ATIS STANDARD

ATIS-0100004

AVAILABILITY & RESTORABILITY ASPECTS OF EMERGENCY TELECOMMUNICATIONS SERVICE (ETS)

TECHNICAL REPORT

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ATIS-0100004, *Availability & Restorability Aspects of Emergency Telecommunications Service (ETS)*

Is an ATIS Standard developed by the **ATIS Network Performance, Reliability, and Quality of Service Committee (PRQC)**.

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ATIS-0100004

Technical Report on

AVAILABILITY & RESTORABILITY ASPECTS OF EMERGENCY TELECOMMUNICATIONS SERVICE (ETS)

Secretariat

Alliance for Telecommunications Industry Solutions

Approved January 2006

Abstract

Standards work on the Emergency Telecommunications Service (ETS) falls within the mission of several of the ATIS Committees. PRQC (formerly T1A1) has been designated as the lead Technical Subcommittee for ETS in Committee T1. T1.TR.79-2003, *An Overview of Standards in Support of Emergency Telecommunications Service (ETS)*, identified a list of eighteen (18) functional requirements for ETS. Out of this list, PRQC is responsible for standards related to four (4) functional requirements on Reliability/Availability, Survivability/Endurability, Restorability, and Enhanced Priority. This Technical Report (TR) addresses aspects of the functional requirements of Availability and Restorability for ETS.

FOREWORD

The Alliance for Telecommunication Industry Solutions (ATIS) serves the public through improved understanding between carriers, customers, and manufacturers. The Network Performance, Reliability, and Quality of Service Committee (PRQC) -- formerly T1A1 -- develops and recommends standards, requirements, and technical reports related to the performance, reliability, and associated security aspects of communications networks, as well as the processing of voice, audio, data, image, and video signals, and their multimedia integration. PRQC also develops and recommends positions on, and foster consistency with, standards and related subjects under consideration in other North American and international standards bodies.

Suggestions for improvement of this document are welcome. They should be sent to the Alliance for Telecommunications Industry Solutions, PRQC Secretariat, 1200 G Street NW, Suite 500, Washington, DC 20005.

PRQC was responsible for the development of this Technical Report (TR).

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1 SCOPE, PURPOSE, & APPLICATION

1.1 Scope

As public communication networks become more critical to the Government's missions, authorized emergency users require high standards from network providers. Network providers need to be able to deliver specific levels of network performance such as availability and restorability of Emergency Telecommunications Services (ETS). Performance measurements must be defined and agreed upon in any Service Level Agreements (SLAs) relating to ETS. Networks comprise many different components (e.g., routers, switches, media gateways, gatekeepers, servers, etc.). Based on network connectivity, specific performance measurements of a single or multiple (packet-based or switched-based) networks need to be made available to emergency organizations prior to any service acquisitions.

For availability, authorized emergency users expect to have access to highly available services in order to fulfill their mission at all times.

For restorability, network redundancy engineering is required to carry or reroute emergency traffic when one or more network components fail to perform -- e.g., Automatic Switch Protection (APS), Automatically Switched Optical Network (ASON), etc.

1.2 Purpose

The purpose of this Technical Report (TR) is to address aspects of two (2) ETS functional requirements: 1) Availability; and 2) Restorability. The purpose of the ETS is to facilitate emergency recovery operations for restoring the community infrastructure and for returning the population to normal living conditions after serious disasters and events, such as floods, earthquakes, hurricanes, and terrorist attacks. The ETS will be provided through shared resources from the public telecommunications infrastructure, which is evolving from a basic circuit-switched configuration of today's conventional telephone networks to an Internet-based, packet-switched technology providing a richness of communication capabilities. The timely establishment of an effective ETS has been given significant urgency as a result of the September 11, 2001 terrorist attacks in the United States (U.S.).

Many challenges and considerations need to be addressed in defining and establishing the functional capabilities for the ETS in the emerging packet-based telecommunications services. This TR addresses the requirements: *d. Restorability* and *n. Reliability/Availability* of the list of the eighteen (18) requirements in T1.TR.79-2003 [1] for ETS that packet-based telecommunication and wireless mobile networks are capable of providing, and that must receive attention during the process of the convergence of these technologies. Disaster situations can occur unexpectedly at any time, any place. These events often significantly damage the community infrastructure and severely disrupt daily living. Recovery requires rapid response by local authorities, immediate reaction from utility service providers, and support from medical, construction, fire, and police resources. Effective communications are essential to facilitate the myriad activities for coordinating lifesaving activities concurrent with reestablishing control in the disaster area. Following a disaster, immediate response operations focus on saving lives, protecting property, and meeting basic human needs.

1.3 Application

As stated above, this TR is meant to be applied by those standards bodies, particularly ATIS Technical Committees, in their work on current and future enhancements to evolving networks. It is hoped that it will provide much-needed guidance concerning where issues are being addressed relating to ETS requirements. It is not meant to imply that certain requirements will be mandated by law.

2 NON-NORMATIVE REFERENCES

At the time of publication, the editions indicated were valid. All standards and reports are subject to revision, and parties to agreements based on this Technical Report are encouraged to investigate the possibility of applying the most recent editions of the standards and reports indicated below.

[1] T1.TR.79-2003, *Overview of Standards in Support of Emergency Telecommunications Service (ETS)*.[1]

[2] ITU-T Recommendation E.106, *Description of an International Emergency Preference Scheme*.[2]

[3] *[reference deleted]*

[4] Telcordia SR-2275, *End-to-end availability objectives for local exchange networks on reference architectures and hypothetical reference networks*.[2]

[5] Jones, V., *High Availability Networking with Cisco,* Addison Wesley Longman; 1st edition (December 21, 2000). [ISBN 0-201-70455-2]

[6] "Executive Overview," *SLA Management Handbook, Volume 1*, TeleManagement Forum, Member Evaluation Version 2.0, July 2004.[3]

[7] "Concepts and Principles," *SLA Management Handbook, Volume 2*, TeleManagement Forum, Version 2.0, April 2004.[3]

[8] "Service and Technology Examples," *SLA Management Handbook, Volume 3*, *TeleManagement Forum,* Member Evaluation Version 2.0.[3]

[9] T1.TR.55-1998, *A Technical Report on Reliability and Survivability Aspects of the Interactions Between the Internet and the Public Telecommunications Network*.[1]

[10] T1.TR.70-2001, *A Reliability/Availability Framework for IP-based Networks and Services*.[1]

[11] ATIS-0100006, *Service Restoration Priority Levels for IP Networks*.[1]

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[1] This document is available from the Alliance for Telecommunications Industry Solutions (ATIS), 1200 G Street N.W., Suite 500, Washington, DC 20005. < https://www.atis.org/docstore/default.aspx >

[2] Telcordia documents are available from Industry Direct Sales, Telcordia, 8 Corporate Place, PYA 3A-184, Piscataway, NJ, 08854-4156, or: < http://telecom-info.telcordia.com >.

[3] Available from the Telemanagement Forum (TMForum) at
< http://www.tmforum.org/DocumentLibrary/SLAHandbookSolution/29298/article.html >

3 DEFINITIONS, ACRONYMS, & ABBREVIATIONS

3.1 Definitions

3.1.1 Emergency Telecommunications Service: A service offering available on communications networks to facilitate the work of authorized emergency personnel in times of disaster.

3.1.2 Availability (A): A measure or calculation of how much time a system, subsystem, or service component is functioning properly.

3.1.3 Reliability (R): The probability that a service system will perform its purpose adequately as specified for the period of time.

3.1.4 Mean Time Between Failure (MTBF): The average time needed to repair a failed component/system and restore it to operation.

3.1.5 Mean Logistics Down Time (MLDT): The average time needed to acquire replacement parts of a failed component.

3.1.6 Mean Down Time (MDT): The average time equipment is down due to failures. Includes MTBF and MLDT.

3.1.7 Mean Time To Repair (MTTR): The average time it takes equipment to be repaired.

3.1.8 Service Duration (SD): The desired period of time a service system must perform as specified.

3.2 Acronyms & Abbreviations

3G	Third Generation
3GPP	3rd Generation Partnership Project
AAP	Alternative Approval Process
ADSL	Asymmetric Digital Subscriber Line
AHG	Ad Hoc Group
ANSI	American National Standards Institute
AT	Access Tandem
ATIS	Alliance for Telecommunications Industry Solutions
ATM	Asynchronous Transfer Mode
BCP	Best Current Practice
BICC	Bearer Independent Call Control
BS	Base Station
CALEA	Communications Assistance for Law Enforcement Act
CSM	Call Service Management
DCE	Data Circuit Terminating Equipment
DTE	Data Terminating Equipment
E911	Enhanced 911
EN	Edge Network
EP	End Point
ES	Errored Seconds
ETS	Emergency Telecommunications Service

ETSMS	ETS Management Service
ETSI	European Telecommunications Standards Institute
GETS	Government Emergency Telecommunications Service
GK	Gate Keeper
GSM	Groupe Speciale Mobile (old definition) Global System for Mobile Communications
GSM-MAP	GSM Mobile Application Part
H.225	ITU H.323 Call Signaling
H.248	ITU Version of MEGACO
H.323	ITU Recommendation on Packet-based multimedia communications systems
ID	Internet Draft
IEMS	International Emergency Multimedia Service
IEPS	International Emergency Preference Scheme
IETF	Internet Engineering Task Force
IP	Internet Protocol
IS-41	TIA Interim Standard 41
ISDN	Integrated Services Digital Network
ISAC	Information Sharing and Analysis Center
ISTP	Internet Signaling Transport Protocol
ITU	International Telecommunications Union
ITU-T	ITU Telecommunication Standardization Sector
LAN	Local Area Network
M3UA	Message Transfer Part 3 User Adaptation
MAN	Metropolitan Area Network
MEGACO	IETF Media Gateway Control
MESA	Mobility for Emergency and Safety Applications
MG	Media Gateway
MGC	Media Access Controller
MGCP	Media Gateway Control Protocol
MPLS	MultiProtocol Label Switching
MSC	Mobile Switching Center
NCS	Network Call Signaling *OR* National Communications System
NS/EP	National Security / Emergency Preparedness
OSS	Operating Support System
PLMN	Public Land Mobile Network
PSTN	Public Switched Telephone Network
RAS	H.323 Registration Authorization Status
RFC	Request for Comments
RTP	Real-time Transport Protocol
SA	Service Availability
SAP	Service Access Point
SC	Service Customers
SCP	Signaling Control Point
SCTP	Signaling Control Transport Protocol

SDF	Service Degradation Factor
SDO	Standards Development Organization
SES	Severely Errored Seconds
SG	Signaling Gateway
SIGTRAN	Signaling Transport
SIP	Session Initiation Protocol
SIP-T	SIP for Telecommunication
SLA	Service Level Agreement
SONET	Synchronous Optical NETwork
SP	Service Provider
SS7	Same as SSN7
SSG	Special Study Group
SSN7	Signaling System Number 7
SSP	Service Switching Point
STP	Signaling Transfer Part
SWG	Sub-Working Group
TCAP	Transaction Capabilities Application Part
TDM	Time-Division Multiplexing
TGCP	Trunking Gateway Control Protocol
TIA	Telecommunication Industry Association
TIPHON	Telecommunications and Internet Protocol Harmonization Over Networks
TMN	Telecommunications Management Network
TR	Technical Report
TSC	Technical Sub-Committee
TSP	Telecommunications Service Priority
UAS	Unavailable Seconds
VDSL	Very High Bit Rate Digital Subscriber Line
WG	Working Group
WI	Work Item
WLAN	Wireless LAN

4 ARCHITECTURE OF EMERGENCY TELECOMMUNICATIONS

The Public Switched Telephone Network (PSTN) has been developed, refined, and optimized for voice traffic and services over many years through the combination of circuit-switching, time-division multiplexing (TDM) and Signaling System Number 7 (SSN7). This voice infrastructure has matured into a ubiquitous architecture with high quality, reliability and security. National Security and Emergency Preparedness (NS/EP) communications such as Government Emergency Telecommunications Service (GETS) and the Wireless Priority Service (WPS)[4] rely heavily on this infrastructure.

The data communications infrastructure, with the growth of computing and networking, has been significantly developed in recent years. This packet-switching infrastructure primarily was developed

[4] See < http://wps.ncs.gov/ > for more information.

to carry data for corporations and private networks. In recent years, it has been extended to residences. Because of the growth and the popularity of the Internet, many service providers have started using packet-switching technology to carry voice traffic and service as well.

The voice and data infrastructures have evolved to become a common infrastructure to support a wide range of applications, including voice, data, video, and multimedia. This converged infrastructure should maintain the high reliability, quality of service, and security offered in the PSTN. Existing NS/EP services -- e.g., Telecommunications Service Priority (TSP), GETS -- will need to function over this converged infrastructure and future emergency services (e.g., ETS) will take advantage of this infrastructure.

ETS services will be provided across different networks where one-to-one or group level communications (e.g., broadcast, multicast, etc.) of authorized emergency users can take place. Because natural or man-made disasters could happen anywhere, emergency users need to have wide communication coverage in order to fulfill their missions. Emergency traffic needs to access, traverse, and egress different networks. Different technologies are deployed in different networks that make up a converged network infrastructure. In order to support ETS traffic, interworking and interoperability of these technologies are needed.

ETS services may utilize several different applications from E-mail to Videotelephony. *Applications*, for our purposes, can be categorized as *elastic* and *inelastic*. Inelastic applications can be further categorized into *tolerant* and *intolerant real-time applications*.

4.1 Elastic ETS Applications

Elastic applications can operate over a range of data rates, delay bounds, and packet loss rate, for example, Telnet, File Transfer Protocol, Web browsing, and Net news. Best effort service is generally acceptable as long as some resource is available for these applications. Most of these applications are built on top of a reliable transport protocol such as TCP. TCP would slow down or speed up the data rate based upon the sender.

4.2 Inelastic ETS Applications

4.2.1 Tolerant Real-Time ETS Applications

Real-time applications (e.g., audio conferencing, video streaming, etc.) are sensitive to delay. They are dependent upon the kinds of codecs implemented in these applications. In *tolerant real-time applications* limited loss and delays can be accepted. These real-time applications run over User Data Protocol (UDP). No flow controls are used and retransmissions are needed at the transmission layer. The application layer would take over flow controls and retransmissions if needed.

4.2.2 Intolerant Real-time ETS Applications

Intolerant real-time applications such as Voice-over-IP and Internet telephony require stringent Quality-of-Service (QoS) from IP networks. In order to maintain a high quality (e.g., Mean Opinion Score) in IP networks equivalent to that in PSTN, these applications must have precise bandwidth, delay, and packet loss constraints. Otherwise, they would be severely degraded.

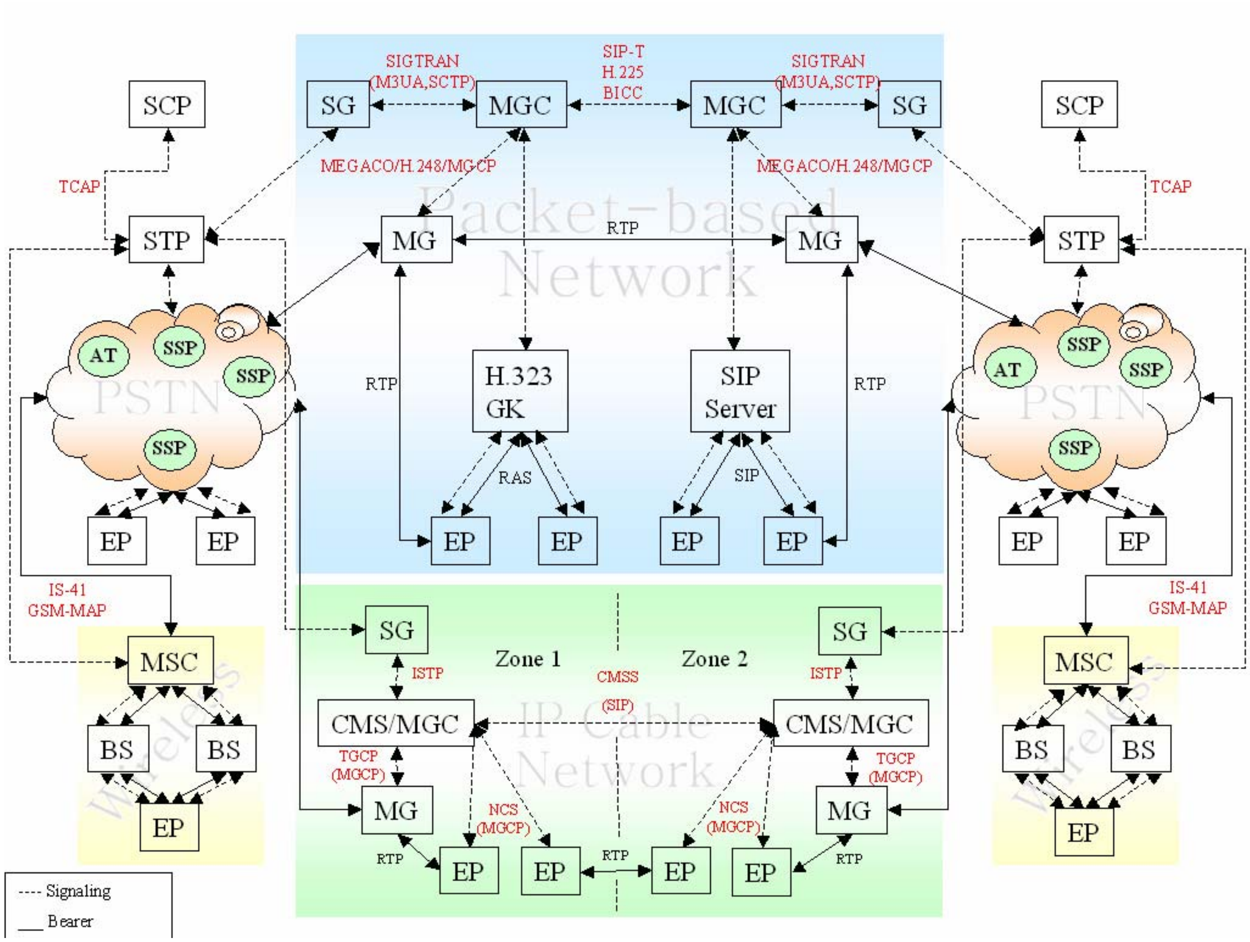


Figure 1 - Example of ETS Interworking in Evolving Networks

Figure 1 shows an example of the interworking of ETS services in evolving networks. Some signaling and transport protocols are identified that need to support the interworking of these networks. ETS users need to communicate with one another via ETS applications and services (e.g., Web access; instant messaging; wireless access; unicast/multicast/broadcast of audio, video, and data; interactive video; remote database access; etc.).

5 AVAILABILITY ASPECTS OF ETS

ETS can be implemented in both Virtual Private Networks and Public Access Networks.

These two types of networks can be used to support a wide range of ETS applications such as Voice over IP, Short Messaging, Instant Messaging, Videoconferencing, Wireless Services, Database Access, etc. IP Networks carrying ETS traffic should have redundant routes (e.g., multihoming, route diversifications, etc.) and be properly engineered to ensure ETS calls and/or sessions can go through during network congestion.

5.1 Availability Calculations

Availability measures the percentage of time the service system is in its operational state. To assure high availability of service, failures of each service system (i.e., MTBF) must be infrequent, service system down time (i.e., MDT) must be kept small, and service recovery (MTTR) must be expeditious (once there is a failure or outage).

$$MDT = MTTR + MLDT$$

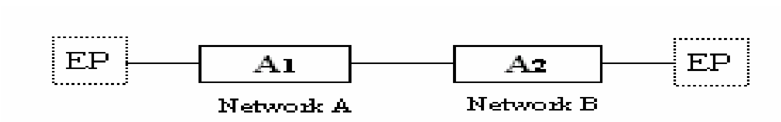
$$A = MTBF/(MTBF + MDT)$$

Where A is Availability, MDT is Mean Down Time, MTTR is Mean Time To Repair, MLDT is Mean Logistical Down Time, and MTBF is Mean Time Between Failures. As noted in [10], "network outages, such as network node or link failures may or may not have an impact on a network service." If adequate provisioning is in place, a catastrophic hardware failure might not result in any service outage.

The following are examples of two end points (EP's) communicating through different networks and the associated availability equations.

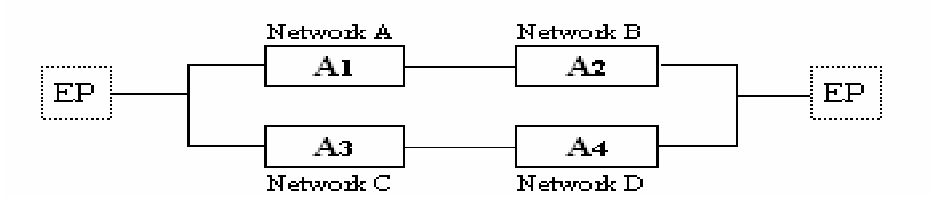
5.1.1 Networks in Series

Given the network A and network B in series, let the availability of network A be A_1 and that of network B be A_2; the composite availability between two EP's is $A_1 * A_2$.



5.1.2 Networks in Parallel

In the network below, A is in series with B, network C is in series with D and the two series networks are in parallel with each other. The availability of A is A_1, of B is A_2, of C is A_3, and of D is A_4. The availability of the composite network transporting traffic between two EP's is given by $(A_1*A_2 + A_3*A_4 – A_1*A_2*A_3*A_4)$.



5.2 Availability Calculations in the SLA Handbook

The *SLA Handbook* [7][8][9] provides guidance on the specification of service availability in Service Level Agreements (SLAs).

The following equation from the *SLA Handbook* [9] defines service availability (SA) for leased lines. The assignment of different weighting to different network elements and to different measures of degradation (i.e. Severely Errored Seconds and Errored Seconds) allows for flexibility in definition and measurement of Service Availability.

$$SA\% = \left(1 - \sum_{k=1}^{2} w_k \left(\frac{SDF_1 \sum_{i=1}^{N_a} UAS_{ik} + SDF_2 \sum_{i=1}^{N_b} SES_{ik} + SDF_3 \sum_{i=1}^{N_c} ES_{ik}}{\sum_{j=1}^{2} TotalSecs_j w_j} \right) \right) x100$$

SA is Service Availability, SDF is Service Degradation Factor, UAS is Unavailable Seconds, SES is Severely Errored Seconds, ES is Errored Seconds, W_k is the weight for Service Access Point (SAP) k. A SAP is defined in the following figure from [9].

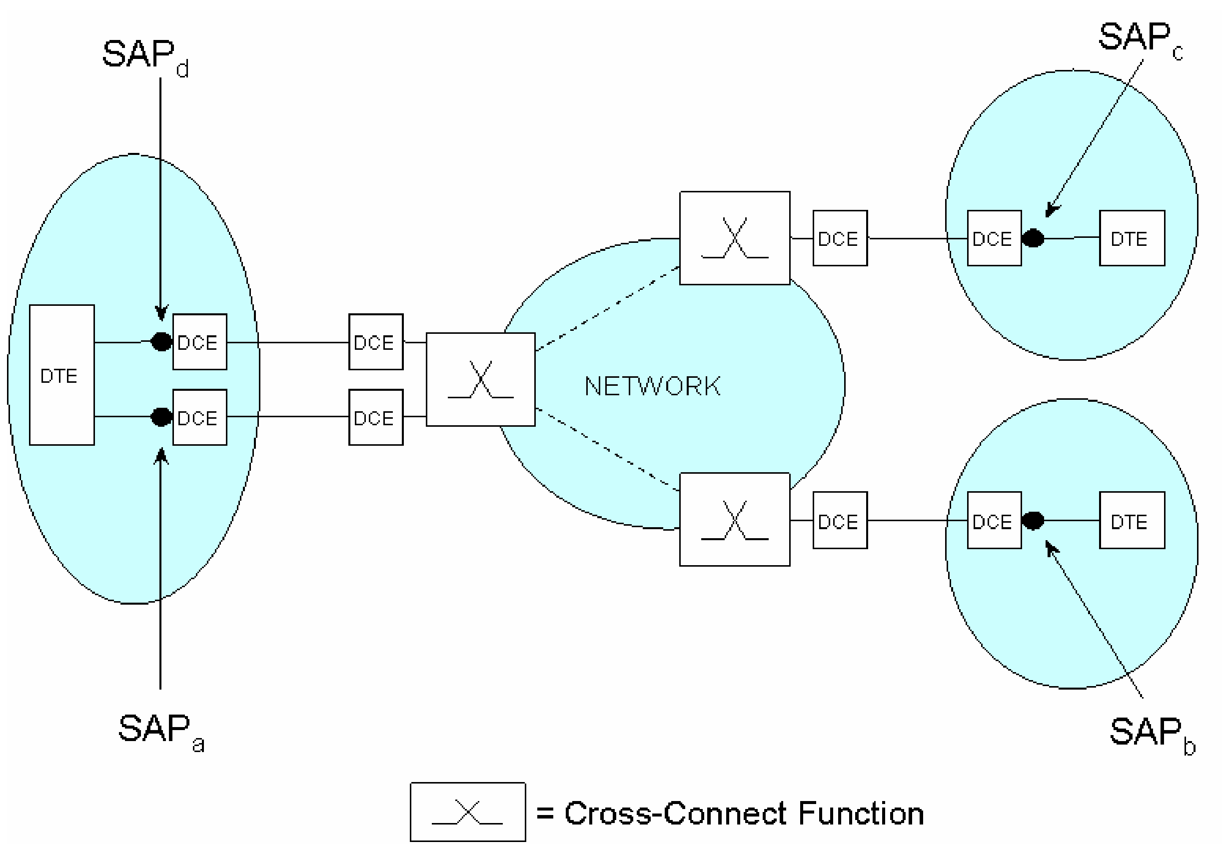


Figure 2 - Network example showing Service Access Point (SAP)

"The data terminating equipment (DTE) and data circuit terminating equipment (DCE) are intended to be functional descriptions. The DCE and the DTE may be physically implemented in the same or in different hardware devices." [9]

The *SLA Handbook* contains several other equations for calculating Service Availability, including some which take into account the user's perception of a degradation of service.

5.3 Availability Objectives for ETS

As part of a service-level agreement between a service provider and its ETS users leasing a connection, the carrier must commit to providing certain availability for the connection. A common goal for end-to-end connection is around 99.9% (three 9s) of the time. This goal corresponds to a connection downtime of less than 9 hours per year as indicated in the table below. A connection is routed through many nodes in a network between its source and its destination, and there are many elements along its path that can fail. In order to obtain 99.9% of service availability for ETS, a service provider must properly design and engineer its network to ensure it continues to provide service (as specified in the SLA) in the presence of failures.

Below is the availability range applicable to communications systems and associated downtime:

Availability	Downtime per Year			
	Seconds	Minutes	Hours	Days
99.9999%	32			
99.999%	315	5		
99.99%	3154	53		
99.9%	31536	526	9	
99%	315360	5256	88	4

The use of redundancy (logical, physical, or both) is typically used to provide the necessary availability for ETS and related services. High availability can also be achieved through other means, such as the use of diverse routing and route weighting.

6 RESTORABILITY ASPECTS OF ETS

Work on establishing restoration priority levels is under active study. (See ATIS-0100006.) ETS should be given the highest restorability class available. It is assumed that restoration schemes will be in compliance with FCC regulations (e.g., TSP).

Within a single provider's network restorability of ETS should be addressed in a Service Level Agreement (SLA) between the ETS service provider and the ETS service customer.

Restorability applies to both service restorability and restorability of the physical layer.

Examples of fast restoration mechanisms for possible use in ETS services are the following:

- *Dedicated 1+1 protection scheme*: With a 1 + 1 scheme, restoration can be done in 60 milliseconds.
- *Example from IETF MPLS GMPLS*: A shared mesh protection. Virtual Ring.
- *Intradomain routing protocols*:

- o Intradomain routing protocols such as Open Shortest Path First (OSPF) and Intermediate System to Intermediate System (IS-IS).
- o Interdomain routing protocols such as Border Gateway Protocol (BGP) can facilitate resotoral across network domain boundaries.
- o Routing policies can be applied that influence how ETS packets can be routed in an IP network.

ATIS Committee TMOC addresses cooperative network management aspects involving multiple network operators which include restoration of network services.

7 EXAMPLE REFERENCE MODELS

The following reference models are offered as examples. Combinations of these models will make up the environment for the ETS service. SLAs might be made between different service providers and calculations of the individual availability will be used to determine if the overall availability will be sufficient to meet the requirements for the ETS.

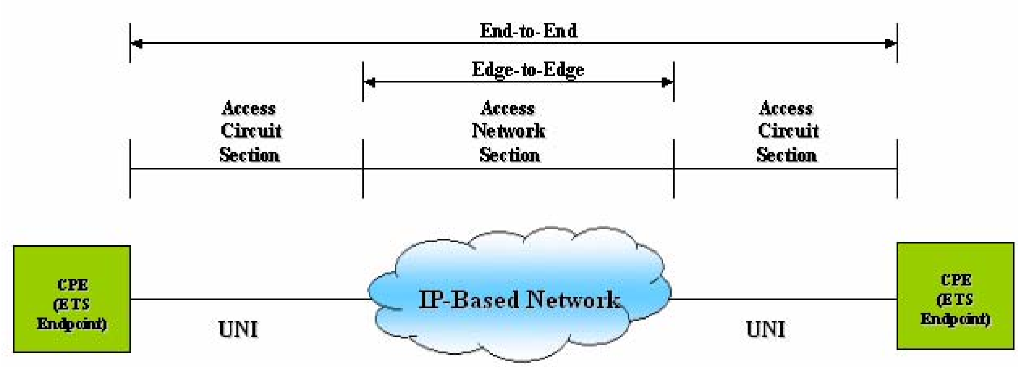
If ETS users expect 99.9 (for example) for end-to-end service across two networks, the two involved providers have to design their networks and work out some network peering agreements with each other to ensure ETS users would get the availability for which they contracted.

If the availability of one network is X and that of another network is Y, then the end-to-end availability is X*Y. For example, given a network X availability of 99.94 [4], in order to meet an end-to-end availability of 99.9 for ETS calls or sessions which traverse through a combined X and Y network, the availability of the Y network must be equal or greater than 99.4/99.9.

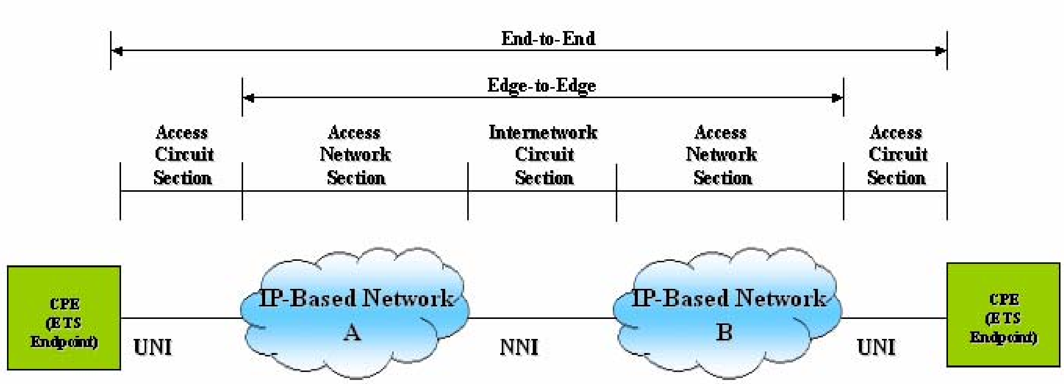
It is possible that different network types would have different availability requirements. For example, an ETS call traversing from an IP-based network to a wireless network might only be able to provide a composite availability less than 99.9 because of the non-ubiquity of the IP network and the potentially spotty coverage of the wireless network.

7.1 Packet-Based to Packet-Based

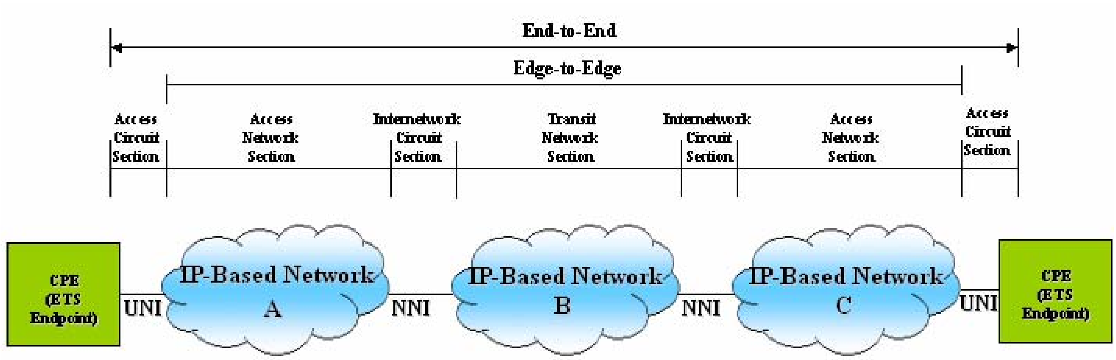
7.1.1 Scenario 1: IP-based services provided by a single provider



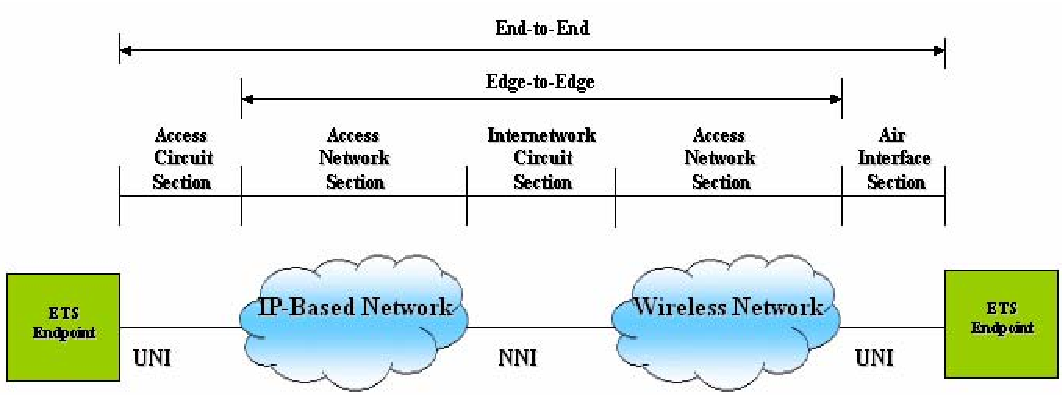
7.1.2 Scenario 2: IP-based services provided by two providers



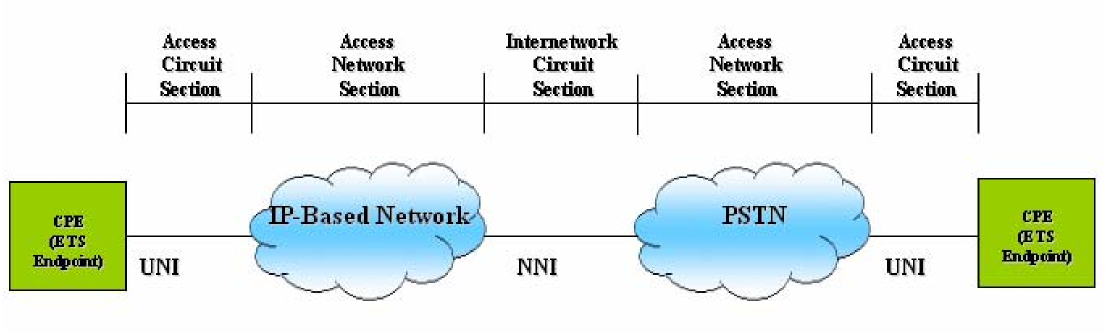
7.1.3 Scenario 3: IP-based services provided by three or more providers



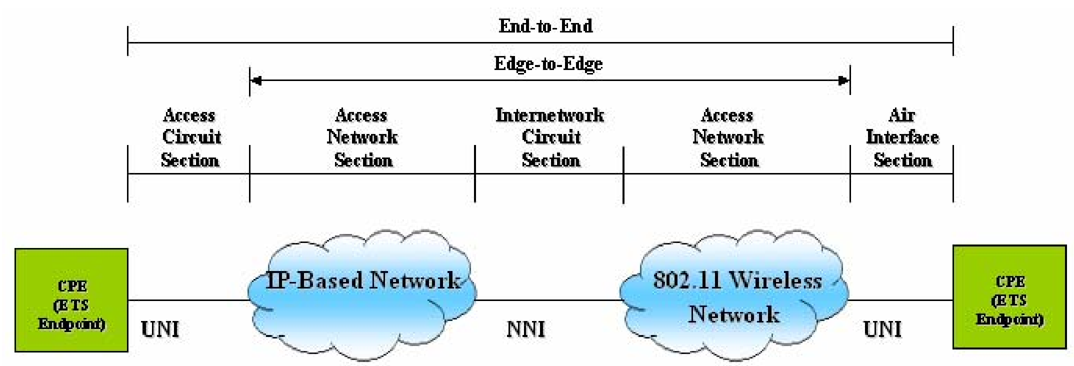
7.2 Packet-Based to Wireless Network



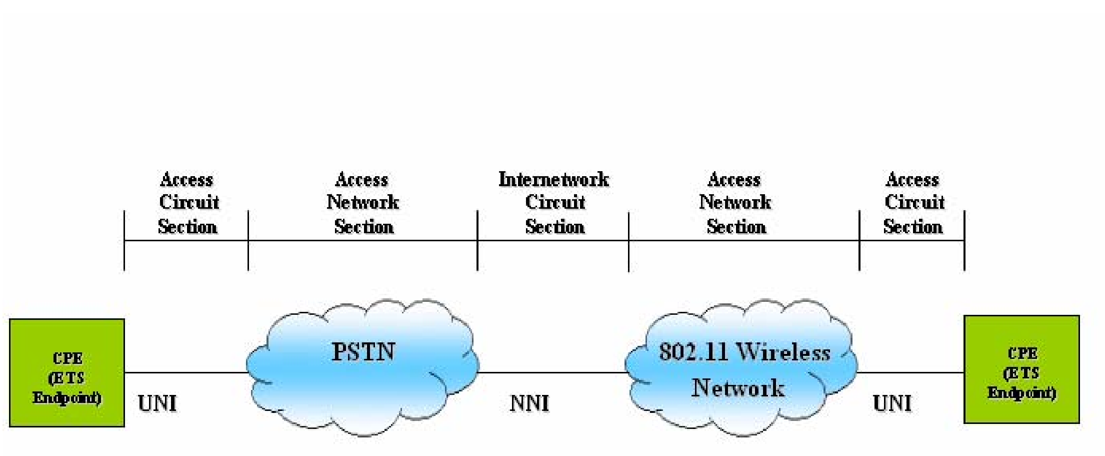
7.3 Packet-Based to PSTN



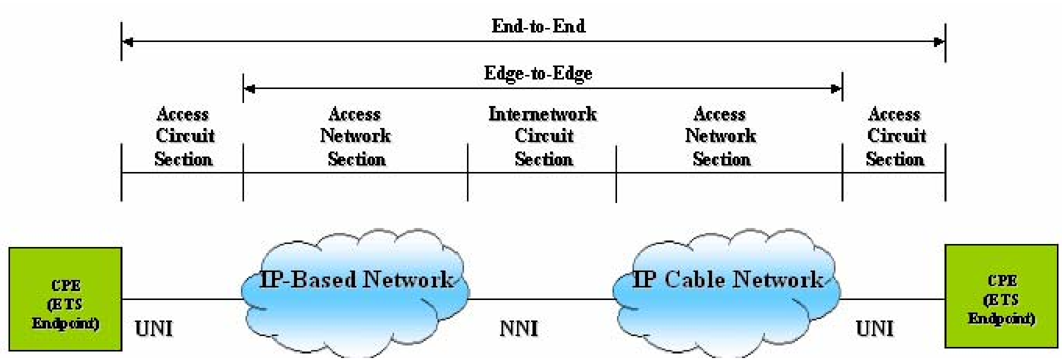
7.4 Packet-based to 802.11 Wireless Network



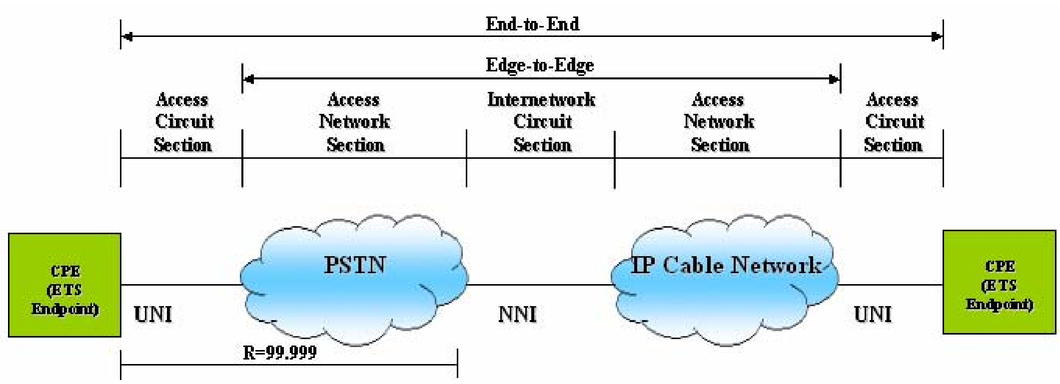
7.5 PSTN to 802.11 Wireless



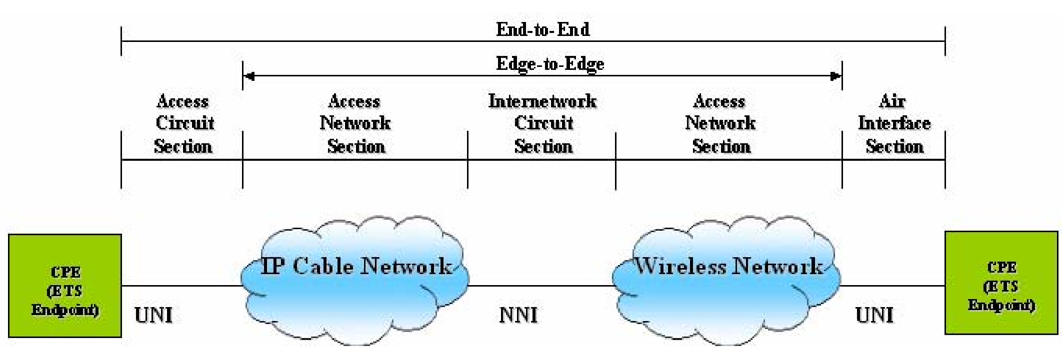
7.6 Packet-based to IP Cable Network



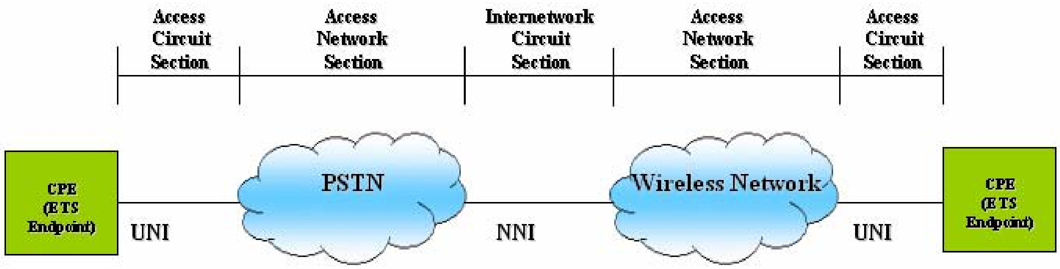
7.7 PSTN to IP Cable Network



7.8 IP Cable Network to Wireless Network



7.9 PSTN to Wireless Network



8 CONCLUDING REMARKS

This TR illustrates some internetworking scenarios where ETS can be offered to authorized emergency personnel (e.g., NS/EP community) during natural and/or man-made disasters. There are two different kinds of ETS applications: *elastic* and *inelastic*. The TR also provides some basic calculations for availability and suggests different service classes for restorability of ETS.

Those network providers who offer ETS need to be able to deliver specific levels of network performance in support of these applications.