UNLOCKING INDUSTRY 4.0 WITH 5G

How 5G Technology Can Fuel True Factory Automation for Manufacturers

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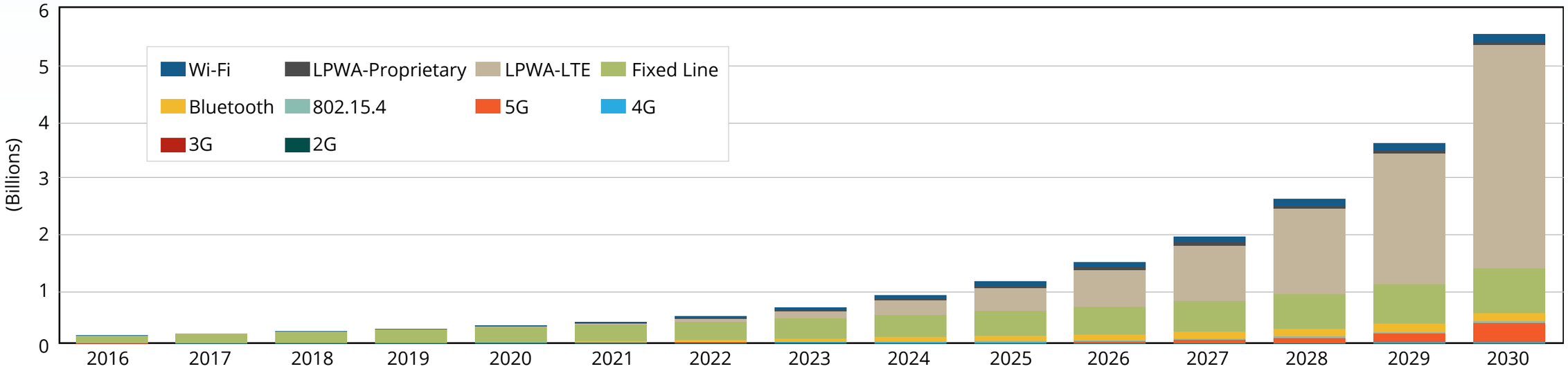
A CONNECTIVITY CONUNDRUM

Digitization and automation have rapidly and radically transformed the factory floor. The number of digital factory connections has exploded from 151 million in 2016 to a forecasted 5.5 billion in 2030.

Digital Factory Connections
World Markets, Forecast: 2016 to 2030

(Source: ABI Research)



Unfortunately, the connectivity technologies in use today prevent manufacturers from fully realizing the benefits of this evolution. The fragmented, often proprietary solutions also make it difficult to implement new concepts, including reconfigurable production lines, mobile robots, and autonomous Automated Guided Vehicles (AGVs).

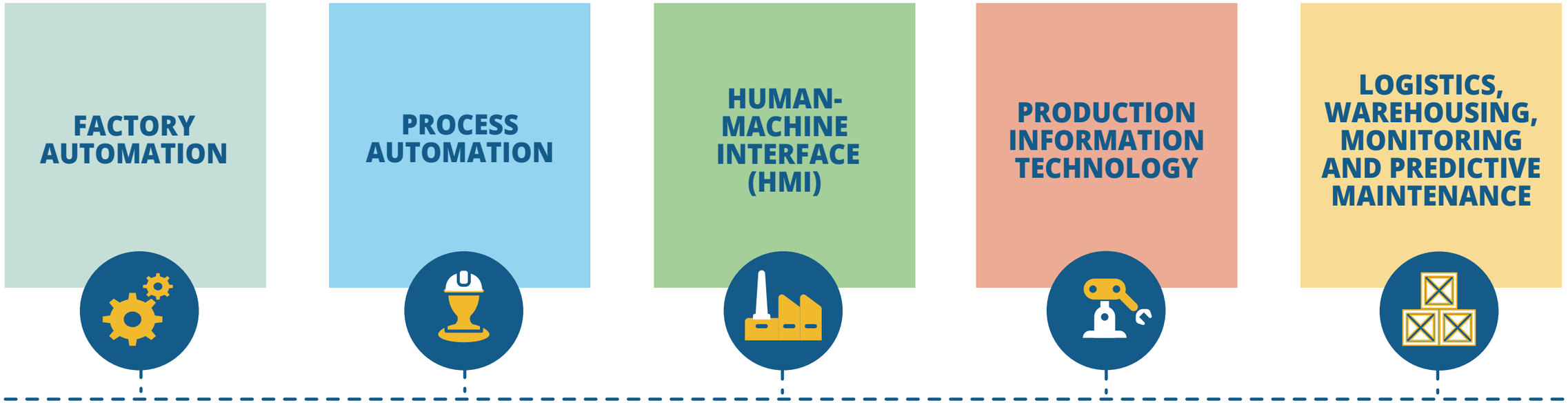
5G technology, which has mostly been used in the consumer space until this point, offers a solution to this challenge. That's why it is so important for manufacturers to understand the technology and to have a plan for adopting 5G within their factories.

THE FIVE ELEMENTS OF AUTOMATION

Enhancing connectivity on the factory floor is becoming increasingly important in the context of fast advancing digitization of manufacturing and increasing automation of production processes, promising factory owners increased efficiency due to a flexible factory layout, opportunities around automated quality control of finished products, and most importantly, predictive and preventative maintenance of production machines by using massive wireless sensor networks and Artificial Intelligence (AI) capabilities.

To unlock these benefits and efficiency enhancements, manufacturers need to adopt a holistic approach to factory automation. There are five distinct areas to consider:

1) **Factory automation:** The automated control, monitoring, and optimization of production processes within the factory
2) **Process automation:** The control of production and handling of different raw materials or substances)
3) **Human-Machine Interface (HMI):** How humans interact with machines throughout the factory
4) **Production Information Technology:** Technology used on the production floor, including mobile control panels
5) **Logistics, warehousing, monitoring and predictive maintenance:** How inventory and assets are physically stored, monitored and maintained



USE CASES AND REQUIREMENTS

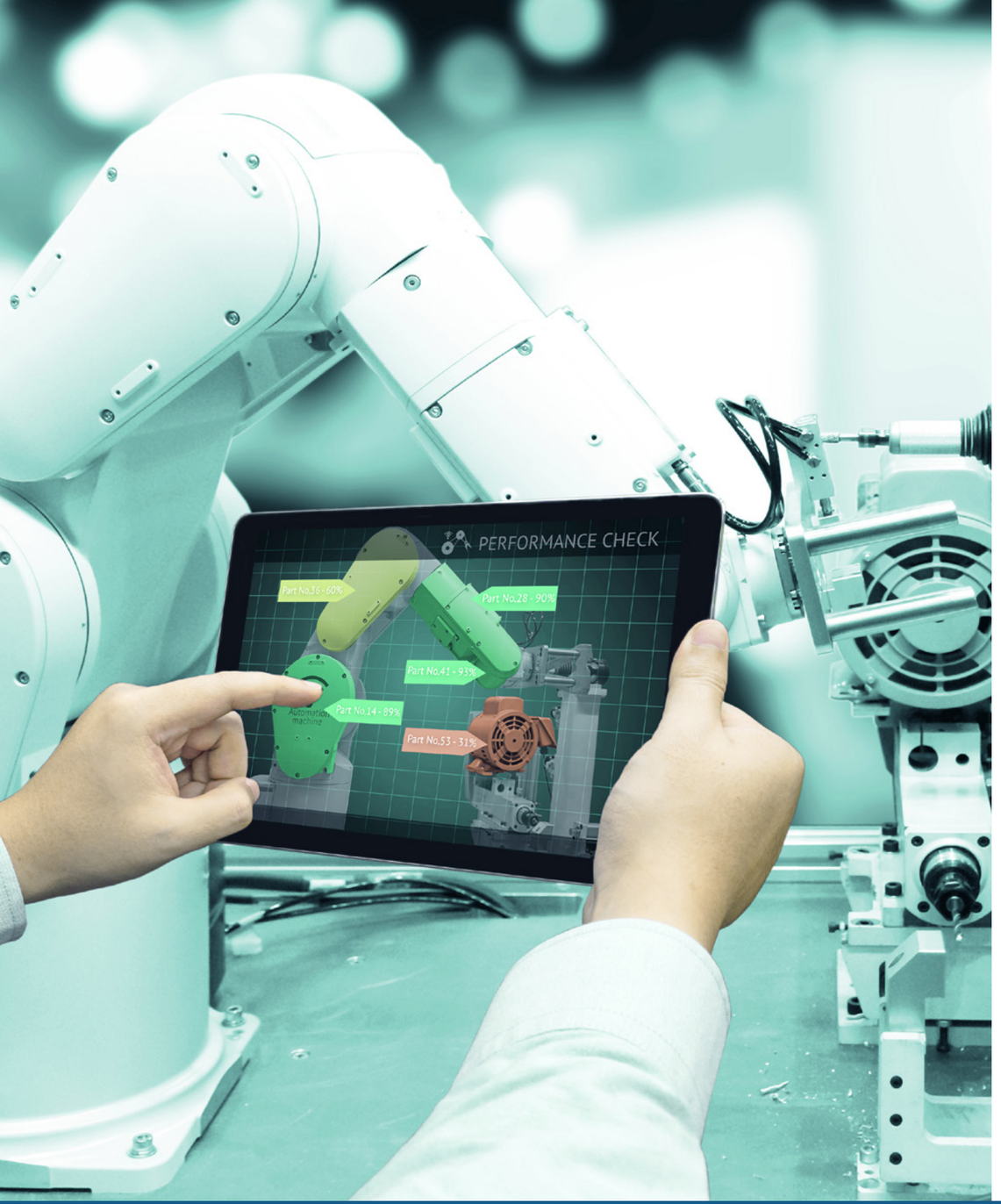
Even though private Long-Term Evolution (LTE) can support most of these use cases, a wholly automated factory would still require a multitude of different connectivity solutions, resulting in expensive infrastructure investment and a lack of interoperability in turn.

A 5G-based connection system would be able to support all of these use cases (see Table 1). More importantly, using network slicing capabilities, the network can dedicate different slices to different use cases depending on your specific requirements. As a result, different use cases can be addressed within the same physical network infrastructure, thereby minimizing the amount of Capital Expenditure (CAPEX) needed to achieve comprehensive connectivity.

Industrial 5G Use Cases Network Requirements

(Source: ZVEI)

Use Case		Availability	Cycle Time (Latency)	Typical Payload Size	Number of Devices
Motion Control	Printing Machine	>99.9999%	<2 ms	20 bytes	>100
	Tooling Machine	>99.9999%	<0.5 ms	50 bytes	~20
	Packaging Machine	>99.9999%	<1 ms	40 bytes	~50
Mobile Control Panels	Assembly Robots/ Milling Machines	>99.9999%	4–8 ms	40–250 bytes	4
	Mobile Cranes	>99.9999%	12 ms	40–250 bytes	2
Process Automation		>99.99%	>50 ms	Varies	10,000 devices per km^2



THE CURRENT CONNECTIVITY LANDSCAPE

Looking at the factory floor of today, wired connections are the predominant way of connecting different production machines and components as 86% of all connections on the factory floor are still currently fixed line. These wired connections are either analog lines (e.g., for Closed-Circuit Television [CCTV] using coaxial cables) or Ethernet connections for a variety of use cases.

A WEB OF PROPRIETARY TECHNOLOGIES

Until the 1980s, industrial automation was achieved by parallel wiring (where all devices were wired individually). An increasing degree of automation has resulted in a constantly growing number of connections, and this has led to more and more complex wiring systems and higher wiring expenditures. As a result, the fieldbus system created in the 1980s was developed to limit these expenses, offering clear advantages in terms of speed, reliability, uniformity, and flexibility when compared with parallel wiring.

However, the development of several competing proprietary protocols (INTERBUS, Profibus, or Modbus, to name a few) resulted in a more fragmented market and could not deliver on the expected uniform communication infrastructure. Similar to fieldbuses, several competing proprietary protocol standards have also been developed for its successor, Industrial Ethernet (e.g., Sercos III, PROFINET, or EtherCAT).

As a result, the current connectivity landscape in industrial manufacturing is a fragmented, often proprietary domain that, in many cases, restricts the application of new concepts and use cases.

Cellular networks have a lot to offer in this area, including standards-driven technologies, commoditized hardware, economies of scale for chipsets and devices, and the ability to choose from dozens of different vendors. However, the application of cellular connectivity is not a panacea; private networks, 4G, and 5G will be a powerful component in industrial manufacturing transformation.

WHY WIRELESS MATTERS

Even though wired connectivity still dominates, manufacturers are beginning to recognize the significant advantages offered by wireless connectivity, which include:

- **Cost Control:** With production processes becoming more and more complex, the number of components requiring a connection is constantly increasing. With costs around US$225 per cable drop, this also increases the overall costs of wiring a factory floor to serval hundred thousand dollars.
- **Less Maintenance:** Wired connections on constantly rotating machine components need to be replaced every 2 to 3 months, incurring additional deployment costs.

WLAN

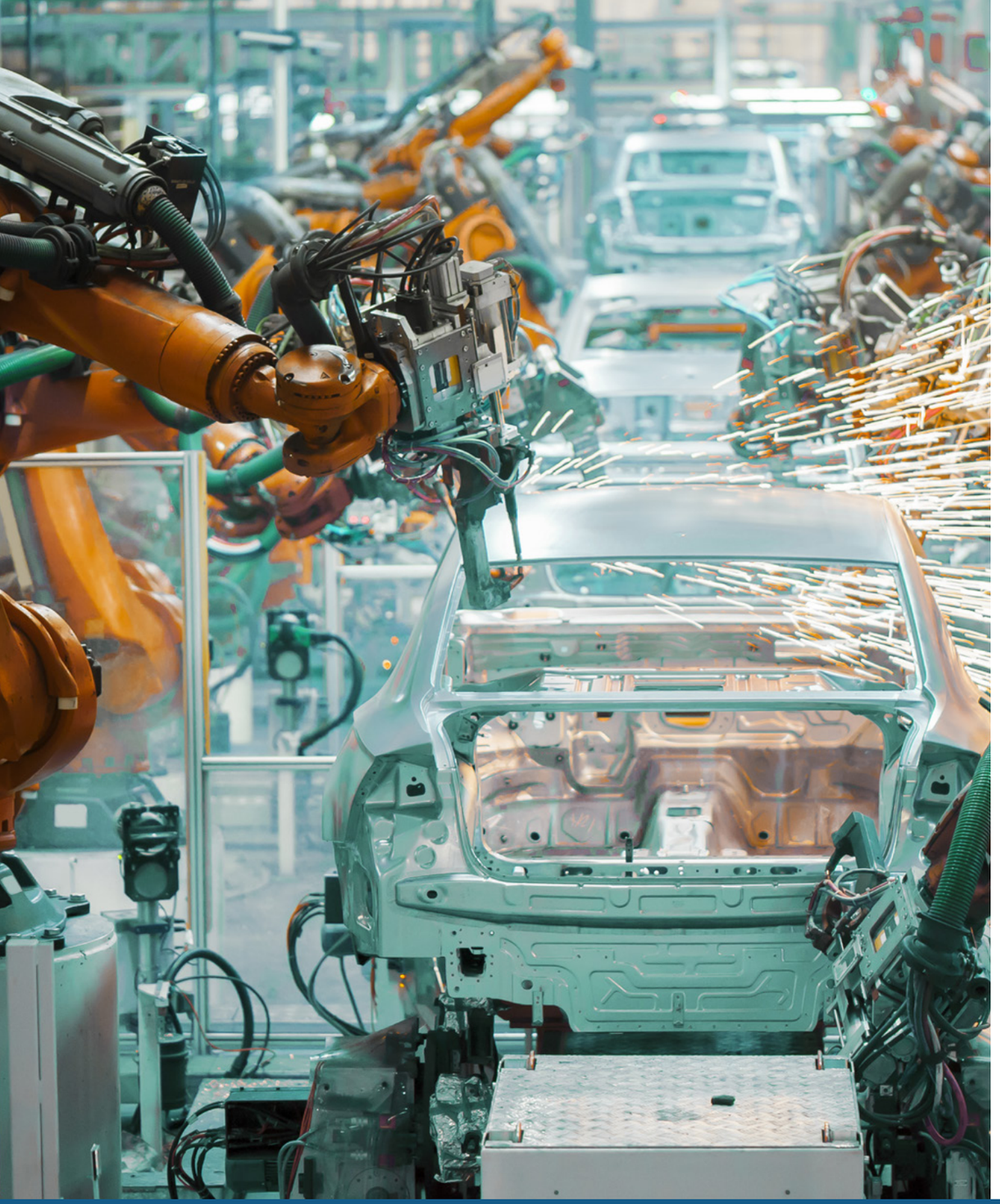
A Wireless Local Area Network (WLAN) provides one of the possibilities for wireless connectivity on the factory floor, based on the Institute of Electrical and Electronics Engineers (IEEE) 802.11 standard. Given its compatibility with wired Ethernet and the fact that Ethernet-based automation networks, such as PROFINET or MODBUS, are still significantly used on the factory floor these days, one of the clear advantages of using Wi-Fi is that it allows any of those Ethernet-based machines or devices to be configured wirelessly.

Cellular

Connecting machines, sensors, and other components *via* a cellular network (most prominently, private Long-Term Evolution (LTE)) has recently become a viable choice, as it offers distinct operational benefits to the factory operator in terms of cost efficiency and quality of service; LTE base stations can provide much more robust handovers than Wi-Fi, which is particularly important for harsh environments, which are often found in industrial applications.

LTE in Action in Industrial

An exemplary example of the power of wireless connectivity is cellular deployment in the Las Bambas copper mine in Peru. Mining operator Rio Tinto managed to replace 17 Wi-Fi Access Points (APs) with three private LTE base stations. While a single LTE base station is reported to cover up to 6 Kilometers (km) of tunnel, it would take 60 Wi-Fi APs for the same area of coverage. In addition, the price advantage of cellular connectivity over Wi-Fi also holds when considering the cost per base station (or Wi-Fi AP).



ADOPTION AND USE CASES IN INDUSTRY

As 5G benefits become more visible for enterprise verticals, the manufacturing community is expected to develop a growing number of initiatives to understand the magnitude and importance that these benefits will bring for manufacturers.

The German Mechanical Engineering Industry Association (VDMA), the largest industry association in Europe (representing the interest of more than 3,200 predominantly medium-sized manufacturing companies), founded the 5G User Group for Mechanical Engineering in May 2019. The group's mission is to give Small- or Medium-Sized Enterprises (SMEs) the opportunity to illustrate 5G-related operational benefits and formulate users' views of the topic in relation to technical aspects.

Further, the world's largest trade fair for all areas of industrial technology, Hannover Messe, introduced the 5G Arena Forum for the first time during the 2018 fair. The forum offered a dedicated exhibition to foster mutual exchange and dialog between network operators and infrastructure vendors on the one hand and manufacturers on the other.

Early Deployment: Mercedes-Benz's Factory 56

Mercedes-Benz is currently installing the world's first 5G network infrastructure for automotive production. Factory 56 (located in the southern German town of Sindelfingen, near Stuttgart) will combine a range of new production technologies—most prominently AI, Augmented Reality (AR), cloud vision, and Virtual Reality (VR)—on a factory floor larger than 22,000 square meters and is expected to commence operation in the beginning of 2020.

At the heart of this development is the introduction of so-called "TecLines" (driverless transport systems) that will be used in certain production zones to move different workstations to a statutory car instead of having to move the car along a predefined assembly line, increasing the flexibility of the production plant. The 5G network will be the key enabler for a massive wireless sensor network, allowing seamless communication among all machines and components.

THREE KEY RECOMMENDATIONS

The decision to deploy 5G on the factory floor should be the last step in the larger strategy toward factory and process automation. There are three key recommendations to consider before arriving at this stage.

- Before deploying 5G on the factory floor, manufacturers need to have a solid automation strategy as well as clearly conceivable and realistic use cases.
- Manufacturers should currently consider private cellular 4G as a best-of-breed connectivity technology and 5G as a foundation to create more advanced use cases on premises.
- Manufacturers need to have a solid understanding of their preferred deployment option as well as the implications of such an adoption. The heart of this decision should be considerations on whether manufacturers will require their data to stay on the implementer's premises at all times (requiring a completely isolated no-public network, which is more expensive to operate) or whether there is some flexibility, allowing for the deployment of public network with a dedicated network slice.

GET MORE INSIGHT INTO THE TECHNOLOGIES SHAPING INDUSTRY 4.0

No matter where you are in the digital transformation process, having access to the right information and the right advice is crucial.

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