ATIS STANDARD

ATIS-0500033

ATIS Standard on -

Overview and Operational Considerations for an IMS-based Next Generation 9-1-1 (NG9-1-1) Service Architecture based on ATIS-0500032

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Overview and Operational Considerations for an IMS-based Next Generation 9-1-1 (NG9-1-1) Service Architecture based on ATIS-0500032

Alliance for Telecommunications Industry Solutions

Approved February 21, 2017

Abstract

This document provides an overview and operational consideration for an IMS-based Next Generation 9-1-1 (NG9-1-1) Service Architecture based upon ATIS-0500032, *ATIS Standard for Implementation of an IMS-based NG9-1-1 Service Architecture*. This document includes considerations related to IMS Emergency Service Networks that are considered terminating networks.

Foreword

The Alliance for Telecommunication Industry Solutions (ATIS) serves the public through improved understanding between carriers, customers, and manufacturers.

The Emergency Services Interconnection Forum (ESIF) provides a forum to facilitate the identification and resolution of technical and/or operational issues related to the interconnection of wireline, wireless, cable, satellites, Internet and emergency services networks.

The ESIF Next Generation Emergency Services (NGES) Subcommittee coordinates emergency services needs and issues with and among SDOs and industry forums/committees, within and outside ATIS, and develops emergency services (such as E9-1-1) standards, and other documentation related to advanced (i.e., Next Generation) emergency services architectures, functions, and interfaces for communications networks.

The mandatory requirements are designated by the word *shall* 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 a 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, ESIF, 1200 G Street NW, Suite 500, Washington, DC 20005.

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

S. Sherwood, ESIF Chair (Verizon Wireless)

R. Hixson, ESIF First Vice-Chair (NENA)

R. Marshall, ESIF Second Vice-Chair (Comtech)

C. Militeau, ESIF NGES Co-Chair (West Safety Services)

T. Reese, ESIF NGES Co-Chair (Ericsson)

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Preface

ATIS has developed a Next Generation 9-1-1 (NG9-1-1) network and emergency call processing architecture based on contributions received since 2011 and requirements by a number of wireless carriers to have an IP Multimedia Subsystem (IMS)-compatible NG9-1-1 design[1]. Additionally, the NENA i3 Architecture Working Group[2] deferred the IMS-based Emergency Services IP network (ESInet) development to ATIS. ATIS' goal in developing this standard has been transparent interoperability between the two network designs.

ATIS' intent in this development work was to produce a standard method for IMS-based carriers to offer NG9-1-1 services wholly within their IMS platforms, while maintaining consistency and interoperability with the NENA i3 ESInet/NGCS (Next Generation Core Services) design goals. This kind of standards approach allows IMS-based carriers to take advantage of complete IMS interoperability and features found in their existing IMS ecosystems, while still remaining interoperable with downstream i3 Public Safety Answering Points (PSAPs) that implement NENA i3 standards and interfaces.

It is also ATIS' goal to assure that terminating NG9-1-1 entities, such as i3 PSAPs, find the upstream networks that are built on the ATIS IMS-based NG9-1-1 Service Architecture to be as completely interoperable with their systems and networks as that of a NENA i3 NG9-1-1 standard SIP-based architecture. This goal of transparency – both upstream and downstream between architectures – ensures that an i3 PSAP should find no difference whether the i3 PSAP interconnects to a NENA i3 ESInet with NGCS, or interconnects to an ATIS IMS-based NG9-1-1 Service Architecture. This consistent interoperability principle has guided all of ATIS' development work since the beginning, as documented within the original Issue Statement underlying this work.

The ATIS IMS-based NG9-1-1 Service Architecture provides compatibility for IMS-based carriers acting as an NG9-1-1 System Service Provider (911SSP) to seamlessly interoperate with NENA i3 ESInet architectures.

For entities early in the process of selecting ESInet solutions, the expectation within this ATIS development work was that the ATIS IMS-based NG9-1-1 Service Architecture would offer a choice for carriers that already had an IMS ecosystem, but not be considered a viable architecture choice for 9-1-1 service entities that had no plans for an IMS infrastructure.

Public Safety entities should naturally understand the applicability of an IMS-based NG9-1-1 Service Architecture network approach to processing emergency calls, yet in this case, they can remain confidently focused on NENA i3-based NG9-1-1 architectures (because IMS may be of interest to carriers, not to jurisdictions), which means that Public Safety's progress and momentum to adopt NG9-1-1 will not be impeded by the introduction of this ATIS NG9-1-1 Service Architecture standard.

1 Scope, Purpose, & Application

1.1 Scope

The telecommunication industry is assessing the sunsetting of the Public Switched Telephone Network (PSTN) as the carriers plan to transition their networks to IP core networks, specifically those utilizing IP Multimedia Subsystem (IMS) architectures. This has implications on legacy emergency services that are based upon Time Division Multiplexing (TDM) technologies. As carriers migrate to IMS, there is value in considering how emergency services can be supported in that environment. This ATIS Standard provides an overview and

[1] IMS is a set of standards based on the IETF RFC 3261 [Ref 18] family of standards that also introduces additional requirements, specific for carrier operators not differentiated in the more general SIP RFCs.

[2] The NENA i3 Architecture Working Group developed NENA-STA-010.2 [Ref 27].

operational considerations for ATIS-0500032. That standard applies Common IMS architecture concepts to NG9-1-1 Service Architectures to encompass:

- Definition of an IMS-based NG9-1-1 Service Architecture that includes an IMS-based NG9-1-1 Emergency Services Network architecture, and a set of additional gateway functional elements adopted from the existing NENA i3 architecture to support the delivery of emergency calls to legacy and NG9-1-1/i3 PSAPs.
- NG9-1-1 network deployment scenarios showing an IMS-based Next NG9-1-1 Service Architecture interconnecting with a variety of originating network and PSAP types and associated Stage 2/3 call flows.

1.2 Purpose

The purpose of this standard is to provide an overview of, and discuss operational and deployment topics related to, ATIS-0500032.

1.3 Application

This standard applies to the following entities:

- NG9-1-1 System Service Providers that support IMS-based emergency services network architectures.
- Originating network providers that interconnect to IMS-based emergency services networks.
- PSAPs (legacy or NG9-1-1) that receive calls from IMS-based emergency services networks.

2 Normative References

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

[Ref 1] ATIS-0500032, *ATIS Standard for Implementation of an IMS-based NG9-1-1 Service Architecture*.[3]

[Ref 2] ATIS-0500023, *Applying Common IMS to NG9-1-1 Networks*.[3]

[Ref 3] NENA-STA-010.2, *Detailed Functional and Interface Standards for the NENA i3 Solution*, September 10, 2016.[4]

[Ref 4] J-STD-036-C, *Enhanced Wireless 9-1-1 Phase II*, June 2011 including the addendum in J-STD-036-C-1, *Addendum to J-STD-036-C, Enhanced Wireless 9-1-1 Phase II*.[3]

[Ref 5] 3GPP TS 29.333, *Technical Specification Group Core Network and Terminals; Multimedia Resource Function Controller (MRFC) - Multimedia Resource Function Processor (MRFP) Mp interface: Procedures Descriptions.*[5]

[Ref 6] NENA 04-001, *Recommended Generic Standards for E9-1-1 PSAP Equipment*.[4]

[Ref 7] NENA 04-005, *NENA ALI Query Service Standard*.[4]

[Ref 8] RFC 5222, *LoST: A Location-to-Service Translation Protocol.*[6]

[Ref 9] RFC 6753, *A Location Dereference Protocol Using HTTP-Enabled Location Delivery (HELD).*[6]

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

[4] This document is available from the National Emergency Number Association (NENA) at: < http://www.nena.org/standards/informational >.

[5] This document is available from the Third Generation Partnership Project (3GPP): < http://www.3gpp.org/specs/specs.htm >.

[6] RFC text is available at < http://www.freesoft.org/CIE/RFC/index.htm >.

[Ref 10] 3GPP TS 23.228, *Technical Specification Group Services and System Aspects; IP Multimedia Subsystem (IMS); Stage 2.*[5]

[Ref 11] 3GPP TS 23.167, *Technical Specification Group Services and System Aspects; IP Multimedia Subsystem (IMS) emergency sessions.*[5]

3 Informative References

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

[Ref 100] NENA-ADM-000.19-2016, *NENA Master Glossary of 9-1-1 Terminology.*[7]

4 Definitions, Acronyms, & Abbreviations

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

4.1 Definitions

E.164 Number	E.164 is an international numbering plan for public telephone systems in which each assigned number contains a country code (CC), a national destination code (NDC), and a subscriber number (SN). There can be up to 15 digits in an E.164 number. The E.164 plan was originally developed by the International Telecommunication Union (ITU).
Emergency Call Routing Function (ECRF)[8]	A functional element in an ESInet that is a Location to Service Translation (LoST) protocol server where location information (either civic address or geo-coordinates) and a Service URN serve as input to a mapping function that returns a URI used to route an emergency call toward the appropriate PSAP for the caller's location or towards a responder agency.
Emergency Services IP network (ESInet)[9]	A managed IP network that is used for emergency services communications, and that can be shared by all public safety agencies. It provides the IP transport infrastructure upon which independent application platforms and core functional processes can be deployed, including, but not restricted to, those necessary for providing NG9-1-1 services. ESInets may be constructed from a mix of dedicated and shared facilities. ESInets may be interconnected at local, regional, state, federal, national and international levels to form an IP-based inter-network (network of networks).
IMS-based NG9-1-1 Service Architecture	An IMS-based NG9-1-1 Service Architecture provides transit, routing, and other services required to support citizen-to-authority multimedia emergency services between the originating network and the emergency authority, e.g., PSAP. The IMS-based NG9-1-1 Service Architecture includes the i3 Legacy Network Gateway and i3 Legacy PSAP Gateway.

[7] This document is available from NENA at: < http://www.nena.org/standards/master-glossary >.

[8] Refer to NENA-ADM-000.19-2016, NENA Master Glossary of 9-1-1 Terminology [Ref 100].

[9] Refer to NENA-STA-010.2 [Ref 3].

Legacy Network Gateway (LNG)	A signaling and media interconnection point between callers in legacy wireline/wireless originating networks and the IMS Next Generation Emergency Services Network. This Functional Element provides MF/SS7-to-SIP signaling interworking, as well as emergency services-specific processing of legacy emergency originations and location acquisition/dereferencing functionality.
Legacy PSAP Gateway (LPG)[8]	A signaling and media interconnection point between the IMS Next Generation Emergency Services Network and legacy PSAPs. This Functional Element provides SIP-to-Traditional/Enhanced MF signaling interworking as well as emergency services-specific processing to support: the delivery of emergency originations to legacy PSAPs; emergency call transfers involving legacy PSAPs; ALI queries from legacy PSAPs; and location and additional data dereferencing functionality.
Location by Reference (LbyR)	Location by Reference refers to the option to deliver a location reference URI in a header of the call request (SIP INVITE) that may be used by the requesting entity (e.g., the PSAP) to query for the location of the caller.
Location by Value (LbyV)	Location by Value refers to the option to deliver the caller's location to the PSAP within the body of the call request (SIP INVITE).
NG9-1-1	An IP-based system comprised of managed IP-based networks (ESInets), functional elements (applications), and databases that replicate traditional E9-1-1 features and functions and provide additional capabilities. NG9-1-1 is designed to provide access to emergency services from all connected communications sources, and provide multimedia data capabilities for PSAPs and other emergency service organizations.[8]
Non Call Associated Signaling (NCAS)	NCAS is a signaling method for legacy wireless calls where the calling (E.164) number and the Reference Identifier are sent. The Reference Identifier is used for routing calls. Both the calling number and the Reference Identifier may be used for retrieving location and additional data. (a) If the call is delivered over an SS7 trunk group, the call setup signaling includes the calling number sent in the Calling Party Number parameter, the Reference Identifier is sent in the SS7 GDP, and the digits "911" in the SS7 Called Party Number parameter. (b) If the call is delivered over an MF trunk group, the call setup signaling includes the Reference Identifier signaled as the called number, and the calling number signaled as the Automatic Number Identification (ANI).
pANI (Pseudo Automatic Number Identification)	A telephone number used to support routing of wireless 9-1-1 calls. It may identify a wireless cell, cell sector or PSAP to which the call should be routed. Also known as routing number. [3]
Policy Store	A functional element in the ESInet that stores policy documents. [8]
Reference Identifier	The term "Reference Identifier" is used in this standard to associate the call with location information of the caller. For routing to a legacy emergency services network, a Reference Identifier may be an Emergency Services Routing Key (ESRK) or Emergency Services Routing Digit (ESRD) as defined in J-STD-036-C [Ref 4]. It may be the Telephone Number that is used by the legacy emergency services network to query for location information. In a legacy emergency services network, the Reference Identifier may also be used by the emergency services network to route the call to the PSAP. For calls routed to a NENA i3 ESInet, the Reference Identifier may be a dereferencing URI that is used by i3 functional elements and i3 PSAPs to obtain location.[10]

[10] Use of an Emergency Services Query Key (ESQK) as a Reference Identifier is for further study, pending the definition of use cases and call flows that illustrate the circumstances under which an ESQK applies.

Wireline Compatibility Mode (WCM)	WCM is a signaling method for legacy wireless calls where only the Reference Identifier is sent and used for routing, and for retrieving location and additional data. The originating MSC sends an emergency call origination from a legacy wireless caller to the Legacy Network Gateway over an MF or SS7-supported trunk group. The call setup signaling includes the Reference Identifier (as the calling number) and the digits “911” (as the called number).

4.2 Acronyms & Abbreviations

ALI	Automatic Location Identification
ANI	Automatic Number Identification
ATIS	Alliance for Telecommunications Industry Solutions
BCF	Border Control Function
BGCF	Breakout Gateway Control Function
CAMA	Centralized Automated Message Accounting
CMSP	Commercial Mobile Service Provider
CPE	Customer Premises Equipment
CSCF	Call Session Control Function
ECRF	Emergency Call Routing Function
EIDD	Emergency Incident Data Document
E-MF	Enhanced Multi-Frequency
ESInet	Emergency Services IP Network
ESN	Emergency Service Number
ESRD	Emergency Services Routing Digits
ESRK	Emergency Services Routing Key
ESGW	Emergency Services Gateway
ESRP	Emergency Service Routing Proxy
FCC	Federal Communications Commission
GIS	Geographic Information System
GMLC	Gateway Mobile Location Center
HELD	HTTP-Enabled Location Delivery
HTTP	Hypertext Transport Protocol
IBCF	Interconnecting Border Control Function
I-CSCF	Interrogating Call Session Control Function
IP	Internet Protocol
ISDN	Integrated Services Digital Network
IWF	Interworking Function

LbyR	Location by Reference
LBS	Location Based Services
LbyV	Location by Value
LIS	Location Information Server
LNG	Legacy Network Gateway
LoST	Location to Service Translation
LPG	Legacy PSAP Gateway
LS	Location Server
MF	Multi-Frequency
MGCF	Media Gateway Control Function
MLP	Mobile Location Protocol
MMS	Multimedia Messaging Service
MPC	Mobile Positioning Center
MSISDN	Mobile Station ISDN Number
MSRP	Message Session Relay Protocol
NCAS	Non-Call Associated Signaling
NENA	National Emergency Number Association
NG9-1-1	Next Generation 9-1-1
OSP	Originating Service Provider
PAM	PSAP to ALI Message
pANI	Pseudo ANI
POI	Point of Interconnection
PRF	Policy Routing Function
PSAP	Public Safety Answering Point
PST	Public Safety Telecommunicator
RS	Routing Server
S-CSCF	Serving Call Session Control Function
SIP	Session Initiation Protocol
SR	Selective Router
SS7	Signaling System 7
TIA	Telecommunications Industry Association
TRF	Transit Function
TTY	Teletypewriter

URI	Uniform Resource Identifier
URN	Uniform Resource Name
VPN	Virtual Private Network
WCM	Wireline Compatibility Mode

5 Overview

5.1 Architecture

Error! Reference source not found. illustrates the architecture defined in ATIS-0500032 that defines the functionality of the 3GPP Common IMS for emergency services networks in North America. The IMS-based NG9-1-1 Service Architecture incorporates common IMS functional elements as well as the appropriate gateways to interwork with legacy originating networks and legacy PSAPs. The architecture adopts gateways defined in NENA-STA-010.2 [Ref 3].

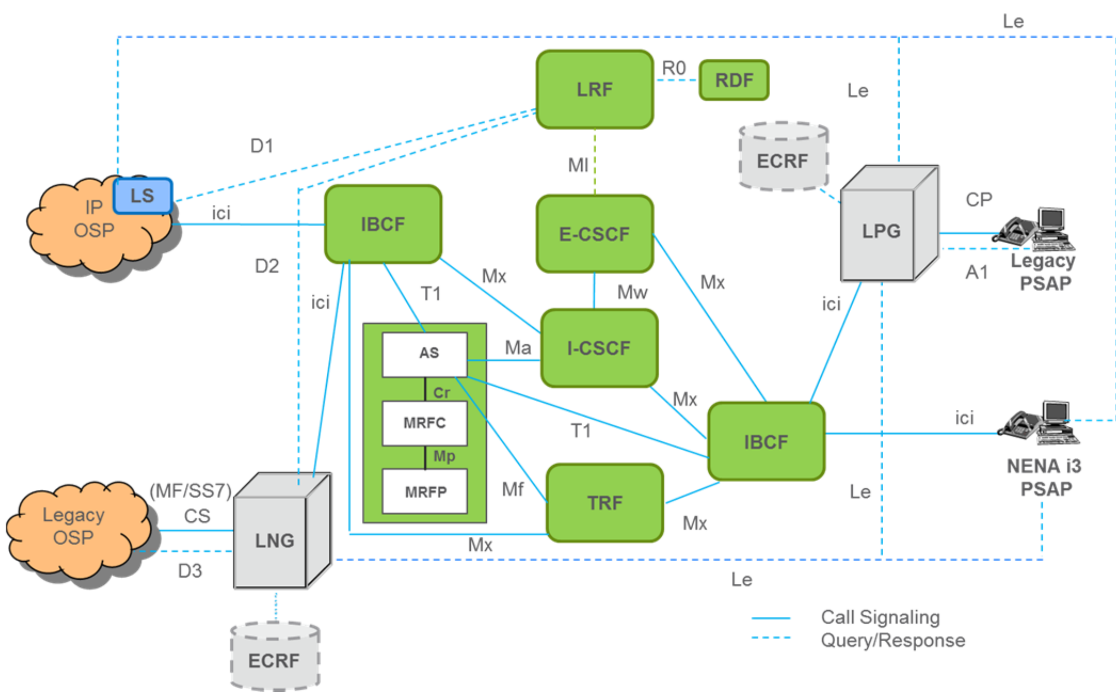

Figure 5.1: IMS-based NG9-1-1 Service Architecture

5.2 IMS-based NG9-1-1 Service Architecture Functional Elements

This section introduces the functional elements defined within ATIS-0500032. ATIS-0500032 refines the functional elements used by 3GPP for their applicability within an IMS-based NG9-1-1 Service Architecture.

5.2.1 Emergency Call Session Control Function (E-CSCF)

The E-CSCF receives the emergency session establishment request from the Interrogating Call Session Control Function (I-CSCF), queries the Location Retrieval Function (LRF) for routing information, and forwards the call request toward the appropriate PSAP per the routing information.

5.2.2 Interrogating Call Session Control Function (I-CSCF)

The I-CSCF forwards the emergency call request to the provisioned (or pre-configured) E-CSCF.

5.2.3 Location Retrieval Function (LRF)

The LRF is queried by the E-CSCF and may obtain location information from the LS (via an LRF) in the IP Originating Service Provider network, from a Location Information Server (LIS) in an i3-compliant Originating Service Provider network, or an LNG, if it is not provided in the call request (i.e., the location information is provided by reference and not by value). The LRF obtains routing information for an emergency session from the Routing Determination Function (RDF). After the LRF receives routing instructions (i.e., a Route URI) from the RDF, it interrogates the PRF with the Route URI to determine if there are policy routing rules associated with that URI. Based on the policy routing rules, the PRF may obtain an alternate URI to be used in routing the emergency call. The Route URI that results from the application of location-based and policy-based routing is returned to the E-CSCF.

5.2.4 Routing Determination Function (RDF)

The RDF provides routing information for an emergency session based upon the location information in a request from the LRF. This routing information will designate a legacy PSAP or a NENA i3 PSAP.

5.2.5 Location Server (LS)

If the emergency call request does not have the location information contained within it, the LRF in the emergency services network may query the LS to obtain it. The LS functionality is dependent upon the type of call in order to obtain location information. The LS is located within the Originating Service Provider network.

If the Originating Service Provider network is a non-IMS i3-compliant originating network, the LS is called a LIS.

If the Originating Service Provider network is an IMS-based network, the LS will be queried via an LRF in the Originating Service Provider network.

5.2.6 Interconnecting Border Control Function (IBCF)

The IBCF is used here as defined in 3GPP TS 23.228 [Ref 10] and in 3GPP TS 23.167 [Ref 11] and its applicability is expanded in this standard. The IBCF functions on the ingress side for calls originated from legacy and IP-based originating networks and on the egress side when terminating calls to legacy PSAPs and NENA i3 PSAPs.

5.2.7 Legacy Network Gateway (LNG)

The LNG is a signaling and media interconnection point between callers in legacy wireline/wireless originating networks and the IMS-based Next Generation Emergency Services Network. The LNG is responsible for interworking the Signaling System Number 7 (SS7) or Multi Frequency (MF) signaling that it receives from the legacy originating network to the SIP signaling used in the IMS-based NG9-1-1 Service Architecture. To support emergency call routing, the LNG applies service-specific interworking functionality to legacy emergency calls to allow the information provided in the call setup signaling by the wireline switch or MSC (e.g., calling number/ANI, ESRK, cell site/sector represented by an ESRD) to be used as input to the retrieval of location information (i.e., routing location) from an associated location server/database. The LNG then uses this location information to query an Emergency Call Routing Function (ECRF) to obtain routing information in the form of a Uniform Resource Identifier (URI). The LNG then forwards the call/session request to an I-CSCF in the IMS-based Next Generation Emergency Services Network, using the URI provided by the ECRF, and includes callback and location information (either by-value or by-reference) in the outgoing signaling. The LNG also supports interfaces to Mobile Positioning Centers (MPCs)/Gateway Mobile Location Centers (GMLCs) in legacy wireless originating networks to support the acquisition of dispatch location. The LNG may create a location reference and must be capable of accepting dereference requests. In addition, the LNG may generate a data structure that contains additional non-location data associated with the call (e.g., class of service, provider contact information).

5.2.8 Emergency Call Routing Function (ECRF)

The Emergency Call Routing Function (ECRF) is a Functional Element that exists outside of the IMS-based Next Generation Emergency Services Network. The LNG queries this Functional Element using the Location to Service Translation (LoST) protocol [Ref 8] to obtain routing information for an emergency origination. The Legacy PSAP Gateway (LPG) may query the ECRF (using the LoST protocol) to obtain the identity of the transfer-to party associated with a transfer request from a legacy PSAP. The ECRF maps location information (either civic address or geo-coordinates) and a Service URN provided by the LNG in the routing query to a URI associated with an I-CSCF in the IMS-based Next Generation Emergency Services Network. The ECRF is out of scope for this standard.

5.2.9 Legacy PSAP Gateway (LPG)

The LPG is a signaling and media interconnection point between the IMS-based Next Generation Emergency Services Network and legacy PSAPs. The LPG is responsible for interworking the SIP signaling that it receives from the IMS-based Next Generation Emergency Services Network to the Traditional MF or Enhanced MF (E-MF) signaling supported by the legacy PSAP. The LPG is also responsible for providing emergency services-specific processing associated with transfer requests to and from legacy PSAPs, and for processing and responding to location queries from legacy PSAPs. The LPG also supports dereference interfaces that allow it to send dereference requests to the appropriate elements to obtain location-by-value and Additional Data (including EIDDs) “by-value” when presented with the associated reference URIs in incoming SIP signaling.

5.2.10 Application Server (AS)

The AS provides conferencing services that allow the Primary PSAP to transfer a call to a Secondary PSAP served by the IMS-based Emergency Services Network. The AS receives SIP-based conference establishment requests from the PSAP through the I-CSCF and interacts with a Multimedia Resource Function Controller (MRFC) to support the conferencing and transfer of emergency calls between PSAPs.

5.2.11 Multimedia Resource Function Controller (MRFC)

The MRFC interprets information coming from an AS and controls the media stream resources in the Multimedia Resource Function Processor (MRFP) to support the conferencing and transfer of emergency calls between PSAPs served by the IMS-based Emergency Services Network.

5.2.12 Multimedia Resource Function Processor (MRFP)

The MRFP provides resources to be controlled by the MRFC to support the conferencing and transfer of emergency calls between PSAPs served by the IMS-based Emergency Services Network. In the context of emergency call conferencing/ transfer, the MRFC provides the mixing of incoming media streams associated with multiple parties.

5.2.13 Transit Function (TRF)

A Transit Function may be used by an AS if the AS does not support routing capabilities. Under these circumstances, an AS may forward an originating request to the Transit Function and the Transit Function will route the session initiation request to the destination. 3GPP allows the Transit Function to reside in a stand-alone entity or to be combined with the functionality of a Media Gateway Control Function (MGCF), a Breakout Gateway Control Function (BGCF), an S-CSCF, or an IBCF. In the context of the IMS-based NG9-1-1 Service Architecture, the Transit Function may be used as an operator option to support transfer scenarios where an AS has to initiate signaling toward a Secondary PSAP that is outside of the IMS-based Next Generation Emergency Services Network.

5.3 Interfaces

The section describes the interfaces between the Functional Elements of the IMS-based NG9-1-1 Service Architecture, as illustrated in Figure 5.1. Further details regarding these interfaces can be found in Section 7.3 of ATIS-0500032.

- IBCF to I-CSCF Interface (Mx)

  The Mx interface supports communication between an IBCF and an I-CSCF using SIP to facilitate the setup and transfer of emergency calls. An ingress IBCF will use this interface to pass SIP messages between an IP Originating Service Provider Network or LNG and an I-CSCF to support emergency call setup. An egress IBCF will use this interface to pass SIP messages associated with the emergency transfer requests between an i3 PSAP/LPG and an I-CSCF.

- E-CSCF to IBCF Interface (Mx)

  The Mx interface supports communication between an E-CSCF and an IBCF to facilitate emergency call setup. An egress IBCF will use this interface to pass SIP messages associated with an emergency origination between an E-CSCF and an i3 PSAP or LPG.

- I-CSCF to E-CSCF Interface (Mw)

  The Mw interface supports SIP-based communication between an I-CSCF and an E-CSCF to facilitate emergency call setup.

- E-CSCF to LRF Interface (Ml)

  The Ml interface uses SIP signaling to support communication between the E-CSCF and the LRF. The E-CSCF sends a SIP INVITE to the LRF that contains sufficient information to allow the LRF to acquire location information for the call, if necessary, and to determine routing (via the RDF). The LRF responds with a SIP 300 Multiple Choices response containing routing information.

- LRF to RDF Interface (R0)

  The R0 interface is used by the LRF to obtain routing information from the RDF. The protocol used between the LRF and the RDF is the LoST protocol. The LRF sends the location and the service URN to the RDF in the LoST query, and a routing URI is returned by the RDF in a LoST response.

- LRF to LS Interface (D1)

  The D1 interface is used to acquire location information from an IP Originating Service Provider Network to support emergency call routing where the location information received by the LRF in incoming signaling is in the form of a location-by-reference. The protocol used on the D1 interface is the Dereferencing Protocol using HTTP Enabled Location Protocol (HELD) [Ref 9]. The use of SIP SUBSCRIBE/NOTIFY on this interface is for future study.

- LRF to LNG Interface (D2)

  The D2 interface is used to acquire location information in support of call routing when the emergency call originates in a legacy network and is routed via an LNG to the IMS-based NG Emergency Services Network with location-by-reference. The LRF will use the Dereferencing Protocol using HTTP Enabled Location Delivery protocol (HELD) to communicate with the LNG over this interface. The use of SIP SUBSCRIBE/NOTIFY on this interface is for future study.

- LNG to Ingress IBCF (ici)

  This interface is used by the LNG to deliver emergency sessions requests toward the PSAP via the IBCF. The SIP protocol is used over this interface.

- Egress IBCF to LPG (ici)

  This interface is used by the IBCF to deliver emergency sessions requests toward a legacy PSAP via the LPG. The SIP protocol is used over this interface.

- IP OSP to Ingress IBCF (ici)

  This interface is used by the IP Originating Service Provider (OSP) to deliver emergency session requests toward the PSAP via the IBCF. The SIP protocol is used over this interface.

- Egress IBCF to NENA i3 PSAP (ici)

  This interface is used by the IBCF to deliver emergency sessions requests toward the NENA i3 PSAP. The SIP protocol is used over this interface.

- I-CSCF to AS Interface (Ma)

  The Ma interface is used to forward SIP requests from an I-CSCF to an AS. In the context of emergency call transfer, the Ma interface is used to forward conference establishment requests initiated by primary i3 PSAPs or LPGs (on behalf of legacy primary PSAPs). The protocol used on the Ma interface is SIP.

- AS to MRFC Interface for Media Control (Cr)

  The Cr interface allows media control protocol requests, responses, and notifications to be sent between the MRFC and an AS. SIP messages sent between the AS and the MRFC support the establishment and management of the media control protocol.

- MRFC to MRFP Interface (Mp)

  The Mp interface allows an MRFC to control media stream resources provided by an MRFP. The protocol used for this interface is based on the Gateway Control Protocol (H.248.1). See 3GPP TS 29.333 [Ref 5] for additional details.

- IBCF to AS Interface (T1)

  The T1 interface supports communication between an IBCF and an AS to facilitate emergency call transfer between PSAPs served by an IMS-based NG Emergency Services Network once the conference has been established between the primary PSAP and the conferencing AS. The protocol to be used over the T1 interface is SIP.

- LPG to Legacy PSAP Interface (CP)

  The CP interface supports call delivery by an i3 LPG to a legacy PSAP. This interface will use Traditional MF or E-MF signaling, as appropriate for the legacy PSAP.

- Legacy PSAP to LPG ALI Interface (A1)

The A1 interface supports ALI queries from legacy PSAPs to LPGs and the return of location information by LPGs using the formats specified in NENA 04-001 and NENA 04-005, as appropriate for the legacy PSAP.

- Legacy Originating Service Provider Network to LNG Interface (CS)

  The CS interface supports the delivery of emergency calls from a legacy originating network to the LNG using MF or SS7 trunking arrangements.

- LNG to Legacy Originating Service Provider Network Interface (D3)

  The D3 interface supports the acquisition of dispatch location by an LNG from an MPC/GMLC in a legacy wireless originating network using the E2 protocol or Mobile Location Protocol (MLP).

- i3 PSAP/LPG to LNG Interface (Le)

  The Le interface is used to acquire dispatch location information when an emergency call originates in a legacy network and is routed via an LNG to the IMS-based NG Emergency Services Network with location-by-reference. The i3 PSAP or LPG will use the HELD Dereferencing Protocol to communicate with the LNG over this interface. The use of SIP SUBSCRIBE/NOTIFY on this interface is for future study.

- AS to Transit Function (Mf)

  The Mf interface supports communication between an AS and a Transit Function using SIP. In the context of the IMS-based NG9-1-1 Service Architecture, the Mf interface supports emergency call transfer.

- Transit Function to IBCF (Mx)

  The Mx interface supports the exchange of messages between an IBCF and other functional elements in an IMS network using SIP signaling. In the context of the IMS-based NG9-1-1 Service Architecture, this interface is used to facilitate communication between the Transit Function and the IBCF to support emergency call transfer.

6 Example Call Flows

This section illustrates example call flows based upon those contained in ATIS-0500032. They show calls originating from either legacy or IP-capable originating networks. They show calls being delivered to either a legacy or NENA i3 PSAP. For calls originating from an IP-capable originating network, they describe calls where the location is delivered by value (LbyV) or delivered using a location reference (LbyR). For simplicity, the IBCF, I-CSCF, and ECRF are not shown.

A fundamental capability of E9-1-1/NG9-1-1 is the ability to transfer emergency calls. IMS-based NG9-1-1 Emergency Services Networks must implement mechanisms to support the transfer of emergency calls between PSAPs served by the IMS-based NG9-1-1 Emergency Services Network. This includes transfers initiated by i3 PSAPs toward legacy PSAPs and other i3 PSAPs, as well as transfers initiated by legacy PSAPs toward i3 PSAPs and other legacy PSAPs. In the context of an IMS-based NG9-1-1 Emergency Services Network, a bridging function will support multimedia (voice, video, text) and will reside in a conferencing AS as shown in Figure 5.1. This architecture assumes that the ingress IBCF implements a Back-to-Back User Agent (B2BUA) and the media is anchored there, as described in Section 8.8 of ATIS-0500032. Therefore, the media is managed there and the media to the user is not impacted. To illustrate this, the IBCF/B2BUA is shown in the transfer call flows. Note that ATIS-0500032, *ATIS Standard for Implementation of an IMS-based NG9-1-1 Service Architecture* [Ref 1] also provides an alternative method for call transfer where media anchoring is done at the egress IBCF.

6.1 Emergency Calls from a Legacy OSP to a Legacy PSAP

In this flow, calls originate from a legacy OSP network (i.e., a legacy wireless carrier using Wireline Compatibility Mode) and are delivered to a legacy PSAP. Calls ingress via an LNG. The LNG obtains a routing location and calls are routed to the legacy PSAP via the LPG based upon that location. The PSAP then queries for dispatch location.

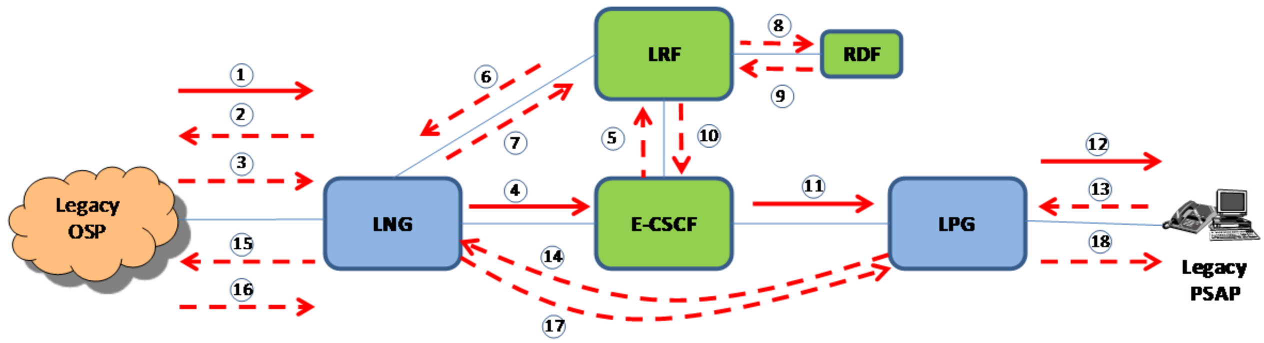

Figure 6.1: Emergency Calls from a Legacy OSP to a Legacy PSAP

1. The call originates from a legacy OSP network with a reference identifier (i.e., an ESRK).
2. The LNG determines the routing location and queries the OSP network for callback number and initial dispatch location.
3. The legacy OSP network returns callback information and initial dispatch location.
4. The LNG creates a location reference and forwards the call to the E-CSCF with the callback number and location reference.
5. The E-CSCF interrogates the LRF for routing information.
6. The LRF queries the LNG for routing location using the location reference.
7. The LNG returns the routing location.
8. The LRF queries the RDF for routing information using the routing location.
9. The RDF returns a URI that can be used for routing to the appropriate PSAP.
10. The LRF returns the routing URI to the E-CSCF.
11. The E-CSCF forwards the call to the LPG with the location reference and callback number.
12. The LPG creates a pANI and forwards the call to the legacy PSAP.
13. The legacy PSAP queries the LPG for dispatch location using the pANI.
14. The LPG queries the LNG for dispatch location using the location reference.
15. The LNG queries the OSP network for dispatch location (if necessary to obtain updated dispatch location).
16. The OSP network returns the dispatch location to the LNG.
17. The LNG returns the dispatch location to the LPG.
18. The LPG returns the dispatch location to the PSAP.

6.2 Emergency Calls from a Legacy OSP to a NENA i3 PSAP

In this flow, calls originate from a legacy OSP network (i.e., a legacy wireless carrier using Wireline Compatibility Mode) and are delivered to a NENA i3 PSAP. Calls ingress via an LNG, and the LNG obtains a routing location. The calls are routed to the NENA i3 PSAP based upon that routing location and the PSAP queries for dispatch location.

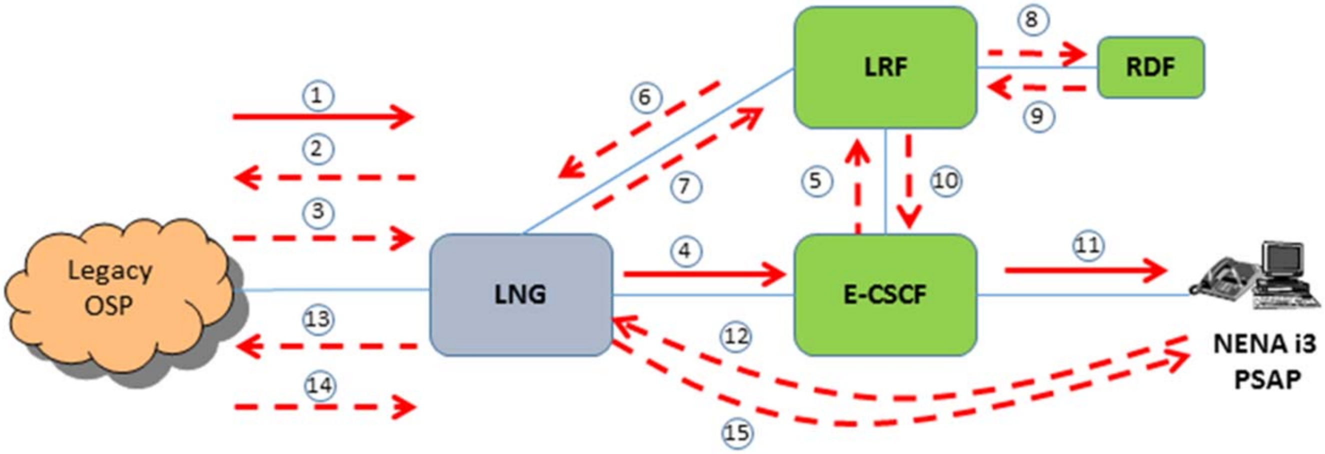

Figure 6.2: Emergency Calls from a Legacy OSP to a NENA i3 PSAP

1. The call originates from a legacy OSP network with a reference identifier (i.e., an ESRK).
2. The LNG determines the routing location and queries the OSP network for callback number and initial dispatch location.
3. The legacy OSP network returns callback information and initial dispatch location.
4. The LNG creates a location reference and forwards the call to the E-CSCF with the callback number and location reference.
5. The E-CSCF interrogates the LRF for routing information.
6. The LRF queries the LNG for routing location using the location reference.
7. The LNG returns the routing location.
8. The LRF queries the RDF for routing information using the routing location.
9. The RDF returns a URI that can be used for routing to the appropriate PSAP.
10. The LRF returns the routing URI to the E-CSCF.
11. The E-CSCF forwards the call to the NENA i3 PSAP with the location reference and callback number.
12. The NENA i3 PSAP queries the LNG for dispatch location using the location reference.
13. The LNG queries the OSP network for dispatch location (if necessary to obtain updated dispatch location).
14. The OSP network returns the dispatch location to the LNG.
15. The LNG returns the dispatch location to the NENA i3 PSAP.

6.3 Emergency Calls with LbyV from an IP Capable OSP to a Legacy PSAP

In this flow, calls originate from an IP-capable OSP network with LbyV and are delivered to a legacy PSAP. Calls ingress using SIP where the location is included in the call request. The network uses this location to determine the PSAP and forwards the call to the LPG. The calls are routed to the legacy PSAP and the PSAP queries the LPG for location.

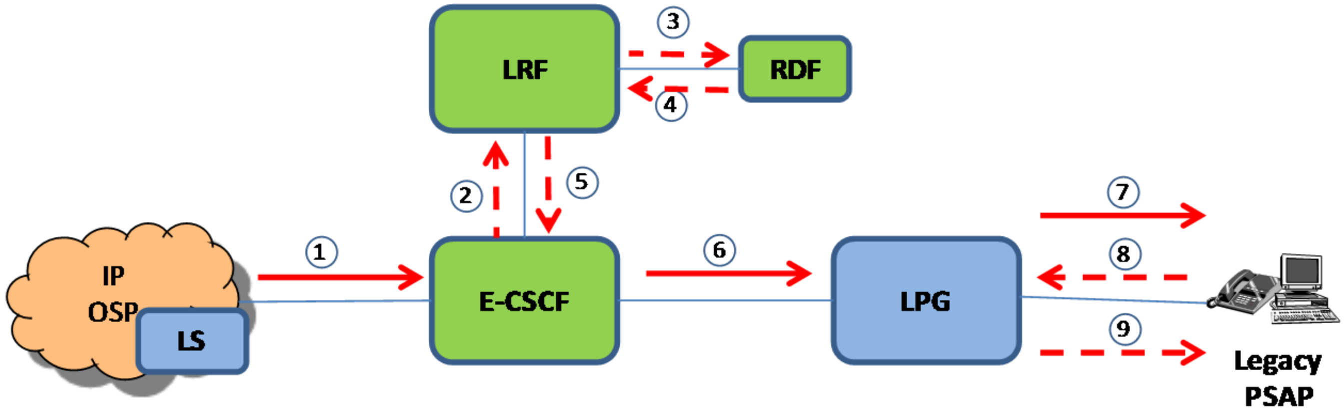

Figure 6.3: Emergency Calls with LbyV from a IP Capable OSP to a Legacy PSAP

1. The call originates from an IP-capable network with the location included in the call request.
2. The E-CSCF interrogates the LRF for routing information passing the LbyV.
3. The LRF queries the RDF for routing information using the LbyV.
4. The RDF returns a URI that can be used for routing to the appropriate PSAP.
5. The LRF returns the routing URI to the E-CSCF.
6. The E-CSCF forwards the call to the LPG with the LbyV.
7. The LPG creates a pANI and forwards the call to the legacy PSAP.
8. The legacy PSAP queries the LPG for location using the pANI.
9. The LPG returns location to the legacy PSAP.

6.4 Emergency Calls with LbyV from a IP Capable OSP to a NENA i3 PSAP

In this flow, calls originate from an IP-capable OSP network with location-by-value and are delivered to a NENA i3 PSAP. Calls ingress using SIP with the location included is in the call request. The network uses this location to determine the PSAP and forwards the call to the NENA i3 PSAP. The location is delivered with the call request.

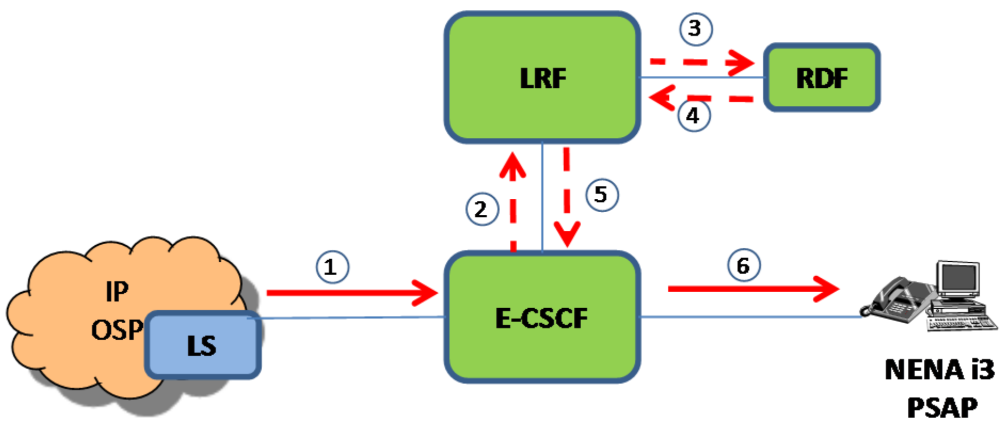

Figure 6.4: Emergency Calls with LbyV from a IP Capable OSP to a NENA i3 PSAP

1. The call originates from an IP-capable originating network with the location included in the call request.
2. The E-CSCF interrogates the LRF for routing information passing the LbyV.
3. The LRF queries the RDF for routing information using the LbyV.

4. The RDF returns a URI that can be used for routing to the appropriate PSAP.
5. The LRF returns the routing URI to the E-CSCF.
6. The E-CSCF forwards the call to the NENA i3 PSAP passing the LbyV.

6.5 Emergency Calls with LbyR from a IP Capable OSP to a Legacy PSAP

In this flow, calls originate from an IP-capable OSP network with location by reference and are delivered to a legacy PSAP. Calls ingress using SIP where the location reference is in the call request. The emergency services network queries the OSP network for the location and uses that location to determine the PSAP. The call is forwarded to the LPG and it forwards the call to the legacy PSAP. The PSAP queries the LPG for location and the LPG obtains that location from the IP-capable OSP network.

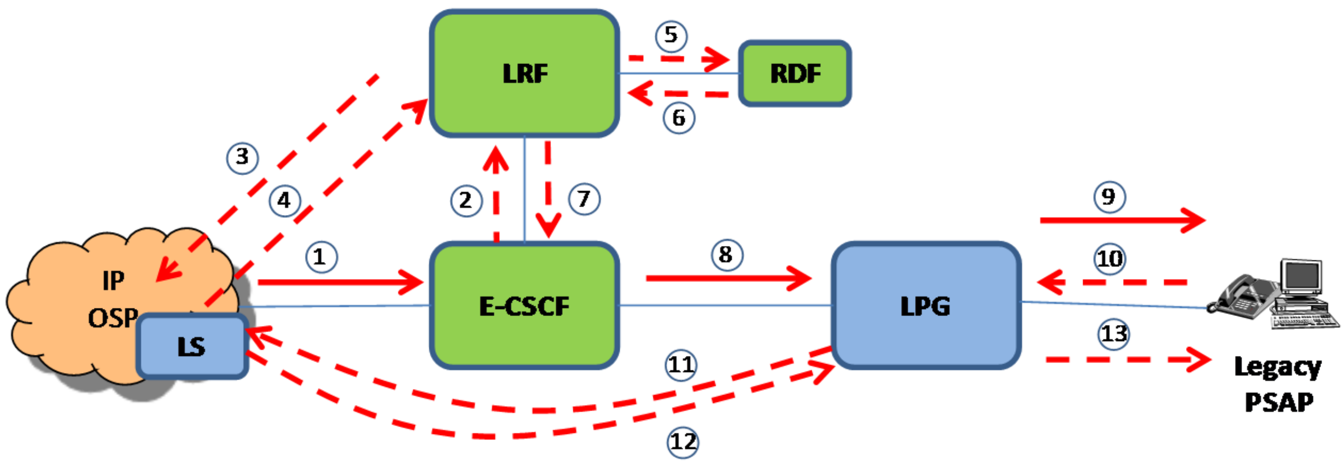

Figure 6.5: Emergency Calls with LbyR from a IP Capable OSP to a Legacy PSAP

1. The call originates from an IP-capable originating network with the location reference in the call request.
2. The E-CSCF interrogates the LRF for routing information, passing the location reference.
3. The LRF queries the IP-capable OSP network for the location using the location reference.
4. The IP-capable OSP network returns the location.
5. The LRF queries the RDF for routing information using the location.
6. The RDF returns a URI that can be used for routing to the appropriate PSAP.
7. The LRF returns the routing URI to the E-CSCF.
8. The E-CSCF forwards the call to the LPG with the location reference.
9. The LPG creates a pANI and forwards the call to the legacy PSAP.
10. The legacy PSAP queries the LPG for location using the pANI.
11. The LPG queries the IP-capable OSP network for location using the location reference.
12. The IP-capable OSP network returns the location.
13. The LPG returns the location to the legacy PSAP.

6.6 Emergency Calls with LbyR from a IP Capable OSP to a NENA i3 PSAP

In this flow, calls originate from an IP-capable OSP network with location by reference and are delivered to a NENA i3 PSAP. Call ingress using SIP with the location reference in the call request. The emergency services network queries the OSP network for location and uses that location to determine the PSAP. The call is forwarded to the NENA i3 PSAP with the location reference. The PSAP queries the IP-capable OSP network for location and the IP-capable OSP network returns the location.

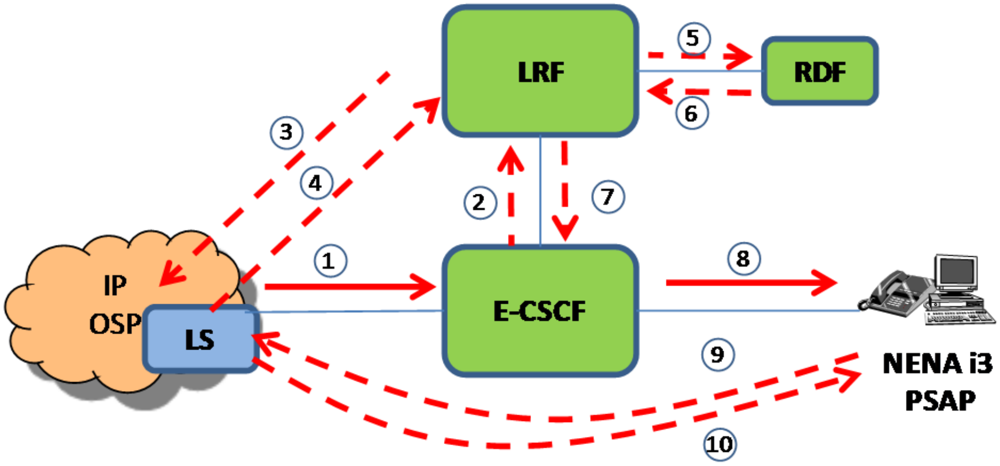

Figure 6.6: Emergency Calls with LbyR from a IP Capable OSP to a NENA i3 PSAP

1. The call originates from an IP-capable originating network with the location reference in the call request.
2. The E-CSCF interrogates the LRF for routing information, passing the location reference.
3. The LRF queries the IP-capable OSP network for the location using the location reference.
4. The IP-capable OSP network returns the location.
5. The LRF queries the RDF for routing information using the location.
6. The RDF returns a URI that can be used for routing to the appropriate PSAP.
7. The LRF returns the routing URI to the E-CSCF.
8. The E-CSCF forwards the call to the NENA i3 PSAP with the location reference.
9. The NENA i3 PSAP queries the IP-capable OSP network for location using the location reference.
10. The IP-capable OSP network returns the location.

6.7 Transfer of Calls from a NENA i3 PSAP to a NENA i3 PSAP

The illustration below, along with the step-by-step description, describes this process.

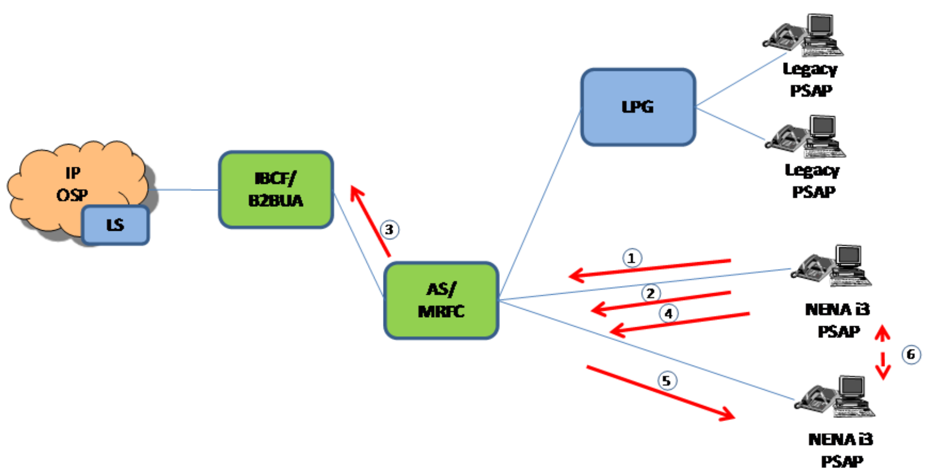

Figure 6.7: Call Transfer from a NENA i3 PSAP to a NENA i3 PSAP

1. After an initial emergency call has been established between the caller and the Primary NENA i3 PSAP, the Primary NENA i3 PSAP determines that the call needs to be transferred to a Secondary PSAP or other destination. The Primary NENA i3 PSAP creates a conference using the AS.
2. The Primary NENA i3 PSAP asks the AS to invite the caller to the conference.
3. The AS asks the IBCF to join the conference and to replace the connection between the IBCF and the Primary NENA i3 PSAP with a connection between the IBCF and the AS. The connection between the caller and the IBCF remains unchanged. Now the caller and the Telecommunicator at the Primary PSAP are in conversation via a conference at the AS.
4. The Primary NENA i3 PSAP asks the AS to invite the Secondary PSAP to the conference.
5. The AS asks the Secondary NENA i3 PSAP to join the conference. Now all three are in conversation.
6. Using the information in the call request, the Secondary NENA i3 PSAP queries the Primary NENA i3 PSAP for the Emergency Incident Data Document (EIDD) that contains location information and other additional data.

6.8 Transfer of Calls from a NENA i3 PSAP to a Legacy PSAP

The illustration below, along with the step-by-step description, describes this process.

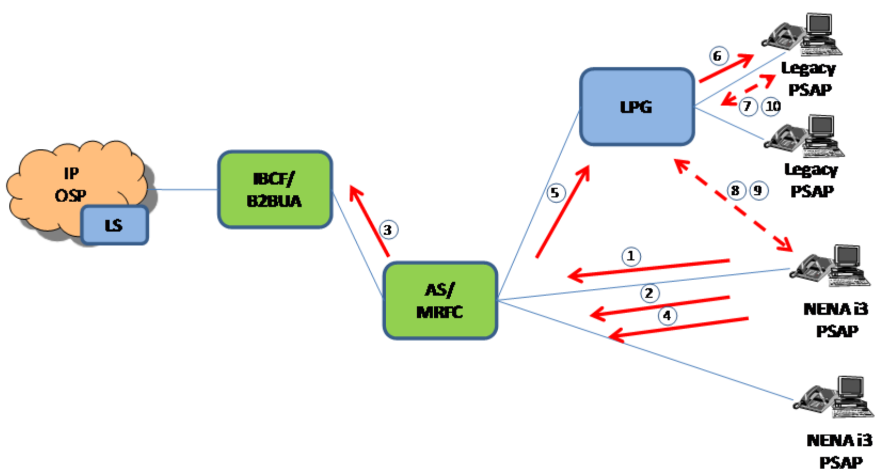

Figure 6.8: Call Transfer from a NENA i3 PSAP to a Legacy PSAP

1. After an initial emergency call has been established between the caller and the Primary NENA i3 PSAP, the NENA i3 PSAP determines that the call needs to be transferred to a Secondary PSAP or other destination. The Primary NENA i3 PSAP creates a conference using the AS.
2. The Primary NENA i3 PSAP asks the AS to invite the caller to the conference.
3. The AS asks the IBCF to join the conference and to replace the connection between the IBCF and the Primary NENA i3 PSAP with a connection between the IBCF and the AS. The connection between the caller and the IBCF remains unchanged. Now the caller and the Telecommunicator at the Primary PSAP are in conversation via a conference at the AS.
4. The Primary NENA i3 PSAP asks the AS to invite the Secondary PSAP to the conference.
5. The AS asks the LPG to add the Secondary legacy PSAP to the conference.
6. The LPG adds the legacy PSAP to the conference. Now all three parties are in conversation.
7. The Secondary legacy PSAP queries the LPG for ALI information.
8. The LPG sends a request to the NENA i3 PSAP for the EIDD containing location information and additional data.
9. The NENA i3 PSAP returns the EIDD.
10. The LPG reformats the EIDD into the ALI response to the legacy PSAP.

6.9 Transfer of Calls from a Legacy PSAP to a NENA i3 PSAP

The illustration below, along with the step-by-step description, describes this process.

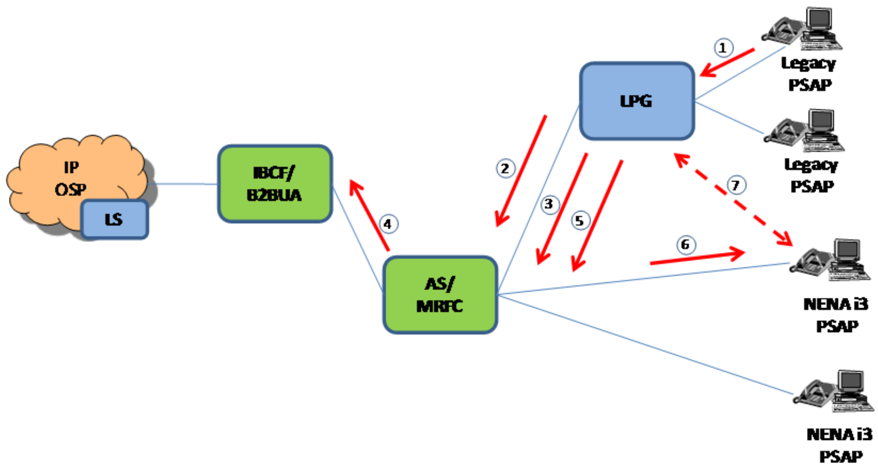

Figure 6.9: Transfer of Calls from a Legacy PSAP to a NENA i3 PSAP

1. After an initial emergency call has been established between the caller and the Primary legacy PSAP via the LPG, the legacy PSAP determines that the call needs to be transferred to a Secondary PSAP or other destination. The Primary legacy PSAP sends a transfer request to the LPG (using DTMF signaling).
2. The LPG creates a conference using the AS.
3. The LPG asks the AS to invite the caller to the conference.
4. The AS asks the IBCF to join the conference and to replace the connection between the IBCF and the Primary legacy PSAP with a connection between the IBCF and the AS. The connection between the caller and the IBCF remains unchanged. Now the caller and the Telecommunicator at the Primary PSAP are in conversation via a conference at the AS.
5. The LPG asks the AS to invite the Secondary PSAP to the conference.
6. The AS asks the Secondary NENA i3 PSAP to join the conference. Now all three parties are in conversation.
7. Using the information in the call request to the Secondary NENA i3 PSAP queries the LPG for the EIDD that contains location information and other additional data.

6.10 Transfer of Calls from a Legacy PSAP to a Legacy PSAP

The illustration below, along with the step-by-step description, describes this process.

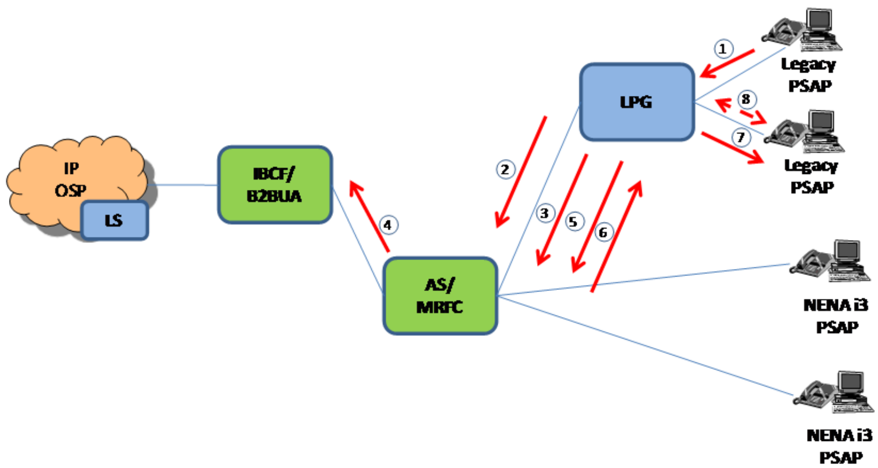

Figure 6.10: Transfer of Calls from a Legacy PSAP to a Legacy PSAP

1. After an initial emergency call has been established between the caller and the Primary legacy PSAP via the LPG, the legacy PSAP determines that the call needs to be transferred to a Secondary PSAP or other destination. The Primary legacy PSAP sends a transfer request to the LPG (using DTMF signaling).
2. The LPG creates a conference using the AS.
3. The LPG asks the AS to invite the caller to the conference.
4. The AS asks the IBCF to join the conference and to replace the connection between the IBCF and the Primary legacy PSAP with a connection between the IBCF and the AS. The connection between the caller and the IBCF remains unchanged. Now the caller and the Telecommunicator at the Primary PSAP are in conversation via a conference at the AS.
5. The LPG asks the AS to invite the Secondary PSAP to the conference.
6. The AS asks the LPG to add the Secondary legacy PSAP to the conference.
7. The LPG adds the legacy PSAP to the conference. Now all three parties are in conversation.
8. The Secondary legacy PSAP queries the LPG for ALI information.[11]

7 Compare and Contrast NENA i3 with ATIS-0500032

This section compares the NENA i3 emergency services architecture described in NENA STA-010.2 and the IMS-based NG9-1-1 Service Architecture described in ATIS-0500032. Despite the differences in architecture, the expectation is that interconnecting networks (originating service provider networks and PSAPs) will see no differences in interfaces or functionality provided to them by the emergency services network, regardless of emergency services network type (i.e., NENA i3 vs. IMS-based). However, the placement of functional capabilities within the emergency services network to implement the required functionality varies for each architecture based upon the assumptions of NENA i3 or ATIS/3GPP specifications.

This section first provides a short overview of the NENA i3 architecture and then illustrates how the same functionality is provided by each architecture. Readers should refer to Figure 5.1 in Section 5.1 for the ATIS IMS-based NG9-1-1 Service Architecture.

[11] Note that if the legacy PSAPs are served by different LPGs, the LPG serving the secondary PSAP will query the LPG serving the primary PSAP for the EIDD containing the location information and additional data before formatting the ALI response.

7.1 Overview of NENA i3

Figure illustrates the NENA i3 call routing architecture. Emergency call requests enter the ESInet from an IP-capable i3-compliant originating service provider network with either LbyV or LbyR. If the call request includes LbyR, the ESRP queries the LIS for location and uses that location to query the ECRF for routing instructions. If the call request includes LbyV, the location passed in the call request is used to query the ECRF for routing instructions. When the ESRP receives routing instructions, it routes the call request to a legacy PSAP via an LPG (and a BCF) or to the i3 PSAP (via a BCF).

Emergency call requests enter the ESInet from legacy originating service provider networks via the LNG. If the call request is from a fixed line OSP, the call request will include the TN. The LNG will query an associated location database/server with that TN to obtain the location information. The LNG then queries the ECRF for the appropriate ESRP URI and forwards the call request to the ESRP with LbyV. If the call request is from a legacy wireless network, the call request received by the LNG will include an ESRK or an ESRD/ESRK plus Callback Number. The LNG will create an associated location that can be used for routing and create a location reference. The LNG will also query the Legacy OSP network to obtain the callback number if one was not included in the call request. The LNG then queries the ECRF for the address of the appropriate ESRP, using the routing location obtained from the location database/server, and forwards the call request to the ESRP with LbyR. When the ESRP receives a call request with LbyR, it will query the LNG to obtain the routing location information. The ESRP then uses either the location received in the call request or the associated location created by the LNG to query the ECRF for routing instructions. When the ESRP receives routing instructions from the ECRF, it consults the Policy Routing Function and routes the call request to a legacy PSAP via an LPG (and a BCF) or to the i3 PSAP (via a BCF).

When the call request is delivered to an LPG, it will create a pANI (if needed) and forward the call request to the legacy PSAP. The legacy PSAP will query the LPG with the pANI as if the LPG were an ALI database. If the LPG received LbyV, it will respond to the PSAP with the location information, formatted as appropriate for the legacy PSAP. If the LPG received LbyR in the emergency call request, it must send a dereference request to obtain the location (by-value). The location reference may either point back to the IP OSP network or it may point back to the LNG, based on the URI delivered. If the dereference request is directed to the LNG, then upon receiving the dereference request, the LNG may query the legacy OSP network for location. The results will be returned to the LPG, which will then re-format the information in a manner appropriate for the legacy PSAP.

The call request may be delivered to the i3 PSAP with LbyV or LbyR. The location reference for LbyR will indicate whether it points back to the IP OSP network or to the LNG. If the dereference request is directed to the LNG, then upon receiving the dereference request, the LNG may query the legacy OSP network for location. The results will be returned by the LNG to the PSAP.

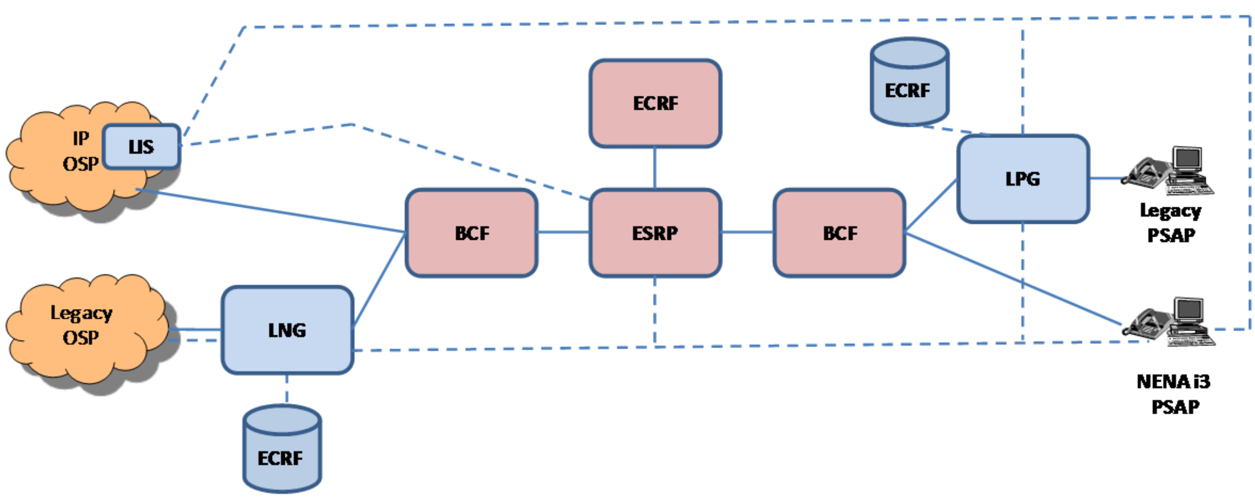

Figure 7.1: NENA i3 Call Routing Architecture

7.1.1 ECRF

The ECRF is a routing function that utilizes a GIS database and is queried to determine how to route the emergency call request. Its input is a location (civic or geodetic) plus a service URN, and its output is a route URI that is used to forward the call request. The ECRF is provisioned with a service boundary layer containing one or more service boundary polygons. Each of the polygons contains attributes that specify the service URN that the polygon applies to and the URI the ECRF should return if the proffered location is within the polygon.

7.1.2 ESRP

The ESRP is the routing proxy that routes call requests based upon location. If a call request to the ESRP contains LbyR, it will interrogate the LIS (or LNG, as appropriate) to obtain location information. It will then use that location, or the one received in the call request, to query the ECRF for routing instructions. The ECRF will return a next hop URI that may be used to route the call request towards the PSAP. After the ESRP receives routing instructions (i.e., a Route URI) from the ECRF, it interrogates the PRF with the Route URI to determine if there are policy routing rules associated with that URI. Based on the policy routing rules, the PRF may obtain an alternate URI to be used in routing the emergency call. The call is routed based on the Route URI that results from the application of location-based and policy-based routing.

7.1.3 Legacy Network Gateway (LNG)

The LNG is a signaling and media interconnection point between legacy wireline/wireless originating networks and an ESInet. The LNG is responsible for interworking the SS7 or MF signaling that it receives from the legacy originating network to the SIP signaling used in the ESInet. To support emergency call routing, the LNG applies service-specific interworking functionality to legacy emergency calls to allow the information provided in the call setup signaling by the wireline switch or MSC (e.g., calling number/ANI, ESRK, cell site/sector represented by an ESRD) to be used as input for the retrieval of location information (i.e., routing location) from an associated location server/database. The LNG then uses this location information to query an ECRF to obtain routing information in the form of a URI. The LNG then forwards the call request to an ESRP, using the URI provided by the ECRF, and includes callback and location information (either by-value or by-reference) in the outgoing signaling. The LNG also supports interfaces to MPCs/GMLCs in legacy wireless originating networks to support the acquisition of dispatch location. To facilitate the use of location-by-reference, the LNG must support a dereference interface so that it can process dereference requests from other functional elements or PSAPs. In addition, the LNG may generate a data structure that contains additional (non-location) data associated with the call (e.g., class of service, provider contact information). The LNG may include the additional data "by-value" in the body of the outgoing SIP message that it sends to the ESRP, and/or it may generate a pointer/reference to that data structure. If the LNG generates a pointer/reference to an additional data structure, it must also support deference requests for additional data.

7.1.4 Legacy PSAP Gateway (LPG)

The LPG is a signaling and media interconnection point between the ESInet and legacy PSAPs. The LPG is responsible for interworking the SIP signaling that it receives from the ESRP to the Traditional MF or E-MF signaling supported by the legacy PSAP. The LPG is also responsible for providing emergency services-specific processing associated with transfer requests to and from legacy PSAPs, and for processing and responding to location queries from legacy PSAPs. The LPG also supports dereference interfaces that allow it to send dereference requests to the appropriate elements to obtain location-by-value and additional data "by-value" when presented with the associated reference URIs in incoming SIP signaling.

7.2 Use of Gateways

In the early stages of the definition of ATIS-0500032, ATIS ESIF anticipated an end-to-end IMS-based NG9-1-1 Service Architecture. That is, ATIS ESIF expected that emergency calls from legacy originating networks (wireline and wireless) would ingress via an MGCF. Then calls would be converted from digital signaling to SIP and passed to the E-CSCF which would interact with the LRF. The LRF would obtain location, if necessary, and routing information and return the information to the E-CSCF. The E-CSCF would then route the call toward the PSAP. Early assumptions also had the MGCF interacting with legacy PSAPs. That is, converting from SIP to the appropriate PSAP protocols. The legacy PSAP would then query the LRF to obtain callback number and location information (i.e., ALI). As discussion evolved, the complexity of modifying the 3GGP standards to accommodate the ingress of legacy originating network emergency calls and the egress of those calls to a legacy PSAP became apparent. Therefore, ATIS ESIF incorporated the NENA i3 LNG and LPG into the IMS-based NG9-1-1 Service Architecture.

In the case of incoming traffic from legacy originating networks to a NENA i3 ESInet, the calls enter the LNG as described in Section 7.1.3. The LNG acquires location, converts the signaling from TDM to SIP, determines the appropriate ESRP, and then forwards the call to it via the BCF. ATIS-0500032 adopted similar concepts by incorporating the i3 LNG into the ATIS IMS-based NG9-1-1 Service Architecture (see section 5.2.7 for further discussion). Calls from legacy networks enter the LNG via MF or SS7 trunk groups; the LNG acquires location, converts the signaling, and forwards the call to the E-CSCF via the IBCF and I-CSCF.

For egressing to legacy PSAPs, NENA i3 defines the LPG as described in section 7.1.4. The LPG receives the call signaling from the ESRP (via a BCF), acquires location if necessary, converts the signaling from SIP to the appropriate PSAP signaling, and responds to queries from the PSAP for callback (depending upon the type of signaling) and location (i.e., ALI). ATIS-0500032 adopted similar concepts by incorporating the i3 LPG into the ATIS IMS-based NG9-1-1 Service Architecture as described in section 5.2.9.

7.3 Dereferencing Capabilities

If a call enters the NENA i3 ESInet with location-by-reference (LbyR) or from a legacy wireless network via the LNG, location information must be obtained to route the call and allow the PSAP to query for dispatch location. If the ESRP receives an LbyR, it must obtain the routing location (via a dereference procedure) in order to route the call as described in section 7.1.2. The ESRP may obtain the routing location from either the LIS in the originating network or the associated location determined by the LNG. That location is then sent to the ECRF to obtain routing information. Once the call is delivered to the NENA i3 PSAP, it may dereference the dispatch location from either the LIS in the originating network or from the LNG. The legacy PSAP obtains location information by querying an LPG which dereferences the LbyR by querying a LIS or LNG.

The ATIS IMS-based NG9-1-1 Service Architecture described in ATIS-0500032 must also support location dereferencing. However, it is the responsibility of the LRF in the IMS-based Next Generation Emergency Services Network to obtain a location that can be used for routing. The LRF may obtain the routing location from either an LS (e.g., a LIS) in the originating network or from the LNG. That location is then sent to the RDF to obtain routing information, which is returned by the LRF to the E-CSCF. If the call is delivered to the NENA i3 PSAP, the i3 PSAP may dereference the dispatch location from either the LS in the originating network or the LNG. If the call is delivered to a legacy PSAP, the legacy PSAP obtains dispatch location by querying an LPG, which dereferences the LbyR by querying a LIS or LNG.

7.4 Route Determination

Call routing is functionally equivalent in the NENA i3 and ATIS IMS-based NG9-1-1 Service Architectures. The routing determination function in NENA i3 is the ECRF, which is queried by the ESRP with location. The ESRP then uses the routing information to route the call towards the PSAP. The routing function in ATIS-0500032 is the RDF, which is queried by the LRF with location. The LRF returns the routing information to the E-CSCF so it can route the call towards the PSAP.

7.5 Call Routing

Call flows for ATIS-0500032 are shown in section 6. The primary differences in routing methodology between the NENA i3 architecture and the ATIS IMS-based NG9-1-1 Service Architecture relate to the placement of functionality. Using Figure 5.1 as a reference, calls from legacy originating networks enter the LNG and the LNG forwards the call request to the E-CSCF. The E-CSCF queries the LRF for routing instructions and the LRF queries the RDF. When the E-CSCF obtains routing instructions, it forwards the call either to the NENA i3 PSAP or to the LPG. In comparison, when routing in an NENA i3 ESInet, calls from legacy originating networks enter the LNG and the LNG forwards the call request to the ESRP. The ESRP queries the ECRF for routing instructions. When the ESRP obtains routing instructions, it forwards the call either to the NENA i3 PSAP or to the LPG. Other call flow differences can be extrapolated from Figure 5.1.

8 Operational Considerations

This section discusses operational considerations for the various stakeholders impacted by implementation of an IMS-based NG9-1-1 Service Architecture.

8.1 Originating Networks

Originating networks supporting legacy interconnection methods will interface to the IMS-based NG9-1-1 Service Architecture through the LNG. IP-capable originating networks are expected to interconnect with the IMS-based NG9-1-1 Service Architecture through a BCF via a native SIP connection.

Calls originating in legacy wireline or wireless networks must undergo signaling interworking to convert the incoming MF or SS7 signaling to the IP-based SIP signaling supported by the IMS-based NG9-1-1 Service Architecture. Thus, the LNG supports a physical SS7 or MF interface on the side of the originating network, and an IP interface which produces SIP signaling towards the IMS-based Next Generation Emergency Services Network, and must provide the protocol interworking functionality from the SS7 or MF signaling that it receives from the legacy originating network to the SIP signaling used in the IMS-based Next Generation Emergency Services Network.

Originating service providers are expected to deploy trunk facilities to the ingress side of the LNG. This may require moving trunks from existing Selective Routers to the LNG. Specifically, the originating service provider will deploy trunks to the LNG in parallel with existing trunks connected to the Selective Router and then define a “cutover” date where the traffic is migrated. The appropriate databases must be provisioned before the transition. In general, the operational considerations are the same as for an LNG connected to a NENA i3 ESInet.

Calls originating from IP-capable originating networks will ingress to the IMS-based Next Generation Emergency Services Network via an IBCF. The originating service provider is expected to provide IP connectivity to the point of presence of the IMS-based Next Generation Emergency Services Network. Specifically, the originating service provider will deploy IP connectivity and then define a “cutover” date where live traffic begins. In general, the operational considerations are the same as for IP traffic connected to a NENA i3 ESInet.

8.2 IMS-based NG9-1-1 Service Architecture Providers

It is most likely that the provider of the IMS-based NG9-1-1 Service Architecture also offers a broader IMS implementation supporting IMS services. Therefore, operational considerations are incremental to the general network operations. Operations processes and procedures will need to be extended to support the gateways (LNG and LPG) and the IMS functional elements that play a critical role in providing 9-1-1-specific service capabilities (e.g. the LRF, LS, E-CSCF, etc.).

In designing the IMS-based Next Generation Emergency Services Network that is part of the overall service architecture, the NG9-1-1 System Service Provider will need to make decisions regarding the way in which certain options described in ATIS-0500032 will be implemented.

One such option is related to the mechanism used to support the transfer of emergency calls. ATIS-0500032 describes two alternatives for supporting emergency call transfer: one where B2BUA functionality is implemented in the originating network-facing IBCF, and a second where B2BUA functionality is implemented in the PSAP-facing IBCF. When transfer is implemented with B2BUA functionality at the originating network-facing IBCF, the connection between the caller and the originating network-facing IBCF is maintained throughout the transfer process, but the connection between the originating network-facing IBCF/B2BUA and the Primary PSAP is replaced by a connection between the IBCF/B2BUA and the conferencing AS and a connection between the conferencing AS and the Primary PSAP.

When transfer is implemented with the B2BUA functionality at the PSAP-facing IBCF, the connection between the caller and the PSAP-facing IBCF/B2BUA is maintained throughout the transfer, and only the connection between the PSAP-facing IBCF/B2BUA and the Primary PSAP is replaced by a connection between the IBCF/B2BUA and the conferencing AS and between the conferencing AS and the Primary PSAP. If the E-CSCF includes itself in the Record-Route when the initial emergency call is established, then its resources will remain utilized for the duration of the transferred call. If an NG9-1-1 System Service Provider chooses to implement the transfer mechanism in which the B2BUA functionality resides at the PSAP-facing IBCF, and it does not wish the E-CSCF to remain in the call path for the duration of the transferred call, the NG9-1-1 System Service Provider may design their networks so that the E-CSCF does not include itself in the Record-Route when the initial emergency call is established.

The decision to implement the IMS-based Next Generation Emergency Services Network in such a way that the E-CSCF does not include itself in the Record-Route during the establishment of the initial emergency call should also consider whether or not the NG9-1-1 System Service Provider wishes to support LRF subscription to call state. ATIS-0500032 supports an option in which the LRF can send a subscription request to the E-CSCF to obtain call state information. If the LRF subscribes to call state information and the E-CSCF does not include itself in the Record-Route associated with the initial call, then the LRF will not receive notification of call state changes by the E-CSCF. The NG9-1-1 System Service Provider must therefore consider the interrelationship of the options regarding LRF subscription to call state, the E-CSCF including itself in the Record-Route of the initial emergency call, and the transfer alternative to be implemented with designing their IMS-based Next Generation Emergency Services Network architecture.

8.3 Legacy PSAPs

The specific operational impacts described in this section relate to the migration from the use of the Selective Router and ALI to the use of the LPG. If a PSAP that is connected to the Selective Router migrates to an LPG, then new trunks will have to be provided from the LPG to the PSAP. New ALI links will be provisioned to the LPG. The NG9-1-1 System Service Provider that is deploying the IMS-based Next Generation Emergency Services Network and the PSAP(s) will then define a “cutover” date where live traffic is migrated. The appropriate databases must be provisioned before the transition. In general, the operational considerations are the same as for IP traffic connected to a NENA i3 ESInet.

8.4 NENA i3 PSAPs

IP connectivity will be provided from the IBCF on the egress side of the IMS-based Next Generation Emergency Services Network to the BCF at the PSAP for SIP signaling. There is not a need for IP connectivity between the IMS-based NG9-1-1 Service Architecture and the PSAP to support dereference requests for location information and additional data, since it assumed that the PSAP will query the appropriate networks directly. The NG9-1-1 System Service Provider and the PSAP(s) will then define a “cutover” date where live traffic is introduced. The appropriate databases must be provisioned before the transition. In general, the operational considerations are the same as for NENA i3 ESInet traffic connected to a NENA i3 PSAP.