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NG112 Emergency Communications

FernmeldeDienstAnbieter (FDA), PublicSafetyAnsweringPoint (PSAP)

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3.0	01.07.2021	Steiner Martin	Released, official version
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To | CC: VSP, PSAP, BAKOM

Contents

1 Introduction

The European Telecommunications Standards Institute (ETSI) has set out standards for localisation and routing of emergency calls to the emergency call centres known as “Public Safety Answering Points” (PSAPs) via VoiceOverIP (VoIP). The basis for this is ETSI ES 203 178, which sets out all the interfaces.

The European Parliament passed the directive on 14 December 2018, whereby all EU regulators must implement the new standards (NG112).

In Switzerland, this is set out by the legislator and regulator in the revised telecommunication legislation by means of the Telecommunications Law (FMG), article 20, the Telecommunications Services Ordinance (FDV), articles 27–30, and the Ordinance on Addressing Elements (AEFV), article 28, (version of 1 January 2021), as well as the Technical and Administrative Regulation (TAV) SR 784.101.113/1.3[9].

1.1 Purpose of this document

This document offers an overview; further details are provided in the documents referenced.

1.2 Target audience

- Customers
- Sponsors
- Project team
- Architecture teams
- Project managers
- Suppliers of PBX
- Suppliers of mission control systems
- Telecommunications service providers
- Providers of public telephone services (VSPs) in Switzerland
- Mobile communication licensees
- Universal service licensees
- OFCOM

It is helpful to have knowledge of the following areas:

- Computer systems and the Internet
- Internet protocols TCP/IP, HTTP, HELD
- Basics of SIP
- SIP protocol headers, PAI, Geopriv, PIDF-LO, Location by Reference
- Basics of emergency call handling

1.3 Referenced documents

No.	Name of document	Description
[1]	es_203178v010101p.pdf	ETSI ES 203 178 describes the EU architecture for emergency call localisation, routing and termination.
[2]	es_203283v010101p.pdf	ETSI ES 203 283 describes in detail the protocols of ES 203 178.
[3]	ts_103479v010101p.pdf	ETSI TS 103 479 describes the protocols of the ESInet.
[4]	ts_103625v010101p.pdf	ETSI TS 103 625 describes AML.
[5]	Next Generation 112 – Long Term Definition	EENA Document. Next Generation 112 – Long Term Definition. Techn. Ber. European Emergency Number As-sociation, 6. März 2013. URL: http://www.eena.org/uploads/gallery/files/pdf/2013-03-15-eena_ng_long-termdefinitionupdated.pdf.
[6]	Next Generation eCall / NG eCall	EENA Document. David Williams. *Next Generation eCall / NG eCall*.Techn. Ber. European Emergency Number Association – EENA 112, 11. Dez. 2015. https://eena.org/knowledge-hub/documents/next-generation-ecall/
[7]	DIN EN 15722:2021-01	DIN Document. Intelligent transport systems - ESafety - ECall minimum set of data; Norm. Jan. 2021.
[8]	GML 3.1.1 PIDF-LO	IETF Document. Martin Thomson Carl Reed. GML 3.1.1 PIDF-LO Shape Allication Schema for use by the Internet Engineering Task Force (IETF). Techn. Ber. 10. Apr. 2007. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjl54T8-NrvAhUJGewKHXvcDlMQF-jAAegQIAxAD&url=https%3A%2F%2Fportal.ogc.org%2Ffiles%2F%3Fartifact_id%3D21630&usg=AOvVaw1ML74Ml11TTEDgAC5iWH-9
[9]	SR 784.101.113/1.3	OFCOM document. Federal Office of Communications. SR 784.101.113/1.3 Routing and identification of location for emergency calls. Techn. div. SR 784.101.113/1.3. 14 November 2014. https://www.bakom.admin.ch/bakom/de/home/das-bakom/organisation/rechtliche-grundlagen/vollzugspraxis/technische-und-administrative-vorschriften/sr-784-101-113-1-3.html

[10]	20200202_PSAP_Anforderungen NOT DB_V1.1.pdf	HPI document. A. Beeler. Re-design of the query to the emergency call database. Techn. div., Swiss Competence Centre for Police Technology and IT (PTI), 16 March 2020 V 1.1.

Table 1: Referenced documents

1.4 Glossary

Term	Definition
3GPP	Third Generation Partnership Project
AGNSS	Supported Global Navigation Satellite System (expansion of AGPS)
AGPS	Assisted Global Positioning System. Supported global positioning system.
AML	Advanced Mobile Location is a function within the Apple iOS and corresponds to ELS
ANP	Access Network Provider
ASCII	American Standard Code for Information Interchange
ASN.1	Abstract Syntax Notation One
OFCOM	Federal Office of Communications. Approves the regulations for telephony in Switzer-land.
BORS	Public authorities and organisations in charge of rescue and safety
CLI	Client Line Identification, landline telephone number
CRS	Coordinate Reference Systems
CSCF	Call Session Control Function
DNS	Domain Name Server
DTD	Document Type Description
ECSP	Emergency Call Service Provider
EENA	European Emergency Number Association
EGID	Federal building identifier used by the Federal Statistical Office
ELS	Emergency Location Service for Android, corresponds to AML
ESInet	Emergency services network that uses IP technology
ETSI	European Telecommunications Standards Institute
FQDN	Full Qualified Domain Name
GEOPRIV	Geolocation and Privacy (IETF Working Group)
GML	Geography Markup Language
GMLC	Gateway Mobile Location Centre
GMPC	Gateway Mobile Positioning Centre
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HELD	HTTP-Enabled Location Delivery

HTML	Hypertext Markup Language
HTTP	HyperText Transfer Protocol
IANA	Internet Assigned Numbers Authority
IMS	IP Multimedia Subsystem
IETF	Internet Engineering Task Force
IMS	IP Multimedia Core Network Subsystem
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ISO	International Organisation for Standardisation
ITU	International Telecommunications Union
IVS	In-Vehicle System
KML	Keyhole Markup Language
LbyR	Location By Reference, refers to the conveyance of a URL in the SIP INVITE, which points to location information in an LIS, e.g. https://lis.sosservice.ch/location/iig4riubr4wbv
LbyV	Location By Value, refers to the conveyance of the location within the SIP INVITE as XML in the PIDF-LO.
LIS	Location Information Server, components in an access network that determine the location (coordinates, address) of a user of the access network. In fig.2 referred as "LS"
LIS proxy	Central Location Information Server in a country that obtains information from localised LISs and can store information itself. In fig.2 referred as "LS proxy"
LoST	Location-to-Service Translation Protocol
LSD	Location Server Discovery provides the address of the LIS service of an access network
MCC	Mobile Country Code
MIME	Multipurpose Internet Mail Extensions
MLP	Mobile Location Protocol
MNO	Mobile Network Operator
MNC	Mobile Network Code
MVNO	Mobile Virtual Network Operator
MPS	Mobile Positioning System
MSD	Minimal Set of Data
MSISDN	Mobile Subscriber Integrated Services Digital Number, unequivocal mobile telephone number
NG112	Next Generation 112

NBL	Network-Based Localisations
NGN	Next Generation Network
OGC	Open Geospatial Consortium
OMA	Open Mobile Alliance
PAI	P-Asserted-Identity, SIP header field, see RFC3325
PIDF-LO	Presence Information Data Format Location Object – a Presence-based GEOPRIV Location Object Format (XML)
PLMN-Id	Identifier of mobile network, consisting of MCC and MNC.
PSAP	Public Safety Answering Point – call centre for emergency services, emergency response centre
PSP	PSAP Service Provider
PSTN	Public Switched Telecommunication Network
PTI	Swiss Competence Centre for Police Technology and IT
PWLAN	Public Wireless LAN
RFC	Requests for Comments, used for IETF standards
SIP	Session Initiation Protocol, see RFC3261 and others
SOAP	Simple Object Access Protocol
TCP	Transmission Control Protocol
TDM	Time Division Multiplexing
TSP	Telecommunications service provider. Corresponds to the ETSI term VSP or German term FDA (Fernmeldedienstanbieter).
UA	User Agent (SIP endpoint); often (for 3GPP) also referred to as UE, User Equipment.
UE	User Equipment
URI	Uniform Resource Identifier
URL	Uniform Resource Locator
UTC	Coordinated Universal Time
UUID	Universally Unique Identifier
VLI	VoIP Location Identifier applied by Swisscom; used for communicating a nomadic location from a private network
VoIP	Voice over IP, telephony via Internet data connections
VSP	Voice Service Provider (provider of public telephone service). Corresponds to the OFCOM term TSP.
W3C	World Wide Web Consortium

WGS	World Geodetic System
XER	XML Encoding Rules (used in the MSD of the eCall)
XML	W3C Extensible Markup Language
XSD	W3C XML Schema Definition

Table 2: Glossary

2 Introduction

The ability to make emergency calls in emergency situations from a telephone connection via a telecommunication network is a civil right, which is governed by national regulations. The state obliges providers of public telephony to create the technical prerequisites whereby the person requiring assistance can be put through to the relevant local emergency call response centre.

European regulations favour one sole number (112) for all emergency services, while Switzerland defines other short numbers alongside 112 for the emergency services, such as 117, 118, 143, 144, 145, and 147. Furthermore, there are rescue services that also use short numbers for their services, such as 1410, 1414, and 1415, some of which are able to get regulated access to location information for the caller.

The current emergency call localisation system in Switzerland is based on a central emergency call database (SOSDB) for geopositions that are updated by the Telecommunications Service Providers (TSPs) for each emergency call. Within the SOSDB, the relevant emergency services (police, ambulance, fire brigade, etc.) can request the geographic positions of callers. The SOSDB dates back to an application that was built for the landline network around 1970 then expanded for the mobile network in 2005, and later trialled by Swisscom for VoIP in 2014. For fixed network connections, each telecommunications service provider now sends all fixed network numbers including names and addresses to the SOSDB on a weekly basis. The Public Safety Answering Points (PSAPs) submit an enquiry based on the telephone number and receive either an address with a point (fixed network) or one or several ellipses denoting mobile locations. Determining locations for fixed network numbers is based on data belonging to GeoPost, Federal Statistical Office (BFS) and Swisscom, which are underpinned by a complete address directory of all buildings in Switzerland. For each address in Switzerland, the coordinates of the official topography of the country are provided, so the location can be determined precisely on maps. When the regulator (OFCOM) called for locations of mobile calls to be determined on the network side too, a new concept had to be developed for mobile localisation. The network of the Mobile Network Operator (MNOs) determines the current position of the mobile caller based on its antenna locations. For each emergency call, a position notification is sent to the SOSDB, and this can change over time.

To transmit the geographic location, the current emergency call application uses the Mobile Location Protocol (MLP) format from the Open Mobile Alliance (OMA, 3GPP) standard.

A diagram from the early days (fig. 1) shows the architecture underlying the current emergency call system in Switzerland. Location conveyance and the voice call flow are largely independent of each other. The establishment of the connection and the forwarding of the emergency call take place based on telephony standards via a Circuit-Switched Network. The developments in the direction of All IP telephony mean the existing system architecture is no longer compatible for the future.

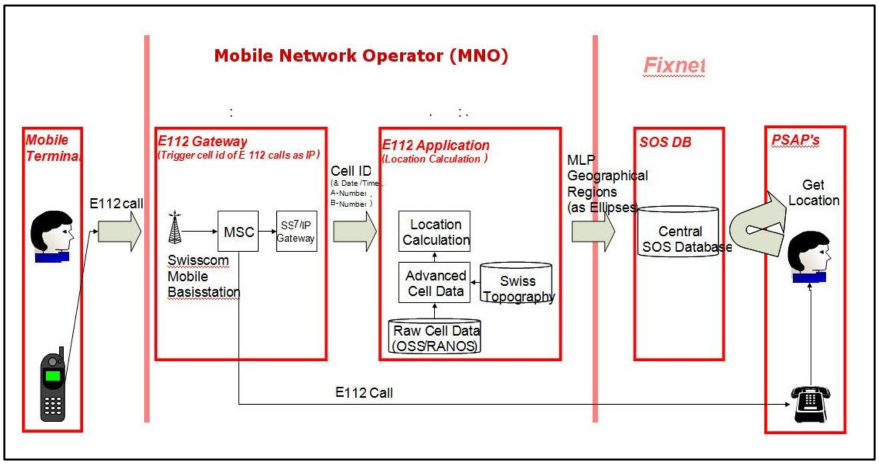


Fig. 1: Dynamic emergency call architecture from the early days

The emergency call localisation system has been functioning reliably for years, but to adapt it to meet future demands, such as handling eCalls, dealing with Wifi calling and VoLTE emergency calls based on SIP, experts have proposed switching the interfaces to Internet standards in broad sections of emergency communications.

This document examines all the geo-query interfaces of the Location Information Server (LIS) that are required for future emergency communications (Next Generation 112, NG112 for short) based on the existing standards. In NG emergency call architecture as proposed by the European Emergency Number Association (EENA) (Next Generation 112 Long Term Definition, V.1.1 06.03.2013[5]), the central LIS supplies the location information for every emergency call to the emergency call centres.

These days, telephony is undergoing a technological transformation, whereby the classic connection-oriented conveyance (TDM/CS-based) is being increasingly replaced by IP-based technologies. In particular, the Session Initiation Protocol (SIP) is being used for modern voice services. This technological shift has far-reaching consequences in terms of requirements for regulating emergency calls and processing them in IP-based networks.

The concepts of the NG112 architecture relate largely to the global Internet standards of the Internet Engineering Task Force (IETF). The standardisation of the emergency call service architecture has advanced over the last few years as a result of various standardisation initiatives. On an international level, the standardisation efforts have been referred to as NG911 (US) or NG112 (EU). In addition, over the last few years telephony has been increasingly merging with Internet technology (IP telephony, VoIP, VoLTE). This has meant the standardisations of the IETF from the European Telecommunications Standards Institute (ETSI) and the International Telecommunications Union (ITU) have been widely adopted for the different areas of telephony. With the SIP standard and the Internet technology, it is possible to establish a voice connection and to convey the location information simultaneously with the call.

3 Objective

3.1 Architecture

The main objective of this document is to compile the currently existing standards that can be used for defining the modern emergency communications system for NG112, which closes gaps in standards and facilitates migration of the current architecture (SOSDB, MLP) to an NG112 architecture defined according to ETSI, IETF, and DIN standards.

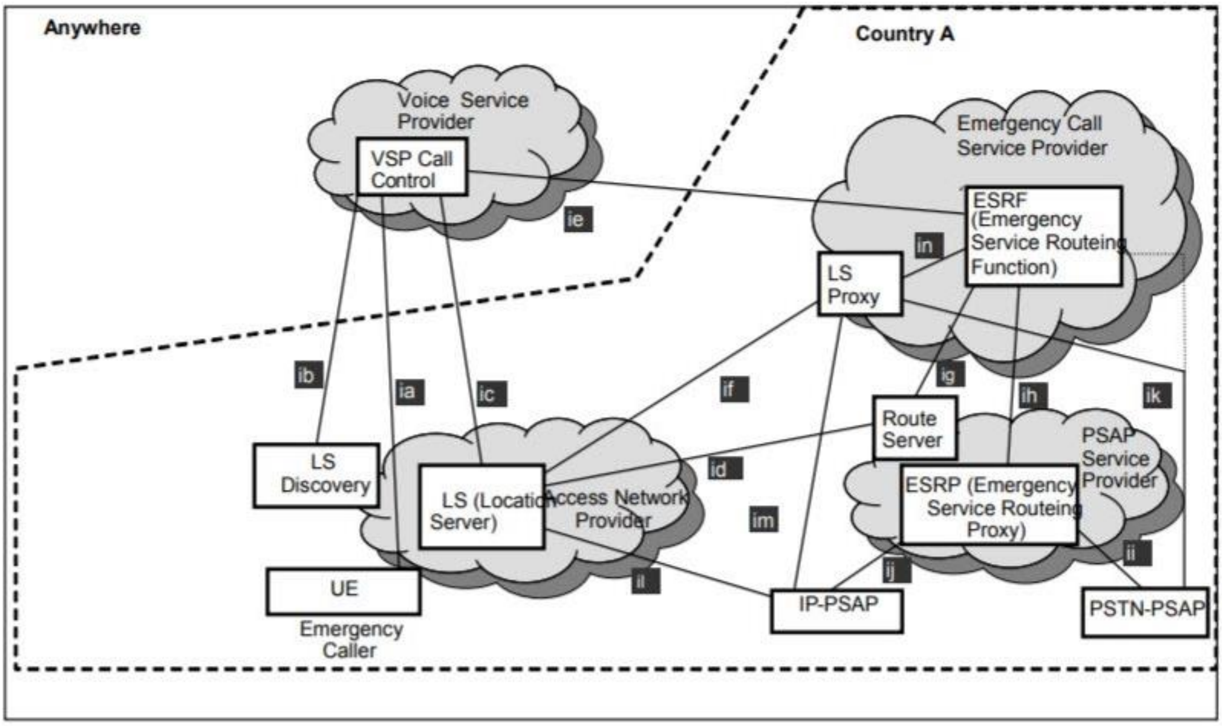


Fig. 2: NG112 architecture according to ETSI ES 203 178

Emergency calls are no different to conventional telephony and are connected by means of the VoIP signalling protocol SIP via any IP-based (package-based) network. The VoIP interconnection service that is currently offered by Swisscom Wholesale to the TSPs (referred to as Voice Service Providers, or VSPs, in the standard) is currently always provided via dedicated (private) IP links.
An important part of the architecture is the LIS (or LS as in fig.2). The LIS is the central point for management of the geo-information for an emergency call. Where and in what context the service (Emergency Call Service Provider, or ECSP) is to be operated in future is determined by the regulatory authorities. Between the VSP, ECSP, LIS, LIS proxy/ECSP (or LS proxy as in fig.2) and PSAP, the following interfaces are of note for the implementation of NG112. Based on the Presence Information Data Format Location Object (PIDF-LO), which will be explained in more detailed in section 4, localisation information is exchanged between the individual system components via the interfaces (e.g. <ic>):

0. **UE <ia> VSP:** The UE used for the emergency call (telephone, app, client) sends the emergency call via the access network to the VSP. The UE can also send a localisation from the device or an app in the form of a PIDF-LO document; this is the device-based localisation. The UE could also send a Location by Reference (LbyR) from the LIS of the access network, a network-based localisation. Since the access network operators are currently unregulated, the VSP will record the network-based localisation where possible.
1. **VSP/ECSP <ic> LIS:** The VSP or ECSP saves the localisation of the emergency call in the form of a PIDF-LO document by means of HELD to the LIS (https://lis.sosservice.ch) and receives a Location URI from the LIS in return.
2. **VSP <ie> ECSP:** Where possible, VSPs add the Location URI of the emergency call to the SIP signalling (SIP INVITE) and connect the emergency call to the central switchboard of the ECSP (Emergency Call Service Provider). This ECSP forwards the emergency call to the relevant local PSAP.
3. **ECSP <ih & ij> PSAP:** The ECSP forwards the emergency call to the relevant local PSAP. The Location URI reference, if available, is conveyed unchanged via SIP protocol to the emergency response centre.
4. **PSAP <im> LIS proxy/ECSP:** The PSAP receives the SIP INVITE to the telephony and shares the SIP INVITE with the mission control system via HTTPS. The mission control system extracts the information from the SIP INVITE, e.g. the PAI that contains the SIP URI, or the Geolocation, or Call-Info that contain an LbyR. By means of HELD and the Location URI or LbyR, or the SIP URI, the mission control system can request the network-based and device-based localisation from the LIS proxy (https://lisproxy.sosservice.ch). The PSAP and/or its operations control system receives a HELD response as a result with a PIDF-LO document from the relevant LIS.
5. **LIS proxy/ECSP <if> LIS:** The LIS proxy forwards the localisation queries to the right LIS. The right LIS is identified based on the Location URI or the SIP URI. The LIS supplies the localisations to the LIS proxy/ECSP in return, and the LIS proxy delivers them to the PSAP.

The NG112 provides for the conveyance of location information via SIP and HTTP. In the XML-defined request for documents, the interfaces <ic>, <im> and <if> use the HTTP Enabled Location Delivery (**HELD**) protocol, which is explained in more detail in section 7.

The NG112 standard provides for the Access Network Providers (ANPs) to be regulated and for an LIS to be operated for each ANP. This is not the case in reality. Regulation applies exclusively to the Voice Service Providers (VPSs), referred to as Telecommunications Service Providers (TSPs) in Switzerland. What this means is that, in contrast to the standard, a central LIS is required for each country.
The NG112 standard lacks a definition of how data are written to the LIS, and there is also no provision for migration of existing architecture. This document takes that into account. The focus is on the elements as in Fig. 3:

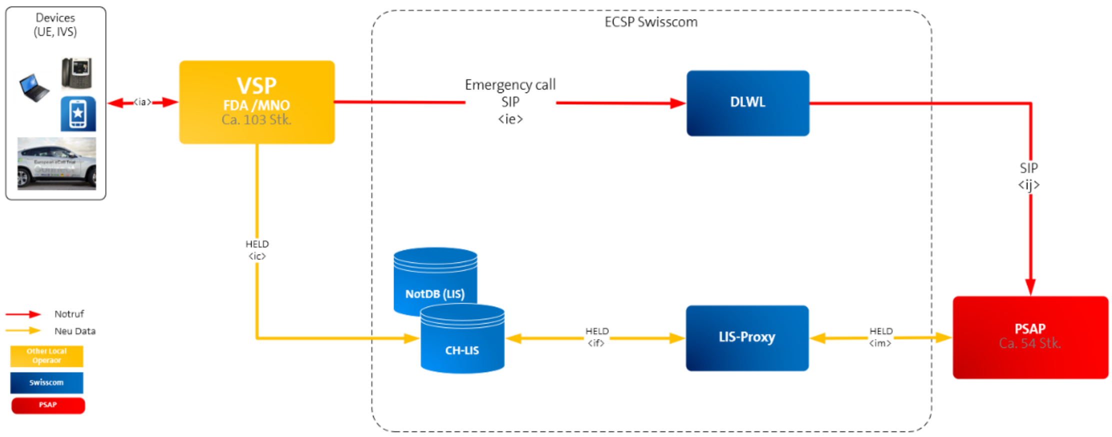


Fig. 3: Future NG112-CH architecture based on ETSI TS 203 178 with expansions

There are three new interfaces that differ from the previously referenced standards due to Switzerland's specific starting position:

- Push Interface VSP/ECSP <ic> LIS for supplying the location information for the emergency caller
- Connecting/signalling and conveyance of the emergency call <ij> by means of SIP to the PSAP, including a location reference for the emergency call
- Pull Interface PSAP <im> LIS proxy/ECSP for procurement of the location information for the emergency caller via the PSAP and/or their operations control system

3.2 Push Interface VSP <ie> ECSP

For the VSP, with the NG112-CH profiles there are two variants for how the location information can be conveyed to the PSAPs for an emergency call. In Switzerland, variant 1 is applied.

Variant 1: VSPs supply the location to the LIS with a HELD request and receive the corresponding Location URI (LbyR) in return. This Location URI is referenced in the SIP "Geolocation" header field (RFC6442) and is conveyed to the PSAP via SIP in the further signalling of the emergency call. The signalling remains compact.

Variant 2: The VSP sends the localisations received from the UE directly with the emergency call or in the SIP INVITE to the ECSP as a Location by Value (LbyV). The ECSP forwards the location information received transparently to the PSAP. The package size of the signalling of this LbyV gets quite big and may result in interoperability problems that can delay the emergency call distribution and localisation or possibly even prevent them.

3.3 Push Interface VSP <ic> LIS and ECSP <ic> LIS

The NG112 architecture and likewise the adaptation NG112-CH with a profile adapted to customer requirements assume a central LIS. The VSPs send the network-based or device-based localisation of an emergency call with a POST request (Push) via an HTTPS connection by means of HELD to the central LIS in the PIDF-LO format of the IETF standard. One exception is the eCall112, which uses the XML (XER) format pursuant to DIN CEN 15722.

In contrast to the standards referenced, the VSP receives a Location URI (LbyR) from the LIS. The VSP inserts the Location URI in the SIP "Geolocation" header field (with eCall it is the SIP "Call-Info" header field, see RFC3261) before the emergency call is forwarded to the PSAP.

3.4 Pull Interface PSAP <im> LIS proxy

When the emergency call is connected via <ij>, the SIP INVITE is sent from the telephony system (e.g. SBC) to the operations control system. This can be achieved with “300 multiple choices” (RFC3261), which permits the SIP INVITE to share with other systems via HTTP.

The operations control system extracts the desired data from the SIP INVITE, or at the very least the header field “PAI”, which contains the SIP URI, the header field “Geolocation”, which contains the Location URI, or the header field “Call-Info”, which contains the Location URI of an eCall.

The operations control system requests the location information from the LIS proxy by means of HELD and the Location URI. If no Location URI is available, then the HELD request can be made with the SIP URI. With “WireLess” emergency calls, a HELD request is subsequently repeated every ten seconds until the device-based localisation arrives, up to a maximum of five times.

3.5 Pull Interface LIS proxy / ECSP <if> LIS

The LIS proxy forwards the HELD requests from the PSAP to the responsible LIS. The LIS replies with a HELD response, which the LIS proxy forwards to the enquiring PSAP.

Based on the content of the HELD request, the LIS proxy will execute forwarding to the LIS as follows:

- Central CH-LIS according to figure 4
- Emergency call database (SOSDB)

4 Standards in emergency communication with location information

One essential component of a modern emergency communications architecture is that of location details for the caller and conveyance of the location information to the emergency response centre. Over the last few years, huge efforts have been made to standardise conveyance of speech and location information for emergency calls. Various committees have addressed standardisation issues and defined international standards.

The IETF consists of various active working groups, which are continually working on the further development of standards. For IP-based emergency communications and conveyance of location information, the following IETF working groups are relevant:

- GEOPRIV http://tools.ietf.org/wg/geopriv
- ECRIT: http://tools.ietf.org/wg/ecrit
- SIPCORE: http://tools.ietf.org/wg/sipcore

GEOPRIV (Geographic Location/Privacy) offers contributions on the general presentation of location information, while ECRIT (Emergency Context Resolution with Internet Technologies) offers contributions on the conveyance of data relevant to emergency calls, and SIPCORE provides proposals for the voice protocol.

For the presentation/format/syntax of geo-information, the Working Standards of the Open Geospatial Consortium (OGS) apply. In contrast to the previously used Mobile Location Protocol (MLP), Geography Markup Language (GMLV3) is a geo-standard proposed by the IETF which is independent of global technology. **http://www.opengeospatial.org/standards/gml** GML V3.

4.1 Location Information Server (LIS)

The Location Information Server is an important component of the NG112 architecture. The standard specifies one LIS for each ANP. The ANPs are currently not subject to regulation, hence by way of derogation from the standard, a central LIS is required in Switzerland.

New standardised interfaces and definitions of an LIS are needed. The technical details of a European emergency call platform with interfaces for emergency call localisation and transport are compiled in [1]. The open architecture is essentially based on four independent service providers:

- Access Network Provider (ANP)
- Voice Service Provider (VSP)
- Emergency Call Service Provider (ECSP)
- PSAP Service Provider (PSP)

The functional units of ANP, ECSP and PSP as components of a country-specific domain are determined within Europe by national regulatory directives. The VSP can operate its voice service inside or outside the domain.

In the standardised architecture (see Fig. 2: NG112 architecture according to ETSI ES 203 178), the LIS supplies the emergency call position in the form of a PIDF-LO (Location by Value) object or a reference in the Location URI (Location by Reference). The concept of 'dereferencing' of the Location URI requires the LIS to have a query interface that supplies a PIDF-LO data in return for a given Location URI or SIP URI.

In addition, with a central LIS a writing interface is required for the VSP, which can transmit a PIDF-LO or an MSD-XML (eCall) data and supplies a Location by Reference or Location URI, which a VSP can send to the PSAP in the SIP INVITE in the "Geolocation" header field.

4.2 LIS proxy

The Location Information Server proxy is a central element in the NG112 architecture for a country. All PSAPs in the country request localisations from the LIS proxy. This procures the localisation from the right LIS, which sends back a PIDF-LO or MSD-XML document in return for a given Location URI or SIP URI, and the LIS proxy passes this on to the PSAP.

The LIS proxy mediates between the various LISs and can, if necessary, include logic for a conveyance solution, e.g. which SIP URI (or User URI) can be found on which LIS.

In future, queries from the ECSP will be possible via the LIS proxy by means of (public/private) IP addresses for callers, and the LIS proxy will then forward them to the right LIS. This is thanks to the registration of the LIS with the LSD (Location Server Discovery), which knows the relevant IP addresses/ranges. This function can only be used, however, once the prerequisites are fulfilled, for example regulation of the ANPs.

4.3 IETF NG standards and useful links

The IETF defines the global standard for the Internet. In the language of the IETF, RFCs are permanently accessible documents that set out the IETF's technical consensus. An RFC specification generally begins with an Internet draft document, much of which will become an RFC document after a prolonged period of discussion.

All of the RFCs used in this document can be queried via the IETF document service:

http://tools.ietf.org/html/<Document Name> (e.g. http://tools.ietf.org/html/rfc5985)

4.4 IETF XML registry

The direct technical implementation of RFCs in communication interfaces is challenging and time-consuming. For this reason, the Internet Assigned Numbers Authority (IANA) (https://www.iana.org/) manages the central repository for registers of protocol names and numbers, which takes care of the global co-ordination of the DNS root, IP addressing and other Internet protocol resources.

RFC3688 defines a registration system managed by IANA for XML documents that are used in IETF protocols. These documents are subdivided into classes: XML namespaces, declarations for document types and schemas. The class and document names are combined to create one unequivocal name (Identifier, Public ID).

https://www.iana.org/assignments/xml-registry/xml-registry.xhtml

The IETF XML registry also contains the technical specifications of the interfaces as W3C XML Schema Definition (XSD), which can be used for automated generation of interface codes. In addition, the XSD file permits verification of the XML interface documents for syntactical accuracy.

Under the XML registry, a series of resources are defined, which are important for the interfaces of emergency call communication and location conveyance. These are the areas of geopriv, EmergencyCallData and pidf.

geopriv:conf	urn:ietf:params:xml:ns:geopriv:conf	ns/geopriv/conf.txt	[RFC7459]
geopriv:held	urn:ietf:params:xml:ns:geopriv:held	ns/geopriv/held.txt	[RFC5985]
geopriv:held:flow	urn:ietf:params:xml:ns:geopriv:held:flow	ns/geopriv/held/flow.txt	[RFC6915]
geopriv:held:id	urn:ietf:params:xml:ns:geopriv:held:id	ns/geopriv/held/id.txt	[RFC6155]
geopriv:held:policy	urn:ietf:params:xml:ns:geopriv:held:policy	ns/geopriv/held/policy.txt	[RFC7199]
geopriv:held:ri	urn:ietf:params:xml:schema:geopriv:held:ri	ns/geopriv/held/ri.txt	[RFC7840]
geopriv:lm	urn:ietf:params:xml:ns:geopriv:lm	ns/geopriv/lm.txt	[RFC7105]
geopriv:lm:basetypes	urn:ietf:params:xml:ns:geopriv:lm:basetypes	ns/geopriv/lm/basetypes.txt	[RFC7105]
geopriv:lm:cellular	urn:ietf:params:xml:ns:geopriv:lm:cell	ns/geopriv/lm/cellular.txt	[RFC7105]
geopriv:lm:dhcp	urn:ietf:params:xml:ns:geopriv:lm:dhcp	ns/geopriv/lm/dhcp.txt	[RFC7105]
geopriv:lm:dsl	urn:ietf:params:xml:ns:geopriv:lm:dsl	ns/geopriv/lm/dsl.txt	[RFC7105]
geopriv:lm:gnss	urn:ietf:params:xml:ns:geopriv:lm:gnss	ns/geopriv/lm/gnss.txt	[RFC7105]
geopriv:lm:lldp	urn:ietf:params:xml:ns:geopriv:lm:lldp	ns/geopriv/lm/lldp.txt	[RFC7105]
geopriv:lm:wifi	urn:ietf:params:xml:ns:geopriv:lm:wifi	ns/geopriv/lm/wifi.txt	[RFC7105]

Fig. 4: IANA geopriv namespace definitions

EmergencyCallData	urn:ietf:params:xml:schema:EmergencyCallData	schema/EmergencyCallData.xsd	[RFC7852]
EmergencyCallData:Comment	urn:ietf:params:xml:schema:EmergencyCallData:Comment	schema/EmergencyCallData/Comment.xsd	[RFC7852]
EmergencyCallData:DeviceInfo	urn:ietf:params:xml:schema:EmergencyCallData:DeviceInfo	schema/EmergencyCallData/DeviceInfo.xsd	[RFC7852]
EmergencyCallData:ProviderInfo	urn:ietf:params:xml:schema:EmergencyCallData:ProviderInfo	schema/EmergencyCallData/ProviderInfo.xsd	[RFC7852]
EmergencyCallData:ServiceInfo	urn:ietf:params:xml:schema:EmergencyCallData:ServiceInfo	schema/EmergencyCallData/ServiceInfo.xsd	[RFC7852]
EmergencyCallData:SubscriberInfo	urn:ietf:params:xml:schema:EmergencyCallData:SubscriberInfo	schema/EmergencyCallData/SubscriberInfo.xsd	[RFC7852]

Fig. 5: EmergencyCallData schema

pidf:geopriv10	urn:ietf:params:xml:schema:pidf:geopriv10	schema/pidf/geopriv10.xsd	[RFC4119]
pidf:geopriv10:basicPolicy	urn:ietf:params:xml:schema:pidf:geopriv10:basicPolicy	schema/pidf/geopriv10/basicPolicy.xsd	[RFC4119]
pidf:geopriv10:civicAddr	urn:ietf:params:xml:schema:pidf:geopriv10:civicAddr	schema/pidf/geopriv10/civicAddr.xsd	[RFC5139]
pidf:geopriv10:civicAddr:ext	urn:ietf:params:xml:schema:pidf:geopriv10:civicAddr:ext	schema/pidf/geopriv10/civicAddr/ext.xsd	[RFC6848]
pidf:geopriv10:civicLoc	urn:ietf:params:xml:schema:pidf:geopriv10:civicLoc	schema/pidf/geopriv10/civicLoc.xsd	[RFC4119]
pidf:geopriv10:dataProvider	urn:ietf:params:xml:schema:pidf:geopriv10:dataProvider	schema/pidf/geopriv10/dataProvider.xsd	[RFC4119]
pidf:geopriv10:dynamic	urn:ietf:params:xml:schema:pidf:geopriv10:dynamic	schema/pidf/geopriv10/dynamic.xsd	[RFC5962]
pidf:geopriv10:lmsrc	urn:ietf:params:xml:schema:pidf:geopriv10:lmsrc	schema/pidf/geopriv10/lmsrc.xsd	[RFC7105]
pidf:geopriv10:relative	urn:ietf:params:xml:schema:pidf:geopriv10:relative	schema/pidf/geopriv10/relative.xsd	[RFC7035]

Fig. 6: Geopriv schema

The following table provides references to the standards (RFCs) that are relevant for emergency call localisation and location conveyance. The standards determine how the notifications should look in detail and what usage information can be exchanged between the communication partners.

The IETF standards for the communications protocol regarding the Location Information Server can be divided into three areas:

PIDF-LO: Presence Information Data Format Location Object. Data interface for conveyance of location information. This format is used both for the PULL and the PUSH interfaces.

HELD: HTTP-Enabled Location Delivery. XML interface for querying the location information from a central LIS.

SIP: Session Initiation Protocol is a signalling protocol that is used for VoIP.

Table 3: Relevant RFC

Feature	Standard	Protocol	XML schema / URI
PIDF-LO		**Presence Information Data Format Location Object**	
	RFC3863	Initially defines the Presence Format PIDF (presence and absence notifications). Contains only rudimentary details on presence location, e.g. home, office, car.	The format is registered as a MIME type application/pidf+xml. The XSD specification is set out in RFC3863.
	RFC4119	Defines the GEOPRIV Location Object PIDF-LO Format for the presentation of geographical location info.	urn:ietf:params:xml:ns:pidf:geopriv10 available in the XSD geopriv10.xsd. urn:ietf:params:xml:ns:pidf:geopriv10:civicLoc available in the XSD file civicLoc.xsd.
	RFC5139	Defines additional information such as the Civic Address in the PIDF-LO	urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr available in the XSD file civicAddr.xsd.
	RFC6848	Defines extensions in the civicAddr in the PIDF-LO	urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr available in the XSD file civicAddr.xsd
	RFC5774	Guideline on creating expansions of the civicAddress for own profiles (IANA registration)	
	RFC7852	Defines additional information on the service such as ServiceInfo, DeviceInfo, SubscriberInfo, ProviderInfo and Comment	urn:ietf:params:xml:ns:EmergencyCallData available in the XSD file EmergencyCallData.xsd.

	RFC7459	Defines the reliability of the location information	urn:ietf:params:xml:ns:EmergencyCallData available in the XSD file EmergencyCallData.xsd.
	RFC5491	Recommends use of PIDF-LO of GML Version 3.1.1 as location information	
	RFC5962	Expansion of the PIDF-LO with components for dynamics (speed, orientation, heading)	urn:ietf:params:xml:ns:pidf:geopriv10:dynamic
	RFC7840	Expansion of the HELD protocol to include the definition of routing information in the location information.	
	RFC3339	Defines the format of Timestamp, including support of time zones.	
HELD		**HTTP-Enabled Location Delivery**	
	RFC5985	HELD basic definitions. Defines LIS queries 'locationRequest' and 'locationResponse' with parameters. The important thing here is the possibility of sending back a Location URISet in the locationResponse. Makes it possible, e.g., to send back multiple MIME types in a 'locationResponse'.	urn:ietf:params:xml:geopriv:held MIME type: application/held+xml
	RFC6155	Definition of the lookup parameters	urn:ietf:params:xml:ns:geopriv:held:id Definition of the device ID in section 6 of RFC6155
	RFC5808	Requirements of a Location by Reference mechanism	
	RFC6753	Describes location dereferencing	
SIP		**Session Initiation Protocol**	
	RFC3261	Defines the Session Initiation Protocol as the basis of IP telephony	
	RFC3311	Defines the Session Initiation Protocol update method	
	RFC3856	Defines the Presence Event Packet for the SIP protocol	

RFC6443	Defines a framework for emergency calls via the SIP protocol. SIP signalling, location determination. LoST server.
RFC3325	Defines the P-Asserted-Identity (PAI) header, private expansions of the Session Initiation Protocol (SIP) for the confirmed identity in trustworthy networks
RFC3455	Private Header (P-Header) Extensions to the Session Initiation Protocol (SIP) for the 3rd Generation Partnership Project (3GPP). Defines the access technology for mobile communications.

LOST		**Location-to-Service Translation Protocol**
	RFC5222	Definition of mapping functions

4.5 ETSI standards

As the basis for the NG112 interfaces, the following supplementary EENA and ETSI documents are used:

- EENA (Next Generation 112 – Long Term Definition) [5]
- ETSI ES 203 178 Functional architecture to support European requirements on emergency caller location determination and transport [1]
- ETSI ES 203 283 Protocol specifications for Emergency Service Caller Location determination and transport [2]
- RFC3856 (A Presence Event Package for the Session Initiation Protocol (SIP))

4.6 Standards in connection with eCalls

With eCalls, position and vehicle data are conveyed automatically by the IVS (In-Vehicle System) as a Minimal Set of Data (MSD) in an emergency situation pursuant to DIN CEN 16062, 17184, 15722 ff. The vehicle's data conveyance (IVS) takes place via the voice channel only works on UMTS network and for 112. In Switzerland, the MSD is extracted from the voice channel by the VSP or MNO, converted into the XML format pursuant to DIN CEN 15722 Annex C, packaged in a PIDF-LO, and written to the central LIS for Switzerland by means of HELD via <ic>. The PSAP procures the MSD from the LIS proxy by means of HELD via <im>. The following standards are relevant for such data exchange:

- DIN CEN 15722 Intelligent transport systems – ESafety –ECall Minimum Set of Data
- RFC3863 Presence Format PIDF
- RFC5985 HELD

5 Presentation of geographical information in NG112

For the presentation of geographical emergency call location information, the IETF standards propose the Presence Information Data Format (PIDF-LO). The schema expansion defined in RFC4119 contains a <location-info> object. The standard leaves open the question of the geo-format used to provide the geographical position. As a minimum, the system must support GML Version 3.0, which is used for NG112 in Switzerland. The following formats would be possible:

- GML (Geographic Markup Language), used in Switzerland for NG112.
- KML (Keyhole Markup Language)
- The MLP (Mobile Location Protocol), used by 3GPP to transmit positions from the mobile communications network.

5.1 Presence Information Data Format Location Object (PIDF-LO)

The PIDF was originally used as an XML-based format for conveyance of the presence status in Internet-based services (status, communication of address). With the aid of the status, the presence or availability of the call recipient can be displayed in an Internet voice application. The PIDF-LO format expands the location to include the geopriv element for presentation of the geographic position.

In the following illustration, the PIDF-LO is presented with its individual elements in diagram form.

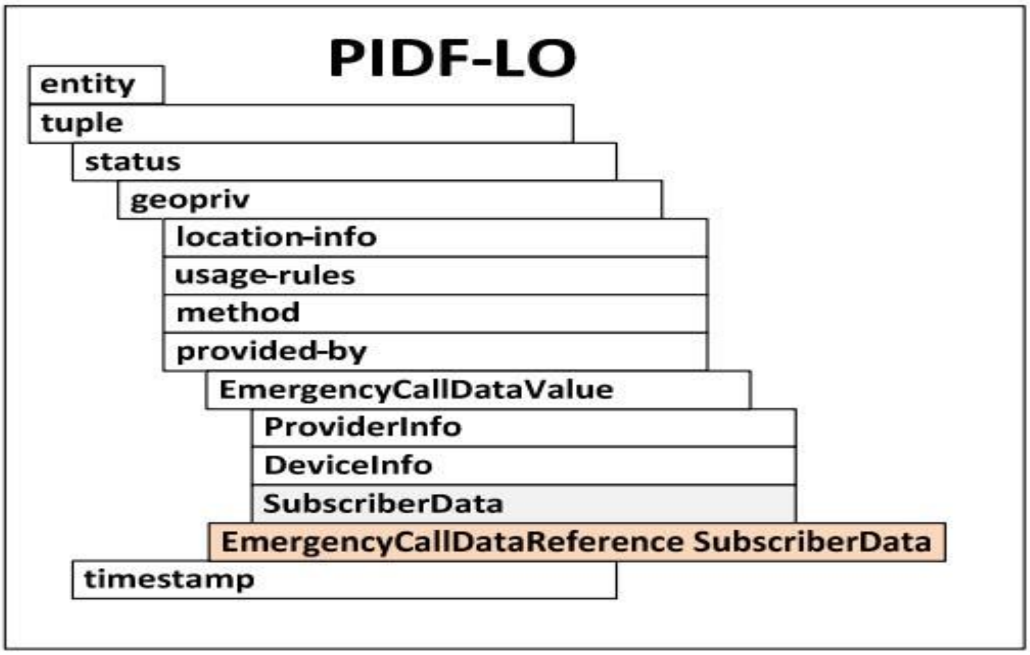


Fig. 7: The Presence PIDF-LO (XML structure)

```xml
<?xml version="1.0" encoding="UTF-8"?>
<presence
   xmlns="urn:ietf:params:xml:ns:pidf"
   xmlns:gp="urn:ietf:params:xml:ns:pidf:geopriv10"
   entity="pres:sample@example.com">
   <tuple id="0815">
      <status>
         <gp:geopriv>
            <gp:location-info>
               <!-- location information is inserted here -->
            </gp:location-info>
            <gp:usage-rules>
               <gp:retransmission-allowed>no</gp:retransmission-allowed>
               <gp:retention-expiry>2021-02-10T09:00:10+02:00</gp:retention-expiry>
            </gp:usage-rules>
         </gp:geopriv>
      </status>
      <timestamp>2021-02-10T08:31:00+02:00</timestamp>
   </tuple>
</presence>
```

Fig. 8: Example of PIDF-LO formatted content

The following section outlines the elements of the PIDF-LO in detail. The relevance of the protocol components for NG112 communication are specified below.

Parameters: entity=uri. In Switzerland, the entity contains the User Part of the SIP URI of the caller (Caller ID) as a pres-URI, e.g. entity="pres:+41790000000"

```xml
<presence
   xmlns="urn:ietf:params:xml:ns:pidf"
   xmlns:gp="urn:ietf:params:xml:ns:pidf:geopriv10"
   xmlns:gml="http://www.opengis.net/gml"
   xmlns:gs="http://www.opengis.net/pidflo/1.0"
   entity="pres:+41790000000">
   <tuple id="fclnzj22sbtoxpj">
      <status>
         <gp:geopriv>
            <gp:location-info>
               <Point
                  srsName="urn:ogc:def:crs:EPSG::4326"
                  xmlns="http://www.opengis.net/gml">
                  <pos>43.623013240241434 7.046184539794921</pos>
               </Point>
            </gp:location-info>
            <gp:usage-rules />
            <gp:method>unknown</gp:method>
         </gp:geopriv>
      </status>
      <timestamp>2019-02-04T16:56:07+00:00</timestamp>
   </tuple>
</presence>
```

Fig. 9: Example from the ETSI plug tests

Element: tuple RFC5491 makes it possible to supplement geopriv elements with a <person> or <device> element. With this element, it is possible to define precisely whether the geographic position relates to the location of persons or devices.

- <tuple> is used for network-based localisations
- <device> is used for device-based localisations

In Switzerland, the "ID" of the element is used for designation of the underlying technology as follows:

- <tuple id ="WireLine"> are network-based localisations from WireLine
- <tuple id ="WireLess"> are network-based localisations from WireLess
- <device id = "AML"> are device-based from AML

Element: status is the container for location and user information.

Element: geopriv The most important additional container elements of geopriv are:

- <location-info> Element with the geo-information presented in GML 3.0 format
- <usage-rules> Element that provides information on the use of geo-information
- <method> Element that denotes the method for determining location information
- <provided-by> Element that contains information on the supplier of the location information.

On this matter, see also the ETSI TS 103 478 V1.1.1 specification (PEMEA) page 43, which provides the precise description of the PIDF-LO content.

Element: ProviderInfo is the container for information on the provider

- <DataProviderString> Element that contains the provider name as text, e.g. Swisscom (Switzerland) AG
- <ProviderID> Element that contains the unequivocal ID of the provider. The possibilities are VSP:255100420 pursuant to the OFCOM list or PLMN-:22801 pursuant to ETSI TS 123003, which denotes the mobile provider. The PLMN is made up of the MCC and MNC combined. Both examples contain the values for Swisscom.

PIDF-LO offers a flexible, versatile instrument for the presentation of location information.

The system presents:

- Civic Location Information (address information)
- Geospatial Location Information (geometric objects, such as dots, polygons, ellipses)
- Various systems of coordinates

One single PIDF-LO can contain any number of location objects. Hence, for example, the same document can contain a network-based mobile localisation with up to 10 ellipses and a device-based AML localisation with a GPS position.

Pursuant to RFC4119, all PIDF data that use a geopriv element must contain one or more import instructions with specification of the XML schema that is used for the geographic location format. In order to guarantee the interoperability of geopriv implementations, GML Version 3.0 is required as the minimum basic prerequisite for all GEOPRIV-supporting systems. In a best-practice document, the Open Geospatial Consortium (OGC) proposes GML Version 3.1.1 in the document [8]. Further information on the GML elements used can be found in section 6 GML.

5.2 NG112-CH profiles and XML namespaces

For the purposes of bundling the different sources of XSD for the interfaces <ic> and <im> for NG112 communication, a specific profile NG112-CH has been created, which summarises the different sources (RFCs, IANA Schema Repository, OGC Schemas) of XSD and adapts the XML semantics accordingly to Swiss requirements. The profile NG112-CH is a clearly defined subset of all possible standard definitions that is derived from the specific practical requirements of modern emergency communications. The advantage of a precisely defined profile is that the code for an interface can be automatically generated from the definitions.

The NG112-CH profile primarily defines the notifications for the deliveries of data by the VSP to the central LIS. The query interface of the LIS proxy for the PSAPs is likewise limited to this profile. However, as soon as the LIS proxy involves localised LISs alongside the central LIS (CH approach), as foreseen in the standard, the limitation to NG112-CH cannot be guaranteed and there may be other elements from that standard that arise in the interface notifications.

To make it possible to implement the dedicated profile, the XSD imported from the various sources has also been adapted and published with a name expansion specific to NG112-CH. However, the adaptations are limited to specification of "Any" elements, definition of values areas to be used, and removal of types and elements not used. The objective here was always to provide an XML schema with which NG112-CH-compatible notifications can be described and validated continuously and in detail. No expansions have been undertaken with regard to the definitions published in the standards.

XML namespaces are a powerful instrument for structuring data. They are used for unequivocal identification of the vocabulary of an XML document and to combine multiple XML languages within one single document. Their function can be compared with that of the prefix for telephone numbers. Namespaces are presented by means of URIs, generally with the use of normal web addresses. It is important to note here that the corresponding address must not already exist. It can be freely defined. Another important point with namespace information is to pay close attention to upper and lower case letters, including in the host section, as well as any URL coding.

If a URL is given as a namespace, additional information can be obtained under this address, such as a Document Type Definition (DTD) or an XML schema, abbreviated to XSD (XML Schema Definition).

In the ZIP file "NG112-CH_XSD-3.0.zip", the XSD is found within a structure that provides the complete NG112-CH profile.

The individual XML schemas are given as attributes and thus define the elements of the XML structure (e.g. the geopriv element in the Presence Object through the definition of the prefixes).

xmlns:ca="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr".

The following XML structure represents a Location Response with embedded Presence Object with location and address information. The geographic location is designated by a circle with a radius of 30 metres, while the postal address can be found in the <civicAddress> element.

```
<?xml version="1.0" encoding="UTF-8"?>
<locationResponse
   xmlns="urn:ietf:params:xml:ns:geopriv:held"
   xmlns:gp="urn:ietf:params:xml:ns:pidf:geopriv10"
   xmlns:gpb="urn:ietf:params:xml:ns:pidf:geopriv10:basicPolicy"
   xmlns:gml="http://www.opengis.net/gml"
   xmlns:gs="http://www.opengis.net/pidflo/1.0"
   xmlns:pd="urn:ietf:params:xml:ns:pidf"
   xmlns:conf="urn:ietf:params:xml:ns:geopriv:conf"
   xmlns:ca="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr"
   xmlns:ad="urn:ietf:params:xml:ns:EmergencyCallData"
   xmlns:pi="urn:ietf:params:xml:ns:EmergencyCallData:ProviderInfo">

   <pd:presence entity="pres:+41790000000">
      <pd:tuple id="WireLine">
         <pd:status>
            <gp:geopriv>
               <gp:location-info>
                  <gs:Circle srsName="urn:ogc:def:crs:EPSG::4326">
                     <gml:pos>46.9469359 7.4352436</gml:pos>
                     <gs:radius uom="urn:ogc:def:uom:EPSG::9001">30.0</gs:radius>
                  </gs:Circle>
                  <conf:confidence pdf="normal">95</conf:confidence>
                  <ca:civicAddress>
                     <ca:country>CH</ca:country>
                     <ca:A3>Ostermundigen</ca:A3>
                     <ca:RD>Alpenstrasse</ca:RD>
                     <ca:HNO>2b</ca:HNO>
                     <ca:NAM>SBB AG</ca:NAM>
                     <ca:PC>3072</ca:PC>
                     <ca:BLD>Bahnhof SBB</ca:BLD>
                     <ca:ADDCODE>EGID:1289317</ca:ADDCODE>
                  </ca:civicAddress>
               </gp:location-info>
               <gp:usage-rules />
               <gp:method>DHCP</gp:method>
               <gp:provided-by>
                  <ad:EmergencyCallDataValue>
                     <pi:EmergencyCallData.ProviderInfo>
                        <pi:DataProviderString>Swisscom (Schweiz) AG</pi:DataProviderString>
                        <pi:ProviderID>PLMN:22801</pi:ProviderID>
                     </pi:EmergencyCallData.ProviderInfo>
                  </ad:EmergencyCallDataValue>
               </gp:provided-by>
            </gp:geopriv>
         </pd:status>
         <pd:timestamp>2021-03-30T20:57:22Z</pd:timestamp>
      </pd:tuple>
   </pd:presence>
</locationResponse>
```

Fig. 10: PIDF-LO example with a point/circle and address information

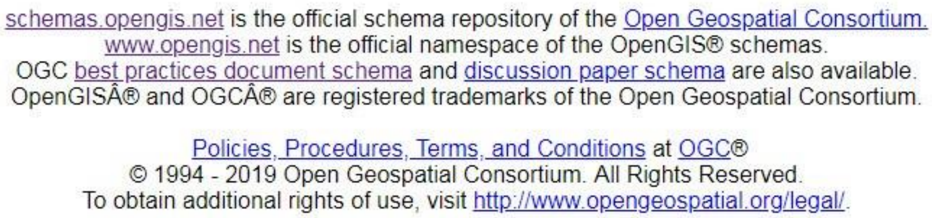
It is worth noting that there are two similar schema definitions in the geopriv10 registry with different namespaces for the addresses: civicLoc (RFC4119) and the newer version civicAddress (RFC5139). civicAddress contains additional address information and can be expanded to include other distinct attributes (xs:any). For additional address attributes, a distinct XSD can be created. An interface expansion takes place, for example, through the definition of a distinct local NG112-CH profile.

6 GML

The GML is defined by the OGC. GML is a standard for the description of geographic data and is comparable with KML. In contrast to GML, KML has achieved broad dissemination in the industry with Google Earth, hence KML is considered the de facto industry standard. The formal standardisation processes generally last too long for commercial services to be able to realise market-ready products in time. For long-term projects like NG112, the use of standards from a standardisation institution (IETF) undoubtedly makes more sense, since it means long-term technical stability is guaranteed.

GML is available in various versions as XSD on the OGC server under the URL

http://schemas.opengis.net/gml in the schema repository to download for free:



schemas.opengis.net is the official schema repository of the Open Geospatial Consortium.
www.opengis.net is the official namespace of the OpenGIS® schemas.
OGC best practices document schema and discussion paper schema are also available.
OpenGISÂ® and OGCÂ® are registered trademarks of the Open Geospatial Consortium.

Policies, Procedures, Terms, and Conditions at OGC®
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To obtain additional rights of use, visit http://www.opengeospatial.org/legal/.

Fig. 11: Official OGC schema repository

6.1 geoshape profiles for GEOPRIV PIDF-LO

Since the GML standard is very comprehensive and therefore imposes numerous requirements on application in practice, GML presents various profiles to be applied in specific usage cases. For the application of GML in a PIDF-LO, the profile known as geoshape/PIDF-LO-1.0 (GML-pidf-lo-shape.xsd) has been created, which is based on GML 3.1.1 and contains the necessary geometric data types.

The profile is available under the following link: http://schemas.opengis.net/gml/3.1.1/profiles/geoshape/

Not all the elements defined in geoshape are relevant in the NG112-CH use case. NG112-CH makes use of the following geometric data types:

- Points
- Circles
- Lines
- Polygons

6.2 Coordinates systems

Alongside the presentation of geometry types, the coordinates reference system must also be indicated for a Geolocation in each case. In GML the geodetic datum must be indicated with reference to a coordinates reference system (CRS). A CRS references a coordinates system by means of a datum on the Earth.

In the field of Geographic Information Systems (GIS), there are two important CRS definitions from different organisations: Oil and gas producers (OGPs), previously known as the European Petroleum Survey Group (EPSG), and the OGC. The two sets of CRS definitions overlap to a great extent. For example, OGC:CRS84 is a variant of EPSG:4326 and differs only in the coordinates sequence of longitude and latitude. The EPSG CRS database is available at http://www.epsg.org. Recommendations for use of CRS references in GML datasets are provided in the OGC recommendation 07-092r3.

Here, GML supports multiple standards. For CH-NG112, the following is defined:

- 2D: World Geodetic System (WGS) 84 (latitude, longitude), as indicated by the URN urn:ogc:def:crs:EPSG::4326. This is a two-dimensional CRS.
- 3D: World Geodetic System (WGS) 84 (latitude, longitude, altitude), as indicated by the URN urn:ogc:def:crs:EPSG::4979. This is a three-dimensional CRS.

6.3 Units of measurement

GML permits definition of units of measurement for all parameters. In this document, we will limit our-selves to the unit of length and two angle units.

Units of length are given in metres, which are specified with the following URN:

URN	Unit of measurement	Note
`urn:ogc:def:uom:EPSG::9001`	Metre	Unit of length in *m*

Table 4: Definition of lengths

Angular dimensions must be given in degrees:

URN	Unit of measurement	Note
`urn:ogc:def:uom:EPSG::9102`	Degree	Angular dimension in 0-360 degrees

Table 5: Definition of angles

6.4 Examples of GML3 geometry types highly relevant to NG112

The following section defines a number of Geography Markup Language (GML) geometries that are suitable for conveyance of location information in connection with NG112. Examples of each XSD specification are provided.

6.4.1 Point in GML

```
<gml:Point srsName="urn:ogc:def:crs:EPSG::4326">
  <gml:pos>46.95324 7.43953</gml:pos>
</gml:Point>
```

Fig. 12: Point in GML

The Coordinates Reference System 'urn:ogc:def:crs:EPSG::4326' corresponds to the WGS84 system. The point is used if no uncertainty has been detected in the determination of the position.

6.4.2 Ellipse in GML

The ellipse is not an elementary object within the scope of the GML3 language, but is defined in the geoshape profile. As shown in fig. 16; an ellipse is defined by the central point (pos), the semiaxis (semiMajorAxis, semiMinorAxis), and the angle of inclination (orientation).

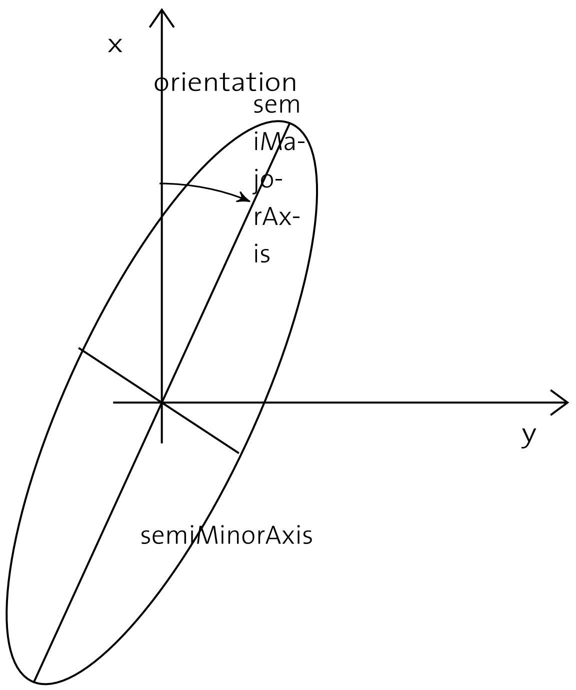

Fig. 13: Presentation of ellipses with the common parameters of pos, semiMajorAxis, semiMinorAxis and orientation.

swisscom

```xml
<gs:Ellipse srsName="urn:ogc:def:crs:EPSG::4326">
   <gml:pos>46.9524 7.439583</gml:pos>
   <gs:semiMajorAxis uom="urn:ogc:def:uom:EPSG::9001">1275</gs:semiMajorAxis>
   <gs:semiMinorAxis uom="urn:ogc:def:uom:EPSG::9001">670</gs:semiMinorAxis>
   <gs:orientation uom="urn:ogc:def:uom:EPSG::9102">43.2</gs:orientation>
</gs:Ellipse>
```

Fig. 14: Ellipse in GML pidflo/1.0

6.4.3 Circle in GML

```xml
<gs:Circle srsName="urn:ogc:def:crs:EPSG::4326">
   <gml:pos>46.9469359 7.4352436</gml:pos>
   <gs:radius uom="urn:ogc:def:uom:EPSG::9001">30.0</gs:radius>
</gs:Circle>
```

Fig. 15: Circle in GML pidflo/1.0

In GML the circle is derived from an arc. Its presentation requires three points on the arc for definition of the circle. This representation is not very common in the NG112 area and therefore the circle element has been redefined by a point- and radius-based representation. The centre of the circle determines the location and the radius gives a degree of uncertainty in determination of the position. In general, the point with the circle is suitable for presentation of positions identified by the Global Navigation Satellite System (GNSS).

6.4.4 Polygon in GML

Polygons consist of a sequence of points that can delimit the probable position more precisely. In GML, it is also possible to depict polygons with holes. This is not an option with geoshape/pidflo, however.

```xml
<gml:Polygon srsName="urn:ogc:def:crs:EPSG::4326">
   <gml:exterior>
      <gml:LinearRing>
         <gml:pos>47.23517808969296 7.5722226525103435</gml:pos>
         <gml:pos>47.23643653270075 7.572919110885395</gml:pos>
         <gml:pos>47.236566833951834 7.576848330502275</gml:pos>
         <gml:pos>47.23494398329502 7.580013591146116</gml:pos>
         <gml:pos>47.23260425511783 7.580931815845777</gml:pos>
         <gml:pos>47.23215617893838 7.579577088886806</gml:pos>
         <gml:pos>47.23391160602631 7.578360162362274</gml:pos>
         <gml:pos>47.23503838078654 7.576316162117978</gml:pos>
         <gml:pos>47.23517808969296 7.5722226525103435</gml:pos>
      </gml:LinearRing>
   </gml:exterior>
</gml:Polygon>
```

Fig. 16: Polygon in GML

6.4.5 Multiple objects in GML

Primarily intended for determining the location of emergency calls made by mobile callers, multi-ellipses are used to a great extent in the current E112 emergency call solution for depiction of the most probable positions of the callers. The network-based location identification is always subject to a certain degree of uncertainty, which is represented by the ellipses.

Fig. 12 shows a real mobile positioning situation. The purple ellipses, see Fig. 17, indicate the caller's most likely location identified by the Mobile Positioning System (MPS). These areas are relayed to the PSAPs, where they are displayed in the operations control systems.

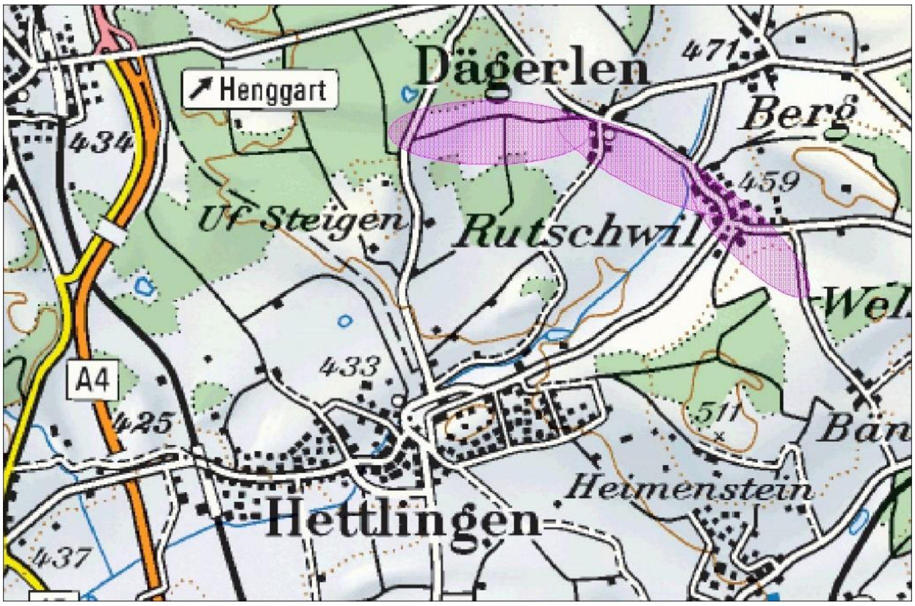

Fig. 17: Application of multi-ellipses:

PIDF-LO specifications (RFC5491) state that multiple geo-elements should only be used within one location information element in exceptional cases. For reasons of backward compatibility, presentation of multiple ellipses is completely unavoidable.

GML defines a MultiGeometry element, which is nevertheless unavailable in PIDF-LO/1.0. Accordingly, the NG112-CH profile permits inclusion of multiple geo-elements (ellipses, polygons) directly within a location information element. See the following examples:

```
    <gs:Ellipse srsName="urn:ogc:def:crs:EPSG::4326">
            <gml:pos>46.530583 6.131859</gml:pos>
            <gs:semiMajorAxis uom="urn:ogc:def:uom:EPSG::9001">2679</gs:semiMajorAxis>
            <gs:semiMinorAxis uom="urn:ogc:def:uom:EPSG::9001">693</gs:semiMinorAxis>
            <gs:orientation uom="urn:ogc:def:uom:EPSG::9102">94</gs:orientation>
    </gs:Ellipse>
    <gs:Ellipse srsName="urn:ogc:def:crs:EPSG::4326">
            <gml:pos>46.522349 6.183542</gml:pos>
            <gs:semiMajorAxis uom="urn:ogc:def:uom:EPSG::9001">2836</gs:semiMajorAxis>
            <gs:semiMinorAxis uom="urn:ogc:def:uom:EPSG::9001">698</gs:semiMinorAxis>
            <gs:orientation uom="urn:ogc:def:uom:EPSG::9102">115</gs:orientation>
    </gs:Ellipse>
       <conf:confidence pdf="normal">95</conf:confidence>
    </gp:location-info>
```

Fig. 18: Multi-ellipses in GML

```xml
<gp:location-info>
   <gml:Polygon srsName="urn:ogc:def:crs:EPSG::4326">
      <gml:exterior>
         <gml:LinearRing>
            <gml:pos>47.23517808969296 7.5722226525103435</gml:pos>
            <gml:pos>47.23643653270075 7.572919110885395</gml:pos>
            <gml:pos>47.236566833951834 7.576848330502275</gml:pos>
            <gml:pos>47.23494398329502 7.580013591146116</gml:pos>
            <gml:pos>47.23260425511783 7.580931815845777</gml:pos>
            <gml:pos>47.23215617893838 7.579577088886806</gml:pos>
            <gml:pos>47.23391160602631 7.578360162362274</gml:pos>
            <gml:pos>47.23503838078654 7.576316162117978</gml:pos>
            <gml:pos>47.23517808969296 7.5722226525103435</gml:pos>
         </gml:LinearRing>
      </gml:exterior>
   </gml:Polygon>
   <gml:Polygon srsName="urn:ogc:def:crs:EPSG::4326">
      <gml:exterior>
         <gml:LinearRing>
            <gml:pos>47.236148728946524 7.568956513444507</gml:pos>
            <gml:pos>47.23567905007111 7.566677315428862</gml:pos>
            <gml:pos>47.234959882286795 7.566312439729331</gml:pos>
            <gml:pos>47.23520429586518 7.568954225406785</gml:pos>
            <gml:pos>47.236148728946524 7.568956513444507</gml:pos>
         </gml:LinearRing>
      </gml:exterior>
   </gml:Polygon>
   <conf:confidence pdf="normal">95</conf:confidence>
</gp:location-info>
```

Fig. 19: Multi-polygons in GML

6.5 The reliability of location information

IETF RFC7459 explicitly introduces a probability-density function to depict the reliability of the location information provided. The element has a PDF (Probability Density Function) parameter. This value can be pdf='normal' or pdf='unknown'. The value element is a number between 0 and 100, which indicates the reliability of the information in percent.

```xml
<gp:location-info>
   ...
   <conf:confidence pdf="normal">95</conf:confidence>
</gp:location-info>
```

Fig. 20: Examples of a PIDF-LO with reliability information (95%) for location information.

6.6 Minimum set of geometry types for NG112

The geometry types (geopriv shapes) listed below are permitted within the NG112 profile and are used for the conveyance of emergency call locations between the VSP/ECSP and the PSAPs:

Point (gml:Point): as an example for a middle point of an ellipse or a circle

Circle (gs:Circle) as an example for a fixed network connection or a GPS position

Ellipse (gs:Ellipse) as an example for an area with uncertain location determination (Cell ID-based)

Polygon (gml:Polygon) as an example for precise delimitation of geographical areas by means of more precise cell calculations

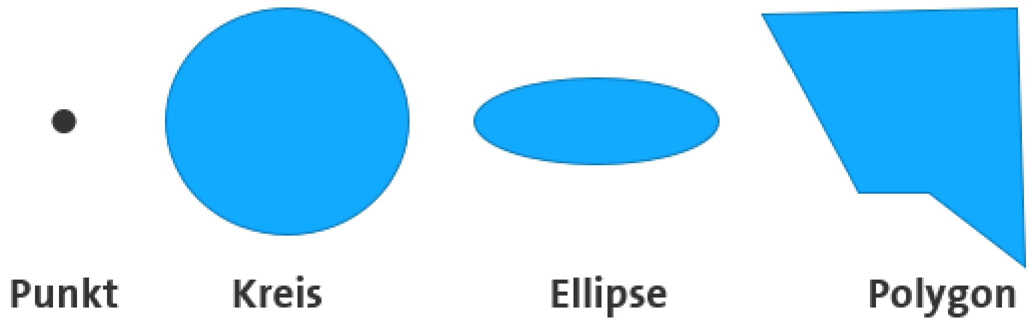

Fig. 21: geopriv shapes

7 LIS interface via HELD protocol

7.1 HELD protocol for querying location information

The HELD protocol defines the functions for location queries sent to an LIS or an LIS proxy. The HELD protocol is standardised in RFC5985.

7.2 HELD protocol for registering location information

The HELD protocol does not officially define any possibilities for location registration with an LIS. However, the protocol in RFC5985 is flexible enough that location information can be provided in the Location Request and a Location URI can be requested as a response. This makes it possible for a Voice Service Provider (VSP) to write network-based and device-based localisations or location information to a central LIS via the interface <ic>.

7.3 HELD request (query for location information)

The HELD Location Request, which is used on the interface PSAP <im> LIS proxy/ECSP asks the LIS or LIS proxy for location information. The request can hereby specify multiple parameters. The most important parameters are:

- **responseTime** (optional) The ResponseTime denotes how long a client is willing to wait for a response (locationRequest)
- **locationType** (optional) Possible values are 'geodetic' and 'civic'. 'civic' supplies the location address, 'geodetic' a geo-object as a <geopriv> element.
- **exact** (optional) The 'exact' attribute influences the LIS, so the result has to be delivered according to the requirements in the locationType.
- **code** All error messages must contain an error code
- **message** A legible error message is issued in case of errors
- **presence** Defines the Location Object (locationResponse)

A sequence diagram for location queries from the PSAP to the LIS via LIS proxy is as follows:

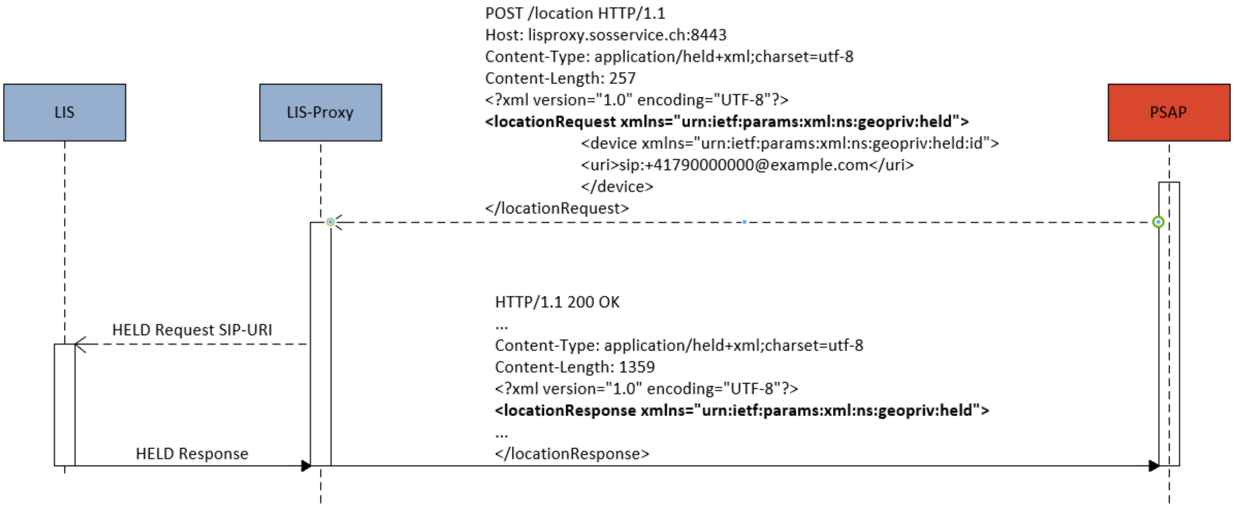

Fig. 22: Location Request with an SIP URI as an identifier

In the standard RFC6155 (section 3.7), other identifiers are indicated for mobile devices, of which only a small proportion are used in NG112-CH. The identifiers used today are:

Location URI: URI (e.g.: https://lis.sosservice.ch:8443/location/357yc6s64ceyoiuy5ax3o) shows on a Location Object (PIDF-LO or MSD-XML for eCalls)

uri Unified Resource Identifier (e.g.: <sip:**+41795935590**@138.187.57.135;user=phone>). sip: , denotes the SIP URI. The User Part in the URI identifier should contain the telephone number of the caller in the valid international E.164 (see E.164) format and is between 6 and 15 digits long. The @ is followed by the Host Part of the SIP URI.

The identifiers are defined unequivocally as xmlns (XML namespaces). There are other identifiers that are not used, however: **Ip, mac, msisdn, udpport, nai, fqdn.**

7.4 HELD request (registration/storage of location information)

The HELD Location Request, which is used on the VSP <ic> LIS interface, requests a Location URI from the LIS. A process going against the standard is the sending of location information in the form of a PIDF-LO (**presence**) for network-based localisations for WireLine or WireLess and device-based localisations such as AML or MSD-XML (eCalls). Sending of location information via <ic>, however, is a prerequisite for a functioning central LIS. The following parameters can be specified in this request:

locationType Possible value is 'Location URI'. 'locationURI' supplies a URI for the Location Object (Location by Reference).

exact The 'exact' attribute tells the LIS to supply the result according to the requirements in the locationType.

device/uri contains the identification of the caller, e.g. an MSISDN with pres:+41790000000

or an SIP URI, e.g. sip:+41790000000@example.com

presence Defines the Location Object (locationRequest)

A sequence diagram on the registration of the location by the VSP to the LIS takes the following form:

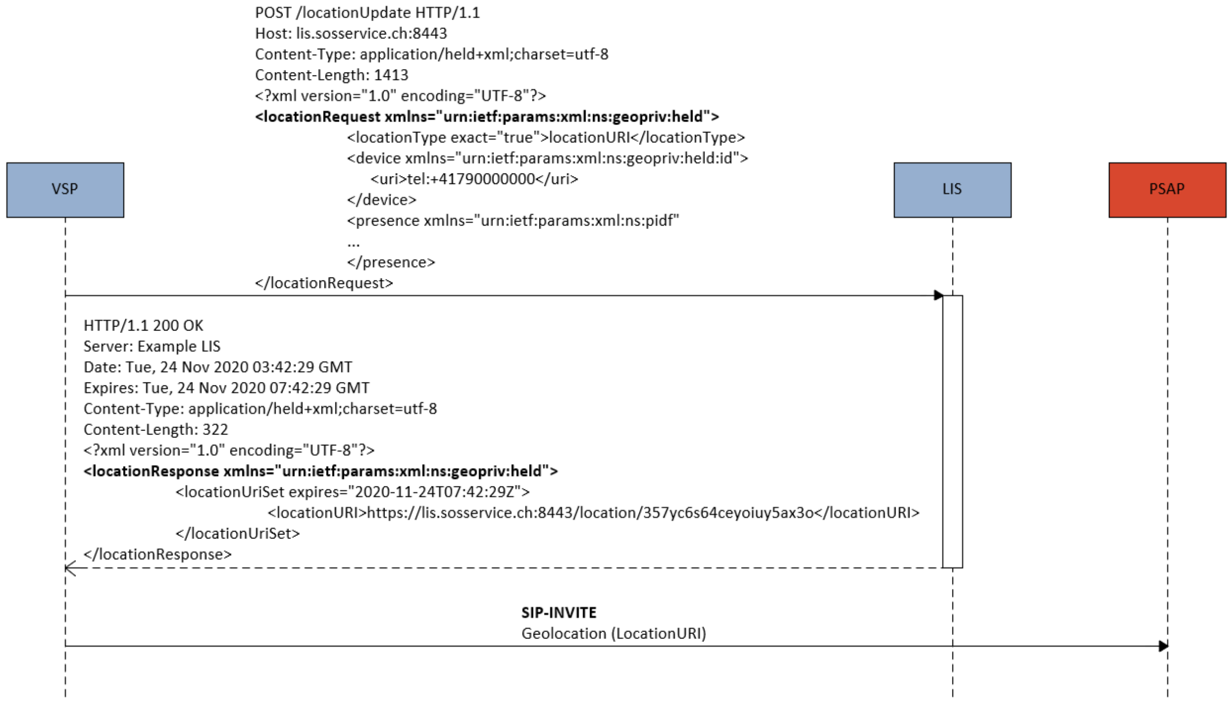

Fig. 23: Location Request for the registration and return of a Location URI

A complete example of registration with POST and HELD request for AML is provided in the following. Examples of the Location Request for network-based localisations such as WireLine can be found in section 9.1, while a WireLess example is provided in section 9.4

```
POST /locationUpdate HTTP/1.1
Host: lis.sosservice.ch:8443
Content-Type: application/held+xml;charset=utf-8
Content-Length: 1413
X-Correlation-ID: afc3d814-83c0-4cc8-a693-c80305f9a008

<?xml version="1.0" encoding="UTF-8"?>
<locationRequest
   xmlns="urn:ietf:params:xml:ns:geopriv:held"
   xmlns:gp="urn:ietf:params:xml:ns:pidf:geopriv10"
   xmlns:gpb="urn:ietf:params:xml:ns:pidf:geopriv10:basicPolicy"
   xmlns:id="urn:ietf:params:xml:ns:geopriv:held:id"
   xmlns:gml="http://www.opengis.net/gml"
   xmlns:gs="http://www.opengis.net/pidflo/1.0"
   xmlns:pd="urn:ietf:params:xml:ns:pidf"
   xmlns:conf="urn:ietf:params:xml:ns:geopriv:conf"
   xmlns:dyn="urn:ietf:params:xml:ns:pidf:geopriv10:dynamic"
   xmlns:ad="urn:ietf:params:xml:ns:EmergencyCallData"
   xmlns:pi="urn:ietf:params:xml:ns:EmergencyCallData:ProviderInfo"
   xmlns:dm="urn:ietf:params:xml:ns:pidf:data-model">

   <locationType exact="true">locationURI</locationType>
   <id:device>
      <id:uri>sip:+41790000000@example.com</id:uri>
   </id:device>
   <pd:presence entity="pres:+41790000000">
      <dm:device id="AML">
         <gp:geopriv>
            <gp:location-info>
               <gs:Circle srsName="urn:ogc:def:crs:EPSG::4326">
                  <gml:pos>46.9469359 7.4352436</gml:pos>
                  <gs:radius uom="urn:ogc:def:uom:EPSG::9001">30.0</gs:radius>
               </gs:Circle>
               <conf:confidence pdf="normal">95</conf:confidence>
            </gp:location-info>
            <gp:usage-rules />
            <gp:method>GNSS</gp:method>
            <gp:provided-by>
               <ad:EmergencyCallDataValue>
                  <pi:EmergencyCallData.ProviderInfo>
                     <pi:DataProviderString>Swisscom (Schweiz) AG</pi:DataProviderString>
                     <pi:ProviderID>PLMN:22801</pi:ProviderID>
                  </pi:EmergencyCallData.ProviderInfo>
               </ad:EmergencyCallDataValue>
            </gp:provided-by>
         </gp:geopriv>
         <dm:deviceID>IMEI:123456789012345</dm:deviceID>
         <dm:timestamp>2021-03-30T20:57:29Z</dm:timestamp>
      </dm:device>
   </pd:presence>
</locationRequest>
```

Fig. 24: Example of registration of AML localisation

7.5 HELD response (geodetic response)

The answer to a HELD `<LocationRequest>` is a `<LocationResponse>`. The response to the resolution of a reference query generally contains a `<geopriv>` element with <locationinfo>.

```
HTTP/1.1 200 OK
Server: Example LIS
Date: Tue, 30 Mar 2021 21:57:22 GMT
Expires: Wed, 31 Mar 2021 01:57:22 GMT
Cache-control: private
Content-Type: application/held+xml;charset=utf-8
Content-Length: 322
X-Correlation-ID: afc3d814-83c0-4cc8-a693-c80305f9a008

<?xml version="1.0" encoding="UTF-8"?>
<locationRequest
   xmlns="urn:ietf:params:xml:ns:geopriv:held"
   xmlns:gp="urn:ietf:params:xml:ns:pidf:geopriv10"
   xmlns:gpb="urn:ietf:params:xml:ns:pidf:geopriv10:basicPolicy"
   xmlns:id="urn:ietf:params:xml:ns:geopriv:held:id"
   xmlns:gml="http://www.opengis.net/gml"
   xmlns:gs="http://www.opengis.net/pidflo/1.0"
   xmlns:pd="urn:ietf:params:xml:ns:pidf"
   xmlns:conf="urn:ietf:params:xml:ns:geopriv:conf"
   xmlns:ca="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr"
   xmlns:ad="urn:ietf:params:xml:ns:EmergencyCallData"
   xmlns:pi="urn:ietf:params:xml:ns:EmergencyCallData:ProviderInfo">

   <locationType exact="true">locationURI</locationType>
   <id:device>
      <id:uri>sip:+41790000000@example.com</id:uri>
   </id:device>
   <pd:presence entity="pres:+41790000000">
      <pd:tuple id="WireLess">
         <pd:status>
            <gp:geopriv>
               <gp:location-info>
                  <gs:Ellipse srsName="urn:ogc:def:crs:EPSG::4326">
                     <gml:pos>46.530583 6.131859</gml:pos>
                     <gs:semiMajorAxis uom="urn:ogc:def:uom:EPSG::9001">2679</gs:semiMajorAxis>
                     <gs:semiMinorAxis uom="urn:ogc:def:uom:EPSG::9001">693</gs:semiMinorAxis>
                     <gs:orientation uom="urn:ogc:def:uom:EPSG::9102">94</gs:orientation>
                  </gs:Ellipse>
                  <gs:Ellipse srsName="urn:ogc:def:crs:EPSG::4326">
                     <gml:pos>46.522349 6.183542</gml:pos>
                     <gs:semiMajorAxis uom="urn:ogc:def:uom:EPSG::9001">2836</gs:semiMajorAxis>
                     <gs:semiMinorAxis uom="urn:ogc:def:uom:EPSG::9001">698</gs:semiMinorAxis>
                     <gs:orientation uom="urn:ogc:def:uom:EPSG::9102">115</gs:orientation>
                  </gs:Ellipse>
                  <conf:confidence pdf="normal">95</conf:confidence>
               </gp:location-info>
               <gp:usage-rules />
               <gp:method>CELL</gp:method>
               <gp:provided-by>
                  <ad:EmergencyCallDataValue>
                     <pi:EmergencyCallData.ProviderInfo>
                        <pi:DataProviderString>Swisscom (Schweiz) AG</pi:DataProviderString>
                        <pi:ProviderID>PLMN:22801</pi:ProviderID>
                     </pi:EmergencyCallData.ProviderInfo>
                  </ad:EmergencyCallDataValue>
               </gp:provided-by>
            </gp:geopriv>
         </pd:status>
         <pd:timestamp>2021-03-30T20:57:22Z</pd:timestamp>
      </pd:tuple>
   </pd:presence>
</locationRequest>
```

Fig. 25: Description of a geographic object in the LocationResponse with MultiGeometry

7.6 HELD response (Location URI response)

If the VSP/ECSP writes a localisation to the LIS via <ic> by means of a HELD `<LocationRequest>`, then the answer is a HELD `<LocationResponse>`. If the Location URI is requested in the `<LocationType>`, the process will be as follows:

```
HTTP/1.1 200 OK
Server: Example LIS
Date: Tue, 30 Mar 2021 21:57:22 GMT
Expires: Wed, 31 Mar 2021 01:57:22 GMT
Cache-control: private
Content-Type: application/held+xml;charset=utf-8
Content-Length: 322
X-Correlation-ID: afc3d814-83c0-4cc8-a693-c80305f9a008

<?xml version="1.0" encoding="UTF-8"?>
<locationResponse
   xmlns="urn:ietf:params:xml:ns:geopriv:held">

   <locationUriSet expires="2021-03-31T01:57:22Z">
      <locationURI>https://lis.sosservice.ch:8443/location/357yc6s64ceyoiuy5ax3o</locationURI>
   </locationUriSet>
</locationResponse>
```

Fig. 26: Example of HELD response with Location URI

7.7 HELD Error Response

The Location Response from the LIS contains a series of defined error codes. Pursuant to the specification RFC5985, the error codes are conveyed as <error> elements. A <message> element is optional. Pursuant to RFC5985, all error notifications listed with HTTP status code 200 OK are answered.

code All error messages must contain an error code

message A legible error message is issued in case of errors

Table 6 contains the valid error codes:

Code	Description	Reference
requestError	This code indicates that the request was badly formed in some fashion.	[RFC5985]
xmlError	This code indicates that the XML content of the request was either badly formed or invalid.	[RFC5985]
generalLisError	This code indicates that an unspecified error occurred at the LIS.	[RFC5985]
locationUnknown	This code indicates that the LIS could not determine the location of the Device.	[RFC5985]

unsupportedMessage	This code indicates that the request was not supported or understood by the LIS. This errorcode is used when a HELD request contains a document element that is not supported by the receiver.	[RFC5985]
timeout	This code indicates that the LIS could not satisfy the request within the time specified in the "responseTime" parameter.	[RFC5985]
cannotProvideLiType	This code indicates that the LISwas unable to provide LI of the type or types requested. This code is used when the "exact" attribute on the "locationType" parameter is set to "true".	[RFC5985]
notLocatable	This code indicates that the LIS is unable to locate the Device, and that the Device MUST NOT make further attempts to retrieve LI from this LIS. This error code is used to indicate that the Device is outside the access network served by the LIS; for instance, the VPN and NAT scenarios discussed in Section 4.1.2.	[RFC5985]
badIdentifier	This error code indicates that a Device identifier used in the HELD request was either: not supported by the LIS, badly formatted, or not one for which the requester was authorized to make a request.	[RFC6155]

Table 6: Error codes in geopriv

Fig. 27 provides a sample response with error code "LocationUnknown" to an LIS query

```
<?xml version="1.0" encoding="UTF-8"?>
<error
   code="locationUnknown"
   xmlns="urn:ietf:params:xml:ns:geopriv:held">

   <message>No location found for the requested entity.</message>
</error>
```

Fig. 27: HELD Error Response

7.8 Location dereferencing with the HELD protocol

RFC6753 defines how a UE can transmit its Location URI to a Location Recipient by means of a HELD request via HTTP. The same definition is used for conveyance of a localisation from a VSP/ECSP. For delivery of HELD via HTTPS, POST is used exclusively.

The two-step process consists of two sequences: In the first step, the location information is registered in the LIS (**Location Registration**). As a response to the HELD request, the VSP receives a Location URI.

The Location URI is conveyed to the Location Recipient (PSAP) by means of an SIP in the **SIP INVITE header field** "Geolocation" on the interface <ij>.

In the second step, the PSAP executes a HELD request to the LIS via LIS proxy with the Location URI (primary) or, if this is not available, with the User Part (E-164 number of the caller) of the SIP URI (secondary) via the interface <im> for the (**Location Dereferencing**). It then receives the location information as a PIDF-LO document.

A query with the SIP URI should be avoided wherever possible, since this query can only be answered by the central LIS. As soon as the LIS proxy has to interact with LISs of other ANPs, queries with the SIP URI can no longer be answered with certainty, since the relevant LIS is not able to determine the details required. Queries with Location URIs can always be answered, however.

A dereferencing with a **Location URI and SIP URI can contain two pieces of location information** (network-based and device-based localisation).

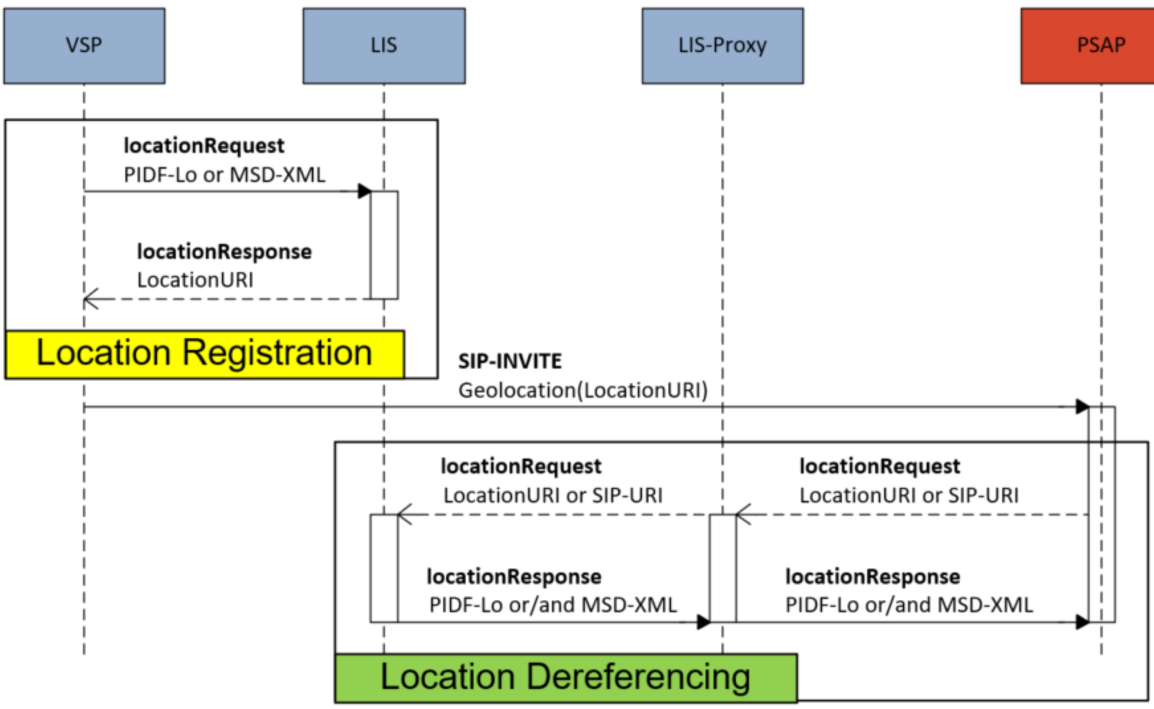

Fig. 28: Transmission of location information with the HELD protocol

```
HTTP/1.1 200 OK
Server: lisproxy.sosservice.ch:8443
Date: Tue, 30 Mar 2021 21:57:22 GMT
Expires: Wed, 31 Mar 2021 21:57:22 GMT
Cache-control: private
Content-Type: application/held+xml;charset=utf-8
Content-Length: 1359
X-Correlation-ID: afc3d814-83c0-4cc8-a693-c80305f9a008
```


```xml
<?xml version="1.0" encoding="UTF-8"?>
<locationResponse
   xmlns="urn:ietf:params:xml:ns:geopriv:held"
   xmlns:gp="urn:ietf:params:xml:ns:pidf:geopriv10"
   xmlns:gpb="urn:ietf:params:xml:ns:pidf:geopriv10:basicPolicy"
   xmlns:gml="http://www.opengis.net/gml"
   xmlns:gs="http://www.opengis.net/pidflo/1.0"
   xmlns:pd="urn:ietf:params:xml:ns:pidf"
   xmlns:conf="urn:ietf:params:xml:ns:geopriv:conf"
   xmlns:ad="urn:ietf:params:xml:ns:EmergencyCallData"
   xmlns:pi="urn:ietf:params:xml:ns:EmergencyCallData:ProviderInfo"
   xmlns:dm="urn:ietf:params:xml:ns:pidf:data-model">

   <pd:presence entity="pres:+41790000000">
      <dm:device id="AML">
         <gp:geopriv>
            <gp:location-info>
               <gs:Circle srsName="urn:ogc:def:crs:EPSG::4326">
                  <gml:pos>46.9469359 7.4352436</gml:pos>
                  <gs:radius uom="urn:ogc:def:uom:EPSG::9001">30.0</gs:radius>
               </gs:Circle>
               <conf:confidence pdf="normal">95</conf:confidence>
            </gp:location-info>
            <gp:usage-rules />
            <gp:method>GNSS</gp:method>
            <gp:provided-by>
               <ad:EmergencyCallDataValue>
                  <pi:EmergencyCallData.ProviderInfo>
                     <pi:DataProviderString>Swisscom (Schweiz) AG</pi:DataProviderString>
                     <pi:ProviderID>PLMN:22801</pi:ProviderID>
                  </pi:EmergencyCallData.ProviderInfo>
               </ad:EmergencyCallDataValue>
            </gp:provided-by>
         </gp:geopriv>
         <dm:deviceID>IMEI:123456789012345</dm:deviceID>
         <dm:timestamp>2021-03-30T20:57:29Z</dm:timestamp>
      </dm:device>
   </pd:presence>
</locationResponse>
```


Fig. 29: Location Dereference Response

7.9 Location by Value / Location by Reference

7.9.1 Location by Value (LbyV)

If a location is sent by an end device (UE) or an app directly in the SIP INVITE as a PIDF-LO or "Presence Object", this conveyance method is known as "Location by Value" (LbyV). According to the SIP protocol, with this conveyance method the location information is provided as PIDF-LO objects directly attached to the SIP protocol. The disadvantage is the large data volume that needs to be conveyed in the signalling and the problems potentially arising from this with, for example, MTU (Message Transfer Unit) size in the packaging and encapsulation of frames in, for example, Jumbo Frames of SIP notifications via UDP or TCP above the core limits of a VSP. For E2E inoperability, best practice is to keep the SIP notifications small and lean, and/or not to bulk them out unnecessarily with headers and the message body.
For this reason, use of LbyV is impossible up to the point of the PSAP.

7.9.2 Location by Reference (LbyR)

In the standard, the UE obtains the LbyR from the LIS of the ANP and sends the LbyR to the PSAP, but the ANPs are currently not regulated and the UEs do not yet have such capabilities.
Hence, one important requirement for the CH-NG112 architecture is that the VSP can receive an LbyR for location information (Location URI) from the LIS and forward this LbyR to a PSAP with the emergency call in the SIP INVITE header field "Geolocation". The PSAP takes the LbyR from the "Geolocation" header field of the SIP INVITE and asks for the location information via LIS proxy by means of a HELD request and the LbyR as a Location URI.

A sequence diagram is provided in the section "HELD protocol for registering location information".

Fig. 30 shows a HELD response from the LIS with a Location URI that contains an LbyR.

```
HTTP/1.1 200 OK
Server: lis.sosservice.ch:8443
Date: Tue, 30 Mar 2021 21:57:22 GMT
Expires: Wed, 31 Mar 2021 01:57:22 GMT
Cache-control: private
Content-Type: application/held+xml;charset=utf-8
Content-Length: 322
X-Correlation-ID: afc3d814-83c0-4cc8-a693-c80305f9a008

<?xml version="1.0" encoding="UTF-8"?>
<locationResponse
   xmlns="urn:ietf:params:xml:ns:geopriv:held">

   <locationUriSet expires="2021-03-31T01:57:22Z">
      <locationURI>https://lis.sosservice.ch:8443/location/357yc6s64ceyoiuy5ax3o</locationURI>
   </locationUriSet>
</locationResponse>
```

Fig. 30: Location Response with Location URI (LbyR)

Fig. 31 shows part of an SIP INVITE with the Geolocation that contains the LbyR.

```
INVITE sip:112@swisscom.ch;user=phone SIP/2.0
Max-Forwards: 69
Via: SIP/2.0/UDP 172.19.227.25:5060;branch=z9hG4bKg3Zqkv7iv323ntuzcjlhrgy5x52b6iy3n
Via: SIP/2.0/UDP 178.193.229.216:5060;received=178.193.229.216;rport=5060;branch=z9hG4bK-1c0-
6d84b-2372f8d3
Max-Forwards: 69
To: "112" <sip:112@swisscom.ch;user=phone>
From: "+41580000000" <sip:+41580000000@swisscom.ch>;tag=h7g4Esbg_f6338b40-101a8c0-13c4-55013-
1c0-76d9a532-1c0
Call-ID: f633f598-101a8c0-13c4-55013-1c0-75f2ef4c-1c0
Geolocation: <https://lis.sosservice.ch:8443/location/357yc6s64ceyoiuy5ax3o>
CSeq: 1 INVITE
Contact: <sip:+41580000000@178.193.229.216:5060;EriBindingId=1561424888080708;eribind-
generated-at=172.19.227.25>
Route: <sip:sos.ims.swisscom.ch;transport=udp;lr>
Record-Route: <sip:172.19.227.25;transport=udp;lr>
Min-Se: 360
P-Asserted-Identity: <sip:+41580000000@swisscom.ch>
P-Charging-Vector: icid-value=hvipisbsgc6p3.sharedtcs.net
P-Visited-Network-ID: sharedtcs.net
Priority: emergency
```

Fig. 31: SIP INVITE with Geolocation (LbyR)

In Switzerland, LbyR is used because this method offers the following advantages:

- **Anonymisation** of the location information during the call handling
- **Location updates**: The position in the LIS can be continuously updated during the SIP session.
- **Compact form**: In general, there are no limitations with regard to the size and complexity of the location information conveyed.

swisscom

7.9.3 Format of the Location URI

Pursuant to RFC3986, a Location URI can be defined as follows:

```
<locationURI>https://lis.sosservice.ch:8443/location/357yc6s64ceyouiuy5ax2o</locationURI>
```

Fig. 32: Location URI

The Location URI consists of two components, see image above:

1. Server URL (e.g. https://lis.sosservice.ch:8443) with a port number (marked in red)
2. (Unequivocal temporary) Location Reference, which is generated by an LIS (marked in yellow)

The "Location URI" is inserted by the VSP and the ECSP as content in the Geolocation header field of the SIP notification (INVITE).

URL and port numbers are dependent on the system architecture and are determined by the operator of the LIS.

7.9.4 Format of the SIP URI

Pursuant to RFC3261, an SIP URI can be defined as follows:

An SIP URI address (e.g. sip:**+41790000000**@mydomain.com)

This consists of two parts, the User Part (+41790000000) and the Host Part (@mydomain.com)

The SIP URI of the sender is found in the P-Asserted-Identity (PAI) of the SIP INVITE. With the SIP URI, all available location information can be requested from the LIS. Fig. 33 provides an example process for a query from a PSAP using the caller number.

```
POST /location HTTP/1.1
Host: lis.sosservice.ch:8443
Content-Type: application/held+xml;charset=utf-8
Content-Length: 257
X-Correlation-ID: afc3d814-83c0-4cc8-a693-c80305f9a008

<?xml version="1.0" encoding="UTF-8"?>
<locationRequest
   xmlns="urn:ietf:params:xml:ns:geopriv:held"
   xmlns:id="urn:ietf:params:xml:ns:geopriv:held:id">

   <id:device>
      <id:uri>sip:+41790000000@example.com</id:uri>
   </id:device>
</locationRequest>
```

Fig. 33: Location dereference request with SIP URI

8 Location conveyance by means of SIP protocol

SIP is used as a signalling and conveyance protocol for VoIP telephony. Location information as Presence Objects are documents that can be conveyed from the **Location Producer**, for example from a Public Wireless LAN (PWLAN), via an IP communication network to the **Location Recipient**. According to today's standard, there are two options for conveying location information in an SIP call.

- Conveyance of location information by value (LbyV), see section 7.9.1
- Conveyance of location information by reference (LbyR), see section 7.9.2

The procedures for conveyance with the SIP protocol are outlined in detail in the following documents:

- [RFC6442: Location Conveyance for the Session Initiation Protocol]
- [RFC8262: Content-ID Header Field in the Session Initiation Protocol (SIP)]:

Fig. 34 shows the information flow via an SIP proxy. The Location Producer (UE, network components, etc.) supplies updated location information to the LIS. The protocol for updating the location information may vary. The SIP proxy is responsible for forwarding the SIP emergency call to the PSAPs. So far, so good. **The standard states:** *"To this end, the SIP proxy sends a Location Query by URI to the LIS and receives the necessary Location Reference, which is added to the SIP signalling as a header."*

But this is not the case in reality! The ANPs are not obliged to operate a LIS. The VSPs are regulated, so the **Location Producer** sends the Location Reference (LbyR) and is responsible for the correct routing of the emergency calls from its voice services The SIP proxy therefore has no connection to the LIS. See also Fig. 3

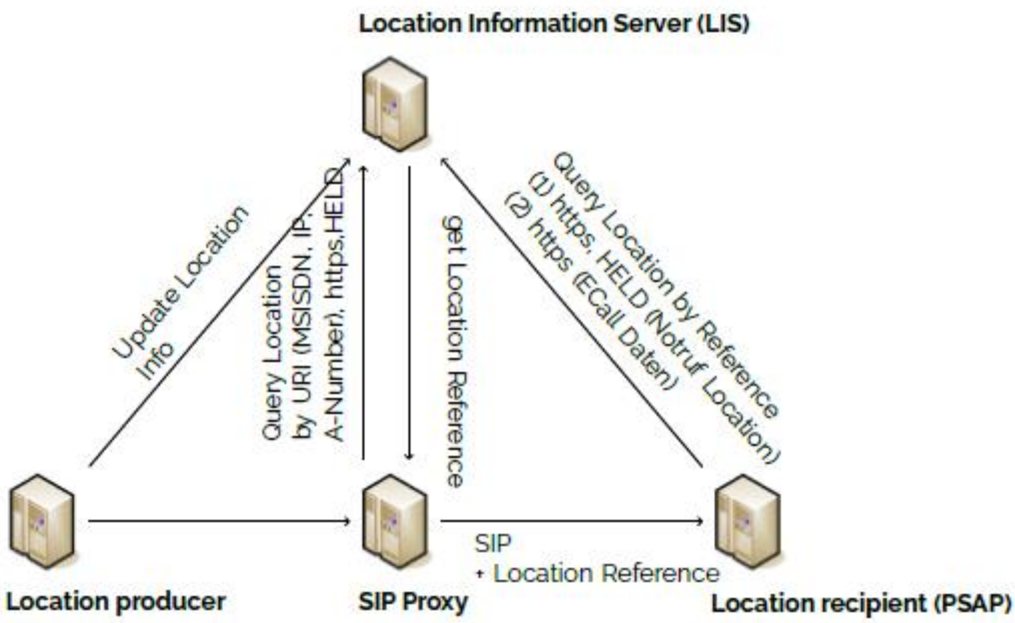

Fig. 34: Architecture for SIP location conveyance according to the standard

8.1 SIP INVITE with Location by Reference

The following example shows an SIP INVITE and how it is conveyed to the recipient of an emergency call during the establishment of the connection. This also contains a Location Reference in the Geolocation header field pursuant to RFC6442 and a Location Reference for an eCall in the Call-Info header field.

RFC6442 (section 4.1) defines how the Location URI is used in the SIP `Geolocation` header field.

```
INVITE sip:112@swisscom.ch;user=phone SIP/2.0
To: "112" <sip:112@swisscom.ch;user=phone>
From: "+41580000000" <sip:+41580000000@swisscom.ch>;tag=h7g4Esbg_f6338b40-101a8c0-13c4-55013-1c0-76d9a532-1c0
Call-ID: f633f598-101a8c0-13c4-55013-1c0-75f2ef4c-1c0
Supported : timer, 100rel, Geolocation-http
Geolocation: <https://lis.sosservice.ch:8443/location/357yc6s64ceyouiuy5ax2o>
Geolocation-Routing: no
Call-Info: https://lis.sosservice.ch:8443/location/124abcd6e68ccgxero8v>;purpose=held+xml
P-Asserted-Identity: <sip:+41580000000@swisscom.ch>
Resource-priority: esnet.0
```

Fig. 5: Sample SIP INVITE with Location by Reference

For eCalls, pursuant to RFC6993, the Location URI is used in the SIP `Call-Info` header field.

8.2 Event notification with SIP protocol

SIP conveys the location information to the recipient with the help of the event notification (SIP INVITE, SIP UPDATE). The advantage of this process is the asynchronous communication. Areas of application include:

- Notification of whether direction and/or speed of device have changed. This requirement is not currently relevant for emergency communications.
- An object moves away from the location or enters a predefined area.
- The attributes of the location address have changed.
- The location is updated.

The SIP event notification forms part of the SIPCORE standard.

8.3 eCall MSD dereferencing

The enhancements to the ETSI standard architecture (TS 103 479) include the proposal to use the SIP header `Call-Info` for eCalls, as for location dereferencing. A decision was taken with the industry to save the eCall data in the LIS as readable XML information (pursuant to DIN CEN 15722-2021 Annex C). This information can then be requested by PSAPs via LIS proxy and LIS by means of HELD. The Call-Info header must govern the "purpose" parameter pursuant to RFC8688. For eCalls, `the value is "held+xml".`

```
Call-Info: <https://lis.sosservice.ch:8443/location/abc357o>;purpose=held+xml
```

Fig. 35: Location by Reference for eCalls

8.3.1 POST HELD request for dereferencing in the case of eCalls

Various media types are under consideration for eCalls. In the CH-LIS, the eCall data are packaged as XML (pursuant to Annex C DIN EN 15722:2021) in a HELD and a presence element and saved in the central LIS.

Content type = application/held+xml

The XML can be requested/dereferenced with a HELD request and a Location URI or SIP URI via LIS proxy from the LIS.

```
POST /location HTTP/1.1
Host: lisproxy.sosservice.ch:8443
Content-Type: application/held+xml;charset=utf-8
Content-Length: 234
X-Correlation-ID: afc3d814-83c0-4cc8-a693-c80305f9a008

<?xml version="1.0" encoding="UTF-8"?>
<locationRequest
   xmlns="urn:ietf:params:xml:ns:geopriv:held">

   <locationURI>https://lis.sosservice.ch:8443/location/abcde12345678</locationURI>
</locationRequest>
```

Fig. 36: eCall HELD request for the dereferencing

8.3.2 HELD response with MSD-XML (XER) in the case of eCalls

As with XML packaged in a HELD and presence element (pursuant to Annex C DIN EN 15722:2021), the eCall MSD data are read from the LIS. The HELD response is sent to the PSAP via LIS proxy through the <im> interface. The following example shows the MSD-XML (XER) in a HELD response. For the definition, see section 9.6 “eCalls”.


```xml
<?xml version="1.0" encoding="utf-8"?>
<locationResponse
   xmlns="urn:ietf:params:xml:ns:geopriv:held"
   xmlns:pd="urn:ietf:params:xml:ns:pidf"
   xmlns:oss="http://www.oss.com/XSD">

   <oss:CurrentVersion>3</oss:CurrentVersion>
   <oss:ECallMessage>
      <oss:msdVersion>3</oss:msdVersion>
      <oss:msd>
         <oss:MSDMessage>
            <oss:msdStructure>
               <oss:messageIdentifier>82</oss:messageIdentifier>
               <oss:control>
                  <oss:automaticActivation>
                     <oss:true />
                  </oss:automaticActivation>
                  <oss:testCall>
                     <oss:false />
                  </oss:testCall>
                  <oss:positionCanBeTrusted>
                     <oss:true />
                  </oss:positionCanBeTrusted>
                  <oss:vehicleType>
                     <oss:passengerVehicleCategoryM1 />
                  </oss:vehicleType>
               </oss:control>
               <oss:vehicleIdentificationNumber>
                  <oss:isowmi>ZJP</oss:isowmi>
                  <oss:isovds>PCB7FW</oss:isovds>
                  <oss:isovisModelyear>8</oss:isovisModelyear>
                  <oss:isovisSeqPlant>2GY5ULP</oss:isovisSeqPlant>
               </oss:vehicleIdentificationNumber>
               <oss:vehiclePropulsionStorageType>
                  <oss:gasolineTankPresent>
                     <oss:true />
                  </oss:gasolineTankPresent>
               </oss:vehiclePropulsionStorageType>
               <oss:timestamp>1617131156</oss:timestamp>
               <oss:vehicleLocation>
                  <oss:positionLatitude>169947828</oss:positionLatitude>
                  <oss:positionLongitude>27133200</oss:positionLongitude>
               </oss:vehicleLocation>
               <oss:vehicleDirection>101</oss:vehicleDirection>
               <oss:recentVehicleLocationN1>
                  <oss:latitudeDelta>-388</oss:latitudeDelta>
                  <oss:longitudeDelta>-414</oss:longitudeDelta>
               </oss:recentVehicleLocationN1>
               <oss:recentVehicleLocationN2>
                  <oss:latitudeDelta>-210</oss:latitudeDelta>
                  <oss:longitudeDelta>-106</oss:longitudeDelta>
               </oss:recentVehicleLocationN2>
               <oss:numberOfOccupants>2</oss:numberOfOccupants>
            </oss:msdStructure>
         </oss:MSDMessage>
      </oss:msd>
   </oss:ECallMessage>
</locationResponse>
```

Fig. 37: eCall dereference response format MSD-XML (XER) in a HELD response

An eCall HELD response contains an oss:CurrentVersion as well as an oss:msdVersion element that stems from the ASN.1, which is sent by the IVS.

The CurrentVersion relates to the ASN.1 version that is used for eCalls in Version 3 (see DIN EN 15722:2021).

The msdVersion relates to the Message Format version that is used for eCalls in Version 3 (see DIN EN 15722:2021).

8.4 GPS application / applications

8.4.1 Use case AML@SMS

One example of GPS applications is Advanced Mobile Location (AML). AML is an application on the smartphone that is integrated into the operating system and activates the existing GPS system and the SMS connection automatically for an emergency call. The call is made via a mobile communication network and an SMS message is sent simultaneously to an end point (AML receiver) defined in the network. Google has integrated the service into the Android operating system as the Emergency Location Service (ELS). Apple's iOS supports AML in the correspondingly prepared networks as default for 112. AML is standardized in ETSI TS 103 625 [4].

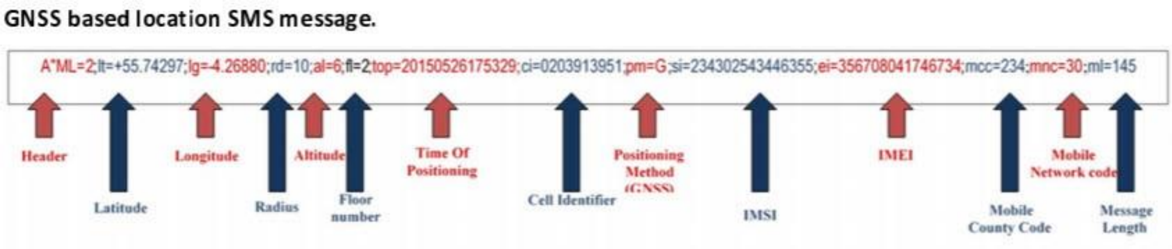

Fig. 38: AML@SMS Message Format

In the conveyance of GPS information via SMS, important information on the location of the caller such as "direction", "altitude" and "speed" are unfortunately lost.
Important questions, such as clarification of a migration path to SIP or the use of AML in roaming scenarios, are not fully answered by the standard.

An "AML service provider" (Swisscom) provides a central SMS service where the SMS receives information with the AML/ELS, then converts it and saves it as a PIDF-LO in the LIS.

8.4.2 Use case AML@SIP

For SIP technologies (4G, 5G) and VoLTE, VoWifi, device manufacturers such as Apple and Google favour conveyance of data in SIP in the form of a PIDF-LO. When the emergency call is connected, the device-based location information is set as LbyV in the PIDF-LO of the signalling (SIP INVITE).

VSPs take the PIDF-LO from the SIP signalling and write the information to the LIS in the PIDF-LO format by means of a HELD request via the <ic> interface. A LIS responds with a Location URI (LbyR) in the HELD response. This Location URI is inserted and provided in the Geolocation header (LbyR) in the SIP signalling.

9 Use cases

The following section outlines use cases with explanatory examples of the interface data formats that may occur in emergency communications. Emergency calls are calls made to certain nationally defined numbers or the use of specially defined URNs in the establishment of a connection in the following areas:

- Fixed network emergency calls
    - Classic fixed network TDM
    - VoIP emergency call (WireLine)
    - VoIP emergency calls from private networks
- Mobile emergency calls
    - Mobile CS emergency call (2G, 3G)
        - eCall (2G, 3G)
    - VoIP over LTE emergency calls (WireLess, 4G, 5G)
        - NGeCall (4G, 5G)
    - VoWiFi emergency call (WireLess, UE connected via Wireline router)

In each case, there will be an explanation of the use case, the technical background information on the use case, and characteristic features of the user information that can be made available via the data interface to the emergency call centre (PSAP). An annotated example aims to highlight the fundamental structures of the information exchange. The relevant standards for each case offer further details.

The localisation method used is set out in the geopriv10 element `<gp:methode>DHCP</gp:methode>`.
For the defined values, see https://www.iana.org/assignments/method-tokens/method-tokens.xhtml#method-tokens-1
For referral of VSPs and ECSPs in Switzerland, the following values are used:

CELL	*-> Cell localisations incl. TA/RTT for WireLess and Wifi calling (LastCell)*
DHCP	*-> IP localisation from WireLine and private networks*
802.11	*-> IP localisation from Wifi calling*
GNSS	*-> Satellite-based localisation (GPS, A-GPS, etc.)*
Manual	*-> are addresses provided by hand that replace "nomadic usage"*

9.1 Fixed network emergency calls (civic address)

An emergency call is made from a classic fixed network connection. The home connection is linked to a fixed, allocated customer address. Based on the address for the connection (at least the main site), the location is identified and compiled in a PIDF-LO with the civic address. The VSP then uses HELD to write the address to the LIS, then the PSAP can obtain the location information for the emergency call via LIS proxy from the LIS. Section Fig. 39 shows the response with location information to a query from the PSAP for an emergency call.

```xml
<?xml version="1.0" encoding="UTF-8"?>
<locationRequest
   xmlns="urn:ietf:params:xml:ns:geopriv:held"
   xmlns:gp="urn:ietf:params:xml:ns:pidf:geopriv10"
   xmlns:gpb="urn:ietf:params:xml:ns:pidf:geopriv10:basicPolicy"
   xmlns:id="urn:ietf:params:xml:ns:geopriv:held:id"
   xmlns:gml="http://www.opengis.net/gml"
   xmlns:gs="http://www.opengis.net/pidflo/1.0"
   xmlns:pd="urn:ietf:params:xml:ns:pidf"
   xmlns:conf="urn:ietf:params:xml:ns:geopriv:conf"
   xmlns:ca="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr"
   xmlns:ad="urn:ietf:params:xml:ns:EmergencyCallData"
   xmlns:pi="urn:ietf:params:xml:ns:EmergencyCallData:ProviderInfo">
   <locationType exact="true">locationURI</locationType>
   <id:device>
      <id:uri>sip:+41580000000@example.com</id:uri>
   </id:device>
   <pd:presence entity="pres:+41580000000">
      <pd:tuple id="WireLine">
         <pd:status>
            <gp:geopriv>
               <gp:location-info>
                  <gs:Circle srsName="urn:ogc:def:crs:EPSG::4326">
                     <gml:pos>46.9469359 7.4352436</gml:pos>
                     <gs:radius uom="urn:ogc:def:uom:EPSG::9001">30.0</gs:radius>
                  </gs:Circle>
                  <conf:confidence pdf="normal">95</conf:confidence>
                  <ca:civicAddress>
                     <ca:country>CH</ca:country>
                     <ca:A3>Ostermundigen</ca:A3>
                     <ca:RD>Alpenstrasse</ca:RD>
                     <ca:HNO>2b</ca:HNO>
                     <ca:NAM>SBB AG</ca:NAM>
                     <ca:PC>3072</ca:PC>
                     <ca:BLD>Bahnhof SBB</ca:BLD>
                     <ca:ADDCODE>EGID:1289317</ca:ADDCODE>
                  </ca:civicAddress>
               </gp:location-info>
               <gp:usage-rules />
               <gp:method>DHCP</gp:method>
               <gp:provided-by>
                  <ad:EmergencyCallDataValue>
                     <pi:EmergencyCallData.ProviderInfo>
                        <pi:DataProviderString>Swisscom (Schweiz) AG</pi:DataProviderString>
                        <pi:ProviderID>VSP:255100420</pi:ProviderID>
                     </pi:EmergencyCallData.ProviderInfo>
                  </ad:EmergencyCallDataValue>
               </gp:provided-by>
            </gp:geopriv>
         </pd:status>
         <pd:timestamp>2021-03-30T20:57:22Z</pd:timestamp>
      </pd:tuple>
   </pd:presence>
</locationRequest>
```

Fig. 39: Fixed network location

For a fixed network connection, a precise position is conveyed in the form of a circle and an address (civicAddress). In Switzerland, the address consists of the following fields:

NAM Customer name (last name, first name OR company name)

RD Street number

HNO House number (in contrast to the standard, both numbers and text can be included so that a number like 12a can be conveyed)

BLD Building designation. BLD can be either in addition to or in place of RD and HNO.

PC Post code

A3 District

ADDCODE Additional code element. Here, additional details can be provided for address identification, e.g. use of Federal Building Identification Numbers EGID:1234567 or VoIP location identifiers VLI:12345678.

9.2 VoIP call from the fixed network (WireLine)

Since the VSPs are regulated and the APNs do not operate any LISs, the VSP determines the location of a VoIP emergency call made via its voice service. It does so by means of IP localisation or location input from the access router (customer's CPE). This means the VSP can only identify locations that are within its own access networks. The VSPs send the identified location in a PIDF-LO with a civicAddr (see section 9.1) to the LIS and receive a Location URI in return. Processing by the PSAP is the same as for an emergency call from a fixed network or mobile phone.

9.3 VoIP emergency calls from private networks

VoIP emergency calls from private networks are fixed network calls coming from the networks of the VSP's customers. The customer determines the location by means of IP localisation in its network and conveys the location in the SIP INVITE to its VSP, which saves the location information to the LIS as for a fixed network emergency call, see section 9.1.

9.4 Mobile emergency calls (WireLess)

The positions from the mobile communication network are determined through various methods and depending on the relevant network technology (2G, 3G, 4G, 5G). The position is determined in accordance with the 3GPP standards. The positions are supplied in the MLP format. A transformation from the MLP in GML is possible, since both formats are defined as XSD formats and equivalent 2D geometry types do exist.

In the following example (see Fig. 40) a transformed MLP notification is presented for the location of an emergency caller calling from a mobile. The ellipses represent the technical uncertainty in the determination of the location. The bigger the ellipses, the more uncertain the location information.

```xml
<?xml version="1.0" encoding="UTF-8"?>
<locationRequest
    xmlns="urn:ietf:params:xml:ns:geopriv:held"
    xmlns:gp="urn:ietf:params:xml:ns:pidf:geopriv10"
    xmlns:gpb="urn:ietf:params:xml:ns:pidf:geopriv10:basicPolicy"
    xmlns:id="urn:ietf:params:xml:ns:geopriv:held:id"
    xmlns:gml="http://www.opengis.net/gml"
    xmlns:gs="http://www.opengis.net/pidflo/1.0"
    xmlns:pd="urn:ietf:params:xml:ns:pidf"
    xmlns:conf="urn:ietf:params:xml:ns:geopriv:conf"
    xmlns:ca="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr"
    xmlns:ad="urn:ietf:params:xml:ns:EmergencyCallData"
    xmlns:pi="urn:ietf:params:xml:ns:EmergencyCallData:ProviderInfo">

    <locationType exact="true">locationURI</locationType>
    <id:device>
        <id:uri>sip:+41790000000@example.com</id:uri>
    </id:device>
    <pd:presence entity="pres:+41790000000">
        <pd:tuple id="WireLess">
            <pd:status>
                <gp:geopriv>
                    <gp:location-info>
                        <gs:Ellipse srsName="urn:ogc:def:crs:EPSG::4326">
                            <gml:pos>46.530583 6.131859</gml:pos>
                            <gs:semiMajorAxis uom="urn:ogc:def:uom:EPSG::9001">2679</gs:semiMajorAxis>
                            <gs:semiMinorAxis uom="urn:ogc:def:uom:EPSG::9001">693</gs:semiMinorAxis>
                            <gs:orientation uom="urn:ogc:def:uom:EPSG::9102">94</gs:orientation>
                        </gs:Ellipse>
                        <gs:Ellipse srsName="urn:ogc:def:crs:EPSG::4326">
                            <gml:pos>46.522349 6.183542</gml:pos>
                            <gs:semiMajorAxis uom="urn:ogc:def:uom:EPSG::9001">2836</gs:semiMajorAxis>
                            <gs:semiMinorAxis uom="urn:ogc:def:uom:EPSG::9001">698</gs:semiMinorAxis>
                            <gs:orientation uom="urn:ogc:def:uom:EPSG::9102">115</gs:orientation>
                        </gs:Ellipse>
                        <conf:confidence pdf="normal">95</conf:confidence>
                    </gp:location-info>
                    <gp:usage-rules />
                    <gp:method>CELL</gp:method>
                    <gp:provided-by>
                        <ad:EmergencyCallDataValue>
                            <pi:EmergencyCallData.ProviderInfo>
                                <pi:DataProviderString>Swisscom (Schweiz) AG</pi:DataProviderString>
                                <pi:ProviderID>PLMN:22801</pi:ProviderID>
                            </pi:EmergencyCallData.ProviderInfo>
                        </ad:EmergencyCallDataValue>
                    </gp:provided-by>
                </gp:geopriv>
            </pd:status>
            <pd:timestamp>2021-03-30T20:57:22Z</pd:timestamp>
        </pd:tuple>
    </pd:presence>
</locationRequest>
```

Fig. 40: Location information from the mobile communication network with two ellipses

The Presence Object is sent to the LIS with a HELD request, and a Location URI is sent back. The Location URI is sent to the PSAP by the VSP in the SIP INVITE under the Geolocation header. The PSAP requests the location information for the emergency call received (Presence Object) from the LIS via LIS proxy, by means of a HELD request and the Location URI or with the identity of the emergency caller from the SIP URI.

9.5 VoWiFi / Wifi calling

VoWifi emergency calls are made from a mobile phone. The mobile phone has an internet connection with any WLAN. The call takes place via the Mobile Voice Service of the VSP.
If the ANP of the WLAN is also the VSP, the network-based localisation can be created as for a fixed network emergency call by means of IP localisation and a PIDF-LO, see section 9.1. If the VSP does not know the IP address, the most recently used mobile radio cell is localised and the PIDF-LO created as described in section 9.4. The VSP sends the PIDF-LO in the HELD request to the LIS, which sends back a Location URI. The PSAP requests the location information for the emergency call received (Presence Object) from the LIS via LIS proxy, by means of a HELD request and the Location URI or with the identity of the emergency caller from the SIP URI.

9.6 eCalls

The following section covers eCalls, their use cases and the MSD.

9.6.1 Use cases

eCall is an automatic emergency call system for vehicles mandated by EU law and is present in all vehicles registered since April 2018. The eCall devices (IVS) transmit data automatically as part of the emergency call when an accident has occurred. The aim of eCall is to reduce the number of people who die in road traffic accidents through faster initiation of rescue efforts.

When an accident takes place, the system automatically triggers an emergency call that transmits a Minimum Set of Data (MSD) and then establishes a voice connection with those travelling in the vehicle. This process can started as well manually without accident.

The location is determined via satellite navigation systems (GPS, Galileo, ...). A mobile network operator (MNO/VSP) forwards the eCall to the relevant local emergency call centre (PSAP). An MNO takes the MSD from the emergency call/eCall and sends the MSD data to the LIS as XML with a HELD request as a PIDF-LO (for an example, see section 8.3.2). The PSAP obtains the MSD from the LIS via LIS proxy and evaluates the Minimum Set of Data. With this additional information, the PSAP can provide targeted assistance.

As soon as the networkprovider send a start bit, the IVS transmits the MSD or a time limit has been reached, a voice channel establishes contact with the people inside the vehicle.

The Minimum Set of Data contains information about the time of the accident, the available coordinates of the accident site, direction of travel, the eCall qualifier (triggered automatically or manually) etc. eCall was developed as part of a youth research project back in 2001, whereby the proposal was to transmit the eCall data as a speech-coded binary data format via the voice channel. This conveyance technology was originally developed for liaison voice telephony (circuit-switched) and is no longer up-to-date given the shift towards Internet telephony (packed-switched).

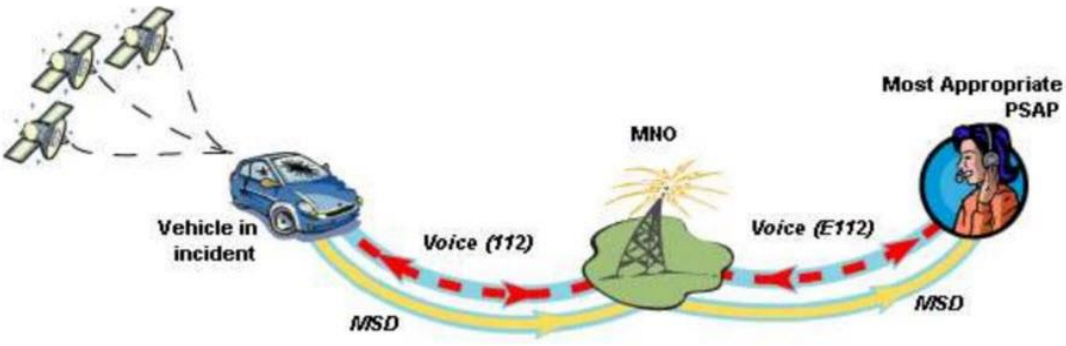

Fig. 41: eCall communication

NGeCall supports package-based conveyance on the basis of the SIP protocol that signals the vehicle data. The ETSI standards for NGeCall are pending. 4G devices are already installed in some vehicles, but 4G is not used for the eCall system. It is not yet clear how vehicles with existing 2G/3G IVSs will be retrofitted with 4G/5G IVSs. This future technology is described in the following documents:

- The EENA position document NGeCall [6] lays the foundations for the IETF and ETSI technical specifications.
- [RFC8147: Next-Generation Pan-European eCall]

9.6.2 The MSD eCall XML notification

The current version of the ESafety eCall **Minimum S**et of **D**ata (MSD) can be found in [7]. The current standard is MSD Version 3 pursuant to DIN EN 15722:2021. The DIN standard definition permits various coding and decoding formats. For the exchange of the MSD between the eCall recogniser (see section 9.6.3) and the LIS, the LIS proxy and the PSAP, XER is used (pursuant to DIN CEN TS 15722:2021 Annex C) packaged in PIDF-LO and HELD. The original XSD can be found in standard DIN CEN TS 15722:2021 Annex C and has been integrated into NG112_CH.xsd. The XML structure and the definition of the elements can be found in Fig. 42.

M – Mandatory data field
O – Optional data field

MSD				
msdVersion	INTEGER (1..255)	-	M	MSD format version The format described in this document carries version 3 *See 5.1.4 for detailed information.*
Msd				
msdStructure				
messageIdentifier	INTEGER (1..255)		M	Message identifier, starting with 1 for each new eCall transaction and to be incremented with every application layer MSD retransmission following a request to resend after the incident event
Control			M	
automaticActivation	BOOLEAN			true = Automatic activation false = Manual activation
testCall	BOOLEAN			true = Test call false = Emergency
positionCanBeTrusted	BOOLEAN			true = Position can be trusted false = Low confidence in position "Low confidence in position" shall mean that there is less than 95% confidence that exact position is within a radius of ± 150 m of reported position
vehicleType	ENUM			The category of the vehicle according to UNECE Vehicle classification ECE-TRANS-WP29-78-r4e for type approval according to Directive 2007/46/EC of the European Parliament and of the Council as referenced in eCall Regulations, esp Commission Delegated Regulation (EU) 2017/79. The supported vehicle categories are: (Category M - Power-driven vehicles having at lea four wheels and used for the carriage of people) - Category M1 passenger vehicle - Category M2 buses and coaches - Category M3 buses and coaches (Category N - Power-driven vehicles having at least four wheels and used for the carriage of goods) - Category N1 light commercial vehicles - Category N2 heavy duty vehicles - Category N3 heavy duty vehicles (Category L – Motor vehicles with less than four wheels- but including light quads) - Category L1 P2WV - Category L2 three-wheeled vehicle - Category L3 P2WV

					- Category L4 three wheels asymmetrically arranged - Category L5 vehicle three wheels symmetrically - Category L6 four wheels limited power - Category L7 four wheels limited power 33(Trailers [including semi–trailers]) - Category O - (Agricultural vehicles) - Category T - Category R - Category S (off-road vehicles) - Category G - - Category "Other"
VIN[a]	VIN[1]		M		VIN number according to ISO 3779
vehiclePropulsionStorageType			M		*Contains information about the presence of propulsion storage inside the vehicle sending the MSD.*
gasolineTankPresent	BOOLEAN				true = present; false = not present If no information about the propulsion storage is known, all elements shall be set to FALSE.
dieselTankPresent	BOOLEAN				
compressedNaturalGas	BOOLEAN				
liquidPropaneGas	BOOLEAN				
electricEnergyStorage	BOOLEAN				
hydrogenStorage	BOOLEAN				
otherPropulsionStorage	BOOLEAN				
timeStamp	INTEGER $(0..2^{32}-1)$	sec	M		Timestamp of the initial data message generation within the current eCall incident event, represented in seconds elapsed since midnight January 1st, 1970 UTC. NOTE 1 The initial message generation immediately follows the eCall generation sequence subsequent to a (confirmed) trigger. NOTE 2 Subsequent transmissions within the given incident use the same timestamp, but the messageIdentifier changes. NOTE 3 Failure value for time stamp set to "0"
vehicleLocation			M		*The last known vehicle position determined at the latest moment possible before message generation.*
positionLatitude	INTEGER $(-2^{31}..2^{31}-1)$	milliarcsec			Position latitude (WGS84) EXPLANATION (calculation example): *48.3003333 = 48°18'1.20" N = 48*60*60.000" + 18*60.000" + 1.20" = 173881.200" = 173881200 milliarcsec* maximum value:

Name	Type	Unit	M/O		Description
					90°00'00.000" = 324000000 minimum value: -90°00'00.000" = -324000000 If latitude is invalid or unknown, the representation of value 2147483647 shall be transmitted. If both latitude and longitude have value 0 then the location shall also be interpreted as invalid/unknown. NOTE If the transmitter or receiver determines either latitude or longitude to be invalid/unknown, then it is advised to transmit both longitude and latitude as unknown.
`positionLongitude`	INTEGER ($-2^{31}..2^{31}-1$)	milliarcsec			Position longitude (WGS84) maximum value: 180°00'00.000" = 648 000 000 minimum value: -180°00'00.000" = -648 000 000 *See latitude for calculation example and notes.*
`vehicleDirection`	INTEGER (0..255)	2° (2 degree)	M		The vehicle's last known real direction of travel, expressed in 2°-degrees steps from (magnetic or geographical) north (0– 358, clockwise) determined at the latest moment possible before message generation. EXPLANATION (calculation example): *due North = 0° = 0 * 2° => 0* *due East = 90° = 45 * 2° => 45* *due South = 180° = 90 * 2° => 90* *due West = 270° = 135 * 2° => 135* The direction shall be unaffected by random fluctuations of GNSS signals. If direction of travel is invalid or unknown, the representation of value 255 shall be transmitted
`recentVehicleLocationN1`			M		*Known location of the vehicle 'some time' before the generation of the data for the MSD message.* The three readings (vehicleLocation, recentVehicleLocationN1 and recentVehicleLocationN2) shall be taken within a timeframe of no more than 15 sec. without the possibility to derive information about the driving speed at the time of triggering.
`latitudeDelta`	INTEGER (-512..511)	100 milliarcsec			Latitude Delta (+ for North and – for South; WGS84) with respect to vehicleLocation. 1 Unit = 100 miliarcseconds, which is approximately 3m (on Earth) maximum value: 511 = 0°0'51.100" (≈1580m) minimum value: -512 = -0°0'51.200" (≈ -1583m)
`longitudeDelta`	INTEGER (-512..511)	100 milliarcsec			Longitude Delta (+ for East and – for West; WGS84) with respect to vehicleLocation. *See latitudeDelta for details*

recentVehicleLocationN2			M	Known location of the vehicle 'some time' before recentVehicleLocationN1. The three readings (vehicleLocation, recentVehicleLocationN1 and recentVehicleLocationN2) shall be taken within a timeframe of no more than 15 sec. without the possibility to derive information about the driving speed at the time of triggering.
latitudeDelta	INTEGER (-512..511)	100 milliarcsec		Latitude Delta (+ for North and – for South) with respect to recentVehicleLocationN1. *See recentVehicleLocationN1. latitudeDelta for details*
longitudeDelta	INTEGER (-512..511)	100 milliarcsec		Longitude Delta (+ for East and – for West) with respect to recentVehicleLocationN2. *See recentVehicleLocationN1. latitudeDelta for details*
numberOfOccupants	INTEGER (0..255)		O	Number of occupants in the vehicle according to available information. If no information about the number of occupants is available, this parameter needs to be omitted or filled with the representation of value 255 NOTE 1 This information is indicative only as it may be not always be reliable in providing exact information about the number of occupants (e.g. because seatbelts may not be fastened by occupants or seatbelts may be fastened for other reasons). NOTE 2 For vehicle categories without enclosing (e.g. motorcycles) 'occupants' will be read as 'riders' or 'vehicle users'.
optionalAdditionalData			O	
oid	RELATIVE-OID			*See 5.1.5*
data	OCTET STRING			*See 5.1.5*

[a] The field is named vehicleIdentificationNumber in the ASN.1 definition. The ASN.1 type VIN is defined in Annex A and codes for a correct representation of the World Manufacturer Index (WMI), the Vehicle Type Descriptor (VDS) and the Vehicle Identification Sequence (VIS) that make up a VIN number, taking into account the preconditions of each part.

Fig. 42: Contents/format of the MSD data concept EN 15722-2021

9.6.3 Mobile communication conveyance for eCalls

ETSI has proposed a solution with an in-band modem, which guarantees secure and rapid conveyance of MSD via the voice channel. The coding of the data takes place with analogue technology and is based exclusively on modem chips from the firm Qualcomm. This solution would make it necessary for every emergency call centre to have a corresponding eCall data modem for decoding the conveyed analogue data signals.

Swiss regulations dictate that each VSP or MNO must be able to recognise the eCall and read the accident data (MSD) by means of an in-band modem (eCall recogniser). The MNOs extract the MSD from the emergency call and save it to the LIS, which sends back a reference (Location URI) that is sent to the PSAP as part of the emergency call. With the reference, the PSAP receives the eCall data (MSD) from an LIS via LIS proxy. See section 8.3.2.

One version of the architecture is presented in the diagram below.

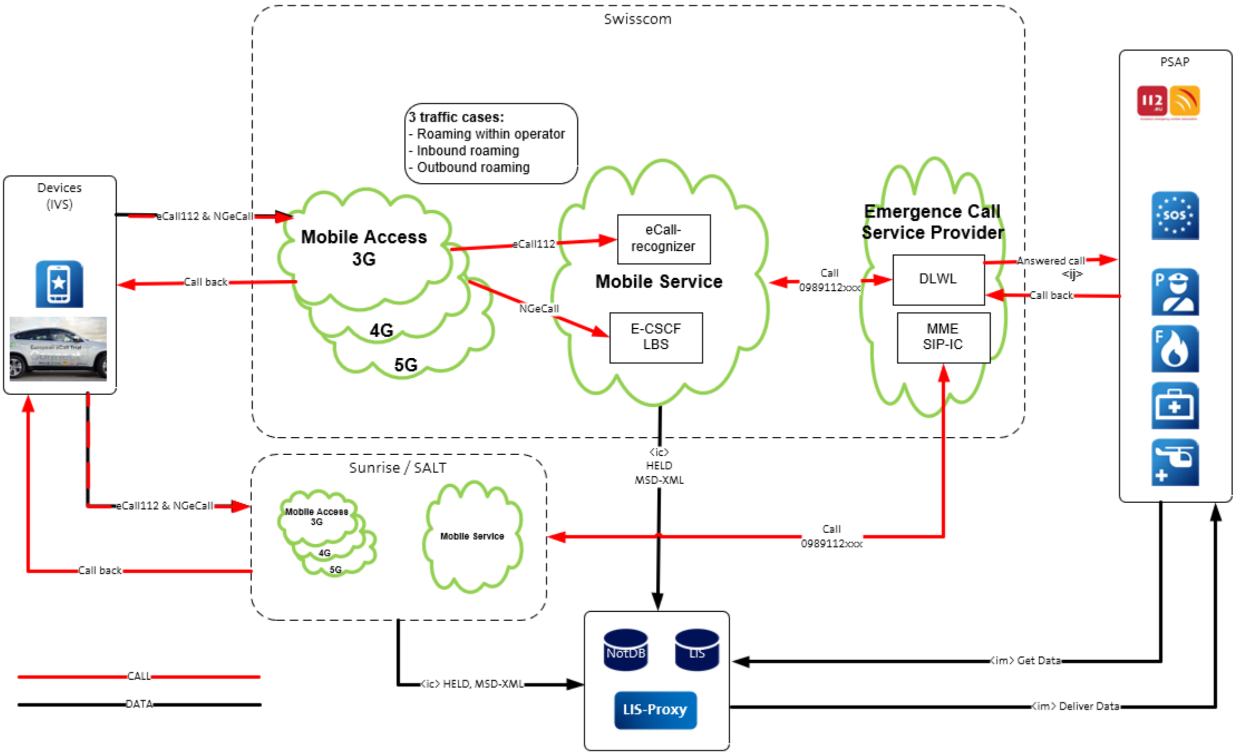

Fig. 43: eCall 1.0 level 1 architecture (Swiss version)

10 Operating aspects

10.1 Transport encryption

All communication with LIS as well as LIS proxy takes place via HTTPS, based on TLS 1.3 as a minimum. The only service certificates used are those issued by official CAs (Certificate Authorities).

10.2 Authentication/authorisation

Clients of LISs, including via an LIS proxy, use a dedicated user and are authenticated and authorised by means of Basic Authentication.

For conveyance of credentials (user name, password), the "Authorization" HTTP header is used pursuant to RFC 2617. With pre-emptive Basic Authentication, the Authorization header can be send directly with the use notification. Here, the credentials are concatenated (user:password) and encoded in Base64.

Example:

```
Authorization: Basic bXlVc2VyOm15UGFzc3dvcmQ=
```

10.3 Correlation IDs

Due to the possible information in the HELD notifications, the correlation of request and responses is either difficult or impossible because of the payload. To make operation easier for the client and/or server operator, the LIS and the LIS proxy support the concept of Correlation IDs.

In a request to a server component, an HTTP header named "X-Correlation-ID" can also be sent containing any chosen unequivocal value (typically a UUID) for each request. If the server component detects this Correlation ID, it will then be used for subsequent requests and also written to the response.
This way, the requests and responses can be correlated on both the client and the server side, and can therefore also be analysed beyond the limits of the system.

Example:

```
X-Correlation-ID: afc3d814-83c0-4cc8-a693-c80305f9a008
```

10.4 Timestamp format

In the HELD requests and responses, time information is used in various formats.

10.4.1 PIDF-LO

In each case, the timestamp in PIDF-LO documents is based on formats pursuant to RFC-3339. Hence a timestamp is interpreted as UTC if no time zone is provided (2021-03-30T20:57:22Z).

If the local time is given, then the difference to UTC must be entered in the timestamp (2021-03-30T21:57:22Z+01:00) so that the time information can be interpreted correctly.

10.4.2 MSD-XML

The timestamps in MSD-XMLs are always sent as Unix timestamps (seconds since 1.1.1970 00:00:00 UTC) and cannot be interpreted as local time information.

10.5 Failover mechanisms

In order to provide a highly available service, the LIS- as well as the LIS-Proxy-Service are deployed and operated in multiple data centres. To eliminate single point of failures as far as possible, a DNS based failover mechanism is being used. This requires the clients to be able to handle DNS based failovers correctly.

10.5.1 Normal operation

Under normal circumstances, the DNS/GSLB (Global Site Load Balancer) supervises the service instances and manages a list of available and healthy service instances.

Once a client application calls the service by its FQDN (lis.sosservice.ch oder lisproxy.sosservice.ch), the DNS resolver first queries the DNS, receives a list of IP addresses and uses the first IP address in the list for sending a HELD request to a service instance.

The DNS answer contains additionally a time-to-live (TTL) for which the entries in the IP address list are valid. After TTL expiration, the client must query the DNS for an updated IP address list. This mechanism is, depending on the used http client, implemented by the DNS resolver/cache. The TTL applied to NG112 DNS entries is 30s.

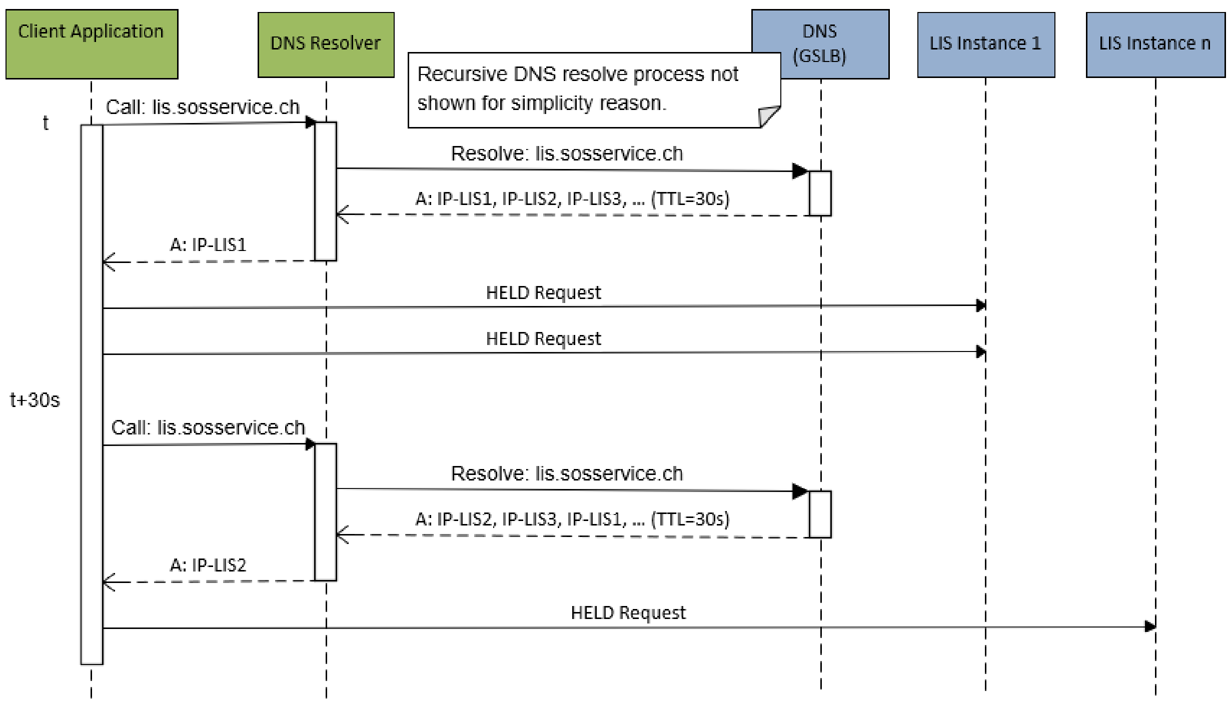

Abbildung 44: DNS normal operation

10.5.2 Outage of a service instance

In case one of the service instance fails, the DNS removes the affected server from the list and only the healthy servers are returned. The failed server will be brought again in the list once healthy again.

Upon the next DNS request (after TTL expiration or the detection of a communication problem), the client receives an updated list of IP addresses (without the failing one) and can then again use the first entry in the list to send the HELD request to an available instance.

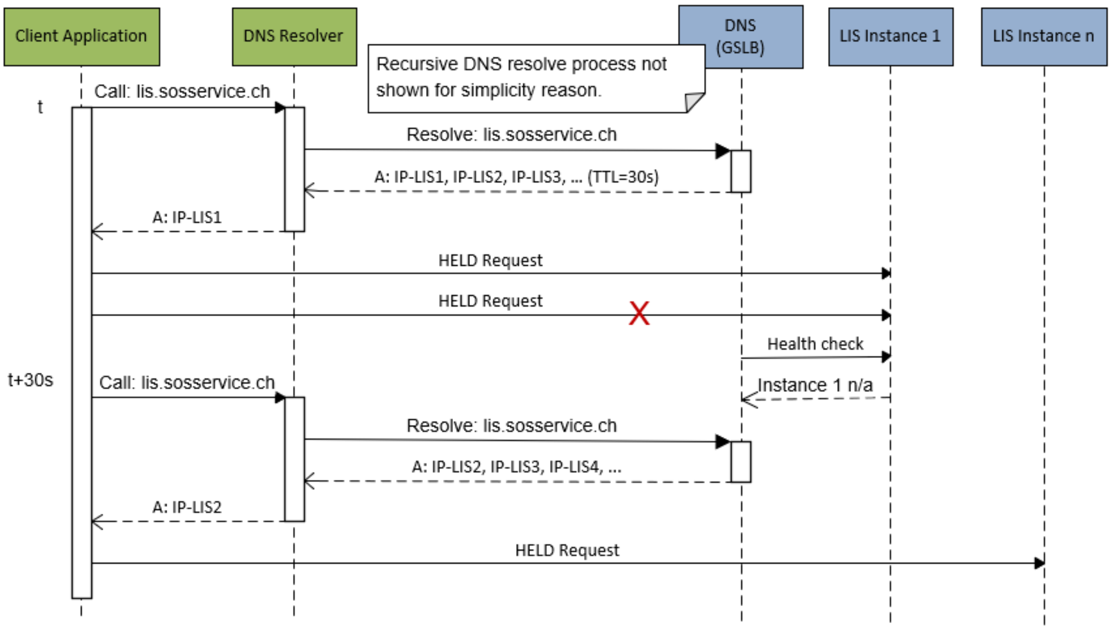

Abbildung 45: DNS failover

10.5.3 Minimal client requirements

In order to support the mechanisms described above, the client must fulfil the following requirements:

- The communication to NG112 services must always be initiated via FQDN (lis.sosservice.ch, lisproxy.sosservice.ch).
- The TTL specified by the DNS must be considered and after expiration of the TTL, the FQDN must be resolved again via DNS.

By fulfilling these requirements, a maximal recovery time of 30 seconds can be guaranteed.

10.5.4 Strongly recommended client requirements

In order to reduce the recovery time, minimize the dependency to the DNS infrastructure and therefore increase the over all availability, the client should act as follows:

- In case of a communication problem while calling the service (e.g. timeout or abnormal connection termination), the client performs a retry.
- Before this retry, the client calls the DNS for an update list of service IP addresses.
- If the DNS is not reachable, the client tries to use the other entries in the previously received IP address list to call the service.

11 Appendix

11.1 List of images

11.2 List of tables