Why Carrier-Based LTE and Private LTE Just Aren’t Enough for IIoT
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Rajant Corporation assembled an industry panel of our channel and strategic partners to discuss the benefits and weaknesses of both carrier-based and private LTE. Here’s what they had to say when it comes to IIoT and why they recommend Rajant’s Kinetic Mesh®.

Types of LTE: Carrier-based vs. Private

There are advantages and disadvantages to both, so which LTE is best?

The first and most common type of Long Term Evolution (LTE) is carrier-based LTE. Typified by a subscription with a smartphone, users are buying subscriber modules from a carrier for industrial clients.

The second type is a private LTE network, where the customer owns and administers the network. If deploying a private LTE network using licensed frequencies, they have to be bought from the regulatory agency or rented from a cellular carrier, or possibly using unlicensed frequencies.
Carrier-based LTE:
Advantages

The primary benefit is to cover a vast area at an enterprise level.

Consider a chain of fuel stations. The chain wants to get IIoT data from different devices over a whole region, an entire city, or a whole country. They retrieve data from every single pump and point-of-sale cash register, sending it up to the cloud.

Think about a quarry customer with one device that needs to connect to the network and has minimal bandwidth requirement. It doesn’t make sense to deploy a full network. The solution is to put an LTE modem on and send that small amount of data to where it needs to go. The data does not cost much to send, and the broad coverage required fulfilled.

If you have small, static devices all over, that you wish to collect sensor data or switch on/off, then carrier-based LTE would be an excellent choice.

Many devices fall into this category. Everything in the world has got an LTE modem in it, and they are inexpensive. Depending on the use case and what precisely the customer is looking to monitor, the fact that there’s a large number of user equipment available is worthwhile.
**Private LTE:**

**Benefits**

One benefit is the low cost of the end-user device.

There’s a lot of publicity about the perceived benefits of LTE, such as LTE’s predictability. You can schedule specific devices to be able to have more bandwidth and so better quality of service. This is seen as one of the benefits of LTE in general. With private LTE, there is the ability to decide how to utilize the bandwidth. It can, for example, be split to 50% uplink and 50% downlink.

Private LTE can be deployed across different premises to link together. Offices in Phoenix, Cape Town, and London, for example, may have small pockets of private LTE networks within those buildings. Standard cell phones could work on that, but it becomes a financial business guess at the end of the day because that company can route their calls internally. These preferential rights over LTE are not well suited for an IIoT environment.

The entire Private Automatic Branch Exchange (PABX) scenario within larger corporations could be taken over by private LTE. Wi-Fi remains an option for in-office data alongside private LTE to allow every user access to either.

Additionally, private LTE could possibly provide the ability to use a frequency that makes good sense for a mining application. For example, if 700 MHz is available, low frequency will propagate well and possibly solve some problems, such as coverage at the face. It’s perceived that 700MHz is going to do a better job than 5 GHz, but a great deal depends on tunnel dimensions and the minerals of the mine.

**Private LTE can also take advantage of strong receiver sensitivity. It can go 40x stronger than Wi-Fi receiver sensitivity.** With a clear channel selected with no interference, there is an argument that users can take advantage of low signal strengths. Speeds of kilobits per second on that really low signal strength may be available.

Lastly, private LTE also means holding onto the network and owning the maintenance to control the coverage. This is unlike carrier-based LTE. Sometimes the network is required where the carriers don’t want to put it, so you can set private LTE where you want it in terms of coverage.
Carrier-based LTE: Weaknesses

A commercial carrier-based network, trying to act as an industrial network, just doesn’t fit.

Carrier-based LTE is entirely out of your control. Communication systems in operational environments are ultra-important for IIoT applications. Carrier-based LTE leaves your organization’s critical communications to someone else.

When you have a distributed wide area network, you are not dependent on real-time activities, but when you’re dependent on real-time events, a carrier-based LTE will not work.

If you have a mine, you will deploy maybe one or two base stations at that mine. The number depends on how big your mine is and what physical barriers to RF are caused by the mine layout, but if you look at the backhaul of that network, it requires multiple fiber links across that site. Often that fiber is hired or taken from one other external supplier. If that fiber goes down, the network goes down, making it a maintenance and availability scenario.

That public cellular tower doesn’t just carry your mine data. Instead, it carries other applications sometimes far outside your critical industrial requirements. If a user is watching a movie at work, for example, then resources will be used that are meant for your IIoT.

As the user, you can’t control the coverage or have visibility of the resilience based on the maintenance. You don’t know what spares you’ve got. You don’t know if you’ve been provided with a fiber network by a third party. Further, you don’t know if you have a spare router ready to go in case one fails. Even if you have service level agreement (SLA) uptime with 99.99% availability, it’s still out of your control. It may be positioned as a guarantee, but at the end of the day, that’s just something on a piece of paper. If you’ve got critical applications, you want to have control of them.

Experiences with carrier-based LTE suggests that there are priority clashes. If a tower goes down at the mine and one goes down in the Central Business District, resources will be allocated to the Central Business District and the mine will be a lower priority.

The issue with the commercial network is that the commercial network is tuned for devices worldwide. And the way they tune is to allocate 80% of the bandwidth to download. It’s an asymmetric service with only 15 or 20 percent of the bandwidth allocated to upload. For high bandwidth applications, such as autonomous vehicles using video, it’s an imperfect solution. In an industrial application, it’s the client that’s generating the data and trying to upload it. So, if you’re trying to use a commercial network, even if the coverage is right, you cannot get around that; you have very constrained throughput.

Beyond just the bandwidth control are the actual client devices themselves. Available industrial cards are MIMO on the downlink and SISO on the uplink. It is designed not only from the spectrum, but it’s designed from the technology itself. Even if you could get control, there would be 20 MHz down and 20 MHz up with SISO on the uplink not providing as much bandwidth.

Carrier aggregation is described as an approach to combine data streams. However, carrier aggregation works on the downlink, and it does not work on the uplink. These limitations provide significant disadvantages in an industrial environment.

With carrier-based LTE and the many interests tugging on the single network resource, having a budget for network capacity rollout can be defeating for IIoT. Think about the Central Business District downtown scenario again. If millions of dollars were available to upgrade and improve the network, guess where that money would go? It never went to the places, like the mine. It goes to the downtown area’s max-capacity hotspots. What happens is, on the cellular side, you try and sweat the capacity as much as possible.
Private LTE: Challenges

For most, the private LTE infrastructure is cost-prohibitive, licensed or unlicensed.

The protocol is built around expecting a noise floor lower than -130, so the sensitivity of the radio sits down right around -130. Wi-Fi, on the other hand, is designed around being in an unlicensed spectrum where it expects to be in the vicinity of other noisy devices so that the radiosensitivity is set closer to -100. When you take LTE and deploy it into an unlicensed band, where it’s not expecting to deal with all that other residual noise, all of the advantages of having LTE in the first place are lost, which is that greater coverage is going out to -130.

An additional significant disadvantage for the licensed band in private LTE is just the availability of spectrum. In Australia, they’re making substantial LTE deployments everywhere because the spectrum is available. This is not the case in North America. One of the biggest problems encountered is again on the user equipment side.

Changes to rapidly evolving technology is driven from the infrastructure side, almost always. New advantages come from the infrastructure side. When you’re trying to deploy a supportable solution at a customer site, these customers don’t want changes every year; they want something that they can deploy, maintain, and support for five years. When the infrastructure side is constantly changing and constantly evolving, trying to build a user device that can be supported for five years is a real challenge. The client card you are using this year won’t be available next year because it’s outdated. Nobody’s buying it because, again, they’re selling it where they will make the most return. Manufacturers want to sell in large volumes, so smaller users supported are forced to upgrade to a new card.

It becomes costly to support a private LTE solution over a long period of time or up to the example of five years. That client device will constantly be changing. A supportable solution will need to have continually evolving client technology when it comes to IIoT. In the mining scenario, this leads to downtime on the equipment and/or fleet problems. It’s an avoidable challenge.

Utilizing a private LTE PABX system has complexity. Unless you have advanced technical networking qualifications, you won’t be able to configure it easily.

Some suppliers are providing the hardware, often for free, with the network as a licensed arrangement. Once the LTE or the private LTE network is deployed, it may initially show real savings, and it might work quite well with the restrictions as identified. But in future years, costs will increase significantly for licensing and features.

Experience shows that with the private LTE, licensed and unlicensed, is cost-prohibitive. Compared to other options, capital expenses and operating expenses do add up.

Whether carrier-based or private, LTE and 5G use the same rudimentary network architecture as the very first cellular networks that were deployed. Density has increased, the radio technology has changed to compress data, and the frequencies have been altered to carry more bandwidth, but the fundamental network architecture is precisely the same. This thirty-year-old technology, that’s had incremental updates to improve throughput, holds the fundamental weaknesses that existed in the earliest cellular networks to this day.

LTE is a useful application when coverage challenges are relatively simple to address, and mobility of infrastructure and assets is not a requirement. LTE deployments can be positioned as low cost with fantastic coverage. However, experience shows that when higher bandwidth is provided, users adopt or develop applications to utilize that additional capacity. In an LTE environment, this significantly increases cost.
Cells on Wheels: When and where required?

Every cell site, whether it’s fixed or COW, has to have a high-capacity backhaul.

Cells on Wheels (COW) are always used for coverage. One example is a customer who deployed LTE as a hybrid solution, employing carrier-based with private LTE. The private infrastructure was deployed as a cell on wheels using solar trailers around the mine, at a lower band. Then they had the carrier-based LTE at a different, much higher frequency. This provided more throughput out of that carrier-based service while aiming coverage at the working face on the lower frequency.

Roaming between the fixed infrastructure and COW is problematic. It’s a minute and a half to roam between them, which is unusable, so the customer had to back out and take the COW away. They thought they had the best of all worlds – bandwidth, coverage, low cost – or everything that LTE could provide. Now, they’re starting from scratch having to deploy something else.

Let’s take the example of mining. The advantages of LTE play in an open, flat area. When we talk about mining, in most cases, we’re talking about a big hole in the ground. That’s where we end up with shadowing from the large, fixed infrastructure. From a coverage standpoint, you need to add COWs, so you’re going to have trailers in the pit. Those trailers would be the same as you would with a Wi-Fi mesh or a Rajant Kinetic Mesh network deployment. You can’t get away from COWs (or trailers) in the pit.

On a carrier-based LTE network, because the operator owns the infrastructure, it would be unlikely for them to spend that money to provide a COW.

On a private LTE network, you could deploy it yourself. Keep in mind, however, that backhaul will become a problem. So, either you lay fiber to it, or you have a microwave link. This becomes problematic in a COW scenario.

The only other reason to use a COW is in a changing environment, providing coverage to service the shadows. You can’t put stationary infrastructure there because tomorrow it’s not going to be there; the area could be blown up, collapse or shift, and you need to move it continually. In any mining environment today, there are people required to move those COW trailers around to avoid daily explosions. For many mines, this move happens twice a day.

When you’re dealing with a cell on wheels, it matters where the cell goes and how the cell is oriented. You have to coordinate network configurations from when the COW is off and change the network configuration to when the COW is turned on. There is a great deal of coordination and network configuration that has to take place in moving a COW. And these LTE COWs are not relocated by entry-level employees, who typically move trailers in Wi-Fi or Rajant Kinetic Mesh networks. Suddenly, you go from having relatively low-paid employees managing your network to having a large staff of highly qualified engineers to handle the complexities of the network configurations. This is a well-hidden cost that LTE salespeople don’t want you to know.
LTE vs Rajant’s Kinetic Mesh®:
Which is better for IIoT?

Today’s mission-critical IIoT applications require continuous connectivity.

Rajant Kinetic Mesh® networks make multiple peer connections that never break. This goes against the traditional “Break-Before-Make” or “Make-Before-Break” approach to connectivity. Today’s mission-critical applications require continuous connectivity.

An LTE client will connect to multiple towers, but it’s got one designated point of communication where it’s always going to be sending that data to until that connection degrades; then it can move over to another connection. The advantage to Rajant, of course, is you can talk to any of your peers at any given time. So, if you have traffic that needs to go over here, and that’s the fastest route, it’s going to go that way versus another connected peer.

In a Rajant system, you have multiple active, persistent connections. In an LTE network, you have numerous connections, but you only have one active connection, and you coordinate with the base station between the client card, the subscriber card, and the base station when you’re going to hand off to an existing connection, which is nonactive. For this reason, there is incrementally more latency involved in the LTE handoff.

Compared to LTE, Rajant has flexibility, ease of deployment, and lower cost. Data can be sent through your peers and not reliant on centralized, fixed architecture that can go down at any time.

For private LTE, it’s still about the client card, and the client card only has SISO on the up and doesn’t have carrier aggregation on the uplink. There are no cards available with the right temperature specs, and no card that has MIMO on the uplink.

In an industrial IoT environment, it’s all about the client pushing data up. There are a lot of customer applications that are video-laden. They can’t tolerate a lot of latency, and so when you’ve got a vast, dense network of clients pushing, that becomes an issue. An example is the Cisco 829, which is an integrated Wi-Fi and LTE device. If you examine the card that’s in the Cisco 829 and you look at that spec sheet, it has two receiver streams, but only one transmit stream.

Using the example of mining again, let’s look at a customer who has tried LTE in the United States and has experienced issues. Struggling with their LTE deployment, the customer is looking to pull as much off of their LTE as they possibly can and putting it back on proper networks that work for what they need. They might keep that LTE out there to do some of the jobs, yet the LTE is incapable of doing all of the jobs.

Rajant has a mining deployment that is now hybrid. Initially, it was to be LTE exclusive, some of the early unrealistic expectations around LTE began backing off. Running in parallel with their LTE network is a Rajant Kinetic Mesh® network. The reason that Kinetic Mesh network is there, and was put in after the LTE network, is because the mine could never get their autonomous drills to function correctly on the LTE network.
Summary
What does it come down to?

Rajant’s Kinetic Mesh® redirects routes to ensure continuous data flow that IIoT demands.

In summary, there are benefits and weaknesses to both types of LTE when it comes to IIoT. What it all comes down to is use case. Each networking option should be utilized in environments and with applications that play to their strengths.

Rajant’s primary use case is mission-critical IIoT in mobile, challenging, and ever-changing environments. Increasingly, the melding together of enterprise information technology (IT) with operations technology (OT) to deliver real-time operational intelligence, that is not just reactive but instead predictive, is on the move. Infrastructure and assets are existing in an age of autonomous operation, which requires consistent bandwidth, flexibility, reliability, and scalability. Architected with autonomous adaptability, Rajant’s Kinetic Mesh® can redirect routes taking new paths that ensure continuous data flow that IIoT demands.

Learn why utilities, ports, mines, agriculture, and more industries rely on Rajant Kinetic Mesh networks for the continuous, fully mobile connectivity required to power today’s data-driven operations. Visit www.rajant.com or contact a representative to learn more.