



ATIS-0100006

## Service Restoration Priority Levels for IP Networks

TECHNICAL REPORT



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ATIS-0100006, *Service Restoration Priority Levels for IP Networks*

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

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Technical Report on

## Service Restoration Priority Levels for IP Networks

Secretariat

**Alliance for Telecommunications Industry Solutions**

Approved March 2006

### **Abstract**

This Technical Report (TR) proposes three levels of service restoration priority for traffic in IP networks. It also proposes that all emergency communications (e.g., ETS and E911) be included in the highest priority for service restoration. This report also provides guidance on restoration compliance with the Telecommunications Priority System as mandated by the Federal Communications Commission (FCC). The goal is to formalize restoration priority levels in IP networks such that appropriate signaling requirements can commence.

## FOREWORD

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This Technical Report (TR) proposes three service restoration priority levels in IP networks. It also proposes that National Security/Emergency Preparedness services are included in the highest restoration priority class.

This TR is intended for providers of IP-based communications networks and services, communications equipment suppliers, and government agencies responsible for addressing emergency situations.

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.

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## TABLE OF CONTENTS

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<b>FOREWORD</b> .....	<b>II</b>
<b>TABLE OF CONTENTS</b> .....	<b>II</b>
<b>1 PURPOSE</b> .....	<b>1</b>
<b>2 SCOPE</b> .....	<b>1</b>
<b>3 APPLICATION</b> .....	<b>2</b>
<b>4 RELATED WORK</b> .....	<b>2</b>
<b>5 RESTORATION PRIORITY PRINCIPLES</b> .....	<b>3</b>
<b>6 RECOMMENDATION FOR RESTORATION PRIORITY LEVELS</b> .....	<b>4</b>
<b>7 FLEXIBILITY</b> .....	<b>4</b>
<b>8 CONCLUSION</b> .....	<b>5</b>
<b>9 DEFINITIONS</b> .....	<b>5</b>
<b>10 ABBREVIATIONS AND ACRONYMS</b> .....	<b>6</b>
<b>11 REFERENCES</b> .....	<b>6</b>

Technical Report on

# Service Restoration Priority Levels for IP Networks

## 1 PURPOSE

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Restoration of communications traffic during severe network outages is a critical function for IP-based networks. For service providers with large volumes of traffic involved, prioritizing traffic for restoration according to traffic criticality – as determined by Service Level Agreements (SLAs), as well as the availability of fast restoration mechanisms – becomes essential. For instance, SONET rings are widely deployed in today’s networks and provide fast (~200 ms) restoration for all traffic that is routed over them. At the same time, SONET rings may not be universally deployed by a service provider seeking to contain capital expense. It is imperative that the facilities transporting critical traffic such as National Security/Emergency Preparedness (NS/EP) services, are provisioned over rings. Similarly, as IP networks evolve, the ability to differentiate traffic for restoration priority, signal the desired restoration priority for traffic flows entering an IP backbone as well as traversing multiple backbones, and implementing appropriate restoration mechanisms capable of recognizing restoration priorities and taking necessary actions, becomes a critical issue.

The ATIS Network Performance, Reliability, and Quality of Service (PRQC) Committee recently published the Technical Report ATIS-0100003, *User Plane Priority Levels for IP Networks and Services*.<sup>[1]</sup> The goal was to enable the ATIS sub-committee on Signaling and Architecture Control of the Packet Technologies and Systems Committee (PTSC-SAC) to commence development of necessary signaling requirements for priority classifications for admission control and consequently, bandwidth reservation, in IP networks. The purpose of this Technical Report is to extend IP service classification to the important function of service restoration. The goal is to enable PTSC-SAC to include restoration priority in the development of necessary requirements for priority-based signaling extensions.

This Report recommends three restoration priority class levels for IP services. It also recommends that NS/EP services such as Emergency Telecommunications Service (ETS) be included in the highest restoration priority class.

## 2 SCOPE

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From the perspective of the network, it is expected that future IP networks will be truly “converged.” That is, all forms of communications traffic will be handled by such networks – control plane traffic (e.g., routing and signaling messages), NS/EP (real-time, data, and video) services, real-time voice and video services, data services, Virtual Private Network (VPN) services, as well as traditional “Best Effort” traffic. In such an environment, it is important to assign priority classifications and establish rules for service restoration such that critical services (e.g., control plane traffic and emergency services) are recognized and restored over other services in case of network overloads or failures. As service flows can be expected to traverse multiple network domains, priority classification is an important step in the development of the necessary signaling protocol extensions as well as the mechanisms for enabling preferential restoration of critical services.

The scope of this recommendation is limited to the determination of restoration priority class levels for communications over IP networks. In particular, the scope of this document is limited to addressing the need for priorities in automated restoration mechanisms in IP networks. The underlying support for this recommendation is based on the potential impact on IP services due to failure conditions. Specifically, the recommendation seeks to cast a broad view on priority classification, namely: what should the proper number of classes be such that critical services are given the highest probability of successful restoration under failure conditions? For example, it is recognized that a class of “emergency services” can comprise Federal ETS (real-time, data, and video) as well as local E911 calls and that this class of traffic requires priority treatment in case of emergency. The goal of this document is to distinguish this class of traffic from other less critical classes of traffic. However, this document does not seek to “fine tune” the treatment of different traffic types within a broad priority class or level. Thus, the ability to distinguish between service types within any given priority class (e.g., distinguish between ETS and E911 services in the emergency service class) is beyond the scope of this document.

### 3 APPLICATION

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The priority level classification is based on the following premise: under reduced bandwidth conditions resulting from network failure, the critical issue for an IP network is the ability to recognize and restore higher priority traffic flows over others. The priority level recommendations proposed in this document strictly relate to the relative importance of traffic classes from this perspective; they do not reflect implementation specific priority definitions. For example, there are mechanisms utilizing Generalized Multi-Protocol Label Switching (GMPLS) based Recovery that define specific recovery capabilities such as 1+1 protection and 1:N protection [2]. Such mechanism-specific priority definitions do not apply to the recommendations in this document.

### 4 RELATED WORK

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A significant amount of work on ETS requirements is ongoing in various standards bodies. A detailed list of such efforts can be found in the ATIS/PRQC Technical Report T1.TR.79-2003, *Overview of Standards in Support of Emergency Telecommunications Service (ETS)* [3]. An ATIS Technical Report originated by the PRQC committee – T1.TR.84-2004, *IP Network Traffic Priorities and ETS* – documents the need for traffic prioritization from the perspective of emergency services [4]. ATIS PRQC has also advanced a Technical Report on restorability aspects of ETS for publication [5].

In the ITU-T, Recommendation E.361 [6] has progressed work on the definition of reliability and priority parameters for QoS service classes. This Recommendation also provides useful insights on the priority signaling across multiple networks. ITU-T Recommendation Y.1291 [7] presents a discussion on priority levels for Connection Admission Control (CAC) and service restoration functions in packet networks. ITU-T Recommendation TRQ-QoS-SIG [8] also provides additional detail on the signaling aspects of restoration priority levels.

In the IETF Next Steps in Signaling (NSIS) Working Group, work is ongoing to define Quality of Service (QoS) modeling parameters in IP networks. Initial efforts include the use of priority parameters as well as a proposal for three levels for restoration priority [9]. The goal of this effort is to eventually embrace QoS and priority parameters that apply to specific mechanisms such that these values can be signaled throughout an IP network. Also in the IETF, the label distribution for Traffic Engineering and

QoS (and hence priority) can be accomplished via the Resource Reservation Protocol - Traffic Engineering (RSVP-TE) [10]. This protocol permits the creation of explicitly routed LSPs and provides fast rerouting [11], traffic and QoS specification, preemption, and other capabilities.

## 5 RESTORATION PRIORITY PRINCIPLES

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In today's PSTN networks, restoration priority is influenced by the Telecommunications Service Priority (TSP) System [4], [12] as mandated by the Federal Communications Commission (FCC). Per these requirements, all TSP services (e.g., NS/EP services), regardless of their restoration priority, are restored before any non-TSP services. Service providers are required to restore TSP services with restoration priority assignments before telecommunications services without restoration priority assignments. However, control services and order-wires that are wholly owned and operated by a service provider and crucial to the operation of that service provider's network are exempted from this requirement.

The applicability of TSP procedures to evolving networks having IP backbones (and generally, large cross-section optical transport systems) requires clarification. For instance, TSP procedures were written when only limited automated restoration methods (e.g., protection switching) were in existence. By contrast, today's automated restoration methods work best "in bulk" - faster restoration is achieved when large amounts of impacted bandwidth are restored regardless of the underlying communications traffic. For example:

- ◆ *SONET rings in transport networks restore all impacted facilities in less than 200 ms regardless of the type of traffic carried on the failed facilities.* Thus, a DS-3 that is provisioned for NS/EP private line traffic - hence governed by TSP priority rules - gets restored at the same time as other less critical DS-3 facilities on the ring.
- ◆ *Re-routes in IP backbones work at the packet layer and are governed by OSPF rules in the event of failure.* Packet streams are re-routed in the order of tens of seconds over alternate paths depending on the availability of spare bandwidth regardless of the type/source of packet. Thus, an ETS packet stream is just as likely to get re-routed as other less critical packet streams.

The scope of this document is limited to addressing the need for priorities in automated restoration mechanisms in IP networks. It should be noted that transport restoration methods (e.g., SONET rings) cannot recognize failures in IP backbone routers, and hence, Layer 3 restoration in today's IP networks is done exclusively at the IP layer. To speed up the restoration process, faster MPLS-based re-route methods [11] are being considered with restoration speeds in the sub-second range - approaching SONET ring speed. However, it is not clear whether such faster methods can apply universally to all traffic in an IP network - the ability of such methods to work efficiently may require that the mechanisms only apply to a limited portion of the total traffic. In that case, it is recommended that all critical traffic, including NS/EP, be assigned to the faster re-route class in the IP network. Less critical traffic can then be re-routed via existing OSPF methods.

The above discussion immediately suggests that at least two restoration priorities are desirable in IP networks. However, the evolution of IP networks is driven by the idea of convergence - the ability to transmit all types of communications traffic over IP backbones. Thus, service providers are increasingly planning the use of "converged" IP networks to carry real-time services such as Voice over IP (VoIP) as well as video, private data traffic (exemplified by VPN traffic), emergency traffic (VoIP, and in the

future, data and video), in addition to today's "traditional" Best Effort services such as e-mail and web browsing. This suggests that simply categorizing IP traffic as "emergency" and "other" may not be sufficient. Under such a two-level scheme, restoration policies may be likely to reject, or use slower restoration mechanisms, VPN and real-time VoIP traffic just as equally as Best Effort traffic in order to preferentially restore NS/EP traffic under emergency conditions. This suggests that while two levels could serve as a lower bound for the number of service restoration priorities, the actual number of levels should be higher. And given that fast restoration schemes work best when done in "bulk" (large volumes of traffic restored as a broad group or class), it is recommended that three levels of IP restoration priority is sufficient. As noted in clause 4, recent work in the IETF NSIS working group has also proposed three restoration priority levels [9].

## 6 RECOMMENDATION FOR RESTORATION PRIORITY LEVELS

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Based on the above discussion, three restoration priority levels are recommended for traffic in IP networks:

- ◆ *High*: Control services crucial to the operation of a service provider's network and NS/EP Emergency services (e.g., ETS and E911).
- ◆ *Normal*: Non NS/EP and control services that require better than Best Effort restoration guarantees. Examples include real-time services (VoIP, video), VPN, and Data services. The selection of this priority class is expected to be determined by appropriate Service Level Agreements (SLA) between service carriers and customers for the desired service.
- ◆ *Best Effort*: Services that do not require specified restorability guarantees. Examples include "traditional" Internet Service Provider (ISP) services (e-mail, web surfing). The selection of this priority class is expected to be determined by appropriate SLA agreements between service carriers and customers for the desired service.

The goal of this classification is the following: under reduced network bandwidth conditions, high and normal priority traffic flows are given higher priorities for faster and successful restoration at the expense of best effort traffic.

## 7 FLEXIBILITY

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As stated in the scope, this document provides a broad classification of IP traffic types from the perspective of restoration in an IP network. This concept is bolstered by the fact that fast and efficient restoration schemes work best when restoring large volumes of traffic as opposed to selectively dealing with several narrowly defined traffic types. Thus, a service provider should be able to utilize flexibility in deciding the best way to restore IP communications traffic flows based on SLA agreements with customers. The only strict requirement is that all control and NS/EP services should be recognized as High priority for fast and complete (100%) restoration.

As an illustration, consider a service provider having an MPLS-based traffic engineered network and who has decided to deploy MPLS-based Fast Reroute schemes into its IP backbone. However, the provider has elected to restrict this scheme for restoring up to 50% of IP traffic, in order to minimize

bandwidth capital expense. The provider plans to utilize existing IP-based OSPF schemes for rerouting the remaining traffic flows with enough bandwidth such that all of the remaining traffic is restored. Assume further that the service flows for this provider are as follows:

- ◆ 5 % High Priority Restoration Traffic;
- ◆ 45% Normal Priority Restoration Traffic; and
- ◆ 50% Best Effort Priority Restoration Traffic.

The service provider may group all the High Priority Label Switched Paths (LSP) along with 45% of the Normal Priority LSPs for MPLS-based Fast Reroute. The Best Effort LSPs would be restored via OSPF after the network has “converged” - all information about the failure has been received by all routers and new LSP paths are developed for the Best Effort LSPs. To extend the notion of flexibility, consider that the service provider decides to enhance the Fast Reroute scheme by allowing 5% of traffic to get even faster restoration by means of 1+1 bandwidth protection - backup LSPs are pre-identified and reserved for critical LSPs. That would permit 1+1 restoration for the High priority traffic LSPs, Fast Reroute for the Normal LSPs, and OSPF-based LSP reconfiguration for the Best Effort LSPs.

## 8 CONCLUSION

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This document proposes three levels for restoration priority in the user plane for IP networks: *high*, *normal*, and *best effort*. It further proposes that the high priority level should be reserved for control services crucial for network operations and emergency services such as ETS and E911. The classification for non-emergency services (normal or best effort) can be determined in appropriate SLA agreements between service providers and their customers.

It is also noted that additional priority levels may be considered in the future depending on service requirements/needs as well as the availability of advanced and mature enabling mechanisms.

## 9 DEFINITIONS

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**9.1 Emergency Telecommunications Service:** A service offering available on communications networks to facilitate the work of authorized emergency personnel in times of disaster, national emergency, or for executive/governmental communications relating to National Security/Emergency Preparedness (NS/EP).

**9.2 Service Restoration:** A set of automated or manual methods, invoked after a network failure, to enhance the ability of successful communications reroute and completion around the failed network element(s).

## 10 ABBREVIATIONS AND ACRONYMS

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ATIS	Alliance for Telecommunications Industry Solutions
CAC	Connection Admission Control
ETS	Emergency Telecommunications Service
G-MPLS	Generalized Multi-Protocol Label Switching
IETF	Internet Engineering Task Force
IP	Internet Protocol
ITU-T	International Telecommunications Union - Telecommunications Standardization Sector
LSP	Label Switched Path
MPLS	Multi-Protocol Label Switching
MPLS-TE	MPLS Traffic Engineering
NS/EP	National Security/Emergency Preparedness
NSIS	Next Steps in Signaling
OSPF	Open Shortest Path First
SIP	Session Initiation Protocol
SLA	Service Level Agreement
TSP	Telecommunications Service Priority
VoIP	Voice over IP
VPN	Virtual Private Network

## 11 REFERENCES

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- [1] ATIS-0100003, *User Plane Priority Levels for IP Networks and Services*.<sup>A</sup>
- [2] IETF I-D, Work in Progress, *RSVP-TE Extensions in Support of End-to-End Generalized Multi-Protocol Label Switching (GMPLS)-based Recovery*, J. Lang (Editor), October 2005.<sup>B</sup>
- [3] T1.TR.79-2003, *Overview of Standards in Support of Emergency Telecommunications Service (ETS)*.<sup>A</sup>
- [4] T1.TR.84-2004, *IP Network Traffic Priorities and ETS*.<sup>A</sup>
- [5] ATIS-PP-0100004, *Availability and Restorability Aspects of Emergency Telecommunications Service (ETS)*.<sup>A, C</sup>
- [6] ITU-T Recommendation E.361, *QoS Routing Support for Inter-working of QoS Service Classes Across Routing Technologies*, May 2003.<sup>D</sup>

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<sup>A</sup> 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> >

<sup>B</sup> IETF I-Ds are available at < <https://datatracker.ietf.org/public/pidtracker.cgi> >; archived copies can be found on that site or < <http://www.potaroo.net/ietf/> >.

<sup>C</sup> Pre-published version; the number of this TR upon formal publication will be ATIS-0100004.

<sup>D</sup> This document is available from the International Telecommunications Union at < <http://www.itu.int/ITU-T/> >.

- [7] ITU-T Recommendation Y.1291, *An Architectural Framework for Support of Quality of Service in Packet Networks*, May 2004.<sup>D</sup>
- [8] ITU-T Recommendation TRQ-QoS-SIG, *Signaling Requirements for IP QoS*, January 2005.<sup>D</sup>
- [9] IETF I-D Work in Progress, *NSIS Signaling Policy for Networks Using Y.1541 QoS Classes*, J. Ash, et al., February 2006.<sup>B</sup>
- [10] IETF RFC 3209, *RSVP-TE: Extensions to RSVP for LSP Tunnels*, December 2001.<sup>E</sup>
- [11] IETF RFC 4090, *Fast Reroute Extensions to RSVP-TE for LSP Tunnels*, P. Pan, et al., May 2005.<sup>E</sup>
- [12] FCC Docket No. 87-505, *Telecommunications Service Priority System*, October 1988.<sup>F</sup>

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<sup>E</sup> This document is available from the Internet Engineering Task Force (IETF) at < <http://www.ietf.org> >.

<sup>F</sup> This document is available from the U.S. Government Printing Office at < <http://www.access.gpo.gov/> >.