McKinsey & Company

# The 5G era

New horizons for advanced electronics and industrial companies

# Contents

# Executive summary

The next generation of wireless connectivity, 5G, is becoming a ubiquitous topic but is still the subject of many myths and misconceptions. Although various use cases are emerging, only a few are compelling enough to generate strong demand in the short term. To help advanced electronics companies and industrials gain clarity about the best opportunities, we researched over 150 potential 5G use cases, focusing on the 5G Internet of Things (IoT) business-to-business (B2B) market, especially developments expected over the next few years. As part of our analysis, we reviewed the events that occurred during the introduction of 4G and other technologies, since that could provide clues about how the 5G market might evolve. We also interviewed industry experts to see how they viewed 5G's potential evolution.

## Many companies will derive great value from 5G IoT – but it will come in waves

— The first 5G IoT use cases to gain traction will be those related to enhanced mobile broadband (EMBB). Those for ultra-reliable, low-latency communication (URLLC) will follow shortly thereafter; use cases for massive machine-type communication (MMTC) will take several more years to gain ground.

— Businesses poised to benefit from the growth of 5G include mobile operators and net-work providers, component and module suppliers, machinery and industrial automation companies, as well as manufacturing companies.

## B2B opportunities abound, especially in Industry 4.0

— Within the B2B sector, the most relevant short-term opportunities for 5G IoT involve Industry 4.0—the digitization of manufacturing and other production processes. In this segment, 5G will provide clear performance benefits for several use cases.

— The Industry 4.0 segment will account for sales of about 22 million 5G IoT units in 2030, with most applications related to manufacturing.

— In other B2B segments, such as smart city, smart energy, and connected health, 5G IoT will be the technology of choice only for niche applications.

## The 5G module market is evolving

— At launch, 5G IoT modules will cost two to three times as much as 4G modules, but prices will steadily decline.

— In the B2B sphere, total revenue for 5G IoT modules will increase from about USD 180 million in 2022 to almost USD 10 billion by 2030.

— By 2030, 5G low-power, wide-area (LPWA) modules are expected to account for almost 30 percent of total B2B 5G IoT module revenues.

— In terms of use cases, almost all value will initially come from distinctive use cases where 5G IoT provides a clear performance benefit; few manufacturers will incorporate 5G into their devices simply to ensure future readiness.

— In 2030, 5G will be incorporated into devices primarily because it has become the industry standard; the use of 5G to enable distinctive use cases with clear performance benefits will be less common.

## It's time for 5G players to revamp their strategies

— Advanced electronics companies should initially focus on B2B use cases that are similar to those now being deployed in the business-to-consumer (B2C) sector; over the medium to long term, they should focus on developing chipsets and modules tailored to specific applications.

— Industrial automation players should first focus on B2B use cases in which they can take advantage of existing B2C components; they should initially focus on early movers in the B2B space.

— Over the medium to long term, industrial automation players should create a comprehensive portfolio of 5G IoT products.

— Manufacturing players that want to move ahead with 5G should create a long list of potential 5G use cases, prioritize the most distinctive ones, find partners to help develop solutions, and initiate rollout at lighthouse factories.

— Manufacturing companies should consider creating private networks to support their efforts, so they do not have to depend on telecommunications operators.

# Introduction

The next generation of wireless connectivity has arrived: 5G has the capacity to support a huge number of connections simultaneously while improving speed, latency, reliability, and power consumption for handsets and Internet of Things (IoT) devices. Spectrum auctions are almost complete, the first 5G-ready smartphones have hit the market, and network deployment has begun around the world. Currently, most 5G innovations involve the business-to-consumer (B2C) market, primarily because network operators are attempting to optimize operational costs and handset makers want to differentiate their products. More recently, however, many new opportunities have begun to open in the business-to-business (B2B) sphere.

As with the transition from 3G to 4G, advanced electronics companies and industrial players are still uncertain about the benefits of the new technology. Where is the value coming from, and who is going to capture it? What are the use cases where 5G performance enhancements will generate most value and demand? Which applications will most benefit from 5G? Many companies did not ask such questions when 4G emerged and only achieved subpar returns. The danger exists that this scenario could repeat with 5G.

To provide greater clarity on future value pools for advanced electronics companies and industrials, we investigated the 5G market through 2030, looking at over 150 potential B2B and B2C use cases, including their potential growth and technological requirements. We concentrated on 5G use cases related to IoT in the business sphere, rather than the more predictable market for consumer handsets, because companies are still uncertain about the B2B space—both the areas for greatest value capture and the timeline over which 5G IoT applications will gain traction within business. We also looked at the introduction of 4G and other technologies to understand how 5G might evolve and interviewed experts to understand market nuances.

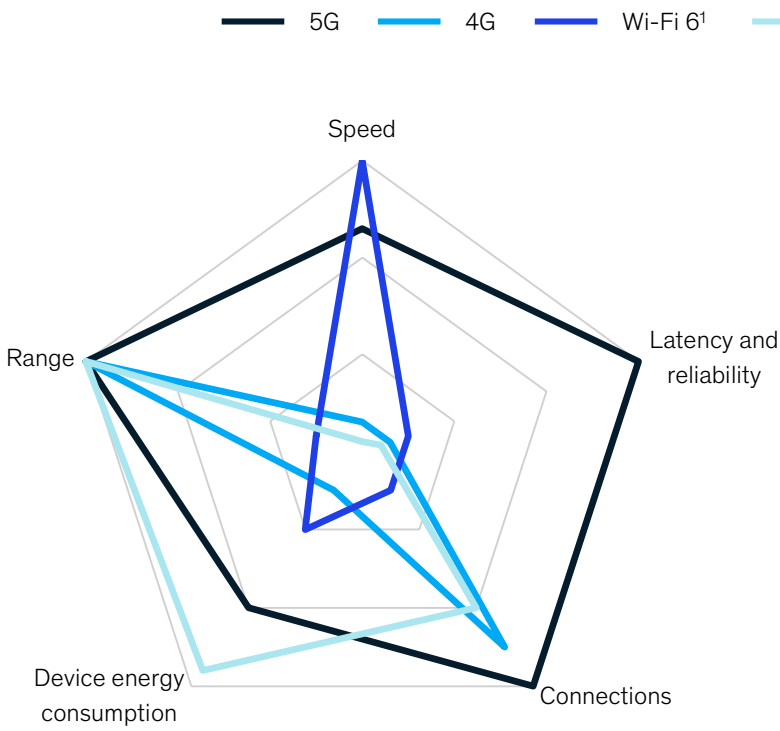
Our research allowed us to make projections about use case uptake, demand for modules and components, and other important developments. Notably, we uncovered numerous pockets of growth within the B2B sphere. Advanced electronics companies that provide 5G modules and components can use this information to optimize their product portfolios. Similarly, the insights will help industrial players determine how they can enhance their operations, products, and business models through 5G technology.

# 1 A comprehensive view of the 5G value proposition

Players are intrigued by 5G because it immensely improves speed, latency, reliability, and power consumption while supporting more device connections (Exhibit 1). Although 5G does not yet provide optimal results for all these dimensions simultaneously because of current technological and infrastructure limitations, it will eventually become the technology of choice for critical communications that require extreme reliability and service quality, including those within industrial settings.

Exhibit 1

## 5G offers many advantages over other wireless technologies




Speed: 100 times faster than LTE, with 1-10 Gb/s

Massive connections: 100-fold increase of supported devices to 1 mn devices/km$^2$

Latency and reliability: improvement from 20 ms to <1 ms with 99.999% reliability

Energy efficiency: power consumption reduced by 90%

Note: Not all performance dimensions can be maximized at the same time. There are trade-offs between speed, range, energy efficiency, and latency.

1 Wi-Fi 6 802.11ax.

Source: McKinsey analysis

## Archetypes of 5G IoT use cases

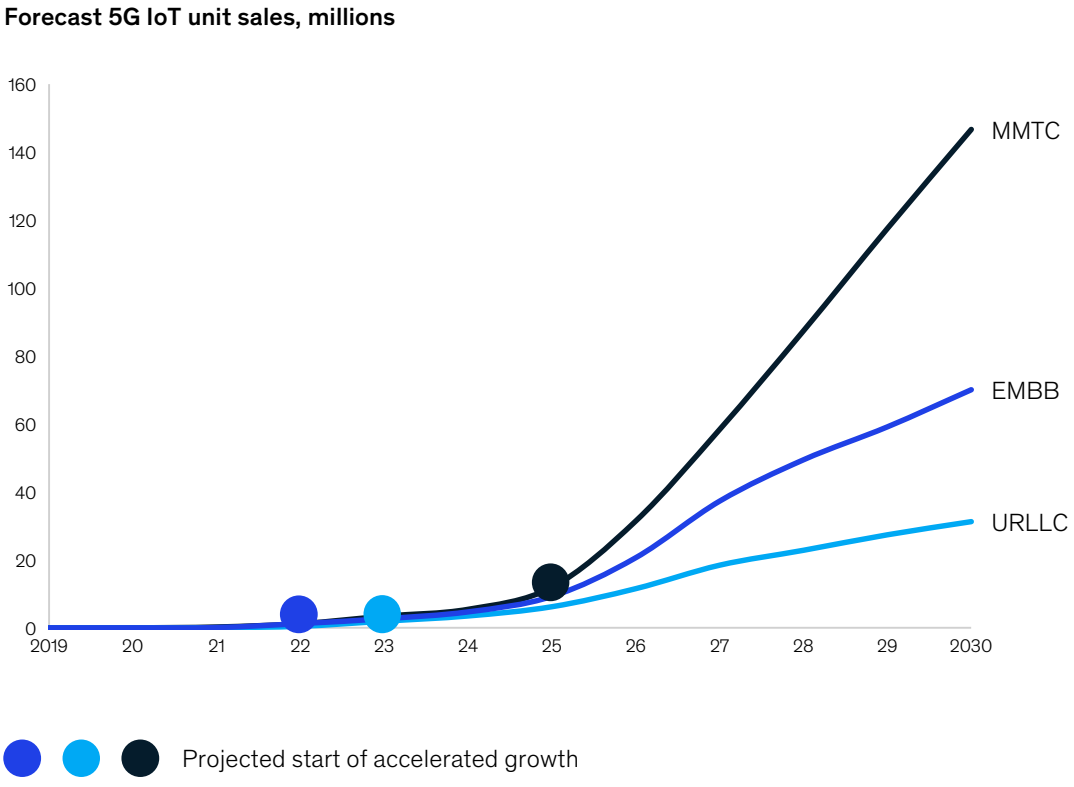
According to the 3rd Generation Partnership Project (3GPP), an organization that develops telecommunication standards, 5G primarily delivers value by enhancing three applications:

- Enhanced mobile broadband (EMBB), which provides faster data rates across wide coverage areas to improve various functions, including ultra-HD video streaming
- Ultra-reliable, low-latency communication (URLLC), which increase the speed and quality of service in critical functions, such as the control of robots and drones
- Massive machine-type communication (MMTC), which involves the automatic generation, transmission, and processing of data among numerous machines with little to no human intervention (for instance, to track goods along the supply chain).

The adoption of 5G will likely happen in waves in major markets, with EMBB reaching mass adoption first, URLLC gaining traction soon afterward, and MMTC trailing the pack (Exhibit 2). For each application profile, adoption will largely depend on the availability of appropriate 5G chipsets, the speed and coverage of 5G network deployments, as well as the evolution of regulations.

Exhibit 2

## 5G IoT growth will occur in waves, with EMBB applications gaining traction first




Source: McKinsey expert interviews and analysis

EMBB applications are growing quickly because chipset manufacturers have already created 5G chipsets that enable this technology in smartphones. Chipset players are also designing similar products for B2B use. On the infrastructure side, mobile operators are significantly investing in the 5G deployments essential for EMBB growth, currently focusing on large cities.

For URLLC to gain traction, both 5G networks and chipsets must advance technologically. First, chipset manufacturers must expand their focus from mass-market EMBB and create specialized products optimized for reliability and latency. The development and testing of these chipsets will likely require about three to four more years, making it unlikely that URLLC-enabled devices will be widely used before 2023.

Even as 5G grows, 4G will continue to exist and provide extensive coverage at lower cost. In consequence, MMTC applications that require low-power, wide-area (LPWA) coverage will continue to rely on 4G technology over the next few years. MMTC-enabled use cases using 5G networks will not gain traction until 5G coverage is available outside major cities—a development not expected until at least 2025.

Current 4G LPWA modules are expected to achieve 5G compatibility through software upgrades, since 5G standards include 4G specifications. But companies are also developing new 5G LPWA modules from scratch with additional features that distinguish them from modules upgraded from 4G, including lower device-level energy consumption and increased or more flexible data rates. In this article, we focus on newly developed 5G LPWA modules, rather than those upgraded from 4G.

## Companies poised to win

The growth of 5G will benefit many businesses – both users and suppliers of this technology or related infrastructure. For instance, operators and network providers will be able to enhance network performance, capacity, and customer experience. Within advanced electronics, our analysis suggests that three groups—component and module suppliers, machinery and industrial-automation players, as well as manufacturing players—are particularly well positioned to realize gains.

**Component and module suppliers**
Leading IoT module providers are also exploring how they can position specific products in the market. Both component and module providers are investing in R&D while simultaneously looking into chipsets for specialized applications. In addition to developing 5G modules, suppliers are pursuing many other innovations, such as modifications that decrease device size and strategies for integration with other modules.

**Machinery and industrial automation players**
These companies are investigating which products will benefit from 5G upgrades. This technology will also enable new autonomously operated and remotely managed products that will improve factory operations, such as automated guided vehicles (AGVs).

**Manufacturing players**
Research suggests that 5G will stimulate the next wave of industrial automation in manufacturing by enabling many innovations, such as vision quality checks involving cameras, computer vision, and machine learning. Many companies are determining how they can integrate this technology into their operations. Some are considering the creation of private 5G networks.

## Myth versus reality in 5G IoT value capture

Although 5G will clearly disrupt both the B2C and B2B markets, this technology is not a panacea. While industry insiders understand 5G's limits, some press reports have encouraged consumers to have unrealistic expectations. In our research and expert interviews, we took a hard look at facts to dispel the hype that has arisen from blurry marketing and wishful thinking.

**5G will not close white spots in 4G coverage**
The first 5G network deployments rely on 4G network infrastructure, which is now undergoing additional densification. Eventually, companies will build stand-alone 5G networks from scratch, with deployment expected to begin in major cities and metropolitan areas. As a second step, 5G deployments will occur along major transport routes, such as highways and railways. In general, 5G cells will be smaller than 4G ones and thus require more access points per area. In selected rural areas, 5G will make use of lower frequencies to increase its reach at a reduced data rate. Given this pattern, it will likely take several years for 5G coverage to reach rural areas with high bandwidth. The exact time frames will depend on local regulations.

**Over the short term, 5G is not always necessary**
At present, 5G is essential only for selected use cases. It provides the greatest performance enhancements—and thus most value—for data-heavy applications, use cases requiring ultralow latency, and environments with a massive number of connections. In other instances, existing alternatives, such as LoRa, Wi-Fi, ZigBee, and fixed connections, might be more suitable and economical. Over the short term, companies will capture full value only from 5G applications that require coverage in a restricted area, such as a production site. They will not capture full value from 5G applications that require coverage over a large area until 5G networks become widely available.

**5G is currently not required for autonomous driving**
Many consumers, and even some journalists, believe that 5G is essential for autonomous driving. But OEMs know that they cannot expect full 5G coverage on all roads, at least in the immediate future, so they are creating cars that have the sensors and computational power necessary to enable autonomous driving in offline mode. For vehicle-to-vehicle and vehicle-to-infrastructure communication, both of which are essential to autonomous driving, 4G connectivity or Wi-Fi protocols are currently sufficient. Likewise, 4G supports all current in-car IoT use cases, such as entertainment, navigation, and emergency response systems.

Eventually, OEMs will incorporate 5G modules into cars to enable future IoT use cases, such as onboard 4K video streaming and 3-D navigation. After 2030, Level 5 autonomous cars—those capable of self-driving—will use 5G as a communication technology because of its low latency, high reliability, and bandwidth.

**5G is not simply a technical upgrade from 4G**
5G will enable technical upgrades to tablets and smartphones. Beyond better HD video streaming and other high-bandwidth applications, consumers will not notice many performance differences. Within the industrial sector, however, 5G represents a massive leap forward. Although 5G networks will initially be built on 4G infrastructure, companies will eventually create a new and densified network infrastructure with different antennas, more and smaller cells, as well as higher computational power. In terms of performance, 5G will deliver a much greater degree of improvement than earlier advances in wireless technology, particularly in terms of speed, latency, and energy efficiency. With these features, 5G will enable better performance for existing use cases and open up entirely new ones.

# 2 Promising B2B 5G IoT use cases

Every new technology brings obvious advantages. What's less clear is where it can deliver business value—and that is the case with 5G IoT. To help companies direct their investments to the right areas, we analyzed over 150 potential B2B and B2C use cases that required either EMBB, URLLC, or MMTC. We also explored the rationale for applying 5G to a use case. In some instances—what we refer to as distinctive use cases—5G was a clear prerequisite or enabler of better performance. For other use cases, however, 5G would not boost performance and was incorporated into devices so that they will be ready when connectivity standards inevitably move to 5G.[1] Our decision to classify a use case as "distinctive" or "new standard" is based on interviews with external and McKinsey industry experts.

For B2B, our analysis primarily uncovered 5G use cases in the following industry segments:

— Industry 4.0, including autonomous systems in factories

— Smart cities, with applications such as HD cameras to monitor safety

— Smart energy, such as smart grid control

— Connected offices, including sensor-based building management

— Smart security, including provision of emergency services

— Connected health, such as mobile medical monitoring.

In these areas, we found more than 60 distinctive B2B use cases in which 5G will be the communication technology of choice. In addition, we found many new standard use cases where 5G will replace existing connectivity solutions to ensure future readiness. Although our analysis is accurate for this point in time, additional 5G use cases may emerge later.

Exhibit 3

## Companies will adopt 5G to enable new use cases or comply with future connectivity standards

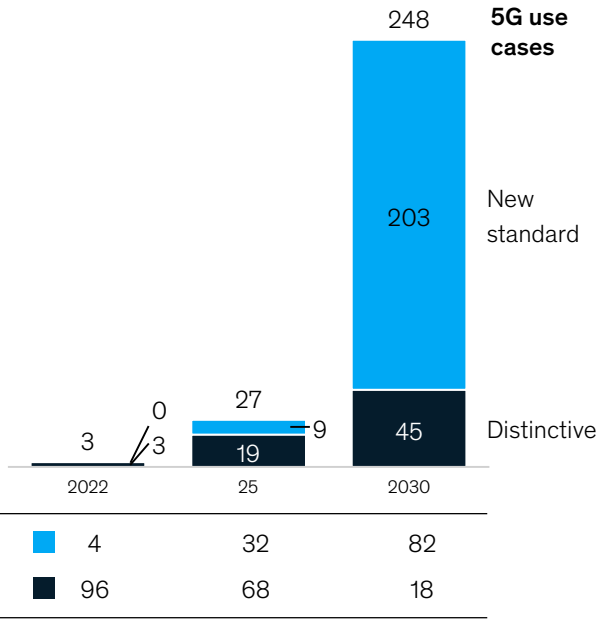
**Distinctive 5G use cases**

Use case requires 5G technology to achieve distinctive performance enhancements

**New standard 5G use cases**

Use case does not require 5G technology, but companies are motivated to switch to ensure future readiness and increase standardization

**Forecast B2B sales of 5G IoT units**
**M**illion units[1]




| | 2022 | 25 | 2030 |
|---|---|---|---|
| **Share** | | | |
| Percent | | | |
| 5G use cases | 4 | 32 | 82 |
| Distinctive | 96 | 68 | 18 |

1 Numbers do not sum because of rounding.

Source: McKinsev analysis

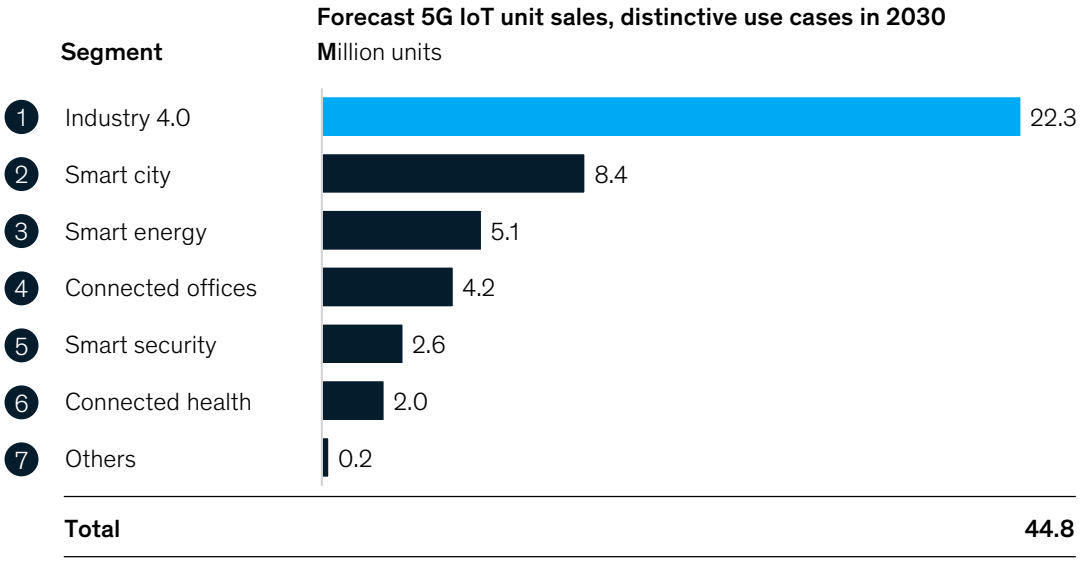
1 Our analysis included only connections using frequencies in the licensed spectrum.

As new use cases gain traction, B2B 5G IoT unit sales will soar. In 2025, more than 27 million units will be sold, with 68 percent for distinctive use cases and 32 percent for new standard use cases (Exhibit 3). By 2030, sales of B2B 5G IoT units will rise to about 250 million annually, but the source of demand will change. New standard use cases will account for about 82 percent of sales that year, with only 18 percent linked to distinctive use cases.

With these trends in mind, we then explored what distinctive use cases were most likely to account for 5G IoT sales in the B2B sphere. We focused on distinctive use cases, because they will drive 5G R&D and encourage companies to create supporting infrastructure. (We also explored distinctive consumer use cases, but those are beyond the scope of this document.) Of the 45 million units expected to be sold in 2030 for distinctive use cases, about half the demand—approximately 22 million units—will come from Industry 4.0 applications (Exhibit 4). In other B2B segments, 5G IoT will mostly be used for niche applications. The next section of this report provides a more detailed exploration of 5G IoT applications for Industry 4.0, focusing on distinctive use cases.

Exhibit 4

## For distinctive B2B use cases, almost half of all 5G IoT sales will be linked to Industry 4.0 applications




**Example use cases**

1. Autonomous systems in factories (e.g., robots, AGVs, computer vision, and automated or virtual reality tools (VR) for manufacturing)
2. HD cameras for public safety and traffic management
   Advanced sensors for environmental monitoring
3. Smart grid control
   Monitoring of microgeneration sites
4. Sensor-based building management
   Video surveillance inside and outside buildings
5. Border security
   Emergency services
6. Mobile medical monitoring
   Remote surgery
7. Smart retail (e.g., payments)

Source: McKinsey analysis

# 3 The 5G IoT value proposition for Industry 4.0

Within factories and plants, the current connectivity options have several major drawbacks that make it difficult to implement Industry 4.0 use cases. Wi-Fi networks often encounter interference, particularly in dense settings, and fixed connections are cumbersome and costly in large manufacturing environments. With the introduction of 5G, manufacturing companies will get a reliable alternative that enables the communication essential to many Industry 4.0 applications, such as the wireless control that is especially critical for mobile tools, machines, and robots.

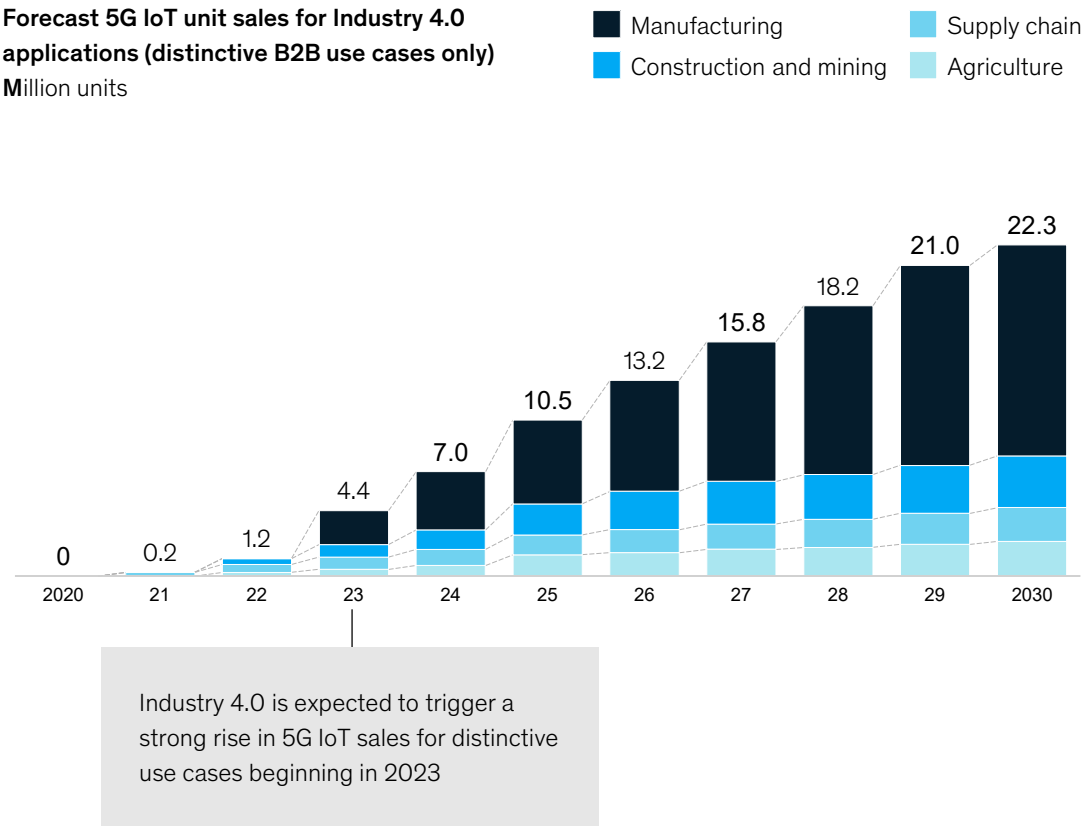
## Distinctive 5G IoT use cases in Industry 4.0

When looking only at distinctive use cases for Industry 4.0, we found that manufacturing will drive most demand for B2B 5G IoT units from 2021 through 2030. At that point, manufacturing will account for over half of all 5G sales for distinctive use cases (Exhibit 5). For all years from 2021 through 2030, 5G IoT demand will be more moderate for other distinctive use cases within Industry 4.0, including those related to construction and mining, supply chain, and agriculture.

Exhibit 5

### For distinctive use cases within Industry 4.0, most 5G IoT unit sales will relate to manufacturing

**Forecast 5G IoT unit sales for Industry 4.0 applications (distinctive B2B use cases only)**
**M**illion units




Source: McKinsey analysis

Based on our research, some of the most compelling distinctive use cases within industrial manufacturing relate to the following innovations and technologies.

**Automated guided vehicles (AGVs)**
At factories, AGVs now rely on sensors to assist with navigation and collision control. They typically operate in fixed paths or have only basic capabilities for optimizing routes. The next generation of AGVs will use advanced analytics and machine learning—the ability of computer systems to analyze information and "learn" from experience—to make decisions. These capabilities will allow AGVs to review data and make sophisticated navigation decisions—for instance, avoiding areas that are congested with other vehicles – provided that they have 5G networks to enable high-speed wireless connectivity, low latency, and reliable communication. In addition, 5G will help next-generation AGVs to run control software and process data in the edge cloud, providing them with immense computing power at a lower cost than onboard processing.

**3-D bin picking**
At most factories, machines pick parts from bins by taking items from a fixed location. With 5G IoT, robots will be able to use sophisticated vision systems to locate parts, regardless of their location. Some companies are already moving ahead with these innovations. Pickit, for example, has created robots equipped with HD cameras that can use computer vision to locate parts. Since 5G enhances computing power beyond device capacity, data analysis can occur in the edge cloud. The robots themselves require minimal processing power.

**Real-time process control**
Companies can capture significant value by using advanced analytics applications to optimize and adjust process parameters in real time. With its wireless, reliable, and low-latency communication, 5G enables this capability. Rather than building a production plant, companies can retrofit old machines with 5G modules and conduct sensor-driven analyses. The upgrade to 5G is particularly important in process industries, since most member companies typically have aging equipment and complex, costly fixed networks that extend across large sites.

**Augmented reality (AR)**
Workers can use AR glasses that display instructions in their visual field to guide the workflow in various tasks, such as quality inspections. Here, 5G is an enabler, since AR glasses must process data in real time to provide a seamless and responsive experience. Low-latency and high-speed communication will allow AR data processing to occur within the edge cloud, which decreases costs and increases energy efficiency.

**Vision quality checks**
Artificial intelligence (AI) enables significant performance improvements in vision quality systems. Thanks to its low latency and high reliability, 5G will improve such remote and real-time analytics by allowing vision quality systems to spot deviations in a unit quickly. Furthermore, 5G may decrease training and deployment time. While development of traditional machine vision models is complex and requires several months, AI algorithms can be trained and deployed within weeks.

## Private-network opportunities

With the advent of 5G, industrial companies are becoming more interested in private networks, because they satisfy their stringent data security requirements while simultaneously providing great reliability, performance, and coverage. Such networks have existed for years, but they are common only at public-safety organizations.

Regulators in several countries are facilitating the creation of private 5G networks for industrial companies by allocating spectrum for their use. In these locations, large industrials will probably be the first to set up private 5G networks, beginning around 2020. Mid-size companies and other industrials are not expected to follow until 2023 or 2024. There are four potential 5G private-network models that B2B players can follow.

**Independent networks**

As the name suggests, all elements of independent networks are fully private and no components are shared. This archetype may be best for companies with highly specialized needs and large-scale operations. Some industrials, including the automotive manufacturers Bosch, Daimler, and VW, have already started testing independent networks with support from network equipment providers.

Companies can build and maintain independent networks themselves or receive assistance from telcos, network equipment providers, or other third parties. Costs vary significantly, depending on the size of the site and a company's specific needs (for instance, the number of device connections and requirements for latency, speed, and reliability). Consider a shop floor of 2,000 square meters with high latency and reliability requirements coupled with a need for very dense network coverage. For this location, infrastructure could cost up to USD 700,000.

**Shared networks**

Different companies at the same geographic location may share the radio access network (both antennas and base stations) while the core and application layers remain private. A third party will typically manage this shared network. This approach may be advantageous when multiple companies occupy the same location, such as at shipping terminals or industrial campuses.

**Mobile virtual network operator (MVNO) networks**

MVNOs do not use a physical infrastructure. Instead, they use a virtual layer provided by a mobile operator to enable the network.

**Network slicing**

In this model, a mobile operator provides a virtual private network on top of its physical network infrastructure to fulfill a company's specific requirements. It is easily deployable and relatively inexpensive because network elements are shared. Thus, it is most appropriate for small-scale manufacturing sites that are covered by a commercial network.

# 4 Opportunities for advanced electronics companies and industrials

With demand for 5G IoT growing, we wanted to understand the market from the perspective of module and component suppliers. We therefore studied product demand, price trends, revenue pools, and the best use cases.

## The 5G IoT module market

We expect IoT players to offer three types of 5G modules for B2B use cases:

- *Standard modules.* Used for classic 5G scenarios that require EMBB, such as ultra-HD video streaming.
- *Special-purpose modules.* Designed for specific use cases that require URLLC, such as autonomous systems and mission-critical control. Their price may be high, since they often must be designed for use in extreme temperatures or rugged conditions. Special-purpose modules also require additional R&D and are sold in lower quantities.
- *5G LPWA modules.* Used for long-distance communication, such as transmissions from sensors with low data rates. They will have an evolving and strong role in the growth of 5G IoT, since they help enable some MMTC applications.

Companies will create standard and special-purpose 5G modules by upgrading existing 4G modules. Existing 4G LPWA modules can be made 5G compatible through software upgrades, but some companies are creating new versions from scratch to increase energy efficiency and provide higher data rates. As noted earlier, our analysis of 5G LPWA modules focuses on modules created from scratch.

### Price evolution

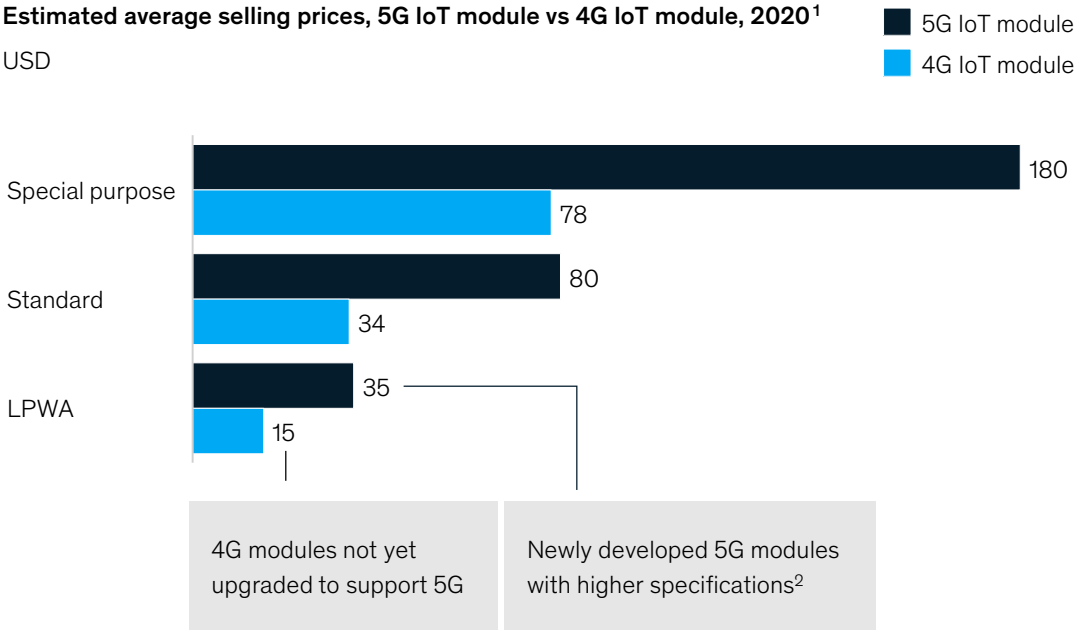
We expect 5G modules to cost two to three times as much as 4G modules at launch. In 2020, the average selling price will be approximately USD 35 for 5G LPWA modules, USD 80 for standard modules, and USD 180 for special-purpose modules in our base case (Exhibit 6). We created our estimates based on baseband prices for the first 5G smartphones and current prices for 4G technology. The predicted price increase from 4G to 5G is in line with premiums seen with previous technology advancements. For example, 4G was about 200 percent more expensive than 3G in its first year of launch, while 3G HSPA+ was about 330 percent more expensive than 2G edge premium.

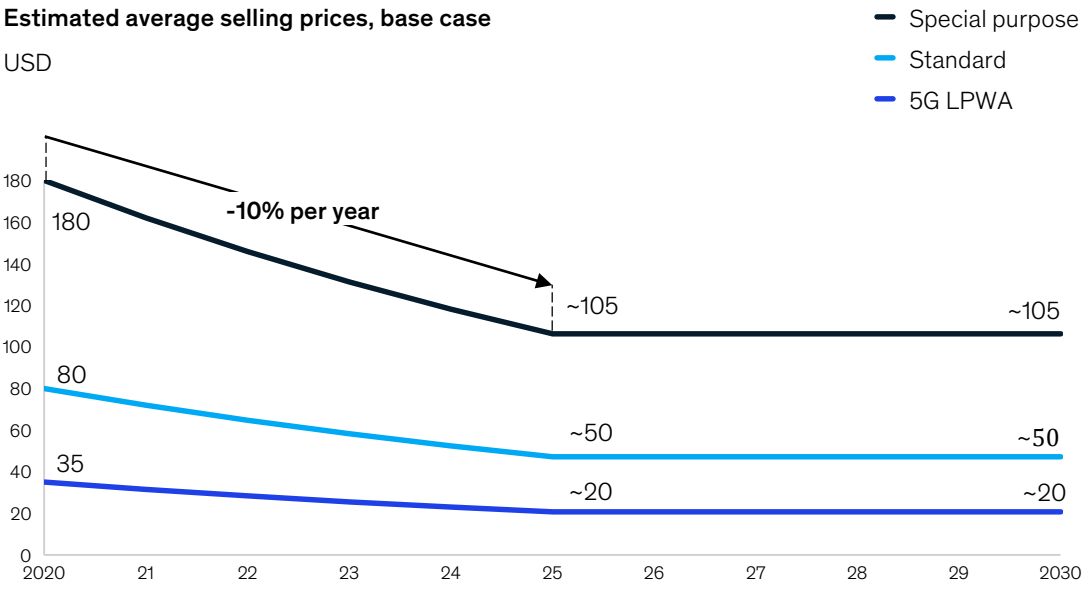
As with previous technologic advances, we expect the average selling price of 5G modules to decline steadily. In our base case, we predicted that values will fall by 10 percent per year through 2025.[2] After 2025, prices should stabilize, because new add-on features will offset decreases in the average selling price. If this occurs, prices will be about USD 20 for 5G LPWA modules, USD 50 for standard modules, and USD 105 for special-purpose modules in 2030.

[2] It is also possible that declines will be greater than 10 percent annually; we created alternative scenarios that showed declines of up to 20 percent.

Exhibit 6

## The average selling price for 5G IoT modules will decline and then stabilize, in line with historic price evolutions




1 Estimates based on 4G/5G handset baseband prices (Q2 2019) and expert judgment for 4G/5G IoT baseband prices and total module cost split.

2 We focus on newly developed 5G LPWA modules, rather than those created by upgrading software in 4G modules. The newly developed modules have lower energy consumption and higher data rates than those created by upgrading 4G modules.

Source: McKinsey analysis

### Revenue trends

In the B2B sphere, we expect total revenue for 5G IoT modules to increase from about USD 180 million in 2022 to almost USD 10 billion by 2030 (Exhibit 7). During the first years of 5G, standard modules will be more popular than special-purpose and 5G LPWA modules and thus will generate the highest revenues.

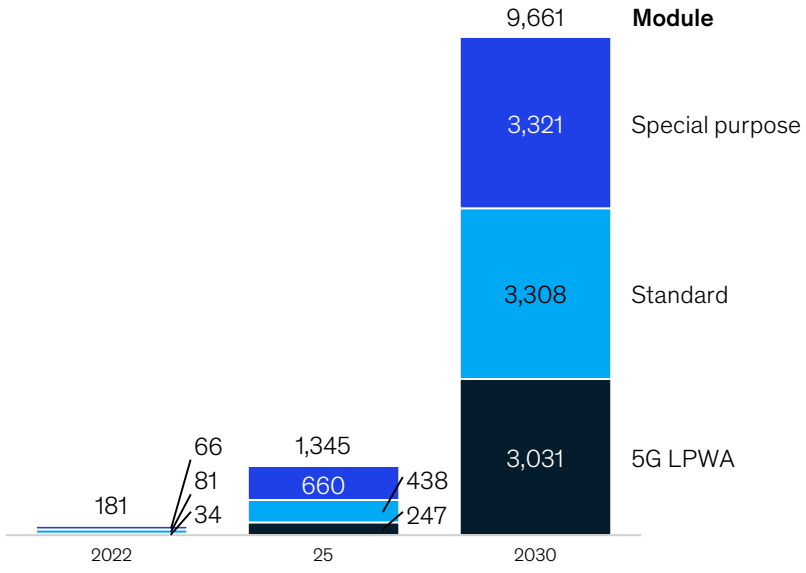
After 2025, however, 5G LPWA modules will be the largest growth driver as 5G networks become widely available, the number of end points increases, and 4G LPWA converges into 5G. By 2030, 5G LPWA modules are expected to account for almost 30 percent of total 5G IoT module revenues in the B2B sector with additional connections originating from upgraded 4G LPWA modules.

Exhibit 7

## B2B revenues for 5G IoT modules will soar between 2022 and 2030

**Forecast B2B market, 5G IoT modules, 2022–30**

USD millions




Source: McKinsey analysis

**The evolution of revenue sources**

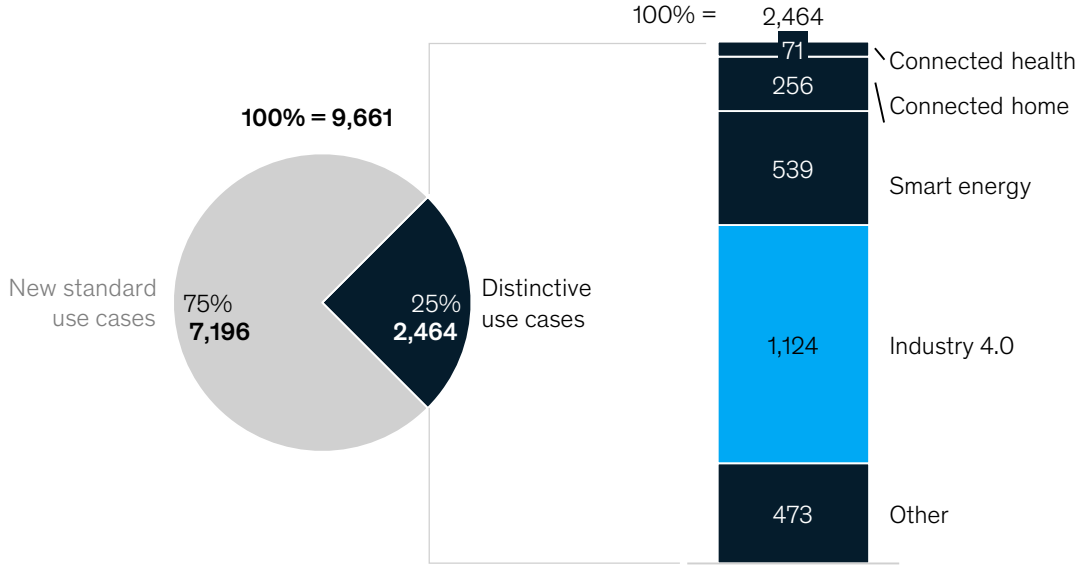
As noted earlier, module demand will evolve over time, shifting the source of value. In 2022, almost all of the three million 5G IoT modules sold in the B2B sector will be linked to distinctive use cases. By 2030, however, new standard use cases will account for over 75 percent of sales (Exhibit 8). During that year, Industry 4.0 will drive the most revenues for distinctive use cases (about USD 1.1 billion). The connected-health segment will drive the most revenue for new standard use cases (USD 1.8 billion).

Exhibit 8

## Distinctive use cases will only represent 25% of the total revenue with Industry 4.0 having the largest contribution

**Forecast B2B market, 5G IoT modules, 2030**

USD millions




Source: McKinsey analysis

## The 5G IoT component market

With module sales increasing, component providers will benefit. The greatest gains will go to providers of radio chips and application processors—the active components—with B2B revenue for this group expected to reach about USD 560 million by 2025 and USD 4.1 billion by 2030 (Exhibit 9). Next in line will be providers of passive components, such as antennae, who will see revenue rise from USD 188 million to USD 1.3 billion over the same period. Providers of testing, assembly, and packaging also will see revenue increases.

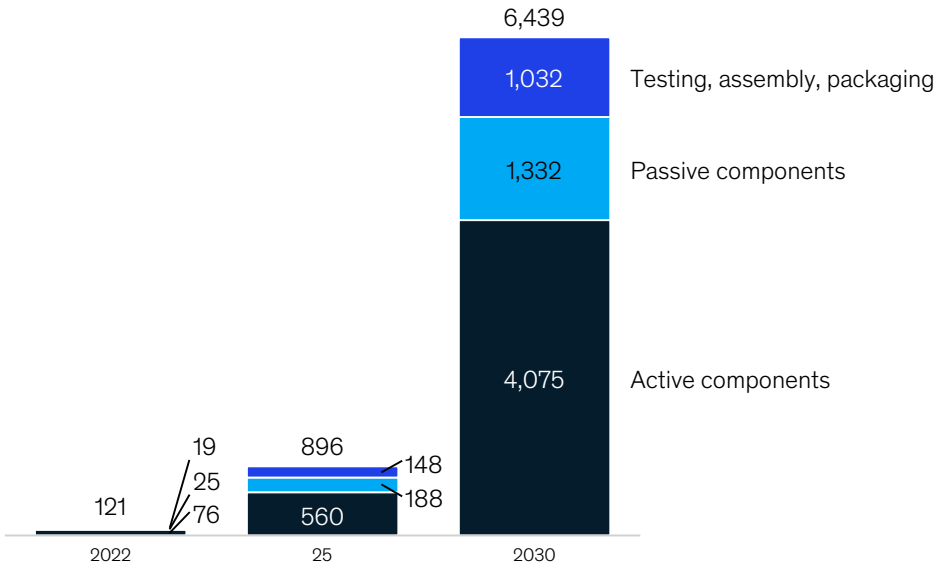
Active components will account for 60 to 65 percent of total costs per IoT module, and passive components will represent 20 to 22 percent of total costs. Testing, assembly, and packaging come in last, at 15 to 18 percent. Together, these three areas will account for about 70 percent of module costs, leaving module suppliers with a margin of 30 percent.

Exhibit 9

## Revenue for module components will rise over time

**B2B market for 5G IoT components**

USD millions




Source: McKinsey analysis

# 5 Strategic implications for advanced electronics companies and industrials

As with previous wireless technologies, 5G will foster innovation, enable new use cases, and trigger widespread adoption until it becomes standard. Companies see the writing on the wall, and they are already preparing to incorporate 5G into their operations and product offerings, even if they have no immediate need for it. But what is the best path forward?

## Advanced electronics players: Using B2C innovations to launch B2B opportunities

Advanced electronics players are most likely to capture value in the short term if they pursue B2B use cases that are similar to those now gaining traction in B2C. For instance, they could create use cases that involve smart glasses and high-bandwidth mobile-streaming consoles. Suitable 5G chips are already available for B2C and could serve as a basis for the new B2B applications, such as HD video transmission for security cameras and the use of AR or VR. To pilot such use cases in B2B settings and establish new sales channels, advanced electronics companies must identify potential partners, such as distributors, software companies, as well as machinery and industrial automation players.

Over the medium to long term, advanced electronics players should focus on creating chipsets and modules tailored to specific applications, such as use cases that require URLLC. Promising use cases include those related to collaborative robots, remote-controlled machinery, and AGVs. In particular, component suppliers and IoT module providers should concentrate on developing the next generation of 5G LPWA chipsets to decrease energy consumption and increase bandwidth for devices and modules, since this advance would allow scaling MMTC use cases.

## Industrial automation players: Becoming 5G ready now

With the first wave of 5G applications transforming the B2C segment, industrial automation companies have the opportunity to learn from this experience. They can also use established B2C 5G IoT modules as a starting point when refurbishing existing B2B products with the new technology.

As noted earlier, the number of 5G IoT modules designed for distinctive Industry 4.0 use cases should begin to soar in 2023 as companies pursue applications related to warehousing, manufacturing, supply chain, and other areas. By 2030, module sales for distinctive Industry 4.0 applications should reach about 22 million units. Companies that develop a 5G strategy now will be best prepared to capture value from this growth.

For their first step, industrials should determine which distinctive use cases are most popular with B2B customers who are early 5G adopters. They should then determine how they must enhance their products to meet the requirements of these use cases. To develop a better understanding of market developments and customer needs, industrials should ensure that their salespeople are trained to identify emerging 5G B2B use cases, determine any necessary enhancements to the product portfolio or product features, and communicate their findings to product development. With much uncertainty remaining about 5G B2B use case adoption, including timing, industrials should frequently review their portfolio of 5G-enabled product offerings.

Over the medium to long term, industrials might benefit from a comprehensive portfolio of 5G-enabled products. To create this portfolio, they must have a clear architecture strategy with cost-optimized optional 5G modules and promote 5G module use across the product portfolio.

## Manufacturing players: Focusing on partnerships

Manufacturing players that want to move ahead with 5G should first create a long list of potential B2B use cases, noting whether they are distinctive or designed to satisfy new standards. They should then prioritize distinctive use cases with the highest value; additional use cases can be rolled out after 5G coverage is widely available.

Given the breadth and complexity of 5G applications, manufacturers may require partners to develop their solutions and secure the best return of investment. Some of the best partners include the following:

- IoT module providers or industrial automation providers who have developed 5G hardware and 5G-enabled products
- Connectivity infrastructure providers for private 5G networks (for larger companies) or telecommunication operators for public 5G networks (for small and medium-size enterprises)
- Software infrastructure and application providers, such as IoT cloud platform providers that offer real-time processing and other 5G-enabled features
- Solution providers that specialize in implementing 5G use cases.

Early movers have already started their 5G B2B partnerships. For example, Ericsson has signed an agreement to implement 5G technology in Audi Production Lab, and Volkswagen is working with AWS to build an industrial cloud for IoT devices. In this environment, industrials that create internal 5G teams to assess potential partners and their offerings may have an advantage.

After developing 5G solutions, manufacturers should implement them first in lighthouse factories – the manufacturing plants that are typically the most advanced in the network and first to deploy new solutions. Lighthouse staff focus on continuous improvement and will easily see the value of 5G use cases. For best results, a designated 5G transformation team should lead the tactical plant rollout and assign change agents to various sites. Ideally, the team will also serve as the interface between the 5G development team and staff at plants.

Once the lighthouse rollout is complete, manufacturers should try to achieve the same benefits at scale by expanding to other plants. They should first deploy 5G solutions at plants where minimal investment is required to become ready. Then they can move to other locations.

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5G has already gained adherents in the B2C segment, and business players can build on this base. Although this technology offers many opportunities, advanced electronics companies and industrials must place their bets carefully to ensure a strong return on investment over the next few years. The companies that move now to pursue distinctive use cases and prepare for standardization may be the ones that will capture the greatest returns.

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**Ondrej Burkacky** is a partner in McKinsey's Munich office, where **Stephanie Lingemann** is a consultant. **Markus Simon** is a partner in the Cologne office. **Alexander Hoffmann** is an alumnus of the Munich office.

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