New Computers (at NCAR Mesa and Wyoming, 07/2007)

- Update on status of NCAR Mesa computers.
- The selection of Wyoming, Jan 2007.
- Information about the NCAR/NSF Geo computer for Wyoming (March 2007).
- Floor space needs for computing (Mesa and Wyoming).
- Some news about other fast computers.
- The technical push to use less electricity for computing.
- Electricity use on NCAR Mesa.
- This text has been compiled during 09/2006 – 07/2007.

III

- Ready to scan July 10, 2007 (Doc RJ0418, 1+3 pages).

Roy Jenne
July 10, 2007
NCAR
New Computers (at NCAR Mesa and Wyoming)

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Roy Jenne
May 11, 2007
Rev June 20, 2007

1. Introduction (4 p)
Outlines the need for an upgrade to the fast computers at NCAR Mesa (one came 10/2006, one for 07/2008). A faster computer for NSF Geosciences is covered. And they started the idea of a “geocollaboratory” in 09/2006. But be careful.

2. Update on status (and plans) of NCAR Mesa computers, May 2007 (2 p)
  o A summary through 2011 (May 2007) (1 p)
  o NCAR had 940 real Gflop of speed (09/2006), from a few computers.
  o Then had 1850 Gflop in 03/2007 after the upgrade (Blueice) in 10/2006.
  o NCAR will have 5400 Gflop real from 10/2008 to 06/2011 after another upgrade in mid-2008. Another upgrade in 2011 (not planned) would give us about 16,000 Gflop on Mesa (equals 16 Tflop real).

3. A few key documents about computing at NCAR, 1963-on (1 p)

4. NCAR selects Wyoming for new NSF Geo Computing Center (6 p)
  o Final selection was University of Colorado-Boulder vs Wyoming
  o Select Wyoming about Jan 20, 2007

5. The fast computer for NSF geoscience work (2 p)
  o Decision was delayed by NSF in Oct 2006.
  o But Wyoming was selected in Jan 2007.
  o A summary about the NCAR/Wyoming computer (1 p).
  o New NCAR chemistry building for comparison (1 p); 78,740 sq ft on 4 floors.

6. Floor space needs for computing.
   o NCAR Mesa and Wyoming

7. A petascale computing collaboratory (09/2006) 7 p
  o What does this mean?
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    - The software is to give what is called, “a more holistic approach.”

8. Speed history of past main Mesa computers, 1964-2011 (7 p)

9. Another short summary of NCAR Mesa computers, 1984 – 2012 (7 p)
  o Speed history from 1984
  o Electrical use to ~2010
  o Extra technical specs for 3 upgrades (Table D), memory and disks
  o Computer power used for NCEP/NCAR reanalysis (one Gflop)
10. Some news about other fast computers, Sep 2006 (9 p)
   - Cray wins $52m contract from DOE NERSC energy lab (Aug 2006); deliver about 16 Tflop real speed.
   - Japan will build another super fast computer; ...250x faster than Japan's Earth Simulator. Wow! (news, Apr 2007)
   - A fast computer for Meteorology Dept, U of WA. A lot of speed for a rather low cost.

11. Actions to develop ultra fast supercomputers (USA) (6 p)
   - Plus: How much money should NOAA spend on new supercomputers versus other needs.

12. Work to use less electricity for computing (11 p)
   - Equipment is getting too hot.
   - And the electricity is costing too much.

13. Discussing how to make a better chip (4 p)
   - And Moore's Law. The speed doubles each 18 months (for same cost)

14. An upgrade for big computers at NCAR Mesa (11 p)
   - More background—could skip some details—no time to rewrite
   - IBM Blueice starts 12/2006 (delivers real 1250 Gflop)
   - IBM upgrade about 08/2008 (delivers real 5400 Gflop)
   - Emails (Tom Bettge, about recent upgrades and plans)

15. Electricity use and cost on NCAR Mesa (12 p)

16. Proposal to upgrade the old power lines to the Mesa (2 p)
   - Cost $1.31m in 2007 dollars
   - What did we say about space and power needs for computers (2 p)

17. The contract to run NCAR (4 p)

18. News stories about an NCAR computer for NSF Geoscience work (9 p)
   - Some universities compete to host the computer.
   - This is news during 12/2005 - 07/2006.

19. Some information about the NCAR Mass Store (3 p)
   - Five tape libraries (each 5000 tapes) use 5 kW. Sixty tape drives use another 5 kW.
   - This is a rather small amount of power.
New Big Computers (at NCAR Mesa and Wyoming)

Roy Jenne
June 1, 2007

INTRODUCTION

During 2006, 2007, NCAR has been trying to obtain two faster computers, one an upgrade to the fast computers for the NCAR Mesa, and the other one is a still faster computer for NSF geosciences.

1. NCAR has been trying to get two faster computers since about Jan 2006.
   - A computer upgrade at NCAR Mesa cost ~$4.5m per year for hardware (over 3 years). I was strongly for this. With all the politics, we could end up with no big computer!
   - Establish and run a separate big computer for the Geoscience division at NSF.

2. An upgrade for the NCAR Mesa computer was needed in 08/2005
   In 08/2005, NCAR obtained the Bluevista computer with a real output of about 470 Gflops. Counting previous computers, we then had a total real capability of about 950 Gflops. In early 2006, we certainly needed more speed; an upgrade was planned for late 2006. It arrived about 10/2006 (IBM Blueice) with a real speed of 1350 Gflops. Then we had a total of 1900 Gflop.
   - See the next section of this report called “Update on Status of NCAR Mesa Computers.”
   - We note that NCAR has served the big computer needs of meteorology, oceanography, climate and related disciplines.

3. Prepare a document
   I decided I had better do a little extra work to document what was happening since some things seemed very fuzzy. This text serves as a history and a clarification of events during 2006 – 06/2007. The text includes information about needs for electricity and cost. Part of the text was ready for a meeting of the executive committee of our NSA (NCAR Science Assembly) held on Oct 13, 2006.
   - On Oct 17, I calculated the implied computing efficiency of the new computer with respect to peak. That seemed too high. I checked with an expert—it was way too high. So new corrections were needed that brought down the exact computing power of the new upgrade to 1380 Gflop. (June 2007: use 10.5 to 12% peak (1310 to 1500 Gflop), use 1350 real Gflop)

4. The faster NCAR computer for NSF Geosciences
   Starting about 12/2005, there were plans for NCAR to partner with a university to establish a $75m class computer for NSF Geosciences. During about Feb – May 2005, there were lots of news stories about the competition between CSU (Colorado State, 45 miles north of NCAR), and Colorado School of Mines, 20 miles south. In May 2006, the University of Colorado, Boulder, was in the pictures. During 05/2006, and 09/2006, NCAR sometimes called this a $200m proposal. Oklahoma was in the picture for a while, but from about July 2006 – on, the competition was mainly between U of CO and Wyoming. Wyoming was chosen to be the main partner in Jan 2007.
   - One sheet describes the status of the Wyoming $60m computer as of June 2007.

5. The collaboratory idea by NCAR came to the fore in Aug – Sep 2006.
   We had been talking about more computer speed needed for modeling. NSF staff seemed to fully accept this idea (good). The idea of lots of software for the collaboratory likely confused NSF. Starting Sep 06 plans seemed in limbo for a while.
Their collaborative idea also includes data systems. With data systems, it is very important to keep the activity focused on real science needs. If things get too big, too general, and less focused, it is increasingly likely that the data systems will not work well (many fail) and that they will put a huge unnecessary strain on science budgets. I worked with NASA and NOAA for many years on data system issues and saw first hand examples of success, failure, and frustration. The “business” info tech community has had similar concerns. They often put people with business knowledge and goals plus data system experience into their data systems. I have collected various short “readings” which help to describe good and bad approaches to data systems.

I have been involved with solving data needs and avoiding design problems for about 40 years. It frightens me to see big plans being extended when too many people do not seem to be aware of the pitfalls to avoid.

6. Big computers use a lot of electricity.
A number of issues are covered about the need for electricity and the cost. The electricity needs (kW) for several big computers are given. We also give some information about mass storage, and about the needs for space.

7. Were key staff aware of plans for the collaboratory (12/2006)
I had the sense that the “Collaboratory” was a big “plan” that could affect the whole of geosciences a lot, yet it was really a primitive idea, not yet defined. I checked with 3 senior staff in Dec 2006 who worked on both the science (either scientific observations, or on models) and on programming. They had not been briefed on the collaboratory. One knew only enough about it to hope that he could retire before it started. The community will need to grope more with these issues.
IBM to Launch Push for Green

New Business to Address Cutting Energy Thirst Of Computer Centers

BY WILLIAM M. BULKELEY

Big Blue sees green in going green. Under an initiative it has dubbed "Project Big Green," International Business Machines Corp. plans to start a major business to help customers slash energy use in data centers that are running up ever larger electricity bills.

IBM has scheduled a press event for today in New York to inaugurate the business, which is part of its global services offering. The business will help customers maximize energy efficiency of their computers and redesign the layout of their data centers to minimize cooling costs.

In addition, IBM, which says it is the world's biggest operator of data centers, will explain its own plans for reducing power consumption.

The amount of energy used by computers—both for running the machines and cooling the rooms they sit in—has increasingly raised concerns both about cost and environmental impact. Global electricity consumption by servers and ancillary equipment doubled to $73.3 billion from 2000 to 2005, Jonathan Koomey, a staff scientist at Lawrence Berkeley National Laboratory and consulting professor at Stanford University, estimated in a study released this year.

Christopher Mines, an analyst with market researcher Forrester Research, Cambridge, Mass., says it found in a recent survey of corporate computer buyers "a high degree of awareness of environmental issues surrounding computing, but a low degree of activity." He said most corporate computer managers focus on high performance and reliability for their networks and ignore electricity use. "They don't pay the bill in the vast majority of companies," he said, adding that energy bills are the province of operations managers.

IBM compares the new project with the commitment it made 10 years ago to embrace the Internet and later Linux free software, both for its own use and as a service business for corporate and governmental customers. Both plans have improved the company's internal business operations and created an opportunity for huge additional services and software revenue.

IBM is training 1,000 services experts in green technology to help clients redesign their data centers and improve their efficiency.

According to materials prepared for the press event, IBM expects to double the computing capacity of its own data centers by 2010 without using additional energy. Under that scenario, it would avoid incurring $500 million in electricity costs.

IBM's announcement today is expected to feature several technologies for reducing air-conditioning costs in data centers, where computers must be kept cool to function optimally. Among those technologies is the IBM Data Center Stored Cooling Solution, which sits outside the data center and uses a synthetic liquid solution to cool chillers that regulate air-conditioning units. The product was named the "best new energy product" by the American Society of Heating, Refrigeration and Air Conditioning Engineers.

Other aspects of IBM's green services include a software program that can analyze heat and air-conditioning use in a data center to find hot spots and suggest ways to move servers to optimize cooling capabilities.

IBM's news event today is expected to include representatives from a number of partner companies, including General Electric Co., PG&E Corp.'s Pacific Gas & Electric Co. and Schneider Electric SA.

May 10, 2007
will it pour.
Page B4
Intel Says It Is Developing Chips That Will Run Faster, While Using Less Power

I.B.M. Vows Similar Step — PCs and Consumer Devices May Benefit

By JOHN MARKOFF

Intel, the world's largest chip maker, has overhauled the basic building block of the information age, paving the way for a new generation of faster and more energy-efficient processors.

Company researchers said the advance represented the most significant change in the materials used to manufacture silicon chips since Intel pioneered the modern integrated-circuit transistor more than four decades ago.

The industry is building chips in what is known as 90-nanometer technology. At that scale, about 1,000 transistors would fit in the width of a human hair. Intel began making chips 65 nanometers in 2005, about nine months before its closest competitors.

Now the company is moving on to the next stage of refinement, defined by a minimum feature size of 45 nanometers. Other researchers have recently reported progress on molecular computing technologies that could reduce the scale even further by the end of the decade.

The Intel announcement is new evidence that the chip maker is maintaining the pace of Moore's Law, the technology axiom that states the number of transistors on a chip doubles roughly every two years, giving rise to a constant escalation of computing power at lower costs.

Intel's imminent advance to 45-nanometer chips will have a huge impact on the industry, Mr. Subramanian said. "People have been working on it for over a decade, and this is tremendously significant that Intel has stepped up to the plate this year in a big way.

The new approach to insulation appears at least temporarily to conquer one of the most significant obstacles confronting the semiconductor industry: the tendency of tiny switches to leak electricity as they are reduced in size. The leakage makes chips run hotter and consume more power.

Many executives in the industry say that Intel is still recovering from a strategic wrong turn it made when the company pushed its chips to extremely high clock speeds — the ability of a processor to calculate more quickly. That obsession with speed at any cost left the company behind its competitors in shifting to low-power alternatives.

Now Intel is coming back. Although the chip maker led in the speed race for many years, the company has in recent years shifted its focus to low-power microprocessors that gain speed by breaking each chip into multiple computing "cores." In its new 45-nanometer generation, Intel will gain the freedom to seek either higher performance or substantially lower power, while at the same time increasing the number of cores per chip.

"They can adjust the transistor for high performance or low power,"

Several analysts said that the technology advance could give Intel a meaningful advantage over competitors in the race to build ever more powerful microprocessors.

"It's going to be a nightmare for Intel's competitors," said G. Dan Hutchenson, chief executive of VLSI Research. "A lot of Mark Bohr's counterparts are going to wake up in terror."

An I.B.M. executive said yesterday that the company had also chosen hafnium as its primary insulator, but that it would not release details of its new process until technical papers are presented at coming conferences.

"It's the difference between can openers and Ferraris," said Bernard S. Meyerson, vice president and chief technologist for the systems and technology group at I.B.M. He insisted that industry analysts who have asserted that Intel has a technology lead are not accurate and that I.B.M. had simply chosen to deploy its new process in chips that are part of high-performance systems aimed at the high end of the computer industry.

Mark Bohr, an Intel physicist who led the research, holds a 45-nanometer wafer using new metal alloys that led the insulation advance.
Update on Status of NCAR Mesa Computers; May 23, 2007

Roy Jenne
May 24, 2007

I was given a short update on the status of NCAR computers (especially the NCAR/Wyoming one) on May 23, 2007. This information was valid during the previous week.

1. The NCAR/Wyoming computer will not become operational before 2011 (definitely not in 2010).

2. The new people in NSF are trying to sort out their ideas on computer purchases, especially the new head of the geosciences division.
   - But they have not told NCAR to stop the Wyoming computer.

3. For many years, NCAR has had a budget of about $4.5 million per year to buy new computing hardware. Usually this is saved up for 3 or 4 years and then a contract for two upgrades is signed, which will be installed during the next 2 or 3 years.
   NCAR was hoping to do a similar thing with the computer for NSF geosciences located in Wyoming, but each upgrade would have about twice the power as the one at NCAR Mesa. To accomplish this, each upgrade would cost twice as much, and the cost for electricity for computing and cooling would be about twice as much. Thus NCAR would need another $3 or 4 million per year to do this (about $70m over 20 years).
   - It is now “very unlikely” that NSF will add this extra money to the NCAR budget.
   NCAR/UCAR are looking for other possible sources of funding for this money.

4. What is NSF thinking about their plans to fund one $200m computer, as well as the $75m class of computer (such as the $60m one for NCAR/Wyoming).
   - NSF is reviewing their plans for the $200m computer. It might not happen.
   - Me: Also recall that NSF is not putting extra money into the NCAR/Wyoming computer. It is being paid for by Wyoming, and by using the present $4.5m/year for NCAR Mesa upgrades, and by $40m of low-interest Wyoming bond money (which NCAR must repay). What is called a $60m computer is only the building, unless they never build the whole structure.

5. The history of computer power at NCAR (1984 – on)

<table>
<thead>
<tr>
<th>Year</th>
<th>Speed</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984-85</td>
<td>54 Mf</td>
<td>From 2 Cray 1A computers, and with one processor</td>
</tr>
<tr>
<td>1987-88</td>
<td>220 Mf</td>
<td>From new Cray XMP-48; computer with 4 processors</td>
</tr>
<tr>
<td>1998</td>
<td>16.6 Gf</td>
<td>From a few computers</td>
</tr>
<tr>
<td>11/2000</td>
<td>~122 Gf</td>
<td>Several computers</td>
</tr>
<tr>
<td>01/2007</td>
<td>1900 Gf</td>
<td>After Blueice upgrade 12/06 + Bluevista still going.</td>
</tr>
<tr>
<td>09/2008</td>
<td>5400 Gf</td>
<td>After the next planned upgrade.</td>
</tr>
<tr>
<td>~09/2011</td>
<td>~16,200 Gf</td>
<td>At the Mesa, if an upgrade done. Not planned.</td>
</tr>
</tbody>
</table>

(Mf = Megaflop, Gf = Gigaflop)

6. The increase in computer real speed has been rapid. Moore’s Law says after 18 months, one can buy a new computer for the same cost as the time zero computer, but with twice the real speed. This also means that the increasing real speeds at NCAR Mesa will be delayed by 18 months compared with a computer that costs twice as much at time zero.

7. (July 6, 2007) A proposal for the Wyoming computer will go to NSF about mid July 2007. It will ask for more money for computer operating costs.
Upgrades for the NCAR Mesa Computers, 2006 – On

Roy Jenne
May 7, 2007

This brief note summarizes the likely real computing speed of big computers on the NCAR Mesa during 2006 -2011. Some other text will not be completely updated.

**Table 1. Upgrades to the big Table Mesa computers 2006 – on**

<table>
<thead>
<tr>
<th>Date</th>
<th>Computer</th>
<th>Elec Power kW</th>
<th>Processors</th>
<th>Real Compute Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/2006</td>
<td>IBM Blueice</td>
<td>283</td>
<td>1600</td>
<td>1350 Gflop</td>
</tr>
<tr>
<td>~08/2008</td>
<td>IBM upgrade</td>
<td>~600</td>
<td></td>
<td>~5400 Gflop</td>
</tr>
<tr>
<td>05/2011</td>
<td>Speed status</td>
<td>--</td>
<td>--</td>
<td>5400 Gflop</td>
</tr>
</tbody>
</table>

**Note 1:** The 08/2008 will have peak speed of 50 to 60 Tflop compared with 12 Tflop on Blueice. We assume that this upgrade will be 4x faster than Blueice above, giving 5400 Gflop.

**Note 2:**
- The 08/2008 upgrade will replace Blueice.
- The upgrade is scheduled to remain at NCAR until mid-2011.

**Table 2. Real Compute Power on the NCAR Mesa (2006 – 2011)**

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gflop</td>
<td>Gflop</td>
<td>Gflop</td>
<td>Gflop</td>
<td>Gflop</td>
<td>Gflop</td>
</tr>
<tr>
<td>Upgrade (Blueice)</td>
<td>0</td>
<td>1350</td>
<td>5400</td>
<td>5400</td>
<td>5400</td>
</tr>
<tr>
<td>Earlier compute (Bluevista)</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Earlier (Bluesky, other)</td>
<td>440</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total speed</strong></td>
<td><strong>940</strong></td>
<td><strong>1850</strong></td>
<td><strong>5900</strong></td>
<td><strong>5400</strong></td>
<td><strong>5400</strong></td>
</tr>
</tbody>
</table>

**Note:** In Table 1, Bluevista was rated at 470 Gflop. Other charts gave about 520 Gflop. We have used 500 Gflop above.

NCAR plans:

Shut down the NCAR Mesa big computers about mid-2011.
- If another upgrade of about 3x could be done in mid-2011, we would then have about 16.2 Tflop of real power on the Mesa.
  - This would be technically possible.
  - But the money needed will likely be used for the NCAR/Wyoming computer.

If another upgrade (of 3x) did happen in mid-2011 (not planned), we would have about 16.2 real Tflop of power on the Mesa.
A Few Key Documents About Computing at NCAR
(and elsewhere)

Roy Jenne
Apr 16, 2003
Rev May 2007

RJ0002: The Evolution of Supercomputing at NCAR (Rotar, Mar 1989, 34 p)


RJ0233: Selected Fast Computers and Options, 10/10/1994 (34 p)

RJ0235: Talks about NCAR Main Computers 04/1997 (47 p)

RJ0076: Accomplishments and Plans of SCD Computing, NCAR, FY93 – 98 (55 p)


How to find documents:
http://dss.ucar.edu/docs/papers-scanned/papers.html
News: NCAR Selects Wyoming for New Computer Center

(This fast computer is for NSF Geosciences)
Wyoming lassos supercomputer

By Todd Neff
Camera Staff Writer

The fastest computer in the West is headed to Wyoming. Boulder's National Center for Atmospheric Research announced Tuesday it will build its new $60 million national supercomputing center in Cheyenne. The supercomputer will, NCAR officials say, keep the United States at the forefront of weather, climate and Earth-system science for decades.

It will replace NCAR's aging Mesa Laboratory center in Boulder, which will reach its floor-space and power-supply limits by the end of the decade.

The Wyoming proposal beat out a University of Colorado offer to host the new center.

NCAR officials say that, pending approvals from NCAR-sponsor National Science Foundation and the state of Wyoming, groundbreaking is expected this year, and the new center should open in late 2010 or early 2011.

Richard Anthes, president of the University Corp. for Atmospheric Research—which manages NCAR—said Wyoming's plan roughly double the computing power possible with the CU offer, and in less time.

"The thing that tipped the balance was more computing power, faster, in Wyoming."

Please see WYOMING on 10A

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Wyoming wins NCAR supercomputer center

Continued from IA

Anthes said. "That had to be our major concern because we're a national center, and computing power is desperately needed."

The increase in power could help lead to "far more accurate forecasts of hurricanes" and more detailed simulations of the Earth's climate, NCAR officials say.

CU Chancellor Bud Peterson said that although losing the bid is a disappointment, the university plans to work with NCAR and Wyoming on aspects of the new center in such areas as biotechnology and space science. He said CU will be making a yet-undetermined "significant investment" in the supercomputing center and that CU scientists will in return get more computing time than the average institution.

CU offered a 13.5-acre parcel along Foothills Parkway on the university's East Campus as well as $5 million up front and long-term spending of about $30 million. But, as Peterson put it, "the state of Wyoming has tremendous resources."

Frances Draper, executive director of the Boulder Economic Council, said her organization supported the CU bid.

"We think NCAR and the computing facility are great economic generators in the state," Draper said. "We were just outgunned by Wyoming."

Revenue from oil and gas drilling have brought Wyoming large budget surpluses - enough that the state is socking away more than $300 million a year in a mineral trust fund.

Wyoming Gov. Dave Freudenthal will give a news conference Thursday to discuss specifics of the deal. Wyoming officials have said the state donated land for the center in the North Range Business Park, west of Cheyenne, and the state will let NCAR issue bonds to pay for the facility. The bonds will be paid by future payments from supercomputer users.

University of Wyoming President Tom Buchanan said the supercomputing center and the relationship with NCAR will "allow us to reap extraordinary benefits in the long term."

Krista Laursen, who is managing the data-center project, said staffing remains uncertain but that 40 to 50 people will work in the new center, some who will relocate from Boulder.

She said the center's supercomputer will be able to perform hundreds of teraflops per second—a teraflop is a trillion floating-point operations per second—and speed up from there. The world's fastest machine as of November ran at 280 teraflops, according to supercomputing ranking site www.Top500.org.
Wyoming win was a close one

CU lost bid to host new $60M supercomputer

By Todd Neff
Camera Staff Writer

Wyoming narrowly won the National Center for Atmospheric Research's new $60 million supercomputing center, and the University of Colorado's loss does not necessarily reflect a deeper competitive deficit for major science projects, NCAR and state officials say.

"It was neck and neck," said Jeff Reaves, NCAR's associate vice president for business services, who was deeply involved in evaluating the bids. "The CU folks really deserve a great deal of credit in my view for really working hard to put together a competitive offer."

The Wyoming supercomputer will keep the United States at the forefront of weather, climate and Earth-system science for decades, NCAR officials say. It also will take Boulder off lists ranking the world's fastest supercomputers and shift high-performance computing expertise out of the state.

Reaves said the decision, announced this week, boiled down to Wyoming putting more money up front, which will enable NCAR to install faster computers when the center opens in late 2010 or 2011.

He said also NCAR will be able to manage construction with a simpler review and approval process than would have been possible on CU land, allowing for faster completion.

Wyoming, in addition to running large budget surpluses thanks to swelling revenues from oil, coal and natural gas, is eligible for National Science Foundation money for states without much scientific investment. The NSF's Experimental Program to Stimulate Competitive Research, or EPSCoR, could bring an additional $6 million or more in National Science Foundation money to stimulate science in research infrastructure in states lacking it.

**THE BIDS**

**Wyoming**

- Wyoming won the right to host NCAR's new $60 million supercomputing center this week.
- Here's how its bid compared with CU's:
  - **Wyoming**
  - **$20 million** toward construction costs, pending legislative approval
  - **$1 million** a year for 20 years from the University of Wyoming
  - Electric grid connection capable of a 24-megawatt feed
  - 24 acres of land in Cheyenne's North Range Business Park
  - NCAR given the ability to issue debt through the state's bonding authority
  - Perhaps $6 million or more in National Science Foundation money to stimulate science in research infrastructure in states

**University of Colorado**

- **$11 million** in cash and building maintenance
- **Free rent** for the life of the project
- **Waiving** of $200,000 annually in overhead charges for 10 years
- **$1 million** a year for guaranteed computer time for 10 years
- **$2.5 million** over 10 years for five joint CU-NCAR faculty positions

CU also was working with state legislators for a $5 million special legislative grant to help cover the cost of a high-power electrical connection to the building.

Sources: State of Wyoming, Wyoming Business Council, University of Colorado
Decision close between CU, Wyoming

Continued from 1B

million to $9 million if recent awards are a yardstick.

Supplying power to supercomputers needing up to a 24-megawatt feed was also a challenge for CU. The entire CU campus has a 19-megawatt line, said Richard Porreca, CU's senior vice chancellor and chief financial officer.

"The land Wyoming was offering had the connection in place," Porreca said. "We were going to have to build it and put it into the CU Research Park."

The combination of the NSF money and power supply put CU at a $10 million to $15 million disadvantage right out of the chute, Porreca said.

He said it was a case where CU did its best and was competitive, given the circumstance, Porreca said.

He said the Boulder Chamber of Commerce, the city of Boulder and private industry folks stepped forward in support, in some cases contributing money.

Porreca did say that, over the long term, "I think Colorado will need to ask itself what levels of investment the state will need to make in order to sustain itself economically and scientifically."

David Skaggs, executive director of the Colorado Commission on Higher Education, said NCAR officials assured him that its atmospheric research work would continue in Boulder.

NCAR officials say the new center will employ 40 to 50 people, including high-performance computing experts who will probably move to Cheyenne.

Skaggs started working on the Colorado bid before he started his job — a reaction, Porreca said, to Wyoming's upping the ante during Colorado's transition to Ritter's leadership.

"I think this happened to have come along at an awkward time for state government to be as supportive of the university as we wanted to be or tried to be," Skaggs said. "I would like to think that if we had three or four months to work it, we would have come a lot closer to matching the Wyoming package."

Stein Sture, an engineering professor who helped lead CU's bid, said the university has deep supercomputing expertise and is negotiating with NCAR for a formal role in supporting the new supercomputing center.

"So I'm cautiously optimistic that the fat lady has yet to sing," Sture said.

Contact Camera Staff Writer Todd Neff at (303) 473-1327 or neff@dailycamera.com.
New data center to be based in Cheyenne

The news that so many were waiting for arrived in January, when NCAR announced that its supercomputers will have a brand new home in Cheyenne in 2010.

And not just any home. With up to 20,000 square feet of raised-floor computing space, the $60 million supercomputing center has been described as the “Taj Mahal of data centers” by NCAR deputy director Larry Winter.

NCAR is building the center in partnership with the University of Wyoming, the State of Wyoming, the Cheyenne—Laramie County Corporation for Economic Development, the Wyoming Business Council, and CU-Boulder.

“We are excited to work on this extraordinary and pathfinding project with our colleagues at the University of Wyoming and the University of Colorado to form new bridges of scientific inquiry,” says Tim Killeen, NCAR director. “The data center project is a major step for NCAR that will advance research in the geosciences and enable us to greatly improve our understanding of the world around us.”

The computers, which will be upgraded regularly, will initially achieve speeds of hundreds of teraflops. A teraflop is a measure of a computer’s speed that can be expressed as a trillion floating-point operations per second.
Data center (continued from page 1)

operations per second. By the time the new center opens, it may be possible to acquire computers with speeds measured in petaflops, or a thousand trillion floating-point operations per second. Such a computer is a million times faster than an already-fast personal computer.

The road to Wyoming

NCAR considered partnerships for the data center with a number of organizations along the Front Range, giving CU-Boulder and the University of Wyoming particularly close scrutiny. NCAR also looked into leasing space and retrofiting an existing data center.

With support from NSF and the UCAR Board of Trustees, NCAR chose to locate the center in Wyoming after a rigorous evaluation, concluding that this partnership would facilitate getting the greatest computing capability for the regional and national scientific community at the earliest possible time.

"The Wyoming offer provides more computing power, sooner, and at lower cost," Tim explained during an all-staff town hall meeting on January 31. "We've secured the future of NCAR's role in leadership computing."

The Wyoming offer consists of a 24-acre "shovel-ready" site for construction in the North Range Business Park in Cheyenne near the intersection of I-80 and I-25, along with physical infrastructure for fiber optics and guaranteed power transmission of 24 megawatts.

The University of Wyoming will provide $20 million in endowment funds for construction, as well as $1 million annually for operations. NCAR will utilize the State of Wyoming's bond program to fund construction, with the state treasurer purchasing bonds that will be paid off by NCAR.

Although CU-Boulder's offer would have given the new center greater proximity to other NCAR facilities, it would have left NCAR with a mortgage of $50 million rather than $40 million and less long-term financial savings. The Cheyenne site offers cheaper construction costs and lends itself to future expansion. It also brings a transformative partnership to a state that has traditionally lacked opportunities in technology and research.

Environmental impacts

The new center will be the first NCAR facility to earn LEED (Leadership in Energy and Environmental Design) certification for its design, construction, and operation. Measuring 108,000 square feet in total with 15,000-20,000 square feet of raised floor, it will be built for 8 megawatts of power, with 4-5 megawatts for computing and 3-4 for cooling. The power will be generated primarily from "clean" coal (coal that has been chemically scrubbed to reduce emissions of harmful pollutants) via Cheyenne Light Fuel and Power. NCAR is also aggressively working to secure the provision of alternative energy (wind and solar) for the facility, hoping to attain an initial level of 10%.

"We're going to push for environmentally friendly solutions," Tim says.

Building bridges

CU-Boulder will serve as one of the center's founding partners with NCAR and Wyoming. According to Tim, NCAR expects these partnerships, stimulated by the data center, to lead to new and fruitful scientific collaborations. The center is expected to generate collaborations with other institutions as well as part of an effort to develop a cyber-collaboratory.

One challenge the new center poses is that it will require staff relocation to Cheyenne, as about 40-50 positions are associated with the new center. CISL director Al Kellie stressed during the town hall meeting that the organization has three years to consider various staffing arrangements and determine how to best manage staff in two locations.

Pending approval by the Wyoming legislature and NSF and completion of a facility design and review process, construction should begin within about one and a half years. Krista Laursen, who served as project director for the acquisition of the NSF/NCAR Gulfstream-V aircraft (HIAPER), will direct the Data Center Project Office.

"All of us working on this project are very excited to get started with the facility design process in the next few months," she says. *Nicole Gordon
NCAR has made a 20-year agreement with Wyoming, which goes into effect Oct 2007. To establish this computing site near Cheyenne, Wyoming has donated 24 acres of land (with a value of $3.5m). Then there are costs for the building, the computer, operating costs, and cost to update the computer each few years.

The cost for the building is $60m. Wyoming will give $20m of the $60m and permit NCAR to purchase $40m of bonds to pay for the rest. NCAR will make annual payments to pay off the bonds. The building will include space for the computer, space for a staff of 40-50, cooling systems for the computer, a line to bring in electricity, but not the computer. About $5m is needed to design the building. This will be paid from other funds, and is not part of the $60m.

Cost for the NSF Geo computer to be installed in 2010/2011. NCAR now receives about $4.5m/year to purchase a new computer each few years. Wyoming will add $1m/year to this amount (thus a gift of $20m over 20 years). It is likely that NSF will augment this by about $3.5m/year (not settled) so that the new Geo computer can be purchased for about $30m in 2010. This computer would have about 20x the real computing power of Blueice (which arrived at NCAR Oct 2006). The real speed of Blueice is 1350 Gflop. Thus its real computing power would be about 27 teraflops.

There will be an upgrade to the NCAR Mesa computer in 08/2008 (from previous contracts). It will have a real speed of about 5400 Gflops. The speed of the 2010/2011 NCAR/Wyoming computer for NSF Geo will be about 5.0x faster than the 2008 upgrade. Then it is planned that there will be no more upgrades to the NCAR Mesa computers. It is anticipated that the roughly $9m/year would continue to buy upgrades in Wyoming for the life of the 20 year contract.

About 2012, the fast computers and the mass store will be removed from the NCAR Mesa. That will be a change. The computers have seemed like part of the family. NCAR has had fast computers in Boulder since 1963. The real computer speed at the Mesa site changed from 54 megaflops (1985) to 120 gigaflops (11/2000) and now is much higher. If the NCAR Mesa computer did have another upgrade in 2010 (it will not), then it’s real speed would be about 18 Tflops.

Operating costs: About 2005, NCAR said that present NCAR operating costs are about $7.5m per year but that the costs to operate a faster distant facility might be twice this. The scale is reduced now. Let us assume that these costs will be $7 to 9m per year. A continuation of present NCAR budgets will pay for these costs. But note that for 1 or 2 years we will need to pay for operations in both locations.

There are additional staff in the computing division at NCAR, and they will continue to be paid by a continuation of NCAR present budgets.

Who will own the land and the building in Cheyenne at the end of 20 years? The 24 acres of land and the building will then belong to NCAR/UCAR. In the bid from U of CO, the land and the building would be owned by the U of CO at the end of 20 years.

There were stories about the NCAR/Wyoming computer agreement in the NCAR Staff Notes (Feb 2007) and in the UCAR Quarterly (Winter 2006-7, available March 2007).

The cost of the computing facility was advertised as $60m but this only pays for the building in Cheyenne.
The NSF Computer for Geosciences

Roy Jenne
Feb 8, 2007

The NSF Geo-computer; how much capability?
(Located at Cheyenne, Wyoming, cost $60m)

The NSF Geosciences computer is expected to start production in late 2010 or in 2011 (in about 4 years). The computing power will be about 20 times the present fast Blueice computer that arrived 10/2006 (which delivers a real 1350 Gflop). Thus the computer for NSF geosciences will deliver a real power of about 27 teraflops. The 20x number was from an NCAR staff briefing on Jan 31, 2007.

The planning for this computer is an NCAR project, with help from Wyoming and others.
The New NCAR Chemistry Building for Comparison

Roy Jenne
March 26, 2007

The Chemistry Division moved from the NCAR Mesa building to the new NCAR chemistry building in the Foothills Lab, 4 miles to the northeast. The division had a lot of chemistry labs on the NCAR Mesa, and their offices were in the B Tower.

When they moved in March 2006, it freed up a lot of space on the Mesa.

◆ The new chemistry building has a total of 78,740 sq ft of floor area (on four floors).
  - The footprint of the building on the land is about 17,700 sq ft (0.41 acre).
◆ The cost of the building was about $23 million. (£23m)
◆ It includes about 170 offices.
◆ It has about 22,650 sq ft of chemistry labs.
◆ The ground floor has about 14,780 sq ft for computers, boilers, chillers, electrical switches, and for future expansion as needed.

NOTE: I have a copy of the floor plans for the building (one 8x10 page for each floor).

ALSO: One acre has 43,560 sq ft (and 4046.87 sq meters). One hectare is 100 by 100 meters.
Computer operations floor space at NCAR Mesa

(Floor Space)

This does not count the operations offices which are outside of the computer room.

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<tr>
<th>Floor sq feet</th>
<th>Comments</th>
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<tr>
<td>7470</td>
<td>Deep raised floor for the main computer area</td>
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<tr>
<td>1220</td>
<td>For 5 data storage sites (concrete floor)</td>
</tr>
<tr>
<td>4030</td>
<td>For backup tape storage (shallow raised floor)</td>
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<tr>
<td>230</td>
<td>For operator area (not raised floor)</td>
</tr>
<tr>
<td>~200</td>
<td>For access to the above items</td>
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<tr>
<td>~9200</td>
<td>For UPS electricity backup and</td>
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<td></td>
<td>(50%) for air conditioning (chiller) (50%)</td>
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<tr>
<td>22,350</td>
<td>Total area for the operations functions</td>
</tr>
<tr>
<td></td>
<td>(not include the offices)</td>
</tr>
</tbody>
</table>

20
2) Compare space needs for computing functions

(At NCAR Mesa and Wyoming)

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<thead>
<tr>
<th></th>
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<th>Wyoming</th>
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<tr>
<td></td>
<td>03/2007</td>
<td>Cag 07</td>
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<tr>
<td>(sq ft)</td>
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<td>35,000</td>
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<tr>
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<td>Data storage silos</td>
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<td>16,000</td>
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<td>Operator area</td>
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<tr>
<td>Air conditioning, UPS</td>
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<td>42,000</td>
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<tr>
<td>elc., etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total for ops area</strong></td>
<td>22,350</td>
<td>93,000</td>
</tr>
</tbody>
</table>

Note: This is preliminary to help us understand these numbers and the comparisons.

— Tony Jerome

Mar 2007

- Note: The total Wyoming computing building will have 108,000 sq ft (if it is completely built). It will have offices for a staff of 40 or 50 people.

- For reference, the NCAR chemistry building (now in early 2006) has 78,740 sq ft.
Gary,

This is what I have for Square footage:

* Blue Vista = 512 sqft
* Blue Ice = 720 sqft
* Lightning = 112 sqft
* Coral = 36 sqft
* Pegasus = 48 sqft

Julie

Gary New wrote:

Julie,

Would you please put together a couple of numbers for me?

1) Square footage (foot print) of all equipment associated with
   * Blue Vista
   * Blue Ice
   * Lightning
   * Coral
   * Pegasus

Please do not forget associated equipment such as DASD (I think that is correct). These should be pretty easy to get off the CAD drawings. Let me know when you have the numbers. Thanks

Gary

Julie Harris
Infrastructure Support Group
National Center for Atmospheric Research
PO Box 3000, Boulder CO 80307

"Life is too short to go slow"

22

7/2/2007 4:24 PM
A Petascale Computing Collaboratory (09/2006)

NCAR pushes a Petascale Computing Collaboratory for Geosciences Research

Roy Jenne
April 2007

1. What does this mean?
   - A very fast computer.
   - Plus various software services.

   *Collaboratory*

   (A collaboratory refers to a community-specific computational environment that, in addition to high-performance computers, provides end-to-end services such as visualization, data and information management, and user interfaces suited to petascale computational problems.)

2. NCAR hosted a planning meeting in Boulder Sep 25 – 27, 2006
   - The head of NSF geosciences was there.
   - NCAR pushed the geocollaboratory idea.

3. News late Oct 2006: NCAR plans for the fast computer for NSF geosciences were put on hold.
   What happened? NSF had been hearing about the need for lots more computing power for geosciences. But now the emphasis seemed to be on lots of software work, even more than on more computing power. I suspect that they were understandably confused at NSF.
   - So the NCAR deal with either the University of Colorado, or Wyoming was put on hold.

4. And a meeting about the geocollaboratory was held at AGU in Dec 2006. See the material from EOS, etc., in this text about geocollaboratory.

5. Concerns: Software systems that are too big and too all encompassing have a poor history. Many big systems just fail. They tend to lack focus, cost too much, take too long, and accomplish too little. More about this later.
Scientists pursue nationwide network

Continued from 1C

"Essentially the NSF came back to us and said they would like to take a much more holistic view as to what the country's geoscience-specific computer infrastructure should look like," said Richard Loft, NCAR's director of technology development in computational information systems. "The NSF wanted to make sure the data center fits into the strategic context of what they want to do."

Such a future geocollaboratory would use so-called visualization tools to make the massive outputs of supercomputers understandable to researchers, just as Excel charts and graphs do for the endless rows and columns of large PC spreadsheets. Such a collaboratory would also standardize the data languages spoken by scientists in different fields of earth science, as well as organize data storage and handle archiving.

Loft gave the example of an expert in ocean plankton trying to share information with someone studying ancient asteroid strikes. Today, they probably would have a hard time working together, he said.

In late September, NCAR arranged a Boulder meeting of 125 scientists to discuss a future earth-science network. The consensus was that scientific models increasingly incorporate diverse fields and make such collaboration vital to future scientific advancement, Loft said.

You can't study the finger and develop a model of human health," he said.

Juri Toomre, a CU astrophysics professor who uses supercomputers to study such things as convection and turbulence, attended the meeting and said scientists were generally enthusiastic about the collaboratory idea.

Stein Sture, the CU engineering professor spearheading CU's bid for the center, says he views the September meeting as an effort by NCAR to build consensus around the new supercomputing center. He said he doesn't expect an announcement on the new data center until late spring.

Krista Laurisen, NCAR's project manager on supercomputing center, said the new NCAR supercomputing center and the proposed geocollaboratory remain separate projects. Despite the delay, the supercomputing center could still open in 2010, she said.

NCAR needs more space for its own supercomputers, and soon: The 13,000-square-foot Mesa Laboratory supercomputing center will be packed by 2009 or 2010, NCAR officials say.

Contact Camera Staff Writer Todd Neff at (303) 473-1327 or neff@dailycamera.com.
A fast computer for Geoscience work

I plan to prepare a few summary
tips about taking one of science
data's pitfalls to avoid; lessons from
NASA experience; how to make a
30 year archive work, etc. -- Roy Neffe
Feb 2007

NCAR data center on hold

Decision delayed while more holistic approach discussed

By Todd Neffe
Camera Staff Writer

The goal of the workshop is to provide the geosciences directorate with a compelling, community-supported plan for implementing the vision of the 'Petacalé Collaboratory for the Geosciences'.

But a "geocollaboratory" has intervened. It could be months before NCAR decides between a University of Colorado bid and one from Wyoming.

Rather than focusing on climate and atmospheric models, the new NCAR supercomputing center would be part of a national geocollaboratory, or network of high-speed computers and specialized software dedicated to research in earth science.

Oct 31, 2006

This focus seems odd!
Petascale Computing for Geosciences Research

A 2005 report describes the opportunities facilitated by and the feasibility of, establishing a leadership-class computing facility dedicated to geosciences research. A forthcoming workshop will focus on implementation of the vision outlined in this report.

The geosciences research community has progressed significantly in its ability to monitor and model components of the Earth system, and now is poised to make significant breakthroughs in understanding the system as a whole. Computational simulation, along with theory and observation, has become established as a fundamental methodology for making progress in Earth system science. Increasingly, numerical simulations are not only tested by observations, but they also provide the first glimpses of new phenomena and quantitative characterization of complex processes. In turn, simulations inspire new theoretical investigations and observational strategies. For example, properties of complex minerals at temperatures and pressures inaccessible to laboratory measurements are beginning to be derived from first-principles-based computations with accuracies sufficient for direct input to Earth models.

Despite the critical reliance on simulation for advancing the field, geosciences research in the United States is being impeded by an acute shortage of high-end computational resources. An ad hoc committee, working on behalf of the atmospheric, solid Earth, ocean, and space science communities, with the encouragement of the U.S. National Science Foundation (NSF), was formed in August 2004 to develop a strategy to address this gap between the scientific requirements for, and the availability of, high-end computational resources. In June 2005, the committee produced a two-part report (available at http://www.joss.ucar.edu/joss_psg/meetings/petascale) containing (1) a technical and budgetary prospectus for a national investment in leadership-class computing systems dedicated to geosciences research, and (2) an overview of the scientific advances such a resource would facilitate.

The overarching recommendation of the committee is to establish a 'Petascale Collaboratory' for the geosciences "with the mission to provide leadership-class computational resources that will make it possible to address—and minimize the time to solution of—the most challenging problems facing the geosciences."

Petascale refers to computational systems with peak speeds of one petaflop ($10^{15}$ floating-point operations per second) or more, and with memory capacities of the order of one petabyte ($10^{15}$ bytes). A collaboratory refers to a community-specific computational environment that, in addition to high-performance computers, provides end-to-end services such as visualization, data and information management, and user interfaces suited to petascale computational problems. By the end of this decade, the leadership-class systems called for should reach petascale capability. Such a resource would enable geoscientists to conduct breakthrough research on the fundamental processes that determine the structure, dynamics, and metabolism of the Earth system.

Scientific frontiers that would be opened across the breadth of the geosciences by establishment of the collaboratory are described in the report. For example, petascale capability would facilitate the expansion of Earth system models to allow investigations of the coupling and feedbacks between climate and Earth system elements such as the global nitrogen cycle, mineral dust and other aerosols, tropospheric and stratospheric chemistry, dynamic ecosystems, and surface and subsurface hydrology.

As another example, from global seismology, petascale capability would allow scientists to simulate and analyze seismic waves down to the shortest observable periods, providing insight into structures and regions within the Earth that are inaccessible with current capabilities.

The National Center for Atmospheric Research is hosting a workshop on 25–27 September 2006 and is seeking participation from the NSF geosciences community in planning and scoping a High Performance Computing Research Consortium for the Geosciences. The goal of the workshop is to provide the geosciences directorate with a compelling, community-supported plan for implementing the vision of the Petascale Collaboratory for the Geosciences.

Key issues to be addressed during the September workshop include the following:

- What governing and allocation models make sense for the full geosciences community?
- How should a high-capability compute node be designed and optimized to support the geosciences community?
- What is the 'sweet spot' for capability computing in the geosciences that balances budgetary realities against geosciences research requirements?
- What research opportunities, in addition to those described in the petascale reports, are being missed due to constraints of the current NSF computing infrastructure?
- What is the best balance between capability and capacity for the geosciences?

Researchers funded by the NSF Directorate for Geosciences are encouraged to attend this workshop and help shape the future of high-performance computing in the geosciences. More information is available at the workshop Web site: http://www.ncar.ucar.edu/Director/dcworkshop

—FRANK BRYAN, National Center for Atmospheric Research, Boulder, Colo.; Email bryan@ucar.edu

1. The issue has been to get more computer power to run models.
2. It surprised me that this article emphasizes the "collaboratory" idea more than the computing power.
   - Roy Jones

5 Sept 2006
At the Fall Meeting: AGU

Toward Broad Community Collaboration in Geoinformatics

A Town Hall meeting at the upcoming AGU Fall Meeting will be held under the theme "Envisioning the future of Earth science data and knowledge access through a broad national geoinformatics collaboration."

Geoinformatics (GI) is understood as a distributed, integrated digital information system and working environment that provides innovative means for the study of the Sun-Earth system and other planets through the use of advanced information technologies. It is an emerging science and technology frontier, and it is increasingly recognized as a relevant part of the broader cyberinfrastructure for the sciences (see U.S. National Science Foundation Blue Ribbon Panel Report at http://www.nsf.gov/od/oci/reports/toc.jsp), both within the academic and applied Earth and planetary science and computer science communities as well as in federal and state agencies.

GI is built on a broad range of disciplinary activities, from major research and development efforts that develop new technologies to provide high-quality, sustained production-level services for data discovery, integration, and analysis, to small, discipline-specific efforts that develop data collections and data analysis tools that serve the needs of individual communities.

Many GI-related service and research activities have become visible over the past five years. However, the impact of GI on research and education, and the efficiency and effectiveness with which it is developed, maintained, and operated, depends on community-based coordination and integration of all these activities. At its heart, GI requires collaboration among geoscientists, information scientists, and computer scientists. The distributed and integrative aspect of GI represent its power as well as its challenges. The Town Hall meeting provides a forum for minimizing redundant GI efforts and for promoting communication and coordination efforts to increase sharing of expertise and technologies.

Over the past few years, a broad consensus has emerged from many workshops, discussions, and white papers that healthy growth in GI will require multiagency and professional society partnerships as well as collaboration among individual projects.

There also is a consensus among the conveners of this Town Hall that no single group can claim that it is the universal organizer, consolidator, or focal point for GI; instead, any GI organization that is accepted on a broad and encompassing basis needs to come from a long and deliberative process of bringing people together where the focus and leadership boils up out of that group.

This Town Hall seeks comments on extending partnerships, such as the Electronic Geo-physical Year (eGY), the International Polar Year (IPY), the International Heliophysical Year (IHY), the International Year of Planet Earth (IYPE), iGeoinfo, and Geoinformatics 2007, as well as on establishing new informatics organizations within professional societies in the United States and in other countries. The Town Hall also is intended to promote communication and to involve scientists and educators who will provide the intellectual rationale for growing GI and seeks to identify synergistic connections to the general cyber-infrastructure community.

The Town Hall Forum includes a panel of leading practitioners and scientists to address questions such as the following:

- What are the challenges in making this a collaborative national or international effort? How do geoscientists continue the process of community building and move the GI community closer to a coherent alliance of projects and people who can advance the promises of GI?
- Are sustainable collaborations between discipline and computer scientists in place now? How do they and how can they help to achieve a balance between a research frontier and a service to science?
- What new approaches can help engage the broad science and education community in GI?
- How can funding agencies support this initiative and what funding opportunities currently exist? What role can professional societies play?
- How does the community define priorities for future international alliances? What specific disciplinary science goals (if any) could not be met without GI?

The panel also will respond to questions and comments from participants.

The meeting will be on Monday, 11 December 2006 at 6:30 p.m. in the Marriott Hotel in San Francisco. For further information, including location details, check the meeting program, flyers at the meeting, and the website: http://vsto.hao.ucar.edu/AGUTownHall.html

-Peter Fox, High Altitude Observatory, National Center for Atmospheric Research, Boulder, Colo.; Email: pfox@ucar.edu; LINDA GUNDERSEN, U.S. Geological Survey, Reston, Va.; KERSTIN LEHNERT, Lamont-Doherty Earth Observatory, Columbia University, Palisades, N.Y.; DEBORAH McGUINNESS, Stanford University, Stanford, Calif.; KRISHNA SINHA, Virginia Polytechnic Institute and State University, Blacksburg; and WALT SNYDER, Boise State University, Boise, Idaho.

Peter Fox, NCAR

This belongs to a certain type of data planning effort. The geosciences community will need to be careful.

Ray Jetta, NCAR
NSF: Director Arden Bement says he's "more than happy" for a budget that has room for a $52 million initiative to add computational elements into the biological and physical sciences and engineering as well as a $24 million increase in a $90 million program for major research infrastructure at universities with limited endowments. NSF hopes to add 200 graduate research fellowships in 2008.

With regard to major new facilities, the agency has requested $32 million to begin upgrading the Laser Interferometer Gravitational-Wave Observatory, and it has stretched out the scheduled ramp-up of national environmental and ocean observatory networks because of continued tweaking of their designs. Bement says he also hopes to win congressional approval in 2007 to begin building a $120 million Arctic research vessel.

SPACE: NASA Administrator Michael Griffin says he is happy with the proposed 3.1% increase over the president's 2007 request. But the 2007 budget coming down the pike from the new Democratic-run Congress is quite another matter. "We're on the receiving end of a budget we don't like," grumbles Griffin, referring to a half-billion-dollar reduction in NASA's effort to build a new launcher to take humans to the moon. That cut, if it holds up, could greatly extend completion of the system, now planned for 4 years after the shuttle's last flight in 2010.

DEFENSE: The silver lining in an 8.7% cut for basic research at the Department of Defense (DOD) is a big boost to the National Defense Education Program, from $19 million to $44 million. The program, begun in 2006, provides scholarships to U.S. undergraduate and graduate students in science and engineering disciplines related to national defense in hopes

### A Science Budget Up for Grabs (in $ Millions)

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<th>2008 Cut</th>
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<td>1,677</td>
<td>76</td>
<td>-4.3%</td>
</tr>
<tr>
<td>National Science Foundation</td>
<td>1,753</td>
<td>1,677</td>
<td>76</td>
<td>-4.3%</td>
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<tr>
<td>National Science Foundation</td>
<td>1,753</td>
<td>1,677</td>
<td>76</td>
<td>-4.3%</td>
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<tr>
<td>National Science Foundation</td>
<td>1,753</td>
<td>1,677</td>
<td>76</td>
<td>-4.3%</td>
</tr>
</tbody>
</table>

Pick a number. The current House spending plan may be the best yardstick to measure the president's request for 2008, because Congress hasn't completed work on the 2007 budget.

9 Feb 2007

Roy Yenna

Feb 2007
Movers >>

FAMILY-FRIENDLY CLIMATE. The head of geosciences at the National Science Foundation is going to work next month for her Silicon Valley–based entrepreneur son on a start-up venture that’s part of a new wave of “greentech” companies. Margaret Leinen, who has led the $700 million directorate for 7 years, announced this month that she will be joining Climos, a San Francisco–based research company backed by her 38-year-old son, Dan Whaley. In 1994, Whaley co-founded an online travel reservations company that was sold in 2000 for $750 million.

Leinen, a paleoclimatologist and former dean of oceanography at the University of Rhode Island, will become the chief scientific officer for Climos, which CEO Whaley says is investigating “a number of promising natural processes to mitigate climate change.” Leinen, who will open a Washington, D.C., office for the company, says that she hopes her efforts will build ties between environmental scientists and industry. “I’m also thrilled to have the chance to work with my son.”

Looking Closely at Oligocene Climate

Changes in solar forcing caused by Earth’s orbital motion not only have direct effects on climate but can also exert indirect effects on greenhouse gases such as CO₂. Pälike et al. (p. 1894) assembled a detailed, 13-million-year–long record of oxygen and carbon isotopes that span the entire Oligocene, a key period of Earth’s transformation from a warm world essentially free of high-latitude ice sheets to one with persistent glaciation in Antarctica. Using a box model of the carbon cycle, they show how the global carbon cycle can amplify long-term solar forcing and attenuate shorter-term ones in a manner controlled mainly by the residence time of carbon in the oceans.

From Red to Dead >>

There has been talk for decades about replenishing the rapidly shrinking Dead Sea, between Israel and Jordan, by channeling water from the Red Sea.

Last week, the two countries and the Palestinian Authority agreed at a meeting in Jordan to study the idea. The World Bank is rounding up donors to finance a 2-year, $15.5 million analysis of the feasibility of transferring water 180 kilometers through Jordan via a canal from the Gulf of Aqaba.

The Dead Sea’s water level is now sinking by about a meter a year, accelerated by draw-offs from its main source, the Jordan River, as well as an 80-year dry phase in the Middle East. In addition to stemming the decline, a water transfer would open opportunities for hydropower and desalination, both of which could harness the 400-meter drop between the Red and Dead seas.

Environmentalists say the project, estimated to cost $5 billion and take a decade, would disrupt numerous ecosystems. The biggest risk is salinization of groundwater near the canal, says Boston University geologist Farouk El-Baz. But he says “it’s a good idea” that could help ease political problems by boosting the economy.
Speed History of past Main NCAR Computers
(1963 - on)

1. A Few Key Documents About Computing at NCAR (1 page)
   (and elsewhere)

   Roy Jenne
   Apr 16, 2003
   Rev May 2007

2. The Speed of Selected Past Main Computers at NCAR (3 pages)
   ((1963 - 2008))

   Roy Jenne
   Oct 11, 2006

3. Part 2. Brief History of Recent NCAR Fast Computers (4 pages)
   ((1984 thru 2012))

   Roy Jenne
   Feb 6, 2007

30
The Speed of Selected Past Main Computers at NCAR

Recent years

1. The total real speed of main computers, NCAR Mesa, 2000 to 2008

<table>
<thead>
<tr>
<th>Date</th>
<th>Real Gflop</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/2000</td>
<td>~122</td>
</tr>
<tr>
<td>11/2002</td>
<td>~381</td>
</tr>
<tr>
<td>09/2005</td>
<td>~950</td>
</tr>
<tr>
<td>01/2007</td>
<td>1900</td>
</tr>
<tr>
<td>09/2008</td>
<td>4640</td>
</tr>
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</table>


(Earlier years), 1966–1998

<table>
<thead>
<tr>
<th>Date</th>
<th>Computer</th>
<th>Power</th>
<th>Steady Mflop</th>
</tr>
</thead>
<tbody>
<tr>
<td>6/1966</td>
<td>CDC 6600</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>7/1971</td>
<td>CDC 7600 + 6600</td>
<td>7.8</td>
<td></td>
</tr>
<tr>
<td>7/1977</td>
<td>Cray 1A + 7600</td>
<td>1.2</td>
<td>34</td>
</tr>
<tr>
<td>1981-82</td>
<td>Cray 1A + 7600</td>
<td>1.2</td>
<td>34</td>
</tr>
<tr>
<td>1984-85</td>
<td>(2) Cray 1A</td>
<td>2.0</td>
<td>54</td>
</tr>
<tr>
<td>1987-88</td>
<td>Cray XMP 4.8</td>
<td>8.3</td>
<td>220 measured</td>
</tr>
<tr>
<td>5/1990</td>
<td>Cray YMP 8.64</td>
<td>20.1</td>
<td>~800</td>
</tr>
<tr>
<td>1/1997</td>
<td>Cray C-90/16</td>
<td>4650</td>
<td>measured</td>
</tr>
<tr>
<td>1998</td>
<td>A few</td>
<td>~16,650</td>
<td></td>
</tr>
</tbody>
</table>

NOTE: A Cray C90/16 was often called a 5 Gflop computer. It was still faster on weather forecast models with long vectors; ECMWF called it a 6 Gflop computer. The above 4.65 Gflop is a steady rate over a mix of jobs at NCAR.
index emphasizes the ability to make numeric calculations. (The PCs, for example, are better than these comparisons for general calculations). The approximate cost of the computer is used to calculate a cost per equivalent CRAY-1A. The comparisons are not exact, but give an indication of costs between recent computers and over 25 years of time. No allowance is made for the decreasing value of the dollar with time. The CRAY-1A could produce calculations on significant codes at a rate of about 27 megaflops. More details are in Appendix III. To obtain cost per megaflop in the tables below, divide the cost per CRAY-1A by 27. (This applies for applications that are similar to Linpack in speed).

a. Supercomputers at NCAR

The series of fast computers at NCAR also represents quite a good history of the world’s fastest computers. The speed comparisons are for a mix of real problems.

<table>
<thead>
<tr>
<th>Year</th>
<th>Computer</th>
<th>Memory</th>
<th>Cost ($1000s)</th>
<th>Speed vs. CRAY-1A</th>
<th>Cost Per CRAY-1A ($1000s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1964</td>
<td>CDC 3600</td>
<td>?</td>
<td>0.015</td>
<td>1.0</td>
<td>8,900</td>
</tr>
<tr>
<td>1966</td>
<td>CDC6600</td>
<td>0.5 MB</td>
<td>6,000(?)</td>
<td>0.044</td>
<td>36,000</td>
</tr>
<tr>
<td>1971</td>
<td>CDC7600</td>
<td>8,200</td>
<td>0.22</td>
<td>20,100</td>
<td>893</td>
</tr>
<tr>
<td>1977</td>
<td>CRAY-1A</td>
<td>8 MB</td>
<td>8,900</td>
<td>20,000</td>
<td>353</td>
</tr>
<tr>
<td>1986</td>
<td>CRAY XMP/4</td>
<td>8x8 MB</td>
<td>20,100</td>
<td>8.0</td>
<td>2,510</td>
</tr>
<tr>
<td>1990</td>
<td>CRAY YMP/8</td>
<td>8x64 MB</td>
<td>20,000</td>
<td>22.4</td>
<td>893</td>
</tr>
<tr>
<td>1992*</td>
<td>CRAY C90,16</td>
<td>8x256 MB</td>
<td>34,000</td>
<td>96.3</td>
<td>353</td>
</tr>
</tbody>
</table>

* Not at NCAR

Note: The CDC 3600 came to NCAR in 1964. It had 32,768 words, 48 bits each (a nice choice). The memory on the CDC 6600 was 65,500 words (60 bits each). On the 7600 there were also 65,500 words of high speed memory. In addition, there were 512,000 words (also 60 bits each) of slower memory.

b. Some Mid-Cost Computers

A small selection of mid-range computers are presented here. The VAX was no bargain for large-scale computing, but it was very useful to the scientific community to accomplish a whole range of tasks at the local level.

In 1988-89, the Ardent and Stellar computers were sold in large part because of superior graphics. However, their cost-effectiveness for calculations also surpassed most competitors.

<table>
<thead>
<tr>
<th>Time</th>
<th>Computer</th>
<th>No. Proc.</th>
<th>Mem.</th>
<th>Disk (MB)</th>
<th>Cost</th>
<th>Speed vs. CRAY-1A</th>
<th>Cost Per CRAY-1A ($1000s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1983</td>
<td>Vax 11/780</td>
<td>1</td>
<td>2 MB</td>
<td>456</td>
<td>$200,000</td>
<td>.01</td>
<td>20,000</td>
</tr>
<tr>
<td>Oct 1988</td>
<td>Ardent</td>
<td>2</td>
<td>32 MB</td>
<td>2x380</td>
<td>$80,000</td>
<td>.27</td>
<td>296</td>
</tr>
<tr>
<td>Oct 1990</td>
<td>Stardent</td>
<td>4</td>
<td>128 MB</td>
<td>2x650</td>
<td>$125,000</td>
<td>.98</td>
<td>128</td>
</tr>
</tbody>
</table>
Tables to show the speed of main computers at NCAR Mesa

- 1963 to now (07/2007)
- When computer came and departed
- Electric power use
- Clock speed of CPU chips
- Number of processors
- Peak possible GFlops
- Sustained (or real) GFlops

Three pages follow:

- Memo from Jim Hack about BlueIce speed
- Table of computers from Tom Engel (Oct 2006)
- Table " " " " " " " " (July 2007)

Ray Fenne
Dear Roy,

I asked for some help in response to the question you taped to my door last week. Your question was related to the sustained performance of blueice. Here is what I found out:

The CAM GFLOP numbers are from a performance site that Tom Engel maintains. According to his analysis CAM (FV, 1.9x2.5) was running at 12.8-GFLOPS sustained on 1 node of blueice, and he claims that that's 10.5% of peak. That implies a peak sustained rate of 122-GFLOPS on 1 blueice node. For the whole machine which comprises 100 16-way nodes, that's 12200-GFLOPS, or 12-TFLOPS. This agrees with the number on the blueice web page:

>> Sixteen hundred processors are dedicated to batch job processing.
>> providing a peak of 12.16 TFLOPs for batch computing.

So, based on CAM, blue ice would deliver 1280 GFLOPS (sustained).

At this point, Roy, I do not spend a great deal of time keeping up with these sorts of details. It's no longer a trivial matter to accurately come up with these performance numbers. I've been satisfied to get into the details at procurement time, and then to verify that the promised performance is what we expected. So far, so good. It seems to me that SCD (aka CISL) does a very good job tracking the performance of the supercomputer equipment on major NCAR applications. So the folks in your division are generally in a much better position to quickly provide the most up to date info on how well the machines are performing.

Best wishes ...

-- Jim
### History of main fast computers at NCAR, 1963 - 9/2006

<table>
<thead>
<tr>
<th>Start Year</th>
<th>End Year</th>
<th>Equipment</th>
</tr>
</thead>
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<td>6/1/1963</td>
<td>6/1/1966</td>
<td>CDC 3600</td>
</tr>
<tr>
<td>6/1/1966</td>
<td>5/1/1977</td>
<td>CDC 6600 S/N 7</td>
</tr>
<tr>
<td>7/1/1971</td>
<td>4/1/1983</td>
<td>CDC 7600 S/N 12</td>
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<tr>
<td>7/1/1977</td>
<td>1/1/1989</td>
<td>CRI Cray 1A S/N 3</td>
</tr>
<tr>
<td>5/1/1985</td>
<td>5/1/1986</td>
<td>CRI Cray 1A S/N 14</td>
</tr>
<tr>
<td>10/1/1986</td>
<td>5/1/1990</td>
<td>CRI Cray X-MP/4</td>
</tr>
<tr>
<td>7/16/1991</td>
<td>9/1/1994</td>
<td>CRI Cray Y-MP/2 (castle)</td>
</tr>
</tbody>
</table>

**Table: Host Name and Specifications**

<table>
<thead>
<tr>
<th>Host Name</th>
<th>Electric Power (kW)</th>
<th>Clock Speed (MHz)</th>
<th>Clock Speed (GHz)</th>
<th># Proc</th>
<th># Flops Peak GFLOPs/s</th>
<th>Sustained GFLOPs (est/real)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>-</td>
<td>0.7</td>
<td>1</td>
<td>1</td>
<td>0.013333</td>
<td>0.00 est'd 15.00%</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>0.01</td>
<td>0.00 est'd 15.00%</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>36.4</td>
<td>1</td>
<td>1</td>
<td>0.04</td>
<td>0.01 est'd 13.74%</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>80</td>
<td>1</td>
<td>2</td>
<td>0.16</td>
<td>0.03 est'd 18.26%</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>80</td>
<td>1</td>
<td>2</td>
<td>0.16</td>
<td>0.03 est'd 18.26%</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>117.6</td>
<td>4</td>
<td>2</td>
<td>0.94</td>
<td>0.23 est'd 23.92%</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>7</td>
<td>8192</td>
<td>7.17</td>
<td>0.07 est'd 1.00%</td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>186.7</td>
<td>6</td>
<td>2</td>
<td>2.67</td>
<td>0.80 est'd 30.00%</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>185.7</td>
<td>2</td>
<td>2</td>
<td>0.87</td>
<td>0.19 est'd 28.50%</td>
</tr>
<tr>
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<td>-</td>
<td>66</td>
<td>4</td>
<td>2</td>
<td>0.53</td>
<td>0.01 est'd 2.00%</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>32</td>
<td>3</td>
<td>2</td>
<td>4.10</td>
<td>0.08 est'd 2.00%</td>
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<td>-</td>
<td>-</td>
<td>6.11</td>
<td>8</td>
<td>4</td>
<td>1.99</td>
<td>0.04 est'd 2.00%</td>
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<tr>
<td>-</td>
<td>-</td>
<td>500</td>
<td>4</td>
<td>2</td>
<td>4.00</td>
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<td>166.7</td>
<td>8</td>
<td>2</td>
<td>2.67</td>
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<td>-</td>
<td>-</td>
<td>12.77</td>
<td>150</td>
<td>64</td>
<td>9.60</td>
<td>0.60 est'd 6.25%</td>
</tr>
<tr>
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<td>-</td>
<td>7</td>
<td>100</td>
<td>20</td>
<td>4.00</td>
<td>1.12 measured 27.93%</td>
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<td>-</td>
<td>-</td>
<td>7</td>
<td>100</td>
<td>18</td>
<td>3.20</td>
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<tr>
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<td>-</td>
<td>493.5</td>
<td>243.9</td>
<td>18</td>
<td>15.5</td>
<td>4.65 measured 29.81%</td>
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<td>-</td>
<td>41.4</td>
<td>150</td>
<td>128</td>
<td>19.20</td>
<td>1.10 est'd 5.73%</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>75</td>
<td>100</td>
<td>24</td>
<td>19.20</td>
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<tr>
<td>-</td>
<td>-</td>
<td>25</td>
<td>180</td>
<td>64</td>
<td>46.08</td>
<td>2.00 measured 4.34%</td>
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<td>-</td>
<td>7.5</td>
<td>100</td>
<td>24</td>
<td>4.80</td>
<td>1.58 measured 32.88%</td>
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<td>51.1</td>
<td>250</td>
<td>128</td>
<td>64.00</td>
<td>7.85 est'd 12.28%</td>
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<td>-</td>
<td>-</td>
<td>8</td>
<td>250</td>
<td>16</td>
<td>6.00</td>
<td>0.98 est'd 12.28%</td>
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<td>356</td>
<td>4</td>
<td>98.00</td>
<td>5.95 est'd 7.00%</td>
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<td>-</td>
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<td>9.5</td>
<td>500</td>
<td>22</td>
<td>32.00</td>
<td>1.98 est'd 6.20%</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>7</td>
<td>375</td>
<td>64</td>
<td>99.00</td>
<td>5.95 est'd 7.00%</td>
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<td>-</td>
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<td>80</td>
<td>375</td>
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<td>805.00</td>
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<td>-</td>
<td>140</td>
<td>375</td>
<td>1308</td>
<td>1862.00</td>
<td>121.64 measured 6.20%</td>
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<td>-</td>
<td>-</td>
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<td>1100</td>
<td>16</td>
<td>70.40</td>
<td>2.92 est'd 9.80%</td>
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<td>-</td>
<td>-</td>
<td>50</td>
<td>500</td>
<td>128</td>
<td>128.00</td>
<td>12.54 est'd 9.80%</td>
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<td>-</td>
<td>-</td>
<td>50</td>
<td>500</td>
<td>128</td>
<td>128.00</td>
<td>12.54 est'd 9.80%</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>15.5</td>
<td>1300</td>
<td>64</td>
<td>332.80</td>
<td>16.57 est'd 4.90%</td>
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<tr>
<td>-</td>
<td>-</td>
<td>415</td>
<td>1300</td>
<td>1800</td>
<td>8320.00</td>
<td>345.28 measured 4.16%</td>
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<tr>
<td>-</td>
<td>-</td>
<td>48</td>
<td>2200</td>
<td>280</td>
<td>1144.00</td>
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<td>-</td>
<td>28</td>
<td>2200</td>
<td>132</td>
<td>580.00</td>
<td>32.54 est'd 5.60%</td>
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<tr>
<td>-</td>
<td>-</td>
<td>25.2</td>
<td>700</td>
<td>2048</td>
<td>5734.40</td>
<td>381.26 est'd 6.65%</td>
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<td>-</td>
<td>-</td>
<td>210</td>
<td>1900</td>
<td>624</td>
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<td>-</td>
<td>-</td>
<td>5.4</td>
<td>1900</td>
<td>16</td>
<td>121.60</td>
<td>12.05 est'd 9.91%</td>
</tr>
</tbody>
</table>

**Comments**

- Real GFlop per KW
- Macchina gona
- Real GFlop per KW
- chart from Tom Engel

Roy Jame - 2006
<table>
<thead>
<tr>
<th>Installed</th>
<th>Equipment</th>
<th>End</th>
<th>Accepted</th>
<th>[%]</th>
<th>Clock Speed (MHz)</th>
<th>Clock Speed (MHz)</th>
<th># Proc</th>
<th># Flop</th>
<th>Peak GFLOPs</th>
<th>Sustained GFLOPs (est/real)</th>
<th>Efficiency [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1963/06/01</td>
<td>1963/06/01</td>
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<td>-</td>
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<tr>
<td>1966/06/01</td>
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<td>0.00133</td>
<td>0.00</td>
<td>est'd</td>
</tr>
<tr>
<td>1971/07/01</td>
<td>1971/07/01</td>
<td>1983/04/01</td>
<td>CDC 7600 S/N 12</td>
<td>-</td>
<td>36.4</td>
<td>-</td>
<td>-</td>
<td>1</td>
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<td>0.01</td>
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<tr>
<td>1977/07/01</td>
<td>1977/07/01</td>
<td>1989/01/01</td>
<td>CRI Cray 1A S/N 3</td>
<td>-</td>
<td>80</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>0.16</td>
<td>0.03</td>
<td>est'd</td>
</tr>
<tr>
<td>1983/05/01</td>
<td>1983/05/01</td>
<td>1986/05/01</td>
<td>CRI Cray 1A S/N 14</td>
<td>-</td>
<td>80</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>0.16</td>
<td>0.03</td>
<td>est'd</td>
</tr>
<tr>
<td>1986/10/01</td>
<td>1986/10/01</td>
<td>1990/05/01</td>
<td>CRI Cray X-MP/4</td>
<td>-</td>
<td>117.6</td>
<td>4</td>
<td>-</td>
<td>2</td>
<td>0.94</td>
<td>0.23</td>
<td>est'd</td>
</tr>
<tr>
<td>1988/09/01</td>
<td>1988/09/01</td>
<td>1993/04/01</td>
<td>TMC CM-2/8192 (capitol)</td>
<td>capitol</td>
<td>-</td>
<td>-</td>
<td>8102</td>
<td>1</td>
<td>7.17</td>
<td>0.07</td>
<td>est'd</td>
</tr>
<tr>
<td>1990/06/01</td>
<td>1990/06/01</td>
<td>1997/06/30</td>
<td>CRI Cray Y-MP/8 (Shavano)</td>
<td>-</td>
<td>166.7</td>
<td>8</td>
<td>-</td>
<td>2</td>
<td>2.67</td>
<td>0.80</td>
<td>est'd</td>
</tr>
<tr>
<td>1991/07/16</td>
<td>1991/07/16</td>
<td>1994/09/01</td>
<td>CRI Cray Y-MP/2 (castle)</td>
<td>-</td>
<td>166.7</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>0.67</td>
<td>0.19</td>
<td>est'd</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Host name</th>
<th>Electric Power (kW)</th>
<th>Clock Speed (MHz)</th>
<th># Proc</th>
<th>FLOP Peak</th>
<th>Sustained GFLOPs (est/real)</th>
<th>Efficiency [%]</th>
</tr>
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<tbody>
<tr>
<td>arapahoe, comanche, navajo, chief</td>
<td>66</td>
<td>4</td>
<td>2</td>
<td>0.53</td>
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<tr>
<td>littlebeau</td>
<td>32</td>
<td>32</td>
<td>4</td>
<td>4.10</td>
<td>0.08</td>
<td>est'd</td>
</tr>
<tr>
<td>eaglesnest,</td>
<td>62.11</td>
<td>8</td>
<td>4</td>
<td>1.99</td>
<td>0.04</td>
<td>est'd</td>
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<td>graywolf</td>
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<td>4</td>
<td>2</td>
<td>4.00</td>
<td>1.12</td>
<td>measured</td>
</tr>
<tr>
<td>antelope</td>
<td>166.7</td>
<td>8</td>
<td>2</td>
<td>2.67</td>
<td>0.80</td>
<td>est'd</td>
</tr>
<tr>
<td>T3D 22.77</td>
<td>150</td>
<td>64</td>
<td>1</td>
<td>9.60</td>
<td>0.60</td>
<td>est'd</td>
</tr>
<tr>
<td>aztec</td>
<td>7</td>
<td>100</td>
<td>2</td>
<td>4.00</td>
<td>1.12</td>
<td>measured</td>
</tr>
<tr>
<td>paitou</td>
<td>7</td>
<td>100</td>
<td>2</td>
<td>4.00</td>
<td>1.12</td>
<td>measured</td>
</tr>
<tr>
<td>antelope</td>
<td>493.5</td>
<td>243.9</td>
<td>16</td>
<td>15.61</td>
<td>4.65</td>
<td>measured</td>
</tr>
<tr>
<td>T3D 41.4</td>
<td>150</td>
<td>128</td>
<td>1</td>
<td>19.20</td>
<td>1.10</td>
<td>measured</td>
</tr>
<tr>
<td>oray</td>
<td>7.5</td>
<td>100</td>
<td>2</td>
<td>4.80</td>
<td>1.50</td>
<td>measured</td>
</tr>
<tr>
<td>sioux</td>
<td>25</td>
<td>180</td>
<td>4</td>
<td>46.08</td>
<td>2.00</td>
<td>est'd</td>
</tr>
<tr>
<td>chipeta</td>
<td>7.5</td>
<td>100</td>
<td>2</td>
<td>4.80</td>
<td>1.50</td>
<td>measured</td>
</tr>
<tr>
<td>ute</td>
<td>51.1</td>
<td>250</td>
<td>2</td>
<td>6.40</td>
<td>7.85</td>
<td>est'd</td>
</tr>
<tr>
<td>dataproc</td>
<td>8</td>
<td>250</td>
<td>4</td>
<td>8.00</td>
<td>9.98</td>
<td>est'd</td>
</tr>
<tr>
<td>babyblue</td>
<td>50</td>
<td>200</td>
<td>4</td>
<td>25.60</td>
<td>1.79</td>
<td>est'd</td>
</tr>
<tr>
<td>blackforest</td>
<td>75</td>
<td>200</td>
<td>4</td>
<td>238.80</td>
<td>16.58</td>
<td>est'd</td>
</tr>
<tr>
<td>prospect</td>
<td>9.5</td>
<td>500</td>
<td>2</td>
<td>32.00</td>
<td>1.98</td>
<td>measured</td>
</tr>
<tr>
<td>babyblue</td>
<td>7</td>
<td>375</td>
<td>4</td>
<td>96.00</td>
<td>9.95</td>
<td>est'd</td>
</tr>
<tr>
<td>blackforest</td>
<td>80</td>
<td>375</td>
<td>64</td>
<td>906.00</td>
<td>58.35</td>
<td>est'd</td>
</tr>
<tr>
<td>blackforest</td>
<td>140</td>
<td>375</td>
<td>1308</td>
<td>1962.00</td>
<td>121.64</td>
<td>measured</td>
</tr>
<tr>
<td>bluedawn</td>
<td>6.5</td>
<td>1100</td>
<td>4</td>
<td>70.40</td>
<td>2.91</td>
<td>est'd</td>
</tr>
<tr>
<td>chinook</td>
<td>15</td>
<td>500</td>
<td>2</td>
<td>12.00</td>
<td>12.54</td>
<td>est'd</td>
</tr>
<tr>
<td>tempest</td>
<td>15</td>
<td>500</td>
<td>2</td>
<td>12.00</td>
<td>12.54</td>
<td>est'd</td>
</tr>
<tr>
<td>bluesky</td>
<td>285</td>
<td>1300</td>
<td>1216</td>
<td>6332.20</td>
<td>281.15</td>
<td>measured</td>
</tr>
<tr>
<td>thunder</td>
<td>15.5</td>
<td>1300</td>
<td>4</td>
<td>332.80</td>
<td>16.49</td>
<td>est'd</td>
</tr>
<tr>
<td>bluesky</td>
<td>415</td>
<td>1300</td>
<td>600</td>
<td>8320.00</td>
<td>343.62</td>
<td>measured</td>
</tr>
<tr>
<td>lightning</td>
<td>48</td>
<td>2200</td>
<td>260</td>
<td>1144.00</td>
<td>63.78</td>
<td>est'd</td>
</tr>
<tr>
<td>pegasus</td>
<td>28</td>
<td>2200</td>
<td>132</td>
<td>580.80</td>
<td>32.38</td>
<td>est'd</td>
</tr>
<tr>
<td>frost</td>
<td>25.2</td>
<td>700</td>
<td>2048</td>
<td>5734.40</td>
<td>196.12</td>
<td>est'd</td>
</tr>
<tr>
<td>otis</td>
<td>0.6</td>
<td>1900</td>
<td>16</td>
<td>121.60</td>
<td>10.02</td>
<td>est'd</td>
</tr>
<tr>
<td>bluevista</td>
<td>210.6</td>
<td>1900</td>
<td>624</td>
<td>4742.40</td>
<td>390.77</td>
<td>measured</td>
</tr>
<tr>
<td>icecube</td>
<td>7.6</td>
<td>1900</td>
<td>32</td>
<td>4824.20</td>
<td>16.85</td>
<td>est'd</td>
</tr>
<tr>
<td>blueice</td>
<td>325.4</td>
<td>1900</td>
<td>1696</td>
<td>2200</td>
<td>48</td>
<td>13312.0</td>
</tr>
</tbody>
</table>

From Tom Engel gave me this in mid June 2007 (I use 1600 processors for batch processing)
He said that different timing tests for Blucasa gave 8.25 to 12 % of peak on top 250G

(!) He said that different timing tests for Blucasa gave 10.5% to 12% of peak on top 250G
Part 2. Brief History of Recent NCAR Fast Computers

(1984 thru 2012)

Roy Jenne
Feb 6, 2007

The real computer power at NCAR on the Mesa, increased from 54 Megaflops (real) in 1984/85 to about 122 Gigaflops per second (real) in year 2000, about 2200 times faster over 15 years (Table A). This certainly did help to run better climate and weather models.

Primary weather forecast facilities such as NCEP (Washington DC) and ECMWF (Europe) have had a similar growth in computer power. This has helped the operational weather forecast scores a lot, giving useful forecasts out to 7 or 8 days.

1. A brief history of real computing power on the NCAR Mesa.

The computer industry has been good at delivering more computing power at a decreasing cost per unit of computing capability. About each 18 months one can purchase twice the capability for the same cost as at time zero. But one does need some budget money to keep buying computer upgrades each 2 or 3 years. Table A shows the history of total real power at NCAR, on the Mesa.

**Table A. The increase in total high-end computing power is given for the NCAR Mesa facility. NCAR had 54 Mflops of total real computing power in 1985. This became 122 Gflop in 2000. By 2005, the total was 1800 Gflop and it will be 5400 Gflop (5.4 real Tflops) in mid-2008.**

<table>
<thead>
<tr>
<th>Date</th>
<th>Real Computing Power at NCAR, Mesa</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984/85</td>
<td>54 Mflop (2 Cray 1A computers)</td>
</tr>
<tr>
<td>05/1990</td>
<td>800 Mflop from Cray YMP with 8 processors</td>
</tr>
<tr>
<td>11/2000</td>
<td>~122 Gflop, real from a few computers</td>
</tr>
<tr>
<td>09/2005</td>
<td>~950 Gflop, total</td>
</tr>
<tr>
<td>01/2007</td>
<td>1800 Gflop</td>
</tr>
<tr>
<td>10/2008</td>
<td>5400 Gflop</td>
</tr>
<tr>
<td>07/2010</td>
<td>~13,500 real Gflop (I hope this 2.5x upgrade can be planned for the Mesa)</td>
</tr>
<tr>
<td>07/2012</td>
<td>~40,000 real Gflop (equals 40 Tflop), a 3x upgrade. An increase of 20x over 5 or 6 years.</td>
</tr>
</tbody>
</table>

2. The active computers at 01/2007 on the NCAR Mesa

The Bluesky computer (415 kW, 345 real Gflop) will be shut down by March 2007. This will decrease the needs for electricity until the next upgrade arrives about 08/2008 (see Table B). The computer called Frost has some issues, so that it is not counted for output now. But it still does use some electricity (very efficient).

**Table B. Electricity needs and real computing output: Some active computers at NCAR. The new fast Blueice uses just 283 kW.**

<table>
<thead>
<tr>
<th>Start</th>
<th>End</th>
<th>Computer</th>
<th>Electric Power</th>
<th>Speed MHz</th>
<th># Proc</th>
<th>Peak Gflop</th>
<th>Real Gflop</th>
<th>Real/Peak</th>
<th>Real per Proc</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/2005</td>
<td>3/2006</td>
<td>Bluesky</td>
<td>415 kW</td>
<td>1300</td>
<td>1600</td>
<td>8320</td>
<td>345</td>
<td>4.15%</td>
<td>0.22</td>
</tr>
<tr>
<td>8/2005</td>
<td></td>
<td>Frost</td>
<td>25 kW</td>
<td>700</td>
<td>2048</td>
<td>5734</td>
<td>381</td>
<td>6.65%</td>
<td>--</td>
</tr>
<tr>
<td>10/2006</td>
<td></td>
<td>Bluevista</td>
<td>210 kW</td>
<td>1900</td>
<td>624</td>
<td>4724</td>
<td>470</td>
<td>9.91%</td>
<td>0.75</td>
</tr>
<tr>
<td>8/2008</td>
<td>upgrade</td>
<td>Blueice</td>
<td>283 kW</td>
<td>1900</td>
<td>1600</td>
<td>12 Tf</td>
<td>1350</td>
<td>~11.5%</td>
<td>0.84</td>
</tr>
</tbody>
</table>

**Note:** The 08/2008 upgrade is expected to have a good deal more computing power per processor.
3. How much electric power for NCAR Mesa fast computers?

The electric load for the computer room (computer gear plus cooling load) was 1400 kW in Sep 2006 before the Blueice computer arrived in 10/2006. Blueice added 283 kW to the compute load, but 30% of Bluesky was powered down (cut the compute load by 125 kW). When the compute load goes up, the cooling load will also increase.

The upgrade for 08/2008 will be about 4x faster than Blueice. It will also be much more energy efficient than Blueice, but will likely add a few hundred kW to the compute load. The existing gear will gradually be shut down, which will decrease the load. Table C shows that the electric loads for big computers on the Mesa should remain under 1800 kW during 2006 – 2009.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Compute load</td>
<td>850 kW</td>
<td>1010 kW</td>
<td>719 kW</td>
<td>~1000</td>
<td>~750</td>
</tr>
<tr>
<td>Cooling load</td>
<td>550 kW</td>
<td>660 kW</td>
<td>470 kW</td>
<td>~650</td>
<td>~490</td>
</tr>
<tr>
<td>Total</td>
<td>1400 kW</td>
<td>1670 kW</td>
<td><strong>1189 kW</strong></td>
<td><strong>1650 kW</strong></td>
<td><strong>1240 kW</strong></td>
</tr>
</tbody>
</table>

4. Selected recent main computers at NCAR.

The 08/2005 computer had 1.2 Tbytes of memory and 55 Tbytes of disks. The faster Blueice (10/2006) has 4.0 Tbytes memory and 150 Tbytes of disks. See Table D for this and other information.

TABLE D.

- The 08/2005 computer (IBM Bluevista)
  - Has 624 processors (clock 1900 MHz).
  - Gives real 470 Gflops of processing (0.75 Gflop/proc).
  - Energy use 210 kW (0.447 kW/Gflop energy efficiency)
  - Memory 1.2 Tbytes, disks 55 Tbytes

- The 10/2006 upgrade (IBM Blueice)
  - This has 1600 processors with 16 processors per node.
  - Peak power of 12 Tflop. Real power on NCAR models about 1350 Gflop (0.84 Gflop/processor).
  - Energy use 283 kW (0.210 kW/Gflop, a good increase in energy efficiency).
  - Memory 4.0 Tbytes, disks 150 Tbytes

- The 08/2008 upgrade (IBM)
  - Peak power of 50 to 60 Tflop.
  - Real power est. 5400 Gflop.
  - The chips will be produced in 1Q2008, using the new 45-nanometer chip process. There will be a good deal more computing speed per chip.

Note: Blueice uses 35% more energy than Bluevista, but it delivers 2.9 times as much output.

5. New computer chips

Jan 27-29, 2007: Three stories about better computer chips were in the news. As chip processes got smaller, there was current leakage which led to hotter chips and more electricity use. People have developed new materials to create some resistance to control the leakage. They deserve a hero medal!
In 1Q2008, IBM will start manufacturing chips using the new 45-nanometer process. These chips will be used in the NCAR upgrade due about 07/2008. AMD also hopes to have 45-nm chips ready for the market in mid-2008. Intel may beat IBM and AMD by a few months.

6. Plans for more computer upgrades on the NCAR Mesa.

NCAR will obtain another upgrade of the main computers about 08/2008 which will give about 5.4 real teraflops (trillion arithmetic operations per second) on the Mesa.

It would be very useful to keep the option open for further computer upgrades on the NCAR Mesa as shown in Table A. The need for more electricity to accomplish this would likely be quite small, if any. The advantage would be to keep some local fast computing at NCAR. It would provide some hedge against all of the politics and related events that can happen on a 10-15 year time scale. For people who design and operate fast computer systems, it really helps if enough real-world experience is maintained.

The Wyoming site should be the primary site. The computer at the NCAR site should stay several times slower than the Geo-computer in Wyoming. This strategy would control costs and decrease the needs for more electricity on the NCAR Mesa. And it would keep the focus on Wyoming.

7. Other recent big computer buys in the USA. Some technical information about other recent computers.

- Texas wins $59m NSF supercomputer grant (Sep 2006)
  The system will be built by Sun Microsystems Inc., during 2007. It will use 13,000 microprocessors from AMD. It will be capable of 400 trillion calculations per second (no doubt a peak speed, not real).

- A $52m computer for Lawrence Berkeley energy research (Oct 2006)
  This system for DOE from Cray, Inc., includes a multi-year services contract. The system will deliver a real sustained performance of “at least 16 trillion calculations per second, with a theoretical peak speed of 100 trillion calculations per second when running a diverse set of scientific applications. The system uses thousands of AMD chips.

The system uses dual-core processors. The contract includes options for future upgrades that would quadruple the size of the system and eventually boost performance to one petaflop (1000 Tflop). The upgrades will use the quad-core AMD chips when these become available (about mid-2008).

Probably the cost does not need to include the cost of a new building.

A 1.0 Gflop computer did 30 days of global weather analyses in each day.


NCEP and NCAR had a joint project to assemble weather observations for the world (surface, upper air, satellite) and use them to make new global analyses each 6-hours for 50 years (1948 – 1997). The analyses of temperature, wind, etc. were at 28 levels and 208 km horizontal resolution. NCEP obtained a faster computer in early 1994 (a Cray C90, 16 processors that could do a real 5.0 Gflops). The older computer (Cray YMP – 8 processors, real 1.0 Gflop) was then used for the production of reanalysis which started 06/2004. With this power NCEP would accomplish 30 analysis days (4x/day) in each 24 hour day. These analyses have been very important for world science. These analyses are now updated through 01/2007 (59.1 years).

A major paper about the NCEP/NCAR reanalysis (Kalnay, et al) was published in March 1996. More good news came in July 2003; this 1996 reanalysis paper in *BAMS* was the most cited paper in all of geosciences in the last decade!
Some News about Other Big Computers, Sep 2006

Roy Jenne
Oct 9, 2006

1. A big computer for Los Alamos (DOE lab in New Mexico)
   Sep 2006 news: IBM will build DOE a new $35m supercomputer for the Los Alamos Lab.

2. In June 2006, Cray Inc signed a $200m contract from DOE for a big computer at the Oak Ridge Lab.

3. Texas wins $59m supercomputer grant from NSF.
   News Sep 2006: The U of Texas at Austin won this grant. During year 2007, Sun Company will build this computer using 13,000 microprocessor chips from the AMD Company. These chips are likely competitive in speed with new gear from IBM or Intel. In this text, we include information about number of processors vs real Gflop for other computers. The U of Texas has several partners on this project.
   - News Sep 30, 2006, Daily Camera, Boulder CO.

4. Cray wins $52m supercomputer contract with DOE’s NERSC energy lab (Aug 2006)
   News 13 Aug 2006: Cray Inc and the DOE Office of Science announce that Cray has won this contract for a massively parallel computer plus multi-year services.

   The system (like Cray’s XT3 system) will be built with 64 bit AMD Opteron dual-core processors, upgradeable to quad-core chips, when made available. It will deliver a sustained performance of at least 16 trillion calculations per second on a scientific job mix. It will have a peak (not real) speed of 100 trillion Tflops. The installation will be during the first half of 2007 and acceptance in mid-2007.

   The computer will be located at the NERSC energy research facility at the Lawrence Berkeley Lab in California.

   The proposal from Cray “was selected because the price/performance was substantially better than other proposals” that they received.

   There will be 19,000 AMD processors, running at 2.6 GHz. The total memory will be 39 Tbytes. More information is in the basic news message.

   19,000 AMD processors (2.6 GHz), deliver 16 Tflop real, of computing power.
   - This is 0.84 real Gflop per processor.

   *We note that the current NCAR upgrade is expected to deliver a real 0.86 Gflop per processor.

5. The big computer at Livermore CA
   A story in 06/2006 said that DOE, Livermore had the IBM bluegene/L computer with 131,072 CPUs.
Recall that NCAR also has a bluegene/L machine in the computer room which can deliver a real 381 Gflop. Three computers at NCAR follow:

<table>
<thead>
<tr>
<th>Computer</th>
<th>Compute kW</th>
<th>Chip rate</th>
<th>No. CPU</th>
<th>Peak Gflop</th>
<th>Real Gflop</th>
<th>Gflop/kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bluegene/L</td>
<td>25</td>
<td>700 MHz</td>
<td>2048</td>
<td>5734</td>
<td>381</td>
<td>15.25-Wow</td>
</tr>
<tr>
<td>Bluevista</td>
<td>210</td>
<td>1.9 GHz</td>
<td>624</td>
<td>4742</td>
<td>470</td>
<td>2.25</td>
</tr>
<tr>
<td>New Blueice</td>
<td>745</td>
<td>1.9 GHz</td>
<td>1600</td>
<td>12,000</td>
<td>1380</td>
<td>1.85</td>
</tr>
</tbody>
</table>

**NOTE:** Blueice will have 1600 processors. These will be arranged in 16 processors/node (8 dual core chips per node).

- **NOTE:** the real Gflop per processor is 0.86 for blueice and 0.75 for NCAR bluevista.

- Estimated peak and real speeds at Livermore
  - The bluegene/L at Livermore has 64 times as many processors as the one at NCAR. It has 64 banks of processors, each with 2048 processors. Based on the NCAR data above, the Livermore computer could have 367 teraflop peak speeds or 24.4 teraflop real.
  - 365 Tflops peak and 24.4 Tflop real

  They claim that Livermore achieved 281 Tflop on a software code (which is much too high for the typical practical model code). Their computer is likely 367 Tflop peak and 24.4 Tflop real (doing NCAR type of work). Recall that bluegene/L is very efficient on electricity. The Livermore big computer may need only 1600 kW of electricity.

  **Likely just 1600 kW for this huge computer at Livermore.**

6. The above big computer at Livermore has 131,072 processors of the type bluegene/L. IBM says that the next generation (bluegene/P) aims to deliver petascale performance with only a 10 to 15% increase in electric power use (Computerworld, July 3, 2006, p 12).
A Digital Star is Born

For years Hollywood has been the last bastion of the film camera, with relatively few features shot digitally. Panavision's Genesis, below, is poised to finally change the industry. It has been used on 13 movies, including the upcoming Superman Returns. Previous filmless cameras cut production costs but were widely criticized for their bulky imaging systems, which required smaller-than-usual lenses. The Genesis, developed by both Panavision and Sony, uses the standard 35mm lenses familiar to cinematographers. Newton Thomas Sigel, director of photography on Superman Returns, says Genesis footage has so little grain it actually projects as well as 65mm film.

—BARRY ROSENBERG

Supercomputers

BY SETH FLETCHER

The latest rankings for the 500 fastest supercomputers in the world will be announced on June 28 at the International Supercomputing Conference in Dresden, Germany. The reigning champ is IBM's BlueGene/L system, which has reached the once-unthinkable speed of 280.6 teraflops (more than 280 trillion floating-point operations per second), over three times as fast as its closest competitor. But what are supercomputers, anyway, aside from world-class chess players?

Supercomputers are simply very fast computers, with exponentially greater computational power than a desktop PC thanks to multiple central processing units (CPUs)—in the case of BlueGene/L, 131,072 CPUs. This lets them perform operations with lists of numbers rather than individual number pairs. Adding more CPUs leads to an array of problems, including information bottlenecks and excessive heat. Scientists are constantly introducing new ways to stack processors, miniaturize circuits and keep those circuits cool (sometimes even submerging them in cryofluids near absolute zero).

The high cost of owning a supercomputer generally restricts the clientele to governments and huge corporations—establishments that need to run calculation-heavy simulations of processes such as nuclear reactions (which is what BlueGene/L does for a living) and global weather events. Of course, winning at chess also requires lots of calculations. Considering that BlueGene/L is about a thousand times more powerful than Deep Blue—the IBM computer that defeated world champion Garry Kasparov in a six-game match in 1997—it's safe to say the machines have already won that war.

June 2006
Texas wins $59M supercomputer grant

Associated Press

AUSTIN — The University of Texas at Austin has been awarded a $59 million grant from the National Science Foundation to build and operate a new supercomputer that would be among the world's most powerful.

The system will be built over the next year by Santa Clara, Calif.-based Sun Microsystems Inc. and use 13,000 microprocessors from Advanced Micro Devices Inc., said officials at UT's Texas Advanced Computing Center, which will run the machine.

The supercomputer will be capable of 400 trillion calculations per second, officials said.

Currently, International Business Machine Corp.'s Blue Gene/L system at Lawrence Livermore National Laboratory in California is the fastest supercomputer, capable of 280 trillion calculations per second, according to the Top500 project.

The University of Colorado is competing with Wyoming to be the site of a National Center for Atmospheric Research supercomputer also expected to be faster than the IBM Blue Gene/L. A decision on the site is expected in coming weeks.

The NCAR supercomputer is projected be in action in 2010.

CU has proposed putting it on 13.5 acres of the university's research campus off Foothills Parkway and Arapahoe Avenue.

The Texas computer will be a collaboration between UT-Austin, Sun Microsystems, Arizona State University and Cornell University.

Through an application process, the computer will be available to academic and government researchers for various projects, from better understanding proteins to predicting severe weather to modeling interstellar supernovas. Ten percent of the machine's capacity is being reserved equally for other Texas universities and for business applications.

"This resource will help Texas academic researchers provide answers to some of the most perplexing scientific questions," said Mark Yudof, chancellor of the University of Texas System.

- NSF grant to build and operate a fast computer.
- It will have 13,000 microprocessors from the AMD company.
- This story mentions the NCAR proposal too.
- Question: How much energy will this Texas computer use?

from NSF

1st Sep 30 - 2006 Daily Canara
Cray Inc. and the U.S. Department of Energy (DOE) Office of Science announced on Thursday that Cray has won the contract to install a next-generation supercomputer at the DOE's National Energy Research Scientific Computing Center (NERSC). The systems and multi-year services contract, valued at over $52 million, includes delivery of a Cray massively parallel processor supercomputer, code-named "Hood."

Cray's Hood supercomputer, named after Mount Hood in the Cascade range of the Pacific Northwest, builds upon the scalable architecture of the Cray XT3 supercomputer and is intended for the most demanding scientific and engineering problems. Like Cray's XT3 system, Hood is designed around a scalable processing element using x86 64-bit AMD Opteron dual-core processors, upgradeable to quad-core when made available, and uses a future generation of SeaStar technology to increase bandwidth between the Opteron and the system network.

The contract provides options for future upgrades that would quadruple the size of the system and eventually boost performance to one petaflops (1,000 trillion floating point operations per second) and beyond.

The Hood system installed at NERSC will be among the world's fastest general-purpose systems. It will deliver sustained performance of at least 16 trillion calculations per second, with a theoretical peak speed of 100 trillion calculations per second, when running a suite of diverse scientific applications at scale. The system uses thousands of AMD Opteron processors running tuned, light-weight operating system kernels and interfaced to Cray's SeaStar network.
Cray will begin shipping the new supercomputer to the NERSC facility at the Lawrence Berkeley National Laboratory later this year, with completion of the installation anticipated in the first half of 2007 and acceptance in mid-2007.

As part of a competitive procurement process, NERSC evaluated systems from a number of vendors using the NERSC Sustained System Performance (SSP) metric. The SSP metric, developed by NERSC, measures sustained performance on a set of codes designed to accurately represent the challenging computing environment at the Center.

"While the theoretical peak speed of supercomputers may be good for bragging rights, it's not an accurate indicator of how the machine will perform when running actual research codes," said Horst Simon, director of the NERSC Division at Berkeley Lab. "To better gauge how well a system will meet the needs of our 2,500 users, we developed SSP. According to this test, the new system will deliver over 16 teraflops on a sustained basis."

"The Cray proposal was selected because its price/performance was substantially better than other proposals we received, as determined by NERSC's comprehensive evaluation criteria of more than 40 measures," said Bill Kramer, general manager of the NERSC Center.

"We are excited that NERSC will again be home to a large Cray supercomputer," said Cray President and CEO Peter Ungaro. "We are proud to have been selected by NERSC in a challenging and competitive evaluation process using a measurement that emulates real-world conditions, rather than a simplistic peak-performance measurement. NERSC joins a growing number of major high-performance computing centers that have selected Cray systems which exemplify our vision of Adaptive Supercomputing by handling scientific applications of ever-increasing complexity and scaling to the highest performance levels."

The Hood supercomputer at NERSC will consist of over 19,000 AMD Opteron 2.6-gigahertz processor cores, with two cores per socket making up one node. Each node has 4 gigabytes of memory and a dedicated SeaStar connection to the internal network. The full system will consist of over 100 cabinets with 39 terabytes (39 trillion bytes) of aggregate memory capacity.

"AMD and Cray continue to collaborate on innovative ways to leverage Direct Connect Architecture and HyperTransport technology," said Marty Seyer, senior vice president, Commercial Segment, AMD. "This innovation, along with Cray's supercomputing expertise and focus on scalable system architectures, has yet again resulted in a significant win. This is confirmation that customers believe that the design and performance of the AMD Opteron processor combined with Cray's superior system architecture provides a winning combination."
In keeping with NERSC's tradition of naming supercomputers after world-class scientists, the new system will be called "Franklin" in honor of Benjamin Franklin, America's first scientist. This year is the 300th anniversary of Franklin's birth.

"Ben Franklin's scientific achievements included fundamental advances in electricity, thermodynamics, energy efficiency, material science, geophysics, climate, ocean currents, weather, materials science, population growth, medicine and health, and many other areas," said NERSC's Bill Kramer. "In the tradition of Franklin, we expect this system to make contributions to science of the same high order."

Full background information on all leading HPC solution providers

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For sponsorship information contact: promote@hpcwire.com
Japan's next supercomputer finds a home in Kobe

Japan is trying to regain its title as possessor of the world's fastest supercomputer, and last week it revealed that the machine will be housed in Kobe, which is aiming to become a major medical hub.

Last year, engineers began drawing up specifications for a computer that can operate at a speed of 10 petaflops, or 10 quadrillion calculations per second. That will make it more than 250 times faster than Japan's Earth Simulator, once the world's fastest supercomputer but currently ranked 14th. The main application for the new Japanese machine will be nanotechnology and life-science research, such as protein analysis, in addition to geoscience and astrophysics.

The ¥11.5-billion (US$1-billion) national project is expected to be completed by 2012.

- Cost US $1 billion
- More than 250 times faster than the Earth Simulator
- Completed by 2012

Russian academy resists state move to gain control

Members of the Russian Academy of Sciences have voted almost unanimously against a government-proposed charter that would transfer control of the academy to the state.

The 1,200-member academy, which oversees a budget of US$1.2 billion, some 400 research institutes and about 200,000 researchers and staff, has enjoyed relative autonomy for nearly 300 years. But last year, steps towards imposing government control began when the parliament passed a law stipulating that the academy's president must be approved by the government.

The new charter, prepared by the Ministry of Education and Science, calls for the creation of a nine-member supervisory board — consisting mainly of government representatives — to oversee the academy's work, budget and property. To be valid, the charter agreed by the academy would have to be ratified by the government.

- 400 research institutes
- About 200,000 researchers & staff
Computing Equipment at Dept of Atmospheric Sciences, U of Washington

(A very fast computer for a low cost)

Roy Jenne
April 27, 2007

Cliff Mass at the University of Washington (Atmospheric Science Dept) told me about their computing setup there. It is impressive.

He can now buy a new Linux board with 8 processors for $5000. This board is made up of two quad-core chips that run at 2.3 GHz, and it includes 8 Gbytes of memory. A number of these boards can be used together. He usually runs the MM5 mesoscale model, and uses about 30 to 40 processors on one job. He personally has about 150 processors. The Dept of Atmospheric Sciences (at UW) total (including Cliff’s) is about 400 to 500 processors.

He also buys Raid online disks. He now has 120 Tbytes of storage and the department has another 300. For $10,000, he can buy 15 TB of this disk capacity with the necessary controllers.

He said that for about $50,000, he can put together a computer that is as fast as NCAR’s fastest computer of 5 years ago. (No, not for $50,000, but still for a very low cost—see below.)

～～～～～ THE LARGE AND MEDIUM-SIZED METEOROLOGY DEPARTMENTS IN USA ～～～～～

Cliff says that the large and medium-sized atmospheric science departments of the US (there are about 15 or 20 of these) are almost totally self-sufficient so far as computing is concerned. These schools only use NCAR for some data inputs. He says that NCAR could disappear and they would hardly notice.

Cliff buys enough interruptible power to avoid any power spikes and to keep the computers running for a few hours. This sounds like a sensible decision.

My note: These latest chips can probably deliver a real computing capability of about 0.85 Gflop per processor if used well. NCAR had about 122 Gflop of real computing power starting in 2001. So with 143 of the new 2007 processors, they could have the same real compute power as NCAR had in 2001.
Actions to Develop Ultra Fast Computers
(and to buy them)

- In the USA and Japan

Roy Jenne
April 2007

1. US actions to develop and purchase faster computers.
   - Defense Dept DARPA (July 2006): Has been working with 3 vendors for several years.
     - Aug 06: IBM and Cray selected to work on next phase of project.
   - Energy Dept (2006) is buying a few big fast computers.
   - NSF: In June 2006 they began seeking proposals for a very fast computer that could cost up to $200m.
     - Story Sep 2006: Texas wins $59m supercomputer grant from NSF.
     - NCAR announces a new $60m supercomputer for NSF geosciences—to be located in Wyoming.

2. ~~~ What is Japan doing on fast computers? ~~~
   - For several years Japan had the world’s fastest supercomputer called the Earth Simulator.
   - Story April 2007: Japan has plans to build a new very fast super computer that will be more than 250 times faster than the Earth Simulator. Wow! It will cost US $one billion and should be completed by 2012.

3. It is important to have competition on design, speed, and price.
   - We hope for 3 or 4 vendors in the world for the fastest computers.
   - And this work paves the way for many mid-scale computers.

4. What level of investment is needed?
U.S. Puts Money on Ultrafast Supercomputers

Awards contracts for systems with petascale performance

BY PATRICK THIBODEAU

The U.S. government is planning to spend hundreds of millions of dollars over the next several years to fund the development of huge supercomputers with power beyond anything available today. The goal is to address the most challenging problems facing science, national security and industry.

Several government agencies have awarded or are about to award contracts for systems capable of sustained petascale computing speeds, which can handle quadrillions of calculations per second. To understand the scale of these planned systems, only one system on the Top500 supercomputer list released last week surpassed 100 TFLOPS.

Earlier this month, Seattle-based Cray Inc. signed a $200 million contract to deliver a petascale-capable system to the U.S. Department of Energy's Oak Ridge National Laboratory by 2008. That system, based on processors from Advanced Micro Devices Inc., will be built in phases of ever-increasing speeds.

The National Science Foundation in June began seeking proposals for a larger high-performance supercomputer.

DOE

NSF

COMPUTERWORLD July 3, 2006

Intel Ships First Dual-Core Xeon Chip

Intel Corp. last week released its dual-core Xeon processor, code-named Woodcrest, the first based on its new Core microarchitecture. The Xeon 5100 chip uses 40% less power than its predecessors while improving performance by a factor of three, said Intel Senior Vice President Pat Gelsinger. Some 150 companies will offer more than 200 Xeon 5100 systems, Intel said.

Grid Industry Groups Complete Merger

Two grid computing groups—the Global Grid Forum and the Enterprise Grid Alliance—last week fulfilled a February promise to merge. The new Open Grid Forum aims to speed the adoption of grid technology worldwide. The forum said it plans to work with other standards bodies, including the World Wide Web Consortium and the Storage Networking Industry Association.

UP TO 80% MORE PERFORMANCE PER WATT.
Ultrafast

Continued from page 1

that could also cost up to $200 million. And this month, the Defense Advanced Research Projects Agency (DARPA) plans to award contracts valued at several hundred million dollars for two even larger supercomputers.

Planning an Approach

The scale of the computing power in the new systems will be so enormous that “we have to change the way we do computational science to really take advantage of these machines,” said Dimitri Kusnezov, head of the DOE’s advanced simulation and computing program, which operates the most powerful supercomputer in the world today, the IBM Blue Gene/L. That supercomputer, with more than 131,000 IBM Power processors, was easily the No. 1 system on the latest Top500 list.

“arbit 

RF

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performance with only a 10% or 15% increase in power consumption, Turek said. IBM isn’t disclosing details or shipment plans for the system.

Turek said the most important goal is building low-cost, high-performance systems that businesses can use, in order to extend the systems’ use beyond government agencies.

To help support that cause, legislation was introduced in the U.S. Senate last month to set aside $5 million to fund up to five supercomputing centers for assisting businesses and manufacturers. Sen. Mike DeWine (R-Ohio) and Sen. Herb Kohl (D-Wis.) sponsored the bill.

The legislation, called the Blue Collar Computing and Business Assistance Act of 2006, gets its name in part from the Ohio Supercomputing Center in Columbus, whose Blue Collar Computing initiative is intended to promote supercomputing in mainstream IT.
Better, faster — and easier to use

The Pentagon is sinking millions of dollars into developing the next generation of supercomputers — and plans to let non-military scientists and engineers share the benefits. Heidi Ledford reports.

Once upon a time, the fastest supercomputers were top-secret. In the days of the cold war, the best US machines were reserved primarily for the use of spy agencies and designers of nuclear weapons.

But now, the Pentagon's crack research agency is funding the development of machines that, it hopes, will be shared by industry and university scientists, as well as by spies and weapons designers. That way, it figures, more people will write code to harness the computers' massive power — and the cost and effort of developing applications will tumble.

Late last month, the Defense Advanced Research Projects Agency (DARPA) said it would grant almost $500 million to Cray and IBM to develop machines that will be about ten times faster than the most powerful existing supercomputers — and easier to program.

The award is the third and final phase of DARPA's High Productivity Computing Systems programme, which began in 2002 by supporting research teams at IBM, Cray, Sun Microsystems, Silicon Graphics and Hewlett-Packard. DARPA is managing the programme in partnership with other government agencies, including the Department of Energy, which runs the US nuclear-weapons programme, and the National Security Agency, which spies on radio signals, phone calls and e-mails.

Need for speed

The selection of IBM and Cray was based not only on project design, but also on the commercial viability of the proposed technologies. DARPA has been trying to whet the commercial sector's appetite for supercomputers, and has helped fund a programme within the nonprofit Council on Competitiveness to tout the usefulness of the machines.

The two companies will now build prototype machines, complete with operating systems and software tools, by 2010. The first customers are likely to be governmental agencies. But smaller versions of the machines will also be available to researchers.

Cray has a distinguished history in the field. The world's first genuine supercomputer — the Cray-1 — was released in 1976. It cost $8.8 million and contained a single central processor, performing up to 80 million floating point operations per second (flops). Today's fastest computer is IBM's Blue Gene/L at the Lawrence Livermore National Laboratory in California, which can perform up to 280 trillion flops and contains more than 130,000 processors.

"Using vast numbers of processors makes supercomputers tough to program."

Processor power

But using vast numbers of processors makes supercomputers tough to program. The more processors you have, the more time they waste just communicating with each other. And although processing speed itself has multiplied over the years, the speed at which they can access computer memory hasn't kept up.

Programmers sometimes try to work around these speed bumps, says Jeffrey Gardner, an astrophysicist and computing specialist at the Pittsburgh Supercomputing Center in Pennsylvania. But he thinks that as more and more processors are added, programming complications will reach the point where scientists simply can't make effective use of the machines. To tackle this problem, both Cray and IBM intend to improve their programming languages so that the computers work more efficiently during lags in communication.

Rick Stevens, a supercomputer specialist at the Argonne National Laboratory in Illinois, says IBM will focus on optimizing its POWER processors. IBM makes its own chips, he says, giving it more control over their properties.

Cray, on the other hand, buys most of its processors from Advanced Micro Devices. According to Jan Silverman, Cray's vice-president for corporate strategy, it will continue to use these standard processors, which handle one calculation at a time, but will combine them with Cray-made versions.

These will include vector processors, which can perform calculations on multiple pieces of data at once, and multithreaded processors, suitable for database mining. Cray also plans to optimize performance by using two distinct operating systems — one to perform basic chores such as accessing memory and regulating input and output, and the other to handle data.

Peter Ungaro, Cray's chief executive, hailed the DARPA award as a sign that Cray will return to market leadership. The company has struggled since the early 1990s — Silicon Graphics bought the firm for $767 million in 1996, only to sell it off again in 2000 for just $50 million. The DARPA award sent stock prices up by $2 to almost $12 — still sharply down from a September 2003 high of more than $50. Nevertheless, Stevens is optimistic about Cray's outlook, saying that several recent contracts bode well.

But Cray still derives most of its research and development money from government grants, as the market for supercomputers isn't large enough to support their high development costs. "The military has always been at the forefront of supercomputing," says Robert Deupree, a physicist at St Mary's University in Nova Scotia, Canada, "in part because they needed it, but also because they had the money to be able to invest in it."

IBM's Blue Gene/L uses 130,000 processors.
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Awards contracts for systems with petascale performance

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Three vendors — IBM, Cray and Sun Microsystems Inc. — have been working with DARPA for several years on initial research for the next generation of computer systems. Next month, the agency is expected to pick two of the three vendors to work on the next phase of the project.

Although much of the focus on supercomputers is on the number of processors being strung together, more vexing problems involve memory and storage subsystems and energy consumption, which "begin to take up a good chunk of the overall cost of the system," said Dave Turek, vice president of deep computing at IBM.

The next-generation Blue Gene system, Blue Gene/P, aims to deliver peta-scale performance with only a 10% to 15% increase in power consumption, Turek said. IBM isn't disclosing details or shipment plans for the system.

*Just 15% more electricity

□ Guess 10x computing ??

From Computerworld
July 3, 2006
Higher Costs, Accident Imperil Plans

The Integrated Ocean Drilling Program (IODP) has hit rough waters. A spike in the demand for oil-drilling equipment and services has added 20% to the cost of a planned extreme makeover of the program’s former workhorse, the drill ship JOIDES Resolution (Science, 23 December 2005, p. 1890). By happenstance, the funding squeeze comes as the program’s future flagship, the new Japanese drilling ship Chikyu, sustained damage to one of its key drilling components during a shakeout cruise off the Japanese coast. "It’s tough going at the moment," admits Bill Ball of the Joint Oceanographic Institutions, which is managing the modernization of the JOIDES Resolution for the U.S. National Science Foundation (NSF).

IODP’s predecessor, the Ocean Drilling Program, was for 2 decades the world’s premier effort to explore beneath the sea floor (Science, 18 April 2003, p. 410). In 2003, the U.S., European, and Japanese members of the consortium reorganized the program and began preparing for the arrival of the $550 million Chikyu, which is equipped with a second pipe, called a riser, that allows it to drill deeper holes and in areas near oil and gas deposits (Science, 11 March 2005, p. 1552). Both the Chikyu and the renovated ship, which NSF leases from an oil-drilling company, were to begin scientific drilling in the fall of 2007.

That schedule now appears impossible to meet for the refurbished ship. For $115 million the NSF vessel, which will be renamed, was to get a 30-foot hull extension that provides 50% more lab space and bigger and better accommodations. The ship is also slated for enhanced instrumentation and drill capacity and faster, more fuel-efficient operations. Now NSF officials must figure out how to either get the most for the budgeted amount or pay for the $25 million overrun by cutting back on another big-ticket construction item. "Any increase has to come from the major research equipment and facilities account, not from the research account," explains Margaret Leinen, head of NSF’s geosciences directorate.

The clock is ticking as NSF awaits a report on how much can be done to improve the ship’s capabilities without stretching the hull. The renovations were supposed to have gotten under way this month at a facility in Singapore, and NSF is paying tens of thousands of dollars each day the ship is tied up. Although work can begin on improvements unrelated to the extension, Leinen stresses that NSF must make a decision "as soon as possible." In the meantime, she says "we definitely won’t be making" the target date of November 2007 to resume operations.

As for the Chikyu, officials at the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) are hoping to fabricate or buy a replacement for a rod that’s part of a device to prevent blowouts when the ship drills into a volatile formation. It got bent when the ship was caught in a sudden storm earlier this month with its drilling equipment deployed. Asahiko Taira, director-general of JAMSTEC’s Center for Deep-Earth Exploration, says the damage is minor and the bent rod will be replaced at sea.

The Chikyu must then rush off to drill for oil off the coast of eastern Africa. Taira says the commercial job will allow the agency to meet rising operating costs while still training the crew and gaining drilling experience in various geologic environments. "We will have this ship ready for scientific drilling in September next year," he vows. —JEFFREY MERVIS

With reporting by Dennis Normile in Tokyo.
Operational Hurricane Intensity Forecasting

THE ARTICLE "A HURRICANE'S PUNCH STILL knocks out forecasters" (E. Kintisch, News of
the Week, 1 Sept., p. 1221) describes conclusions reached in a report submitted to the
Science Advisory Board of the National Oceanographic and Atmospheric Adminis-
tration (NOAA) by a Hurricane Intensity Research Working Group. As noted in the arti-
cle, a major conclusion of this report was the
perceived need for high-resolution numerical
modeling (with grid sizes as fine as 1 km) to
easure accurate forecasts of hurricane intensity.
However, the Working Group also submitted a
minority report, written by the present authors.

We have concluded that adoption of some
prominent recommendations in the majority
report will perpetuate a narrow focus on highly
detailed computer simulation. That focus is
incommensurate with both available NOAA
in-house numerical-analysis support staff and
available in-house computing power. It also
presumes a detailed level of understanding of
many phenomena that does not exist. The
strong emphasis in the majority report on
highly detailed computer simulation, and the
need for greatly enhanced computer resources,
obscure the fact that existing NOAA computa-
tional facilities are substantial by international
civil-sector standards. Furthermore, NOAA's
commitment of resources for further ex-
pansion of those computational facilities is
impressive, within the constraints of the
agency's overall budget. On the other hand,
little attention is given to the possibility of
using more traditional techniques of simplified
analysis and numerical modeling (combined
with laboratory experimentation), in conjunc-
tion with existing numerical models, to pro-
vide an alternative, rapidly executed aid for
operational forecasters.

At the recent meeting of the Advisory
Board, both reports were presented by John
Snow, the Working Group Chairman. A
motion to forward only the majority report
was defeated, and the Advisory Board explic-
itly recommended that NOAA's Administrator
consider both reports.

HOWARD R. BAUM1 AND FRANK FENDELL2

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Technology, Redondo Beach, CA 90278, USA.
Work to Use Less Electricity for Computing

Roy Jenne
April 19, 2007

INTRODUCTION

The world’s computer companies are working very hard to produce computers that are faster, but which do not need to use a lot more electricity. There is a tendency for small computing switches to leak power as they become smaller in size. The leakage makes chips run hotter and consume more power. They have found a new material that can stop this leakage, and act as an insulator. Please see the 2-page story in The Economist (Mar 3, 2007).

They are also making chips that are having 4 arithmetic cores per chip rather than 2 as now. This will help make computers that are faster and cheaper. Intel seems to be first with the 4-core systems. IBM will have these in mass production in Q1 2008, and they will go into NCAR’s upgrade of July 2008. AMD Company supplies fast chips for some makers of supercomputers (like Cray). They are working on a 4-core chip. Other manufacturers will also soon have them.

In Computerworld (July 5, 2006), IBM said they hope to build a next generation computer (I guess 10x faster) and yet only use 10 to 15% more electricity.

~~~ JAPAN IS BUILDING A SUPER FAST COMPUTER ~~~

Another very fast computer is coming. Japan plans to build a new super computer. It will operate at 10 petaflops, cost US $1.0 billion, and be completed by 2012. It will be more than 250 times faster than their Earth Simulator which was very, very fast (Nature, 5 Apr 2007, story here). This is amazing.

NCAR should try to gather information on real speed, chip type, number of chips, and energy use for a selection of present computers, and estimates for future computers.

~~~ THE REAL SPEED, IF MORE UPGRADES ON THE MESA ~~~

The NCAR Mesa upgrade of 08/2008 should give us real computing power of about 5400 Gflops. Our total kW use for hardware should stay under 1800 kW through at least 2010. We may not be able to get another upgrade on the Mesa. If we could get one about 2011, we would likely have real speed on the Mesa of about 14,000 real Gflop.

- So by 2011 we would have 14,000 real Gflop of speed on the Mesa and still likely use only about 1700 kW of electricity for hardware.

~~~ ELECTRICITY NEEDED FOR NCAR MASS STORAGE OF DATA ~~~

Electricity for NCAR’s Mass Store in 2006: We had 5 tape silos that each held about 5000 cartridge tapes and had a robot to mount the tape. All 5 silos together use about 5 kW and the necessary 60 tape drives use an addition 5 kW.

- Thus the electricity needed for mass storage is not a problem.
Computing

Going green

Mar 3 - 2007

Is the growing power consumption of
data centres a threat or an opportunity?

The people, places and things inside
Second Life, a thriving online world
with millions of residents, may be imagi-
nary—but the power consumption of the
computers that maintain the illusion is all
too real. Nicholas Carr, a business writer
and blogger, recently worked out that each
of the 15,000 or so residents logged in at
any one time consumes electricity as a re-
sult of their activities in the virtual world
almost as fast as the average inhabitant of
Brazil does in real life. Second Life’s resi-
dents, Mr Carr concluded, “don’t have
bodies, but they do leave footprints.”

It is just one example of the growing
concern over the increasing power con-
sumption and environmental impact of
computers, and in particular the ware-
houses full of corporate machines known
as data centres. A study by the Lawrence

March 3, 2007
The Economist

Roy James
March 2007
NCAR
Berkeley National Laboratory, released last month, found that the power consumption of data centres doubled between 2000 and 2005, and now accounts for 1.2% of American electricity consumption, though other estimates put the figure at 4%. Companies now spend as much as 10% of their technology budgets on energy, says Rakesh Kumar of Gartner, a consultancy. (Only around half of this is used to run computers; much of it goes on cooling.) IDC, a market-research firm, says power consumption is now one of systems managers’ top five concerns.

Power consumption has increased because of the rise of the internet, of course, but also because of way in which computers have historically been designed: to maximise performance at all costs. Between 1996 and 2006, says Jed Scaramella of IDC, the number of servers in use went from 6m to 28m and the average power consumption of each server grew from 150 watts to 400 watts. But things are now starting to change and the computer industry has been seized with enthusiasm for “green computing”.

Dell, a big PC-maker, recently launched a scheme that allows its customers to plant trees to offset the carbon emissions generated by their computers. Digiplex, a Scandinavian data-centre firm, boasts that locating servers in its Oslo facility is greener than elsewhere in Europe, since Norway generates 99% of its electricity from hydropower. And this week several of the industry’s main firms, including AMD, Dell, HP, IBM, Intel, Microsoft and Sun, launched a “Green Grid” consortium dedicated to reducing data-centre power consumption.

Three technological fixes in particular could help. The first is new “multi-core” processor chips, in which performance is improved not by increasing clock speed, but by building several processing engines, or “cores”, into each chip—a far more energy-efficient approach, AMD, Intel and Sun now boast of their chips’ “performance per watt” (ie, work done for each unit of energy), rather than simply emphasising raw performance. Dual-core chips are commonplace, and quad-core chips are spreading too. The switch from dual-core to quad-core over the past 18 months increased performance per watt by a factor of 4.5, says Stephen Smith of Intel. This ought to mean that average power consumption per server will level off in coming years, says Mr Scaramella.

The second fix comes from using more efficient power supplies. At the moment, data centres perform many conversions between alternating current (AC) and direct current (DC). This wastes energy, which is emitted as heat and increases the need for cooling. It would be far more efficient to power servers directly from a central DC supply. Datapiq, a data-centre company based in Denver, Colorado, has tried this approach and says it can reduce power consumption by nearly 20%. The problem is that there is no single standard for DC power supplies, so such savings cannot easily be achieved in a data centre filled with equipment from different vendors. Developing new power-supply standards is one of the aims of the new consortium.

The third fix is the more careful use of cooling systems. HP, for example, has devised a scheme called Dynamic Smart Cooling, which links temperature sensors installed on servers to air-conditioners so that blasts of cool air can be directed towards particular servers only when needed. Such systems can reduce cooling costs by 25-40%, says Paul Perez of HP. Once again, however, standards are needed to ensure that different sensors and cooling systems can talk to each other. All this will take time. “It’s all talk so far,” says Mr Kumar. Energy costs will continue to rise and will rival annual hardware spending by 2010, Mr Scaramella predicts (see chart). As managers worry about energy costs, they will grow more interested in replacing old servers with new ones based on multi-core chips, installing more efficient power supplies and switching to more sophisticated cooling systems—in other words, buying lots of new gear. For vendors, mushrooming energy bills represent a big opportunity.

<table>
<thead>
<tr>
<th>Power struggle</th>
<th>Worldwide server costs, $bn</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>New servers</strong></td>
<td><strong>Power and cooling</strong></td>
</tr>
<tr>
<td>1996</td>
<td>98</td>
</tr>
<tr>
<td>1996</td>
<td>98</td>
</tr>
<tr>
<td>Source: IDC</td>
<td></td>
</tr>
</tbody>
</table>

March 3, 2007
The Economist
Computer Rooms Feel the Heat

IT Managers Find Novel Ways to Cool Powerful Servers

By Jim Carlton

Companies and institutions are exploiting the new power of video, fancy Web graphics and expanded data storage, and they also are finding an old problem has come back: The servers that do those tasks are getting too hot to handle for some computer rooms.

Today's powerful computers may be more cost-effective and typically don't take up any more space than the machines they replace, but they produce far more heat. Since 2000, the average power per watt in data centers—a measure on how much heat computers generate—has, in some cases, quadrupled to more than 200 from about 50, industry officials said.

The result can be a power outage in these data rooms, and a scramble by information-technology managers to cope. Many IT managers prefer to keep the temperature of their computer rooms in the 60s, and they are battling the heat with both traditional and novel approaches, ranging from bigger facilities with more air conditioning to on-board liquid coolers and floor tiles equipped with fans.

The Pomona Valley Hospital Medical Center in Pomona, Calif., had packed so many servers in a computer room that temperatures soared to almost 100 degrees. Some of the computers started malfunctioning, and in one case several servers failed altogether, said Kent Hoyos, chief information officer for the 443-bed hospital. The hospital's technicians worked frantically to get more cooling into the 6,000-square-foot room, but they still couldn't get temperatures down much.

"We were just on the edge all the time," said Mr. Hoyos. The hospital has solved its problem by spending about $300,000 to install a network of 20 overhead air conditioners.

Many other businesses and institutions face a similar predicament. A 2005 review of 19 data centers by the Uptime Institute, a think tank in Santa Fe, N.M., found that most of the centers couldn't cool their computer equipment. Moreover, the review found 10% of the server "racks"—or panels of servers—were receiving air hotter than they were specified to handle in order to remain reliable. "This is hitting businesses like a ton of bricks," said William Clifford, chief executive officer of Aperature, an industry consulting firm in Stamford, Conn.

If a heat problem persists or worsens, a business ultimately may have to build a new facility. Stand-alone data centers can cost upward of $10 million.

Managers of a computer center for the National Center for Atmospheric Research in Boulder, Colo., have been adding more air-conditioning units to attack their heat problem. Typically, the units are mounted against walls so the cool air can fan out across the room. But after adding five big air conditioners to an existing seven, the managers at the U.S. government facility said design issues of the building and other factors make it so they won't be able to keep the 7,200-square-foot room cool enough much longer without expanding to a new site.

Computer managers are turning to a range of other ways to cool the hotter new machines. One solution is to pipe cooling liquid directly on top of the microprocessor, which generates much of the heat. A liquid-cooling product called SprayCool, made by ISR Inc. of Liberty Lake, Wash., costs about $25,000 per rack of servers.

Other businesses deploy cabinet-size air conditioners that can be rolled right next to a row of computer racks—providing better cooling than wall air conditioners. Officials of APC-MGE, West Kingston, R.I., said demand has been running so brisk for its line of InRow rack coolers that sales in 2006 tripled from 2005, with sales on track to more than double again this year. The unit of France's Schneider Electric SA doesn't disclose sales figures.

Another vendor, Emerson Network Power, of St. Louis, reports sales of its Liebert XD products—smaller air conditioners that fit on top of server racks and are connected with pipes containing waterless refrigerant—doubled in 2006 from the year before. The unit of Emerson Electric Co. also declined to cite specific numbers.

One of the customers for the Emerson product was the Pomona hospital. Another was US Internet Corp., a small Internet-service provider in Minneapolis that by 2005 was experiencing daily breakdowns of its servers and storage drives due to temperatures soaring above 90 degrees in one of the company's data centers in Minnesota, officials there said. "Our issue was we were frying our computers," said Travis Carter, co-founder and chief technology officer of the company. "Quite frankly, we were dead in the water." US Internet has since installed a network of the Liebert XD air conditioners to help bring down room temperatures in the center to 70 degrees. Breakdowns are now a rarity.

Some tech vendors are looking to the floor for answers. Degree Controls Inc. of Milford, N.H., sells floor-mounted tiles for $1,800 each that are outfitted with powerful fans that direct cool air onto the servers. It can cost as much as $50,000 to configure a computer-room floor, but people who have used the tiles say they have helped. Officials of Navisite Inc., a provider of computer-room facilities for corporations, said they can handle heating loads up to 200 watts per square foot in places where the tiles have been installed.

Advanced software also is being deployed to attack the problem. Hewlett-Packard Co. in November announced an energy-management system called Dynamic Smart Cooling that is designed to help deliver cool air where it is most needed in the computer room.

Then, there are truly low-tech approaches. At the Data Center World show in Las Vegas last month, attendees crowded around a booth that featured sections of foam to plug holes and openings that let cool air seep out in computer rooms. Sections of the material by Aclon Inc., Salt Lake City, sell for $25.
Electricity Needed for Main Computers, NCAR Mesa

Arrival year of main fast computers. The height of each bar shows the amount of electrical power needed for the computer. Power to cool it is extra. The real speed of the computer is shown in Gflop above each bar. More information is in the associated table. The power needs of the 2008 computer might be less than shown. The computer companies are working very hard to limit the use of electricity.

Roy Jenne
April 2007
Intel Says It Is Developing Chips That Will Run Faster, While Using Less Power

Mark Bohr, an Intel physicist who led the research, holds a 45-nanometer wafer using new metal alloys that led the insulation advance.

Intel's imminent advance to 45 nanometers will have a huge impact on the industry, Mr. Subramanian said. "People have been working on it for over a decade, and this is tremendously significant that Intel has

The new approach to insulation appears at least temporarily to conquer one of the most significant obstacles confronting the semiconductor industry: the tendency of tiny switches to leak electricity as they are reduced in size. The leakage makes chips run hotter and consume more power.

Many executives in the industry say that Intel is still recovering from a strategic wrong turn it made when the company pushed its chips to extremely high clock speeds—the ability of a processor to calculate more quickly. That obsession with speed at any cost left the company behind its competitors in shifting to low-power alternatives.

Now Intel is coming back. Although the chip maker led in the speed race for many years, the company has in recent years shifted its focus to low-power microprocessors that gain speed by breaking up each chip into multiple computing "cores." In its new 45-nanometer generation, Intel will gain the freedom to seek either higher performance or substantially lower power, while at the same time increasing the number of cores per chip.

"They can adjust the transistor for high performance or low power,"

Several analysts said that the technology advance could give Intel a meaningful advantage over competitors in the race to build ever more powerful microprocessors.

"It's going to be a nightmare for Intel's competitors," said G. Dan Hutcheson, chief executive of VLSI Research. "A lot of Mark Bohr's counterparts are going to wake up in terror."

An I.B.M. executive said yesterday that the company had also chosen hafnium as its primary insulator, but that it would not release details of its new process until technical papers are presented at coming conferences.

"The difference between can openers and Ferraris," said Bernard S. Meyerson, vice president and chief technologist for the systems and technology group at I.B.M. He insisted that industry analysts who have asserted that Intel has a technology lead are not accurate and that I.B.M. had simply chosen to deploy its new process in chips that are part of high-performance systems aimed at the high end of the computer industry.

Word of the announcement, which is planned for Monday, washed off a war of dueling statements as I.B.M. rushed to announce that it was on the verge of a similar advance. I.O.C.

I.B.M. executives said their company was planning to introduce a comparable type of transistor in the first quarter of 2008. Many industry analysts say that Intel retains a six-month to nine-month lead over the rest of the industry, but I.B.M. executives disputed the claim and said the two companies were focused on different markets in the computing industry. The I.B.M. technology has been developed in partnership with Advanced Micro Devices, Intel's main rival. Modern microprocessor

Currently much of the industry is building chips in what is known as 90-nanometer technology. At that scale, about 1,000 transistors would fit in the width of a human hair. Intel began making chips 65 nanometers in 2005, about nine months before its closest competitors.

Now the company is moving on to the next stage of refinement, defined by a minimum feature size of 45 nanometers. Other researchers have recently reported progress on molecular computing technologies that could reduce the scale even further by the end of the decade.

Intel's advance was in part in finding a new insulator composed of an alloy of hafnium, a metallic element that has previously been used in filaments and electrodes and as a neutron absorber in nuclear power plants

THE NEW YORK TIMES, SATURDAY, JANUARY 27, 2007

By JOHN MARKOFF

Intel, the world's largest chip maker, has overhauled the basic building block of the information age, paving the way for a new generation of faster and more energy-efficient processors.

Company researchers said the advance represented the most significant change in the materials used to manufacture silicon chips since Intel pioneered the modern integrated-circuit transistor more than four decades ago.

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Continued on Page B9
Tech Giants to Unveil Power-Usage Plan

AMD, IBM, Rivals To Focus on Efficiency Of Servers, Data Centers

By DON CLARK and JIM CARLTON

The rising cost of energy to operate computer rooms is forcing high-tech competitors to work together—and maybe even agree on ways to measure the problem.

The Green Grid, an industry group launched in April, today is revealing its plans to address the increasing power consumption of servers and the data centers that use them.

Advanced Micro Devices Inc., which helped organize the effort, initially enlisted computer makers Hewlett-Packard Co., International Business Machines Corp. and Sun Microsystems Inc. Dell Inc., the fourth big server maker, soon joined the group.

Now, the Green Grid is disclosing that it has 11 companies represented on its board—with the additions of software giant Microsoft Corp. as well as Intel Corp., AMD's archival in selling chips for servers and personal computers.

"At the end of the day, we knew we couldn't solve the problem alone," said Bruce Shaw, AMD's director of world-wide enterprise and commercial marketing.

The problem of data-center power has spurred several other industry collaborations as well as the attention of the White House. In December, Andy Karsner, an assistant secretary of the Department of Energy, led a Silicon Valley roundtable on the topic and this week is scheduled to meet with executives of AMD and Dell at their offices in the Austin, Texas, area.

Global electricity consumption by servers and ancillary equipment doubled between 2000 and 2005, estimated Jonathan Koomey, a staff scientist at Lawrence Berkeley National Laboratory and consulting professor at Stanford University, in an AMD-funded study released this month. The total annual electricity bill rose to $7.3 billion during that period, he found.

One of Green Grid's primary goals is to come up with more-accurate data to measure power efficiency in computer rooms. The lack of standard measure of computing performance has posed a big obstacle in coming up with ways to improve the energy efficiency of computer equipment and consumption practices.

"It's the most absurd thing," Mr. Koomey said. "Once people agree on a way to measure performance, things will change very quickly."

More than a decade ago, hardware makers stopped quoting a figure called MIPS—millions of instructions per second—in favor of an array of specialized benchmark tests that reflect how machines handle specific jobs. As a result, computer managers can't easily compare how much work is getting done in exchange for their rising utility bills.

An industry group called SPEC—the Standard Performance Evaluation Corp.—is working on new performance tests to be used in combination with power-consumption figures being developed by the Environmental Protection Agency.

Larry Gray, an Intel executive involved in the SPEC effort, noted that servers come in many sizes and combinations of memory and other accessories to handle different chores—making it impossible to have just one server performance number. But he expressed optimism that new benchmark measures will be delivered this year, likely starting with figures for low-end servers.

Besides servers, one focus for improving efficiency is the power supply itself, including the devices that convert alternating current into direct current used by most computing equipment. Many such devices convert less than 70% of the voltage they receive into usable energy, industry executives say.

An effort called 80 Plus, managed by electric utilities and Ecos Consulting Inc., operates a certification program to encourage PC power-supply makers to boost efficiency to 80% or more, and it is planning to shift its attention to server power supplies.

Meanwhile, a company called Cold-Watt Inc. today is announcing a line of server power supplies that it says generate 45% less heat than other products on the market and can cut total server power consumption by 30%.

The Austin, Texas, company says initial customers include server maker Open Source Systems Corp.

The Green Grid hopes to attract such technology suppliers as well as data-center managers to become paid members. Companies on its board include computer maker Rackable Systems Inc., a maker of server-cooling technology called SprayCool Inc., and American Power Conversion Corp., which makes a variety of data-center equipment.
Selected fast computers at NCAR

(Computer, else power, processors, real speed)

1) Select fast computers

<table>
<thead>
<tr>
<th>Date</th>
<th>Computer</th>
<th>Electric Power (kW)</th>
<th>Processors</th>
<th>Real Compute Speed (GFlop)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/1997</td>
<td>Cray C90</td>
<td>4.94 kW</td>
<td>16</td>
<td>4.65 GFlop</td>
</tr>
<tr>
<td>8/1999</td>
<td>IBM blackbird</td>
<td>75</td>
<td>29.6</td>
<td>16.58</td>
</tr>
<tr>
<td>5/2000</td>
<td>IBM blackbird</td>
<td>80</td>
<td>60.4</td>
<td>58.35</td>
</tr>
<tr>
<td>10/2001</td>
<td>IBM blackbird</td>
<td>140</td>
<td>1308</td>
<td>121.6 GFlop</td>
</tr>
<tr>
<td>10/2002</td>
<td>IBM bluesky</td>
<td>265</td>
<td>1216</td>
<td>258.6</td>
</tr>
<tr>
<td>10/2003</td>
<td>IBM bluesky</td>
<td>415</td>
<td>1600</td>
<td>345.3</td>
</tr>
<tr>
<td>8/2005</td>
<td>IBM bluevista</td>
<td>210</td>
<td>624</td>
<td>470.0</td>
</tr>
<tr>
<td>10/2006</td>
<td>IBM blueice</td>
<td>283</td>
<td>1600</td>
<td>1350 GFlop</td>
</tr>
<tr>
<td>~8/2008</td>
<td>IBM upgrade</td>
<td>~600</td>
<td>?</td>
<td>~5400 GFlop</td>
</tr>
</tbody>
</table>

2) Electric Power use for computer, suite cooling (NCAR Mesa)

The upgrade for 08/2008 will be about 4x faster than Blueice. It will also be much more energy efficient than Blueice, but will likely add a few hundred kW to the compute load. The existing gear will gradually be shut down, which will decrease the load. Table C shows that the electric loads for big computers on the Mesa should remain under 1800 kW during 2006 – 2009.

TABLE C. ELECTRIC POWER FOR THE NCAR BIG COMPUTERS (kW).

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Compute load</td>
<td>850 kW</td>
<td>1010 kW</td>
<td>719 kW</td>
<td>~1000</td>
<td>~750</td>
</tr>
<tr>
<td>Cooling load</td>
<td>550 kW</td>
<td>660 kW</td>
<td>470 kW</td>
<td>~650</td>
<td>~490</td>
</tr>
<tr>
<td>Total</td>
<td>1400 kW</td>
<td>1670 kW</td>
<td>e1189 kW</td>
<td>e1650 kW</td>
<td>e1240 kW</td>
</tr>
</tbody>
</table>

Total GFlop: ~140 GFlop

~1380 GFlop ~6800 GFlop 5400 GFlop

Ray Jones
Apr 10, 2007

64
Discussing how to make a better chip

Companies show off latest tools, techniques

By Tom Abate
San Francisco Chronicle

SAN FRANCISCO — Smaller, faster and above all cheaper — those words will rule through Friday as the toolmakers of the semiconductor industry gather to show off the industrial wizardry to create the chips of the future.

The annual Semicon West trade show at the Moscone Center draws about 1,300 companies and 35,000 people to show off the latest tools and techniques for turning thin slices of silicon into electronic brains inside everything from computers to cell phones.

Locally, the semiconductor industry is of interest, not only because it drives a variety of products and devices, but also because San Jose, Calif.-based chipmaker Xilinx Inc. employs about 350 people in Longmont.

Making chips is a capital-intensive business. Worldwide sales of semiconductors totaled $227 billion in 2005. The toolmakers whose wares are on display this week booked sales of $32.9 billion last year.

That works out to roughly 14 cents spent on equipment for every dollar's worth of chips sold. Before the dot-com crash, spending on equipment was higher, ranging from 17 percent to 20 percent of semiconductor sales, according to Dan Tracy, research director for Semiconductor Equipment and Materials International, the trade association behind the show.

In recent years, however, caution in the aftermath of the crash, coupled with a change in the nature of the electronics marketplace, have lowered the tool-to-chip spending ratio.

Many semiconductors now end up in cars, cameras and music players, rather than in computers. About 46 percent of chips went into computers in 2005, according to the Semiconductor Industry Association, which represents the chipmakers who buy equipment from the tool vendors meeting in San Francisco. The next-biggest chunk, 20.9 percent, went into communications equipment, followed by 17.2 percent for consumer electronics. Automobiles and industrial equipment each consumed roughly 8 percent of the chip market.

This trend has increased the pressure to cap costs throughout the production chain from toolmakers to chipmakers to finished-goods makers.

"A lot of the (electronics) industry is moving toward the consumer and price becomes essential when you're dealing with consumer rather than corporate buyers," said Doug Andrey of the Semiconductor Industry Association.

The working parts of a chip are so small as to be scarcely imaginable. A state-of-the-art chip incorporates millions of transistors, each 65 nanometers wide. How small is that? Well, a human hair is about 80,000 nanometers thick — which means that 1,230 or so transistors could sit side-by-side in a hair's width.
Supercomputer Users Plan Fast Quad Adoption

BY PATRICK THIBODEAU

Users of high-performance computers are already making plans for x86-based, quad-core processors due from Intel Corp. next month and from Advanced Micro Devices Inc. by mid-2007.

By year's end, the Louisiana Optical Network Initiative (LONI), a network of high-performance computers run by eight state research universities, expects to have 1,440 Intel quad processors, code-named Clovertown, running on Dell servers and delivering 50 trillion floating-point operations per second (TFLOPS) of power.

Officials declined to disclose the cost of the systems.

When combined with the installed IBM p5 servers running various Intel processors, the capacity of the LONI network is expected to reach 85 TFLOPS.

Meanwhile, the Texas Advanced Computing Center at the University of Texas in Austin intends to buy 13,000 quad-core processors from AMD to run on Sun Microsystems Inc. servers. The quad-core Opteron chips are due out by mid-

The $59 million purchase will be funded by the National Science Foundation as part of its project to build a 400-TFLOPS system.

Widespread use of the quad systems depends on the development of software that can take advantage of the technology, noted John Fruehe, worldwide business development manager for Opteron at AMD. Each core in a multicore processor runs at a lower clock speed than single-core chips, and performance gains depend on how well the software can run in parallel environments, he said. "So much more relies on the software than ever before," Fruehe said.

Boyd Davis, director of marketing for the server product division at Intel, noted that many server-based business applications have already been adapted for multicore environments. "In a server market, most of the applications that customers care about have already been built with multithreading in mind," he said.

Many high-performance applications, such as those the Texas Advanced Computing Center plans to run on its Opteron quad chips, use the Message Passing Interface (MPI) communication protocol to work in large parallel environments. Tommy Minyard, assistant director at the center, said researchers there plan to find ways to improve the protocol's ability to increase the performance of applications running on quad chips.

One problem with the protocol, Minyard said, is that it causes network communications to use significant processor overhead. "If processors are trying to communicate with one another, they are not doing floating-point operations per se," said Minyard, who plans to work on developing hybrid techniques that would limit or move MPI's communications work off the processor. "We want to maximize the amount of floating-point operations that can be done with these systems at large scale."

In an effort to encourage businesses to utilize high-performance computing systems, 10% of the computing capacity in the LONI project will be reserved for businesses whose use of the system will create jobs in the state, said Charles McMahon, executive director. He said the group expects that companies willing to come to Louisiana and create jobs can benefit by using some of its compute cycles.

McMahon said LONI members hope to have their quad system in production as early as January.

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IBM to Invest $100M In Mainframes

IBM said it will invest $100 million in a five-year effort to promote mainframe computers. The plan calls for developing tools and processes that make mainframes easier to configure and operate, and to promote the systems as an alternative to server networking. IBM said it will also build tools to help programmers automate the process of developing and deploying software on mainframes.

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IBM Procurement HQ Moves to China

IBM has shifted its global procurement headquarters from Somers, N.Y., to Shenzhen, China, a symbolic move that the company said does not indicate any upheaval in its purchasing operations. For now, the move involves the relocation of one person, Chief Procurement Officer John Paterson. He will focus first on ramping up the purchase of third-party software and services from Asian suppliers.

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Microsoft Releases 'Last' Vista Beta

Microsoft Corp. has released what it said will be the last test version of Windows Vista. The software was released to participants of the company's Customer Preview Program, as well as to TechBeta, TechNet, the Technology Adoption Program and MSDN members. Microsoft said it will release Vista, which has been delayed several times, to business customers next month and to consumers in January 2007.
SEMICONDUCTORS

MORE LIFE FOR MOORE'S LAW

Chipmakers can't keep using the same tricks to boost speed. New ones are coming.

By Adam Aston

In the race to produce ever-faster chips, it sometimes feels like enough is enough. Our desktops have sufficient horsepower to simulate the birth of galaxies if anyone wants to. Phones and PDAs are stuffed with fascinating communications tricks that few people will ever use. So do we still need Moore's Law—the precept that chip performance should double roughly every 18 months?

The electronics industry says yes, for reasons of cost and capability. There are still a few billion people on the planet who have yet to purchase a cell phone, let alone a PC. So if chipmakers can keep Moore's Law on track for a few more years, the digital amenities that rich countries take for granted will be cheap enough for everyone to buy, brainy enough to understand requests in natural spoken language, and even to answer back.

Now more than ever, though, upholding Moore's Law will require imagination.

So far chip companies have relied mostly on one clever trick: They shrink the transistors on chips so that electrons have less distance to travel, thereby speeding up the processing of data. But that trick is getting harder to perform. In the 1990s, shrinking led reliably to faster speeds. It was "the cream-puff era," says Gary Smith, chief analyst at Gartner Dataquest in San Jose, Calif. Today, though, circuits are packed so closely that chips are heating up, and performance is starting to suffer. That's one reason giants such as Intel Corp., No. 52 on this year's Info Tech 100, and IBM, No. 44, have fallen behind schedule in launching new generations of microprocessors in recent years.

Even so, chipmakers think they can still pull off a few more generations of shrinking before they hit the wall. They're trying new materials and production tools, and most experts see an orderly progression deep into nanotechnology. Today's circuit lines measure about 90 nanometers in width—or 90 billionths of a meter. This year and next they'll go down to 65 nm, then 45 nm by 2010, 32 nm by 2013, and 22 nm by 2016, says International Technology Roadmap for Semiconductors, an industry research group. After that, says Paolo A. Gargini, Intel's director for technology strategy, "it's unclear what will come next."

Fortunately, shrinking is just one way to solve the problem. Another strategy that is already moving into the marketplace involves linking several microprocessor "cores" together on the same semiconductor. This will require overhauling the software running on the chip. In addition, engineers are devising new ways to stack circuitry, layer upon layer, into multi-story, 3D structures. Together, these developments should sustain momentum in the $227 billion global chip sector for years, if not decades. They could even lead to a quantum leap in performance. "We're going to see a lot of evolution happening very fast," says IBM's Philip Emmons, manager of systems technology and microarchitecture.

Among these different approaches, the first superfast chips coming out of the gate are the multicore devices that boost performance by replacing a single high-speed processor with two or more cores that don't need to be so speedy. "A 300-pound man can generate a lot of power," says IBM's Emmons. "But two 160-pound guys can do the same work with less overall effort." On your desktop, this means replacing a single 3-gigahertz chip...
Best to get a Big Computer with 9x the Power?
(Or first get 3x more speed and then get upgrades each 18 to 30 months?)

The local needs, and proposed hardware costs must be analyzed to answer these questions. However, several factors typically make it best to initially obtain a smaller increase in computer capability, and then get one or two more upgrades during the length of the 3 to 5 year contract. First the more capable computer processors are not available at time zero. Thus the only way to obtain more speed at time zero is to buy many more processors. Moore’s Law says that after 18 months we can usually obtain twice (2x) the computer power of time zero, for the same cost. By getting upgrades we can obtain more computer power for a lower cost. Also, the computer company can offer a lower price, if it has upgrades during one contract.

There is another reason not to get a huge step in computer power at time zero. The real progress in science typically depends on a balance between computer speed and the use of expertise and time to develop better software to tell the computer how to include better science. Quick computer speed permits us to run climate models at higher resolution, and for more years, but this does not replace the need for science development tasks, which take time.

Roy Jenne
Oct 25, 2006
An Upgrade for the Big Computers at NCAR Mesa, 12/2006

Roy Jenne
Oct 9, 2006
Rev Oct 23, 2006

We will summarize a number of facts and issues that relate to the 12/2006 computer upgrade at NCAR.

At first (about Oct 2, 2006) I had Figure 1 which was my only source of information about the speed of the upgrade itself. Fig 1 had been used to brief the staff of the computing division about the upgrade (on Sep 22, 2006). From that I found that the speed of the upgrade was a real 2190 Gflop, a nice addition (but this would turn out to be wrong). I also had Table 1 with speed and technical information for the older computers. Plus several helpful discussions with computer staff.

By Oct 17, most of the main text was pulled together, but I did another calculation: The implied power of the upgrade (blueice) as a percent of peak power was 18% (2.19/12 Gflop) which seemed much too high. I talked with the main expert and found that it should be about 11.5% which gives a real speed for the upgrade of 1380 Gflops (not 2190). Figure 2 is based roughly on these numbers (that are much more accurate). But this gives a smaller increase in speed for the Fall 2006 upgrade. We will move from 0.96 TFlop real before, to 1.9 to 2.0 TFlop in 02/2007. Remember that there will be another upgrade in 08/2008.

Figure 1 shows 2190 Gflop for the upgrade. Also note that Fig 2 actually shows 1505 Gflop for the upgrade. The best value is 1380 Gflop. So the real total power after the upgrade (Feb 07) will be about 1.9 to 2.0 TFlop. The numbers cannot be utterly precise because they depend on the job mix, etc.

- The computer advisory panel (met Oct 5, 2006) was told that NCAR would have a real 2100 Gflop after the Fall '06 upgrade and 5300 Gflop after the 07/2008 upgrade. We now show 4640 after the 2008 upgrade.

1. Introduction

NCAR is getting a major upgrade to its “big” computing power in Fall 2006 (IBM blueice). It has 1600 processors, and will be in full production by 02/2007. We will try to summarize a number of issues to help readers understand what is happening:

- The present real computing power and electricity use (09/2006).
- Real computing capability (in Gflop) before and after the upgrade.
- The before and after use of electricity in the NCAR Mesa computing room. This has two electrical feed lines.

Future compute capability at the Mesa:

- If NCAR can keep getting regular upgrades to this new computer, how much real computer capability might we have by 2014.
- Options to bring more electrical power to the NCAR Mesa, if needed.
- The cost of the electricity, and the reasons that higher prices per kWh are likely.
- A brief overview of past real computing power at NCAR Mesa.
- Sample of news about other recent big computers in the USA.

2. Energy use and real Gflop by main NCAR computers (09/2006).

The use of electricity by the three main computers in 09/2006 is listed separately. A total that includes the other main computers is also given.
<table>
<thead>
<tr>
<th>Computer</th>
<th>kW</th>
<th>Real Gflop</th>
<th>Ratio/Gflop/kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bluesky</td>
<td>415</td>
<td>345.3</td>
<td>0.83</td>
</tr>
<tr>
<td>Bluegene</td>
<td>25</td>
<td>381.3</td>
<td>15.25</td>
</tr>
<tr>
<td>Bluevista</td>
<td>210</td>
<td>470</td>
<td>2.25</td>
</tr>
<tr>
<td>650</td>
<td></td>
<td>1197</td>
<td></td>
</tr>
<tr>
<td>Other computers</td>
<td>152</td>
<td>141</td>
<td></td>
</tr>
<tr>
<td><strong>Total computers</strong></td>
<td><strong>802</strong></td>
<td><strong>1338</strong></td>
<td></td>
</tr>
<tr>
<td>Other gear</td>
<td>-50</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Gflop</strong></td>
<td><strong>850</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** By Feb 07, the bluesky will be gone. The bluegene will be at NCAR before and after the upgrade, but it is not listed on Figure 1 for the power we have. It is a partnership computer and NCAR has a right to use 1/3 of the power.

3. NCAR change in real compute power, NCAR slide, Sep 22, 2006.
   Figure 1 shows that NCAR has about 0.96 Tflop of power in Sep 2006 and will have about 2.80 Tflop of real power in 02/2007. But this slide was wrong. The real power in 02/2007 will be about 2.0 Tflop (Fig 2).
   ➢ This is a gain of a factor of 2.1x increase.
   ➢ But the CISL email of Oct 2, 2006, said that the gain would be 2.5x. But people later said that this was intended to be a general number.

4. The real power of NCAR big computers in Sep 2006, before upgrade.
   In Sep 2006, the present computers at NCAR Mesa delivered about 1338 Gflop of real power. The bluegene is a shared computer (1/3 NCAR) and they decided not to count it in either the before or after conditions in Figure 1 and Figure 2. That removes 381 Gflop, leaving 957 Gflop for the "before" state in Fig 2.
   ➢ And during the upgrade, the bluesky will be removed (which takes away 345 Gflop), and removes 415 kW of energy use.

5. The computer power of the upgrade (blueice).
   Fig 2 shows about 2100 Gflop in 02/2007 after the upgrade. By then bluesky will be gone (lose 345 Gflop). The compute power of the upgrade is expected to be 1380 Gflop.
   ➢ Thus the upgrade (blueice) is expected to have a total real Gflop of 4.0x bluesky.
   ➢ The change in total real compute power (09/2006 to 02/2007) will be 2100/957 based on a slide, factor of 2.19x. A better number is 1900/957 = 1.99x.
   ➢ The email (Oct 2) said that this speedup would be 2.5x, not 2.0x. But on Oct 6, it was explained to me that the 2.5x was intended to be a very rough number.
   ➢ What will really happen is a gain of 2.0x. (But note that Fig 2 and 2.0x do not include the power of bluegene which is 381 Gflop.)

The agreement for the computer upgrade of Fall 2006.
The vendors were told that NCAR would expect an average of 6 times more real power than bluesky (345.3 Gflop) when averaged over the next 3 years of operations. This gives an average of 2072 real Gflop for the new computer (during 2007 – 2009).
7. The IBM blueice will have 1600 processors. Each processor will have a clock speed of 1900 MHz. There will be 1600 batch processors (16 processors per node). This computer will use dual core chips, thus there will be 8 chips per node. The computer is rated at 12 Tflops peak speed and is expected to deliver 1.38 Tflop real speed. This implies that NCAR will achieve 11.5% of peak speed which may be a little high for this type of computer. For example, the bluevista which arrived 08/2005 can achieve 9.9% of peak and bluesky could only do 4.2% of peak.

During 2007 several companies will deliver computers that have quad core chips.

8. The speed, memory and disks of a few NCAR computers. With a faster speed, a computer may be dealing with more simultaneous users. Also the models for the atmosphere and ocean now have more levels and better horizontal resolution. This requires more memory and more short term disk storage on the computer.

Real Gflop speed, memory and disks at NCAR

<table>
<thead>
<tr>
<th>Date</th>
<th>Computer</th>
<th>Clock MHz</th>
<th># Proc</th>
<th>Gflop Real</th>
<th>Gflop Real/proc</th>
<th>Memory Tbytes</th>
<th>Disks Tbytes</th>
</tr>
</thead>
<tbody>
<tr>
<td>01/1997</td>
<td>Cray C90</td>
<td>244</td>
<td>16</td>
<td>4.7</td>
<td>(.29)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>08/2005</td>
<td>Bluevista</td>
<td>1900</td>
<td>624</td>
<td>470</td>
<td>(.75)</td>
<td>1.2</td>
<td>55 Tb</td>
</tr>
<tr>
<td>12/2006</td>
<td>Blueice</td>
<td>1900</td>
<td>1600</td>
<td>1380</td>
<td>(.86)</td>
<td>4.0</td>
<td>150 Tb</td>
</tr>
</tbody>
</table>

9. The hardware cost to purchase the main computers and upgrades at NCAR. For 8 to 10 years, or more, the contracts for big computers from vendors have usually run from 3 to 5 years and cost a little over $4m per year. A contract includes an initial upgrade plus one or two more upgrades during the duration of the contract. If we include some other costs such as the maintenance of older computers, the cost may come close to $5m per year. The cost of the electricity, which is about $600,000 per year (in 09/2006) is an extra item, not included in the above $4 to 5m/year numbers. There are also other costs for mass storage, networks, workstations, etc.

10. Change in NCAR Mesa main computing electricity (09/2006 – 02/2007). (Move in the blueice upgrade, and remove bluesky)

<table>
<thead>
<tr>
<th></th>
<th>09/2006</th>
<th>02/2007</th>
<th>Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compute load</td>
<td>850 kW</td>
<td>1180 kW</td>
<td>39%</td>
</tr>
<tr>
<td>Cooling load</td>
<td>550 kW</td>
<td>750 kW</td>
<td>36%</td>
</tr>
<tr>
<td>Total</td>
<td>1400 kW</td>
<td>1930 kW</td>
<td>38%</td>
</tr>
</tbody>
</table>

The gain in computing Gflops during the Fall 2006 upgrade
From Sep 06 to Feb 07 the real Gflop output at NCAR will go from 957 Gflop to 1900 Gflop (a 2.0x gain). The compute electricity use will be up by 39%. The kW use includes electricity used by bluegene (not much), but the Gflop output of bluegene is not counted as part of the total Gflops we have during the upgrade.
11. How much electricity does the upgrade (blueIce) use?
During the upgrade the “compute load” power needs will go from 850 kW to 1180 kW (gain of 330 kW). At the same time, NCAR will retire bluesky (uses 415 kW). Thus the upgrade by itself uses 745 kW (330 plus 415).
▶ BlueIce will deliver about 1380 real Gflop and use 745 kW (thus energy efficiency, Gflop/kW is 1.85). The efficiency of the present bluevitva is 2.24.
▶ During the Fall 2006 upgrade, the total use of power for the NCAR Mesa big computers (and cooling) will change from 1400 kW to about 1930 kW, a 38% increase.
  ◦ Later on we will probably have more precise numbers for the speed and energy efficiency of blueIce.

12. How much electrical power can the computer room line to NCAR Mesa deliver?
I thought that it was limited to about 1.0 mW, but we have seen that it delivered 1.4 mW in Sep 06, and will deliver 1.93 mW after the upgrade in Feb 07. Then another computer upgrade will come in mid-2008.
▶ CISL staff says that 1.93 mW is about the limit of what we can use.
▶ See the attached sheet about options to bring more electricity to the Mesa.


<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Upgrade (blueIce)</td>
<td>0</td>
<td>1380</td>
<td>4140</td>
<td>4140</td>
</tr>
<tr>
<td>Earlier compute (blueVista)</td>
<td>500</td>
<td>500</td>
<td>500</td>
<td>0</td>
</tr>
<tr>
<td>Earlier (bluesky, other)</td>
<td>440</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total speed</strong></td>
<td><strong>940</strong></td>
<td><strong>1880</strong></td>
<td><strong>4640</strong></td>
<td><strong>4140</strong></td>
</tr>
</tbody>
</table>

NOTE: In Table 1, blueVista was rated at 470 Gflop. Figs 1 and 2 were based on about 520 Gflop. We have used 500 Gflop above.

And we hope that another upgrade of about 3x will happen about 01/2010, giving about 12.4 Tflop real, on the NCAR Mesa.

Moore’s Law promises that after 18 months one can buy twice the computer power for the same cost as at time zero.
▶ This gives a factor of 4x gain in computing output each 3 years…if the regular upgrades can continue.
▶ NCAR will have 1.9 Tflop of real power in 02/2007 and probably 4.6 Tflop by 08/2008.

Real computer power at NCAR if upgrades continue each 18 months:

<table>
<thead>
<tr>
<th>Real Power</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Another 4x</td>
<td>18 Tflop</td>
</tr>
<tr>
<td>Another 4x</td>
<td>74 Tflop</td>
</tr>
<tr>
<td>Another 16x</td>
<td>1180 Tflop</td>
</tr>
</tbody>
</table>

NOTE: 150 TFLOP REAL IS ABOUT 2 PFLOP PEAK.
An Upgrade for the Big Computers at NCAR Mesa, 12/2006

- The real speed of the NCAR fast computers in 09/2006 was 940 Gigaflops.
- By 02/2007 the speed will be 1900 Gflop.
- And by 08/2008 there will be 4640 Gflop.
- Will there be enough electricity for more upgrades?
- Other recent big computer purchases in USA.

Also: The NCAR Proposal for Geosciences Computing for NSF.

- 10/31/2006: NSF put the proposal on hold.
  The idea of a “geo-collaboratory” has intervened. This would be a network of high-speed computers with special software to do research. But what would this look like? NSF needs more time.

Roy Jenne
Nov 3, 2006
NCAR real compute power (CISL slide, Sep 22, 06)

(This shows too much Tflops for the upgrade)

Sustained TeraFLOPs at NCAR

Figure 1 shows .96 Tflop in 09/2006 and 2.80 Tflop in 02/2007. But see Figure 2. It is better. This also implies a real speed of the fall 06 upgrade of 2190 Gflops which is much too high.
Estimated Sustained TFLOPs at NCAR (Production Systems)

(This shows 1500 GFlop for real power of blueice)

Figure 2. Real T flop of big computers at NCAR

Revd from Tom Engel on Oct 18, 2006
CISL Staff:

I am pleased to announce that late last week NSF gave UCAR the approval to award the ICESS supercomputer procurement contract to IBM.

The UCAR scientific community and many technical and business support experts provided guidance over many months, ultimately recommending the IBM proposal which we believe provides both best value and maximum benefit to the science communities served by CISL.

The ICESS procurement will result in a two-phased increase in sustained computational capacity at NCAR. In phase 1 (early 2007), bluesky will be replaced by an IBM POWER5 system named blueice, which will increase computing capacity by a factor of 2.5 beyond current (2006) levels. During phase 2 (mid-2008) blueice will be replaced by an IBM POWER6-based product which is expected to provide at least a 2.5-fold increase over the 2007 levels. The POWER6-based equipment is scheduled to remain at NCAR until mid-2011.

Many CISL staff have already begun planning for the delivery of blueice, which will be positioned near the windows looking into the machine room. The blueice hardware is scheduled for delivery in late October, acceptance by the end of the year, and available for general use by the user community by February, 2007.

Because of machine room power/cooling constrains, a small portion of bluesky will have to be powered off in November in order to provide the power needed by blueice. We are committed to maintaining bluesky through a short overlap period with blueice while the users transition to either bluevista or blueice. The operating environment on blueice will be nearly identical to that of bluevista, thus users can begin to port their codes immediately.

For those interested in the specific configuration of the phase 1 system, blueice:

IBM BlueIce computer
1.9 GHz POWER5+ p575 SMP nodes
dual-link Federation switch (High Performance Switch)
4 TB memory, 150 TB disk
1600 batch processors - 16 processors/node
12 TFLOPs peak

Over the next few weeks, we will be announcing more specific aspects of blueice, the bluesky decommission schedule, and plans for the deployment of blueice to the users.

..Tom Bettge

10/2/2006
Cecilia Banner

From: "Tom Bettge" <bettge@ucar.edu>
To: "NCAR Computer Users" <computer-users@ucar.edu>
Sent: Monday, October 09, 2006 1:55 PM
Subject: NCAR's Next High Performance Computer System

Next High Performance Computer System

On September 28 the National Science Foundation approved UCAR's request to award the contract for NCAR's next generation supercomputing environment - the Integrated Computing Environment for Scientific Simulation (ICESS) - to IBM. The UCAR scientific community and many technical and business support experts at NCAR provided guidance over many months, ultimately recommending the IBM proposal, which provides both best value and maximum benefit to the science communities served by NCAR and its Computational and Information Systems Laboratory (CISL).

The ICESS procurement will result in a two-phased increase in sustained computational capacity at NCAR. In phase 1 (early 2007), bluesky will be replaced by an IBM POWERs-based system named blueice, which will have 1600 1.9 GHz batch compute POWERs+ processors, 4 TeraBytes (TB) of memory, and 150 TB of disk. With the introduction of blueice, the total computing capacity at NCAR will increase by a factor of nearly three beyond current (2006) levels. During phase 2 (mid-2008) blueice will be replaced by an IBM POWER6-based product which is expected to provide at least an additional 2.5-fold increase over the 2007 levels. The POWER6-based equipment is scheduled to remain at NCAR until mid-2011.

To facilitate the installation of blueice while staying within the electrical power and cooling constraints of the NCAR’s Mesa Lab computer facility, a portion of bluesky (perhaps as much as 20%) will be removed in November 2006. Bluesky queue wait times are expected to increase. Porting your codes to bluevista now should shorten your wait times and will ease your transition to blueice, which will have a nearly identical environment to bluevista. Another advantage to porting your codes now is that a recent compiler upgrade on bluevista increased the efficiency of user codes, and thus bluevista users get more computing per GAU than bluesky users.

It is expected that blueice will be available for general use as early as 1 February 2007. Again, we encourage users of bluesky to port their codes to bluevista as soon as possible. Bluesky will be decommissioned in February 2007.

Join us for a special meeting in San Antonio, TX, during the 87th AMS Annual Meeting, at 5:00 PM, Tuesday, January 16, 2007. We
New Supercomputer (Blueice) in Production at NCAR
February 1, 2007

CISL has completed the installation and testing of NCAR's newest high performance computer, named blueice. With the introduction of blueice, the total computing capacity at NCAR nearly triples early 2006 levels.

If you have a bluevista account and have used it for batch jobs within the past six months we have already set up an account on blueice using your bluevista password. If you only have a bluesky account, we have used your bluesky password. If you do not have a bluevista or bluesky account, but you have a valid NCAR project number (with GAUs still available) you may request a blueice account by submitting a work request to Extraview at: https://cislcustomersupport.ucar.edu/evj/

Please note: people that have used bluevista or bluesky only interactively will have to request a blueice logon.

For more information on blueice see our user documentation at: http://www.cisl.ucar.edu/docs/blueice/

The batch system on blueice is LSF. Loadleveler is not available, so people who have only been using bluesky will need to learn LSF.

For the next three months (February through April) approximately 1200 processors out of blueice's 1600 processors will be reserved for eight special projects selected by the NSF, NCAR management and the CISL HPC Advisory Panel. The other processors will available to university, CSL and NCAR computer users.

Beginning May 1 when the special projects have completed, allocations will increase for the CSL and NCAR. The CISL HPC Advisory Panel will increase its allocations to the university community at its meeting on April 5. For information on requesting an additional university allocation see: http://www.cisl.ucar.edu/resources/overviewalloc.html

As a reminder, bluesky will be decommissioned and will no longer accept new jobs after 11:59 PM (MT) February 28. Batch jobs in the running state will be allowed to complete etc., not needed

Tom Bettge

Feb 28, 2007
NCAR makes Blue change

Supercomputer upgrade will quadruple modeling speed

By Todd Neff
Camera Staff Writer

Blue Sky, make way for Blue Ice.

The National Center for Atmospheric Research in Boulder is installing an IBM supercomputer named Blue Ice that is capable of sustaining four times the processing speed of its current top machine, Blue Sky, officials from NCAR and IBM are announcing today.

In February, the transition will be complete, with 90-foot-long Blue Sky disassembled and removed from its Mesa Laboratory home. It will have been just four years since Blue Sky's installation as one of the world’s fastest machines in late 2002.

Such is the fate of supercomputers, which live fast and die young, burning out at a pace dictated by Moore's Law, which says processor speed shall double every 18 months.

In 2005, Blue Sky was still the 125th fastest in the world, according to supercomputer-tracking Web site Top500.org. Blue Ice would have come in at No. 30 last year.

The new machine is a descendant of the Blue Gene machine that in 1997 famously beat world chess champion Gary Kasparov at his own game, IBM officials said. The Blue Ice machine is a cluster of 10 roughly refrigerator-sized racks, or frames. They hold liquid-cooled computer processors burning through calculations at a pace of 12 teraflops — trillion floating-point operations per second.

Blue Ice is optimized for the sort of atmospheric modeling that has long been NCAR’s scientific calling card, NCAR officials said. There are at present no plans to pit it against Gary Kasparov.

Blue Ice represents the first half of a two-phase NCAR computing buy to be completed in mid-2008, when a similar machine with faster-yet processors will occupy the Mesa Lab raised flooring once supporting Blue Sky.

"These systems pretty much max out the power and cooling we have at this facility," said Tom Engel, an NCAR high-performance computing specialist.

Engel said the new machines are simply keeping up with the ever-rising processing demands of NCAR’s computationally taxing climate models.

Engel said Blue Ice’s IBM successor will boost computational speed four times again.

He said modeling more chemical reactions, physical and biological processes interactions will consume the new computing power. In addition, he said, the number of grid boxes representing a given depth of ocean, expanse of land or bit of sky will increase, boosting model detail and helping scientists more accurately model climate, ocean and atmospheric phenomena.

The march of technology and the development of climate models increasingly true to Earth’s complex processes is continuing.

NCAR’s proposed $75 million national supercomputing center, to be located in either Boulder or Cheyenne, Wyo., is slated to open in 2010. By 2014, just 12 years after Blue Sky’s installation, NCAR officials expect its first supercomputers to provide 100 times more computing power than the retiring machine.

Contact Camera Staff Writer Todd Neff at (303) 473-1327 or neff@dailycamera.com.

Figure 2. The article is helpful, but has some technical problems. Bluesky was obtained 10/2003 and has 345 Gflops of real speed. Bluevista was obtained two years later (8/2005) and has 470 to 500 Gflop of real speed.

Bluevista is about 40% faster than Bluesky and is the present fastest computer at NCAR (not Bluesky as in the story). The new Blueice will double the total computing power at NCAR, from 940 Gflop before to 1880 Gflop in 02/2007, after the upgrade.

The new computer (blueice) is quoted as “burning through calculations at 12 Teraflops a second.” But this is a “peak” speed which has little to do with how fast NCAR can run science models (Blueice will deliver a real speed of 1380 Gflop, which is about 11.5% of peak speed). After the next upgrade in 08/2008, NCAR is expected to have a total of about 4640 Gflop, up from 1880 in 02/2007.

-Roy Jenne
Electricity use and cost on NCAR Mesa

Questions:

- How fast will the computers become more efficient in the use of electricity?
- Can we get enough power to the Mesa?
- When will Moore’s Law start to break down?
(People think we have at least ten years more.)

15. Use of electricity in the Mesa computer room. The cost.
   The present load (Sep 06) in the NCAR Mesa computer room is 1400 kW. It is on at least 99% of the time (it has only been down about 24 hrs/yr). NCAR gets a very good commercial rate for electricity (only 5.25 cents per kWh).
   - Amount of electricity used in a month (1400 kW)(24 hr, 30.5 day)(.99) = 1,025,000 kWh/mo.
   - Cost: (1,025,000)(.0525) is $53,800/month.
   - The bills have been observed to be about $50,000/month (see attached sheet).

   Colorado now requires excessively high subsidies for PV power projects and demands that a rather large amount of this must be used. The main energy company (Xcel) is required to do this. The other customers who buy energy will have to pay these extra costs. This will give some increase in the price per kWh.

   - The price will go up.
   The Colorado Public Utilities Commission is asking for a $209.9 million rate increase on electricity. If the increase is granted, the NCAR electricity cost would likely increase by about 11%. The cost for the computer room power line has been about $50,000 per month before the upgrade.
   - After the upgrade the Mesa compute electricity cost would increase by 38% due to more use.
   - And a rate increase of 11% would give an additional increase.

News update on Oct 21, 2006: The agreement reached Oct 20 would mean a $107 million increase in Xcel’s base electrical rates, and allow Xcel to pass along to customers up to $30 million of annual costs of buying power from other utility companies. The news story is in this report. This may give Xcel an increase of about $137 million of the $210 million that they had requested for electricity.

18. Present price of electricity in USA.
   - Average retail prices of electricity, USA (cents/kWh)
     
     | Year | Residential | Commercial | Industrial |
     |------|-------------|------------|------------|
     | 1980 | 5.4         | 5.5        | 3.7        |
     | 1990 | 7.83        | 7.34       | 4.74       |
     | 2000 | 8.24        | 7.43       | 4.64       |
     | 2005p| 9.42        | 8.68       | 5.57       |

     SOURCE: Annual Energy Review 2005 from DOE.
     NOTE: The chart of these prices for 1960 – 2005 is available.

   - Present (09/2006) price of electricity
     - For NCAR Mesa computing it is 5.25 cents/kWh. For other NCAR use, the price is somewhat more.
     - Thus NCAR gets it 3.4 cents cheaper than the US average.

- end -
Request for an increase in price for Electricity

UTILITIES

Commission hosting Xcel hearings

The Colorado Public Utilities Commission will host a public hearing on Oct. 23 regarding several Xcel Energy requests, including one for a $209.9 million electric-rate increase.

The hearing will take place at the PUC building, 1580 Logan St., Hearing Room A, in Denver.

The electric-rate request would raise typical residential electric bills by $6.52 a month, or 11.6 percent. Small business bills would increase by an average of $9.96 a month, or 11.1 percent.

Xcel also is asking for its authorized rate of return on equity, or profit, to rise from 10.75 percent to 11 percent; an approval for late-payment fees; an increase in the charge for returned checks; and an increase in Windsourse voluntary wind-power rates.

Daily Camera - Boulder

Xcel shrinks electric rate hike

By Greg Avery
Camera Business Writer

Xcel Energy, the metro area's main power utility, reached a settlement with consumer advocates and businesses that knocked $65 million off the company's proposed electricity rate increase.

The increase, scheduled to kick in next year, would help finance the expansion of its coal-burning power plant in Pueblo.

The agreement reached Friday would mean a $107 million increase in Xcel's base electrical rates and allow Xcel to pass along to customers up to $30 million in the annual costs of buying power from other utility companies.

Xcel's plan would increase the average household's monthly electricity bill by $4.34, or 7.7 percent — instead of the $6.52 per month, or 11.6 percent, increase previously proposed — if the settlement's rates are approved by the Colorado Public Utilities Commission later this year.

The commission is scheduled to take public comments on Monday in Denver about the proposal.

The base rate increase would help Xcel finance construction of the $1.4 billion, coal-fired expansion at its Comanche plant in Pueblo. Construction on the 750-megawatt plant started late last year.

Xcel reached the settlement with the utilities commission staff, the state Office of Consumer Counsel, grocery company Kroger Co., the operator of the Climax mine, Adams County and other parties who objected to Xcel's original proposal. That plan originally aimed to raise base rates by a total of $117.8 million, which Xcel later reduced to $172 million.

Boulder County's government was among the critics of the previous proposal, which also increased rates for Xcel's Wind Source program. Wind Source provides wind-generated electricity. The settlement preserves the program and likely will result in a rate reduction for participants, said Tom Henley, an Xcel spokesman.

The settlement did little to satisfy those fighting to stop the Comanche plant expansion, though.

Clean Energy Action, which is suing to prevent Xcel's Comanche plant from receiving its permits, plans a protest before Monday's hearing.

The group and its allies aim to stop the rate increase as a way to prevent Xcel from increasing its coal-burning and worsen global warming, it says.

Xcel has pledged to install scrubbers in its two existing, coal-burning generators at the Comanche plant. The company says that will make the expanded three-generator plant less polluting than the current, smaller one.

Oct 21, 2006

This may give Xcel energy about $137 million of the 210 million that they had requested for electricity.
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2 Transportation sector, including railroad and railway
3 Public street and highway lighting, interdepartmental sales, other sales to public authorities, agriculture and irrigation, and transportation including railroads and railways.
4 Commercial sector. For 1980 million or more during the previous year. For 1963 data are for a sample of electric utilities.
5 In chained (2000) dollars, calculated by using gross domestic product implicit price deflators. See Table D1.

Revised. P=Preliminary, NA=Not available. = Not applicable.
Notes: Beginning in 2003, the category "Other" has been replaced by "Transportation," and the categories "Commercial" and "Industrial" have been defined as follows:
- "Commercial" represents revenue from electricity retail sales divided by electricity retail sales.
- "Industrial" prices include State and local taxes, energy or demand charges, customer service charges, environmental surcharges, franchise fees, fuel adjustments, and other miscellaneous charges applied to end-use customers during normal billing operations. Prices do not include deferred charges, credits, or other adjustments, such as fuel or revenue from purchased power, from previous billing periods.
- Through 1979, data are for Class A and B privately owned electric utilities only. For 1980-1982, data represent selected Class A utilities whose electric operating revenues were $100 million or more during the previous year. For 1983-1990, data are for a sample of electric utilities.
- Beginning in 1984, data are for a census of electric utilities. Beginning in 1996, data also include energy services providers selling to retail customers.

Web Page: For related information, see http://www.eia.doe.gov/fuel/electric.html.

- 1991—EIA, "Electric Utility Monthly (March 2006), Table 5.3."
### SCD Electrical Consumption (kwh)

(Revd Dec 11, 2006) - On the NCAR Mesa

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Fig. 1. Based on the total Mesa Lab electricity (as on XCEL bill) and a % of that, includes a little for water pumping as well as computer ops & cooling. This was a 2nd version on Dec 11, 2006. The items with a dot to the left got fixed. Numbers for Feb, Mar, Apr 1996 were checked and found to be correct, as in; but Mar & Apr had been reversed 2 versions back. (Revised)
## SCD ELECTRICAL COSTS (Rev'd Dec 11, 2006)

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The monthly cost for electricity for SCD computing on the NCAR Mesa (in US dollars), Another sheet gives a broad view of when different main computers were started at NCAR and when they were shut off to save.

The average cost per kWh can be calculated from two tables here.
### SCD Usage Percent

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<td>44%</td>
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<td>67%</td>
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<td>48%</td>
<td>70%</td>
<td>65%</td>
<td>71%</td>
<td>77%</td>
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</table>

The % of total mass lab electricity that will be charged to the SCD computing (for computers & their cooling) account.
TOTAL ML ELECTRICAL CONSUMPTION (PPS and SCD) Kwh

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The total mass lab (ML) use of electricity. This includes a relatively small amount of electricity to pump water to the ML. The (SCD kWh of consumption) is calculated by multiplying the "SCD usage percent" by these numbers in this table. R. Jones
### Total Electric Consumption

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<tr>
<th>Month</th>
<th>ML EL TOTAL</th>
<th>FL EL</th>
<th>CG-1 ELECTRIC</th>
<th>CG-2 ELECTRIC</th>
<th>CG-3 ELECTRIC</th>
<th>FL4 ELECTRIC</th>
<th>JEFFCO ELECTRIC</th>
<th>MARSH EL</th>
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<td>24,323.47</td>
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<td>724.33</td>
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<td>1027.34</td>
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<td>1040.26</td>
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<td>1060.41</td>
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### Use

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<th>CG-1 KWH</th>
<th>CG-2 KWH</th>
<th>CG-3 KWH</th>
<th>FL4 KWH</th>
<th>JEFFCO KWH</th>
<th>MARSHALL KWH</th>
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<td>46,640</td>
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Summary Statistics (Sep, Oct 2006, Daily)

NCAR - 1850 Table Mesa Drive - Meter 13735T

Energy Expert

Total Consumption (kWh)
1,187,507.16

Demand (kW)
2,026.08

This sheet: 1,187,507 kWh
Water Usage: 65,979
Total: 1,253,044 kWh

Kwh in ML table: 1,253,044 kWh

Water pumping is done at night off of the peak load.

From: John Pereira, NCAR, on Dec 12, 2006

Royanne
### Total Electric Consumption

<table>
<thead>
<tr>
<th>MONTH</th>
<th>ML EL TOTAL</th>
<th>FL EL</th>
<th>CG-1 ELECTRIC</th>
<th>CG-2 ELECTRIC</th>
<th>CG-3 ELECTRIC</th>
<th>FL4 ELECTRIC</th>
<th>FFCC ELECTRIC</th>
<th>MARSH EL</th>
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<td>21,551.37</td>
<td>24,323.47</td>
<td>3,835.20</td>
<td>5827.68</td>
<td>964.32</td>
<td>5,272.68</td>
<td>2611.28</td>
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### Mesa lab + SED (ML w SCD kWHR)

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### Mesa Computing

#### SCD Cost & Estimated Consumption

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### Notes

1. Expected to see n 1,000,000 kWh/yr - based on the title guess n 1,800,000 kWh/yr.
2. For CG1 & CG2 6.48 & 5.81 @/kwh.
3. For SCD 8@/kwh.
4. FY 2005 This year.

R J Turner
### SCD Electricity Costs

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<tr>
<th>Month</th>
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### SCD Electrical Consumption (KWH)

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Source: John Pereira in NCAR office for electricity statistics.
National Science Foundation  
Funds Request  

2. FACILITY NAME & LOCATION  
NCAR - Mesa Lab  
Boulder, Colorado  

3. PROJECT NAME  
REPLACE OBSOLETE 13.2KV POWER FEEDS  

4. UCAR TRACKING NUM.  
NSF07-ML001  

Failure of one feeder would put the Mesa Lab in crisis since the other "old" feeder would be the only power link for the Mesa Lab. If both feeders should fail together the Mesa Lab could potentially be out of power for several months while at least one new feeder is installed.

Conduit/ Ductbank System: The existing ductbank system is unusable. The old conduits have swelled closed so new feeders can not be pulled through. The best long-term solution is to install a new conduit ductbank next to the old, reuse the manholes, and pull one new feeder to the Mesa thus replacing the older 45 year feeder. Spare conduits installed during this construction would be used in the future to add a second new feeder once the old direct buried feeder failed. A new ductbank system, versus installing shorter life direct bury cables, provides a solution that would server the Mesa Lab for the next 50+ years.

Pole Mounted Switches: The existing pole mounted switches are hanging from decayed wooden structures. It is feared that if someone were to operate the pole cut-out devices the entire crossarms, switches, and 15kV lines could potentially fall on the operator. If we were to simply replace the old pole hardware we would have to re-terminate the old 15kV feeders. Consultants have informed us that it is very likely new terminations would cause the old feeder cables to completely fail. The best time to replace the the pole equipment is the same time the feeders are replaced.

For safety, it is proposed to also modernize the high voltage switch arrangement by installing metal enclosed ground mounted 15kV electrical gear. Ground mounted equipment is safer and less costly to perform maintenance on than pole mounted devices.

18. IMPACT IF NOT PROVIDED  
Conduit/ Ductbank System: One or both 15kV feeders are going to fail sometime in the coming years. When it happens, the time it takes to request and receive funding, plan, procure materials, and perform construction may cause the Mesa Lab to be shutdown for several months. Additionally, "hurry up" design and materials may not result in the best long-term solution for the Mesa Lab.

Pole Mounted Switches: The pole mounted equipment is unsafe and must be replaced. An accident may occur.

19. ALTERNATIVE SOLUTIONS CONSIDERED  
1. Direct bury one new 15kV feeder and retire the older 45 year old feeder. Replace the other direct bury cable with a new one when it fails. Reason for rejecting: Rocky soil and shifting soil conditions could damage direct bury cables at any time. In the long-term, a new duct bank/ conduit system will make future feeder replacements cheaper than direct burying cables each time a new one is needed.

2. We considered trying to "route out" the Orangeburg conduits and reline the conduits inside the ductbank. Reason for rejecting: It is not a common technology for electrical conduits and Orangeburg conduits contain asbestos. Grinding or routing out asbestos containing materials is not recommended.

20. ADDITIONAL  

See next page too

21. ESTIMATED SCHEDULE  

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<th>NSF Funding Approval:</th>
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<td>Estimated Construction Completion:</td>
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Cost to upgrade the two 5 MW lines to new technology - $1.35 million

- If NCAR Mesa ever needed more power, the conduits will be big enough to pull through another wire - not much cost.

-Ray Jonna, May 2007
National Science Foundation
Funds Request

2. FACILITY NAME & LOCATION
NCAR - Mesa Lab
Boulder, Colorado

3. PROJECT NAME
REPLACE OBSOLETE 13.2KV POWER FEEDS

4. UCAR TRACKING NUM.
NSF07-ML001

5. INVESTMENT CATEGORY
☐ New Program ☐ Expansion ☑ Replace Obsolete ☐ Energy Savings
☐ Cost Improvement ☐ Environmental ☐ Other (explanation)

6. DATE SUBMITTED
01/31/2007

7. TECHNICAL LEAD
David Patterson (303) 497-8507

8. UCAR POINT OF CONTACT
Jeff Reaves (303) 497-8890

9. (REV. NUM.) & DATE

10. PRIORITY LETTER
A

10. PRIORITY LETTERS: A = CRITICAL  B = IMPORTANT  C = LESS IMPORTANT

COST ESTIMATES

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Fund Request Awarded in Future, Adjusted for Inflation (3.2%)
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16. DESCRIPTION OF PROPOSED CONSTRUCTION

The primary goal of this project is to replace at least one existing 15kV feeder to the Mesa Lab plus create a good conduit path to pull in a future second feeder.

This work requires that we utilize a conduit ductbank, for now and future cable pulls. An old, existing ductbank has been found to be unusable; its spare conduits are Orangeburg conduits which are swelled shut and contain asbestos materials. Rather than trying to refurbish the old it would be less expensive to install a new ductbank next to, or on top of, the existing ductbank. We are required to stay close to the existing ductbank to avoid granite boulders and rock.

When one or both 15kV feeders are replaced, ancillary connected equipment shall be replaced for reasons of safety and poor condition.

Therefore, this project shall 1) install a new conduit ductbank, with one (1) new 15kV feeder cable, from Xcel Energy's demarcation point to the Mesa, and 2) replace obsolete, hazardous pole mounted 15kV switches with ground mounted 15kV metal-clad switchgear.

17. CURRENT SITUATION

The Mesa Lab facility is electrically served by two 15kV feeder lines from Xcel Energy. One feeder, in conduit, is 45 years old and the other, direct buried, is 25 years old. Both are past their predicted lifetimes and both may fail at any time. Several other ancillary 15kV components are also in bad condition.
Rolando and Joe,

Computer issues that I briefly raised on the Jan 2, 2007 meeting:
(What did we tell NCAR/UCAR staff and the media?)

Here are some notes from the meeting with Tim Killeen on Jan 2. I wanted to document my brief summary of issues.

I said that we need to evaluate some of the basic "facts" that led us to this point on the computing center for Geo because these affect future options. The information given to the UCAR staff and to the public was as follows (about computing, electricity, space, etc.):

1. Electricity and space on the Mesa
We told people that we could not bring enough computer power to the NCAR Mesa. We said it would cost $15-20m and the computers would have to be shut down for 6 months to make the change. Thus we needed an off-site location for the Geo computer. (Also true: We told people that now we are at the limit of how much power we can use, and thus there is no extra capacity for computer expansion on the NCAR Mesa.)

The present facts: All the power needs for the NCAR Mesa are now no larger than 2.5 MW (for the big computers, the building, and water pumping). There are now two 5 MW power lines to the Mesa. These back each other up, plus a full 10 MW could be used most of the time. But it does have to go through transformers and motor generators before it is fed into a computer.
---Update March 2007: There will be a Mesa computer upgrade on 07/2008. The Mesa computers and building will need over 2.5 mW through at least 2011. And likely there is already enough power for at least one or two more upgrades such as 2011 and 2014.

How much would it really cost to bring even more electricity to the Mesa? The NCAR section (Pereira) that monitors the use of electricity by all of NCAR and UCAR is evaluating this. They have access to consultants and to Xcel engineers which should be able to provide good cost numbers. These numbers may be available by 15-30 Jan 07. (Also true: An NCAR source told me that it was NSF that asked for these estimates. And NSF may be able to provide some funds to do this work.)
---Text update April 2007: It would cost a little over $1.35 m. See proposal.

2. The space problem on the Mesa
We also told many people that there was no space on the NCAR Mesa for computer expansion. We say that the Geo initiative needs 10 to 15 acres. That is a lot of space! We need to see rough estimates of the numbers of staff and visitors that are foreseen. Also, comparisons should be made with a few existing large computer centers in the US. (Also true: An NCAR expert told me that there was no space problem on the Mesa for some growth. I can't evaluate this, but in 2006, NCAR Chemistry did move off of the Mesa.)
Tim Killeen said that this was taking us back several steps (true) and we need to continue with the current issues.

There were 25 of us in the Damon Room. I did have enough time to introduce most of the essential info that I wanted to. I suspect that at most, 2 or 3 others in the room were aware of these facts. And such facts are bound to make people nervous.

3. Moore’s Law on computer speed should affect computer decisions:
I had one more main issue that people need to know about. They need to realize that Moore's Law should affect a number of top level computer decisions. This law says that after 18 months you can buy twice the computer capacity for the cost at time zero. After 3 years you get 4x the capacity (as time zero) for same cost.

One needs to look at how much compute power a continuation of the present $4.5m/year for upgrades to the Mesa computer will give us in 3 or 6 or 12 years. This needs to be compared with how much capacity we will get from the Geo computer, when it will come online, and the cost. I have some numbers showing the growth of real computer speed from regular upgrades (each 18 months or 3 years).

4. Which partners should NCAR choose for the NSF Geo work?
It seemed that the NSA (science assembly) was being asked for inputs about which partners NCAR should choose for the Geo work (University of Colorado or Wyoming). Rolando asked on what basis we would help decide this. We had not been provided with a significant amount of info (about 4 of us were there from NSA exec).

Tim Killeen said that they did not need NSA help on that. They have a tiger team: Anderson, Buja. In Jan 2007, they decided that the main work will be with Wyoming.

5. What are needs? More computer power or more software?
Rolando, the two EOS papers are in the 5 Sep 06 issue (Frank Bryan) and the 14 Nov 06 one (Peter Fox). I suspect that Tim had a heavy input to both papers. At one time we seemed to talk mainly about the need for more computer power. More recently the main emphasis seems to be on the Geo collaboratory. That worries me. I will send a copy of these and one more sheet in a day or so.

6. There are often problems with software systems that are too big.
Big software systems that are "too grand," too fuzzy, or poorly focused have a bad history. At some point, I will try to summarize a bit of the history of such systems.

Regards,
Roy Jenne

P.S. I was hoping to provide an update on the real computing power and the electricity needs of the new Dec 06 computer. I still need a few more numbers. (April 2007 text update: The numbers are now available.)
UCAR will likely maintain NCAR

Contract being reconsidered in order to allow bids

By Todd Neff

The University Corporation for Atmospheric Research is in a strong position to retain its management of one of the world's leading climate-research centers after the current deal ends in 2008, UCAR President Richard Anthes said Wednesday.

UCAR, a Boulder-based consortium of 70 North American universities that grant Ph.D.s in atmospheric sciences, has managed the National Center for Atmospheric Research under no-bid contracts since 1960. National Science Foundation officials told UCAR in 2003, when closing the most recent five-year NCAR contract, that it would be the last of such deals.

"We've known for several years," Anthes said. "The National Science Board policy is to compete these things periodically unless there is a compelling national policy not to compete them."

The National Science Board is the governing body of the National Science Foundation, which pays NCAR's bills. NCAR has roughly 950 employees and an annual budget of about $100 million via a five-year, $548 million management contract from UCAR.

Anthes characterized the direct link between universities and NCAR as key in future bids for the contract.

continued from 1C

UCAR's advantage is we have this large consortium of universities that govern UCAR, and UCAR governs NCAR," Anthes said. "Universities have ownership of this national lab."

As a nonprofit, UCAR could also have price advantages, he said. UCAR's fee for managing NCAR is $75,000 a year. He said U.S. Department of Energy laboratories typically build in management fees of $50 million per contract.

"If the fee would go up, presumably the amount of money available for NCAR research would go down," Anthes said.

He cited UCAR's "squeaky clean" management record as another advantage.

Like champion boxers in title fights, incumbents appear to have a leg up in the business of managing federal labs. Two National Science Foundation astronomy-lab contracts have gone to incumbents. In addition, a University of California team in December 2005 won a seven-year contract to manage Los Alamos National Laboratory, continuing UC's 63-year leadership of the lab despite well-publicized security lapses and accusations of mismanagement.

UCAR's decades-long uncontested management of NCAR was a key motivation of a February request by U.S. Sen. James Inhofe, R-Okla., for detailed information regarding the employees, research projects and funding sources of both NCAR and UCAR, a senate committee spokesman said at the time.

Inhofe is the most outspoken skeptic of global warming in U.S. Congress.

U.S. Rep. Mark Udall, D-Eldorado Springs, said he felt that UCAR has done a "phenomenal job" managing the national lab.

"If putting this out to bid would improve what NCAR produces, then that makes sense," he said. "If this is to put an overriding profit motive in place or to put a political prism on NCAR, then you're going to hear from me in a lot of different ways."

About 100 of UCAR's 350 employees are in financial administration and corporate roles that would be affected if the National Science Foundation chooses another manager, Anthes said. UCAR's own science and education programs would feel no direct impact.

Anthes said he expected the National Science Foundation's request for bid to arrive in the next two weeks, with preliminary proposals due back by the end of January. Final proposals will be due in August.

Contact Camera Staff Writer Todd Neff at (303) 473-1327 or neff@dailycamera.com.

October 26, 2006
Daily Camera
Boulder, Colo.

NCAR has roughly 950 employees
Competition News:

An interview with Katy Schmoll

This is the second in a series of Staff Notes Monthly updates to keep staff apprised of the competition for the management of NCAR. As most people are probably aware, NSF has issued a request for proposals, and UCAR is in the process of preparing its submission. In this column, Katy Schmoll, vice president for finance and administration, talks to Lucy Warner about the process and how it might affect staff. They also welcome individual questions, which can be addressed to Katy at kschmoll@ucar.edu.

Lucy: Tell us a little about what's going on. Who is preparing the response and what will it say?

Katy: There is a small group—including the President's Council and a handful of key staff members—drafting a preliminary proposal in response to the NSF request for proposals. For those who are curious, the solicitation is posted on the NSF Web site (see "On the Web"). Our response is due on April 13.

Lucy: Will staff be able to see the proposal?

Katy: No. Because there may be competitors, our proposal will be confidential and proprietary.

Lucy: I know you've already sent a memo to staff about this, but explain again how competitors get their information and how staff should respond if they are contacted.

Katy: All requests for information about UCAR and NCAR operations should be directed to Kristin Spencer at NSF (kspencer@nsf.gov). She's in the Division of Acquisition and Cooperative Support, and it's her job to relay questions to me if she needs UCAR support in developing answers. There are strict rules governing this kind of bidding and it is important to follow the protocols. The answers to any questions received are provided to all potential bidders.

Lucy: So what are staff supposed to do if they get a call they suspect is related to the competition?

Katy: It's possible that staff might be contacted directly for information about things like our salary ranges or our policies. Those questions should be directed to NSF and staff should absolutely not answer them.

Lucy: So are you saying staff can't help with any competing bids?

Katy: No. Staff are free to help with a competing proposal under certain conditions. They can't disclose proprietary information like indirect rates or salary ranges. However, they can work on the other aspects of management proposals. Since we are all UCAR employees, working on a proposal that competes with UCAR's falls under the Conflict of Interest Policy (1-1-4). In accordance with policy, anyone in this situation has to notify me by submitting a written disclosure through his or her supervisor up the chain of command to the relevant member of the President's Council. Any work done with a competitor must be done on the employee's own time, either outside of work hours or using PTO or vacation time. Any activity of this kind cannot involve the use of UCAR or government resources, including computers.

Lucy: Doesn't that give UCAR an unfair advantage?

Katy: It shouldn't. Those of us who are working on the UCAR proposal can't use government funds either.

Lucy: So have you been notified of anyone other than UCAR preparing a proposal?

Katy: No.

Lucy: Will we know?

Katy: Actually we may never officially know unless the competition comes down to a contest between official finalists.

Lucy: And when would that be?

Katy: Well, as I said, the preliminary proposals are due April 13. A full proposal will be due August 31. At that point, only submitters who have successfully completed the first phase will be considered.

Lucy: And when will we know the outcome?


Lucy: Rick [UCAR president Rick Anthes] has said he's taking this process seriously but that staff shouldn't be worried. Would you agree with that?

Katy: Absolutely. We've laid a lot of groundwork for this proposal in the last year and we've got a strong record on which to base our plans for the coming five years. We're in a very strong position. But, as Rick said, we are not taking this for granted.

On the Web

Competition for the Management and Operation of the National Center for Atmospheric Research


IPY (continued from page 2)

produced video, "A Tour of the Cryosphere," will begin showing in the lobby theater later this spring.

And in COMET, staff are laying the groundwork for a Webcast this summer that will feature interviews with polar scientists. "We'll talk with several scientists who are doing cutting-edge research, and we'll learn what tools they use, what issues are driving their work, and what they see as exciting future areas for investigation in this fascinating and unique location," says COMET's Vickie Johnson.

Staff Notes Monthly 2007
To all UCAR Staff:

I wanted to give you a brief update on the status of the NSF competition to manage NCAR. We submitted our preliminary proposal on April 13, and in early May received review comments and an invitation to submit a full proposal. We are hard at work on the full proposal, which is due on August 31. The review comments are providing a good basis for focusing this new effort, and we continue to be confident that we will have a strong, competitive proposal to submit to NSF.

Best wishes to all,

Rick

Dr. Richard A. Anthes
Phone: 303-497-1652

President
University Corporation for Atmospheric Research
P.O. Box 3000
Boulder, CO 80307-3000

For delivery via express mail, please use:

1850 Table Mesa Drive
Boulder, CO 80305
Anthes, Killeen to preside over AMS, AGU

Both UCAR president Richard Anthes and NCAR director Tim Killeen will take on high-profile leadership positions in the broader scientific community over the next year. Anthes has been elected to the presidency of the American Meteorological Society (AMS). His one-year term begins next January. Killeen, elected president of the American Geophysical Union (AGU), begins his two-year term this July.

At the AMS, Anthes will oversee planning for the 2008 annual meeting in New Orleans. He envisions the theme for that meeting as the transfer of research findings to applications. Another important area for Anthes will be helping to formulate AMS statements on important issues using a newly streamlined approach. One such statement, on freedom of scientific expression, was approved on 17 February (see www.ametsoc.org/POLICY/2006statement_freedom.html). "It is essential to have vigorous and honest debate about science in order to keep society well informed and help policymakers in the public and private sectors make the best decisions," says Anthes.

As president-elect of the AGU, Killeen has led the effort to develop the organization’s strategic plan, which emphasizes interdisciplinary collaborations. He also is chairing a development board that will create endowments at the AGU for education and outreach activities. Killeen is working on an initiative to better communicate science to policymakers, and he and colleagues have introduced AGU experts conferences, a new tool to focus attention on specific areas of scientific and policy interest.

"The presidency involves a lot of varied work, ensuring that the AGU remains responsive to its membership and relevant to the broader needs of society," says Killeen. He adds, "The AGU has been a professional home for me. I’m just thrilled to be in this role."
Some News Stories about the NCAR Computer Proposed for NSF Geoscience Work

03/10/2006:  - NCAR plans for supercomputers.

03/30/2006:  - Schools vie to partner with NCAR.
  - CU, CSU, School of Mines, want the NCAR computer on their campus.
  - Mar-May 2006: Much of the news was about the competition between CSU at Fort
    Collins, and School of Mines in Golden.

05/20/2006:  - City of Boulder and CU woo center.


03/07/2006:  - US puts money on ultra fast computers.
  - Includes plans by Dept of Energy, Defense (DARPA) and the National Science
    Foundation (NSF). Each have plans for multiple new high-end computers. The
    story is here.

NCAR → THE COST: The news stories were calling this a $75m proposal. But some internal
briefings in May and Sep 2006 called it a $200m proposal.

07/20/2006:  - New NCAR center may come to CU
  - CU, Wyoming, are finalists to host mind-boggling supercomputer.
  - CU, Wyoming, detail their offers to NCAR.

10/31/2006:  NCAR data center on hold (See the news story)

  - Another university wins a similar NSF proposal.

09/30/2006:  - “Texas wins $59m supercomputer grant” (from NSF)

Roy Jenne
Oct 25, 2006

This is part of the History
1) The main topic for this test has been:

- The Fall 2006 Computer upgrade located on the NCAR Mesa

2) But NCAR/UCAR have also proposed to establish a still faster computer —

- For the Geosciences Division at NSF

- About 10 pages follow about this subject:

   [Signature]
   Ray James
   Oct 24, 2006
New computing power for geosciences
Proposed center would be the computational equivalent of the Hubble telescope

by David Hosansky and Bob Henson

With the Mesa Lab almost at its limit for providing electricity and floor space for increasingly powerful supercomputers, NCAR has been scouting alternative sites for new generations of machines. But instead of focusing on a supercomputing facility purely for atmospheric scientists, the organization has started to work with NSF and potential partners in academia and industry to develop a national supercomputing center that would serve the entire geosciences community.

Scientists envision an expandable facility that would eventually house supercomputers with peak speeds in excess of one petaflop (10^15 operations per second). In contrast, today’s supercomputers have peak speeds that are measured in teraflops, or trillions of operations per second. The new facility will be designed with sufficient flexibility to accommodate many generations of increasingly powerful machines to support cutting-edge geoscience research.

“This is extremely important, probably the number-one UCAR/NCAR priority,” explained UCAR president Rick Anthes at a recent meeting of the UCAR Management Committee (UMC). “It is a science-driven project and is exactly what a national center should be doing.” NCAR plans to submit its prospectus for such a center to NSF this summer.

NSF is contemplating several computing centers as part of its strategic plan for strengthening cyberinfrastructure for the sciences. The most recent NSF plan calls for one new overarching computing center for NSF as well as several satellite centers, most likely including the one being planned in conjunction with NCAR.

The new geosciences facility would be governed by a community consortium. Among the facility’s possible locations is the Colorado Front Range. The center would be designed with 20,000 square feet of raised-floor computer space, eventually increased to 60,000 square feet. It would be located on a 10- to 15-acre site and powered by up to 24 megawatts of electricity depending on the choice of computers and their power requirements.

Such a center would lead to greatly expanded scientific computing capability. For example, atmospheric researchers would be able to model regional climate on such a fine scale that they could capture individual mountain ranges and ocean currents. They could also fully integrate climate and weather models and simulate detailed cloud, ocean, land, and ice processes.

The center’s supercomputers would enable geoscientists to better predict seismic activity and glean insights into Earth’s inner core. In addition, researchers would use the center to assimilate data from increasingly sophisticated instruments into computer models to learn more about Earth’s weather and climate, as well as biogeochemical and biogeophysical processes and space physics.

A presentation assembled by NCAR and UCAR staffers working on the project describes the facility as “a computational equivalent of the Hubble telescope for geoscience simulation.”

The timeline

The goal is to have the new center operational by 2009. However, a number of issues must first be tackled:

• How should the facility be governed? NCAR has been discussing the operation of the facility with potential partners in government, industry, and academia. It’s possible that a broad consortium of organizations may manage the center.

• How will it be financed? The facility is expected to cost between $40 to $75 million to build, and $15 million a year to operate (about twice the budget to operate NCAR’s current suite of supercomputers). Funding may come from a mix of government and private sector sources.

• An NCAR project committee, appointed by NCAR director Tim Killeen and co-chaired by Lawrence Buja and Peter Fox, is studying the various issues. The committee is consulting with a blue-ribbon panel of NSF community scientists from across the geosciences. “It’s been an exhilarating experience working with so many of the nation’s top scientists and the talented experts here to develop this important facility,” Buja says.

Winter 2005-06

UCAR Quarterly ♦ 5
NCAR plans for supercomputers

Lab is searching for funding and expansion sites

By Jason Williams
For the Camera

Scientists at the National Center for Atmospheric Research in Boulder long have endeavored to unlock the mysteries of the planet's climate with elaborate computer models, which take serious computer power.

NCAR is in the early stages of planning a $75 million supercomputing lab to rev up its modeling speed. The facility is intended to be capable of accommodating not only more detailed climate models but many other geoscience applications, according to an internal NCAR newsletter.

NCAR, operated by the University Corporation for Atmospheric Research, is collaborating with a UCAR committee to plan and secure funding for the project.

"This is extremely important, probably the No. 1 UCAR/NCAR priority," the newsletter quoted UCAR president Rick Anthes saying at the October meeting of the UCAR Management Committee. "It is a science-driven project and is exactly what a national center should be doing."

NCAR planners hope to have the facility operational by 2009, but many details have to be resolved.

Financing for the $75 million facility has not been determined yet. Planners are considering a combination of federal and private sector funding, the newsletter said.

Please see NCAR on 19A

NCAR seeks funds, expansion site

Continued from 18A

Once built, the cost of operating the supercomputing lab would be an estimated $15 million each year, approximately twice the current budget for running supercomputers at NCAR.

Details of the project likely will be more concrete within 6 months, said Nicole Gordon, a UCAR spokeswoman.

Experts planning the supercomputer facility have called it the Hubble Telescope, for geoscience simulation, the newsletter said.

The new supercomputers could be capable of running at speeds of more than 1 petaflop, or 1 quadrillion operations per second. Current supercomputers have top speeds measured in teraflops, or trillions of operations per second.

The proposed facility would be expandable, starting with 20,000 square feet of raised-floor computer space but eventually tripling that size.

Room for new supercomputers is getting tight at NCAR's Mesa Lab in the foothills above southwest Boulder. And the lab's ability to provide the power-hungry supercomputers with electricity is near its limit, too, the newsletter said.

NCAR planners are scouting appropriate 10- to 15-acre sites in Boulder County and elsewhere along the Front Range.

The new supercomputer lab is expected to need up to 13 megawatts of electricity, or roughly enough to light 13,000 homes.

The increased computing capabilities would allow researchers to run detailed regional climate simulations for specific mountain ranges or ocean currents, according to the newsletter. The supercomputers also would be capable of better predicting seismic activity and producing simulated glimpses into the earth's core.

Details about management of the facility are to be determined, but it could be a cooperative operation by the government, universities and private industry, the newsletter reported.
BOULDER COLO — Three universities along the Front Range said they will aggressively compete to be the main partner for the National Center for Atmospheric Research's proposed new $75 million supercomputing center.

Officials with the University of Colorado in Boulder, Colorado State University in Fort Collins and the Colorado School of Mines in Golden confirmed they have talked with NCAR about locating the new supercomputing facility on their respective campus.

"We have 120 faculty involved in the computational science arena, so a partner-ship with a supercomputing center like that would be extremely beneficial for CU," said Paul Tabo, CU Vice Chancellor for Administration.

"We're definitely interested," Tabo said. "We have 120 faculty involved in the computational science arena, so a partner-ship with a supercomputing center like that would be extremely beneficial for CU."

The new center is expected to begin operations in 2009 and will increase NCAR's supercomputing power from 15 teraflops (at the existing Mesa Lab in Boulder) to 1,000 teraflops. One teraflop equals one trillion computations per second.

See Partner page 38A

BY DAVID CLUCAS
Staff Writer

March 30 2006
City, CU woo center

CU property a finalist for $75M UCAR project

By Greg Avery
Camera Business Writer

The University of Colorado, the Boulder Chamber of Commerce and the city have teamed up to land a $75 million, University Corporation for Atmospheric Research project to build one of the world’s most powerful supercomputers.

The effort may be close to paying off.

UCAR’s selection process has narrowed to two candidate sites in recent days — one at the CU research park and one outside Cheyenne, Wyo.

CU has offered 16 acres to 16 acres at its East Campus Research Park off Foothills Parkway between Arapahoe and Colorado avenues and some construction money to lure UCAR’s supercomputer facility and the dozens of jobs it would house.

UCAR is a consortium of 69 universities that, with funding from the National Science Foundation, runs the 1,372-employee National Center for Atmospheric Research laboratories in Boulder.

What Boulder is up against from Wyoming isn’t clear since its bid is covered by a nondisclosure agreement.

Officials with UCAR met with the National Science Foundation on Thursday to start studying the benefits of each offer. It’s not clear when the site decision will be made, but it is expected before summer’s end.

“We do want to converge on a single partner as soon as possible, but we really have to under the two sites,” said Lawrence Buja, a UCAR project manager.

The computing center is intended to be one of the most — if not the most — powerful ever built, capable of handling more than a quadrillion computations per second. It would attract researchers from afar needing computing muscle to power models of things as complex as the Earth’s climate.

Susan Graf, executive director of the Boulder Chamber, said winning the facility could be as monumental for the community as landing the federal labs in the 1950s or the International Business Machines Corp. campus in the 1960s.

Both led to spin-off companies and solidified Boulder’s status as a technology and research hub.

“I think this project really is on that same scale,” Graf said. “It’s special for a community to have something that’s unique in the world. We could be that place.”

The supercomputing center could raise the profile of CU’s research park, already home to the Laboratory for Atmospheric and Space Physics, the Center for Astrophysics and Space Astronomy and the Synapse and LQwest research labs.

The research park has about 45 acres that CU would like to develop and turn into a world-class science center, with a particular emphasis on alternative energy studies, said Paul Tabolt, CU vice chancellor for administration.

Having the UCAR supercomputer there would bring scientists from around the world for ground-breaking collaborations, Tabolt said.

“There’s a huge potential for improvement over the knowledge we have today,” Tabolt said. “It could really bring the research campus together and be significant for the entire community.”

Contact Camera Business Writer Greg Avery at (303) 473-1307 or avergy@dailycamera.com.

In recent days the candidates cut to 2 finalists
- CU & Wyoming

Still a $75M UCAR project.
Oklahoma, Wyoming join race for supercomputer center

BY DAVID CLUCAS
Staff Writer

BOULDER — Two more states have entered the ring to join three Colorado schools competing for the National Center for Atmospheric Research’s proposed $75 million supercomputing center.

Institutions in Oklahoma and Wyoming are being considered among the possible partners for the new 60,000-square-foot NCAR center, said Lawrence Buja, co-lead of the project at NCAR.

“We’re getting interest from both inside and outside of the state,” Buja said. He declined to say whether the two other states had recently offered proposals, or if they have been in the running from the start. He also did not reveal which institutions in Oklahoma and Wyoming were involved.

The Wyoming Business Council, a state economic development group, has talked to NCAR, spokeswoman Rachel Girt confirmed. She did not know the details of the state’s proposal.

“We came into this a little later into the game,” she said.

Officials with The Oklahoma Professional Economic Development Council could not be reached for comment.

NCAR is completing feasibility studies, and a decision narrowing the options to two choices among the Colorado schools, private businesses and three states is expected within the next month, Buja said.

“They are all working with us, and we are clear that this is important to them as well,” he said.

In early March, The Boulder County Business Report first reported that the University of Colorado in Boulder, Colorado State University in Fort Collins and the Colorado School of Mines in Golden were among the three competitors to partner and locate the new supercomputing center for NCAR. NCAR Director Tim Killeen said a private business in Colorado, such as IBM, also could serve as a partner in the project.

All three Colorado schools with proposals to NCAR have said the most important thing for them — behind gaining the facility on their respective campuses — would be to keep the new facility in Colorado. Wherever the center ends up, NCAR will remain head.

See Supercomputer, page 47A

SUPERCOMPUTER from page 3A

quartered in Boulder, Killeen said.

The center is expected to be operational in 2009 and would increase NCAR’s supercomputing power from 15 teraflops (at the existing Mesa Lab in Boulder) to 1,000 teraflops, which is equal one petaflop, or one quadrillion (1,000,000,000,000,000) computations per second.

NCAR has said that new facility would allow it to move beyond its studies in the field of atmospheric sciences and expand into supercomputing operations for geosciences and social sciences that could benefit governments and private businesses.

The attempt by Oklahoma and Wyoming to garner the proposed new NCAR supercomputing center is different than that of Oklahoma’s attempt to move some of Boulder’s existing National Oceanic Atmospheric and Administration labs to Oklahoma last year, said Lawrence Pacheco, press secretary for U.S. Rep. Mark Udall, D-Colo.

In that case, Oklahoma was trying to grab the existing labs in Boulder, before Udall and other Colorado politicians put an end to the attempt. In this case, it’s an open competitive bid, he said.

“The congressman does support locating the supercomputing facility in Colorado, and has weighed in on behalf of Colorado,” Pacheco said. “But it is a competitive bid process, so it would not be appropriate for him to become too involved in any kind of lobbying effort. We do hope that they locate the facility in Colorado, and we look forward to seeing what the final decision is.”

Contact David Clucas at (303) 440-4950 or e-mail dclucas@bcbr.com.
New NCAR center may come to CU

CU, Wyoming finalists to host mind-boggling supercomputer

By Todd Neff  7-24-06
Camera Staff Writer

The National Center for Atmospheric Research wants one of the world's fastest computers but won't yet say where it would go.

It could be in Boulder, at the University of Colorado. Or it could be in Cheyenne. NCAR officials are keeping their decision on the host of its planned $75 million national supercomputing center to themselves until late this month or early next month.

The center promises to be a boon for American earth science as well as the winning local partner, which would become a magnet for both diverse science and supercomputing specialists.

It will be a raging machine, wherever it lands. The system could one day be 1,000 times faster than NCAR's fastest computer, able to keep U.S. weather, climate and earthsystem science "at the absolute forefront for decades," as NCAR director Tim Killeen put it in a recent interview.

By about 2014, the new supercomputer will be 100 times faster than the center's current speed-demon, Killeen said. One hundred times is roughly the difference between a brisk walk and an airline cruise.

The ultimate goal — 1,000 times today's processing speed — means a peta-scale machine. Such a computer would be capable of at least a petaflop per second. A flop is a floating-point operation, or calculation; "peta" stands for a number followed by 15 zeroes, or a million times a billion.

The fastest machine on Earth today, a 131,072-processor IBM Blue

Please see CU on 11A
Next page

July 20, 2006
Daily Camera
Boulder, Colo
Gene/L machine at Lawrence Livermore National Laboratory runs at about a quarter of a petaflop, according to the supercomputer-tracking Web site Top500.org. It's about three times faster than anything else in the world.

Petaflop speed at NCAR would allow scientists to sharpen the detail of global climate models to the point of resolving individual mountain ranges and ocean currents. The system also would let scientists add to global climate models' computation-intensive processes, such as ice-sheet behavior and the biogeochemical cycle, which describes the chemical interplay among plants, animals and the Earth's sediments.

The new NCAR center, pegged for a 2010 opening, would do more than just climate modeling. Krista Laursen, the NCAR project manager on the new data center project, said NCAR saw the computing center as the center of a consortium extending from the atmosphere to earth sciences, the oceanic community and possibly energy research.

Peter Fox, a scientist with NCAR's High Altitude Observatory and co-chair of the project team proposing the new supercomputing center, said the building would span about 100,000 square feet, with options to expand up to twice that size. Computers, storage and related equipment would fill 15,000 square feet, with room to grow to 60,000 square feet.

NCAR's Mesa Laboratory has 13,000 square feet of computer space, Fox said in an e-mail last week. Without a new building center, NCAR would have to retire much of its equipment by 2009 or 2010, Fox said.

Power consumption is another factor. The current supercomputing center's capacity is 1.2 megawatts, Fox said, enough to power about 1,200 Colorado homes according to Xcel Energy's methods of calculation. The new center will open with a 4-megawatt capacity, expandable to 24 megawatts. Electricity is among the major elements of the center's expected $15 million annual operating cost.

Both potential hosts of the supercomputing center can supply that kind of power.

Tucker Fagan, chief executive officer of the Wyoming Business Council, a government-funded, business-led organization that works to develop the Wyoming economy, said his state was eager to host the center.

It would be located in the North Range Business Park west of Cheyenne, which has open land and ample pipes for data and utilities, Fagan said. He said the NCAR proposal coincided with the state legislature asking the University of Wyoming to develop a school of energy resources, which would be a supercomputer user. Wyoming wants to diversify beyond mining and drilling into high-tech endeavors, Fagan said.

"If you had access to this size of a computer you would, I believe, attract world-class researchers and world-class professors for endowed chairs," he said.

In addition to offering the land, Wyoming would let NCAR issue bonds to pay for the facility through the state, Fagan said. The bonds would be paid by future payments from supercomputer users. Fagan said despite Wyoming's budget surpluses, "It's not as if we're writing a gift check" to NCAR, which the state constitution forbids.

The University of Colorado's bid includes a 13.5-acre parcel along Foothills Parkway on the university's East Campus, said Stein Sture, CU's vice chancellor for research.

The university also is offering $5 million up front and long-term spending of about $30 million, Sture said. That money includes the creation of five new faculty positions to be employed at a joint CU-NCAR supercomputing center.

"It's going to be a hybrid of JILA and CIRES, almost like an institute," Sture said, referring to the joint efforts already under way with the National Institute of Standards and Technology and the National Oceanic and Atmospheric Administration.

In return, CU would get a dedicated fraction of computer time and all the benefits of having such a system in its backyard.

Researchers in the business school, social sciences, geology, physics, chemistry, biochemistry, astrophysics and engineering are among those who would want to run models on the new machine, Sture said.

"Having it on campus would be big in attracting the best possible faculty interested in high-end computing," Sture said. "Although the state itself is poor and hasn't really volunteered to put things on the table, we've really scraped anything we've had available."

Contact Camera Staff Writer
Todd Neff at (303) 473-1327 or nefft@dailycamera.com.

20.07.2006
Some Information about the NCAR Mass Store

Roy Jenne
27 Oct 2006

1. How much data can one silo hold?
A silo holds about 5000 tapes, and has a robot to fetch the tapes. It has several tape drives to read the data. Each tape cartridge is rather small (12.2 cm x 10.7 cm x 2.4 cm) or about 4.8 inch x 4.2 inch x 0.9 inch. One terabyte (TB) is 1000 billion bytes (GB). Each byte has 8 bits. NCAR has five silos. The 4th and 5th ones were obtained in 03/1999.

<table>
<thead>
<tr>
<th>Tape Start</th>
<th>Tape Holds</th>
<th>5000 Tapes</th>
</tr>
</thead>
<tbody>
<tr>
<td>01/1986</td>
<td>200 MB</td>
<td>1 TB</td>
</tr>
<tr>
<td>09/1991</td>
<td>800 MB</td>
<td>4 TB</td>
</tr>
<tr>
<td>10/1998</td>
<td>20 GB</td>
<td>100 TB</td>
</tr>
<tr>
<td>02/2001</td>
<td>60 GB</td>
<td>300 TB</td>
</tr>
<tr>
<td>05/2004</td>
<td>200 GB</td>
<td>1000 TB</td>
</tr>
<tr>
<td>est 12/2007</td>
<td>500 GB</td>
<td>2500 TB</td>
</tr>
</tbody>
</table>

NOTE: The mass store II used the 15 pound Ampex tapes which each held 5 GB. During 01/1986 – 07/1987, these data were moved to the 200 MB cartridge tapes. Also some production data was moved from half-inch round tapes (usually 12” diameter, 2400 feet of tape), to the new cartridges.


2. Electricity use by the tape drives and silos.

From: "John Merrill" <jhm@ucar.edu>
To: <jenne@ucar.edu>
Sent: Wednesday, October 04, 2006 4:04 PM
Subject: Silos and tape drives

Roy,

A single 9310 "Powderhorn" library unit (1 silo) is 1.1 kVA; we have 5 of these, so the total for all 5 is 5.5 kVA.

A single 9940-B tape drive is 82 VA. We have 60 of these total (spread out among the 5 silos), for a total of 4.9 kVA. 

Grand total: 5.5 + 4.9 = 10.4 kVA

(Mass store uses about 10 KW of power)

-- John

3. The older round half-inch wide tapes for NCAR, and world.
Most of these tape reels were 12 inches in diameter and held 2400 ft of tape. A few were smaller and held only 1200 ft of tape. BPI means bytes per inch on the tape. On the 9-track tapes, each byte had 8 bits. A blank tape cost about $10 to $12 in those dollars.

<table>
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<tr>
<th>Tape Starts</th>
<th>BPI</th>
<th>Tape Holds (full)</th>
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</thead>
<tbody>
<tr>
<td>~1959</td>
<td>7 \text{ tr} 556</td>
<td>10 MB (6-bit bytes)</td>
</tr>
<tr>
<td>~1966</td>
<td>800</td>
<td>12 MB</td>
</tr>
<tr>
<td>1972</td>
<td>9 \text{ tr} 1600</td>
<td>40 MB (8-bit bytes)</td>
</tr>
<tr>
<td>1980</td>
<td>6250</td>
<td>125 MB (8-bit bytes)</td>
</tr>
</tbody>
</table>
History of Mass Storage at NCAR

Blue text indicates systems currently in the NCAR/CISL computing facility

- Production Machines
- Non-Production Machines, short bars

- MSS-I (7 & 9 track tape)
- MSS-II (Ampex TBM S/N 3)
- STK 9940B
- STK 9940A
- STK Powderhorn 9310 (#5)
- STK Powderhorn 9310 (#4)
- STK 9840A technology
- STK Powderhorn 9310 (#3)
- STK 9840A Beta Test
- STK SD-3/Redwood technology
- STK Powderhorn 9310 (#2)
- STK SD-3/Redwood Beta Test
- IBM 3490 & 3494 ESP test
- STK 4490 technology (3490E)
- STK 4490 Beta Test (3490E)
- IBM 3490E technology
- STK Powderhorn 9310 (#1)
- MSS-III (IBM 3480)
- STK Optical Disk Beta Test

Source: Gene Harano, NCAR, Oct 2006

Revised Sep '06
<table>
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<tr>
<th>Component</th>
<th>Start Date</th>
<th>Duration</th>
<th>End Date</th>
<th>Production</th>
<th>Experimental to Production Tape Capacity</th>
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<td>01/01/65</td>
<td>13759</td>
<td>09/03/02</td>
<td>13759</td>
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<tr>
<td>MSS-II (Ampex TBM S/N 3)</td>
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<td>08/01/87</td>
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<td>STK Optical Disk Beta Test</td>
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<td>09/01/84</td>
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<td>09/30/06</td>
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<td>1st silo - S:16</td>
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<td>08/31/03</td>
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<td>11/01/93</td>
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<tr>
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<td>2313</td>
<td>04/01/00</td>
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<td>120</td>
<td>03/01/97</td>
<td>120</td>
<td>50 GBs per tape</td>
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<td>STK SD-3/Redwood technology</td>
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<td>01/01/99</td>
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<td>20 GBs per tape</td>
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<td>STK 9840A technology</td>
<td>1/1/1999</td>
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<td>200 GBs per tape</td>
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</table>

To add a new machine, click on the green line above, then do "insert row" and add info ... The chart should automatically update.

Width of the tape: It was 1/2-inch wide in the old "round tapes." Then it was also 1/2-inch wide in the cartridge tapes starting Jan 1986. – Roy Jennie

3/1/2009

Ignore this

Igno	ne this

| 40179 | 1/1/2010     | 624 |
| 39814 | 1/1/2009     |     |
| 39448 | 1/1/2008     |     |
| 39083 | 1/1/2007     |     |
| 38718 | 1/1/2006     |     |

7-track 556 bpi tapes that held 10 MB started about 1959. In 1972 1600 bpi started (held 40 MB). In 1980 6250 bpi started (held 125 MB).

Source: Gene Harano, Oct 2006