Workshop on Educational Opportunities Associated with a Green High Performance Computing Facility

April 15, 2010
Holyoke Community College
Holyoke, MA

citi.mass.edu/ghpc

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For additional details on the workshop, including speaker presentations and appendices, go to the conference website: citi.mass.edu/ghpc

CITI
Commonwealth Information Technology Initiative

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CITI is a public/private partnership to promote IT education, through strategic investments, that prepares graduates to participate, lead and innovate in the knowledge-based economy of Massachusetts. Launched in 2000, CITI brings together K–12, community colleges, public universities and industry to promote IT education across the curriculum and respond to technology workforce needs.

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Executive Summary

More than 70 stakeholders gathered in April 2010 in Holyoke, Mass., to discuss how and why a new green high-performance computing center (GHPCC) might expand its mission of providing computational power for university researchers to encompass education and outreach needs of the Holyoke community and serve as an anchor for the Holyoke Innovation District. It was the first large meeting where higher education and industry partners talked extensively with public school educators, community-based organizations, and members of the public and private sectors.

Keynote speaker Francine Berman, drawing on her experiences with two similar facilities, asked: What role does the GHPCC plan to play, why does it matter, and what are some of the choices that must be made?

Panelists addressed: What have other facilities done related to education and outreach, and how can industry also be involved in these efforts?

Small groups discussed: What are the needs, possibilities, and visions for making this facility more than a locked down "server farm" located in Holyoke and have the GHPCC be a catalyst for economic change? Among the many ideas voiced, five were loudest:

1. Plan for education, outreach and training (EOT) activities from the outset, not as an afterthought.
2. Involve the community, in the broadest sense, in all phases of the project.
3. Appoint a community liaison as soon as possible.
4. Plan for dedicated space and financial resources for EOT activities in the facility.
5. Develop EOT programs that will prepare Holyoke residents to participate in and benefit from the Center, the Innovation District, and associated economic opportunities.

The following report details these and other recommendations from the day that urge the work of the Holyoke GHPCC project forward.

Overview of the Holyoke GHPCC Workshop

Rick Adrion, Parviz Kermani, James Kurose

On April 15, 2010, the Commonwealth Information Technology Initiative (CITI) sponsored a workshop on Educational, Outreach and Economic Opportunities with the Holyoke Green High Performance Computing Center (GHPCC) at the Kittredge Center, Holyoke Community College. The GHPCC partners (Boston University, Harvard University, MIT, Northeastern University, University of Massachusetts, Cisco, EMC Corporation and the Commonwealth of Massachusetts) have committed to insuring that the GHPCC plays a crucial role in creating educational and economic opportunities for the City of Holyoke. This workshop was another step in the process of engaging the stakeholders in identifying the opportunities and challenges around the GHPCC. The website for the workshop is www-net.cs.umass.edu/ghpcc_workshop_april_2010, where additional information, including the agenda and speaker materials, can be obtained.

Planning for the GHPCC began in June 2009 when Massachusetts Governor Deval Patrick, MIT President Susan Hockfield, University of Massachusetts President Jack Wilson, Boston University President Robert Brown, Massachusetts Housing and Economic Development Secretary Greg Bialecki, Cisco CEO John Chambers, EMC CEO Joseph Tucci and Holyoke Mayor Michael Sullivan signed a Memorandum of Understanding announcing the desire to locate a state-of-the-art Green High Performance Computing Center in Holyoke, Massachusetts. Since that time, new partners have joined, the state and university partners have committed to funding the center, the state has organized an Innovation District planning group, and two finalist sites in downtown Holyoke have been identified.

The timing of the GHPCC workshop was opportune, given that planning on all aspects of the GHPCC (including education and outreach) has been moving forward since the Governor's June 2009 announcement. Representatives from Boston University, Cisco Systems, EMC Corporation, Holyoke Community College, Massachusetts Institute of Technology, Northeastern University, Springfield Technical Community College and the University of Massachusetts, led by UMass Amherst Computer Science professors Rick Adrion, Parviz Kermani and James Kurose, organized the workshop. Holyoke Community College and HCC Dean Susan Mackler and HCC Vice President Jeffrey Hayden hosted the event. CITI Project Manager Renee Fall and Communications Assistant Hillary Rathbun handled the logistics.

Rick Adrion

The workshop brought together stakeholders in the GHPCC to (1) learn about educational and outreach activities at other HPC centers in the US; (2) brainstorm about specific educational and outreach activities and programs that could take place at, leverage, or be enabled by the GHPCC; and (3) identify individuals and institutions with the vision, energy and interest to begin moving forward on such activities as well as funding sources that might be approached individually and collaboratively for such programs. More than 70 people from higher education, public schools, community-based organizations, state, local and federal government, industry and the private sector attended the workshop (see attendee list in the appendices). Dr. Francine Berman, Vice President for Research at RPI and former San Diego Supercomputing Center Director, gave an outstanding keynote address on the state of high-performance computing, the choices faced in identifying an appropriate role for the GHPCC, and how such a center might impact Holyoke, the state and the nation. Panelists Patrick Dreher (RENCI), Roscoe Giles (BU), and Ann Redelfs (Redelfs LLC) shared their experiences in managing HPC centers. Kim Yohannan (EMC) offered her perspective on how the GHPCC can support education and outreach. Susan Mackler (HCC) and Gordon Snyder (STCC) provided insight on the role of community colleges in the GHPCC.

Following the keynote address and the panel, attendees divided into three groups, one focused on four year colleges and universities, one on community colleges and one on K–12 and community groups. Each group addressed the following questions

and issues: how to meet local and regional needs; how to support activities for community organizations and K–12; how to leverage other activities being undertaken by the partner institutions; how to interact with state-wide STEM efforts; how to identify new programs or other academic opportunities such as transfer/articulation agreements, new specialization programs and curriculum materials; and what role can industry play.

Key issues identified by K–12, community and economic development organizations included the following: (i) providing access in the neighborhood in the Canal District; (ii) providing space and staff for outreach efforts and identifying a community liaison immediately; (iii) involving the city, its schools, community-based organizations and residents directly in the planning, design and execution of programs; (iv) leveraging and coordinating closely with existing outreach programs and efforts in Holyoke and in the region; (v) offering professional development for teachers; and (vi) involving parents and families in the education and outreach programs. The community college group discussed several valuable activities that could be associated with the GHPCC: (i) offering tours; (ii) providing professional development opportunities for community college teachers; (iii) providing "Space Camp" like experiences, student mentoring and boot camps for high school and community college students; (iv) establishing an educational collaborative; (v) identifying currently available courses/curriculum/content/programs; (vi) providing student and faculty access to new/recycled equipment/technology; and (vii) identifying subject matter expertise, e.g., storage, networking including NAS and SAN, virtualization, elastic computing, data, etc. The university group identified (i) a need and the opportunity for the GHPCC to be a source for an on-demand, virtual resource in K–12 education and in community colleges; (ii) the need to align with MCAS curriculum concerns; (iii) the opportunity to provide a locus for summer training for science teachers in using resources in classrooms; and (iv) the need to connect community colleges and K–12 schools to university research.

Workshop panelists Ann Redelfs, Roscoe Giles and Patrick Dreher discussed education and outreach activities at other HPC centers.

Attendees and observers felt that the workshop was a great success and an important step toward insuring that the GHPCC has strong education, outreach and training programs and facilities built into the Center's plans from the beginning. This workshop was followed by another CITI-sponsored activity, the Green High Performance Computing Educators' Conference held May 25, 2010 at HCC. (More information about this conference is available here: www.citi.mass.edu/ghpc.) A direct outcome of the workshop was the establishment of the C4 Project—Canals & Computers, Community & Collaboration—a collaboration among the GHPCC partners; Five Colleges, Inc. Community Based Learning and Public School Partnership programs; the "5+2 colleges," (Amherst College, Hampshire College, Holyoke Community College, Mount Holyoke College, Smith College, Springfield Technical Community College and the University of Massachusetts); the Commonwealth Alliance for IT Education (CAITE); Holyoke Public Schools; Girls Inc.; Boys & Girls Club; FIRST Robotics; Nuestras Raices; Enlace de Familia; Hamden Regional Employment Board; and Hamden-Hampshire TechPrep. The C4 Project would open a facility at the Picknelly Center and move to the GHPCC when it opens.

In the sections that follow, this report provides details on the issues, opportunities and challenges identified by the GHPCC workshop.

Keynote: Computational Cyberinfrastructure in Research and Education

Dr. Francine Berman, Vice President for Research, Rensselaer Polytechnic Institute

Dr. Berman began her address with the idea there are many opportunities, challenges and decisions involved in developing the computational cyberinfrastructure needed to address contemporary issues in science and technology research, education and practice. This cyberinfrastructure is critical because of its importance in addressing societal challenges and answering key questions such as these: What is the potential impact of global warming? How will natural disasters affect urban centers? Can we accurately predict market outcomes? What plants work best for biofuels? What therapies can be used to cure or control cancer?

On the federal level, there has been an increased recognition of the importance of science and technology in addressing societal challenges. Moreover, the challenges of the 21st century require 21st century tools, which include sensors, visualization, models, computation and data. Digital data is needed to create new therapies to treat diseases such as cancer. Computation can drive efficient manufacturing workflows for biofuels. Mathematical models help to predict market outcomes. In our fight against global warming, sensor data is used to develop a clearer comprehension of what is happening. Visualization can be helpful in better understanding the behavior of natural disasters. All these technologies in aggregate create an information-based cyberinfrastructure, a necessity for our information age and knowledge economy.

Berman proceeded to give the specific example of how cyberinfrastructure has enabled the science of earthquake prediction. She started with the question, "What is the impact of a large-scale earthquake on the southern San Andreas Fault?" The answer was as follows. A computer model used to predict seismic activity, developed by the Southern California Earthquake Center, was parameterized by sensor data.

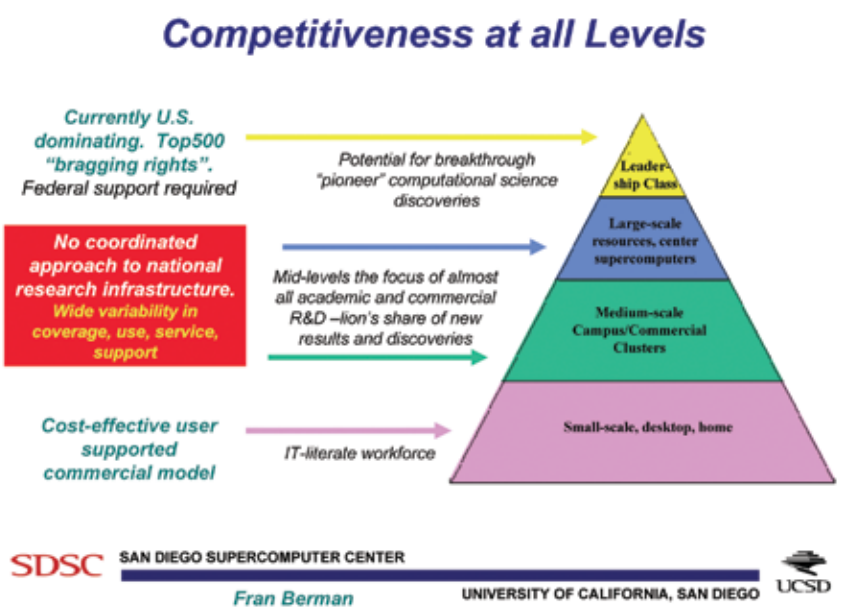
Dr. Francine Berman

A high-resolution model of the earthquake's behavior was then run on a supercomputer and large-scale data storage environment. The results from this predicted the behavior of the earthquake. Additional computation was needed to produce scientific visualizations of seismic predictions. The end result was that the new knowledge —made possible by the cyberinfrastructure—was able to drive the development of more earthquake-resistant buildings, better disaster response and targeted retrofitting. The faster and more powerful the computers, the higher resolution the models the researchers can run, and the more accurate the predictions will be. For example, higher resolution models enable building by building predictions instead of neighborhood by neighborhood predictions.

The next section of Dr. Berman's talk was entitled "The Computational Cyberinfrastructure Continuum." Her overall point was that the cyberinfrastructure environments at supercomputing centers vary widely, and the way to determine what works best for a specific constituency depends on a number of different parameters. Dr. Berman showed a slide of the Branscomb Pyramid, a way of looking at high performance computing that was developed in the early 1990s by Louis Branscomb. The Branscomb Pyramid is a graphic way of displaying the size of the user base in correlation to the power of the computer. At the bottom of the pyramid are the least expensive and least powerful computers that most people have. At the top of the pyramid are huge and powerful computers that may have relatively few users but are capable of executing programs that require huge capacity. Berman then looked at how the Branscomb pyramid applies to today's computing world. At the bottom of the pyramid are small scale devices and home computers. The middle levels include small to medium scale campus centers, commercial clusters and data centers. The top of the pyramid includes leadership class supercomputers.

Berman pointed out that it is not necessary to have the most powerful machines to make breakthroughs—breakthroughs can happen at any level of the pyramid, including the lowest. It just depends on the needs of the discipline. Berman went on to discuss the issue of "setting the bar" and deciding what kinds of computer resources an institution might really need. She differentiated between local resources and remote resources (resources elsewhere including national supercomputers and commercial clouds) and how an institution can utilize them. Where you draw the bar has consequences in a number of different ways including cost, accessibility, cyber- and physical infrastructure, workforce, user base, performance and reliability, among others. In terms of the Holyoke center, the question is how powerful a computer or cluster of computers will suit the needs of the user community? There are several possible models, all of which are viable, and the current analysis will help determine what level and configuration is best.

The next section of Berman's talk was entitled "A Tale of Two Cyberinfrastructures," in which she discussed the models of the San Diego Supercomputing Center



(SDSC), where Berman served as the director from 2001 to 2009, and Rensselaer Polytechnic Institute (RPI), where she is currently.

The San Diego Supercomputing Center was "born" as a National Science Foundation (NSF) national supercomputer center in 1986. SDSC's initial large scale computers were at the top of the Branscomb pyramid. By the time the national supercomputer centers program ended some years later, SDSC's ranking had dropped, although the recent purchase of a new machine means that it is due to rise again. Berman pointed out that any supercomputer will move up and down in the national rankings in a "sawtooth" fashion. When the machine is new and relatively powerful compared to other machines, it is high in the rankings. When a machine is older and other more powerful machines have moved higher in the rankings, it is lower. "Bragging rights," which come from providing one of the most powerful machines, only last for so long. SDSC competed for national supercomputer grants a number of times, some of which they won and some of which they didn't. During that time, they decided to buy a small-scale data-intensive computer cluster that worked well for their users. SDSC's most recent successful HPC grant will result in new system called "Gordon," which, when complete, should rate among the top 30 or so supercomputers in the world. In addition, SDSC has built a new green building extension in which to house Gordon. This includes LEED silver equivalent; a ventilation system that allows the building to "breathe"; sensors to measure energy consumption and thermal effectiveness; and various other green aspects that make the building more energy efficient.

Rensselaer Polytechnic Institute's supercomputer center was "born" under different circumstances. The Computational Center for Nanotechnology Innovation (CCNI) developed as part of an integrated strategic plan for Rensselaer, which includes, in addition to CCNI, core facilities including a micro- and nano-fabrication clean room; an experimental media and performing arts center; and a biotech center. The plan was used to drive rapid change that included the campus network, campus researchers, educational curricula, centers, multi-disciplinary programs and partnerships.

RPI's CCNI was a collaboration between the institution, the vendor (IBM, whose computer Blue Gene is in the Center) and the state of New York (NYSTAR). This center houses the 5th largest academic supercomputer in the US and supports a broad computational science portfolio including nanoelectronics modeling and simulation; modeling of material structure and behavior; modeling of complex flows; computational biology; biomechanical system modeling; multiscale methods; and parallel simulation technologies. Fifty percent of its 500 users are from RPI.

Berman's next section was called "Setting the Bar: Where is the greatest return on investment." Her answer was this: it depends on what is important to that particular center. Bragging Rights? Number of users? Power-efficiency? It's important to determine what kinds of programs the center wants to run. Ideally, any center should satisfy real local computational needs, serve as a ramp into what is available remotely, provide a unique environment for users and give visibility to the institution.

One key question is how much power will be required to run the computers, as the cost of power often drives the cyberinfrastructure options. Berman noted that in the 1980s, the question was "How much speed?" In the 1990s, it was "How much data?" The question now is "How much power?" A list called the "Green 500" indicates the most efficient machines.

It's also important not to forget the data. Digital data from computer simulations and experiments may be substantial, and archival storage is needed to preserve valuable digital data for months, years, decades and more. Data costs may include replication to minimize risk of data loss; backups, updates and metadata; regular storage refresh and data migration; data services such as mining and analysis; documentation and reporting; and labor.

The final section of Berman's talk was entitled "Making the most of computational cyberinfrastructure." Computational resources are most useful when coupled with other services and complementary components. These include adequate network bandwidth to the desktop; visualization; scientific instrumentation; software and toolkits; data and archival storage; and other services.

She noted that engineering counts. Effective cyberinfrastructure starts with a focus on the user. It's engineered for specific, well-defined outcomes; pays attention to the "last mile" in terms of robustness, usability, ease-of-use, connectivity to labs and desktops; and offers sufficient documentation and help. At the same time, effective cyberinfrastructure fits within a larger context. It integrates well with other components; is attentive to relevant legal

A Girls Inc. Holyoke team learned to build and program robots at Girls Connect FIRST Robotics event at UMass Amherst. Similar activities were suggested for the Holyoke GHPCC.

and policy issues (such as data privacy); has a long term strategy which incorporates planned evolution; and is supported by a viable and cost-effective business model.

Users are the key to getting the most out of the facility. The key is to grow the user base—the limiting factor should not be the technology. It's important to develop more sophisticated users, and in order to develop the user base, it's crucial to make sure that there are low barriers to access. Ways this can happen include a help desk and front line support; usable web-based tools that serve as "gateway" environments; "sandbox" environments; user-friendly scheduling; and useful services for the users. In addition, user sophistication can be developed through resource-limited applications such as sustained personal attention and short project-focused courses and summer institutes.

Other on-ramps include education—mainstream courses that incorporate computational assignments; external partnerships—allocation of facility resources to industry, state and other academic users; and "fun stuff" such as competitions and student internships.

Berman also pointed out that it's important to define metrics of success—what does it mean for a computational cyberinfrastructure to be successful? How can cyberinfrastructure be developed to be self-sustaining? Does it create new jobs or contribute to the local economy? Does it get a good number on the top 500 list? Is the user base of a particular size or character?

She stressed that it's important not to forget about improving the cyberinfrastructure itself, as current cyberinfrastructure drives the development of next-generation cyberinfrastructure. Both university and private sector research and development are critical to advance the state of the art. She also noted that it's important to integrate cyber infrastructure into the curriculum.

A well-rounded curriculum to create next-generation cyberinfrastructure would include these features: solid grounding in computer science, mathematics and engineering; understanding of statistics and probability; awareness of impact of policy on cyber-environments (e.g. privacy, accounting, security); knowledge of economics and social science; and awareness of IT trends that impact design and development (social networks, cloud computing, collaborative technologies, etc.)

Her final point was that the goal is synergy between research and development and broad-use cyberinfrastructure. Cyberinfrastructure R & D is engineered to become useful and usable to cyberinfrastructure, which supports solutions for new discoveries and innovation. This then motivates new cyberinfrastructure R & D, and the cycle continues.

Holyoke, Massachusetts.

Panel Discussion

Chair: Rick Adrion, Professor of Computer Science, University of Massachusetts

Panelists:

- Patrick Dreher, Chief Domain Scientist for Cloud Computing, RENCI, & Adjunct Professor of Computer Science at North Carolina State University
- Roscoe Giles, Deputy Director, Center for Computational Science & Professor of Computer and Electrical Engineering, Boston University
- Susan Mackler, Dean, Business Division, Holyoke Community College
- Ann Redelfs, Independent Consultant to academia and industry, Redelfs LLC
- Gordon Snyder, Executive Director, ICT Center at Springfield Technical Community College
- Kim Yohannan, Manager, Educational Services, EMC Corporation

This panel identified and discussed educational and outreach activities that could be associated with the GHPCC. The questions addressed included the following:

- What are best practices and recipes for success for education and outreach that can be identified from HPC or related centers around the US? What works, and why?
- What are the workforce development opportunities associated with the confluence of data centers, energy-efficient computing, and HPC applications?
- What are the particular opportunities enabled by the close proximity of several community colleges, many four-year colleges, and the University of Massachusetts? How can partners from the eastern part of the state be engaged most fruitfully in education and outreach?
- What educational and outreach activities are enabled by the unique partnership among the Commonwealth, leading research universities and industry?

Patrick Dreher:

Patrick Dreher is the Chief Domain Scientist for Cloud Computing at Renaissance Computing Institute (RENCI) at the University of North Carolina, Chapel Hill. RENCI was launched in 2004 as a collaborative institute involving the University of North Carolina at Chapel Hill, Duke University and North Carolina State University and the State of North Carolina. Since then, RENCI has expanded their collaborations and their virtual organization to include East Carolina University, UNC Asheville, UNC Charlotte and UNC's Coastal Studies Institute. RENCI's mission is to develop and deploy advanced technologies in order to enable both research discoveries and practical innovations.

Dreher offered the RENCI idea of partnering with multiple universities and the State of North Carolina as a potential model for the Holyoke GHPCC. RENCI is a unique institution but also similar in structure to the Holyoke Center in that a number of universities have banded together for a common purpose. In addition, the state of North Carolina is an active participant in RENCI, just as Massachusetts is taking an active part in the Holyoke Center. Dreher's presentation demonstrated examples of RENCI's participation within the community, including examples of projects for the state of North Carolina and collaborations with educational institutions including K–12 and university level activities.

Dreher noted that the Holyoke GHPCC will need to be in service to the state of Massachusetts. He encouraged the Center to reach out to the state to do projects that no one else can do. For example, at the request of the state of North Carolina, RENCI looked at hurricanes which affect the state because of its geography. In undertaking this project, RENCI assembled a multi-disciplinary team of experts from several academic disciplines and used their supercomputers to model how hurricanes impacted the coastal areas of the state. As a result of this project, the state was able to update their flood plain maps and develop better emergency planning and management.

RENCI's goal is to develop a coherent cyberinfrastructure within the state of North Carolina and beyond. Dreher pointed out that RENCI seeks to use its cyberinfrastructure expertise to partner with collaborators rather than competing with academic disciplines within each university's system for grant funding. RENCI's expertise in building a coherent cyberinfrastructure provides it with a unique niche that complements academic departments and domains. The intellectual strength within academic departments along with the cyberinfrastructure that RENCI offers together provide a powerful combination of skills to advance knowledge and research without having each academic department duplicate the computational cyberinfrastructure needed to move such programs forward. In this way, RENCI delivers value added to collaborations through partnering with many universities and programs. Dreher believes that the important computational components necessary for research in the 21st century need to have a mechanism for delivering a coherent cyberinfrastructure to multiple institutions and organizations.

Roscoe Giles:

Roscoe Giles is Deputy Director of the Center for Computational Science and a Professor of Computer and Electrical Engineering at Boston University. He works in computational science education and has been active in the area of Education, Outreach and Training as a member of the NCSA Alliance Executive Committee and as a team leader for the Education, Outreach, and Training Partnership for Advanced Computational Infrastructure (EOT-PACI). Giles has also been actively involved in the Empowering Leadership Alliance.

Giles began by asking the question, "How can the Holyoke GHPCC become something that goes beyond the role of holding computers?" He pointed out that

the Holyoke Center is still in its early stages, and many resources and experiences from other centers are available for its partners to draw on as they consider this question.

Giles would like to see the Holyoke Center serve as a means of extending understanding and empowering students, especially K–12 students, to broaden their horizons. He noted that there is an artificial gap created between people who study science and math and those who don't. In his view, computing can help bridge that gap, as it can bring ideas to life and give people another way of understanding them. If there is only one artificially narrow pathway through which to learn science, then people may not choose to study it if they lack a specific aptitude for it. But computing can offer a different pathway into science and can demonstrate an alternative way of looking at and learning science. Giles would like to see computing bring people into science who might not be interested otherwise. He further suggested that elements of computational science such as modeling, simulation and data analysis should be an important part of the science and math curriculum at all levels, including in K–12 schools. This could serve as another way of empowering students early on and giving them a different kind of confidence and mastery in the areas of math and science.

One indicator of success with integrating K–12 education into the Holyoke GHPCC might be that students and teachers are actually using the high performance computing equipment, but Giles stressed that this is not the only option and that successful integration can happen on many levels. Students and teachers might build a model that uses only a fraction of the power that scientists use in their modeling—thousands of equations per minute rather than millions of equations per minute, for example—but this exercise still extends their reasoning and understanding. By performing on a smaller scale what scientists are performing on a larger scale, students and teachers would still be making good use of what the Center has to offer.

Giles went on to discuss the importance of supporting teachers in the most effective way possible. He suggested that including more computing and modeling at colleges of education might be one way of doing this. Educating those who will educate the next generation of teachers might have more impact than working with students directly. Those in the field should continue to consider what kind of education and support for teachers will provide the greatest impact.

Giles noted that his projects over the years have involved many scientists and educators, and he found that it was just as important to credit what was going on behind the scenes as the outcomes. Getting different groups to talk to each other and to continue to interact is an important part of the process that will hopefully lead to a successful outcome. Investing in this "glue" from the beginning is crucial. Usually only concrete activities are rewarded, but Giles emphasized the importance of what happens behind the scenes as well.

Ann Redelfs:

Ann Redelfs is a independent consultant to academia and industry. She has held positions at the Cornell Theory Center, the Center for Research on Parallel Computation at Rice University and at the San Diego Supercomputing Center, where she was the director of external relations and education/outreach programs.

Redelfs began by noting that in the early days of supercomputing, supercomputing centers were no more than "machine shops." Very little money was set aside for education, and very little attention was paid to it. This began to change when the NSF began to include "broadening participation" as one of the criteria needed for a proposal even to be considered for funding. The "broadening participation" criteria meant that groups of people needed to be included beyond the people traditionally involved in the supercomputing industry: women, minorities, people with disabilities, people in rural areas, K–12 schools, etc. While intellectual merit remained a factor, the new merit review criteria changed the way people thought about their proposals because without a "broadening participation" element built into it, their proposal wouldn't be considered. Education, Outreach and Training (EOT) became much more common at supercomputing centers, and the percentage of the annual budget at some supercomputing centers that goes to outreach and education is significantly larger now.

From the beginning, Redelfs recommends that education be integral to Holyoke's plans. Relationships in education need to be long term. Initially, the National Science Foundation was interested in the numbers of "touches" each center made, the quantity of contacts with the public. But people began to realize that it's not enough for students to take a tour and get a sticker and have that be the end of the contact. It's not enough to hold a single workshop for teachers each year. It's important to start involving teachers from the very beginning and to look at those relationships with local educators and educational organizations in a long-term way. Education needs to be part of what the Holyoke GHPCC is.

At the beginning, the NSF was mostly concerned about numbers, but numbers don't change people's lives. Redelfs gave the example of the San Diego Supercomputing Center, which developed a relationship with a Girl Scout troop. It began with the girls taking apart a computer and putting it back together again and ended up being a relationship between the center and the girls that began in 6th grade and lasted through high school. Many of these girls ended up going to college, which is not something that would have happened otherwise. This is just one way that long-term relationships make a difference. She noted that every supercomputing center has an example of involving people in the community and making a difference.

Redelfs feels strongly that in order for a supercomputing center to be robust, it needs to have community involvement and that the center needs to involve community and educational groups early on rather than after it's started. If the center thinks it's going to involve people at the end, then it should involve them at the beginning.

When things aren't done well, it's often because teachers and/or the community aren't included at the beginning. Redelfs gave an example of attempting to "help" Native American communities

by archiving artifacts . . . only this wasn't allowed by the tribe.

In another instance, several faculty members wanted to create curriculum development/ educational software but had no plans to consult with K–12 teachers before the proposal was due. They saw no need for this and thought they could just tell them about it once their proposal had been funded and the software was underway. When they finally agreed to talk to some teachers, they were astonished to learn that while they were designing software under the assumption that each child had a computer at his/her desk, in fact, the students only had access to a single computer in the library for 30 minutes a week. This meeting, of course, forced them to change what they were doing in significant ways, and if they hadn't met with the teachers, they would have designed software for an ideal classroom rather than an actual one.

Redelfs also emphasized that community building is crucial, and she stressed that it's important not to forget the "public." Everyone in the organization can go out and give talks and become voices in the community. Public meetings and workshops are critical, partly to promote a national culture of scientific literacy, but also to build support and gain partners in the community. Scientists involved in the center and leaders of the center can help by being active in the community and by talking about their jobs, why they love technology and what can be done with it. Those conversations should be happening all the time, a constant flow out, like blood flowing from the heart to legs. It's important to keep people excited about science and technology so that the employees of the center aren't separate from the community.

Redelfs gave the example of how San Diego Supercomputing Center employees were asked to model San Diego Bay, in the days before visualization was as advanced as it is now. Seventeen state, federal and private agencies and organizations gave their data to SDSC. These included the Port of San Diego, the parks department, the fisheries department and the Sierra Club, all groups/ agencies that had been isolated or opposed to each other. They were rivals, but once they'd given their data to the Center, they could all share it; they all had common data with which to work. The San Diego Center could be seen as neutral, a place where data could be analyzed and could also bring disparate groups together.

Redelfs also pointed out that it's equally important to keep the government engaged and make sure that those relationships are maintained over time. She encouraged inviting someone from government to every meeting. In addition, the media is often forgotten, but they're also a part of the community and need to be kept as part of the community. The media should be an ally, she said, a friend and a resource. She encouraged keeping them involved and informed, so that they can get the word out about what's going on in and around the Center.

Redelfs' final suggestion was to consider having a community advisory board as well as an industrial advisory board so there is a place to regularly discuss issues around community involvement at the Holyoke Center.

Sue Mackler and Gordon Snyder:

Sue Mackler is the Dean of the Business Division of Holyoke Community College; for many years, she was also a professor in the Computer Information Systems department there. Gordon Snyder is Executive Director of the NSF-funded National Center for Information and Communications Technologies (ICT Center) at Springfield Technical Community College. They spoke about the possibilities for connections between the community colleges and the Holyoke GHPCC.

Mackler began by showing a hard disk drive from 1968 and noting that the idea of newness is missing from the computer world today. Since every student has a computer, or access to one, it isn't exciting for them. She would advise beginning with High Performance Computing (HPC) 101 —what it is and how it relates to what's in our pockets.

The tenets of HPC 101 are as follows: We are at the beginning of a High Performance Computing Era; High Performance Computing can be a source of new competitive advantage since it enables us first to model, then manipulate those things that are important to us; HPC is not available at the corner office supply center (yet), and it requires a dedicated commitment to learning about new technologies; and, HPC is a community computing model: hundreds, thousands and even tens of thousands of servers work together on a single problem.

Mackler offered examples of ordinary products—chips, soda, golf clubs, cars—that are affected by HPC. These products include Pringles potato chips. Procter and Gamble has used HPC to work on the aerodynamics of Pringles. The aerodynamics is important because the chips are produced so quickly that they are almost flying down the production line. The design of mud flaps on trucks is also a product of High Performance Computing. This is something that students could tangibly see or work on by using modeling.

Mackler noted that she was there when Doug Englehart invented the computer mouse. In order for students to be engaged, they have to be in the "presence of something wonderful." This is what inspires people.

The presentation continued with Gordon Snyder discussing the educational, outreach and research needs in HPC, IT and related areas that might be provided by the Holyoke GHPCC that would benefit STCC and HCC. These include the following: employer/student relationships; internships and co-ops; access to subject matter expertise; access to new emerging technology/equipment; faculty externships; relationships and transferability to four-year institutions.

He also looked at the educational and outreach programs that are the foundations for next steps by STCC and HCC. These include workforce development; specialized programs such as those offered by the ICT Center; degrees, certificates, and relationships to other institutions; and cooperative education and internships

Snyder also noted that special facilities that would meet certain community college needs should be included in the Holyoke Center. One such facility is media rich "class-

room" space including computer/network connectivity; classroom video conferencing capabilities (cameras, audio, etc.); access to new equipment and subject matter expertise and equipment as it comes into the center; and hands-on laboratory space.

Snyder's next point focused on what new programs or other academic opportunities might be enabled at the community colleges, including new "academy-like" certification programs. He suggested that existing and emerging certifications—such as virtualization (VMWare, Microsoft), storage (EMC), high performance networks (Cisco, Juniper) and cloud computing (Microsoft, Amazon)—could be bundled into customized academic programs. In addition, these programs could be rich in new media and offered in an online or hybrid format in order to take advantage of the unique opportunities and access the community colleges will have due to the presence of the Holyoke GHPCC.

Snyder concluded the presentation with the thought that "innovation = interaction of knowledge, ideas, action." A community college degree, workforce training, and certificate- level curriculum will build upon a common IT core with specialization in data center technologies including storage area networks, network addressable storage, high speed networking, virtualization, green computing, and cloud computing. In addition, community colleges will help innovate, commercialize, and produce new knowledge, new ideas, new actions, producing a "smart and connected community" of learners. In Snyder's view, community college is *the* place to find out what HPC is about and contribute to the innovation that comes out of it.

Kim Yohannan:

Kim Yohannan is an academic alliance manager at EMC corporation. Her focus on the panel was on "Education and Industry Partnerships: Bridging the Gap between Education and the Workplace." Yohannan was asked for the industry perspective on how it works with educational institutions and how that might apply to the work done at the Holyoke GHPCC.

The Academic Alliance program at EMC, like similar programs offered by Cisco and other large computer corporations, offers a technology-based course to faculty members who then can offer it to their students. When schools enroll in the program, they are given free software and the curriculum and are thus able to offer the latest technology to their students for training. After taking the course, the students then can get certified in that technical area.

Yohannan works with more than 80 institutions, including STCC, many of which have NSF-funded Advanced Technology Education (ATE) Centers. She had several suggestions as to how the Holyoke Center might use the best practices of some of these institutions and apply them to the work to be done in Holyoke.

First, she suggests that the Center engage with industry to leverage academic programs that support degree and certificate programs, which provide valuable resources for students and faculty both. These include the following: courseware in current technologies; professional development for faculty; certification opportunities for faculty and students; industry speakers for classes and events; facility tours; and career opportunities, including internships, co-ops, and jobs.

These types of connections between industry and academia have several benefits. Colleges may get help with student recruitment into classes and programs since they are offering valuable and concrete learning experiences. In addition, students have a way to bridge their education into industry. A student who has been trained in a specific high tech area in college may find it easier to find a job, even in a different IT field. A new employer would have the advantage of not having to provide training for a student who's been through this kind of course.

One specific example of this is the new certificate in Network Virtualization. This is a 33 credit certificate program encompassing 9 courses, from Network Fundamentals to Server Configuration to Information Storage Management. The Network Virtualization technical certificate program prepares students to install, deploy, configure, manage, secure, and analyze a virtual network infrastructure. Graduates can be employed as server administrators, server systems administrators, enterprise systems administrators, or network virtualization specialists. This technical certificate prepares the student for the EMC Proven Professional Associate, VMware Certified Professional, and Implementing Citrix Server certification exam. In addition, all courses in this technical certificate are also included in the Networking Services Technology (Network Support) degree.

Yohannan offered several possibilities for ways that the Holyoke GHPCC could forge alliances with local educational institutions. It could host IT equipment on the internet that would offer hands-on learning for faculty and students; software is available that enables resources to be scheduled, automated and accessed remotely. The Center could provide training classrooms. Yearly faculty professional development courses could be offered in the spirit of "training the trainer." In addition, faculty workshops could be offered throughout the year.

The Center could also enable colleges to mentor each other on best practices and successful programs. Such a program—the Mentor College Program—is currently running at the Convergence Technology Center at Collin College in Texas. The Center could also leverage NSF-funded ATE centers to provide colleges with expertise and resources. Models for this kind of program include the Information and Communications Technologies (ICT) Center and the Mid-Atlantic Institute for Telecommunications Technologies (MAITT).

Recommendations from Breakouts

K–12, community and economic development organizations

- Provide access in the neighborhood in the Canal District
- Provide space and staff for outreach efforts
- Hire a Community Liaison ASAP
- Involve the city, its schools, community-based organizations and residents directly in the planning, design and execution of programs
- Provide K–12 outreach programs, activities and tours focused on computing
- Identify outreach programs and efforts that already exist and build on those
- Focus on education, including professional development for teachers and family involvement

Community college partners

- Provide activities for community college students:
  - Tours
  - Professional development
  - "Space Camp"-like experience
  - Student mentoring
  - Boot Camps
  - Institutional collaboration—offer a "parallel institute" (an educational collaborative)
- Consider ways to leverage existing activities:
  - Identify currently available courses, curriculum, content and programs
  - Provide student and faculty access to new and recycled equipment and technology along with remote access
  - Provide access to subject matter expertise, e.g. storage, networking including NAS and SAN, virtualization, elastic computing, data, etc.

University partners

- Serve as on-demand, virtual resource in K–12 education and in community colleges
- Align with MCAS curriculum concerns
- Serve as source for common infrastructure base for schools; this would allow teachers to focus on the curriculum rather than the "plumbing"
- Provide locus for summer training for science teachers in using resource in classrooms
- Connect community colleges and K–12 schools to university research

Springfield Technical Community College students share their technology projects with high school students each spring. The Holyoke GHPCC could be a host to events like these in the future.

Breakout Discussion: K–12, Community and Economic Development

Facility/Space Ideas:

- Space in the GHPCC for community use
- An inviting physical plant that adds warmth to the community
- Access to the space and low bureaucracy regarding space use; community input, voice and power in the scheduling of the space
- Virtual classrooms and networks to connect with other schools and colleges
- Kitchen /food prep area as food is involved in virtually all community activities; side benefit of working in healthy choices with youth and families

Ideas for Partnering with Community Programs

- Hire a bi-lingual Community Liaison, the sooner the better, to make sure the communication with residents, schools and organizations is consistent and expectations are realistic
- Engage community members to help oversee, facilitate and lead outreach programming
- Engage residents of the community in conversations: How can this project benefit K–12 and families?
- Hold many small neighborhood meetings to get input, disseminate info, engage the community. Build excitement about this project in the community even if people don't understand all the details of HPC. This foundation is very important to future connections and the success of Center programs.
- Make sure that both Spanish and English are spoken/written at all points: at meeting, events, signage, etc.
- Involve the STEM curriculum development people from the local schools
- Plan for parental and family engagement. There will be more youth engagement when parents are involved. This is one major cultural facet to working with the Latino community here.
- Take inventory of the community programs and campus/ community partnership
- Connect new initiatives to existing ones; bolster and help to expand existing organizations and programs, utilize existing campus/community partnerships such as UMass CSL and the Five College Community-based Learning group
- Provide help in accessing grants and other funds for existing programming, possibly adding new programs such as MIT SEED Academy, building on existing partnerships with the Five Colleges
- Find the successful "stories" and build on those: Holyoke Boys & Girls club, Girls, Inc., Peck School, Homework House
- Begin with Holyoke and then open the programming up to other communities, especially where there are existing partnerships (e.g. Five College CBL has partnerships in Springfield and many other local communities), then scale to build beyond Holyoke to Springfield and the rest of Western Massachusetts after current relationships have built a foundation.
- Determine work force needs in IT fields and develop adult programming to prepare the residents to fill the jobs

Specific Community Needs Discussed:

- K–12 support; improve graduation rate, vision for college, college access
- Adult education, ESL, GED and workforce development (for adults and youth)
- Gap between workforce needs/ jobs and skills (adult learners)
- Building awareness of and vision for opportunities for employment/ careers
- Stimulate excitement for learning — math, problem solving, innovation, creative thinking.
- Connections with all segments of community (concern exists that the Latino community will be left out of the wave of progress in Holyoke)
- Computational skills
- Early intervention to guide students to STEM, computing, etc.
- Tangible ways to bridge the cultural, digital, access, class and language divides
- Digital divide issues — past funding dried up. Is there any possible new funding?
- Canal district and Flats need to have thorough wi-fi connectivity for all
- Teacher support and training around IT, computing, tying it to STEM
- Help with programmatic development around STEM and computing
- A way to connect with others around the world (TelePresence, equipment donations?)
- Workforce development, regionally, IT and full industry sector
- Creating jobs for people, especially those who live in the Canal District/ Flats/South Holyoke

Breakout Discussion: Community Colleges

What are the local and regional needs?

- Define regional as the state of Massachusetts, including the "knowledge corridor"
- Provide technical expertise, e.g. storage, networking including NAS and SAN, virtualization, elastic computing, data, etc.
- Assist in bridging community college students to industry by providing projects, internships, Co-op positions; help to get students out of the classroom and into the real world
- Hire marketing and outreach person for HPC staff
- Foster collaboration between institutions, business, industry, public (parents, students), etc.

What activities might be centered at the GHPCC, for students, for teachers, for parents and for local, regional, and statewide programs?

- Tours
- Professional development
- "Space Camp"-like experience
- Student mentoring
- Boot Camps, with awarded certificates and different acceptance levels (prestige). Bring in high level faculty from universities involved.
- Institutional collaboration—a "parallel institute" (an educational collaborative)
- Activities for municipal employees, depending on needs
- Classes from universities offered virtually
- Certificate "stacking" for academic credit and articulation agreements
- Repository with ready materials and examples for marketing/dissemination
- Tangible evidence

How can existing activities be leveraged?

- Identify currently available courses/curriculum/content/programs
- Recycle equipment from HPCC to community colleges
- Provide access for students and faculty to new equipment/technology
- Consider possibility of remote access to Center equipment
- Leverage existing user groups
- Create high performance community college consortium
- Investigate how marketing is done; consider social networks

Are there opportunities for interacting with state-wide STEM efforts?

- Connect with the new STEM council (run by the lieutenant governor) for the state. Consider using the center for meeting space.
- Identify existing efforts
- Use conference facility at the center to hold STEM events
- Consider holding student robotics, programming and other competitions
- Leverage university connections through center — collaboration on proposals, etc.
- Encourage each of the five universities to do two lectures per year for a broad audience.

What new programs or opportunities might be enabled?

- STEM across the curriculum at community colleges and earlier
- Development of instructor-led synchronous online/hybrid specialized courses. Faculty could include community college, university and industry experts
- Access to subject matter expertise, e.g. storage, networking, virtualization, elastic computing, data, etc.
- Funding put aside for virtual classrooms
- Entrepreneurship collaboration

What is the role of industry?

- Subject matter expertise
- Leveraging of existing academic programs
- Student internships and co-ops
- Faculty externships
- Visiting faculty / industry experts teaching courses evenings and online
- New graduate hiring programs
- Job shadow days for students
- Marketing career options
- Advocacy
- Assessment
- Advice

What are the funding opportunities?

- State and federal sources (Department of Labor, Department of Education, Department of Energy, NSF)
- Proposal collaboration (high school/community college/university/industry)
- Private industry funding (community relations divisions of companies)
- Equipment donations (EMC, Cisco, Juniper)
- Training donations
- Private foundations

Breakout Discussion: University and Four-Year Colleges

GHPCC as infrastructure for K–12

- Serve as on-demand virtual resource in K–12 education and in community colleges; one thousand to ten thousand times more powerful than a desktop in terms of both storage and computation
- Serve as source for common infrastructure base for schools; would allow teachers to focus on the curriculum rather than the "plumbing"
- Serve as facility for training trainers; GHPCC could provide locus for summer training for science teachers in using resources in the classroom
- Assist schools in engaging with local companies such as Mathworks.
- Make sure Center aligns with MCAS curriculum concerns; junior high school is the latest point at which to have any influence regarding STEM
- Make Center available for K–12 with help of colleges and universities; help teach teachers, help align curriculum, connect with industry

Role of Higher Education in Workforce Development

- Provide training in broad HPC/IT fields rather than jobs at the Center itself
- Start training with basic IT but include HPC "flavor"—application domains with strong HPC element, systems administration, etc.
- Serve as a networking and computing technology training facility
- Partner with industry for state-of-the-art equipment not easily afforded in community colleges
- Specialize in training for skills that are relevant to the Massachusetts region: health, financial, research, defense, education
- Assist in developing a workforce that can be a catalyst for economic development
- Align with idea of "21st century skills:" technical skills, social skills, global skills, writing skills; idea is to create a next generation of globally aware, technologically aware, creative citizens. Focus on more than just the technological skills.

How to Bring Students (High School and Community College) into Research

- Recognize importance of connecting community colleges and schools to university research and education
- Enhance university-developed open courses to include simulation
- Offer internships, summer and weekend program partnerships around HPC
- Offer potentially large-scale, multiplayer games with an educational foundation to encourage collaborative problem solving

Examples of educational activities the Holyoke GHPCC can support

- Citizen Schools Collaborations
  - Focuses on middle school students
  - Offers after school teaching programs
  - Explores programming in engaging ways
  - Teaches mathematical concept of functions
- Math of geo/earth sciences
  - Follow the model of MIT course that uses handheld devices for accessing HPC; a simple handheld device allows students to run sophisticated geology experiments
  - Provide opportunities for observations, experiments and theory