Accelerating AI with Fiber Systems and Strategies

PERFECT PAIR FOR DATA CENTERS, NETWORKS, AND THE AI FIBER HOME

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Fiber Broadband ASSOCIATION

When fiber leads, the future follows.

SUMMARY

Fiber is Critical Infrastructure for AI: Fiber-connected data centers and AI Fiber networks serve as critical infrastructure for the AI revolution underway. The impact in 2025 shows that Fiber's growth, promise, and strategic value of integrating AI into networks all the way to the AI Fiber home sets the stage for massive impact to subscribers nationwide.

FBA's View on AI and Fiber: Gary Bolton, President and CEO of the Fiber Broadband Association (FBA), has emphasized the critical role of AI in advancing Fiber networks and technology. He relates that AI-driven automation and optimization are essential for managing complex networks, improving customer experiences, and leveraging increasing bandwidth. With the acceleration of AI across all industries and into the AI Fiber home, the Fiber industry is meeting the challenge.

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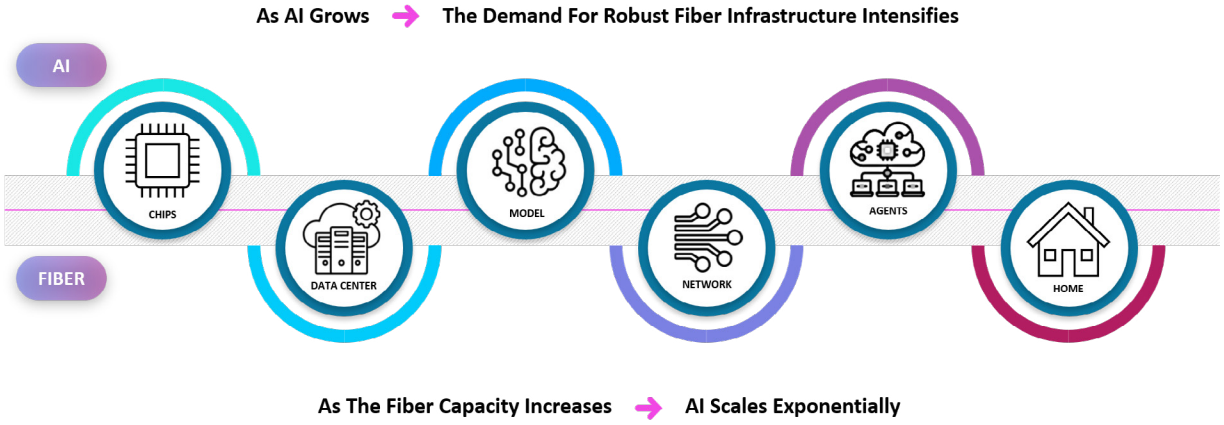
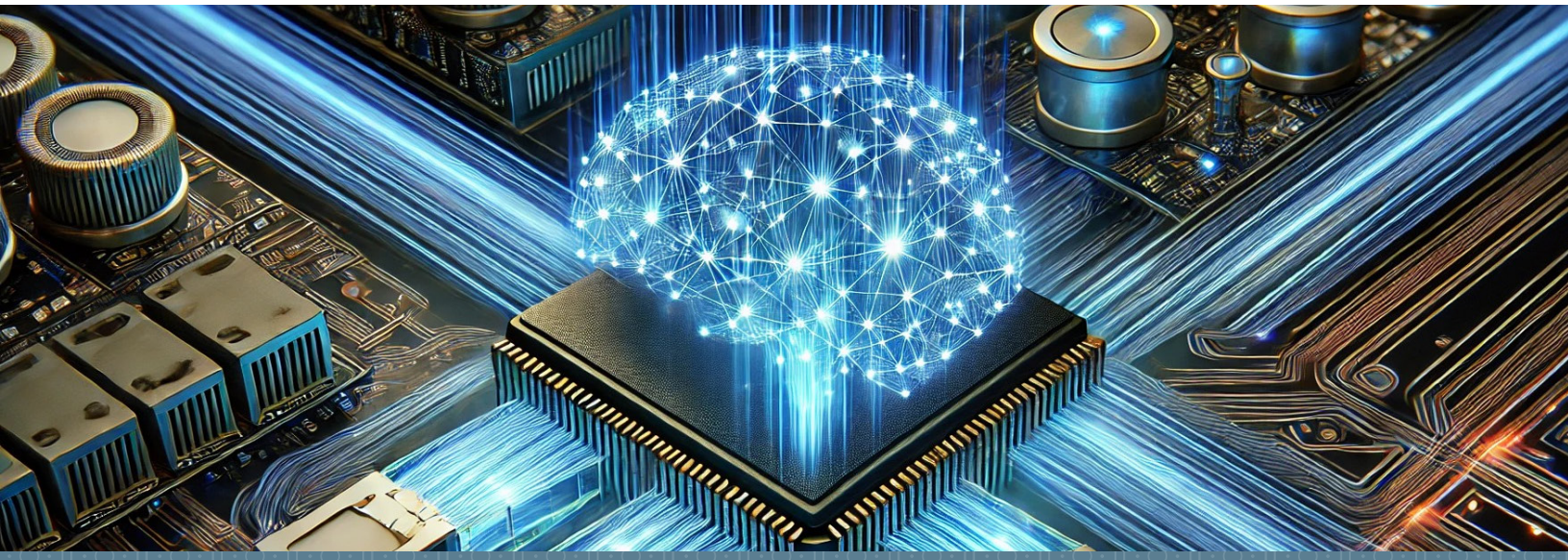
AI AND FIBER – PERFECT PARTNERS

Fiber Networks Represent the Core of AI Critical Infrastructure: Without the high capacity, speed and low-latency advantages of Fiber, AI data and applications cannot scale or move effortlessly from the chip processing/GPUs to users in a transformative world. AI needs data, data needs data centers, and data centers need Fiber connectivity.

AI Fiber is Backbone to AI Growth: The new AI workflow is built on AI applications and agents feeding and managing data using deep learning models and reasoning powered by processor/GPU chips. As AI grows, more Fiber is needed.

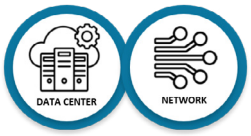


Fiber works in tandem with AI's exponential growth by providing capacity and dense Fiber to the data center, a robust network, and an AI-experience to the connected home. AI Fiber density enables data to the learning models for even greater performance and can scale AI exponentially with advanced Fiber capacity.

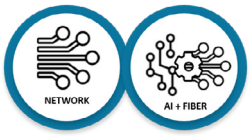


THE TRIAD OF AI FIBER VALUE: DATA CENTERS, NETWORKS, AND CONNECTED HOMES

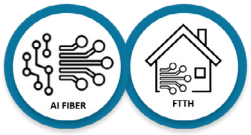
With the pure power and speed of Fiber broadband connectivity, the new generation of AI is assured. The nearly unfathomable concept of trillions of transactions and bytes of data — all learning, stored, and accessed – can now be managed by Fiber from the data center across the network to the AI Fiber Home.



Data Centers and Fiber Work Together: Fiber has been instrumental in the build-out of data centers, the middle mile, 5G, hybrid satellite-Fiber networks, and most importantly, high-speed internet to the consumer. The power of Fiber architectures has become like water in our infrastructure, moving down and upstream carrying gigabytes of data for thousands of applications across media, IoT, logistics, retail, automotive, and mobile. As hub and spoke AI centers evolve, Fiber also provides critical interconnects for smaller centers feeding off the hub.



Network and AI-ready Fiber Architectures are increasingly designed for a gigabit world. Major impacts for Fiber are seen in data processing, Cloud connectivity, edge computing, and revitalized services to end users of Fiber networks. Fiber enables faster transfer of data for AI systems and ensures edge devices connect with central servers. As more AI applications move closer to the edge, the power of Fiber networks enables low latency and high-speed data transmission, crucial for real-time AI processing.



Impact on the AI Fiber Connected Home: A revitalized AI Quality of Experience (QoE) is evolving for subscribers from inside the AI Fiber Home using new applications and data center delivery for a seamless integration of network infrastructure and services. While Quality of Service (QoS) continues its high performance with Fiber, autonomous networks and edge computing are now pivotal in AI user experiences as well as decreasing subscriber churn for Fiber service providers.

Further, when we explore the concept of "PCHP" (Persistent Contextual Hyper Personalization) for AI subscribers, it becomes evident that AI deep learning capabilities form a persistent relationship using hyper-learning and contextual data to deliver a highly personalized experience. As subscribers continually adapt alongside applications, they gain more than just a high-speed connection in the AI Fiber Home — there are compelling applications such as Telehealth, Gaming, and AI-led Education, to name a few.

THE OPPORTUNITY FOR INTELLIGENCE IS ENABLED BY FIBER

AI is not a rebirth of the internet – we are now in the age of intelligence. Yesterday's network cannot totally manage the massive growth of AI needs and therein lies the opportunity for the Fiber industry. We just need more – of everything. AI is the perfect storm of astronomical data volume, learning models, and the infrastructure of chips, Cloud, software, and networks supporting a scale of growth we have never seen, as shown in the following examples.

The Internet represents a connected age of humanity, but AI is far more existential as it reshapes work and what it even means to be human. We are now beyond the computing stage and into chain-of-thought reasoning, and well on our way to AI machine sentience or consciousness under an Artificial General Intelligence (AGI) trend.

Rethinking Technology: This new age of AI forces a re-think of what's been done and where we are moving on a technical front. We are speeding ahead past older Excel-driven dashboards, Machine Learning (ML) processes, and limitations of a megabit-mentality for scores of applications in the new AI digital home. AI-data is evolving more in value with context and syntax beyond the data assets themselves. In addition, Cloud storage and processing are growing with virtualization and services to manage massive data feeding new AI-driven needs.

On the Deep Learning (DL) front, where Generative AI (GenAI) requires massive compute and transport from Large Language Models (LLMs), Fiber networks stand ready for this low-latency, high-capacity transport. LLM growth alone is estimated to grow from $6 billion in 2024 to $36 billion in 2030 — driving massive amounts of infrastructure and a need for Fiber well into the future. Newer reasoning models help to drive beyond the creation of content, but autonomous management of decisions.

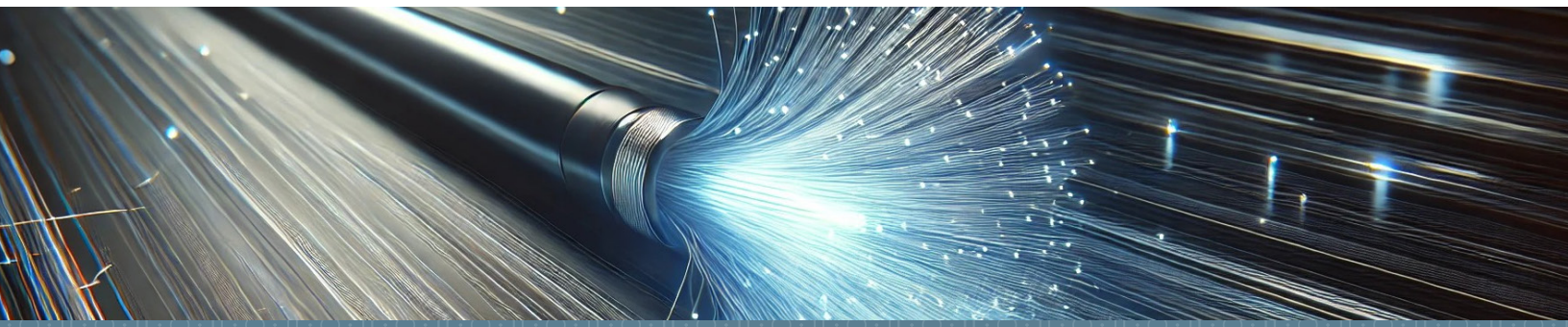
THE FIBER INDUSTRY IS READY TODAY

Fiber, networks, and architectures are moving beyond just the transport of a fast pipe. With AI's unprecedented acceleration for size and scale, Fiber critical infrastructure is the backbone of a transformative future.

The Fiber Industry is ready and evolving along with AI investment strategies. The strongest example is data center Fiber — both for interconnections and network distribution — feeding any strategy for data learning across the world. The pureness of Fiber — in terms of raw speed and flexibility are two of many advantages for AI scalability to billions of users. For example, Meta touches almost four billion people every day.

Finally, as networks convergence for wireless and wired subscribers, Fiber network management is agile enough to bring compelling applications of both downstream and upstream connectivity. In fact, AI agents in 2025 will be rolled out for greater network efficiency and speedier support. Initial autonomous agents will be used for alarms, support tickets, and network failure predictions. This will bring subscriber Quality of Experience to an unprecedented level.

THE CHALLENGE: Fiber industry people across the board — from install to support to marketing to leadership — must learn and evolve with new opportunities using AI agents and tool sets to augment human-led Fiber systems.



AI'S IMPACT TO THE FIBER COMMUNITY

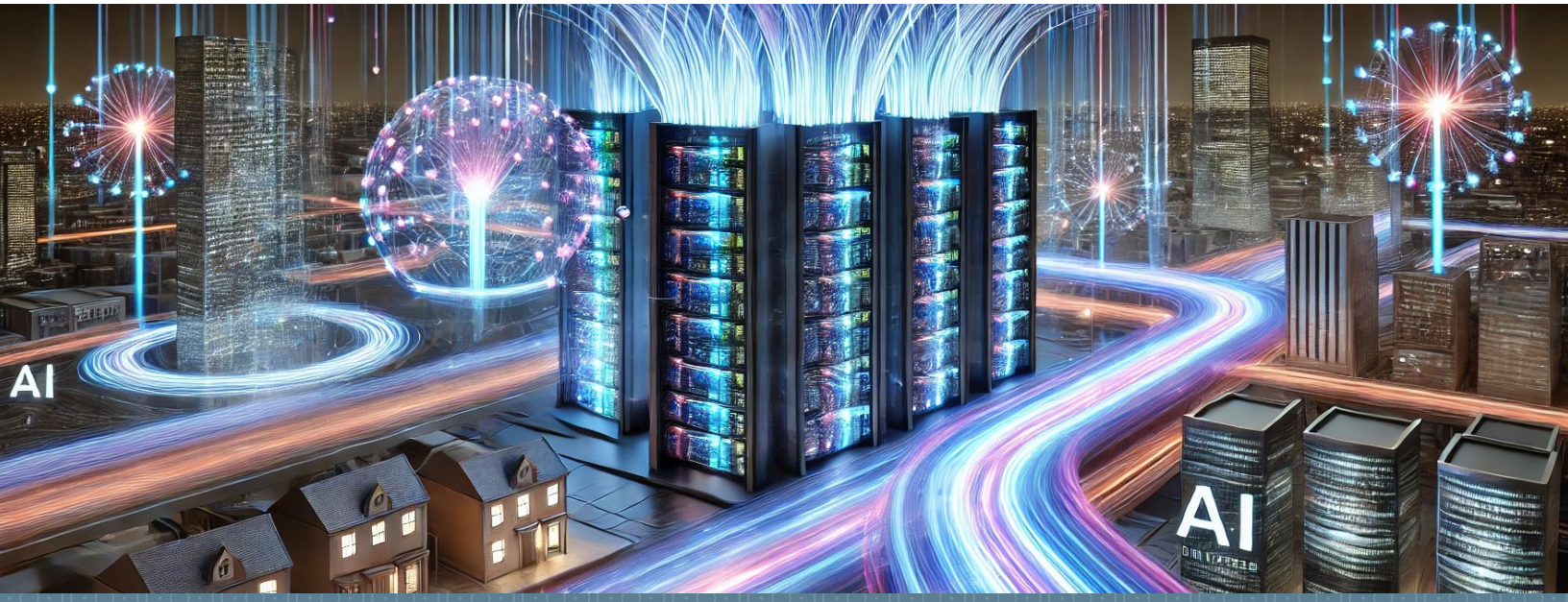
A Generational Inflection for Fiber Networks is Driving AI

Growth: There is no doubt AI has created the most significant potential for network and Fiber growth in history due to its sheer scale and reach. As we move from an information age to knowledge systems to automation to reasoning, AI and the infrastructure required to support it remains critical in terms of utility and growth. Fiber represents the best network means to manage AI well into the distant future.

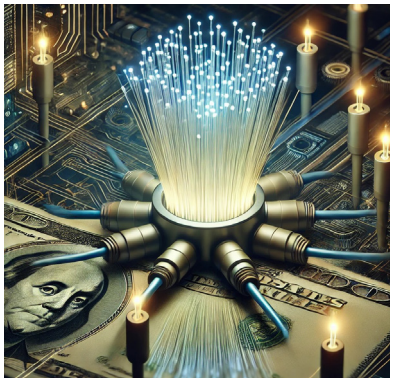
AI-Ready: In a multi-Cloud and AI world, the networking protocols and network architectures need necessary upgrades. Becoming AI-ready requires pathways for high bandwidth, high security, and low latency to transfer AI workloads. This then provides three vectors for Fiber strategies including the initial backbone, revised AI-driven support, and new digital services that lead to better enterprise and customer experiences.

Fiber Serves More than Just Hyperscalers: Fiber's initial build-out is to support the large Cloud and AI hyperscalers (e.g., AWS, Microsoft, Google, Meta) and the AI data centers that support them. Just look at Microsoft's $80 billion dollar commitment to data center build and the re-opening of the nuclear powered Three Mile Island. In addition, the roll-out of smart network and support systems will continue with next generation management across the network. Coming next are large enterprises that need more capacity, followed by real digital home value. Far-term explosive growth will be seen in the out-years where AI-to-AI learning will automate anything it can get its machine-hands on.

Impact on Critical Infrastructure with AI Fiber: Just like any great service and infrastructure, Fiber is fast becoming invisible in an effective way — it just works. Doing that requires investment and acknowledgment that AI Fiber is critical infrastructure. Add the value of enhanced security and privacy protocols, and then we can see the value of AI Fiber shining ahead for the future.



WHAT ROLE DOES FIBER PLAY IN THE AI BUSINESS?



Looking at business roles helps define where Fiber companies play in AI:

- Buying or selling the new AI technology.
- Operating networks more efficiently or enabling other systems to do so.
- Providing greater value to customers or enabling AI all the way to subscribers.

Reconciling each condition helps define if AI is generating revenue or mitigating cost. In the near term, AI promises to increase efficiency saving cost, or to provide technology, Fiber, and services into the critical infrastructure. In the mid- to farther-term, Fiber network operators can begin to realize greater revenue from subscribers, especially as wired Fiber and cable converge together with wireless networks.

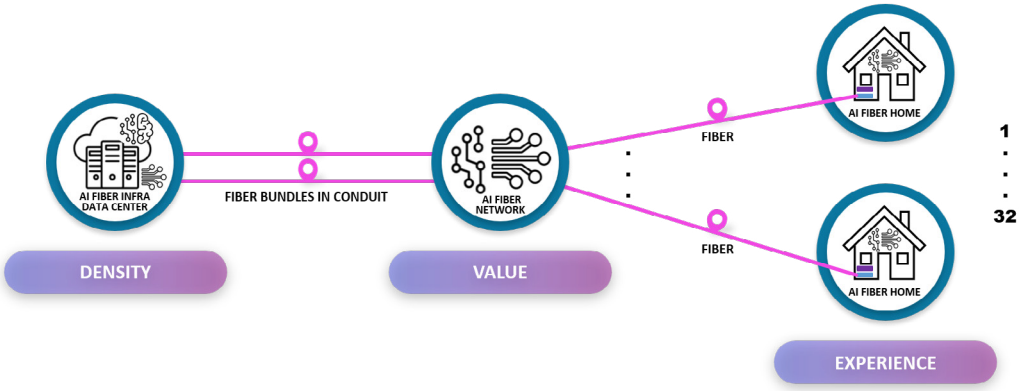
AI data workload is dramatically driving up bandwidth demand, necessitating robust Fiber optic networks to support an array of AI-driven services. AI significantly enhances network management and operational efficiency by optimizing data flow and reducing downtime.

Notably, AI also bolsters the security and resilience of critical infrastructure through advanced threat detection and mitigation. The economic implications of these AI-driven infrastructure upgrades are profound, stimulating investments and fostering innovation across industries.

According to a 2024 survey by The Futurum Group's Intelligence Team to better understand AI trends, companies expect to enhance customer experience, reduce costs, improve employee productivity, improve network operations, and meet revenue targets with the use of AI.

THE IMPACT OF AI FIBER TODAY – DENSITY, VALUE, EXPERIENCE

The framework of understanding for AI Fiber is in three principal areas — data centers, the network, and the AI Fiber Home. If we build on the tenets of AI Fiber – density, value, and experience — we can now look to how Fiber is vital to the growth of AI today and tomorrow. In essence, the growing AI landscape demands a major upgrade to our digital infrastructure, placing Fiber networks at the forefront. This architecture supports the massive data requirements from the core (data centers) across the network to the edge, ensuring a seamless and efficient AI-driven world to the home or enterprise.



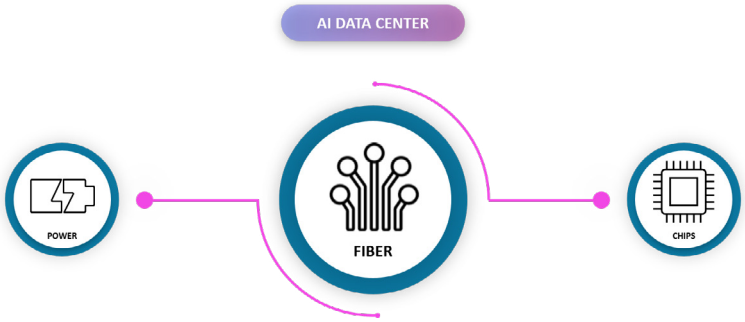
- **Density for AI Fiber Infrastructure and Data Centers:** As AI engines churn through massive data (in Cloud or virtually anywhere) they require high-speed connections to manage vast information flow. Fiber optic technology, with its superior bandwidth and low latency, is crucial for ensuring that AI data centers feed the middle mile to efficiently manage AI workloads. From the data centers, Fiber's ability to seamlessly carry data without significant loss or delay makes it the backbone of AI. *The AI Fiber attribute: Density.*
- **Value for AI Transport and Access Networks:** As data moves closer to the network edge for efficient processing and low latency it reaches nodes which function as hubs, ensuring data is routed to end-users, vital for supporting AI applications. In addition, AI-managed network services, AI agents, Cloud portals, and software work in tandem with service people to create a smarter network with both superior QoS and QoE. *The AI Fiber attribute: Value.*
- **Experience for the AI Fiber Homes:** The final step in the journey is delivering high-speed, low-latency data connections to AI-integrated homes. Whether it is for Tele-health, smart assistants, home automation systems, or AI-driven entertainment, robust Fiber connections ensure these AI applications provide a Quality of Experience (QoE) beyond QoS for a remarkable AI-driven capability. An important point is that Fiber Homes enjoy both downstream and upstream at the gigabyte level — unmatched by another network medium. That will mean Fiber subscribers can feed back data to their own AI personal model. *The AI Fiber attribute: Experience.*

DEEPER DIVE INTO ELEMENTS OF AI FIBER

1. AI Data Center

Triad of Value: In 2025, AI data centers need dense, efficient, scalable, and smart management. At a top level, an AI data center revolves around "density" — Fiber, Power, and processor/GPU chips. Both power and chips are in short demand while Fiber remains the bright anchor to aggregate and transport information into the network with Cloud-based architectures. Data centers are power and chip limited today — Fiber fills that gap.

Fiber-Dense: The relentless growth of AI is revolutionizing Fiber connectivity both within and beyond the data centers. Corning reports that facilities designed for large-language-model AI applications will necessitate up to five times more connectivity compared to current hyperscaler architectures.



"AI is quickly driving the need for more optical connectivity," said Michael O'Day, Chief Technology Officer, Corning Optical Communications. "In doing so, it creates the need for new applications across many vertical markets and industries that consumers and businesses will use. And those applications will require more broadband access and connectivity." Looking at the greater attribute of AI Fiber for infrastructure and data centers, there is now focus in the following areas.

- **Interconnected Data Centers will Fuel the Future of AI:** Speed and scalability are not the only challenges brought on by the data demands of AI. Operators and key vendors will build new AI-enabled connectivity methods to expand network capacity, including long-haul connectivity between data center campuses, in addition to smaller data center/head-end Fiber for access networks.
- **Space Optimization:** Optimizing space in AI-enabled data centers is crucial as they may require up to ten times more optical Fiber than traditional networks. As back-end networks for GenAI evolve, GPU clusters and Fiber-rich interconnects must also meet complex and massive data-intensive processing requirements. Finally, Fiber with low attenuation and exceptional bend performance must also ensure efficient and reliable performance in constrained spaces.
- **Speed, Scalability and Flexibility:** As bandwidth needs grow, network deployment speeds and scalability are paramount. To increase data processing capabilities, structured cabling for multiple generations of optical transceivers is critical. Cable and Fiber flexibility is also crucial for maximizing space and computations for a considerable amount of data. It offers improved control over signal loss and facilitates connections over large networks.

KEY INDUSTRY DEVELOPMENT

Lumen Technologies recently entered into a significant supply agreement with Corning Inc. estimated at $5 billion to provide next generation Fiber optic cable. This deal reserves 10% of Corning's global Fiber capacity for the next two years to support AI-enabled data centers. The agreement will more than double Lumen's intercity network miles, enhancing its capacity to meet the growing demands of cloud data centers and AI workloads.

Power's Influence on Data Centers and AI Fiber: In the short term, by any measure, the AI-revolution is power limited, with megawatt needs and the timeline to build new centers far into the future (three to five years). Access to greater power accelerates Fiber's growth.

- On the power side, high-density AI-ready data centers are testing the limits of existing power infrastructure, requiring a fundamental rethink of how these systems are powered. This shift is not just an evolution but a revolution — one that will have profound implications for both data centers and the Fiber industry. New thinking is evolving to drive AI Fiber to a dominant strategic position.
- Historically, data centers were built near accessible power infrastructure, with Fiber deployments expanding to meet their needs. However, AI is driving a shift in how data centers are powered and where that power originates. Advancements in onsite power generation, including modular DC power systems, could now shift location strategies from being power-centric to Fiber-centric.
- Implications for the Fiber Industry are straightforward — thinking beyond traditional grid power sources may allow data centers to be close to the best Fiber connectivity. This transition can dramatically redefine the calculus — prioritizing proximity to network connectivity over proximity to traditional power sources. Locations optimized for Fiber rather than power could become the new standard for data center placement.

KEY POWER INDUSTRY DEVELOPMENT

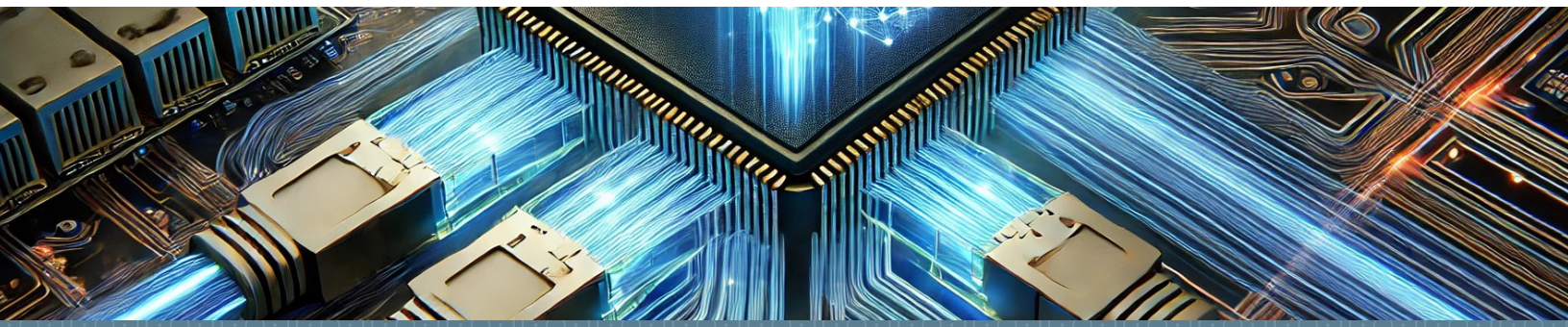
Microsoft recently signed a major deal with Constellation Energy to purchase power from the Three Mile Island Unit 1 nuclear plant. This move is aimed at providing the substantial energy for Microsoft's data centers essential for running AI applications. The plant, once revived, will supply enough energy to power roughly 800,000 homes.

Chips Influence on Data Centers and AI Fiber: GPUs significantly impact the Fiber infrastructure in AI systems by driving the need for high-bandwidth, low-latency connectivity. These chips perform intensive computations, requiring rapid data transfer to function efficiently.

- As AI applications using LLMs and massive general knowledge or RAG data sources become the norm for effective learning processes, the demand for higher capacity and faster data transmission across data centers intensifies. Fiber optics, with their ability to support high data rates over long distances, are essential in ensuring AI systems operate without bottlenecks, facilitating seamless communication between AI chips and other components within data centers.
- In addition, the demand for chip processing and memory windows of context is driving data center operators to optimize their network architectures to meet the unique demands of AI workloads. This includes implementing high-density Fiber interconnects and advanced cabling solutions to support the vast data processed by AI chips. Integrating these advanced Fiber solutions enhances the overall performance and scalability of AI systems, enabling the deployment of more complex and sophisticated AI applications.
- As AI technologies continue to evolve, the symbiotic relationship between AI chips and Fiber infrastructure will be crucial in driving innovations and efficiencies in data processing and network management.

KEY CHIP DEVELOPMENT

Nvidia's recently launched the Blackwell GPU, which is designed to significantly boost performance for generative AI, quantum computing, and other high-performance tasks. The demand for Blackwell has been described as "staggering," and Nvidia is racing to scale up supply to meet this incredible demand.



Don't Forget Fiber Developments in the Middle Mile

The middle mile refers to the intermediate stage of broadband infrastructure, connecting local networks to larger, high-capacity networks. Recent developments in this area have focused on expanding and improving fiber networks to enhance connectivity and bridge the digital divide.

AI is playing a crucial role in optimizing and managing middle-mile networks, enhancing efficiency and performance with enterprises integrating AI into customer-facing products to drive growth and profitability. This technology is being used to improve marketing, sales, and service functions, potentially increasing revenue by up to 25% over five years. AI is breaking out in two areas:

- **Federated Wavelength Services:** AI is enabling more agile and responsive digital platforms that allow for faster service turn-up and global connectivity.
- **Network Re-Architecture:** Enterprises are re-architecting their networks to support AI and cloud services, leading to significant growth in cloud service revenue. The demand for ultra-high capacity and multi-cloud models is driving innovation in this space.

For more on the middle mile and AI, see MEF's in-depth analysis

2. AI Fiber Networks

Greater Network Value: By any measure, Fiber network providers aim to minimize network cost, increase subscriber revenue, and mitigate churn. It is in this context "performance" is attained; in other words, a healthy financially sound operation that generates greater EBITDA over the mid to long term. AI Agents can greatly assist and grow the bottom line.

The network itself must be reliable, available, and evolvable —– Fiber networks deliver these aspects extremely well. More sophisticated AI agents will enhance the ability to manage and operate these networks simply and effectively. Looking ahead to the convergence of wired and wireless networks will increase complexity and that is where AI really kicks in for greater network value.

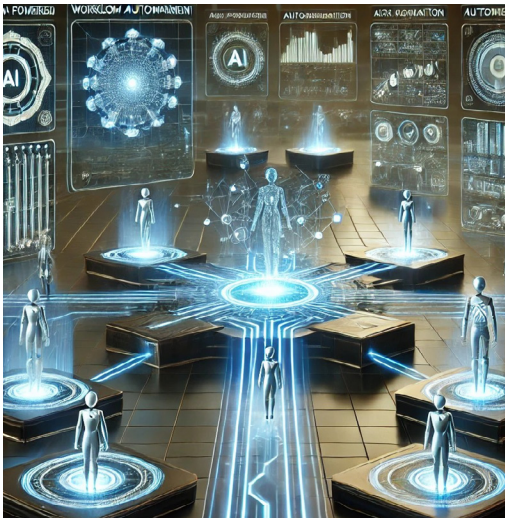
Legacy Machine Learning: While there is much focus on the potential of Deep Learning for LLM-driven GenAI, machine learning still plays a role in network performance — at a cost-effective price. Reviewing certain advantages of ML for networks is important because it gives a baseline and sets the stage for the next generation of AI LLMs into the performance of the network. Today, ML is cooling down as AI Agents look to fill the gap in services and support in 2025. What is certain is that ML will transition to AI agents as reasoning models grow and applications make decision-making autonomous.

Looking To Smarter AI Networks: The Futurum Group's latest insights report, *Fiber, and AI: Meant for Each Other* spotlighted how natural language processing (NLP) comprehends and engages with human language in a natural, conversational way. GenAI chatbots have made inroads by simplifying interactions for operations teams, allowing them to manage complex systems without requiring extensive technical expertise.

Virtualization: Another important aspect of the network is virtualization, which uses cloud native orchestration to deliver touchless real time service management. This ensures more personalized services to any user on an as needed basis and sizing the network dynamically, saving bandwidth and precious capacity.

For example, 5G networks are beginning to use standalone cores which implement this capability. Cable networks have virtualized their data service control hardware and have a program in place to produce consistent and single architecture for wireless and wireline services. As Fiber grows into this converged space, virtualization will be key to its future. AI agents must also be part of the mix here as well.

AI agents, outlined next, are revolutionizing network virtualization by enhancing predictive capabilities and real-time monitoring. They analyze vast amounts of data to dynamically allocate resources, ensuring high-quality service and meeting user demands. This proactive approach replaces traditional reactive methods, optimizing network performance and reliability.



AI Agents: Today, AI agents are the most influential aspects of network management and support services because they change the nature of work itself. Fiber network providers and vendors must reevaluate network workflow in this new age.

In short, the primary goal of AI agents is to perform tasks autonomously to achieve specific objectives and enable them to make plans and decisions, as well as interact with their environment. They exhibit a high degree of autonomy, operating with minimal human intervention.

Generative and Conversational AI can handle routine inquiries such as billing, technical support, and account management, providing instant, 24/7 support. Using both customer data and context proactive notifications during outages can be super-fast and accurate.

AI Agents Provide More for the Fiber Network: AI Fiber agents can use deeper network data to also optimize energy, security and provide a new level of planning. AI agents autonomously execute the next steps in a workflow via a single prompt by creating tasks, executing them, collecting feedback from the environment, and then planning and prioritizing the remaining tasks until the objective is achieved. SLMs (System Learning Models) serve as the reasoning and planning component, making the AI agents more efficient and responsive. At a top level, examples of AI agent applications in Fiber networks include:

- **Network Performance Metrics:** Analyzing signal strength, latency, and error rates to identify issues.
- **Analyzing Network Patterns:** Anomalies in data usage to predict future demand and optimize capacity.
- **Automated Network Restoration:** Automation of traffic in cases of Fiber cuts to minimize service disruption.

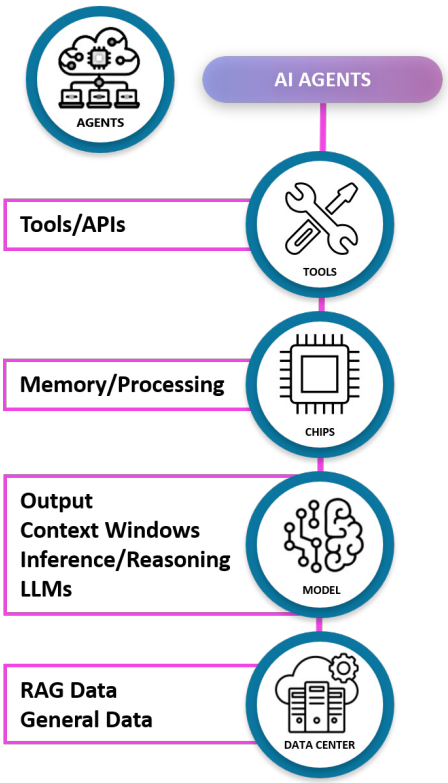
More specifically, AI agents can also be thought of as useful members of the team, in an AI-machine roles such as:

- Network Monitoring Agents
- Predictive Maintenance Agents
- Resource Optimization Agents
- Security Agents
- Customer Support Agents
- Data Analytics Agents
- Field Technician Agents

NOTE: A salient and crucial point is that although we use the word "agents," it is much more than that. What is really happening is the establishment of a new "agentic workflow," where master and subagents work together under a prescribed orchestration feeding off each other, the data, and the model being used. Agents are both a product and a process.

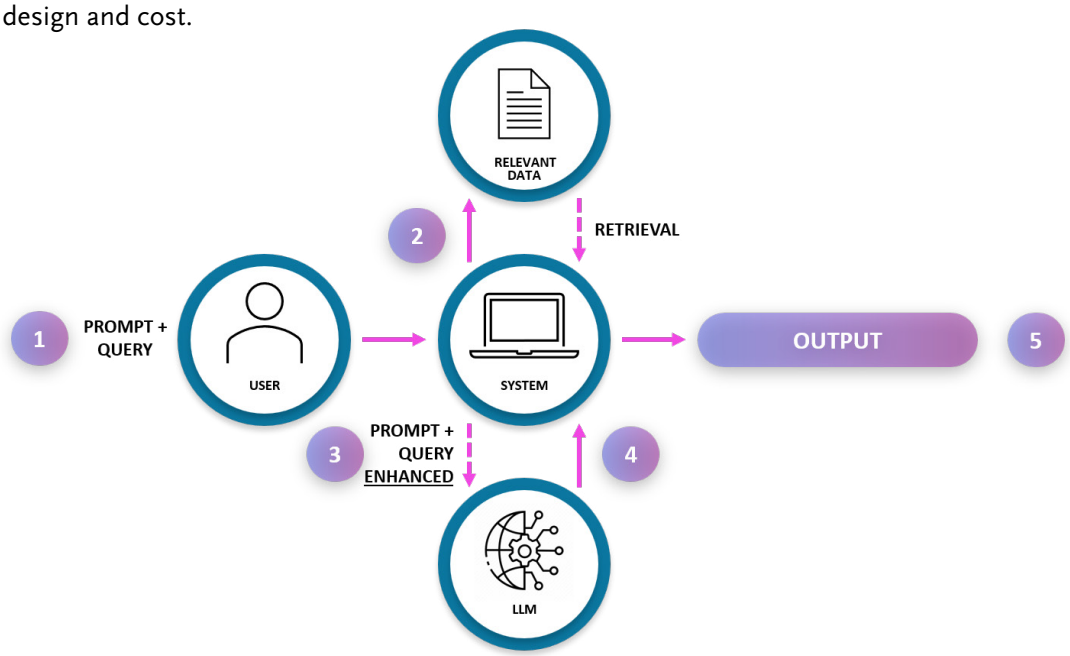
Steps to Effective AI Agentization: Data feeds a model generating an outcome. AI workflow for Fiber operations using AI agents begins with selecting network data sets and collecting info from network sensors, SNMP log data from Fiber network devices (e.g., OLT's, ONT's, W-Fi routers). This data is then fed to the model for a series of learning and then used in the network. The AI network agent becomes a new automated process robot – actually learning and making decisions. AI agents continuously monitor and refine these processes to improve accuracy and efficiency.

- **Impact:** Model training involves using deep learning and supervised learning models to predict network performance and user behavior, with AI agents assisting in data preprocessing and parameter tuning. Once trained, these models are deployed for real-time network monitoring and predictive analytics, with AI agents ensuring smooth deployment and continuous model updates. Actionable insights are generated, including alerting network operators to anomalies and implementing automated responses to common issues, all facilitated by AI agents.
- **Workflow:** The workflow concludes with a feedback loop where models are refined based on new data and user feedback, enhancing user experience and network performance. AI agents play a vital role in collecting feedback and integrating it into the refinement process.



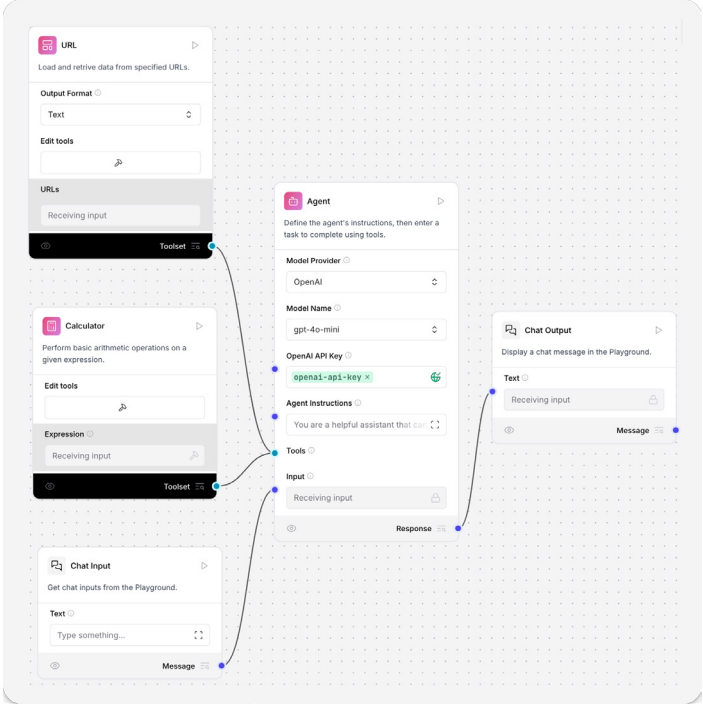
The Importance of RAG Data in the AI Agent Process: RAG (Retrieval-Augmented Data) optimizes the output of an LLM by extending the initial prompt into specific domain or company data, without the need to retrain the model. Using RAG data can also allow a level of security and Intellectual Property (IP) protection if you do not want to mix or share data with a wider data set.

In the case of Fiber networks, vendors and network providers can retain their IP for all aspects of service and support and differentiate themselves from other networks or equipment in the market. RAG data can feed AI agent process and as models become smaller and more sophisticated, this will be critically important in both design and cost.



Network Agentic Workflow: Current workflow on a Cloud portal provides a linear approach shown for operations, support, and promotion (shown below). However, when network management is transitioned to agentic workflow, the approach changes to increase efficiency and learning from the model. Data, such as from SNMP log data or NID's, is managed by the agents, where the power of RAG and foundation models speed up the process.

The best approach for design is to solve for pain points in the network based on where is the greatest impact for Quality of Service (QoS), access to security measures, or speed to understand what's happening during an outage. Sample questions will center around where AI agents can automate, what learning is important for trends, and finally, the impact that QoS has on Quality of Experience (QoE) in the digital home.



AI Agent Development: AI agentic framework and AI agents in the area of alarms and predictive maintenance can be created. This represents a cost-saving approach to faster support, as well as a deeper commitment to both QoS and QoE for Fiber networks. Fiber integrators and device manufacturers will launch AI agents in 2025 to automate support and services.

This will augment existing teams and leverage what has been done for machine learning in their Cloud portals. Shown left is a typical agent workflow using Langflow.

3. AI Fiber Home

The AI Fiber Home is emerging and is much more than just being connected. The new expectation in many homes is at a Gbps level which allows multiple devices and strategies to grow well into the future.

Fiber networks have looked for pathways to reduce subscriber churn and allow greater ARPU (Average Revenue Per User), and AI-driven experiences are top means to do so.

New and real impact is being seen in the AI home today using devices for Smart Home Hubs, AI Thermostats, Security Systems, Smart Lighting, and Appliances, to name a few. With the advent of Telehealth and new education initiatives, the AI revolution continues to fuel the incipient demand for both bandwidth and Quality of Experience. In fact, the AI Fiber home looks to the future in areas such as:

- **Increased Bandwidth Demand:** AI applications, including legacy machine learning, data analytics, and Internet of Things (IoT) devices, require substantial bandwidth and low latency. This surge in demand is prompting Fiber broadband providers to upgrade their networks to handle massive data transfers efficiently.
- **Upstream** (from the subscriber back to the central office/headend) is an area where the AI Fiber home will have great potential. In a sense, as people feed the model with their data upstream, homes will become AI creation hubs for personalized models.
- **Network Value to the Home:** AI agents predict and prevent network congestion, ensuring high-speed and reliable internet connectivity. This results in smoother streaming, faster downloads, and overall improved performance for all connected devices in the AI Fiber home. Most of all will be how AI Fiber users communicate to the model or for applications requiring multi-modal techniques using a combination of text, video, imaging, and syntax.

- **AI Fiber Impact** to people is already moving, including healthcare, education, manufacturing, finance, and transportation. AI holds the promise of helping doctors and clinicians in their life saving work to help detect abnormalities in medical imaging or for oncologists to make more sophisticated data-driven cancer treatment regimens.
- **ARPU and Customer Service Engagement:** An AI program can guide customer service reps to effectively personalize engagements and sales with customers. They can now utilize publicly available information, a databank of past customer interactions, and deep-learning AI processes to provide recommendations for every subscriber interaction through an interface. We see an initial push to integrate with customer relationship management (CRM) systems, such as Salesforce's Agentforce platform, to automate and augment Fiber marketing programs.

Building on the Fiber Connected Home Legacy: In FBA's recent article, "Finding More Monetization Opportunities in the Connected Home," greater opportunities in the connected home market were suggested such as offering premium smart home features, developing data-driven insights and analytics, creating integration in the smart home ecosystem, providing proactive maintenance and support, and exploring opportunities to sell targeted advertising based on user data. Each can be enabled with AI, but none are near-term game-breakers for revenue.

Quality of Experience (QoE): Meeting end-to-end QoE broadband service needs from inside the home to the application host and datacenter requires a seamless integration of network infrastructure and service delivery. The emerging plethora of new services and specific user applications demands robust application awareness and adherence to QoE and QoS requirements. Innovations in network architectures and features are essential to embody a service-led approach, ensuring high performance and reliability.

One Fiber network leader, GFiber, has committed to QoE by enhancing the quality of experience by rolling out ultra-high-speed internet services, including 2 Gig, 5 Gig, and 8 Gig products. These advancements ensure seamless videoconferencing, large data transfers, and access to cloud resources, providing a competitive edge in the market. The CEO's vision focuses on delivering exceptional internet performance and customer satisfaction, pushing the boundaries of what an ISP can be.

Convergence: Leading providers of home internet service recognize that the optimum relationship must embrace them for something greater than just bandwidth — no matter where they are or what devices they use. As wireless and wireline providers converge, the value of subscribers coming from the AI Fiber home increases. As network convergence continues, we will see how AI networks use data from common subscriber sets for greater ARPU and access to deeper network learning.

AT&T CEO John Stankey has been vocal about the convergence of mobile and Fiber-based services. At the Goldman Sachs Communacopia + Technology Conference, he highlighted AT&T's focus on integrating technologies to compete more effectively with cable companies with connectivity and a seamless, high-quality experience.

Fiber Remakes the AI Experience in the Home: AI applications require fast connectivity, low latency, and robust reliability beyond a traditional Mbps experience. This is where Fiber shines. There are many applications today and soon that demand will fuel AI hungry Fiber applications, discussed below.

The delivery of the metaverse and next generation entertainment requires a Fiber network unmatched by other transport mediums. In addition, as more devices create automation in the digital home, all of those will be AI-driven, meaning that the learning aspect of the data collected and shared will be critical to both the experience and the performance. A few promising areas for the AI Fiber Home include:

Healthcare AI encompasses a wide range of applications, from AI-driven diagnoses to precision medicine tailored to individual patients. Fiber can assist in seamlessly transferring medical imaging, records, and real-time video across providers. Additionally, AI Telehealth for seniors facilitates virtual medical consultations, health monitoring, and timely medication reminders.

Work at Home AI redefines how the AI Fiber Home makes remote work a seamless reality. Videoconferencing, accessing massive datasets, or using AI-driven SaaS applications all depend on reliable Fiber as part of a new workflow. This shift enhances productivity but also fosters a more flexible work environment, catering to the evolving needs of modern professionals.

Home Gaming is being revolutionized by AI, powering a realistic, immersive, and low-latency experience. From generating dynamic, adaptive game worlds to creating intelligent, lifelike non-player characters, AI enhances gameplay and pushes the boundaries of interactive entertainment. Additionally, AI-powered personalization algorithms tailor gaming experiences to individual preferences, and as AI advances, even more innovative gaming emerges, blurring both the virtual and real worlds. Beyond gaming, AI-powered Fiber networks will transform home entertainment with a deeply personal experience.

Virtual Reality (VR) and Augmented Reality (AR) enable interactive storytelling where you become a character in a movie or TV show, is now possible. AI-driven VR and AR transport you to distant lands or enhance real-world surroundings with digital overlays. This promises a future where entertainment is tailored to your personal preferences and again blurs the lines between the digital and physical worlds.

Education: AI-powered Fiber homes will revolutionize education for children, transforming learning into new learning experiences using AI-powered tutors to provide feedback and adapt to each child's learning pace, making lessons more effective. Immersive virtual field trips will transport children to distant lands and historical events, sparking curiosity and fostering a deeper understanding of the world. Additionally, AI-driven language learning apps will make language acquisition fun and interactive, opening new cultural horizons for young learners.

The New AI User in the AI Fiber Home – "PCHP"

In 2016, the vision for Deep Learning was outlined by Sundar Pichai who stated, "Using Neural Machine Translation, we improved our translation ability more in one single leap than all our improvements over the last ten years combined." Roll forward to 2025 and the power of neural networks is taking hold over a new business paradigm called Persistent Contextual Hyper Personalization or "PCHP."

PCHP, first coined by Paul Connolly, a nationally recognized executive and network thought leader has identified a new foundation for what it means to be an AI Fiber Home User. Paul builds on what Sam Altman, Open AI's CEO, calls the Intelligence Age. We simply have harnessed deep learning into a realm of human reasoning. Combine that with the context of what people actually do, and you then can create a deep immersive, engaging, and personalized experience.

PCHP will form the backbone of the economic value of a subscriber because it provides a path to how to reduce churn rate (i.e., the switching of services) and add new applications that create both time and impression engagements for greater advertising revenue. With both this cost-saving and revenue-generating model, ISPs and application providers can fight their way out of being just a fast Fiber pipe.

Initial PCHP user growth builds off the massive uptake of ChatGPT and extends into the everyday home in entertainment, health, security, and home device management. Because it is the best combination of persistence and context for specific user needs, the experience not only feels personal, it is personal.

The business value is clear, especially as wired, and wireless providers converge together to serve a larger set of subscribers. This network convergence is now underway, and the payoff comes from AI-driven strategies that leverage PCHP marketing and services beyond selling Gbps services.

The Powerful Combination of BEAD and AI Fiber: The original impetus of the Broadband Equity, Access, and Deployment (BEAD) program was to address the digital divide by ensuring universal broadband access.

Part of the Infrastructure Investment and Jobs Act (IIJA) signed into law in November 2021, BEAD provides high-speed internet to underserved and unserved areas, thereby promoting economic development, educational opportunities, and improved healthcare services through better connectivity. Adding AI Fiber to the mix creates a far deeper payoff than was originally imagined.

The Real Payoff of the AI Fiber Home: Without question, Fiber connectivity to the underserved communities in the U.S. will ensure that everyone has access to the information worldwide for a host of advantages. But more, as these homes get connected is the ability to hear the voices of each community — lower economic communities, native tribes, and rural workers providing food, electricity, and infrastructure to the nation. AI Fiber in the Home does that.

One aspect of AI is that the machine speaks any language or communicates because it is built that way. We now will not need to become PC-literate, we can enjoy all the advantages of AI. In addition, because the upstream potential of AI Fiber is significant in the Gbps realm, every person in the spectrum can be part of both a personal and larger model. This will impact how we get to know, how to better fund, and how to really serve constituents — all powered by AI Fiber.

AI FIBER USE CASES

Data Centers

Powered by American fiber and AI network know-how, the use cases demand optimization of managing data at scale with low latency. The importance of Fiber: it is the backbone of the AI Economy.

AI Data Center Use Case: Lumen's® Private Connectivity Fabric℠

Need: Many organizations today are racing towards AI readiness and often overlooking the network's impact on their goals. In fact, 86% of CIOs feel their networks aren't ready for AI ecosystems.[1] Businesses are stretching their network capacity using adaptive applications powered by AI and ML which facilitate data in larger quantities than ever before. To innovate and grow, these organizations need a modernized, secure, and scalable infrastructure to handle their workloads today and for the future.

Where AI Plays: Private Connectivity Fabric℠ enhances business agility by providing network resilience that withstands increasing data volumes and applications. The vast Lumen network is built to power AI initiatives. Lumen expects to end 2025 with 16.6M intercity fiber miles and for that total to increase to 47M intercity fiber miles by the end of 2028. These custom network architectures are designed to provide high-speed, secure connectivity, that supports AI and real-time decision making.

Payoff: PCF℠ enables an AI-ready infrastructure with -25%[2] optical loss vs. wider market, ≤5ms of latency at the edge, designed to cover up to 97% of U.S. business demand, and 60% more capacity vs. legacy fiber.

Visit Lumen.com and learn more about the trusted network for AI here.

LUMEN TECHNOLOGIES

[1] IDC, Enterprise Horizons 2024, June 2024
[2] ~25% less fiber optic loss per km; less loss translates to less frequent need for fiber optic signal regeneration, decreasing equipment costs; figure is based on a comparison to vintage 2000 fiber (decrease from .22 db/km loss to.17 db/km).

Middle Mile for Heavy AI Transport

Optimization of massive AI data at scale requires deep attention to the Network Middle Mile using Fiber to feed hub and spoke data centers which feed Fiber networks. The importance of Fiber. Fiber manages dynamic distribution of AI applications and data.

AI Network Use Case: Adtran Optimizing the Middle Mile

Need: Optical transport solutions are needed for AI-driven middle-mile networks in the areas of:

1. High bandwidth and scale to handle massive data;
2. low latency for real-time decision-making;
3. Energy efficiency for AI operations;
4. Flexibility and programmability using SDN (software-defined networks), and;
5. Integration with edge and core AI optical networking design for the alignment of edge-to-cloud AI processing.

Where AI Plays: AI is catalyzing a generational optical-network build cycle. The largest cloud service providers are constructing gigawatt AI training centers, and communication service providers (CSPs) are responding with connectivity at Pbps scale.

A significant bandwidth opportunity in interconnecting enterprise data lakes with the AI training centers is all driven and enabled by AI and its massive data needs.

Payoff: AI solutions in the middle mile are all about unlocking the coherent optical network edge.

With Adtran's partner Coherent, the industry's first coherent 100ZR plug in a QSFP28 form factor with less than 5-watt power consumption suitable for outdoor cabinets was developed.

In addition, a corresponding open line system (OLS), without active components and free of any spectral limitations is available. This all works in tandem with Mosaic One, a software suite that unlocks SDN and automation capabilities.

Learn more about Adtran's commitment to the AI Middle Mile

Management Cloud for Network AI Support

Using the perfect combination of Cloud services, AI optimization and attention to RAG data purview and security demands complex AI know-how. The importance of Fiber: Subscribers see the difference for a pure AI network experience.

AI Network Use Case: Calix Operations Cloud

Need: Simplify network operations, subscriber engagement, and services to provide flawless customer experience with broadband that is fast, stable, and always on. Leverage network data for the LLM.

Where AI Plays: Transforms network operations into a subscriber experience differentiator using ML, AI Agentization and predictive analytics for network health monitoring, intelligent alarm management and subscriber impact visualization — moving from reactive to proactive.

By using RAG (Retrieval-Augmented Generation), network and subscriber data is kept within the purview for both learning and efficiency, as well as protecting the data. RAG enhances the reliability of Large Language Models (LLMs) like GPT4 or Llama and addresses limitations of traditional LLMs.

The network value is for RAG optimized LLMs to deliver contextually relevant information, diminish hallucinations, delete outdated knowledge, and decrease untraceable reasoning. Combine that with AI governance and security, and AI RAG LLMs shines.

Payoff: Leveraging AI drives results in Net Promoter Score (NPS®) and customer satisfaction (CSAT) metrics.

In addition, reduction of truck rolls using real-time network visibility and monitoring enable operations teams to address many issues remotely — reducing or eliminating the need to deploy field technicians. Finally, responding quickly to unexpected outages for faster resolution times.

Info on Calix' view on RAG

AI Agents for Automated Network Management

New AI workflows for autonomous decision-making, greater efficiency, and the agentification of Fiber ensures network optimization. The importance of Fiber: Automated AI agents provide deeper Quality of Services as networks grow.

AI Network Use Case: IdeaBoxAI

Need: As AI Fiber networks scale with greater data, AI learning and millions of subscribers, the expectation for both Quality of Service (QoS) and Quality of Experience (QoE) increases. As costs grow and service teams become over extended, AI agents can lighten the load and increase all metrics for customer satisfaction and lower churn.

Where AI Plays: AI agents are required to create more efficient and intelligent network operations by automating tasks, improving service quality, and enhancing subscriber engagement.

This will be seen for AI agents in Network Health Monitoring, Intelligent Alarm Management, Subscriber Impact Visualization, and Proactive Maintenance. In addition, marketing programs using AI agents will be critical to maximize revenue return from subscribers.

Payoff: Leveraging AI in network operations results in significant improvements in customer satisfaction, cost reduction, and overall efficiency, driving long-term business value.

- **Enhanced Customer Satisfaction:** AI agents help maintain a stable and fast broadband service, leading to improved customer satisfaction and loyalty.
- **Reduced Operational Costs:** By automating tasks and reducing the need for manual intervention, AI agents lower operational costs.
- **Increased Efficiency:** AI agents streamline network operations, allowing operators to focus on more strategic tasks.
- **Faster Issue Resolution:** AI agents enable quicker responses to network issues, minimizing downtime and improving overall network reliability.
- **Implementing Network:** AI agents can transform network operations, leading to more efficient processes, better service quality, and higher customer satisfaction.

Learn more about IdeaBoxAI for AI Agentification

IdeaBoxAI
EMPOWER YOUR IDEAS WITH AI

FBA engaged Entropy, Inc., a firm specialized in business, systems, and technical advisory to outline the impact of AI and Fiber today.

With a focus on real world value and business impact, the report sets a baseline for Fiber industry assessments and strategies that must evolve along with the massive AI growth today.

More info is available by contacting Entropy, Inc. at pc@entropybusiness.com or visiting www.entropybusiness.com