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Technology in Industry Report

Is Your Factory 5G Ready?

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Current State of 5G

Industry 4.0 has proven that better connectivity leads to greater productivity, and 5G, the fifth generation of wireless technology, is the enabler that will truly transform global production systems. Since 1979, wireless telephone communication has evolved from the first generation of analog technology to the fifth. 5G wireless technology pledges to provide end-users faster data rates, higher connection density, lower latency levels, energy savings, and more. 5G has the potential to deliver transparent communication throughout a product's lifecycle across processes and assets between goods and services, production systems, logistics, and people. Despite 5G's revolutionizing promise, small and medium-sized manufacturers have yet to realize maximum levels of connectivity.

Today's Factories

Today's factories operate on a hierarchical network design model (cable and WiFi) that focuses on three functional areas: the access layer, distribution layer, and core layer. Each layer has its own goal and function. The core layer is the nerve center of the network with high-end switches and high-speed cables (often ethernet but can be legacy OT layer tech like Modbus or Profibus). The core is concerned with speed and reliable transformation of data across the network. See figure 1.

Access layer

Laptop | Computer | WEB, FTP, Email server | Repeater | Hub | Database server

Distribution layer

LAN Router | Bridge | VPN access router
Layer 3 switch | Filter (like firewall) | Brouter

Core layer

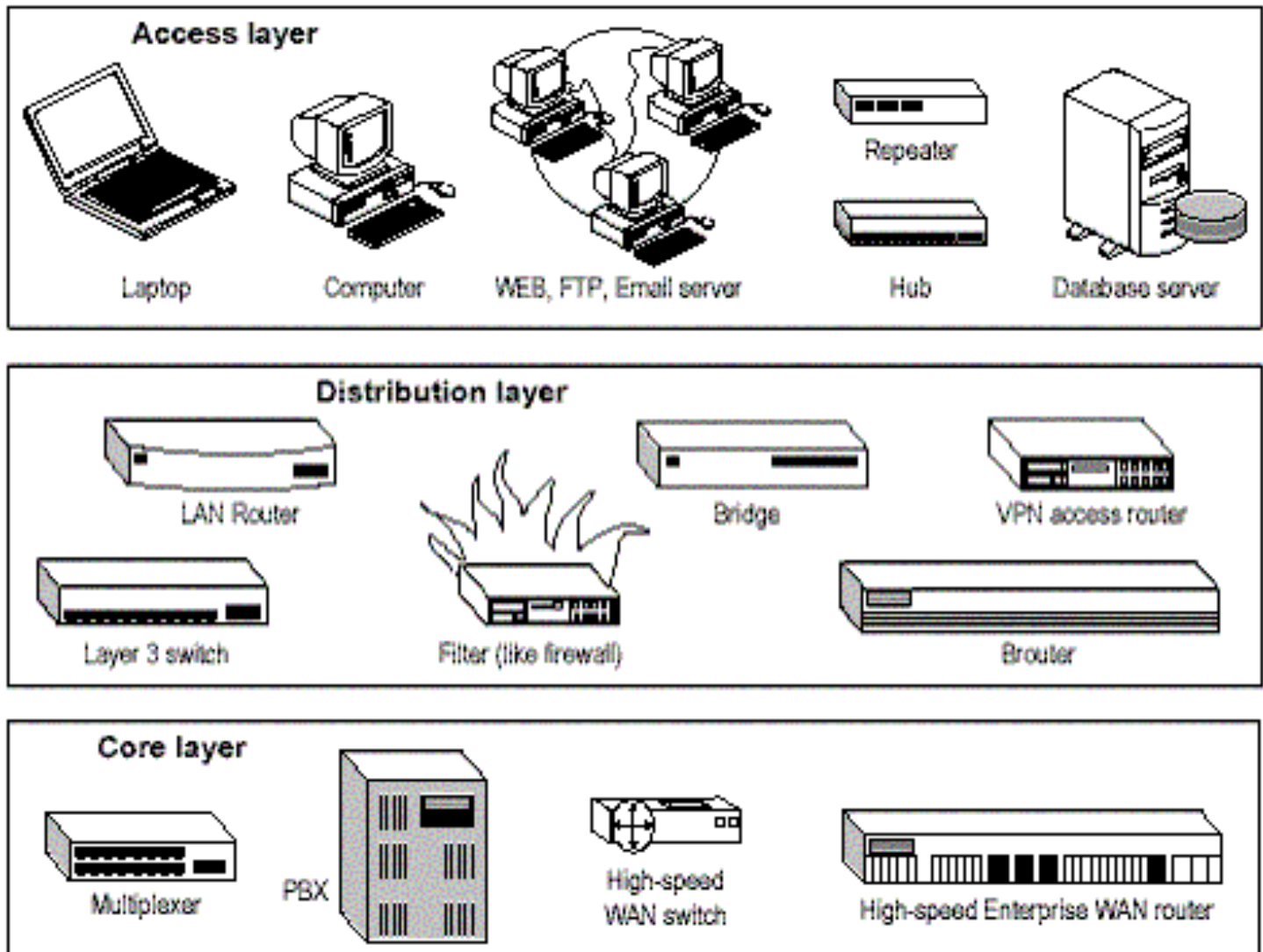Multiplexer | PBX | High-speed WAN switch | High-speed Enterprise WAN router

Figure 1: The Cisco three-layered Figure 1: The Cisco three-layered hierarchical model overview and related [1]

Cable (fiber and copper) wired technology and wireless communication are the most common communication networks used in factory automation. Cable has proven to be:

·   High Performance: Manufacturers can design high-performance networks where only specific layers are susceptible to congestion.

·   Efficient management & troubleshooting: Allows organizations to organize network management and isolate causes of network trouble efficiently.

·   Policy creation: Manufacturers can easily create policies and specify filters and rules.

·   Scalability: SMEs can grow the network quickly by dividing their network into functional areas or subnets.

·   Behavior prediction: When planning or managing a network, this model allows SMEs to determine what will happen to the grid when new stresses are placed on it [1].

Wireless communication—such as IEEE 802.11, ZigBee 802.15.4, Bluetooth, Low-power wide-area network (LPWAN), NB-IoT, LoRa, and Sigfox—are the most popular for SMEs because they offer lower cost, mobility transmission, reliable and controlled process systems, and are proven to improve worker productivity [2].

Battery life	Coverage	Speed
LoRa/ NB-IoT	NB-IoT	Wi-Fi
LoRa/ NB-IoT	Sigfox	Bluetooth
Sigfox	LoRa	ZigBee
ZigBee	Wi-Fi	NB-IoT
Bluetooth	ZigBee	LoRa
Wi-Fi	Bluetooth	Sigfox

Figure 2: Comparisson of various wireless technologies [2]

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Wireless technologies have apparent advantages and disadvantages. The advantage of using WiFi for SMEs is the higher speed of transmission and lower research and development needs. Equally, WiFi is disadvantaged by high power consumption, decreased security, and reduced propagation paths. WiFi, limited by its physical location, leads to a high degree of interference and poor diffraction; thus, in an industrial environment, WiFi can be unstable with limited coverage. Figure 2 shows the difference between standards used in wireless networking [2]. Wireless IoT solutions often have a battery powered end point device (e.g. some kind of stand-alone sensor, so batteries become something else to manage).

In preparation for Industry 4.0, SMEs will have to transition from an industrial automation pyramid to one that is fully connected. For connectivity, at the field level, a variety of Ethernet technologies are used. Ethernet and IP are well-established communication protocols at higher levels. Wired technologies separated by switches, routers, and gateways dominate the field level. For all factories, gateways are limited by a segregated design prohibiting information from flowing and being easily extracted.
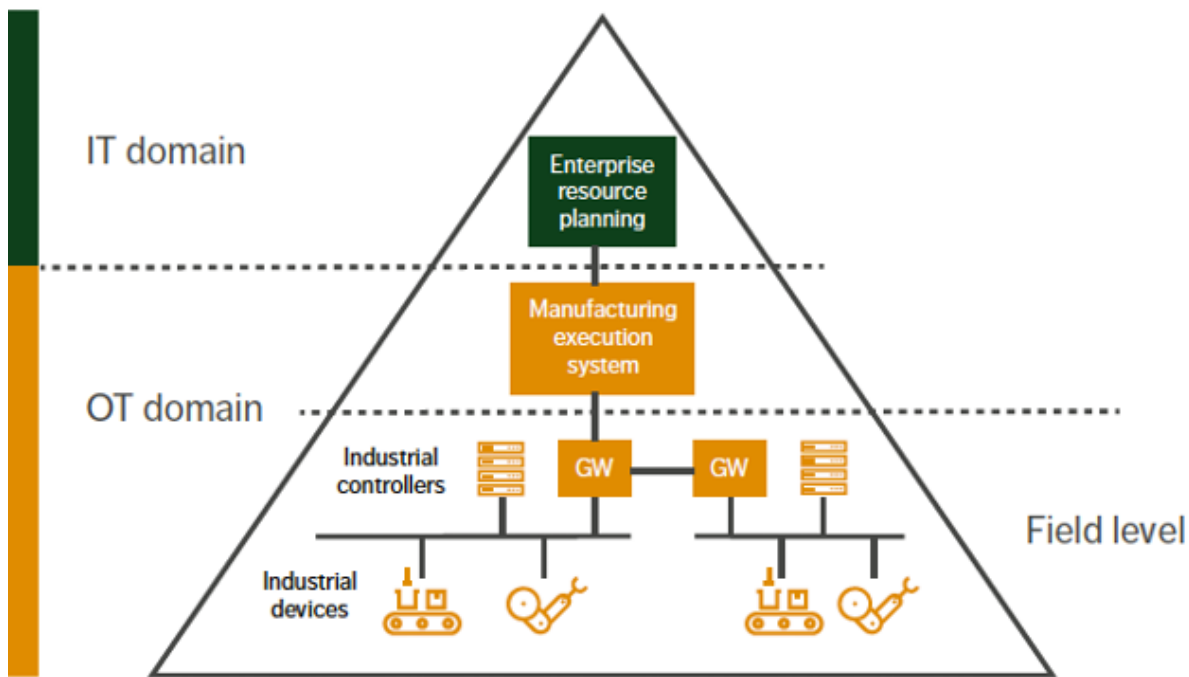
Figure 3: Industrial automation pyramid [3]

The Future of Connectivity

Ground-breaking in wireless communication, 5G proposes broadcasting extensive data, lowering latency, and reducing manufacturing and automation costs. 5G is a perfect tool for Industry 4.0, offering real-time wireless communication between humans and machines. "Everything that can benefit from being connected will be connected." [2] And 5G is already being used across the globe in many interesting ways, from smart factories and smart cities to autonomous vehicles, drone technology and immersive entertainment experiences. Because 5G networks are still being rolled out, many of these use cases are still in the testing phase.

In the manufacturing sector, 5G is poised to revolutionize communication between goods, production systems, logistics chains, people, and processes throughout a product's complete life cycle, spanning everything from design, ordering, manufacturing, delivery, and field maintenance to recycling and reuse [3].

5G is already transforming large manufacturers, enabling people, machines, and data to communicate. However, SMEs with limited resources for intangible spending in research and development, information technology, and human resources are not basking in the glory of 5G. 5G is an investment in innovation. While it can transform manufacturing and make factories more efficient and productive, 5G remains a risky proposition for many SMEs without a strong business case on how to use 5G as a means to connect data, Internet of Things (IoT) technologies, and equipment.

Challenges: Converting to 5G

Generally, SMEs don't have a great sense of 5G. Its capabilities because it isn't a natural part of their ecosystem. Most manufacturers have separate pieces of equipment that are stand-alone machines or devices and not easily connected. Data and IoT (a system of interrelated computing devices, mechanical and digital) are separate processes from SMEs' equipment. Thus, many SMEs don't have a sense of connectivity and what 5G could mean across the factory floor. Manufacturers utilize Programmable Logic Controllers (PLCs) and industrial digital computers to connect these machines by inputting logic. In this space, SMEs are beginning to think of ways to use connectivity, data, and information. However, the transference of PLCs has not risen to the integration of 5G. Only a small number of manufacturer SMEs are unaware of 5G and what digital technologies can do to help them be more competitive across the supply chain. Ready or not, Industry 4.0 and wireless 5G will force SMEs into the rehlm of smart manufacturing requiring higher levels of connectivity. The challenge for SMEs is not knowing what you don't know, which is how connectivity can improve a manufacturer's business proposition. Figure 4 illustrates where 5G has the most potential in manufacturing, according to technology research company Omdia's recent survey.

Where 5G Has the Greatest Potential	
Quality sensing and detecting	34%
Autonomous vehicles	32%
Virtual reality and augmented reality	31%
Factory synchronization	29%
Robotics/advanced robotics	25%
Asset intelligence/performance	25%
Plant consumption and energy management	22%
Smart warehouse solutions	21%
Smart connected products	18%
Digital twin and simulations	17%
Synchronized supply chain	13%
Additive manufacturing	13%

(Source: 2020 MAPI Next-Generation Connectivity Survey)

5G is not just speed; it's also bandwidth allowing more data to flow. Part of the challenge is technology availability. Commonly, telecommunication and internet providers are looking for the big wins from: large manufacturing companies that have funding readily available. Smaller and medium-sized companies with more technology needs require an introduction to technology that is affordable in order to start down that digital road. SMEs are perceived to be in the right spot for a wait-and-see approach to 5G. Let it mature and let the big companies work out the research design and go through the trails before the SMEs head down that path.

The short game for SMEs is to continue to focus on Ethernet. Ethernet is a wired standard. An adapter device would need to be added into the wired network to move the signal to wireless. Most factories are legacy plants. Ethernet is available, and the cost and security are well defined. Independent of size, security remains a crucial issue for all organizations. Cellular users trust the 5G connection because of their experience with cell phones. Concerns linger about the safety of large quantities of proprietary data. Is there a way for someone to hack into that cloud service and back door into my factory? Is my supply chain secure? Typically, SMEs don't employ a team of engineers to answer these questions, and resolve real-world issues in real-time.
It will be important for SMEs to have more access points or more towers because 5G doesn't travel as far. 5G uses millimeter

waves, which are a lot shorter than the wavelengths 4G uses. The shorter wavelength means 5G can carry a lot of data much faster than 4G, but it also means a much shorter range, so the infrastructure is a challenge even for large manufacturers owning the entire 5G structure [4]. For an SME, it could be a bit overwhelming without the expertise in-house, which places a heavy reliance on the telecommunication company. How much is it going to cost to make this change? It's new, and SMEs don't employ the experience to know how to do it. SMEs can rely on vendors but don't have the expertise internally to hold the telecoms accountable.

5G Opportunities

SMEs already down the path of connectivity are wired and can transfer data. The question for 5G is: is it going to make a step-change for your operation? Is there a business case to be made? A coming alternative is the next generation of WiFi. There hasn't been a lot out there that makes the business case. However, 5G offers factories not currently connected a chance to leap ahead. No wiring is an excellent place to start and potentially a time and cost saver. 5G, a consumer application, will give plant managers remote visibility on what's happening in the factory and share information faster.

Before investing in 5G, SMEs must question the value proposition for their organization switching to 5G or wired to wireless. Have a vision of what your company can do with it; cost and security. Despite a degree of uncertainty around overall cost, SMEs can make a business case for:

- Cost reduction
- New use cases for connectivity
- Greater use of space with a reconfiguration
- Remain competitive

In the end, it's still about improving the same things SMEs have been trying to improve; cost, throughput, quality, and safety.

For SMEs

Determine your organization's value proposition. Don't get hung up on the technical details, particularly if you are starting from scratch. Educate yourself and work with your team to determine how 5G will help you on the factory floor, connect with your supply chain, and engage with customers. Evaluate your process to determine where the bottlenecks are and what the solution could be and what technology might apply in that solution. SMEs shouldn't buy some extensive system and shoehorn it in. Start with something small and build your eventual transformation, and then expand. Somewhere down the line, add on.

Finally, the implications of 5G are vast; much is still unimagined and realized. Consult with an external provider to access your organization's need for 5G.

For Telecommunication Companies

Manufacturing industrial requirements for 5G go beyond the public cellular broadband. Large corporations have the infrastructure and expertise in-house to understand the cost-benefit of 5G fully. To attract SMEs to 5G, telecommunication providers must:

- Educate SMEs on how 5G wireless technology can integrate with existing Ethernet LAN and industrial nodes.
- Provide greater awareness and understanding around how 5G can connect various industrial devices with different service needs.
- Address how 5G can transform manufacturing facilities to Industry 4.0.
- Advise SMEs on data protection/security and data storage solutions in cloud-based systems.

Sources

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