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Requirements for 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

ITU-T FG-DR&NRR Deliverable

Requirements for network resilience and recovery

Summary

This deliverable describes requirements for network resilience and recovery before, at or during and after disasters.

Keywords

network resilience and recovery

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Requirements for network resilience and recovery

1 Scope

This document describes ways to improve network resilience and recovery against disasters.

Information and communication technologies (ICT) provide crucial services and systems for our daily life as well as emergency and disaster situations. Based on the layering model, systems robust against disasters can be viewed from two aspects: service/application and infrastructure. Regarding the infrastructure aspect, it is necessary to improve the network tolerance against damage and enable quick restoration to cope with large-scale communication congestion and the loss of network function by the destruction and failure of communication facilities. Network resilience is the robustness of the network infrastructure and should ensure the continuity of telecommunication services against any damage caused by the disaster. Network recovery is restoration of the network infrastructure and telecommunication services to their original status or a certain level of availability, even temporarily, to provide the users with an adequate grade of services after the disaster.

According to past experiences and by considering latest available technologies [b-FG-Overview][b-FG-Frame][b-FG-Gap], some of the network resilience and recovery technologies are considered to need further investigation with the development of common specifications as standards.

This document discusses the high-level category of network resilience and recovery (NRR) technologies, identifies the systems and components that need common specifications, and describes the requirements for them towards the next steps in standardization. To facilitate future enhancements, the document consists of the main body as the general part and annexes as baseline documents for standardization.

The requirements on disaster relief (DR) services and systems are described in the companion document [b-FG-DR].

2 References

None.

3 Definitions

3.1 Terms defined elsewhere

3.1.1 Movable and deployable ICT resource unit (MDRU) [b-FG-MDRU]: a collection of information and communication resources that are packaged as an identifiable physical unit, movable by any of multiple transportation means, and workable as a stand-in for damaged network facilities and so reproduce their functionalities as a substitute.

NOTE – Packed into a container or box, an MDRU accommodates equipment for reproducing ICT services such as switches/routers, wired/wireless transmitters/receivers, servers, storage devices, power distribution unit, and air conditioners.

3.2 Terms defined in this Document

This deliverable defines the following terms:

3.2.1 Delay tolerant networks (DTN): DTN technology stores the information when it is connected to the source (e.g. mobile terminal), and delivers the information to the destination when it finds the end-user.

3.2.2 Local wireless mesh network: a local-area network which consists of multiple relay-capable nodes connected with each other via wireless links (i.e., in a mesh form), governed by de-centralized control for discovering communication paths from among available nodes and wireless links, and provides information relay services to the user terminals (which are typically WiFi terminals).

NOTE – The relay nodes are assumed to be placed on the top of the buildings or ground with good visibility in preparation for disaster, installed where needed, or transportable by car or plane. Local communication service in a relatively limited area provided by a private company or local government (rather than public network operators) is an initial design target.

3.2.3 Network recovery: The process of recovering the level of services of a given communication network after a disaster.

3.2.4 Network resilience: The ability to provide and maintain an acceptable level of service in the face of faults and challenges to normal operation of a given communication network, based on prepared facilities.

4 Abbreviations and acronyms

This deliverable uses the following abbreviations and acronyms:

DTN	Delay tolerant network
DR	Disaster relief
EDFA	Erbium-Doped Fibre Amplifier
ICT	Information and communication technology
IP	Internet protocol
IX	Internet exchange
LAN	Local area network
MDRU	Movable and deployable ICT resource unit
NRR	Network resiliency and recovery
SDO	Standards developing organization
SMS	Short Message Service

5 Conventions

In this document:

The keywords "is required to" indicate a requirement which must be strictly followed and from which no deviation is permitted if conformance to this Document is to be claimed.

The keywords "is prohibited from" indicate a requirement which must be strictly followed and from which no deviation is permitted if conformance to this Document is to be claimed.

The keywords "is recommended" indicate a requirement which is recommended but which is not absolutely required. Thus this requirement need not be present to claim conformance.

The keywords "is not recommended" indicate a requirement which is not recommended but which is not specifically prohibited. Thus, conformance with this specification can still be claimed even if this requirement is present.

The keywords "can optionally" indicate an optional requirement which is permissible, without implying any sense of being recommended. This term is not intended to imply that the vendor's implementation must provide the option and the feature can be optionally enabled by the network operator/service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with the specification.

For the purpose of this Document, the terms "enterprise network" and "corporate network" can be used interchangeably.

6. Overview of network resilience and recovery

6.1 General objectives of network resilience and recovery

The telecommunications infrastructure including both landline and mobile communication networks with fixed-line and mobile phones, makes instant exchange of information possible even in remote areas, and constitutes a vital part of the social underpinning for daily life and economic activities.

In particular, given the technological advances in recent years, the convenience and importance of the Internet and broadband connections have grown dramatically, and the communications infrastructure has become even more fundamental to society not only as a means of providing traditional telephone service, but also as a medium for the delivery of all manner of information and services provided by government and businesses, etc.

During states of emergency such as major natural disasters, the telecommunications infrastructure also provides a means of confirming people’s safety status through emergency calls and emergency priority-line phones, and provides a necessary means of communication for the maintenance of basic administrative functions such as police and fire departments. The telecommunications infrastructure is essential to ensuring the safety and wellbeing of citizens and underpins the ability to function as a nation.

Just after or during the disaster, voice calls over the telephone and mobile phone network are mostly used for the safety confirmation and information exchange in the disaster area. Voice calls are easy for anyone to make, used for emergency communication, and thus trigger an enormous surge in the number of calls. Network congestion is the best-known issue in the event of a disaster, which we can tackle using different approaches by leveraging the latest technologies and new user behavior.

It is also essential to restore the telecommunications infrastructure swiftly. Mobile base stations, local switches and transmission cables may undergo major damage in disasters. In order to respond effectively to post-disaster emergency situations, verify the safety of individuals, facilitate information-gathering, and provide means of communication, infrastructures should be recovered by employing every possible means.

From the viewpoint of network resilience and recovery, the above two issues are considered fundamental and crucial. Preventing, mitigating, or circumventing congestion in an emergency situation and minimizing disruption to communications in the event of infrastructure damage are two major objectives of NRR.

6.2 Approaches to achieve the objectives

The telecommunications infrastructure is important for social life, and there are many measures, including existing and proven ones as well as those under study and newly developed ones, to keep communication stable both in normal use and emergency use in response to a disaster. Approaches to achieve NRR objectives can be summarised as follows.

1) Redundancy: for equipment and functions that are likely be damaged, extra capacity or capabilities are prepared in advance and activated as needed, or used in normal operation.

2) Congestion control: the rapid increase in voice call number in response to a disaster causes congestion by overloading of the switching equipment. To detect this congestion and control the traffic, some functions must be installed. Mitigating or circumventing the congestion is also a valid solution.

3) Repair: systems for switching equipment and transmission facilities, multiple route of transmission facilities, spare equipment, and materials necessary to restore temporarily (emergency restoration construction, installation of temporary telecommunications lines, electric power supply) are prepared to repair the damaged equipment and facilities.

4) Substitute: damaged equipment and facilities are replaced by newly deployed multi-purpose facilities or surviving resources originally installed for a different purpose.

Robustness by maintaining the buildings and facilities in a physically-stable state is another common approach to prevent or mitigate infrastructure damage, in practice. The following guidelines are widely employed. The specific requirements on this approach are described in clause 8.

a) For earthquakes, storms, floods, and large-scale fire, facilities must be sited in a stable structure that resists physical collapse. Also, automatic fire alarms and extinguisher systems must be installed.

b) The outdoor facilities should endure the external environment (allowing for meteorological change, vibration, shock, pressure) in the setting area.

c) The buildings hosting the facilities must resist natural disasters.

d) Spare power supplies, backup generators or batteries are prepared to ensure stable electric power supply sufficient to continue the communication service after main power failure.

6.3 Classification and landscape of network resilience and recovery measures

Two categories are introduced to examine existing and newly developed NRR measures; target or effective time phase related to the disaster and relevant network parts. Based on the classification, possible NRR technologies and measures are summarized as a landscape in Table 1.

1) Time phase of the disaster

(1) Before disaster

(2) At or 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

Table 1 – Landscape of network resilience and recovery measures

Phase and approach / Parts of the network	Preparedness before disaster	Response and relief at and during disaster	Recovery and reconstruction after disaster
	Network resiliency (Redundancy and congestion control)		Network recovery (Substitute networks and repair)
Satellite	Increase in switching capacity at the satellite		Portable earth station to reach the 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 Increase in switching capacity Emergency priority voice calls Flexible allocation of network resources (including relevant processing resources)(New)		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)
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 duct of

		cables
Mobile access and terminal equipment	Offload of voice calls to other means (text messages, e-mail, Internet, storage-type media for emergency situations, packet communications) Mobile IP phones Sending SMS over the data transmission network	Large-zone (long reach) mobile base stations Mobile and compact base stations (including femtocells). Satellite mobile phones
Internet access	Increase in line capacity for ensuring Internet connectivity Bandwidth control Distributed Internet exchanges (IXs) and data centers 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 which needs study for standardization.

Regarding the time phase of the disaster and reaction approaches to be taken, there is a general relationship between them, which is shown at the top of Table 1. Figure 1 shows the relationship with available resources shown in vertical axis. As the telecommunication infrastructure, tolerance is the very basic approach applicable to all phases. Before the disaster, the network infrastructure should prepare for the coming disaster by implementing redundancy and relevant control mechanisms. Once the disaster occurs, the infrastructure should resist the physical damage caused by the disaster. Some disasters will take some time to pass. As for traffic handling, the network just after the disaster should handle the surge of traffic with available resources, which may be less than normal operation. After the disaster, the infrastructure should again provide communication services by fixing damaged facilities, reconfiguring available facilities, and/or installing new resources which replace the original infrastructure or provide alternative communication means.

NOTE – On Figure 1, the amount of infrastructure and complementary resources and their transition pattern depend on disaster type, implemented technologies, and recovery policies.

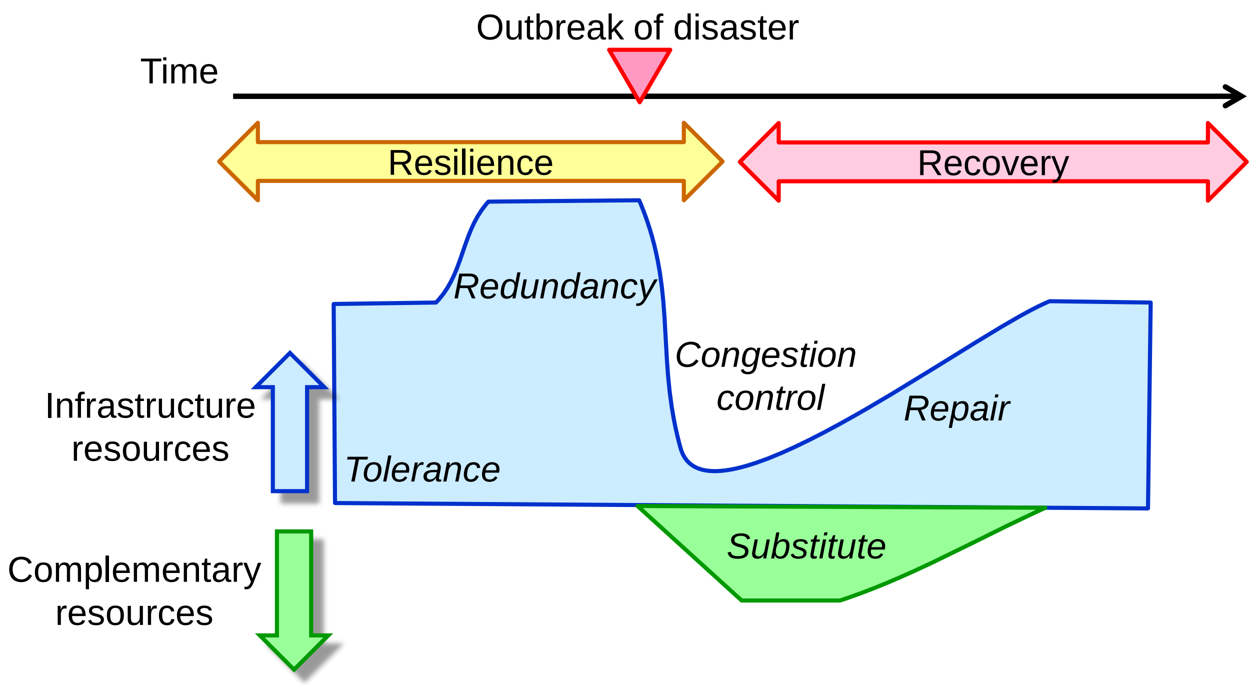

Figure 1 – Disaster phases and relevant approaches for network resilience and recovery

The following additional distinctions and observations are useful for some technologies and their use.

1) The term "public network" is used for all networks that provide services and features not only to a specific user group, but also to the general public. The term "private network" is used to describe a network which provides services and all other features only to a single customer or to a group of customers (restricted user group) and which is not available to the general public.

2) Some types of network for resilience and recovery have been designed, implemented and operated only for dedicated purposes. One example, special toll-free public phones, can be called a dedicated network. The other systems are commonly used for both usual networks and irregular networks. One of example is the Satellite mobile phone. Those can be called shared systems.

6.4 New study areas of network resilience and recovery

As shown in Table 1, there are a variety of measures and technologies for network resilience and recovery, some of which are new and need development and standards. This sub-clause introduces those new study areas in accordance with the approaches described in sub-clause 6.2.

6.4.1 Redundancy and congestion control

Just after the 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 e-mails. With regard to access to the network, Wi-Fi will be congested even if the access point is available.

The issues of design and planning of switching equipment capacity, emergency priority calls, backups system, 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

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

2) User experience improvement given unstable or intermittent network connectivity

One problem in a disaster situation 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 higher quality of user experience in use, it is important for the terminal devices to control their processes of data storage and transmission, such as online or offline, to match network status.

6.4.2 Substitute networks and repair

After a disaster, it is essential to restore affected network facilities as soon as possible. However, it may take much time to repair all facilities. Network recovery technologies are needed to recover the telecommunications infrastructure as much as possible. The 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)

When a serious disaster occurs and a key network facility such as a local switch or edge node is destroyed, its lengthy repair time will cause serious communication failure in the disaster area. Even if the facility works, the decreased capacity cannot handle the post-disaster traffic, which will propagate network congestion and thus cause more serious network-wide blackouts. To tackle this situation, a effective set of ICT resources that allows various settings and quick deployment, are prepared as a transportable package and sent to the area. The new ICT resource units substitute for the role of the lost network facilities as well as providing extra ICT resources to meet the explosive communication demands in the disaster area. Rescue-oriented ICT applications can be installed and activated on the unit. Movable-and-instantaneously-deployable ICT resources are expected to work together with the remaining ICT facilities including user terminals. Physical appearances, reference resource components, their configuration procedures, and pre-installed application profiles are candidates for standardization.

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

Underground optical cables have high survival rates after disasters. Using this surviving underground optical cable, a portable burst-mode optical amplifier would be effective in enabling the swift re-connection of surviving fibre links to optical fibre networks or provide a means of by-passing damaged network infrastructure.

3) Delay Tolerant Networking (DTN)

Currently, most user terminals such as Smartphone or tablet devices are equipped with Wi-Fi, and it is possible to implement DTN over these devices' Wi-Fi functionality can achieve a network where each mobile terminal is able to send delay tolerant messages to other terminal in multi-hop fashion.

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

Wireless technology, which does not depend on physical wired networks alone, plays an important role in planning resilient data communications networks. Alternative means of communication must be prepared against disasters by updating mobile phone networks so they do not become congested, are resistant to damage, and can adapt to local requirements upon deployment. Local private wireless networks based on the decentralized mesh architecture are effective in avoiding complete network blackout caused by some partial damage in the network.

7 Requirements on new study areas for network resilience and recovery

New study areas are identified in clause 6. Relevant requirements specific to the study areas are given in the Annexes to this Document and in a separate document [b-FG-MDRU].

8. Requirements on maintaining telecommunication network building and facilities

In practice, maintaining the buildings and facilities in a physically-stable state is one of the common approaches to prevent or mitigate infrastructure damages. The specific requirements on this subject are described below.

NOTE – Stringency of the requirements are indicated by (required) or (recommended).

8.1 Requirements on telecommunications network facilities

(1) The important regional centres are placed in a decentralized manner (recommended).

NOTE – The important regional centre refers to the building that hosts the equipment whose breakage or failure, or whose breakage itself, seriously damages the telecommunication functions of the region.

(2) The important regional centre is backed up by other regional centres (recommended).

(3) For switching networks, two important regional centres are connected to other regional centres via a detour route when the original connection route is broken (recommended).

(4) The transmission facilities that connect the important regional centres are physically multiple (i.e., multi-routed) (recommended).

(5) The important fibre access facilities are installed as two routes by loop design (recommended).

(6) The transmission facilities for telecommunications business to connect the switching equipment are multi-routed; provided, however, that this does not apply to cases where multi-routing is difficult due to the topography, or where comparable measures are taken to deal with the failure of transmission facilities more effectively (required).

(7) The transmission facilities for telecommunications business to connect more than three switching equipment by loop design are installed with additional transmission facilities crossing the area serviced by the transmission facilities concerned (recommended).

(8) The telecommunication lines that connect the important regional centres are laid in different transmission facilities (recommended).

(9) Spare telecommunications lines are prepared for the important transmission facilities; provided, however, that this does not apply to cases where other means are used to ensure connection (required).

(10) The important transmission facilities are arranged with the function for telecommunications lines to be switched to spare telecommunications lines immediately when necessary (recommended).

(11) The important transmission facilities and telecommunications lines are provided with a function to monitor the operation, detect failures immediately, and report the status of operation (required).

(12) The important transmission facilities are provided with a function to monitor the overall operation in integrated manner (recommended).

(13) The switching equipment for telecommunications business is provided with a function to monitor the traffic, detect unusual traffic congestion immediately, and report the status of congestion; provided, however, that this does not apply to cases where there is a mechanism that controls the traffic so that it does not concentrate at the same switching equipment at the same time (required).

(14) The switching equipment for telecommunications business is provided with a function to monitor the overall traffic in integrated manner (recommended).

(15) The switching equipment for telecommunications business is provided with a function to isolate the traffic or comparable function; provided, however, that this does not apply to cases where there is a mechanism that controls the traffic so that it does not concentrate at the same switching equipment at the same time (required).

(15) The switching equipment for telecommunications business is provided with a function to notify users of unusual traffic congestion; provided, however, that this does not apply to cases where there is a mechanism to control the traffic so that it does not concentrate at the same switching equipment at the same time (recommended).

(16) Emergency restoration measures

(16-1) The important transmission facilities are arranged with the emergency restoration measures such as the deployment of the emergency restoration cable (required).

(16-2) During disasters, the temporary telephones or comparable functions are available via radio facilities such as satellite earth stations (recommended).

(16-3) Two party telecommunications lines are available, temporarily, by radio facilities when the transmission lines between the mobile base station and the switching station have failed (recommended).

(16-4) Temporary telecommunications lines are established by one or more movable radio base stations when the mobile base station has failed (recommended).

(16-5) Temporary mobile communications service for a large zone area established by a large zone base station or comparable measures are available when the mobile base station has failed in the area to support the important communication needed for disaster recovery (recommended).

(16-6) Temporary telecommunications lines by spare facilities are available when the communications becomes difficult due to the failure of other transmission facilities (recommended).

(17) The criteria for deploying the spare equipment and power supplies are clearly defined (required).

(18) The telecommunications facilities that manage the information used to implement the provision and/or control of telecommunications services, or authorizing the terminal equipment are installed in regionally separated areas if said facilities can cause significant communication service failures in a wide area. If the facility fails, it is desirable that another similar facility functions as its substitute (recommended).

(19) When installing multi-routed transmission facilities, one route is installed geographically as far as possible from the other routes (recommended).

8.2 Requirements on outdoor facilities

(1) For outdoor facilities installed in places where extreme wind pressures are likely to occur, the appropriate measures are taken to prevent break down due to strong wind, and the vibration caused by wind (required).

(2) For outdoor facilities, appropriate measures are taken to prevent break down by the vibration caused by earthquakes (required).

(3) For important outdoor facilities installed in the place where lightning is likely to occur, the appropriate measures are taken to prevent break down by lightning (recommended).

(4) For outdoor facilities installed in the place where fire is likely to occur, the appropriate measures are taken to prevent the occurrence of fire (recommended).

(5) For outdoor facilities installed under water, the appropriate measures are taken to prevent break down by water pressure and the facilities are waterproofed (required).

(6) Do not install important outdoor facilities in places where floods are likely to occur; provided, however, that this does not apply if there are reasons to do so and the facilities are waterproofed (required).

(7) Do not install important outdoor facilities in places where tidal waves are likely to occur; provided, however, that this does not apply if there are reasons to do so and the facilities are waterproofed (recommended).

(8) For the outdoor facilities installed in places where freezing is likely to occur, the appropriate measures are taken to prevent break down by freezing (required).

(9) For the outdoor facilities installed in the places where damage from salt-laden winds, corrosive gas, or dust is likely to occur; the appropriate measures are taken to prevent break down by those causes (required).

(10) For the outdoor facilities installed in the places where temperature is high or low, the facilities are to work stably under those conditions, or sudden changes in temperature (required).

(11) For the outdoor facilities installed in the places where humidity is high, the facilities are to be humidity resistant and rust protected (required).

(12) For the important outdoor facilities installed in special places such as undersea, or outer space, the facilities are to be highly reliable through the use of highly reliable parts (required).

(13) For the important outdoor facilities, the appropriate spare equipment is deployed or the comparable measures are taken (required).

(14) For the communications cables, they should be installed underground to prevent the damage due to the collapse of the building, fire, and tidal waves at the time of the disaster (recommended).

8.3 Requirements on indoor facilities

(1) For the indoor facilities, measures are to be taken to prevent falling over, movement by the earthquake which is not significant scale. The measures are also taken to prevent disconnection of facilities by the earthquake which is not significant scale. For the important indoor facilities, the measures to prevent the break down by earthquake, must consider a large-scale earthquake (required).

(2) For the important indoor facilities installed in places where lighting is likely to occur, the appropriate measures are taken to prevent break down by lightning (recommended).

(3) For the important indoor facilities, the appropriate measures are taken to prevent the occurrence of fire (recommended).

(4) The equipment of the important indoor facilities are to be redundant or comparable alternatives taken. The equipment of the important indoor facilities are switched to the spare equipment immediately when necessary (required).

(5) The important indoor facilities are provided with a function to detect failures immediately, and report the failures. Unmanned important indoor facilities are arranged to have a remote report function; provided, however, that this does not apply to cases where comparable alternatives are taken (required).

(6) The important indoor facilities are provided with a function to identify which part of the facilities has failed (recommended).

(7) The appropriate test and measurement equipment are deployed or comparable measures are taken (required).

(8) For the important indoor facilities, the appropriate spare equipment is deployed or comparable measures are taken (required).

8. 4 Requirements on surroundings and environmental aspects

(1) The places to install telecommunications facilities are determined in compliance with the disaster prevention plan of municipal government or local community and the natural disasters assumed (hazard map) (recommended).

(2) When determining the place to install the telecommunications facilities, the building constructed on the solid ground is selected; provided; however, that this does not apply if there are reasons to do so and the measures are taken to prevent unequal land subsidence (required).

(3) When determining the place to install the telecommunications facilities, the building is to resist the storm, flood, and so on; provided, however, that this does not apply if there are reasons to do so and the appropriate measures are taken to prevent break down by wind, or water (required).

(4) When determining where to install the telecommunications facilities, the building is to resist strong electromagnetic fields; provided, however, that this does not apply if there are reasons to do so and the appropriate measures are taken to prevent breaking down by electromagnetic fields such as electromagnetic shields for machine rooms (required).

(5) Placing the building that is to host the telecommunications facilities adjacent to other buildings that accommodate dangerous materials which can cause an explosion or fire is to be avoided (recommended).

(6) The building is stable enough to resistant earthquake. The building is fireproofed. The building has enough structural resistance for design floor load (required).

(7) Automatic fire alarms and fire extinguishers are to be deployed appropriately for the building and the machine room (required).

(8) The machine rooms are placed where there is least influence from external threats such as natural disasters (required).

(9) The machine rooms are to be placed where there are least influence from the flood SEE #8?; provided, however, that this does not apply if there are reasons to do so and the appropriate measures are taken such as raising the floor, installing watertight bulkheads and/or the drainage (required).]]

(10) The machine rooms are placed where there is least influence from strong electromagnetic fields; provided, however, that this does not apply if there are reasons to do so and the appropriate measures are taken such as electromagnetic shields (required).

(11) For the furniture installed in the machine room, the appropriate measures are to be taken to prevent falling and movement caused by an earthquake of regular scale (required).

(12) The machine room with important facilities are placed in isolation with doors of adequate strength (required).

(13) For the interior material used for the floor, inner walls, ceiling, appropriate measures are to be taken to prevent falling and movement caused by the earthquake which is not significant scale (required)

(14) The interior material used for the floor, inner walls, and ceiling, are to be made of flame retardant materials and/or incombustible materials (required).

(15) The appropriate measure is to be taken to prevent electrostatic buildup or electrostatic discharge in the machine room (recommended).

(16) If the power supply is installed in the machine room, appropriate measures are to be taken to prevent failure by electromagnetic fields if needed (required).

(17) For through-holes in the machine room, the appropriate measures are to be taken to prevent the spread of fire (recommended).

Annex A

Requirements for improvement of network recovery with a portable burst-mode EDFA

(This annex forms an integral part of this Document.)

A.1 Introduction

This Annex describes ways to improve network recovery by quickly and effectively utilizing the temporary optical fibre network in conjunction with surviving facilities in the disaster area. Underground optical cables have high survival rates after a disaster. Using this surviving underground optical cable, the portable optical amplifier compensates the propagation loss to enable the swift re-connection of surviving fibre links to optical fibre networks or provide a means of by-passing damaged network infrastructure. The requirements for the portable burst-mode erbium-doped optical fibre amplifier (EDFA) are studied.

A.2 Background and Concept

A.2.1 Background

Underground optical cables have high survival rates after disasters. By allowing the use of this surviving underground optical cable, the portable burst-mode optical amplifier is effective in enabling the swift re-connection of surviving fibre links to optical fibre networks or providing a means of by-passing damaged network infrastructure.

A.2.2 Concept

The optical amplifier for emergency restoration is required to be small and light enough that maintenance personnel can carry it by foot or bicycle when a vehicle cannot be used. The severe environment of the disaster area requires that it be waterproof, shock-proof, and battery driven.

Normal EDFAs distort the wave pattern of the amplified signal if the input light signal is bursty. A burst mode EDFA can prevent distortion regardless of signal burstiness, and so is suitable for emergency restoration in the disaster area with unstable communication traffic.

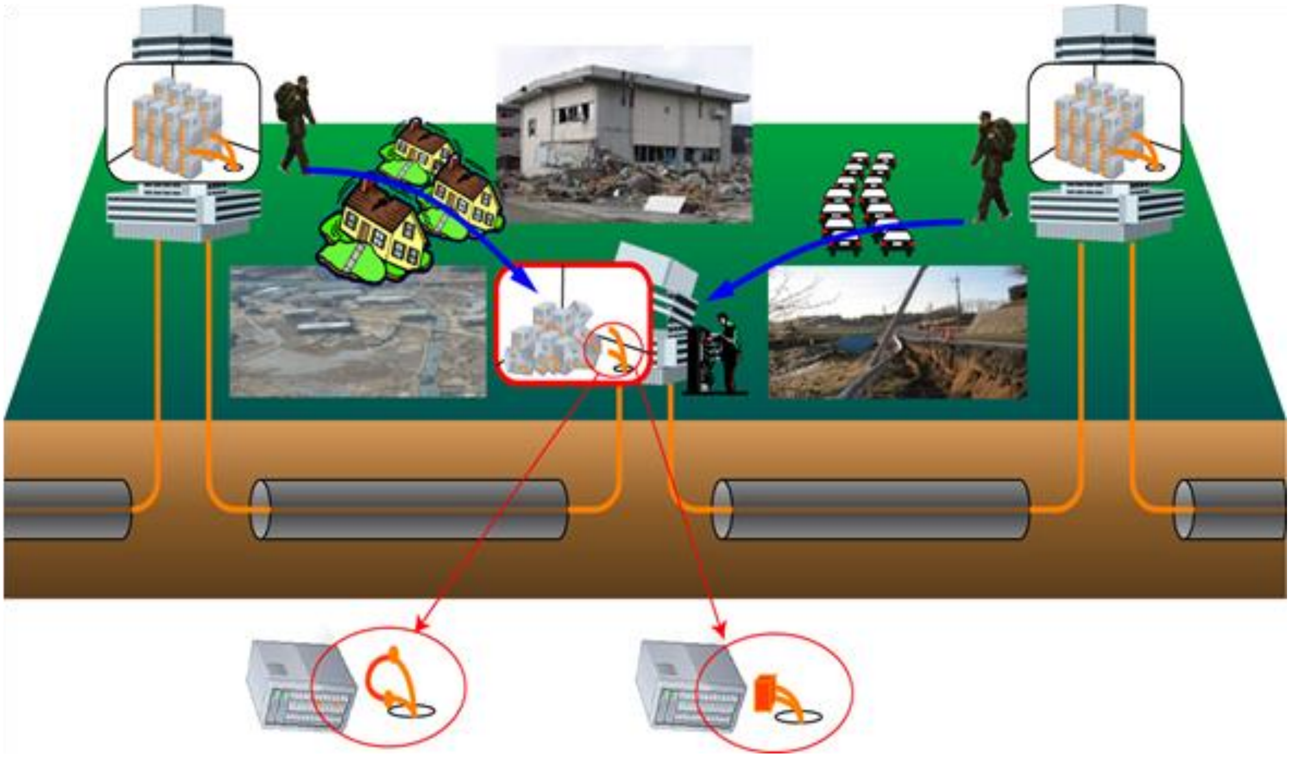

Figure A.1 – A portable burst-mode erbium-doped optical fibre amplifier (EDFA)

A.3 Usage scenarios

A maintenance person carries the portable burst-mode optical amplifier to the destroyed exchange office, break point, or bypass point by foot or bicycle. By using this amplifier to connect a pair of surviving underground optical fibres, a part of the physical network is temporarily restored and connected to an undamaged exchange.

A.4 General requirements

A.4.1 Burst mode optical fibre amplifier

Amplifier keeps the wave pattern undistorted for any kind of input light signal given the unstable communication traffic.

A.5 Operation requirements in the disaster area

A.5.1 Small and light

It is required to be small and light enough that a maintenance person can carry it by foot or bicycle when a vehicle cannot be used.

A.5.2 Waterproof and shock-proof

The severe environment of the disaster area requires that it be waterproof and shock-proof.

A.5.3 Battery driven

The severe environment of the disaster area requires it to be battery driven, and offer continuous operation during battery change. It is also recommended to use easily obtainable batteries such as smartphone's batteries.

A.6 Amplifier requirements

6.1. Burst mode optical fibre amplifier

Amplifier keeps the output wave pattern undistorted for any kind of input light signal given the unstable communication traffic.

6.2. Reconfigurable for the purpose of compensating 2nd order chromatic dispersion

6.3. Duplex amplification

A.7 Other open issues

7.1. Feeding by the remote excitation method

7.2. Operation in a destroyed exchange office

7.2.1. Identification method of fibers to be connected

7.2.2. Confirmation method of amplifier gain

7.2.3. Other necessary tools

Annex B

Requirements for improvement of network resilience and recovery with local wireless mesh network based on de-centralized mesh architecture

(This annex forms an integral part of this Document.)

B.1 Introduction

This Annex describes ways to improve network resilience and recovery by a wireless communication technology that connects radio relay nodes into a mesh where each relay node operates independently (even if it is not connected to the backbone network).To quickly restore the information and communication network stopped by a disaster and to restart the information exchange for "safety confirmation" and "emergency responses", the wireless mesh network based on a decentralized mesh architecture is effective. This wireless mesh network is also effective to realize a local network that can fully utilize the available radio resources. The requirements for the local wireless mesh network are studied.

B.2 Background and Concept

B.2.1 Background

Wireless technology, which does not depend on physical wired networks alone, plays an important role in planning resilient data communications networks. Alternative means of communication must be prepared to counter a disaster in addition to mobile phone networks so they do not become congested, are robust against damage, and can be deployed while adapting to local requirements. The local wireless network based on the decentralized mesh architecture is effective in avoiding entire network blackout caused by some partial damage in the network.

B.2.2 Concept

This mesh network consists of fixed and portable mesh relay nodes placed on the top of buildings or ground. They also provide wireless LAN access areas around the nodes. WiMAX links are also introduced in order to wirelessly link the separated mesh nodes. This mesh network has a significantly enhanced disaster-resilience due to its distributed database and distributed application technologies. This mesh network assumes that local governments allow them to run by themselves in normal situation. In addition, it also employs connections to on-vehicle satellite earth stations and mobile repeaters to be provided by vehicles and program-controlled small unmanned aircraft. These earth stations and mobile repeaters are expected to rapidly establish communication and monitoring links to isolated areas until the infrastructure is recovered.

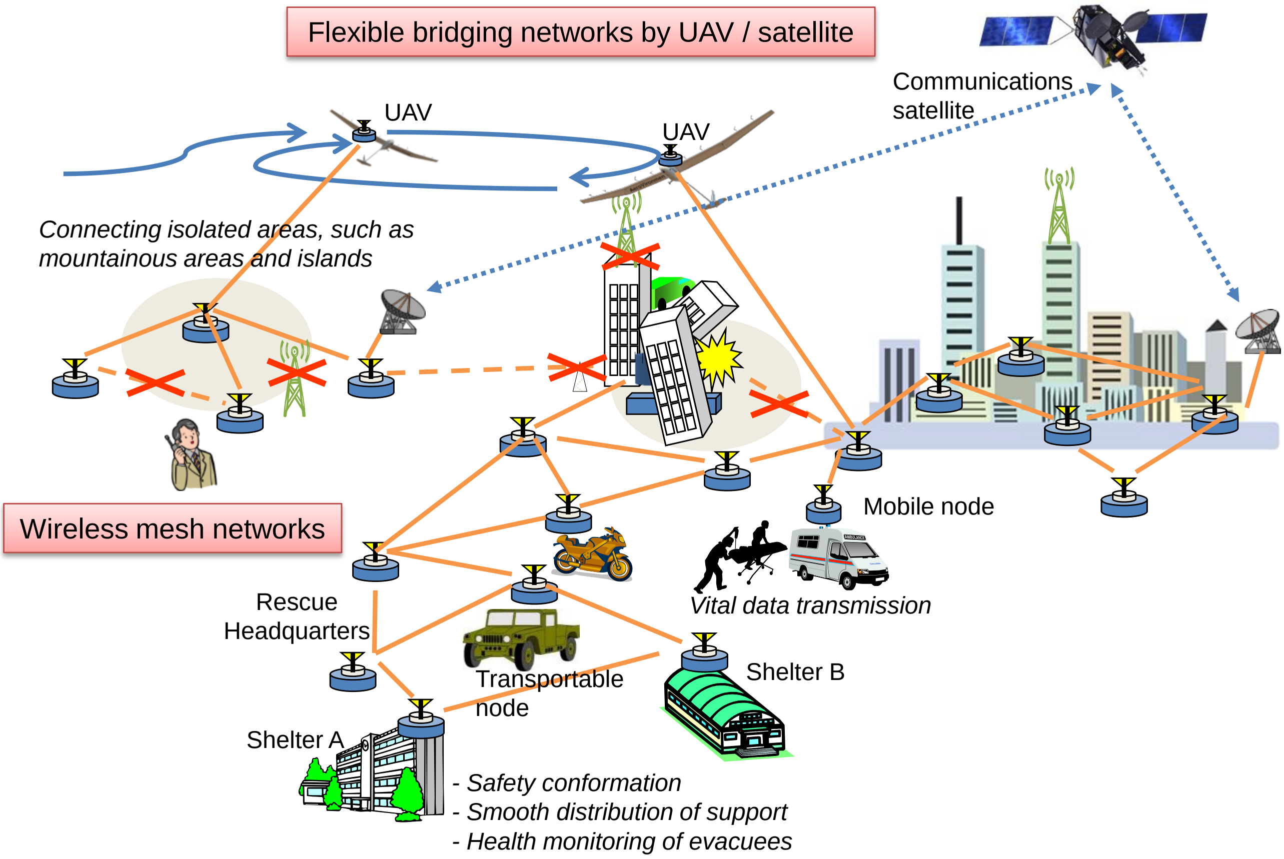

Figure B.1 – Local wireless mesh network based on de-centralized mesh architecture

B.3 Usage scenarios

Several applications are needed to handle the various emergency situations possible. Example applications are information sharing among groups, and safety confirmation to individuals. Some healthcare applications will also be implemented to help the elderly or the sick residents after a disaster. The nearest evacuation point and the user's current position are displayed on a map on the smartphone of the user after accessing a wireless LAN. In addition, one's state and position input via a smartphone are delivered to other radio base stations as safety confirmation. As a result, a family can confirm the latest safety information even the members are in separate places. Children and the elderly who may not have a smartphone can register their safety information just by touching their chip card to an outdoor signage type radio relay node(with IC card reader) and can view the safety information of others on the signage.

B.4 General requirements

B.4.1 Wireless mesh network

This mesh network consists of fixed and portable mesh relay nodes placed on the top of buildings or the ground. They also provide wireless LAN access areas around the nodes.

B.5 Network requirements

3) Continue communication automatically using the surviving and operating facilities when parts of the network are damaged or congested

4) Use the self-sustaining mesh architecture to support mobility, address resolution, and multicast even if the Internet connection is lost

5) Quick rerouting with distributed database of operation status of nearby radio relay nodes in each radio relay node

6) Quick restoration by the temporary communication network in areas where the communications infrastructure is damaged

B.6 Portable radio relay node

7) Provide antenna to connect to adjacent radio relay node(s), an antenna (WiFi etc.) for wireless LAN to connect nearby users, solar panel and/or a battery. Provide wheels to permit hand carry etc.

8) B.5.3 Quick restoration of the temporary communication network in an isolated area

B.7 Aerial radio relay node

9) Quick restoration of the temporary communication network in an isolated area by unmanned aerial vehicle (UAV) with small radio set, hand carry, runway-free, and computer controlled autonomous flight.

B.8 Fully-automatic portable satellite earth station

10) Connect to the wide area network via a satellite line with antenna by a fully-automatic portable earth station with antenna feed, antenna footstool with a chest, and easy assembly without tools.

B.9 Satellite earth station on vehicle

11) Connect to the wide area network via a satellite line by an earth station on a vehicle that also holds antenna, an integrated power amplifier, and automatic satellite tracker; high-speed transmission is to be possible by using a multi-beam satellite antenna .

B.10 Service platform requirements in the local private network

12) Continue communication and applications for “safety confirmation” and “emergency responses” at least in even if connection to the backbone network and the Internet is lost

13) Continue service even if the main server is stopped, using a synchronized and distributed database in each radio base station

14) Deliver alerts on daily use services via local access network

15) Pass refuge instructions, safety confirmation, and relief requests after the disaster

B.11 Other open issues

16) Guarantee of power supply, battery life

17) Positioning the radio base stations with consideration of topology.

Appendix I
Information for considering detailed requirements

(This appendix does not form an integral part of this Document.)

This appendix introduces additional information for considering detailed requirements of disaster relief brought by The Pacific Islands Telecommunications Association (PITA).

The PITA is a non-profit organisation formed to represent the interests of small island nations in the Pacific Region in the field of telecommunications. The objective of the association is to improve, promote, enhance, facilitate and provide telecommunications services within Member and Associate Member Countries. PITA Members are telecommunication entities in Melanesia, Micronesia, Polynesia, Australia and New Zealand. Associate Members are suppliers of telecommunication equipment and services. Partner agencies are regional and international organisations with vested interest in telecommunications and its development. Telecom Regulatory body from government has a special membership category.

Further information about PITA is available below:

http://www.pita.org.fj/

I.1 Background

Many Pacific Island Telcos have inbuilt redundancy and physical diversity that continuously provides contingency capability on International links. Many of those with two or more satellite antennas would still be severely impaired if one antenna or their international voice gateway failed. Many Pacific Islands only have one antenna for all international services. Disasters can also be in isolated regions where it is difficult to restore unprotected local network e.g., 2009 Tsunami that devastated Samoa.

I.2 Concepts and Rationale

- to save lives and minimise losses
- small Islands and most members not able to afford disaster & emergency communication systems
- Dimension to provide for public
    - 3 phases:
        - Survey/triage teams with handhelds
        - response team with mini setups
        - public systems

I.3 Emergency/Disaster Recovery Requirements

A fully integrated service restoration solution that:

- Addresses both domestic and international services
- Covers loss of terrestrial and / or satellite backbone services
- Supports essential services (Telephony & IP) during an emergency
- Offers service capacities of up to 2 Mbit/s plus per site
- Is scalable to support a large number of sites if needed
- Offers optional emergency access network for government & agencies
- Employs open standard technology / transparent network architecture
- Uses standard building blocks for transmission, switching and customer access to interface with or replace existing network infrastructure
- May be activated automatically or with a minimal level of expertise
- Can achieve critical service restoration
    1. LEVEL 1 RESTORATION: Almost immediately using equipment/expertise within country – basic phone/internet connectivity for lifeline services
    2. LEVEL 2 RESTORATION: Within 24 hours – landline/mobile and high speed internet for lifeline service/vital communications/limited media release
    3. LEVEL 3 RESTORATION: Within 48 hours – full communications capability
- Is Cost effective to implement

Disaster Scenarios

1. Catastrophic failure of main communications – satellite antenna
2. Catastrophic failure of main communications and international gateway switch
3. Catastrophic failure of communications to a region within Island e.g. tsunami to remote area

Restoration Levels

1. LEVEL 1 RESTORATION: Almost immediately using equipment/expertise within country – basic phone/internet connectivity for lifeline services
2. LEVEL 2 RESTORATION: Within 24 hours – landline/mobile and high speed internet for lifeline service/vital communications/limited media release
3. LEVEL 3 RESTORATION: Within 48 hours – full communications capability

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