

Cooperative Research with Industry

Outputs

- PC-based tools that measure the quality of audio and video signals that have been transmitted through a telecommunications system.
- Measurements defining the electromagnetic environment near military and air-traffic control radar facilities.
- Characterization of the antenna pattern of a narrow beam antenna.

The Technology Transfer Act of 1986 (FTTA), as amended, allows Federal laboratories to enter into cooperative research agreements with private industry, universities, and other interested parties. The law was passed in order to provide laboratories with clear legal authority to enter into these arrangements and thus encourage technology transfer from Federal laboratories to the private sector. Under this Act, a cooperative research and development agreement (CRADA) can be implemented that protects proprietary information, grants patent rights, and provides for user licenses to corporations, while allowing Government expertise and facilities to be applied to interests in the private sector.

ITS participates in technology transfer and commercialization efforts by fostering cooperative telecommunications research with industry where benefits can directly facilitate U.S. competitiveness and market opportunities. ITS has participated for a number of years in CRADAs with private sector organizations to design, develop, test, and evaluate advanced telecommunication concepts. Research has been conducted under agreements with Bell South Enterprises; Telesis Technology Laboratories; US WEST Advanced Technologies (US WEST); Bell Atlantic Mobile Systems; GTE Laboratories Inc.; US WEST New Vector Group; General Electric Company; Motorola Inc.; Hewlett-Packard Company (HP); Integrator Corporation; AudioLogic, Inc.; Industrial Technology, Inc.; Netrix Corporation; Lucent Technologies; ARINC; Lehman Chambers; Lucent Digital Radio; Intel Corporation; and the American Automobile Manufacturers Association (AAMA). Not only does the private industry partner benefit,

but the Institute is able to undertake research in commercially important areas that it would not otherwise be able to do. Recent CRADAs are described below.

- Intel Corporation and ITS have entered into a CRADA to conduct cooperative research and development in the area of telecommunications and multimedia for development of test equipment and products. The areas of interest include subjective and objective video quality, subjective and objective audio quality, and wireless communications.
- ITS is conducting a CRADA with AAMA to collect field data that will define the electromagnetic environment at specific locations in the United States. As electronic devices proliferate, it becomes important for the motor vehicle industry to have knowledge of the electromagnetic environment in which vehicular electronics will operate. Of specific interest are electromagnetic environments near military and air-traffic control facilities using radars. This knowledge is essential to the development of future automotive electronics.
- ITS has been a premier laboratory in millimeter-wave research for two decades. Now ITS is applying this unique expertise while conducting research into radio propagation considerations for local multipoint distribution service (LMDS). ITS has initiated CRADAs with HP and Lucent Technologies for LMDS research. Under these agreements, ITS has developed propagation models for the LMDS channel, conducted field measurements to characterize radio frequency propagation of an LMDS system, and developed a three-dimensional signal coverage map of the area of interest for LMDS transmission. The field measurements use an innovative ITS-developed impulse response measurement system called a digital sampling channel probe. This system allows measurement of the complex-valued radio channel impulse response, and is ideally suited for making outdoor impulse response measurements.



ITS Video Quality Assessment System (photograph by F.H. Sanders).

- Lucent Technologies, Bell Laboratories, and ITS have entered into a CRADA to characterize the antenna pattern of a narrow beam antenna supplied by Bell Laboratories. Future work will verify the operation of this antenna in a variety of environments. The data obtained will be used in planning further measurements to determine channel characteristics of fixed wireless loop communication systems.
- Lucent Digital Radio and ITS entered into a CRADA to conduct research on a digital audio broadcasting (DAB), in-band on-channel (IBOC) radio system. The IBOC system permits the simultaneous transmission of a digital signal and an analog signal within an AM and FM station's current spectral allocation. DAB will have the capability to provide higher-quality audio than is currently available from existing analog FM and AM broadcasting. ITS served as an objective evaluator during testing of this system.

Cooperative research with private industry has helped ITS accomplish its mission to support industry's productivity and competitiveness by providing

insight into industry needs. This has led to adjustments in the focus and direction of other Institute programs to improve their effectiveness and value.

ITS is interested in assisting private industry in all areas of telecommunications. The pages of this technical progress report reveal many technological capabilities that may be of value to various private sector organizations. Such organizations are encouraged to contact ITS if they believe that ITS may have technology that would be useful to them. Because of the great commercial importance of many new emerging telecommunication technologies, including PCS, wireless local area networks, digital broadcasting, LMDS, and intelligent transportation systems, ITS plans to vigorously pursue technology transfer to the private sector through CRADAs and thereby contribute to the rapid commercialization of these new technologies. In addition, ITS plans to commit substantial resources of its own to the development of these new technologies and standards.

For more information, contact:
Ronald L. Ketchum
(303) 497-7600
e-mail rketchum@its.bldrdoc.gov

ITU & Related National Standards Activities

Outputs

- Leadership of ITU and related U.S. telecommunications standards committees.
- Technical contributions presenting U.S. standards proposals and ITS research results.
- Proposed ITU Recommendations and associated U.S. industry standards.

The Institute has a long and distinguished history of leadership, technical contributions, and advocacy of U.S. government and industry proposals in international and related national telecommunication standards committees. These activities have been focused in the International Telecommunication Union (ITU) — the United Nations-affiliated standards organization responsible for the cooperative planning and interoperation of public telecommunication systems and services worldwide. The ITU's technical work is centered in two permanent organs: the Telecommunication Standardization Sector (ITU-T), and the Radiocommunication Sector (ITU-R). The ITU-T develops international standards (Recommendations) addressing technical, operating, and tariff questions relating to all aspects of wireline telecommunications. The ITU-R develops Recommendations and contributes to Regulations addressing radio spectrum use, interference, propagation, and radio services. The ITU-T and ITU-R work programs are conducted in Study Groups whose responsibilities are distinguished on the basis of particular technical specialties and standards development needs. The Recommendations developed in these international organizations strongly impact both the evolution of U.S. telecommunications infrastructures and the competitiveness of U.S. telecommunications equipment and services in international trade.

ITU-R Recommendations provide the technical basis for spectrum allocation decisions and spectrum use both globally and regionally. They help to ensure compatibility between radio systems operated by U.S. government and industry organizations and those operated in other countries. The agreements reached at ITU-R sponsored World Radiocommunication Conferences ultimately become international treaties for the United States. These impacts make it

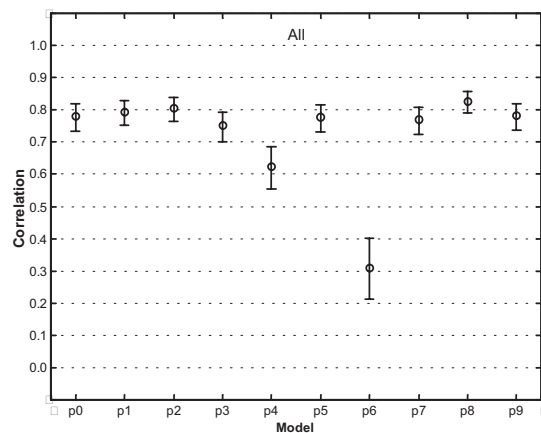
vital that U.S. interests and positions be effectively represented in ITU-R Recommendations and conference negotiations. Institute staff members have played a central role in the development of ITU-R (previously CCIR) Recommendations for over three decades, and a substantial proportion of existing ITU-R/CCIR Recommendations are based on ITS research. Experimental results and mathematical models developed at ITS are used throughout the world in the prediction of radio wave propagation, noise and interference, and area coverage. They provide technical information used by the FCC and other regulatory agencies in controlling the locations, frequencies, and power levels of radio and television broadcast transmitters, and in regulating terrestrial mobile communications. In recent years, Institute staff members have led and contributed to the technical activities of three ITU-R Study Groups: SG 1 on Spectrum Management, SG 3 on Radio Wave Propagation, and SG 8 on Mobile Services. During FY 2000, an ITS staff member assumed a new ITU-R leadership role as Chair of Task Group 3/2 on Broadcast and Land Mobile Point-to-Area Propagation Predictions.

The Institute's ITU-R activities support international efforts to advance existing radio wave propagation, noise/interference, and coverage prediction techniques to substantially better levels of accuracy and resolution. In prior work, ITS staff members obtained the National Geophysical Data Center (NGDC) 1-km world-wide terrain database from the National Oceanic and Atmospheric Administration (NOAA) and successfully introduced the database for international use in ITU-R Study Group 3. During FY 2000, ITS developed and standardized algorithms for extracting path profiles from such terrain databases. To support the use of the new terrain databases, ITS is providing algorithms to the ITU-R that utilize terrain characteristics to make point-to-point propagation predictions. ITS participates in the Correspondence Group that will evaluate the point-to-point prediction methods and develop a new Recommendation on the topic. Finally, ITS has provided material for a new ITU-R Handbook that will guide users in the application and interpretation of propagation calculations used in the Land Mobile Radio Service. The material includes information on radio and man-made noise in the Mobile Service

bands and on the topics of ray-tracing, geometric theory of diffraction-uniform theory of diffraction (GTD-UTD), and parabolic and integral equation methods.

ITS has also played a strong role in international negotiations of the ITU-T. The Institute's long-term technical goal there — and in related national standards work — is to motivate the development and standardization of user-oriented, technology-independent measures of telecommunication service quality. Such measures promote competition and technology innovation among equipment and service providers; facilitate interworking among independently-operated networks and dissimilar technologies in the provision of end-to-end services; and give users a quantitative, practical means of defining their specific telecommunication requirements and selecting the products that most effectively meet those needs. The Institute's long-term work towards that goal has progressed in three broad phases. In the first phase, ITS participants led ITU-T and related U.S. standards committees in defining the basic principles and framework that underpin a user-oriented approach to telecommunications quality assessment. In the second phase, participants developed a set of generic, user-oriented quality measures for call processing and data transfer functions, and applied those generic measures in deriving technology-specific performance parameters and measurement methods for X.25-based packet switching, frame relay, narrowband and broadband integrated services digital network (ISDN), and asynchronous transfer mode (ATM) technologies. This work has produced over a dozen ITU-T Recommendations and related U.S. industry standards, and has strongly influenced both the theory and practice of digital network performance description. In the third phase, still in progress, ITS participants are applying the performance description principles and framework to integrated IP-based networks, and are developing objective, perception-based quality metrics for voice, video, and multimedia services.

The Institute's ITU-T activities in 2000 were focused in two groups: Study Group 13 Working Party 4 and Study Group 12 Working Party 2. The former group develops performance Recommendations for high-speed synchronous digital hierarchy (SDH), broadband integrated services digital network (B-ISDN), asynchronous transfer mode (ATM), wave division multiplexing (WDM), and Internet protocol (IP)-based technologies. The latter group defines performance parameters and



Correlation of objective video quality metrics (models) with subjective perception.

objectives for end-to-end transmission networks and terminals. ITS also provides leadership and technical contributions to related work in the American National Standards Institute (ANSI) accredited T1 (Telecommunications) Committee's T1A1 (Performance) Subcommittee and its three Working Groups. During FY 2000, ITS leadership in Study Group 13 contributed to the completion or substantial revision of ten ITU-T Recommendations: I.356 (ATM cell transfer performance); I.355, I.357, G.827, and G.827.1 (availability performance); G.828 and G.829 (broadband network transmission error performance); G.824 and G.825 (network time and frequency distribution performance); and I.351 (structure, content, and relationships among ITU-T performance Recommendations). The Institute's leadership in Study Group 12 assisted the Video Quality Experts Group (VQEG) in completing a comprehensive multi-laboratory evaluation of video quality assessment technologies proposed for international standardization. The Figure shows the correlations with subjective perceptions (and associated 95% confidence intervals) for each of the ten objective video quality metrics (models) evaluated by VQEG. The Institute's continued leadership in T1A1 advanced U.S. voluntary consensus standards and contributions to ITU-T in these and several other technology areas. A particular focus of ongoing T1A1 work is the standardization of QoS objectives for voice over Internet protocol (VoIP) and other real-time IP network services.

For more information, contact:
 Neal B. Seitz
 (303) 497-3106
 e-mail nseitz@its.blrdroc.gov