MIC
Ministry of Internal Affairs and Communications

# Efforts toward Disaster-Resilient Network

*～ Lesson learned from Great East Japan Disaster ～*

May 2013

Ministry of Internal Affairs and Communications (MIC)

Japan

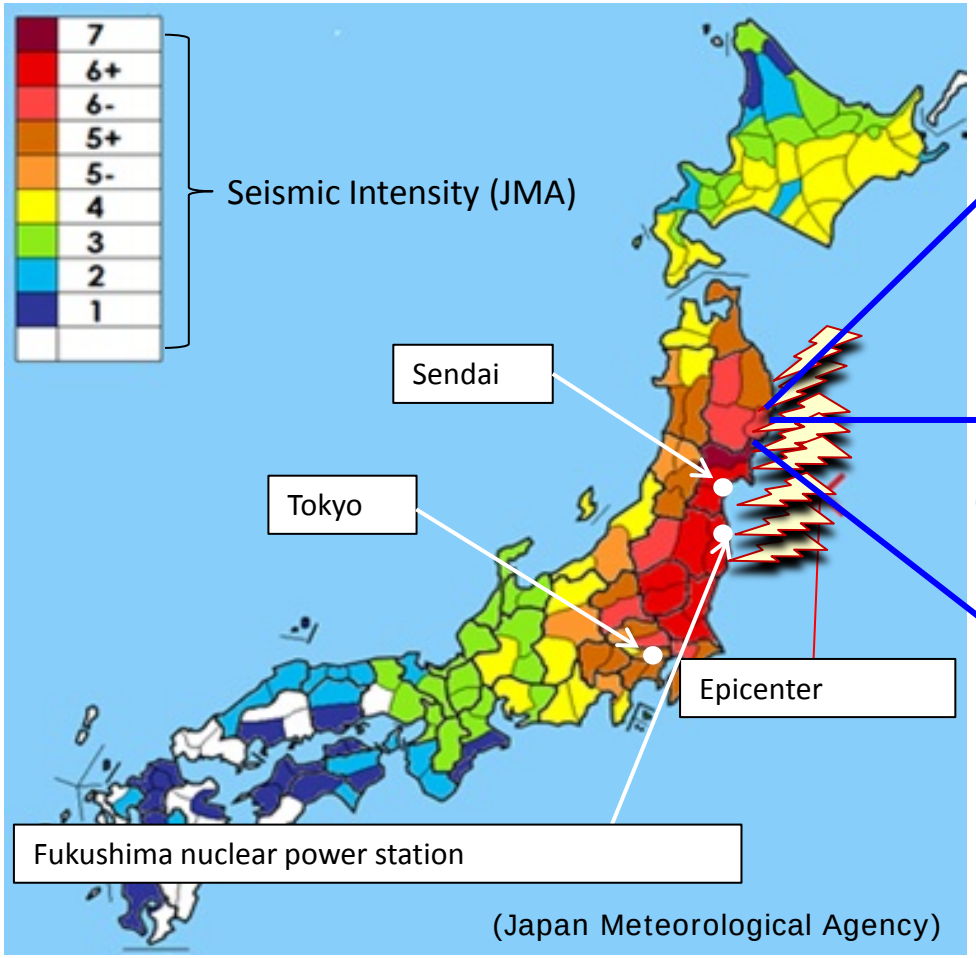
# Contents

# 1. The Great East Japan Disaster

*～ What has happened ～*

# The Great East Japan Earthquake & Tsunami

- Date and Time: 11 March 2011 (FRI) 14:46 JST (05:46 UTC)
- Magnitude: 9.0 (the largest magnitude recorded in Japan's history)
- Epicenter: N38.1, E142.9 (130km ESE off Oshika Peninsula) Depth 24km




Miyako (Iwate)
Run-up height:38m*

Otsuchi (Iwate)
Run-up height:17m*

Kesennuma (Miyagi)
Run-up height: 20m*

* The 2011 Tohoku Earthquake Tsunami Joint Survey Group (http://www.coastal.jp/)

# The 3.11 Disaster

Miyako City,
Iwate Prefecture

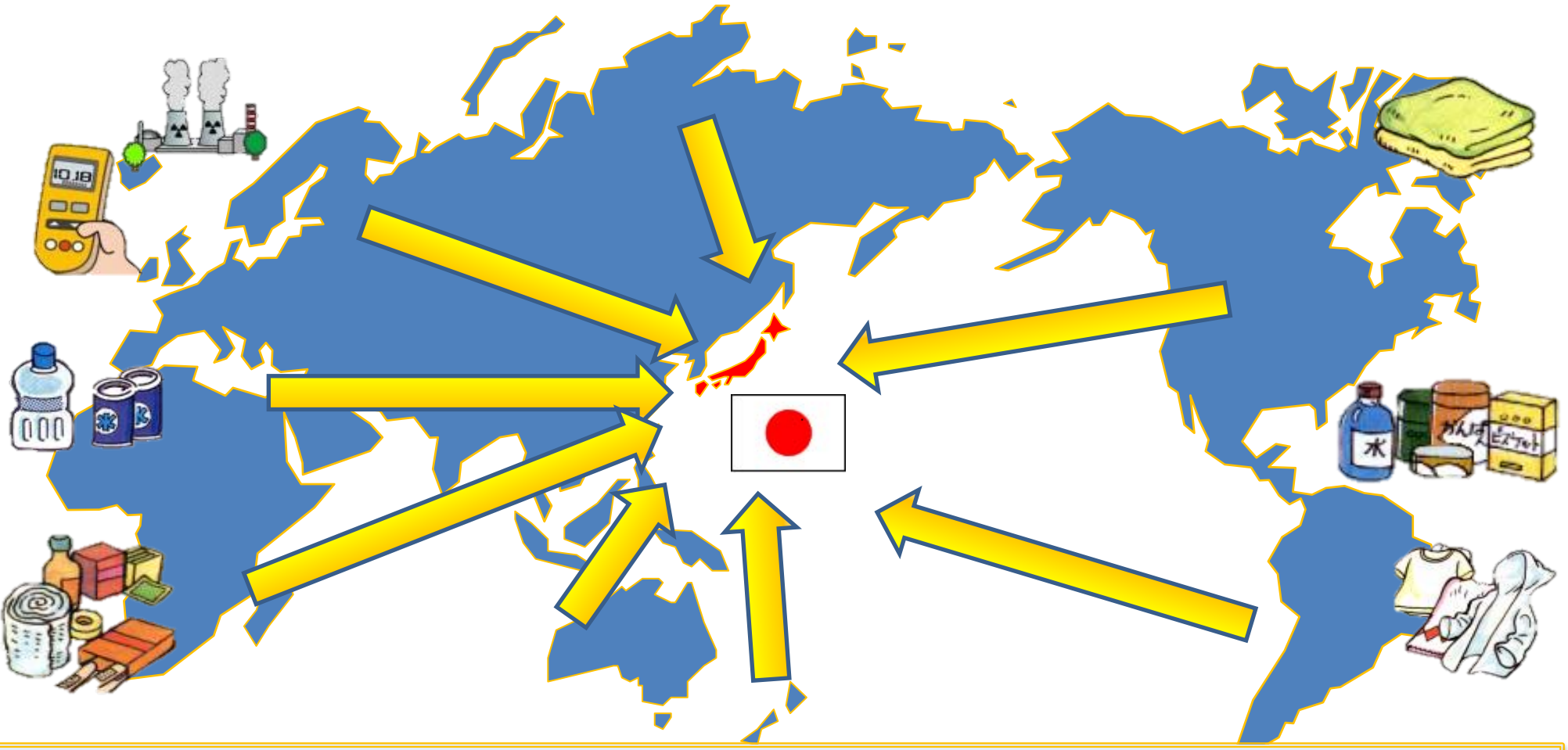
# Summary of Damages

| | Great East Japan Earthquake (2011.3.11) | Great Hanshin Earthquake (1995.1.17) |
|---|---|---|
| Magnitude | 9.0 | 7.3 |
| Dead | 15,835 | 6,434 |
| Missing | 3,669 | 3 |
| Damaged Houses | 903,220 | 639,686 |
| Damaged Fishing Boats | > 22,000 | 40 |
| Damaged Fishing Ports | > 300 | 17 |
| Damaged Farmland | 23,600ha | 214ha |

*1 As of November 7, 2011 (source: National Police Agency)

*2 As of November 24, 2011 (source: MAFF)

# Thanks for assistance from all around the world



Offers from 163 countries and regions, and 43 international organizations
Condolences expressed by **more than 180** countries and regions,
and **more than 60** international organizations

As of October 17,2011, survey by Ministry of Foreign Affairs Japan

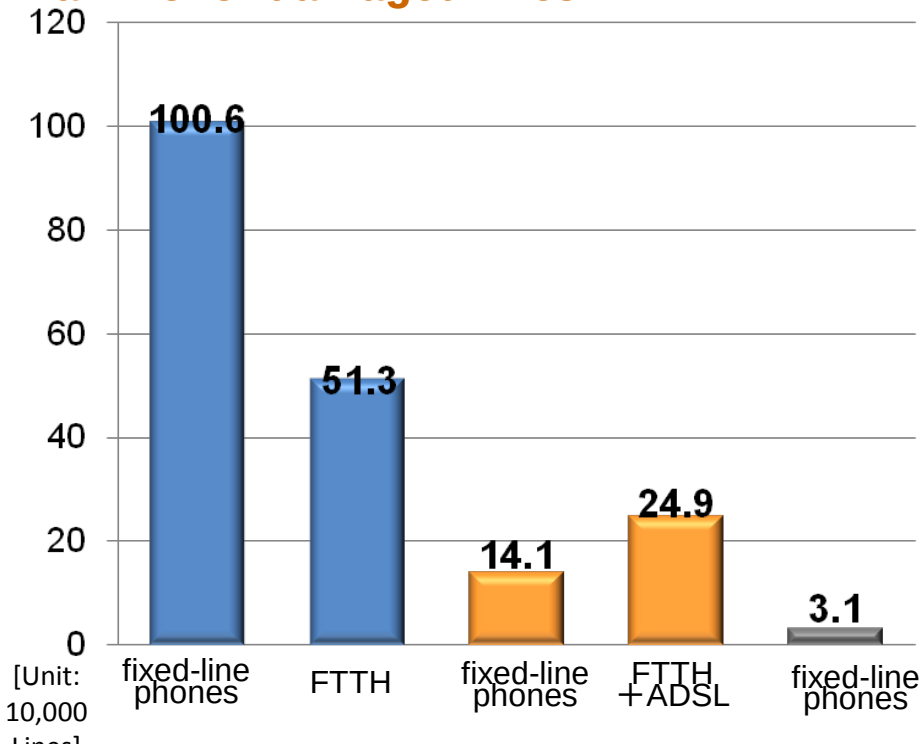
# 2. Damage to the Telecommunication Network

# Damage to Fixed Lines, Mobile Base Stations

## Fixed-line Communications

- In total, around 1.9 million communication lines were damaged.

### Max. no. of damaged lines

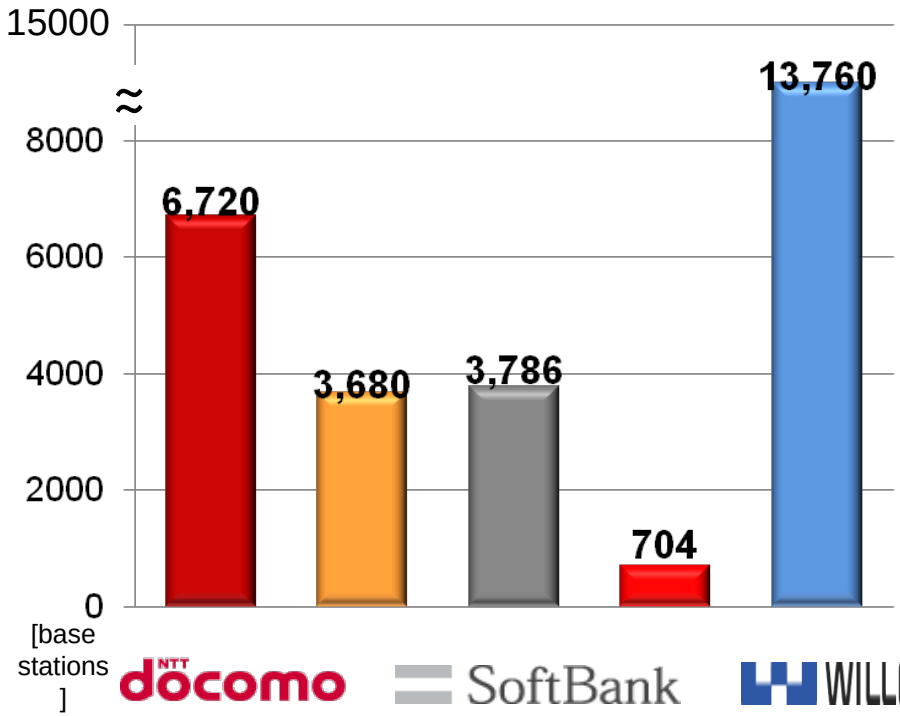



NTT東日本 KDDI SoftBank

## Mobile Communications

- In total, about 29,000 base stations were damaged.

### Max. no. of damaged base stations




docomo SoftBank WILLCOM au by KDDI EMOBILE

# Restoration of disconnected line

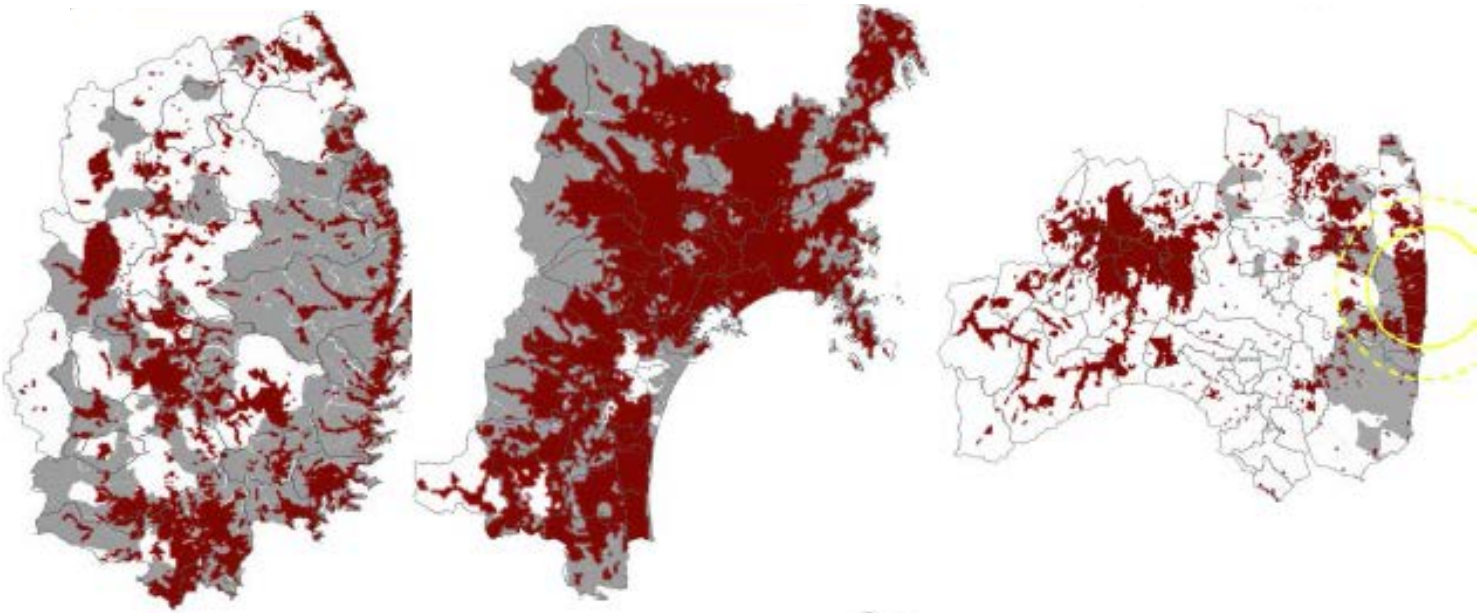
NTT East &
NTT DoCoMo

Iwate Pref.

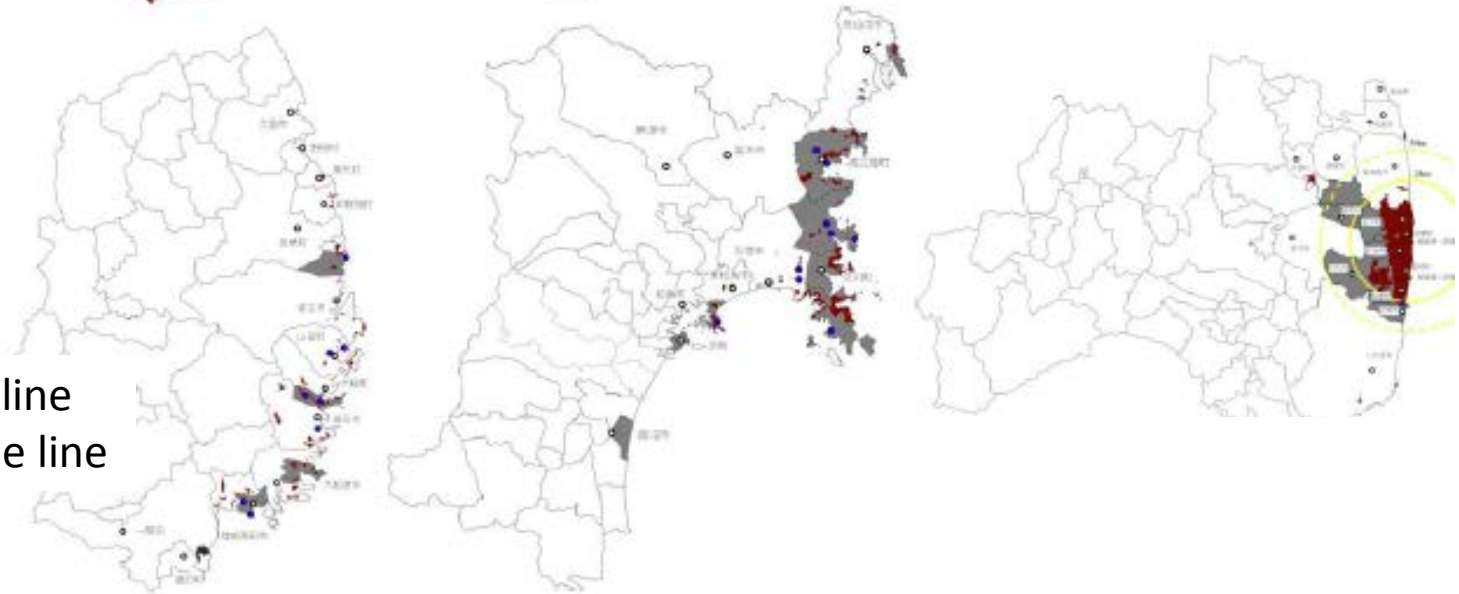
Miyagi Pref.

Fukusima Pref.

March 13, 2013



April 11, 2013



Disconnected Fixed line
Disconnected Mobile line

# Locations of Damage to Mobile Networks

Base stations collapsed or backup batteries ran out

Backup generators ran out of fuel because of long power outages

NTT central office (housing building)

NTT central office, customer building, etc. (relay building)

Transmission line relay station

Area A

Base station

Communication cable

RNC

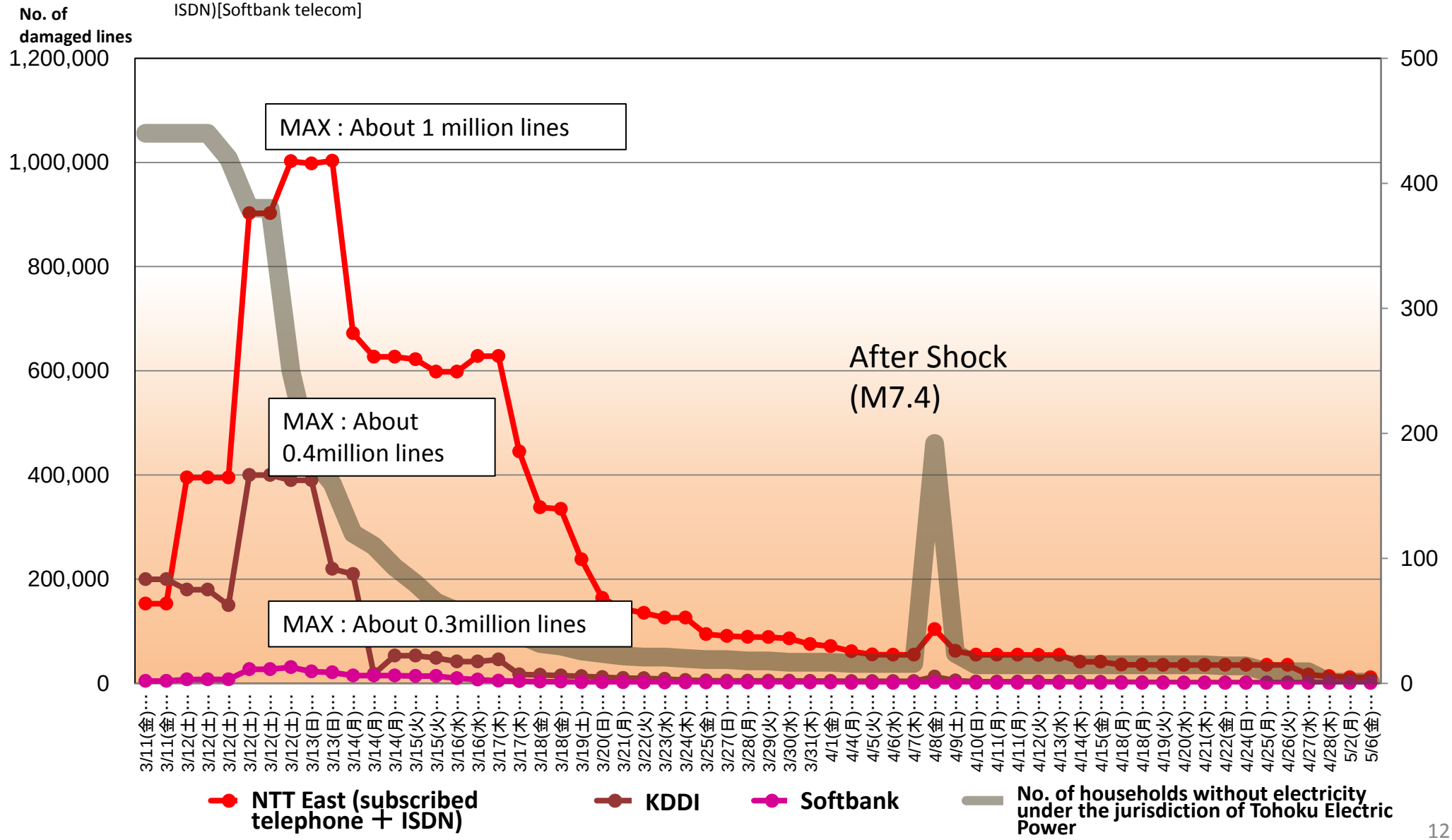
Trunk exchange

Area B

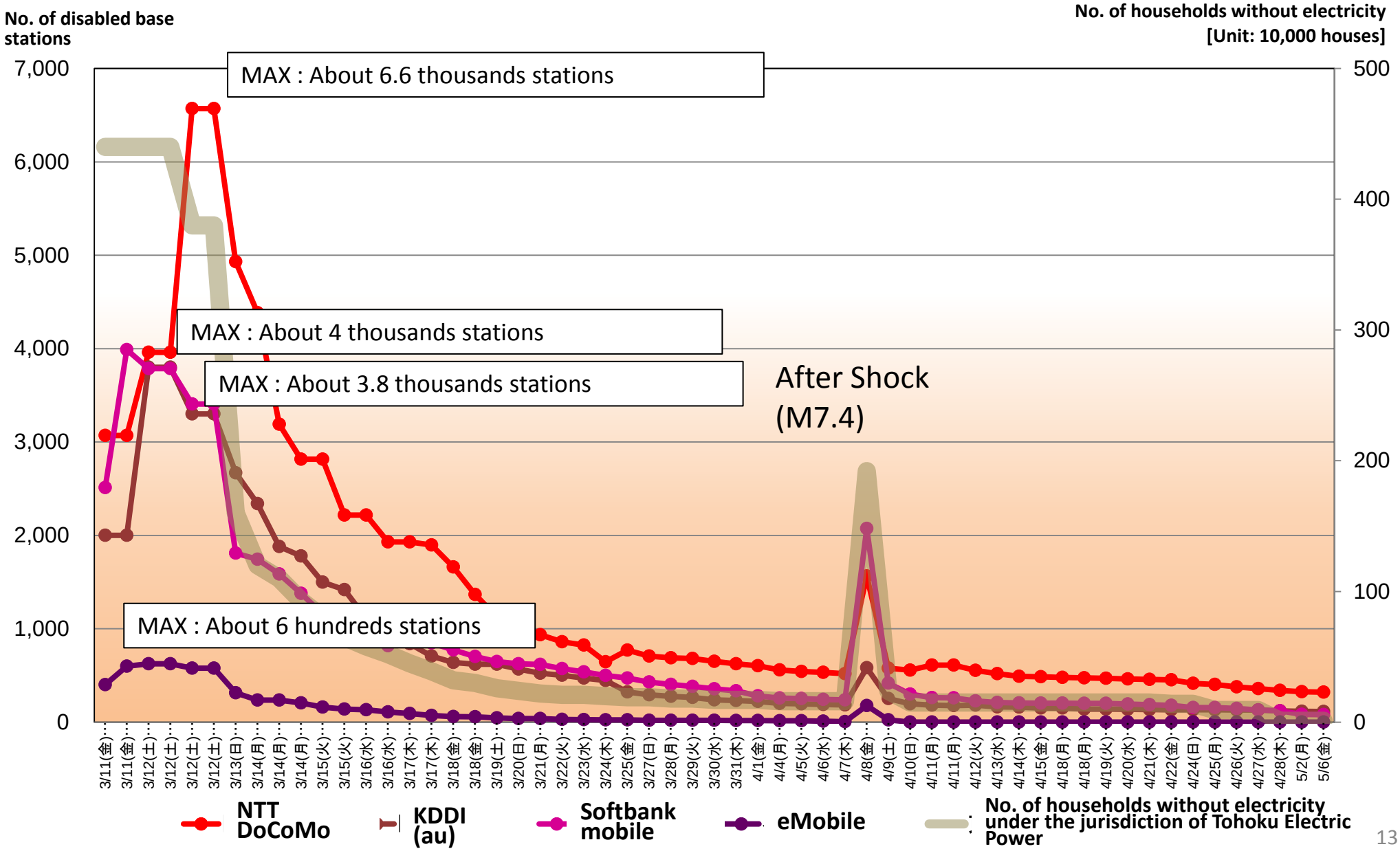
Cables cut off or network duct destroyed

# Trend of disconnected fixed line after the disaster

※ This graph is made by MIC on its own accord based on reports from telecommunication carriers and shows the number of fixed telephones (subscribed telephone＋ISDN)[NTT East ], the number of fixed telephones(subscribed telephone＋ISDN)・FTTH・ADSL[KDDI] and the number of fixed telephones(subscribed telephone＋ISDN)[Softbank telecom]



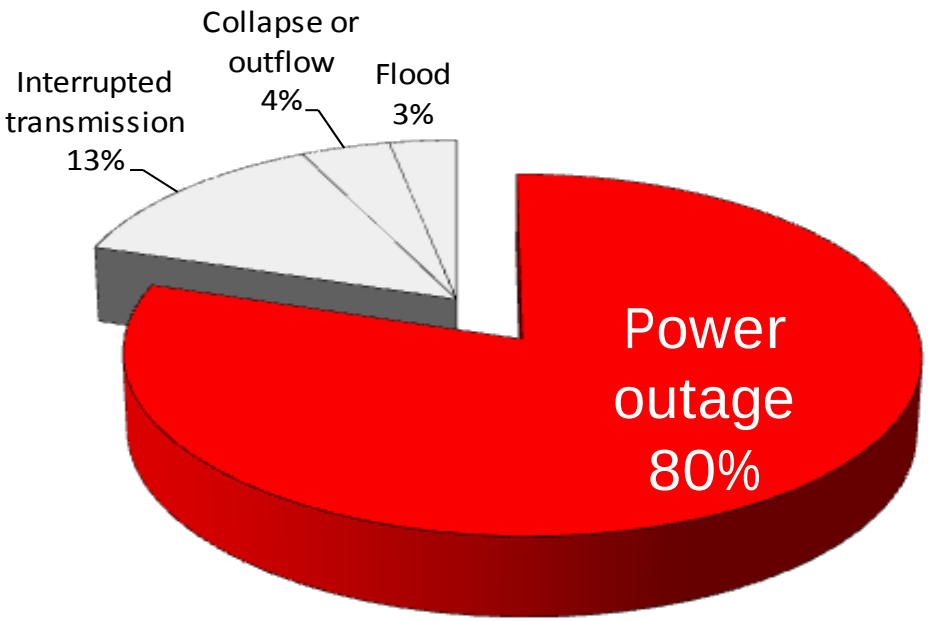
# Trend of shut down mobile base stations



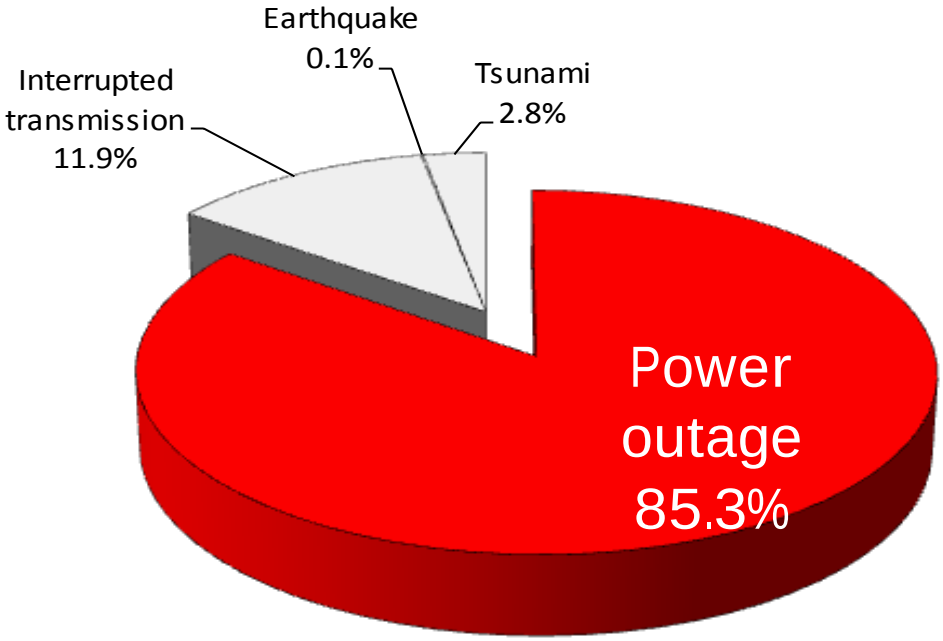
# Causes of Disconnection Resulting from the Great East Japan Earthquake

- Over 80% of communications disconnection of fixed and mobile was caused by widespread and prolonged power outages.

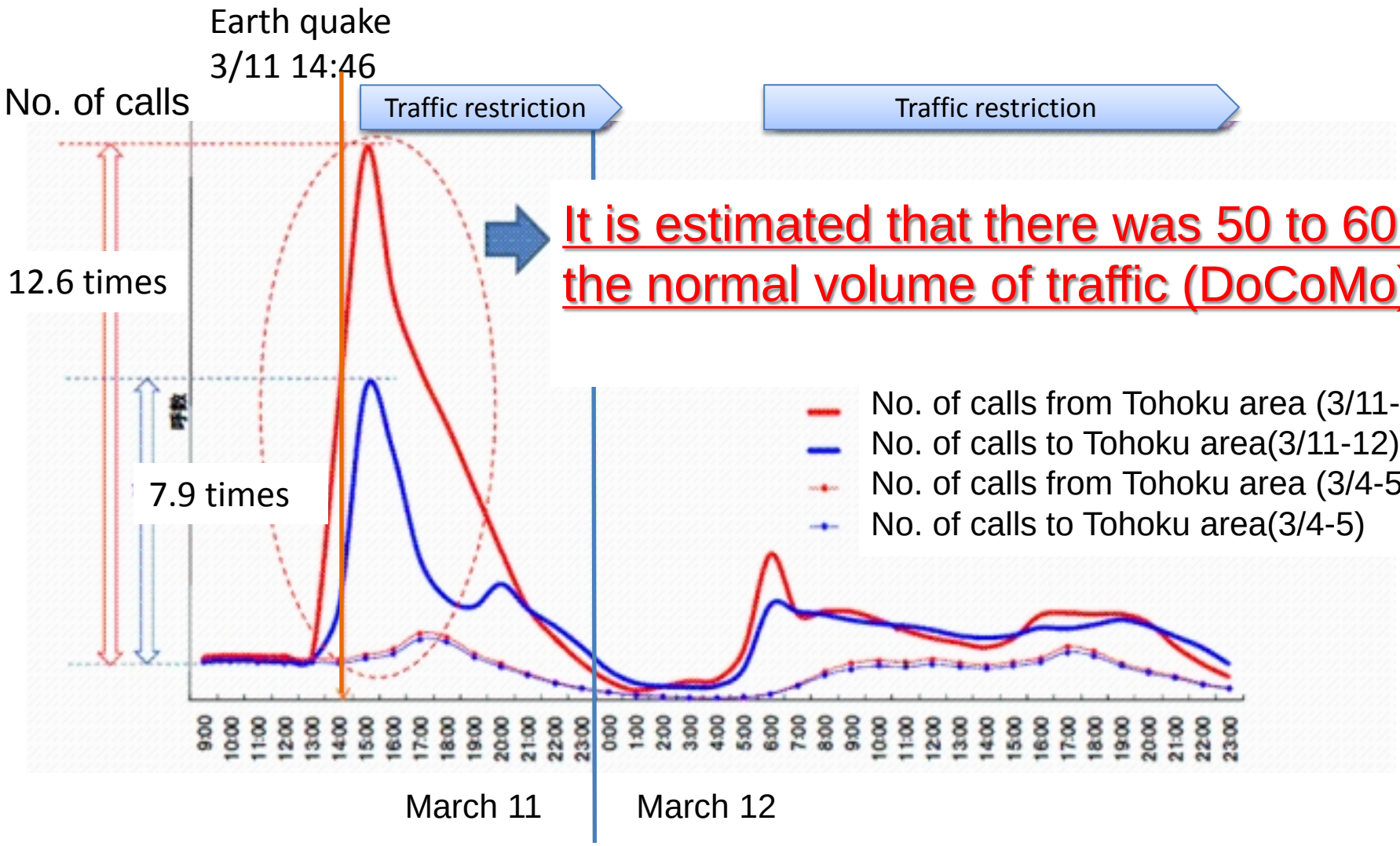
## Fixed telephone




## Mobile telephone



# Network Congestion and Traffic Restriction




- 80% of traffic restriction was conducted
- 12.6/(1-0.8)=60 times traffic was generated

http://www.soumu.go.jp/menu_news/s-news/01kiban05_01000014.html

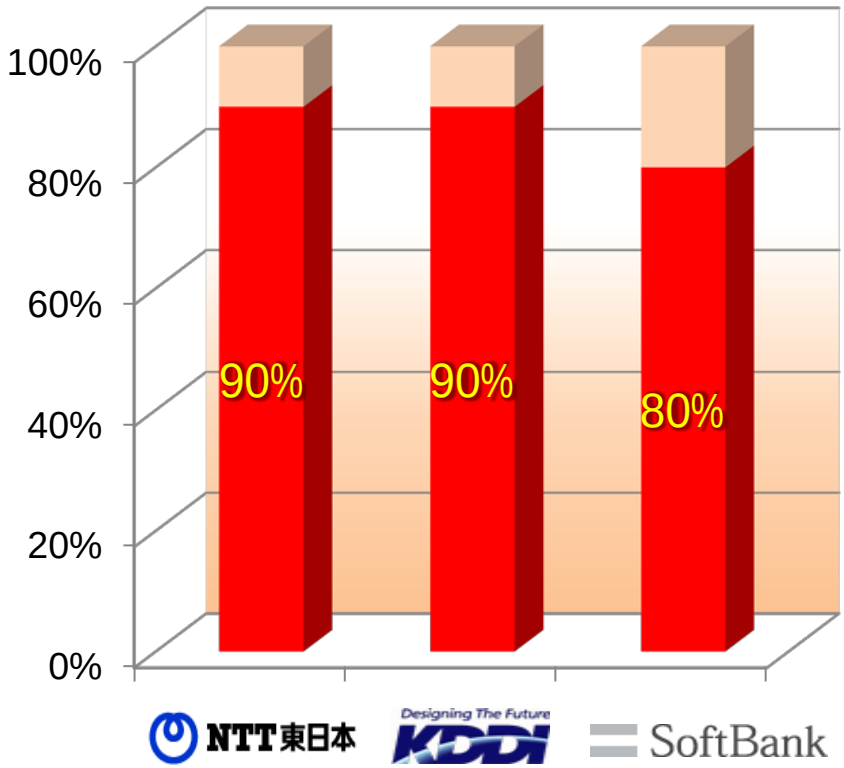
# Traffic Restrictions by Telecom Operators

## Fixed-line Communications

- Carriers restricted phone traffic by as much as 80 to 90 percent.*

* There was 4 to 9 times the normal volume of traffic (NTT East.)

### Max. outgoing traffic restrictions

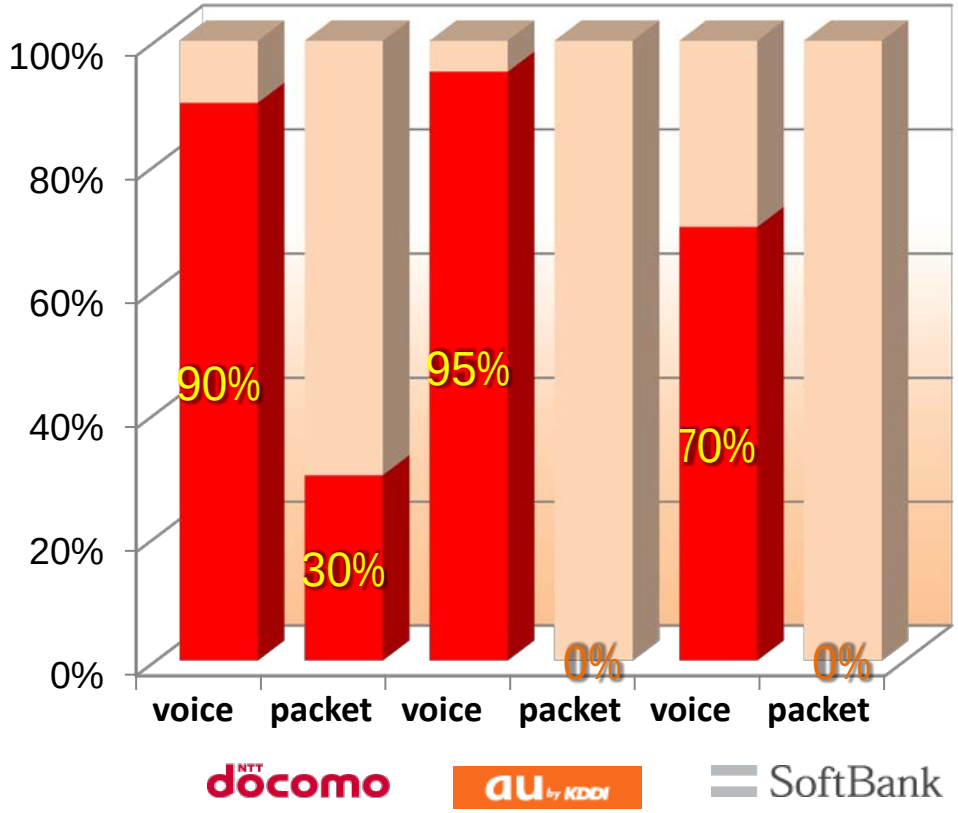



## Mobile Communications

- Carriers restricted voice traffic by as much as 70 to 95 percent.*
- Packet traffic, however, was either not restricted or restricted at a lower rate (0 to 30 percent).

* There was 50 to 60 times the normal volume of traffic (DoCoMo).
eMobile was not subject to restrictions.

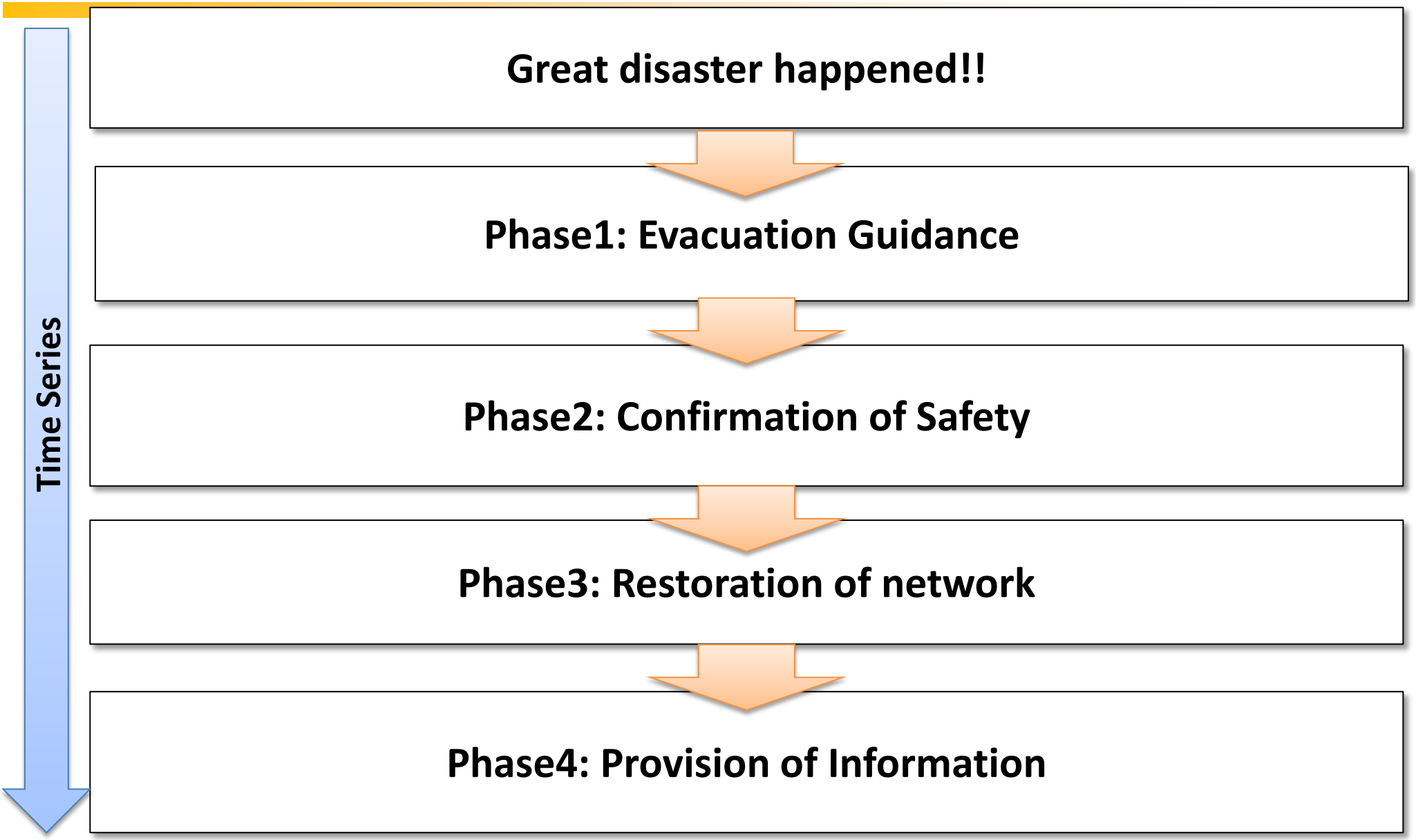
### Max. outgoing traffic restrictions



# 3. Efforts for Realizing Disaster Resilient Network

# What should we do after occurrence of great disaster ?

*from Disaster Management's Point of View*



# Issues in Evacuation Guidance

**Phase1 : Evacuation Guidance**
**Residents couldn't obtain the necessary information for evacuation**

Difficulties identified in the disaster

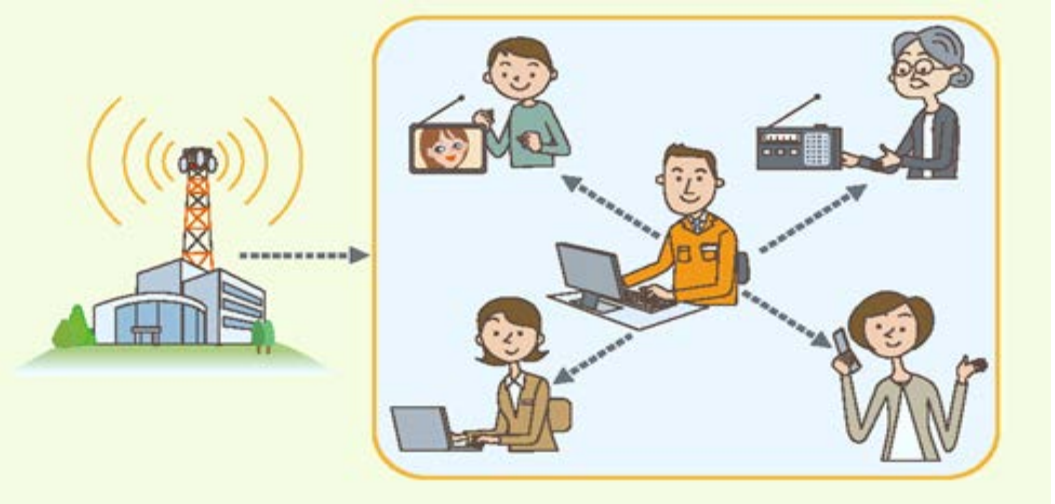
- ✓ Updated emergency information could not be provided to local governments and residents
- ✓ Tsunami warning could not be heard from outside public speakers if people stay inside buildings
- ✓ Tsunami image could not be transmitted from live cameras set on the seashore

# Goal and R&D Promotion

Even great disaster happened,

Goal

High-utility, high-reliability information can be acquired.



- MIC's R&D promotion;

✓ Detailed local disaster information is provided to several devices such as smart TV, tablet, smart phone, etc.

*- R&D on Integrated broadcasting and communications: NHK, etc.*

✓ Live camera can be continuously transmitted with high-quality and low latency if the communications network is degraded

*- R&D on High compression, low latency: Mitsubishi Electric. Etc.*

✓ People can obtain reliable information on the Internet

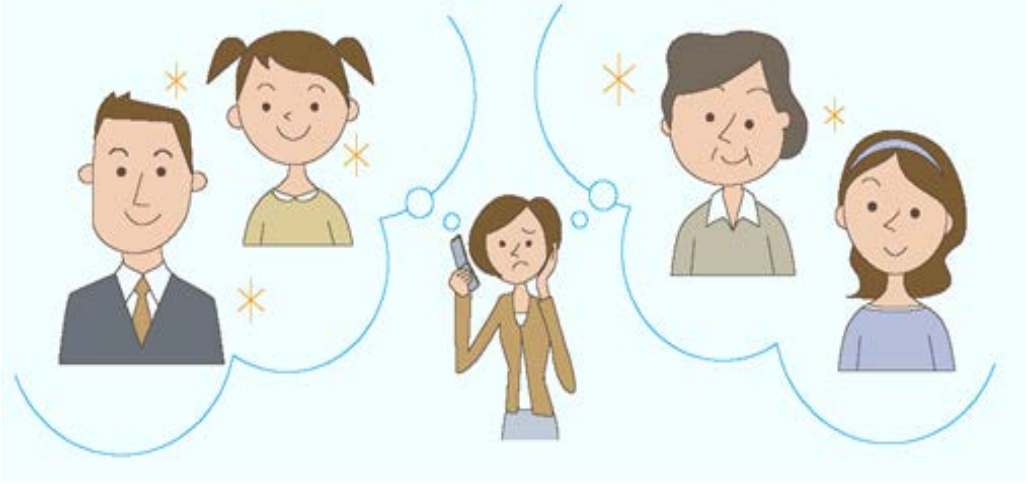
*- R&D on Information distribution platform: NICT*

# Issues in Confirmation of Safety

**Phase2 : Confirmation of Safety**
**Telephone calls didn't connect and disaster-prevention wireless broadcasts couldn't provide information**

Difficulties identified in the disaster

- ✓ Telephone calls could not get through due to destruction of telecommunications networks and equipment by earth quake and tsunami, and power outage.
- ✓ Fixed and mobile telephone networks congested because many people made phone calls to confirm safety of families, friends, etc.
- ✓ Staff for disaster officials could not contact each other due to congestion of network and interference problems in disaster warning wireless system



# Goal and R&D Promotion

Even great disaster happened,

Goal

Telephone calls, e-mail, etc. can continue to get through by back up systems

-MIC's R&Ds promotion;

- ✓ Basic services, such as voice and email, is connected easily by reallocating network resources from other services or from distant location.
  *- R&D on control for alleviating congestion: NTT DoCoMo, etc.*

- ✓ Voice and email can be used for longer periods by lowering energy use of network equipment even if limited electrical power is provided

*- R&D on disaster-resistant network management and control: KDDI R&D Lab., etc.*

# Issues in Restoration of Network

**Phase3: Restoration of network**
**Restoration of the communications network took long time**

Difficulties identified in the disaster

- ✓ Restoration of communications networks took considerable time since central telephone exchanges were destroyed completely by the tsunami.

- ✓ Communications equipment such as mobile base station and network cable was completely wiped out by the tsunami

- ✓ Even satellite mobile phones and disaster warning system didn't work due to destruction of equipment and power outage.

# Goal and R&D Promotion

Even great disaster happened,

Goal

Restoration of communications network can be accomplished promptly

-MIC's R&Ds promotion;

- ✓ Trucks with network exchange functions (Network Resource Unit) rushed to the disaster area and provide connection functions
  - *R&D on Resource unit: NTT, etc.*
- ✓ Satellite network can be used immediately with portable size satellite equipment (The antenna of it can seek a available satellite automatically.)
  - *R&D on VSAT ground station: SKY Perfect JSAT, etc.*
- ✓ Backup networks become available very soon.
  - *R&D on multilayered communications networks, Tohoku University, etc.*

# Issues in Provision of Information

**Issue4: Provision of Information**
**Proper information provision at evacuation centers couldn't be provided**

Difficulties identified in the disaster;

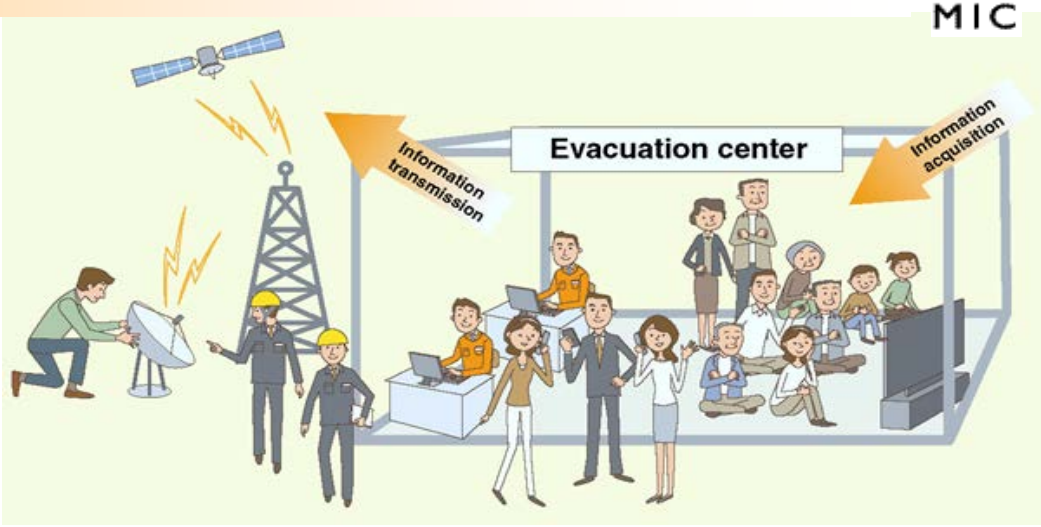
- ✓ Existing communications equipment and circuits to evacuation centers were broken due to tsunami and earthquake
- ✓ Only radio was available.
- ✓ No satellite mobile phone and disaster-prevention wireless broadcasts etc.
- ✓ Evacuation centers had television sets but they could not be used because of electrical power outages.

# Goal and R&D Promotion

Even great disaster happened,

Goal

Basic ICT infrastructure is installed and necessary information is provided




-MIC's R&Ds promotion;

- ✓ Cable Television services are restart quickly.
  *- R&D on Provisional headend, Radio transmission: DX ANTENNA, Kyocera Com. Sys.*
- ✓ Satellite network can be used immediately with portable size satellite equipment(The antenna of it can seek a available satellite automatically.)
  *- R&D on VSAT ground station: SKY Perfect JSAT, etc.*
- ✓ Disaster information can be provided to various device such as mobile phone, PC, TV, one-seg TV, fire alarm , etc.
  *- R&D on Diverse-means data communication: NTT Data, etc.*
- ✓ Internet connection can be secured with Wi-Fi at evacuation center
  *-R&D on Disaster-Resistant Network Management and Control: NEC, etc.*

*Thank you for your attention!*

# Reference

## R&D projects promoted by MIC toward disaster-resilient network

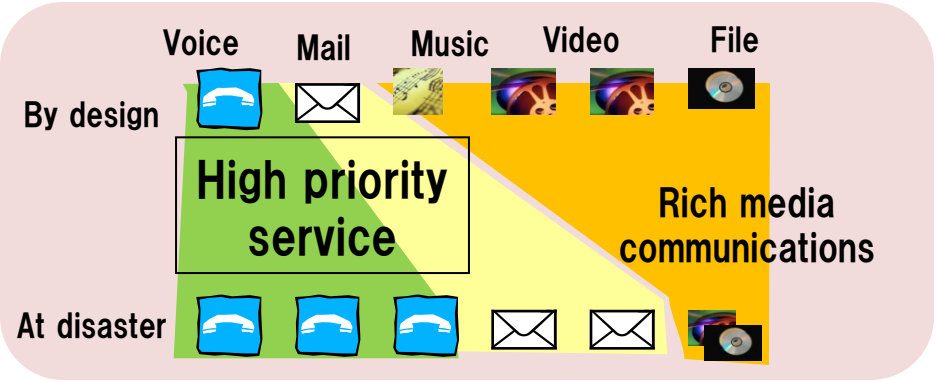
Reference

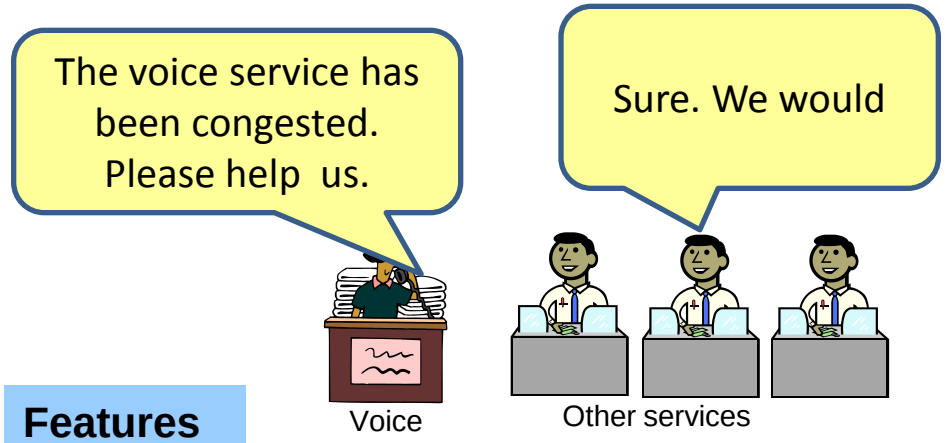
# Control for Alleviating Congestion

- To research and develop technologies for dynamic resource control by making the best use of available resources to cope with massive traffic congestion after Great East Japan Earthquake.
- Target: Improving the acceptance ratio from 5% up to 25%
  To success once in 20 trials to once in 4 trials
- By reallocating resources in a certain site

**Reallocating resources to Voice from Other services**

## Resource reallocation by dynamic control




## Features

- Use of the 3GPP IMS and EPC packet services
- Application of emerging technologies such as virtualization or SDN/OpenFlow.
- Empirical evaluation on the large-scale testbed deployed in Tohoku area.

## Trial of information services for disaster evacuation

By incorporating the experience of universities and ICT companies in disastrous area.



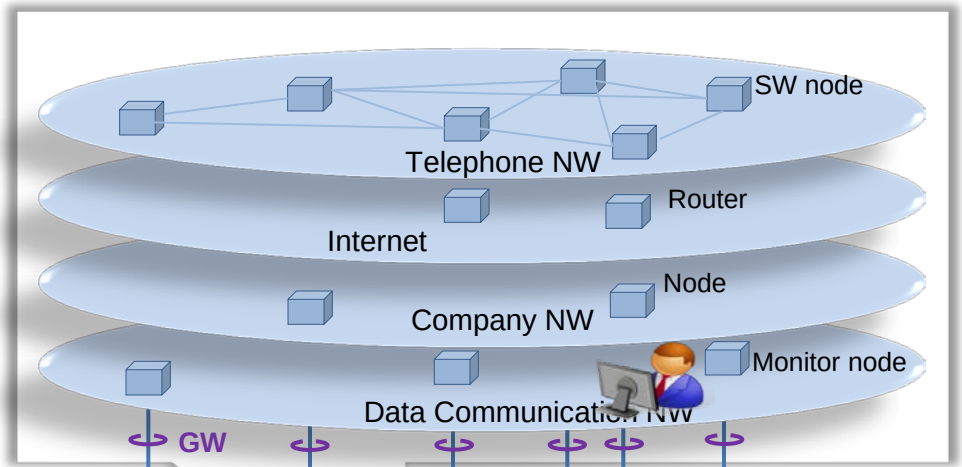
*IMS: IP Multimedia Subsystem **EPC: Evolved Packet Core

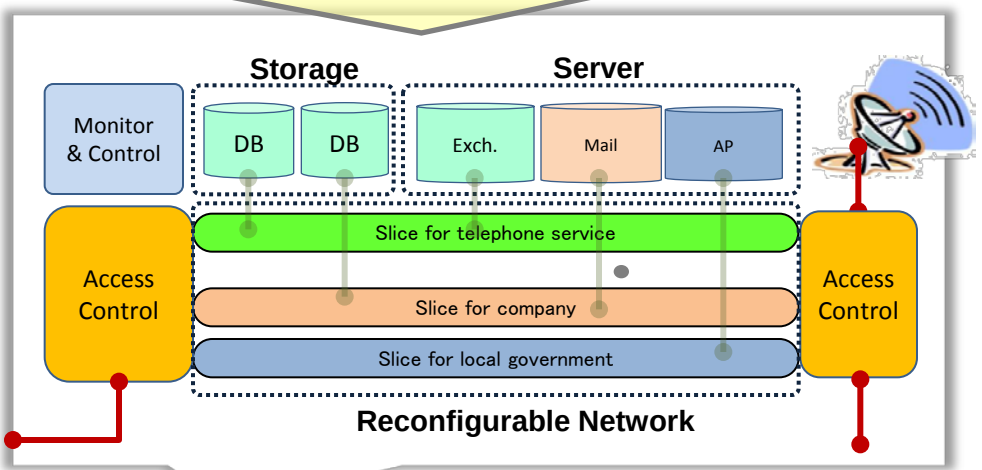
Reference

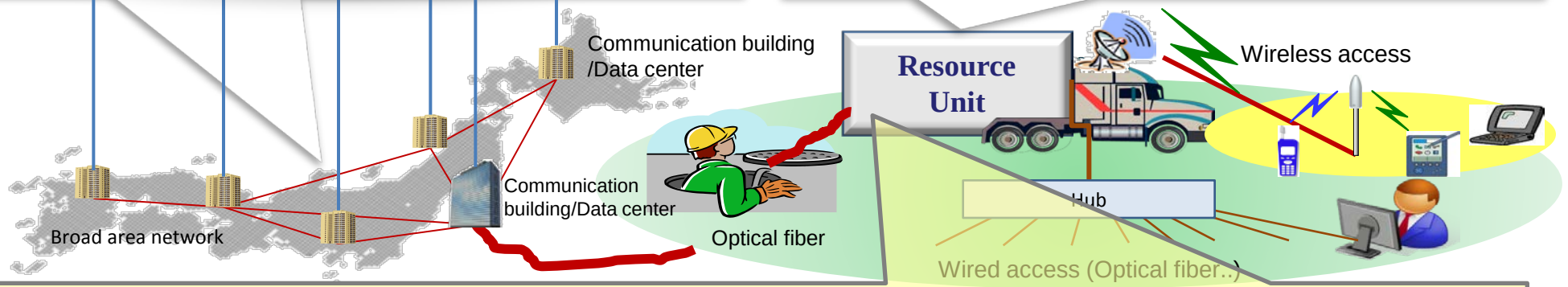
# Resource Unit

**This R&D project aims at the establishment of movable ICT resource unit's basic technology, which enables us to promptly deploy it to disaster areas and to recover ICT services. Our goal is to offer ICT services (Telephone, etc) to thousands of users in disaster area within one hour since the resource unit deployment..**

IssueB: Functional reconfiguration technology for communication networks
B-1: Functional reconfiguration tech. (Fujitsu) A-2: Resource unit management & operation tech. (NTT, Tohoku Univ.)




IssueA: Resource unit deployment technology
A-1: Resource unit architecture tech. (NTT Com, NTT) A-2: Resource unit interconnection tech. (Tohoku Univ., NTT)

Reference

# *Disaster-Resistant Network Management and Control*

## support early restoration of network connection in disaster

**Identify the damaged points in telecom network for early restoration of networks**

Restoration process generation system

- calculation of restoration route
- Calculation of restoration priority
- Generate restoration process

Operator

Disaster Info.

Earth quake

Power outage

①collect alarm information from communications network and disaster information

②Share damaged situation with other telecom carriers

Standardization actives are ongoing at international standardization body (TMForum)

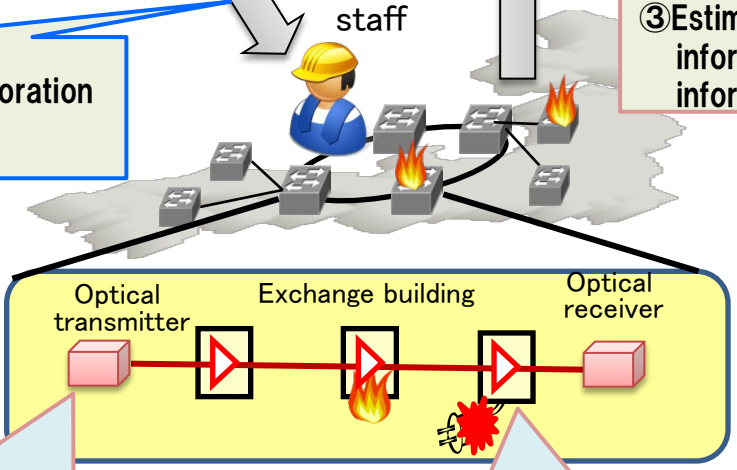
Restoration support system

Damage estimation system

③Estimate damages of network based on information of disaster information and shard information with telecom carriers

④Automatically calculate restoration point and process

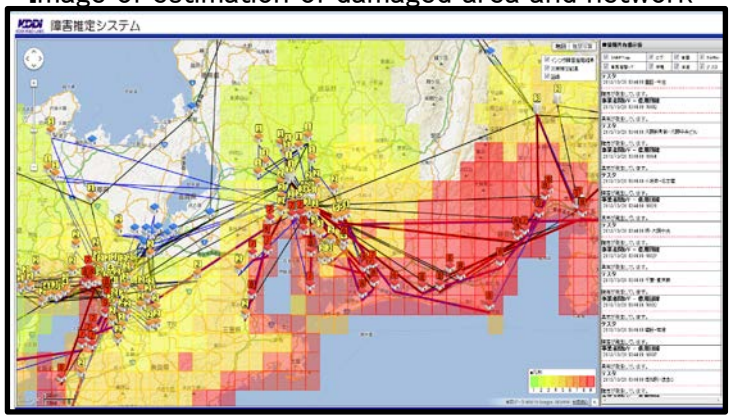
staff




Depend on the damages of networks, decide route of traffic and arrange the volume of traffic

Depend on power supply, low power consumption operation

Image of estimation of damaged area and network



**Continue communications service by using limited undamaged network infrastructures and power supply**

Reference

# *Disaster-Resistant Network Management and Control*

## Be able to share information at evacuation center

**Realize information sharing with smart phones at evacuation center where network congestion occurs**

Portable Type DTN Access Point

**After disaster, bring DTN access point and install it at evacuation center where there are no access points to network**


WiFi

**With DTN technologies, 500 wireless LAN terminals can be available per one access point**

WiFi

WiFi

User terminal

Evacuation Center

**Important information and safety confirmation information**

Fixed Type DTN Access Point

**This can be available for a charge equipment of mobile phone batters**

DTN: Delay/Disruption-Tolerant Network

# *VSAT ground station*

## R&D of VSAT terminal of easy installation by anybody (First phase )

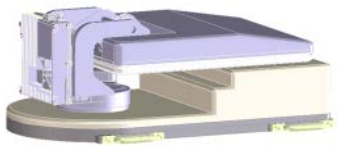
**○ Research and Development for a Very Small Aperture Terminal (VSAT) that can be installed by easy operations during disasters**

**[Status quo] Conventional VSAT terminals require skilled workers for its installation.**

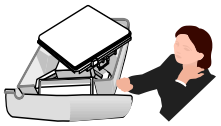
***The strong point of VSAT terminals "wherever, it is usable with flexible and dynamic installation" cannot be fully reached.**

**Our R&D is aimed at realizing a VSAT terminal that can be carried and installed easily, and that can be adjusted its antenna direction with a simple operation.**

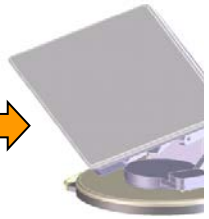
Image of the developed system



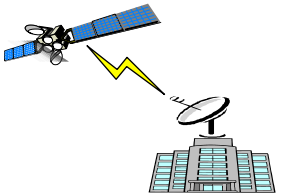
Carried with ease.



Easily installed by staff members with no handling experience.



Automatic acquisition

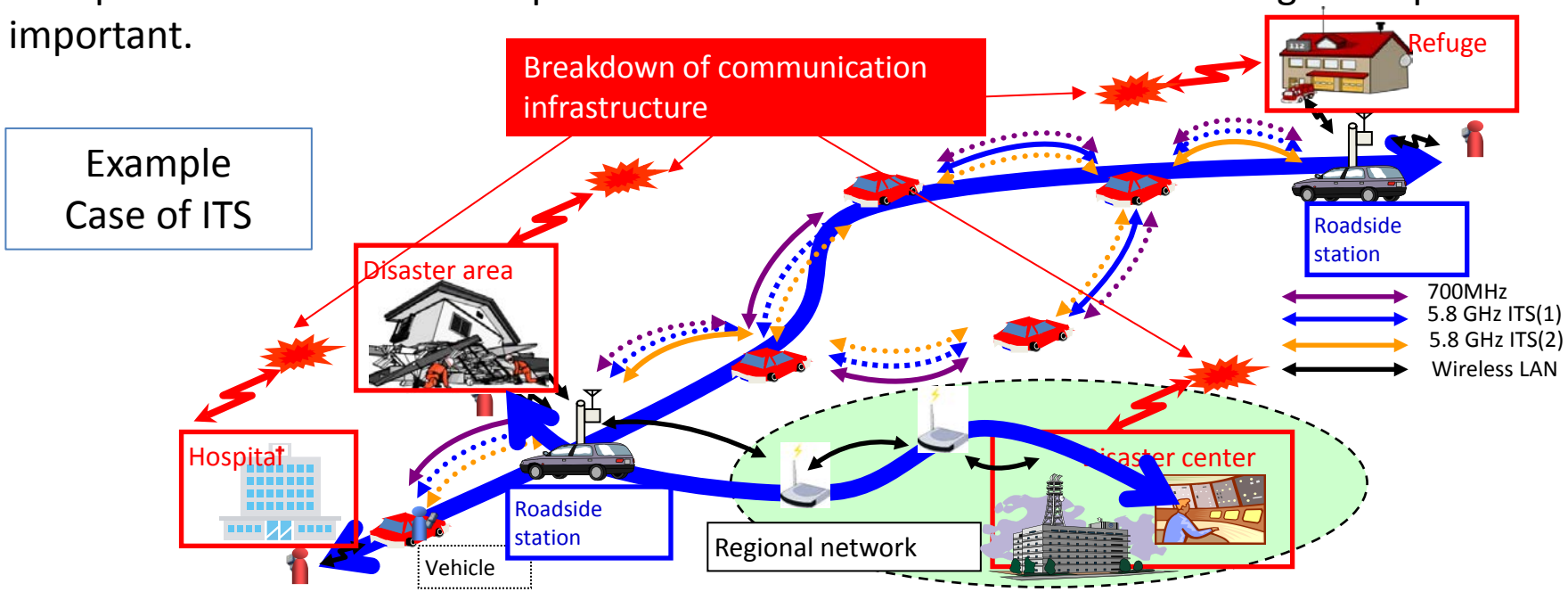


Possible to construct a satellite communications network with ease.

Reference

# *Multilayered Communications Networks*

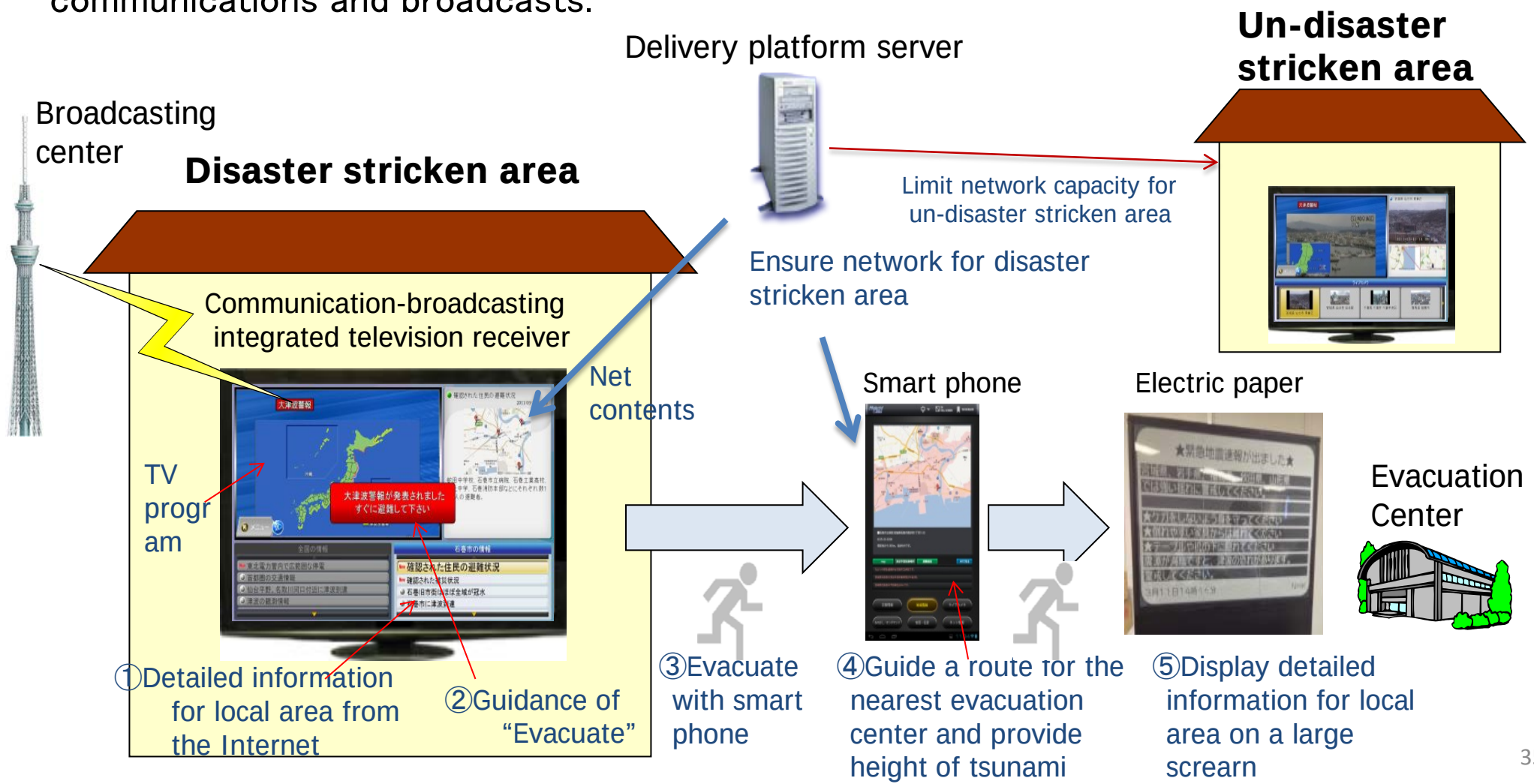
- Objective
  - Using smart phones not only in daily lives, but also in case of disasters and emergencies.
  - Smart phones equipped with 3G, Wi-Fi and WiMAX are becoming popular right across Japan.
  - The project will develop “Multilayered network” which will ensure communication links in case of disasters by detouring traffics to regional networks which are “alive”.
- Multilayered communications network
  - “Multilayered network” consists of such regional networks as WiMAX, Wi-Fi, ITS and satellite networks.
  - Secure communication is important even in a disaster situation.
  - Group communications and specified-information transmissions to designated person are also important.



Reference

# *Integrated broadcasting and communications*

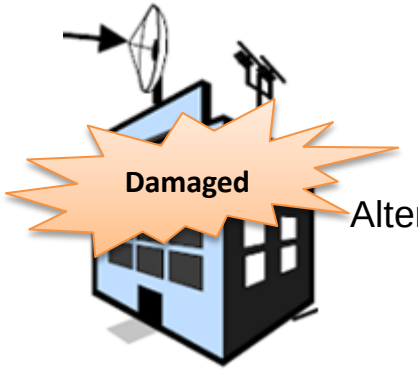
To realize an environment to be able to properly provide important information in occurrence of disaster, develop technologies for automatic processing and generating contents, network control technologies, and functions of cooperation of communications and broadcasts.



Reference

# *Emergency Restoration of CATV [provisional headend]*

**Develop and demonstrate simple and portable provisional headend equipment with function of transmitting terrestrial digital broadcast and community channel if the headend equipment is damaged by disaster.**



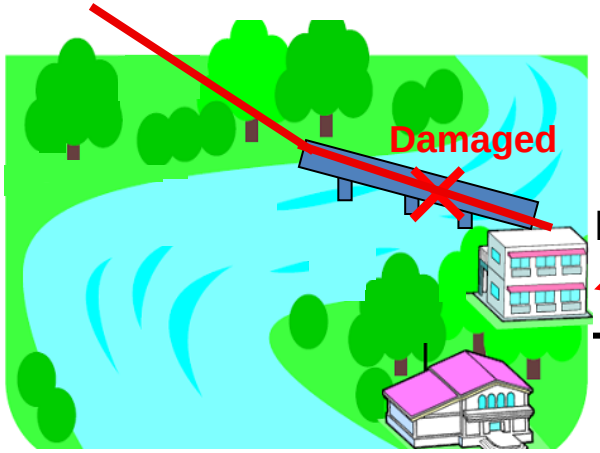

Broadcast building

Alternative


Temporary broadcast building

Early recovery of information distribution from temporary broadcast building

**Developed portable provisional headend equipment**




Available to information distribution if transmission network lines are cut off or damaged due to corruption of bridge

Install

**Potable emergency headend**

Reference

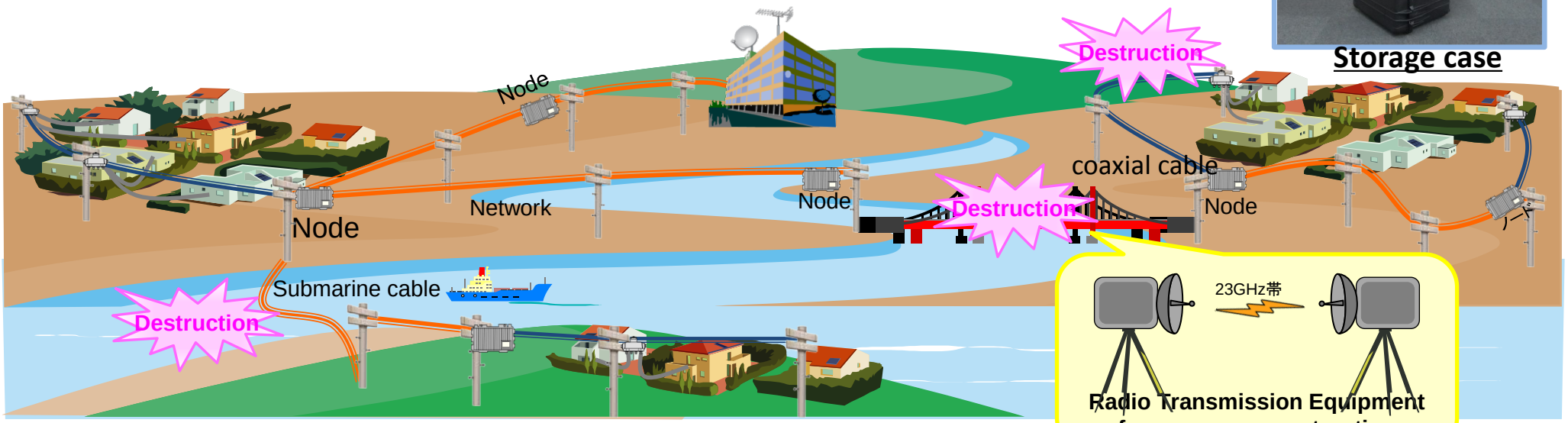
# *Emergency Restoration of CATV[Radio Transmission]*

- Develop and demonstrate the radio transmission equipment of CATV to restore transmission route, if the restoration of trunk transmission equipment of CATV takes long time.
  - Transmit several digital signals such as digital terrestrial broadcasting and community channel
  - Support power supply from car battery and power generator
  - Connection interfaces with coaxial cable network and optical fiber
  - Small, installable, portable and low power consumption

**23GHz band radio antenna and equipment**

**transmission equipment**

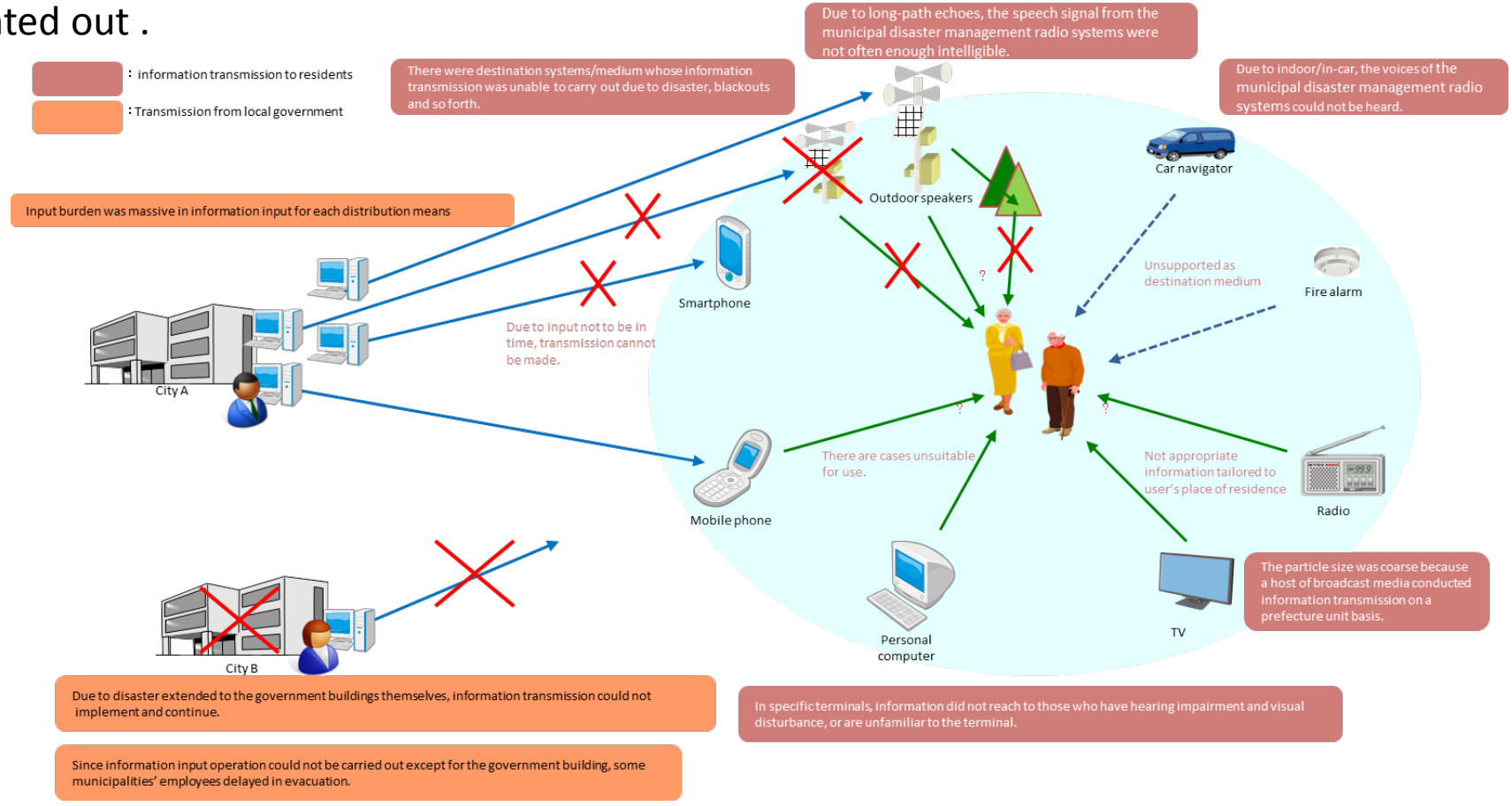
**Storage case**



Reference

# *Diverse-Means Data Communication ①*

The damages due to the Great East Japan Earthquake spread extensively. The disaster information transmission systems including the municipal disaster management radio systems were severely damaged not only by the earthquake itself but also by flood and flow caused by a series of tsunami which caused breakdown and collapse of facilities. In addition, a problem that emergency evacuation information from the municipal disaster management radio systems could not be heard has been pointed out .

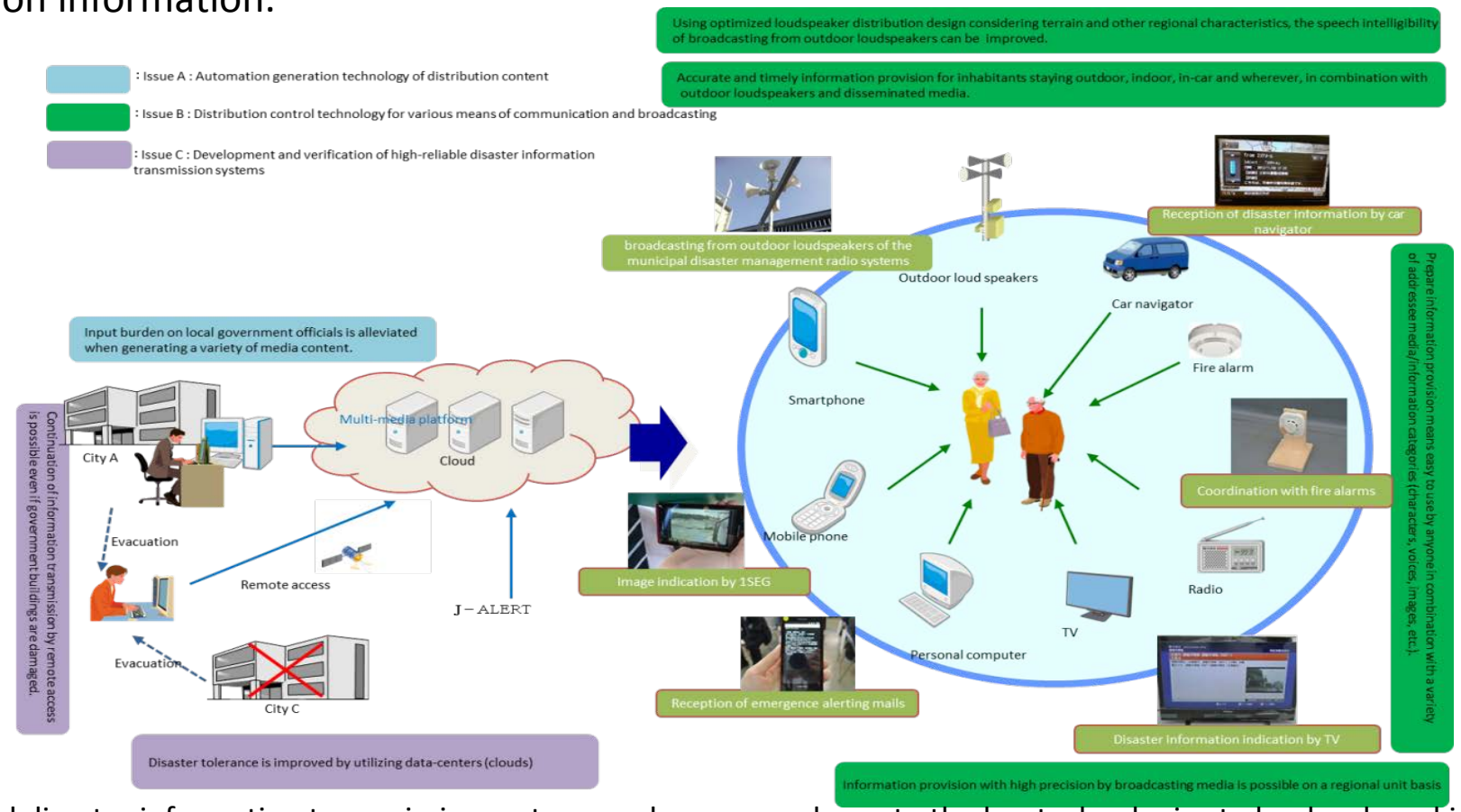



Major issues related to transmission of disaster information to local residents observed in the Great East Japan Earthquake

Reference

# *Diverse-Means Data Communication ②*

It is extremely important to transmit the evacuation information swiftly and alarms related to disaster to the local residents in case of a large-scale and wide-area disaster like the Great East Japan Earthquake. We conducted a technical development and demonstrations of multitier disaster information transmission systems linking various means of communication and broadcasting for the purpose of establishing technologies which enables the swift and secure transmission of the disaster-prevention information.




Desired disaster information transmission systems and correspondence to the key technologies to be developed in this project