ATIS-0300118

Next Generation Interconnection Interoperability Forum (NGIIF) NGN Reference Document

NGN Interconnection

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ATIS-03000118

ATIS Standard on

Next Generation Interconnection Interoperability Forum (NGIIF)
NGN Reference Document

NGN Interconnection

Alliance for Telecommunications Industry Solutions

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Abstract

This document focuses on providing information for connecting service provider (SP) networks using next generation connections, including internetwork routing.

Foreword

The Alliance for Telecommunications Industry Solutions (ATIS) serves the public through improved understanding between carriers, customers, and manufacturers. The Next Generation Interconnection Interoperability Forum (NGIIF) addresses next generation network interconnection and interoperability topics associated with emerging technologies. Specifically, it develops operational procedures that involve the network aspects of architecture, disaster preparedness, installation, maintenance, management, reliability, routing, security, and testing between network operators. In addition, NGIIF addresses issues that impact the interconnection of existing and next generation networks and facilitate the transition to emerging technologies.

The mandatory requirements are designated by the word *shall* and *must,* and recommendations by the word *should*. Where both a mandatory requirement and a recommendation are specified for the same criterion, the recommendation represents a goal currently identifiable as having distinct compatibility or performance advantages. The word *may* denotes an optional capability that could augment the standard. The standard is fully functional without the incorporation of this optional capability.

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

At the time of consensus on this document, NGIIF, which was responsible for its development, had the following leadership:

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1 Scope, Purpose, & Application

1.1 Scope

Next generation technology [i.e., Internet Protocol (IP)] reflects the ongoing evolution of the Public Switched Telephone Network (PSTN). Historically, the PSTN has been based on Time Division Multiplexing (TDM) equipment and processes as the backbone of the network. As the industry transitions, IP technology provides an alternative means for voice and data transmission and the potential for many new services and processes (i.e. TN authentication frameworks). However, the transition, and ultimately IP technology, presents a need to address its impact on telephony functions and processes that have been developed over time in order for calls to be reliably completed. These are related to such functions as network reliability, operational efficiencies, intercompany interconnectivity, network/call troubleshooting, and many other areas that permit networks to interwork with each other consistently and effectively.

Within the wide scope of IP related impacts, this document focuses on providing information for connecting service provider (SP) networks using next generation connections, including internetwork routing.

As industry standards, best practices, and regulatory decisions relative to IP become further defined, this document will be modified as applicable.

1.2 Purpose

This document serves as a guide to provide an industry understanding of the operational needs for next generation interconnection and interoperability.

1.3 Application

The intended use of this document is for assistance in deployment of next generation interconnection by SPs but should not replace technical discussions and/or agreements between interconnecting parties. This document is expected to be updated as pertinent regulatory decisions are made and as industry standards evolve; therefore, the reader should ensure the latest version of this document is being referenced. This document does not replace industry standards or regulatory decisions recently made that may not have yet been reflected in this document.

2 Informative References

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

ATIS-1000010, *Support of Emergency Telecommunications Service ETS in IP Network.*[1]

ATIS-1000011, *ETS Packet Priority for IP NNI Interfaces - Use of Existing DiffServ Per Hop Behaviors.*[1]

ATIS 1000020, *ETS Packet Priority for IP NNI Interfaces - Requirements for a Separate Expedited Forwarding Mechanism.*[1]

ATIS-1000023, *ETS Network Element Requirements for A NGN IMS Based Deployments.*[1]

ATIS-1000062, *IP Interconnection Routing.*[1]

ATIS-1000063, *Joint ATIS/SIP Forum Technical Report -IP NNI Profile.*[1]

ATIS-1000065, *Emergency Telecommunications Service (ETS) Evolved Packet Core (EPC) Network Element Requirements.*[1]

ATIS-0300106, *Intercarrier Call Completion/Call Termination Handbook.*[1]

GSMA FCM.01, *VoLTE Service Description and Implementation Guide (Version 2.0).*[2]

IETF RFC 2474, *Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers.*[3]

IETF RFC 2597, *Assured Forwarding PHB Group.*[3]

IEFT RFC 2833, *RTP Payload for DTMF Digits, Telephony Tones and Telephony Signals.*[3]

IETF RFC 3246, *An Expedited Forwarding PHB (Per-Hop Behavior).*[3]

IETF RFC 3247, *Supplemental Information for the New Definition of the EF PHB (Expedited Forwarding Per-Hop Behavior.*[3]

IETF RFC 4412, *Communications Resource Priority for the Session Initiation Protocol (SIP).*[3]

IETF RFC 5865, *A Differentiated Services Code Point (DSCP) for Capacity-Admitted Traffic.*[3]

ITU-T Recommendation Y.1566, *QoS and Mapping and Interconnection.*[3]

FCC-15-70, Numbering Policies for Modern Communications, IP-Enabled Services, and Telephone Number Requirements for IP-Enabled Services Providers et al.[4]

FCC 11-161, Connect America Fund; A National Broadband Plan for Our Future; Establishing Just and Reasonable Rates for Local Exchange Carriers; High-Cost Universal Service Support; Developing an Unified Intercarrier Compensation Regime; Federal-State Joint Board.[4]

FCC 11-189, Connect America Fund, A National Broadband Plan for Our Future, Establishing Just and Reasonable Rates for Local Exchange Carriers, High Cost Universal Service Support et al.[4]

FCC 15-24, Report and Order on Remand Declaratory Ruling and Order, In the Matter of Protecting and Promoting the Open Internet.[4]

WC Docket 11-119, TW Telecom Inc. Petition for Declaratory Ruling Regarding Direct IP-to-IP Interconnection.[4]

3GPP TS 24.229, *3rd Generation Partnership Project; Technical Specification Group Core Network and Terminals; IP Multimedia Call Control Protocol based on Session Initiation Protocol (SIP) and Session Description Protocol (SDP); Stage 3.*[5]

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[1] This document is available from the Alliance for Telecommunications Industry Solutions (ATIS) at <https://www.atis.org >

[2] This document is available from GSMA at: < http://www.gsma.com >.

[3] This document is available from the Internet Engineering Task Force (IETF) at: < https://www.ietf.org >.

[4] This document is available from the Federal Communications Commission at: < https://apps.fcc.gov/edocs_public/ >

[5] This document is available from the 3rd Generation Partnership Project at: < https://portal.3gpp.org >

3 Definitions, Acronyms, & Abbreviations

3.1 Definitions

For a list of common communications terms and definitions, please visit the *ATIS Telecom Glossary*, which is located at < https://glossary.atis.org/ >.

3.2 Acronyms & Abbreviations

3GPP	3rd Generation Partnership Project
AMR-WB	Adaptive Multi-Rate – Wideband
ATIS	Alliance for Telecommunications Industry Solutions
BGP	Border Gateway Protocol
CAC	Call Admission Control
CALEA	Commission on Accreditation for Law Enforcement Agencies
CDR	Call Detail Record
CLLI™ Code	Common Language® Location Identifier™ Code
CODEC	Compressor/Decompressor
COS	Class-Of-Service
CPC	Calling Party's Category
CPS	Characters Per Second
DDOS	Distributed Denial of Service
DiffServ	Differentiated Services
DSCP	Differentiated Services Code Point
DTMF	Dual-Tone Multifrequency
E164	Defines a general format for international telephone numbers.
EF	Expedited Forwarding
ENUM	E.164 NUmber Mapping
EO TDM	End Office Time-Division Multiplexing
ETS	Emergency Telecommunication Service
EVRC-B	Enhanced Variable Rate Codec B
FCC	Federal Communications Commission
G.771	An ITU-T standard for audio companding
GETS	Government Emergency Telecommunications Service
HD	High Definition
IETF	Internet Engineering Task Force
IP	Internet Protocol
IP NNI	Internet Protocol Network-to-Network Interface
ITU	International Telecommunication Union
LNP	Local Number Portability
MPLS	MultiProtocol Label Switching
MSC	Mobile Switching Center
NANP	North American Numbering Plan
NGN	Next Generation Network
NNI	Network-to-Network Interface
NOC	Network Operations Center

NPAC	Number Portability Administration Center
NS/EP	National Security and Emergency Preparedness
OSI	Open Systems Interconnection
PE	Provider Edge
PHB	Per Hop Behavior
POI	Point of Interface
POP	Point of Presence
PRACK	Provisional Response ACKnowledgement
QoS	Quality of Service
RCS	Rich Communications Service
RFC	Request for Comments (from IETF)
RPH	Resource Priority Header
RTP-UDP	Real-time Transport Protocol – User Dataram Protocol
SBC	Session Border Control
SDR	Session Detail Record
SHAKEN	Signature-based Handling of Asserted information using toKENs
SIP	Session Initiation Protocol
SLA	Service Level Agreement
SP	Service Provider
SS7	Signaling System 7
TDM	Time Division Multiplexing
TN	Telephone Number
TOS	Type-Of-Service
VLAN	Virtual Local Area Network
VoIP	Voice over IP
VoLTE	Voice over Long-Term Evolution
WB	Wide-Band
WPS	Wireless Priority Service
NANP	North American Numbering Plan

4   Responsibilities

SPs who desire to interconnect their networks to exchange IP traffic using Session Initiation Protocol (SIP) should mutually agree on a SIP interconnection plan prior to exchanging traffic.

5   Interconnection Design Considerations

5.1 IP Interconnection Design

5.1.1 Traffic Forecasts

Prior to establishing any SIP interconnection facilities, the SPs should exchange good faith forecasts of the traffic volumes they anticipate exchanging at each Point of Interconnection (POI). Such traffic forecasts should conform to the SIP traffic forecasting guidelines as agreed to in the SIP interconnection plan.

5.1.2 Traffic Monitoring

SPs should monitor originating and terminating traffic volumes on their side of the POI(s). The SPs should meet as needed to review data on traffic volumes exchanged at each POI, to determine the need for additional SIP interconnection facilities and/or bandwidth, and to plan any other changes in SIP interconnection facilities.

5.1.3 Network Management

SPs should work cooperatively in a commercially reasonable manner to install and maintain reliable SIP interconnection facilities and networks. SPs can include and periodically update appropriate information in the SIP interconnection plan to achieve this desired reliability.

Each SP should maintain a professionally managed Network Operations Center (NOC) with continuous staffing – i.e., 24 hours per day, seven days per week, and 365 days per year. SPs should include and timely update their respective NOC contact information, trouble reporting process, and escalation procedures in the SIP interconnection plan.

SPs should work cooperatively in a commercially reasonable manner to apply sound network management principles to alleviate and prevent traffic congestion.

SPs should be "CALEA Compliant" under the provisions of the Communications Assistance for Law Enforcement Act (CALEA) (Pub. L. 103-414, Title 1, October 25, 1994, 108 Stat. 4279, as amended), as well as any regulations or industry standards that implement the provisions of CALEA. SPs should include in their SIP interconnection plan their respective contact information for compliance with requirements of law enforcement and national security agencies.

5.2 IP Interconnection Interoperability Parameter

An important consideration for IP interconnections is the preservation of capabilities and services across network boundaries. This clause provides various methods for IP interconnection parameters:

- Switch Manufacturer.
- Gateway Model.
- Session Border Control (SBC) Model.
- Physical Location or Common Language® Location Identifier™ (CLLI™) Code (if dedicated/private).
- Signaling Type (i.e., SIP-I, SIP-T).
- Packet Transport Protocol.
- Traffic Direction (unidirectional or bidirectional).
- Compressor/Decompressor (CODEC) Type(s) Supported.
- PHB and Priority Services Markings [i.e., Differentiated Services (DiffServ) values, Resource PriorityHeader (RPH) support].
- Support for Signature-based Handling of Asserted information using toKENs (SHAKEN).[6]
- Packet Interval/Sampling Rate.
- Dual-Tone Multifrequency (DTMF) Standards (e.g., audio tones, RFC 2833).
- Fax T.38 Support/Fallback.
- Silence Suppression.
- Support for follow-on dialing that passes in-band signaling after the call is connected, referred to as "EarlyMedia Cut-Through", "Early Answer Voice Cut-Through", and "Cut-Through in Both Directions".
- Globalized (add+).
- E164 Compliance.

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[6] ATIS-1000074, *Signature-based handling of Asserted information using toKENs (SHAKEN)*

- Privacy.

- SIP Unavailable Code.

- Provisional Response ACKnowledgement (PRACK) - Reliability of Provisional Response support (or call100REL).

- Parties need to agree to the use of diversion or history-info in the SIP header.

- Connection Type Preference: Public or Dedicated/Private.

- Direct Connect Location(s): [i.e., Collocation, Point of Presence (POP), CLLI, or Commercial Agreement].

- Border Gateway Protocol (BGP) or Static Routes (Dedicated Path).

- IP Security (or equivalent security/encryption protocol)

- Signaling IP Address.

- Media Endpoint IP Address.

- Signaling IP Port.

- Real-time Transport Protocol – User Dataram Protocol (RTP UDP) Port Range.

- IP Precedence or Differentiated Services Code Point (DSCP) (Required for government priority services).

- Session Quantity & Calls/Second [Characters Per Second (CPS)].

Further information can be found in ATIS-1000063, *Joint ATIS/SIP Forum Technical Report – IP NNI Profile,* and other ATIS documents.

Detailed technical discussions should be held between the parties to an agreement on technical items, including but not limited to SIP Header expectations, SIP Responses, and SIP Profile specifications.

5.3 IP Interconnection Routing

Some SPs are already exchanging voice traffic over IP facilities. This clause provides various methods for IP interconnection routing as described in ATIS-1000062, *Joint ATIS/SIP Forum Technical Report –IP Interconnection Routing.*

- *Aggregate Approaches Based on Existing North American Numbering Plan (NANP) Data Structures*

  o Both the LERG™ Routing Guide and Number Portability Administration Center (NPAC) databases have fields to input IP routing URIs which would allow internal routing tables to convert such URIs to unblocked IPs.

  o Using existing industry database systems, architectures and processes, with LERG Routing Guide enhancements as needed.

  o Enhancing LERG Routing Guide to provide a Tier 1 E.164 NUmber Mapping (ENUM) Registry, to include Tier 2 name server information.

- *Per-Telephone Number (TN) Overview and Approaches*

  o NPAC TN registry.

  o NPAC as a tier 1 ENUM Registry.

  o Independent ENUM Registry.

  o Bulk transfer using Independent Service Bureaus.

  o Query using Independent Service Bureaus.

When considering interoperating between carriers, it is important to recognize that the interconnection process has a number of steps that are in common. For example:

- Interconnection agreements are formally negotiated between carriers on a bilateral basis. This

negotiation process will lead to a formal agreement between the carriers on a number of key points related to the interconnection, including an agreed to mechanism for exchanging routing data. As a result, there is no need to define an approach where two carriers with arbitrary preferences interconnect and exchange data without first agreeing on the approach each will use.

- Under all scenarios being considered, carriers will use data from a variety of sources as input to their internal Business Support Systems/Operation Support Systems (BSS/OSS) to build and maintain an internal database for routing calls/sessions. Each carrier uses their own system with their own algorithm(s) for this.Thus, it is out of scope for this document. The routing data defined in this document is an important enablerfor interconnection, but it is just one of the data sources used by the carrier to construct their own routing table.

Where carriers prefer to use different approaches, the following are intermediate options that discuss potential industry "middle ground" positions.

- *Interoperability between Aggregate & Per-TN Routing Data Approaches:*
  o Routing data from an aggregate SP to a per-TN SP.
  o Routing data from a per-TN SP to an aggregate SP.
  o Registry supporting both aggregate and expanded per-TN routing data.
  o Using the NPAC to interoperate on a per-TN and aggregate basis.

6 Interconnection Agreement Consideration

IP connectivity agreements directly between Voice over IP (VoIP) providers and other network providers may beobtained directly or indirectly. Some network providers may not operate IP based networks, so network IP connectivity may not be available.

Although commercial agreements established directly with originating providers can create network efficiencies,indirect interconnection may also be considered due to potential economic benefits.

VoIP providers should consider the terms and conditions for direct and indirect interconnection in negotiating suchcommercial IP interconnection agreements.

In addition to the considerations in this section, the interconnection agreement may consider other provisions in this document.

Drivers for IP Interconnection:

- *Service Features and Enhancements*
  o Enable High Definition (HD) voice via the use of Wide Band (WB) Codecs between end subscribers.
  o Have the potential to enable video calls between end subscribers.
  o Have the potential to enable the exchange of the full suite of Rich Communication Service (RCS) between end subscribers.
  o RCS = messaging, chat (IM), file transfer, content sharing, user capability exchange, presence, etc.
- *Network Efficiencies*
  o Parties seeking to exchange traffic over IP interconnection should consider the network and economic efficiencies/inefficiencies of connecting directly or indirectly. The parties of IP interconnection should consider potential service quality issues that may be encountered using indirect interconnection versus direct connection. Agreements should consider terms and conditions that best fit the benefits of either direct or indirect interconnection and may include service quality terms that address potential deficiencies of direct or indirect

interconnection. This may include reference to established industry practices.[7]

Other considerations include:

- o Consolidation of traffic at fewer high-capacity (Gb-level) POIs [Network-to-Network Interface (NNI) IPs].
- o Decommissioning of Mobile Switching Center (MSC)/End Office Time-Division Multiplexing (EOTDM) interconnections.
- o Centralization of call routing (translations).

IP Interconnection Arrangements:

- *Bilateral (two-way) Direct IP Interconnection between end SPs*
  - o Typically used for traffic originating and terminating between the subscribers of the end SPs.
  - o Typically, a nearly balanced exchange of traffic.
  - o Bilateral Agreement established between the end SPs.

- *Bilateral (two-way) Indirect IP Interconnection involving an intermediary provider*
  - o Can allow IP Interconnection with multiple SPs.
  - o Bilateral Agreeemnt established between end SPs.
  - o Unilateral Agreement established between originating SPs and the intermediary SPs.

- *Unilateral (one-way) IP Interconnection*
  - o Typically used for the termination of third-party traffic to an end SP.
  - o Unilateral Agreement established between the intermediary SP and the terminating SP.

IP Interconnection Traffic Measurement:

- *Traffic Measurement*
  - o IP Network Nodes will generate Session Detail Records (SDRs).
  - o TDM Network Nodes will continue to generate Call Detail Records (CDRs).
  - o SPs must prepare to support traffic measurement based on both SDRs and CDRs.

IP Interconnection Technical Considerations:

- *SIP Interconnection Plan*

  The SIP Interconnection Plan is a critical part of the implementation of IP Interconnection; SIP can provide a plethora of information regarding calls (sessions) and SIP Interconnection introduces a tremendous amount of flexibility regarding signaling and call (session) control:

  - o Negotiated between end SPs.
  - o Negotiated between an end SP and an intermediary provider.
  - o Referenced in (associated with) the P Interconnection Agreement but treated as a separate technical specification.
  - o Contains technical details such as but not limited to the following:
    - Supported CODECs [G.711, Enhanced Variable Rate Codec B (EVRC-B), Adaptive Multi-Rate – Wideband (AMR-WB), etc.].
    - Transcoding requirements:
      - – The originating SP typically transcodes to a CODEC supported by the terminating SP.
      - – Intermediary SPs may perform transcoding on behalf of end SPs.

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[7] ATIS-0300106, *Intercarrier Call Completion/Call Termination Handbook*

- Service Level Agreement (SLA) criteria.

- Operations procedures.

- SIP specifications.

  - Latency, Jitter, Packet Delivery, and Distributed Denial of Service (DDOS).

o As SPs agree to expand the scope of traffic they exchange via IP Interconnection, the SIP Interconnection Plan must be updated to provide the required technical specifications.

o It is recommended than an RPH be carried across the NNI and through to the end point, without regard to whether the carrier supports priority, as this is equivalent to Calling Party's Category (CPC) – National Security and Emergency Preparedness (NS/EP) in a Signaling System 7 (SS7) message.

7 IP Interconnection Routing

7.1 The IP NNI Reference Model

For information regarding the IP interconnection architecture interface, please reference ATIS-I-0000045, *IP Services Interconnect Technical Report: Assessment of Requirements and Specifications*.

7.1.1 Points of Interconnections (POIs) & SIP Interconnection Facilities

To facilitate development of the SIP interconnection plan, SPs should exchange good faith forecasts of the IP traffic volumes that they anticipate exchanging using SIP interconnection facilities.

It is recommended to establish a minimum of two (2) geographically diverse POIs at mutually agreed locations, with fully redundant failover capabilities at both the session layer and IP layer within the SPs' networks. The number of POIs and the location of each POI should be mutually agreed by the SPs and set forth in the SIP interconnection plan. To determine the number and location of POIs, it is helpful to consider each SP's IP traffic patterns and customer locations.

The agreed-upon bandwidth of SIP interconnection facilities at each POI should be set forth in the SIP interconnection plan. SPs may self-provision SIP interconnection facilities or obtain SIP interconnection facilities from a third party or the other SP. The SP should have access to its SIP interconnection facilities at each POI at all times – i.e., 24 hours per day, seven days per week, and 365 days per year.

7.1.2 Traffic Types

SPs should agree on the types of IP traffic exchanged (e.g., permitted traffic such as voice traffic originating from the SP's end user), and the types of IP traffic that will not be exchanged (e.g., prohibited traffic such as voice traffic whereby the SP is only transporting the traffic).

7.1.3 Traffic Exchange

7.1.3.1 Testing

SPs should develop and mutually agree on a SIP test plan for the exchange of IP traffic. Such SIP test plans should include, without limitation, specific testing procedures and protocols and establish specific, objective criteria for successful completion of testing. Prior to exchanging live IP calls, interconnecting SPs should successfully complete agreed upon the SIP test plan.

7.1.3.2 Routing Information

Prior to exchanging live IP calls, the SP should provide its SIP routing table to the other SP in a mutually-agreed format. The SIP routing table should enable the originating SP to deliver IP permitted traffic to the terminating SP. It is recommended that each interconnecting SP SIP routing table should designate at least two (2) geographically

diverse routing points on the terminating SPs network for termination of IP permitted traffic. The SIP interconnection plan should include IP addresses for the media associated with SIP signaling messages.

7.1.3.3 Local Number Portability (LNP) Queries

The originating SP should query the LNP call routing database before delivering IP permitted traffic over the SIP interconnection facilities. SPs should mutually agree and specify in their SIP interconnection plan how the originating SP should indicate in its SIP signaling messages that the LNP query has been performed.

7.1.3.4 SIP Signaling Messages

SPs should have the capability to exchange SIP signaling messages to facilitate the exchange of IP permitted traffic and the full interoperability of SIP signaling features, as applicable. SPs should exchange information associated with its SIP signaling implementation as necessary for the routing and completion of IP permitted traffic.

7.1.3.5 Transcoding

SPs should mutually agree upon and set forth in their SIP interconnection plan the Codec(s) that each SP will use to terminate IP permitted traffic. SPs should also provide an estimate of capacity per Codec such that the combination of Codecs can support the highest rate of expected traffic.

7.1.3.6 Service Quality

The SP should design SIP interconnection facilities to meet the target service quality standards mutually agreed to between the SPs. The SP should also design methods to measure and monitor service quality and incorporate such methods in the SIP interconnection plan.

7.1.3.7 SIP Option Testing

Onboarding processes should determine if the interconnected SPs will establish SIP Options, a testing solution used to determine if a shared trunk is live. SIP Option testing can be one-way or bidirectional on the trunk. These messages allow the originating SP to send a SIP option down an established SIP trunk with their interconnected partner to understand if the respective trunk group is live and able to receive traffic. If a response is not received within a specified time-period, the originating SP knows that the trunk group is not active and cannot be used for live traffic. Operations and implementation personnel should understand the requirements for establishing SIP Options, such as:

- Differences in UDP vs. TCP SIP responses, and
- Determining timeframes for SIP Option responses.

8 National Security & Emergency Preparedness (NS/EP) Priority Support on the IP Network-to-Network Interface[8] [9]

To support emergency government communications, interconnected carriers must exchange with each other unique markings used to differentiate Emergency Telecommunication Service (ETS) traffic from non-ETS traffic on the Internet Protocol Network-to-Network Interface (IP NNI). In the U.S., ETS traffic consists of the Government Emergency

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[8] ATIS-1000065, *Emergency Telecommunications Service (ETS) Evolved Packet Core (EPC) Network Element Requirements.*

[9] GSMA FCM.01 – *VoLTE Service Description and Implementation Guide (Version 2.0)*, October 7, 2014.

Telecommunications Service (GETS) and the Wireless Priority Service (WPS). This traffic's unique markings include, a unique Class-Of-Service (COS) value or Virtual Local Area Network (VLAN) identifier at Open Systems Interconnection (OSI) Model Layer 2 (Data Link) and a unique DSCP or MultiProtocol Label Switching (MPLS) identifier at Layer 3 (Network). The markings are exchanged between carriers on a bilateral basis.

8.1 Signaling

Government ETS sessions are identified by the RPH in the associated SIP signaling messages defined in IETF RFC 4412, *Communications Resource Priority for the Session Initiation Protocol (SIP)*. The RPH is acted upon to provide priority within the network and at the SBCs by NS/EP-supporting networks and must be transparently passed, both within the network and over the NNI by non-NS/EP supporting networks.

ATIS-1000063, *Joint ATIS/SIP Forum Technical Report -IP NNI Profile* provides an IP Interconnection Profile, which describes a reference architecture and specifications for both the protocol and media as they appear "on-the-wire" at interconnect points for one service: voice. In addition, the following ATIS standards are applicable for the SIP profile for ETS signaling across an IP-to-IP NNI:

- ATIS-1000010, *Support of Emergency Telecommunications Service ETS in IP Network.*
- ATIS-1000023, *ETS Network Element Requirements for A NGN IMS Based Deployments.*

The unique markings used at the IP and transport layers to differentiate ETS signaling from non-ETS signaling are based on industry standards and are documented in specific SLA for the IP NNI. Such markings may include a COS value or VLAN identifier at Layer 2 and a unique DSCP or MPLS identifier at Layer 3 based on the SLA for the IP NNI.

8.2 Transport/Media

The unique markings used at the IP and transport layers to differentiate ETS media traffic from non-ETS media traffic are based on industry standards and are documented in the SLA for the IP NNI. Such markings may include a unique COS value or VLAN identifier at Layer 2 and a unique DSCP or MPLS identifier at Layer 3.

8.3 ETS Packet Priority for IP NNI Interfaces – Use of Existing Differentiated Services Per Hop Behaviors

ATIS-1000011, *ETS Packet Priority for IP NNI Interfaces - Use of Existing DiffServ Per Hop Behaviors*, provides guidelines for the application of existing DiffServ Per Hop Behaviors (PHB) and their associated DSCP values when ETS packets are transported in the media stream at the IP NNI. These guidelines are intended to facilitate the formulation of interconnection agreements between public domain service carriers by providing guidance with respect to the per hop queuing treatment to be provided for ETS sessions, thereby allowing for satisfactory end-to-end transport of ETS sessions over multiple IP-based networks.

8.4 ETS Packet Priority for IP NNI Interfaces – Requirements for a Separate Expedted Forwarding Mechanism

ATIS-1000020, *ETS Packet Priority for IP NNI Interfaces – Requirements for a Separate Expedited Forwarding Mechanism*, and IETF RFC-5865, *A Differentiated Services Code Point (DSCP) for Capacity-Admitted Traffic*, provide the requirements for a separate Expedited Forwarding (EF) mechanism ("VOICE-ADMIT") that can recognize a class of limited-access, real-time traffic for preferential treatment via a unique DSCP. This class of traffic, which uses a Call Admission Control (CAC) procedure involving authentication, authorization, and capacity admission, differs from the real-time traffic class that is not subject to capacity admission (or subject to very coarse capacity admission) and includes ETS sessions with the requirement of a pre-determined quantity of reserved bandwidth for ETS service.

8.4.1 NNI Traffic Classes

Table 8.1 identifies the traffic classes defined for use across the NNI.

Table 8-1: NNI Traffic Classes

Traffic Class	Traffic Type
Voice Media	Speech/Voice bearer
Limited-Access Voice Media	Speech/Voice bearer
Voice Signaling	Voice control traffic (SIP signaling protocol)
Limited-Access Voice Signaling	Voice control traffic (SIP signaling protocol)
Other Customer Traffic	Internet traffic, other data traffic

8.4.2 Distinguishing Traffic Classes

In order to distinguish among traffic classes, the use of the DSCP marking scheme is recommended.

> NOTE: Using classification based on the DSCP value, packet marking is pre-agreed to by both carriers. The receiving carrier assumes that the sending carrier has marked the packet correctly according to the industry standards.

When a carrier uses non-standard packet markings within its own domain, it is the non-standard carrier's responsibility to re-mark packets to the standard values, both on and off the interconnecting link. This would be consistent with ITU-T Recommendation Y.1566, *QoS and Mapping and Interconnection* and encourages adoption of the packet marking requirements in the interconnection specification. Support of the specification means offering a single set of class markings on the NNI to all interconnecting parties, regardless of their internal network marking practices.

8.4.3 IP Marking Table

Table 8.2 presents the IETF- and ATIS-specified differentiated services codepoints and IP Precedence Type-Of-Service (TOS) marking scheme plus the coding scheme at the MPLS and Ethernet layers that should be supported on the IP NNI. It applies to all the traffic to be transmitted.

Table 8-2: Packet Marking Schemes

Traffic Type	DSCP Marking	IP Precedence	802.1Q VLAN
Non-ETS Voice Signaling and Media	DSCP 46/EF (101110)	5	5
	DSCP 46/EF (101110) or DSCP 00/DF (000000)	5 Or 0	5 Or 0
ETS Voice Signaling and Media	DSCP 44/VOICE-ADMIT (101100)	5	5
Other Traffic	DSCP 00/DF (000000)	0	0

The markings for other control/management traffic depend on the specific network implementation.

Signaling and media traffic associated with ETS voice that is leaving the sending Border Functional Entity toward the receiving Border Functional Entity should be treated according to the VOICE-ADMIT Forwarding Per-Hop Behavior [IETF RFC 5865, *A Differentiated Services Code Point (DSCP) for Capacity-Admitted Traffic*].

Signaling and media traffic associated with non-ETS voice that is leaving the sending Border Functional Entity toward the receiving Border Functional Entity should be treated according to the Expedited Forwarding Per-Hop

Behavior [IETF RFC 3246, *An Expedited Forwarding PHB (Per-Hop Behavior);*RFC 3247, *Supplemental Information for the New Definition of the EF PHB (Expedited Forwarding Per-Hop Behavior)*)], or alternatively according to the Default Forwarding Per-Hop Behavior [RFC 2474, *Definition of the Differentiated Services Field (DS Field)* ("Best Effort")].

Signaling traffic leaving the sending Border Functional Entity toward the Provider Edge (PE) router must be treated according to one of the following schemes:

- Expedited Forwarding Per-Hop Behavior, as specified in RFC 3246, *An Expedited Forwarding PHB (Per- Hop Behavior)*, and RFC 3247, *Supplemental Information for the New Definition of the EF PHB (Expedited Forwarding Per-Hop Behavior)*.

- Assured Forwarding Per-Hop Behavior, as specified in RFC 2597, *Assured Forwarding PHB Group.*

- Default Forwarding Per-Hop Behavior, as specified in RFC 2474, *Definition of the Differentiated Services Field (DS Field)*.

9 Regulatory Environment

This section describes various Federal Communications Commission (FCC) rules and regulations, valid as of the date of publication of this document, with the intent to assist SPs interconnecting networks that use next generation interconnections. Noted references are not inclusive or intended to provide legal guidance, and based on date of this document, may have been subsequently revised. State commissions may also have issued rules and regulations on the subject addressed by this document.

As of the publication of this document, the following orders can be used as reference for IP Interconnection:

- FCC 15-24, Report and Order on Remand Declaratory Ruling and Order, In the Matter of Protecting and Promoting the Open Internet.

- FCC-15-70, Numbering Policies for Modern Communications, IP-Enabled Services, and Telephone Number Requirements for IP-Enabled Services Providers, et al.

- FCC 11-161, Connect America Fund; A National Broadband Plan for Our Future; Establishing Just and Reasonable Rates for Local Exchange Carriers; High-Cost Universal Service Support; Developing a Unified Intercarrier Compensation Regime; Federal-State Joint Board.

- FCC 11-189, Connect America Fund, A National Broadband Plan for Our Future, Establishing Just and Reasonable Rates for Local Exchange Carriers, High Cost Universal Service Support, et al.

- WC Docket 11-119, TW Telecom Inc. Petition for Declaratory Ruling Regarding Direct IP-to-IP Interconnection.