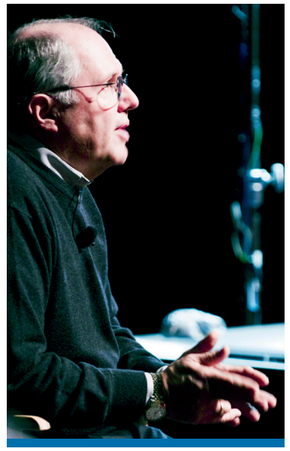


Microsoft Executive Mundie Demonstrates the Future of Computing

Craig Mundie, chief research and strategy officer of Microsoft, visited UC San Diego on Oct. 10 to meet with faculty and students and to share his vision of where technology is moving in the near future. Mundie is one of the two executives who assumed Bill Gates' responsibilities at Microsoft. He now directs Microsoft's long-term technical strategy and investments and oversees Microsoft Research, which employs more than 800 Ph.D. level researchers.

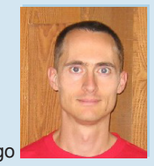
At UC San Diego, Mundie connected with students through a dynamic new-technology demonstration and lecture that ended with a Q&A moderated by CNS Director Amin Vahdat. To watch a webcast of the talk, go to *http://video-jsoe.ucsd.edu/asx/CraigMundie.asx*.

"Microsoft Research is one of the last remaining corporate research laboratories in the world dedicated to computer science and engineering — and a consistent and important source of fundamental advances in computing," explains Vahdat. "I can't overestimate the importance of our research collaborations with Microsoft Research, or the valuable experiences our students gain when they intern or take full-time jobs there." Mundie demonstrated prototypes of flexible screens that will connect wirelessly to powerful cell phones of the future, and a collaborative computing interface called Microsoft Surface, a tabletop computing display that allows several users to work either independently or cooperatively without the use of a mouse or a keyboard. CSE and CNS Ph.D. student Justin Ma thinks the presentation "showcased the breadth of Microsoft" and he calls "very impressive" Microsoft's efforts to integrate various technologies. "During the Q&A, I thought Craig Mundie provided some insights into Microsoft's role in technology and how that technology will affect the ways people will interact socially in the future," says Ma.

Craig Mundie's visit also included a poster session with CNS graduate students, and a lively meeting with CNS faculty members.

Upcoming Events

Event: Windows Azure: An Operating System for the Cloud
Speaker: Brad Calder, Microsoft Director of Engineering; Adjunct Professor, CSE
Date: December 3
Time: 1 p.m.
Location: Room 1202, CSE Building, UC San Diego



Dr. Brad Calder is the Architect of "Windows Azure Storage" and will give a talk co-sponsored by the department of Computer Science and Engineering and CNS, on "Windows Azure: An operating System for the Cloud." Windows Azure is the lowest layer of the Microsoft cloud platform, recently unveiled at Microsoft's Professional Developers Conference (PDC) 2008. It is an "operating system for the cloud" that provides virtualized computation, scalable storage, automated management, and a rich developer SDK for the cloud. Dr. Calder will provide an overview of the opportunities and key problems that cloud computing is solving, and the solutions provided by the computation, storage and management components of Windows Azure.

The public is welcome to attend. For more information, please contact *kkrane@ucsd.edu* or call 858-822-5964. For a map of the campus, go to: *http://maps.ucsd.edu/Default.htm*.

Event: CNS Winter 2009 Research Review
Date: January 14-15
Time: All day
Location: Room 1202, CSE Building, UC San Diego

The CNS Winter 2009 Research Review will include talks by the Center's industry members about their companies' current research challenges and concerns. The research review will also include progress reports from UC San Diego researchers who are investigators on CNS-sponsored projects. Graduate students will discuss their research at a poster session, and the two-day event will offer numerous opportunities for informal interactions among CNS faculty and graduate student researchers and research executives from industry.

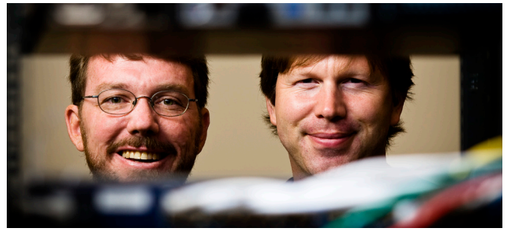
Attendance at the Winter 2009 Research Review is limited to industry sponsors and invited guests. For more information, please contact Kathy Krane at *kkrane@ucsd.edu* or call 858-822-5964.

Mission and Objectives of CNS

The mission of CNS is to develop key technologies and frameworks for networked systems. By combining our research talents and strengths in partnership with industrial leaders, CNS achieves critical mass and relevant focus, accelerating research progress and creating key technologies, frameworks and systems understanding for robust, secure networked systems and innovative new applications. CNS also works to educate the next generation of top students with a perspective on industry-relevant research and to train students on how to continue their leadership throughout their careers. This is accomplished by bringing together leading faculty, students, and companies to investigate the most challenging, interesting and important problems in computer networks.

If you are interested in joining the Center, please contact Director Amin Vahdat at vahdat@cs.ucsd.edu.

Center for Networked Systems



CNS Researchers Infiltrate Worm to Track Spam Profits

The ubiquity of email spam, despite its illegality, implies that it must be profitable. But how profitable and how successful spam campaigns are has not been quantitatively measured. One reason that this has yet to have been studied is that designing a methodology for the inquiry into the strategies and success of spammers has presented a number of knotty problems for researchers. But in a bold move, CNS faculty researchers Geoffrey Voelker and Stefan Savage (pictured above, l-r) deduced that "the best way to measure spam is to be a spammer." Savage and Voelker reported the first such analysis based on this daring technique in their recent paper presented at the 2008 ACM conference on Computer and Communication Security, "Spamalytics: An Empirical Analysis of Spam Marketing Conversion."

By infiltrating the Storm botnet and highjacking a small portion of its advertising campaign, spam recipients were directed to storefronts controlled by the researchers, where the functionality that normally compromised users' systems or harvested their personal information was removed. In this way, they could accurately and ethically measure not only rates of "click-through" (the ratio of responses to spam emails) and of "conversion" (the ratio of the number of spam emails sent to the number of responses resulting in sales), but also how many pieces of spam manage to get past popular anti-spam solutions.

What the researchers found was that over a 26-day period, 350 million email messages resulted in 28 sales averaging around $100 each. That would be a net profit of over $100 per day. Since they estimated that they had infiltrated only around 1.5 percent of the Storm network, they believe that "Storm-generated pharmaceutical spam would produce roughly $3 million of revenue a year."

Computer Scientists Propose New Data Center Architecture Based on Commodity Network Elements

Computer scientists at the Center for Networked Systems have proposed a new way to build data centers that could save companies money and deliver more computing capability to end-users. "Large companies are putting together server farms of tens of thousands of computers, and the big challenge is to interconnect all these computers so that they can talk to each other as quickly as possible, without incurring significant costs," says Amin Vahdat, Director of CNS, who recently was named to the Science Applications International Corp. (SAIC) Chair in the Computer Science and Engineering (CSE) department "We are proposing a new topology for Ethernet data center connectivity."

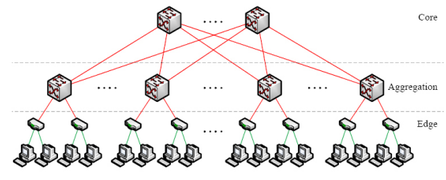


Figure 1: Common data center interconnect topology. Host to switch links are GigE and links between switches are 10 GigE.

The innovation is outlined in a paper, titled "A Scalable, Commodity Data Center Network Architecture," presented in August by Vahdat at the annual meeting of SIGCOMM, the premier academic conference for researchers in computer networks. Professor Vahdat co-authored the paper with two CSE graduate students, Mohammad Al-Fares and Alexander Loukissas. *continued...*

CNS Members

AT&T · hp invent · Google · Motorola · Qualcomm · NetApp · Sun microsystems · Cisco

New Algorithm Significantly Boosts Routing Efficiency of Networks

A time-and-money-saving question shared by commuters in their cars and networks utilizing ever-changing Internet resources is: "What's the best way to get from here to there?"

A new algorithm developed by computer scientists from the Center for Networked Systems helps answer that question, at least for computer networks; and it promises to boost significantly the efficiency of network routing.

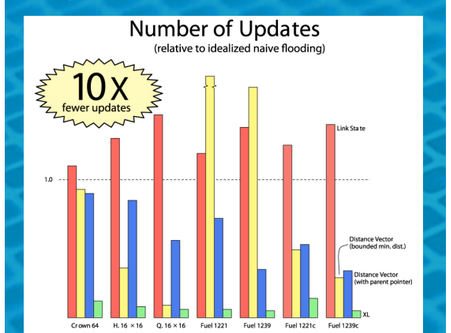
Called XL, for approximate link state, the algorithm increases network routing efficiency by suppressing updates from parts of the system - updates which force connected networks to continuously re-calculate the paths they use in the great matrix of the Internet.

"Routing in a static network is trivial," say the authors in their paper, which was presented in August at the ACM SIGCOMM conference. "But most real networks are dynamic... and thus some nodes need to recalculate their routes in response."

The traditional approach, said Stefan Savage, a computer science professor and member of CNS, "is to tell everyone; flood the topology change throughout the network and have each node re-compute its table of best routes - but that requirement to universally communicate, and to act on each change, is a big problem."

What the team did with their new routing algorithm, according to Savage's student Kirill Levchenko, was to reduce the "communication overhead" of route computation - by an order of magnitude.

"Being able to adapt to hardware failures is one of the fundamental characteristics of the Internet," Levchenko says. "Our routing algorithm reduces the overhead of route re-computation after a network change, making it possible to support larger networks. The benefits are especially significant when networks are made up of low-power devices of slow links."



New Data Center Architecture - continued from page one

It was also announced in August that Vahdat is one of only 41 researchers worldwide to be awarded a newly-created Hewlett-Packard Labs Innovation Research Award. The award will allow Vahdat and his team to develop further their proposed new networking architecture outlined in their SIGCOMM paper. The researchers' work addresses problems inherent to current data center networks found in scientific computing, financial analysis, social networking, or any industry with large-scale computation or storage needs. Explained Vahdat: "Our work addresses the problem of data center network connectivity in a world where consolidation is increasingly taking place in data centers."

Typically, computers are connected by a network architecture that consists of a "tree" of routing and switching elements regulated by specialized equipment, with expensive, non-commodity switches at the top of the hierarchy. But even with the highest-end IP switches and routers, the networks can only support a small fraction of the combined bandwidth available to end hosts. This limits the overall cluster size, while still incurring considerable costs. Application design is further complicated by non-uniform bandwidth among data center nodes, which limits overall system performance.

The CNS researchers envision creating a data center that will have scalable interconnection bandwidth, making it possible for an arbitrary host in the data center to communicate with any other host in the network at the full bandwidth of its local network interface. Their approach requires no modifications to the end-host network interface, operating system or applications, and is fully backward compatible with Ethernet, IP and TCP. Ideally, the data center would also use inexpensive, off-the-shelf Ethernet switches as the basis for large-scale data center networks, thereby replacing high-end switches.

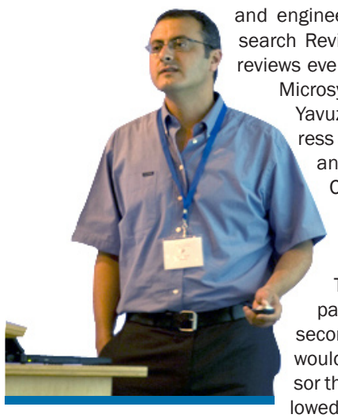
As for the cost differential between his team's technique and those in current use, Vahdat says it's significant: "From a cost perspective, to build out a 25,000-node cluster today using current techniques with 100 percent bandwidth, just the switching equipment would cost somewhere in the order of $28 million, whereas with our technique using the identical network elements, it would deliver the same performance but incur costs of maybe $4 million. That's a factor-of-seven difference."

CNS Welcomes Motorola, Inc. As Newest Member

In September 2008, Motorola, Inc. became the newest member of CNS. Motorola is a leader in global communications and is devoted to developing communications solutions with a focus on connectedness and mobility for individuals, governments, and businesses. This dedication to investment in research and to the development of networking and mobile device innovation makes Motorola a natural fit for the mission of CNS.

Dr. Hamid Ahmadi, Corporate Vice President, Senior Fellow and Chief Architect, Motorola Technology, says that Motorola joined the Center because, "UCSD's Center for Networked Systems' broad research portfolio and diverse faculty expertise complement Motorola's research vision of converged computing, content and connectivity to deliver multimedia and information product and service solutions to our customers."

At Summer 2008 Research Review, CNS Members Vote to Fund Six New Projects



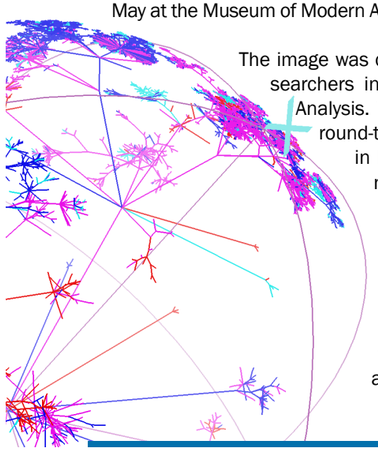
Over 75 industry representatives, UC San Diego graduate students and engineering faculty attended the CNS Summer 2008 Research Review, making it one of the Center's most successful reviews ever. Featured speakers included Greg Lavender of Sun Microsystems, Inc., Brad Chen of Google, Inc., and Mehmet Yavuz of Qualcomm, Inc. Faculty members presented progress and summary reports on projects sponsored by CNS, and they proposed new projects that could benefit from Center support. There was also a lively poster session where CNS graduate students got a chance to interact closely with members from industry.

The CNS Advisory Board, comprised of member company representatives, met the morning of the Review's second day to decide which of the new project proposals would be granted Center support. The Board voted to sponsor the following projects from CNS membership funds (followed by names of each project's CNS investigators):

- **Bluesky: System Support for Transparent Cloud Computing**
  Stefan Savage, Geoffrey M. Voelker, Alex Snoeren and Amin Vahdat
- **Energy and Thermal Management in Virtualized Environments**
  Tajana Rosing and Amin Vahdat
- **Energy Efficient Design of Heterogeneous Wireless Sensing Systems for Healthcare Applications**
  Tajana Rosing
- **Scam Analysis and Defense Via Botnet Infiltration**
  Stefan Savage and Geoff Voelker
- **Can Coarse Circuit Switching Work and What to Do When it Doesn't**
  Bill Lin
- **Investigating Proximal Resource Architectures for Thinner Client Computing**
  Joe Pasquale and Amin Vahdat

Depiction of Internet Universe on Display at MoMA

A visualization depicting a frozen moment of activity in the Internet universe, created by researchers affiliated with the Center for Networked Systems and UCSD's San Diego Supercomputer Center, is part of a special exhibit that ran through mid-May at the Museum of Modern Art in New York called *Design and the Elastic Mind*.



The image was created by Young Hyun and Bradley Huffaker, researchers in the Cooperative Association for Internet Data Analysis. The visualization on display at MoMA depicted round-trip times for data packets sent from a web site in Herndon, Virginia, to hundreds of thousands of nodes on the Internet, and back again. It was generated using a visualization tool created by Hyun called Walrus, which enables researchers to view large data sets using 3D "hyperbolic geometry" — a form of image distortion resembling a view through a fish-eye lens. This allows users to examine a smaller area while always having the whole graph, rendered inside a sphere, available as a frame of reference.

Graduating Student Members of CNS

Varun Almaula, M.S., CSE, June 2008
Advisor: Stefan Savage
Work: Cisco Systems, Inc.

Darren Dao, M.S., CSE, July 2008
Advisor: Amin Vahdat
Work: Software Engineer, Ripple Networks, Inc.

Diwaker Gupta, Ph.D., CSE, November 2008
Advisor: Amin Vahdat
Work: industry offers pending

Chip Killian, Ph.D., CSE, June 2008
Advisor: Amin Vahdat
Work: Assistant Professor, CS, Purdue University

Alexander Loukissas, M.S., CSE, June 2008
Advisor: Amin Vahdat
Work: Software Engineer, Cisco Systems, Inc.

Marvin McNett, Ph.D., CSE, November 2008
Advisor: Geoff Voelker
Work: Microsoft Research

Nikolay Topilski, M.S. CSE, July 2008
Advisor: Amin Vahdat
Work: Akamai Technologies, Inc.

Kashi Vishwanath, Ph.D., CSE, November 2008
Advisor: Amin Vahdat
Work: Researcher, Microsoft Research

Professor George Varghese Receives Gift from Cisco University Research Program Fund

CNS faculty member and CSE Professor George Varghese received a generous gift at the recommendation of CNS industry partner Cisco Systems, Inc., from the Cisco University Research Program fund. The gift is intended to support Professor Varghese's research project studying randomized admission control with applications to video congestion control and Intrusion Detection System logging.