NEW RESEARCH PROGRAM AIMS TO OVERHAUL THE INTERNET

BY DAVID ORENSTEIN

The Internet is enough of a marvel that most people would never ask, "Is this really how we would build it if we could design it all today?" But asking that very question is the job of a broad-based team of Stanford researchers. Taking a nothing-is-sacred approach to better meet human communications needs, last month they launched a new program called the Clean Slate Design for the Internet. They presented their ideas March 21 during a daylong workshop at the annual meeting of the Stanford Computer Forum.

"How should the Internet look in 15 years?" asks Nick McKeown, an associate professor of computer science and electrical engineering who is leading the effort. "We should be able to answer that question by saying we created exactly what we need, not just that we patched some more holes, made some new tweaks or came up with some more work-arounds. Let's invent the car instead of giving the same horse better hay."

Hardly some naïve dreamer, McKeown is a seasoned expert and entrepreneur who has made substantial contributions to developing the router technology at the core of today's Internet. Project co-director and electrical engineering Professor Bernd Girod meanwhile has both contributed directly to standards for digital video encoding and founded and advised startup companies. Also sharing in this vision of fundamentally new ways to engineer a global communications infrastructure are faculty from three engineering departments and the Graduate School of Business who have signed on to conduct research in the program. Supporting them are several industrial affiliates including Cisco Systems, Deutsche Telekom Laboratories, NEC, and Xilinx.

The research also closely complements two projects underway at the National Science Foundation. The first, called GENI, for Global Environment for Network Innovations (www.geni.net), aims to build a nationwide programmable platform for research in network architectures. The second, called FIND, for Future Internet Network Design (find.isi.edu), aims to develop new Internet architectures.

The point of these efforts is not that the Internet is broken—just that it has become ossified in the face of emerging security threats and novel applications.

"The Internet was one of the truly great human achievements of the 20th century, but much more can be done if we rededicate ourselves to its redevelopment with the same creative spirit," says Stanford University President John Hennessy, also a professor of computer science and electrical engineering. "Stanford can make a unique contribution because of the breadth and depth of world-class expertise in all aspects of global communications, networking, economics and security, and because of our longstanding collaboration with key innovators in industry."

EARLY IDEAS FOR A FRESH START

McKeown and his colleagues already have identified and begun working on four projects that constitute the initial research direction of the program. Some of these efforts are developing prototypes that may presage how a new Internet could work.

A prime example is a prototype 400-user wireless network in the Gates Computer Science building called Ethane. Ethane embodies a more straightforward approach to designing a secure corporate network than the awkward administrative tricks corporate networks today rely on for security. Graduate student Martin Casado leads the project. He is joined by McKeown; Dan Boneh, an associate professor of computer science and electrical engineering; David Mazieres, an assistant professor of computer science; Mendel Rosenblum, an associate professor of computer science; and Scott Shenker, a professor of computer science at UC Berkeley.

"The Internet was one of the truly great human achievements of the 20th century, but much more can be done if we rededicate ourselves to its redevelopment with the same creative spirit."

Normal corporate networks allow open communication by default, which makes implementing effective security and privacy rules an onerous task for network administrators. Much simpler is Ethane, which starts out prohibiting all communications. Administrators then simply open whatever channels are appropriate within an organization while security is retained by default.

"Ethane is a strict way of controlling who can talk to whom and over what path they can communicate," McKeown says.

A second project addresses the mismatch between the availability of wireless network capacity and the huge growth in the use of wireless devices to access the Internet. Electrical engineering Associate Professor Andrea Goldsmith and management science and engineering Assistant Professor Ramesh Johari are researching ways to give wireless devices (personal digital assistants, phones and other handheld devices) the flexibility to find and access pockets of unused spectrum when they need it.

"We are proposing a 'clean slate' redesign of wireless spectrum allocation, to ensure efficient utilization of scarce spectrum across both space and time in future wireless systems," says Johari, who holds a courtesy appointment in electrical engineering.

In another project, electrical engineering Professor (Research) Leonid Kazovsky and McKeown are working to overhaul the interaction between routers closer to the Internet's "edge," where users connect to it, and those routers that govern the Internet's telecommunications backbone. Called Lightflow, the project aims to replace big routers in the backbone with high-efficiency optical switches that would be more flexible and responsive to the demands of the routers at the edge. This would allow Internet Service Providers to get the bandwidth they need exactly when their users need it.

The optical switches are about 10 times cheaper, use 10 times less power and have 10 times the capacity of electronic routers, so using them could cut the cost and power consumption of communications while increasing capacity. But so far no one has been able to develop effective ways to make this happen, McKeown says. Much of the research will focus on developing effective protocols to make such an overhaul feasible.

A fourth project, led by electrical engineering and computer science Associate Professor Balaji Prabhakar and management science and engineering Assistant Professor Amin Saberi, would improve theoretical research models of the Internet to allow for better understanding of the network at larger scales than simulations can handle.

"We will measure our success in the long-term," McKeown says. "We intend to look back in 15 years time and see significant impact from our program."