

# Submission in Response to NSF CI 2030 Request for Information

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## Research Domain, discipline, and sub-discipline

Research IT

## Title of Submission

South Dakota: on the frontier of cyberinfrastructure deployment

## Abstract (maximum ~200 words).

South Dakota's plan for research and development includes five emphases leveraging capabilities of its public university system as well as internationally recognized science assets located within the state. Recent Cyberinfrastructure awards have begun to bridge the gap between South Dakota's research and development vision and the underlying cyberinfrastructure necessary to support it. NSF can best support CI in states like SD by: 1) promoting education and facilitation in a manner accessible to rural isolated research communities; 2) funding infrastructure aimed at distributed big data movement and analysis.

**Question 1** Research Challenge(s) (maximum ~1200 words): Describe current or emerging science or engineering research challenge(s), providing context in terms of recent research activities and standing questions in the field.

South Dakota has identified five key areas of research development:

1. Value-Added Agriculture and Agribusiness
2. Energy and Environment
3. Materials and Advanced Manufacturing
4. Human Health and Nutrition
5. Information Technology/Cyber Security/Information Assurance

These areas are addressed by specific initiatives at state universities:

\* The Post Traumatic Stress Disorder and Traumatic Brain Injury Research Program and the Catalysis Group at USD

\* The Animal Disease Research and Diagnostics Lab, the Seed Technology Center and the Geographic Information Science Center of

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Excellence at South Dakota State University (SDSU)

\* The Composites and Polymers Engineering Lab, the Additive Manufacturing Laboratory, Arbegast Materials Processing and Joining Laboratory and the Center for Friction Stir Processing at the South Dakota School of Mines and Technology (SDSM&T)

\* The Center for Technology Security and the Center for the Advancement of Health Information Technology at Dakota State University (DSU)

South Dakota is also home to two internationally recognized innovation-enabling research assets:

1. The Sanford Underground Research Laboratory (Sanford Lab) near Lead, SD
2. The United States Geological Survey's National Center for Earth Resources Observation and Sciences (EROS) in Sioux Falls

Sanford Lab, a world-class multidisciplinary underground science and engineering research facility located in the Black Hills of South Dakota, provides an environment free from cosmic radiation disruption to conduct extremely sensitive experiments. Experiments now installed nearly a mile underground, protected by a thick layer of rock from cosmic noise, could yield answers to some of the deepest mysteries of modern physics in the next few years.

Sanford Lab is home to South Dakota's Governor's Research Center for Ultra Low Background Experiments (CUBED), which, among other activities, is pursuing materials purification and crystal growth research with applications in advanced manufacturing and materials, human health and nutrition, and energy and environment target industry sectors. The facility is also engaged in applied research on the use of exotic "extremophile" life forms that could boost production of biofuels. Fourteen research collaborations are active at the Sanford Lab and they include nearly 1,000 scientists from throughout the United States and Europe.

EROS is a unique resource because it is the largest civilian repository of remote sensing data in the U.S. and is recognized as a global leader in applied earth systems science. As an interdisciplinary innovation-enabling asset, EROS features strong collaborative research capacity in geographic information systems, digital mapping, and geostatistics domains with the potential to generate high value applications in the plant and animal bioscience, human health and nutrition, and energy and environment industry sectors. In addition, EROS is a participant in a joint collaboration with SDSU in the Geographic Information Science Center of Excellence (GIScCE).

**Question 2** Cyberinfrastructure Needed to Address the Research Challenge(s) (maximum ~1200 words): Describe any limitations or absence of existing cyberinfrastructure, and/or specific technical advancements in cyberinfrastructure (e.g. advanced computing, data infrastructure, software infrastructure, applications, networking, cybersecurity), that must be addressed to accomplish the identified research challenge(s).

South Dakota is an EPSCoR state where infrastructure for computing- and data-enabled research are continuing to emerge. Both researcher literacy in advanced cyberinfrastructure (CI) and Information Technology (IT) organization literacy in scientific domains are unmet needs.

South Dakota has made recent strides towards an advanced computing infrastructure with successful high performance computing (HPC) system deployments at both USD and SDSU. SDSM&T was recently awarded an MRI Instrument Development award for an HPC system specifically geared towards large image data acquisition. USD and SDSU both received NSF CC\*IIE awards for developing Science DMZ networks in 2014, and both universities have recently deployed the Globus software platform for data movement and management.

Both USD and SDSU participate in Henry Neeman's novel Advanced Cyberinfrastructure Research and Education Facilitator (ACI-REF) Virtual Residency program, aimed at building the skills necessary for campus CI facilitators. USD and SDSU both participate in the XSEDE organization's Campus Champion program, and USD's Campus Champion serves on the Champion Leadership and Sustainability committees. Efforts are underway to bring the Software and Data Carpentry communities to South Dakota. As part of its 2017 CC\* Storage award, USD will host South Dakota's first Data Carpentry workshop in 2018 in coordination with the Midwest Big Data Hub.

While recent strides have been made, there is still significant effort required to bridge the gap between South Dakota's research and development strategy and the CI necessary to enable it.

The single largest gap in South Dakota's cyberinfrastructure is expertise and facilitation. South Dakota universities primarily support research computing with traditionally enterprise-focused IT organizations which do not (yet) have a long history of direct collaboration with

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researchers. Online workshops, webinars, and learning materials covering CI literacy for researchers and CI development and support for IT organizations would help bridge this gap.

Underlying this lack of expertise and facilitation is South Dakota's small population distributed over a large geographic region which makes distance learning and professional development technology vital. Travel to leading CI centers for professional development or training is often financially prohibitive and psychologically intimidating in a region where many have never traveled out of the state.

In 2016 USD hosted site visits from both the XSEDE Campus Engagement program and Internet2's Broadening the Reach program. The results have been palpable: USD has strengthened its relationship with Internet2 and continues to optimize and expand its Science DMZ and advanced networking initiatives; and Campus Engagement has helped make South Dakota researchers and administrators more aware of the benefits and challenges associated with deploying advanced cyberinfrastructure.

Continued development and expansion of this kind of activity is vital to the advancement of CI-enabled research in rural states like South Dakota.

To best develop cross-institution collaboration and expertise sharing, online tools must be complemented by face to face meetings. Regional meetings can provide opportunities 1) for institutions to develop relationships across campuses, and 2) for small or isolated institutions to access national expertise that would be difficult to obtain either at their local campus or a larger national meeting. For example, a group of national experts invited to speak at a regional meeting would be very valuable to small institutions which may not be able to travel to larger conferences. NSF should encourage and support the development of accessible regional CI training activities.

Lastly, while South Dakota has a strong network of technical and vocational schools, a strong pipeline for HPC administrators and other technical CI professionals is lacking. Specific programs should fund programs at technical, vocational, and community colleges to develop a technical CI workforce

The next largest hole in South Dakota's Cyberinfrastructure is advanced networking for big data movement. Advanced CI is a fast moving target that is particularly difficult to hit in an EPSCoR state. For example, South Dakota's Research, Education, and Economic Development (REED) network was established in 2008 and connects the state's higher education institutions at 10Gb. It was one of the last state higher education networks to implement a 10G based network. In 2010 SD partnered with North Dakota and won a grant award to connect the REED network to the Northern Tier. The improved network has helped in many areas including winning grants from NSF and other organizations.

As of 2017 many state research networks (including SD's neighbors IA and NE) are now operating at 100Gbps with research data volume and variety continuing to grow as researchers increasingly communicate directly through data. At a recent meeting held by Internet2 discussions were already underway for funding the next I2 upgrade which is likely to be 1000G.

Programs specifically funding connectivity for rural states is vital as they will enable data movement, analysis, and discovery not otherwise possible.

## Consent Statement

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