International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

FG-DR&NRR

Version 1.0
(05/2014)

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

---

Overview of Disaster Relief Systems, Network Resilience and Recovery

Focus Group Technical Report

ITU-T

ITU International Telecommunication Union

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

ITU-T FG-DR&NRR Deliverable

Overview of Disaster Relief Systems, Network Resilience and Recovery

Summary

This Deliverable provides an overview of Disaster Relief Systems, Network Resilience and Recovery (DR&NRR), including the objective, study area, and an outline of other major deliverables made by the FG-DR&NRR. The category classification of ITU-T Recommendations and activities in other organisations outside ITU-T relevant to DR&NRR are also described.

Keywords

Disaster Relief, Network Resilience, Recovery, Overview

Table of Contents

ITU-T FG-DR&NRR Deliverable

Overview of Disaster Relief Systems, Network Resilience and Recovery

1. Scope

This deliverable provides an overview of Disaster Relief Systems (DR), Network Resilience and Recovery (NRR). Disaster Relief Systems provide the users with telecommunication services to mitigate the damage caused by the disaster before, during, and after the disaster incident. Network Resilience means the robustness of the network infrastructure and the continuity of the telecommunication services despite damage caused by the disaster. Network Recovery restores the network infrastructure and telecommunication services to their original status or to a certain level of availability even temporarily to provide the users with services after a disaster.

The objective of this deliverable is to describe the following:

- Overview of expected study areas, categorization, and definition of terminologies
- Brief introduction of activities of ITU and other organizations relevant to DR&NRR.
- Summary of contents of other major deliverable documents in the Focus Group.

2. Related work

Related work in SDOs and related organizations are described in Chapter 6. Major companion deliverables developed by this Focus Group are described in Chapters 7 and 8.

3. Terms and definitions

General/common terms related to DR&NRR are defined in Terms and Definitions; deliverable and specific terms are defined in individual deliverables. Major notions dealt with in this Focus Group are described in Chapter 5, “Overview of DR&NRR”.

4. Abbreviations and acronyms

This deliverable uses the following abbreviations and acronyms:

DR&NRR	Disaster Relief Systems and Network Resilience and Recovery
IARU	International Amateur Radio Union
IEC	International Electrotechnical Commission
IETF	Internet Engineering Task Force
ISO	International Organization for Standardization
ITU-D	International Telecommunication Union –Development Sector
ITU-R	International Telecommunication Union – Radiocommunication Sector

ITU-T International Telecommunication Union – Telecommunication Standardization Sector

SARS Severe Acute Respiratory Syndrome

UNISDR United Nations International Strategy for Disaster Reduction (United Nations Office for Disaster Risk Reduction)

5. Overview of DR&NRR

5.1 Objective of DR&NRR

DR&NRR are designed to provide users with telecommunication services to protect their lives and assets when there is a disaster that may significantly destroy network infrastructures and disrupt connectivity.

5.2 Study area of FG-DR&NRR

The study area of this FG is very broad and so some study items are classified according to the particular phases of a disaster as shown in Fig. 1, which can be categorized as "before disaster", "at and during disaster" and "after disaster".

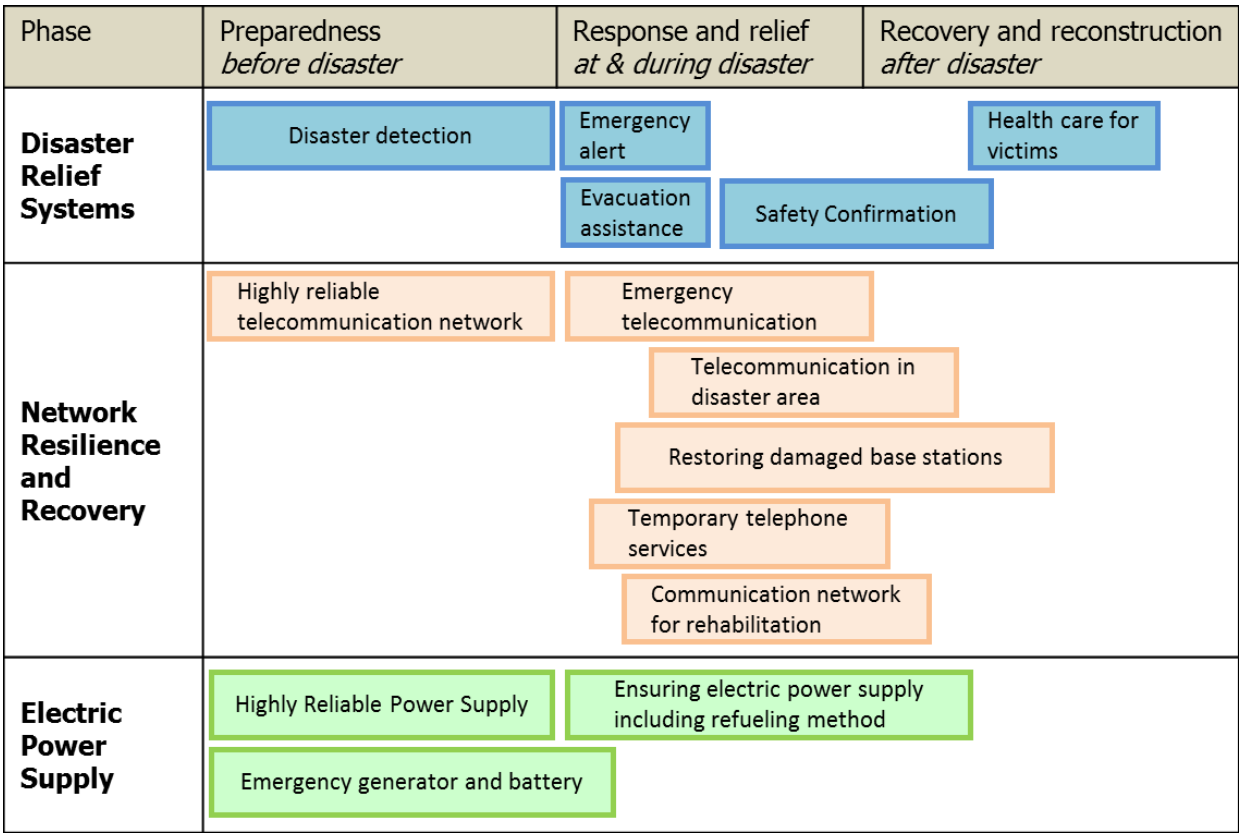

Figure 1. Overview of expected study areas for FG-DR&NRR

5.2.1 Disaster relief systems

A disaster detection and early warning system is required so that we are prepared before a disaster occurs. During an incident or a disaster, an emergency alert system and an evacuation assistance system are used to evacuate people from potentially dangerous areas and rescue those in danger. A safety confirmation system is utilized to confirm the safety of each person and assist rescue work immediately after an incident and for a certain period of time during a disaster. A system supporting health care and for sustaining the lives of the victims may also be necessary for a relatively long time after an incident.

Until now, radio and TV broadcasting, amateur radio and fixed phones have been mainly used for disaster relief systems. But new disaster relief systems that employ mobile and digital signage have recently been introduced and these new types of disaster relief systems should be developed further.

In addition, the care of the disabled must also be considered when developing these systems.

5.2.2 Network resilience and recovery

Network resilience and recovery depends on a highly reliable network design, such as a multiple network route. For emergency telecommunications it is useful to establish temporary telephone services by temporarily restoring damaged mobile base stations after a disaster.

In addition to the scenarios (or use cases) involving the of strengthening existing networks in operation, it is necessary to consider a complementary approach that mobilizes ICT facilities surviving in the devastated area, connects them with instantly deployable and configurable ICT resources, and then builds local networks to satisfy the urgent need for local communication between rescue teams and local citizens in the area.

5.2.3 Electric power supply

A highly reliable way of guaranteeing an electrical power supply for telecommunication equipment must be ensured by using, for example, multiple electrical distribution routes and an electrical generation system. An effective way of refuelling electrical power generators after a disaster should be considered.

5.3 Categorization of disasters and their impacts

Hazards endangering the telecommunication services in a disaster may be technological and societal in addition to environmental. Natural disasters include earthquakes, landslides, tsunami, cyclones, floods, and droughts, and they physically damage part of the network infrastructure. A technological disaster may be caused by chemicals, radiological agents, and transport accidents. Societal disasters include conflicts and acts of terrorism. A biological disaster may also impact on telecommunication services by limiting the availability of network operators and could include epidemics of diseases such as SARS, influenza, cholera, and pest infestations.

6. Activities of world-wide organizations relevant to DR&NRR

6.1 ITU-T activities

Various ITU-T study groups are undertaking advanced work on emergency telecommunications. As the lead study group on this theme, ITU-T Study Group 2 is continuing 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. Regarding the classification category, it seems that there are few standardization activities in the study areas of safety confirmation, health care for victims, temporary telephone services and power supply issues before/during a disaster. This information will be helpful for considering the gap in the standardization activities on disaster relief and emergency telecommunications. The gap analysis document shows a list of related ITU-T Recommendations categorized by the phases of a disaster.

Relevant ITU-T activities for each of the study areas are summarized below.

6.1.1 Disaster detection

Ubiquitous sensor network applications and services studied by ITU-T Study Group 16 (Multimedia coding, systems and applications) can be used for the early detection of natural disasters. ITU-T Recommendation L.81 (Monitoring systems for outside plant facilities) approved by Study Group 15 can also be useful for disaster detection.

6.1.2 Emergency alert

ITU-T Study Group 2 has studied ways of passing disaster warnings from authorities to citizens. Study Group 17 has developed the Common Alerting Protocol (CAP), which is a general format for exchanging all-hazard emergency alerts and public warnings over all kinds of networks.

6.1.3 Evacuation assistance

ITU-T Study Group 16 has studied emergency service access for people who need to communicate via media other than voice, e.g. text, sign language, lip reading supported speech.

6.1.4 Safety confirmation

There is no related ITU-T recommendation.

6.1.5 Health care for victims

ITU-T Focus Group on M2M Service Layer (FG M2M) discussed e-health. ITU-T Study Group 16 has started to study a multimedia framework for e-health applications.

6.1.6 Emergency telecommunication

ITU-T Study Group 2 has developed Recommendation E.161.1 related to Guidelines for selecting an Emergency Number for public communications networks. Study Group 2 has also developed Recommendation E.106 for an International Emergency Preference Scheme for disaster relief operations (IEPS) dealing with the prioritisation of calls during a disaster. Study Group 11 has studied Signalling Protocols for emergency telecommunication and Multi-level precedence and a Pre-emption (MLPP) mechanism for public communications networks. Study Group 2 has also worked on a Priority service or MLPP service. Study Group 9 has studied emergency communication over cable networks.

6.1.7 Telecommunication in disaster area

Power Line Communication (PLC) technology can be applied easily to telecommunication in a disaster area immediately after the power supply has been restored because PLC uses the same line for communication as that used for electrical power. PLC has been standardized as the ITU-T G.996x series in Study group 15 and IEEE standard 1901 for broadband communication, and is discussed as smart grid technology in ITU-T FG-smart grid, IEEE P1901.2 and elsewhere. But PLC use is forbidden for outside plants in certain countries. Before PLC can be used for telecommunication in disaster areas in such countries, legal regulations should be relaxed.

6.1.8 Restoring damaged base stations

The restoration of damaged base stations has been approved by ITU-T Study Groups 2 and 15. SG 2 discussed terminology and general principles, and SG 15 discussed equipment specifications. The restoration technology can be adapted to protection, which falls into category 6.1.9 related to a highly reliable telecommunication network.

6.1.9 Highly reliable telecommunication network

Study Group 5 has studied the protection of telecommunication equipment against lightning. Study Group 15 is studying transport equipment functionality Recommendations to provide survivability capabilities as well as addressing multi-layer survivability interactions. The approved Recommendations are G.808.1, G.873.1 and G.8031 for linear protection, and G.808.2, G.873.2 and G.8032 for ring protection. Shared mesh protection technology is under discussion. Study Group 15 is also studying disaster countermeasures for outside facilities in L.92.

6.1.10 Temporary telephone services

Study Group 2 has developed Supplement E.Sup.1 that describes operational aspects for the implementation of E.164 country code 888 for E.1100 series Recommendations.

6.1.11 Highly-reliable power supply

There is no related ITU-T recommendation. It could be discussed in IEC.

6.1.12 Emergency generator and battery

ITU-T Study Group 15 has studied an electric power supply for the outside plants of telecommunication networks such as power feeding and backup systems.

6.1.13 Ensuring electric power supply including refuelling method

There is no related ITU-T recommendation. It could be discussed in IEC.

6.1.14 Care for the disabled using emergency telecommunications

ITU-T Focus Group on AVA and JCA-AHF discuss accessibility for those with disabilities.

6.2 Standardization organizations other than ITU-T

6.2.1 ITU-R

Aspects of radio communication services associated with disasters include disaster prediction, detection, alerting and relief. In certain cases, when the “wired” telecommunication infrastructure is significantly or completely destroyed by a disaster, only radio communication services can be employed for disaster relief operations. The relevant ITU-R activities may be categorized into the following 5 study items.

6.2.1.1 Disaster prediction and detection

Disaster prediction and detection have been investigated by ITU-R Study Group 7 (Science services). They include providing weather warnings and climate predictions, and the detection and tracking of earthquakes, tsunami, hurricanes, typhoons, forest fires, and oil leaks.

6.2.1.2 Emergency alert

ITU-R Study Group 5 (Terrestrial services) has studied the use of amateur services for receiving and distributing alert messages. ITU-R Study Group 6 (Broadcasting service) has studied

the use of terrestrial and satellite broadcasting services (radio, television, etc.) for disseminating alerts and providing advice to large sections of the public. ITU-R Study Group 4 (Satellite services) and Study Group 5 have studied fixed terrestrial and satellite services for delivering alerts and instructions to telecommunication centres for further dissemination to the public. ITU-R Study Groups 4 and 5 have also studied the use of mobile services (land, satellite, maritime services, etc.) for distributing alerts and advice to individuals.

6.2.1.3 Evacuation assistance

ITU-R Study Group 7 has studied an earth exploration-satellite service for assessing damage and providing information related to planning relief activities.

6.2.1.4 Telecommunication in disaster area

ITU-R Study Groups 4 and 5 have studied amateur satellite services for disaster communications.

6.2.1.5 Highly reliable telecommunication network

ITU-R Study Groups 4 and 5 have studied a harmonized frequency channel plan to reduce frequency interference and to maintain a highly reliable telecommunication network.

6.2.2 ISO/IEC

A highly reliable power supply and electric power distribution technology are being discussed by IEC technical committee 96 (Transformers, reactors, power supply units, and combinations thereof).

6.2.3 IETF

The Internet Engineering Steering Group (IESG) established an IETF Working Group (WG) in the Real Time Applications and Infrastructure Area) to address Internet Emergency Preparedness (IEPREP). Some informational RFCs in two specific technical areas were developed: "Requirements for Internet Emergency Preparedness in the Internet", and the "Framework for Supporting Internet Emergency Preparedness in Internet Protocol (IP) Telephony." The following IETF Working Groups may also be relevant to FG-DR&NRR:

ECRIT (Emergency Context Resolution with Internet Technologies), http://datatracker.ietf.org/wg/ecrit/

EMAN (Energy Management), http://datatracker.ietf.org/wg/eman/

SOC (SIP Overload Control), http://datatracker.ietf.org/wg/soc/

SALUD (Sip ALerting for User Devices). http://datatracker.ietf.org/wg/salud/

6.3 Promotion organisations

6.3.1 ITU-D

ITU-D Study Group2 has published "Utilization of ICT for disaster management, resources, and active and passive space-based sensing systems as they apply to disaster and emergency relief situations" as a result of Question 22/2. The document provides some guidelines regarding the Common Alerting Protocol (CAP).

ITU-D SG2 has developed the ITU Handbook "Telecommunication outside plants in areas frequently exposed to natural disasters" and "Emergency Telecommunications".

6.3.2 International Amateur Radio Union (IARU)

When ordinary communication measures are disrupted by a disaster, the Amateur Service provides a tool that allows disaster victims to report their situation to the outside world and to ask for rescue. Once a certain number of amateurs are licensed in a country or territory, they can be located throughout the area. Some of these amateur radio stations will remain operational even during a large disaster and provide communications assistance for disaster relief operations.

6.3.3 United Nations Office for Disaster Risk Reduction (UNISDR)

United Nations Office for Disaster Risk Reduction (UNISDR) is the UN office dedicated to disaster risk reduction. UNISDR was created in 1999 with the purpose of ensuring the implementation of the International Strategy for Disaster Reduction.

6.3.4 UN Office for the Coordination of Humanitarian Affairs (OCHA)

The United Nations (UN) system includes specialized agencies for various aspects of humanitarian work, including disaster response. Their cooperation is ensured through the UN Office for the Coordination of Humanitarian Affairs (OCHA), headed by the UN Emergency Relief Coordinator with offices in Geneva and New York, and with field offices in a number of countries. Using a permanent, 24 hours per day/365 days per year duty system, OCHA uses all available means of telecommunication to monitor events and immediately alert the international community of the need to mobilize appropriate resources in cases where international assistance is likely to be required.

6.3.5 US National Oceanic and Atmospheric Administration (NOAA)

The principle device of the Deep-ocean Assessment and Reporting of Tsunami (DART) buoy system developed by US National Oceanic and Atmospheric Administration (NOAA) is an ocean bottom pressure sensor that can record a wave amplitude of less than 1 cm in the open ocean. The DART system can detect an impending tsunami threat and thus is an important system in relation to disaster detection.

6.3.6 UNITAR'S Operational Satellite Applications Programme (UNOSAT)

UNOSAT is a technology-intensive programme of the United Nations Institute for Training and Research (UNITAR), a training arm of the UN system. UNOSAT delivers imagery analysis and satellite solutions in the form of maps, reports and GIS-ready data layers for direct integration into in-field and headquarter mapping systems. The analysis results are provided to relief and development organizations within and outside the UN system. Most of these analysis results pertain to hydro-meteorological disasters, but also increasingly relate to conflict and complex emergencies occurring in areas that are difficult or risky for humanitarian workers to access.

6.3.7 United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER)

UN-SPIDER is a programme within the UN that is designed to provide universal access to all types of space-based information and services relevant to disaster management. The programme ensures that all countries and regional and international organizations have access to any type of space-based information that can be helpful during all the phases of disaster management.

6.3.8 Group on Earth Observations (GEO)

GEO was launched in response to calls for action by the 2002 World Summit on Sustainable Development and by the Group of Eight (G8) leading industrialized countries. It is a voluntary partnership of governments and international organizations that is coordinating efforts to build a Global Earth Observation System of Systems, or GEOSS. It will be a global and flexible network of

content providers allowing decision makers to access an extraordinary range of information and provide decision-support tools to users. GEOSS is a system of systems that will proactively link together existing and planned observation systems around the world. It will promote common technical standards for forming coherent data sets from the diverse range of data received from different systems.

6.3.9 Meteorological systems of the World Weather Watch

It requires a near instantaneous exchange of weather information across the world to enable meteorological agencies to predict the weather. Established in 1963, the World Weather Watch is a programme of the World Meteorological Organization that combines observation systems, telecommunication facilities, and data-processing and forecasting centres and provides meteorological and related environmental information to all countries.

The World Weather Watch is composed of three integrated core system components. The Global Observing System (GOS) that provides standardized observations of the atmosphere and ocean surface from all parts of the globe and from outer space. The Global Telecommunication System (GTS) that provides the real-time exchange of meteorological observational data, processed products, and related information between national meteorological and hydrological services. And the Global Data Processing and Forecasting System that provides analysis, warnings, and forecasts that are generated by a network of World Meteorological Centres and specialized regional centres.

7. Framework and use cases

Various use cases have been collected, categorized and analysed by the FG and the deliverable document, “Framework and use cases” was created to extract the requirements for DR&NRR [b-FG-DR] [b-FG-NRR] [b-FG-MDRU], which is briefly described in Section 8. The categorization of use cases can be based on a network technology area and the phase of a disaster event.

7.1 Integrated view of promising DR&NRR technologies

Telecommunication and ICT systems are important in relation to disaster preparedness and relief.

To maintain and/or increase opportunities for communication even during disasters, terminals may be enhanced by further access technologies in order to utilize systems on different networks (e.g. fixed access networks, public Wi-Fi, Intelligent Transport Systems (ITS) and satellite networks). The networks will also be enhanced by providing several unconventional communication paths and combining currently independent networks and their capabilities (which are owned and/or operated by different organizations with different policies) in an integrated manner.

The integrated view of promising DR&NRR technologies describes the overall structure of networks that support disaster relief services and systems. The networks are divided into three categories; core networks, access networks and users. They are also categorized into two types; owned or not owned by service providers. Making the most of these different options, communication paths in an emergency situation can be secured in a more robust way.

7.2 Components of integrated view

The following items are promising technologies that can be employed in a disaster with regard to both one level and different levels.

- Local wireless mesh network system
- Delay Tolerant Networking (DTN)
- Mobile terminals with DTN functionalities
- Nomad Stations with DTN functionalities
- Resilient network architecture based on Movable and Deployable Resource Unit (MDRU); Portable Emergency Communication System (PECS)
- Recovery of optical fibre links in remote areas
- Satellite communication network
- Low-power VSAT technology
- Bandwidth optimisation control technology
- VSAT recovery

7.3 Disaster relief systems and other promising technologies

This part describes promising DR&NRR technologies that do not appear explicitly in the integrated view shown below. First early warning systems are considered followed by systems for disaster relief. Finally, the concept of hybrid broadcast-broadband television systems is addressed.

- Early warning system
- Early warning system for mobile terminals
- Warning system using digital signage
- Disaster relief system
- Hybrid broadcast-broadband television systems

7.4 List and repository of FG-DR&NRR inputs and use cases

The use cases are classified into certain categories based on the phase of the disaster. The categorization is not necessarily consistent with that described in *Overview of the expected study areas for FG-DR&NRR* in this overview.

- Mitigation and prevention
- Preparedness
- Prediction and early warming
- Response
- Impact assessment
- Recovery
- Reconstruction

8. Requirements for DR&NRR

Information and communication technologies (ICT) provide crucial services and systems for emergency and disaster situations as well as daily life. ICT systems against disasters have two aspects, namely service/application and infrastructure. In all of these case studies, loss of power and insufficient fuel for back-up generators was a major factor in putting telecommunications equipment out of service. Thus, deliverable documents describing requirements are categorized into disaster relief systems (DR), network resilience and recovery (NRR), and the electric power supply issue.

8.1 Disaster relief systems

During and after disasters disaster relief systems provide people with timely and useful information that is used for rescue, evacuation, safety confirmation and even to sustain life. Regarding the service and application aspect, systems that provide early warning against imminent disasters help people prepare for them, prevent serious damage, minimize the damage if it cannot be prevented, and reduce the loss of human life to the bare minimum.

The response of people affected by a disaster is to attempt to call to report that they are safe or to call to check whether others are safe, causing telecommunications network congestion. It is therefore necessary to implement measures to alleviate congestion. Congestion can be avoided by:

- encouraging alternative means of communication,
- reducing call hold times,
- reducing call quality,
- reassigning network resources to telephony, or
- developing new network architectures that can handle spikes in telephone traffic.

Priority can also be given to users with special privileges to make calls during disaster situations. Services for emergency and disaster related organizations are also given high priority.

8.1.1 Categories of disaster relief systems

Radio and TV broadcasting, amateur radio and fixed phones have mainly been used for disaster relief systems. Table 1 summarizes potential systems for Disaster Relief and Early Warning.

Table 1 Systems for disaster relief and early warning

Timing	***Before Disaster (for Preparedness, Prevention)***	***During Disaster (for Rescue, Evacuation)***	***After Disaster (for Safety confirmation, Life sustainability)***
Type of notification / Notification flow direction	**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 individual2)	***Mobile Broadcast to Phone (new)-Shared***	
		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 –1) Pubic agency to general public and public agency to individual are distinguished in the sense that the former assumes a large audience and recipients receive general information, whereas the latter assumes that a number of recipients with the same characteristics receive information specifically applicable or useful to them.
2) (new) indicates new study areas for standardization.

8.1.2 Consideration for people with disabilities

The accessibility of media including broadcasting and telecommunications is very important for people with disabilities especially in connection with natural and man-made disasters. During disasters, access to telecommunication and broadcasting is vitally important for people with disabilities. A survey of emergency communication during the East Japan Earthquake and subsequent tsunami in 2011 showed that the death rate for people with disabilities was twice that for those without disabilities [1], [2].

In many countries, emergency calls are made through telephone networks by voice communication with an emergency call communicator and people with hearing and speaking disabilities cannot describe an emergency situation directly to an emergency call communicator. Thus, an emergency call arrangement using a smart phone that does not necessarily depend on voice communication will be beneficial for those with hearing and speaking disabilities, the aged who might become partially hearing impaired, and foreigners who may have a difficulty engaging in voice communication in the language of a country they are visiting in an emergency situation.

Information such as tsunami alerts and evacuation announcements should be expressed in a variety of ways so that those with hearing or visual impairments can access it. For example, if a siren to alert people to the occurrence of a tsunami is accompanied by a flashing light, those with hearing impairments and those with normal hearing will recognize the warning.

In addition, broadcast emergency alerts should also be accessible to those with visual and/or auditory impairments by simultaneously offering speech, captions/subtitles and sign language. As an emergency develops, TV and radio broadcasting play key roles in transmitting emergency alerts to people living in areas affected by the disaster. Broadcasting provides reliable information collected and collated from reliable news sources such as the authorities and the site of the incident. Such information is therefore vitally important for everybody regardless of his or her capabilities or disabilities. Emergency information presented visually during a non-news program (such as when information about emergencies appears as a news ticker at the bottom of the television screen

during a regularly scheduled program) should be provided aurally on a secondary audio stream. Certain equipment used to receive, play back, or record television programs can make secondary audio streams available. Secondary audio streams will convey emergency information, as well as video description, to make programs and emergency information more accessible to individuals who are blind or visually impaired.

Early-warning systems that alert citizens about the occurrence of a disaster and provide information about the steps they should take (including evacuation) save lives in affected areas. Mobile reception terminals for these systems are especially important as regards saving the lives of those who have to remain outdoors. For people with disabilities, multi-modal alert expressions are important as mentioned above.

Examples of such warning systems include the Emergency Warning Broadcasting System (EWBS) of the Japanese digital broadcasting system, the Early Earthquake Warning System (EEW) in Japan and the Emergency Alert System (EAS) in the USA. When a huge tsunami struck just after the East Japan Earthquake, passengers on a train running in Fukushima Prefecture were just able to escape from the tsunami and were evacuated safely, thanks to the EWBS for mobile TV receivers [3][4].

The accessibility of information provided to evacuees is also important. Communication tools for deaf people such as a sign language interpretation service, a sign language relay service for telephone communication and text communication tools such as e-mail are vital. Without them, evacuees may lack food and water, and may become isolated even when staying in a public refuge with other people.

Similarly, communication with visually impaired people should also be carefully considered. For example, important information such as food delivery times and the safety of members of their families and acquaintances is usually placed on bulletin boards in refuge sites. Visually impaired people find it difficult to obtain information that is only provided in a visual form.

When emergencies occur, access services for foreigners should also be provided so that they can understand the nature of the incident as quickly as citizens of the country. Announcements should be provided in a *lingua franca* such as English, or possibly in multiple languages both in written and spoken form. Emergency alerts can be provided via a bilingual audio or subtitle service on TV, or via an internet news service. In the future, integrated broadcast systems (i.e. hybrid broadcast-broadband television systems) have the potential to provide subtitles in multiple languages for foreigners.

Automatic translation technology would also assist such a service. A possible solution may be through a smart-phone application that can provide multilingual machine translation.

8.2 Telecommunication network resilience and recovery

NRR denotes the following capabilities of telecommunication networks and related processes to cope with disasters:

Resilience: the ability to provide and maintain an acceptable level of services in the face of faults and challenges to the normal operation of a given communication network, based on prepared facilities

Recovery: the process of restoring the normal level of service of a given communication network after a disaster, possibly with the deployment of additional available facilities

Based on an analysis of use cases, the following general requirements for NRR have been identified (the list is not all-embracing).

- redundancy in facilities
- facility placement at secure locations
- effective use of radio communications
- inter-operation of heterogeneous networks
- availability of quickly deployable facilities
- congestion mitigation

It is clear that locating equipment where it is least exposed to risk can reduce infrastructure damage. The use of aerial facilities should be avoided and critical equipment such as authentication servers should be geographically dispersed.

Detailed NRR requirements are defined in [b-FG-NRR], which is organized into a general requirement part and several specific requirement parts. Each specific requirement part deals with specific situations to be solved and defines the functions to be incorporated in the solution.

The NRR requirements document includes the following:

- General objectives regarding network resilience and recovery
- Approaches for achieving the objectives
- Classification and landscape of network resilience and recovery measures
- New study areas of network resilience and recovery
- Redundancy and congestion control
- Substitute networks and repair

This also includes requirements for

- Telecommunications network facilities
- Indoor facilities
- Outdoor facilities
- And surroundings and environmental aspects.

8.3 Electric power supply

The loss of the power supply is one of the main factors preventing the use of communications equipment and causing the interruption of services during a disaster. The cause may be severed power lines, damaged or destroyed generators, insufficient fuel for emergency generators or lack of spare batteries. It is clear that locating equipment where it is least exposed to risk can reduce infrastructure damage. A steady power supply and power generation equipment should be located at a place where it is least exposed to potential damage from a disaster.

Disasters related to water, including flooding and tsunami, may cause significant damage to power supply systems. The equipment should be installed at a higher location on land or in a building where the risk of flooding is reduced. The use of multiple electrical distribution routes is recommended and aerial facilities should be avoided.

An autonomous power supply is critical and there should be sufficient fuel for back-up generators as power outages can be lengthy. Equipment should be installed in buildings in higher locations where the risk of flooding is reduced and basements should be avoided as sites for equipment and reserve generators. Spare power supplies, back-up generators, or batteries should be prepared to ensure a stable power supply and thus maintain continuous communication services when the main power fails. The autonomous power supply should be capable of lasting at least 72 hours to allow time for sufficient and effective rescue work.

However, these power supply issues have not yet been sufficiently addressed and need to be considered.

Bibliography

[1] http://www.dinf.ne.jp/doc/english/twg/escap_121031/fujii.html

[2] http://www.asahi.com/special/10005/TKY201105230516.html (in Japanese)

[3] http://www.itu.int/ITU-D/asp/CMS/Events/2012/emergencyworkshop/Toshiyuki_Yokota.pdf

[4] http://www.yomiuri.co.jp/national/news/20110329-OYT1T00626.htm (in Japanese)

[b-FG-Overview] ITU-T Focus Group on Disaster Relief Systems, Network Resilience and Recovery FG-DR&NRR-O-074 (2014), *Overview of Disaster Relief Systems, Network Resilience and Recovery*

[b-FG-Frame] ITU-T Focus Group on Disaster Relief Systems, Network Resilience and Recovery, FG-DR&NRR-O-075 (2014), *Disaster Relief Systems, Network Resilience and Recovery (DR&NRR): Promising technologies and use cases.*

[b-FG-Gap] ITU-T Focus Group on Disaster Relief Systems, Network Resilience and Recovery, FG-DR&NRR-O-076 (2014), *Gap Analysis of Disaster Relief Systems, Network Resilience and Recovery.*

[b-FG-Term] ITU-T Focus Group on Disaster Relief Systems, Network Resilience and Recovery, FG-DR&NRR-O-077 (2014), *Terms and Definitions for disaster relief systems, network resilience and recovery*

[b-FG-DR] ITU-T Focus Group on Disaster Relief Systems, Network Resilience and Recovery, FG-DR&NRR-O-078 (2014), *Requirements for Disaster Relief System.*

[b-FG-NRR] ITU-T Focus Group on Disaster Relief Systems, Network Resilience and Recovery, FG-DR&NRR-O-079 (2014), *Requirements for network resilience and recovery*

[b-FG-MDRU] ITU-T Focus Group on Disaster Relief Systems, Network Resilience and Recovery, FG-DR&NRR-O-080 (2014), *Requirements on the improvement of network resilience and recovery with movable and deployable ICT resource units*

[b-ITU-TR] ITU-T Focus Group on Disaster Relief Systems, Network Resilience and Recovery, Technical report (2013), *Technical Report on Telecommunications and Disaster Mitigation*

_____