MIT technology insider

FROM THE EDITORS OF TECHNOLOGY REVIEW

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SPINOFF SPOTLIGHT

Best Behavior

Software from Mazu Networks watches computer systems to detect security breaches

Network security has been much in the news lately, with revelations that thieves have stolen credit-card data and other financial information from companies such as supermarket chain Stop & Shop and clothing retailer TJX. Mazu Networks, an MIT spinoff based in Cambridge, MA, says it can prevent that kind of security breach with software that monitors everything happening on a computer network from moment to moment.

TJX officials have said the intrusions into their system, in which unauthorized users collected data about customers' credit cards, checks, debit cards, and possibly driver's licenses, may have started in 2005. "Things were going on deep inside their network and they didn't know about it," says Paul Brady, CEO of Mazu. It's an example, he says, of why firewalls and antivirus software do not provide all the protection today's increasingly complex networks require. Such systems screen individual users or e-mails and provide some protection, but "it's limited protection at best," Brady says. "You better understand who's on your network and what they're doing."

That understanding is what Mazu Profiler aims to provide. This software analyzes network behavior, keeping constant tabs on network activity and issuing alerts if anything suspicious appears to be going on. It keeps track of which machines are communicating with each other, which servers and routers are carrying the data, and which types of protocols are being run—for example, whether a computer is sending an e-mail or downloading a Web page. From these data, it builds a statistical model of network traffic patterns. It might notice, say, that after workers log on in the morning, there's a spike in requests to the e-mail server as people check their messages, or that communications with bank computers increase in the finance department when paychecks are issued.

Once Profiler has the statistical model, which it constantly updates as it continues watching the network, the software can detect any unusual activity. If one server suddenly starts sending out a lot of traffic, for instance, the software might suspect that the server has been hijacked by a virus and is churning out spam. It can alert the IT department to the unexpected surge in traffic and identify—and, if necessary, cut off—the computers producing it.

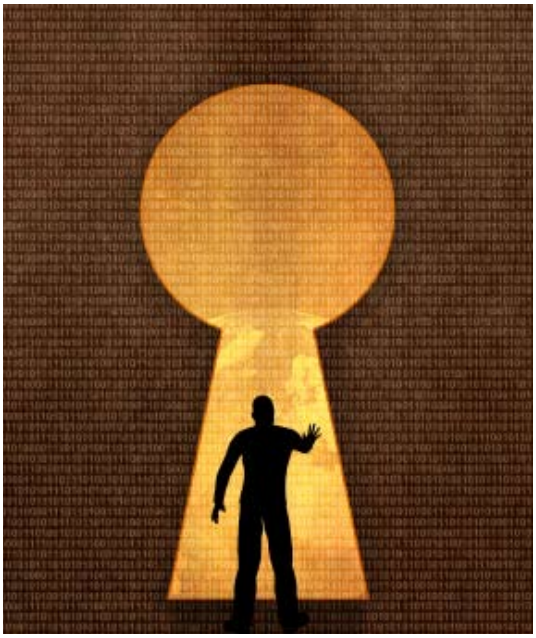

IMAGE: ISTOCKPHOTO.COM

If computers suddenly start connecting to an outside server that they've never connected to before, it could mean that someone has created a botnet on the company's machines. A botnet is an illicit network created by placing a piece of unauthorized software on a series of computers; the computers can then be used in tandem to send spam or launch denial-of-service attacks that shut down servers by bombarding them with requests for access. The network could also be used to gather and deliver sensitive information, such as credit-card numbers. Botnets, once the province of teenage hackers out to show their computing prowess, are increasingly being used by organized

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crime, says Max Poletto, chief technology officer and a cofounder of Mazu. If computers monitored by Profiler started behaving strangely because of a botnet, the software would notice.

Poletto points out that traffic monitoring not only warns network administrators of possible nefarious activity but can also help them catch operational problems. If a normally busy server suddenly stops sending out traffic, for instance, it could be a sign that the server has crashed and needs to be fixed. If traffic between the New York and Los Angeles offices slows down, the software might identify a router that is handling too much traffic, allowing the operator to redirect data flow and avoid congestion. "Essentially, it's providing the operator with information they can use to decide which pieces of their infrastructure are being stressed by some activity or event," Poletto says.

In addition to deriving its own rules for what constitutes normal network activity, the software allows users to define specific rules for what's allowed. The IT department could specify that computers in the human-resources department aren't supposed to communicate with computers in finance. If they did, the software would send an alert that something fishy might be going on. Or the IT department could ban certain applications on the network. Some companies, for instance, don't want their employees using instant-messaging software, for fear they'll accidentally spill proprietary information.

The software also archives the information it collects. This allows a company to audit its network activity—something that's especially important for financial-services companies, which are legally required to log all communications. It also allows the software to discern subtler patterns that build up over time. Once the program "learns" that a particular computer may log in to a particular server only at the end of a fiscal quarter, the fact that it's doing something this week that it didn't do last week is not suspicious at all.

Financial-services companies were among Mazu's early clients when it began selling network behavior analysis software in 2003: clients include Merrill-Lynch, American Express, Fidelity, and AmeriTrade, as well as NASDAQ and the Chicago Mercantile Exchange. Lately, though, Mazu has branched out into other areas, selling software to health-care and media companies. The University of California, San Diego, added the software to its network late last year.

Poletto earned an SB in computer science in 1994 and a PhD in 1999, both from MIT. As a postdoc, he collaborated on fellow '94 graduate Eddie Kohler's PhD thesis, a system called Click; it created software modules in C++ that could be used to build routers, firewalls, and the like without starting from scratch.

In 2000, Poletto and Kohler (now a professor at UCLA) founded Mazu with the idea of using Click to create security tools. Another MIT alum, Paul Hsiao, and Hsiao's Harvard Business School classmate Sulaiman Mamdani were also cofounders. Frans Kaashoek, an MIT professor of computer science, sits on the board of directors. At first, the company concentrated on protecting networks from denial-of-service attacks, but Brady—himself a 2001 MBA graduate of the MIT Sloan School of Management—says that was too narrow a niche; network analysis, he says, could become a billion-dollar market.

Mazu has raised $42 million in four rounds of financing, with substantial support from Symantec, the maker of antivirus software. Brady says he expects the money on hand to take them to profitability. There are no current plans for a merger or an IPO, but he says both are conceivable down the road. Mazu has about 80 employees, and Brady expects steady growth. The company has more than 30 patents pending on its technology.

"Mazu's got some play and some pretty sizable accounts," says George Hamilton, a research director at the Yankee Group. Hamilton calls the company one of three main players in network behavior analysis and says that as the software matures over the next year or so, he wouldn't be surprised to find one of those three acquired by a larger company and its software incorporated into a broader suite of security and operations tools. As corporate networks strive to accommodate more mobile users and a wider array of applications, they're becoming more complex to manage, making the features of Mazu Profiler more appealing. "Behavior analysis on the network is becoming more important for more network managers, not just security operations guys," Hamilton says.

IN BRIEF

COMPANY
Mazu Networks

CEO
Paul Brady

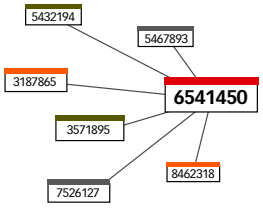
CONTACT
www.mazunetworks.com

MAJOR PRODUCTS
Network behavior analysis software

FUNDING
More than $10 million

PATENT STRENGTH
Core protection

TIME TO MARKET
Now



PATENT MAP
For a graphical analysis of Mazu Networks's patent position, go to www.ipvisioninc.com/techinsider/03/07.

Bubble Logic

Labs-on-a-chip are useful for chemical synthesis or biomedical assays, but practical applications have been limited by their need for external control circuits and plumbing mechanisms. Now researchers in MIT's Center for Bits and Atoms are applying the design principles behind computer chips to these microfluidic chips, using bubbles in fluid as bits. Neil Gershenfeld, associate professor of media arts and sciences, and his graduate student, Manu Prakash, have eliminated the external controls from a prototype silicon chip by creating Boolean AND/OR/NOT gates in which the *1*s and *0*s are represented by the presence or absence of a bubble. Hydrodynamic forces, such as surface tension, viscosity, and pressure, control the flow of the bubbles. The system is a thousandth the speed of an electronic circuit but 100 times as fast as existing lab-on-chip systems. This increased speed and simpler architecture could make the systems more useful for portable diagnostics, and for automated, large-scale testing in drug discovery. The researchers can also create a chemical memory using thousands of chemicals as the "bits" stored on the chip, which could serve as a general-purpose chemical analyzer.

Gas Relief

For decades scientists have hypothesized that carbon dioxide produced by power plants could be pumped deep into the ground, keeping tons of the greenhouse gas out of the atmosphere. But many worried that the gas—a major contributor to global warming—would quickly find its way back to the surface. Using experimental data and physical theory, Ruben Juanes, assistant professor of civil and environmental engineering, and colleagues from Chevron, Stanford University, and Imperial College London modeled the behavior of carbon dioxide injected into saline aquifers surrounded by porous rock. They concluded that the gas would remain trapped in the pores indefinitely.

In Juanes's model, carbon dioxide injected into a deep well forms a bubble, forcing the water out of pores in the rock. The gas then moves upward into the rock with the water behind it, until the large bubble becomes a series of tiny, isolated bubbles. Unable to push the water out of their way, the tiny bubbles stay trapped. Juanes believes engineers could realistically trap 50 megatons of carbon dioxide per year for the next 50 years; pilot projects are under way. The biggest barrier is probably the expense of the technology.

Blocking a Tumor's Path

Scientists in MIT's Center for Cancer Research have identified a new biological pathway to attack when treating tumors. Assistant professor of biology Michael Yaffe, biology professor Jacqueline Lees, and postdoc Hans Christian Reinhardt studied the MK2 pathway, which is associated with the body's inflammatory response. They found that about 80 percent of human tumors rely on this pathway to survive chemotherapy. They used RNA interference, a technique that can shut down production of particular proteins, to disrupt the pathway in mice. When they also administered an anticancer drug, the tumors essentially melted away; normal cells were unaffected.

The group discovered that one drug already in clinical trials works by interfering with the MK2 pathway. Yaffe hopes researchers will discover other drugs that work the same way. Such drugs, he says, could be used in lower doses to produce better results and fewer side effects than current chemotherapeutics.

Signal Advance

A new type of circuit that helps bridge the gap between the analog and digital realms could make consumer electronics less power hungry. Hae-Seung Lee, a professor in MIT's Microsystems Technology Laboratories, and his graduate student, Lane Brooks, demonstrated a prototype of the circuit at the International Solid State Circuits Conference in February. Though most data is processed digitally, much of it originates as analog signals, such as the light entering a digital camera or the radio transmissions of a cell phone. To convert continuous analog signals to discrete digital bits, electronics use a series of circuits called operational amplifiers, or op-amps, which rely on measuring feedback between the circuits' input and output. The new device, a comparator-based switched capacitor, evaluates two signals to see which is stronger or weaker, a yes/no result that is essentially digital. This requires much less voltage than op-amp systems and could potentially use an order of magnitude less power. Complex processing that isn't currently feasible, such as switching signal processing for software-defined radio, might become practical with such a system.

NEWS LINKS

Team develops nanoparticles to battle cancer
web.mit.edu/newsoffice/2007/bhatia.html

MIT "optics on a chip" may revolutionize telecom, computing
web.mit.edu/newsoffice/2007/optics.html

MIT experts foresee sustainable ethanol production
web.mit.edu/newsoffice/2007/biofuels.html

Academy of Engineering elects 5 from MIT
web.mit.edu/newsoffice/2007/nae-0214.html

MULTIMEDIA LINKS

Creativity: The Mind, Machines, and Mathematics: Public Debate
mitworld.mit.edu/video/422/

The Invisible Forest: Microbes in the Sea
mitworld.mit.edu/video/421/

The Role of New Technologies in a Sustainable Energy Economy
mitworld.mit.edu/video/414/

The Elements of Taste
www.technologyreview.com/video/taste/

Concentrating on Biomarkers

Micro/Nanofluidic BioMEMS Group makes chips to sort and concentrate proteins for better understanding and detection of diseases

Imagine a day in the future, when you're getting on in years and starting to question your mental acuity. Using a simple home test kit, you discover you're in the early stages of Alzheimer's disease, so you head to your doctor for state-of-the art treatment. If new treatment options make such testing worthwhile, technology being developed by Jongyoon Han could help make it possible.

Han, the Karl Van Tassel Career Development Assistant Professor of Electrical Engineering and Computer Science, heads MIT's Micro/Nanofluidic BioMEMS Group. He and his students are developing microelectromechanical systems that use electrical fields to disperse fluids through channels on a silicon chip in an effort to separate and concentrate chemicals that serve as markers for disease and other biological activities.

All sorts of molecules serve as biomarkers, or molecular proxies for what's going on in the body. Cytokines, for instance, are hormones associated with immune responses to disease. Other hormones, signaling molecules, or even debris from cells destroyed by a disease can be clues to problems such as cancer or Alzheimer's. Researchers have a variety of techniques for detecting protein biomarkers, from mass spectrometry to antibody-based assays. But these detection methods, Han says, are only one side of the equation. He's working on providing better samples, no matter how they are analyzed. "Most people have focused on developing new biosensors," he says. "I believe there are a lot of improvements you can achieve simply by improving the sample preparation."

Many biomarkers exist only in tiny concentrations—on the order of a trillionth of a mole per liter—in blood and urine samples. That can mean there are too few molecules for even sensitive sensors, like mass spectrometers, to detect. And the multitude of proteins—perhaps more than 10,000 different kinds in a sample—can complicate matters further. The older sample preparation method, gel electrophoresis, relies on a gel with a random assortment of pore sizes. There's no way to optimize the size and layout of the pores, so researchers have little control over the separation. But Han's chips can sort proteins by characteristics such as size or charge density, and concentrate them so they're easier to detect.

Another advantage is that Han's chips allow the process to be automated. Instead of having to spend hours preparing, say, a blood sample, graduate students or lab technicians would simply place it on a chip. Just one chip could contain a device to sort the proteins, another to concentrate them, and a sensor to measure them. "Sensitivity of your bioassay would go up dramatically," Han says. Such tools will initially give scientists ways to correlate the presence and relative concentrations of particular biomarkers with a particular disease; the chips could eventually evolve into diagnostic devices.

Han has created a number of chips designed for different applications. For one device, which sorts molecules by size, he etches channels several nanometers wide into silicon. Vertical and horizontal channels form a crosshatched pattern. Fluid containing the proteins to be separated is injected into the chip, and an electrical field forces the proteins through the channels. The particles move in a roughly diagonal direction—across one horizontal channel, down a vertical one, and so on. Their size determines which channels they travel through, so users can select particles of a certain size based on the channel they exit. The device is "really cool," says Mark Shannon, a bioMEMS expert at the University of Illinois at Urbana-Champaign. He finds the chip's ability to handle a continuous flow particularly impressive; it allows researchers to process many milliliters of fluid without having to keep feeding in smaller amounts. That saves a lot of time and effort. "It's just a very nice advance," he says.

Another setup allows Han to concentrate previously sorted proteins. In this system, Han applies an electrical field across the intersection of two channels, which pushes positively and negatively charged ions out of the intersection. The junction thus becomes an energy barrier blocking any charged molecule, including the proteins in question. Rather than passing through, the proteins inside a channel build up on one side of the intersection until there's a high enough concentration to provide a better sample to the sensor.

Han and his group of about 12 students use MIT's electron-beam lithography facility to build the chips, then take them back to their lab in Building 36 to test them. The group works with biological-engineering professors Scott Manalis and Steven Tannenbaum, who are developing their own biosensors, to integrate their preparation systems with those sensors.

Shannon says the work by Han and others in the field could cut the price of diagnostic equipment and significantly reduce the rate of false positives associated with some types of detectors. With the right sample preparation, sensors that register parts per billion aren't necessary. "When you can do a separation and concentration first, your detector becomes a much less important issue," he says.

IN BRIEF

NAME
Micro/Nanofluidic BioMEMS Group

DIRECTOR
Jongyoon Han

CONTACT
www.rle.mit.edu/micronano/

MAJOR PROJECTS
Microfabricated structures for rapid biomolecule separation

Multidimensional protein/peptide separation

Biomolecule concentration using nanofluidic filters

A Mesh of Funds

A startup that aims to bring wireless mesh networks into people's homes has received $5 million in Series A funding. Meraki Networks, of Mountain View, CA, received the financing in a round led by Sequoia Capital.

Meraki makes a small wireless router that plugs into a wall outlet. The device provides dynamic and inexpensive wireless service by connecting with other routers in neighboring homes to create a mesh network that forwards data from one node to another until it reaches one directly connected to the Internet. The company grew out of Roofnet, a project in MIT's Computer Science and Artificial Intelligence Laboratory that created hardware and software allowing people in Cambridge, MA, to connect to the Internet wirelessly, using nodes mounted on roofs and in windows. Two students involved with Roofnet took time off from their PhD programs to found Meraki in 2006. Both of them—Sanjit Biswas, now the company's CEO, and John Bicket, chief technical officer—have SM degrees in computer science from MIT. A third cofounder, Hans Robertson, earned an SB and a MEng in computer science from MIT and is now chief operating officer. Associate professor Robert Morris and professor Hari Balakrishnan are technical advisors to Meraki.
www.meraki.net

Amping Up

A company seeking to improve cell-phone towers has licensed enabling technology from MIT. Beam Power Technology, of Boston, signed an exclusive license agreement for seven patents owned by MIT. The patents are based on the work of Chiping Chen, a principal research scientist in MIT's Plasma Science and Fusion Center and cofounder of the company.

The technology is a ribbon-beam amplifier. It combines vacuum-tube technology with a method for making an electron beam that is elliptical in shape. This type of beam provides a more efficient way to amplify radio signals and could cut the cost of voice and data transmissions by as much as 90 percent. The amplifiers would be smaller than those currently in use, and they would cost less, use less electrical power, and generate less heat. Such savings are becoming important to communications companies as the amount of data being transmitted continues to increase.

Chen founded the company in 2003, along with Bruce Anderson, former director of MIT's Industrial Liaison Program. The company's proof-of-concept work was supported by a grant from MIT's Deshpande Center for Technological Innovation.
www.ignitestartups.com/IGNITE%20Portfolio.htm

Virtual Computing, Real Money

Software maker rPath, of Raleigh, NC, has received $9.1 million in Series B funding. Investors include General Catalyst, North Bridge Venture Partners, and Wakefield Group. The company says it will use the money to expand marketing for its product, a software package called rBuilder.

The software allows users to create virtual appliances, which are streamlined pieces of software such as a firewall or a router that can be easily and quickly installed on a computer system without installing other components to run the application. With rBuilder, programmers can also more easily make a piece of software designed for, say, Windows compatible with the Linux or Mac operating system. The company offers rBuilder online to software developers working in such varied categories as content management, voice over Internet protocol, network management, and photo sharing.

Billy Marshall, who earned a master's degree in mechanical engineering from MIT and an MBA from MIT's Sloan School of Management in 1995, founded rPath in early 2006, along with Erik Troan. Marshall is the company's CEO.
www.rpath.com

Group Support

A social-networking website for people with life-threatening illnesses has received $5 million in Series A funding. The financing round for PatientsLikeMe, of Cambridge, MA, was led by Collaborative Seed and Growth Partners, with investments from Invus. Previous seed investors include CommerceNet, a founding partner, and Omidyar Network.

The company creates a virtual support group that lets people talk to fellow patients and track their treatment and progress. The first community is for people with amyotrophic lateral sclerosis (ALS, or Lou Gehrig's disease), but users can request groups for other illnesses.

PatientsLikeMe was founded in 2004 by two brothers who earned bachelor's degrees from MIT—Benjamin Heywood, now company president, and James Heywood, chairman of the board—along with Jeff Cole, who earned an SB and SM in mechanical engineering from MIT and is the company's chief technology officer. The Heywoods are sons of John Heywood, the Sun Jae Professor of Mechanical Engineering and director of the Sloan Automotive Lab. Their struggle to help their brother Stephen, who died of ALS last November, was documented in the book *His Brother's Keeper*.
www.patientslikeme.com

DATEBOOK

March 8
20th Annual HST Forum
Martinos Center for Biomedical Imaging,
149Thirteenth Street,
Charlestown, MA

hst.mit.edu/servlet/ControllerServlet?handler=PublicHandler&action=browse&pageid=944

March 15, 4:00–5:30 P.M.
Bipedal Bugs, Galloping Ghosts, and Gripping Geckos: Neuromechanical Systems Biology
Building 32-123, MIT

events.mit.edu/event.html?id=7833174&date=2007/03/07

March 29–30
MIT Europe Conference: Achieving Growth through Strategic Innovation II
Management Centre Europe
Brussels, Belgium

ilp-www.mit.edu/display_event.a4d?key=P4&fromKey=P4&eventId=2343

March 30–31
CSD Conference:The Business of Race and Science
MIT Faculty Club

web.mit.edu/csd/BRS/Welcome.html

Grants and Fellowships 2006

Each year, MIT faculty and centers receive support for research from government agencies, corporations, and private institutions. Here are some of the grants and fellowships that have been awarded to MIT and its faculty over the past year.

RECIPIENT	FUNDER	AWARD	PROJECT SUPPORTED
Olumuyiwa Ogunnika, graduate student, Electrical Engineering and Computer Science	Center for Integration of Medicine and Innovative Technology	MIT-CIMIT Medical Engineering Fellowship, $50,000	An integrated circuit for a handheld probe that can help assess neuromuscular disease
Matthew Orosz and Amy Mueller, graduate students, Civil and Environmental Engineering	World Bank	Development Marketplace grant, $100,000	An electrical generator powered by mirrors that concentrate heat from the sun
Shiladitya Sengupta, assistant professor of medicine, Harvard-MIT Division of Health Sciences and Technology	U.S. Department of Defense Breast Cancer Research Program	Era of Hope Scholar Award, $4.1 million over five years	The nanocell, a novel structure for delivering drugs to tumors
AgeLab, Center for Transportation and Logistics	U.S. Department of Transportation's Research and Innovative Technology Administration	$6.25 million over three years	A study of how an aging population affects transportation policy, conducted by the New England University Transportation Center, a consortium of MIT, Harvard, and the state universities of the six New England states
Broad Institute of MIT and Harvard	Starr Foundation	$100 million over five years	The Starr Cancer Consortium, a project with four other research institutions to use genomics to understand and treat cancer
Broad Institute of MIT and Harvard	U.S. National Human Genome Research Institute	$200 million over four years	A search for the genetic basis of diseases; comparison of genomes of certain mammals; development of new gene sequencing technologies
National Center for Genotyping and Analysis, Broad Institute of MIT and Harvard	U.S. National Heart, Lung, and Blood Institute	$18 million	Survey of the DNA of 50,000 people to find genetic variations underlying disease
Center for Cancer Research	The Ludwig Fund	$20 million	Establishment of the Ludwig Center for Molecular Oncology to study cancer metastasis
Science, Technology, and Global Security Working Group; Program in Science, Technology, and Society	John D. and Catherine T. MacArthur Foundation	$1.2 million	Support for science and security experts; technical studies on security issues; technical analyses for policy makers
MIT	Howard Hughes Medical Institute	$1.8 million	Improvement of undergraduate biology education through research opportunities, new faculty and facilities, training of teachers and mentors, and work with high-school students and teachers