# An introduction to 5G in the industrial domain

***Ashok Debnath**, Senior Consultant,*
*IoT, Data & Services Innovation, FORCE Technology (asde@force.dk)*

***Michele Colli**, Industrial IoT Specialist,*
*IoT, Data & Services Innovation, FORCE Technology (mic@force.dk)*

***Anders Struwe Mynster**, Head of Department - IoT Technology & Architecture,*
*IoT, Data & Services Innovation, FORCE Technology (apm@force.dk)*

Date of publication: July 2021

# Table of Contents

# 1. 5G: what and why

It is estimated that, by 2025, the total installed base of connected devices will constitute 55.7 billion units globally, 75% of them connected through the Internet of Things (IoT) (Afuang et al., 2020). Today, IoT devices are connected through diverse wireless technologies, either short-range – such as Wi-Fi, Bluetooth, ZigBee, and Z-wave – or long-range - including GSM, LTE and 5G.

5G is the fifth and latest generation of mobile technologies dedicated to wireless transmission of data, which started in the 1980s with 1G. 5G has been developed to address the exponential increase of connected devices and the related data traffic, both enabling new technology-driven opportunities and enhancing the current ones, on which businesses increasingly depend on.

5G promises an increase of wireless network coverage and a higher-than-ever data transmission rate - with speed anticipated to be 25 times faster than 4G - low-latency data transmission – below 10 ms within a 1000-1500 km transmission distance - a larger bandwidth - supporting 1 million of IoT devices per square km - and an ultra-reliable and more energy-efficient communication.

The major factors driving the growth of 5G in the industrial domain are related to (1) the growth in data traffic due to the exponential increase of the number of connected IoT devices within factories and across supply chains and (2) the increasing demand for ultra-reliable and low-latency networks for supporting human-to-machine and machine-to-machine communication and enable the latest technology applications built on top of IoT – such as collaborative robotics and AR/VR assistance tools. In addition to that, the COVID-19 pandemic underlined the importance of 5G for industry. The forced need for remote work highlighted the importance of fast and reliable connections and the limits of current mobile technologies when dealing with a large number of devices transmitting data at the same time across the globe – whether related to online meetings or remote controlling of production equipment.

The purpose of this whitepaper is to address the growing interest and the need for awareness around 5G from an industrial perspective. As 5G is currently in the process of being deployed worldwide, the intent is to provide a synthetic overview of its key characteristics, use categories and potential application cases in the industrial domain, to help future users in approaching the topic and in starting “cracking the nut”.

# 2. Key characteristics of 5G networks

There are several key features characterizing 5G network infrastructures and necessary for their successful roll-out. These are presented in the following.

**Network Slicing.** Network slicing enables a mobile network to be split into multiple “Service Based Architecture” virtual networks “slices” – independent from each other - to support different service requirements/purposes. Each network “slice” has specific infrastructural characteristics to address the specific service requirement/purpose. For instance, there might be a "slice" dedicated to self-driving cars or emergency communications, where a very high degree of reliability is required. There might also be a "slice" for remote reading of water and electricity meters which would require a lower degree of reliability.

**Network Neutrality**. A neutral internet does not discriminate traffic based on the content or of its origin. Within the European Union, there are specific rules about network neutrality to ensure that consumers have access to an “unbiased” internet. This implies that the provider of an internet connection must treat all traffic equally, and that consumers have an equal access to all the content transmitted through the network.

**Network Programmability.** All the network functions and the underlying infrastructure should be programmable to optimize the use of physical resources and to automate network maintenance and management. This will also help in automating deployment or dynamic configuration of network resources depending on traffic pattern and user demand.

**Network Function Virtualization.** Network Function Virtualization is a way to design networks that decouples network functions from the dedicated hardware by moving these functions to virtual machines. This significantly reduces both operating and capital expenses and enables faster scaling of the network as well as the introduction of new services without having to introduce additional hardware.

**Edge Computing.** Edge Computing (i.e. the local processing of data, performed on the device, before transmitting the data through a network) aims to reduce network latency and optimize resource usage by performing several data processing tasks – such as analytics – locally and minimizing the data to transmit through a mobile network.

**Network Capability Exposure.** 5G network supports Network Capability Exposure, which enables the applications to specify their custom requirements by invoking the Northbound Network API and using the Common API Framework. For example, an application providing AR/VR based banking services could ask the network to provide the following:

- 50 Mbps user experience bandwidth during the active service usage period
- 50ms latency during the active service usage period, best effort otherwise
- Edge Computing resources for dealing with 1000 concurrent AR/VR sessions (e.g. intelligent cache controller application requiring 4 virtual cores, 16 GB RAM and 1 TB storage)

The Network Service Orchestrator would decompose the requirements into specific Network Slicing, Network Functions and Virtualized Resources.

# 3. Use categories

The International Telecommunications Union has defined three key use categories for 5G technologies. These include ultra-reliable low latency communications (URLLC), enhanced mobile broadband (eMBB), and massive machine-type communications (mMTC) (Figure 1).

**Ultra-Reliable and Low Latency Communications (URLLC).** Ultra-Reliable and Low Latency Communications focus on critical missions and regard the application of 5G to transmit a large amount of data ensuring low latency and high reliability. Some examples of latency- and reliability-sensitive applications include factory automation, autonomous driving, remote surgery and money transfer.

**Enhanced Mobile Broadband (eMBB).** Enhanced Mobile Broadband focuses on system capacity and regards the application of 5G to handle large volumes of data ensuring a low data transmission latency over a large area. This is meant to guarantee optimal coverage in public spaces that are densely populated, such as stadiums during sport events. This can be useful in terms of business applications, facilitating the transmission of data at high speed in crowded (from humans and/or machines) environments.

**Massive Machine Type Communications (mMTC).** Massive Machine Type Communications focus on extreme density and regards the application of 5G to target the cost-efficient and robust connection of a large number of devices transmitting low volumes of data that does not require low latency, without overloading the network and ensuring a long battery life. mMTC create an opportunity for the scalability of IoT for consumers, businesses and public sector organizations.

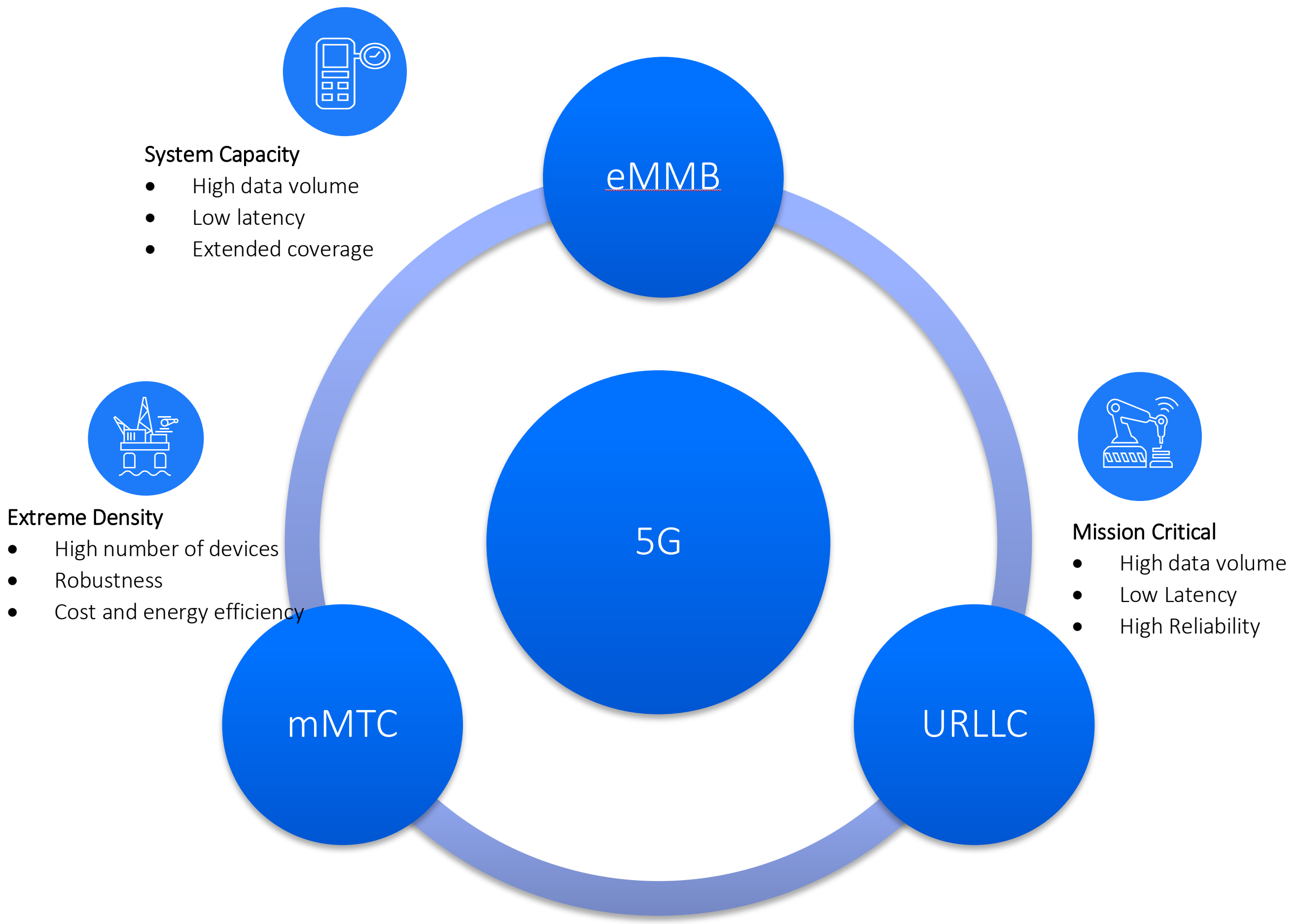


*Figure 1 – Use categories for 5G*

# 4. Core industrial applications

By increasing wireless data transmission capabilities – speed, volume, reliability – 5G promises to enhance several industrial processes and to enable new ones.

**Manufacturing.** As production equipment is becoming increasingly connected and dependent on each other performance and data inputs (e.g. machines along a production line), 5G enhances the performance as well as the safety of factory operations through its ability to handle a fast and reliable transmission of data from a high amount of devices – such as collaborative robots that interact with human operators. In addition to that, the capability to deal with a high number of connected devices, facilitates the introduction of modular production equipment, enhancing factories' flexibility. Nevertheless, the capability to process a large amount of data across long distances and with low latency enables new activities such as remote support and maintenance through assistance tools based on augmented or virtual reality (AR/VR).

**Logistics.** As logistics is moving towards autonomy, logistics assets (such as autonomous guided vehicles – AGVs – or drones) take advantage of advanced navigations systems that rely both on the communication between different and distant logistic assets – providing each other with movement information to, for instance, avoid collisions – and between each logistic asset and a data analytics platform – processing all the data collected by the asset's sensors and providing the asset with movement inputs accordingly. These navigation systems need to be able to process large quantities of data, coming from sensors or cameras, to analyze them to provide movement inputs within a very short amount of time. Because of that, 5G is crucial to create an autonomous logistics fleet.

**Healthcare.** 5G is enabling remote diagnosis supported by the use of audio, visual and haptics tools, which entails the transmission of a high volume of data over long distances and requires low latency. In addition to that, the combination of low latency data transmission over long distances and ultra-reliable communication enables the adoption of robots controlled remotely for performing surgeries. These application cases are two examples of how 5G is fostering the availability of very specific skills on-demand and all over the world in near real-time, a concept labelled as the "Internet of Skills".

# 5. Conclusions

As a mobile technology dedicated to wireless data transmission, 5G provides significant improvement potentials regarding lowering data transmission latency over long distances, improving reliability, data transmission volumes and quantity of devices that can be handled at the same time. This is promising both the enhancing of existing Industrial IoT applications as well as the enabling of new ones.

It is worth considering that there are several technical aspects when implementing 5G, which still have to be investigated. These aspects concern, for instance, the need for extra repeaters to support data transmission over an extended network range, while also maintaining consistent speed and reliability. This depends on the size of the area that needs to be covered, the location of the production sites and the type of building where the production is taking place, as well as on its data traffic and on the tasks that the 5G network has to support – whether Ultra-Reliable and Low Latency Communications, Enhanced Mobile Broadband or Massive Machine Type Communications. Based on them, the absolute cost of any 5G implementation varies.

There is another essential cost driver to be taken into account, dependent on whether the production site is a locally contained system or not. If so, this requires a “private network”, where each production site has its own base station, which can be accessible by company devices only. This is closely coupled to the decision of deploying either a private or public cloud solution for the IoT backend.

Another factor to be aware of when considering the implementation of 5G is the current lack of end-devices. Although they are becoming increasingly available, low-cost sensor devices and specialized 5G equipment are not yet a commodity due to the complexity – and related cost - of the 5G modems compared to other wireless IoT technologies, such as LoRa, Sigfox, Bluetooth or RFID.

In addition to that, regulations-related aspects still require improvements, as the process of obtaining a permit to install 5G technology and establish 5G networks is currently lengthy, e.g. months, and there are fees charged by local authorities if the 5G technologies need to be installed on public soil, e.g. to utilize street furniture such as utility poles.

Nevertheless, with its increased data transmission capabilities concerning low latency, ultra-reliability and high data (and devices) volumes, there is no doubt that 5G will have a central role in next years’ mobile communications.

As industry is increasingly dependent on them – since IoT is increasingly deployed for generating, collecting and taking advantage of data in production companies - it is paramount for industrial players to start building awareness in regard to 5G and its application potentials and needs within their organizations.

# References


Afuang, A., Rago, T., Mukherjee, A., Rojas, B., Ujhazy, U. (2020). IoT Growth Demands Rethink of Long-Term Storage Strategies, says IDC. IDC: The Premier Global Market Intelligence Company. https://www.idc.com/getdoc.jsp?containerId=prAP46737220

AT&T Business. (2021). How 5G will Impact the Transportation Industry. https://www.business.att.com/learn/tech-advice/how-5g-will-impact-the-transportation-industry.html

Burkacky, O., Kolesova, Z., & Lingemann, S. (2020). Smarter factories: How 5G can jump-start Industry 4.0. McKinsey & Company. https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/digital-blog/smarter-factories-how-5g-can-jump-start-industry-40

Clain, A. (2020). Characteristics of 5G Networks. Accesswire. https://www.accesswire.com/620426/On-the-Characteristics-of-5G-networks

Ericsson. (2021). 5G in Manufacturing & Industrial Automation. https://www.ericsson.com/en/reports-and-papers/5g-for-manufacturing

Finegold, E. (2020). Delivering on 5G and digital transformation. TM Forum Inform. https://inform.tmforum.org/insights/2018/07/delivering-5g-digital-transformation/

Mehra, A. (2021). 5G Industrial IOT Market worth $15.7 billion by 2026 - Exclusive Report by MarketsandMarkets. https://www.prnewswire.com/news-releases/5g-industrial-iot-market-worth-15-7-billion-by-2026--exclusive-report-by-marketsandmarkets-301226755.html

RCR Wireless News. (2020). New industrial IoT capabilities in 5G pave the way for Industry 4.0. https://www.rcrwireless.com/20200420/5g/new-industrial-iot-capabilities-in-5g-pave-the-way-for-industry-4-0

Research and Markets. (2020). Worldwide 5G in IoT Industry to 2025 - 5G and IoT Enabled Smart Machines Represent a $1.7 Billion Global Opportunity by 2025. https://www.globenewswire.com/news-release/2020/10/01/2101955/0/en/Worldwide-5G-in-IoT-Industry-to-2025-5G-and-IoT-Enabled-Smart-Machines-Represent-a-1-7-Billion-Global-Opportunity-by-2025.html

Surepelly, N. K.. (2020). Industrial 5G Will Transform Industrial IoT and the Connected World. ARC Advisory Group. https://www.arcweb.com/blog/industrial-5g-will-transform-industrial-iot-connected-world

Susak, T. (2019). Benefits of 5G can usher in a new era for Industrial IoT – and maybe new taxes, too. IIoT-World.Com. https://iiot-world.com/industrial-iot/connected-industry/benefits-of-5g-can-usher-in-a-new-era-for-industrial-iot-and-maybe-new-taxes-too/#:%7E:text=In%20particular%2C%20the%20industrial%20IoT,product%2C%20safety%2C%20and%20more

T-Mobile for Business. (2020). Unlocking Industry 4.0: Understanding IoT In The Age Of 5G. Forbes. https://www.forbes.com/sites/tmobile/2020/08/06/unlocking-industry-40-understanding-iot-in-the-age-of-5g/?sh=628b7a247f31