ATIS-0700031

ATIS Standard on -

Location and Routing Support for Non-Operator-Managed Over the Top (OTT) Citizen-to-Authority Emergency Services

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ATIS-0700031

ATIS Standard

Location and Routing Support for Non-Operator-Managed OTT Citizen-to-Authority Emergency Services

Alliance for Telecommunications Industry Solutions

Approved February 9, 2017

Abstract

This document defines technical methods in the case of an Operator-managed interconnected VoIP or Text Messaging over IP (ToIP) service by which location information can be acquired and conveyed for routing VoIP emergency calls or ToIP emergency sessions and made available for presentation to the appropriate Public Safety Answering Point (PSAP) for dispatch purposes. The standard also defines technical methods by which an operator of a user access network can acquire and convey location for an Over The Top VoIP emergency call or ToIP emergency session.

Foreword

As a leading technology and solutions development organization, the Alliance for Telecommunications Industry Solutions (ATIS) brings together the top global information and communications technology (ICT) companies to advance the industry's most pressing business priorities. ATIS serves the public through improved understanding between carriers, customers, and manufacturers.

This standard was developed jointly between ESIF, PTSC, and WTSC.

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 Packet Technologies and Systems Committee (PTSC) develops and recommends standards and technical reports related to services, architectures, and signaling, in addition to related subjects under consideration in other North American and international standards bodies. PTSC coordinates and develops standards and technical reports relevant to telecommunications networks in the U.S., reviews and prepares contributions on such matters for submission to U.S. ITU-T and U.S. ITU-R Study Groups or other standards organizations, and reviews for acceptability or per contra the positions of other countries in related standards development and takes or recommends appropriate actions.

The Wireless Technologies and Systems Committee (WTSC) develops and recommends standards and technical reports related to wireless and/or mobile services and systems, including service descriptions and wireless technologies. WTSC develops and recommends positions on related subjects under consideration in other North American, regional, and international standards bodies.

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

At the time of initiation or issuance of the letter ballot for this document, the committees responsible for its development had the following leadership:

S. Sherwood, ESIF Chair (Verizon)
R. Hixon, ESIF First Vice-Chair (NENA)
R. Marshall, ESIF Second Vice-Chair (Comtech)

M. Dolly, PTSC Chair (AT&T)
V. Shaikh, PTSC Vice-Chair (Applied Communication Sciences)

D. Zelmer, WTSC Chair (AT&T)
M. Younge, WTSC Vice-Chair (T-Mobile)

Farrokh Khatibi, Technical Editor (Qualcomm)

The IP Multimedia Subsystem (IMS) Emergency Procedures for IMS Origination and Emergency Services IP Network (ESInet) (IMSESINET) joint project group was responsible for the development of this document.

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1   Scope

The scope of this standard is twofold. First, to identify and evaluate technical methods by which an operator of a user access network can acquire and convey location used for routing an Over The Top VoIP emergency call or an Over The Top IP-based text messaging emergency session. Secondly, to identify and evaluate technical methods in the case of an IP Multimedia Subsystem (IMS)-based operator-managed interconnected VoIP or Text Messaging over IP (ToIP) service by which location information can be acquired and conveyed for routing VoIP or ToIP emergency calls. For both cases, the location information is made available for presentation to the appropriate Public Safety Answering Point (PSAP) for dispatch purposes.

In evaluating different methods, the standard considers feasibility, compatibility with existing deployment, security, privacy, regulatory constraints, and inter-operator charging. The standard applies to multiple access types including wireless (e.g., Long Term Evolution [LTE], Wi-Fi) and wireline (e.g., DSL) broadband networks.

The standard is intended to support location acquisition, conveyance, and dereferencing for the purposes of both routing and dispatch for an IP-based emergency call or text messaging session using voice Global Text Telephony (GTT) or text messaging made by a fixed, nomadic, or mobile subscriber in North America. Also, in this standard the term access network refers to 3GPP access technologies.

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 Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

[Ref 1]   ATIS-0700015, *ATIS Standard for Implementation of 3GPP Common IMS Emergency Procedures for IMS Origination and ESInet/Legacy Selective Router Termination.*[1]
[Ref 2]   draft-ietf-ecrit-phonebcp-20, *Best Current Practice for Communications Services in support of Emergency Calling*, September 2011.
[Ref 3]   IETF RFC 6443, *Framework for Emergency Calling Using Internet Multimedia.*[2]
[Ref 4]   IETF RFC 6881, *Best Current Practice for Communications Services in Support of Emergency Calling.*[2]
[Ref 5]   3GPP TS 23.271, *Technical Specification Group Services and System Aspects; Functional Stage 2 description of Location Services (LCS).*[3]

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[1] This document is available from the Alliance for Telecommunications Industry Solutions (ATIS), 1200 G Street N.W., Suite 500, Washington, DC 20005 at: < https://www.atis.org/docstore/product.aspx?id=28140 >.

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

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

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 Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

[Ref 100] NENA 08-003, *Detailed Functional and Interface Standards for the NENA i3 Solution*, June 14, 2011.[4]

[Ref 101] NENA ADM 000, *NENA Master Glossary of 9-1-1 Terminology*.[5]

4 Definitions, Acronyms, & Abbreviations

4.1 Definitions

4.1.1   Emergency Services Capable Access Network (ESCAN): An Access Network (AN) whose provider is able to offer IP-based voice emergency services to attached users according to the ATIS-0700015 standard [Ref 1]. The associated IMS support will be provided by the operator of the ESCAN.

4.1.2   Over The Top (OTT) Voice Service Provider (VSP): A VSP offering voice services and voice emergency services to users whose AN is supported by a different operator. Typically (but not always), an OTT VSP will not own or operate an AN.

4.1.3   OTT MSP: A text messaging service provider offering text messaging services and text messaging emergency services to users whose AN is supported by a different operator. Typically (but not always), an OTT MSP will not own or operate an AN.

4.1.4   Text Messaging over IP (ToIP): A two way text messaging service between two users that may provide near-real time text message conversational capabilities (e.g., instant messaging chat) or store and forward text message conversational capabilities (e.g., Short Message Service [SMS]). The ToIP service operates over IP for both the UNI and Network-to-Network Interface (NNI).

4.2 Acronyms & Abbreviations

3GPP	3rd Generation Partnership Project
ALI	Automatic Location Identification
AN	Access Network
ANSI	American National Standards Institute
ATIS	Alliance for Telecommunications Industry Solutions
BCF	Border Control Function
CMRS	Commercial Mobile Radio Service
CPNI	Customer Proprietary Network Information
CS	Circuit Switched
CSRIC	Communications Security, Reliability and Interoperability Council (FCC)
DDoS	Distributed Denial of Service
DN	Directory Number
DNS	Domain Name System

[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 National Emergency Number Association (NENA) at:
< http://www.nena.org/standards/master-glossary >.

ECRF	Emergency Call Routing Function
E-CSCF	Emergency Call Session Control Function
ELS	Emergency Location Server
ESCAN	Emergency Services Capable AN
ESInet	Emergency Services IP network
E-SLP	Emergency SLP
E-SMLC	Enhanced Serving Mobile Location Center
ESRD	Emergency Services Routing Digits
ESRK	Emergency Services Routing Key
ESRP	Emergency Services Routing Proxy
GMLC	Gateway Mobile Location Center
GPRS	General Packet Radio Service
GTT	Global Text Telephony
HELD	HTTP-Enabled Location Delivery
HSPA	High Speed Packet Access
HSS	Home Subscriber Server
IAM	Initial Address Message
IBCF	Interconnecting Border Control Function
IMEI	International Mobile Equipment Identity
IMS	IP Multimedia Subsystem
IMSI	International Mobile Subscriber Identity
IP	Internet Protocol
ISUP	Integrated Services for Digital Network User Part
LByR	Location By Reference
LByV	Location By Value
LoST	Location-to-Service Translation
LPP	LTE Positioning Protocol
LRF	Location Retrieval Function
LS	Location Server
LTE	Long Term Evolution
MGCF	Media Gateway Control Function
MLP	Mobile Location Protocol
MME	Mobility Management Entity
MMS	Multimedia Messaging Service
MNO	Mobile Network Operator
MSISDN	Mobile Subscriber ISDN Number
NAT	Network Address Translator
NENA	National Emergency Number Association
NNI	Network-to-Network Interface
OTT	Over The Top
PCN	Packet Core Network
P-CSCF	Proxy Call Session Control Function
PDN	Packet Data Network
PDP	Packet Data Protocol

PSAP	Public Safety Answering Point
PSTN	Public Switched Telephone Network
RDF	Routing Determination Function
S-CSCF	Serving Call Session Control Function
SGSN	Serving GPRS Support Node
SIP	Session Initiation Protocol
SLA	Service Level Agreement
SLP	SUPL Location Platform
SMS	Short Message Service
SP	Service Provider
SR	Selective Router
SUPL	Secure User Plane Location
ToIP	Text over IP
UE	User Equipment
UNI	User Network Interface
URI	Uniform Resource Identifier
URL	Uniform Resource Locator
USIM	Universal Subscriber Identity Module
VPN	Virtual Private Network
VSP	Voice Service Provider
WebRTC	Web Real-Time Communication

5 Introduction

The FCC has raised questions to the telecommunications industry in public and Communications Security, Reliability and Interoperability Council (CSRIC) proceedings regarding the provision of Automatic Location Information (ALI) for interconnected VoIP and Over The Top (OTT) applications of VoIP for emergency calls.

The purpose of this standard is to support location and routing for non-operator-managed emergency services. The distinction between the access network operator and an OTT Service Provider (OTT SP) is key to this standard. In this standard, the term "non-operator-managed emergency service" is used to describe the emergency service capabilities of the OTT SP. Identified methods are evaluated for technical feasibility, efficiency, security aspects, and location privacy considerations. This standard considers detailed location only for emergency service use. Consideration of overall end-to-end session support may be employed to verify suitable operation of location acquisition and conveyance (e.g., to support PSAP emergency location update requests through the OTT application provider and assist routing to the PSAP).

Figure 5.1 shows the overall architecture considered in this standard. It is composed of the common elements of the access network provider, in addition to a new OTT service provider that needs the user's location.
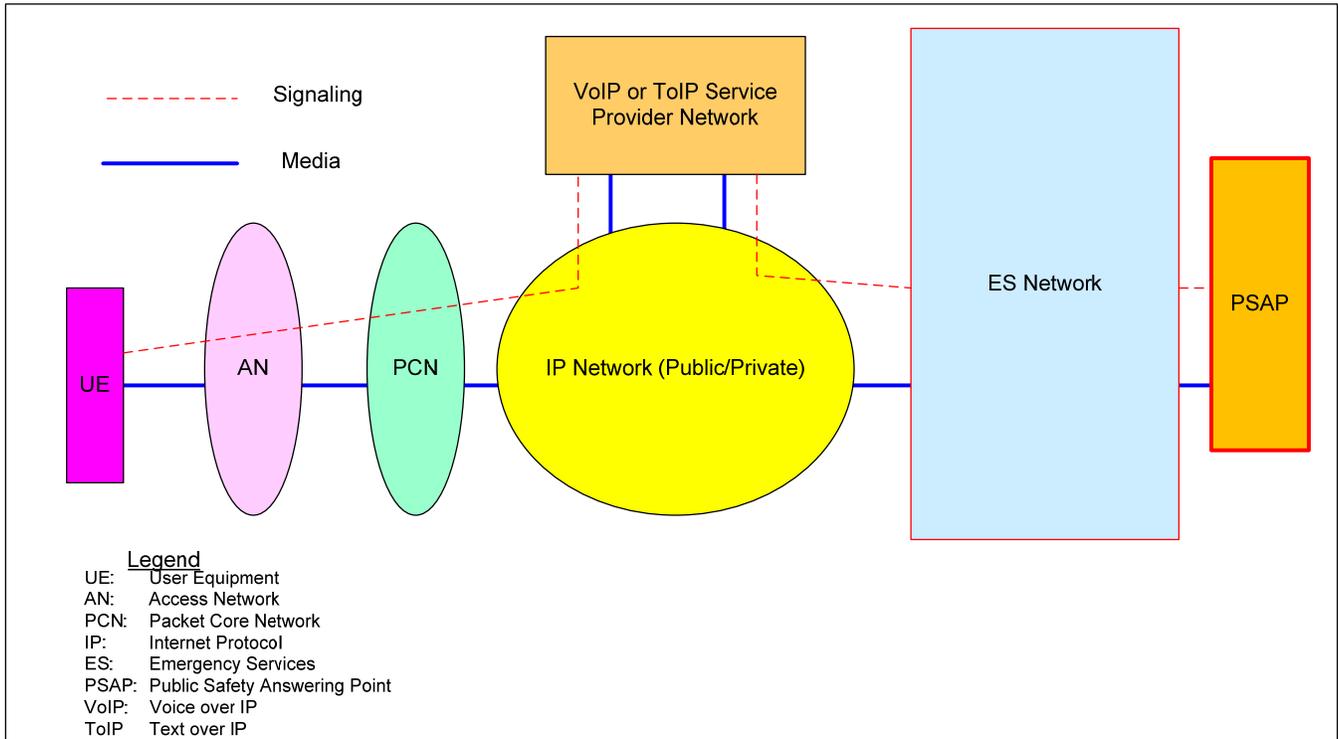
Figure 5.1 – Overall Architecture

6 Assumptions

The following assumptions are used to develop methods for location and routing support for OTT.

6.1 UE/User

The following assumptions are for the User Equipment (UE)/user:

1. The user of the UE is at least registered for voice services with the OTT SP.
2. The UE is minimally subscribed to data services with a home network operator.
3. The UE accesses the OTT SP using the access network operator.
4. The UE instigates an emergency services call with the OTT SP.
5. The UE is in the service area of the access network operator.

6.2 OTT SP

The following assumptions are for the OTT SP:

1. The OTT SP is reachable from the access network operator.
2. The OTT SP supports emergency services calls instigated by registered users.
3. When the OTT SP needs to utilize the access network operator for assistance with routing or location of the emergency services call, a business and trust relationship shall exist between the OTT SP and the access network operator.

6.3 Access Network Operator

The following assumptions are for the Access Network operator:

1. Initiation of an emergency services call to an OTT SP is transparent to the access network operator (e.g., does not utilize the emergency attach procedures defined in 3GPP).

7 Architecture & Stage 2 Call Flows

Figure 7.1 shows the various alternative solutions that have been proposed for transferring the location of a UE that has invoked an emergency service (e.g., emergency voice call, emergency text message session) to an OTT SP.
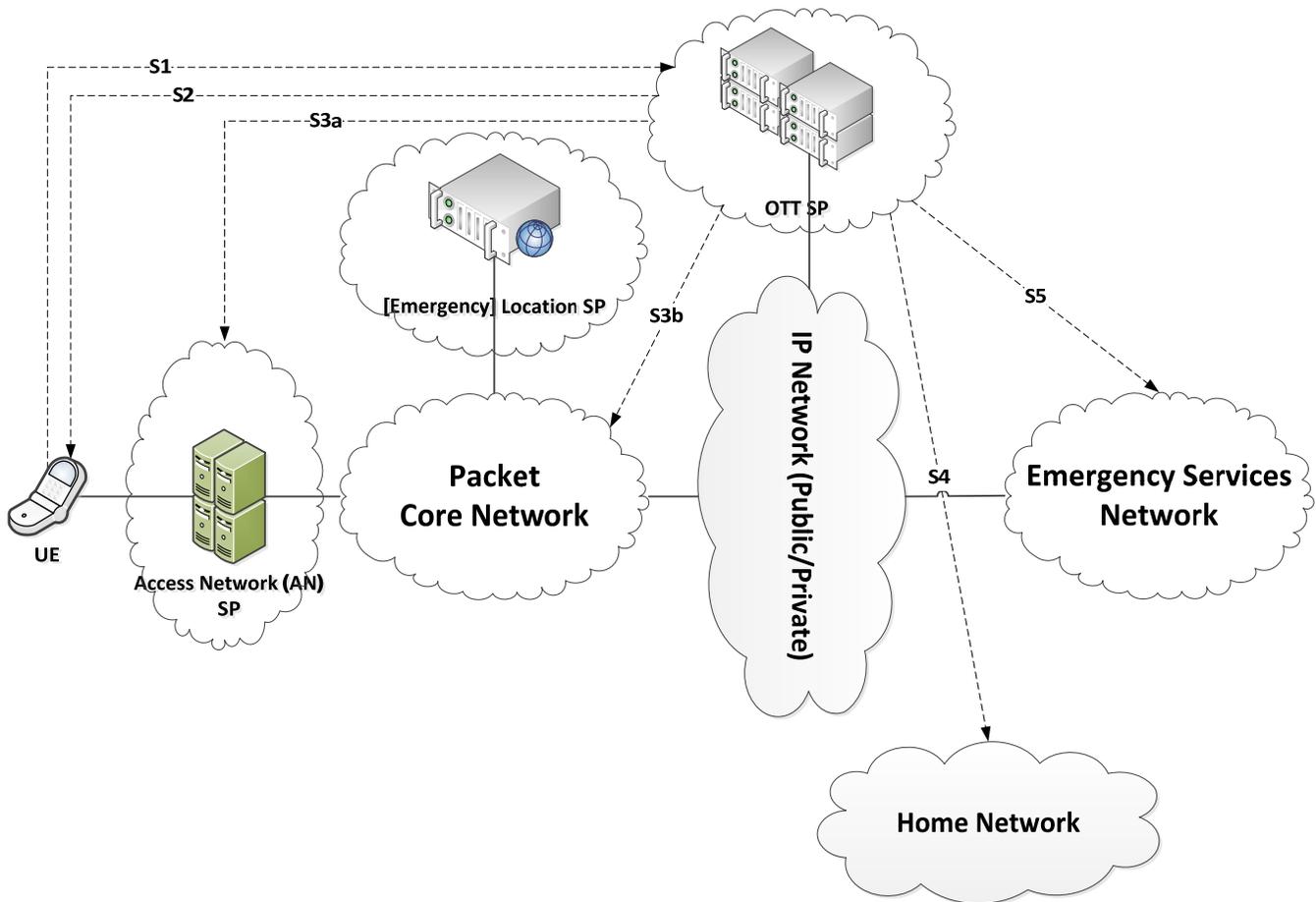
Figure 7.1 – Architecture for Emergency Services over an OTT SP showing alternative location

Alternative Solution 1 (S1): The UE pushes a location suitable for routing (and possibly dispatch) to the OTT SP. The location (either Location By Value [LByV] (geographic, civic) or Location By Reference [LByR]) may be obtained from an emergency Location Server or may be determined solely by the UE in the case of LByV. In the by reference case, the OTT SP must perform dereferencing by requesting a location value from the server indicated in the location Uniform Resource Identifier (URI). The means of location transfer can include in service signaling (e.g., inclusion within a Session Initiation Protocol [SIP] INVITE) or out of service signaling where a separate data or signaling path is used.

Alternative S2: The OTT SP queries the UE for location. The query may use in service signaling (e.g., request via a SIP INFO message) or out of service signaling (e.g., request via a separate data or signaling path). The UE should return the location using means analogous to the request – e.g., in call signaling if the request used in call signaling.

Alternative S3: The OTT SP queries a location server (or location service) in the Access Network (AN) (S3a), or in the Packet Core Network (PCN) (S3b). The OTT SP may determine the AN or PCN and location server using the UE IP address or an identifier for the AN or PCN provided by the UE. For example, in case of the IP address, known ranges of IP address or particular sub-fields in an IP address may be configured by the OTT SP (e.g., in a call server) and mapped to particular ANs and PCNs.

Note that the issue of location server discovery and location retrieval using a client IP address is subject to a number of failure cases. In theory, the OTT SP can do a reverse Domain Name System (DNS) lookup on the client IP address to determine the domain owner, and then use any of a variety of techniques (such as a DNS SRV query) to locate the location server for that domain. Once the location server has been discovered, the OTT SP queries using the client IP address.

Alternative S4: The OTT SP queries a location server (or location service) in the Home Network (HN). The UE may be referenced using a global public identity (e.g., SIP URI, Mobile Subscriber ISDN Number [MSISDN]). The OTT SP may determine the HN and location server using the global public identity. The HN may know the general location of the UE (e.g., from information received from the PCN to support roaming) and/or can locate the UE directly – e.g., using Secure User Plane Location (SUPL).

Alternative S5: The ESInet/SR SP queries the OTT SP for a location needed for routing or dispatch, The OTT SP may provide a LByV (e.g., geographic location or civic address) or a LByR in which case the ESInet/SR SP would need to query a location server in the AN or PCN. The UE can be referenced using a global identity or by a local reference assigned by the OTT SP. Alternative S5 may be used in combination with one of the other alternatives to enable the OTT SP to obtain the UE location.

Details for this alternative are out of scope of this standard.

7.1 Alternatives S1 & S2 Discussion

To facilitate discussion of various alternatives of S1, three sub-variants are identified and labeled as S1a, S1b, and S1c. When only "S1" is used, it refers to alternative S1 in general (all variants of S1).

- Sub-alternative S1a: The UE includes the location information in the Geolocation header field of the SIP INVITE, as described in RFC 6443 [Ref 3] and RFC 6881 [Ref 4].
- Sub-alternative S1b: The UE sends location information to the OTT SP using SMS before initiating the emergency call or during the call.
- Sub-alternative S1c: The UE sends location information to the OTT SP using a separate data connection (such as HTTP) to the OTT SP before initiating the call or during the call.

In alternative S1, the UE provides the OTT SP with a LByV or LByR. In the case of LbyR, the OTT SP must perform dereferencing of the LbyR by querying the server as indicated in the location reference (this will typically be an emergency Location Server in the serving Mobile Network Operator [MNO]) to obtain the UE location. The means of location transfer from the UE to the OTT SP can include in service signaling (e.g., inclusion within a SIP INVITE) or out of service signaling where a separate data or signaling path is used.

In alternative S2, the OTT SP queries the UE for location information. The query may use in service signaling (e.g., request via a response to the SIP INVITE or via a SIP INFO request) or out of service signaling (e.g., request via a separate data or signaling path). The UE should return the requested location information using means analogous to the request – e.g., in call signaling if the request used in call signaling. The location information that is returned can be the same as for alternative S1 – e.g., either a LByV or LbyR. When the UE returns a location reference, the OTT SP must perform dereferencing on the provided location reference to obtain the location value, as described above for S1.

Alternatives S1 and S2 can be considered as complimentary to one another and could both be supported. For example, alternative S1 can be used when a UE detects that a user is invoking an emergency call and has time to

obtain location information prior to sending an emergency call request to the OTT SP; alternative S2 can be used when the UE does not detect that a user is invoking an emergency call or does not have enough time to obtain location information prior to sending an emergency service request to the OTT SP. Both S1 and S2 may be used in the same session. For example, using alternative S1, a UE may provide whatever location value it currently has in the initial SIP INVITE and may also indicate support for an in-call request and response mechanism. During the call, the OTT SP may use this mechanism to request location information. The UE would then respond with updated location.

The emergency Location Server for alternatives S1 and S2 could be an Location Retrieval Function (LRF) since this already supports an external interface for location dereferencing and could have access to location determination capability inside a serving MNO using a control plane solution and/or user plane solution.

7.1.1 High Level Analysis of Alternatives S1 & S2

Following is a high level analysis of Alternatives S1 and S2. Detailed analysis is included later.

Pros

1. In the case of LbyR and where the address of the associated location server can be validated (e.g., belongs to a known operator domain), the resulting location may be trusted because of provision by a trusted source.
2. Location can be used for routing to the correct PSAP and may also be usable for dispatch.
3. For S2, updated location and more accurate initial location can be supported.
4. For S1, location can be available when an emergency call request is first received by an OTT SP.
5. For S1, there may be little or no impact to the serving MNO.
6. S1 and S2 are potentially available for other applications – e.g., OTT voice service application.

Cons

1. LByV may not be trusted and may not always be available.
2. Serving MNO may be impacted for LByR.
3. There may be user privacy issues (particularly for LbyV) – e.g., that may block location provision.

7.2 Alternatives S3, S3a, & S3b Discussion

In S3, the OTT SP has direct access to the location server. In S3a and S3b the location server is managed within the Commercial Mobile Radio Service (CMRS) carrier network. It is either the AN or the PCN that can access the location server to obtain the UE location. For S3a and S3b, the OTT SP must know the underlying CMRS carrier in order to query for location. The OTT service provider may determine the AN or the PCN using the UE IP address; particular sub-fields in the IP address may be configured by the OTT service provider or other parameters to be used to map to a particular AN or PCN.

For S3, when the UE initiates an emergency request, the request is forwarded to the OTT SP through the PCN. Once the location server has been discovered, the OTT SP queries it directly using the client IP address to obtain the UE location. For S3a and S3b, when the UE initiates an emergency request, it is forwarded to the OTT SP through the Packet Core Network. The OTT SP then queries the CMRS network (either the AN or PCN) for location. The OTT SP may query with MSISDN or the UE IP address. The AN or PCN then interrogates the location server for the UE location.

7.2.1 High Level Analysis of Alternatives S3, S3a, & S3b

Following is a high level analysis of Alternatives S3, S3a, and S3b. Detailed analysis is included later.

Pros

1. The location should be the same location as used by the CMRS carrier for emergency services.
2. This method may use the procedures already specified in 3GPP TS 23.271 [Ref 5].

Cons

1. There is a dependence upon a business relationship between the OTT SP and the CMRS carrier.
2. All techniques that rely on the OTT provider knowing the IP address of the UE as assigned by the AN will fail when Network Address Translators (NATs), Virtual Private Networks (VPNs), or other technologies are in use. When the OTT provider does know the UE's IP address as assigned by the AN, determining the AN will be less reliable for smaller ANs that do not receive IP allocations directly from a regional registry, especially when it depends on correct provisioning of the DNS reverse zone. For larger ANs that receive IP address allocations directly from regional registries, the OTT provider can access the regional registry to obtain the AN identification.
3. The real time identification of CMRS carrier (AN or PCN) needs further study.

7.3 Solution Alternatives S1 & S2

7.3.1 Summary

In alternative S1, the UE provides the OTT SP with a LByV or LByR. In the case of LbyR, the OTT SP must perform dereferencing of the LbyR by querying an Emergency Location Server (ELS) in the serving MNO using the LbyR to obtain the UE location. The means of location transfer from the UE to the OTT SP can include in service signaling (e.g., inclusion within a SIP INVITE) or out of service signaling where a separate data or signaling path is used.

In alternative S2, the OTT SP queries the UE for location information. The query may use in service signaling (e.g., request via a SIP INFO message) or out of service signaling (e.g., request via a separate data or signaling path). The UE should return the requested location information using a means analogous to the request – e.g., in call signaling if the request used in call signaling. The location information that is returned can be the same as for alternative S1 – e.g., either a LByV or LbyR.

Alternatives S1 and S2 can be considered as complimentary to one another and could both be supported. For example, alternative S1 can be used when a UE detects that a user is invoking an emergency call and has time to obtain location information prior to sending an emergency call request to the OTT SP; alternative S2 can be used when the UE does not detect that a user is invoking an emergency call or does not have enough time to obtain location information prior to sending an emergency service request to the OTT SP.

The ELS for alternatives S1 and S2 could be an LRF since this already supports an external interface for location dereferencing and could have access to location determination capability inside a serving MNO using a control plane solution and/or user plane solution.

In order to solve a number of problems described further down here, alternatives S1 and S2 are extended further here to allow a UE to provide additional location related information to an OTT SP and not just LbyV or LByR. In addition, while the UE remains the source of all initial location information to the OTT SP, the OTT SP is allowed to receive additional location related information and/or other assistance from the serving MNO as well. The end result is to make alternatives S1 and S2 more generic and more capable than was earlier proposed.

7.3.2 Limitations on Supporting Location & Routing

This subclause describes several limitations that may need to be overcome by a serving MNO when helping an OTT SP to support location and routing on behalf of an emergency call that was initially sent by a UE to the OTT SP.

7.3.2.1 Limitations Related to Legacy PSAPs

Limitations associated with supporting location and routing for an emergency call that needs to be sent to a legacy PSAP, where the legacy PSAP is not supported by an ESInet, include the following.

Limitation L1   A legacy PSAP may not be able to retrieve location from an OTT SP using the ANSI J-STD-036 E2 interface (e.g., if the OTT SP is in a foreign country or if the PSAP does not have an E2 interface relationship with the OTT SP).

Limitation L2   It may not be possible to send a LbyV to a legacy PSAP as part of call signaling (e.g., if the emergency call is routed through an SR that uses an MF trunk to reach the PSAP).

Limitation L3   A legacy PSAP will not normally support dereferencing of a LbyR.

These limitations mean that without additional enhancement, alternatives S1 and S2, or any solution based only on provision of a LbyV or LbyR to an OTT SP, may not support provision of a dispatchable location to a legacy PSAP if the legacy PSAP is not supported by an ESInet.

7.3.2.2 Limitations Related to Control Plane Location in a Serving MNO

With the 3GPP control plane location solution for LTE or High Speed Packet Access (HSPA) access, the identity of the current serving Mobility Management Entity (MME) or Serving GPRS Support Node (SGSN) for a target UE needs to be known at an LRF or Gateway Mobile Location Center (GMLC) in order to route a request for the UE's location to the correct serving MME or SGSN. For emergency calls that are established by a serving MNO without involvement of an OTT SP (as described in ATIS-0700015 [Ref 1]), this information is kept updated in the LRF and GMLC by the serving MME or serving SGSN when a UE establishes an emergency Packet Data Network (PDN) connection or emergency Packet Data Protocol (PDP) context and by the new or previous MME or SGSN when handover occurs. However, for an emergency call for a UE that is established through an OTT SP, the serving MNO will not be aware of the emergency call and thus the LRF (and GMLC) will not be kept updated with the identity of the serving MME or serving SGSN for the UE. Without this information, a GMLC will not be able to route a location request to the correct serving MME or serving SGSN. This means that when servicing a location dereferencing request from an OTT SP, an ELS (e.g., LRF) may not be able to use the control plane solution to obtain the UE location – except possibly in the case of a home subscriber when the ELS has sufficient information to query this information from the HSS.

7.3.2.3 Limitations Related to User Plane Location in a Serving MNO

When a UE accesses an OTT SP via a VPN that is intermediate between the serving MNO and OTT SP, the IP address of the UE that is seen by the OTT SP may have been assigned by the VPN and may thus differ from any IP address assigned to the UE by the serving MNO. If an Emergency SUPL Location Platform (E-SLP) in the serving MNO only accepts incoming location requests on behalf of UEs with IP addresses known to or assigned by the serving MNO, this could prevent use of SUPL location by the serving MNO if the VPN-assigned IP address is included in a location request sent to the serving MNO by the OTT SP. A similar limitation may occur for a roaming UE whose IP address is assigned by the home MNO (e.g., where the PDN Gateway for LTE access is in the home MNO). However, in this case, a serving MNO (e.g., E-SLP) could be configured with the IP addresses (e.g., address ranges) assigned by roaming partners in which case use of user plane (e.g., SUPL) location could still be possible.

7.3.2.4 Limitations Related to Routing of an Emergency Call to an Emergency Services Network

While an OTT SP may be able to route an emergency call to an Emergency Services Network (e.g., via the Internet) if the correct address for the Emergency Services Network is known (e.g., a SIP URL), some OTT SPs may lack the ability to convert a geographic location for a UE to an Emergency Services Network address – e.g., if in a different country to the UE and without an ability to obtain routing information using Location-to-Service Translation (LoST). In some cases, even if the Emergency Services Network address is known, it may not be possible to reach the Emergency Services Network due to restrictions on ingress at the Emergency Services Network side.

7.3.3 Alternatives S1 & S2 with Enhanced LbyR Support

With normal LbyR support, shown in Figure 7.2 for alternative S1, the UE sends an emergency call request to the OTT SP containing a LbyR. The OTT SP then dereferences the LbyR by sending a location query to an ELS (e.g., an LRF in the serving MNO) indicated by the LbyR. The ELS (shown as an LRF in Figure 7.2) obtains a location for the UE and returns the location and/or routing information to the OTT SP. The OTT SP then routes the emergency call to a Gateway to an Emergency Services Network (for a legacy PSAP) or to a NENA i3-capable PSAP based on the routing information or the location and containing the originally received LByR. The PSAP may then query the ELS (e.g., LRF) at a later time for a dispatchable location using the received LByR. As discussed in subclause 7.3.2.1 (e.g., limitation L3), such a query may not be possible for a legacy PSAP unless the PSAP is supported by an ESInet.
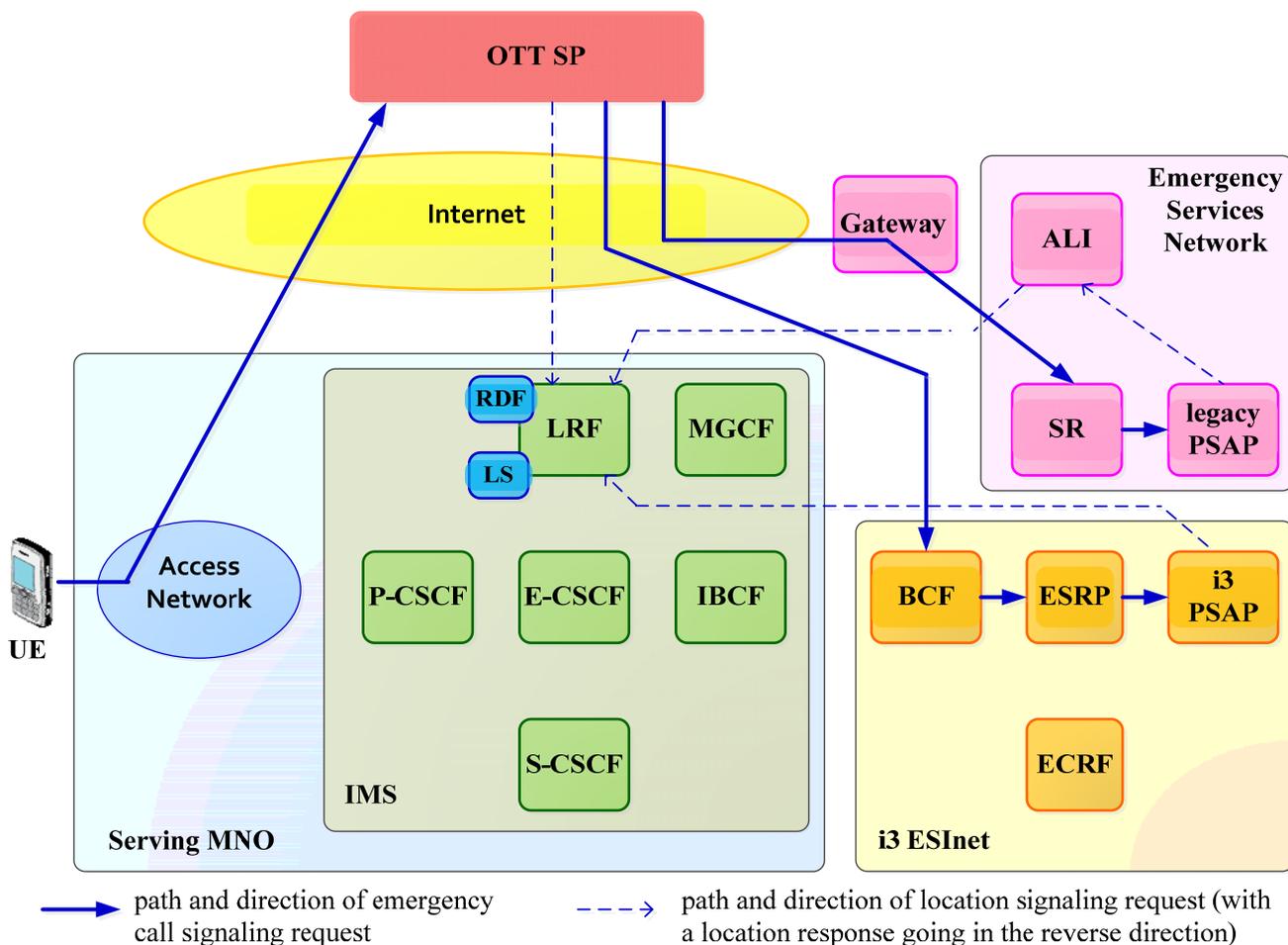
Figure 7.2 – Architecture for LbyR Support for Emergency Services over an OTT SP

The basic LbyR solution just described can be enhanced for alternatives S1 and S2 to overcome the limitations described in subclauses 7.3.2.2 and 7.3.2.3. Specifically, a location URI that is assigned by the serving MNO as a LbyR can be formatted to contain the following information:

a) Local UE IP address if the MNO will use user plane location and if a local IP address was assigned.

b) Local identity of a serving MME or serving SGSN if the MNO will use control plane location.

c) UE identity if the serving MNO will use control plane location (e.g., MSISDN, International Mobile Subscriber Identity [IMSI] or a local ID assigned by a serving MME or SGSN).

The above information can be included as the part of the LByR normally used as a local reference for the UE and would allow LbyR assignment by the AN or PCN in the serving MNO rather than by the ELS which may simplify implementation. The formatting of this information can be specific to the serving MNO (i.e., need not be standardized). An ELS (e.g., an LRF) in the serving MNO that receives such a location URI in a dereferencing request for a LbyR from an OTT SP and knows the formatting can extract the information and use it to invoke either control plane or user plane location of the UE. An added benefit is that the ELS does not need to maintain state information for the call or for the UE and can respond to each dereferencing request based solely on the information included in each new request.

The above enhancement is referred to as "S1 with enhanced LbyR" in the case of alternative S1 and "S2 with enhanced LbyR" in the case of alternative S2. These enhanced variants of solutions S1 and S2 solve the limitations described in subclauses 7.3.2.2 and 7.3.2.3 but are not perfect. For example, even though the LbyR may contain the identity of the current serving MME or SGSN for a UE, the information becomes out of date as soon as the UE is handed off to a new serving MME or SGSN unless the UE sends new information (e.g., a new LbyR) to the OTT SP (e.g., in a SIP INFO) which then forwards this, as applicable, to the NENA i3-capable PSAP or to the Gateway to an Emergency Services Network for a legacy PSAP.

7.3.4 Alternatives S1 & S2 with Enhanced IMS Support

Enhanced IMS support is a more radical solution that may be capable of overcoming all the limitations listed in subclause 7.3.2. With enhanced IMS support, the serving MNO can offer support as either an LRF or Emergency Call Session Control Function (E-CSCF). The solutions described here are hybrid solutions that rely on UE-provided information according to the principles for solutions S1 and S2, but also make use of OTT SP interaction with the CMRS PCN according to the principles for alternative S3b.

7.3.4.1 Alternatives S1 & S2 with IMS LRF Support

With IMS LRF support, shown in Figure 7.3 for alternative S1, the OTT SP receives an address of an LRF in the serving MNO from the UE (which the UE may obtain from the serving MNO AN or PCN – e.g., on network attachment). The OTT SP then behaves similarly to an E-CSCF and forwards the emergency call request in the form of a SIP INVITE to the LRF which obtains location and routing information similarly to that described for an LRF in ATIS-0700015 [Ref 1] for the Ml interface. The LRF then returns the location and routing information to the OTT SP in the form of a SIP 300 Multiple Choices (as occurs on the Ml interface in ATIS-0700015 [Ref 1]). The OTT SP then routes the emergency call to the PSAP (either a legacy PSAP or a NENA i3-capable PSAP) using the routing information and containing the location information. The location information may contain a LbyV, LbyR, Emergency Services Routing Key (ESRK), or Emergency Services Routing Digits (ESRD)+MSISDN and can correspond to the reference identifier in ATIS-0700015 [Ref 1]. For the last 3 alternatives, the PSAP would typically query the LRF at a later time for a dispatchable location using the Le interface. Figure 7.3 shows the path and direction of the initial emergency call request message (e.g., a SIP INVITE) from the UE to the OTT SP, the path to the LRF and back to the OTT SP (for the SIP 300 Multiple Choices) and the path and direction from the OTT SP to the PSAP. The Internet may be used to convey the initial call request between the serving MNO and the OTT SP and from the OTT SP to the ESInet, whereas a Gateway may be used to convey a CS call request from the OTT SP to an SR to reach a legacy PSAP. Figure 7.3 also shows the path and direction for a location request for the UE sent by a legacy PSAP or NENA i3 PSAP to the LRF.
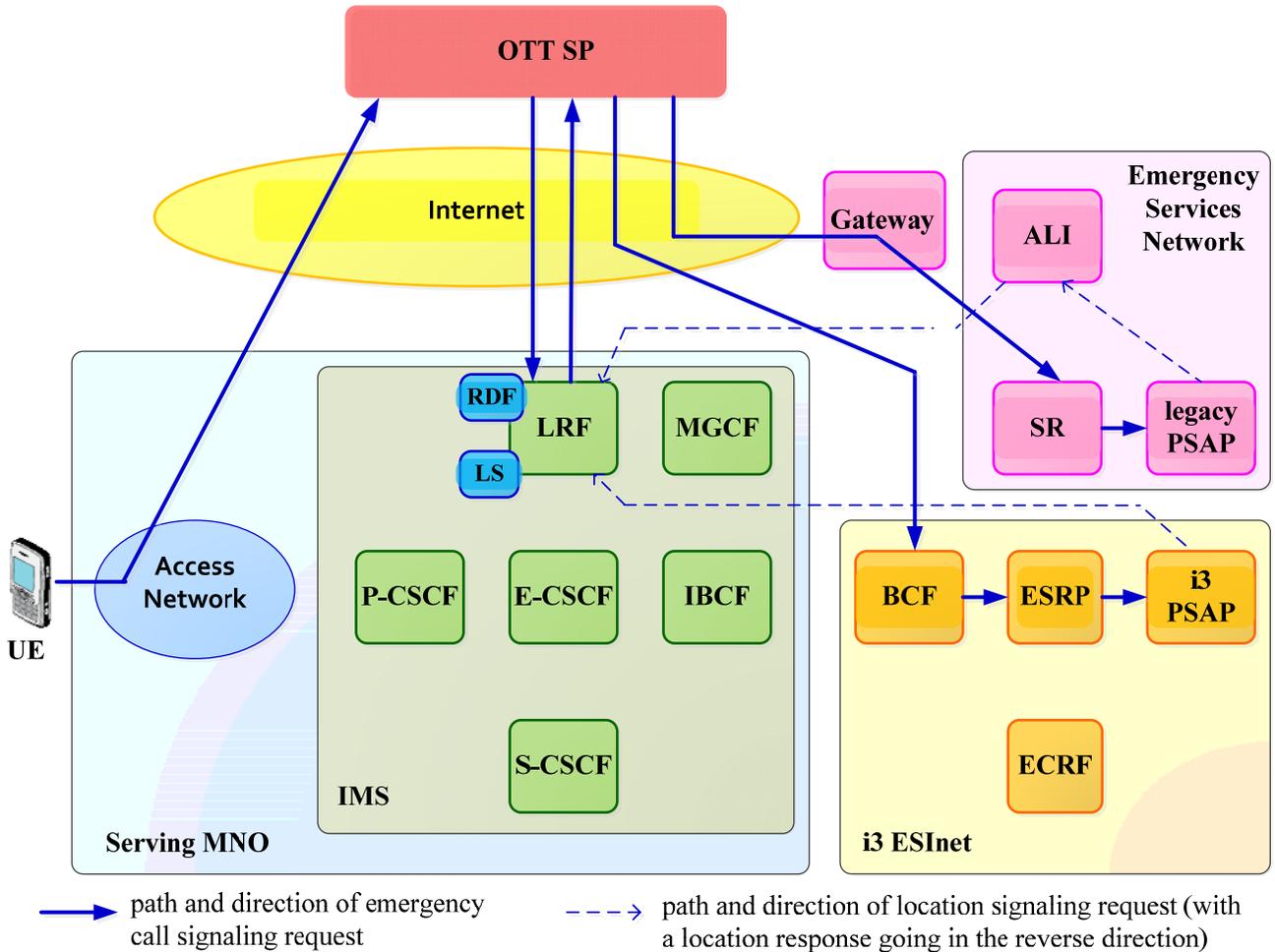
Figure 7.3 – Architecture for IMS LRF Support for Emergency Services over an OTT SP

7.3.4.2 Alternatives S1 & S2 with IMS E-CSCF Support

With IMS E-CSCF support, shown in Figure 7.4 for alternative S1, the OTT SP receives an address of an E-CSCF in the serving MNO from the UE (which the UE may obtain from the serving MNO AN or PCN – e.g., on network attachment). The OTT SP then behaves similarly to a P-CSCF and forwards the emergency services request using a standard SIP INVITE to the E-CSCF which then forwards the call to a PSAP, using an LRF to obtain any routing and location information needed to perform the forwarding. This variant may improve the likelihood of a successful call (or service) transfer to a PSAP at the cost of greater involvement by the serving MNO. Similarly to Figure 7.3, Figure 7.4 shows the path and direction of the initial emergency call request message (e.g., a SIP INVITE) from the UE to the OTT SP, the path to the E-CSCF, and the path and direction to the PSAP, with location and routing assistance provided to the E-CSCF by an LRF as for the solution in ATIS-0700015 [Ref 1]. Figure 7.4 also shows the path and direction for a location request for the UE sent by a legacy PSAP or NENA i3 PSAP to the LRF.
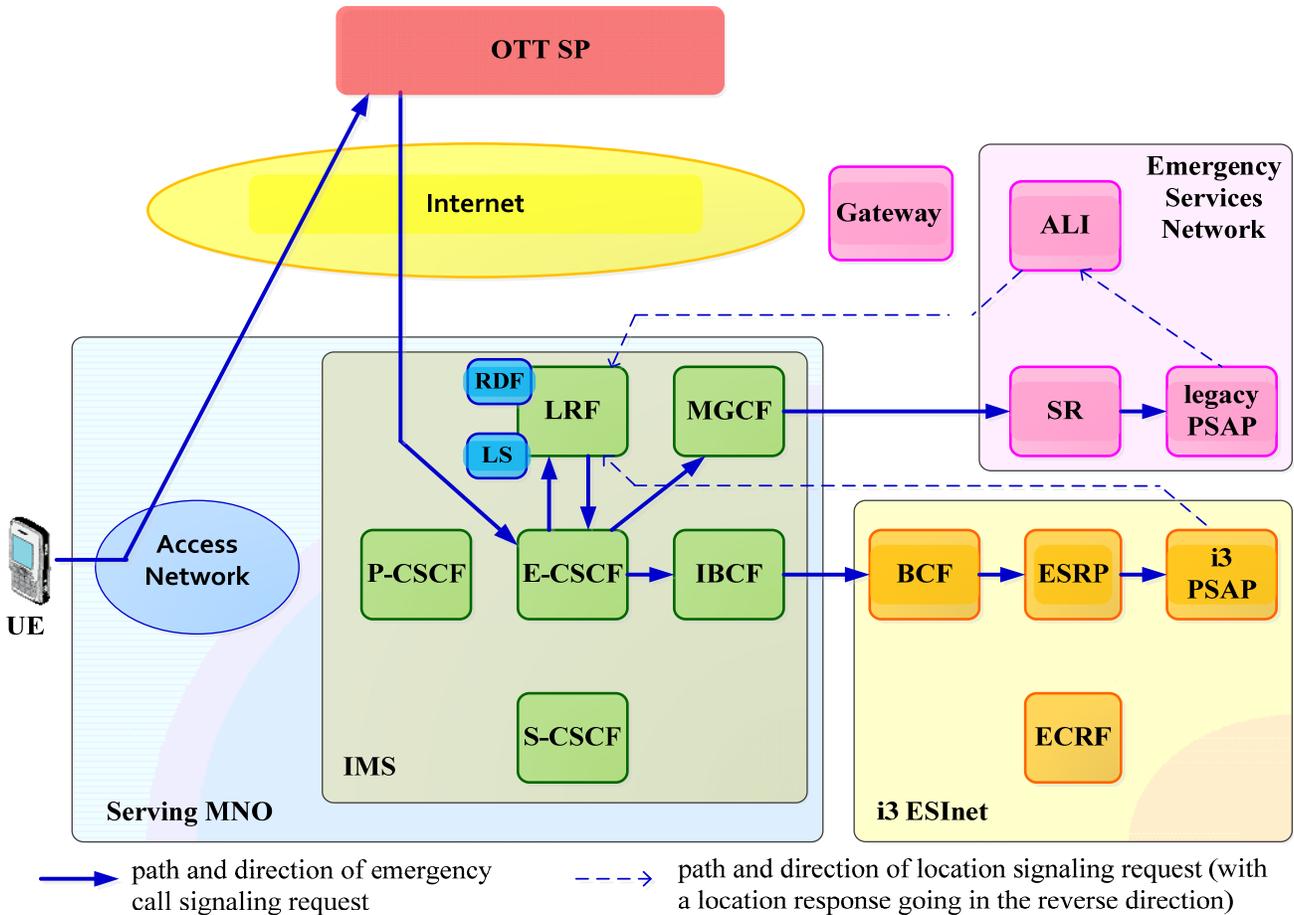
Figure 7.4 – Architecture for IMS E-CSCF Support for Emergency Services over an OTT SP

7.3.4.3 Evaluation of Alternatives S1 & S2 with Enhanced IMS Support

Alternatives S1 and S2 with IMS LRF support and IMS E-CSCF support would each require some changes to an LRF and RDF, and to an E-CSCF for IMS E-CSCF support, in comparison to the solution in ATIS-0700015 [Ref 1] but could also reuse existing functionality from ATIS-0700015 [Ref 1].

For each solution, the UE would provide the OTT SP with certain information to (i) enable routing to the correct entity in the serving MNO (either an LRF or E-CSCF) and (ii) provide to this entity to assist in obtaining the UE location and to support routing. Some of this information can come from what is normally known to the UE whereas other information may have to be provided to the UE by the AN or PCN in the serving MNO – e.g., at UE attachment, on handover to a new MME or SGSN and whenever a tracking area or routing area update occurs to a new MME or SGSN. The information is shown in the table below along with the likely source of each item of information, applicability to User Plane (UP) or Control Plane (CP) location and possible SIP headers that could be used to transfer each item to the OTT SP (and thence to the serving MNO) when SIP is used between the UE and OTT SP.

Table 7.1 – Information sent by a UE to an OTT SP when a serving MNO provides IMS support for an OTT SP emergency call

Information Item	Source	CP or UP applicability	Possible SIP Header
Local UE IP address	UE or MNO	UP	Contact Header
Global UE Address	UE or MNO	Both	From Header

Information Item	Source	CP or UP applicability	Possible SIP Header
LRF or E-CSCF address	MNO	Both	Route Header
Serving MME/SGSN ID	MNO	CP	Contact Header
Local UE reference in serving MME or SGSN	MNO	CP	Contact Header

The LRF or E-CSCF in the serving MNO will need to maintain state information after receiving the initial INVITE from the OTT SP to maintain the call in the case of IMS E-CSCF support or to respond to any subsequent location request from the PSAP or an ESInet in the case of IMS LRF support. In the case of IMS LRF support, this means knowing when the call has ended. In addition, since the serving MME or SGSN may change, the E-CSCF or LRF will need to know the new serving MME or SGSN address (or ID) when control plane location is used. For IMS LRF support, these objectives can be achieved if the LRF separately subscribes to event notification from the OTT SP for call termination and, when control plane location is used, for change of serving MME or SGSN. For IMS E-CSCF support, notification of a change in serving MME or SGSN address would be possible with a SIP INFO update from the OTT SP. The UE can keep the OTT SP updated with any new serving MME or SGSN identity using a SIP INFO (when the OTT SP uses SIP) or some proprietary OTT SP message.

Both IMS solutions can use the same information shown in **Error! Reference source not found.** except that the address in the serving MNO provided to the OTT SP by the UE would be an LRF address for IMS LRF support and an E-CSCF address for IMS E-CSCF support. This combined with common signaling can allow both IMS solutions to be supported as part of a single common solution by the UE and by the OTT SP which could allow a serving MNO to decide which of the two IMS solutions to use and could enable migration from one IMS solution to the other without affecting support by UEs and OTT SPs.

7.3.5 Call Flow for Alternative S1 with Enhanced LbyR Support

Figure 7.5 shows a call flow for emergency call establishment using Alternative S1 with enhanced LbyR support. A call flow for Alternative S2 would be almost the same except that the emergency call request at step 3 would not carry a LbyR and the OTT SP would need to query the UE for the LbyR following step 3 and before step 4.
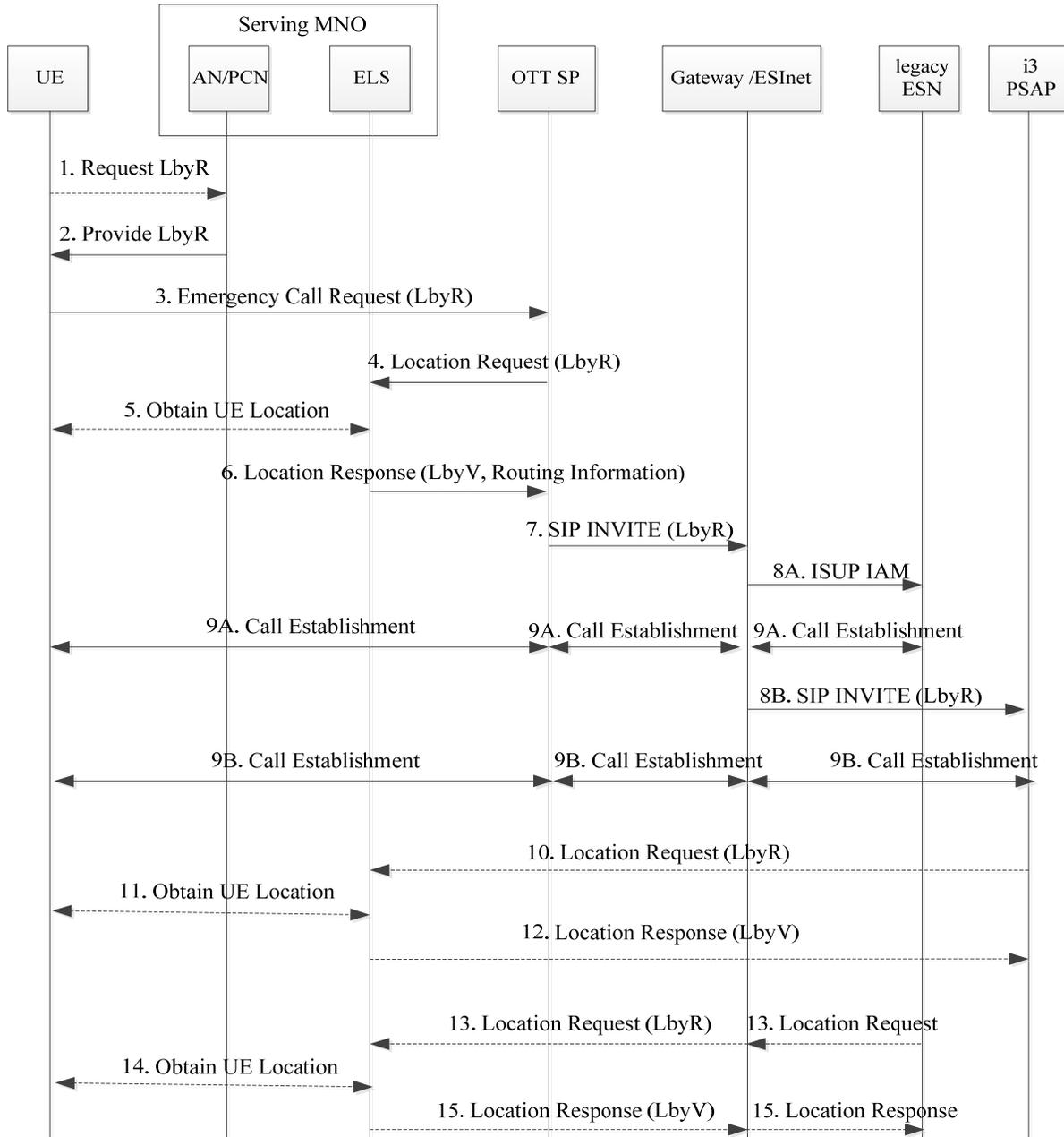
Figure 7.5 – Call Flow for Alternative S1 with enhanced LbyR support

Step 1. The UE may optionally request a LbyR from the serving AN or PCN. For example, this may occur when the UE detects that the user is instigating an emergency call.

Step 2. In response to step 1, or when certain conditions occur (e.g., UE attaches to the AN/PCN, performs a tracking or routing area update to a new MME or SGSN or handover occurs to a new MME or SGSN), the AN or PCN sends a LbyR or an updated LbyR to the UE. The LbyR may be determined by the AN or PCN or obtained from an ELS (e.g., an LRF) which is not shown in Figure 7.5.

Step 3. The UE sends an emergency call request to the OTT SP and includes the LbyR obtained in step 2. The emergency call request may be a SIP INVITE or may be a message for some other protocol specific to the OTT SP.

Step 4. The OTT SP dereferences the LbyR by sending a location request to the ELS URL (e.g., an LRF URL) indicated in the LbyR and includes the LbyR in the request and an indication that this is for an emergency call.

Step 5. The ELS uses the information included in the LbyR (e.g., a local or global UE identity and a serving MME/SGSN ID for control plane location or a local UE IP address for user plane location) to obtain the current location of the UE.

Step 6. The ELS returns the current UE location to the OTT SP and/or returns routing information determined from the UE location.

Step 7. If a UE location only was returned in step 6, the OTT SP determines an intermediate destination using the UE location (e.g., using a LoST query). Otherwise, the OTT SP may use any routing information returned in step 6 to identify an intermediate destination.[6] When the final destination is a legacy PSAP, the intermediate destination corresponds to a Gateway into a legacy ESN. When the final destination is an i3-capable PSAP, the intermediate destination corresponds to an ESInet. In some cases, the intermediate destination may be a Gateway associated with an ESInet capable of routing to either a legacy ESN or to an i3-capable PSAP. The type of intermediate destination is not visible to the OTT SP. The OTT SP forwards the emergency call to the intermediate destination by sending a SIP INVITE containing information for the UE received in step 3 including the LbyR. The intermediate destination may query the ELS in the serving MNO for the location of the UE using steps similar to steps 4-6 (not shown in Figure 7.5) and use the UE location to determine the destination PSAP.

Step 8A. When the destination PSAP is a legacy PSAP, the intermediate destination (a Gateway) forwards the call without the LbyR to a legacy ESN for forwarding to the destination legacy PSAP.

Step 9A. The rest of call establishment occurs.

Step 8B. When the destination PSAP is an i3 PSAP, the intermediate destination (an ESInet) forwards the SIP INVITE containing the LbyR received at step 7 to the i3 PSAP.

Step 9B. The rest of call establishment occurs.

Step 10. When the destination PSAP is an i3 PSAP, the i3 PSAP may dereference the LbyR by sending a location request to the ELS URL indicated in the LbyR and includes the LbyR received in step 8B in the request.

Step 11. The ELS uses the information included in the LbyR (e.g., a local or global UE identity and a serving MME/SGSN ID for control plane location or a local UE IP address for user plane location) to obtain the current location of the UE.

Step 12. The ELS returns the current UE location to the i3 PSAP.

Step 13. When the destination PSAP is a legacy PSAP, the legacy PSAP may request the location of the UE by sending a location request via the legacy ESN to the Gateway intermediate destination. The Gateway then dereferences the LbyR received in step 7 by sending a location request to the ELS URL indicated in the LbyR and includes the LbyR in the request.

Step 14. The ELS uses the information included in the LbyR (e.g., a local or global UE identity and a serving MME/SGSN ID for control plane location or a local UE IP address for user plane location) to obtain the current location of the UE.

Step 15. The ELS returns the current UE location to the Gateway intermediate destination which returns the location to the legacy PSAP via the legacy ESN.

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[6] It is assumed that an OTT SP will never route directly to a PSAP (e.g., an i3 PSAP) and will always be constrained to route via a Gateway and legacy ESN or via an ESInet in order to enable security and flexibility of PSAP selection on the PSAP side.

7.3.6 Call Flow for Alternative S1 with Enhanced IMS LRF Support

Figure 7.6 shows a call flow for emergency call establishment using Alternative S1 with enhanced IMS LRF support. A call flow for Alternative S2 would be almost the same except that the emergency call request at step 3 would not include UE Data or MNO Data. Instead, the OTT SP would need to query the UE for this data following step 3 (e.g., by sending a SIP INFO containing the request to the UE and with the UE returning the requested data in a SIP 200 OK or in another SIP INFO). For Alternative S2, the OTT SP may also need to query the UE for the updated MNO data that the UE sends at step 13. However, this request could instead be implicitly or explicitly combined with the request for the initial UE Data and initial MNO Data sent to the UE following step 3.
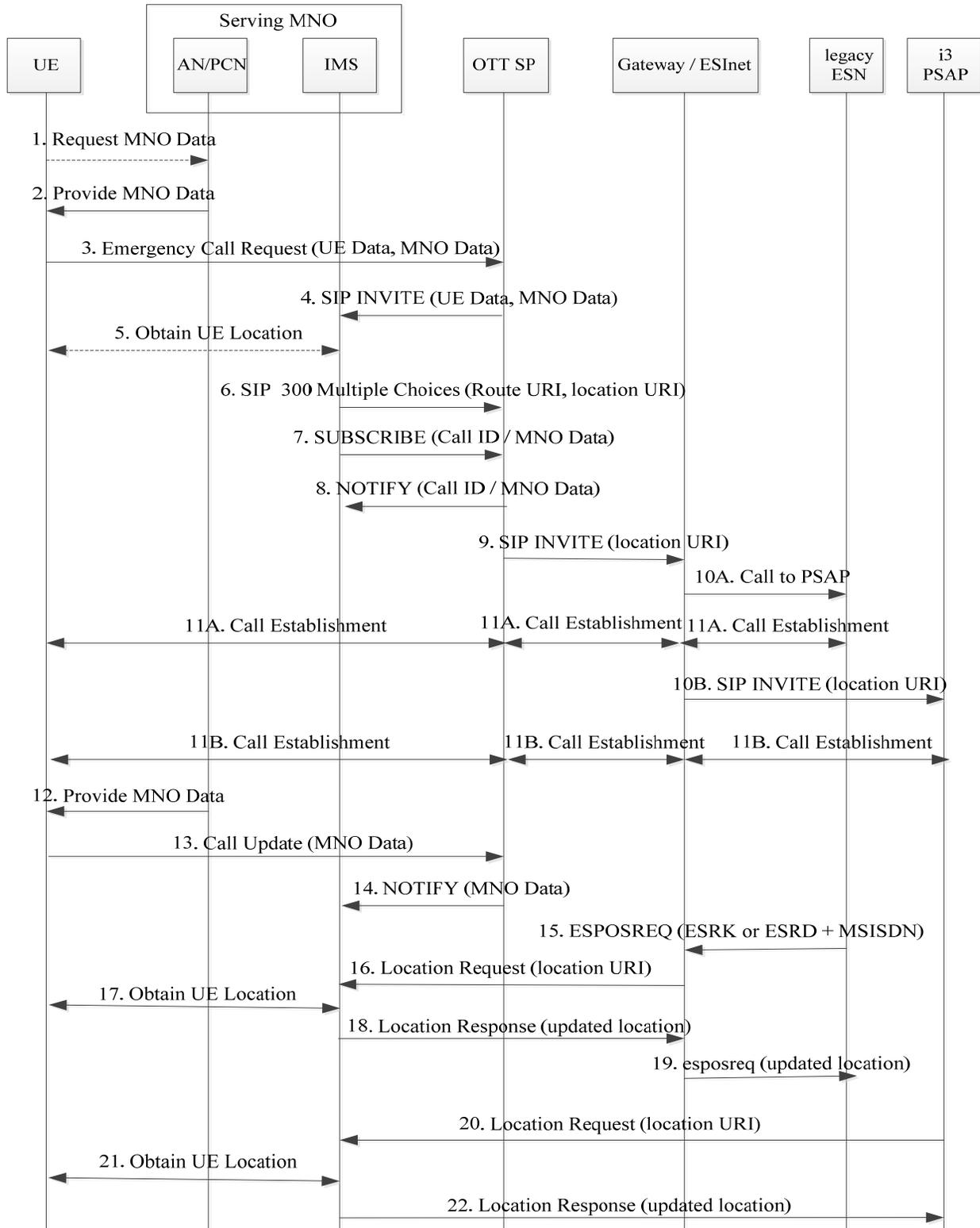
Figure 7.6 – Call Flow for Alternative S1 with enhanced IMS LRF support

Step 1. The UE may request data from the AN or PCN in the serving MNO to support an emergency call using an OTT SP. For example, this may occur when the UE detects that the user is instigating an emergency call. Step 1 is optional and may not always occur.

Step 2. In response to step 1, or when certain conditions occur (e.g., UE attaches to the AN/PCN, performs a tracking area or routing area update to a new MME or SGSN, or handover occurs to a new MME or SGSN), the AN or PCN sends MNO data to the UE. The MNO data includes (i) an IMS address in the serving MNO (in this case the address of an LRF), (ii) if control plane location may be used, an identity for a serving MME or SGSN, (iii) if user plane location may be used, an MNO assigned IP address for the UE, and (iv) either a global UE identity (e.g., IMSI or MSISDN) or a local identity for the UE assigned by the serving MME or SGSN.

Step 3. The UE sends an emergency call request to the OTT SP and includes the MNO Data obtained in step 2 and possibly additional UE data known to the UE. The UE data may include a global identity for the UE and possibly an MNO assigned IP address for the UE if not received in step 2. The emergency call request may be a SIP INVITE or may be a message for some other protocol specific to the OTT SP.

Step 4. Based on receipt of an IMS address as part of step 3 (e.g., an LRF address in the Route header of a SIP INVITE), the OTT SP sends a SIP INVITE to the IMS address in the serving MNO. The SIP INVITE includes the UE data and MNO data received at step 3, indicates an emergency call and includes the identity and possibly the location (e.g., country) of the OTT SP. The SIP INVITE could be a partial or complete copy of any SIP INVITE received at step 3.

Step 5. In some cases, the SIP INVITE sent at step 4 may first be received at a border control function (e.g., an Interconnecting Border Control Function [IBCF]) in the serving MNO IMS for security before being forwarded to the LRF (not shown in Figure 7.6). The IMS (e.g., LRF or IBCF) may first verify that the SIP INVITE sent at step 4 comes from a valid OTT SP – e.g., using preconfigured data based on some business relationship between the serving MNO and OTT SP and possibly using a secure IP connection between the OTT SP and the serving MNO IMS to transfer the SIP INVITE. In some cases, the IMS (e.g., LRF) then uses the MNO data and UE data sent at step 4 to obtain a location for the UE – e.g., using a control plane or user plane location solution. The IMS (e.g., an RDF in the IMS) then determines an intermediate destination corresponding to the UE location and derives a routing URI to enable call routing from the OTT SP to the intermediate destination.[7] When the final destination is a legacy PSAP, the intermediate destination corresponds to a Gateway into a legacy ESN. When the final destination is an i3-capable PSAP, the intermediate destination corresponds to an ESInet. In some cases, the intermediate destination may be a Gateway associated with an ESInet capable of routing to either a legacy ESN or to an i3-capable PSAP. The type of intermediate destination is not visible to the OTT SP. The intermediate destination may depend on the OTT SP identity and/or OTT SP location (e.g., whether in North America or outside North America). The IMS (e.g., an LRF) also determines a location URI (LbyR) to enable a subsequent location request for the UE at a later time.

Step 6. The IMS (e.g., an LRF) returns the routing URI and location URI to the OTT SP in a SIP 300 Multiple Choices. Note that the IMS may not return a location (e.g., LbyV) to the OTT SP if the identity of the OTT SP was not fully validated or if the business relationship with the OTT SP only allows for routing support by the serving MNO.

Step 7. If the IMS (e.g., LRF) may need to use control plane location, the IMS sends a SIP SUBSCRIBE message to the OTT SP to subscribe to notification of changes in the MNO

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[7] It is assumed that an OTT SP will never route directly to a PSAP (e.g., an i3 PSAP) and will always be constrained to route via a Gateway and legacy ESN or via an ESInet in order to enable security and flexibility of PSAP selection on the PSAP side.

data (e.g., change of serving MME or serving SGSN address). The IMS may also send a separate SIP SUBSCRIBE message to subscribe to notification of call termination.

Step 8. If step 7 occurs, the OTT SP returns a 200 OK (not shown) and then a NOTIFY message for each SUBSCRIBE message carrying the current MNO data in the case of subscription to MNO data and/or current call state in case of subscription to call termination.

Step 9. The OTT SP forwards the call to the intermediate destination indicated by the route URI received in step 6 by sending a SIP INVITE containing the location URI received at step 6. The intermediate destination may query the IMS (e.g., LRF) in the serving MNO for the location of the UE using steps similar to steps 16-18 (not shown in Figure 7.6) and may use the UE location to determine the destination PSAP.

Step 10A. When the destination PSAP is a legacy PSAP, the intermediate destination (a Gateway) forwards the call without the location URI to a legacy ESN for forwarding to the destination legacy PSAP. The intermediate destination may generate and include an ESRK or ESRD+MSISDN in the forwarded call (e.g., Integrated Services for Digital Network User Part [ISUP] Initial Address Message [IAM]) to comply with emergency call procedures for a legacy PSAP.

Step 11A. The rest of call establishment occurs.

Step 10B. When the destination PSAP is an i3 PSAP, the intermediate destination (an ESInet) forwards the SIP INVITE containing the location URI received at step 9 to the i3 PSAP.

Step 11B. The rest of call establishment occurs.

Step 12. If there is a change in MNO data (e.g., the UE is handed over to a new SGSN or MME) and if the serving MNO may use control plane location, the AN or PCN provides new MNO data to the UE (e.g., the identity for a new serving MME or SGSN and a local identity for the UE in the new serving MME or SGSN). Sending of this data may be automatic whenever the data changes (with no knowledge by the AN or PCN in the serving MNO that an emergency call via an OTT SP is in progress) or may be triggered by the UE having previously sent a request in step 1.

Step 13. The UE forwards the new MNO data to the OTT SP – e.g., using a SIP INFO message when SIP is used between the UE and OTT SP.

Step 14. If the IMS subscribed to notification of changes in MNO data in step 7, the OTT SP sends the new MNO data to the IMS (e.g., an LRF) in a SIP NOTIFY message. The MNO data is stored for future use by the IMS.

Step 15. In the case of a legacy PSAP, the PSAP may send an E2 interface ESPOSREQ to the intermediate destination Gateway via the legacy ESN to request the location of the UE and includes the ESRK or ESRD+MSISDN received at step 10A.

Step 16. The intermediate destination Gateway dereferences the location URI received at step 9 by sending a location request containing the location URI to the serving MNO IMS indicated by the location URI (e.g., an LRF).

Step 17. The IMS (e.g., LRF) uses the location URI to identify the UE and uses the UE data received at step 4 and the MNO data received at step 4 or step 14 if step 14 occurs to obtain a location for the UE using a control plane or user plane location solution.

Step 18. The IMS (e.g., LRF) returns the location to the intermediate destination Gateway.

Step 19. The intermediate destination Gateway returns the location to the legacy PSAP via the legacy ESN.

Step 20. In the case of an i3-capable PSAP, the i3 PSAP dereferences the location URI received at step 10B by sending a location request to the IMS (e.g., LRF) indicated in the location URI and carrying the location URI.

Step 21. The IMS (e.g., LRF) uses the location URI to identify the UE and uses the UE data received at step 4 and the MNO data received at step 4 or step 14 if step 14 occurs to obtain a location for the UE using a control plane or user plane location solution.

Step 22. The IMS (e.g., LRF) returns the location to the i3-capable PSAP.

8 Security & Privacy

This clause discusses security and privacy aspects of the alternative approaches described in clause 7.

8.1 Security & Privacy Assumptions

The following assumptions apply to the security and privacy aspects in the current specification.

- Any location determination that can identify a specific subscriber may be covered by Customer Proprietary Network Information (CPNI) or other privacy regulations.
- Any reference points that are between networks (NNIs) are expected to provide the following basic security, as for existing emergency service interfaces:
  - o Protection against replay attacks.
  - o Integrity protection.
  - o Mutual authentication.
- Any reference points that are between networks (NNI) and transport location information that can identify specific subscribers are expected to provide confidentiality protection as well, as for existing emergency service interfaces.

8.2 Threat Scenarios

The following scenarios illustrate attack vectors that are specific to OTT emergency services. Other attack vectors common to IT systems and VoIP communication networks are assumed to be addressed as well but are not described here.

8.2.1 Distributed Denial of Service (DDoS)

This attack vector is characterized by creating a traffic overload on one or more network elements involved in providing emergency service location services. One form of the attack involves having a large number of end mobile devices initiate a low to moderate traffic to particular network elements near simultaneously, creating a large overload condition. Another form of the attack involves the attacker spoofing requests for emergency location to the OTT, AN, or ESInet. The DDoS for this discussion considers a large number of near simultaneous emergency location requests and reporting overloading network elements in the AN, OTT SP infrastructure, and ESInet infrastructure. This attack vector can be present in alternatives S1, S3, S4, and S5 in clause 7.

8.2.2 False Emergency Location Request (not real emergency)

This attack vector is characterized by maliciously obtaining a device's location through emergency location procedures, bypassing any privacy, charging, and location security mechanisms that have been set up. This attack can be initiated by the OTT SP intending to bypass any security, charging, and privacy protections set up in the device and AN; it can be initiated by a malicious attacker who either infiltrates the OTT SP, or spoofs the OTT SP NNI to the application running on the device to obtain the emergency location. This attack vector can be present in alternatives S2, S3, and S4 in clause 7.

8.2.3 Fake Location Reporting

This attack vector is characterized when an OTT communication on the device is able to report a false location for the caller in an emergency service call. It can be initiated either by the user deliberately modifying the location that is reported or can be the result of malware or other attack infiltrating the device affecting applications running on the device. This attack vector is enabled when the location to report is processed in the user application level on the device or transferred over the user plane in an unsecured and unauthenticated fashion. This attack vector can be present in alternatives S1 and S2 described in clause 7.

8.3 Security & Privacy Solutions

Further work on approaches need to address the security capabilities listed below:

- Trust and security on the mobile device.
- Trust, security, and authentication between networks (NNI).
- Compliance with CPNI and privacy regulations.
- DDoS mitigation.

9 Conclusions

This clause provides conclusions and recommendations.

Five alternative solutions are identified and summarized in clause 7 for supporting location acquisition and routing of an emergency services call in a Public Switched Telephone Network (PSTN)-interconnected OTT SP. These alternatives are labelled S1, S2, S3, S4, and S5. Detailed examples of solutions S1 and S2 are also described and evaluated in clause 7.

The summaries and detailed examples show that supporting location acquisition and routing of an emergency services call in an OTT SP may be technically possible with routing to the correct PSAP and providing of a potentially accurate initial UE location also supported.

However, there has not been any detailed evaluation of the relative merits of the different alternatives (e.g., in terms of impacts to the access network operator, OTT SP, and UE) nor has there been an evaluation of security and privacy aspects.

Finally, there has not been any consideration for non-PSTN interconnected OTT SPs such as those highlighted in the high-level use cases in annex A.1.

It is therefore recommended that as a next phase in developing a preferred solution or solutions that further more detailed evaluations be performed to provide a solution(s) suitable for access network operators and at least PSTN-interconnected OTT SPs, as well as identifying solutions that may apply to non-PSTN interconnected OTT SPs.

Annex A: Use Cases

(informative)

A.1 High Level Use Cases

A.1.1 OTT User Identity Use Cases

These use cases describe different ways that OTT VoIP and ToIP services identify service users. These scenarios will need to be considered when the user of the OTT service invokes an OTT emergency service (voice or text messaging) and location acquisition, conveyance, and dereferencing is needed for the emergency service request.

Note for the use cases in this clause:

1. These use cases apply equally to VoIP and ToIP.
2. The PSTN is assumed to be either CS or regulated and interconnected VoIP service[8].
3. An OTT service provider may support several different user identity scenarios simultaneously.
4. An OTT service user may have multiple identities, each fitting in a different user identity scenario.

A.1.1.1 Interconnected OTT Uses a Separate E.164 Number

Description

This OTT service assigns a unique E.164 number to the user.

Pre-conditions

The OTT service is interconnected to the PSTN or an SMS routing gateway.

The OTT service assigns a unique E.164 number to users who want to communicate with non-OTT service users through the PSTN or SMS. This number is different from the E.164 number assigned to the UE by the CMRS provider for CMRS voice, SMS, or Multimedia Messaging Service (MMS) services.

The same user identity (E.164 number) can be used on multiple devices.

The user identity can be used on any IP-capable devices without any CMRS network support such as Wi-Fi only tablets without Universal Subscriber Identity Modules (USIMs) or IP Multimedia Services Identity Module (ISIMs).

Actors

User A is using an OTT service through his UE.

Post-conditions

User A is communicating with a call taker in the PSAP describing the emergency over a VoIP or ToIP session at least to the OTT service Point of Presence.

Normal flow

1. User A initiates an OTT emergency call or text messaging session using his OTT service provider assigned E.164 number, not the CMRS provider E.164 number assigned to the UE.
2. The OTT service initiates an emergency call through the PSTN or SMS routing gateway using the OTT service provided E.164 number.
3. The OTT service Point of Presence establishes an emergency session to a call taker in the PSAP using the OTT service-provided E.164 number.

---

[8] At the time of publication of this specification, the FCC had not provided a regulatory definition for VoIP that is not capable of interconnecting to the CS PSTN but may interconnect with other non-interconnected VoIP services. Non-interconnected VoIP services and in particular emergency VoIP calling have yet to be explored fully from a regulatory and technical perspective.

A.1.1.2   Non-interconnected OTT Uses the CMRS-Assigned UE E.164 Number

Description

This OTT service uses the E.164 number present in the UE. This is the E.164 assigned by the CMRS provider.

Pre-conditions

The OTT service is not interconnected to any PSTN or SMS routing gateways.

The OTT service uses the unique E.164 number found in the UE. This is assigned to the UE or subscriber by the CMRS provider during provisioning activities. This is typically located in the USIM or ISIM.

Actors

User A is using an OTT service through his UE.

Post-conditions

User A is communicating with a call taker in the PSAP describing the emergency over a VoIP or ToIP session at least to the 9-1-1 infrastructure.

Normal flow

1. User A initiates an OTT emergency call or text messaging session through the OTT service using his E.164 number assigned by the CMRS provider to the UE or subscriber.
2. The OTT service initiates an emergency call to the 9-1-1 infrastructure with the E.164 number assigned to the subscriber or UE.
3. The OTT service establishes an emergency session to a call taker in the PSAP using the E.164 number assigned to the subscriber or UE.
4. Any session re-establishment by the call taker is routed to the OTT service provider rather than the PSTN or SMS routing gateway with the caller's E.164 number (i.e., call-back or text-back).

A.1.1.3   Non-interconnected OTT uses a non-E.164 identity

Description

This OTT service either assigns a non-E.164 number identity or allows the user to create an identity.

Pre-conditions

The OTT service is not interconnected to any PSTN or SMS routing gateways.

The OTT service uses non-E.164 identities for OTT service users. The identities can:

   a. Contain characters, digits, and special characters.
   b. The service may allow multiple identities for a user – username, names, nicknames, etc.
   c. Some OTT service identities may allow duplicate identities for different users.

The same unique user identity can be used on multiple devices.

The user identity can be used on any IP-capable devices without any CMRS network support such as Wifi only tablets without USIM or ISIMs.

Actors

User A is using an OTT service through his UE.

Post-conditions

User A is communicating with a call taker in the PSAP describing the emergency over a VoIP or ToIP session at least to the OTT service Point of Presence.

Normal flow

1. User A initiates an OTT emergency call or text messaging session using his OTT service user identity.
2. The OTT service initiates an emergency call to the 9-1-1 infrastructure with the OTT service user identity.

3. The OTT service establishes an emergency session to a call taker in the PSAP using the OTT service user identity.

> NOTE: The issue of what identity may be provided to the 9-1-1 infrastructure and location infrastructure, especially if duplicate identities are allowed, is for future study. SIP does not have any requirement that a SIP identity be globally unique or even service unique which may cause problems for 9-1-1 capabilities.

A.1.2 OTT Functional Architecture Use Cases

These use cases describe different OTT service deployment models that will need to be considered when the user of the OTT service invokes an OTT emergency service (voice or text messaging) and location acquisition, conveyance, and dereferencing is needed for the emergency service request.

Note for the use cases in this clause:

1. These use cases apply equally to VoIP and ToIP.
2. The PSTN is assumed to be either CS or regulated and interconnected VoIP service[9].
3. These use cases are idealized scenarios and actual OTT VoIP or ToIP implementations may divide service logic between the UE client and a cloud service platform.

A.1.2.1 Interconnected OTT, Distributed Service Logic

Description

In this OTT platform, all of the OTT service logic is contained in a client operating on the UE platform. The OTT service is interconnected with the PSTN or SMS routing gateways.

Pre-conditions

The OTT service routes emergency service requests through the PSTN or SMS routing gateways.

The OTT service deployment is illustrated in the following figure:

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[9] At the time of publication of this specification, the FCC had not provided a regulatory definition for VoIP that is not capable of interconnecting to the CS PSTN but may interconnect with other non-interconnected VoIP services. Non-interconnected VoIP services and in particular emergency VoIP calling have yet to be explored fully from a regulatory and technical perspective.
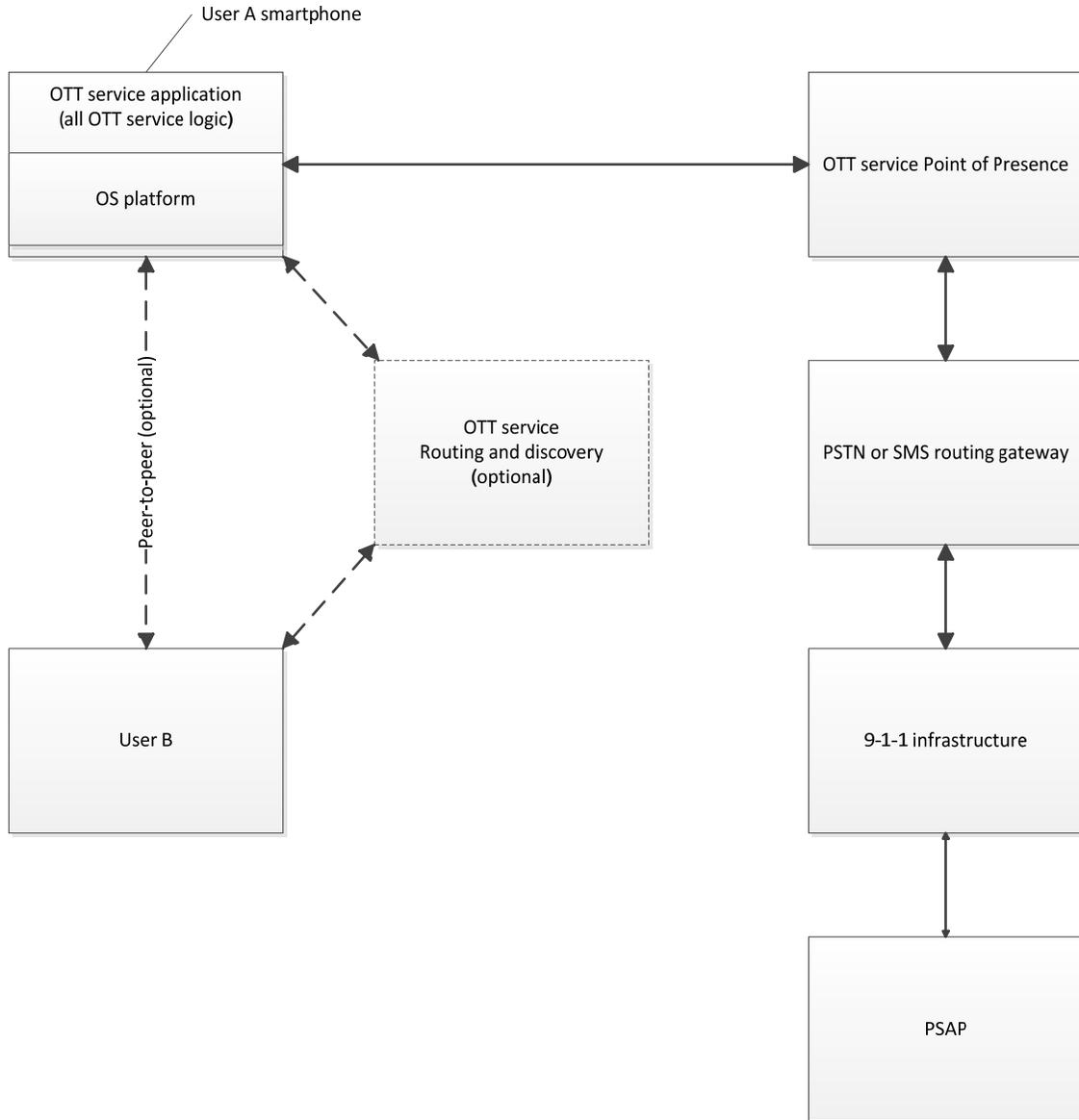
User A smartphone

OTT service application
(all OTT service logic)

OS platform

OTT service Point of Presence

OTT service
Routing and discovery
(optional)

PSTN or SMS routing gateway

Peer-to-peer (optional)

User B

9-1-1 infrastructure

PSAP

Figure A.1 – Interconnected OTT, distributed service logic

The OTT service uses standard or proprietary methods over IP for OTT service subscribers to communicate with each other. The OTT service uses one or more Point of Presence interconnections with the PSTN or SMS routing gateway to communicate with non-subscribers including emergency services (e.g., 9-1-1).

Actors

User A is using an OTT service through his smartphone.

Post-conditions

User A is communicating with a call taker in the PSAP describing the emergency over a VoIP or ToIP session at least to the OTT service Point of Presence.

Normal flow

1. User A initiates an emergency call or text messaging session.

2. The OTT service client in User A's UE contacts the OTT service Point of Presence to set up an emergency VoIP or ToIP session.
3. The OTT service Point of Presence establishes an emergency session to a call taker in the PSAP.

A.1.2.2 Non-interconnected OTT, Distributed Service Logic

Description

In this OTT platform, all of the OTT service logic is contained in a client operating on the UE platform. The OTT service is not interconnected with any PSTN or SMS routing gateways.

Pre-conditions

The OTT service routes emergency service requests through an interconnection with the 9-1-1 infrastructure.

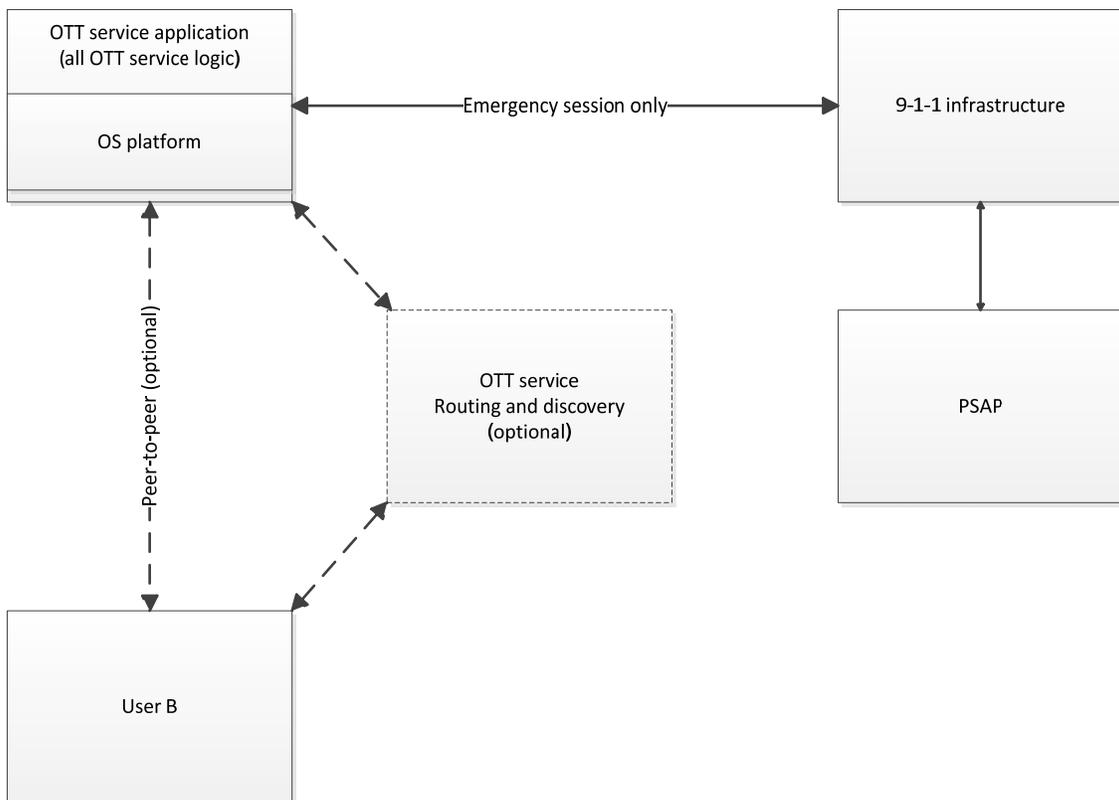The OTT service deployment is illustrated in the following figure:

Figure A.2 – Non-interconnected OTT, distributed service logic

The OTT service uses standard or proprietary methods over IP for OTT service subscribers to communicate with each other. The OTT service uses one or more interconnections with the 9-1-1 infrastructure for emergency services (e.g., 9-1-1).

Actors

User A is using an OTT service through his smartphone.

Post-conditions

User A is communicating with a call taker in the PSAP describing the emergency over a VoIP or ToIP session.

Normal flow

1. User A initiates an emergency call or text messaging session.
2. The OTT service client in User A's UE contacts the 9-1-1 infrastructure to set up an emergency VoIP or ToIP session.
3. An emergency session is established to a call taker in the PSAP.

A.1.2.3 Interconnected OTT Service, Centralized Cloud Service Logic

Description

In this OTT platform, all of the OTT service logic is contained in a cloud server in a large data center. The UE contains a Web Real-Time Communication (WebRTC) client providing basic IP communication capabilities. The OTT service is interconnected with the PSTN or SMS routing gateways.

Pre-conditions

The OTT service routes emergency service requests through the PSTN or SMS routing gateways.

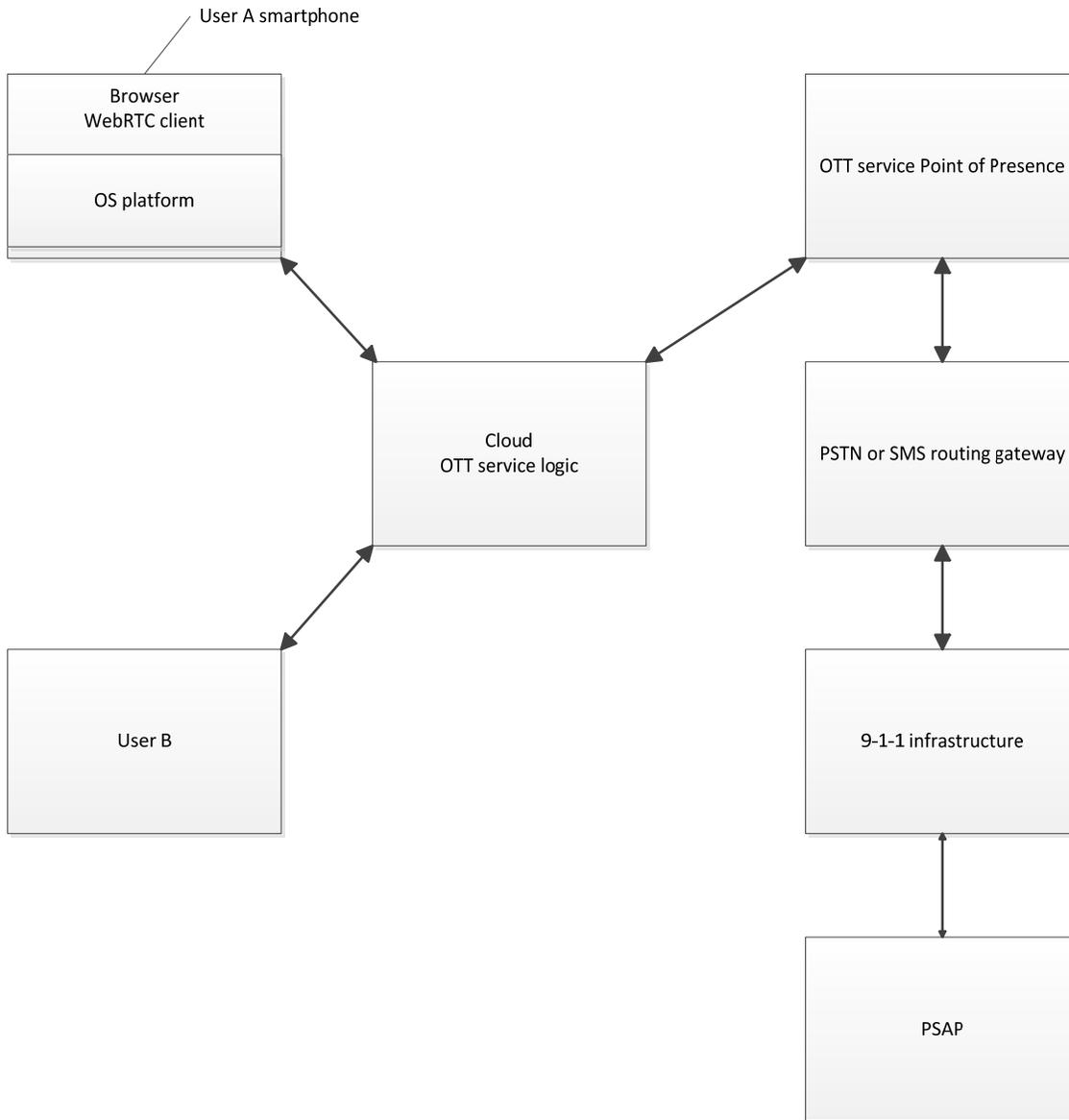The OTT service deployment is illustrated in the following figure:

Figure A.3 – Interconnected OTT service, centralized cloud service logic

The OTT service uses standard or proprietary methods over IP for OTT service subscribers to communicate with each other. The OTT service uses one or more Point of Presence interconnections with the PSTN or SMS routing gateway to communicate with non-subscribers including emergency services (e.g., 9-1-1).

Actors

User A is using an OTT service through his smartphone.

Post-conditions

User A is communicating with a call taker in the PSAP describing the emergency over a VoIP or ToIP session at least to the OTT service Point of Presence.

Normal flow

1. User A initiates an emergency call or text messaging session.

2. The OTT service in the cloud service platform contacts the OTT service Point of Presence to set up an emergency VoIP or ToIP session.
3. The OTT service Point of Presence establishes an emergency session to a call taker in the PSAP.

A.1.2.4 Interconnected OTT Service, Centralized Cloud Service Logic, Distributed Sessions

Description

In this OTT platform, all of the OTT service logic is contained in a cloud server in a large data center. The UE contains a WebRTC client providing basic IP communication capabilities. The OTT service is interconnected with the PSTN or SMS routing gateways.

Pre-conditions

The OTT service routes emergency service requests through the PSTN or SMS routing gateways.

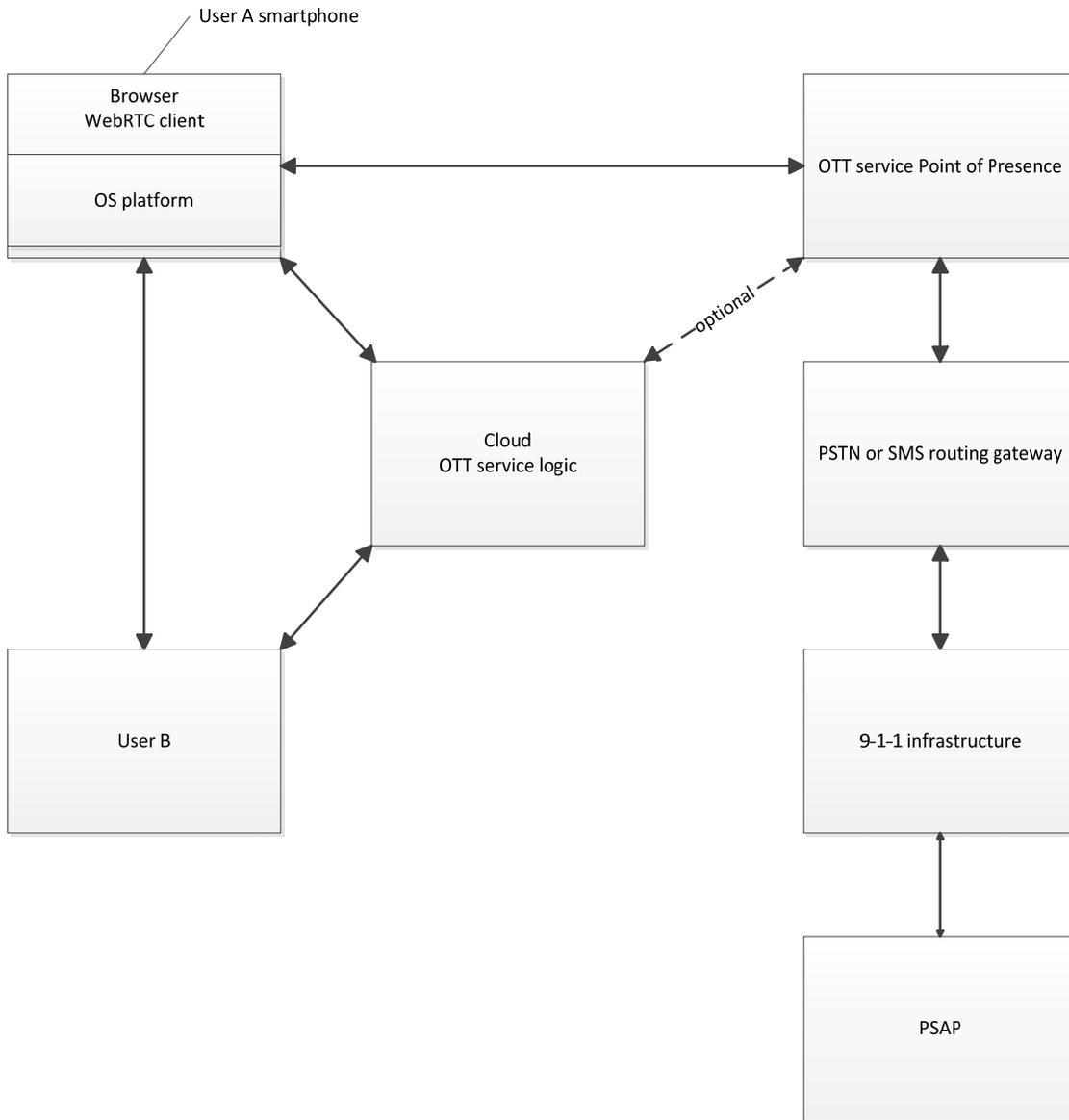The OTT service deployment is illustrated in the following figure:

Figure A.4 – Interconnected OTT service, centralized cloud service logic, distributed sessions

The OTT service uses standard or proprietary methods over IP for OTT service subscribers to communicate with each other. The OTT service uses one or more Point of Presence interconnections with the PSTN or SMS routing gateway to communicate with non-subscribers including emergency services (e.g., 9-1-1).

Actors

User A is using an OTT service through his smartphone.

Post-conditions

User A is communicating with a call taker in the PSAP describing the emergency over a VoIP or ToIP session at least to the OTT service Point of Presence.

Normal flow

1. User A initiates an emergency call or text messaging session.

2. The OTT service in the cloud service platform either contacts the OTT service Point of Presence to set up an emergency VoIP or ToIP session with the UE, or the cloud service platform directs the UE to set up an emergency VoIP or ToIP session with the OTT service Point of Presence.

3. The OTT service Point of Presence establishes an emergency session between the UE and a call taker in the PSAP.

A.1.2.5 Non-interconnected OTT Service, Centralized Cloud Service Logic

Description

In this OTT platform, all of the OTT service logic is contained in a cloud server in a large data center. The UE contains a WebRTC client providing basic IP communication capabilities. The OTT service is not interconnected with any PSTN or SMS routing gateways.

Pre-conditions

The OTT service routes emergency service requests through an interconnection with the 9-1-1 infrastructure.

The OTT service deployment is illustrated in the following figure:
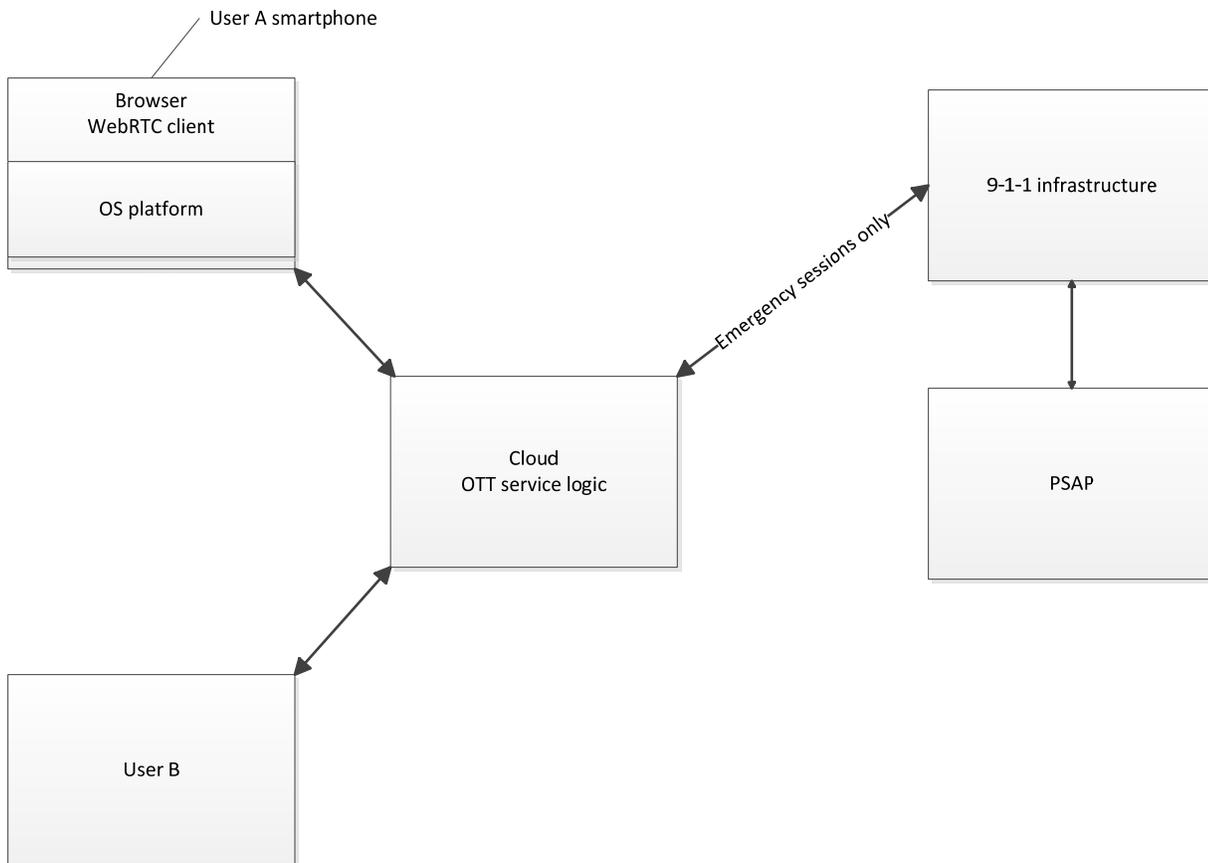
Figure A.5 – Non-interconnected OTT service, centralized cloud service logic

The OTT service uses standard or proprietary methods over IP for OTT service subscribers to communicate with each other. The OTT service uses one or more interconnections with the 9-1-1 infrastructure for emergency services (e.g., 9-1-1).

Actors

User A is using an OTT service through his smartphone.

Post-conditions

User A is communicating with a call taker in the PSAP describing the emergency over a VoIP or ToIP session.

Normal flow

1. User A initiates an emergency call or text messaging session.
2. The WebRTC client in User A's UE uses service logic in the OTT cloud server to contact the 9-1-1 infrastructure to set up an emergency VoIP or ToIP session.
3. The cloud service logic server sets up an emergency session with the 9-1-1 infrastructure.
4. An emergency session is established to a call taker in the PSAP.

A.1.2.6 Non-interconnected OTT Service, Centralized Cloud Service Logic, Distributed Sessions

Description

In this OTT platform, all of the OTT service logic is contained in a cloud server in a large data center. The UE contains a WebRTC client providing basic IP communication capabilities. The OTT service is not interconnected with any PSTN or SMS routing gateways.

Pre-conditions

The OTT service routes emergency service requests through an interconnection with the 9-1-1 infrastructure.

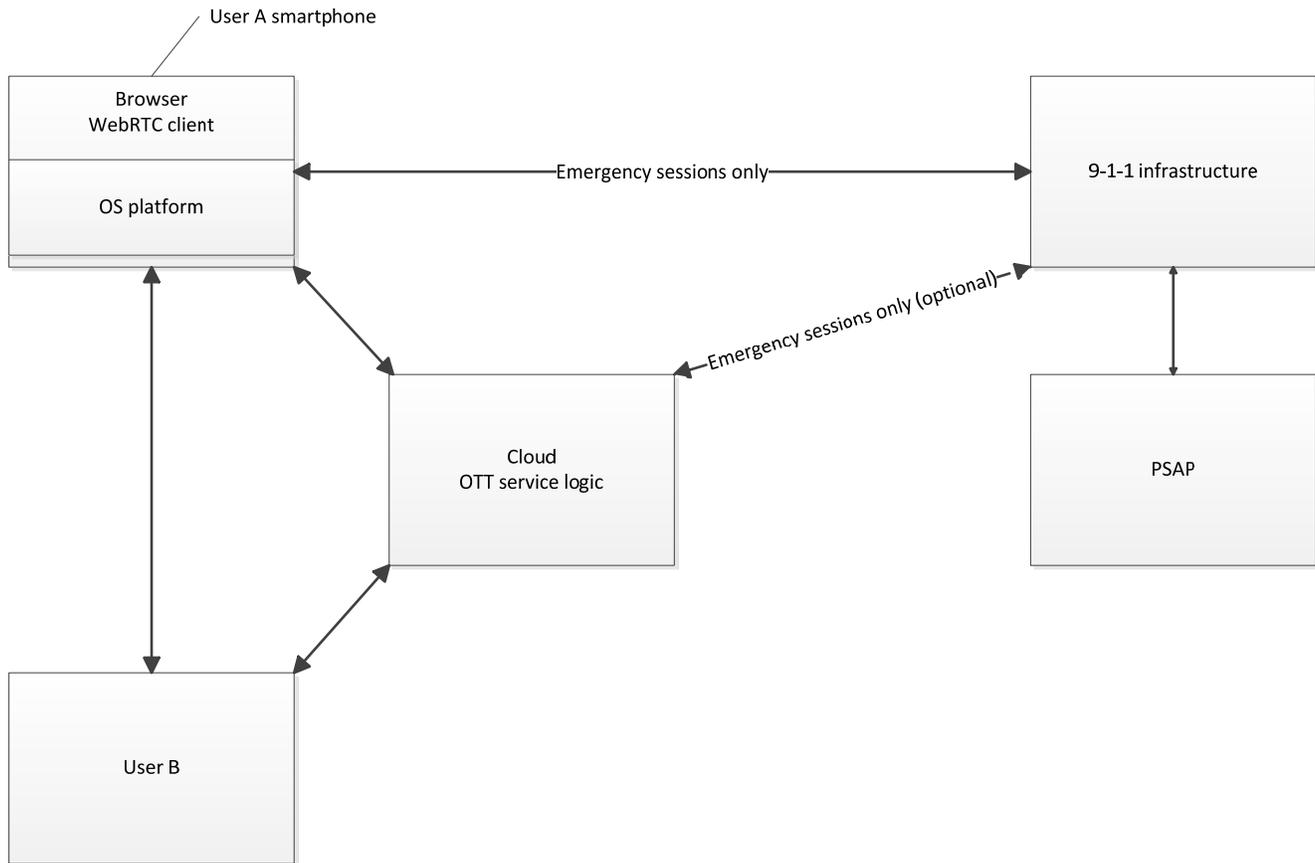The OTT service deployment is illustrated in the following figure:

Figure A.6 – Non-interconnected OTT service, centralized cloud service logic, distributed sessions

The OTT service uses standard or proprietary methods over IP for OTT service subscribers to communicate with each other. The OTT service uses one or more interconnections with the 9-1-1 infrastructure for emergency services (e.g., 9-1-1).

Actors

User A is using an OTT service through his smartphone.

Post-conditions

User A is communicating with a call taker in the PSAP describing the emergency over a VoIP or ToIP session.

Normal flow

1. User A initiates an emergency call or text messaging session.
2. The OTT service in the cloud service platform either contacts the 9-1-1 infrastructure to set up an emergency VoIP or ToIP session with the UE, or the cloud service platform directs the UE to set up an emergency VoIP or ToIP session with 9-1-1 infrastructure.
3. An emergency session is established to a call taker in the PSAP.

Use Case #1 – OTT VoIP service for Fixed user – location information is provided by known access provider that is different from the service provider (referred to as "independent provider" from now on).

Description

In this use case, an end user with a fixed location makes an emergency call using VoIP services provided by an Over The Top service provider with network access provided by an independent network access provider. The Over The Top service provider does not have the capability for directly obtaining the location of the emergency caller and must rely on the access provider for the location information of the emergency caller.

Actors

Bob is the emergency caller.

Over The Top service provider A is the OTT Voice Service Provider (VSP).

Access provider B is how Bob's 9-1-1 call accesses the emergency services network.

Pre-Conditions

Bob obtains VoIP services from Over The Top service provider A, and network access from ccess provider B. Service provider A does not have the capability for directly obtaining the location of the emergency caller and must rely on Access provider B for the location information of the emergency caller. Service provider A has a Service Level Agreement (SLA) with Access provider B to provide location information services, and Service provider A can identify the user with Access provider B.

Post Conditions

Bob's emergency call with his location information is forwarded to the emergency services network, and eventually received by the PSAP call taker.

Normal Flow

1. Bob makes an emergency call from a fixed location to report an accident.
2. Service provider A receives Bob's emergency call.
3. Service provider A sends a request to Access provider B. The request identifies Bob as the emergency caller and requests his location.
4. Access provider B obtains Bob's location and sends it to service provider A.
5. After receiving Bob's location information, service provider A forwards Bob's emergency call with his location information (by value or reference, as appropriate) to the emergency services network.

6. Bob's emergency call with his location information is received by the PSAP call taker.

Use Case #2 – OTT VoIP service for Fixed/Nomadic/Mobile user – independent access but location information is provided directly by OTT service provider.

Description

In this use case, a fixed/nomadic/mobile end user makes an emergency call using VoIP services provided by an Over The Top service provider with network access provided by an independent network access provider. The Over The Top service provider has the capability for directly obtaining the location of the emergency caller without assistance from Network Access provider B.

Actors

Bob is the emergency caller.

Over The Top service provider A is the OTT VSP.

Access provider B is how Bob's 9-1-1 call accesses the emergency services network.

Pre-Conditions

Bob obtains VoIP services from Over The Top service provider A, and network access from Access provider B. Service provider A has the capability for directly obtaining the location of the emergency caller without assistance from Network Access provider B. There is no need for Service provider A to have a SLA with Access provider B to provide location information services.

Post Conditions

Bob's emergency call with his location information is forwarded to the emergency services network, and eventually received by the PSAP call taker.

Normal Flow

1. Bob, as a fixed/nomadic/mobile end user, makes an emergency call to report an accident.
2. OTT service provider A receives Bob's emergency call.
3. OTT service provider A obtains Bob's location without assistance from Network Access provider B and sends Bob's emergency call with Bob's location information to the emergency services network.
4. Bob's emergency call with his location information is received by the PSAP call taker.

Use Case #3 – OTT VoIP service for Nomadic/Mobile user – access is provided by unknown independent access provider.

Description

In this use case, a nomadic/mobile end user makes an emergency call using VoIP services provided by an Over The Top service provider with network access provided by an independent network access provider that is unknown to the Over The Top service provider. The Over The Top service provider does not have the capability for directly obtaining the location of the emergency caller and must determine a source for providing the location information of the emergency caller.

Actors

Bob is a nomadic/mobile emergency caller.

Over The Top service provider A is the OTT VSP.

Access provider B is an independent network Access provider that is unknown to the Over The Top service provider.

Independent Location provider C, who may or may not be the same as Access Provider B.

Pre-Conditions

Bob obtains VoIP services from Over The Top service provider A, and network access provided by an independent network access provider that is unknown to the Over The Top service provider. OTT service provider A does not have the capability for directly obtaining the location of the emergency caller and must look to Independent Location provider C as a source for providing the location information of the emergency caller. The Independent Location provider C must have SLA with service provider A. The Independent Location provider C must have a SLA with Access provider B unless the Independent Location provider C directly obtains the location of the UE.

Post Conditions

Bob's emergency call with his location information is forwarded to the emergency services network, and eventually received by the PSAP call taker.

Normal Flow

1. Bob, as a nomadic/mobile end user, makes an emergency call to report an accident.
2. Service provider A receives Bob's emergency call.
3. Service provider A requires an independent source for Bob's location information and makes a request to the Independent Location provider C identifying Bob as the emergency caller and requests his location.
4. The Independent Location provider C obtains Bob's location and sends it to Service provider A.
5. After receiving Bob's location information, service provider A forwards Bob's emergency call with his location information to the emergency services network.
6. Bob's emergency call with his location information is received by the PSAP call taker.

A.1 Detailed Use Cases
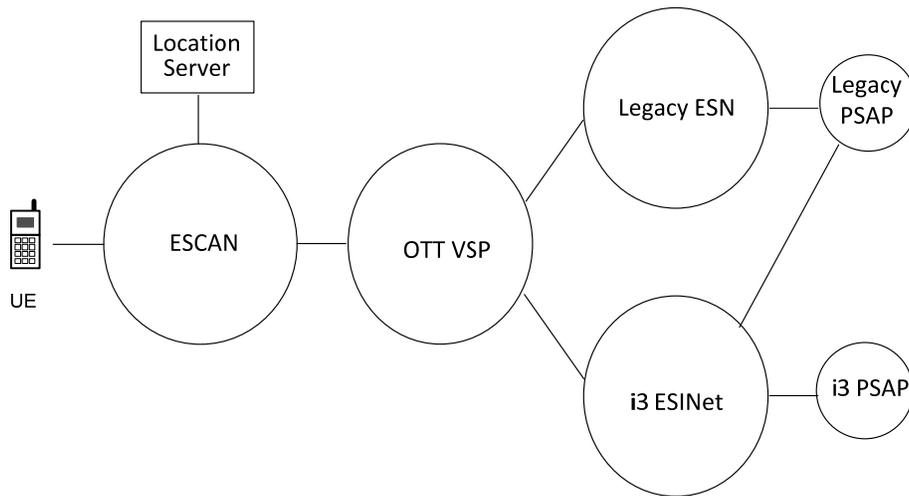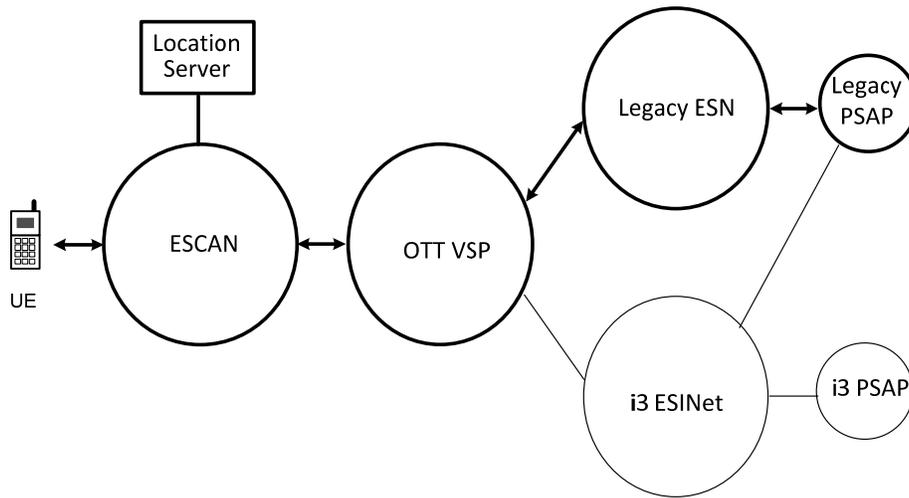
A.2.1   High Level Architecture Diagram

Figure A.7 – Emergency Services Call via an Emergency Services Capable Access Network (ESCAN) and OTT VSP

NOTE: All networks are located in North America (NA).

A.2.2   User Case Descriptions

1) IP-Based Emergency Call via an ESCAN and OTT VSP routed to a legacy emergency services network with *LByV* provided by the UE.

Short Description

The OTT VSP receives an emergency call/session request containing a location value from an originating device/UE. The call is routed via a legacy Emergency Services Network to a legacy PSAP and the PSAP has to query for location information. The location value provided by the UE may be obtained via UE interaction with an access network location server.

Actors

Bob is the caller whose UE originated the emergency call.

Carol is the PSAP call taker at a legacy PSAP to which the emergency call is delivered.

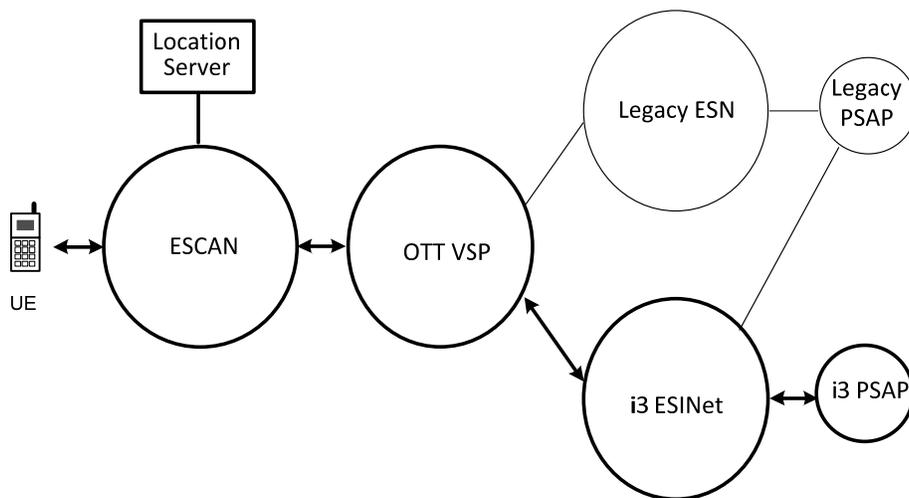**Pre-Conditions**

None.

Post-Conditions

Carol is in communication with Bob and is viewing his location information.

Normal Flow

1. Bob initiates an emergency call which is recognized by Bob's UE.
2. Bob's UE either autonomously obtains its own location or interacts with a location server provided by the ESCAN to help obtain its location. In some implementations, step 2 may occur before step 1.
3. The call request is forwarded by Bob's UE to the OTT VSP and carries Bob's location.
4. The OTT VSP may use the location provided with the emergency call request to determine the routing for the call.
5. The OTT VSP caches Bob's location and creates a Reference Identifier.
6. The OTT VSP routes the call toward the legacy emergency services network passing the Reference Identifier for delivery to Carol's PSAP.
7. Carol answers the call.
8. In parallel, Carol's call handling equipment uses the Reference Identifier to query the OTT VSP for Bob's location.

9. Bob's location cached in step 5 and callback information are returned and displayed on Carol's Customer Premises Equipment (CPE).

10. IP-Based Emergency Call using an ESCAN and an OTT VSP routed to an ESInet with *LByV* provided by the UE.

Short Description

The OTT VSP receives an emergency call/session request containing a location value from an originating device/UE. The call is routed via an i3 ESInet to an i3 PSAP[10], and the location and callback information are delivered to the i3 ESInet with the call. The location value provided by the UE may be obtained via UE interaction with an access network location server.

Actors

Bob is the caller whose UE originated the emergency call.

Carol is the PSAP call taker at a NENA i3 PSAP to which the emergency call is delivered.

Pre-Conditions

None.

Post-Conditions

Carol is in communication with Bob and is viewing his location information.

Normal Flow

1. Bob initiates an emergency call which is recognized by Bob's UE.

2. Bob's UE either autonomously obtains its own location or interacts with a location server provided by the ESCAN to help obtain its location. In some implementations, step 2 may occur before step 1.

3. The call request is forwarded by Bob's UE to the OTT VSP and carries Bob's location.

4. The OTT VSP may use the location provided with the emergency call request to determine the routing for the call.

5. The OTT VSP routes the call toward the ESInet (passing the LByV and callback information received in the emergency call request) for delivery to Carol's PSAP.

---

[10] Routing to a legacy PSAP is also possible but is not covered in this user case.

6. Carol answers the call and Bob's location information is displayed on her CPE.
7. IP-Based Emergency Call using an ESCAN and an OTT VSP routed to a legacy emergency services network with LByR provided by the UE.
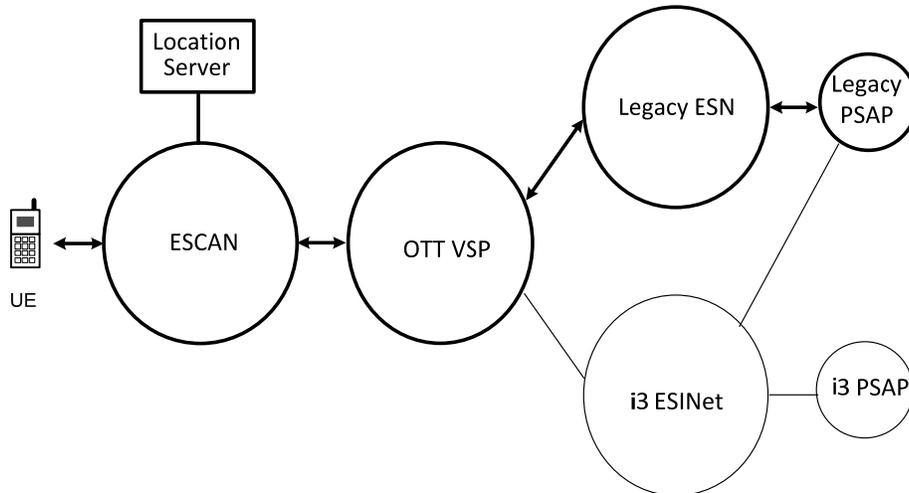
Short Description

The OTT VSP receives an emergency call/session request containing a location reference from an originating device/UE. The OTT VSP queries a location server in the ESCAN for the UE location. The call is routed via a legacy Emergency Services Network to a legacy PSAP. The PSAP queries the OTT VSP for location information and the OTT VSP in turn queries the location server in the ESCAN.

Actors

Bob is the caller whose UE originated the emergency call.

Carol is the PSAP call taker at a legacy PSAP to which the emergency call is delivered.

Pre-Conditions

Bob's UE has access to a location server in that is able to deliver a location reference.

Post-Conditions

Carol is in communication with Bob and is viewing his location information.

Normal Flow

1. Bob initiates an emergency call which is recognized by Bob's UE.
2. Bob's UE interacts with a location server in the ESCAN to obtain a location reference R1.
3. The call request is forwarded by Bob's UE to the OTT VSP and carries the location reference R1.
4. The OTT VSP queries the location server in the ESCAN for the location of Bob's UE using the location reference R1.
5. The OTT VSP may use the location provided by the location server in the ESCAN to determine the routing for the call.
6. The OTT VSP caches Bob's location and the location reference R1 and creates a reference identifier R2.
7. The OTT VSP routes the call toward the legacy emergency services network passing the reference identifier R2 for delivery to Carol's PSAP.
8. Carol answers the call.

9. In parallel, Carol's call handling equipment uses the reference identifier R2 to query the OTT VSP for Bob's location.

10. Bob's location cached in step 6 and callback information are returned and displayed on Carol's CPE.

11. At some later time, Carol's call handling equipment uses the reference identifier R2 to query the OTT VSP for an updated or more accurate location for Bob's UE.

12. The OTT VSP queries the location server in the ESCAN for the location of Bob's UE using the location reference R1.

13. The location of Bob's UE is obtained by the location server in the ESCAN and returned to Carol via the OTT VSP and Carol's call handling equipment.

14. IP-Based Emergency Call using an ESCAN and an OTT VSP routed to an ESInet with LByR provided by the UE.
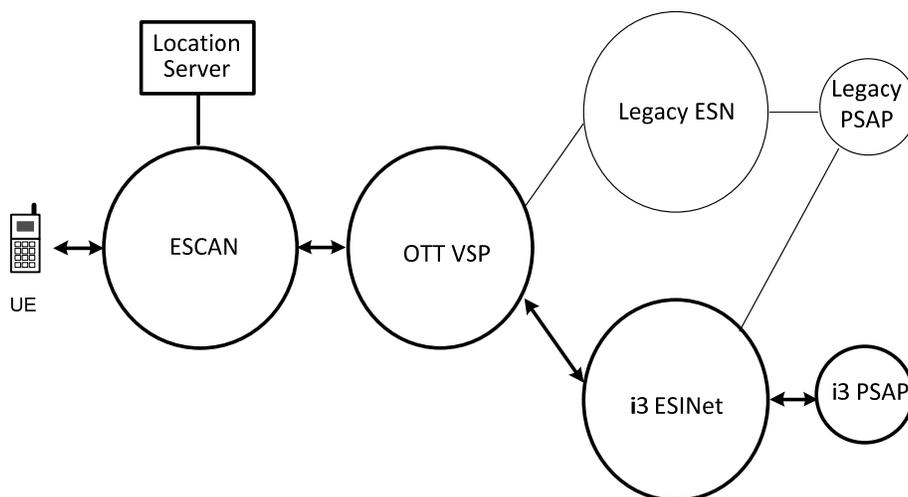
Short Description

The OTT VSP receives an emergency call/session request containing a location reference from an originating device/UE. The OTT VSP queries a location server in the ESCAN for the UE location. The call is routed via an i3 ESInet to an i3 PSAP[11]. The PSAP queries the OTT VSP for location information and the OTT VSP in turn queries the location server in the ESCAN.[12]

Actors

Bob is the caller whose UE originated the emergency call.

Carol is the PSAP call taker at a NENA i3 PSAP to which the emergency call is delivered.

Pre-Conditions

Bob's UE has access to a location server in the ESCAN that is able to deliver a location reference.

Post-Conditions

Carol is in communication with Bob and is viewing his location information.

---

[11] Routing to a legacy PSAP is also possible but is not covered in this user case.

[12] This user case assumes the ESCAN and OTT VSP each provide their own location reference resulting in two hops to perform location dereferencing for the PSAP. In an alternative and equally valid user case, the location reference provided by the ESCAN is forwarded to the PSAP by the OTT VSP enabling location dereferencing by the PSAP in one hop.

Normal Flow

1. Bob initiates an emergency call which is recognized by Bob's UE.
2. Bob's UE interacts with a location server in the ESCAN to obtain a location reference R1.
3. The call request is forwarded by Bob's UE to the OTT VSP and carries the location reference R1.
4. The OTT VSP queries the location server in the ESCAN for the location of Bob's UE using the location reference R1.
5. The OTT VSP may use the location provided by the location server in the ESCAN to determine the routing for the call.
6. The OTT VSP caches Bob's location and the location reference R1 and creates a location reference R2.
7. The OTT VSP routes the call toward the ESInet (passing the location reference R2 and callback information received in the emergency call request) for delivery to Carol's PSAP.
8. Carol answers the call.
9. In parallel, Carol's call handling equipment uses the location reference R2 to query the OTT VSP for Bob's location.
10. Bob's location cached in step 6 is returned and displayed on Carol's CPE.
11. At some later time, Carol's call handling equipment uses the location reference R2 to query the OTT VSP for an updated or more accurate location for Bob's UE.
12. The OTT VSP queries the location server in the ESCAN for the location of Bob's UE using the location reference R1.
13. The location of Bob's UE is obtained by the location server in the ESCAN and returned to Carol via the OTT VSP and Carol's call handling equipment.