cradlepoint

VoIP Over LTE

Advantages & Best Practices

WHAT YOU'LL GET:

- Understanding of VoIP & VoLTE
- Insights into QOS
- Advantages of VoLTE over standard VoIP
- Network considerations for deployment
- Testing overview & results

OVERVIEW

Voice over Internet Protocol (VoIP), when used over LTE, can offer significant benefits to your network—and your business. These benefits include: cost-savings, reduced complexity and hardware, flexibility, and speed-to-deployment. Optimizing VoIP over LTE can also help your employees, customers, and IT teams focus on the work at hand, instead of the mechanics behind it. Furthermore, pairing wired and LTE connectivity moves your mission-critical applications from "three-nines" (99.9%) availability to "four-nines" (99.99%) availability—saving you money while increasing customer confidence and brand loyalty.

BENEFITS:

- High-definition voice
- Faster call setup time
- Longer device battery life
- Cost-savings
- Reduce complexity
- Reduce hardware
- Network flexibility
- Increased reliability
- Speed-to-deployment

VoIP ON AN LTE NETWORK VS. VoLTE

A common misconception is that VoLTE (Voice over LTE) and VoIP on an LTE network are one and the same. When we talk about Voice over IP in the traditional sense, we're talking about using either SIP protocol, H.323 protocol, or VoIP to run data across any connection media. The carriers do not see the data traffic as separate VoIP calls. In a traditional VoIP scenario, carriers see voice transmission as data coming from the customer that does not require special treatment. Cradlepoint recommendations will delineate how to surmount these challenges by leveraging the mechanisms on the Cradlepoint router.

VoLTE is a very specific implementation of VoIP on an LTE network, requiring the carrier's direct participation in the call because the function is using the IMS infrastructure to create the call control and quality. Thus, in a VoLTE scenario carriers are able to distinguish between what is voice and what is data—ensuring maximum call quality. Voice and data are treated differently and have different priorities.

NETWORK CONSIDERATIONS

For years, conventional wisdom among IT professionals has held that VoIP promises to enable the next generation of voice communications within the enterprise. However, its adoption has been slower than anticipated. The main culprits have been poor performing IP-PBX systems and the perception that VoIP technology is not ready for prime time. The latest generation of LTE networks means VoIP for the enterprise is now ready for the mainstream.

To successfully employ VoIP over LTE, two prime factors must be evaluated: **signal quality** and **network conditions**.

SIGNAL QUALITY

Two metrics are used to evaluate signal quality:

1. Signal to Interference plus Noise Ratio (**SINR**; measured in decibels [dB]; higher result is better)
2. Received Signal Strength Indicator (**RSSI**; measured in decibel-milliwatts [dBm]; closer to 0 is better)

SINR represents how clean the LTE signal is, while RSSI represents how strong the LTE signal is.

NETWORK CONDITIONS

The key factors to look for when assessing network quality are latency, jitter, and packet loss.

Latency (measured in milliseconds [ms]; closer to 0 is better) is how long it takes voice packets to go from their original source to their intended destination. For VoIP calls, this round trip process should take fewer than 100 milliseconds. If the delay is too long, the phone call will have pauses while the packets travel over the network and the other person hears the voice; the caller will then have to wait for the response to come back. People often will talk over each other when this occurs, resulting in deterioration of the quality of the phone call and the quality of VoIP services.

Jitter (measured in milliseconds [ms]; closer to 0 is better) refers to the variance in packet delay. If a high volume of voice data packets hit the router at the same time, followed by a pause, and then followed again by more voice packets, it requires the external destination to buffer the data as the packets arrive (instead of absorbing them as a continuous stream). If the network has high jitter, the call quality will be affected in ways that result in issues such as garbling.

Packet loss refers to minimal packets of data being dropped as they travel across the network. Packet loss can occur if the packets are significantly delayed while traversing the network, or if they arrive out of order. Low packet loss helps prevent poor call quality or even dropped calls.

	SINR	RSSI	Latency	Jitter
Excellent	Above 12.5 dB	Above -65 dBm	Below 100 ms	Below 20 ms
Good	10-12.5 dB	-65 to -75 dBm	100-150 ms	20-30 ms
Fair	7-9.9 dB	-76 to -85 dBm	151-400 ms	31-40 ms
Poor	Below 7 dB	Below -85 dBm	Above 400 ms	Above 40 ms

OPTIMIZING VoIP ON AN LTE NETWORK

Assuming network conditions are suitable, there are a few simple steps to take to initially optimize VoIP over LTE:

- Verify the network is on LTE and not 3G
- Ensure a strong, clean signal without interference
- Know where phones are located on the network and prioritize voice and data traffic
- Set up Quality of Service (QoS) rules within the router (ensuring voice calls are always given the highest priority when exiting the network)
- Limit the number of simultaneous calls so as to not overwhelm the capacity of the network

For some organizations, such as a tech support call centers or large outbound-dialing sales departments, VoIP over LTE is not an ideal solution—at least, not with today's technologies. However, for a small business or small enterprise environment, like a branch or retail store, optimizing VoIP over LTE provides four distinct advantages:

1. **Prioritizes voice data over other data:** If an email is delayed by one second, no one really notices. By contrast, if a VoIP packet is delayed by that long, it can greatly interrupt a phone call. Traffic identification and prioritization make the distinction between voice data and other data—and how a router should handle each type. By segmenting and prioritizing voice traffic, network administrators can shape the outgoing voice traffic, ensuring VoIP packets have the highest priority and are ushered to the front of the line.

2. **Produces a one-device solution:** With LTE, customers can deploy an all-in-one Cradlepoint routing platform that provides multiple functions: primary connectivity, firewall and security services, and multi-carrier failover. Businesses can save time and money by having a single-box solution.

3. **Establishes carrier independence:** Companies are not tied to a single carrier's network solution. VoIP on an LTE network allows network administrators to utilize the best carriers in the area or region. Mix and match carriers as needed to provide the best coverage for specific locations.

4. **Enables failover as true redundancy:** For many companies that rely on wired connections, such as a retail location in a mall, it's likely service will be disrupted in some way or another because of physical damage to wired lines or and ISP outage. When this occurs, LTE automatically provides redundancy as a failover connection. For a small retailer, VoIP over LTE can make a significant difference in ensuring business can proceed as usual. Phone calls and Point-of-Sale (POS) terminals can automatically be prioritized and maintained as mission-critical, whereas other services, such as customer WiFi, can be deactivated until the primary connection has been repaired.

TESTING OVERVIEW

A common question when deploying VoIP on an LTE network is how to take advantage of existing networks to do both VoIP and data. In a traditional setting, a carrier-provided wired broadband connection or other type of dedicated Ethernet connection would be secured, and this primary connection would be used for a mission-critical application.

Service disruptions to primary connections expose businesses to lost revenue and productivity while decreasing the quality of the customer experience—and ultimately diminish brand loyalty. Thus, seamless failover is a key factor in the overall connectivity scheme of mission-critical applications.

CRADLEPOINT METHODOLOGY

Many Cradlepoint customers already employ LTE as failover for their data services. A common question is whether they can use—for VoIP (Voice over Internet Protocol)—the same reliable LTE failover that works for their traditional data applications like POS, email, and web browsing. To answer this question, Cradlepoint performed a variety of real-world application tests. Cradlepoint utilized an Ixia performance test server and client on a PC connected to the Cradlepoint router. This allowed Cradlepoint engineers to control the testing environment and capture the results simultaneously. The G.729 codec was chosen due to its lower data usage and high voice quality.

Each set of tests ran on two different cellular carriers. The tests ran for three days; quality of the connection was decreased each day.

The tests were conducted over a 24-hour period to ensure network load on the carrier networks was taken into account. For each of these tests, engineers ran sets of tests with 1 VoIP call, 5 simultaneous calls, 10 simultaneous calls, and finally with 20 simultaneous calls.

For all tests, engineers ran the tests first as a VoIP-only connection, then added data transfers to the connection to simulate non-voice traffic on an LTE connection.

To express call quality in one broad, overarching measurement, Cradlepoint also calculated Mean Opinion Score (MOS)[1].

SUCCESS STORY
JACKSON-HEWITT

During tax season, Jackson-Hewitt offers tax preparation services in retail locations like Walmart and K-Mart. It sets up temporary kiosks in these retail locations that require Internet access and phone service.

Provisioning Internet connectivity and phone lines every tax season was costly, time consuming, and frustrating. Just ask Jackson-Hewitt franchise owner John Beazle. "Have you ever tried to get a DSL line into a Walmart?" he asked with a laugh.

The difficulties Jackson-Hewitt faced were having Day-1 connectivity, creating Parallel Networks separate from the big box retailer locations, and implementing phone systems.

Jackson-Hewitt implemented Cradlepoint solutions to connect to the Internet and provide the connectivity and provide the connectivity needed—without the provisioning or installation hassles of wired lines. The VoIP phone systems also allow the retail sites to become extensions of the main phone networks, eliminating the need to pay for new phone lines or individual phone numbers every tax season.

"I can't believe that Cradlepoint is so affordable–and reliable too. We've had zero downtime."

—JOHN BEAZLE, FRANCHISE OWNER, JACKSON-HEWITT

TESTING RESULTS[2]

As Cradlepoint tests were not intended to determine which carrier(s) may be better than others for VoIP traffic, the carriers will be referred to as Carrier 1 and Carrier 2.

As you can see with Carrier 1 on the MOS graph (Figure 1), MOS remained over 3.6 for the majority of the tests. Only on Day 3, with a higher number of calls and a high amount of data traffic did the quality drop below the minimum MOS threshold.

The MOS scores take a dip on Day 3 of each test. Again, on Day 3 there were lower signal strength than on Days 1 & 2.

SINR represents how clean the signal is; here the Average SINR was at or above the minimum for most of the test and never dipped below.

RSSI measures how strong the signal is. Only during the last day of the test did the RSSI dip below the minimum.

CARRIER 1 OBSERVATIONS

Call quality was excellent without a network load: MOS was above 3.8. Call quality was impacted by a heavy network load: MOS was good, not excellent. Day 3 ("Poor Reception Day"): Call quality was severely impacted by heavy network load (cutoff was 10 simultaneous calls).

CARRIER 1 CHARTS

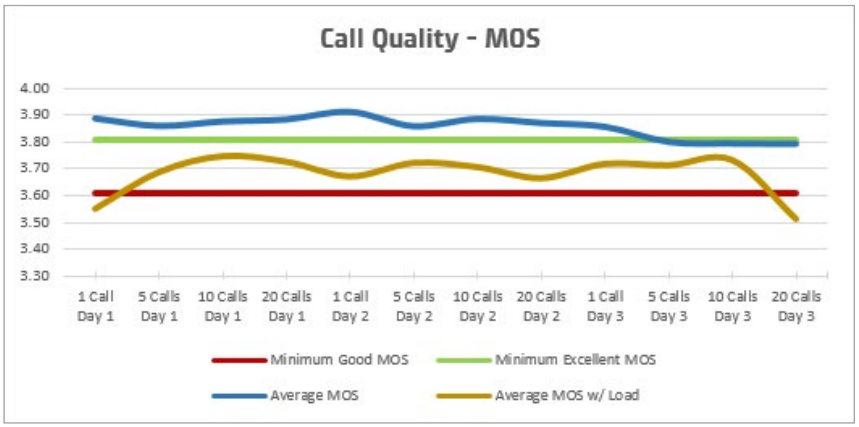


Figure 1: Carrier 1 MOS

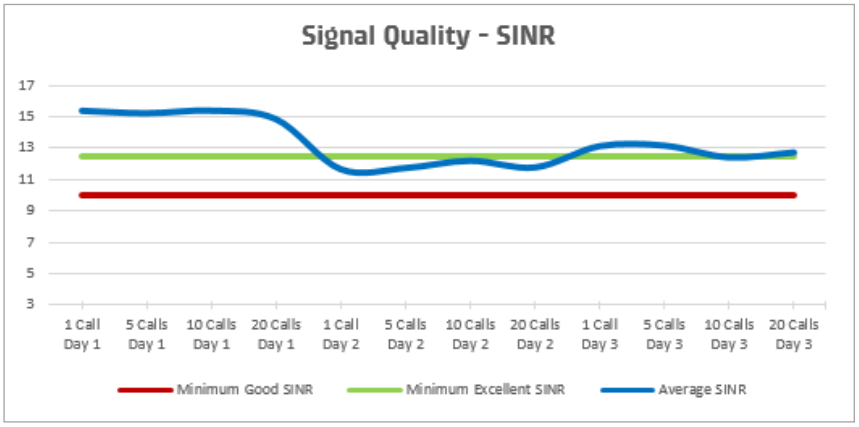


Figure 2: Carrier 1 SINR

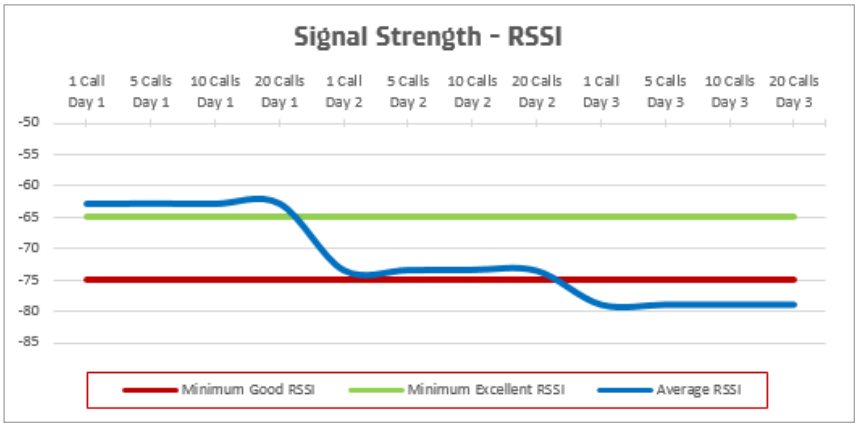


Figure 3: Carrier 1 RSSI

In Figure 4, the MOS was consistently above the minimum regardless of load until the network load was exceeded.

Figure 5 shows the SINR (how clean the signal is) varied depending on the day. Interestingly, it exceeded the minimum on Day 2 when above twenty calls.

The RSSI (how strong the signal is) dipped below the minimum only on Day 3.

CARRIER 2 OBSERVATIONS

Call quality was excellent without a network load: MOS was above 3.8, except for Day 3. Call quality was impacted by a heavy network load: MOS was good, not excellent; Day 3 was poor, with high calls and network load. Day 3 ("Poor Reception Day"): Call quality was severely impacted by heavy network load (cutoff was 10 simultaneous calls).

CONCLUSION

As LTE networks become faster, deploying VoIP over LTE is now a viable option for organizations looking to take advantage of existing networks to do both VoIP and data. Given proper network conditions and optimization, Cradlepoint's testing shows small-footprint environments can deploy VoIP over LTE as a voice failover solution, just as LTE is deployed for data applications.

CARRIER 2 CHARTS

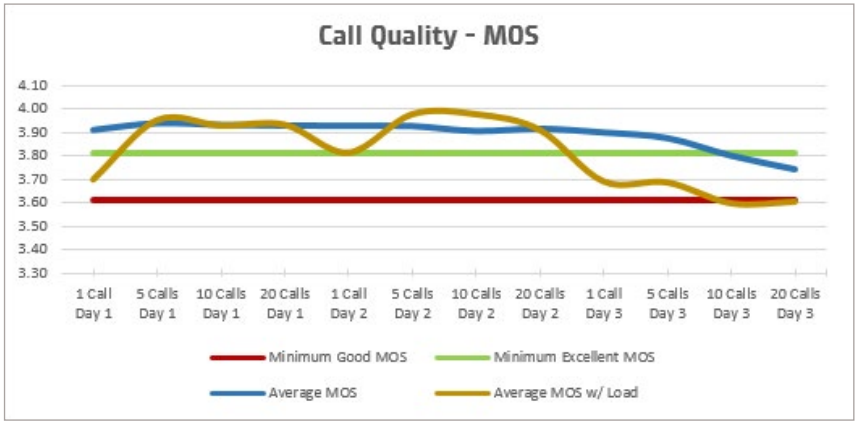


Figure 4: Carrier 2 MOS

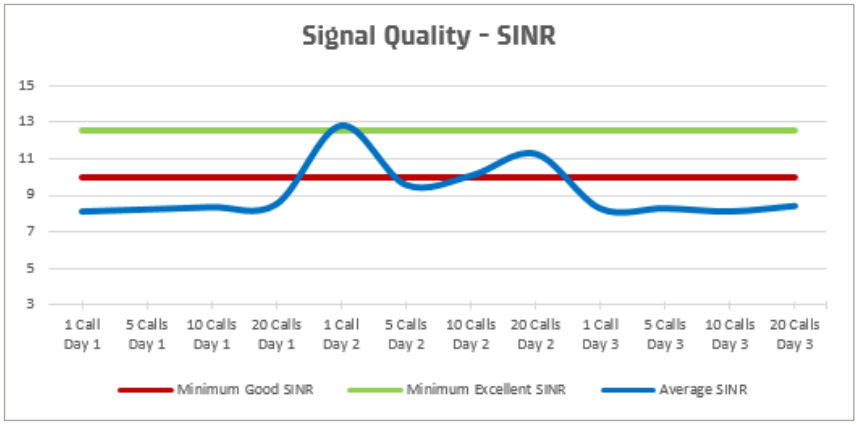


Figure 5: Carrier 2 SINR

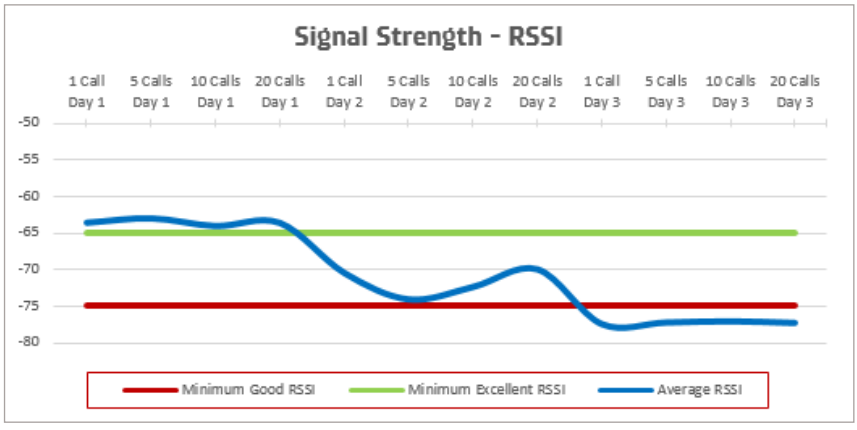
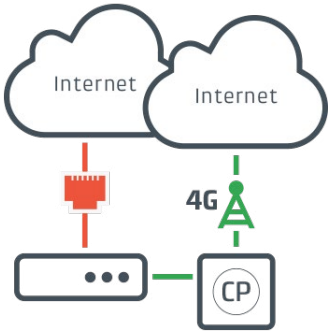


Figure 6: Carrier 2 RSSI

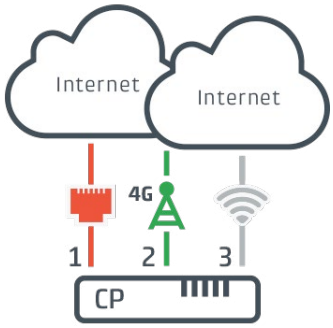
Properly configured Cradlepoint solutions offer significant advantages to organizations looking to streamline voice operations. By setting these parameters, VoLTE becomes a compelling solution: faster call setup times, flexible call location options, and increased call quality.

USE CASE ADVANTAGES



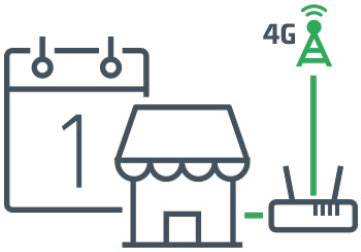
FAILOVER: RETAIL LOCATIONS

+ Better employee mobility via use of handsets
+ Faster response time due to mobility: employees patrol the retail floor answering questions rather than coming back to a central location for phone access
+ Cost savings over traditional solutions



FAILOVER: SMALL BRANCH OFFICES

+ Faster call setup times
+ More flexible solutions
+ Cost savings over traditional solutions



PRIMARY, POP-UP & DAY-1 NETWORK

+ No need for network setup: leverage existing LTE cellular connection
+ Better call quality to ensure effective communication
+ Better battery life for mobile devices
+ Cost-savings over traditional solutions

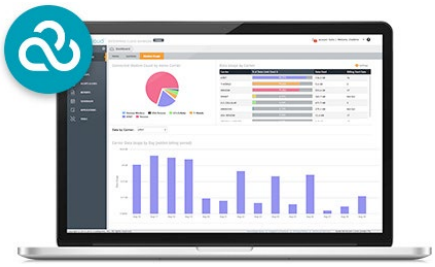
CRADLEPOINT SOLUTIONS

PRIMARY ROUTING FOR BRANCH NETWORKS: AER SERIES ROUTERS

The Cradlepoint AER family offers distributed enterprises advanced wired and 4G wireless networking performance they need to confidently deliver connected experiences across branch locations.

Learn more: cradlepoint.com/aer

REAL-TIME INTELLIGENCE AT THE NETWORK'S EDGE: CRADLEPOINT NETCLOUD



Rapidly deploy and manage networks at geographically distributed locations with Enterprise Cloud Manager, Cradlepoint's network management and application solution within the Cradlepoint NetCloud platform.

Learn more: cradlepoint.com/netcloud

TO LEARN MORE, VISIT **CRADLEPOINT.COM.**

Sources

[1]For more information about MOS, see Mean Opinion Score (MOS) - A Measure Of Voice Quality.
[2]Testing performed October 2015 using a Cradlepoint AER2100 router running Firmware version 6.0.1 with MC400LPE modems.