



In this issue

| | |
|---|---|
| NIT celebrates official opening of the Open Research Facility | 1 |
| Director's Message | 2 |
| Open Research Facility | 3 |
| Antenna Test Labs | |
| RF and Microwave Testing Lab | |
| Device Prototyping & Fabrication | |
| Network Architecture Labs | |
| Photonic and Optoelectronic Characterization Labs | |
| Announcements | 8 |



NIT celebrates official opening of the Open Research Facility

On May 30, 2003, the Nortel Institute for Telecommunications of the University of Toronto will be having the official “grand opening” of the NIT Open Research Facility.

The first of its kind in Canadian universities, the NIT Open Research Facility is a large, open, integrated laboratory facility to support information technology and telecommunications research and training. It represents a new and substantial research capacity for university-based, large-scale, exploratory telecommunications research.

The Facility will be officially opened by University of Toronto President Robert Birgeneau together with key university, government, and industry stakeholders who have contributed to the Facility.

In addition to providing first-class research infrastructure, the Open Research

Facility also provides a forum where NIT researchers and partners can meet and exchange information. This facility, with its specialized advanced equipment, will play a key role in training generations of highly qualified personnel to continue the pursuit of innovation in telecommunications.

The Facility is a focal point for a multidisciplinary group of academic, government and industrial researchers. It consists of is a grouping of laboratories at the University of Toronto that includes a collection of equipment resources and technical expertise, enabling scientists from across academia, government, and industry to pursue research and development projects related to the research thrusts of NIT. These facilities are available to any researchers having need of the specialized equipment and operational expertise.

NIT is the first of its kind in Canada, an example of a leading-edge research infrastructure that is making Ontario a leader in telecommunications innovation.

NIT provides Canadian university-based global leadership in advanced information technology and telecommunications research and innovation, strategic analysis, education, and training.

@NIT is published by the Nortel Institute for Telecommunications. We welcome your comments and suggestions.

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Peter W.E. Smith



In this issue of @NIT, we are featuring our Open Research Laboratories. These new facilities represent a major milestone in the development of the Nortel Institute, and they will provide the foundation for much of the program development that we will be undertaking in the coming years.

From a research perspective, these facilities are permitting the undertaking of larger and more ambitious projects than would normally be possible in a university setting. These facilities are currently being utilized for research in a wide variety of areas including studies of novel microwave and optical devices, metamaterials, organic and polymer materials and devices, and novel communication network architectures and management. The availability of these research facilities significantly assists the university in attracting and retaining top research professors and graduate students, and improves the quality of student training.

The Open Research Laboratory facilities are also serving as focal points for the development of partnerships with new industrial partners and with researchers from around the world. For example, we have recently submitted a proposal for a new research program enabled by the establishment of an agile photonic network testbed that would address the critical challenge of building a truly dynamic network using light - a network that responds independently to the ever-changing needs of the users. This program will elevate innovation in true photonic networks to a new level of excellence in Canada. It will unite researchers in photonics, systems and control, and communications at the University of Toronto, and will involve partnerships with both Nortel Networks and Corning.

A recent article in the University of Toronto Bulletin suggested that the key benchmarks for a great university are the three "I"s: innovation, indiscipline and internationalism. The NIT plays an important role in addressing all of these points.

Innovation is enhanced when close contact is maintained between basic researchers in the university, applied development in industry, and government programs for research support. The NIT, through our close connections with government and industrial partners is well situated to stimulate innovation. Our aim is to further

develop our programs with the aid of the resources of the Open Research Laboratories by attracting additional industrial users and establishing new partnerships.

The NIT is organized to encourage interdisciplinary. Because it is not situated within any single Department of the University, it is well positioned to coordinate cross-departmental and cross-faculty projects, and to take advantage of these collaborations to generate new multidisciplinary research proposals. One example is our recent development of a new research thrust in organic and polymer optoelectronics that involves researchers from several universities in the fields of physics, chemistry, and electrical engineering.

The NIT is involved in a number of international research collaborations. The organic and polymer optoelectronics thrust has strong ties with several research groups in France -- most notably the ENS-Cachan group of Prof. J. Zyss. Another major effort this year is an NIT workshop planned for this Fall with a delegation of Scottish representatives from universities and industries meeting with their Canadian counterparts for a series of technical sessions to explore and develop collaborations in areas of mutual interest.

In closing, let me summarize my message by stating that Nortel Institute is dedicated to establishing new partnerships. We welcome inquiries from interested parties and would be pleased to set up lab tours, meetings with key researchers, information sessions, etc to provide further information on the opportunities available.

*P. W. E. Smith
May, 2003*

NIT Open Research Facility

continued from page 1

Building on more than two decades of outstanding achievement in collaborative research and education, the University and Nortel Networks created the Institute in 1997. One of the mandates of the Institute was to foster and accelerate research in select targeted areas of network, wireless and emerging technologies. To achieve this mission, the Institute boldly proposed the "Open Research Facility" as a key resource.

The Institute was successful in obtaining substantial funding from the Canada Foundation for Innovation (CFI), the Ontario Research and Development Challenge Fund (ORDCF) and the Ontario Innovation Trust (OIT). The CFI supports research excellence and helps strengthen research training at institutions across Canada by investing in research infrastructure projects. The OIT provides capital funding in support of research, while the ORDCF is designed to promote research excellence in the province by increasing the R&D capacity of Ontario universities and other research institutions through private and public sector partnerships.

With this funding, the Institute acquired extensive space for 10 laboratories (1100 square metres) distributed across the University of Toronto downtown campus. The labs are contained within the Bahen Centre for Information Technology (BCIT), Sandford Fleming and Pratt buildings.

The resources of the Facility are maintained by professional staff. The staff are not dedicated to particular research projects but are available to help users in the execution of their projects. The flexible nature of the

facility, its equipment and staff, as well as its open structure, make it ideal for prototype development and testing. The facilities are open to University and industrial researchers who can use the facility to take advantage of its equipment and researcher expertise.

The NIT multidisciplinary, hands-on environment provides a valuable educational experience for the users. It provides an opportunity to interact in the laboratory with researchers from many different research fields and institutions.

The facility's funding supports only the lab infrastructure, equipment, and limited staff resources. Research projects in the facility are separately supported by industry and government agencies through the normal research grant mechanism.

NIT encourages interested researchers to discuss potential research collaborations and partnerships with the appropriate NIT Research Thrust Leader. Proposals to utilize the facility are reviewed to ensure high scientific standards and efficient use of this facility and are evaluated on an individual basis.

For questions and correspondence regarding the Open Research Facility, please visit our web site, www.nit.utoronto.ca, or contact:

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The Facility is drawing researchers from diverse fields such as engineering, chemistry, physics, biomedicine, and material science.



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pour l'innovation



Ontario
Innovation
Trust

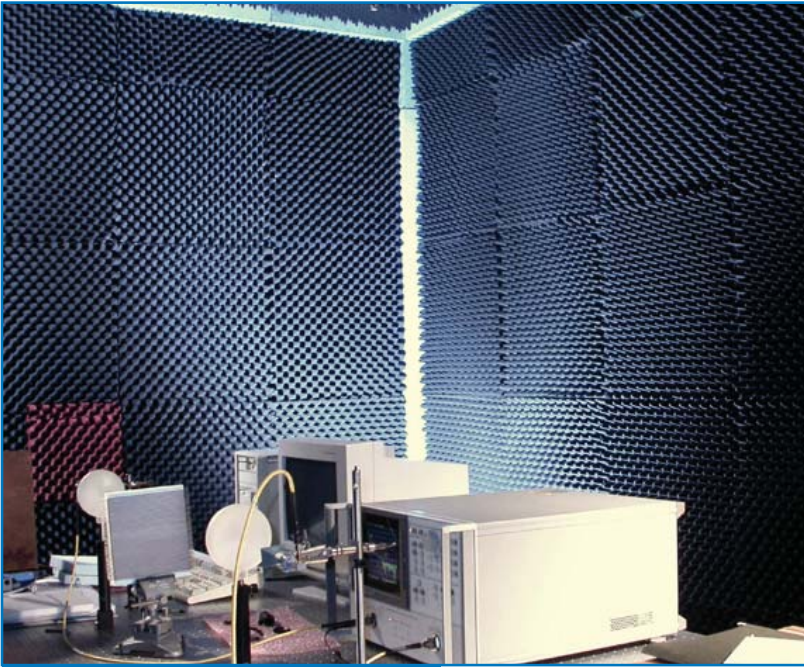


Open Research Facility goals:

- ◆ Create a new and substantial research capacity for university-based, large-scale, exploratory telecommunications research.
- ◆ Provide researchers from Canadian industries and institutions access to advanced equipment for research leading to innovations in the field.
- ◆ Train new generations of highly qualified personnel as industrial and academic researchers to continue the pursuit of innovation in telecommunications.
- ◆ Provide unique capacities for innovation in strategic research thrusts:

All-Optical Networks Emerging Technologies/Device Prototyping
Novel Network Architectures and Management
Novel Microwave Technologies
Advanced Wireless/Mobility
Organic and Polymer Optoelectronics

Antenna Test Labs



Millimetre Wave Antenna Test Range

The antenna testing laboratories consist of two separate anechoic chambers fully shielded against electromagnetic interference. One chamber is lined with microwave frequency absorbing material and the second with millimetre-wave frequency absorbing material.

The **Antenna Pattern Measurement Lab** is a full anechoic chamber that operates in two frequency ranges: at lower microwave frequencies from 1GHz to 40GHz and in the millimetre-wave frequency range 34GHz to 75GHz. Antennae under test are mounted on a pedestal and antenna patterns are made using computer controlled positioners in azimuth and elevation. Absolute antenna gains can be carried out over both frequency ranges. In-house developed software is programmed to computer control the network analyzer, signal source and two axis positioner.

The **Millimetre Wave Antenna Range** enables swept-frequency measurements of amplitude as well as absolute antenna gains at millimetre-wave frequencies from 50GHz to 100GHz. Antennae under test are mounted on a rail on an optical table and antenna patterns are made using a computer controlled azimuth positioner.

RF and Microwave Testing Lab

This is a state-of-the-art RF/Microwave testing lab that houses a complete set of RF, microwave and millimetre-wave sources, spectrum and vector network analyzers as well as a load-pull characterization facility. The testing lab enables coaxial as well as on-wafer probing and testing of devices and circuits.

Examples of devices and circuits that are characterized include metamaterial-enabled microwave devices, silicon micromachined and RF-MEMS devices, RF ICs and MMICs, and antenna input impedances. Current research includes millimetre-wave systems, integrated-circuit planar antennas and arrays, adaptive antennas, micromachined components, high-speed digital backplanes and interconnects, and the characterization and applications of novel electromagnetic materials.



RF and Microwave Testing Lab

Device Prototyping and Fabrication

The Device Prototyping and Fabrication labs include: Organic Lead-Emitting Diode (OLED) Cluster Tools, Cleanroom/Prototyping, and Micromachine Etching labs.

One lab contains Canada's first **OLED cluster tools** for molecular thin films and optoelectronics device prototyping. The cluster tools' unique capabilities help us leapfrog many other research groups into the forefront of this very competitive field. Indeed, the lab is quickly becoming a premier research resource in North America. Professor Zheng Hong Lu has assembled a unique set of investigative tools and techniques to study the fundamental science of cathode formation. He has developed important and innovative techniques such as in-situ cleaving at the cathode/organic interface to directly study the physics and chemistry at this interface.

The **Cleanroom/Prototyping Lab** enables researchers to fabricate functional devices in silicon, compound semiconductors, ceramic, glass and polymer.

The main laboratory consists of an 800 square feet Class 1000 (ISO 6) cleanroom for photolithography and wet chemistry. It houses two fully exhausted wet-chemical benches, laminar workstations, mask aligner and associated equipment for conventional lithographic process and the capability for developing novel patterning techniques. One of the first major pieces of equipment that has been installed is a Suss-Microtec MA6 mask aligner that will allow pattern transfer to photoresist-coated substrates.

The second cleanroom is a 480 square feet Class 10000 (ISO 7) for the etching and deposition machines such as e-beam thermal evaporator, chemical vapor deposition and reactive ion etching.

Finally, there is a 250 square feet "General Purpose" work area located outside of the cleanrooms with a six-foot long fumehood. This area is to be used for sample preparation and sample characterization.

The lab has its own dedicated heating, ventilation, air conditioning system (20C, 45% relative humidity) and dedicated exhaust system (for wet benches, fumehood, gas and chemical storage cabinets, vacuum pump exhaust, etc.).

The **Macromachine Etching Lab** is used to compliment other NIT laboratories. The function of this laboratory is to fabricate etched microwave circuits for printed antennas, metamaterials and microstrip circuits, and for micromachining of bulk silicon devices. The laboratory consists of a photoresist safe room with an exhausted fume hood and acid resistant work benches and wet benches.



OLED fabrication cluster tools: The cluster tools are capable of OLED display prototyping on 4"x4" substrate. The system includes: (a) one central distribution chamber; (b) one loadlock chamber; (c) one plasma cleaning/etching chamber; (d) one sputtering chamber (three magnetrons powered by RF, DC, and pulsed DC); (e) one organic thin film deposition chamber (eight VPD sources); and (f) one metallization chamber.

Inset: Canada's first commercial 2"x2" OLED display fabricated on a commission for Kurt Lesker Company for a trade show at the 2002 MRS conference.



Cleanroom/Prototyping Lab: Researcher preparing to expose a pattern onto a silicon sample on the newly installed Suss MA6 mask aligner.

Network Architecture Labs

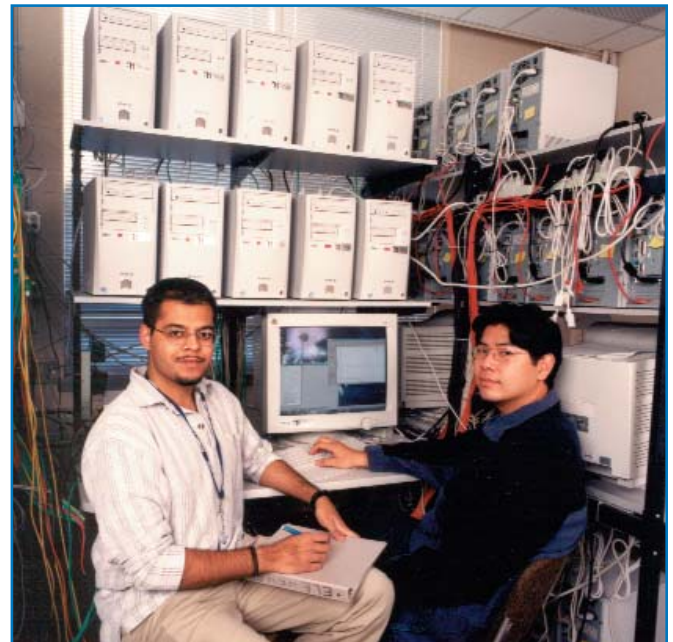
Encompassing research relevant to next-generation network architecture and future information services, the Network Architecture labs are being used to develop, test, and assess networking concepts that can form the basis of flexible, programmable, multi-domain network architectures to provide a platform for the delivery of a wide range of services. Ideally, this future generation network will combine the reliability of the existing telephone network, the flexibility of the Internet, the bandwidth of cable television networks, and the mobility of cellular radio.

The lab is equipped to facilitate the investigation of novel network-based applications and services, network architecture design, management and performance, heterogeneous networking, novel network elements, and network protocols and algorithms. An array of programmable end systems serves as a platform for the investigation of new applications (e.g., client-server, peer-to-peer, overlay networks). A complementary programmable node testbed provides the required network services and also provides a platform for the investigation of network architecture issues (e.g., signaling, security, QoS, routing).

The computing facility currently has 110 PC computers. The PCs run the Linux operating system to enable programmability of the network protocols. The computers are interconnected by a network of high speed layer 2/3 switches that allow the topology to be rearranged as required. One of the PCs is officially assigned as an access router to the ABone (Active Networks Backbone Testbed) with hostname, abone.nal.toronto.edu. This machine allows researchers to access an experimental testbed that is dedicated to active networking research in North America. The facility is being upgraded to support Windows applications as well as emerging communicating devices.



Students working in the Network Architecture computing facility.

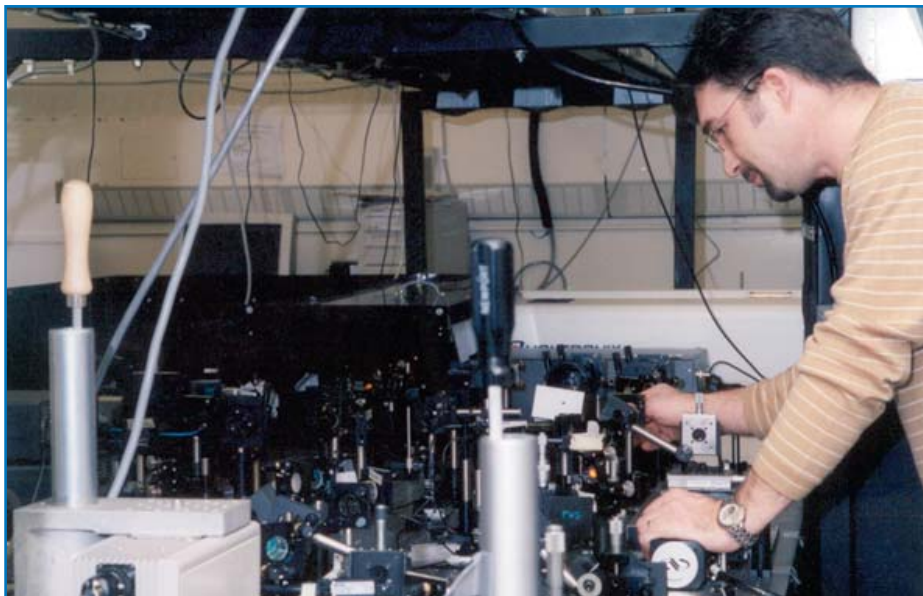


The testbed provides an excellent setup for many research projects to be run simultaneously.

Photonic and Optoelectronic Characterization Labs

The photonic characterization laboratory is based on a tunable high-power, ultrashort-pulse laser system which can be used to characterize novel organic and polymer materials and devices over a wide range of optical wavelengths and power levels. Professors Ted Sargent and Peter Smith and their research teams provide the expertise on nonlinear and ultra-fast measurement techniques.

Current applications include studies of optical nonlinearities and dynamical processes in semiconductors, semiconductor nanocrystals, and organic polymer materials. Versatile equipment and a unique suite of in-house developed diagnostic and analytical tools allow performing a broad range of nonlinear and time-resolved experiments.



Researcher overseeing a non-linear experiment that is in progress.

The labs are also equipped for characterization of the **optoelectronic** properties of new materials and devices. A combination of low-noise current sources, monochromators, optical detectors spanning various wavelength ranges, and laser excitation sources allow a suite of experiments. Photoluminescence quantum efficiency, photoluminescence excitation, photoinduced absorption, and electroluminescence efficiency and spectra can all be acquired in the steady-state and with time resolution.



Optical parametric amplifier (TOPAS), pumped by a Ti-Sapphire regenerative and multipass chirped pulse amplifier (TITAN). (Output avg. power: 20 - 400 mW, WL range 280 nm - 2,6 um, Rep rate: 1 kHz tun., Pulse width: fs-ps).



Strategic Workshop

Emerging Technologies for Future Optical and Wireless Networks

Nortel Institute, September 2003

The workshop's aims are to foster discussion and further collaboration among academics and industrial researchers from Scotland and Canada in the rapidly evolving field of emerging technologies. Topics to be discussed include:

- nonlinear optics,
- photonic crystals,
- organic and polymer materials,
- ultrafast lasers,
- optical integration,
- metamaterials, and,
- integrated microwave circuits.

The workshop is co-sponsored by Scottish Enterprise and the Nortel Institute. Scottish Enterprise is Scotland's main economic development agency.

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The Future of the Telecom Industry

June 2-6, 2003

Bahen Centre for Information Technology, University of Toronto

The MET Executive Development Program (EDP) gives participants an interactive opportunity to gain a solid appreciation of the industry structure and dynamics, taking into consideration the regulatory and competitive landscape.

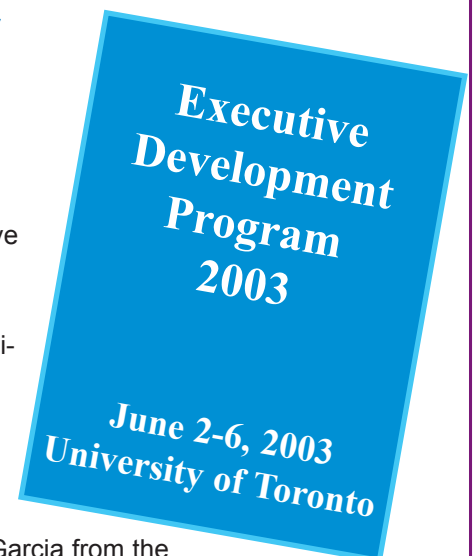
This year's focus will be on the critical regulatory, business, technology and architectural factors that will impact the future of the telecommunications industry. While an overall assessment of the global service provider and equipment vendor industries will be given, special emphasis will be placed on the future of the North American scene, especially the implications to the Canadian telecom and cable operators.

The principal faculty lecturers this year are: Professors Tony Yuen and Al Leon-Garcia from the Edward S. Rogers Sr. Department of Electrical and Computer Engineering and Professor Joseph D'Cruz from the Rotman School of Management. The keynote speakers are: Dan Shea, Chief Technology Officer, Celestica; Michael Cole, VP Solutions and Process Delivery, Bell Canada; Greg Mumford, Chief Technology Officer, Nortel Networks; and Larry Shaw, Director General Telecommunications Policy, Industry Canada.

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