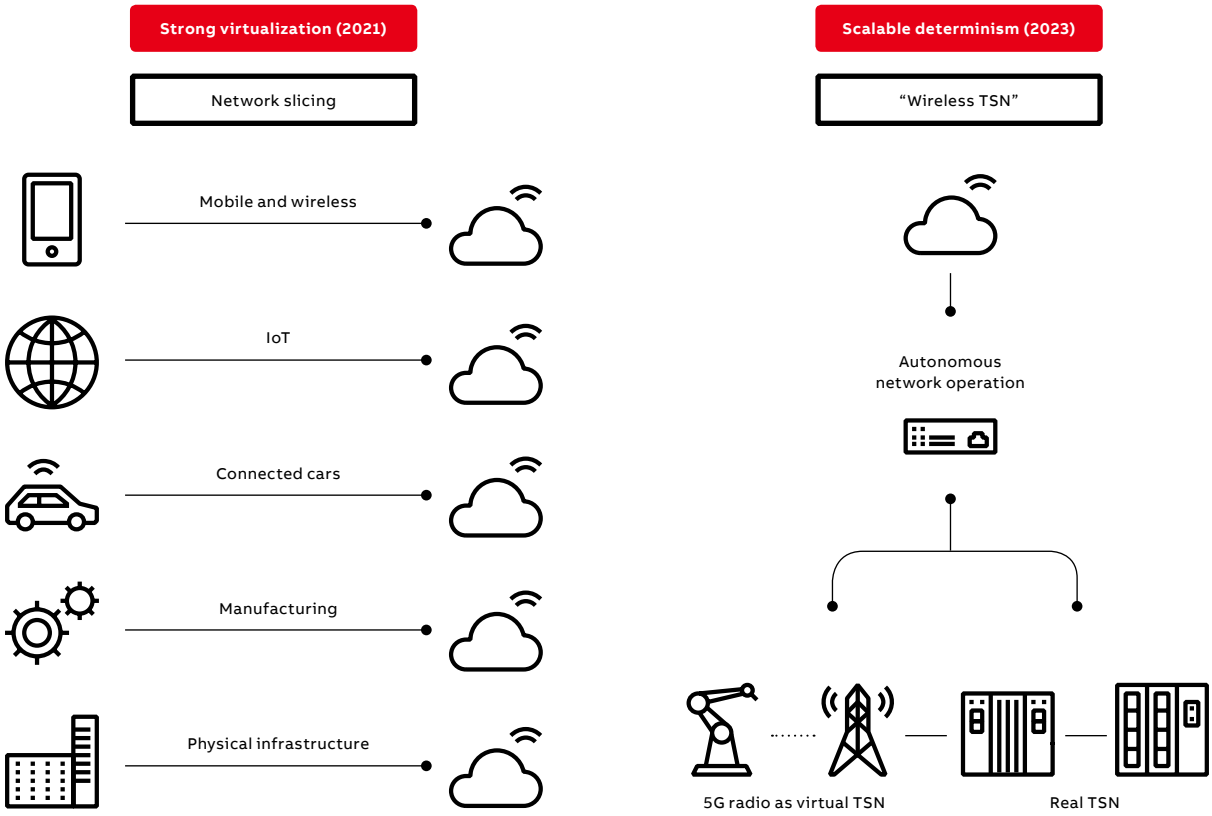

04 **Universal connectivity for production systems**

5G has the potential to provide universal connectivity for industrial systems.

Since network performance can be tailored in a very granular manner, incremental cost (by adding resources) adds incremental value (application-specific performance).

Beyond the technical innovations described above, added customer value is the main driver behind ABB's engagement in 5G. For example, for the first time, it may be feasible to offload the ownership and operation of a mission-critical automation infrastructure to an automation provider. Plant and factory owners can choose to rid themselves of the cost and effort of operating and maintaining DCS hardware but retain control of their fieldbuses, controllers and I/O devices. In this way, it becomes possible to keep or to transfer operational risk.

5G also helps to improve productivity. The ability to add and connect sensors without added infrastructure cost is a catalyst for increasing the digitalization level of physical production processes and infrastructures. Added data means added insight into processes and products that can be used by machine-learning algorithms to predict and prevent system downtime and quality issues.

Further key value propositions are:

- 5G will improve flexibility within production processes. Wireless communication, in general, allows for easier re-arrangement of machines, production modules, or material transport with AGVs. 5G specifically adds the reliability and determinism needed for such flexibility on an industrial scale.
- 5G fosters sustainability and is itself a sustainable technology. 5G infrastructure can be shared between different applications and industrial domains. And the sensors or cellular automation equipment invested in today are expected to last for many years.

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04 Key innovations of 5G and TSN.

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05 5G will have a major impact on many of the industries in which ABB is involved.

Together, 5G and IEEE time-sensitive networking (TSN) – a set of IEEE standards that provides deterministic networking at lower levels – set out to provide universal connectivity and computation for industrial systems and (large-scale) infrastructure. Automation functions in safety applications, closed-loop control, operations, data analytics, or machine learning will be able to negotiate the resources they require without having to consider communication protocols or deployment questions →04.

Making 5G a reality

5G is a complex yet versatile communication ecosystem that incorporates a range of different radio technologies, global wire-bound wide-area networks, powerful computers and a significant amount of intelligent software functions. 5G has

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the potential to provide universal connectivity for industrial systems →05. The availability of 5G over the coming years is shown in →06. With configurable communication performance, low-power radio option, collocated computation and availability through subscriptions, 5G surpasses existing communication technologies for industrial applications.

Today, ABB delivers telecommunications solutions in oil and gas environments and cellular technology is already a part of many ABB products. ABB also is among the first companies to leverage the NB-IoT cellular protocol to enable fleet management and telemetry applications for improved asset availability.

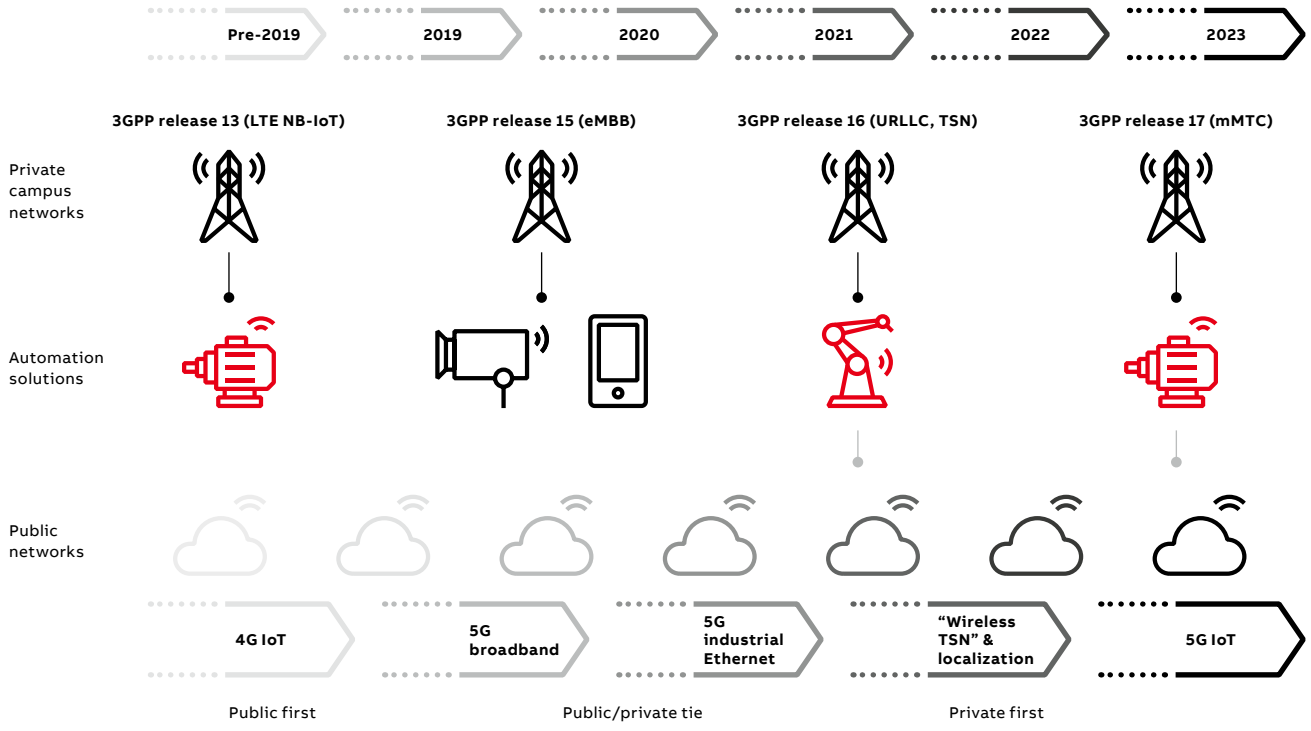
To exploit the digital opportunities ahead, ABB partners with world-leading companies in the information and communication technology industries such as IBM (AI), Microsoft (ABB Ability™ cloud), HPE (edge computing) and, recently, Ericsson (for 5G). Together, ABB and Ericsson are driving the standardization, regulation and technology development of 5G. Key objectives here are the availability of local spectrum and hardening of technology for industrial use cases. •

Together, ABB and Ericsson are driving the standardization, regulation and technology development of 5G.

06 When will 5G automation solutions be available? The 5G roadmap from the perspective of vertical industries.

Reference

[1] D. Schulz, "Buzzword demystifier: 5G," *ABB Review* 3/2020, pp. 78-79.



3GPP: 3rd Generation Partnership Project, an umbrella term for a number of standards organizations that develop protocols for mobile telecommunications.

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