

University of Pittsburgh

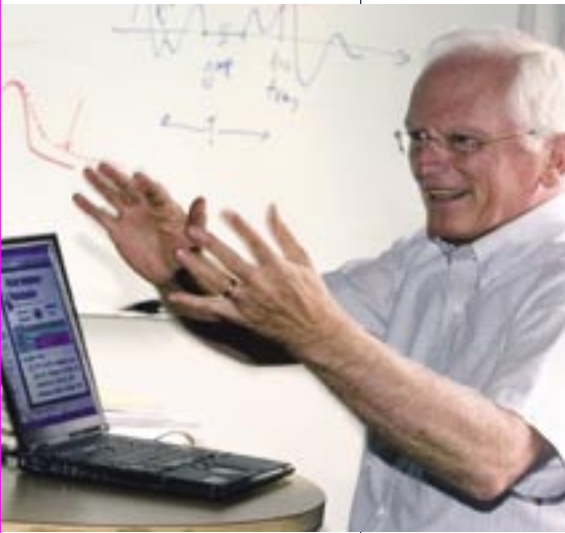
## TeleNet@Pitt



**School of Information Sciences**  
**Graduate Program in Telecommunications and Networking**  
**Connecting People, Information, and Technology**



## Letter from the Director



Telecommunications is more than moving bits from one machine to another—it's moving thoughts from one brain to another. In other words, it is technology used in service to society. Our faculty members strive to provide useful lifelong knowledge to our students, research results to the telecommunications profession, service and excellent employees to the international telecommunications industry, and curriculum leadership to the emerging telecommunications discipline.

In addition to classroom learning, the curriculum emphasizes hands-on lab experiences. Students use test equipment; build circuits; write programs; and experiment with a variety of personal computers, data networks, and commercial multiplexing and switching equipment. All faculty members are active researchers sharing their passion for discovery with our students. Every term, students are hired as research assistants on grants from federal agencies such as the National Science Foundation and the National Institute of Standards and Technology as well as from private industry.

We take pride in our labs and maintain them with state-of-the-art equipment, thanks in part to gifts from equipment manufacturers. Currently we have an electronics lab, a computer networking lab, a wireless lab, and a router/Voice over Internet Protocol (VoIP) lab, all of which are available for classroom exercises, student experimentation, independent studies, and research.

We are proud that in the past seven years the telecommunications program has hosted 14 Fulbright scholars. We believe that this testifies to the excellent worldwide reputation our programs enjoy.

For information about our faculty's individual backgrounds and interests, we invite you to view our Web page at [www.tele.pitt.edu](http://www.tele.pitt.edu).

A handwritten signature in black ink that reads "RD Thompson". The signature is written in a cursive, flowing style.

Sincerely,  
Richard A. Thompson  
Professor and Director,  
Graduate Program in Telecommunications and Networking

## Graduate Study in Telecommunications and Networking

The graduate program in telecommunications and networking, housed within the School of Information Sciences, offers graduate study leading to a master's degree, a certificate of advanced study, or a PhD, and it is closely linked to the Departments of Computer Science, Electrical Engineering, and Communications, and the Joseph M. Katz Graduate School of Business. Our program prepares you for careers in a variety of arenas including industry, business, government, health care, education, and the nonprofit sector in positions such as:

- network engineers or analysts,
- network administrators or managers,
- consultants,
- systems engineers,
- research and development engineers (with appropriate undergraduate education), and
- sales or customer-support engineers.

### Master of Science in Telecommunications (MST)

The MST program is a 36-credit program that can be completed in one year of full-time study or as many as four years of part-time study. Prerequisites for admission to the MST program include mastery of computer programming in at least one scientific programming language, probability (a three-credit course), and calculus (a three-credit course). You may then select an area of specialization such as telecommunications systems, computer networks, policy and management, wireless, or security, or choose to become a telecommunications generalist.

You will find additional information about the MST program at [www.tele.pitt.edu](http://www.tele.pitt.edu).



### Certificate of Advanced Study (CAS)

The 24-credit CAS provides a structured, personalized program of studies beyond the MST degree. Designed for people who do not wish to pursue the PhD degree, it enables post-master's-level students to explore a specific field of interest or to update skills and competencies. The CAS is an ideal way to refresh proficiencies and gain expertise in the most current areas of professional interest.

### Doctor of Philosophy (PhD)

The PhD program prepares you for advanced work in research and teaching, providing research-oriented graduate study and professional specialization in the science of telecommunications. Candidates must demonstrate evidence of superior scholarship and mastery of a specialized field of knowledge, and they also must show evidence of their ability to do significant and relevant research. Our PhD graduates are members of faculties at universities around the world, as well as senior researchers in public and private enterprises. If you are interested in doctoral study, you would benefit from meeting with potential faculty advisors before applying to the program.

"Our telecommunications program is not for everyone. It is fast-paced, technically challenging, and broadly multidisciplinary. It prepares students for lifelong careers in a global industry that never sleeps and is always changing. Our graduates become pioneers in areas as diverse as network architecture, protocol analysis, spectrum allocation, wireless security, and regulatory policy."

**Dean Ronald L. Larsen**

## Specializations

"We have the best people, curriculum depth and breadth, and labs. Whatever you need to develop your skills is here, and that's part of what makes us so successful. Employers are interested in applications, people who understand the system. Our students gain knowledge of protocol and excellent software skills by working on systems and solving problems.

"Much of my research involves wireless devices and wireless systems. Our students are engaged in developing solutions to problems, such as what happens to wireless transmissions in a building if a coke machine is added, or how to make batteries that power devices more efficiently, or complex issues such as security of wireless devices like laptops and PDAs. Wireless signals go everywhere, so there are many significant issues to address, especially in the area of security. You can always encrypt information, but who holds the keys, who is in control of the information being exchanged? These are hot topics, and we're educating people to develop solutions. Companies need the type of qualified people graduating from Pitt."

**Prashant Krishnamurthy**  
Assistant Professor,  
Graduate Program in  
Telecommunications  
and Networking

### Telecommunications Systems

Telecommunications systems are built on an infrastructure, similar to that classically used for telephony. In this specialization, you will investigate the physical technologies (copper and fiber) used for information transmission, the enabling transmission processes (such as multiplexing, synchronization, and noise filtering), and the systems that provide telephony (classic circuit switched and VoIP). If you pursue this track, you would likely be hired by a carrier, equipment manufacturer, consultant, or business for a career

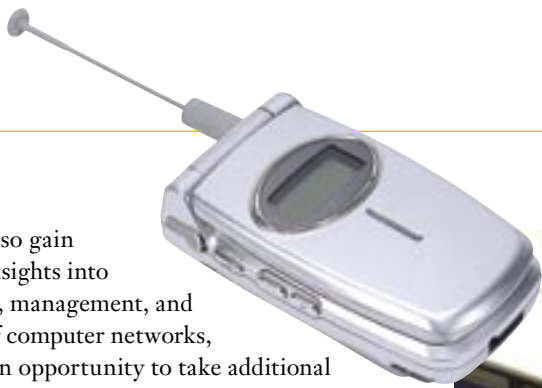
as a system engineer, network designer or manager, switching system designer, or telecom manager.

### Computer Networks

Computer networking enables efficient communication and information sharing to take place among widely dispersed participants. The recent emergence of the global Internet—and the availability of ever cheaper, more powerful computation and communication devices—is paving the way to a new generation of ubiquitous and pervasive networks.

In this specialization, you will explore a variety of problems encountered in designing computer networks and learn common techniques to solve these problems. Courses are designed to equip graduates with the knowledge and skills required to contribute to the field of data communication and networking. The focus is on network models and architectures, protocol design and implementation, resource management, quality of service support, and security. You will acquire a solid conceptual and practical understanding of how computer network technologies operate and the ability to analyze the benefits and limitations of current and future networking technologies.





You will also gain valuable insights into the design, management, and security of computer networks, and have an opportunity to take additional electives from the Department of Computer Science, depending on your interests.

A wide variety of career opportunities exists for you in this specialization. Network designers, data network managers, or information technology officers specializing in the provision of networking and distributed systems technologies can be employed in end-user organizations or other organizations in the public and private sectors, such as financial, manufacturing, advertising, healthcare and education.

## Policy and Management

Telecommunications systems exist in social and organizational contexts. In this specialization, you will explore the relationships among telecommunications technologies, service providers, end users, and governmental entities. In telecommunications, industry structure and government regulation is closely tied to the details of technology, so it is important that students forging a career in this area have a thorough understanding of not only the technology, but also the historical and existing economic and political structures. In this track you may take additional courses from the Katz Graduate School of Business or the Graduate School of Public and International Affairs, depending on your interests. Upon graduation, you will be prepared for a career as a policy analyst or network manager.

## Wireless

Wireless systems have become a vital infrastructure in today's society, and significant professional opportunities exist in this growing field. In this area, you will investigate the physical technology and enabling processes; the systems that provide cellular telephony, wireless LANs, and sensor networks; and mobile applications. You may select additional electives from the Department of Electrical Engineering. Graduates of this track have been hired by wireless carriers, manufacturers, and other organizations as system engineers and wireless network designers.



## Security

Just as we safeguard data within computers, we must also assure that the information flowing over networks is protected. In this specialization you will investigate firewalls, encryption, fault tolerant network design, and other procedures for information assurance. Additional electives may be taken from both the Department of Computer Science and the Department of Mathematics. If you follow this track, you will be prepared for a career as a network security specialist with carriers, manufacturers, consulting firms, the government, financial institutions, and other enterprises.

## Generalist

If you choose not to specialize in one particular area, as a generalist you will sample courses from all the specialties in preparation for dealing with the constant changes in telecommunications technology. Since change is the only constant in the telecommunications industry, your versatility as a generalist will enable you to handle challenges as they arise to the industry. Generalists have been hired by carriers, manufacturers, consultants, and other organizations (especially smaller ones) for careers as system engineers, network designers or managers, and telecommunications managers.

"I'm halfway through the wireless security track program. It's really high-tech and keeps evolving with the industry. Pitt is way ahead of the curve. You won't find in other schools the innovation being taught here."

**Rick Anderson**  
Current MST student

"I was looking to make a transition into IT administration and had a 17-year gap from earning my MBA. The reputation of the school played a major part in my decision to enroll in the program, and I wanted a program that featured results automation. I wanted to be able to build the whole system, make machines talk to each other. I had done some programming in the past, so this was a great complement to the skills I already had. I went part time and was able to work out all the classes I needed to finish in two and a half years."

**Terry Nypaver**  
MBA, 1985  
MST, 2004

## The Right Place: Tom Reinsel's Success Story

"The program here has many strengths. There are people teaching at Pitt who are quite well-known in the industry, and they are experts in every area of telecommunications—wireless, security, telephony, switching, policy, you name it. They have published books and are well-respected, so when you graduate from the program, you have a distinct advantage.

"Our ability to work in wireless labs that have really good equipment is very important. We use the same modern devices that industry uses, so having lots of experience working on the same equipment that employers use is beneficial. And the relationship that the SIS telecommunications program has with other departments is important, too. We share resources with the computer science department, and that's important for networking application development. And we also have a relationship with the Katz Graduate School of Business, so we can relate what we learn here with how to market products—the business element of the program. The professors are willing to share their knowledge; they are very generous."

### Julio Arauz

MST 2003,  
current PhD student

Fullbright Scholarship  
Recipient



Tom Reinsel was at the right place at the right time, and that place was the University of Pittsburgh's School of Information Sciences.

Reinsel came to Pitt in 1984 and did not declare a major. As he considered what career path to pursue, he explored computer science, but that seemed too technical for his

liking. Then he was introduced to information science. And because of the unique interdisciplinary approach and the emphasis on helping people use technology to meet challenges, he was convinced this was the right major.

Twenty years later, Reinsel knows he made the right decision. His consulting company, Pepperweed, made the *Inc.* 500 list of the fastest-growing companies in 2003, placing 229th after generating \$22 million in revenue.

Looking back on his experiences at Pitt, he said, "Everything in the (IS) building created a sense of community. I felt like I had a place to go. I felt like I had a home."

Reinsel worked his way through Pitt's undergraduate program, earning his Bachelor of Science in Information Science degree in 1990. And once he found his home, things started to happen. "There was a lab upstairs where you could interact with graduate students, and that attracted me. It felt open and the people were really encouraging. I got to rub elbows with faculty and grad students, and the experiences inspired me to get my master's.

One of his most significant classroom and project experiences was creating a distributed mail system on various types of servers and clients found in the lab. Everything needed to be created, starting with the network, software communication protocols, and finally the mail application itself.

"A start-from-scratch project where you build upon classroom knowledge to implement a working distributed IT application was a phenomenal experience. To this day, the concepts remain solid in a digital media world where everyone expects on-demand information to any device."

"Life in the school was a broad survey of what was happening in the industry. There were voice, data, and video paths, and you crossed over all of them. It was like a big sandbox. The professors and people in the labs were good at allowing you to figure out what you were good at. I was good at LANs [local area networks]."

Boy was he ever. After earning his Master of Science in Telecommunications (MST) in 1991, he was hired by Eli Lilly and Co. after an on-campus recruiting event. At Lilly, he had the opportunity to be part of building a global Internet along with six or eight other Pitt graduates.

"When other companies began recruiting me, a few people encouraged me to do some independent consulting. I bought a laptop, printed a few business cards, and flew to Kansas City for a meeting with AT&T."

What happened next transformed his life. He was awarded an \$800,000 contract, and Pepperweed Consulting was born. "It was more than I could handle, so I called some of my fellow colleagues from Pitt including MST graduate Bob Horenkamp (1992), and we executed the AT&T contract."

He credits faculty members Martin Weiss and Michael Spring for encouraging him to gain exposure to various aspects of technology and how to apply it.

"Faculty encourage you to try things early in your career because it can pay huge dividends later. The faculty, especially Richard Thompson, Ken Sochats, and Martin Weiss, give so unselfishly to your personal advancement ... what a gift. In our capitalistic world, where people guard intellectual property so tightly, these guys give and share their expertise. I admire that."

Reinsel and Pepperweed continue to lead in the field of IT management, helping senior information technology executives at companies and organizations achieve three primary goals of information technology systems: high performance, cost effectiveness, and alignment with the needs of the business.

"The education at SIS is a combination of software knowledge applied to hardware systems—it's a magical blend. SIS equips you for a broad world that will change rapidly in the next few years."

And because he was in the right place at the right time, Reinsel will be prepared to meet the unknown challenges ahead.

## Placement

When you commit to graduate study, you are interested in what follows—a rewarding career. Historically, one-third of our graduates have entered the user community of the telecom industry, working at corporations, universities, banks, or hospitals as members of their telecommunications staff. Our graduates build and manage telecommunications systems, LANs, and/or private global networks. Another third of our graduates are employed by companies that manufacture the actual telecommunications equipment (such as Lucent Technologies, Cisco Systems, or Marconi). These alumni design equipment, provide technical support for sales and customers, and work as systems engineers. The final third of our graduates work in the carrier domain for companies such as AT&T, Sprint, Verizon, or AT&T Wireless designing and planing networks, updating technology, and re-engineering systems.

The U.S. Department of Labor Bureau of Labor Statistics predicts that network systems and data communications analysts will be the second fastest growing occupations in the years between 2002 and 2012 with a growth rate of 57 percent in contrast to the average of 15 percent during those years. The Bureau anticipates employment in those jobs to increase from 186,000 to 292,000 during those years. With the combination of theory, practical experience, and exposure to current research gained from graduate study in our dynamic graduate programs, you will be well prepared for both your first job and long term career growth.

### Employers of graduates include:

- Consulting firms/military contractors such as: Boeing, Deloitte, Lockheed Martin, MITRE, Pepperweed Consulting, Raytheon, and Telcordia Technologies
- Large telecommunications/network users such as: Eli Lilly, FedEx, Mellon Financial, Sabre, UPMC, and US Steel

- Government agencies such as: Federal Communications Commission, National Institute of Standards and Technology, National Security Administration, National Telecommunications and Information Administration, and Public Utilities Commission
- Network services providers such as: AT&T, Nextel, Sprint PCS, T-Mobile, and Verizon
- Software companies such as: Ansoft, IBM, and Microsoft
- Equipment manufacturers such as: Agilent Technologies, Cisco, Ericsson, HP, Laurel Networks, Lucent, Marconi, Motorola, Nokia, and Qualcomm

### Job titles of alumni include:

- Network Engineer
- Network Analyst
- Network Administrator
- Network Manager
- Systems Engineer
- Systems Analyst
- Telecommunications Manager
- Consulting Engineer
- Sales Engineer



“Companies can hire electrical engineers or computer scientists to address certain elements of wireless telecommunications, but oftentimes they can’t find anybody who can understand the whole system. We teach whole systems, and that makes our graduates very marketable.

“Some of my research involves wireless connectivity to the Internet, long-term ad hoc sensor networks. What will happen when everything is processed on the network? Car engines, coffee makers, and control mechanisms will eventually be operated on the Internet. Nobody is exactly sure what form this will take, but there will be wireless connectivity and there will be an entire revolution. This is a tremendous opportunity for our students ... teaching microprocessors to communicate. Our research might lead to a few dead ends, or momentous breakthroughs, who knows, but the process will be a lot of fun no matter where it leads.

“I’m also working on a fascinating project with handheld wireless devices in classrooms, where we are studying use of PDAs by kindergarten kids and fourth-graders. Even in kindergarten, kids have elective time. Studies show boys spend 22 of 30 minutes working on computers, while girls spend just two of 30 minutes working on computers. But when a PDA is involved instead of computers, both groups spend about 25 minutes each. Why? Schools can’t afford laptops for each student, but they might be able to afford PDAs.”

### Joseph Kabara

Assistant Professor,  
Graduate Programs  
in Telecommunications  
and Networking

## Application and Financial Aid

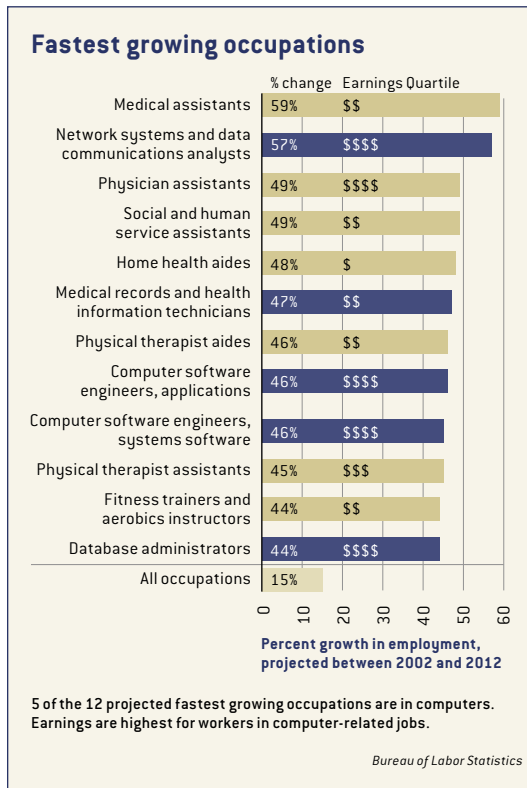
Please consult our Web site, [www.tele.pitt.edu](http://www.tele.pitt.edu), for additional information and to apply online.

Each term the faculty awards financial aid to outstanding full-time students in the form of graduate student assistantships or graduate research assistantships. These awards are competitive and granted on the basis of academic achievement and financial need. Follow these deadlines for financial aid applications:

Fall Term: January 15

Spring Term: September 15

Summer Term: January 15



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[www.sis.pitt.edu](http://www.sis.pitt.edu)

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