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SERIES L: ENVIRONMENT AND ICTS, CLIMATE  
CHANGE, E-WASTE, ENERGY EFFICIENCY;  
CONSTRUCTION, INSTALLATION AND PROTECTION  
OF CABLES AND OTHER ELEMENTS OF OUTSIDE  
PLANT

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## **Framework of disaster management for network resilience and recovery**

ITU-T L-series Recommendations – Supplement 35

ITU-T

## ITU-T L-SERIES RECOMMENDATIONS

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# Supplement 35 to ITU-T L-series Recommendations

## Framework of disaster management for network resilience and recovery

### Summary

Network resilience, the robustness of the network infrastructure, should ensure the continuity of telecommunication services against any damage caused by disasters. 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.

ITU-T L-series Supplement 35 provides a framework of disaster management for improving network resilience and recovery (NRR) by reviewing high-level objectives of NRR against disasters, identifying several approaches (i.e., redundancy, congestion control, repair, substitution and robustness) that meet the objectives, and clarifying the approaches with regard to the effective time frame (i.e., phase) for disaster recovery. Based on the identified approaches with effective disaster recovery phases, information about relevant technologies, including those already available and those emerging, is also provided.

### History

| Edition | Recommendation    | Approval   | Study Group | Unique ID*                                                                |
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### Keywords

Congestion control, disaster management, disaster relief, network resilience and recovery, redundancy, repair, robustness, substitute, tolerance.

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

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

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# Supplement 35 to ITU-T L-series Recommendations

## Framework of disaster management for network resilience and recovery

### 1 Scope

This Supplement provides a framework of disaster management for improving network resilience and recovery (NRR) by reviewing high-level objectives of NRR against disasters, identifying several approaches (i.e., redundancy, congestion control, repair, substitution and robustness) that meet the objectives and clarifying the approaches with regard to the effective time frame (i.e., phase) along with disaster.

Regarding outside plant facilities such as cables, poles and manholes, [ITU-T L.390/L.92] considers disaster management for them and describes countermeasures for natural disasters such as earthquakes, strong winds and floods.

### 2 References

- [ITU-T G.694.1] Recommendation ITU-T G.694.1 (2012), *Spectral grids for WDM applications: DWDM frequency grid*.
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- [ITU-T L.392] Recommendation ITU-T L.392 (2016), *Disaster management for improving network resilience and recovery with movable and deployable information and communication technology (ICT) resource units*.
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- [ITU-R M.1854-1] Recommendation ITU-R M.1854-1 (2012), *Use of mobile-satellite service in disaster response and relief*.
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- [IEC 60794-3-70] IEC 60794-3-70:2016), *Optical fibre cables – Part 3-70: Outdoor cables – Family specification for outdoor optical fibre cables for rapid/multiple deployment*.

## 3 Definitions

### 3.1 Terms defined elsewhere

This Supplement uses the following term defined elsewhere:

**3.1.1 movable and deployable ICT resource unit (MDRU)** [ITU-T L.392]: A collection of information and communication resources that are packaged as an identifiable physical unit, movable by any of multiple transportation modalities, and which act as a stand-in (substitute) for damaged network facilities, and reproduce and extend their functionalities.

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 Supplement

This Supplement defines the following terms:

**3.2.1 delay-tolerant networking (DTN)**: A technology that stores information when it is connected to a source (e.g., a mobile terminal), and delivers the information to a destination when it finds the end-user.

NOTE – A DTN is a technology that provides communications with and among extreme and performance-challenged environments where continuous end-to-end connectivity cannot be assumed. The addressed challenges include: large delay for transmissions resulting from either physical link properties or extended periods of network partitioning, routing capable of operating efficiently with frequently disconnected, pre-scheduled or opportunistic link availability, high per-link error rates making end-to-end reliability difficult, heterogeneous underlying network technologies [including networks not based on the Internet protocol (IP)], and application structure and security mechanisms capable of limiting network access prior to data transit in an environment where round-trip times may be very large. Refer to [b-DTNRG] and [b-Farrell].

**3.2.2 local wireless mesh network**: A local-area network that consists of multiple relay-capable nodes connected with each other via multiple wireless links (i.e., in mesh topology), governed by specialized control for discovering communication paths from among available nodes and wireless links and which provides information relay services to user terminals [typically wireless fidelity (Wi-Fi) terminals].

NOTE – The relay nodes are assumed to be placed on top of buildings or on the ground with good visibility in preparation for disasters, installed where needed or transported 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 service level of a given communication network after a disaster.

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

## 4 Abbreviations and acronyms

This Supplement uses the following abbreviations and acronyms:

|      |                                      |
|------|--------------------------------------|
| BPSK | Binary Phase Shift Keying            |
| DTN  | Delay-Tolerant Networking            |
| DR   | Disaster Relief                      |
| EDFA | Erbium-Doped Optical Fibre Amplifier |

|       |                                                 |
|-------|-------------------------------------------------|
| HVAC  | Heating, Ventilation, and Air Conditioning      |
| IC    | Integrated Circuit                              |
| ICT   | Information and Communication Technology        |
| IP    | Internet Protocol                               |
| LAN   | Local Area Network                              |
| MDRU  | Movable and Deployable ICT Resource Unit        |
| NE    | Network Element                                 |
| NEBS  | Network Equipment – Building System             |
| NMS   | Network Management System                       |
| NRR   | Network Resilience and Recovery                 |
| OSC   | Optical Supervisory Channel                     |
| QAM   | Quadrature Amplitude Modulation                 |
| SMS   | Short Message Service                           |
| UAV   | Unmanned Aerial Vehicle                         |
| Wi-Fi | Wireless Fidelity                               |
| WiMAX | Worldwide interoperability for Microwave Access |

## 5 Conventions

None.

## 6 Introduction

Information and communication technologies (ICTs) 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 network tolerance against damage and enable quick restoration to cope with large-scale communication congestion and the loss of network function by the destruction or 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 users with an adequate grade of services after a disaster.

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

The requirements for disaster relief (DR) services and applications are described in [b-FG-DR] and [b-ITU-T E.108].

## 7 Overview of network resilience and recovery

### 7.1 General objectives of network resilience and recovery

The telecommunications infrastructure including, both wireline 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 of daily life and economic activities.



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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 business, 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 brigades. 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 a disaster, voice calls over the telephone and mobile phone networks are mostly used for safety confirmation and information exchange in the disaster area. Voice calls are easy for anyone to make when 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.

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, the infrastructure should be recovered by employing every possible means.

From the viewpoint of NRR, these 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.

## **7.2 Approaches to achieving the objectives**

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

- Redundancy: for equipment and functions that are likely to be damaged, extra capacity or capabilities are prepared in advance and activated as needed or used in normal operation.
- Congestion control: the rapid increase in the number of voice calls in response to a disaster causes congestion by overloading the switching equipment. To detect this congestion and control the traffic, some functions are expected to be installed. Mitigating or circumventing the congestion is also a valid solution.
- Repair: systems for switching equipment and transmission facilities, multiple route of transmission facilities, spare equipment and resources necessary for temporary service restoration (emergency restoration construction, installation of temporary telecommunication lines, electric power supply) are prepared to repair damaged equipment and facilities.
- Substitution: damaged equipment and facilities are replaced by newly deployed multi-purpose facilities or surviving resources originally installed for a different purpose.

Robustness by maintaining buildings and facilities in a physically stable state is another common approach to prevent or mitigate infrastructure damage in practice. The following are the steps for consideration and the guidelines to each step that are widely employed in terms of robustness.

- a) Location: the location of telecommunications buildings should be stable and at a low enough risk of disaster susceptibility to maintain the network buildings in normal operation without experiencing serious service breakdown. Probability of severe earthquakes, storms, floods