Increased Interconnection
Task Group II Report

Network Reliability Council

January 14, 1996

Terry J. Yake, Task Group Chair

Ross K. Ireland, Group Mentor

Contact: Terry J. Yake
Sprint Corporation
9350 Metcalf
Overland Park, KS 66212
913-534-5230
terry.yake@qm.sprintcorp.com

Task Group Members:

Mike Billings
GTE

Christine Butler
U S WEST Communications, Inc.

Chris Cairns
Pacific Bell

Dick Gove
Ameritech Cellular

Peter Guggina
MCI

Neale Hightower
BellSouth Mobile Data

Rick Harrison
ATIS NOF

Dennis Schnack
Sprint

Barry Lewin
Bellcore

Art Reilly
ATIS Committee T1

Clyde Miller
Nortel

Lee Wollgast
ICG Access Services,
Representing ALTS

Floyd Stuart
Hughes Communications, Inc.

Pete Shelus
AT&T

Terry J. Yake
Sprint
Task Group Leader

Ross K. Ireland
Pacific Bell
Task Group Mentor

Increased Interconnection Task Group

NRC Task Group II

Report Index

Section

Increased Interconnection
Task Group Report
Network Reliability Council
December 1, 1995

1. EXECUTIVE SUMMARY

Interconnections of service providers in the evolving Public Switched Telecommunications Network (PSTN) are increasing rapidly due to technology and competitive business factors. The responsibilities for telecommunications network integrity and reliability are integral to the continuing success of this industry. The real time two-way interoperable nature of the network requires close cooperation among all the service element providers, even while many of them are competing for the business of the same customer set. This task group was chartered to identify and propose solutions to the issues of network reliability resulting from an increasing number of interconnected service providers that make up the national telecommunications network, e.g., local service, inter-exchange service, wireless "cellular" service, satellite mobile service and competitive variations of these types. In the context of this report, reliability is defined as measures of the network's resiliency to failures, ability to restore a failed service and apply preventative fault migration techniques. The fifteen (15) participants on the task group team selected to complete this study were from companies that represent the interests of current and future service providers.

The study was limited to switched voice service networks and the reliability issues to be expected within 3-5 years. Understandably, data networking will continue to influence the composition of the network fabric and will become increasingly important as the National Information Infrastructure capability evolves. However, the more urgent nature of inter-connected voice networks was the assigned scope of the task group's efforts. Most of the processes described and the recommendations made are believed to be applicable to data networks, as well. However, this group did not focus specifically on the growing Internet-like services, e.g., e-mail, or enhanced database services that span multiple carriers. New technologies, e.g., ATM(Asynchronous Transfer Mode), are covered by Task Group III of this Network Reliability Council.

This report presents an analysis of critical network reliability issues, currently highlighted by the increasing number of service providers requiring interconnected networks that are now forming the national telecommunications network infrastructure. Recommendations are suggested to maintain or enhance network reliability (Appendix 3). Two associated issues are addressed: standards development process assessment and funding the coordination of national inter-network interoperability testing.

In the body of this report, analyses of current processes and techniques applicable to points of interconnection between networks yield recommendations to maintain and enhance reliability. Some companies are already very knowledgeable in the areas of interoperability, as a result of operational experience with their own diverse networks. Others are in the beginning stages of awareness, as they enter the telecommunications business and the maturing process is problematic. Recognizing that new service providers have a set of business priorities in front of them, issues of interconnection reliability are not considered critical at this time. However, for those companies able to sense and appreciate the multi-faceted scopes-of-work and efforts needed to achieve network interconnection and meet network reliability expectations, this report can be of value to provide a guide to suggest places to start and methods/processes to implement. Specifically, Section 5.6 provides two sets of procedural templates that may be used as "how to" guides to assist in developing reliable interconnections. The overriding recommendation is for all businesses comprising the national network of networks to get involved with each other in industry fora, in addition to one-to-one relationships necessary to interconnect.

Data were collected by an industry survey sent to manufacturers and service providers, as well as from presentations by recognized industry experts. It is important to note there was limited data from the cable TV industry to formulate a thorough understanding of the issues they will face during interconnections to the PSTN.

Throughout this report various industry documents are referenced. There was no evaluation of these documents that imply they are what has become known in the previous NRC work efforts as “Best Practices”. The definition of “Best Practices” or “Recommended Practices” as used in this report is as follows:

> The terms “Best Practices”, “recommended Practices” or “Recommendation” are those countermeasures (but not the only countermeasures) which go furthest in eliminating the root cause(s) of outages. None of the practices or recommendations are to be construed as mandatory.
>
> Service providers and equipment suppliers are strongly encouraged to study and assess the applicability of all countermeasures for implementation in their company products. It is understood that all countermeasures, including those designated as “recommended”, may not be applied universally.

1.1 GENERAL FINDINGS, CONCLUSIONS, KEY MESSAGES

The NRC survey was distributed to a large number of wireline, wireless , satellite, cable and alternate access companies. Most of the responses received came from the wireline and cellular telecommunications industries, which are more experienced at interconnection than satellite and cable TV industries at this time.

(A list of acronyms can be found in the Glossary, Section 11.2.)

1.1.2 *Wireline Carriers*

The wireline industry is mature, but it has undergone tremendous changes since the breakup of the Bell System. These carriers have had to develop processes to accommodate connections among local exchange, interexchange and cellular carriers.

The wireline industry has pioneered many of the standards for interconnection and installation/turn-up testing. The industry’s planning, testing and monitoring/surveillance systems are generally the most mature of all of the industries surveyed and can, in many cases, be used as a model by other parts of the industry.

The wireline carriers have developed a system of “firewalls” to minimize the possibility of problem propagation across network boundaries. While such systems are always being enhanced, we believe future connections at current network interconnection points can be accommodated within this framework and that radical changes to the present system are not needed.

1.1.3 *Wireless "Cellular" Carriers*

The wireless "cellular" industry generally consists of two groups of carriers. The first is the 800 MHz cellular business which is both expanding and maturing. Many wireless "cellular" carriers already operate complex regional or national voice networks. Over time, they have developed standards and testing procedures for interconnection. The importance of standards, interoperability testing --some of which are best performed on a nationally coordinated basis -- and bilateral agreements is highlighted with specific recommendations to ensure continued reliability of interconnections between wireless and other types of networks.

The second group, emerging PCS and wireless data businesses, is much less mature. While it is expected that many of the PCS carriers will adopt procedures similar to the cellular (800 MHz) industry, these carriers are only now formulating their plans and completing the design of their networks. These carriers are encouraged to participate in these standards, interoperability testing and bilateral agreement processes.

1.1.4 *Satellite*

The domestic satellite industry has matured as the provider of dedicated transmission capacity for video, voice and data services to the community of private user networks. The user community includes major television networks, cable TV operators, private Very Small Aperture Terminal (VSAT) networks carrying data/voice/video and direct to home (DTH) entertainment providers. These satellite-based services often interface with the transport segments of the PSTN, but do not provide switching as part of it and therefore are not viewed as a risk to network reliability.

This model is expected to change with the introduction of satellite-based mobile telecommunications services. There are several architectural concepts under development that differ primarily in the space segment, e.g., number of satellites, orbital planes and altitudes above the earth. A satellite-based mobile service will provide voice, data and facsimile communications through interfaces with the PSTN and cellular networks. The interface will be through a ground-based mobile switching center (MSC) that meets existing PSTN and wireless interface standards.

1.1.5 *Cable TV*

The cable companies are emerging voice telecommunications service providers. They will have the same level of responsibility as other service providers to ensure the reliability of the National network. The focus of this study was to examine the differences and similarities of cable operators to other types of service providers to determine if their needs for interconnection require special requirements. As a result of this investigation, it appears that there will be many similarities and few differences between cable companies and other wireline providers in the telecommunications environment.

The NRC Task Group on Interconnection lacked direct participation by the cable industry, even though efforts were made to encourage participation. Moreover, since the cable operators will play a large role in telecommunications in the near future, it would have been desirable for the cable networks to have been represented in this study. Contact was made with a cable industry representative to gather data. Some information was provided to the task group by the NCTA. Also, information from the non-cable companies who did respond to the questionnaire was used to help reach these conclusions, although they answered the questions from the perspective of entities who will be interconnecting with cable companies.

When reviewing the material and studying the proposed architectures for the cable companies to enter into the telecommunications service provider scenario, it became apparent that cable companies begin to look like other wireline carriers. They will be using similar technologies from the same equipment vendors and have the same requirements for interconnection to complete calls across multiple networks. For these reasons, it is recommended that the cable operators' responsibility for critical reliability issues fall under the same guidelines and requirements as other wireline network providers. To the extent they offer wireline network services, they should follow the same recommendations made to other wireline service providers.

Through interviews with knowledgeable cable industry people, we concluded that cable companies would agree with the respondents to the industry survey that service providers are primarily responsible for developing, planning and ensuring inter-network reliability and interoperability between their networks.

1.1.6 *Standards Development Process Assessment*

Telecommunications standards development in the United States is driven by the ANSI accredited democratic procedures of consensus and open participation by interested volunteer subject matter experts who submit and work issues/contributions through the process. (See note below.) No major weaknesses in the processes as they relate to network reliability issues were identified. Recommendations to further enhance the standards development process include:

- Earlier identification of standards needs
- Increased liaison with associated groups
- Developing performance requirements for complex network elements, as well as element interfaces
- Extension of existing standards groups work efforts relating to interconnection of cable television and satellite industry systems

A general concern was also expressed relative to the future role of Bellcore and its influence on industry standards. Results from the industry survey indicate a high reliance on Bellcore TRs/GRs. Since the RBOCs announced their intention to sell Bellcore, the task group noted potential concern regarding the future management of generic requirements. This subject is presented further in Section 6.

> Note: A general criticism of standards is the time it takes to develop them. For the specific interests of network reliability, standards revisions are more quickly paced and were rated as acceptable. However, as stated in the lead-in paragraph, the ANSI-accredited process is consensus based, democratic and dependent on volunteered technical contributions and volunteered industry resources to accomplish the work. The North American competitive telecommunications standards development process is viewed by other countries, e.g., Japan-TTC and European-ETSI, as positive process examples for their systems. North American standards groups maintain close working level contact with these international organizations to ensure continual improvements are applied to the standards development processes.

1.1.7 *Interoperability Testing/ Funding and Management*

The goal of the task group's work was extended beyond the specific charge to recommend an IITP (Inter-network Interoperability Test Plan) funding method. This report not only offers funding methods, but it also outlines a functional management structure that will continue present inter-network-interoperability test requirements development and stress testing and also allow evolution to address future network interconnection reliability issues.

In the NRC I Report, "Network Reliability: A Report to the Nation", dated June, 1993, the activities of the IITP were recommended "to continue on an ongoing basis." The IITP-type testing methodology and industry functional cooperation have proven to be successful in improving the nation's telecommunications network reliability. This task group reaffirms the NRC I recommendation to continue these cooperative industry relationships. The interconnection management processes should be institutionalized to permit continual evolution based on the following phased organizational approach.

Phase 1
The current process, with seven RBOCs funding Bellcore as the overall IITP coordinator and with industry-wide resource participation, should continue until a replacement system is operational.

Phase 2
The Alliance for Telecommunications Industry Solutions (ATIS) is recommended to sponsor a new, financially self-supporting, industry function to be called the IITC (Inter-network Interoperability Test Coordination). Mandatory fees for supporting the IITC function and the associated testing would be assessed to all telecommunications service providers and manufacturers who sell telecommunications services or equipment. Mandatory financial support of the IITC by service providers and equipment manufacturers is seen as beneficial to increase awareness and uphold network reliability objectives and thus improve the increasing and technologically evolving network interconnections. The task group developed a number of funding principles that resulted in an illustrative fee structure. However, an exact fee structure was impossible to determine because of the number of unknown parameters. These details are best handled by the IITC. Beyond the industry's work, the FCC should consider alternative long-term funding methods in the context of other emerging funding requirements, e.g., NANPA administration, that will surface from increased network interconnection, if the recommended methods do not provide adequate funding.

Phase 3
Once the IITC is operational, manufacturers and service providers will participate in the management and conduct of ongoing nationally coordinated interconnection testing.

2. Background

2.1. Several driving forces are at the root of this study effort: deregulation, competition and technology changes. These dynamic changes will result in increased complexity and numbers of interconnected networks which need to be considered to ensure the continued stability of the national telecommunications infrastructure. The Network Reliability Council (NRC) was chartered by the Federal Communications Commission (FCC) in 1994 to study and recommend policy changes that will ensure the continuation of the high quality of telecommunications service offered as competition and technology evolve.

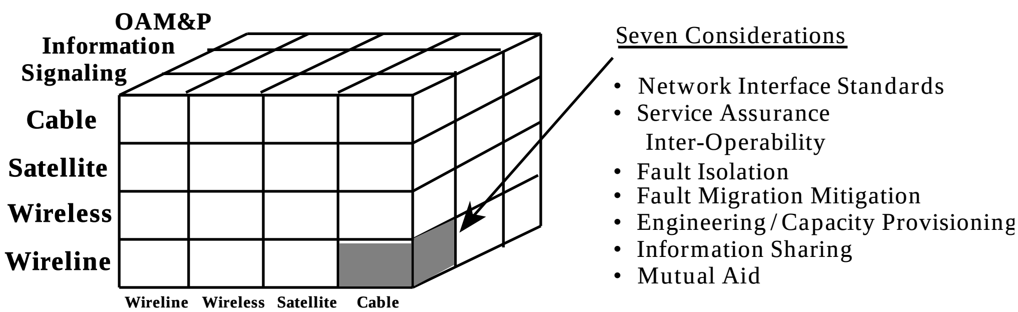
The NRC's NOREST II Steering Committee identified five areas for study. This area of focus for this report is titled "Increased Interconnection" and the group was charged by the NOREST II Issue Statement found in Appendix 5.

The detailed contributions of this report are presented in three sections:

- Section 5. Study Results by Type of Network Service Provider
- Section 6. Technical Standards Development Process Assessment, Analysis and Recommendations
- Section 7. Analysis and Recommendations for Network Interoperability Testing and Funding

The task group divided the analysis function into three basic types of interconnections where interoperability/reliability issues materialize: information channel, signaling channel, OAM&P channel, all contained in a physical channel that carries the three aforementioned logical channels. Then, the industry was segmented into wireline, wireless , satellite and cable TV providers. This defined all possible points of inter-connection and compartmentalized the work efforts into a number of subject specific boxes for study.

Chart 2.1
Work Breakdown Structure



As shown above in Chart 2.1, there were seven areas of consideration for each interconnection possibility identified in the Issue Statement charge from the NRC. Applied to the matrix shown above, that yielded 336 possible areas to study. However, many of the segments are duplicated and were combined by the task group.

The 15-member task group met each month, January to November 1995, to conduct research, analyze and identify strengths and weaknesses in the present system of managing interconnected networks. (The mission statement and milestone chart in Appendix 5 describes the work initiatives and project goals.) The intent of the report is to create a reference that critiques present processes, presents recommendations for improvement and provides new network service providers with a prescription for technical success as a reliable service provider in the national telecommunications infrastructure.

A summary of the recommendations is presented in the form of templates (see Section 5.6). In addition, sections 6 and 7 address issues of Technical Standards Development Process Adequacy and recommendations for Inter-network Interoperability Testing and Funding.

###

3. Team Membership

A team representing the present and future businesses in the telecommunications industry was selected to conduct this study. Representatives from competitive access providers, local exchange carriers, inter-exchange carriers, telecom equipment manufacturers, satellite, cable TV and certain key industry associations were asked to participate in the task group. The following list of people were the primary contributors to the task group effort.

Industry Segment	Name	Company
Satellite Carriers	Floyd Stuart*	Hughes Communications, Inc.
Wireless Carriers	Dick Gove* Neale Hightower	Ameritech Cellular BellSouth Mobile Data
Local Exchange Carriers	Christine Butler* Christine Cairns Mike Billings	U S WEST Communications, Inc. Pacific Bell GTE
Competitive Access Providers	Lee Wollgast	ICG Access Services, Representing ALTS
Inter-Exchange Carriers	Peter Guggina Dennis Schnack Pete Shelus*	MCI Sprint AT&T
Associations & Telecom Consultants	Barry Lewin* Art Reilly Rick Harrison	Bellcore ATIS Committee T1 ATIS Network Operations Forum
Equipment Manufacturers	Clyde Miller	NORTEL
Task Group Chair	Terry Yake	Sprint

Note: An asterisk indicates this team member also served as a subgroup leader.

Each of the five task groups within the NRC was assigned a mentor to help guide the group through the study effort and meet the intended goals. Ross K. Ireland from Pacific Bell was this group's champion and mentor.

###

4. DATA COLLECTION AND ANALYSIS METHODOLOGY

In order to adequately study the current and future national network reliability issues that derive from the increasing number of communications service providers, the Network Interconnectivity task group determined that it required an industry-wide view of these issues. Such a view would necessarily recognize the diverse nature of the various industry segments (e.g., traditional wireline telcos, wireless providers, cable TV companies, satellite service providers, equipment manufacturers, etc.). Accordingly, the group developed a questionnaire to survey representatives of these industry segments and solicit their opinions about the importance of various network interconnection reliability issues, the efficacy of several proposed solutions and additional suggestions for future procedures.

The remainder of this section describes the questionnaire and the process used to administer it and summarizes the response rates from the industry.

4.1 *Questionnaire Description*

The questionnaire had three parts. The first part requested background information on the responding company's role in the telecommunications industry. It included questions concerning the industry segment of the company, the size of the company and the extent of the company's participation in various industry fora. The industry segments included:

1. Cable networks
2. Satellite networks
3. Wireless networks
4. Wireline networks
5. Others (equipment manufacturers)

If a company was involved in more than one of these segments, it was asked to complete one copy of the questionnaire for each of the segments in which it was active.

The second part of the questionnaire involved an assessment of the current and future situation concerning inter-network connectivity. Included were questions concerning the criticality of inter-network connections between the responding company's network and networks of the various types listed above, the risk associated with various interface types (i.e., physical, signaling channel, user interface channel and OAM&P), reliability and performance requirements for network interconnections and methods for coordinating inter-company OAM&P.

The third part was focused on processes and practices designed to mitigate potential future interconnection problems and ensure end-to-end network reliability as more service providers interconnect and increase the complexity of national and international communications networks. The questions in this part addressed the allocation of responsibility for inter-network reliability and interoperability; the processes used to ensure such reliability and interoperability; methods such as firewalls used to protect against fault migration, intrusion on control channels and negative performance impacts; methods to be used for establishing new interconnection interfaces; and the extent of existing disaster recovery plans.

While numerous types of interconnections may be available now and in the future, the scope of the questionnaire was limited to those interconnections that result in the provision of switched voice telecommunications services. A complete copy of the questionnaire is provided in Appendix 2.

4.2. *Data Collection and Analysis Process*

The NRC designated Bellcore as the central point for requesting, collecting, compiling and aggregating data for all task groups. All data provided to Bellcore was protected under a non-disclosure agreement. The data were treated as proprietary information and specific references to individual respondents were removed during the aggregation process.

The NRC was directed to obtain a view of all segments of the industry. The NRC asked each company to identify a Single Point of Contact (SPOC). In total, 6 inter-exchange carriers, 12 local exchange carriers, 18 wireless companies (including the 10 largest), 9 cable TV companies, 9 satellite (or mobile satellite) companies and 14 manufacturers identified SPOCs. Only three (3) companies who were asked to provide a SPOC refused. Bellcore sent all data requests to the SPOC in each company. All the largest companies in the industry were asked to participate. The companies represented over 90 percent of the subscribers in each industry segment.

The questionnaires were sent to the SPOCs on April 12 (the companies that were late in identifying their SPOCs received their questionnaires within one day of receiving the necessary information). The original cutoff date for responses was April 30, 1995. However, this date was extended to July 12, 1995, to include as many responses as possible. An additional three (3) companies sent in responses after the due date and were not included. The final tally of responses was as follows:

Industry Segment	Number of Responses
Cable network	1*
Satellite network	5
Wireless network	11
Wireline network	18
Manufacturer	9
Total	44

* This response was represented as the cable industry's consensus.

The responses were aggregated and summarized in various tables and graphs on both an overall basis and by industry segment. These results were then analyzed by industry segment-specific subgroups by the Increased Interconnection Task Group. Selected results, taken from the industry questionnaire results, follow which support Section 5. The findings and recommendations appear in the following sections of the report.

The remainder of this page intentionally left blank.

Figure 4-1. Standards Bodies Participation (Chart 7)

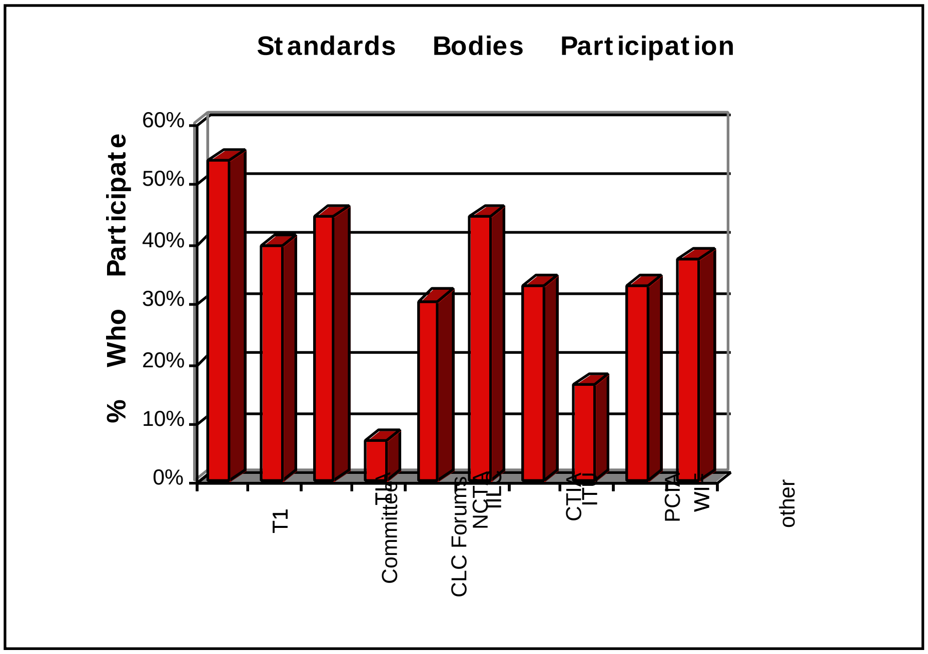


Figure 4-2. Critical Inter-network Connections (Chart 9)

Rating

3 - High
2 - Medium
1 - Low
0 - None

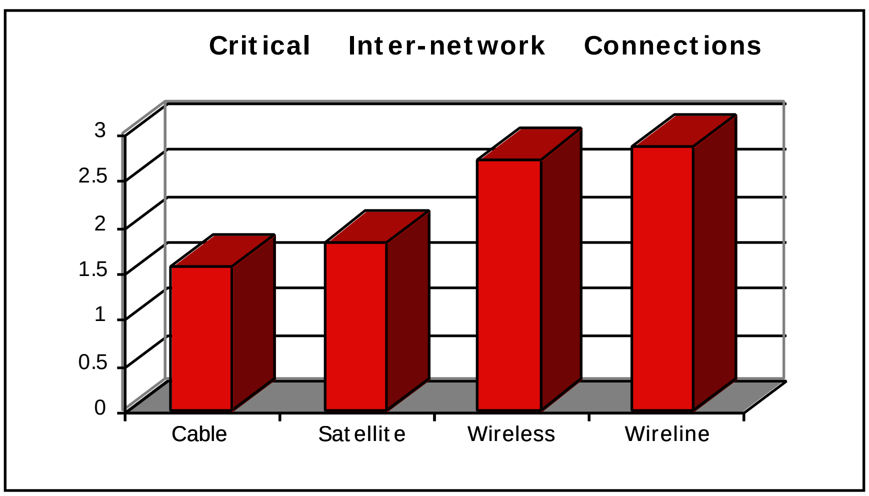


Figure 4-3. Key Interfaces That Show the Survey Results (Chart 10)

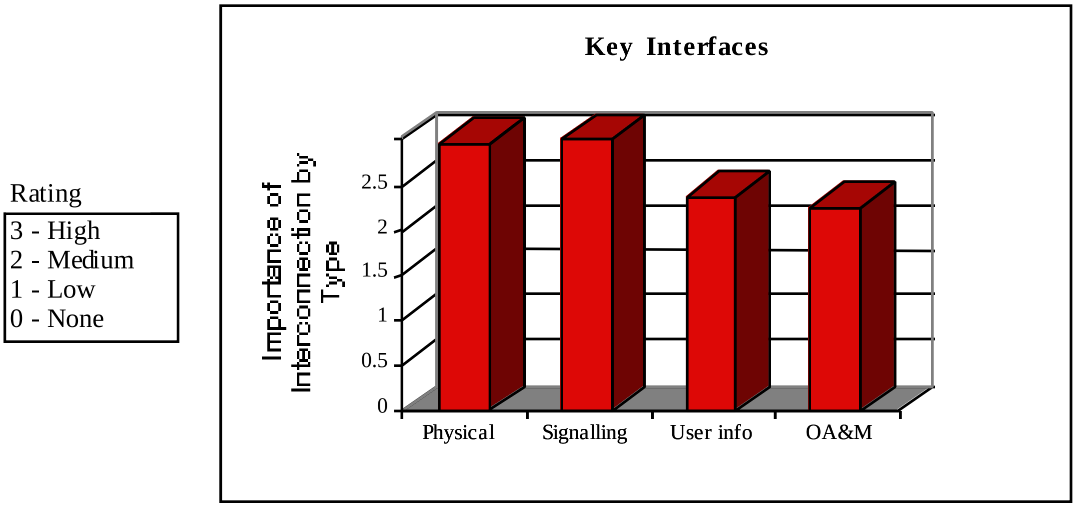


Figure 4-4. Bilateral Agreement Specifications (Chart 11d)

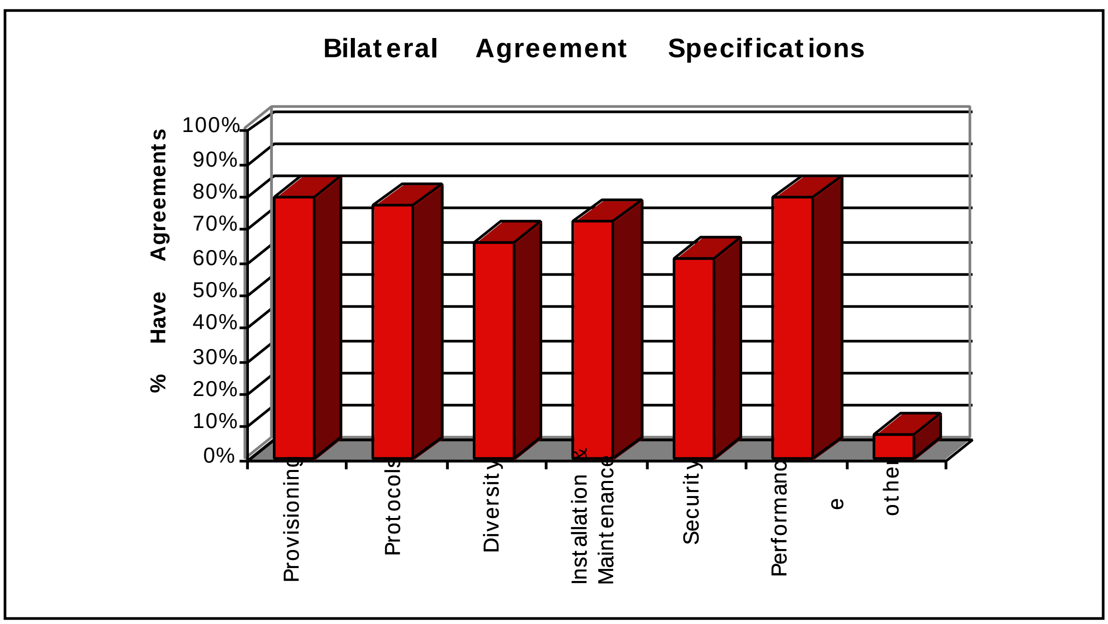


Figure 4-5. Firewalls/Safeguards (Chart 18)

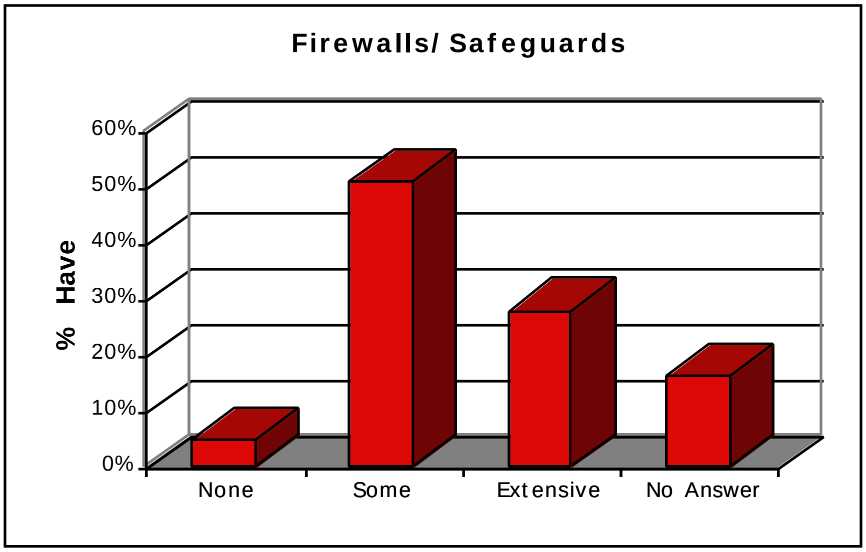


Figure 4-6. Disaster Recovery Plans (Chart 19a)

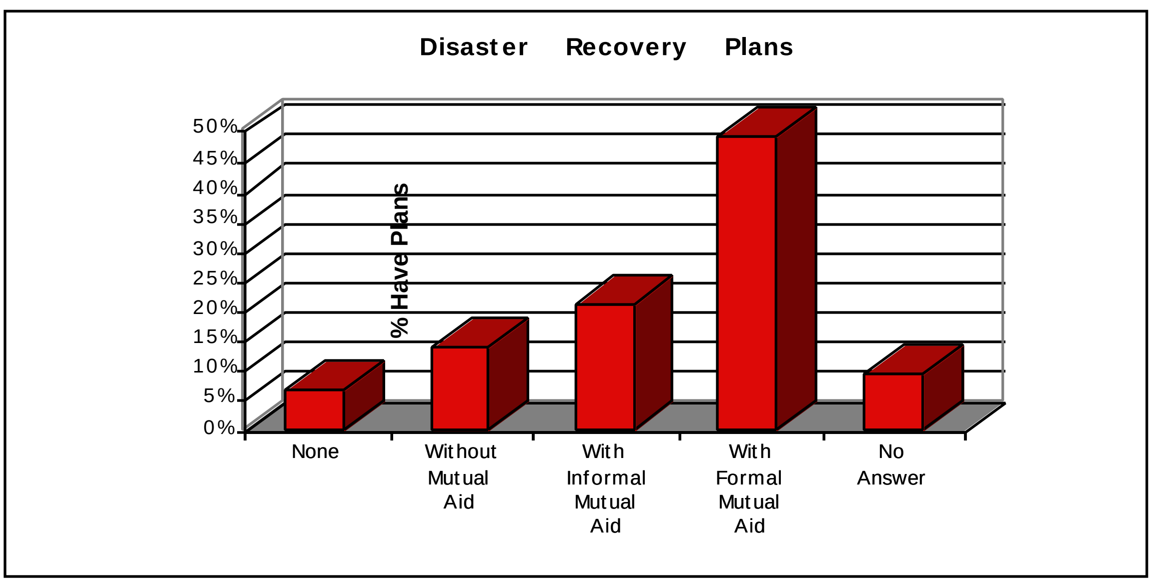
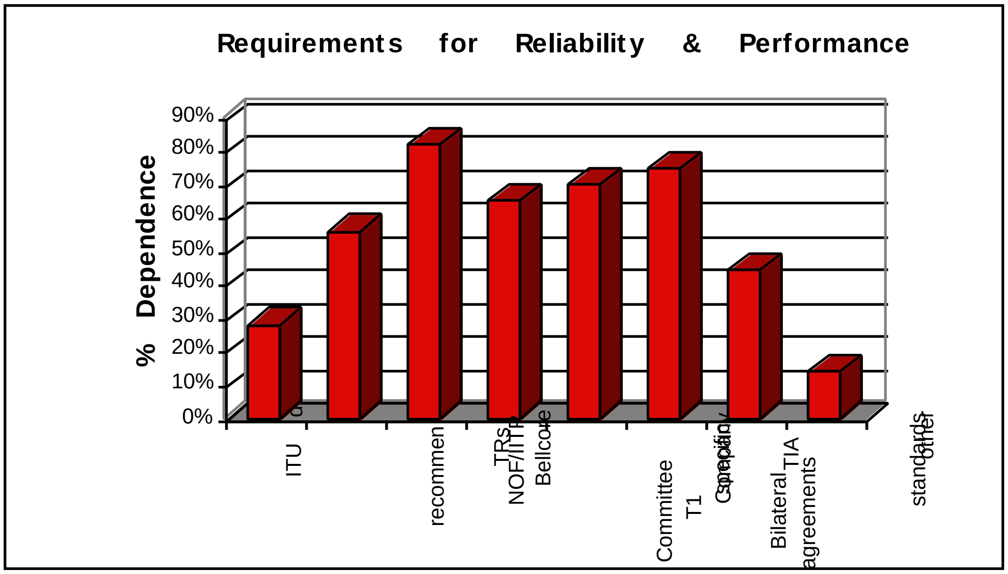


Figure 4-7. Requirements for Reliability & Performance (Chart 11a)



###

5. STUDY RESULTS BY TYPE OF NETWORK PROVIDER

5.1 WIRELINE INTERCONNECTIONS

5.1.1 *DESCRIPTION*

With the invention of the telephone came the development of Public Telephone Service (PTS), whereby a customer had a dedicated connection to a central office and could be connected to any other customer of the service. This was sometimes referred to as plain old telephone service (POTS). The traffic network that provides PTS or POTS is referred to as the Public Switched Telephone Network (PSTN). While many different technologies are employed in the provision of the PSTN, for the purpose of this report the network providers who currently provide the PSTN are referred to as wireline providers. This section of the report will examine the implications of new interconnections to the PSTN from the perspective of the wireline network providers.

The PSTN has been the basis for providing POTS for well over a century. The PSTN has enabled end user customers to communicate with others in their local areas, across the United States and throughout the world. For a transcontinental call, the PSTN consists of the following basic interconnected networks and elements:

End User----Local Exchange----Inter-Exchange----Local Exchange----End User
Equipment Carrier Carrier Carrier Equipment

The End Users are the customers who want to communicate with each other; Local Exchange refers to the companies that provide dial tone to the end users; Inter-Exchange refers to those providers that provide facilities that cross defined geographic boundaries, e.g., exchange, local access transport areas (LATAs), or state. Thus, for a typical call, at least three different wireline companies could be involved in providing service to enable a customer to originate and/or terminate calls. Traditionally, the Local Exchange element has been performed by the Local Exchange Carriers and, prior to 1984, AT&T Long Lines was the predominant Inter-Exchange provider. Today, there are over 500 Inter-Exchange providers and several companies are emerging to become Competitive Local Exchange Carriers. In the near future, a wide variety of new entities are expected to emerge to perform the functions of these basic PSTN elements, primarily in the Local Exchange portion of the network. For the purposes of this report, attention is focused on the emergence of the cable TV, satellite and wireless industries, as well as new Local Exchange Carriers, as the new players that will interconnect to the PSTN.

Much has and is still being written about the “information superhighway” and the “convergence” of computers, telecommunications and television technologies. It is beyond the scope of this report to examine all the implications of this transformation of the telecommunications industry. One prominent industry leader has stated, “When it comes to development, information technology today is in its infancy. Just like automobiles at the turn of the century, just like television in the 1940s and just like jet travel in 1950s, if we’ve learned anything from the development of those technologies, it’s that growth will be wild and chaotic and what ultimately happens will defy anyone’s prediction.”

Thus, this report will more narrowly focus on how voice services will be provided in the next 3 to 5 years as new entities interconnect to the PSTN to offer voice telecommunications services.

The emergence of these new business entities is driven by the expanding marketplace, technology and changes in regulation. With respect to the marketplace, it should be noted that local and long distance telecommunications in the United States is a $150 billion industry. Thus, it is an attractive market for new entrants. In addition, advances in technology will continue to make it easier for new entities to enter the telecommunications market. (For example, cable video operators will be able to handle POTS as well as TV programs over their facilities.) With respect to regulation, the prime drivers have been actions by the FCC to increase competition (for example, see FCC Dockets 91-141 regarding increased interconnection and Docket 91-213 regarding the restructuring of the local transport/access) and actions by the State Utility Commissions and legislatures to increase competition. In addition, legislation being considered by Congress will markedly increase the number of entrants into the PSTN marketplace.

5.1.2 *CRITICAL INTERCONNECTION POINTS*

A network interconnection is considered to be critical if messages or events, or the absence of messages or events, presented to an interface could reasonably cause a serious impairment at or beyond that interface.

For purposes of this task group report, a serious impairment is an event that meets the FCC's reportable impact criteria contained in FCC CC Docket 91-273, regardless of whether or not the service is subject to the specified reporting requirements.

Before considering the criticality of actual interconnection points, the task group examined interconnections from a wireline provider perspective. The projected potential growth in interconnections is occurring between the wireline network and the following types of networks:

- other wireline networks
- wireless networks
- cable TV networks
- satellite networks

While the general focus of the report was to look 3-5 years beyond today's network interconnections, the team hypothesized, at least for the next 1-2 years, there will not be significant growth in interconnection between the wireline and cable TV networks, or between the wireline and satellite networks, to make them critical. Further, the team hypothesized, interconnections between the current wireline network and emerging wireline network entities, such as Competitive Local Exchange Carriers (CLECs) and Alternate Local Telephone (ALTs) providers and between the wireline network and wireless entities, such as wireless "cellular" carriers and Personal Communications Systems (PCS) entities, would see strong growth within 1-2 years and thus would be critical.

The response from the questionnaire sent to the industry confirmed the team's conclusion. In addition, the response showed the industry believed that connections between cellular networks would be critical. Section 5.2 addresses wireless "cellular" connections, while the remainder of this section will be devoted to connections between the wireline network and other wireline networks and between the wireline network and cellular networks. Satellite and cable TV interconnections will be covered in detail in Sections 5.3 and 5.4 of this report. Section 12 Figure 1 describes the basic interfaces utilized in the interconnected PSTN network and shows how satellite and cable TV interconnections will be accommodated.

The second phase of the examination of criticality of interconnection points was the examination of elements common to specific interconnection points and includes:

- Physical Channels

- Signaling Channels
- User Information Channels
- OAM&P Channels
- Synchronization and Timing

The definition of these elements and a discussion of their criticality is given below.

A theme throughout the questionnaire responses and the presentations made to the team was the importance of the need to comply with existing standards to assure network reliability and interoperability. In addition, it became clear that compliance with new standards addressing interconnection points between existing wireline and emerging local service providers would be critical for continued network reliability and interoperability.

Recommendation 1. Special attention should be given to utilizing applicable existing standards and implementing new standards addressing interconnection points between existing wireline and emerging local service providers.

5.1.2.1 *PHYSICAL CHANNEL*

The physical channel is the facility that is used to carry the Signaling Channel, the User Information Channel and the OAM&P Channel, as described below. The physical channel interface is the point where two telecommunications systems/facilities interconnect. Usually, it is described by industry terms such as copper or fiber, which may be inferred from the capacity of the facility at the interface, e.g., DS-O, DS-1, DS-3, OC-12 and the like.

The physical channel interface is the best defined of all the channel interfaces. The primary importance of the physical channel is its use as an integral component in carrying user information, signaling and OAM&P messages. The team did not focus on the reliability of physical channel interfaces since standards and operational procedures are well documented. Further, physical channel reliability is already the subject of continuing industry efforts to identify root causes and improve this element's reliability. However, the responses from the questionnaire showed the industry to be still focused on the high level of risk to the physical channel. This task group did expand its project scope to address the written comments concerning network timing and synchronization, as we surmise some respondents expanded the definition of physical channel interface to raise these concerns. Network timing and synchronization, an element of the physical channel reliability, are covered in Section 5.1.2.5 of this report.

5.1.2.2 *SIGNALING CHANNEL*

For traditional telecommunications services, signaling refers to the mechanism necessary to establish a connection, monitor and supervise its status and terminate it through the transmission and switching fabric of the underlying networks. These signals are messages generated by the user or some internal network processor, pertaining to call management. Signaling interconnections transfer this information to and among remote network elements. The signaling network is the collection of physical transport facilities and network elements that carry call routing signals.

The signaling channel interface is commonly available in two varieties, in-band and out-of-band. Multi-frequency (MF) is an example of in-band signaling. SS7 is an example of out-of-band signaling. For the purposes of this report, the signaling channel interface indicates an interface interconnection of the signaling systems between two network entities.

The current trend in signaling in the wireline environment is a rapid migration away from in-band signaling to out-of-band signaling. This migration has resulted in the consolidation of signaling onto single-purpose dedicated data links. Thus, there is a greater potential risk of a signaling problem resulting in major service disruptions with out-of-band signaling than in-band signaling because of the number of call management signals that are concentrated in the data linkages. As a result, the team viewed the signaling channel interface as having the highest potential risk and therefore being the single most critical interconnection point. The responses from industry supported this conclusion.

The reliability of the signaling channel is dependent on:

a) the reliability of its physical channels and network components/applications; and,

b) the signaling network architecture.

The architecture adopted in SS7 networks requires paired deployment for all critical network components and redundancy, as well as 2 or 3-way physical diversity for the signaling links. Such an architecture greatly increases the reliability of SS7 networks. In addition, industry-wide SS7 interoperability testing (as described in Section 5.1.3.2) is routinely conducted to ensure reliability of the signaling protocol design and implementation before these protocols are installed for commercial use. This activity has significantly improved signaling network reliability.

Consideration also must be given to the reliability of the signaling message content. Specifically for SS7/C7 link signaling, the issue of how initial address messages configure the switching equipment should be reviewed and a common agreement reached by interconnecting company engineering design groups. As more interconnection opportunities develop, both domestically and internationally, service providers frequently and accurately follow the standards, only to find differing options within the standards cause end-to-end service incompatibilities. For example, SS7/C7 calls marked “voice” versus “3.1 KHz” are both acceptable but produce service incompatibilities, especially on facsimile calls.

Numerous ANSI standards, Committee T1 publications and Bellcore publications are available on various aspects of signaling. (See Section 11 - References for a listing). The Bellcore Technical Reference employed by many LECs for interconnection to their signaling networks to interexchange carriers‘ signaling networks is Bellcore GR-000905-CORE (also referred to as TR-905), entitled “Common Channel Signaling Network Interface Specification Supporting Network Interconnection (Message Transfer Part, ISDN User Part).” This document can also be applied to the interconnection of LEC signaling networks.

Recommendation 2. The task group recommends that changes in network-to-network signaling standards and requirements (e.g., standards, fora, TR-905, etc.) be reviewed by the Network Operations Forum (NOF) and considered a) for inclusion in appropriate testing procedures, and b) development of additional operational guidelines.

5.1.2.3 *USER INFORMATION CHANNEL*

The user information channel refers to the bearer or payload channel in a telecommunications network and the interconnection point between network entities. The user information channel is most visible to the end user since it is this channel that an end user's application, be it an ordinary voice call or a data transaction, is carried. The reliability of this channel is dependent upon the reliability of the physical channel described earlier and the specific application being utilized by the end user. The end user applications are, in turn, dependent upon the end user's hardware, software and other operative processes that are not part of the telecommunications network infrastructure.

Based upon the definition of "critical," the team did not feel the information channel would be a critical interface for interconnected networks. While a problem associated in this channel would affect end users and be important to them, there was little likelihood that such a problem would be spread into other interconnected networks and affect *other* users. The responses from industry tended to confirm this conclusion.

5.1.2.4 *OAM&P CHANNEL*

OAM&P is an acronym that stands for Operations, Administration, Maintenance and Provisioning. The OAM&P channel refers to the facility utilized by interconnected networks for the exchange of information regarding the management/control of interconnected networks. The reliability of the OAM&P channel is dependent on the reliability of the physical channel and the network systems applications utilizing the physical channel.

Several technical standards exist addressing OAM&P issues. For instance, ANSI OAM&P standard T1.115 addresses issues concerning diagnostics and management of the SS7 network; the Simple Network Management Protocol (SNMP) standard and Telecommunications Management Network (TMN) standard facilitate standardized implementation and information exchanges of telecommunications network management systems.

The team did not feel the OAM&P channel interface was a critical interface and the survey results agreed with this approach. However, this does not mean that this interface is unimportant. To the contrary, the importance of this interface will increase as the interactions between interconnected networks become more complex and require real time coordination.

The NOF has the responsibility for addressing various OAM&P issues. In February, 1994, the NOF reissued its Reference Document, NOF Reference Document Issue 11. The document provides industry guidelines for administrative and operational procedures involving exchange access and telecommunications network interconnection. These guidelines were developed as a minimum set of procedures to be followed by personnel in the installation and maintenance of access service. These guidelines can be used as a foundation for more specific, local procedures provided by individual companies. In addition, the NOF is currently looking at OAM&P issues involved with the interconnection between LECs operating in the same or different franchise areas. This issue has been identified as Issue 229. The resolution of this issue will address the Interconnection Testing requirements and the Installation and Maintenance guidelines for Competitive LECs that ensure an equal playing field for all interconnecting companies. Progress on this issue should be monitored for its impact on future interconnections.

5.1.2.5 *SYNCHRONIZATION AND TIMING*

In response to the questionnaire sent to industry, some companies identified network timing and synchronization as a key interface. The need for synchronization is the result of digital switching and transmission systems directly interconnected by digital facilities requiring the use of some means of synchronizing clock signals. The term synchronization refers to an arrangement for operating digital switching and transmission systems at a common (or synchronized) clock rate with proper phase alignment at the bit and byte level between the transmitter and receiver. Improperly synchronized clock rates and/or phase misalignment will cause portions of the bit streams to be lost in transmission.

Numerous documents exist regarding network synchronization. (For example, see ANSI T1.101 Digital Network Synchronization Standard and Bellcore SR-TSV-002275, entitled "BOC Notes on the LEC Networks.") Entities wishing to interconnect with the wireline network should become familiar with these industry documents. As a start, these entities should appoint a Synchronization Coordinator to assist their company in becoming familiar with this discipline (SR-TSV-002275 outlines the responsibilities for such a coordinator.) In addition, these entities should also provide the coordinator's name to the ICCF for its Synchronization Directory. This will facilitate industry coordination for planning, designing, installing, testing and administering the synchronization network.

Recommendation 3. Companies should appoint a Synchronization Coordinator who will perform the responsibilities contained in SR-TSV-002275. Companies should provide the name of their Synchronization Coordinator to the ICCF for inclusion in its Synchronization Directory.

Recommendation 4. Companies should comply with the synchronization standards addressed in ANSI Standard T1.101, entitled "Digital Network Synchronization."

5.1.2.6 *GENERIC INTERCONNECTED PSTN NETWORK*

The above sections examined interconnection from a company perspective and then from those elements common to specific interconnection points. The next level of examination employed by the team involved a look at how these common elements are actually utilized in the interconnected PSTN network.

Section 12 Figure 1, entitled "Generic Interconnected PSTN Network" diagrams a signaling network interconnection and information channel interconnection. The signaling network interconnection is based on ANSI SS7 Standards T1.110 through T1.116. Bellcore TR246 also describes signaling requirements. The database requirements are given in Bellcore TR1149 and TR954. The information channel diagram describes five basic interfaces utilized in the interconnected PSTN network. These interface type groupings depicted in Section 12 Figure 1 are:

a) An End Office* type connection to an IC

b) An Access Tandem type connection to an IC

c) A PBX type connection to an End Office*

d) A Mobile Switching Center Type connection to an Access Tandem

e) A Base Station Controller (associated with PCS) to an End Office*

*Note that an end office may belong to a LEC or to a CLEC, CAP, or a cable provider.

Items a) and b) are currently in use today for the interconnection of LECs and ICs. The primary signaling system documents that detail the protocols to facilitate these interconnections are Bellcore TR-905 and ANSI Standards T1.110 through T1.116. The primary documents that detail the physical layer network interconnection are ANSI Standards T1.101, T1.102, T1.105 and T1.107. In the future, although different entities will be involved in these interconnections, e.g., CAPS, CLECs, satellite providers and cable TV providers, these same interfaces, plus others, will be utilized for the interconnection. Likewise, the same standards and interface specifications can be used to facilitate the protocols for information transfer.

Item c) is currently in use today for the interconnection of a cellular carrier to a LEC. (In this context, it is referred to as a Type 1 interface.) The primary document that details the protocols to facilitate this interconnection is Bellcore TR-NPL-000145, entitled "Compatibility Information for Interconnection of a Cellular Service Provider and Local Exchange Carrier Network." In the future, this document and other industry specifications can be used by any entity where a PBX to end office protocol is required.

Item d) is also in use today for the interconnection of a cellular carrier to a LEC. (In this context, it is referred to as a Type 2 interface.) The primary documents that detail the protocols to facilitate this interconnection are TIA/EIA Interim Standard-93 ("IS-93"), entitled "Cellular Radio Telecommunication Ai-Di Interfaces Standard" and Bellcore TR-145. In the future, these documents and other specifications can be used for the interconnection of a wireless network to any other network employing a local switching function.

Item e) is viewed as employing protocols for signaling interconnection between the BSC and a connecting message switch. It has not been implemented in today's networks.

It is impossible to predict all the possible interconnections that will be available in the future. However, it is highly probable that the vast majority of interconnections to be accomplished in the next three to five years can be accommodated by the interfaces described within this section. In addition, there are existing documents that describe the protocols to facilitate these interconnections.

5.1.3 *AREAS OF CONCERN*

5.1.3.1 *NETWORK INTERFACE*

Respondents to the industry survey indicated they utilize multiple sources to develop requirements for reliability and performance. (See Figure 4-1 - Standards Bodies Participation, for a breakdown of the standards bodies that are utilized. Further, see Figure 4-7 - Requirements for Reliability & Performance, for a listing of the primary information sources used by the respondents.) The primary sources that were identified include:

- NOF/IITP procedures
- Bellcore TRs/GRs
- Committee T1 standards and reports
- Company-specific documents

- Bilateral agreements

The respondents determined the responsibility for development of standards should be shared by the standards bodies, industry fora, service providers and equipment manufacturers with little role for either the FCC or State Utility Commissions. This same pattern should be continued with respect to the planning for reliability standards. This view changed with respect to the responsibility for ensuring reliability standards. In this case, industry felt the primary responsibility was with service providers and equipment manufacturers. The FCC, Industry Fora, Standards Bodies and State Utility Commissions had a supportive role, but significantly less than that of the service providers and equipment manufacturers.

The team believed bilateral agreements were critical for ensuring reliable interconnections. This hypothesis was validated by the industry response. First, bilateral agreements were ranked high as a source for reliability and performance specifications. Second, the respondents indicated that all of the following need to be specified in a bilateral agreement: (See Figure 4-4 - Bilateral Agreement Specifications, for a ranking of the specifications used in bilateral agreements.)

- Provisioning information and guidelines
- Protocol implementation agreements
- Diversity requirements
- Installation and maintenance guidelines
- Security requirements
- Performance standards / service level agreements

Because of the importance of bilateral agreements, a template for potential use by interconnecting parties is included as Section 5.6 in this report.

One conclusion drawn from the analysis of the data is that carriers use a multitude of data sources for the development of their performance and operating standards. Thus, new entrants into the telecommunications industry who plan to interconnect to existing networks should participate in a wide variety of organizations to influence the development of standards. This is significant since the respondents have indicated that the existing standards process should continue to play a prominent role when establishing a new interconnection interface. Therefore, any future network interconnection interface standards (e.g., TR-905) should be developed by standards bodies and industry fora organizations.

Another interesting observation concerns the future role of Bellcore. The data indicates a high reliance by the industry on Bellcore TRs/GRs. Since the RBOCs announced their intention to sell Bellcore, the task group noted concern regarding the future of generic requirements. Bellcore responded that it plans to continue developing generic requirements, although its future business model has not been finalized. Bellcore noted the model under development takes into account the potential for a change in its ownership. The industry should continue to monitor the entire standards process to assure it continues to meet network reliability needs. The Standards process is discussed in Section 6.

Recommendation 5. Companies should monitor and if applicable, consider active participation in standards development organizations and industry fora.

Recommendation 6. Bilateral agreements should be established between interconnecting network providers in accordance with the bilateral agreement template contained in Section 5.6.

Recommendation 7. Any future network interconnection interface should be developed by standards bodies and industry fora to ensure design compatibility and interoperability.

5.1.3.2 *SERVICE ASSURANCE/INTEROPERABILITY*

Interoperability testing is a mechanism for all service providers and manufacturers to jointly develop, approve and execute test scenarios in an off-line environment that will enhance the reliability, stability and survivability of the interconnected networks.

The only industry-wide interoperability testing that occurs today is the IITP, which is concerned with interconnected SS7 based networks. Interoperability testing plans are administered by the NOF IITP Committee. The IITP guidelines and participant responsibilities are contained in the IITP Reference Document.

Interoperability testing provides the capability to ensure interconnecting networks are compatible at implementation and remain compatible for the duration of the interconnection arrangement.

The team recognized the importance of interoperability testing to the overall reliability for interconnected networks. This view was shared by industry, where the vast majority of respondents indicated they or their vendor actually had participated in IITP testing. In addition, a majority of wireline respondents indicated they had participated in IITP testing along with their vendors. Thus, IITP serves as an excellent model for an interoperability testing scheme that should be adopted for future interconnections. Some of the key elements associated with IITP are given below. It is important to note that interoperability testing does not provide an absolute guarantee that network problems associated with interconnection will be eliminated. Such a guarantee is impossible since it is impractical to test every possible situation that could occur in a real installation. Testing provides an important role in ensuring reliability, but it must be coupled with a total commitment to quality in all phases of the design and installation of the interconnected networks. Thus, quality processes must be utilized in the development of the equipment to be used in the interconnection, as well as in the development of standards and specifications (Section 6 - for additional information on the Standards Development and Compliance Process) and the actual interconnection of the networks. Thus, interoperability testing must be viewed as an important component for ensuring reliability but not as a substitute for any of the quality processes leading up to the interconnection. (See Section 7 for a discussion of a future direction for interoperability testing.)

With respect to IITP, carriers being interconnected will test to prove that compatibility and interoperability exist. In addition, many wireline carriers have a policy of testing all interconnecting networks prior to service turn-up. These carriers have developed testing suites to satisfy network integrity, compatibility and network interoperability concerns. These are applied as required. ANSI, NOF and interconnected company standards are used as the basis for testing and analysis.

An example of a testing suite for SS7 that is utilized by a wireline carrier is given in Section 12, Exhibit 8. Typically, these testing suites, along with any company specific requirements, are included in bilateral agreements between the interconnecting carriers.

In addition to nationally-coordinated industry-wide interoperability testing, respondents have indicated that they participate in various forms of bilateral testing before interconnecting.

Recommendation 8. Interoperability testing of all new/changed network interfaces having potential national PSTN reliability impacts should be performed via the IITP process to ensure continued network reliability.

5.1.3.3 *FAULT ISOLATION*

Fault isolation refers to the process that locates the source of trouble so corrective action may be taken. For interconnected networks, this process involves diagnostics isolating the service problem.

The primary method identified by industry respondents was the use of Network Control Centers that monitor the network on a 7 day a week, 24 hour, 365 day a year basis. These Centers utilize operational support systems and processes to monitor their own networks up to the network boundary between their network and any other interconnected network. The systems monitor traffic flows for any unusual patterns. In addition, the processes provide surveillance of critical network elements, such as signaling, switching and transport.

Recommendation 9. Bilateral agreements between interconnecting networks should address the issue of fault isolation. At a minimum, these agreements should address the escalation procedures to be used when a problem occurs in one network. Second, the agreement should address which company will be in charge for initiating various diagnostic procedures. Finally, the agreement should address what information will be shared between the interconnected companies.

5.1.3.4 *FAULT MIGRATION MITIGATION*

Fault migration refers to the situation where a fault originating in one system spreads across a network interconnection boundary to cause further service impairment in another system.

To prevent or mitigate such migrations, industry respondents reported on the use of several techniques. One of the techniques indicated was the use of existing standards, especially SS7 standards. Presentations made to the team by subject matter experts revealed the SS7 standards define effective “firewalls” to prevent fault migration in the signaling network. Since the signaling channel was viewed as a critical interconnection point, the adherence to the SS7 standards is a critical piece in a fault migration mitigation strategy. Also related to SS7 was the use of “gateway screening.” This technique involves examining the format of certain SS7 messages and addresses for conformance to a specified format before they are allowed to enter into an interconnected network. This technique prevents misdirected messages from causing problems in the interconnected signaling network.

Another technique identified by the respondents involved real time network surveillance. Network control centers monitor network traffic and look for any abnormalities, especially at the network boundaries. Problems detected are immediately addressed utilizing network management controls.

A third technique involves a follow-up analysis that correlates troubles across network elements and/or elements to determine root causes of problems.

In short, wireline carriers use a three-pronged approach to mitigate fault migration that includes:

- Prevention (adherence to standards, use of firewalls)
- Detection (real time network surveillance)

- Correction (use of root cause analysis).

To gauge the actual use of prevention techniques, industry was asked to report on their use of “firewalls.” Only 5 percent of the total respondents indicated they did not use any “firewalls.” Thus, an overwhelming majority of the industry is currently using some type of prevention technique as indicated in Section 4, Chart 18 - Firewalls/Safeguards.

Recommendation 10. The SS7 current "firewall" techniques should continue to be used to ensure network messaging integrity. For the future, these techniques should be used as a benchmark for "firewalls” that can be used for new technology introductions.

5.1.3.5 *ENGINEERING CAPACITY PROVISIONING*

Wireline providers have had extensive experience in dealing with the challenges of having sufficient network capacity to handle traffic from interconnected networks because of the experiences gained from the interconnection of the Local Exchange Carrier and Interexchange Carriers’ networks.

In response to the industry survey, wireline carriers indicate they use two basic elements to address capacity concerns resulting from interconnected networks. The first element involves preplanning. The parties to be interconnected provide estimates of their projected traffic for an upcoming period and the necessary facilities are provisioned. The second element involves network traffic management, surveillance and monitoring. Wireline carriers use network control centers to monitor their networks on a 7 day a week, 24 hour a day basis using trained personnel and expert systems. These centers employ call flow controls, such as, choke or call gapping, for general problems such as outages. For mass calling events, joint agreements for capacity control measures are utilized. In addition, if a problem is occurring in one network that can impact an interconnected network, the network control centers of the affected networks will be in contact regarding the nature of the problem and steps to be taken to mitigate the problem.

Certain network elements (switches, databases) are equipped with capabilities to automatically detect and control abnormally high volumes of traffic. One example of this would be for 800 call control where the 800 number database can recognize a focused overload from a switch and evoke call gapping controls to decrease the traffic volume. This prevents an overload of the database system and aids in protecting other elements of the network.

Recommendation 11. To control overflow traffic conditions from adversely affecting interconnected networks, interconnected network providers should utilize network surveillance and monitoring. In addition, companies should follow the guidelines for advanced notification of media-stimulated call-in events as outlined in Section VI of the NOF Reference Document concerning Media Stimulated Call-in Events. Further, interconnecting companies should include a contact name for inclusion in the Media Stimulated Call-in Event Contact Directory. Finally, interconnecting companies should address the control of overflow call attempt and signaling message conditions in their bilateral agreements.

5.1.3.6 *INFORMATION SHARING*

Information sharing enables all service providers and vendors/manufacturers to utilize non-competitive information uncovered by other service providers and/or vendors/manufacturers through the testing, validation/application of software, hardware, documentation and conformance to agreed-upon standards in order to:

- Minimize the possibility of major outages and service interruptions that can affect our collective customer’s service

- Maintain and improve the reliability, capacity and performance of our interconnected networks

- Meet or exceed the expectations of our “customers”

Respondents to the industry survey indicated industry forums are widely used for sharing information. This is especially true when problems have industry-wide application. The primary forum for this purpose is the NOF. The NOF has developed a Reference Document (See Section 11) that addresses information sharing. In addition, when issues are brought to the NOF for resolution, the results are shared with the industry. Finally, generic results from IITP testing are shared with the industry. When issues are uncovered that are not industry-wide concerns, the affected parties work on these issues on a one-to-one basis, usually as the result of a bilateral agreement and sometimes pursuant to a nondisclosure agreement.

Recommendation 12. Information sharing should be utilized by all network providers to minimize recurrence of service disruptions. The guidelines contained in the NOF Reference Document can be used for this purpose. Additional requirements for the timely sharing of information between interconnected companies should be addressed in bilateral agreements.

5.1.3.7 *MUTUAL AID*

One of the outage mitigation techniques utilized by the telecommunications industry is to develop mutual aid arrangements with other network entities. These arrangements may be for resource-lending and/or network-sharing. They may be formal agreements or informal arrangements. The first NRC studied this topic and in “Network Reliability: A Report to the Nation” found there is extensive inter-carrier and carrier-vendor cooperation and coordination prior to and during emergencies/disasters threatening or impairing telecommunications networks.

The team surveyed the industry use of mutual aid arrangements. The results showed widespread use of mutual aid arrangements throughout the industry as indicated in Section 4, Chart 19a - Disaster Recovery Plans (Influenced by NRC I recommendations). However, the predominant users of these arrangements were the wireline providers. This is probably attributable to the relative maturity of the wireline industry and the long standing relationships between and among the LECs and long distance carriers. As more and more entrants interconnect with the wireline network and serve significant numbers of customers, it will be necessary for these new entrants to consider the development of mutual aid arrangements. Of immediate importance should be consideration of agreements that involve National Security Emergency Preparedness (NS/EP). In addition, new entrants should, at a minimum, have a communications structure in place to be used for timely notification of affected parties in the event of disasters or emergencies. The minimum requirements for such an emergency communications structure are:

- Carriers’ Network Management/Operation Centers knowing who and how to contact one another and having pre-determined procedures for doing so

- These contact lists must be updated and published regularly

Further, a carrier experiencing a significant telecommunications service outage must be prepared to contact all relevant Network Management/Control Centers quickly to facilitate the evaluation of restoration alternatives. To enhance inter-company communications, the NOF maintains a Mutual Aid Contact Directory. New entrants should provide a contact name for this directory. The NOF has also established procedures for emergency communications to facilitate Control Center communications in the event of a catastrophic outage. New entrants should consider becoming a part of this network.

Recommendation 13. New entrants should, at a minimum, have a communications structure in place for timely notification of affected parties in the event of disasters or emergencies.

Recommendation 14. Companies should appoint and provide the name of a Mutual Aid Coordinator to the NOF for inclusion in the Mutual Aid Contact Directory which is published on a bi-annual basis.

5.2 CELLULAR "WIRELESS" INTERCONNECTIONS

Cellular is considered to part of the broader term "wireless" and currently is an extensively deployed "wireless" technology. Wireless also refers to paging services, both one-way and two-way, a variety of Specialized Mobile Radio services, and the emerging Personal Communoications Services. The bulk of the industry survey responses pertaining to wireless came from companies engaged in cellular and PCS business. Hence, the findings reflect that response. To the extent that other wireless services exhibit the same type of network interconnections as cellular and PCS, the broader use of the term "wireless" is intended to apply.

Current wireless "cellular" services are typically provided by two carriers serving an area - an "A-side" carrier and a "B-side" carrier-based radio frequency spectrum allocation. Resellers utilize the access services provided by these two carriers to further increase the distribution of services to the marketplace. This picture is changing, however, with the entrance of Specialized Mobile Radio (SMR) carriers and new Personal Communications Services (PCS) carriers, licensed to serve in a new area of frequency spectrum (~1.8 GHz).

A number of technology and regulatory initiatives are creating a significant impact on the future structure and interoperability of wireless networks. This NRC Task Group examined the potential future impacts on network reliability, integrity and standards requirements arising from these changes. Noteworthy regulatory proceedings include the following:

- FCC Notice of Proposed Rule Making (NPRM) regarding "Interconnection and Resale Obligations Pertaining to Commercial Mobile Radio Services" (CC Docket No. 94-54)

- InterLATA Wireless Waiver Order signed by Judge Greene, lifting some of the restrictions regarding the routing of traffic across LATA boundaries for RBOC-owned wireless subsidiaries

- Pending telecommunications legislation, updating the 1934 Communications Act and further opening-up the telecommunications infrastructures to foster competition and innovation.

The scope of this wireless section includes the voice technologies listed below, which generally employ SS7 and such signaling protocols as IS 41 Mobile Application Part (MAP) and GSM MAP as the signaling infrastructure.

- Cellular (AMPS, NAMPS, TDMA, CDMA)
- "PCS" upbanded TDMA and CDMA
- Global System Mobile (GSM)
- Specialized Mobile Radio (SMR)

A work activity has been identified in TIA Standards TR46 to develop interworking between dissimilar MAPs. All such inter-system signaling interfaces will be important to monitor to ensure the continued reliability of interconnected networks.

5.2.1 *DESCRIPTION AND DIAGRAM*

This section provides a high level description of cellular systems (refer to Section 12 Figure 1 and Figure 1 below). For further detail, the reader is referred to TIA - TR45 Network Reference Model (Section 12 Figure 2) and TR46 PCS Network Reference Model for 1800 MHz (Section 12 Figure 3).

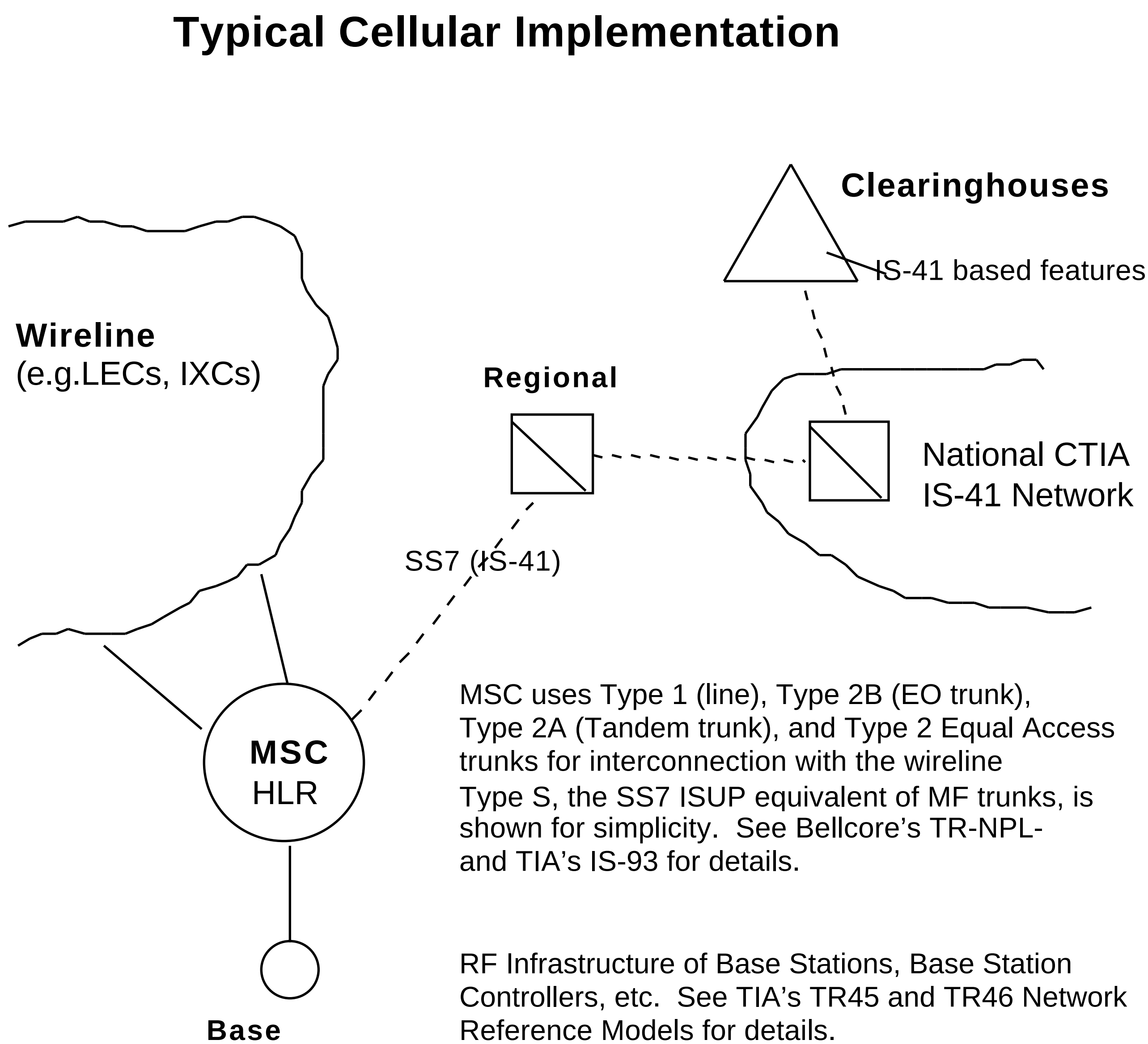


FIGURE 1

A Base Station, or Radio System per TR46 Network Reference Model in Figure 3, provides radio frequency management and other functions for cellular systems and provides radio network access to the Mobile Switching Center (MSC).

The MSC is a switching system that is connected to one of several types of interfaces: (1) a landline End Office (EO) through a line (Type 1) or trunk (Type 2B) interface, (2) a landline Access Tandem (AT) through a trunk (Type 2A or Equal Access) interface or (3) an Interexchange Carrier (IXC) through a trunk interface. These connections provide access to the wireline and other wireless networks.

The MSC may also be connected to Signaling Transfer Points (STPs), in a mated-pair configuration, for connectivity to wireline and other wireless switches for call set-up signaling. The MSC may use these same signaling links, or a separate set of signaling links, for IS-41 MAP signaling for autonomous registration, call delivery and related wireless services. These signaling links also provide connectivity between the MSC and wireless network Service Control Point databases or wireline network SCP databases.

5.2.2 *CRITICAL INTERCONNECTION POINTS*

From the NRC Survey, network interconnections between cellular carriers and between cellular and wireline carriers are deemed critical and physical and signaling interfaces are both of about equal risk when considering their criticality.

Interfaces between cellular and wireline carriers are covered in Section 5.1.2.6. This section primarily addresses signaling interfaces between wireless networks that are unique to cellular , e.g., IS-41 inter system signaling. These interfaces are not explicitly shown on the network diagrams, Section 12 Figure 1.

5.2.2.1 *PHYSICAL CHANNEL*

The physical channel is used to carry the Information Channel, Signaling Channel and OAM&P Channel described above. It is the point where two telecommunications systems/facilities interconnect. Usually, it is described by the medium (e.g., copper, fiber and microwave) and capacity (e.g., DS0, DS1, DS3, T1, T3, OC12 and the like). This study does not specifically address the reliability of physical channels; rather, the use of physical channels as an integral component in carrying user information, signaling, or OAM&P information discussed below.

5.2.2.2 *SIGNALING CHANNEL*

The reliability of the signaling channel is dependent on the reliability of the physical channel[1] (see Section 5.2.2.4) and the network component applications utilizing the physical channel. Scope includes Signaling System #7 (SS7) network interconnection for both call setup (ISDN User Part, or ISUP) and services (Mobile Application Part, or MAP).

- <u>ISUP</u> For the first decade of wireless service, cellular networks were generally interconnected using inband MF signaling. Signaling was therefore highly distributed in the sense that a single point of signaling failure could not cause a major disruption of service. The trend in call setup signaling, however, is toward utilizing out-of-band Signaling System #7 with ISUP signaling messages, which represents a consolidation of signaling onto data links and an increase in vulnerability to major service disruptions.

- <u>MAP</u> For the first decade of cellular service, suppliers generally provided mobility control and features within the Mobile Switching Center. Networking for call control (e.g., pre-call validation and call delivery) was provided by means of direct data links between networks

[1] The SS7 link, while used in support of cellular access services, is itself a wireline facility. SS7 links are deployed in pairs from the MSC for reliability in the event one link should experience an outage. Consequently, each link of an SS7 link-pair should typically be deployed in diversely routed paths, including entrance facilities.

and "clearinghouses." A major transition is currently taking place within the industry to utilize SS7 with IS-41 inter system messaging, which represents a consolidation of signaling onto data links and an increase in vulnerability to major service disruptions. With the advent of a Cellular Intelligent Network, there will be an even greater dependence on SS7 to carry information between two network components and between networks. It is envisioned that cellular subscribers will receive a wide variety of "seamless" services both in their home networks and in roaming networks.

Other summary points regarding IS-41 are as follows:

- IS-41 has been developed from specific needs of the wireless "cellular" industry
- Early applications focused on inter system hand-off and fraud control
- Currently, customer feature capabilities are being developed
- It appears that SS7 will be the primary means by which cellular operators distribute IS-41 messages both internally and externally

Interface Specifications:

- "Compatibility Information for Interconnection of a Wireless Services Provider and a Local Exchange Carrier Network" TR-NPL-000145 Issue 2, December, 1993 (edited and published by Bellcore through the combined efforts of the Wireless Interconnection Forum)

- "Cellular Radio Telecommunications Ai-Di Interfaces Standard" TIA/EIA Interim Standard-93 ("IS-93") December 1993

  TIA TR 45.2 is responsible for keeping IS-93 updated

- "Cellular Features Description" EIA/TIA IS-53 Revision A, May, 1995

- "Cellular Radio-Telecommunications Inter system Operations" EIA/TIA/IS-41 Rev. A (also, Rev. B December 1991 and PN-2991, which was approved November 17, 1995, for publication as IS-41 Rev. C).

5.2.2.3 *USER INFORMATION CHANNEL*

The reliability of the information channel is dependent on the reliability of the physical channel (see above) and end user application utilizing the physical channel. While this is important to the user, it was not considered critical by survey respondents. In reality, the end user application is a function of the end users' hardware, software and other operative processes, not telecommunications infrastructure. Further, while it may affect other networks in terms of loss, noise and delay, it is not envisioned that problems on information channels would affect interconnected networks as defined within the scope of "critical interconnection."

5.2.2.4 *OAM&P CHANNEL*

The reliability of the OAM&P channel is dependent on the reliability of the physical channel (see above) and network system applications utilizing the physical channel. Survey respondents did not identify the OAM&P channel as critical. Nevertheless, it is important that the cellular carriers work together with other types of carriers to develop "as seamless as possible" access to the PSTN. The significant differences in the air interfaces (e.g., analog or digital; - frequency, time, or code division multiple access; 800 MHz or 1.9 GHz) make it increasingly important that carriers cooperate in exchanging information via OAM&P channels. Following are additional items for consideration:

- Electronic bonding
- O-interface standard TIA TR 45.2 that would enable a centralized OAM&P platform

5.2.2.5 *SYNCHRONIZATION AND TIMING*

In response to the questionnaire sent out to industry, some companies identified network timing and synchronization as a key interface. The need for synchronization is the result of the fact that digital switching and transmission systems directly interconnected by digital facilities require some means of synchronizing clock rates. The term synchronization refers to an arrangement for operating digital switching and transmission systems at a common (or synchronized) clock rate with proper phase alignment at the bit and byte level between the transmitter and receiver. Improperly synchronized clock rates and/or phase misalignment can cause portions of the bit streams to be lost in transmission.

One source of information on architecture and requirements for synchronization is described in Section 11 of "BOC Notes on the LEC Network" SR-TSV-002275 Issue 2, April 1994.

Recommendation 1. Companies should appoint a Synchronization Coordinator for their company who will perform the responsibilities contained in SR-TSV-002275. Companies should provide the name of their Synchronization Coordinator to the ICCF for inclusion in its Synchronization Directory.

Recommendation 2. Companies should comply with the synchronization standards addressed in ANSI Standard T1.101, entitled "Digital Network Synchronization."

5.2.3 *AREAS OF CONCERN*

5.2.3.1 *NETWORK INTERFACE STANDARDS*

Survey results indicate that wireless carriers primarily use the following requirements or specifications for reliability and performance before interconnecting with other networks:

- Company-specific requirements
- Bilateral agreements
- TIA standards (see Section 7.1)
- Bellcore TRs

Of eleven (11) cellular company responses to the survey, the following were considered important to establishing processes for ensuring reliability and interoperability:

- Intra-company testing (11)
- Inter-company testing (11)
- Conformance testing (11)
- Standards & specifications (9)
- Load simulations (2)
- Stress to failure testing (2)

Examples cited in the NRC Survey by which carriers may monitor interconnections once in service include the following:

- Service monitoring (alarms) 24x7x52
- Maintenance routines
- Automated testing processes
- Traffic statistics

Network Operations Forum Reference Document Section III "Installation & Maintenance Responsibilities, SS7 Link and Trunk Installation & Maintenance Access Services" provides operational guidelines for interconnected SS7 networks.

Networks wishing to exchange signaling messages should develop interoperability agreements and undergo testing. For example, the CTIA "Seamless Roaming Implementation Guide (SRIG)" January, 1995 provides operational guidelines for exchange of IS-41 messages between cellular networks. Recommendation 3. below, addresses emerging PCS carriers.

Recommendation 3. Industry standards should be the foundation for any network interconnections. Any carrier wishing to interconnect with another carrier should mutually agree upon industry specifications. See Section 5.6 for the recommended interface specification template.

Recommendation 4. Wireless carriers should participate in, or be represented in, the standards process so that needs will be met in a timely and effective manner. Areas of particular interest to oversee include:

- *Prioritize standards work efforts*
- *Ensure standards address reliability and performance concerns*
- *Increase velocity of standards development to meet service providers' needs*
- *Improve processes to ensure overall quality within and between standards bodies*

Recommendation 5. Within the wireless "cellular" industry, many interconnection standards and processes are already in place. They should be adapted or extended, as appropriate, to accommodate the needs of new PCS carriers.

5.2.3.2 *SERVICE ASSURANCE/INTEROPERABILITY*

New and/or existing testing practices between carriers (see Section 7 for a discussion of a future direction for interoperability testing):

- <u>ISUP Interoperability Testing</u> The Network Operations Forum and the Wireless Interconnection Forum (NOF/WIF) finalized work on developing test scripts for interconnection between wireless and wireline carriers, namely
  - Message Transfer Part (MTP) Compatibility Tests
  - ISDN Signaling User Part (ISUP) Compatibility Tests

  These test scripts are published as Attachment A and B to Section III of the NOF Reference Document.

- <u>IITP Testing.</u> IITP provides network management, failure and congestion scenarios. It utilizes lab switches configured as an interconnected national testbed and tests routing functions, not features. The IITP Committee of the NOF develops and approves test scripts and configurations. Participation in the IITP Committee is open to all interested parties. The NOF IITP Reference Document describes the functions and roles for participation in IITP testing.

- <u>MAP Interoperability Testing.</u> The CTIA Advisory Group for Network Issues (AGNI) managed the testing of IS-41 Rev A between cellular carriers with dissimilar network infrastructure equipment and published a matrix for the benefit of the industry. AGNI then sponsored an Interoperability Ad Hoc Group of cellular carriers and vendors in 1995 to develop a detailed test plan for IS-41 Rev. B network interoperability. Actual testing will then be conducted based on the test plan to ensure network interoperability. This work is similar to IITP and could be extended to future releases of the IS-41 inter system messaging standard.

- System Testing. This is normally conducted by the carrier and/or vendor supplying network products. Typically, it is used in connection with first applications, acceptance testing and feature testing.

CTIA has developed a set of guidelines to assist cellular carriers in joining the nationally interconnected SS7 network for exchange of IS-41 messages. The following test procedures are taken from the "Seamless Roaming Implementation Guide (SRIG)" dated January, 1995:

- These are a standard set of acceptance tests prescribed for SS7 links. They should be executed by the SS7 Network Provider to ensure that all the facilities are ready to be placed in an operational status. Most Network Providers have automated these tests and will run them on their own schedules. If any problems are discovered during the testing, the Cellular Carrier and the SS7 Network Provider will correct those problems up to the Meet Point.

- The first test ensures that the physical facilities can support the end-to-end reliability required. These are measuring the quality of the facilities in terms of errors per time period. The cellular switch is not involved in this test, since the test signals are automatically returned (the facilities are placed in a "loop back" mode).

- The second and third tests involve the switch. The second test checks the compatibility of switch generic software against the software of the network switches. Failures in this test can usually be quickly corrected by changing software (timer) values in the cellular switch.

- The fourth test involves the interaction with at least one of every type of cellular switch active on the network before initial implementation. It ensures that unusual conditions in either the network or the cellular switches will not adversely affect other facilities. Most cellular switch manufacturers have conducted similar tests to certify their software against the standards, so failures at this test level are not common.

- This testing should be possible to complete within 10 business days and will indicate the readiness for live operation. This could also serve as the "Service Ready Date" for network operation.

The Wireless Carrier and the SS7 Network Provider may wish to perform further tests involving other market segments on the signaling network, prior to passing traffic to those segments. These are at the Wireless Carrier's discretion and are usually beyond the scope of network testing. Most switches that use generic software loads have passed such switch-to-switch tests. CTIA publishes a Switch Interoperability Matrix describing the interworking of switch pairs, and it is available upon request.

Recommendation 6. Interoperability testing by equipment suppliers and service providers should be performed prior to service turn up to ensure successful and reliable interconnections. See Section 5.6 - Templates for the recommended set of issues to be addressed in a bilateral agreement governing testing, implementation, operations coordination and related activities. Bilateral agreements governing test and turn up procedures are needed so that existing services are not interrupted when new interconnections are established. Bilateral agreements also help to ensure continuity of operations. Some issues to address in testing include:

- *Product operation and functionality*
- *Interoperability to establish operation across an interface, per standards*
- *Performance under stress and anomalies*

Recommendation 7. Some testing should be accomplished in nationally coordinated efforts so that all carriers and equipment manufacturers benefit without an undue outlay of resources and time. Cellular carriers should participate directly or through representation by an industry association(s). Some of the nationally-coordinated testing currently taking place includes:

- *IITP (SS7 ISUP)*
- *AGNI (IS-41)*

5.2.3.3 *FAULT ISOLATION*

When faults do occur, the source of trouble must be located through testing so that corrective action may be taken. Considerations include:

- Cellular networks are basically access networks, interconnecting to the wireline network for ubiquitous connectivity. These network interconnections are relatively straight-forward and well-defined. Testing must therefore be a cooperative arrangement between the cellular carrier and the wireline carriers.
- Some offices will not be staffed on a 24x7 basis and some will not be staffed at all. Therefore, operational procedures should ensure that Mean Time To Repair (MTTR) is kept to a minimum.
- Analysis tools may be needed to help synthesize and correlate network reports, activities and events as a result of increased network interconnections.
- A multiplicity of signaling protocols and software "versions" impact the complexity of the maintenance function. Continual training and upgrading of test equipment are important to maintaining high performance.

The Signaling Network Systems (SNS) Committee of the first NRC identified similar concerns and problems, which are documented in "Network Reliability: Report to the Nation." The NOF Reference Document also addresses some of these concerns.

Recommendation 8. Inter-company OAM&P processes should continue to be enhanced by the carriers so they can effectively establish and maintain service across a network interface. Key components of this recommendation include:

- *Service Providers' key role (e.g., 24x7x52 surveillance center)*
- *Qualified individual(s) to maintain an SS7 node and an SS7 network, including IS-41 and ISUP as required. (See SNS Best Practices.)*
- *Existing fora and associations' assisting role in developing guidelines and practices or use by interconnecting networks to foster network reliability*
- *Up-to-date Disaster Recovery Plan (ref. NOF Reference Document Section VI Network Management Guidelines and Contact Directory and its Appendix A Emergency SS7 Restoration)*
- *Contact information in the following Contact Directories of the NOF Reference Document Section VI Network Management Guidelines and Contact Directories*
    - *Network Management Contacts*
    - *Catastrophic SS7 Failure/Restoration Contacts*
    - *Media Stimulated Calling Event Contacts*
    - *LIDB Contacts*
    - *Mutual Aid Contacts*

5.2.3.4 *FAULT MIGRATION MITIGATION*

The best protection against fault propagation is to protect against 1) fault migration, 2) intrusion on network control channels, and 3) negative impacts to performance or call processing delay.

Selected narrative responses from the Survey, respectively:

1) Firewalls, load simulation testing, network monitoring, diversification, redundancy
2) Password access, gateway screening, alarm monitoring, secure facilities
3) Overlapping coverage, alternate call routing, alarm monitoring, periodic testing

The possibility that incorrect or corrupted messages (either unintentional or intentional) may affect a transiting or terminating network must be minimized. Example: Two cellular systems are networked via IS-41 Rev. A protocols and direct signaling links. After a database had been changed at System B, causing incorrect MSCID information to be sent, System A took excessive defensive check failures that triggered a system initialization. This resulted in total system outage for System A.

There is also a need to react to media-stimulated call-in events and network spill-over during focused overloads, which effectively look like “faults.” When these occur, resolution is required, but steps should also be taken to design networks and procedures to limit such occurrences and the impacts they may have on the network. Advanced notification of these events to interconnecting carriers is very important to effect control and mitigate the impact of these events.

Considerations include:

- Careful system design and software development
- Notification procedures prior to network software changes
- Thorough system testing and interoperability testing
- Gateway or mediation devices
- Automatic call gapping procedures to limit signaling channel overloads

The Signaling Network Systems (SNS) Committee of the first NRC identified similar concerns and problems, which are documented in “Network Reliability: Report to the Nation.” The NOF Reference Document also addresses some of these concerns. More specifically:

- Guidelines for advanced notification of media-stimulated call-in events are outlined in Section VI of the NOF Reference Document, which also contains a Media Stimulated Call-in Event Contact Directory. Interconnecting companies should consider including a contact information in this directory.

- Section III contains network security base guidelines and a CCS network logical security checklist.

5.2.3.5 *ENGINEERING CAPACITY PROVISIONING*

Most operators use manufacturer-recommended design specifications initially. After initial design, local company methods based on actual traffic experience are used.

Wireless service demand can be particularly unpredictable due to the mobile nature of end users as well as the rapid growth occurring in the industry. Competitive forces with new wireless carrier entrants will further affect the unpredictability of traffic demand.

5.2.3.6 *INFORMATION SHARING*

Industry forums are now prominently used for sharing information. Specific service agreements are frequently mentioned in the NRC Survey.

The Signaling Network Systems (SNS) Committee of the first NRC identified similar concerns and problems, which are documented in the "Network Reliability: Report to the Nation." The NOF Reference Document also addresses some of these in Section VII entitled *Information Sharing*.

5.2.3.7 *MUTUAL AID*

Wireline operators have a well-defined mutual aid process, as evidenced by survey results that show about 78 percent of carriers have formal mutual aid arrangements. Conversely, of eleven (11) survey respondents from cellular carriers, only two indicated their disaster recovery plans included formal mutual aid arrangements. Three others indicated their plans included informal mutual aid arrangements.

Competitive cellular operators often purchase equipment from different manufacturers, each with its own proprietary (internal) specifications and interfaces. For this reason, mutual aid is difficult. Mutual aid can be aligned within company ownership and between companies with equipment compatibility.

The Signaling Network Systems (SNS) Committee of the first NRC identified similar concerns and problems, which are documented in "Network Reliability: Report to the Nation." The NOF Reference Document also addresses some of these concerns.

5.3 SATELLITE INTERCONNECTIONS

5.3.1 *DESCRIPTION AND DIAGRAM*

Communications satellite services are categorized into three classes: Fixed-Satellite services (FSS), Broadcasting-Satellite services (BSS) and Mobile-Satellite services (MSS). Satellite communications networks, regardless of application, have a common architecture comprised of satellite(s), earth station(s) and a complex array of communications, data handling and processing equipment. FSS and BSS satellites are usually operated in geostationary earth orbits (GEO) designed to provide the maximum earth coverage. Earth station equipment provides Telemetry, Tracking and Commanding (TT&C) functions and communications (User Information Channels) functions for the network. (See Figure 5-2 - FSS/BSS System Interconnections)

A satellite in GEO has visibility to and from an area that can cover up to 40 percent of the earth's surface depending on antenna design; this allows simultaneous broadcast of video, voice and data to any earth station within the satellite's footprint. Earth stations must have line of sight access to a satellite to be able to communicate with it via a radio frequency (RF) link through an earth station antenna.

Domestic satellite operators, FSS providers, offer transponders for lease or sale to private business customers for dedicated video, voice and data networks. These satellite-based services often interface with the public switched telecommunications network (PSTN) through the use of commonly offered wireline services. FSS satellite networks rely on terrestrial connections (wireline, fiber, microwave, etc.) to link their earth stations with users of the network. FSS providers do not provide telephony services to the general public as part of the PSTN.

FSS satellite operators will either provide services themselves, or sell or lease capacity on their satellites to third parties for resale or value-added services. Service providers have capitalized on the unique capabilities of GEO satellites to become the primary means of programming distribution for the domestic and international television industry. Major TV networks and cable TV operators rely almost exclusively on GEO satellites for this service.

A TV network or cable operator can receive and distribute programming via multiple satellites/service providers, depending on economic preferences and technical compatibility needs. Programming or other information to be carried by the satellite is collected from many sources at an earth station for uplink: e.g., down-links from other satellites, terrestrial wireline and fiber and pre-recorded tapes, etc. Interfaces with wireline service providers are usually established through common offerings, such as T1, etc., and are specified by the service provider.

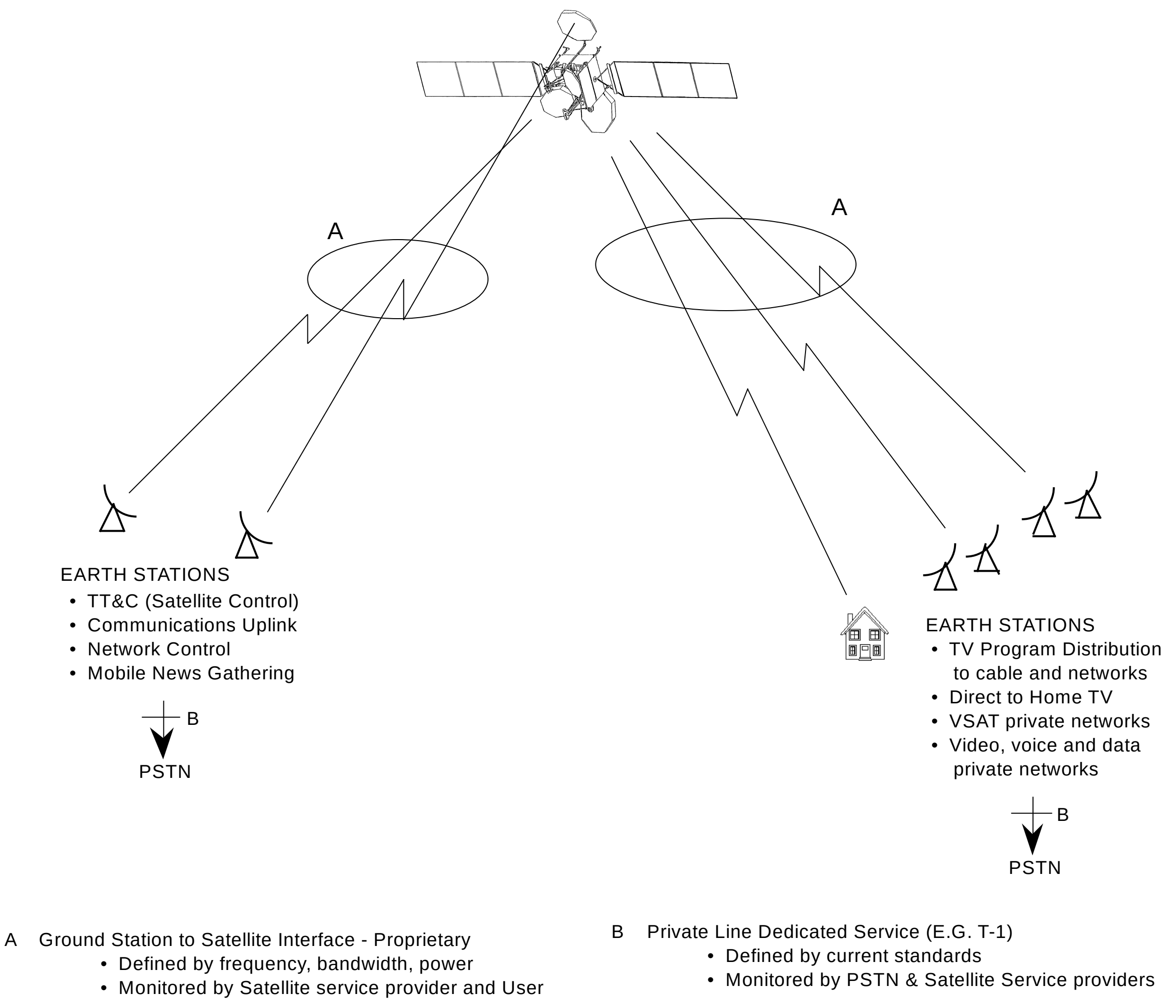
Advances in technology have allowed satellites to operate at higher frequencies and power. These capabilities can be used either to increase data rates and information content of the planned network or to reduce the size of earth station antennas. Direct to home television and dedicated business networks are two new services that have benefited from these advances.

The FCC has designated certain GEO positions and frequency spectrum as BSS and has licensed several direct to home service providers to build and operate high power satellites at these positions. BSS differs from FSS services in that signals transmitted from the satellite are intended for direct reception by the general public. Direct to home television employs a high powered satellite that can be received by a small antenna placed on the subscriber's premises. These systems offer their subscribers the choice of hundreds of program channels.

Very Small Aperture Terminal (VSAT) network is another example of BSS and Businesses have found VSAT networks to be a cost-effective means of establishing a dedicated communications capability. Data on point of sale information for inventory control and credit validation are examples of real time uses. The VSAT terminal is also capable of receiving video, which allows a corporate headquarters to broadcast new product information and pass on other vital information to all its branches simultaneously. The system provides a voice link among all the nodes as well. Video, voice and data are sent to the VSAT hub station (remote control and uplink functions) via wireline interconnections for uplink to the satellite. A hub station can be owned and operated by the company using the network or by a third party operating a shared hub providing service to multiple VSAT networks.

The remainder of this page intentionally left blank.

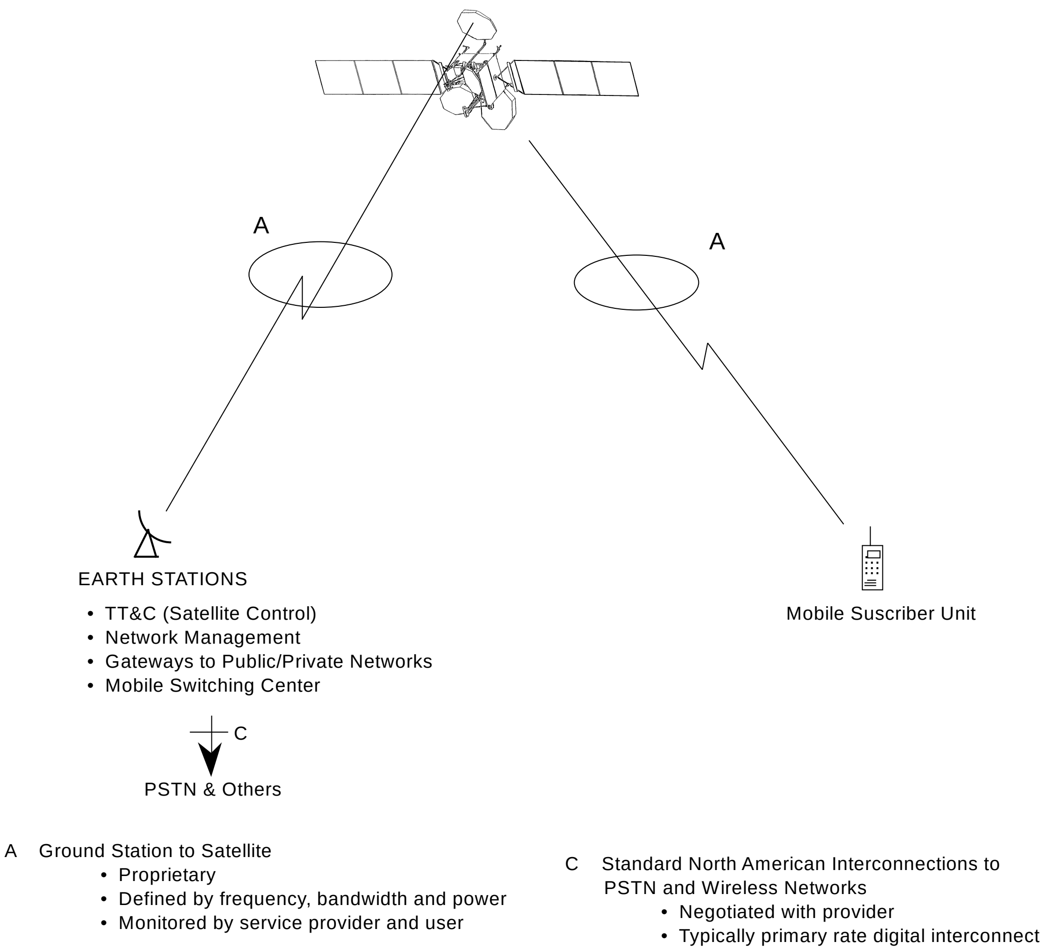
FSS/BSS SYSTEM INTERCONNECTIONS



Mobile satellite services are the newest to enter the marketplace; they will provide the equivalent of cellular telephone service to the general public. One company will begin service in late 1995, offering subscribers worldwide voice, data and facsimile communications to land, maritime and aeronautical users throughout the United States and Canada from a satellite in GEO. Several other concepts and competing systems are in various stages of development. These new system architectures employ multiple satellites in orbits below GEO (Medium (MEO) and Low Earth Orbit (LEO)) and also offer world wide connectivity either by satellite to satellite cross links or direct connectivity to existing international service providers.

MSS systems will interconnect with the PSTN and other cellular networks through earth station “gateways.” The gateways are actually hybrid cellular mobile switching centers (MSC).
MSS designs rely on existing PSTN and cellular interface specifications and equipment to interconnect with other networks. The ultimate goal is to provide the subscriber worldwide voice and data connectivity from a hand-held unit. See MSS diagram.

MSS SYSTEM INTERCONNECTIONS



Technology will continue to increase the capability of satellites and satellite-based services. Advances in computer technology have allowed the transfer of functions from earth to space, making a space-based switched network a future option. Higher frequency systems with increased data rates will provide high speed duplex links and bandwidth on demand in support of the information highway and personal communications services (PCS).

A typical satellite-based system can take from eight (8) to ten (10) years to develop and implement, therefore networks that will interface with the PSTN as we know it today, are already in development. The high up-front cost and implementation risk of a satellite-based system (launch vehicle reliability is less than 95 percent for the industry) will necessarily limit the number of new services that actually make it to market. Satellite networks offer an option for diversity to services carried on terrestrial cellular networks and the PSTN and can provide an increase in overall service reliability if terminal unit multi-modality exists.

5.3.2 *CRITICAL INTERCONNECTION POINTS*

Respondents to the Task Group II questionnaire identified interconnection to the wireline networks as most critical. This response reflects today's architectures and the dependence on wireline for end-to-end connectivity. This response is expected to change in the future with the growth of direct to home services that do not require wireline for connectivity and the introduction of satellite-based mobile services. Other responses indicated that, at this time, satellite-based networks have limited interconnection to wireless and other satellite networks and evaluated these interconnections as lower risk.

5.3.2.1 *PHYSICAL CHANNEL*

Satellite-based networks interface with the PSTN and other networks through interconnections of physical channels. These connections are described by industry terms such as copper, fiber or microwave, which imply the capacity or data rates that can be accommodated at the interface, e.g., DS-O, DS-1, DS-3, etc. The physical channel interface is well defined and standardized; satellite service providers that use these channels comply with existing specifications. Satellite respondents to the questionnaire did not single out the physical channel as a significant risk to network reliability.

5.3.2.2 *SIGNALING CHANNEL*

FSS and BSS do not utilize signaling channels of the PSTN or other networks for connectivity and therefore do not affect the reliability of this important interface. Mobile satellite networks, however, will require interfaces with the PSTN and cellular networks to provide telephone services to their subscribers. Current architectures are planning to take full advantage of existing signaling standards, i.e., SS7 and IS-41 and equipment that complies with current specifications for call management. Satellite network interfaces to the signaling channel were not considered a significant risk to PSTN reliability by respondents. This reflects the industry's confidence in existing standards and current experience.

5.3.2.3 *USER INFORMATION CHANNEL*

As with wireline and cellular networks, the user information channel of a satellite network is the most visible to the end user and therefore of great importance to the service provider. If customers are unhappy with the availability or quality of this channel, they will seek other options to satisfy their needs. Respondents assigned the least risk to the PSTN resulting from satellite network interconnections using this channel.

5.3.2.4 *OAM&P CHANNEL*

Satellite network operators and service providers responding to the questionnaire did not assign a high risk to the Operations, Administration, Maintenance and Provisioning Channel. Inter and Intra network coordination are important functions that allow smooth operations and support fault isolation and service restoral. Procedures to implement bilateral agreements are usually coordinated through this channel. Coordination will become more important and complex as the number of networks and services grow.

5.3.2.5 *SYNCHRONIZATION AND TIMING*

Some companies identified network timing and synchronization as a critical interconnection issue. Many satellite-based networks are designed to use digital technology and therefore must have a method of ensuring their networks are synchronized with interconnecting networks. The issues are not unique to type of network; wireline, wireless and cable all face the same requirements for digital systems.

The term synchronization refers to an arrangement for operating digital switching and transmission systems at a common (or synchronized) clock rate with proper phase alignment at the bit and byte level between the transmitter and receiver. Improperly synchronized clock rates and/or phase misalignment can cause portions of the bit streams to be lost in transmission.

Numerous documents exist regarding network synchronization. (For example, see ANSI T1.101 Digital Network Synchronization Standard and Bellcore TR-NPL-0002275, entitled "Notes on the BOC Intra-LATA Networks.") Service provider entities wishing to interconnect networks should become familiar with these various industry documents. As a start, these entities should appoint a Synchronization Coordinator to assist their company in becoming familiar with this area (TR-NPL-0002275 outlines the responsibilities for such a coordinator.) In addition, the coordinator's name should also be provided to the ICCF for its Synchronization Directory. This will facilitate industry coordination for planning, designing, installing, testing and administering the synchronization network.

Recommendation 1. Each company should appoint a Synchronization Coordinator who will perform the responsibilities contained in TR-NPL-0002275. Companies should provide the name of its Synchronization Coordinator to the ICCF for inclusion in its Synchronization Directory.

Recommendation 2. Companies should comply with the synchronization standards addressed in ANSI Standard T1.101, entitled "Digital Network Synchronization."

5.3.3 *AREAS OF CONCERN*

5.3.3.1 *NETWORK INTERFACE STANDARDS*

From the industry survey questionnaire, satellite service providers indicated a reliance on the following for reliability and performance requirements and standards when implementing an interconnection to other networks: bilateral agreements, Bellcore TRs and internal company specifications were identified by most as the primary sources; ITU recommendations, NOF/IITP procedures and Committee T1 were cited by fewer of the respondents. The FCC licensing role in the satellite service industry for satellite orbital positions and earth station operations was identified as an additional factor contributing to reliability and performance.

Bilateral agreements were clearly seen as a key element in defining network interfaces. The set of important issues to be included in bilateral agreements identified by satellite network respondents was similar to that identified by other type providers. Performance, provisioning, installation and maintenance and protocols were cited by most respondents; diversity and security requirements were cited by fewer respondents.

The need to monitor interconnections, once implemented, was pointed out by specific reference to procedures used by each provider. Respondents indicated reliance on several methods used to monitor their networks. Full-time automatic monitoring including alarms that identify fault conditions, reliance on user/customer notification of reduced performance and performance bench marking at service initiation with periodic testing to establish trend data.

Several comments relating to OAM&P activities were included in responses. The focus was on the potential for interference among/between satellites operating at the same frequencies and close orbital locations. The FCC has mandated that domestic service providers work together, through a process of coordination, to ensure that their services do not cause interference with other service providers operating in nearby orbital positions. The coordination process requires that designated representatives of each provider exchange information regarding future plans and changes to existing services that potentially affect services on one or the other satellites. The coordination process usually starts prior to launch using data from system testing and analysis. Satellites already in operation have priority over new systems; some problems may not be identified until both satellites are in operation, in which case an operational work-around is usually developed by the parties to resolve the issue. Examples of operational work-arounds include the establishment of a defacto requirement that all FM analog C-Band television transmissions be centered in the transponder and the requirement to notify all operators of satellites that will be passed by a satellite that is moved from one orbital position to another. In addition to inter-satellite coordination, the service provider must maintain intra-satellite coordination among it's customers to ensure interference free operation for all transponders.

Respondents indicated strong reliance on inter-company testing, existing standards and specifications, and conformance testing to ensure inter-network reliability and interoperability once an interface between networks has been established.

Several suggestions were offered for a process to establish and implement standards for a new, previously unspecified, interconnection interface. The need to start very early with the development of requirements and a standard against which simulation, manufacture and verification testing can be compared was highlighted. One respondent proposed a strategy for developing a new standard that included providing a draft to all standards bodies and service providers who would be affected by the new service. The need for a single project manager to be the process owner/champion, with full responsibility from creation to adoption, was strongly recommended.

Satellite service provider responses to the series of questions relating to the level of responsibility for developing, planning and ensuring compliance with new inter-network service standards paralleled the other industry responses. Respondents levied primary responsibility on service providers, manufacturers, standards bodies and industry fora for developing and planning new standards; governmental agencies, FCC and State Utility Commissions were seen to have less responsibility. Responsibility for ensuring inter-network reliability/interoperability was also primarily levied on service providers, manufacturers and industry fora; standards bodies were thought to have less involvement in this phase of the process, as were the FCC and State Utility Commissions.

*Recommendation 3***.** *Satellite service providers are encouraged to continue their reliance on existing standards and interface specifications, bilateral agreements and end-to-end testing to define and verify performance and reliability requirements.*

5.3.3.2 *SERVICE ASSURANCE/INTEROPERABILITY*

Respondents to the survey indicated mixed participation in existing standards bodies; no preference or industry focus was identified. Further, the satellite service providers as a group have not participated in the IITP. This most likely reflects the current level of satellite network interconnection with the public network, e.g., a wireline connection to the PSTN for transmission of video, voice and data to and from an earth station. These connections are defined service offerings and are specified by the service provider.

There is universal support for the requirement to conduct end-to-end testing when establishing a new network or bringing a new service on line. Several methods were identified, starting with system design including review of customer's service requirements, worst case analysis and detailed RF transmission path (link budget) calculations. Certification by the vendor and pre-service acceptance testing were included in the process. Verification of engineered values and operating parameters are accomplished to establish a baseline that will allow performance evaluation in the future. (See Section 7 for a discussion of a future direction for interoperability testing.)

Recommendation 4. Satellite service providers are encouraged to participate in existing standards bodies and industry fora to ensure future standards accommodate their requirements.

Recommendation 5. *The newly-formed Satellite Industry Association (SIA) should be encouraged to interface with existing standards bodies and industry fora to ensure interoperability and reliability issues are properly addressed.*

5.3.3.3 *FAULT ISOLATION*

Performance problems in a satellite network can be identified by the satellite operator, the service provider or the subscriber. The satellite operator monitors the satellite continuously and can determine if a fault is the result of a satellite sub-system problem or caused by the interconnecting ground system. If the problem is with a satellite unit the operator can switch to a redundant unit and restore service quickly. Once the satellite is ruled out, all parties must coordinate efforts to identify the network section that is causing the problem and the party responsible for restoring service. For example, an uplink earth station may have a noisy or failed high power amplifier that is introducing noise into the user information channel; once identified, the circuit can be brought down/isolated and the failed unit replaced. The usual methods of fault isolation include loop backs, swapping units, alternate routing and uplink/downlink signal comparison.

5.3.3.4 *FAULT MIGRATION MITIGATION*

Service providers were asked to identify means they employ to protect their networks against fault migration, control channel intrusion, negative impacts on performance and call processing delay. Responses varied, reflecting the different services and importance of each issue to the network. Satellite operators are concerned with intrusion and fault migration into the TT&C and network control channels as well as the user information channel.

Intrusion on network control channels is protected against in various ways, depending on specific application and type of control channel in question. For example, command and control of a satellite on orbit is protected from intrusion by frequency of the command RF link and by requiring each command to be uniquely formatted and addressed to the satellite. The earth station having command and control responsibility for the satellite can verify, through telemetry, that the desired command has been received before executing it. Some satellite operators have taken the additional step of encrypting all commands to their satellites to further protect against the possibility of intrusion. Intrusion into the command and control link of a satellite has not been a problem and has not contributed to network outages.

User information channel transmissions through a satellite are a simple reproduction of the information received (video, voice or data), either analog or digital in format. The satellite transponder will change the frequency of the received signal, amplify it and broadcast it back to earth. Once the satellite is configured to complete the desired link it will act as a “bent pipe,” a simple pass through and provide the equivalent of a dedicated wireline circuit until the user no longer requires it. If there is a fault associated with the information at the interface between a terrestrial and satellite network, it will be retransmitted.

The potential for information channel interference exists, but service providers and users are constantly monitoring the information channel and can take quick action to restore signal quality. An earth station operating at an incorrect frequency or pointed at the wrong satellite can interrupt user information channels; when this occurs, operators rely on OAM&P channels to identify and correct the problem.

Methods for protection against fault migration include installation and monitoring of upstream and downstream alarms to isolate/locate faults, diversity of interconnects, load shedding, reliance on connecting service providers and interface specifications and automated service diagnostic testing. Respondents indicated that firewalls and safeguards were part of their network protection plans; usage varied, however.

Since most networks are computer controlled through terrestrial links to earth stations, operators employ the usual methods of passwords and compartmentalization to protect those elements of the network. When links are required to or from remote sites, passwords and dial-back modems are often used for intrusion protection.

Proper performance of the satellite as a part of the end-to-end circuit, regardless of the contents of the information channel, is assured by continuous monitoring of the down link signal. This monitoring can be done by the service provider, the circuit user or both, depending on the nature of service being provided and the terms and conditions of the contract between them. Transmitting and receiving earth stations are continuously monitored to assess the status of equipment; many key units are redundant and are automatically switched in the event of a failure.

In addition to the above mentioned protections, respondents identified the following procedures and practices as significant parts of their overall network protection plans: some operators reserve the right, through contract terms and conditions, to terminate service to a customer that is causing problems in the larger network until the customer is able to restore nominal operating conditions; others cited the use of authorization codes and restricted interconnects.

5.3.3.5 *ENGINEERING CAPACITY PROVISIONING*

The satellite is usually the limiting factor in capacity provisioning for services. Size, weight and power are constrained by the capability of launch vehicles to put the satellite in orbit; in addition, frequency spectrum is allocated by the FCC and is limited. The service provider must determine if the limiting factors will allow sufficient capacity to support a profitable business. Once this determination is made the satellite service provider will work with interconnecting networks to ensure that end-to-end capacity is available.

5.3.3.6 *INFORMATION SHARING*

Satellite service providers recognize the need for information sharing and the benefits it brings to the industry. The recently formed Satellite Industry Association, an operating arm of the Satellite Broadcasting and Communications Association (SBCA), is made up of satellite owners, operators, manufacturers, launch vehicle manufacturers and service providers. It will provide a forum for information sharing and will represent the U.S. commercial industry.

5.3.3.7 *MUTUAL AID*

All respondents but one indicated they have disaster recovery plans. The responses highlighted the fact that plans are unique to the network provider and vary considerably in the formality of agreements with other providers for mutual aid and/or emergency resources. Not all providers rely on other networks for mutual aid. Responses to the question regarding frequency of review for these plans ranged from continuously to infrequently to annually.

Some providers have sufficient on-orbit resources to provide backup in the event of a catastrophic satellite failure; most satellites are designed with redundant on-board units that either switch automatically or can be commanded from the earth station to take over for a failed unit. Earth stations are also designed with considerable redundancy; most have Uninterrupted

Power Supplies (UPS) to take over in the event of loss of commercial electric power and many have completely redundant backup stations that are geographically separated from the prime site to take over in the event of a major outage.

5.4 CABLE TV INDUSTRY INTERCONNECTIONS

The cable companies are projected to be emerging players in the telecommunications industry in the near future. They will have the same level of responsibility as other service providers to ensure the reliability of the "national" network. The focus of this study was to examine the differences and similarities of cable operators to other types of service providers to determine if their needs for interconnection require special requirements. As a result of this investigation, it appears that there will be many similarities and few differences between cable companies and other wireline providers in the telecommunications environment.

The NRC Task Group II on Increased Interconnection lacked direct participation by the cable industry. Although there were no written responses to the task group's questionnaire, the views of the cable industry were represented by a member of the NCTA. Also, information from the non-cable companies who did respond to the questionnaire was used to help reach these conclusions even though they answered the questions from the perspective of entities who will be interconnecting with cable companies.

Based on a discussion with a cable industry association representative, there is currently active participation in Committee T1, CLC fora, TIA, NCTA, PCIA, ITU and, for those who have cellular interests, CTIA. There has been no past need for cable involvement in IITP because they have not been in the telephony business, nor do they have operational SS7 signaling in their own networks at this time.

In the survey results, when non-cable respondents were asked, "How critical was interconnection with the cable companies to their networks?", the wireline companies expressed a greater concern with other service providers, i.e., cellular and satellite. Manufacturers felt the cable interface was more critical than any of the service providers expressed, but they still don't view it as the most critical interface.

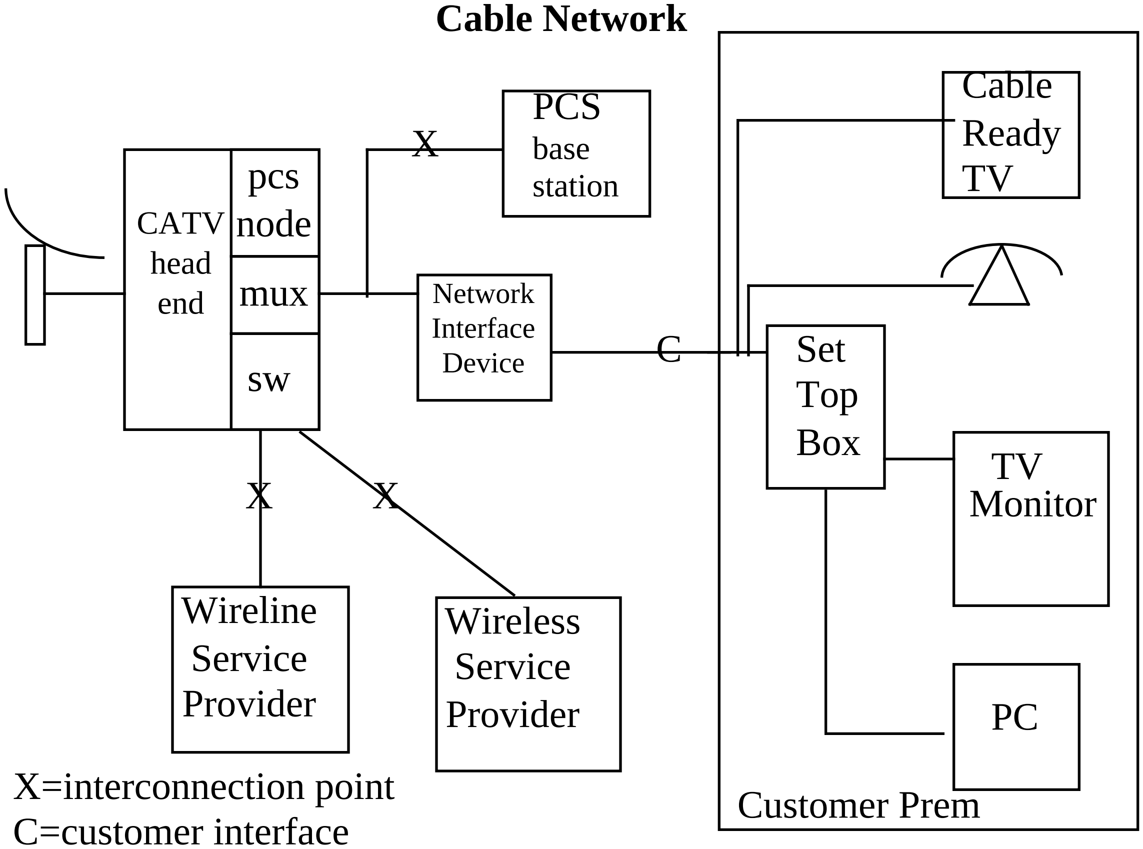
When reviewing the material and studying the proposed architectures for the cable companies to enter into the telecommunications service provider scenario, it becomes apparent that the cable companies begin to look like other wireline carriers. They will be using similar technologies from the same vendors and have the same requirements for interconnection to complete calls across multiple networks. For these reasons, it is recommended that the cable operators' responsibility for critical reliability issues fall under the same guidelines and requirements as other wireline providers. To the extent they proceed into the wireless environment, they should follow the same recommendations made to other cellular service providers.

The task group believes the cable companies would agree with the respondents to the industry survey that the service provider is the primary responsible party to develop, plan and ensure inter-network reliability and interoperability between players.

5.4.1 *DESCRIPTION AND DIAGRAM*

By the end of this decade, cable television companies are expected to represent large providers of local distribution transport and switching. Their interconnection points to the PSTN are anticipated to occur at traditional locations where existing telecommunications industry standard interfaces already exist. In addition, interconnection may occur at unbundled interconnection points currently being defined that will also be subject to technical specifications. The diagram below illustrates one possible cable network architecture:

Cable Network



5.4.2 *CRITICAL INTERCONNECTION POINTS*

5.4.2.1 *PHYSICAL CHANNEL*

The physical channel is the facility that is used to carry the Information, Signaling and OAM&P Channels. The physical channel interface is the point where two telecommunications systems/facilities physically interconnect. Usually, it is described in industry terms as copper or fiber, which may be inferred from the capacity of the facility at the interface, e.g., DS0, DS1, DS3, T1, T3, OC12 and the like.

One cable contact indicated that a problem in the physical interface was more likely to affect a large number of customers than some of the other interfaces.

Recommendation 1. Appropriate safeguards or firewalls should be implemented so problems from one network are not spread to another. Additionally, the creation of new network elements used to support the physical channel should meet present loop performance requirements.

5.4.2.2 ***SIGNALING CHANNEL***
and
5.4.2.3 ***USER INFORMATION CHANNEL***

The signaling channel was not viewed as the most critical inter-network interface by cable companies, mainly because they do not use SS7 signaling in their networks today. To the extent they begin building their own SS7 networks or begin building dependence on someone else's SS7 signaling in their networks, these interfaces will require compliance to industry standards as well as bilateral agreements to establish interoperability.

Cable companies are expected to require interconnections at traditional points in the PSTN where the technical issues have already been identified and have been resolved through industry standards and operations policies.

A possible interconnection problem can develop for the information channel interconnection in the form of fault migration. Because of the industry requirements for two-way transmission performance and because this interface is not being rigidly monitored, there should be special attention applied to loss, noise and transport delay design issues:

Recommendation: 2. Cable telephony providers should comply with generally accepted industry standards and processes when connecting to the PSTN, as described in the wireline section of this report.

5.4.2.4 ***OAM&P CHANNEL***

The OAM&P channel was described by one representative from the cable industry as the most risky interface. According to this source, although the user interface is the cause of most difficulties, the entire user base can be affected by a problem in the OAM&P environment. This is an area of concern with the existing cable providers. Development is needed to define OAM&P processes in this arena.

Recommendation 3. When interconnection begins between cable networks and the PSTN, appropriate safeguards should be developed to avoid propogation of OAM&P problems into each other's network. Information sharing is essential.

5.4.2.5 ***SYNCHRONIZATION AND TIMING***

In response to the questionnaire sent out to the industry, some non-cable companies identified network timing and synchronization as a key interface. The need for synchronization is the result of digital switching and transmission systems directly interconnected by digital facilities requiring some means of synchronizing clock signals. The term synchronization refers to an arrangement for operating digital switching and transmission systems at a common (or synchronized) clock rate with proper phase alignment at the bit and bite level between the transmitter and receiver. Improperly synchronized clock rates and /or phase misalignment can cause portions of the bit stream to be lost in transmission.

Numerous documents exist regarding network synchronization. (For example, see ANSI T1.101, Digital Network Synchronization Standard and Bellcore TR-NPL-002275, entitled "Notes on the BOC IntraLATA Networks.") Entities wishing to interconnect with the wireline network should become familiar with these various industry documents.

Recommendation 4. Cable companies should appoint a Synchronization Coordinator for their company who will perform the responsibilities contained in TR-NPL-002275. Cable companies should provide the name of their Synchronization Coordinator to the ICCF for inclusion in its Synchronization Directory.

Recommendation 5. Cable companies should comply with the synchronization standards addressed in the ANSI Digital Network Synchronization Standard.

5.4.3 AREAS OF CONCERN

5.4.3.1 *NETWORK INTERFACE STANDARDS*
and
5.4.3.2 *SERVICE ASSURANCE/ INTER-OPERABILITY*

In general, cable companies have little experience in interconnecting with other telecommunications networks. In the past they had no need to interconnect because their transmission of information was one way to the customer and their networks were independent of others. A problem in one cable system did not spread into other systems. As cable companies enter into the telecommunications world and begin to interconnect with other networks and carry two-way communications, however, they will face new requirements, standards and industry processes to ensure compatibility across networks. (See Section 7 for a discussion of a future direction for interoperability testing.)

5.4.3.3 *FAULT ISOLATION*
and
5.4.3.4 *FAULT MIGRATION MITIGATION*

With present cable network design, fault isolation and fault migration mitigation are not issues for the cable industry. However, as they enter the telecommunications business, procedures for handling fault isolation and fault migration mitigation will be necessary. The potential of service impairment spreading to other service providers' networks becomes critical and must be addressed.

5.4.3.5 *ENGINEERING CAPACITY PROVISIONING*

The views of the cable industry did not identify capacity issues as a critical concern. However, when cable network interconnection with the PSTN occurs, engineering capacity issues will need to be addressed. Cable providers' networks in this form of interconnection will resemble wireline provider exchange networks. As described in Section 5.1.3.5, the task group recommends that cable providers should be expected to adopt two basic elements to address capacity concerns resulting from interconnected networks. The first element involves preplanning. The parties to be interconnected provide estimates of their projected traffic for a future period and the necessary facilities are secured. The second element involves network surveillance and management. The task group recommends cable providers use network control systems to monitor their networks on a 7-day-per-week, 24-hour-per-day basis using a combination of trained personnel and performance monitoring systems. These network management locations have the capabilities to implement traffic flow control measures to choke traffic and/or perform call gapping to minimize the overall network impact of outages and network stress conditions. In addition, the network management locations should be part of a nationwide inter-network team, capable of responding to local, regional and national stress conditions to cooperatively mitigate traffic stress conditions when they occur.

Recommendation 6. To keep overflow traffic conditions from adversely affecting interconnected networks, interconnected network providers should utilize network surveillance and monitoring.

In addition, companies should follow the guidelines for advanced notification of media-stimulated call-in events as outlined in Section 6 of the NOF Reference Document concerning Media Stimulated Call-in Events. Further, interconnecting companies should include a contact name for inclusion in the Media Stimulated Call-in Event Contact Directory. Finally, interconnecting companies should address the control of overflow conditions in their bilateral agreements.

5.4.3.6 *INFORMATION SHARING*

As a service provider in the telecommunications industry, the cable companies would be expected to participate in industry fora and share information in the form of contributions to help preserve the integrity of the "national" network. They would also be encouraged to participate in the IITP and other industry testing activities and testbeds.

5.4.3.7 *MUTUAL AID*

From the data gathered, it appears the cable companies already have limited mutual aid agreements, both formal and informal, within their own industry. To ensure service continuity in the case of a disaster or major outage, they will need to develop new agreements with other telecommunication providers as well.

Recommendation 7. Cable companies need to participate in industry fora such as ICCF and NOF and should appoint a mutual aid coordinator to be included in the "NOF" mutual aid contact directory. Engineering practices need to reflect the fact that they are interconnecting with other service providers and that overload conditions on their network can affect those to which they are interconnected.

5.5 STUDY CONCLUSIONS

5.5.1 *WIRELINE*

The wireline carriers represent a mature industry that has undergone tremendous changes since the breakup of the Bell System. The wireline carriers have developed processes to accommodate connections of local exchange carriers to interexchange carriers and of wireless "cellular" carriers to both local and interexchange carriers that can serve as the basis for interconnections that should occur in the next 3 to 5 years. These processes encompass the following basic elements: Standards and Specifications Development, Intra-Company Testing and Inter-Company Testing.

Similarly, the wireline carriers have developed a basic process to maintain the reliability of interconnected networks that consists of planning, testing and ongoing monitoring and surveillance.

In addition, there is evidence of the use of "firewalls" by the wireline carriers to minimize the possibility of a problem in one network causing a problem in an interconnected network(s). The process to be followed to develop a new interface should include the use of industry fora and, as appropriate, the use of standards bodies.

Existing processes will need to evolve to accommodate future interconnections. A key to successful evolution is the continuation of overall industry cooperation and willingness to participate in industry fora and committees. However, radical changes do not appear to be needed.

5.5.2 *WIRELESS "CELLULAR"*

The existing cellular carriers have experienced substantial growth and technology change while maturing as an increasingly significant part of the telecommunications industry infrastructure. Cellular and wireline carriers have identified and established standards and interfaces necessary for reliable line, trunk and signaling interconnections. Where necessary, new standards and processes were developed to meet industry-specific needs, especially in the case of inter system signaling to support seamless roaming operations.

Interoperability testing processes have been established to ensure reliable signaling interconnections and interoperability testing is becoming important. Industry associations have been tasked to coordinate some aspects of this testing on a national basis and thus speed new features to the marketplace.

Bilateral roaming agreements between carriers wishing to offer seamless services by exchanging signaling messages have become common practice. These agreements specify technical, operational and administrative practices and procedures across physical and logical interfaces. These bilateral agreements will be increasingly useful as cellular carriers begin interfacing with wireline carriers for the exchange of SS7 call setup messages.

As the cellular industry segment continues to evolve, these processes (standards, interoperability testing and bilateral agreements) should be utilized and enhanced. The emerging PCS carriers and other new wireless service providers are also encouraged to embrace these as well as developing whatever standards, testing and administrative processes may be required to support their technology and business specific needs.

5.5.3 *SATELLITE*

The domestic satellite industry has matured as the provider of dedicated transmission capacity for video, voice and data services to the community of private user networks. The unique attributes of a satellite in GEO have offered cost-effective and highly reliable means of providing these services. The user community includes major television networks, cable TV operators, private business VSAT networks and direct to home entertainment providers. These satellite service providers/customers are users of the PSTN but are not "interconnected" to provide switched telephony services. Responses to the industry questionnaire from all network types, wireline, cellular , etc., support the position that interconnections with satellite networks do not present an increased risk to PSTN reliability.

Evolution of satellite-based mobile telecommunications and the introduction of high data rate services will increase the number and complexity of interconnections with the PSTN and will require continued vigilance on the part of the connecting parties to ensure reliability is not degraded with the addition of new services. Satellite service providers have traditionally relied on existing interface specifications, e.g., Bellcore TRs, bilateral agreements and end-to-end testing to ensure reliable performance. Respondents to the questionnaire indicated this practice will continue.

5.5.4 *CABLE*

The cable companies will emerge to become network providers in the voice telecommunications industry in the near future. They will have the same level of responsibility as other service providers to ensure the reliability of the "national" network.

When reviewing the material and studying the proposed architectures for the cable companies to begin offering voice telecommunications services, it becomes apparent they begin to look like other wireline carriers. They will be using similar technologies from the same vendors and have the same requirements for interconnection to complete calls across multiple networks. For these reasons, it is recommended that the cable operators' responsibilities for critical reliability issues fall under the same guidelines and requirements as other wireline providers. To the extent they expand into the wireless environment, they should follow the same recommendations made to other cellular service providers.

5.6 TEMPLATES

Many of the recommendations contained in this report are directed toward developing standards, defining and approving industry specifications and actually interconnecting different service provider networks. Two templates are offered in this section that summarize and list activities to accomplish these goals. The first, titled "Network Interconnection Bilateral Agreement Template," is for use whenever two service providers are implementing a specification and will actually interconnect their networks. The second is titled "Network Interface Specification Template" and is proposed for use in developing standards and in defining and approving industry interconnection specifications. When used in standards, it is expected that some of the items may have options or ranges, but the important point is that a standard not be developed without consciously addressing the entire list. When used by industry fora to define and approve detailed interconnection specifications, the possible options would be narrowed to ensure reliability and network integrity of the specific interconnection type.

Custodial responsibilities are indicated on each template page to define ongoing ownership, although other industry groups may want to adopt them also.

5.6.1 *NETWORK INTERCONNECTION BILATERAL AGREEMENT TEMPLATE*

The following worksheet should be used during the joint planning sessions between interconnecting service providers. This is an outline of the minimum set of topics that need to be addressed in bilateral agreements for critical interconnections. These worksheets should be used as follows:

- The types of interconnections to be established are agreed upon.
- Each Service Provider develops a version of this worksheet for each interconnection type.
- Specific references, including citations, relating to industry documentation, standards and references are identified.
- Individual company practices, policies and procedures are also identified and provided to the other party.
- All significant differences in practices, policies or procedures should be reviewed and resolved in joint planning sessions. Changes in individual practices, policies or procedures may or may not be required. Procedural symmetry is not required if differing policies produce a compatible, agreed-to outcome.

The Network Operations Forum is the recommended custodian of this template. Other organizations may also find the processes that evolve from this template useful and are encouraged to make use of and enhance it.

RELIABILITY CRITERIA	CHECK OFF
Interconnection Provisioning information and guidelines	
- Tariff Identification	
- NOF References	
- Interface Specifications	
- Network Design	
- Service Interworking Requirements	
SS7 and Other Critical Interface Inter-network Compatibility Testing	
- Service Protocols / Message Sets	
- Testing Plans	
- CCS Interconnection Questionnaires	
Protocol implementation Agreements	
- Timer Values	
- Route set congestion messages	
- Optional Parameters	
- Switch parameters	
- TR246, T1.114, T1.116, GR 317, GR 394	
- Gateway screening	
Diversity Requirements	
- Route identifications	
- Diversity definition	
- SS7 Diversity Verification and Validation	
- Committee T1 Report No. 24 on Network Survivability Performance	
Installation, provisioning, maintenance guidelines and responsibilities	
- NOF Reference Document	
Network Admin / Ops Security requirements	
- Access methodology	
- Functional partitioning	
- Applicable tariffs on confidential information	
- Password and encryption control	
Performance service level agreements	
- Interface specifications	

- MTBF / MTTR - Contact / Escalation procedures - Performance Thresholds	
Specific versions of protocol and / or interface specifications	
- Network interface standards, version control, mandatory and optional categorizations	
Maintenance procedures, including trouble and status reporting, etc.	
- NOF Reference Document	
- Contact lists	
Inter-network trouble resolution and escalation procedures	
- NOF Reference Document	
- Contact lists	
In-depth root cause analysis of significant failures	
- Failure analysis procedures	
- FCC Outage Reporting Criteria	
- Service configuration	
- Protocol tests	
- Compatibility testing	
Network Traffic Management	
- NOF Reference Document, Section VI	
Synchronization Design and Company-wide coordination contacts	
- Establish conformance	
- Identify contacts	
- T1.101 Digital Facility Standard	
- BOC Notes on the LEC Network, SR-TSY-002275	
Performance Requirements	
- Interface Specifications	
Information sharing for analysis and problem identification	
- NOF Reference Document	
Network Rearrangement Management	
- NOF Reference Document - notification procedures	

Traffic engineering design criteria and capacity management	
- Alternate routing designs	
- Call Blocking criteria	
Mutual Aid agreements	
- NOF Reference Document	
- National Security / Emergency Preparedness	
Emergency Communications plan	
- Emergency Preparedness and Response Program	
- NOF Reference Document - Emergency Communications	
- Equipment Supplier participation	
Equipment manufacturer responsibilities	
- Written requirements	
- Software validation	
- Optional requirements	
- Testing	
- Emergency equipment availability	
RELATED ISSUES	
Explicit forecasting information	
- Direct traffic	
- Subtending / transiting traffic	
Network transition	
- growth / consolidation of network elements	
- NPA splits	
- Major rehoming, rearrangement plans	
- NOF Reference Document	
Routing and screening administration	
- Network call routing administration and management	
Responsibility assignments	
- Facility assignment	
- Network control	
- Automatic testing	
Calling Party Number Privacy management	
Tones and Announcements for unsuccessful call attempts	

- Network interface specification	
- NOF Reference Document	
Billing Records Data Exchange	
- EMR standards	
- Ordering and Billing Forum documentation	
Pre-cutover Inter-network Connectivity testing	
- Network Interface specification	
- NOF Reference Document	
Documentation Requirements	
- Network configuration	
- Contact numbers	
- Service Level Agreements	
- Implementation plan / milestones	
- Interoperability test results	

###

5.6.2 *NETWORK INTERFACE SPECIFICATION TEMPLATE*

The following template is a generic model for the development of network interface standards or specifications. It identifies the minimum list of items that must be effectively addressed by the affected service providers to establish and maintain each point of network interface. The ATIS-sponsored ICCF is the suggested custodian of this template. Other organizations may also find the processes that evolve from this template useful and are encouraged to make use of and enhance it.

INTERFACE SPECIFICATION CRITERIA	CHECK OFF
Define the physical/software interfaces in terms of existing tariffs and technical standards and government regulation.	
Establish a clear point of demarcation that allows for non-intrusive test access.	
Define the environmental operating requirements according to security and reliability needs.	
Develop power and grounding requirements in accordance with safety and protection regulations, codes and standards.	
Define diversity requirements and survivability capabilities needed.	
Define interference generation protection levels relative to radiated and conductive electromagnetic properties.	
(Radio interfaces only) Define frequencies channelization, bandwidth, power level frequencies, tolerances and adjacent channel interference levels.	
Identify protocol elements in terms of the seven layer model OSI protocol stack.	
Define the message set that will be transmitted across the interface.	
Develop gateway screening functional requirements to block accidental or intentional intrusion of unwanted/inappropriate messages.	
Build for robustness by defining error correction, re-transmission overload controls and fault migration mitigation criteria.	
Develop message sets to facilitate fault detection, identification, diagnosis and correction.	

Develop network interface performance design objectives in terms of signal transport time (delay) availability (downtime) lost message probability and transmission criteria (BER, loss, noise, phase jitter)	
Define synchronization and timing requirements and establish monitoring and back-up capabilities.	
Ensure that forward and backward compatibility of the protocol is addressed for transition management.	
Provide local and remote network management notification and control capabilities.	
Develop a network impact statement to predict/specify the backward compatibility and purpose of the standard.	
Develop demonstrable performance criteria at agreed stages of specification development.	
Define and conduct acceptance testing to validate the defined stages of specification development.	

###

6. TECHNICAL STANDARDS DEVELOPMENT PROCESS ADEQUACY ASSESSMENT

6.1 *ISSUE STATEMENT*

The Network Reliability Council charged Task Group II to examine and report its findings on the industry standards process, as described in the following Issue Statement:

"Consider the adequacy of the Standards Development and Compliance process. Is the voluntary development of and conformity to, standards keeping pace with increased interconnection and will it be able to in the future? If the standards development process is unable to keep pace with the needs, what escalation/resolution method is proposed?"

6.2 *BACKGROUND*

Standards form the basis for telecommunications network interconnection and are updated over the life of the standard to enhance or extend their capabilities to meet user and industry needs. The standards applicable to most telecommunications issues in the U.S. are developed by Committee T1 - Telecommunications sponsored by the Alliance for Telecommunications Industry Solutions (ATIS) and by the Telecommunications Industry Association (TIA). Exhibit 1 highlights T1 and TIA focus areas and standards structures. Some of the work of other standards groups may relate to telecommunications issues, e.g., IEEE (LANs, test equipment, etc.), X3 (private data networks, information technology, etc.), Internet Engineering Task Force (Internet protocol), SCTE (physical layer for cable television) and ITU-T (global telecommunications). Exhibit 2 contains additional information on the above groups. In addition, industry forums (e.g., ATM, Frame Relay and SONET Integration) use and influence standards to create user application profiles of standards and implementation agreements based on options approved in standards. These profiles and agreements are utilized by industry service providers and manufacturers to meet user needs.

6.3 *ANALYSIS METHODOLOGY*

To collect information on this subject beyond the knowledge of the focus group team, three standards bodies, an industry consortium and several manufacturers were invited to present their internal processes and descriptions of how they are linked to the development of industry standards. In addition, data was collected from a wide range of industry players on the role and effectiveness of the standards process in ensuring network reliability.

6.4 *THE STANDARDS DEVELOPMENT PROCESS AND RECOMMENDATIONS*

As a result of their ANSI accreditations, the technical standards development processes for the TIA Engineering Committees and Committee T1 are similar. The complete standards development process as viewed by Committee T1 follows.

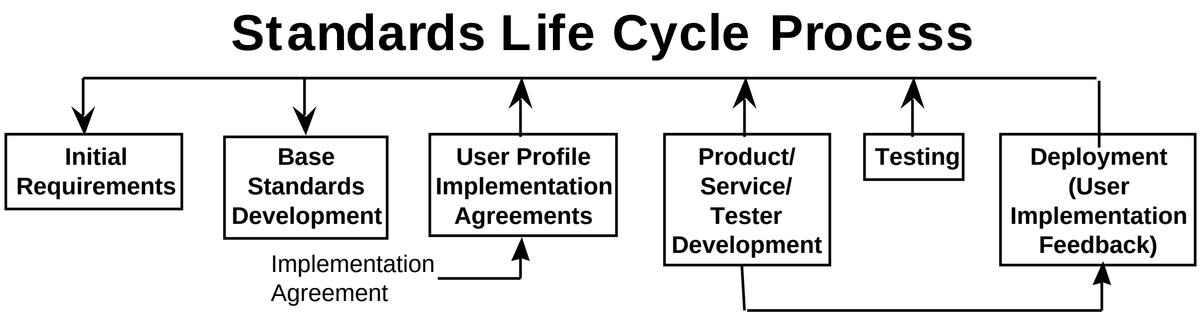


Figure 6.4.1 - Standards Life Cycle Process

The standards process is cyclic and so could theoretically start at any stage. In general, a flow beginning from the far left to the right, with feedback as shown, provides the most orderly introduction of a service or technology interface.

Stage 1: Initial Requirements. Inputs from users, manufacturers, or service providers that can provide an initial, perhaps high-level, basis for defining the service or technology interface.

The standards development initiation process is activated by a variety of sources. Listed here are some of them.

- Emergence of new technologies (PCS, ATM) may require new interfaces
- Industry group(s) submit requirements to exploit a business opportunity.
- Network user requests for additional capabilities stimulates new features or enhancements
- Industry evolution causes necessary accommodation of new interfaces
- Regulatory/legislative action mandates new interconnections

Stage 2: Base Standards Development. A minimum set of requirements defining interoperability provides an opportunity for individual manufacturers and service providers to be innovative in additional features and performance capabilities. This standards stage may require the cooperation of multiple organizations that develop standards within the U.S. (e.g., T1, TIA, IEEE and Committee X3) and harmonization with other standards bodies around the world. With regard to the latter, Committee T1 is the primary source of U.S. contributions to the ITU-T through a U. S. State Department process. It originates approximately 1,000 such contributions a year.

User and industry needs for reliable interoperability can be facilitated by the base standards development process that provides a comprehensive set of standards addressing the broad range of issues critical to interoperability. Program management techniques, including clear objectives, a customer involvement process, project milestones and identification of the dependencies between project elements can focus standards work to provide timely outputs. Reliable interoperability can also be aided, in some cases, through performance requirements for network elements that are consistent with performance and protocol specifications at the network interface.

Recommendation 1. Use of a network interface specification template is advised when a new network interface is identified for standardization. Standards bodies should use this type of template in developing the initial Standards Project Plan(s) for new interfaces to address the important areas for interconnection reliability. An example template for standards development planning is contained in Section 5.6.

Recommendation 2. Industry associations, such as ATIS and TIA, should consider the value of incorporating <u>performance</u> requirements for complex network elements with the interface standards requirements. Also, the associations should consider how such requirements should be developed and funded.

Recommendation 3. A careful technical and editorial review process, similar to and expanding upon the TIA/T1 JTC Validation and Verification process, should be utilized for all standards that have the potential for affecting network interconnection reliability to ensure technical clarity and consistency. This would be an appropriate method to validate technical adequacy in meeting the intent of the interconnection reliability template and project plan described in Recommendation 1. Exhibit 9 is the TIA/T1 JTC procedure.

<u>Stage 3: User Profile Implementation Agreements.</u> Standards should be forward-looking and provide a target for the features a specific technology or service interface may develop. It is beneficial to identify how a new technology or service interface standard can be used with other standards to provide an application that meets a user's need. With new technologies or services it may be difficult to initially provide all capabilities ubiquitously. Therefore, it is essential that capabilities be prioritized to lead service requirements. In addition, fora frequently identify priority user applications, the profile of standards to provide that application and agreements of the key standardized features to implement in the technology/service interface introductions. New technology or service concepts that emerge in this process stimulate inputs to standards bodies.

Recommendation 4. Wherever appropriate, standards bodies should work with other industry groups that use standards, such as the ATM Forum, to more precisely define standards requirements and minimize complexity and optionality. Excessive optionality can be dealt with through an appropriate contribution to the affected standards committee. The Network Interface Specification, contained in Appendix 4 of this report, should also be used by industry forums to further define, detail and approve implementation for the industry.

<u>Stage 4: Product/Service/Tester Development.</u> Individual companies develop products, services and test equipment based on standards. Since the standards are voluntary, these products/services may fully or partially comply with the standard. In addition, they include features or capabilities beyond the base standards or the implementation agreements. These features and capabilities may provide a source of inputs to standards bodies.

<u>Stage 5: Testing.</u> Industry Testing (including interoperability testing) of telecommunications technologies can provide users and the industry with insight into characteristics (including interoperability between multivendor products) for a specific technology. Issues identified can be the basis for enhancements to the standards for that technology. Such testing is particularly important for widely deployed and critical network control technologies, e.g., Common Channel Signaling (SS7).

<u>Stage 6: Deployment (User implementation Feedback)</u> Deployment of standardized telecommunication technology provides an opportunity for user needs to be satisfied and for prove-in of network reliability. Feedback on introductory capabilities can stimulate needs for additional features and for improvements in standards to support new products, services and test equipment. This feedback is also important in the evaluation of the associated standards.

Recommendation 5. Interconnecting network operators should consider using interface survivability designs with redundancy and diversity such as those outlined in "A Technical Report on Network Survivability Performance" (Committee T1 Report No. 24).

6.5 *STANDARDS ORGANIZATIONS*

Within the U.S. telecommunications industry, Committee T1 and TIA have been the primary standards developers. The focus of their activities and organization information is given in Exhibit 1. The Society of Cable Telecommunications Engineers (SCTE), working on behalf of the cable television industry, will focus on "physical layer" standards for coaxial cable systems, while looking to Committee T1 and TIA groups to address other telecommunications needs.

Telecommunications systems interoperability is not limited to national interests. International interconnection demands cooperation on standards, now well beyond that needed for simple voice telephony. The Global Information Infrastructure (GII) requires global telecommunications standards within such groups as the International Telecommunications Union (ITU) and increasing collaboration among the various national/regional standards bodies (e.g., ETSI in Europe, TTC in Japan, Committee T1 and TIA in the U.S.). Committee T1 and TIA have been leaders in initiating harmonization and collaborative efforts.

6.5.1 *TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)*

TIA's Standards Committees are open to materially interested parties in accordance with TIA's ANSI-approved Engineering Manual. For TIA membership-eligible parties, voting participation on TIA engineering committees or subcommittees requires either being an active dues-paying member of TIA or paying a non-member participation fee. The non-member fee currently ranges from $1,000 to $6,800 yearly, depending on the number of weeks of meetings the committee/subcommittee plans to hold and the resource needs of the Formulating Group. TIA and Committee T1 costs are managed differently. TIA fees cover Secretariat, hotel, audio/visual and other costs, while Committee T1 members host their own meetings. Users can vote by paying a fee ranging from $200 to $6,800, depending on the activity level of the Formulating Group. Some Formulating Groups meet two weeks /year; some others meet as often as 15 to 16 weeks/year.

The TIA's Mobile and Personnel Communications Division organization and process flow is shown in Figure 6.5.1 below.

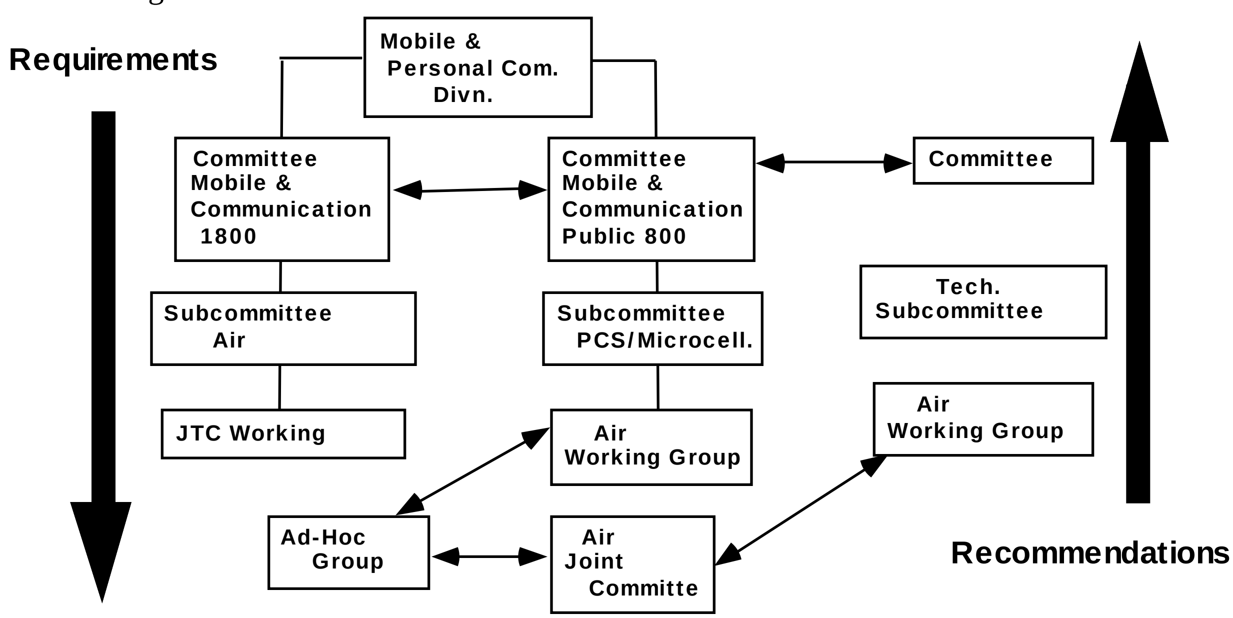


Figure 6.5.1 **TIA Mobile and Personal Communications Division**

6.5.2 Committee T1

The mission of the Committee T1 is to develop technical standards and reports supporting the interconnection and interoperability of telecommunications networks at interfaces with end-user systems, carriers, information and enhanced-service providers and customer premises equipment (CPE). The T1 Committee currently has six Technical Subcommittees that are advised and managed by the T1 Advisory Group (T1AG). Each recommends standards and develops technical reports in its area of expertise. The subcommittees also recommend positions on matters under consideration by other North American and international standards bodies.

The Alliance for Telecommunications Industry Solutions (ATIS) sponsors and provides the secretariat support for Standards Committee T1.

Membership and full participation in Committee T1 and its Technical Subcommittees is open to all parties with a direct and material interest in the T1 process and activities. Free of dominance by any single interest, this open membership and balanced participation safeguards the integrity and efficiency of the standards formulation process. ANSI due process procedures further ensure fairness.

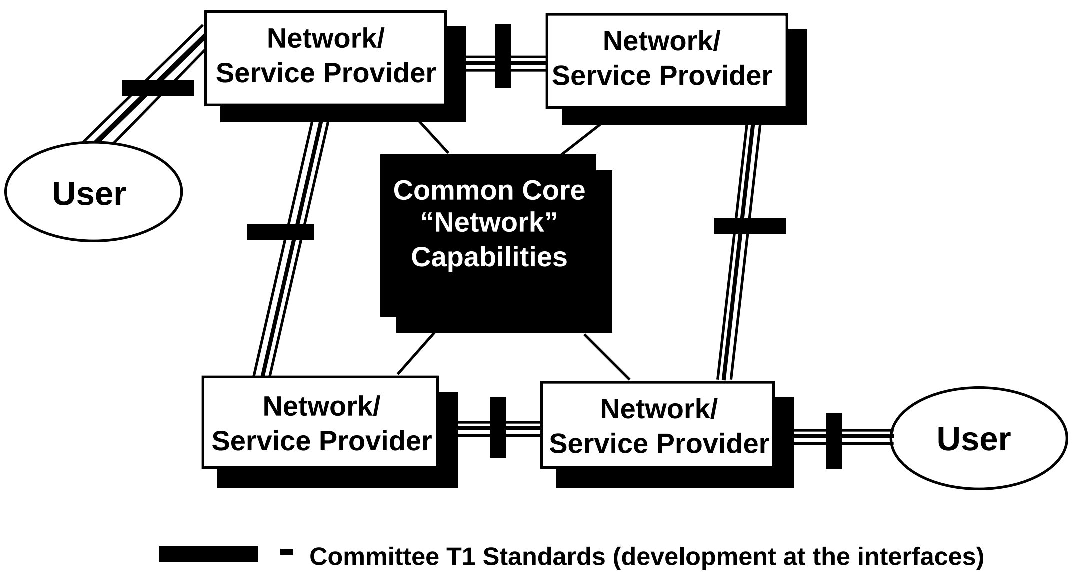


Figure 6.5.2.1 Sample Subset of U.S. Network of Networks, Committee T1 Standards

TIA AND COMMITTEE T1 KEY ITEM COMPARISON

Item	TIA	Committee T1
Membership eligibility	Manufacturers at the Division level IECs, LECs, Users can also participate at the Engineering Committee level	Manufacturers, IECs, Users, LECs
Process	Open, consensus-based, balanced, due process at the Engineering Committee level	Open, consensus-based, balanced, due process at all T1 levels

Item	TIA	Committee T1
Dues structure	Dues range from $1,000 to $50,000 depending on annual product/service sales. This provides full mbrship in TIA.	$2,500/yr.-voting $1,500/yr.-observer $1,500/yr.-subscriber $850 TSC member
Accreditation	ANSI (organization method)	ANSI (Committee method)
Life cycle mgmt	Yes (maximum re-issue/re-affirmation interval - 5 years)	Yes (maximum re-issue/re-affirmation interval - 5 years)

6.6 DEFACTO STANDARDS

There is a cooperative relationship between telecommunications equipment suppliers, service providers and users. While competition exists among service providers and among suppliers for business in the same markets, a high level of cooperation is needed to achieve interoperability through standards. Success in creating a *de facto standard* by one or more companies to quickly achieve market presence is difficult since interconnection with user equipment and multiple networks in a multi-vendor environment is required. The need for backward compatibility and interoperability can create disincentives to de facto standards since such standards can create economic disadvantages and reliability problems for users, manufacturers and network providers.

However, there is concern that, as the industry evolves to respond to more competitive pressures, service providers may feel pressured to implement interfaces before standards are available. Network reliability can best be maintained if service providers follow the interconnection guidelines contained in this report.

Recommendation 6. New network providers are encouraged to participate in existing telecommunications industry standards processes, either directly or through associations, via membership or contributions to Committee T1 or TIA.

6.7 PRE-STANDARD IMPLEMENTATIONS

Manufacturers benefit from participation in the standards and forum processes. System requirements and equipment specifications yield the opportunity to design, build and sell products to the network providers and telecommunications end users. However, if consensus develops slowly, manufacturers or service providers may be motivated to try to anticipate the standards. This can create a high risk opportunity to begin equipment fabrication before stable standards are available. In the mid-1980s this was the case for Basic Rate ISDN where the major U.S. switch manufacturers developed equipment based on two different technical specifications including different option selection (not a single standard). Later network requirements and components were changed to gain network interoperability.

Recommendation 7. Where adequate network interface standards exist, suppliers should develop and evolve their products to meet those standards. If interface standards are not established, network service providers and network equipment suppliers should actively participate in the development of robust network interface standards.

Recommendation 8. Interconnecting network providers should utilize industry-proven interconnection standards.

Recommendation 9. While standards are generally voluntary, increased emphasis should be placed on the value of compliance in ensuring network interoperability and reliability. However, in the case of public safety concerns, standards are identified with a "mandatory" emphasis.

6.8 *OTHER GROUPS INFLUENCING STANDARDS*

TINA (Telecommunications Information Networking Architecture) is a consortium of 40 companies that are developing an open architecture for telecommunications-distributed software applications, which makes use of recent advances in distributed computing and object-oriented design to achieve interoperability. TINA is presently collaborating with the standards bodies and industry forums. TINA's work is intended to have an impact on ATM, TMN, IN and multimedia.

6.9 *TIMELINESS OF STANDARDS DEVELOPMENT*

Experiences such as the pre-standard developments described in Section 6.7 and a greater market focus by U.S. telecommunications standards developers has dramatically improved the quality and timeliness of standards development. A few recent examples where timely standards development has been achieved in *12 to 18 months* interval (from initial proposal or issue identification to stable standard) are:

Timely Standards Development Examples

Personal Communications Air Interface (approx. 8000 pages)	T1/TIA Joint Technical Committee (T1P1 and TR46.3)
PCS Mobility Management Application Program	T1S1 to meet TIA TR46 needs
Outage Index based on FCC-Reportable Outage Data	T1A1 for NRSC
SONET Directory Services	T1X1 and T1M1
Asymmetrical Digital Subscriber Line	T1E1 to meet market needs
ATM Adaptation Layer for Data, Signaling and Video Application (AAL.5)	T1S1 with input requirements from the ATM Forum
SS7 Protocol Enhancements and Architectural Analysis	T1S1 for NRC I

Standards groups such as TIA and T1 are continuously improving their processes to meet user and industry needs. For example, Exhibits 3 and 4 describe improvements that have been implemented in the last few years and Exhibit 5 outlines the elements of the implementation Plan for the 1995 Committee T1 Strategic Plan.

However, broad concern still exists in the industry with respect to the ability of the standards process to keep pace with the accelerating requirements of new technology.

Recommendation 10. The most effective means to accelerate the standards development process is to ensure new standards work has sharp technical focus and clear standards deliverables, plus final and interim milestones for those deliverables. Exhibits 6 and 7 contain information on standards project proposals and project tracking based on this recommendation.

Recommendation 11. All telecommunications standards bodies should implement by year end 1996 interactive electronic access methods to expedite the submission, creation, acceptance, review and finalization of technical standards. This is already underway but a completion date has not been specified.

Recommendation 12. The Forum Process should be employed by the industry and companies/agencies to foster innovation and to produce contributions to the development of standards, not in lieu of standards. Industry fora have been instrumental in specifying implementation agreements.

Recommendation 13. Industry associations /fora, such as ATIS, TIA, ATM Forum, etc., should sponsor early (pre-standardization) industry interactions on emerging technology and service concepts. It was agreed that an initial "industry needs" framework would provide parallel inputs to industry standards activities and the development of generic requirements for network elements.

Recommendation 14. Industry associations, such as ATIS and TIA, should determine how the necessary generic requirements, described in Recommendation 13 should be developed, funded, approved and maintained. This approach will promote compatibility between standards and generic requirements.

6.10 *CONCLUSIONS ON STANDARDS ADEQUACY FOR NEW NETWORK INTERCONNECTION NEEDS*

The voluntary, open, consensus-based standards process, including Industry Forums and Generic Requirements Process, is viewed as being adequate to support network interoperability and reliability issues relating to basic voice services on wireline networks.

The industry survey data gathered for this report indicates a high degree of dependence on standards bodies to develop service, reliability and interoperability standards and specifications. However, the industry views standards bodies as having little responsibility for ensuring inter-network reliability and interoperability. Therefore, it is highly recommended that interconnecting network operators execute bilateral agreements and compatibility testing to ensure reliable interoperability. The survey data indicates a high level of support throughout survey respondents for the use of the standards process, industry forums, interoperability testing and bilateral agreements.

Recommendation 15. Bilateral agreements should be developed and put in place before networks interconnect in order to ensure reliable interconnection and interoperability. In addition, the forum process (e.g., NOF and ICCF) provides the framework for developing national technical and operational industry agreements for new network interconnections. Participants in these agreements should demonstrate compatibility with established industry standards, procedures and processes as a condition for interconnection. Exhibit 8 provides a Model Process for SS7 Network Interconnection. (Appendix 4 is a template for such a bilateral agreement.)

Quickly maturing and innovative standards development processes relating to cellular applications and interconnections with wireline networks are evident. The development or adaptation of interconnection standards for wireline and wireless networks with other networks, i.e., cable television, some new satellite systems, and mobile satellite systems, is still very much in the future.

Since 1984, the U.S. telecommunications network has grown, while introducing new technologies and services in a multi-vendor environment of more than 500 Interexchange Carriers, 1,500 Exchange Carriers and 1,000 Cellular service providers. The development by telecommunications standards bodies of working relationships with industry forums, a focus on the positive impact of the standards and continuous improvement processes have allowed standards bodies to meet industry and user needs for timely standards development in the face of rapid evolution of technologies and the convergence of industries. Moreover, process improvements, including use of electronic document handling to facilitate and expedite standards development and dissemination, should ensure that the standards process can continue to improve to meet future challenges. In addition, the strategic impact of standards and increased executive awareness of the standards impact, where necessary, can stimulate corporate escalation processes for critical industry standards issues.

###

The remainder of this page intentionally left blank.

7. ANALYSIS AND RECOMMENDATIONS FOR COORDINATED NETWORK INTEROPERABILITY TESTING AND FUNDING

7.1 *ISSUE STATEMENT*

In its Second Report and Order (FCC 94-189, FCC Docket No. 91-273), Released August 1, 1994, the Federal Communications Commission discussed comments provided to it by various industry members relative to long-term funding for the industry-wide Inter-network Interoperability Test Plan (IITP) efforts. The Commission noted in paragraph 77, "The NRC is the best mechanism for resolving any IITP funding problem that may exist, either by means of specific recommendations to the industry or, if such a solution is not possible, by means of a recommendation to the FCC. We refer this question to the NRC." The currently commissioned NRC asked this task group to address this issue.

7.2 *SUMMARY*

The goal of the task group's work was extended beyond the specific charge to recommend an IITP funding method. This report not only recommends a funding method, but it also outlines a functional management structure that will facilitate inter-network interoperability requirements development and testing and also allow evolution to address future network interconnection requirements, beyond current IITP efforts.

Relative to this expanded management structure, now to be called Inter-network Interoperability Test Coordination (IITC), the task group accepted input from many sources, including AT&T, Ameritech, Bellcore, GTE, DSC Communications Corporation, MCI, the Network Operations Forum, NORTEL, Pacific Bell, Sprint, U S WEST and other members of the task group. Based on this input, combined with a broader industry survey and internal discussion, the task group is making the following recommendations:

Recommendation 1. This task group reaffirms the NRC 1 Recommendation in the report "Network Reliability: A Report to the Nation", dated June, 1993 to continue the IITP cooperative industry relationships. The interconnection management test coordination processes should be institutionalized to permit continual evolution to address national network testing requirements.

Recommendation 2. The existing industry fora (e.g., ATIS-Network Operations Forum, CTIA-Advisory Group for Network Issues) should continue to be used proactively by existing and new service providers and manufacturers for recommending and planning network interoperability testing to ensure service compatibility and reliability across common interfaces.

Recommendation 3. The existing IITP (Inter-network Interoperability Test Plan) program should evolve as the basis of the more generalized IITC function. The present focus on interoperability vulnerabilities in the signaling networks should continue, but the focus should also be broadened to consider other high risk and critical interfaces resulting from the introduction of increased network interconnections and new technologies. (This recommendation is not meant to preclude the obvious need for industry-specific or technology-specific testing where there is no logical reason for IITC nationally coordinated testing.)

Recommendation 4. Once the IITC is operational, manufacturers and service providers will participate in the management and conduct of ongoing nationally coordinated interconnection testing.

Recommendation 5. The telecommunications industry should fund and manage the IITC. (See Chart #2, National Interoperability Test Management and Section 7.5.) A Steering Committee *will be staffed by industry executive volunteers, as outlined in Recommendation 8 of this section, to oversee this organization.*

Recommendation 6. The IITC should be made a financially self-supporting organization within the Alliance for Telecommunications Industry Solutions (ATIS) business structure, at least initially and be similar to the ATIS method now used for the Committee T1 and SONET Interoperability Forum (SIF) groups. ATIS administrative costs would be covered by a portion of the annual fees as outlined in Recommendation 7 of this section.

Recommendation 7. A mandatory annual fee should be collected from telecommunications carriers and equipment manufacturers to support the interoperability test coordination function. (See Sections 7.5.1 and 7.5.2 for the detailed funding and reporting presentation.) IITC participation should be mandatory for the service providers and manufacturers.

Recommendation 8. The telecommunications industry associations should identify technical management representatives selected by their boards of directors or engineering committees to serve on a steering committee that would manage the IITC financial requirements, set IITC policy, prioritize testing activities and provide overall management guidance of this industry-wide program.

Recommendation 9. Bellcore and the industry organizations should continue their present responsibilities and financial support for the applicable IITP testing and coordination until the new IITC function is operational. (See also Section 1.1.7)

Recommendation 10. The test coordination funding issue is believed to be one of several potential industry-wide initiatives driven by the evolving competitive environment. Therefore, the FCC should consider a more appropriate long-term method of IITC funding in the context of other additional industry funding requirements, e.g., NANPA administration, that will surface from increased network interconnection, if the recommended methods do not provide adequate funding.

Recommendation 11. Based on approval of this plan, the NRC Chairman is requested to initiate the appropriate IITC formation processes necessary to establish the organization.

A number of management issues were of concern to the task group. They included the need for a stable funding mechanism that is relatively easy to administer, a mechanism that allocates the cost burden equitably among those companies benefiting from the test results and a general knowledge of the total funding needed that is sufficient to conduct the necessary nationally coordinated tests. The task group recommendations for the organizational structure and principles of business conduct represent the best alternatives of those considered. Ultimately however, these issues are believed best managed by the Steering Committee and should be among their first responsibilities to validate. These issues are presented more fully in the other paragraphs of Section 7.

7.3 *SCOPE OF WORK ON INTEROPERABILITY TESTING/FUNDING*

The goal of the task group's work was extended beyond the specific charge to recommend an IITP funding method. This report not only recommends a funding method, but it also outlines a functional management structure that will continue present inter-network interoperability development and testing requirements and also allow evolution to address future network interconnection requirements as they evolve.

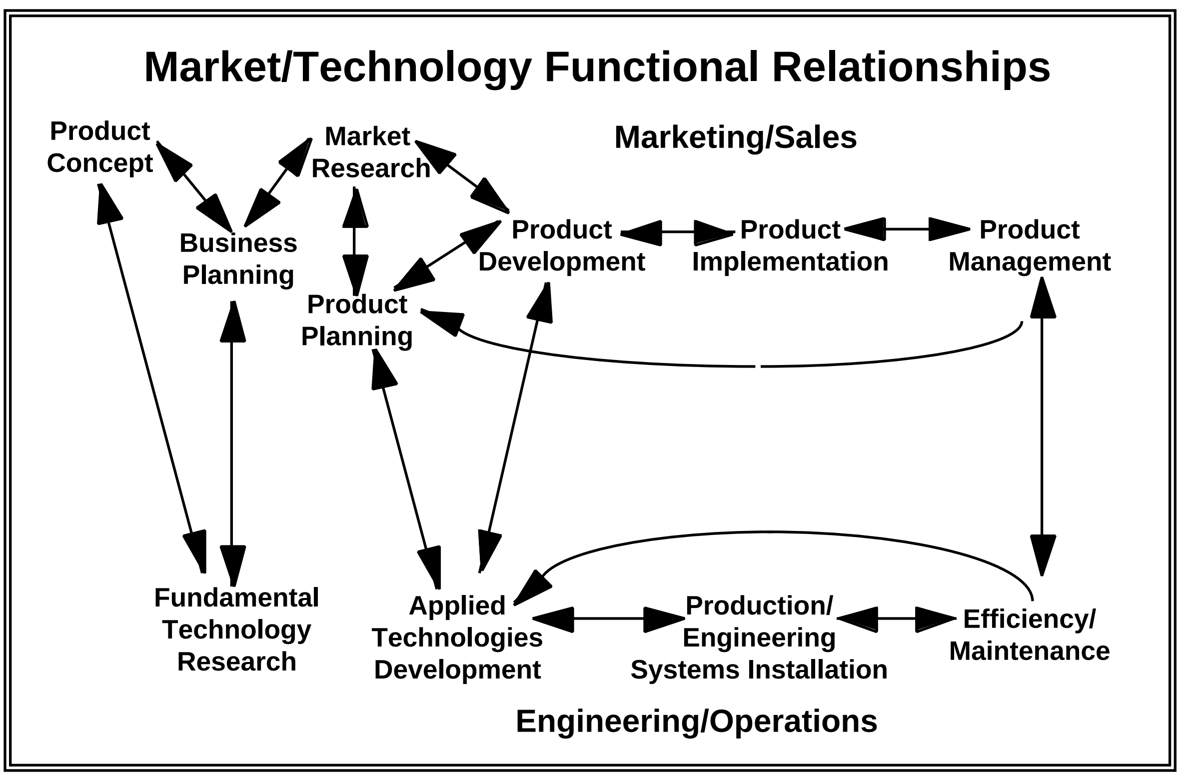
The current IITP process may be viewed as a model for the more generalized IITC function recommended in this report. In IITP, industry members (service providers and manufacturers) voluntarily develop test plans, test scripts and test network configurations. They also provide their own facilities/equipment and human resources for cooperative test execution. Bellcore, today funded solely by the RBOCs, provides a facility interconnection hub for testing, overall coordination for test network set-up and execution and administrative support for the IITP. However, the types of roles like those currently provided by Bellcore should be funded more uniformly across the industry.

7.3.1. *MARKET/TECHNOLOGY FUNCTIONAL RELATIONSHIPS*

Although the FCC and the telecommunications industry have identified interoperability testing as a key component of sustained network reliability, it is only one of the critical steps necessary in the process of successfully creating and deploying any new component of the national telecommunications network. It is helpful to place interoperability testing in perspective, as it is only one of many tasks to accomplish in deploying a network capability.

The following generic chart depicts the continual interaction and progression of activities between marketing and engineering groups to conceive and deploy a new product and manage it over its life cycle. Reading from left to right in chart #1 demonstrates one way this could be accomplished. Notice that all lines of flow are two-way, i.e. interactive, except two. This is indicative of the departmental interplay within companies. Any two telecommunications companies who intend to interconnect will experience the same interaction, albeit with business developers replacing marketers, but probably the same engineering groups.

Chart #1



7.3.2. ***<u>STEPS TO ESTABLISH INTERCONNECTIONS BETWEEN COMPANIES</u>***

Expanding on the Production/Engineering Systems Installation portion of the Chart #1, the four steps outlined below are necessary before any successful system deployment can be expected.

Step 1. System Design Requirement (Testing for alignment between the system design and available feature expectations. Typically, this is a paperwork exercise at this point.)

Step 2. Application Development (Pre-production testing against benchmark functional/feature criteria)

Step 3. System Deployment (Pre- in-service systems inter-operability testing against benchmark operational criteria to ensure overall compatibility)

Step 4. System Operation Testing, in general, is required before successfully moving from one step to the next in the process. When successfully accomplished, each subsequent step is more assured of success.

When applied to a business arrangement between two or more companies who must develop an interconnection between their networks, the above steps manifest themselves as follows:

Note: Three cases are possible: Both networks already exist, both networks are new or one is new and the other already exists.

<u>Testing for alignment between the system design and available feature expectations:</u> This is the first opportunity for interfacing companies to bring together, compare and resolve differing technical design approaches and develop common feature performance standards and expectations. Results of this work are incorporated in the application development of the systems that are to inter-operate. (At this point, only paper designs are available for comparison to expectations.)

<u>Testing against benchmark functional/feature criteria:</u> Testing interconnected networks at this phase is accomplished between vendor and/or service provider testbeds, an environment where conformance to industry standards and interoperability conventions can be validated without jeopardizing existing customers and where feature functionality is tested against industry network design expectations. This testing involves hardware and software design, capacity capability determination, fault tolerance performance, management interface systems, and operations, administration and maintenance provisions.

<u>Interoperability testing against benchmark operational criteria</u> is where the cooperative relationship between the new network and existing network service providers is most evident. This is the last opportunity to functionally test the interfacing components and ensure proper integrated performance before field installation and "turn-up." This very controlled testing must answer the question, "Will a network service provider's hardware, software and signaling protocols inter-work at all levels in steady state, error and overload conditions with no foreseen catastrophic failures to the network service providers comprising the Public Switched Telecommunications Network?" Usually, this testing phase occurs between new network provider units at testbed sites, or where the pre-operational equipment is installed and the existing network providers' already proven testbed systems. (As experience and expertise grows and installed equipment matures, more of the interoperability testing occurs between field locations of the network providers, by temporarily and carefully partitioning the incumbent's on-line equipment, thereby restricting access to the national network until operational tests are completed and performance history is established satisfactorily.)

7.3.3. *LESSONS LEARNED*

Participation in the industry standards development teams is of great benefit to any applications developer/service provider. However, conformance to standards does not automatically ensure interoperability when it comes to interconnected systems, nor does standards compliance imply that competing carriers' systems will always operate in the exact same way. What the interoperability testing does ensure is the accommodation of a permissible way of operation at common points of interface. (Example: Two competing IXCs with unique network protocol options interface to one LEC.) In addition to standards development issues, the telecommunications industry also operates fora concerned with inter-company network systems and operations issues that are equally critical to network reliability. (See Section 6.)

As an increasing number of competitive service providers interconnect to participate in the telecommunications market, there will be a corresponding increase in the number of interfaces that must be managed. In this NRC task group, three interfaces were identified as potentially critical to reliable interconnections: information channel, signaling channel and OAM&P channel interfaces. All three logical channels are transported by a physical channel(s). As these channels affect network reliability, the logical signaling channel and the physical channel carrying all information, i.e., signaling, OAM&P and information yielded the greatest degree of industry concern.

The required and beneficial tests between network signaling systems may include several types of testing. If service providers intend to connect ISUP (ISDN User Part) protocol signaling channels between voice message switches, TCAP (SS7 Transaction Capability Application Part) signaling channels to databases, or linkages to or between STPs (Signal Transfer Point), then test and acceptance arrangements between each combination of the interconnecting network service providers are necessary. This may be accomplished using a manufacturer's personnel and testbed facilities, properly equipped third party facilities, or the service providers' own laboratories. In any event, there are agreements to negotiate before connecting with each of the network providers' testbeds and ultimately between the operational networks.

The expressed industry concern for the physical channel reliability is traditional, because without it, there are no connections. It is important to the service provider, as the established connection between circuit end points is well documented and practiced in design, deployment and service maintenance. Industry efforts to maintain and improve network reliability are well documented by Task Group I of the NRC (Network Reliability Council.) Please refer to the reports of the ATIS Network Reliability Steering Committee.

As an ongoing concern for a sustainable interoperable network testing capability, there are continual changes in network software and hardware that require tests before "going live" on the national network. So, establishing a presence as a network service provider carries an ongoing responsibility thereafter to maintain and evolve network performance to accommodate new features and functionality of all interconnected network service providers.

The present IITP program provides the industry with several benefits, including a unique penalty-free testbed for performing cooperative stress-to-failure testing. This program is unique among wireline service providers and manufacturers. Data collected via the NRC survey indicate stress-to-failure testing is currently not done by other than wireline service providers and the associated manufacturers.

Overall, a major benefit of interoperability testing is the ability to test multi-manufacturer system compatibilities and stress network components, arranged in a system configuration, without service penalty or compromising the integrity of the national network.

7.3.4. *INTEGRATING CURRENT AND NEW NETWORK PROVIDERS*

As a generic requirement, business and technical arrangements must be negotiated between interfacing network owners before any interconnection will be permitted. Having knowledgeable and experienced technical resources on both sides of this arrangement will allow more equity in the relationship and probably allow more flexibility in managing through the pre-service test plans.

Existing competitive network providers will offer a number of ways for new service providers to accomplish the interconnection testing required. It is recommended that all network providers join industry groups to establish the broad technical awareness and working relationships required for interoperability, but the business arrangement aspects of that interoperability are left to the interfacing companies to determine.

In Section 7.1 concerning Industry Standards Development Process Assessment, a diagram of the standards development process describes the cooperative industry efforts that parallel Chart #1. Further, industry forums are working common issues of concern necessary to ensure not only network interoperability, but also customer account management and operational support systems interface compatibilities. Both of these methods of participation are open to interested company participants.

7.4 *PURPOSE AND BENEFITS OF THIRD PARTY INTEROPERABILITY COORDINATION*

The needs satisfied by third-party test coordination are:

- Protection of company-specific proprietary information while enabling the identification of national network service problems and improvement opportunities
- Management of the performance of interoperability tests that have been shown to have national network value and importance
- Conduct of portions of interoperability test plans that are most cost-effectively accomplished from a single location
- Synchronization of test data collection for analysis and reports

Where third-party testing and coordination is actually needed, a properly equipped and staffed national facility is required. As observed from industry survey data, the task group agrees with the industry view that funding for this national facility should be shared among the recipients benefiting from the knowledge obtained from the network interconnection testing. Benefits accrue to the industry participants by providing:

- Advanced knowledge of interoperability problems, solutions and operating recommendations
- Test report material and functional test documentation
- Interoperability status reports
- Opportunities to contribute/participate in the process (direct knowledge gained)
- Evidence of good faith efforts to prevent a major service outage, if one actually does occur
- The telecommunications industry with a self-monitoring capability
- The industry with an inter-connected standby testbed network for diagnosis of systemic problems

Chart #2 describes the proposed organizational relationships to manage the national inter-network interoperability test coordination (IITC) function. Note, the coordination function may be carried out by one or a combination of several qualified physical entities, selected as appropriate by the Steering Committee to meet test coordination requirements.

7.5. *FUNDING AND MANAGEMENT*

Management/funding of the interoperability testing coordination function can be accomplished in a number of ways. Factors to consider include:

- The present and future benefit to the industry of network provider and manufacturer voluntary contributions of facility testbeds and skilled human resources

- The expected maturation of the equipment, human resources and industry players which will create, reduce, alter, or eliminate the need for various types of third-party test parameters to assess the value received in comparison to the actual coordinated testing accomplished

- The test coordination funding system needs to provide financial stability to recognize the continuing nature of interoperability test requirements. The expected set of interconnected and geographically disbursed testbed systems are not easily assembled or disassembled to follow sporadic testing programs or reactionary test requirements

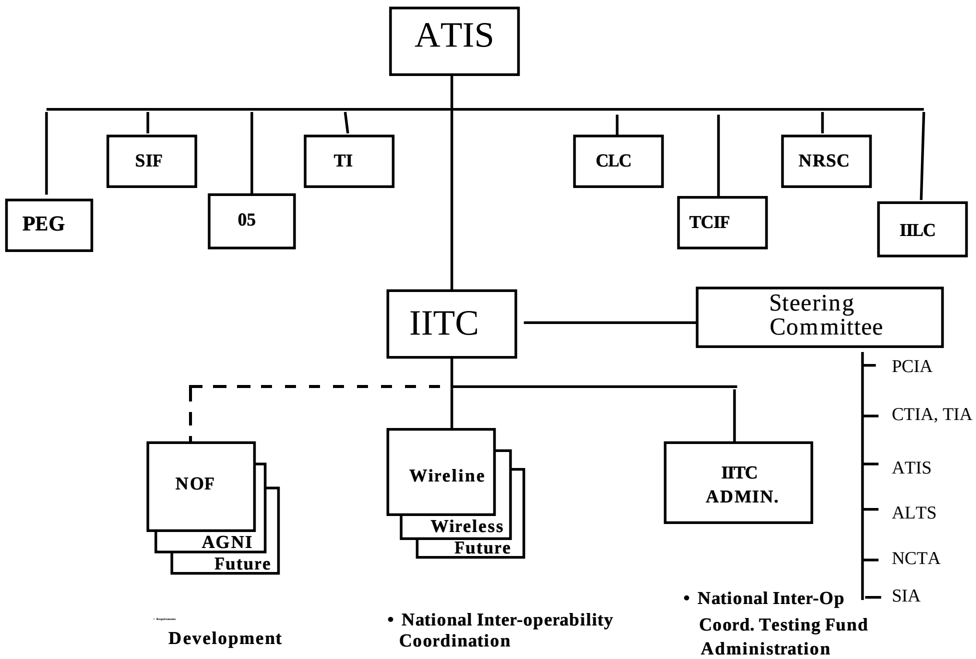
- The funding system must be easily administered and share costs equitably among those benefiting from the test plans

Based on the industry's general sense of responsibility to provide a highly reliable national network infrastructure, an IITC fee structure would be determined and payments contributed to an industry-led organization that will manage and fund centralized interconnection test coordination. Since the ATIS (Alliance for Telecommunications Industry Solutions) industry standards and forums organization is not affiliated with any trade association and has open membership opportunities, ATIS is recommended to provide an "organizational sponsoring home" for the interoperability testing activities. Chart #2 depicts the organizational structure to manage this function.

A suggested set of guiding management principles for the IITC should include:

- A requirement for members to actively support and participate in the testing functions since its work is in the interest of the public
- A requirement that all service providers and equipment manufacturers financially support the IITC
- A requirement for the IITC to maintain financial self-sufficiency
- A requirement to provide an equitable fee structure for its members
- A requirement to provide equitable membership representation for IITC management oversight
- A stable funding mechanism to ensure availability and readiness of interconnected test coordination facilities

Chart #2



The IITC-controlled organizational elements are the two functions to be funded by the annual fees.

If the recommendations from this report are accepted in early 1996, it may be possible to establish the IITC and have it operationally ready to assume its responsibilities in 1997. This will require timely decisions and direction by the NRC and ATIS. The recommendation of the task group is for 1996 to be a transition period to create the IITC and develop the functional capabilties for full operation in 1997. To accomplish these goals, the organization and fee structure must be in place and collections begun by mid-year, 1996.

The remainder of this page intentionally left blank.

7.5.1. *SUGGESTED RESPONSIBILITIES AND ORGANIZATIONAL ELEMENTS*

ATIS

- Solicit participation from industry associations to populate the Steering Committee and Requirements Development functions
- Provide administrative/facilitation support for the IITC management function
- Act as the legal entity for contracts that may be required for test coordination.
- Perform the interoperability test fund administration function described below

National Interoperability Test Coordination Function

This function performs the inter-network interoperability test coordination (IITC) and is the second of two functions funded by the annual fees. A number of test coordination entities could be established depending on the technical facilities and human resource expertise required. (Examples: Bellcore currently performs this responsibility for the SS7 ISUP wireline test coordination activities and the CTIA/AGNI coordinates IS-41 interoperability testing.)

- Project manage the tests specified by the Requirements group
- Perform portions of a test plan appropriate to conduct at a central location
- Collect, aggregate, partition and distribute data to appropriate test participants
- Participate in the data analysis and report generation. Conduct follow-up to ensure corrective action where needed
- Submit financial budget requirements through the IITC Director for Steering Committee approval

This function could also include, as appropriate, other centralized functions similar to today's "hub function" for IITP testing.

IITC Steering Committee

A voluntary industry Steering Committee selected from the ATIS, CTIA/TIA, PCIA, NCTA, SIA, ALTS board members and others as appropriate, would be established to oversee the management of the national test coordination responsibility. The steering committee would be charged with assessing the need and opportunity for nationally coordinated tests, approving test plan initiatives and managing the funds to accomplish these tests. Thus far, Bellcore and CTIA/AGNI possess the experience in conducting these types of test plans and there are valuable lessons to learn from these two organizations. This steering committee would be charged with assessing cross-industry testing needs for the future and to determine the best course of action to accommodate the requirements. Suggested responsibilities include:

- Ensure the value of the nationally coordinated testing is commensurate with the costs to support it
- Financial policy management
- IITC Directorship management

IITC Directorship

This position is responsible for the day-to-day management of the IITC. This position would be charged to,

- carry out the Steering Committee policies
- develop and manage the resources dedicated to the conduct of IITC business
- solicit and administer memberships in the IITC
- report on the financial and membership status of the IITC
- assess and report activities and actions to the respective federal agencies and associations

- solicit and select the appropriate entity or entities to perform the test coordination function based on requirements and plans

This is one of two functions funded by membership fees.

Requirements Development: Identification/ Specifications

The current organizations of ALTS, NCTA, PCIA, CTIA/TIA, SIA and ATIS would continue to identify and bring forward (to the respective Requirements Development groups) interoperability tests for coordination by a national test coordination facility.

- Test script development in response to industry requirements
- Determination of required interoperability tests that must utilize the national coordination function. (All other interoperability testing is assumed to not require any national coordination function.)

National Interoperability Membership and Test Fund Administration

This is envisioned as a responsibility within the IITC organization.

- Take direction from the IITC Director.
- Manage the collection and disbursement of the funds collected from the member companies.
- Develop administrative reports for the IITC organization.
- Manage the production and distribution of reports to the federal agencies, member companies and the industry.

This is the second of the two functions funded by the membership fees.

IITC Member Companies (Service Providers)

This group is composed of companies who see value in interoperability testing and are willing to support it with equipment, human and/or financial resources. (The membership motivation would include competitive forces to secure and maintain customers, provide high quality reliable service and demonstrate network performance to meet state and federal agency criteria.)

- Participate in the planning and conduct of recommended nationally coordinated interoperability test plans with appropriate resources and facilities
- Support the maintenance of the national coordination function (IITC) by sharing in the funding of that organization (see member fees in Section 7.5.2.)
- Participate in the data analysis and report generation. Conduct follow-up to ensure corrective action where needed

The present responsibilities and funding of Bellcore are recommended to continue for applicable IITP testing until the IITC organization is operational.

IITC Member Companies (Manufacturers)

Considering their interest in developing and selling high quality equipment and systems, switching equipment manufacturers offer their financial, technical and hardware/software resources to participate in required interoperability testing.

- Participate in the planning and execution of recommended nationally coordinated interoperability test plans with appropriate resources and facilities
- Support the costs of maintaining the national test coordination function (IITC) by sharing in the funding of that organization (see Section 7.5.2.)
- Participate in the data analysis and report generation. Conduct follow-up to ensure corrective action where needed

7.5.2. *FUNDING AND REPORTING RECOMMENDATION*

Beneficiaries of the testing were found to be in two classes, i.e., equipment manufacturers and service providers. Equipment manufacturers are fundamentally linked to interoperability issues, but only benefit from testing if they participate in those tests. Service providers receive benefit even if they do not participate directly, as long as the manufacturers they utilize participate. However, service providers accrue additional benefit when they do participate, by learning how their implementations interact with others in stress-to-failure conditions. Several funding alternatives were studied to gain insight into the issues of who pays, how much each member pays and their willingness to pay and to understand the administrative issues to comply with the guiding principles of section 7.5. As an illustration, the following chart describes a two-tier fee structure the task group believes will accumulate the $3.0 - $3.5 million Bellcore estimates it now spends annually for IITP coordination activities.

Company	Fee
Service Providers (> $5 million operating revenues)	$10,000
Service Providers ($1-5 million operating revenues)	$ 2,000
Manufacturers (> $100 million sales revenues)	$20,000
Manufacturers ($50-100 million sales revenues)	$ 2,000

The task group recognizes there are small companies that are inappropriate to consider for IITP funding support. Service providers with less than $1 million operating revenues and equipment providers with less than $50 million sales revenues are suggested exclusion levels.

Reporting requirements would include:

- The IITC will provide verification of IITC membership and maintain a list of current members in and out of good financial standing.
- The NRSC will publish the current IITC member list and the funding adequacy in its annual report to the FCC, as a leading indicator of network reliability.
- The IITC will invoice service providers and equipment providers, initially identified from FCC and industry association lists of carriers and manufacturers.
- 1996 will be a transitional year from the existing methods of funding nationally coordinated interoperability testing. Fees for IITC will be collected during 1996, based on 1995 reported revenues. The IITC will begin operation in 1997.

7.6 *CONCLUSION*

The current IITP is a unique cooperative arrangement among the telecommunications industry equipment suppliers and service providers. It serves a vital need to permit off-line stress testing across multiple network boundaries. Although not specifically referenced in this report, the achievements of the IITP function to identify and resolve actual and potential network interconnection problems are well documented.

The present funding of national SS7 ISUP test coordination has come from the RBOCs via Bellcore. The recommendation of this task group to expand the program into a function called IITC provides a method to spread the costs of future interoperability test coordination among all those equipment suppliers and network service providers benefiting from the knowledge gained. With increasing deployment of competitive networks and new technologies, the potential service reliability issues grow. However, the mandatory cooperation among telecommunications industry competitors to ensure overall reliable network performance is seen to benefit all market segments and the national public interests. To achieve this industry cooperation, the industry should be held responsible for finalizing the funding and management issues.

8. METRICS

8.1 PROPOSED METRICS

While there are several methods of measuring the success and implementation of recommendations offered in this document - such as percentage of template usage, growth of standards and fora body membership and expansion of bilateral agreement execution - these are soft measures of established processes. The task group concluded the best measure of success would be actual network performance metrics, as currently tracked and reported to the FCC. The present FCC reporting, in addition to following the principles of RQMS as defined in Bellcore GR929, were considered more than adequate to monitor overall network performance. One specific suggestion concerning the IITC organization is to report funding adequacy and membership data to the public via the NRSC Annual Report as a leading indicator of network reliability.

While investigating network reliability concerns created by increased interconnection among multiple service providers, the task group suggests PSTN integrity may well be supported by competitive pressures through service substitution in tomorrow's telecommunications marketplace. Consumer expectations for reliable and continuous telecommunications services as a prerequisite market requirement will drive new entrants to meet or exceed service levels of incumbents.

Looking to the future, the definition of continuous telecommunications service is expected to gradually evolve as overlay and alternate networks emerge and integrate to develop a new public network of networks. As more and more subscribers gain multiple paths to access essential services, the need for continuous availability on any given network may change. However, developing this evolution was considered outside the scope of the task group study.

9. PATH FORWARD

9.1 SUSTAINING RECOMMENDATIONS

1. Although the emergence of ATM switching and SONET transport interoperability are already topics of industry interaction, future inter-company and nationally coordinated testing is expected. The IITC is the logical organization to manage the tests determined necessary by the various industry fora.

2. As satellite operators begin to offer switched telecommunications voice and data services, the processes outlined by this report's templates will become valuable tools for reliable interconnection planning and execution. The interoperability issues will surface as challenges to overcome in industry fora. The bilateral agreement template will become the vehicle for addressing a wide range of interconnection issues with the incumbent carriers.

3. Cable television operators offering telecommunications services will have the same learning experiences as the satellite operators. This report represents a good informational source for them to gain an understanding of the issues associated with network interconnection reliability.

This report is intended to go beyond the specific solutions needed for today's issues. The processes presented are generally applicable to envisioned industry needs for interconnection and for nationally coordinated inter-network testing.

10. ACKNOWLEDGMENTS

Several of the team member companies generously supported informational needs with presentations and data from subject matter experts. In the group's monthly meetings, the "ad hoc people" brought in by the team members and their alternate representatives in attendance added significantly to the discussion topics. The following non-members attended several meetings to support the study effort and are gratefully acknowledged.

John Sweitzer, NORTEL
Dr. Yi Shen, MCI
Bill Blatt, NORTEL
Dan Nielsen, U S West
Jim Joeger, MCI

Although the one-time participants are not named here, we appreciate the contributions from all of them.

Each task group of the NRC II was assigned a mentor to provide leadership during the work effort. Ross Ireland, Pacific Bell, was this focus group's mentor and we appreciate his guidance.

Not listed as a team member is Rob Hausman from Bellcore. He was responsible for the questionnaire distribution, data aggregation of the responses and presentation of the results to the task group. His contribution was of significant benefit to the overall task effort. Matthew Orr from Sprint provided helpful editorial and report formatting expertise to improve the presentation of this report.

As a further acknowledgment, each of the companies that arranged and funded the monthly meeting locations and supported the attendance of company's representatives is gratefully appreciated. Because of well qualified and supportive people who participated, the nearly year-long task has yielded a useful product and a new set of acquaintances to support the evolving network infrastructure.

###

11. References and Glossary

11.1 Reference Document List

1. ANSI-OAM&P (T1.115) -- SS7 Monitoring and Measurements

2. Bellcore SR-TSV-002275 -- BOC Notes on the LEC Networks. Available from the Bellcore document coordinator.

3. Committee T1 Standards:

   T1.101 Digital Network Synchronization
   T1.102 Digital Hierarchy - Electrical Interface
   T1.105 SONET Interface Standard
   T1.107 Digital Hierarchy Formats Specification
   T1.110 SS7, General Information
   T1.111 SS7, Message Transfer Part (MTP)
   T1.112 SS7, Signaling Connection Control Part (SCCP)
   T1.113 SS7, ISDN User Part (ISUP)
   T1.114 SS7, Transaction Capabilities Application Part (TCAP)
   T1.115 SS7, Monitoring & Measurements
   T1.116 SS7, Operations, Maintenance & Administration Part (OMAP)

4. FR 64 -- 1995 LSSGR (Local Switching System Generic Requirements) Describes the content and structure of the 1995 LSSGR document set. Available from the Bellcore document coordinator.

5. GR929 -- Generic Requirements 929. Reliability and Quality Measurements for Telecommunications Systems. Available from the Bellcore document coordinator.

6. The Local Exchange Routing Guide (LERG) is an industry recognized document used to provide network configuration and NXX/NPA code activation/change information for the purpose of routing calls within and between networks. The LERG is available from Bellcore-Traffic Routing Administration.

7. Network Reliability: A Report To The Nation. Issued by the NRC I. (copies available from the ATIS 1200 'G' Street, N.W. Suite 500, Washington, D.C. 20005, telephone 202-628-6380)

8. NOF ISSUE 229 -- OAM&P Issues of Interconnected LEC Networks

9. TRNPL 145 -- "Compatibility Information for Interconnection of a Wireless Services Provider and a Local Exchange Carrier Network," Issue 2, December, 1993.

10. TR374 -- See FR64

11. TR246 -- Bellcore Specification of Signaling System Number 7 (SS7). Contains proposed generic requirements specifying the SS7 protocol and architecture. Available from the Bellcore document coordinator. 1,838 pages.

12. TR905 -- Common Channel Signaling (CCS) network interface specification supporting network interconnection. States Bellcore's preliminary view of proposed generic requirements stating the required interfaces between the CCS architectures utilizing the

Signaling System 7 protocol deployed by the Bellcore client companies. Available from the Bellcore document coordinator.

13. TR 1149 -- OSSGR (Operational Support System Generic Requirements) Section 10. Details the information contained in the Transaction Capabilities Part (TCAP) messages exchanged between an operator services system and the Line Information Database (LIDB) or billing validation database. Available from the Bellcore document coordinator. 108 pages.

14. NOF Reference Document -- Available in paper or diskette form from the NOF Secretary. (Contact ATIS for this information.)

15. TIA References

TR45	Network Reference Model
TR46	Network Reference Model
IS-41 Rev. C	"Cellular Radio Telecommunications Inter system Operations.
IS-93	"Cellular Radio Telecommunications Ai-Di Interfaces Standard", dated December, 1993
IS-53	"Cellular Features Description," dated August, 1991

16. CTIA "Seamless Roaming Implementation Guide (SRIG)," dated January, 1995 (Contact the CTIA for this document.)

###

11.2 Glossary

A/D LINK Analog to Digital Link
ABS Automated Billing System, or Alternate Billing System
AGNI Advisory Group for Network Issues (a CTIA Organization)
AIN Advanced Intelligent Network
ALTS Association for Local Telecommunications Services
AMPS Advanced Mobile Phone Service
AT Access Tandem, a switching point in a LEC network
ATIS Alliance for Telecommunications Industry Solutions
ATM Asynchronous Transfer Mode (a cell-based data switch technology)
Bilateral Agreement - An agreement developed between two entities for the purpose of securing commitments to perform equally beneficial acts or in equally beneficial manners concerning the design, performance and reliability of interfacing telecommunications networks.
BOC Bell Operating Company
BSC Base Station Controller, associated with cellular telecom networks to control access and utilization of the radio frequency spectrum among the subscribers.
CAP Competitive Access Provider
CCIS (Common Channel Inter-office Signaling) Out-of-band signaling network deployed mainly by AT&T in the 1970's. This system pre-dated SS7.
CCS Common Channel Signaling. Related terms: SS7
CDMA Code Division Multiple Access
CLC Carrier Liaison Committee. One of the sponsored committees of the Alliance for Telecommunications Industry Solutions (ATIS). The CLC has three subgroups: Network Operations Forum, Industry Carriers Compatibility Forum, Ordering and Billing Forum.
CLEC Competitive Local Exchange Carrier
Committee Tl - One of the sponsored committees of the Alliance for Telecommunications Industry Solutions (ATIS). It produces standards for the telecommunications industry.
Control channel - A means of interconnecting networks for the purpose of conveying network control information.
Critical Interconnection - A network interconnection is considered to be critical if messages or events, or the absence of messages or events, presented to an interface could reasonably cause a serious impairment at or beyond that interface.
CTIA Cellular Telecommunications Industry Association.
DB Database, a network element providing information to validate and route calls in a telecommunications network
Electronic Bonding - The application-to-application communications between telecommunications jurisdictions as they are defined in Telecommunications Management Network (TMN).
EO End Office, the first/last point of network switching intelligence in a voice network
Emergency Resources - Those resources that are planned and/or reserved for extraordinary service restoral requirements. The resources may be human, tools, power equipment, parts, production capacity and materials necessary for the accelerated restoral of the products and/or services delivered normally by a telecommunications company.
ESP Enhanced Service Provider.
Fault migration - A fault originating in one system that spreads across the network interface to cause fault(s) in another system.

GEO Geostationary Earth Orbit. - A satellite orbit located in the earth's equatorial plane (approximately 22,300 mi.). A satellite in this orbit appears to remain stationary with respect to a point on earth.

GHz Giga-Hertz (one billion Hertz), a measure of radio frequency rate

GSM Global System for Mobile Communications. Previously called Group Special Mobile. European standard cellular telecommunications

IC Inter-exchange Carrier

ICCF Industry Carriers Compatibility Forum, sponsored by ATIS

IILC Information Industry Liaison Committee. One of the sponsored committees of the Alliance for Telecommunications Industry Solutions (ATIS). The IILC manages industry interests for Open Network Architectures (ONA), the ONA User Guide and evolving network services architectures.

IITP **Inter-network Interoperability Test Plan** - A plan administered by the NOF to identify, develop and carry out nationally coordinated testing of the SS7 network. The test network is composed of network provider and manufacturer testbed equipment interconnected by network provider transport facilities through Bellcore for test configuration and coordination.

IITG **Increased Interconnection Task Group** - One of five task groups commissioned by the Network Reliability Council of the FCC to conduct studies and make recommendations concerning the national network reliability issues generated by an increasing number of interconnected network service providers.

Inter-LATA A term established at the time of Bell System divestiture to geographically differentiate the business interests of Local Exchange Carriers (LECs) and Long Distance Carriers (IXCs). The term is also used to describe telecommunications traffic transiting LATA boundaries.

IS-41 Interim Standard 41. A signaling system developed by the cellular telephone industry for inter system control messages. Packaged for transmission over the SS7 network.

ISDN Integrated Services Digital Network

ISUP ISDN User Part

ITU-T International Telecommunication Union - Telecommunications. The international telecommunications standards management body headquartered in Geneva, Switzerland.

IXC Inter-exchange Carrier

LATA Local Access & Transport Area. A geographic area defined at the time of the Bell System divestiture to prescribe the business domain of the Local Exchange Carriers

LEC Local Exchange Carrier

LEO Low Earth Orbit. **-** A satellite orbit in any plane at an altitude above the earth of a few hundred to a few thousand miles. Orbits are usually inclined to the equator and provide repeated access to areas within the satellite footprint.

LIDB Line Information Data Base. A repository used for call validation and accounting data needed to bill long distance calls.

Link Budget - Engineering assessment of the ability to provide connectivity between a satellite and an earth station. The budget includes RF power, antenna efficiencies, transmission losses etc.

MAP Mobile Application Part, part of the SS7 message protocol

MHz Mega-Hertz (one million Hertz). A measure of radio frequency rate.

MEO Medium Earth Orbit. **-** A satellite orbit in any plane at an altitude above the earth of several thousand miles. Orbit not precisely defined but is between LEO and GEO.

MF Multi-frequency. A method of switched circuit signaling using a combination of audible tones.

MSC Mobile Switching Center, associated with cellular access services

MSCID MSC Identification

MTP Message Transfer Part, part of the SS7 message protocol

MTTR Mean Time To Repair

Mutual aid Agreements - Agreements between telecommunications companies in similar lines of business to share resources (human, tools, equipment, service capabilities) to effect the accelerated restoral of service caused by a disproportionate outage by a minority of the parties to the agreements.

NCTA National Cable Television Association. An association of cable television system owners/operators whose purpose is to coordinate, among other things, the technical issues facing this industry.

Network Reliability - (a) the ability of a network to maintain or restore an acceptable level of performance during network failures by applying various restoration techniques and (b) the mitigation or prevention of service outages from network failures by applying preventative techniques.

NOF Network Operations Forum. One of the CLC responsibilities as described under CLC. NOF conducts industry interest forums concerning telecommunications network management, SS7 testing, toll fraud protection and installation/test and maintenance of telecommunications systems.

NPRMNotice of Proposed Rule Making, Federal Government

NRC Network Reliability Council. A 35-member council established by the Federal Communications Commission in 1994 to study and recommend solutions to five tasks. Focus Groups I & V- Network Reliability Performance and Application of Best Practices; Focus Group II - Increased Interconnection, Focus Group III - Reliability Concerns Arising Out Of Changing Technologies, Focus Group IV - Essential Communications During Emergencies.

NRSC Network Reliability Steering Committee. A group managed by ATIS that periodically reports the status of the nation's network performance to the FCC.

NSEP Network Security/Emergency Preparedness, a government/industry cooperative effort to manage resources during national stress conditions.

NSTAC-CCS Task Force - National Security Telecommunications Advisory Committee - Common Channel Signaling Task Force

OAM&P Interface - Operations, Administration & Maintenance. In this context, the interconnection point between network entities where OAM&P information is provided/received and utilized for the management and /or control of interconnected networks.

OAM&P Operations Administration Maintenance & Provisioning

PBX Private Branch Exchange

PCIA Personal Communications Industry Association.

PCS Personal Communications System

Physical Interface - The point where two telecommunications systems/facilities interconnect. Usually, these are described by industry terms such as, copper and fiber and may be inferred by the capacity of the facility at the interface, e.g., DS-0, DS-1, DS-3 T-1, T-3, OC-1 2 and the like.

POTS Plain Old Telephone Service

PSTN Public Switched Telecommunications Network

PTS Public Telephone System

PUC Public Utility Commission

RBOC Regional Bell Operating Company

RF Radio Frequency - a term describing a portion of the electromagnetic spectrum applicable, in this context, to frequencies used for telecommunications

RQMS Reliability and Quality Measurement System

SIA Satellite Industry Association. - The national trade association that represents the U.S. commercial satellite industry.

Signaling Channel Interface - Commonly available in two varieties, in-band and out-of-band. Multi-frequency (MF) is an example of in-band signaling. SS7 is an example of out-of-band signaling. Used here to indicate an interface interconnection of the signaling systems between two network entities.

SMR Special Mobile Radio

SNMP Simplified Network Management Protocol

SNS Signaling Network Systems (a committee established by the first NRC)

SP Switching Point, associated with the voice switch interface to the SS7 signaling network

SRIG Seamless Roaming Implementation Guide (a CTIA publication)

SS7 (Signaling System 7) An out-of-band signaling system for telecommunications network similar to the international version called CCITT7. SS7 is the ANSI accredited version used in the United States.

STP (Signal Transfer Point) A specialized packet switching system used for out-of-band signal routing in telecommunications networks.

SW Switch, refers to a voice message switch in a telecom network

TCAP Transaction Capability Applications Part

TDMA Time Division Multiple Access

TIS Telecommunications Industry Standards. Committee Tl is the ANSI accredited standards body for the development of telecommunications industry standards in the United States.

TIA Telecommunications Industry Association. An association of telecommunications industry manufacturers whose purpose is to ensure the compatibility/interoperability of equipment manufactured.

Timer Values - Refers to optionable logic timing parameters requiring specification in a SS7 network of Signal Transfer Points (STP's) and SSP's for proper system operation.

TMN Telecommunications Management Network

TR Technical Requirement (as developed and issued by Bellcore). Now replaced by the GR (General Requirement).

TRS Telecommunications Relay Service

TT&C Telemetry, Tracking and Command. - Functions required to maintain the orbital position, attitude and desired operating status of an orbiting satellite.

TVRO Television Receive Only. - An earth antenna that is capable of receiving signals from a satellite in orbit but has no capability to transmit signals to the satellite.

User information channel interface - Refers to the bearer or payload channel in a telecommunications network and the interconnection point between network entities.

VSAT Very Small Aperture Terminal. - A satellite earth station that employs a small antenna, one to two meters in diameter, to both transmit and receive signals from a satellite in GEO. Used primarily in private communications networks.

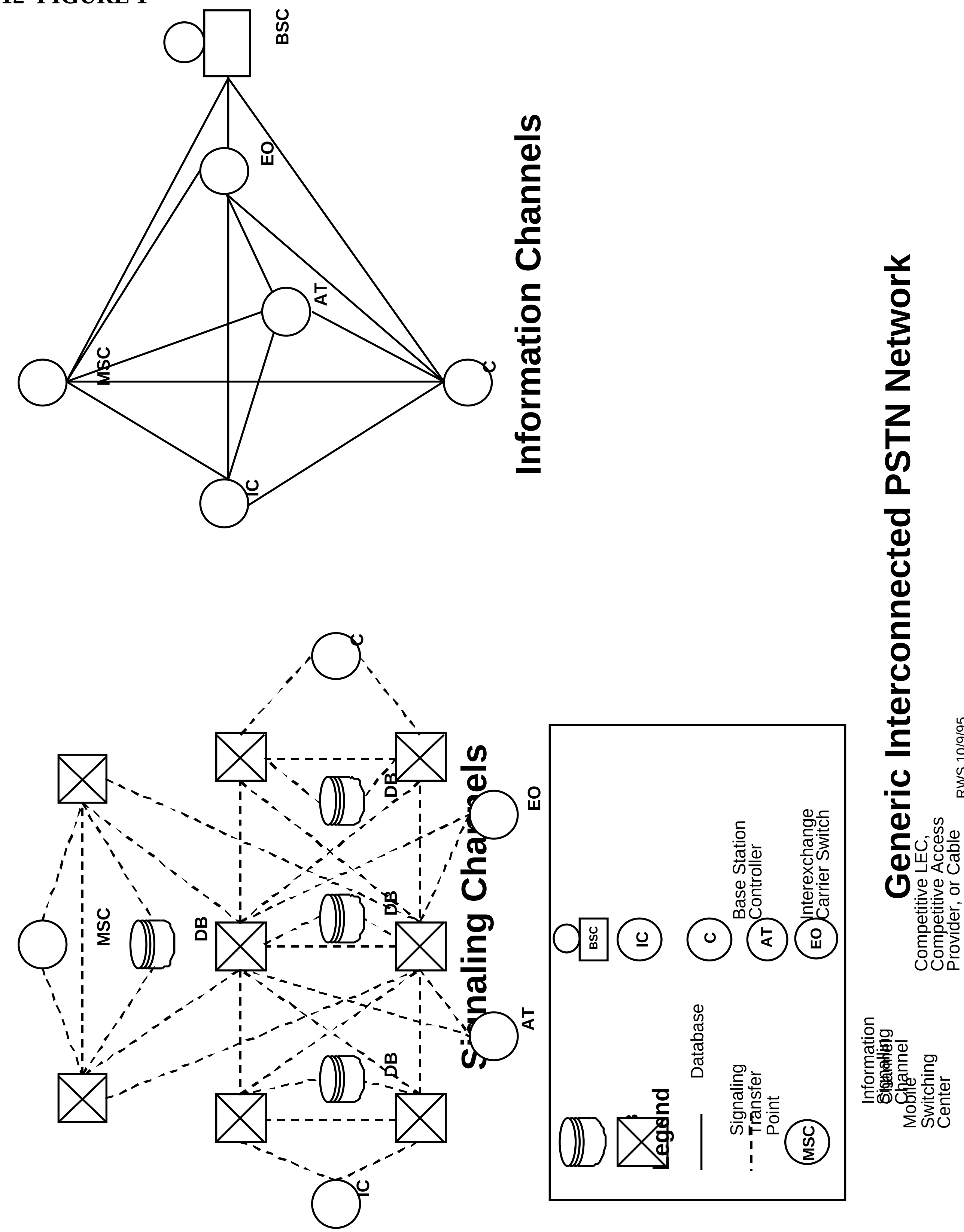
WIF The Wireless Interconnection Forum meets semi-annually to discuss and resolve interconnection issues. The WIF is sponsored by the Southern Telecommunications Industry Association, PCIA and AMTA. For ISUP SS7, WIF has participated in joint activities with the wireline SS7 providers at the Network Operations Forum.

###

12. FIGURES AND EXHIBITS

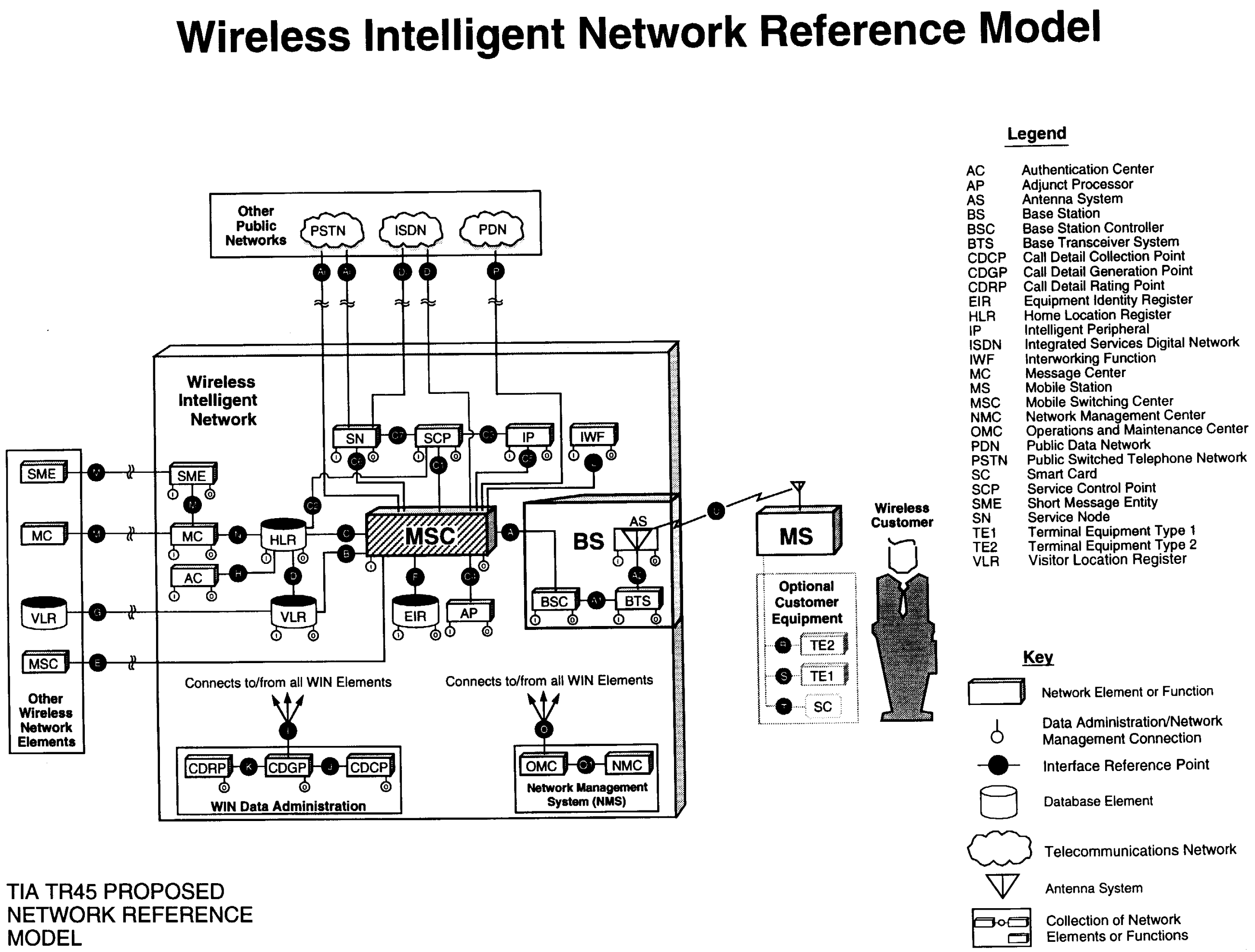
###

SECTION 12 FIGURE 1



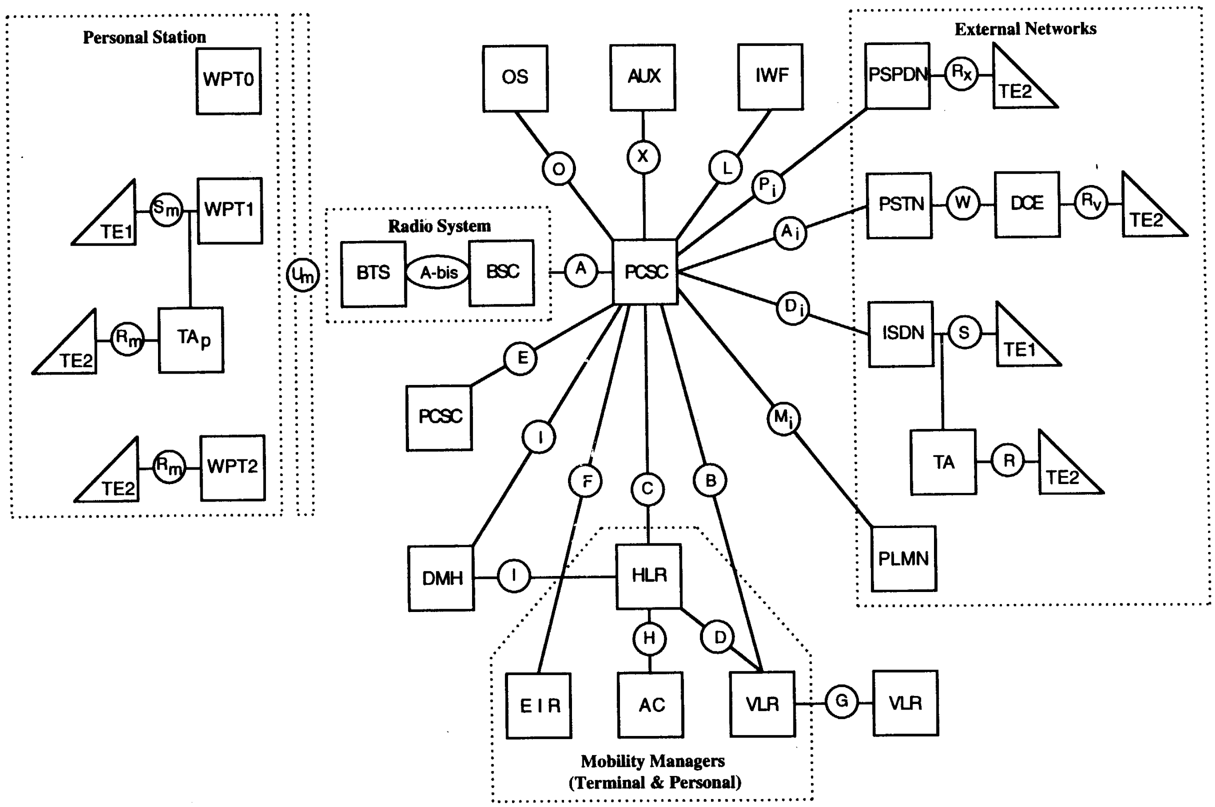
SECTION 12, FIGURE 2

TIA TR45 NETWORK REFERENCE MODEL



SECTION 12, FIGURE 3

TIA TR46 PCS Network Reference Model for 1,800 MHz



Legend:

AC	Authentication Center
AUX	Auxiliary Services
BSC	Base Station Controller
BTS	Base Transceiver System
DMH	Data Message Handler
EIR	Equipment Identity Register
HLR	Home Location Register
ISDN	Integrated Services Digital Network
IWF	Interworking Function
OS	Operations Center
PCSC	Personal Communications Switching Center
PLMN	Public Land Mobile Network
PSDN	Packet Switched Public Data Network
PSTN	Public Switched Telecommunications Network
TA	Terminal Adapter
TE	Terminal Equipment
VLR	Visitor Location Register
WPT	Wireless Personal Termination

SECTION 12 EXHIBIT 1

T1 and TIA Focus and Organization

T1 Focus Areas for Strategic Plan

ATM/BISDN/ADSL
Intelligent network
SONET Common Channel Signaling (SS7)
Network Reliability /Survivability
Telecommunications Management Network (TMN)
Personal Communications
National Information Infrastructure/Global Information Infrastructure

T1 Technical Subcommittees

T1A1	Performance and Signal Processing
T1E1	Interfaces, Power and Protection of Networks
T1M1	Inter-network Operations, Administration, Maintenance and Provisioning
T1P1	Systems Engineering, Standards Planning and Program Management
T1S1	Services, Architecture and Signaling
T1X1	Digital Hierarchy and Synchronization

TIA Engineering Committees

TR-8	Landmobile Services
TR-14	Point-to-Point Communications Systems
TR-29	Facsimile Systems and Equipment
TR-30	Data Transmission systems and Equipment
TR-32	Personal Radio Equipment
TR-34	Satellite Equipment and Systems
TR-41	Telecommunications Equipment Requirements
TR-45	Mobile and Personal Communications Public 800 Standards
TR-46	Mobile and Personal Communications 1800
FO-2	Optical Communications
FO-2.6/FO-6.10	Fiber Optic Components, Systems, Quality Assessment & Reliability
FO-6	Fiber Optics

SECTION 12 EXHIBIT 2

Key Telecommunications-Related Standards Groups

	Key Areas of Standardization	Key Technologies/Focus Areas	Sponsor	Location	Contact (US) Phone Fax E-mail
Committee T1-Telecommunications **T1**	Telecom Network Interfaces; Interoperability	BISDN, SS7, PCS, IN, TMN, SONET, Multi-media; Network Reliability, NII/GII	Alliance for Telecommunications Industry Solutions (ATIS)	Suite 500 1200 G St. NW Washington, D.C. 20005	Alvin Lai 202 434-8829 202 347-7125
Telecommunications Industry Assoc. **TIA**	Telecom Equipment	PBXs, Telephones, Cellular, PCS, Fiber Systems, Satellite, Radio Systems	TIA	Suite 300 2500 Wilson Blvd. Arlington, VA 22201	Dan Bart 703 907-7700 703 907-7727 TIASTDS@aol.com
Society of Cable Telecommunications Engineers **SCTE**	Cable TV Systems, especially physical layer	Cable TV Components - cable, connectors, modulation	SCTE	669 Exton, PA 19341	Bill Riker 610 363-6888 610 363-5898
International Telecommunication Union - Telecommunications Sector **ITU-T**	Telecom	BISDN, SS7, FLMPTS, IN, TMN, SDH, Multi-media, Satellite, Fiber Systems, Radio systems, Broadcast Video	United Nations' ITU	U.S. State Dept 2201 C St NW Washington DC Geneva: ITU-T Place des Nations CH1211 Geneva 20 Switzerland	U.S. Earl Barbely 202 647-0197 202 647-7407 Geneva: Theo Irmer 41 22 730 5851
Committee X3 **X3**	Information Technology	Video, Imaging, Storage Media, Data Protocols	Information Technology Industry (ITI) Council	Suite 200 1250 I (Eye) Street NW Washington DC 20005	Jean-Paul Emard 202 737-8888 202 638-4922
Institute of Electrical and Electronics Engineers **IEEE**	Electrical and Electronics	Local Area Networks, Software Languages, Test and Measurements	IEEE	445 Hoes Lane Piscataway, NJ 08855	Judy Gorman 908 562-3820 908 562-1571 j.gorman@ieee.org

Internet Engineering Task Force **IETF**	Internet	TCP/IP and its Uses to Trans-port Informa-tion -Telnet, FTP	Center for National Research Initiatives (CNRI)	Reston, VA	Steve Coya 703 620-8990 703 620-9913 scoya@ietf.cnri.reston.va.us
Satellite Broadcasting and Communica-tions Association **SBCA**	Satellite Communica-tions	Satellite Broadcast Equipment Earth Station Equipment	SBCA	Alexandria, VA	Ed Reinhart 703-448-9552
Satellite Industry Association **SIA**	Satellite Com-munications	Satellite Earth Station Equipment	SIA	Alexandria, VA	Clay Mowry 703-549-9697

###

SECTION 12 EXHIBIT 3

Improvements in the Committee T1 Standards Process

Background

Committee T1 and the standards process, in general, are not perfect. Committee T1 has viewed the "quality process" as one of continuous improvement; a journey without end. The Committee T1 process does not limit the industry or T1 participants in developing timely, high quality standards. Standards leaders and participants, however, must not limit themselves by imposing unnecessary restrictions and need to remain open to ideas and processes that would streamline the standards development effort.

Committee T1's Quality Improvement Program includes an annual, informal workshop where processes and operations are reviewed, as well as a five-year strategic plan. This workshop is distinct from business meetings and provides a creative atmosphere for new ideas. This has proven effective, since many of the most recent improvements were developed as a result of the Leadership Workshop. The Five-Year Plan provides specific direction and includes an Implementation Plan that highlights specific actions to pursue.

Standards Development and Liaison

The pace of Committee T1 standards and technical report production has increased significantly. Some of the specific actions taken to achieve this so far include establishment of Technical Focus Areas, implementation of a T1 Bulletin Board System (TIBBS) and T1 training programs.

Technical Focus Areas

While there are 150 individual projects, committee T1 has identified eight areas of Technical Focus that are deemed critical to the future U.S. "network of networks" and are certain to be important elements of a national information infrastructure. These areas are highlighted in Exhibit 1. With the exception of the Network Survivability and SS7 Interconnection areas, these topics are supported by a number of global standards counterparts to Committee T1.

In each of the focus areas, Committee T1 pays special attention to building liaisons with other industry fora, user groups and organizations. This has become an important addition to the Standards Life Cycle. The NIUF, ATM Forum, Frame Relay Forum, NRC, etc. are just a few examples of the organizations with which linkages have been established and maintained.

Exhibit 2 describes many of the organizations where excellent interactions have been established.

Electronic Document Handling

Committee T1 believes that electronic document handling (EDH) is critical to the future of the standards process. T1BBS has dial up unrestricted access and offers File Transfer Protocol and self subscribing e-mail capabilities. There is a program to stimulate utilization of the system, although it is not currently a requirement. An award is presented to the company that has provided the most leadership on EDH. One PCS group meets monthly and handles more than 90 percent of their work through EDH capabilities.

Training Programs

A T1 Leadership Training Workshop is held annually for leaders at all levels within T1. The workshop includes reviews of all processes, procedures and legal issues and includes case studies and practical experience reviews for difficult problems. EDH seminars are held and Information Directors are named to assist individual subgroups in resolving their questions and issues.

Committee T1 Standards Approval Process

In 1993-94 Committee T1 conducted a successful one (1) year trial of parallel voting processes for T1 and TSC letter ballots. It is believed that this enhancement shortened the approval process by 3 to 6 months. This is now the normal mode of operation.

Publication

ANSI publishes Committee T1 standards and ATIS, the T1 Secretariat and sponsor, publishes Committee T1 Technical Reports. There was a lengthy process involved in getting these publications out. New processes are in place that save one to two months in publishing standards, without compromising the quality of the documents.

###

SECTION 12 EXHIBIT 4

Improvements in the TIA Standards Process

The Telecommunications Industry Association (TIA) is accredited by the American National Standards Institute (ANSI) as a Standards Developing Organization (SDO) in the field of telecommunications. TIA's telecommunications standards-setting activities have been actively undertaken for over 50 years via TIA or one of its predecessors, such as the Electronic Industries Association (EIA) Information and Telecommunications Technologies Group. The more than 70 Engineering Committees and Subcommittees of TIA are supported by product-oriented divisions in areas such as Fiber Optics, Mobile and Personal Communications, Satellite Communications, Network Equipment and User Premises Equipment.

In the past two (2) years TIA has undertaken numerous activities to expand and enhance its Standards and Technology Department and speed up the development of TIA Standards:

- Additional human resources have been added and more are planned. Computer resources have been upgraded, including a state-of-the-art fiber optics Local Area Network (LAN) and direct connection into the Internet backbone.

- Expanded the use of electronic dissemination of information by bulletin board systems (BBS), Internet (including World Wide Web and e-mail) and broadcast facsimile.

- Undertook an updating of TIA's Engineering, Style and Scope Manuals to improve the standards process.

- Expanded joint and cooperative standards setting both domestically and internationally, with agreements with other SDOs such as Committee T1-Telecommunications (T1), the Canadian Standards Association (CSA), the European Telecommunications Standards Institute (ETSI), the Society of Cable Telecommunications Engineers (SCTE), as well as participating in international sectoral activities such as the Global Standards Collaboration (GSC), RAdio STandardization (RAST), International Telecommunication Union (ITU), International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC), Future Advanced Mobile Universal Service (FAMOUS), InterAmerican Telecommunications Commission (CITEL) and the Consultative Committee Telecommunications (CCT), for which TIA is the USA Secretariat.

- Actively participated in National and Global Information Infrastructure (NII/GII) issues including co-sponsor of R&D Forum on NII; participated on the Steering Committee of the ANSI-sponsored Infrastructure Standards Panel (IISP), jointly published White Papers with EIA on NII and GII and organized three-day conference in Warsaw, "GII: Agenda for Cooperation in the East/Central European Region," and other fora activities directed to these NII/GII standards issues.

- Launched an Intelligent Transportation Systems (ITS) activity to support Intelligent Vehicle Highway Systems (IVHS) and other wide-area communications needs of this part of the nation's information infrastructure.

- Added as a member of the FCC's Network Reliability Council (NRC) and active participant on FCC's Negotiated Rulemaking Committee on Hearing Aid Compatibility.

- Supported Mutual Recognition Agreement (MRA) discussions between the United States and the European Union (EU) and member states of the EU in the areas of testing results and type approval of equipment.

- Published a Standards and Technology Annual Report (STAR) in 1994 to highlight TIA's 50 years of standards setting activities.

- Recognizing the convergence of technologies, in 1995, organized TIA's and EIA's Standards and Technology activities under a single vice president.

TIA's standards-setting activities recognize the strategic importance of standards to TIA's members, service providers, users (including federal and state governments) and the overall welfare, security and reliability of our telecommunications infrastructure.

###

SECTION 12 EXHIBIT 5

Elements of Implementation Plan For the Year 2000 Committee T1 Strategic Plan

Identify and Maintain Technical Focus Areas

1. The list of Focus Areas will be reviewed annually to ensure that it is up-to-date and reflects industry needs.

2. New projects will identify which focus area they address, as appropriate.

Improve the Timeliness of Standards Products

1. Increase the use of T1BBS for distribution of contributions and comments prior to meetings.

2. Provide access to draft standards on T1BBS.

3. Implement a single ballot process.

Enhance Quality Awareness

1. Expand the T1 leadership training program.

Advance the Program Management Process

1. T1P1 to take a pro-active role in the management of standards for NII.

2. T1AG to regularly review the role of program management.

Expand the Synergy of Work Plans

1. Share information at the earliest possible time with other domestic, regional and international standards organizations.

2. TSCs to assist in the identification of the work and purpose of fora and other organizations.

3. Develop guidelines to accept appropriate work items for standardization from forums and other organizations.

4. TSCs to take a pro-active liaison/participation with forums.

Increase Industry Awareness And Support

1. Focus on "Hot" technologies in the press i.e., PCS, ATM, ADSL, NII, ISDN.

2. T1 Secretariat PR group to contact TSC Chairmen after each TSC meeting to assure that the PR group is updated on actionable items. Secretariat to make press releases when new work begins, milestones are reached and when a standard or report is completed.

3. Angels to work with Secretariat PR group to maintain updated information on focus areas.

4. T1 to encourage members' participation in seminars and to make submissions to journals.

5. Secretariat to provide inputs to the ANSI Reporter regarding Committee T1 activities.

Enhance Executive Awareness and Support

1. T1 leadership to communicate with executive management of member companies the appreciation for funding of T1 participants, and hosting meetings and the accomplishments resulting from this support.

2. T1 Secretariat to notify the official representative of member companies of articles mentioning T1 activities for distribution to company executives.

Optimize T1 Structure/Organization

1. T1AG to undertake a review of the structure and organization of the TSCs.

Advance and Implement an Effective Electronic Document Handling Plan

1. T1EDH Standing Committee to:
   - Define and develop WWW interface
   - Establish home pages for each TSC
   - Provide a linkage for access to the server
   - Secure committed workers for BBS development
   - Maintain close liaison with the ATIS public relations group
   - Establish a method for electronic balloting

2. Continue to work with ANSI to encourage electronic access to standards.

3. T1, T1AG and TSCs will provide all meeting notices and agendas electronically no later than June 1996.

Optimize Meeting Logistics and Effectiveness

1. Secretariat to investigate alternative meeting funding arrangements.

2. Encourage the use of EDH to distribute meeting contributions electronically.

Maintain a Multi-Year Financial Plan

1. T1 secretariat will develop a multi-year financial plan based upon projected participation in Committee T1. This plan will be presented to T1/T1AG for approval.

###

SECTION 12   EXHIBIT 6.

Description of an Example Standards Project Proposal

(Based On The 1994-95 Committee T1 Procedures Manual)

This exhibit, by way of example, describes the preparation process for project proposals used by Committee T1 - Telecommunications.

Preparation Of Project Proposals

Introduction.

A project may be introduced by any individual, corporation, organization, technical subcommittee, the T1 Advisory Group, or any other party, whether or not a member of Committee T1. Once the need for a project has been identified, a project proposal must be prepared that clearly identifies the purpose and scope of the project. This proposal should also clearly identify the expected outputs of the project, that may include any of the draft documents covered in this section of the manual. The preparation of a project proposal is set forth below.

Project Proposal Form.

Figure A-1 is the outline to be used in preparing a project proposal. The initial draft of a project proposal need not include all the required data. However, the final draft submitted for T1 Technical Subcommittee (TSC) and T1 approval must include all the data specified in this section. If the proposed project is a candidate American National Standard (or set of closely related standards), the project proposal should address that standard (or set of standards) only.

STANDARDS COMMITTEE T1-TELECOMMUNICATIONS

PROJECT PROPOSAL

1. PROJECT IDENTIFICATION
    - 1.1 Title
    - 1.2 Submitted by
    - 1.3 Date

2. DESCRIPTION
    - 2.1 Description of proposed project
    - 2.2 Proposed program of work
        - 2.2.1 Work Products
        - 2.2.2 Milestones
    - 2.3 Project assignment and resources
        - 2.3.1 Technical Subcommittee assignment
        - 2.3.2 Technical Subcommittee resources
        - 2.3.3 External resources required

3. JUSTIFICATION OF NEED FOR PROPOSED PROJECT
    - 3.1 Description of the need
    - 3.2 Existing standards or practices

4. RELATED STANDARDS ACTIVITIES

4.1 Other Technical Subcommittee activities
4.2 Other domestic standards activities
4.3 International standards activities
4.4 Standards related group activities

Project Proposal Outline

A study project may identify the need for several standards projects. If this is the case, separate standards project proposals should be prepared for each candidate American National Standard (or set of closely related standards) identified by the study project. A study project may also identify contributions to international standards organizations and/or may identify a technical report as an intended product. Each item on the form is discussed below. The same form is used whether the project is a standards project or a study project.

<u>Project Identification</u>

Title. Clearly identify the subject of the proposed project and indicate whether it is for the development of an American National Standard or whether it addresses a study project. The title should be brief and to the point. Recommend an abbreviated or "short-form" title where the definitive title is extensive.

Submitted By. Identify the name of the individual or organization submitting the current version of the proposal. This should be updated, as required, to reflect the degree of approval the project proposal has received. When an organization is indicated, also list the name of an individual who can be contacted for questions.

Date. Insert the latest date of preparation.

<u>Description</u>

Description of Proposed Project. State the purpose and scope of the proposed project in sufficient detail to permit proper evaluation. List areas covered (e.g., protocols, services, interfaces, etc.,) and related areas the project does not address. Describe the expected outputs (e.g., standards, reports, contributions).

Proposed Program of Work. Describe the steps to be taken to complete the project. Be as specific as possible concerning milestones and scheduled deliverables. The final draft must include estimated dates for the following specific milestones (target dates) where applicable to provide input for the Committee T1 Project Tracking System:

- Project approved by TSC
- Project approved by T1
- Draft standard or technical report submitted to the TSC
- Draft standard or technical report ready for TSC ballot
- Standard or technical report approved by TSC
- Standard or technical report approved by T1
- Standard approved by ANSI (Normally eight (8) weeks after T1 approval)

- Standard reaffirmation date (Five (5) years after ANSI approval date)

Project Assignment and Resources

Technical Subcommittee Assignment. Recommend a TSC to work on the project. Project assignment to a particular TSC is based on the current mission and scope of the TSC. It is the responsibility of each TSC to ensure that all project proposal efforts are confined to projects within its mission and scope. When in doubt, the chairman of the identified TSC should submit the project proposal to the T1 Advisory Group for assignment clarification. Project proposals submitted directly to Committee T1 or the T1 Advisory Group will be assigned to a TSC by the T1 Advisory Group.

Technical Subcommittee Resources. Identify the skills and expertise required within the TSC to complete the proposed project.

External Resources Required. List any external resources required to perform the work contemplated by the proposed project. Examples of external resources that may be required are testing, lab facilities, user requirements, or individual experts in a specified field.

Justification of Need for Proposed Project

Description of the Need for Standard. Describe the reasons for developing this standard or study project (e.g., compatibility, advances in technology, market/user requirements, etc.).

Existing Standards Practices. Identify existing standards, technical publications, etc. and current practices that are similar or comparable to the proposed project. Also list existing standards or practices that may be used as references in the planned work.

Related Standards Activities

Other TSC Activities. List in this section other standards projects or study projects currently underway in other TSCs of Committee T1. Describe liaisons needed for effective completion of this project. Be specific.

Other Domestic Standards Activities. List potentially related projects or activities in other domestic standards bodies (e.g., X3, EIA, IEEE, etc.). Describe the specific liaisons required for the effective completion of the proposed project. Organizations should be listed if it is expected that they will coordinate with the proposed project or need to be aware of it.

International Standards Activities. List related international standards development activities such as CCITT. Be specific. Indicate where contributions are likely to be submitted to the international groups as a result of this project.

Standards Related Group Activities. List related groups (fora). Indicate related outputs, inputs and dependencies.

SECTION 12 EXHIBIT 7.

Description of an Example Project Tracking Process

Objectives Standards Process Management.

It is necessary to manage the standards development progress through changes in personnel, structure and issues addressed in Committee T1. This exhibit is intended to tie together those aspects that assist in managing the standards development process. Particular attention has been given to assure that this process is simple and flexible to use. The primary benefit of using this process is that standards are developed in a more timely fashion due to the interactive identification and development of action plans with targeted objective dates, which are then effectively used with a tracking and monitoring system.

Components of Standards Process Management. The basic components of the management process are:

- Initial Objectives and Milestones
- Action Plans
- Project Tracking Reports
- Monitoring System

Initial Objectives and Milestones. The initial objectives and milestones are set at the project proposal stage. Section 6 and in particular 6.1.4.1 and 6.1.4.2, provide instructions to specify the objectives (e.g., areas covered, expected outputs, etc.), the steps to be taken to complete the project and the setting of milestones and deliverables. The estimated dates for the specified milestones are then used to populate the project tracking report. The specified milestones are given in 6.1.4.2 and 15.3.1.

TSC Action Plans. The action plans to accomplish the standard development process in accordance with the objectives and milestones are developed by the TSC (Technical Subcommittee) and WG (Working Group) Chairmen and other work leaders, in conjunction with the members. There are a variety of components that constitute effective action plans, including the following:

- Prioritizing work in accordance with the established target dates
- Breaking the work program into phases with associated milestones and calls for contributions for each phase
- Structuring agendas to accomplish the above
- Assigning defined tasks to sub working groups and ad hoc groups
- Selecting a roll call vote or a letter ballot

The action plans should assure process timeliness, but not inhibit due process or preclude technological innovations.

Project Tracking Reports. A common project tracking report and system has been developed for use by all TSC's for the purpose of tracking the status of all projects within Committee T1. It is the responsibility of the TSC Chairman to update the project tracking report quarterly after each meeting of the respective TSC. This project tracking report shall also be used in the Annual Report of the TSC.

A format description of the Project Tracking Report is found later in this exhibit.

Monitoring System. The monitoring system component of the standards process management has a very close tie with the project tracking system. A monitoring system should provide a means to measure the effectiveness of the process, reassess/change initial objectives and milestones and optimize the entire standards development process. The monitoring system includes action by the TSC Chairman, its members, the T1AG and all members of Committee T1. A scenario of a functional monitoring system is as follows:

- Initial objectives and milestones are approved
- The project information is loaded into the project tracking system
- Action plans are developed and intermediate milestones/phases established
- The project status report is updated quarterly to reflect progress
- The work leaders, members and T1AG monitor the milestone achievement and note any areas where progress is not meeting milestones and the associated reasons
- The work leaders and T1 Committee members:

    - reallocate resources to meet the established milestones

    - assess any long-term penalties of individual issue delays

    - feed back changes to milestones to reflect the realities of the particular project

After a standard is approved, it is so noted permanently in the project tracking system along with the ANSI reaffirmation date to remind the organization of the timing requirements for the next generation or reaffirmation of the standard.

Project Tracking Report Description

Milestones. The project tracking report accepted for Committee T1 usage to record critical milestone dates and information on the status of projects has the following specific milestone dates chosen for tracking:

- Project approved by TSC
- Project approved by T1
- Draft standard or technical report submitted to the TSC
- Draft standard or technical report ready for TSC ballot

- Standard or technical report approved by TSC
- Standard or technical report approved by T1
- Standard approved by ANSI
- Standard reaffirmation date

Historical, Projected and Target Dates. Dates for these milestones are tracked for each project proposal on a per deliverable basis (i.e., standards and technical reports). Looking both ahead and back in time, the date information is summarized graphically in a matrix form. Historical, Projected and Target dates are defined as follows:

> A Historical date is the actual date a milestone was completed. Since a Historical date represents actual completion, it is posted only once and retained without change.
>
> A Projected date is a future date for which completion of a milestone is anticipated. A Projected date is changed as necessary to reflect the current estimate of the milestone completion.
>
> A Target date is the future date for which completion of a milestone was anticipated at the time of the Project Proposal approval. A Target date is posted only once in accordance with the dates on the Project Proposal and retained without change.

Column Headings. Explanations of the project tracking report column headings are as follows:

> WG - The Working Group to which the project has been charged.
>
> ANSI PROJECT - The ANSI project designation.
>
> DESCRIPTION - The subject or title of the project.
>
> STATUS - The status (Active or Inactive) as determined by the TSC.
>
> TYPE OUTPUT - The type of output document(s) (Contribution, Standard, etc.) intended by the TSC for the project.
>
> PROJECTED APPROVAL DATE - A future date for which completion of a milestone is expected. Two types of dates described in 15.3.2 are entered here: Target and Projected.
>
> LETTER BALLOT - The TSC and/or T1 letter ballot designation associated with the type of output.
>
> APPROVAL DATE - The actual (Historical) date a milestone was completed.
>
> COMMENTS - For use by the TSC as desired (e.g., a standard's subject or title, relation to other projects, final ANSI standard designation number, etc.)

Update When Standard Approved. Upon final ANSI approval of a standard, the first six (6) milestones (i.e., the standards development milestones) and their corresponding dates are removed from the project tracking report. Permanent entries are made for the ANSI approval date (including the ANSI designation number) and the standard reaffirmation date. The TSC may wish to retain record of those six (6) dates removed as a track record for use in estimating development time for other projects.

SECTION 12   EXHIBIT 8.

Model Process for SS7 Network Interconnection

Interconnecting Networks

A Service Provider tests all interconnecting networks prior to service turn-up. These networks include, but are not limited to:

- Local Exchange Carriers
- Competitive Local Carriers
- Interexchange Carriers
- Radio Common Carriers
- Enhanced Service Providers
- Satellite Service Providers
- Cable TV Service Providers

Scope

The purpose of this document is to define, in broad terms, a model for CCS Network testing a Service Provider performs when interconnecting CCS networks. Testing is performed with interconnecting network elements to verify signaling network integrity, signaling compatibility and application interoperability.

General Methods

Testing is performed by technical staffs of or representing the Service Providers. Technical requirements are specified for each suite of tests. Testing must prove that compatibility and interoperability exist. Testing will be performed with each interconnecting network. Exceptions requiring either a test subset or repetitive testing are identified in the testing suites section on the following page. Technical requirements are prepared for each suite and are available separately.

Testing Architectures

A variety of environments as required by the interconnecting network architectures and by the service or application provided through network interconnection will be used. Four test strategies are employed:

- Intrusive Testing (Lab environment)

  This test strategy requires interconnecting elements to be directly connected (via “A” or ”D” links as appropriate) to a captive STP pair. This test architecture supports intrusive tests at the link and network level of the Message Transport Part (MTP), using specialized test equipment. These tests are used to verify signaling compatibility.

- Monitoring/non-intrusive (Live/Controlled Environment)

  This test strategy supports an interconnection architecture of live CCS signaling elements to an in-service STP pair. Test data are acquired via non-intrusive bridge monitoring of the signaling links. This test architecture supports verification tests for traffic routing translations, signaling network management implementations and signaling network integrity.

- Controlled Testbed (Live/Controlled Environment)

  This test strategy requires interconnecting networks to establish live signaling and trunking connections to a controlled test network. It supports interoperability testing of the services and applications for ISDN-UP for call control (ISUP-CC).

- Pre-Service and Vertical Services Testing (Live/Controlled Environment)

  This test strategy supports pre-service verification of ISUP-CC application translations and implementations in the live network. It is most commonly applied at the start of message trunk conversion from in-band (MF) signaling to out-of-band (SS7) signaling.

Scheduling and Approval

Test scheduling can begin after a bilateral interconnection agreement is in place. Approval to interconnect is issued immediately after successful completion by the testing staffs. Interconnection can proceed after formal compatibility and interoperability acceptance. All testing data, results and compatibility and interoperability acceptances are to be archived.

Testing Suites

Specialized tests are developed by the Service Provider to satisfy network integrity, network compatibility and network interoperability concerns. These test suites are applied for network interconnection based on the services or applications supported. NOF or ANSI standards are used to form the foundation of the actual test suites, when they are available.

Examples of Test Suites are Message Transfer Part (MTP), ISDN User Part for Call Control (ISUP-CC) and Vertical Services.

- Message Transfer Part (MTP)

SS7 Level 2 and 3 protocol and procedures testing is performed as follows:

- STP to STP:
  Lab/Intrusive tests are performed in a Lab-to-Lab or Lab-to-Live environment for every interconnecting network using an STP to STP architecture.
- "A" Link Access:
  Lab/Intrusive Signaling Point to Lab tests are performed on switch types and or generic levels that are not already deployed within the Pacific Bell CCS network.
- "A" Link Access
  MTP Subset/Non Intrusive SP to STP Pair (live) tests consisting of a MTP subset for routing translations and network management implementation verification are performed when switch types and generic loads are identical to switches currently deployed within both interconnecting networks.

- Signaling Connection Control Part (SCCP)

Protocol and Procedures Testing are performed for the Signaling Connection Control Part (SCCP) to address the following items:

- Subsystem Management
- Subsystem Routing and Mated Pair
- Global Title Translations

- ISUP-Call Control

Controlled Testbed tests are conducted subsequent to successful completion of MTP testing for interconnecting networks requesting conversion of trunk groups from in-band (MF) to out-of-band (SS7) signaling. These tests include:

- Controlled Routing
These tests are conducted in a live test environment using restricted line and trunk groups.

- Switch Type
Testing is applicable to interconnecting signaling points which are not deployed within both interconnecting networks.

- Interworking Combinations
Testing is performed between the interconnecting network and all SS7 capable switch types deployed within both networks. All potential call paths and points of MF to SS7 interworking are tested.

- Live Routing
These call-through tests are conducted in a live environment in a pre-service mode on switch types and generics that are currently deployed in both networks.

- Maintenance Verification
Circuit and Group state control tests are performed on trunk groups in both the Controlled Routing and Live Routing test environments.

• Vertical Services (TCAP Messaging)

Controlled Testbed tests are required for vertical services; these tests are conducted after successful completion of MTP compatibility testing and ISUP if they are ISUP dependent (e.g., CLASS, ISDN services).

These tests are customized, by application. Tests include:

- 800 Query
- ABS/LIDB
- CLASS
- ISDN
- AIN-TCAP
- IS-41 TCAP for PCS and Cellular

• Service Monitoring/Element Testing

Service Providers should monitor SS7 network interconnections for anomalous signaling conditions as a matter of course. This includes additional testing as required, for example:

- SCP Performance Testing
- 800 Call Sample Testing
- LIDB Global Title Routing Testing
- PCS Phase 1 Network Integration

• Generic Changes

New generic loads for network elements should be tested by Service Providers prior to placing them in service. There is no policy to re-test with interconnecting networks based on changes in those networks. Service Providers should monitor SS7 network interconnections for anomalous signaling conditions as described under service monitoring/element testing.

Process and Roles

Both interconnecting Service Providers will maintain parallel functional roles, consistent with their internal organizational structures.

- Industry Market Management - responsible for direct inter-Service Provider interface.
  - Acquaint new interconnecting Service Providers with bilateral agreement, test and order processes
  - Arrange for completion of bilateral agreements
  - Define test architecture and serving arrangements
  - Exchange test plans and contact lists
  - Obtain agreement on schedule and test plans
  - Coordinate test schedules with respective Systems Engineering and Network Services groups
  - Ensure Service Orders and trunk orders are placed
  - Notify Systems Engineering and Network Services of due dates, orders and delays

- Network Services Planning - responsible for testbed coordination.
  - Provide detail of test architecture to affected work centers, such as switch routing and translations, circuit information, signaling network routing and translations
  - Coordinates orders and changes with work centers
  - Provide Industry Market Management with test architecture information
  - Track and link trunk orders
  - Notify Systems Engineering when MTP and/or ISUP testbed is ready

- Network Operations- responsible for testbed installation and control.
  - Input translations and routing
  - Verify trunk circuits
  - Notify Network Services Planning when orders completed
  - Perform trunk group busy/idle commands during testing

- Signaling Network Control Center- responsible for SS7 network testbed installation and control.
  - Complete link orders and verify alignment
  - Input routing and translations in the STP
  - Notify Network Services when orders completed
  - Perform on-site link patches and cross-connects
  - Perform link maintenance and administration during testing

- Systems Engineering - responsible for test control, analysis and acceptance.
  - Verify testbed SS7 link, translation and routing for MTP tests
  - Verify ISUP testbed translations, routing and trunking
  - Conduct MTP and ISUP tests
  - Analyze test results and report findings with other participating Service Provider
  - Coordinate non-compliance process and retest when required
  - Issue formal compatibility and interoperability acceptance for MTP and for ISUP
  - Issue formal compatibility and interoperability acceptance for SS7 interconnect
  - Release testbed for next Service Provider testing.
  - Archive test results

SECTION 12 EXHIBIT 9.

Joint Technical Committee Validation and Verification Procedures

(Reference: JTC(AIR)/94.08.04-541R2)

1. A Validation and Verification (V&V) committee must be established for each document. Procedures will require that Technical Ad hoc Group (TAGs) request that the Joint Technical Committee (JTC) approve and form a V&V committee for each of their respective documents. The TAGs must provide the names of those who have committed to participate in the proposed V&V committee (at least six) in order to gain approval. This will ensure that everyone will know who the V&V committee members are.

2. A V&V committee must consists of at least six participants that include the following (additional participation is encouraged):
   - Chairman
   - Document editor
   - Subject Matter Experts (SME) from two different companies
   - Participants from two different Service Providers or Potential Service Providers

   This is recommended as the minimum participation level for a V&V committee to ensure that editorial changes can be efficiently made in the actual document and that there will be adequate technical competence and service provider review. The chairman will have the additional responsibility of facilitating the work and providing reports on the progress of the committee to the JTC.

3. All V&V committee members should participate to the fullest extent possible from the beginning of V&V through its completion and are expected to read the entire document to ensure adequate review and facilitate rapid completion.

   In addition, the document should be made available to any JTC participant who may participate in the V&V process by completing a Document Discrepancy Report (DDR) and submitting it to the appropriate TAG chairman. This DDR will follow the same review process as documented in Item 5 below.

4. Large documents (i.e., greater than 500 pages) may be subdivided or broken into logical segments such as topics or "chapters" and the V&V committee divided accordingly (i.e., a minimum of six participants per segment as specified in item 2). However, it is preferable for a single V&V committee to review an entire document.

5. V&V committee members are to review the document for:
   - Editorial clarity (grammar, ambiguous phrases, etc.)
   - Editorial consistency (style, references, terminology, etc.)
   - Technical clarity (adequate specification)
   - Technical consistency (consistency between requirements)

6. V&V committees will be empowered to make editorial corrections and clarifications.

7. V&V committees will identify in writing all questions regarding technical clarity and consistency and forward them to the TAG for resolution. <u>V&V committees are empowered to make technical changes.</u>

The V&V committee should document all changes to the document, both from the DDR participants as well as the committee itself, in a line in/~~line out~~ format until the document is approved by the TAG to transmit out as a clean document.

8. After V&V is completed to the satisfaction of the TAG, the TAG may make a recommendation to the JTC regarding the disposition of the document (e.g., recommending the document be forwarded to TR46 and T1P1 for ballot).

9. In order to ensure completeness of the V&V process within each TAG, a final report (which might simply be copies of the V&V meeting reports) and a copy of the draft document should accompany the recommendation of the V&V committee.

V&V of Large Documents

Paper copies are required for members of the V&V committee.

Paper copies of sections of the document to be reviewed can be distributed all at once, or as a V&V review schedule. A complete copy is preferable so that cross references can easily be checked.

Mail out electronic copies on both MAC and DOS disks to the JTC mailing list.

Include the complete test of the document to be reviewed.

Include a soft copy of the Discrepancy form, the V&V review schedule and an appropriate READ_ME.TXT file on both MAC and DOS disks. The READ_ME.TXT file should contain instructions on how to print out the document.

Sufficient time should be allocated so that disks can be received by JTC participants so that they will have the benefit of the complete review period (a minimum review period of 5 weeks) to fill out and return Discrepancy sheets (i.e., allow x business days for disk duplication and y business days for distribution by mail, etc.).

Participants should record only one discrepancy per discrepancy sheet.

Discrepancy sheets should be returned to the contact person listed at the bottom of the discrepancy sheet.

Only one (1) copy of discrepancy sheets needs to be made available to the V&V committee (i.e., the contact person listed at the bottom of the discrepancy sheet).

SECTION 13

APPENDICES

Appendix 1

Network Reliability Council
Issue Statement

Author: Ross Ireland
Pacific Bell

Problem Statement/Issues to be Addressed

The number of Telecommunications Service Providers and new network configurations will continue to grow at an increasing pace. The larger the number of providers and interconnected network configurations, the more complex the reliability problem becomes. This is due to the difficulty in identifying and isolating network problems to the responsible element or the entity containing the problem so that it can be fixed, while not affecting other parts of the network. Telecommunications Service Providers that are providing interconnection must do so in a way that does not compromise reliability.

Areas of Concern/Problem Quantification

The following are the major areas that should be considered for increased interconnectivity.

- Impact of New Networks. Identify the impact on existing networks of interconnection with new networks such as cable networks, satellite networks and wireless networks, over the next 5-10 years.
- Unbundling of Existing Networks. Identify the impact of increasing interconnections of a variety of service providers into the current networks.

The list below represents areas where reliability may be jeopardized if not well cared for prior to interconnection.

- Network interface, performance standards and operating standards. Clear, well documented standards for network interconnection.
- Network interface and service assurance, interoperability testing. Demonstrated performance in a realistically simulated operational environment.
- Fault isolation. The ability to identify and isolate a problem to specific network elements and service providers.
- Fault migration mitigation. Network firewalls to prevent problems from spreading across networks.
- Engineering/capacity provisioning. Identification and assessment of higher/different traffic volumes and/or traffic patterns.
- Information sharing between service providers. Data requirements in a standard format disseminated rapidly to aid service provider problem identification and analysis processes.
- Mutual aid. Expedited mutual aid recovery requirements through collaboration.

Consider the adequacy of the Standards Development and Compliance Process. Is the voluntary development of, and conformity to, standards keeping pace with increased interconnection and will it be able to in the future? If the standards development process is unable to keep pace with the needs, what escalation/resolution method is proposed?

To the degree that interoperability testing or other centralized work is recommended, include a recommendation for how such work should be funded (including the current SS7 Interoperability testing).

Description of Proposed Work

The team working this issue should consider the following total quality process to assess network reliability vulnerability due to increased interconnection and should propose problem solutions.

1. Collect appropriate data from all available industry sources to determine/confirm areas of greatest current criticality and risk and to determine greatest potential future concern.

2. Perform sufficient analysis of the data to determine the high reliability risk areas of increased interconnection. Sub-analysis should include:
    - Current interconnections network reliability problems:
        - Designs, shortcomings
        - Operations, Administration, Maintenance and Provisioning Plans
        - Documentation
        - Testing
    - New network interconnection reliability risks for cable, satellite, wireless
    - Reliability risks of unbundled interconnection of various service providers to the current network.

3. From the analysis of reliability risks, determine an appropriate action plan to reduce the possibility or severity of failures in high risk areas.

4. Determine industry "Best Practices" for dealing with the high reliability risk areas and share this information with industry participants as soon as possible. Also consider cost/benefit tradeoffs of these "Best Practices." (Attached are some initial areas for consideration.)

5. Consider the development of principles and/or templates that depict the areas of interest that should be addressed prior to interconnection. Attached is an example offered by the steering team of which areas might be considered for inclusion in an interconnection template. This is meant to be an example only and may be accepted or rejected by the interconnection focus team.

6. Consider a recommendation for the following if the "template" example or a similar recommendation is made. Determine which group or organization should be responsible for:
    - Ongoing stewardship for templates and minimum interconnection requirements
    - Any interoperability testing to be performed on a centralized or national basis
    - Dispute resolution between interconnect parties

7. Develop a timeline and metrics to measure the effectiveness of the team's recommendation.

A. Network Interfaces Specification Template. Establishes a generic criteria for the development of Network Interface Specifications that identifies the minimum list of items that must be effectively addressed to establish and maintain a point of network interconnection for all service providers who interconnect their networks. This template can be used to insure key issues such as fault isolation, fault migration mitigation and performance objectives. Following is a draft outline of such a template:

Network Interface Specification Template

- Physical interface defined
  - Clear point of demarcation, allowing test access, surveillance access
  - Mechanical, environmental, power, grounding and security requirements
  - Specification of radiated and conductive electromagnetic properties
  - Spectrum allocation and management standards
- Message set defined and published (proprietary or network specific messages should not be transmitted across the network interface)
- Defined/robust protocol, without proprietary extensions
  - Error correction, retransmission
  - Message overload controls and management
  - Fault migration mitigation, etc.
- Compatible Routing and Addressing Plan
  - Point Code, CIC, NXX requirements defined
  - Standard circuit assignment and identification
- Network Performance design objectives defined
  - Signal transport time (delay)
  - Availability (downtime by node, access, service)
  - Lost message probability
  - Undetected error
  - Transmission plan and performance specified (e.g., Bit Error Ratio, loss)
  - Network congestion design objective
- Regulatory Issues, e.g., Calling Party Number Privacy Management Capability
- Forward and backward compatibility of protocol for transition management
- Route Status (available, not available, etc.) to be maintained for all interconnected points.
- Which group/organization should be responsible for
  - Ongoing stewardship for templates and minimum interconnection requirements.
  - Any interoperability testing to be performed on a centralized or national basis
  - Dispute resolution between interconnecting parties.

B. Service Specification Template. Establishes a generic criteria for the development of Service Specifications that identifies the minimum list of items that must be effectively addressed to establish and maintain a service across a network interconnection. This template can be used to address key issues such as fault isolation, fault migration mitigation and performance objectives for services on their specified network interface and protocol.
Following is a draft outline of such a template:

Service Specification Standard Template
- -Functional requirements
- -Interconnection architecture
- -Routing Plan
- -Network Interface Specification
- -Protocol requirements
- -Physical interface requirements
- -Performance requirements
- -Billing data recording requirements
- -Network data information administration and sharing agreement
- -Regulatory constraints, such as Calling Party Number Privacy Protection Policy and Operating Rules

C. Operations, Administration, Maintenance and Provisioning Plans Template. Establishes a generic criteria for the development of Operations, Administration, Maintenance and Provisioning plans that identify the minimum list of items that must be effectively addressed to establish and maintain a service across a network interconnection. This template can be used to insure key issues such as network management, network security and operating procedures are effectively addressed. Following is a draft outline of such a template:

Operations, Administration, Maintenance and Provisioning Plans Template:
- -Network Management
- -Network Security
- -Operating procedures
- -Maintenance procedures, including trouble isolation
- -Routing and Screening Administration
- -Inter-network provisioning procedures
- -Responsibility assignments (control, testing, etc.)
- -Information sharing for analysis and problem identification
- -Network transition management
- -Calling Party Number Privacy Management
- -Traffic engineering design criteria and capacity management
- -Tones and Announcements for unsuccessful call attempts
- -Joint planning on network transition (e.g., CIC expansion to 4 digits, NPA split, etc.)
- -Mutual aid agreement
- -Emergency Re-routing plan

D. Compliance Plan. Processes should be established to insure compliance to the development of standard specifications for network interconnections. Methods for insuring the adequate implementation of such specifications should be evaluated and recommendations made.

Existing Work Efforts:

Various industry standards development groups work to resolve interconnection standards issues. This work should be evaluated for applicability and adequacy for increased interconnection of networks.

Various methods are used today to maintain network reliability of interconnected networks. These are outlined below:

Network element manufacturers currently perform regression and compatibility testing among the various network elements within their own product lines. In addition, some have similar test programs for other manufacturers' typically interconnected devices in support of the service providers and end users they support.

Protocol compliance testing is performed by several third party and industry segment sponsored test laboratory services.

Some service providers establish and maintain compatibility testing requirements for interconnected network providers in the following areas:

-Interconnection design and installation
-Facility transmission tests
-Interconnection acceptance and performance tests
-Protocol functional compatibility tests

For ongoing SS7 interoperability assurance, some service providers and manufacturers participate in ongoing interoperability test efforts such as the FTP, under the auspices of the ATIS Network Operations Forum.

Recommended Team Leader:

Industry "Best Practices" Initial Areas for Investigation

For established interconnection services some service providers have well established procedures that have served network reliability concerns. Examples of these include:

- For Feature Group D, the Pacific Bell Access Services Installation and Maintenance Handbook

- For the provisioning of Message Trunks between Pacific Bell and other California Local Exchange Carriers practices such as BSP 002-580-915T (GTE) and 002-580-916PT (Continental Telephone Co.).

Finalized by the NRCTG2 Team
January 17-18, 1995

Appendix 2

NRC Increased Interconnection Task Group Data Request Questionnaire

Single Points of Contact for NRC Data Collection:

The Federal Communications Commission (FCC) has chartered the Network Reliability Council (NRC) to address a number of significant issues concerning maintaining and improving network reliability. These issues include, among other things, the impact of increased interconnection and the introduction of new technologies into the network.

To carry out its charter, the NRC has formed five task groups. Each group will address an FCC identified issue:

Task Group 1	Network Reliability Performance
Task Group 2	Increased Interconnection
Task Group 3	Reliability Concerns Arising Out of Changing Technologies
Task Group 4	Essential Communications During Emergencies
Task Group 5	Telecommuting as Back-Up in Disasters

Recently, you were notified that data requests for each of the task groups would be sent to you for you to coordinate in your company. Attached is the data request (questionnaire) for the Increased Interconnection Task Group. The Increased Interconnection Task Group is conducting a study to gather input on various interconnection issues from the Local Exchange Carriers (LECs), Inter-exchange Carriers (ICs), CATV Service Providers, Wireless Service Providers and Satellite Service Providers to determine the effects of increased interconnection to the public telecommunications network.

Attached is a questionnaire asking for your input on interconnection issues and possible suggestions to address critical areas.

All data collected from your company will be protected by the nondisclosure agreement (see attachment). Data received will be aggregated by Bellcore and shared only on an aggregate basis.

Your personal support of this data collection effort is essential for an effective accomplishment of the mission of the NRC. Please return the completed questionnaires within 30 days (i.e., by April 30, 1995) to:

John Healy
Bellcore, Room 2X-227
331 Newman Springs Road
Red Bank, NJ 07701
Tel: 908-758-3065
Fax: 908-758-4370

If you have any questions, please call either John Healy at 908-758-3065 or Rob Hausman at 908-699-3408.

Thank you very much in advance for your cooperation.

Casimir S. Skrzypczak
President, NRC Steering Committee

Attachments (3)
Nondisclosure Agreement
Questionnaire
Glossary

Copy (without Attachments) to
Terry Yake
NRC Interconnection Task Group Members

NETWORK RELIABILITY COUNCIL

INCREASED NETWORK INTERCONNECTIVITY TASK GROUP

DATA REQUEST FOR INTERCONNECTION ISSUES

In order to support the industry initiatives requested by the FCC (Federal Communications Commission), the members of the Network Interconnectivity Task Group under the Network Reliability Council (NRC) asks for your company's support in completing this questionnaire. We are studying current and future national network reliability issues that derive from the increasing number of communications service providers. Since your company provides equipment, systems and/or service that ultimately serve end-user customers, we are soliciting your opinions on various network interconnection issues. While numerous types of interconnections may be available now and in the future, the scope of this questionnaire is limited to those interconnections that result in the provision of switched voice telecommunications services.

Please complete one copy of the questionnaire for each of the following categories in which your company is involved.

1. CATV network
2. Satellite network
3. Wireless network
4. Wireline network
5. Other (e.g., ESP, access purchaser, regulatory body, etc.)

The questionnaire has three parts. The first part requests background information on your company's role in the telecommunications industry. The second part involves an assessment of the current and future situation concerning inter-network connectivity. The third part is focused on processes and practices designed to mitigate potential future interconnection problems and ensure end-to-end network reliability as more service providers interconnect and increase the complexity of national and international communications networks.

PART 1 - COMPANY BACKGROUND

1. Company name: ____

2. Contact name: ____

3. Contact title: ____

4. Contact phone number: ____

5. What type of network does your company provide to support public telecommunications (check one):

   __ Cable TV
   __ Satellite Based Telephony
   __ Wireless
   __ Wireline
   __ Other (define) ________________________________

6. How many telephony customers do you serve? (check one in each column)

	currently	the year 2000
none	_______	_______
- 10,000	_______	_______
- 100,000	_______	_______
- 1,000,000	_______	_______
more than 1,000,000	_______	_______

7. Regarding network interconnection issues, in which of the following standards bodies and industry fora do you currently participate?

   __ Committee T1 __ CTIA
   __ CLC Forums __ ITU
   __ TIA __ PCIA

__ NCTA __ WIF

__ IILC __ other(s) ___________________________

8. Has your company and/or your vendor(s) participated in the Inter-network Interoperability Test Plan (IITP)? (check as applicable)

__ your company __ your vendor(s)

PART 2 - ASSESSMENT OF INTERCONNECTION ISSUES

9. In terms of reliability and continuity of telephony service, how critical are/will be the inter-network connections between your network as identified in #5 and each of the following types of networks:

	High	Medium	Low	None
Cable TV	H	M	L	N
Satellite Based Telephony	H	M	L	N
Wireless	H	M	L	N
Wireline	H	M	L	N
Other (define ____________________)	H	M	L	N

10. The following are the key inter-network interfaces identified (see definitions in glossary) by the Increased Interconnection Task Group. Please rank these interfaces in terms of potential risk to inter-network reliability and continuity of service.
(4 - greatest risk, ... 1 - least risk)

__ physical interface
__ Signaling channel interface
__ User information channel interface
__ Operation, administration and maintenance (OAM&P) interface
__ other ______________________________________

Comments: ____

____

11. a. What are your company's requirements or specifications for reliability and performance before interconnecting with other networks?

__ ITU recommendations
__ NOF / IITP procedures
__ Bellcore Technical Requirements
__ Committee T1 standards
__ Company-specific requirements
__ Bilateral agreements between the interconnecting parties
__ TIA standards
__ other ____________________________

b. How are requirements and specifications in question 11(a) validated prior to turn-up for service? ____

____

____

c. How are these interconnections monitored and maintained once in service to ensure they are performing according to expectations? ____________________________

____

____

____

d. Within bilateral agreements, what needs to be specified?

- __ Provisioning information and guidelines
- __ Special protocol implementation agreements (e.g., timer values, etc.)
- __ Diversity requirements
- __ Installation and maintenance guidelines
- __ Security requirements
- __ Performance standards / service level agreements
- __ other(s) ____

  ____

12. What current activities or future plans do you have for coordinating inter-company operation, administration and maintenance (OAM&P) information?

____

____

PART 3 - IDENTIFICATION OF EXISTING AND FUTURE PROCESSES

13. In your opinion, what level of responsibility should each of the following have to **develop** inter-network service standards?

(H - High, M - Medium, L - Low, N - None)

__ the interconnecting service providers themselves
__ network equipment manufacturers
__ the industry fora (service providers, equipment manufacturers and end users)
__ standards bodies (service providers, equipment manufacturers and end users)
__ FCC
__ state utility commissions
__ other (please specify) ________________________________

14. a. In your opinion, what level of responsibility should each of the following have to **plan** for inter-network reliability/interoperability?

(H - High, M - Medium, L - Low, N - None)

__ the interconnecting service providers themselves
__ network equipment manufacturers
__ the industry fora (service providers, equipment manufacturers and end users)
__ standards bodies (service providers, equipment manufacturers and end users)
__ FCC
__ state utility commissions
__ other (please specify) ________________________________

b. In your opinion, what level of responsibility should each of the following have to **ensure** inter-network reliability/interoperability?

(H - High, M - Medium, L - Low, N - None)

__ the interconnecting service providers themselves
__ network equipment manufacturers
__ the industry fora (service providers, equipment manufacturers and end users)
__ standards bodies (service providers, equipment manufacturers and end users)
__ FCC
__ state utility commissions
__ other (please specify) ________________________________

15. a. Which processes or procedures do you use to ensure inter-network reliability and interoperability? (check all that apply)

__ Identify defined standards and specifications
__ Intra-company testing procedures
__ Inter-company testing procedures
__ Load simulations (in a testbed environment)
__ Stress to failure testing (in a testbed environment)
__ Conformance testing with interconnecting networks
__ IITP recommendation implementation
__ Others (please specify) ____

What additional processes are needed? __________________________________

____

16. With respect to network interconnections, how do you protect against

a. Fault migration ____

____

b. Intrusion on network control channels __________________________________

____

c. Negative impacts to performance or call processing delay __________________

____

17. What process should be used for establishing and implementing a new, previously unspecified, network interconnection interface? ____________________________

____

____

18. a. Are there firewalls/safeguards to protect your network from intrusions and incompatibilities from other interconnecting networks?

__ Extensive __ Some __ None

b. If so what are the significant ones? ____________________________________

____

19. a. Do you have disaster recovery plans?

__ Yes, with **formal** agreements for mutual aid and/or emergency resources
__ Yes, with **informal** agreements for mutual aid and/or emergency resources
__ Yes, but without agreements for mutual aid and/or emergency resources
__ No

b. How often are your disaster recovery plans reviewed? ______________________

20. Additional comments:

____

____

____

____

____

____

Appendix 3

RECOMMENDATIONS

This compilation of recommendations clarifies the action items. In most cases current network providers will need only minor adjustments in current processes to conform. New and emerging providers should begin implementing these recommendations early in their service processes development. In some cases, the recommendations are applicable to more than one type of service provider. So, read and utilize them for the full benefit.

WIRELINE

Recommendation 1

Special attention should be given to utilizing applicable existing standards and implementing new standards addressing interconnection points between existing wireline and emerging local service providers.

<u>Implementation Target Date</u>
Incumbent Service Providers: Ongoing.
New Service Providers: During the service design/development phase of implementation.

Recommendation 2

The task group recommends that changes in network-to-network signaling standards and requirements (e.g., standards, fora, TR-905, etc.) be reviewed by the Network Operations Forum (NOF) and considered a) for inclusion in appropriate testing procedures, and b) development of additional operational guidelines.

<u>Implementation Target Date</u>
Incumbent Service Providers: Immediately for any TR-905 changes.
New Service Providers: During the service design/development phase of implementation.

Recommendation 3

Companies should appoint a Synchronization Coordinator for their company who will perform the responsibilities contained in SR-TSV-002275. Companies should provide the name of their Synchronization Coordinator to the ICCF for inclusion in its Synchronization Directory.

<u>Implementation Target Date</u>
Incumbent Service Providers: Now and as personnel changes occur.
New Service Providers: During the service design/development phase of implementation.

Recommendation 4

Companies should comply with the synchronization standards addressed in the ANSI Standard T1.101, entitled "Digital Network Synchronization"

<u>Implementation Target Date</u>
Incumbent Service Providers: Now.
New Service Providers: During the service design/development phase of implementation.

Recommendation 5

Companies should monitor and if applicable, consider active participation in standards development organizations and in industry fora.

Implementation Target Date
Incumbent Service Providers: Now.
New Service Providers: During the service design/development phase of implementation.

Recommendation 6

Bilateral agreements should be established between interconnecting network providers in accordance with the bilateral agreement template contained in Section 5.6.

Implementation Target Date
Incumbent Service Providers: Prepared in advance, implemented upon contact for interconnection.

New Service Providers: Prepare as part of service implementation planning.

Recommendation 7

Any future network interconnection interface should be developed by standards bodies and industry fora to ensure design compatibility and interoperability.

Implementation Target Date: Now.

Recommendation 8

Interoperability testing of all new/changed network interfaces having potential national PSTN reliability impacts should be performed via the IITP process to ensure continued network reliability.

Implementation Target Date
Incumbent Service Providers: Present to NOF/CTIA for determination of need as required.
New Service Providers: Present to NOF/CTIA during the network design phase of implementation.

Recommendation 9

Bilateral agreements between interconnecting networks should address the issue of fault isolation. At a minimum, these agreements should address the escalation procedures to be used when a problem occurs in one network. Second, the agreement should address which company will be in charge for initiating various diagnostic procedures. Finally, the agreement should address what information will be shared between the interconnected companies.

Implementation Target Date
Incumbent Service Providers: As part of bilateral interconnection discussions.
New Service Providers: As part of bilateral interconnection discussions.

Recommendation 10

The SS7 current "firewall" techniques should continue to be used to ensure network messaging integrity. For the future, these techniques should be used as a benchmark for "firewalls" that can be used for new technologies introductions.

Implementation Target Date
Incumbent Service Providers: Ongoing and with future design modifications.
New Service Providers: As part of the initial network design considerations.

Recommendation 11

To keep overflow traffic conditions from adversely affecting interconnected networks, interconnected network providers should utilize network surveillance and monitoring. In addition, companies should follow the guidelines for advanced notification of media-stimulated call-in events as outlined in Section 6 of the NOF Reference Document concerning Media Stimulated Call-in Events. Further, interconnecting companies should include a contact name for inclusion in the Media Stimulated Call-in Event Contact Directory. Finally, interconnecting companies should address the control of overflow conditions in their bilateral agreements.

Implementation Target Date
Incumbent Service Providers: With initial interconnection planning/ ongoing.
New Service Providers: With initial interconnection planning.

Recommendation 12

Information sharing should be utilized by all network providers to minimize recurrence of service disruptions. The guidelines contained in the NOF Reference Document can be used for this purpose. Additional requirements for the sharing of information between interconnected companies should be addressed in bilateral agreements.

Implementation Target Date
Incumbent Service Providers: Annually.
New Service Providers: With initial bilateral interconnection discussions.

Recommendation 13

New entrants should, at a minimum, have a communications structure in place for timely notification of affected parties in the event of disasters or emergencies.

Implementation Target Date
Incumbent Service Providers: N/A
New Service Providers: With initial bilateral interconnection discussions.

Recommendation 14

Companies should appoint and provide the name of a Mutual Aid Coordinator to the NOF for inclusion in the Mutual Aid Contact Directory which is published on a bi-annual basis.

Implementation Target Date
Incumbent Service Providers: Update twice yearly.
New Service Providers: During initial operations planning phase for service deployment.

WIRELESS "CELLULAR"

Recommendation 1

Companies should appoint a Synchronization Coordinator for their company who will perform the responsibilities contained in SR-TSV-002275. Companies should provide the name of their Synchronization Coordinator to the ICCF for inclusion in its Synchronization Directory.

Implementation Target Date
Incumbent Service Providers: Now and as personnel changes occur.
New Service Providers: During the service design/development phase of implementation.

Recommendation 2

Companies should comply with the synchronization standards addressed in the ANSI Standard T1.101, entitled "Digital Network Synchronization."

Implementation Target Date
Incumbent Service Providers: Now.
New Service Providers: During the network design phase of the business plan execution.

Recommendation 3

Industry standards should be the foundation for any network interconnections. Any carrier wishing to interconnect with another carrier should mutually agree upon industry specifications. See Section 5.6 for the recommended interface specification template.

Implementation Target Date
Incumbent Service Providers: NA
New Service Providers: Not later than the bilateral agreement development.

Recommendation 4

Wireless carriers should participate in, or be represented in, the standards process so that needs will be met in a timely and effective manner. Areas of particular interest to oversee include:

- Prioritize standards work efforts
- Ensure standards address reliability and performance concerns
- Increase velocity of standards development to meet service providers' needs
- Improve processes to ensure overall quality within and between standards bodies

Implementation Target Date
Incumbent Service Providers: Ongoing.
New Service Providers: During the network design phase of the business plan execution.

Recommendation 5

Within the wireless "cellular" industry, many interconnection standards and processes are already in place. They should be adapted or extended, as appropriate, to accommodate the needs of new PCS carriers.

Implementation Target Date
Incumbent Service Providers: NA
New Service Providers: During the network design phase of the business plan execution.

Recommendation 6

Interoperability testing by equipment suppliers and service providers should be performed prior to service turn up to ensure successful and reliable interconnections. See Section 5.6 - Templates for the recommended set of issues to be addressed in a bilateral agreement governing testing, implementation, operations coordination and related activities. Bilateral agreements governing test and turn up procedures are needed so that existing services are not interrupted when new interconnections are established. Bilateral agreements also help to ensure continuity of operations. Some issues to address in testing include:

- Product operation and functionality
- Interoperability to establish operation across an interface, per Standards
- Performance under stress and anomalies

Implementation Target Date
Incumbent Service Providers: Ongoing.
New Service Providers: Not later than the bilateral agreement development.

Recommendation 7

Some testing is applicable for nationally-coordinated efforts so that all carriers and equipment manufacturers benefit without an undue outlay of resources and time. Cellular carriers should participate directly or through representation by an industry association(s). Some of the nationally coordinated testing currently taking place includes:

- IITP (SS7 ISUP)
- AGNI (IS-41)

Implementation Target Date
Incumbent Service Providers: As the technology and industry indicates.
New Service Providers: As the technology and industry indicates.

Recommendation 8

Inter-company OAM&P processes should continue to evolve so that carriers can effectively establish and maintain service across a network interface. Key components of this recommendation include:

- Service Providers' key role (e.g., 24x7x52 surveillance center)
- Qualified individual(s) to maintain an SS7 node and an SS7 network, including IS-41 and ISUP as required. (See SNS Best Practices.)
- Existing fora and associations' assisting role in developing guidelines and practices for use by interconnecting networks to foster network reliability
- Up-to-date Disaster Recovery Plan (ref. NOF Reference Document Section VI Network Management Guidelines and Contact Directory and its Appendix A Emergency SS7 Restoration)
- Including contact information in the following Contact Directories of the NOF Reference Document Section VI Network Management Guidelines and Contact Directories
    - Network Management Contacts
    - Catastrophic SS7 Failure/Restoration Contacts
    - Media Stimulated Calling Event Contacts
    - LIDB Contacts
    - Mutual Aid Contacts

Implementation Target Date

Incumbent Service Providers: Ongoing
New Service Providers: Not later than the bilateral agreement development.

SATELLITE

Recommendation 1

Each company should appoint a Synchronization Coordinator for its company who will perform the responsibilities contained in TR-NPL-0002275. Companies should provide the name of their Synchronization Coordinator to the ICCF for inclusion in its Synchronization Directory.

Implementation Target Date
Incumbent Service Providers: Now.
New Service Providers: During the network design stage of the new network.

Recommendation 2

Companies should comply with the synchronization standards addressed in ANSI Standard T1.101, entitled "Digital Network Synchronization."

Implementation Target Date
Incumbent Service Providers: Now and as personnel changes occur.
New Service Providers: During the network design stage of the new network.

Recommendation 3

Satellite service providers are encouraged to continue their reliance on existing standards and interface specifications, bilateral agreements and end-to-end testing to define and verify performance and reliability requirements.

Implementation Target Date
Incumbent Service Providers: N/A
New Service Providers: During the service design/development phase of implementation.

Recommendation 4

Satellite service providers are encouraged to participate in existing standards bodies and industry fora to ensure future standards accommodate their requirements.

Implementation Target Date
Incumbent Service Providers: Begin 1Q96.
New Service Providers: During the service design/development phase of implementation.

Recommendation 5

The newly-formed Satellite Industry Association (SIA) should be encouraged to interface with existing standards bodies and industry fora to ensure interoperability and reliability issues are properly addressed.

Implementation Target Date
During the service design/development planning phase by the first associated member.

CABLE

Recommendation 1

Appropriate safeguards or firewalls should be implemented so that problems from one network are not spread to another. Additionally, the creation of new network elements used to support the physical channel should meet current loop performance requirements.

Implementation Target Date
Incumbent Service Providers: Before the field trial of any new network interconnection.
New Service Providers: During the new network design stage.

Recommendation: 2

Cable telephony providers should comply with generally accepted industry standards and processes when connecting to the PSTN, as described in the wireline section of this report.

Implementation Target Date
Incumbent Service Providers: Now and continuously going forward.
New Service Providers: During the network design stage.

Recommendation 3

When interconnection begins between cable networks and the PSTN, appropriate safeguards should be developed to avoid propagation of OAM&P problems into each other's networks . Information sharing is essential.

Implementation Target Date
Incumbent Service Providers: Incorporate any changes before interconnection modification.
New Service Providers: During the network interconnection design phase.

Recommendation 4

Cable companies should appoint a Synchronization Coordinator for their company who will perform the responsibilities contained in TR-NPL-002275. Companies should provide the name of their Synchronization Coordinator to the ICCF for inclusion in its Synchronization Directory.

Implementation Target Date
Incumbent Service Providers: Now and as personnel changes occur.
New Service Providers: During the network design stage of the new network.

Recommendation 5

Companies should comply with the synchronization standards addressed in ANSI Standard T1.101, entitled "Digital Network Synchronization."

Implementation Target Date
Incumbent Service Providers: Now and as personnel changes occur.
New Service Providers: During the network design stage of the new network.

Recommendation 6

To control overflow traffic conditions from adversely impacting interconnected networks, interconnected network providers should utilize network surveillance and monitoring. In addition, companies should follow the guidelines for advanced notification of media-stimulated call-in events as outlined in Section 6 of the NOF Reference Document concerning Media Stimulated Call-in Events. Further, interconnecting companies should include a contact name for inclusion in the Media Stimulated Call-in Event Contact Directory. Finally, interconnecting companies should address the control of overflow conditions in their bilateral agreements.

Implementation Target Date
Incumbent Service Providers: Update information and process assurances annually.
New Service Providers: During the network implementation development stage.

Recommendation 7

Cable companies need to participate in industry fora such as ICCF and NOF and should appoint a mutual aid coordinator to be included in the "NOF" mutual aid contact directory. Engineering practices need to reflect the fact that they are interconnecting with other service providers and that overload conditions on their network can impact those to which they are interconnected.

Implementation Target Date
Incumbent Service Providers: Now and with annual reviews.
New Service Providers: During the network operations management plans development stage.

INDUSTRY STANDARDS

Recommendation 1

Use of a network interface specification template is advised when a new network interface is identified for standardization. Standards bodies should use this type of template in developing the initial Standards Project Plan(s) for new interfaces to address the important areas for interconnection reliability. An example template for standards development planning is contained in Section 5.6.

Implementation Target Date: Now.

Recommendation 2

Industry associations, such as ATIS and TIA, should consider the value of incorporating performance requirements for complex network elements with the interface standards requirements. Also, the associations should consider how such requirements should be developed and funded.

Implementation Target Date: Now

Recommendation 3

A careful technical and editorial review process, similar to and expanding upon the TIA/T1 JTC Validation and Verification process, should be utilized for all standards which have the potential for impacting network interconnection reliability to ensure technical clarity and consistency. This would be an appropriate method to validate technical adequacy in meeting the intent of the interconnection reliability template and project plan described in Recommendation 1. Exhibit 9 is the TIA/T1 JTC procedure.

Implementation Target Date: Now

Recommendation 4

Wherever appropriate, standards bodies should work with other industry groups that use standards, such as the ATM Forum, to more precisely define standards requirements and minimize complexity and optionality. Excessive optionality can be dealt with through an appropriate contribution to the affected standards committee. The Network Interface Specification, contained in Appendix 4 of this report, should also be used by industry forums to further define, detail and approve implementation for the industry.

Implementation Target Date: Now

Recommendation 5

Interconnecting network operators should consider using interface survivability designs with redundancy and diversity such as those outlined in "A Technical Report on Network Survivability Performance" (Committee T1 Report No. 24).

Implementation Target Date
Incumbent Service Providers: Now.
New Service Providers: During the design phase of the service implementation plan.

Recommendation 6

New network providers are encouraged to participate in existing telecommunications industry standards processes, either directly or through associations, via membership or contributions to Committee T1 or TIA.

Implementation Target Date: Prior to the design phase of the service implementation plan.

Recommendation 7

Where adequate network interface standards exist, suppliers should develop and evolve their products to meet those standards. If interface standards are not established, network service providers and network equipment suppliers should actively participate in the development of robust network interface standards.

Implementation Target Date: Now.

Recommendation 8

Interconnecting network providers should utilize industry-proven interconnection standards.

Implementation Target Date: Now.

Recommendation 9

While standards are generally voluntary, increased emphasis should be placed on the value of compliance in ensuring network interoperability and reliability. However, in the case of public safety concerns, standards are identified with a “mandatory” emphasis.

Implementation Target Date: Now.

Recommendation 10

The most effective means to accelerate the standards development process is to ensure new standards work has sharp technical focus, clear standards deliverables, plus final and interim milestones for those deliverables. Exhibits 6 and 7 contain information on standards project proposals and project tracking based on this recommendation.

Implementation Target Date: Now.

Recommendation 11

By year end 1996 all telecommunications standards bodies should implement interactive electronic access methods to expedite the submission, creation, acceptance, review and finalization of technical standards. This is already underway but a completion date has not been specified.

Implementation Target Date: Year end 1996.

Recommendation 12

The Forum Process should be employed by the industry and companies/agencies to foster innovation and to produce contributions to the development of standards, not in lieu of standards. Industry forums have been instrumental in specifying implementation agreements.

Implementation Target Date: As identified.

Recommendation 13

Industry associations /fora, such as ATIS, TIA, ATM Forum, etc. should sponsor early (pre-standardization) industry interactions on emerging technology and service concepts. (It was agreed that an initial "industry needs" framework would provide parallel inputs to industry standards activities and the development of generic requirements for network elements.)

Implementation Target Date: Annually.

Recommendation 14

Industry associations, such as ATIS and TIA, should determine how the necessary generic requirements, described in Recommendation 13, should be developed, funded, approved and maintained. This approach will promote compatibility between standards and generic requirements.

Implementation Target Date: Year end 1997.

Recommendation 15

Bilateral agreements should be developed and put in place before networks interconnect in order to ensure reliable interconnection and interoperability. In addition, the forum process (e.g., NOF, ICCF) provides the framework for developing national technical and operational industry agreements for new network interconnections. Participants in these agreements should demonstrate compatibility with established industry standards, procedures and processes as a condition for interconnection. Exhibit 8 provides a Model Process for SS7 Network Interconnection. Appendix 4 is a template for such a bilateral agreement.

Implementation Target Date: During the operational design phase of interconnection planning.

NETWORK INTEROPERABILITY TESTING and FUNDING

Recommendation 1

This task group reaffirms the NRC 1 recommendation to continue the IITP cooperative industry relationships. The interconnection management test coordination processes should be institutionalized to permit continual evolution to address national network testing requirements.

Implementation Target Date: Now and then continuing.

Recommendation 2

The existing industry fora (e.g., ATIS-Network Operations Forum and CTIA-Advisory Group for Network Issues) should continue to be used proactively by existing and new service providers and manufacturers for recommending and planning network interoperability testing to ensure service compatibility and reliability across common interfaces.

Implementation Target Date: Now and then continuing.

Recommendation 3

The existing IITP (Inter-network Interoperability Test Plan) program should evolve as the basis of the future IITC function. The present focus on interoperability vulnerabilities in the signaling networks should continue, but the focus should also be broadened to consider other high risk and critical interfaces resulting from the introduction of increased network interconnections and new technologies. (This recommendation is not meant to preclude the obvious need for industry specific or technology-specific testing where there is no logical reason for IITC nationally coordinated testing.)

Implementation Target Date: Transition to take place during 1996.

Recommendation 4

Once the IITC is operational, manufacturers and service providers will participate in the management and conduct of on-going nationally coordinated interconnection testing.

Implementation Target Date: Continuing under the IITP and then transition to IITC during 1996.

Recommendation 5

The telecommunications industry should fund and manage the IITC. (See Chart #2, National Interoperability Test Management and Section 7.5.) A Steering Committee will be staffed by industry executive volunteers, as outlined in Recommendation 6 of this section, to oversee this organization.

Implementation Target Date: 2Q96 start.

Recommendation 6

The IITC should be made a financially self-supporting organization within the Alliance for Telecommunications Industry Solutions (ATIS) business structure, at least initially and be similar to the ATIS method now used for the Committee T1 and SONET Interoperability Forum (SIF) groups. ATIS administrative costs would be covered by a portion of the annual fees as outlined in recommendation 7. of this section.

Implementation Target Date: 2Q96 start.

Recommendation 7

A mandatory annual fee should be collected from telecommunications carriers and equipment manufacturers to support the interoperability test coordination function. (The fees would fund activities similar to those accomplished presently by Bellcore in its IITP role as coordinator and Hub Provider and the administrative costs indicated in section 7.5.) (See Sections 7.5.1 and 7.5.2 for the detailed funding and reporting presentation.)

Implementation Target Date: 2Q96 start.

Recommendation 8

The telecommunications industry associations should identify technical management representatives selected by their boards of directors or engineering committees to serve on a steering committee that would manage the IITC financial requirements, set IITC policy, prioritize testing activities and provide overall management guidance of this industry-wide program.

Implementation Target Date: 2Q96 start.

Recommendation 9

Bellcore and the industry organizations should continue their present responsibilities and financial support for the applicable IITP testing and coordination until the new IITC function is operational. (See Section 1.1.7)

Implementation Target Date: Continue through 1996 or until transferred to the industry.

Recommendation 10

The test coordination funding issue is believed to be one of several potential industry-wide initiatives driven by the evolving competitive environment. Therefore, the FCC should consider a more appropriate long-term method of IITC funding in the context of other additional industry funding requirements, e.g., NANPA administration, that will surface from increased network interconnection, if the recommended methods do not provide adequate funding.

Implementation Target Date: During 1996.

Recommendation 11

Based on approval of this plan, the NRC chairman is requested to initiate the appropriate IITC formation processes necessary to establish the organization.

Implementation Target Date: Not later than second quarter 1996, in time to allow operational readiness for 1997.

TEMPLATES

Recommendation 1

The NOF is the suggested custodian of the Network Interconnection Bilateral Agreement Template. Other organizations may also find the processes that evolve from this template useful and are encouraged to make use of and enhance it.

Implementation Target Date: 2Q96 start.

Recommendation 2

The ICCF is the suggested custodian of the Network Interface Specification Template. Other organizations may also find the processes that evolve from this template useful and are encouraged to make use of and enhance it.

Implementation Target Date: 2Q96 start.

Appendix 4

INCREASED NETWORK INTER-CONNECTION

TASK GROUP II

MISSION STATEMENT

To research, develop, analyze and recommend technical and operational considerations to ensure continued reliability of interconnected networks and systems.

CHARTER

Utilizing a broad representation of communications companies, draw on past work and forecasts of knowledgeable people and research to determine current and possible future root cause issues affecting the reliability of interconnected networks and systems. Develop methods to ensure service reliability as more service providers become part of the evolving "national network." Investigate the reliability concerns arising from expanded interconnection of networks, particularly satellite, cable and wireless networks.

Determine and recommend methods to ensure reliability criteria are integrated into all components of the service and equipment design, standards, construction, implementation and on-going operation. (Integration testing to ensure inter-operability is one factor, compliance to hardware and software standards and conformance to operating conventions are others.)