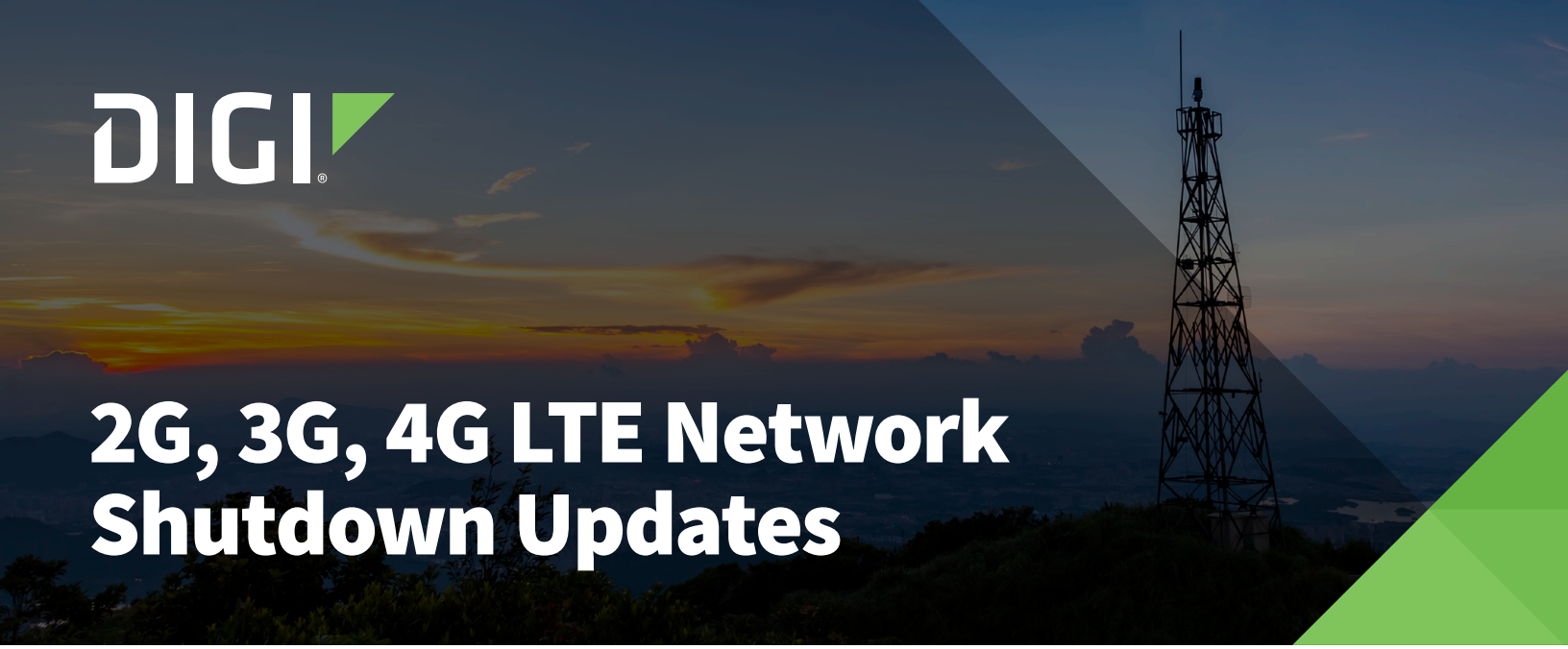

2G, 3G, 4G LTE Network Shutdown Updates

Cellular networks are changing, and some are sunsetting. This leads to many concerns and questions from businesses, governments and industries with deployed devices based on older networks. When will 2G and 3G networks go away? And will 4G LTE networks also be scheduled for shutdown, or is it safe to invest in them now? This technical brief will further explore and answer these questions.

Why older networks shut down

The main reason for network shutdowns is that the carriers have limited spectrum available for expansion. To provide a faster, more responsive network to their customers, carriers must re-use their spectrum with newer, more efficient cellular technology. Old 2G/3G infrastructure is removed to make way for new networks, and older cellular devices must therefore be retired.

There are two metrics in this context that matter most:

1. Spectral efficiency, measured in bits per second/hertz. This is an indicator of how efficient the data is transferred per available bandwidth. Modulation, coding schemes and error correction play a key role here. Higher order modulation schemes like 64-QAM and 256-QAM commonly used in 4G LTE allow data to transfer up to 8 times more bits/Hz as compared to 2G or 3G.
2. This is the delay from request to response, and is an indicator of how responsive a cellular network is. Through cellular network and technology upgrades, latency has come down from seconds in the early 2G days, and triple-digit milliseconds in 3G, to double-digit milliseconds in 4G LTE and an anticipated single-digit latency in future 5G Stand-Alone (SA) networks.

The good news is that 4G LTE will be available for at least a decade to come, and will co-exist with 5G networks. In this technical brief, we'll provide updates on the sunsetting of 2G and 3G networks and the outlook for 4G LTE and 5G networks, to support those who are planning their migration path.

Most of America's largest carriers have already shuttered their 2G service or plan to soon:

- AT&T stopped servicing its 2G network in December of 2016.
- T-Mobile plans to sunset their 2G network in December of 2020.
- Sprint will do the same a year later with their 2G CDMA network, in December of 2021.
- Verizon Wireless will phase out its 2G CDMA network at the end of 2020. Originally it had planned to sunset the network at the end of 2019 but the company later decided to push the date back a year.

It's important to note that there will most likely be restrictions on 2G network usage even before the actual sunset date. This is for two reasons:

1. Carriers will stop activating new 2G devices well in advance of the network shutdown. If you already have a cellular router or phone connected to the network you'll still be able to use it but new device registration may be impossible.
2. Carriers will re-farm spectrum ahead of the network shutdown, which means that 2G-only devices may no longer work as well as they used to in these locations.

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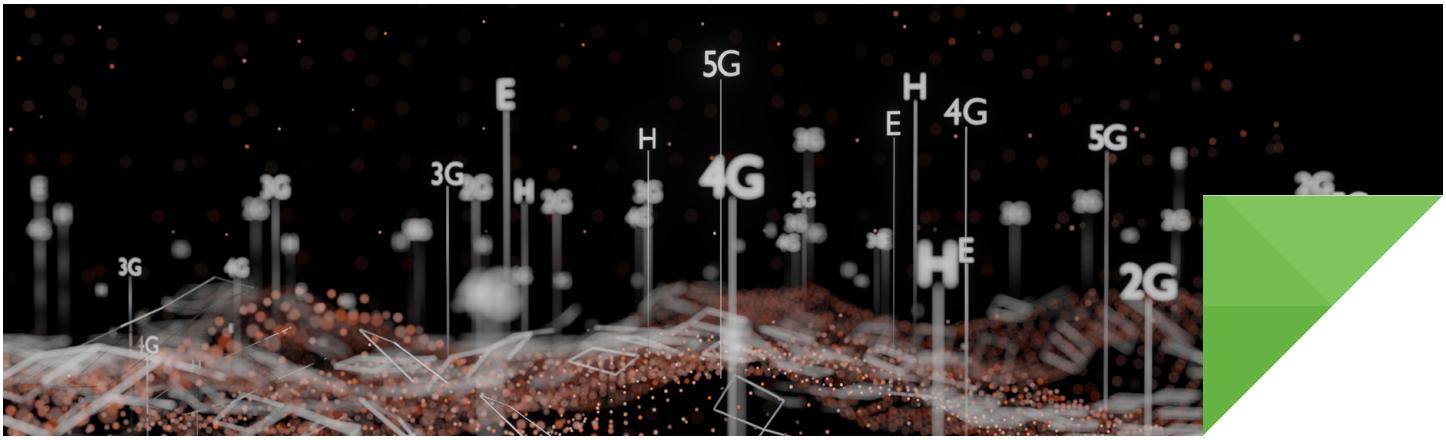

In Canada, Bell shut down their 2G network in June of 2018. Both Telus and Rogers have also stopped supporting 2G devices. In Europe, where active 2G installations are more prevalent, Vodafone has promised that they won't sunset their 2G service until at least 2025, but that does not mean they don't start re-farming spectrum ahead of that date.

When will 3G shut down?

As with 2G networks, carriers are eager to sunset older 3G networks so that they can repurpose that spectrum to support 4G LTE. New devices need more speed, and 3G tops out around 3 Mbps. Besides being faster, 4G LTE is also more efficient, as it allows more devices to share the spectrum.

Here are some at-a-glance dates:

- Verizon is sunsetting its CDMA network at the end of 2020.
- AT&T has stated they will sunset their 3G network in February of 2022 with the last date for phone activation on the 3G network being already past.
- As of this writing, T-Mobile has not made a public statement regarding the date they plan to shutter their 3G network. However, many speculate T-Moible will sunset their 3G networks by the end of 2021.
- The last activation date for 3G on the Sprint network was April 2019 and the Sprint 3G network will be shut down in December of 2022.

To learn more about the transition from 3G to 4G and how to make that move as smoothly as possible, see the Digi blog post, **How to Ensure a Successful Migration from 2G and 3G to 4G LTE**.

When will 4G LTE be phased out?

Like anything else, 4G will become obsolete one day. However, that day is far enough in the future that IoT deployments today and in the foreseeable future will be deployed on 4G networks.

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In fact, not only will it be at least a decade or more before 4G has been fully eclipsed by 5G, but today 4G LTE is a more cost-effective choice – and offers plenty of bandwidth – for most IoT applications. 4G LTE, which stands for Long Term Evolution, has evolved significantly since its launch and still has a long track ahead.

Meanwhile, 5G is a revolutionary new technology and very exciting, but at this time, it is only advised for early adopters. As with all new technology, testing and full rollout involve some bumps in the road, and important incremental development.

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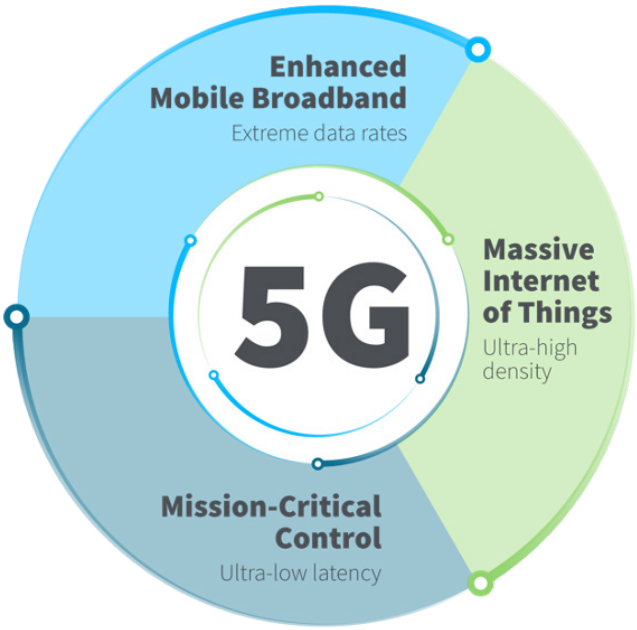
Key considerations for 5G adoption

Here are some important considerations to help with your migration planning:

- 5G networks are cutting edge, but coverage is limited today, and network infrastructure must evolve to deliver the 5G vision of "one ubiquitous network for all use cases."
- Technologies like 5G mmWave are not ideal in areas with obstructions, such as buildings or dense foliage, or locations that experience a lot of precipitation or snow. Even double-paned glass can block a 5G mmWave signal.
- Due to the need for development and testing to ensure signal viability, as well as node density, the full 5G rollout will occur over the next 3-5 years and longer, depending on the geographic area.



- Like 4G LTE, 5G is about taking a long-term evolution approach and providing incremental value along the way. This can best be seen in the specifications behind the technology, which are bundled into releases by the 3rd Generation Partnership Project (3GPP).
  - 3GPP Release 15 was the first 5G release in December 2018, focusing on the foundation and Enhanced Mobile Broadband (which means high-speed applications).
  - Release 16 (sometimes referred to as 5G Phase 2) was released in July 2020. It focused on mission-critical control, but also evolved Enhanced Mobile Broadband.

How will 4G LTE and 5G co-exist?

To transition to 4G LTE, carriers needed to shut down the 3G spectrum in order to "make room" for the new networks. 5G is fundamentally different in two ways: First, it uses new spectrum, such as mmWave spectrum. And second, it can work in conjunction with 4G in existing spectrum, thanks to Dynamic Spectrum Sharing (DSS).

What is Dynamic Spectrum Sharing (DSS)?

DSS is a technology that allows the deployment of both 4G LTE and 5G in the same frequency band. It dynamically allocates spectrum resources between the two technologies, based on user demand.

Without DSS, an operator who has 20 MHz of 4G LTE spectrum available would have to split that spectrum, meaning they would have to allocate 10 MHz of spectrum to 4G LTE and cram all their LTE users into that 10 MHz of spectrum. Then, the remaining 10 MHz spectrum could be used for 5G, even though initially there will only be a minimal number of 5G users.

With DSS, an operator doesn't have to split their spectrum or have a dedicated spectrum for either 4G LTE or 5G. Instead, they can share that 20 MHz of spectrum between the two technologies. Initially, the spectrum will be mostly used for 4G LTE, but as the number of 5G devices grows, more and more spectrum will be used for 5G. Eventually, in an estimated 15 to 20 years when there are few 4G LTE devices in use, most if not all of the spectrum will be used for 5G.

Dynamic spectrum sharing lets carriers use the same spectrum band for both 4G and 5G. To use a traffic analogy, instead of building different roads for buses and cars, DSS is like having one big highway with separate lanes for the different types of vehicles.

From 5G non-standalone to 5G stand-alone

Many 5G devices, like cellular routers, will be built with both 4G and 5G radios so that they're capable of connecting to either network. In the early days of 5G, they must connect to 4G LTE first, and then connect to a 5G network if it's available. This is also called 5G Non-Standalone (NSA).

At first, most data will be transmitted via 4G LTE. However, over time as 5G coverage expands and the cellular infrastructure moves to 5G Stand-alone (SA), more and more data will be transmitted via 5G and cellular devices can connect to the 5G network directly without the detour over 4G LTE. Therefore, to continue with the traffic analogy, 5G will eventually overtake 4G as the bigger lane on the freeway.

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How do LTE-M and NB-IoT fit into 5G?

Suppose you want to deploy a larger installation of LTE-M or NB-IoT devices in the near future. Will these devices soon be obsolete, as 5G becomes available? Should you wait for 5G?

The answer is you made a great technology choice with LTE-M or NB-IoT, because while these are 4G LTE technologies, they were developed as part of LTE's long-term evolution paradigm with 5G in mind.

When LTE-M and NB-IoT were initially designed, special attention was given to the design of 5G to make certain LTE-M and NB-IoT can operate or exists in-band to a 5G system. This provides a forward-compatible path well into the 5G future, beyond when 4G LTE may no longer be available.

And as mentioned earlier, Release 17, scheduled for late 2021/early 2022, will be the first release focusing on the Massive Internet of Things, which means that chipsets and devices will follow the earliest in 2022/2023.

Four ways to prepare for 5G today

What can I do today to prepare for 5G? Should I upgrade now or wait? Do I really need 5G today? Here at Digi we are hearing these and many other questions from our customers, so we have put together the following actionable process:

1. Identify 5G applications

Identify applications where much faster speed and lower latency would optimize their operations. A prime example are applications that leverage edge compute for machine learning and predictive maintenance.

Will your application needs change over the next 5 years, in terms of data volume, latency, and power requirements? For example, LTE-M and NB-IoT enable new battery-operated devices and new business models that were previously not possible with 2G/3G.

Additional questions to ask yourself: What flavor of 5G do you need? Do you need 5G sub-6 with its nationwide coverage but with similar performance to 4G LTE today, or do you need the high-speed of 5G mmWave, which is mostly available in densely populated, urban environments? This is an important factor, because as mentioned earlier, not all spectrum will be available everywhere, and spectrum availability will evolve over time. Do you want to 5G-enable or replace existing equipment?

2. Take stock of your device inventory

Understand your 4G to 5G evolution path. Knowing where you are today will help you to plan the future. Perhaps you are still using 2G or 3G devices. Or your application is using first-generation 4G devices, and may benefit from an upgrade to newer 4G LTE devices with faster processors and 4G Gigabit LTE cellular speeds.

Look for modular devices or devices that are 5G ready, which typically means that they have the horsepower and interfaces to support 5G via a radio upgrade.

3. Quantify the cost or risk of maintaining the current deployment

If you're still using 2G or 3G devices, you are running the risk of connectivity loss and service interruption due to network shutdowns. If you are using 4G LTE devices, you are generally in a good spot, but look at the age of the device and determine if you want to replace 1:1 or upgrade to a newer device. Key factors to consider are device security and firmware updates. As always, we can be your guide in these choices.

4. Create a business case for migration

Do a cost/benefit analysis that shows when and if moving to 5G is a worthwhile move. Look at meaningful interim technology steps as part of a larger migration. For example, consider a modular, higher-end 4G LTE/5G-ready device now that also provides you an upgrade path when 5G becomes available and your business case can support a migration to 5G.

Work with your device and mobile network operator partners to align on device and network availability timelines. Consider installation costs, such as for outdoor 5G mmWave equipment.

In summary: Prepare for change

Within the U.S., it's reasonable to assume that by the end of 2022 there wont be a single major carrier supporting 2G. The same fate awaits 3G. 4G operates under a different scenario, and we can confidently say that 4G will be around for at least another decade. And because 4G LTE has plenty of speed and reasonably low latency for most applications, it is an excellent choice for IoT applications today.

Those guidelines apply to developed countries like the U.S., Canada and Europe. In less developed countries, 4G LTE will likely remain the standard for several decades to come. Meanwhile, 5G networks will expand and ultimately deliver on their full promise, alongside the continued growth of 4G and the deployment of IoT applications.

Now is the time to plan and take action if you still have 2G/3G device deployments. With 4G LTE, you can continue growing your 4G deployments. If you are an early adopter, 5G may make sense for you soon.

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