Long-Form 683 Technology and System Design Description

Chariton Valley Communications Corporation ("Chariton Valley" or "Applicant") will demonstrate it is technically qualified to meet the public interest obligations in our winning bid census block groups (CBG) in this document It contains a detailed technology and system design description including a network diagram certified by a professional engineer.

Network to be Built, Feasibility, and Network Diagram

Chariton Valley has a history of success in deploying, maintaining, and provisioning voice and broadband service for over 15 years in the state of Missouri. We deploy a buried fiber-to-the-home network using active ethernet via a Calix Ethernet Service Access Platform. Active Ethernet enables us to deliver 1Gbps down/500 Mbps up in bandwidth to the customer premise. This network and technology offers a low latency network and meets the Voice MOS requirements. At present our two upstream providers are CenturyLink and Bluebird Networks. We continue to shop for bandwidth to maintain competitive pricing and keep costs as low as possible. Evident from our past and current operations, and detailed below, Chariton Valley has described in detail a network that fully supports the delivery of consumer voice and broadband service.

As a growing Broadband Internet Provider, we have years of experience providing, monitoring and increasing internet bandwidth capacity to meet growing demands. We assume all subscribers will use 1 Gbps of capacity and have engineered the network to provide this speed. Chariton Valley identifies peak transitions for increasing capacity as new customers are acquired. This supports our proposed performance tier and latency during peak periods. Chariton Valley's network operations center (NOC) monitors current bandwidth utilization compared to available bandwidth. The network, including backhaul for interconnection, is fully redundant. The redundancy throughout our design along with a complete network description is detailed below and guarantees feasibility, reliability, and the ability to meet the required performance obligations during periods of peak usage throughout the deployment of buried fiber-to-the-home in our winning bid CBGs.

Project Plan

Chariton Valley's vision is to enhance opportunities for rural America by delivering premier telecommunications and technology in Missouri. We are committed to taking Broadband to as many locations as possible, as fast as possible. Chariton Valley is in year 2 of an 8 year build out plan in competitive rural communities in North Missouri. We mapped the communities into Zones and created a business plan based on the cost to construct and install by Zone, and the revenue requirement to meet a 60 month return on investment (ROI). Using a system to track interest and orders for service we build Zones as they reach our ROI goal. Expanding our fiber network into areas which are unserved or underserved provides the best opportunity for Chariton Valley to execute our vision.

The Connect America Fund Phase II Auction is a perfect fit for unserved areas adjacent to our existing fiber network and service areas, and to Chariton Valley's existing broadband deployment plan. Merging the construction of the CBG locations with the existing construction schedule is the most efficient and economical. Chariton Valley's Attachment 1 CAF Costs and Support and Attachment 2 Financial Projections reflect projected costs and revenues of the CAF locations, as well as our existing Zone build construction costs and revenues. Merging the construction

plans will make it feasible to meet the requirement of 95% of the number of locations well ahead of the end of the sixth year. Specifically, our plan projects completion of the 95% requirement by the end of the second year.

Chariton Valley's Attachment 2 Financial Projection includes building to the following construction of last mile and middle mile facilities to both CAF Locations and Community Zone Build Locations:

	Locations		
	CAF	Zones	Total
2019	382	1,146	1,528
2020	451	682	1,133
2021	14	780	794
Total	847	2,608	3,455

Chariton Valley doubled net broadband subscriber additions from 2017 to 2018 going from 2400 to 3100. We project to double net broadband subscriber additions again in 2019 ending with a projected 4500 broadband subscribers by year end. Chariton Valley has been ramping up for two years and expect to peak in 2019 with broadband additions. With our construction background and aggressive planning Chariton Valley will meet the projected milestones well in advance of the requirement.

Monitoring and Maintaining Performance

Chariton Valley has a formidable track record, over 15 years, in monitoring and maintaining its current network and public interest obligations. The same level of service will be provided to all future connections. CAF Phase II CBGs will be merged into our current and future network and customer base. By the end of construction to the CAF locations, it will be a small % of our broadband customer base, approximately 13%. Chariton Valley will continue to monitor and maintain the performance of our network for the duration of the 10-year support term, as well as enumerable years to come.

Connect America Fund
CAF Phase 2

Exhibit 4

By: Beau Harrington
Cisco Certified Network Professional
Cisco ID: CSCO12847328

GLOSSARY

AE – Active Ethernet
Active Ethernet network provides each subscriber with their own fiber link to the network node switch, which links the local network to the Internet

CO – Central Office
A Central Office is a location within the Chariton Valley network that houses network devices and other Chariton Valley equipment in our service area.

FHRP – First Hop Redundancy Protocol
First Hop Redundancy Protocols (FHRP) provides failover for IP network gateways to prevent loss of service during router failure or connectivity loss by utilizing a second router.

L2 – Layer 2
Layer 2 refers to the data link layer of the Open Systems Interconnection (OSI) model that describes IP network connectivity.

LAG – Link Aggregate Group
Link Aggregate Groups are interfaces that are bundled together as a single interface. LAGs are utilized to provide additional bandwidth and interface redundancy.

MPLS – Multiprotocol Label Switching
MPLS is a data-carrying technique for high-performance telecommunications networks. MPLS directs traffic by the use of short labels versus using the full IP address for routing data across the network.

NAT – Network Address Translation
NAT is a method of remapping an IP address or blocks of IP addresses to one or many publicly routable IP addresses. NAT is necessary to conserve public IP addresses as IPv4 space is becoming sparse.

NOC – Network Operations Center
This is the location for most of the core network equipment and where Chariton Valley technicians reside.

OSI – Open Systems Interconnection Model
Open Systems Interconnection model (OSI model) is a conceptual model that characterizes and standardizes the communication functions of a telecommunication or computing system without regard to its underlying internal structure and technology.

ROADM – Reconfigurable Optical Add/Drop Multiplexer
ROADM utilizes multiple wavelengths to send multiple 10/100Gbps connections over a single fiber. Chariton Valley uses a Ciena Z-Series platform for mid-mile transport.

SIP – Session Initiation Protocol
VoIP utilizes SIP to initiate phone calls and signaling for voice traffic to a PBX to then route voice traffic over the public switched telephone network.

VRF – Virtual Routing and Forwarding
A VRF creates segregated routing tables on a router that work simultaneously. VRFs allow service providers to separate different services from each other to increase security and default routes to different destinations.

Chariton Valley
Last Mile Deployment

Chariton Communications Corporation (Chariton Valley) of Macon, Missouri, has been awarded locations to serve from the Connect America Fund Phase II Auction (Auction 903). The locations are geographically located in the following counties in Missouri; Chariton, Linn, Macon, Randolph and Shelby. Chariton Valley currently provides the following services; internet, phone, video and wireless to locations in following counties in Missouri; Carroll, Chariton, Howard, Linn, Livingston, Macon, Monroe and Randolph. Chariton Valley will expand its existing fiber to the home technology and networks to provide low latency gigabit internet and telephone services to the locations Chariton Valley was awarded from the Connect America Fund Phase II Auction (Auction 903).

Chariton Valley will deploy a state of the art Active Ethernet network that will provide each subscriber with their own fiber to the network node switch to provide gigabit internet and voice services.

Chariton Valley
Multiprotocol Label Switching (MPLS) Routed Core and Edge Network Descriptions

(Voice and Data flow routers only)

MPLS Routed Core Description

The Chariton Valley MPLS routed core is geographically redundant between our network operations center in Huntsville, MO and our Jacksonville CO in Jacksonville, MO. This MPLS core segregates services logically and physically with the use of multiple routers and the use of Virtual Routing and Forwarding (VRF). All of the different service routers are connected to a pair of core routers which ties the whole MPLS network together.

The MPLS routed core is connected to our Ciena Z-series (previously Cyan) 96 channel ROADM optical network. The Ciena Z-series is our backhaul for our last mile platform bringing layer 2 (L2) connectivity from our last mile platforms to the geographically redundant service routers. First Hop Redundancy Protocols (FHRP) are utilized for all data and voice services to prevent a catastrophic failure from causing outages.

Edge Network Description

Chariton Valley currently has two 10 gigabit connections for Internet uplinks. Chariton Valley currently utilizes two upstream internet providers that provide 10 gigabit connections to the Internet. Both edge routers are peered to each provider so that a switch or router failure does not drop connectivity to either upstream provider. The Edge Routers are connected to our MPLS core with 10 gigabit links which are also geographically redundant.

Data Throughput Scalability

The Chariton Valley MPLS routed network is currently 10 gigabit. Chariton Valley monitors network congestion daily and alerts are sent when congestion reaches 90% capacity. The network can be expanded by bundling additional 10 gigabit interfaces into a Link Aggregate Group (LAG) to provide additional throughput to avoid congestion. Additional 10 gigabit interfaces can be added when necessary to the LAGs facing our Ciena Z-series backhaul platform to provide additional L2 throughput to bring last mile services to the MPLS core. Chariton Valley is currently exploring redundant 100 gigabit Optical Wave to St. Louis, MO and 100 gigabit Optical Wave to Kansas City, MO for expected data growth.

Voice Services

Voice services gateways reside on VOICE_EDGE_PE1 and VOICE_EDGE_PE2. First Hop Redundancy Protocols are utilized to give customers geographically redundant gateways. Chariton Valley owns geographically redundant Metaswitch to route calls and Perimeta Session Border Controller to protect voice services. The Metaswitch and Perimeta are located in Huntsville and Jacksonville and connected to the voice router at that location. SIP and voice services that come through the public internet are also protected by our Cisco ASA 5585 firewall.

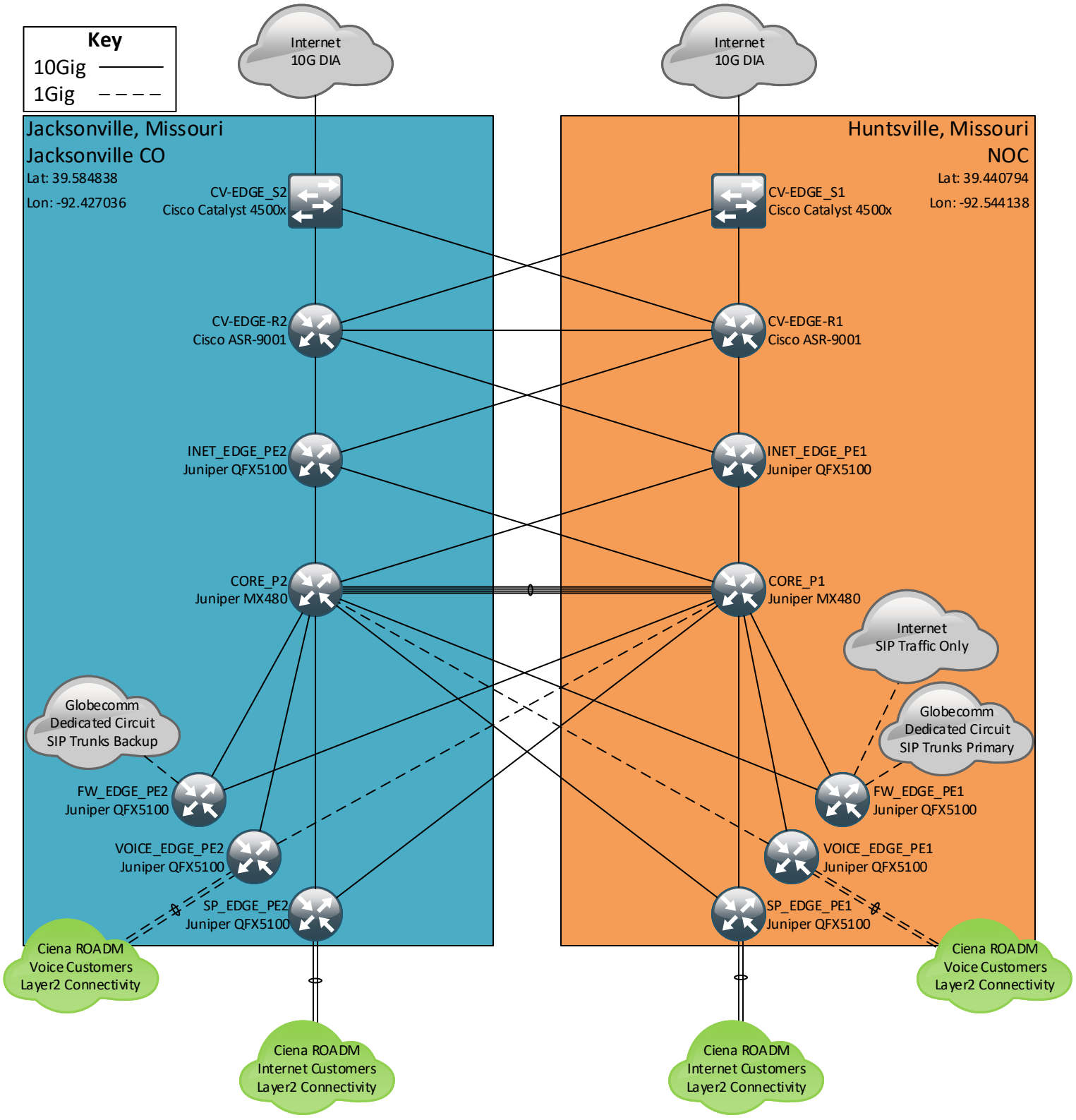
Voice traffic that is routed over the internet have a dedicated circuit so that voice traffic is not competing with data traffic through Blue Bird Networks. Chariton Valley also has SIP trunks to Globecomm located in Hauppauge, NY over redundant 1 gigabit dedicated circuits.

Data Services

Data service gateways reside on the SP_EDGE_PE1 and SP_EDGE_PE2 routers. First Hop Redundancy Protocols are utilized to provide geographically redundant gateways in the situations of catastrophic failures. Customers that have public IP addresses are routed straight to the internet. Basic internet services utilize private IP address space and are NAT'ed by our geographically redundant F5 Carrier Grade NAT platform.

Chariton Valley
MPLS Routed Core and Edge Network Logical Topology

(Voice and Data flow routers only)



Chariton Valley
Ciena Z-Series Backhaul Description

(Voice and Data backhaul transport only)

Ciena Z-Series ROADM Backhaul Overview

The Ciena Z-Series platform is a 96 Channel Reconfigurable Optical Add-Drop Multiplexer (ROADM) system that is capable of 10/100Gig transport in a multitude of configurations of optical rings. Chariton Valley currently uses four 10 gigabit optical rings using Ethernet Ring Protection Switching (ERPS) as a loop prevention mechanism to transport all triple play services from our Calix E-Series last mile platforms to the georedundant core.

Our deployment of the Ciena Z-Series platform involves card redundancy for the ROADM ring protection and 10 gigabit downlinks to our Calix E-Series last mile platforms. With this configuration, a single card or interface failure will not impact services or reduce the available throughput to the MPLS core.

Chariton Valley will use the "Connect America Fund" to construct last mile connectivity for the following Census Block Group locations; 290414701001,290414702003, 291754902001, 291754901003, 292054503002, 291219603001, 291154903002, 291154905001, 291154904001, 291154904002, 291154901001, 291154902001, 291154901003. Below are the locations sharing 10gig ERPS ROADM rings and the maximum estimated users for these locations.

(Please note that the potential customers listed below represent the maximum potential subscribers for that area)

TCOM Ring 1 – Shared 10 gigabit ROADM Channel

Marceline MO – 1000 potential voice/data customers. **(CBG 290414701001 & 291154905001 = 198 Funded Locations)**
Macon MO FD1 – 1000 potential voice/data customers. **(CBG 291219603001 = 1 Funded Location)**
Macon MO FD9 – 650 potential voice/data customers.

TCOM Ring 2 – Shared 10 gigabit ROADM Channel

Brookfield MO – 3000 potential voice/data customers **(CBG 291154901001, 291154902001, 291154903002, 291154904001 & 291154904002 = 232 Funded Locations)**
Macon MO FD3 – 750 potential voice/data customers
Macon MO FD6 – 750 potential voice/data customers

ILEC North Ring – Shared 10 Gigabit ROADM Channel

Bucklin MO – 500 potential voice/data customers **(CBG 291154901001 & 291154901003 = 92 Funded Locations)**
Excello MO – 300 potential voice/data customers **(CBG 292054503002 = 6 Funded Locations)**
Bevier MO – 600 potential voice/data customers
Callao MO – 400 potential voice/data customers
Atlanta MO – 400 potential voice/data customers
Ethel MO – 200 potential voice/data customers
New Boston MO – 150 potential voice/data customers
New Cambria MO – 400 potential voice/data customers

ILEC West Ring – Shared 10 Gigabit ROADM Channel

Jacksonville MO – 550 potential voice/data customers **(CBG 291754901003 = 260 Funded Locations)**
Huntsville MO – 1000 potential voice/data customers **(CBG 291754902001 = 8 Funded Locations)**
Bynumville MO – 400 potential voice/data customers **(CBG 290414701001 = 48 Funded Locations)**
Brunswick MO – 750 potential voice/data customers **(CBG 290414702003 = 2 Funded Locations)**
Clifton Hill MO – 250 potential voice/data customers
Indian Grove MO – 100 potential voice/data customers
DeWitt MO – 150 potential voice/data customers
Bosworth MO – 250 potential voice/data customers
Hale MO – 450 potential voice/data customers

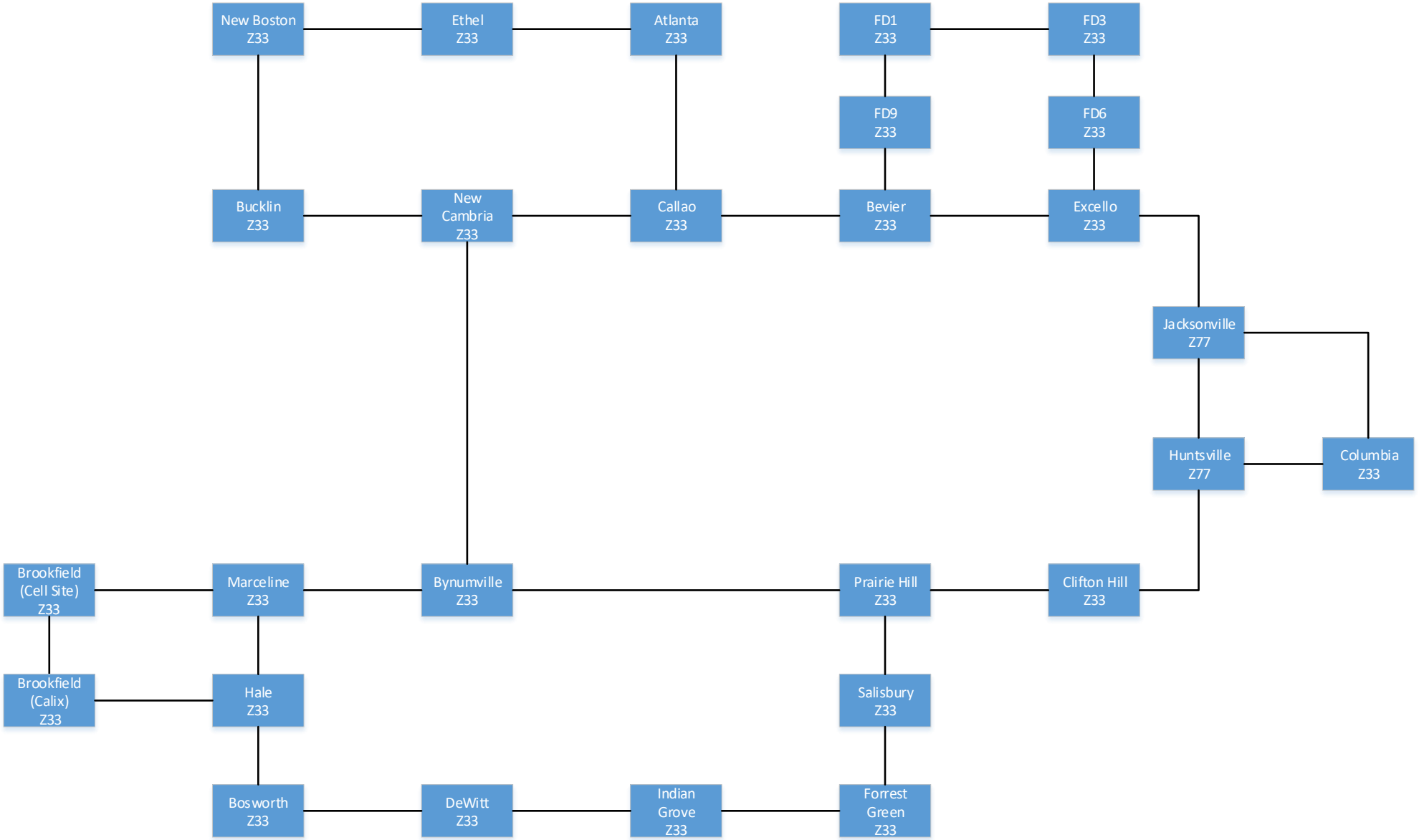
Bandwidth Scalability Plans

When congestion on one of the 10Gigabit ROADM channels reaches 90%, Chariton Valley will turn up an additional 10 gigabit ROADM channel and reduce the number of locations within the congested 10 gigabit ROADM ring. We have about 80 remaining 10 gigabit ROADM channels unused and have plenty of room for expansion for last mile backhaul to the MPLS core routed network.

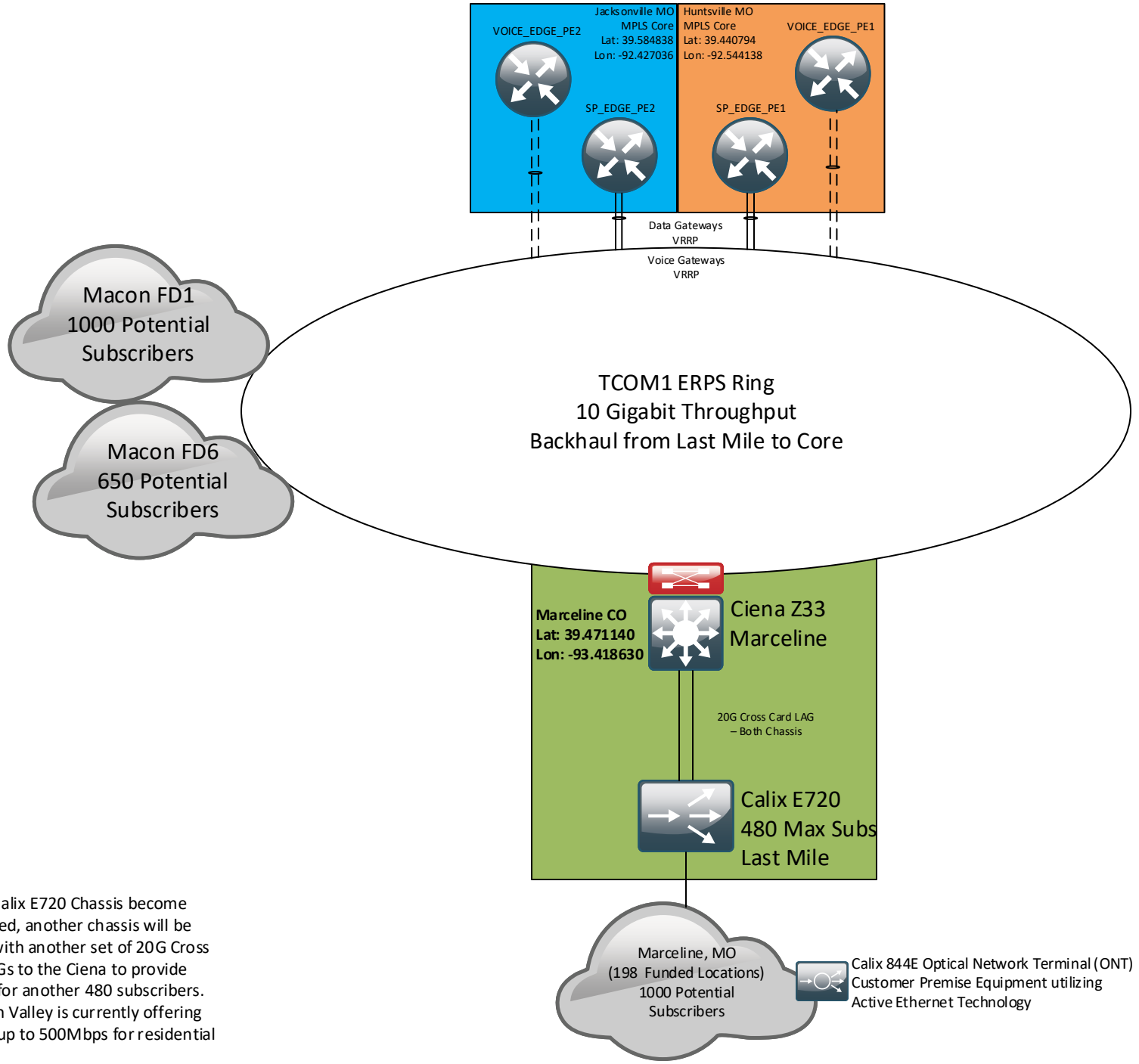
Chariton Valley

Ciena 96 Channel ROADM Backhaul – Physical Fiber Path

Ciena Z-Series Optical Network



CAF Funded Town - Marceline Missouri
Last Mile to Backhaul



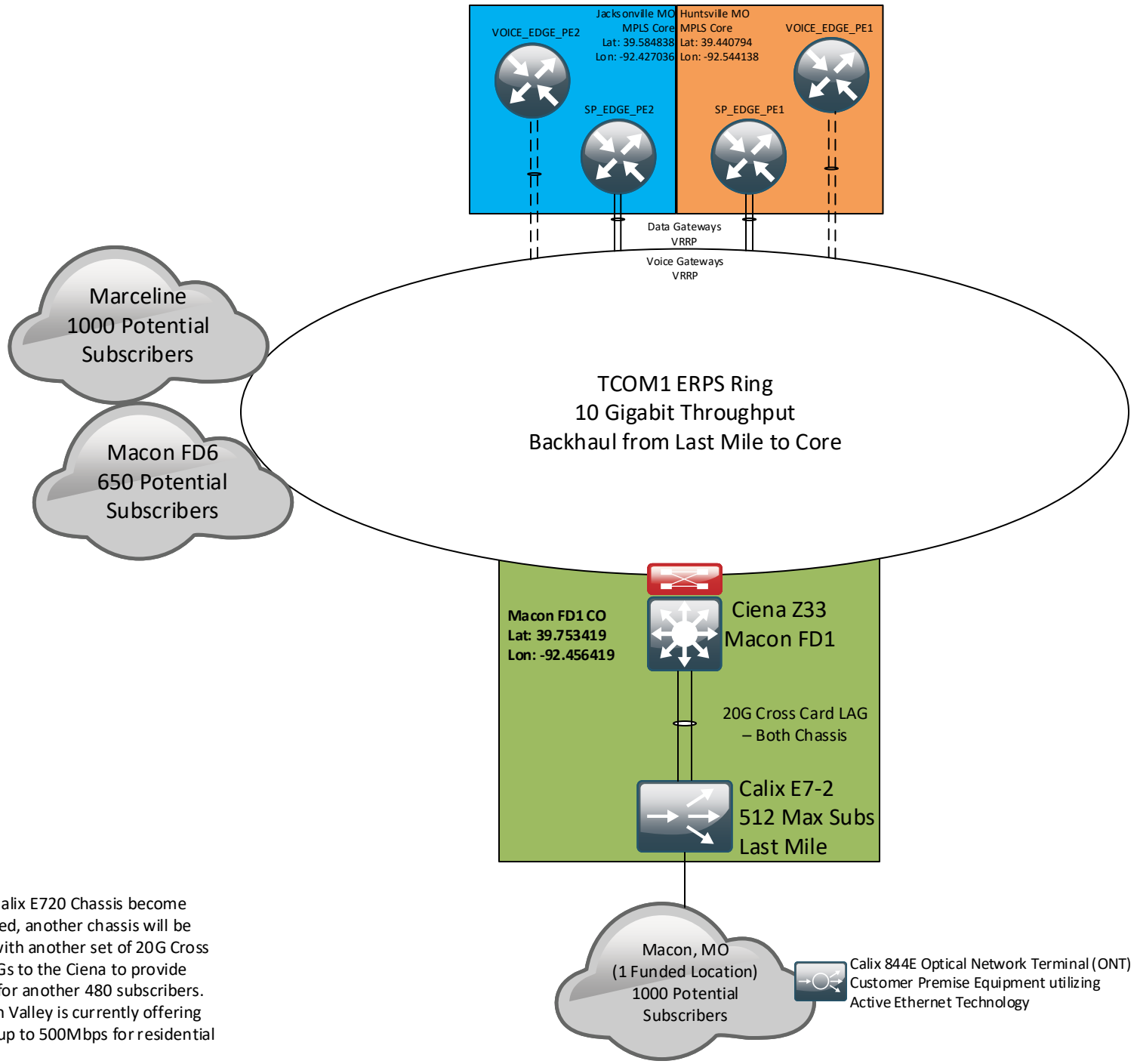
Note:
As the Calix E720 Chassis become populated, another chassis will be added with another set of 20G Cross card LAGs to the Ciena to provide service for another 480 subscribers. Chariton Valley is currently offering speeds up to 500Mbps for residential service.

Key

10Gig ———

1Gig – – – –

CAF Funded Town - Macon Missouri
Last Mile to Backhaul



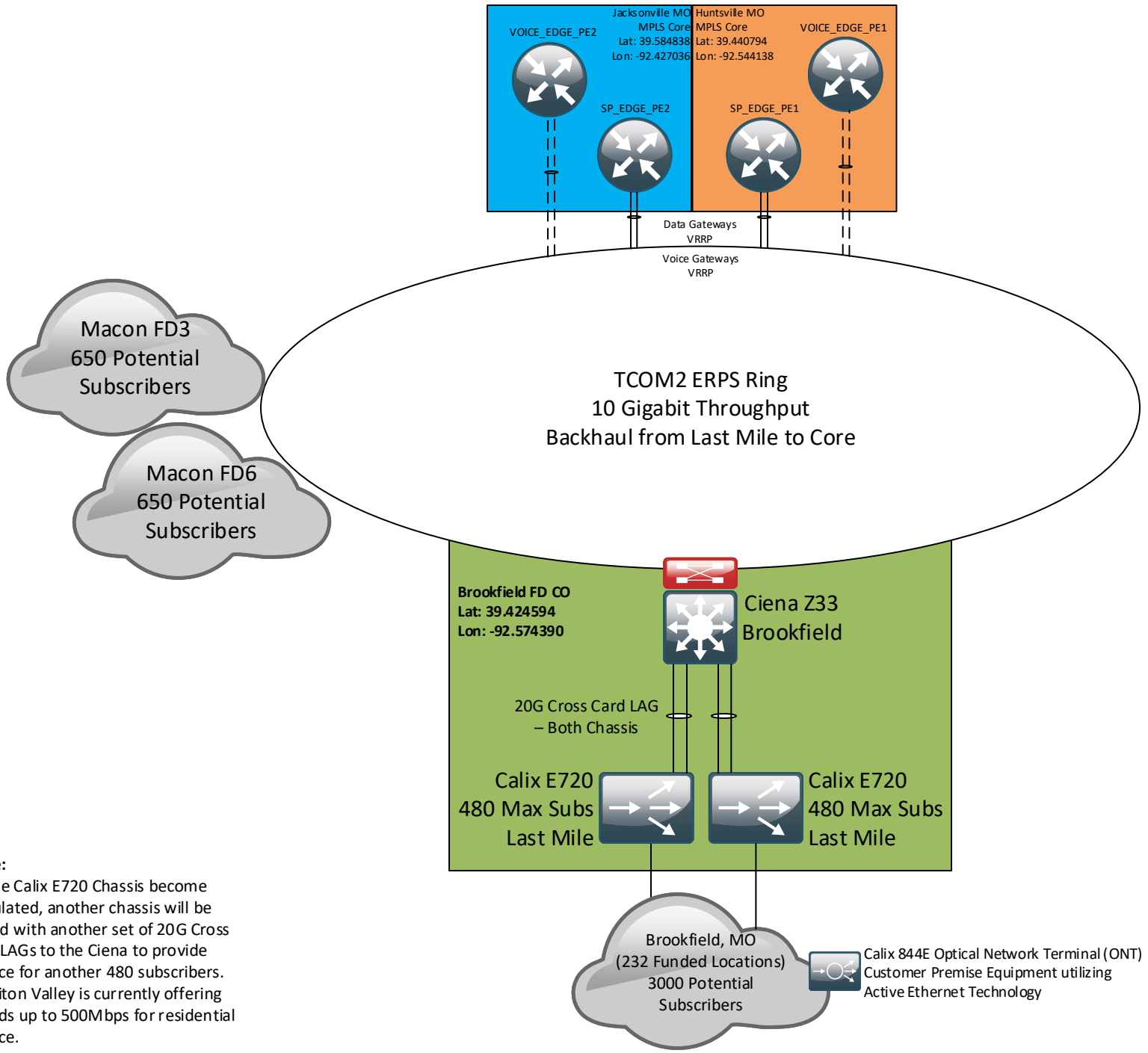
Note:
As the Calix E720 Chassis become populated, another chassis will be added with another set of 20G Cross card LAGs to the Ciena to provide service for another 480 subscribers. Chariton Valley is currently offering speeds up to 500Mbps for residential service.

Key

10Gig ———

1Gig – – – –

CAF Funded Town - Brookfield Missouri
Last Mile to Backhaul



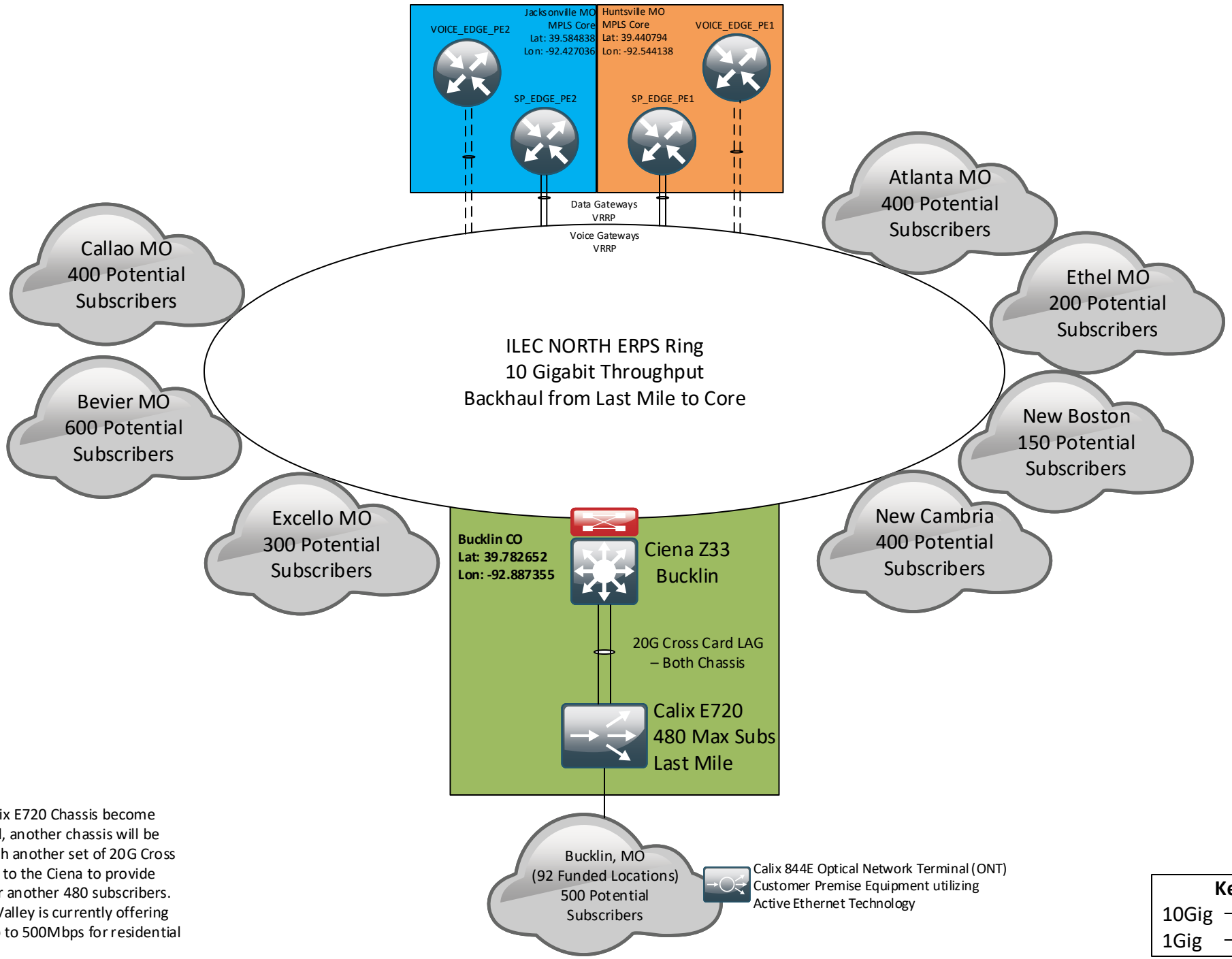
Note:
As the Calix E720 Chassis become populated, another chassis will be added with another set of 20G Cross card LAGs to the Ciena to provide service for another 480 subscribers. Chariton Valley is currently offering speeds up to 500Mbps for residential service.

Key

10Gig ——

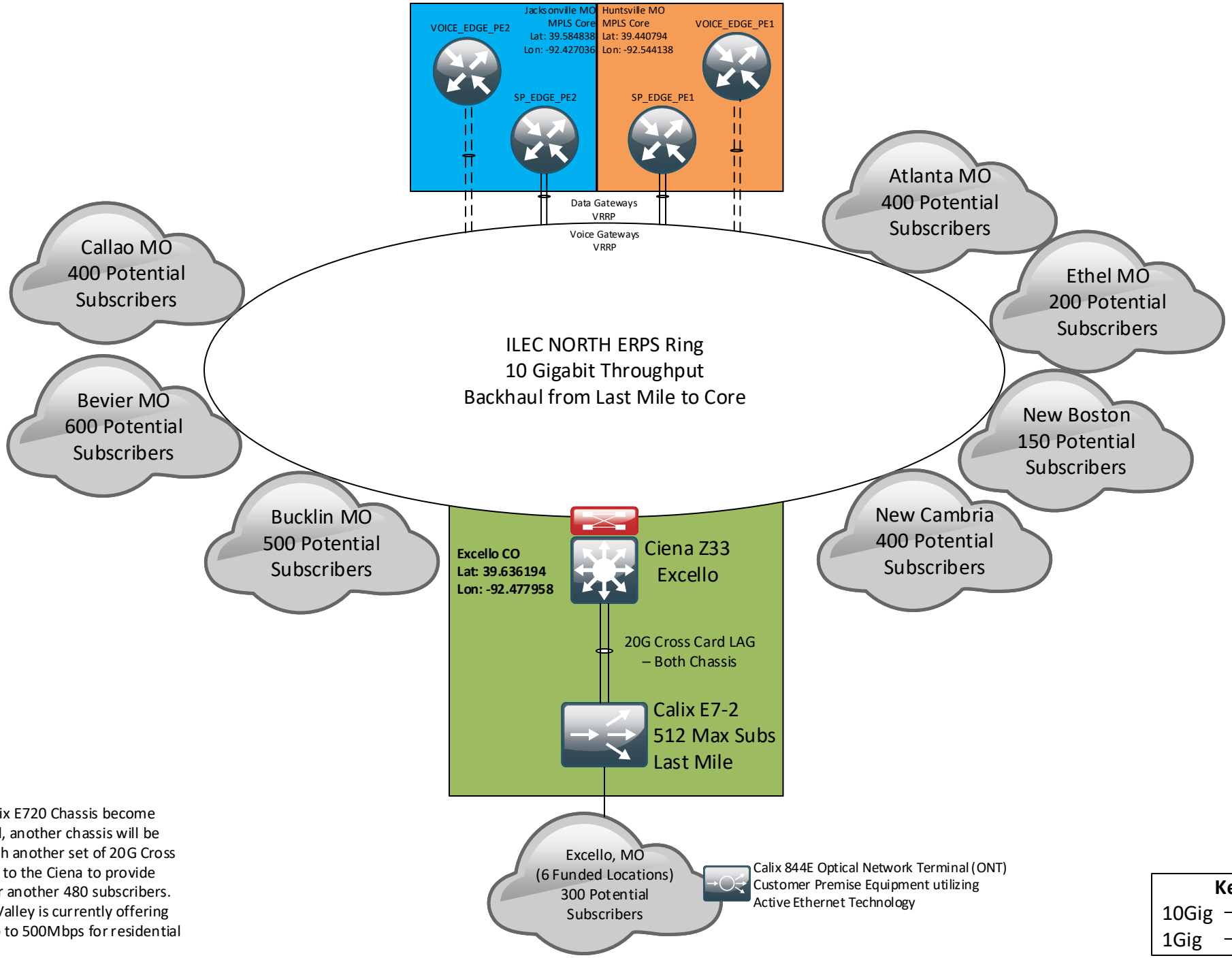
1Gig – – – –

CAF Funded Town - Bucklin Missouri
Last Mile to Backhaul



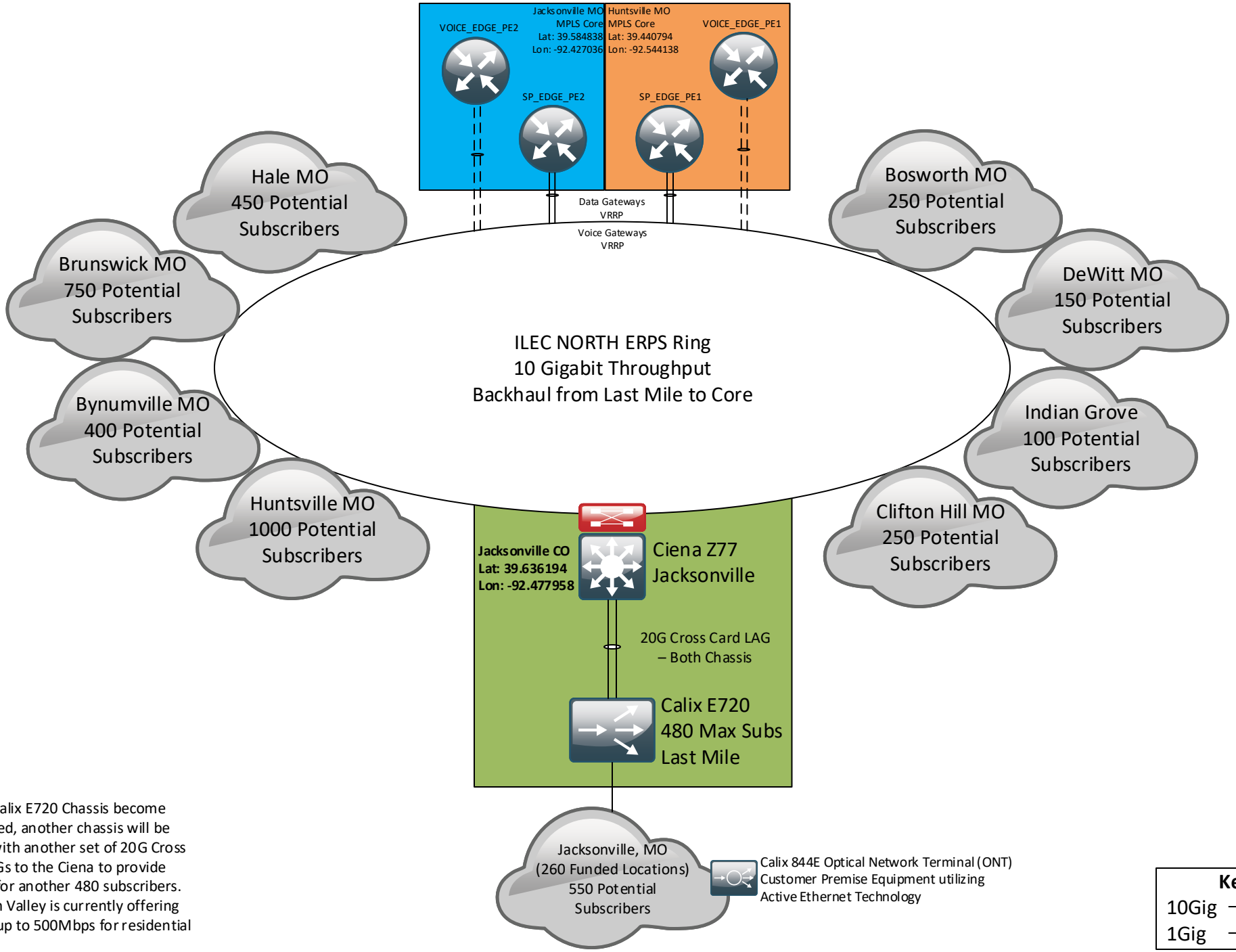
Note:
As the Calix E720 Chassis become populated, another chassis will be added with another set of 20G Cross card LAGs to the Ciena to provide service for another 480 subscribers. Chariton Valley is currently offering speeds up to 500Mbps for residential service.

CAF Funded Town – Excello Missouri
Last Mile to Backhaul



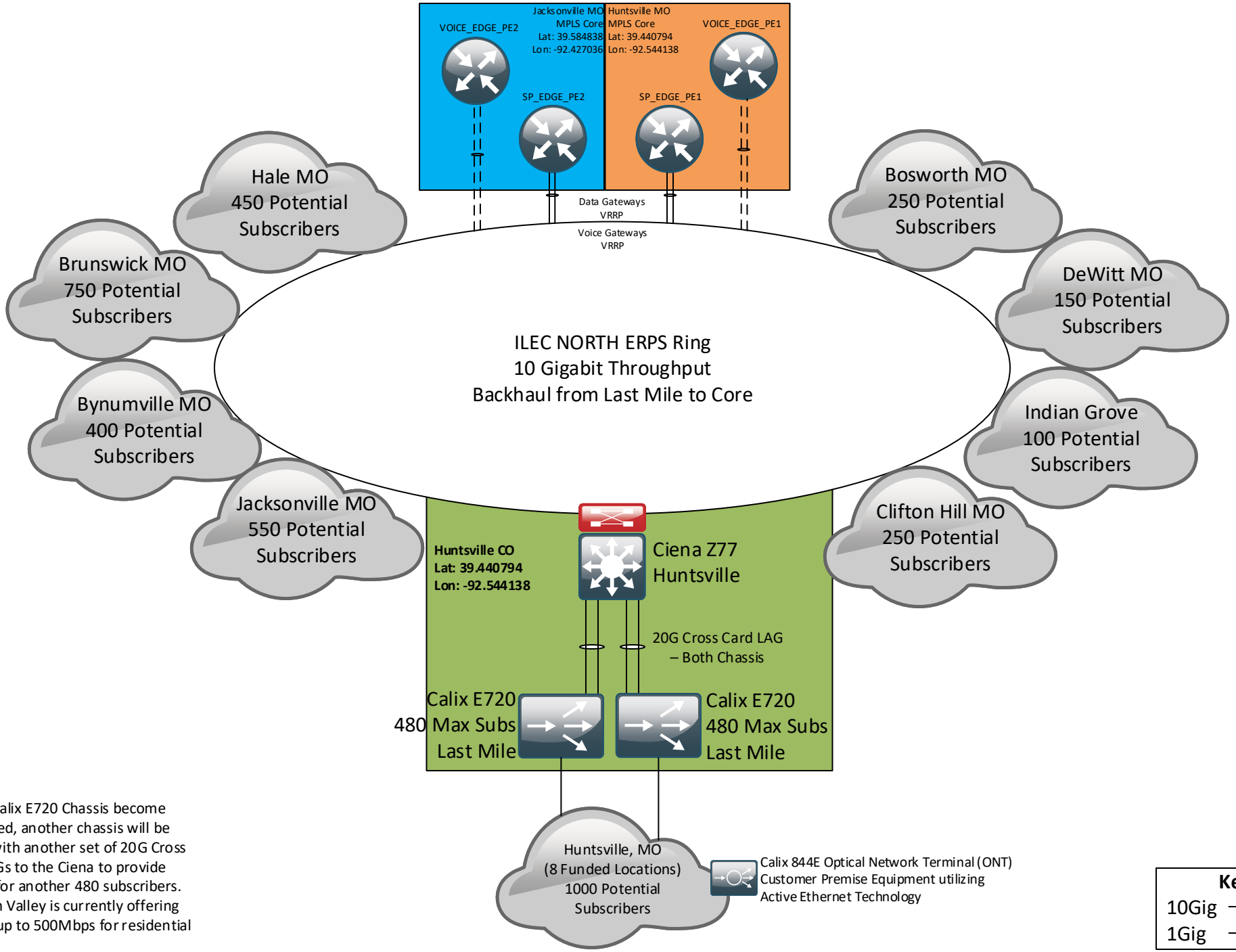
Note:
As the Calix E720 Chassis become populated, another chassis will be added with another set of 20G Cross card LAGs to the Ciena to provide service for another 480 subscribers. Chariton Valley is currently offering speeds up to 500Mbps for residential service.

CAF Funded Town – Jacksonville Missouri
Last Mile to Backhaul



Note:
As the Calix E720 Chassis become populated, another chassis will be added with another set of 20G Cross card LAGs to the Ciena to provide service for another 480 subscribers. Chariton Valley is currently offering speeds up to 500Mbps for residential service.

CAF Funded Town – Huntsville Missouri
Last Mile to Backhaul



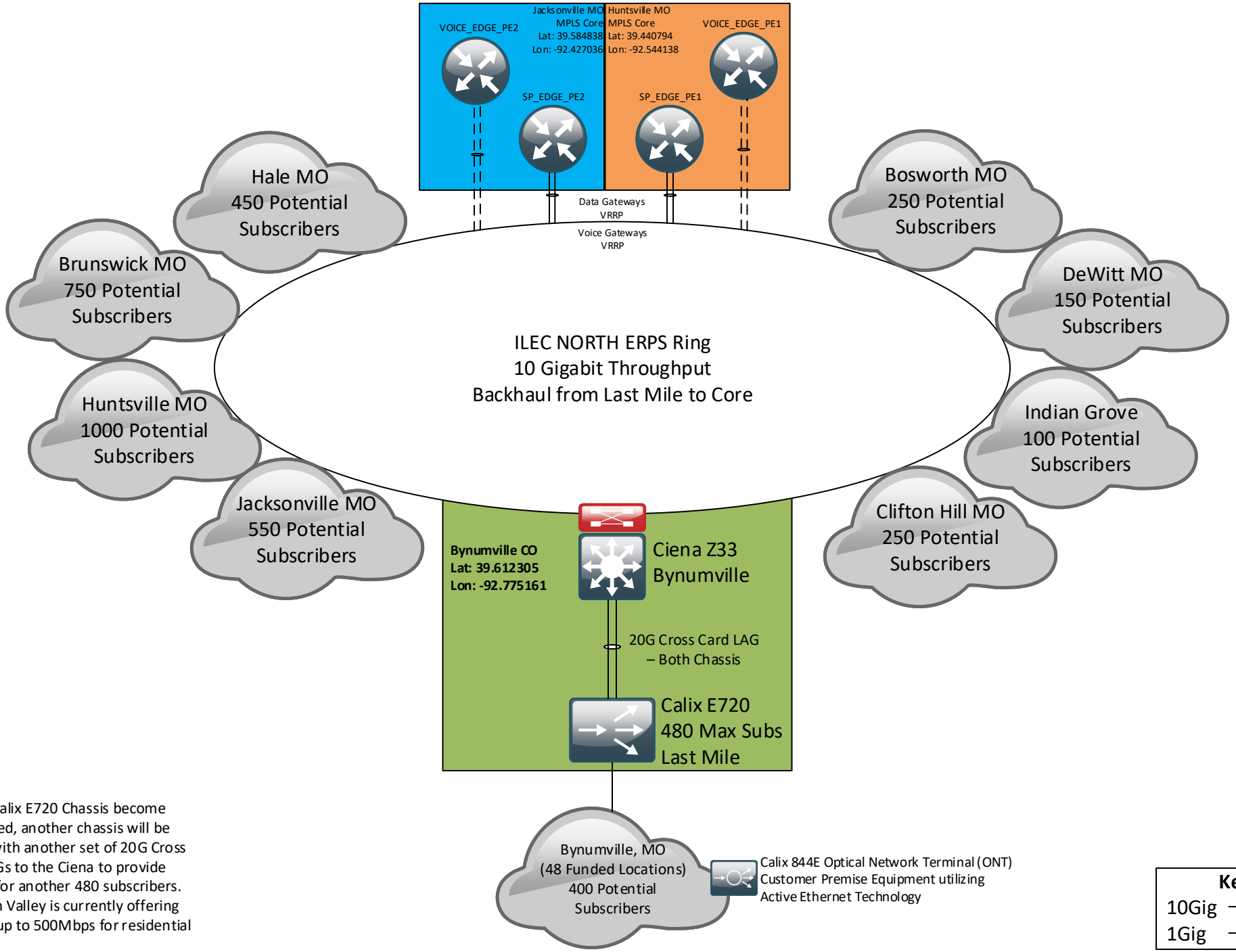
Note:
As the Calix E720 Chassis become populated, another chassis will be added with another set of 20G Cross card LAGs to the Ciena to provide service for another 480 subscribers. Chariton Valley is currently offering speeds up to 500Mbps for residential service.

Key

10Gig ——

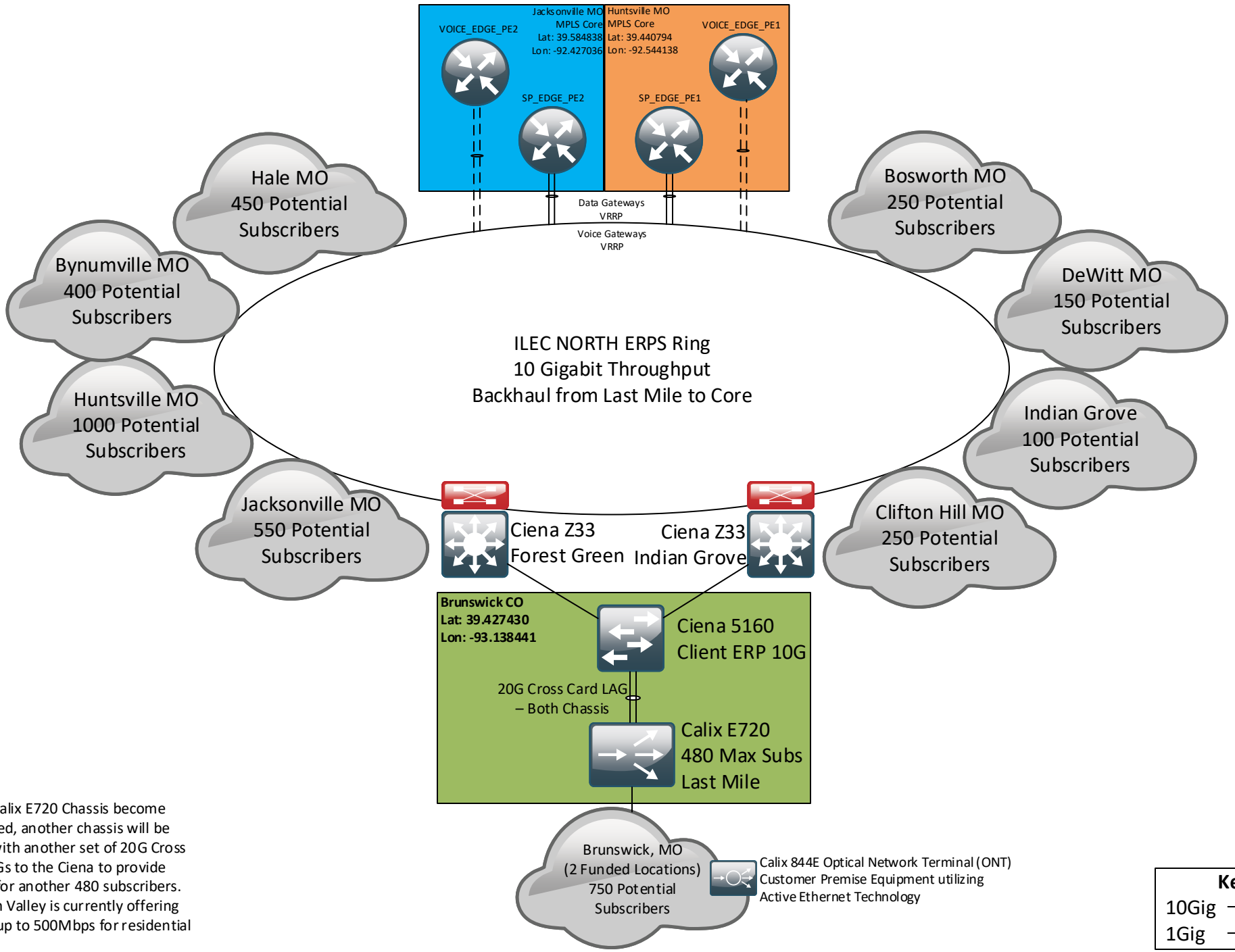
1Gig – – – –

CAF Funded Town – Bynumville Missouri
Last Mile to Backhaul



Note:
As the Calix E720 Chassis become populated, another chassis will be added with another set of 20G Cross card LAGs to the Ciena to provide service for another 480 subscribers. Chariton Valley is currently offering speeds up to 500Mbps for residential service.

CAF Funded Town – Brunswick Missouri
Last Mile to Backhaul



Note:
As the Calix E720 Chassis become populated, another chassis will be added with another set of 20G Cross card LAGs to the Ciena to provide service for another 480 subscribers. Chariton Valley is currently offering speeds up to 500Mbps for residential service.

Key

10Gig ——

1Gig – – – –

Chariton Valley Communications Corporation

Connect America Fund
CAF Phase 2

Finley Engineering Company, Inc
Consulting Engineers

P.O. Box 148
Lamar, Missouri 64759
417-682-5531

I, Larry W. Fausett, hereby certify that: (1) I am a duly Licensed Professional Engineer under the laws of the State of Missouri, (2) I have reviewed the network diagram of Chariton Valley Communications Corporation, and (3) the network is capable of delivering, to at least 95 percent of the required funded locations in Missouri, voice and broadband service that meets the requisite Connect America Fund Phase II performance requirements as set-forth in 47 C.F.R. § 54.309.

STATE OF MISSOURI
LARRY W. FAUSETT
NUMBER E-2000150014
REGISTERED PROFESSIONAL ENGINEER

Signature: _____

Date: 11-2-18

Larry W. Fausett, P.E.

Missouri Registration Number: **2000150014**