Urban Land Institute

BROADBAND AND REAL ESTATE

Understanding the Opportunity

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About the Urban Land Institute

The Urban Land Institute is a global, member-driven organization comprising more than 45,000 real estate and urban development professionals dedicated to advancing the Institute's mission of shaping the future of the built environment for transformative impact in communities worldwide.

ULI's interdisciplinary membership represents all aspects of the industry, including developers, property owners, investors, architects, urban planners, public officials, real estate brokers, appraisers, attorneys, engineers, financiers, and academics. Established in 1936, the Institute has a presence in the Americas, Europe, and Asia Pacific regions, with members in 80 countries.

The extraordinary impact that ULI makes on land use decision-making is based on its members sharing expertise on a variety of factors affecting the built environment, including urbanization, demographic and population changes, new economic drivers, technology advancements, and environmental concerns.

Peer-to-peer learning is achieved through the knowledge shared by members at thousands of convenings each year that reinforce ULI's position as a global authority on land use and real estate. In 2020 alone, more than 2,600 events were held in cities around the world.

Drawing on the work of its members, the Institute recognizes and shares best practices in urban design and development for the benefit of communities around the globe.

More information is available at uli.org. Follow ULI on Twitter, Facebook, LinkedIn, and Instagram.

About the ULI Curtis Infrastructure Initiative

The ULI Curtis Infrastructure Initiative aims to build a movement to promote infrastructure solutions that are equitable and resilient and that enhance long-term community value. By creating new global and strategic partnerships, providing technical assistance, building capacity at the local level, and acting as a feedback loop to promote the most innovative and effective best practices, the Curtis Infrastructure Initiative will ensure the success of ULI's mission to positively shape the future of the built environment for transformative impact in communities worldwide. A thoughtful approach to infrastructure planning and implementation addresses the pressing needs of today and improves diverse communities for the long term.

A building block for communities everywhere, infrastructure encompasses transportation, critical utilities, and the means of communication. But beyond those foundational physical and digital structures and facilities, infrastructure broadly includes the key spaces that build community—the anchor institutions, the civic commons, and the housing. Because infrastructure provides the means for connection, creative placemaking, and opportunity, smart infrastructure investment is an imperative for our cities now and in the future.

Together we can build the future of equitable and resilient communities. Learn more about the Curtis Infrastructure Initiative at uli.org/infrastructure.

"The purpose of [the Curtis Infrastructure Initiative is] to contribute toward the building of a better future by providing resources of inspiration, discovery, and innovation."

—James J. Curtis III, ULI Life Trustee

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KEY TAKEAWAYS

- As the world becomes more digitalized, those without access to reliable, affordable, and fast internet access will be increasingly left behind. A clear need exists to develop and implement a tangible action plan that will identify what broadband needs are and how to address them effectively and equitably. This plan will involve no longer viewing broadband as a luxury but as a necessary infrastructure for communities to thrive and grow economically.
- Availability of widespread, high-speed broadband networks already has a wide variety of benefits to the real estate industry, communities, and individuals. Those networks create an opportunity for innovation and value that has led and will continue to lead to benefits that may come from unexpected and unpredictable places.
- As a result of its fundamental role in shaping the built environment, the real estate industry can be a major voice in the planning of future internet infrastructure decisions and can ensure that the industry's needs are met while it is also being a partner with regional planning authorities and providers.
- Real estate owners and developers do not need to know every technical detail about connectivity to use it as a differentiator for their projects. Broadband connectivity should not be considered a difficult specialization or niche that only a few developers conduct, but rather it is a key pillar of placemaking and of the development process for every project.
- Increasing mobility opportunities can present potential value that real estate owners and managers can harness for their buildings. Such opportunities include repurposed or reduced parking facilities, denser projects, and higher rates of return.
- The economic impact that comes with broadband access has further deepened inequities. Businesses that do not have broadband cannot maintain a web presence or access services on the web. As schools switched to virtual learning during the pandemic, a deep academic divide grew; moreover, individuals without current access to the internet cannot take advantage of working from home as it relates to opportunities for economic mobility.
- Current regulatory definitions of acceptable internet speeds are inadequate and will not be adequate for future needs that are expected to grow substantially in the coming years. This reality was true even before the accelerations brought on by COVID-19.
- There is no one way to address the digital divide, but without concerted action, that divide will not go away. Many options exist for addressing the divide, and there are examples of public and private approaches—and combinations of the two—in both large and small communities. The key is choosing a solution that works for each community's needs.

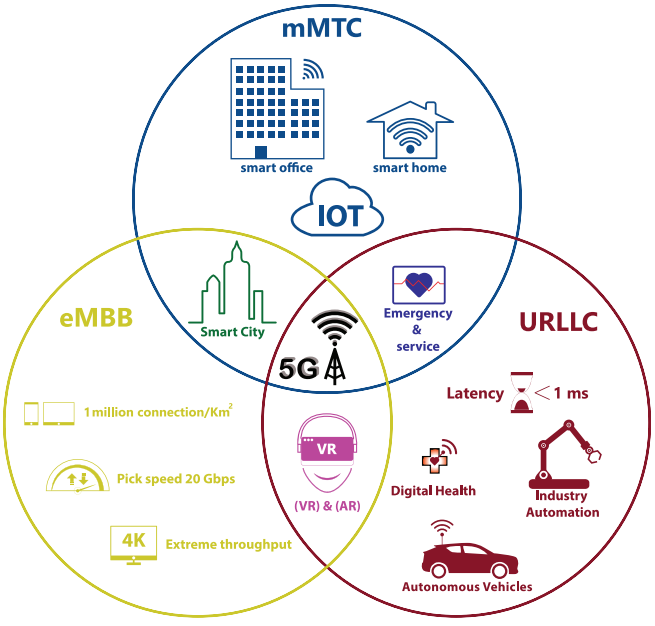
INTRODUCTION

We live in a world that is increasingly interconnected and digitalized. Even before the COVID-19 pandemic, the real estate and land use industry had felt the effects of connectivity and had taken advantage of it, from the increased interest in property technology—or proptech, the innovative use of technology in the real estate industry—to the rise of e-commerce affecting worldwide logistics and manufacturing markets. All this connectivity and digitalization relies on the speed, capacity, and reliability of our world's internet infrastructure.

However, with the onset of the global COVID-19 pandemic in 2020, internet infrastructure was brought to the forefront as a pressing need. The demands of large-scale work from home, school from home, accelerated e-commerce, telehealth, and even family gatherings pushed more of our lives online and exponentially increased demands on internet infrastructure to unprecedented levels and strained capacity in unanticipated ways. This demand also helped shift the real estate industry itself from thinking just in terms of physical space to also considering how to engage within a virtual environment.

As conversations about the future of working from home and other COVID adaptations continue, one thing has become abundantly clear: the need for increased bandwidth will only continue to accelerate. Moreover, for people to be full participants in a 21st-century society, both economically and socially, they will need modern digital connectivity. Unfortunately, like so many other aspects of society, access to this connectivity and its many benefits are often deeply uneven—both between urban and rural communities and between neighborhoods and zip codes within the same city—thus creating what is known as the digital divide.

The goal of this report is to identify both the challenges and the opportunities presented in addressing the digital divide, the tools and techniques available for both the real estate and land use industry, and the need for communities to expand and best take advantage of this connectivity.



The opportunities presented by broadband are endless, but equitable access needs to be part of its implementation.

GLOSSARY

This glossary includes terms used throughout the report.

5G—Fifth generation, the next-generation technology standard for broadband cellular networks, which is being deployed to replace the currently dominant 4G network. The 5G technology delivers higher speeds in part by using higher-frequency radio waves than those used by 4G networks.

bandwidth—The amount of data that can be transmitted over a connection in a given period, typically measured in megabits per second (mbps). Bandwidth is not only a measurement of the volume of information traffic, but also the upper limit of transmission speed.

backbone infrastructure—Extremely high-capacity fiber-optic cables that carry information over long distances, across continents and oceans, and between internet network access points.

broadband—As defined by the Federal Communications Commission, any internet data-transmission technology able to deliver at least 25 mpbs download and 3 mbps upload speeds—known as 25/3.

cable internet—An internet connection transmitted to the customer through a cable coaxial connection.

digital divide—The difference between those who have access to broadband and those who do not. A rural divide is characterized by a lack of availability resulting from the cost of infrastructure construction; an urban divide is characterized by availability but a lack of affordability, which leads to limited access.

DSL—Digital subscriber line, a broadband internet connection transmitted through copper telephone lines.

FCC—Federal Communications Commission.

fiber optics—A transmission type that converts electronic information into light and transmits that information through cables containing thin glass fibers rather than copper wiring. Sometimes referred to as "fiber," this technology has been in use for decades and has much faster transmission speeds and capacity than does DSL or cable.

fixed wireless—A high-speed internet signal that uses radio airwaves to connect the end user to an internet access point, such as a fiber-optic line through receivers located on the user's premises. Fixed wireless requires a line of sight to the main access point, thus potentially limiting range. Because the technology uses radio waves, fixed wireless deployment also requires available spectrum, which is limited and increasingly scarce as the FCC seeks to support 5G networks and because the use of wi-fi devices is increasing.

ISP—Internet service provider, the company or organization that provides connection to the internet for the individual user or business.

last-mile networks—Similar to use of the term in logistics, the infrastructure connecting the middle-mile ISP network to the customer. For instance, it is the connection between a utility pole and the customer's home or the connection between a cellphone and the tower. Those networks are typically the largest speed bottleneck for the subscriber because they use cheaper, lower-capacity wiring than do higher-tiered networks.

middle-mile networks—The segment of the telecommunications network that connects backbone infrastructure to a network operator's local infrastructure, which is typically operated by an ISP. The barriers to expanding or sharing of those networks is considered one of the main causes of the digital divide.

proptech—Property technology, an umbrella term for leveraging technology to improve the way people research, rent, buy, sell, and manage a property in new and innovative ways.

satellite—A form of wireless broadband not bound by any fixed infrastructure and thus offering coverage in very remote areas. However, the cost to each user is high.

small cells—Small radio antennas that connect to fiber lines and extend 5G coverage to a small area.

spectrum—Information transmitted wirelessly using radio waves; it is a form of electromagnetic (EM) radiation. The waves are measured by wavelength or frequency and are just a small portion of the overall EM spectrum. The spectrum is owned and managed by the federal government via the FCC, and only a finite amount is available. Once a portion of the spectrum is in use for one purpose, its use for other purposes is limited.

wi-fi—Wireless fidelity, a technology that connects devices to the internet within a short range using radio waves.

wired connections—Any transmission technique or technology that sends data over a physical connection, including fiber optic, DSL, or cable modem connections. Wired broadband is currently the dominant mode of internet infrastructure.

PART I:
THE DIGITAL DIVIDE

This section lays out background about the state of broadband nationally, as well as the technical, economic, and market challenges for expanding broadband access to communities that lack it. Such challenges constitute what is known as the digital divide. Those challenges are not the same across all communities, and this section will seek to delineate the differences.

Ways to Measure the Digital Divide

The first step in solving the problem of inequitable digital access is understanding where and why communities do not have access. Current definitions and measurement techniques may constitute more of an obstacle than an aid to effective action.

FCC Definitions

The traditional data definitions of the Federal Communications Commission (FCC) have posed a challenge in properly assessing the picture of market availabilities. For wireless connections, such as cellular service, the FCC has traditionally used data sets that consider a census tract to be fully serviced by a wireless service provider if the geographic center point of that census tract is served. This approach leads to the possibility of error and overrepresentation in service measurement.

For fixed internet services, the FCC considers a census tract served "if the provider does, or could, within a service interval that is typical for that type of connection . . . provision two-way data transmission to and from the Internet with advertised speeds exceeding 200 kbps in at least one direction to end-user premises in the census block." In layman's terms, a service provider is not required to have a connection to every home—or even an active connection to any home—in a census tract in order for that tract to be considered served under the FCC guidelines.[1] A service provider must simply be able to provide that connection to a single home within the census tract in a reasonable amount of time for the area to be considered "served."

This weakness has been acknowledged by the FCC with its launch of the new Digital Opportunity Data Collection, which seeks to collect more granular data from providers.[2] Although these more granular and specific data may result in more accurate pictures of actual internet infrastructure deployment in the United States, as of summer 2021 this program has not yet completed its first full cycle of data collection and verification.

Another obstacle is the FCC's definition of broadband internet as 25 megabytes per second (mbps) download speed and 3 mbps upload speed. Even before the COVID-19 pandemic, many advocates in the field of internet access and infrastructure thought this definition was no longer adequate for the speeds needed by the average household. The pandemic confirmed those concerns, with its requirements that people work and be schooled from home. Because both often occurred at the same times, the reality proved those speeds to be woefully inadequate for 21st-century demands on internet bandwidth. A further concern with this benchmark is that because many areas have reached that level of service from at least one provider, tracking data in that way no longer shows a picture of differentiation among markets, making it a useless tool for analysis and comparison.

Understanding 5G and Range

Over recent years, 5G has become an increasingly prevalent topic of conversation as the technology has advanced and as cellular companies have begun rolling out their 5G networks. The term 5G is short for "fifth generation"—the next-generation technological standard for cellular data connectivity, a form of broadband. The transmission has a much higher frequency and shorter wavelength, which allows data to be transmitted at much higher speeds.

The higher transmission speed comes with drawbacks, though: because the signal cannot travel as far, the coverage area must be divided into much smaller geographic "cells," each with its own signal transmission point. This point is usually a box attached to an existing vertical asset such as a streetlight and can be as small as a wi-fi router or as large as a minifridge. Although the fast transmission speeds open significant possibilities, the ultra-fast promises of 5G cannot be fulfilled without traditional fiber-optic infrastructure connecting to the towers or antennas.

Jeff Reiman, president of The Broadband Group, explains: "5G should be viewed as an application [that] is enabled by fiber, not as a replacement for it. . . . Absent fiber infrastructure, you don't have the bandwidth backhaul required for a high-quality 5G wireless signal." In addition, absent proper planning, property owners could face difficulty trying to implement this wireless technology in their buildings if they chose to implement it in their buildings.

"Around 80 percent of all mobile data traffic is consumed indoors, and many buildings that have low-E glass and concrete foundations will not support 5G networks," said Tom Redmayne of WiredScore, an organization that rates connectivity of commercial and residential real estate properties. "The ultra-fast 5G signals do not travel through walls and energy-efficient glass. Developers and owners will have to invest heavily in making sure they can boost the phone signal within buildings to ensure that they can provide the 5G networks that renters and tenants will rely on."

TOMMY FAWCETT/UNSPLASH

A water tower in Allenhurst, New Jersey, serves as a signal transmission point that can generate revenue for building owners.

New Definitions

Several proposals have been offered in recent years for updating the FCC's definitions of broadband speed to better measure internet quality and availability. Redmayne views broadband "as a minimum of 50 mbps download and 15 mbps upload as the bare minimum to function in the home. For businesses, this number needs to be closer to 50/50 minimum to operate seamlessly." The Electronic Frontiers Foundation has proposed an even higher new definition of broadband internet of 100/100—100 mbps of both upload and download speed—up from the current definition of 25/3.[3]

A bipartisan group of senators, including Joe Manchin (D-WV) and Rob Portman (R-OH), has also called for the FCC to update its definition of broadband internet to the 100/100 level.[4] A part of the July 2021 bipartisan infrastructure deal that has moved forward for debate would establish a minimum standard for the FCC of a 100 mbps download speed and 20 mbps upload speed for broadband.[5] This constitutes progress but remains insufficient, according to Redmayne and the group of senators.

The U.S. Department of Commerce's National Telecommunications and Information Administration (NTIA) has a newly released Indicators of Broadband Need tool that pulls data from a much wider variety

The Need for Symmetry in Upload and Download Speeds

Most internet connections are asymmetric, meaning they provide faster download speeds than upload speeds, as evidenced by the current definition of broadband—at least 25 mbps of download speed but only 3 mbps in upload speed. This range is premised on the idea that the overwhelming majority of internet users are exclusively or primarily consumers of the internet and that they are only taking information, data, files, and entertainment from the internet and not using it to send information out. Changes brought by the COVID-19 pandemic—the increased prevalence of work from home, the associated increase in virtual meetings, the necessity for remote education, and the requirements for telehealth, all of which were already gaining in popularity before 2020—have rendered this view obsolete.

For many internet users, uploading is now just as important as downloading. In a virtual meeting, it is just as important for others to be able to see and hear you as it is for you to see and hear them, and the same goes for remote schooling. In a telehealth situation, what is more important, for the patient to see the doctor or for the doctor to be able to observe the patient clearly?

"The importance of broadband has never been clearer," said Reiman. "In the 'remote everything' world that is now our reality, the quality of the connection matters now more than ever before. And the importance will only continue to increase. Whether one has access to high-quality broadband affects your employment trajectory, educational opportunities, health care options, and more."

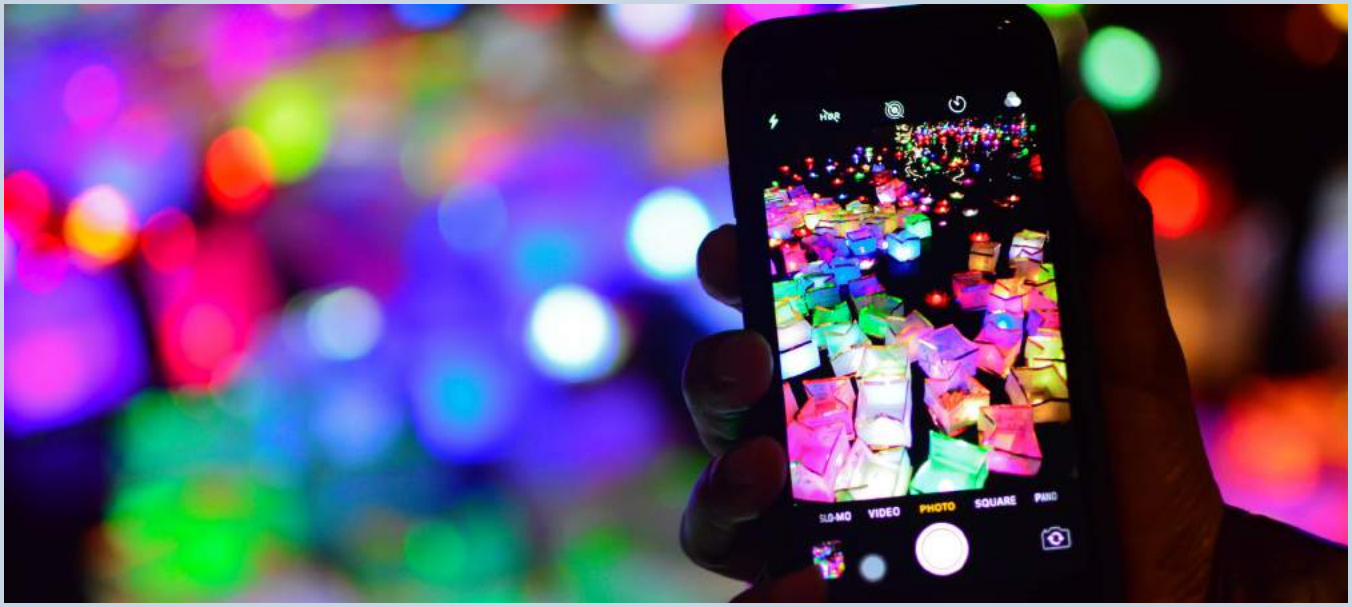
In the current digital landscape, most people are both producers and consumers, so they upload and download in a more balanced ratio than ever before. Those usage

of sources than does the FCC's traditional mapping techniques, showcasing the importance of creating new definitions. In addition to using the internet service provider's (ISP) volunteered data that the FCC primarily relies on, NTIA takes data from the Microsoft update services, the M-Lab and Ookla speed tests, and the American Community Survey data about internet access and device use. This tool paints a much clearer picture of which areas have the greatest need.

Another potential change is updating the definitions for the FCC's Connect America Fund, which has the goal of connecting unserved communities. The fund has a definition of 4/1 mbps as the minimum service definition for a served community, meaning efforts to connect communities will receive grants from the fund only if they are serving a community with less than 4/1 mbps speeds. This definition leads to what is known as the "donut hole" phenomenon. More developed town center areas, which have speeds higher than 4/1 but that might have less than even the current 25/3 broadband speed, are eligible for those funds. New, modern networks are being installed in less-populated areas, leaving an aging infrastructure in small towns and cities without funds for upgrades.[6]

trends are expected to continue. Cisco estimates that globally by 2023 there will be 50 percent more devices and connections to the internet per capita than there were in 2018, and U.S. internet traffic in that same time frame is estimated to triple.[7]

The antiquated notion of asymmetric usage patterns is no longer a reality for most users of the internet and should be set aside by regulatory bodies in favor of symmetrical upload and download speed standards in future broadband definitions.



NAVEEN RAJ DHANAPAL/UNSPLASH

Fast upload and download speeds are essential for effective broadband networks.

Different Communities, Different Challenges

There is no single right way for all communities to address the digital divide because each community is facing a different and unique challenge. There are effectively two different digital divides: one in rural communities, which is caused by a lack of availability of internet services and the necessary infrastructure, and one in urban communities, which is caused by a lack of affordability of those services and therefore a lack of access to infrastructure that is readily available.

The Rural Digital Divide

According to the FCC, although 97 percent of Americans in urban areas can access fixed internet service that meets federal broadband speed standards, only 65 percent of Americans living in rural areas have access to such service.[8] The most significant barrier to expanding high-speed internet access to rural communities is the cost of installing the necessary middle-mile fiber infrastructure. Cost estimates for installation of those networks can vary widely on the basis of unique factors and considerations at each site.

ULI Louisiana Broadband Symposium

For a 21st-century community to thrive, broadband is a necessity rather than a luxury. Evidence shows that access to reliable internet improves communication and connection. Furthermore, significant economic benefits come with access to high-quality internet—for businesses, commerce, academics, and everyday life. For every dollar invested in broadband access, there is a defined economic multiplier.

In Baton Rouge, the lack of broadband access in certain portions of the city had been a problem before COVID-19. When the reliance on online communication and virtual learning dramatically increased during the pandemic, the digital divide was exacerbated further. Consolidation of the broadband industry and the economics of creating a robust fiber network have created barriers to allowing the free market to solve the connectivity issue on its own. Further support from public and private entities may be needed.

As part of a ULI Louisiana Broadband Symposium in May 2021, the following key takeaways were identified to mitigate the lack of connectivity in Baton Rouge and to provide solutions and ideas that can improve the situation. The state's goal is to eliminate the digital divide in the next seven-and-a-half years.

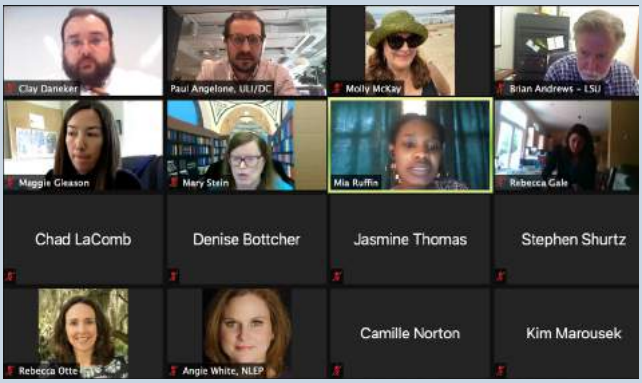
- There is no one-size-fits-all solution for every community when it comes to broadband. There is support for public/private partnerships, including those through NTIA, that can be explored further for Baton Rouge.
- A variety of factors work against expansion of broadband in majority Black communities such as those in Baton Rouge, in other communities of color, and in communities with low incomes. Such factors include relying on a single major carrier, not being able to implement 5G networks, and having "digital redlining," a situation in which high-speed broadband is available for those who can afford it while others go without.
- The economic impact that comes with broadband access has further deepened inequality in the region along the digital divide. Businesses that do not have broadband cannot maintain a web presence or access services on the web. Further, as schools switched to virtual learning during the pandemic, a deep academic divide grew.

An analysis of West Virginia's right-of-way policies used a budgeted cost per mile of fiber installation at $27,500 per mile;[9] OTELCO, a publicly traded telecommunications provider, estimates the cost per mile for fiber infrastructure at $18,000 to $22,000 per mile.[10] There are also cases displaying costs much higher than these. For instance, a Charles County, Maryland, broadband strategic plan estimated a cost of $1 million to install eight miles of backbone infrastructure, or $125,000 per mile.[11]

Because of the much lower density of households and businesses in rural areas, the infrastructure required to provide a high-speed, middle-mile internet connection between the home or business and the backbone data networks simply must go much further in linear distance to serve the same number of customers as urban or suburban networks might. This distancing dramatically increases the cost per customer for installing such a network. Then, despite fiber internet networks having a very long operating lifetime, the networks also have a long payoff period that can make it difficult for typical internet service providers to make the large investments required for such rural projects.

- Panelists and participants discussed the issue of *affordability* being of greater importance than *access* to broadband, though both remain an issue throughout the region.
- Panelists and participants expressed concern that policymakers and influencers still do not understand many of the issues involving broadband access. More must be done to bring the stakeholders and the planning and zoning professionals together to address the problem.
- Terminology in discussing broadband is crucial. There is a need to shift the view of broadband from being as a "luxury" to being a "need" and to focus on the "democratization of data" so everyone in the community has access to information, regardless of income, class, or race. There should also be a standardization of definitions, including for "competence," "reliance," and "access."
- Digital literacy is critical to increase internet subscriptions—absent affordability or access constraints. Panelists discussed how to engage with residents who may be reluctant to use the internet or who feel less secure about doing so. This finding also relates to the different needs of a community for broadband speed and capacity. Not every household will need the highest capacity and speed of internet access.
- A clear need exists to develop and implement a tangible action plan that will identify broadband needs and how to deliver them effectively. This approach will involve no longer viewing broadband as a luxury but as a necessity for communities to thrive.

Learn more about the Baton Rouge project and the symposium at uli.org/infrastructure.



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A screenshot of ULI Louisiana's Broadband Symposium.

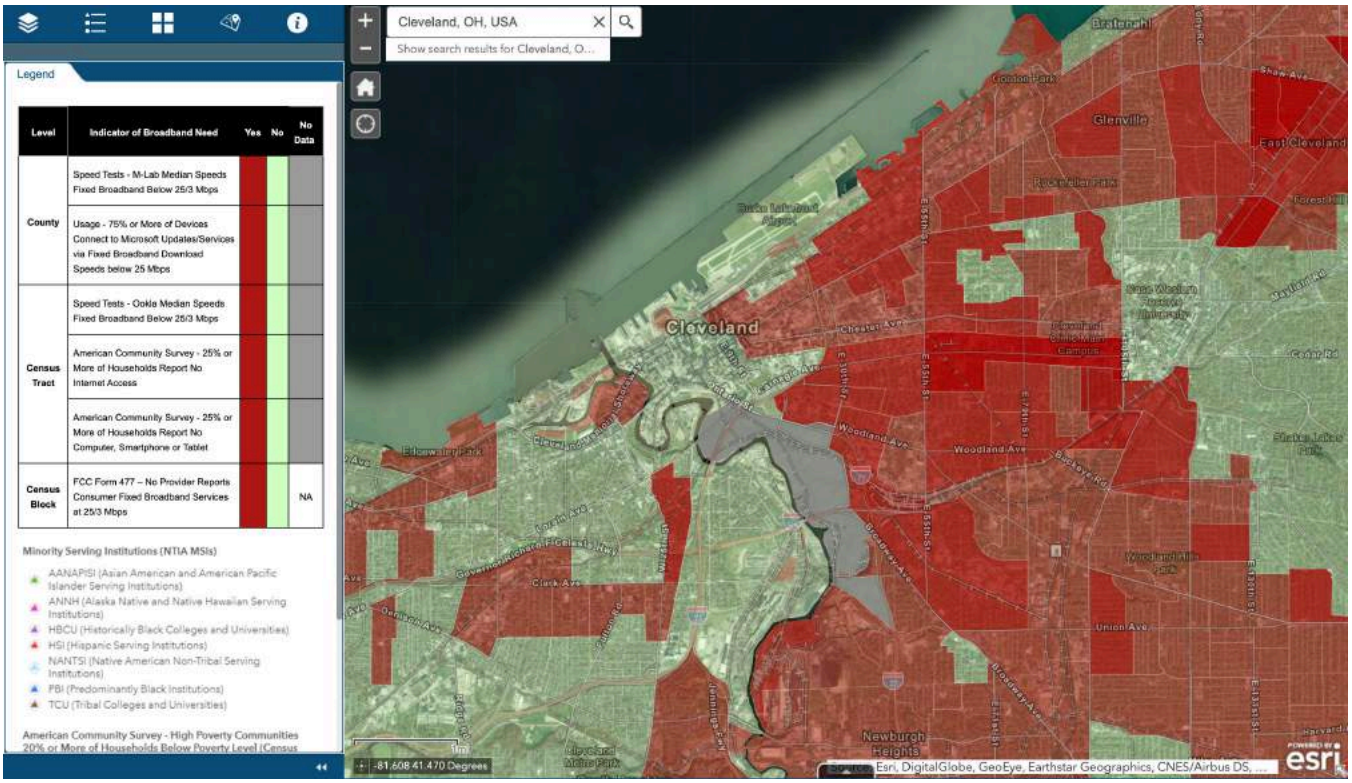
In this way, the current problem with rural access to high-speed internet is somewhat akin to rural electrification efforts in the 1930s and 1940s, which was recognized as an economic development imperative that required significant government intervention through loans, funding, and regulatory changes. Rather than requiring a new or inventive solution to a complex market or technical problem, the question in rural markets is more one of incentivization in order to close this gap.

"Connectivity is the fourth utility," said Marta Soncodi, director of the Smart Buildings Program at the Telecommunications Industry Association. "[Just as in t]he way you have water, gas, and electricity, you need ubiquitous, seamless connectivity. It's not a 'nice to have'; it's a must have."

Variation in Urban Markets

According to the FCC, although almost all Americans in an urban setting can be expected to have the availability of at least one internet service provider with broadband-level speeds, the issue becomes more one of affordability. In New York City, ostensibly the richest city in the world, the city's Internet master plan states that "40 percent of New York City households lack the combination of home and mobile broadband connections, including 18 percent, [or] more than 1.5 million people, who lack both."[12]

The research of Build Baton Rouge confirms that this issue is even more exacerbated in disinvested areas such as the Plank Road Corridor, where the Curtis Infrastructure Initiative supported a ULI Louisiana technical assistance panel. As many as 40 percent of residences in the study area in east Baton Rouge have neither an internet subscription nor a cellular data plan, meaning a significant portion of the area's residents are effectively cut off from the digital world. But for the past year, that digital world is where many essential functions of life, including school, work, and



NTIC/BROADBAND NEED, ULI

The Indicators of Broadband Need tool showing the Cleveland, Ohio, region. The areas marked in darker reds have less access to broadband, which mirrors the historical redlining map.

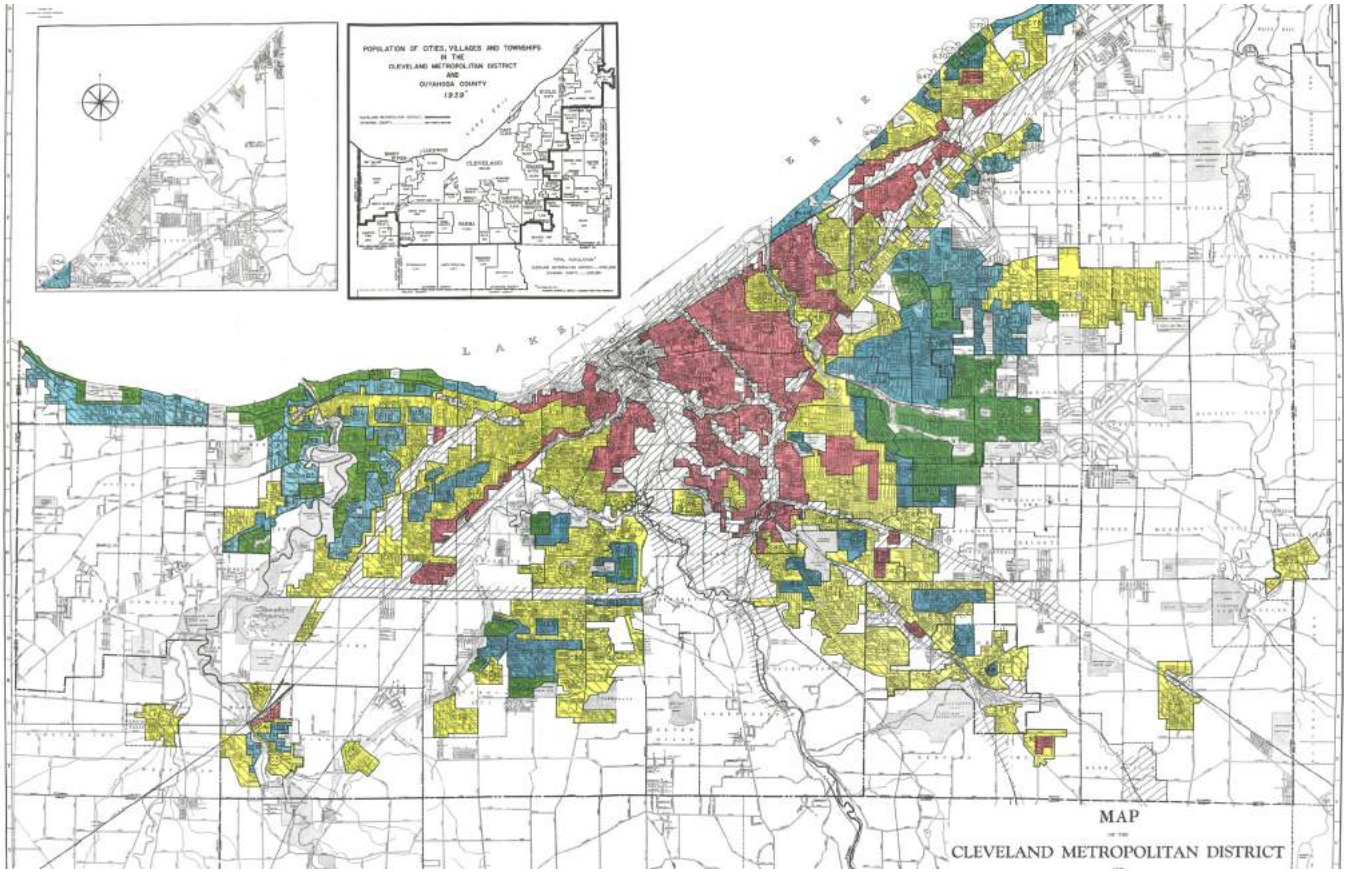
health care, have largely existed and where many of such functions will increasingly depend in the future.

A substantial contributor to the unaffordability of high-speed fixed internet connections is a lack of meaningful competition and choice. According to the Institute for Local Self-Reliance, at least 47 million Americans live in a market where one of just two companies, Comcast or Charter, has an absolute monopoly. An additional 33 million people live in areas where the only "competitor" is aging DSL networks that are slower, less reliable, and unable to provide the bandwidth needed for modern demands.[13]

This lack of competition often proves to be a self-fulfilling prophecy. As shown in the previous discussion about cost of installing infrastructure, entering a new market is already a difficult proposition for internet service providers. For instance, the highly touted city-owned fiber network in Chattanooga, Tennessee,

"In addition to changed attitudes and cultural norms towards remote working accelerated by COVID, improved access to health care, improved internet infrastructure, and efforts to connect divided urban communities will promote increased employment mobility and flexibility and disruptions to typical commuting patterns."

—Respondent to the ULI Member Global Infrastructure Survey



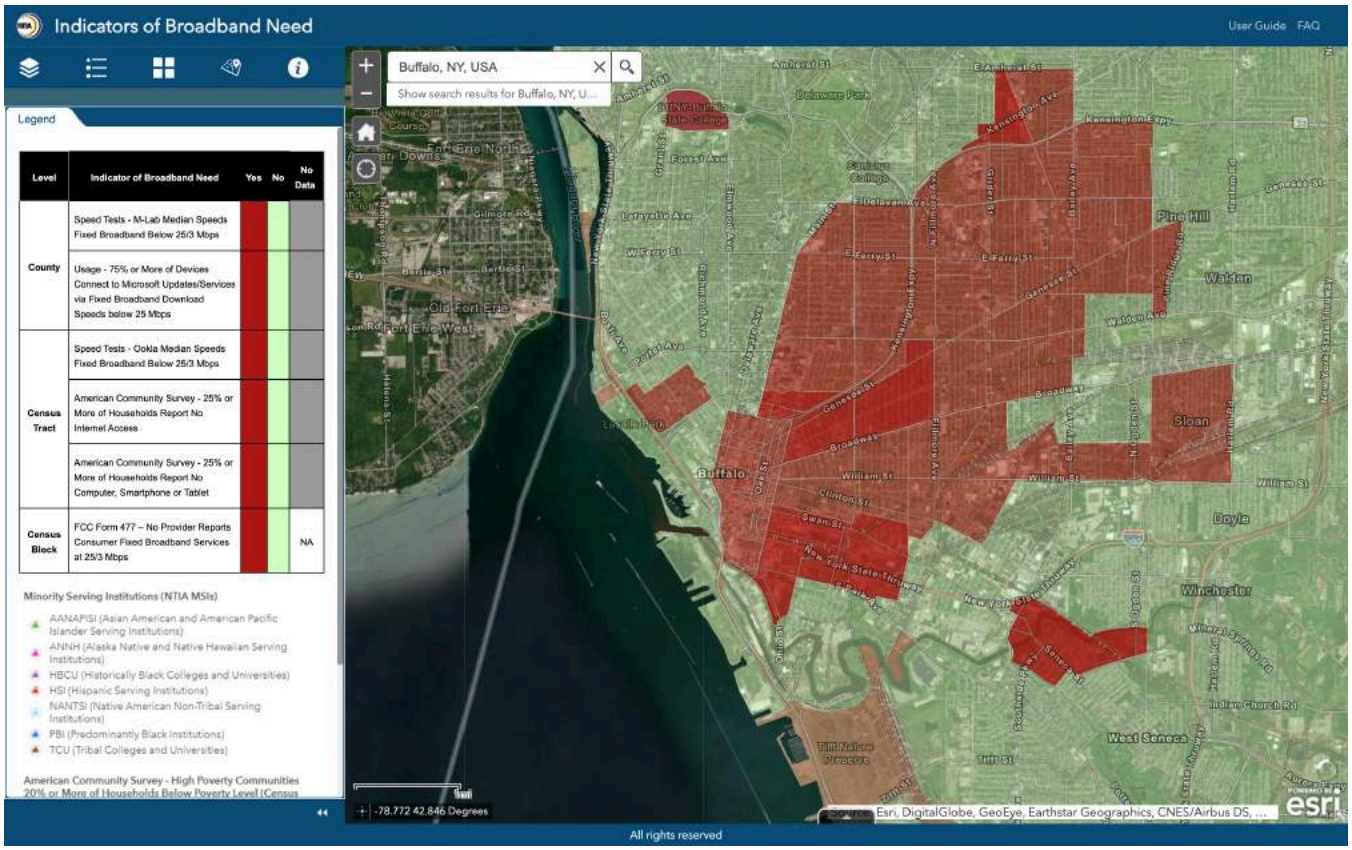
Home Owners' Loan Corporation map of Cleveland.

cost roughly a half billion dollars and took three years to complete.[14] The investment was made when the city-owned utility looked for opportunities to develop a smart grid to reduce power outages.[15] The investment has been credited recently with $2.69 billion of overall economic benefit to the city; however, a private provider must take a much more limited view of the cost/benefit analysis and must consider accounting only for subscription fees that will be collected.[16]

In an economically disadvantaged area where currently only a slim majority of households have an internet subscription, the expected return on investment for a new provider—for building new infrastructure and for competing with an incumbent provider for a share of a currently small potential customer base—is not favorable for the quick, safe returns needed by a publicly traded company. This finding explains why many providers look only to markets where they are already established with a pseudo-monopoly or duopoly. To end this log jam, citizens, policymakers, utility providers, private industry, and developers will need to work together to find creative solutions that benefit all stakeholders, including incumbent providers.

Legacy of Redlining

Though racial discrimination in housing and the practice of redlining was formally banned with the Fair Housing Act of 1968, it is indisputable that decades of discriminatory lending and sales practices



NTIC/BROADBAND NEED, ULI

The Indicators of Broadband Need tool showing the Buffalo, New York, region. The areas marked in darker reds have less access to broadband, which mirrors the historical redlining map.

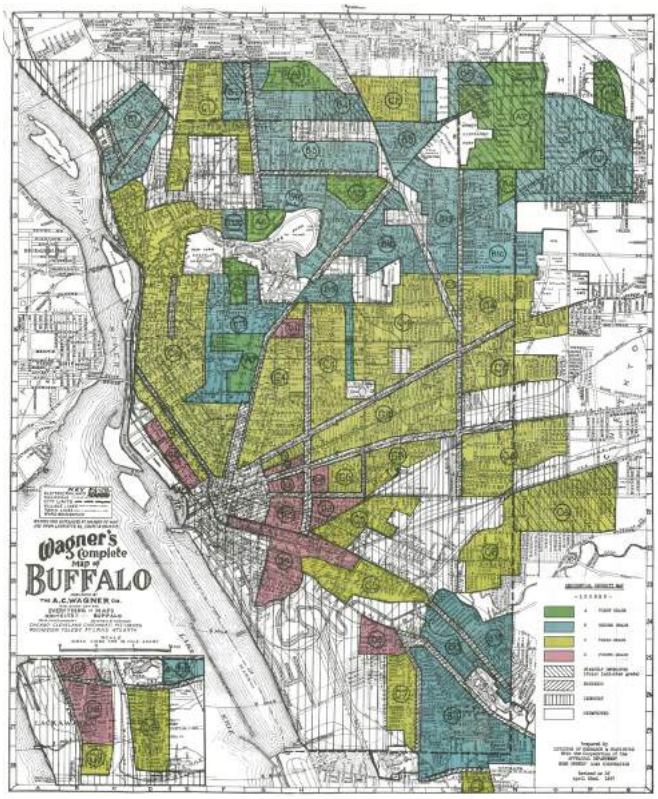
significantly shaped our cities in ways that persist today. One of the many areas affected by redlining is internet access, which may come as a surprise because the internet was not widely available for non-academic civilian use until the early 1990s—20 years after the end of redlining. If one uses the Indicators of the Broadband Need tool, released by the NTIA in June 2021, it is hard to ignore the correlations between broadband access, poverty, and redlining. There is significant overlap in most major U.S. cities between the areas of greatest need regarding broadband, urban areas of high poverty, and areas historically redlined.

There are two Cleveland maps. One is from the NTIA showing areas of greatest broadband access need in red. The other is a historical redlining map created by the Home Owner's Loan Corporation. Not only do the areas of broadband need and high poverty closely correlate today, but also those areas closely overlap with historically redlined and segregated communities.

The map from Buffalo further underlines two key points. The first is that the trend is not an isolated case study; there is a significant link between broadband access and economic stagnation. The second is that the issue of broadband access in most urban areas is not one of infrastructure availability but of affordability of service to gain access to existing networks. FCC data show that Buffalo, for instance, is well covered with two or three providers who offer the broadband minimum of 25/3 speeds. However, the newer NTIA data, which account for how many people actually have internet subscriptions, show that many do not subscribe to the service.

Given that those areas are a typical if not a true monopoly or a comfortable duopoly, there is little competition pressure between providers that would reduce the price for consumers. The current state of the market and expense of creating a new network to enter a geographic region results in market stagnation with no market forces incentivizing change. This situation leaves low-income households with little choice available for a service that, though expensive, is also increasing in its importance to daily economic and social life. As our economy, health care, education, and social systems are increasingly online, those without access to realistically affordable high-speed internet are going to be increasingly left behind.

Debra Campbell, city manager of Asheville, North Carolina, and a member of the Curtis Infrastructure Initiative board, summed it up, saying, "Everyone is going to be more digital. COVID-19 taught us that the more connected you can be, the more resilient, competitive, and healthy your community can be, both economically and socially. But we need it to be accessible."



Home Owners' Loan Corporation map of Buffalo, New York.

MAPPING INEQUALITY

PART II:
LEVERAGING DIGITAL OPPORTUNITIES

A tremendous opportunity exists for increasing broadband service and access for the real estate and land use fields. This section provides examples of how leveraging broadband connectivity can be applied broadly to create benefits in areas such as proptech, transportation improvements, telehealth, economic development, and smarter maintenance programs—benefits that can be provided both to individuals and organizations. This section also touches on best practices advocated by experts interviewed for this report, though it is not intended to be a comprehensive examination of all opportunities presented by broadband.

Real Estate Applications

Broadband connectivity has a wide variety of applications in the real estate field, and over the years, the industry has become increasingly aware of them. Not only is this digital connectivity now a must for space occupiers, but also it can be a key tool in maximizing the efficiency of building operations and in improving tenant experience and satisfaction.

Proptech

Broadband has a growing number of applications in the real estate industry, but one area that is poised to have by far the most impact is through proptech, which is an umbrella term for leveraging technology to improve the way people research, rent, buy, sell, and manage a property in new ways. Examples could include building sensors, control mechanisms, and programs that allow a property manager or owner to control more aspects of the building than ever before and to do so more easily and to a finer degree than has ever been possible. Proptech also includes elements as such as climate tech; contech, or construction technology; and fintech, or financial technology.

Such technologies can lead to significant efficiency gains in operating expenses for items such as HVAC and lighting. It can also provide information and data about air flow, air quality, and building fixtures that will help owners and managers curate healthier work environments for tenants, as well as its creating greater understanding of how occupants use space and creating opportunities to maximize the use of space and amenities that will improve the overall satisfaction of tenants.

ULI

ULI published two reports in July 2021 about proptech, including a deep dive into the growing investment in climate tech, which is expected to exceed $20 billion annually. Learn more at knowledge.uli.org.

In the words of Eric Bill, who is chief economist of a real estate analytics platform titled Autocase, "Investments in systems that have ongoing, real-time measurement and verification of information [are] highly valuable. From an optimization point of view, having that internet access—that high-speed data that can translate actual performance within a space—can yield better outcomes."

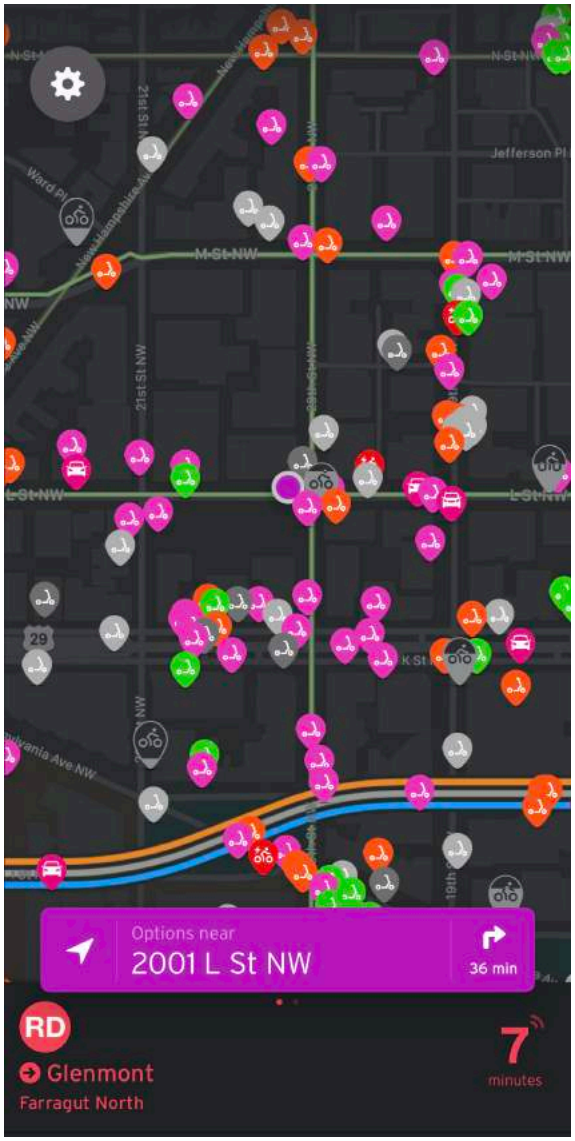
For instance, the interconnectedness of the facility and occupants in other facilities can create more understanding on which upfront investments will yield dividends and why, thereby increasing tenant satisfaction and an ability to cut waste and create more productive environments for employees and occupants. All of those insights and information represent data that need to be quickly and reliably moved within and without a building for storage and analysis, which means the building relies on broadband connections to the internet.

Mobility

Having better connected transportation options is another emerging value generator for real estate that has been enabled by broadband. Such broadband enables Mobility-as-a-Service (MaaS), which is a concept that leverages digital services that will better integrate public transportation, car-sharing, and other micromobility services (such as public bikes, ebikes, and e-scooters) to be a seamless way for people to make transportation decisions and to reduce the use of single-occupancy vehicles.

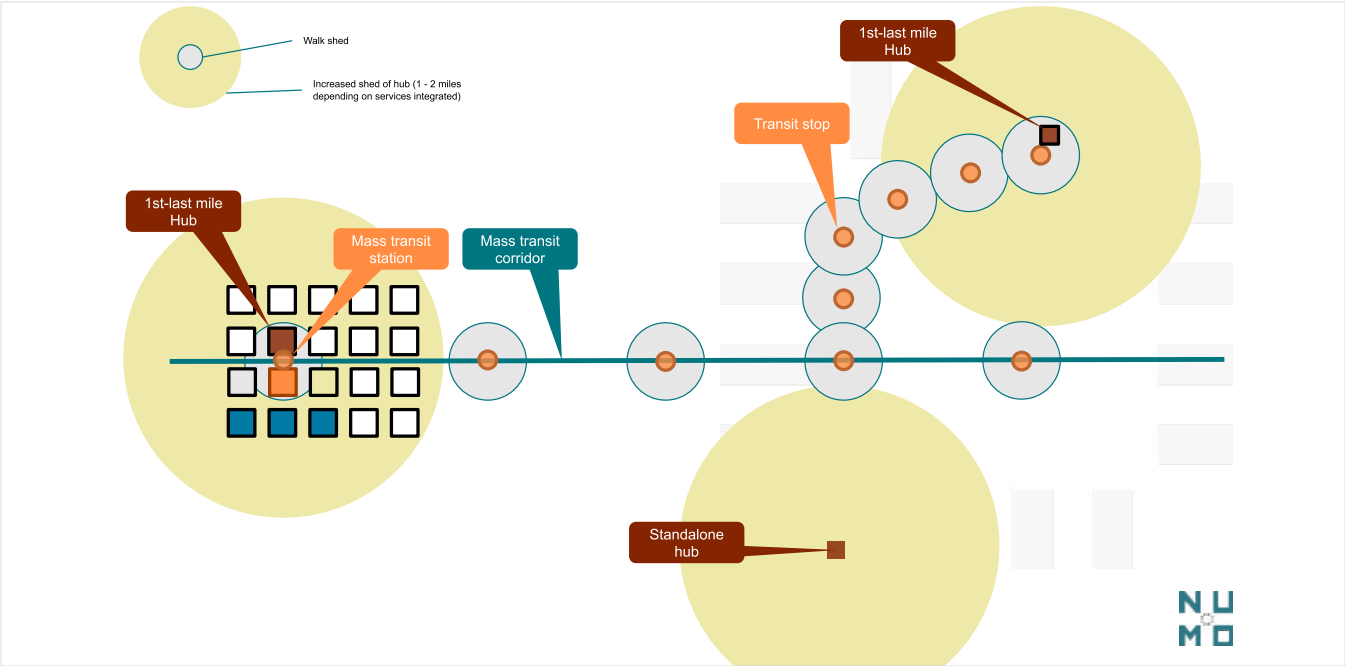
During the 2021 ULI Shaw Forum, Harriet Tregoning, director of the New Urban Mobility Alliance, described the need and called on transit agencies to better bundle payments across modes through a more integrated fare systems. She described the value of making transit more like car ownership, in which "all their costs are sunk so every trip is a seemingly free one."[17]

Mobility hubs (locations where several transportation options and information services are provided to users) can also have a much greater impact when broadband is available. Increasing mobility opportunities can present a potential value that real estate owners and managers can harness for their buildings—values such as repurposed or reduced parking facilities, denser projects, and higher rates of return. However, MaaS at scale is not possible without readily available broadband.



PAUL ANGELONE/ULI

Transportation options are available near ULI's offices in Washington, D.C., through use of open data. Learn more about creating open data standards for increasing mobility at https://blog.transitapp.com/case-study/the-guide-to-open-mobility-as-a-service/.



This illustration shows the mobility hub concept, which can be deployed on major transit corridors or can stand alone. Learn more about how the Curtis Infrastructure Initiative is supporting this type of work in San Antonio by visiting uli.org/infrastructure.

Some of those concepts were explored in the recent ULI report *Small Vehicles, Big Impact: Micromobility's Value for Cities and Real Estate*. That report cites early research that predicts a bump in real estate rents and property value from micromobility options similar to that provided by transit-oriented development (TOD).

All the benefits from micromobility lean on broadband connectivity, which such applications typically access over cellular networks. The benefits include connecting potential riders with the nearest available vehicles, tracking and charging the rider, monitoring the location and battery level of the vehicles, controlling use of the vehicles to only appropriate areas, and alerting local contractors as to which bikes and scooters need to be picked up for recharging. This approach functions in a way not dissimilar to how rideshare services use mobile broadband to operate their services—a system that would not have been possible without 4G deployment. The approach is also related to the concept of mobility hubs, described earlier.

Like traditional bike-sharing system, micromobility options not only provide an attractive amenity for commercial and residential properties, but also offer first- and last-mile solutions for commuters either to connect to more traditional transit modes or to make short inter-city trips that cover gaps not served well by existing transit infrastructure networks. There is also a potential that micromobility can create sufficient transportation flexibility to decrease the demand for parking or even to allow developers to negotiate for reduced parking requirements if they include micromobility infrastructure on site in a manner similar to TOD incentives, through which they allow developers to reduce the amount of parking on a site and in turn allow for higher and better use of a property.[18]

Autonomous vehicle technology could have immense capability to change the ways in which cities and real estate function, and it will also depend on broadband connectivity before autonomous vehicles can take their next leap forward in capability. Currently, autonomous vehicles rely only on internal sensors, cameras, and programming, but that reliance may not be the case forever.

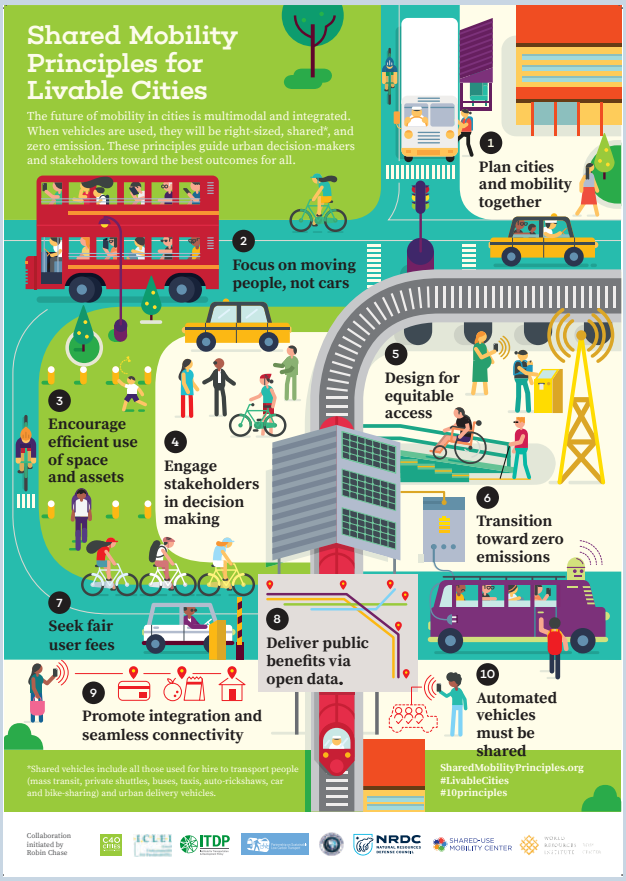
Tradeoffs Required for Real Estate and Transportation Technology

Autonomous vehicles have an immense potential to shape our cities. However, communities, planners, and developers must decide if those changes are things that they want so their cities can truly reap the benefits of the technologies, especially for the most vulnerable citizens. Autonomous vehicles typically work best on segregated, long, straight, high-speed roadways such as highways and urban arterial routes. The vehicles, especially those operating on virtual track principles, will usually require some constructed infrastructure to indicate their use as a warning to other roadway users as well as to show their permanence in attracting ridership and real estate investment. Some initiatives, such as shared mobility principles, suggest that autonomous vehicles must be electric and must be shared if they are really to improve mobility without overwhelming negative consequences such as greatly increased vehicle travel, pollution, inequality, and congestion.

Planners and developers must be careful not to implement technology for its own sake; in fact, they should measure and compare potential benefits against costs as well as against other possibilities and opportunities so they ensure that the infrastructure being built in communities remains focused on the users.

Regarding exploration of new options in the community, Campbell of Asheville said, "Asheville is very innovative, always wants to be at the forefront, but as a city manager I have to be more cautious."

Those technologies and their rapid, unfettered adoption could potentially serve the real estate industry and local governments very well and could produce monetary and community benefits. But we must also ask ourselves the fundamental question, "Who are our cities for?" The quality of life for the individual should not be lost in a pursuit of more technologically advanced solutions.



WORLD RESOURCES INSTITUTE

"The next step of automation of vehicles is communication between vehicles to other vehicles, and communication between infrastructure and vehicles—whether it's through 5G implementation or wi-fi on the roadway systems dedicated for automated automobiles," said Dr. Kevin Heaslip, professor of civil engineering at Virginia Tech. "If you wanted to build a community that is very forward thinking, having 5G implementation that could be used for the automotive spectrum would be an interesting way to distinguish that community."

Those technologies can also be applied to automated vehicles following *virtual track*, which is considered a kind of fixed guideway transportation.[19] One example is Jacksonville's planned U^{2}C system—short for ultimate urban circulator—which will convert an existing elevated monorail into an elevated roadway that can be used by autonomous vehicles running along the track and using preplanned routes at street level. The system as planned will allow the city to take advantage of the existing infrastructure and to significantly expand service at a minimal cost while enabling more TOD opportunities.

Those principles are also being explored to automate vehicles that could be used for cargo movement, which would allow for significantly faster movement with a higher capacity than is currently possible on existing roadways. This arrangement could have a major effect on real estate by changing the capacity of last-mile delivery and onsite storage.

The benefits from unexpected places can highlight how innovations that capitalize on reliable and widespread broadband access can provide significant value for the real estate and land use industry in ways that can be difficult to predict in advance.

Creation of New Markets

The overall real estate market is becoming more and more sensitive to internet connectivity levels. Homes with access to high-speed fiber connections have been shown to sell for around 5 percent more than do those without, and office and retail property uses now require connectivity for their daily functions.[20]

John Gilbert, chief operation officer of Rudin Property Management, put it simply: "Location, location, location is now location, bandwidth, location." However, it is perhaps more relevant to consider specifically the markets created by the growing use of that internet infrastructure. A growing demand on digital infrastructure—from having cloud-based applications, regularly increasing data storage and processing needs, and ongoing ability to work from home—is creating new and changing opportunities and markets for the real estate and land use industry. One opportunity is the growing demand for data center facilities.

Like logistics facilities, data centers are large buildings created to serve a unique purpose near key intersections of backbone infrastructure. In the case of data centers, what is being stored, processed, and transferred is information rather than physical goods; like logistics facilities, this industry can be a powerful economic engine. Northern Virginia has seen a massive explosion in its data-center market share and overtook the New York City region as the top data-center capacity market in the United States in 2016. By 2019, just three years later, Northern Virginia had almost seven times the data center capacity of the New York City region.[21]

Magnum Economics and the Northern Virginia Technology Council (NVTC) estimates that this rapidly growing industry provides to the state 14,644 full-time equivalent jobs and $4.5 billion in economic output.[22] As global demands on digital infrastructure increase, this unique real estate market should also expect an increase in demand and, according to the NVTC, should expect increased incentives in a way that mirrors the logistics center boom driven by e-commerce. More generally, changes in work and education patterns may provide both opportunities and challenges.

Soncodi said work from home "will definitely provide more opportunity. . . . [T]he boundaries have shifted; people still need to conduct business where they are . . . restaurants, grocery shopping, commercial, [were] close to my office. [N]ow [they are] moving elsewhere, and that creates opportunity for those economic providers to expand the area where they offer service. I think this will

only expand the need for services to be available in larger areas than before. The office is not going away, and people will continue from work from home as employers offer flexibility."

City and Community Benefits

The potential benefits of widespread broadband connectivity for cities and communities are innumerable and too extensive to fully detail in this report. Those benefits include water and electrical efficiencies, resilience and emergency management, public safety and health advantages, and many more that go beyond the scope of this report such as smart agriculture and smart manufacturing capabilities.

Smart Cities

Similar to proptech benefits brought to property owners by high-speed internet access, broadband infrastructure has opened the possibility of similar technology to be used by communities for larger-scale applications known as smart cities technology. The Smart Cities Council itself admits that the technologies and concepts of smart cities are still in the "I'll know it when I see it" phase of implementation, but its "Smart Cities Readiness Guide" offers the broad definition of a city that "uses information and communications technology to enhance its livability, workability, and sustainability."[23]

Those technologies are broadly operating on the same principle as the previously discussed proptech; they collect data and information about the operation of systems, activity and movement of residents, use of spaces, utilities demand, and much more, and then they use analytics to process the large amounts of data and to derive insights and opportunities so they can operate more efficiently or can better use assets. One example is through "smart grid" technology for electricity grid management, a concept that will be expanded on in the next section; another example is in water systems management.

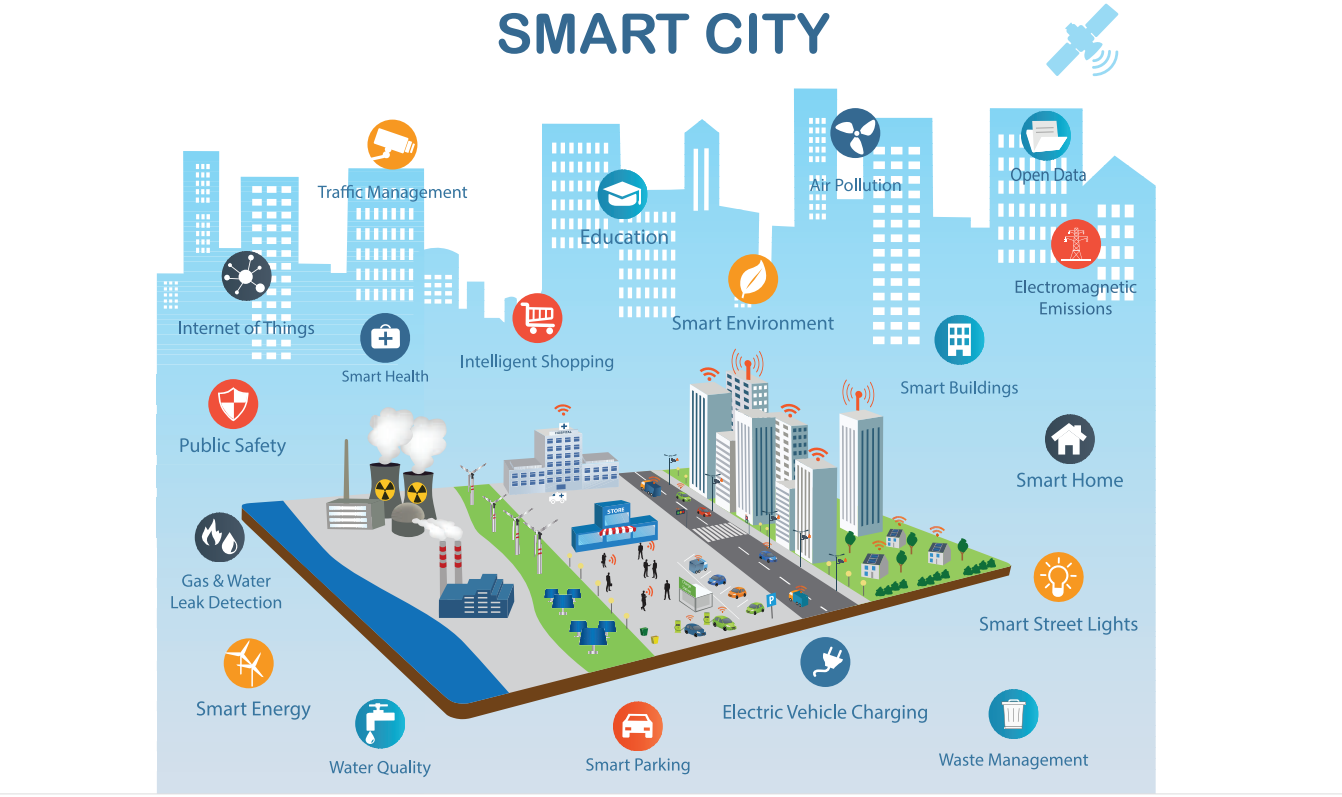


Illustration of the smart cities concept.

The EPA's Water Infrastructure and Resiliency Finance Center estimates that there are about a quarter million water main breaks in the United States every year, resulting in the leakage of trillions of gallons of treated water. Billions of gallons of raw sewage are discharged into local surface waters, an estimated annual loss of over $2.6 billion.[24] Smart cities technologies have the ability to help mitigate those losses by using more comprehensive monitoring to detect the leaks faster than would otherwise be possible.[25] Benefits in the water and power sectors are symbiotic because water systems are one of the largest consumers of electricity, typically comprising about 50 percent of a city's energy expenditures according to WaterWorld. In turn, the energy sector is a significant consumer of water.[26] Any efficiency gains in one sector will result in significant savings in the other.

Parking has also provided case studies for use of smart city style technology. Ellicott City, Maryland, was dealing with a long-standing perception that it did not have enough parking although multiple studies had shown otherwise. To avoid construction of more surface lots in a historic town that is prone to flooding, the county government partnered with StreetLine Inc., which installed sensors in parking spots to detect if they were in use. The partnership developed an app to provide this information to the public, thus making it easier for shoppers, tourists, and local residents to find parking quickly, which resulted in a more efficient use of existing parking. The system included a dashboard that allowed city officials to monitor usage trends and space occupancy in real time.[27]

Likewise, public safety has already proven that it is able to benefit from broadband-dependent smart city technology. One example is through ShotSpotter, a system that uses acoustic sensors to detect firearms discharges and that nearly instantaneously notifies law enforcement of the precise location of the discharge, thus significantly improving response time and office safety.[28] This technology has been implemented in numerous cities including Baltimore, Boston, Chicago, Pittsburgh, and Washington, D.C.

Internet of things (IoT) sensors can be used to monitor air and water pollution. Thus, IoT could help cities and regions better understand the causes of pollution and better mitigate it. This is an area of potentially significant importance given that air pollution alone in the United States has been estimated to have an negative economic impact equal to about 4 percent of GDP.[29] There are also many public health applications, which have been demonstrated in a Virginia Tech study that was able to detect the COVID-19 virus in wastewater.[30] In the future, broadband and IoT principles could potentially be used to create widespread network of automated testing of wastewater, which would then be able to detect many known viruses and diseases and to help public health officials pinpoint outbreaks before those problems become widespread pandemics.

The technology uses are not without their opponents, however. Fear of both invasions of privacy and misuse of collected data has sparked opposition to this technology in some cities that have implemented or proposed the use of the technology. The fears could seem justified, given how San Diego's sidewalk and traffic usage cameras—which were meant to help track and manage traffic flow and streetlight efficiency—came to be used for criminal investigations by the local police department.[31,32] Other community leaders may be concerned that the benefits and return on investment may not be as significant as claimed and that the systems will not justify their costs. Some cities have responded to such concerns by scrapping plans or by going so far as to ban use of such technologies. In fact, Portland, Oregon, and San Francisco, California, have banned the use of facial recognition technology.[33,34]

Smart city technology concepts, while coming with challenges that will be unique to each city, also come with potentially significant impacts. All parts of this family of technologies rely first on a variety of sensors to collect data, then on high-speed data transmission networks to communicate that data to another location where it can be analyzed, and finally on transmitting it

again to city occupants and officials for action. None of this could be possible without broadband connectivity, and none of it is possible in locations without high bandwidth capacity to move such large amounts of information quickly.

Smart Grids

Smart grid technology is sometimes considered a subset of smart cities technology. In short, a traditional electrical grid is a one-way path, with electricity flowing from a local generation station over transmission lines to an end destination business or residence. A smart grid is an electricity grid that is a two-way street, with information as well as electricity able to pass both ways along the grid. The smart grids typically involve installing fiber-optic cable along an entire electrical grid for the electricity provider, which then will enable the passage of information. This ability to quickly transmit data has a wide variety of benefits for communities. It creates opportunities for more efficient transmission of electricity and for reduced operations costs for the utility, which can lower overall rates for the consumer. It also provides faster restoration of electricity after an outage by helping the utility operator quickly isolate the source of the disruption.

The smart grid substantially increases the resilience of a power grid; on a traditional grid without the data transmission ability of a smart grid, outages can cause a domino-effect of cascading failures that greatly expand the footprint of a blackout and affect the communications, security, and transportation infrastructure. A smart grid by contrast can detect outages and isolate them by re-routing power transmission to minimize the scale of a blackout, thus substantially improving the resilience of the grid to natural disasters and reducing disruptions to businesses and property owners.

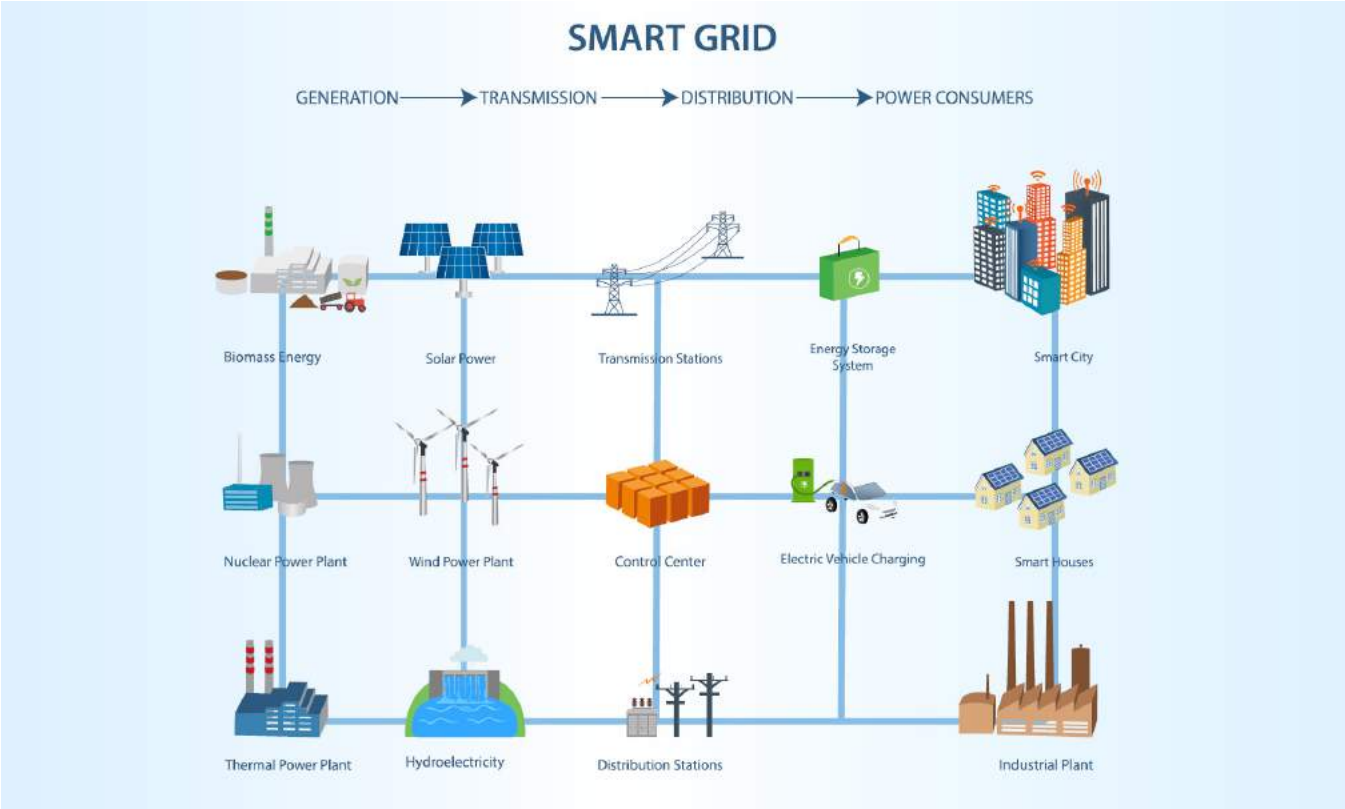


Illustration of the smart grid concept.

In addition, the smart grid gives a greater ability to leverage distributed power sources, such as customer-owned solar or wind power, thereby better incorporating excess electricity generated at a customer site to the overall grid and enabling the local government to leverage such resources in an emergency situation. This capability can potentially give a community the ability to keep shared infrastructure such as emergency services, traffic lights, or even community centers and anchor institutions powered by using the customer-owned generation sources when power is otherwise unavailable from utilities.[35]

The benefits of the smart grid can flow to consumers, giving them a clearer picture of their usage and enabling the utility to provide real-time pricing, thus allowing consumers the ability to make decisions to save by conserving electricity when electricity is at peak demand and is most expensive. This benefit can be a powerful tool for large electricity consumers such as commercial building owners and managers.[36] In addition to providing significant benefits on their own, the necessary fiber-optic upgrades that enable a smart grid can be used to create high-speed internet service for homes and business, which has been a key tool in closing the rural digital divide through electrical co-ops, as well as in urban areas such as Chattanooga. Case studies detailing this possibility will be explored later in this report.

Individual and Organizational Benefits

Many individual and organizational benefits of access to fast and reliable broadband connections were on prominent display in 2020 and 2021 as a result of the COVID-19 pandemic. Work from home and telehealth have all provided significant opportunities, advantages, and convenience for both individuals and organizations.

Work from Home

The COVID-19 pandemic has often been called an accelerator of existing trends, and work from home is possibly the single most accelerated trend. According to the Bureau of Labor Statistics, in 2017 and 2018,

Increased Need for Cybersecurity

As the number of workers performing their jobs remotely rapidly expanded during 2020, many organizations were concerned about the cybersecurity risks associated with work from home and about the comparative lack of control over security measures. Those concerns were not likely to be alleviated as evidenced by a series of high-profile cyberattacks in the first half of 2021, including an attacker who accessed a water system in Florida and attempted to poison the water supply by increasing the amount of sodium hydroxide, a ransomware hacking of a global meatpacking company, and—perhaps the most publicized of all—a cyberattack of a U.S. fuel pipeline operator titled Colonial Pipeline that shut down about half of the East Coast's fuel supply for five days.[37,38,39]

Heaslip's work at Virginia Tech covers the intersection of infrastructure and technology issues, including cybersecurity. Heaslip expressed that "when you have a fully closed system, you can manage the potential points of attack very well. [T]he broader the reach of your networks, the more likely you are to be expanding your threat surface, making the door bigger for people to take advantage of any vulnerabilities." He went on to say that protecting your organization "comes back to basic cyber hygiene: complex passwords, devices that use complex encryption, and so on."

The U.S. Small Business Administration emphasizes employee training about cyber hygiene and risk assessment and about backing up important data. Ready.gov, which is a U.S. government emergency readiness campaign, also recommends that cyberattack victims contact appropriate local, state, and federal law enforcement agencies as soon as they become are aware of a cyberattack, including the FBI's Internet Crime Center and the Federal Trade Commission. As more of our economy and society takes advantage of the incalculable benefits of digital connectivity, those practices must continually be at the forefront of risk management and must become a part of every employee's and employer's skill set to manage the risks of cybercrime.

only 12 percent of workers did paid work from home at least once a month.[40] In ULI/PwC's *Emerging Trends in Real Estate® 2021* report, 94.3 percent of U.S. and Canadian respondents agreed or strongly agreed with the statement "In the future, more companies will choose to allow employees to work remotely at least part of the time."[41] Although it remains to be seen exactly how many workers will continue working from home and to what degree they will do so in a post-COVID world, there was little doubt among the *Emerging Trends* respondents that work from home will continue to some degree.

Work from home can have benefits to some employees and employers, especially for high-income workers, and can result in increased productivity while negatively impacting office owners and downtown retail establishments.[42] But research has suggested that the ability to telework increases employee retention and job satisfaction, which suggests the possibility of benefits to both employee and employer from increased flexibility, from eliminating commutes, and from location independence.[43,44]

However, not all jobs can be done from home. A recent University of Chicago report found that in the United States, only about 37 percent of jobs can be done from home, though those jobs represent nearly half of all U.S. earned wages.[45] Moreover, the jobs that can be done remotely stand to benefit from a much larger talent pool than they otherwise might have, and workers could have new economic opportunities opened to them, which reiterates the purpose of digital infrastructure as both an economic development engine and an equity measure. Those without access to adequate connectivity and those unable to afford the necessary subscriptions will inevitably be left behind by such changes in the workplace.

Telehealth

Remote health service has become more common in 2020—particularly in urban areas—as physicians and patients both explored and experimented with virtual patient "visits" through telehealth platforms. Marcus and Millichap research found that between March 23 and May 11, 2020, the share of primary care offices using virtual health options increased from 40 percent to 91 percent in an effort to reduce risks to patients and providers. Importantly, Marcus and Millichap's research projected that medical office space demand would not be reduced by increases in virtual medicine and that long-term trends would continue to fuel growth in this property type.

Though some kinds of visits cannot be replaced by telemedicine, existing research implies significant benefits for offering it as an option. The University of Pittsburgh Medical Center estimates that its own overhead costs are reduced by more than $86 for every patient who choses telehealth over an in-person visit, and Oregon Health and Science University estimates telehealth saves its patients $6.4 million per year in travel costs.[46]

In addition, a *Becker's Hospital Review* case study of Nebraska Children's Hospital found that appointment no-shows, a costly outcome for both patient and provider, were reduced by 50 percent after a targeted telehealth service was begun. The reduction was due to the reduced burden of travel on rural families who were required to drive long distances for their appointments.[47] Harvard Medical School further quantified this saving by determining that virtual office visits consumed more than 85 percent less time than did in-person visits, primarily due to reduced travel and wait time, which translated to savings of more than 90 minutes per visit for the average patient. This reduction could be critical for those in the service industry and other professions that might not have offer flexible scheduling and sick time.[48]

However, without closing the digital divide and improving access to rural and low-income urban communities, those who have the most to gain from the offerings of telehealth will be closed off from the potential of the benefits entirely.

PART III: CASE STUDIES

This section provides case studies of implementing and taking advantage of broadband connectivity, both in the real estate and land use industry at the building level and at the city or community level. The case studies highlight different techniques for closing the digital divide by providing availability, affordability, and reliability in broadband networks to open economic mobility and development opportunities.

Lessons for Real Estate Connectivity

The case studies display many core principles for real estate and land use professionals to consider when designing their properties to take best advantage of digital connectivity and to provide the best possible experience for occupants. The case studies highlight potential obstacles, pitfalls, and things to avoid. Some key lessons in this section include the following.

- As a real estate owner or developer, you do not need to know every technical detail about connectivity to use it as a differentiator for your project.
- Redundancy and neutrality are key. If you have redundant systems, you create reliability for your tenants, and if you control neutral systems within your project, you can offer your tenants a choice in their providers, which may lead to lower costs for them as well. As Christopher Mitchell of the Institute for Local Self Reliance said, "In commercial spaces, there is a major issue of reliability; developers need to create redundant connections and reliability to preserve labor hours of their tenants, which is even more so than speed at the gig level."
- Connectivity should not be considered a difficult specialization or niche that only some developers specialize in, but rather it is a key pillar of placemaking and the development process for every project. "[I]t should be incorporated into the core development principles of your plan," said Reiman. "It doesn't matter if you're on the highest end [of] communities or in [an] economically challenged area, having that connectivity incorporated into your core plan will help your community stand apart."
- Closing the digital divide is an area where the real estate community can lead rather than follow. Chuck Kirby, vice president of smart communities at the Center for Innovative Technology, said, "The most important thing is for real estate leaders, HOAs [homeowners associations], etc., to reach out to their localities and ask to be more involved with the planning. The real estate industry has a huge stake in this but doesn't yet realize how influential they can be in it."

55 Broad Street—New York, New York

The structure at 55 Broad Street in the financial district of Lower Manhattan was originally built in the 1960s as the headquarters for Goldman Sachs. In the early 1990s, Rudin undertook renovating the building. Wired connectivity was a key feature of the updates; in 1995, 55 Broad Street became the first fully wired building in New York City, offering its tenants an entirely unprecedented level of connectivity to the then fledgling internet. At the time of those advancements, debate was ongoing in the political world over the principle of mandatory access for all providers. The key personnel at Rudin made the decision to install and own all of the internet infrastructure in their building themselves.

RUDIN PROPERTIES

55 Broad Street was the first fully wired building in New York City.

"What is the owner's role here? We decided back in the 1990s that our role was to ensure our tenant's choice and to provide carriers access into our buildings in a way that created less friction," said John Gilbert, chief operating officer of Rudin Properties.

Owning the physical wires and fiber carrying the internet within the building, as well as the outside access points, allowed the property managers at Rudin to ensure that their tenants had ample choice of providers while controlling the internals of their own building. The capacity was scalable as needed and organized in a way that was manageable to the building team. Gilbert continued that using this model provides benefits for all parties: " . . . choice for the tenant, access to the carriers, and sleep at night for the owner knowing you don't have spaghetti in your risers." Redundancy is a key for property owners. Gilbert mentioned that one of Rudin's properties was bounded on three sides by water, so Rudin ensured that there were multiple sources of internet, including fixed wireless transmission from the roof.

Mitchell mirrored Gilbert's advice: "Set multiple carrier neutral wiring sets to each unit, so that if any ISP comes to offer service to any unit, you don't want to have them go to anywhere but the telecoms closet. You want to make sure that the building owns the wiring so that it's independent, and I would say that because of the low cost of doing it, you would want to have multiple sets of wiring."

The future site of Amazon HQ2 in National Landing.

AT&T and JBG SMITH have partnered to build the first smart city at scale at National Landing.

National Landing—Arlington County and Alexandria, Virginia

National Landing is an area in Northern Virginia encompassing parts of the neighborhoods of Crystal City, Pentagon City, and Potomac Yard in Arlington County and the city of Alexandria. It provides excellent examples of forward-thinking connectivity that has been incorporated as a part of place-making and tenant competition. The branding of the area as National Landing was done in conjunction with the winning bid for Amazon HQ2 and was the first step in several neighborhood improvements and investments to coincide with a significant and ongoing development boom in the area. Those traditional neighborhood improvements have been largely undertaken by the National Landing Business Improvement District, but it may not be long before other business improvement districts, community improvement districts (CIDs), and related districts venture into the realm of connectivity.

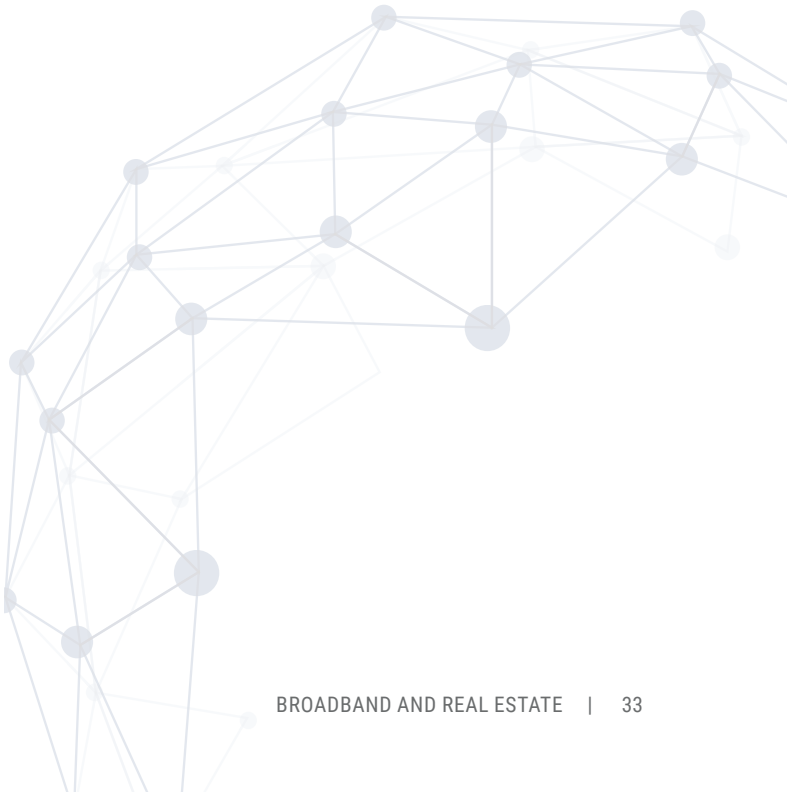
"CIDs have a lot of experience in mobility and infrastructure; as mobility has advanced through technological innovation, CIDs have adopted it. When a CID staff is more familiar with technology, [it can] go harder, better, faster, stronger," said Malaika Rivers, partner at Lexicon Strategies. "CIDs [can be] uniquely positioned to adopt technological innovations . . . especially as a pilot."

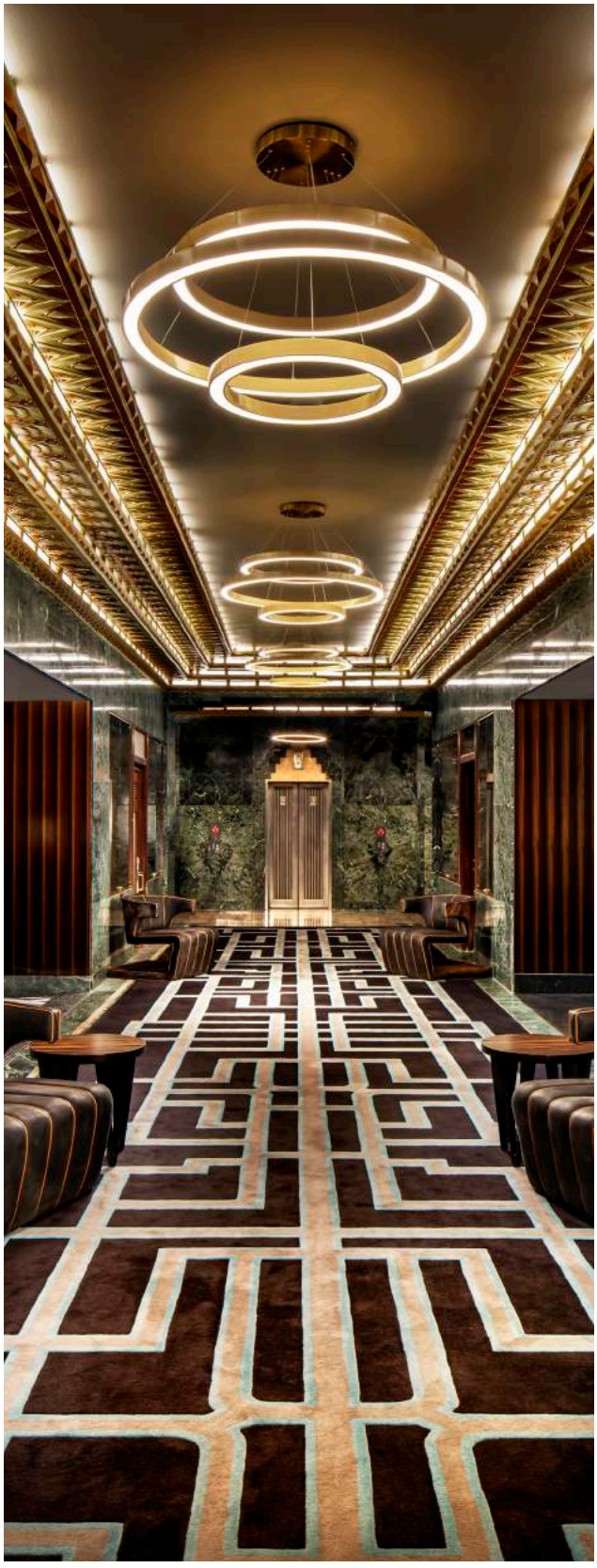
In National Landing, efforts to brand the area as a hub for technology and innovation tenants were led by JBG SMITH, one of the largest landlords in the area. JBG SMITH purchased seven blocks of Citizen Band Radio Spectrum (CBRS) at auction from the federal government in 2020 at a cost of more than $25 million. The licenses—four in Arlington (the maximum allowed to one entity in a single jurisdiction) and three in Alexandria—will cover an area where JBG SMITH controls 6.2 million square feet of real estate and another 6.9 million square feet of proposed properties.[49]

The reason behind purchasing the spectrums was to enable JBG SMITH to accelerate and control deployment of the 5G signal in the neighborhood, thus providing further benefits to technology-oriented tenants; to provide an amenity for residents; and to establish National Landing as a hub for innovation and technology.

"JBG SMITH recognized that the FCC's CBRS spectrum auction was an opportunity to align National Landing with the needs of cutting-edge tenants, while significantly enhancing our broader smart city and digital placemaking plans throughout the neighborhood," said Evan Regan-Levine of EVP Strategic Innovation and Research. "Our investment in next-generation connectivity infrastructure will further cement National Landing as a premier global destination for entrepreneurs, universities, and global technology companies to ideate, innovate, and scale globally."[50]

Being able to ensure the early deployment of a cutting-edge communications network in an area where the firm control as significant share of the square footage thus allows JBG SMITH to further its branding and placemaking efforts in National Landing, as well as its being able to provide a significant competitive advantage when pursuing tenants.





BRANDON BARRE PHOTOGRAPHY

A hallway at the Sinclair Hotel.

Sinclair Hotel—Fort Worth, Texas

Originally constructed in the 1930s, the 17-floor Sinclair Oil Building in Fort Worth, is considered one of the city's most iconic and aesthetically pleasing examples of art deco style. In 2019, the building was renovated and reopened as the 164-room Sinclair Marriott Autograph Hotel. One of the most innovative changes made during the repurposing of the 90-year-old structure was the extensive use of power over ethernet (PoE). PoE is a system that permits both electrical power and data to be transmitted over ethernet cabling, thus allowing a single cable to provide both data connection and electricity to devices such as routers, cameras, and telephones.

Although this technology has been available and in use since 2003, the Sinclair Hotel is one of the first commercial real estate properties to make extensive use of the technology in its building design. Currently, more than 2,000 lights, sensors, and items such as window shade motors, minibars, and smart mirrors in the building are all run by PoE.[51]

There are several significant advantages of PoE, the most obvious being the ability to transmit data over the real estate owner's power cords, which means that any device in the building connected to PoE has real-time communication built into the system. One example of why this arrangement is advantageous is that when a device stops working, even something as small as a light bulb going out, the building maintenance personnel are immediately notified not just of the outage, but of the exact location of the problem, thus allowing the building operations team to work much more efficiently and to improve the occupant's experiences.

Another substantial advantage with PoE is that the electricity is low voltage DC, which leads to significant cost savings in two key ways because licensed electricians are not typically required to install such low voltage lines and attached devices and because LED light installations on PoE no longer need a driver

attached to every fixture to convert high voltage AC electricity to DC as it normally would, both of which create savings in the installation process.

But the largest savings from PoE come from the recurring efficiency increased by eliminating the AC to DC power conversion on all PoE devices mentioned. All LED lights and almost all other motors or devices inside a building are actually low voltage DC inside, but because buildings are traditionally wired with high voltage AC power, a driver is required to convert the electricity to power the end device (think of your laptop charger in which you've got the AC plug connected to a "brick" that gets really hot before the smaller plug that goes into your laptop). Those drivers cause significant energy loss and generate heat causing the buildings' heating, ventilation, and air-conditioning (HVAC) systems to respond by cooling more.

PoE-powered LED lighting and other low-voltage devices—by eliminating the driver—operate much more efficiently than will LED lighting and other low-voltage devices powered by traditional building systems. Such devices can lead to savings as high as 14 percent in energy expenses on those fixtures and 10 percent on reduced cooling needs.[52]

BRANDON BARRE PHOTOGRAPHY

The bar at the Sinclair Hotel.

BRANDON BARRE PHOTOGRAPHY

The lobby of the Sinclair Hotel.

Curvy road in Issaquah Highlands, Washington.

Issaquah Highlands—Issaquah, Oregon

Issaquah Highlands is a planned community designed in the new urbanism style in the town of Issaquah, a suburb of Seattle that is about a 30-minute drive from downtown. Home today to about 9,000 residents, the first of whom moved in when the first homes were constructed in 1998. During the planning and construction phase, significant emphasis was placed on using the most forward-thinking technology in home construction, with a special emphasis on sustainable development and energy efficiency. This forward thinking continued with the construction of a fiber optic internet network.

The developer wanted to offer internet service to contribute to the sense of place in the community and wanted to future-proof the network to ensure that the speed and capacity would withstand community growth and increasing bandwidth demands by existing residents. The network, Highlands Fiber Network (HFN), was built by a private company under an agreement with the developer. It was a model of internet infrastructure expansion that was common in North America at that time.

Greenfield developments in master-planned communities such as Issaquah Highlands were the first places providing fiber to the home networks and with networks where the high-capacity, high-speed fiber-optic cable extends all the way to the end user's residence. Those networks avoid bottlenecks caused by more traditional ideas of network construction that gradually use lower capacity and lower speed, albeit cheaper, wiring the closer the network gets to the end user. However, such networks were primarily being initiated by the developers, who led the project and approached service providers.

Although this is a terrific example of how the real estate community can influence the construction of internet infrastructure in the same way as it can

roads, electricity, and water infrastructure, such a network also opens developers to risk. By being the leading voice of those initiatives rather than a partner and advocate, developers can stray outside their area of expertise and expose themselves to risk. Issaquah Highlands and its HFN are an example of exactly that.

In late 2000, only a few years after construction of the fiber network, the third-party provider hired by the developer to build and operate the network went out of business.[53] The developer, Port Blakely Communities, was put in the position of taking over the network and operating it while seeking a new service provider. It took both time and several failed efforts to find the right provider to operate the network. ISOMEDIA, now known as GigabitNow, operates several smaller independent networks such as HFN.

When the first provider went out of business, Port Blakely Communities took ownership of the fiber-optic network, which was financed over several decades. The income of the network was protected by its inclusion in the neighborhood covenant, which requires all residents to be subscribed to the service. In exchange, the network operator is able to offer significantly cheaper prices to the community, plus the community organization gets strong representation on the governing board of HFN.[54]

When the network is paid off, the ownership will transfer from Port Blakely Communities to the community association, making it a truly community-owned network. This network shows examples of several of the potential challenges and pitfalls that can arise in implementing small, independent networks, including both the design mistakes that can cost money to correct later and the risk of being left holding the bag on the network, a position the developer likely was not prepared for. It also shows that the real estate industry can be a powerful voice in the creation and expansion of internet infrastructure and can use that voice as a key tool in its projects as a differentiator and a place-making tool.

Of small networks like this, Kirby of the Center for Innovative Technology said, "Broadband planning is going to be happening at the county level; population centers with towns and real estate industries need to make themselves heard for that subregional planning effort. It is harder to fund an island of coverage than it is a huge swath." Lessons learned as part of this process can serve to show how future planning efforts can create community ownership and value upfront.

Issaquah Highlands, Oregon.

Lessons for Community Connectivity

A consistent theme throughout this report is that various strategies have been developed to combat and shrink the digital divide in those communities in which it exists. Models that work well for one community may not be viable in another for many reasons. As a result, this section will focus on presenting a range of potential options to consider for planning officials, rather than prescriptive solutions.

Elements that are fundamental to each of the following case studies include these:

- **Know there is no one way to address the digital divide.** The overwhelming takeaway from the following case studies is that there is no one way to address the digital divide, but it must be addressed and will not go away without concerted action. From extremely large, long-term programs such as Chattanooga's to be rapidly implemented and for surgically precise programs such as Allendale's, a wide spectrum of available options exists for communities seeking to tackle the digital divide. The key is choosing a solution that works for your community's needs.
- **Understand your need and have a plan.** Perhaps the two most important aspects are understanding your community's need and developing your tangible goals. Is your community suffering from issues of availability such as where internet infrastructure simply does not exist and there are no existing providers of broadband-level speed? Or is your community facing an access challenge where availability has been negated by a lack of affordability? Mapping those challenges is fundamental to any action undertaken to close the digital divide. Understanding exactly where and why your community has needs can be crucial to developing a plan to address those needs. Most localities do not yet have a defined plan of what the need might be, but they should, Kirby said. "The need should dictate the technology; technology should not dictate the need. I think that's the biggest reason it's important to unpack what your community vision is, because that's going to determine your need, and that need is going to dictate the kind of technology used and where it goes."
- **Understand your local provider landscape.** Incumbent internet providers are businesses with their own business model and are neither guaranteed to be opponents nor allies in any potential changes. Establishing communication pathways between planning entities and incumbent providers early on can help find opportunities for shared efforts as well as helping avoid potential pitfalls.
- **Coordinate among stakeholders.** The synergies between stakeholders are evident in each of the following case studies. Because of the wide range of sectors of economy and government that stand to benefit from better connectivity, any efforts to close the digital divide have several potential partners: from community anchor institutions to utility companies to small and large businesses, including the real estate industry. Efforts can include potential solutions such as dig-once policies, which can be where local road construction is coordinated with internet service providers to allow them access to upgrade or install new infrastructure.

Chattanooga

The much-touted Chattanooga EPB Fiber Network was certainly not cheap to install, the initial investments included a $169 million loan and an $111 million federal grant, followed by an additional $110 million in investments for a total of close to $400 million. However, this substantial investment yielded an expansive network and the United States's first "gig city," a term for a city with citywide availability of 1 gigabit per second internet speeds, 40 times the FCC's definition of broadband level speed.[55,56] Currently, the entire city of Chattanooga is served by EPB, and much of the surrounding suburbs outside the city limits of Chattanooga is served as well.[57]

Downtown Chattanooga, Tennessee.

The EPB network was created when the local electric utility undertook efforts to implement a smart grid. The utility installed significantly more fiber capacity than needed for its purposes and formed a new entity to serve as an internet service provider; the new entity, EPB Fiber, then was able to use the excess fiber-optic capacity to provide high-speed internet throughout the city and to some surrounding communities.

This nation-leading status led to significant economic benefits. A recent economic benefit analysis conducted by the University of Tennessee at Chattanooga estimated that the network produced a total of $2.69 billion in economic benefits between 2011 and 2020. Roughly 9,500 jobs, about 40 percent of Hamilton County's (where Chattanooga is located) job growth, could be attributed to the broadband development, with more than half the growth coming from the high-tech sector.

In addition, the new smart grid provided significant benefits to the city's residents and business community through ripple effects from reduced interruptions to electric supply and faster restoration in event of an outage. The study concludes that in the nine-year study period, the Chattanooga smart grid's effects alone have generated $750 million in economic benefit through such means.[58]

The study also cites substantial business investment and a strong and growing entrepreneurial environment; however, attributing any of this change specifically to the fiber network is difficult. Although it is not feasible for every community to install a network of such significant size and scope, the Chattanooga network does provide a compelling case study about the overall economic benefits of widespread, high-speed internet access and about effectively closing the digital divide.

Rural Electrical Co-Ops

Rural electrical co-ops are nothing new. In fact, many of them trace their origins to President Franklin Roosevelt's New Deal, when federal efforts to make electrification a national standard led to the creation

of co-ops that were managed by local citizens and that serviced the newly connected areas. By their providing broadband, rural electrical co-ops stand to be at the forefront of the next massive service expansion in many rural communities.[59]

Rural electrical co-ops are typically well suited to undertake this work as a result of a combination of factors. As an electricity provider, the co-op is already maintaining right-of-way utility connections to each of its members' homes, thus putting it in a good position to begin rollout and servicing. For smart-grid technology, the U.S. Department of Agriculture provides loans under its authority from the 1936 Rural Electrification Act.[60] As noted earlier in this report, smart-grid technology requires the installation of fiber to operate. Such fiber installation can be used as a starting point for an independent fiber network. In addition, rural communities are rarely well served by incumbent internet providers, which allows the co-op an opportunity to enter the market and to be well positioned for a strong adoption rate among its existing electrical customers.

FireFly, a subsidiary of the Central Virginia Electrical Co-Op, is an example of an early adopter of this rural model. The co-op began building its fiber network in 2018, with the goal of connecting 37,000 members by installing a total of 3,500 miles of fiber.[61] The project is expected to be completed by 2023 at a cost of about $120 million.[62]

A study of similar projects in Indiana found that the broadband co-operatives created a roughly 4-to-1 benefit-to-cost ratio, with the largest share (27 percent of the benefits) being attributed to growth in government revenue through increased income and sales tax generation, as well as being attributed to health care savings through the use of telehealth services.[63] Additional sources of the economic benefits include increased access to distance education, economic and workforce development, consumer savings, and efficiency, plus increased revenue for local businesses.[64]

Huntsville, Alabama

In Huntsville, the city-owned utility has pursued what has been termed a *utility-lease* model. Under that model, the utility builds out a citywide fiber network that is required as a result of its own internal operational needs. The utility then leases excess capacity (i.e., strands of fiber) primarily to internet service providers (Huntsville has a lease agreement with GoogleFiber), to private businesses such as data centers, and to local government entities such as the school system and city government that use the capacity for smart cities type applications.

This model requires significant upfront investment by the utility; the Huntsville network was originally estimated to cost $70 million over three years to install throughout the city. However, the longevity of the proposed fiber infrastructure positioned the utility to sign a 20-year lease with GoogleFiber to use the excess fiber capacity and to serve residents and businesses with Gigabit Internet. This lease secured a long-term, guaranteed revenue stream for the utility that in turn enabled the expedited deployment of the network.[65]

Huntsville's model involved the local utility's building the fiber network "to the curb" with terminals installed that would allow an ISP to make connections between the terminal and its subscribers, known as the fiber drop. The ISP then would install the fiber drop connection between that terminal and the home as it secured customers, thereby aligning the ISP's capital allocation with contracted subscriber revenue.

Downtown Huntsville, Alabama.

Although leases of fiber capacity are typically protected by nondisclosure agreements, the city of Huntsville has published its rate card. From a single—albeit major—lease, the agreement with GoogleFiber alone would generate enough revenue to fully cover the cost of the fiber network over the aforementioned 20-year span.[66] The long-term revenue generation is evidence of the dividends and return on investment that properly planned fiber networks can pay. The utility system itself has also been a major beneficiary and has used the added speed and capacity to improve its electrical and water service and systems.[67] The ability for the city-owned utility to derive revenue from the lease of fiber and its realizing economic development benefits and opportunities in recruiting business and industry to the city are a potent combination.

Allendale County, South Carolina

Since at least 2014, Allendale County had been considering how to best get broadband to those who lack it. "Every state has a community like Allendale—in continuous need, continuous distress," said Jim Stritzinger, broadband coordinator at the South Carolina Office of Regulatory Staff. When dealing with communities with no connectivity at all, the emphasis should be on getting them some connection—any connection—as quickly as possible, he said. In a rural area facing "every challenge imaginable" and having no incumbent providers, the COVID-19 pandemic raised the need to a critical level. "There's no better time to swing for the fences than in the middle of a pandemic," he said.

The state used CARES Act funding in 2020 to pilot a broadband access project and partnered with South Carolina Educational Television (SCETV), University of South Carolina Salkehatchie, Allendale County School District, Allendale Hampton Jasper Regional Library, and technology consultant Revolution D Inc. The pilot program provides free wi-fi to students and the public by taking advantage of existing, underused "vertical assets" such as unused cell towers and water towers to provide elevated locations from which to emit the signal.

The project's partners worked together with the local telephone company and electricity provider to connect fiber and additional electricity to SCETV towers in the county. The TV towers were then retrofitted with equipment to provide residences in the towers'

The Carolina Theatre in Allendale, South Carolina.

vicinity with access to wireless broadband service up to 78 mbps upload/6 mbps download speeds. Those numbers far exceed the FCC's definition of high-speed internet and have a radius capable of reaching about 1,000 homes. The project also included the distribution of 300 routers to assist residents in connecting to the new service. Further, the efforts spurred several additional measures, such as connecting the local senior center to the network and increasing bandwidth at the library, which could then provide better public connections at those community anchor institutions.

Although still too early to make a judgment about the economic benefits of this project, it is an example of a successful and rapidly executed public/private partnership in response to the COVID-19 pandemic. Stritzinger explained, "[I]t is important to get something, anything, fast to communities with nothing. If you've never had anything reliable, you've never been able to take advantage of what's out there, and a wireless bridge buys you time to reach the wired future." The entire project was implemented in just 61 days, and service is currently being provided free of charge to residents.

LAGOS TECHIE/UNSPLASH

Increased bandwidth can serve the public.

CONCLUSION

The need for digital connectivity is not going away, and the need for it will only continue to increase in coming years. As Rivers of Lexicon Strategies said, "The world is not going to become any less digital; you have to plan for it and be prepared for it, whether you're an organization, a city, or an employee." Communities and individuals without access to affordable, fast, and reliable digital connections will be cut off from the expansive future of opportunities that this connectivity is creating and will simply be left behind. Thus, closing the digital divide becomes an imperative, whether from the perspective of economic growth or from the perspective of equity.

The real estate and land use industry is well positioned both to take significant advantage of this connectivity and to be a major voice in planning and deploying the networks. Because of legitimate need by commercial and residential tenants for substantial broadband connectivity, real estate developers who incorporate this service into their plans and designs with thoughtfulness and intentionality will continue to be ahead of the curve and give themselves a competitive advantage.

"Broadband connectivity is now a top priority for both renters and businesses as it is a fundamental requirement for connecting to the world around us," said Redmayne of WiredScore. "Buildings are moving from being bricks and mortar to computers with roofs on them, and making sure you have the in-house expertise or are partnering with people who have expertise early on in the process will be key." Just as the experts interviewed for this report have advised developers to ensure that their properties are open for multiple internet service providers to compete in their building and to provide choice and affordability for their tenants, the local and regional governments must do the same and take measures to ensure that a competitive market creates affordable access to the digital world for infrastructure that reaches every corner of their community.

Digital connectivity and internet infrastructure will define our economy in coming decades in a manner similar to electrification in the 1930s and 1940s or highway expansion in the 1950s and 1960s. The issue is rapidly becoming critical both to the private real estate industry and to community planners, and addressing it should be as fundamental as providing water and electricity to both in their future plans.

Takeaway Actions for Real Estate Professionals and ULI Members

Real estate professionals and ULI members are in a unique position to ensure better and more equitable outcomes. The following are some key ULI mission commitments related to broadband.

- **Connect.** It is important to engage with communities and other real estate and land use professionals to understand the opportunity created by broadband. In fact, broadband is as important as electricity to the built environment. A technologically advanced and inclusive future is not possible without an efficient and equitable broadband network.

- **Inspire.** There is no one way to create broadband networks, and it is necessary to learn lessons and best practices from existing projects. Practitioners do not need to know every technical detail about connectivity to use the resource, but their understanding the opportunity of broadband is essential.

- **Lead.** The real estate and land use industry can be a major voice in future internet infrastructure decisions that will ensure that needs are met while also being a partner to regional planning authorities and providers to ensure equitable outcomes—especially in addressing the urban digital divide.

NOTES

[1] Federal Communications Commission. *Local Telephone Competition and Broadband Reporting: Instructions for Filings as of December 31, 2019, and Beyond.* Washington, D.C.: Federal Communications Commission, June 19, 2021. https://us-fcc.app.box.com/v/Form477Instructions.

[2] FCC. "Broadband Data Collection." Washington, D.C.: Federal Communications Commission, June 25, 2021. https://www.fcc.gov/BroadbandData.

[3] Falcon, Ernesto. *In the Matter of Modernizing Unbundling and Resale Requirements in an Era of Next-Generation Networks and Services.* Before the Federal Communications Commission, WC Docket No. 19-308. San Francisco: Electronic Frontier Foundation, February 5, 2020. https://ecfsapi.fcc.gov/file/10205307376015/EFF%20FCC%20UNEs%202020%20comment%20Feb%205%202020.pdf.

[4] Bennet, Michael F.; Joe Manchin III; Rob Portman; and Angus S. King Jr. "Letter to Biden-Harris Administration on Broadband Speed." Washington, D.C.: U.S. Senate, March 4, 2021. https://www.bennet.senate.gov/public/_cache/files/c/7/c76028fb-488d-498e-8506-7d8a2dce3172/05DDC9148CC7F12A9F09235F77BB7A0D.bipartisan-broadband-speed-letter.pdf.

[5] Farivar, Cyrus. "White House Touts Broodband Part of New Infrastructure Deal." Washington, D.C.: NBC News, July 28, 2021. https://www.nbcnews.com/tech/internet/white-house-touts-broadband-part-new-infrastructure-deal-n1275352.

[6] Otelco. *Creating a Broadband Policy without Doughnut Holes.* Otelco, Oneonta, AL: May 11, 2017. https://www.otelco.com/broadband-policy-no-doughnut-holes/.

[7] Cisco. *Cisco Annual Internet Report (2018–2023).* San Jose, CA: March 9, 2020. https://www.cisco.com/c/en/us/solutions/collateral/executive-perspectives/annual-internet-report/white-paper-c11-741490.pdf'

[8] FCC. *Homework Gap and Connectivity Divide.* Washington, DC: 2021. https://www.fcc.gov/about-fcc/fcc-initiatives/bridging-digital-divide-all-americans.

[9] Tilson Technology Management Inc. "Analysis of State Right-of-Way (ROW) Policy and Fees." Portland, ME: October 17, 2018. http://broadband.wv.gov/wp-content/uploads/2019/10/ROW-Policy-Review-Final-Report-2018.10.19-2.pdf.

[10] Otelco. *Lightwave Fiber Infrastructure: Where, When, Why, and How.* Oneonta, AL: Otelco, June 1, 2018. https://www.otelco.com/fiber-infrastructure/.

[11] Columbia Telecommunications Corporation. *Broadband Strategic Plan Prepared for Charles County, Maryland.* Kensington, MD: January 2020. https://www.charlescountymd.gov/home/showpublisheddocument?id=3945.

[12] Mayor's Office of the Chief Technology Office. *The New York City Internet Master Plan.* New York, NY: January 2020. https://www1.nyc.gov/assets/cto/downloads/internet-master-plan/NYC_IMP_1.7.20_FINAL-2.pdf.

[13] Torstle, H., and Christopher Mitchell. *Profiles of Monopoly: Big Cable and Telecom.* Minneapolis, MN: Institute for Local Self-Reliance, August 2020. https://ilsr.org/wp-content/uploads/2020/08/2020_08_Profiles-of-Monopoly.pdf.

[14] EPB. "A long-standing history of serving Chattanooga." Chattanooga, TN: EPB, 2021. https://epb.com/about-epb/our-history.

[15] Rushe, Dominic. "Chattanooga's Gig: How One City's Super-Fast Internet Is Driving a Tech Boom." *The Guardian*, August 30, 2014. https://www.theguardian.com/world/2014/aug/30/chattanooga-gig-high-speed-internet-tech-boom.

[16] Lobo, Bento J., PhD, CFA. *Ten Years of Fiber Optic and Smart Grid Infrastructure in Hamilton County, Tennessee.* University of Tennessee at Chattanooga: August 31, 2020. https://assets.epb.com/media/Lobo%20-%20Ten%20Years%20of%20Fiber%20Infrastructure%20in%20Hamilton%20County%20TN_Published.pdf.

[17] Urban Land Institute. *Shaw Symposium on Urban and Community Issues: Equitable Investment in Infrastructure and Housing.* Washington, DC: ULI, June 22, 2021.

[18] Bubny, Paul. "Apartment Developers Get Revved Up over Electric Scooters." New York, NY: December 13, 2019. https://www.connectcre.com/stories/developers-and-electric-scooters-mutually-beneficial/.

[19] Build America Bureau. *Guidance for Transit-Oriented Development.* Washington, DC: U.S. Department of Transportation, May 2021. https://www.transportation.gov/buildamerica/about/resources-mode/transit-oriented-development.

[20] Molnar, Gabor; Scott Savage; and Douglas Sicker. "The Impact of High-Speed Broadband Availability on Real Estate Values: Evidence from United States Property Markets." August 15, 2013. TPRC 41: The 41st Research Conference on Communication, Information, and Internet Policy. SSRN: https://ssrn.com/abstract=2241926 or http://dx.doi.org/10.2139/ssrn.2241926.

[21] Fairfax County Economic Development Authority. *Northern Virginia Leads the World in the Data Center Market.* https://www.fairfaxcountyeda.org/media-center/northern-virginia-leads-world-data-center-market/.

[22] Mangum Economics. *The Impact of Data Centers on the State and Local Economies of Virginia.* Falls Church, VA: Northern Virginia Technology Council, 2020. https://www.nvtc.org/NVTC/Insights/Resource_Library_Docs/2020_NVTC_Data_Center_Report.aspx.

[23] Smart Cities Council. *The Definition of a Smart City.* https://rg.smartcitiescouncil.com/readiness-guide/article/definition-definition-smart-city.

[24] U.S. Environmental Protection Agency. *About the Water Infrastructure and Resiliency Finance Center.* Washington, DC: EPA, 2021. https://www.epa.gov/waterfinancecenter/about-water-infrastructure-and-resiliency-finance-center.

[25] Read, Anna; Gulafshan Ghori; and Will Frick. *Smart Communities: Rethinking infrastructure.* Washington, DC: International City/County Management Association. October 2017. https://assets.new.siemens.com/siemens/assets/api/uuid:18bfd2fa-8ba0-440a-933d-ed72ca099bc5/smart-communities-rethinking-infrastructure-icma-report.pdf.

[26] Leinmiller, Mark, and Melissa O'Mara. *Smart Water: A Key Building Block of the Smart City of the Future.* Palatine, IL: Schneider Electric, December 8, 2013. https://www.waterworld.com/international/wastewater/article/16190746/smart-water-a-key-building-block-of-the-smart-city-of-the-future.

[27] Lafferty, Steve. *Overview and Impacts of the Ellicott City Smart Parking System***.** Howard County [Maryland] Government: October 7, 2013. http://itsmd.org/wp-content/uploads/Steve-Lafferty-Overview-and-Impacts-of-the-Ellicott-City-Smart-Parking-System.pdf.

[28] Baltimore Police Department. *New Technology Initiatives*. 2021. https://www.baltimorepolice.org/transparency/newtechnologyinitiatives.

[29] Neuhauser, Alan. "100,000 Americans Die from Air Pollution, Study Finds." *U.S. News:* April 8, 2019. https://www.usnews.com/news/national-news/articles/2019-04-08/100-000-americans-die-from-air-pollution-study-finds.

[30] Gendreau, Henri. "Virginia Tech Scientists Explore Wastewater as a Way to Detect COVID-19 Outbreaks." *Richmond Times-Dispatch,* Richmond, VA: September 14, 2020. https://richmond.com/news/state-and-regional/virginia-tech-scientists-explore-wastewater-as-a-way-to-detect-covid-19-outbreaks/article_a9118314-2638-5df8-bb56-8c902bee684e.html.

[31] Brink. "Why Is There a Backlash to Smart Cities? An Interview with Eugenie L. Birch." Brink: December 11, 2019. https://www.brinknews.com/why-is-there-a-backlash-to-smart-cities/.

[32] Marx, Jesse. "The Mission Creep of Smart Streetlights." *Voice of San Diego,* San Diego, CA: February 3, 2020. https://www.voiceofsandiego.org/topics/public-safety/the-mission-creep-of-smart-streetlights/.

[33] Simonite, Tom. "Portland's Face-Recognition Ban Is a New Twist on 'Smart Cities.'" *Wired:* September 21, 2020. https://www.wired.com/story/portlands-face-recognition-ban-twist-smart-cities/.

[34] Conger, Kate; Richard Fausset; and Serge Kovaleski. "San Francisco Bans Facial Recognition Technology." *New York Times,* San Francisco, CA: May 14, 2019. https://www.nytimes.com/2019/05/14/us/facial-recognition-ban-san-francisco.html.

[35] U.S. Department of Energy's Office of Electricity. "The Smart Grid." Washington, DC: U.S. Department of Energy. https://www.smartgrid.gov/the_smart_grid/smart_grid.html.

[36] Energetics Incorporated. *The Future of the Grid: Evolving to Meet America's Needs.* Washington, DC: U.S. Department of Energy, December 2014. https://na.smartcitiescouncil.com/system/tdf/public_resources/Future%20of%20the%20Grid.pdf?file=1&type=node&id=1703&force=.

[37] Cisco. "Oldsmar's Cyber Attack Raises the Alarm for the Water Industry." Cisco: February 24, 2021. https://www.govtech.com/sponsored/oldsmars-cyber-attack-raises-the-alarm-for-the-water-industry.html.

[38] McCrimmon, Ryan, and Martin Matishak. "Cyberattack on Food Supply Followed Years of Warnings." Washington, DC: *Politico,* June 5, 2021. https://www.politico.com/news/2021/06/05/how-ransomware-hackers-came-for-americans-beef-491936.

[39] Bing, Christopher, and Stephanie Kelly. "Cyber Attack Shuts Down U.S. Fuel Pipeline 'Jugular,' Biden Briefed." Washington, DC: Reuters, May 8, 2021. https://www.reuters.com/technology/colonial-pipeline-halts-all-pipeline-operations-after-cybersecurity-attack-2021-05-08/.

[40] U.S. Bureau of Labor Statistics. *Job Flexibilities and Work Schedules Summary.* Washington, DC: U.S. Department of Labor, September 24, 2019. https://www.bls.gov/news.release/flex2.nr0.htm.

[41] PwC and the Urban Land Institute: *Emerging Trends in Real Estate® 2021*. Washington, DC: PwC and the Urban Land Institute, 2020. ISBN: 978-0-87420-464-3.

[42] Thompson, Derek. "Winners and Losers of the Work-From-Home Revolutions." *The Atlantic.* June 14, 2021. https://www.theatlantic.com/ideas/archive/2021/06/winners-losers-work-home-remote/619181/.

[43] Linos, Elizabeth. "When Working from Home Changes Work at the Office." Cambridge, MA: Harvard. Working paper. https://scholar.harvard.edu/elinos/publications/does-teleworking-work-organizations-measuring-impact-working-home-retention-and.

[44] Wheatley, Dan. "Good to Be Home? Time-Use and Satisfaction Levels among Home-based Teleworkers." *New Technology, Work and Employment,* Vol. 27 (3): October 26, 2012; pp. 224–41. https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1468-005X.2012.00289.x.

[45] Dingel, Jonathan I., and Brent Neiman. *How Many Jobs Can Be Done at Home?* Chicago: Becker Friedman Institute for Economics at the University of Chicago, June 19, 2020. https://bfi.uchicago.edu/wp-content/uploads/BFI_White-Paper_Dingel_Neiman_3.2020.pdf.

[46] Abassi, Lila. *Virtual Doctor's Visits: The Promises of Telemedicine.* New York, NY: American Council on Science and Health, January 19, 2016. https://www.acsh.org/news/2016/01/18/virtual-doctors-visits-the-promises-of-telemedicine.

[47] OrthoLive. "Top 10 Benefits of Telehealth for Patients and Doctors." Cincinnati, OH: OrthoLive, December 13, 2018. https://www.ortholive.com/blog/top-10-benefits-of-telehealth-for-patients-and-doctors/.

[48] Miller, Jake. "Paying for Health Care with Time." Cambridge, MA: *Harvard Gazette,* October 5, 2015. https://news.harvard.edu/gazette/story/2015/10/paying-for-health-care-with-time/.

[49] Medici, Andy. "Amazon Landlord JBG Smith Lays Foundation for National Landing 5G Network." Washington, DC: *Washington Business Journal,* September 21, 2020. https://www.bizjournals.com/washington/news/2020/09/21/amazon-jbg-5g-covid.html.

[50] Medici, Andy. Business Wire. "JBG SMITH Awarded CBRS Spectrum in National Landing Through FCC Auction." Bethesda, MD: *Business Wire,* September 21, 2020. https://www.businesswire.com/news/home/20200921005192/en/JBG-SMITH-Awarded-CBRS-Spectrum-in-National-Landing-Through-FCC-Auction.

[51] Temblador, Alex. "The Sinclair Hotel Is the First in the World to Power Itself with This New Technology." New York, NY: *Architectural Digest*, November 5, 2019. https://www.architecturaldigest.com/story/the-sinclair-hotel-is-the-first-in-the-world-to-power-itself-with-this-new-technology.

[52] Verma, Urvashi. "Marriott Autograph Hotel in Texas to Becomes PoE Technology Showplace." Newark, NJ: *Connected Real Estate Magazine,* April 17, 2019. https://connectedremag.com/smart-buildings/proptech/marriott-autograph-hotel-in-texas-to-become-poe-technology-showplace/.

[53] Sivils, Dan. "Fiber to the Home in a Planned Community." *Broadband Communities,* July 13, 2013. http://www.bbpmag.com/2013mags/july/BBC_July13_FTTHPlannedComm.pdf.

[54] Sivils, Dan. "Highlands Fiber Network and GigabitNow Offer Gigabit Internet for $70." Seattle, WA: GigabitNow, November 2, 2015. https://www.gigabitnow.com/blog/hfn-gigabit-internet.

[55] *Chattanoogan.* "EPB Awarded $111 Million Grant for Smart Grid." The Chattanoogan.com: October 27, 2009. https://www.chattanoogan.com/2009/10/27/161784/EPB-Awarded-111-Million-Grant-For.aspx.

[56] Marvin, Rob. "Gig City: How Chattanooga Became a Tech Hub." *PC,* May 4, 2018. https://www.pcmag.com/news/gig-city-how-chattanooga-became-a-tech-hub.

[57] EPB. "About EPB Internet." High-Speed Internet.com, 2021. https://www.highspeedinternet.com/providers/epb.

[58] Lobo, Bento J., PhD, CFA. *Ten Years of Fiber Optic and Smart Grid Infrastructure in Hamilton County, Tennessee*. University of Tennessee at Chattanooga: August 31, 2020. https://assets.epb.com/media/Lobo%20-%20Ten%20Years%20of%20Fiber%20Infrastructure%20in%20Hamilton%20County%20TN_Published.pdf.

[59] Ali, Christopher. "Cooperatives: The Unsung Heroes of Broadband." Evanston, IL: Benton Institute for Broadband and Society, February 22, 2021. https://www.benton.org/blog/cooperatives-unsung-heroes-broadband.

[60] Rural Development. "Electric Programs." Washington, DC: U.S. Department of Agriculture. https://www.rd.usda.gov/programs-services/all-programs/electric-programs.

[61] Conexon. "CVEC Listens to the Echoing Sentiment from Its Members and Moves Forward to Build a FTTH Network." Kansas City, MO: Conexon LLC. https://conexon.us/case-studies/central-virginia-electric-cooperative/.

[62] Central Virginia Electric Cooperative. "Purpose of the Fiber Optic System." Colleen, VA: Central Virginia Electric Cooperative. https://www.mycvec.com/broadband/project-overview.

[63] Grant, Alison; Wally Tyner; and Larry DeBoer. "Economic and Policy Analysis of Potential Deployment of Rural Broadband in Indiana." West Lafayette, IN: Purdue University, November 29, 2018. https://ag.purdue.edu/agecon/Pages/PAEPB-2018_12.aspx.

[64] Barth, Mandy. "Report: Broadband Access Would Benefit Rural Areas, State." West Lafayette, IN: Purdue University, August 27, 2018. https://www.purdue.edu/newsroom/releases/2018/Q3/report-broadband-access-would-benefit-rural-areas,-state.html.

[65] Zager, Masha. "Huntsville Becomes a Gig City." *Broadband Communities*, October 2017. https://www.bbcmag.com/community-broadband/huntsville-becomes-a-gig-city.

[66] Huntsville Utilities. "Commercial Rates" Fiber Lease Rates. Huntsville, AL: Huntsville Utilities. https://www.hsvutil.org/hu-hub/rates/commercial-rates/.

[67] Marcattilio-McCracken, Ry. "Transcript: Broadband Bits Episode 433." Community Networks, November 10, 2020. https://muninetworks.org/content/transcript-community-broadband-bits-episode-433.

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