



Ready for Multi-Gig Services and Beyond?

Preparing for an Uncertain Future and New Customer Needs

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This report by Parks Associates, in partnership with NCTC and DZS, discusses the rise of multi-gig services in the broadband market. It examines how NCTC members are approaching multi-gig deployments, the technologies and strategies being used, and the evolution of customer needs. It also investigates the role of climate resiliency in network planning.

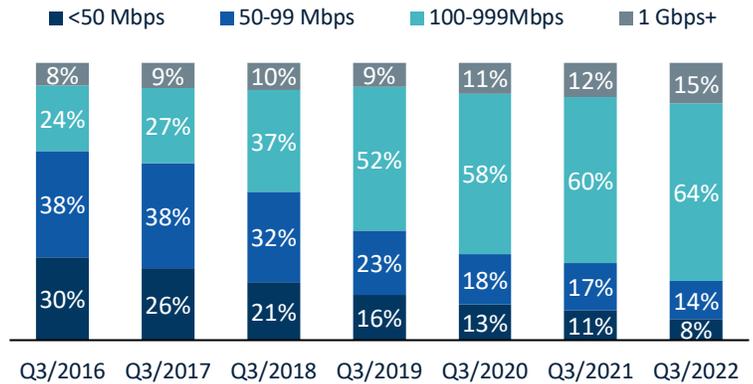
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Current State of Network Deployments

Speeds and network capability for end users have dramatically increased over the past several years as internet service providers upgrade their networks. Parks Associates consumer surveys find that over half of US home internet households report downlink speeds of over 250Mbps. These speeds are overall higher in urban and suburban versus rural areas, where 54-56% of households report 250Mbps+ service versus 42% in rural areas.

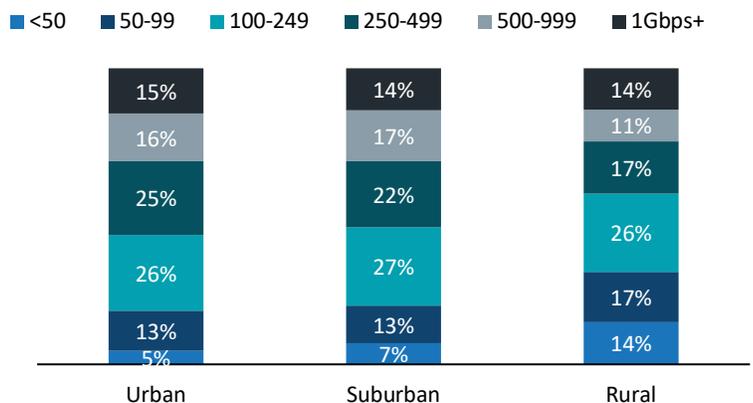
US Home Internet Downlink: 2016-2022



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Gigabit service adoption is slowly but steadily increasing across the United States, reaching 15% of households in 2022. Although many might assume that gigabit service is more common in urban or suburban areas, this has not been the case. Parks Associates consumer survey work finds that, among US internet households, self-described “rural” residents report receiving gigabit speeds at the same rate as those living in urban or suburban areas.

US Home Internet Downlink by Community Type



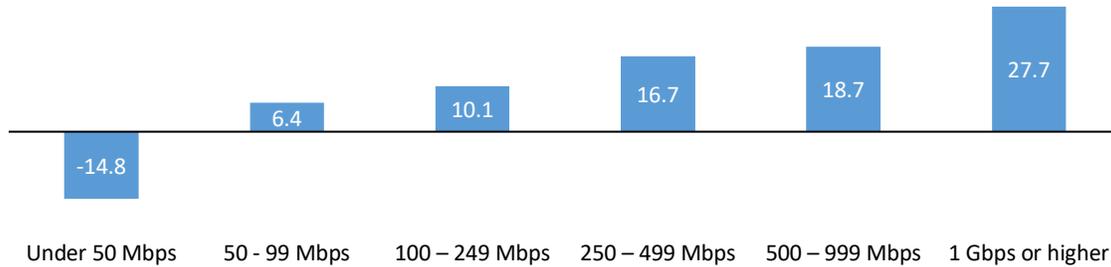
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Many consumers place an emphasis on the availability of gigabit service from an internet service provider (ISP) - over half of US internet households (55%) report that the availability of gigabit internet services is an important factor when looking for a home to rent or buy. Speeds also impact consumer perception of ISPs. Net promotor scores for ISPs, a measure¹ of customer satisfaction and willingness to

¹ Net promotor scores are a measurement of the ratio of promotors minus detractors of a product or service. Any score above a zero indicates that the brand has more supporters than detractors; below a zero, the opposite.

recommend a product or service to friends and family, are highly correlated with internet download speeds. Gigabit subscribers report the highest levels of satisfaction, with an average NPS of 28 compared to an overall industry average of 6 in 2022.

Internet Service Providers' Net Promotor Score by Downlink Speed



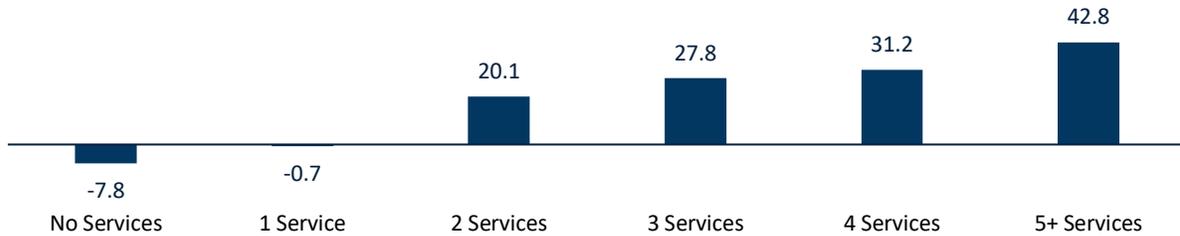
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Customer satisfaction leads to lower customer churn, fewer complaints and resulting truck rolls, higher customer spending and ARPU, and new customer acquisition by way of word-of-mouth promotions. Gigabit internet’s fast speeds are its most notable feature, offering a pipe capable of meeting any residential user’s needs, including near-immediate downloads of large files and operating system updates.

Higher customer satisfaction, as measured by NPS, has significant impacts on businesses.

Another key component of this satisfaction is the high availability of value-added services in gigabit and high-speed packages – 75% of gigabit subscribers report receiving at least one tested value-added service such as streaming video, managed Wi-Fi, whole-home cybersecurity, or technical support and monitoring, compared to less than half of those with under 50Mbps downlink.

Internet Service Provider's Net Promotor Score by Number of Value-Added Subscriptions



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To enable the high speeds that serve as the basis of these premium packages, ISPs have made substantial investments in their network infrastructure, including their core, middle-mile, and last-mile networks. Companies have likewise invested in robust IP transport connections to connectivity partners, enabling local providers to offer more reliable and robust service to their customers. For small ISPs in remote locations, the throughput and capacity of these connections is critical in allowing their customers access to the wider internet. The decisions companies make with regard to these investments determine their roadmaps for the coming decades.

Broadband networks as a whole are in the midst of an evolution. DSL is being phased out, coaxial cable is being re-evaluated, and many companies are looking to fiber connections as the technology that will form the core of their operations for the next fifty years. Large to medium telcos are aggressively moving to fiber across both greenfield and brownfield deployments, while large cablecos are looking to roll out fiber-to-the-premises in greenfield markets, and for network edge-outs, and pursuing DAA and DOCSIS 4.0 upgrades in brownfield markets.

Many companies are looking to fiber connections as the technology that will form the core of their operations for the next fifty years.

NCTC Member Perspective

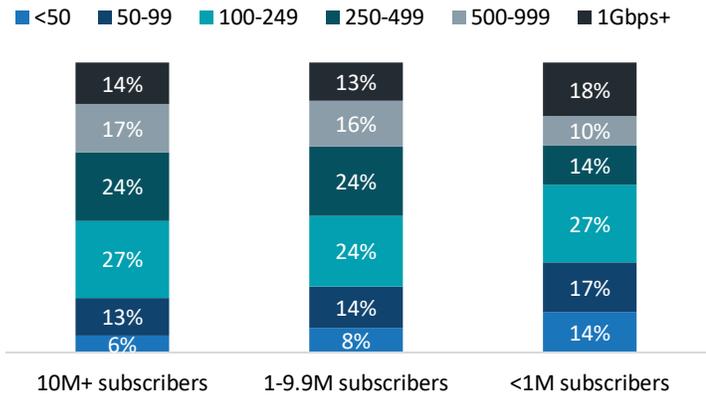
Smaller ISPs and NCTC members are likewise upgrading their networks, exploring or actively deploying gigabit and even multi-gigabit services to their residential and business customers. NCTC members have largely upgraded to fiber in their network core and/or the middle mile, but many that began as cable TV providers still maintain coaxial cable networks in the last mile. Others have shifted to – or began by – deploying fiber-to-the-home across

their footprints, many deploying gigabit services. The data supports this. Looking at average download speeds for smaller ISPs, the market is highly bifurcated: nearly a third have speeds under 100Mbps, and just under 60% have speeds under 250Mbps, but smaller ISPs also have a higher percentage of their customer bases taking gigabit service than their larger peers.

NCTC members deploying fiber-optics are largely turning to XGS-PON in the last mile to support their residential and business customers. There are several advantages of XGS-PON over previous generations: it is symmetrical – offering 10Gbps of both upstream and downstream, and essentially future-proofing networks for the next decade. XGS-PON’s symmetrical uplink offers it an advantage over GPON which offers slower asymmetrical speeds. XGS-PON is additionally capable of co-existing with GPON. Another key advantage is the ability to split up to 128 ways and maintain gigabit service – requiring a fraction of the number of ports while only paying a small premium over GPON.

NCTC members with last-mile coax deployments are evaluating the benefits and drawbacks of deploying new fiber versus upgrading to a gigabit-capable standard, either DOCSIS 3.1 or a next generation standard such as DOCSIS 4.0. For many NCTC members, moving to fiber for greenfield deployments is a given, with fiber and PON offering both cost and performance advantages over coax and DOCSIS. Members are more uncertain about brownfield deployments, and whether it makes financial and operational sense to maintain legacy cable, upgrade to new standards, or overbuild with fiber and

US Home Internet Downlink by Provider Size



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transition to a new network. This depends on the age of the network, its capabilities, and the competitiveness of the operator’s market.

NCTC members are increasingly upgrading to fiber in their current brownfield deployments, overbuilding their existing coaxial cable networks. Many are finding that new fiber deployments are less costly than upgrading existing aging coaxial cable infrastructure to DOCSIS 4.0, require less maintenance and labor, offer resiliency during power outages, and offer a competitive advantage. In areas with fierce competition, a fiber offering allows companies to better retain their customers – and even attract new ones.

“Fiber sells itself.”
- NCTC member, in interview with Parks Associates analyst

Case Study: Sister Lakes Cable

Sister Lakes Cable serves three counties in Michigan, east of Chicago and midway between Chicago and Detroit, including a resort community of nine lakes. It first began offering customers cable TV service in 1986 and deploying home internet in 2001. Over the decades, Sister Lakes has switched from full coaxial cable to a hybrid fiber/cable network, upgrading from 450MHz to adding node segmentation and upgrading its CMTS to DOCSIS 3.1 prior to the COVID-19 pandemic. During the pandemic, the network was overwhelmed with remote workers fleeing the Chicago area and making heavy use of uplink.

Sister Lakes explored many different ideas to upgrade its network, looking at the cost of more node segmentation and changing ANT systems to get to 800MHz and the ability to reach 1Gbps download speeds. Then they considered GPON and began talking to NCTC. After learning they could begin deploying GPON for less than \$50,000, they evaluated other benefits: lower maintenance costs, less need for labor, fewer truck rolls to customers, resilience during times of power outages or temperature swings, recognition among consumers, and futureproofing for the next 20 years.

When Sister Lakes began beta testing, the technology quickly proved itself within four months, and the company began converting existing accounts from DOCSIS to XGS-PON. The company soon began attracting *new* customers to its fiber product – with 38% of its fiber accounts coming from new customers in its existing footprint. Today Sister Lakes Cable is steadily growing its fiber network and overbuilding itself with fiber. The company plans on being completely XGS-PON by 2026.

Of course, the last mile is not the only part of the network receiving upgrades. NCTC members are also overhauling their network cores and the middle-mile, pursuing 100/400Gbps connectivity from the core to their nodes and optical line terminals (OLTs). As more and more sports entertainment switches to streaming as a method of distribution, simultaneous consumption of high-quality and high-fidelity streamed content will continue to grow. While the last mile is easily capable of handling this load, Tier 3 operators, such as many NCTC members, feel the pressure in the middle mile and in the interconnection points with transit providers or peering partners. For this reason, many NCTC members are upgrading from 10Gbps connections to 100 or 400Gbps in their middle mile.

With hybrid-fiber cable deployments, distributed hardware and cabinets close to the end-user were necessary for ensuring a good customer experience. With all-fiber networks – including GPON, XGS-PON, and future PON technologies – this has become less important. FTTH adoption allows companies to consolidate their central offices, reducing their power consumption and maintenance needs. NCTC members are able to serve more homes and residential customers with gigabit or multi-gigabit service with a single central office location.

Use Cases Driving End-User Demand

Today, residential customers and even businesses commonly have much more bandwidth available to them than they actually require. Among consumers, the most common bandwidth-intensive activities are streaming 4K video, streaming cloud-hosted video games, and performing remote work tasks such as file manipulation or video conferencing. The requirements for these tasks are typically met with a <100Mbps downlink connection. Even 8K video, which remains niche, does not require more than 50Mbps of downlink for a single stream.



87%

of US internet households subscribe to an OTT video service



71%

of US internet households play video games weekly



36%

of US internet households work remotely at least once per week



27%

of US internet households own and use a smart security camera or video doorbell

However, network pressures *are* evolving. While many residential customers may not require high downlink speeds to serve everyday use cases, these households still benefit from being able to quickly download large files, allowing them to quickly update their devices and access valued content such as video games and movies. Many households continue to work remotely, online and cloud-based video gaming are popular forms of entertainment, and adoption of cloud-connected security cameras is growing. Beyond downlink, consumers increasingly benefit from high uplink speeds, low latency, and high degrees of internet service reliability and availability.

Compounding this challenge, households are increasingly performing the aforementioned activities simultaneously; creating environments where multiple UHD video streams may be streaming at the same time, all while gaming, security monitoring through cameras, and even video conferencing are also taking place. Parks Associates consumer surveys find that across the US, internet households owned an average of 16 tested internet-connected products in 2022 – almost double the number owned in 2015.

| Application | Recommended Service (single user) | Recommended Service (4 simultaneous users) |
|-----------------------------------|--|---|
| Interactive 8K AR/VR applications | 200Mbps downlink, <20ms latency | 1Gbps+ downlink, <20ms latency |
| Current-gen 360° 4K video | 50Mbps downlink | 200Mbps downlink |
| 8K UHD Video | 50Mbps downlink | 200Mbps downlink |
| Cloud gaming (highest quality) | 45Mbps downlink; <40ms latency | 180Mbps downlink; <40ms latency |
| UltraHD Video (4K/2160p) | 25Mbps downlink | 100Mbps downlink |
| Cloud gaming (lowest quality) | 15Mbps downlink; <80ms latency | 60Mbps downlink; <80ms latency |
| Livestreaming (HD) | 6Mbps uplink; <100ms latency | 24Mbps uplink; <100ms latency |
| Video calling | 8Mbps downlink; 512Kbps uplink; <100ms latency | 32Mbps downlink, 2Mbps uplink; <100ms latency |

Use Cases Across the Coming Decade

Use cases and broadband applications are shifting in residential, enterprise, and government spaces. Demand for uplink is growing, and with the growth of connected infrastructure and IoT technologies connectivity is needed in more and more places. The current rollout of 5G mobile networks is likewise increasing demand for backhaul over fiber networks – and the eventual rollout of 6G will do the same in the 2030s. Operators must make the most of their investments in their networks and be prepared to meet future needs.

AR/VR and the Future of Computing

For the past decade, technologists have discussed the next evolution of personal computing and content consumption. The most recent transformative innovations in how we access and consume content have been the smartphone and smart TV. With smartphones at majority adoption and smart TVs having reached the mass market, the question of what’s next is at the forefront of everyone’s minds.



89%

of US internet households own and use a computer



87%

of US internet households own and use a smartphone



62%

of US internet households own and use a smart TV



12%

of US internet households own and use a VR headset

At present, adoption of Virtual Reality products is low – 12% of US internet households own and use a device as of the first quarter of 2023 – and VR content and experiences are most commonly distributed in the form of downloads. There are many reasons why VR remains niche – there are limited use cases beyond gaming, many users find the headsets uncomfortable to wear beyond long periods of time, and the user experience leads to a disconnect between the wearer and the world around them. The factors that have limited AR/VR are set to change.

For years, virtual and augmented reality have been hailed as the next-generation computing method.

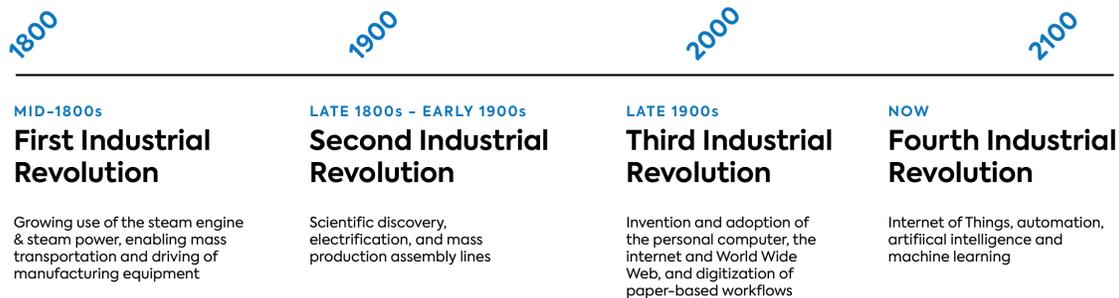
In June 2023, Apple announced the launch of its Vision Pro AR/VR headset, building off of its existing suite of AR technology as well as its application environment for iPad and iOS. Apple has previously been instrumental in bringing niche technologies to mass market, including smartphones and more recently smart watches. The high price tag for this product’s initial launch (\$3,500USD) will lead to a slow initial adoption, but Apple is likely to introduce a lower priced version in several years once it has refined the ecosystem and technology. Apple’s entry into this segment may well mark a sea change in the extended reality market.

The network implications for this may be profound, as immersive AR/VR experiences are not only experienced individually in the household but are optimized separately for each eye. In order to minimize motion sickness and optimize the experience, not only are 8K UHD technologies likely to be used but also delivered at extremely low latency. All of these factors combine to dramatically expand the network performance and bandwidth requirements of individual homes as well as businesses.

Internet of Things

Beyond AR/VR, IoT adoption and Industry 4.0 rollouts are continuing in the business and government spaces, and increasingly among entities of all size. Organizations are adopting cloud-based solutions making use of machine and computer vision² for increasingly diverse use cases, ranging from traditional security monitoring with added features like facial recognition and presence detection to new use cases such as identifying traffic flow in retail stores or wait times in drive throughs. Sensor technology use is growing, as is adoption of automated tools making use of cloud-hosted decision making. This is impacting industries ranging from manufacturing, to utilities, transportation, construction, multifamily housing, and even restaurants and retail stores. Governments, similarly, are turning to IoT to better understand their communities and deliver services to residents and guests.

FOUR INDUSTRIAL REVOLUTIONS



However, many of these businesses and organizations are experiencing challenges along their journey to Industry 4.0. A common roadblock many organizations experience is connectivity: both having

² Machine and computer vision are terms describing the families of artificial intelligence and machine learning technologies used for automated image and video processing and analysis. Within this model, high-resolution cameras capture and send images and stream video to cloud systems for processing.

connectivity to the site needing to be served and having adequate networking infrastructure that can connect the IoT devices.

Installing sufficient connectivity may be as easy as moving a restaurant or retail store to a higher-tiered broadband plan and upgrading existing networking equipment, or as difficult as connecting a far-off oilfield or performing major construction work to install throughout a 50-year-old multifamily property. To better understand needs and make these decisions, organizations are

looking to providers of connectivity – including internet service providers – as partners for their upgrade journey. In turn, many ISPs are seeking to optimize their networks in advance of these upcoming challenges, pushing bandwidth and intelligence as close to the edge as possible to maximize customer responsiveness and performance, including lower latency, higher bandwidth, and increased flexibility.

The challenges that organizations face in readying their networks may vary greatly according to their unique needs and operating environments.

NCTC Member Perspective

NCTC members report that the primary use cases among residential subscribers have not changed much over the past several years. Streaming video continues to be the number one driver of data traffic, with much of the past decade's traffic growth happening as a result of OTT video consumption and especially simultaneous viewing by household members. Post-pandemic, residential data consumption among many NCTC members' customer bases has stalled, with growth of video consumption slowing compared to pandemic highs.

However, video is continuing to drive network traffic. NCTC members are increasingly shifting their pay-TV offerings from cable TV to IPTV, reducing costs and freeing up bandwidth that can be used for higher tiered broadband packages. With the shift of sports content to streaming services, consumers are also tuning in at the same time more frequently – putting additional pressure on NCTC members' core networks and the middle mile. Members are increasingly upgrading from 10Gbps to 100Gbps or even 400Gbps to meet this demand.

NCTC members are also seeing increased demand for uplink speeds, both among their customers and through the grant funding programs such as BEAD. Remote work in particular has increased demand for

uplink beyond the capabilities of some legacy coaxial networks, driven by video conferencing and the need to remotely access and manipulate large files. Greater adoption of cloud-connected and AI-enabled security cameras by residential households, businesses, and governments is also driving increased need for uplink speeds. Grant funding programs such as BEAD have set service standards at 20Mbps uplink for sites to qualify as adequately served, and the FCC is considering redefining minimum residential broadband speeds as 100Mbps down and 20Mbps up.

Beyond residential, NCTC members are seeing increased demand for connectivity in more ways and places than before. Mobile providers are investing heavily in their 5G networks and require high-speed connectivity as backhaul, often in excess of 10Gbps per carrier per tower, in order to offer their services. Electric vehicle charging facilities are rolling out nationwide, and many require connectivity in order to function. Cities of all sizes are offering public Wi-Fi to residents and guests, ensuring good experiences.

The rollout of Industry 4.0 Internet of Things technology is accelerating, with municipalities deploying sensors, cameras, and other technologies to monitor and operate infrastructure. Once the domain of large enterprises, small and medium businesses are also adopting smart technologies to control costs, gain information and insights, automate business processes, and deliver new services to their customers. Medical providers continue to leverage telehealth to offer services to their patients, and an increasing number are making use of AI and machine vision to better diagnose and treat their patients.

Environmental Hardening: Climate Resiliency and Cost Savings

Environmental hardening is becoming increasingly important for ISPs across the United States. As NCTC members make investments into their networks that they expect to pay off for the next twenty years, they require equipment that can perform in changing environmental conditions. Beyond climate resiliency, ISPs are seeing benefits from deploying environmentally hardened equipment, including substantial cost savings when deploying into rural locations and 5G backhaul.

Climate Resiliency and Disaster Preparedness

The story of climate resilience and disaster preparedness is in many ways the story of network resiliency. End users – residential, business, and government – require connectivity in order to perform regular daily functions. Network failures or outages may not just cause inconvenience but impede critical functions. To future-proof and protect networks from natural disaster, internet service providers must plan ahead.

Different geographic areas and climates may face radically different challenges when it comes to hardening their networks and equipment. Cable and fiber have different needs and perform differently in times of network stress. Large temperature swings result in cable operators needing to recalibrate their network. Fiber OLTs may produce more heat and require more powerful cooling mechanisms. In areas with frequent or extended power outages, fiber PON offers an additional benefit – so long as the central office has power, and the end user has a generator or battery back-up capable of powering their router, they are able to access the internet. There is no need for a power source in the cabinet. This greater resiliency during power outages is of great value to customers.

Environmental Hardening as a Cost Savings Measure

Beyond climate resiliency, environmentally hardened equipment is becoming strategically necessary as ISPs expand their networks into ever more rural locations. Grant funding initiatives, including BEAD, are focused on bridging the digital divide, and NCTC members are capitalizing on this opportunity. Mobile providers are working to deploy 5G connectivity nationwide, including in remote locations, and are contracting with NCTC members for backhaul.

However, in many cases deployment locations are beyond even the range of traditional PON – 12 miles, up to 20 with specialized enhancements. In these scenarios hardened PON and transport may save tens to hundreds of thousands of dollars on upgraded cooling or new facilities built to house equipment. Another component of ISPs' strategies is deploying OLTs and backhaul/transport closer to the network edge, allowing them to minimize time-to-market for upgrades, new opportunities, and to reduce latency times for use cases such as 5G backhaul.

NCTC Member Perspective

NCTC members are designing their networks to handle blazing highs and freezing lows, temperature swings of up to 80 degrees Fahrenheit; environmental hazards such as blizzards, floods, or lightning strikes, wild animals, falling trees or tree branches, and cottonwood or leaves capable of clogging AC intakes. Power outages, downed or flooded lines, clogged AC vents, all put pressure on networks and create operational challenges for members. With higher average summer temperatures and the increasing occurrence of hundred-year events, ISPs must be prepared for changing operational challenges.

To ensure smooth operation and avoid network downtime and outages, NCTC members are designing their networks to incorporate redundancy and route diversity, ensuring that connectivity comes from

multiple angles to support multiple network edge points. Members are protecting their central offices with battery backups and generators that make use of alternative fuel sources, including solar. The use of PON and fiber provides greater network resiliency for customers – customers are unaffected by power outages so long as the central offices remain online.

With the ongoing shift to fiber in the last mile, NCTC members are looking to more efficient cooling strategies. Data center rack density is increasing, requiring more efficient HVAC systems. Members are looking to the way they design data centers, particularly for PON networks. Density is increasing, and data centers require greater cooling. XGS-PON runs hotter than other network technologies, and OLTs may require a greater degree of cooling. NCTC members in hotter climates in particular are looking to their peers near the equator to learn best practices for passive and cost-efficient cooling.

Network upgrades as a whole are reducing power usage for many NCTC members. Although XGS-PON requires more power within the central office than a traditional CMTS, the greater range provided by fiber allows companies to consolidate their central office sites resulting in a net reduction in power usage. As NCTC members increasingly move to retire their legacy telephone networks, electricity consumption is further falling, allowing for higher cost savings.

Conclusions

Networks transformation is underway, with terrestrial internet service providers increasingly moving towards gigabit or even multi-gigabit offerings to their residential and business customers. Cablecos are carefully evaluating the pros and cons of overbuilding with fiber-to-the-home, versus maintaining current DOCSIS 3.1 deployments or moving to DOCSIS 4.0. These decisions must consider not just cost, but also grant funding opportunities and obligations, evolving revenue sources, and growing market competition. They must also consider members' long-term roadmaps: investments in fiber connectivity promise to pay off in the long run, providing a foundation for another 20 or more years of upgrades and network evolution.

For many end users, gigabit or multi-gigabit services are beyond their current needs. However, consumers widely recognize fiber as a desirable technology and are likely to consider high downlink speed a sign of superior service. In that sense, fiber and gigabit/multi-gigabit offerings serve as valuable marketing tools that may differentiate NCTC members from competitors. Beyond speed, NCTC

members' customer experience benefits from the improved reliability, lower latency, and greater uplink capabilities that come with network upgrades.

High net promotor scores associated with gigabit speed packages point to a further benefit: internet service providers are emerging as trusted brands, a major transformation from how they have historically been perceived. This lays the foundation for new service offerings and better business outcomes in the future. New technology points to the future of connectivity – augmented and virtual reality are evolving and are poised to either enter the mass market or die on the vine. An increasing number of devices and functions are becoming connected in consumers' homes, in the enterprise, and in public spaces. The needs of companies and governments are likewise evolving, with many looking to ISPs for new services.

NCTC members are planning to stay ahead. Members are investing in future-flexible technologies and equipment that allows them to evolve to meet the requirements and use cases of tomorrow. They are taking a strategic and holistic view of their networks, recognizing that the middle mile is as crucial to the customer experience as the last. They are making use of hardened equipment to ensure network performance and longevity in times of changing climate, capitalizing on these solutions to offer connectivity in areas they never have before.



The Future of ISPs: It’s Riding on the EDGE

Forwarded by Charlie Vogt, President and CEO, DZS

The communications technology landscape is undergoing a transformational shift in the way broadband networks are architected and intelligence is gathered and utilized. Internet Service Providers (ISPs) seeking a competitive edge are delivering more than a mere broadband service – they are leveraging new fiber-based broadband technologies and AI-driven insights to increase agility and create personalized multi-gigabit and converged wireline/wireless experiences. As we enter a once-in-a-generation industry upgrade cycle driven by investment in fiber-rich networks, exploding broadband demand, new applications, and technology evolution and supported by unprecedented broadband subsidies and private investment, one thing is clear: **successful ISPs will invest in pushing capacity and intelligence closer to a location where they can be most responsive to the needs of their subscribers and best glean actionable AI-driven insights that can create new subscriber experiences – the EDGE.**

What is The EDGE?

The EDGE is the frontier of connectivity in the ISP network, where data is generated, processed, and consumed. By bringing bandwidth and intelligence closer to end users, CSPs can drastically improve responsiveness and agility, reduce latency, enhance reliability, and enable a host of emerging technologies, including AI, that can guide optimal levels of network performance and elevate broadband experiences. This shift towards embracing the EDGE is imperative, as the demands of the future are quickly escalating, driven by trends ranging from the Internet of Things (IoT) and ultra-high-definition content, to augmented reality in the form of innovative new devices and services like the Apple Vision Pro.

How Can ISPs Gain Their Competitive EDGE

To keep ahead of their competition, agile ISPs are embracing a software-defined, fiber-first strategy that pushes bandwidth and intelligence to all fronts of the EDGE in the ISP network.

First, we have the **Subscriber EDGE** - that portion of the access network that connects broadband delivered to the home or business directly to the consumer across their broadband-enabled devices. More than just the speed of connectivity within the customer premises, the Subscriber EDGE has become the focal point of the customer experience (WiFi integrity, agility, security). This interface, no matter the device, is critical in personalizing the broadband experience, both managing and optimizing subscriber satisfaction as well as serving as a platform for new subscriber insights and revenues.

Demand for a more holistic subscriber experience is higher than ever with increased demand across the board for online applications, whether for staying in touch, entertainment, or healthcare as well as a

willingness to pay more for services that customize or optimize these applications. Customers no longer value broadband as just a “service” – they demand an experience.

Second, we have the **Access EDGE** – a modification to the traditional “last mile” of connection between the central office or data center and the subscriber’s home or business where the service termination now occurs inside the customer premises.

The Access EDGE continues to be redefined as accelerating bandwidth demand has pushed the location of access system deployment closer to the subscriber, often creating the need for environmentally hardened equipment with extraordinary performance (high capacity, ultra-low latency, user intelligence) to be deployed in entirely new and increasingly remote locations in the network. This is also underpinned by increasing government investment in rural and underserved community broadband.

New applications and new technologies have also emerged, creating both a need and a necessary upgrade path from 10G technology today to 50G/100G PON technologies in the future. With next generation technologies already on the horizon, ISPs making network investment decisions today should be considering efficient upgrade paths to 50G and 100G PON in the not-so-distant future.

Third is the **Optical EDGE** – an enhancement of the transport network that has always been the essential enabler of the access and mobile network. As access networks have increasingly enabled multi-gigabit speeds and mobile networks have pushed to 5G and beyond, the transport network has not only become dominated by optical signals over fiber, but DWDM signals to enable high-speed data transmission over longer distances, offer better support of 5G technologies and provide more resilient services.

Additionally, new use cases like CDN caching, 5G densification and low latency requirements make deployment of DWDM closer to the Access EDGE more necessary. ISPs are now carefully planning for assurance monitoring and AI-driven performance management of this network, as well as new flexible deployment options and strategic roadmaps for cost-effective scale. For example, multi-billion dollar rural broadband initiatives like the Middle Mile Grant and BEAD (Broadband, Equity, Access and Deployment) programs in the U.S. and many others across the world will depend in large part on the high-capacity, high-speed transport capabilities of these optical networks to bridge the digital divide.

Last is the **Cloud EDGE** – the essential cloud-based software infrastructure that provides the insights and analytics, often enhanced by AI, to both optimize and assure subscriber quality-of-experience and drive operational efficiency and agility across increasingly multi-vendor networks. Whether for home or business, the Cloud EDGE not only provides the virtual infrastructure to host the services subscribers need, but also gives them control, even remotely, over those services.

Transforming at the EDGE – More Than a Leap of Faith

By embracing DZS EDGE innovations and architectures and leveraging insights gleaned from being close to the subscriber, DZS customers have decreased their customer churn by 20%+, improved subscriber quality-of-experience by 35%+ and more than doubled their Average Revenue Per User (ARPU). One key

reason – DZS customers are redefining service agility, leveraging AI to anticipate subscriber needs and potential network performance issues, and enabling new services to be launched in days rather than the traditional multi-month roll-out process. With results like these, we anticipate that embracing the EDGE on all fronts – Access, Subscriber, Optical and Cloud – will become essential for ISPs, including NCTC members, seeking to gain their competitive edge and achieve long-term sustainable success.

About NCTC Members

For 37 years, NCTC has been serving our members' needs by providing cost savings, knowledge sharing, innovation, and strategy. Our goal is to provide the highest level of quality service and value with accountability, innovation, integrity and commitment to our independent community. NCTC was originally founded by 12 members of the Mid-America Cable Association on the premise that rate savings could be achieved by aggregating their cable subscribers. This mission is still at the heart of NCTC today.

Today our membership consists of over 700 independent cable and broadband companies that connect with great programming networks and leading technology companies to provide their subscribers with exceptional service. With 60+ employees and two offices, NCTC provides our members and partners with the operational and strategic support they need to succeed in our rapidly evolving competitive landscape. We have formed new partnerships and developed new tools that enable our members to bring the best of service to their subscribers. Guided by a diverse board of directors, NCTC brings our members and partners the best in customer service while fostering connections that create value for all.

About Parks Associates

Parks Associates is an internationally recognized market research and consulting company specializing in emerging consumer technology products and services. Founded in 1986, Parks Associates creates research capital for companies ranging from Fortune 500 to small start-ups through market reports, primary studies, consumer research, custom research, workshops, executive conferences, and annual service subscriptions. The company's expertise includes the Internet of Things, digital media and platforms, entertainment and gaming, home networks, internet and television services, mobile applications and services, support services, consumer electronics, energy management, and home control systems and security.