Exhibit B
RDOF Auction 904 Long Form
Stage II Detailed Technical Submission
Valley Telecommunications Cooperative Association, Inc.

Rural Digital Opportunity Fund
Auction 904 Long-Form Stage II Detailed Technical Submission

Date: February 15, 2021
Applicant: Valley Telecommunications Cooperative Association, Inc.
FRN: 0002430510
State(s): South Dakota
Performance Tier(s): Gigabit Tier

1. <u>Overall Network Design</u>. A long-form applicant, regardless of the technology (or technologies) it proposes to use, is expected to:

a) Describe the proposed last mile architecture(s), design, and technologies.

Valley Telecommunications Cooperative Association, Inc. (Valley) intends to build a FTTP architecture to serve its residential and business subscribers in the awarded areas. Valley will be using a "home-run" fiber design. Valley's design will utilize fiber optic splitters to enable 32 subscriber locations with a single optical line terminal (OLT) port. Gigabit passive optical network (GPON - ITU G.984) technologies will be deployed.

With this design, Valley will be able to provide speeds up to 2.4 Gbps downstream and 1.2 Gbps upstream per 32 subscribers. Subscribers that reside on the same OLT port will share this bandwidth. The network design being deployed by Valley allows oversubscription to be reduced by implementing some minor changes when it is needed. One of those methods would be to change the splitters from a 32-way split to a 16-way split. Additionally, simple electronics upgrades allow Valley to provide active Ethernet services with additional broadband speed capability.

b) Describe the proposed middle mile/backhaul topology, architecture, design, and technologies.

Valley is in the process of creating requests for proposal to implement a new middle mile network to haul their subscriber traffic on their network. Valley is working with Vantage Point Solutions to procure a Dense Wave Division Multiplexing (DWDM) solution that has integrated carrier ethernet features to aggregate ethernet interfaces from the access layer to the core/edge of the network. The procurement process will include a request for proposal (RFP) process with vendor technical sessions to select the best solution. The DWDM system calls for a 40-channel system with each channel being able to carry 10 or 100 Gbps of ethernet traffic. The proposed system will be in a ring and will either use multi-protocol label switching (MPLS) or ethernet ring protection switching (ERPS) to achieve sub 50 millisecond failovers.

c) Describe the proposed interconnection architecture, design, and technologies solution to connect to the Internet. This will include the likely service providers, link data-rate/size, locations, dual-homing, and multi-homing characteristics.

Valley will be using their existing 20Gbps LAG connection to SDN. This connection is currently between 20-30% utilization and has enough capacity to handle the additional RDOF locations being added to the network. Valley also can increase their 20Gbps LAG by adding 10Gbps interfaces to the LAG. Valley leverages SDN's regional transport network to get the subscriber traffic back to Sioux Falls, SD where subscriber PPPoE sessions are terminated on the SDN Alcatel Lucent BNG routers. From the SDN Alcatel

Lucent routers, SDN has three primary bandwidth providers that they peer with. SDN is multi-homed to Cogent, Telia and Zayo.

d) Describe the proposed architecture that will be used to provide voice service. Describe whether the proposed voice services will: 1) be internally provided, 2) use a managed voice service provider, 3) use a voice over the top service, or 4) use another type of voice service.

Valley will leverage its existing internally designed and operated voice solution to provide VOIP services. Valley owns and operates its own Ribbon C15 softswitch to provide VOIP services to its existing subscriber base. Valley interconnects with SDN via SIP Trunks to provide these services. Voice standards such as H.248 and SIP are used to communicate between the softswitch and the endpoint locations. Communication flows over a carrier-grade network core from the access network. Each network element is engineered and configured with redundancy in mind.

e) Describe the network's scalability to support customer growth and network data usage growth to account for: 1) ever increasing application requirements, 2) increasing quality demands, and 3) lower response/latency demands for ever increasing usage of highly interactive applications.

Valley's outside plant architecture lends itself to a PON technology (GPON, XGS-PON, or NG-PON2) or a dedicated technology (Active Ethernet) and will be based on the Full Service Access Network (FSAN) industry standard architecture. This allows for services of 1 Gbps to each subscriber today and can be easily upgraded to support 10 Gbps subscriber services. The broadband connection will not only be fast but will be of a very high-quality and characterized by the following:

- High Speed – The network will be able to deliver speeds of at least 1 Gbps today and positioned for faster speeds in the future as user demand increases.
- Low Latency – FTTP has inherently low latency. The latency of light traveling through fiber optic cable is approximately 0.005 milliseconds per kilometer. The last-mile fiber optic cable infrastructure used to deliver the state-of-the-art broadband service to the eligible census blocks will be less than 20 kilometers from the FTTP central office electronics to the customer premises. Therefore, the total latency across this last mile fiber optical cable infrastructure is less than 0.1 milliseconds. A small amount of latency will be introduced by the FTTP central office electronics and the FTTP optical network terminal (ONT) at the customer premises; however, the total latency for this FTTP last mile service will be low. Because of this low latency, it is the best architecture for interactive applications, including telehealth, distance learning, and remote working.
- High Capacity – The network will not have low monthly caps that could hinder users from making use of the applications they need for personal and business uses.
- High Reliability – As described in other sections of this response, the network will be built with redundancy and architected for reliability.

An entirely fiber-based network, as planned by Valley, meets all these characteristics and no other technology can provide as high-quality broadband services. With FTTP, each new generation of FTTP electronics allows service providers the ability to offer significantly higher broadband speeds over greater distances. There is no foreseeable end to the amount of bandwidth that can be provided over

fiber optic cables. This will allow Valley to support increasing application requirements, increasing quality demands, and low latency demands.

Additionally, in accordance with its current network management practices, Valley will monitor the combined Internet usage of all subscriber traffic on the network to ensure sufficient uplink sizing to the Internet. As the total bandwidth usage at peak times approaches the purchased capacity plus the allowed burst amount for middle mile and Internet bandwidth services, Valley will increase the middle mile and purchased Internet capacity to mitigate the potential for network congestion.

f) Describe the design and features that it proposes to implement that will: improve reliability (such as redundancy) for equipment, links and software; dual homing; and multi-homing connectivity.

Valley implements redundancy all the way through their network from the access layer all the way through the core/edge of their network. First starting with the Calix E7 access network, Valley implements redundant uplinks out of the Calix E7 shelves into the DWDM transport node. Link Aggregation Groups (LAG) are provisioned between the access and transport layer for added throughput and reliability.

The proposed middle mile transport nodes will be equipped with Dense Wave Division Multiplexing (DWDM) nodes that have Ethernet packet cards equipped as part of the solution. These Ethernet packet cards will aggregate the Ethernet signal from the Calix E7 nodes and multiplex them onto the DWDM system to be transported. The proposed DWDM system with carrier ethernet capabilities will either be and MPLS based or ERPS based protection switching. Each of the proposed transport nodes will be fully redundant with processor cards, amplifiers, line cards and power supplies.

Valley terminates all of their subscriber PPPoE sessions at redundant Alcatel Lucent nodes at SDN's location in Sioux Falls. The traffic is handed off to the SDN Infinera DWDM transport network at either De Smet, Flandreau, Mound City or Glenham with multiple 10Gbps interfaces. The Alcatel Lucent nodes are fully redundant with processor cards, switch fabrics, line cards and power supplies. SDN is a statewide network that BGP multi-homes with Cogent, Telia, Zayo and others.

To aid in the reliability of the network, Valley provides the customer with an option of battery backup for the ONT's at their homes. In addition, all locations (central offices, huts, cabinets) that have electronics have battery backups that can last 6-8 hours depending on load. Valley has also wired these locations to allow generators to power the equipment for extended periods of time.

g) Describe network infrastructure ownership. Indicate which parts of the network will use the long-form applicant's or another party's existing network facilities, including both non-wireless and wireless facilities extending from the network to customers' locations. For non-wireless facilities that do not yet exist, the description should indicate whether the new facilities will be aerial, buried, or underground. This includes leased lines, transit services, rented tower space for radios, etc.

Valley will own much of the network and will lease capacity from SDN to get subscriber traffic out to the Internet. Valley is one of many SD broadband providers that are member owner of SDN communications.

Valley will need to build new fiber into the census blocks that were awarded. The design will be constructed with a dedicated fiber to each subscriber to the Valley aggregation points. Using a home

run design will allow Valley to choose economically feasible electronics for the life of the fiber. This design is vendor and technology agnostic.

Valley will build to these areas using buried fiber optic cable. These new subscriber locations will be aggregated back to the Valley central offices and into the Calix E7 access nodes. The FTTP network will be 100% owned by Valley and not leased.

h) Provide technical information about the design methods, "rules of thumb," and engineering assumptions used to size the capacity of the network's nodes (or gateways), links and wireless base stations. These are often expressed as ratios, such as "oversubscription ratio" applied in the middle-mile/backhaul and interconnection network levels that funnel the consumer traffic to the Internet. The information provided should demonstrate how the required performance for the relevant performance tier will be achieved during periods of peak usage, downstream and upstream speed, and latency assuming a 70% subscription rate by the final service milestone. For example, the diagram below shows the various oversubscription ratios, link media (wired, wireless, etc.), redundancy and multi-homing in a visual format. It can also be described in text with no need for a diagram. Regardless, we do expect sufficient technical detail rather than a simplistic approach. We expect several ratios as shown and not a simple statement that the network "will use a 20:1 ratio" since ratios are generally different at different levels and locations.

Access

From an overall design perspective, Valley will size the network electronics at the respective sites to accommodate the specific capacity requirements for those locations. The last mile FTTP electronics will be equipped with sufficient chassis capacity to slot OLT cards to serve 100 percent of locations within the eligible census blocks served by that node. The OLT circuit cards and associated optics will be equipped to support the quantity of customers in that area that subscribe to broadband and/or voice services.

A FTTP GPON OLT can be oversubscribed for both upstream and downstream traffic. The oversubscription ratio is dependent on the quantity of subscribers assigned to the fiber splitter, as well as the bandwidth provisioned to each subscriber. Below is an example of how the bandwidth is shared utilizing the typical 1:32 fiber splitter. Since Internet traffic is bursty in nature, it is uncommon that all 32 subscribers would be utilizing all their bandwidth at the same time. The example below assumes the worst-case scenario of all 32 customers utilizing their full bandwidth.

Downstream: 75.0 Mbps/customer = 2,400 Mbps / 32 customers

Upstream: 37.5 Mbps/customer = 1,200 Mbps / 32 customers

If we assume that all 32 customers on one OLT port are subscribed to a 1,000 Mbps downstream and 500 Mbps upstream data profile the following oversubscription ratios could be achieved. These oversubscription ratios are common for the telecommunications industry.

Downstream: 13.3 oversubscription = (32 customers x 1,000 Mbps) / 2,400 Mbps

Upstream: 13.3 oversubscription = (32 customers x 500 Mbps) / 1,200 Mbps

The uplink from the FTTP electronics to the core network will utilize multiple 10 Gbps interfaces in a link aggregation group. This design provides additional uplink capacity during normal operations, as well as resiliency and automatic failover in the event of a service-effecting event on one of the 10 Gbps interfaces.