

A CTOs Guide to 5G and 5G Edge Computing

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Initiatives: [Digital Products and Services](#)

Enterprise architecture and technology innovation leaders, including CTOs, should plan for 5G to support a wide range of enterprise digital initiatives and provide new options for latency-sensitive edge computing. However, some aspects of 5G will be a disappointment for several years.

Additional Perspectives

- [Invest Implications: A CTOs' Guide to 5G and 5G Edge Computing](#)
(14 January 2022)
- [Summary Translation + Localization: A CTOs Guide to 5G and 5G Edge Computing](#)
(18 February 2022)

More on This Topic

This is part of an in-depth collection of research. See the collection:

- [The Top 5 Trends in Enterprise Networking and Why They Matter: A Gartner Trend Insight Report](#)

Overview

Key Findings

- Many business and technology aspects of 5G strategy should be the concern of the CTO or the office of the CTO (OCTO).
- 5G will enable digital business transformation and optimization, but many applications need greater technical or commercial 5G maturity and some applications won't be feasible for several years.
- 5G is not a commodity and there is still confusion over the capabilities, coverage and maturity of 5G.

Recommendations

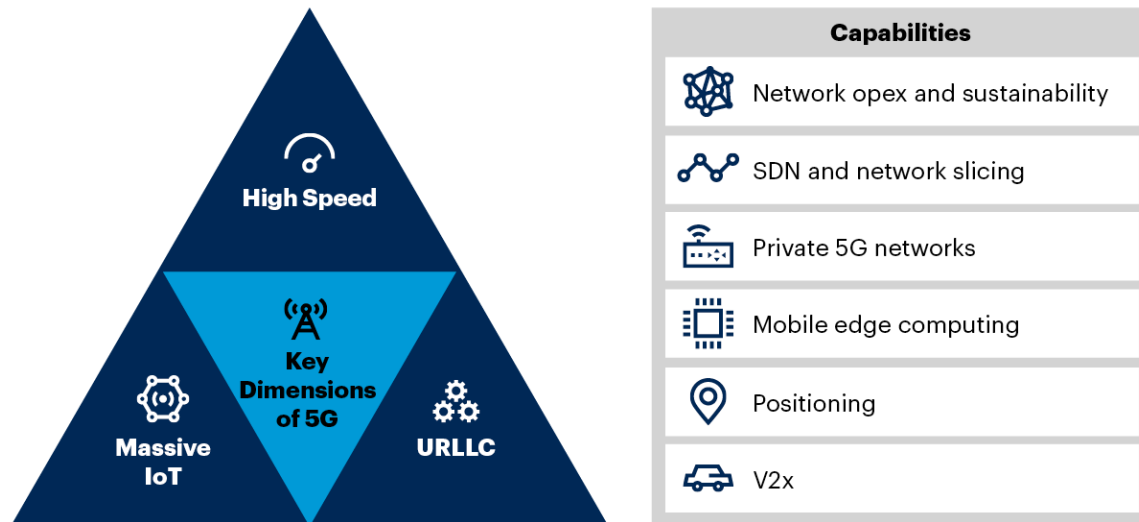
Enterprise architecture and technology innovation leaders, including CTOs, wanting to exploit 5G for digital transformation and optimization should:

- Focus effort on those elements of 5G strategy CTOs need to own given their persona and industry by identifying those situations where lack of management will incur costs and risks.
- Identify how and when 5G and 5G edge computing should be adopted by creating a 5G roadmap and key technology strategy.
- Explain the 5G strategy to key stakeholders and communicate it using role-specific radar screens and roadmaps.

Introduction

5G will impact the entire organization. It will enable digital innovation through new networking capabilities, new edge computing options and new services delivered by partners such as telcos. The high bandwidth and low latency offered by 5G can support industrial applications; and capabilities such as position sensing will enable new forms of track and trace. However the 5G promise summarized in Figure 1 hides many complexities and several potential disappointments.

Figure 1. 5G Overview

5G Overview

IoT: Internet of things; URLLC: ultra reliable low latency communication; V2x: Vehicle-to-everything

Source: Gartner

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5G is not a commodity; different telcos will offer different services depending on their business strategies, technical capabilities and the spectrum they own. Also, telcos won't be the only providers of 5G services. Furthermore, 5G is a work in progress; many innovations will demand capabilities planned for future releases of the standard. To further add to the complexity, 5G adoption isn't a simple process determined by when a telco deploys services, because most organizations' timetables will have many dependencies on other vendors, regulators and industry associations. 5G planning must be driven by a team that understands both the potential and complexity of 5G and, as such, the CTO and the office of the CTO is ideally placed to guide this process.

Analysis

Focus Efforts on 5G Strategy

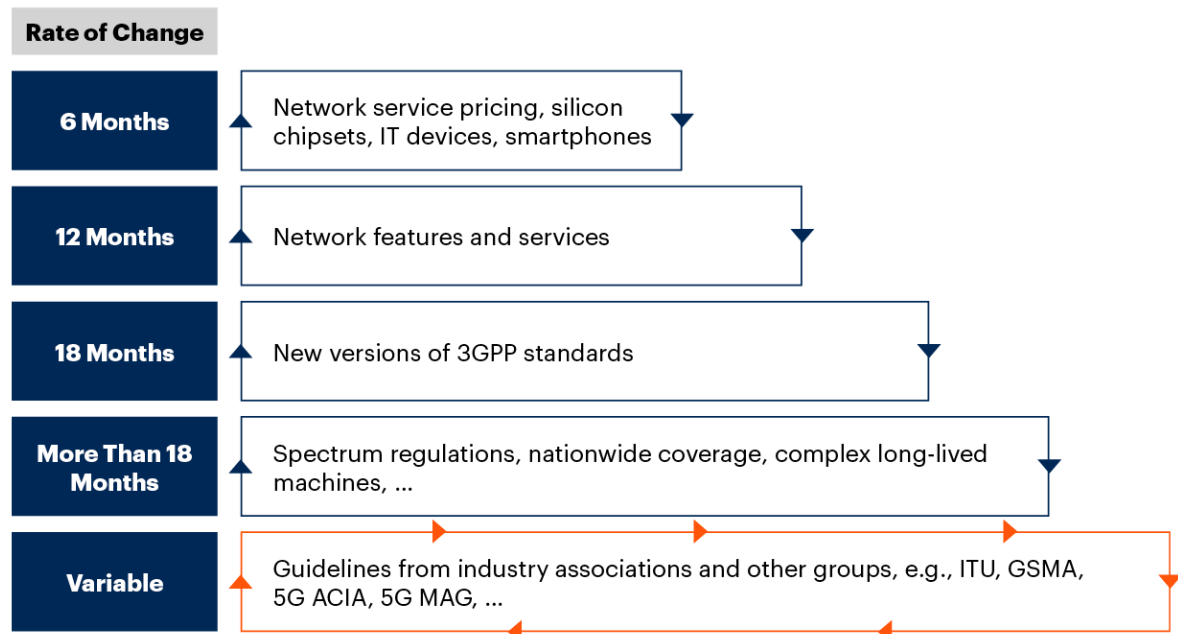
5G will influence business and technology strategy in most organizations, so 5G strategy will intersect with many CTO responsibilities, such as:

- **Digital business innovation.** The digital transformation potential of 5G has been somewhat overhyped, but it will nevertheless provide opportunities for business models based on new devices, higher and more reliable bandwidth, and new hybrid cloud partners such as telcos.

- **Digital business operation and optimization.** High-speed connectivity, edge services, private 5G networks and capabilities such as integrated positioning will offer ways to improve the performance of digital business applications.
- **Innovation management.** Many CTOs own technology innovation teams who should be tasked to investigate opportunities enabled by 5G and its associated edge services, for example, in areas such as new devices, new services, more agile delivery models and better connectivity.
- **Technology roadmaps and supplier strategy.** 5G strategy will impact many other technology strategies in areas such as wireless networking, the Internet of Things (IoT), hybrid cloud, digital twins, artificial intelligence (AI) and edge computing. The CTO as leader of technology strategy must establish how 5G fits into the wider enterprise technology portfolio. Every organization will need roadmaps and guidance to recommend which 5G capabilities should be adopted, and when they'll be technically and commercially mature for specific use cases.

Figure 2 illustrates that 5G adoption isn't an event, but an ongoing process that will continue for many years influenced by stakeholders such as telcos, standards organizations, regulators and equipment manufacturers. The CTO is uniquely placed to align this complex 5G roadmap with business goals to create an adoption plan and timetable.

Figure 2. Selected 5G Drivers

Selected 5G Drivers

Source: Gartner
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5G strategy isn't something that can be safely devolved to individual business units or projects. Issues such as telco contracts and pricing, enterprise networking policies, and security are best managed centrally to ensure consistency. The CTO persona will define the exact type of 5G strategy that can be delivered, but some aspects should involve all types of CTOs (see [How to Demystify the Chief Technology Officer's Many Personas](#)).

Also, the CTO is well-placed to inject a dose of reality into the 5G discussion. In most countries 5G coverage is incomplete and, in the case of some frequency bands, won't ever be complete. 5G is not a commodity; every network operator has a different set of capabilities and services depending on their commercial strategy, network technology and the frequency bands they are using. The CTO must explain to business peers the gap between 5G hype and what's achievable. Even more in need of a dose of reality is 6G, which is starting to be hyped even though it's a decade away and may never emerge as a separate cellular generation.

Create a Key Technology Strategy for 5G

One common responsibility for CTOs is to maintain what we term “key technology” strategies. These are required for technologies that will have a broad impact across the organization; and 5G is a perfect example of this. (See [Understanding the CTO’s Role in Technology Strategy](#).) Such a strategy addresses:

- Desired business outcomes and goals
- Innovation and brainstorming of new opportunities
- Practices and principles such as architectures, vendors, timetable
- Impact and alignment, which systems will be affected, adoption plan, financial implications
- Exit strategy, e.g., to switch to new vendors or alternative technologies
- Risks and cautions

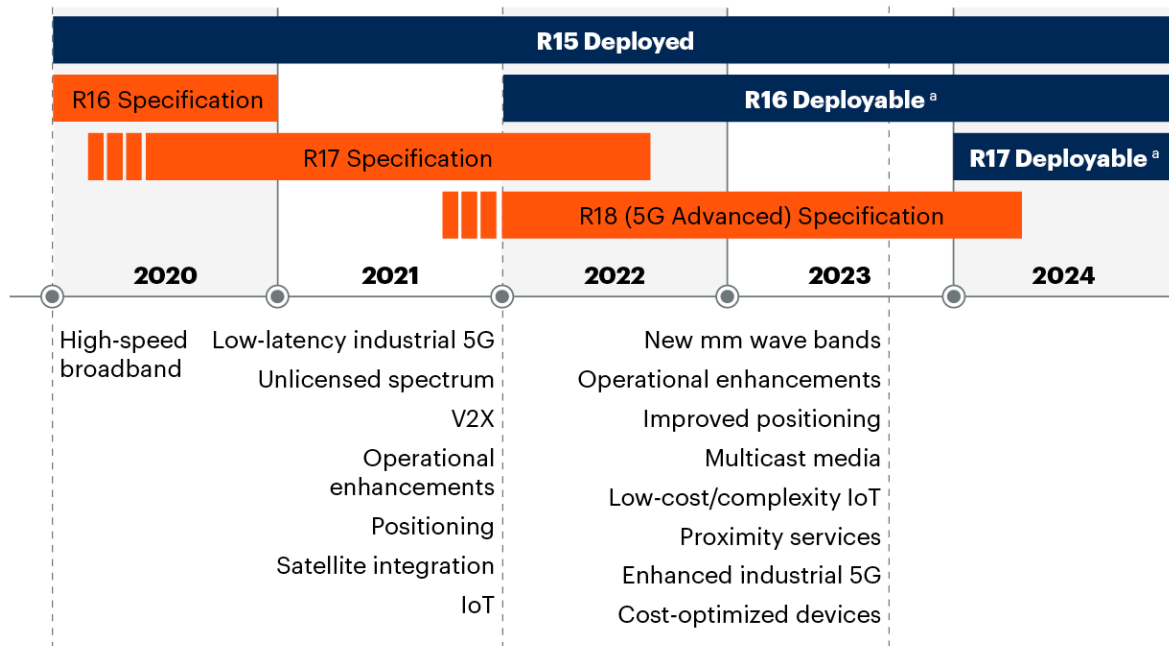
A CTO’s 5G key technology strategy should include the following 10 elements.

1. Understand and Communicate the 5G Roadmap

The 5G standards roadmap will be one of the key inputs to a 5G strategy as it defines the basic capabilities of 5G. A simplified version of the current roadmap is shown in Figure 3.

Figure 3. 5G Standards Roadmap

5G Standards Roadmap



Source: Gartner

^a Actual deployment dates depend on individual network operator's decisions

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Note that:

- Figure 3 is derived from information published by the 3rd Generation Partnership Project (3GPP), the organization that develops the 5G standard. The timetable and features may change as 3GPP refines its plans.
- A new release of the 5G standard is published approximately every 18 months.
- Publication of the standard isn't the same as availability of 5G features. There is usually a gap between features being standardized and being available in the market. However, sometimes equipment manufacturers may release features before the standard codifies them. In 2021 many network operators have deployed 5G Release 15, which provides little more than high-speed broadband. Much of the innovation potential of 5G demands Release 16 or Release 17 features.

- Features defined in the standard are not necessarily available to buyers, because, for example:
 - The operator makes a commercial decision not to support them
 - There is a delay because new network equipment must be installed
 - Regulators impose restrictions on the way certain frequency bands can be used

A CTO will typically need to create a customized, organization-specific roadmap that overlays information from other stakeholders (see the 7. Identify External Dependencies and Resources section).

2. Identify Network Operator's Capabilities and Plans

5G features and pricing depend on an operator's commercial and technical decisions and the constraints of the spectrum licensed. This means that the CTO must understand what's available from each operator the organization might deal with. Issues include:

- 5G is a very complex standard delivered globally on around 50 frequency bands from less than 1 GHz to tens of GHz. More bands are planned in the future. In low-frequency bands, 5G performance may be no better than LTE. In millimeter wavebands, 5G can attain speeds more than 1 Gbps.
- 5G performance and capacity will depend on many engineering decisions the operator makes, e.g., how it shares bandwidth between 4G and 5G. The network's capabilities may also be significantly influenced by which network equipment vendor the operator selected.
- As with all wireless systems, lower-frequency bands tend to provide better coverage and so allow the operator to deploy 5G more rapidly. Higher-frequency bands provide better performance. 5G operating in millimeter wavebands delivers exceptional performance exceeding 1 Gbps at the cost of very limited coverage, e.g., restricted to central urban areas or special cases such as sports stadiums.
- The diversity of frequency bands means that 5G roaming will be problematic for multinational organizations or vendors manufacturing products with embedded cellular wireless for global distribution. It's unlikely that manufacturers will build a handset that supports all possible 5G bands. Multinational 5G strategies are further complicated because availability varies between regions. Early adopters include the U.S., some mature APAC markets and China. Most Western European countries are fast followers, and parts of Africa will be late adopters.

Because of the diversity of 5G the CTO should set up a dialogue with several 5G operators to understand their varying plans and capabilities.

3. Evaluate Network Operators' Hosted Services

Many network operators see 5G as a platform on which they can deliver a range of new services, often exploiting low-latency edge computing hosted in their network (see the 4. Align 5G Strategy With Edge and Cloud Strategy section). The architecture of 5G also enables new connectivity offerings, such as private networks and slicing. The latter is a mechanism that allows the operator to reserve a portion of network capacity for a specific organization, thereby guaranteeing quality of service and enabling new connectivity services.

Examples of such services might include:

- Hosted augmented and virtual reality devices and tools.
- Asset monitoring, track and trace.
- Hosted services using video analytics and AI, for example, security monitoring, smart city traffic analytics, retail footfall monitoring, video quality assurance and inspection.
- Vehicle, robot and drone monitoring.





The CTO should exercise caution because such initiatives will take many operators into vertical industries and commercial models with which they're not familiar. There is no guarantee that operators' experiments will mature into successful long-term businesses. However, such services may provide a way for organizations to test and deploy new capabilities very rapidly.

4. Align 5G Strategy With Edge and Cloud Strategy

Edge computing is designed as an integral part of 5G networks, as shown in Figure 4.

Figure 4. 5G Edge Computing

5G Edge Computing

Latency	Location	Location of Processing		Typical Provider
~ 0 ms	Endpoint		Local Processing	• Endpoint hardware manufacturer
~ 2 ms	Near Edge		On-premise processing Hard real-time control, data ownership and security	• On-prem. cloud appliance • On-prem. servers/gateways
~ 10 ms	Far Edge		Within ≈ 200 Km of radio E.g., metro data center, 5G cloud	• Cloud provider • Metro data center • Telco cloud
30+ ms	Cloud		Classic Cloud	• Cloud provider

Source: Gartner
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Two variants of 5G edge computing will likely have the most impact on the CTOs technology strategy:

- **Near-edge computing**, so called because it's physically near to the endpoint devices providing latencies from one to a few milliseconds. This is the style of edge computing used to exploit 5G's ultra-reliable low latency communications (URLLC) capability to replace physical cables. 5G near-edge computing will typically be used in conjunction with on-premises processing in situations where low latency is critical, for example, for factory automation. 5G private networking combined with on-premises edge processing can also offer high levels of data security. Near-edge 5G with on-premises processing is sometimes known as private mobile edge computing (MEC).
- **Far-edge computing**, so called because it's farther from the endpoint than "near edge," offering latencies of a few milliseconds to 10 milliseconds. This allows the processing to be located a fair distance from the endpoint, e.g., up to approximately 200 km. Far-edge services will often be provided as a hybrid cloud solution through partnerships between telcos and hyperscale providers, such as Amazon or Microsoft, who are locating cloud appliances in telco networks. Far-edge latency is low enough to support video devices and applications such as real-time video analytics and virtual reality. Far-edge 5G using telco or partner computing resources are sometimes known as public MEC.

5. Identify 5G Data Networking Opportunities

In the long term (through 2025), 5G will likely play an increasing role in the organization's data networking strategy. Areas where 5G may replace or augment other technologies include:

- Coverage of large areas such as ports, warehouses, campuses and large factory sites, as discussed in the 6. Identify Private 5G Opportunities section
- Low-latency 5G, which can replace expensive industrial-grade wired Ethernet systems in areas such as mines, factories and process plants, saving substantial cabling costs.
- Connecting high-bandwidth mobile applications and equipment, e.g., involving video, high-data-rate IoT devices such as lidar, and robots or drones.
- Providing high-speed data networking facilities. First, in temporary situations such as construction sites or pop-up retailers, and second, potentially providing backhaul for small offices or as an emergency fallback connection.
- Fixed wireless access (FWA) for remote workers as an alternative to wired broadband.

Areas where 5G is less likely to impact enterprise networking strategy in the five-year time frame include:

- Low-bandwidth IoT devices won't make early use of 5G for three reasons:
 - IoT isn't even supported until 5G Release 16, when it incorporates the current 4G IoT standards narrowband IoT (NB-IoT) and Long Term Evolution for Machines (LTE-M).
 - In most regions current 4G systems have considerable spare IoT capacity so there is little need for 5G.
 - There are several competing low-cost technologies for low-power wide-area networks (LPWANs) such as LoRa.

- 5G won't replace Wi-Fi in applications such as carpeted office spaces. Wi-Fi is much less expensive to integrate into IT devices such as tablets, laptops and printers. Also Wi-Fi's low cost and ubiquity mean we expect to see it used in a wide range of future devices in smart spaces. Future versions of Wi-Fi will also address some of the areas where 5G currently has a technical advantage, e.g., related to bandwidth, handoff and location-sensing precision.

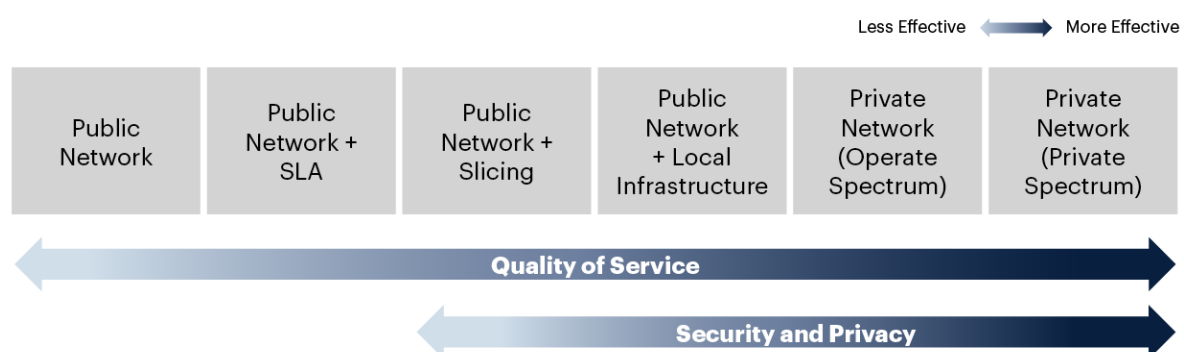
The CTO's technology strategy for networking should establish where 5G fits in the organization's networking portfolio, and identify situations where early adoption of 5G would be beneficial.

6. Identify Private 5G Opportunities

A key question for many CTOs is whether a private 5G network has a place in their enterprise strategy. There are five main variants of private 5G networks, as illustrated in Figure 5.

Figure 5. Public and Private 5G Network Options

Public and Private 5G Network Options



Source: Gartner
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These are:

- **Public network with a service-level agreement (SLA).**
- **Slicing.** A proportion of the network's capacity is reserved for a specific customer.
- **Public network with local radio infrastructure.** This can be designed so that organizational data doesn't leave the private region of the network. This capability is sometimes known as "local breakout."

- **Private network using telco spectrum.** The network equipment is private and isolated from the telco network, but is managed by the telco and uses licensed spectrum.
- **Private network using private spectrum.** The network equipment is private and isolated from the telco network and is not managed by a telco. Private spectrum availability varies by region and may take different forms (see Note 1).

5G isn't always necessary for private networks. Private cellular systems can be delivered using 4G (LTE), which may provide a more mature solution with an upgrade path to 5G in the future.

A private 5G network is likely to be interesting to organizations that have one of more of the following needs:

- High-speed data networking over a physically large site where it's not economical to populate the area with large numbers of Wi-Fi access points, e.g., ports, airports, open cast mines, very large warehouses.
- Seamless indoor/outdoor high-speed data coverage.
- Fast-moving endpoints such as vehicles where Wi-Fi handoff may not be reliable.
- Equipment that requires 5G's URLLC capability (see the 4. Align 5G Strategy With Edge and Cloud Strategy section).
- Positioning information about connected endpoints. From Release 16 onward, 5G networks know the location of connected endpoints; precision will vary depending on the network design.

7. Identify External Dependencies and Resources

Figure 2 illustrates that many preconditions for 5G adoption are outside the CTO's direct control. These include:

- Which features operators have chosen to deliver and when.
- The rate at which consumers, employees or partners adopt 5G.

- The availability of 5G-equipped endpoints. These could include IT devices (such as laptops, tablets and smartphones), industrial computing devices, wearables, drones, robots, manufacturing machines, video cameras, sensors, and many other items. In 1H22 we expect the availability of mainstream devices such as smartphones and IT equipment to be good. However, specialized devices such as ruggedized industrial devices, IoT equipment and special-purpose machines may lag in 5G adoption.
- Knowledge and experience in applying 5G to specific equipment or domains. Various industry bodies and subgroups within standards organizations have emerged to address application-specific issues of 5G in industries such as media, automotive and mining (see Note 2).
- Network equipment for nonoperator purposes, such as private 5G networks. Some suppliers may be problematic for political as well as technical or financial reasons.
- Regulators releasing spectrum for private networks.

CTOs should identify external dependencies that will impact their ability to deploy 5G for specific applications. They should also task staff to monitor or join organizations such as those listed in Note 2 to gain more insight into 5G deployments in specific vertical domains.

8. Security and Risk Management

Risk management addresses issues such as security, availability and commercial risk. Risks will differ between applications and providers, but might include:

- 5G has new security features compared to 4G, but most are designed to protect operator revenue rather than customer data. So the organization can't forgo control of encryption and identity.
- Some 5G configurations, such as private networks using private infrastructure, have the potential to provide excellent security in certain situations.
- Some 5G configurations and features pose new security challenges, e.g., 5G edge computing typically complicates security and could improve or degrade it depending on how it's used. Edge also creates potential new availability risks.
- Future versions of 5G will integrate noncellular wireless bearers (such as satellites), which have different security considerations to a conventional cellular network.

- Some network operators will use 5G features such as slices to offer more secure connections.
- Location sensing could reveal unwanted information about people or things.
- 5G networks are mostly implemented in software running on commodity hardware. Security professionals have commented that this increases the theoretical attack surface of the network compared to its 4G predecessors. This is not to say that 5G networks have been attacked by hackers, but the possibility (even if remote) should not be entirely discounted.
- Network operators see 5G as an opportunity to deliver new public MEC services, often hosting them in their own edge data centers. Such technical and business models don't yet have an established track record.

As 5G adoption progresses, the CTO should ensure that architects and security staff create policies, templates and patterns for 5G security in a range of applications.

9. Identify Innovation Opportunities Enabled by 5G

There are many potential applications of 5G. Some will be straightforward, e.g., replacing 4G for mobile worker connectivity; however, some will enable significant business optimization and even transformation. For example, a private 5G network in a port can enable every significant piece of equipment to be networked and could be the backbone for innovations, such as remote crane operations or robot vehicles moving containers. A less innovative, but equally practical, approach uses 5G to backhaul dispersed Wi-Fi access points, reducing the need for cable infrastructure across a campus or building. CTOs who own an innovation team or function should therefore ensure that 5G is among the technologies their staff are evaluating. CTOs should encourage broad ideation across the business to identify 5G opportunities.

Innovation teams should pay particular attention to the fine details of the 5G roadmap summarized in Figure 3 because some of them may translate into valuable capabilities, for example:

- Location sensing for tracking people and equipment
- Satellite integration to provide 5G on a cargo ship
- Low-cost 5G modules to enable new 5G IoT applications

However, such roadmaps also hide many complexities, for example, the location precision will be highly dependent on network design and equipment selection. Therefore, as with many innovations, it will be necessary to create pilots and proofs of value (POVs) to validate assumptions and understand when and whether 5G is appropriate.

Many 5G opportunities will be combinatorial; they'll involve several technologies and vendors in addition to 5G and a telco. Therefore, 5G will likely provide opportunities for innovation teams to collaborate with external partners who are experts in other pieces of the puzzle, for example, academics, ecosystem partners, equipment manufacturers, system integrators and industry associations such as those listed in Note 2. It's likely that 5G and edge AI will be a key combination, for example, for high-bandwidth video analytics such as industrial inspection and smart city monitoring, or applications such as equipment monitoring and predictive maintenance.

10. Consider Exit Strategies

4G is a relatively commoditized technology and, as such, switching suppliers is relatively simple. This will be more challenging with 5G because:

- Your telco may also be your edge computing host. Different telcos may choose different edge processing allies and technologies, impacting workload portability.
- Different telcos may locate their edge data centers in different places with different latencies, which may impact application performance if you switch to another provider.
- Telcos will offer a wider range of services exploiting 5G, e.g., video analytics, track and trace, equipment monitoring, and logistics management. Switching may not be an option if no other telco offers a comparable service. Also, if a telco decides that a 5G service isn't commercially viable and wants to abandon it, the contract should provide adequate time to find an alternative.
- Telcos may not offer directly comparable 5G services, especially in the areas such as guaranteed latency, edge and millimeter wave. So switching suppliers may not be trivial.
- 5G private networks may involve on-premises infrastructure, making switching suppliers more complex.

These factors translate to a higher risk of lock-in to specific suppliers. Educate business peers such as procurement staff on the issues of lock-in and exit strategies, and ensure they're considered before signing 5G contracts.

Communicate the 5G Strategy Using Radar Screens and Roadmaps

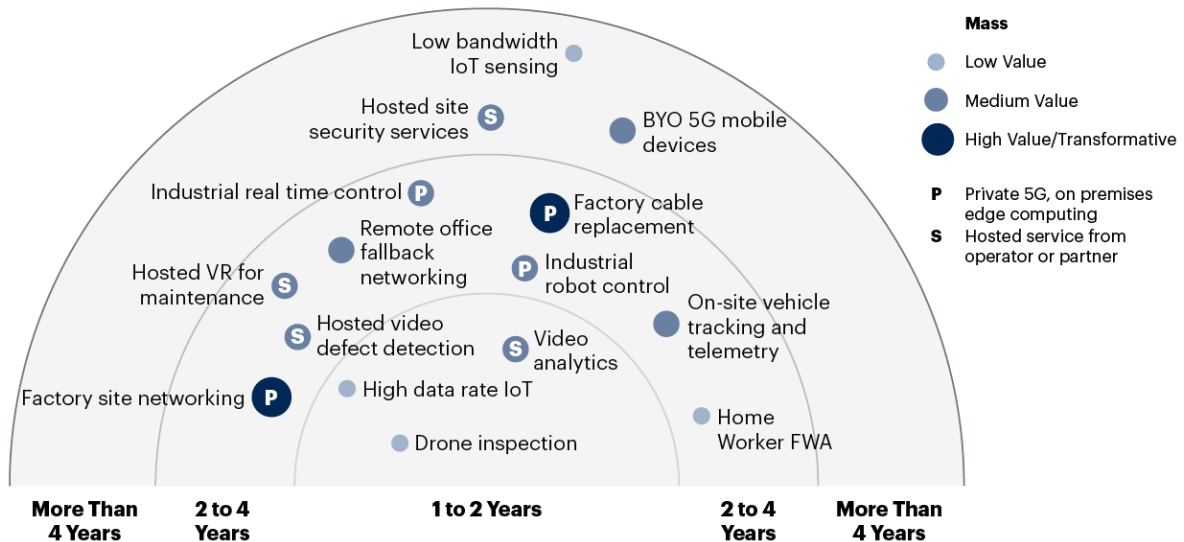
A CTO must not only develop technology strategy but must also market it to business peers and the IT organization. In the case of 5G this is particularly important because of the hype and confusion that still surround the topic. Two deliverables may help.

- **A two-page 5G strategic plan.** This is a high-level view summarizing the CTO's goals and beliefs regarding a technology. See [Understanding the CTO's Role in Technology Strategy](#) for a discussion of the format. This provides an easily digestible summary of the 5G strategy and can be aimed at relatively nontechnical readers.
- **A 5G radar screen.** The radar screen format is a convenient way to summarize the potential, and the timetable, for technology adoption and to highlight issues and risks. Figure 6 illustrates a hypothetical 5G radar screen. Note that this is an illustration of the notation, not a suggested adoption timetable. The positions and attributes of the radar screen dots will depend on each individual organization's needs and risk tolerance.

The impact of 5G will vary across the organization. CTOs should therefore develop multiple radar screens and strategic plans focused on the goals, needs and metrics of different stakeholders, for example, one per business unit.

Figure 6. Example 5G Radar Screen

Example 5G Radar Screen



Source: Gartner
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Evidence

Information from standards bodies and industry associations, discussions with clients, vendors and colleagues.

Note 1. Private Spectrum

Different countries have different arrangements for private organizations to license and use spectrum. There are many different approaches such as:

- **Private monopoly spectrum**, e.g., in this case, a private organization can license and own nationwide spectrum in a similar way to a telco.
- **Private shared spectrum**, e.g., spectrum is licensed but the same bands can be used by different organizations, perhaps in different locations.
- **Dynamically allocated spectrum**, using a central management database.
- **Constrained spectrum**, e.g., where the license can be temporarily rescinded if a higher-priority user (such as the military) needs the spectrum urgently.

Note 2. Examples of Organizations and Industry Associations Addressing 5G Adoption Opportunities and Challenges

[5G Alliance for Connected Industries and Automation \(5G-ACIA\)](#) is working to ensure that 5G standards have the features necessary for industrial and time-sensitive networks to be used in areas such as manufacturing and robotics.

[5G Media Action Group \(5G MAG\)](#) is addressing the use of 5G in media production and distribution.

Research projects such as Next Generation Mining (NGMining) coordinated by VTT (a Finnish research organization) are bringing together network equipment manufacturers and industry representatives to address the challenges of using 5G underground. See [VTT, Nokia & Sandvik Collaborate in 5G Powered Research Project on Next Generation Underground Mining Technology, VTT](#).

[5G Automotive Association \(5GAA\)](#) works to connect the telecom and automotive industries.

The [5G Health Association](#) assesses, develops and evaluates 5G applications in the health technology sector.

Recommended by the Author

Some documents may not be available as part of your current Gartner subscription.

[Understanding the CTO's Role in Technology Strategy](#)

[How CTOs Can Create Effective Technology Roadmaps](#)

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