Innovations Report

Feb 2006 Part I

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ICT

IST Results

Enter the Semantic Grid

To allow business and people to rapidly, and easily, establish virtual organisations to share information, services and computing resources a team of European researchers are laying the technological foundations that will open the door to the era of the Semantic Grid.

Working under the IST programme-funded OntoGrid project, they are catalysing the evolution of the Grid from a distributed network of computers in which the meaning of information is implicit and hidden into a medium that will allow computers as well as humans to interpret and share semantically-enriched data.

OntoGrid Logo

The upshot is a technological infrastructure in which semantically-aware middleware allows collections of resources - computing, storage, data sets, digital libraries, scientific instruments, businesses and people – to rapidly come together to form virtual organisations to solve a specific problem and disband just as easily once a solution is found. By overcoming cross-organisational, cross-industry and cross-country boundaries, and increasing interoperability by making semantic assumptions explicit, the Semantic Grid promises to aid organisations and businesses in any field where input from multiple and potentially highly differentiated actors is required.

OntoGrid on track for Semantics

“What we are doing is enriching the Grid with semantics,” explains Asunción Gómez-Pérez at the Universidad Politécnica de Madrid, and one of the OntoGrid coordinators. “This is a visionary initiative. Few other researchers are working in this area at present.”

To test its highly innovative approach, the project partners are developing two semantic applications to be run over Grid infrastructure. One will consist of an insurance settlement system linking together the various parties involved in resolving insurance claims as a way to reduce costs, increase cross-organisational collaboration and fight fraud. The other will offer quality analysis for satellite images, allowing users to transparently obtain and analyse information from different data centres.

“The insurance settlement system solves a very real problem facing the insurance sector: how to resolve claims in which many very different actors are involved,” notes Carole Goble, the OntoGrid’s technical coordinator at the University of Manchester.

“Imagine you crash a car in Spain that you rented in France with a German-registered car driven by a Dutchman: resolving the paperwork is a major problem,” Goble notes. Similarly, the lack of collaboration and communication mechanisms between insurers and other actors raises the potential for fraud. With a Semantic Grid application a virtual organisation linking all actors involved could rapidly be established to settle the claim using semantically-enriched information to overcome their procedural differences and ensure they all use the same terminology.

Middleware for any context

“The problem with the Grid that has existed to date is that it is rigid, systems aren’t easily configurable and there is no way to do things quickly,” the technical coordinator says. “In OntoGrid we are developing flexible and configurable middleware that can be reused.”

To do so, the project has developed Semantic-OGSA, a reference architecture that represents an evolution of the Open Grid Service Architecture (OGSA) and defines a mechanism for the explicit use of semantics in components and applications.

From a business perspective, the more flexible middleware will allow companies to be more agile in finding solutions to problems as and when the need arises, and is particularly beneficial in sectors where actors are distributed. The Semantic Grid middleware could also easily be connected to existing (legacy) systems.

The enhanced information aggregation and exchange the Semantic Grid provides also offers other benefits. The quality analysis system for satellite images, for example, would help aerospace firms collect different data streams from different organisations that use different processes and aggregate it for different purposes, whether it is weather analysis or crop assessment.

Though adopting Semantic Grid systems today is likely to entail large upfront costs for companies (as the technology is still under development), in Goble’s view it will pay off in terms of increased productivity and lower costs in the long term. But as the technology matures (which is something that OntoGrid is contributing to), the upfront costs should go down by orders of magnitude. And she is confident that such systems will be used widely in the future, probably in part thanks to the groundwork carried out by the OntoGrid researchers.

Software-defined radio could unify wireless world

A device capable of skipping between incompatible wireless standards by tweaking its underlying code has been given world's first go-ahead for outdoor trials in Ireland.

Ireland's communications regulator Comreg has issued the licence for publicly testing a "software-defined radio" device, which has been developed by researchers at the Centre for Telecommunications Value-Chain Research (CTVR) in Dublin.

The device can impersonate a multitude of different wireless devices since it uses reconfigurable software to carry out the tasks normally performed by static hardware. "I'm interested in a future where a single device can use every possible frequency," says Linda Doyle, who heads up the CTVR project, which is one of several competing projects worldwide.

The technology promises to let future gadgets jump between frequencies and standards that currently conflict. A cellphone could, for example, automatically detect and jump to a much faster Wi-Fi network when in a local hotspot. Devices could even decide for themselves which standard to use and might even be able to tease information from overlapping, or interfering, signals.

Although software-defined radio devices use a normal antenna and amplifier to receive a signal they are fundamentally different from conventional radio-based equipment. An analogue-to-digital converter changes the signal into a digital format, which can be then be processed and manipulated by the software. And the software can reconfigure itself to let the device retrieve information sent at alternative frequencies or encoded (modulated) in a different way.

Allocated spectrum

The CTVR trial will involve testing communications between software-defined radio devices across the radio frequencies of 2.08 gigahertz to 2.35 GHz, at several sites across Ireland.

The researchers will try switching the radios between frequencies and modulations for different applications, such as audio and streaming video or data transmission, and will also let the devices automatically select the best standard to use.

The underlying technology has the potential to revolutionise wireless communications but has been difficult to test outside the laboratory until now as the majority of the radio spectrum has already been allocated. Licences are normally limited to a particular radio frequency and modulation but the one issued to CTVR permits a device to hop quickly between many different standards.

The CTVR trial will also test how easily frequencies can be dynamically allocated to different devices. One idea is for companies that own a licence to automatically "sublet" access depending on demand. "The licence means we will be the first research centre in the world to practically investigate the commercial potential of dynamic spectrum-allocation," Doyle adds.

Light and atoms get entangled

Physicists have for the first time entangled two atomic quantum bits, or "qubits", that are separated by long distances. Alex Kuzmich, Brian Kennedy and colleagues at the Georgia Institute of Technology in the US did this by entangling an atomic qubit with a photon, sending the photon down an optical fibre to a neighbouring lab, and then converting the photon into another atomic qubit. Meanwhile, Harald Weinfurter and co-workers at the Max-Planck Institute for Quantum Optics in Garching and the Ludwig-Maximilians University in Munich have entangled an atom with a photon at a wavelength suitable for low-loss communication over long distances.

Entanglement allows particles to have a much closer relationship than is possible in classical physics: if two particles are entangled, we can know the state of one particle by measuring the state of the other. For example, two particles can be entangled such that the polarization of one particle is always "horizontal" when the spin of the other is "vertical", and vice versa; or that the spin of one particle is "up" when the other is "down", and vice versa. An additional feature of quantum mechanics is that the particle can exist in a superposition of both these states at the same time. By taking advantage of such quantum phenomena, a quantum computer could, in principle, outperform a classical computer for certain tasks.

Although physicists can now routinely entangle photons and send them over long distances down optical fibres, these particles are difficult to store for long periods and so are not ideal as qubits for real quantum information systems. In contrast, qubits based on ground-state atoms have long lifetimes and so can be stored. Kuzmich and colleagues have now succeeded in remotely entangling two such atomic qubits using a photon (*Phys. Rev. Lett.* **96** 030405).

The Georgia Tech team made each long-lived qubit using "collective" spin states of a cold cloud of about 100,000 rubidium-85 atoms. Only a single spin is "flipped" in these collective states but the flip is distributed over all of the atoms involved in the qubit. The physicists began by preparing an entangled state of one of these atomic qubits and a single photon in a magneto-optical trap in their laboratory.

Next, the scientists transmitted the photon down an optical fibre to a magneto-optical trap in another lab located 5.5 metres away. Finally, they converted the photon into another atomic qubit, also consisting of rubidium-85 atoms. The team then measured the resulting entanglement of the two atomic qubits by "transferring" their quantum states onto photons and then measuring the polarization correlations of the photons.

"It should now be possible to teleport quantum states of matter over long distances," says Kuzmich. "The breakthrough also indicates that atoms and photons can be used for larger quantum networks -- though further work on practical issues is still necessary."

Meanwhile, in a separate experiment, Weinfurter and colleagues have entangled a single trapped atom with a single photon at a wavelength of 0.78 microns, which is suitable for low-loss communication over long distances, using similar experimental techniques to the Georgia Tech group (*Phys. Rev. Lett.* **96** 030404). The entanglement is between the polarization of the photon and the internal site of a rubidium-87 atom stored in an optical trap. Kuzmich and colleagues have also demonstrated atom-photon entanglement at "telecommunications" wavelengths of 1.5 microns (quantum-physics/0601055).

Optics: Longest laser

Phys. Rev. Lett. 96, 023902 (2006)

A fibre-optic system that could dramatically cut signal power losses in telecommunications has been created by a group led by Sergei Turitsyn and Juan Diego Ania-Castañón at the University of Aston in Birmingham, UK.

The team placed reflectors at each end of an optical fibre and pumped photons into the system. This excited atoms in the fibre and produced another, longer-wavelength set of photons. Because these photons were contained by the reflectors, they acted as a laser amplifier, boosting signals passing through the fibre.

The Aston group showed that there was minimal variation in signal power over 75 kilometres. The device may qualify as the longest laser ever built.

Microelectronics & Nanotech

smalltimes
BIG NEWS IN SMALL TECH.

European nano roadmap paves way for next decade

By Genevieve Oger
Small Times Correspondent

Jan. 31, 2006 - For investors, selecting which nanotechnologies to favor over others can be a little like looking into a marble ball to see what the future holds. The European Commission wants to take some of the guesswork out of the equation. That's why it has invested about $800,000 to draw up a nano roadmap aimed at identifying the technologies most likely to develop into applications by 2015.

"Roadmaps are key to defining Europe's research policy," said Renzo Tomellini, head of the nanotechnology unit at the European Commission. "They serve to identify areas of interest and contribute to establishing priorities in future research actions."

At issue is the European Union's 7th Framework Program, a research budget of almost $90 billion to be spent on scientific and technological research between 2007 and 2013, $5.8 billion of which is to be allotted to nano projects. Individual European member states and private businesses are expected to invest in projects as well.

The final roadmap was handed to the European Commission in December. It featured three individual nano plans: one on the future of materials, one on health and medical applications and a third on energy. The document of a few hundred pages was a collaborative pan-European effort. Nanotec IT, the Italian Center for Nanotechnology, acted as coordinator, working with groups in France, Germany, the Netherlands, Spain, the UK, the Czech Republic, Finland and Israel. Elvio Mantovani, Nanotec IT's managing director said the nano roadmap looks only 10 years into the future because it wants to be as accurate as possible.

"Any prediction is difficult, but the farther you look into the future, the less reliable the prediction becomes," Mantovani said. "A shorter time frame is safer, but still a prediction."

The partners began the project two years ago by sending a detailed questionnaire to about 350 nano experts worldwide. About 60 percent of them responded. Answers were analyzed and formed the basis of a second questionnaire sent to the same experts for confirmation and further probing. Ottilia Saxl, chief executive of the Scotland-based Institute of Nanotechnology and one of the roadmap partners, said the second round of questioning was crucial to getting an accurate picture.

"There is a tendency for experts working on solar energy to say solar energy will be the most important in the future, those working on wind power will say wind power, and those working on nuclear will say nuclear," she said, explaining that sending the second questionnaire helped draw up a more comprehensive view of things to come.

The European Union commissioned the roadmap and funded 80 percent of it for its own use. But the document will be publicly available online. The idea is to share the information so that small- and medium-size businesses, research institutions and the public can benefit.

The roadmap isn't going to add to the strategy of large chemical companies like Degussa or BASF, "because they have people working on this kind of thing internally," said Laszlo Bax, partner at Willems and Van den Wildenberg, R & D strategic consultants in the Netherlands and Spain and roadmap partners. "But there is a huge number of companies below that

mark who need this information and can't afford to carry it out."

The roadmap team adopted a pragmatic, application-based approach. Transforming research into marketable products is one of Europe's top priorities and one of the region's shortcomings. Europeans are generally good at producing top-notch research and nanotech-related scientific publications. But they haven't been as effective at transforming this knowledge into products and services, through patents and startups. According to the European Commission, European companies apply for 170 patents a year per million people, compared with 400 for American companies. The EU imports $28 billion more high tech products than it exports.

Large multinational organizations like the European Commission sometimes get flack for spending too much time and energy doing research, instead of focusing their resources on real work. But Bax contends that spending a little bit on research ensures funding is allocated more efficiently. "Any money you invest in research to prune the different aspects of current research is better spent than funding projects with less focus."

Battery alternative from nanotubes

Traditional batteries haven't progressed far beyond the basic design developed by Alessandro Volta in the 19th century.…Until now.
Work at MIT's Laboratory for Electromagnetic and Electronic Systems (LEES) holds out the promise of the first technologically significant and economically viable alternative to conventional batteries in more than 200 years.

Joel E. Schindall, the Bernard Gordon Professor of Electrical Engineering and Computer Science (EECS) and associate director of the Laboratory for Electromagnetic and Electronic Systems; John G. Kassakian, EECS professor and director of LEES; and Ph.D. candidate Riccardo Signorelli are using nanotube structures to improve on an energy storage device called an ultracapacitor.

Capacitors store energy as an electrical field, making them more efficient than standard batteries, which get their energy from chemical reactions. Ultracapacitors are capacitor-based storage cells that provide quick, massive bursts of instant energy. They are sometimes used in fuel-cell vehicles to provide an extra burst for accelerating into traffic and climbing hills.
However, ultracapacitors need to be much larger than batteries to hold the same charge.

The LEES invention would increase the storage capacity of existing commercial ultracapacitors by storing electrical fields at the atomic level.
The LEES ultracapacitor in fact overcomes the energy limitation of conventional ultracapacitors by using vertically aligned, single-wall carbon nanotubes - one thirty-thousandth the diameter of a human hair and 100,000 times as long as they are wide.

How does it work? Storage capacity in an ultracapacitor is proportional to the surface area of the electrodes. Today's ultracapacitors use electrodes made of activated carbon, which is extremely porous and therefore has a very large surface area. However, the pores in the carbon are irregular in size and shape, which reduces efficiency. The vertically aligned nanotubes in the LEES ultracapacitor have a regular shape, and a size that is only several atomic diameters in width. The result is a significantly more effective surface area, which equates to significantly increased storage capacity.

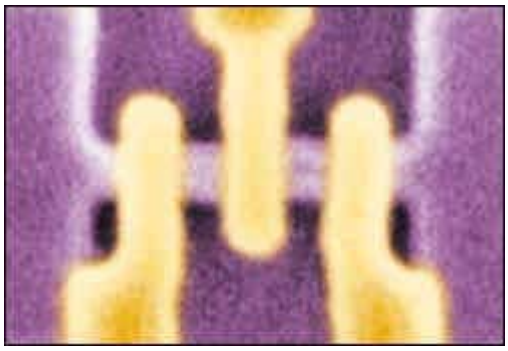
The new nanotube-enhanced ultracapacitors could be made in any of the sizes currently available and be produced using conventional technology.

"This configuration has the potential to maintain and even improve the high performance characteristics of ultracapacitors while providing energy storage densities comparable to batteries," Schindall said. "Nanotube-enhanced ultracapacitors would combine the long life and high power characteristics of a commercial ultracapacitor with the higher energy storage density normally available only from a chemical battery."

National Institute of Standards and Technology (NIST)

New design for transistors powered by single electrons

Scientists have demonstrated the first reproducible, controllable silicon transistors that are turned on and off by the motion of individual electrons. The experimental devices, designed and fabricated at NTT Corp. of Japan and tested at NIST, may have applications in low-power nanoelectronics, particularly as next-generation integrated circuits for logic operations (as opposed to simpler memory tasks).



Colorized micrograph of three tunable gates across an electrical channel in a single electron tunneling (SET) transistor.

The transistors, described in the Jan. 30, 2006, issue of Applied Physics Letters,* are based on the principle that as device sizes shrink to the nanometer range, the amount of energy required to move a single electron increases significantly. This makes it possible to control individual electron motion and current flow by manipulating the voltage applied to barriers, or "gates," in the electrical circuit. At negative voltage, the transistor is off; at higher voltage, the transistor is turned on and individual electrons file through the circuit, as opposed to thousands at a time in a conventional device.

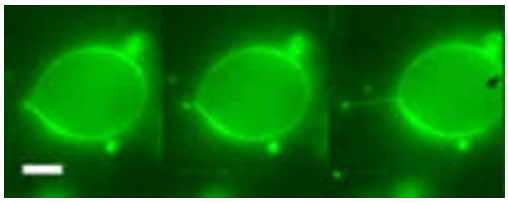
This type of innovative transistor, called a "single-electron tunneling" (SET) device, is typically made with a metal "wire" interrupted by insulating barriers that offer a rigid, narrow range of control over electron flow. Silicon devices, by contrast, have barriers that are electrically "tunable" over a wider operating range, offering finer, more flexible control of the transistor's on/off switch. Particular voltage levels are applied across the barriers, to manipulate charge, as a means of encouraging or impeding electron flow. Silicon-based devices also allow fabrication using standard semiconductor technology. Until now, however, no silicon SET transistor designs have been reported that are reproducible and controllable.

The NIST/NTT team made five uniform, working silicon transistors with tunable barriers. Each device consists of a silicon channel 360 nanometers (nm) long and 30 nm wide, with three gates crossing the channel. The gates have two levels; the upper level turns the current on and off, while the lower level controls electron flow in small local areas. The team was able to tune gate conductance properties over a wide range, by more than three orders of magnitude.

National Institute of Standards and Technology (NIST)

Stable polymer nanotubes

Scientists at the National Institute of Standards and Technology (NIST) have created polymer nanotubes that are unusually long (about 1 centimeter) as well as stable enough to maintain their shape indefinitely. Described in a new paper in Proceedings of the National Academy of Sciences,* the NIST nanotubes may have biotechnology applications as channels for tiny volumes of chemicals in nanofluidic reactor devices, for example, or as the "world's smallest hypodermic needles" for injecting molecules one at a time.



This sequence of images taken at NIST shows the creation of a nanotube as a highly focused infrared laser tugs on a polymer membrane that has been colored with a fluorescent dye. The white scale bar indicates 10 micrometers.

Carbon nanotubes are of keen interest in nanotechnology research, especially for making ultrastrong fibers and other structures. Nanotubes made from other materials are used for transport in biochemical applications, but are typically fragile and usually collapse within a few hours. The NIST team developed processes for extending the shelf life of polymer nanotubes--considered essential for commercial applications--and forming sturdy nanotube network structures.

First the researchers made tiny, fluid-filled spherical containers with bi-layer membranes consisting of polymers with one end that likes water and one end that does not. (These fluid-filled containers are a spin-off of liposomes, artificial cells with fatty membranes used in cosmetics and for drug delivery.) The researchers made the membranes stretchy by adding a soap-like fluid to change the polymer membranes' mechanical properties. Then they used "optical tweezers" (highly focused infrared lasers) or tiny droppers called micropipettes to pull on the elastic membranes to form long, double-walled tubes that are less than 100 nanometers in diameter. (View a movie of this process at: http://www.nist.gov/public_affairs/images/Polymer_Nanotubes_Animation.htm.)

A chemical was added to break bonds between atoms in one section of the polymers and induce new bonds to form between the two different sections, forming a rigid "cross-linked" membrane. The nanotubes are then snipped free from the parent cell with an "optical scalpel" (highly focused ultraviolet laser pulse). The nanotubes maintain their shape even after several weeks of storage, and can be removed from the liquid solution and placed on a dry surface or in a different container.

Life Sciences

Missing a few brain cells? Print new ones

A printer that spits out ultra-fine droplets of cells instead of ink has been used to print live brain cells without causing them any apparent harm

A PRINTER that spits out ultra-fine droplets of cells instead of ink has been used to print live brain cells without causing them any apparent harm. The technique could open up the possibility of building replacement tissue cell by cell, giving doctors complete control over the tissue they graft.

The device is a variant of a conventional ink-jet printer. Instead of forcing individual droplets of ink through a needle-shaped nozzle and onto the page, the cell printer uses a powerful electric field to produce droplets just a few micrometres in diameter, far smaller than is achievable by other means.

Several research groups have shown that modified ink-jet printers can spray droplets of live cells suspended in a sustaining solution. But these devices have not been able to print droplets smaller than 20 micrometres across, because ultra-fine nozzles are prone to blocking. Now the "electro-spray", developed by Suwan Jayasinghe of University of University College London and colleagues at Kings College London, overcomes this problem. The new technique involves passing a liquid suspension of live human cells through a stainless-steel needle with a diameter of 500 microns at a controlled flow rate. A voltage of up to 30kV is applied between the needle and an electrode, which charges the liquid. After leaving the needle, the external electric field turns the liquid into a jet that becomes unstable and disperses into a myriad of droplets.

The advantage of this method compared to conventional ink-jet technology is that it can create droplets as small as just a few microns across from needles with diameters as large as hundreds of microns. Until now, however, researchers were unsure if the high voltages required for this technique would damage living cells. Jayasinghe and co-workers have demonstrated that cells can be processed at electric fields as high as 30 kilovolts without being harmed.

The technique may have huge potential for patterning predetermined 2D and 3D biological architectures, such as tissues and organs, at the micron and nanometre scales says Jayasinghe -- a feat currently impossible using other jet-based methods.

Uppsala Universitet

Proof that proteins can be custom-designed

Ever since the advent of recombinant-DNA technology, scientists have conceived that it will be feasible to create entirely new enzymes for specific needs. In an article in today's issue of the journal Science, researchers from Uppsala and Korea present concrete proof of this. They have succeeded in converting an enzyme involved in normal human metabolism into an enzyme that is custom-designed to break down a specific substance, cefotaxime.

"The product in this case is not the main point, but we have shown that it is possible to totally transform an enzyme for a new and pre-determined activity. We have succeeded by using a rational reconstruction of the enzyme's active site in combination with directed molecular evolution in test tubes," says Professor Bengt Mannervik, at the Department of Biochemistry and Organic Chemistry, who planned the study.

In the cells of all organisms, proteins are involved in molecular functions of highly disparate types: as receptors of light and smells, for transmission of signals, mechanical work, control of the function of genes, and the synthesis and degradation of chemical substances. Despite all of these diverse functions, only an insignificant number of all imaginable protein structures ever come to existence in living cells. With the help of recombinant-DNA technology and chemical modifications scientists around the world are therefore trying to produce entirely new proteins that can be used for biotechnological applications in medicine, the drug industry, forestry and agriculture, and the production of foodstuffs. However, researchers have had to look for proteins at random after reconstructions, like a needle in a haystack.

Bengt Mannervik and his research team at Uppsala University, in collaboration with Hak-Sun Kim's research team in Korea, have converted an enzyme in human cells that participates in normal metabolism into an enzyme that degrades cefotaxime, an antibiotic similar to penicillin. The human enzyme was complemented with parts from the bacterial enzyme beta-lactamase, which bacteria use to break down antibiotics of the penicillin type. The scientists then managed to isolate bacteria with the new enzyme and to show that they enhanced their capacity to survive by degrading cefotaxime.

"The study shows that it is possible to drastically alter the properties of a natural protein and that an enzyme's functions can be custom-designed for new uses," says Bengt Mannervik.

New Fast Technique for Identifying Protein Molecules

A team of scientists at the Weizmann Institute of Science and the Hebrew University of Jerusalem has developed a method that could speed up the process of identifying novel protein molecules for medical or biological research hundreds of times over.

In today's high-throughput searches for specific genes, proteins or protein interactions, plates containing rows of tiny wells have replaced old-fashioned test tubes. However, trawling for a gene or protein with just the right qualifications may require sorting through millions, or even billions, of possibilities. Instead of wells, the new method, developed by Dr. Dan Tawfik and Amir Aharoni of the Institute's Biological Chemistry Department and Prof. Shlomo Magdassi of the Hebrew University's Institute of Chemistry with support from the Israel Ministry of Science and Technology, relies on microscopic droplets of water suspended inside oil droplets. Using their system, millions of tests can be performed at once.

The method, which relies on a type of emulsion dubbed WOW, for water-oil-water, takes a page from living cells, which employ a fatty membrane to keep the inside and outside environments separate. The oily layer surrounding each miniscule water droplet acts as a barrier, keeping genes, proteins and other materials contained. Alternately, the team inserted harmless bacteria containing genes for testing into the drops. Confining individual tests within a cell-like bubble allowed them to employ a widely-used method for analyzing living cells. This method involves adding a fluorescent marker that lights up in color when activated by the right protein and sorting through the cells for those containing the marked proteins and their coding genes. Automated devices for sorting cells can handle many thousands of droplets per second. "Searches that now take a year to complete can be done in a matter of days," says Tawfik.

University of Pennsylvania School of Medicine

A real time look at interactions between RNA and proteins

Intracellular observation of RNA metabolism will help identify disease-associated RNAs

For the first time, researchers can now peer inside intact cells to not only identify RNA-binding proteins, but also observe–in real-time–the intricate activities of these special molecules that make them key players in managing some of the cell's most basic functions. Researchers at the University of Pennsylvania School of Medicine who developed the new technology see this advance as one of the next logical steps in genomics research. Senior author James Eberwine, PhD, Professor of Pharmacology at Penn, and colleagues published their research this week in the Proceedings of the National Academy of Sciences.

"Now we have a workable system to understand all aspects of RNA metabolism in a cell," say Eberwine. "For the first time, we can study how manipulation of cellular physiology, such as administering a drug, changes RNA-binding protein and RNA interactions. This technology allows us to see that in real time in real cells."

RNA is the genetic material that programs cells to make proteins from DNA's blueprint and specifies which proteins should be made. There are many types of RNA in the cells of mammals, such as transfer RNA, ribosomal RNA, and messenger RNA–each with a specific purpose in making and manipulating proteins.

The workhorses of the cell, RNA-binding proteins regulate every aspect of RNA function. Indeed, RNA is transported from one site to another inside the cell by RNA-binding proteins; RNA is translated into protein with the help of RNA-binding proteins, and RNA-binding proteins degrade used RNA. "They're really the master regulators of expression in the cell," says Eberwine.

With their system, the researchers are trying to identify RNA-binding proteins that bind RNAs of interest–such as those involved in the targeting, degradation, and translation of RNAs into proteins. Once identified, the Eberwine team uses another technology they developed to find the other RNA cargos that bind to that RNA-binding protein. These are other RNAs that likely co-regulate RNAs associated with disease.

The Mount Sinai Hospital / Mount Sinai School of Medicine

Role of the nervous system in regulating stem cells discovered

Study led by Mount Sinai School of Medicine may provide new hope for cancer patients and others with compromised immune systems

New study by Mount Sinai researchers may lead to improved stem cell therapies for patients with compromised immune systems due to intensive cancer therapy or autoimmune disease. The study is published in this week's issue of Cell.

A group, led by Paul Frenette, Associate Professor of Medicine at Mount Sinai School of Medicine, found that the sympathetic--or "fight or flight" branch--of the nervous system plays a critical role in coaxing bone marrow stem cells into the bloodstream. Bone marrow cells known as hematopoietic stem cells are the source for blood and immune cells.

Hematopoietic stem cell transplants are now routinely used to restore the immune systems of patients after intensive cancer therapy and for treatment of other disorders of the blood and immune system, according to the National Institutes of Health. While physicians once retrieved the stem cells directly from bone marrow, doctors now prefer to harvest donor cells that have been mobilized into circulating blood.

In normal individuals, the continuous trafficking of the stem cells between the bone marrow and blood fills empty or damaged niches and contributes to the maintenance of normal blood cell formation, according to the researchers. Although it has been known for many years that the mobilization of hematopoietic stem cells can be enhanced by multiple chemicals, the mechanisms that regulate this critical process are largely unknown, they said.

The results of the new work suggest that differences in the sympathetic nervous systems may explain "conspicuous variability" in the efficiency with which they mobilize hematopoietic cells into the bloodstrea. Furthermore, drugs that alter the signals transmitted by the sympathetic nervous system to the stem cells in bone may offer a novel strategy to improve stem cell harvests for stem cell-based therapeutics.

The unexpected findings by Frenette and his colleagues further "suggest that the pharmacological manipulation of the sympathetic nervous system may be a means of therapeutically targeting the stem cells in their niche for the purpose of either mobilization or, conversely, attracting stem cells to the niche following transplantation,".

"The nervous system plays an important role in producing signals that maintain the stem cell niche and retention in bone marrow," Dr. Frenette said.

"The new findings add another dimension of complexity to the processes involved in stem cell maintenance and mobilization and emphasize the interrelationships among the nervous, skeletal and hematopoietic systems," he added. "They all have to work together – to talk to each other to produce blood and maintain stem cells."

Ohio State University

Common molecular 'signature' identified in solid tumors

Scientists have discovered that a wide variety of different cancers actually share something in common – a molecular "signature" made up of tiny bits of genetic material called microRNA (miRNA) that target key cancer genes and promote malignant growth.

The finding provides more insight into miRNA as an emerging class of gene regulators and may also pave the way for new approaches in diagnosis and treatment. The study appears online in the Proceedings of the National Academy of Sciences.

Scientists have only recently begun to understand how important microRNA may be in regulating gene expression. For years, these tiny bits of genetic material went unnoticed – nestled within vast stretches of the genome that appeared to be non-functional. They may have been easy to overlook: miRNAs are usually only 22 or so nucleotides in length – miniscule in size when compared to their cousins, messenger RNA, which can be several hundred to a thousand times that long.

But several years ago, researchers studying roundworms noted that properly functioning miRNA was necessary for normal development. Since then, scientists in laboratories around the world have identified hundreds of miRNAs and found that they are highly conserved over time – meaning that they show up in generation after generation in everything from plants to mice to humans – confirming their important roles in growth and survival.

Carlo Croce, professor and chair of molecular virology, immunology and medical genetics at The Ohio State University and the first researcher to discover miRNA involvement in human cancer, had a hunch that there might be shared patterns of miRNA among certain cancers. Under his direction, researchers looked for miRNA activity, or expression, in 540 samples of lung, breast, stomach, prostate, colon and pancreatic tumors and in the normal tissue surrounding them.

Croce predicts that miRNAs themselves may one day be used as treatments. "If we can replace miRNAs that are lost and block those that are overly abundant, then maybe we can prevent some of the very earliest changes that happen in the development of cancer. There is a lot of work that still needs to be done, but I am convinced that this field will give us more precise and less toxic ways of dealing with cancer than we have today – even considering some of our new, molecularly-targeted therapies." Support from the research came from the National Cancer Institute, the Italian Ministry of Public Health, the Italian Ministry of University Research Telethon, the Italian Association for Cancer Research and a Kimmel Scholar award to George Calin.

Mine Buster Targets Breast Cancer

A University of Nebraska scientist has developed a technology that makes undersea mud as clear as water, revealing deadly land mines. Now, she's adapting the technique to detect a type of biological land mine -- breast-cancer tumors.

Magda El-Shenawee, an associate professor of electrical engineering, is adapting her rough-surface computational analysis -- which, put very simply, is an algorithm that models dirt -- to detect breast tissue cells that have gone awry. It turns out seeing through dirt is not so different from seeing through breast tissue.

She's collaborating with University of Arkansas professor Fred Barlow to develop, design, build and test a microwave imaging system to detect early stage breast cancer. The Arkansas Biosciences Institute has funded their efforts to develop what might be an alternative or complement to traditional mammography.

"Eventually, we may be able to use this technology to not only reveal whether a tumor is present," said Barlow, "but to find out what type of tumor it is."

The work stems from El-Shenawee's previous work at Northeastern University in Boston, where she developed the land-mine detection technique.

The technique is based on an algorithm that analyzes how electromagnetic waves scatter as they bounce off rough surfaces and calculates the electric and magnetic currents thus induced. Subtracting the ground contribution one can identify the weak effect of the land mine.

Molecular force field helps cancer cells defend against attack

UF scientists find weakness in cancer's armor

Much as the famed starship Enterprise would deploy a deflector shield to evade enemy attack, tumor cells are capable of switching on a molecular force field of their own to fend off treatments aimed at killing them. Now University of Florida researchers have found a chink in their armor.

The cells churn out an enzyme that bonds with a protein, creating a protective barrier that deflects damage from radiation or chemotherapy and promotes tumor cell survival. But in laboratory experiments, UF scientists were able to block the union, and the malignant cells died. The findings are opening new avenues of research that could lead to improved cancer therapies, the researchers report this week in the journal Cancer Research.

"We have found a gene called focal adhesion kinase which is produced at very high levels in human tumors, and our work has shown this makes the tumors more likely to survive as they spread throughout the body and grow," said William G. Cance, M.D., a researcher at the University of Florida Shands Cancer Center and chairman of the department of surgery at UF's College of Medicine. "It also makes them more resistant to our attempts to kill them. And we're trying to understand exactly why this gene, which is a small enzyme molecule, is very intimately associated with tumor cell survival."