Network Reliability Council (NRC)

Reliability Issues - Changing Technologies Focus Group

Wireless/PCS Subteam Final Report

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1. Executive Summary

The Network Reliability Council's "Changing Technologies Focus Group" established the Wireless/PCS subteam to investigate the network reliability issues related to the evolving wireless industry. The primary objective of the subteam's work was to evaluate from a network reliability perspective whether a mobile switching center (MSC) differed from a "wireline" switch.

The areas of study concerned interconnection of both trunking and signaling resources of an MSC to the "network." Although MSCs have an air interface and mobility management component, their interfaces to the network are essentially the same as those of a landline switch. The network views the wireless switch as an "end office."

The net result of this study is that existing wireless network reliability policies, procedures, best practices, and recommendations are applicable regardless of the air interfaces utilized.

Rather than reiterate the findings of the other subteams, this subteam concurs with the recommendations regarding interconnection, standards development, interoperability testing, and intelligent networking.

2. Background

2.1 Mission

The mission of the subteam was to investigate wireless/Personal Communcations Services (PCS) network from a reliability perspective. The team believed from the onset that it should not duplicate the work of the other subteams; therefore, the team concentrated on the specific external network reliability issues. If it was determined that a specific subject was explored by another subteam, references are made to the work of other subteams.

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. Subteam Membership

The members of the Wireless/PCS subteam were as folows:

Jeff Crollick (Chair)	GTE Telecommunication Services, Inc.
Dick Gove	Ameritech Cellular
Ed Hall	Cellular Telecommunications Industry Association
Bob Montgomery	Cellular Telecommunications Industry Association
Art Prest	Cellular Telecommunications Industry Association

4. Data Collection and Analysis Method

4.1 Data Collection

The subteam reviewed the activities and documentation of the following standards bodies:

- Telecommunications Industry Association (TIA) Subcommittee TR-45.2 – 800 Mhz Intersystem Operations
- TIA Subcommittee TR46.2 – 1800 MHz Intersystems Operations
- Alliance for Telecommunication Industry Solutions (ATIS) Subcommittee T1P1

The simplified network reference model shown in Figure 4.1 is a high-level view of the areas of review. Specifically, the A_i, D_i, C_1, C_5, and C_6 interfaces were reviewed. The A_i, D_i reference points are common between IS-41 based and DCS-1900 systems. The C_1, C_5, and C_6 reference points are being developed within TIA TR-45.2 as the Wireless Intelligent Network (WIN). The A and U_M were not reviewed because they are not interfaces to the "network." Documents relating to these interfaces were reviewed for relevancy.

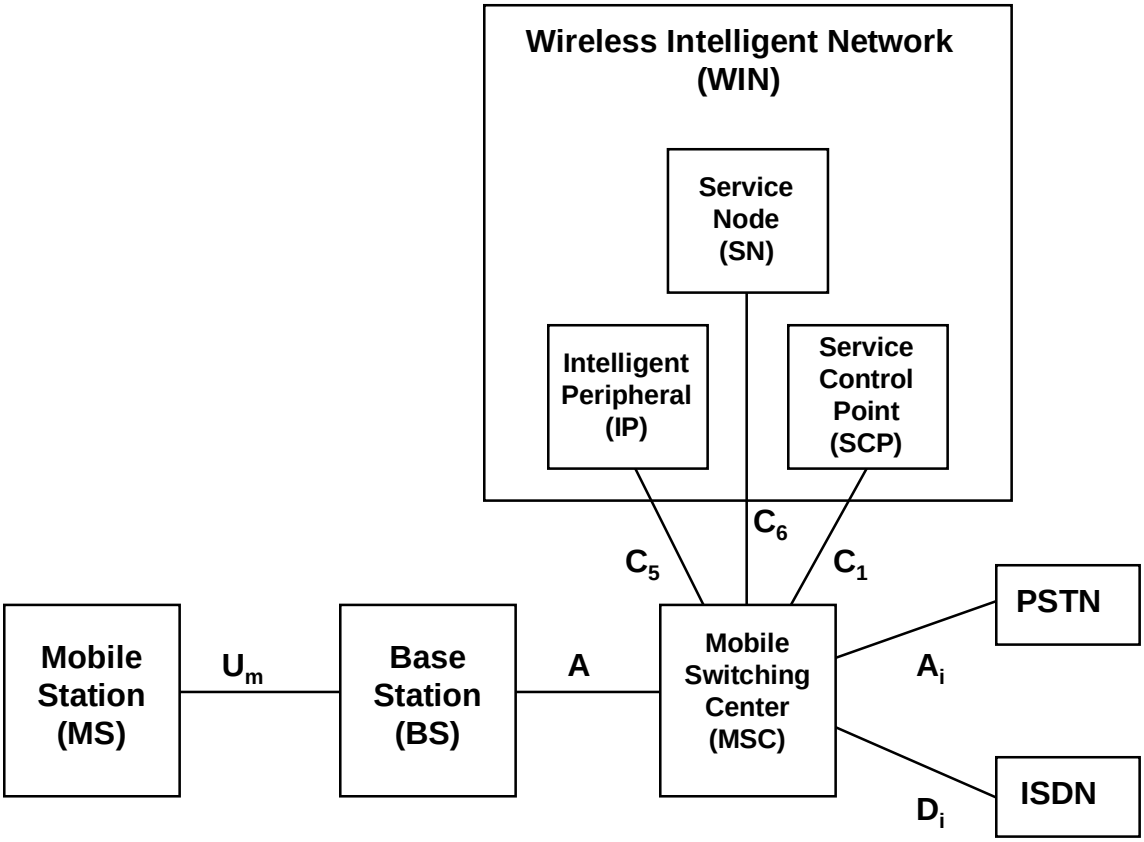

Figure 4.1 - Network Reference Model

4.2 Analysis Method

This subteam reviewed the work of the other subteams for relevancy. The documentation was specifically reviewed by the subteam as it related to network reliability of trunking and signaling resources.

5. Study Results

The subteam's findings from its review of the standards documentation are as follows:

1) 800 MHz (cellular) and 1800 Mhz (PCS) systems use various air interfaces that do not directly affect network reliability.
2) From a network reliability perspective, an MSC is similar to a wireline switch; cellular and PCS switches have the same network interface requirements.
3) The network views the wireless switch as an end office with the same signaling and trunking requirements as a wireline end office.
4) Signaling System 7 (SS7) reliability requirements are the same as landline with the addition of mobility management.

6. Recommendations

As a result of the review process, the Wireless/PCS Subteam recommends the following:

<Recommendation 1>

Existing wireless network reliability policies, procedures, best practices, and recommendations should be applied to all wireless technologies and signaling systems regardless of air interface technology.

<Recommendation 2>

Recommendations of Working Group II (Increased Interconnection) on interconnection, standards development, and interoperability testing should be followed.

<Recommendation 3>

The applicable recommendations of Working Group III, AIN sub-team, on Advanced Intelligent Networking, should be followed.

7. References

EIA/TIA IS-41 Rev. C	– "Cellular Radio Telecommunications Intersystem Operations"
EIA/TIA IS-93	– "Cellular Radio Telecommunications Ai-Di Interfaces Standard"
TIA/EIA IS -652	– "PCN to PCN Intersystem Operations based on DCS 1900"
TIA TR-45/94.11.29.17	– "CTIA's Network Reference Model"
TIA TR-45/94.11.29.07	– "CTIA's Wireless Intelligent Network (WIN) Standards Requirements Document (SRD)"

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:

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:

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.

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

a) Determine the reliability issues associated with AIN services (e.g., management of many different versions of software).

b) Identify efforts taken to date to address AIN reliability issues and to ensure AIN service reliability. Identify existing "best practices."

c) Identify potential reliability "holes" or problem areas and recommend solutions.

d) 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 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 users 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.

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?	

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	

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	

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	

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	