



Connectivity as the fourth utility in Smart Cities:

Enhancing mobility, safety and
digital transformation

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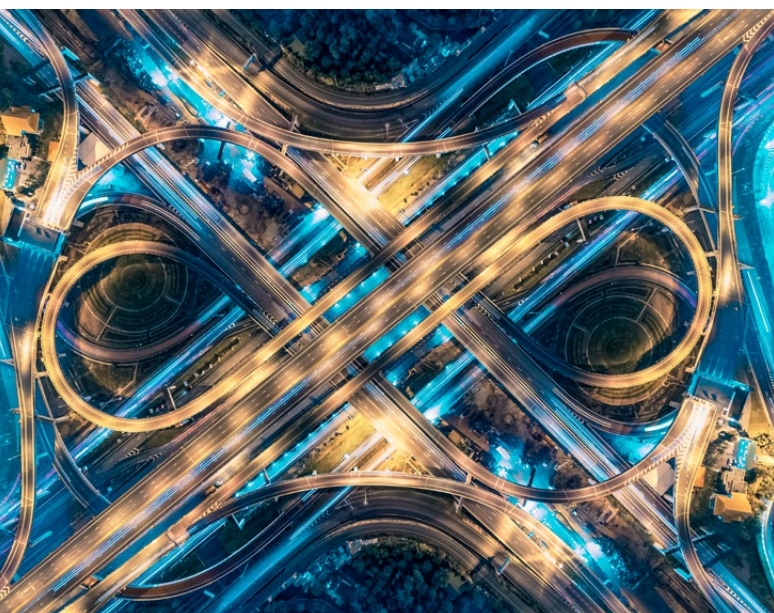
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By 2050, 68% of the world's population of 9.8 billion will live in urban areas, [according to the United Nations](#). By then, it is projected that India will have added 416 million urban dwellers and China 255 million.

This demographic shift globally, together with growing digitalization, compels urban areas to leverage innovative and sustainable infrastructure solutions that harness data, energy, space, budgets and time efficiently for the benefit of individuals and businesses. This is the vision of the smart city, which is built on the foundation of pervasive, high-performance, and reliable connectivity.



SOCIO-ECONOMIC HUBS

The concept of a smart city would not be possible without ubiquitous broadband telecommunications, according to the [Smart Cities Council](#). The connectivity that drives successful implementation of innovative solutions turns smart cities into vibrant socio-economic hubs that help businesses thrive. Various studies have invariably shown that communities with access to ultrafast, all-fiber broadband network achieve higher per capita GDP, create more jobs and spur more business start-ups than communities with slower access.

CONNECTIVITY AS A UTILITY

The quality and reliability of connectivity become critical to the smart city, especially for businesses that rely on it as providers of new services and as consumers of data generated from a wide array of connected things. For these enterprises, broadband infrastructure is increasingly being viewed as a utility like gas, electricity and water. The development of metro broadband networks that underpin smart cities has led to a gradual upsurge in demand for fiber because this is the primary technology that will support current and emerging applications and enable the digital transformation of enterprises operating in these cities.

EMPOWERING APPLICATIONS

Wireline and wireless broadband communications networks connect Internet of Things (IoT) devices and sensors that supply the data from which information is derived to manage assets and resources efficiently. These smart city applications enable enterprises to transform the way they operate their business and thrive in a globally connected digital economy.

High-bandwidth, low-latency, future-proof networks support the need for real-time data analysis capacities and an unprecedented degree of interconnectivity and convergence. Broadband networks (wireline and wireless) drive edge-device applications (IoT, cell tower, camera, etc.) that enhance:

- **Mobility:** Applications such as transportation, traffic and vehicle parking management, dynamic parking, tolling, and smart meters along with transit hubs support vehicles and mobility devices that are becoming ever more connected to the transport infrastructure; to drivers, riders and pedestrians; and to data centers supporting new business models, such as ride-hailing and bike-sharing in the sharing economy.

Businesses benefit from IoT-enabled, location-based applications that identify the most efficient transport or delivery routes; mobility management systems that provide predictive analysis and insights that help city councils to significantly reduce traffic congestion and pollution; and electronic road pricing and smart meter technologies that can be used to introduce variable toll pricing and peak-hour charges (as in Singapore) and demand-response pricing for parking.

The ability of people and things to connect with other things to access vital information while on the move is dependent on the quality and reliability of connectivity. Always-on broadband wireline and wireless connectivity ensure secure exchange of electronic data and transmission of critical information. With cameras communicating via IoT, smart cities could collect real-time data on open parking spaces and communicate with a search engine like Google to ease parking in crowded areas.

- **Safety:** Enterprises and their customers and stakeholders are increasingly interconnected and more dependent than ever on the smart infrastructure and data that bind the city together. As with mobility, smart cities must remain connected every second of every day, especially where safety comes first. For example, street light poles are being transformed into a critical asset of the big data analytics era for not only traffic management but also surveillance.

Running fiber cabling to a smart light pole will facilitate connectivity nodes linked to metro cells, Wi-Fi, HD cameras, 5G fixed wireless and future IoT as cities and technology evolve. As cities install smart lighting and [security cameras](#) on the pole, such connectivity paves the way for a whole new gamut of use cases.

Visibility and monitoring via connected HD cameras on street light poles, coupled with data analytics, can be used to re-route cars and direct emergency vehicles to the fastest route; scan license plates and car details for real-time tracking and rescue in emergency cases like a missing child report; alert first responders and police at the sound of a gunshot, a fist fight or certain words to prevent violent situations. Such connectivity will also bring increased efficiency in the surveillance of buildings.

- **Digital transformation:** Digitalization is disrupting all industries and digital transformation initiatives have become a necessity for enterprises competing in a globally connected economy. The resulting surge in demand for bandwidth calls for ubiquitous broadband connectivity.

The significance of this is underscored by the [value of cross-border data flows](#) at the heart of today's global digital trade surpassing the value of merchandise trade since 2015. Enterprises themselves will be able to capture a wealth of data from digital operations and IoT sensors and devices to drive better decision-making; create solutions to complex business problems; and constantly adapt to change and technological disruption. The presence of broadband in smart cities will also increase business collaboration and access to talent.

Wireline and wireless networks connecting 5G, cloud, IoT, mobile computing, HD video, and bandwidth-hungry applications enable revenue generation and business growth. Fiber connectivity is ideally suited to support these applications and makes it possible to transport huge volumes of data with low latency. More than that, the trend toward convergence of different types of network and functionalities onto a single network promises greater efficiencies.

As users' demand for low-latency, highly available access to applications and web services escalates, so has the scale of IT resources being migrated to and consumed in "smart" edge locations. In these locations – commercial buildings, hospitals, factories, transportation hubs and other urban spaces in smart cities – fiber complements enterprises' quest to deliver exceptional user experience to high concentrations of people and smart devices. This is the key to boosting business velocity, scalability and operational flexibility.



Smart city infrastructure strategies

Building a city with ubiquitous connectivity to unlock the untapped advantages of mobility, safety and digital transformation requires a long-term approach to broadband infrastructure development; wireline-to-wireless network convergence; and funding and planning for connectivity everywhere.

By connecting people and the IoT, service providers can deliver a wider range of innovative services efficiently on a common infrastructure while getting municipal networks up to speed. The reuse of infrastructures, platforms, data and systems will also help enterprises save cost and improve productivity in service innovation and delivery. They can harness more data for deeper understanding of the needs of customers and stakeholders.

Wireline networks leverage fiber and copper cabling as well as Powered Fiber Cable Systems (PFCS) to connect smart buildings and “edge devices” such as Power-over-Ethernet (PoE) Wi-Fi access points and surveillance cameras; small cells to increase capacity of wireless networks in high-usage areas to augment macro cell towers; and distributed antenna systems (DAS) to support multiple service providers. CommScope’s PFCS combines power and optical fiber communications into one system. The hybrid system is designed to support devices that accept PoE input for power and communications, especially useful in outdoor environments. It helps to overcome the PoE distance limitation of 100 meters and runs power to the precise desired location prior to device installation. This eliminates the hassle of negotiations among wireless network operators, local utility companies and building owners as well as the extra expense associated with installing low-power connected things.



Four key smart city strategies ensure sustainable innovation that enables enterprises to thrive and transform from legacy-laden incumbents to agile competitors.

- **Take the long view:** Instead of pursuing short-term goals with low-hanging-fruit applications such as switching to LED street lighting, city planners should be equipped to support emerging applications. A longer-term view would be to lay fiber connectivity to light poles along with installation of security cameras on the poles. This allows small cells or real-time facial recognition applications for the cameras to be easily and cost-effectively added and implemented.

City planners who consider new and emerging possibilities, consult with IoT and network connectivity vendors, and plan for the long term will minimize network upgrades and disruptions in the future. For example, Singapore is laying high-speed fiber infrastructure as the foundation of its next-generation nationwide broadband network capable of supporting IoT devices and applications well into the future.

- **Plan for network wireline-to-wireless network convergence:** Behind the new IoT applications that are mostly based on some form of wireless technology is a fiber backbone that offers the most cost-effective way to transport large data sets for the long term. This is a major consideration for incumbent service providers that have both wireline and wireless operations already and face the prospect of supporting yet another wireline network to support the emergence of 5G wireless service if it is not adequately planned for.

Converging these disparate networks into one build-out and maximizing asset utilization alleviates substantial maintenance cost while boosting efficiency and cost-effectiveness in expansion. The trend of converged networks inside buildings – one Ethernet or fiber backbone carrying voice, data, video and wireless traffic – should be extended to cities with fiber networks.

Cities are typically served by different networks built by traditional telcos, cable operators, emerging Internet providers like Google, neutral host providers, utilities and municipalities. Wasteful and disruptive practices, such as building a fiber-to-the-home (FTTH) network and having the same construction crew dig up the same street to lay fiber for a cell site a few months later, should be a thing of the past.

- **Plan for ubiquity:** Plans for city-wide network convergence should bring connectivity to all – those who can pay as well as the underprivileged. To erase this “digital divide”, adequate wireline and wireless broadband service must be accessible to commercial and industrial communities as well as residential communities of all income levels.
- **Get creative with funding:** To make ubiquitous broadband networks possible, cities can partner with service providers, network operators, utility companies and other organizations to co-fund projects. Globally, models that have been considered include streamlined permitting, infrastructure bonds and private-public partnerships.



Why fiber cabling

FIBER EVOLUTION

Fiber-optic cable is ideally suited to accommodate today's smart city applications as well as future technologies. Fiber has the capacity required by the backbone of all current networks: internet, cable TV, telephone (including mobile), private business and data centers. In particular, fiber satisfies the fast-growing demand for IP streaming video, which will represent [82% of all Internet traffic by 2021](#). Internet video surveillance traffic will increase sevenfold between 2016 and 2021 as smart city use cases for HD surveillance cameras widen.

With the advent of IoT, fiber connectivity will be extended not only to homes but also to the curb or cabinet, the building or basement and to nodes in the neighborhood. Industry analysts have estimated that there will be 1 billion subscribers of [fiber-to-the-X broadband access](#) globally by 2021. Without fiber, many everyday tasks – banking, working from home, online shopping, streaming audio and video, mobile phone and tablet usage, and healthcare applications – will not be possible.



NETWORK CONVERGENCE

[Network convergence](#) enables the use of multiple communication modes on a single network that offers convenience and flexibility not possible with separate infrastructures. Enterprises can now subscribe to a wider range of services from any service provider or adopt a best-of-breed multi-provider strategy.

New IoT applications leverage on wireless technologies as well as the fiber backbone behind them to transport large volumes of data from myriad sensors, cameras, smartphones and other devices. Digital data will be delivered from a data or processing source through a broadband network to a wireless distribution point and reverse for the upstream.

The demand for bandwidth in an internet-centric world, especially with the evolution of 4G/LTE densification and 5G wireless, has driven the convergence of three types of networks – multi-service organization, telephony networks and a traditional cellular network – supporting different communications applications.

- A *multi-service organization* or legacy television network may use a high-bandwidth hybrid fiber coax (HFC) network with a headend connected via router to data centers, and Wi-Fi connectivity in the home or in the office.
- The *legacy telephony network* consists of a legacy copper network, fiber to the node or fiber to the home.
- A *traditional cellular network* is comprised of macro cells – each independently powered and interconnected by a backhaul network of fiber, HFC, copper and microwave.

As implied above, three things are needed to [converge these networks](#):

- **Power:** The requirement for power at every wireless access point is essential. For instance, wireless access points can be activated via Power over Ethernet (PoE). Further, each legacy telecommunications network has different powering considerations.
- **Backhaul:** Data has to be sent from the edge access points to the central data storage or processing centers. Traditionally, backhaul from cell sites has been done either through high-speed twisted pair, microwave or fiber links from radio locations to centralized equipment locations. Meanwhile, for small cells, concerns around tight timing and latency requirements are being addressed in standards organizations.
- **Site acquisition:** Going forward, most wireless mobility for LTE densification or 5G will be deployed in high capacity urban and suburban areas. For any wireless network, site acquisition is a major factor and typically takes time and money to secure. With the goal of 4G/LTE wireless densification being to increase capacity, not coverage, a small cell coverage of 20-30 feet in the air is adequate to create the additional capacity desired.

BENEFITS OF FIBER AND CONVERGENCE

In the context of smart city implementations, fiber offers the following practical benefits:

- Very high bandwidth to transport large volumes of data with low latency. This ensures that smart city applications run smoothly without interruption.
- Works well across distances of 65 kilometers or more without signal degradation with no need to boost the signal along the path.
- Relatively easy to ship and install since fiber can be packaged in various cable profiles and hidden easily under surfaces or in walls. Once installed, fiber performance can be upgraded by changing the electronics that create and receive light pulses transmitted by the cables without needing to replace the cable itself.
- Rugged and weatherproof so it does not corrode; it is not easily affected by water; and it generates no heat.
- Immunity to electromagnetic interference makes fiber cabling inherently more secure since transmitted signals cannot be interfered with.

As the foundation of a smart city's communications network, a fiber backbone might connect to a wireless access point or it could terminate in a company's basement, a distribution point on a street corner or in an apartment building. Approaches for linking the fiber backbone to the end-user device in the home or business should consider the following benefits of network convergence:

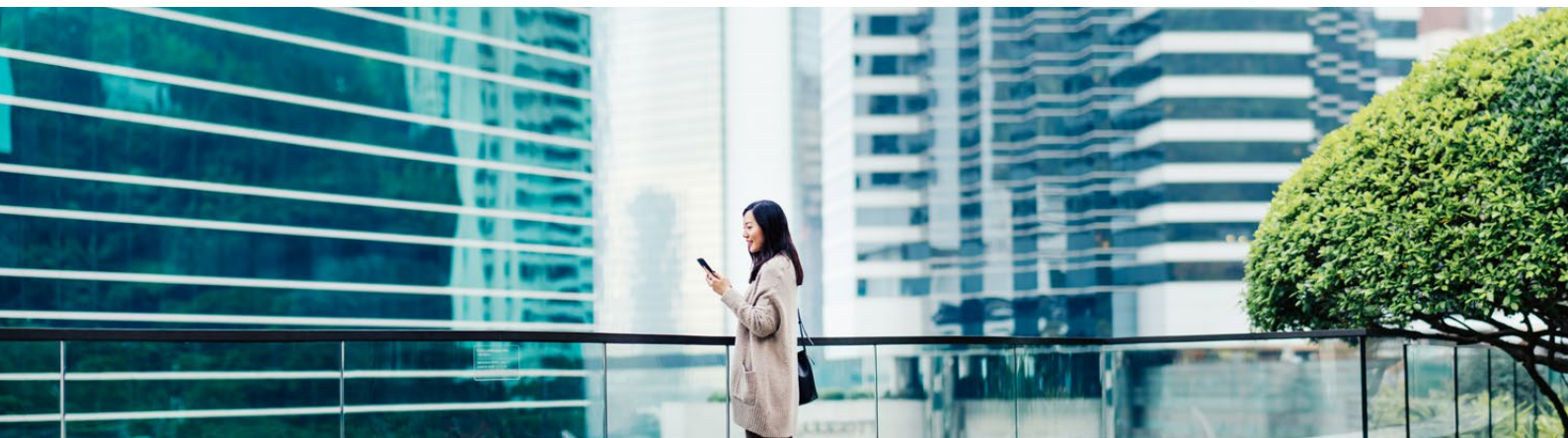
- Sharing physical assets between fixed and wireless: With small cells moving deeper into the network and centralized radio access network (CRAN) allowing pooling of baseband resources, sharing of fiber cables and physical real estate

becomes significantly important. Building a new FTTH network – followed several months later by the same construction crew having to dig up the same street to lay fiber for a cell site – won't be an issue.

- Sharing data stream for fixed and mobile: Additional efficiencies are gained for companies willing to share fibers for multiple applications. Furthermore, wavelength-division multiplexing systems, Next-Generation Passive Optical Network 2 and other technologies are allowing the merging of bit streams and enhanced network efficiency. Spare capacity can be marketed as “virtual dark fiber” or wavelength services which are less costly and faster to deploy.
- Sharing processing and management resources: The trends toward Software-Defined Networking and Network Function Virtualization allow network operators to share processing and management of the network regardless of the end application. As multiple services are delivered from a single network, reliability becomes paramount – and quality and standardization will increasingly play a critical role.

Migration toward network convergence will continue to be driven by the natural economic and technical evolution expedited by smart city applications harnessing IoT and wireless small cell densification to boost efficiencies; maximize asset utilization and leverage economies of scale.

Regardless of the objective, smart city applications continue to evolve and grow, and they need reliable, high-speed connectivity today. The earlier a foundation of fiber-based converged network is planned and built, the more prepared and smarter cities can be in the future.





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