Strategic Plan
Revised August 2009

Vision Statement

The Vision of the Supercomputing Challenge is to be a nationally recognized program that promotes computational thinking in science and engineering so that the next generation of high school graduates is better prepared to compete in an information based economy.

Mission Statement

The Mission of the Supercomputing Challenge is to teach teams of middle and high schools students how to use powerful computers to analyze, model and solve real world problems.

Core Values

The Supercomputing Challenge supports a governance process that is open, respectful and collaborative. A high regard for excellent student scholarship, integrity, hard work, creativity, and teamwork are core values that board members, staff, and a key team of volunteer workers' model. They are committed to making pathways to careers in science, mathematics, engineering, and computing for students throughout the state of New Mexico. The Challenge community believes that aggressive outreach is crucial to guaranteeing that Challenge teams are diverse and represent young people from all of our neighborhoods.

Program Overview

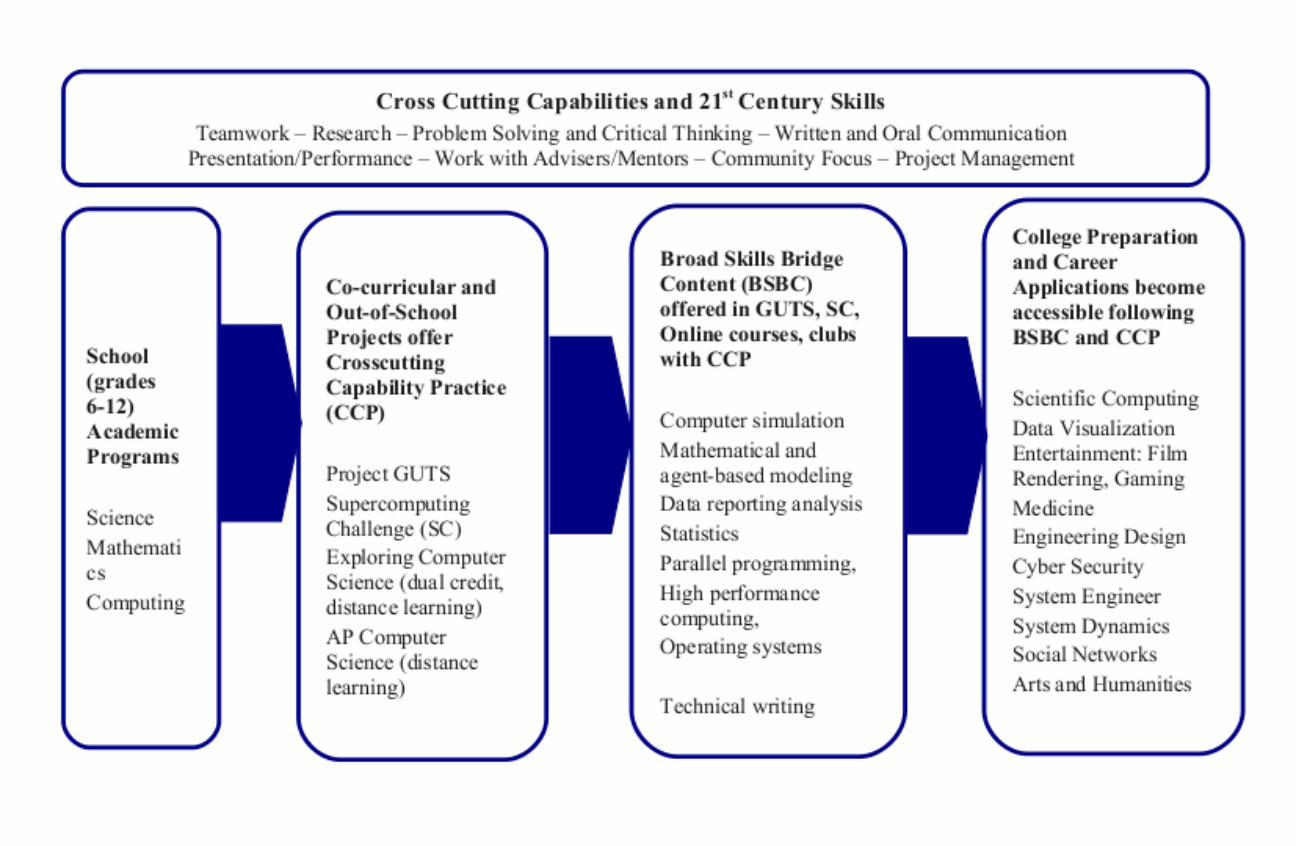
The Supercomputing Challenge is a school year long program that teaches mid-school and high school students how to use powerful computers to model real world problems and explore computational approaches to their solutions. Teams of one to five students compete for prizes and scholarships conducting independent research on scientific problems of interest to them. The program is open to all interested students in New Mexico in grades 6 through 12 on a non-selective basis. Participants come from public, private, parochial and home-based schools in all areas of the state. The program has no grade point, class enrollment or computer experience prerequisites. The only requirement for participating is a real desire to learn about science and computing.

The NM Supercomputing Challenge <http://challenge.nm.org> turns 20 this year. This is an astonishing feat in the world of science and educational technology. The main goals of the Challenge are to foster student's creativity in devising computational solutions to scientific

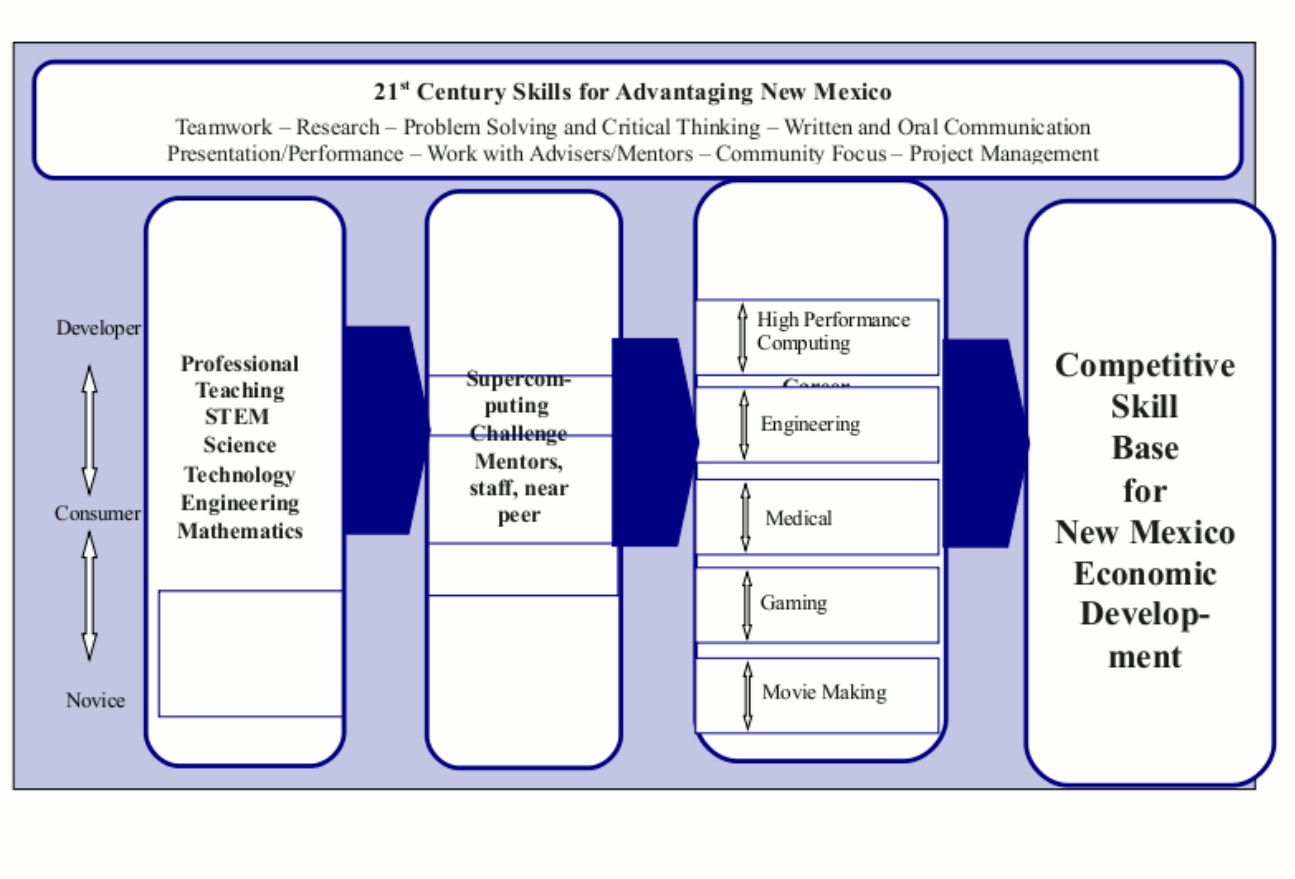
problems, to learn about the challenges facing their environment, to better understand properties of the physical universe, to look at trends in the social sciences that have implications for their own lives, and to develop useful career preparation skills such as teamwork, oral, written and visual communication, problem solving, and project management. These skills have all been identified as 21st century skills. The program emphasis will naturally direct students toward a greater understanding of the scientific process and inspires career choices in mathematics, science, and engineering.

Program Scope

The Supercomputing Challenge promotes connections between academic programs, co-curricular and out-of–school programs, college and career paths. Bridge Skills are developed in Co-curricular and Out of School Project participation; Career and College Applications become accessible following the development of Bridge Skills. The following graphic shows the proposed flow of learning.



How the Challenge can Promote Economic Development



Program Relevance

The Department of Workforce Solutions has identified "seven strategic market sectors, or clusters, that form the foundation for the future economy of the state"(see http://www.workinnewmexico.gov). The seven clusters are:

Arts and Entertainment
Business Services
Communications and Information
Energy and Environmental Technologies
Engineering, Construction, Manufacturing and Agriculture
Health and Biosciences
Hospitality and Tourism

The career pathways fostered by the Supercomputing Challenge include careers in all scientific disciplines, engineering, film and gaming.

The New Mexico Office of Science and Technology has created a Science and Technology Roadmap for New Mexico's Future (see http://nmsciencetech.com/index.php/home). In the Document titled Technology21 Innovation and Technology in the 21st Century, Creating Better Jobs for New Mexicans,

the state provides guidance on “how the State should effectively leverage its remarkable science and technology” to drive technology-based economic development. The document states:

“Scientific supercomputing is rapidly becoming an essential element of innovation and competitiveness. Computer-based methods and the solutions they bring now play a central role in all areas of economic development, education, and research. In fact, the states that choose to move their science and technology forward rely heavily on computational analysis, modeling, and simulation to stay competitive.

Skills taught by the Supercomputing Challenge focus on computational analysis, modeling and simulation.

What is Supercomputing?

Over the last thirty years there has been an evolution in the use of computers from helping scientists to perform experiments and calculations to helping them understand complex problems and to predict solutions or prevent undesirable outcomes. **These problems may be too large, too expensive, too dangerous, and/or too time consuming for physical experimentation.** Use of computers enables scientists to look at numerous factors that can influence the outcome of a problem that are often difficult, or impossible, to predict simply by looking at the individual interactions. **The number of variables is typically so computationally intensive that it might take human beings years to solve the problem by traditional pencil and paper methods.** Thus, scientists use powerful computers where the work can be accomplished in relatively little time. **Similarly, the output can be so complex that a computer must also interpret the data.** Often this means displaying the output in some type of graphical format. For some projects a single computer by itself may not have the capacity to perform all the calculations required to reach a solution. The problems are broken down into various tasks with each assigned to a separate computer. Also by breaking the problem into smaller tasks, many can be performed simultaneously thus increasing the speed at which the overall solution is achieved. **Linking of computer systems to allow for parallel processing puts them in the category of supercomputers.** More precisely, this process is should be described as high performance computing, differentiating from the fastest computers in the world.

Historical Overview

The New Mexico High School Supercomputing Challenge was conceived in 1990 by former Los Alamos Director Sig Hecker and Tom Thornhill, president of New Mexico Technet Inc., a nonprofit company that established a computer network in 1985 to link the state's national laboratories, universities, state government and some private companies. Sen. Domenici, and John Rollwagen, then chairman and chief executive officer of Cray Research Inc., added their support. The idea was to provide a truly unique experience to students in our state; an opportunity to work on the most powerful computers in the world.

Two hundred and thirty Five students participated in the Supercomputing Challenge during the first year. Teams from over 40 schools participated.

Over the next five years the Supercomputing Challenge grew to over 765 participants from 62 schools in 44 different school districts. **The increase in participants was a direct result of face-to-face recruiting in the schools.** Technet hired a retired UNM professor to travel throughout the state to explain the benefits of participation in the Supercomputing

Challenge. The most powerful incentive to participate was an opportunity for schools to get computer equipment from Technet and access to the Internet.

At the time, everyone involved with the Supercomputing Challenge realized that 765 students was not manageable. It was expensive, difficult to provide sufficient mentors, teacher preparation was inadequate and there was a high attrition rate. The overall quality of projects was also poor. A conscious decision was made to limit recruiting. In addition, there was less incentive to participate in the Challenge as schools gained Internet access and obtained computer equipment from other sources. The situation was exacerbated when the Department of Energy decided that they didn't belong in the education business and cut funding for outreach programs. By the 2000-2001 school year, the number of participants in the Supercomputing Challenge had dwindled to 253 students representing 41 schools.

The Supercomputing Challenge was able to survive financially through continued sponsorship of Technet and a shift in funding at LANL to the Computer and Computational Science (CCS) division. CCS continues to support the Supercomputer Challenge through earnings on royalties and patents.

In recent years, participation in the Supercomputing Challenge has fluctuated between 300 and 400 students, primarily due to a merger with the Adventures in Supercomputing (AiS) and collaboration with Adventures in Modeling (AiM). The Adventures in Supercomputing was a program supported by Sandia National Laboratory through a federal government grant. Adventures in Modeling was a program developed by Santa Fe Institute under an NSF grant. Funding for both programs has run out.

Under constraints of finances and manpower, 300 to 400 students was deemed manageable. Our budget supports two half time equivalent teachers, and LANL provides one half time employee to run the Challenge.

In 2003 Technet underwent sudden reorganization and withdrew financial support from the Supercomputing Challenge. Los Alamos stepped in with funding for our teacher professional development seminar in July 2003 and picked up the contracts for our two part time master teachers.

Loss of Technet financial support caused new hardship for the Supercomputing Challenge. It also stimulated positive changes in the way we conduct our business. The sudden loss of funding pushed the board of directors to seek financial help from the New Mexico state legislature. It also stimulated an application for tax-exempt status under the Internal Revenue Service Code section 501 C 3. Tax-exempt status was granted in May 2006.

As a not-for-profit entity, the board of directors has adopted new ideas and policies. We have fostered new partnerships to strengthen program instruction, expanded recruiting and developed broader financial support. We have sought to work more closely with the Public Education Department, Sandia National Laboratory, UNM, the Santa Fe Institute, the New Mexico Information Technology and Software Association (now New Mexico Tech Council), the New Mexico Computer Applications Center and private businesses. We have established relationships with other non-profit educational organizations like MESA, Inquiry Facilitators,

Scientifically Connected Communities, Fractal Foundation, Innovate-Educate, Robo Rave and Star Base La Luz. We have solicited sponsorship from the New Mexico State Legislature, the Public Education Department, Sandia National Laboratory and private businesses.

Santa Fe Institute Collaboration

Collaboration with Santa Fe Institute has made a major impact on The Supercomputing Challenge. Santa Fe Institute's Adventures in Modeling program (AIM) introduced the Supercomputing Challenge to agent based modeling techniques. Hiring AIM participants and program manager to teach Supercomputing Challenge seminars and tutor Challenge teams has significantly improved the quality of student projects, according to our judges. Also, AIM had a strong core of schools participating in their program and many of those schools now sponsor Supercomputing Challenge Teams.

Santa Fe Institute now has developed a new program called Project GUTS – Growing Up Thinking Scientifically. Project GUTS is a summer and after-school science, technology, engineering and math (STEM) project for middle school students based in Santa Fe, New Mexico and serving northern New Mexico. Growing up thinking scientifically means learning to look at the world and ask questions, develop answers to the questions through scientific inquiry, and design solutions to their problems. Project GUTS is hosted by the Santa Fe Institute and is funded by the National Science Foundation, the Los Alamos National Laboratory Foundation, the Bengier Foundation, the Los Alamos National Bank, Lockheed-Martin/Sandia Laboratory, the New Mexico Public Education Department Math and Science Bureau, in conjunction with the Challenge and by private donors. The program focuses on modeling problems that the students encounter in their own community and allows them to achieve success in solving science problems with age appropriate math and science classes. We expect many of those students will participate in the Supercomputing Challenge when they enter high school. In fact, some GUTS students already have developed Supercomputing Challenge projects.

The Project GUTS model appears to be very successful. Features of the program include specific curricular units to be taught to all students, regardless of where they go to school. Professional development classes are required for all club leaders and project coordinators provide support on a weekly basis.

Board Analysis of Strengths

The power of personal computers has increased significantly since the inception of the Supercomputing Challenge in 1990. Most students do not require the power of supercomputers today to complete their projects. As a result, our emphasis has been focused on computational analysis, and we are very good at it. We do an excellent job of teaching 21st century skills in critical thinking, problem solving, research, project management, written and oral communication.

Los Alamos National Laboratory provides one employee half-time to manage the Supercomputer Challenge. This individual has been with the Challenge since its inception. He organizes all our events, facilitates use of the LANL supercomputer when needed and manages all our technical details. He has developed and maintains a phenomenal web page posting materials from our student seminars, teacher professional development classes and all student reports since 1995. The web page contains tutorials for students.

The Supercomputing Challenge employs two extremely hard-working, knowledgeable and dedicated teachers that have been with the program since 2000. These two exceptional individuals have a broad base of knowledge about technology and connections in the educational community. They organize all our seminars for students and professional development classes for teachers. These employees provide constant on-line support for students and classroom teachers even though they are only paid to work 20 hours per week.

The Supercomputing Challenge has a very strong and stable corps of volunteers from the national laboratories, state universities and private industry. We have been very successful in connecting students with mentors in almost every scientific discipline. Our mentors provide strong guidance to students regarding their projects and teach many things to students.

Over the years, we have developed a strong corps of teacher sponsors that recruit student teams for the Challenge. Most of these teachers attend our summer professional development seminars and keep up with trends in technology and continue to hone their skills.

The Computer and Computational Science Department of Los Alamos provides the majority of funding for scholarships awarded by the Supercomputing Challenge. Our state universities also provide many scholarships, because Challenge participants are well prepared for college.

The Public Education Department provides strong support for the Supercomputing Challenge professional development classes because they recognize that the Challenge is one of the few extracurricular programs that actually provide instruction to students. PED also recognizes that project-based learning is extremely powerful and the ability of students to apply what they have learned in class is very important.

The Supercomputing Challenge has done an excellent job in recruiting female participants. The percentage of girls participating in the Challenge is very high relative to overall participation in science, technology, engineering and math occupations. The numbers of native American participants over the years is also high.

Board Analysis of Weaknesses

Funding for the Supercomputing Challenge has been highly inconsistent making it difficult to plan and diverts energy from our mission. Lack of funding also makes it hard to recruit new participants, teacher sponsors and administrative support. With just three half-time employees there is little time to develop new relationships with other educational institutions, programs, sponsors and volunteers.

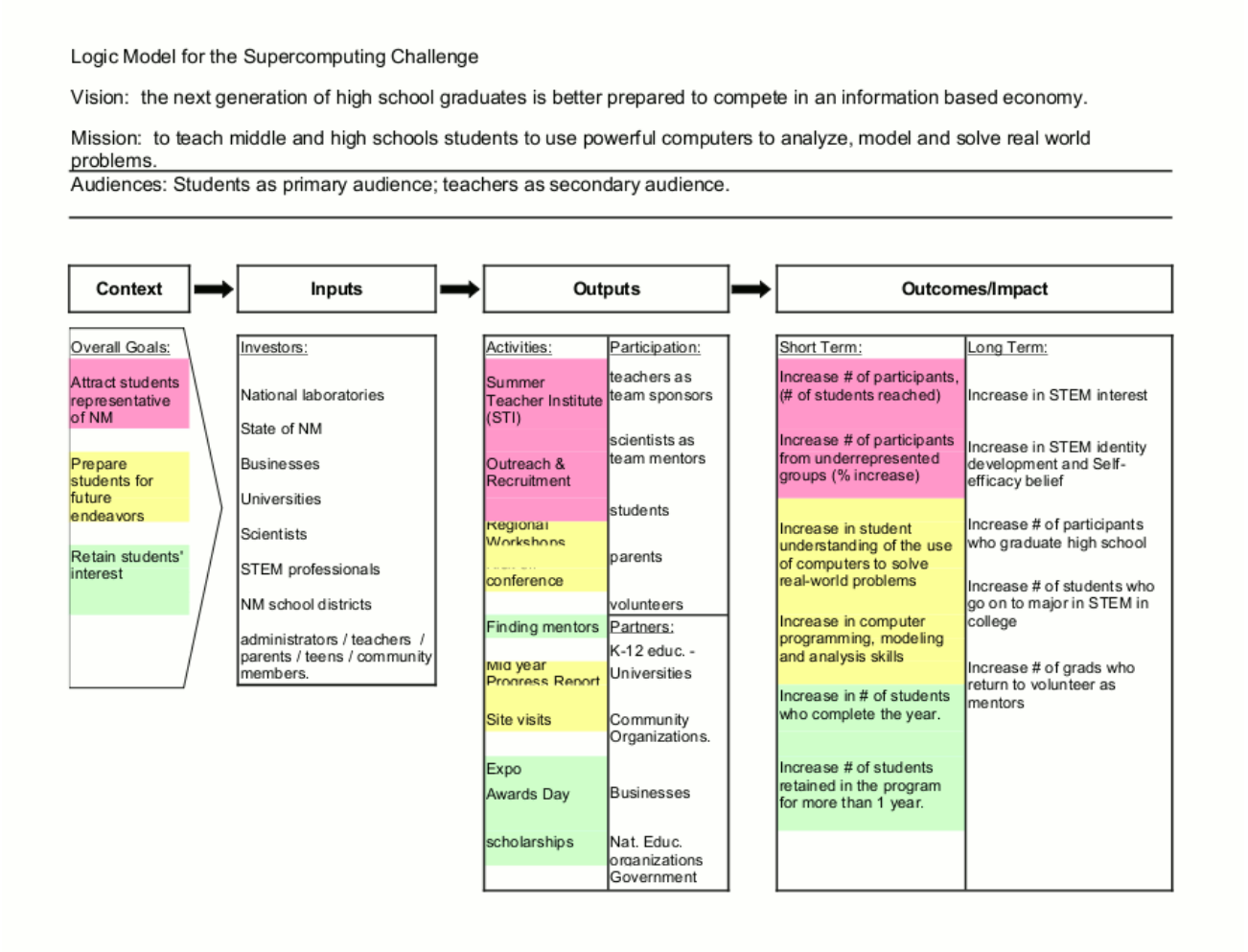
The Supercomputing Challenge has not done an adequate job educating students about what supercomputing is. Our name implies that the program is only for geeks. Also, we are working to overcome the image that the Challenge is only for nerdy, white boys."

Because of the increased power of personal and laptop computers little time has been devoted to teaching parallel programming techniques. Demand for employees with supercomputing programming skills are in high demand, and college students are not adequately prepared for high performance computing classes.

With an emphasis on scientific computing we have neglected many applications for supercomputers. We have not done a good job in creating career pathways in Data Visualization, Film Rendering, Gaming, Engineering Design, Cyber Security, System Engineering, System Dynamics, Social Networks and Medicine. We have not been able to work with our universities, colleges and community colleges to promote dual credit classes.

The board has not done an adequate job of cultivating volunteers to do the administrative tasks that non-profit organizations must do. Our strategic plan has been very slow in evolving. We have not created action plans for fund-raising. We have not arranged for independent analysis of program.

Logic Model for the Supercomputing Challenge



Intended Impacts Matrix (based on short-term impacts listed in Logic Model)

Category	Impact	Audience Objectives	Evidence / Measures
Attract students representative of the NM population.	Outreach and recruitment efforts will result in an increase in the number of participants in the Supercomputing Challenge	Youth will learn about the Supercomputing Challenge.	20% increase in # of students reached through outreach and recruitment efforts. (each year)
		Youth will participate in the Supercomputing Challenge	10% increase in # of students participating in the Supercomputing Challenge (each year)
	Outreach and recruitment efforts will result in an increase in the number of participants from underrepresented groups in STEM.	Youth participating in the Supercomputing Challenge will be representative of the ethnic, cultural, and socio-economic diversity of the state of NM.	10% Increase in # of participants from underrepresented groups, (each year)
Prepare students for futures in information based economy	Participation in workshops and computational science projects will result in preparation for 21 Century jobs.	Youth will gain understanding of how computers are used to solve real-world problems	95% of youth participating in the Kickoff conference and year-long program will be able to describe how computers are used to solve real-world problems.
		Youth will gain skills in computer programming.	75% of youth participating will learn to write a computer program.
		Youth will gain skills in computer modeling and simulation.	75% of youth participating will learn how to use a computer model as an experimental test bed.
		Youth will gain skills in data collection and analysis	75% of youth participating will learn how to collect and analyze data outputed from a computer model.
Retain students interest in STEM and computing	Participation in conferences, workshops, finding supportive mentors and sponsors will result in an increase in the number of students who stay involved with the Supercomputing Challenge.	Youth will demonstrate interest in and ability to complete a year-long project.	80% of participating students are able to complete the full Challenge year.
		Youth will demonstrate retention of interest by praticipating more than one year.	55% of youth return to participate in a following year.