Network Reliability Council (NRC)

Reliability Issues - Changing Technologies Focus Group

Satellite Communications Networks Subteam Final Report

February 22, 1996

Bill Garner	American Mobile Satellite Corporation
Robert Wiedeman	Loral Qualcomm
Floyd Stuart	Hughes Communication
Robert Groom	Iridium Inc.
Jay Krakora (Chair)	Motorola SATCOM
Roger Rusch	Odyssey Service Organization
Bob Leeper	Sprint
David Patterson	Teledesic Corporation

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY 3

2. BACKGROUND 4

2.1 CHARTER/ISSUE STATEMENT 4
2.2 RECOMMENDATION AND BEST PRACTICE DEFINITION 4

3. TEAM MEMBERSHIP 5

4. STUDY METHODOLOGY 5

5. STUDY RESULTS 5

5.1 SERVICES 5
5.2 ARCHITECTURE 6
5.3 FAILURE MODES, EFFECTS, AND MITIGATION 9
5.3.1 Satellite Failure Modes 9
5.3.2 Earth Terminal Failure Modes 10
5.3.3 Controller and Switching Center Failures 10
5.4 PSTN INTERCONNECTION 10
5.5 OPERATIONS, ADMINISTRATION, AND MAINTENANCE 10

6. FINDINGS AND RECOMMENDATIONS 11

7. APPENDICES 12

APPENDIX A - ISSUE STATEMENT 12
APPENDIX B - TECHNICAL CHARACTERISTICS OF PLANNED SATELLITE COMMUNICATIONS SYSTEMS 16
APPENDIX C - NEW TECHNOLOGY RELIABILITY TEMPLATE 18

1. Executive Summary

The focus of this report is the emerging satellite communications technologies that will be providing communications services to the general public in the near future. These technologies are expected to interface with the Public Switched Telecommunications Network (PSTN). It is important to maintain network integrity and reliability as the new satellite based services and technologies are deployed.

The emerging satellite-based personal communications systems, most of which are still in the design stage, have no related data on reliability issues based on actual experience. The new systems have varied architectures and therefore different failure modes and expected availability. These factors will affect the overall quality of service as perceived by the end user. Because the systems are not expected to be a vehicle for providing essential services, it is more appropriate for the marketplace to determine the relevant quality of service levels, rather than establish specific levels at this time. As the systems are deployed and experience is gained, more specific recommendations can be made regarding expected levels of reliability. Because the new satellite communications systems are all in the process of being designed or initially deployed, their manufacturers should take maximum advantage of existing industry knowledge on best practices and methods of interconnection to the Public Switched Telephone Networks.

A summary of the recommendations of the Satellite subteam is as follows:

<Recommendation 1>

Defer specific recommendations on architectures, availability objectives, and quality of service until experience is gained and impact on essential services is known.

<Recommendation 2>

As new satellite communications systems are deployed, service providers should plan to use industry “best practices” for fault isolation, root cause analysis, and tracking information on failures and service outages.

<Recommendation 3>

For PSTN interconnection points, use industry standard interfaces and protocols with proven reliability and security.

2. Background

2.1 Charter/Issue Statement

In 1994, the Federal Communications Commission asked the Network Reliability Council (NRC) to study and recommend policy changes that would ensure the continuation of high-quality telecommunications services as competition and technologies evolve. Five study areas were identified:

- Network Reliability Performance
- Impact of Increased Network Interconnection on Reliability
- Reliability Concerns Arising Out of Changing Technologies
- Essential Communications During Emergencies
- Telecommuting in Disaster Situations

Within the Changing Technologies area, five study areas were identified:

- Advanced Intelligent Networks (AIN)
- SONET Facilities and ATM Technology
- New Wireline Access Technologies
- Wireless Networks - Cellular and PCS
- Satellite Communications Networks

The overall Issue Statement for the Changing Technologies focus group is included in Appendix 1. This report discusses the results of efforts of the Satellite Communications Networks Study Group. The focus of the study effort is limited to the emerging technologies that will initially provide mobile personal communications services, and later provide higher bandwidth point-to-point communications services. Existing geosynchronous satellite communications systems used for point-to-point and broadcast services are not addressed in detail in this report.

2.2 Recommendation and Best Practice Definition

The terms “recommendation” or “Best Practice” as used in this report is defined as follows: “recommendations” are those countermeasures (but not the only countermeasures) that go furthest in eliminating the root cause(s) of outages. None of the recommendations are construed to be mandatory.

Service providers and 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 may not be applied universally.

3. Team Membership

The following individuals participated in developing and/or reviewing the information in this report:

Bill Garner	American Mobile Satellite Corporation
Robert Wiedeman	Loral Qualcomm
Floyd Stuart	Hughes Communication
Robert Groom	Iridium Inc.
Jay Krakora (Chair)	Motorola SATCOM
Roger Rusch	Odyssey Service Organization
Bob Leeper	Sprint
David Patterson	Teledesic Corporation

4. Study Methodology

The study effort focused on collecting the available information on the new satellite communications systems to determine potential reliability concerns and to develop recommendations to address the concerns. Although extensive data collection was undertaken for the overall Network Reliability Council effort, data collection and analysis of existing failure modes and their effects for the new mobile satellite communications systems were not possible because the systems are in the development stage.

Since limited data based on actual experience was available, analysis was performed and recommendations developed based on the similarity of the new systems to existing systems where reliability experience, data exists. Characteristics of the new satellite communications systems were obtained from public disclosures and filings required for licensing purposes, because the new systems are under development and there is limited detailed information available within the public domain. A summary of the technical characteristics for the new satellite communications systems is shown in Appendix B.

Also part of the overall study effort for the Changing Technologies area was the development of a New Technology Reliability Template. The purpose of this template is to provide an assessment screen and checklist as new technologies are deployed. The template is shown in Appendix C.

5. Study Results

The study results are provided in this section. The first two sections describe typical services and architectures of satellite communications systems. The next sections describe the major failure modes of the systems, the methods of interconnection to the Public Switched Telephone Networks, and Operations, Administration, and Maintenance issues. Appendix 2 summarizes the major technical characteristics of the new satellite systems that are planned to be deployed in the next few years.

5.1 Services

Existing satellite communications services are categorized into three areas: Fixed Satellite Services (FSS), Broadcast Satellite Services (BSS), and Mobile Satellite Services (MSS). FSS are characterized by dedicated point-to-point service for voice, data, or video. Although they may be used for transport of public switched network services, the FSS providers do not directly provide telephony services. One of the major uses of FSS systems is for the distribution of television programming. Two of the new planned global satellite communications systems, Teledesic and Galaxy/Spaceway, will offer higher rate global point-to-point services through a constellation of interconnected satellites. BSS are used to directly provide voice, data, and video services to end users. Direct broadcast television to small antennas on the subscriber's premises is one of the new BSS allowing direct reception of hundreds of program channels.

Mobile Satellite Services are just starting to be deployed. They are expected to initially provide end users with the voice, data, and messaging services now available to cellular subscribers, but on a regional or global roaming basis. They will be interconnected to public switched networks throughout the world to allow calling to and from the satellite systems. MSS systems are not expected to be a means of providing essential services within the United States, where there is a well-developed infrastructure for telecommunications services. However, they may be the only means of communications in countries with poor telecommunications infrastructures. The MSS systems are expected to utilize existing standards for both call processing functions and interconnection to the public switched telephone networks.

5.2 Architecture

Fixed and Broadcast Satellite Systems typically utilize satellites in geo-synchronous orbits, whereas the new Mobile Satellite Systems will be using satellites in Low Earth Orbits (LEO), Intermediate Circular Orbits (ICO), and GEO orbits. Each of the systems requires an Earth station antenna that is used for telemetry, tracking, command, and the information channels that form the basis of the services. The higher capacity communications links used to collect and distribute information from a satellite to an Earth station are called feeder links. The channels used to directly connect with individual users in MSS systems are called subscriber links.

With their support of switched services to individual users, MSS systems have two additional functional components not required for FSS or BSS systems. The equivalent of a cellular Base Station Controller (BSC) is required to connect and maintain terrestrial connections to individual satellite channels serving an end user in a particular location. The connectivity must be managed and maintained as the satellite resources required to serve the user change, in a similar way that handoffs are managed in cellular systems as users move. A Mobile Switching Center (MSC) is also required to perform the same functions it performs in terrestrial cellular systems. The MSC maintains logical location of the user so that roaming services can be supported, provides call processing functions, and is the point of interconnection to Public Switched Telephone Networks. Some of the MSS systems planned for deployment will interface with existing cellular providers through their existing MSCs. Other MSS systems will deploy separate switching centers throughout the world and then directly interface with the Public Switched Telephone Networks.

Some of the MSS systems will have crosslinks to interconnect the satellites within the constellation and minimize the number of locations where earth stations are required. The systems without crosslinks require the service to be transmitted and received within the footprint of the serving satellite. Figures 5.1 , 5.2, and 5.3 depict representative FSS, BSS, and MSS architectures.

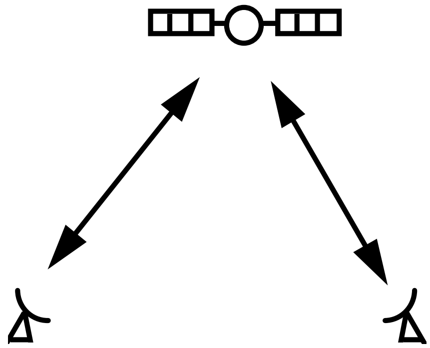

Figure 5.1 - Representative FSS Architecture

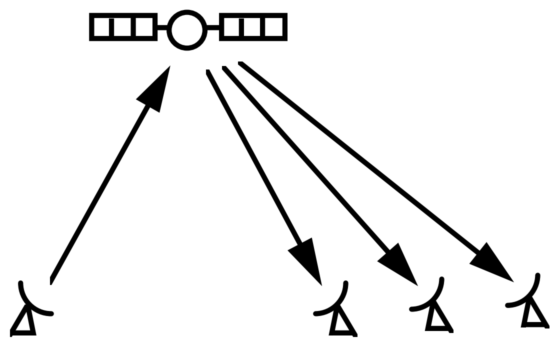

Figure 5.2 - Representative BSS Architecture

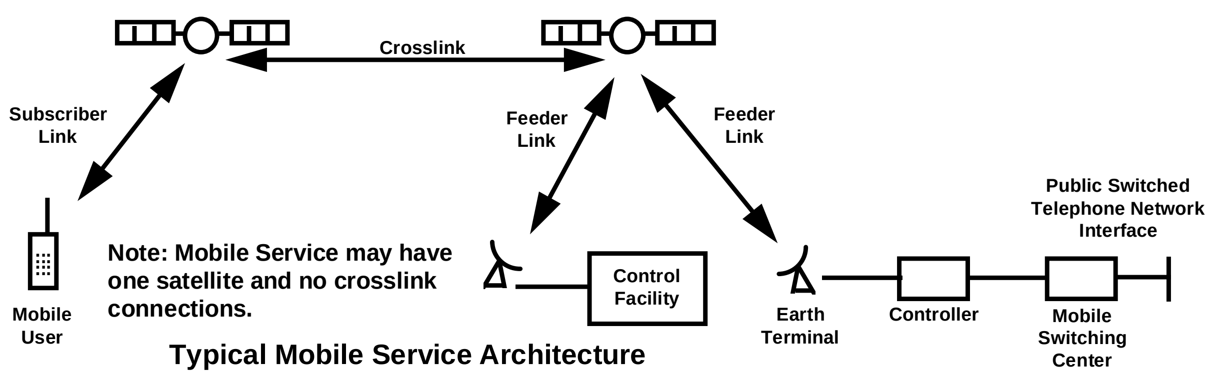

Figure 5.3 - Representative MSS Architecture

GEO satellites have the advantage of remaining stationary with respect to a point on the Earth, which means they can be tracked with a stationary Earth terminal antenna; however, their higher orbits mean that greater power or larger antennas have to be used. They also have larger signal delay characteristics because of the longer distances the signals have to travel. The roundtrip delays are significant enough to be noticeable during voice conversations. LEO satellites' lower orbits have the advantages of lower power requirements, smaller antennas, and lower signal delay characteristics; however the nonstationary view of the satellite requires movable antennas and the ability to handoff from one satellite to another to maintain connectivity. Their lower power requirements, smaller antennas, and lower delay have made LEO satellite communication systems suitable for mobile personal communications. ICO satellite systems, with orbits inbetween LEO and GEO systems, represent a compromise in advantages between GEOs and LEOs.

5.3 Failure Modes, Effects, and Mitigation

This section summarizes the typical failure modes for satellite communications systems, their effects, and potential mitigation alternatives. Operating experience data is available for the GEO-based FSS and BSS systems;but no data based on experience is available for the soon-to-be-deployed MSS systems. Some of the experience data from existing systems can be used to draw conclusions; however, the complexity of the new systems, which require onboard management of individual switched subscriber connections, crosslink routing management, and connection handoff management. These requirements represent a different complexity and reliability characteristics than existing systems. Actual reliability and availability characteristics will be better understood after the systems design, deployment, and operating experience data is obtained.

5.3.1 Satellite Failure Modes

Satellites, their subsystems, and components are designed to meet specific reliability characteristics based on the desired life of the satellite. Component or subsystem failures should usually result in a reduction in capacity, not a complete failure of the satellite. Failure at the end of a satellite's life is usually designed to occur either when fuel required for station-keeping is expended or the battery is no longer able to maintain a sufficient charge. Spare capacity and redundant components are used to mitigate partial failures prior to the end of the satellite's life. Failures of crosslinks and feeder links can also be mitigated by alternative routing of the information through another working link. Another reliability factor for satellites is their exposure to radiation particles, which can cause single event upsets where single bits of computer registers or memory can unexpectedly change in value. Both hardware and software solutions exist to detect and correct these single event upsets.

Because of the long lead time required, launching a new satellite to replace the failed one is not usually the desired way to maintaining high availability. When a satellite completely fails two approaches can be used to mitigate the failure and restore the availability of the system. One is to use multiple satellites as part of a constellation to provide service, so that overlapping coverage can be designed into the system to at least partially fill the gap created by the failed satellite. The other method of mitigating the failure is use spare on-orbit satellites that can be moved into position to replace the failed satellite.

5.3.2 Earth Terminal Failure Modes

The availability characteristics of Earth Terminals vary considerably depending on whether they are used to communicate with GEO stationary satellites and, therefore, have minimal movement, or whether they are used to track satellites that are constantly moving with respect to a position on the Earth. Earth terminals that connect to GEO stationary satellites can be designed for high reliability and availability, and one antenna is normally sufficient to maintain connectivity. They are not one of the major factors in a system's unavailability.

Earth Terminals that communicate with LEO satellites raise several reliability issues. Unlike GEO satellites, which remain stationary with respect to a point on the earth, LEO satellites move rapidly across the sky. The constant movement of the antennas required to track the satellites creates wear on mechanical parts that must be periodically taken out of service for maintenance. Because the satellites are constantly moving from one horizon to another, multiple antennas are required to maintain continuous connectivity. As one satellite is setting on one horizon, another antenna must be positioned to acquire a different satellite that is rising. The process of continually having to reacquire communication with a satellite creates reliability issues. The reliability of the connections are further affected by the heavy rainfall on the radio transmission frequencies that are typically used for the feeder link. All of these reliability problems can be significantly mitigated through the use of multiple antennas, three or four, spaced sufficiently apart so heavy rain cells are not over all of the sites simultaneously. Multiple antennas allow one to be scheduled out of service for maintenance. Multiple antennas also allow two antennas to track the satellite during acquisition to increase the reliability of this process.

5.3.3 Controller and Switching Center Failures

In addition to satellites and earth terminals MSS systems require the equivalent of a cellular Base Station Controller (BSC) and a Mobile Switching Center (MSC). These components will have failure modes, reliability, and availability similar to their terrestrial cellular counterparts. Because they will typically be designed to have the same high availability characteristics, they are not expected to be a major factor in a system's unavailability.

5.4 PSTN Interconnection

All of the planned MSS systems are expected to interface with PSTNs using standard industry proven interfaces. This approach will minimize any interconnection concerns as the new MSS systems are deployed. A comprehensive discussion of PSTN interconnection is provided in the Increased Interconnection Task Group Report. The Satellite Communications Study Group supports the satellite communications recommendations made in the report.

5.5 Operations, Administration, and Maintenance

The OA&M functions for satellite communications systems can be categorized into three areas: satellite control functions responsible for monitoring satellite health and status and maintaining orbital positions, network management functions responsible for maintaining overall connectivity of the network nodes and flow of information through the systems, and ground systems management responsible for maintaining health and status of the equipment that interfaces with the public switched and private networks on the ground. The ground systems management function is the primary area that will interface with Public Switched Telephone Network

Operations. To maintain reliable Public Switched Telephone Network service, these ground systems management functions should take advantage of existing industry best practices in the areas of fault isolation, root cause analysis, and tracking information on failures and service outages.

6. Findings and Recommendations

The emerging satellite-based personal communications systems, most of which are still in the design stage, can provide no experience-based reliability data. The new systems have varied architectures and, therefore, different failure modes and expected availability. These factors will affect the overall quality of service as perceived by the end user for the various systems. Because the systems are not expected to be a vehicle for providing essential services, it is more appropriate for the marketplace to determine the relevant quality of service levels, rather than establish specific levels now. As the systems are deployed and experience is gained, specific recommendations can be made regarding expected levels of reliability. Because the new satellite communications systems are all being designed or initially deployed, their manufacturers should take maximum advantage of existing industry knowledge on best practices and methods of interconnection to the Public Switched Telephone Networks.

<Recommendation 1>

Specific recommendations on architectures, availability objectives, and quality of service should be deferred until experience is gained and effect on essential services is known.

<Recommendation 2>

As new Satellite Communications systems are deployed, service providers should plan to use industry best practices for fault isolation, root cause analysis, and tracking information on failures and service outages.

<Recommendation 3>

For PSTN interconnection points, industry standard interfaces and protocols with proven reliability and security should be used.

7. Appendices

Appendix A - Issue Statement

Issue Title: Reliability Concerns Arising Out of Changing Technologies **Author:** Gary Handler
Bellcore

Problem Statement/Issue to be Addressed

The national Public Switched Network (PSN) which is truly a network of networks, has the deserved reputation of providing its users highly reliable, survivable and secure end-to-end services. The FCC and its Network Reliability Council (NRC) want to ensure that this remains the standard mode of operation in spite of a dramatic increase in the number of new technologies being deployed, the implementation of advanced new services offered to the public, and the emergence of a proliferation of new service providers. In specific, the NRC will study a) the reliability aspects of the provision of key services over new network facilities, (i.e., broadband hybrid fiber/coaxial cable distribution, SONET and ATM, wireless, and satellite), and b) reliability concerns arising out of new technology providing expanded services over new or traditional facilities, i.e., Advanced Intelligent Network (AIN) capabilities. The emphasis of this Focus Team should be on new technology that will be implemented in the public network within the next three years.

Areas of Concern and Problem Quantification

The following are the main areas of concern:

1. **Reliability Aspects of Provision of Key Services Over New Network Facilities**
   - **a)** *Broadband Networks* - One concern about new network technologies is how the reliability of services such as plain old telephone service provided over new broadband networks will compare with that of the same service provided over existing wireline technology. These new systems should be modeled and analyzed for potential reliability risks and possible reliability improvement techniques. Implementation "Best Practices" should be developed and a plan for their dissemination and implementation should be derived. Two specific areas should be addressed:
     - **i)** *Hybrid Fiber/Coaxial Cable Distribution Systems* - This technology is expected to be providing telephone service shortly. The reliability issues with this technology need to be defined and addressed.
     - **ii)** *SONET Facilities and ATM Technology* - SONET transport and ATM technology are rapidly progressing and will be providing new broadband services as well as existing narrowband services over common facilities. The reliability issues with these technologies need to be defined and addressed.
   - **b)** *Wireless Network (Cellular and PCS)* - Another example of a concern about new technologies is the role and reliability of cellular facilities in connection with line-

based networks. This issue was discussed by the NRC at its September 30, 1992 meeting and in the document *Network Reliability: A Report to the Nation.* The reliability of the telecommunications services provided over a combination of new technologies has to be reviewed. Customers who rely on cellular technology need service providers to have and follow established "best practices." These do not now exist. Best practices for Personal Communications Services (PCS) and Networks should also be considered in this study.

c) *Satellite Networks* - Another area of reliability concern is the provision of telephone services over new satellite technology networks such as low earth orbiting satellites. The reliability issues with this technology should also be defined and addressed.

2. Reliability Concerns Arising Out of New Technology Providing Expanded Services over New or Traditional Facilities, i.e., Advanced Intelligent Network (AIN) Capabilities - Concerns have also been raised regarding the interoperability and reliability of multiple advanced intelligent services with their inherently independently developed software management and control. As John Clendenin stated at the July 6, 1994 NRC meeting "this is not the kind of problem that could be solved (once) and laid aside". However, to provide a near term objective from which a model or process might be developed, it is suggested that the team focus on the interoperability and reliability concerns in the development of Advanced Intelligent Network Services.

Description of Proposed Work

The team working this issue should consider the following total quality process to identify reliability concerns arising out of changing technologies, quantify network vulnerabilities, identify the major reliability issues and propose problem solutions.

1. Identify the new technologies being introduced into the network.

2. Collect appropriate data from all available industry sources to determine and/or confirm areas/technologies of greatest criticality and risk, and those with the greatest potential for network reliability improvement potential. (Work with the ATIS Network Reliability Steering Committee (NRSC) and its Network Reliability Performance Committee to coordinate data collection activities).

3. Collect data from the industry concerning the reliability of new technologies if already deployed. (Work with the ATIS Network Reliability Steering Committee (NRSC) and its Network Reliability Performance Committee to coordinate data collection activities)

4. Perform sufficient analysis of the data to determine the root cause(s) of the problem(s).

5. From the root cause analysis determine an appropriate action plan to reduce/eliminate the possibility or severity of failures in high risk areas. Also consider ways that recovery procedures may be implemented more quickly or efficiently.

6. Determine industry "best practices" for dealing with the root cause analysis findings and share this information with industry participants as soon as possible. Deployment should consider cost/benefit tradeoffs of "best practices."

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

8. Consider the following tactics/ideas offered by the Steering Team as potential means to supplement the total quality process and address the findings of the root cause analysis. These represent ideas from the Steering Team that we want to share.

   A. New Technology Reliability Template - Design a generic template that serves as a reliability screen for assessing the reliability of new network technologies. This could be used as a process for the rapid and reliable evolution of the telecommunications networks.

   B. Provision of Key Services Over New Network Facilities

1. Broadband Networks (Hybrid Fiber/Coaxial Cable Distribution and SONET Facilities & ATM Technology), Wireless Networks (Cellular & PCS), and Satellite Networks.

- **a)** For each technology, determine the scope of the reliability study. Develop a bounded definition of the reliability problem; for example, the provision of basic telecommunications over a new broadband hybrid fiber/coaxial cable distribution network.
- **b)** Construct an order of magnitude (major failure modes and vulnerabilities) reliability model of a reference system for each technology.
- **c)** Collect available reliability data (e.g. current coaxial cable systems network outage & failure data, current cellular network outage and failure data, current SONET network outage and failure data and ATM switch reliability), concerns and "best practices" associated with each technology.
- **d)** Analyze data to quantify reliability and determine the most significant problem areas, and the areas with the greatest risks.
- **e)** Determine applicability of current "best practices" to the new technology and identify any additional "best practices" that describe quality as part of the introduction of new technologies (i.e., "best practices" applicable to hybrid fiber/coaxial cable networks, cellular networks, and SONET networks).
- **f)** Recommend implementation strategies for "best practices" and on-going process information for insuring continued quality.

2. Advanced Intelligent Network (AIN) Capabilities

- **g)** Determine the reliability issues associated with AIN services (e.g., management of many different versions of software).
- **h)** Identify efforts taken to date to address AIN reliability issues and to ensure AIN service reliability. Identify existing "best practices."
- **i)** Identify potential reliability "holes" or problem areas and recommend solutions.

j) Identify the role that the IITP process might play as part of an implementation strategy for interoperability control and as a reliability qualification process for new AIN platforms, services and software. (Coordinate potential overlapping interconnection issues with the Network Interconnection Focus Team)

Existing Work Efforts

There are several work efforts that have addressed or are addressing some of these issues. The Fiber Cable Focus Team recommendations in the *Network Reliability: A Report to the Nation*, *the Telecommunication Industry Benchmark Committee (TIBC) Report*, Draft Congressional Bills S2101 and HR4394 on one-call legislation, and the ATIS/NRSC Annual Report provide significant data from which to begin to address the Provision of Key Services Over New Network Facilities issue. The ATIS Working Group on Network Survivability Performance, T1A1.2 and the News Release, DA-1343, requesting comments on Joint Petition for Rulemaking on Cable Television Wiring, RM No. 8380, November 15, 1993 provide background on the cellular and coax cable concerns. The Switching Systems (focus on software) Focus Team Recommendations in the *Network Reliability: A Report to the Nation* as well as ATIS/NOF/IITP charter and test plans give good background material for addressing the services and software concerns.

Recommended Team Leader
Ken Young - Bellcore

Appendix B - Technical Characteristics of Planned Satellite Communications Systems

AMSC (American Mobile Satellite Corporation)

- Prime Contractor - Hughes for spacecraft
- Development Status - Initial service started 4th quarter 1995
- Services Offered - Regional voice services to vehicles with roof-mounted antenna
- Constellation - Presently one geo-synchronous satellite
- Transmission Method - FDMA
- PSTN Interface - Same standards as existing cellular providers

GLOBALSTAR

- Prime Contractor - Loral Qualcomm
- Development Status - FCC Construction authorized, service expected 1999
- Services Offered - Global Voice, Data, and Fax Services to mobile users
- Constellation - 48 LEO satellites, no crosslinks
- Transmission Method - CDMA
- PSTN Interface - Standard PSTN interfaces from carriers or cellular providers

IRIDIUM

- Prime Contractor - Motorola SATCOM
- Development Status - FCC construction authorized, service expected 1998
- Services Offered - Global Voice, Data, FAX, and Messaging to handheld equipment
- Constellation - 66 LEO satellites, with crosslinks, 48 Beams per satellite
- Transmission Method - TDMA
- PSTN Interface - SS7 based interface to International Switching Center

INMARSAT-P (ICO Global Comm Ltd)

- Prime Contractor - Hughes for spacecraft
- Development Status - Service expected 1999
- Services Offered - Global Voice, Data, and FAX to portable equipment
- Constellation - 10 Intermediate Circular Orbit satellites, no crosslinks, 163 beams
- Transmission Method - TDMA
- PSTN Interface - Through existing international carriers

Technical Characteristics of Planned Satellite Communications Systems (Continued)

ODYSSEY

- Prime Contractor - TRW
- Development Status - FCC construction authorized, initial service expected 1998
- Services Offered - Global Voice services to portable equipment
- Constellation - 12 Intermediate Circular Orbit satellites, no crosslinks, 37 Beams
- Transmission Method - CDMA
- PSTN Interface - Standard PSTN interfaces from carriers or cellular providers

GALAXY/SPACEWAY

- Prime Contractor - Hughes Communications
- Development Status - Design activities started, service expected 2000
- Services Offered - Global higher bandwidth point-to-point services
- Constellation - 17 GEO Satellites, with crosslinks, 48 Beams per satellite
- Transmission Method - TDMA
- PSTN Interface - No direct switched interfaces to PSTN

TELEDESIC

- Prime Contractor - Not yet determined
- Development Status - Design activities started, service expected 2001
- Services Offered - Global higher bandwidth point-to-point services
- Constellation - 840 LEO Satellites, with crosslinks, 64 Beams per satellite
- Transmission Method - TDMA
- PSTN Interface- No direct switched interfaces to PSTN

Appendix C - New Technology Reliability Template

The New Technology Reliability Template is a generic template that can serve as a reliability screen for assessing the reliability of new network technologies. It would be used primarily by a service provider but also is useful to a supplier of the particular technology to understand the important reliability criteria from the service provider’s perspective. A person or organization in the service provider company who has primary responsibility for network reliability, planning for integration of a new technology, or having overall technical responsibility for a network would be potential users. These potential user's have the need to assure that all of the issues in the template have been adequately considered/addressed before the technology is integrated into the network. This template could be used as part of the service provider’s process for the rapid and reliable evolution of their telecommunications networks.

New Technology Reliability Template

Criteria	Comments
1.0 Architecture	
Technology complies with industry/company standard architecture	
Specific architecture and its reliability features	
Architecture is robust enough to prevent FCC reportable outage	
Worst case percentage of key services restorable with this technology	
New operations support systems identified and meet architectural guidelines	
All changes to existing (legacy) systems have been identified	
Disaster recovery requirements identified and addressed	
Official network interfaces consistent with networking architectural plans and guidelines	
Industry "best practices" exist and have been considered	
List industry "best practices" to be followed	
Architecture is robust enough to meet customer reliability requirements	
Mechanism exists to evaluate end-to-end customer reliability for key services	
Customers have such a mechanism	
If so, what is observed reliability?	

New Technology Reliability Template

2.0 Technology Reliability	**Comments**
Technology reliability criteria defined	
Supplier documentation of reliability reviewed and meets criteria	
Operations support systems reliability criteria defined and met	
Is provision of key services using this technology as reliability of current technology?	
For each major failure mode of the technology providing key services, list:	
Describe the failure mode	
What is the failure mode impact in terms of equivalent blocked calls?	
What is the estimated duration of the failure mode?	
What is the estimated frequency of the failure mode?	
What actions(s) are required to recover from the failure mode?	
3.0 Installation	
Standard equipment configurations developed	
Installation methods and procedures developed	
Acceptance procedures documented	

New Technology Reliability Template

4.0 Service Provisioning	**Comments**
Service order documents have sufficient detail for field personnel and network element administration	
Service provisioning methods and procedures developed	
Feature interaction testing plan developed	
5.0 Monitoring	
Availability objectives exist	
Technology has self-diagnostic and auditing capabilities	
Technology can be remotely monitored and is consistent with existing monitoring system architecture	
Technology has full alarming capabilities	
Monitoring methods and procedures developed	
Required changes to monitoring systems completed	
Network element and OSS tested to ensure surveillance integrity	

New Technology Reliability Template

6.0 Maintenance/Repair	Comments
Technology operation consistent with current maintenance process flow and supporting systems	
Routine maintenance methods, procedures and time frames developed	
Software maintenance plans exist	
Non-intrusive software change/maintenance capabilities exist	
Appropriate test tools/equipment selected and available	
Remote testing and inventory capability exists	
OSS provides technology work force management reports	
Troubleshooting procedures exist including fault visibility, trouble verification and isolation, recovery/repair	
Is operator action or conformation required to recover from failures?	
Post-mortem analysis methods exist	
Process exists to feedback findings and recommendations to improve future reliability	

New Technology Reliability Template

7.0 Interoperability	**Comments**
Does this technology interoperate with other networks in provision of key services?	
How does the technology achieve reliable operation when interconnecting?	
How is reliable operation monitored and controlled?	
8.0 Training	
Required training courses available in time frames consistent with deployment schedule	
List required training	
9.0 Reliability Monitoring	
Process to collect outage data exists	
Process to do root cause analysis on outage data exists	
Process to develop best practices to improve new technology reliability exists	