

Engaging Minority-Serving Institutions (MSIs) in Cyberinfrastructure (CI) through CI Days

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1 INTRODUCTION

Science, technology, engineering and mathematics (STEM) fields are undergoing a radical transformation based in large part on technological advances producing a qualitative shift in the STEM resources available through the commodity Internet and advanced networks. The TeraGrid is a key part of this qualitative shift in remote resources which is loosely termed cyberinfrastructure (CI). Other components include Open Science Grid, Internet2 and National LambdaRail, and community or virtual organization (VO) support tools, like wikis, Second Life and other Web 2.0 developments. Minority-serving Institutions (MSIs) are colleges and universities that were created or evolved to provide post-secondary education to a specific underrepresented minority group, African Americans, American Indians or Hispanics. These institutions typically lack the resources that institutions must have to participate in CI. Unless purposeful efforts are made to engage MSIs, this can result in a widening of the “digital divide”. Part of the solution to this next generation digital divide may reside in CI itself which can intrinsically democratize science.

One CI-focused effort is the use of “CI Days” to at a minimum raise awareness of CI at MSIs and other institutions. We will briefly discuss MSIs, CI, the Minority-Serving Institutions Cyberinfrastructure Empowerment Coalition (MSI-CIEC), and the CI Days approach. This will be followed by the presentation of two cases of CI Days for MSIs, CI education which is an area of keen interest to MSIs and other higher education institutions, and the lessons learned.

1.1 MSIs

Minority-serving Institutions (MSIs) include Historically Black Colleges and Universities (HBCUs), Hispanic-serving Institutions (HSIs), and Tribal Colleges and Universities (TCUs). As the term implies, HBCUs are institutions established prior to 1964 with the historical intent and mission of providing higher education to African Americans. They are both public and private, mostly four-year with some two-year colleges and universities. The

National Association for Equal Opportunity in higher education (NAFEO) is a membership organization of HBCUs and predominately black institutions.

Tribal Colleges and Universities (TCUs) were established to address the higher education needs of American Indians, especially those living in geographically isolated areas like reservations without other higher education venues. They are predominately two-year institutions with some four-year institutions, including a few that offer a master’s degree. In 1972 the existing TCUs formed the American Indian Higher Education Consortium (AIHEC) which continues to serve as the primary vehicle for collaboration among TCUs and partners.

Hispanic-serving Institutions (HSIs) are colleges and universities that have 25% or more Hispanic student enrollment. They are about evenly mixed between two-year and four-year institutions; most are public institutions. The Hispanic Association of Colleges and Universities (HACU) was formed in 1986 to confront the barriers to Hispanic higher education and continues to grow in membership. It is the only national association of HSIs.

MSIs provide an efficient strategy to reach the minority communities underrepresented in STEM and higher education in general. Although they represent less than 10% of U.S. institutions, they enroll a much higher percentage of students from their respective communities; e.g. HSIs enroll about 50% of all Hispanic college students [10]. HBCUs and HSIs produce about 33% of African American and the same percentage Hispanic STEM baccalaureates, respectively [5, 6]. They are also well represented on the Top 50 baccalaureate institutions of Hispanic and African American doctorates [7].

MSIs are usually teaching institutions, both small and large, with a mostly regional service area, with some notable exceptions particularly among the HBCUs. MSI students can be extremely talented, and can help meet current and anticipated STEM workforce demands.

1.2 Cyberinfrastructure & MSI-CIEC

The National Science Foundation (NSF) 2003 report of the

Blue Ribbon Panel on Cyberinfrastructure, the Atkins Report [1], coined the term cyberinfrastructure (CI) stating that in much the same way that power grids, roads, railroads, etc. are infrastructure for an industrial economy, CI is the infrastructure needed for a knowledge economy. The NSF Office of Cyberinfrastructure's (OCI) Cyberinfrastructure *Vision for 21st Century Discovery* defines (CI) as follows:

"The comprehensive infrastructure needed to capitalize on dramatic advances in information technology has been termed cyberinfrastructure (CI). Cyberinfrastructure integrates hardware for computing, data and networks, digitally-enabled sensors, observatories and experimental facilities, and an interoperable suite of software and middleware services and tools. Investments in interdisciplinary teams and cyberinfrastructure professionals with expertise in algorithm development, system operations, and applications development are also essential to exploit the full power of cyberinfrastructure to create, disseminate, and preserve scientific data, information and knowledge [8, p. 6]."

The TeraGrid (TG) set of high performance computing (HPC) resources, connected by high performance networks, with many resident experts, is an obvious example of CI accessible to the broad science and engineering community. CI, like TeraGrid, is defined as much by its application, the science that it enables, e-science, as by the hardware, software and resource expertise. The Atkins Report emphasized that CI is enabling a new way of doing science in addition to theory and experimentation [1].

CI with its focus on remote collaboration of resources and people significantly expands the number of those who can participate in the new science and what science they can do. This is a great opportunity for under served populations, like MSIs. CI-enabled science is the new world for research, industry and education, that all students must be prepared to enter. Its significance is highlighted by NSF Director Bement who termed it the "Second IT Revolution" [3].

The Atkins Report specifically pointed out the importance of engaging MSIs in the emerging developments of CI [1]. Not as add-ons or simple recipients of outreach efforts, but fully engaged. The CI Vision document has as one of its general goals to "Broaden access to state-of-the-art computing resources, focusing especially on institutions with less capability and communities where computational science is an emerging activity, [8, p. 7]," and "To promote broad participation of underserved groups, communities and institutions, both as creators and users of CI [8, p. 39]" as one of its learning and workforce development specific goals, and speaks to broadening access and participation to MSIs and other underserved communities in other places as well [8]. Director Bement spoke to the importance of minority participation in his TG '06 keynote address [2].

The MSI CI Empowerment Coalition (MSI-CIEC) was formed to meaningfully engage MSIs in CI and to help promote research and education collaborations. AIHEC, NAFEO and HACU, as part of the Alliance for Equity in Higher Education, working closely with Geoffrey Fox,

Indiana University, Richard Aló, University of Houston-Downtown, Diane Baxter, San Diego Supercomputer Center (SDSC), and evaluator Julie Foertsch, established MSI-CIEC with funding from the NSF CI-TEAM program

The group represents the vast majority of MSIs. It also enjoined an advisory board representing a wide array of CI resources or programs, including TG, National Center for Supercomputer Applications (NCSA), Texas Advanced Computing Center (TACC), Renaissance Computing Institute (RENCI), Calit2, LBNL, Globus, Rice University Center for Excellence and Equity in Education, National e-Science Centre (UK), Biomedical Informatics Research Network (BIRN), and Linked Environments for Atmospheric discovery (LEAD). Like CI, MSI-CIEC's basic mode of operation is that of collaboration.

1.3 Cyberinfrastructure (CI) Days

MSI-CIEC proposed a few activities for meeting its vision, including the development of a collaboration portal, and to the topic at hand, campus visits and assessments.

MSI-CIEC applied the term "CI Days" to these visits following a TG Campus Partnerships Requirements Analysis Team (RAT) discussion with Jill Arnold, Internet2, who by all accounts coined the term. Given the relative newness of the concept of CI, helping campuses become aware of what it is and how they might take advantage of and contribute toward it is not a notion unique to MSIs at this time. CI Days was conceived as something for all campuses, from MSIs to R1 institutions since all are trying to understand CI and the potential of CI resources like TG. MSI-CIEC saw CI-Days as closely aligned, albeit not identical, to its campus visits which are intended to facilitate a close working relationship with individual campuses. The idea blossomed independently into a collaboration of organizations, a virtual organization (VO) of organizations, which adopted the name CI Days. The CI Days VO includes Internet2, TG, Open Science Grid (OSG), Educause, National LambdaRail (NLA), SURA, and MSI-CIEC [4]. Russ Hobby, Internet2, is the primary lead.

The general approach of a CI Days event is that of a series of presentations by representatives from the involved national organizations and others. These are followed by or intertwined with discussions with campus faculty, staff, and administrators, particularly IT staff, CIOs and Vice Presidents/Chancellors for Research. Through these activities, a campus can begin to comprehend the nature of CI in relation to their current research and campus infrastructure, and begin to consider the appropriate actions to take and resources needed. The event may last one or two days. Faculty may see how some of their research fits within CI, or the discussions may shed light onto new areas, particularly collaborative or interdisciplinary ones. The CIO and IT staff may see how the current campus infrastructure fits within CI or could be transformed into a campus CI as part of the regional or national CI. Campus leaders can begin to consider the importance of CI for campus research, education and reputation. Campuses with resources can start to make realignments, plans or preparations to move forward on their own.

This is not the typical scenario for MSIs, albeit with notable exceptions. Many MSI faculty and administrators have never heard of CI. If they have, it appeared to be entirely irrelevant to their locally-focused, primarily teaching institution, particularly at small or two-year institutions. They may also be skeptical that their institution could become engaged given their limited resources.

The MSI-CIEC strategy for sponsoring CI Days is for the MSI organization (AIHEC, HACU or NAFEO) to take the lead in approaching a campus that is a good candidate for hosting the event. The campus knows that their problems with engaging in CI are MSI-CIEC's problems. The issues are those that MSI-CIEC was created to identify and overcome. The campus knows that MSI-CIEC will work with them, assist and learn from them to the benefit of the entire MSI community and the students they serve. The campus will not be added to a proposal simply to enhance funding, and then forgotten.

MSI-CIEC project team members and the campus faculty and administrators will plan the event together. The campus will choose the general science or other topic areas to be covered, and MSI-CIEC will then suggest possible speakers and specific topics. The speakers may be recruited from within the CI Days VO where appropriate. Occasionally individuals not otherwise associated with the VO will be invited to speak. There will be some limited time allotted for each of the CI Days VO organizations wishing to present on their programs or services. The campus has the final say on all specifics of the agenda. MSI-CIEC will then make arrangements for the speakers; unless the campus wishes to make a specific contact. The campus will arrange local accommodations, such as general meeting and breakout rooms, meals and refreshments. MSI-CIEC and the campus discuss the meeting goals, desired outcomes and possible next steps as part of the planning process.

As important to the actual event for MSIs is the pre- and post event work. Arrangements are made with the approval and collaboration of the campus CIO to conduct a campus assessment of the current IT infrastructure. The assessment involves meeting with campus personnel, visiting IT campus facilities and reviewing campus plans and other documents. External experts are brought in as necessary. Often the other CI Days VO organizations provide the needed expertise. Sometimes other campuses or regional entities will contribute their expertise. Following the event a report is generated reviewing the current state of the IT infrastructure and making recommendations where needed. The report is discussed with the CIO and made available for further campus distribution, unless otherwise specifically requested.. Additionally, discussions will ensue to follow-up on next steps identified at the event or from the evaluation.

The above describes the instance of a CI Days event focusing on a single campus. There is also the instance of a regional CI Days where faculty and administrators from a number of campuses are brought together to learn about CI. There is an obvious efficiency to this approach. The difficulty can be in ensuring that the right people are in

attendance. Identifying next steps is further complicated by the involvement of multiple institutions. Next steps could begin with the campus representatives going back to the campus and stimulating the campus to consider and strategically plan for CI, which could lead to the campus hosting their own CI Days.

It must be emphasized that all MSIs, like most higher education institutions, are committed to providing a quality education. If CI is as significant as many believe, then MSIs will have to come to terms with it as they are with the "first IT revolution." There currently may be limited funding opportunities to seed initial efforts which may be more competitive, and therefore more difficult to secure as CI becomes more broadly adopted.

Approaching MSIs about CI and meaningfully engaging them is a difficult problem, for which there is no single solution. MSI-CIEC's approach stems from within the MSI community -- fully acknowledging that the cooperation and assistance of external entities is essential to its success. The resulting benefits should primarily be to the MSIs, although benefits are realized by all parties.

2 CASES OF CI DAYS

Two cases of CI Days at MSIs are briefly presented below. The first is a single campus CI Days, the second is a regional CI Days. There are presently only preliminary results for the regional event.

2.1 CI Days @ Elizabeth City State University

Elizabeth City State University (ECSU) is a four-year, public HBCU founded in 1891 and located in northeastern North Carolina close to the Atlantic coast and the northern state border. It is located in one of the poorer regions of the state. ECSU is a constituent institution of the University of North Carolina (UNC) system. ECSU currently enrolls approximately 3,000 students in 38 baccalaureate and four Masters programs. ECSU is situated on an approximately 200-acre campus with a faculty of approximately 200 educators and researchers.

2.1.1 Planning of the event

Most involved on the campus in the planning of the CI Days were the CIO and the Office of Sponsored Programs (OSP) which supports the campus community with grant proposal preparation and management. There is no office of research per se. Although the CIO was new to the campus, the OSP was very well connected with the campus community. The initial contact at ECSU was made through a faculty member who is very involved with MSI-CIEC activities and known for her CI research and education. She assisted as needed particularly with the campus assessment, was frequently asked for advice, and spoke at the event. Other administrators were also involved, particularly the Provost who oversees the OSP. Both the Provost and the President fully supported the event, and were interested in learning the event outcomes. Deans were also consulted for their input, and provided suggestions and comments with genuine interest. To help fund and ensure a good faculty turn-out, the event was incorporated into an existing campus activity intended to

provide faculty professional development where attendance is part of faculty service duties.

The goals of “Cyberinfrastructure Days at ECSU” were to (1) provide faculty, staff, and administrators in attendance with information about cyberinfrastructure developments in education and research, (2) facilitate networking opportunities with national cyberinfrastructure organizations and experts, and (3) provide breakout sessions for faculty within each of the university’s four colleges to brainstorm ways that cyberinfrastructure might be used in their classrooms and labs.

2.1.2 Agenda

The agenda was developed based largely upon the campus input. There was a desire that to the extent feasible there be something for every member of the campus community, from the sciences to the arts. MSI-CIEC also attempted to build a “scaffold” of geographic relevance by incorporating local faculty presenters, speakers from within the state, as well as speakers from further away, in addition to the national organizations involved in CI Days.

First on the agenda was a broad but brief overview of CI activities at the national and international levels in a variety of fields, which was presented by a national leader in CI. This was followed by specific presentations in the areas of education presented by a leader in computational science education who happens to be based in North Carolina, research using remote sensors on polar ice sheets as an example of campus science research, and multimedia art using resources at RENCI, a national HPC resource located in North Carolina. The national organizations from the CI Days VO then gave very brief overviews of the services provided by their organizations as resources available to the campus. The statewide regional network provider, NCREN, presented briefly, as did the UNC System CIO. Finally, the presentations were followed by breakout group discussions with a group for each of the campus schools, ending with reporting out to the entire larger group. Despite a very full day, faculty were very engaged in the group discussions considering and proposing campus needs, plans and next steps!

2.1.3 Outcomes from the breakout groups

Faculty groups from all four schools showed interest in the potential of CI, although at times had difficulty relating it to current research interests. As would be expected, some of the discussion seemed focused on more everyday aspects of campus technology. Most faculty seemed interested in general IT and are clearly focused on teaching and education with some interest in research. The new biotechnology/bioinformatics program and others seemed to have real CI potential. Most spoke to the potential for collaboration with others in their fields for both research and education. Most perceived a need for increased bandwidth. Some saw starting the collaborations as a primary focus for next steps. Overall, among those faculty remaining to participate in the breakout groups, there was a clear expression of interest in CI.

2.1.4 Workshop evaluation results

The evaluation survey provided further insight into the

perspectives of the participants. It should be noted that the evaluation survey was administered three weeks after the event due to delays outside of the control of the evaluator. This provided the faculty time to reflect and to review the material presented at their leisure. Unfortunately, it may have also led to a lower response rate of 34%, 31 out of the 90 who signed-in. Consequently, the results may not necessarily be representative of the attitudes of the attendees, but they do provide a good sense of the general response to the event, the sessions that were particularly useful, and expectations on the part of attendees regarding future implementations of CI at the campus. The respondents were from a wide range of academic disciplines, including Music, Education, Psychology, Biology, Chemistry, and Computer Science. Tenured faculty composed 74% of the respondents, 23% were non-tenure track, 10% were administrators and 3% were technical staff.

The results seemed to be consistent with the outcomes from the breakout groups. Respondents were asked about their prior experience with cyberinfrastructure and high performance computing. Most had “never explored using CI in research or teaching” or only “explored using CI in teaching or research but hadn’t implemented it yet” (35% respectively for each response), the two lowest responses on a scale from 1 to 5 with 5, “I am an expert at using CI in teaching or research,” being the highest. The average participant rating was 2.13. Interestingly, when asked “Now that you have attended CI Days, which statement best describes your position on the relevance of cyberinfrastructure to the work/teaching/research that *you* do,” 67% indicated “I can see a lot of relevance and am willing to work with others on finding resources or developing applications” the highest scale rating with “0” being “I cannot see how it will ever be relevant” (0%), “1” being “It doesn’t seem relevant now, but it might be in the future” (7%), and, “2” being “I can see some relevance, but don’t have the time/resources to pursue it” (27%). The average response was 2.6 out of three.

Although there could be a selection effect to those that choose to respond to the survey, the high response to the perceived relevance to CI did not appear to be influenced by the prior level of experience, mentioned above, nor the academic discipline of the respondent. There were no statistical correlations found between perceived CI relevance and CI expertise or academic discipline.

The respondents were also asked to indicate for each of the presentations whether they found it interesting, wanted to know more about the topic, or wanted to collaborate with others on the topic. The actual numbers of respondents marking each presentation varied as varying numbers were present at the different presentations. Some faculty would leave at the breaks and not return, or return later in the day. Each indicator was independent of the others and so a respondent could mark all three responses for each presentation if they felt that each of the statements was true for the given presentation. Only the highest percentage response for each presentation will be given. Fifty-five percent of respondents in attendance found the CI Overview “interesting.” The CI Education presentation

was the most interesting with 74% finding it interesting. Sixty-one percent found the CI Enabled Science presentation on remote sensing of ice sheets to be interesting. About equal numbers of people found the CI Art presentation to be interesting, 42%, or “wanted to know more,” 37%. Fifty-three percent found the brief introductions to the CI national organizations to be interesting; while 59% “wanted to know more” about the state network provider’s and the UNC system CIO’s presentations. Of those participants wanting to go as far as collaborating, the highest percentages and counts wanted to begin collaborating with others regarding CI in general or, on CI education, 23% and 32% (5 and 6), respectively. This is not necessarily a rating of the quality of the presentations, but could be more an indication of each topic’s relevance to the respondent’s personal work or interests.

The respondents were asked to make the same indications for the breakout discussion groups reported upon earlier. Of course, each respondent could only attend one of the four simultaneous breakout groups. About a third to one half of the respondents in each of the four groups found them interesting with a slightly higher percentage in each of the groups, 43% to 56%, wanting to know more; with one exception where only 17% wanted to know more. Finally, 50% and 56% of respondents in two of the groups wanted to collaborate while only 14% of each of the other two remaining groups so desired.

When asked “What do you see as the greatest obstacles to people in your department or college moving forward in exploring or developing the use of CI” most of the open ended responses indicated a lack of time and resources; as is generally true for most educational reforms.

When asked “how to make events like this more useful,” many --about a third -- indicated tailoring the sessions to the audience or breaking the audience into smaller interest groups and having separate talks. Some mentioned having more interactive, hands-on components. Some indicated needing more time without individual schedule conflicts drawing people away.

2.1.5 Campus IT assessment and report

The campus assessment was conducted the day before the event. It was conducted as described above with visits to campus facilities and discussions with campus technical faculty and staff, and with the CIO, Provost and briefly with the President. The campus assessment team consisted of five individuals with expertise in IT in higher education, including the principal architect of the regional network in California and the director of the regional network in North Carolina. The campus strategic plan, including the IT component, and other relevant documents were reviewed. The 33 page report, including the 10 page workshop evaluation report as an appendix, was considered to be very thorough, and the 16 recommendations helpful by the CIO and the Office of Sponsored Programs upon initial informal inquiry. Areas covered included the campus computing, video conferencing and networking facilities, individual school or department facilities and specialty labs, distance and online instruction, curriculum

development, teaching and learning with technology, staff and faculty training, among other areas. The CIO, OSP, the Provost and President will be interviewed by the evaluator as to their opinion of the report once they have all had a chance to review it.

The report is intended to help the campus continue the dialog and strategic planning to determine how to engage meaningfully in CI. Along these lines a funding program has been identified and a solicitation distributed for a proposal to help fund the campus’ next efforts.

2.2 CI Days @ New Mexico

Most, colleges or universities in the state of New Mexico are MSIs, either one of the three tribal colleges or an Hispanic-serving Institution (HSI). This provided an opportunity to pilot a regional CI Days to see if economy of scale-type efficiencies could be realized, particularly in facilitating within-state collaborations. Approximately 1.96 million people live in the state of New Mexico. There are three larger universities in the state, University of New Mexico (UNM) in Albuquerque, New Mexico State University (NMSU) in Las Cruces and New Mexico Institute of Mining and Technology (NMIMT or New Mexico Tech) in Socorro among about a total of 30 college or university campuses or branch campuses, about 21 of which are two-year/community colleges. Both UNM and NMSU are HSIs, and New Mexico Tech is close and may be an HSI this current year. The state recently made some significant investments in technology with the establishment of the New Mexico Computing Applications Center (NMACC), which recently acquired Encanto, an SGI Supercomputer ranked third on the Top 500 list in November 2007. This provided a local focal point for thinking about the relevance and applicability of CI.

There were also some interesting developments on the Navajo Nation at Navajo Technical College (NTC, or Navajo Tech) involving wireless connectivity and grid cluster computing --the DinéGrid, a component of the Internet to the Hogan project [11]. This project involves a collaboration with UNM, Internt2, National LambdaRail, TG, SDSC, and MSI-CIEC, but clearly driven and primarily implemented by NTC staff and students.

Under the leadership of Governor Bill Richardson, the collaborative technology activities seemed to have prepared the state for further exploration of the development and utilization of CI.

2.2.1 Planning of the event

The main campus involved in the planning was UNM which also worked closely with the New Mexico Council for Higher Education Computing/Communication Service (CHECS) with representatives from most of the higher education institutions (both main and branch campuses) in the state, primarily CIOs or other IT staff. The CIO of New Mexico Highlands University (NMHU) in Las Vegas, NM, a past president of CHECS, agreed to host the CI Days. It was reasoned that holding the event at a well regarded institution that is not one of the “big three” would encourage more campuses to attend.

Setting a date that was optimal for most campuses

proved challenging. It was hoped that the date could be set for a time sufficiently prior to the state legislature's convening to allow proposal development for state funding of specific initiatives identified during the event.

Since UNM was already well known to most of the organizations involved with the CI Days VO, the UNM representative joined the weekly conference calls and interacted directly with the group. For example, OSG and MSI-CIEC had independently made initial contacts with UNM. UNM has been involved with both groups, as well as most of the other CI Days VO membership.

The goal for the event, in addition to the first two goals of the ECSU CI Days, was "to bring together users and suppliers of cyberinfrastructure to find solutions for both national and local needs that support New Mexico."

It should be mentioned, that since this was a multi-institution event, no campus assessments were carried out, and no single campus recommendations developed. Also, the results reported here are very preliminary pending the analysis of the evaluation survey from the 30 participants..

2.2.2 Agenda

The agenda was initially developed by the New Mexico representative, based upon internal discussions and discussions with the CI Days team. As preparations continued, UNM and MSI-CIEC worked closely on the development of the agenda. With UNM's participation on the weekly calls, they received suggestions from the overall group. An effort was made to include a good number of presenters from New Mexico campuses, in addition to CI Days VO representatives and other national leaders. The agenda was scheduled over two days, interspersed with ample opportunities for discussion. In addition to the moderator, UNM brought in a professional facilitator to lead the discussions, particular the planning sessions.

The agenda began with a session covering CI for education. There followed brief sessions reviewing CI in New Mexico, a broad overview of CI activities across the country and internationally, a simplified technical presentation about CI with a brief mention of the national organizations of the CI Days VO, and a brief introduction to science gateways as a user interface to some CI resources. These overview sessions were followed by sessions with more detailed information on instruments and sensors, digital assets repositories and information assurance and security in grids, all by local New Mexico presenters, e.g, the remote sensors used by the Long Term Ecological Research (LTER) units in New Mexico.

The second day began with a presentation by a local artist regarding her work on visualization of avant-garde music. The music and visualization are intended to be produced live in domed theaters across the county with instruments distributed over the net performing as a single entity. Representatives from some of the organizations of the CI Days VO briefly introduced each of their respective organizations as national resources available to any campus. These were followed by presentations about some local activities in the state, such as the NMCAC and the DinéGrid mentioned above, an innovation centered design approach to foster scientific collaboration, and brief reports

from NMSU, New Mexico Tech, and UNM.

The event culminated in strategic planning small group work in which participants were to 1) identify goals for CI at their home institutions or for New Mexico, 2) identify gaps between their goals and their current situation, especially obstacles to reaching their goals, 3) generate a list of the top assets needed to bridge the gaps, and 4) develop brief action plans to address the most critical perceived gap.

2.2.3 Selected outcomes from the small groups

The small working groups generated the following possible goals for CI in New Mexico (NM) among others:

- Create Information Technology Extension Services
- Explore cross-campus research opportunities
- Increase partnering opportunities for small schools
- Increase CI marketing efforts within universities and regionally
- Virtualization of New Mexican assets (in-state collections and virtual repatriation of out-of-state collections) with a gateway for access.
- Use CI for research, education, preservation of cultural information, and to enhance communities to allow for the persistence of value of place among New Mexicans.
- Connectivity: increase resources to realize the promise of what's there (ie., Lambda Rail) and create what's missing (first mile/last mile in NM)
- Improved cooperation between NM government and local telecoms.
- Make NM the model for cross-disciplinary collaboration with translational services in support of education, local communities, and research (with emphasis on problem-based research).
- Focus on people necessary for CI success: integrate CI into all levels of education to create necessary expertise; consider CI personnel needs in planning and funding for state-wide CI initiatives.
- Use CI and technology to address issues of poverty, especially among tribal communities.
- Blend research collaboration and teaching tools to make STEM more exciting for K-20 students.
- Increase the technical knowledge (especially re: wireless communication) and understanding of the deployment of technology to aid tribal communities in reaching their goals.

The groups identified the following possible gaps or obstacles, among others:

- Marketing. People don't know what's going on in NM
- Peoples' attitudes. The tendency to join rather than initiate efforts/projects; a seeming lack of urgency
- Broadband connectivity to specific sites (LTER, first/last mile); access to assets; and related communication issues regarding.
- IT people are overworked/overtasked.
- Lack of meaningful collaboration among researchers & faculty; between research & education
- Lack of collaboration between state government and CI expert community.
- Gap between research and practice

- Some legislators, members of the press, and others who need CI/IT education to be effective representatives, partners, and education advocates.
- Regulatory and legislative jurisdictional issues work against collaboration, especially in tribal issues.
- Communication between technologists and user communities
- Gap between large and small educational organizations.

The key assets identified by the groups include the following:

- Support of Governor Richardson and NM US Senators
- People (good ones)
- Supercomputer
- State and national collaborations (labs & universities)
- Existing grids, HPC
- Lambda rail
- Supercomputer, high performance computing centers
- Cultural institutions: museums, libraries, archives, tribal and other cultural and science centers
- Expertise/information in communities and museums

The four groups generated brief action plans summarized as follows:

- Create key collaborative project that demonstrates the value of CI (solve a NM problem: maybe water?)
- Use assets to raise awareness, educate and market, especially regarding the overriding issues of need for connectivity and a recurring funding model
- Develop examples of success stories and prototypes of the kinds of NM resources available through CI
- Use "Prosperity Game" strategic planning methodology bringing together key sometimes opposing groups to develop workable strategic plans to build NM CI to address key state problems

3 CONCLUSIONS AND LESSONS LEARNED

The results from the small break-out groups at both events and the evaluation of the first, demonstrate that CI Days can be a useful method for engaging an MSI campus, or to a more limited degree a set of MSI campuses, in CI; reinforcing current or generating new CI activity. There are some lessons to be learned which we will address below, and it is still too early in the follow-up activities to say if this interest will be manifested more concretely. The desires for collaboration expressed at both events, and the more concrete plans sketched out at the NM event appear promising in their potential for moving forward.

For TeraGrid the increased interest in CI and HPC, particularly in New Mexico and in some departments at ECSU, may translate into additional users or increased use by some currently with DAC accounts. There are about 27 TeraGrid users from 11 MSIs, including UNM[9]. This and other activities are working to increase these numbers. The experience of these users in acquiring accounts, the ease of using the TeraGrid, and most important, the significance to the user of the science or scholarship done will determine if the user persists in using HPC and how likely she or he will recruit other MSI colleagues.

There is an area of particular importance we wish to focus on before turning to lessons learned.

3.1 CI Education

Education was identified as a major interest at both CI Day events. This is to be expected at most MSI centered events, since currently MSI's have a major teaching emphasis and the impact of CI on teaching is the aspect of CI that the majority of faculty are likely to appreciate. Further, many institutions are concerned about their pipeline and so the possibility of using CI to motivate middle and high school students is particularly interesting. We found it very difficult to satisfy this interest since current CI activities do not include a major educational emphasis.. There are several dimensions to CI and education:

- a) Training users or potential users of TeraGrid or other high end Grids such as the Open Science Grid, BIRN or GEON. There are several summer schools focusing on Grid technology training
- b) K-12, Undergraduate or Graduate Grid web resources. There are of course a large number of these resources, including the National Science Digital Library, the collections of curricula material such as those at MIT or even CiteSeer or Google Scholar. For example China with the RealCourse project from Peking University is particularly advanced in the curricula area.
- c) Involvement of students at various levels with research. REU activities are very popular and successful with undergraduates.
- d) Support for students and faculty to attend conferences such as SC 'XY and at which research projects can be presented. ADMI, SC 'XY, and MSI-CIEC have a strong emphasis on conference opportunities as a strategy for engaging faculty and students. While attending conferences has educational value and is an important adjunct to REU's, they do not directly support the teaching mission of MSI's.

The above four areas are reasonably well appreciated; however, they are only a small part of what is needed. Other education and CI areas include.

- e) Teaching Cyberinfrastructure at an undergraduate, graduate or even K-12 level. There are significant activities in computational science as illustrated by the work of Shodor foundation. The Open Grid Forum has a working group defining "Certificates of Grid expertise" building on the European Union ICEAGE activity led by Edinburgh University. This has a training focus and there is no clear consensus on how cyberinfrastructure or e-Science should be taught at universities. It is perhaps most often included in network or distributed system courses. This contrasts with computational science where several conferences, articles and projects have examined curriculum in detail.
- f) Use of Web 2.0 technology like Second Life, Wiki's, Blogs, Drupal, Flickr, YouTube in education (and research).

- g) Use of collaboration technology like Polycom, WebEx and Access Grid to support real-time teaching
- h) Use of Course management systems including the open source Sakai and commercial WebCT (now part of Blackboard suite)
- i) Science Gateways with an emphasis on education. Here the NanoHub portal is a notable example but there is much more to be done both in education gateways for other domains and in defining best practices for needed technologies and approaches.
- j) K-12, undergraduate or graduate grid resources going beyond traditional web sites and exploiting cyberinfrastructure with a focus on student involvement. QuarkNet is a well known example and there were several other projects such as the Biology Work Bench and ChickScope which do not appear to be as active as they had been.

There are interesting examples in the areas e) through j) but no clear best practice that CI Days can bring to MSI's. This contrasts with the research use of cyberinfrastructure where there are disagreements in detail (e.g. should one use SOAP, WSRF or REST?) but broad agreement in principles and several good examples in many domains. We would recommend NSF funded activities aiming broadly at education and cyberinfrastructure and specifically at establishing best practice for dissemination to a broad community.

3.2 Lessons learned

Overall, both events could be considered successful as described above from the evaluation of the ECSU CI Days and more informally from the impressions and discussions with participants at New Mexico during the event and in the weeks since. Between the two, the single campus event at ECSU was clearly better able to attract more faculty as opposed to IT staff and administrators. This may be a shortcoming of a regional event or may indicate that much more and longer term effort be put into recruiting faculty for the regional events. Having the ECSU event part of a known annual faculty activity may have been part of its high attendance. It seems reasonable to suggest that the regional event should be incorporated into an established regional event well attended by faculty, if such an event exists. Something similar was considered for NM, but the concern was that if the CI Days became an add-on before or after the event, the total event would be too long and unattractive. Having an added stimulus or enticement, or more intense marketing of the event, may be necessary for both single-campus and regional CI Days; at least until CI is better known and its importance sufficiently recognized to serve as an attractor without additional incentives. The strong success of these two cases suggests that this may not be too far away.

One of the key lessons learned is that each event is unique to some degree and must be customized to fit the interests and priorities of the campus or group of campuses. This is difficult to accomplish until one knows something about the interests of those who will be attending. However, most people are not willing to commit to a new event regarding a relatively new area, until they

know what is being presented. Perhaps, with some additional incentives, a registration interest survey, and a sufficiently advanced cut-off registration date, some specific audience customization may be possible.

One clear lesson from the New Mexico event was the added-value of having a professional facilitator. The expectations and discussions were much clearer and directed. The outcomes were more concrete and focused.

Finally, the need for follow through is very important to making real advancements. The event, even with a campus assessment and thorough assessment report, cannot be the end to the activity. The follow-up to both of these events has been very difficult and time-consuming. One can become concerned about the scalability of CI Days given the need for good follow through to actually have something concrete come from the event. The follow through must be planned as an essential part of the event, and even though not all outcomes can be pre-determined, some sense of what the follow through will be should be discussed and considered prior to the event. It can be modified appropriately based upon the specific outcomes of the event

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