



Kansas Research and Education Network – Regional CI Plan

Background

KanREN, Inc. is a Kansas-based 501(c)(3) non-profit organization which provides research connectivity, security, education, and engagement services throughout the state. In 1992 a consortium of 35 Kansas higher education institutions led by the University of Kansas and the other Regents Universities established an organization to facilitate the design, assembly, and management of a network that could connect any Kansas universities or colleges wishing to participate. This organization became known as KanREN. In 1993, KanREN was awarded a \$700,000 National Science Foundation (NSF) "Connections" grant to begin building the network and to provide connectivity for KanREN's charter members. The first institutions were connected by the fall of 1993 and within a year all of the original KanREN charter members were a part of the network; and many remain members today.

In 1997 KanREN, in cooperation with the Great Plains Network, became the first connector to the Internet2 "Abilene" network; enabling universities in Kansas to be the first in the country with access to the new backbone. The KanREN network became fully dual-stacked (IPv4 with IPv6) for all members in 2004. Historically, KanREN has deployed advanced protocols years ahead of the commercial carriers, and typically, well ahead of most peers in the research community.

The KanREN organization has grown and evolved over the years, it began as a "service unit" of the University of Kansas Center for Research Inc. In 2002 KanREN's governing body began re-organizing KanREN as a 501(c)(3) non-profit organization to better reflect the modern direction of the organization. Throughout the change some things have remained constant; KanREN has always been governed by its member institutions. KanREN's Board of Directors counts 16 seats; elected or appointed by our member institutions. Those directors help to shape the vision, direction, and mission of our organization and ensure that year after year we are providing the most advanced network services and that we're always focused on the needs of our member institutions.

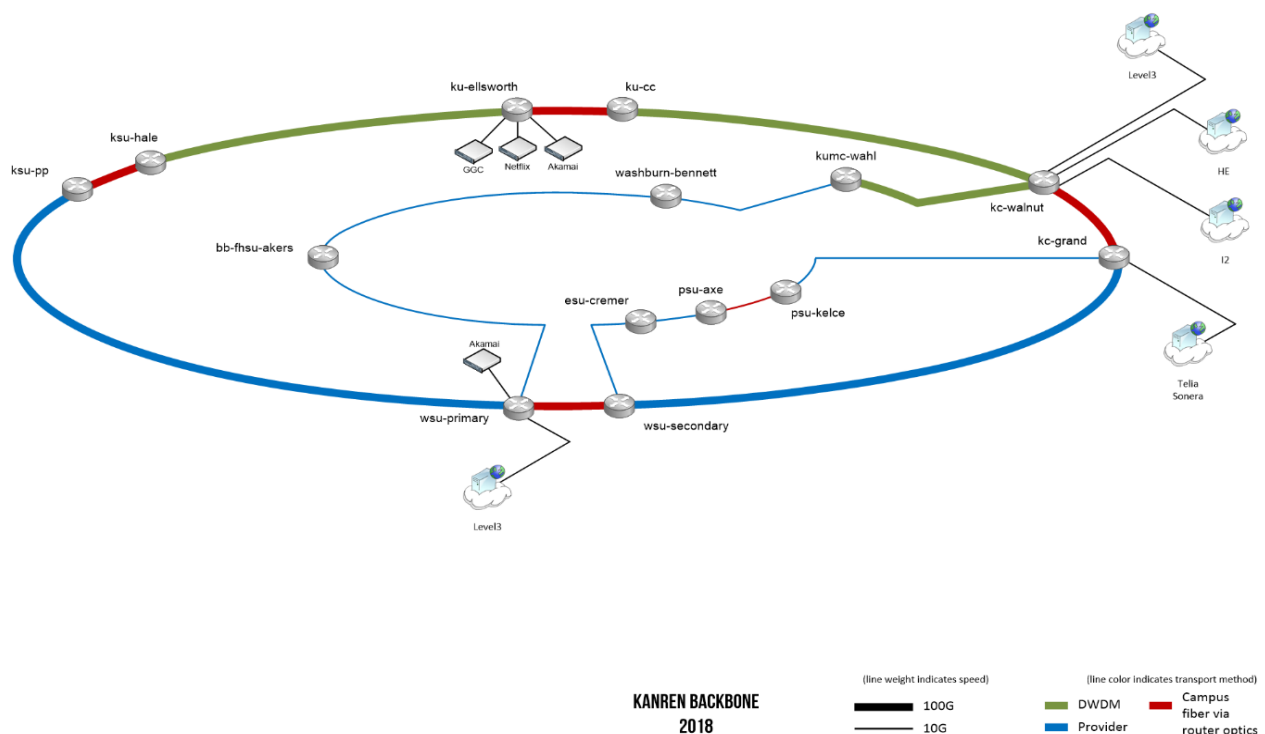
Another constant throughout these evolutions; KanREN has a singular goal for the future – to remain at the forefront of network technologies for the benefit of Kansas Community Anchor Institutions. By implementing advanced technology in its earliest stages KanREN continues to provide leading-edge expertise, capacity, and network sophistication. Just as KanREN supported rich QOS, VPN, Multicast, IPv6, MPLS L2 VPN, and Internet2 access years ahead of widespread adoption, its singular focus will remain on putting technology into production that opens opportunities, removes limitations, and addresses technical challenges for our members.

Network and data security

KanREN provides connectivity to our members throughout the state primarily via two IP/MPLS rings. The larger ring is a 100Gbps ring specifically designed to provide our larger research universities with fully redundant connectivity at a minimum of 100Gbps capacity. The secondary ring connects our smaller, regional universities to the same IP/MPLS framework. This provides those regional universities with fully redundant connectivity at a minimum of 10Gbps. We also maintain POP locations around the

100Gbps ring in large carrier facilities which provide access to commodity Internet access, Internet2, and other regional peers.

The northern span of the 100Gbps optical ring operates on university leased fiber that connects Kansas State University (KSU), the University of Kansas (KU), a carrier facility at 1100 Walnut (the Internet2 colocation area) and the University of Kansas Medical Center (KUMC). KanREN lights and maintains this 260km span using DWDM optical equipment and regularly expands capacity between the campuses as needed to promote and support research projects, HPC initiatives, disaster recovery services, and campus to campus communications. The system can provide 100Gbps or 10Gbps clear or encrypted services via 100, 200, 400, or even 600 gigabit coherent waves to those campuses quickly and cost-effectively. On initial deployment of this optical network, KanREN staff pre-built 100Gbps of research capacity beyond the universities' day one needs so we could respond quickly and at no additional cost to their evolving requirements. Much of that initial research capacity has been utilized over some parts of the span and we remain dedicated to responding to researchers wherever and whenever they need extra network capacity.



It is a central goal of the KanREN technical staff to create a regional network environment that supports the Cyberinfrastructure objectives of Kansas Regents universities, and the Internet community as a whole. We regularly engage with all of our university consortium members to discuss the evolution of their Science DMZs and Cyberinfrastructure – especially where it intersects with or traverses our backbone. We deploy a rich set of tools to ensure that our university partners have a secure, effort-free backbone to meet their enterprise and research network service needs. Networking and security best practices are emphasized in all areas of KanREN's network and systems. KanREN joined the Mutually Agreed Norms for Routing Security (MANRS) June 8, 2018 and fully employs all four MANRS actions. KanREN has meticulously verified and maintained IRR and RIR routing information registry data, and after discussion and guidance from the KanREN NTAC we have recently deployed RPKI BGP Origin

validation across our backbone to mark a validation state and apply a BGP community for future policy action. BCP38 and BCP84 filtering is applied at all network edge interfaces to prevent source spoofing. All KanREN members regardless of size enjoy DDOS protections and access to Akamai Enterprise Threat Protector Service, and numerous other security services, as well as quarterly security workshops offered through strategic partnerships with the R&E community and commercial organizations. These are offered to our community on a voluntary basis at little or no cost to the member, to help our members improve their CI security stance. KanREN's current perfSONAR deployment consists of 8 measurement nodes strategically distributed at research universities, regional universities and carrier hotel locations along with a central measurement archive and easy to use MaDDash dashboard. The perfSONAR deployment is used to empower researchers at member institutions with performance data about the statewide CI infrastructure as well as to provide them with known quantity, off-network test points with trusted back-end support staff. KanREN provides training and work sessions with members who wish to deploy their own perfSONAR nodes.

To ensure the availability of our large, and regional university CI data pathways Wichita State University (WSU), KSU, and KU, KUMC, and Pittsburg State University (PSU) each have established multiple diverse geo-redundant borders with the KanREN network. These two locations allow for geographically diverse (east/west) exit points from the campus using fiber paths, protected to the highest degree possible from single points of failure within the outside plant fiber infrastructure. At each border location on campus, these universities maintain a single (or multiple) 10Gbps or 100Gbps connection into a KanREN Juniper MX960 or MX480 router. KanREN deploys core IP/MPLS nodes in a fully redundant configuration with four power supplies, maximum switch control boards, two routing engines, utility from diverse power circuits, backbone interfaces taken from physically diverse line cards in diverse chassis power zones, and WAN fiber pathways which never collapse into single conduits. Regional campuses that do NOT have two diverse border locations on campus are fed from a single KanREN router. These IP/MPLS nodes are outfitted similarly in terms of power supplies, switch control boards, routing engines, utility power, line card diversity and fiber capacity diversity.

KanREN employs Shibboleth for identity management and single sign-on for internal services. KU, KSU, and WSU are members of InCommon, it is KanREN's intent through our recently established CI advocacy program to join InCommon and create a common, regional framework that can help researchers and academics at all campuses join and gain access to key CI and HPC resources in Kansas and around the globe. Those who are unable to deploy InCommon on their own will be encouraged to use KanREN's deployment as an entry point into these resources.

Data protection and privacy

If during the process of this project, either through the deployment of the network, equipment, InCommon, Globus or in working with university personnel or via another method, KanREN comes to hold personally identifiable information, or any other sensitive information, industry best practices will be applied to protect that information. All OS and software updates will be applied in a timely manner and reasonable, customary steps will be taken to secure any systems where the data is stored. KanREN already employs standard industry policies and best practices to ensure that our staffers do not reset, recite, know or divulge any passwords or user token to any persons in person, or electronically, without properly verifying the request as valid. In all such instances the preference will be to establish web systems or electronic systems that use industry best practices to validate the identity of those persons before allowing reset of any stored information; including passwords on file. Additionally we intend to utilize multi-factor authentication mechanisms whenever possible.

Our project in support of regional Universities – Plains Regional Optical Platform for Education and Research (PROPER)

Most of KanREN's history has been spent as a network program with a strong emphasis on supporting, enabling, and reacting to member network needs. The largest single member classification in terms of capacity and network agility includes the Kansas Board of Regents research universities. The research activities on those campuses have driven innovation, in every facet of design and architecture of the regional network. While those research needs have driven much of what we do, KanREN, until last year, has never featured a dedicated CI program to engage directly with key CI and HPC stakeholders and bridge the gap between the domain researcher and the wide-area network. Our contacts at those research universities are typically the university CIO and/or the enterprise networking group. More often than not, we have learned the research needs of the university through the lens of central IT. We have been fortunate over the years to informally make contacts with a number of those researchers and even, occasionally, form close collaborations with them to help achieve individual project goals. These contacts happen almost exclusively at our largest universities and expose a great opportunity for analyzing and extending these efforts to our smaller, regional campuses.

We've come to recognize over the last 3 years that there are domain scientists at our smaller, regional universities who have specific CI and HPC needs that are not addressed by the KanREN network program in its current state. An effective PROPER Science DMZ will allow domain scientists at regional universities to have the same access to low latency, high speed science DMZ connectivity that their R1 and R2 counterparts enjoy today. HPC and other critical CI resources are increasingly common tools in undergraduate programs in the STEM fields at all levels of higher education. By concentrating our design on dark fiber and wave technologies, we can react more quickly to changing research needs and we can deploy services more quickly and economically when new needs arise. We also can ensure that the research workflows can be isolated from the enterprise traffic. This will allow the researcher to take advantage of HPC resources at WSU, KSU, and throughout the region without constantly having to consider the cost/benefit analysis of competing with the enterprise traffic.

For the entirety of our existence, the bulk of the KanREN backbone has been comprised of “lit” telecommunications circuits at a given bandwidth. If we analyze just the core backbone circuits (just those that comprise the 2 core rings that serve our universities), 66.6% of those circuits are lit services and 33.3% are dark fiber (DWDM) connections. More importantly, all of the smaller regional universities and private colleges are served with traditional, lit services. These lit services represent a substantial disadvantage to our regional universities. Lit services are bandwidth limited, difficult to upgrade, the upgrade process is lengthy, and most often, cost-prohibitive. Because of this, once a contract is signed, the institution is consigned to that bandwidth level for a term of 5-7 years. The bandwidth must be shared between research and enterprise, and these needs must constantly be analyzed and adjusted to determine the most effective usage of the circuit. Dark fiber builds would allow KanREN to deploy new waves more quickly and more cost-effectively to respond to the needs of all of our universities. For that reason, KanREN has committed over the next 24 months to shifting our design model for the next generation of our backbone to deploying only dark fiber wherever possible in the core backbone. The backbone feeds our R1 and R2 universities and most of our (smaller) regional research universities directly. We are also committed to trying to reach each of our other research institutions and private colleges with dark fiber over that timeframe, or shortly thereafter. This is a substantial commitment by our Board of Directors and university CIOs. While the long-term cost of this investment will be lower, the cost of procuring the fiber IRUs in such a short time-frame will be one of the largest up-front commitments in our history. We are not seeking NSF funding for the fiber procurement, the funding requested for the PROPER Science DMZ award will only be used to acquire equipment that will directly connect regional universities to the new dark fiber network. The equipment purchased through the program will help the regional colleges

and universities gain access to existing HPC resources created through NSF grant awards in the state (e.g. Beocat at KSU NSF grants CNS-1006860, EPS-1006860, and EPS-0919443.) and elsewhere throughout the world. We recognize that many of these smaller institutions won't have InCommon, or even have the resources locally to deploy it. The proposed regional Science DMZ will put all Kansas research institutions on the KanREN backbone on a level playing field and give them a dedicated science connection that is low latency, highly predictable, and monitored 24/7 with perfSONAR to ensure they understand the capabilities of network. The proposed "shared" InCommon instance and Globus tools will give regional university researchers an entry point into these resources until their University has the training, staff skill set and resources to implement a suitable federated ID service locally. It will be the primary responsibility of the PI, Mr. Russell to coordinate, implement, and oversee most aspects of this program under the supervision of the KanREN Executive Director and guidance from the Board of Directors.

For 27 years KanREN has been the longest-running and arguably most successful standing cooperative agreement between every one of the state's public universities. We believe we are the organization that is best-positioned to implement and coordinate this CI program. This program will consist of establishing a state-wide, distributed Science DMZ that puts all Kansas researchers on a near equal footing from a CI standpoint, and enables transformative science at all institutions. The focus of the program will be to put appropriate tools into the hands of HPC and CI researchers at smaller institutions especially those who are pursuing innovate or transformative research. It is our expectation that our larger institutions will be able to use their membership in the Great Plains Network (GPN) CI Program (NSF OAC-1925681) to assist and strengthen this statewide program. Indeed, care will be taken throughout the implementation, not to duplicate the efforts of the multi-state, regional GPN program which tends to focus on our larger universities, but to strengthen that program by extending it into the regional campuses, beyond where its current resources may allow. By engaging with the researchers at these smaller institutions, we expect to not only help them obtain access to CI and HPC resources but we also hope to better understand what they need from the KanREN network to succeed in their research.

Sustainability

KanREN's board of directors, which is made up of our member institutions, determines our rates, fees, and what programs and services we offer to members. This CI program is being pursued at the direction of our board of directors because they see a need for the program and a current vacuum in the area that needs to be filled. Ultimately at the end of the grant funding, it will be this board of directors who determines how we incorporate this program into the current KanREN rate models and how much of the program is incorporated or expanded. It is our expectation that the value of the program will be such that it is incorporated wholly into the standard KanREN budget model before, or at the end of the grant funding. It is indeed our intent that the value to the membership is such that the program is extended and even grown beyond what this current grant funding allows for year after year. We expect that expanded dark fiber acquisitions for added redundancy, and investment in Science DMZ architecture will become the norm for the KanREN backbone for the foreseeable future.