University of California, Davis (UC Davis)

UC Davis' High Performance Grid Solution, Dramatically Raising Level of Research as a Sun Center of Excellence

Organization
University of California, Davis (UC Davis)

Vertical Market
Education/Research

Key Challenges
UC Davis needed an affordable, easy to manage, high performance grid solution to improve its compute power for research, and enable collaboration among four high profile centers. The four centers are the Computational Science and Engineering Center, the Center for Information Technology Research in the Interest of Society (CITRIS), the Genome Center, and the Institute for Data Analysis and Visualization.

Solution
The Sun Solution, which is based on the Grid Infrastructure Reference Architecture, establishes UC Davis as a Sun Center of Excellence in Public Health and Safety Informatics. UC Davis purchased 57 Sun Fire™ V20z servers featuring AMD Opteron™ processors, switches for communication of nodes, and the Education Software Portfolio, including Sun™ Grid Engine 5.3 Enterprise Edition software and Sun Java™ Enterprise System; the entire system was built by the Sun Customer Ready Systems (CRS) program reducing time and complexity of the implementation.

Business Results
- Improved price/performance ratio of one of UC Davis' key grid computing infrastructure.
- Improved collaboration among researchers.
- Increased effectiveness and efficiencies of compute resources.
- Dramatically improved manageability of the grid computing infrastructure.
- Improved problem solving by enabling access to research from multiple disciplines.

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– Dr. Bernd Hamann, Computer Science Professor and Associate Vice Chancellor for Research at UC Davis, and former Co-Director of the Institute for Data Analysis and Visualization.

Research IT Infrastructure Gets a Boost From Sun™ Grid Computing Environment

UC Davis is known as an excellent research university in subjects such as Computational Science and Engineering, Physics, Chemistry, and BioInformatics. Wanting to stay competitive and even improve on its status as a leading research institution, some of the University's technology users knew they needed to gain more compute power, better utilize its current compute resources, simplify manageability, and improve collaboration among its researchers. Furthermore, it needed these improvements in a very affordable manner.

After considering technology solutions by various vendors, UC Davis turned to Sun Microsystems, Inc. for its grid computing environment. The Sun Grid Infrastructure Reference Architecture simplified the decision making process for UC Davis; Sun's Reference Architectures are designed, tested, tuned, and documented proof-of-concept deployment architectures that prove that in this case, the grid environment would meet their requirements. The Sun solution established UC Davis as a Sun Center of Excellence in Public Health and Safety Informatics. The benefit of this esteemed designation is that UC Davis will serve as an example of best practices for other universities around the world to emulate. Specifically, the Sun solution consisted of 57 Sun Fire™ V20z servers based on the AMD Opteron™ processor, and an annual subscription to Sun's Education Software Portfolio. This software portfolio includes more than 90 Sun software products including Sun Grid Engine Enterprise Edition, and Sun Java™ Enterprise System.

In addition to more compute power and collaboration, the Sun solution provides the Sun Center of Excellence virtualization. Virtualization means the disaggregation of computing resources from the physical component to allow users to run their application on remote servers, sharing memory subsystems and externalizing graphic cards regardless of the physical location of their systems. By removing the physical barriers, system administrators benefit because of greater flexibility, and the ability to maximize the availability and utilization of the computing environment. "The Sun Center makes it transparent to the user where the computer resides," says Dr. Bernd Hamann, Computer Science Professor and Associate Vice Chancellor for Research at UC Davis, and former Co-Director of the Institute for Data Analysis and Visualization. "Contemporary campuses can no longer afford going without such a computing infrastructure."

The biggest benefits to a grid portal include increasing collaboration, utilization, and researchers' access to compute power.

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– Bill Broadley, an Information Architect at UC Davis who is now part of the Sun Center of Excellence team

UC Davis and Sun Solution Can Better Predict Earthquakes

One of the key users of the Sun Center of Excellence at UC Davis is the Computational Science and Engineering Center. The focus of this center is to use computer computation to better understand complex systems by using inter-disciplinary science and engineering. "We needed to run applications much faster and also run new numeric intensive applications," explains Dr. John Rundle, Director of the Center. "Furthermore, we needed to run more sophisticated simulation technologies and perform more detailed data mining to help us get a better understanding of whatever research problem we're working on."

For instance, one project currently going on within the Center of Computational Science and Engineering is QuakeSim. This project is a NASA-sponsored initiative to develop computer models that may forecast some types of earthquakes with accuracy similar to that of current forecasts for hurricane paths.

However, scientists have indications that there may be different classes of earthquakes, and that some earthquakes are inherently unpredictable. The goal of QuakeSim is to produce five to ten year forecasts at a resolution of about 10 kilometers (6.2 miles). A 10-kilometer resolution corresponds to a magnitude six earthquake which will damage poorly constructed buildings within 10 kilometers from the epicenter.

The Sun Center of Excellence runs the powerful computer models representing a virtual world based on what scientists know about the real world. "When this virtual world is robust enough to reflect the real world, scientists can gain insight to the real phenomenon by asking the virtual model questions," explains Dr. John Rundle, Director of the Computational Science and Engineering Center. "How does stress get transferred? How does it build up? What are the observable patterns in smaller earthquakes that lead up to big earthquakes?" Dr. Rundle and his team can ask questions like these about the virtual world, and once they find answers, they can go look at the real world and ask if that is what's going on there as well. Basically it is the same process meteorologists have used over the past several decades to develop the computer models that are now the basis of their daily weather forecasts. Dr. Rundle and his team are adapting the same philosophy of forecasting and predicting to the earthquake world. And, it is Sun's grid computing solution and the Sun Grid Engine software that helped make this possible.

UC Davis' prior grid software had been unreliable, according to Bill Broadley, an Information Architect at UC Davis who is now part of the Sun Center of Excellence team. "The newest release of Sun Grid Engine supports Windows and OSX, which makes it friendly and cross-platform. So I get to support UNIX®, Windows, plus OSX in my environment."

One of the things Dr. Rundle and his colleagues are beginning to learn from their simulations is that earthquakes tend to cluster in space and time. An earthquake on one fault section can increase or decrease earthquake activity on nearby fault sections. "Earthquake activity really depends on the orientation of the neighboring faults and their position relative to the fault that has an earthquake on it," Dr. Rundle said.

High Performance, Robustness, and Reliability Are Key IT Considerations for Future Society

Another key user of the Sun Center of Excellence is the Center for Information Technology Research in the Interest of Society (CITRIS), which is a multi-campus center of UC Berkeley, Davis, Santa Cruz, and Merced (http://www.citris-uc.org/). This partnership is unique in that it was designed to harness information technology to tackle society's most critical needs, such as transportation, seismic safety, health care, education, and the environment. CITRIS uses the Sun Center of Excellence for performing the research from multiple disciplines on campus when tackling these societal issues. In addition, UC Davis CITRIS will work with CITRIS centers at UC Berkeley, UC Santa Cruz, and Merced. "We needed a grid computing solution that would be robust and stable, included an established reputation for excellence, was easy to program, and supported high-performance, research-grade networking," explains Dr. Ben Yoo, Director of UC Davis Campus CITRIS. "The center promotes high-performance research networking because we pursue solving societal issues by using cutting-edge applications such as real-time virtual reality."

The main focus of CITRIS is to sponsor research on problems that have a major impact on the economy, quality of life, energy conservation, education, saving lives, and property and restoring productivity in the wake of disasters. Further wide-reaching problems include boosting transportation efficiency, advancing diagnosis and treatment of disease and expanding business growth through much richer personalized information services. For example UC Davis CITRIS is involved in environmental monitoring. UC Davis has many sensors throughout California to monitor climate and other data, which it simulates, analyzes, and visualizes with the goal to facilitate large-scale monitoring and address global warming. UC Davis CITRIS differs from other global monitoring systems in that it is collaborating with numerous disciplines on UC Davis's campus to get a bigger picture of what changes are occurring and how they may impact the environment. "CITRIS works like a Center of many other Centers to solve difficult problems. Multi-campus collaborations across broad disciplines provide significantly increased value," summarizes Dr. Yoo. "And this multi-disciplinary effort is made possible by running a high performance, robust network."

The Institute of Data Analysis and Visualization (IDAV) is another UC Davis partner in the Sun Center. IDAV is a leading unit specializing on the analysis and visualization of very large data sets. The technologies being developed by IDAV researchers allow scientists to explore their data (simulated data or experimental data) in effective interactive ways. One example is the use of virtual reality and immersive visualization technology which allows a chemist to assemble complicated three-dimensional molecules in a stereo visualization and interaction environment. "This type of technology will revolutionize our ability to digitally design, manipulate and analyze extremely complex molecular structures," explains Dr. Hamann. "The technology is likely to have a major impact on numerical simulations of phenomena at the nano-scale, where it is crucial to have effective means available to define intricate molecular structures atom-by-atom."

IDAV has a history of working with application scientists from a variety of areas, including computational science and bio-medical imaging. The Sun Center of Excellence will enable IDAV researchers to further increase and improve their research efforts, specifically in the area of massive data exploration. The Sun Center is using the Sun StorEdge™ 3310 Arrays and Sun Fire™ V210 server to quickly access these large data sets which is important for visualizing the data in a useful and interactive manner.

Powerful Sun Grid Solution Enables Collaboration and Calculation Intensive Research for the Genome Center

The fourth key user of the Sun Center of Excellence is the UC Davis Genome Center. In this recently built state-of-the-art Center, UC Davis plans to establish a nationally competitive campus program in genomics and is already busy staffing faculty positions in genetics, expression analysis, proteomics, metabolomics and bioinformatics. The main focus of the Genome Center is two-fold. First it specializes in the study of Genomics – the study of the genetic endowment of all organisms, including all the genes, the regulatory processes, the raw data of DNA sequencing, and how interactions impact the genes. The second focus is BioInformatics. Bioinformatics encompasses the development and application of rigorous quantitative methods for producing or analyzing information from large biological datasets. This might include predictions of protein structure, dynamic modeling of complex physiological systems, or the statistical treatment of quantitative traits in populations in order to determine the genetic basis for these traits.

In short, the Genome Center requires huge amounts of compute resources to support these calculation intensive research endeavors. "We like to do our calculations on cluster architectures, so the researchers can carve up the project and send pieces to different processors and reduce processing time," explains Dr. Craig Benham, Director of Genome Center.

Before the Sun solution was implemented UC Davis had no grid computing solution. Today, the University has plans to set up a grid portal so that different cluster components can talk to each other, and researchers can utilize other peoples' compute resources. The biggest benefits to a grid portal include increasing collaboration, utilization, and researchers' access to compute power.

"For instance, a researcher having access to 500 nodes wasn't realistic before, but soon our researchers can design their research projects to run on 500 nodes, which will dramatically improve the scale and type of projects they do," says Dr. Benham. "This will significantly change how our researchers plan and quickly perform their calculation intensive research projects."

A current project Dr. Benham and his team are working on is Multi Gene DNA regulation. This study involves how DNA structure changes while under stress. The study looks at conditions and evaluates how the structural changes affect gene regulation, gene interaction, and global gene coordination. Given that there are three billion bases in the Human Genome, it would currently take six months to analyze the whole Human Genome. Once UC Davis ramps up to 240 nodes, as expected within a year, it will take only 14-18 days to analyze the Human Genome.

Sheer compute power, resources, and time-savings like these are what will make any leading-edge research university more successful in its efforts.

Sun Technology

- 57 Sun Fire™ V20z servers
- Sun StorEdge™ 3310 arrays
- One Sun Fire™ V210 server
- Grid Infrastructure Reference Architecture
- Education Software Portfolio (including Sun™ Grid Engine 5.3 and Sun Java™ Enterprise System)

Get the details.

For more information on University of California, Davis, visit www.UCDavis.edu

For more information about Sun Microsystems, please visit www.sun.com/edu

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