International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

Series Q

Supplement 68

(12/2015)

SERIES Q: SWITCHING AND SIGNALLING

Technical Report on emergency telecommunications service (ETS) interoperability limitations

ITU-T Q-series Recommendations – Supplement 68

ITU-T Q-SERIES RECOMMENDATIONS

SWITCHING AND SIGNALLING

SIGNALLING IN THE INTERNATIONAL MANUAL SERVICE	Q.1–Q.3
INTERNATIONAL AUTOMATIC AND SEMI-AUTOMATIC WORKING	Q.4–Q.59
FUNCTIONS AND INFORMATION FLOWS FOR SERVICES IN THE ISDN	Q.60–Q.99
CLAUSES APPLICABLE TO ITU-T STANDARD SYSTEMS	Q.100–Q.119
SPECIFICATIONS OF SIGNALLING SYSTEMS No. 4, 5, 6, R1 AND R2	Q.120–Q.499
DIGITAL EXCHANGES	Q.500–Q.599
INTERWORKING OF SIGNALLING SYSTEMS	Q.600–Q.699
SPECIFICATIONS OF SIGNALLING SYSTEM No. 7	Q.700–Q.799
Q3 INTERFACE	Q.800–Q.849
DIGITAL SUBSCRIBER SIGNALLING SYSTEM No. 1	Q.850–Q.999
PUBLIC LAND MOBILE NETWORK	Q.1000–Q.1099
INTERWORKING WITH SATELLITE MOBILE SYSTEMS	Q.1100–Q.1199
INTELLIGENT NETWORK	Q.1200–Q.1699
SIGNALLING REQUIREMENTS AND PROTOCOLS FOR IMT-2000	Q.1700–Q.1799
SPECIFICATIONS OF SIGNALLING RELATED TO BEARER INDEPENDENT CALL CONTROL (BICC)	Q.1900–Q.1999
BROADBAND ISDN	Q.2000–Q.2999
SIGNALLING REQUIREMENTS AND PROTOCOLS FOR THE NGN	Q.3000–Q.3899
TESTING SPECIFICATIONS	Q.3900–Q.4099

For further details, please refer to the list of ITU-T Recommendations.

Supplement 68 to ITU-T Q-series Recommendations

Technical Report on emergency telecommunications service (ETS) interoperability limitations

Summary

New capabilities in modern terminals and public communication networks, such as sharing multimedia, exchanging location and status information, and call transfer, could be used by emergency telecommunications service (ETS) users in cross-borders operations (i.e., between national networks). Supplement 68 to ITU-T Q-series Recommendations is a Technical Report (TR) that aims to identify how the use of such features by ETS users could be problematic because of limitations in the international interoperability of ETS, beyond technology-to-technology priority mapping.

The TR comprises:

– An initial comprehensive list of ETS-related functional requirements and capabilities analysed in the Report.

– Identification of resulting limitations of ETS interoperability:

  • Interfaces between ETS national implementations (ENIs) supporting the ETSs considered;

  • Interoperability problems foreseen due to current lack of support for such telecommunication services in ENIs with different technologies.

The description of limitations includes both a technical analysis of standardized interfaces and use cases to illustrate the involved operations.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Q Suppl. 68	2015-12-15	11	11.1002/1000/12787

Keywords

Emergency telecommunication service, ETS, ETS interoperability, ETS limitations, multiCONF, NNI.

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this publication, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this publication is voluntary. However, the publication may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the publication is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the publication is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this publication may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the publication development process.

As of the date of approval of this publication, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this publication. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

Table of Contents

Introduction

Supplement 68 to ITU-T Q-series Recommendations is a Technical Report (TR) that describes the study of possible limitations in emergency telecommunications service (ETS) interoperability that may prevent ETS users from taking full advantage of new capabilities in modern user terminals (i.e., smartphones), public communication networks and applications (e.g., fourth generation (4G) mobile broadband networks using voice over long term evolution/rich communication services (VoLTE/RCS) applications).

This TR identified and analysed a comprehensive list of telecommunications services and features for ETS interoperability limitations. The identified limitations comprise not only the interfaces between ETS national implementations (ENIs) supporting the ETSs considered, but also foreseen interoperability problems due to current lack of support for such telecommunication services in ENIs with different technologies. The description of interoperability limitations includes both a technical analysis of standardized interfaces and use cases to illustrate the involved interactions.

Supplement 68 to ITU-T Q-series Recommendations

Technical Report on emergency telecommunications service (ETS) interoperability limitations

1 Scope

According to ITU-T Recommendations, an emergency telecommunications service (ETS) is a national service providing priority telecommunications to the ETS authorized users in times of disaster and emergencies. Concretely, the scope of ETS involves authority-to-authority communications designed to respond to emergency situations through prioritized access to public telecommunications infrastructures [i.e., the public switched telephone network (PSTN) or public land mobile network (PLMN)] as described in [ITU-T Y.2205].

More specifically, Figure 1 of [ITU-T Y.2205] constricts the scope of ITU-T activities concerning emergency telecommunications to telecommunications for disaster relief (TDR) and interconnection of ETS national implementations (ENIs).

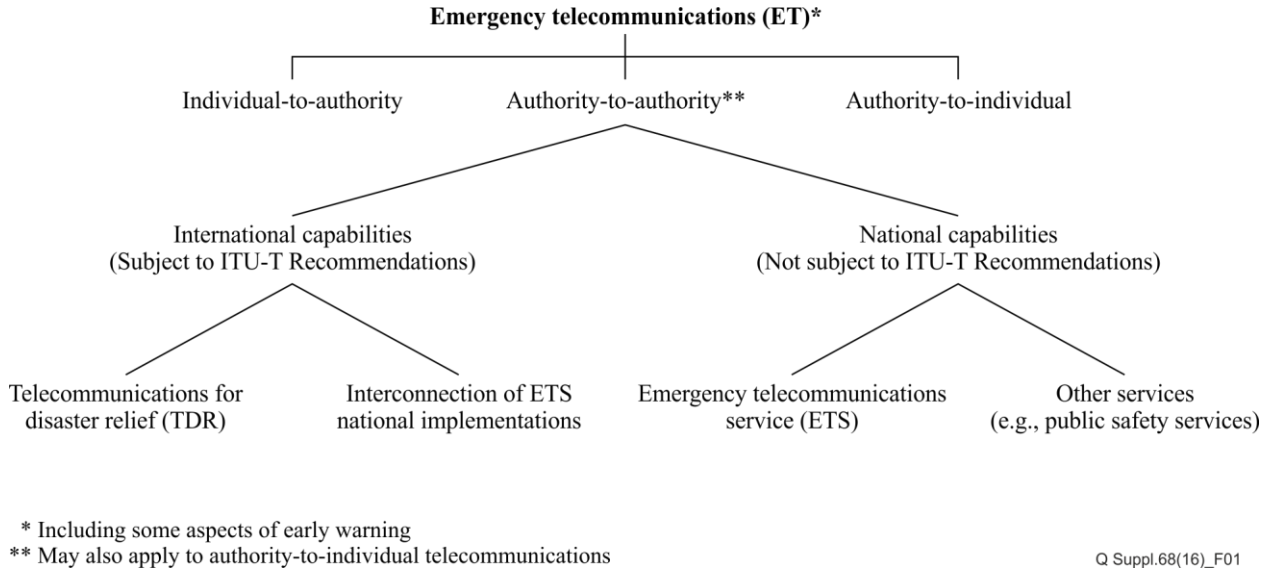

Figure 1 – ITU-T activities concerning emergency telecommunications (Figure 1 of [ITU-T Y.2205])

In that sense, fostering the interconnection of different emergency-related authorities that may belong to different countries or international organizations is of utmost relevance in this type of event.

One of the challenges is how to address a common interconnection framework taking into account that the ETS national implementations (ENI) are subject to national regulations. This Supplement aims to analyse possible limitations of such a standardized framework when applied to complex multimedia services.

2 References

[ITU-T E.105] Recommendation ITU-T E.105 (1992), *International telephone service.*

[ITU-T E.106] Recommendation ITU-T E.106 (2003), *International Emergency Preference Scheme (IEPS) for disaster relief operations.*

[ITU-T E.107] Recommendation ITU-T E.107 (2007), *Emergency Telecommunications Service (ETS) and interconnection framework for national implementations of ETS.*

[ITU-T H.248.1] Recommendation ITU-T H.248.1 (2013), *Gateway control protocol: Version 3*

[ITU-T H.323] Recommendation ITU-T H.323 (2009), *Packet-based multimedia communications systems*.

[ITU-T J.260] Recommendation ITU-T J.260 (2005), *Requirements for preferential telecommunications over IPCablecom networks.*

[ITU-T J.261] Recommendation ITU-T J.261 (2009), *Framework for implementing preferential telecommunications in IPCablecom and IPCablecom2 networks.*

[ITU-T M.1400] Recommendation ITU-T M.1400 (1992), *Designations for interconnections among operators' networks.*

[ITU-T M.3350] Recommendation ITU-T M.3350 (2004), *TMN service management requirements for information interchange across the TMN X-interface to support provisioning of Emergency Telecommunication Service (ETS).*

[ITU-T Q Suppl.47] ITU-T Q-series Recommendations – Supplement 47 (2003), *Emergency services for IMT 2000 networks – Requirements for harmonization and convergence.*

[ITU-T Q Suppl.53] ITU-T Q-series Recommendations – Supplement 53 (2005), *Signalling requirements to support the International Emergency Preference Scheme (IEPS).*

[ITU-T Q Suppl.57] ITU-T Q-series Recommendations – *Supplement* 57 (2008), *Signalling requirements to support the emergency telecommunications service (ETS) in IP networks.*

[ITU-T Q Suppl.61] ITU-T Q-series Recommendations – Supplement 61 (2010), *Evaluation of signalling protocols to support ITU-T Y.2171 admission control priority levels.*

[ITU-T Q Suppl.62] ITU-T Q-series Recommendations – Supplement 62 (2014), *Overview of the work of standards development organizations and other organizations on emergency telecommunications service.*

[ITU-T Q Suppl.63] ITU-T Q-series Recommendations – Supplement 63 (2013), *Signalling Protocol Mappings in Support of the Emergency Telecommunications Service in IP Networks.*

[ITU-T X.810] Recommendation ITU-T X.810 (2004), *General overview of NGN.*

[ITU-T Y.1271] Recommendation ITU-T Y.1271 (2014), *Framework(s) on network requirements and capabilities to support emergency telecommunications over evolving circuit-switched and packet-switched networks.*

[ITU-T Y.2001] Recommendation ITU-T Y.2001 (2004), *General overview of NGN.*

[ITU-T Y.2011] Recommendation ITU-T Y.2011 (2004), *General principles and general reference model for Next Generation Networks.*

[ITU-T Y.2012] Recommendation ITU-T Y.2012 (1992), *International telephone service.*

[ITU-T Y.2111] Recommendation ITU-T Y.2111 (2011), *Resource and admission control functions in next generation networks.*

[ITU-T Y.2205] Recommendation ITU-T Y.2205 (2011), *Next Generation Networks – Emergency telecommunications - Technical considerations.*

[ITU-T Y.2211] Recommendation ITU-T Y.2211 (2007), *IMS-based real-time conversational multimedia services over NGN.*

[ITU-T Y.2254] Recommendation ITU-T Y.2254 (2014), *Capabilities of multi-connection to support enhanced multimedia telephony services.*

[ITU-T Y.2701] Recommendation ITU-T Y.2701 (2007), *Security requirements for NGN release 1.*

[ITU-T Y.2702] Recommendation ITU-T Y.2702 (2008), *Authentication and authorization requirements for NGN release 1.*

[ITU-T Y.2705] Recommendation ITU-T Y.2705 (2013), *Minimum security requirements for the interconnection of the Emergency Telecommunications Service (ETS).*

[ITU-T Y.3501] Recommendation ITU-T Y.3501 (2013), *Cloud computing framework and high-level requirements.*

[ITU-T Y.3510] Recommendation ITU-T Y.3510 (2016), *Cloud computing infrastructure requirements.*

[ITU-T Y.3520] Recommendation ITU-T Y.3520 (2015), *Cloud computing framework for end to end resource management.*

3 Definitions

3.1 Terms defined elsewhere

This Supplement uses the following terms defined elsewhere:

3.1.1 border element [ITU-T Y.2701]: Network element providing functions connecting different security and administrative domains.

3.1.2 emergency telecommunications service (ETS) [ITU-T E.107]: A national service providing priority telecommunications to the ETS authorized users in times of disaster and emergencies.

3.1.3 ETS user [ITU-T E.107]: A user authorized to obtain priority telecommunications in national and/or international emergency situations.

3.1.4 international emergency preference service (IEPS) [clause 1 of ITU-T E.106]: The IEPS enables the use of public telecommunications by national authorities for emergency and disaster relief operations. It allows users, authorized by national authorities, to have access to the International Telephone Service, as described in [ITU-T E.105], while this service is restricted either due to damage, congestion or faults, or any combination of these.

3.1.5 international emergency situation [ITU-T Y.1271]: An emergency situation, across international boundaries, that affects more than one country.

3.1.6 IMS-based real-time conversational multimedia services [ITU-T Y.2211]: Multimedia services provided in real time by using an IMS-based service environment.

3.1.7 media [ITU-T Y.2012]: One or more of audio, video or data.

3.1.8 media stream [ITU-T Y.2012]: A media stream can consist of audio, video, or data, or a combination of any of them. Media stream data conveys user or application data (i.e., a payload) but not control data.

3.1.9 mediated services [ITU-T Y.2012]: Services that are based on intermediate service stratum facilities provided by one or more service providers.

3.1.10 MC-eMMTel (eMMTel service over multi-connection) [ITU-T Y.2254]: A service over multi-connection which provides real-time bidirectional conversational transfer of multiple media types (e.g., audio, video, data) between two or more terminals simultaneously.

3.1.11 network operator [ITU-T M.1400]: An operator that manages a telecommunications network. A network operator may be a service provider and vice versa. A network operator may or may not provide particular telecommunications services.

3.1.12 next generation network (NGN) [ITU-T Y.2001]: A packet-based network able to provide telecommunication services and able to make use of multiple broadband, QoS-enabled transport technologies and in which service-related functions are independent from underlying transport-related technologies. It enables unfettered access for users to networks and to competing service providers and/or services of their choice. It supports generalized mobility which will allow consistent and ubiquitous provision of services to users.

3.1.13 NGN service stratum [ITU-T Y.2011]: That part of the NGN which provides the user functions that transfer service-related data and the functions that control and manage service resources and network services to enable user services and applications (see also clause 7.1 of [ITU-T Y.2011]).

3.1.14 NGN transport stratum [ITU-T Y.2011]: That part of the NGN which provides the user functions that transfer data and the functions that control and manage transport resources to carry such data between terminating entities (see also clause 7.1 of [ITU-T Y.2011]).

3.1.15 service provider [ITU-T Y.2705]: Service Provider (initial capital letters) is a public telecommunications service provider authorized to provide emergency telecommunications service (ETS).

3.1.16 trust [ITU-T Y.2701]: Entity X is said to trust entity Y for a set of activities if and only if entity X relies upon entity Y behaving in a particular way with respect to the activities.

3.1.17 trusted third party [ITU-T X.810]: A security authority or its agent that is trusted with respect to some security-relevant activities (in the context of a security policy).

3.1.18 trusted zone [ITU-T Y.2701]: From the viewpoint of a NGN provider, a security domain where a NGN provider's network elements and systems reside and never communicate directly with customer equipment. The common characteristics of NGN network elements in this domain are that they are under the full control of the related NGN provider, they are located in the NGN provider premises (which provides physical security), and they communicate only with elements in the "trusted" domain and with elements in the "trusted-but-vulnerable" domain.

3.1.19 un-trusted zone [ITU-T Y.2701]: From the viewpoint of a NGN provider, a zone that includes all network elements of customer networks or possibly peer networks or other NGN provider zones outside of the original domain, which are connected to the NGN provider's border elements.

3.2 Terms defined in this Supplement

None.

4 Abbreviations and acronyms

This Supplement uses the following abbreviations and acronyms:

4G 4th Generation wireless systems

codec	coder-decoder
CT	Call Transfer
DiffServ	Differentiated Services
DSCP	Differentiated Services Code Point
e2e	end-to-end
ENI	ETS National Implementation
eMMtel	enhanced MultiMedia telephony services
ETS	Emergency Telecommunications Service
ETSU	ETS User
ETSMS	ETS Management Service
GC	Group Communication
IEPS	International Emergency Preference Scheme
IM	Instant Messaging
IMS	IP Multimedia Subsystem
IMT-2000	International Mobile Telecommunications-2000
IP	Internet Protocol
IPSec	Internet Protocol Security
ISDN	Integrated Services for Digital Network
ISUP	ISDN User Part
MMtel	MultiMedia telephony services
MPC	Multi-Party Communication
MultiCONF	Multimedia CONFerence
NGN	Next Generation Network
NNI	Network-to-Network Interface
PII	Personally Identifiable Information
PLMN	Public Land Mobile Network
PS	Presence Sharing
PSTN	Public Switched Telephone Network
QoS	Quality of Service
RACF	Resource Admission and Control Function
RCS	Rich Communication Services
RSVP	ReSource reserVation Protocol
RTP	Real-time Transport Protocol
SDO	Standards Development Organization
SIP	Session Initiation Protocol
SLA	Service Level Agreement
SMS	Short Message Service
TMN	Telecommunication Management Network
URI	Uniform Resource Identifier

VoLTE Voice over Long Term Evolution

5 Evolution of ETS-related activities

Fostering the interconnection of different emergency-related authorities who may belong to different countries or international organizations is of utmost relevance in emergency and crisis events. One of the challenges is how to address a common interconnection framework taking into account that the ETS national implementations (ENIs) are subject to national regulations.

[ITU-T E.107] is the reference document for the implementation of an international ETS interoperability framework. [ITU-T E.107] defines the criteria that such a system shall comply with (e.g., priority mapping between different ENIs, decentralized management of authorized ETS users, bilateral/multilateral agreements between institutions) and depicts the network architecture with border gateways at each ENI isle. [ITU-T E.107] is a general document that only provides guidance and main requirements on the interconnection of ENIs, without going into technical details.

Prior to the publication of the next generation network (NGN) release 1, several documents provided guidance on the interconnection of international ENIs. [ITU-T E.106] provides guidance concerning the international emergency preference service (IEPS) defined in clause 3.1.4 to implement the prioritized ETS access to network resources. Although those concepts are mainly targeted to circuit-switching networks, [ITU-T Q Suppl.47] provides information regarding the harmonization of ETS in international mobile telecommunications-2000 (IMT-2000) systems. Thus, these recommendations are applicable to both circuit-switching and packet-switching IMT-2000 connections. Also, [ITU-T Q Suppl.53] provides details for IEPS in the scope of the integrated services for digital network public land mobile network/ public switched telephone network (ISDN/PLMN/PSTN), including the PSTN-to-Internet protocol (PSTN-to-IP) gateways.

[ITU-T Y.1271] is the first document to include concepts of the NGN in the network requirements and capabilities to support ETS over evolving circuit-switched and packet-switched networks. Yet, [ITU-T Y.1271] outlines the requirements and capabilities in general and abstract terms, as a technology neutral document.

The definition of NGNs introduced new technical mechanisms to support the underlying network requirements of ETS. Therefore, [ITU-T Y.2205] provides the technical aspects (identification of issues and potential solutions) to support ETS over NGN, including both the service stratum and the transport stratum. Appendix III of [ITU-T Y.2205] provides an example of ETS call flow for NGN, based on the proposals in [ITU-T Q Suppl.57], including the use of session initiation protocol (SIP) for call signalling and the SIP resource priority header for interoperability between different ETS systems.

[ITU-T Y.2205] details the interoperability of the protocols in the service and transport strata:

– In the service stratum, different ENIs are possible and thus mapping principles between the SIP (i.e., SIP resource priority header), IEPS, [ITU-T H.323] and DIAMETER protocols are detailed.
– In the transport stratum, different quality of service- (QoS-) enforcing mechanism options (e.g., resource reservation protocol (RSVP), differentiated services (DiffServ)) are proposed to support the traffic prioritization in IP-based networks.
– The orchestration between the two strata is based in the resource and admission control functions (RACF) element, for QoS-related negotiation and reservation in the NGN architecture.

[ITU-T Y.1271] defines the basic set of functional requirements and capabilities for emergency telecommunications, further extended by [ITU-T Y.2205]; see Table 1.

Table 1 – Functional capabilities for ETS

Enhanced priority treatment	
Secure networks	
Location confidentiality	
Restorability	
Network connectivity	
Interoperability	
Mobility	
Ubiquitous coverage	
Enhanced priority treatment	
Survivability/endurability	
Voice transmission (circuit-switched and packet-switched)	
Video transmission (mainly packet-switched)[a]	
Data transmission[a]	Real-time text and imagery [b]
	Non-real-time messages and streams (audio/video)[b]
	Prioritized versions of the following commercial services: web service, file transfer, e-mail, short message service (SMS) over IP and instant messaging (IM)[c]
Scalable bandwidth	
Reliability/availability	
Preferential treatment in congestion control mechanisms[a]	

[a] New items introduced in the 2014 edition of [ITU-T Y.1271].
[b] Data services defined in [ITU-T Y.2205].
[c] Cited in [ITU-T Y.1271].

In addition to service compatibility and reliability, network- and service-level security are of utmost importance when considering the applicability of IP-based services to ETS within the scope of a NGN. In [ITU-T Y.1271], two levels of security are depicted:

– Rapid authentication of authorized users for emergency telecommunications.

– Security protection of emergency telecommunication traffic.

More specifically, [ITU-T Y.2705] analyses the security requirements for the interconnection of ENIs, including references to authentication in NGN in [ITU-T Y.2702]. Again, [ITU-T Y.2705] covers the requirements and general specifications of the security mechanisms in ENI-to-ENI interoperability, but technical details are avoided in the document.

Additionally, [ITU-T M.3350] deals with the integration of ETS into the telecommunication management network (TMN) framework, defining an emergency telecommunications service management service (ETSMS) and the required information flows between the service customer and service provider. However, [ITU-T M.3350] is focused on the IEPS and does not incorporate either NGN concepts or interoperability aspects.

Towards analysing the current status of ENI-to-ENI interoperability, two related Supplements are available:

– [ITU-T Q Suppl.62] summarizes the most relevant activities in ITU-T and other standards development organizations (SDOs) in the scope of ENIs.

– [ITU-T Q Suppl.63] addresses the protocol details of different types of ENI technologies as a step forward to implement the technical mapping between different ENIs.

The historical evolution of ETS-related standards is illustrated in Figure 2.

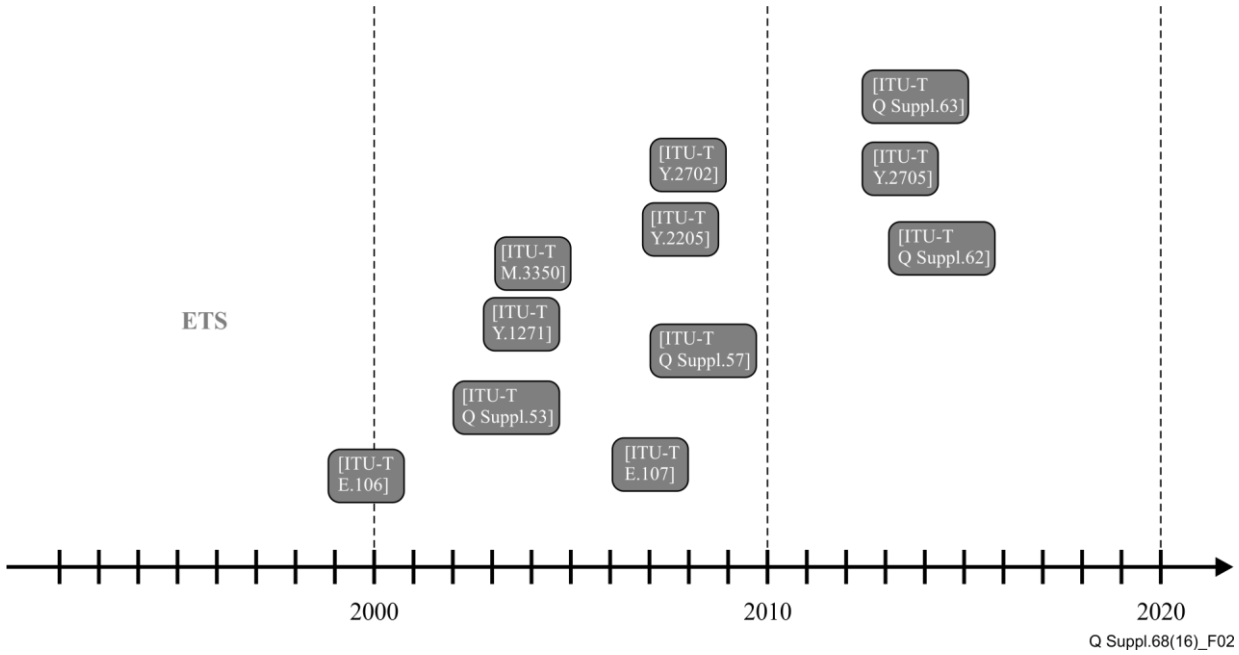

Figure 2 – Evolution of ITU ETS standardization activities and relation to IMT and NGN

Finally, ITU-T SG 13 has started to work on the applicability of future telecommunication systems to ETS. In this way, the use of cloud infrastructure resources for ETS is analysed in [ITU-T Y.3501] ,[ITU-T Y.3510] and [ITU-T Y.3520]. ETS functional requirements are analysed and addressed from the high-level standpoint of the cloud computing paradigm.

6 Identification of ETS interoperability limitations

Taking into account the list of ETS functional capabilities in Table 1 and the current status and trend of commercial telecommunications services, this clause identifies and analyses possible limitations in ENI-to-ENI interoperability contexts.

Considering that most interoperability limitations in multi-ENI environments could to some extent be solved either by multiple bi-lateral or multilateral service level agreements (SLAs), associated limitations are listed upfront.

This clause is organized as follows:

– Clause 6.1 presents a series of use cases to illustrate complex scenarios where possible limitations are analysed.

– Clause 6.2 summarizes ETS functional capabilities for which possible limitations have been detected and whether they could benefit from some enhancement in terms of protocol mapping or further protocol clarification.

6.1 Analysis of selected use cases

This clause introduces a subset of possible scenarios where possible limitations need to be analysed including specifically the following NGN-based real-time conversational multimedia services:

– Multimedia Telephony Services (MMtel) [ITU-T Y.2211], including:
  - Voice transmission.
  - Video transmission.
  - Real-time text/instant messaging.

– Call transfer (CT) [ITU-T Y.2211]:

- Group communication (GC) [ITU-T Y.2211].
- Multi-party communication (MPC) [ITU-T Y.2211].
- Multimedia conference (MultiCONF) [ITU-T Y.2211].
- Enhanced multimedia telephony services (eMMtel) – presence sharing (eMMtel-PS) [ITU-T Y.2254].

In this clause, security and confidentiality issues are analysed as sample use cases, which are further detailed in clause 06.2, in which a comprehensive analysis, extended to all functional requirements, is provided, see Table 2.

Table 2 – Possible inter-ENI interoperability limitations

Functional requirements	Limitations	Affected services	Sample use cases
Secure networks • Need for expanded encryption techniques and user authentication. [ITU-T Y.1271] • Protect the integrity of all inter-network ETS signalling traffic. [ITU-T Y.2705] • Protect the integrity of all inter-network ETS media traffic. [ITU-T Y.2705]	Cryptographic measures may impact the interoperability between ETS users at different ENIs. • Signalling protection shall be compatible between ENIs. • Different ENIs may implement different encryption requirements on a media plane. Media flows may need to be cross-ciphered between ENIs so that user devices can support interoperable communication.	MMtel	Ciphering/key agreement and security association in a multi-ENI environment. Signalling and security implications for MPC and MultiCONF servers in bilateral and multilateral ETS sessions.
	Complex technical issues due to multi-party multi-ENI communications. • Possible service disruption when transferring a media flow to a third party. • Possible service incompatibilities in multi-party group communications.	CT MPC MultiCONF	
Secure networks • Personally identifiable information (PII): allow selected ETS users to use ETS anonymously [ITU-T Y.2705] • PII: protect the confidentiality of selected ETS user identities [ITU-T Y.2705]	Exposition of PII issues: • Possible exposition of personal information (e.g., naming, addressing, transport stratum information) in call signalling and media flows. • Complex technical issues related to call transfer and group communications.	MMtel CT GC MPC MultiCONF	Security and PII constraints in individual multimedia session. Information exchange in multimedia group session among different ENIs. Information exchange on CT.

Table 2 – Possible inter-ENI interoperability limitations

Functional requirements	Limitations	Affected services	Sample use cases
Location confidentiality: • ETS users may need to organize emergency operations without risk of their location being discovered. [ITU-T Y.1271] • PII: protect the confidentiality of the location of selected ETS users [ITU-T Y.2705]	Location information included in presence sharing or in pre-defined group information.	GC eMMtel-PS	ALL
	Location-related information (e.g., IP address) included in signalling and media planes.	MMtel CT MPC MultiCONF	

6.1.1 Security and PII constraints in individual multimedia sessions

[ITU-T Y.2701] defines a security trust model in order to identify the security specific requirement for NGN. More specifically, for the interconnection of any NGN to other networks, [ITU-T Y.2701] suggests considering other providers as un-trusted, even under the so-called peering trust model. Moreover, specific nodes called domain border elements in the limit between trusted and un-trusted or trusted but vulnerable zones would be those considered in situations such as a network-to-network interface (NNI) between NGNs. In fact, [ITU-T Y.2705] summarizes some technical mechanisms (i.e., Internet protocol security (IPSec) tunnels for the exchange of information in the peering points or differentiated services code point (DSCP) marking for enforcing priority across domains). Although not completely specified in ITU-T Recommendations, the list of high-level requirements in [ITU-T Y.2705] covers most interoperability issues. However, the current trend of evolution in broadband mobile multimedia towards voice over long term evolution/rich communication services/Internet protocol multimedia subsystem (VoLTE/RCS/IMS) introduces new details to be considered in the exchange of information of the NNI. Example features to be considered are: location information in the session setup (i.e., SIP INVITE location and contact headers), the need for standardized border-controlling/topology hiding mechanisms and identity mapping, which will be specifically linked to the interoperable MultiCONF-enabling architecture.

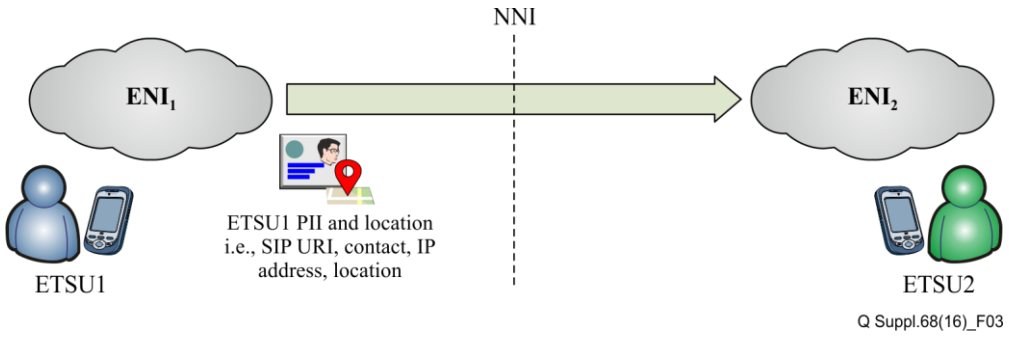

Figure 3 – Security and PII constraints in individual multimedia session

6.1.2 Information exchange on CT

As in the previous case, the initial caller should have the identity (addressing) information of the callee in ENI_2 prior to the session setup. Therefore, anonymized or controlled identifiers could be

used to prevent PII protection problems according to ENI_2 directives. However, transferring the session to another user could compromise such security policies if there is not a uniform border-controlling mechanism to be applied to the whole data exchange in the NNI. Moreover, the same constraints applied to the initial session should be also supported in the subsequent iteration.

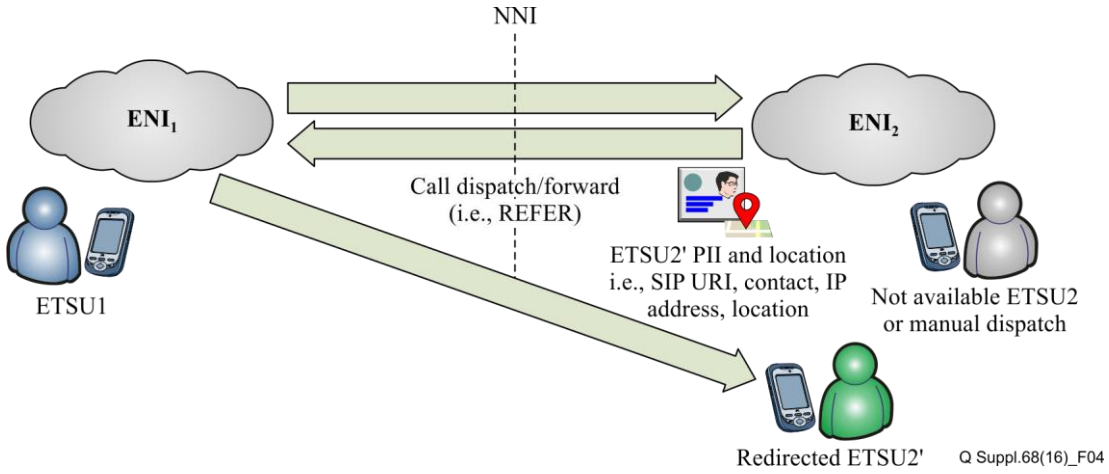

Figure 4 – Information exchange on CT

6.1.3 Signalling and security implications for MPC and MultiCONF servers in bilateral and multilateral ETS sessions

[ITU-T E.107] specifies the potential settlement of a bilateral/multilateral agreement between cooperating countries/administrations to link their respective ETS systems. However, most of the subsequent analysis of NNI signalling when addressing ETS interoperability problems focuses on bilateral (i.e., ENI_1 to ENI_2) agreements only. National responsibility for ensuring the required security, PII, availability and prioritization within the ENI itself and the current framework of information exchange fully covers those requirements for single (one to one) sessions and when considering traditional services (i.e., individual voice calls).

However, enhanced multimedia services including group sessions – such as MultiCONF as defined in [ITU-T Y.2211] – and the capability to exchange presence and contact information and multimedia data in MPC introduces additional technical issues.

For example, as depicted in Figure 5, [ITU-T Y.2705] deals with security recommendations in the NNI between two ENIs, and specifies a set of requirements to be fulfilled by such interaction. However, a more complex scenario with more than two ENIs or dynamic group communications involving the invitation of new users to the ongoing session will have to tackle additional constraints depending on the actual location of the media and signalling relaying MultiCONF server.

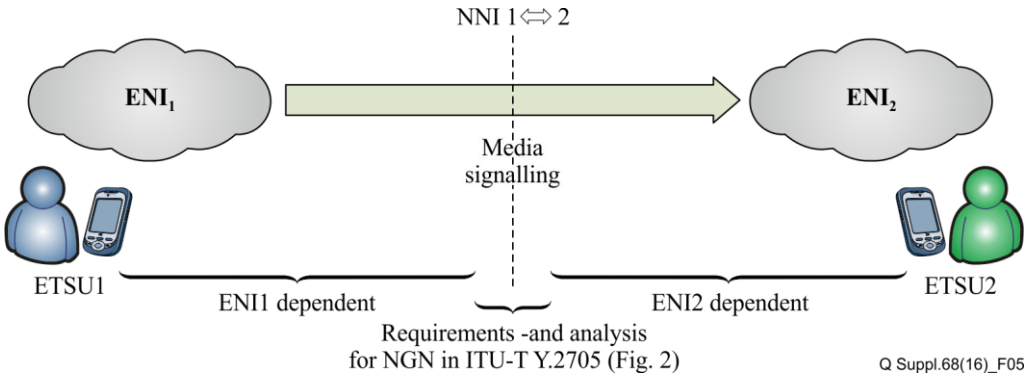

Figure 5 – Security recommendation in the NNI between two ENIs from [ITU-T Y.2705]

Three different location/schemes can be identified, as illustrated in Figure 6:

– Location a). The multiCONF server is located in the *caller* ENI_1. Emergency telecommunications service user 1 (ETSU1) should have the (initial) composition of all the members of the *callee* group. It seems reasonable that this is in fact a pre-requisite for the session setup and would therefore imply a-priori inter-ENI security and PII protection mechanisms agreement based on the bilateral SLA scheme. However, the trust transference between called ETSU2 and ETSU3 may demand an unclear multilateral agreement. Furthermore, the addition of new users to the ongoing group session will have to deal with real time PII protection mechanisms if any user of ENI_2 or ENI_3 wants to include an additional member of their national ENIs in that session.

– Location b). A trusted third party (or interface) built upon multilateral agreement enforces security, PII protection and compatibility to participants from any ENI. However, its role and technical relationship with NGN and traditional ETS should be properly analysed.

– Location c). Each ENI provides a MultiCONF server responsible for handling all the internal signalling and media exchanges, together with the possible addition of new users to the ongoing session. This satisfies internal ENI constraints, but on the other hand might allow undesired anonymous/uncontrolled access from other ENI users to the ongoing inter-ENI session.

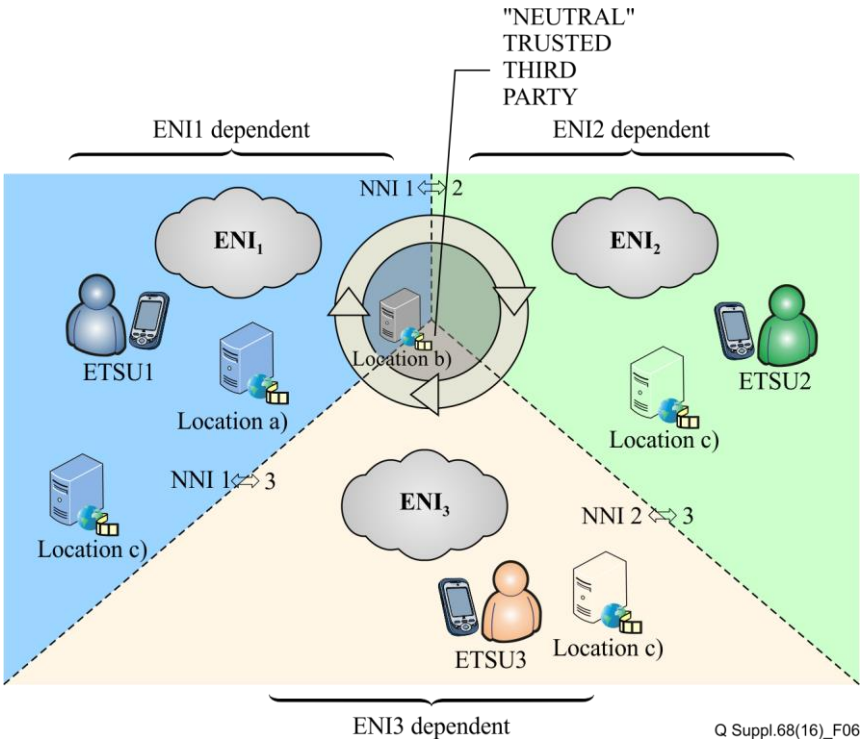

Figure 6 – Signalling and security implications for MPC and MultiCONF servers in bilateral and multilateral ETS sessions

6.1.4 Information exchange in multimedia group session among different ENIs

As introduced previously, the location of the node responsible for hosting MultiCONF sessions in a multi-ENI environment and subsequent signalling and media relay imposes a set of constraints due to the need to harmonize multi-bilateral information exchange. As depicted in Figure 7, a group session hosted in the caller ENI would require the full composition of the group prior to session setup.

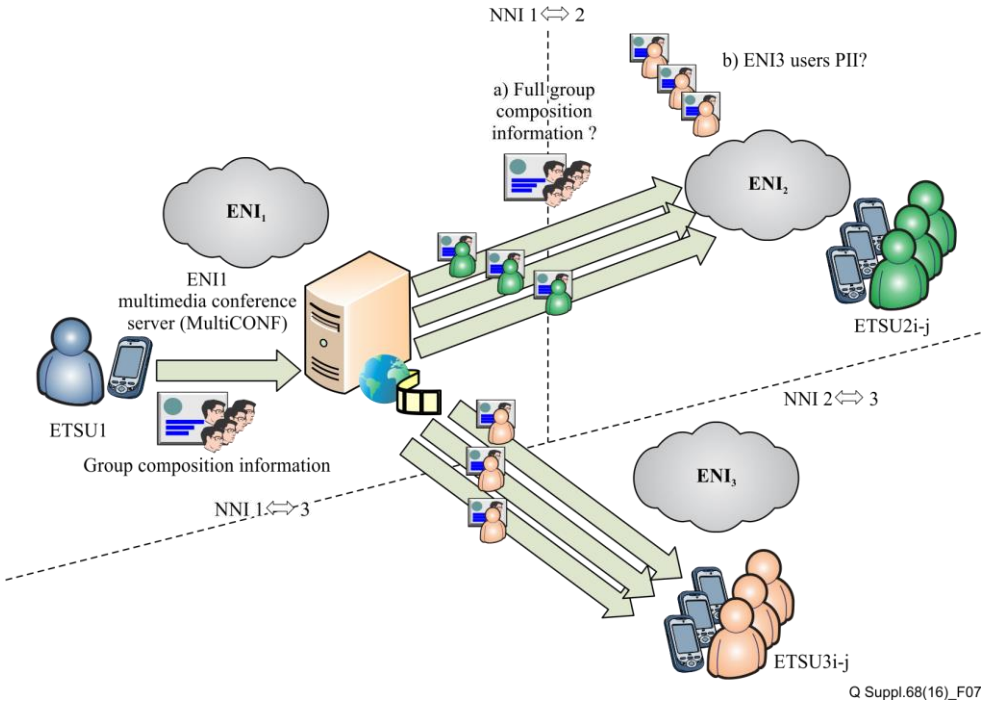

Figure 7 – Information exchange in multimedia group session among different ENIs

Multiple ENIs are involved in a group session to which extent not only ENI_3 ETS users' identities, but also PII information in general, can be exchanged between ENI_1 and ENI_2 for session management purposes (i.e., sharing multimedia content). Furthermore, depending on whether location a), b) or c) is selected, the combinatorial problem for the bilateral/multilateral agreements will increase.

The problem illustrated in Figure 8 applies to multi-party communications where one of the ETS users is capable of adding another member of the same ENI to the multi-ENI group. As reflected in Figure IV.3 of [ITU-T Y.2211] for group communication, a given user may need to send a request to the external server with the naming/addressing information of another user, which may compromise the PII data.

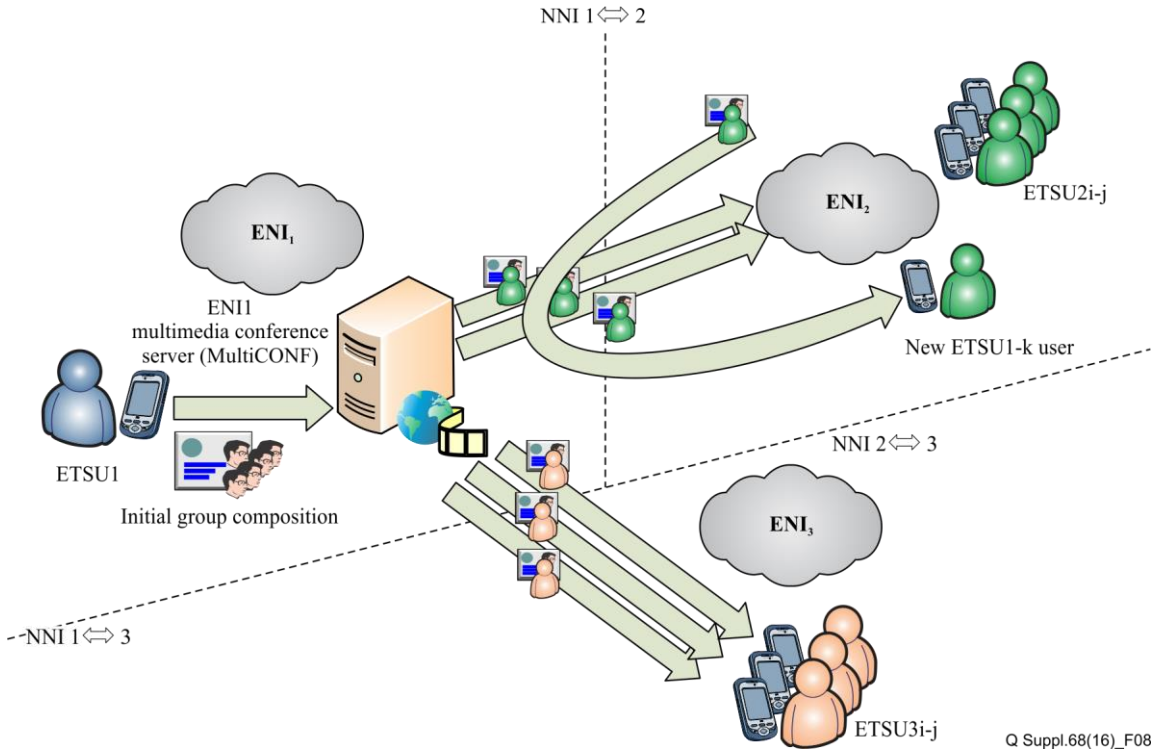

Figure 8 – Information exchange in a dynamic group composition

6.1.5 Ciphering/key agreement and security association in a multi-ENI environment

ENIs may implement media plane encryption techniques to reinforce the integrity and confidentiality of ETS communications. Additionally, interoperable communications between ETS users in different ENIs may also require encryption when traversing the intermediate networks.

The encryption features may be implemented in the transport stratum (e.g., at IP level) and/or in the service stratum (e.g., at real-time transport protocol (RTP) level).

At service level, the media encryption capabilities are negotiated in an end-to-end basis through the SIP dialog in the call setup procedure. As a result, different ETS users with different encryption capabilities or requirements may be incompatible at media protection level.

Additional issues may arise in MPC, where the security associations and the key agreement schemes get more complex. Ensuring the multi-bilateral agreements and the multilateral agreements may be not a trivial issue in multi-ENI contexts, as illustrated in Figure 9.

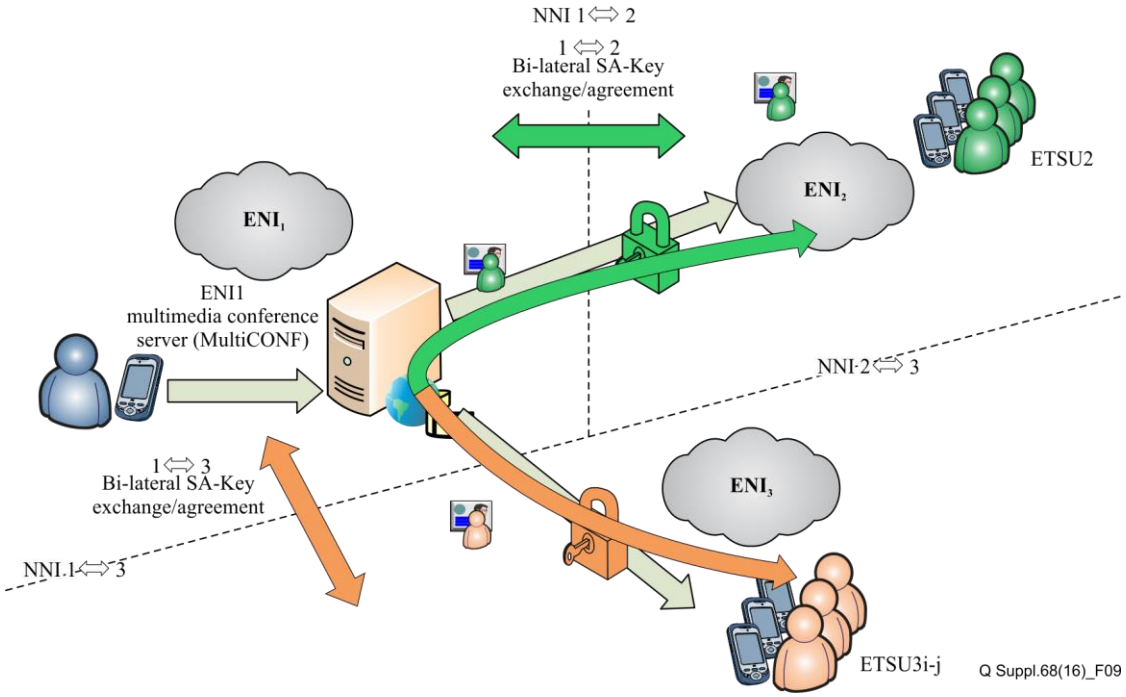

Figure 9 – Ciphering/key agreement and security association in a multi-ENI environment

6.2 Extended analysis of ETS requirements and capabilities and detected possible limitations

Once sample use cases have been described and in order to have an overall view of any possible interoperability limitation, this analysis considers not only security concerns covered in previous examples, but also how different layers are affected for each ETS functional requirement and capability included in Table 2. Most of the interoperability limitations can be addressed via multilateral SLAs, so that other issues are only noted.

According to the concepts in Figure 2 of [ITU-T Y.2205] and Figure 3 of [ITU-T Y.2705], the reference layers considered are:

– user equipment, including circuit-switched wireless and wireline equipment and IP-enabled equipment;

– access network, including wireless accesses, narrowband wireline accesses and IP accesses;

– core network, including originating and terminating core networks, transit networks, ETS provider core network and international provider networks.

Application Services, deployed at ETS Provider network.

Tables 3 to 16 follow the following structure.

– **Functional requirements** in [ITU-T Y.1271] and [ITU-T Y.2205] (see Table 1) requirements under analysis.

– **Layer** consideration.

– **Interoperability aspects** to be examined.

– **References** to ITU-T or other SDO standards involved.

– **Interoperability observations** providing guidance and examples determining gaps that may result in limitations.

– **Possible limitations to analyse** in terms of needs of protocol enhancements, protocol clarification, protocol mappings or SLA issues.

6.2.1 Compilation of common aspects solvable by multilateral SLAs

Harmonization frameworks, such as trusted third parties-based application servers and/or international agreements on mandatory coder-decoders (codecs) and encryption and security mechanisms, would facilitate both technical interoperability among ENIs and multilateral SLA settlement.

According to Figure 10, each ENI would agree through a single SLA with a neutral mediation service provider on a common set of codecs and security requirements. That neutral element would also be responsible for managing trust delegation issues in group communications. By contrast, the traditional schemes, e.g., like that in Figure 6, demand multiple NNI i_to_j (covering all possible combinations of ENIs to be connected) bi-lateral interfaces and SLAs together with some multilateral agreement on trust delegation and security association handling.

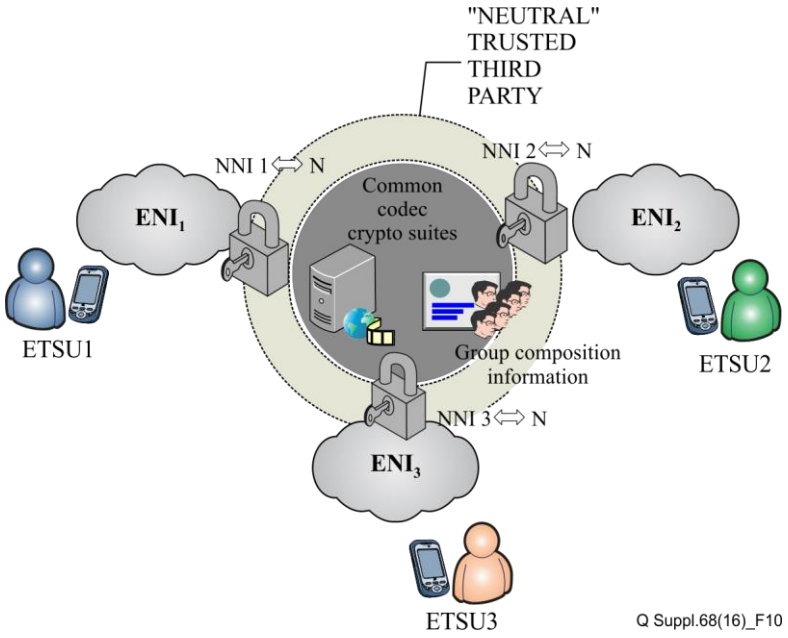

Figure 10 – Role of a neutral third party

However, the aforementioned complexity does not result in a technical problem, so that no specific need for additional protocol mapping, clarification or new definition is foreseen. Examples of such cases are as follows.

– The need for explicit notification from the callee/caller ENI of the fulfilment of QoS preconditions, prioritization and preemptiveness-related mapping as well as prioritized access to remote application servers. Although technically desirable, they would not be needed if granted by multilateral SLAs.

– Multilateral SLAs can be used to define a common minimum set of ciphering suites or expanded encryption techniques. Therefore, end-to-end (e2e) security will be granted without needing any additional protocol clarification.

– Explicit notification of network capabilities with regards to restorability, survivability and endurability are not considered and are again left for a multilateral SLA.

– Although, according to clause 7.6 of [ITU-T Y.1271]: "In order to have interoperable capabilities among different operators offering emergency telecommunications, a common configuration will be helpful." The definition of such framework is outside the scope of ITU-T activities and will be left to multilateral SLAs among ENIs of different countries.

– In terms of voice and video transmission capabilities, the deployment of specific gateways to cope with every peer-to-peer mapping may result in costly solutions. Although implementing

a mapping solution from any local technology to a commonly agreed format could benefit the deployment of interoperability solutions, such problems could also be solved by multilateral SLAs defining a common set of voice/video capabilities to be supported by different ENIs.

– Similarly, the location/management of an ETS group server in a multi-ENI scenario is not clear (i.e., clause 6.1.4). At least one reliable entity is required to handle group communications. However, again, although a cascade of multiCONF servers (one per ENI) may increase security and reliability, common PII exchange and reliability aspects could still be agreed via multilateral SLAs.

– Scalable bandwidth and other adaptation mechanisms may be beneficial in crisis situations leading to resource exhaustion. Therefore, remote caller/callee user equipment or an application service should be capable of triggering such procedures. Currently existing protocols already allow similar techniques [i.e., via SDP (re)negotiation] so that any harmonization could be enforced by SLA and no additional protocol mapping need is envisioned.

A detailed analysis is provided in Tables 3 to 16.

6.2.2 Enhanced priority treatment

See Table 3.

Table 3 – Enhanced priority treatment analysis

Functional requirements	Layer	Interoperability aspects	References	Interoperability observations	Possible limitations to analyse
Preferential access to telecommunications facilities. Preferential establishment, use of remaining operational resources and completion of emergency traffic. Preferential routing of emergency telecommunication traffic. Optional pre-emption of non-emergency traffic. Allowable degradation of service quality for traffic, as infrastructure resources become unavailable.	User equipment	N/A: How ETS users are authenticated and authorized, and how ETS sessions are enabled with prioritized resources, is a national matter.	ITU-T Q Suppl.62: admission control, authentication, preferential treatment, preferred routing priority, signalling in support of IEPS, QoS, and transport.	None identified	**None identified**
	Access network capabilities	Preferential access to telecommunication facilities should be granted to ETS users by the ENI. However, in scenarios with complex services, the need for specific notification of preferential access to resources needs further analysis.	ITU-T Q Suppl.62: admission control, authentication, preferential treatment, preferred routing priority, signalling in support of IEPS, QoS, and transport. Multi-technology interworking: Clause 8 of [ITU-T Q Suppl.63], protocol mappings to support ETS in (e.g., ISDN user part (ISUP) vs SIP vs [ITU-T H.248.1]) NGN interworking: ITU-T Q Suppl.61	Although preferential access would be granted at ENI level, explicit notification that the required resource reservation procedures (i.e., [ITU-T Y.2111]) to ensure such preferential access are provided to the other end in some specific implementations (i.e., QoS local/remote media attributes in SDP negotiations in SIP dialogs) to guarantee proper e2e performance should be analysed.	**Protocol clarification.** Most ENIs simply progress any incoming ETS request with the proper priority mapping applied, but with no explicit notification of the resulting treatment for that setup. In clause 7 of ITU-T Q Suppl.63, the sentence "Priority is honoured across the NNI based on security policy" would therefore cover not only basic priority mapping signalling, but also that related to enhanced priority treatment, such as resource reservation. A specific reference to priority also covering preferential access to telecommunication facilities and more specifically reservation of access network capabilities would satisfy this functional requirement.

Table 3 – Enhanced priority treatment analysis

Functional requirements	Layer	Interoperability aspects	References	Interoperability observations	Possible limitations to analyse
	Core network capabilities	N/A: Preferential access to telecommunication facilities should be granted to ETS users by the ENI. Furthermore, in clause 7 d) of [ITU-T E.107] "If a transit network is not able to distinguish an ETS call/session request from a normal call/session request, then the ETS call/session request should be processed as a normal call/session request and any international call markings associated with the call/session should be passed without change."	ITU-T Q Suppl.62: admission control, authentication, preferential treatment, preferred routing priority, signalling in support of IEPS, QoS, and transport. Multi-technology interworking: Clause 8 of [ITU-T Q Suppl.63], protocol mappings to support ETS in (e.g. ISUP vs SIP vs [ITU-T H.248.1]) NGN interworking: ITU-T Q Suppl.61	None identified	**None identified**

Table 3 – Enhanced priority treatment analysis

Functional requirements	Layer	Interoperability aspects	References	Interoperability observations	Possible limitations to analyse
	Application services	Preferential access to telecommunication facilities should be granted to ETS users by the ENI. However, those situations where the application servers may be located in a remote ENI require additional discussion. See example use cases in clauses 6.1.3 and 6.1.4	Multi-technology interworking: N/A NGN interworking: N/A	Preferential access to application servers and/or computing resources not addressed in general. Some discussions for cloud-enabled ETS in clause 7.16 of [ITU-T Y.1271] and Appendix IV of [ITU-T Y.3510].	**Protocol clarification.** The ENI hosting the application server should guarantee via multilateral SLAs when needed preferential access to telecommunication facilities to different callers/callees from other ENIs properly identified by existing priority mapping mechanisms. In clause 7 of [ITU-T Q Suppl.63], the sentence "Priority is honoured across the NNI based on security policy" would therefore cover also this case. A specific reference to priority also covering preferential access to telecommunication facilities and more specifically application servers would satisfy this functional requirement.

6.2.3 Secure networks

See Table 4.

Table 4 – Secure networks analysis

Functional requirements	Layer	Interoperability aspects	References	Interoperability observations	Possible limitations to analyse
Rapid authentication of authorized users for emergency telecommunications Authentication and authorization	User equipment	N/A: How ETS users are authenticated and authorized is a national matter.	Clause 8.4 of [ITU-T Y.2705]. Clause 7.3.6 of [ITU-T Q Suppl.62].	None identified	**None identified**
	Access network capabilities	Preferential access to telecommunication facilities should be granted to ETS users by the ENI. Upon initiation of an emergency communication request, for evolving networks, it is desirable to request the establishment of an innovative method for a streamlined rapid user authentication process in these evolving telecommunication networks, including mobile networks, which verifies the user's identity to protect the telecommunication resources against excessive use and abuse during an emergency situation.	Clause 8.4 of [ITU-T Y.2705. Clause 7.3.6 of [ITU-T Q Suppl.62].	None identified	**None identified**

Table 4 – Secure networks analysis

Functional requirements	Layer	Interoperability aspects	References	Interoperability observations	Possible limitations to analyse
		Once an authentication is validated and emergency telecommunication travels across networks, such authentication information may be associated with labels that then should be transported from the call initiation until termination. It may be necessary for the label to remain throughout the duration of the emergency call.			
	Core network capabilities	Once an authentication is validated and emergency telecommunication travels across networks, such authentication information may be associated with labels that then should be transported from the call initiation until termination. It may be necessary for the label to remain throughout the duration of the emergency call	Clauses 8.4 and 8.7 of [ITU-T Y.2705]. Clause 7.3.6 of [ITU-T Q Suppl.62]	None identified	**None identified**
	Application services	Once an authentication is validated and emergency telecommunication travels across networks, such authentication information	Clause 8.4 of [ITU-T Y.2705] Clause 7.3.6 of [ITU-T Q Suppl.62]	None identified	**None identified**

Table 4 – Secure networks analysis

Functional requirements	Layer	Interoperability aspects	References	Interoperability observations	Possible limitations to analyse
		may be associated with labels that then should be transported from the call initiation until termination. It may be necessary for the label to remain throughout the duration of the emergency call			
Security protection of emergency telecommunication traffic Measures against spoofing, intrusion and denial of service Expanded encryption techniques and user authentication	User equipment	Expanded encryption techniques.	Clauses 8.5 and 8.6 of [ITU-T Y.2705]	Functional requirements involving security aspects in e2e communications would demand both caller and callee in different ENIs supporting the same/equivalent information protection capabilities, expanded encryption techniques or countermeasures. Lack of expanded user authentication and measures against spoofing, intrusion and denial of service in the remote caller/callee ENI	**None identified.** Reliable mapping between different crypto suites supporting the equivalent level of security protection is not feasible. Therefore, commonly agreed multilateral SLAs should be put in place. Such analysis actually affects user equipment, access and core networks and application services in a multi-ENI scenario. Security protection includes PII in situations like those considered in clauses 6.1.1 to 6.1.5. As mentioned in clause 6.2.1, although current call signalling mechanisms (i.e., in MultiCONF services) may reveal PII depending on the server placement, multilateral SLA and proper domain border control would fulfil the functional requirement without requiring additional
	Access network capabilities	Expanded user authentication in every involved ENI. Measures against spoofing, intrusion and denial of service in every involved ENI.	Clauses 8.5 and 8.6 of [ITU-T Y.2705]		
	Core network capabilities	Expanded user authentication in every involved ENI. Measures against spoofing, intrusion and denial of service in every involved ENI.	Clauses 8.5, 8.6 and 8.7 of [ITU-T Y.2705]		
	Application services	Expanded user authentication in every involved ENI. Measures against spoofing, intrusion and denial of	Clauses 8.3, 8.5 and 8.6 of [ITU-T Y.2705]		

Table 4 – Secure networks analysis

Functional requirements	Layer	Interoperability aspects	References	Interoperability observations	Possible limitations to analyse
		service in every involved ENI. Support for data-related expanded encryption techniques in call signalling.			protocol mapping, clarification or definition.

6.2.4 Location confidentiality

See Table 5.

Table 5 – Location confidentiality analysis

Functional requirements	Layer	Interoperability aspects	References	Interoperability observations	Possible limitations to analyse
Special security mechanisms to prevent the identification of the location of certain authorized users of emergency telecommunications from being revealed to non-authorized parties should apply in order to protect such authorized users from being located.	User equipment	User equipment shall not be capable of determining if counterparts are authorized to access location information.	Clause 8.6 of [ITU-T Y.2705]	If user equipment is capable of inserting location information in the service or transport strata, it can be instructed by an ETS provider to remove location information from specific ETS communications.	
	Access network capabilities	Access network shall not be capable of determining if counterparts are authorized to access location information.	Clause 8.6 of [ITU-T Y.2705]	If an access network is capable of inserting location information in the service or transport strata, it can be instructed by an ETS provider to remove location information from specific ETS communications in the service or transport strata.	

Table 5 – Location confidentiality analysis

Functional requirements	Layer	Interoperability aspects	References	Interoperability observations	Possible limitations to analyse
	Core network capabilities	Core network shall not be capable of determining if counterparts are authorized to access location information.	Clause 8.6 of [ITU-T Y.2705]	A core network could be instructed by an ETS provider to remove location information from specific ETS communications in the transport stratum.	**None identified.** Special care should be taken in group ETS communications, where an authorized ETS user could reveal location information of another ETS user to a third non-authorized ETS user. Such a scenario (illustrated in clauses 06.1.2 to 6.1.4) will demand proper configuration of the elements in the NNI in order to remove sensitive PII information in CT, MPC and MultiCONF without need for additional protocol clarification (some recommendation/best practices may be needed). Multilateral SLAs must be enforced to guarantee PII information removal in the NNI when needed.
	Application services	ETS provider should control whether to delete ETS user location from specific ETS communications**.**	Clause 8.6 of [ITU-T Y.2705]	Application services should be capable of handling the insertion of location information in thet service and transport strata. Application services should be able to remove location information from session signalling in the service stratum. If application services are included in the data path, they should be able to remove location information from ETS data in the transport stratum.	

6.2.5 Restorability

See Table 6.

Table 6 – Restorability analysis

Functional requirements	Layer	Interoperability aspects	References	Interoperability observations	Possible limitations to analyse
Should a disruption occur, telecommunication network functionalities should be capable of being reprovisioned, repaired or restored to required levels on a priority basis.	User equipment	N/A		None identified	**None identified.** Explicit notification covered by multilateral SLA.
	Access network capabilities	All access networks used by any of the ENIs involved should comply with quick restorability requirements.	From ITU-T Q Suppl.62: ITU-T Y.2172.		
	Core network capabilities	All core networks used by any of the ENIs involved should comply with quick restorability requirements.	From ITU-T Q Suppl.62: ITU-T Y.2172.		
	Application services	All application services used by any of the ENIs involved should comply with quick restorability requirements.	From ITU-T Q Suppl.62: ITU-T Y.2172.		

6.2.6 Network connectivity

See Table 7.

Table 7 – Network connectivity analysis

Functional requirements	Layer	Interoperability aspects	References	Interoperability observations	Possible limitations to analyse
Interworking preferential treatment at reference points that are deemed to constitute international and/or regulatory boundaries between national networks that provide emergency telecommunications may create international emergency systems, e.g., when [ITU-T E.106] and/or [ITU-T E.107] is applicable.	User equipment	N/A, unless roaming issues are considered.	Clause 10 of [ITU-T Y.2205]	None identified	**None identified**
	Access network capabilities	N/A, unless roaming issues are considered.	Clause 10 of [ITU-T Y.2205]	None identified	**None identified**
	Core network capabilities	Inter-ENI functional requirements apply to these reference points between core networks.	Clause 10 of [ITU-T Y.2205] Clause 8.6 of [ITU-T Q Suppl. 62]. [ITU-T Q Suppl. 63].	Possible incompatible protocols between core networks supporting different ETS providers.	**None identified.** Any incompatibility should be covered by the commercial service
	Application services	Inter-ENI functional requirements apply to ETS communications involving different ETS providers, both in the service stratum and the transport stratum, if applicable.	Clause 10 of ITU-T Y.2205. Figure 3 of [ITU-T Y.2705].	Possible incompatibility regarding transport protocols between application services deployed at different ETS providers. Thorough ETS analysis of underlying protocols should be carried out.	**None identified.** Any ETS incompatibility could be addressed as part of the compatibility solution for the underlying commercial service support of ETS communication.

6.2.7 Interoperability

See Table 8.

Table 8 – Interoperability analysis

Functional requirements	Layer	Interoperability aspects	References	Interoperability observations	Possible limitations to analyse
Different schemes for interworking between the circuit-switched and packet-switched technologies need to be considered. Configuration issues are often a major cause of interoperability problems. The goal of this requirement is to provide interconnection and interoperability among all networks (evolving or existing).	User equipment	Beyond simple connectivity, different user equipment in different ENIs should be able to establish ETS communications and other services.	Interworking requirements for preferential treatment methods over heterogeneous networks have been addressed for PSTN and IPCablecom networks in clause 6 of [ITU-T J.261] and clause 6.2 of [ITU-T J.260]. These requirements may also be applied to other heterogeneous networks.	According to clause 7.6 of [ITU-T Y.1271]: "In order to have interoperable capabilities among different operators offering emergency telecommunications, a common configuration will be helpful. Note this does not imply operators must all configure their internal networks the same if they are to support emergency capabilities. It only implies they will translate appropriate configurations at the appropriate ingress/egress locations."	**None identified.** Any ETS incompatibility could be addressed as part of the compatibility solution for the underlying commercial service support the ETS communication.
	Access network capabilities	N/A, since ETS interoperability deals with specific ETS procedures and data sets in the service and transport strata.		None identified	**None identified**
	Core network capabilities	N/A, since ETS interoperability deals with specific ETS procedures and data sets in the service and transport strata.		None identified	**None identified**

Table 8 – Interoperability analysis

Functional requirements	Layer	Interoperability aspects	References	Interoperability observations	Possible limitations to analyse
	Application services	Beyond simple connectivity, application services in different ETS providers should be able to establish ETS communications and other services among them, and to enable ETS sessions between ETS users in different ENIs.	Interworking requirements for preferential treatment methods over heterogeneous networks have been addressed for PSTN and IPCablecom networks in clause 6 of [ITU-T J.261] and clause 6.2 of [ITU-T J.260]. These requirements may also be applied to other heterogeneous networks.	Thorough ETS analysis of underlying protocols should be carried out. According to clause 7.6 of [ITU-T Y.1271]: "In order to have interoperable capabilities among different operators offering emergency telecommunications, a common configuration will be helpful. Note this does not imply operators must all configure their internal networks the same if they are to support emergency capabilities. It only implies they will translate appropriate configurations at the appropriate ingress/egress locations."	**None identified.** Covered by multilateral SLAs.

6.2.8 Mobility

See Table 9.

Table 9 – Mobility analysis

Functional requirements	Layer	Interoperability aspects	References	Interoperability observations	Possible limitations to analyse
Mobility calls for a telecommunications infrastructure that is integrated with transportable, re-deployable and fully mobile facilities. With most wireless terminals supporting both Wi-Fi and cellular technologies, data off-loading to enable increased voice traffic on mobile networks is gaining importance.	User equipment	N/A to inter-ENI communications, since mobility and offloading issues are specific to local implementations.	Clause 7.3.4 of [ITU-T Q Suppl.62].	None identified	**None identified**
	Access network capabilities	N/A to inter-ENI communications, since mobility and offloading issues are specific to local implementations.	Clause 7.3.4 of [ITU-T Q Suppl.62].	None identified	**None identified**
	Core network capabilities	N/A to inter-ENI communications, since mobility and offloading issues are specific to local implementations.	Clause 7.3.4 of [ITU-T Q Suppl.62].	None identified	**None identified**
	Application services	Mobility and offloading issues are specific to local implementations. If applications services provide detailed connection information related to ETS in inter-ENI sessions (e.g., location information or access technology), applications services may need to implement the updating granularity required for mobile ETS users.	Clause 7.3.4 of [ITU-T Q Suppl.62].	Lack of accurate information related to highly dynamic parameters from remote caller/callee during ongoing ETS sessions. Feedback from remote ENI user's mobility could be beneficial for the application service (i.e., in terms of location, applying data flows adaptation mechanisms or codec re-negotiation upon such feedback).	**None identified.** Covered by multilateral SLAs.

6.2.9 Ubiquitous coverage

See Table 10.

Table 10 – Ubiquitous coverage analysis

Functional requirements	Layer	Interoperability aspects	References	Interoperability observations	Possible limitations to analyse
Public telecommunication infrastructure resources over large geographic areas should form the framework for ubiquitous coverage of emergency telecommunications. In situations where networks do not (or may not) support emergency communication requirements/capabilities, then emergency communication users will default to communication capabilities available to the general public.	User equipment	ETS users should be able to use their user equipment over commercial networks without added ETS capabilities.		Possible ETS user equipment configuration issues avoiding use of regular commercial networks or failing due to unavailability of specific procedures (e.g., authorization response). ETS user equipment could be dynamically configured by ETS application services to add extended capabilities in response to the lack of network-supported capabilities.	
	Access network capabilities	N/A		None identified.	**None identified**
	Core network capabilities	N/A		None identified.	**None identified**
	Application services	ETS provider application services should be able to allow ETS sessions over commercial networks without added ETS capabilities.		Some specific ETS capabilities (e.g., location information, prioritization and data security) may be lost when using commercial networks without ETS capabilities. However, ETS application services could provide these kinds of capabilities (or at least to some extent) in inter-ETS communications, through a proper handling of communications in the service stratum.	

6.2.10 Survivability/endurability

See Table 11.

Table 11 – Survivability/endurability analysis

Functional requirements	Layer	Interoperability aspects	References	Interoperability observations	Possible limitations to analyse
Key network infrastructure supporting emergency telecommunications needs to be as robust as possible so as to endure throughout the disaster.	User equipment	N/A.		None identified.	**None identified**
	Access network capabilities	Endurability aspects are specific to ENI deployments.		Remote feedback regarding survivability/endurability of different network elements would be desirable in order to fulfil e2e requirements (if any).	**None identified.** Covered by multilateral SLAs.
	Core network capabilities	Endurability aspects are specific to ENI deployments.			
	Application services	Endurability aspects are specific to ENI deployments.			

6.2.11 Voice transmission (circuit-switched and packet-switched)

See Table 12.

Table 12 – Voice transmission analysis

Functional requirements	Layer	Interoperability aspects	References	Interoperability observations	Possible limitations to analyse
Networks need voice transmission capabilities for emergency operations. Circuit-switched and packet-switched networks should provide voice transmission quality service for emergency telecommunications users.	User equipment	User equipment needs to support voice communications according to its native infrastructure (circuit-switched or packet-switched network).	[ITU-T Q Suppl.62] and [ITU-T Q Suppl.63].	According to clause 7.6 of [ITU-T Y.1271]: "In order to have interoperable capabilities among different operators offering emergency telecommunications, a common configuration will be helpful." If no common configuration can be agreed in the service or transport strata, specific gateways shall be deployed at other layers to ensure interoperability.	**None identified.** Any ETS incompatibility could be addressed as part of the compatibility solution for the underlying commercial service support the ETS communication.
	Access network capabilities	If required by the local ETS provider, access networks may need to deploy specific service or transport gateways for inter-ENI communications.	[ITU-T Q Suppl.62] and [ITU-T Q Suppl.63].	The deployment of specific gateways to cope with every peer-to-peer mapping may result in costly solutions. Implementing a mapping solution from any local technology to a commonly agreed format could benefit the deployment of	**None identified.** Covered by multilateral SLAs.

Table 12 – Voice transmission analysis

Functional requirements	Layer	Interoperability aspects	References	Interoperability observations	Possible limitations to analyse
				interoperability solutions.	
	Core network capabilities	If required by the local ETS provider, core networks may need to deploy specific service or transport gateways for inter-ENI communications.	[ITU-T Q Suppl.62] and [ITU-T Q Suppl.63].	The deployment of specific gateways to cope with every peer-to-peer mapping may result in costly solutions. Implementing a mapping solution from any local technology to a commonly agreed format could benefit the deployment of interoperability solutions.	**None identified.** Covered by multilateral SLAs.
	Application services	Application services may need to handle possible interoperability issues between different sets of user equipment involved in inter-ENI communication. Application services may deploy specific gateway functionalities in the service or transport strata to support protocol or codec mappings. Group voice communications require	[ITU-T Q Suppl.62] and [ITU-T Q Suppl.63]. [ITU-T Y.2211].	According to clause 7.6 of [ITU-T Y.1271]: "In order to have interoperable capabilities among different operators offering emergency telecommunications, a common configuration will be helpful. Note this does not imply operators must all configure their internal networks the same if they are to support emergency capabilities. It only	**None identified.** Covered by multilateral SLAs.

Table 12 – Voice transmission analysis

Functional requirements	Layer	Interoperability aspects	References	Interoperability observations	Possible limitations to analyse
		handling of multi-user communications in at least one of the ENIs involved.		implies they will translate appropriate configurations at the appropriate ingress/egress locations." The deployment of specific gateways to cope with every peer-to-peer mapping may result in costly solutions. Implementing a mapping solution from any local technology to a commonly agreed format could benefit the deployment of interoperability solutions. The location/ management of an ETS group server is not clear. At least one reliable entity is required to handle group communications. A cascade of conference servers (one per ENI) may increase security and reliability.	

6.2.12 Video transmission (mainly packet-switched)

See Table 13.

Table 13 – Video transmission analysis

Functional requirements	Layer	Interoperability aspects	References	Interoperability observations	Possible limitations to analyse
Within packet-switched networks, video services can be delivered over the same session-oriented reference architecture used for voice, including similar signalling. Audio and video components may be used in different modes (e.g., two-way audio conversations with two-way video, or two-way audio conversations with one-way video).	User equipment	User equipment needs to support video communications according to its native infrastructure (mainly packet-switched networks).		According to clause 7.6 of [ITU-T Y.1271]: "In order to have interoperable capabilities among different operators offering emergency telecommunications, a common configuration will be helpful." If no common configuration can be agreed in the service or transport strata, specific gateways shall be deployed at other layers to ensure interoperability.	**None identified.** Any ETS incompatibility could be addressed as part of the compatibility solution for the underlying commercial service support the ETS communication.
	Access network capabilities	If required by the local ETS provider, access networks may need to deploy specific service or transport gateways for inter-ENI communications.		The deployment of specific gateways to cope with every peer-to-peer mapping may result in costly solutions. Implementing a mapping solution from any local technology to a commonly agreed format could benefit the deployment of interoperability solutions.	**None identified.** Covered by multilateral SLAs.

Table 13 – Video transmission analysis

Functional requirements	Layer	Interoperability aspects	References	Interoperability observations	Possible limitations to analyse
	Core network capabilities	If required by the local ETS provider, core networks may need to deploy specific service or transport gateways for inter-ENI communications.		The deployment of specific gateways to cope with every peer-to-peer mapping may result in costly solutions. Implementing a mapping solution from any local technology to a commonly agreed format could benefit the deployment of interoperability solutions.	**None identified.** Covered by multilateral SLAs.
	Application services	Application services may need to handle possible interoperability issues between different sets of user equipment involved in inter-ENI communication. Application services may deploy specific gateway functionalities in the service or transport strata to support protocol or codec mappings. Group voice communications require handling of multi-user communications in at least one of the ENIs involved. Video services used for emergency recovery could become part of a priority video conferencing		According to clause 7.6 of [ITU-T Y.1271]: "In order to have interoperable capabilities among different operators offering emergency telecommunications, a common configuration will be helpful. Note this does not imply operators must all configure their internal networks the same if they are to support emergency capabilities. It only implies they will translate appropriate configurations at the appropriate ingress/egress locations."	**None identified.** Covered by multilateral SLAs.

Table 13 – Video transmission analysis

Functional requirements	Layer	Interoperability aspects	References	Interoperability observations	Possible limitations to analyse
		service offered by a service provider.		The deployment of specific gateways to cope with every peer-to-peer mapping may result in costly solutions. Implementing a mapping solution from any local technology to a commonly agreed format could benefit the deployment of interoperability solutions. The location/ management of an ETS group server is not clear. At least one reliable entity is required to handle group communications. A cascade of conference servers (one per ENI) may increase security and reliability	

6.2.13 Data transmission (mainly packet-switched)

See Table 14.

Table 14 – Data transmission analysis

Functional requirements	Layer	Interoperability aspects	References	Interoperability observations	Possible limitations to analyse
These communication methods offer more choices for ETS users both as alternative paths of communication and alternative methods to reach areas that may have damaged infrastructure. Different data services are mentioned for ETS, such as prioritized versions of the following commercial services: web service, file transfer, e-mail, SMS over IP and IM.	User equipment	User equipment needs to support data communications according to common protocol and data format schemes.		Some of the data services considered (e.g., web service) are commonly deployed over standard transport protocols, but application data formats may result in incompatibility issues. Other services (e.g., IM) are available with many different versions and underlying transport protocols. User equipment should be compatible in both transport protocols and data formats to establish ETS communications between different ENIs.	**None identified.** Any ETS incompatibility could be addressed as part of the compatibility solution for the underlying commercial service support the ETS communication.
	Access network capabilities	The QoS for emergency telecommunications, based on standards, should be maintained as much as possible. The QoS in terms of minimum loss of packets should be provided by the data networks in such a scenario.		N/A, according to ETS priority mappings.	**None identified**
	Core network capabilities	TheQoS for emergency telecommunications, based on standards, should be maintained as much as possible. The QoS in terms of minimum loss of packets should be provided by		N/A, according to ETS priority mappings.	**None identified**

Table 14 – Data transmission analysis

Functional requirements	Layer	Interoperability aspects	References	Interoperability observations	Possible limitations to analyse
		the data networks in such a scenario.			
	Application services	Different data services are mentioned for ETS, such as prioritized versions of the following commercial services: web service, file transfer, e-mail, SMS over IP and IM.		According to clause 7.6 of [ITU-T Y.1271]: "In order to have interoperable capabilities among different operators offering emergency telecommunications, a common configuration will be helpful. Note this does not imply operators must all configure their internal networks the same if they are to support emergency capabilities. It only implies they will translate appropriate configurations at the appropriate ingress/egress locations."	**None identified**

6.2.14 Scalable bandwidth

See Table 15.

Table 15 – Scalable bandwidth analysis

Functional requirements	Layer	Interoperability aspects	References	Interoperability observations	Possible limitations to analyse
Scalable bandwidth may be used as a method to prioritize emergency telecommunications in situations where infrastructure resources are leading to exhaustion.	User equipment	User equipment should support the configured variable bandwidth capabilities.		Being a configuration issue at local ENI, different sets of user equipment in different ENIs may react in different ways to similar resource exhaustion situations. This may lead to unstable ETS communications. Likewise, user equipment should properly configure its behaviour upon adaptation requests from counterparts.	**None identified.** Any ETS incompatibility could be addressed as part of the compatibility solution for the underlying commercial service support the ETS communication.
	Access network capabilities	N/A, since scalable bandwidth is configured from the service stratum.		None identified.	**None identified**
	Core network capabilities	N/A, since scalable bandwidth is configured from the service stratum.		None identified.	**None identified**
	Application services	Authorized users should be able to select the capabilities of emergency telecommunications to support variable bandwidth requirements.		In addition to user equipment, application servers may be configured to react to resource exhaustion situations and to adapt multiple ETS communications. Inter-ENI SLAs should be considered in order to determine whether inter-ENI and/or local ETS communications shall be adapted.	**None identified.** Any ETS incompatibility could be addressed as part of the compatibility solution for the underlying commercial service support the ETS communication.

6.2.15 Reliability/availability

See Table 16.

Table 16 – Reliability/availability analysis

Functional requirements	Layer	Interoperability aspects	References	Interoperability observations	Possible limitations to analyse
Emergency telecommunications need to be both reliable and available. All components that encompass hardware, software and other resources of telecommunications should perform consistently and precisely according to their design requirements and specifications, and should be usable with high confidence – in accordance with SLAs.	User equipment	N/A, subject to local ENI hardware/software usage.		None identified.	**None identified**
	Access network capabilities	N/A, subject to local ENI hardware/software deployment.		None identified.	**None identified**
	Core network capabilities	Reliability/availability of interconnection reference points.		How to evaluate inter-ENI SLA fulfilment capabilities.	**None identified.** Covered by multilateral SLAs.
	Application services	Reliability/availability of interconnection between application services at different ETS providers. Availability due to security risks.	Clause 8.8 of [ITU-T Y.2705].	How to evaluate inter-ENI SLA fulfilment capabilities.	**None identified.** Covered by multilateral SLAs.

7 Conclusions

As stated in [ITU-T E.107], ETS users should be able to use their normal telecommunication terminals to initiate ETS sessions during emergency situations. The current tendency will bring new communication capabilities to ETS users, but will also entail new challenges in the interoperability of ETS national implementations.

Even assuming that network operators will solve the basic interoperability issues (e.g., core signalling and media flows) between NGN-based systems and between NGN and other circuit-switching systems, new technical issues arise from the use of NGN concepts in interoperable secure ETS communications.

This Technical Report revisits the basic functional requirements and capabilities of ETS and identifies a series of possible interoperability limitations mostly related to real-time conversational multimedia services such as call transfer, multi-party communications and group communications. Also, security aspects inherent to ETS communications may entail some interoperability limitations concerning the anonymity of ETS users or location confidentiality issues.

The possible ETS interoperability limitations identified require a more detailed technical study, in order to propose possible solutions to these problems.

Specifically, the following issues are identified in this Technical Report.

– Rapid authentication of authorized users for emergency telecommunications
  - ITU-T ETS recommendations state the need to forward an authentication-related label associated to the communication setup. The specific use and format of this label should be clarified, and the specific protocol mappings analysed.
– Voice/Video/Data transmission
  - ITU-T ETS recommendations propose a shared set of configuration options in order to guarantee application-level interoperability. Although multilateral SLAs would guarantee such a common set of capabilities and configuration options, a harmonized framework would no doubt foster easier inter-ENI interoperability.
– Secure networks
  - In recent ITU-T ETS recommendations, more advanced encryption and privacy protection capabilities are proposed. The level of security and interoperability may be in conflict when different ENI support different security options. Again, further clarification and a common harmonized framework may be beneficial. Although mapping between different encryption suites and security levels may need to be analysed in order to ensure e2e communication requirements are fulfilled, peer-to-peer detailed SLAs would be enough.
– Privacy protection and location confidentiality
  - Some ETSs beyond individual communications may compromise privacy and location information. For example, call transfers from a trusted party to a non-reliable party may disclose personal information included in the call setup information. However, the use of domain border controllers, SLAs and proper PII information removal techniques could also circumvent associated issues. Although protocol revision in terms of call setup procedures and/or location of multiCONF and CT mechanisms in every ENI could no doubt reduce the complexity of the aforementioned technical adaptations, trust issues could also be handled by multilateral SLAs.

This Technical Report does not identify any specific area where SG11 protocol work is needed to address the identified interoperability limitations. However, additional guidance and best practices could be provided to help reduce interoperability issues.

Finally, some minor clarification of clause 7 of [ITU-T Q Suppl.63], regarding "Priority is honoured across the NNI based on security policy" dealing not only with basic priority mapping signalling, but also that related to enhanced priority treatment (i.e., resource reservation), is only recommended.

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	General tariff principles
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Environment and ICTs, climate change, e-waste, energy efficiency; construction, installation and protection of cables and other elements of outside plant
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Terminals and subjective and objective assessment methods
Series Q	**Switching and signalling**
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	Global information infrastructure, Internet protocol aspects, next-generation networks, Internet of Things and smart cities
Series Z	Languages and general software aspects for telecommunication systems

Printed in Switzerland
Geneva, 2016