Gibson Electric Membership Corporation

Your Touchstone Energy® Cooperative

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Fiber in the utility space, I GOT FIBER, NOW WHAT?

About the speaker:

- BUS degree with Computer Science focus from University of Tennessee, Martin (2002)
- Cisco CCNA certified (2009) with CCNP/CCIE/CCDE level training in MPLS Service Provider Networks the last 10 years, Attended the last 6 Cisco Live Events for specific MPLS service provider training and deep dives
- 17 Years in the TVA Utility I.T. Business at Gibson EMC
- 3 Years in the CLEC/ISP business prior to utility work
- Consulting services at Gibson EMC have kept me busy the last few years working with other utilities, building their fiber networks and hiring their IT personnel
- 39 years old, married with 2 children (9) and (2), both girls

Who is Gibson EMC?

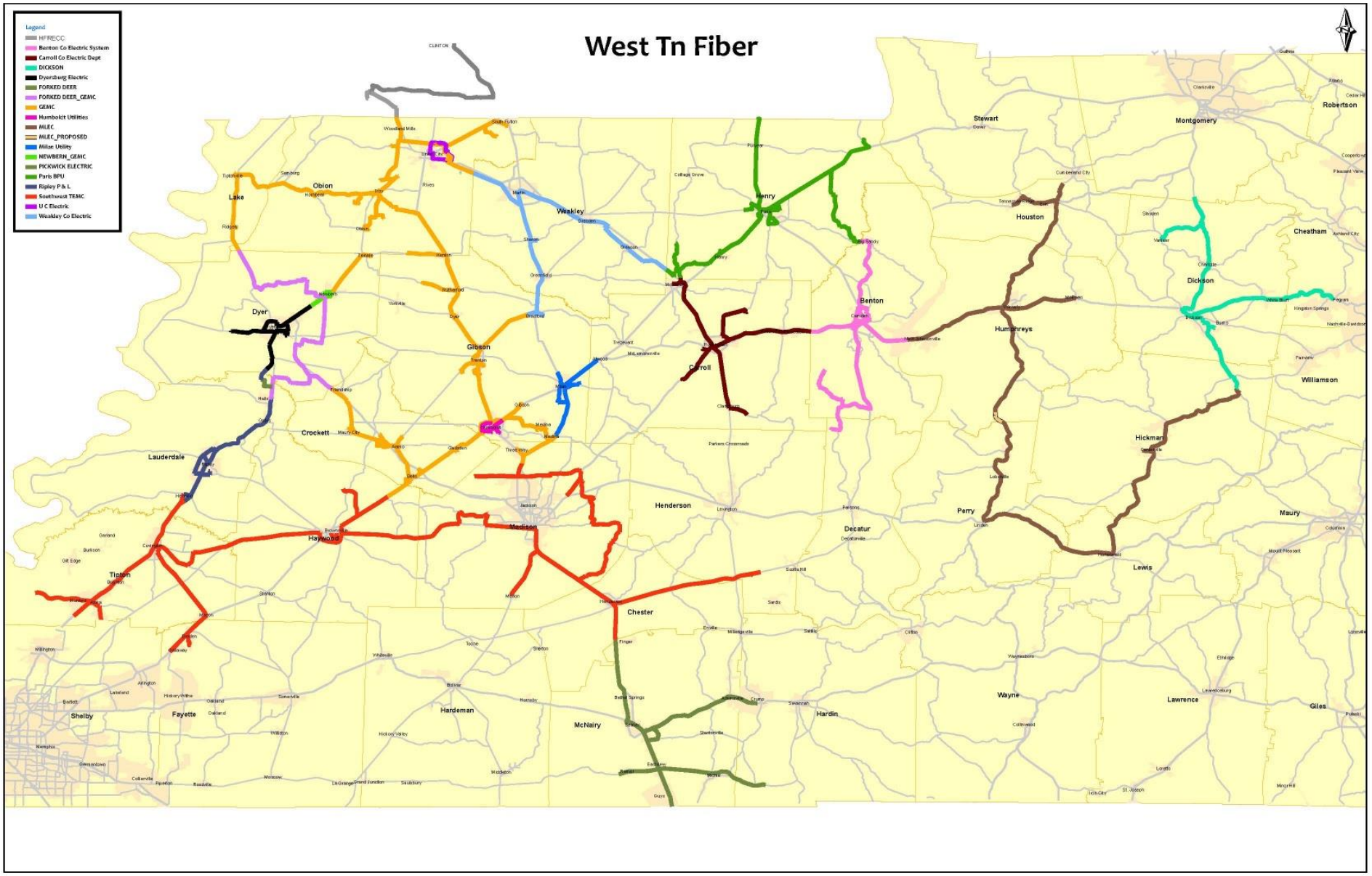
- 39,928 Meters
- 3500 miles of primary distribution, 19 substations across 6 NW TN and 3 West KY counties
- 6 Customer Service Centers
- PLC Aclara metering system, SEDC billing and plant accounting, SEDC Pre-Pay, SEDC MDM V1, Survelant SCADA, MilSoft OMS, US Payments Kiosks, and Futura staking and mapping
- 100 employees, 6 in Technical Services

Primary Purpose = Electric

- 10 Gb/s transport fiber rings connecting 6 customer service centers for robust WAN services
- 10 Gb/s connectivity to all substations for SCADA, AMI and Video
- 45 Downline Devices (Smartgrid)
- Approximately 400 endpoints on Gibson EMC lead contracts (Banks, Schools, etc)

Facts and Figures

- Gibson EMC – 350 miles of ADSS Fiber
- WEST TN Fiber – approximately 1500 miles
- Majority of systems standardized on AFL 535 mini-span with capacity of up to 96 fibers to meet capacity and ruling span criteria
- ADSS fiber designed for installation in power space and normally hung just below the neutral utilizing the value of the utilities' ROW
- Each system maintains ownership of their own fiber within their electric footprint


West Tn Fiber
Legend
HFRECC
Benton Co Electric System
Carroll Co Electric Dept
DICKSON
Dyersburg Electric
FORKED DEER
FORKED DEER_GEMC
GEMC
Humboldt Utilities
MLEC
MLEC_PROPOSED
Millar Utility
NEWBERN_GEMC
PICKWICK ELECTRIC
Paris BPU
Ripley P & L
Southwest TEMC
U C Electric
Weakley Co Electric
CLINTON
Stewart
Montgomery
Robertson
Houston
Cheatham
Dickson
Henry
Weakley
Obion
Lake
Dyer
Gibson
Crockett
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Haywood
Fayette
Shelby
Hardeman
McNairy
Chester
Henderson
Madison
Carroll
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Humphreys
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Perry
Decatur
Lewis
Maury
Wayne
Hardin
Lawrence
Giles

West Tennessee Fiber Journey

In order to regionally accomplish the model, a vision of cooperatives and municipals working together in their own electric footprint was established.

What are we?

- Loose Association of Electric Utilities to provide fiber services to West Tennessee
- Primary Goal is to provide communication services for internal use
- Secondary Goal is to help area businesses and school systems connect disparate facilities across larger geographic areas
- Products include dark fiber leases, Carrier Ethernet transport, and support services to schools and businesses using excess fiber capacity

What do the utilities have in common?

- Fiber Optic Cable Plant
- Geographical proximity to each other in order to make fiber interconnects
- Common Network Platform for Carrier Ethernet when providing lit transport
- Willingness to look past our differences in organizational structure (co-op vs. municipal) in order to achieve something greater; the whole is greater than the sum of the parts
- Respect for each utilities customer base and service footprint

Revenue

- Customers:
  - Cable TV
  - Local, Regional and National Telecom providers
  - Cellular Networks
  - Internet Service Providers
  - Education (Headstart, Primary, Secondary, College, & Technical)
  - Financial Institutions
  - Commercial and Industrial businesses
  - Medical
  - Government
  - Other Utilities

Now

- 21 cooperative and municipal fiber systems that are interconnected but independently owned covering most of western Tennessee and Kentucky
- About 1500 total miles of fiber cable installed (not including JEA's backbone or FTTH drops)
- Common carrier class network equipment (Cisco) and key nodes for lit transport
- Redundancy for internal and external customers provided across joint system
- Multiple joint customers across system with lead utility providing support and billing

Contracts

- Provide a single point of contact and payment for the customer with back office - joint agreements between the utilities
- Lead utility varies with the “primary” utility serving customer electrically having first choice to own the contract with customer
- Each utility individually prices their portion of the network and total price is aggregated
- Dark Fiber – customer direct or third parties
- Lit Transport utilizing Carrier Ethernet – customer direct or through third parties

What is the dark fiber product?

- Local Utility provides the facilities in the customers premise that allows access to the fiber plant
- Customer puts their own equipment on the fiber and lights up the fiber
- Serving utility is responsible for billing the customer for use of the fiber optic plant
- Serving utilities maintain a Service Level Agreement (SLA) for the integrity of the fiber optic cable in their respective service territory
- Inter-Utility Compensation occurs if a dark fiber lease spans multiple systems (transparent to the customer)

L2VPN Lit Ethernet Product offerings

- Ethernet over MPLS (EoMPLS): A Layer 2 transport product that provides a point-to-point link across the interconnected utilities backbone, can preserve customer vlan tagging and transports traffic like a long Ethernet cable (MEF defined Ethernet Private Line (EPL))
- Virtual Private LAN Service (VPLS): A Layer 2 transport product that provides a point-to-multipoint connection to multiple customer sites across the interconnected utilities backbone, transports traffic as if all sites were connected to the same switch (MEF defined E-LAN)
- No L3VPN services offered (No VRFs for Customers)

Why has a joint fiber system been good for West TN?

- Redundant paths for utility traffic
- Provides ancillary revenue source using excess capacity (fiber and Ethernet) that can be put back into fiber plant for future build outs/expansion of the fiber plant and future SmartGrid projects
- Lower electric rates
- Enables joint services such as offsite backup for disaster recovery purposes, offsite rack space, or sharing of data and mobile communication systems (truck radios, AVL) across multiple utilities
- Economic Development—fiber access is a must
- Lower cost telecommunication services

Challenges

- Doves (hunters) and Squirrels (themselves)
- Complexity of Networks (you got a router guy?)
- Varying pricing by utilities on multi-utility contracts
- Long circuits across multiple utilities are not cheap
- Record keeping
- Lack of structure
- Service Level Agreements
  - Original thoughts were electric first and then worry about fiber
  - Came to realize that a customer is a customer

Things Robin is working on:

- Adding ITU-T G.8275.2 Clocking Profile for 1588-PTP Clock Source, provides clocking for both frequency and phase in the carrier Ethernet network (TCP efficiency)
- Flow Aware Transport (FAT) Pseudowires—allows load balancing across equal cost paths per flow (per L2VPN)
- Push for Gibson EMC and Southwest EMC to place native IP smartgrid traffic into L2VPNs just like customer traffic (NERC CIP future encryption is a possibility)
- Bidirectional Forwarding Detection (BFD) reduces time to detect an interface fiber failure and use fast-reroute
- Remote Loop Free Alternate (R-LFA) < 50ms convergence time in fiber cut (closer to 7ms in lab)
- TVA metering project to read highside substation meters over joint lit network, VPLS Cloud with 7 endpoints so far

What is the Lit Network future?

- Finish Transition to Cisco ASR Platform (ASR 9k,903,920) at substations and offices (replacing ME 3600x/3800x and 7600s routers)
- Upgrade to 40 Gb/s /100 Gb/s Interfaces on Gibson EMC's Core Rings (ASR 9k/903) as FTTH ramps up
- Software Defined Networking as implemented using Segment Routing on the MPLS Dataplane for IPv4
- Segment Routing using TI-LFA for sub 50ms convergence regardless of topology and ECMP (equal cost multipath load balancing) for all L2VPN customers
- More 10 Gb/s Access Nodes for Schools/Banks/etc.
- FTTH L3 over L2VPNs using GPON

What do we do with fiber? We connect the following:

1. Member Service Centers/Substations ✓
2. Downline devices/Metering AMI stuff ✓
3. Dark Fiber Leases ✓
4. Lit Ethernet Transport, L2VPNs ✓
5. Wholesale Internet/ISP services ✓
6. As of July 2017, Retail Internet! ✓

What just happened!

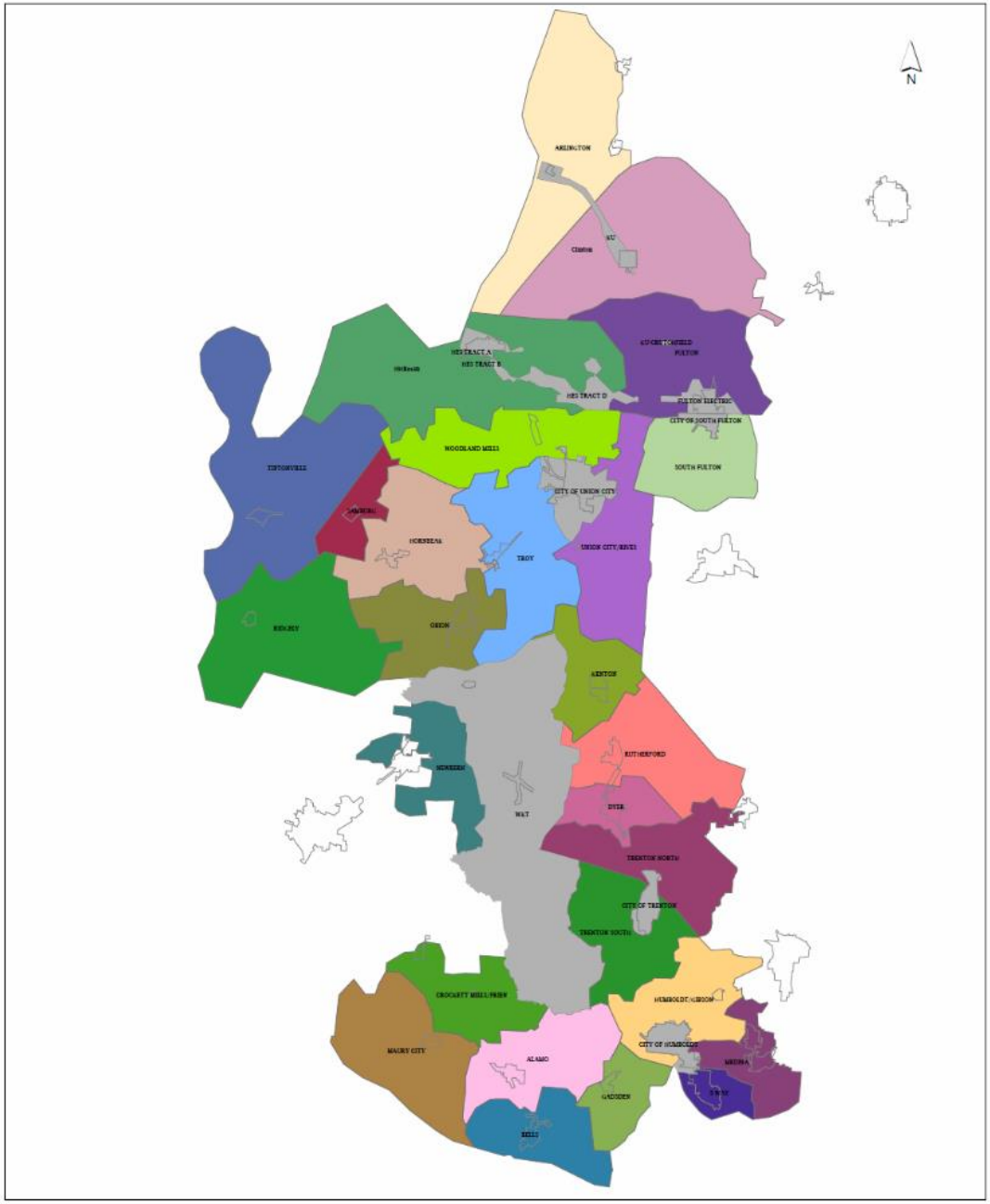
What is Gibson Connect, LLC.?

- Wholly owned startup subsidiary of Gibson EMC
- Created in response to the TN Rural Broadband Accessibility Act which allows electric cooperatives to provide retail broadband, phone, and video services in their electric footprint
- Initial residential service offerings for internet are $49.95 for 100 Mb/sec $69.95 for 1 Gb/sec with no data caps
- join.gibsonconnect.com is the frontend for the signup process, site went live October 10th, 2017
- Site uses the crowdsourcing method to determine where to build FTTH first, taking the risk off the CEO/board
- 100 % member-owner driven approach that is broken down into zones of participation

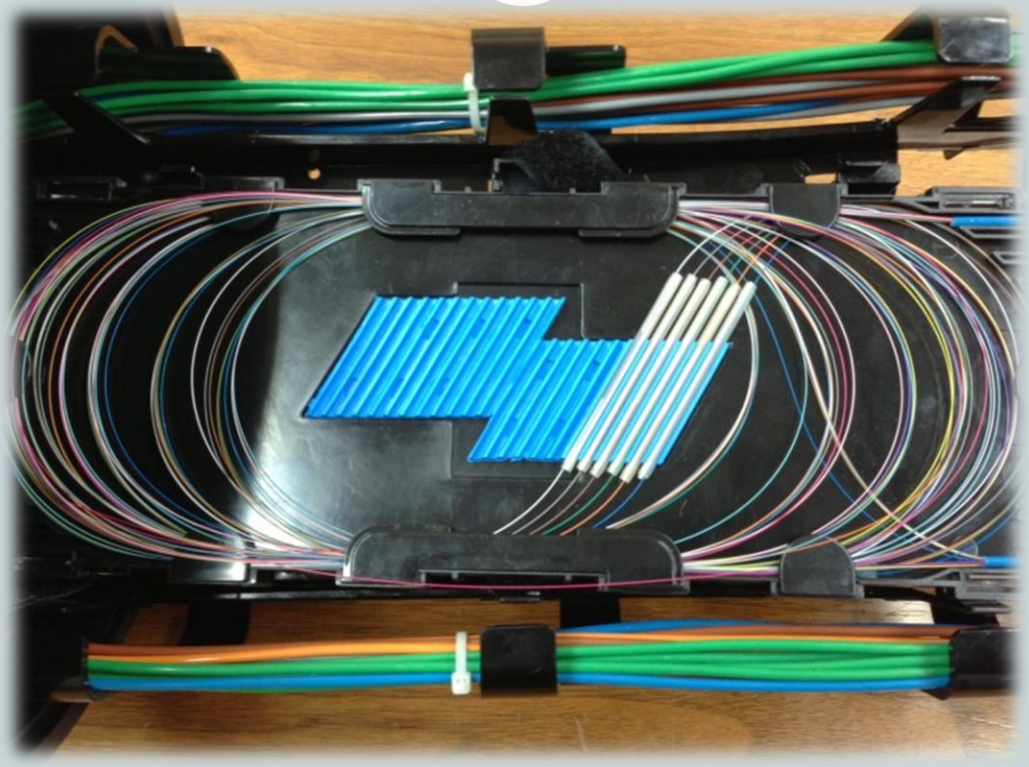
How do the zones work?

- Gibson EMC's electric service territory has been broken down into 27 member participation zones based on population, serving substation feeders, and/or community areas/towns served where there was a logical grouping of people.
- When the participation level metric is reached via signups, the Gibson EMC board votes on building FTTH to that particular zone. Each signup costs $20 that will be credited back on the first month of Internet service.
- System wide average across all zones is 40% participation needed to build each zone. For example, if a zone has 1200 meters, then 480 people have to sign up for service before we build FTTH in that entire zone.
- The zones that meet the metric first, are built first, so go tell your friends and neighbors!

GIBSON CONNECT™



That's Great Robin, but how do you make it all work together?



The truth is…

- Most of the work is already done from a network backbone perspective, 10 Gb/s to most every substation already
- Middle-Mile Ethernet transport services have been keeping our electric rates down for the last 5-8 years due to the additional revenue
- Security concerns were already addressed by using L2VPNs over MPLS encapsulated circuits for customers and/or internal traffic
- FTTH is just more L2VPNs at the substations from a backhaul perspective

However, caveats!

- The last mile build is the most critical piece, have good GPS accurate maps and lots of field engineering
- Have a good plan and trust in your people to execute that plan, people who have buy-in will work hard for you
- Work with your vendors to validate engineering and design characteristics
- Learn what works and doesn't work by asking others who have done it; don't reinvent the wheel
- The complexity of the new business and the service culture of your organization may cause issues when entering a competitive marketplace, Telecom is ruthless
- Hiring people with the right skillsets to do support, sales, billing, etc.
- Training, Training, Training

So, what is Gibson EMC going to do?

- Install Calix OLTs (E7/E9) AXOS in new adjacent substation houses (48 volt DC!) plus generators
- Depending on price and area, deploy GPON (2.5 Gbps/1.25 Gbps) or NGPON2 (10 Gbps) 1:32 splits
- Indoor Calix ONT with managed Wi-Fi capability
- Complete IPV6 native network from Internet Edge to ONT (across L2VPNs enabled by EoMPLS)
- DNS/DNS64 via Infoblox Grid Appliances
- MAP-T requires support from both the Calix ONT and Cisco ASR Platform (ASR1K, ASR9K) to work
- Deployment of MAP-T (RFC-7599) to translate IPV4 Internet to IPV6 native networks

What is MAP-T?

- MAP-T is an (almost) stateless alternative to Carrier Grade NAT and DS-Lite that pushes the IPv4 IP address/port translation function (and therefore the maintenance of NAT state) entirely into the existing customer premises equipment IPv4 NAT implementation, thus avoiding the NAT444 and statefulness problems of Carrier Grade NAT in operator network, and also provides a transition mechanism for the deployment of native IPv6 at the same time with very little added complexity.

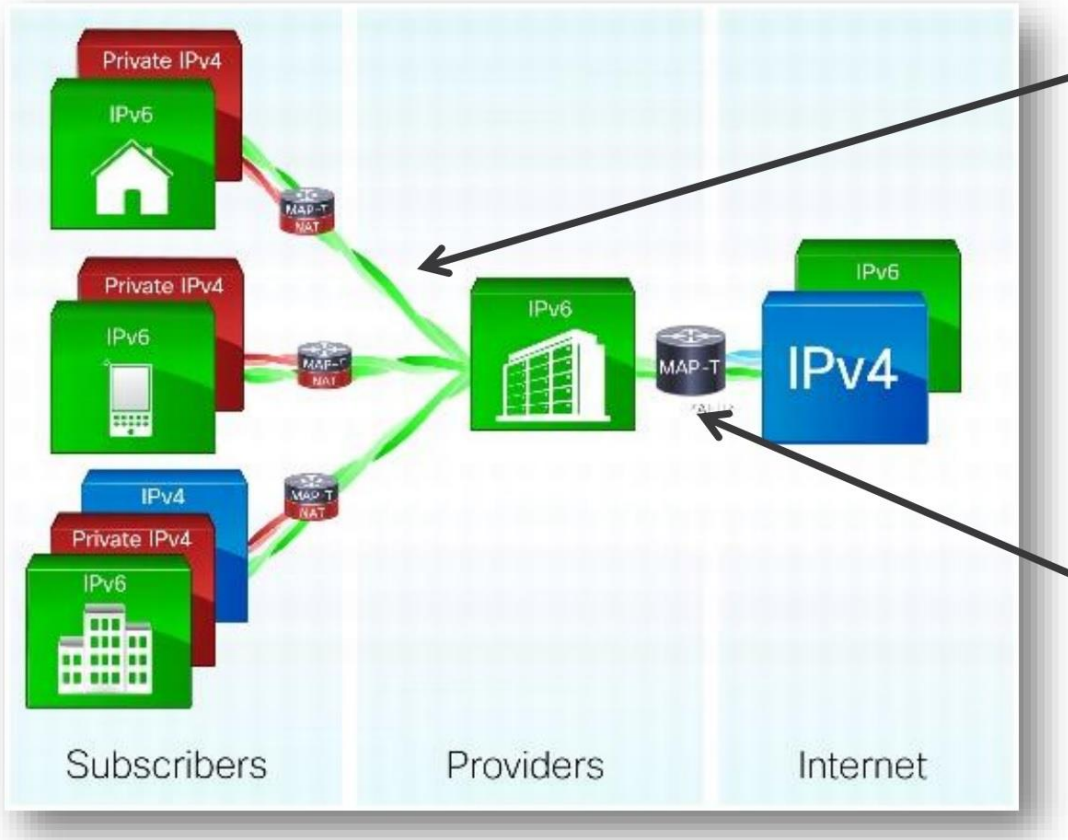
Why, Robin, Why?

- Limited number of IPV4 address space (2 /22s), and lots of IPV6 address space (/36) #winning!
- CGN requires lots of logging to figure out who has what IP address at what time (Lawful Intercept, CALEA concerns) and is a disk space issue long term (1 yr.)
- CGN breaks when you want multiple exit points in the network, state symmetry must be maintained
- CGN breaks some applications (FTP, Skype, etc.) and others require Application Level Gateways (ALGs)
- Limit the number of ports per customer to prevent DDOS outbound attacks (with either MAP-T or Carrier Grade NAT)

MAP-T Diagram

MAP-T : Stateless 464 Translation

Supported on ASR9K, ASR1K



Native IPv6

Stateless 64 translation function (on routers)

- No CGN -

So, you want to deploy FTTH too?

Things to do:

- Establish your Subsidiary (Coop) or Private Act (Muni)
- Establish your Autonomous System and IP addresses from ARIN/ARIN IP Broker and brush up on your BGP
- Do a feasibility study and customer broadband survey
- Pick a fiber cable vendor
- Decide on how to engineer
- Pick an access vendor
- Hire admins and techs
- Figure out who owns what
- Secure financing
- Look for Grant Money
- Secure Back-end Systems

Questions?

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What is MPLS Lit transport (Wikipedia)?

- MPLS is defined as Multiprotocol Label Switching, defined as an extension of either OSPF or ISIS link-state routing protocols.
- In an MPLS network, data packets are assigned labels. Packet-forwarding decisions are made solely on the contents of this label, without the need to examine the packet itself. This allows one to create end-to-end circuits across any type of transport medium, using any protocol. MPLS belongs to the family of packet-switched networks.
- It was designed to provide a unified data-carrying service for both circuit-based clients and packet-switching clients which provide a datagram service model. It can be used to carry many different kinds of traffic, including IP packets, as well as native Ethernet frames.
- Developed in Late 1990s, Mature Transport Mechanism to transport disparate flows across an interface yet keeping the traffic logically separated between customers (security!, security!, security!)