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U.S. Department of Agriculture Forest Service Eastern Region Strategic Telecommunication Plan 1994-2003

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PREFACE

This report is provided by the Institute for Telecommunication Sciences (ITS) to the Eastern Region of the U.S. Department of Agriculture (USDA) Forest Service, headquartered in Milwaukee, Wisconsin, in partial fulfillment of USDA Agreement Number 11-TU-91-02.

The Agreement authorizes ITS to perform the following tasks:

1) Identify Forest Service telecommunication needs.

2) Assess existing telecommunication systems in the Eastern Region.

3) Assess internal and external factors that affect telecommunications in the Eastern Region.

4) Assess current and evolving telecommunication technologies.

5) Develop a 10-year regional telecommunication strategy that incorporates the results of Tasks 1 through 4.

6) Develop a Tactical Telecommunication Plan for each of the 15 National Forests in the Eastern Region.

This report documents the results of Tasks 1 through 5. Each of the 15 tactical telecommunication plans is a separate document. The recommendations contained herein are those of the authors, and should not be construed as official policy of the U.S. Department of Agriculture, the Forest Service, or the Eastern Region, unless so designated by other official documentation. Likewise, this document does not convey official policy of the U.S. Department of Commerce, the National Telecommunications and Information Administration, or the Institute for Telecommunication Sciences.

Forest Service management, administration, and technical monitoring of this Agreement have been provided by Mr. Norbert Kluhsman, Electronics and Communications Group Leader for the Eastern Region.

Certain commercial equipment, software products, service providers, vendors, and contractors are identified in this report to adequately describe the design, operation, and maintenance procedures of the telecommunication systems utilized by the Forest Service and its cooperating agencies. In no case does such identification imply recommendation or endorsement by the U.S. Department of Agriculture, the USDA Forest Service, any of its cooperating agencies, the U.S. Department of Commerce, the National Telecommunications and Information Administration, or the Institute for Telecommunication Sciences, nor does it imply that the material, equipment, providers, vendors, or contractors identified are necessarily the best available for the purpose.

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EXECUTIVE SUMMARY

This report documents the development of a telecommunication strategy for 1994-2003 for the Eastern Region of the U.S. Department of Agriculture (USDA) Forest Service. The Institute for Telecommunication Sciences (ITS) identified telecommunication needs, assessed the existing telecommunication systems of the 15 National Forests in the Region, assessed internal and external factors that impact telecommunication planning, and assessed telecommunication technologies. Based on the foregoing, ITS developed a telecommunication strategy intended to ensure that Eastern Region telecommunication systems and services support the mission of the organization in a reliable and cost-effective manner.

Identification of Telecommunication Needs

Engineers from ITS interviewed personnel from each of the Eastern Region's 15 National Forests to determine telecommunication needs associated with carrying out the general business objectives and organizational functions that arise from the Forest Service mission. ITS also studied a variety of Forest Service literature and reference material to understand the context for agency telecommunications. The analysis resulted in the formulation of six goals for the future of Eastern Region telecommunications.

Connectivity — All parts of the Forest Service organization will be interconnected by telecommunication networks that support the flow of voice, data, and video information. The Forest Service will be interconnected with other Federal, state, and local government cooperators, commercial cooperators, and the general public.

System Interoperability — The Forest Service will have open, standards-based telecommunication networks that support network services across levels of connectivity in a manner that is transparent to the user.

Network Integration — The Forest Service will implement integrated digital networks that carry voice, data, and video information over a variety of media, as opposed to separate networks for voice, data, and video. Integration will enable consolidation of network management functions such as administration, monitoring, and maintenance.

Performance and User Satisfaction — Forest Service telecommunication networks will provide sufficient capacity to support fast, reliable transmission of information. User interfaces will encourage the novice to use the networks yet provide the skilled user with power to be creative in the application of telecommunication technology to analysis and problem solving.

Mobility — Users will have access to the voice, data, and video information they need to make decisions regardless of their location or the time of day.

Telecommunication Management — The Forest Service will provide the staff, administrative support, and network management tools to effectively plan, procure, implement, operate, and maintain telecommunication networks and services.

The regional strategy will seek to move the Eastern Region from its current telecommunication environment toward the goals described above. The strategic planning process is illustrated in Figure ES-1.

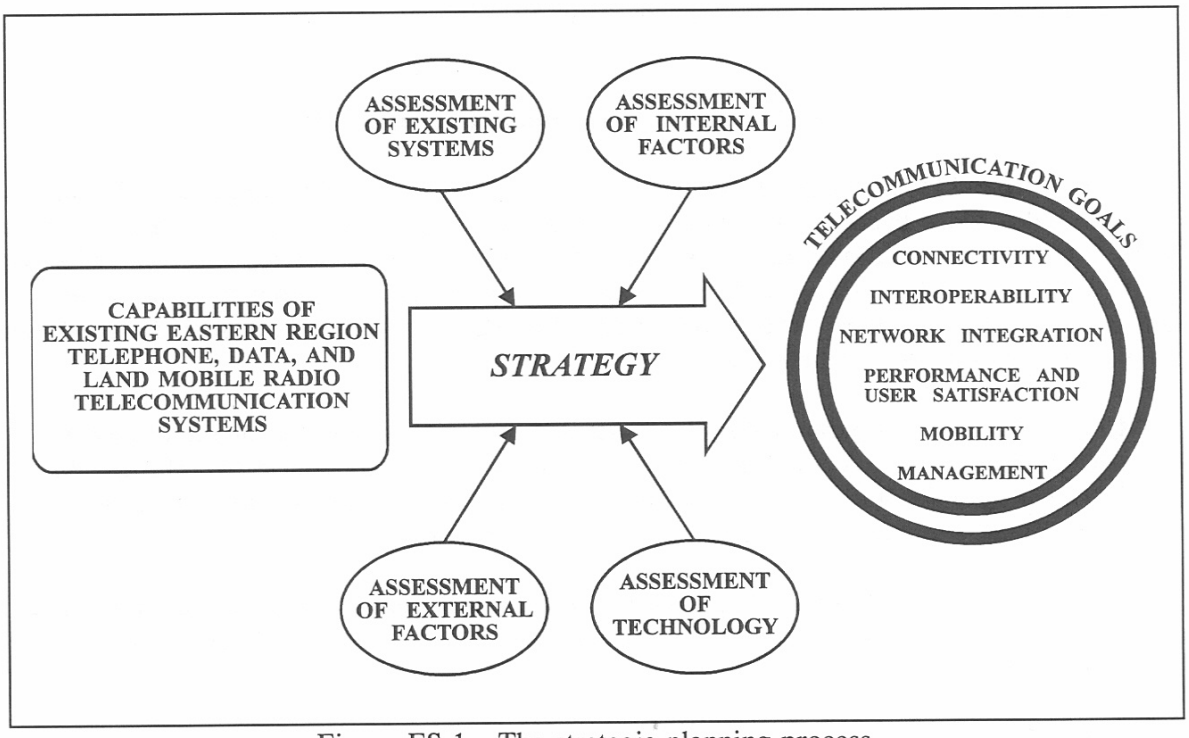

Figure ES-1. The strategic planning process.

Assessment of Existing Telecommunication Systems

Telephone Systems

Eastern Region telephone systems are generally well-maintained and functioning properly. The age and suitability of systems varies widely, however. Systems less than 5 years old typically provide users with the capabilities and features they need now and will need over the next 3 to 5 years. Software upgrades should help to maintain the viability of these systems. Some older systems are no longer cost-effective to operate and maintain, and should be replaced immediately. Electrical power disturbances are relatively common, especially at Ranger

Districts (RDs), and systems should be protected with an uninterruptible power supply or power conditioner.

Because of their rural locations and large size, most Forests are served by several small local exchange carriers (LECs) and have more than one maintenance provider. The telephone services available are not consistent; for example, a number of RDs do not yet have access to dual-tone multifrequency (TouchTone™) dialing or cannot designate Federal Telecommunication System 2000 (FTS2000) as their primary long-distance carrier. LECs should be encouraged to upgrade their equipment to offer at least dual-tone multifrequency dialing capability. An ongoing dialog about future needs should be established to help LECs plan for additional service upgrades, including circuits that will support digital transmission at 1.544 Mbps and above.

Data Communication Systems

Supervisor's Offices (SOs) and RDs are equipped with Data General minicomputers and terminals running proprietary Data General software. These computer systems are based on a national contract, which locks the Forests into a very structured information systems environment. Systems at the SOs and RDs are generally well-managed. Expansion of existing capabilities is limited, but a replacement system known as Project 615 is being planned and procured. Eastern Region Forests should follow Washington Office (WO) and Regional Office (RO) guidance in preparing for the new system. Investments in Data General systems should be limited to relatively low-cost improvements in reliability, processing power, port capacity, or storage capacity as required on a site-by-site basis.

Premises data communication cabling varies from site to site, depending on the age and type of building and other local factors. Existing cabling is adequate for current applications, but most sites will need to install a new cable plant to support Project 615 local area networks (LANs).

All Forest Service Data General computers are interconnected via a packet switched wide area network provided under the FTS2000 contract. Network performance and reliability are adequate for current applications, but ITS does not expect that performance will be adequate to support Project 615.

Access to FTS2000 Wide Area Network

Wide area voice and data communication services are provided for the Forest Service by FTS2000. FTS2000 access configurations are generally satisfactory for current needs, though some RDs still lack access to FTS2000 voice service and should be connected as soon as possible. RDs will likely be forced to change their access configurations to adequately support Project 615.

Land Mobile Radio Systems

Eastern Region Forests use land mobile radio (LMR) systems to provide voice communication for Forest Service field personnel. Field personnel may be either in a vehicle or on foot, and may need to communicate with the SO, the RDs, other Forest Service field personnel, local public safety agencies, and cooperating Federal and state natural resource management agencies. Forest LMR systems are generally not well-maintained and do not provide reliable service or coverage. With proper maintenance, the performance of most Forest base station and repeater systems could be brought within design specifications, and they could be operated reliably for an additional 3 to 5 years. They are, however, nearing the end of their useful lives. Within the next 3 to 5 years, radios will begin to fail more often, and repair parts will become more expensive and difficult to find. Many coaxial cables and antennas have already degraded after too many years of exposure to weather. Some mobile and portable radios are well over 10 years old and are unreliable and obsolete. System replacement has become a complex issue due to impending changes in regulation and technology; large investments in current technology would be unwise at this time.

Assessment of Internal Factors

Among the constraints the Eastern Region must consider in developing a long-range telecommunication strategy are "internal factors," which for the purposes of this document are defined as policies, regulations, directives, initiatives, or programs that arise from within the Forest Service, and which the Forest Service has the power and authority to change.

Forest Service internal factors fall into three main categories: telecommunication management, information management, and special initiatives or programs.

Telecommunication Management

The Forest Service Manual (FSM) establishes appropriate objectives and policies for telecommunication management. Telecommunication systems and services are to be planned and managed to ensure reliable and cost-effective support of Forest Service programs.

The FSM defines telecommunication management responsibilities at the Region level, but the number of RO telecommunication management staff is inadequate to effectively carry them out. An additional staff position should be created. The FSM does not clearly define telecommunication management responsibilities at the Forest level. Most Forests split the telecommunication management function between several individuals with other primary responsibilities and minimal telecommunication background. This fragmented approach and the lack of adequate guidance from the FSM and the RO hinder effective telecommunication management. The poor condition of most Forest LMR systems is attributable to poor

management. Most Forests would benefit from a reorganization of their telecommunication management structure.

The FSM tightly couples procurement of telecommunication systems and services to strategic and tactical plans. This emphasis on comprehensive planning is appropriate. The current procurement process, however, has a built-in delay of 2 to 3 years between system design and actual purchase. This delay virtually assures that the system(s) procured by a Forest will lack the most up-to-date capabilities. A funding mechanism is needed that will allow system purchase and implementation within months after the design is completed, not years.

Information Management

The Forest Service is in the midst of two major information management programs that will have a significant impact on telecommunications. One is the implementation of an Information Management Framework for the Future (IM Framework), and the other is the Project 615 computer system acquisition. The integrated data and information environment envisioned by the IM Framework and the graphics-oriented Project 615 will require extensive telecommunication support in the areas of internetworking and high-bandwidth wide-area transport. The Project 615 Request for Proposal, however, specifies the same wide area network (WAN) and WAN access configurations used to interconnect the current Data General computers. ITS expects that the performance of the specified WAN will be inadequate to support Project 615 and the IM Framework, but alternative WAN technologies are becoming available.

Special Initiatives

The 1990 Resources Planning Act Program, a renewed management emphasis on forming partnerships with Forest Service cooperators, and the New Perspectives Program reinforce the fact that the Forest Service is becoming an information-driven agency. There are acute needs to process and distribute information within the agency as well as exchange it with cooperators and the general public. These needs suggest an increasing amount of telecommunication network traffic during the next decade.

Assessment of External Factors

In addition to internal factors, the Eastern Region must consider certain "external factors" in developing a long-range telecommunication strategy. These external factors are beyond the direct control of the Forest Service, and include telecommunication policies and regulations established by other Federal agencies. They also include the current and planned telecommunication systems of Forest Service cooperators such as Federal and state natural resource management agencies and local public safety agencies.

Recent and pending regulatory actions by the National Telecommunications and Information Administration (NTIA), Congress, and the Federal Communications Commission will have a great impact on Eastern Region LMR systems. These actions include reallocating some Federal spectrum to the Private Sector and requiring Federal LMR systems to use spectrum more efficiently. It is very unlikely that Eastern Region Forests will be forced out of their present frequency bands, but they will be required to use narrower radio channels and explore the use of spectrum-efficient commercial systems or systems shared with other agencies. The wideband analog LMR systems currently owned and operated by Eastern Region Forests will not operate properly at reduced channel spacing, and they offer no migration path to the digital, integrated voice and data "mobile office" future. NTIA has established a 10-year transition period for moving to narrowband channels that begins January 1, 1995, giving Federal agencies time to plan wisely for the implementation of next-generation systems.

Assessment of Telecommunication Technologies

Tremendous advances in telecommunication technologies have taken place over the past decade, and the next decade will bring more of the same. Advances in integrated circuits, microprocessors, switching, transmission, digital signal processing, fiber optics, wireless networking, and computer hardware and software are all being applied to improve the capabilities and reliability of telecommunication equipment. Anticipated technological advances in three key areas especially important to the Eastern Region are reviewed below.

Land Mobile Radio Systems

Digital modulation techniques are being introduced that will greatly expand the capabilities of LMR systems. Digital radio technology will accommodate both voice and data communication from the field. Digital radios will have built-in encryption capabilities to discourage monitoring by scanners. Systems will allow access to the public switched telephone network. From a system management console, each radio will be remotely programmable, allowing changes in the configurations of user groups and radio features. Systems will support trunking, or sharing of channels, and offer the possibility of shared use and administration by Federal, state, and local agencies. Such an arrangement would conserve spectrum and save on construction and maintenance costs. Voice quality and transmission/reception range will be comparable to analog systems.

Interagency communication is a key need for public safety agencies, and an unprecedented government/industry cooperative effort to develop digital LMR standards, known as Project 25, has begun. The broad scope of Project 25 includes specifying an open system architecture with six standardized interfaces. Though no formal standards have been adopted, the effort has strong support and holds promise for ensuring that those who implement future digital systems will not be locked into proprietary solutions.

Digital LMR technology holds the potential for meeting many of the field communication needs identified by Forest Service personnel, and digital systems will operate on the narrowband channels specified by NTIA. ITS estimates that it will be at least 3 years, however, before standards are completed and compatible products from different manufacturers become available at prices in the neighborhood of $1000 (mobiles and portables).

Land Mobile Satellite Systems

Communication from certain areas in Eastern Region Forests presents a challenge to ground-based LMR systems. It is difficult to provide adequate signal coverage in narrow river gorges, along lake shores or roads below bluffs, and in wilderness areas where towers and antennas are prohibited. Land mobile satellite systems currently being developed offer a solution, since topography has a limited effect on communication between the ground and a satellite positioned high above the horizon. Voice, data, position determination, and paging services will likely be offered by these new systems. Various manufacturers and consortia are working on several types of systems, but a number of regulatory and technological issues remain to be worked out before commercial land mobile satellite services become widely available. When the services finally do become available, probably during the 1995-1998 timeframe, the cost for transceivers is expected to range from $500 to $3000, with airtime charges ranging from $0.50 to $3.00 per minute; monthly fees from $25 to $45 may also be charged.

Land mobile satellite systems offer an alternative to the use of land-based systems to provide complete communication coverage over a Forest. Many uncertainties remain concerning the development of these systems, however. ITS expects them to supplement terrestrial systems, providing communications for personnel working in areas without good coverage from terrestrial transmitters.

Broadband Networking

Several technologies are evolving to support the transmission of voice, data, and video information over both LANs and WANs. They should become available to the Federal Government either through FTS2000 or other General Services Administration-sponsored procurement vehicles. Although Project 615 will initially be implemented with older, more established LAN and WAN technologies, ITS expects that at least the WAN technology will prove inadequate for Forest Service applications by the mid-1990s. Eastern Region telecommunication management should anticipate the demand for higher wide area transmission rates, and begin working in cooperation with the WO during the next 2 years to lay the groundwork for a transition to new WAN technology.

Regional Telecommunication Strategy

The regional telecommunication strategy and its associated implementation steps are designed to move the Forests of the Eastern Region from their current telecommunication capabilities toward the telecommunication goals that arose from the needs analysis. The strategy takes into account the foregoing assessments of existing systems, internal factors, external factors, and technologies. ITS recognizes that some of the Forests in the region have already implemented parts of the strategy, and that some Forests will move more quickly than others in implementation. The strategy is broken down below into six components. They are not listed in any particular order; each is considered an essential element of the strategy.

Ensure Effective Telecommunication Management

As noted above, the FSM adequately defines telecommunication management responsibilities at the Region level, but the RO does not have enough telecommunication management staff to effectively carry them out. ITS views the direction and training of Forest-level telecommunication management as a key responsibility of the RO, and an area of weakness in the Eastern Region. Centralized coordination of Forest-level telecommunication management would be efficient and cost-effective. Forest managers could be built into a team that would provide a sense of identity, purpose, camaraderie, and technical support.

Telecommunication management responsibilities at the Forest level must be clearly understood before they can be carried out. ITS believes these responsibilities should include planning systems, supporting users, tracking costs, preparing budgets, monitoring system performance, working with maintenance contractors, and coordinating telecommunications with cooperators. Carrying out these responsibilities will require time equivalent to a full-time position, technical knowledge of telecommunication systems and services, program management skills, and relational skills to work with people ranging from Forest Service users to maintenance contractors to vendors to local telephone companies. Eastern Region Forests must dedicate an individual or team of individuals to telecommunication management; it is ineffective to ask someone with full-time responsibilities in forestry, civil engineering, or administrative support to manage telecommunication systems in addition to their normal duties. The investment of time and money in telecommunication management will pay off in improved productivity and safer working conditions for all Forest personnel.

Implementation Steps for the Regional Office —

- Ensure that the responsibilities of telecommunication management are well-defined, both at the Region and Forest levels. Track any WO efforts to revise FSM sections on telecommunication management and be alert to any changes in telecommunication management resulting from Project 615 implementation.

- Assist Forests in developing the capability to effectively manage their telecommunication systems; coordinate Region-wide training in telecommunication management. Strengthening this effort in the Eastern Region will require the hiring of an additional Telecommunication Specialist (GS-391) or Electrical/Electronics Engineer (GS-850/855) to work out of the RO. Estimated cost: up to $50,000 per year.

Implementation Step for Eastern Region Forests —

- Hire or develop a Telecommunication Specialist (GS-391) to manage Forest telephone, data communication, and LMR systems or designate and develop a half-time Coordinator for telephone and data communication systems and a half-time Coordinator for LMR systems. Support telecommunication management personnel with funds for adequate training, tools, and equipment. Estimated cost: up to $50,000 per year.

Accommodate Diverse Capabilities of Telecommunication System Users

A wide variety of personnel use Eastern Region telecommunication systems, and there is a corresponding wide variation in the level of comfort they have with electronic and computer technology. Training users in the use of telecommunication systems is necessary to obtain the greatest benefit from the investment in the systems. Users are also a crucial source of information about system performance and can provide valuable suggestions for system improvements. In short, Region and Forest telecommunication management must have a "customer service" attitude.

Implementation Step for the Regional Office —

- Assist Forests as requested.

Implementation Steps for Eastern Region Forests —

- Provide adequate training for all users of Forest telecommunication systems. Cultivate the attitude among employees that the Forest Service is an information management agency, and that the effective use of telecommunication systems and services is a standard part of an employee's job.

- Implement user interfaces to telecommunication systems that are simple yet powerful.

- Establish mechanisms for users to provide feedback to telecommunication management.

Establish Telecommunication Systems Accounting and Funding Mechanisms

Without an accurate understanding of telecommunication costs, Forest telecommunication management cannot identify costly equipment or services that could be replaced by less expensive alternatives, and cannot plan or budget effectively for the future. Current funding processes virtually assure that systems procured by a Forest will lag current technology when they are finally implemented.

Implementation Step for the Regional Office —

- Lead an effort to improve telecommunication accounting and funding mechanisms; involve Forest telecommunication management personnel and fiscal personnel in developing a savings vehicle for capital investments in telecommunication systems, most likely a working capital fund. Assist Forests in implementation.

Implementation Steps for Eastern Region Forests —

- Establish a mechanism for tracking all costs associated with telecommunication systems and services: monthly usage charges, maintenance and repair costs, maintenance contracts, telecommunication management personnel salaries and expenses (training, travel, vehicle, etc.).

- Make telecommunication costs visible in the budget process. Allow the Forest Telecommunication Specialist or Coordinators to develop and manage a single telecommunication budget rather than dividing funds for the purchase of equipment and services between different staff budgets.

- Estimate the useful life of existing systems and set target dates for replacement of systems. Consider not only how long it will take the system to "wear out," but when the system will no longer be cost-effective to operate and maintain.

Pursue Telecommunication Cooperation

Changes in telecommunication regulation and technology are creating opportunities for Eastern Region Forests to realize advanced communication capabilities, particularly in land mobile radio. However, making wise system investments to meet growing mission demands for interagency communication will require joint planning with telecommunication service providers and other agencies during the next decade.

Implementation Steps for the Regional Office —

- Provide leadership in exploring policy and technology issues involved in telecommunication cooperation.

- Assist Forests in identifying cooperators and developing the proper contacts; develop contacts with other agencies at a level corresponding to the RO.

Implementation Steps for Eastern Region Forests —

- Establish technical rapport with local telecommunication service providers such as LECs and maintenance contractors; share short- and long-term Forest telecommunication needs to help them plan future service offerings.

- Identify local cooperators, establish contacts and rapport, and ascertain existing systems and opportunities for cooperation. Ascertain long-range plans and work together toward a mutually beneficial future.

- Explore the development of an interagency incident coordination center or shared dispatch arrangement; identify possible benefits, seek out interested cooperators.

Migrate Toward Integrated Digital Networks and Open Systems

ITS believes that migrating toward integrated digital networks and open systems offers the greatest potential for reaching the Forest Service telecommunication goals, and will keep Eastern Region Forests in step with the rest of the Federal Government and the Private Sector. The transition will not be immediate; ITS expects that it will be several years before the convergence of technology, standards, regulation, and market demand will bring about widespread implementation of high-speed, integrated digital networks that will support the transmission of voice, text, graphics (or image), and video information. In general, new Forest systems purchased during the next decade should manipulate information in digital form as much as possible and should have a well-defined upgrade path for future enhancements. The purchase of proprietary equipment that will not readily interface with digital transport facilities should be avoided.

Implementation Steps for the Regional Office —

- Track developments in regulation and technology, particularly with regard to the availability of high-speed WAN services to Federal agencies and digital LMR systems.

- Explore options for integrated digital access to FTS2000 services; analyze costs. Guide Forests in the acquisition of premises telecommunication equipment with modules/interfaces to the WAN that are upgradeable as new technology becomes available.

- Assist Forests in preparing to take advantage of digital LMR technology in the mid-1990s. Help them explore options to obtain service from commercial sources, share systems with other Federal or state agencies, or install new Forest systems.

- Track developments in mobile satellite systems; evaluate costs and potential benefits to Forests as a means to augment coverage by land-based systems.

- Assist Forest telecommunication management in preparing for telecommunication support of Project 615.

Implementation Steps for Eastern Region Forests —

- Link all telecommunication purchases to the regional telecommunication strategy. Always be looking to the future; avoid simply replacing existing systems with "the same thing, only newer." In most cases, avoid wholesale LMR system replacement for the next 3 to 5 years; changes in Federal and non-Federal regulation and impending advances in digital radio standards and technology make large investments in new wideband analog equipment unwise at this time. Base stations, repeaters, mobiles, and/or portables that cannot be repaired or reliably operated should, however, be replaced. Begin planning with cooperators now for future field communication support.

- Prepare for telecommunication support of Project 615. The Request for Proposal (RFP) for this procurement specifies the use of digital networks and conformance to open systems standards. Follow WO and RO guidance concerning the installation of LAN cable plants in the SO and RDs.

Restore Existing Systems and Address System Shortcomings

ITS visits to Eastern Region Forests revealed that some Forest telecommunication systems, most frequently LMR systems, were not operating within design parameters due to system degradation or malfunction. In the majority of these cases, repairs can be made to return system performance to design levels, and proper system maintenance should ensure 3 to 5 additional years of dependable service.

ITS visits also revealed that some Forest telecommunication systems are simply obsolete and inadequate to meet mission needs; these systems should generally be replaced as soon as possible. In addition, some systems have design inadequacies that should be corrected to improve reliability, enhance performance, or improve communication with cooperators.

Implementation Step for the Regional Office —

- Provide technical guidance to Forests as required; most Eastern Region Forests have very limited technical expertise in telecommunications.

Implementation Steps for Eastern Region Forests —

- Ensure adequate system capacity, reliability, and performance. Actions taken could include adding a module to a key telephone system to increase capacity, installing an uninterruptible power supply to protect telephone and data communication systems from electrical power disturbances, establishing contract maintenance that includes periodic inspections and performance checks on all LMR systems, replacing faulty coaxial cables and antennas at LMR sites, replacing worn out LMR systems, increasing repeater frequency spacing from 600 kHz to 2 MHz or greater (requires Radio Frequency Authorizations), and augmenting existing radio coverage by adding a repeater or moving antennas. Estimated cost: from a few thousand dollars to several tens of thousands of dollars, depending on the particular Forest.

- Add capabilities commonly available to and used by cooperating agencies, contractors, vendors, and the general public; the intent here is not simply to have all the latest technology, but to improve productivity. Actions taken could include purchasing facsimile machines and adding voice mail capability to a telephone system. Estimated cost: from a few thousand dollars to several tens of thousands of dollars, depending on the particular Forest.

- Replace obsolete, inadequate systems with systems that manipulate information in digital form as much as possible and that have a well-defined upgrade path for future enhancements. Actions taken could include replacing an electromechanical key telephone system with a digital electronic key telephone system. Estimated cost: from a few thousand dollars to several tens of thousands of dollars, depending on the particular Forest.

- Consider use of a Personal Locator Beacon (PLB) emergency position determination system for personnel working in remote areas not well-served by the Forest LMR network. The PLB is a handheld transmitter that works in conjunction with a network of satellites to report the position of a party in distress to emergency rescue authorities. Estimated cost: $2000 for each PLB purchased.

Reaching the Forest Service Telecommunication Goals

ITS believes that following the strategy outlined above will effectively move Eastern Region Forests toward the telecommunication goals that arose from the needs analysis. In summary of

the strategic plan, a time line illustrating key strategic assessments and the implementation of the various strategy components is shown in Figure ES-2.

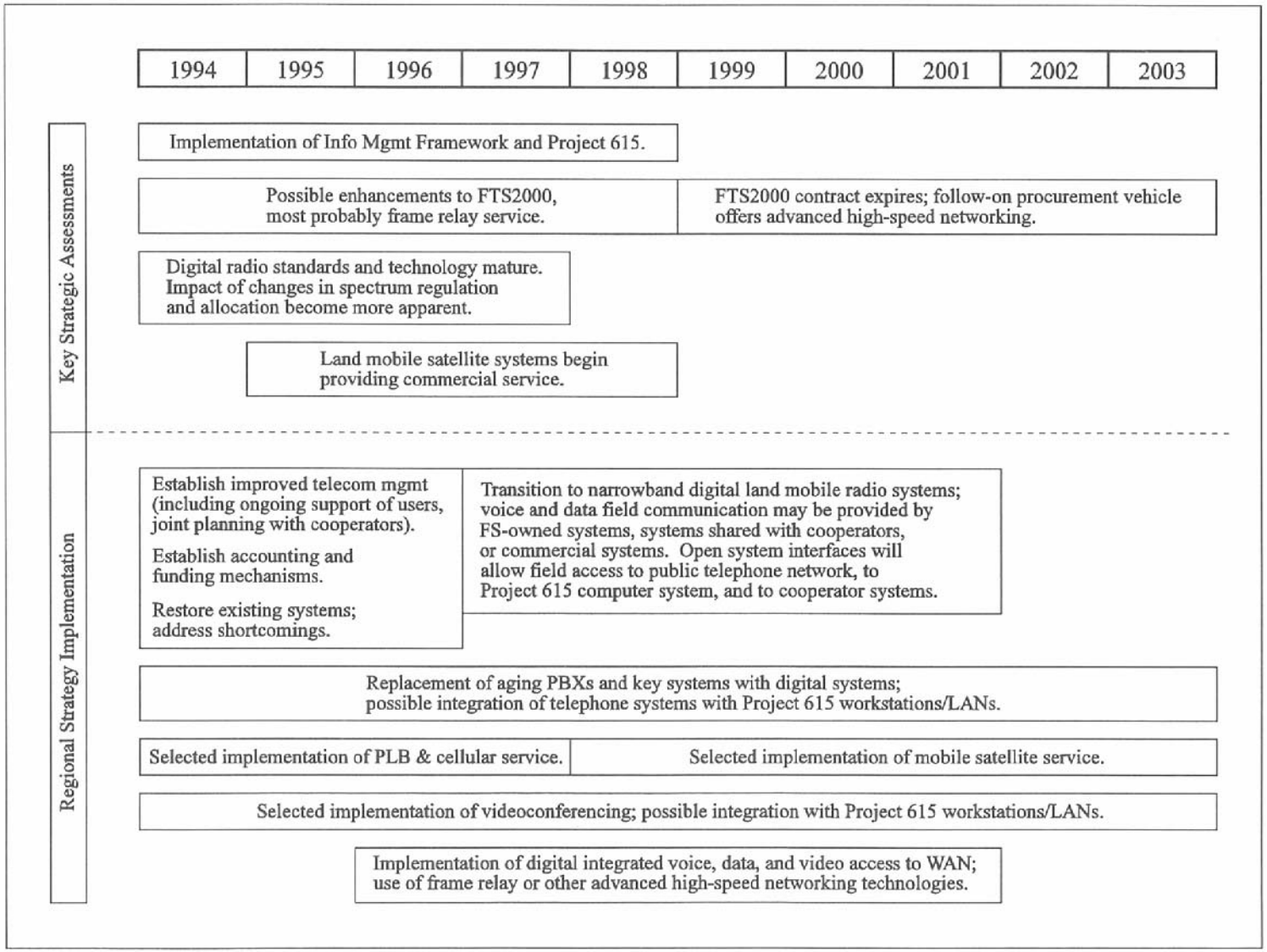

Figure ES-2. Timeline summarizing the regional strategic telecommunication plan.

U.S. DEPARTMENT OF AGRICULTURE FOREST SERVICE EASTERN REGION STRATEGIC TELECOMMUNICATION PLAN, 1994-2003

Wayne R. Rust, Eldon J. Haakinson[1]

This report documents the development of a telecommunication strategy for 1994-2003 for the Eastern Region of the U.S. Department of Agriculture Forest Service. The Institute for Telecommunication Sciences (ITS) identified telecommunication needs, assessed the existing telecommunication systems of the 15 National Forests in the Region, assessed internal and external factors that impact telecommunication planning, and assessed telecommunication technologies. Based on the foregoing, ITS developed a telecommunication strategy intended to ensure that Eastern Region telecommunication systems and services support the mission of the organization in a reliable and cost-effective manner.

Key words: data communication system; digital integrated network; Forest land mobile radio network; land mobile radio system; strategic telecommunication plan; tactical telecommunication plan; telecommunication management; telephone system

1. INTRODUCTION

The Eastern Region of the U.S. Department of Agriculture (USDA) Forest Service has taken steps to establish a strong telecommunication position for the future by developing telecommunication plans with the assistance of the Institute for Telecommunication Sciences (ITS). One of the mandates of ITS is to assist other Federal agencies in telecommunication system planning and design, and the Institute has performed a variety of work for the Forest Service during the last decade. ITS was tasked to develop an Eastern Region Strategic Telecommunication Plan and a Tactical Telecommunication Plan for each of the Region's 15 National Forests.

The Strategic Plan and the Forest tactical plans work in tandem to help ensure that Forest Service telecommunication systems and services support the mission of the organization in a reliable and cost-effective manner. The Strategic Plan addresses the period from 1994 through 2003, and is intended to provide overall guidance in telecommunication planning and implementation for the Forests in the Eastern Region.

The Forest tactical plans address the period from 1994 through 1996. They are unique to each Forest, and identify specific steps to take to begin to implement the regional strategy. They address telecommunication management issues, and they include product recommendations and estimated costs for equipment repair and/or replacement.

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The Strategic Plan and the tactical plans are intended to be "living documents," and they should be reviewed yearly and updated as necessary. A key aspect of telecommunication management is the management of change — technological, regulatory, economic, and political change. Though developed rigorously, there are elements of prediction and uncertainty in the plans, and they will need to be adjusted as the future unfolds.

The remainder of this report comprises the Strategic Plan. Sections 2 and 3 identify telecommunication needs and establish goals for the future of Forest Service telecommunications. Sections 4 through 7 incorporate assessments of existing Forest telecommunication systems, internal and external planning constraints, and telecommunication technologies. Section 8 describes a long-range strategy that takes all of the above factors into account; this strategy provides the framework for decision-making at the Forest level. Section 9 contains a timeline summarizing the assessments and implementation of the strategy. The Appendix contains a brief description of the Forest Service organizational structure and a map of the Eastern Region. The tactical plans for each of the National Forests in the Eastern Region are separate reports.

2. IDENTIFICATION OF FOREST SERVICE MISSION, GENERAL BUSINESS OBJECTIVES, AND ORGANIZATIONAL FUNCTIONS

Information is an organizational resource, and telecommunication systems should support the flow of information in accordance with the business objectives and functions of the organization. These objectives and functions must be understood so that telecommunication needs associated with them can be identified. These interrelationships are illustrated in Figure 1.

An organization's mission and accompanying business objectives are typically set by top-level management. In the case of the Forest Service, top-level management must ultimately be responsive to the general public, the President, Congress, and the Secretary of Agriculture; mission and objectives may be set directly by legislation.

Organizational structures and functions are developed to gather, store, transfer, process, evaluate, and generate information as needed to accomplish the mission and reach the business objectives.

Telecommunications is that portion of the Forest Service infrastructure that seeks to provide connectivity between personnel and access to the information needed by personnel to make decisions. Forest Service personnel identify their needs for telecommunication support to accomplish their role in the overall mission.

The Forest Service telecommunication goals describe a telecommunication environment wherein the needs expressed by Forest Service personnel will be met.

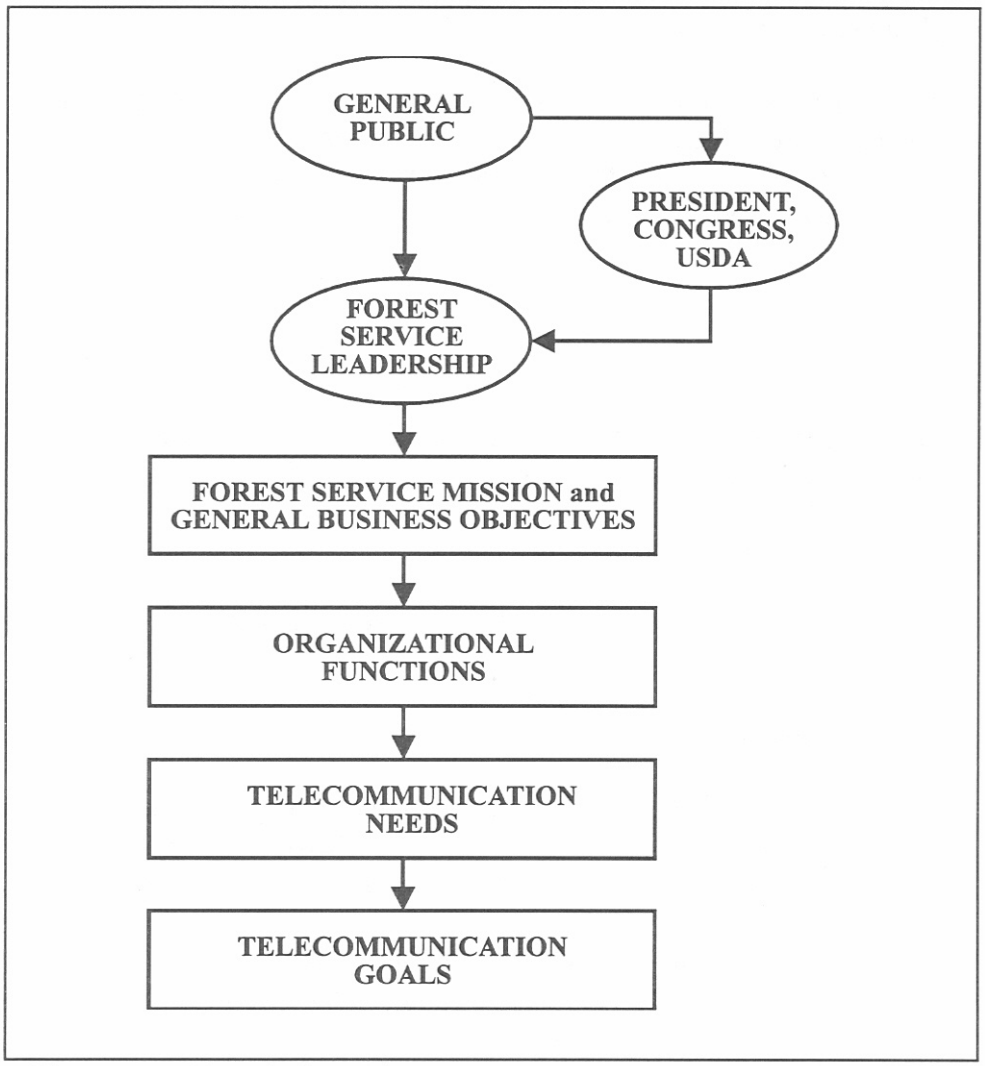

Figure 1. The mission-driven structure of the Forest Service and its impact on telecommunications.

To identify and understand the Forest Service mission, general business objectives, and organizational functions, ITS gathered and studied a variety of Forest Service literature and reference material. Each Forest of the Eastern Region was visited, and interviews were conducted with a cross-section of Forest personnel at the Supervisor's Office *(SO)* and at least one Ranger District (RD). Our findings are summarized below:

Forest Service Mission Statement —

- "Caring for the Land and Serving People."

General Business Objectives —

- Management of National Forest ecosystems in an integrated, systems-level manner for sustained yields of renewable resources such as water, wildlife, forage, timber, and recreation, thereby assuring the quality of the environment and the productivity of the land for present and future generations.

- Employee safety.

- Public safety.

- Cooperation/partnership with other agencies and organizations on the local, national, and international levels.

- Cooperation/partnership with the public.

- Efficient and effective use of the financial resources allocated to the agency.

Organizational Functions —

- Natural resource management — includes the management of lands, timber, fish and wildlife, soils, water and watersheds, vegetation and forage, mining/minerals/energy, recreation, wilderness, pests, air, and culture.

- Incident management — includes wildland fire suppression, disaster and accident relief operations, search and rescue operations, handling of demonstrations and environmental protests.

- Law enforcement.

- Administration — includes the management of personnel, funds, facilities, capital equipment, purchasing, information, and telecommunications.

3. IDENTIFICATION OF TELECOMMUNICATION NEEDS

Once the Forest Service mission, objectives, and functions were established in our interviews, ITS asked Forest personnel to identify telecommunication needs. No attempt was made to constrain these needs to the capabilities of existing systems, current technologies, or potential budget limitations. Instead, personnel were encouraged to identify any telecommunication capabilities that they felt would help them to more effectively carry out their role in accomplishing the overall mission of the Forest Service (FS).

The needs identified are listed below according to five categories, one for general needs and one each for needs associated with the organizational functions of natural resource management, incident management, law enforcement, and administration. The needs are not listed in order of priority. For the purpose of developing a long-range regional telecommunication strategy, they are considered equally important, though it is recognized that on a Forest-by-Forest basis, some needs would be considered more important than others.

Telecommunication Needs, General —

- User-friendly systems — equipment should be simple to operate, systems simple to use.

- Effective training — how to use equipment and systems. Those who would benefit from using advanced capabilities should be trained in the proper procedures.

- High system reliability — consistent performance, minimal downtime.

- Adequate system capacity — sufficient number of communication channels to ensure that users can access the system on demand, and sufficient channel capacity to ensure that users don't experience unacceptable delays in system response.

Telecommunication Needs, Natural Resource Management —

- Voice communication access for FS personnel in the Regional Office (RO), SOs, and RDs to their counterparts in other FS offices, cooperating agency offices, and the offices of contractors and vendors.

- Voice communication access for FS cooperators, contractors, and vendors to FS offices.

- Voice communication access for the general public to FS offices; demand for access fluctuates seasonally.

- Facsimile transmission between FS offices and the offices of cooperators, contractors, and vendors.

- Voice communication access for FS personnel or representatives[2] on duty in the field to SO, RD — 100% Forest coverage, during standard business hours.

- Voice communication access for FS personnel or representatives on duty in the field to other FS personnel in the field — 100% Forest coverage, 24 hours/day.

- Immediate voice communication access for FS personnel or representatives on duty in the field to emergency assistance (county sheriff, 9-1-1, local police, fire, medical-could be aircraft) — 100% Forest coverage, 24 hours/day.

- Voice communication access for FS personnel in the SOs, RDs, and on duty in the field to FS representatives, cooperators, contractors working in the field — 100% Forest coverage.

- "Secure" voice communication access for FS personnel on duty in the field.

- Direct voice communications access for FS personnel or representatives on duty in the field to the Public Switched Telephone Network (PSTN).

- Data communication links between FS personnel in the RO, SOs, and RDs and their counterparts in other FS offices that will support electronic mail, high-speed[3] text and graphics file transfer and database queries, video transmission.

- Data communication links between FS personnel in the RO, SOs, and RDs, their counterparts in cooperating agency offices and the offices of contractors and vendors, and the general public that will support electronic mail, high-speed text and graphics file transfer and database queries, electronic data interchange, video transmission.

- Data communication links between FS personnel on duty in the field and their counterparts in other FS offices, cooperating agency offices, and the offices of contractors and vendors that will support electronic mail, text and graphics file transfer and database queries, facsimile transmission.

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[2] FS representatives include non-FS employees who may be authorized to use FS communication systems; campground hosts and concessionaires are examples.

[3] High-speed> 64 kbps.

- Position determination capability that would allow a FS or emergency dispatch center to locate FS personnel or representatives at all times when on duty in the field. Non-verbal alarm capability for FS personnel or representatives down in the field, available at all times.

- Data communication links between remote sensors/monitors and recording/reporting (alarm) locations.

- Data communication links between remote video surveillance cameras and recording/reporting locations.

Telecommunication Needs, Incident Management —

- Voice communication access for incident management personnel in the RO, SOs, and RDs to their counterparts in other FS offices and cooperating agency offices.

- Voice communication access for FS cooperators, contractors, and vendors to FS offices.

- Facsimile transmission between FS offices and the offices of cooperators, contractors, and vendors.

- Voice communication access for incident management personnel on duty in the field to SO, RD — 100% Forest coverage, during standard business hours.

- Voice communication access for incident management personnel on duty in the field to incident dispatch, other FS personnel in the field — 100% Forest coverage, 24 hours/day.

- "Secure" voice communication access for incident management personnel on duty in the field.

- Field voice communication capability between FS and other-agency cooperators (Federal and non-Federal).

- Capability to monitor all voice communications (may be on different channels) from dispatch centers, RD base station.

- Sufficient number of voice communication channels to avoid system overload even during multiple initial attacks on the same Forest, allow assignment of various channels to different Incident Command System functions (Command,

Operations, Planning, Logistics, Finance) and networks (command, tactical, support, ground-to-air). Effective frequency management, including coordination at an incident and across regions/agencies.

- Access to the PSTN from the Incident Command Post; facsimile transmission capability .

- Data communication links between fixed field locations (such as the Incident Command Post) and dispatch centers that will support FS incident management computer applications such as INCINET, the Automated Resource Ordering System (AROS), and electronic mail.

- Data communication links between incident management personnel in the RO, SOs, and RDs and their counterparts in other FS offices that will support electronic mail, high-speed text and graphics file transfer and database queries, video transmission.

- Data communication links between incident management personnel in the RO, SOs, and RDs and their counterparts in cooperating agency offices that will support electronic mail, high-speed text and graphics file transfer and database queries, video transmission.

- Data communication links between fixed field locations (such as the Incident Command Post), FS offices, and other-agency offices that will support electronic mail, text and graphics file transfer and database queries.

- Data communication links between fixed field locations (such as the Incident Command Post), FS offices, and the media that will support video transmission.

- Data communication links between fixed field locations (such as the Incident Command Post) and aircraft that will support real-time transmission of infrared and video images.

- Capability to summon FS incident management personnel (without tying them down to the telephone in their house) if an incident occurs outside of normal working hours.

- Equipment that is environmentally ruggedized and mobile. Systems for use in the field must be flexible and expandable — speed is of the essence in set-up.

Telecommunication Needs, Law Enforcement —

- Voice communication access for each FS officer or agent in the RO, SOs, and RDs to their counterparts in other FS offices and cooperating agency offices.

- Voice communication access for FS cooperators, contractors, and vendors to FS offices.

- Facsimile transmission between FS offices and the offices of cooperators, contractors, and vendors.

- Voice communication access for each FS officer or agent on duty in the field to SO, RD - 100% Forest coverage, during standard business hours.

- Voice communication access for each FS officer or agent on duty in the field to other FS personnel in the field — 100% Forest coverage, 24 hours/day.

- Immediate voice communication access for each FS officer or agent on duty in the field to emergency assistance (county sheriff, 9-1-1, local police, fire, medical - could be aircraft) — 100% Forest coverage, 24 hours/day.

- Voice communication access for each FS officer or agent on duty in the field to other-agency law enforcement personnel also in the field — 100% Forest coverage.

- "Secure" voice communication access for each FS officer or agent on duty in the field.

- Direct voice communication access for each FS officer or agent on duty in the field to the PSTN.

- Data communication links between each FS officer or agent in the RO, SOs, and RDs and their counterparts in other FS offices that will support electronic mail, high-speed text and graphics file transfer and database queries, video transmission.

- Data communication links between each FS officer or agent in the RO, SOs, and RDs and their counterparts in cooperating agency offices that will support electronic mail, high-speed text and graphics file transfer and database queries, video transmission.

- On-line access for each FS officer or agent on duty in the RO, SOs, RDs, or in the field to law enforcement databases such as the National Crime Information Center (NCIC) and those maintained by the states.

- Data communication links between each FS officer or agent on duty in the field and their counterparts in other FS offices and cooperating agency offices that will support electronic mail, text and graphics file transfer and database queries, facsimile transmission.

- Position determination capability that would allow a FS or emergency dispatch center to locate FS officers or agents at all times when on duty in the field. Non-verbal alarm capability for FS personnel or representatives down in the field, available at all times.

- Data communication links between remote sensors/monitors and recording/reporting (alarm) locations.

- Data communication links between remote video surveillance cameras and recording/reporting locations.

Telecommunication Needs, Administration —

- Voice communication access for FS personnel in the RO, SOs, and RDs to their counterparts in other FS offices, cooperating agency offices, and the offices of contractors and vendors. Audio conferencing capability.

- Voice communication access for FS cooperators, contractors, and vendors to FS offices.

- Facsimile transmission between FS offices and the offices of cooperators, contractors, and vendors.

- Voice communication access for FS personnel on duty in the field to SO, RD — 100% Forest coverage, during standard business hours.

- Voice communication access for FS personnel on duty in the field to other FS personnel in the field — 100% Forest coverage, 24 hours/day.

- Immediate voice communications access for FS personnel on duty in the field to emergency assistance (county sheriff, 9-1-1, local police, fire, medical — could be aircraft) — 100% Forest coverage, 24 hours/day.

- Voice communication access for FS personnel in the SOs, RDs, and on duty in the field to contractors working in the field — 100% Forest coverage.

- "Secure" voice communication access for FS personnel on duty in the field.

- Direct voice communication access for FS personnel on duty in the field to the PSTN.

- Data communication links between FS personnel in the RO, SOs, and RDs and their counterparts in other FS offices that will support electronic mail, high-speed text and graphics file transfer and database queries, video transmission.

- Data communication links between FS personnel in the RO, SOs, and RDs and their counterparts in the USDA's National Computer Center and National Finance Center that will support electronic mail, high-speed text and graphics file transfer and database queries.

- Data communication links between FS personnel in the RO, SOs, and RDs and their counterparts in cooperating agency offices and the offices of contractors and vendors that will support electronic mail, high-speed text and graphics file transfer and database queries, electronic data interchange, video transmission.

- Capability for employees to access FS computer systems from home, other fixed sites while on travel.

- Data communication links between FS personnel on duty <u>in the field</u> and their counterparts in other FS offices, cooperating agency offices, and the offices of contractors and vendors that will support electronic mail, text and graphics file transfer and database queries, facsimile transmission.

- Position determination capability that would allow a FS or emergency dispatch center to locate FS personnel at all times when on duty in the field. Non-verbal alarm capability for FS personnel down in the field, available at all times.

- Data communication links between remote sensors/monitors and recording/reporting (alarm) locations.

- Data communication links between remote video surveillance cameras and recording/reporting locations.

- Capability to summon FS personnel (without tying them down to the telephone in their house) in case of an emergency outside of normal working hours.

3.1 Telecommunication Goals

It is useful to reduce the preceding detailed lists of telecommunication needs into a. set of goals for the future of Forest Service telecommunications.

Connectivity — All parts of the Forest Service organization will be interconnected by telecommunication networks that support the flow of voice, data, and video information. The Forest Service will be interconnected with other Federal, state, and local government cooperators, commercial cooperators, and the general public.

System Interoperability — The Forest Service will have open, standards-based telecommunication networks that support network services across levels of connectivity in a manner that is transparent to the user.

Network Integration — The Forest Service will implement integrated digital networks that carry voice, data, and video information over a variety of media, as opposed to separate networks for voice, data, and video. Integration will enable consolidation of network management functions such as administration, monitoring, and maintenance.

Performance and User Satisfaction — Forest Service telecommunication networks will provide sufficient capacity to support fast, reliable transmission of information. User interfaces will encourage the novice to use the networks yet provide the skilled user with power to be creative in the application of telecommunication technology to analysis and problem solving.

Mobility — Users will have access to the voice, data, and video information they need to make decisions regardless of their location or the time of day.

Telecommunication Management — The Forest Service will provide the staff, administrative support, and network management tools to effectively plan, procure, implement, operate, and maintain telecommunication networks and services.

The regional strategy will seek to move the Eastern Region from its current telecommunication environment toward the goals described above. As mentioned in Section 1, certain constraints affect the development of a strategy to reach the goals. Among these are the existing telecommunication systems on the Forests, internal factors that the Forest Service has c~mtrol over, external factors that the Forest Service has little or no control over, and current and evolving telecommunication technologies. These constraints are the subject of the next four sections of this report, and their relationship to the strategic planning process is shown in Figure 2.

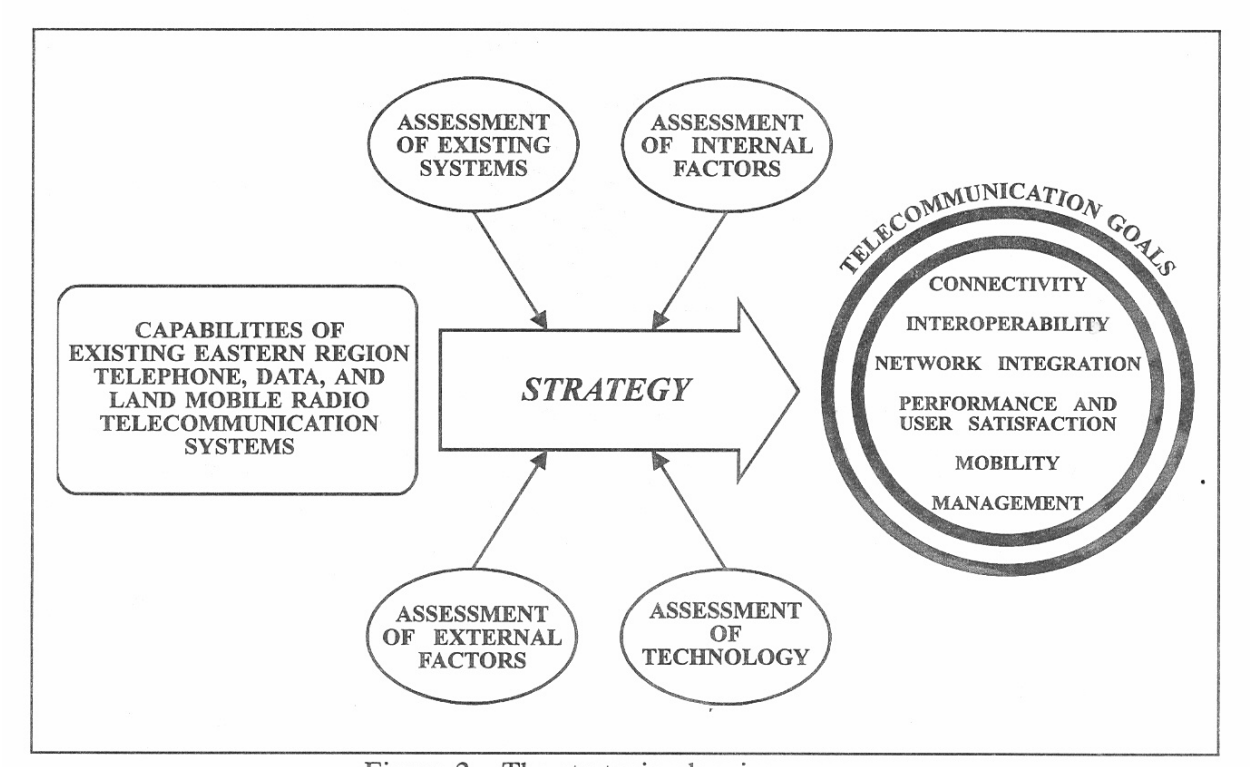


Figure 2. The strategic planning process.

4. ASSESSMENT OF EXISTING TELECOMMUNICATION SYSTEMS

The types of telephone, data communication, and land mobile radio (LMR) systems used by Eastern Region Forests are similar, allowing them to be addressed in general here. Detailed descriptions of Forest systems can be found in the individual Forest tactical plans. This assessment will attempt to answer the following strategic questions:

- Do existing systems function as intended, and can they be operated in a cost-effective manner? What is their life expectancy?

- Can existing systems be adapted and evolved to reach the telecommunication goals described in Section 3, or do they need to be replaced with fundamentally different technologies/ systems?

Telephone, data communication, and LMR systems exist largely as separate entities in the Eastern Region, and will be examined as such below. Access to the wide area voice and data services of Federal Telecommunication System 2000 (FTS2000) is also described.

4.1 Premises Telephone Systems and Local Exchange Service

Most SOs in the Eastern Region have a private branch exchange (PBX) installed. Equipment typically dates from the mid-to-late 1980s, and manufacturers include AT&T, Northern Telecom, Mitel, and ITT. The SOs are usually served by 4 to 10 central office trunks, and 40 to 100 stations are connected to the systems. There are a few SOs that obtain Centrex® service from their local exchange carrier (LEC), which provides many of the features of a PBX through the local central switching office.

RDs in the Region are served by small key systems. The age and type of equipment varies, even within the same Forest. Several RDs still have electromechanical 1A2 systems dating back to the 1960s, but most systems are analog electronic systems manufactured during the 1980s by AT&T, Northern Telecom, ITT, GTE-Comdial, Eagle, TIE, Mitel, Panasonic, NEC, Siemens, etc. The RDs are usually served by two to four central office trunks, and in a number of cases indicated a need for additional trunks, especially in locations which receive a large volume of calls from the public. Typically 12 to 36 stations are connected to the systems, depending on the number of personnel working at the RD. Some RDs have outgrown their systems and are unable to provide a telephone for each full-time permanent employee.

SO and RD telephone systems carry voice traffic only (no data). Most are owned rather than leased. Usually they are located in a basement or utility room near the building entrance point for the LEC trunks. Most systems are not protected by an uninterruptible power supply or power conditioner. Maintenance arrangements vary from an annual service contract to a "call as needed" arrangement. Because of their rural locations and large size, most Forests are served by several small LECs and have more than one maintenance provider. The telephone services available from the LECs are not consistent; for example, a number of RDs do not yet have access to dual-tone multifrequency (TouchTone™) dialing or cannot designate FTS2000 as their primary long-distance carrier.

Other equipment such as modems, facsimile machines, and text telephones may be connected to PBXs or key systems, or may have dedicated line connections. Dedicated lines may also be leased from the LEC for emergency voice communications with other-agency incident management or law enforcement personnel, for land mobile radio control circuits, or for emergency bypass of a failed PBX or key system.

Strategic Assessment

Eastern Region telephone systems are generally well-maintained and functioning properly. Systems less than 5 years old typically provide users with the capabilities and features they need now and will need over the next 3 to 5 years. Software upgrades should help to maintain the viability of these systems.

SOs and RDs with telephone systems that are more than 5 years old should begin to consider system replacement. The need to replace existing premises telephone systems must be evaluated on a case-by-case basis. In general, existing systems should be replaced if any of the following conditions exist:

- System is unreliable
- Maintenance and parts costs are prohibitive
- System manufacturer has gone out of business or has stopped supporting the system
- Demand for central office trunks or stations exceeds system capacity
- Features and capabilities of new systems offer significant improvements in productivity and/or reductions in operating costs.

Section 7.4 of this report reviews developments in customer premise telephone system technology, and offers guidelines concerning the selection of replacement telephone systems or Centrex® service.

Electrical power disturbances are relatively common, especially at RDs, and systems should be protected with an uninterruptible power supply or power conditioner.

Local exchange carriers should be encouraged to upgrade their equipment to offer at least dual-tone multifrequency dialing capability. An ongoing dialog about future needs should be established to help LECs plan for additional service upgrades, including circuits that will support digital transmission at 1.544 Mbps and above.

4.2 Data Communication Systems

SOs and RDs in the Eastern Region are equipped with Data General minicomputers and terminals running proprietary Data General software. The systems typically consist of an MV/15000 or MV/7800 central processing unit (CPU), dumb terminals connected via RS-232 lines, and peripherals such as printers, disk drives, and tape drives. The CPU is usually located in an air-conditioned computer room and may be protected by an uninterruptible power supply or power conditioner. Personal computers, used for such applications as computer-aided-design and mapping, may be part of the system as well. They are often directly connected to an RS-232 port and communicate with the CPU via Data General terminal emulation software.

Modems are often installed to allow employees at home or on travel the flexibility of a dial-up system access. Most sites are also equipped with a modem to allow remote diagnosis of minicomputer problems from Data General's Remote Access Center (RAC). Some Forests have additional facilities such as work stations or visitor centers with terminals which are connected via modems/dial-up line or multiplexers/leased line to the CPU. Line speeds range from 2.4 to 9.6 kbps.

Premises data communication cabling varies from site to site, depending on the age and type of building and other local factors. Most sites use multi-conductor RS-232 cable terminated with 25-pin D-subminiature connectors or flat telephone cable terminated with RJ-type connectors. A few sites use twisted pair cable terminated with RJ-type connectors.

All Forest Service Data General computers are interconnected via a packet switched wide area network provided under the FTS2000 contract. Packet transmission is based on the X.25 protocol. Network traffic includes electronic mail, file transfers, and database queries.

Strategic Assessment

The Data General computer systems are based on a national contract, which locks the Forests into a very structured information systems environment. Systems at the SOs and RDs are generally well-managed. Expansion of existing capabilities is limited, but a replacement system known as Project 615 is being planned and procured (see Section 5.2.2). Eastern Region Forests should follow Washington Office (WO) and RO guidance in preparing for the new system. Investments in Data General systems should be limited to relatively low-cost improvements in reliability, processing power, port capacity, or storage capacity as required on a site-by-site basis.

Existing data communication cabling is adequate for current Data General applications. Sites using RS-232 or telephone cable will need to install a new cable plant to support the new Project 615 computer system. Sites using twisted pair cable may be able to use it for the new system. Section 5.2.2 discusses these issues in more detail.

The performance and reliability of the FTS2000 X.25 packet switched network is adequate for current Data General applications. ITS does not expect that it will provide adequate performance for the new Project 615 computer system; this is discussed in more detail in Section 5.2.2.

4.3 Access to FTS2000 Wide Area Network

Wide area voice, data, and video communication services are provided for the Forest Service by FTS2000. AT&T operates the portion of FTS2000 used by the Forest Service, and currently offers the following six services:

- Switched Voice Service (SVS) — connections for voice circuits and analog data up to 4.8 kbps.

- Switched Data Service (SDS) — synchronous, full-duplex, digital circuit-switched data service at 56 or 64 kbps.

- Packet Switched Service (PSS) — packet-switched data service, based on the X.25 protocol.

- Dedicated Transmission Service (DTS) — dedicated, point-to-point, and point-to-multipoint private line services (analog and digital).

- Video Transmission Service (VTS) — compressed (near full-motion) and wideband (full-motion) video transmission services.

- Switched Digital Integrated Service (SDIS) — integration of voice, data, and video services by means of digital connectivity to network users.

SOs in the Eastern Region typically access SVS and PSS via SDIS. This allows the integration of voice and data, and the traffic aggregate results in cost savings over separate SVS and PSS access. The PSS access rate is typically 56 kbps.

RDs access SVS and PSS separately, since their lower levels of traffic do not justify integrated digital access at present. The PSS access rate is 9.6 kbps.

Figures 3 and 4 illustrate typical Forest access to FTS2000 services. A complete discussion of FTS2000 service access configurations and pricing is beyond the scope of this report; more information can be obtained from an AT&T publication, *FTS2000 Integrated Custom Network Reference Guide* [1], or by contacting the Electronics and Communications Group in the RO.

Strategic Assessment

The FTS2000 access configurations illustrated above are generally proving satisfactory for Eastern Region Forests. As LEC central offices upgrade to equal-access capability (a Federal Communications Commission requirement), RDs should consider moving to the more convenient and flexible virtual on-net configuration for their SVS. Ranger Districts without access to SVS should be connected as soon as possible. Integrated digital access to FTS2000 services at RDs should be considered to provide higher data rates in support of Project 615 (see Section 5.2.2).

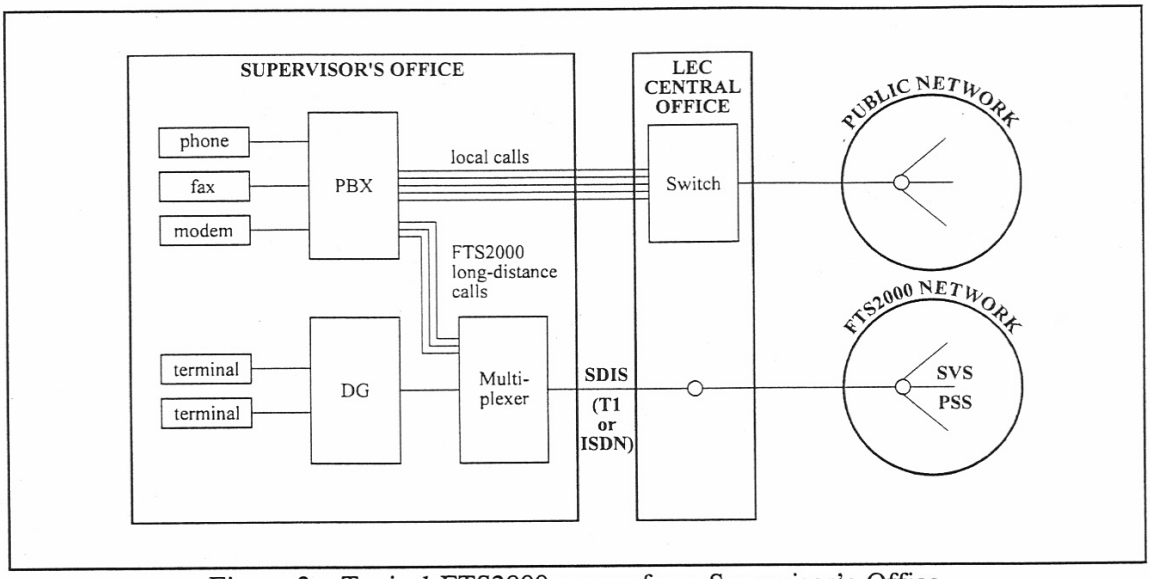
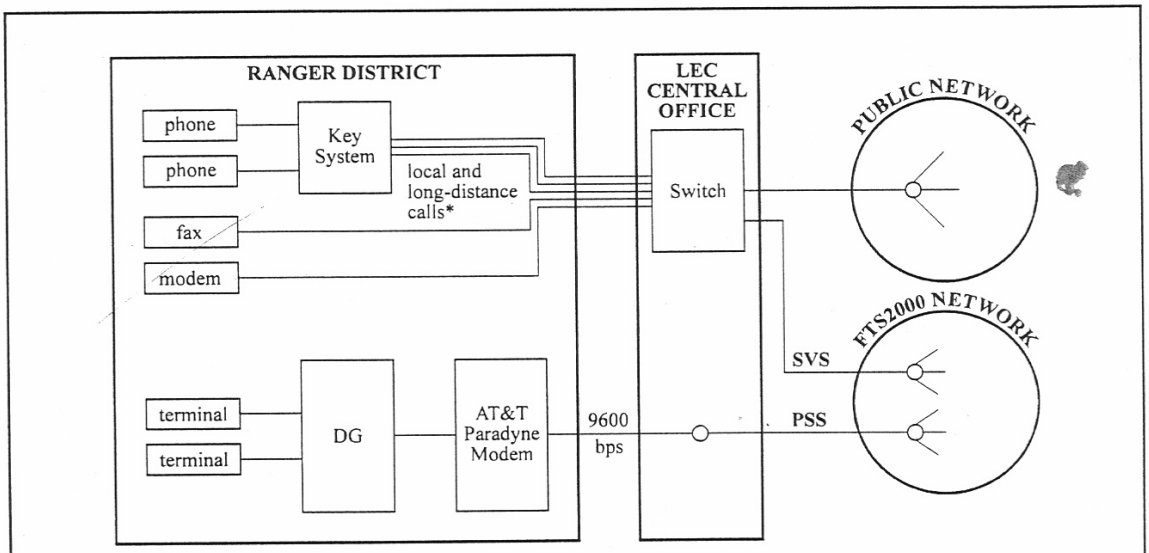


Figure 3. Typical FTS2000 access for a Supervisor's Office.



* This diagram depicts an RD served by an equal-access LEC central office capable of designating FTS2000 as the primary long-distance carrier, a configuration known as "virtual on-net." RDs served by LEC central offices that do not have this capability gain access to SVS directly through lines that bypass the central office switch, a configuration known as "on-net." On-net locations must select between local and long-distance lines before making a call, while in virtual on-net locations this selection is made automatically by the LEC switch.

Figure 4. Typical FTS2000 access for a Ranger District.

4.4 Land Mobile Radio Systems

Each Forest in the Eastern Region owns and operates a land mobile radio (LMR) network.[4] The networks are intended to provide voice communication for Forest Service personnel in the field. Field personnel may be either in a vehicle or on foot, and may need to communicate with the SO, the RDs, other Forest Service field personnel, local public safety agencies, or cooperating Federal and state natural resource management agencies.

LMR networks in the Eastern Region operate in the 162-174 MHz Federal frequency band, except for the Monongahela National Forest LMR network, which operates in the 30-50 MHz band. The reason for this exception is to minimize interference to the National Radio Astronomy Observatory, which is within the boundary of the Forest. Channel spacing is 25 kHz, and all equipment is analog. Typical network architecture is illustrated in Figure 5.

Base stations are located at the SO and RDs, and sometimes at work stations, visitor centers, or other facilities. Two equipment configurations are common:

1) Base station radio located within the SO or RD, usually in a basement or utility room, with the tower and antenna located just outside the building. Forest Service-owned wiring connects the radio control console(s) to the radio, and coaxial cable connects the radio to the antenna mounted on the tower.

2) Base station radio located at a site remote from the SO or RD, usually in a small enclosed shelter on high ground, with the tower and antenna located just outside the shelter. A leased telephone line or a radio link connects the radio control console(s) in the SO or RD to the radio, and coaxial cable connects the radio to the antenna mounted on the tower.

Control consoles typically are able to select one of two channels for communication with field personnel. "Channel 1" transmits to mobile and portable units directly, using a single radio frequency for transmit and receive. "Channel 2" is used to transmit to mobile and portable units through a repeater, thus extending the system range. Most Forests have more than one repeater, and base stations are equipped to select the desired repeater through the use of a tone that is transmitted in addition to the normal audio signal. Some knowledge of where the mobile or portable unit might be on the Forest is necessary for selecting the proper repeater. Transmissions from the field are always received on the same frequency, and can be heard on Channel 1 or Channel 2 if the audio output level of the control console is adjusted properly.

[4] The term "land mobile radio system" as used in this report refers to the interconnected set of components that comprise a single base station, repeater, mobile, or portable. The term "land mobile radio network" as used in this report refers to the collection of base station and repeater radio systems that serve an entire Forest.

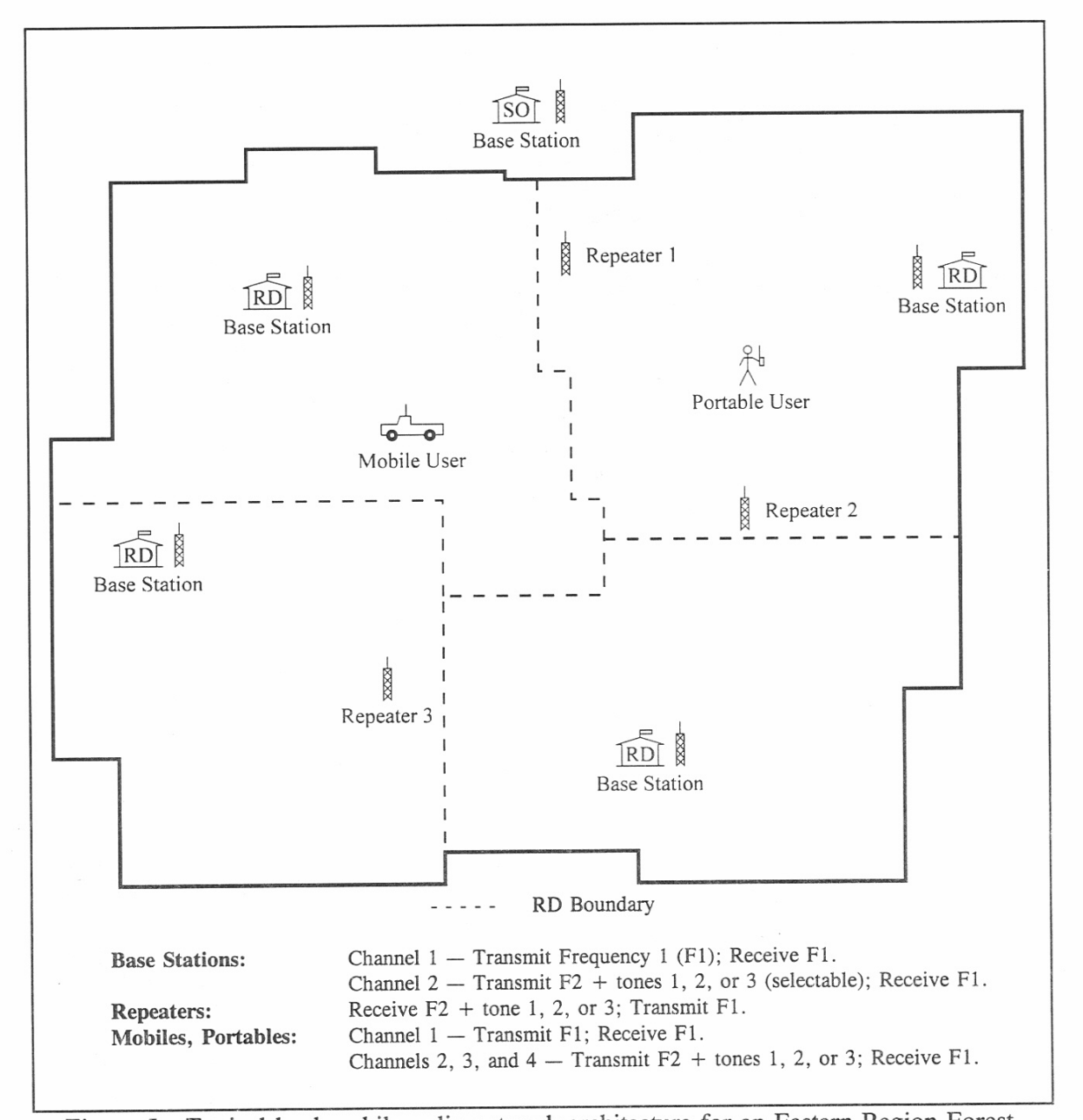


Figure 5. Typical land mobile radio network architecture for an Eastern Region Forest.

Base station radios in the Eastern Region are most commonly manufactured by Motorola, General Electric, and Aerotron. They are rated for radio frequency (RF) power output of 60 to 100 watts. Capacity is from two to four channels, and transmit and receive frequencies are crystal-controlled. Towers are usually galvanized steel, range in height from 40 to 120 feet, and

may be guyed or free-standing. They are typically owned by the Forest Service and located on Forest Service land. Antennas are usually omnidirectional, 6-dBd-gain, collinear or exposed dipole arrays, mounted at the top of the towers.

Repeaters are used in Forest radio networks to extend the communication range of base stations, mobiles, and portables. Upon receiving a signal, they rebroadcast it. Repeaters are usually located on top of mountains, hills, or ridges to maximize the coverage they provide. These radio sites are usually on Forest Service land, and may be shared with other natural resource management and public safety agencies. A four-wheel drive vehicle may be required for access, and commercial AC power may not be available. As with a remote base station, the radio is located in a small enclosed shelter, with the tower and antenna located just outside the shelter. A high tower (180 to 400 feet) may be used to compensate for a lack of ground elevation.

Repeater radios are typically manufactured by Motorola and General Electric. AC-powered units provide RF power output of 60 to 100 watts. Units powered by solar panels or fossil fuel generators are usually operated at lower power output to reduce the load on the power source. Transmit and receive frequencies are crystal-controlled. Single antennas, usually omnidirectional, 6-dBd-gain, collinear or exposed dipole arrays, are used in conjunction with duplexers, which isolate the transmitter and receiver. Spacing between the receive and transmit frequencies is usually only 600 kHz, which demands a well-tuned duplexer to prevent receiver desensitization.

A wide variety of mobile and portable radios are in use in the Eastern Region. They range from crystal-controlled units with only two channels and no tone capabilities for repeater selection to the latest synthesized programmable radios with over 200 tone-enabled channels. Users manually select the proper channel to communicate directly with base stations, other mobiles, other portables, or to use a repeater. Manufacturers include Motorola, General Electric, Repco, Midland, E.F. Johnson, and Bendix/King. Rated RF output power for mobiles ranges from 30 to 100 watts, and for portables from 1.5 to 5 watts. The newer synthesized programmable mobiles and portables are capable of communication with radios from state natural resource management agencies and local public safety agencies that operate in the 150-162 MHz band (30-50 MHz band for the Monongahela). This is accomplished by sharing allocated frequencies through a Memorandum of Understanding and programming the appropriate frequencies into the radios. For agencies that operate in bands other than the one used by the Forest, separate radios must be borrowed or purchased to facilitate interagency communication.

Strategic Assessment

During ITS visits to Eastern Region Forests, complaints were consistently heard about existing LMR networks. These included poor coverage, unreliable equipment, an inadequate number of channels for incident management, and poor or non-existent user training. Our interviews and radio site inspections typically revealed networks that had not been properly maintained, a lack of network and service documentation, and inadequate radio network management. The Forests

lack the capability to monitor system performance and perform periodic system checks themselves (due to a lack of telecommunication management personnel and diagnostic equipment). They lack the technical management skills to adequately supervise the work of local radio contractors. LMR systems degrade over time and require periodic maintenance, but ITS found that maintenance is typically performed only when systems quit functioning completely. Repairs are usually made by a contractor who has no network-level perspective and no sense of ownership.

With proper maintenance, the performance of most Forest base station and repeater systems could be brought within design specifications, and they could be operated reliably for an additional 3 to 5 years. They are, however, nearing the end of their useful lives — within the next 3 to 5 years radios will begin to fail more often, and repair parts will become more expensive and difficult to find. Many coaxial cables and antennas have already degraded after too many years of exposure to weather. Some mobile and portable radios are well over 10 years old and are unreliable and obsolete. System replacement has become a complex issue due to impending changes in regulation and technology; large investments in current technology would be unwise for most Forests. Sections 6.4 and 7.1 discuss this issue in more detail.

Proper management of Forest LMR networks is crucial. Without a clear understanding of radio network management functions and a commitment to see that they are carried out, even new, state-of-the-art systems will soon degrade and fail to perform as they should. Sections 5.1 and 8.1 address telecommunication management issues in more detail.

5. ASSESSMENT OF INTERNAL FACTORS

Among the constraints the Eastern Region must consider in developing a long-range telecommunication strategy are "internal factors." For the purposes of this report, internal factors are defined as policies, regulations, directives, initiatives, or programs that arise from within the Forest Service, and which the Forest Service itself has the power and authority to change. These factors may impact telecommunications directly; an example would be a policy requiring adherence to an industry standard for telecommunication cabling in buildings. These factors may also impact telecommunications indirectly; an example would be a new natural resource management program requiring a certain level of telecommunication support to be successful.

Forest Service internal factors fall into three main categories: telecommunication management, information management, and special initiatives or programs. The remainder of this section explores factors from each of these categories in more detail.

5.1 Telecommunication Management

The Forest Service Manual (FSM) [2] establishes objectives and policies for telecommunication management. It defines telecommunication management responsibilities and establishes procurement regulations.

5.1.1 Objectives

The FSM establishes several objectives for telecommunication systems management. Telecommunication systems are to support the wide-ranging mission and programs of the Forest Service, including natural resource management; administration; employee and public safety; public assistance in emergencies; fire prevention, detection, suppression, and rehabilitation; and law enforcement. Systems are to be planned, procured, operated, and maintained to meet needs in an economical and efficient manner. Staff competence in telecommunication management is to be maintained.

Strategic Assessment

These objectives are appropriate. They properly emphasize the support role that telecommunications plays in an organization, and establish the need for a broad range of telecommunication management skills.

5.1.2 Policies

The FSM establishes telecommunication management policies which are closely related to the objectives identified above. Telecommunication systems and services are to be planned and managed to ensure reliable, cost-effective support of Forest Service programs. The Forest Service is to operate a distributed computing system consistent with the decentralized nature of its organization and functions, with computing facilities linked by a data communication network. Information flow and workload measurements and projections are to be used to appropriately size computing and data communication facilities. Service-wide standards to guide managers and help assure hardware and software compatibility are to be developed. The Forest Service is to be a user, not a provider, of telecommunication services, with the following exceptions:

- The needed service is not available from outside sources.
- The needed service is not adequate from outside sources.
- The needed service is significantly more costly from outside sources.

When one or more of the above exceptions is met, the Forest Service is encouraged to share its telecommunication services with other Federal agencies.

Strategic Assessment

These policies are consistent with the objectives identified above. To effectively implement them, telecommunication management expertise must be distributed throughout the organization. The important role of standards is appropriately emphasized.

Because of the rural locations of many Forest Service facilities, needed telecommunication services are sometimes not available from outside (commercial) sources. The pace of technological change in telecommunications is rapid, however, and new and/or expanded commercial services are being introduced. The Forest Service is likely to find it increasingly difficult and expensive to operate, maintain, and upgrade the complicated telecommunication technology required to deliver advanced services, particularly in land mobile radio. The policy emphasis on using outside sources for telecommunication services is appropriate, but the Forest Service must maintain in-house telecommunication knowledge and technical management skills to ensure reliable, cost-effective support of Forest Service programs.

5.1.3 Responsibilities

The FSM provides a definition of telecommunication management responsibilities at the Region level. These responsibilities include

- Develop and maintain a Region Strategic Telecommunication Plan. Coordinate the development and maintenance of a Tactical Telecommunication Plan for each Forest within the Region. Approve tactical plans.

- Provide leadership, direction, and coordination of the management of telecommunication systems at the Forest level (within national guidelines). Direct training for the management of telecommunication systems.

- Evaluate Forest proposals for the procurement and implementation of telecommunication systems and services; provide technical consultation and formal technical approval.

- Manage all radio frequencies used by the Forest Service within the Region.

- Provide regional telecommunication liaison with other Federal and state government agencies, universities, and industry.

- Develop and maintain a Tactical Telecommunication Plan for Regional Office systems.

- Manage Regional Office telecommunication systems and services.

- Acquire and maintain personal expertise in all aspects of technical and operational areas of telecommunications.

Telecommunication management responsibilities at the Forest level are not clearly defined by the FSM.

Strategic Assessment

These telecommunication management responsibilities adequately define an appropriate role for the Regional Office. In relation to assisting Forests, they emphasize planning, leading, coordinating, training, and technical consulting. They also address the need to effectively manage RO telecommunication systems.

The Eastern Region maintains a Communications and Electronics Group in the RO consisting of two Electronics Engineers (GS-855). They are part of the Management Systems staff, which also oversees computer and information management. The two engineers are charged with carrying out the responsibilities listed above. They are spread too thin to be effective, and are not able to provide adequate assistance to the Forests. An additional staff position should be created.

At the Forest level in the Eastern Region, the telecommunication management function is typically split between three staffs. Telephone systems are usually managed by administrative or support services personnel; data communication systems by computer systems personnel; and LMR systems by administrative, civil engineering, or fire management personnel. Individuals responsible for these telecommunication systems usually have other primary responsibilities, and usually have no formal telecommunication background or training. Expenditures for telecommunication equipment and services often come from a number of different staff budgets, making it difficult to track costs. Coordination of Forest telecommunication systems from the SO is often lacking — RDs may act independently when it comes to maintaining or upgrading the systems that serve them. This fragmented approach and general lack of telecommunication expertise hinders effective telecommunication management. The poor condition of most Forest LMR systems is attributable to poor management.

There are a few exceptions to the above scenario. The Superior National Forest has a full-time Information Manager who is responsible for Forest telephone, data, and LMR telecommunication systems (among other responsibilities). A full-time Telecommunication Specialist (GS-391) works for the Information Manager. The Superior has implemented an effective program of performance monitoring and maintenance for its LMR systems. Its telecommunication systems are, in general, in the best condition of any in the Eastern Region. The Hiawatha National Forest has a full-time Telecommunication Specialist with a strong background in LMR systems. This Specialist also provides support to the Chippewa, Ottawa, and Huron-Manistee National Forests. This arrangement has not proven effective; four Forests spread across two states are simply too much for one person to cover. The Chequamegon and Nicolet National Forests in

northern Wisconsin share a full-time Electronics Technician (GS-856) whose primary responsibility is the management of LMR systems. This arrangement is proving effective in improving LMR management, but was phased in only recently during 1992 and 1993. The Mark Twain National Forest has a full-time Electronics Engineer (GS-855) whose primary responsibility is the management and maintenance of Forest computer systems. Forest telephone and LMR systems suffer from a lack of management.

There is a need in the Eastern Region for a clear definition of the telecommunication management responsibilities that should be carried out at the Forest level. Most Forests would benefit from a reorganization of their telecommunication management structure. These issues are addressed in Section 8.1.

5.1.4 Procurement

The procurement of telecommunication systems and services in the Forest Service is tightly coupled to strategic and tactical plans. According to the FSM, these plans are to serve as the basis for requests for formal technical approval, which is required for procurement, and for implementation.

Historically, telecommunication planning in the Eastern Region has centered around the replacement of Forest LMR systems. A Forest knew that every 11 years the RO would allocate funds for the replacement of its system, as long as a "radio plan" had been prepared and approved. This plan was to be completed 3 years in advance of procurement and installation so that the replacement dollars could be included in the regional budget process. The funds were held at the RO as "special project" dollars until released to a Forest. An RO task team that undertook a telecommunication review in 1989 concluded in its report that "what was considered to be telecommunication planning was actually only a radio replacement effort at best, and never attempted to link the other voice and data capabilities to resolve communication problems [3]. "

The report of the RO task team emphasized the importance of needs analysis and an integrated approach to telecommunication planning. It also identified the need for a well-defined budget process that would allow the Forests to maintain control and responsibility for telecommunication budgeting and spread the cost of telecommunication systems over several years. The team developed a Seven Step Process for telecommunication analysis, budgeting, and procurement, which was, according to [3], to apply to budgets starting in Fiscal Year 1990. The Process requires a Forest to perform an in-depth telecommunication needs assessment and complete a system design addressing those needs before submitting the telecommunication system replacement proposal as a capital investment project to be considered in the outyear budget package. When outyear budgets are developed, the applicable dollars for the telecommunication system replacement are to be shown as a Forest project and placed directly in the Forest proposed budget. The current year budget dollars for the telecommunication system replacement are to be given directly to the Forest and not held in the RO. The task team report also

recommended the eventual establishment of a working capital fund for the replacement of telecommunication systems on each Forest.

Strategic Assessment

The development and maintenance of strategic and tactical plans are critical to deploying telecommunication systems that reliably and cost-effectively support Forest Service programs. Comprehensive planning requires considerable time and effort, however, and can easily become a low priority because of more immediate concerns. To avoid this problem, telecommunication management personnel at the regional and Forest levels must be supported in the planning process with sufficient training, time, and funding to develop plans or to hire outside assistance.

The 1989 report of the RO task team contains many sound recommendations. Emphasis is well-placed on needs assessment and integrated planning that addresses telephone and data communication systems as well as land mobile radio systems. The breakup of AT&T and the variety of wide-area network services offered under the FTS2000 contract have made many more options available for voice and data communication. The Seven Step Process, however, has a built-in delay of 2 to 3 years between system design and actual purchase. As rapidly as telecommunication technologies are advancing, this virtually assures that the system(s) procured by a Forest will lack the most up-to-date capabilities. This could hamper productivity and cooperation with other agencies using more advanced technology. The establishment of a working capital fund would help overcome this problem by allowing dollars to be set aside for telecommunication systems while needs are being assessed and system designs are being prepared instead of after they have been completed.

5.2 Information Management

The Forest Service is in the midst of two major information management programs that will have a significant impact on telecommunications. One began in June 1991 when the Chief of the Forest Service assigned a national team to develop a strategic information management plan. In February 1992, this team published a report entitled *Information Management: A Framework for the Future* [4]. The recommendations of this report are currently being implemented. The second program, Integrated Information Management Project 615, began during the late 1980s, and is aimed at replacing the current Data General computer system with a new system designed to facilitate the storage, retrieval, analysis, and presentation of spatial information. System requirements have been defined, and a Request for Proposal (RFP) [5] was released to industry in October 1992. The following sections review these programs and assess their potential impact on the regional telecommunication strategy.

5.2.1 Information Management Framework

The Information Management Framework (IM Framework) was developed to help the Forest Service more effectively process, display, and use critical information resources. The IM Framework highlights the need to recognize that sharing and managing information are critical to performing the business of the organization, and the need to organize information management around the way the Forest Service conducts its business.

The IM Framework describes the current information environment as being characterized by separate databases that support individual Forest Service plans and programs. Inconsistently defined data, duplicated in separate databases and systems, has led to wasted effort in data collection and maintenance. Incompatible information cannot be effectively brought together for quality decision-making or timely, consistent response to requests for information. The Forest Service envisions a new information management environment where data are entered only once at the source, shared and available to all users, and systematically integrated with Forest Service plans and programs. The new environment will handle graphical as well as textual information, and support the decision-making and responsiveness missing in the current environment. The goal is to bring quality information, in the right form, to the right people at the right time to support sound and deliberate decisions and to generate ideas.

The IM Framework further states that the migration from the current local information environment to a shared information environment will be a long and challenging evolution, and that the process will require a very structured, organized approach built upon interdisciplinary field involvement. Seven strategies are outlined to help the Forest Service make the transition. The IM Framework was approved early in 1992.

Strategic Assessment

The integrated data and information environment envisioned by the IM Framework will require extensive telecommunication support in the areas of internetworking and high-bandwidth wide-area transport.

5.2.2 Integrated Information Management Project 615

In 1983 the Forest Service began implementing a distributed processing system that was designed to be accessible to all employees. This system now consists of over 900 Data General MV Series minicomputers spread across some 880 field sites. The system supports administrative, scientific, and technical applications, including data analysis, electronic mail, spreadsheets, word processing, statistical analysis, and database management. The system has served the Forest Service well, and has fundamentally changed the way the organization communicates and shares information. It has become apparent, however, that the Forest Service must upgrade its

information technology in order to carry out effectively its mission of "Caring for the Land and Serving People" through the end of this century and into the next.

The acquisition of a new information processing system has become known as "Project 615." A certain philosophical base underlies the program. The next-generation system is intended to move the Forest Service into an environment where all data is accessible electronically. This environment will be based on a combination of new technology and the appropriate management direction for its use. The Project 615 RFP identifies the following goals for the Forest Service information environment of the 1990s:

- **Mission Oriented.** The keys to the Forest Service's ability to achieve its mission are data and information. Data and information management systems will contribute to delivering Forest products, including water, wildlife, range, minerals, timber, and recreation opportunities, to constituents. They will provide for sharing data and information and effectively involving the public in decision-making processes. The hardware and software systems employed will be the tools to effectively manage the information resource. To be most effective, the information environment must be flexible, tailored to local needs, responsive to regional and national management concerns, and free Forest managers and their staff from routine tasks to enhance their professional decision-making ability.

- **People Oriented.** Every employee, and others as appropriate, will have ready access to the Forest Service data and information they need to do their job. To make data and information easy to use, a full range of flexible information support tools are needed to facilitate all aspects of work and to stimulate innovation.

According to the RFP, Project 615 has eight objectives.

- **Migration Path.** Provide a path for the migration of office automation functions currently performed by Data General minicomputers to a new system with similar or improved functionality.

- **Spatial Data.** Provide the capability to deal with spatially related data to all levels of the Forest Service.

- **Graphical User Interface (GUI).** Provide a consistent GUI for all users, for all applications, and for access to all information and computing resources.

- **Information Sharing.** Provide the capability to transparently share information among users within a local site.

- **Distributed Information.** Provide the capability to easily share information among the many locations where agency employees work.

- **Client/Server.** Acquire a technology platform based on client/server architecture that is flexible, scalable, and can grow with the Forest Service as needs change during the contract life.

- **Standards.** Support the Federal Government's move to the full Applications Portability Profile (APP) and Government Open Systems Interconnection Profile (GOSIP).

- **Non-developmental.** Base solutions on non-developmental hardware and software to the maximum extent possible.

The Project 615 RFP describes a distributed computing system of workstations and X-terminals connected via Ethernet LANs and an X.25 WAN. Key requirements are summarized below.

- The software is to include a multi-user, multi-tasking operating system; a geographic information system (GIS) that will support both spatial coordinate data and associated attribute data in analysis and display; a database management system that will support distributed databases over the LANs and WAN; and an office automation package that will support word processing/publishing, spreadsheet, business/presentation graphics, calendar, and electronic mail applications.

- The hardware is to include processors based on a full 32-bit implementation; servers, workstations, and X-terminals equipped with 16- and 19-inch high resolution color monitors; and peripherals such as mass storage devices, laser printers, color printers, small and large color plotters, monochrome and color scanners, and digitizers.

- LAN hardware is to include transceivers, bridges, routers, and gateways that provide support for twisted pair (10BaseT) and thin coaxial (10Base2) Ethernet cabling; network control devices; and Ethernet adapters. Servers, workstations, X-terminals, and peripherals are to be connected to the LAN in configurations ranging from a few machines to hundreds of machines. The contractor is responsible for equipment up to and including the transceiver, but not for the LAN medium itself. Both Open System Interconnection (OSI) and Transmission Control Protocol/Internet Protocol (TCP/IP) protocol suites are required for full system connectivity. LAN management tools shall be accessible both locally and remotely over the WAN or through a dial-in modem.

- LAN hardware and software are to operate over synchronous connections to an X.25 packet-switched WAN. Speeds up to at least 64 kbps are required, including 4.8 kbps, 9.6 kbps, 19.2 kbps, and 56 kbps. The LAN architecture shall provide full connectivity for all workstations and terminals comprising a system through a single X.25 port connected to the WAN at each office. The contractor shall provide a capability to configure and manage the WAN access capabilities of the offered

system. WAN management tools shall be accessible both locally and remotely over the WAN or through a dial-in modem.

- The file transfer capabilities of the OSI and TCP/IP protocols on both the LAN and WAN shall be capable of transferring files of any size up to and including at least five megabytes in a single transfer.

The Project 615 RFP was released October 16, 1992. The General Services Administration's Federal Computer Acquisition Center (FEDCAC) is handling the procurement. Bids were due in April 1993, and a contract award is targeted for spring 1994. The first 12 to 18 months of the contract will consist of a pilot phase during which systems are installed in a sampling of Forest Service offices to "iron out" implementation issues. Full implementation should begin in 1995, and take 2 to 3 years to complete.

Strategic Assessment

The Project 615 computing platform, with its support of a GIS and graphics applications, will offer users capabilities that are significantly more advanced than those offered by the Data General system. Use of these capabilities will gradually increase with user training and experience, and these factors, combined with the establishment of the shared information environment envisioned by the IM Framework, will result in heavy data traffic between the SO and RDs of a Forest and between the RO and all the SOs. This traffic will include

- electronic mail messages
- small file transfers (text and simple graphics; file size less than 100 kilobytes)
- large file transfers (text with complex graphics, GIS files, engineering drawings, and images; file size 100 kilobytes to several megabytes)
- frequent database queries.

Current data communication traffic in the Eastern Region consists of mainly electronic mail messages and small file transfers. Despite the additional traffic which will result from the implementation of Project 615, the RFP specifies the same X.25 WAN and WAN access configurations used to interconnect the Data General computers. Consider the transfer of a one megabyte GIS file across the WAN. Assuming a WAN access rate of 64 kbps and taking into account the X.25 protocol overhead and the presence of other traffic, the file transfer time will be several minutes. ITS expects that such delays will prove unacceptable to Forest personnel, and that the performance of the X.25 WAN will prove inadequate to support Project 615 and the IM Framework. See Section 7.6 for a discussion of alternative WAN technologies.

The Project 615 RFP requires that the contractor provide equipment that can support twisted pair (10BaseT) or thin coaxial (10Base2) cabling, but notes that the Forest Service will be responsible for installing the LAN cable plant at each site. A well-engineered and properly installed cable plant is critical to the successful operation and management of a LAN. The Information Systems and Technology staff of the WO has provided wiring recommendations in a February 1993 letter [6] that will become part of the Forest Service Handbook. The recommendations are intended "to provide a utility that will meet the total telecommunications connectivity requirement of a building or facility." Forests are to adhere to Electronic Industries Association (EIA)/Telecommunications Industry Association (TIA)-568, *Commercial Building Telecommunications Wiring Standard* [7] and EIA/TIA-569, *Commercial Building Standard for Telecommunications Pathways and Spaces* [8]. Fiber optic and unshielded twisted pair cable are to be used in a distribution scheme that will bring two four-wire-pair cables to each work location to provide connectivity for digital or analog voice telephones and Project 615 workstations. Installing new premises wiring will take considerable planning and will require oversight of a wiring contractor. Forests should begin planning and budgeting for their Project 615 cable plants now to ensure that they will be ready when their computing equipment arrives. Installation of the new cable plant should be coordinated with any moves to new office space.

5.3 Special Initiatives

The mission of the Forest Service is "Caring for the Land and Serving People." At the core of this mission is a Congressional mandate to implement "multiple-use management" of National Forest System lands for sustained yields of renewable resources such as water, forage, wildlife, timber, and recreation. Under this management concept, the best combination of uses benefits the American people and assures the productivity of the land and quality of the environment for present and future generations [9]. A number of special Forest Service initiatives have arisen recently that shape the way this mission is carried out.

5.3.1 1990 Resources Planning Act Program

The Forest and Rangeland Renewable Resources Planning Act (RPA) of 1974 and the National Forest Management Act (NFMA) of 1976 established a long-range planning framework that the Forest Service must follow. An Assessment of long-term demands and supplies of renewable resources on the Nation’s 1.6 billion acres of Forest and rangeland under all ownerships is prepared every 10 years, and a long-range Program for all Forest Service activities, based on the Assessment, is prepared every 5 years. The 1990 RPA Program [10] identifies four major themes that will be "vigorously pursued" over the next 5 to 10 years:

- Recreation, wildlife, and fisheries enhancement
- Environmentally acceptable commodity production

- Improved scientific knowledge about natural resources

- Response to global resource issues.

The 1990 RPA Program renews the Forest Service's commitment to a rounded-out multiple-use management program within the context of increased environmental sensitivity. All of the Forest Service's organizational components will focus their objectives and activities on these themes.

5.3.2 Strengthen Partnerships

Forest Service management has placed a renewed emphasis on forming partnerships [11]:

- With the American people — to better incorporate their views and values into Forest Service thinking and management, to improve "customer service" for users of the Forests.

- With other conservation and land management agencies and organizations — to share information and resources, to improve cooperation.

- With outdoor recreation and user groups, other recreation providers — to cooperate in developing new opportunities, programs, and facilities.

5.3.3 New Perspectives Program

The Forest Service is initiating a program in the 1990s called "New Perspectives for Managing the National Forest System" to take a fresh look at Forest Service management practices. It commits the agency to a broadened sensitivity to ecological and social values in providing a sustained yield of multiple uses from the National Forests and Grasslands [10]. Elements of the New Perspectives program include [12]

- Stewardship of the land to sustain natural communities and provide opportunities for people to enjoy public lands and resources.

- Relationships that involve people in public land management decisions to help meet their needs and interests.

- Cooperation between Forest Service land managers and scientists to integrate research and resource management.

- Flexibility in research, thinking, and management practices so that resource managers and scientists use their creativity and experience to explore, develop, and demonstrate new technology and good land stewardship.

- Applications that address critical natural resource issues such as biological diversity, range conditions, timber harvest methods, oil and gas leasing, and old-growth Forests.

Strategic Assessment of Special Initiatives

The Forest Service mission and these special initiatives associated with it set the context for the IM Framework, Project 615, and national and regional telecommunication strategies. More than ever, the Forest Service is becoming an information-driven agency, with acute needs to process and distribute information within the agency as well as exchange it with cooperators, who may be domestic or international, and the general public. These needs suggest an increasing amount of telecommunication network traffic during the next decade.

6. ASSESSMENT OF EXTERNAL FACTORS

In addition to the internal factors described in Section 5, the Eastern Region must consider certain "external factors" in developing a long-range telecommunication strategy. These external factors are beyond the direct control of the Forest Service, and include telecommunication policies and regulations established by other Federal agencies. They also include the current and planned telecommunication systems of Forest Service cooperators.

Several Federal entities outside the Forest Service set telecommunication policies and regulations that impact the Forest Service. These include the General Services Administration (GSA), the National Communications System (NCS), the National Institute of Standards and Technology (NIST), the National Telecommunications and Information Administration (NTIA), the United States Department of Agriculture (USDA), and the President and the Congress. The Federal Communications Commission (FCC) is responsible for the regulation of non-Federal telecommunications, and since the Forest Service works with various state and local agencies, an examination of the FCC's activities is also relevant here. The following sections describe in general the roles of the above Federal agencies, and discuss specific issues related to Eastern Region telecommunication strategy.

6.1 General Services Administration

The General Services Administration was established under the Federal Property and Administrative Services Act of 1949, in which the GSA was authorized to prescribe standard purchase specifications and to direct their use in the Federal procurement process. The Federal

Information Resources Management Regulation (FIRMR) [13] is issued by the GSA and applies to the acquisition, management, and use of information processing resources by Federal agencies. From time to time, the GSA issues nonregulatory publications to provide guidance and information. FIRMR bulletins, handbooks, and reports are the documents most frequently used to issue this guidance material.

Several parts of the FIRMR have important ramifications for Eastern Region telecommunication planning. Subpart 201-20.2 prescribes policies and procedures for identifying and analyzing feasible alternatives to satisfy telecommunication needs. Agencies are required to

- Use GSA's mandatory-for-use programs when their requirements can be met by these programs, unless they have requested and received an exception to the use of these programs from GSA.

- Use GSA's mandatory-for-consideration programs when their requirements can be met by those programs and using them is the most advantageous alternative to the Government.

- Consider using resources available for reuse within the agency and from other agencies.

- Consider using existing resources on a shared basis.

- Consider acquiring resources by contracting.

Subpart 201-24.1 describes GSA mandatory-for-use programs. Federal agencies must use FTS2000 for long-distance telecommunication services. The FIRMR states that GSA will enhance existing services and add features to FTS2000 to maintain technologically current services and to improve services to user agencies. Agencies must also use GSA consolidated local telecommunication service where it is provided. GSA's policy is to provide local service where it can add value compared with similar service offered directly in the marketplace, and such service is available in most buildings or complexes occupied by concentrations of Federal employees. GSA may also designate a Federal agency to be responsible for meeting the needs of other agencies at a particular location. Purchase of Telephones and Services (POTS) contracts provide for the purchase, installation, maintenance, repair, removal, and relocation of telephone equipment, and are mandatory sources of supply at most locations where GSA provides consolidated local service. POTS contracts are available for optional use at other locations. Requests for exceptions to mandatory use must demonstrate unique requirements that cannot be satisfied and must justify a cost-effective alternative. FIRMR Bulletins C-15 (Mandatory local service), C-18 (FTS2000), and C-21 (POTS contracts) provide additional guidance in these areas.

Subpart 201-24.2 describes GSA mandatory-for-consideration programs. They include the Federal Software Exchange Program, the Excess Federal Information Processing Equipment

Program, the Federal Secure Telephone Service, and GSA-provided information systems security services.

FIRMR Bulletin C-l provides additional information and guidance about the sharing of local telecommunications resources. Agencies are encouraged to share resources not only with other Federal agencies, but to consider sharing systems with state and local agencies, as well. GSA is available to assist in developing a Memorandum of Understanding (MOU) between the involved agencies.

Part 201-18 of the FIRMR notes that Section 508 of the Rehabilitation Act Amendments of 1986 (Public Law 99-506) requires the Federal Government to adopt guidelines for electronic equipment accessibility designed to ensure that individuals with disabilities may use electronic office equipment. FIRMR Bulletin C-10 provides guidelines for acquiring products and services that provide telecommunications accessibility for hearing and speech impaired individuals.

Strategic Assessment

The mandatory use provisions of the FIRMR generally serve the Eastern Region well. While most sites make effective use of FTS2000 long-distance voice and data services, only a handful of sites are in locations where GSA provides consolidated local telecommunication service.

GSA's emphasis on sharing resources and systems should be given careful consideration by Eastern Region Forests. The sharing of systems presents certain administrative challenges, but also offers considerable potential for reducing expenses and improving interagency communication. In particular, standards-based trunked digital LMR systems designed to support many users with a limited number of frequencies are expected to become available within the next several years, and sharing such a system could allow an Eastern Region Forest and its state and local cooperators to respond more effectively to incidents. See Sections 7.1 and 7.2 for additional discussion of digital LMR technology and shared systems.

Many Eastern Region Forests are already purchasing and installing text telephones to accommodate those with hearing impairments; this effort should continue until all sites are equipped. The Project 615 RFP specifies that computing equipment must be available to accommodate those with disabilities.

6.2 National Communications System

During the Cuban Missile Crisis in 1962, President John F. Kennedy and other Federal officials came to realize that their efforts to manage the crisis were greatly hampered by the lack of effective means for the Federal Government to communicate and coordinate time-sensitive information. In August 1963, the President established the National Communications System (NCS) to ensure that the Federal Government has the telecommunications necessary to meet its

national security and emergency preparedness (NS/EP) responsibilities under all conditions [14]. As an organization, the NCS brings together the assets of 23 Federal departments and agencies (including the Department of Agriculture) to address the full range of NS/EP telecommunication issues. It incorporates changing legislative, judicial, and technical issues in interagency emergency telecommunication planning activities. The NCS functions through an administrative structure that includes the Secretary of Defense as the Executive Agent; the Director, Defense Information Systems Agency, as the Manager; and a Committee of Principals with representation from each of the Federal member organizations.

Telecommunication standards are critical to achieving interoperability among systems used by the Federal Government. The NCS Office of Technology and Standards conducts the Federal Telecommunication Standards Program (FTSP), which develops Federal standards, participates with industry in national and international standards forums, and provides technical guidance required to achieve interoperability among networks of the NCS. Whenever feasible, the FTSP utilizes existing or evolving industry, national, and international standards as the basis for Federal telecommunication standards.

The Federal Telecommunication Standards Committee (FTSC), chaired by the Assistant Manager, Office of Technology and Standards, serves as the primary mechanism for NCS member agencies and other entities to participate in FTSP work. The FTSC is comprised of members from 16 Federal agencies, and is broken down into various subcommittees to address different issues. The FTSC coordinates proposed Federal standards with manufacturers, state and local governments, and the public. The committee approves proposed Federal telecommunication standards for transmittal to GSA for final approval and publication.

The chairman and several members of the Land Mobile Radio Subcommittee of the FTSC have been participating in a joint effort known as Project 25 to develop standards for narrowband digital LMR equipment. This standards development effort is described more fully in Section 7.1. A Federal Standard is likely to result from this work in 3 to 4 years.

Strategic Assessment

The FTSP provides important coordination and guidance for the Forest Service in telecommunication planning. A Federal standard for narrowband digital LMR systems that is well-coordinated with Project 25 and resulting industry standards will be critical to ensuring that Eastern Region Forests can make a cost-effective transition to the next generation of LMR systems and improve field communication with other agencies. RO telecommunication management should support the WO and the Department of Agriculture in their participation in the FTSP, and should remain abreast of Federal standards development to be able to help keep Forest telecommunication management informed.

6.3 National Institute of Standards and Technology

The National Institute of Standards and Technology, among other responsibilities, develops computer and related telecommunication standards and guidelines, and provides technical assistance to agencies. The National Computer Systems Laboratory (NCSL), one of NIST's major science and engineering organizations, administers the Federal Information Processing Standards (FIPS) program. The focus of the program is to help Federal agencies make effective use of computers and information technology, and includes the development of standards, test methods, performance measures, guidelines, and information documents, as well as the conduct of research on computer and related telecommunication systems. Work is performed in close cooperation with other standards bodies such as the American National Standards Institute (ANSI) and the Institute of Electrical and Electronics Engineers (IEEE). Documents issued by the NCSL are known as FIPS Publications (FIPS PUBS).

FIPS PUB 146-1 [15] defines a suite of telecommunication protocols based on the Open Systems Interconnection (OSI) Reference Model and corresponding protocols developed by the International Standards Organization. This protocol suite is known as the Government Open Systems Interconnection Profile (GOSIP), and its use is mandated for all new Federal computer systems. Section 5.2.2 noted that the Project 615 RFP specifies GOSIP compliance.

Although adherence to GOSIP has been mandated since 1990 and the profile has been updated to include more protocols, implementation in the Federal sector has been very slow [16]. Few GOSIP products are available from vendors, and the ones that are available are expensive and difficult to implement. In the Private Sector, a suite of internetworking protocols commonly known as TCP/IP has been widely and successfully implemented. The TCP/IP suite is in the public domain, and therefore is available free of charge to manufacturers. The Internet is based on TCP/IP, and in corporate networks, TCP/IP is beginning to supplant traditional proprietary protocol suites such as IBM's System Network Architecture and DEC's Digital Network Architecture.

Open-systems advocates have been pushing for a compromise that would allow the incorporation of at least part of the TCP/IP suite into GOSIP. In July 1993, NIST agreed to set up the Federal Internetworking Requirements Panel to evaluate the current and potential fit between Government requirements and the two protocol suites and make recommendations on the feasibility of alternative scenarios for coexistence, interoperability, and convergence. The Panel is also expected to consider the cost and impact on agencies of the alternate scenarios [17,18]. Panel recommendations will likely be factored into the next revision of GOSIP, Version 3.

Strategic Assessment

Though any revisions to GOSIP that might be made in 1994 will come too late to affect the specification and award of the Project 615 contract, these developments should still be tracked by the RO. Blending the TCP/IP protocol suite into GOSIP would offer Federal agencies more

flexibility in implementing internetworks and sharing information with the Private Sector, and should result in reduced costs for networking equipment and software.

6.4 National Telecommunications and Information Administration

The National Telecommunications and Information Administration, an agency of the Department of Commerce, is responsible for managing the Federal Government's use of the radio spectrum. NTIA establishes policies concerning frequency assignment, allocation, and use, and provides the various departments and agencies with guidance to ensure that their conduct of telecommunication activities is consistent with these policies. In addition, NTIA serves as the President's principal advisor on telecommunication policies pertaining to the Nation's economic and technological advancement and to the regulation of the telecommunication industry. NTIA helps develop telecommunication policy and seeks to effectively present Executive Branch views on telecommunication matters to Federal agencies, the FCC, Congress, and the public. NTIA also works with the FCC to plan for the efficient use of the electromagnetic spectrum. [19]

The frequency management support organization of NTIA includes the Interdepartment Radio Advisory Committee (IRAC). The IRAC consists of representatives from some 20 Federal departments and agencies and a liaison from the FCC. Its basic functions are to assist NTIA in assigning frequencies to U. S. Government radio stations and in developing and executing policies, programs, procedures, and technical criteria pertaining to the allocation, management, and use of the spectrum [19]. Each radio station operated by a Federal agency must have a Radio Frequency Authorization (RFA) that assigns a frequency and constrains the station to certain parameters to avoid interference with other stations.

The 162-174 MHz frequency band is the band most heavily used for Federal non-military land mobile communications. The LMR systems used by 14 of the 15 National Forests in the Eastern Region operate in this band. In response to increased demand for land mobile frequency assignments, NTIA moved in 1992 to halve channel widths from 25 kHz to 12.5 kHz in the 162-174 MHz band. After January 1, 1995, all new equipment, and after January 1, 2005, all equipment in the band must be capable of operating within a 12.5 kHz channel in accordance with certain transmitter and receiver characteristics. The new narrowband channeling plan may be used at present, but wideband (25 kHz channel) assignments will continue to be authorized until January 1, 1995. Wideband renewals may be granted through January 1, 2005, at which time all assignments must conform to the 12.5 kHz channeling plan. Existing operations will remain on their currently assigned channel when rechannelization becomes effective. Exceptions to the rule may be authorized on a case-by-case basis, provided they are needed to satisfy mission requirements and have been properly coordinated with all affected agencies. [20]

Under the National Telecommunications and Information Administration Organization Act of 1992 [21], NTIA is to advance policies "fostering national safety and security...and the delivery of critical social services through telecommunications... fostering full and efficient use of the radio spectrum by the Federal Government, in a manner which encourages the most beneficial

uses thereof in the public interest." The Act requires that "in assigning frequencies for mobile radio services... the Secretary of Commerce [acting through NTIA] shall promote efficient and cost-effective use of the spectrum to the maximum extent feasible", and "the Secretary of Commerce shall adopt and commence implementation of a plan for Federal agencies...to use...technologies that are at least as spectrum-efficient and cost-effective as readily available commercial mobile radio systems." Furthermore, the Act authorizes the Secretary "to withhold or refuse to assign frequencies for mobile radio services...in order to further the goal of making efficient and cost-effective use of the spectrum."

A summary report was sent to Congress in October 1993, and the complete plan is detailed in [22]. The objectives of the plan are to ensure that Federal agencies using LMR technologies and services

- Use spectrum-efficient and cost-effective radio technologies to satisfy LMR communication requirements, thereby minimizing both the amount of spectrum used and the long-term cost.

- Use commercial sources or shared systems to provide LMR communication services unless services or systems that can meet telecommunication mission requirements are not available or the available services or systems would cost more than alternatives.

The NTIA Report contains an analysis of existing Federal Government use of the spectrum for mobile services, the status of mobile communication technology, and existing NTIA and other agency policies regarding mobile services. A list of findings is included, and the key recommendations of the plan are summarized below.

- NTIA should implement regulations that require Federal Government agencies replacing aging land mobile communication systems and implementing new ones to use available commercially offered land mobile services, or to share land mobile services operated by other Federal, state, or local government agencies whenever possible.

- NTIA should implement regulations requiring Federal Government agencies seeking to own and operate land mobile communication systems as either replacements for aging systems or to satisfy new requirements to

    a) Certify to NTIA that alternate land mobile services offered by commercial vendors or operated on a shared basis with other Federal agencies or state and local governments are either not available or that the use of such services could not meet requirements, would cause unacceptable delay or disruption, or would cost more.

    b) Select spectrum-efficient and cost-effective technologies to meet mission requirements.

- Review of agency plans should be accomplished as an extension of NTIA's procedures for Certification of Spectrum Support (the granting of RFAs).

A schedule of milestones proposes working with the IRAC to develop and implement appropriate regulations and procedures by the end of calendar year 1994.

Strategic Assessment

The rechanneling of the 162-174 MHz frequency band and the recommendations of the spectrum efficiency plan have serious implications for telecommunication planning in the Eastern Region. The wideband (25 kHz channel spacing) analog FM LMR systems currently owned and operated by the Forests will not operate properly at reduced channel spacing, and they offer no migration path to the digital integrated voice and data "mobile office" future. During the next decade, Forests will be required to implement narrowband (12.5 kHz channel spacing) technology (either analog or digital), and will be required to consider commercial and shared systems. This transition will require careful coordination with Forest Service cooperators such as

- Other Federal agencies, including the National Park Service, the Bureau of Indian Affairs, the Fish and Wildlife Service, the Coast Guard, and the Federal Bureau of Investigation's National Crime Information Center.

- State agencies such as Departments of Natural Resources (managers of state Forests and parks, which are often neighbors to National Forests), Highway Patrols, law enforcement information networks, and fire marshall's offices.

- Local agencies such as police and fire departments (including volunteer fire departments), county sheriffs, aerial surveillance contractors, various other contractors and vendors, and county governments (parks, land records).

No two Eastern Region Forests are the same in the condition and age of their existing LMR systems and in their set of cooperators, but ITS makes the following observations with regard to LMR systems:

- NTIA is requiring that new equipment purchased after January 1, 1995 be capable of operating on narrowband channels (some analog FM radios available now can operate at either 25 or 12.5 kHz channel spacing), but this date represents the beginning of a long process. Existing systems may continue to operate on wideband channel assignments until 2005; if a Forest must add a new repeater site or move an existing site after January 1, 1995, it is likely that NTIA will grant a wideband RFA through a waiver process rather than force immediate replacement of all Forest systems with narrowband equipment.

- Digital LMR technology offers the greatest potential for reaching the Forest Service telecommunication goals outlined in Section 3.1. However, the convergence of digital radio standards, maturation of the technology, and "reasonable" prices are still three to five years away. Purchasing narrowband digital LMR systems for a Forest before 1996 will probably be cost-prohibitive and may cause interoperability problems.

- Interagency field communication is critical to carrying out the Forest Service mission. Over the past 20 to 30 years, wideband analog FM LMR technology has been dominant and used by almost all Forest Service cooperators. Today, new technologies, services, and regulations are emerging that promise greater capability, but also the potential for different agencies to choose to use different systems that may not be compatible. Now more than ever, cooperative planning is required to ensure that agencies that must work together can effectively communicate. Trunking systems that allow a limited number of radio channels to serve many users offer the potential for several agencies to share a system, thus guaranteeing compatible communication and eliminating duplicate systems each requiring their own separate channels.

- Although shared systems offer the potential to use spectrum efficiently and save capital costs, a lack of spectrum allocated for shared Federal and non-Federal use limits the ways a shared system might be configured. For example, a National Forest and a state could not jointly operate a trunked radio system in the 800 MHz band because the Federal Government has no frequency allocations in that band. The state would have to operate the system and work out a "lease" arrangement with the National Forest. Section 6.7 provides additional background on this issue from the non-Federal perspective.

Based on NTIA constraints, the above observations, and the condition of existing systems on most Forests, ITS makes the following strategic recommendations concerning Eastern Region LMR systems:

- Forests should avoid making an immediate transition to narrowband analog LMR systems and then be faced with a second transition to narrowband digital systems. Making two transitions over the next decade would be cost-prohibitive, and an immediate switch to narrowband analog FM would seriously impair communications with cooperators still using wideband analog FM systems.

- On most Eastern Region Forests, existing wideband analog LMR systems can, with proper maintenance and incremental improvements, serve reliably for the next 3 to 5 years. In some cases, obsolete and unreliable systems should be replaced immediately with current wideband analog technology.

- Forests should begin working immediately with cooperators to plan future land mobile communication systems. The use of commercial services or a shared system should be fully explored before moving ahead with separate agency systems. Moving to a standards-based narrowband digital system or systems is strongly urged, with system transition targeted sometime during a window from 1997 to 2000.

6.5 United States Department of Agriculture

During 1992, USDA's Office of Information Resources Management (OIRM) embarked on two major planning efforts. One was the development of a Strategic IRM Plan, and the other was the development of a Strategic Telecommunications Plan. Detailed reviews of these plans are beyond the scope of this report, but content relevant to Eastern Region strategic telecommunication planning is summarized below.

6.5.1 USDA IRM Strategic Plan

The IRM Strategic Plan [23] identifies a number of critical information issues facing USDA.

- In the past, there was a limited need for interaction between USDA agencies. For the most part, each agency had a clearly defined clientele, and many were able to conduct business largely on their own. Recent legislation, however, has mandated that USDA address issues which cross the functional boundaries of many agencies and the agricultural community. These issues include international competition, environmental concerns, food safety issues, conservation issues, and the impact of biotechnology. It has become vital for agencies to share resources, particularly information resources, to develop and implement programs to address these issues, but agency information systems and data formats are in large part non-standard and incompatible.

- Agency and USDA executives need timely and accurate program information for decision-making and upward reporting.

- USDA operates in a dynamic environment; legislation and policy changes can have broad ramifications for programs and internal initiatives. Information systems must be designed for flexibility and responsiveness.

- A reassessment of USDA's field structure is currently underway. Relocation of personnel and realignment of technical resources is being carefully considered. Information management policies and standards must be in place to support upcoming changes in order to provide for flexible coordinated systems.

- Due to Federal budgetary constraints, total funding and personnel resources have been more limited in recent years. This trend is expected to continue.

An IRM Planning Model, Planning Principles, and a Planning Cycle are established to ensure that information systems effectively support the business of the organization. The planning cycle includes development of business plans and information resources management plans at the Departmental and agency levels.

The plan spells out a vision for the future of information resources management at USDA. Quoting from the plan,

> "The future...will be based on central coordination and management of distributed information systems. USDA will standardize and share program and administrative information common to multiple agency applications. Agencies will use open systems and portable applications to maximize benefits gained from IRM investments and provide flexibility for growth and redirection of programs. Critical information will be readily available to Departmental executives and USDA clientele. The Department will make optimal use of information resources in support of USDA program missions."

The plan outlines a number of strategic initiatives to be led by OIRM. USDA agencies and staff offices will be cooperators in each initiative. The initiatives, to be carried out during the next five years, include

- Development of a USDA Business Plan and supporting agency business and IRM plans.

- Programs to foster standardized, interoperable agency systems, portable applications, compatible data, and information security.

- Continuation of the modernization of administrative processes (MAP) project that began in Fiscal Year 1992.

- Revision of OIRM oversight functions and procedures.

- Establishment of an IRM career development program.

- Development of a USDA Strategic Telecommunications Plan.

Strategic Assessment

The Forest Service has already moved to address many of the problems identified in the USDA IRM Strategic Plan through the recommendations of its February 1992 report, *Information Management: A Framework for the Future* (see Section 5.2.1). Project 615 is also in close

accord with the IRM Plan in its emphasis on distributed computing, open systems, and applications portability. OIRM oversight of Forest Service information management is not expected to result in any major shifts in current plans for agency information systems.

6.5.2 USDA Strategic Telecommunication Plan

An unpublished annotated outline of the USDA Strategic Telecommunication Plan (developed with the assistance of The MITRE Corporation) expects that USDA will follow Government and industry trends in information management and telecommunication technology during the next 5 to 10 years The Plan forecasts an increase in telecommunications traffic, with non-voice traffic comprising an increasing percentage of the total. Consolidation of voice and data traffic and migration to all-digital services is recommended. The Plan anticipates the need to support geographic information systems, electronic data interchange, image processing, interoperable electronic mail, and video conferencing. Distributed processing is expected to supplant mainframe processing, and numerous local area networks will need to be interconnected, most likely through wide-area services offered over an evolving FTS2000. The access and backbone arrangements will most likely change to support the larger bandwidth requirements of the various data-intensive applications; technologies expected to play a future role include dedicated T3 circuits, frame relay, Switched Multi-megabit Data Service, and the Fiber Distributed Data Interface. The implementation of standards-based systems and network management protocols is recommended. Furthermore, increased demand for public access will require more network and information systems security measures. The Telecommunication Plan reinforces the IRM Plan emphasis on Departmental management rather than agency management of information resources and telecommunications. The final version of the Plan is expected to be completed in early 1994.

Strategic Assessment

The broad guidelines of the USDA Strategic Telecommunication Plan are appropriate, and they are consistent with the needs of the Forest Service and the assessments of this report.

6.6 The President and the Congress

With strong support from the Clinton Administration, Congress included the Emerging Telecommunications Technologies Act of 1993 in the budget reconciliation package it passed in the summer of 1993 [24]. The Act includes provisions for spectrum reallocation, auction licensing, regulatory parity, and user fees [25].

Of most immediate impact to the Federal Government is the Act's requirement to transfer 200 MHz of spectrum currently allocated on a primary basis to the Federal Government to the Private Sector. At least 100 MHz of spectrum must be below 3 GHz, and the remainder must

be below 5 GHz. At least 100 MHz must be reallocated for exclusive non-Federal use, while the remainder may be reallocated on a shared basis. The first 50 MHz of spectrum to be reallocated must be identified within six months of enactment, and the frequency assignments in this spectrum must be withdrawn within two years of enactment. The other 150 MHz must be identified with 18 months of enactment, and may be transferred over the next 15 years. NTIA and the IRAC have been working to carry out the Act's provisions, and initial identification of candidate bands has been made. It is highly unlikely that the frequency bands used by Eastern Region Forests for their LMR networks will be reallocated; the 162-174 MHz band is one of the most heavily used Federal bands, and forcing the Forest Service and other users out would be prohibitively expensive and greatly complicate radio communication with cooperators who operate in the neighboring non-Federal bands between 150 and 162 MHz.

The other provisions of the Act are geared more toward the FCC and how it regulates commercial land mobile services. The FCC is directed to auction licenses for the use of the 200 MHz of spectrum transferred from exclusive Federal use. Mobile service providers that formerly operated under differing rules for common and private carriage are to be treated equally. Cellular, paging, personal communication services, enhanced specialized mobile radio, and other common carriers operating under the newly created commercial mobile service category will be shielded from most state regulations and potentially freed of Federal tariff filing requirements [25].

Strategic Assessment

As noted above, the Eastern Region of the Forest Service is not expected to be forced out of the frequency bands it currently uses for its LMR networks. The availability of new spectrum and streamlined regulation may, however, spur the development of commercial alternatives to Forest Service-owned and -operated radio networks. The potential use of such alternatives should be fully explored in joint telecommunication planning with Forest Service cooperators.

6.7 Federal Communications Commission

The Federal Communications Commission was created by the Communications Act of 1934 to regulate interstate and foreign communications by radio, television, wire, and cable. It is responsible for the orderly development and operation of broadcast services and the provision of rapid, efficient nationwide and worldwide telecommunication services at reasonable rates. This also includes the promotion of safety of life and property through radio and the use of radio and television facilities to strengthen the national defense [26]. The FCC manages those portions of the electromagnetic spectrum not allocated exclusively to the Federal Government.

Two of the FCC's rulemaking proceedings are of particular interest to the Forest Service at this time. One is an initiative to move public safety LMR systems into the 800 MHz band, and the

other is a set of proposals intended to encourage the use of more spectrum-efficient technologies in the frequency bands below 470 MHz.

In December of 1983, Congress directed the FCC to establish a plan to ensure that the communication needs of state and local public safety authorities would be met. These public safety authorities include state highway patrols; state departments/divisions of conservation, natural resources, forestry, and wildlife; county sheriffs; and local police, fire, and medical services, all key Forest Service cooperators. Over the years these authorities have been hampered by insufficient spectrum and splintered frequency assignments, making mutual aid difficult in routine operations and more so during emergency or disaster situations [27]. High demand for radio channels in metropolitan areas has made it difficult to accommodate both public safety and commercial users. After four years of work and with the assistance of the National Public Safety Planning Advisory Committee, a Report and Order [28] was released in December 1987. The Report and Order established a structure for a National Plan, allocated the 821-824 MHz and 866-869 MHz bands for public safety use, and strongly encouraged the use of shared trunked radio systems. It divided the country into 55 regions (most of which coincide with state boundaries), each of which was to submit a plan for migrating public safety LMR systems to the new allocations. The last of the regional plans was submitted to the FCC in early 1993, and they generally target system transitions as part of long-range planning [27].

Public safety agencies have some concerns about moving to the new bands, however. Current 800 MHz trunked systems are proprietary, and standards-based open digital trunked systems are still probably several years away (see Section 7.1). In addition, the free-space propagation loss associated with 800 MHz signals is higher than with signals in the traditional frequency bands below 470 MHz. This means that more transmitters are required at 800 MHz to provide equivalent coverage. For rural jurisdictions that must cover a large area on a tight budget, increasing infrastructure is very difficult. Frequency congestion is less of a problem in these areas than in urban centers, and some rural public safety authorities probably will seek to continue to operate systems below 470 MHz into the next century.

In June 1991, the FCC made an additional move to address the increasing commercial demand for spectrum in the traditional LMR bands below 470 MHz. It initiated a Notice of Inquiry "to explore options for promoting more effective and efficient use of the bands below 470 MHz" by private LMR licensees [29]. After gathering input from users, service providers, and manufacturers, proposed rules for the "refarming" were issued on October 8, 1992 [30]. Several proposals were put on the table, including [31]

- The splitting of existing channels between 72 and 512 MHz.

- Giving applicants the ability to obtain channel exclusivity in the non-Federal allocations between 150 and 174 MHz and between 450 and 470 MHz.

- Designating a block of channels for wide-area, highly spectrum-efficient operations.

- Providing users technical flexibility to convert to more advanced technology.

- Introducing three broad radio service categories to replace or supplement the 19 existing private land mobile radio services.

- Reducing permissible power and antenna height to minimize interference and increase frequency reuse.

In approving these proposals, the Commission stated that they were designed to "reduce congestion, meet future communications capacity needs, and permit, facilitate, and encourage licensees to be spectrum efficient [31]."

The refarming proposals have generated considerable controversy and protest. The FCC has continued to take comments and input, and it is still not clear what rules and what kind of implementation timetable will finally be adopted. As noted above, even though the FCC has encouraged public safety LMR users to move to 800 MHz, some will probably still be operating below 470 MHz when the refarming rules take effect.

Strategic Assessment

The FCC's 800 MHz public safety and refarming initiatives have important strategic implications for Eastern Region telecommunication planning. The Federal Government does not have any frequency allocations in the 800 MHz band, so a Forest would not be able to operate its own 800 MHz system and work out MOUs to share channels with public safety cooperators operating systems at 800 MHz. Joint use of a state-owned trunked system is a possibility, but adequate Forest coverage would be a key issue to address. Should a Forest's public safety cooperators continue to operate in the 150-162 MHz band, it is not clear yet how the FCC's refarming rules concerning channel width and implementation schedule will mesh with NTIA's narrowband regulations (see Section 6.4). Again, Eastern Region Forests need to begin now to plan their communications future with cooperators; regulation and technology are creating a situation that offers Forest LMR users the potential for enhanced capabilities, but careful choices must be made to avoid incompatibility with cooperators.

7. ASSESSMENT OF TELECOMMUNICATION TECHNOLOGIES

Tremendous advances in telecommunication technologies have taken place over the past decade, and the next decade will bring more of the same. Advances in integrated circuits, microprocessors, switching, transmission, digital signal processing, fiber optics, wireless networking, and computer hardware and software are all being applied to improve the capabilities and reliability of telecommunication equipment. Anticipated technological advances in several areas important to Forest Service telecommunications are reviewed below.

7.1 Digital Land Mobile Radio Systems

For the last 30 or 40 years, the LMR systems most commonly used by the Federal Government and state and local public safety agencies have transmitted and received voice and control signals using analog frequency modulation. Digital modulation techniques are now being introduced that will greatly expand the capabilities of such systems.

7.1.1 Features and Benefits

Digital radio technology will allow users to have both voice and data communication capability from the field. Digital radios will have built-in encryption capabilities to discourage monitoring by scanners. Systems will allow access to the public switched telephone network. From a system management console, each radio will be remotely programmable, allowing changes in the configurations of user groups and radio features. Systems will support trunking, or sharing of channels, and offer the possibility of shared use and administration by Federal, state, and local agencies, an arrangement that would conserve spectrum and save on construction and maintenance costs. Voice quality and transmission/reception range will be comparable to analog systems.

A key need for public safety agencies is interagency communication, and an unprecedented cooperative effort to develop digital LMR standards, known as Project 25, has begun. The Associated Public-Safety Communications Officers (APCO), the National Association of State Telecommunications Directors (NASTD), and several Federal agencies are working with a group of land mobile radio manufacturers under the auspices of the Telecommunications Industry Association (TIA) to develop open system standards so multiple vendors can make competing products that are compatible. A basic requirement of the standards process is for new digital radio equipment to be backward-compatible with existing analog frequency modulated radio systems [32]. This is intended to support an orderly migration into mixed analog and digital systems, enabling radios and infrastructure equipment to be gradually traded out. In January 1993, a system architecture involving six interfaces was proposed, along with a partial definition of one of the interfaces, the Common Air Interface [33]. None of the Project 25 proposals have yet been formally adopted by the TIA, a recognized standards body, and much work remains to define the rest of the interfaces. Nevertheless, manufacturers are beginning to introduce digital products, promising to upgrade (primarily through software) to the standards as they are adopted.

7.1.2 Anticipated Costs

Present costs for digital mobile and portable radios are in the $3000 range, but prices are expected to drop considerably over the next several years.

Strategic Assessment

Digital LMR technology holds the potential for meeting many of the field communication needs identified by Forest Service personnel in Section 3. The Project 25 Common Air Interface specifies a 12.5 KHz channel width, which meets NTIA's Federal narrowbanding requirement (see Section 6.4). Those involved in the standards development process are strongly committed to seeing it through, but ITS estimates that it will be at least three years before the standards are completed and compatible products from different manufacturers become available in the $1000 price range (mobiles and portables).

7.2 Cellular Telephone and Specialized Mobile Radio Systems

Two commercial radio services are becoming increasingly available in the rural areas where Eastern Region National Forests are located. The first service, cellular telephone, was designed for the mobile public as an extension of the public switched telephone network (PSTN). The second service, specialized mobile radio (SMR), was designed for the business community in need of fleet dispatch service and, to a lesser extent, mobile interconnection to the PSTN. Cellular telephone has two competing companies in every rural statistical area and metropolitan service area of the country. SMR operators can be licensed to provide service in any market provided that frequencies are available. Both services operate in the 800 MHz frequency band. Both services are now concentrated in metropolitan areas, but are expanding into rural areas, especially along major roads, to meet growing public demand for wireless communications.

7.2.1 Features and Benefits

Cellular telephone provides voice communications via a cell-based wireless network that is interconnected with the PSTN. Data can be transmitted if a specialized cellular modem is used between the data device and the cellular telephone. Digital cellular systems offer greater capacity and more features than analog systems, and are being introduced in high-demand metropolitan areas. (Digital cellular telephones are not necessarily compatible from one provider to another; analog cellular telephones are compatible). Cellular carriers are also working to add digital packet data service to their networks. Analog service is expected to be provided well into the next century, especially in rural areas. Cellular telephone provides one-to-one communication and is not presently configured to provide dispatch or one-to-many communication.

SMR provides dispatch, private voice and data networks, paging, and interconnection to the PSTN. An SMR network would allow a Forest to define user groups for work details or incidents. Then, as an SMR user, a supervisor could select a button on the radio to talk to one user group or another. Using an SMR network would be much like using an existing Forest radio network, but the SMR operator would obtain the license, construct the network, provide the maintenance, and, of course, bill the users.

Both cellular carriers and SMR operators are aggressively moving to upgrade their technology and enhance the services that they can offer. While they once served largely separate markets, they are becoming competitors, and the customer should reap the benefits of their battle for market share.

7.2.2 Anticipated Costs

Cellular telephone obtains its revenue by charging for the "air time" to both receive and initiate calls. Air time costs vary throughout the country depending upon local competition between the two providers. Some service agreements have a flat fee to provide a limited amount of free air time each month and charge a fixed rate for time after the free amount. Others provide a rate schedule with different rates for different amounts of air time; some combine the usage of all users within an organization. As a promotion, some providers sell cellular telephones at heavily discounted prices with a service contract. Prices for cellular telephones range from $100 to $500 for a portable or installed unit, with an average of $300; monthly charges range from $25 to $100; air time charges range from $0.15 to $0.75 per minute.

SMRs provide dispatch only or dispatch plus telephone interconnect services. The cost of the mobile radios depend on whether they operate half-duplex (as with the Forest radio network) for dispatch operations or full-duplex (as with the telephone network) for telephone interconnect and dispatch operations. Half-duplex SMR radios cost $700 to $1000 each and full-duplex radios cost $1200 to $1500 per radio. The average monthly charges are $12 to $15 per mobile unit for dispatch-only services; with the ability to place and receive telephone calls, the monthly charges are $30 to $50 depending upon the length of the calls.

Strategic Assessment

Parts of many Forests in the Eastern Region already have cellular telephone service, and during the next several years, cellular service will become more available, especially along well-traveled roads. Sparsely populated backcountry and wilderness areas are not likely to receive service, however. Cellular telephones have become relatively inexpensive, and access to the PSTN from the field was identified as a telecommunication need by several groups of Forest Service personnel. ITS views cellular telephone as providing a supplemental service to Forest radio networks, but not as a replacement for them because of the lack of dispatch capability and a lack of coverage in some areas.

Obtaining dispatch and telephone interconnect service from an SMR operator may be an alternative to a Forest operating and maintaining its own LMR network. This would have to be examined on a Forest-by-Forest basis, considering such factors as coverage area, cost of the service, and ability to communicate with state and local agency cooperators. Unlike cellular, SMR systems do not adhere to any central equipment standard or protocol; currently there are three major manufacturers who make SMR systems that are not compatible with each other. A

Forest Service user on an 800 MHz SMR network would not be able to communicate with State forestry personnel using a separate high-band VHF (150-162 MHz) network unless the SMR operator provided some kind of gateway between the two systems. If, however, the Forest Service and local cooperators were all on the same SMR network, the potential for interagency communication would be great.

7.3 Land Mobile Satellite Systems

Communication from certain areas in Eastern Region Forests presents a challenge to ground-based LMR systems. It is difficult to provide adequate signal coverage in narrow river gorges, along lake shores or roads below bluffs, and in wilderness areas where towers and antennas are prohibited. Land mobile satellite systems currently being developed offer a solution, since topography has a limited effect on communication between the ground and a satellite positioned high above the horizon. Various manufacturers and consortia are working on four types of systems:

- Geostationary systems
- Medium-Earth orbit, or MEO, systems
- Low-Earth orbit (LEO) systems operating at frequencies less than 1 GHz, known as "little LEOs"
- Low-Earth orbit systems operating at frequencies above 1 GHz, known as "big LEOs".

A number of regulatory and technological issues remain to be worked out before commercial land mobile satellite service becomes widely available, but these systems are beginning to take shape. Each type of system is reviewed below [34,35].

7.3.1 Geostationary Mobile Satellite Systems

Geostationary systems depend on satellites that orbit at altitudes of approximately 22,500 miles and maintain a consistent footprint. A single geostationary satellite can serve most of North America. Services offered will include voice, data, position determination, and paging. The high altitude of the satellites results in a propagation delay that is experienced as pauses between speakers in a conversation. Because of the transmitter power required to reach the satellites from the ground, transceivers will be of the mobile (vehicle mounted and powered), not portable (handheld and battery powered), type. The transceivers will be designed to use terrestrial cellular networks when within a coverage area and switch to the satellites when no land-based connection can be established. One company is estimating that transceivers for its system will retail for around $1800, with airtime costs of $1.50 per minute. Another company is claiming

its transceivers will cost around $500, with airtime $0.25 per minute. Users may also be charged monthly fees of from $25 to $45. Service is expected to be available in the 1994 to 1996 timeframe.

7.3.2 Medium-Earth Orbit Mobile Satellite Systems

One company is currently developing an MEO system, which is projected to use a constellation of 12 satellites orbiting at an altitude of approximately 4800 miles. The worldwide system is intended to provide voice, data, paging, radio determination, and messaging services. As with the geostationary systems, subscribers will be linked into terrestrial cellular systems when appropriate. No estimates are yet available for the cost of transceivers, airtime, or start of service.

7.3.3 Low-Earth Orbit Mobile Satellite Systems Operating Below 1 GHz

Little LEOs plan to offer non-voice services such as position determination, two-way messaging, remote telemetry, and monitoring. Satellites will orbit at altitudes of 650 to 1300 miles and thus require lower power ground transceivers than the geostationary and MEO satellites. Transceiver costs are expected to be around $500, with service becoming available in the 1994 to 1996 timeframe.

7.3.4 Low-Earth Orbit Mobile Satellite Systems Operating Above 1 GHz

Big LEOs plan to offer voice, data, position determination, and paging services from mobile and handheld transceivers. Several companies are working on systems with from 16 to 66 satellites that project constantly moving footprints on the ground. Voice delay should be virtually unnoticeable. Transceivers will try to use terrestrial cellular networks first and switch to the satellites only if a local cellular circuit is unavailable. Transceiver cost estimates range from several hundred dollars up to $3000, and airtime from $0.50 to $3.00. Because of the number of satellites and the sophisticated switching and routing functions required by these systems, service is not expected to become available until 1996 to 1998.

Strategic Assessment

Land mobile satellite systems offer an alternative to the use of land-based systems to provide complete communication coverage over a Forest. Many uncertainties remain concerning the development of these systems, however. ITS expects them to supplement terrestrial systems, providing communications for personnel working in areas without good coverage from terrestrial transmitters.

7.4 Premise Telephone Systems

SOs and RDs have two basic choices when it comes to their premise telephone systems: buy or lease a private switching system, or lease switching capability (Centrex®) from their LEC (if the LEC has the technology to offer this capability to individual customers).

7.4.1 Private Telephone Switching Systems

Small private telephone systems are called *key systems*. In a typical key system, each telephone can access two or more lines, and lamps on the telephone indicate whether the lines are busy. The caller selects a line by pushing a button on the telephone to seize the line, then dials the call. The telephone usually has a hold button so that a call on one line can be held while a second call is made or answered. An incoming call rings at an attendant console, and the called party must be notified in some manner that they have a call. Key systems typically support 4 to 12 central office lines and 16 to 48 stations. Basic station features such as conference call, last number redial, and speed dial are commonly available.

Hybrid key systems are characterized by enhanced system architecture and more sophisticated microprocessor control. They provide increased call handling capacity, a wide range of telephone management capabilities, greater flexibility in configuration, and more station features.

The most sophisticated private telephone switching systems are called *private branch exchanges* (PBXs). They are designed to serve from 50 to over 10,000 stations, depending on model and configuration. They offer a wide variety of call processing features, management capabilities, network interface configurations, and station features.

Technology trends for hybrid key systems and PBXs include a smooth migration path for increasing capacity or upgrading features, interfaces to computer systems, automatic call distribution and voice mail capabilities, data communication capability, and wireless links between handheld stations and the central processing unit. Many of these capabilities will be realized by integrating the traditional telephone instrument into personal computers or workstations; within the next several years, premises telephone systems will be available that consist of a central processing unit, "phone cards" that plug into a PC or workstation, and software that ties the two together and allows individual users to customize their "phone" with their own directories and voice processing preferences. Voice recognition technology will likely allow calling another party simply by speaking their name.

7.4.2 Centrex®

Centrex® differs from a private telephone switching system in that the switching equipment is located in the LEC’s central office rather than at the customer's premises. Part of the central office switch is actually partitioned for use by the private customer. The station features

available are similar to those offered by hybrid key systems and PBXs. The main advantage of Centrex® service is that system maintenance and administration is handled by the LEC rather than the customer. Centrex® is not typically available from small central offices because of the sophistication required in the switch.

Strategic Assessment

The choice for an SO or an RD between a private telephone switching system and Centrex® service must be made on a case-by-case basis. If Centrex® service is available, the station features and cost should be compared to those of a private system.

In selecting a private switching system, an SO or RD should look for a hybrid key system or small PBX that is digital, modular (to allow for expansion), and upgradeable (primarily through software). Digital network interfaces are a desirable option. The ease with which fax machines, modems, telecommunication devices for the deaf, and answering machines can be connected to the system should be considered. The station features desired by Forest personnel should be available. Such a system should be expected to have a service life of up to ten years, so selection of a reliable manufacturer and a vendor who can provide good service and support is crucial.

7.5 Local Area Networking

With the award of the Project 615 contract sometime in 1994, the Forest Service will begin installing Ethernet LANs to interconnect workstations and X-terminals via a 10BaseT cable plant (see Section 5.2.2). The LAN technology used will be tightly controlled by the contract and the WO in order to help ensure Forest Service-wide interoperability, ease network management, and simplify user training. There are some LAN technology trends to be aware of, however, and these are reviewed below.

7.5.1 Wiring Hubs

A 10BaseT Ethernet LAN has a "star" topology, with each workstation or X-terminal connected to the LAN through a wiring hub. Several hubs may be interconnected. The hub is the key to the network infrastructure, and hub technology continues to evolve at a rapid pace. Hubs will be available through the Project 615 contract, and in selecting a hub or hubs for a Forest Service installation, LAN managers should look for a product that offers flexibility for the future. Hubs should be expandable and should allow remote management. They should be capable of being upgraded to accommodate potential improvements in LAN and WAN protocols.

7.5.2 Ethernet Enhancements

A number of companies are developing modifications to 10 Mbps Ethernet protocols that will allow 100 Mbps data rates. An industry standard will probably be adopted sometime during the next three years. Upgrading from 10 Mbps to 100 Mbps would require modifications to the network interface circuitry of workstations, X-terminals, and wiring hubs, and might require a wiring upgrade. For applications involving intensive graphics or imagery, these upgrades may be worth considering.

Several vendors are also working on a technique to transport voice and video over Ethernet LANs on unshielded twisted pair wiring. Known as isochronous Ethernet, the technology combines a 6.144 Mbps channel for multimedia with a standard 10 Mbps packet channel for data [36,37]. Isochronous communications are carefully synchronized to deliver time-sensitive traffic such as voice and video. Again, workstations, X-terminals, and hubs would have to be retrofitted to use the technique.

7.5.3 Multimedia and Asynchronous Transfer Mode

Color, graphics-oriented personal computers (PCs) and workstations are replacing text-based computers and terminals, and as PCs and workstations continue to increase in performance, multimedia applications which incorporate text, graphics, voice/audio, and video are being developed. These applications have the potential to significantly improve productivity by making information more easily grasped and understood by users. For multimedia applications to be successful across the enterprise, however, they must be networked locally and across the wide area. The LAN protocols most commonly in use today were designed to support primarily text-based applications; they do not have the capacity to support image- or graphics-intensive applications, and they do not handle time-sensitive voice and video information well.

Asynchronous Transfer Mode (ATM) is part of the evolving set of international standards that are intended to support the deployment of Broadband Integrated Services Digital Networks (BISDNs). It refers to a technique whereby digital data is packaged into fixed-length cells and relayed through a network based on an address contained within each cell. A detailed explanation of the technology is beyond the scope of this report, but the technique allows the implementation of very high-speed switches to route the cells, thus allowing high data transfer rates. The use of fixed length cells and statistical multiplexing give ATM the flexibility to carry many different kinds of traffic, including voice and video. These capabilities are attractive not only for transport across the wide area, but for LANs, as well. Manufacturers are beginning to develop ATM switches to serve as LAN hubs and ATM network cards to plug into PCs and workstations. Though these products are expensive now, they offer the promise of support for multimedia and other demanding client/server applications, provided that the LAN cable plant can support the required transmission rates. A single network could potentially serve the local area, instead of separate telephone and computer networks. Network managers also are attracted to the idea of using the same set of protocols at the local and wide area levels to improve

network performance and ease network management. Many telecommunications professionals anticipate that ATM will become the basis for local and wide area networking over the next 5 to 10 years.

7.5.4 Wireless Local Area Networks

LANs are being developed that interconnect PCs or workstations via radio frequencies rather than wires. Such LANs allow network managers to avoid installing cabling, which can be especially difficult and costly in older or historic buildings. Reconfiguration of cabling when offices or employees are moved is also avoided. Although several of the wireless LANs on the market today will support Ethernet, industry standards remain under development and systems remain proprietary. Costs are slightly higher than for wired LANs, and careful system engineering is required to ensure reliable operation.

Strategic Assessment

Project 615 will tightly control the LAN technology implemented by the Forest Service over the next 10 years. Forests should begin planning and budgeting for the installation of the LAN cable plant at the SO and each RD if they have not done so already. It might be possible to build Project 615 LANs using existing twisted pair cable plant. The WO and the RO are providing guidance in these matters.

The specified 10BaseT Ethernet configuration should serve the general needs of Eastern Region SOs and RDs well for the next 5 years. However, the communications requirements of developing applications will probably begin to put pressure on LAN capabilities in the late 1990s. RO telecommunication management should track the development of the technologies mentioned above, and consider their potential for application to Forest Service LANs. While Forest Service-wide implementation of ATM-based multimedia LANs will probably have to wait for the computer system that follows Project 615, special needs may dictate limited application of some of the advanced technologies mentioned above during the next decade.

7.6 Wide Area Networking

Any assessment of WAN technology for the Forest Service must be set within the context of the long-distance services offered through the FTS2000 contract. Federal agencies are required to use services off the contract unless they can justify a special need to GSA. As noted in Section 4.3, the following six basic services are offered:

- Switched Voice Service (SVS)
- Switched Data Service (SDS)
- Packet Switched Service (PSS)

- Dedicated Transmission Service (DTS)
- Video Transmission Service (VTS)
- Switched Digital Integrated Service (SDIS).

The Forest Service makes use of PSS to interconnect its Data General computers and support electronic mail, file transfer, and database applications across the wide area. Data is broken down into packets which contain data plus control information such as addresses, sequence numbers, and error control codes. The packets are then routed throughout the network by switches which process the control information. PSS operates according to the well-established X.25 standard for packet switched networks. The X.25 standard was developed during the 1970's for use over electrically noisy analog copper transmission facilities that tended to introduce errors. Every switching node in an X.25 network goes through a rigorous, time-consuming procedure to check the validity of the structure and routing of a packet before passing it along to the next node where the process is repeated. The technique has been widely and successfully implemented, but it is limited to a speed of 64 kbps, and it is not suitable for the transmission of voice or video information.

Section 7.5.3 noted the proliferation of increasingly powerful PCs and workstations that are networked locally, and how this trend toward distributed computing and client/server applications is pushing LAN technology forward. The need for LAN interconnection and the support of voice, data, image, and video transmission is also pushing WAN technology forward, and two broadband wide area transport techniques are emerging that are likely to see extensive use during the 1995-2000 timeframe.

The first of these techniques is known as frame relay. It is essentially an enhancement of X.25, and takes advantage of the widespread implementation of fiber optic communication links by long-distance carriers. Fiber is much less prone to introducing errors in a data stream, and so frame relay does away with most of X.25's extensive checking at switching nodes, leaving these processes to the sending and receiving devices. It is designed to operate at speeds up to 1.544 Mbps, but may be enhanced to operate at higher speeds in the future. Frame relay is particularly well-suited to the interconnection of LANs which generate bursty traffic consisting of variable-length frames of data. Frame relay accepts this traffic as is, adding only a wide area network address at the front and its own check sequence at the end of each frame. Frame relay interfaces for customer premise equipment such as routers, bridges, and hubs are being introduced by a number of vendors, frame relay switches are available, and carriers are beginning to introduce public frame relay services. As the technology and standards are refined and carrier tariffs are clarified, frame relay networks are expected to replace many X.25 networks during the next 2 to 5 years. Frame relay is not well-suited to the transmission of real-time voice or video, however, because of the variable delay allowed between frames.

The second emerging broadband wide area transport technique is known as cell relay. Cell relay is a high-bandwidth, low-delay, switching and multiplexing packet technology. Its combination of simplified error and flow control, fixed-length cells which allow high-speed switching, and procedures for allocating network bandwidth enable it to support voice, data, image, and video

traffic. ATM, mentioned in Section 7.5.3, is the international standard implementation of cell relay for BISDN. It is defined to work over different physical media and at speeds ranging from 45 Mbps to 622 Mbps, with extensions to lower and higher speeds possible. Vendors are beginning to produce ATM network equipment and carriers are beginning to put together ATM networks, but current service offerings are developmental in nature and it is expected to take several years for the technology to mature. Significant infrastructure investments by carriers will be required to make ATM widely available.

Switched Multi-megabit Data Service (SMDS) is another standards-based implementation of cell relay. It is presently being implemented by LECs to provide connectivity within their service regions, mostly in major metropolitan areas. Access and transmission speeds range from 1.544 to 45 Mbps. The future of SMDS is somewhat cloudy — interexchange carriers appear to be more interested in implementing ATM rather than providing wide area connectivity for SMDS, and given the potential of ATM at the LAN level, telecommunication managers may prefer local access to ATM rather than SMDS. The two implementations of cell relay are similar, however, and there is a clear migration path for carriers to move from SMDS to ATM.

A number of Federal departments and agencies are expressing strong interest in advanced WAN services not currently offered through the FTS2000 contract. The Energy Department last year requested a 45 Mbps dedicated circuit to connect two of its laboratories. MCI Telecommunications Corp. and WilTel, Inc. protested, however, claiming that the service should be regarded as new, outside the scope of the original contract, and subject to competitive procurement. The GSA's Contract Board of Appeals upheld the protest, casting serious doubts on GSA's ability to add advanced services to FTS2000. The Justice Department appealed, and a Federal appeals court has recently ruled that the service could indeed be offered, thus reopening the possibility of adding advanced services to the contract [38-40]. Several agencies have requested that frame relay service be made available, and GSA has asked the FTS2000 program vendors, AT&T Co. and Sprint Corp., to submit proposals to begin providing the service [41]. Despite the appeals court ruling, frame relay and any other advanced services may still face legal challenges from other vendors, and Federal users will likely face procurement headaches in trying to obtain advanced services either through FTS2000 or outside the contract.

The FTS2000 contract is set to expire in 1998, and several complementary efforts are underway within the Federal Government to help define GSA's follow-on program. Various panels are seeking to determine what telecommunication services should be available and how they should be procured [42]. The follow-on program is likely to include ATM and/or SMDS [43].

Strategic Assessment

As noted in Section 5.2.2, the Project 615 RFP specifies that the new LANs at the RO, SOs and RDs are to be interconnected via an X.25 wide area network. The existing PSS of FTS2000 will meet this requirement. As noted in the Strategic Assessments of Sections 5.2.1 and 5.2.2, ITS expects that an X.25 network operating at a maximum speed of 64 kbps will prove to be

inadequate to support the Project 615 computing platform and the integrated information environment envisioned by the IM Framework. By the time Project 615 LANs are being implemented in the Eastern Region (1995 to 1998), frame relay service should be available via either the FTS2000 contract or a GSA-managed competitive procurement, and its use should be strongly considered. Effective use of frame relay will require access lines from LECs that will support digital data at a rate of 1.544 Mbps; obtaining such access lines from some of the small LECs that serve Eastern Region RDs is a potential problem, but AT&T is planning to allow alternate access to FTS2000 via Very Small Aperture (Satellite) Terminals that will support this data rate. Frame relay does not support the transport of time-sensitive voice and video information, however. The Eastern Region should track the development of cell-relay services and the follow-on to FTS2000 to be aware of opportunities to apply these technologies on probably a limited basis to special situations during the 1998 to 2003 time frame. The next-generation Forest Service computer system should be planned to take full advantage of the multimedia capabilities of the BISDN that will evolve by early in the next century.

7.7 Mobile and Portable Computing

Mobile and portable computing advances are occurring at a rapid rate, fueled by consumer demand and technology development. The term "mobile" refers to vehicle-based devices and systems, and the term "portable" refers to devices and systems that are not installed in a vehicle and that can be carried by an individual.

A significant percentage of the U.S. workforce, certainly including Forest Service employees, is often away from the traditional desk, and being able to maintain communication with coworkers, vendors, and customers improves productivity. As people get used to pagers, cellular telephones, and home cordless telephones, they are beginning to demand networked mobile and portable computing capabilities, as well.

Computer manufacturers are responding; new generations of portable computers are coming out within months instead of years, and this segment of the personal computer market is booming. Increased processing power, improved battery life, decreased size and weight, improved color display technology, convertible systems that allow input from either a keyboard or the screen via a stylus, integrated communications options that allow connection to wireless data networks, and reasonable prices are all contributing to the popularity of these machines. Although the vast majority of portable computers today are designed to run Microsoft DOS and Windows, machines intended to run UNIX are also expected to become more commonly available. Computer peripherals are also shrinking in size and weight; portable fax machines, printers, digital cameras, and Global Positioning System (GPS) receivers are all available, and some companies are integrating these devices into complete "briefcase" systems.

Several wireless network services are expected to compete during the 1990s to link the mobile and portable computer user with other users and the home office. Two companies, Ardis Co. and RAM Mobile Data, Inc., currently provide wide-area wireless data services via packet radio

networks that operate in the 800 MHz band. A new cellular technology, known as cellular digital packet data (CDPD), is being adopted by several major cellular service providers to allow them to provide capabilities similar to Ardis and RAM over their existing cellular networks. Some specialized mobile radio operators are enhancing their networks with digital technology that will allow them to support both voice and data communications, most notably Nextel Communications, Inc. Unfortunately for the Forest Service, the focus of these services is on major metropolitan areas that have high numbers of potential users, and expansion of coverage to include significant portions of Eastern Region Forests is unlikely during the next 10 years, if ever. Satellite-delivered two-way voice and data communication services offer a high degree of coverage, but terminal equipment is costly and monthly charges high.

As noted in Section 7.1, Project 25 is seeking to standardize a system architecture for public safety digital radio systems. Interfaces between portable digital radios and portable computers and between the radio network and host computers/data networks are part of the proposed architecture. Once standards are developed, systems integration would allow users in the field to access host- or LAN-based applications and databases such as Project 615 applications and law enforcement databases housed on other-agency systems.

Data rates for the terrestrial systems described above are 19.2 kbps or less, with actual throughput less due to packet and signal processing overhead. Such data rates are acceptable for electronic mail and the transmission of small text files or database records, but they are not practical for image or video transmission. Advances in data compression technology coupled with eventual upgrades in transmission speeds could support these applications more effectively by the end of the decade.

Strategic Assessment

A wide range of mobile and portable computing devices will be available to Forest Service personnel in the 1990s. To provide personnel in the field with effective data communications, it is likely that the Forests in the Eastern Region will need to implement digital radio systems and interface them with portable computers, Project 615 LANs, and the systems of cooperating agencies. Over the next several years, the standards-based technology to do this should gradually become available and affordable.

7.8 Open Systems Interconnection

An open system is one whose characteristics comply with specified standards and that therefore can be connected to other systems that comply with the same standards. Standardization permits multiple vendors to produce products for particular applications, and gives the consumer the opportunity to select a product that offers the best combination of features, price, quality, service, etc. Standards are becoming more important to the computer and telecommunication industries, with proprietary products and systems being replaced with interoperable products and

systems. Compliance with applicable standards is a key component of many Federal procurements, including Project 615, and fosters interagency cooperation.

Strategic Assessment

Future telecommunications planning and procurement in the Eastern Region should specify open, standards-based systems and interfaces. This requirement will allow Forests to consider multiple vendors for equipment and services, to have a greater selection of options and features, to choose among more sources for maintenance and repair, and to pay less due to competition.

7.9 Emergency Position Determination Systems

Global Positioning System (GPS) receivers are going through an evolutionary phase similar to that of portable computers. They are becoming more sophisticated, smaller, lighter, and less expensive. During the next several years ITS expects the development of technology that will allow the integration of mobile and portable GPS receivers with digital LMR systems to provide the capability to track vehicles and personnel when in the field. This capability would aid in dispatching assistance to personnel in emergency situations.

Another type of satellite-based emergency position determination system has recently been introduced. World Wide Satellite Rescue Systems, Inc., Westminster, Colorado, is now marketing a device known as a Personal Locator Beacon (PLB). The PLB is a radio transmitter roughly the size of a portable two-way radio, and when activated sends out a 406.025 MHz signal that is received by one of four low-earth orbiting satellites. A satellite may not be within range of the PLB when it is first activated, but the time gap between satellite passes typically ranges from a few minutes to about an hour. The receiving satellite relays the signal to a ground station which calculates the position of the sending PLB and transmits this information, along with the unique identification number of the sending PLB, to the National Oceanic and Atmospheric Administration's United States Mission Control Center (USMCC) in Maryland. All PLBs are registered with the USMCC prior to being sent into the field with someone, so the owner of the signaling PLB is identified and an emergency response through the appropriate agency is initiated. The position of the party in distress is typically determined within a kilometer (0.6 mile), and the PLB also continuously transmits a 121.5 MHz homing signal that can be used to home in on a party in distress under conditions of darkness or poor visibility due to smoke, fog, blowing snow, or dense foliage. The system has been used for 20 years for aviation and maritime rescues, but the PLB technology for land use has only recently been developed. Signals from PLBs have initiated several successful rescues in Alaska and Canada during the last year.

The Rocky Mountain Region of the Forest Service successfully completed a full-scale simulated emergency rescue using a PLB on May 24, 1993 [44]. The PLB was activated at 10:00 AM in a rugged, mountainous area of the Arapahoe-Roosevelt National Forest west of Fort Collins,

Colorado. Portable radio communication from the location was not possible. The PLB signal was received by a satellite and the USMCC notified; they in turn notified the designated Search and Rescue Point of Contact, the Rocky Mountain Area Coordination Center. The Northern Dispatch Center in Fort Collins was notified, and they initiated a search and rescue mission. An Air Force helicopter was dispatched from Warren Air Force Base in Cheyenne, Wyoming, and established visual contact with the "party in distress" at 10:58 AM. A report fully describing the simulation is available from World Wide Satellite Rescue.

The PLB is watertight and will float. A single unit costs approximately $2000, including a specialized battery. The battery has a "shelf life" of five years, and will keep the PLB transmitting for several hours, even in extreme cold. World Wide recommends replacing the battery of a PLB after it has been activated; the cost of battery replacement is approximately $300. The Arapahoe-Roosevelt and Rio Grande National Forests in the Rocky Mountain Region have each purchased a PLB for use by field-going personnel.

Strategic Assessment

While GPS tracking systems integrated with Forest radio networks are still several years away, as are the land mobile satellite systems described in Section 7.3, the Personal Locator Beacon offers proven emergency rescue technology today. The satellite-based system provides better coverage than a terrestrial radio network reasonably can, and the system is operational 24 hours a day, 365 days a year. Effective use of the system requires a planned and structured response procedure, but the Eastern Region already has the basics of this in place with the Regional Coordination Center in Milwaukee and individual Forest dispatch centers. Implementation of the system across the region should be considered.

7.10 Videoconferencing

Improvements in digital signal compression techniques and the proliferation of digital transmission facilities have fueled significant advances in videoconferencing technology during the past few years. Vigorous competition between several vendors has helped speed the introduction of new features and force prices downward. Installations range from permanent videoconference rooms with multiple large-screen monitors, to portable systems that can be rolled about, to desktop systems integrated with personal computers. A family of standards known as H.320 has been developed by the former International Telegraph and Telephone Consultative Committee (CCITT, now replaced by the Telecommunications Standardization Sector (ITU-T) of the International Telecommunications Union) that has laid the foundation for interoperability among multivendor videoconferencing equipment [45]. Typical applications include routine staff meetings, project management meetings, training sessions, formal briefings, informational exchanges, emergency sessions, field location updates, personnel interviews, budget reviews, and meetings with vendors and contractors. Video conferencing can reduce the time and costs associated with traveling to remote sites for such meetings.

Several building blocks make up a videoconferencing system, as illustrated in Figure 6. The codec is the heart of the system; it encodes the analog video and audio signals from the camera and the microphone into digital signals and compresses them for transmission over the network. The codec also decompresses digital signals received from the network and decodes them into analog video and audio for reproduction by the monitor. The compression algorithms allow the transmission of the video and audio information at bit rates ranging from 56 kbps to 1.544 Mbps, with some penalty in resolution and display of motion compared to broadcast television image quality. (Uncompressed, full-motion, television-quality video and audio would require transmission rates of approximately 90 Mbps; such wide-area digital facilities are not yet commonly available and are prohibitively expensive).

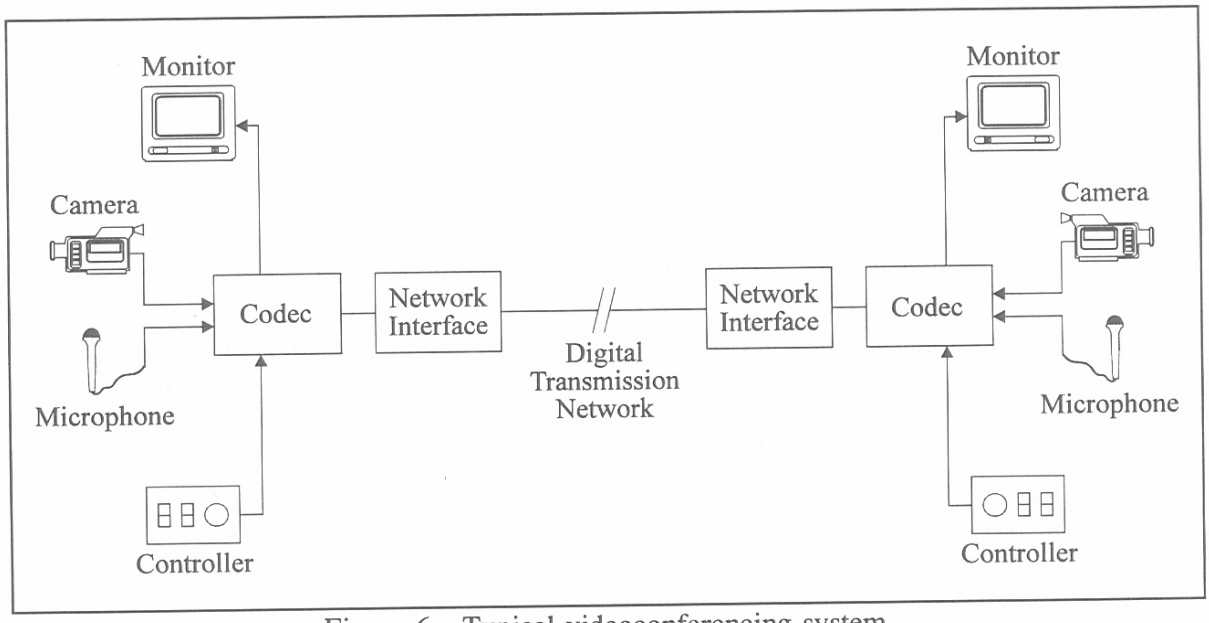


Figure 6. Typical videoconferencing system.

Two approaches to implement videoconferencing are available to the Eastern Region. One would involve the purchase of all the equipment indicated in Figure 6 and making arrangements for up to several 56 kbps transmission channels that could be used to dial up other locations for conferences. A second approach would involve subscribing to the Compressed Video Transmission Service (CVTS) offered through the FTS2000 contract; AT&T supplies the codec and network interface equipment and supports the installation for a monthly fee. CVTS operates at 384 kbps, and thus also requires part of a T1 (1.544 Mbps) transmission facility. Videoconferences can normally be set up within 15 minutes by calling (toll-free) AT&T's Service Support Center.

The second approach makes the most sense for the Forests in the Eastern Region, at least until the Forests more fully develop their telecommunication management skills. Setting up a

videoconferencing system and configuring the network interface is not a simple matter, and AT&T's equipment and support would probably make the difference between a technological headache and a dependable, useful system. The use of CVTS via FTS2000 is common to the Federal Government and simplifies making connections within an agency and with other agencies, and AT&T is developing gateways to allow conferences with cooperators served by the Sprint Meeting Channel or the AT&T Global Business Video Service [46]. The latest revision of the Forest Service Handbook addresses videoconferencing and provides some guidelines for system installation and CVTS administration.

Costs for CVTS can be broken down into the following three categories:

1) Customer premise equipment — includes room and any lighting or audio modifications necessary, camera(s)/monitor(s)/microphone/system controller, and premises wiring. Anticipated one-time cost: $4000—$25,000; varies widely based on desired system features and physical facilities.

2) Monthly recurring cost — includes charges for codec, network interface equipment, ready availability of service, and network management. Anticipated monthly recurring cost: $1000—$1500.

3) Usage cost — includes charges for network access, network transport, and a small conference establishment charge. Anticipated cost: $300 to $600 per hour; as monthly usage increases, cost per hour decreases. Cost varies considerably based on FTS2000 access arrangements at the site; aggregating voice, data, and video traffic over a Switched Digital Integrated Service (SDIS) access arrangement is more cost-effective than separate SVS, PSS, and CVTS network access.

More accurate, site-specific costs can be obtained by working with the Eastern Region Designated Agency Representative for FTS2000, the Forest Service FTS2000 Account Representative, and AT&T's Service Analysis Tool (SAT), a software package that can be used to estimate FTS2000 prices.

Strategic Assessment

Despite advances in technology and falling prices, installing a videoconferencing system is still costly. The RO and Eastern Region Forests should think carefully about how they might use videoconferencing and try to accurately assess savings in travel costs before purchasing equipment and CVTS; a system that is only used occasionally will not prove to be cost-effective. The T1 interfaces to FTS2000 at the SOs in the Region would support CVTS, but current FTS2000 access arrangements at the RDs would not. ITS expects that continued advances in digital transmission and compression techniques will help to further decrease videoconferencing costs, and that workstation-based systems will probably emerge that can eventually be used with

the Project 615 computing and networking platform. These factors should enable wider implementation of videoconferencing in the Eastern Region in the late 1990s.

8. REGIONAL TELECOMMUNICATION STRATEGY

The regional telecommunication strategy and its associated implementation steps are designed to move the Forests of the Eastern Region from their current telecommunication capabilities toward the telecommunication goals outlined in Section 3. The strategy takes into account the foregoing assessments of existing systems, internal factors, external factors, and technologies. ITS recognizes that some of the Forests in the region have already implemented parts of the strategy, and that some Forests will move more quickly than others in implementation. The strategy is broken down below into six components. They are not listed in any particular order; each is considered an essential element of the strategy.

- Ensure that telecommunication management responsibilities are adequately defined and effectively carried out at the Region and Forest levels.

- Accommodate the diverse technical capabilities of Forest Service telecommunication system users.

- Establish Forest-level accounting and funding mechanisms that provide for the cost-effective management and timely procurement of telecommunication systems and services.

- Pursue telecommunication cooperation with other agencies, commercial interests, academia, and the general public.

- Migrate toward high-speed, integrated, digital networks capable of supporting the transmission of voice, text, graphics, and video information; migrate toward open, standards-based systems and interfaces.

- Restore existing telecommunication systems to designed operating parameters; address immediate system shortcomings.

Implementing these strategy components will involve a partnership between the RO and the Forests. Each component is discussed in more detail in the following sections, and implementation steps for the RO and the Forests are identified.

8.1 Ensure Effective Telecommunication Management

The FSM as reviewed in Section 5.1, establishes appropriate telecommunication management objectives and policies. The FSM adequately defines telecommunication management

responsibilities at the Region level, but the RO does not have enough telecommunication management staff to effectively carry them out. ITS views the direction and training of Forest-level telecommunication management as a key responsibility of the RO, and an area of weakness in the Eastern Region. Centralized coordination of Forest-level telecommunication management would be efficient and cost-effective. Forest managers could be built into a team that would provide a sense of identity, purpose, camaraderie, and technical support.

The FSM does not provide a definition of corresponding telecommunication management responsibilities to be carried out at the Forest level. During visits to Eastern Region Forests, ITS observed that most of them split the management of telephone systems, data communication systems, and LMR systems between various staffs and lack a consistent, structured approach to telecommunication management. LMR systems, in particular, suffered from poor management, resulting in unreliable systems that left users wondering if they would be able to communicate from the field on a given day or under emergency conditions.

Telecommunication management responsibilities must be clearly understood before they can be carried out. ITS recommends the following working definition of Forest-level telecommunication management responsibilities. This definition is meant to be refined and improved over time as the RO and Forests work together to improve the management of telecommunication systems in the Region.

- Review the Tactical Telecommunication Plan annually; update as necessary to create a new version of the plan covering the next three years. Procure necessary systems, equipment, and services in accordance with the tactical plan. When existing telephone, data communication, or LMR systems are in need of replacement, Forest telecommunication management is responsible for the design and implementation of new systems. Standards and guidelines established by USDA, the WO, and the RO should be adhered to.

- Support users of Forest telecommunication systems. This includes providing user training, implementing systems that are simple to use yet powerful enough to meet mission needs, and encouraging user feedback to telecommunication management. Forest telecommunication management must have a "customer service" attitude. Communicate user needs to the RO to aid in the regional strategic planning process and to aid the WO in specifying requirements and estimating quantities for national telecommunication equipment contracts.

- Track Forest telecommunication costs, including all equipment and services purchased or leased. Continuously monitor the cost-effectiveness of existing telecommunication systems and management practices and consider alternatives to reduce costs. Prepare an annual telecommunication budget. Establish depreciation schedules for systems and equipment to aid in long-range planning and budgeting.

- Monitor the performance of Forest telecommunication systems. This includes establishing mechanisms for periodic system performance testing and for users to report problems they are experiencing. When system performance degrades or components fail, Forest telecommunication management should initiate corrective action. Forest telecommunication management is not necessarily expected to perform system maintenance and repairs; for the most part, these tasks are better performed by professional contractors. However, Forest telecommunication management must have a technical understanding of system operation and also be conversant with system performance test metrics, equipment, and techniques to effectively manage the work of outside contractors.

- Pursue telecommunication cooperation with other agencies to serve the mission needs of the Forest. Forest telecommunication management should explore various means to enable interagency communication and implement those that are appropriate. These may include sharing system resources such as radio frequencies, supporting efforts to establish an interagency incident coordination center, procuring interoperable telecommunication equipment, establishing a dialogue concerning needs and future plans with other agencies and with service providers such as local telephone companies, and sharing telecommunication systems with other agencies.

Sound Forest telecommunication management is of critical importance in providing reliable, cost-effective telecommunication systems that support Forest personnel in carrying out their mission. The demands of effective Forest telecommunication management are high; carrying out the responsibilities listed above will require time equivalent to a full-time position, technical knowledge of telecommunication systems and services, program management skills, and relational skills to work with people ranging from Forest Service users to maintenance contractors to vendors to local telephone companies. Eastern Region Forests must dedicate an individual or team of individuals to telecommunication management; it is ineffective to ask someone with full-time responsibilities in forestry, civil engineering, or administrative support to manage telecommunication systems in addition to their normal duties. The investment of time and money in telecommunication management will payoff in improved productivity and safer working conditions for all Forest personnel.

8.1.1 Implementation Steps for the Regional Office

- Ensure that the responsibilities of telecommunication management are well-defined, both at the Region and Forest levels. Track any WO efforts to revise FSM sections on telecommunication management and be alert to any changes in telecommunication management resulting from Project 615 implementation.

- Assist Forests in developing the capability to effectively manage their telecommunication systems; coordinate region-wide training in telecommunication management. Strengthening this effort in the Eastern Region will require the hiring

of an additional Telecommunication Specialist (GS-391) or Electrical/Electronics Engineer (GS-850/855) to work out of the RO. Estimated cost: up to $50,000 per year.

8.1.2 Implementation Steps for Eastern Region Forests

- Hire or develop a Telecommunication Specialist (GS-391) to manage Forest telephone, data communication, and LMR systems or designate and develop a half-time Coordinator for telephone and data communication systems and a half-time Coordinator for LMR systems. Support telecommunication management personnel with funds for adequate training, tools, and equipment. Estimated cost: up to $50,000 per year.

8.2 Accommodate Diverse Capabilities of Telecommunication System Users

A wide variety of personnel make use of Eastern Region telecommunication systems, and there is a corresponding wide variation in the level of comfort they have with electronic and computer technology. Training users in the use of telecommunication systems is necessary to obtain the greatest benefit from the investment in the systems. Users are also a crucial source of information about system performance and can provide valuable suggestions for system improvements. In short, Region and Forest telecommunication management must have a "customer service" attitude.

8.2.1 Implementation Step for the Regional Office

- Assist Forests as requested.

8.2.2 Implementation Steps for Eastern Region Forests

- Provide adequate training for all users of Forest telecommunication systems. Cultivate the attitude among employees that the Forest Service is an information management agency, and that the effective use of telecommunication systems and services is a standard part of an employee’s job.

- Implement user interfaces to telecommunication systems that are simple yet powerful.

- Establish mechanisms for users to provide feedback to telecommunication management.

8.3 Establish Telecommunication Systems Accounting and Funding Mechanisms

Section 5.1.3 noted that expenditures for telecommunication equipment and services often come from a number of different staff budgets on Eastern Region Forests, making it difficult to track costs. Without an accurate understanding of telecommunication costs, Forest telecommunication management cannot identify costly equipment or services that could be replaced by less expensive alternatives, and cannot plan or budget effectively for the future. Section 5.1.4 pointed out that the current Seven Step Process for telecommunication analysis, budgeting, and procurement virtually assures that the systems procured by a Forest will lag current technology. ITS recognizes that the Federal budget process involves requesting funds two to three years before they will be spent, but options are available to couple system design more closely in time with system procurement.

8.3.1 Implementation Step for the Regional Office

- Lead the effort to improve telecommunication accounting and funding mechanisms; involve Forest telecommunication management personnel and fiscal and budget personnel in coming up with a workable savings vehicle for capital investments in telecommunication systems, most likely a working capital fund. Assist Forests in implementation.

8.3.2 Implementation Steps for Eastern Region Forests

- Establish a mechanism for tracking all costs associated with telecommunication systems and services on the Forest: monthly usage charges, maintenance and repair costs, maintenance contracts, telecommunication management personnel salaries and expenses (training, travel, vehicle, etc.).

- Make telecommunication costs visible in the budget process. Allow the Forest Telecommunication Specialist or Coordinators to develop and manage a single telecommunication budget rather than dividing funds for the purchase of equipment and services between different staff budgets.

- Estimate the useful life of existing systems and set target dates for replacement of systems. Consider not only how long it will take the system to "wear out," but when the system will no longer be cost-effective to operate and maintain.

8.4 Pursue Telecommunication Cooperation

Changes in telecommunication regulation and technology are creating opportunities for Eastern Region Forests to realize advanced communication capabilities, particularly in land mobile radio.

However, making wise system investments to meet growing mission demands for interagency communication will require joint planning with telecommunication service providers and other agencies during the next decade. Sections 6.1, 6.4, 6.6, 6.7, and 7.2 of this report highlight this need for interagency cooperation.

8.4.1 Implementation Steps for the Regional Office

- Provide leadership in exploring the policy and technology issues involved in telecommunication cooperation.

- Assist Forests in identifying cooperators and developing the proper contacts; develop contacts with other agencies at a level corresponding to the RO.

8.4.2 Implementation Steps for Eastern Region Forests

- Establish technical rapport with local telecommunication service providers such as LECs and maintenance cooperators; share short- and long-term Forest telecommunication needs to help them plan future service offerings.

- Identify local cooperators, establish contacts and rapport, and ascertain existing systems and opportunities for cooperation. Ascertain long-range plans and work together toward a mutually beneficial future.

- Explore the development of an interagency incident coordination center or shared dispatch arrangement; identify possible benefits, seek out interested cooperators.

8.5 Migrate Toward Integrated Digital Networks and Open Systems

Advances in signal processing and transmission technology are enabling the transmission of voice, text, graphics, and video information in digital form. Once this information is digitized, a single digital network can support its transmission, providing certain economies over using a mix of separate analog and digital networks. Customer premise equipment, too, can be consolidated; current hardware and software trends indicate the development of a single desktop device that will serve as a telephone, a personal computer, a graphics processor, and a videoconferencing station. Market demand is pushing the development of open interface and protocol standards intended to enable the compatible operation of equipment from different manufacturers (see Section 7.8).

ITS believes that migrating toward integrated digital networks and open systems offers the greatest potential for reaching the Forest Service telecommunication goals, and will keep Eastern Region Forests in step with the rest of the Federal Government and the Private Sector. The

transition will not be immediate; ITS expects that it will be several years before the convergence of technology, standards, regulation, and market demand will bring about widespread implementation of high-speed integrated digital networks that will support the transmission of voice, text, graphics (or image), and video information. In general, new Forest systems purchased during the next decade should manipulate information in digital form as much as possible and should have a well-defined upgrade path for future enhancements. The purchase of proprietary equipment that will not readily interface with digital transport facilities should be avoided.

8.5.1 Implementation Steps for the Regional Office

- Track developments in regulation and technology, particularly with regard to the availability of high-speed WAN services to Federal agencies and digital LMR systems.

- Explore options for integrated digital access to FTS2000 services; analyze costs. Guide Forests in the acquisition of premises telecommunication equipment with modules/interfaces to the WAN that are upgradeable as new technology becomes available (frame relay, SMDS, ATM).

- Assist Forests in preparing to take advantage of digital LMR technology in the mid-1990s. Help them explore options to obtain service from commercial sources, share systems with other government agencies, or install new Forest systems.

- Track developments in mobile satellite systems; evaluate costs and potential benefits to Forests as a means to augment coverage by land-based systems.

- Assist Forest telecommunication management in preparing for telecommunication support of Project 615.

8.5.2 Implementation Steps for Eastern Region Forests

- Link all telecommunication purchases to the regional telecommunication strategy; always be looking to the future, avoid simply replacing existing systems with "the same thing, only newer." In most cases, avoid wholesale LMR system replacement for the next three to five years; changes in Federal and non-Federal regulation and impending advances in digital radio standards and technology make large investments in new wideband (25 kHz channel spacing) analog equipment unwise at this time. Base stations, repeaters, mobiles, and/or portables that cannot be repaired or reliably operated should, however, be replaced — see Section 8.6. Begin planning with cooperators now for future field communication support.

- Prepare for telecommunication support of Project 615. The RFP for this procurement specifies the use of digital local and wide area networks and conformance to open systems standards. Follow WO and RO guidance concerning the installation of LAN cable plants in the SO and RDs.

8.6 Restore Existing Systems and Address System Shortcomings

ITS visits to Eastern Region Forests revealed that some Forest telecommunication systems, most frequently land mobile radio systems, were not operating within design parameters due to system degradation or malfunction (see Section 4). In the majority of these cases, repairs can be made to return system performance to design levels, and proper system maintenance should ensure 3 to 5 additional years of dependable service.

ITS visits also revealed that some Forest telecommunication systems are simply obsolete and inadequate to meet mission needs; these systems should generally be replaced as soon as possible. In addition, some systems have design inadequacies that should be corrected to improve reliability, enhance performance, or improve communication with cooperators.

8.6.1 Implementation Step for the Regional Office

- Provide technical guidance to Forests as required; technical expertise in telecommunications is very limited on most Eastern Region Forests today.

8.6.2 Implementation Steps for Eastern Region Forests

- Ensure adequate system capacity, reliability, and performance. Actions taken could include adding a module to a key telephone system to increase capacity, installing an uninterruptible power supply to protect telephone and data communication systems from electrical power disturbances, establishing contract maintenance that includes periodic inspections and performance checks on all land mobile radio systems, replacing faulty coaxial cables and antennas at land mobile radio sites, replacing worn out land mobile radio systems, increasing repeater frequency spacing from 600 kHz to 2 MHz or greater (requires RFAs), and augmenting existing radio coverage by adding a repeater or moving antennas. Estimated cost: from a few thousand dollars to several tens of thousands of dollars, depending on the particular Forest.

- Add capabilities commonly available to and used by cooperating agencies, contractors, vendors, and the general public; the aim here is not simply to have all the latest technology, but to improve productivity. Actions taken could include purchasing facsimile machines and adding voice mail capability to a telephone

system. Estimated cost: from a few thousand dollars to several tens of thousands of dollars, depending on the particular Forest.

- Replace obsolete, inadequate systems with systems that manipulate information in digital form as much as possible and that have a well-defined upgrade path for future enhancements. Actions taken could include replacing a 1A2 electromechanical key telephone system with a digital electronic key telephone system. Estimated cost: from a few thousand dollars to several tens of thousands of dollars, depending on the particular Forest.

- Consider use of a PLB emergency position determination system for personnel working in remote areas not well-served by the Forest radio network. Estimated cost: $2000 for each PLB purchased.

9. REACHING THE FOREST SERVICE TELECOMMUNICATION GOALS

ITS believes that following the strategy outlined in the preceding section will effectively move Eastern Region Forests toward the telecommunication goals that arose from the needs analysis detailed in Section 3. In summary of the strategic plan, a time line illustrating key strategic assessments and the implementation of the various strategy components is shown in Figure 7.

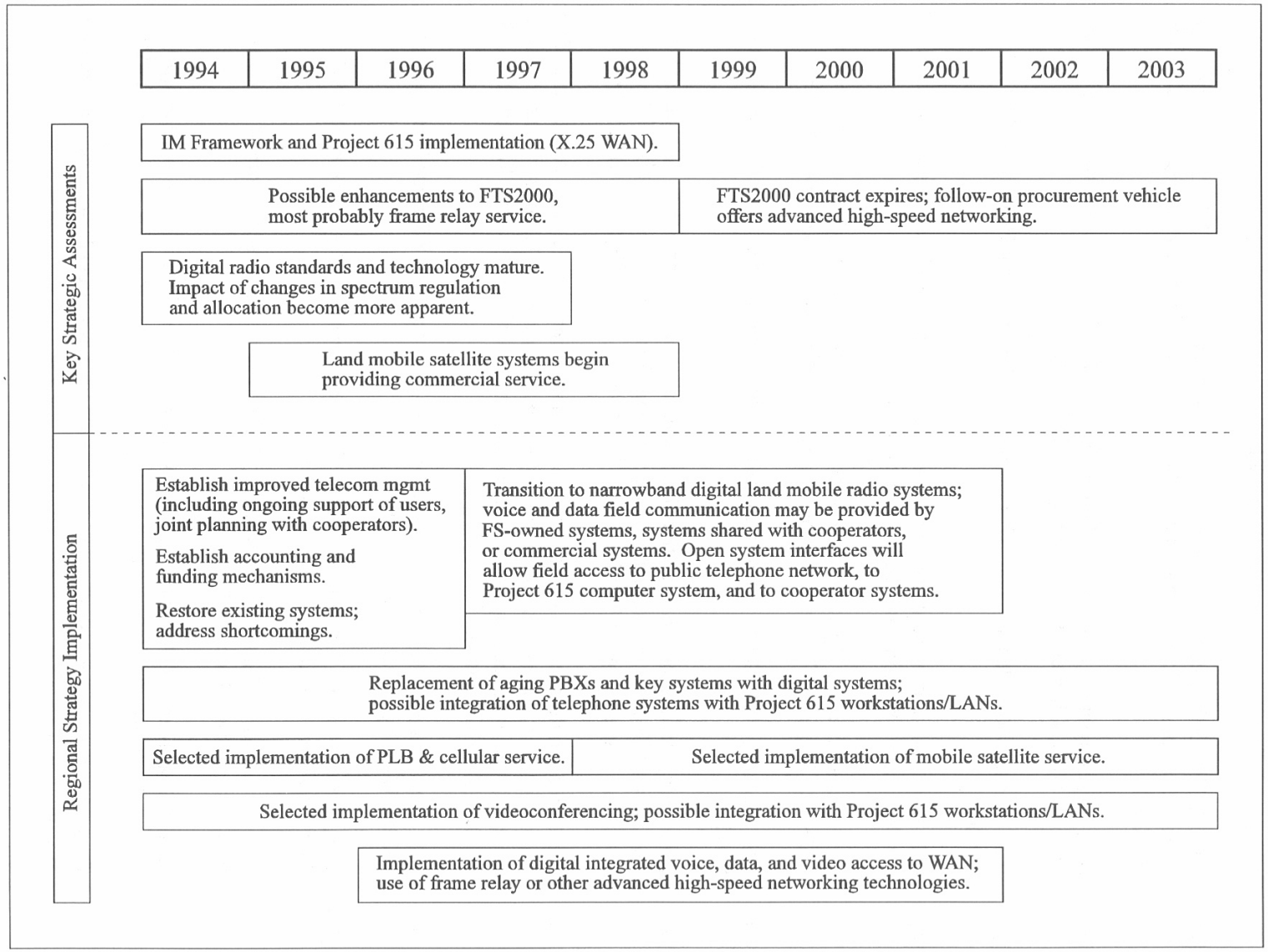


Figure 7. Timeline summarizing the regional strategic telecommunication plan.

10. REFERENCES

[1] AT&T, *FTS2000 Integrated Custom Network Reference Guide,* 1992. (Available from AT&T Customer Information Center, (800) 432-6600; document order number is 309-292-200).

[2] U.S. Department of Agriculture, Forest Service, *Forest Service Manual,* Title 6600, Chapter 6610, Chapter 6640, Washington, DC, 1990.

[3] F.J. Marita, 6640 letter dated 12 December 1989, Eastern Region, USDA Forest Service.

[4] U. S. Department of Agriculture, Forest Service, *Information Management: A Framework for the Future,* Washington, DC, February 1992.

[5] U.S. Department of Agriculture, Forest Service, *Request for Proposal KRF-92-007, FEDCAC Project 107/Forest Service Project 615,* Washington, DC, October 1992.

[6] J.H. Haskell, 6640 letter dated 4 February 1993, Washington Office, USDA Forest Service.

[7] Electronic Industries Association/Telecommunications Industry Association-568, *Commercial Building Telecommunications Wiring Standard.* (Distribution rights belong to Global Engineering, 1990 M St. NW, Washington, DC 20036, (202) 429-2860).

[8] Electronic Industries Association/Telecommunications Industry Association-569, *Commercial Building Standard for Telecommunications Pathways and Spaces.* (Distribution rights belong to Global Engineering, 1990 M St. NW, Washington, DC 20036, (202) 429-2860).

[9] U.S. Department of Agriculture, Forest Service, *What the Forest Service Does,* pamphlet FS-20, Washington, DC, October 1986.

[10] U.S. Department of Agriculture, Forest Service, *Summary of the Recommended 1990 RPA Program,* Washington, DC, May 1990.

[11] F.D. Robertson (Chief, Forest Service), *USDA Forest Service Centennial Newsletter,* Washington, DC, June 1991.

[12] U.S. Department of Agriculture, Forest Service, *New Perspectives — Managing the National Forests and Grasslands,* pamphlet PA-1482, Washington, DC, March 1992.

[13] General Services Administration, *Federal Information Resources Management Regulation,* Washington, DC, 1991.

[14] National Communications System, *Emergency Communications for a Changing World*, pamphlet celebrating 30th anniversary of NCS, Washington, DC, 1993.

[15] U.S. Department of Commerce, National Institute of Standards and Technology, National Computer Systems Laboratory, *Government Open Systems Interconnection Profile* (*GOSIP*), *FIPSPUB 146-1*, Washington, DC, 1991. (Available from the National Technical Information Service, (703) 737-4650).

[16] S.A. Masud, "GOSIP barely makes a dent in real-world fed networks," *Government Computer News*, March 15, 1993.

[17] S.A. Masud, "NIST aims to harmonize TCP/IP and OSI suites," *Government Computer News*, August 2, 1993.

[18] S.A. Masud, "Eight chosen to study federal internetworking needs," *Government Computer News*, October 11, 1993.

[19] U.S. Department of Commerce, National Telecommunications and Information Administration, "Authority and Organization," Chapter 1 of *Manual of Regulations and Procedures for Federal Radio Frequency Management*, Washington, DC, May 1993.

[20] U.S. Department of Commerce, National Telecommunications and Information Administration, "Channeling Plan for Assignments in the Band 162-174 MHz," Section 4.3.7 of Chapter 4 of *Manual of Regulations and Procedures for Federal Radio Frequency Management*, Washington, DC, May 1993.

[21] *National Telecommunications and Information Administration Organization Act of 1992*, Public Law No. 102-538 (to be codified at 47 U.S.C. § 901).

[22] D.J. Cohen, "Land mobile spectrum-efficiency — A plan for federal government agencies to use more spectrum-efficient technologies," NTIA Report 93-300, 1993.

[23] U.S. Department of Agriculture, Office of Information Resources Management, *Information Resources Management Strategic Plan*, Washington, DC, December 1992.

[24] *Omnibus Budget Reconciliation Act of 1993*, Public Law No. 103-66 (to be codified at 47 U.S.C. § 923).

[25] J. Silva, "Clinton's budget bill reshapes landscape of wireless industry," *Radio Communications Report*, August 30, 1993.

[26] Federal Yellow Book, Monitor Publishing Co., Washington, DC, Summer 1993.

[27] J. Silva, "Toil pays off as national plan on public-safety is submitted," *Radio Communications Report,* March 22, 1993.

[28] Federal Communications Commission, Report and Order No. 87-112.

[29] Federal Communications Commission, PR Docket No. 91-170.

[30] Federal Communications Commission, PR Docket No. 92-235.

[31] L. Manuta, "Shaking it up in D.C.," *Communications,* January 1993.

[32] Associated Public Safety Communications Officers (APCO), Inc., *APCO* 25 — *Your Voice in Determining the Future of Digital Two-way Radio,* pamphlet, April 1993.

[33] S. Adler, "A public safety digital system development," *APCO Bulletin,* April 1993.

[34] Editors, "Special report — mobile satellite service wi11launch wireless communications into the global frontier," *Radio Communications Report,* June 7, 1993.

[35] D. Hartshorn, "LEOs: protector or predator?," *Communications,* November (Part I) and December (Part II) 1992.

[36] M. Semilof, "Voice and video over Ethernet LANs aired," *Communications Week,* November 23, 1993.

[37] M. Semilof, "Plan for sending voice and video over Ethernet to get hearing," *Communications Week,* March 1, 1993.

[38] B. Bass, "Appeals court OKs new tech for FTS2000," *Federal Computer Week,* August 9, 1993.

[39] S.A. Masud, "U.S. appeals court gives green light to FTS T3 service, reverses GSBCA," *Government Computer News,* August 16, 1993.

[40] S.A. Masud, "T3 flap ushers in FTS2000's midlife crisis," *Government Computer News,* August 30, 1993.

[41] S.A. Masud, "GSA moves to add frame relay service to FTS2000 this year," *Government Computer News,* May 10, 1993.

[42] S.A. Masud, "After FTS2000, what's next?," *Government Computer News,* July 7, 1993.

[43] B. Bass, "FTS2000 follow-on to focus on bandwidth," *Federal Computer Week,* February 15, 1993.

[44] World Wide Satellite Rescue Systems, Inc., *Report — 406 MHz Personal Locator Beacon Experimental Program, USDA Forest Service,* June 1993. (Copies of the report may be obtained by contacting World Wide Satellite Rescue at (303) 438-1120).

[45] E. Gold, "Videoconferencing interoperability report," *Networking Management,* September 1992 (Part I) and June 1993 (Part II).

[46] AT&T, *Government Issue,* product marketing newsletter, November/December 1993.

APPENDIX: FOREST SERVICE ORGANIZATIONAL STRUCTURE

The Forest Service employs a hierarchical organizational structure. Agency headquarters is referred to as the Washington Office. Regional Offices oversee the National Forests located in each of nine geographic regions. The headquarters for each Forest is known as the Supervisor's Office. Each Forest is divided into several Ranger Districts, each with its own office.

A map of the Eastern Region is shown in Figure A-1. The Regional Office is located in Milwaukee, Wisconsin. Administratively, there are 15 National Forests in the Region; the Huron and Manistee National Forests are managed as a single Forest (the Huron-Manistee), and the Finger Lakes National Forest is managed as a unit of the Green Mountain National Forest.

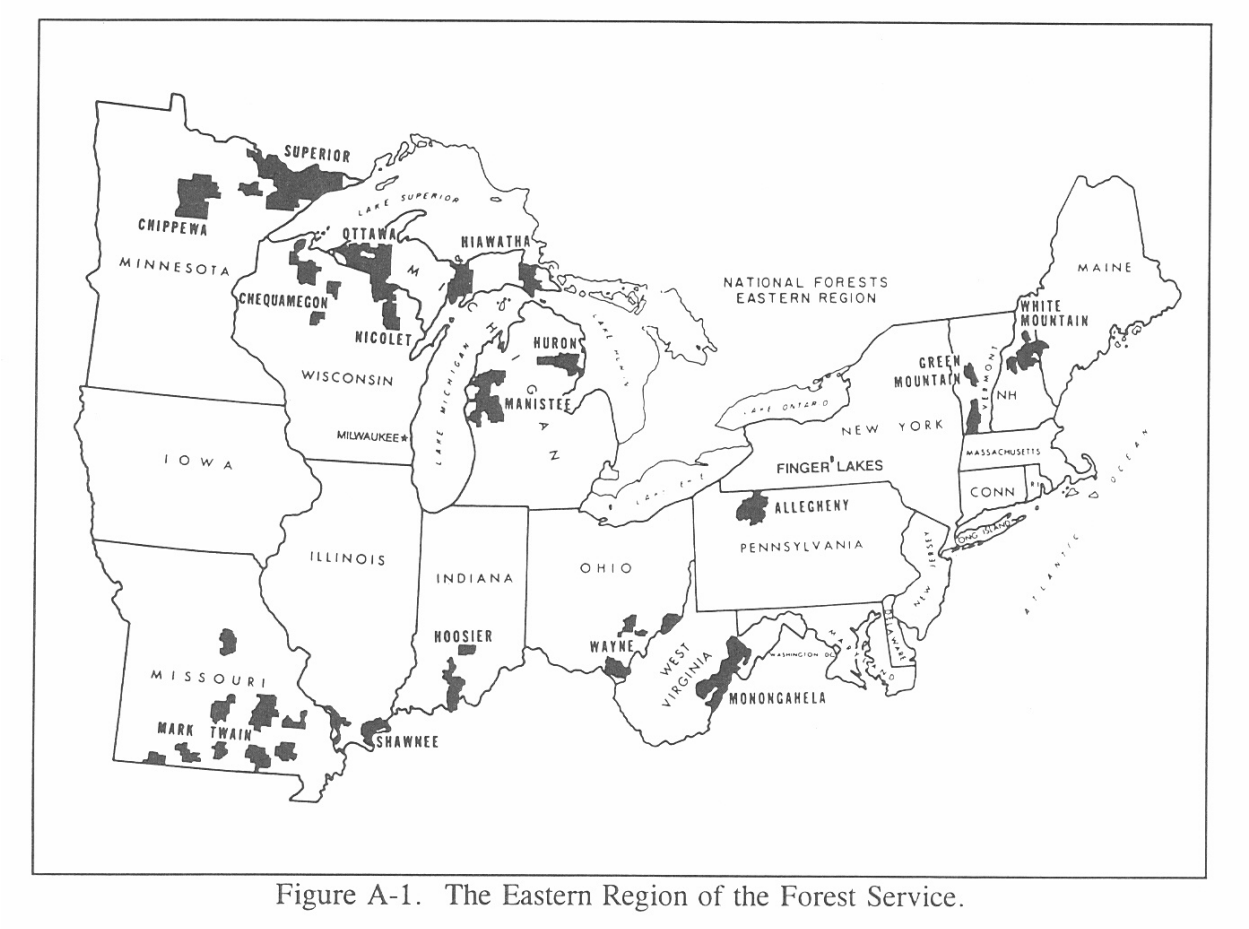


Figure A-1. The Eastern Region of the Forest Service.

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15. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

This report documents the development of a telecommunication strategy for 1994-2003for the Eastern Region of the U.S. Department of Agriculture Forest Service. The Institute for Telecommunication Sciences (ITS) identified telecommunication needs, assessed the existing telecommunication systems of the 15 National Forests in the Region, assessed internal and external factors that impact telecommunication planning, and assessed telecommunication technologies. Based on the foregoing, ITS developed a telecommunication strategy intended to ensure that Eastern Region telecommunication systems and services support the mission of the organization in a reliable and cost-effective manner.

16. Key Words *(Alphabetical order, separated by semicolons)*

data communication system; digital integrated network; Forest land mobile radio network; land mobile radio system; strategic telecommunication plan; tactical telecommunication plan; telecommunication management; telephone system

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