Background

The Louisiana Optical Network Infrastructure (LONI) is a state-of-the-art, fiber optics network that runs throughout Louisiana, and connects Louisiana research and education institutions to one another as well as Internet2. LONI connects Louisiana's major research universities–Louisiana State University (LSU), Louisiana Tech University, LSU Health Sciences Center in New Orleans, LSU Health Sciences Center in Shreveport, Southern University, Tulane University, University of Louisiana at Lafayette and University of New Orleans–allowing greater collaboration on research that produces results faster and with greater accuracy. Other members include, but are not limited to Louisiana's flagship institution, 4-year universities, 2-year universities/colleges, higher education systems, state and local government, and specialized research and education entities.

LONI is a statewide fiber optic, high-performance computing, and distributed storage network infrastructure funded by a $50M state investment from the State of Louisiana. With more than 1600 miles of backbone fiber, LONI is geographically distributed across the entirety of Louisiana, portions of Mississippi, and portions of Texas. The robust 40 Gbps backbone network has connections to Internet 2, Commodity Internet, and other major national and international networks. It currently connects approximately 2 petaflops of supercomputing resources, and more than a petabyte of storage distributed around the statewide grid from LONI and member resources. LONI is available for use by academic, government, and industry partners in collaboration with LONI member research institutions and is managed by the Louisiana Board of Regents through the LONI Management Council. Points of Presence (POPs) are located at major research universities, 4-year universities, both state owned and commercial datacenters, and the network is managed and operated by LONI staff at LSU.

A primary objective of LONI was originally to connect supercomputers at the participating universities and other computing resources throughout Louisiana, and centers to a 50-teraflops supercomputer, Queen Bee. Located in the state Information Systems Building in downtown Baton Rouge, Queen Bee functioned as the core cluster of LONI and one of the Top 50 supercomputers in the world. The supercomputer's name comes from the nickname of former Governor Kathleen Blanco and was named to honor her commitment to building LONI during her administration.

LONI offers its participants a world-class network and high-performance computing environment with the strategic integration of highly available and scalable bandwidth, computational, storage and personnel resources. This network was conceived to transform research and education in Louisiana and to attract industry and government partners into the State to capitalize upon this resource. LONI is available to academic and research entities in Louisiana, providing the following benefits:

- The ability to support cyber-related training activities using high-definition multi-cast conferencing with high-speed access to most major research universities and national laboratories across the country.
- Access to a cadre of knowledgeable professors, staff, students, and graduates who are highly trained in the use of leading-edge networks and high-performance computers.
- Access to high performance computers and data storage resources for research and development.
- The ability to demonstrate, test and evaluate software and hardware in a configurable wide area network.

LONI 2.0 Network Capabilities

The current network architecture consists of a 30-node Cisco 15454 DWDM system providing N x 10G optical channels and a 7-node Ciena 6500 DWDM system with N x 100G optical channels for backbone capacity. Backbone and member ethernet services are provided by a mix of platforms from Juniper and Ciena. Layer 3 services are delivered using Juniper's MX router product set, specifically the MX960 and MX10003. Providing Layer 2 services and extending Layer 3 services to POP sites that do not house a router is the Ciena Carrier Ethernet Services (CES) platform, namely the 5160 aggregation switch and the 3916 service delivery switch. While the Ciena 5160 nodes are connected to each other, the Juniper MX nodes also have direct connectivity amongst themselves, thanks to the DWDM platform capabilities.

While only sites in Shreveport, LA, Jackson, MS, Lafayette, LA, and Baton Rouge, LA are considered LONI core sites, containing Juniper MX routers, many LONI member sites serve as LONI POP sites, housing the DWDM and CES equipment previously mentioned. The network was designed to not only connect the original research institutions, but also the other 4-year public higher education institutions using a fiber optic network. LONI provides Internet access to its members and is a regional connector for Internet2, utilizing services in Baton Rouge and Jackson for resiliency. More recently, LONI has expanded connectivity to its neighboring Research and Education Networks (RENs) by connecting to ARE-ON in Arkansas and LEARN in Texas. Both partners provide a geographically diverse 100G DWDM service to LONI for access peers, internet, and content providers in Dallas, TX. LONI provides its members with network access services using several protocols and deployment methods, including BGP and MPLS. The network supports both IPv4 and IPv6. See Figure 1 for a depiction of the LONI backbone and interconnect design. LONI maintains Ookla speed test servers as a resource for members to perform general performance testing.
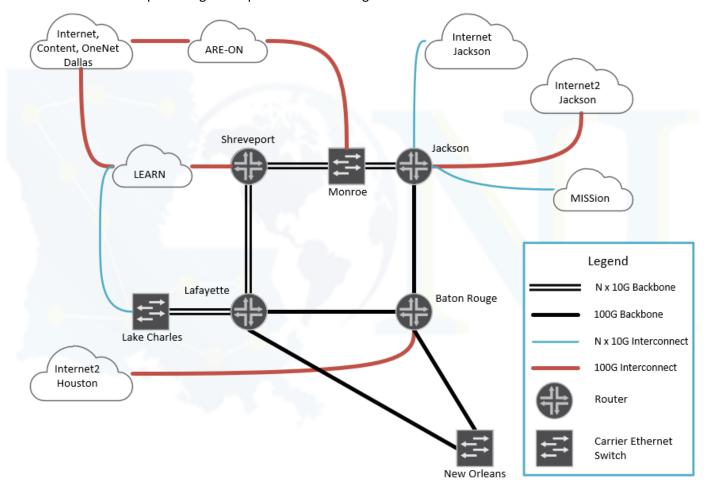

Figure 1

LONI's Research Support and Capabilities

LONI provides High Performance Computing (HPC) resources to its members in the form of an HPC supercomputer cluster, known as Queen Bee. Operating its 3rd generation platform, Queen Bee 3 (QB-3), LONI HPC promotes scientific computing and technology across all disciplines, enabling education, research, and discovery using emerging, advanced technologies. Queen Bee 2 (QB-2) also continues to provide service to the LONI community as researchers transition their workloads to the newer architecture. LONI HPC provides the infrastructure and support necessary to facilitate heroic research efforts, utilizing cutting-edge technology to push the limits of scientific discovery.

LONI HPC serves as a central point to access HPC resources and user expertise, provides production HPC cycles and services to researchers in Louisiana, throughout the nation, and across the world.
A brief glimpse of the LONI HPC resources available to LONI members:

- QB-2 cluster: a 480 node 16-way (8,144 total cores) Red Hat Enterprise Linux (RHEL v6) cluster (Intel 2.7 GHz 64-bit Ivy Bridge-EP processors), 64 GB to 1.5 TB of RAM per node, 56 Gbps (FDR) InfiniBand fabric, 481 pairs of NVIDIA K20X GPUs, 17 pairs of Intel Xeon Phi accelerators, 4 pairs of NVIDIA K40 GPUs, 1.5 PB Lustre file system (shared with QB-3).
- QB-3 cluster: QB3 a 202 node 24-way (79,696 total cores) Red Hat Enterprise Linux (RHELv6) cluster (Intel 2.4 GHz Cascade Lake processors), 193 GB to 1.5 TB RAM per node, 8 pairs of NVIDIA V100 GPUs, 100 Gbps (HDR) InfiniBand fabric, 1.5PB Luster file system (shared with QB-2).

LONI HPC is in the LONI Science DMZ connected to Internet2 via two (2) dedicated 100 Gbps connections and other LONI member institutions through the LONI Network backbone. In addition, the LONI network offers seven fully functional perfSONAR instrumentation nodes for performance monitoring and troubleshooting. Traffic between LONI HPC and other research IT systems within the DMZ is facilitated over 25/40/100 Gbps links, while users outside of the DMZ will be able to access ACCEL via a 1/10 Gbps link. LONI members participating in ScienceDMZ projects connect to the LONI ScienceDMZ router in Baton Rouge, where Internet2 and its members also connect to collaborate on research and moving large data sets between institutions in the community.

Network Improvements and Future Strategy

LONI intends to provide a statewide 400G optical backbone network (equipment purchased and deployment underway), delivering a 4x100G core routed network, plus a 100G independent bandwidth between non-core POP sites on LONI's fiber and DWDM footprint to (2) nearest core routers. (See Figure 2 for example of Monroe, LA). This new network, called LONI Next Generation Infrastructure (LONI NGI) replaced every existing network device (Juniper and Ciena) with Cisco's NCS platform, specifically the NCS 55A1 as core routers and the N540 at every other POP on the network, giving LONI an all-layer3 network with the ability to provide advanced services to its members. With the deployment of this NGI network, the ScienceDMZ can and will be more easily offered via an L3VPN to any location on the network. Using a VRF approach to service isolation, LONI staff will have the ability to create L3VPN services for any members or group of members as a solution for any collaboration efforts they may desire to take on. LONI also continues to invest in dark fiber construction to migrate more POPs away from last mile ethernet circuits by 3rd party providers, enabling members served by those POPs to obtain higher bandwidth connectivity to LONI resources. It is the intention to provide LONI members with up to (2) 100G connections into the LONI network as part of the NGI deployment.

LONI has recently announced a strategic change in philosophy to being a Managed Services Provider (MSP). As a Research and Education Network (REN), community members and industry partners often mistake LONI for a traditional internet service provider (ISP). It's more accurate to state that LONI is an MSP instead of an ISP, as unlike a traditional ISP, LONI staff try to develop community relationships and foster a collaborative environment for the members to participate.

Service Portfolio

As LONI has transitioned to an MSP, several services above standard network access and HPC resources have been added. Foundationally, LONI has shifted its business approach to a membership model, which includes several services. This membership is called LONI's Platform-as-a-Service (PaaS) and each member renews annually. Included in the PaaS membership is Network-as-a-Service (NaaS) or general network access which contains L2VPN and L3VPN services, access to commodity internet and Internet2, as well as HPC services like access to CPU and GPU cycles, plus storage. The PaaS is also inclusive of access to expertise from LONI engineering and LONI HPC support expertise.

Layered on top of the PaaS are additional services such as Router-as-a-Service (RaaS), which provides a managed BGP border router for members that might wish to realize cost savings by not needing to purchase a new border router periodically, as LONI can provide this with the router already deployed at the member site with just a configuration change. If a member selects the RaaS, they will also have the option to select a Firewall-as-a-Service (FaaS), where LONI would supply either a physical appliance or virtual next generation firewall using either Palo Alto Networks or Fortinet solutions. LONI staff manage event, incident, and change management in coordination with the member's personnel to ensure a successful operation of the solution. LONI also offers Cloud-as-a-Service (CaaS), which is a private cloud virtual environment for LONI members to utilize within the boundaries of Louisiana for Linux or Windows workloads.

Two new additions launching soon are Queen Bee 4 (QB4), a new version of LONI's HPC supercomputer with the intention to manage and operate Artificial Intelligence (AI) workloads. Work begins to outfit the datacenter space for this machine soon and an order has already been made for the new cluster. Secondly, LONI will begin to offer a Security Operations Center-as-a-Service (SOCaaS) and is piloting the solution now with a member institution. The SOCaaS will be a 24x7 Managed Detection and Response service provided in conjunction with an industry partner. The service uses a Security Information and Event Management (SIEM) toolset to automate mitigation techniques for security events. For those events that cannot be mitigated without manual intervention, LONI's partner will be monitoring the service to provide a quick response to the member and assist with resolution efforts. The SOCaaS solution also contains an Endpoint Detection and Response (EDR) piece with the intention of stopping bad actors by monitoring and automating mitigation at the endpoint level.
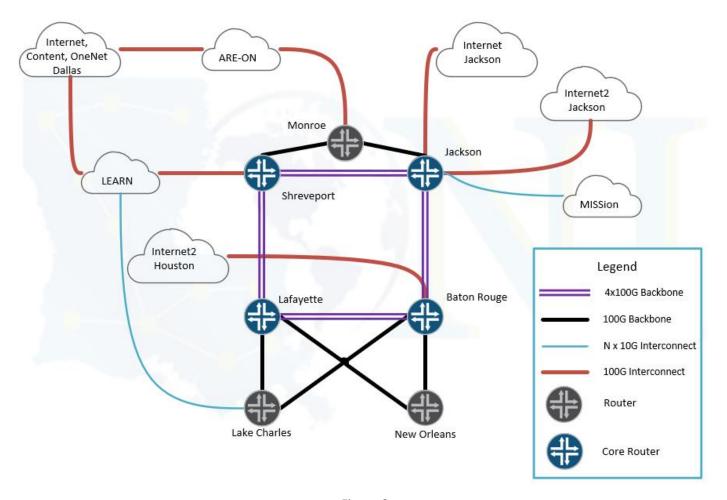

Figure 2