
Telecommunications and Information Technology Planning

The telecommunications and information technology planning function represents the highest-level system or network perspective of the Institute. This work can be characterized generally as planning and analyzing existing, new, and proposed telecommunications and information technology systems, especially networks, for the purpose of improving efficiency and enhancing the technical performance and reliability of those systems. In many cases, ITS performs this work for both wireline and wireless applications. This portion of the ITS technical program encompasses work that is frequently referred to in industry as “systems engineering.”

All phases of strategic and tactical planning are conducted under this work area; problem solving and actual implementation engineering also are done. ITS engineers identify or derive users' functional

requirements and translate them into technical specifications. Telecommunication system designs, network services, and access technologies are analyzed, as well as information technologies (including Internet and Internet-related schemes). Associated issues, such as network management and control and network protection and privacy, also are addressed. Integration of individual services and technologies is a common task in many projects, along with the application of new and emerging technologies to existing applications.

Following is a summary of significant activities that occurred in the area of telecommunications and information technology planning during FY 04. By far, telecommunications interoperability was the largest program area.

Areas of Emphasis

Interoperability Efforts for Justice/Public Safety/Homeland Security

The Institute conducts a broad-based technical program aimed at facilitating effective telecommunications interoperability and information-sharing among dissimilar wireless and information technology systems within the justice/public safety/homeland security community. ITS activities are sponsored by a number of Federal agencies and programs, and are planned and performed only after close coordination with local, State, tribal, and Federal practitioners. Technical thrusts within the program, which are described in separate sections on the following pages, include:

Engineering Support and Coordination.

Information Technology Interoperability Standardization and Quality.

Wireless Telecommunications Interoperability Standardization.

Emergency Telecommunications Service (ETS)

The Institute develops and verifies ETS Recommendations for ITU-T Study Group 9. A second project provides ETS expertise relating to Network Survivability for Technical Subcommittee T1A1. These projects are funded by the National Communications System (NCS).

Networking Technology/Interoperability

The Institute characterizes and analyzes the fundamental aspects of networks, and network interoperability. Methodologies and tools are developed to address discovery, monitoring/measurement, simulation, management, security/protection, and quality issues. This project is funded by NTIA.

Engineering Support and Coordination for Justice/Public Safety/Homeland Security

Outputs

- Technical evaluations of industry R&D and community grant proposals.
- Interoperability and performance evaluations of Project 25 equipment.

ITS is conducting a technical program aimed at facilitating effective interoperability and information sharing among dissimilar wireless telecommunications and information systems within the justice/public safety/homeland security community. The primary focal points of the program are: (1) Standards support, (2) Research and Development (R&D) support, (3) Test and Evaluation (T&E), and (4) Technical Coordination among local, state, tribal, and Federal departments and programs associated with interoperability activities. All efforts described here are complementary to the ITS technical programs focused on wireless telecommunications interoperability standardization and information technology interoperability standardization. The ITS program is sponsored by a number of different Federal departments and programs that have a keen interest in public safety interoperability, including: National Institute of Standards and Technology (NIST) Office of Law Enforcement Standards (OLES), National Institute of Justice (NIJ) Communications Technology (CommTech) Program (formerly AGILE Program), Department of Justice Office of Community Oriented Policing Services (COPS), National Communications System (NCS), Department of Homeland Security's Public Safety Wireless Communications (SAFECOM) Program, Federal Partnership for Interoperability Communications (FPIC) (formerly Federal Law Enforcement Wireless Users' Group (FLEWUG)), and NTIA.

Standards Support

Through research conducted in its Interoperability Research Laboratory (IRL), ITS tendered key contributions to standards development organizations supporting justice, public safety, and homeland security goals. In cooperation with NTIA's Office of Spectrum Management, the IRL catalogued the receiver selectivity of a cross section of Land Mobile Radios (LMRs) operating in a variety of

simulated environments employing different modulations and conflicting channel plans. The underlying data were used to validate a new radio receiver selectivity model proposed in the draft of TIA Technical Service Bulletin (TSB)-88, Rev. B. Results of Project 25 Radiofrequency Subsystem throughput delay measurements performed on base stations provided a much needed context for anticipated throughput delays in the extended Inter-RF Subsystems Interface (ISSI) currently being specified in the Project 25/Telecommunications Industry Association (TIA) TR-8 committee. IRL engineers are currently reconstructing the Delivered Audio Quality (DAQ) test methodology referenced in TSB-88-B. Effective use of DAQ as a system quality metric for LMR coverage testing has been hampered by the absence of documented, repeatable test methods. The DAQ definition project will provide clear and concise instructions on how to perform such measurements. The published results will be backed by a publicly available, exhaustive compendium of thousands of audio recordings of impaired RF channels.

R&D Support

At the request of several Federal Departments and Programs, ITS worked alongside practitioners from the justice/public safety/homeland security community to technically evaluate grant proposals. By acting as the Government's common "technical thread," ITS engineers helped ensure that R&D proposals from industry and telecommunications integration proposals from local, state, and tribal government agencies were feasible and consistent with long-term interoperability strategies. Evaluations were conducted on behalf of SAFECOM's Request for Information on Rapidly Deployable Interoperability Solutions, the COPS Program, and the Department of Homeland Security's Emergency Preparedness and Response Directorate.

Test and Evaluation

The IRL has been equipped to support a broad variety of testing requirements, especially public safety applications. Testing continues along three radio-centric thrusts: receiver and transmitter performance measurements, interoperability of the common air interface, and evaluation of the effect of interconnect or network impairments. Leveraging the core

automated testing capabilities developed last year, IRL engineers expanded the lab's repertoire of performance tests well beyond the initial suite of Co/Adjacent-Channel Rejection measurements to include several additional tests defined in the TIA-102 suite of standards. Interoperability testing of subscriber units continued with more than 3000 test conditions and dozens of documented functional failures having been observed to date. This first stage of testing illustrated several common functional discrepancies in the subscriber units and motivated more efficient testing methods for future work. Accordingly, IRL engineers continue to lay the groundwork for automated testing through the creation of a standard P25 Super-frame generation program capable of simulating nearly every combination of channel parameters in the overhead data. IRL engineers completed an extensive analysis of the effect of latency, jitter, and packet loss on a Project 25 repeater employing a new proprietary Voice over IP (VoIP) protocol. In addition to exhaustively characterizing this device, lessons learned in the course of testing promise to lay the foundation for similar measurements on the aforementioned P25 ISSI. Finally, IRL engineers' core competencies were brought to bear for subscriber radio and infrastructure testing in support of the State of Wyoming's Wyolink radio communications system.

Technical Coordination

In FY 2004 ITS entered into a cooperative research and development agreement with the State of Wyoming's Wyolink project team to assist in the proposal, evaluation, and performance testing phases of a multi-year, statewide, VHF trunked LMR system. Practical experience gained in this effort will be applied to the development of Request for Proposal templates which public safety agencies at all levels of government can use to simplify the procurement process and ensure the integrity of the performance confirmation process.



Equipment in the new ITS screen room (photograph by E. Nelson).

Other Support

In addition to the established areas of activity mentioned above, ITS frequently responds to the immediate needs of its sponsors by performing a variety of other research and applied engineering activities. These activities may include strategic and tactical planning, system engineering, technical analysis, and economic benefit studies.

For more information, contact:

Eric D. Nelson
(303) 497-4445
e-mail enelson@its.bldrdoc.gov

Information Technology Interoperability Standardization and Quality for Justice/Public Safety/Homeland Security

Outputs

- XML Data Model and Data Dictionary.
- Acoustic coupling facility for public safety audio quality testing.

ITS is conducting a technical program aimed at facilitating effective interoperability and information sharing among dissimilar information systems within the justice/public safety/homeland security community, and ensuring that there are standardized procedures to measure the quality of speech delivered through public safety's communications systems.

The primary focal points of the IT interoperability portion of the program are: (1) the identification and delineation of applicable information sharing architectures, (2) coordination between major Federal players and local, state, and tribal public safety practitioners to collegially develop a nationwide strategic plan for information sharing, and (3) the identification and/or development of standards that address the community's requirements and are in conjunction with the strategic plan. All efforts are aimed at allowing local, state, tribal, and Federal agencies to exchange information, without requiring substantial changes to internal systems or procedures.

The primary focal point of the audio quality portion of the program is to provide a facility that can emulate, in a controlled laboratory environment, the field conditions experienced by public safety practitioners.

The ITS program is sponsored by a number of different Federal departments and programs that have a keen interest in public safety interoperability, including: National Institute of Standards and Technology (NIST) Office of Law Enforcement Standards (OLES), National Institute of Justice (NIJ) CommTech Program (formerly AGILE Program), Department of Justice Office of Community

Oriented Policing Services (COPS), National Communications System (NCS), Department of Homeland Security's Public Safety Wireless Communications (SAFECOM) Program, Department of Homeland Security Chief Information Officer's Wireless Management Office (WMO), and NTIA.

XML Data Model and Data Element Dictionary Development

In prior years, ITS played a significant role in providing technical assistance and coordination in the initial development of an Extensible Markup Language (XML) Data Element Dictionary that can provide common "words" for a common "language" to be used by the justice/public safety/homeland security community. In 2003, the XML development work skyrocketed, with an order of magnitude increase in the size of the data element dictionary and 2004 saw the public release of the enlarged dictionary along with an associated data model.

The development of the Global Justice XML Data Model (GJXDM) is a significant step forward in achieving information sharing interoperability among members of the justice and public safety community. It provides a foundation for the structure of a consistent data element dictionary, documents to be exchanged, and messages to be passed. The core of the data model is the XML Data Dictionary and the corresponding "Justice" namespace. Users and developers use the "words" of the Data Dictionary to build documents that represent a particular information exchange. Based on their requirements, they can import the words by reference and can extend or restrict the definitions.

The significantly-expanded data dictionary contains over 2000 elements and is expected to meet over 90% of the information sharing requirements of the justice/public safety/homeland security community. The GJXDM was initially released in February 2004 and the current released version of the dictionary is available to the public at <http://it.ojp.gov/gjxdm/>.

Audio Quality Testing for Public Safety

There are several reasons for developing high-quality acoustic coupling capabilities which are not common in telecommunications laboratories to provide speech stimulus to public safety communications devices. One reason is that the electrical interfaces are non-standard and highly specific to each manufacturer and/or device model. Another is that acoustic coupling provides a means to perform calibrated laboratory emulation of the acoustic environment experienced in the field.



Head and torso simulator with public safety headset and microphone installed (photograph by D.J. Atkinson).

One of the most significant challenges that public safety practitioners face in communicating effectively is the severe nature of the environment in which they must operate. Speech quality is directly impacted by a variety of surrounding conditions that produce high noise levels, even before operationally required tools, such as sirens, are employed. These make for very challenging communication scenarios.

The Institute's acoustic coupling facility provides emulation of practitioners within these scenarios through the use of an international standard Head and Torso Simulator (HATS). The HATS provides calibrated speakers that represent an artificial mouth, and calibrated microphones that represent artificial ears. A handset positioning system allows public safety communications equipment to be positioned as it would be used in real life. The figure shows the HATS with a headset and noise canceling microphone installed.

Once the communications equipment is properly positioned, the HATS is placed into the sound-attenuated chamber where high-quality digital recordings of operating public safety equipment are played through a surround-sound system. The acoustic environment from a particular public safety event is then introduced (e.g., police car in pursuit, fire truck in route; helicopter in the air, boat involved in high-speed chase).

For more information, contact:
D. J. Atkinson
(303) 497-5281
e-mail dj@its.blrdoc.gov

Wireless Telecommunications Interoperability Standardization for Justice/Public Safety/Homeland Security

Outputs

- Wireless telecommunications Statement of Requirements (SOR) for Public Safety.
- Functional and performance specifications for Project 25/TIA digital radio and system standards.
- Standardized measurement methods for testing Project 25 radios and systems.

Five steps are needed to specify and implement wireless systems for communications and information exchange to allow seamless interoperability among public safety agencies and practitioners: (1) define *user requirements* for communications and information exchange, (2) specify the *architecture framework* to support the communications, (3) develop *standards* for the systems, (4) conduct *technology performance tests* to evaluate proposed solutions for the standards, and (5) conduct *vendor products functional tests* to validate that tested equipment supports the standards prior to user implementation. ITS is the common technical thread through all these steps in direct support of the justice/public safety/homeland security community users to standardize their wireless systems.

ITS is conducting a technical program aimed at facilitating effective interoperability and information sharing among dissimilar wireless telecommunications systems within the justice/public safety/homeland security community. The primary focal points of the program are: (1) the identification and delineation of wireless telecommunications functional and interoperability requirements, (2) coordination with major Federal players and local, state, and tribal public safety practitioners to collegially develop an architecture framework that is in effect “a system of systems,” and (3) the identification and/or development of standards that address the defined requirements and are in concert with the architecture framework. Standardization efforts are aimed at allowing local, state, tribal, and Federal agencies to exchange communications and information.

The ITS program is sponsored by a number of different Federal departments and programs with a keen interest in public safety interoperability, including: National Institute of Standards and Technology (NIST) Office of Law Enforcement Standards (OLES), National Institute of Justice (NIJ) CommTech Program (formerly AGILE Program), Department of Justice Office of Community Oriented Policing Services (COPS), National Communications System (NCS), Department of Homeland Security’s Public Safety Wireless Communications (SAFECOM) Program, Federal Partnership for Interoperable Communications (FPIC) (formerly Federal Law Enforcement Wireless Users’ Group (FLEWUG)), and the Department of Homeland Security Chief Information Officer’s Wireless Management Office (WMO).

Wireless Telecommunications Statement of Requirements (SOR)

The first comprehensive set of wireless telecommunication requirements for public safety is now available, supplementing the PSWAC (Public Safety Wireless Advisory Committee) Final Report (1996). The development of any far-reaching nationwide strategy for wireless interoperability (and the standards to implement it) demands that practitioners’ needs be clearly understood before approaches are drawn. On behalf of the public safety community, ITS took the lead in developing a contemporary SOR in 2003. The final document underwent practitioner review and was released in April 2004. The document title is *Statement of Requirements for Public Safety Wireless Communications and Interoperability – Version 1.0*, and is available at http://www.safecomprogram.gov/files/SCI_Statement_of_Requirements_v1_0.pdf. This SOR is focused on the functional needs of public safety first responders — Emergency Medical Services (EMS) personnel, fire fighters, and law enforcement officers — to communicate and share information as authorized when it is needed, where it is needed, and in a mode or form that allows the practitioners to use it effectively. The communications mode may be voice, data, image, video, or multimedia that includes multiple forms of information. To keep the emphasis on functional requirements, the SOR avoids specifying either technologies or business models (i.e., whether requirements should be addressed through owned products and systems, or via commercial services).

Wireless Communications and Information Exchange Architecture Framework

Through its sponsors, the Institute is supporting the development of an architecture framework for wireless communications and information exchange interoperability. Working with those in the Federal Government responsible for the final plan, most notably SAFECOM, ITS is expediting the overall Federal effort by taking advantage of background engineering work already conducted at the Institute and elsewhere. For example, ITS has investigated frameworks for high-level enterprise architectures, and is also reviewing and analyzing the wireless integration activities being performed, and being contemplated, by local, state, tribal, and regional governmental organizations to characterize common architectural elements that have been successfully applied in the field. Governance and other non-technical issues have also been researched. Once the architecture framework (system of systems) document matures, it will be reviewed and approved by the practitioners as was the SOR. The framework will then guide the development of standards that support it.

Project 25/TIA TR-8 and Project MESA

The Institute contributes widely to Project 25, a program devoted to developing a comprehensive series of interoperability standards for the new generation digital land mobile radio (LMR) operating in narrowband channels for public safety applications. Comprised of representatives from the Association of Public-Safety Communications Officials (APCO) International, the National Association of State Telecommunications Directors (NASTD), industry as represented by the Telecommunications Industry Association (TIA), and local, state, tribal, and Federal governments, Project 25 is closely aligned with TIA's Standards Committee TR-8 (TR-8 is the body that formally develops, approves and releases Project 25 standards as TIA 102 series documents). While Project 25/TIA TR-8 "Phase II" work is now addressing interoperability standards for the network portions of Project 25, the specification of interface standards for (Phase I) 12.5-kHz digital LMRs also continues. "Phase III" (also referred to as Project 34 and Project MESA) is a joint effort between TIA and



Two ITS engineers recording audio noise in a typical Public Safety first responder's noise environment.

the European Telecommunications Standards Institute and is focused on the development of standards for broadband mobile data applications.

An ITS engineer represents NCS on the Project 25 Steering Committee, and chairs the Project 25 Encryption Task Group where Information System Security (INFOSEC) standards have been developed. ITS also contributes heavily to other TIA TR-8 committees and Project 25 task groups. For example, ITS' technical and editorial efforts have enabled the completion of initial drafts of two new TIA standards that will define Inter-RF Subsystem Interface (ISSI) measurement methods and specify recommended ISSI performance objectives. ITS continues to have the responsibility for developing procedures to test the interoperability of Project 25 radio systems. To date, procedures have been developed to test radios employing conventional voice, encrypted voice, over-the-air re-keying, trunking, and data applications.

Project MESA efforts have concentrated on defining the public safety requirements for broadband mobile applications. To date, the Institute has provided user operational requirements to Project MESA. These requirements represent the United States position. An ITS engineer was elected Chair of the Technical Specification Group — Systems. One objective of the Chair is to ensure that public safety user requirements — rather than industry solutions — are the drivers of the specifications and standards that are developed.

For more information, contact:
 Eldon J. Haakinson
 (303) 497-5304
 e-mail eldon@its.bldrdoc.gov

Emergency Telecommunications Service (ETS)

Outputs

- Technical contributions to ANSI Working Group T1A1.2.
- Technical contributions to ITU-T Study Group 9.

In the aftermath of the recent terrorist attacks, the Federal Government has become very interested in priority treatment for emergency communications. While the Government Emergency Telecommunications Service (GETS) has served emergency workers well for many years, it is limited to the Public Switched Telephone Network (PSTN) and to the United States. ETS is envisioned as a GETS-like service that will be available internationally and encompass virtually all wireless and wireline communications networks. The types of traffic to be carried include voice, video, database access, text messaging, e-mail, ftp, and web-based services.

The ETS effort at ITS encompasses two projects — Packet-Switched Networks, and Network Survivability and Restoral. For both of these projects, laboratory studies, security analyses, and traffic engineering are used to support Critical Infrastructure Protection (CIP) initiatives. These two projects are funded by the National Communications System (NCS). This work supports NCS in its mission to protect the national security telecommunications infrastructure, and to ensure the responsiveness and survivability of essential telecommunications during a crisis.

In the first project, Packet-Switched Networks, ITS develops and verifies ETS Recommendations for ITU-T Study Group 9. The major goal of this project is to ensure that future ETS mechanisms will interoperate over broadband cable television networks. Additionally, the project is working to facilitate the evolution of GETS over the IPcablecom network.

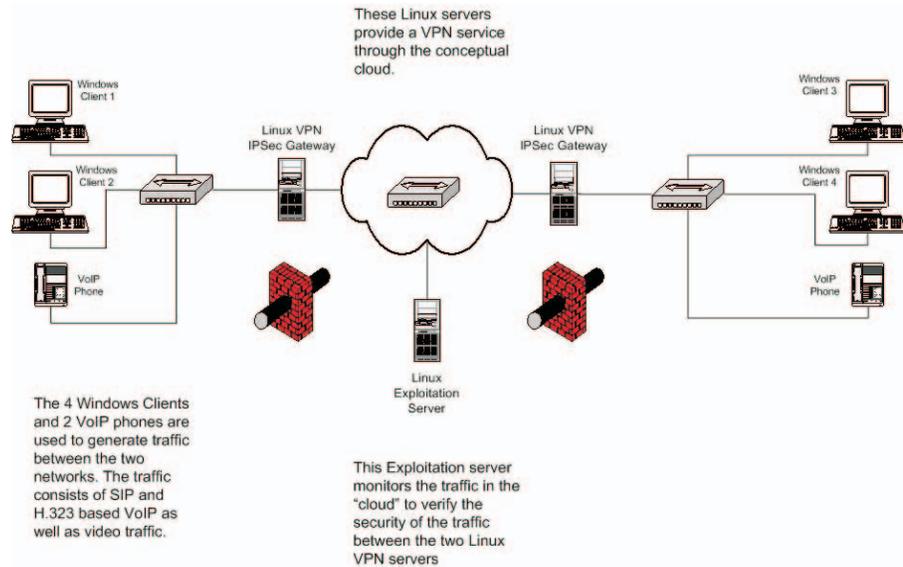
The second project, Network Survivability and Restoral, provides ETS expertise relating to network survivability and security for the ANSI-accredited Performance, Reliability, and Quality of Service Committee, PRQC (formerly T1A1). Within this project, an ITS engineer served as co-editor and principle author of a new ANSI Standard: “User Plane Security Guidelines and Requirements for ETS.” This Standard provides guidelines and requirements for security aspects of ETS communications relevant to the user plane. These specifications are necessary for implementation and maintenance of secure and reliable ETS communications. Guidelines and requirements regarding cryptographic standards are provided as well.

Table A-1. Priorities for NS/EP Users

Priority Level	Responsibility	Qualifying Criteria
1	Executive Leadership and Policy Makers	Users who qualify for the Executive Leadership and Policy Makers priority will be assigned Priority 1. A limited number of PLMN technicians who are essential to restoring the PLMN networks shall also receive this highest priority treatment. Wireless carrier may assign Priority 1 to its technicians with operational responsibilities.
2	Disaster Response / Military Command and Control	Users who qualify for the Disaster Response / Military Command and Control priority will be assigned Priority 2. Individuals eligible for Priority 2 include personnel key to managing the initial response to an emergency at the local, State, regional, and Federal levels. Personnel selected for this priority should be responsible for ensuring the viability or reconstruction of the basic infrastructure in an emergency area. In addition, personnel essential to the continuity of government and national security functions (e.g., conducting international affairs and intelligence activities) are included.
3	Public Health, Safety, and Law Enforcement Command	Users who qualify for the Public Health, Safety, and Law Enforcement Command priority will be assigned Priority 3. Eligible for this priority are individuals who direct operations critical to life, property, and maintenance of law and order immediately following an event.
4	Public Services / Utilities and Public Welfare	Users who qualify for the Public Services/Utilities and Public Welfare priority will be assigned Priority 4. Eligible for this priority are those users whose responsibilities include managing public works and utility infrastructure damage assessment and restoration efforts and transportation to accomplish emergency response activities.
5	Disaster Recovery	Users who qualify for the Disaster Recovery priority will be assigned Priority 5. Eligible for this priority are those individuals responsible for managing a variety of recovery operations after the initial response has been accomplished.

The table on the previous page is taken from the Appendix of the new ANSI Standard. It defines 5 levels (1 is highest) of emergency users or priorities. The Standard goes further and offers descriptive scenarios to further clarify the distinctions. These levels will be used in the classification of ETS users regarding their security needs. An ITS engineer is now serving as editor on four new draft Standards and Technical Reports related to Security and/or ETS in PRQC's Network Reliability and Security Subcommittee (formerly T1A1.2).

The standardization work in ITU-T Study Group 9 is focused on the IP-Cablecom family of Recommendations. These Recommendations define the protocols and signaling to be used on broadband cable television networks to support telephony, multimedia, and Internet access. The IP-Cablecom Recommendations have been standardized in ITU-T Study Group 9, and equipment implementing them is currently in production worldwide. One of the goals of this project is to identify where additions or changes might be needed to support the ETS. This effort also involves work with the Internet Engineering Task Force (IETF), since many of the underlying protocols used in IP-Cablecom (as well as some of the ETS mechanisms) are under development in the IETF. An ITS engineer serves as the Editor of Draft new ITU-T Recommendation J.260 — "Requirements for preferential telecommunications over IP-Cablecom networks" in Study Group 9. This Recommendation is currently in review under the Traditional Approval Process (TAP). An ITS engineer also serves as the Editor of Draft new ITU-T Recommendation J.PREF — "Specifications for preferential telecommunications over IP-Cablecom networks" in Study Group 9. This Recommendation will provide specifications to satisfy the requirements set forth in J.260.



Laboratory setup for testing security and ETS protocols.

Another important study under way at ITS is a series of tests of GETS over IP-Cablecom networks. The evolution of GETS from a PSTN-only service to one that will interoperate over the wireless, IP-Cablecom, and Next Generation networks (NGN) is one of the goals of NCS. Determining the security needs of ETS in IP-Cablecom networks is another goal of the ETS effort. The figure above shows a laboratory setup to test proposed ETS mechanisms over virtual private networks (VPNs) and through firewalls. The lab setup is currently used to test the performance of videoconferencing and Voice over IP over SIP. Proposed ETS mechanisms will be coded and tested over the same network to determine if they are viable from a Quality of Service (QoS) standpoint.

In FY 2005, ITS will continue to address work on the development and standardization of ETS in ATIS PRQC, the IETF, and ITU-T Study Group 9. The projects will address technologies in the NGN and interactions with the IP-Cablecom networks. This work on ETS must of necessity be conducted with the help of representatives from network providers and cable television equipment manufacturers, as well as NCS. The work in FY 2005 will focus on survivability and security in the NGN ETS as well as GETS compatibility in the IP-Cablecom networks.

For more information, contact:
 Arthur A. Webster
 (303) 497-3567
 e-mail awebster@its.blrdoc.gov

Networking Technology/Interoperability

Outputs

- Transportable equipment suite for network characterization and simulation.
- Automation for public safety audio quality testing facility.

ITS has a long history of assisting other agencies and organizations with their telecommunication planning, assessment, and interoperability studies, but the complexity of today's telecommunication and information technology (IT) requirements, and the technology available to satisfy those requirements, create demands for enhanced sophistication in the methodologies and tools used to perform these studies. The Networking Technology/ Interoperability projects have defined structured methods for such studies, examined many tools and techniques that can be used in conducting such studies, and identified those tools and methodologies most likely to provide the greatest benefits. Previous years' work focused on the selection and use of a suite of networking tools that aid in discovering the topology of

a network, the load on segments of a network, and the simulation of a network, as well as the development of a structured approach to applying these tools, along with a systems engineering method to address the complex issue of network interoperability. This past year's work focused on packaging and automating tools that can be used to implement the structured approach, resulting in two significant packages that can be used by ITS projects to meet the needs of their sponsors.

Network Characterization/Simulation Suite

Essential in determining how to get to where one wants to go is knowledge of where one is starting from. This is true of many things, including network and interoperability planning. In order to provide assistance in determining the current state of a network (i.e., network characterization), ITS has developed a suite of equipment that can be used to characterize networks of significant complexity.

The suite, housed in two shock-mounted equipment racks, can be shipped to a sponsor's site to provide network monitoring and analysis over a pre-determined time interval. It provides tools to perform four stages of characterization for networks:

- 1) discovery and analysis, providing a big picture of the network and identifying critical components;
 - 2) network management and monitoring based on Simple Network Management Protocol (SNMP) for aggregate link analysis and determination of problem areas;
 - 3) protocol analysis and application-specific monitoring for isolation of specific issues; and
 - 4) simulation that can be used to re-create the network as-is and overlay new services and components to ensure any changes will meet the user's requirements.
- This high level process is shown in Figure 1.

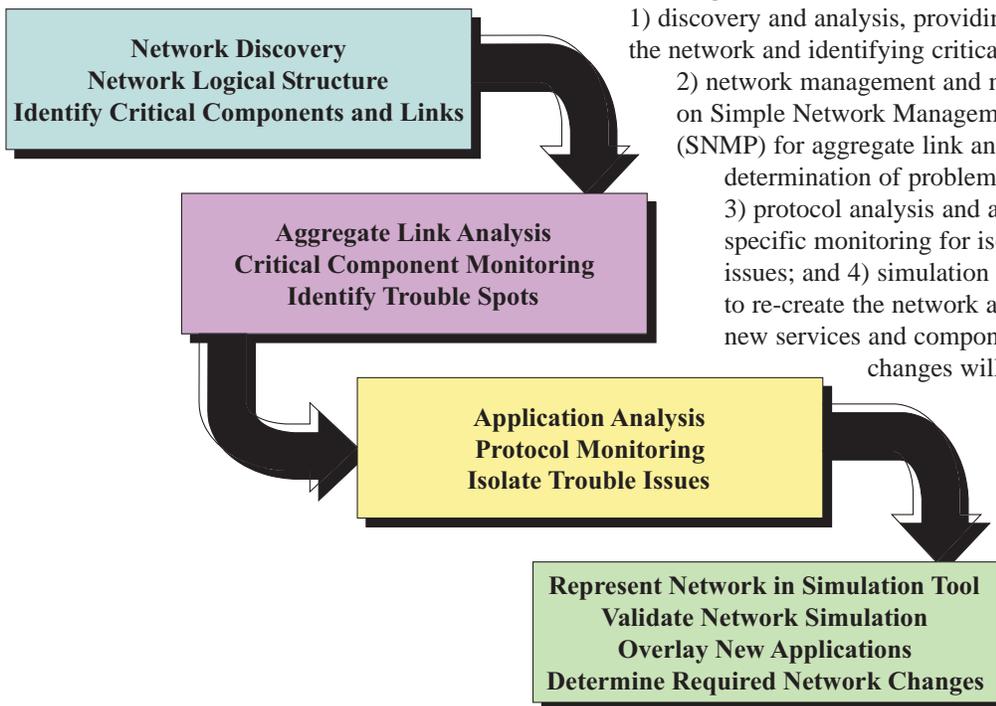


Figure 1. Network characterization process.



Figure 2. Public safety audio quality laboratory (photograph by D.J. Atkinson).

Public Safety Audio Quality Laboratory Automation

Determining the audio quality level that is required by public safety is complicated by several factors. Mixing different disciplines, environments, equipment types, frequency bands, and technologies greatly increases the number of communications variables for the public safety community. All of these factors need to be considered when it comes time to test a piece of communications equipment to determine if it provides adequate quality to the end user of the system. Further, these tests must be both accurate and repeatable.

In order to achieve this, and to support the Public Safety efforts within the division, this NTIA-sponsored program provided support to automate the public safety audio quality laboratory. The base of the audio laboratory is provided by two sound-attenuated chambers with full surround-sound capability to enable the emulation of the noise environments encountered by public safety practitioners. The sound mixing and distribution systems utilize 48 kHz digital audio (higher than CD quality) to ensure the fidelity of the testing, and the software-controlled digital mixing and recording system ensures that tests are reproducible. This is shown in

Figure 2. The public safety practitioners are represented by International Telecommunication Union (ITU) standardized Head and Torso Simulators (HATS). The HATS systems provide calibrated speakers to represent the mouth and calibrated microphones to represent the ears.

This project provided automation software to ensure tests conducted in the facility are accurate and reproducible, including calibration, level setting, and automated speech processing. Accurate calibration is essential when using acoustic coupling to a communications device, so the calibration feature allows the audio path to be accurately regulated (to within ± 0.2 dB). The ability to set and recall configuration and level settings for the mixer ensures that the audio path is unchanging from test to test. Finally, the analysis feature either allows digital recording of the output from the communications device for later analysis or will do immediate processing with the ITU-approved Perceptual Evaluation of Speech Quality (PESQ) objective audio quality measurement algorithm.

For more information, contact:
DJ Atkinson
(303) 497-5281
e-mail dj@its.bldrdoc.gov