

Broadband Design Considerations

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Agenda

- Broadband Considerations
- Architecture and Design
- Implementation and Management

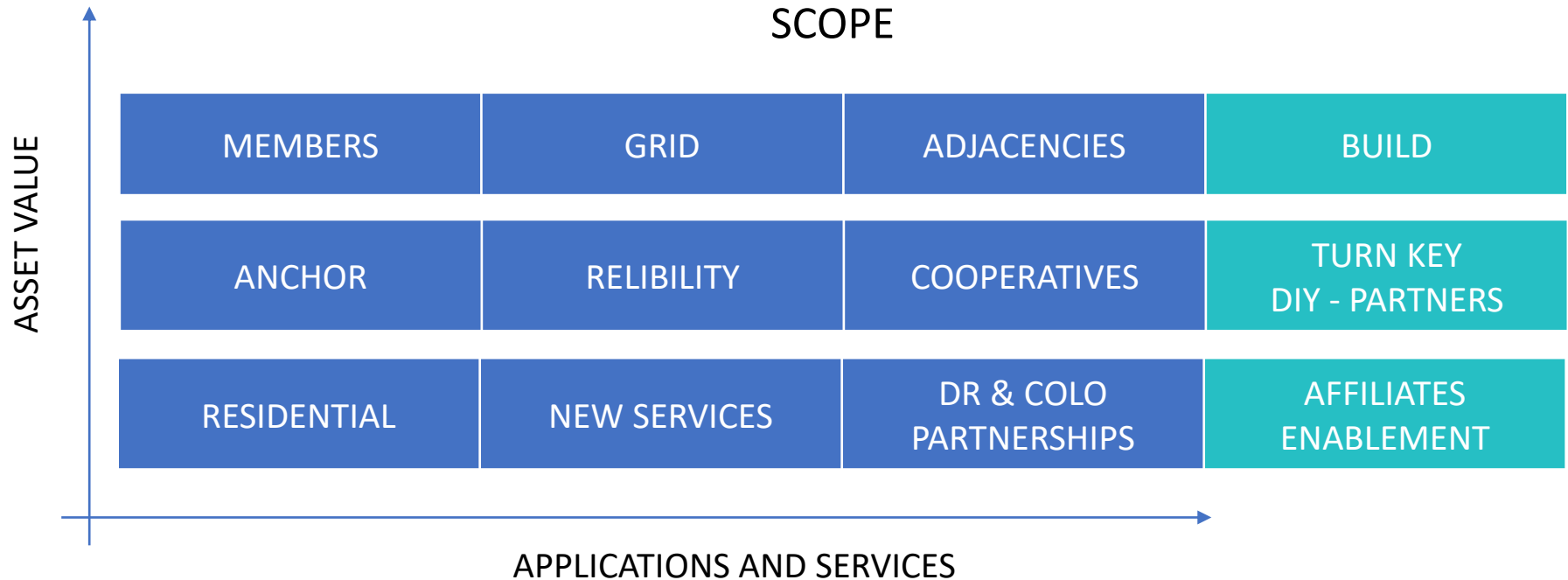
Broadband Considerations

- What is Broadband?
- FCC
 - 2015 - Residential – 25 up / 3 down Mbps
 - 2018 – Schools – 1Mbps / student
- Telemedicine - 50 Mbps +
- Internet Search

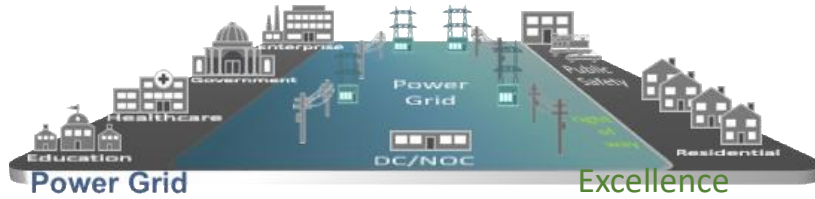
'Broadband' is a service which provides for the reliable, high quality transport of information between multiple end points.
- Consider

A service that satisfies any application for your distribution grid or any member, tomorrow.

Broadband Considerations



Broadband Considerations



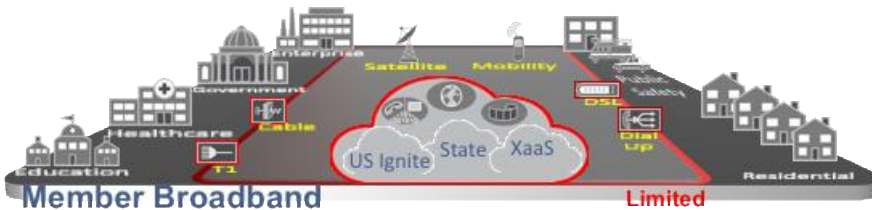
Electricity Service

- Trusted provider to all members
- Right-of-way access for last mile
- Non-profit drives a high value to \$ ratio



IT / OT Infrastructure

- Limitations for advanced IT / OT applications
- Many manual processes
- Limitations to automate services

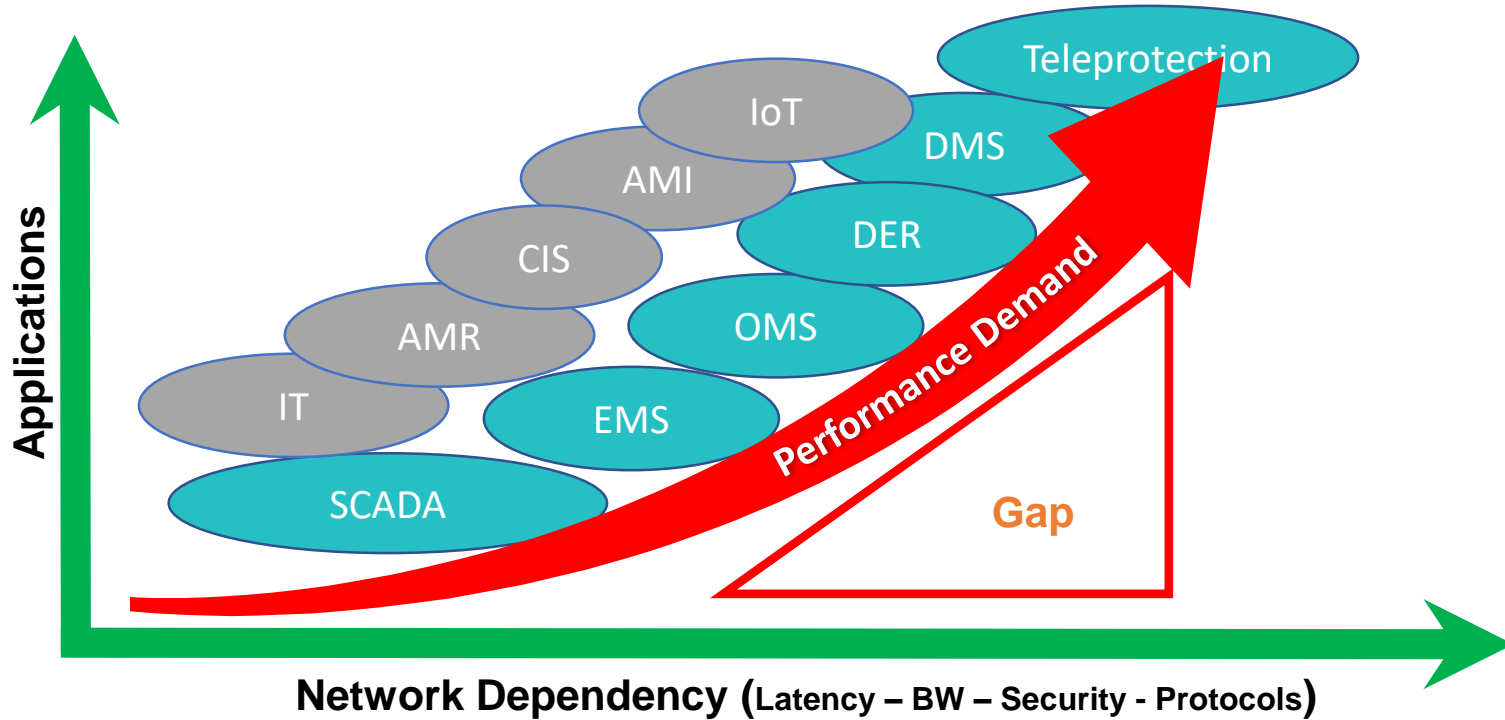


Broadband Access

- Limited or no access
- Low value to \$ ratio for broadband
- **Anchor members need (x) Gbps**

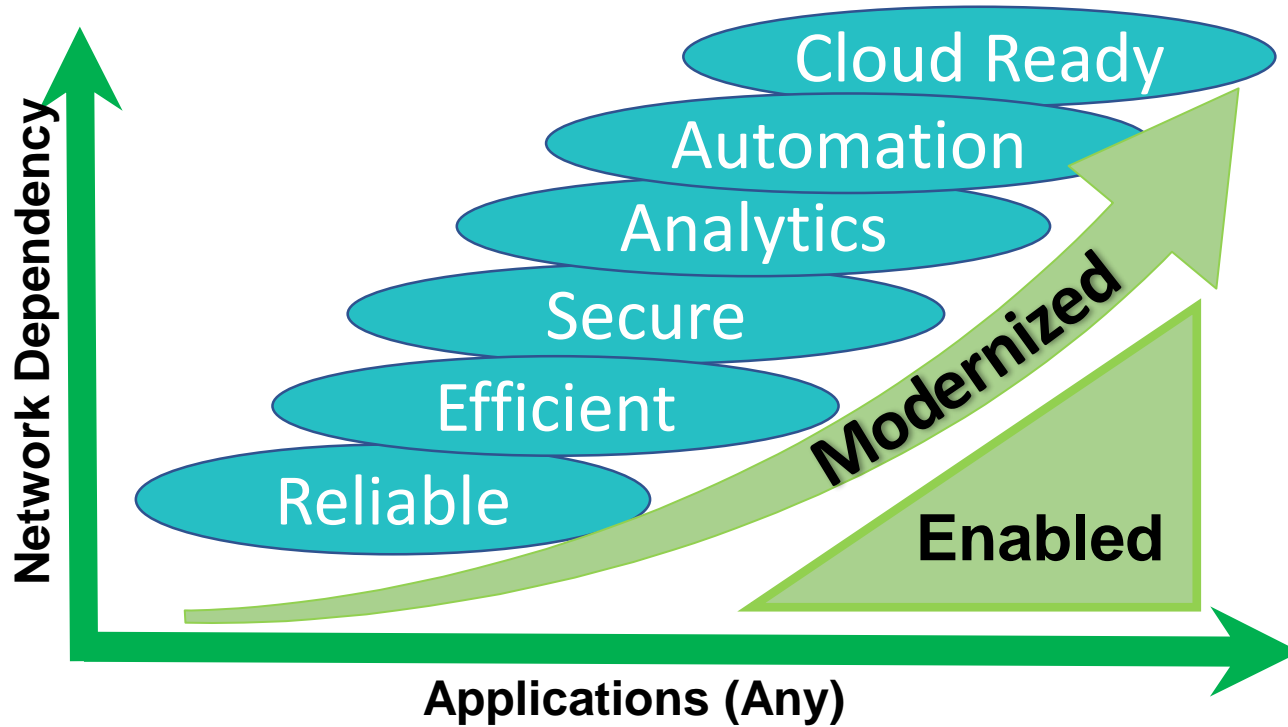
Broadband Considerations

“Separate Networks,
TCO and Scale Concerns”

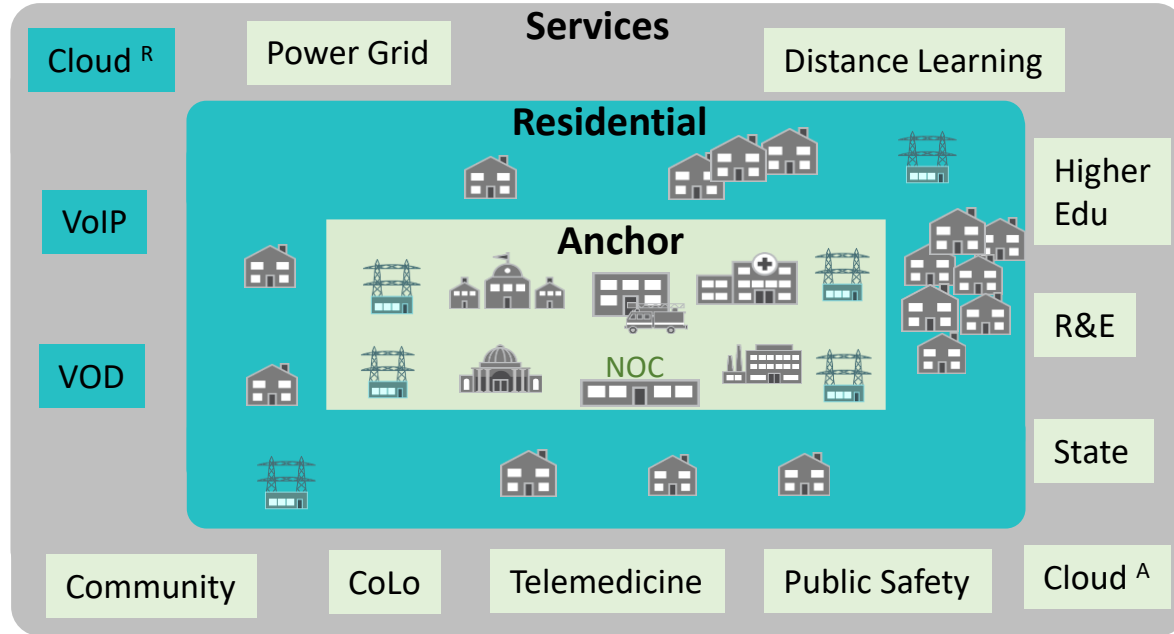


Broadband Considerations

“Secure & Deterministic,
Packet Switched Architecture”

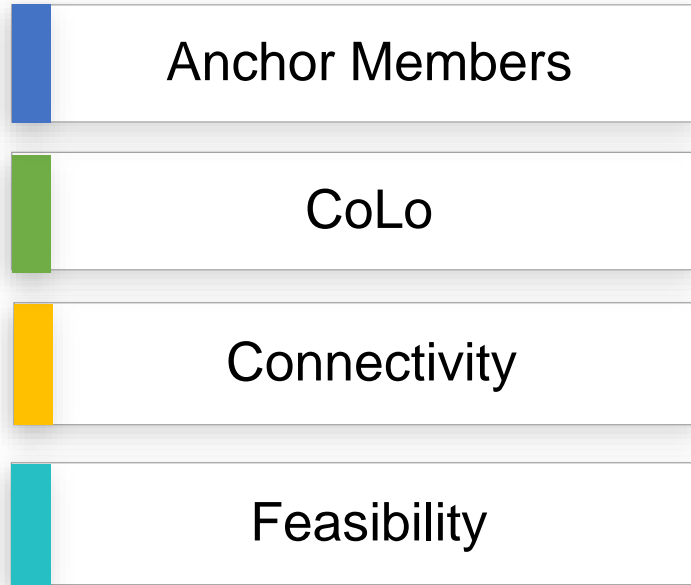


Broadband Considerations



ADVANCED MEMBER ECOSYSTEM

Broadband Considerations



FCC - Schools

- 2018 – 1 Mbps / Student
- 53%, 71 % of School Districts
- Data Center Services for Anchor Members About **\$5B Annually** for E-Rate
- Disaster Recovery with Other Members 498 ID (SPIN) – USAE
- Centralized Delivery of Services
- Simplify Fiber Cable Plant
- FCC – AHA – Healthcare
- FCC – Broadband 25 up / 3 down Mbps
- Fiber Cable Plant 36 % of Hospitals
- Substations Telehealth Top 4 Strategy
- Turn Key Anchor Member About **\$571M Annually** for HCF
- Assemble Your Team of Trusted Partners
- PTH or PT to Multi-Point (NEW) release
- Assessment

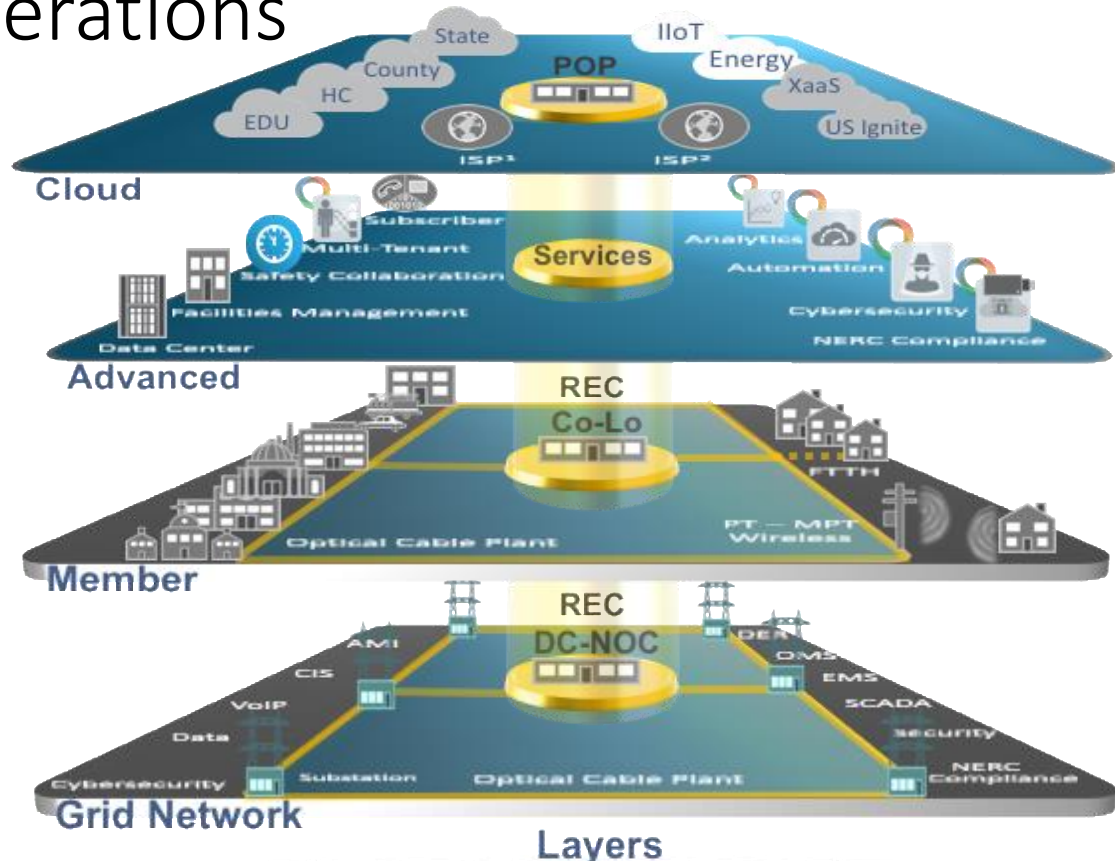
Broadband Considerations

Access

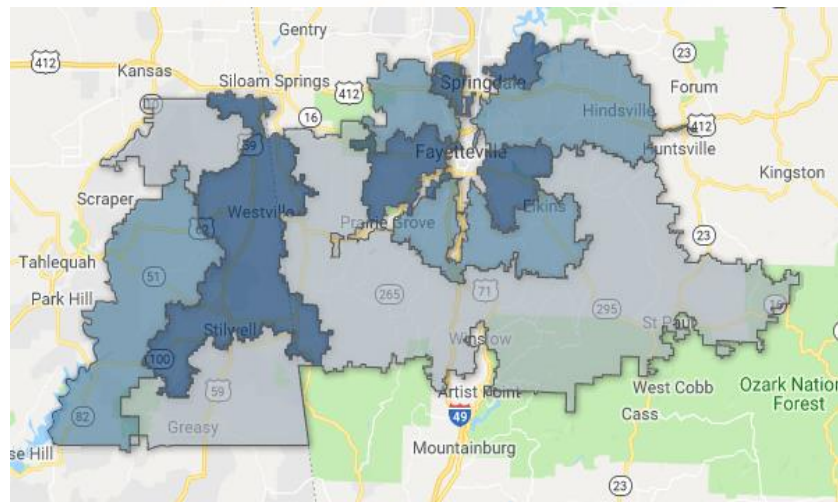
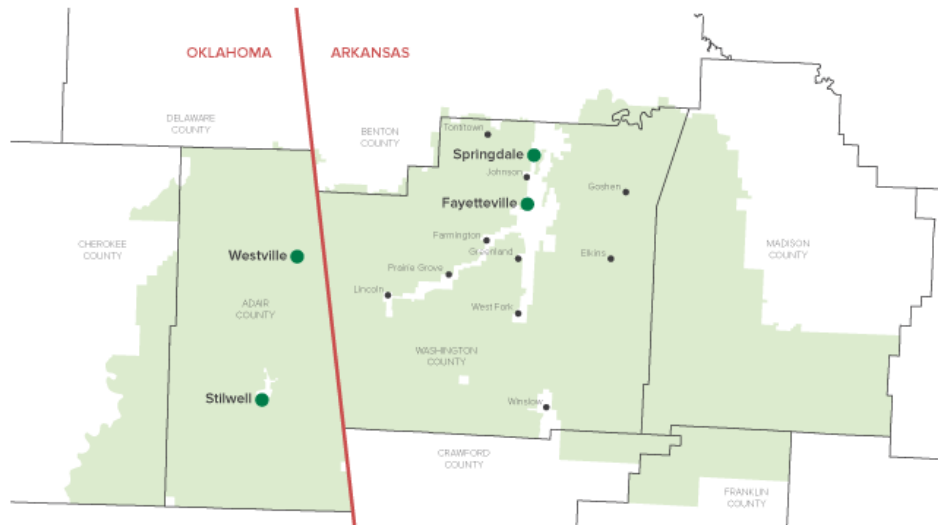
Deliver

Enable


Modernize



Architecture and Design



Architecture and Design Options



G.8032 v2 Rings



Hub and Spoke over DWDM



MPLS 100G

Architecture and Design Options

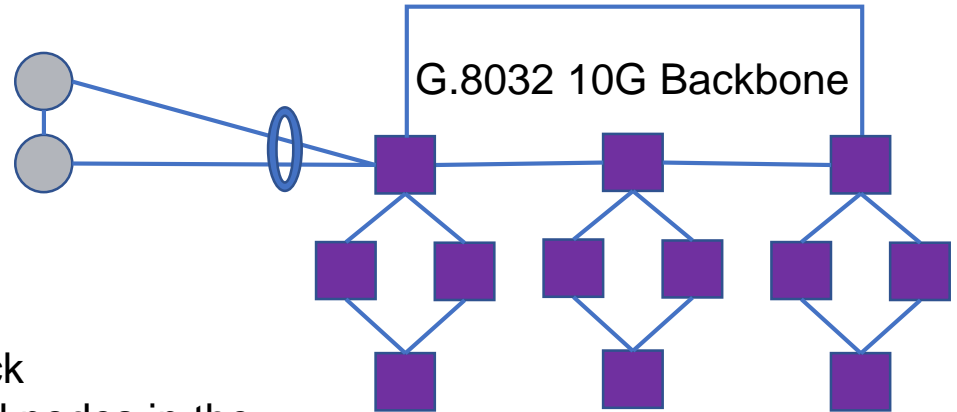
G.8032 v2 Rings

Benefits

- Low cost 10G rings

Draw Backs

- MAC scale
- One segment of each ring must block
- New services require provisioning all nodes in the path



Architecture and Design Options

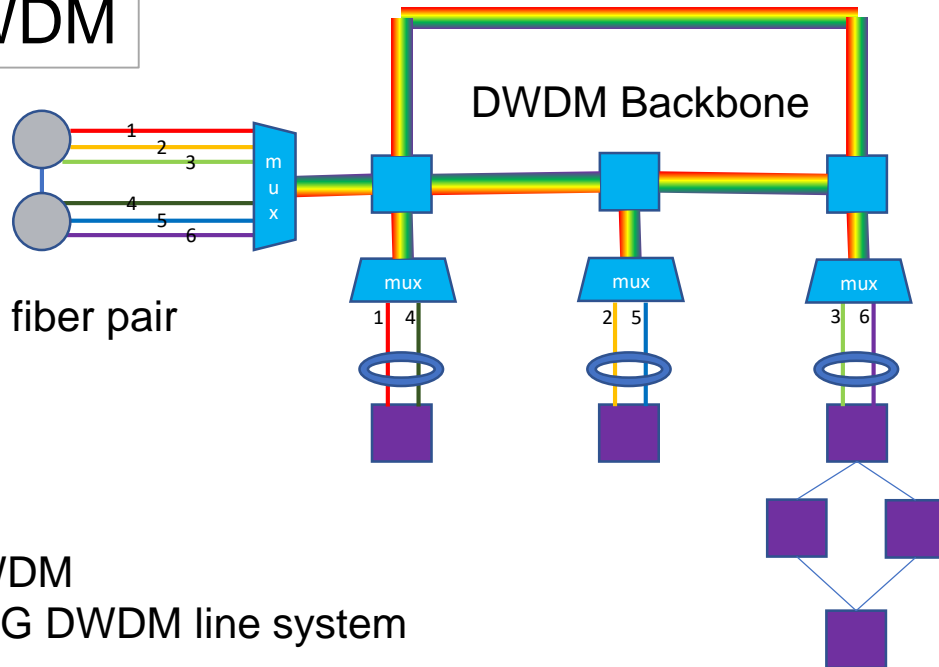
Hub and Spoke over DWDM

Benefits

- Dedicated bandwidth to each node
- Uses 1 pair of backbone fiber
- Scale up to 96 waves per backbone fiber pair

Draw Backs

- DWDM layer is expensive
- Requires more core router ports
- More skills and tools to manage DWDM
- Bad industry timing to buy a new 10G DWDM line system



Architecture and Design Options

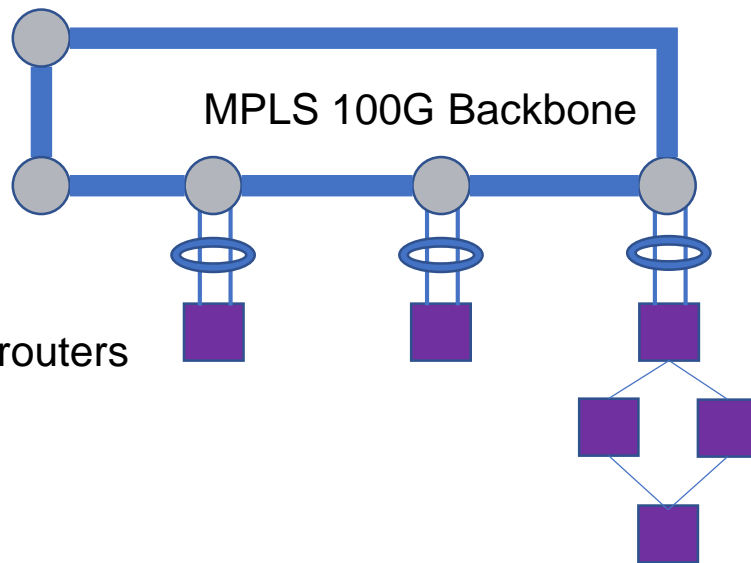
MPLS 100G

Benefits

- All links are forwarding traffic
- Simpler than DWDM
- Smaller core routers
- Most resilient
- Only provision service on ingress and egress routers

Draw Backs

- L2 HA requires two routers at a POP
- Requires MPLS training



Motivating Outage

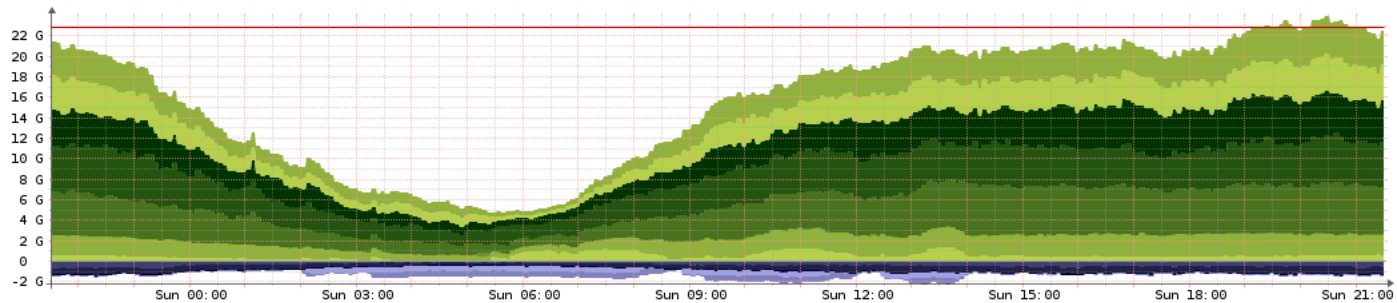
- 69 KV transmission downed by storms November 30, 2018
- Multiple substations went dark for hours
- Poor chickens



OzarksGo Design Requirements

- Physically diverse path fiber optic backbone
- 50 ms failover
- Multiple routing tables
- Virtualized multicast IPTV
- Scalable fault isolation
- Scalable MAC tables
- 8 hour minimum battery backup
- Eliminate single points of failure
- 10km, 20km, and 40km 100G segments
- Up to 80km 10G segments

OzarksGo Design Requirements



REUTERS / TOBI OETIKER

- 23 Gbps of Transit and Peering traffic last month
- Today the OzarksGo 100G MPLS backbone carries:
 - 23 Gbps of Internet traffic
 - 2 Gbps of full HD IPTV channel line-up

MPLS Applications

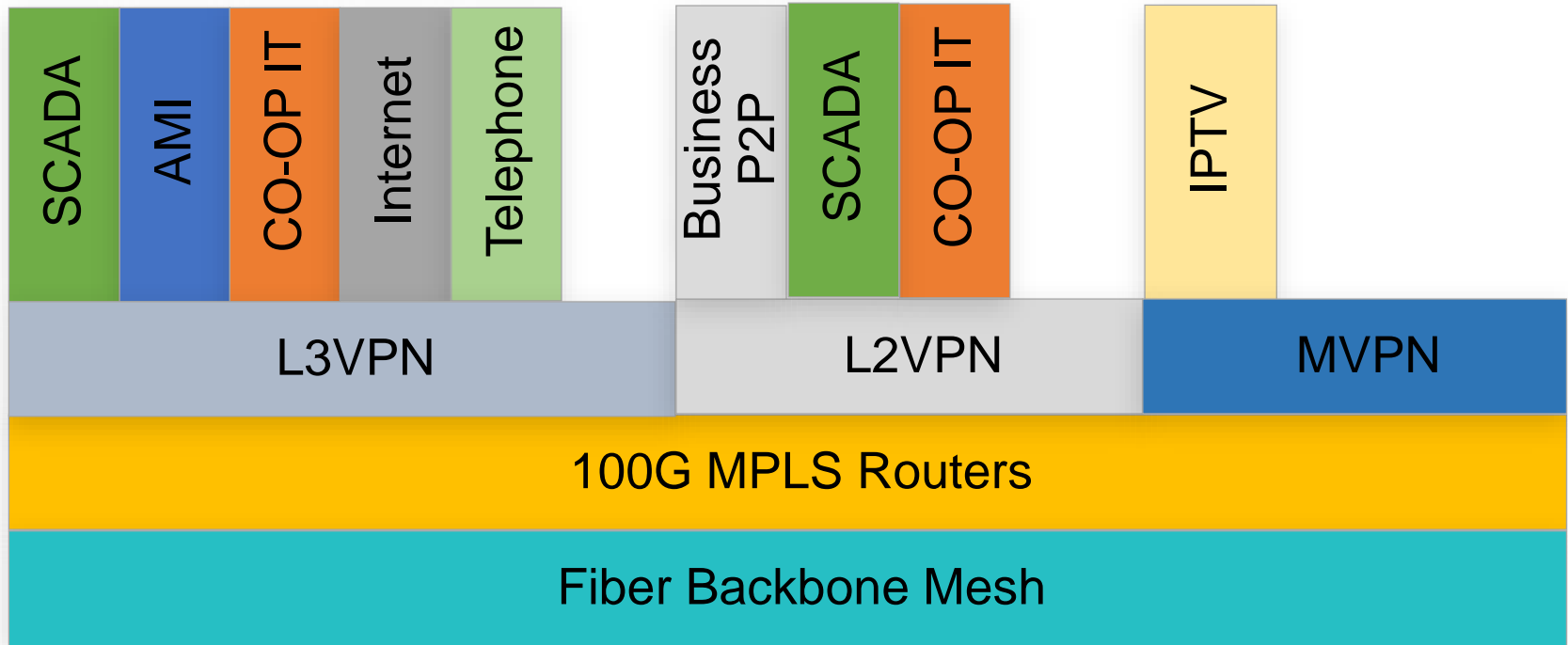
- Layer 3 Virtual Private Network (L3VPN) = Virtual Routed Backbone
- Layer 2 Virtual Private Network (L2VPN) = Virtual Point to Point Circuit
- Multicast Virtual Private Network (MVPN) = Multicast IPTV over MPLS

OzarksGo MPLS Converged Backbone

- 100G MPLS backbone on dark fiber
- No separate DWDM layer necessary
- Virtualize each type of network with MPLS L3VPN instances
- One backbone to serve all L3VPN instances securely

- No traffic leaking between L3VPN instances
- Firewalls control inter L3VPN traffic

MPLS Architecture and Design



MPLS Protocol Stack

- OSPF or ISIS
 - RSVP and / or LDP
 - Multi-protocol BGP
 - MVPN
-
- Simplifies router configs and eliminates need for:
 - VLAN bridging
 - Spanning Tree
 - per-instance routing protocols
 - Multicast config on the backbone

Questions?

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- Steven Karp <skarp@ozarksgo.net>