SOUTH CAROLINA STATE UNIVERSITY
CAMPUS CYBERINFRASTRUCTURE PLAN

A. INTRODUCTION

a. South Carolina State University (SC State), an 1890 land grant, senior comprehensive institution is South Carolina's only public, Historically Black College and University (HBCU). There are several programs unique to SC State

   i. The only Bachelor of Science program in Nuclear Engineering in South Carolina and at any HBCU in the nation.
   ii. The only Master of Science degree in Transportation and the only Master of Business Administration degree with a concentration in agribusiness in South Carolina.
   iii. The only Doctor of Education degree in the state with a concentration in educational administration and is ranked third in the nation in graduating minorities with the Doctor of Education degree.
   iv. The only undergraduate environmental science field station in the nation
   v. The only HBCU in the country with an interdisciplinary art museum and planetarium in one facility, the I.P. Stanback Museum and Planetarium.
   vi. A Bachelor of Science degree in physics with an option or concentration in Medical Physics.

   SC State consists of approximately 107 buildings on 160 acres of land on its main campus in Orangeburg, and an additional 267 acres at Camp Harry E. Daniels in Ellore, S.C. An Engineering and Computer Science Complex opened in early 2013. The 24.5 million, 86, 500-square-foot complex features innovative classrooms, research centers, and laboratories. The James E. Clyburn Center conducts research in the transportation industry. The Leroy Davis Sr. Science and Research Complex, an extension of Hodge Hall, is a recently constructed state-of-the-art facility housing the Department of Biology and Physical Sciences.

b. The SC State's strategic IT plan is to develop a coordinated integrated service of cyberinfrastructure (CI) components, which leads to higher levels of performance, reliability and predictability for learning and science applications and distributed research projects. The technology based environment will serves as the University's Next-Generation of Connectivity and Learning Ecosystem (NGC-LC) and must reduce the Benjamin Bloom's 2-sigma gap in learning and workforce development (LWD) and science-driven requirements by

   i. Meeting surging expectations for Internet bandwidth, reliable security, multitenancy, science networks, big data transfers, policy-based automation and Cloud access.

ii. Supporting student learning style of an anytime, anywhere activity with technology at the backbone to provide these services
iii. Enabling students to take advantage of different modes of learning.
iv. Making University resources available for online and on-demand education.

c. Key academic partnerships with the IT organization:
   i. Workshops for faculty members at SC State and other regional institutions on Big Data/Analytics and regional and national High Performance Computing (HPC) resources.
   ii. Nuclear Engineering Program (NEP) workstations and servers in the Applied Radiation Sciences Laboratory (ARSL), Radiation Data Mining Laboratory (RDML), and NEP reactor simulation laboratory for radiation spectra acquisition, numerical analysis, data storage, data mining, and reactor visualizations.
   iii. Real-time onsite and remote observations (e.g. via Internet) at ground-based observatories in Arizona and other sites by the Physics department. Additionally, researchers use NASA space-based observatories such as Kepler. The acquired data sets is downloaded to workstations and servers at SC State where data analysis takes place. Data analysis with Python, IDL and IRAF are used in these studies

B. PROGRAM(S) THAT BENEFIT FROM CAMPUS CI

a. Describe primary research programs, education, outreach programs that are the focus for CI support
   i. <u>Nuclear Engineering Program (NEP):</u> The Applied Radiation Sciences Laboratory (ARSL), Radiation Data Mining Laboratory (RDML), and the NEP reactor simulation laboratory for radiation spectra acquisition, numerical analysis, data storage, data mining, and reactor visualizations.
   ii. <u>Computer Science</u>: The cyber-security laboratory, and the development of programs in Internet of Things (IOT), Big Data, Analytics, and Machine Learning, and Cloud Computing.
   iii. <u>Biology</u>: The SmartState© Endowed Chair in Prostate Cancer Disparities and the South Carolina Cancer Disparities and Research Center (SC CADRE) to facilitate collaboration between SC State and MUSC with a focus on prostate cancer research and training for underrepresented students in the biomedical sciences.
   iv. <u>Physics</u>:
      1. Faculty members in physics conduct ground and space-based astronomical research. This includes studies of the Sun, variable stars and peculiar stars. These programs include real-time onsite and remote observations (e.g. via Internet) at ground-based observatories in Arizona and other sites.

Additionally, researchers use NASA space-based observatories such as Kepler where a scripted set of instructions are uploaded into the spacecraft observing que. The acquired data sets are later downloaded to workstations and servers at SC State where data analysis takes place. Data analysis with Python, IDL and IRAF are used in these studies.

2. Physics faculty members participate in a large number of education and public outreach (EPO) programs. Topics include: (a) hydrological studies of soil using space-based technology; (b) creation and implementation of web-based cosmological demonstrations and lab exercises based on a server located on the SC State LAN but accesses by individuals outside of the university; (c) laboratory exercises in earth science classes taken by SC State students requiring real-time access to remote data bases from NOAA, NASA and others.
3. SC State and Clemson are negotiating a Memorandum of Agreement between science programs at the two institutions (initially physics, but later expanded to other programs) which will include distance learning course offerings and student exchanges between the two institutions.
4. We note that the research and EPO activities discussed above engage a number of colleagues at institutions such as Clemson University, NASA Ames Research Center, the Space Telescope Science Institute (Johns Hopkins University), the National Solar Observatory, Western Kentucky University, Villanova University and others. Videoconferencing, email, and the exchange of large data sets require a robust, high-bandwidth access to the Internet.

v. <u>The University Transportation Center</u>: Support for the masters of Transportation related research

vi. <u>Distance Education Programs</u>: Smart Classrooms and access to online Cloud resources

vii. <u>The 1890 Research & Extension Program</u>: Offers public service for rural and urban limited-resource families who are in need of the latest research-based scientific knowledge, sustainable practices in agriculture, financial management, business development, parenting skills, health and nutrition, and computer skills.

b. Describe your primary CI goals *(enable X, expand Y, introduce Z – describe function, not equipment)*

SC State's IT goal is to transform the learning experience for students by deliver an enhanced educational experience while dramatically lowering costs, and management complexity. The Next-Generation Connectivity and Learning Ecosystem (NGC-LE) is a propose development and deployment of an agile, manageable and secure CI that leverages the Software Defined Network (SDN) paradigm. SDN is an emerging paradigm that offers network programmability by decoupling the control plane and data plane in the network switches. It uses a logically centralized software controller that populates the switches with the forwarding rules. As a result, the traffic is prioritized and the load can be managed efficiently. SDN also allows the virtualization of the infrastructure resources where the virtual slices (e.g. bandwidth) are allocated on demand based on the load. SDN also allows faster deployment of science applications and experiments, which in turn enhances the research productivity. In an SDN enabled infrastructure, the switches will be programmed to perform security related tasks such as network monitoring and packet filtering. Moreover, the programmatic SDN interfaces allow quick enforcement of security policies and access rights.

In the first activity, we will identify the SDN use cases in the campus network and the capabilities (e.g. network virtualization and security) needed to support the use case requirements. In the second activity, we design the SDN based architecture for the campus network. In the third activity, we will carry out an investigation of the open source and proprietary based SDN projects and select one of them to start the development of the prototype. We will implement a centralized SDN controller and the programmatic interfaces. In the third activity, we deploy the prototype in a lab environment. In the fourth activity, we evaluate the prototype using performance metrics such as latency, throughput and flow set up time. Based on the observations, we will perform improvements if needed. In the fifth activity, we integrate the prototype with the campus infrastructure. We hope to realize a network that can support the following:

- Capex and Opex reduction offered by the SDN paradigm.
- Implementation of Science DMZs
- Implementation and support of local HPC Clusters
- Centrally managed storage for researchers

C. DESCRIBE YOUR NETWORK INFRASTRUCTURE *(if any of this was paid for by EPSCoR, NSF, or other federal or state funds, mention that)*

A significant amount of our data center IT components and network was paid for by Tittle III federal funds e.g. firewall, storage, Wireless access points

a. Local area network (what routers, how connected) – backbone speed

   Three-tier model which consist of a Cisco Nexus 7000 (core), Cisco Catalyst 4500 (distribution), and various Cisco level 2 access switches. 10Gbps fiber connection between cores

b. Building switches & fiber connections – speed to buildings

   Cisco Catalyst 4500 series 10Gbps fiber connections
   Cisco Catalyst 29xx series 1Gbps fiber connections
   Cisco Catalyst 35xx series 1Gbps fiber connections
   Cisco Catalyst 37xx series 1Gbps fiber connections

c. R&E connection – speed & point of connection

N/A

d. Commodity WAN

N/A

e. Campus Wireless (describe equipment)

Mixture of Cisco and Aruba APs

Cisco – 4400, 4500 Controllers
Cisco – 1242s, 1142s (APs)
Aruba – 6000 Controller
Aruba – 105, 135, 205, 305

f. <u>IPV6</u>

<u>Not Deployed</u>

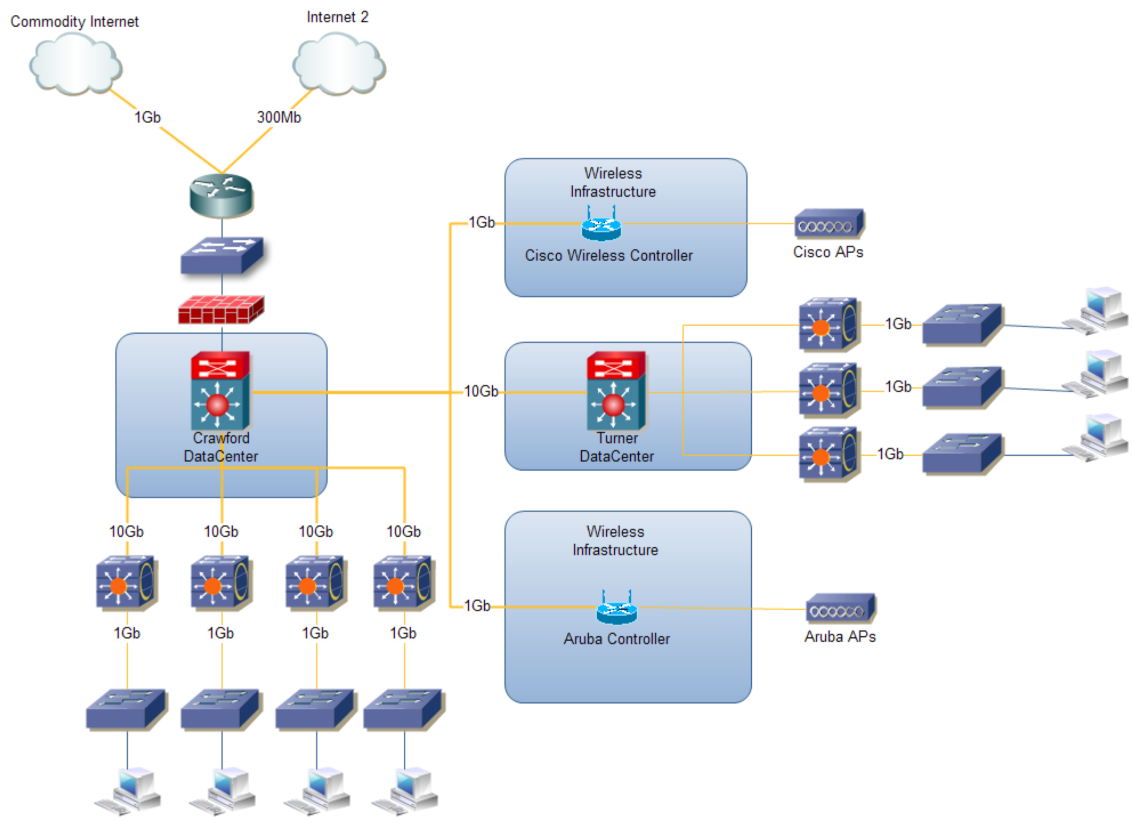
g. Any special connections (e.g. A Planetarium used by the public)

The Planetarium does not have a special network connection

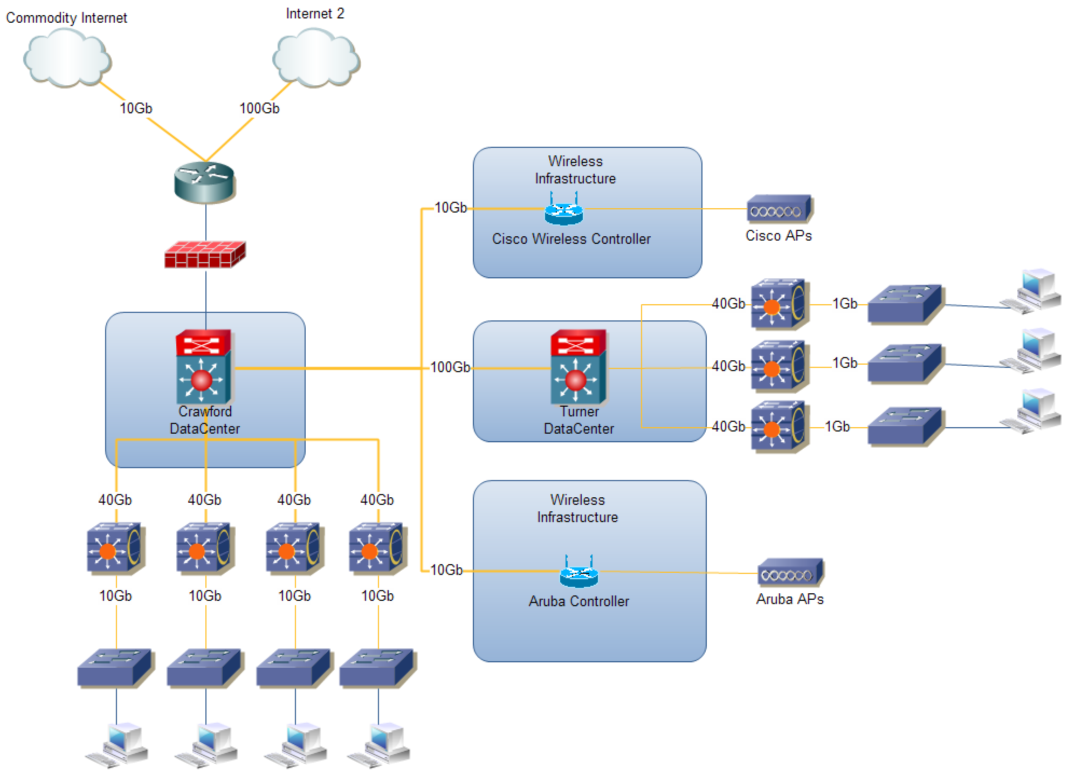
h. Any of the network items in the table below that have been implemented

No

i. A little campus network diagram is nice



j. Future Directions



- Incresed bandwith for commodity and Internet2 bandwidth
- Increase bandwidth for network back bone
- Implement a Passive optical network (PON) layer within research buildings
- Implement HPCs for specific research areas e.g. NEP, CS and Physics

D. COMMUNITY CLUSTER AND RESEARCH STORAGE REPOSITORY

a. If you have a cluster, provide brief technical description & who gets to use it
We do not have a Cluster

b. Use of national resources – Open Science Grid or XSEDE
Physics Department:

- The Mikulski Archive for Space Telescopes (MAST) is used for research and education purposes. This is a NASA-funded archive of data collected by a large number of ground and space-based observatories. The data is used both in research and in Education and Public Outreach (EPO) activities at SC State.
- The American Association of Variable Star Observers (AAVSO) maintains a data archive of ground-based observations of variable stars that is used at SC State for both research and EPO projects.

E. IDENTITY MANAGEMENT AND COLLABORATION

a. Do you have a central identity store – describe (LDAP, AD….)
   AD
b. Do you support campus single sign-on authentication and authorization
   Yes
c. Are you a **member of the InCommon federation**?
   No
d. Have you installed Shibboleth ?
   i. **If yes, do you release R&S attributes**
      No
e. Do you participate in **eduroam ? (*requires InCommon & Shibboleth)***
   No

F. CYBERSECURITY

a. How does your campus provide cybersecurity for researchers, their equipment & data?
We provide enterprise virus/malware protections, network device protection, firewalls, secured access for researchers and their data, and mandatory training for faculty and staff. The Cybersecurity training is also available for students employed on campus.

b. **What is your campus approach to data and privacy?**
We adhere to FERPA and State mandated requirements

c. **address the relevant cybersecurity issues and challenges related to their proposed activities**
Each research area may need specific security support; however, we are not able to support research specific requirements.

G. EDUCATION AND OUTREACH

a. Do you provide any on-campus training in how to use any of the CI?
Yes, the IT department very limited training at faculty/staff orientation and throughout the year

b. Do you have any %FTE dedicated to CI support?
Yes, 5%

c. **ongoing opportunities for student engagement, education, and training**
The IT department provide a limited amount of student worker employment, which allow for training in CI. Physics and computer science faculty train student researchers in software development and use (e.g. Java, C, Python, IDL, IRAF) for research and education programs in which the students are involved.
The Nuclear Engineering Program provide the following educational opportunities: (1) Dr. Danaji is guiding students on computer modeling of used fuel drying by vacuum and gas circulation for dry cask storage. This project requires applying multiphysics codes (e.g. TRACE and COBRA-SFS) to nuclear waste management, and makes a close collaboration with the colleagues at the University of South Carolina. Another project of his group is about development of multi-scale experimental and modeling capabilities for radionuclide waste disposal, in collaboration with Clemson University. (2)

Dr. Okafor is leading the investigation of alternative sources of vegetable oil from non-edible plant seeds for biodiesel production. His research employs computer modeling and simulations. (3) Dr. Sun and his students are applying instrumental neutron activation analysis (INAA) to the study of toxic trace elements in cotton seeds. One task of this project is establishing a web based computer calculation system for Nuclear Activation Analysis (NAAS) (see http://naas.scsu.edu). This work depends on the collaboration of two state universities in the Carolinas (NCSU and SCSU). In addition, Dr. Sun has another DOE project, which is about the design and implementation of a real-time data acquisition system for in-situ decommissioning (ISD) sensor network test bed located at the Savanah River National Laboratory (SRNL). Through both the data acquisition system at SRSL, real time data from various sensors (radiation field, temperate, pressure, humidity, leakage, etc.) will be synchronized and then streamed into the data servers at NEP with time stamps. The data acquisition system will also have the capability to control the devices remotely according to the feedbacks from data analysis and temporal data mining. The system can be accessed over the internet through a securely membership authorization.

d. How will students be involved in installing or operating the CI?
   The IT Department provide a limited amount of student worker employment, which allow for training.
e. How will the CI provide new training and education opportunities for students?
   IT Department will provide more student worker employment, which allow for further training of students, assist academic programs to access regional HPC resources, and develop HPC locally.

   NEP has pending NSF and DOT proposals around the development of smart containers for nuclear/hazardous material transportation. It will transform standard containers into smart and connected devices, and introduce the traditional transportation system into the big data era. The implementation of smart container network will greatly improve the security of the nuclear/hazardous material transportation, reduce the accident rate in transit and handling, and give us the capability to know where and in what condition the hazardous material shipment is. All these future projects are multimodal and multidisciplinary by their nature and will require close collaborations among faculty members in nuclear engineering and the IT department.

H. SUSTAINABILITY AND RESPONSIBILITY FOR MAINTAINING FEDERAL INVESTMENTS

a. **Sustainability** -- Something about ongoing maintenance and support for equipment, or continued funding for a person. Refer to a letter of support in Supplementary documents.
   Regional network organization

Consider everything below this line to be NOTES.

You're telling a story here – This is our institution; here's what's important to our institution, and here's where CI for research and education fit in our big picture. We have this vision/goals – here's where we are on the path to that vision, here's how we've funded it so far, and here's where some extra CI funding will impact our research, scholarship, teaching, and students.

Here is what the NSF requires for CC* solicitation Campus CI Plans:

A. "All proposals into the CC* program must include a Campus Cyberinfrastructure (CI) plan within which the proposed CI improvements are conceived, designed, and implemented in the context of **a coherent campus-wide strategy** and approach to CI that is integrated horizontally intra-campus and vertically with regional and national CI investments and best practices. "
B. "Proposals are expected to address within the Campus CI plan the **sustainability** of the proposed work in terms of ongoing operational and engineering costs."
C. "The plan should also describe campus **IPv6** deployment and use of the **In Common Federation global federated system**, and if applicable, campus federation approaches to supporting scientific Virtual Organizations"
D. "Since security and resilience are fundamental issues in Campus CI, the campus CI plan should **address the campus-wide approach to cybersecurity in the scientific research and education infrastructure, including the campus approach to data and privacy**."
E. "All proposals submitted to CC* are expected to **address the relevant cybersecurity issues and challenges related to their proposed activities.** Depending on the type of proposal, these issues may include, but are not limited to: data integrity, privacy, network security measures, federated access and identity management, and infrastructure monitoring."
F. "funded activities should represent **ongoing opportunities for student engagement, education, and training**. Proposals that demonstrate opportunities to engage students directly in the deployment, operation, and advancement of the CI funded activities, consistent with the required Campus CI plan, are welcome.

G. *(not needed in this plan, but might be needed for future network submissions")"Also, for proposals into the Data Driven Networking Infrastructure for the Campus and Researcher area, the Campus CI plan should address efforts to prevent IP spoofing by potential adoption of "**BCP 38**". If it is determined that "BCP 38" cannot be deployed due to cost or technical reasons, discussing those reasons is an acceptable form of addressing the issue."*

1) This CI Plan template meets the requirements named in the CYBERTEAM solicitation. When applying for other NSF programs that require a CI plan, check for any new requirements that might be listed in the solicitation
2) The elements listed in the table below are components that **could** be integrated into an overall CI plan . You don't need to address all of these topics nor do you have to have implemented all of these in 3 years. Elements that are required are highlighted in yellow.
3) You don't need to use this table format; you can describe the topics in text.
4) Think about describing HORIZONTAL integration across your campus, and VERTICAL integration with regional and national cyberinfrastructure.

ITEM	CURRENT	FUTURE
NETWORK		
• Campus Backbone speed	10GB	100GB
• Commodity Internet speed	1G	10GB
• Campus to Internet2 R&E Network speed	300MB	10GB
• *CAT5 cabling or better to researchers' desktops?*	1GB	10GB
• IPV6 implemented	No	Yes
• PerfSONAR installed	No	Yes
• Campus Network Monitoring	No	Yes
• Research & Scholarship DMZ	No	Yes
• Software Defined Network (SDN)	No	Yes
• Anti-spoofing BCP38	No	Yes
IDENTITY AND COLLABORATION		
• Member of the InCommon Federation	No	Yes
○ If yes, release R&S attributes?		
• "eduroam" wireless	No	Yes
HIGH PERFORMANCE COMPUTING		
• On-campus HPC clusters & management	No	Yes
• Use of Open Science Grid	No	Yes
STORAGE		
• Data Transfer Node	No	Yes
• Research data storage & management	No	Yes
SUPPORT		
• Technical staff to support campus researchers' use of the cyberinfrastructure, eg: a CI Engineer or CI Facilitator.	No	Yes
• XSEDE campus champion	No	Yes