Smart Cities and 5G in the 21st Century

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

The transition to 5G is creating new opportunities to introduce a whole class of next generation technologies to enable next generation mobile and fixed wireless services. Much of the initial focus is on the plans of the major mobile operators to deploy their 5G mobile services networks. But there are many other areas where 5G-class technology will be deployed with major impact. Cutting edge municipalities are looking to deploy numerous Smart Cities applications to improve services, improve safety, and improve the quality of life for its citizens. As cities look for solutions, they can decide between 5G mobile networks, or deploying their own dedicated Gigabit Wireless Access (GWA) solutions to support high bandwidth applications. The two primary considerations are network prioritization and cost. When a municipality contracts with a Mobile Network Operator for 5G mobile capacity, they could find their fixed wireless public safety traffic may get a lower priority once these networks are filled to capacity, and they will have to pay a high rate for bulk data. If the city can build its own network using Gigabit Fixed Wireless technology, it can prioritize its own traffic, like a real-time video camera network, with low cost after the network has been deployed. Another option could be to find an operator that will build and operate a dedicated fixed wireless network, with the city paying the operator for capacity. Siklu's fixed wireless access products can help a city deploy its own city-wide network in licensed or unlicensed spectrum for a fraction of the total cost of ownership of working with a commercial mobile network operator.

INTRODUCTION

The development of Smart Cities applications is one of the key challenges and developments as cities look to reshape themselves for the rest of the 21st century. Smart Cities provide a great opportunity for municipalities to reduce traffic congestion, improve and expand public Wi-Fi, provide new services and improve existing city services, improve safety services, and boost economic growth. Touted as one of the benefits of the 5G-era of wireless services, Smart Cities has become a key development priority for cities large and small.

But the implementation of Smart Cities networks is a challenge, and one that most cities do not have the direct technical expertise to support. While many cities have adequate coverage for LTE, some are challenged with capacity, and all will be upgraded with new 5G technology at some point. Along with the upgrades to the mobile network, a new parallel network needs to be developed to support the connectivity of all of the IOT sensors, public safety cameras, traffic and parking management systems and other elements needed for Smart Cities applications. The primary technical network challenge is choosing the right technology to connect all of these elements, as well as the architectural implementation of the network.

For instance, one of the challenges in deploying IoT elements is that they fall into two primary categories:

- Low data elements that send small bits of data periodically. Examples of these might be air-quality sensors, traffic sensors, gun-shot sensors, tracking sensors, and other elements that perform specific functions.
- High data throughput devices that are sending a large stream of data, either continuously, or frequently. These might include public cameras, video display boards, high bandwidth real time controllers, Wi-Fi access points, autonomous vehicles, and other elements that need to send lots of data on a near continuous basis.

Each of these network elements has very different requirements for the network connecting them. Low data elements need to communicate periodically, likely have more emphasis on wide coverage instead high data throughput, and do not have stringent latency requirements. While these can be supported by today's 4G or next-generation 5G mobile networks, there are dedicated networks that are well suited to support these requirements. Technologies, like LoRa, SigFox, Bluetooth and Zigbee, are focused on these low throughput applications. Mobile operators have even developed a variant of mobile technologies, NB-IoT to support low throughput devices on a mobile network. These technologies can be deployed fairly economically. But they cannot support the high throughput applications.

While fiber is an option, it is not ubiquitous and is not typically available where cities want to locate high bandwidth cameras and access points for example. Most cities will adopt an approach of using fiber where it exists, and expanding coverage with wireless where it does not.

Smart Cities higher throughput applications are one of the areas that are often touted as new use cases that can use the higher speed and higher capacities of next generation 5G mobile networks. Many cities will eventually have good coverage for 5G throughout much of the center city areas. And initially operators will want to find ways to use the bandwidth of these networks. But as more users and additional use cases fill the capacity of these networks, operators will want to focus on high value data, like supporting mobile users. Lower value data, like public safety cameras and other devices, would receive lower priority from the operators while they service their higher value traffic. Municipalities would be better served to look at dedicated fixed Gigabit Wireless Access (GWA) networks to support their high throughput Smart Cities applications. These networks can provide Gigabit speeds, low latency, and dedicated spectrum to deliver prioritized capacity for these new applications.

TECHNICAL CHALLENGE OF HIGH THROUGHPUT SMART CITIES APPLICATIONS

There are many options for supporting low bandwidth Smart Cities applications, and most of these options, whether it is via the 4G or 5G mobile network, or over a dedicated network designed to support low power applications, can be supported with a minimum of capacity load, and at a relatively low cost. Supporting high bandwidth applications, however, entails more stringent technical requirements and more critical cost considerations. Ultimately, municipalities must decide whether to support these requirements with a 5G NR mobile network from a commercial provider, or develop their own dedicated Fixed 5G GWA network.

High bandwidth applications are some of the most critical of the Smart Cities applications, in particular those that support safety and communications. These include HD /4K video surveillance, backhaul for municipal Wi-Fi networks, safety networks hosting real time communications for police and fire departments, and video boards for community communications. For instance, an HD/4K video stream can require up to 25 Mbps. In some cases, there might be 4 cameras in one location which can produce a total throughput requirement of 100 Mbps for a single location. Therefore, a network of hundreds of fixed cameras and dozens of municipal Wi-Fi hotspots and video boards can create a huge capacity burden. And given the need for high Quality of Service, making sure the video is smooth and un-interrupted, especially in an emergency, support from a commercial network could be problematic.

The first consideration for the technical solution is the spectrum that can be used. To support high bandwidth applications, the network must have over 100 MHz or more of available bandwidth. 5G New Radio, the latest mobile standard, supports networks that depend on a smaller amount of sub 6 GHz spectrum aggregated with 100 MHz of microwave spectrum in either the 28 GHz or 39 GHz bands. All of these bands are licensed bands, typically distributed on a national or wide regional basis, are mostly owned by the large national carriers, and are very expensive to buy at auction. And while 5G networks can provide good coverage with their sub 6 GHz spectrum, the high throughput comes from the bandwidth provided by the microwave spectrum, which does not propagate well. It also may be difficult for NR networks to provide high throughput throughout its coverage footprint.

Alternatively, dedicated fixed 5G wireless networks can run on higher frequency mm wave spectrum bands, such as 60 GHz unlicensed bands, or 70 and 80 GHz lightly licensed bands (for example in the USA), which can be obtained as a local license for a fraction of the cost of other microwave bands. Further, these bands are readily available in most locations and have tens of GHz of clear and unused spectrum available to support the needs of the dedicated network.

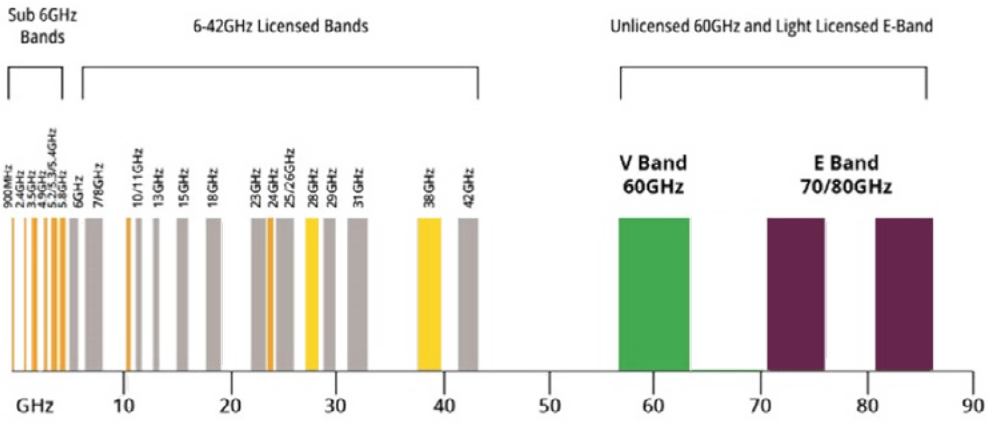


Figure 1
Frequency Bands for Fixed Wireless Access

The next critical choice is the technology selection. 5G NR commercial networks will be deployed with wide coverage targeted to mobile users. Throughput can range between 100 Mbps and 1 Gbps, depending on the coverage of the aggregated microwave spectrum. A dedicated Fixed 5G GWA network can support up to 10 Gbps Full Duplex on its dedicated spectrum. But more importantly, a dedicated network can provide the prioritized throughput needed for safety services and critical smart cities infrastructure. Knowing that the bandwidth can be focused and prioritized, especially in times of emergencies, can be critical. If a crime is in progress, a video feed from a camera on a wireless network in that area could be critical for foiling that crime (or solving it rather quickly). Dedicated networks can focus on the prioritized needs of new high bandwidth applications deployed by the municipality, providing performance advantages beyond only the technical specifications of the network.

The network prioritization effort is driven by the economics of the network. MNOs are interested in supporting numerous applications from the 5G networks in order to "load" the network (and derive more revenue from it). But the vast difference in value between mobile data for subscribers and data for fixed applications will inevitably lead to prioritization of the higher value data streams. Mobile data is valued at around $1.80 per GByte, a value that can justify the high cost for MNOs to invest billions of dollars in next generation networks. But fixed applications data has a much lower value, in the range of $0.05-0.10/GByte. In order for the MNOs to support their investment in 5G networks, they will need to load their networks with high value traffic. Therefore, municipalities would be better served with their own dedicated GWA networks to support high capacity Smart Cities applications.

SIKLU'S SOLUTIONS FOR GWA NETWORKS

To look at the needs for a high-speed network for a city, consider a network of 200 HD or 4K security cameras. Each camera can use up to 25 Mbps per feed. This would lead to a total network load of 5 Gbps of continuous streaming video. A high-speed network must be deployed to support this load and must still have capacity to support other functions such as, backhaul for Municipal Wi-Fi hotspots and Community Video boards. The latter can generate revenue for the city through advertising, in addition to providing an important channel to send community information or weather alerts to the public. Siklu's GWA solutions are focused on supporting these kinds of high throughput functions.

A good example of how a city can deploy a high-speed fixed wireless network, is Wichita, Kansas. https://www.siklu.com/press-release/city-wichita-deploys-siklus-multi-gigabit-mmwave-wireless-system/

Siklu's products support high frequency 60 GHz unlicensed spectrum, and licensed spectrum in 70 and 80 GHz. In these frequency bands, municipalities can easily obtain up to 2000 MHz of spectrum to ensure that the network can support the required capacity loads for a city-wide camera network. With both point-to-point and point-to-multipoint solutions, the network can be designed to connect to a network of fixed and mobile cameras, with the base stations connected by fiber to a central video monitoring center. Siklu's products can be scaled to support 1, 2, 5 or 10 Gbps throughput and can be tailored to the throughput needs at each point in the network.

ECONOMIC TRADE-OFFS OF A DEDICATED NETWORK

While it is critical to have prioritized capacity, perhaps the more important consideration is economic value or "ROI". If a municipality were to rely upon a commercial operator for capacity from a 5G NR network, it would be paying for capacity at mobile capacity rates. For low throughput applications like sensors and meters, this cost would not be too burdensome. But for high-capacity applications, paying mobile rates of $1.80 could result in a network bill of over $200,000 per month. If this capacity were delivered from a fixed network, the cost would be less than 5% of the cost versus the cost from a mobile 5G network. An alternative would be to have a third-party operator (3PO) finance, build and operate the Smart Cities network for the municipality. This option retains the benefits of deploying a dedicated Gigabit Fixed Wireless Access network, but would remove the CapEx burden and still dramatically lower the monthly costs, paying cents/Gb vs dollars/Gb.

Table 1

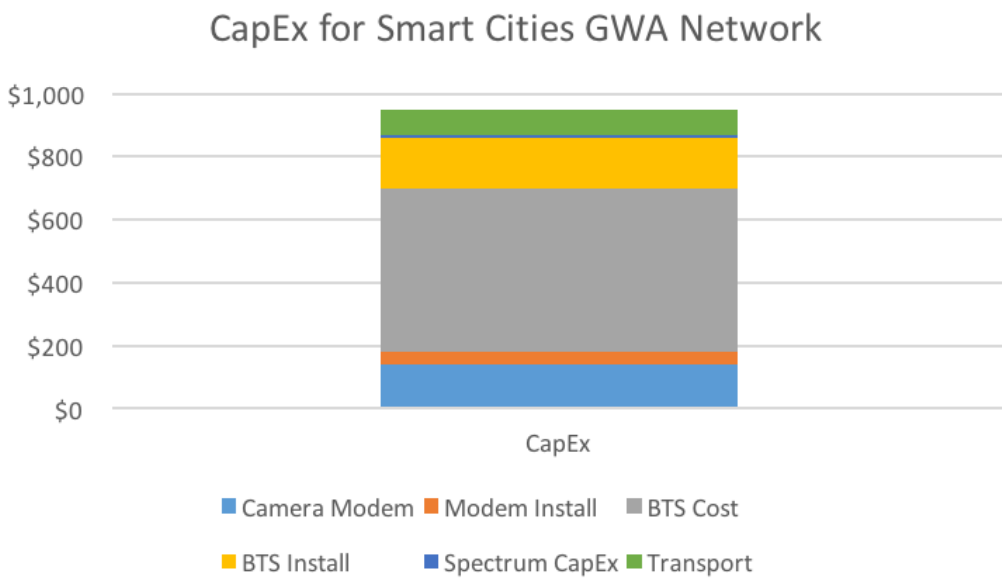
Cost Analysis Results for High-Speed Smart Cities Applications

Operator Type	*Major MNOs*	*Tier 2 & 3 MNOs*	*Post-Paid MVNOs*	*Pre-Paid MVNOs*	*Lifeline MVNOs*
Monthly Usage (GB/Sub)	*6.0*	*4.0*	*4.0*	*2.0*	*1.5*
Percentage Wi-Fi	*55%*	*55%*	*55%*	*55%*	*25%*
Additional Mobile Data Offloaded to Wi-Fi Due to Wefi Connection Manager	*8%*	*10%*	*12%*	*10%*	*10%*
Additional Wi-Fi Offloaded	*3.6%*	*4.5%*	*5.4%*	*4.5%*	*7.5%*
Saving on Mobile Capacity (GB/Sub)	*0.216*	*0.180*	*0.216*	*0.090*	*0.113*
Cost for GByte	*$0.75*	*$1.25*	*$5.00*	*$6.00*	*$6.00*
Monthly Saving/Sub	*$0.16*	*$0.23*	*$1.08*	*$0.54*	*$0.68*
Yearly Savings/100K Subs	*$194,400*	*$270,000*	*$1,296,000*	*$648,000*	*$810,000*

We have used the WiROI Fixed Wireless Business Case Tool to analyze the cost for the city to build its own dedicated network (www.wireless2020.com). The WiROI Tool can be used to analyze the cost to deploy and operate a fixed wireless network and compare it to the cost for purchasing capacity either from a mobile operator or a 3PO. The analysis below outlines the CapEx cost for a city to deploy its own GWA network. A similar cost model would apply to a 3PO deploying a similar network. This model implements a point to multipoint solution, with about one base station for every 8 cameras. This provides enough capacity to support the network of 200 cameras, 100 HD/4K video boards, and 200 municipal Wi-Fi hot spots and still have lots of capacity for other high-speed smart cities applications.

Figure 2

CapEx Analysis for Deployment of Gigabit Fixed Wireless Access



The total cost for deploying the network would be less than $900K. This cost would amount to a 5- to 6- month payback period for the city, as compared to sending this money to a commercial operator to pay for 5G NR capacity. This would be a fairly clear trade-off for the city to build out its own dedicated fixed wireless access network. In the case of buying capacity from a 3PO fixed network, the payback period would be closer to 12 to 15 months. Here it may well be valuable, depending on the city and its technical organization, for a city to bring in a partner to build and operate the network. In either case, the analysis provides a clear economic trade-off for municipalities looking to deploy their own GWA network in order to support their Smart Cities high-bandwidth applications.

CONCLUSION

For many cities around the world, developing a Smart Cities infrastructure and deciding how to best support new applications are at the top of their list of priorities. While there is great promise in the new capabilities of next generation 5G NR networks, mobile operators will be under great pressure to justify the billions of dollars in investment they will need to deploy these networks. High bandwidth applications however, use tremendous amounts of data and would be extremely expensive to support if a municipality were buying data from a 5G provider. Instead, the city can deploy its own high-speed GWA network, either on its own or with a 3PO partner, and have prioritized bandwidth at its disposal both in everyday use and in emergencies.

Siklu can provide the equipment and support to make the development and deployment of GWA Smart Cities networks at a fraction of the cost of buying capacity from a mobile 5G network provider.

This White Paper was authored by Randall Schwartz, Principal Consultant at Wireless 20/20.

Wireless 20|20 helps mobile operators and their vendors develop their Wireless Network strategies, service offerings, marketing plans, technology roadmaps and business cases. Wireless 20/20 also leverages its WiROI® Business Case Analysis Tools to assist clients in issuing RFPs and evaluating responses.

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