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White Paper

Building a Wireless Network on WiMAX

Siemens can show how this versatile and under utilized wireless networking technology can be a practical and economical approach for your broadband coverage applications.

Siemens RUGGEDCOM WIN (WiMAX-based equipment) delivers a strong combination of hardware and software to provide the communication infrastructure for private wireless networks in a variety of utility and industrial applications. It addresses situations where networks have to cover diverse geography such as a large and spread-out manufacturing complex, or where wireless communication has to go well beyond the fence lines. The RUGGEDCOM WIN solution offers a combination of capabilities unavailable using any other wireless approach, making it the perfect choice for a variety of applications.

Point-Multipoint (PMP) Topology



What is WiMAX?

You’ve probably heard of WiMAX but don’t know much about it. It might be easiest to say what it isn’t: WiMAX is not Wi-Fi and it is not a cellular network, but it has important characteristics of both. WiMAX uses the IEEE 802.16e standard, so it is not a proprietary system. It was developed around 2000 to support the physical layer of cellular communications, but with the rapid growth of cellular carrier networks, carriers soon realized they needed another method better suited for much larger high-capacity networks.

WiMAX is designed to support private networks by providing a layer 2 broadband solution. The communication topology is point-to-multipoint, meaning that a base station has bi-directional communication with up to 64 individual subscriber radios, often referred to as CPEs. These radios can be stationary or move around within and between coverage areas.

The practical transmission limit related to usable frequency options from the FCC in the U.S. is approximately 10 miles, so a single network can cover much more ground than Wi-Fi. Moreover, subscriber radios can move from one base station coverage zone to another seamlessly, handing off communication automatically as needed. So if a large plant facility or even a city needs coverage over a wide area, a WiMAX network can cover a lot of ground and users can be mobile while maintaining access.

WiMAX can transfer relatively large amounts of data like Wi-Fi, although in recent years, the latter has made greater progress in that respect. If brute data volume and speed is your primary objective, Wi-Fi is a better choice but it has many other

limitations. WiMAX compensates for more limited transfer speeds by allowing users to prioritize what information gets through fastest. There are five levels assignable to specific users, or kinds of application data, to get the most critical data through ahead of less time-sensitive data. This ability to manage communication via Quality of Service (QoS) is a key advantage of WiMAX in many applications.

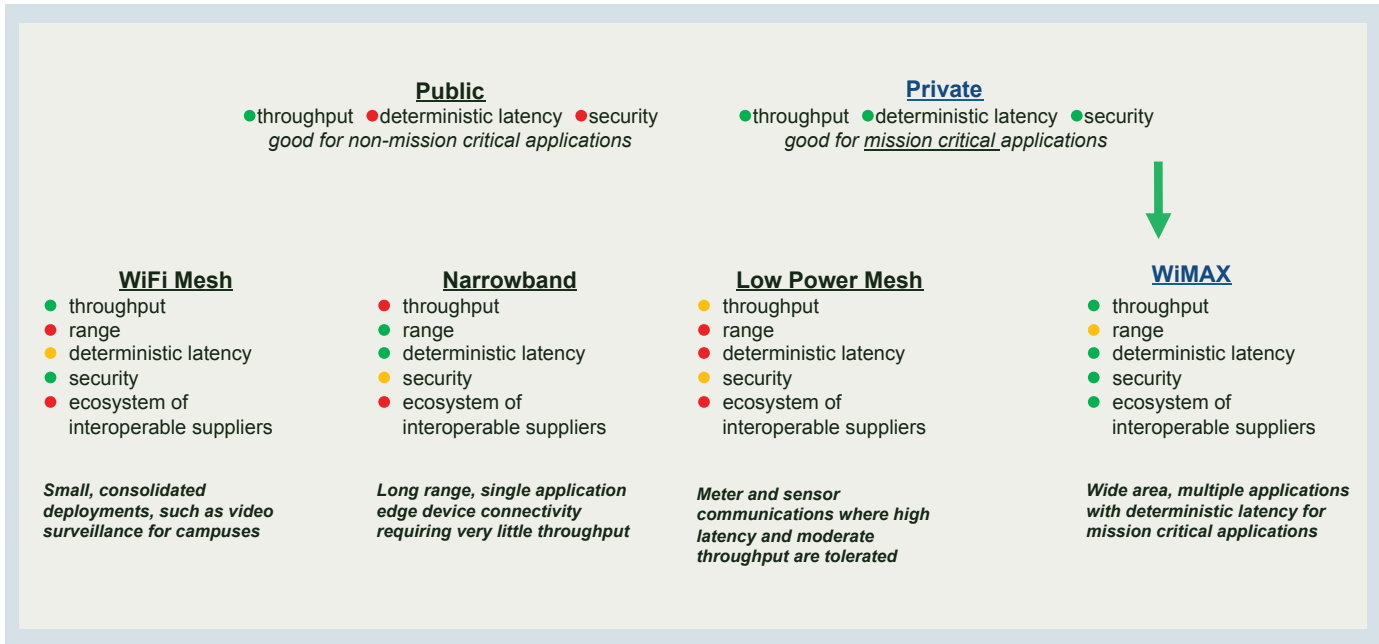
While Siemens is one of the largest suppliers in the field, there is an established ecosystem of suppliers allowing for a high degree of interoperability across platforms since WiMAX is standards-based.

Security for any wireless communication is naturally a concern and WiMAX uses multiple layers of security in protecting data transmission. Subscribers must be authorized to use the network, so CPEs use AAA authentication to keep rogue radios from joining and AES encryption to avoid signal interception. MAC address filtering also prevents unauthorized users from gaining network access. Secure HTTPS and SSH management via password authorization provides administrative access to any radio for monitoring and maintenance.

Ideal Applications

The capabilities of WiMAX have made it ideal for a variety of private network applications where a high degree of network control is required, covering relatively large geographical territories. A key market for WiMAX is the electrical utility industry where it is necessary to gather information – across a service territory – from generation plants, substations/ SCADA, pole transformers, electrical switchgear and even individual residential meters. The smart grid currently being constructed comprises these elements, and WiMAX ties them all together.

Wireless Communications: Private vs. Public Network



The table illustrates some of the key characteristics comparing Wi-Fi, narrowband, low-power mesh and WiMAX on a variety of important performance parameters.

The ability to prioritize data transmission is ideal for such a situation, giving the highest priority to important things like breaker trips and outages, while routine meter readings can be delayed and retrieved when necessary. A key capability allows the system to address multiple applications such as the following over the same wireless link:

- AMI backhaul
- SCADA connectivity
- Distribution automation
- Mobile workforce (nomadic or handoff)
- Video surveillance
- VOIP

Other utilities, such as water and wastewater systems, are also WiMAX proponents for similar reasons, and the benefits of a controlled private WiMAX wireless network are applicable to communications needs for oil and gas, industrial, mining, and general enterprise markets.

CAPEX or OPEX?

Users responsible for large coverage networks have a choice of adopting commercial carriers with public networks, or creating their own private wireless infrastructure. Naturally there are cost and benefit considerations, but other key points center on network control and deserve examination.

Public networks are the easiest to set up and use, but they offer little in the way of management. Users cannot control latency in a deterministic way, so there may be times when things simply don't work as needed or expected. Communication security is also up to the carrier, and if an invader manages to break into one part of the carrier network, it may be possible to move into yours as well.

Additionally, if there is a major outage after bad weather or some other emergency incident, users can be at the carrier's mercy in restoring communications. Often decisions as to what gets fixed hinges on the number of customers involved, so getting a cellular tower repaired to restore service for hundreds or thousands of customers can take precedence over a single company's communication needs.

Private network ownership provides control. When a company owns its infrastructure, it has responsibility to maintain it, but it can quickly act as needed to ensure it gets fixed after a disaster. It also has the ability to manage network performance, tailoring it as desired according to operational priorities and making modifications whenever necessary. When communication is truly mission-critical, a CAPEX ownership approach is the clear choice in most situations.

Planning a Deployment

The mechanics of setting up a WiMAX network are very straightforward, and all the hardware elements necessary are available in the RUGGEDCOM WIN product offering. Propagation is largely line-of-site (LOS) which means the transmitting antenna is best situated on available vertical assets such as rooftops and tower sites. The necessary antenna height is determined by the local terrain, foliage and desired coverage distance.

Designing an effective network requires some analysis and design work up front to ensure coverage is as expected. Where large or congested geographical areas are involved, a thorough site survey is important since in a span of 10 miles or more, there can be many elements capable of influencing

signal propagation. Siemens uses software tools capable of performing various what-if scenarios based on transmitter location, antenna height, antenna configuration and other considerations. When all CPEs have to communicate with the same antenna, positioning is critical. At the same time, it is a relatively simple matter to add base stations for strategic network extension and RF coverage.

WiMAX operates in a number of FCC approved frequency bands, and the best selection for a given application will need to consider a variety of factors discussed during the design process.

Siemens has the base station transmitters, subscriber radios and all the other hardware for a full deployment. The RUGGEDCOM WIN solution is all industrial grade outdoor equipment, capable of operation in the most hostile environments, exposed to the elements with high and low temperatures.

Application Examples

WiMAX technology excels for building private networks that work primarily outdoors covering moderate geographies. As previously mentioned, it is ideal for various utility systems, but this is certainly not the limit of its capabilities. Examples of other creative WiMAX deployments include:

- A major metropolitan light rail system uses WiMAX for its positive train control safety mechanism. The system uses about 50 base station transmitters positioned along the track to communicate with CPEs on the trains. With dual WiMAX paths backed up by LTE for redundancy, the communication is fast and reliable enough to qualify for this safety mechanism to stop trains before a collision. With antennas only 35 feet off the ground, the transmission distance is still greater than 2 miles.
- An oil platform service company replaced its satellite communication in the Gulf of Mexico between oilrigs, ships and onshore locations with WiMAX. Due to the distances involved, this application required a careful survey, but it

proved possible to reach all the locations and even ships moving in between the platforms. While the older satellite communication worked, it was very slow due to the latency caused by bouncing every transmission off the satellite. Average latency for the old system was 625 ms, but with WiMAX it dropped to 100 ms. The new system made it practical to use video conferencing, VOIP and to move data to and from oil rigs much more quickly, while eliminating the high monthly costs of satellite connectivity.

- A large theme amusement park now uses WiMAX to control its parades within the park. Accurate tracking of parade floats, synchronization of music, movement speed and other logistical concerns have now moved to the new network. Previously, the park had used Wi-Fi, but RF congestion in the surrounding area made it far too unreliable.
- One common add-on application that has grown in popularity with WiMAX users is creating Wi-Fi hotspots, both fixed and mobile, throughout the networks. A single CPE can support a Wi-Fi router anywhere within the coverage. This allows conventional consumer-grade laptops, tablets and smartphones to be used on the private network wherever necessary with proper security access applied.

A Practical Alternative

WiMAX is not a household word like Wi-Fi and cellular, but that is one of its hidden benefits. For the right applications, it offers many advantages without the drawbacks of the more common and more heavily deployed alternatives. There is a large ecosystem of interoperable equipment available based on the IEEE 802.16e standard which makes WiMAX an attractive solution vs. other proprietary best-effort radio systems offered by other manufacturers. If the other wireless networking strategies don't exactly fit your application, or you want a higher degree of control over your network, give WiMAX a look.

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