Approved: Carl Dean Holmes
Date 1-26-99

MINUTES OF THE HOUSE COMMITTEE ON UTILITIES.

The meeting was called to order by Chairperson Rep. Carl Holmes at 9:13 a.m. on January 20, 1999 in Room 522-S of the Capitol.

All members were present except: Rep. Sloan (Excused)

Committee staff present: Lynn Holt, Legislative Research Department
Mary Torrence, Revisor of Statutes
Jo Cook-Whitmore, Committee Secretary

Conferees appearing before the committee:

Others attending: See Attached List

Chairman Holmes asked for bill introductions. Rep. Alldritt stated that he felt it was an appropriate time for the committee to introduce a bill to begin discussion about a mandatory rollback, i.e. a 10% reduction in electric rates from border to border across the state. Upon inquiry by the Chair, Rep. Alldritt moved for the committee to introduce a bill to begin discussion on a mandatory rollback, motion was seconded by Rep. O'Brien. Motion carried.

Mr. Victor Frost, Dan F. Servey Distinguished Professor of Electrical Engineering and Computer Science and Acting Director of Information and Telecommunications Technology Center at the University of Kansas presented a program entitled "Information Technology: 'The Unpredictable Certainty'" (Attachment 1). Mr. Frost began by stating "The information infrastructure is going to change over the next 5 - 10 - 15 years. Exactly how that's going to happen is unpredictable at this point and I want to show a variety of alternate, alternatives that are being proposed, some in the market place to day, to illustrate that." He concluded his remarks by answering questions from the committee.

Lynne Holt, Legislative Research, distributed additional materials from the presentation by Matthew Brown on January 19.

Meeting adjourned at 10:12 a.m.

Next meeting will be Thursday, January 21 at 9:00 a.m.

HOUSE UTILITIES COMMITTEE GUEST LIST

DATE: January 20, 1999

NAME	REPRESENTING
Mike Moffet	SWBell
Paul Snider	SWBT
Marc Hamann	Div. of the Budget
John D. Pinegar	State Independent Telephone Assn.
Sandy Powell	~~KBA~~ Administrative Svcs.
Jim Ludwig	Western Resources
Patrice Scott	Sprint
Mary Peters	Sprint
Jon Josserand	KU
David Bybee	KDOCH
Tom Gleason	Independent Telecom Group

Information Technology: "The Unpredictable Certainty"

Victor S. Frost

Dan F. Servey Distinguished Professor
Electrical Engineering and Computer Science
Acting Director
Information and Telecommunications Technology Center
University of Kansas
2291 Irving Hill Dr.
Lawrence, Kansas 66045
Phone: (785) 864-4833 FAX:(785) 864-7789
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http://www.ittc.ukans.edu/

Outline

- Drivers: Customer expectations
- Drivers: Technology
- The Essence of Networking Science
- Alternatives in Access Technologies
- Voice over the Internet
- Conclusion

Communications Networks

- Voice
- Data
  - E-mail
  - Web
  - Network based applications
- Video
  - Broadcast
  - Video on Demand
- Today => **Separate networks**
- Future => **An integrated network**

Drivers: Customer Uses

- Work
  - 80% corporate computers are connected
  - E-mail
  - Telecommuting
- Learning
  - Web cased courses
  - Access to vast repositories of **multimedia** information

Drivers: Customer Uses

- Financial and commercial uses
  - On-line browsing
  - Retrieval of product information
  - On-line purchasing
  - On-line customer service
- Entertainment
  - Chat rooms
  - Video (TV)
  - Network based games

Drivers: Customer Expectations

- Sense of always connected
- Instant response
- Ubiquitous connectivity
- Multimedia support
- Conferencing (simultaneous communications with multiple users)

Drivers: Customer expectations

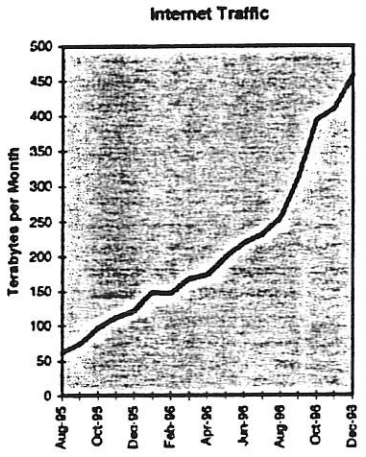
- Mobility support
- Personalized information services
- Context sensitive information services
- Absolutely secure
- Cheap

Drivers: Technology
Value of a Network

- Number of Connections: Metcalf's Law
  - The value of a network increases as the square of the number of connected users
- Access Bandwidth
  - The value of a network increases as the square of the access bandwidth
- Host capabilities
  - The value of a network increases as the square of the host capabilities

Drivers: Technology
Traffic Growth

- Sidgemore's Law
- Internet traffic doubles every three months

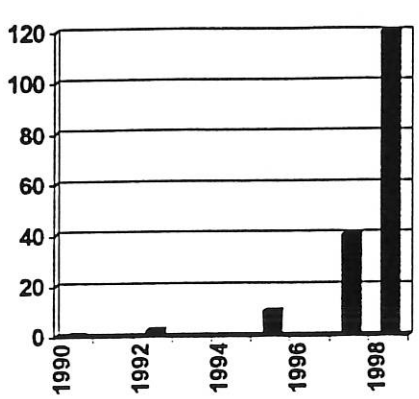


From: "The Dark Fiber Paradigm", Gilder Technology Report, Vol. II, No 2, Feb. 1997

Drivers: Technology
Processors and network capacity

- Moore's Law
  - Processing power doubles every 18 months
  - Moore's Law has been true for the past 20 years
- Gilder's Law (The Law of Telecoms)
  - Total telecommunications system capacity (b/s) triples every three years

Drivers: Technology
Available bandwidth

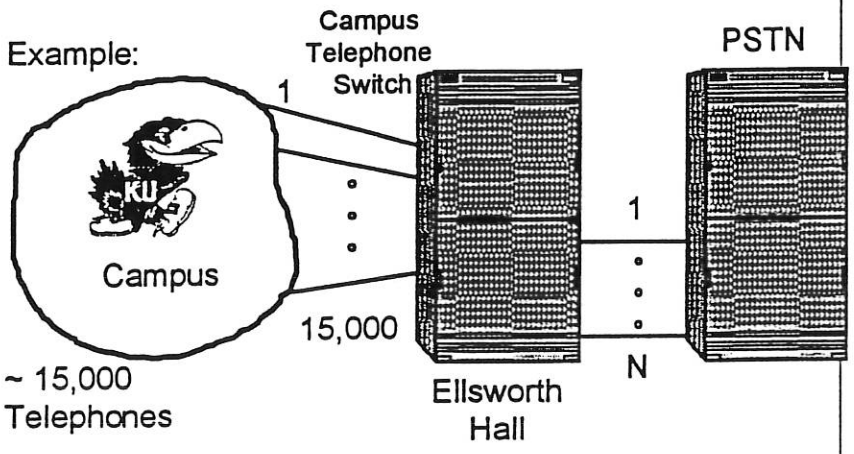


- Capacity of each fiber used to interconnect communications switches
- Projected to reach 1000 Gb/s soon

Drivers: Technology
Ramifications

- Rapid change in enabling technologies
- Products go obsolete before they ware out
- Terminal cost decreases
- Cost of bandwidth decreases
- Value of the ***network*** increases
- Network capacity and software technologies will be there to support the customer expectations
- Expect the trend to continue for the next 20 years.

Essence of Networking Science



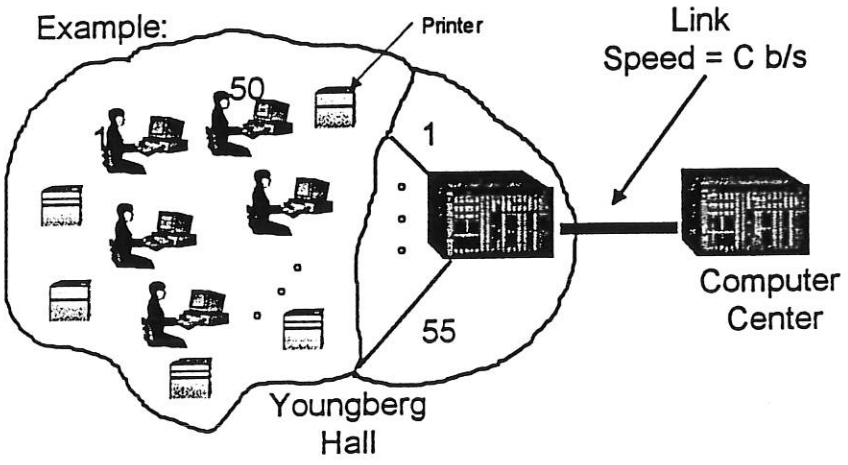
Essence of Networking Science

- How many lines do you lease?
- To **guarantee** every campus phone can always get an outside line:
  N=15,000
- Too expensive: lines cost per month

Essence of Networking Science

- Solution: Gamble
- Make "reasonable" assumptions about the call patterns (traffic)
- Apply network engineering
- Result: N reduces to 160 from 15,000

Essence of Networking Science



Essence of Networking Science

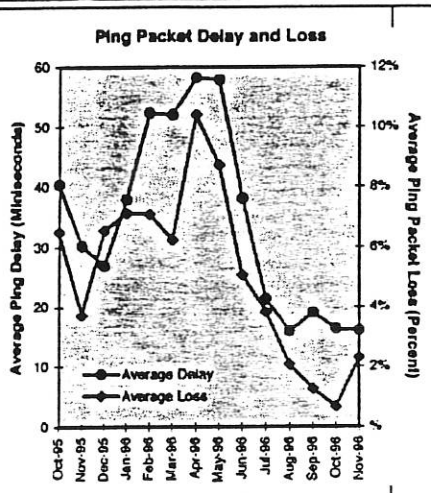
- Assume each customer and printer is connected using Ethernet, i.e. at 10 Mb/s
- How fast does the link between Youngberg and the computer center have to be to **guarantee** all the customers can use the 10 Mb/s.
- C = 550 Mb/s
- Too expensive

Essence of Networking Science

- Solution: Gamble
- Assume:
  - Break up messages into 'smallish' units called *packets*
  - Packets from each customer are sent to a waiting line, buffer, to wait their turn to use the link
  - Packets arriving to a full buffer are discarded
- Customer information now experiences:
  - Delay, e.g., 0.1 sec
  - Loss, e.g., 1 in 100
- Make "reasonable" assumptions about the call patterns (traffic)
- Apply network engineering
- Result: C reduces to 16 Mb/s from 550 Mb/s

Essence of Networking Science

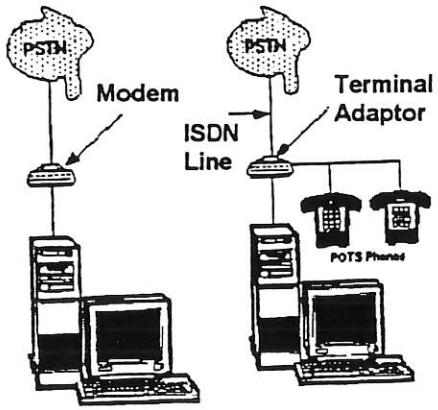
What happens when you lose your gamble



From: "The Dark Fiber Paradigm", Gilder Technology Report, Vol. II, No 2, Feb. 1997

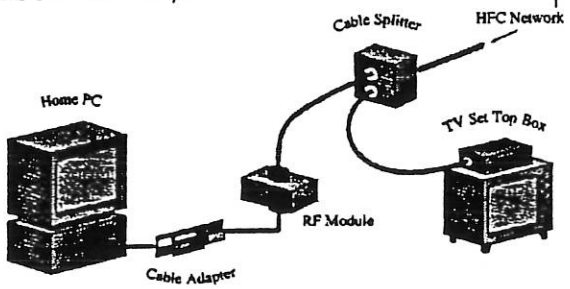
New Modes for Information Distribution to the Home: ISDN

- Integrated Services Digital Network (ISDN)
- What it is
  - Transmission over standard telephone wires
  - Peak rate 128 kb/s
  - Max Length ~18,000ft
  - Available now



New Modes for Information Distribution to the Home: Cable

- What it is: Simultaneous transmission over cable TV coax facilities
  - Current technology - Cable modems @ Peak rate = 500 kb/s
  - Available now
  - Future technology: Digital TV + 10's Mb/s



For more information see:
http://cabledatacomnews.com/cmic1.htm

New Modes for Information Distribution to the Home: Satellite

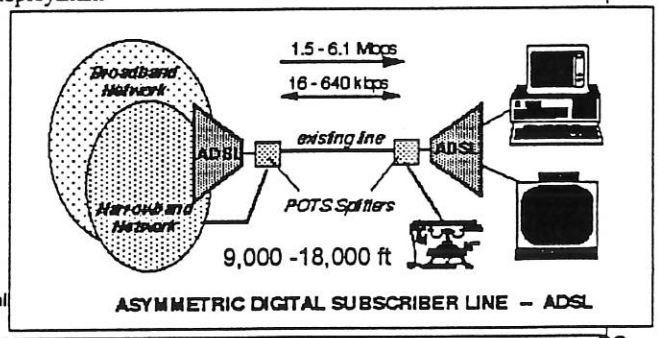
- What it is: Satellite access
  - Asymmetric
  - Requests are sent via modems
  - Responses sent via satellite at 400 kb/s
  - Available now

New Modes for Information Distribution to the Home: HDSL

- What it is
  - High-bit-rate digital subscriber line (HDSL)
  - Peak rate ~10's Mb/s
  - Access over standard telephone copper wires
  - In trials and limited deployment

Maximum distance 1,000 to 18,000 ft depending on the data rate

For more information see:
http://www.adsl.com/tech_info.html



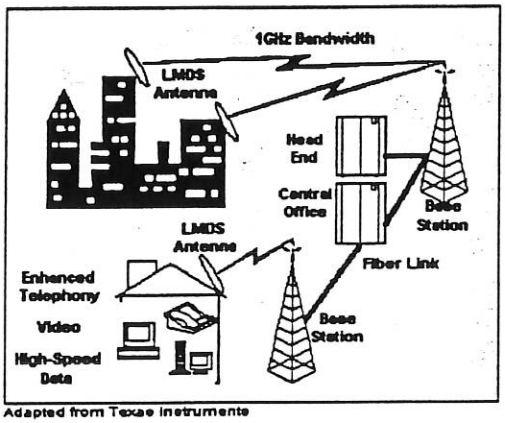
ASYMMETRIC DIGITAL SUBSCRIBER LINE – ADSL

New Modes for Information Distribution to the Home: Wireless

Local Multipoint Distribution System (LMDS)

High Speed Wireless Access for
- Telephone
- Video
- Internet

LMDS Infrastructure



Adapted from Texas Instruments

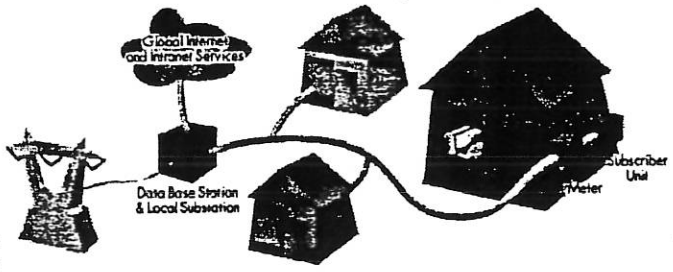
New Modes for Information Distribution to the Home: Wireless

- What it is
  - Symmetric Access ~ 10's Mb/s
  - Asymmetric wireless access
    - Over 100 Mb/s to home
    - 1.5 Mb/s from home
  - Line of sight communications
  - In trials
  - A future technology

New Modes for Information Distribution to the Home: Powerline Communications

- What is it:
  - It is a data communication technology that operates over the electricity supply.
  - Rates range up to 1 Mb/s
  - In trials
  - Future technology
  - Coverage anywhere on one side of a transformer

Basic Data Networking Configuration



For more information see:
http://www.adaptivenetworks.com/

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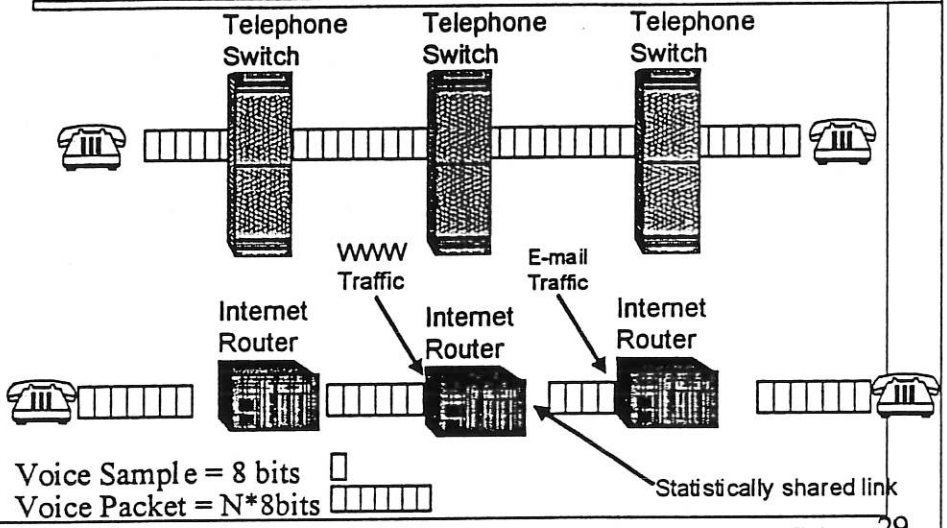
New Modes for Information Distribution to the Home: Costs (Estimated as of 2/98)

- Cable modem cost
  - Installation ~ $25
  - ~ $30/mo
- ISDN
  - Installation ~ $200.00
  - ~ $50 - $100/mo
- ADSL
  - ~ $95/mo (for 1.5 Mb/s)
  - SOURCE: http://www.3com.com/xdsl/05_30_97b.html
- Satellite
  - Hardware ~ $400
  - ~ 24.95/month up to 64MB(approximately 25 hours online)

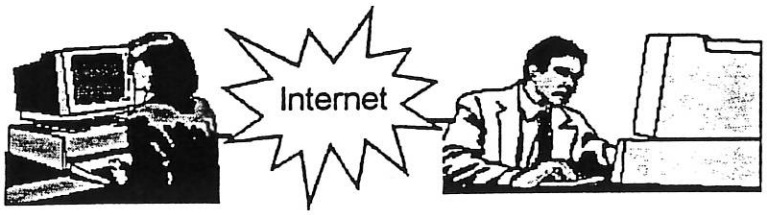
Voice over the Internet: What is it?

- A digitized voice signal is *sliced* into packets and sent in using the same infrastructure and protocols as www, e-mail and other internet traffic
  - Private/campus infrastructure--intranet
  - Public internet

Voice over the Internet

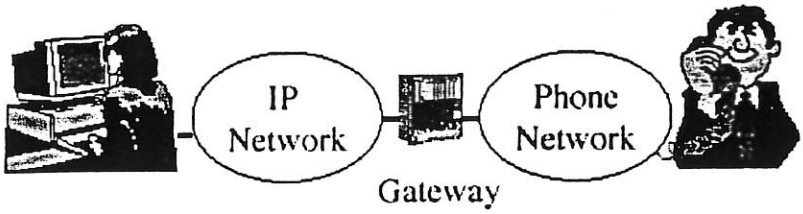


Voice over the Internet: Common Operational Modes



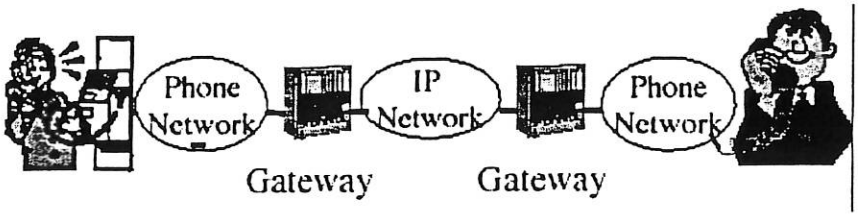
- PC-to-PC
  - Requires connection to "Internet"
  - Requires PC sound card
  - Requires internet voice software

Voice over the Internet: Common Operational Modes



- PC-to-Phone
  - Requires connection to "Internet"
  - Requires PC sound card
  - Requires internet voice software
  - Requires an internet-to-telephone gateway (switch-to-router)

Voice over the Internet: Common Operational Modes



- Phone-to-Phone
  - Requires connection to "Internet"
  - Requires PC sound card
  - Requires internet voice software
  - Requires an internet-to-telephone gateway (switch-to-router)

Voice over the Internet: Benefits

- Can place a phone call to any other internet telephony user anywhere in the world and only pay for call to local ISP
- Simplifies voice/data conferencing
- Enhanced helpdesks
- Enhanced on-line order placement
- Integration offers potential to reduce administrative cost

Voice over the Internet: Problems

- Quality of Service
  - The internet is currently *"best effort"*
  - The internet is unreliable
- Lack of standards
  ~~> plethora of proprietary solutions
  - Lack of **Interoperatability**
- Lack of high volume call processing capability

Voice over the Internet: Projections

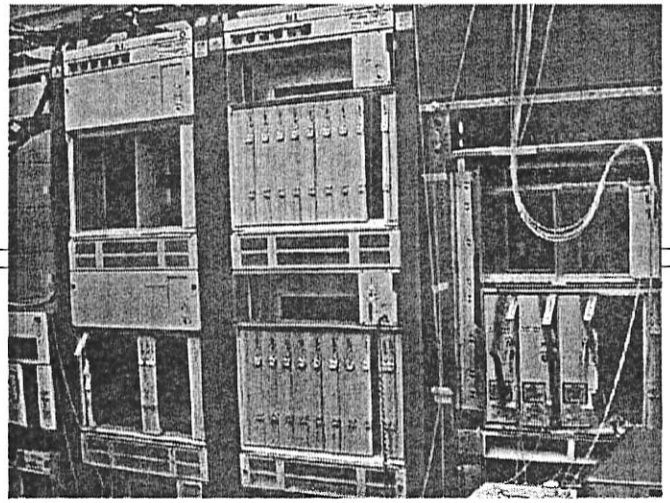
- International Data Corporation predicts that the Internet telephony market will grow from US$3.5 million in 1995 to US$560 million 1999.
- Frost & Sullivan estimates that Internet telephony will be a $1.8 billion market by 2001.
- Forrester predicts that Internet telephone calls will take 4% of U.S. telephone company revenues by 2004.
- International Data Corp. predicts that packet-switched networks will account for about 1% of global long distance traffic by 2001 (about 12.5 billion minutes).

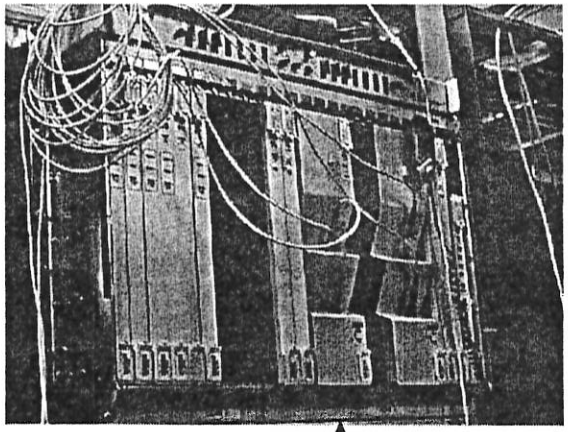
Conclusions

- Rapid advance in networking technology will continually changing the way we learn, work, and play
- Past experience indicates that change will continue for many years
- View the development of the information infrastructure as "The Unpredictable Certainty"

"The Unpredictable Certainty: Information Infrastructure through 2000" Computer Science and Telecommunications Board National Research Council, 1996

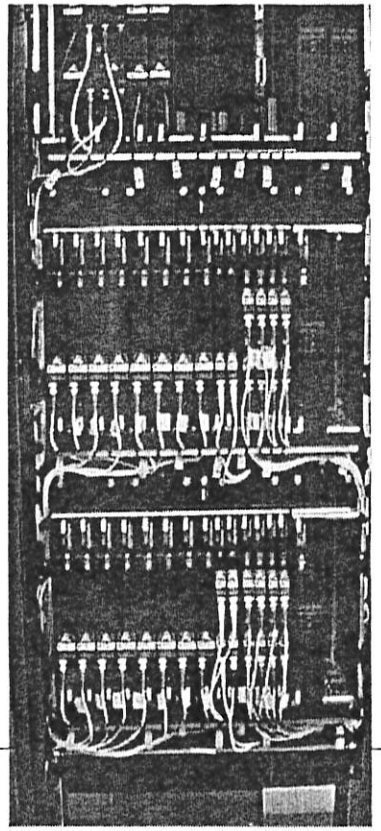
Research Networking Facilities at the
University of Kansas
Information and Telecommunications
Technology Center

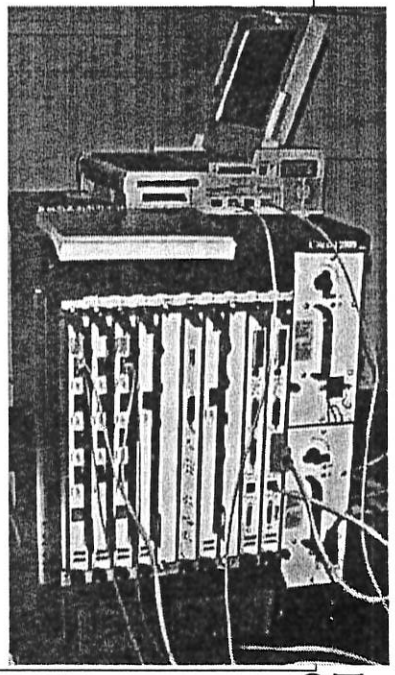




20 Gb/s
WDM
Lightwave System

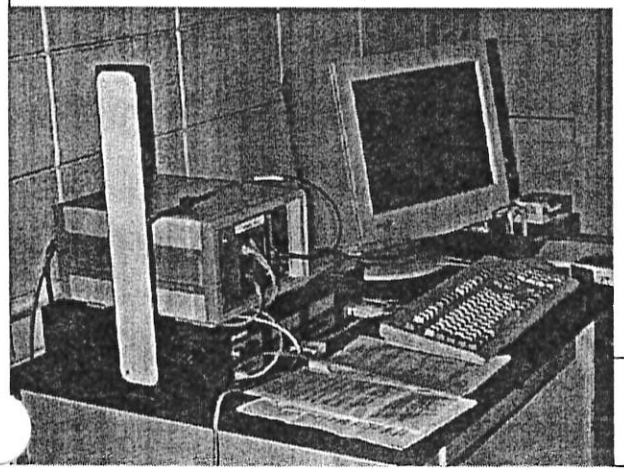
IP Router





2.4 Gb/s Fiber Terminal

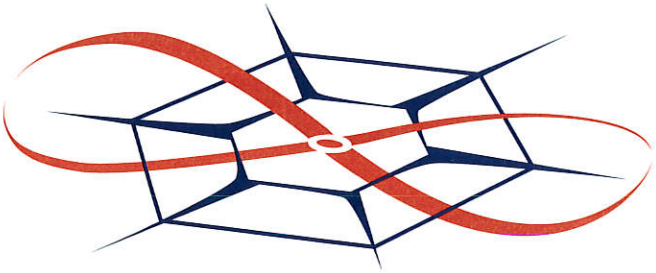
25 Mb/s Wireless System



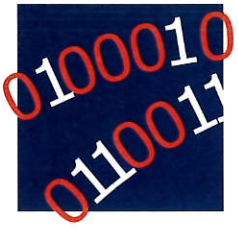
40 Gb/s
WDM
Lightwave
System

I-37

Information and Telecommunication Cent

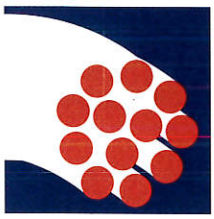


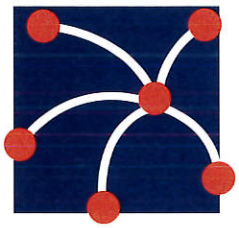
Research, Development a Transfer of Advanced Information and Telecommunication Technologies



Intelligent Systems & Information Management —
emphasizes the application of advanced, intelligent methodologies as applied to solving problems in information identification, retrieval, analysis, and fusion.

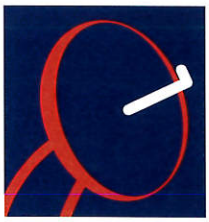
Lightwave Communication Systems —
explores new lightwave technologies, with the aim of increasing the capacity and reliability of commercial lightwave communication networks.





Networking and Distributed Systems —
aims at developing innovative networking and system technologies, understanding their behavior, and improving their performance.

Radar Systems and Remote Sensing —
develops, evaluates, and applies new radar systems and other related sensing technologies for remote sensing of the land, sea, ice, and atmosphere.



Wireless Communications & Digital Signal Processing —
focuses on software radio signal processing algorithms, adaptive beamforming, spread spectrum, and code division multiple access communications.

Software Prototyping and Toolkits —
uses Center expertise in communications, networking, modelling, simulation, intelligent systems, and information management, to develop and apply commercially viable software and toolkits.

The University of Kansas

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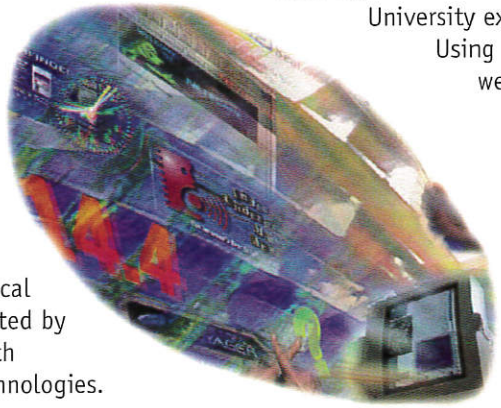
Information and Telecommunication Technology Center

The Information and Telecommunication Technology Center (ITTC) is a University of Kansas based research Center that performs advanced research, development, and transfer of new technologies in the areas of transmission systems, including fiber-optic and wireless communications; digital-signal processing; communications networking; intelligent systems; distributed systems; information management; and radar systems and remote sensing.

Utilizing the resources of the University and the experience of the faculty, staff, and students, the Center has the capability to research and deliver high-tech solutions in critical technology areas. The Center is broadly supported by industry and by Federal and State programs, with research often leading to investment-grade technologies.

Working with Industry



ITTC is dedicated to the principle of a private/public partnership. We work with regional and national companies of varying sizes to leverage University expertise to investigate and solve problems. Using licensing and sponsored research agreements, we can provide a flexible environment to help businesses increase their competitive advantage.

Utilizing state-of-the-art equipment and world-renowned engineering faculty, the Center can provide unique opportunities for businesses to take advantage of the abilities of some of the leading researchers and developers in their fields.

Affiliated Faculty and Investigators

Arvin Agah: applied artifical intelligence, intelligent agents technology, robotics, human-intelligent system interaction.

Christopher Allen: radar systems, microwave engineering, high-speed digital circuits, fiber optics.

Michael Ashley: programming language design and implementation.

Swapan Chakrabarti: neural networks, advanced spectral estimation techniques, computer architecture.

Kenneth Demarest: microwave engineering, radar, electromagnetic theory, antennas, lightwave communication systems.

Joseph B. Evans: high performance (gigabit) networks, mobile networking, digital signal/speech processing, special-purpose computer architecture, VLSI implementations.

Victor Frost: high performance networks, network measurement, modeling, control and simulation.

John M. Gauch: computer graphics, image processing, computer vision.

Susan Gauch: corpus linguistics, information retrieval, multimedia, distributed information sources.

Prasad Gogineni: radar systems, RF and microwave engineering, radar remote sensing, microwave radiomaters.

Jerzy Grzymala-Busse: data mining, knowledge discovery, machine learning, expert systems, reasoning under uncertainty, rough set theory.

Rongqing Hui: high speed optical transport, WDM optical systems.

Tim Johnson: communications, digital signal processing, management of software development and technology-based intellectual property.

Gary J. Minden: MAGIC Testbed, wide area distributed systems, mobile communication systems, adaptive computational systems, active networking.

Richard K. Moore: radar systems, radar remote sensing, radio wave propagation, radar oceanography, microwave radiometers.

Douglas Niehaus: high performance networks, network performance evaluation tools, real-time systems, operating systems.

Karen J. Nordheden: plasma processing of semiconductors, fabrication of GaAs-based high electron mobility transistors and microwave integrated circuits.

David W. Petr: high-speed, wide-area networks; network traffic and congestion management; traffic integration for networks; performance analysis and simulation.

Glenn E. Prescott: spread spectrum systems and military tactical communication radios and systems, software radio systems, application of FPGAs to DSP, design and implementation of wireless communication systems.

James Roberts: wireless communication systems, CDMA and spread spectrum systems, coding and information theory.

W. M. Kim Roddis: applications of artificial intelligence to civil and structural engineering; design of computer-aided tools for civil engineering; qualitative, quantitative, and causal reasoning.

K. Sam Shanmugan: wireless communication systems, simulation and analysis of communication systems, signal analysis, smart antenna systems, adaptive communication systems.

James M. Stiles: radar, microwave engineering, antennas, array processing.

Costas Tsatsoulis: multiagent systems, data mining, case-based reasoning, knowledge-based systems, intelligent image analysis.

Victor. L. Wallace: interactive graphics, virtual reality, and human interface design; distributed and real time systems (scheduling and load distribution policies); computer network performance modeling, ATM traffic analysis models; operating systems theory; queuing theory.

Center Facts

- Over $2.5 million/year in Center expenditures.
- 25 Faculty, 23 Core Staff, 130 Students.
- High-speed networking lab with a 2.4 Gb/s SONET connection; DSP and digital radio lab; integrated, diverse networking environment; leading-edge lightwave research lab; fully equipped radar and remote sensing facility.
- BONeS Designer®, SPW™.
- CORBA, C++, Java, Lisp.

Information and Telecommunication Technology Center

2291 Irving Hill Road, Lawrence, KS 66045-2969

Telephone: 785-864-4896 • Fax: 785-864-0387 • http://www.ittc.ukans.edu • info@ittc.ukans.edu

A KTEC Center of Excellence at The University of Kansas Center for Research, Inc. (CRINC)

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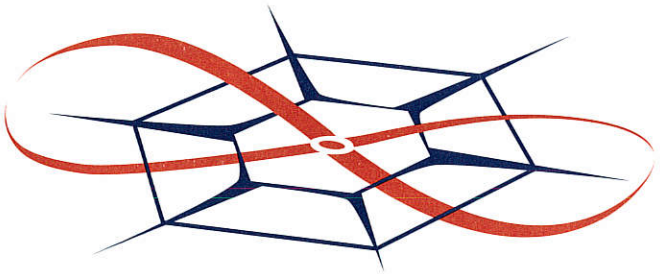
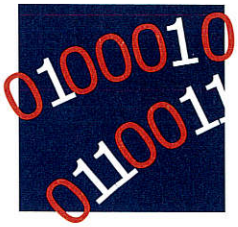
Information and Telecommunication Technology Cent



Research, Development a
Transfer of
Advanced Information and
Telecommunication
Technologies

Intelligent Systems & Information Management

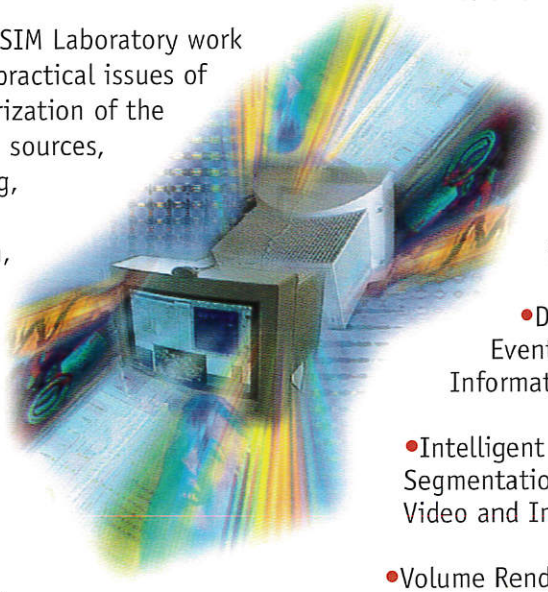
- » Artificial intelligence
- » Information retrieval
- » Intelligent agents
- » Data mining
- » Digital and video libraries
- » Knowledge-based systems
- » Information presentation
- » Image processing and computer vision
- » Human-intelligent systems interactions
- » Applied artificial intelligence
- » Robotics



The University of Kansas

Intelligent Systems & Information Management Laboratory

The ISIM Laboratory studies theoretical and application issues of artificial intelligence, intelligent agents, information retrieval from distributed and heterogeneous sources, and data mining. Most of our applications are related to information retrieval, presentation and management.



The researchers in the ISIM Laboratory work on the theoretical and practical issues of the automatic characterization of the contents of information sources, intelligent query routing, softbots, information fusion and visualization, video indexing, discovery of knowledge in very large databases, learning of user profiles, collaborative patterns of information seeking agents, and anticipation of the user's information needs in a dynamic, distributed data environment.

Project Areas

ISIM researchers are currently involved in research projects that concentrate on the creation of an intelligent information environment. Examples of the funded research projects undertaken include the following:

- Agent-Based Intelligent Information Dissemination; Learning User Information Profiles; Intelligent Agents for Information Discovery; Automated Characterization of Information Sources; Learning Coherent Behavior in Multiagent Systems; Adaptive Agent Systems; Corpus Linguistics for Information Retrieval.
- Data Mining of Very Large Databases of Catastrophic Events; KDD for Image Content Mining and Segmentation; Informatics Tools and Medical Prenatal Knowledge Building.
- Intelligent Classification of Remotely Sensed Images; Temporal Segmentation of Video Sequences; Content-Based Searching of Digital Video and Image Libraries.
- Volume Rendering; Stereo Visualization; Multisensor Data Fusion.
- Performance of CORBA-Based Agent Systems; Systems-Level Implementation of Physically Distributed Agent Systems.

Affiliated Faculty and Investigators

Arvin Agah: applied artificial intelligence, intelligent agents technology, robotics, human-intelligent system interaction.
John M. Gauch: image processing, computer vision, computer graphics, data fusion, video segmentation, motion analysis.
Susan Gauch: corpus linguistics, information retrieval, multimedia, distributed information sources.
Jerzy Grzymala-Busse: data mining, knowledge discovery, machine learning, expert systems, reasoning under uncertainty, rough set theory.
Douglas Niehaus: high performance networks, network performance evaluation tools, real-time systems, operating systems.
W. M. Kim Roddis: applications of artificial intelligence to civil and structural engineering; design of computer-aided tools for civil engineering; qualitative, quantitative, and causal reasoning.
Leen-Kiat Soh: intelligent image interpretation, image processing, clustering and segmentation, data mining, applied artificial intelligence.
Costas Tsatsoulis: multiagent systems, data mining, case-based reasoning, knowledge-based systems, intelligent image analysis.
Oscar Waddell: programming languages, optimizing compilers, runtime systems, partial evaluation, dynamic specialization.

Laboratory Capabilities

- Multiagent development tools:
  CORBA, C++, ACCS, Java, MAGE
- Information retrieval and Web tools:
  KUIR Information Retrieval Library
- Data mining tools:
  SNOB, Cobweb, ID3, C4.5, statistical analysis packages, LERS
- Artificial intelligence development tools and languages:
  Lisp, CLOS, CLIPS, Prolog, GBB, OPS, MEM-1
- Image processing and computer vision tools:
  KUIM Image Processing Library
- Human-intelligent system interaction tools:
  Mobile robots, VR user interface, head mounted display, force feedback joysticks

Dr. Costas Tsatsoulis, Intelligent Systems & Information Management (ISIM) Laboratory

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Information and Telecommunication Technology Cent

Research, Development a
Transfer of
Advanced Information and
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Technologies

Lightwave Communication Systems

» Lightwave systems

» Wavelength division multiplexing (WDM)

» Performance prediction of lightwave systems

» Solitons

» Polarization-mode dispersion (PMD)

» Electromagnetics

» Photonics

The University of Kansas

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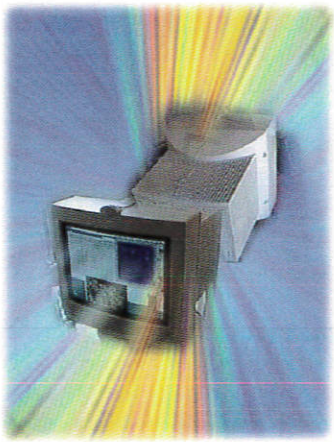
Lightwave Communication Systems Laboratory

The thrust of the Lightwave Communications Laboratory is to explore new lightwave technologies and determine their impact on future optical communication networks. These technologies are examined from two points of view. The first is the photonic properties of these technologies, including issues such as cost, speed, and reliability. The second is the impact of these technologies on the network flexibility and protocols of existing optical networks. By merging these two points of view, the Lightwave Communications Laboratory evaluates these new technologies from the standpoint of total network performance, including both the hardware and networking aspects of these systems.



Lightwave Communications Laboratory boasts a state-of-the-art measurement facility that is capable of examining device and network characteristics of state-of-the-art optical components and networks. It also contains an analytical modeling facility, capable of performing numerical component and network performance studies. Technologies that are currently under investigation by the Lightwave Communications Laboratory include wavelength division mutiplexing (WDM); high-speed, time-domain multiplexing (TDM); and photonic switching.

Project Areas

Research projects undertaken by the Lightwave Communication Systems Laboratory pertain to several aspects of optical communications. These include the study of fiber optic communications systems, with an emphasis on increasing capacity utilization of long-distance lightwave communications networks; experimental studies including wavelength divison multiplexing (WDM), solitons, photonic switching, all-optical clock recovery, and polarization-mode dispersion (PMD); and fiber optic link performance prediction through numerical simulations including fiber (attentuation, dispersion, nonlinearities), lasers, modulators, optical amplifiers filters, and detectors.

Affiliated Faculty and Investigators

Christopher Allen: radar systems, microwave engineering, high-speed digital circuits, and fiber optics.

Kenneth Demarest: microwave engineering, radar, electromagnetic theory, antennas and lightwave communication systems.

Joseph B. Evans: high performance (gigabit) networks, mobile networking, digital signal/speech processing, special-purpose computer architecture, and VLSI implementations.

Victor Frost: high performance networks, network measurement, modeling, control and simulation.

Rongqing Hui: high speed optical transport and WDM optical systems.

Gary J. Minden: MAGIC testbed, wide area distributed systems, mobile communication systems, adaptive computational systems, and active networking.

Laboratory Resources

- The Lightwave Laboratory is equipped with modern lightwave equipment:
  - spectrum analyzer
  - tunable sources and filters
  - 12Gb/s BERT
  - modulators, multiplexers, demultiplexers
  - photodetectors
  - etc.
- Commercial WDM systems (complete with 360 km of fiber), have been installed for systems level testing.

Dr. Kenneth Demarest or Dr. Christopher Allen, Lightwave Communication Systems (LCS) Laboratory

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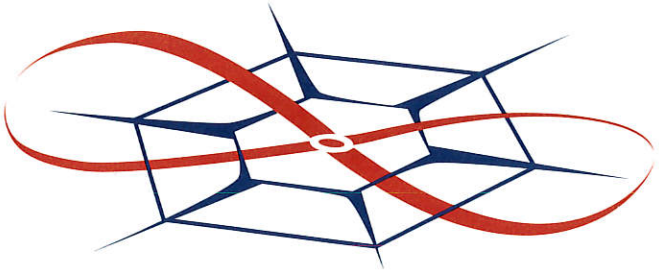

Research, Development a
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Networking & Distributed Systems

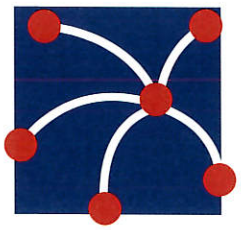
» **Distributed performance measurement and modeling**
- tools, analysis techniques, and simulation models
- accurate performance prediction

» **Network control and management systems**
- self-configuring networks
- signalling systems
- protocols

» **Integration of wireless networks**
- architectures & protocols
- reliability and robustness
- ubiquitous and ad-hoc systems

» **High capacity network systems**
- study, implementation, and integration of multiple network types at multiple levels
- integration of optical networking systems

» **Distributed network services**
- active networking
- routing
- management and control functions



The University of Kansas

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Networking & Distributed Systems Laboratory

The Networking & Distributed Systems Laboratory (NDSL) performs research on innovative high performance networks and systems with a particular emphasis on the areas of performance measurement, modeling, and improvement, network control and signalling, and integration of lightwave and wireless technologies into systems. NDSL engages in experimental studies, enabled by its unique interconnection to several wide area testbeds, as well as analytical and simulation work on the behavior of networks and systems focussing on performance and scalability issues. Work on the control of networks includes the development of active networks, off-board signaling platforms, and other innovative control and signaling architectures. With the support of other ITTC laboratories, NDSL develops strategies and implementations for the integration of both lightwave and wireless technologies into system-level solutions. In the course of NDSL investigations, both hardware and software implementations are developed, designed, and tested in prototype networks.

Project Areas

NDSL has many funded research projects that cover many different areas in networking and systems. These include involvement in the MAGIC gigabit network and the ACTS ATM Internetwork testbed, both of which focus on high performance wide area networking research.

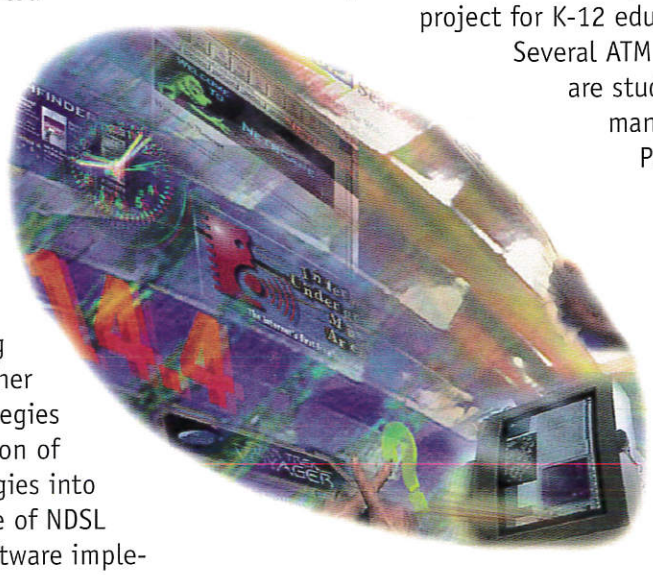
Early work on the Web was performed as part of the UNITE project for K-12 educational resource delivery.

Several ATM and TCP/IP networking projects are studying diverse areas such as traffic management, signalling, and control.

Performance benchmarking and measurement collection are being pursued in several projects.

NDSL also has long experience in network modelling and simulation, with several ongoing projects.

Collaborative projects with other ITTC laboratories involve various wireless and optical networking topics.



Affiliated Faculty and Investigators

Joseph B. Evans: high performance (gigabit) networks, mobile networking, digital signal/speech processing, special-purpose computer architecture, VLSI implementations.

Victor Frost: high performance networks, network measurement, modeling, control and simulation.

Jason Keimig: high performance IP networking, IP routing architectures, IP/ATM integration, system-level design/implementation, TCP evaluation/performance, distributed/object-oriented programming.

Gary J. Minden: MAGIC testbed, wide area distributed systems, mobile communication systems, adaptive computational systems, active networking.

Douglas Niehaus: high performance networks, network performance evaluation tools, real-time systems, operating systems.

David W. Petr: high-speed, wide-area networks; network traffic and congestion management; traffic integration for networks; performance analysis and simulation.

Laboratory Capabilities

- Extensive high-speed networking infrastructure
  - connected to high speed wide area networks
  - MAGIC backbone connection at 2.4 Gb/s
  - AAI testbeds for coast-to-coast experimentation
  - wide variety of switches and network interfaces
- Hardware and software design experience
  - developed:
    - 622 Mb/s ATM switch hardware
    - network testing and measurement tools
    - network simulation and modeling tools
    - early web applications and servers
  - integrated wireless, mobile systems with fixed networks.
- BONeS Designer®, SPW™

Dr. Joseph Evans, Networking and Distributed Systems (NDS) Laboratory

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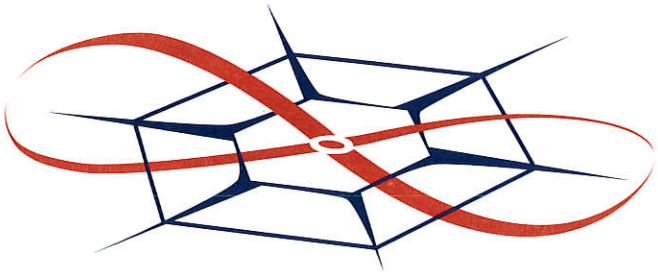

Research, Development a
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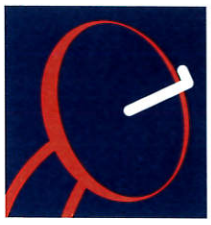
Radar Systems and Remote Sensing Laboratory (RSL)

- » Ice-sounding radar
- » Ground-penetrating radar
- » Oceanographic radar
- » Scanning radiometer system analysis
- » Synthetic-aperture radar system analysis
- » RF and microwave engineering
- » Radar data analysis



The University of Kansas

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Radar Systems and Remote Sensing Laboratory

Since 1964, the Radar Systems and Remote Sensing Laboratory (RSL) has been

- educating engineers and future leaders in the area of radars, microwaves, communications, and remote sensing techniques for the 21st Century;
- exploring new ways to use electromagnetic waves in the remote sensing of the land (surface and subsurface), sea, polar ice, and the atmosphere;
- producing new remote sensing sensors (primarily radar); and
- developing new methods for solving electromagnetic problems.

To accomplish these goals, a broad range of laboratory activities is involved, including sensor development, data collection, data analysis and modeling, and data dissemination. Remote sensing areas where RSL has made significant contributions through the years include remote sensing of the ocean, atmosphere, sea ice, polar ice sheets, vegetation, soil moisture, subsurface, and snow.

Project Areas

Ice-sounding radar: mapping of polar ice sheet thickness, outlet glacier profiles, and internal layering features in support of global climate change research.

Ground-penetrating radar: detection of anti-personnel land mines and detecting and mapping subsurface contaminants.

Oceanographic radar: mapping surface wind fields and rain events for climate models, and local surface slope for oceanographic research.

Synthetic-aperture radar systems: design of spacebased SAR systems, data processing techniques, and image analysis techniques.

RF and microwave engineering: development of novel RF signal generation and signal processing systems, antenna systems, and data collection systems for various remote sensing applications.

Radar data analysis: reduction of raw radar signal data to extract information on target characteristics.

Affiliated Faculty and Investigators

Chris Allen: radar systems, microwave engineering, high-speed digital circuits, fiber optics.

Kenneth Demarest: microwave engineering, radar, electromagnetic theory, antennas, lightwave communication systems.

Prasad Gogineni: radar systems, RF and microwave engineering, radar remote sensing, microwave radiometers.

Richard K. Moore: radar systems, radar remote sensing, radio wave propagation, radar oceanography, microwave radiometers.

Glenn Prescott: spread spectrum systems, military tactical communication radios and systems.

James Stiles: radar, microwave engineering, antennas, array processing.

Laboratory Capabilities

- Radars with operating frequencies from 150 MHz to 35 GHz
- 40 GHz network analyzer
- 22 GHz spectrum analyzer
- 20 GHz frequency synthesizer
- High-speed oscilloscope
- Field-programmable logic
- Antenna measurement range
- Variety of high-end workstations and personal computers

Radar Systems and Remote Sensing Laboratory (RSL)
Telephone: 785-864-4835 • Fax: 785-864-7789

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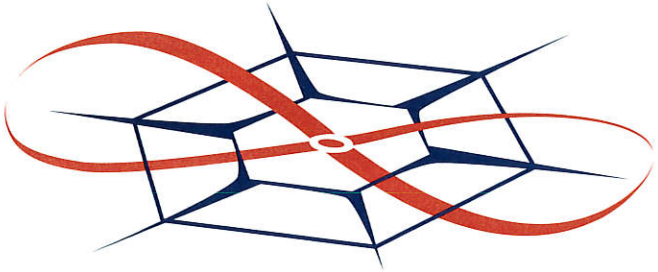

Research, Development a
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Wireless Communications & Digital Signal Processing

» Software radio systems

» Communication and radar applications of DSP

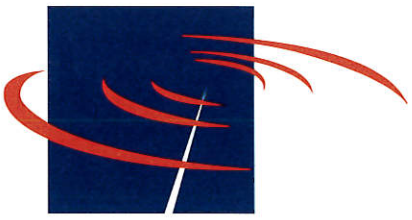
» FPGA applications for DSP

» Wireless CDMA

» Spread spectrum systems—commercial and military

» Radio system implementation—analog and digital

» RF system design



» Smart antennas

» Communication system simulation and analysis

The University of Kansas

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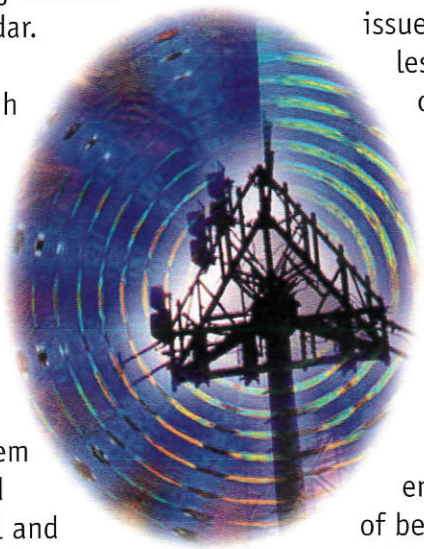
Wireless Communications & Digital Signal Processing Laboratory

The Wireless Communications and Digital Signal Processing Laboratory is established to serve as a focal point for collaborative research on wireless communication, and the innovative application of signal processing technology to communications and radar. The emphasis is on theoretical investigation supported through implementation, test, and measurement. The principal areas of research are software radio systems; radio system implementation—analog and digital; RF system design; communication and radar applications of DSP; smart antennas; communication system simulation and analysis; spread spectrum systems—commercial and military; wireless CDMA; and FPGA applications for DSP.



Project Areas

Research projects in the Wireless and DSP Laboratory pertain to the investigation of a variety of communication link level issues. Projects include simulation and analysis of wireless communication links, design and implementation of RF channel simulators, the implementation and testing of wireless communication systems, rapidly deployable radio networks, spread spectrum radio detectability and vulnerability, smart antenna systems, and the design and testing of software radio algorithms using field programmable gate arrays and other advanced DSP hardware. Of special interest is the application of RF hardware and advanced DSP technology to make communication systems more robust and adaptive to their environment. Recent projects include an investigation of beamforming transmitters and receivers and the implementation of interference excision algorithms using field programmable gate arrays.

Affiliated Faculty and Investigators

Michael Ashley: programming language design and implementation.
Swapan Chakrabarti: neural networks, advanced spectral estimation techniques, computer architecture.
Joseph B. Evans: high performance (gigabit) networks, mobile networking, digital signal/speech processing, special-purpose computer architecture, VLSI implementations.
Victor Frost: high performance networks, network measurement, modeling, control and simulation.
Gary J. Minden: MAGIC Testbed, wide-area distributed systems, mobile communication systems, adaptive computational systems, active networking.
Doug Niehaus: high performance networks; computer system and network evaluation; distributed, operating, and real-time systems; hardware-software co-design; device drivers; high performance network simulation.
Glenn E. Prescott: spread spectrum systems and military tactical communication radios and systems, software radio systems, application of FPGAs to DSP, design and implementation of wireless communication systems.
James Roberts: wireless communication systems, CDMA and spread spectrum systems, coding and information theory.
K. Sam Shanmugan: wireless communication systems, simulation and analysis of communication systems, signal analysis, smart antenna systems, adaptive communication systems.
James M. Stiles: radar, microwave engineering, antennas, array processing.

Laboratory Resources

- Oscilloscopes and function generators
- RF signal generators
- High-speed workstations
- Logic analyzers
- Network analyzers
- Spectrum analyzers
- Field programmable circuit cards (APTIX)
- DSP rapid prototyping system
- Variety of DSP platforms and evaluation boards
- Prototype PC board fabrication tools

Dr. Glenn Prescott, Wireless Communications & Digital Signal Processing (WDSP) Laboratory

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The Link

NEWS FROM Information and Telecommunication Technology Center

August 1998 ■ Vol. 1, Issue 3

Working with Companies—Size Doesn't Matter

Sprint is an international telecommunications company that utilizes the services of the Information and Telecommunication Technology Center for research.

Accelerated Care Plus is a small Topeka company that sought ITTC's assistance in developing a software system targeted to the delivery of clinical program services.

Worldwide Broadcasting Network, located in Cambridge, Mass., has discovered new marketing avenues for an ITTC-developed product known as VISION.

The common thread to each of these stories is ITTC's adaptability in working with any size company that is seeking information and telecommunication research, development, or technology transfer. In each case, the Center checked off the following criteria: Does the project fit ITTC's technical focus? Is there an opportunity for university, State, Federal or industry partnership? Is there opportunity to transfer the technology to industry? Is the project beneficial to Kansas? Does the project enhance the educational and research experiences of those associated with ITTC?

When the answer is yes to these criteria, the nuts and bolts of the project probably will connect.

Sprint has been coming to the University for more than 10 years to fund sponsored research, to which Sprint retains rights. "Sprint has us working on ideas that are maybe five years out there," according to Dr. Victor Frost, acting director of the Center. "They also have found great worth in the connection with our students, and hire many of them."

With Accelerated Care Plus, ITTC engineers designed the Remote Therapist Support System from the ground up, meeting the company's specifications. This included the development of the user interface, the communications link, and the database. Once the project was completed, it was licensed to Accelerated Care Plus in 1997.

Vision, licensed to the Worldwide Broadcasting Network in 1997, was developed by KU faculty with support from ITTC. It's a smart search technology that makes creating customized information channels simple and efficient. It allows users to get video clips from breaking news, market reports, etc., by using key search words or terms. Professors John and Susan Gauch of the KU Engineering Dept. were the principal investigators on the project.

All three methods of working with companies present different challenges and opportunities to the Center as they satisfy a variety of needs for the companies themselves. ■

ITTC Receives FY99 Funding

The Information and Telecommunication Technology Center received core funding of $720,000 for FY 1999 from the Kansas Technology Enterprise Corporation. ITTC is a KTEC Center of Excellence, and funding is based on an annual review of the Center's accomplishments in the development of new technologies, and the Center's success in leveraging State and Federal funds for research and development. Approximately $100,000 of the funding is earmarked for the Johnson County MAMTC office operations.

In FY 1998, the Center leveraged KTEC funding with approximately $4 million in funding from industry, the Federal Government, and the University. The Center's FY 1999 budget is expected to be over $5 million.

Accomplishments for FY 1998 included initiation of 10 new projects and follow-on funding for eight current projects; receipt of four new Federally funded research projects; and attraction of four new industry-funded research projects, three of which are agreements with Kansas companies.

The Center continues to forge successful relationships with the private sector. Two recent grants, from large private-sector telecommunications companies, total $750,000. This funding is earmarked for sponsored research in the Lightwave Communications Laboratory. ■

Director's News

Successful Fiscal Year 1998!

Fiscal year 1998 was a great one for ITTC, and we're looking forward to FY 1999.

When you consider the reorganization of the Center and the flurry of new activities we've had during the past 12 months, I find it gratifying that our list of accomplishments is lengthy.

In administrative and operational issues, for the first time our Center received about 4% of its income from royalties and license fees. We also created an industry advisory board, which met twice and participated in developing a vision and mission for the Center as well as providing input on research directions.

In Center "outcomes," ProFusion, a technology developed by Dr. Susan Gauch, Associate Professor of electrical engineering and computer science, with investment by the Center, received national recognition by *PC Magazine* as the best metasearch engine. Several other technologies developed at the Center have made great strides toward commercialization as well.

With reference to the future, an important recent event for the Center was the laying of dedicated fiber between our laboratories and the Sprint corporate offices in Overland Park. This connection sets the stage for impressive information technology research in the future. In other research areas, we have expanded dedicated staff who will initiate new research and development to begin refilling the commercialization pipeline.

As we begin FY 1999, I'm encouraged by the new projects we soon will have under way. New partnerships with industry and the Federal government will fuel development and future "tech" transfer activities in information technology and telecommunications. We also look forward to promoting our Affiliates Program with industry to help support students and Center activities that are of a general interest to the industry.

"When you consider the reorganization of the Center and the flurry of new activities we've had during the past 12 months, I find it gratifying that our list of accomplishments is lengthy."

Victor S. Frost
Dan F. Servey Distinguished Professor of EECS
Acting Director of ITTC ■

How ITTC Works with Companies

Although the Center is growing in scope and capacity, our project selection continues to be focused on quality rather than quantity of projects. We want to work on projects that offer the greatest opportunity to advance knowledge, and to develop and transfer technologies.

Just to give you a brief overview, we find that working with companies in the private sector falls into two categories. There are the projects that are R&D, where the company seeks answers to specific questions. In this situation, the company pays full costs through a sponsored research agreement.

There are also projects where the company seeks the expertise of the Center to help develop a technology. In those situations, the company may enter into a joint development partnership with ITTC where the company and ITTC share in the risk and rewards associated with the effort. In this case, the ITTC-developed technology is licensed back to the company; and hopefully, both the company and the Center will reap financial rewards down the road.

Every project is different, although the initial project selection process follows the same track. We like to meet with the company to discuss what their expectations are, and explain what the Center's expectations are. We like to examine the resources required, and talk about timelines and feasibility. We also have to discuss other items such as cost estimates, how the intellectual property will be handled, and what the mechanism will be for technology transfer to the company.

Once these issues are agreed upon, the next steps are to develop the project description, negotiate the project agreement, and begin the work.

These discussions can occur very quickly or may take several months; every project is different. Our goal is to meet the expectations of the company within our technical areas of expertise and available resources.

If you are interested in learning more about ITTC and how we work with companies, call Tim Johnson, ITTC Director of Operations, 785-864-3442. ■

Refurbished Website

Over the past several months, ITTC has expanded and updated its Website to include project information, technology information, newsletters, press releases and other news items, and extensive personal contact information.

If you're a company interested in working with ITTC, you'll find a wealth of information on how we work with companies and how to initiate the first move.

Check us out at <http://www.ittc.ukans.edu> ■

Staff, Postdoctoral Changes at ITTC

Two long-time staff members at ITTC have chosen new employment opportunities and left the Center this summer. **Scott Woodward**, a systems engineer with the Center for more than six years, has taken a position as Systems Engineer/Product Manager with Accelerated Care Plus in Topeka. **Cathy Ambler**, the Center's Assistant Director of Technology Transfer for nine years, has accepted a position as Assistant Director of the Cultural Resources Division at the Kansas Historical Society, Topeka.

Mike Hulet joined the ITTC Staff as a computer systems administrator on July 1. Hulet holds a Bachelor of Science degree in electrical and electronic engineering from North Dakota State University and a Master of Science degree in systems management from the University of Southern California. He most recently was employed as an electronics engineer for the Naval Warfare Assessment Div. in Riverside, CA.

In addition, the Center has hired three new individuals in postdoctoral research positions:

Ben Zhu. An interest in optical fiber communications led Zhu first from China to England and then from England to ITTC to continue his postdoctoral research in February 1998. He received his bachelor's and master's degrees in physics from East China Normal University in Shanghai. He received his Ph.D. in opto-electronics from Bath University in Bath, England. He did postdoctoral research at Bath University and the University of Bristol in Bristol, England, as well.

At ITTC, Zhu is doing research in the area of high-speed optical fiber communications systems. He has authored or co-authored more than 20 technical papers in leading international journals and conferences.

Leen-Kiat Soh. Originally from Malaysia, Soh came to the University of Kansas because his older siblings were attending classes here. After receiving a Bachelor of Science degree with Highest Distinction in Electrical Engineering, Soh studied for a Master's degree in electrical engineering and then pursued a Ph.D. in electrical engineering. He received his Ph.D. degree with Honors this spring.

Soh joined the team at ITTC as a research scientist, working with Associate Professor Costas Tsatsoulis in the Intelligent Systems and Information Management Laboratory. His doctoral thesis work focused on using image processing and machine learning methodologies to perform automated segmentation on satellite sea ice imagery. His research interests are data mining, image processing, computer vision, machine learning, and expert systems.

As post-ITTC work, Soh hopes to teach at the university level and continue to be involved in research. Currently, he is working with several faculty members on grant proposal writing in digital libraries, in addition to collaborating with researchers from other centers on sea ice classification.

Kumar ("Vijay") Peddanarappagari. Although you can never be quite sure who will pick up on your advertising, it's a good thing that Vijay noticed an ad on ITTC and followed up on it shortly thereafter. It led him to one of the few postdoc positions nationwide with a Lightwave Communications Laboratory.

Vijay has a Bachelor of Science degree in electronics and communication engineering from Osmania University, India. He completed his Master's and Ph.D. work in electrical engineering at the University of Virginia, Charlottesville. Currently he's a research assistant engineer, assisting students in their master's thesis topics and coordinating work in the lightwave laboratory.

Once Vijay completes his postdoc work with ITTC, he hopes to move into private industry and specialize in design. ■

SPARTAN Symposium Well Attended

More than 100 information technology professionals attended the Second Annual Sprint Applied Research Partners Advanced Networking (SPARTAN) Symposium, held May 19-20 at ITTC. The two-day meeting, organized by Sprint and ITTC, featured presentations by a mix of presenters from the public and private sectors. In addition to presenters from KU, individuals represented Harvard University, UCLA, Brigham Young University, Purdue University, the Naval Research Laboratories, and major companies such as Lucent, NEC America, and Sprint.

Dr. Victor Frost, acting director of ITTC said, "The high level of interest in this area is directly related to the growth of the Internet, which is necessitating rapid advances in wide area network technology. Fortuitously, it is happening at the same time that the communications industry is aggressively deploying a new technology called 'wave-length division multiplexing.'"

He explained that as recently as four years ago, fiber optic cable carried only one color of wavelength, which transported 37,500 calls at once. Today that same fiber can carry 8, 16, and 64 wavelength colors and up to 150,000 calls per color. "A lot of our discussion centered on building efficient networks using new technologies to support the transfer of the ever-increasing volume of information."

Papers presented at the symposium can be accessed via the ITTC home page: www.ittc.ukans.edu/. ■

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Center Selects New Projects for Funding

Research proposals seeking internal funding by ITTC were reviewed in May and awarded in July. Four projects were selected for funding and will get under way late this summer. Principal Investigator (PI) Susan Gauch will develop an information retrieval system that can query a collection of Web pages relative to a specific time or time frame.

PI John Gauch will develop a fully-automated television commercial analysis system for detecting and identifying commercials in television signals.

PI John Gauch also will continue a project that explores the development of an efficient client/server for browsing video databases. This project was first funded in 1997.

PI Costas Tsatsoulis will continue development of intelligent agents that relieve users of low-level administrative and clerical tasks. This project was first funded in 1997. ■

MAGIC II Demo Completed with DARPA

Nearly 30 participants from the public and private sectors were on hand July 14 and 15 to participate in the MAGIC II demo in Nichols Hall. The ITTC component of MAGIC II provides an environment for experimenting with mobile wireless access to broad band services. In its second phase, MAGIC II is funded by DARPA (Defense Advanced Research Projects Agency) with support from Sprint. Principal Investigators (PI's) on the project include Victor Frost, ITTC Acting Director, Gary Minden Chief Technologist for the Center, Joe Evans, Director of the Wireless Communications and Digital Signal Processing Laboratory, and ITTC affiliated faculty member Doug Niehaus. ■

SPTA Sponsors Technology of the Year Award

The Fifth Annual Technology of the Year Awards will be hosted by the Silicon Prairie Technology Association on November 10 in Kansas City. Submissions are currently being sought from individuals or companies who have an innovative technology product developed in Kansas or Missouri. There are five categories for nominations: BioScience, Consumer Technology, Electronics, Information Technology, and General.

The deadline for nominations is August 28, 1998. To receive a nomination form, contact SPTA at 816/221-0555. ■