



**Subscribers
Are Demanding
Highly Available
Broadband—
Here's How
To Deliver It**



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Today, access to high-speed internet is considered a utility, on par with electricity or water. Without it, many people would be unable to do their jobs or access essential services, such as education and healthcare. The availability of reliable broadband is even becoming a critical factor in determining where people choose to live. Real estate prices are estimated to increase by 3.4 percent when high-quality fiber broadband is available.¹

In addition, broadband service providers (BSPs) are looking to differentiate from the competition with value-added services for residential subscribers. Plus, diversify into new market segments (such as MDUs or small businesses)

to drive new revenue—making having a reliable broadband connection even more critical. As a result of these trends, how subscribers select a broadband provider is changing. Fast download speeds are still valued, but service availability is now a key priority for subscribers—and even more so for businesses.

BSPs must be able to design reliable and robust networks that can provide an array of services without costs and complexity spiraling out of control. This eBook highlights how BSPs can deploy reliable and highly available networks to deliver the ultimate subscriber experience.



Why Network and Service Availability Matter

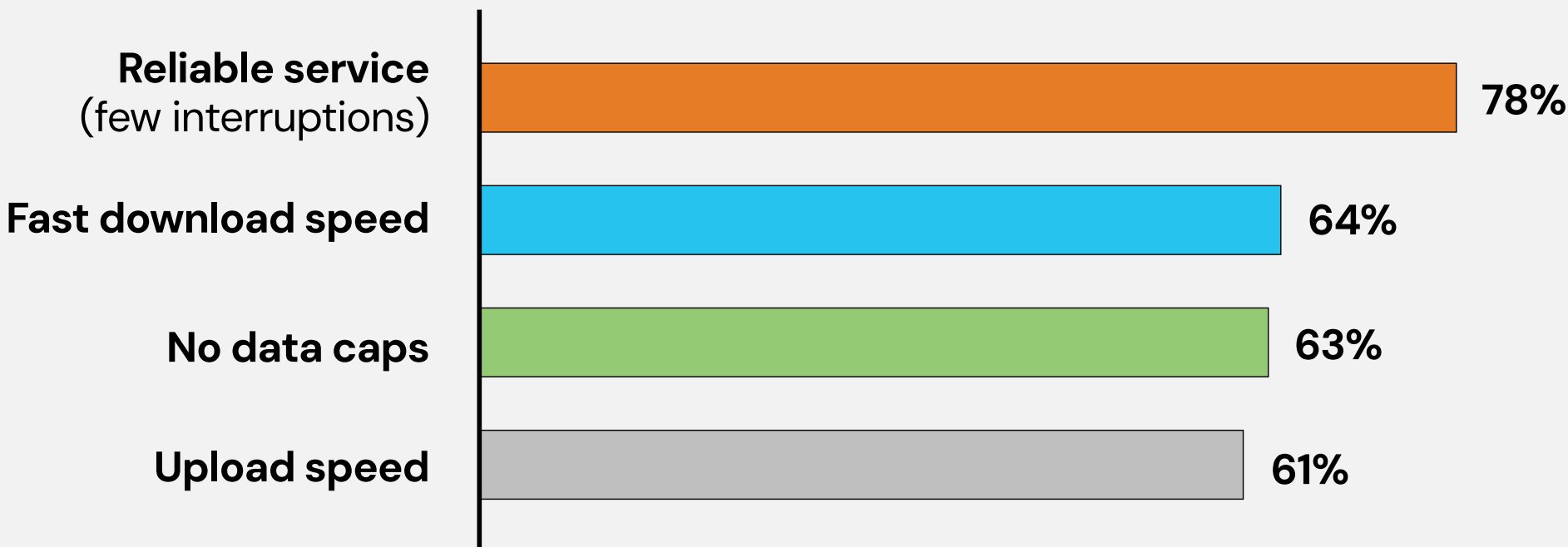
Subscriber expectations around fixed broadband are changing. The typical motivation for selecting (and remaining with) a BSP used to be focused on advertised speeds and prices. But shifting patterns in how subscribers work, learn, and spend their leisure time brought another important factor to light—the availability and reliability of the broadband network.

According to a recent study by the Fiber Broadband Association, network reliability was the most critical factor when selecting a broadband service, cited by 78 percent of respondents.ⁱ Speed was cited as the second most crucial factor.

A separate study by Analysys Mason found that a 1 percent increase in subscriber satisfaction around reliability and speed corresponded to a 4.7 percent decrease in their likelihood to churn—making reliability and speed a greater defense against churn than price or subscriber service.ⁱⁱ

Fiber is the fastest and most reliable broadband access technology. According to a 2021 study by the Fiber Broadband Association (FBA), fiber has the highest reliability of any access technology based on reported outages and the lowest latency based on random speed tests.ⁱ This is a factor in fiber’s average net promoter score of 20 percent—considerably higher than other broadband types, which range from -5 to 45 percent.

A study by the Fiber Broadband Association found that reliability of broadband services is the most important factor for consumers, surpassing download/upload speeds and data caps. The study also found that reliability of service is a factor in subscriber satisfaction.



Source: Fiber Broadband Association

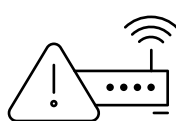
The Many Threats Facing Your Network

Despite the growing importance of broadband service reliability, network outages caused by extreme weather, natural disasters, operator error, or fiber cuts are expected. Major outages are usually subject to investigation by the Federal Communications Commission (FCC). The FCC also scrutinizes the disaster resiliency plans of major providers.

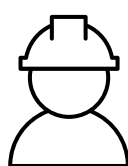
There are several causes for network problems, from a minor outage lasting a few minutes to a significant event causing the network to be down for days. The primary sources of network outages include:



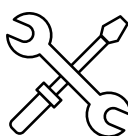
Natural disasters: Outdoor network equipment is susceptible to unexpected events such as earthquakes, storms, floods, and wild animal attacks. These impacts can be mitigated but are impossible to predict or prevent entirely.



Equipment failure: Both hardware and software can fail or degrade over time. Backup capabilities such as reserve batteries (in the case of power loss) can be implemented to guard against such failures.



The human factor: Network configurations and cable installations are susceptible to human error. These issues can be avoided by adopting network automation technologies. Automation can also speed up workflows and reduce costs.



Planned events: Maintenance windows and network upgrades may require network downtime. These events should be planned and communicated in advance to the users likely to be affected.



Cyberattack: As critical infrastructure, broadband networks are at an increased risk of cyberattacks. Cybersecurity must be a significant component of any network resiliency plan.



What Are the Consequences When the Network Goes Down?

Regardless of the cause and severity of the network outage, there are several negative impacts for both the BSP and the end user, including:



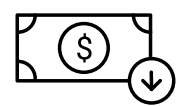
Lost connectivity: The inability to connect to the fixed broadband network leaves subscribers seeking other (less reliable or affordable) ways to get online—such as via cellular networks.



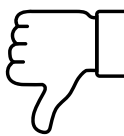
Lost productivity: Subscribers relying on fixed broadband for work will suffer lost productivity and potentially more severe impacts on a home business.



Lost information: Important data is increasingly backed up in the cloud, but sudden outages may still lead to losing vital information—such as the inability of businesses to process transactions.



Financial loss and liability: For BSPs, outages may cause a breach of service agreements, and the BSP is liable to pay compensation or regulatory penalties. In the case of a cyberattack, criminals may use ransomware to demand a ransom to restore service.



Damaged brand reputation: Outages also cause damage to the BSP's reputation, which can impact Net Promoter Scores® (NPS) and lead to negative subscriber feedback and increased subscriber churn rates.



Where To Build Resiliency Into Your Network

No network architecture is entirely immune to network outages and technical vulnerabilities. When planning a network, some tradeoffs must be made to ensure maximum network availability and reliability while still delivering a reasonable return on capital investment.

These are core design principles to consider for service and network uptime:

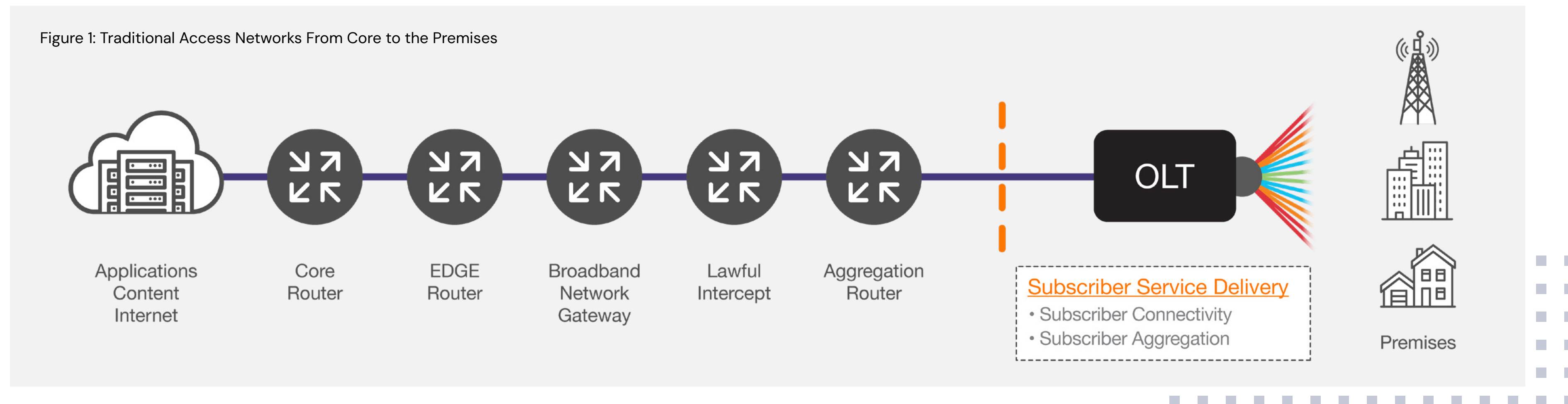
- **Reliability:** How can you minimize network and service failures?
- **Availability:** How can you ensure the network is highly available and minimize the impact of unforeseen issues and maintenance downtime?
- **Survivability:** In the case of failure, how resilient is your network?
- **Security:** How safe is your network against security attacks, and are your subscribers secure?

During the network design phase, it is essential to consider the nature of the services offered and the subscribers' expectations of service reliability. In the traditional access model (Figure 1), the network spans from the source of the services provided (such as internet connectivity, apps, and other content) to the peering gateway and into the subscriber's premises.

In between are the service-enabling network functions used to manage subscriber profiles, aggregate, and optimize traffic. Network availability must be considered at three critical domains in the network:

1. At the subscriber premises
2. In the access network domain
3. In the aggregation and core network domain

Figure 1: Traditional Access Networks From Core to the Premises



1

Network Availability at the Subscriber Premises

The most common reason for equipment failure at the subscriber premises is a power outage, usually affecting an optical network terminal (ONT). These types of failures are easily avoided.

In an essential services situation—such as a hospital—some power backup should be available on the premises. Many ONTs and residential gateways (RGs) have a battery backup during a power failure in a residential setting, but they typically only support voice services.

However, because these batteries are rarely used, they are often not regularly maintained or replaced and may not be fully functional. Uninterruptible power supplies cover all RG functions but come at additional expense and maintenance. Finally, generators can be used to support critical services and broadband access.

Service providers can offer backup capabilities as a managed service. Such a service is easier to support when dealing with integrated ONTs/RGs/routers and would only require a single truck roll to replace the system in the event of equipment failure.

BSPs may also offer a fallback network as a service for business users. This alternative network could be a wireless or fixed wireless network made available by the BSP during an outage.

2

Protecting the Access and Aggregation Network

This part of the network involves the outside plant and other external facilities that extreme weather events and natural disasters can impact. A failure at the access and aggregation part of the network could affect thousands of subscribers. Fault types could include fiber cuts, failure of an active component, or the degradation of equipment, causing intermittent issues.

Protection against failures and faults in the network consists of:

- **Equipment redundancy.** A modular system fiber routing protection line card can switch to a second line card in case of equipment failure or if a network upgrade fails. This redundancy eliminates any single point of failure and allows for uninterrupted services and reduced downtime. For example, a line card can switch to a secondary (protected) fiber port if an outside plant failure (like a fiber cut) is detected on the active route using type B PON or geo-redundant PON protection. With diversified routes and redundant node locations, BSPs can leverage geo-redundant PON to create new service offerings for businesses, municipal services, and critical applications. Software upgrades can be completed with little downtime, reducing maintenance windows. Higher service availability leads to a better subscriber experience, resulting in lower churn rates, higher satisfaction, and brand loyalty.
- **Ethernet ring protection switching (ERPS).** Based on the G.8032 protocol, ERPS prevents “loops” on ring networks by detecting and emanating redundant loops, allowing devices on a ring network to continue to communicate.
- **Link aggregation.** The link aggregation control protocol (LACP) enables several physical ports to be bundled together to form a single logical channel (LAG). LAGs multiply the bandwidth, increase port flexibility, and provide link redundancy.

Building Resiliency in the Aggregation Core Domain

At the network layer, there are various tools to enhance subscriber management and traffic routing, such as segmenting the network to handle specific traffic types. These tools can reduce the risk of failure and speed up network recovery. Some examples include:

- **Interior gateway protocol (IGP).** IGP is a dynamic class routing protocol used by autonomous system routers operating at the network layer. IGP overcomes network limitations and supports multiple routing metrics, including delay, bandwidth, load, and reliability.
- **Equal-cost multipath (ECMP).** This network routing strategy allows traffic of the same session or flow (i.e., traffic with the same source and destination) to be transmitted across multiple paths of equal cost.
- **Virtual router redundancy protocol (VRRP).** This IP routing redundancy protocol is designed to allow for backup in the case of a router failure. VRRP enables a group of routers to form a single virtual router, thereby maintaining continuity.

Designing a Simplified Network That is Highly Available

The key to network availability is a simplified network. A simplified approach adds resiliency and, as it sounds, means the network is easy to deploy and simple to operate. Figure 2 demonstrates a simplified network architecture, consolidating and moving service-enabling functions closer to the subscriber. In doing so, these functions become software modules on a software-defined operating system.

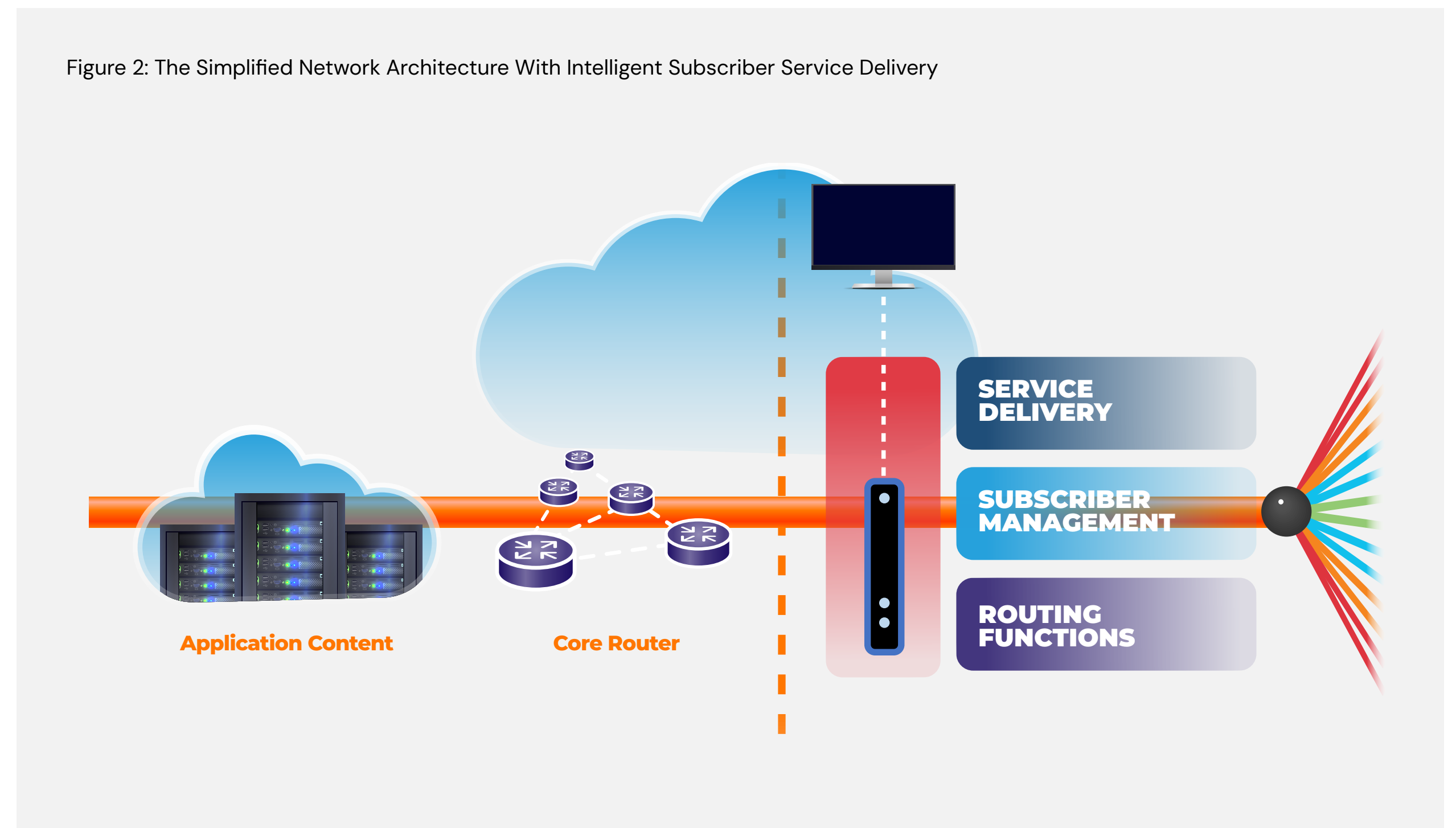
- **Service delivery:** Service connectivity and aggregation.
- **Subscriber management:** Authentication authorization, IP address management, and lawful intercept.
- **Routing functions:** Service mapping, service scalability, and network performance.

Benefits of a Simplified Network

Moving essential functions closer to the subscriber enables BSPs to:

- Cut operating costs by reducing the number of systems and router ports to purchase, configure, manage, and operate.
- Improve operational efficiency with automated network configuration and operational workflows.
- Support a distributed architecture, allowing networks to scale with subscriber growth easily.
- Use common operational models to simplify troubleshooting, reducing service downtime and trouble ticket time—ultimately enhancing the subscriber experience.

Figure 2: The Simplified Network Architecture With Intelligent Subscriber Service Delivery



Delivering Highly Available Services with Software Defined Access Operating System

Calix makes broadband networks easy to deploy and simple to operate with AXOS, our software defined access (SDA) operating system (OS). AXOS is unique because it is the only SDA OS that incorporates:

- **Hardware independence:** All AXOS systems run the same OS regardless of the underlying hardware technology (copper, fiber, coax, or wireless)—enabling BSPs to accelerate the pace of technology adoption and deployment.
- **Services abstraction:** AXOS is the world’s only fully YANG-modeled access OS. With AXOS, BSPs can establish service workflows the first time they deploy and use the same workflow for all new AXOS systems added to the network. BSPs dramatically reduce complexity and operational costs by establishing common services and setting a single method and operating procedure (MOP) for their entire network.
- **Modular architecture:** AXOS is the world’s only modular, semantically versioned access OS. Because AXOS modules can be upgraded and restarted independently, the architecture ensures that changes to one function do not impact other system functions.
- **Stateful operation:** AXOS is the only full stateful access OS. AXOS ensures that the variables required by every module are stored and available upon restart of any individual module. Any changes in module status will be recognized and corrected, enabling a self-healing network that is always on. The same stateful operation eliminates the need for maintenance windows during network upgrades.
- **SDN interfaces:** AXOS is the world’s only natively NETCONF-enabled OS. Whether service providers are transitioning to a software-defined network today or working with existing OSS/BSS systems, AXOS provides the northbound and southbound connections needed to eliminate middleware and reduce cost and complexity.

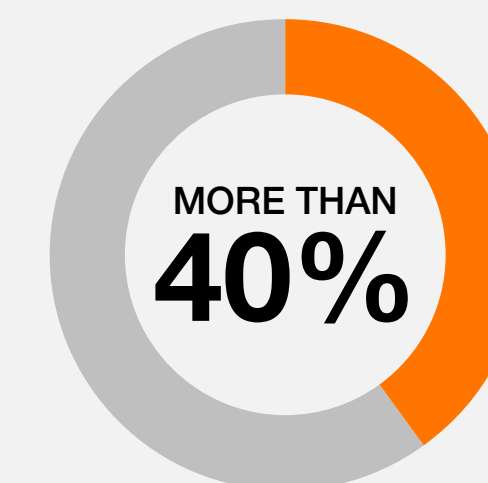
CASE STUDY

BrightRidge

BrightRidge partnered with Calix to deploy this simplified architecture. The not-for-profit electric cooperative based in northeastern Tennessee launched broadband services to its 78,000 members in 2019. By deploying the end-to-end Calix solution, BrightRidge saved more than 40 percent in network deployment costs compared to competing solutions.

BrightRidge’s Chief Broadband Officer, Stacy Evans, highlighted the following advantages:

- Pay-as-you-succeed subscriber management
- Reduced failures, subscriber impacts, and security issues
- Ability to move caching appliances closer to the subscribers
- Reduction in “back and forth” transport costs



Saved in network deployment costs

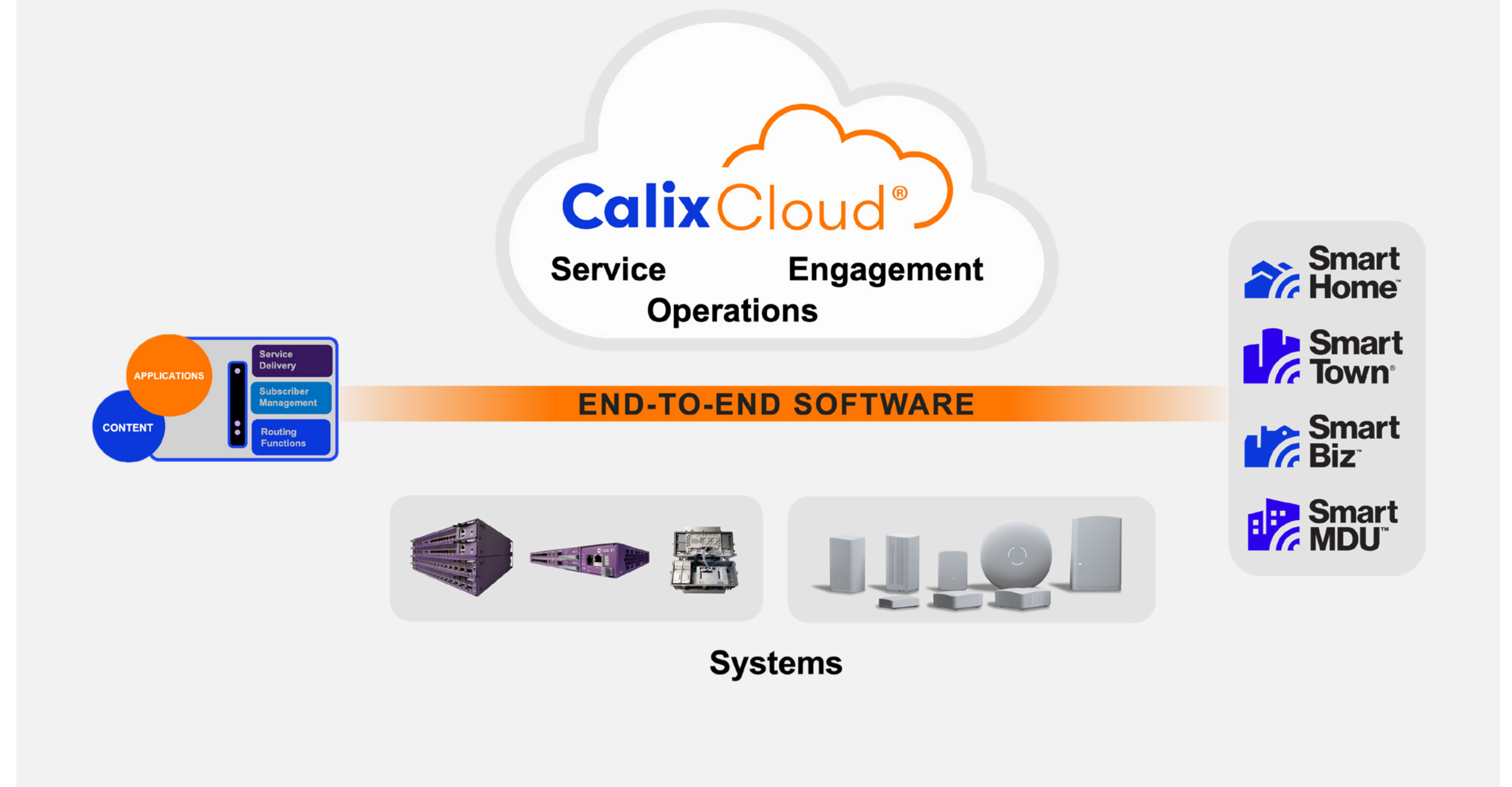
Managing a Simplified Network in The Cloud

Operating a simplified network using cloud-based technology gives BSPs immediate access to data and analytics that empower teams to anticipate subscribers' needs, quickly resolve problems, and improve satisfaction. By leveraging the Calix broadband platform to deliver automation, insights, and analytics across all service offerings, operations teams can become efficiency drivers within the organization.

The Calix broadband platform combines Calix Cloud®, Intelligent Access™, Unlimited Subscriber™, and Calix Success Services. The platform enables BSPs to provision, monitor, and manage the end-to-end network in one place, driving even greater operational efficiencies.

A platform-based approach simplifies network operations, optimizes network performance, and delivers better customer experiences. The Calix platform provides unique automation and insights, enabling teams to work faster and smarter and unlock ways to do more with less. Automation isn't about replacing people but empowering operations teams to handle advanced tasks as efficiently as possible. This includes processes for network monitoring, outage management, and service provisioning.

Figure 3: The Calix End-to-End Broadband Platform



Benefits of Calix Cloud

Calix Cloud aggregates subscriber insights, network intelligence, and platform performance to give BSPs a 360-degree view of the subscriber experience. This ensures all teams have the right information they need at the right time.

- **Calix Operations Cloud:** With advanced visibility into the network, operations teams can move from reactive to proactive. Teams can quickly identify service disruptions and network outages, along with impacted subscribers. Using advanced alarm filtering, automated outage notifications, and quick access to all network health KPIs, operations teams have all the information they need in a single dashboard.
- **Calix Service Cloud:** Customer service teams can gain an in-depth understanding of subscribers and proactively anticipate needs. Support teams have end-to-end visibility from the WAN to residential gateways, Wi-Fi, connected devices, and subscriber apps. This visibility allows BSPs to simplify support processes and drive even greater efficiency.
- **Calix Engagement Cloud:** Marketing teams can deliver automated communications to subscribers, notifying them of an outage and the expected time to resolution. This proactive approach changes the conversation with customers, reduces the number of incoming support calls, and builds trust with subscribers—benefits that are ultimately reflected in a BSP’s customer satisfaction score.

Easily Enter New Markets Leveraging a Broadband Platform

The ability to market, deploy, manage, and support diverse services is fundamental for BSPs to succeed. That’s why a platform approach is so powerful—it enables BSPs to enter new markets and turn up new services using the same workflows and tools teams already know.

BSPs have a unique opportunity to break into new markets by leveraging the growing array of SmartLife™ managed services delivered on the Calix broadband platform. Using the latest automation features, operations teams can provision new types of subscribers (such as small businesses or MDU) or new services (such as community Wi-Fi) as quickly as home internet service—avoiding error-prone manual steps and labor-intensive processes.

With the Calix broadband platform, operations teams use the same systems, cloud services, and workflow automation to serve different markets. This helps BSPs efficiently bring new managed services to market and operate them at a lower cost while delivering an exceptional subscriber experience.

CASE STUDY

Tipmont REMC

Tipmont is one BSP leveraging Calix Cloud to transform its operations.

- Operations Cloud enables real-time alerts of network issues and geo-mapping features to identify impacted subscribers instantly.
- Service Cloud enables Tipmont to support its subscribers proactively.
- Engagement Cloud helps Tipmont to increase take rates, even in saturated areas.

Calix Cloud enables Tipmont to deliver a subscriber experience that is far beyond what it’s larger competitors can manage.

“Where we were once reactive in managing service disruptions and outages, we’re now proactive. This enables us to address problems faster than ever before, resulting in fewer calls to our support team and huge cost and efficiency savings because we only roll repair trucks when absolutely necessary.”

—Josh Rice, Network Operations Center Supervisor, Tipmont

Plus, by deploying SmartLife™ managed services on the Calix broadband platform, Tipmont can now look at market segments beyond residential, and seamlessly manage them on the Calix platform with no additional tools, training, or staffing required.

Best Practices for Highly Available Networks

Building resiliency into your broadband network is not only about technology choices. It's also about implementing these best practices:

- **Identify critical areas and develop a plan.** Whether designing a network from scratch or expanding into new territories, network resiliency must be fundamental to network design.
- **Consolidate network functions.** Reducing the number of points of failure points reduces complexity. In addition to eliminating separately deployed systems, you eliminate operational failure points throughout the network lifespan.
- **Minimize Layer 2 broadcast domain size.** Segmenting the network as much as possible into smaller, separate domains minimizes the introduction of broadcast storms and loops that lead to network failures and troubleshooting difficulties.
- **Automate workflows to eliminate errors.** Reduce human error by introducing “zero-touch” or “light touch” automation in service provisioning, system configuration, and network maintenance.
- **Keep software up to date.** Ensuring software updates are performed frequently delivers new capabilities and the latest enhancements and protects against the latest security vulnerabilities.
- **Test backup and disaster recovery procedures.** Don't wait for disaster to strike before discovering your backup and recovery systems aren't fit for purpose. Run regular drills to test alarms and recovery processes.
- **Communicate with your stakeholders.** Build a communications plan. Then, in the event of a network failure, activate the plan and use established channels to communicate with various stakeholders, from senior management to subscribers.



CONCLUSION

More than 60 million households across the United States utilized fiber broadband at the end of 2022, up 13 percent over the prior year^{iv}. With continued infrastructure deployment, the number of households is expected to grow exponentially. The quality and reliability of fiber are vital factors for subscribers when choosing and remaining with a fiber-based service provider.

However, subscriber expectations are quickly evolving due to the necessity of broadband services. To deliver the ultimate subscriber experience—and win against the competition—BSPs must use networks that are easy to deploy, simple to operate, reliable, agile, and innovative.

To achieve these goals, BSPs of all sizes must simplify their access networks by provisioning, monitoring, and managing the entire subscriber-facing network from a single point closer to the subscriber. The Calix Intelligent Access solution makes this simplified network possible, transforming network functions into modules to enable a dynamic and robust subscriber experience.

To learn more about designing a highly available broadband network to meet subscriber demands, schedule a network consult with Calix.

Get a Network Consult



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