Arkansas Research Educational Optical Network (ARE-ON)
Cyber Infrastructure Plan

Background

The Arkansas Research Educational Optical Network (ARE-ON) is a regional education network (REN) that connects its member institutions to the internet, Internet2, commercial cloud providers, and other research and educational networks. The mission of ARE-ON is to promote, develop, and apply advanced application and communication technologies to support and enhance education, research, public service, and economic development.

ARE-ON provides a resilient high-speed fiber-optic backbone network throughout the state of Arkansas and reaching into four neighboring states. The network consists of approximately 2,200 miles of long-haul fiber optic cable and about 85 miles of metro fiber. ARE-ON's extensive reach allows institutions to connect, collaborate, and innovate within the organization's core agendas of education, telemedicine, research, and emergency preparedness. ARE-ON serves eleven public universities, twenty-two two-year colleges, two hospitals, and the University of Arkansas, Division of Agriculture.

Current Network Capabilities

Current Backbone Network Architecture

The ARE-ON network consists of a DWDM optical platform with 51 nodes capable of up to 40 waves. The primary layer 2/3 architecture is made up of Juniper MX480, MX960, and MX10003 backbone routers. Each router is connected to its neighbor with multiple 10G or 100G waves. The optical platform consists of ADVA FSP 3000 optical nodes placed on more than half of its member campuses with 100G waves to major Internet connection points for Internet2 in Tulsa, Oklahoma, and numerous cloud and services providers at Equinix in Dallas, Texas. The network is fully enabled for IPv4 and IPv6 support and leverages MPLS, BGP, and other interconnect protocols. See Figure 1 below for a depiction of the ARE-ON backbone network and its connections.

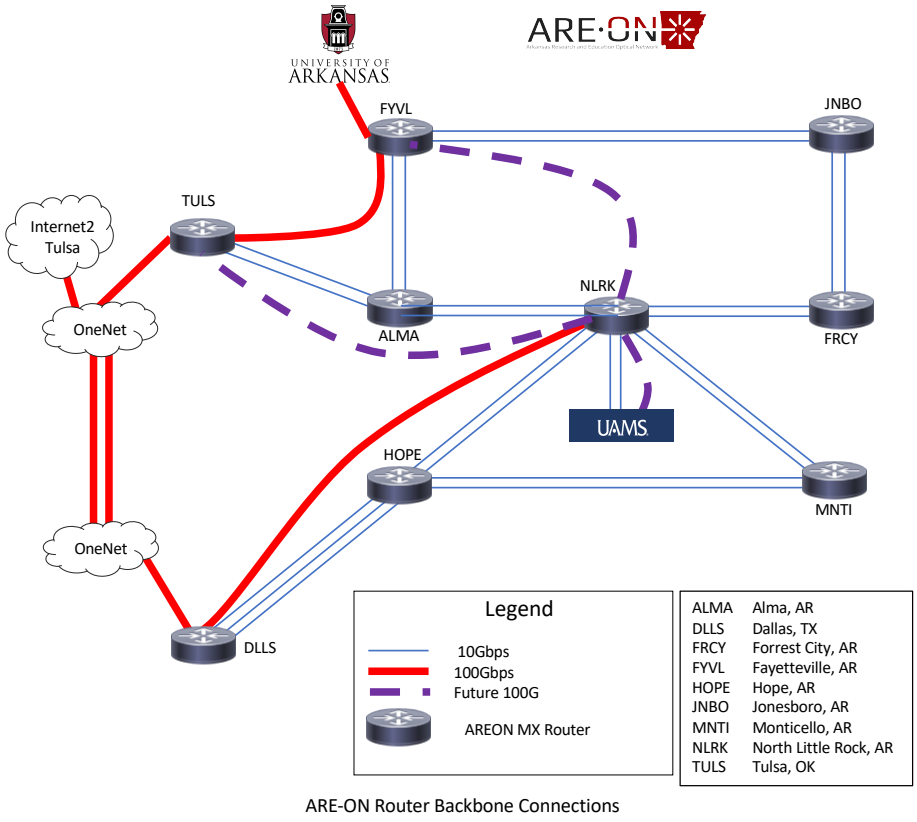

Figure 1: ARE-ON Backbone Network

Research and Education Campus Capabilities

ARE-ON member campuses range in size from small two-year community colleges such as the University of Arkansas - Rich Mountain in rural western Arkansas to the very-high research activity institution of the University of Arkansas. Most ARE-ON members have two connections to diverse routers on the ARE-ON backbone network, an arrangement that provides for a highly resilient service. The connections range from dual 1G links for most two-year schools to dual 10G links for four-year universities. While these connections have been adequate for the daily traffic in the past, including traffic to the internet, researcher bandwidth needs continue to grow to support large data transfers between collaborating research institutions. Several campuses currently have or are planning to develop a Science DMZ, some with 100G connections to the ARE-ON backbone, to facilitate collaborative research that requires moving large data sets from one institution to another.

Member campuses are increasing their dependence on cloud computing and other cloud-based resources. These cloud-based resources include learning management systems such as Blackboard, remote classroom systems such as Zoom and WebEx, media-rich lecture capture

for remote learning, and support for their IT operations such as “data center in the cloud” and virtual desktop environments (VDI). The current 1G or dual 1G links to the ARE-ON network are proving to be inadequate for these campuses’ future growth.

Future Strategy

Plans for Addressing Needs

ARE-ON intends to provide a statewide 100G backbone network to facilitate the interconnections between the campus Science DMZs and ultimately to institutions beyond the state through the Internet2 network. Besides the need to provide additional 100G optical paths, ARE-ON will replace or upgrade routers and switches in its backbone to support additional 10G and 100G connections to current and future campus participants.

Network Support for Additional Bandwidth

ARE-ON is currently in the process of designing the “100G Capable ARE-ON Network”. Plans call for replacing many of our core routers with a new routing platform capable of multiple 100G connections, and that has a smaller footprint and requires less energy to run. Other core routers will either be replaced or supplemented by 100G capable aggregation switches. We anticipate the project's design phase to be completed in 2021 and an RFP issued in early 2022 for implementation in late 2022. The backbone links between our North Little Rock router and our Fayetteville router will be upgraded to 100G in 2021. This will provide 100G rings between all of our primary routers, including the one in Dallas, and can be easily upgraded to 200G or more in the future as demand for bandwidth increases. The new 100G backbone links are shown as dashed lines in Figure 1. Additional 100G links (not shown) between the remaining backbone router will also be upgrades to 100G in 2022 to replace the multiple 10G links now in place.

Members’ Network Enhancements to Support Research and Educational Needs

ARE-ON proposes a standard set of capabilities for conducting research and learning activities and intends to upgrade members’ current 1G connections to 10G by replacing their campus border router and firewall with one capable of dual 10G connections. This will provide the needed additional bandwidth to support both their research and their increased education needs. Additionally, a 10G capable network switch will be placed to bypass their firewall to establish a Science DMZ with unrestricted data flows. In most cases, additional optical equipment will be added to the ARE-ON network to support the members’ new 10G connections to remote ARE-ON core routers.

Science DMZ Support for Research and Large Data Flows

As member campuses develop their Science DMZs to support collaborative research, the need to facilitate high-performance connections between member data transfer nodes is crucial. The network architecture must be secure, scalable, reliable, and distinct from the general network. In order to support big data flows, ARE-ON will create a Science Virtual Routing Facility (VRF) within the ARE-ON cloud. The Science VRF will provide a private, secure routing domain to connect members' Science DMZs. Figure 2 depicts the ideal member connection into the Science VRF with a Science DMZ that bypasses the member's border firewall and has a direct path to the ARE-ON Science VRF. Using BGP, the campus border router would advertise only the routes to their Science DMZ with the ARE-ON Science VRF. This would create a virtual and isolated network between members for the explicit purpose of communicating between Science DMZs at each institution.

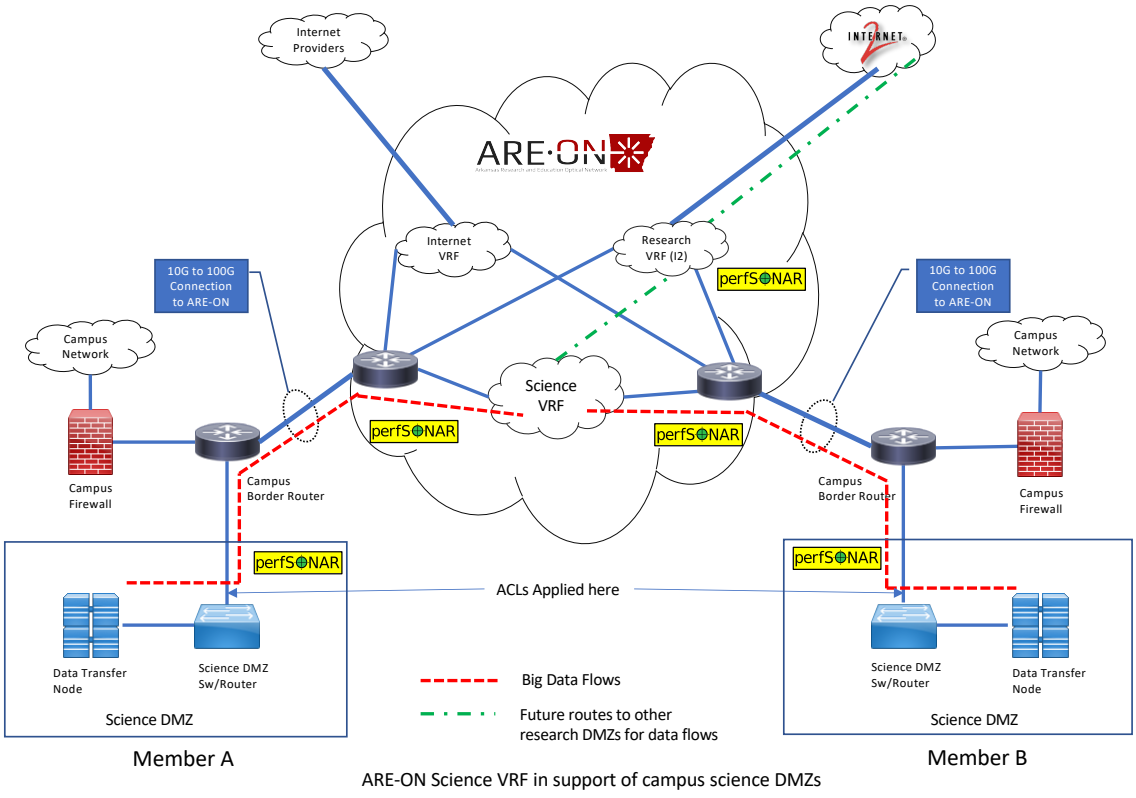

Figure 2: ARE-ON Science VRF Interconnect

Once a connection is established across the ARE-ON Science VRF, data would flow from a data transfer node (DTN) through the campus border router to the ARE-ON VRF and to the destination member's DMZ bypassing the campus firewalls on both campuses. Security is

provided in two ways. First, only trusted routes are accepted via BGP at the ARE-ON interface to the Science VRF by using BGP filters and community strings. Secondly, each campus can apply Access Control Lists (ACLs) at their Science DMZ router or at their DTN.

A later step in developing the Science VRF/DMZ is the acceptance of routes from other regional and national networks by allowing routes from the Internet2 research and education route table to be included in the Science VRF route table. Although this increases the exposure risk to DART Project participants, it will facilitate data transfer to institutions outside of Arkansas. Besides using ACLs to limit who can communicate with hosts in the Science DMZs, Zeke[1] clusters may be used to do deep packet inspection on all traffic flowing to and from their Science DMZ from the outside world. By passively monitoring traffic through a mirrored port, the Science DMZ is not subjected to the types of packet delays or drops causing performance degradation that a firewall would normally introduce in high-capacity data transfers. ARE-ON could potentially do the same from a central platform in its network in the future, but that is beyond the scope of this plan.

Performance measurements of the network are critically important to the ongoing support of the network and research. To enable a means of visualizing and diagnosing network performance issues, ARE-ON will place perfSONAR nodes connected to the Science VRF at core routers in its network and provide a MaDDash instance for members to access. Members joining the Science VRF are highly encouraged to place their perfSONAR node in their Science DMZ and include it in the ARE-ON MaDDash matrix.

[1] Zeek is a passive, open-source network traffic analyzer. It is primarily a security monitor that inspects all traffic on a link in depth for signs of suspicious activity. https://zeek.org/