Ensure Successful Field Deployment of Digi 5G-enabled Cellular Routers

Introduction

The Fifth Generation (5G) cellular network is the latest cellular technology being deployed around the world by over 100 Mobile Network Operators (MNOs). This new technology delivers many advancements, but with these comes new considerations to ensure optimized device and network performance, and longevity in the field. 5G brings about a lot of new advancements like the ability for increased data speeds and lower latency. There are also new considerations that must be taken into account when comparing to legacy 3G/4G technologies to ensure optimized performance and field longevity.

This technical brief outlines five key points to consider when deploying Digi 5G-enabled cellular routers, as well as tips to ensure optimized router and network performance after deployment.

✓ Consideration #1

Additional Radio Frequencies

Make sure the antennas on your Digi routers support the required frequency bands. These antennas need to receive/transmit frequency bands in the 600 MHz to 6 GHz range.

Digi often observes customers upgrading to new 5G-capable routers and then attaching previously used 3G or 4G antennas. With MNOs widely adopting the higher frequency C-Band (CBRS), not having the appropriate 5G antennas attached affects the router and network performance as these older antennas do not support the frequency range 5G routers require.

5G cellular technology offers more radio frequencies than the previous 3G and 4G technologies. The main frequency range for both 3G and 4G technologies is approximately 600 MHz to 2200 MHz. 5G adds additional frequencies including those in the 3300 MHz to 5000 MHz range. This includes the adoption of the C-Band, which is a wide band allowing for increased channel bandwidth, resulting in higher data speeds. C-Bands (n77, n78, n79) are core bands used by MNOs worldwide. In the United States, these core bands are currently being used by AT&T, Verizon, and T-Mobile.



✓ Consideration #2

Multiple Input, Multiple Output (MIMO) Transceiver Advancements for Communication over a 5G Cellular Network

If upgrading to 5G-enabled routers, make sure you have a deployment plan. That plan should include a step confirming that all antennas are used and attached correctly.

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The advancements made to MIMO transceivers, bandwidth support, and spectrum allocation make it a critical part of any 5G cellular network and the deployment of communication systems over that network. The number of antennas has also increased to at least four antennas to support the communications load required for an IoT (Internet of Things) ecosystem. This is at least twice as many antennas as was required by legacy networks. It is important to use all the antennas that come with your 5G-enabled router, as these routers are calibrated and optimized for MIMO transceiver/antenna pairings. Not using the full complement of antennas may lead to several issues, including:

- Loss in coverage
- Loss of data throughput/performance
- Reduced battery life
- Loss of frequency bands supported by the 5G device

5G is taking advantage of advancements in multiple transmitters and multiple receivers, also known as MIMO (Multiple Input, Multiple Output). Legacy technologies like 3G and 4G deployed receiver antenna diversity via two antennas. 5G has taken this much further with the use of MIMO, which requires the use of four or more antennas.

The use of the required number of antennas is essential for good field performance. 5G networks and devices are calibrated and optimized with all required antennas. Some legacy device deployments may have two antennas and do not have room to move up to four or even eight 5G cellular antennas. There are several ways to ensure you use all required antennas, including using small antennas, cabled antennas, and internal antennas.

✓ Consideration #3

APN Setting Configuration for the MNO's 5G Network

Many 5G network operators have deployed new 5G APNs and you need to make sure you are using the correct one for your rate plan. 5G devices may continue to work on legacy 3G/4G APNs providing a false sense of comfort for field deployments. It is imperative that you work with your connectivity provider to ensure the proper 5G APN is being used. The use of the wrong APN can lead to a reduction in performance or use of legacy IP addresses (for example, IPv4), and worst of all may lead to devices becoming inoperable down the road as MNOs look to sunset the 4G network and 4G APNs in the future.

✓ Consideration #4

5G Cellular Network Types and Longevity

Confirm with your MNO that:

- **You are using the correct APN for their 5G network for your rate plan**
- **They support a Stand-Alone (SA) 5G network**
- **The SIM/UICC they provide supports a Stand-Alone (SA) 5G network**

Make sure you configure your settings for the SA 5G network option



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There are two types of 5G cellular networks: 5G Non-Standalone (NSA) and 5G Standalone (SA).

Most of the MNO network deployments today are NSA, meaning they require a 4G network to work. 5G NSA networks are great because they support both 4G and 5G networks, allowing Digi routers to optimize performance by using all resources available from both technologies. The challenge with NSA is that over time more resources will shift to 5G and eventually 4G networks will be sunsetted (turned off). When this happens, 5G devices will have to move their support over to 5G SA mode. If any of your devices do not support 5G SA, they may stop working once your MNO sunsets their 4G technology.

✓ Consideration #5

5G Data Speed Performance and Coverage Can Vary

- **When analyzing 5G data throughput performance results be mindful of signal strength and in-use frequency bands**
- **Ensure that you understand the fine print of your 5G connectivity plan (data limits, throttling, etc.)**



5G data speed performance can vary and is affected by the availability of 5G bands and channels.

- Low-frequency 5G bands: In most cases, the 5G bands at lower frequencies provide slower data throughout since they have narrow channel bandwidths of 5-20 MHz, such as n1, n2, n5, n12, n13, n14, n66
- High-frequency 5G bands: The 5G bands at higher frequencies provide faster data throughput since they have wider channel bandwidths of 40-100+ MHz, for example n41, n48, n77, n78, n79

Some 5G bands are optimized for coverage, and this often includes the lower frequency bands under 1 GHz — for example, n5, n12, n13, n14, n71. Other 5G bands are optimized for performance, and include the higher frequency bands between 2-5 GHz — for example, n41, n48, n77, n78, n79. These high frequency bands travel less distance and may not provide the coverage seen in the bands below 1 GHz.

In addition, many 5G bands are narrow in bandwidth, typically 20 MHz or less and include n1, n2, n5, n12, n13, n14, n66. Other 5G bands are optimized for high data throughput and support 40, 60, 80 or 100+ MHz of channel bandwidth. These wide bandwidth bands include n41, n48, n77, n78, n79.

While a 5G network provides you with much higher data speeds compared to legacy 3G/4G technologies, the amount of data being used/consumed may also increase (depending on your use case). A couple common practices being used by mobile network operators are to (1) Limit the max data speeds of certain rate plans, and (2) Throttle max data speeds on certain rate plans after a specific amount of data is consumed.

Work with your MNO or connectivity provider to fully understand your rate plan and details to ensure your plan will meet your 5G cellular network needs. You may need a plan that does not throttle after a specific data limit, or a plan that only throttles to an acceptable limit so your business continues to run seamlessly and uninterrupted.



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5G Optimal Values

The following fields are important to understand when analyzing cellular connectivity.

- Signal strength
- RSRP
- RSRQ
- SINR
- Access Technology
- Cell ID and Physical Cell ID

Signal strength — The signal strength value indicates the level of the signal received by the modem. These values correspond to the RSSI (Received Signal Strength Indicator) reading of the connection. The signal strength value is one of several indicators of the cellular environment and provides a general summary of the connection. However, the following three indicators provide a more thorough and qualitative view of the cellular connection. The value is measured in dBm.

RSRP — Reference Signal Received Power indicates the average power of the received pilot signals (Reference Signal) or the level of the received signal from the Base Station. The RSRP values are measured in dBm. As this is a negative value, the lower the number the better — meaning the result is better the closer it gets to zero (0).

RSRQ — Reference Signal Received Quality characterizes the quality of the received pilot signals. The RSRQ value is measured in dB. As this is a negative value, the lower the number the better.

SINR — Signal to Interference + Noise Ratio, also called CINR (Carrier to Interference + Noise Ratio), is the ratio of the signal level to the noise level (or simply the signal-to-noise ratio). The SINR value is measured in dB. Simply put: the higher the value the better the signal quality.

NOTE: The RSRQ and SINR are the two most important values for obtaining optimal performance. While RSRP is important for connectivity in general, a strong RSRP will not guarantee the best performance. Having the RSRQ and SINR values at the best possible levels will provide great speeds even when the overall RSRP is low.

Access technology — This determines what kind of connection technology the device currently uses. There are a few main technologies: 3G, LTE, 5G NSA, 5G SA. 5G NSA is a combination of LTE and 5G. 5G SA is the “pure” 5G.

Cell ID and physical cell ID — These stand for the physical cell ID the device is connected to. In some cases, you might want to connect to a specific tower that is further away than the closer one to have a less crowded tower. This information can be obtained by the Digi device or from the ISP.

RF conditions	RSRP (dBm)	RSRQ (dB)	SINR (dB)
Excellent	>= -80	>= -10	>= 20
Good	(-80 to -90)	(-10 to -15)	13 to 20
Low	(-90 to -100)	(-15 to -20)	0 to 13
Poor	>= -100	>= -20	<= 0



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5G Challenges that Reduce Bandwidth and Connectivity

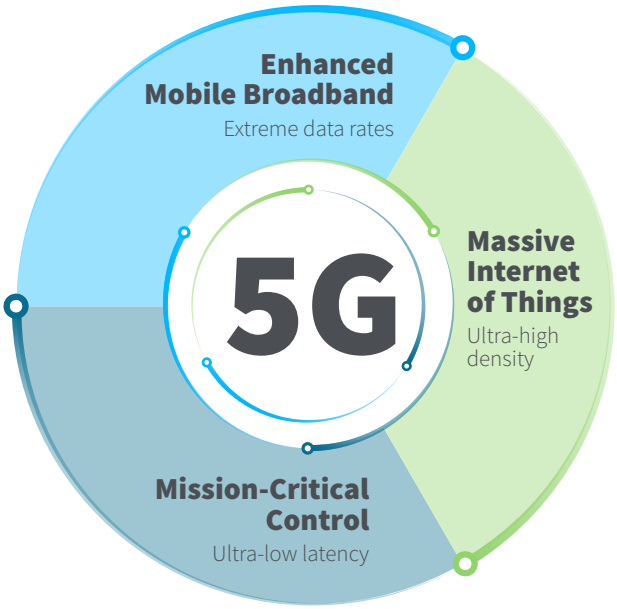
There are three primary issues to address to ensure you have the bandwidth and connectivity required for optimal network performance.

Reach — To accommodate higher bandwidth and speed, 5G tower technology does not have the reach of traditional cell towers. Where low-band signal can easily travel dozens of miles, some sub-6 GHz and mmWave signals will be limited to tens-to-hundreds of meters. This means one of the 5G challenges to be aware of is reach, which can break your integration strategy. In this scenario, you may need to use external antennas to place them in the optimal location to obtain a signal.

Signal degradation — In metropolitan areas, 5G challenges exist in the form of interference from large buildings, densely packed electrical or communication lines and even traffic signals. Because sub-6 GHz and mmWave signals do not penetrate or travel as far as low-band signals, the deployment will need to be much closer in proximity to the tower to receive optimal performance.

Coexistence with LTE and other wireless communications — To fulfill the promises of 5G, devices need to operate in many different frequency bands and with many different operating models. 5G will need to operate in adjacent cellular bands and sometimes within the same spectrum as other wireless communications systems such as Wi-Fi, Citizens Broadband Radio Service (CBRS), and military and satellite services.

Want to learn more? Learn how to calculate free space path loss in cellular deployments, in this **Examples and Guides article**.



Next Steps

Seeking next-generation solutions and support? Here are some next steps:

- Ready to talk to a Digi expert? **Contact us**
- Want to hear more from Digi? **Sign up for our newsletter**
- Or shop now for Digi solutions: **How to buy**

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