Exhibit C

Alliance Communications Cooperative, Inc.
dba Alliance Communications

RDOF Long Form Technical Submission

Date: 2/10/2021
Applicant: Alliance Communications Cooperative, Inc.
FRN: 0002432672
State(s): South Dakota
Performance Tier(s): Gigabit Performance Tier

GENERAL GUIDANCE:

- The use of this template is optional and voluntary.
- This template does not supersede or modify any of the orders, public notices, rules, or policies that have been or will be adopted by the Commission for the Rural Digital Opportunity Fund and Auction 904.[1] See the Commission's Auction 904 website for more information, including a tutorial regarding the Stage II detailed technical submission: https://www.fcc.gov/auction/904.
- The long-form is meant to be detailed in nature and approaches an LLD (Low Level Design).
- This is a document submitted from one engineer to another engineer.
- We encourage the use of technically valid TERMINOLOGY.
- We encourage the use of precision language for technical terms.
    - Do not say priority or QoS; Use terms such as: DSCP, Diff Serv, TOS, etc.
    - Do not say routing protocols; Use terms such as: OSPF, IS-IS, EIGRP, BGP, etc.
    - Do not say traffic engineering; Use terms such as: MPLS, VPLS, VLANs, etc.
- This is a forward-looking – future-oriented document for the 10-year span of this program.
- Our questions are asking for the minimum. You can add more.
- Each question must be answered completely. There will be portions of your answers that may be repetitious and may have been used as part of an answer to other questions. This is expected. Answer each question completely where it is asked.
- **The spacing between questions below DOES NOT INDICATE THE DESIRED LENGTH OF YOUR ANSWER. Indeed, the blank lines merely represent a placeholder. LONGER ANSWERS ARE EXPECTED.**
- If an answer encompasses multiple technologies – please use separate paragraphs in your answers below to differentiate between how separate technologies or network designs are to be implemented. For example, one paragraph for fiber, a second for Cable and a third for fixed wireless when answering question 1a) for last-mile. Separate paragraphs could also be done if there are variations in the network due to differences such as state(s) in question 1c).
- Please add equipment and software vendor names for most answers that use equipment and software. Not every minor vendor name but the major or significant vendors.

[1] Commission decisions adopting rules and policies for the Rural Digital Opportunity Fund and Auction 904, as well as detailed public notices outlining the procedures, terms, and conditions for the auction control and can be found on the Auction 904 website and through the FCC's Electronic Document Management System (EDOCs) database.

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[2].

Alliance Communications Cooperative, Inc. (Alliance) has deployed Fiber to the Premises (FTTP) networks throughout its service territory. Alliance has typically designed their fiber optic cable network using a "home run" or dedicated fiber design. This architecture dedicates fiber strands from the broadband central office or FTTP optical line terminal (OLT) electronics location to the subscriber premises. The dedicated fiber design offers a technology agnostic fiber optic cable plant that can support virtually any FTTP technology. Alliance intends to utilize this same fiber cable architecture for its RDOF deployment.

Alliance intends to deploy 10 Gbps symmetrical PON (XGS-PON) technology via the Calix E7 platform. This technology is standardized by the International Telecommunications Union in ITU-T G.9807.1. As the name of the technology implies, XGS-PON provides 10 Gbps data rates in both the downstream and upstream directions that are shared amongst the end-user locations being fed via that OLT port. Alliance has standardized on 32-way splitters in its PON networks, and it intends to follow this same standard for service in the RDOF funded areas. This technology and network design enables Alliance to provision data rates of up to 10 Gbps to subscribers on the network, which far exceeds the 1 Gbps downstream and 500 Mbps upstream that is required to meet the obligated performance tier.

Alliance intends to utilize redundant 100 Gbps interfaces to uplink voice and broadband data services from its Calix E7 FTTP electronics platform to its middle mile transport network. These redundant uplinks will use link aggregation group (LAG) protocol to provide connectivity between the FTTP and middle mile electronics during normal operations, as well as failover protection in the event of a failure of a single 100 Gbps interface or link between these two network segments.

   b) Describe the proposed middle mile/backhaul topology,[3] architecture, design, and technologies.

For middle mile connectivity, Alliance has deployed an existing dense wavelength division multiplexing (DWDM) system using reconfigurable optical add drop multiplexer (ROADM) technology. This system will support up to 40 individual wavelengths, each of which can transport 10 Gbps or 100 Gbps of traffic.

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[2] Architectures include, for example, wireless licensed or unlicensed, fiber, coaxial cable, satellite, digital subscriber line, hybrids, etc. Protocols encompass a wide variety of use categories and standards organizations to include: routing, e.g., OSPF, IS-IS, iBGP, BGP, eBG; traffic engineering, e.g., MPLS, PBB, VPLS; Quality of Service, e.g., DSCP, DiffServ, RSVP, IntServ, ToS, 802.1Q; last-mile, e.g., DOCSIS, Active Ethernet, GPON/PON, VDSL, ADSL, LTE, WiMAX, 5G-NR, and 802.11 variants; voice services, e.g., TDM, SIP, H.323, VoLTE, H.248, MGCP, and RTP. Design includes the links/connectivity in the network, including link speeds, redundancy, load-balancing, fail-over, and associated protocols, topologies, and technologies. Technologies include traffic-engineering, QoS (Quality of Service), or both methods that aid in the performance of its network. Generally, methods of traffic engineering include, but are not limited to, MPLS, PBB, VPLS, SD-WAN. Methods of Quality of Service (QoS) include, but are not limited to, DSCP, DiffServ, RSVP, IntServ, ToS, and 802.1Q.

[3] For example, describe its network topologies (the layout pattern of interconnections between node devices in a network). There are many different types of network topologies, including point-to-point, linear, daisy-chain, bus, tree, star, ring, dual-ring, mesh (partial & full), and hybrid. There are also technology-specific topologies such as FTTH, FTTN, HFC, PTP, PTMP, and ERPS.

In addition to its existing DWDM transport network, Alliance will deploy a 100 Gbps transport ring to backhaul traffic from the FTTP electronics node locations to the DWDM backbone. The middle mile transport network will utilize ring architectures with diversely routed fiber optic cable to facilitate the automatic failover of traffic with no single point of failure. The middle mile transport electronics will use standards-based protocols including, but not limited to, Ethernet ring protection switching (ITU-T G.8032) and link aggregation groups (LAG) to ensure redundancy and resiliency in the event of a hardware failure.

The middle mile transport network utilizes redundant 100 Gbps interfaces to the existing Alliance edge routers to provide survivable and resilient connectivity to the core data network. This connection between the middle mile transport electronics and the core data network uses LAG to provide for additional data throughput during normal operations, as well as failover protect in the event of an interface or link failure.

c) Describe the proposed interconnection architecture, design, and technologies solution to connect to the Internet. This will include the likely service providers,[4] link data-rate/size, locations, dual-homing, and multi-homing characteristics.

Alliance has deployed two diverse border routers that aggregate Internet traffic and connect to the upstream Internet service provider (ISP). Each of those routers currently have numerous 10 Gbps connections to the middle mile transport for terminating the traffic from each FTTP electronics node cluster. The border routers also currently have a total of eight 10 Gbps connections (four from each router) to SDN Communications, the upstream ISP. The two border routers for Alliance connect to separate SDN Communications data centers for geodiversity. In addition, the 40 Gbps connection from each border router to SDN Communications is sufficient to handle all customer Internet traffic for Alliance. Border gateway protocol (BGP) is used for traffic optimization, load balancing, rerouting of traffic in the event of a failure.

Prior to the implementation of the last-mile FTTP service to the RDOF eligible locations, Alliance will upgrade its BGP routers in Brandon and Valley Springs, South Dakota. These routers will be equipped with 100 Gbps interfaces to connect to the middle mile transport network, as well as to SDN Communications. The Brandon router will have a 100 Gbps connection to the SDN Communications 2900 data center, while the Valley Springs router will have a 100 Gbps connection to the SDN Communications La Mesa site.

[4] This includes selected transient or Internet service provider names and IXP location names or at a minimum city and state location.

d) Describe the proposed architecture that will be used to provide voice service.[5] 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.[6]

The voice services associated with the incumbent service territories for Alliance utilize existing centrally located, redundantly configured, Ribbon C15 Class 5 softswitches located in Brandon, South Dakota, and Inwood, Iowa. Voice standards such as H.248 and SIP are used to communicate between the softswitch and the endpoint locations. Communication flows over a geo-diverse, carrier-grade, DWDM transport system, and each transport and access network element is engineered and configured with redundancy in mind. Alliance has established SIP trunks to its centralized equal access (CEA) provider, SDN Communications, who provides connectivity to other carriers on the public switching telephone network.

Alliance intends to utilize voice services provided by a Managed Voice Service Provider, Inteliquent, for the proposed RDOF service areas. The purpose of this voice implementation option is to better manage voice interconnection requirements and 911 connectivity in the new areas, allowing for rapid deployment of voice services. Alliance also utilizes Inteliquent to provide voices services for its Rock County, Minnesota, broadband expansion area. Alliance has established dedicated facilities to Inteliquent via SDN Communications for the exchange of this voice traffic.

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.

The network that Alliance intends to deploy to serve the locations within eligible census blocks for its awarded RDOF areas is scalable in numerous ways. In order to provide for ever increasing application requirements and increasing quality demands, it is imperative that the broadband network is scalable from the perspective of the maximum supported data rates. With respect to the last mile portion of the network, the proposed XGS-PON network deployment will enable Gigabit services to be offered to every location within the funded census blocks. This technology implemented via the Calix E7 platform enables Alliance to provision peak data speeds to individual users in increments of 1 Mbps or less, which allows Alliance to provide a wide variety of data rates up to 10 Gbps (including raw data and Ethernet overheads).

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[5] If the long-form applicant obtains these or other voice service functions as services from another provider or providers (for example, an over-the-top VoIP provider, or an incumbent or competitive local exchange carrier), the description should so indicate. Voice solutions are a collection of integrated sub-systems dependent on selected architecture and design implementation. These architectures can include items such as: SIP, H.323, and MGCP; internal trunking, e.g., SIP trunks; quality of service protocols and use; connectivity to the PSTN and other VoIP providers; associated internal traffic-engineering to support voice quality; and more. If the applicant is using a hosted or Managed Service Provider (MSP) for its voice solution it must provide and sufficiently describe its infrastructure support. Such network infrastructure support solutions may include Quality of Service (QoS), voice paths setup by traffic-engineering protocols, trunking, and other methods, e.g., when using a voice MSP (Managed Service Provider).

[6] *See Rural Digital Opportunity Fund Phase I Auction Scheduled for October 29, 2020; Notice and Filing Requirements and Other Procedures for Auction 904*, AU Docket No. 20-34 et al., Public Notice, 35 FCC Rcd 6077, 6127-29, paras. 135-39 (2020) (*Auction 904 Procedures Public Notice*). (describing how an ETC must offer qualifying voice service using its own facilities, at least in part).

As stated previously, Alliance intends to deploy a new 100 Gbps middle mile transport ring to backhaul end-user traffic from the RDOF eligible census blocks and other adjacent areas. Alliance analyzed its existing broadband operations to estimate the middle mile transport requirements, including the estimated annual growth in average bandwidth utilization per broadband subscriber during peak usage periods. This analysis confirmed that the 100 Gbps transport ring will provide sufficient middle mile capacity throughout the useful life of these electronics.

The existing Internet connectivity, via diverse core routers connected to diverse data centers for the upstream Internet service provider, is scalable well beyond the data rates of 100 Gbps to each data center. Based on the incremental number of customers that are anticipated to be added to the network via RDOF, no additional network enhancements of upstream providers are anticipated. If additional bandwidth is required, the router platform deployed by Alliance is capable of multiple 100G connections, making large increases in capacity available with changes to optics and line cards. Alliance will monitor capacity requirements as they do currently with the growing network to account for RDOF customer growth.

Alliance will service its customers in the RDOF funded census blocks via fiber optic cable infrastructure from the customer premises to the Internet content source. This data will travel at the speed of light through fiber, and there is no way to increase this speed. The proposed 100 Gbps middle mile transport network is relatively small with respect to the overall fiber distance it traverses, which reduces the distance that the data packets will travel during normal operations. In addition, Alliance has access to caching services that brings the content source closer to the end users. This use of caching helps to decrease the distance in which the data packets travel, which decreases the latency of the service. Alliance will continue to investigate other opportunities to connect to Internet content sources that are closer to its edge router locations to help further reduce the minimal latency its customers experience on their broadband service.

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.

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Alliance intends to implement a variety of features and functionality as part of its overall design to maximize the network reliability. For the last mile access network, Alliance intends to utilize multiple XGS-PON line cards to provide OLT ports that will serve the end users. The use of multiple line cards allows for Alliance to separate the uplinks to the middle mile transport network across two separate line cards. This diversity in hardware ensures that the integrity of the uplinks will be intact in the event of the failure of a single circuit card. Alliance will utilize LAG for the uplink interfaces being fed from separate circuit cards to maximize the redundancy and resiliency of this portion of the network.

From a middle mile perspective, the proposed 100 Gbps Ethernet transport ring will utilize diversely routed fiber optic cable to ensure that a single fiber cut does not isolate traffic on the network. This proposed ring will utilize Ethernet ring protection switching (ITU-T G.8032), or a comparable carrier-grade Ethernet ring protocol, to provide a rapid, automated ring restoration in the event of a fiber cut or optics failure. LAG protocol will be used on interfaces to the last-mile FTTP electronics and to the core data routers to provide an additional layer of redundancy on the network.

As part of its core data network, Alliance has deployed two separate border routers to aggregate traffic and connect to upstream Internet service providers, and it will utilize this existing infrastructure to serve the

proposed RDOF areas. These routers use border gateway protocol (BGP) for traffic optimization, load balancing, rerouting of traffic in the event of a failure. Alliance is in the process of establishing 100 Gbps connectivity from each of its border routers to its upstream ISP, SDN Communications. These 100 Gbps connections terminate at geo-diverse points of presence within the SDN Communications network. If one of the border routers or its 100 Gbps connection to SDN Communications were to fail, the other router can the entire bandwidth utilized by Alliance's customers, including those customers in the RDOF eligible census blocks.

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.

All portions of the last-mile network that will be used to serve FTTP to the awarded RDOF census blocks will be owned by Alliance. This will primarily be new infrastructure including fiber optic cable, FTTP electronics, and miscellaneous materials. Alliance intends to utilize buried construction for all new fiber optic cable.

For the middle mile network, Alliance will deploy a new 100 Gbps Ethernet transport ring. The middle mile electronics and the fiber optic cable used to connect the sites will be owned by Alliance.

The core data network electronics for aggregating the Internet traffic is existing and owned by Alliance. This includes core/edge routers, Ethernet switches, various servers, firewalls, and other miscellaneous equipment.

Alliance has two existing connections to its upstream ISP, SDN Communications. Alliance is in the process of upgrading the data rates to 100 Gbps on each Internet uplink, and the connections terminate at separate data centers owned by SDN Communications for geo-diversity.