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Simplifying Networks for Efficiency

CUMBERLAND CONNECT powered by CEMC

Mike Neverdusky

Network Operations Manager at Cumberland Connect
(Clarksville, TN)

Mike has 14 years experience managing fiber optic network builds, re-designs, and operations. In 2008, he began his telecommunications career with CDE Lightband, one of the earliest and largest active ethernet projects among electric utilities. Located in Clarksville TN, he served the municipal provider as their Network Technical Supervisor.

After spending several years in network consulting in the Atlanta area, Mike came home to Tennessee and joined Cumberland Connect (a subsidiary of electric Co-Op, Cumberland Electric) as their Network Operations Manager. He oversees network design, operations, and technical support for Cumberland Connect's greenfield which is 100% fiber-optic deployment that will span 5 counties and 105,000 homes and businesses in northern middle Tennessee over a 5 year build-out.

BrightRidge® Broadband

Stacy Evans

Chief Broadband and Technology Officer at BrightRidge.
(Johnson City, TN)

Stacy has 33 years of experience working in telecommunication networking and management. For over 16 years, he served in the telecommunications division at Bristol Virginia Utilities in the capacities of Lead Network Engineer later as Manager of Network and Fiber Engineering.

Beginning in 2002 he was involved with BVU OptiNet's startup operations and support of the first municipal broadband network to provide triple-play services over an 100% fiber-optic network.

In June 2018, Stacy joined BrightRidge (a local power company in Johnson City, TN) as their Chief Broadband Officer to lead a new initiative that will provide Broadband services to a customer base of 80,000 homes and businesses in Northeast Tennessee. BrightRidge is deploying a combination of Fiber-optic and Fixed Wireless network technologies over a seven-year build-out.

Best architecture Investment

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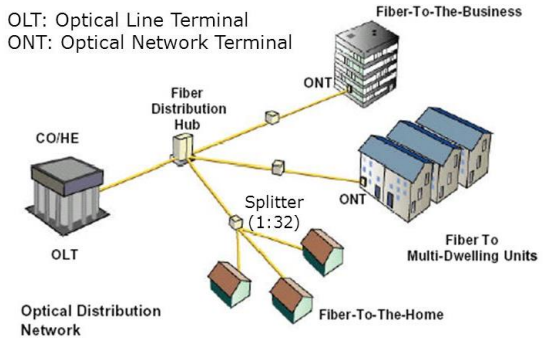
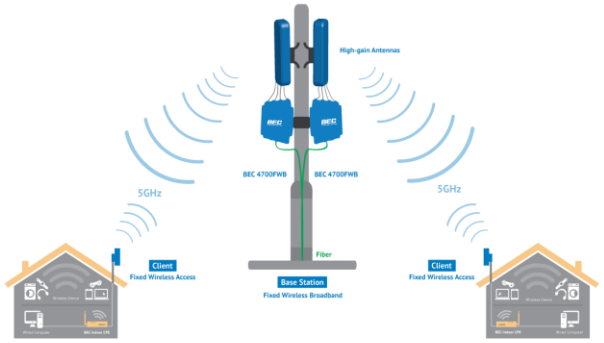
Passive Optical Network (PON)





Choosing between Fiber optic vs. Fixed Wireless

- Fiber network installed in Bristol, VA in 2002 was initially deployed with B-PON (622Mb/155Mb) equipment and could only provide up to 50Mb to each customer. Few years later forklift upgraded to GPON, & it could easily support XGS today.
- BrightRidge has a hybrid Broadband network utilizing Fiber to the premise in densely populated areas and fiber connected CBRS Fixed Wireless in some rural areas.
- Macro cell Fixed Wireless – (CBRS 3.5Ghz or unlicensed 5Ghz) challenges with line-of-sight obstructions (terrain, buildings) ,distance, rain fade ,and limited bandwidth. Asymmetric 25Mb to 50Mb per customer bandwidth.
- Fiber enabled Small Cell Fixed Wireless – Technologies that are based on 5G, Terragraph standard, or proprietary designs. Can provide up to 1Gb to the home with short distances.

> *With our Fixed Wireless network, we can serve 45% of the rural customers within the tower footprint, as hills, trees, buildings obstruct the line-of-sight. The deliverable bandwidth per customer varies based on distance, obstructions, and available frequency spectrum.*
>
> *With our Fiber based network, we can guarantee availability to 100% of the customers passed with up to 10Gb/10Gb bandwidth.*
>
> *Macro cell Fixed Wireless is a stop-gap solution until we can build fiber to an area.*
>
> — Stacy Evans, CTO BrightRidge Broadband

Best architecture Investment

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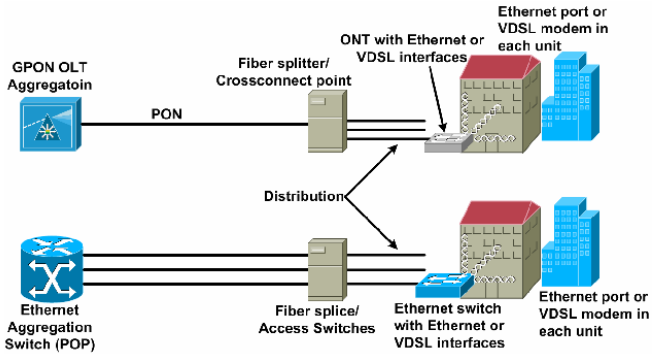

Choosing between PON or Active Ethernet

- Differences in costs for fiber, network equipment, and facility space.
- Time to restore of services when damage to mainline fiber.
- Differences in complexity. (single subscriber upgrades, difference in need for splitters and WDM)
- Customer to Access Port ratio. Single fiber degradation less impactful.
- Fiber requirements in the backbone. Requirements for electric power, battery backup, and facility in distributed Active model.

> *We found that a passive optic distribution network helped us to reduce the backbone fiber requirements and avoid the need for power and electronics in the local distribution cabinet..*
>
> — Mike Neverdusky, Net Ops Mgr CUMBERLAND CONNECT powered by CEMC

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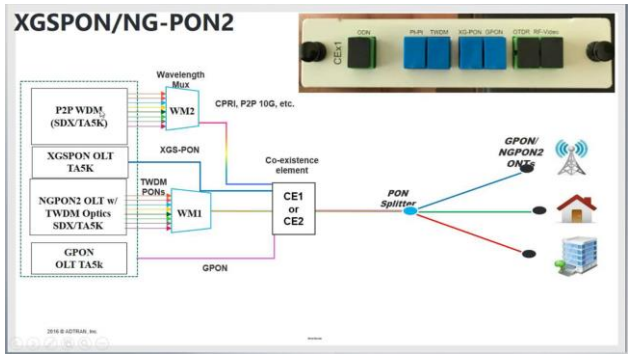
Fiber distribution network design



- Don't expect GPON to be the last network technology you deploy.
- By planning your optical budget with consideration for coexistence elements, you can be prepared for XGS, NGPON2. (normally from 1 to 2 dB based on wavelength)
- With both GPON and XGS/NGPON2 to a common splitter, you select the ONT type to match the bandwidth requirements.
- Bandwidth multiplier. This provides two parallel networks with no extra fiber requirements and only a $600 delta in 32/64 splitter costs.

> *We enabled both GPON and 10G XGS in each of our LCCs (Local Convergence Cabinets) with 64-way splitters.*
>
> *It's a network bandwidth multiplier.*
>
> — Stacy Evans, CTO, BrightRidge Broadband

> *We have been strategically deploying XGS 10G-PON for customers needing more than 1Gb service.*
>
> — Mike Neverdusky, Net Ops Mgr, Cumberland Connect powered by CEMC

Real PON usage statistics

BrightRidge Residential Customer product mix

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- 50.4% subscribe to 500Mb / 500Mb Internet ($60)
- 35.2% subscribe to 200Mb / 200Mb Internet ($50)
- 14% subscribe to 1-Gb / 1-Gb Internet ($80)
- < 1% subscribe to 10-Gb / 10-Gb Internet ($150)
- Average residential subscribed service is 480Mb per customer.
- At peak time (9:30pm) each customer is averaging **3.67Mb** (30 days)
- Highest single event utilization (145 PONs) over month was peak of **4.13Mb**
- We deployed all **1x64 way splitters** with 50% loaded from 40 to 64 ONTs.
- At peak times, only **21% of the PON** is being used by 64 customers.
- By doing this we saved $$$ on the costs on PON cards/optics, feed fibers, splitters

- **What should we do with this information?**

Open the Internet bandwidth pipes in both directions and stop limiting fiber networks to DSL or DOCSIS speeds.

Real PON usage statistics

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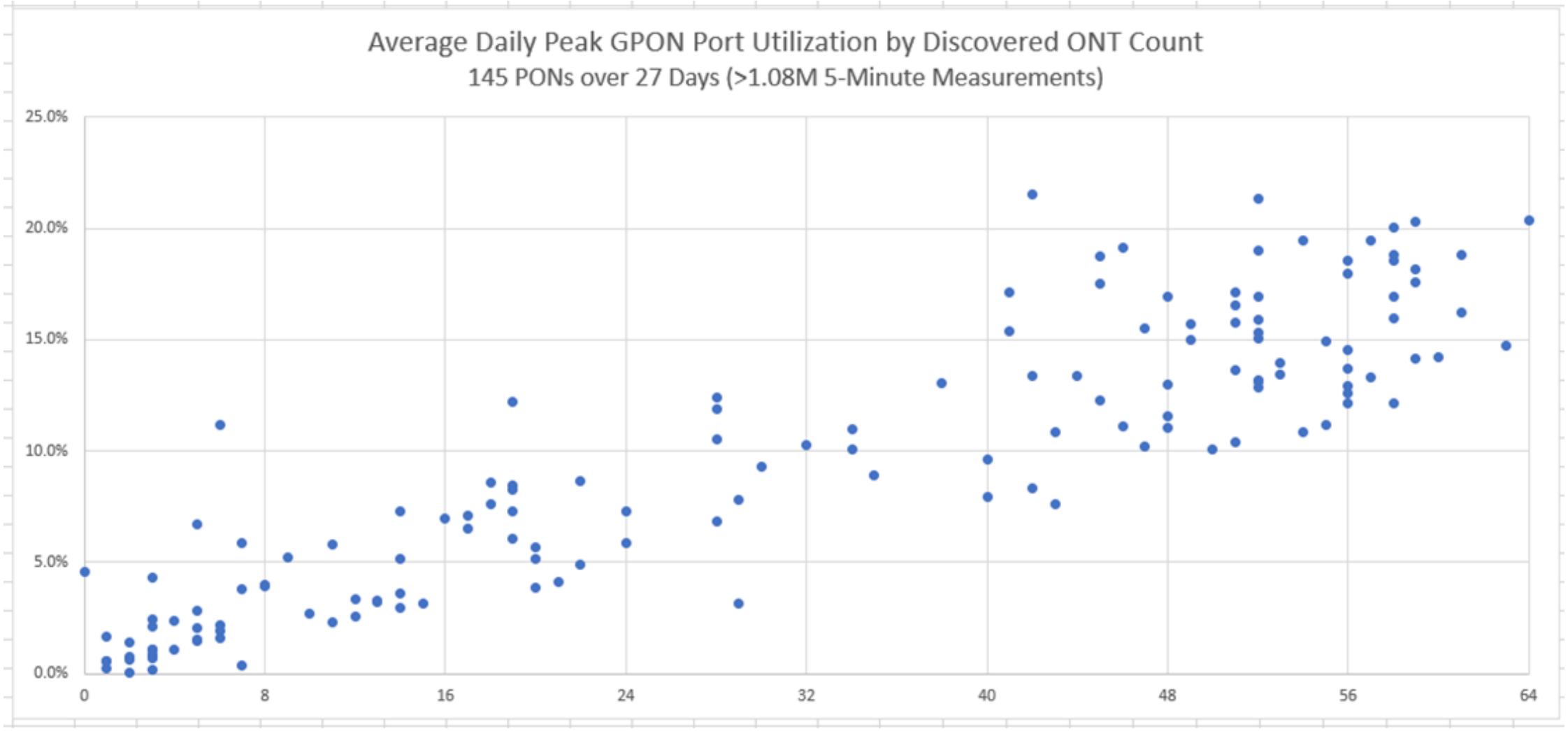
21% utilization for a full 1x64 splitter PON.



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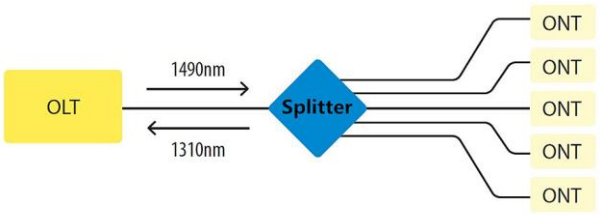
Fiber distribution network design



- What is the right number of passive optical splits to use? (16, 32, 64, 128)
- Optical budget for distance and LCC placement.
- With a 64-way split, we have options to go from 32 to 64 GPON ONTs per PON or mix with XGS ONTs.
- Centralized optical splitters vs. cascaded splitters.

> *We enabled both GPON and 10G XGS in each of our LCCs (Local Convergence Cabinets) with 64-way splitters.*
>
> *It's a network bandwidth multiplier.*
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> *This provides a two parallel networks with no extra fiber requirements and only a $600 delta in splitter costs.*
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BNG or Router

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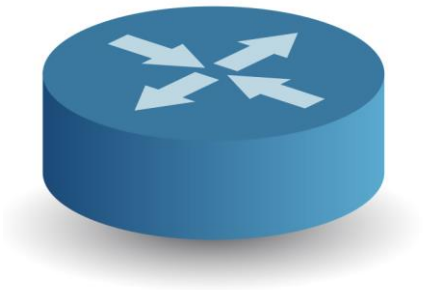
What functions do Broadband Network Gateways (BNG) provide?



- Aggregates circuits or vlans from one or more access devices and provides centralized control with per subscriber granularity.
- Subscriber session management for authentication, authorization, accounting (AAA), IP assignment (DHCP) /restrictions (static), IP Routing, Rate limiting, enforces prioritization (QOS), IP restrictions, anti-spoofing, policies for filtering and control, traffic separation per vlan.
- Manage IP space as single pool and create /32 routes.
- VLAN assignment can be arbitrary – locally significant.
- Individual VLAN per sub avoids network loops/customer issues impacting other customers. Small MAC address tables.
- Control downstream bandwidth per protocol via policy (DDoS filters).
- Provides Lawful Intercept point.
- Provide authentication/authorization/accounting via Diameter/Radius.
- Walled garden environment/URL redirection with dynamic policy management.
- As a general rule, networks with 15k or more subs can realize greatest benefits.

> *We deployed distributed BNGs with each OLT. We can control all customer from one management tool but can specify unique settings per subscribe.*
>
> — Stacy Evans, CTO BrightRidge Broadband

BNG or Router

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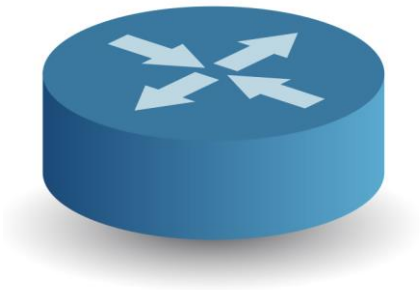
Options to manage subscriber sessions without a BNG



- Lower cost deployment for core Routers than specialized BNGs.
- Common vlan for DHCP IP addressed subscribers to core Router.
- Management IP address space.
- Rate-limiting performed at Access Network (OLT/ONT)
- Subscriber to subscriber communication via Proxy ARP.
- Protocols used for the Core to Access Network.
- MAC address management. DHCP snooping, Mac-Forced Forwarding.
- Resource limitations of routers. (VLANs, route table, MAC addresses…)

> *We did not use a BNG, but deployed centralized routers.*
>
> — Mike Neverdusky, Net Ops Mgr, Cumberland Connect powered by CEMC

Centralized vs Distributed Router/BNG

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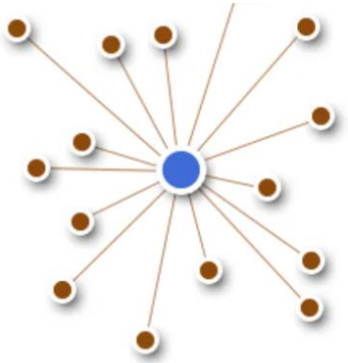

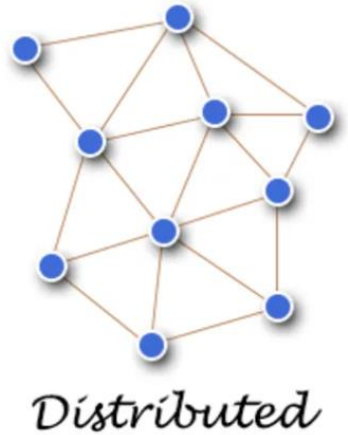

- Characteristics of **Centralized core Router / BNG design**
  - Minimal number of Routers required.
  - Fewer devices to maintain and support.
  - Centralized equipment can be duplicated for redundancy.
  - All traffic from Access Network is carried Layer-2 back to core routers.
  - Requires Layer-2 transport network and protection protocols from distribution node to core. No layer-3 protection until reaches core.
  - VLAN planning is more system wide or regional.

> *We did not use a BNG, but deployed centralized routers.*
>
> — Mike Neverdusky, Net Ops Mgr, Cumberland Connect powered by CEMC

Centralized vs Distributed Router/BNG

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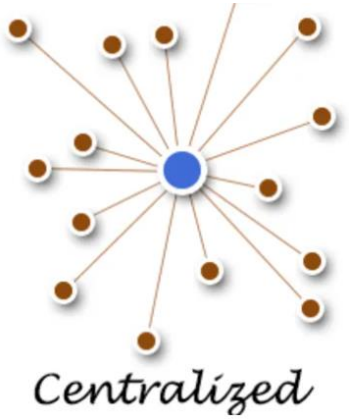
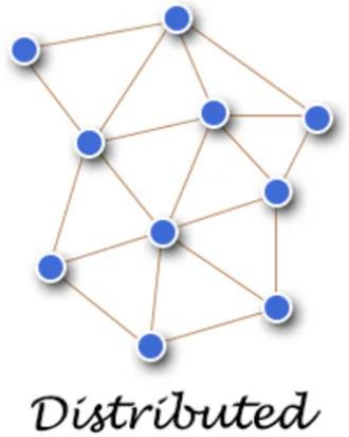
- Characteristics of **Distributed core Router / BNG design**.
  - 'Don't span the WAN' – keep local traffic local
  - Reduces unneeded traffic on network backbone.
  - Pushes routing and network redundancy closer to customer. Allows for multiple levels of protection using LACP/LAG, ERPS, and Routing protocols.
  - Integration for CDN (content delivery network) caching of unicast traffic (video streaming).
  - Increase network reliability. By places your eggs in multiple baskets should an equipment failure, network loop, or DDoS attack occur.
  - Simplify core network using enterprise utilized protocols. Potential to reduce skill sets required to troubleshoot.
  - BNGs can be OLT Integrated, Dedicated hardware, or virtualized.





> *We deployed distributed BNGs with each OLT, which pushes the routing closer to the customer and allows us to use of multiple OSI layer protocols for fault tolerance.*
>
> *Provisioning only requires 4 items: Subscriber info, ONT ID, Service Template name, Control policy. No need to know the OLT or ONT serial number in advance, nor assign VLANs.*
>
> — Stacy Evans, CTO BrightRidge Broadband

Bandwidth scaling, diversity, costs

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Benefits of using high-capacity data center colocation services

EQUINIX

DIGITAL REALTY

CyrusOne

CORESITE

QTS
Quality Technology Services

- Lower cost Tier 1 DIA (dedicate Internet access) per megabit.
- Reduce network latency with less routers/providers.
- Peer exchange access - Neutral Internet Business Exchange Model.
- Direct peering with content owners & cloud services. (AWS, Netflix, Google…)
- Don't rely on your local competitors to control your destiny.
- Easy Bandwidth scaling. Fiber cross-connect 1G,10G,100G
- ISPs can provide dual port peering in multiple colo centers with shared bandwidth for redundancy.
- Easy access for National/International circuit access for customer WAN needs.
- Options to collaborate with peers to share colo space and access circuits.
- Easy to keep partner traffic separate with layer-2 vlan path switching.
- Top 7 data centers are in Northern Virginia, Silicon Valley, New York & New Jersey, Chicago, Dallas-Fort Worth, Phoenix, and Atlanta.

> *70% of our Internet traffic is supplied by the Peer Exchanges and direct peering. Those are "all you can eat buffets", which reduces the costs paid tier 1 ISP costs..*
>
> — Stacy Evans, CTO BrightRidge Broadband

Choosing partners & solutions

Startup or new project considerations

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- Match the best technology option to the customer density for each area.
- Match the technology to the type of customer & bandwidth demands.
- Select technology with proven reliability. Talk to your peers and listen to their experiences with various solutions.
- Supply Chain challenges – By seeking out peers using common products, provides opportunities to share stock when supply issues occur.
- Scalability - to have the ability to pay as we grow
- Capacity - ability to support next generation Broadband speeds
- Affordable in both initial capital and ongoing costs of ownership.
- Apply standardization and automation to all processes.
- A proven partner invested in fiber access networks for the long haul.
- Don't underestimate the Integration time and costs.
- Don't overlook needs for IT servers, firewalls, Billing integration, Provisioning, Tech Support, Installation contractors, Procurement/contract delays, warehousing, equipment testing, and training for personnel.
- If you are going to invest in next generation networks, provide next generation products that blows the competition away.

> *We looked for the best of breed products for each major category such as Access networks, Routing, Telephony, video, OSS/BSS systems, mapping, & OSP.*
>
> — Stacy Evans, CTO
>
> BrightRidge Broadband

Questions?

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