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

---

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

Focus Group Technical Report

ITU-T

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

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

Summary

This Document introduces an approach to improve network resiliency against disasters and to assist network recovery after disasters by packaging movable and instantaneously-deployable resources on information and communication technologies (ICT) as one unit.

The movable and deployable ICT resource unit (MDRU) is a collection of ICT 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. The MDRU also brings extra ICT resources to meet explosive communication demands at the disaster area.

This Document shows key factors for examining various usage scenarios of MDRUs and introduces one promising use of the MDRU as a local node. Focusing on this use, this Document describes design principles for the MDRU and its requirements, which will impact subsequent standardization works.

Table of Contents

ITU-T FG-DR&NRR Deliverable

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

1. Scope

This Document shows key factors for examining various usage scenarios of movable and deployable ICT resource units (MDRUs) and introduces one promising use of the MDRU as a local node. Focusing on this use, this Document describes design principles for the MDRU and its requirements, which will impact subsequent standardization works.

One of the purposes of this Document is to identify MDRU-related issues for facilitating a future, full-fledged, standardization work and by gathering them into a single Document.

2. References

None.

3. Definitions

3.1. Terms defined elsewhere

3.2. Terms defined in this Document

This Recommendation defines the following terms:

3.2.1 Movable and deployable ICT resource unit (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.

4. Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

3GPP	The third generation partnership project
AAA	Authentication, authorization, and accounting
EMC	Electro-Magnetic Compatibility
HDD	Hard disk drive
ICT	Information and communication technologies
IP-PBX	IP Private Branch eXchange

LTE	Long-term evolution
MDRU	Movable and deployable ICT resource unit
QoS	Quality of service
SSD	Solid state drive
UNI	User-network interface
VM	Virtual machine
VoIP	Voice over IP

5. Introduction

Network resiliency and recovery against disasters can be tackled with multiple approaches, which are discussed in [b-FG-NRR]. The primary approach is to strengthen networks in operation as much as possible and minimize potential damages. This approach includes redundancy, backups, and switch-over of the system or part of it. Another approach is to prepare transportable replacements that can stand-in for the operational networks. When a disaster occurs and part of the network is destroyed, these prepared resources will be deployed immediately into the damaged area. The new units will replicate the role of the lost network facilities as a substitute. This approach should work well when a severe disaster occurs and network facilities, protected by the primary approach, are destroyed or rendered impossible to fix quickly. These two approaches complement with each other.

In the second approach, movable-and-instantaneously-deployable ICT resources are expected to work together with the remaining ICT facilities, until local networks in the damaged area are recovered.

The movable and deployable ICT resource unit (MDRU) is expected to bring two benefits. 1) Quick recovery of the capabilities lost to realize the communications demanded for disaster relief activities in the area. 2) Quick deployment of extra ICT resources will increase network capacity locally and thus minimize the impact of the explosion in communication demand that is usually carried by facilities outside the devastated area. This traffic spike can cause wide area failures of the network. As a consequence, movable-and-instantaneously-deployable ICT resources will enhance network resiliency and recovery.

To promote the above approach, as the movable and deployable ICT resource unit, MDRU, should be identified and specified. It should be physically movable by the widest possible range of transportation modes, deployable and made operational in the minimum time, capable for replicating the lost network facilities, and compatible with the remaining facilities. To make the MDRU meet the requirements above, standard specifications are essential. The physical appearance of the MDRU to meet the transportation requirements, implementation guidelines and operational instructions to minimizing the time to make the MDRU ready, underlying universal ICT resources and service-creating capabilities to be built-in, and the way to connect with the core network and survived terminals are all standard matters. Realizing compatible and easy-to-operate resource units allows the units to be treated as shared resources that can be used

efficiently against multiple and different disasters. Even when provided by other operators, organizations, or foreign countries, units that follow the common specification can be made fully operational as if they were the operator's own systems.

6. Usage scenarios of MDRUs

Depending on disaster type and which parts of the network facilities survive the damage, there are multiple scenarios for which different types of MDRUs, in terms of size and functionality, are foreseen. In this clause, the factors underlying usage scenarios for MDRUs are described first. Then, a promising MDRU application and an implementation example are introduced.

ITU-T technical report [b-ITU-TR] includes a number of case studies of the performance of public telecommunications systems in recent disasters along with a review of the activities concerned with the use of telecommunications for disaster mitigation.

6.1. Factors underlying MDRU usage scenarios

The following factors should be taken into account when studying the usage scenarios of MDRUs:

- Disaster types, severity and timing – Disasters can be characterized from the viewpoints of spatial extent and timing. First, the size and uniformity of the damage vary with the disaster type. Some disasters, such as tsunamis, tend to create areas of large uniform damage. Other types, such as earthquakes, can yield relatively-light-damaged areas in which facilities may survive sandwiched between heavy-damaged areas. The type of disaster also changes the temporal pattern of damage. The timing viewpoint includes whether the disaster has sufficiently long lead times to allow prediction and thus preparation, and whether the end of the disaster can be reliably predicted and thus allowing the start of recovery procedures at full power. Hurricanes and typhoons can be predicted in advance, while earthquakes are hard to predict and secondary earthquakes are common;
- Expected damages and survived network facilities – As a consequence of the disaster type and severity, specific network facilities are destroyed, while other facilities may remain operational with high probability. Each network facility and portion should be examined to discover whether they are prone to being damaged or not according to the type of disaster. Even in case of a tsunami, for example, some facilities such as optical fibers may remain undamaged because of their water-shielding. An earthquake damages on-the-ground facilities rather than under-the-ground ones. Resource units should be designed to replicate the greatest possible range of facilities so as to cover eventualities as many as possible. The network facilities and portions to be considered are links to core networks, local data centers and telephone switches, access networks, residential facilities, and terminals;

  NOTE – It is obvious that availability of electric power supply or local backup battery lifetimes should be considered when estimating remaining facilities. If backup batteries are working, the real problems may occur not just after the disaster but several hours after the disaster when the batteries are exhausted.

NOTE – Backups for public mobile networks (e.g., mobile switch center, base stations, and antennas) and their relationships with newly deployed MDRUs should be studied further.

- Conditions and possible behavior of users – whether users are safe or not, which actions they can take, and which actions they are trying to take, should be considered to estimate required communication services and the amount of the demands;
- Service types to be considered – It may be hard to provide all services at the same time or to recover all services at the same pace after a severe disaster. Priority may need to be introduced so that critical services are recovered immediately in given resource limitations;
- Types of ICT resources to be deployed – local tangible physical objects such as the integrated resource unit packaged as a container or a box, temporary antennas for satellite communications, or remote access to cloud services are ICT candidates to be deployed.

6.2. Usage scenario of an MDRU as a local node simulation

The MDRU, which simulates a local telephone switch and an edge node for Internet access, can be used to replicate a local network that has been destroyed. Figure 1 shows an example of an MDRU use case.

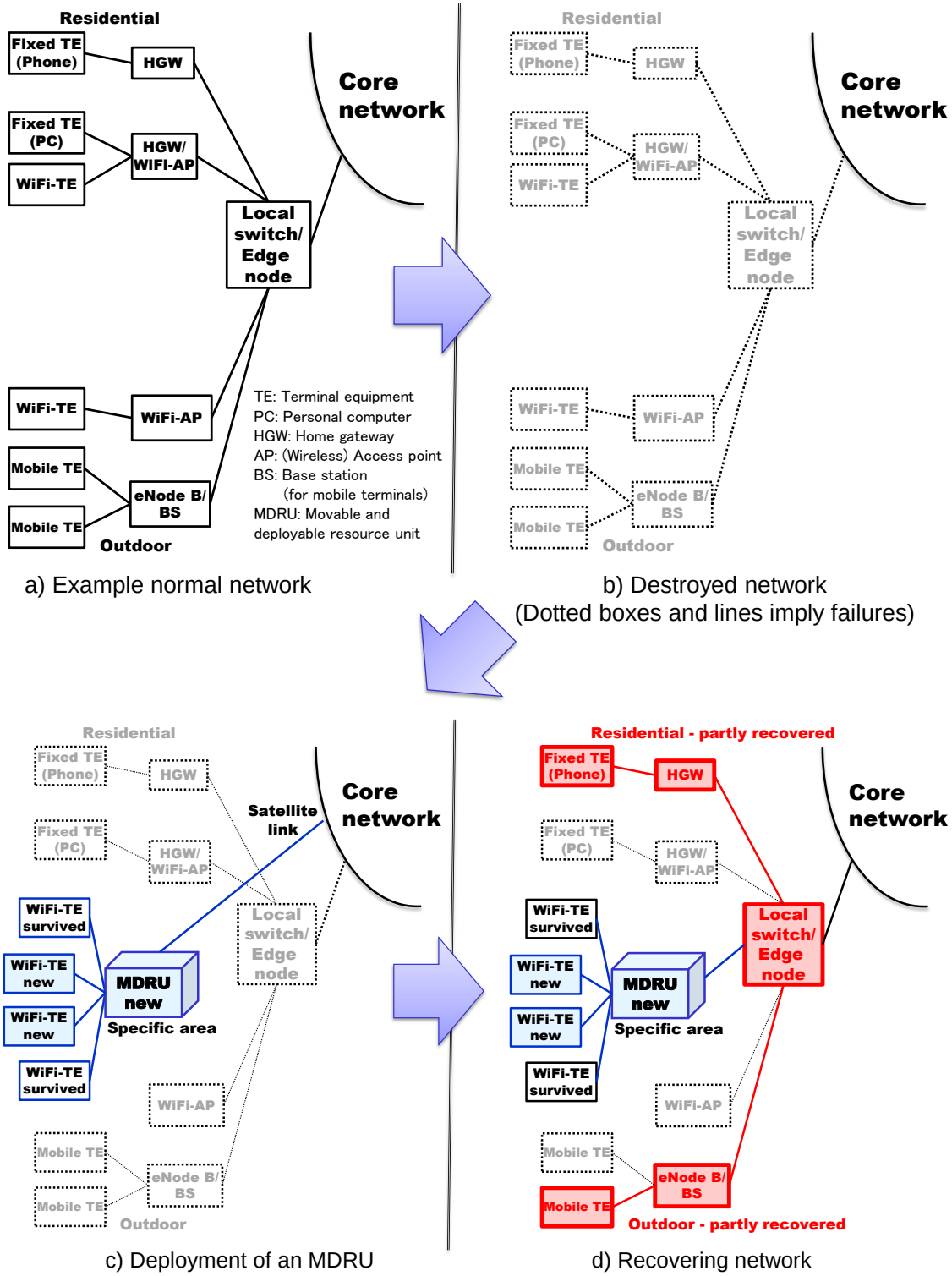

Figure 1 – Example of MDRU use for network recovery

If a tsunami attacks a fibered area, local data centers and telephone switch offices may be totally destroyed while the fibers remain available. Some of the residential facilities, such as broadband routers (shown as home gateways in the figure) and smartphones (shown as mobile terminal equipment in the figure), may also survive. Just after the disaster and several days thereafter, local voice communications and distribution of local community information are the most crucial services to be provided. In such a case, the MDRU that replicates the local data center servers and telephone switches is most effective for recovering local communications in the devastated area.

Figure 1 shows an MDRU use case and a recovery scenario of the destroyed local network. The scenario assumes that both residential and outdoor services are damaged due to a severe disaster as is shown in b) of Figure 1. To provide urgent communication services over a particular area, an MDRU is deployed near the area, and works as a local communication node (shown in c) of Figure 1). The MDRU supports WiFi terminals both surviving and recent introductions. The MDRU provides a satellite link to access the core network. Long distance fiber is alternative to access the core network. Users in the affected area download telephony applications from the MDRU and communicate with each other. It should be noted that access via satellite or a long distance fiber to the core network allows the MDRU to bypass the congesting local switch even if available or recovered, and thus offload the traffic from the switch.

The destroyed network is recovered step-by-step as is shown in d) of Figure 1. Once the public local node becomes available, the MDRU will switch from the satellite link to the broadband access to the node and thus support higher-speed services and more terminals.

It should be noted that the figure shows MDRU position from the overall network perspective. Terminals and access networks are modeled in an abstract way, and the actual access network technologies used, terminal capabilities, and business relationships might alter the perspective. From the MDRU's viewpoint, whether and how to support specific equipment and relevant access networks needs further study.

The following pictures in from Figure 2 to Figure 6 give an example of MDRU implementation. Figure 7 shows another MDRU implementation which is installed in a van-type vehicle.

Figure 2 – Transporting an MDRU to a remote site

Figure 3 – Deploying and configuring the MDRU at the remote site

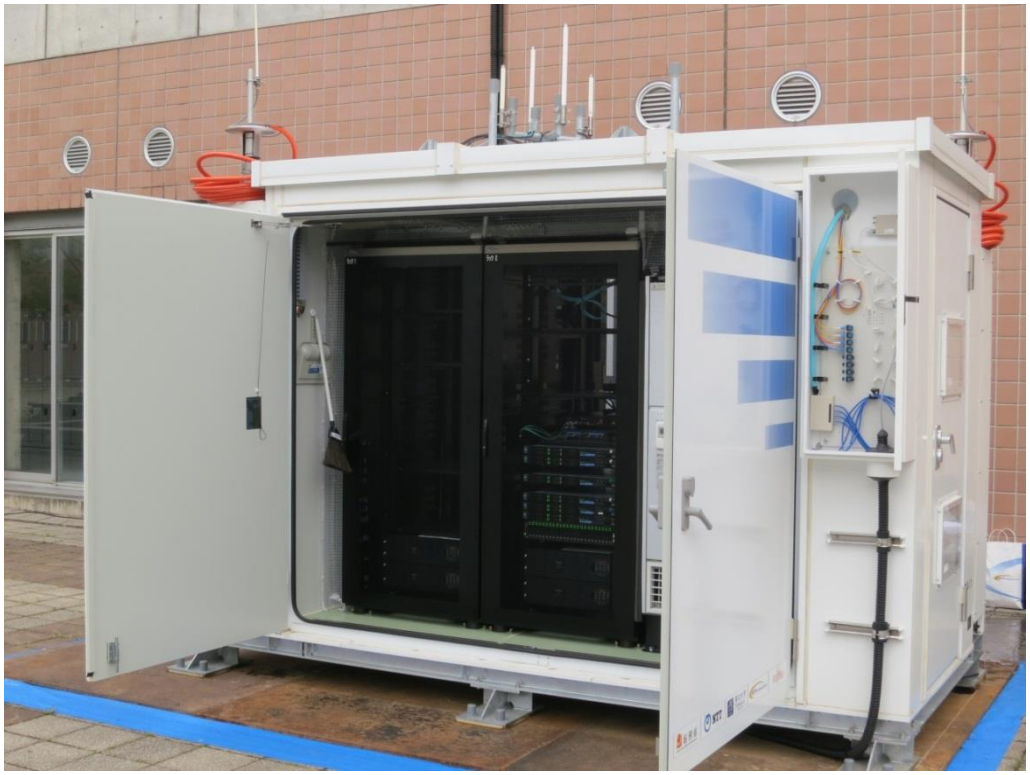

Figure 4 – Opening the front panel of an MDRU

Figure 5 – System configuration and startup of an MDRU

Figure 6 – Components inside the MDRU

Figure 7 – A van-type vehicle equipped with an MDRU

7. Design principles for MDRUs

The following principles are to be recognized when MDRUs are designed and related standards are discussed.

Disasters create a network situation where the resources are unknown, heterogeneous, and quite limited. To cope with such a situation, MDRUs should be designed as follows:

- Provide bare minimum connectivity by essential-part standardization;
- Achieve fluidity/mobility of node functionality to compensate for function-rich network nodes, which need a very long time to recover;
- Offer easy, rapid and automated configuration to shorten the time to service delivery;
- Be adaptable and dynamic for control and operation to maximize the use of limited available resources and their usage restrictions;
- Support security and privacy to restore original complex ICT environment as much as possible.

8. General requirements on MDRUs

Assuming that the initial version of this Document focuses on the container type of MDRUs that simulates data center servers and local office switches, this clause describes the top-level requirements to be met for making the MDRU common and widely used.

NOTE – Other MDRU types, such as a van-type vehicle, needs further study.

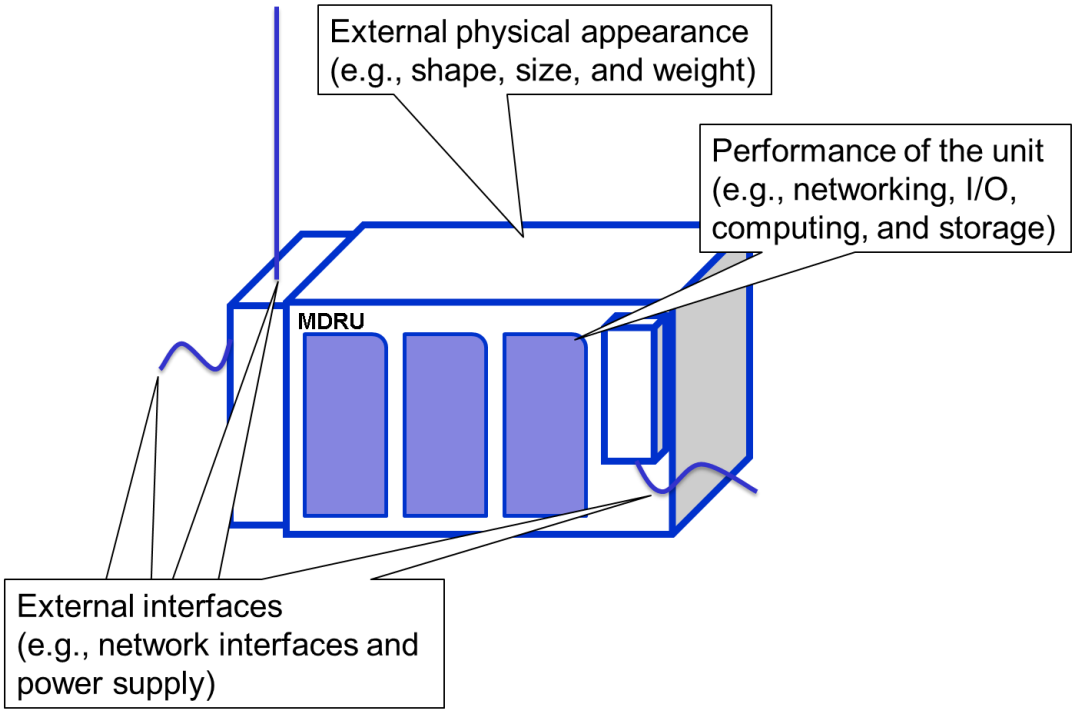

Figure 8 – General requirements on the MDRU

8.1. External physical appearance

The most fundamental requirement for the MDRU is its ability to be conveyed by ordinary transportation. To meet this requirement, the basic physical appearance should be specified.

[REQUIREMENT] The MDRU is required to comply with physical appearance standards as follows.

Basic physical parameters:

- Shape, size, and weight

NOTE – Long antennas hinder transportation. They should be separated into small pieces and reconstructed when installed. The extendible antenna is another solution to easy transportation.

When carried,

- Tolerance against transportation stress (e.g., degree of tilt and shock loads)
- Capabilities that remain operational even when carried

NOTE – To reduce system setup time, some capabilities should remain in the hot state even when the unit is being transported.

After installed,

- Electric power to be supplied or battery capacity if it is equipped with the unit,,
- Electro-Magnetic Compatibility (EMC) requirements to be met,
- Tolerance with respect to temperature and humidity, and
- Conditions in operation such as indoor or outdoor.

8.2. External interfaces

To connect with network facilities toward the core network and to accommodate surviving access networks and terminals, interfaces to support the two should be specified.

[REQUIREMENT] The MDRU is required to support specified external interfaces to connect with network facilities towards the core network and to accommodate surviving access networks and terminals. The specification should cover physical to logical interfaces on each layer.

NOTE – As for physical implementation, radio and fixed cable interfaces should be considered.

8.3. External logical appearances

It is crucial to mobilize sufficient ICT resources (provided by the MDRUs) and sufficient service capabilities over the resources to satisfy the devastated area’s requirements. To treat multiple MDRUs in the same manner without concern for machine-specific or manufacturer-specific settings, parameters associated with the MDRU should be the same.

[REQUIREMENT] The MDRU is required to express its logical appearance, which should characterize the fundamental capabilities of the MDRU, its quantitative capacity, and related performance. Standard specifications should provide a set (or a limited number of sets) of reference parameters and target values.

The MDRU reference parameters should, at least, characterize the following fundamental capabilities:

- Supported input and output interfaces (in terms of physical medium type, their speed, and the number of ports);
- Networking (with regard to address space capacity for dynamic allocation, registration, routing and switching throughput, and the number of end terminals supported);
- Computing capacity (usually indicated in the number of the reference processers);
- Storage (the size of available memory on board and on hard disk drive (HDD) or Solid State Drive (SSD)).

8.4. Preferred setting of MDRU

To encourage the introduction of MDRUs into particular disaster scenarios or damaged area, some typical settings of the capabilities and performances of the MDRU may be specified as useful references.

The following are initial considerations for those reference settings.

- Standalone or building block type
  NOTE – A building block type MDRU assumes the use in combination with other units. They interact with each other and provide higher performance in total.
- Super light type
- Switching-intensive, interface-rich, processor-intensive, or memory-rich type
- Ultra power saving type
- High- or low- temperature tolerant type
- Types targeted for rural or urban areas

9. Service-provisioning and network-operation requirements

Following the top-level requirements described in Clause 8, the next level requirements refer to the service-specific aspects and the network operation aspects.

9.1. Service-specific requirements provided for the users

Depending on the type of disaster and requirements in the devastated area, particular services will be targets for recovery.

9.1.1. Telephony and related services

The real-time communication service, which includes voice and video telephony, reflects the existence and activity of the communicator. The service is considered essential in reassuring people that their family, relatives, and friends are safe and sound.

The service is also useful for supporting the assured and stable work environment necessary for rescue operations.

[REQUIREMENT] The MDRU is required to support the real-time communication service. The followings are included in the service:

- Ordinary voice calls;
- Complementary services such as multi-party calls, text messaging, presence, and voice mail;
- Access to and download of the application that provides the service above.

[REQUIREMENT] In support of the above services, the MDRU is required to support the followings capabilities:

- Identification of terminals and/or users (i.e., numbering, naming, and addressing);
  NOTE – In some case where the MDRU is to be operated without any interaction with public networks, the original numbers associated with the subscribing operator may not be available. Alternative identification, authentication, and authorization schemes should be considered.
- Registration of terminals and/or users;
  NOTE – If simpler operation is required, authentication, authorization and accounting for terminals and/or users may not be necessary. Logging of use may compensate the simple operation.
- Connection/session setup, release, and management;
  NOTE – The connection/session includes calls between one terminal in the damaged area and one in an undamaged area. Traversing networks and gateways involved in the calls should be considered. The networks include the network established by the MDRU and other public undamaged networks beyond the MDRU's control. To locate and operate the gateways properly is another issue for network planning. The consideration should cover both incoming and outgoing calls to/from the damaged area.
  NOTE – In the case of a large-scale disaster, multiple MDRUs may be installed, each of them supports a particular area independently. Some of the MDRUs may become interconnected or disconnected. Some of them may be connected to the core network or disconnected. Depending on the disaster and resultant damages, the interconnections may be intermittent. Scenarios and required capabilities need further study.
- Congestion avoidance and prioritized call handling;
- Adequate security and privacy.

One example implementation would be to operate the MDRU as an IP-PBX, which tentatively accommodates smartphone users via the VoIP application. From the terminals outside the disaster area, the IP-PBX is identified as a dedicated number and the terminals under the MDRU control are identified with the dedicated number as a prefix. The terminals directly accommodated by the IP-PBX are reachable by local numbers, while they are reached by two-step dialing from outside the disaster area.

9.1.2. Data center services

If network facilities involving Internet access are destroyed, all Internet services will be stopped in a certain area. To cope with this situation, the MDRU is expected to offer alternative Internet access by providing temporary communication channels (e.g., via satellite). If the temporary channel is limited or impossible, it is also expected that the MDRU should work as an independent local data center and provide Internet-type services by itself for local users. The following are tentative requirements in support of this scenario.

[REQUIREMENT] The MDRU is required to provide alternative routes for Internet access to handle cases where original Internet access has been dropped.

[REQUIREMENT] The MDRU is required to provide a virtual machine (VM) and web applications running on the VM.

[REQUIREMENT] The MDRU is required to support web-based information services and related database management by itself even if Internet access is not available,

[REQUIREMENT] The MDRU is recommended to support migration of the local web–based services and related database management to the Internet service when the Internet access becomes available.

9.1.3. Services for early warning and disaster relief

The FG-DR&NRR document on early warning and disaster relief systems [b-FG-DR] describes 1) alarm services for imminent disasters as early warnings and 2) services to support people in the devastated area as disaster relief. Further investigation is necessary to support these identified services by the MDRU.

Example services to be studied are:

- Information distribution from authority to ordinary citizens in the damaged area (One-to-many multicasting or broadcasting);
- Directory of afflicted people in the damaged area: instead of collecting papers and using message boards, database creation about people in the area is the very first task to be done. The task includes user ID allocation, profile registration and maintenance.
- Local information sharing inside the damaged area (Information upload and retrieval, or event notification service with/without subscription);
- Information publication from the damaged area to undamaged areas;
- Other information services.

9.2. Network-operation requirements

The following are the potential requirements expected by the MDRU operators.

9.2.1. Agile deployment and installation through all processes and operations

[REQUIREMENT] The MDRU is required to be deployed and installed in an agile manner. The requirement should cover all processes of operations:

- Time reduction in planning phase: Planning the use of MDRUs and their preparation including procurement should be shortened. Reference manuals for MDRU preparation may be useful;
- Time reduction for system configuration phase: Schemes and technologies should be investigated that divide the conventional interrelated configuration processes into independent ones and thus allow parallel processing to reduce configuration time. This may involve simple process examination and re-arrangement. It also includes separating the interrelated processes, which are to be treated in a sequential manner, into independent ones by resource abstraction technologies;
- System configuration in transport phase: It is recommended that MDRUs should be configurable before the system is deployed and installed in the target area, even while it is being transported. The configuration process should be re-organized so as to minimize the processes to be done after installation at the damaged area. To improve system stability for in-transport processing, more robust devices such as solid state drives (SSDs) should be considered rather than hard disk drives (HDDs);
- Mobility/fluidity of applications: To reduce the application installation time and continue the service with minimum interruption, cloud-computing live migration over the MDRU resources should be investigated. It should be noted that this is valid only when the MDRU is connected to the core network and the cloud service is available through the core network.

9.2.2. Local switch and access server replication

[REQUIREMENT] The MDRU is required to replicate the functionalities of main node functions, such as telephony switches, access servers to the Internet, and ICT servers.

[REQUIREMENT] The MDRU is required to provide intensive ICT resources; these will be needed to meet the explosive demands raised by post-disaster communications.

[REQUIREMENT] The MDRU is required to operate as a user facility from the public commercial network viewpoint and to be connected to the public commercial networks via their UNI interface. This provides the MDRU with stronger connectivity without regard to operator-specific restrictions and thus enables quick replication. The UNI connection is also favorable for the public networks to secure the network.

[REQUIREMENT] The MDRU is required to work in a standalone fashion, and so must not mandate any connection to the public network while providing local services by itself.

[REQUIREMENT] The MDRU is also required to work with the functionalities in the core networks, when they are available, in a cohesive manner.

9.2.3. Access network recovery

Recovery of access networks in the damaged area is one of the critical tasks.

[REQUIREMENT] The MDRU should make maximum use of surviving access network facilities, as available, to recover user and terminal reachability.

Remaining access and user network facilities may be used more efficiently with a slight configuration change. One example is to reconfigure surviving residential WiFi access

points so as to connect with each other and build a transient local network as a new operation mode. Several technical issues have been identified; what should be the trigger to change the operation mode of WiFi access points, how should the trigger be given, how should be the local network be created, how should packets be forwarded through the network.

9.2.4. Mobile terminal support

Thanks to advanced terminal capabilities and strong demands for the use of them for public safety including disaster recovery operations, direct communications and group communications among some LTE terminals are under consideration in 3GPP release 12, which should be completed by the end of 2014 or early 2015.

The MDRU may work well with those terminals by providing local database and information processing to offset the lack of core network connectivity. Support for those advanced mobile terminals by the MDRU is for further study.

9.2.5. High-speed transport (up to 100Gbps) over multi-mode fibers

In some disasters, fiber remains available even though termination devices are damaged. An intelligent fiber-termination device that accommodates unknown fibers, adjusts its characteristics to the fibers automatically, and provides the maximum throughput is another technical challenge. Recent digital signal processors (DSPs) applied to optical signal processing allow the fine tuning and make the adjustment possible.

9.2.6. Media processing enhancement

To make use of limited resources (such as storage and bandwidth), contents of communication sessions may be further compressed while maintaining the minimum level of meaning. Enhanced media processing, i.e., changing the codec of the same media type or changing the media type itself while maintaining the meaning of the contents can be useful.

After a disaster, normal user procedures that rely on the traditional method may be damaged or not work properly. For example, users may lose their mobile phones and thus their stored number directories; few people have memorized the numbers of their relatives. For elderly people who still rely on fixed phones, they are not reachable if the phone is lost. Voice and face recognition to eliminate the need for relying on telephone numbers may be helpful for identifying users and their messages.

Just after a disaster, network configurations become too complicated to operate in the normal way. To save time and resources, some service may be offered without precise accounting of the use. Only overall records of use may be stored for later detailed analysis. Enhanced log analysis may be necessary.

Complicated and unstable network configurations may create problems that are hard to diagnose in the normal way. It would be useful to identify what type of network information is the best indicator of abnormality. Collection and analysis of the large volume of data is another challenge in media processing domain.

The followings are the candidate areas for media processing enhancement for the MDRU:

- Media codec/type change to suit the limited resources available and to economize on their use (such as storage and transmission bandwidth);
- Voice and video recognition for user identification and communication support;
- Usage log analysis;
- Fault notification collection and their analysis for fault management.

9.2.7. New network QoS and performance criteria allowing for heterogeneous network operation

The situation where the MDRU is deployed is quite different from the situation of normal network operations. QoS and performance requirements of the so-called heterogeneous network consisting of public networks and MDRUs may be different from the normal homogeneous situation. By introducing a new set of criteria for them, the operator can run the heterogeneous network in a flexible manner.

Some QoS and performance objectives need to be maintained for the heterogeneous network, whereas some of them may be acceptable to be degraded, and some may be stricter.

9.2.8. New criteria and parameters for designing appropriate MDRUs

There can be different types of MDRUs, e.g., in terms of size. A criterion for showing the effectiveness of MDRUs may be useful. A guideline based on the new criterion is helpful to estimate the appropriate number of units and their capacities against the expected damage caused by disasters.

10. Other open issues

This clause briefly lists the issues related to MDRUs.

- Cost consideration – even against the disasters, we are unable to expend unlimited investments for the backup facilities such as MDRUs. Reasonable cost calculation methods to justify the investment are necessary.
- Life cycle consideration – Similar to other network products, the MDRU should use the latest technologies. Different from others, the MDRU may have a longer time span, which may need longer term product maintenance. Maintenance for the long-life-cycle products should be considered ranging from individual devices for repair to maintenance experts skills.

11. Security consideration

For combating natural disasters and providing the rapid services needed to offset severe disaster damage, security criteria that are different from those in normal operation may be applied. Careful consideration is necessary.

In this Document, the following descriptions are relevant to security considerations.

- The MDRU is assumed to be connected to the public network via the UNI, which provides secure connection from the public network perspective.

- The MDRU is recommended to support flexible authentication, authorization, and accounting (AAA) management, some of which allows light AAA management and quick service offering.

Bibliography

[b-Sakano-1] Sakano, T.; Fadlullah, Z.M.; Thuan Ngo; Nishiyama, H.; Nakazawa, M.; Adachi, F.; Kato, N.; Takahara, A.; Kumagai, T.; Kasahara, H.; Kurihara, S. (2013), *Disaster Resilient Networking - A New Vision based on Movable and Deployable Resource Units (MDRUs)*, IEEE Network, Vol. 27, Issue 4, August, pp. 40-46.

[b-Sakano-2] Sakano, T. ; Kotabe, S. ; Sebayashi, K. ; Komukai, T. ; Kubota, H. ; Takahara, A. (2013), *A Rapidly Restorable Phone Service to counter Catastrophic Loss of Telecommunications Facilities*, Humanitarian Technology Conference (R10-HTC), 2013 IEEE Region 10, pp. 200-205.

[b-Sakano-3] Sakano, Toshikazu ; Kootabe, Satoshi ; Sebayashi, Katsuhiro ; Komukai, Tetsuro ; Takahara, Atsushi (2013), *Improvement of Network/Service Resiliency with a Movable and Deployable ICT Resource Unit*, Signal-Image Technology & Internet-Based Systems (SITIS), pp. 883-888.

[b-ICTCar] NTT press release (18 January 2014), " ICT Car" enables communication to promptly recover after large-scale disasters. http://www.ntt.co.jp/news2014/1401e/140128a.html

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

_____