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The 5G for Business Guidebook

A Guide to Understanding and Exploring the Pathway to 5G

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Cradlepoint 5G Strategy Group

Version 2

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01 Why You Should Care About 5G

Besides swapping a "4" for a "5" and being able to download Netflix movies faster, should you really care about 5G? Well, consider this: How did 4G change your life and transform entire industries?

To name a few examples, 4G turned the transportation-for-hire industry on end with Uber and Lyft. 4G fueled social media's exponential growth with the likes of Facebook, WhatsApp, and Instagram. And 4G brought educational opportunities to millions in remote areas throughout the world.

The "hype train" tells us 5G will spawn unimaginable applications. While that may be an exaggeration, most technology experts agree that 5G will be as disruptive as 4G was — at the very least.

*The bottom line for organizations? **Wireless WAN** applications that are good with 4G will be great with 5G, and applications that couldn't be run with 4G are now feasible in 5G.*

Table 1 – Sample of Wireless WAN Use Cases

	4G LTE
Video for public safety	Visual recognition and recording
Video for marketing	Digital signage
Wireless WAN	Cut the cord (lower bandwidth requirements)
Branch high availability	Critical application failover
Industrial operations	Wireless monitoring
Workforce collaboration	Video collaboration
Medical	Remote consultation
Transportation	Tracking and telemetry

Pushing wireless broadband performance to unprecedented levels likely will benefit businesses even more than consumers. For instance consider the following examples. Organizations that could only use 4G LTE for failover of its most critical traffic can now use wireless for failover of all traffic. Organizations using wireless video for facial recognition can deploy machine recognition. Firefighters who today can use cellular sensors can now have building diagrams fed into their masks, allowing them to virtually see through the smoke.

Wireless WAN: Also called wireless broadband, the transmission of data between different geographical sites using a cellular network as the edge connection mechanism.

Table 1 offers a more exhaustive sample of wireless WAN use cases. Although Gigabit-Class LTE will be introduced later, this table shows how each wireless use case dramatically improves with each step toward 5G. In many ways, 4G simply created an appetite for the greater opportunities that 5G will bring to the table.

Gigabit-Class LTE	5G
Live HD visual recognition	Machine recognition and response
Interactive digital signage	Immersive augmented reality
Cut the cord (higher bandwidth requirements)	Cut the cord (fiber-like requirements)
All application failover	Built-in wireless failback
Wireless remote operation	Wireless autonomous operation
HD video collaboration	Augmented reality collaboration
Remote diagnosis	Remote assisted surgery
Multimedia tracking and telemetry	Autonomous operation

02 What You Should Know About 5G

5G Has Three Spectrum Bands – and You Will Likely Use All of Them

Despite what you may have heard, 5G is far more than one type of spectrum. In fact, there are three ***spectrum bands*** in 5G that businesses will need to understand: 4G LTE (including Gigabit-Class LTE), Sub-6 GHz, and mmWave.

Spectrum Bands: A contiguous grouping of radio frequencies.

Each category of 5G spectrum has unique characteristics and tradeoffs. Most important to know is the tradeoff between ***propagation*** and performance in each spectrum band. Spectrum bands with high propagation have lower performance characteristics while spectrum bands with low propagation have higher performance characteristics. Now let's look at the essentials you should know about each.

Propagation: The distance a radio signal can travel and the degree to which a radio signal can penetrate obstacles before losing integrity.

4G LTE is the Foundation of 5G

4G LTE is the foundation technology for 5G. For 5G, modems will maintain two connections: 5G and 4G LTE (including Gigabit-Class LTE). If a 5G signal weakens, traffic automatically flows through the LTE connection.

Officially known as LTE-Advanced Pro, Gigabit-Class LTE is the latest version of the 4G LTE standard and is rolling out throughout the world.

With the same spectrum but using technologies including carrier aggregation, 256 QAM, and 4x4 MIMO, Gigabit-Class LTE can achieve theoretical download speeds of 1.2 Gbps. The information below presents the practical (in-field) performance characteristics of 4G LTE and Gigabit-Class LTE.

Practical Performance of 4G LTE

Download: 10–50 Mbps
Upload: 5–15 Mbps
Latency: 40–80 ms
Propagation: High

Source Cradlepoint 5G Strategy Group

Expected Practical Performance of Gigabit-Class LTE

Download: 50–350 Mbps
Upload: 30–60 Mbps
Latency: 30–70 ms
Propagation: High

Gigabit-Class LTE provides a significant performance improvement over 4G LTE in download and upload measures.

Because Gigabit-Class LTE is really just applying new techniques to current infrastructure, its market penetration will be rapid. Because of their high propagation characteristics, and as you can see from Diagram 1, 4G LTE and Gigabit-Class LTE will be the primary spectrum for rural territories, obstructed locations, and IoT applications.

Sub-6 GHz: The Intersection of Propagation and Performance

As mentioned, "Sub-6" refers to spectrum below 6 GHz and above 1 GHz and has the following expected practical performance characteristics.

Expected Practical Performance of Sub-6 5G

Download: 100 Mbps–1.5 Gbps
Upload: 30–60 Mbps (with 5G Standalone Core: 50–350 Mbps)
Latency: 30–70 ms (with 5G Standalone Core: 8–12 ms)
Propagation: Medium

As you can see, Sub-6 5G offers dramatic performance improvements over 4G technologies. You will also notice that propagation is worse than 4G, but as you will see next, Sub-6 propagation is still significantly better than mmWave.

Because it mitigates the tradeoffs of both propagation and performance, many believe that the Sub-6 5G spectrum is the sweet spot of wireless broadband.

However, in some countries, like the U.S., access to the Sub-6 spectrum has been challenging for many operators. Regardless, Sub-6 5G is gaining attention from operators and onlookers alike as they imagine the benefits of enabling balanced propagation and performance within the same spectrum.

5G Standalone Core: The use of 5G cells for both signaling and information transfer. Early 5G deployments will use the 4G Evolved Packet Core for signaling. Use of the 5G Standalone Core will provide greater network efficiency and performance.

Introducing the New Millimeter Spectrum

The high end of cellular frequencies is called millimeter spectrum (mmWave), named for the actual distance between radio waves. This range typically is identified as above 24 GHz and can carry much more data than low and mid bands. While these higher frequencies are more susceptible to weather, structural interference, and distance, operators have discovered how to better use this spectrum with new antennas, dense architectures, and beam-forming techniques.

These technologies have been incorporated into the new 5G standard, and most operators are incorporating mmWave into their 5G plans. However, mmWave 5G will be limited to areas where line-of-site transmissions can reach greater populations.

mmWave 5G will roll out more slowly than Gigabit or Sub-6 5G and will initially only cover small parts of large cities. That said, the projected performance of mmWave 5G is tantalizing.

Here are the performance characteristics of mmWave 5G.

Expected Practical Performance of mmWave 5G

Download: 300 Mbps–3 Gbps
Upload: 30–60 Mbps (with 5G Standalone Core: 150 Mbps–1.5 Gbps)
Latency: 30–70 ms (with 5G Standalone Core: 8–12 ms)
Propagation: Low

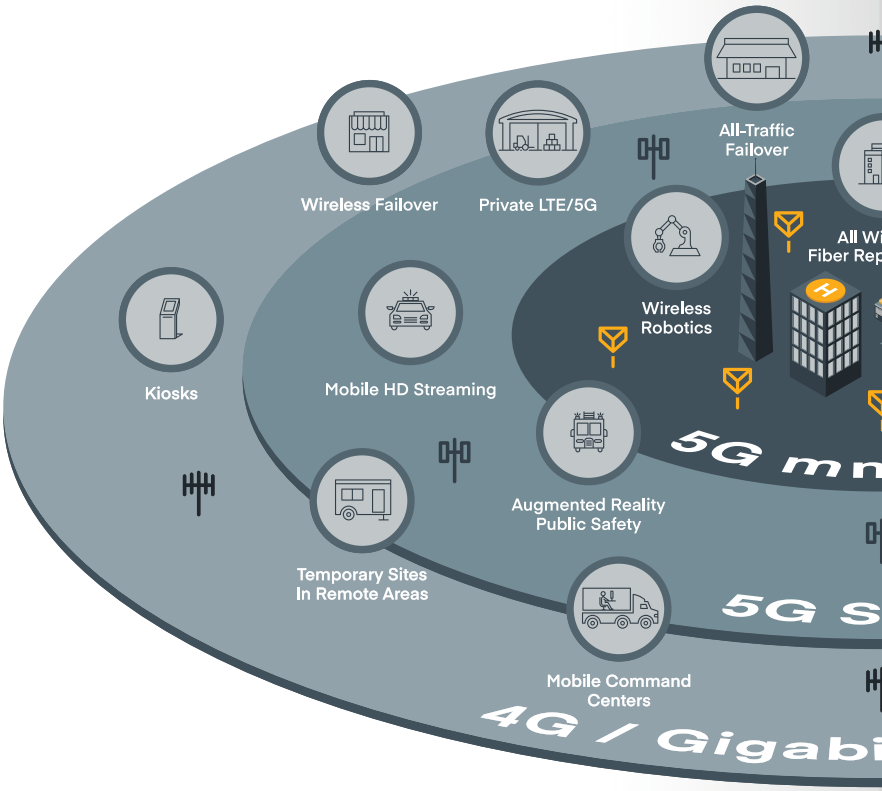
Let's Talk Money — Flat-Rate Business Data Plans

With these unprecedented performance characteristics, operators around the world have begun to roll out flat-rate data plans to pair with their high-performance wireless broadband services. This means organizations can worry less about billing and focus more on the flexible applications that wireless broadband can enable.

The Diverse Technologies and Uses of 5G

So, let's put it all together. As you may have gathered from reading the prior sections, the 5G landscape is quite diverse. This means that organizations will have some sites, vehicles, and IoT deployments in 4G LTE coverage, and others in Gigabit-Class LTE, Sub-6, and mmWave coverage. Organizations will need to ensure that their edge networking solutions can seamlessly adapt to each technology area and to the phases of network operator rollouts.

Diagram 1 shows each spectrum band supporting the 5G landscape along with sample use cases that would fit well in those bands. Many applications will run well in the 4G LTE band while others require 5G performance.

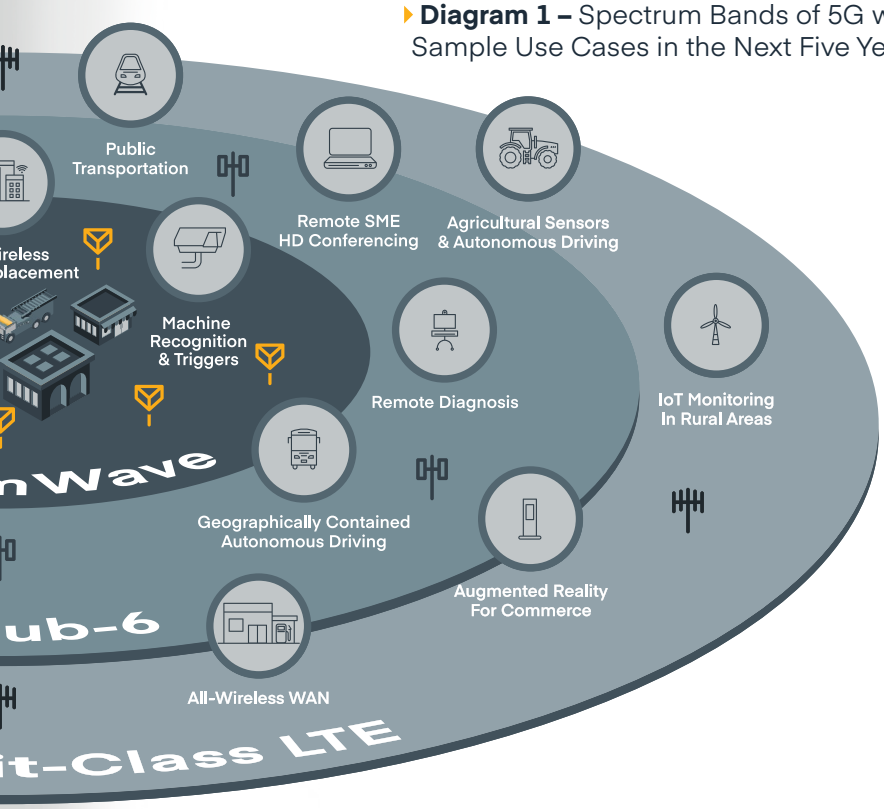


The Sub-6 band requires greater densification than 4G LTE, and therefore will be less pervasive. Since Sub-6 has significantly better performance compared to 4G LTE, high-bandwidth applications will run capably.

Due to the acute densification required by mmWave, coverage areas will be smaller than other spectrum bands. Applications requiring the highest performance will be deployed in mmWave coverage areas.

Other applications naturally perform well in multiple spectrum bands, such as temporary sites, public transportation, and augmented reality for commerce. And some apps run in independent environments such as Private LTE/5G.

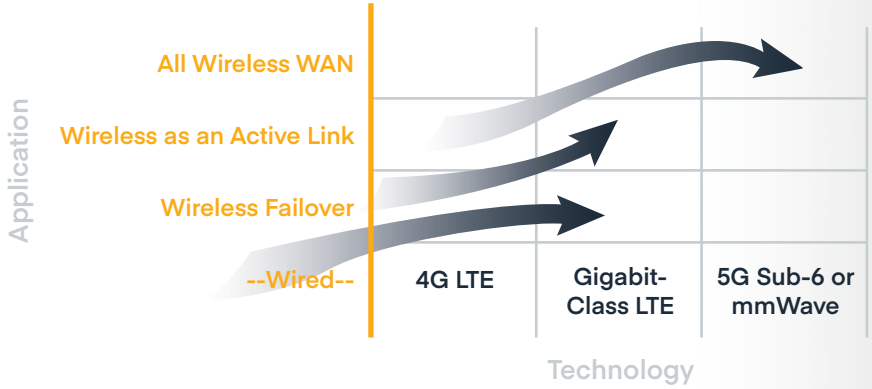
Diagram 1 – Spectrum Bands of 5G with Sample Use Cases in the Next Five Years



03 Your Pathway to 5G

Because 5G is a collection of new technologies and spectrum that will roll out over time, 5G is less of an event and more of a pathway. The time has arrived for organizations to learn about and invest in these new technologies that are available now and will immediately advance their operations and prepare them for fully deployed 5G. In most cases Gigabit-Class LTE is the first step on the Pathway to 5G. Diagram 3 shows a two-dimensional view of the Pathway to 5G.

Diagram 3 – Your Pathway to 5G



Organizations will move from the lower left to the upper right of Diagram 3 as they advance their edge networks. Different sites may be on different pathways, depending upon availability of operator services in each area. An organization with multiple sites must ensure it can effectively run a hybrid wireless edge network composed of 4G LTE, Gigabit-Class LTE, and various types of 5G technologies. Now let's explore how your organization might move along the Pathway to 5G.

Situation: If Only 4G LTE is Available

What if some of your small or medium-sized sites are in remote areas where 4G LTE is the only feasible wireless WAN option, and Gigabit-Class LTE isn't available?

Your first step on the Pathway to 5G could be to deploy 4G LTE for failover or as an active link.

With most organizations moving to cloud-based applications, and with the general reliance on Internet services, the cost of downtime due to a WAN link outage is dramatic. All organizations with branches or distributed sites should consider the value of high availability. A wireless WAN link provides a diverse pathway to divert traffic if the wired links go down.

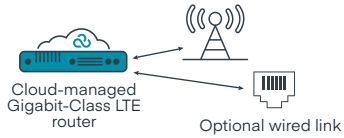
Situation: If Both 4G LTE and Gigabit-Class LTE are Available

What if both 4G LTE and Gigabit-Class LTE are available? There are two important reasons to consider deploying Gigabit-Class LTE today. First, Gigabit-Class LTE solutions are 4G LTE backwards compatible. This means even if you deploy a Gigabit-Class LTE solution in an area where Gigabit capability has not been turned up, you can use 4G LTE in the meantime and turn on Gigabit once it is available.

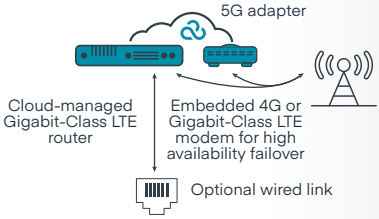
Second, industry-leading, enterprise-class Gigabit-Class LTE solutions are 5G Ready. They support 4G LTE or Gigabit-Class LTE today and also will support enterprise-class 5G adapters — via an Ethernet port — once they hit the market. (See Diagram 4).

Diagram 4 – Gigabit-Class LTE / 5G Deployment

Now: Deploy Gigabit-Class LTE Today



Later: Add 5G Adapter



Operators are rolling out Gigabit-Class LTE rapidly; soon it will be available in most markets around the globe.

With minimal effort an organization could deploy Gigabit-Class LTE today and gain double or triple the performance of 4G LTE when the service lights up.

So, how do you know a Gigabit-Class LTE solution is 5G Ready? Here is a quick list of 5G Ready capabilities.

Software-Defined Control – The edge networking solution should offer traffic steering between multiple wireless or wired links to ensure maximum efficiency and seamless high availability.

Wireless High Availability – Although 5G adapters will offer 4G failback, things can happen to hardware. Having an embedded 4G modem in your edge router with the ability to intelligently failover to another operator will ensure wireless high availability.

Multi-Operator and Multi-Service Flexibility – The ability to use different operator networks simultaneously with different modems is crucial for organizations seeking high availability and greater flexibility.

Wireless Management – Ensure that your edge networking solution can track, forecast, and send notifications based upon detailed metered usage across hundreds or even thousands of wireless devices.

Situation: If Sub-6 5G is Available

If Sub-6 5G is available in your area, you should consider using it for wireless failover, as an active link, or for all-wireless broadband.

The performance of Sub-6 may enable your failover to include all traffic, not just critical data, depending on the type of traffic running at each of your small to large sites.

Using Sub-6 as an active link will greatly increase your overall bandwidth while using SD-WAN to intelligently load balance and have built-in link diversity for failover. The performance of Sub-6 may rival fiber performance in your area, while also offering more flexibility and operational simplicity. Many nationwide organizations have switched from using many regional wired broadband providers to one nationwide cellular operator.

Situation: If mmWave 5G is Available

If you are fortunate enough to be in an area where mmWave 5G is available, you definitely should consider using it or failover, as an active link, or for all-wireless broadband.

However, the most compelling use of mmWave 5G is as an all-wireless-WAN deployment. In some locations, mmWave will offer better performance and lower cost than fiber, but with the hallmark flexibility of wireless. With Gigabit-Class LTE as a failback and with a second Gigabit-Class LTE modem in the connected router, you can run a wireless high-availability deployment.

04 What You Can Do Today

> **Planning is bringing the future into the present so that you can do something about it now."**
>
> **Alan Lakein,** author

In the spirit of "bringing the future into the present," the full promises of 5G will not be realized without foresight and alignment of resources today. Below is a suggested planning exercise that could bring significant value to your organization.

Explore Transformative Use Cases for a Competitive Edge

The recommended first step is to meet with strategic lines of businesses. Hold several sessions to look at your business from a visionary perspective. You likely will ask the following questions:

How will our market and customers change in 2, 5, and 7 years?

How can technology help us exploit those changes?

What technology gaps could prevent us from seizing these opportunities?

What role can wireless wide area networking play in these advancements?

What steps should we take now to prepare?

After this exercise, you will want to document these directions in a technology roadmap. Then consider meeting with stakeholder groups — such as finance, marketing, and procurement — that can help turn these plans into active projects. You may consider using the matrix in chapter one as a starting point for potential use cases.

Meet with Wireless Operators to Discuss Plans and Options

There is great value in meeting with carriers today and sharing your high-level plans. Not only will you learn more about their plans, but you can also forge valuable relationships for later deployments. At the minimum you will want to discuss:

1. Wireless broadband technology coverage for all your sites
2. Flat-rate plans and national discounts
3. How POCs might work in each of your sites

Meet with Network Vendors or Resellers

Next, you should consider meeting with edge networking vendors or their resellers. In the early days of 5G, edge networking is the glue that makes hybrid networks run at enterprise-class levels. Similar to discussions with operators, you will want to:

1. Share plans and ask about various ways to accomplish your goals
2. Diagram solutions
3. Plan out what a POC might look like and compare to the plans suggested by your operator

05 What to Consider for Your Next Edge Network Refresh

The software and hardware that directly make 5G connections work are only part of what you need for a next-generation wireless WAN.

Review VPN Tunnel Design

Reducing latency is a big thrust of 5G. Unfortunately, VPN tunnel latency may negate the benefits. Your IT team will want to make changes to the VPN architecture to prepare for the advantages of 5G. The team could consider architectures that avoid sending data back and forth between the edge, the cloud, and data centers. They also could consider architectures in which branches directly connect to cloud applications via TLS.

Plan for Multi-Access Computing Advantages

Applications that haven't been practical due to high latency may now be practical because of an element of 5G called Multi-Access Computing (MEC). MEC places computing power at the edge of the cellular network to process real-time computing tasks, saving critical milliseconds. Organizations may need to work with cloud computing companies and operators to appropriately stage computing resources for ultra-low latency applications.

Consider a Distributed Architecture at the Network's Edge

Unfortunately, critical tools such as firewalls, routers, IDS/IPS, and computing banks add latency to edge networks. The closer these services can move to the network's edge, and away from a centralized architecture, the better for latency.

Implement Higher-Throughput Endpoints at the Network Edge

With the possibility of multi-Gigabit speeds, it would be a shame if network edge devices were limited by their interface speeds and CPU capabilities. As organizations look to refresh their edge infrastructure, they should consider minimum interface speeds of 2.5 Gbps. Processors should be able to run full services and broadband speeds well over 1 Gbps to best prepare for the future.

Increase Core Network Bandwidth

It stands to reason that if the edge is significantly growing its capacity, the core of the network will experience a multiplying effect. Backbone infrastructure changes take time, so planning ahead will be important.

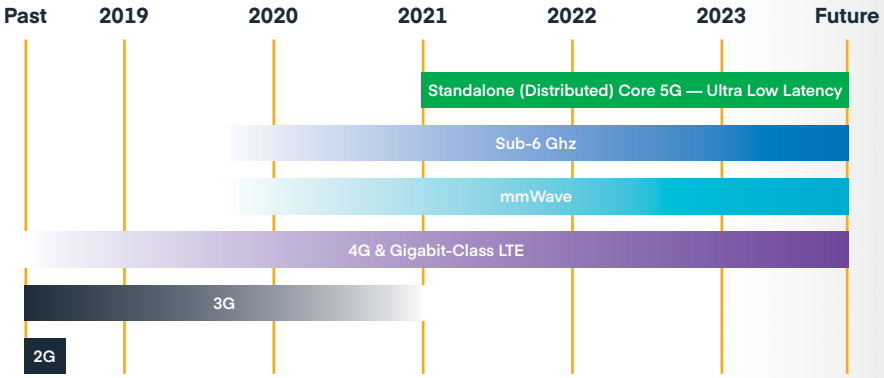
Pathway to 5G Consulting Workshop

Cradlepoint offers a personalized half-day 5G consulting workshop to help your organization understand and begin to develop strategies that take advantage of 5G. The workshop facilitators are seasoned telecommunications veterans. Many are from the large wireless operators, and have participated in the 5G working groups, and have been involved in early 5G network trials. If your organization is interested, please visit this link to request a workshop:

cradlepoint.com/5g-workshop-program

06 Looking Forward

As with any disruptive technology, the early years of 5G will be transitionary as operators build out their networks and react to consumer and business demand. In Diagram 2, the Cradlepoint 5G Strategy Group provides estimates of average global operator rollout timeframes. As you can see in Diagram 2, rolling out Sub-6 and mmWave 5G will take several years. In particular, deploying mmWave 5G line-of-sight towers will be a monumental undertaking. Gigabit-Class LTE will quickly replace 4G LTE as the 4G technology of choice in most markets. 2G and 3G will be phased out, and their spectrum will be re-farmed for 5G.



Source: Cradlepoint 5G Strategy Group, 2019

During this transition, some organizations may be inclined to hold back and wait for more clarity. However, those same organizations may regret their position in a few years when competitors roll out new technologies and applications and rapidly gain significant competitive advantage.

There are many ways to enter the Pathway to 5G (see diagram to the right) that mitigates your risk today and helps propel your organization into a technology leadership position for tomorrow. As the 5G landscape changes over the next few years, stay informed about changes not only by reading technology news, but by staying close to best-in-class vendors, resellers, and operators who can help you prepare for the future. For more information on 5G edge network solutions, go to: **cradlepoint.com/5G**

About Cradlepoint

Cradlepoint is a global leader in cloud-delivered wireless edge solutions for branch, mobile, and IoT networks. The Cradlepoint NetCloud service — based on the Elastic Edge™ architecture — delivers an agile, pervasive, and software-defined wireless edge that connects people, places and things everywhere over LTE and 5G cellular networks with resiliency, security, and control. More than 18,000 active enterprise and government organizations around the world, including 75 percent of the world's top retailers, 50 percent of the Fortune 100, and first responder agencies in 25 of the largest U.S. cities, rely on Cradlepoint to keep critical branches, points of commerce, field forces, vehicles, and IoT devices always connected and protected. Major service providers use Cradlepoint wireless solutions as the foundation for innovative managed network services. Founded in 2006, Cradlepoint is a privately held company headquartered in Boise, Idaho, with a development centre in Silicon Valley and international offices in the UK and Australia.

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