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ITU-T Focus Group on Disaster Relief Systems, Network
Resilience and Recovery

**Gap Analysis of Disaster Relief Systems,
Network Resilience and Recovery**

Focus Group Technical Report



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 procedures for establishment of focus groups are defined in Recommendation ITU-T A.7. The ITU-T Focus Group on Disaster Relief Systems, Network Resilience and Recovery (FG-DR&NRR) was established further to ITU-T TSAG agreement at its meeting in Geneva, 10-13 January 2012. ITU-T Study Group 2 is the parent group of FG-DR&NRR. This Focus Group was successfully concluded in June 2014.

Deliverables of focus groups can take the form of technical reports, specifications, etc. and aim to provide material for consideration by the parent group or by other relevant groups in its standardization activities. Deliverables of focus groups are not ITU-T Recommendations.

SERIES OF FG-DR&NRR TECHNICAL REPORTS

Technical Report on Telecommunications and Disaster Mitigation

Overview of Disaster Relief Systems, Network Resilience and Recovery

Promising technologies and use cases – Part I, II and III

Promising technologies and use cases – Part IV and V

Gap Analysis of Disaster Relief Systems, Network Resilience and Recovery

Terms and definitions for disaster relief systems, network resilience and recovery

Requirements for Disaster Relief System

Requirements for network resilience and recovery

**Requirements on the improvement of network resilience and recovery with
movable and deployable ICT resource units**

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ITU-T FG-DR&NRR Deliverable**Gap Analysis of Disaster Relief Systems, Network Resilience and Recovery****Summary**

This document presents the current work on disaster relief systems, network resilience and recovery that has been carried out by different standards development organizations (SDOs) and the disaster communication networks and technologies used by other national and international disaster relief bodies. Based on these inputs this document identifies gaps, namely issues that are not currently receiving sufficient attention in the standardization work of ITU, and also adopts technologies for standardization that are already well developed and being used in disaster relief systems, network resilience and recovery.

Table of Contents

1. Scope	6
2. References.....	6
3. Terms and definitions.....	6
4. Abbreviations and Acronyms.....	6
5. Present SDO activities on disaster relief systems, network resilience and recovery	7
5.1 Before disaster (Preparedness)	7
5.1.1 Radio communication sector of ITU	8
5.1.2 Standardization sector of ITU.....	9
5.1.3 The Internet Engineering Task Force (IETF)	12
5.2 During disaster (Response and relief)	14
5.2.1 Radio communication Sector of ITU.....	14
5.2.2 Standardization sector of ITU.....	16
5.2.3 The Internet Engineering Task Force (IETF)	26
5.3 After disaster (Recovery and reconstruction).....	27
5.3.1 Radio communication Sector of ITU.....	27
5.3.2 Standardization sector of ITU.....	27
6. Gap analysis	28
6.1 Gap analysis for disaster relief systems	28
6.2 Gap analysis for network resilience and recovery	31
Redundancy and congestion control.....	32
Substitute networks and repair	33

ITU-T FG-DR&NRR Deliverable

Gap Analysis of Disaster Relief Systems, Network Resilience and Recovery

1. Scope

As stipulated by the Terms of Reference of the Focus Group this document constitutes a deliverable on performing a gap analysis of the standardization work on disaster relief systems, network resilience and recovery. The document aims at providing a living list of standards bodies, forums, and consortia dealing with aspects of telecommunication/ICT, including information concerning their activities and documents related to disaster relief systems, network resilience and recovery and also at identifying:

- Existing standardization work catering to the requirements
- The requirements that have not been met by the present state of standardization and finding a way to meet them.

Based on above, this document identifies and proposes work that needs to be carried out within ITU.

2. References

None.

3. Terms and definitions

This document uses terms and definitions found in [b-FG-Term].

4. Abbreviations and Acronyms

This deliverable uses the following abbreviations and acronyms:

APS	Automatic Protection Switching
CAP	Common Alerting Protocol
DS	Digital Signage
ETS	Emergency Telecommunications Service
EW	Early Warning
GMDSS	Global Maritime Distress and Safety System
IARU	International Amateur Radio Union
ICT	Information and Communication Technologies
IETF	Internet Engineering Task Force
ISDN	Integrated Services Digital Network
ISO	International Organization for Standardization

ITU	International Telecommunication Union
ITU-D	International Telecommunication Union –Development Sector
ITU-R	International Telecommunication Union – Radiocommunication Sector
ITU-T	International Telecommunication Union – Standardization Sector
MLPP	Multi-Level Precedence and Preemption
MPLS	Multi-Protocol Label Switching
NAVTEX	Navigational Telex
NGN	Next Generation Network
ODU	Optical Data Unit
PPDR	Public Protection and Disaster Relief (PPDR)
RA	Radiocommunication Assemblies
RFC	Request for Comments
SDO	Standard Development Organization
SIP	Session Initiation Protocol
SMTP	Simple Mail Transfer Protocol
UN	United Nations
WRC	World Radiocommunication Conference

5. Present SDO activities on disaster relief systems, network resilience and recovery

Disaster relief systems, network resilience and recovery are required in all three phases of disasters, which are categorized as before a disaster (Preparedness), at and during a disaster (Response and relief), and after a disaster (Recovery and reconstruction). And the forms and means of communication for disaster management use are varied and contribute significantly corresponding to the requirements in different phases of the disaster. The requirements for disaster communication in terms of reliability, ruggedness and resilience also differ in different phases of a disaster. The broad scope of disaster management from a communication perspective needs to be handled as regards the type of communication technologies and their utilization in the various phases of the disaster. Accordingly, the document intends to cover the standardization work that has been undertaken on communication technologies for the different phases of a disaster. Various standardization organizations undertake advanced work on disaster relief systems, network resilience and recovery as shown in [b-FG-Overview]. Related ITU-T and ITU-R Recommendations and IETF RFCs are classified in relation to the three above-mentioned disaster phases. The classification in each phase is described in detail in [b-FG-Overview].

5.1 Before disaster (Preparedness)

Preparedness for disaster, including prediction and detection, in the before-disaster phase is very important because the alert and early warning systems are inherently related to the information gathered and assessed by these systems for prediction and detection.

5.1.1 Radio communication sector of ITU

The Radiocommunication Sector (ITU-R) of ITU plays a vital role in the global management of the radio-frequency spectrum and satellite orbits that help ensure the safety of life on land, at sea and in the skies. The prediction and detection of weather and climate parameters mainly utilize radio communication to provide meteorological aids, a meteorological-satellite service, and an earth exploration-satellite service. Radiocommunication and satellite services are utilized for detection, tracking and providing warning information about tsunamis, hurricanes, typhoons, forest fires, oil leaks etc.

Standardization and related work in ITU-R is summarized below.

i) SG-4 and SG-5

a) RECOMMENDATION ITU-R M.1746

This Recommendation addresses system interoperability and harmonized frequency channel plans for the protection of property using data communication.

b) RECOMMENDATION ITU-R M.1826

This Recommendation addresses harmonized frequency channel plans in the 4940-4990 MHz band for broadband public protection and disaster relief radio-communication in Regions 2 and 3. The recommendation considers the desire of many governments to promote interoperability and interworking between systems used for PPDR radiocommunication, both nationally and for cross-border operations in emergency situations and for disaster relief.

ii) SG-5

a) RECOMMENDATION ITU-R M.2009

This Recommendation identifies radio interface standards applicable for public protection and disaster relief (PPDR) operations in some parts of the UHF band. The broadband standards included in this Recommendation are capable of supporting users at broadband data rates, taking into account the ITU-R definitions of “wireless access” and “broadband wireless access” found in Recommendation ITU-R F.1399.

This Recommendation addresses the standards themselves and does not deal with the frequency arrangements for PPDR systems, for which a separate Recommendation exists:

iii) SG-7

a) RECOMMENDATION ITU-R RS.1859

This Recommendation provides guidelines on the use of satellite-provided remote sensing data in the event of natural disasters and similar emergencies but does not provide information on data dissemination.

b) RECOMMENDATION ITU-R RS.1883

This Recommendation contains guidelines on the provision of remote sensing data obtained from satellites for the purpose of studying climate change.

Table 1 - List of ITU-R Recommendations for before-disaster phase and their potential application areas

Study Group	Document No.	Potential Application Area
SG4 and SG5	M.1746 M.1826	Highly Reliable Telecommunication Network
SG-5	M.2009	Highly Reliable Telecommunication Network
SG7	RS.1859 RS.1883	Disaster Detection

5.1.2 Standardization sector of ITU

Various ITU-T study groups undertake advanced work on emergency telecommunications. As the lead study group on this theme, ITU-T Study Group 2 has continued to develop Recommendations for Telecommunication for Disaster Relief/Early Warning. Study Groups 5, 9, 11, 13, 15 16 and 17 have developed Recommendations for communications in emergency situations and for a telecommunication network that remains highly reliable in a disaster.

Standardization and related work in ITU-T is summarized below.

i) SG-5

a) RECOMMENDATION ITU-T K.40

This Recommendation is aimed at setting out the installation and testing principles needed to protect a telecom structure against a Lightning Electro Magnetic Pulse (LEMP). It focuses on the design of an effective protective system for the telecom structure environment.

b) RECOMMENDATION ITU-T K.56

This Recommendation provides a quantitative procedure designed to protect radio base stations (RBS) used for wireless access networks against lightning strikes. The level of protection is based on the tolerable frequency of damage that is assigned to the RBS by the operator, considering the consequences of service interruption and loss of equipment. The RBS covered by this Recommendation consists of a shelter or small building to house the equipment and a nearby tower to accommodate the antennas. The protection procedures include earthing, bonding, shielding and the installation of surge protective devices (SPD).

ii) SG-15**a) RECOMMENDATION ITU-T G.180**

This Recommendation specifies the characteristics of equipment for N + M type direct transmission restoration systems (protection link switching) for digital transmission links (see Recommendation G.701). This Recommendation refers to the equipment referred to as Restoration Switching Equipment (RSE) and Restoration Switching Control Equipment (RSCE). This Recommendation is also intended to cover cases where the signals at the interfaces T belong to different hierarchical levels.

b) RECOMMENDATION ITU-T G.181

This Recommendation specifies the characteristics of equipment for 1 + 1 type transmission restoration systems (protection link switching) for digital transmission links (see Recommendation G.701). The general arrangement of a system of this type uses a hybrid on the send side, and the input path is split into two output paths. On the receive side the two paths are supervised and are further connected by a switch that is automatically controlled by the received signals. The switch may also be operated manually or by some kind of remote procedure. The two transmission directions are handled independently. This Recommendation refers to the equipment labelled as hybrid (H) restoration switching equipment (RSE) and restoration switching control equipment (RSCE).

c) RECOMMENDATION ITU-T G.808.1

Recommendation ITU-T G.808.1 defines the generic functional models, characteristics and processes associated with various linear protection schemes for circuit-switched connection-oriented layer networks; e.g., optical transport networks (OTN), synchronous digital hierarchy (SDH) networks and packet-switched layer networks, e.g., asynchronous transfer mode (ATM) networks and Ethernet transport networks. It also defines the objectives and applications for these schemes. The protection schemes described in this Recommendation are trail protection and subnetwork connection protection schemes with various ways of monitoring individual signals or groups of signals. Furthermore, the survivability offered by the link capacity adjustment scheme (LCAS) is described.

d) RECOMMENDATION ITU-T G.808.2

This Recommendation, “Generic Protection Switching - Ring Protection” is to be published.

e) RECOMMENDATION ITU-T G.873.1

This Recommendation defines the automatic protection switching (APS) protocol and protection switching operation for the linear protection schemes for the Optical Transport Network at the Optical Channel Data Unit (ODUk) level. These schemes are based on the generic linear protection specifications in [ITU-T G.808.1].

In addition, client-related protection architectures are described.

f) RECOMMENDATION ITU-T G.873.2

This Recommendation describes the automatic protection switching (APS) protocol to support optical data unit k (ODUk) shared ring protection (SRP) in the optical transport network (OTN). Shared ring protection provides two types of switching: SRP-1 with 1 ODU per lambda, and SRP-p

with p ODUs per lambda. SRP protects ODUs within a physical ring with ODU cross-connects.

g) RECOMMENDATION ITU-T G.8031/Y.1342

This Recommendation defines the APS protocol and linear protection switching mechanisms for point-to-point VLAN-based ETH subnetwork connection (SNC) in Ethernet transport networks. All other protection schemes, including point-to-multipoint and multipoint-to-multipoint, require further study.

h) RECOMMENDATION ITU-T G.8032/Y.1344

This Recommendation defines the automatic protection switching (APS) protocol and protection switching mechanisms for ETH layer Ethernet ring topologies. The protection protocol defined in this Recommendation enables protected point-to-point, point-to-multipoint and multipoint-to-multipoint connectivity within a ring or interconnected rings, called a "multi-ring/ladder network" topology.

The ETH layer ring maps to the physical layer ring structure. Protection schemes for the other layers, including the ETY layer, are beyond the scope of this Recommendation.

i) RECOMMENDATION ITU-T G.8132/Y.1382

This Recommendation specifies T-MPLS Shared Protection Ring (TM-SPRing) protection switching mechanisms and the APS protocol to be applied to T-MPLS layer networks as described in G.8110.1. The mechanisms defined herein protect T-MPLS sections and are designed to support point-to-point as well as point-to-multipoint T-MPLS connections.

j) RECOMMENDATION ITU-T L.92

Recommendation ITU-T L.92 provides an overview of the technical considerations as regards protecting outside plant facilities from natural disasters. Disaster management for outside plant facilities such as cables, poles and manholes is introduced, and countermeasures against such natural disasters as earthquakes, strong winds and floods are described. The appendices introduce Korean and Japanese experiences of disaster management. Responses to a related questionnaire are also included to provide basic information about natural disasters around the world. The objective of this Recommendation is to share observations, knowledge, experiences and practices internationally, so that local engineering practices can be adopted to improve the disaster resistance performance of outside plant facilities.

k) RECOMMENDATION ITU-T L.81

Natural disasters such as those caused by strong winds, floods, landslides, and earthquakes happen more frequently than ever and the damage they cause is increasing. Disasters resulting from human activity such as those caused by fire, explosion, and collapse also happen on a large scale. Outside plant facilities including telecommunication buildings are exposed to these disasters and may be affected adversely, which implies that preventive measures are needed. Recommendation ITU-T L.81 deals with monitoring systems designed to mitigate damage and to secure outside plant facilities against disasters.

l) RECOMMENDATION ITU-T L.44

This Recommendation describes the provision of an electric power supply for the outside plants of

telecommunication networks. It deals with methods for feeding power and backup systems. Some equipment (e.g. repeaters) that needs a power supply existed before optical fibres were installed. At that time, electrical power was mainly supplied from a central office by using a superimposition technique or by having insulated communication and power conductors in the same cable. After optical fibres were introduced, many kinds of optical/electrical equipment requiring a power supply system were installed in telecommunication networks, in order to increase capacity. The problem is that optical fibre cannot be used to directly transmit electrical power. Power is supplied in one of three ways. First, power can be fed from a central office via metallic wires. To connect the power supply between the central office and the equipment, individual metallic cables or cables with both fibres and copper conductors may be used. Second, a local power supply can be used. With this method, one power supply provides power to all the equipment located within its area by using metallic cables or cables with both fibres and copper conductors. Two to several tens of pieces of equipment can be supported in this way. Third, each piece of equipment has its own power supply.

Table 2 - List of ITU-T Recommendations for before-disaster phase and their potential application areas

Study Group	Document No.	Potential application area
SG-5	K.40, K56	Highly reliable telecommunication network
SG-15	G.180, G.181, G.808.1, G.808.2, ,G.873.1, G.873.2, G.8031/Y.1342, G.8032/Y.1344, G.8132/Y.1382	Highly reliable telecommunication network
	L.92,	
	L.81	Disaster detection
	L.44	Highly-reliable power supply

5.1.3 The Internet Engineering Task Force (IETF)

The Internet Engineering Steering Group (IESG) established an IETF Working Group (WG) (under the Real Time Applications and Infrastructure Area) to address Internet Emergency Preparedness (IEPREP). Some informational RFCs were developed in two specific technical areas: “Requirements for Internet Emergency Preparedness in the Internet”, and the “Framework for Supporting Internet Emergency Preparedness in Internet Protocol (IP) Telephony.”

Standardization and related work in IETF is summarized below.

a) RFC 3487 (Requirements for Resource Priority Mechanisms for the Session Initiation Protocol)

This document outlines the requirements for prioritising access to circuit-switched networks, end system and proxy resources for emergency preparedness communications using the Session Initiation Protocol (SIP).

b) RFC 3523 (Internet Emergency Preparedness Telephony Terminology)

This document defines the topology naming conventions that are to be used in reference to Internet Emergency Preparedness (IEPREP) phone calls. It outlines some terminology and covers four basic topologies ("IP Bridging", "IP at the Start", "IP at the End", and "End-to-End IP") for reference by other standards.

c) RFC 3689 (General Requirements for Emergency Telecommunication Service)

This document presents a list of general requirements in support of the Emergency Telecommunications Service (ETS). It outlines high-level requirements including the optional use of Signalling, the application of Labels, the use of Policy, and the Network functionality. These are followed by the security related requirements of Authorization, Integrity and Authentication, and Confidentiality.

d) RFC 3690 (IP Telephony Requirements for Emergency Telecommunication Service)

This document provides a list of requirements in support of the Emergency Telecommunications Service (ETS) within the context of IP telephony. It is an extension to the general requirements presented in RFC3689. It outlines the requirements related to telephony signalling as used in Internet-based telephony services. These include the ability of the signalling protocol to carry arbitrary labels, which are needed to map to the various emergency related labels/markings used in other telephony based networks, such as the Public Switched Telephone Network (PSTN).

e) RFC 4190 (Framework for Supporting Emergency Telecommunication Service in IP Telephony)

This document presents a framework for supporting authorized, emergency-related communication within the context of IP telephony. The framework describes how various protocols and capabilities (or mechanisms) can facilitate and support the traffic from ETS users. These are divided into five areas; Signalling, Policy, Traffic Engineering, Security and Routing.

f) RFC 4375 (Emergency Telecommunication Service Requirements for a Single Administrative Domain)

This document presents a list of requirements in support of the Emergency Telecommunications Service (ETS) within a single administrative domain, focusing on a specific set of administrative constraints.

g) RFC 4958 (A Framework for Supporting Emergency Telecommunication Service Within a Single Administrative Domain)

This document presents a framework discussing the role of various protocols and mechanisms that could be considered candidates for supporting Emergency Telecommunication Services (ETS) within a single administrative domain.

5.2 During disaster (Response and relief)

5.2.1 Radio communication Sector of ITU

Standardization and related work in ITU-R is summarized below.

i) SG-4

a) RECOMMENDATION ITU-R M.830-1

This Recommendation provides operational procedures for mobile-satellite networks or systems in the 1530-1544 MHz and 1626.5-1645.5 MHz bands, which are used for distress and safety purposes as specified for the GMDSS. The means for ensuring the necessary priority access for maritime mobile-satellite distress and safety communications are given in the Recommendation.

b) RECOMMENDATION ITU-R S.1001-1

This Recommendation describes the use of systems in the fixed-satellite service in the event of natural disasters and similar emergencies for warning and relief operations

ii) SG-4 and SG-5

a) RECOMMENDATION ITU-R M.1042-3

This Recommendation provides guidance on the development of amateur and amateur-satellite service networks supporting preparedness and radio communications during disaster and relief operations.

b) RECOMMENDATION ITU-R M. 1579-1

The purpose of this Recommendation is to establish the technical basis for the global circulation of IMT-2000 terrestrial terminals based on the terminals not causing harmful interference in any country in which they circulate:

- by conforming to IMT-2000 terrestrial radio interface specifications
- and by complying with unwanted emission limits for IMT-2000 terrestrial radio interfaces.

c) RECOMMENDATION ITU-R M.1854

This Recommendation provides information about the range of frequencies used by mobile-satellite service (MSS) systems that could be identified by Member States for early warning and disaster

relief telecommunications in accordance with Resolutions ITU-R 53 (RA-07), ITU-R 55 (RA-07), 644 (Rev. WRC-07), 646 (WRC-03) and 647 (WRC-07).

iii) SG-5

a) RECOMMENDATION ITU-R F.1105-2

This Recommendation provides the characteristics of fixed wireless systems used for disaster mitigation and relief operations. Several such systems including transportable equipment are specified according to channel capacity, operating frequency band, transmission distance and propagation path conditions.

b) RECOMMENDATION ITU-R M.1467-1

Recommendation ITU-R M.1467 provides guidance to administrations for predicting sea area A2 and NAVTEX coverage areas by taking into account variations in the propagation conditions. These coverage areas can be confirmed by measurement. This information is provided for administrations that are upgrading, or planning to upgrade, their shore-based facilities for global maritime distress and safety system (GMDSS) operation in the A2 sea area.

c) RECOMMENDATION ITU-R M.1637

This Recommendation addresses issues to be considered in order to facilitate the global circulation of radio communications equipment to be used in emergencies and for disaster relief.

d) RECOMMENDATION ITU-R M.2015

This Recommendation provides guidance on frequency arrangements for public protection and disaster relief radio communications in certain regions in some of the bands below 1 GHz identified in Resolution 646 (Rev.WRC-12). Currently, the Recommendation addresses arrangements in the 380 470 MHz ranges in certain countries in Region 1, 746-806 MHz and 806-869 MHz in Region 2, and 806-824/851-869 MHz in some countries in Region 3 in accordance with Resolutions ITU-R 53, ITU R 55 and WRC Resolutions 644 (Rev.WRC-07), 646 (Rev.WRC-12), and 647 (WRC-07).

iv) SG-6

a) RECOMMENDATION ITU-R BT.1774

This Recommendation provides the characteristics of satellite and terrestrial broadcasting systems used for disaster mitigation and relief operations.

Table 3 - List of ITU-R Recommendations for the during-disaster phase and their potential application areas

Study Group	Document No.	Potential application area
SG-4	M.830-1,	Telecommunication in disaster area
	S.1001-1	Emergency alert
SG-4 and SG-5	M. 1579-1	Emergency alert

	M.1042-3, M.1854	Telecommunication in disaster area
SG-5	F.1105-2, M.1637, M.2015	Telecommunication in disaster area
	M.1467-1	Emergency alert
SG-6	BT.1774	Emergency alert

5.2.2 Standardization sector of ITU

Standardization and related work in ITU-T is summarized below.

i) SG-2

a) RECOMMENDATION ITU-T E.106

This Recommendation describes an international preference scheme in relation to the use of public telecommunications by national authorities for emergency and disaster relief operations. The International Emergency Preference Scheme for Disaster Relief Operations (IEPS) is needed when there is a crisis causing an increased demand for telecommunications when use of the International Telephone Service may be restricted because of damage, reduced capacity, congestion or faults. In a crisis IEPS users of public telecommunications should be treated preferentially.

b) RECOMMENDATION ITU-T E.107

This Recommendation provides guidance that will enable telecommunications between one ETS national implementation (ENI) and other ENI(s) (authority-to-authority), in addition to providing a description of ETS. Early warning (EW) of disasters is not part of this Recommendation, but is left for future studies that may add to this Recommendation or become a separate Recommendation.

c) RECOMMENDATION ITU-T E.123

This Recommendation applies specifically to the printing of national and international telephone numbers, electronic mail addresses and web addresses on letterheads, business cards, bills, etc.

Regard has been given to the printing of existing telephone directories. The standard notation for printing telephone numbers, E-mail addresses and web addresses helps to reduce difficulties and errors, since this address information must be entered exactly to be effective.

d) RECOMMENDATION ITU-T E.161.1

This Recommendation is intended for use by Member States who are in the process of selecting:

- a single emergency number for the first time
- a secondary alternative emergency number.

Either emergency number will be made available to users and subscribers, and therefore the mapping of these numbers to technology requirements is considered beyond the scope of this Recommendation.

In the long run, this Recommendation will contribute to the global harmonization of emergency numbers.

e) RECOMMENDATION ITU-T I.255.3

The multi-level precedence and pre-emption (MLPP) service is provided as a network provider's option to a network domain. The domain can be the entire network or a subset of the network. The MLPP service applies to all network resources in the domain that are in common use. The maximum precedence level of a subscriber is set at the time of subscription by the service provider, based on the subscriber's need. The subscriber may select a precedence level up to and including the maximum precedence level subscribed to, on a per call basis.

f) RECOMMENDATION ITU-T I.255.4

The Priority service provides for preferential treatment in the network to calls originating from and/or addressed to certain numbers in the order of path selection.

g) RECOMMENDATION ITU-T M.3350

This Recommendation describes the ETS Management Service (ETSMS) and identifies functional requirements for the interchange of critical service management information, which relates to ETS features, among TMNs across the X-interface of the service management layer as defined by ITU-T Rec. M.3010 [2]. The requirements described will enable authorized disaster response and recovery operations personnel, as Service Customers (SCs), to interact with Service Providers (SPs) and share knowledge of the availability of services, configure services, and activate required services. Some aspects of the ETSMS may be used at any time independent of the occurrence of actual emergencies.

h) RECOMMENDATION ITU-T E.sup1

The scope of this supplement is to explain the operational aspects linked to the implementation of the ITU-T E.164 country code +888.

ii) SG-9

a) RECOMMENDATION ITU-T J.260

This Recommendation defines requirements for preferential telecommunications over IPCablecom networks. The essential aspects of preferential telecommunications over IPCablecom that this Recommendation covers can be grouped into two areas: prioritisation and authentication. These two areas include the capacity to support telecommunications in IPCablecom that may require preferential treatment (e.g., Telecommunications for Disaster Relief and Emergency Telecommunications Service). The implementation of priority and authentication is necessary for the support of preferential telecommunications in IPCablecom networks.

b) RECOMMENDATION ITU-T J.261

Recommendation ITU-T J.261 provides a framework for implementing preferential capabilities in IPCablecom and IPCablecom2 networks. The approach of this Recommendation is to define a framework for capabilities that can be utilized to meet the requirements in Recommendation ITU-T

J.260 and forms the basis for detailed IPCablecom and IPCablecom2 Recommendations in support of preferential telecommunications.

c) RECOMMENDATION ITU-T J.262

Recommendation ITU-T J.262 is one of a series of Recommendations designed to enable support for preferential telecommunication services over IPCablecom networks. It defines the specifications for authentication in preferential telecommunications over IPCablecom2 networks. These specifications satisfy the requirements defined in Recommendation ITU-T J.260. The essential aspects of preferential telecommunications over IPCablecom2 can be grouped into two areas: prioritisation and authentication. This Recommendation defines specifications for authentication only.

d) RECOMMENDATION ITU-T J.263

Recommendation ITU-T J.263 is one of a series of Recommendations designed to enable support for preferential telecommunication services over IPCablecom2 networks. It defines the specifications for priority for preferential telecommunication services over IPCablecom2 networks. These specifications satisfy the requirements defined in Recommendation ITU-T J.260. The essential aspects of preferential telecommunications over IPCablecom2 can be grouped into two areas: prioritisation and authentication. This Recommendation provides specifications for prioritisation only.

iii) SG-11

a) RECOMMENDATION ITU-T Q.85.3

This Recommendation defines stage 2 of the Multi-Level Precedence and Preemption (MLPP) supplementary service of the integrated service digital network (ISDN) as provided by public telecommunications operators. Stage 2 identifies the functional capabilities and the information flows needed to support the service description. The stage 2 description also identifies user operations not directly associated with a call.

b) RECOMMENDATION ITU-T Q.735.3

The MLPP service is provided as a network provider's option to a domain of a network. The domain can be the entire network or a subset of the network. The MLPP service applies to all network resources in the domain that are in common use. The maximum precedence level of a subscriber is set at the time of subscription by the service provider based on the subscriber's need. The subscriber may select a precedence level up to and including the maximum precedence level subscribed to on a per call basis.

c) RECOMMENDATION ITU-T Q.761Amd.3

This amendment was produced to meet the need for the implementation of the International Emergency Preference Scheme (IEPS) for disaster recovery operations as specified in ITU-T Rec. E.106. It contains modifications to ITU-T Rec. Q.761 (1999) that accommodate these needs. This amendment should be read in conjunction with Amendment 3 to ITU-T Rec. Q.762, Amendment 4 to ITU-T Rec. Q.763, and Amendment 4 to ITU-T Rec. Q.764.

d) RECOMMENDATION ITU-T Q.762Amd.3

This amendment was produced to meet the need for the implementation of the International Emergency Preference Scheme (IEPS) for disaster recovery operations as specified in ITU-T Rec. E.106. It contains modifications to ITU-T Rec. Q.762 (1999) that accommodate these needs. This amendment should be read in conjunction with Amendment 3 to ITU-T Rec. Q.761, Amendment 4 to ITU-T Rec. Q.763, and Amendment 4 to ITU-T Rec. Q.764. This amendment incorporates Amendment 1 to ITU-T Rec. Q.762 and provides enhancements.

e) RECOMMENDATION ITU-T Q.763Amd.3

This Amendment 3 to the ISUP Specification Q.763 (12/1999) contains two modifications:

- 1) Calling party's category; new code values for a "mobile terminal located in the home PLMN" and a "mobile terminal located in a visited PLMN";
- 2) Automatic re-routing parameter; new parameter.

f) RECOMMENDATION ITU-T Q.764Amd.3

This Amendment 3 to the ISUP Specification Q.764 (12/1999) contains three modifications:

- 1) Fallback procedures; modification of clause.
- 2) Procedures to support the calling party's category for calls from mobile terminals; new procedures in a new clause.
- 3) Signalling procedures for automatic re-routing (crank back); new procedures in a new clause.

g) RECOMMENDATION ITU-T Q.955.3

The MLPP supplementary service is provided as a network provider's option to a domain of a network. The domain can be the entire network or a subset of the network. The MLPP supplementary service applies to all network resources in the domain that are (*Note: Please see earlier note.*) in common use. The maximum precedence level of a subscriber is set at the time of subscription by the service provider based on the subscriber's need. The subscriber may select a precedence level up to and including the maximum precedence level subscribed to on a per call basis.

h) RECOMMENDATION ITU-T Q.1902.1 Amd.2

This amendment was produced to meet the need for the implementation of the International Emergency Preference Scheme (IEPS) for disaster recovery operations as specified in ITU-T Rec. E.106. It contains modifications to ITU-T Rec. Q.1902.1 (2001) that accommodate these needs. This amendment should be read in conjunction with Amendment 3 to ITU-T Rec. Q.1902.2, Amendment 3 to ITU-T Rec. Q.1902.3, and Amendment 3 to ITU-T Rec. Q.1902.4.

i) RECOMMENDATION ITU-T Q.1902.2 Amd.3

This amendment was produced to meet the need for the implementation of the International Emergency Preference Scheme (IEPS) for disaster recovery operations as specified in ITU-T Rec. E.106. It contains modifications to ITU-T Rec. Q.1902.2 (2001) that accommodate these needs.

This amendment should be read in conjunction with Amendment 2 to ITU-T Rec. Q.1902.1, Amendment 3 to ITU-T Rec. Q.1902.3, and Amendment 3 to ITU-T Rec. Q.1902.4.

j) RECOMMENDATION ITU-T Q.1902.3 Amd.3

This amendment was produced to meet the need for the implementation of the International Emergency Preference Scheme (IEPS) for disaster recovery operations as specified in ITU-T Rec. E.106. It contains modifications to ITU-T Rec. Q.1902.3 (2001) that accommodate these needs. This amendment should be read in conjunction with Amendment 2 to ITU-T Rec. Q.1902.1, Amendment 3 to ITU-T Rec. Q.1902.2, and Amendment 3 to ITU-T Rec. Q.1902.4.

k) RECOMMENDATION ITU-T Q.1902.4 Amd.3

This amendment was produced to meet the need for the implementation of the International Emergency Preference Scheme (IEPS) for disaster recovery operations as specified in ITU-T Rec. E.106. It contains modifications to ITU-T Rec. Q.1902.4 (2001) that accommodate these needs. This amendment should be read in conjunction with Amendment 2 to ITU-T Rec. Q.1902.1, Amendment 3 to ITU-T Rec. Q.1902.2, and Amendment 3 to ITU-T Rec. Q.1902.3.

l) RECOMMENDATION ITU-T Q.1950 Amd.1

This Recommendation provides the procedures, commands, parameters, messages and signalling information of the Bearer Independent Call Bearer Control (CBC) protocol for the support of narrow-band ISDN services independent of the bearer technology and signalling message transport technology used.

m) RECOMMENDATION ITU-T Q.2630.3 Amd.1

This amendment was produced to meet the need for the implementation of the International Emergency Preference Scheme (IEPS) as specified in ITU-T Rec. E.106. It contains modifications to ITU-T Rec. Q.2630.3 (2003) that accommodate these needs. This amendment is designed to be compatible with implementations conforming to ITU-T Rec. Q.2630.3 (2003).

n) RECOMMENDATION ITU-T Q.2726.2

This Recommendation specifies optional extensions to the Broadband ISDN User Part to support call priority handling. These specifications allow for the preferential treatment of high priority calls when the network is congested based on the priority level of the call.

o) RECOMMENDATION ITU-T Q.2761 Amd.1

This amendment was produced to meet the urgent need for the implementation of the International Emergency Preference Scheme (IEPS) as specified in ITU-T Rec. E.106. This amendment contains modifications to ITU-T Rec. Q.2761 (12/99) that accommodate these needs. This amendment should be read in conjunction with the amendments related to ITU-T Recs Q.2762, Q.2763, and Q.2764.

p) RECOMMENDATION ITU-T Q.2762 Amd.1

This amendment was produced to meet the urgent need for the implementation of the International Emergency Preference Scheme (IEPS) as specified in ITU-T Rec. E.106. This amendment contains modifications to ITU-T Rec. Q.2762 (12/99) that accommodate these needs. This amendment should be read in conjunction with the amendments related to ITU-T Recs Q.2761, Q.2763, and Q.2764.

q) RECOMMENDATION ITU-T Q.2763 Amd.1

This amendment was produced to meet the urgent need for the implementation of the International Emergency Preference Scheme (IEPS) as specified in ITU-T Rec. E.106. This amendment contains modifications to ITU-T Rec. Q.2763 (12/99) that accommodate these needs. This amendment should be read in conjunction with the amendments related to ITU-T Recs Q.2761, Q.2762, and Q.2764.

r) RECOMMENDATION ITU-T Q.2764 Amd.1

This amendment was produced to meet the urgent need for the implementation of the International Emergency Preference Scheme (IEPS) as specified in ITU-T Rec. E.106. This amendment contains modifications to ITU-T Rec. Q.2764 (12/99) that accommodate these needs. This amendment should be read in conjunction with the amendments related to ITU-T Recs Q.2761, Q.2762, and Q.2763.

s) RECOMMENDATION ITU-T Q.2931 Amd.5

This amendment was produced to meet the need for the implementation of the International Emergency Preference Scheme (IEPS) as specified in ITU-T Rec. E.106. It contains modifications to ITU-T Rec. Q.2931 (1995) that accommodate these needs. This amendment is designed to be compatible with implementations conforming to ITU-T Rec. Q.2931 (1995) and its Amendments 1, 2, 3 and 4.

t) RECOMMENDATION ITU-T Q.2959

This Recommendation defines the operation of the Digital Subscriber Signalling System No. 2 (DSS 2) for handling the Call priority that may be provided as a service provider option, for Basic call and connection control at the TB or at the coincident SB and TB reference point of the User-Network Interface of the Broadband-Integrated Services Digital Network (B-ISDN). The call priority capability defined in this Recommendation allows for preferential treatment of high priority calls during network congestion, based on the priority level allocated to the call.

iv) SG-13

a) RECOMMENDATION ITU-T Y.1271

Many challenges and considerations need to be addressed when defining and establishing the functional capabilities needed to support emergency telecommunications in evolving circuit- and packet-switched telecommunications networks. This Recommendation presents an overview of the basic requirements, features, and concepts for emergency telecommunications that evolving networks are capable of providing.

b) RECOMMENDATION ITU-T Y.2171

This Recommendation proposes three admission control priority levels for services seeking entry into Next Generation Networks. The admission control priority indicator is intended as a guide for use in the development of appropriate signalling protocol extensions, and the necessary priority enabling mechanisms.

c) RECOMMENDATION ITU-T Y.2172

ITU-T Recommendation Y.2172 proposes three levels of restoration priority for services in Next Generation Networks. This indicator is intended as a guide for the development of appropriate signalling protocol extensions and restoration/re-route mechanisms.

d) RECOMMENDATION ITU-T Y.2205

Recommendation ITU-T Y.2205 specifies technical considerations that can be optionally applied within the next generation network (NGN) to enable emergency telecommunications (ET). This Recommendation also outlines the underlying technical principles involved in supporting ET.

e) RECOMMENDATION ITU-T Y.2705

The Emergency Telecommunication Service (ETS) is a national service, providing priority communications services to ETS authorized users in times of disaster and emergency. Recommendation ITU-T Y.2705 provides the minimum security requirements for the inter-network interconnection of ETS. This will allow ETS to be supported with the necessary security protection between different national networks with bilateral and/or multilateral agreement in times of disaster and emergency.

v) SG-15

a) RECOMMENDATION ITU-T G.9960

This Recommendation specifies the system architecture and functionality of all the components of the physical (PHY) layer of home network transceivers designed for the transmission of data over premises wiring including inside telephone wiring, coaxial cable, power-line wiring, plastic optical fibres, and combinations of these. This Recommendation defines:

- the home network architecture and reference models;
- the physical layer specifications (PCS, PMA and PMD).

These transceivers are intended to be compatible with other devices sharing the in-premises wiring.

Additionally, this Recommendation provides for spectrum notching for compatibility with amateur radio services.

b) RECOMMENDATION ITU-T G.9961

This Recommendation specifies reference models and functionalities for all components of the data link layer (DLL) of home network transceivers designed for the transmission of data over premises wiring including inside telephone wiring, coaxial cable, and power-line wiring, and combinations of

these.

c) RECOMMENDATION ITU-T G.9963

Recommendation ITU-T G.9963 specifies the basic characteristics of a multiple-input multiple-output (MIMO) high-speed home networking transceiver capable of operating over premises power-line wiring. This Recommendation includes the additions and modifications to Recommendations ITU-T G.9960 and ITU-T G.9961 needed to fully define a MIMO home networking transceiver. MIMO transceivers are able to transmit over three power-line conductors (phase, neutral, and ground) from more than one Tx port and receive at more than one Rx port, thus providing an increased data rate and enhancing the connectivity (i.e., service coverage) of the home network. This Recommendation also specifies the means by which transceivers that comply with ITU-T G.9960, ITU-T G.9961 and ITU-T G.9963 interoperate when operating on the same wires.

d) RECOMMENDATION ITU-T G.9964

This Recommendation specifies the control parameters that determine spectral content, power spectral density (PSD) mask requirements, a set of tools to support reduction of the transmit PSD, ways of measuring this PSD for transmission over telephone wiring, power line wiring and coaxial cable, as well as the allowable total transmission power into a specified termination impedance. It complements the system architecture and physical layer (PHY) specification in [ITU-T G.9960], and the data link layer (DLL) specification in [ITU-T G.9961] as well as the modifications and additions to these Recommendations specifying the multiple input/multiple output (MIMO) home networking transceiver in [ITU-T G.9963].

vi) SG-16

a) RECOMMENDATION ITU-T H.246 Amd.1

This Recommendation describes Gateways that provide protocol interworking between H-Series multimedia terminals and other H-Series multimedia terminals, voice/voice band terminals on GSTN, ISDN or PLMN, V.70 terminals on the GSTN, and multi-call applications on the GSTN. H.246 Gateways provide the required translation of control and media streams to allow interworking between terminals running different protocols.

b) RECOMMENDATION ITU-T H.248.44

This Recommendation defines a package designed to provide the signals and procedures necessary to realize multi-level precedence and pre-emption applications under H.248. Although bandwidth and overload control, as well as the judicious use of the Priority and Emergency Context Attributes, go a long way toward achieving these goals, existing systems also utilize tonal signals to inform end-users about the nature of the traffic, whether their current call is being pre-empted and whether or not their origination is being treated as priority traffic. These systems find a wide range of applications, including military command and control, government priority traffic and many types of disaster recovery and relief efforts. Priority traffic control and pre-emption are especially important immediately following a disaster when communications resources may be scarce.

c) RECOMMENDATION ITU-T H.248.81

Recommendation ITU-T H.248.81 provides guidelines on the use of the international emergency preference scheme (IEPS) call indicator and priority indicator in ITU-T H.248 profiles for ITU-T H.323 and NGN systems. These guidelines may be used by other standards development organizations (SDOs) when defining their profiles in support of priority services, e.g., the emergency telecommunications service (ETS) and the multimedia priority service (MPS).

d) RECOMMENDATION ITU-T H.460.4

This Recommendation specifies the call priority designation and country/international network of call origination identification for H.323 priority calls. The use of call priority designation provides a mechanism that indicates the desired or approved call establishment priority for an H.323 call. It is necessary to signal the call priority during registration, admission, location, and call set-up signalling to allow Gatekeepers, Gateways, and other network elements to take appropriate action as they attempt to ensure the successful establishment of priority calls over normal traffic during times of degraded operation caused by damaged resources or heavy loads. The use of a country/international network of call origination identifies the country or the international network from which the priority call originated. It is necessary to signal the country/international network of call origination during registration, admission, location, and call set-up signalling so that Gatekeepers, Gateways, and other network elements can take appropriate action associated with the country or the international network from which the priority call originated.

e) RECOMMENDATION ITU-T H.460.14

This Recommendation describes the procedures and the signalling protocol for Multi-Level Precedence and Pre-emption (MLPP), which allow the originator of a call in an H.323 environment to specify the precedence level of the call and for an existing lower precedence call to be pre-empted to release the resources needed to complete that higher precedence call. For the networks and domains that allow this functionality, the H.460.14 mechanism ensures that important calls can be established and can remain connected during periods of congestion.

f) RECOMMENDATION ITU-T H.460.21

This Recommendation describes the signalling and procedures needed to provide a message broadcast feature for H.323 systems. The message broadcast feature is one wherein a message server or H.323 endpoint in the network transmits a message to one or more endpoints in a predefined multicast group. The message may result in alerting the user or transmitting an audio message to a speaker on the phone without alerting the user. Messages sent to an H.323 device may interrupt active communication or may be discarded, depending on priority. Messages are not limited to audio. They may be audio, video, or text messages, and the choice is negotiated through the procedures described herein.

g) RECOMMENDATION ITU-T H.780

This Recommendation describes a general framework for digital signage (DS) services based on IPTV architecture from the viewpoint of technical and service aspects. First, DS domains, a generic DS architecture and the classification of DS services are introduced. As the technical IPTV specifications are close to those of DS, a brief comparison of the two services is provided (e.g., the structure of a functional group and detailed media processing). Subsequently, high-level

requirements for DS services are described. In addition, this Recommendation contains content delivery methods and details of functionalities of both server- and client-side applications for DS services.

vii) SG-17

a) RECOMMENDATION ITU-T X.1303

ITU-T has published a Recommendation for the Common Alerting Protocol (CAP), which is an international XML-based data format for exchanging public warnings and information about emergencies between alerting technologies that was originally developed by OASIS.

Table 4 - List of ITU-T Recommendations for the during-disaster phase and their potential application areas

Study Group	Document No.	Potential application area
SG-2	E.123	Evacuation assistance
	E.106, E.107 I.255.3, I.255.4 E.161.1, M.3350	Emergency telecommunication
	E.sup1	Temporary telephone services
	SG-9	J.260, J.261, J.262, J.263
SG-11	Q.85.3, Q.735.3 Q.761Amd.3, Q.762Amd.3 Q.763Amd.3, Q.764Amd.3 Q.955.3, Q.1902.1 Amd.2 Q.1902.2 Amd.3, Q.1902.3 Amd.3, Q.1902.4 Amd.3, Q.1950 Amd.1, Q.2630.3 Amd.1, Q.2726.2, Q.2761 Amd.1, Q.2762 Amd.1 Q.2763 Amd.1, Q.2764 Amd.1, 2931 Amd.5, Q.2959	Emergency telecommunication
SG-13	Y.1271, Y.2171, Y.2172 Y.2205, Y.2705	Emergency telecommunication
SG-15	G.9960, G.9961, G.9963, G.9964	Telecommunication in disaster area
SG-16	H.246 Amd.1, H.248.44, H.248.81, H.780	Evacuation assistance
	H.460.4, H.460.14, H.460.21	Emergency telecommunication

SG-17	X.1303	Emergency alert
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5.2.3 The Internet Engineering Task Force (IETF)

Standardization and related work in IETF is summarized below.

a) RFC 4412 (Communications Resource Priority for SIP)

This document defines two Session Initiation Protocol (SIP) header fields for communicating resource priorities, which can be used to influence the behaviour of SIP user agents (such as telephone gateways and IP telephones) and SIP proxies.

b) RFC 5115 (Telephone Routing over IP (TRIP) Attribute for Resource Priority)

This document defines a new attribute for the Telephony Routing over IP (TRIP) protocol. The attribute is based on the NameSpace.Value tuple defined for the SIP Resource-Priority field.

c) RFC 5865 (DSCP for Capacity-Admitted Traffic)

This document requests one Differentiated Services Code Point (DSCP) from the Internet Assigned Numbers Authority (IANA) for a class of real-time traffic that conforms to Expedited Forwarding Per-Hop Behaviour.

d) RFC 6401 (RSVP Extensions for Admission Priority)

This document specifies extensions to the Resource reSerVation Protocol (RSVP) that can be used to support such an admission priority capability at the network layer.

e) RFC 6679 (Explicit Congestion Notification Support for RTP/RTCP Flows)

This document specifies how Explicit Congestion Notification (ECN) can be used with the Real-time Transport Protocol (RTP) running over the User Datagram Protocol (UDP) using the RTP Control Protocol (RTCP) as a feedback mechanism.

f) RFC 6735 (Diameter Priority Attribute Value Pairs)

This document defines Attribute-Value Pair (AVP) containers for various priority parameters for use with Diameter and the Authentication, Authorization, and Accounting (AAA) framework

g) RFC 6710 (SMTP Extension for Message Transfer Priorities)

This RFC defines an extension to the Simple Mail Transfer Protocol (SMTP) service whereby messages are given a label to indicate preferential handling, and thus enable mail handling nodes to take this information into account for onward processing.

h) RFC 6758 (Tunnelling of SMTP Message Transfer Priorities)

This RFC defines a mechanism for tunnelling Simple Mail Transfer Protocol (SMTP) Message Transfer Priority values through Message Transfer Agents (MTAs) that do not support the MT-PRIORITY SMTP extension.

5.3 After disaster (Recovery and reconstruction)

5.3.1 Radio communication Sector of ITU

Standardization and related work in ITU-R is summarized below.

None.

5.3.2 Standardization sector of ITU

Standardization and related work in work in ITU-T is summarized below.

i) SG-2

a) RECOMMENDATION ITU-T M.495

The purpose of transmission restoration and transmission route diversity is to protect the continuity and quality of international telecommunication services by minimizing the effects or potential effects of a transmission failure. This Recommendation applies to both analogue and digital transmission.

b) RECOMMENDATION ITU-T M.496

This Recommendation is a description of the functional organization for three general types of automatic transmission restoration systems:

- 1+1 transmission restoration;
- N+M direct transmission restoration (protection link switching);
- N+M automatic rerouting (protection network switching).

c) RECOMMENDATION ITU-T M.725

The restoration control point (RCP) is an element within the general maintenance organization for international telecommunication services. It initiates and coordinates service restoration activities in case of failures or planned outages of transmission systems in accordance with plans and ad hoc arrangements agreed by the technical services of the Administrations concerned.

d) RECOMMENDATION ITU-T M.2102

This ITU-T Recommendation defines maintenance thresholds and procedures for the protection and restoration of international SDH VC trails, multiplex sections and subnetwork connections in case of failure, degradation, and maintenance activities (e.g. planned outages). This ITU-T Recommendation deals with protection and restoration including a return to the original configuration. The internal protection capabilities of network element hardware are beyond the scope of this Recommendation. Maintenance thresholds and procedures given in this Recommendation are only used for the automatic protection and restoration of VC trails, multiplex sections and subnetwork connections.

Table 5 - List of ITU-T Recommendations for the after-disaster phase and their potential application areas

Study Group	Document No.	Potential application area
SG-2	M.495, M.496 M.725, M.2102	Restoring damaged base stations

ITU-T carries out studies and develops ITU-R Recommendations, Reports and Handbooks on various technologies that help during the relief phase of a disaster.

6. Gap analysis

The objective of gap analysis is to identify relevant technical areas where progress should be made on standardization. As the result of the gap analysis of the study area of FG-DR&NRR, the requirements for specific technical areas are detailed in the DR and NRR requirement deliverables, respectively. Although the provisional result of the gap analysis may not cover the all relevant technical areas for DR&NRR, it will be a helpful guide in relation to making progress on future works for the development of ITU-T Recommendations

6.1 Gap analysis for disaster relief systems

An early warning system is a system that can deliver warning notifications of an imminent disaster or about the possible effects of a disaster that has already occurred to those who may suffer from the disaster.

A disaster relief system is a system that can provide information or support actions designed to reduce and suppress serious disruptions to the functioning of society. The disruptions may be caused by accidents, natural phenomena or human activity, and result in a significant widespread threat to human life, health, property or the environment.

In practice, the systems generally include features designed to provide both early warning and disaster relief that match the time frame. The systems can be used to provide preparedness and prevention before a disaster, for rescue and evacuation assistance during a disaster, and to confirm safety and life sustainability after a disaster. The systems are classified into the following four categories.

(1) Timing, namely the time at which the service or system is applicable or effective in relation to the disaster

- 1) Before disaster
- 2) At and during disaster
- 3) After disaster

(2) Flow Direction of Notification

- 1) Public agency to general public (victims)
- 2) Public agency to public agency
- 3) Public agency to people within the agency

- 4) Public agency to individual (victims)
- 5) Individual to public agency
- 6) Individual to individual (victims) or vice versa

(3) System Technology

- 1) TV broadcasting
- 2) Radio broadcasting
- 3) Fixed radio communication
- 4) Digital Signage
- 5) Satellite with Fixed Land Station
- 6) Satellite with Mobile Land Station
- 7) Fixed/Mobile Phone
- 8) Mobile Broadcast
- 9) Mobile Phone
- 10) Amateur Radio

(4) Shared or Dedicated System

Some systems are designed, implemented, and operational only in disaster situations and not used in normal situations. One example is a fixed radio emergency communication system implemented between local governments. These can be called dedicated systems. The other systems are commonly shared in both disasters and normal situations. TV broadcasting is an example. These can be called shared systems.

On the basis of the above classification, the landscape of these systems is shown in Table-7.

Table-7 System landscape for Early Warning and Disaster Relief

Timing	Before Disaster (for Preparedness, Prevention)	At and during Disaster (for Rescue, Evacuation)	After Disaster (for Safety confirmation, Life sustainability)
Type of Notification Flow Direction of Notification	Early Warning	Disaster Relief	
Public agency to General public ¹⁾	TV broadcasting including Hybridcast -Shared		
	Radio broadcasting-Shared		
	Digital signage (new) –Shared		
	Fixed radio communications-Dedicated		
Public agency to Public agency	Fixed radio communication-Dedicated		
	Satellite with fixed land station-Dedicated		
	—	Satellite with mobile land station-Dedicated	
Public agency to people within the agency	Mobile Phone-Dedicated		
	Fixed Phone-Dedicated		
	Safety Confirmation and Message Broadcast (new)		
Public agency to	Mobile Broadcast to Phone (new)-Shared		

Individual2)		Disaster Relief Guidance (new)-Dedicated	
Individual to Public Agency	—	Mobile-Phone-Shared	
	—	Fixed-Phone-Shared	
	—	Amateur Radio ³⁾ -Shared	
Individual to Individual	—	Mobile-Phone-Shared	
	—	Fixed-Phone-Shared	
		—	Disaster Message Board (new) -Dedicated
		—	Disaster Voice Delivery (new)-Dedicated

NOTE – (new) indicates new study areas for standardization.

The landscape includes various early warning and disaster relief systems. Most systems have already been developed, implemented and standardized. However, the mobile and digital signage systems are two major systems that needed to be newly developed and standardized. The specific new study areas on early warning system and disaster relief by ITU-T are as follows.

(1) Early warning system

- 1) Warning system with mobile terminals
- 2) Warning system with digital signage

(2) Disaster relief system

- 1) Disaster message board system
- 2) Disaster voice delivery system
- 3) Disaster relief guidance system
- 4) Disaster relief system with digital signage
- 5) Safety confirmation and message broadcast system.

Until now, TV and radio broadcasting systems have been used to provide the general public with early warnings, and have been used to distribute information to the general public regarding disaster relief. A dedicated radio communication system and dedicated radio and satellite communication systems are used by local governments. The specifications of these systems have been developed and standardized by ITU-R, ITU-D and other SDOs.

Recently, a system for sending an early warning to individual mobile terminals is being developed although some mobile network operators (MNOs) have already provided it.

When it comes to networks and systems, disaster relief systems must operate even when there is heavy voice traffic congestion. Unlike traditional voice traffic over a circuit switched network, and according to several experiences, IP packet traffic may not be heavily congested even after a disaster. An IP-based mobile system could be effective.

Additionally, some systems must operate without being connected to core networks.

ITU-T has a suitable body for studying and standardizing early warning systems for mobile terminals and is a potential standardization body for studying disaster relief systems that distribute information to mobile terminals. In addition, the use of digital signage for a digital relief system is a new study area for ITU-T.

6.2 Gap analysis for network resilience and recovery

Two categories are introduced to examine existing and newly developed network resilience and recovery measures; target or effective time phase related to the disaster and relevant network parts.

(1) Time phase of the disaster

- 1) Before disaster
- 2) At and during disaster
- 3) After disaster

(2) Parts of the network

- 1) Satellite network
- 2) Core network
- 3) Fixed access
- 4) Mobile access
- 5) Internet access

Based on the above classification, possible NRR technologies and measures are summarized as a landscape in Table-8.

Table-8 Landscape of network resilience and recovery measures

Phase and approach	Preparedness before disaster	Response and relief at and during disaster	Recovery and reconstruction after disaster
Parts of network	Network resiliency (Redundancy and congestion control)		Network recovery (Substitute networks and repair)
Satellite	Increase in switching capacity at satellite		Portable earth station to reach satellite Mobile base station with satellite entrances
Core network	Spares for switching equipment and transmission facilities Multiple routes of transmission facilities Installation of fault detection device Installation of congestion detection and traffic control function Installation of automatic fire alarms and extinguisher systems Secure facilities to a stable structure robust against collapse Stable outdoor facilities and solid building to ameliorate effects of disasters		Spares for switching equipment and transmission facilities Materials for makeshift (emergency restoration construction, installation of temporary telecommunications lines, electric power supply) Emergency restoration equipment (outdoor line trunk accommodation units (New), temporary repeater (New)) Movable and deployable ICT resource units (New)

	Increase in switching capacity Emergency priority voice calls Flexible allocation of network resources (including relevant processing resources)(New)	
Fixed access and terminal equipment	Offload voice calls to other media (text messages, e-mail, Internet, storage-type media for emergency situations, packet communications) IP phones	Special toll-free public phones Satellite mobile phones Repurpose resources from other stations (laying in cable from other areas and out-rigging of network facilities) Underground multipurpose cable duct
Mobile access and terminal equipment	Offload voice calls to other means (text messages, e-mail, Internet, storage-type media for emergency situations, packet communications) Mobile IP phones Send SMS over data transmission network	Large-zone (long-reach) mobile base stations Mobile and compact base stations (including femtocells). Satellite mobile phones
Internet access	Increase line capacity to ensure Internet connectivity Bandwidth control Distributed Internet exchanges (IXs) and data centres over a wider geographical area Mirror sites User experience improvement with unstable or intermittent network connectivity (New)	Free access to wireless LAN and Internet including in evacuation centres Autonomous network construction for continuous communication (delay tolerant networking (New), local wireless mesh network with portable advanced wireless base station (New))
Electric power supply	Spare power supply Backup generators or batteries	Power-supply car

NOTE – (New) means a new NRR measure that needs study prior to standardization.

As shown in Table 8, there are a variety of measures and technologies for network resilience and recovery, some of which are new and need development and standards.

Redundancy and congestion control

Immediately after a disaster the communication traffic rapidly increases due to safety confirmation, medical status confirmation, and evacuation control, so the communication processing server will be overloaded, and it will be difficult to complete telephone calls and send e-mails. With regard to access to the network, WiFi will be congested even if an access point is available.

The issues related to the design and planning of switching equipment capacity, emergency priority calls, backup systems, multiple routing in transmission facilities, and IP phones are already being discussed and standardized in several SDOs. The following topics are under development, and well suit ITU-T for standardization as a new study area.

1) Flexible assignment of network processing resources

The flexible reconfiguration of communication processing resources (shifting from normal use to emergency use) can maximise the use of limited resources to prioritise support for indispensable communication services during and after a disaster.

2) User experience improvement given unstable or intermittent network connectivity

One problem during a disaster is that terminal devices are often disconnected from the public wireless LAN owing to radio wave interference and it is often difficult for people to share information among their devices. To overcome this unstable and intermittent network connectivity and maintain a higher quality user experience, it is important to control the data storage and transmission processes of the terminal devices, for example online or offline, to match the network status.

Substitute networks and repair

After a disaster, it is essential to restore the affected network facilities as soon as possible. However, it may take much time to repair all facilities. Network recovery technologies are needed that can restore the telecommunications infrastructure as much as possible. Movable and deployable ICT resource units etc. are under development, and well suit ITU-T for standardization as a new study area.

1) Movable and deployable ICT resource units (MDRU)

2) A portable burst-mode Erbium-Doped Fibre Amplifier (EDFA) for the post-emergency recovery of optical fibre links in remote areas

3) Delay Tolerant Networking (DTN)

4) Local private wireless mesh network based on de-centralized mesh architecture

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