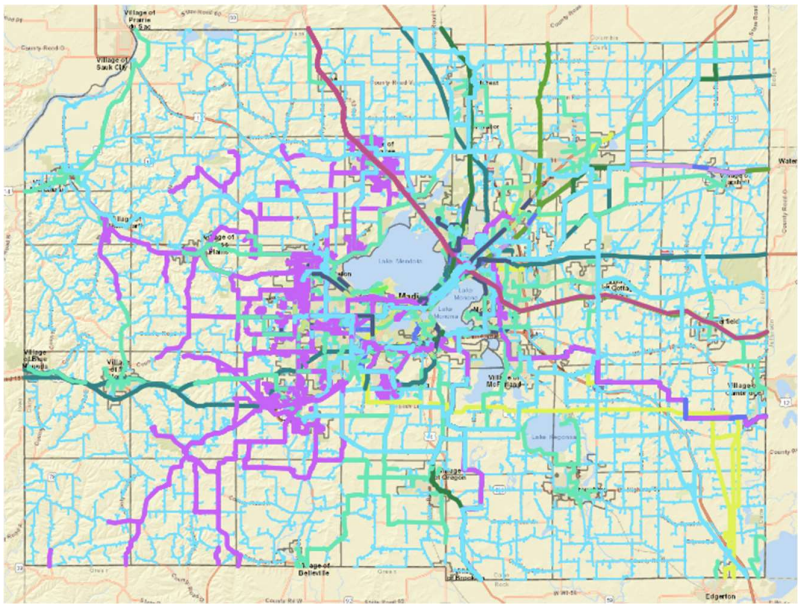
Dane County - Broadband Infrastructure Engineering Assessment

Final Report

Purpose

The primary purpose of this report is to provide recommendation strategies for follow on coordination efforts to enable practical, informed and cost-effective broadband expansion across Dane County. These recommendations include both technical and policy related aspects of expanding broadband infrastructure along with developing strong working partnerships with public and private sector organizations.



The following goals of the project were defined and determined through the project document and stakeholder meetings for the assessment and expansion of broadband throughout Dane County.

Goals

1. Improve broadband access across the entire county
2. Address gaps in service
3. Support municipalities as they prepare to seek grants
4. Provide strategies to achieve 100Mbps service to every home and business
5. Interim and transitional solutions for broadband connectivity

Background

The primary responsibility of the Dane County Task Force is to identify where broadband access is and is not, explore alternative solutions and make recommendations to the County Board on the role of Dane County in facilitating the expansion of broadband services to residents. As such, AECOM was contracted by Dane County to conduct a comprehensive Broadband Infrastructure Engineering Assessment to strategize on how best to facilitate reliable, high-speed broadband expansion to every resident and business. The project covered three primary milestones: Current Assessment, Technology Options and Broadband Expansion Coordination.

Current Assessment

AECOM completed an inventory of all existing fiber networks and broadband providers in the county. The project team focused on providers using fiber and/or copper to provide services to end users. The mapping in Diagram 2 provides a view of network owners and the routing of fiber throughout the county. Secondarily, the project team reviewed existing data that provided a view of broadband service levels and the gaps that are present throughout the county.

Existing Network Owners

There are a total of 33 fiber network owners and/or broadband providers that have a presence in Dane County. The offerings consist of facilities-based providers that deliver services over fiber or copper (Spectrum/Charter Communications, TDS, AT&T, CenturyLink, etc.), Wireless ISP's (WISP's) such as United States Cellular, and satellite providers like VSAT Systems. The map below provides a view of all the owned fiber networks within Dane County with owners identified by color. Spectrum/Charter and TDS Telecom, by far have the most robust fiber presence. Respondents to the UW River Falls survey showed that these two companies served 56% of the households responding. Their density of fiber gives both organizations a greater reach and penetration compared to the other providers in the county.

While there is a varied presence of fiber networks in the county, not all network owners provide residential services to end users. Internet Service Providers (ISP's) such as Spectrum/Charter, TDS, AT&T Wisconsin, CenturyLink, Frontier, and others do not deliver directly to residences. Some of the networks are carrier-based service providers serving only businesses, governments agencies, and community anchor institutes (CAI's). This would include networks and companies such as MUFN, Crown Castle Fiber, EarthLink Business, PAETEC Business Services, etc. While these fiber providers do not sell directly to residential users, they typically provide the opportunity for other companies to purchase internet service in bulk and resell it on their networks. The table below shows current fiber network owners and broadband providers offering services in Dane County.

5NINES	eSecureData	Natus Medical	SupraNet
Accuray Incorporated	Exact Sciences Corporation	NetProtect	Surfshark Ltd.
Airstream Communications	FDC Servers	NetwurX	Synergy
Amazon	Ficolo	Nexeon Technologies	Tata Communications (america)
American Family Insurance	Frontier	Nord VPN	TDS Telecom
AMTELCO	GigeNET	OneNeck IT Solutions	T-Mobile
Apple	Google Wi-Fi	Oracle Cloud	TPx Communications

Astrea	Granite	OVH	tzulo
AT&T Internet	GTT Communications Inc.	PacketHub	UK2.NET
Atlantic Metro	Heficed	Palo Alto Networks	Unitas Global LLC
Bertram Internet	HEG	Pavlov Media	University of Wisconsin Whitewater
Bigleaf	Hoyos Consulting	Performive	UpNet Wi
Blain Supply	HughesNet	PROMEGA CORPORATION	US Cellular
Bug Tussel Wireless	iCloud Private Relay	Proservice LLC	US Dedicated
CDW	IPVanish	Psychz	US Signal
CenturyLink	IPXO	QBE Americas	USDA
Charles River Operation LLC	Lands' End	RackNation	UW
Cisco-iot	Latitude.sh LTDA	ResTech Services	Verizon
CITY OF MADISON	LeaseWeb	SageNet LLC	Viasat
CloudFlare	LEE ENTERPRISES	Sentry Insurance a Mutual Company	Western Independent Networks (WIN)
CMFG Life Insurance Company	Limestone Networks	SMITHGROUP Companies	WhiteSky
Cogent Communications	LiteWire	SpaceX Starlink	Windstream
ColoCrossing	Lumen	Spectrum	WiscNet
Comcast Business	M247	SSM	Wisconsin Physcians

Core BTS	MetTel	St. Norbert College	Wisconsin Public Power
Datacamp Limited	Mgm Telecom Comunicacao Ltda	Stackpath	XFINITY
DEDIPATH	MHTC	State of WI Dept. of Administration	Zayo
DigitalOcean	Microsoft Azure	State of Wisconsin Investment Board	Ziply Fiber
EGIHosting	Midwest Fiber Networks	Strong VPN	Zscaler
Epic	National Park Service	Sub-zero Group	

Table 1 - Current Broadband Providers

The fiber map below (and within Plan.Engage) represents the existing CAI's, cell towers, and all address points within the county. Within Plan.Engage, each of these layers can be individually overlayed on the fiber network and broadband provider layer to view where the fiber networks traverse with relation to each of the data points. As can be seen in the map below, when the address points are viewed with the existing fiber networks the most apparent issue is the lack of fiber infrastructure footprint to residential users. Deploying and maintaining fiber optic networks can be costly and ISP's weigh build costs against their return on investment (ROI), e.g. how many homes per mile can be served and at what monthly recurring service fee. It is often less expensive to utilize existing, inferior network infrastructure, such as copper, to provide service, than to overbuild an entire network with a new fiber optic cable. It is also not cost effective for providers to build fiber into rural areas where the population density lacks the sufficient business case to support long stretches of middle mile builds with a low density of homes along the route(s). The result is less fiber available to the overall population, perpetuating the lack of connectivity issues to unserved and underserved areas of Dane County's communities.

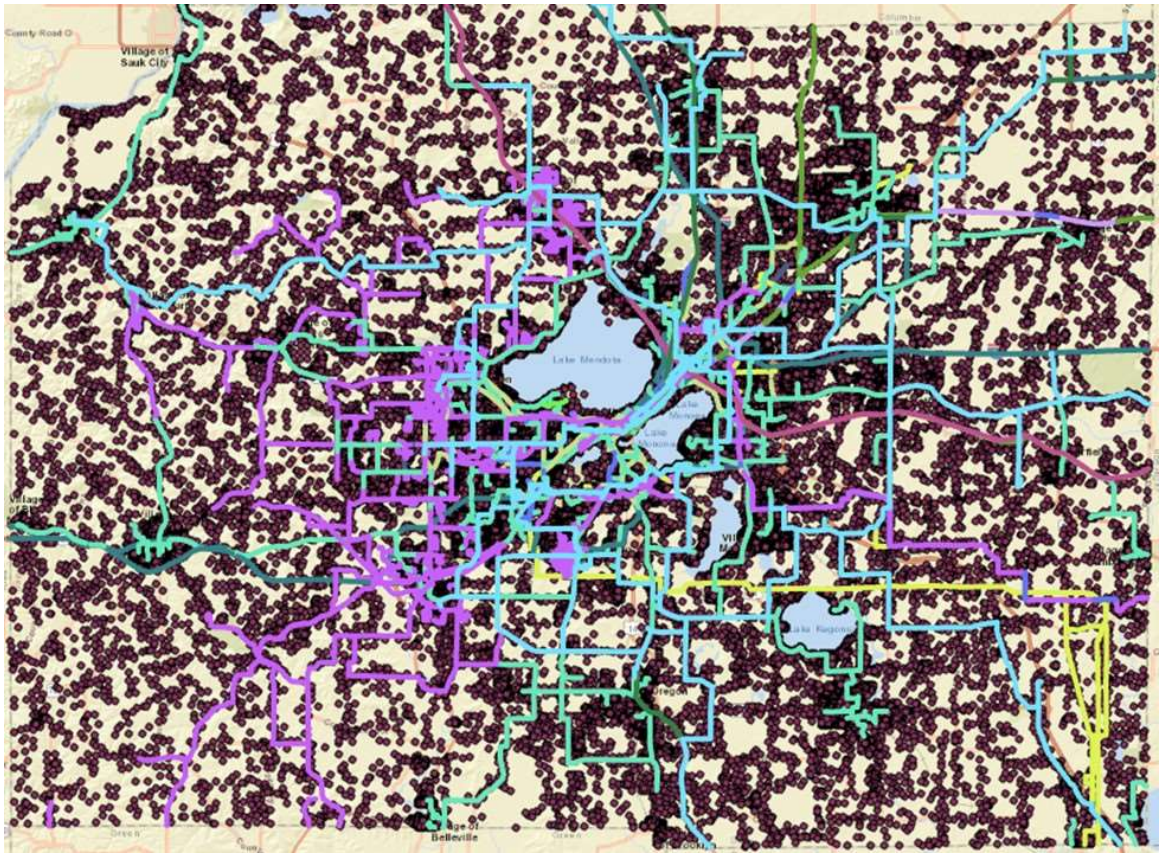


Diagram 2: Fiber Routes and Address Points

MUFN

Diagram 3 below provides a view of an existing, middle mile metro network known as the Metropolitan Unified Fiber Network (MUFN) that serves the Madison, Middleton, and Monona areas. The network was built with a Broadband Technologies Opportunities Program (BTOP) grant under the American Recovery and Reinvestment Act of 2009 (ARRA). The MUFN conduit and cable assets are owned and maintained by two entities, the City of Madison with approximately 90% ownership. MUFN's network is a consortium of 19 Madison area entities consisting of 15 non-profit groups and 2 commercial partners. The current MUFN affiliates are shown below in Table 2. MUFN does own and operate its own network over the backbone, and MUFN is not a broadband provider. The consortium works directly with non-profits and commercial clients. Non-profit organizations can join MUFN as a member or work with either of the two commercial entities to determine how the network can be best utilized for their needs. Agreements to use the MUFN fiber are written as Memorandum's off Understanding (MOU's) between the organizations. MOU's are agreements between parties defining the mutually agreed upon nature and terms of the parties relationship. Organizations who are for-profit can work directly with MUFN's commercial partners to determine what they can do to support the for-profit entity. MUFN's network serves all members with services or fiber that can be used for public and private networks. Connections to the MUFN Fiber network can accomplished by MUFN extending into an end user location or the affiliate building to connect to the existing fiber. The fiber network currently connects many of the Community Anchor Institutes (CAI's) in its footprint. CAI's are defined as schools, libraries, medical and healthcare providers, community colleges and other institutions of higher education, and other community support organizations

and entities such as police and fire stations. MUFN also connects to commercial and residential buildings for broadband services that are delivered by the commercial partners. MUFN is currently not interested in extending broadband beyond Dane County but has expressed supporting high-speed, affordable broadband throughout the county. Dane County and MUFN continue to hold conversations and MUFN wishes to continue working with the county and taskforce on how best to expand broadband throughout Dane County

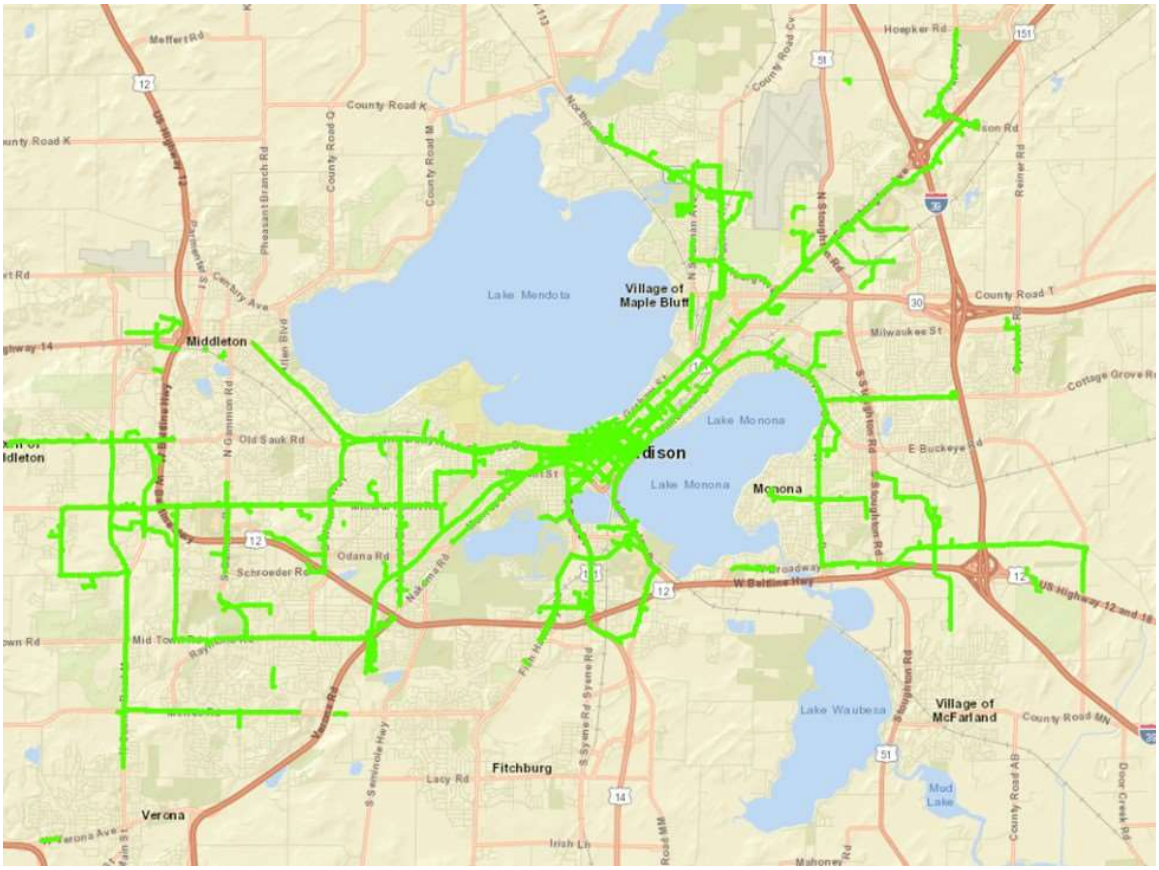


Diagram 3: MUFN

Non-Profit Affiliates
City of Madison
City of Middleton
City of Monona
Dane County
DaneNet
Madison College
Madison Metropolitan School District
Middleton-Cross Plains School District

Monona Grove School District
South Central Library System
UnityPoint Health – Meriter
University of Wisconsin – Madison
UW Health
Wisconsin Department of Public Instruction
Wisconsin Geological and Natural History Survey
Wisconsin Independent Network
Wisconsin State Lab of Hygiene
Broadband Technologies Opportunity Program
Commercial Affiliates
SupraNet Communications
Wisconsin Independent Networks (WIN)

Table 2: MUFN Affiliates 2022

Wireless Broadband

Wireless broadband delivery is another option used for providing broadband services. The UW River Falls Survey found that 18% of the respondents use some form of wireless broadband internet access. The use of fixed wireless access accounted for 7% of wireless broadband access. Fixed wireless technology delivers internet over signals that are delivered from a fixed point that could be miles away to a fixed point in the home such as an antenna or modem that remains in a fixed location. Cellular internet also delivers broadband over signals transmitted through the air, but there is a difference from a fixed wireless service. Cellular service generates the signal from a fixed location, but the receiving device is a mobile phone or hotspot device that is not in a fixed location. Survey respondents reported that 6% of the participating households use cellular or hotspot internet access for their broadband needs. The remaining 5% of respondents use satellite services for broadband access. Satellite broadband is delivered by communication satellites to the consumer. Wireless broadband deployment does have some advantages over fiber optic networks. Fiber networks deployment is typically a time consuming and lengthy process where most wireless applications can be deployed very quickly. Fiber optic is also more costly than wireless deployment regarding the materials and equipment used. These advantages are why wireless is often deployed to more rural areas where fiber networks do not exist today. However, fiber optic networks deliver a superior broadband experience in many ways. Fiber optics uses light to transmit data as opposed to signals propagated through the air for wireless broadband. The light waves are not susceptible to interference like wireless signals and give a less interrupted experience. Fiber networks can carry a higher maximum speed and continue to provide a consistent speed when the network becomes congested with users. Wireless in theory can do the same, but the user speeds typically decrease as the network congestion increases, e.g., too many devices in one area, and service degradation can occur due to weather like fog, severe storms and blizzards. Distance is a limiting factor for both fiber and wireless, but fiber can carry the signal, with less signal degrade, much further than wireless. Fiber can travel up to 100km without a need to regenerate its signal. While fiber is considered superior, wireless does have an application and technology continues to improve.

Diagram 4 shows the existing cell tower infrastructure in Dane County. Cell towers are the most common fixed point for generating wireless broadband signals. The area in Dane County that is most densely populated with cell towers is in and around the more urban areas. This area is already populated with various fiber optic network options. The rural areas could benefit with wireless access as an option, but those parts of the county are sparsely populated with towers.

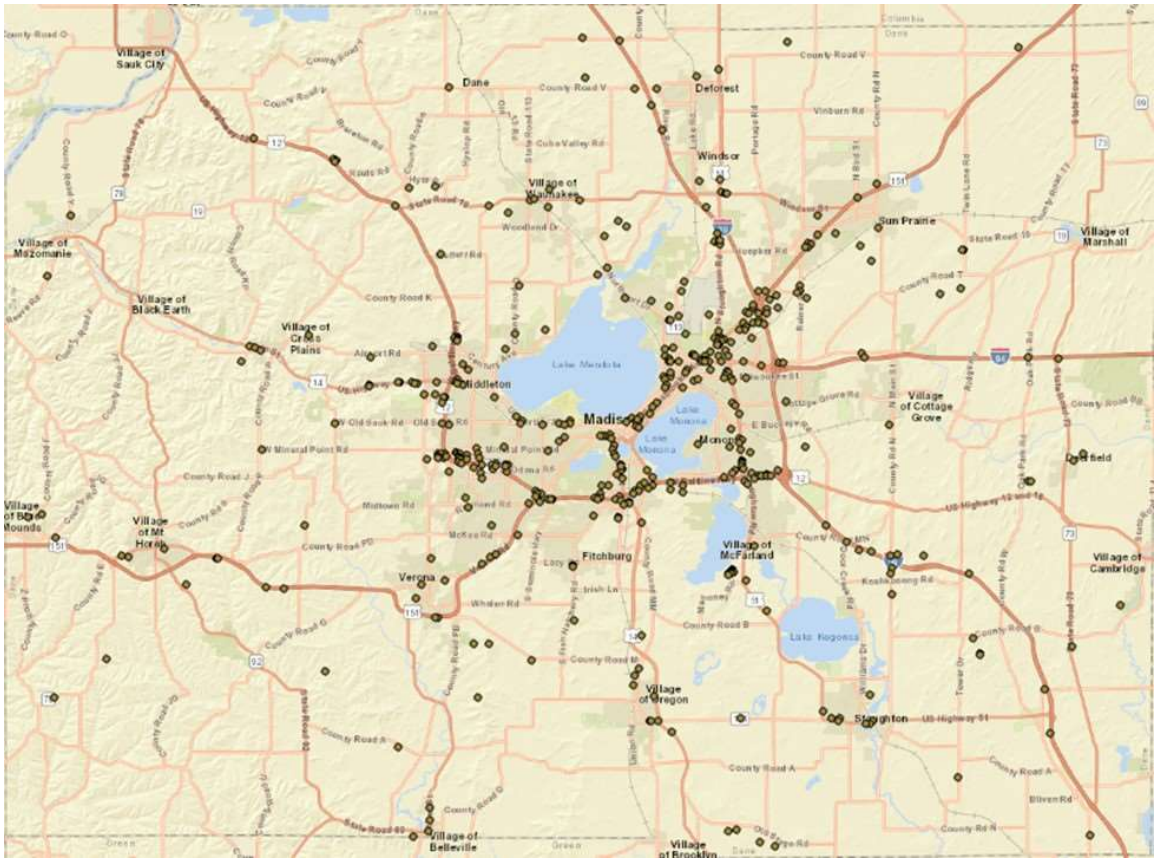


Diagram 4: Cell Towers

Broadband Service Max Advertised Download Speeds

This assessment also reviewed internet quality experienced by users who currently subscribe to services. The majority of residents outside of the greater Madison area are considered underserved or unserved by NTIA guidelines. By NTIA guidelines, underserved broadband users are defined as having a download speed of less than 100Mbps and 20Mbps upload speed. Unserved users have an average download speed of less than 25Mbps and less than 3Mbps upload speed. In most circumstances, neither classification is considered reliable, high-speed broadband service. The need for reliable, high-speed broadband has been increasing for years and became immediately apparent during the pandemic. Post-pandemic need for broadband continues to grow as the world has shifted to more automated and application driven services, remote education options, telecommuting for work and telehealth services. The UW survey asked respondents to define their most popular uses for internet. The most popular use for the internet was for entertainment such as streaming services. 71% of the respondents said they frequently use internet for entertainment purposes. The next most popular household uses are telecommuting for work (48% of respondents) and as a primary way to access medical information or services (41%). Remote education accounted for almost a third (32%) of the respondent's frequent usage. The survey also asked respondents about how better internet would change aspects of their lives related to business, telecommuting, and agricultural businesses. While most respondents (74%) were unsure or unlikely to start, move, or grow a business, 26% said they were somewhat

likely or very likely to start, move, or grow a business with better internet. Improved internet access would also impact telecommuting opportunity for 46% of the respondents with 32% saying they would be very likely to telecommute and 11% being somewhat likely to consider the option. Agricultural businesses expressed that they view internet as valuable (32%) or very valuable (38%). All the responses point to the need for better internet access for all aspects of Dane County's residents' lives. Residents of the county could potentially expand options for employment and improve their quality of life. There is also an economic impact that could be had as businesses would potentially be created or grow, and agricultural businesses could modernize and scale efficiencies to increase production and bottom-line growth.

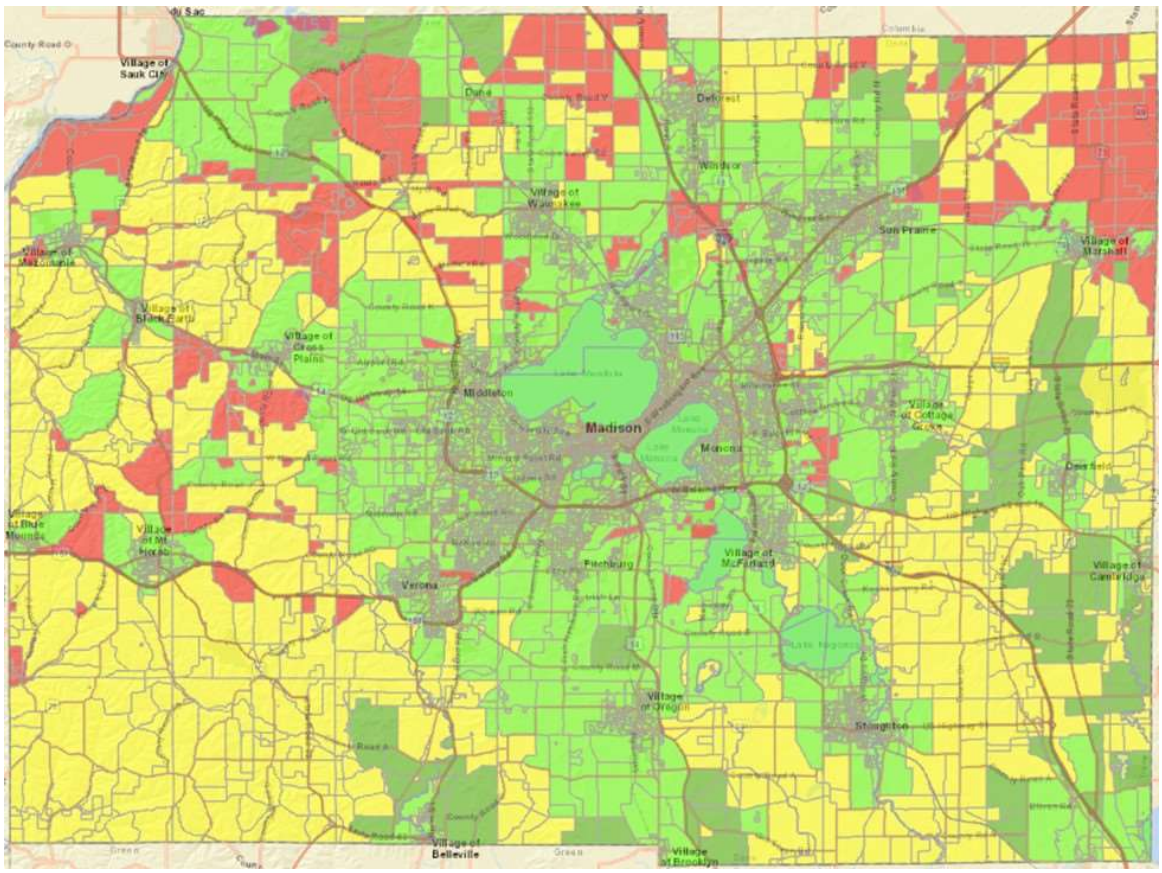


Diagram 5. Max Advertised Download Speeds (FCC Form 477)

FCC Average Max Download Speeds vs. Max Advertised

The initial assessment of broadband services consisted of mapping the maximum advertised speeds throughout the county. Below is a map showing the maximum advertised download speeds across Dane County from the FCC Form 477 data. Bright green indicates maximum advertised download speeds between 300Mbps and 1Gbps, dark green represents advertised download speeds 100Mbps to 300Mbps, yellow shaded areas are advertised download speeds between 25Mbps and 100Mbps, and red shading shows areas that have advertised download speeds of 2Mbps to 25Mbps. The map shows the two predominant advertised maximum download speeds fall in the 1) 300Mbps-1Gbps range and 2) 25Mbps-100Mbps. The map shows large parts of the county with access to advertised speeds between 100Mbps and 1Gbps. Speed test data compared to maximum advertised download speeds provides a clearer picture of the internet quality available to Dane County residents.

Ookla Average Max Download Speeds vs. Max Advertised

The below map, Diagram 6, is a view of Ookla speed test results showing that actual services throughout Dane County are well below advertised maximums. Bright green indicates speed test results within advertised speeds and red indicates speed test results that are below advertised speeds. When compared to the map showing the maximum advertised speeds, most of the county is receiving much less speed than currently advertised. UW River Falls study also queried respondents about their download and upload speeds. Download speeds were broken into six different categories. The highest download speed category was 100.1Mbps or faster which is above the download speed threshold for classifying service as underserved. 30% of the polled respondents stated their broadband download speeds fell into this category. The remaining five categories for download speeds, with response percentages, were 100Mbps-20.1Mbps (31%), 20Mbps-10.1Mbps (12%), 10Mbps-5.1Mbps (10%), 5Mbps-1.1Mbps (12%), Under 1Mbps (6%). The responses show that 70% of the respondents download speed is at or below the underserved threshold and of the 70% that are underserved, approximately 18% are considered unserved. Upload speeds were also collected as part of the study and show similar results. The study broke the upload speeds into six categories as well. The two categories that were above the underserved threshold were 100.1Mbps or faster and 100Mbps-20.1Mbps. Responses showed that 10% of the people have upload speeds at or greater than 100.1Mbps and 11% fell into the 100Mbps- 20.1Mbps range. The remaining four upload speed categories, and their associated percentages, were 20Mbps10.1Mbps (20%), 10Mbps-5.1Mbps (19%), 5Mbps-1.1Mbps (21%), and Under 1 (19%). Upload speeds show similar results with the majority of the respondents (79%) at or below the upload speed threshold for underserved and approximately 40% would fall into the unserved classification. The collected data supports the results shown in the map that show much slower user speeds than advertised.

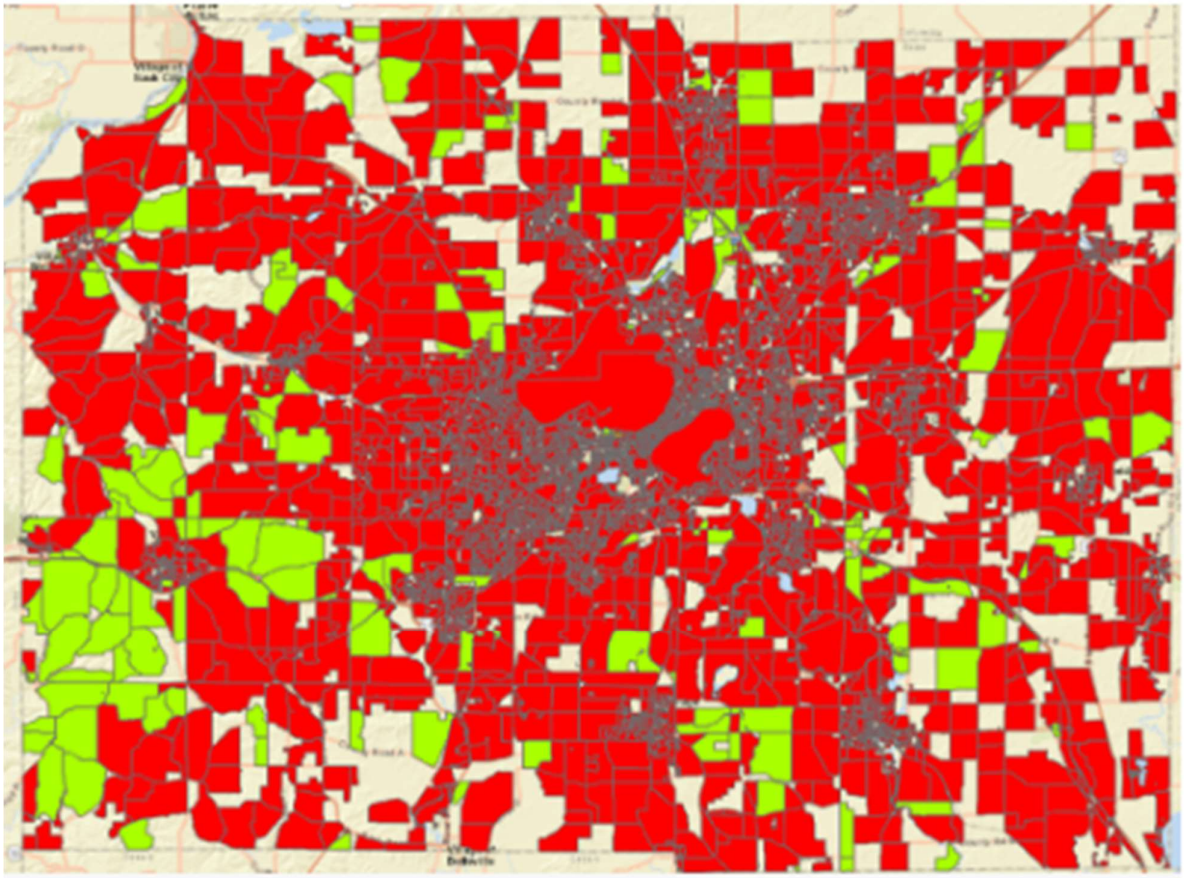


Diagram 6: Speed Test Below Advertised

Broadband Satisfaction

Broadband user satisfaction correlates directly to the quality of the service they are receiving. Customers pay for their connections and expect to receive the corresponding service levels. The quality of the connection is also important for the subscribers intended broadband use. Connections that are too slow, intermittent or unavailable cannot service the higher bandwidth needs to transmit data to engage in more popular activities like streaming services, gaming and on-line applications for telecommuting, remote learning, or remote healthcare. Responses to the UW River Falls survey show that only 19% of those reporting are very satisfied. The remaining 81% fall into four categories of somewhat satisfied (30%), neutral (17%), somewhat dissatisfied (19%) and very dissatisfied (15%). 51% of the respondents are not satisfied with their service. The reason respondents are dissatisfied with their service fell into four main categories. The highest percentage of responses (39%) said the services are too expensive. This also correlates with another part of the survey where 34% of the responses state they had no internet at home currently because it is too expensive. The remaining 61% of respondents were not satisfied with their service because it was too slow (32%), unreliable (27%), or they received poor customer service (11%). The data shows that 89% of the respondents are dissatisfied because of poor quality.

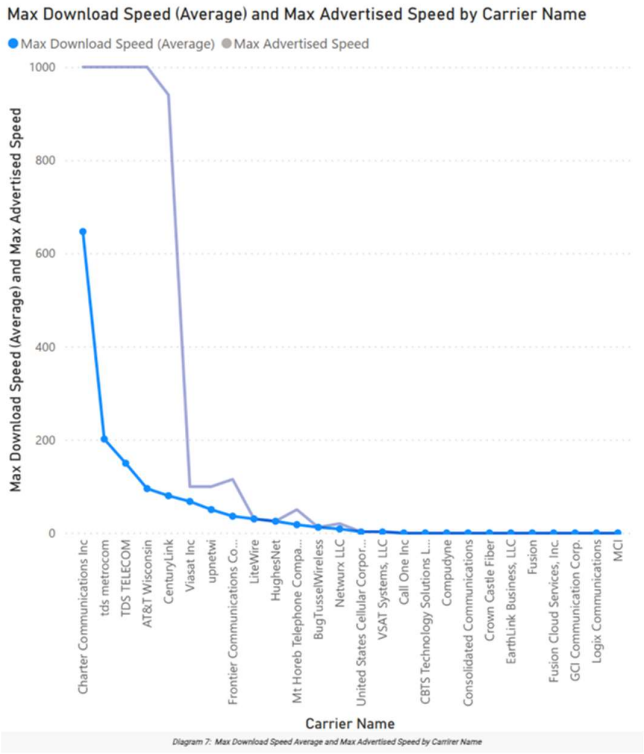


Diagram 7: Max Download Speed Average and Max Advertised Speed by Carrier Name

Affordable Care Program

Dane County population in 2020 was 542,459 residents. The poverty rate was 11% which puts 59,670 people at or below the poverty line. The Affordable Connectivity Program (ACP) is a federally funded program that aims to provide affordable, high-speed internet to low-income households. The current ACP provides a discount of up to $30.00 per month for eligible households and up to $75.00 per month for Tribal lands. Eligible households are also able to receive a one-time discount of up to $100.00 to purchase a laptop, desktop computer, or tablet from a participating provider. There are 67,000 Dane County residents who are eligible to participate in ACP, but only approximately 19,000 of the eligible households are enrolled. This shows that 78.2% of the eligible households are not enrolled in the program (see Diagram 6). With a discount of $130.00 per household (includes the $100.00 purchase discount), and only 21.8% of those eligible participating, the amount of federal funding not being used by eligible households is approximately $8,710,000.00. Lack of ACP participation in the program can be attributed to residents not knowing about the program or not knowing how to apply. The FCC recognizes the need to bring awareness to the program and opened an Affordable Connectivity Outreach Grant program on November 10, 2022. The purpose of the grant program is to facilitate the promotion of the ACP and increase awareness and participation in the ACP. There is a total of $70,000,000.00 available for this program and it is split across two different grants. The National Competitive Outreach Program (NCOP) is allocated $60,000,000.00. Of the $60,000,000.00, $27,000,000.00 will be reserved for each state to receive a minimum of $500,000.00 for ACP outreach initiatives. The Tribal Community Outreach Program (TCOP) receives the remaining $10,000,000.00 to be used for ACP outreach activities specific to tribal communities. Applications must be submitted by 11:59pm EST January 9, 2023 withmonies to be awarded on or before March 10, 2023. Additional information on the

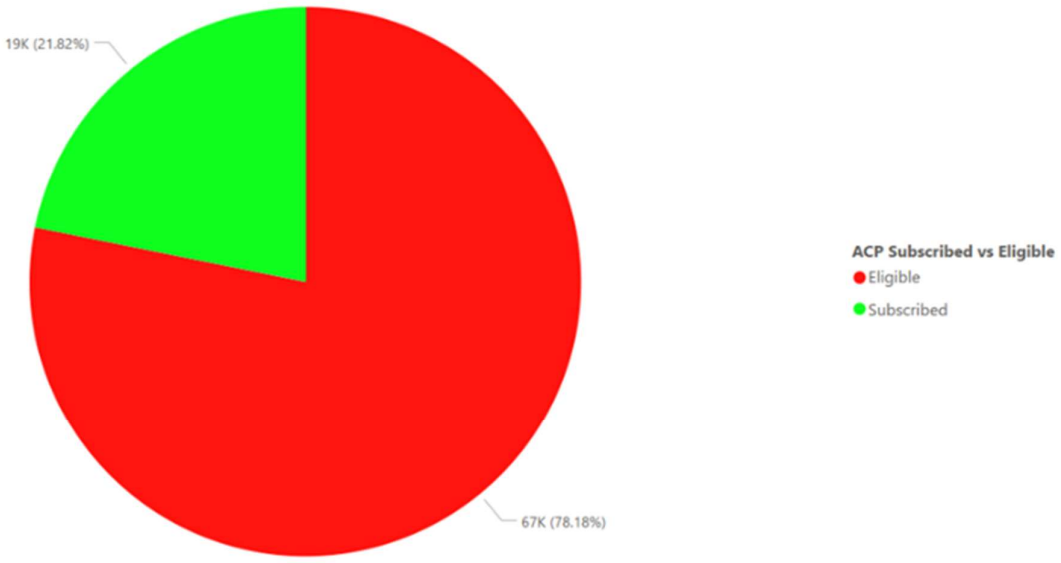


Diagram 8: ACP Eligible Households vs. Subscribed Households

Technology Options

This second segment of the project aimed at analyzing the most practical technology options to improve broadband across Dane County. The project team included in the Current Assessment, the current and future wired and wireless broadband technologies, the evaluation of existing broadband infrastructure assets necessary to connect to serviceable locations, and a conceptual fiber design to future-proof a county-wide, middle mile broadband expansion that connects to the diverse needs of the local communities and the County's various user groups. Ultimately, the goal is to offer a path forward for Dane County to effectively plan broadband expansion, identify funding sources to facilitate that expansion and implement a solution that will contribute to the long-term and sustainable success of Dane County.

Technology Options Overview:

Access to high-speed, reliable and affordable broadband internet has become essential for modern life, with applications ranging from entertainment and telecommuting to remote education and telehealth. In Dane County, various broadband technologies are employed to deliver internet services, including fiber optics, wireless broadband, and satellite services. The Technology Options aims to provide a comprehensive overview of these technologies and their current implementation in the county.

As the project team completed its analysis of the current broadband technology options available in Dane County, the technology options analyzed and evaluated three (3) primary broadband delivery methods: fiber optic networks, wireless broadband (licensed and unlicensed) and satellite services. As part of this evaluation of technology options, the project team quantified what it would take to provide these services to facilitate broadband across all unserved locations within Dane County. Within each technology option, the project team evaluated its advantages, limitations, financial costs and its eligibility related to 3rd party funding sources to bring about sound broadband expansion across Dane County.

Funding Constraints - NTIA's BEAD Program: The NTIA's Broadband Equity, Access, and Deployment (BEAD) Program provides funding to expand broadband access in unserved and underserved areas. However, the NTIA has determined by Rule 70 that unlicensed terrestrial fixed wireless and satellite broadband technology are not eligible for BEAD funding. Additionally, there are areas that are considered excluded for additional federal funding such as RDOF zones. The exclusionary areas may not be able to receive other federal funds that received RDOF funds.

Technology Decision Matrix Summary

Category	Technology		
	Fiber	Wireless	Satellite (Low Orbit)
Bandwidth	High	Moderate	Low
Reliability	High	Moderate	Low
Scalability	High	Moderate	Low
Meets Federal Funding Requirements (March 2023)	Yes	Only Licensed	No
"Future Proof"	High	Low	Unknown
Coverage Range/Distance	High	Moderate	Moderate
Latency	Low	Moderate	High
Geographic Limitations	Low	Moderate	Low
Opportunities for Partnership	High	Low	Low
Life Expectancy	Fiber: 30 years	Network Equipment: 5-7 Years	Network Equipment: Unknown, technology in infancy
Portability	Low	High	High
Opportunities to add additional Communication / Infrastructure	High	High	Low
Expected Impact of Emerging Technology	Greater demand for fiber	Moderate	Moderate
Initial Infrastructure Cost	High	High	Low

Technology Option #1 - Fiber Networks

A fiber optic network refers to a telecommunication infrastructure employing fiber optic cables for the long-range transmission of data at high speeds, while maintaining minimal signal degradation. Fiber optic networks surpass traditional copper wire networks in various aspects, including extended transmission distances with minimal signal loss and increased data transfer rates.

These networks find application in numerous sectors, encompassing telecommunications, internet services, cable television, and data center connectivity. They are prevalent in both urban and rural regions, frequently employed to establish global interconnections through subsea Internet cables.

Within Dane County, 33 fiber network proprietors and broadband providers operate, with Spectrum/Charter and TDS Telecom possessing the most expansive fiber presence. Despite this, rural regions suffer from insufficient fiber infrastructure, resulting in numerous unserved and underserved residents.

This option conceptualizes the expansion of high-speed fiber-optic infrastructure to 5,403 unserved broadband serviceable locations(BSLs) across Dane County by leveraging federal grants matched with a 30% contribution by Dane County.

Advantages of Fiber Networks

Fiber optic cables serve as the bedrock of broadband connectivity, setting the benchmark for broadband services due to their superior speed, capacity, reliability, and scalability. Modern data centers rely on fiber optic connections through public and private networks, extending last-mile connectivity to constituent communities.

Fiber optic cables exhibit a lifespan exceeding 30 years, further highlighting their significance in modern telecommunication systems.

Dane County may encounter several challenges when implementing this technology option:

Time constraints: Deploying fiber-optic infrastructure is a time-intensive process that often takes several years to complete. As technology rapidly evolves, Dane County may need to reassess the feasibility of this option as the project progresses, factoring in potential advancements and alternative and hybrid last mile solutions.

Regulatory and permitting barriers: Securing the necessary permits and complying with various regulations (environmental, cultural, historic) may further complicate the implementation process. Such hurdles could potentially result in delays and increased costs, affecting the overall project timeline and budget.

Maintenance and operation costs: The costs related to maintaining and operating the fiber-optic network are an essential factor to consider. These ongoing expenses may place additional strain on the county's budget, affecting its ability to allocate resources to other pressing needs.

Financial Analysis: The total cost of expanding the fiber-optic network to exclusively target and prioritize unserved BSLs under this technology option amounts to $265,035,284. If Dane County secures a 70% federal grant allocation, it would receive $185,524,699 in funding. However, the county would still be responsible for funding the remaining 30% of the project cost, totaling $79,510,585.

Technology Option #2a. Licensed Wireless (Cellular)

Licensed Wireless Broadband consists of mobile and fixed cellular services, providing moderate bandwidth which may not be sufficient for advancing technologies and has a network equipment life expectancy of 5-7 years. These technologies offer some advantages in terms of cost and deployment speed, but its performance and reliability are generally inferior to fiber network. In Dane County, 18% of residents use some form of wireless broadband.

Wireless Broadband explores the potential of wireless solutions as an alternative to fiber-optic network buildout for providing broadband access in Dane County. Wireless solutions, either through a licensed wireless carrier or a Wireless Internet Service Provider (WISP), can be considered for addressing the immediate connectivity needs of unserved BSL locations.

Advantages of Wireless Broadband Solutions: Implementing wireless solutions for broadband access in Dane County offers several benefits:

Faster deployment: Depending on the wireless technology selected, can be deployed more quickly than fiberoptic networks, providing immediate connectivity to unserved BSL locations.

1. **Lower initial costs:** Wireless infrastructure generally requires less upfront investment than fiber-optic networks, making it a more affordable short-term option.
2. **Flexibility:** Wireless technology can be adapted to various geographical and topographical challenges, such as remote or hard-to-reach areas and can provided "bolt on" supplemental connectivity to fiber networks.

Limitations of Wireless Solutions: While wireless solutions can address immediate connectivity needs, they present several limitations as a long-term broadband strategy:

1. **Capacity and speed constraints:** Wireless networks typically offer lower capacity and slower speeds compared to fiber-optic networks, limiting their ability to support the increasing bandwidth demands of modern applications or emerging technologies. The denser the quantity of cellular devices in a service area, the more degraded the service can become, e.g., too many devices trying to connect to a single tower or base station. This can lead to a degradation of service such as dropped calls, slower data speeds or difficulty connecting to the network.
2. **Network congestion:** Wireless networks are more susceptible to congestion and interference, which can negatively impact the quality and reliability of the service. The more devices connected to a single tower introduces the potential for degradation of service. For example, fog or heavy cloud cover and reduce throughput and capacity on certain types of wireless connections.
3. **Scalability:** As the number of users and their data usage grow, wireless networks may struggle to accommodate the increased demand, requiring further, more costly infrastructure investments. To scale effectively, wireless services rely on fiber optic cable backhaul to interconnect towers and other network infrastructure.

Financial Analysis: As we see today, more and more cellular service providers are offering in-home broadband services, e.g., T-Mobile 5G home internet offering, Verizon 5G home. This financial analysis summary examines the costs associated with building a cellular network in Dane County. The construction of such a network involves various expenses, including network infrastructure, site acquisition, permits, equipment, installation, and ongoing operational costs. Licensed wireless solutions (such as cellular), currently qualifies for the latest round of BEAD funding NOFO rules and guidelines.

1. **Network Infrastructure:** A significant portion of the total cost arises from the establishment of the necessary network infrastructure. This includes building, purchasing or leasing fiber optic backhaul connections, setting up base stations, and deploying cell towers to ensure optimal coverage across the county.
2. **Site Acquisition and Permits:** Securing suitable locations for cell towers and base stations is vital to the network's performance. This process involves negotiating land leases or purchasing property, obtaining necessary zoning permits, and ensuring compliance with local regulations and environmental standards.

3. **Equipment:** The acquisition and installation of essential equipment, such as antennas, radio transceivers, power systems, and network management systems, contribute to the overall costs. These components must be compatible with the chosen network technology (e.g., 4G, 5G) and adhere to industry standards to guarantee seamless operation.
4. **Installation:** Installing the infrastructure and equipment requires skilled labor, further adding to the expense. This process includes tower construction, mounting antennas, connecting backhaul, configuring network elements, and performing tests to verify network performance.
5. **Operational Costs:** Post-installation, ongoing expenses encompass maintenance, repairs, software updates, and staff salaries. Additional costs may arise from leasing third-party facilities or contracting out certain services, such as network monitoring and customer support.
6. **Regulatory Compliance:** The private cellular network must comply with the Federal Communications Commission (FCC) regulations, which entails acquiring licenses for spectrum usage, adhering to safety standards, and meeting specific reporting requirements.

Estimating the cost of building a 5G network across 1,238 square miles requires consideration of various factors, including terrain, population density, network infrastructure, equipment, site acquisition, and regulatory compliance. Without a detailed feasibility study, it is difficult to provide an accurate cost estimate. However, as a rough approximation, the cost of deploying a 5G network can range from $150,000 to $500,000 per square mile.

Based on this approximation, the cost estimate for building a 5G network across 1,238 square miles would range from approximately $185.7 million to $619 million.

Please note that these figures are only rough estimates and can vary significantly depending on the specific circumstances of the project. Factors such as existing infrastructure, the number of cell sites required, and the availability of suitable locations for base stations and cell towers will all influence the final cost. To obtain a more accurate estimate, it is essential to conduct a thorough feasibility study and cost-benefit analysis tailored to the region.

Technology Option #2b. Unlicensed Wireless

Unlicensed fixed wireless technology provides a cost-effective alternative to traditional broadband options by utilizing free frequency bands for data transmission. This option involves the deployment of fixed wireless equipment to establish a high-speed, reliable Internet connection without requiring a wired infrastructure. This technology option focuses on unlicensed wireless solutions, including Wireless Internet Service Providers (WISPs) as an alternative to fiber-optic networks for providing broadband access in Dane County.

Advantages of Unlicensed Wireless Solutions:

1. Cost-effective: Unlicensed fixed wireless is more affordable than licensed options, as it does not require the purchase of spectrum licenses from regulatory authorities.
2. Rapid deployment: With no need for extensive infrastructure, unlicensed fixed wireless networks can be quickly deployed, often in a matter of weeks or months.
3. Scalable: The capacity of unlicensed fixed wireless networks can be easily expanded to accommodate increased demand.
4. Broad coverage: Unlicensed fixed wireless networks can provide moderate-speed Internet access to rural and underserved areas that may be challenging or expensive to serve with traditional wired infrastructure.
5. Spectrum efficiency: Utilizing underused frequency bands helps maximize spectrum efficiency and reduces potential interference with other wireless services

Limitations of Unlicensed Wireless Solutions:

1. Interference: Unlicensed fixed wireless networks may experience interference from other devices using thesame frequency bands, which can lead to degraded performance or service disruptions.
2. Line of sight: For optimal performance, a clear line of sight between the transmitter and receiver is necessary. Obstacles such as buildings or trees can reduce signal strength and reliability.
3. Limited capacity: The capacity of unlicensed fixed wireless networks can be limited by the available spectrum, which may not be sufficient to support high-demand applications or a large number of users.
4. Weather susceptibility: Unlicensed fixed wireless networks can be affected by poor weather conditions, such as heavy rain or snow, which may cause signal degradation and service disruptions.
5. Regulatory restrictions: While unlicensed fixed wireless does not require a spectrum license, operators must still adhere to local regulations and power limits, which may impact network performance.
   Financial Analysis:
   The construction of an unlicensed wireless network involves various expenses, including network infrastructure, site acquisition, permits, equipment, installation, and ongoing operational costs.
6. Initial investment: The initial investment for unlicensed fixed wireless networks is significantly lower than that of licensed alternatives, mainly due to the absence of spectrum licensing fees. However, operators will need to invest in fixed wireless equipment and infrastructure, such as towers and antennas.
7. Operating costs: Unlicensed fixed wireless networks have lower operating costs compared to wired broadband alternatives, as they do not require extensive cabling and maintenance. Nevertheless, ongoing costs include network management, equipment maintenance, and potential upgrades to accommodate future demand.
8. Return on investment: The lower initial investment and operating costs of unlicensed fixed wireless networks can result in a quicker return on investment. However, the revenue potential may be limited by factors such as interference, line of sight, and capacity constraints.
9. Funding opportunities: As of March 2023, unlicensed wireless solutions are not currently eligible for federal BEAD funding. In future rounds of federal funding programs, operators may be eligible for government grants or subsidies aimed at expanding broadband access to rural and underserved areas. Calculating the cost to build an unlicensed Wireless Internet Service Provider (WISP) solution on 1238 square miles with 5408 households requires several assumptions and estimates based on various factors, including the terrain, population density, and network technology.

Here are some possible cost estimates for building a WISP in this scenario:

Network Infrastructure: Assuming a WISP requires at least one tower per 3-mile radius, the WISP may need approximately 413 towers for a 1238 square mile area. The cost of building a single tower can range from $50,000 to $150,000, depending on the height, materials, and location. Assuming an average cost of $100,000 per tower, the total cost for building 413 towers would be $41,300,000.

Site Acquisition and Permits: Assuming the WISP can negotiate land leases or purchase property at an average cost of $10,000 per site, the total cost for site acquisition would be $4,130,000. Obtaining necessary zoning permits and ensuring compliance with local regulations and environmental standards may cost an additional $100,000 per site, totaling $41,300,000.

Equipment: Assuming the WISP needs to acquire and install essential equipment, such as antennas, radio transceivers, power systems, and network management systems, the total cost for equipment may range from $500,000 to $2,000,000 per tower, depending on the network technology and capacity. Assuming an average cost of $1,000,000 per tower, the total cost for equipment would be $413,000,000.

Installation: Assuming the WISP requires skilled labor to install the infrastructure and equipment, the total cost for installation may range from $50,000 to $200,000 per tower, depending on the complexity and location. Assuming an average cost of $100,000 per tower, the total cost for installation would be $41,300,000.

Regulatory Compliance: Assuming the WISP needs to comply with the Federal Communications Commission (FCC) regulations, the total cost for regulatory compliance may range from $10,000 to $50,000 per tower, depending on the licensing and safety requirements. Assuming an average cost of $25,000 per tower, the total cost for regulatory compliance could be estimated at $10,325,000.

Total Cost Estimate: The total cost to build a WISP on 1238 square miles with 5408 households may range from $325,505,000 to $547,225,000, depending on the network technology, capacity, and other factors. This estimate does not include marketing and customer acquisition costs, which may vary based on the competition and demand.

Technology Option #3 – Satellite Services (Low Orbit)

Satellite (low orbit) broadband services are provided through communication satellites orbiting the Earth at approximately 340 miles above the Earth's surface. These satellites receive and transmit internet signals from ground stations, allowing users in remote or hard-to-reach locations to access the internet via satellite dishes installed at their premises.

Satellite broadband is another option for delivering internet services in Dane County, especially in remote areas where other technologies may be unavailable. However, satellite services often suffer from high latency and lower speeds compared to fiber and wireless broadband options. Low orbit satellite technology has an uncertain life expectancy due to its infancy as a broadband option for residential or business service.

The satellite option examines services as a potential solution for providing internet access in Dane County's most remote locations. However, satellite technology comes with inherent limitations, such as higher latency and lower data caps. Additionally, the NTIA has determined that satellite technology is not eligible for BEAD funding.

Advantages of Satellite Broadband

Global Coverage: One of the most significant advantages of satellite broadband is its ability to provide internet access to users in remote or rural areas, where traditional wired connections are unavailable or difficult to

establish. Satellite broadband can reach virtually any location on Earth, making it an ideal solution for people living in isolated regions, travelers, or businesses with operations in multiple locations around the world.

Faster Deployment and Scalability: Satellite broadband can be deployed quickly and easily, without the need for extensive infrastructure, such as underground cables or cell towers. This allows service providers to reach new customers in a shorter timeframe and makes it possible for users to access the internet as soon as their satellite dish and modem are installed. Additionally, satellite broadband networks can be scaled up or down to meet changing demand, providing a flexible solution for businesses and communities experiencing rapid growth or fluctuations in connectivity needs.

Network Resilience and Redundancy: Satellite broadband systems are less susceptible to outages caused by natural disasters, such as earthquakes, floods, or storms, as their infrastructure is located in space rather than on the ground. This makes satellite broadband a more reliable and stable option compared to terrestrial networks, which can be disrupted by damaged cables or infrastructure. Additionally, satellite networks can serve as a backup or fail-safe option for other communication systems, ensuring uninterrupted connectivity during emergencies or unforeseen events.

Limitations of Satellite Broadband: Despite offering coverage in remote areas, satellite broadband has several limitations compared to other broadband technologies:

High latency: Due to the vast distance's signals must travel between the Earth and satellites, satellite broadband experiences higher latency (delay in data transmission) than terrestrial-based broadband solutions. This can negatively impact real-time applications such as online gaming, video streaming and video conferencing (work, telehealth, remote learning).

Lower Data Caps: Satellite broadband services typically impose lower relative data caps on users compared to wired or wireless alternatives, which may limit their usage, especially for data-intensive applications.

Weather and Space Interference: Satellite signals can be affected by weather conditions, leading to disruptions in service during heavy rain, snow, or storms. Satellites can also suffer from a variety of space interference such as solar flares and space debris. In 2022, it was widely reported 40 out of 49 recently launched Starlink satellites were "knocked out of commission by solar flares.

Higher costs: The equipment and installation costs for satellite broadband can be higher than other connectivity options, making it less affordable for some users.

Financial Analysis: The Starlink satellite network, developed by SpaceX, is designed to provide global broadband coverage rather than focusing on a specific area. Therefore, the costs associated with deploying and operating Starlink cannot be directly attributed to a specific 1,238 square mile region or a set number of households. However, an estimate of the costs incurred by the end-users, in this case, the 5,408 households, to access the Starlink service over ten years.

As of March 2023, the cost for Starlink equipment (including the satellite dish, modem, and router) was approximately $599 per household. Please note that these costs may change over time due to technological advancements and economies of scale.

Assuming the equipment cost remains constant, the total cost for the 5,408 households would be:

5,408 households * $599 = $3,239,392

Over the course of 10 years, the customer premise equipment (CPE) is estimated to be replaced twice and that figure would double to approximately $6.5M.

It is important to note that these calculations are based on the pricing information available as of March 2023 and do not account for potential changes in pricing, technological advancements, or regional factors that could impact the costs. Additionally, these figures do not include any costs associated with installation, maintenance, or upgrades to the equipment or service.

This also does not consider the availability of service in any one location.

Broadband Expansion Coordination & Expansion

Continued support from AECOM will consist of coordinating with Dane County to prioritize and implement recommendations from the Broadband Infrastructure Assessment Final Report, maintain awareness and monitor status of state and federal grants and help local communities in their broadband expansion goals. Additionally, work will take place on Dane County's BEAD 5-year plan contribution for submission to Wisconsin's Broadband Office. It will be imperative to work directly with the state to reconcile broadband availability challenges and understand BEAD funding allocations for Dane County.

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Telecommunication Providers

Dane County, WI, hosts a number of prominent Internet Service Providers (ISPs). The ISPs in this region include Charter Spectrum, AT&T, TDS Telecom, CenturyLink, and Frontier Communications. These ISPs are aware of the digital divide in Dane County and have proposed various initiatives to tackle this issue, such as implementing strategies to update or upgrade its aging infrastructure and extend services to underserved areas.

Charter Spectrum:
Charter Spectrum is one of the largest ISPs in Dane County, offering services ranging from basic internet plans to high-speed broadband and fiber optics. To solve the issue of aging infrastructure, Charter Spectrum is investing heavily in upgrading its network from traditional coaxial cable to more advanced fiber-optic technology. They also plan to extend fiber lines to more remote areas of Dane County.

Charter Spectrum has established the "Spectrum Internet Assist" program to tackle the digital divide, offering high-speed internet at an affordable rate for lowincome families and senior citizens. Moreover, to reach unserved and underserved areas, Charter Spectrum has the "Rural Spectrum Strategy", deploying new wireless spectrum technology to provide high-speed broadband to challenging rural areas.

ISP	Services Offered	Infrastructure Plan	Program for Low-Income Families	Strategy for Underserved Areas
Charter Spectrum	Broadband, Fiber Optics	Upgrading to Fiber Optics	Spectrum Internet Assist	Rural Spectrum Strategy
AT&T	DSL, Fiber, Fixed Wireless	Replacing Copper with Fiber	AT&T Access Program	Using FWI Technology
TDS Telecom	DSL, Fiber Optics	Upgrading to Fiber Optics	None Specified	Connected Communities
CenturyLink	DSL, Fiber Optics	Upgrading to Fiber Optics	Lifeline Program	Infrastructure Development
Frontier Communications	DSL, Fiber	Upgrading to Fiber Optics	Lifeline Service	Connect America Program
Mt. Horeb Telephone Co.	Broadband, Fiber	Increasing Broadband	Financial Assistance Program	Public Wi-Fi Hotspots

AT&T:
AT&T is another major ISP in Dane County, offering DSL, fiber optics, and fixed wireless internet services. AT&T is taking steps to replace its older copper-based systems with fiber-optic technology, enhancing the quality of internet services and expanding capacity.
AT&T addresses the digital divide through the "AT&T Access Program", providing low-cost internet services to qualifying low-income households. For unserved and underserved communities, AT&T is using Fixed Wireless Internet (FWI) technology, transmitting a signal from an existing cell tower to a fixed antenna on the customer's home. This approach provides a home internet connection even in remote locations lacking wired infrastructure.

TDS Telecom:
TDS Telecom provides DSL and fiber optic services to Dane County residents, including urban and some rural areas. TDS Telecom is engaged in a long-term project to replace its aging infrastructure with advanced fiber-optic technology.

TDS has initiated a program called "Connected Communities", investing in infrastructure development in rural and underserved areas. The aim is to increase access to high-speed broadband services. They have also

developed public Wi-Fi hotspots to provide internet services to communities that lack home-based internet access.

CenturyLink:
CenturyLink serves parts of Dane County with DSL and fiber optic services. CenturyLink is focusing on upgrading its infrastructure by converting its DSL-based network to fiber-optics, increasing internet speed and service reliability.

CenturyLink's "Lifeline Program" provides a monthly discount on internet services for eligible low-income customers. The company also actively participates in infrastructure development projects aimed at expanding coverage to underserved areas. Their "Price for Life" program offers affordable, high-speed internet services with a price that won't change as long as the customer keeps their plan.

Frontier Communications:
Frontier Communications provides DSL services to parts of Dane County, with an emphasis on rural areas. Frontier has been implementing a plan to modernize their existing DSL infrastructure by investing in fiber-optic networks.

Frontier's "Connect America" program is a significant step towards resolving the digital divide. It focuses on expanding broadband access to rural areas. They also provide a "Lifeline" service, a federal assistance program that makes communication services more affordable for low-income customers. To serve unserved and underserved areas, Frontier is using funds from the Federal Communications Commission's (FCC) Connect America Fund to build out broadband services to these underserved areas in Dane County.

Mt. Horeb Telephone Company:

In an attempt to bridge the digital divide, Mt. Horeb Telephone Company has been proactive in developing a comprehensive strategy. This includes increasing its investment in broadband infrastructure to underserved areas, offering affordable high-speed internet packages, and partnering with local schools and community centers to create public Wi-Fi hotspots. They are also running digital literacy programs aimed at educating communities on the benefits and usage of internet technology. Furthermore, they have established a financial assistance program for lower-income households to ensure they can afford reliable internet service.
Through these initiatives, Mt. Horeb Telephone Company aims to ensure that all members of their community have equitable access to the digital world.

Name	Technology	Advertised Download Speed	Monthly Subscription	Notes
AT&T Wisconsin	DSL/Fiber	Up to 1Gbps	$55 - $80	Introductory Pricing
Bertram Internet	Fixed Wireless	1.5 Mbps to 25Mbps	$50 - $145	
BugTusselWireless	Fixed Wireless	Up to 50 Mbps	$40 - $150	
Call One, Inc.	Fiber	No Public Information*		Business
CBTS Technology Solutions, LLC	Fiber	No Public Information*	No Public Information*	Private Fiber Network

CenturyLink/Lumen	Fiber	No Public Information*	No Public Information*	Dark Fiber/Business Services
Compudyne	Fiber	No Public Information*	No Public Information*	Private Fiber Network
Consolidated Communications	Fiber	No Public Information*	No Public Information*	ISP in other states,
Crown Castle Fiber	Fiber	No Public Information*	No Public Information*	Dark Fiber/Cell Node Owner
EarthLink Business, LLC	Fixed Wireless	No Public Information*	No Public Information*	Reseller
Frontier Communications	DSL	10 - 115 Mbps	No Public Information*	
Fusion Cloud Services, Inc.	Fiber	No Public Information*	No Public Information*	Birch Communications Business Services
GCI Communication Corp.	Fiber	No Public Information*	No Public Information*	Alaska ISP - Unsure of the Presence
HughesNet	Satellite	Up to 25 Mbps	$50 - $150	
LiteWire	P2P?	Unadvertised	$35 - $150	
Logix Communications	Fiber	No Public Information*	No Public Information*	Business Internet Provider
MCI	Fiber	No Public Information*	No Public Information*	Verizon Owned - Long Haul
McLeod USA Telecommunications Services, LLC	Fiber	No Public Information*	No Public Information*	Windstream Owned - Long Haul
Mt Horeb Telephone Company	DSL/Fiber	Up to 2Gbps	$60 - $150	
MUFN	Fiber	No Public Information*	No Public Information*	
Netwurx LLC	Fixed Wireless	Up to 100 Mbps	$63 - $150	
PATEC Business Services	Fiber	No Public Information*	No Public Information*	Business Internet Provider
Spectrum/Charter Communications	Cable/Fiber	Up to 1Gbps	$50 - $130	

Tailwind Voice and Data	Fiber	No Public Information*	No Public Information*	Business Internet Provider
TDS Telecom/metrocom	DSL/Fiber	Up to 2Gbps	$40 - $150	
T-Mobile 5G Home Internet	Fixed Wireless	33 - 245 Mbps	$50	Limited Availbility and Speed
TPx Communications	Fiber	No Public Information*	No Public Information*	Business Internet Provider
Upnetwi	Fixed Wireless/Fiber	10 Mbps - 1 Gbps	$67 - $152	Limited Availbility and Speed
US Cellular	Fixed Wireless	Up to 300 Mbps	$30 - $50	Limited Availbility and Speed
US Signal Company	Fiber	No Public Information*	No Public Information*	Business Internet Provider
Viasat	Satellite	Up to 30 Mbps	$70 - $150	

Voyant Communications	Fiber	No Public Information*	No Public Information*	Business Internet Provider
VSAT Systems	Satellite	No Public Information*	No Public Information*	Business Satellite Provider
*	Carriers that either provide business service, dark fiber service, or other service. All of these services are done by quote only. There is no public speed or subscription information.			

Community Engagement

Taking place over the course of numerous months across various town in Dane County, town hall meetings and broadband listening sessions were held with community leaders and citizens, which captured and highlighted the varying levels of satisfaction, challenges, feedback and ambitions related to improved broadband connectivity and affordability. It provided key elements for the recommendation's roadmap of the specific areas of focus for future broadband development projects, targeted areas of expansion for private service providers and the reality of broadband gaps in these communities.

The Broadband Listening Sessions, a platform for dialogue with local leaders, emphasized the power of open discussion in understanding, capturing and ideating on ways to address broadband issues. Its success advocated for the continuation of such exchanges and facilitated a dynamic discourse to generate solution oriented discussions. Much of the local, community feedback was produced during the Broadband Listing Sessions, a practice that should continue a regular and frequent interval throughout the funding cycle of state and federal grant programs. The Towns listed below are a few examples of the in person and virtual engagement sessions that took place over the course of the project.

In Stoughton, the city is undertaking an ambitious plan to bolster its broadband infrastructure by incorporating fiber optic cables across every street. The scale of this endeavor points towards a substantial commitment and awareness to improving connectivity for all residents. This initiative, if successful, may position Stoughton as a leader in the county's broadband landscape, and aligns with the city's Smart City initiative.

In the Town of Berry, Mike Theis is leveraging his expertise in telecommunications grant writing to address connectivity issues by helping craft and evaluate grant language. His efforts underscore the importance of strategic collaborations and the potential impact of grant funding in addressing such infrastructural challenges. The lack of clarity about the collective status of grant applications throughout Dane County necessitates ongoing communication with the local communities to bring forth seamless and coordinated execution and transparency.

In contrast, The Town of Perry's broadband infrastructure can be classified as typical for a smaller town, aging and legacy equipment to serve the town hall. This illustrates a picture of significant infrastructure challenges that require immediate attention and partnership with either Dane County or private service providers to update or upgrade their connectivity infrastructure. The recent partnership with the local non-profit, The Madison Group Consultants, represents a significant step in addressing these challenges. It also underscores the potential role that Dane County could play in supporting such initiatives, both technically and financially.

The Town of Westport and Town of Oregon highlight the importance of nuanced understandings of local broadband needs. Despite the perception that most of
Westport is adequately served, there are still numerous pockets of the community that are not receiving sufficient service. Similarly, Oregon has specific regions underserved by existing broadband services. These cases

- underscore the importance of more granular assessments needing to be performed to identify areas in need and allocate resources effectively.

Lastly, the Town of Rutland presents an example of dissatisfaction with a service provider, illustrating the importance of holding service providers accountable and the necessity of ongoing negotiations to bridge digital gaps. It emphasizes the importance of transparency, consistency, and accountability from service providers and more importantly the role of the County to partner with local communities to bring forth real change in the broadband landscape.

Overall, the local coordination efforts paint a varied and diverse picture of the state of broadband infrastructure across various towns in Dane County, each with their unique and locally specific needs, challenges, and potential solutions. Unfortunately, there is no one solution to fix all, highlighting the importance of Dane County to continue to work with and partner with the local communities to create a consistent expectation of broadband access and affordability across the entire footprint of the County. It serves as a reminder of the need for Dane County to continue its concerted broadband expansion efforts, build strategic private and public sector partnerships, perform further granular analysis, and facilitate future open discussions in improving the state of broadband connectivity across these communities.

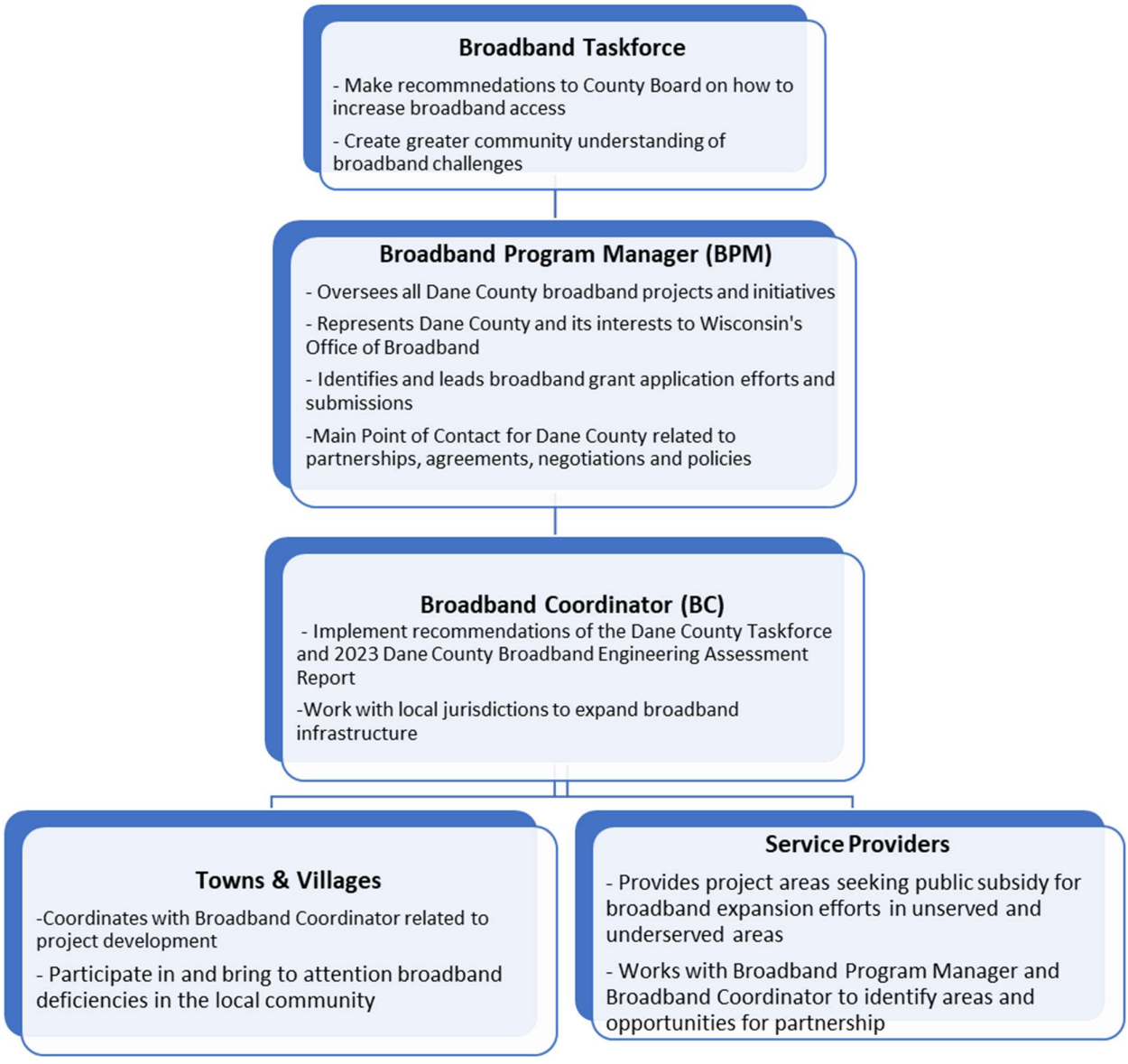
Recommendations

Universal connectivity refers to the aspiration to provide all individuals, regardless of their geographic location, socio-economic status, or other distinguishing characteristics, with access to reliable and affordable high-speed

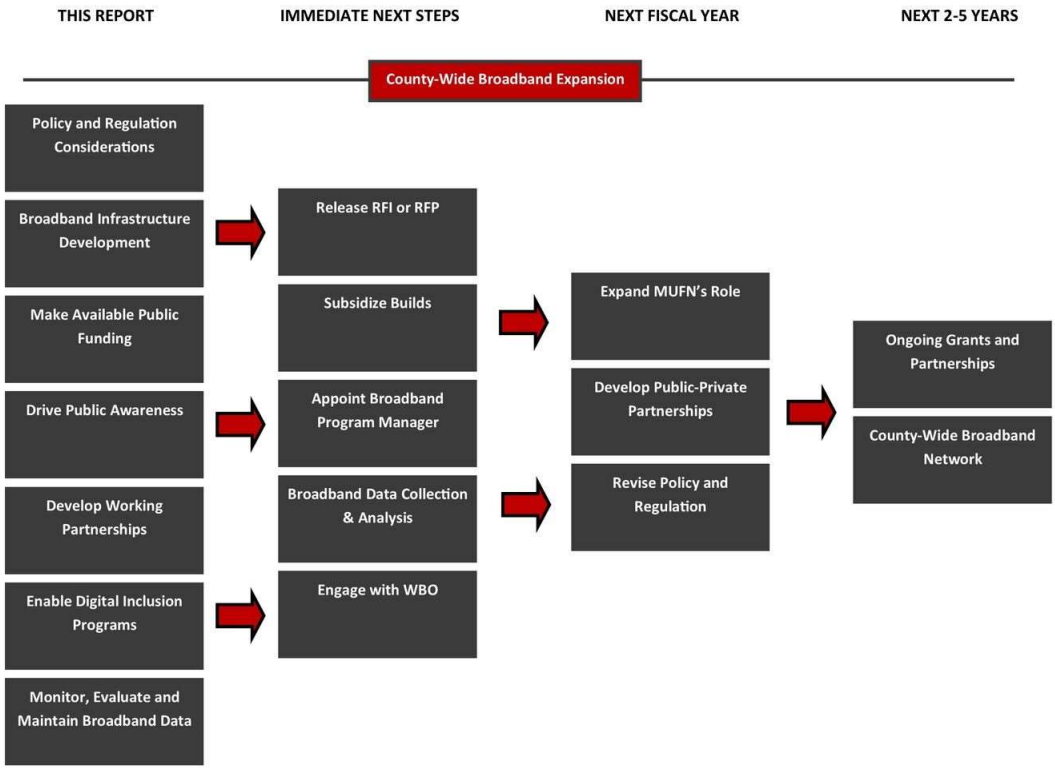
internet services. The core concept behind this is to eliminate the digital divide that exists in societies across the globe, fostering an environment where everyone has equal opportunity to participate in the economy and benefit from the advancements of the digital age. Bridging the broadband divide is foundational to closing the digital divide.

In the context of Dane County, Wisconsin, universal connectivity can play a substantial role in elevating the county's societal, educational, and economic status. By ensuring that all residents, businesses, and institutions have access to high-speed internet, the county can stimulate economic development, enhance access to educational and healthcare services, and enable the full participation of its citizens into the digital economy. Given the fractured nature of broadband availability and cohesiveness in the county and the goal of universal connectivity to solve this complex issue, it will take a multi-pronged and comprehensive approach.

The findings from this report can help Dane County move directly into the next steps of broadband expansion and facilitation. While each of these immediate next steps and recommendations have interdependencies, they can be performed in parallel.



Next Steps



1. **Policy and Regulation:** It is recommended that Dane County create or revise policies and regulations that incentivize the expansion of broadband infrastructure. These would include subsidies for companies that extend their services to unserved and under-served areas, create a more simplified permitting processes for broadband infrastructure expansion, work with the state to revise the definition of minimally accepted broadband service speeds, and develop public-private partnership initiatives. Additionally, these policies and regulation changes can help with transparency and policy updates to further enable universal broadband access.
2. **Subsidies for Companies:** The county government can provide financial incentives to internet service providers to encourage the building of fiber optic cable infrastructure in areas that currently lack adequate broadband speeds and service. In the form of direct subsidies, tax breaks, or other forms of financial support, a county might offer a subsidy for every new broadband connection that a company installs in an unserved or underserved area. These incentives could be particularly effective if they are tiered or targeted based on the needs and speeds of specific areas (passing larger percentages of unserved homes and businesses,

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the greater the subsidy) . For example, higher subsidies might be provided for installations in rural or low-income areas where the market may not otherwise provide adequate service.

3. **Simplified Permitting Processes:** The process of installing new broadband infrastructure often involves obtaining numerous permits and navigating complex regulatory processes. By simplifying these processes, Dane County can reduce the cost and time required for companies to expand their services. For instance, a "one-stop-shop" **f**or permits could be established, streamlining the process and reducing the bureaucracy companies need to wade through. In addition, the government could consider implementing "dig once" policies, which coordinate infrastructure projects so that broadband fiber is installed whenever streets are opened for other construction projects, reducing costs and disruptions.
4. **Public-Private Partnerships:** By forming partnerships with private companies, Dane County can leverage the resources and expertise of the private sector while still ensuring that public needs and goals are met. These partnerships might involve shared funding for infrastructure projects, collaborative planning processes, joint builds, or agreements that provide companies with access to public resources (like utility poles or public rights of way) in exchange for commitments to serve unserved and underserved areas. This could involve establishing service quality standards, setting affordable pricing requirements, or requiring companies to offer service to all residents within a designated area. In Westminster, Maryland, the city has partnered with Ting to provide the use of the City's owned infrastructure for a negotiated fee, this public-private partnership began in 2015 and continues today.
5. **Transparency and Accountability Measures:** To ensure that these policies are achieving their intended effects, the government should establish mechanisms to monitor and report on the progress of broadband expansion. This might include regular public reporting on the number of new broadband connections, public facing project dashboard providing status and progress, including the quality of service provided, the level of customer satisfaction and where broadband expansion will be taking place.
6. **Legal Frameworks:** The government should also consider legal frameworks that support broadband expansion and affordability. This could involve local ordinances that require new developments to include broadband infrastructure or zoning laws that allow for the construction of necessary physical infrastructure like cell towers or fiber ready conduit infrastructure for new home developments. Additionally, modifying and updating current state laws to align with the goals of expanding broadband infrastructure by a public sector or public/private consortium entity. Allowing a public sector entity to own its own broadband infrastructure can allow the use of private sector service providers to utilize that infrastructure for a fee which can help reduce capital costs of private service providers while enabling cost effective connectivity for its CAIs.
7. **Infrastructure Development:** It is recommended Dane County spearhead the development of the necessary infrastructure for internet connectivity. This can involve constructing fiber-optic networks, wireless towers, and other necessary physical structures.
8. **Broadband-Ready Building Policies**: As part of its infrastructure development efforts, Dane County could mandate that all new residential and commercial constructions are "broadband-ready." This means they should be equipped with the necessary broadband use conduit(s), internal wiring and other infrastructure to

meet a minimum standard of 100Mbps/100Mbps symmetrical service. This forward-looking policy could help future-proof the public's ability to connect to consistent and equitable services throughout Dane County.

9. **Subterranean Conduit Infrastructure:** Dane County could mandate the installation of empty conduit during the construction of new roads or renovation of existing ones. These conduits can later be filled with fiberoptic cables, significantly reducing the cost and disruption of future broadband expansion efforts. This effort would be in partnership with Wisconsin's Department of Transportation to understand where road projects will be taking place, alerting private service providers and monitoring those projects for participation.
10. **Shared Infrastructure Agreements:** Dane County could explore agreements that allow internet service providers to use existing infrastructure, such as utility poles railroad or public buildings, to install broadband infrastructure. This can significantly reduce the cost and time required for broadband expansion. These agreements can also enable supplemental wireless technologies to enhance broadband connectivity for both consumer and government services.
11. **Public Wi-Fi Hotspots:** Public Wi-Fi can provide a valuable service to residents who lack home internet or have limited data plans. Dane County could invest in creating public Wi-Fi hotspots in parks, libraries, and other public places. These hotspots can help bridge the digital divide and provide an essential service to residents.
12. **Fiber-Optic Networks:** Fiber-optic cables, which use light to transmit data, offer the fastest and most reliable internet connection. Dane County could take a direct role in building out a fiber-optic network, especially in underserved areas, connecting community anchor institutions (CAIs), while passing unserved and underserved homes. This might involve investing county funds in construction, creating a countyowned internet service provider, or forming partnerships with private companies to construct the necessary infrastructure. It's worth noting that the initial costs can be high, but the long-term cost savings and cost avoidance benefits often outweigh the short-term capital outlay. This publicly owned infrastructure can also be leased (either conduit or fiber) for the private sector use while at the same time, connecting schools, libraries, government buildings and higher education buildings. Numerous counties across the nation, have taken this step, savings millions and avoiding costs for higher bandwidth services that are provisioned from the private service providers. Carroll County, Maryland, the Carroll County Public Network (CCPN) has a publicly owned 160-mile fiber optic network that serves the CAIs while at the same time facilitates the use of the same infrastructure to private sector service providers. This middle mile infrastructure enables the private sector to get to hard to reach unserved and underserved homes and businesses.
13. **Metropolitan Unified Fiber Network (MUFN):** Focused on collaborating with CAIs, MUFN could take on a larger role in expanding broadband infrastructure throughout Dane County. By expanding its infrastructure and continued private sector service provider partnership, there could be cost savings to lessen the fiber footprint needed to expand high-speed services throughout Dane County.
14. **Wireless Towers:** For areas where laying fiber-optic cable might not be feasible, such as very rural or remote areas, wireless internet can be an effective, short or intermediate terms solution. Dane County could support the construction of wireless internet towers, which can transmit internet signals over long distances. The county could work to streamline the permitting and zoning process for these towers and could consider offering financial incentives to companies that build them in unserved or underserved areas.

15. **Public Funding:** It is recommended the county allocate public funds (ARPA, BEAD, CPF and other state and local grants) to initiatives aimed at expanding internet access. This could include grants or loans for companies willing to provide internet service in unserved and underserved areas or subsidies for low-income households.
16. **Grants or Loans for Service Providers:** Dane County could establish a fund to provide grants or low interest loans to internet service providers that are willing to expand their service to unserved or underserved areas. These funds could be used to offset the high cost of building new infrastructure and could be particularly helpful for smaller, local service providers that may not have the financial capacity of the larger, national service providers. The provisioning of these funds could be conditional upon meeting certain service standards, require certain thresholds to be met for project completion, offer low-cost service options or mandate minimum service coverage areas. *We are recommending that Dane County issue a Request for Information (RFI) to solicit public interest by eligible service providers to help solve the digital divide in Dane County. The RFI will help identify where service providers need public subsidy to serve hard to reach homes and businesses and quantify what that cost would be for both the service providers and the county. Additionally, the areas that are identified can be shared and coordinated with Wisconsin's Broadband Office to confirm inclusion into the BEAD 5 Year Plan.*
17. **Subsidies for Low-Income Households:** Broadband access is not just a matter of infrastructure, it's also a question of affordability. Dane County could establish a subsidy program to help low-income households afford high-speed internet service and the tools needed to connect. This could take the form of direct subsidies that reduce the monthly cost of service, require service providers to offer a low-cost service option, provide devices to eligible families or a voucher program that households can use to pay their internet bill. A similar approach to the free and reduced school lunch program has been used in other Counties across the country and the county could evaluate similar evaluation metrics to identify eligible households and families.
18. **Publicly Funded Infrastructure Projects:** Dane County could use public funds to directly invest in the construction of or to subsidize broadband expansion. This might involve building a county-owned enhancing existing fiber-optic networks, constructing wireless internet towers, or installing broadband conduit during road construction projects. While these projects could require significant upfront investment, they can also have long-term cost benefits in terms of improving connectivity, enhancing public safety and attracting new businesses to all parts of the county.
19. **Broadband for Community Anchor Institutions (CAIs):** Schools, libraries, healthcare facilities, and other public institutions play a crucial role in local communities. By ensuring these institutions have access to high-speed and reliable broadband, Dane County can support digital learning, telehealth services, public WiFi hotspots, digital literacy and other important digital initiatives, public funds allocated specifically for the purpose of CAI connectivity, ensures these critical community hubs remain connected at higher speeds.

20. **Broadband Expansion Coordination, Planning and Implementation:** Part of the allocated public funds should be used to support the research, planning and implementation of effectively expanding broadband access and affordability across Dane County. This would involve continued and consistent broadband expansion coordination, additional targeted studies and granular analysis based on the most up to date funding and mapping data, more direct and involved local and state coordination efforts and the oversight of broadband expansion projects throughout Dane County. A single point of contact should be identified and serve in the role as Broadband Program Manager. This position will be the face of Dane County when it comes to all interactions at the local, state and federal level. This position is focused on continued strategic planning, stakeholder engagement, partnerships and negotiations, and program evaluation and monitoring. Pointed and sustained coordination and advocacy with Wisconsin's Broadband Office should occur on a regular and recurring basis, focusing on how Dane County fits into the state's BEAD 5 Year Plan. In support of this role, the currently advertised Broadband Coordinator role should be focused on implementation, specifically, the tasking from plans, community engagement and outreach, and data analysis and reporting.
21. **Public Awareness:** It is recommended Dane County take an active role in educating its residents about the importance of internet connectivity and digital literacy. This can be done through public awareness campaigns and community education programs.
22. **Public Awareness Campaigns:** One of the first steps Dane County can take is to launch public awareness campaigns about the importance of internet connectivity and how it contributes to education, employment, healthcare, and other essential aspects of modern life. These campaigns could utilize various media platforms — from local newspapers and radio to social media and county websites — to reach as wide an audience as possible and could take place onsite at designated locations so eligible residents can learn how to apply for the Affordable Connectivity Program (ACP).
23. **Community Education Programs:** Dane County could develop and implement community education programs aimed at enhancing digital literacy among residents. These programs could cover a range of topics from basic computer skills to more advanced subjects like online privacy and cybersecurity. The County could partner with local schools, libraries, and community centers to deliver these programs.
24. **Promotion of Publicly Funded Internet Services:** As Dane County works on expanding its internet infrastructure and accessibility, it's crucial that residents are aware of the services available to them. This could involve publicizing any subsidies or discount programs for low-income households, spreading awareness of public Wi-Fi hotspots, or informing residents about new internet services in their area. Digital **Divide Awareness:** A crucial part of this public awareness initiative would involve highlighting the digital divide and its impacts. Dane County could use statistical data and personal stories to show how a lack of internet access can disadvantage residents, particularly those in rural areas, low-income households, and seniors.
25. **Online Safety Education:** The internet, while being a source of limitless information and opportunities, also has its share of risks, including identity theft, online scams, and cyberbullying. Dane County could establish programs to educate residents about these risks and how to protect themselves online.
26. **Public Forums and Town Hall Meetings:** To involve residents in the process and to hear their thoughts and concerns, Dane County should continue to host public forums, Broadband Listening Sessions and participate in local town hall meetings focused on broadband access and digital literacy. These forums could serve as a platform for residents to voice their needs and for the county to communicate their efforts and plans in expanding internet connectivity.

27. **Partnerships:** It is recommended the county form partnerships with ISPs, tech companies, nonprofit organizations, and other entities to facilitate internet access. This can result in collaborative efforts to extend broadband services and develop innovative solutions to connectivity challenges.
28. **Collaborations with Tech Companies:** Tech companies, especially those involved in developing connectivity solutions, could provide valuable expertise and resources. Dane County could partner with these companies to pilot new technologies, such as wireless broadband or satellite internet, especially in areas where traditional wired broadband is impractical. Additionally, tech companies could support digital literacy programs, providing devices, software, or training materials.
29. **Nonprofit Organizations and Community Groups:** These entities often have a deep understanding of local needs and challenges and can be valuable allies in reaching out to the community. Dane County could work with nonprofit organizations on initiatives like digital literacy training, community outreach, and providing affordable internet options to low-income families.
30. **Academic Institutions:** Dane County could partner with local universities and colleges to conduct research on the digital divide, explore innovative solutions, and provide digital literacy programs. Students could also be engaged in service-learning projects to help expand broadband access and digital literacy in the county.
31. **Inter-County and Regional Cooperation:** Collaborating with neighboring counties or regional entities can result in shared resources, joint advocacy at the state or federal level, and coordinated efforts that address larger regional connectivity challenges. This can be particularly effective in addressing issues that cross county lines, such as connecting rural areas.

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32. **Digital Inclusion Programs:** It is recommended Dane County implement programs aimed at increasing digital inclusion. These might include providing affordable devices to low-income households, offering free or discounted internet services, and providing training and education on digital skills.
33. **Affordable Devices for Low-Income Households:** One of the barriers to digital inclusion is the cost of devices. Dane County could partner with tech companies or local businesses to provide discounted or refurbished devices to low-income households. This can help ensure that families have the necessary hardware to access the internet.
34. **Discounted or Free Internet Services:** Access to the internet can be expensive, particularly for low-income households. Dane County could negotiate with ISPs to offer discounted services for these households. The county could also consider setting up its own municipal broadband network and providing free or subsidized service to residents who meet certain income criteria.
35. **Digital Skills Training:** Even with access to the internet and devices, people need to know how to use them effectively. Dane County could create programs to provide training and education on digital skills. This could cover everything from basic computer skills and internet navigation to more advanced topics like online safety and privacy.
36. **Community Digital Literacy Centers:** These centers can provide a physical space where residents can go to access the internet, learn new digital skills, and receive tech support. Dane County could establish these centers in partnership with local libraries, schools, or community centers.
37. **Outreach to Seniors and Other Underserved Groups**: Certain groups, such as seniors, individuals with disabilities, non-English speakers, and other Justice 40 may face additional barriers to digital inclusion. Dane County could create specialized programs to reach these groups, such as senior-friendly digital literacy courses or multilingual tech support.
38. **Public Wi-Fi Hotspots:** For residents who lack home internet or have limited data plans, public Wi-Fi can provide a valuable service. Dane County could invest in creating public Wi-Fi hotspots in parks, libraries, and other public spaces. These hotspots can help bridge the digital divide and provide an essential service to residents.
39. **Digital Inclusion Initiatives:** As part of its infrastructure development efforts, Dane County could establish programs to ensure that all residents not only have access to broadband but are also equipped with the necessary devices and skills to use it. This might involve partnerships with technology companies to provide discounted devices, programs to offer affordable home internet service, or digital literacy training to help residents make the most of the internet. Beyond the physical infrastructure, it is essential to ensure that residents have the skills and knowledge necessary to use the internet effectively. This includes understanding how to safely navigate the internet, use online services, and protect personal information. The county could establish digital literacy programs and partner with local schools, libraries, and community organizations to deliver this training.

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40. **School-Based Programs:** Schools are a natural place to promote digital inclusion. Dane County could work with local school districts to ensure students have home internet access and the devices they need for digital learning. They could also incorporate digital literacy into the curriculum.
41. **Monitoring and Evaluation:** It is recommended that the county continues to track, monitor and maintain awareness of broadband expansion efforts throughout the entire county. It plays a significant role in the progress of connectivity initiatives. By keeping track of changes in connectivity levels, identifying areas where access is lacking, and adjusting strategies based on the results, the county can facilitate efforts to achieve universal connectivity and remain effective and responsive to the community's needs.
42. **Data Collection and Analysis:** Dane County should establish regular data collection mechanisms to measure the extent of ongoing internet coverage, the speed and reliability of connections, and the number of residents with access to high-speed internet. This data needs to be constantly analyzed to identify areas of the county where connectivity is still lacking and guide strategic planning for future infrastructure investments.
43. **Surveys and Feedback Mechanisms:** Surveys should be used to gather real-time and county-wide feedback from residents about their internet access and usage. This feedback will offer valuable insights into the effectiveness of the county's connectivity initiatives, the quality of service provided by ISPs, and the specific needs and challenges of different communities.
44. **Performance Indicators:** Dane County should establish a set of key performance indicators (KPIs) to evaluate the progress of its connectivity initiatives. These might include the percentage of residents with access to high-speed internet, the average internet speed across the county, or the number of public WiFi hotspots.
45. **Monitoring of Partnership Agreements:** If Dane County enters into partnership agreements with ISPs or other entities, it will be important to monitor these agreements to ensure the partners are meeting their obligations. This might involve regular progress reports, site inspections, or performance audits. Dane County should identify a county resource to monitor, maintain and negotiate P3 agreements, resource share agreements (RSAs) or memorandums of understanding (MOUs).
46. **Evaluating Digital Inclusion Programs:** In addition to monitoring infrastructure expansion, Dane County should evaluate the effectiveness of its digital inclusion programs. This would involve tracking participation rates, measuring improvements in digital literacy, or surveying participants about their experiences.
47. **Adjusting Strategies Based on Results:** The purpose of monitoring and evaluation is not just to track progress, but to inform future decision-making. If the data shows that certain strategies are not working as well as expected, Dane County should be prepared to adjust its approach. This could involve reallocating resources, exploring new technologies, or forming new partnerships.

Prioritized Recommendations

Recommendations Table

Description	Timeframe	Goals of Taskforce (GT)	Taskforce Recommendations (TR)	Stakeholder Needs (SN)
Subsidies for Companies	Short Term	GT-2	TR-1, TR-2, TR-4	SN-1, SN-4
Simplified Permitting Processes	Short Term	GT-2	TR-1	SN-1
Public-Private Partnerships	Long Term		TR-1, TR-2, TR-4	SN-1
Transparency and Accountability	Long Term	GT-2	TR-2	SN-1
Legal Frameworks	Long Term	GT-2		SN-1
Infrastructure Development				
Broadband-Ready Building Policies	Long Term	GT-2	TR-1, TR-2	SN-1, SN-2
Subterranean Conduit Infrastructure	Long Term	GT-2	TR-1	SN-1, SN-2
Shared Infrastructure Agreements	Long Term	GT-2	TR-1, TR-2	SN-1, SN-2
Public Wi-Fi Hotspots	Long Term		TR-1, TR3	SN3, SN-1, SN-4
Fiber-Optic Networks	Long Term		TR-1, TR-2	SN-1
Metropolitan Unified Fiber Network	Long Term		TR-1	SN-1
Wireless Towers	Long Term		TR-1, TR3	SN3, SN-1
Public Funding				
Grants or Loans for Service Providers	Long Term	TR-1, TR-4	SN-1	
Subsidies for Low-Income Households	Short Term		TR-2, TR-4	SN-1, SN-4
Publicly Funded Infrastructure Projects	Long Term	GT-2, GT-3	TR-4	SN-1, SN-2, SN-4
Broadband for Public Institutions	Long Term		TR-1, TR-4	SN-1, SN-4
Broadband Expansion Coordination, Planning and Implementation	Short Term	GT-1, GT-2, GT-3	TR3, TR-4	SN3, SN-1, SN-2
Public Awareness				
Public Awareness Campaigns	Short Term	GT-1, GT-3		SN-1
Community Education Programs	Short Term	GT-3	TR-2	SN-1
Promotion of Publicly Funded Internet Services	Short Term	GT-1, GT-3	TR-2, TR-4	SN-1
Digital Divide Awareness	Short Term	GT-3	TR-2	SN-1
Online Safety Education	Long Term	GT-3	TR-2	SN-1
Public Forums and Town Hall Meetings	Short Term	GT-1, GT-3	TR-2	SN-1
Partnerships				
Collaborations with Tech Companies	Long Term	GT-2	TR-1, TR-2, TR3, TR-4, TR-5	SN3, SN-1, SN-2
Nonprofit Organizations and Community Groups	Long Term	GT-2	TR-1, TR-2, TR3, TR-4	SN3, SN-1, SN-2
Academic Institutions	Long Term	GT-2	TR-1, TR-2	SN-1, SN-2
Inter-County and Regional Cooperation	Long Term	GT-2	TR-1, TR-2, TR-5	SN-1, SN-2
Digital Inclusion Programs				
Affordable Devices for Low-Income	Short Term		TR-1, TR-4	SN-1, SN-4

Goals	
Goals of Taskforce	
GT-1	1. Create a greater understanding of broadband challenges in Dane County
GT-2	2. Prepare local partners to apply for grant funding
GT-3	3. Increase awareness of issues related to day-to-day internet access
Taskforce Recommendations	
TR-1	1. Internet Service Provider Collaboration
TR-2	2. Outreach, Education and Alliance Building
TR-3	3. Interim Methods to Provide Service
TR-4	4. Funding and Research
TR-5	5. Advocacy
Stakeholder Needs	
SN-1	1. Improve broadband across the County
SN-2	2. Support municipalities as they prepare and seek grants
SN-3	3. Alternative methods of deploying broadband
SN-4	4. Funding sources

Affordable Devices for Low-Income Households	Short Term		TR-1, TR-4	SN-1, SN-4
Discounted or Free Internet Services	Short Term		TR-1, TR3, TR-4	SN3, SN-1, SN-4
Digital Skills Training	Short Term		TR-1, TR3	SN3, SN-1, SN-4
Community Digital Literacy Centers	Long Term		TR-1, TR-4	SN-1, SN-4
Outreach to Seniors and Other Underserved Groups	Short Term	GT-1, GT-3	TR1, TR-4, TR-5	SN-1, SN-4
Public Wi-Fi Hotspots	Long Term		TR-1, TR3, TR-4	SN3, SN-1, SN-4
Digital Inclusion Initiatives	Long Term	GT-1, GT-3	TR1, TR-4, TR-5	SN-1, SN-4
School-Based Programs	Long Term		TR-4, TR-5	SN-1, SN-4
Monitoring and Evaluation				
Data Collection and Analysis	Short Term	GT-1, GT-2, GT-3	TR1, TR-4	SN-1, SN-2
Surveys and Feedback Mechanisms	Short Term	GT-1, GT-3	TR1, TR-4	SN-1
Performance Indicators	Long Term	GT-1, GT-3	TR1, TR-4	SN-1
Monitoring of Partnership Agree-	Long Term	GT-2, GT-3	TR1, TR-4	SN-1, SN-2
Evaluating Digital Inclusion Programs	Long Term	GT-1, GT-3	TR1, TR-4	SN-1
Adjusting Strategies Based on Results	Long Term	GT-2, GT-3	TR1, TR-4	SN-1, SN-2

Addendum 1 – Case Studies

Case Study #1 - Carroll County Public Network (CCPN)

County Owned and Operated Broadband and Middle Mile Network, Westminster, MD

Overview

The Carroll County Public Network (CCPN) initiative entailed a collaborative approach involving various county agencies who undertook the establishment of a consortium for the development and expansion of a broadband infrastructure to serve county, local and state agencies, and provide extra fiber capacity for leasing to private service providers.

The CCPN consortium includes Carroll County Government, Carroll County Public Schools, Carroll County Public Library, and Carroll Community College. Owning and managing a county-wide fiber optic network, the CCPN has under its wing approximately 160 miles of county-owned backbone fiber and links over 125 government, school, library, municipality, first responder, and community college sites.

The CCPN consortium has yielded numerous benefits, including:

1. Boosting productivity and reducing operating costs through economies of scale, distance learning capabilities, disaster recovery/business continuity, enhanced mobility, voice network evolution, multi-media content and collaborative services, centralized technology management & support, security/public safety, and connection to county and state resources.

2. Enhancing teaching and learning environments, improving communication and collaboration, and introducing dark fiber leasing and public-private partnerships.

3. Offering continuous network maintenance and support, providing multiple services from a single interface, and ensuring connectivity to major carrier hotels in the region.

4. Providing last-mile services to unserved and underserved residents and businesses and enhancing geographic Tier 1 ISP provider diversity.

Key Performance Metrics

Some of the critical measures reflecting the success of the CCPN project include:

1. Installation of 160 miles of backbone fiber and connection of 125 community anchor institutions including schools, government locations, libraries, community college, public safety, and 8 municipality sites.
2. Significant cost avoidance with annual savings of approximately $900,000, previously paid to 3rd party voice/data service providers.
3. Provision of 1Gb & 10Gb availability to community anchor institution sites.
4. Completion of the original project within a three-year timeline.
5. Successful Resource Sharing Agreement (RSA) with networkMaryland™, providing redundant 10Gb ISP connections in exchange for dark fiber sharing.

Case Study #2 – City of Westminster and Ting FTTx Community Connectivity Model

FTTx Public – Private Partnership, Westminster, MD

Background

Westminster, Maryland, is a small city of around 20,000 inhabitants located about 35 miles northwest of Baltimore. The city officials realized that their broadband infrastructure was aging and could no longer support the digital demands of their residents and businesses. Recognizing the importance of high-speed internet in stimulating local economic development, the City decided to invest in its own Fiber-to-the-Premises (FTTP) network.

In 2015, Westminster officials partnered with Ting Internet, a division of Tucows, a Toronto-based publicly traded internet services company, to develop and operate the new fiber optic network. The partnership was set up as a public-private partnership (PPP) with the City owning the infrastructure and Ting leasing it to provide the actual services to residents and businesses.

Implementation:

Under the agreement, Westminster would finance and own the dark fiber network while Ting would lease the network's capacity, light the fiber, provide the customer equipment, and handle customer service and billing. This approach allows Westminster to focus on what it does best – building and maintaining infrastructure – while leaving the service delivery to the experts at Ting.

As part of the agreement, Ting pays a lease to the City based on the number of users it connects to the network, providing Westminster with a return on its investment. In addition, the city gets a state-of-the-art, municipally owned network that could attract new businesses and residents, stimulate local economic growth, and potentially be leased to other internet service providers in the future.

Outcomes:

The public-private partnership between Westminster and Ting has been largely successful. As of mid-2023, most residents and businesses in Westminster have access to gigabit internet service, with speeds up to 1,000 Mbps for both upload and download – much faster than what was previously available in the area.

The network has spurred local economic development by attracting new businesses that require high-speed internet to operate efficiently. Existing businesses have also benefited, with many reporting improved productivity due to the faster and more reliable internet service.

Challenges:

While the partnership has been successful, it has not been without challenges. Financing the network required significant upfront investment from the City, and there were some delays in construction due to the complexity of building a city-wide fiber network.

Also, while the partnership with Ting allowed Westminster to avoid many of the challenges associated with operating an internet service, it did give the City less direct control over pricing and service quality.

Lessons Learned:

The Westminster-Ting partnership provides a model for other small cities looking to improve their broadband infrastructure. Key lessons learned include:

- PPPs can be an effective way to finance and operate municipal broadband networks.
- Cities should carefully select their private partners, looking for companies with experience in delivering highquality internet service.
- The importance of local buy-in and ongoing communication with residents and businesses throughout the process.
- With careful planning and a strong partnership, small cities can successfully develop their own high-speed internet networks, promoting local economic development and improving the quality of life for their residents.

Case Study #3 – Smartest Street in America

Smart City Infrastructure

Background

The Middlefield Road Smart Corridor initiative in San Mateo County, California, is a visionary project focused on designing and executing a future-proofed, intelligent infrastructure system. This ambitious project aimed to harness Smart City architecture and IoT technologies to enhance corridor connectivity, government services, and public WiFi, ultimately improving the quality of life for its local community.

The selected area for this initiative was a segment of Middlefield Road, where the goal was to optimize the entire "Middlefield Road Experience". The core objectives involved focusing on arrival, connecting and engaging with citizens, improving health and safety, stimulating economic development, and leveraging data to influence policy.

The project's multi-faceted requirements necessitated coordination with multiple stakeholders, technology vendors, Public Works, Civil and Construction Management Teams, and the General Contractor. Together, they defined the technology architecture and established its feasibility for integrating the requested Smart City and IoT infrastructure. The outcome was a comprehensive plan for telecommunication carrier connectivity, including site surveys, existing drawings/specifications, client's design standards, client's use cases, device specifications, schedule, and budget.

This collaboration resulted in a thorough evaluation of the current broadband infrastructure and alignment of project goals with potential Smart City technology solutions. Regular meetings with stakeholder groups, technology vendors, and the general contractor ensured all key goals were met for residents, businesses, and visitors.

The project also required the exploration of synergies with other access technologies such as Passive Optical Networking, 5G, CBRS, and private LTE services.

As a result, a strategic technology plan was devised for the fiber-optic infrastructure's implementation and its integration with communication technologies.

The project will implement approximately 6,400 feet of county-owned fiber optic cable, connect more than 24 IoT devices and provide public broadband access to unserved and underserved residents.

Middlefield Road has become one of the "Smartest Streets in America", ensuring a brighter, more connected future for the San Mateo community.


COUNTY of DANE
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