Network Reliability Council (NRC)

Reliability Issues - Changing Technologies Focus Group

Focus Group Overview

February 22, 1996

Ken Young	Bellcore	Focus Team Chair
Gary Handler	Bellcore	Focus Team Mentor
Clint Hamilton	Bellcore	AIN Subteam Chair
Dave McDysan	MCI	SONET/ATM Subteam Chair
Roy Koelbl	Bellcore	NWAT Subteam Chair
Jay Krakora	Motorola	Satellite Subteam Chair
Jeff Crollick	GTE	Wireless/PCS Subteam Chair

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1. Executive Summary

The Network Reliability Council's Focus Group on Reliability Concerns Arising Out of Changing Technologies was tasked with analyzing the reliability aspects of new technologies in two specific areas:

- Provision of key services over new network facilities
- Provision of expanded services over new or traditional facilities

Four specific technologies that can provide key services were identified in the focus team's Issue Statement (Appendix A):

- Synchronous Optical Network/Asynchronous Transfer Mode (SONET/ATM)
- New wireline access technologies (NWAT) (e.g., hybrid fiber-coax and fiber-to-the-curb)
- Satellite communications networks
- Wireless/Personal Communications Services (PCS).

The Issue Statement also identified a fifth topic area that falls into the category of provision of expanded services over new or traditional facilities:

- Advanced Intelligent Network (AIN).

In total, the focus group developed more than 50 recommendations concerning the reliability of these new technologies. Those recommendations can be found in the individual subteam reports. The focus group also developed a New Technology Reliability Template, which can be used as a screening tool for assessing the reliability of any new technology and for introducing it into the network so as to avoid network reliability problems.

2. Background

2.1 Focus Team and Subteam Structure

The Public Switched Telephone Network (PSTN) has a well-deserved reputation for reliability. Today's PSTN, and the telecommunications industry in general, are undergoing unprecedented changes resulting from the rapid introduction of new technologies, the implementation of new advanced services to endusers, and the entry of new service providers. Maintaining the reliability of the PSTN in the face of these changes will be an ongoing challenge for the industry for the foreseeable future.

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The Issue Statement also identified a fifth topic area that falls into the category of provision of expanded services over new or traditional facilities:

- Advanced Intelligent Network (AIN).

The focus group was organized into five subteams, each charged with analyzing the reliability aspects of one of the technologies identified in the Issue Statement.

The focus group and four of the subteams had problems getting started due to difficulties in finding chairs and subteam members who could dedicate the significant effort needed to accomplish the focus group's mission. Although the NRC effort began in late 1994, the final (4th) focus group chair was not in place until June, 1995. Only one subteam (AIN) was staffed and operational in early 1995; effective start dates for the other subteams were approximately as follows: SONET/ATM (June, 1995), New Wireline Access Technologies (July, 1995), Satellite (September, 1995) and Wireless/PCS (September, 1995). The focus group was able to effectively accomplish its mission due to the hard work and dedication of those who worked diligently to complete this report within a very compressed time frame.

2.2 Recommendation and Best Practice Definition

The term “recommendation” or “Best Practice” as used in this report is defined as follows: “recommendations are those countermeasures (but not the only countermeasures) which 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

Subteam chairs were chosen from a group of known industry experts. Each subteam chair then staffed his own subteam with a cross-section of members representing different sectors of the particular topic area and from various players from across the industry. Subteam membership is listed in each of the individual reports. The focus team chair, focus team mentor and subteam chairs were as follows:

:

Ken Young	Bellcore	Focus Group Chair
Gary Handler	Bellcore	Focus Group Mentor
Clint Hamilton	Bellcore	AIN Subteam Chair
Dave McDysan	MCI	SONET/ATM Subteam Chair
Roy Koelbl	Bellcore	NWAT Subteam Chair
Jay Krakora	Motorola	Satellite Subteam Chair
Jeff Crollick	GTE	Wireless/PCS Subteam Chair

4. Study Methodology

One difficulty in analyzing the reliability of a new technology is that there is a common deficiency of extensive field data on which to base the assessment, particularly for those technologies that have not yet been deployed or which are only in the early stages of field trials and initial deployment. Therefore in each of the studies carried out, the subteams relied on a variety of sources of data and means of soliciting information including:

- Wide industry representation on each team
- Formal industry surveys and data collection
- Publicly available data sources
- Subject matter expert presentations
- Team analysis and recommendation development

Because of time and budget constraints, only the AIN subteam was able to conduct an extensive formal survey of industry outage data and expert opinion. The SONET/ATM subteam was able to complete a formal industry survey on the status of SONET/ATM technology and its deployment, but was not able to collect detailed outage information. The other three subteams were limited to using existing publicly available data and informal surveys of expert opinions. Given the wide

industry representation on each subteam and the subject matter expertise that subteam members brought to this study, the focus group does not believe that this lack of industry data compromises the applicability of its findings and recommendations.

As outlined in the individual subteam reports, each sub-team developed its own process for constructing its findings and recommendations. Approximately once each month, the focus group chair and subteam chairs held a teleconference to review progress and to share preliminary results. The focus group chair and subteam chairs had a face-to-face meeting on November 7, 1995 to plan for the NOREST II and NRC readouts. The focus group also worked with the subteams to develop the generic New Technology Reliability Template (Appendix B).

Each subteam made a presentation to the NOREST II steering committee of its findings and recommendations—AIN, SONET/ATM and NWAT subteams on November 8, 1995, and the Satellite and Wireless/PCS subteams on November 29, 1995. NOREST II approved the findings and recommendations and provided the subteams with constructive recommendations on refining the recommendations. A summary of the focus group's findings and recommendations was presented to the NRC on December 13, 1995, and the report was unanimously approved.

5. Study Results

The individual subteam reports detail the findings and recommendations on the five specific areas that were outlined in the Issue Statement. From those findings and recommendations we abstracted several generic recommendations that we believe apply to any new technology. These are outlined in this section.

One theme common to all subteam reports is the importance of establishing a process for collecting of reliability data, doing root cause analysis and developing best practices to improve the reliability of new technologies. Such a process should be an integral part of the integration of any new technology into the network and should be established early in the planning for field trials and the deployment stage of a new technology. Establishing such a process will help ensure both that reliability issues and problems can be addressed in a systematic manner and that the reliability of the new technology can be continually improved as experience is gained.

<Recommendation 1>

Network operators should, in cooperation with their equipment suppliers, establish a reliability monitoring process during trials and early deployment of a new technology as a means for identifying sources of failures, doing a root cause analysis and implementing corrective actions before widespread deployment of the new technology.

Another theme common to all reports is the important role that standards bodies and industry fora play in developing standards and specifications that enhance the reliability and availability of new technologies. Industry players, especially those who are new entrants in the provision of key services, are encouraged to actively participate in such standards bodies and fora and to share their new technology reliability data and expertise to promote the overall reliability of the PSTN.

<Recommendation 2>

Service providers using new technology and their suppliers, especially those who are new to the provision of key or expanded services requiring high reliability, are encouraged to participate in relevant standards bodies and industry fora.

In addition to the specific findings and recommendations, the focus group also worked to develop the New Technology Reliability Template provided in Appendix B. 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 will be used primarily by a service provider but will also be useful to an equipment supplier of a particular technology to foster understanding of the important reliability criteria from the service provider's perspective. Potential users would be persons or organizations in the service provider company that have primary responsibility for ensuring network reliability, planning for integration of a new technology, or having overall technical responsibility for a network. These potential users have the need to ensure that all of the issues listed in the template have been adequately considered and 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 its telecommunications networks.

<Recommendation 3>

Both service providers and technology suppliers should use the New Technologies Reliability Template to assess the reliability impact that a new technology will have on providing key or expanded services.

6. Findings and Recommendations

The following are recommendations that apply in general to new technologies:

<Recommendation 1>

It is recommended that network operators, in cooperation with their suppliers, establish a reliability monitoring process during trials or early deployment of a new technology as a means to identify sources of failures, to do a root cause analysis and to implement corrective actions before widespread deployment of the new technology.

<Recommendation 2>

Service providers using new technology and their suppliers, especially those who are new to the provision of key or expanded services requiring high reliability, are encouraged to participate in relevant standards bodies and industry fora.

<Recommendation 3>

Both service providers and technology suppliers should use the New Technologies Reliability Template to assess the reliability impact that a new technology will have on providing key or expanded services.

7. Acknowledgments

The focus group chair would like to acknowledge the hard work and dedication of the subteam chairs, without whose expertise and diligence it would not have been possible to complete the

focus group’s mission. The focus group also acknowledges the assistance and advice provided by its mentor, Gary Handler, and by the members of the NOREST II committee.

8. 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 FocusTeam 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:

I. 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:

1. *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.

2. *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.

II. 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

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

a) 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 For each technology, determine the scope of the reliability study. 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 - 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 will be used primarily by a service provider but will also be useful to an equipment supplier of a particular technology to foster understanding of the important reliability criteria from the service provider's perspective. Potential users would be persons or organizations in the service provider company that have primary responsibility for ensuring network reliability, planning for integration of a new technology, or having overall technical responsibility for a network. These potential users need to ensure that all of the issues listed in the template have been adequately considered and 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 its 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 reliable as current technology?	
For each major failure mode of the technology providing key services, provide the following information/:	
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	