



SMART CITIES & THE IMPORTANCE OF THE FIBER NETWORK

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INTRODUCTION

Within the city construct there are a lot of considerations to delivering "Smart Solutions and Services". In this white paper we will explore the opportunities and benefits from a foundational perspective of connectivity strategies that leverage Fiber as the backbone for "Smart" service delivery.

EXECUTIVE SUMMARY

Since the initial use of Fiber Optic Cable in the mid 70's to connect US Government computers, we have seen an increase over the years in the use of fiber networking. However, it has not been as broadly recognized until recently just how integral the fiber backbone is to reliable, resilient broadband communications infrastructure is for the future of cities and municipalities alike.

While fiber networks are not new, the technology has continued to advance, and they are indeed the catalyst to just about every use case where "Smart" is included, supporting critical infrastructure and beyond. Fiber networks are not just for the purpose of faster internet, but think about latency sensitive solutions such as traffic monitoring and general multi-modal transportation, first responder services in the city and likewise utility distribution services to improve utility reliability and outage management.

Pre-pandemic, cities across North America were deploying Municipal Wi-Fi as a means of improving connectivity and access for citizens. These municipal networks often times leverage city deployed fiber but were typically only in the metropolitan downtown areas. This was shown to be an oversight, as with a bit more consideration, additional investment and partnership, the thousands of underserved citizens could have benefited from connectivity where there was none. Distance learning and the huge uptick in bandwidth utilization due to the pandemic have caused cities to rethink their connectivity strategy. Fiber networks, again, are the supporting foundation to service delivery to the cities and communities at large

Smart city solutions across the board depend on reliable communications infrastructure. For each application there is an endpoint that then requires the data to be backhauled to the cloud. Data analysis for any real-time insights depends heavily on receiving the data in a timely fashion, edge computing and the analytic insights will falter without the speed and throughput delivered by a fiber backbone.

Smart Grid solutions, likewise, depend on reliable networking solutions that often times have latency requirements that can, in aggregate only be supported with fiber network

connections. In large, 5G (5th Generation Cellular Technology), LPWAN(Low Power Wide Area Network) and WAN(Wide Area Network) technologies all depend on fiber networks to deliver their services and even more so if there are SLA's (Service Level Agreement) associated with them

At the foundation of all of this, fiber networks are hugely important to delivering on the promises of Smart Cities, Smart Grid, Smart Building augmented with other wired and wireless technologies to improve cities and municipalities operational efficiency and improve the livability of citizens across the board.

The Path to "Smart" is paved with a reliable connectivity strategy

Deploying a fiber backbone for any city, municipality or community should be considered the core of the connectivity strategy. Everything else is built as an offshoot of that, including 5G.

[1]The fourth industrial revolution is here and like the revolutions that preceded it, there is a strong precedence for the communications infrastructure to serve the fusion of technologies that will deliver on the possibilities of billions of people, devices and machines being connected. For all of the areas under consideration, there is no communications medium that exceeds the performance of fiber optic networks, as a backbone it is resilient and has the capability to support all of the other wireless technologies as spur networks are required to deliver end solutions

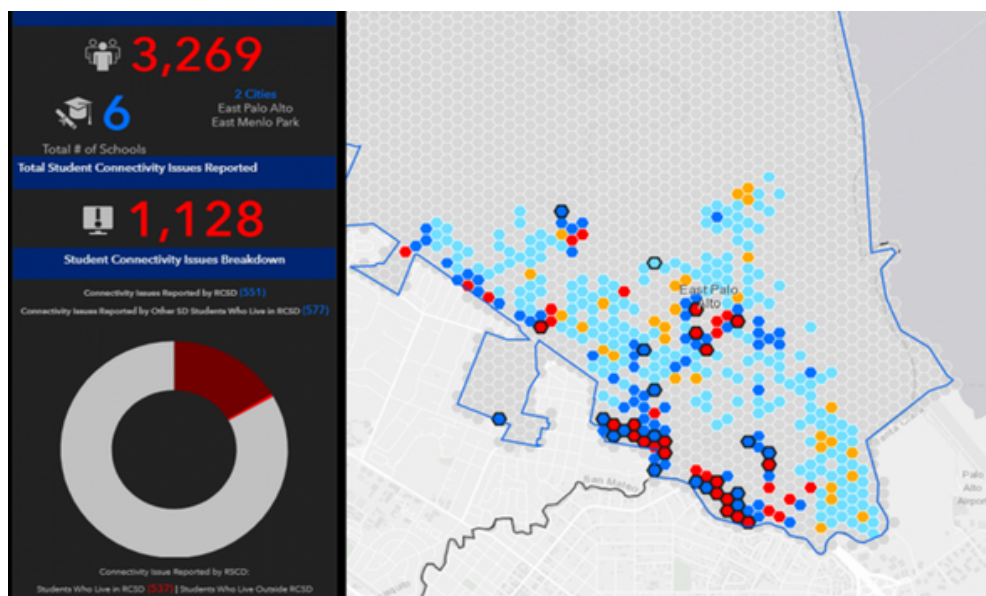
This means, at the same time cities and communities are at the forefront of this digital transformation, we can look at anchor areas that help lay the groundwork for investment in broad scale deployment of fiber to allow adjacent use cases to be supported.

[1] <https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/>

Departments of Education

The educational departments within cities would benefit from a fiber backbone as they all seek to support increased traffic on their networks. The influx of traffic on the network, most recently, stressed the importance of reliability, availability and overall flexibility due in part to the recent modifications to how education is being delivered. However, even without the presence of the current pandemic, there have been challenges for the educational systems, especially when we consider the inherent need to provide equitable services across the board. The lack of inclusive connectivity is not only an under resourced area concern it impacts all demographics and socio-economic groups, from K-12 to those seeking higher educational opportunities. Cities large and small need to deliver the connected services required to establish equal learning opportunities. This is a paramount consideration, because, while benefiting the students in the respective districts, this same infrastructure can leveraged by the educators, libraries and other educational services with a highly reliable network that is capable of supporting the engagement between teacher to student and student to, community while improving the inter-departmental communications with high-speed data transfer

Example of how a small city benefits from the larger city/county fiber for bridging the digital divide. [2]The city of East Palo Alto with a population of approx. 28K has received connectivity via the County of San Mateo's "SMC Public WiFi" program. This extension of services is delivered due in large part because the County is leveraging their fiber backbone and extending connectivity to these areas. In the image below The County of San Mateo County utilized data to map and identify the areas within East Palo Alto where unconnected students are located. Hexagons in red and dark blue represent the highest concentrations of unconnected students largely located in the Woodland Park Apartments, on the west side of East Palo Alto.



City Services

Public services that range from utility centric (water, gas and electric) to renewables, community microgrids, waste management and overall conservation are front and center. In the area of energy conservation, water monitoring and leak detection is often times left behind. Instrumentation of water distribution is becoming of larger importance, due in part to the amount of electricity required to deliver the water to residences. Fiber presents a compelling medium for transporting all energy related data as part of a larger connectivity strategy and brings the utility and city together to improve service delivery and efficiency. If we look forward, we can see that the information received from the energy sector become integral to the cities operational efficiency and resiliency. Outages become more manageable through the use of energy storage technology that is connected via city owned fiber, keeping the city functioning during times of emergency. And while the endpoints could be a variety of connectivity options, all of this is monitored and managed across the fiber backbone as a common medium and shared infrastructure.

An example of what water monitoring as an energy efficiency initiative provides:

APPLICATION	Description	Technologies	Benefits
WATER MONITORING	While it may not be that apparent, smart grid solutions play a large role in smart city solutions. Non-revenue water loss not only impacts available drinking water, but is directly related to increased energy use	Various technologies have been used to deliver this application. Ultrasonic flow detection Low Power Wide Area Networks in a variety of frequencies	<ul style="list-style-type: none">- Reduce non-revenue water loss- Improve energy efficiency- Improved flood detection- Identify and remediate leaks

Economic development is far often a siloed activity and forgotten when it comes to the strategy of a smart city. Economic development can drive technology requirements on its own merit, businesses will need more than just internet connectivity. They need to interact with the citizens and the city alike in an environment that inspires local community, enriches visitor and consumer experiences and inspires innovation that drives local entrepreneurship within their core competencies. There are various market forces that illustrate, through a high bandwidth network backbone, economic development can be realized.

1 Consider the opportunity for Telehealth/Telemedicine. A city that provides a fiber backbone throughout the city can help improve hospitals ability to diagnose remote patients earlier, improve patient to doctor interactions and ultimately save lives

2 High bandwidth service delivery to communities will attract new citizens and retain existing citizens that live in the cities. Especially those that elect to live outside of the downtown areas, this means growth in the housing market which drives more business for the local small/medium sized businesses

3 The presence of fiber as the core information communications technology will support advanced technological solutions in both the urban and suburban areas where services are delivered. Thereby, driving the cities economics in a positive direction. For those younger generations the advancement of AR/VR will require far more than the 1GB connection and rapidly move to the 10GB connections. On top of that those connections will require functionality closer to the source of use (at the edge). This part ties directly into the above points as we will need as symmetrical an experience as possible.

Businesses will experience an improved opportunity to engage with the citizens of the city, those that rely on tourism will have greater marketing opportunity and improved brand awareness because the city elects to deploy digital signage, wayfinding applications, which results in new ways of advertising leading to business owners establishing new data-centric ways of engaging with the city services that improve their costs to operate and drive citizens to visit establishments and spend both more time and money.

Public Safety

From gunshot detection to vision zero initiatives. Public safety is one of the most important initiatives facing local governments today. Leveraging technology will improve the cities outcomes in that regard. Those technological solutions will depend on a high bandwidth, reliable network to deliver the volume of data and insights to first responders and law enforcement in a timely fashion.

Examples of these solutions, technologies used and how they benefit cities and its citizens:

APPLICATION	Description	Technology	Benefits
Smart Street Lights	Streetlights - Targeted at city and residential streets parks and bus stops for energy efficiency purpose as well as potential add on applications	Various technologies have been used to deliver this application; Wi-Fi Low Power Wide Area Networks in a variety of frequencies	<ul style="list-style-type: none"> - Energy efficiency - Dimming controls further enhance energy savings - improved lighting for public safety purposes at bus stops and other public settings
Security Monitoring	Public Safety is paramount within the city. This is an opportunity to leverage new technology to ensure that citizens feel safe and first responders have the information in as near real time as possible to improve time to arrival and resolution	Image sensors - Cameras LiDar - Light detection and ranging Low power cellular technologies for connectivity	<ul style="list-style-type: none"> - Deter criminal activity - Improve cities situational awareness - When tied to additional data, improve first responders time to arrival
Gunshot Detection	As part of a public safety initiative, gunshot detection can help deliver lifesaving value in specific areas of interest	<ul style="list-style-type: none"> - Acoustic sensors - LTE/5G - Some Low Power Wide Area Network technologies 	<ul style="list-style-type: none"> - Real time notification and location information where a gunshot has occurred - Improve first responder response time - Improve citizen safety

The Challenge in Delivering Smart Cities

The first thing to address is the fact that each city has or will have their own vision of what makes their city smart. That said, one of the largest challenges aside from budget is a comprehensive strategy that starts with “Connectivity”. Connectivity is the foundation that will drive the success of all smart city applications and that connectivity as a “Backbone” has to embody attributes that support growth and sustainability over time:

High bandwidth – Smart city applications will drive a significant amount of data across the backbone and no other technology supports the amount of data and throughput as fiber. When you consider access to video for surveillance and public safety, business and educational internet access, the significant number of new sensors that will be deployed, it becomes clear that you need a solid foundation to build these applications and deploy applications on.

Resilience and Reliability - A large portion of the applications will be deployed for critical services (as mentioned in the previous point), the need for resilience is paramount. Most wireless technologies will suffer in poor environmental conditions, and therefore are not well suited as the backbone for these applications.

Interoperability – As a network backbone, interoperability is critical. Support for other wired and wireless technologies creates an opportunity to groom in new solutions in a streamlined fashion with the same reliability and common medium.

Smart Home – While city services are what we tend to focus on, there is indeed the element of how homes will benefit from a fiber backbone. The connectivity within a home and the advances in augmented reality/virtual reality (AR/VR) directly impact both a smart home interaction with cloud-based voice assistants and gaming systems to the advances in telemedicine and telecommuting. All require significant broadband access, and fiber is the perfect foundation to support all of that demand, from now and into the future. Think of how many appliances, streaming applications, smart locks, connected vehicles for charging and other devices will consume significant bandwidth, there truly is no better option to build around.

Deciding to build on a fiber network as a connectivity foundation unlocks the benefits on both the IT (Information Technology) and OT (Operational Technology) side of the city. Adding new wireless networks or devices to the backbone for the various applications becomes significantly easier than building out discreet networks for each application area and makes the support of city network services easier to maintain.

Taking the time to consider the benefits of a well thought out connectivity strategy will help improve services today and significantly reduce the challenges of tomorrow. Specifically, cities are attempting to address deploying distributed edge devices to help deliver insights, make localized decisions and reduce congestion on the network while delivering a “lag-free” experience to the end customer. Fiber networks aid in the implementation of edge-based intelligence by providing a common infrastructure to deliver the insights and make local decisions easier and with the speed required irrespective of the connecting devices. A prime example of this would be the use of connected traffic signals and traffic detection cameras in a traffic calming scenario. Monitoring the flow of traffic and feeding that data across the connected intersections to adjust the traffic lights, improving the flow of traffic without sending all of the data back to a centralized location. This is enabled by having edge-based intelligence and a high bandwidth network capable of sending these messages in real time, which results in adaptive traffic signaling. This is a critical step in making V2I(Vehicle to Infrastructure) and V2X(Vehicle to Everything) a reality, but it is not successful without the network supporting the latency requirements and a common infrastructure.

A secondary use case example of how this comes together for the city, utility and community (large and small) – EV, Electrification and Equitable Mobility options are gaining momentum and several city initiatives are focused on “Fleet Electrification” for buses and city owned vehicles for several purposes:

- Energy efficiency initiatives
- Sustainability by using renewable energy resources
- Making shared sustainable mobility an option for all citizens

The challenge with EV's and the deployment of fleet charging depots as it relates to a Smart Grid and Smart City solution indeed rests on a foundational connectivity strategy to deliver data about not only the EV's that are connected, but the integrity of the grid in as near real-time as possible. This is where the two entities (City and Utility) need to share communications infrastructure to deliver the greatest value and insight (when to charge, how long will it take, can the grid support the number of vehicles). Introducing demands on the Smart Grid by way of vehicle charging increases the opportunity for unplanned outages and decreased grid efficiencies. With a highspeed, reliable fiber backbone, both city and utility will experience the ability to connect the variety of transports required to deliver the insights for distributed energy resources without disrupting the grid operations while providing the fleet operators with the ability to charge, and offering citizens that don't have the option of charging at home a subsidized method of charging their vehicles as well. Ultimately, when V2I/V2X becomes more mainstream EV drivers will need to communicate with the infrastructure to determine where charging stations are and how many are available.

City of San Leandro - Lit San Leandro

[3]The city of San Leandro is considered one of the premier cities of digital transformation and have built their strategy around a deployment of fiber through a PPP (Public/Private Partnership).



[4]The Smart City Strategy was developed by Staff working across all City Departments and functions. It identifies specific areas where the city can utilize its fiber optic network to deliver technology services now and in the future.

These broad areas include:

- Digital Transformation, the process of creating a digital City government experience, often called “e-Government,” which includes digital services and open data;
- Smart Buildings & Facilities, connecting facilities and using integrated management systems for climate control, HVAC, energy;
- Smart Streetlights, Small Cells, and preparing for the deployment of 5G;
- Intelligent Traffic Signal Systems that adapt to real-time traffic conditions, making San Leandro streets more efficient;

- Using technology as a force multiplier for data and intelligence to improve public safety;
- Digital Inclusion, which entails connecting the unconnected and helping community members engage in the digital economy;
- Public Wi-Fi and infrastructure to drive economic development and bridge the digital divide.

The city of San Leandro has a comprehensive smart city strategy with a list of application areas that will be founded by their fiber optic network deployment.

These examples include:

-  Transportation Congestion Sensors
-  Water and Wastewater Monitoring
-  Parking Apps and Kiosks to Coordinate with Smart Metering
-  Bridge Inspection Systems
-  Self-driving cars shuttling people in or out of the city or making deliveries
-  Waste Management Sensors

 **AND
MORE**

[3] <https://www.sanleandro.org/civicax/filebank/blobdload.aspx?BlobID=29084>

[4] <https://www.sanleandro.org/depts/it/fiber.asp>

Conclusion

In conclusion, smart cities are being built today and are part of the 4th Industrial Revolution heavily predicated on a city's connectivity strategy. A fiber optic networking backbone is critical to improving a city's ability to improve; citizen engagement, public safety, economic development, livability and improving digital equity.

Authored By



Bill Pugh is Co-Founder and Managing Partner of Smart Connections and has a solid background in delivering Smart Grid, Smart City and IoT innovations for more than 15 years. While the technology is important, the main interest is what benefits are delivered to the clients, citizens and constituents across the board.



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