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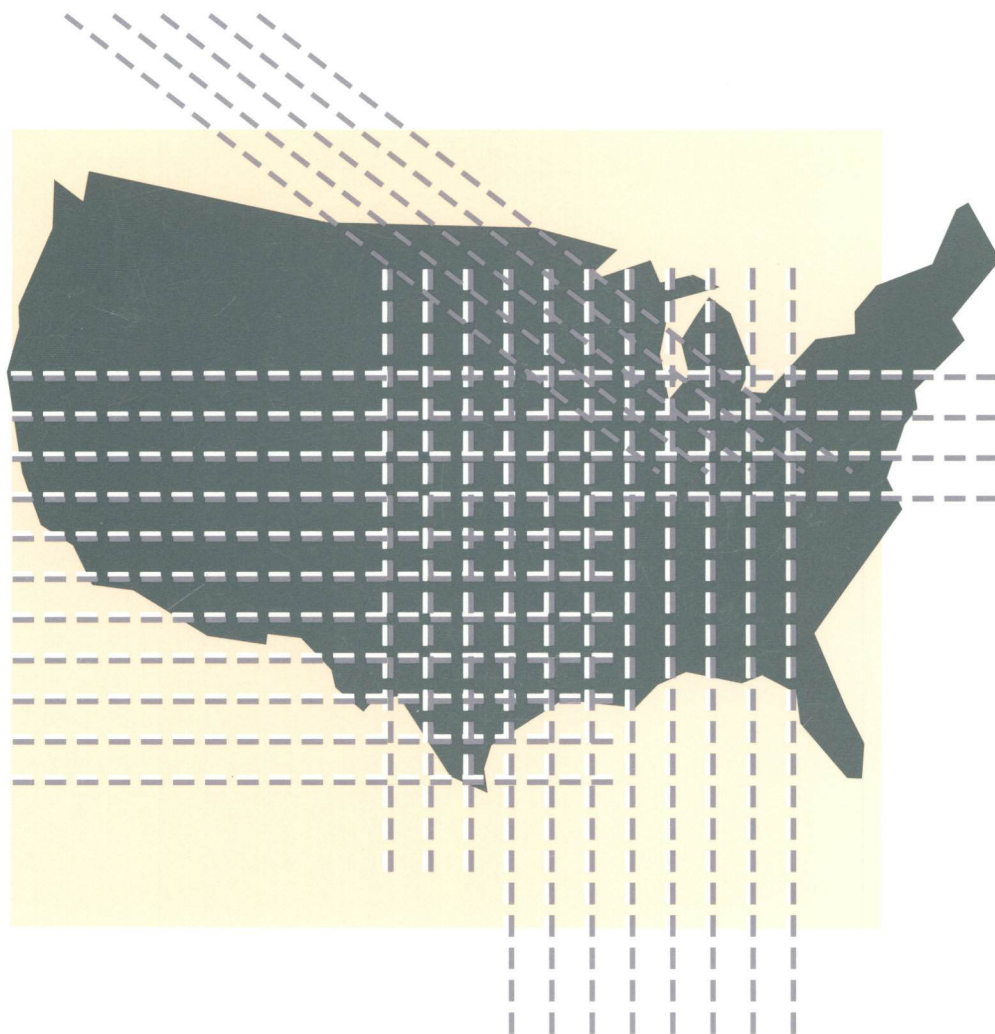
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ENDURING TELECOMMUNICATIONS — A NEW PERSPECTIVE



REPORT ON NATIONAL LEVEL

TELECOMMUNICATIONS

INFRASTRUCTURE IMPROVEMENTS

OCTOBER 1991

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Subject: Report of the Panel of Experts on a Review of the National Level NS/EP Telecommunications Program

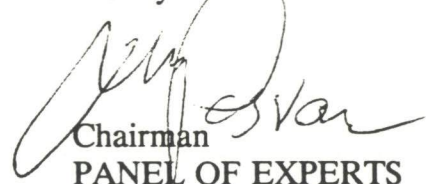
We have completed our review of the National Level NS/EP Telecommunications Program (NLP) and hereby submit our report for your review. To complete our task, the panel reviewed the current NLP, previous studies of the Nationwide Emergency Telecommunications Service, the interagency Committee of Principals' special subcommittee report of May 1990, and alternative architectures and technologies. Assisted by a staff working group, we completed our work in five months.

After reviewing the current NLP and five other approaches to providing NS/EP telecommunications services, we recommend a public switched network-based approach--the Commercial Access and Priority Service (CAPS). In light of the evolving threat, improvements in cost effectiveness and performance, and the conservatively phased implementation of the proposed programs, the panel strongly urges that CAPS proceed without delay.

CAPS is recommended because it meets the functional requirements for an NS/EP telecommunications service and leverages both the capital investment and technology improvements of the commercial carriers. CAPS can also take advantage of new technologies or services as they are available. Performance estimates indicate that CAPS compares favorably with the predicted performance and cost of the current NLP.

Based upon our review, the panel is confident that the evolutionary implementation of a PSN-based service is the most cost-effective means to ensure a survivable and enduring telecommunications capability for the NS/EP community.

Wesley W. Posvar



Chairman
PANEL OF EXPERTS

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EXECUTIVE SUMMARY

The Nation's telecommunications infrastructure is a critical component of our national security posture. Our dependence on reliable telephone service was illustrated by a recent network outage in New York City, which closed three local airports for 5 hours. This outage resulted from a power failure and not hostile intent. In the event of a limited or full-scale nuclear attack, terrorist action, or natural disaster, the loss of the telephone system would significantly impair government efforts to coordinate disaster response and recovery operations.

The mission of the National Communications System (NCS) is to ensure that communications are available when needed. To this end, the NCS developed a National Level National Security and Emergency Preparedness (NS/EP) Telecommunications Program (NLP) to enhance the Nation's public switched networks (PSN) to ensure communications continuity in any crisis. Recent guidance from the White House and the NCS Executive Agent delayed the program for 2 years and recommended a review of alternate technologies that might reduce costs.

To conduct this review, a panel of experts was established. The panel was chaired by Dr. Wesley Posvar, past President of the University of Pittsburgh, whose expertise is in, among other areas, national security policy. Panel members included: Mr. Frank Carr, past Commissioner of Information Resources Management Service of the General Services Administration; Mr. Robert Everett, past President and Chief Executive Officer of the MITRE Corporation and past Chair of the Defense Sciences Board; Lieutenant General Vaughn Lang (U.S. Army retired), a distinguished military leader and expert in defense mobilization; and Mr. Edward Minkel, past Managing Director and Defense Director of the Federal Communications Commission.

The panel met over the course of 5 months in 1991 to consider the changing threat to communications, underlying policy guidance, requirements for an NS/EP service, and concerns regarding energy supplies for telecommunications. They compared a number of technical approaches on the basis of the functional requirements for an NS/EP telecommunications service, risks, and costs.

Massive nuclear war has been by far the most demanding threat to the Nation and the Nation's communications. Lately, this threat has been decreasing. Therefore, large expenditures for improved communications survivability are questionable. Communication improvements need to be justified on the basis of expected performance against large- and small-scale nuclear attack scenarios and the potential for specific targeting of telecommunication assets.

A major concern in the NS/EP community is the provision of power to telecommunication facilities in the event of natural or man-made disasters. The Department of Energy, the telecommunications industry, and the NCS are working to ensure energy continuity. These efforts include a system to manage electric power restoration and curtailment on a priority basis, use of state set-asides, and priority fuel resupply agreements. The panel notes that efforts to ensure electric power and fuel to satisfy long-term needs of the NS/EP telecommunications infrastructure have progressed more rapidly than for other comparable infrastructures. Therefore, the panel recommends that implementation of an NS/EP telecommunications improvement program proceed.

The panel assessed the current NLP and five other technical approaches to providing a complete NS/EP telecommunications service. These approaches use very small aperture terminal satellite technology, high frequency radios, packet-switched message service, low earth orbit satellite service (Iridium), and the public switched networks. The panel concluded that the current NLP and the new PSN-based approach are the only ones that meet all of the functional requirements.

The predicted performance of the new PSN-based approach, including Commercial SATCOM Interconnectivity (CSI) and Commercial Network Survivability (CNS), compares favorably to the predicted performance of the current NLP. Moreover, the new PSN-based approach should be less expensive than the current NLP. While investments in past design work contribute to either approach, use of the new PSN-based approach could significantly reduce nonrecurring costs and recurring costs. According to the panel's cost estimates for the new PSN-based approach, nonrecurring costs would be \$32 million, and annual recurring costs would be \$40 million. These estimates include the costs of CSI and CNS enhancements.

Therefore, the panel recommends that a PSN-based approach be implemented without delay. The main component of the approach should be named Commercial Access and Priority Service (CAPS) to emphasize the Government's strategy of relying upon access to commercial services and priority treatment within the PSN. CAPS builds upon the PSN and government networks and systems (e.g., Federal Telecommunications System 2000), meets all of the functional requirements for the service, and can be implemented on an evolutionary basis. CAPS would replace the Nationwide Emergency Telecommunications Service program. The National Level Program would then comprise: Commercial Access and Priority Service and the existing Commercial SATCOM Interconnectivity and Commercial Network Survivability programs.

Although the new PSN-based approach was selected, the other technologies also provide opportunities to improve end-to-end performance for selected sets of users or users with special needs. The panel recommends that very small aperture terminal satellite systems, high frequency radios, packet-switched message service, and Iridium be considered as they evolve in the future as enhancements to the new CAPS-based NLP.

1. INTRODUCTION

In response to White House guidance, the Secretary of Defense as the National Communications System (NCS) Executive Agent issued a memorandum dated March 15, 1991, to the Manager, NCS, delaying the implementation of the Nationwide Emergency Telecommunications Service (NETS) for 2 years. The revised schedule was based upon the premise that, by 1996, the Department of Energy would have satisfactory emergency energy and power programs in place to support NETS. The memorandum also directed the review of new or alternate technologies that could satisfy NETS functional requirements at reduced cost.

To respond to this direction, the Manager, NCS, established an independent panel, composed of experts in federal telecommunications and national security policy to "perform an independent assessment and review of: the current NLP (National Level National Security and Emergency Preparedness (NS/EP) Telecommunications Program), previous studies of NETS, interagency COP (Committee of Principals) special subcommittee report of May 1990, and alternative technologies or architectures." The panel members were: Dr. Wesley W. Posvar (Panel Chair), Frank J. Carr, Robert R. Everett, Lieutenant General Vaughn O. Lang (United States Army retired), and Edward J. Minkel. The panel met five times between June and October of 1991 and completed this report to the Manager, NCS, in late October 1991.

The panel received information briefings from both government and telecommunications industry representatives on security threat, national policy, requirements, enduring emergency power, evolving technology of the public switched networks (PSN), and proposed alternatives to the current NLP. Panel deliberations resulted in the identification of six technical approaches to meeting NS/EP

telecommunication needs, including the current NLP. A comparative analysis of the approaches considered support to the functional requirements for an NS/EP telecommunications service, risks, and costs.

This report summarizes the panel's deliberations and findings and presents its recommendations to the Manager, NCS. Panel findings and recommendations reflect analysis of the threats motivating NS/EP telecommunications planning, national policy, NS/EP telecommunication requirements, emergency energy and power improvement programs, and the six technical approaches.

2. THREATS TO NS/EP TELECOMMUNICATIONS

Since the establishment of the NCS, presidential guidance has regularly reaffirmed that NS/EP telecommunications must remain responsive to a broad variety of threats. This need presents challenges in planning and executing NS/EP missions, because the threats vary in magnitude, duration, geographic scope, and probability of occurrence.

2.1 Threat Spectrum

The current threat spectrum includes variations in both the geographic range and severity of threats. It encompasses threats ranging from local, less severe emergencies (e.g., fire, flood) to national and international crises, involving nuclear war and reconstitution of the nation. In broad terms, the threat spectrum involves two types of threats: those posing direct challenges to the survival of the nation or parts of the nation, and those directed specifically against national or regional communication functions.

The first type of threat, **destruction threats**, includes general or limited nuclear war, nuclear terrorism (including the prospect of accidental nuclear strikes on the United States [U.S.]), major industrial accidents such as those involving significant releases of radiation, and large-scale natural disasters. These threats have several common elements:

- Survival of significant portions of the public switched network (PSN). Even in the extreme case of a large-scale nuclear attack against the U.S., significant portions of the PSN would survive. However, effects of destruction and extreme demand for service may cause significant outages or denial of service due to congestion without compensating transmission and control enhancements.

- Increased demand for government telecommunications. Although the scope and severity of these potential threats vary considerably, any scenario would require extensive interagency communications as government services are reestablished and reconstitution efforts are organized.
- Limited warning time. Although the general nuclear war scenario may require reexamination, most of these threats can be manifested with little effective warning time.

The second type of threat -- efforts directed specifically against national or regional communication functions, including continuity of government functions -- has received comparatively less attention in planning for NS/EP telecommunications. However, these **disruption threats** pose unique challenges for the NCS and merit special attention because they are focused and more discriminating than destruction threats. Three specific types of disruption threats directed against national communication assets and functions are:

- Hostile intelligence collection efforts targeting the PSN and other networks
- Sabotage and terrorist attacks on communication facilities
- A growing threat from "hackers" attempting unauthorized use or disruption of communication networks.

These threats are qualitatively different from destruction threats, because they are of an ongoing nature and involve limited, or no, physical destruction of network facilities. They also directly threaten continuity and security of government operations. In a network as complex, heterogeneous, and software-driven as the PSN, a high degree of security against disruption threats is technically difficult to achieve.

2.2 Changing Threat Environment

The recent signing of the Strategic Arms Reduction Treaty (START) and the Administration's announcement of major modifications in the U.S. nuclear force posture reflect changes in the destruction threat environment. One of the most important planning contingencies for general nuclear war -- a Soviet-led attack on Western Europe -- appears less likely to develop than at any time since the end of World War II. This condition appears likely to continue, as the Warsaw Pact command structure has been dissolved, the Soviet Army is redeploying its forces that were formerly in Eastern Europe, and the governments of the principal non-Soviet Warsaw Pact states (Poland, Hungary and Czechoslovakia) have adopted an explicit pro-Western line and are reducing the size and readiness levels of their armed forces.

START force level reductions and related U.S. and Soviet unilateral efforts will achieve the smallest force structures and lowest nuclear readiness levels since before 1980. These actions represent a 37 percent reduction in Soviet strategic nuclear delivery vehicles (to 1,600) and a 33 percent reduction in countable nuclear warheads (to about 7,160).

While these developments are certainly favorable, the risk of accidental nuclear war remains clear and present, and may be increasing in light of the recent instability in the Soviet Union. In addition, the possibility of small-scale nuclear strikes launched by third world countries cannot be discounted.

The risk associated with disruption threats is highly uncertain, but it is believed to be increasing. The recorded number of software intrusions into PSN elements confirms the ability of hackers to attack networks and confirms the vulnerability of some networks to hostile penetration. According to the November 1990 report of the National Security Telecommunications Advisory Committee Network Security Task Force, industry and government should assume that "a motivated and resourceful adversary, in one concerted

manipulation of network software, could degrade at least portions of the PSN and monitor or disrupt the telecommunications serving NS/EP users." The risk of smaller-scale disruptions from individuals is even greater.

Response to the threat environment is influenced by national policy priorities. NS/EP telecommunications planning should be based on threat assumptions consistent with those used by other federal agencies. In this regard, federal-level threat planning assumptions used by the Federal Emergency Management Agency, the Joint Staff and military services, and the Department of Defense assign a relatively lower priority to the most severe destruction threats (those posed by general nuclear war) and are attaching higher priority to regional conflicts and natural disasters. For example, nuclear command and control facilities, including the "Looking Glass" nuclear command and control aircraft, are operating at reduced readiness levels and plans to upgrade or modernize general nuclear war-related communications systems are receiving lower priorities. In contrast, an increase in the number of attempted and successful disruptions of communications and information systems has heightened federal agency and telecommunications industry awareness of vulnerabilities to these types of threats.

2.3 Panel Findings and Recommendations

With respect to the threat to NS/EP telecommunications, the panel offers the following findings:

- The threat spectrum presents challenges in planning and executing NS/EP missions because the threats arrayed along this spectrum vary in magnitude, duration, geographic scope, and probability of occurrence.
- The threat environment has been changing in a number of ways. Most important, there is a perceived reduction in the risk of a large-scale nuclear

laydown and an increase in the risk of smaller-scale attacks. Another concern is the possible targeting of telecommunication assets in a nuclear attack.

- . The risk of disruption to telecommunication assets, including hostile intelligence collection efforts, terrorist attacks on communication facilities, and unauthorized use or disruption of communication networks, is increasing.
- . The nuclear attack scenario, albeit at a lower level, is the primary justification for the NLP. As a consequence, NS/EP telecommunication programs should be evaluated on the basis of expected performance in view of a reduced nuclear attack scenario and the potential for specific targeting of telecommunication assets.

The panel recommends that the NCS select telecommunication programs and initiatives that allow for easy adaptation to heightened nuclear scenarios if the threat escalates in the future. NS/EP telecommunication initiatives that provide small numbers of clearly identifiable targets for destruction or disruption should be avoided.

The panel also recommends that the Manager, NCS, in coordination with the intelligence community, continue to take a leadership role in the investigation and mitigation of network security threats to our nation's telecommunications and information systems.

3. POLICY GUIDANCE

The NCS was established in 1963 in the aftermath of the Cuban Missile Crisis. A Presidential Memorandum, signed on August 21, 1963, created the NCS to ensure ". . . the necessary communications for the Federal Government under all conditions ranging from a normal situation to national emergencies and international crises, including nuclear attack." The organization of the NCS is illustrated in Exhibit 3-1. The current NCS members and their primary telecommunication assets are listed in Exhibit 3-2. Subsequent policy guidance:

- . Identified telecommunications as a vital element of U.S. deterrence
- . Prescribed functional characteristics for the development of an enhanced national telecommunications infrastructure
- . Directed use of commercial, government, and private telecommunication assets
- . Expanded the scope of policy to include emergency preparedness in addition to national security requirements
- . Prescribed priority order for NS/EP requirements
- . Affirmed the requirement for voice capability for presidential operations
- . Established guidelines for multi-agency funding of the national-level NS/EP telecommunications program
- . Delayed the implementation of the NETS program.

EXHIBIT 3-1

NCS Organization

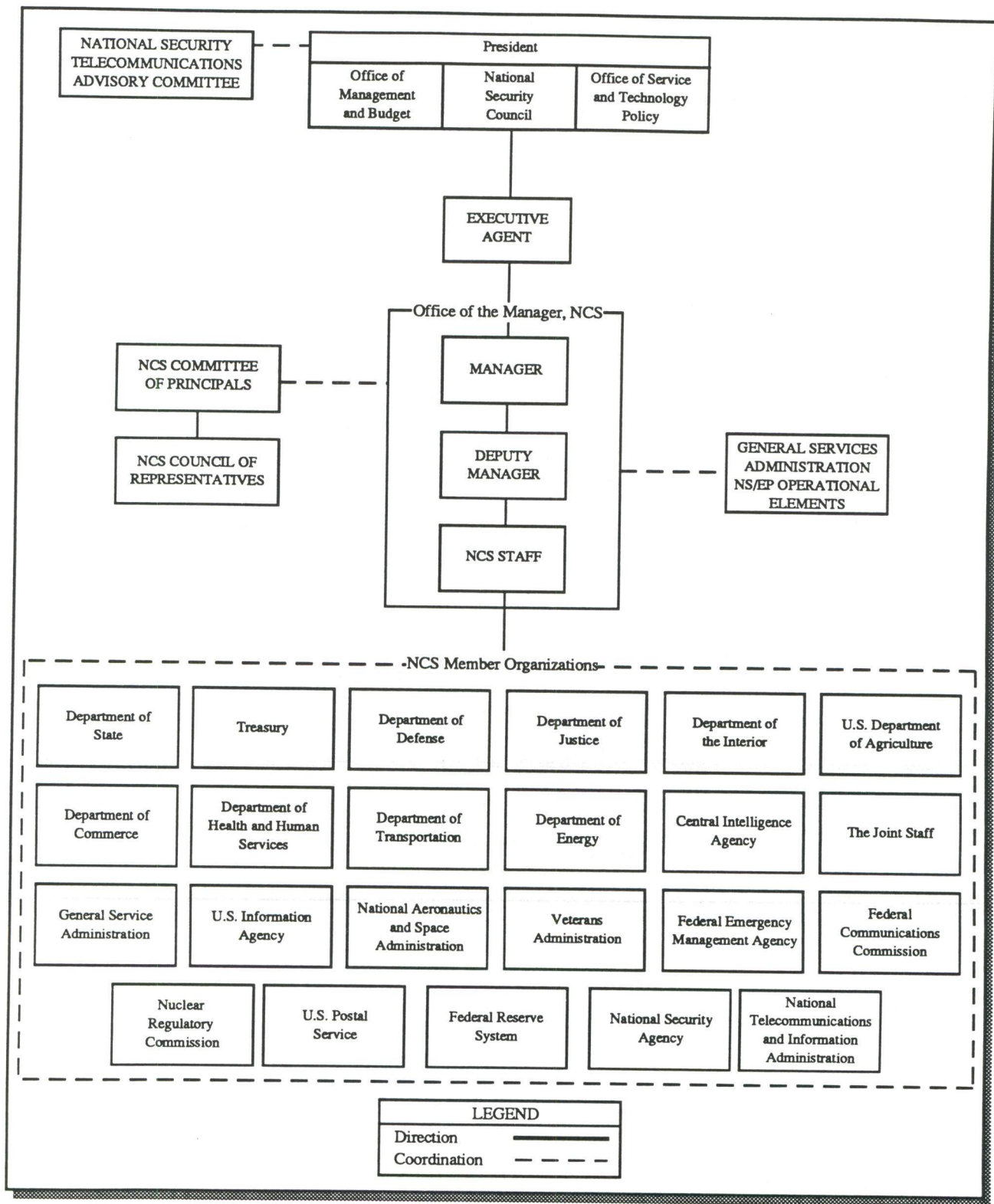


EXHIBIT 3-2

NCS Primary Assets

UNCLASSIFIED LIST OF SELECTED NCS PRIMARY ASSETS

DEPARTMENT OF STATE

- Diplomatic Telecommunications Service
- Nuclear Risk Reduction Center

DEPARTMENT OF THE TREASURY

- Consolidated Data Network
- Federal Reserve Communications System
- Treasury Enforcement Communications System
- Digital Telecommunications System

DEPARTMENT OF DEFENSE

- Advanced Research Project Agency Network
- Defense Data Network
- Defense Message System
- Defense Satellite Communications System
- Defense Switched Network
- Direct Communications Link (Washington-Moscow Hotline)
- Future Secure Voice System
- Joint Chiefs of Staff Alerting Network
- National Military Command System
- Washington Area Wideband System
- Worldwide Military Command and Control System

DEPARTMENT OF JUSTICE

- Automatic Data Processing Teleprocessing System
- Drug Enforcement Administration Nationwide VHF Radio System
- Drug Enforcement Administration Secure Voice System
- Immigration and Naturalization Service Tactical Radio System
- Immigration and Naturalization Service Integrated Network Communications
- Justice Network
- Justice Telecommunications Service
- National Crime Information Center
- U.S. Marshals Service Communications System
- U.S. Marshals Service Special Operations Group

DEPARTMENT OF THE INTERIOR

- Boise Interagency Fire Center Transportable Radio Cache

DEPARTMENT OF COMMERCE

- Automation of Field Operations and Services
- National Oceanic and Atmospheric Administration Weather Radio

DEPARTMENT OF TRANSPORTATION

- Emergency Transportation Radio Network
- Federal Aviation Administration*
- Aeronautical Fixed Telecommunications Network
- Aeronautical Message Circuits (Service B)
- Electronic Tandem Network
- Emergency Voice Communications System
- Integrated Communications Switching System
- National Airspace Data Interchange Network
- National Airspace System Network
- National Radio Communications System
- Radar Microwave Link Trunking
- Radio Communications Link
- Television Microwave Link
- Voice Switching and Control System

United States Coast Guard

- Hybrid Data Network
- Long-Range Aid to Navigation
- Message Transfer and Distribution System
- OMEGA

United States Coast Guard (continued)

- Operations Information System
- Radio Communication Systems
- MF and HF Long-Range Radio: MF-SSB Distress System
- VHF and UHF: National VHF-FM Distress System
- Search and Rescue Telephones
- Secure Command and Control Network
- Transportable Communication Centers
- Vessel Traffic Services

Federal Highway Administration

- Federal Highway Administration Emergency Communications Systems

DEPARTMENT OF ENERGY

- Nuclear Emergency Search Team/Aerial Measuring System
- Secure Automatic Communications Network

DEPARTMENT OF VETERANS AFFAIRS

- Emergency Command Control Radio Network
- Network Resource Information System
- Veterans Affairs Data Transmission System
- Veterans Affairs HF Emergency Radio Network
- Veterans Affairs Selective Signaling Voice Conference System

JOINT STAFF (see Department of Defense)

GENERAL SERVICES ADMINISTRATION

- Federal Telecommunications System 2000
- Federal Secure Telephone Service
- Washington Interagency Telecommunications System
- Government-owned Centrex Service Arrangements
- Regional Consolidated Local Centrex Service Arrangements

UNITED STATES INFORMATION AGENCY

- Voice of America

NATIONAL AERONAUTICS AND SPACE ADMIN.

- NASA Operational Communications System
- NASA Tracking and Data Relay Satellite System
- NASA Program Support Communications Network

FEDERAL EMERGENCY MANAGEMENT AGENCY

- FEMA Interagency Communications System
- Federal Emergency Response Capability
- Direction, Control, and Warning System
- Mobile Air Transportable Telecommunications System
- Information Display System
- FEMA Switched Network
- FEMA National Automated Message System
- FEMA National Radio System
- FEMA Secure Voice Program
- Local Area Network/Wide Area Network Development Project

- FEMA Frequency Management System

- FEMA Facsimile and Record System

- National Warning System

- Emergency Broadcast System

- Emergency Education Network

NUCLEAR REGULATORY COMMISSION

- Emergency Notification System

UNITED STATES POSTAL SERVICE

- U.S. Postal Service Data Network

NATIONAL SECURITY AGENCY (see Department of Defense)

3.1 National Security Telecommunications Policy

President Carter issued Presidential Directive 53, *National Security Telecommunications Policy*, in 1979. It specifically identified telecommunications as a vital element of U.S. deterrence. In addition, it stated that national security telecommunications were required to gather intelligence, conduct diplomacy, command and control military forces, provide continuity of essential government functions, and ensure national recovery after nuclear war or natural disaster.

President Reagan validated the concepts of Presidential Directive 53 in National Security Decision Directive 97, *National Security Telecommunications Policy*, in 1983. This directive adopted the same policy objectives, but took them one step further by creating a high-level steering group to oversee their implementation. The National Security Decision Directive 97 Steering Group, composed of high-level officials from the Executive Branch, was replaced in 1989 by the Policy Coordinating Committee on National Security Telecommunications and Information Systems.

National Security Decision Directive 97 assigns specific responsibilities to the Manager, NCS, and federal departments and agencies. It establishes the policy, goals, objectives, and principles of national security telecommunications to support national security leadership requirements. These requirements are embodied in the President's responsibilities as Commander-in-Chief, Head of State, and Chief Executive. The direction reaffirms the requirements for a survivable telecommunications infrastructure as a crucial element of deterrence. It also states that the national telecommunications infrastructure must possess the necessary connectivity, redundancy, interoperability, restorability, and hardness to allow federal agencies to accomplish their wartime and non-wartime functions.

3.2 Assignment of NS/EP Telecommunication Functions

In 1984, President Reagan revitalized the NCS by issuing Executive Order 12472, *Assignment of National Security and Emergency Preparedness Telecommunications Functions*. It is the principal source of legal and policy guidance for federal NS/EP telecommunication needs. Executive Order 12472 reflects and reinforces the key provisions of National Security Decision Directive 97, and expands its scope by encompassing emergency preparedness as well as national security telecommunication functions and concerns. The order defined a new NCS administrative structure, establishing a Committee of Principals to serve as the forum for presenting to the Executive Office of the President views and recommendations regarding NS/EP telecommunication needs.

In addition, Executive Order 12472 defines the NS/EP telecommunication responsibilities and functions of the NCS, the Executive Office of the President, and the federal departments, agencies, and other entities. Executive Order 12472 assigns to the NCS the mission to coordinate the planning and provisioning of NS/EP telecommunications for the Federal Government under all circumstances, including crisis or emergency, attack, recovery, and reconstitution. Moreover, this order states that the NCS shall seek to ensure the development of a national telecommunications infrastructure, consistent with the guidance in National Security Decision Directive 97. It directs the NCS to use all available commercial, government, and privately-owned telecommunication resources for this purpose.

The Manager, NCS, is assigned several responsibilities by Executive Order 12472. The most important of these responsibilities is the development of planning, procedural, and standards initiatives for consideration by the NCS Committee of Principals and Executive Agent. This includes the development of a recommended evolutionary telecommunications architecture designed to meet current and future federal government NS/EP telecommunication needs. Executive Order 12472 also directs the Manager,

NCS, to conduct technical analyses to identify improved approaches that may assist federal organizations in fulfilling NS/EP telecommunication objectives.

3.3 Assignment of Emergency Preparedness Responsibilities

Executive Order 12656, issued by President Reagan in 1988, establishes policy to ensure sufficient capabilities at all levels of government to meet essential defense and civilian needs during any national security emergency. Emergencies that seriously threaten national security may result from natural disaster, military attack, technological accidents, or other causes. Executive Order 12656 requires each federal department and agency to work within the framework established by Executive Order 12472. It also requires each department or agency to cooperate with those organizations assigned responsibility in Executive Order 12472.

3.4 Additional Relevant Policy Guidance

A number of policy statements issued since 1987 provide important guidance on the approach to meeting NS/EP telecommunication needs. A December 18, 1987 memorandum from the Director, Office of Management and Budget, to the heads of all NCS member organizations addresses the Nationwide Emergency Telecommunications Service (NETS) program. The memorandum states that the National Security Decision Directive 97 Steering Group concluded that augmenting the commercial PSN with NETS enhancements provides a valuable capability for intra- and interagency emergency communications.

More important, it directs that the NCS continue to give emphasis to telecommunications supporting the following, in priority order:

1. Presidential communications
2. Continuity of government operations

3. International interface for diplomatic telecommunications service and defense communications systems
4. Agency essential emergency functions
5. National Telecommunications Management Structure
6. Emergency Broadcast System
7. State emergency operations centers.

In 1989, President Bush issued National Security Directives 1 and 10. National Security Directive 1 establishes a new National Security Council structure based on high-level interagency groups called Policy Coordinating Committees. National Security Directive 10 establishes a Policy Coordinating Committee on National Security Telecommunications and Information Systems to replace the National Security Decision Directive 97 Steering Group. This committee is chaired by the NCS Executive Agent and includes senior representatives from the Office of Science and Technology Policy, the Office of Management and Budget for National Security and International Affairs, and the National Security Council.

A more recent memorandum from the National Security Council provides additional guidance on the capability of the NLP. Issued October 8, 1990, the memorandum affirms that "[a] voice capability is essential for Presidential operations, and the NLP should have this capability."

In 1991, new guidance for funding national-level NS/EP telecommunication programs that benefit multiple federal departments and agencies was issued by the Executive Office of the President. National Security Directive 56 directs that implementation and recurring costs for national-level programs be shared by the Department of Defense (at 70 percent) and the Federal Emergency Management Agency (at 30 percent). These funding guidelines will take effect in fiscal year 1993. The

directive also states that the Manager, NCS, will develop a proposed NLP. National Security Directive 56 supersedes the funding methodology established under National Security Decision Directive 201.

Consistent with a February 1991 White House memorandum, a memorandum from the Office of the NCS Executive Agent requested that the current NETS solicitation for an integration contractor be terminated and that the initial operating capability for NETS be delayed until fiscal year 1996. This memorandum, dated March 15, 1991, also asked the Manager, NCS, to assist Department of Energy (DOE) with emergency energy and power programs for NS/EP telecommunications and to review "new or alternate technologies to satisfy NETS functional requirements."

3.5 Panel Findings

The panel found sufficient policy guidance to confirm the need for a government-wide NS/EP telecommunications program. Its focus is to provide national leadership with telecommunication services to ensure the continuity of essential government functions during and after emergencies. The program should also maximize the use for government purposes of all available telecommunication assets, commercial, government, and private.

There is an obvious need for national communications under both normal and emergency conditions. The need is not just for communications within the Federal Government, but among the Federal Government, other levels of government, and civilian organizations and individuals. Policy emphasis on intra-government communications, while largely ignoring the importance of non-governmental communications, is a weakness. In addition, emergency communications must be primarily voice, since voice is the usual mode in normal times.

4. REQUIREMENTS

Executive Order 12472 directs that: "The National Security Council, the Director of the Office of Science and Technology Policy and the Director of the Office of Management and Budget shall, in consultation with the Executive Agent for the NCS and the NCS Committee of Principals, determine what constitutes national security and emergency preparedness requirements." Historically, requirements for NS/EP telecommunications have been considered in two forms: functional requirements, which serve to define the necessary capabilities and characteristics of an NS/EP telecommunications service; and user requirements, which relate to the type of service, quantity of lines, and locations to be served.

4.1 Functional Requirements

To respond to the Executive Agent memorandum dated March 15, 1991, which encouraged refinement of NETS user requirements, the Manager, NCS reexamined the functional requirements for an NS/EP telecommunications service. The resulting list of functional requirements, shown in Exhibit 4-1, was forwarded by memorandum on June 24, 1991, through the Office of the NCS Executive Agent for confirmation by the Policy Coordinating Committee on National Security Telecommunications and Information Systems. The Policy Coordinating Committee confirmed these requirements in mid-October 1991.

4.2 NS/EP User Requirements

Since 1984, the Office of the Manager, NCS (OMNCS) has worked with individual member organizations to identify specific telecommunication services needed by location and service type to support agency-specific essential emergency functions. As

EXHIBIT 4-1

Functional Requirements for NS/EP Telecommunications Service

VOICE BAND SERVICE	The service must provide voice band service with voice recognition in support of presidential communications.
INTEROPERABILITY	The service must interoperate with and use the resources of selected other government or private facilities, systems, and networks through the application of standards.
SURVIVABILITY/ ENDURABILITY	The service must provide for the interconnection of surviving users under a broad range of circumstances from widespread damage from natural or manmade disaster to and including nuclear war.
INTERNATIONAL INTERFACE	The service must provide access to and egress from international service.
NATIONWIDE COVERAGE	The service must provide ubiquitous nationwide coverage to support national security leadership and intra/interagency emergency operations.
INTRA/INTERAGENCY EMERGENCY OPERATIONS	Service must provide NS/EP traffic with priority over all other traffic.

of June 1, 1991, the NCS members have officially submitted line requirements that number about 22,000 lines at 7,000 locations. These data may not reflect all communications needed for coordination among federal agencies, state and local governments, industry, and civilian organizations and individuals under all circumstances. However, they clearly establish the need for a nationwide service.

Detailed user line requirements historically served two purposes:

- To provide a basis for selecting from among competing approaches to meeting NS/EP telecommunication needs (e.g., performance analysis of connectivity among 7,000 user locations)

- . To support the design and implementation of the specific approach selected (e.g., placement and sizing of call controllers in NETS).

Alternatives to NETS require different types of NS/EP user requirements data and varying levels of details. Information to characterize general traffic and capacity requirements may become more relevant.

In emergency situations, severe dislocations of organizations and personnel are likely. The user requirements data base could provide the information necessary to be able to locate users of the NS/EP telecommunications service.

4.3 Panel Findings and Recommendation

The panel offers the following findings regarding requirements:

- . NS/EP user requirements are not limited to federal government organizations. The NLP must support communications among federal agencies, state and local governments, industry, civilian organizations, and individuals.
- . The functional requirements forwarded by the Office of the NCS Executive Agent to the Policy Coordinating Committee of the National Security Council adequately define the necessary capabilities and characteristics of an NS/EP telecommunications service for the government. Non-government communications are also important and mechanisms are needed for setting priorities among all users.

- While the existing user requirements data base may not be complete, the number and geographic distribution of the reported user requirements confirm the need for a nationwide system or service to support NS/EP telecommunications.
- The functional requirements and the existing user requirements data base provide a reasonable basis for conducting comparative analyses of the expected performance of competing system approaches to meeting NS/EP telecommunication needs. However, the existing user requirements data base may not be adequate to satisfy the design, implementation, and operational needs of the newly-selected systems approach. For example, it is important to be able to locate users of the NS/EP telecommunications service during emergency operation.

The panel recommends that the Manager, NCS, work with NCS member organizations to develop their requirements in a form that will support the design, implementation, and operation of the selected NS/EP telecommunications system or service. Resulting requirements should then be forwarded through the Committee of Principals to the Policy Coordinating Committee on National Security Telecommunications and Information Systems.

5. ENERGY ISSUE

The critical interdependence of NS/EP telecommunications and energy has been recognized by a number of authorities. In particular, the President's National Security Telecommunications Advisory Committee recognized in February 1987 that: "An extended power outage was (and is) a major vulnerability of the telecommunications industry." This concern has been echoed in recent years by the President's National Security Advisor and by the Science Advisor, as well as by the NCS Executive Agent in his March 1991 memorandum regarding the delay in the implementation of the NETS program.

5.1 Current Efforts

The telecommunications industry, the Department of Energy (DOE), and the OMNCS are pursuing actions to mitigate the vulnerabilities associated with the interdependency of the power and telecommunications infrastructures. Previously, a National Security Telecommunications Advisory Committee task force examined this issue and surveyed the backup power capabilities of the PSN. Results of this study indicate that the telecommunications industry is prepared for power outages of short duration (3 to 7 days). Most PSN sites have backup generators and batteries. PSN backup power capability ranges from 12 hours of battery power without recharging (fiber optic repeaters) up to 21 days of generator power without fuel resupply.

Telecommunications industry representatives indicate that some carriers have already taken steps to mitigate their vulnerability to extended outages by negotiating priority fuel resupply agreements with local fuel suppliers. There are also existing state energy programs that address fuel resupply. These fuel "set-aside" programs enable state emergency managers to allocate special fuel reserves to pre-identified priority users, which may include telecommunication facilities.

The DOE has proposed an Electric Service Priority program to respond to policy guidance identifying the need to develop a prioritization scheme for the provision of electric power for use by telecommunication and other critical NS/EP assets. Within the Electric Service Priority program, a "telecommunications fast track" has been established to address priority electric service for NS/EP telecommunication assets nationwide. The OMNCS is assembling information on telecommunication locations that should be a part of DOE's programs, and is scheduled to provide this information to DOE shortly.

The Electric Service Priority approach applies both to the curtailment and restoration of electric power service during national security emergencies. Although the work plan developed in support of the Policy Coordinating Committee on Emergency Preparedness and Mobilization Planning provides national-level consistency and guidance on the development of the Electric Service Priority system, an electric service priority system has existed for years at the local level. In general, utility companies possess established emergency protocols for the prioritized curtailment and restoration of power, based on essential functions identified to them by electric power users. The approach establishes federal "sponsorship" of the program and requires the Federal Government to work in concert with State Emergency Coordinators to develop federal-level and state-level NS/EP essential functions. These functions and their respective facilities will be incorporated, in turn, in the emergency restoration and curtailment plans and protocols of the various operating utilities.

The work plan for the proposed Electric Service Priority system includes the following priority categories:

- . National leadership and federal management of a national security emergency
- . Mobilization and national defense, including defense production and distribution

- Public health, safety, and law and order
- Public welfare and maintenance of the national economic posture.

Given Policy Coordinating Committee approval of the work plan, DOE foresees a fast-paced implementation of the Electric Service Priority system. Current planning anticipates development of an integrated list of federal and state NS/EP functions in 1993 and incorporation of these functions in utility company restoration plans in 1994.

In parallel efforts, the OMNCS is helping the DOE to define an emergency management capability and to develop specific operational plans for energy restoration during emergencies. The objectives of the emergency management capability are:

- To restore to DOE leadership the ability to manage DOE resources nationwide
- To work with industry in restoring those portions of the nation's energy infrastructure required to support NS/EP telecommunications and other critical services.

With OMNCS support, the DOE is developing the framework for this emergency management capability, as well as specific operational and corresponding exercise plans. These plans focus on specific emergencies (e.g., an earthquake in the New Madrid region of the central U.S.) and provide opportunities to test and exercise DOE's procedures for managing national, regional, and field resources in support of energy restoration.

The usual mode of emergency operation in PSN facilities is with all equipment fully powered. Since solving the power supply problem will continue to be difficult, some approach to dealing with the demand side appears to be worth pursuing.

5.2 Panel Findings and Recommendations

The panel offers the following findings regarding the need for emergency power and fuel distribution programs to support NS/EP telecommunications:

- Enduring energy (electric power and fuel) is a critical problem for all national infrastructures (e.g., transportation, health care, law enforcement). It is not a problem solely for the NS/EP telecommunications infrastructure.
- Most major PSN assets have existing backup power to satisfy short-term outages (3 to 7 days). Current efforts of the NCS, the telecommunications industry, and the DOE to enhance capabilities to handle longer-term outages include:
 - Identification of existing backup power capabilities and vulnerabilities.
 - Characterization of damage to the power grid and the resulting effects on NS/EP telecommunications.
 - Development of the DOE Electric Service Priority system to manage the restoration and curtailment of electric power on a priority basis
 - Use of state set-asides and priority fuel resupply agreements.
- Efforts to ensure electric power and fuel to satisfy long-term needs of the NS/EP telecommunications infrastructure have progressed more rapidly than for other comparable infrastructures.

Progress in meeting NS/EP telecommunication needs should not be delayed until enduring energy programs are in place. Therefore, implementation of an NS/EP telecommunications improvement program should proceed. The DOE and the OMNCS should continue to work together to define further the interdependencies of the energy and telecommunication infrastructures and to pursue effective solutions to the enduring energy issue. Additionally, efforts to understand and reduce power demand by telecommunication resources should be pursued.

6. ASSESSMENT OF TECHNICAL APPROACHES

Guidance from the NCS Executive Agent delaying the implementation of the NETS program directed the Manager, NCS, to consider other technologies that might reduce program costs. The approaches examined by the panel incorporate various technologies and services, such as very small aperture terminal (VSAT) technology, packet-switched message services, low earth orbit satellite services, and high frequency radio technology. Some of the approaches are consistent with alternatives contained in the Subcommittee Report to the NCS Committee of Principals, *Review of the National Level NS/EP Telecommunications Program*, dated May 29, 1990. Detailed descriptions and evaluations of individual approaches are included in Appendix A. The appendix also details the assessment methodology. Throughout this section, the term "current NLP" is used to refer to the NLP as defined in the NETS solicitation of 1989.

6.1 Methodology

The assessment of the current NLP and alternative approaches was accomplished as a two-step process. The technical approaches were evaluated as complete alternatives to the current NLP. The first step was a technical evaluation of each approach using the six functional requirements (described in Section 4.1) for an NS/EP telecommunications service as the criteria. The scoring guidelines for the panel's initial evaluation are shown in Exhibit 6-1. Following the initial evaluation, the panel revisited certain criteria and added the terms "Minimally Acceptable" and "Very Good" to differentiate further among the approaches.

The second step of the process was a comparison of the risks and estimated costs of the approaches. Three categories of risk were considered: engineering and development risk, schedule risk, and operational risk. The cost estimates used by the panel were developed to facilitate a consistent comparison among approaches.

EXHIBIT 6-1
Technical Evaluation Scoring Guidelines

SCORE CRITERIA	UNACCEPTABLE	ACCEPTABLE	GOOD
VOICE BAND SERVICE	Alternative does not support voice communications.	Alternative supports voice and low-speed data communications.	Not Applicable.
INTEROPERABILITY	The alternative is a totally closed system.	The alternative inter-operates with the PSN.	The alternative inter-operates with the PSN and other government/private networks/systems.
SURVIVABILITY/ENDURABILITY	Targeting of few points greatly reduces capability and/or no emergency power plans.	Targeting of hundreds of points is necessary to greatly reduce capability. Emergency power plans.	Targeting of thousands of points necessary to greatly reduce capability. Uninterruptible power.
INTERNATIONAL INTERFACE	Alternative does not allow international access/egress capability.	International access/egress capability available to all users.	Alternative enhances international connectivity (e.g., more gateways).
NATIONWIDE COVERAGE	Service cannot be accessed from all NS/EP user locations.	Alternative provides on-net access from all NS/EP user locations.	There are more on-net access points than NS/EP user locations.
INTRA/INTER-AGENCY EMERGENCY OPERATIONS	Alternative does not provide priority treatment to NS/EP users (or exclude all other traffic).	Alternative provides priority treatment with manual activation and implementation.	Alternative provides priority treatment with automatic activation and implementation.

Estimated costs included nonrecurring costs (pre-implementation and implementation costs) and recurring costs. The costs of hardware reflected in nonrecurring cost estimates were based on purchase costs, not lease costs. In addition, recurring costs were estimated for one year after achieving final operating capability. Smaller recurring costs that might be incurred before achieving final operating capability were not considered in

the panel's assessment. For each approach, a range of options was considered that incrementally added capability and costs.

6.2 Technical Approaches

This section discusses the basic concept of each technical approach and summarizes the technical, risk, and cost assessments of each approach. The six approaches, including the current NLP, fall into two categories:

- Closed/Private Systems - This category includes the VSAT satellite approach, the high frequency (HF) radio approach, and the Message-Based Emergency Telecommunications Service (METS) approach. Disadvantages of these approaches include reliance on a limited number of network control facilities and the use of the unaugmented PSN for connectivity to off-net users.
- Open/Public Network-Based Services - The Iridium approach uses a proposed public satellite service. It shares the disadvantages of the closed/private system approaches, because it relies on a limited number of network control facilities and uses the unaugmented PSN for connectivity to non-Iridium users. The current NLP and the new PSN-based approach exploit the physical connectivity and ubiquity of the PSN. Both of these approaches overlay a service on a national infrastructure representing billions of dollars in carrier capital investments. The approaches use access control, priority treatment, and routing and transmission augmentations to enhance PSN capabilities for NS/EP telecommunications. The PSN is subject to regulation by the Federal Communications Commission under the Communications Act of 1934.

6.2.1 Very Small Aperture Terminal Satellite Approach

The VSAT approach would employ a private VSAT network operating in a mesh configuration through multiple hubs and providing nationwide access to and egress from the PSN. VSAT networks differ from traditional satellite networks because of their lower power, smaller antennas, and reduced call capacity. VSAT networks use a class of intelligent satellite earth stations suitable for on-premise installation, and usually operate in conjunction with a hub earth station. These terminals typically have antennas with diameters ranging from 1.2 to 3.6 meters, power amplifiers ranging from 1 to 3 watts, and operate in the Ku frequency band. International access and egress would be provided through selected PSN international gateways. Exhibit 6-2 shows the concept of the proposed VSAT system.

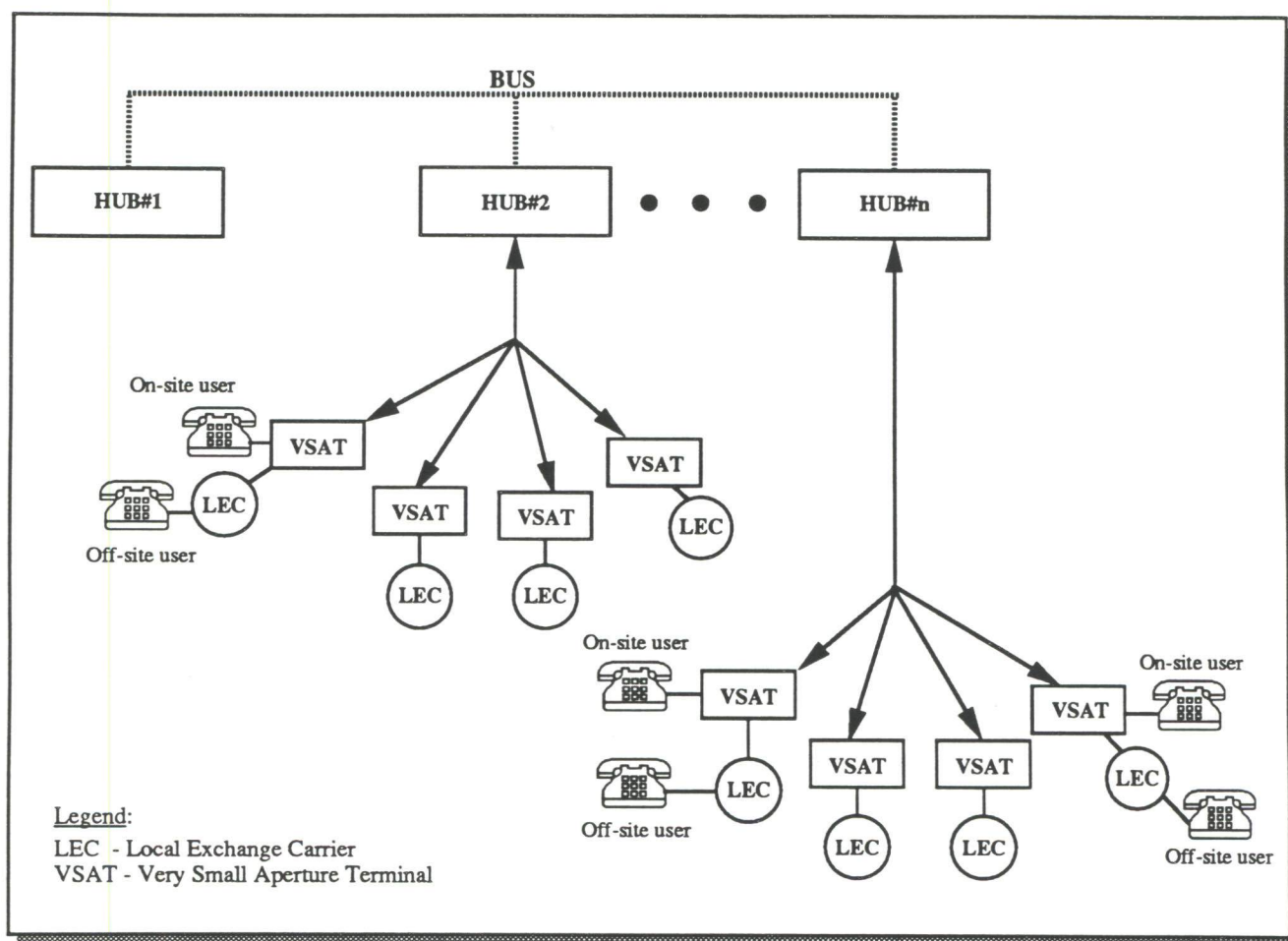
An advantage of the VSAT approach is the low risks associated with engineering and development and schedule. VSAT systems are commercially available and use proven technology. A VSAT system could provide nationwide coverage and an international interface and meet the requirement for voice band service. However, there are several specific disadvantages that translate into high operational risk. These disadvantages include:

- Vulnerability of a single satellite
- Susceptibility to jamming
- Network hub survivability
- Survivability of the telemetry, tracking, and control facility
- Reliance on an unaugmented PSN for connectivity to off-net users.

Because of these disadvantages, the VSAT approach was considered unacceptable in the survivability/endurability category.

The VSAT approach was also one of the more costly approaches. Three options were considered, ranging from \$219 to \$947 million in nonrecurring costs and \$29 to \$49 million per year in recurring costs. The first and least expensive option has 10 hubs; no interoperable telemetry, tracking and control facility; and no priority treatment for off-net PSN call segments. The second option adds the interoperable telemetry, tracking, and control facility and has 20 hubs. The third option has 30 hubs; an interoperable telemetry, tracking, and control facility; and PSN priority treatment.

EXHIBIT 6-2
Very Small Aperture Terminal Satellite Approach



6.2.2 High Frequency Radio Approach

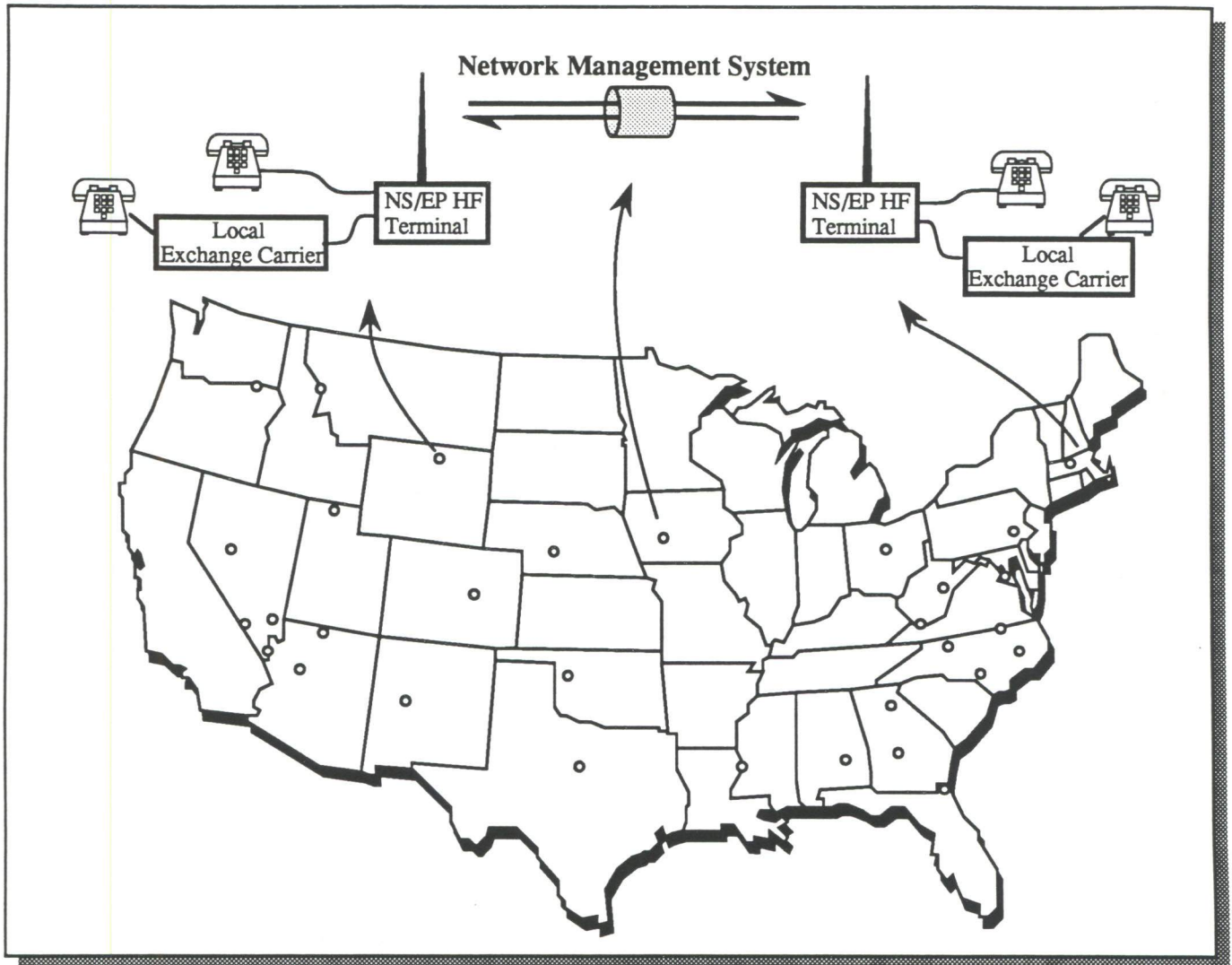
HF radio systems have traditionally played an important role in local and regional emergencies. The Committee of Principals subcommittee reviewed an HF radio system as an NLP alternative in its May 1990 report. For these reasons, the panel examined an HF system as an alternative to the current NLP. The proposed HF approach would use a series of area or regional networks that would provide connectivity throughout the U.S. via direct or indirect station-to-station links. The system would interface with the PSN for access to/egress from off-net locations. Exhibit 6-3 depicts the HF system concept.

Advantages of the HF radio approach include the low-to-medium risk associated with engineering and development and schedule and the ease of providing backup power. The HF radio approach would function primarily as a closed system, even though it could interoperate with other HF networks using similar modulation schemes, and with the PSN with the addition of the appropriate interfaces. The network would support voice and low-speed data and permit the use of secure terminals. Disadvantages of this approach make the operational risk high. The available bandwidth on the network would limit the number of user channels, and there would be no means for implementing priority treatment or controlling access to the network. This would result in a high probability that the HF network would not meet traffic volume requirements. For this reason, the approach received an unacceptable rating for the intra/interagency emergency operations category. In addition, the HF signal would be susceptible to jamming, and the links would be subject to degradation due to natural and nuclear effects.

Two options were considered for this approach. The main difference between the options is the type of radios used: less sophisticated analog radios for option A, and digital radios with automatic link establishment and automated frequency selection for option B. The nonrecurring cost for option A is \$59 million, reflecting the lower cost of analog radios. The nonrecurring cost for option B is \$425 million because of the higher

cost of digital radios with more features. Recurring costs ranged from \$537 million per year for option A to \$60 million per year for option B. The recurring cost for option A is higher because technicians/operators are needed at each HF terminal site.

EXHIBIT 6-3
High Frequency Radio Approach



6.2.3 Message-Based Emergency Telecommunications Service Approach

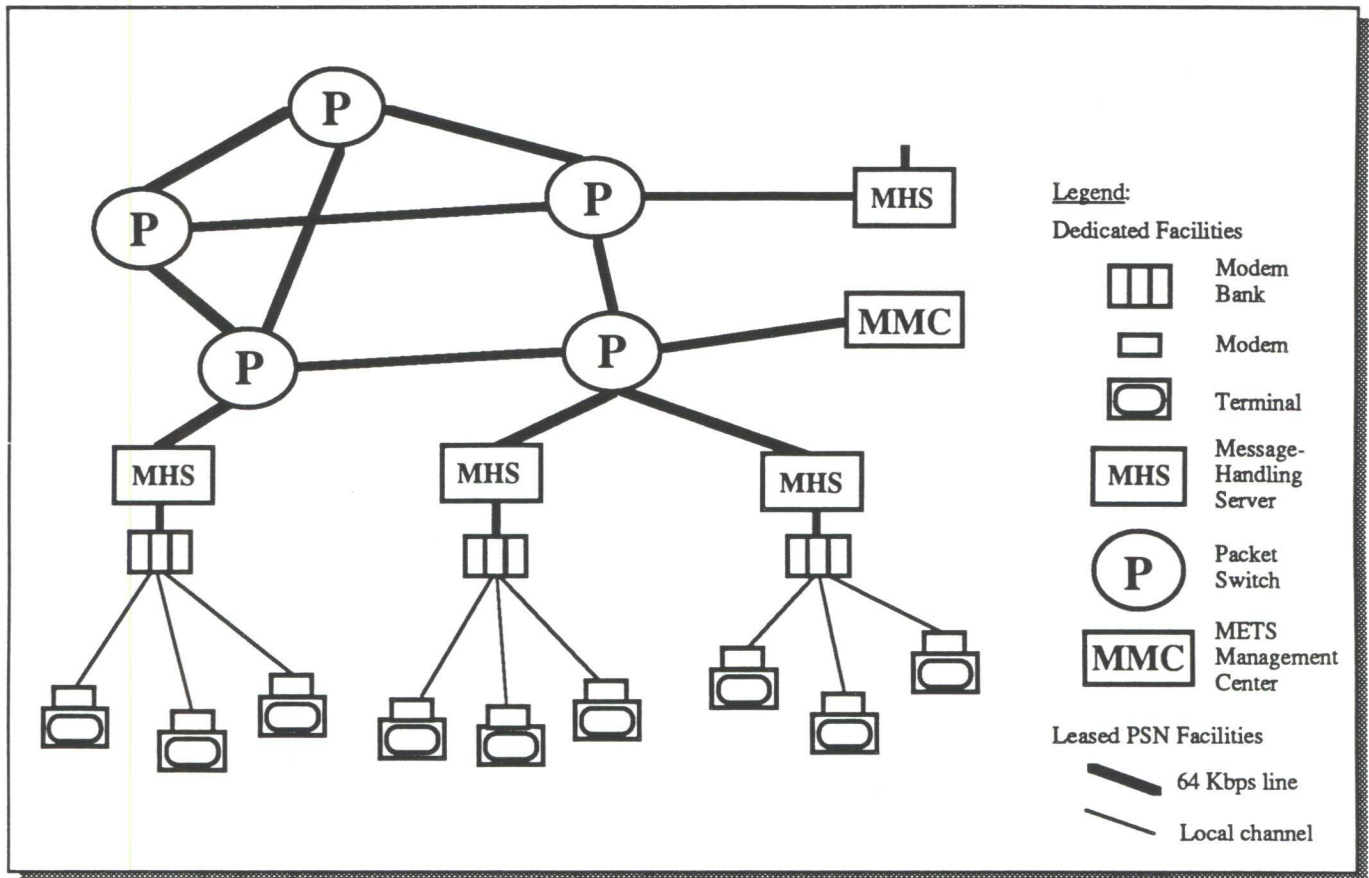
METS is a proposed message-based communications service that was recommended for further study by the Committee of Principals subcommittee as an alternative to the current NLP. METS would consist of a packet-switched network designed to provide message service in a stressed environment. The proposed baseline METS system would include 104 packet switches, 487 message handling servers, and 4,000 terminals. Users would access the service through terminals with modems at user locations. The METS concept is illustrated in Exhibit 6-4.

The METS approach has low engineering and development risk because it would use commercial off-the-shelf equipment. Another advantage is its ability to provide directory services, which would enable users to relocate to alternate sites and continue to send and receive messages. METS, however, does not meet the functional requirement for voice band service. The approach would use a network of private lines for its backbone and access, some of which could be provided from existing Federal Telecommunications System 2000 (FTS2000) and Defense Switched Network services. Because METS would rely on a network of private lines, the approach was considered unacceptable with respect to interoperability and the provision of international interfaces. The METS approach would provide an opportunity to extend the duration of backup power at PSN facilities. However, the development and implementation of this capability, which would entail carrier action at numerous PSN sites nationwide, would be difficult. The METS approach would restrict the mobility of NS/EP users, since users would have to interface with the system at preplanned locations. Users would also have to access the system through a computer terminal and modem.

Three options were considered for the METS approach. The number of user terminals varied from 4000 terminals in option A to 20,000 in option C. Nonrecurring costs ranged from \$161 to \$293 million, and recurring costs ranged from \$32 to \$69 million per year.

EXHIBIT 6-4

Message-Based Emergency Telecommunications Service Approach



6.2.4 Iridium Service Approach

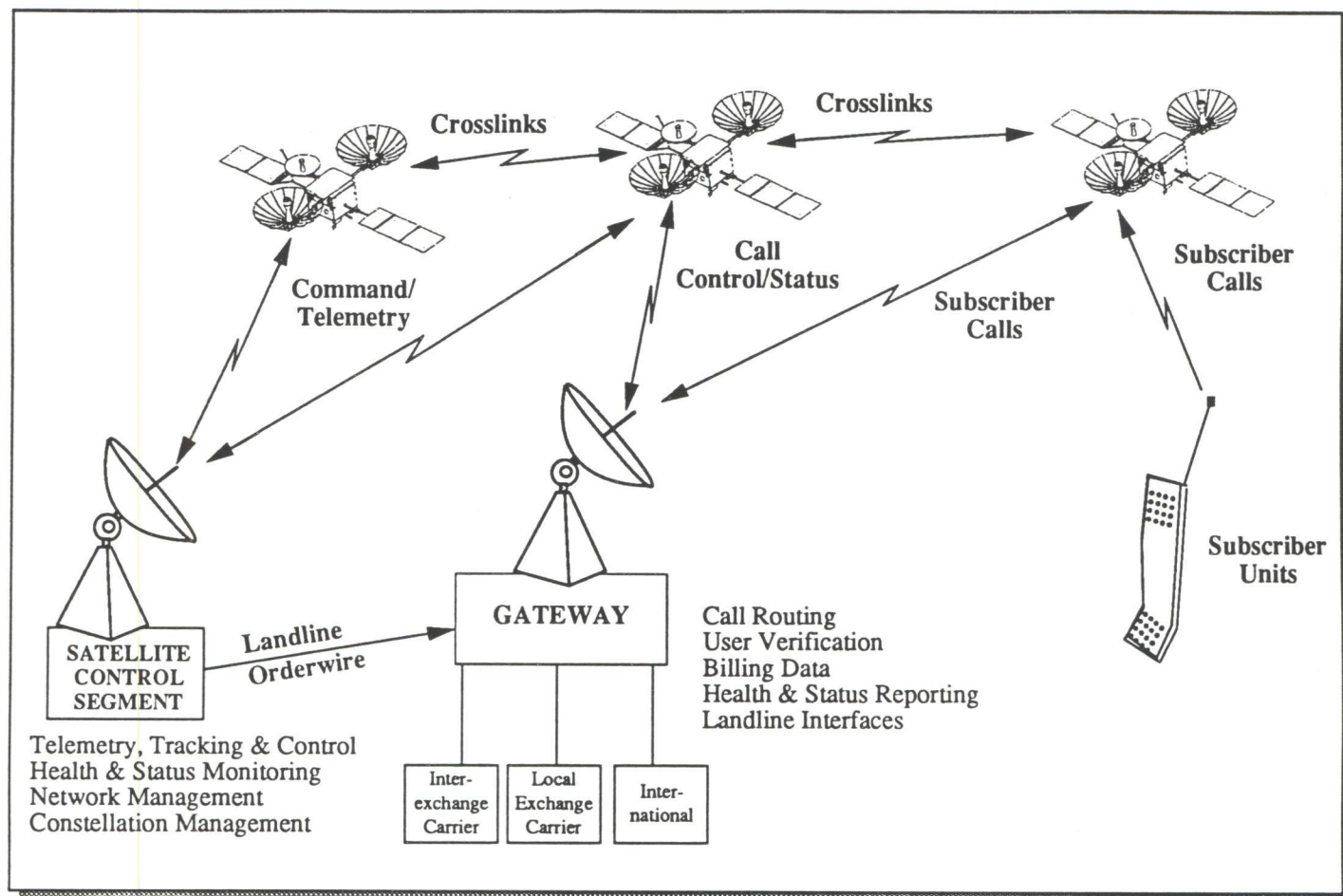
Motorola has proposed a worldwide communications service, Iridium, to provide voice, data, facsimile, paging, and radiodetermination satellite services to users who might otherwise be unable to connect directly to the PSN. If approved, Iridium would be a digital communications system using a constellation of 77 low earth orbit satellites and interfaces to public networks throughout the world. Users would access the system through hand-held transceivers similar in construction and operation to cellular phones. Motorola plans to have a fully operational system in place by 1996. However, domestic frequency allocation is not yet approved and significant coordination must take place before deployment of the satellites can begin. The proposed Iridium system is illustrated in Exhibit 6-5.

Motorola's proposed Iridium service has several advantages. These include global connectivity for NS/EP users, easy-to-use subscriber transceivers, and battery-operated subscriber units. There are, however, several disadvantages to low earth orbit satellite systems in general and Iridium in particular. The limited number of gateways and control facilities make this approach unacceptable in the survivability/endurability category. The risk of scheduled deployment due to regulatory, frequency allocation, and funding issues is high. There is a lack of access control and no provision for priority treatment for NS/EP users. This results in an unacceptable rating for intra/interagency emergency operations support. There are also a number of engineering and development risks associated with the deployment and effective operation of the approach.

For this approach, four options were considered. The options differed in the number of transceivers and the deployment of gateways. A single government control facility was assumed for each option. The costs of an Iridium service approach are relatively high. The lowest cost option, option A, includes 7,000 transceivers and

1 gateway. Nonrecurring cost is \$116 million, and recurring cost is \$10 million per year. The highest cost option, option D, has a nonrecurring cost of \$288 million and recurring cost of \$25 million per year.

EXHIBIT 6-5 Iridium Service Approach



6.2.5 Current National Level Program

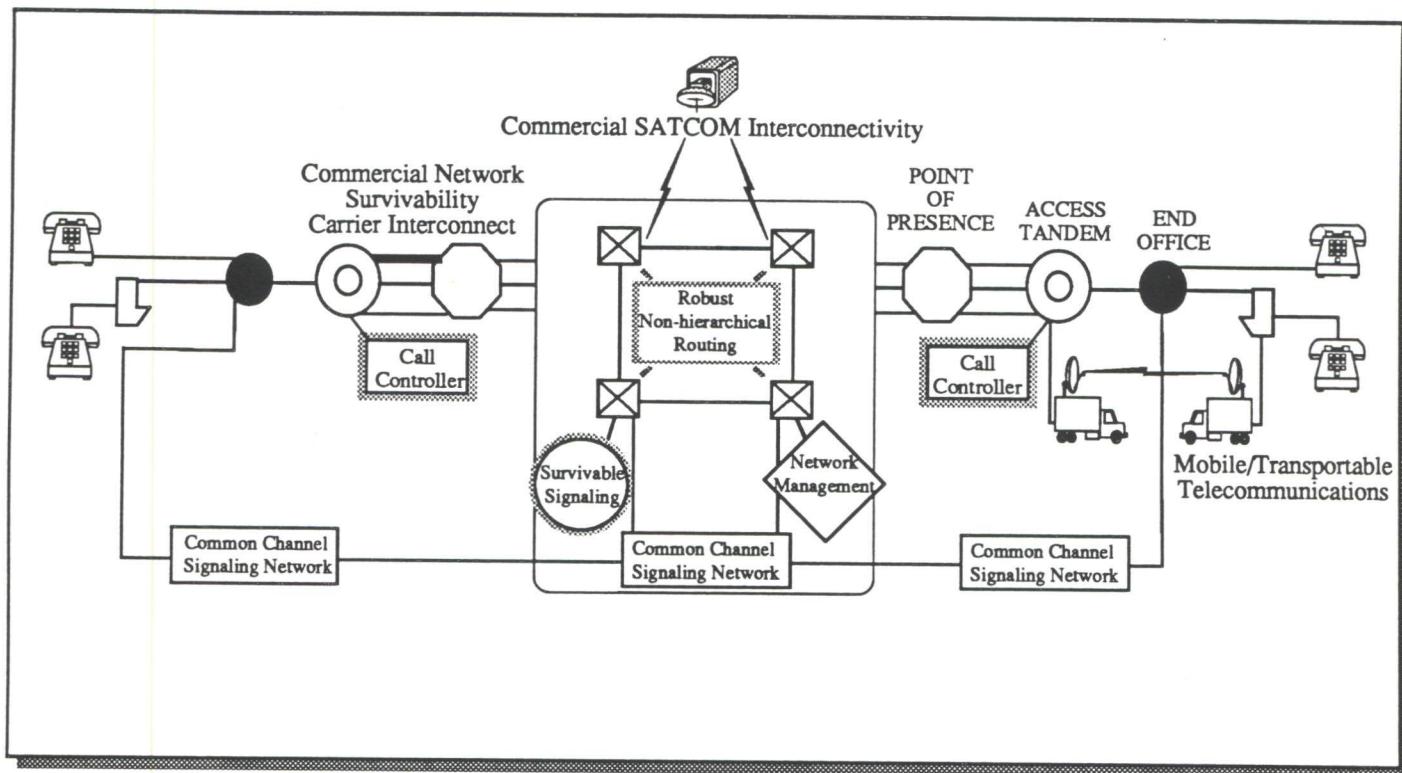
The current PSN-based NLP enhances routing, survivability, connectivity, and interoperability of telecommunications traffic. The NLP comprises three programs: the Nationwide Emergency Telecommunications Service (NETS), the Commercial SATCOM Interconnectivity (CSI) program, and the Commercial Network Survivability (CNS) program. NETS includes elements to improve routing flexibility and signaling survivability. CSI uses commercial satellites to augment interexchange transmission capabilities for NS/EP traffic. The purpose of the CNS program is to improve terrestrial telecommunications survivability and interoperability. CNS provides route augmentations through the use of fixed and deployable assets. The PSN was selected as the basis of the NLP because of its ubiquity and the percentage of surviving PSN assets under all stress levels. In addition, the use of the PSN allows easy incorporation of new technologies and interoperation with government and private networks, such as FTS2000. NLP enhancements are illustrated in Exhibit 6-6.

The current NLP, which uses the features of NETS, CNS and CSI, meets all of the functional requirements. The engineering and development, schedule, and operational risks are low to medium. The approach provides ubiquitous access, including international access. The current NLP capitalizes on carrier investments in the PSN and other network resources. It enhances routing capabilities and uses satellite and terrestrial augmentations to bypass damage. The current NLP controls service access and permits priority treatment of NS/EP traffic nationwide. Disadvantages include the dependency on PSN backup power plans and capabilities, possible traffic congestion on portions of the call path, and the need for coordination among many carriers.

The current NLP is one of the less costly approaches. The two options considered differed in the number of NETS call controllers deployed in the local exchange carrier networks. According to estimates used in the panel's analysis,

nonrecurring costs of the options ranged from \$90 to \$95 million. Recurring costs ranged from \$65 to \$69 million per year. Option A includes 60 NETS call controllers, and option B includes 106 call controllers.

EXHIBIT 6-6
Current National Level Program



6.2.6 New Public Switched Network-Based Approach

The new PSN-based approach would take advantage of the ubiquity, traffic capacity, and evolving capabilities of the PSN. It would also use CSI and CNS network augmentations. The panel's name for the main component of this approach is Commercial Access and Priority Service (CAPS) to emphasize the Government's strategy of relying upon access to the commercial services of the PSN and priority treatment within the PSN. CAPS would be a replacement for NETS.

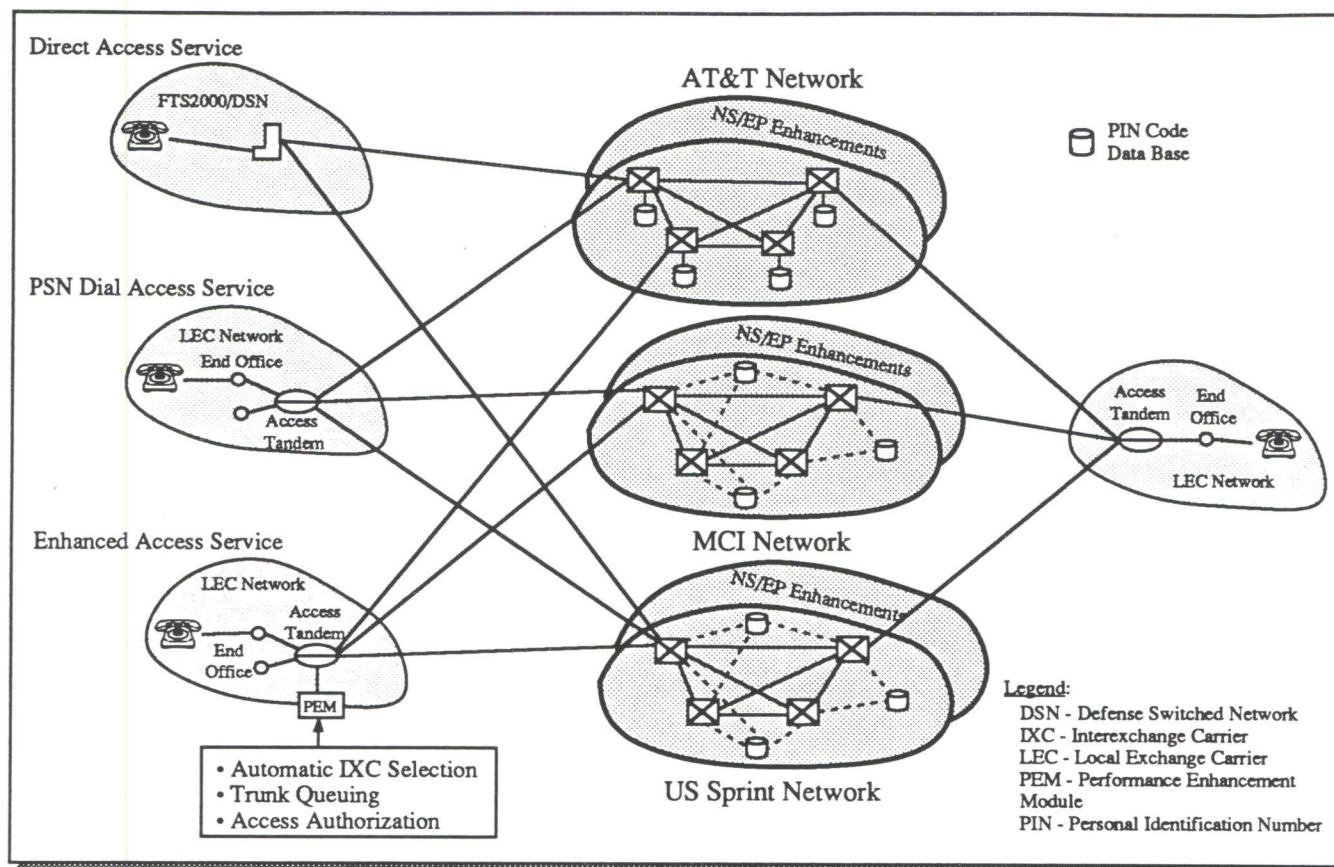
Over the past few years, interexchange carriers have enhanced their networks, particularly in the areas of routing and distributed access control. These features have significant potential for supporting NS/EP telecommunication needs. CAPS is designed to use PSN capabilities in a more cost-effective manner than NETS. It could also easily incorporate future enhancements resulting from further deployment of Signaling System 7 and Integrated Services Digital Network features. NS/EP users would access the service from any PSN end office or by off-net calling from FTS2000 and the Defense Switched Network. Deployment of performance enhancement modules at selected access tandem switches could enhance access capabilities by providing protection against access and egress traffic congestion. These modules would also have access authorization functions. The CAPS concept is depicted in Exhibit 6-7.

This new PSN-based approach (i.e., CAPS, CSI, and CNS) meets all of the functional requirements and has low-to-medium engineering and development, schedule, and operational risks. The approach allows for the incremental implementation of service levels. As new technology becomes available in the PSN, it could be easily integrated into the service. The approach also offers access, with priority treatment, from virtually any telephone. Disadvantages of the new PSN-based approach include the dependency on PSN backup power, possible traffic congestion on portions of the call path, and the amount of coordination needed among carriers.

For this approach, four options were considered in the analysis. The number of performance enhancement modules ranged from 0 in option A to 250 in option D. The nonrecurring cost of option A (no modules) is \$32 million, and the recurring cost is \$40 million per year. The nonrecurring cost for the most expensive option (250 modules) is \$87 million, and the recurring cost is \$57 million per year.

EXHIBIT 6-7

Commercial Access and Priority Service Concept



6.3 Evaluation Results

After evaluating each approach's ability to meet the functional requirements for an NS/EP telecommunications service, the panel differentiated further among the approaches by adding "Minimally Acceptable" and "Very Good" scores to the scale. These additional ratings were deemed necessary to more clearly reflect the relative merits of the various approaches. For example, in the category of interoperability, both VSAT and HF approaches could be made to interoperate with some existing networks and systems, but would require special interface equipment and network enhancements. As a consequence, both approaches received minimally acceptable ratings in the interoperability category. Both the current NLP and new PSN-based approach, on the other hand, were upgraded to very good in this category. These final technical evaluation results are shown in Exhibit 6-8. The exhibit also contains the overall results of the risk assessment.

The technical approaches considered by the panel were developed as complete alternatives to the current NLP. In many cases, the desirable attributes of the technologies used in the approaches were overshadowed by significant drawbacks of relying on a single technology to meet all NS/EP telecommunication needs. Although an unacceptable rating for any technical criterion eliminated an approach from consideration as an alternative to the current NLP, the panel recognized the merits of these approaches as improvements to the selected approach.

Only the current NLP and the new PSN-based approach were rated acceptable or better in every technical category. The risks associated with these two approaches were also acceptable (i.e., low-to-medium ratings in risk categories).

The VSAT approach would use proven technology and commercially available equipment. However, its dependence on a limited number of hubs and control facilities, reflected in its survivability/endurability rating, make it an unacceptable alternative.

EXHIBIT 6-8
Technical and Risk Evaluation Results

ALTERNATIVE CRITERIA	CLOSED/PRIVATE SYSTEMS			OPEN/PUBLIC NETWORK-BASED SERVICES		
	VSAT	HF	METS	IRIDIUM	CURRENT NLP	NEW PSN
VOICE BAND SERVICE	Acceptable	Acceptable	Unacceptable	Acceptable	Acceptable	Acceptable
INTEROPERABILITY	Minimally Acceptable	Minimally Acceptable	Unacceptable	Acceptable	Very Good	Very Good
SURVIVABILITY/ ENDURABILITY	Unacceptable	Good	Acceptable	Unacceptable	Acceptable	Acceptable
INTERNATIONAL INTERFACE	Acceptable	Minimally Acceptable	Unacceptable	Very Good	Good	Good
NATIONWIDE COVERAGE	Acceptable	Acceptable	Minimally Acceptable	Good	Very Good	Very Good
INTRA-/INTERAGENCY EMERGENCY OPERATIONS	Good	Unacceptable	Good	Unacceptable	Acceptable	Good

SCALE:	Very Good	Good	Acceptable	Minimally Acceptable	Unacceptable
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ALTERNATIVE RISK	CLOSED/PRIVATE SYSTEMS			OPEN/PUBLIC NETWORK-BASED SERVICES		
	VSAT	HF	METS	IRIDIUM	CURRENT NLP	NEW PSN
ENGINEERING AND DEVELOPMENT	Low/ Medium	Low/ Medium	Low	Medium	Low/ Medium	Low/ Medium
SCHEDULE	Low	Low/ Medium	Medium	High	Low/ Medium	Low/ Medium
OPERATION	High	High	Medium/ High	Medium/ High	Low/ Medium	Low

Although the benefits of using HF radios in emergencies is well known and accepted, relying solely on HF radios to carry out NS/EP missions and functions was determined to be unacceptable by the panel. The limitations on available bandwidth and the inability to control access and provide priority treatment are reflected as an unacceptable rating in the intra/interagency emergency operations category and a high rating for operational risk.

A message system, such as METS, would restrict access and use of dedicated facilities to authorized NS/EP users. Because METS would not support the functional requirement for voice service, this approach was unacceptable to the panel.

The Iridium service approach received good and very good ratings for interoperability, international interface, and nationwide coverage. However, unacceptable ratings in the survivability/endurability and intra/interagency emergency operations categories eliminate this approach as an acceptable alternative. The Iridium service approach also has a high schedule risk because of regulatory, frequency allocation, and funding issues.

The estimated nonrecurring and recurring costs for each approach are listed in Exhibit 6-9. Cost estimates for each approach option and details of what each option includes are provided. These costs reflect a philosophy of equipment and service deployment that maximizes the survivability of the assets needed to provide service. Lower costs for the HF, VSAT, and METS alternatives could be achieved by using fewer assets and/or using them in conjunction with one of the PSN-based approaches. Costs for such "hybrid" solutions were not estimated for this report, but would clearly be lower than the costs for completely independent solutions. At a minimum, these hybrid approaches would include the costs of the basic access and priority treatment capabilities of the new PSN-based approach.

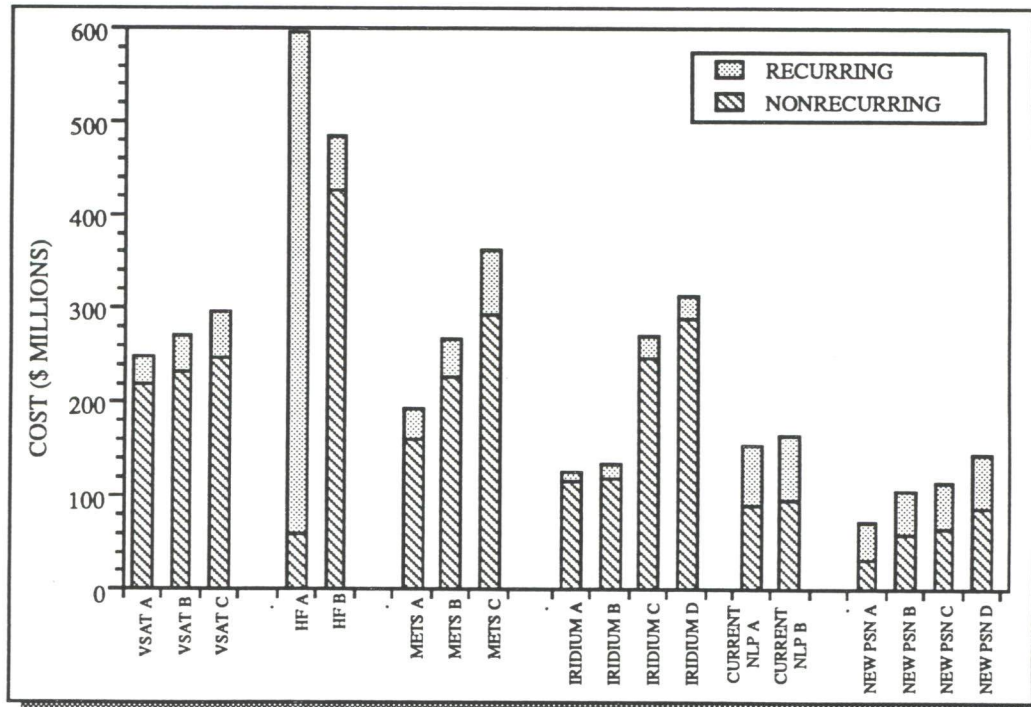
EXHIBIT 6-9

Cost Evaluation Results

COST (\$MILLIONS)	CLOSED/PRIVATE SYSTEMS			OPEN/PUBLIC NETWORK-BASED SERVICES		
	VSAT	HF	METS	IRIDIUM	CURRENT NLP	NEW PSN
	<u>Option A:</u> 219 + 29/yr (10 hubs)	<u>Option A:</u> 59 + 537/yr (analog radios)	<u>Option A:</u> 161 + 32/yr (4000 terminals)	<u>Option A:</u> 116 + 10/yr (7,000 transceivers, 1 gateway)	<u>Option A:</u> 90 + 65/yr (60 call controllers)	<u>Option A:</u> 32 + 40/yr (0 PEMS)
	<u>Option B:</u> 233 + 37/yr (20 hubs, ITT&C)	<u>Option B:</u> 425 + 60/yr (digital radios with automatic link establishment and automated frequency selection)	<u>Option B:</u> 226 + 41/yr (12,000 terminals)	<u>Option B:</u> 181 + 17/yr (14,000 transceivers, 2 gateways)	<u>Options B:</u> 95 + 69/yr (106 call controllers)	<u>Option B:</u> 59 + 46/yr (50 PEMS)
	<u>Options C:</u> 247 + 49/yr (30 hubs, ITT&C PSN priority treatment)		<u>Option C:</u> 293 + 69/yr (20,000 terminals)	<u>Option C:</u> 247 + 23/yr (21,000 transceivers, 3 gateways)		<u>Option C:</u> 66 + 49/yr (100 PEMS)
				<u>Option D:</u> 288 + 25/yr (21,000 transceivers, 4 gateways)		<u>Option D:</u> 87 + 57/yr (250 PEMS)

NOTE: ITT&C - Interoperable Telemetry, Tracking & Control

PEM - Performance Enhancement Module



Because the current NLP and new PSN-based approach were the only acceptable approaches based on technical criteria and risks, the panel focused on these two approaches for the cost comparison. The panel reviewed classified information on the performance of these two approaches to better understand the trade-offs among the various options. Predicted performance of option A of the new PSN-based approach (i.e., no performance enhancement modules) was comparable to predicted performance of the current NLP at reduced cost. In addition, the new PSN-based approach would increase the number of points that would need to be targeted in an attack directed against the PSN.

In addition to its technical and economic viability, the panel recognized other strengths of the new PSN-based approach, such as:

- . **Technology Diversity** -- The approach uses a range of service offerings, networks, and transmission technologies (e.g., microwave, fiber, cable).
- . **Ease of Technical Evolution** -- The approach easily incorporates evolving PSN technology (e.g., Signaling System 7, Integrated Services Digital Network).
- . **Flexibility of Subscriber Assignment** -- Adding, deleting and changing the status of authorized users is easy.
- . **User Familiarity** -- All users are familiar with telephone use.
- . **Insensitivity to Disaster Scenario** -- The new PSN-based approach does not need to be designed to a specific scenario and is therefore insensitive to changes in disaster scenarios.

- . **Use of Existing Resources** -- The new PSN-based approach builds upon NCS efforts and investments in CSI, CNS, robust nonhierarchical routing, and the survivable signaling network. It uses existing government networks and services (e.g., FTS2000) and leverages carrier investments of billions of dollars in the PSN.

The main component of the new PSN-based approach, Commercial Access and Priority Service (CAPS), supports the two basic functions of any NS/EP telecommunications service, local access and priority treatment. It provides opportunities to use the other approaches to meet special service needs and increase end-to-end performance. For example, VSATs could be placed at access tandems to provide satellite links for transporting NS/EP calls, and HF radios could be used as an orderwire system. A message system similar to the METS concept could be overlayed on the service, and Iridium could be used in the future as an alternate access technique to the PSN and CAPS.

6.4 Panel Findings and Recommendations

The panel concluded the following based on an evaluation of the six technical approaches and a review of preliminary performance results for the new PSN-based approach:

- . The new PSN-based approach is superior to all other approaches examined, including the current NLP.
- . An approach based on the capabilities of the PSN and existing government networks and systems (e.g., FTS2000) results in cost-effective service arrangements.

- . The new PSN-based approach provides advantages to non-government NS/EP users that would not be as easily achieved through the use of non-PSN-based approaches. Furthermore, carrier improvements to the PSN, initiated by the government or not, will benefit government and civilian users.
- . The VSAT, HF, METS, and Iridium approaches, as well as other technologies and services that may become commercially available in the future, could offer end-to-end performance improvements to a PSN-based service.
- . The new PSN-based approach eliminates the risks associated with a single, unique system approach without excluding the potential to derive benefits from selective use of the other approaches.
- . Implementation of the new PSN-based approach, instead of the currently programmed NLP, should result in cost savings to the Government. Estimated costs of the new PSN-based approach without performance enhancement modules are \$32 million nonrecurring and \$40 million per year recurring. These costs are significantly lower than the current NLP. Nonrecurring costs would be reduced by approximately \$60 million, and recurring costs would be reduced by approximately \$25 million per year.
- . The performance analysis results presented in classified briefings to the panel indicate that the new PSN-based approach, without performance enhancement modules, compares favorably to predicted performance of the current NLP (with NETS).

- The performance of the new PSN-based approach may exceed performance predictions for the current NLP under scenarios directly targeted against the nation's telecommunications infrastructure.

The panel recommends that the new PSN-based approach, without performance enhancement modules, be implemented to satisfy NS/EP telecommunication requirements and to serve as the foundation of the new NLP.

Implementation of performance enhancement modules, as well as the application of other technologies discussed in this report, should be analyzed as possible end-to-end performance improvements. Selective use of other technologies and performance enhancement modules should be justified independently of the conclusions of this report.

The panel strongly urges that implementation of the new NLP, consisting of Commercial Access and Priority Service (CAPS), Commercial SATCOM Interconnectivity (CSI), and Commercial Network Survivability (CNS), proceed without delay. The basis for this recommendation is the changing threats, and the potential cost savings, expected performance, and incremental implementation strategy of the new approach.

7. RECAPITULATION OF FINDINGS AND RECOMMENDATIONS

The panel completed its review of the NCS NLP consistent with White House and NCS Executive Agent direction. This section restates the panel's findings and its recommendations to the Manager, NCS.

Threats to NS/EP Telecommunications. The threat spectrum presents challenges in planning and executing NS/EP missions because the threats arrayed along this spectrum vary in magnitude, duration, geographic scope, and probability of occurrence. The threat environment has been changing in a number of ways. Most important, there is a perceived reduction in the risk of a large-scale nuclear laydown and an increase in the risk of smaller-scale attacks. Another concern is the possible targeting of telecommunication assets in a nuclear attack. The risk of disruption to telecommunication assets, including hostile intelligence collection efforts, terrorist attacks on communication facilities, and unauthorized use or disruption of communication networks, is increasing.

The nuclear attack scenario, albeit at a lower level, is the primary justification for the NLP. As a consequence, NS/EP telecommunication programs should be evaluated on the basis of expected performance in view of a reduced nuclear attack scenario and the potential for specific targeting of telecommunication assets.

The panel recommends that the NCS select telecommunication programs and initiatives that allow for easy adaptation to heightened nuclear scenarios if the threat escalates in the future. NS/EP telecommunication initiatives that provide small numbers of clearly identifiable targets for destruction or disruption should be avoided.

The panel also recommends that the Manager, NCS, in coordination with the intelligence community, continue to take a leadership role in the investigation and mitigation of network security threats to our nation's telecommunication and information systems.

Policy Guidance. The panel found sufficient policy guidance to confirm the need for a government-wide NS/EP telecommunications program. Its focus is to provide national leadership with telecommunication services to ensure the continuity of essential government functions during and after emergencies. The program should also maximize the use for government purposes of all available telecommunication assets, commercial, government, and private.

There is an obvious need for national communications under both normal and emergency conditions. The need is not just for communications within the Federal Government, but among the Federal Government, other levels of government, and civilian organizations and individuals. Policy emphasis on intra-government communications, while largely ignoring the importance of non-governmental communications, is a weakness. In addition, emergency communications must be primarily voice, since voice is the usual mode in normal times.

Requirements. NS/EP user requirements are not limited to federal government organizations. The NLP must support communications among federal agencies, state and local governments, industry, civilian organizations, and individuals. The functional requirements forwarded by the Office of the NCS Executive Agent to the Policy Coordinating Committee of the National Security Council adequately define the necessary capabilities and characteristics of an NS/EP telecommunications service for the government. Non-government communications are also important and mechanisms are needed for setting priorities among all users.

While the existing user requirements data base may not be complete, the number and geographic distribution of the reported user requirements confirm the need for a nationwide system or service to support NS/EP telecommunications. The functional requirements and the existing user requirements data base provide a reasonable basis for conducting comparative analyses of the expected performance of competing system approaches to meeting NS/EP telecommunication needs. However, the existing user requirements data base may not be adequate to satisfy the design, implementation, and operational needs of the newly-selected systems approach. For example, it is important to be able to locate users of the NS/EP telecommunications service during emergency operation.

The panel recommends that the Manager, NCS, work with NCS member organizations to develop their requirements in a form that will support the design and implementation, and operation of the selected NS/EP telecommunications system or service. Resulting requirements should then be forwarded through the Committee of Principals to the Policy Coordinating Committee on National Security Telecommunications and Information Systems.

Energy Issue. Enduring energy (electric power and fuel) is a critical problem for all national infrastructures (e.g., transportation, health care, law enforcement). It is not a problem solely for the NS/EP telecommunications infrastructure. Most major PSN assets have existing backup power to satisfy short-term outages (3 to 7 days). Current efforts of the NCS, the telecommunications industry, and the DOE to enhance capabilities to handle longer-term outages include:

- . Identification of existing backup power capabilities and vulnerabilities.
- . Characterization of damage to the power grid and the resulting effects on NS/EP telecommunications.

- . Development of the DOE Electric Service Priority system to manage the restoration and curtailment of electric power on a priority basis
- . Use of state set-asides and priority fuel resupply agreements.

Efforts to ensure electric power and fuel to satisfy long-term needs of the NS/EP telecommunications infrastructure have progressed more rapidly than for other comparable infrastructures.

Progress in meeting NS/EP telecommunication needs should not be delayed until enduring energy programs are in place. Therefore, implementation of an NS/EP telecommunications improvement program should proceed. The DOE and the OMNCS should continue to work together to define further the interdependencies of the energy and telecommunication infrastructures and to pursue effective solutions to the enduring energy issue. Additionally, efforts to understand and reduce power demand by telecommunication resources should be pursued.

Assessment of Technical Approaches. The new PSN-based approach is superior to all other approaches examined, including the current NLP. An approach based on the capabilities of the PSN and existing government networks and systems (e.g., FTS2000) results in cost-effective service arrangements.

The new PSN-based approach provides advantages to non-government NS/EP users that would not be as easily achieved through the use of non-PSN-based approaches. Furthermore, carrier improvements to the PSN, initiated by the government or not, will benefit government and civilian users.

The VSAT, HF, METS, and Iridium approaches, as well as other technologies and services that may become commercially available in the future, could offer end-to-end performance improvements to a PSN-based service.

The new PSN-based approach eliminates the risks associated with a single, unique system approach without excluding the potential to derive benefits from selective use of the other approaches.

Implementation of the new PSN-based approach, instead of the currently programmed NLP, should result in cost savings to the Government. Estimated costs of the new PSN-based approach without performance enhancement modules are \$32 million nonrecurring and \$40 million per year recurring. These costs are significantly lower than the current NLP. Nonrecurring costs would be reduced by approximately \$60 million, and recurring costs would be reduced by approximately \$25 million per year.

The performance analysis results presented in classified briefings to the panel indicate that the new PSN-based approach, without performance enhancement modules, compares favorably to predicted performance of the current NLP (with NETS). The performance of the new PSN-based approach may exceed performance predictions for the current NLP under scenarios directly targeted against the nation's telecommunications infrastructure.

The panel recommends that the new PSN-based approach, without performance enhancement modules, be implemented to satisfy NS/EP telecommunication requirements and to serve as the foundation of the new NLP.

Implementation of performance enhancement modules, as well as the application of other technologies discussed in this report, should be analyzed as possible end-to-end performance improvements. Selective use of other technologies and performance enhancement modules should be justified independently of the conclusions of this report.

The panel strongly urges that implementation of the new NLP, consisting of Commercial Access and Priority Service (CAPS), Commercial SATCOM Interconnectivity (CSI), and Commercial Network Survivability (CNS), proceed without delay.

The basis for this recommendation is the changing threats, and the potential cost savings, expected performance, and incremental implementation strategy of the new approach.

APPENDIX A

**DETAILED ASSESSMENT OF
TECHNICAL APPROACHES**

APPENDIX A

DETAILED ASSESSMENT OF TECHNICAL APPROACHES

This appendix details the assessment methodology, describes the current National Level Program (NLP) and other technical approaches, and presents evaluation results. Throughout this appendix, the term "current NLP" is used to refer to the NLP as defined in the NETS solicitation of 1989.

The panel reviewed the current NLP and other approaches. The other approaches incorporate various technologies and services, such as very small aperture terminal (VSAT) technology, packet-switched message services, low earth orbit satellite services, and high frequency radio technology. Some of the approaches are consistent with alternatives contained in the Subcommittee Report to the National Communications System (NCS) Committee of Principals, *Review of the National Level NS/EP Telecommunications Program*, dated May 29, 1990.

A.1 Assessment Methodology

The assessment of the current NLP and other technical approaches was accomplished as a two-step process. The approaches were evaluated as complete alternatives to the current NLP. The first step was a technical evaluation of each approach using six criteria. The second step of the process was a comparison of the risks and estimated costs.

A.1.1 Technical Evaluation

The six functional requirements for a national security and emergency preparedness (NS/EP) telecommunications service were used by the panel as the

technical evaluation criteria. Each approach was given an Unacceptable, Acceptable, or Good rating for each criterion. The criteria are defined below:

1. **Voice Band Service** -- This criterion measures the ability to provide voice band service with voice recognition by the user in support of presidential communications.
2. **Interoperability** -- This criterion is used to evaluate the ability to interoperate with the public switched network (PSN), other government networks and systems, and private networks and systems.
3. **Survivability/Endurability** -- The ability to interconnect surviving users under a broad range of circumstances and operate over an indefinite period is evaluated under this category.
4. **International Interface** -- This criterion measures the ability to provide communications access to and egress from international locations.
5. **Nationwide Coverage** -- This criterion is used to evaluate the geographic ubiquity, or coverage, of an approach.
6. **Intra/Interagency Emergency Operations** -- This criterion refers to the ability to provide priority treatment to NS/EP traffic over all other traffic or to deny access to all other traffic (i.e., closed system).

The guidelines used for scoring approaches against the criteria are shown in Exhibit A-1. Following the initial evaluation, the panel revisited certain criteria and added the terms "Minimally Acceptable" and "Very Good" to differentiate further among the approaches.

EXHIBIT A-1

Technical Evaluation Scoring Guidelines

SCORE CRITERIA	UNACCEPTABLE	ACCEPTABLE	GOOD
VOICE BAND SERVICE	Alternative does not support voice communications.	Alternative supports voice and low-speed data communications.	Not Applicable.
INTEROPERABILITY	The alternative is a totally closed system.	The alternative inter-operates with the PSN.	The alternative inter-operates with the PSN and other government/private networks/systems.
SURVIVABILITY/ ENDURABILITY	Targeting of few points greatly reduces capability and/or no emergency power plans.	Targeting of hundreds of points is necessary to greatly reduce capability. Emergency power plans.	Targeting of thousands of points necessary to greatly reduce capability. Uninterruptible power.
INTERNATIONAL INTERFACE	Alternative does not allow international access/egress capability.	International access/egress capability available to all users.	Alternative enhances international connectivity (e.g., more gateways).
NATIONWIDE COVERAGE	Service cannot be accessed from all NS/EP user locations.	Alternative provides on-net access from all NS/EP user locations.	There are more on-net access points than NS/EP user locations.
INTRA/INTER-AGENCY EMERGENCY OPERATIONS	Alternative does not provide priority treatment to NS/EP users (or exclude all other traffic).	Alternative provides priority treatment with manual activation and implementation.	Alternative provides priority treatment with automatic activation and implementation.

A.1.2 Risk and Cost Evaluation

The technical approaches were evaluated in the second step of the methodology based on risk and cost. Three categories of risk were considered: engineering and development risk, schedule risk, and operational risk. Examples of engineering and development risks are the use of technology that is not proven and equipment that is not

commercially available. Schedule risk refers to the ability to field a system/service in the necessary time frame. For example, some proposed satellite service offerings have not yet been approved by the Federal Communications Commission. An approach based on an unapproved service has a high schedule risk. Operational risks pertain to the risk that a system or service will not perform as intended. An approach with a high operational risk may have a single point of failure or require complex operating procedures.

The cost estimates used by the panel were developed to facilitate a consistent comparison among approaches. The following assumptions were used to estimate costs for each approach reviewed by the panel:

- . System management costs incurred prior to implementation were estimated to be 10 percent of the implementation cost.
- . System management costs incurred during implementation were estimated to be 15 percent of the implementation cost.
- . Where possible, equipment implementation costs were based on estimates obtained from suppliers for purchase, not lease, of equipment. In addition, costs included an additional 10 percent for spare equipment.
- . Recurring system management cost generated after an alternative reaches full operational capability was estimated to be 5 percent of the implementation cost.
- . Maintenance costs were included in recurring costs and vary by alternative.
- . Where possible, recurring service costs were obtained from service providers and tariffs.

The total nonrecurring cost for an approach is all costs incurred prior to the start of service, pre-implementation and implementation costs. Recurring costs were estimated for one year after achieving final operating capability. In some cases, smaller recurring costs might be incurred prior to reaching the amounts shown in the following section. These recurring costs were not included in the estimates. For each approach, a range of options was considered that incrementally added capability and costs.

A.2 Technical Approaches

This section provides descriptions of each approach, including the current NLP. These descriptions include an overview of the system or service and its operation. They also address technical advantages and disadvantages, risks, and estimated costs. The six approaches fall into two categories:

- Closed/Private Systems - This category includes the Very Small Aperture Terminal (VSAT) satellite approach, the high frequency (HF) radio approach, and the Message-Based Emergency Telecommunications Service (METS) approach. Disadvantages of these approaches include reliance on a limited number of network control facilities and the use of the unaugmented PSN for connectivity to off-net users.
- Open/Public Network-Based Services - The Iridium approach uses a proposed public satellite service. It shares the disadvantages of the closed/private system approaches, because it relies on a limited number of network control facilities and uses the unaugmented PSN for connectivity to non-Iridium users. The current NLP and the new PSN-based approach exploit the physical connectivity and ubiquity of the PSN. Both of these approaches overlay a service on a national infrastructure representing billions of dollars in carrier capital investments. The

approaches use access control, priority treatment, and routing and transmission augmentations to enhance PSN capabilities for NS/EP telecommunications. The PSN is subject to regulation by the Federal Communications Commission under the Communications Act of 1934.

A.2.1 Very Small Aperture Terminal Satellite Approach

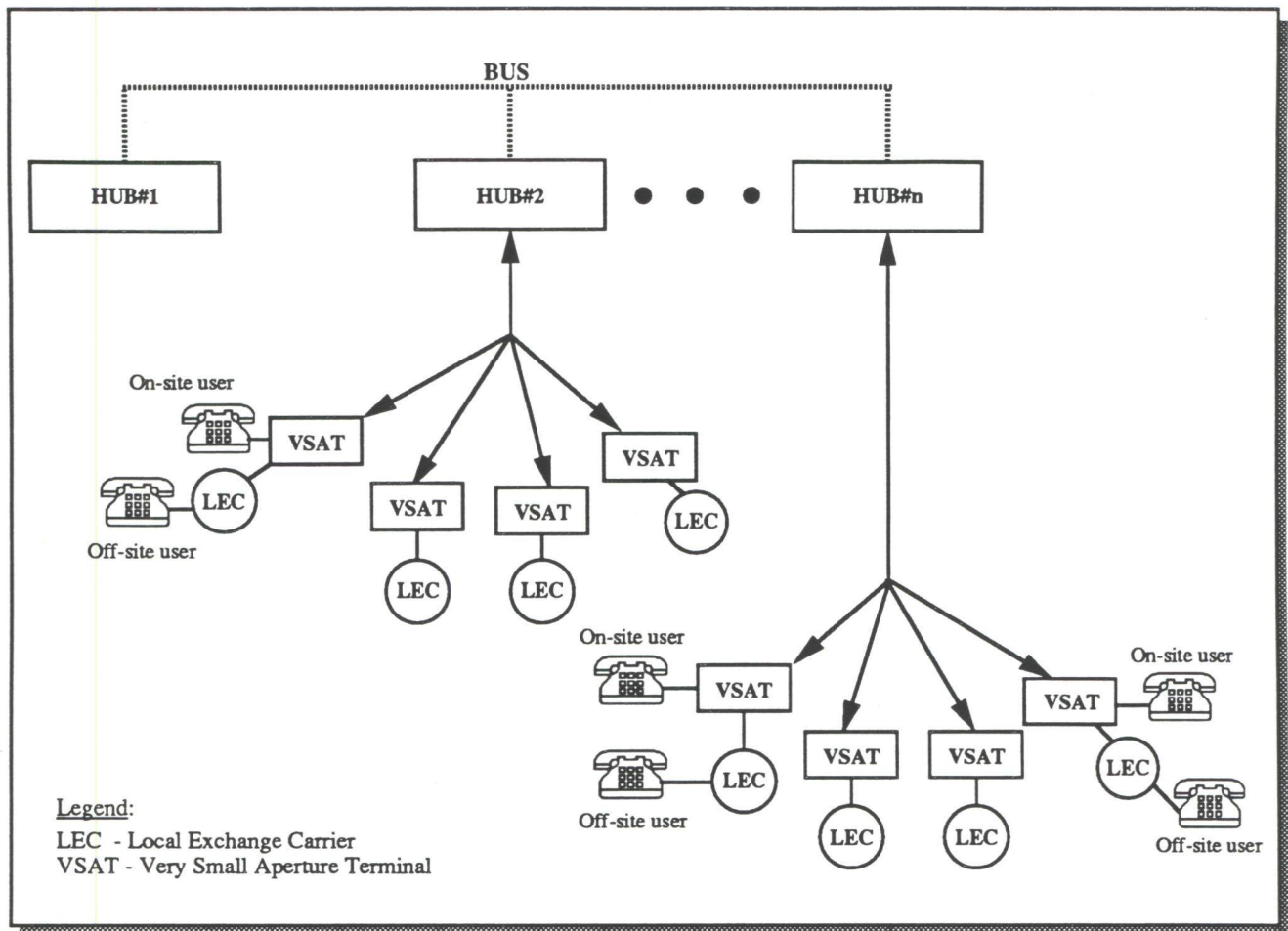
The VSAT approach would employ a private VSAT network operating in a mesh configuration through multiple hubs and providing nationwide access to and egress from the PSN. VSAT networks differ from traditional satellite networks because of their lower power, smaller antennas, and reduced call capacity. VSAT networks use a class of intelligent satellite earth stations suitable for on-premise installation, and usually operate in conjunction with a hub earth station. These terminals typically have antennas with diameters ranging from 1.2 to 3.6 meters, power amplifiers ranging from 1 to 3 watts, and operate in the Ku frequency band. International access and egress would be provided through selected PSN international gateways.

Description. The VSAT approach would employ multiple hubs, each of which would monitor and control a portion of the VSAT terminal population. Each hub would be capable of monitoring and controlling the whole network. Exhibit A-2 illustrates the proposed VSAT system.

The VSAT terminals would be installed at NS/EP telecommunications user sites and would be accessed directly by on-site users. Off-site users could access the VSAT terminals on a dial-up basis through the PSN. The hubs would communicate through the satellite with associated VSAT terminals over one set of channels and with other hubs over a separate set of channels.

EXHIBIT A-2

Very Small Aperture Terminal Satellite Approach



The key hub functions are to: (1) monitor and control the associated VSAT terminals, (2) manage the assignment of voice channels to the terminals, and (3) manage the overall network. Inter-hub signaling and monitoring information would be transmitted over the satellite bus and used by the hubs to coordinate the establishment of a voice circuit between two VSAT terminals. For normal operations, an off-site to off-site user call would be established in the following steps:

- The off-site user dials a standard PSN number to access a VSAT terminal and is provided with a second dial tone.
- The user dials the destination off-site user PSN number.
- The calling party's terminal sends the call request and the dialed destination number information to the hub.
- The hub selects an available satellite channel and the appropriate destination VSAT according to an established routing table.
- The hub sends channel assignment information and dialing information to the calling and called VSAT, and the PSN destination number to the called VSAT.
- The destination VSAT dials the off-site user through its local exchange carrier.
- When the call is completed, the voice frequency assignments are released.
- The hub sends an acknowledgement to the VSATs.

Because this VSAT network would encompass multiple hubs, VSATs assigned to a damaged or inoperable hub would be reassigned to an operable hub according to an established devolution plan. The space segment could be leased such that an inoperable satellite could be replaced by an on-orbit spare, or an on-ground spare when launch capability was available. Additionally, satellites that belonged to other common carriers could be made available for emergency use after the invocation of Section 706 of the Communications Act.

The VSAT system could also be affected by the failure or destruction of the telemetry, tracking, and control stations. This vulnerability, however, could be mitigated by the provision of an interoperable telemetry, tracking, and control capability for the Ku-band satellite families in similar fashion to that used for the Commercial SATCOM Interconnectivity program.

Evaluation. The engineering and development risk for this approach is low because it uses off-the-shelf equipment. There are several manufacturers of this equipment (e.g., Hughes, Contel, Scientific Atlantic, NEC). Implementation schedule risks are also low. There is some software development required for network management control capabilities, but the technical risk is considered to be low to medium due to the expected level of software complexity.

Development risk of the telemetry, tracking, and control system is considered low since this is a capability similar to that already provided for the Commercial SATCOM Interconnectivity program and other programs. The panel concludes that the VSAT approach has several advantages:

- . Transportable terminals
- . Low backup power requirements for VSAT network
- . Low recurring cost
- . Easily expandable
- . Low-to-medium engineering and development risk
- . Low schedule risk.

On the other hand, VSATs have several disadvantages that may preclude their use by the NS/EP user community as an alternative to the current NLP:

- . Network vulnerability due to failure of single satellite
- . Susceptibility to jamming

- . Hub survivability and devolution of network control
- . Telemetry, tracking and control system survivability.

The results of the technical evaluation for the VSAT approach are summarized in Exhibit A-3. Risk and cost information is contained in Exhibit A-4. Cost estimates for the VSAT architecture were based on the following:

- . Terminals are deployed to 7,000 NS/EP user locations.
- . Network management functions are performed in each hub.
- . Small generators are used for backup power.
- . Equipment costs include an additional 10 percent for spares.
- . Unit cost of terminal is \$22,000.
- . Unit cost of hub is \$1 million.
- . Terminals operate unattended.
- . Hubs are manned by one operator and one technician per shift.

Three options were considered to develop cost estimates. The first option has 10 hubs; no interoperable telemetry, tracking, and control facility; and no priority treatment for off-net PSN call segments. The second option adds the interoperable telemetry, tracking, and control facility and has 20 hubs. The third option has 30 hubs; an interoperable telemetry, tracking, and control facility; and PSN priority treatment.

EXHIBIT A-3

VSAT Technical Summary

CRITERIA	RATING	COMMENTS
Voice Band Service	Acceptable	• Provides 16 kilobits per second digitized voice • Can support high-speed data transmission • Supports use of secure terminals • Can support video transmission between hub and VSAT
Interoperability	Minimally Acceptable	• Intended to function principally as a closed system • Can interoperate with the PSN with appropriate interfaces • Can interoperate with private and government networks through gateways
Survivability/Endurability	Unacceptable	• Space segment is a single point of failure, with no antijamming and high altitude electromagnetic pulse protection • Terminals dispersed to all user locations, but limited number of hubs and control facilities • Small generators can be used to meet emergency power requirements of individual VSATs • Hubs and control facilities require backup power
International Interface	Acceptable	• International interface is feasible via gateways
Nationwide Coverage	Acceptable	• VSATs located at all user locations • Off-net users gain non-priority access through the PSN • Satellite footprint includes all of the contiguous U.S.
Intra/Interagency Emergency Operations Support	Good	• Closed system for government users on the VSAT network • No priority provided in PSN for off-net users

EXHIBIT A-4
VSAT Risk and Cost Summaries

RISK	COMMENTS
ENGINEERING AND DEVELOPMENT	• Low risk due to use of commercially available hardware. Medium risk due to software and procedures development needed to operate degraded network.
SCHEDULE	• Low risk because of minimal new hardware and software development.
OPERATION	• High risk due to single point of failure (satellite). Complex reconfiguration needed to use spare satellite or to reassign hub responsibilities also poses high risk.

COST CATEGORY	COSTS (\$MILLIONS)		
	OPTION A	OPTION B	OPTION C
PRE-IMPLEMENTATION			
• SYSTEM MANAGEMENT	17	18	19
IMPLEMENTATION			
• HUBS	11 (10 hubs)	22 (20 hubs)	33 (30 hubs)
• VSATs* (7000)	165	165	165
• SYSTEM MANAGEMENT	26	28	30
RECURRING			
• SATELLITE CHANNELS	8	8	8
• INTEROPERABLE TT&C	—	1	1
• PSN PRIORITY TREATMENT	—	—	5
• PSN INTERFACE**	4	4	4
• SYSTEM MANAGEMENT	17	24	31
TOTAL COST	219 + 29/year	233 + 37/year	247 + 49/year

*Includes 10% spares and generators for backup power.

**Includes 1 business line at each VSAT location.

NOTE: TT&C - Telemetry, Tracking and Control

A.2.2 High Frequency Radio Approach

High Frequency (HF) radio systems have traditionally played an important role in local and regional emergencies. The Committee of Principals subcommittee reviewed an HF radio system as an NLP alternative in its May 1990 report. For these reasons, the panel examined an HF approach as an alternative to the current NLP.

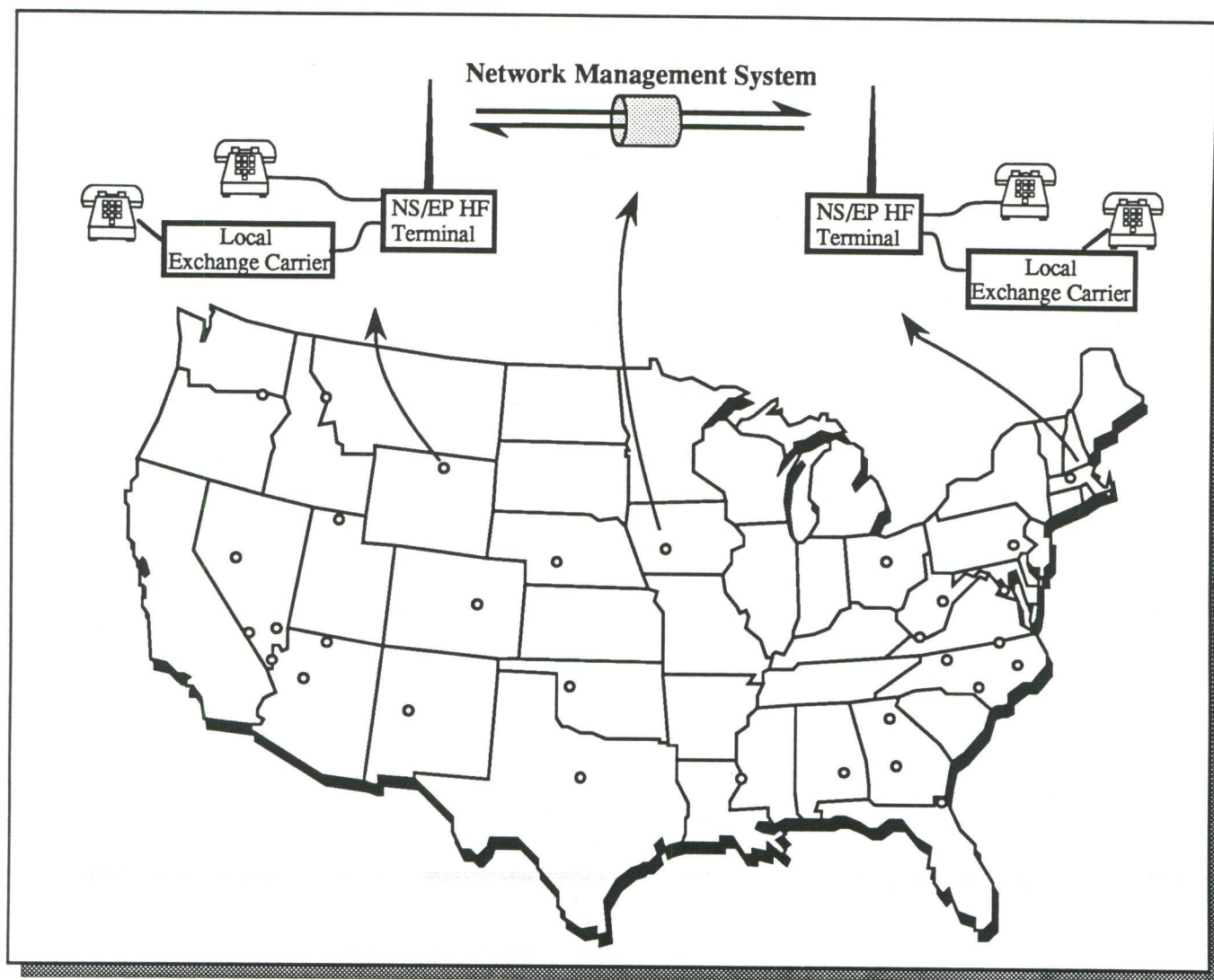
Description. The HF radio approach would provide a low-rate voice system consisting of a series of area/regional networks capable of providing connectivity throughout the continental United States (U.S.). Connectivity would be accomplished via direct or indirect station-to-station links. Exhibit A-5 depicts the HF radio approach.

The concept is to divide the geographic coverage area into service areas based on expected user density and assign service area codes similar to telephone area codes (e.g., 703 for Northern Virginia). Based on expected user traffic density, a number of frequencies or address codes distributed across the HF transmission band would be assigned to each service area. Each user location would be assigned a call sign (e.g., Fort Apache) or address (e.g., UTM12345) to identify the called and calling party. A call could then be placed to a given user by calling the service area and call sign (or address). Once the radio link has been established, each user could monitor the frequencies or code addresses assigned to their service area. By using the concept of a service area, calls could be completed via the local PSN to the intended recipient with other user locations receiving the initial contact if the intended recipient did not respond to the initial transmission.

To place a call, a caller would use a telephone (standard or encryption capable) to contact the call management subsystem of the HF radio station serving the user. That

EXHIBIT A-5

High Frequency Radio Approach



connection could be made over dedicated cable, the PSN, dedicated line-of-sight radio, or cellular radio, depending on local circumstances such as caller-station distance or local environment. The call management subsystem would set up or address a call by looking up the proper set of frequencies and user code of the called party. The network management subsystem would establish network parameters and the radio link to the called party. The HF radio transmitter would convert analog voice signals to radio frequency signals and, in advanced systems, digitize the signal.

Evaluation. The HF radio approach would support voice and low-rate data transmission, as well as secure telephones. HF radio has several advantages:

- Off-the-shelf components present low risk.
- HF terminals are as survivable as users themselves.
- Backup power is easily provided.
- Engineering/development and schedule risks are low to medium.

Although intended to function principally as a closed system, the HF system could interoperate with other HF networks using similar modulation schemes, and could interoperate with the PSN with the addition of appropriate interfaces. In spite of these advantages, there are several disadvantages to depending on HF radio for NS/EP telecommunications:

- Available bandwidth limits the number of user channels.
- HF links subject to degradation due to natural and nuclear effects.
- No means for implementing priority treatment or access control schemes.
- High risk that an HF system could not meet traffic volume requirements.
- Susceptibility of HF signal to jamming.
- Substantial call setup and message delivery time.

The technical evaluation of the HF radio approach is summarized in Exhibit A-6. The estimated costs and associated risks of this alternative are given in Exhibit A-7. Cost estimates for analog and digital HF options were based on the following:

- HF terminals are deployed to 7,000 NS/EP user locations.
- 70 network management sites are required for system control.
- Diesel generators are used for backup power.
- Equipment costs include an additional 10 percent for spares.
- Operator/technician staffing is minimal.

EXHIBIT A-6
HF Technical Summary

CRITERIA	RATING	COMMENTS
Voice Band Service	Acceptable	• Supports voice and low-speed data • Permits use of secure terminals
Interoperability	Minimally Acceptable	• Functions principally as a closed system • Can interoperate with PSN using appropriate interfaces • Interoperates with other HF networks using similar modulation
Survivability/Endurability	Good	• Relies on 70 network management terminals for optimum performance • HF terminals are as survivable as user locations • Fading and scintillation effects may degrade performance • Small generators can be used to meet emergency power requirements
International Interface	Minimally Acceptable	• International access without priority treatment available through PSN • Can communicate with compatible radios overseas
Nationwide Coverage	Acceptable	• HF terminals located at all NS/EP user locations • Usable frequency band compressed during daylight hours • Off-net users can gain nonpriority access to HF terminals through PSN
Intra/Interagency Emergency Operations Support	Unacceptable	• Cannot ensure priority service due to interference with and demand from other HF systems • No priority treatment in PSN for off-net users

EXHIBIT A-7

HF Risk and Cost Summaries

RISK	COMMENTS
ENGINEERING AND DEVELOPMENT	Low risk due to use of off-the-shelf components. Network management software development poses Medium risk.
SCHEDULE	Low/Medium risk because of availability of hardware and minimal software development.
OPERATION	High risk of inadequate information throughput due to complex network management, vagaries of HF communications, limited frequencies, weapons' effects on atmosphere, potential interference with other HF users, denial if jammed, and time delays from call relay points.

COST CATEGORY	COSTS (\$MILLIONS)	
	OPTION A	OPTION B
PRE-IMPLEMENTATION		
• SYSTEM MANAGEMENT	5	34
IMPLEMENTATION		
• NS/EP HF TERMINALS* (7,000)	46 (analog radios)	339 (digital radios with automatic link establishment and automated frequency selection)
• NETWORK MANAGEMENT SYSTEM TERMINALS	1	1
• SYSTEM MANAGEMENT	7	51
RECURRING		
• PSN INTERFACE** (70)	4	4
• SYSTEM MANAGEMENT	533	56
TOTAL	59 + 537/year	425 + 60/year

*Includes 10% spares and generators for backup power.

**Includes 1 business line at each HF terminal location; option A assumes 1 operator/technician (\$70,000/year) at each location with 24-hour coverage provided by sharing of other staff; option B assumes 1 operator/technician only at network management system sites.

Two sets of cost estimates were developed. The first set, option A, was based on less sophisticated, analog radios and the use of operators/technicians at HF terminal locations. The second set, option B, was based on digital radios with automatic link establishment and automated frequency selection and on fewer operators/technicians.

A.2.3 Message-Based Emergency Telecommunications Service Approach

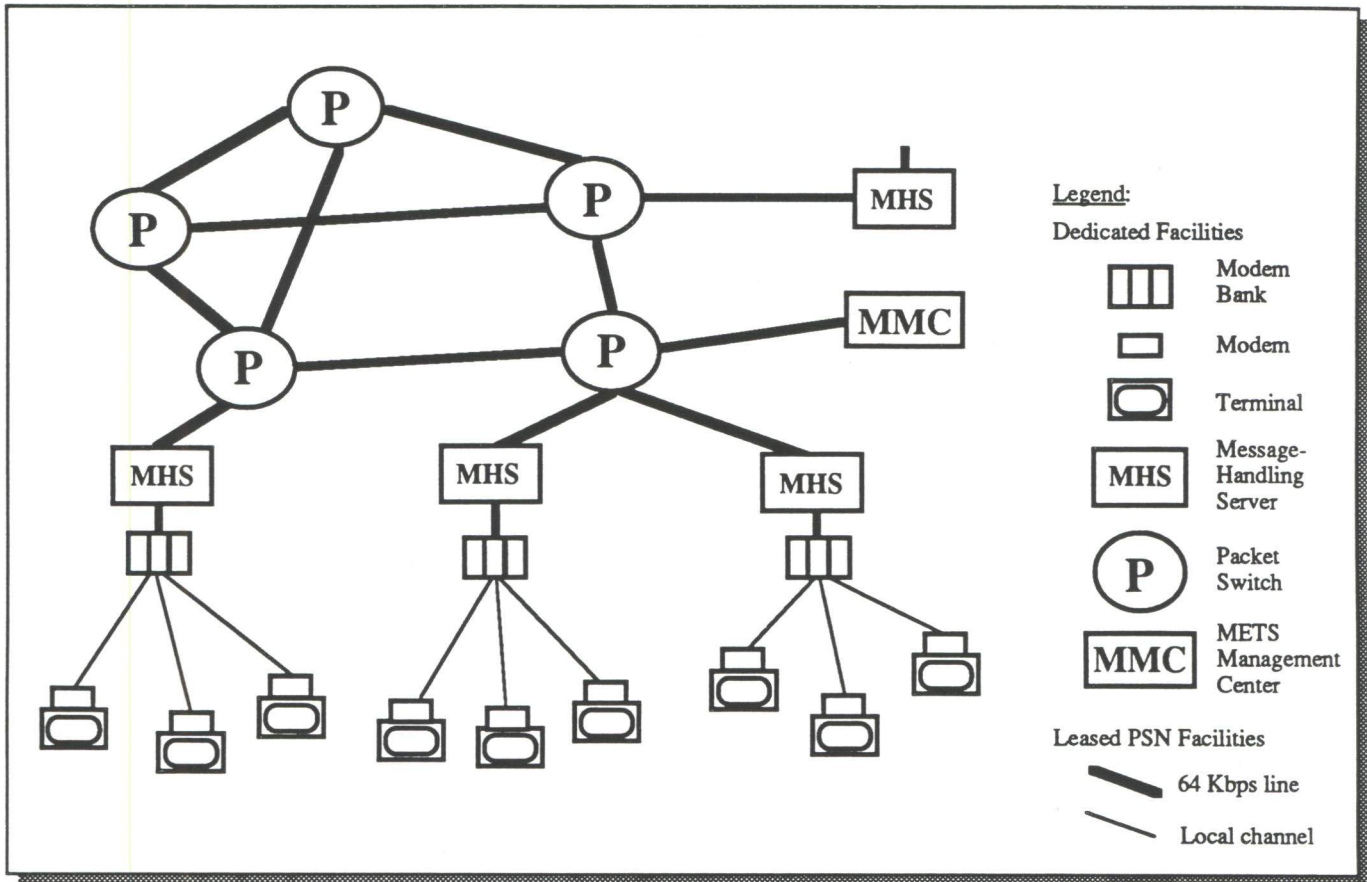
Message-Based Emergency Telecommunications Service (METS) is a proposed message-based communications service that was recommended for further study by the Committee of Principals Subcommittee as an alternative to the current NLP. METS would consist of a packet-switched network designed to provide message service in a stressed environment. The proposed baseline METS would include 104 packet switches, 487 message handling servers, and 4,000 terminals. Users would access the service through terminals and modems at user locations.

Description. The METS approach comprises five main elements: message handling servers, user terminal equipment, packet switches, fiber-optic transmission links, and a METS management center. Each element is described in the following paragraphs and depicted in Exhibit A-8.

The message handling servers would be X.400 message servers equipped with X.500 directory applications. The message handling servers would provide mailboxes that users could access to send and receive messages. Mailboxes could be moved from one message handling server to another if the user relocated. The X.500 directory feature would allow users to communicate with other users' mailboxes by name and not by location. Personal computers with modems and software would be used as terminals to permit exchange of messages. Access to the message handling server would be via dedicated access links. A message handling server would be placed at selected PSN access tandem locations to support users distributed throughout the continental U.S. The message handling servers would be linked through a network of packet switches.

EXHIBIT A-8

Message-Based Emergency Telecommunications Service Approach



The packet switches would be located at selected switches and in some cases collocated with a message handling server. The packet switches would interconnect through dedicated 64 kilobits per second fiber-optic transmission links leased from commercial carriers. Operational readiness would be maintained by the METS management center during peacetime. Dedicated facilities would connect the METS management center to a METS packet switch.

As shown in Exhibit A-8, packet switches would connect to one another and the message handling servers with dedicated links. Each message handling server location would have a bank of 2400 bits per second modems for communication with its user terminals. One packet switch would connect with the METS management center. User terminals would connect to a message handling server over leased private lines.

METS operation would depend on PSN facilities to provide dedicated access and transport. METS users would access their message handling server through dedicated links at defined user locations. A password data base replicated at all message handling server nodes would validate users requesting access.

Evaluation. The proposed approach for METS has several advantages, including the use of commercially available equipment and provisions for delivering messages to NS/EP users who have moved to emergency relocation sites. The METS approach has the following disadvantages:

- . Does not provide voice service
- . Requires equipment reconfiguration at PSN locations during emergencies to reduce PSN power usage so that backup power life is extended
- . Restricts mobility of NS/EP users to preplanned locations
- . Uses fiber-optic transmission that limits PSN route diversity.

The technical evaluation of the METS architecture is summarized in Exhibit A-9. The risks and estimated costs of this alternative are shown in Exhibit A-10. Cost estimates were based on the following assumptions:

EXHIBIT A-9
METS Technical Summary

CRITERIA	RATING	COMMENTS
Voice Band Service	Unacceptable	• Cannot support voice communications
Interoperability	Unacceptable	• Operates principally as a closed system • Dedicated access from FTS2000 or Defense Switched Network is possible • Nonpriority dialed access for users with appropriate terminal equipment could be provided
Survivability/ Endurability	Acceptable	• Uses fiber routes in interexchange carrier networks that are sparsely distributed • Could include CSI routes to improve survivability • Emergency power depends upon a complex and costly energy redistribution plan that would impair operation of surviving PSN
International Interface	Unacceptable	• Current METS concept does not support international interface
Nationwide Coverage	Minimally Acceptable	• Message handling services located in all local access transport areas • Access available only at predetermined locations via dedicated links
Intra/Interagency Emergency Operations Support	Good	• Only government users on the network (closed system)

EXHIBIT A-10
METS Risk and Cost Summaries

RISK	COMMENTS
ENGINEERING AND DEVELOPMENT	• Low risk associated with off-the-shelf hardware and access procedures and data base development.
SCHEDULE	• Component acquisition poses Low risk, but backup-power plans (power isolation) pose High risk.
OPERATION	• Alternative does not meet minimum operating requirements. Medium/High risk of successful operation of backup power plans.

COST CATEGORY	COSTS (\$MILLIONS)		
	OPTION A	OPTION B	OPTION C
PRE-IMPLEMENTATION			
• SYSTEM MANAGEMENT	13	18	23
IMPLEMENTATION			
• TERMINALS*	25 (4,000 terminals)	73 (12,000 terminals)	122 (20,000 terminals)
• SWITCH TRANSLATIONS (20,000)	20	20	20
• MESSAGE HANDLING SERVERS* (487)	67	72	77
• PACKET SWITCHES (104)	15	15	15
• DEDICATED CIRCUITS	1	1	1
• SYSTEM MANAGEMENT	20	27	35
RECURRING			
• TERMINALS	4	8	21
• MESSAGE HANDLING SERVERS	2	3	4
• PACKET SWITCHES	1	1	1
• DEDICATED CIRCUITS	6	10	22
• SYSTEM MANAGEMENT	10	10	12
TOTAL COST	161 + 23/year	226 + 32/year	293 + 60/year
TOTAL COST PLUS CSI (\$9M)	161 + 32/year	226 + 41/year	293 + 69/year

*Includes 10% spares.

- . The initial cost for packet switches is \$19,950.
- . The initial cost for terminals is \$6,088 (estimate based on high-end equipment and includes software).
- . The initial cost for message handling servers is \$12,148.
- . The initial cost for the METS management center is \$95,000.

Three options were considered to develop cost estimates: option A with 4,000 user terminals, option B with 12,000 terminals, and option C with 20,000 terminals.

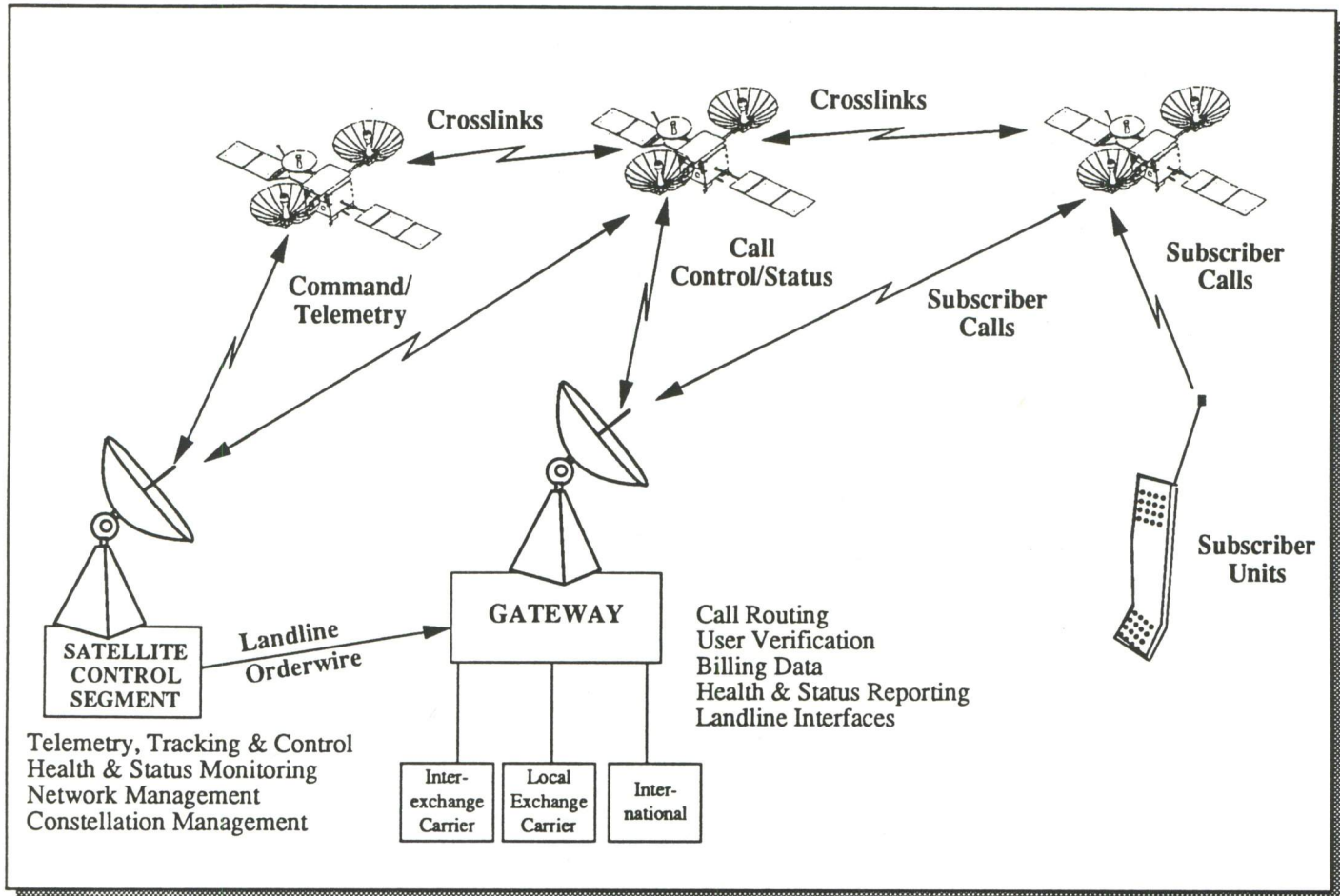
A.2.4 Iridium Service Approach

Iridium is a worldwide communications service proposed by Motorola to provide voice, data, facsimile, paging, and radiodetermination satellite services to users who might otherwise be unable to connect directly to the PSN. If approved, the system will be a digital communications system using a constellation of 77 low earth orbit satellites and interfaces to public networks throughout the world. Users would access the system through hand-held transceivers similar in construction and operation to cellular phones. Motorola plans to have a fully operational system in place by 1996. However, domestic frequency allocation is not yet approved and significant coordination must take place before deployment of the satellites can begin.

Description. The Iridium service approach would comprise five segments: space, launch, satellite control, gateway, and subscriber. Each segment is described in the following paragraphs and depicted in Exhibit A-11.

The Iridium space segment would include 77 low earth orbit satellites, each weighing about 850 pounds on-orbit. The satellites would be in seven highly inclined

EXHIBIT A-11
Iridium Service Approach



orbital planes at an altitude of about 425 miles. Each plane would contain seven satellites, phased to maintain equal separation. All satellites would be crosslinked to the satellite immediately in front and back in each plane, as well as interplane links to adjacent spacecraft. Ten spare spacecraft would remain on the ground until needed.

To date, Motorola has not released many details about the Iridium launch vehicles or launch scenarios. Given the small size of the payloads, multiple spacecraft launches would be possible, with concomitant increases in risk (and launch insurance rates) as the number of satellites per launch increases.

Motorola proposes using three ground stations located at about 52 degrees north latitude and spaced equally in latitude to allow observation and control of every satellite in every orbit. Satellite control stations, similar in construction to the gateways, would be responsible for station keeping, constellation operations, and network control functions, such as routing calls around a failed satellite. The three stations would be linked to a central Motorola facility located in Chandler, Arizona.

Gateways are key elements of the Iridium service approach, allowing users to access the PSN from anywhere on the globe. Two planned gateway ground stations in the U.S. would be responsible for call routing, user verification, billing, and health and status reporting, in addition to providing interfaces to the interexchange carriers, local exchange carriers, and international carriers.

Subscribers to Iridium voice services would use a small, hand-held transceiver to place and receive calls over the system. Similar in size and operation to a modern cellular telephone, subscriber units would have a 3-inch antenna and about 3 watts of power to establish links to the nearest satellite. The voice signal would be encoded at a bit rate of 4.8 kilobits per second with a 10^{-2} error rate. The high error rate would preclude the use of secure terminals. Voice operations would be full duplex over an 8 kilobits per second channel. A satellite would pass over the user in 9 minutes; however, this would be transparent to the user, as would call setup and routing.

An NS/EP user would place an Iridium call the same way he or she currently uses day-to-day telephone service. First, the user would dial the destination number, sending the call request up to a satellite, which would route the call request to a gateway. The gateway would verify the user's request and billing information, determine the appropriate call routing, and establish the links, sending the appropriate call control signals. Since PSN interoperability is an integral part of the Iridium architecture, gateways would be compatible with relevant international standards. When the user has completed the call and hangs up, the gateway would terminate all links. All call setup,

routing, crosslinking, PSN connection, and satellite handovers would be transparent to the user, that is, he or she would not notice any interruption in service during the call. However, gaps in service of up to 9 minutes could be experienced if a satellite is lost or inoperable.

Evaluation. Motorola's proposed Iridium service, which would employ low earth orbit satellite technology, has several advantages: global connectivity for NS/EP users, easy-to-use subscriber transceivers, and battery-operated subscriber units. There are, however, several disadvantages to low earth orbit satellite systems in general and Iridium in particular:

- Limited number of gateways and satellite control facilities
- High schedule risk due to regulatory, frequency allocation, and funding issues
- Lack of access control and priority treatment for NS/EP users
- Medium engineering/development risks
- Control facilities and gateways located in foreign countries.

The technical evaluation of the Iridium service approach is summarized in Exhibit A-12. The risks and estimated costs are shown in Exhibit A-13. Cost estimates were based on the following assumptions:

- Motorola projects transceivers to cost about \$3,000 each and gateways to cost about \$16 million each.

EXHIBIT A-12
Iridium Technical Summary

CRITERIA	RATING	COMMENTS
Voice Band Service	Acceptable	• Provides 4.8 kilobits per second voice communications • Planned error rate (10^{-2}) precludes use of secure terminals
Interoperability	Acceptable	• PSN interoperability is an integral part of the architecture (compatible with international standards)
Survivability/Endurability	Unacceptable	• Space segment has no antijamming or high altitude electromagnetic pulse protection • Limited number of control facilities and gateways • Any interruption of station-keeping function would rapidly degrade service reliability • Battery-powered transceivers distributed to all users • Gateways and control facilities require backup generators • Satellite constellation vulnerable to ground-based attack
International Interface	Very Good	• Connectivity to international carriers via gateways integral to architecture
Nationwide Coverage	Good	• All users have transceivers • PSN connectivity via two contiguous U.S. gateways • 40 cells to cover contiguous U.S. and coastal waterways
Intra/Interagency Emergency Operations Support	Unacceptable	• No plans for implementing priority treatment or access control • Network-wide priority treatment requires international cooperation • No priority treatment in PSN portions of calls • Motorola reluctant to consider special government requirements

EXHIBIT A-13
Iridium Risk and Cost Summaries

RISK	COMMENTS
ENGINEERING AND DEVELOPMENT	• Medium risk for acquiring L-band frequencies already allocated to other users and potential interference with geostationary satellites and ground terminals.
SCHEDULE	• High risk due to uncertainty of FCC approval, complex global regulatory issues, uncertainties in consortia financing, ambitious construction schedule for spacecraft, and launch schedule and logistics.
OPERATION	• Medium/High risk due to potential for losing satellites in degraded control environment, significant service degradation caused by resulting gaps in coverage, required coordination among independent gateway operators, susceptibility to nuclear effects, and lack of priority treatment for NS/EP traffic.

COST CATEGORY	COSTS (\$MILLIONS)			
	OPTION A	OPTION B	OPTION C	OPTION D
PRE-IMPLEMENTATION	9	14	19	23
IMPLEMENTATION				
• TRANSCEIVERS	21 (7,000 transceivers)	42 (14,000 transceivers)	63 (21,000 transceivers)	63 (21,000 transceivers)
• GATEWAYS	32	64	96	128
• SATELLITE CONTROL	40	40	40	40
• FACILITIES				
• SYSTEM MANAGEMENT	14	21	29	34
RECURRING				
• SYSTEM MANAGEMENT*	4	7	9	11
• SUBSCRIBER FEES	5	9	13	13
• TEST CALLS	1	1	1	1
TOTAL COST	116 + 10/year	181 + 17/year	247 + 23/year	288 + 25/year

* Includes 10 staff each at \$70,000/year at control facilities and gateways for 24-hour coverage.

- Satellite control facilities are simply gateways with increased functionality. Costs for these facilities are projected to be in the \$20 to \$25 million range.
- Additional costs include costs of hardening ground facilities, recurring operating costs, subscriber fees, and installation and test costs.

Cost estimates for four options were developed. Estimates varied depending on the number of transceivers and gateways.

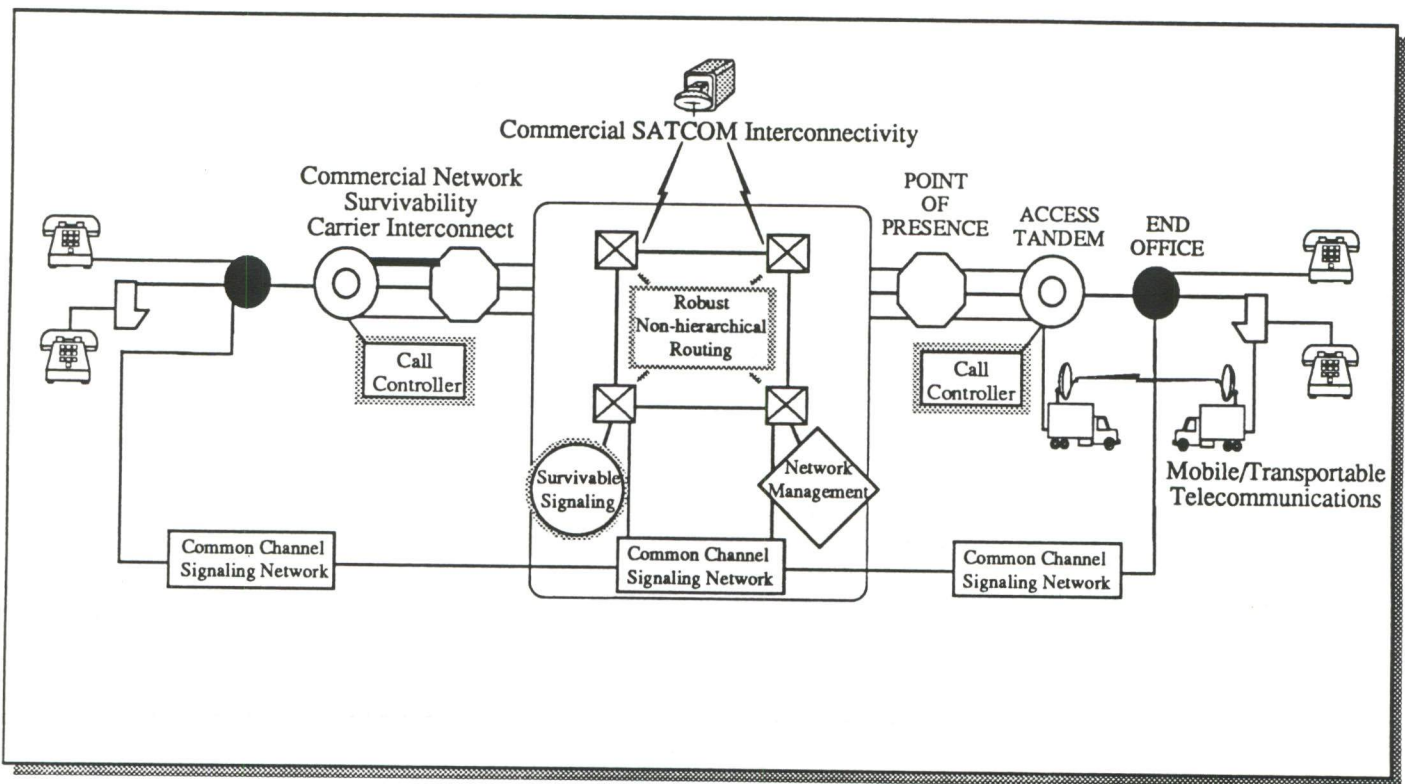
A.2.5 Current National Level Program

The current PSN-based NLP enhances routing, survivability, connectivity, and interoperability of telecommunications traffic. The NLP comprises three programs: the Nationwide Emergency Telecommunications Service (NETS), the Commercial SATCOM Interconnectivity (CSI) program, and the Commercial Network Survivability (CNS) program. NETS includes elements to improve routing flexibility and signaling survivability. CSI uses commercial satellites to augment interexchange transmission capabilities for NS/EP traffic. The CNS program improves terrestrial telecommunications survivability and interoperability through fixed and deployable transmission augmentations. The PSN was selected as the basis of the NLP because of its ubiquity and the percentage of surviving PSN assets under all stress levels. The use of the PSN also allows easy incorporation of new technologies, such as the Integrated Services Digital Network and interoperation with government and private networks, such as Federal Telecommunications System 2000 (FTS2000).

Description. The current NLP is designed to support surviving NS/EP users in the late trans-attack and early post-attack periods. NETS includes elements to enhance access control, routing, network management, and signaling survivability. CNS provides additional routes for those NS/EP users that may become isolated from portions of the

PSN. CSI improves the robustness of the interexchange carrier networks by providing backup satellite links for those portions of the networks that may have very limited connectivity in a post-attack environment. The combination of NETS, CNS, and CSI is expected to result in a significant nationwide enhancement of existing services for the restoration of NS/EP telecommunications. NLP enhancements are illustrated in Exhibit A-14.

EXHIBIT A-14
Current National Level Program



While designed for the late trans-attack and early post-attack environment, the NLP also provides enhanced communication features in peacetime and crisis/mobilization periods. During this time period, NLP capabilities could be used to support stress and crisis situations such as a cable cut or natural disaster. The NLP is interoperable with government networks, such as the FTS2000 and the Defense Switched Network. Although the CSI concept of operations specifically addresses post-attack reconstitution of the PSN, many of the plans and capabilities developed under this program can be applied to support a variety of non-wartime emergencies. The CNS program offers fixed route augmentations and mobile support in the event of a peacetime or wartime emergency.

The ability of NS/EP users at any specific location to access and use the enhancements provided by the NLP depends on the telecommunications equipment and services at the user location. A PSN-based NLP offers flexibility for NS/EP users to improve their access by obtaining direct access, essential line services for priority dial tone, and multiple homing arrangements to end offices. Such features can be evaluated and implemented by the NS/EP user according to the feature's cost effectiveness.

The operation of NETS requires the NS/EP user to receive a dial tone from the PSN and enter a special access code. The access code directs the call to a NETS call controller. Using a personal identification number transaction, the call controller then determines if the call is from a valid NS/EP user. If the number is invalid, the calling party is disconnected. If the number is valid, the call controller processes the call through the PSN and other call controllers to the destination. NETS calls use surviving assets plus CSI and CNS augmentations as required.

The current NLP capitalizes on PSN and other network resources and employs several PSN, satellite, and terrestrial augmentations to bypass damage. It offers a diverse range of capabilities to ensure reconstitutable communications under all emergency situations.

Evaluation. The current NLP, which uses the unique features of NETS, CNS, and CSI, has several advantages:

- . Meets the six functional requirements
- . Supports voice, data, and secure terminals
- . Interoperates with other government and private networks
- . Allows incorporation of new telecommunications technology
- . Provides ubiquitous access, including international access
- . Effectively uses the resources of the PSN
- . Controls service access and permits priority treatment of NS/EP traffic.

There are some disadvantages to the current NLP architecture: dependency on PSN backup power plans and capabilities, possible traffic congestion on portions of the call path, and need for coordination among many carriers. The technical evaluation of the current NLP is summarized in Exhibit A-15.

The risks and estimated costs of the current NLP are shown in Exhibit A-16. Cost estimates were based on the number of NETS call controllers (60 in option A, 106 in option B) and the following assumptions:

- . NS/EP users number 25,000 at 7,000 locations.
- . Call controller cost is estimated at \$125,000 (purchased, not leased).
- . Switch translation costs are estimated at \$15 million per year and priority treatment is estimated at \$14 million per year.

EXHIBIT A-15
Current NLP Technical Summary

CRITERIA	RATING	COMMENTS
Voice Band Service	Acceptable	• Provides PSN quality voice and data • Allows use of secure terminals
Interoperability	Very Good	• Architecture embedded in the PSN • Interoperable with FTS2000, Defense Switched Network and other government and private networks
Survivability/Endurability	Acceptable	• Targeting of hundreds of points in architecture required to seriously degrade capability • Emergency power programs are being developed
International Interface	Good	• International gateway connectivity
Nationwide Coverage	Very Good	• Permits calling with priority treatment from and to virtually any telephone
Intra/Interagency Emergency Operations Support	Acceptable	• Provides priority treatment of NS/EP traffic with no activation procedures necessary

EXHIBIT A-16

Current NLP Risk and Cost Summaries

RISK	COMMENTS
ENGINEERING AND DEVELOPMENT	Use of PSN represents low risk, and call controller development represents Low/Medium risk.
SCHEDULE	Low/Medium risk due to existing specifications to support acquisition cycle and required development and installation time.
OPERATION	- Low risk due to use of standard dialing plans, automated operations, and lack of dependency on functioning maintenance and administration center. - Medium risk of availability of backup power programs and plans.

COST CATEGORY	COSTS (\$MILLIONS)	
	OPTION A	OPTION B
PRE-IMPLEMENTATION		
• INTEREXCHANGE CARRIER SERVICES	20	20
• CALL CONTROLLER DESIGN/ENGR.	12	12
• SYSTEM MANAGEMENT	25	25
IMPLEMENTATION		
• CALL CONTROLLERS	8 (60 Call Controllers)	13 (106 Call Controllers)
• TRANSLATIONS	15	15
• SYSTEM MANAGEMENT	10	10
RECURRING		
• PRIORITY TREATMENT	14	14
• SERVICE TARIFFS	18	18
• TRUNK TERMINATION TARIFFS	4	4
• USAGE	1	1
• SYSTEM MANAGEMENT	10	13
TOTAL	90 + 47/year	95 + 51/year
TOTAL PLUS CNS/CSI	90 + 65/year	95 + 69/year

A.2.6 New Public Switched Network-Based Approach

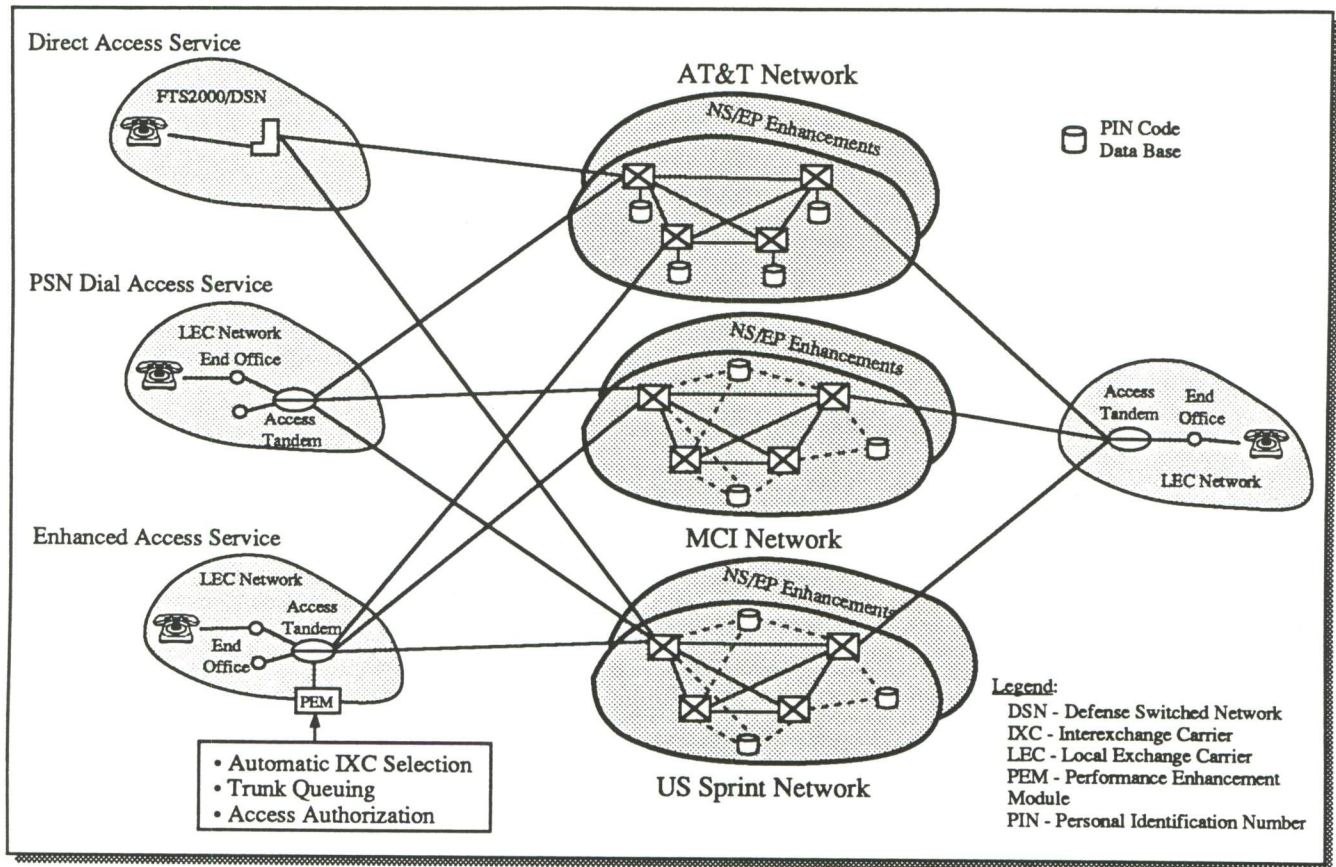
The new PSN-based approach would take advantage of the ubiquity, traffic capacity, and evolving capabilities of the PSN. It would also use CSI and CNS network augmentations. The panel's name for the main component of this approach is Commercial Access and Priority Service (CAPS) to emphasize the Government's strategy of relying upon access to the commercial services and of the PSN and priority treatment within the PSN. CAPS would be a replacement for NETS.

Over the past few years, major interexchange carriers have enhanced their networks, particularly in the areas of routing and distributed access control. These features have significant potential for supporting NS/EP telecommunication needs. CAPS is designed to use PSN capabilities in a more cost-effective manner than the NETS. It could also easily incorporate future enhancements resulting from further deployment of Signaling System 7 and Integrated Services Digital Network features.

Description. The new PSN-based approach would use the services of the major interexchange carriers (AT&T, MCI, and US Sprint) to provide NS/EP telecommunications. NS/EP service enhancements would be implemented in each of these networks to improve call completion and access authorization capabilities. Service enhancements to the AT&T network would include an updated routing capability based on a commercial feature, the survivable signaling network, and CSI augmentations between switches. A credit card type of access authorization would be used. Service enhancements to the MCI and US Sprint networks would consist of, at a minimum, credit card type access authorization and improved call completion. The MCI and US Sprint network enhancements would probably grow in robustness as these networks continue to evolve. The CAPS concept is depicted in Exhibit A-17. This exhibit does not show CSI and CNS augmentations.

EXHIBIT A-17

Commercial Access and Priority Service Concept



NS/EP users would be able to access the service from any PSN end office or by off-net calling from FTS2000 and the Defense Switched Network. Users would select an interexchange carrier, or use their presubscribed carrier, and dial the 710-950-0627 access code. The call would be routed to the selected network and a prompt tone would be returned to the user. The user would respond by entering his or her personal identification number and the call destination number. The interexchange carrier would authenticate the user and complete the call using NS/EP services provided on its network. If a user could not complete the call on the first network selected, then he or she would have to go "on hook" and attempt another call using a different interexchange carrier network.

The new PSN-based approach could include a second type of access, called completion enhanced service access. Performance enhancement modules could be deployed at access tandems in the local exchange carrier networks to provide robust protection against traffic congestion on access and egress connections to the interexchange carrier networks. The performance enhancement modules would accomplish this by providing automatic selection of interexchange carrier networks and trunk queuing if calls could not reach an interexchange network on the first attempt. The modules would also have access authorization functions to restrict service access to valid NS/EP users.

With the completion enhanced service, users would dial the access code without selecting an interexchange carrier. The call would be routed to the performance enhancement module at the access tandem serving the user, and the module would return a prompt for the personal identification number and call destination number. The module would verify that the user's personal identification number is legitimate and attempt to complete the call over one of the interexchange carrier networks. If the attempt should fail because no trunks are available, the call would be held in a queue until a trunk is available, or the predetermined time interval expires. This queuing feature would provide a substantial amount of protection against traffic congestion.

Evaluation. The results of the evaluation of the new PSN-based approach using the six criteria defined in Section A.1 are shown in Exhibit A-18. The major advantages of this architecture are listed below:

- . Allows incremental implementation of service levels
- . Allows easy incorporation of new technology
- . Permits access with priority treatment from virtually any telephone

- Poses low-to-medium engineering and development, schedule, and operational risks because service is based on proven PSN technology and development is minimized.

Disadvantages of the approach include the dependency on existence of adequate backup power programs, the possibility of traffic congestion of portions of the calling path, and requirement for coordination among many PSN carriers.

The risks and costs for the new PSN-based approach are summarized in Exhibit A-19. Cost estimates were developed assuming that there are approximately 25,000 NS/EP users at 7,000 locations and the unit cost for performance enhancement modules is \$100,000. One-time switch translation costs are estimated at \$1 million to \$5 million, and priority treatment costs are estimated at \$1 million to \$3 million per year. Four options were considered that varied in the number of performance enhancement modules implemented. The first option did not include any modules. The other three options included from 50 to 250 performance enhancement modules.

EXHIBIT A-18
New PSN Technical Summary

CRITERIA	RATING	COMMENTS
Voice Band Service	Acceptable	• Supports voice, high-speed data, and video communications • Enhanced services expected from Signaling System 7 and Integrated Services Digital Network deployment in the PSN • Permits use of secure terminals
Interoperability	Very Good	• Architecture is based on PSN • Interoperates with other government and private networks • Easily accommodates alternative technologies (e.g., Commercial SATCOM Interconnectivity)
Survivability/Endurability	Acceptable	• Hundreds of points need to be targeted to eliminate capability • Emergency power plans and programs are in development
International Interface	Good	• International connectivity is an integral capability of the PSN
Nationwide Coverage	Very Good	• Permits calling with priority treatment from and to virtually any telephone (fixed or mobile)
Intra/Interagency Emergency Operations Support	Good	• Provides priority treatment with no activation needed

EXHIBIT A-19

New PSN Risk and Cost Summaries

RISK	COMMENTS
ENGINEERING AND DEVELOPMENT	Low risk without performance enhancement modules because only currently available telecommunication services are used. Low/Medium risk if performance enhancement modules are used.
SCHEDULE	Low risk without performance enhancement modules. Low/Medium risk with performance enhancement modules because of specification and development.
OPERATION	Low risk due to use of PSN dialing plan, PSN is in constant operation, all surviving assets can be used, service can gracefully accommodate more users, and service is technology independent and can evolve as the PSN evolves.

COST CATEGORY	COSTS (\$MILLIONS)			
	OPTION A	OPTION B	OPTION C	OPTION D
PRE-IMPLEMENTATION				
• INTEREXCHANGE CARRIER SERVICES	20	20	20	20
• PEM DESIGN/ENGR.	—	10	10	10
• SYSTEM MANAGEMENT	10	20	20	20
IMPLEMENTATION				
• PEMs	— (0 PEMs)	5 (50 PEMs)	10 (100 PEMs)	25 (250 PEMs)
• SWITCH TRANSLATIONS	—	1	2	5
• SYSTEM MANAGEMENT	2	3	4	7
RECURRING				
• PRIORITY TREATMENT	—	1	2	3
• NS/EP SERVICE TARIFFS*	18	18	18	18
• TRUNK TERMINATION TARIFFS	—	2	2	2
• USAGE	1	1	1	1
• SYSTEM MANAGEMENT	3	6	8	15
TOTAL COST	32 + 22/year	59 + 28/year	66 + 31/year	87 + 39/year
TOTAL COST PLUS CSI/CNS	32 + 40/year	59 + 46/year	66 + 49/year	87 + 57/year

* Includes robust non-hierarchical routing and survivable signaling.

NOTE: PEM - Performance Enhancement Module

APPENDIX B

PANEL MEMBER BIOGRAPHIES

APPENDIX B

PANEL MEMBER BIOGRAPHIES

Dr. Wesley Wentz Posvar (Panel Chair)

Dr. Posvar has served the U.S. Government in many capacities, and recently left the presidency of the University of Pittsburgh after 24 years in office. Dr. Posvar earlier served in the Air Force and attained the rank of brigadier general. He was a fighter test pilot, professor at the Air Force Academy, where he founded the political science department, and had combat service in Vietnam. Dr. Posvar is chairman of the National Advisory Council on Environmental Policy and Technology. He was founding chairman of the Federal Emergency Management Advisory Board, and serves as an advisor to the Government on foreign intelligence and on civil aviation. He has been a director of the Rand Corporation and major airlines and is a trustee of various mutual funds, public service organizations, and the Carnegie Endowment for International Peace.

Frank J. Carr

Mr. Carr served as Commissioner, Information Resources Management Service in the General Services Administration for 11 years. He was responsible for the Government's transition to the Federal Telephone System 2000 (FTS2000) service and the Washington Interagency Telecommunications System. He was also directly responsible for managing the regulatory framework within which the federal agencies handled information resources procurements. Earlier, Mr. Carr had worked for the Westinghouse Electric Corporation for 25 years. He was a visiting lecturer in operations management at the Sloan School of Management at MIT and participated in the Advanced Management Program at the Harvard Business School.

Robert R. Everett

Mr. Everett is the past President and Chief Executive Officer of the MITRE Corporation. He retired in 1986 after nearly 30 years with MITRE, 17 years of which he served as President of the corporation. He has been a member of the Defense Science Board since 1987, and was Chairman from 1988 through 1989. He is a Senior Scientist of the Air Force Scientific Advisory Board and a member of the Federal Emergency Management Agency's Advisory Board and the Strategic Defense Initiative Advisory Committee. He is also Chairman of the Federal Aviation Administration's Research, Engineering, and Development Committee and serves on the Board of Directors of Digital Equipment Corporation. In 1989, President Bush awarded Mr. Everett the National Medal of Technology for his work in computer technologies and applications.

Lieutenant General Vaughn O. Lang (U.S. Army retired)

LTG Lang has extensive experience in command, control and communications systems. While in the Army, he managed the implementation and operation of several large-scale communications and automated data processing systems. LTG Lang directed the consolidation of communication resources in Vietnam, commanded all communications personnel in the Republic of Korea for 2 years, served as Director and Senior Communications Officer on the Joint Chiefs of Staff, and managed the installation and operation of the present Worldwide Military Command and Control System involving the NATO countries. He also directed a staff responsible for providing command, control, communications, and data processing support to our defense mobilization requirements.

Edward J. Minkel

Mr. Minkel is the past Managing Director and Defense Director of the Federal Communications Commission. While at the Federal Communications Commission, he received numerous outstanding performance awards, including the first Gold Medal Award for Distinguished Service. Mr. Minkel received the Legion of Merit, the Bronze Star, and many other honors for his service in the U.S. Army during World War II and the Korean and Vietnam Wars. He retired from the Army Signal Corps as a colonel. Mr. Minkel is currently involved with the Armed Forces Communications and Electronics Association and is a board member of Family Place, a social service agency.

LIST OF ACRONYMS

CAPS	Commercial Access and Priority Service
CNS	Commercial Network Survivability
COP	Committee of Principals
CSI	Commercial SATCOM Interconnectivity
DOE	Department of Energy
FTS2000	Federal Telecommunications System 2000
HF	High Frequency
METS	Message-Based Emergency Telecommunications Service
NCS	National Communications System
NETS	Nationwide Emergency Telecommunications Service
NLP	National Level NS/EP Telecommunications Program
NS/EP	National Security and Emergency Preparedness
OMNCS	Office of the Manager, National Communications System
PSN	Public Switched Network
START	Strategic Arms Reduction Treaty
VSAT	Very Small Aperture Terminal

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