



CORNING



# Meeting the Needs of Rural Subscribers for Generations to Come

## INTRODUCTION

In today's fast-paced, highly connected world, next-generation technologies are essential to ensure that subscribers can take full advantage of the latest voice, video, and data capabilities while maintaining a secure experience. Among these technologies, fiber stands out as the best overall solution for providing a superior user experience and a sustainable future. While wireless, satellite, and coaxial technologies can meet many next-generation communication needs in areas where fiber is not economic to deploy, fiber offers unparalleled benefits. In contrast, legacy copper networks are no longer sustainable, and they are increasingly incapable of securely providing the voice, video, and data capabilities subscribers need and want, and therefore, are not sustainable over the long term.

## OVERVIEW

Our world is moving rapidly, and our lives are more connected than ever before. We rely on the internet for our most essential activities, from setting up medical appointments to conducting banking transactions to completing school homework and research. We also depend on the internet to deliver streaming multimedia, gaming, and entertainment services. And it plays a critical role in public safety and as the backbone for "smart" everything technologies. In a word, the internet enables all manner of connectedness for society, governments, and commerce. While some applications can be performed on networks with very low bandwidth capacity and speed—like copper, the vast majority of today's (and tomorrow's) use cases require high bandwidth capable networks that are highly reliable and secure. Importantly for American competitiveness and digital fairness, those who lack access to high-speed networks will increasingly find it difficult to keep up and fall behind.

This paper discusses the most critical services and applications that subscribers need and desire today and the way different network providers deliver them, and describes some of the technical requirements for service delivery relevant to policymakers and other stakeholders. In addition, this paper will examine the most used communication technologies—copper, fiber, wireless, low Earth orbiting ("LEO") satellite, and coaxial cable—and evaluate their ability to meet current and future application requirements and user needs. By the end of this paper, readers will understand that whatever its historic utility, copper does not and will not meet society's or the economy's needs now or tomorrow due to its lack of reliability, availability, and security. Newer technologies meet today's needs while addressing future requirements to varying degrees. But in the end, fiber is clearly the superior choice for service providers to ensure needs are met for generations to come.

## SUBSCRIBER SERVICES AND THEIR USAGE

Traditionally, connectivity has been discussed in terms of three primary components: voice, video, and data. These elements have formed the backbone of communication technologies, enabling people to interact, share information, and access entertainment.

- Voice communication, initially facilitated by landline telephones, has evolved with the advent of mobile phones and Voice over Internet Protocol (VoIP) services
- Video connectivity has transformed from traditional broadcast television to streaming services, allowing users to watch content on-demand
- Data connectivity, encompassing internet access and online services, has become increasingly vital for everyday activities, from browsing the web to conducting business transactions

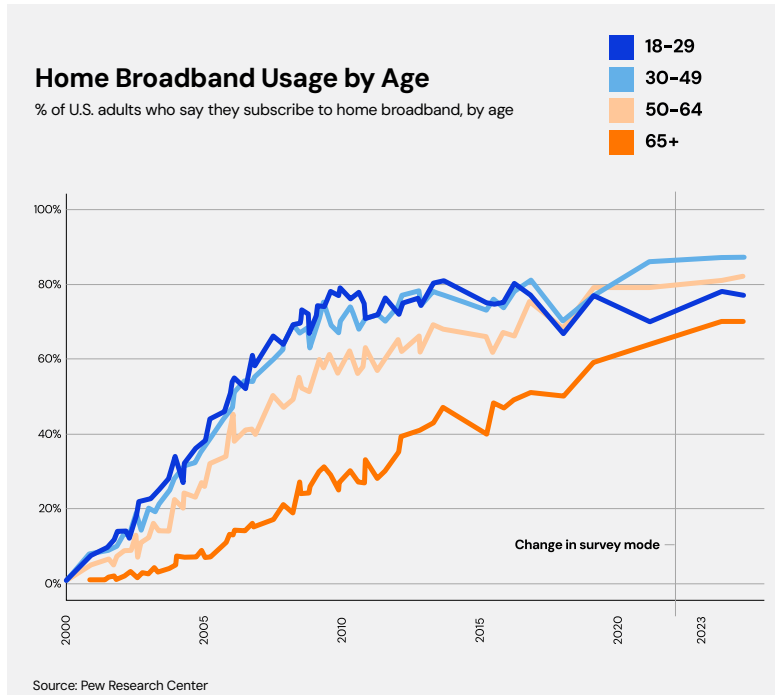
Together, these three components have shaped the way we connect and communicate in the modern world.

In recent years, subscriber usage of connectivity—more commonly called broadband services today—has undergone significant changes, driven by technological advancements and evolving consumer needs. According to the Cisco Annual Internet Report, 2018–2023 there were on average 13.6 devices per capita in North America and that number continues to grow. This surge in connected devices has strained home networks, leading to a higher demand for new networking solutions. The COVID-19 pandemic further accelerated this trend, as businesses sought solutions to support a remote workforce, crossing both enterprise and residential markets. Consequently, there has been a significant increase in demand for both download and upload speeds to enable tasks such as video conferencing.

The **Center on Rural Innovation (CORI)** provides additional insights into the changing landscape of broadband usage. Between 2015 and 2020, there was a 26 percentage point increase in broadband access at 25/3 Mbps speeds and a 49 percentage point increase in high-speed access at 100/20 Mbps speeds in rural areas. This growth in broadband access has been driven by the need for reliable and high-speed internet connections to support various online activities, including remote work, virtual learning, and streaming services. The share of the rural population with fiber access doubled from 20% to 40% during this period, highlighting the increasing adoption of fiber-optic technology as a solution for high-speed internet.

The share of the rural population with fiber access doubled from 20% to 40% between 2015 and 2020

The **Pew Research Center** has documented the growth and distribution of internet and home broadband usage in the United States over the past 20 years. According to their data, the share of U.S. adults with high-speed broadband service at home increased rapidly between 2000 and 2010, and this growth continues today. As of 2024, 79% of U.S. adults say they subscribe to a broadband internet service at home with the most rapidly growing age group being the age 65+ group.



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The **Fiber Broadband Association's** report on the status of U.S. broadband highlights the growing preference for fiber broadband. By the end of 2022, there were 63 million unique homes with access to Fiber-To-The-Home (FTTH), indicating significant progress towards the goal of connecting every American by 2030.

Overall, these references illustrate the evolving trends in broadband usage, with a growing emphasis on higher speeds, increased connectivity, and the adoption of advanced technologies like fiber optics. As consumers continue to rely on the internet for a wide range of activities, the demand for reliable and high-speed broadband services is expected to remain strong.

In the following sections we will explore how subscribers' trends are impacting each of the traditional service options of voice, video and data.

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## VOICE

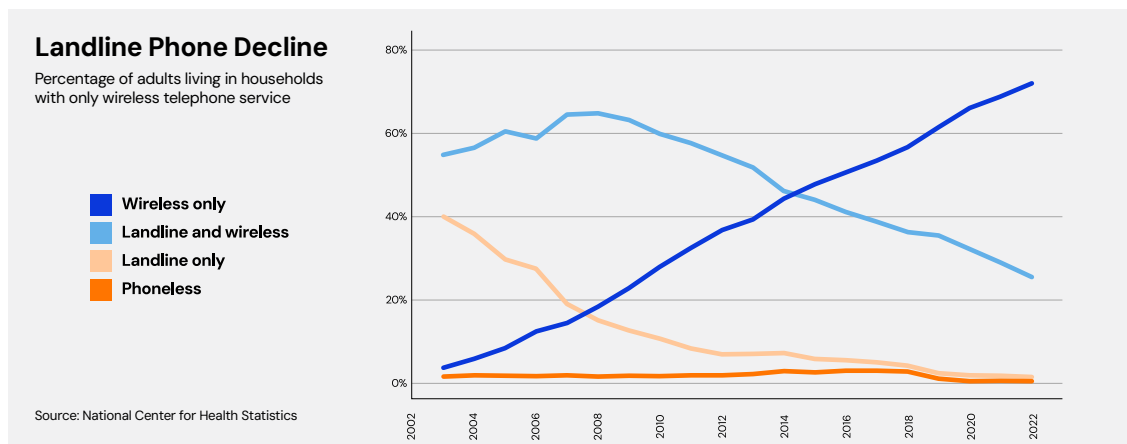
### The Decline of Traditional Plain Old Telephone Services

In recent years, traditional Plain Old Telephone Services (POTS) have experienced a significant decline in use. This trend can be attributed to several factors, including the rise of wireless technology, the decline in copper network performance and customer satisfaction due to aging infrastructure and the lack of replacement components, the increasing popularity of Voice over Internet Protocol (VoIP) services, and the overall shift towards more advanced and versatile communication methods.

### The Rise of Wireless Technology

One of the primary reasons for the decline of POTS is the widespread adoption of wireless technology. According to recent statistics, over 76%<sup>1</sup> of adults now rely solely on wireless phones, while only 1.3%<sup>1</sup> of adults continue to use a traditional analog POTS phone only. Wireless technology offers greater mobility and convenience, allowing users to make and receive calls from virtually anywhere. This flexibility has made wireless phones the preferred choice for many consumers, leading to a dramatic decrease in the demand for traditional landline services.

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### The Decline of Copper Networks

Copper networks, designed long before the internet era to deliver POTS, are facing significant challenges due to their aging infrastructure. These networks are expensive to maintain and offer slower data speeds compared to modern alternatives. As the infrastructure continues to age, finding replacement parts for these systems has become increasingly difficult making repairs and restoration of service more challenging, lengthy, and costly. The lengthy repair times significantly impact those using relying on copper-based POTS, leaving them out of service and unable to make phone calls for days or longer. Consequently, many service providers are looking to transition to more reliable and efficient technologies, such as fiber optics, to meet the growing demands of today's highly connected world.

<sup>1</sup> National Center for Health Statistics Wireless Substitution: Early Release of Estimates from the National Health Interview Survey, July – December 2023

## The Popularity of VoIP Services

Another significant factor contributing to the decline of POTS is the increasing popularity of Voice over Internet Protocol (VoIP) services. VoIP technology allows users to make voice calls using a broadband internet connection instead of a traditional copper phone line. VoIP offers several advantages over POTS. VoIP services are digitized and transmitted across the network/Internet as data, thereby increasing their reliability due to the greater redundancy built into digital networks. VoIP services also are lower in cost to operate because of multiple factors, including the elimination of legacy copper plant and switching equipment. Outdated POTS switching technology requires large buildings to house the equipment and consumes significantly more energy to power them than the digital equipment used for VoIP. For subscribers VoIP services provide enhanced features, including portability which has helped drive remote work and work-from-home. As a result, many consumers and businesses have transitioned away from traditional copper services to digital (VoIP) services as well as video applications like Zoom and Microsoft Teams.

## Shift Towards Advanced Communication Methods

The overall shift towards more advanced and versatile communication methods has also played a role in the decline of POTS. Modern communication technologies offer a wide range of features that traditional copper landlines cannot match. For example, video conferencing, instant messaging, and file sharing have become integral parts of everyday communication. These advanced methods of communication provide a richer and more interactive experience compared to traditional voice calls. As consumers and businesses continue to embrace these technologies, the reliance on POTS has diminished significantly.

## Regional Trends and Future Outlook

Regional trends further illustrate the decline of traditional POTS services. In the Northeast United States, for example, a significant number of users still combine wireless and landline services. This is primarily due to the early rollout of Verizon FIOS, which offered a “bundle” VoIP fiber-based landline phone with the internet service. (Washington Post, 2023) Thus, FIOS customers landline and data (internet) services both operated over fiber infrastructure instead of copper. Fewer than 25% of homes still have landlines, and more are prevalent in the Northeast, but because of Verizon’s FIO deployment many of them are actually fiber based versus copper based. (USA Today , 2024)

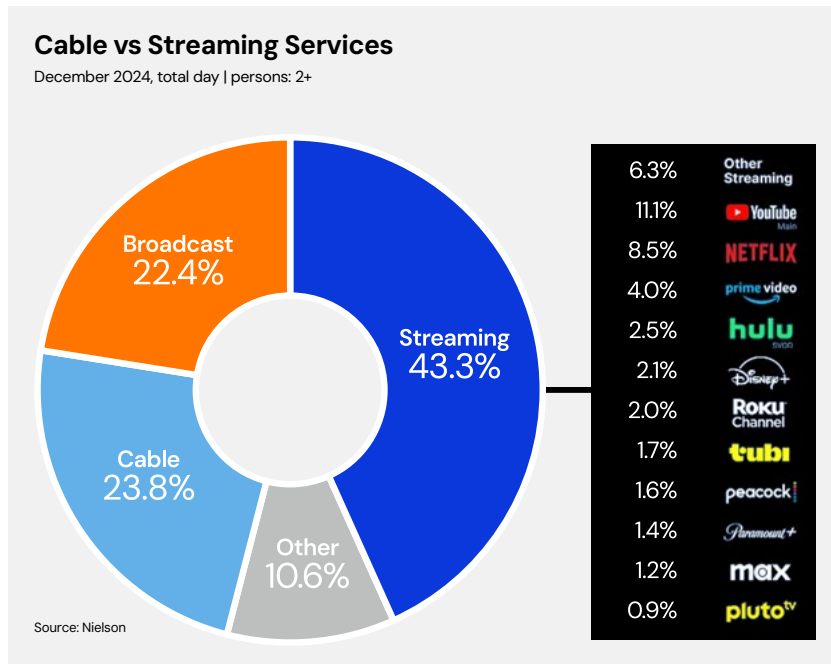
Recognizing the finite utility of copper-based landline networks, the United Kingdom, is taking drastic measures to turn off the entire copper-based landline network by 2027, completely transitioning away from traditional POTS. (British Telecom, 2025)

The decline of traditional POTS is driven by the rise of wireless technology, the popularity of VoIP services which can be run over fiber or wireless technologies, and the overall shift towards more advanced fiber-based communication methods. As technology continues to evolve, the reliance on traditional copper landlines will continue to decline, paving the way for more innovative and versatile communication solutions.

The United Kingdom is taking more drastic measures. British Telecom, for instance, plans to turn off the entire copper-based landline network by 2027

## The Changing Landscape of Traditional Cable Services to Streaming Services

In recent years, the landscape of television services has undergone a significant transformation. Traditional cable TV services, once the dominant method of delivering television content, has seen a steady decline in viewership. Traditional cable TV services are now reduced to only 23.8% of video content consumed according to Nielson. This shift is largely due to the rise of streaming services, which offer greater flexibility, convenience, and a wider range of content options.



Traditional cable TV services are now reduced to only 23.8% of video content consumed according to Nielson

## The Rise of YouTubeTV

One of the most significant developments in the shift from traditional cable to streaming services is the rise of YouTubeTV. Set to become the top US Pay TV provider by 2026, YouTubeTV offers both broadcast and streaming options for subscribers. This service allows viewers to access their local news, sports, and favorite shows without the need for a traditional cable subscription. However, unlike traditional cable TV, YouTubeTV requires a broadband internet connection to function. To watch standard definition programming, subscribers need an internet connection that provides at least 3 Mbps of bandwidth. For high-definition (HD) content, a minimum of 7 Mbps is required. Sports enthusiasts who wish to watch multiple streams simultaneously will need at least 13 Mbps to ensure a smooth viewing experience. To experience 4K Ultra HD then 25 Mbps is required. Each of these is per TV or streaming device.

For a household with a family of four that has multiple TVs and kids using streaming devices, the bandwidth requirements can quickly add up. Additionally, other activities such as online gaming and video conferencing also consume bandwidth, with online gaming requiring approximately 3-6 Mbps and video conferencing needing 2-3 Mbps per call. Considering these various uses, a household today with multiple TVs and streaming devices would need a minimum of a 100 Mbps broadband connection to ensure a smooth, simultaneous and uninterrupted internet experience.



## Advantages of Streaming Services

Streaming services like YouTubeTV offer several benefits over traditional cable TV. They provide flexibility, allowing on-demand viewing at any time, and are often cheaper than cable subscriptions. Streaming platforms also have a wide range of content for diverse preferences.

Cable TV usually costs between \$74.99 and \$217.42 per month, depending on the provider. In contrast, YouTube TV is more affordable at \$82.99 per month. (Cord Cutter News, 2024)

## The Importance of Speed and Security in Broadband Data

In today's digital age, broadband data has become an essential part of our daily lives. From streaming videos and online gaming to remote work and virtual learning, the demand for high-speed and secure internet connections has never been greater. The quality of the subscriber experience is heavily influenced by three critical factors: speed, security and reliability.

### Speed: The Backbone of Modern Connectivity

Broadband speed is a crucial determinant of the overall user experience. It affects how quickly users can access information, stream content, and perform online tasks. According to recent data, the average internet speed in the United States is 219 Mbps for downloads and 24 Mbps for uploads. (USA Today, 2024) This speed is sufficient for most household activities, including streaming high-definition videos, participating in video conferences, and online gaming across multiple devices.

However, as discussed above the speed or bandwidth required even for today's use cases can vary based on the specific applications used, the number of people in the household and number of devices connected.

### Security: Protecting Users in the Digital World

While speed is essential, security is equally critical in providing a positive broadband experience. With the increasing prevalence of online activities, the risk of cyber threats and online fraud has also risen. Over 43% of people have experienced online fraud, and it is expected that between 2023 and 2027, individuals might lose up to \$343 billion due to online payment fraud. (Fintech & Payments, 2022) This is a significant concern, especially for vulnerable populations such as seniors.

Cyber threats have a significant impact on broadband connectivity, affecting both service providers and subscribers. As cyberattacks become increasingly more sophisticated, they can cause service disruptions, data breaches, and ultimately lead to financial losses. Because of this, broadband service providers (BSPs) deploy robust security measures to help protect their networks and subscribers from cyber-based criminal activities.

### Reliability: Users Expect an Always On Experience

At home, a reliable broadband connection is essential. It helps ensure uninterrupted streaming of high-definition videos, smooth participation in video conferences, and seamless online gaming. In addition, it facilitates seamless access to online education platforms, allowing students to learn without technical disruptions. It also enables access to other home essentials, like e-commerce, online banking, remote medicine and government services. Users expect these services to be available when they want to access them and more importantly when they are needed.

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Over 43% of people have experienced online fraud

## TECHNOLOGIES USED TO DELIVER THOSE SERVICES

### Fiber Optic Internet

Fiber optic broadband is widely regarded as the best and most sustainable option for internet connectivity, offering numerous advantages over traditional technologies like copper and coaxial cables. One of the key benefits of fiber optic broadband is its ability to provide extremely fast symmetrical speeds for both downloading and uploading. This high-speed connectivity is essential for modern applications such as streaming high-definition videos, online gaming, and video conferencing. Fiber optic cables can carry vast amounts of bandwidth, with the potential to support speeds of up to 50 Terabits ensuring its viability for many generations to come. This makes fiber an ideal choice for households and businesses that require reliable and high-speed internet access.

In addition to its speed, fiber optic broadband is also the most sustainable option for the future. Fiber optic cables are made from silicon dioxide, an abundant and easily accessible raw material with minimal environmental impacts during extraction. Fiber optic networks consume significantly less electricity compared to traditional copper networks, resulting in a lower carbon footprint. This energy efficiency is due to the superior data transmission capabilities of fiber optics, which generate minimal heat and reduce the need for energy-intensive cooling systems in data centers and network infrastructures. It has been shown that fiber optic services used 80%<sup>2</sup> less energy than copper services when considering energy usage per access point. Calix, a platform, cloud and managed services company that has been helping broadband service providers for over 25 years to deploy over both copper and fiber, supports this data. In addition, Calix own data showing that when you consider newer more energy efficient equipment in the network and updated network architectures the savings can be as high as 94%.

As service providers decommission copper networks, they must also upgrade their voice solutions from the traditional analog plain old telephone systems to new VoIP systems. These legacy voice systems take up a large amount of space and power. One service provider, AltaFiber has determined that its legacy voice systems use on average 36% of the power at their many central office locations throughout the network. They have turned down 74 of these systems to date saving over 12 million kilowatt hours of power having a 5.8% impact on green house gases used by the company.

Another significant advantage of fiber optic broadband is its long-term cost-effectiveness. While the initial installation costs of fiber networks can be higher than those of traditional technologies, the long-term benefits far outweigh these initial expenses. Fiber optic cables are constructed from robust materials that can last decades, reducing the need for frequent replacements and maintenance. This longevity translates to lower operational costs over time, making fiber a more economical choice in the long run. Additionally, fiber networks are less susceptible to interference and signal loss, ensuring a more reliable, secure and consistent internet connection. This reliability further contributes to the overall cost savings, as fewer resources are needed for repairs and troubleshooting.

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Fiber optic cables are constructed from robust materials that can last up to 100 years

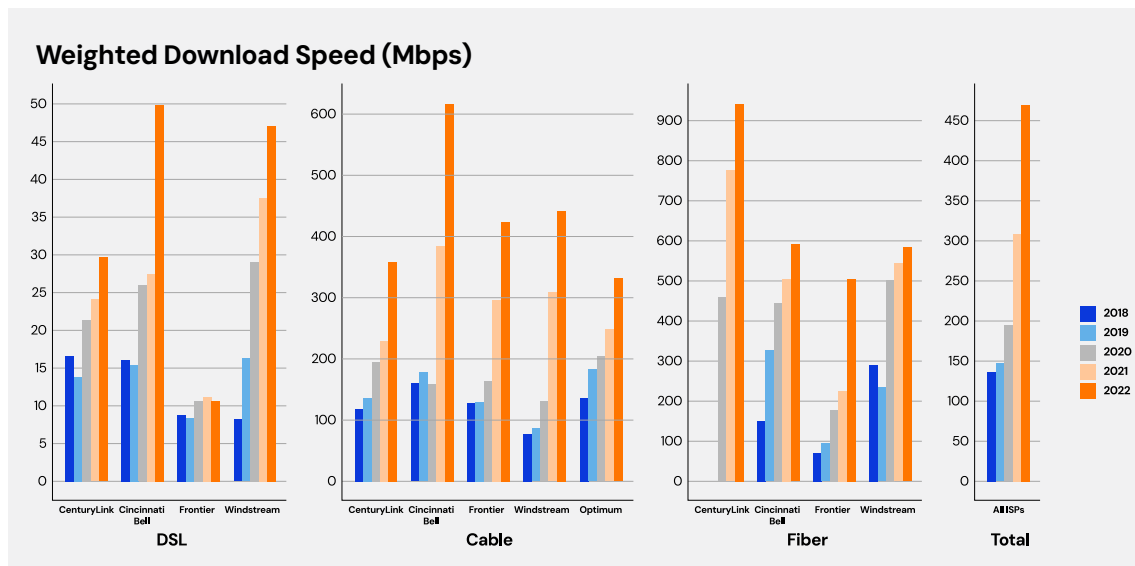
<sup>2</sup> Greener Connections: Understanding the Environmental Impacts of Fiber and Copper Communications Networks



## Copper

Copper has been a foundational technology for broadband and voice services for many decades. One of the primary advantages of copper is its widespread availability and established infrastructure. Copper phone lines, which have been in use for over a century, are capable of carrying voice signals and data. However, the bandwidth capacity of copper is limited. Bandwidths of over 200 Mbps are achievable but at distances less than 600 meters. This limitation makes copper less suitable for modern high-speed internet demands, where higher bandwidth is essential for activities like streaming, online gaming, and video conferencing.

In the recent **Federal Communications Commission (FCC)**'s Measuring Fixed Broadband report, the FCC provided insights into the performance of different broadband technologies. The report notes that the speed achievable by DSL depends on the distance between the subscriber and the central office and is substantially less than the speeds available from cable-based and fiber-based broadband.



In terms of security, copper networks are more susceptible to interference and signal degradation compared to fiber optics. Copper cables can be affected by electromagnetic interference (EMI) and radio frequency interference (RFI), which can compromise the quality and security of the data transmission this can be mitigated somewhat with good installation practices<sup>3</sup>. Additionally, copper networks are more prone to physical damage and wear over time, leading to increased maintenance costs and potential service disruptions. AT&T estimates that it is reasonable to expect roughly \$5 billion of private and public telco investment will go into the maintenance of outdated copper networks in just the state of California over the next five years<sup>4</sup>. The combination of the maintenance costs and the downtime required to make needed repairs makes copper less reliable compared to newer technologies like fiber optics, which offer better resistance to interference and physical damage.

From a sustainability perspective, copper has several disadvantages. The extraction and processing of copper is energy-intensive and has significant environmental impacts. Mining copper involves the removal of large amounts of earth, which can lead to habitat destruction and soil erosion. Additionally, the production process generates greenhouse gas emissions and other pollutants. In contrast, fiber optic cables are made from silicon dioxide, an abundant

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There were nearly 4000 incidents of copper-related theft and vandalism during a three month period in 2024

<sup>3</sup> Fiber vs Copper Cabling: Comparing Performance & Cost

<sup>4</sup> Progressive Policy Institute: The Opportunity Cost of Maintaining Copper Networks in California. Nov 2023

and environmentally friendly material. Fiber optics also consume less electricity and have a longer lifespan, making them a more sustainable option for broadband and voice services. The costs of mining copper and the ease of accessing it along streets and outside homes and buildings has increased copper prices significantly making it a target of theft. When the copper that is in service is stolen the telephone company must replace it which means customers can be out of service for a substantial amount of time. There were nearly 4000 incidents of theft and vandalism during a three-month period in 2024 impacting a wide variety of services including residential voice and data<sup>5</sup>.

Several companies are actively retiring their copper networks in favor of more advanced technologies. For example, Brightspeed is transitioning from copper to fiber to reach 4 million (Fierce Network, 2024) residential and business customers. This multi-billion-dollar upgrade aims to provide faster, more reliable, and secure internet services. Similarly, British Telecom (BT) in the United Kingdom plans to turn off its entire copper network by 2027, (British Telecom, 2025) signaling a complete transition away from traditional copper-based services. Verizon has indicated that when it switched to fiber in New York, it saw a 60% reduction in energy and maintenance, including a reduction in truck rolls in the area. (Light Reading, 2015) But the more important result of Verizon's switch to fiber in New York was that subscribers saw a 90% increase in the reliability of their service<sup>6</sup>. These initiatives and results highlight the reason why the industry must shift towards more secure, reliable, sustainable and efficient technologies.

## Fixed Wireless Internet

Fixed wireless internet is an increasingly popular option for providing broadband connectivity, especially in underserved and rural areas. One of the primary advantages of fixed wireless internet is its ability to deliver high-speed internet without the need for extensive cable infrastructure. This makes it a cost-effective and quick solution for areas where laying fiber would be prohibitively expensive. Fixed wireless internet can offer speeds comparable to those of traditional wired connections, with some providers offering speeds of up to 1 Gbps. This makes it suitable for a wide range of applications, from streaming high-definition videos to online gaming and remote work.

However, fixed wireless internet also has its limitations. One of the main challenges is the need for a clear line of sight between the transmitter and receiver. This means that any physical obstructions, such as buildings or trees, can interfere with the signal and reduce the quality of the connection. Fixed wireless internet can also be susceptible to weather conditions, such as heavy rain or snow, which can impact the reliability of the service. Another disadvantage is that the cost per unit of bandwidth tends to be higher compared to other types of broadband, which can make it less economical in the long run. (Insight into Fixed Wireless Access – Pros and Cons, 2023)

## Line of Sight Connections



Verizon has indicated that when it switched to fiber in New York, it saw a 60% reduction in maintenance & subscribers saw a 90% increase in the reliability of their service

<sup>5</sup> Broadband Breakfast: Protecting the Nation's Critical Communications Infrastructure from Theft & Vandalism

<sup>6</sup> RAMBOLL: Greener Connections: Understanding the Environmental Impacts of Fiber and Copper Communications



In terms of security, fixed wireless internet can offer enhanced security features, such as encryption and secure access protocols, to protect data transmitted over the network. However, like any wireless technology, it is still vulnerable to certain types of cyber threats, such as signal interception and unauthorized access. It is essential for providers to implement robust security measures to safeguard user data and ensure a secure browsing experience. Despite these challenges, fixed wireless internet can provide a reliable backup for businesses and connect users in remote areas without the need for cables.

From a sustainability perspective, fixed wireless internet has several advantages. It eliminates the need for extensive digging and installation of cables, which can have significant cost and environmental impact. By using existing cell towers and infrastructure, fixed wireless internet can reduce the carbon footprint associated with deploying new broadband networks. Additionally, the technology can be easily scaled and expanded to new subscribers within the range of the network, making it a flexible and sustainable solution for providing broadband access. However, the long-term sustainability of fixed wireless internet depends on the continued development and deployment of advanced technologies, such as 5G or 6G, and the availability of adequate wireless spectrum, to ensure it can meet the growing demand for high-speed internet.

## Satellite Internet

Low Earth Orbiting (LEO) satellites have emerged as another promising solution for providing broadband internet access, especially in remote and underserved rural areas. One of the primary advantages of LEO satellites is their ability to offer lower latency as compared to traditional geostationary satellites. LEO satellites orbit at altitudes ranging from 500 to 1,500 kilometers above the Earth, resulting in a shorter signal travel time and reduced latency, typically around 25–60 milliseconds. This makes LEO satellites suitable for real-time applications such as video conferencing and online gaming. Services like Starlink and Amazon's Project Kuiper are leveraging this technology to provide high-speed internet with download speeds ranging from 50 Mbps to 220 Mbps for Starlink (Starlink, 2025) and while Project Kuiper is not providing service yet, they indicate they will achieve up to 400 Mbps.

However, LEO satellites also have their disadvantages. One significant challenge is the need for a large number of satellites to provide continuous coverage. Due to their lower altitude, each LEO satellite covers a smaller area of the Earth's surface, necessitating a constellation of thousands of satellites to ensure global coverage. Today's coverage by LEO satellites supports one housing unit per square mile at the bandwidth of 100 Mbps downstream/20 Mbps upstream per a recent Cartesian research study partnered with Fiber Broadband Association. These limitations make the deployment and maintenance of LEO satellite networks costly and complex<sup>7</sup>. Additionally, LEO satellites have a shorter lifespan, typically around 5 to 8 years, compared to geostationary satellites, which can last up to 15 years<sup>3</sup>. This requires frequent replacements and increases the overall cost of maintaining the network. Beyond these disadvantages, subscribers may also find it challenging depending on location to get a clear signal due to obstructions like trees and buildings as the satellite signal works best with a clear line of sight.

Today's  
coverage by  
LEO satellites  
supports one  
housing unit  
per square  
mile at the  
bandwidth  
of 100 Mbps  
downstream/  
20 mbps  
upstream

<sup>7</sup> RF Wireless World: Advantages of LEO Orbit | Disadvantages of LEO Orbit



In terms of security, LEO satellites offer several advantages. Their lower altitude allows for stronger signal strength and reduced power requirements for transmission, which can enhance the security of data transmission. However, like any wireless technology, LEO satellites are still vulnerable to certain types of cyber threats, such as signal interception and jamming. It is crucial for providers to implement robust encryption and security protocols to protect user data and ensure a secure browsing experience. Despite these challenges, LEO satellites can provide a reliable backup for businesses and connect users in remote areas without the need for extensive ground infrastructure.

From a sustainability perspective, LEO satellites present both opportunities and challenges. On one hand, they eliminate the need for extensive digging and installation of cables, reducing the environmental impact associated with deploying traditional broadband networks. Additionally, the use of smaller, more efficient satellites can reduce the overall carbon footprint of the network. However, the frequent replacement of satellites and the potential for space debris pose significant sustainability concerns. It is essential for providers to develop strategies for satellite deorbiting and recycling to mitigate these environmental impacts. Overall, while LEO satellites offer a promising solution for expanding broadband access, careful consideration of their advantages and disadvantages is necessary to ensure their long-term viability and sustainability.

## CONCLUSION

Copper has historically been the foundational technology for voice and broadband services, but its limitations make it far less suitable for modern high-speed internet demands. Its bandwidth capacity is limited, security can be compromised by susceptibility to interference, and maintenance costs are high due to theft, physical damage and wear over time. Copper networks also pose significant environmental challenges due to energy-intensive extraction and processing.

In contrast, fiber optics offer higher speeds, high reliability, better security, and lower maintenance costs. Many companies, including Brightspeed, AT&T and British Telecom, are transitioning from copper to fiber, highlighting this technological shift.

For hard-to-reach locations where fiber is not cost-effective, wireless options such as fixed wireless and low earth orbiting satellites serve as excellent substitutes, providing reliable and high-speed internet access.

In conclusion, while copper has been valuable historically, fiber optics and wireless technologies are better suited to meet the contemporary and future broadband needs of American consumers and businesses.