Great East Japan Earthquake and research and development for network resilience and recovery

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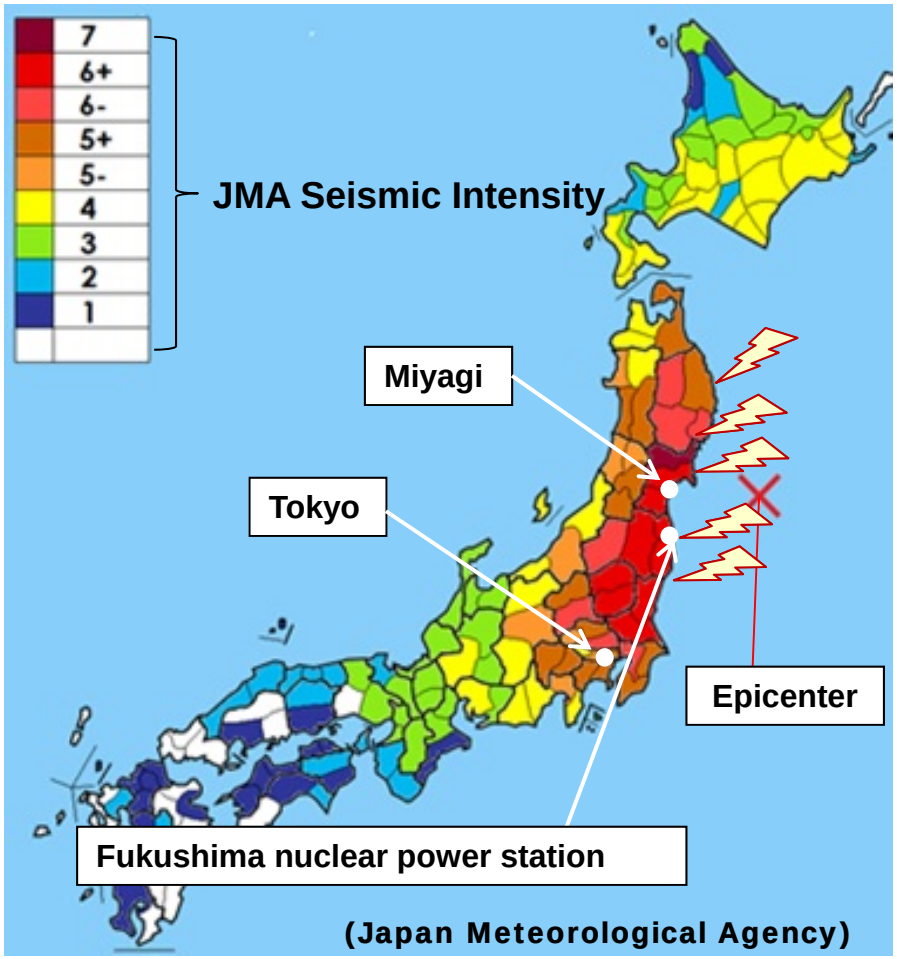
Outline

1. Overview of Great East Japan Earthquake
2. Damage situation
3. Recovery and countermeasures
4. Future research and development
5. Summary

Overview of Great East Japan Earthquake

On March 11th, 2011, there was a magnitude 9 earthquake, the biggest in the modern era in Japan. A huge tsunami was generated, and it caused a catastrophe whose dead and missing reached about 20,000. 3,669 people remain missing.



1. Date: March 11th , 2011

2. Epicenter: Sanriku coast
   38.1° N / 142.9° E
   Depth 24km, Magnitude 9.0

3. Japan Meteorological Agency Seismic Intensity Scale (Over 6):
   7: (North of Miyagi)
   6: (South and middle of Miyagi, Fukushima etc.)

4. Tsunami
   A huge tsunami was generated by this quake, and its maximum height was about 38m, which far exceeded expectation.

The 3.11 Disaster

Damage status of telecommunication facilities

NTT

Damage Status

NTT East

- Damage to exchange office buildings

Demolished buildings: 18
Flooded buildings: 23

- Damage to telephone poles

Flooded/collapsed : approx. 65,000 poles (coastal areas)

- Transmission lines & switchboards washed away

Relay transmission lines: 90 routes disconnected
(excluding nuclear power plant area)

Flooded/damaged: approx. 6,300 km (coastal regions)

DOCOMO

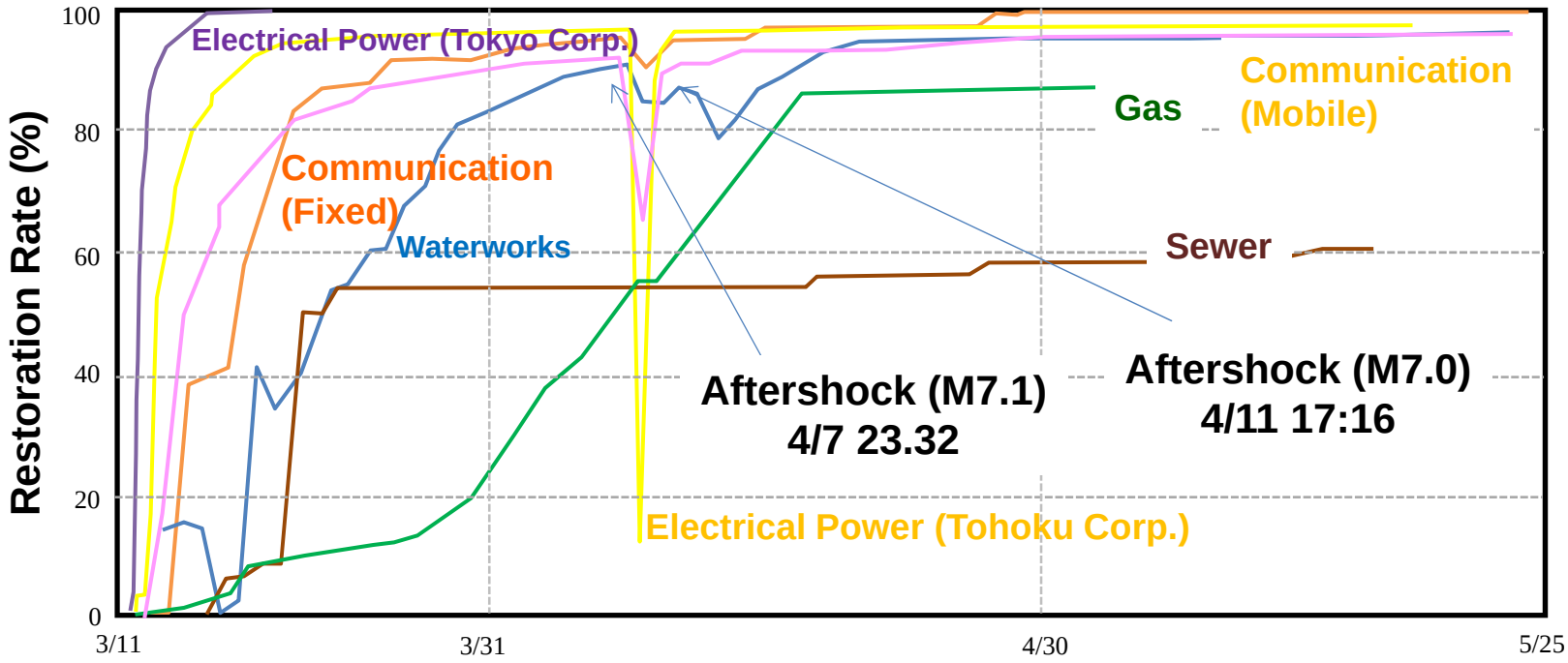
- Damage to base stations

Number of stations requiring restoration: 375 stations

(including 68 stations within a 30km radius surrounding nuclear power plant)

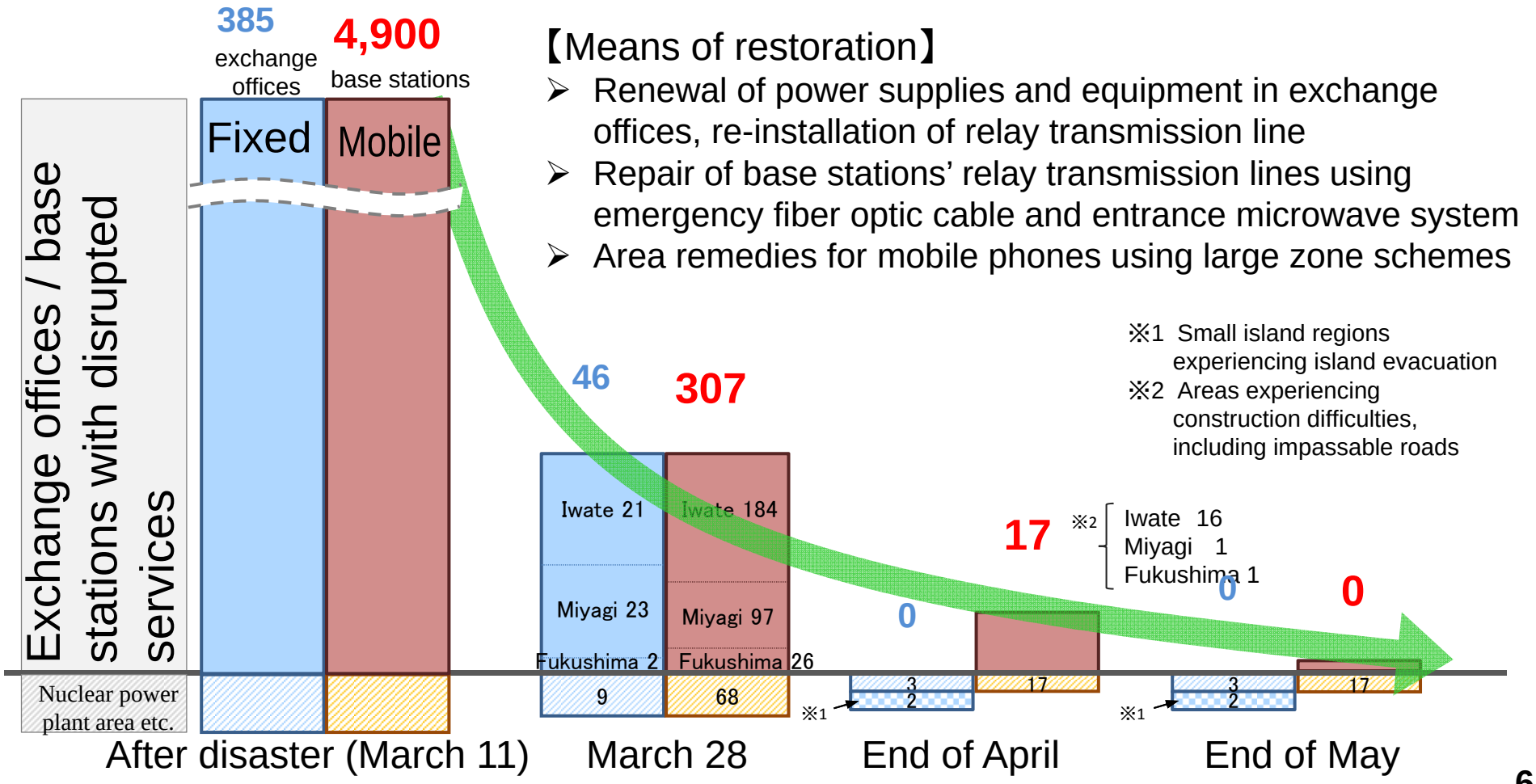
Restoration of lifeline equipment

- Restoration of electricity, gas, water, and communication services, which are important lifelines.
- Regarding Tohoku Electric Power service, restoration took about 1 day in Akita and Yamagata, about 2 days in Aomori, and one week or more in Iwate, Miyagi and Fukushima.
- Regarding NTT's telecom infrastructure, about 90% of communication systems were restored by 10 days after the earthquake.



Restoration status in NTT

Restoration was mostly completed by end of May 2011 for exchange office buildings and mobile base stations in areas where customers reside.



1. Overview of Great East Japan Earthquake
2. **Damage situation** ***-photographs-***
3. Restoration and countermeasures
4. Future research and development
5. Summary

Damage caused by liquefaction

Damage to poles, mobile base stations, manholes and drains by liquefaction

(a) Tilting and subsiding utility poles

(b) Surfacing of NTT's manhole by liquefaction

(a) Collapse of drawing pillar at NTT DoCoMo's base station

(b) Surfacing drainage tube (about 0.4m)

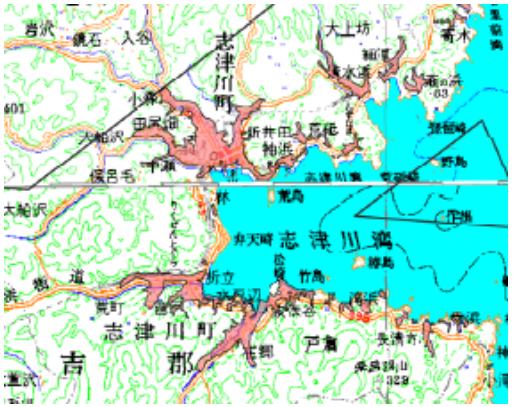
Damage caused by subsidence

Damage to cable conduits installed under a bridge in Tobe-city, Miyagi prefecture

Damage of cable conduit installed under bridge

Damage caused by Tsunami (1)

Tsunami damage in Minamisanriku-cho, Miyagi prefecture



(a) NTT manhole exposed
by destruction of riverbank protection

(b) Equipment damaged by falling bridge

Damage caused by tsunami (2)

- There was no building left standing after the tsunami except for NTT central office.
- Cable tubes have come away from the bridge.

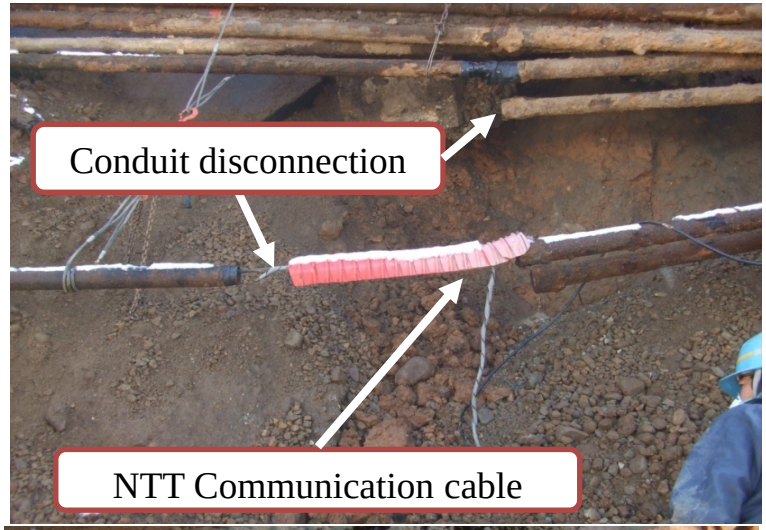
Damage caused by landslide (1)

Damage of junction cables by landslide in Fukushima-city, Fukushima prefecture.

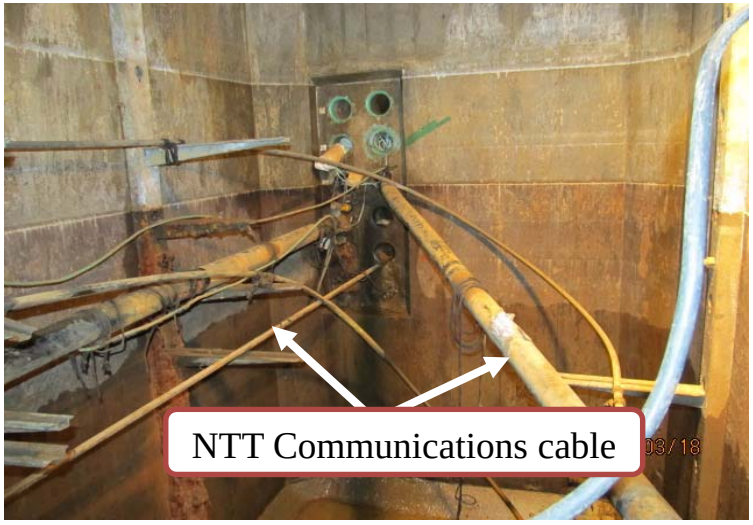
Damage of NTT' junction cable

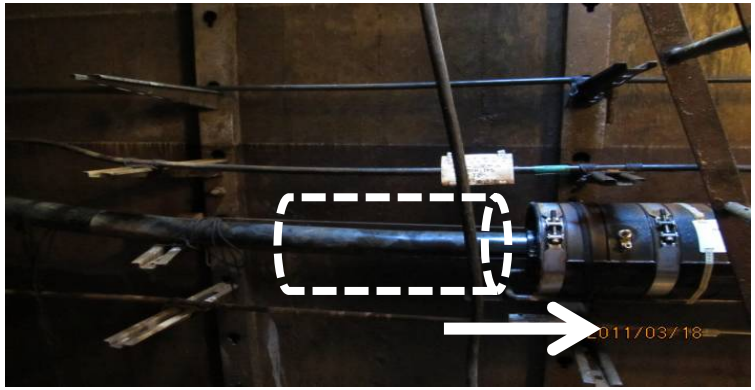
Damage caused by landslide (2)

Damage to cable tunnel caused by a landslide and temporary restoration



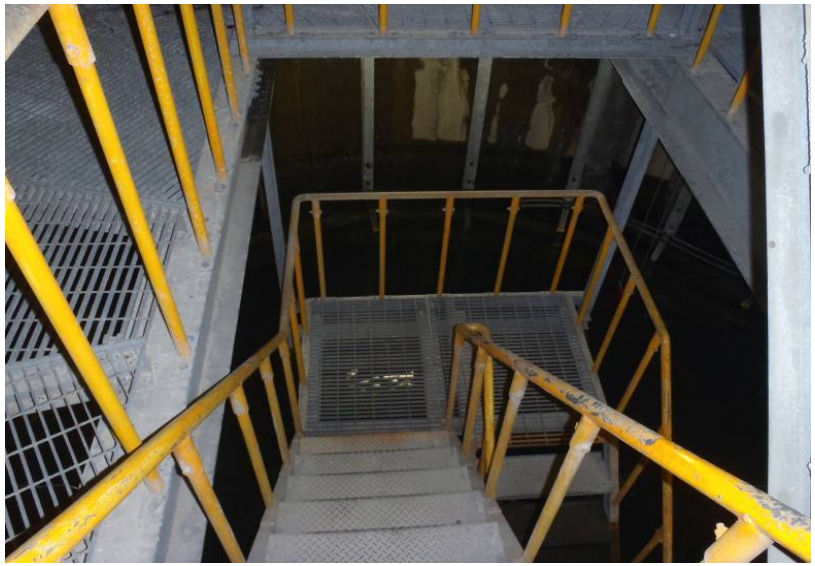
(a) Restoration state





(b) Movement of closure by quake

Water leak in cable tunnel



Other damage (1)

A fallen bridge section caused by extension of bridge girder interval

Other damage (2)

(a) Onahama Fishing Port

(c) Hitachinaka Kaihin Railway

(b) Road near Nakaminato port

(a) A barge (flat-bottomed ship) stranded on road

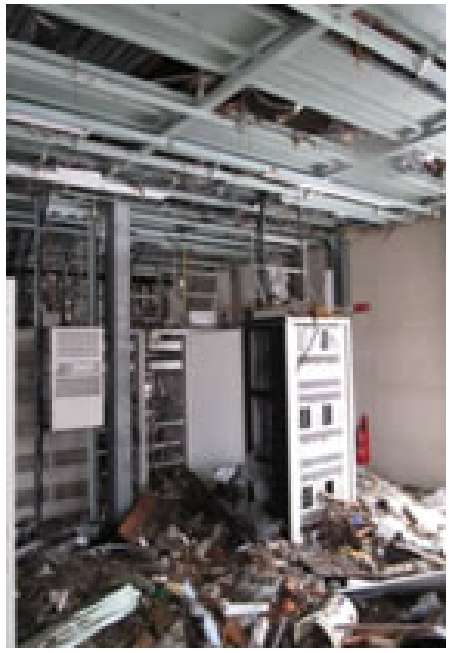
(b) Undulating road near port

(c) Undulating Hitachinaka Kaihin railway line

Damage to NTT buildings

Nobiru Building (Higashi Matsushima City, Miyagi)

Yamada Building (Yamada Town, Iwate)



Kitakami Building (Ishinomaki, Miyagi)

Problems caused by earthquake

1. Network Infrastructure

(1) Congestion of telephone (mobile and fixed)

(2) Telephone communication system shut down by blackout

(3) Backup power stopped after blackout

(4) Destruction and flooding of communication equipment by tsunami

2. Services

(1) Telephone could not be used
- Services shut down by black out and destruction
- Congestion regulation

(2) E-mail unavailable
- Services shut down by blackout and destruction

(3) Earthquake warning system would not work.
- Some mobile terminals, such as smart phones, could not receive warnings.

(4) Destruction of information distribution systems, disappearance of important data, destruction and disappearance of family registers, resident information, etc. in local government

1. Overview of Great East Japan Earthquake
2. Damage situation
3. **Recovery and countermeasures**
4. Future research and development
5. Summary

Restoration Situation - Rikuzen Takada city-

- **Rubble has been removed. But almost nothing remains except some buildings.**
- **A new electrical pole has been installed to supply electric power and communication services are available.**

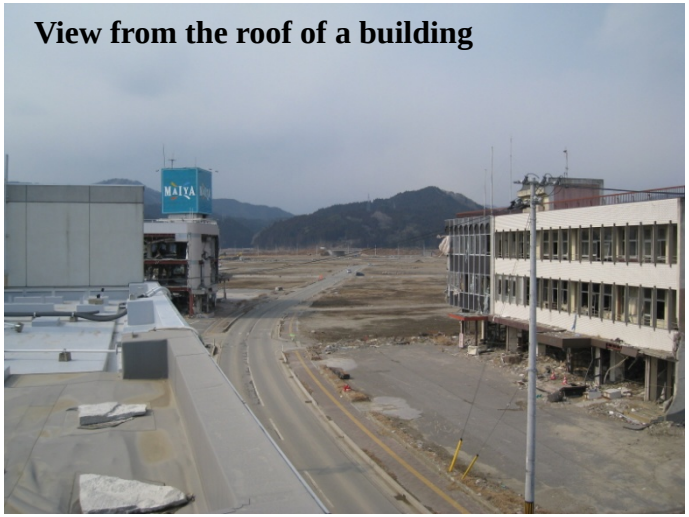
Restoration Situation - Rikuzen Takada city-

NTT

Restoration of NTT central office

Restoration Situation - Rikuzen Takada city-

Battery prepared beside communications system to cope with power failure.



Restoration Situation - Shizugawa -

- Two trunk lines were installed along with the bridge. One of the trunk lines was destroyed by tsunami.
- The remaining live line will be moved underground.

Restoration Situation - Shizugawa -

Shizugawa area seen from a mountain located about 4 km from the coast

Countermeasures must be accomplished in the near future

1. Against tsunami

(1) Higher relocation of central offices: Iwate/7, Miyagi/12, and Fukushima/0

(2) Flood proofing : Iwate/4, Miyagi/3, and Fukushima/2

2. Against earthquake (Trunk line route)

(1) Remove trunk line from coast to inland area

(2) Recommend underground routing

3. Against power failure

(1) Deployment of dynamo-electric generators : Iwate/7, Miyagi/11, and Fukushima/6

(2) Storage battery renewal : Iwate/12, Miyagi/35, and Fukushima/22

Relief measures using satellite communication system

- **Mobile satellite communication systems were set up throughout Japan.**
- **Telephone services provided in local government building or in evacuation centers.**

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Commitment to securing communication

<Network reliability enhancement>

➢network design

- such as data center distribution and physical redundancy technologies of transmission routes

➢network monitoring and control technologies

➢quake resistance enhancement technologies for physical network equipment

High network reliability

[Network Configuration]

(1)Decentralization of important communication centers

(2) Relay transmission line made multi route

(3)Loop configuration of communication transmission line

[Observation and Control]

(1)Around-the-clock network monitoring

[Securing earthquake resistant equipment]

(1)To endure large earthquakes, cable tunnels, buildings, and wireless iron towers are designed.

Securing important communication

[Ensuring safety]

(1)Voice mail service for disaster 171, i-mode mail service for disaster,web171

(2)Setting up special temporary public telephones

(3)Opening street public telephones

[Ensuring communication in disaster]

(1)Priority telephone at disaster

-Fire fighting and country and local public entity, etc.

(2)Telephone call control during disaster

Early restoration of service

(1)A temporary telephone office will be constructed by transporting about ten portable digital switchboards.

(2)Mobile power supply car

(3)Restoration of communication that uses satellite

-Portable satellite

-Micro satellite communication device

-Digital satellite in-vehicle car

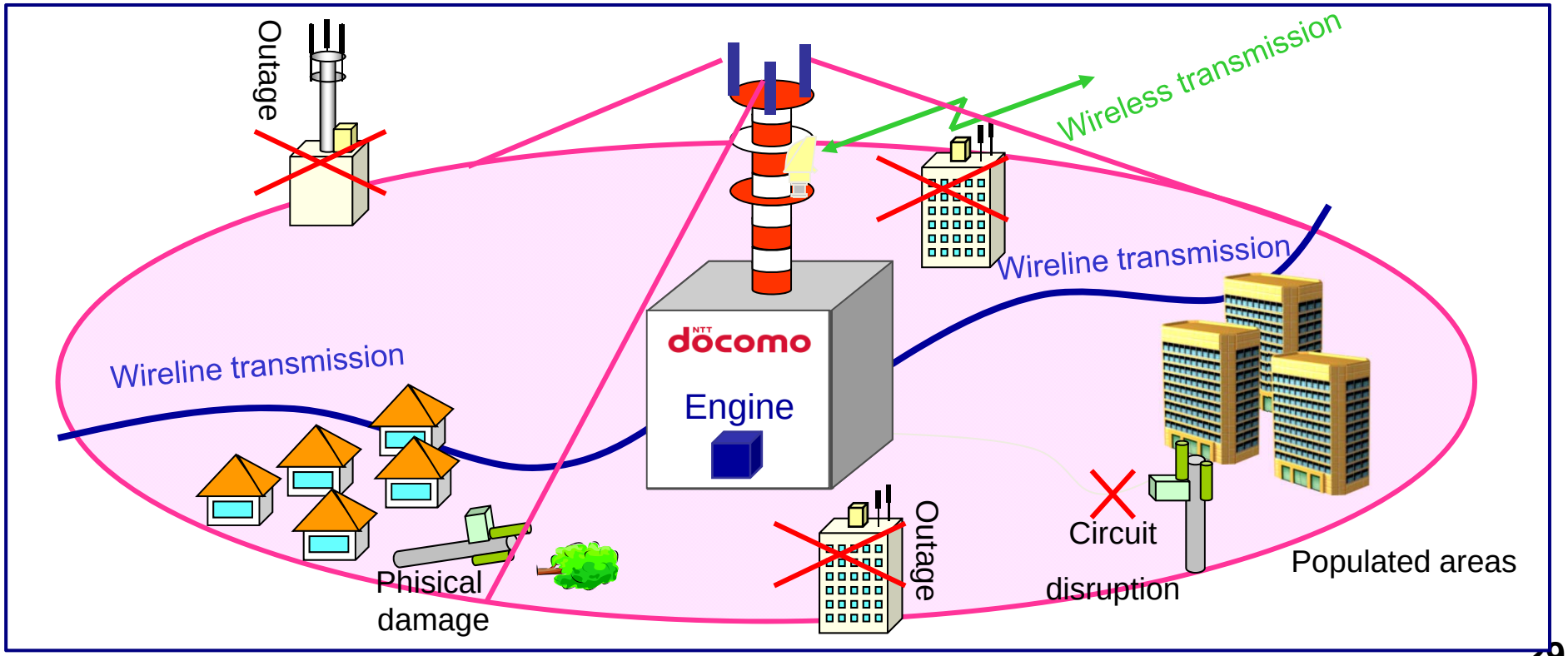
<Reference> Earthquake-proof level of access equipment

seismic intensity	Indicator of communication securing	Earthquake-proof indicator of equipment outside place
5	Problem-free operation	No damage
6	Deterioration in quality but not cut off.	Underground equipment has negligible damage.
7	Shut down of a large communication network can be prevented.	Cable tunnel damaged but doesn't collapse.

Construction of large-zone base stations

Newly construct base stations using **large-zone scheme** to efficiently secure communications over **densely populated areas** in the event of a widespread disaster or power outage

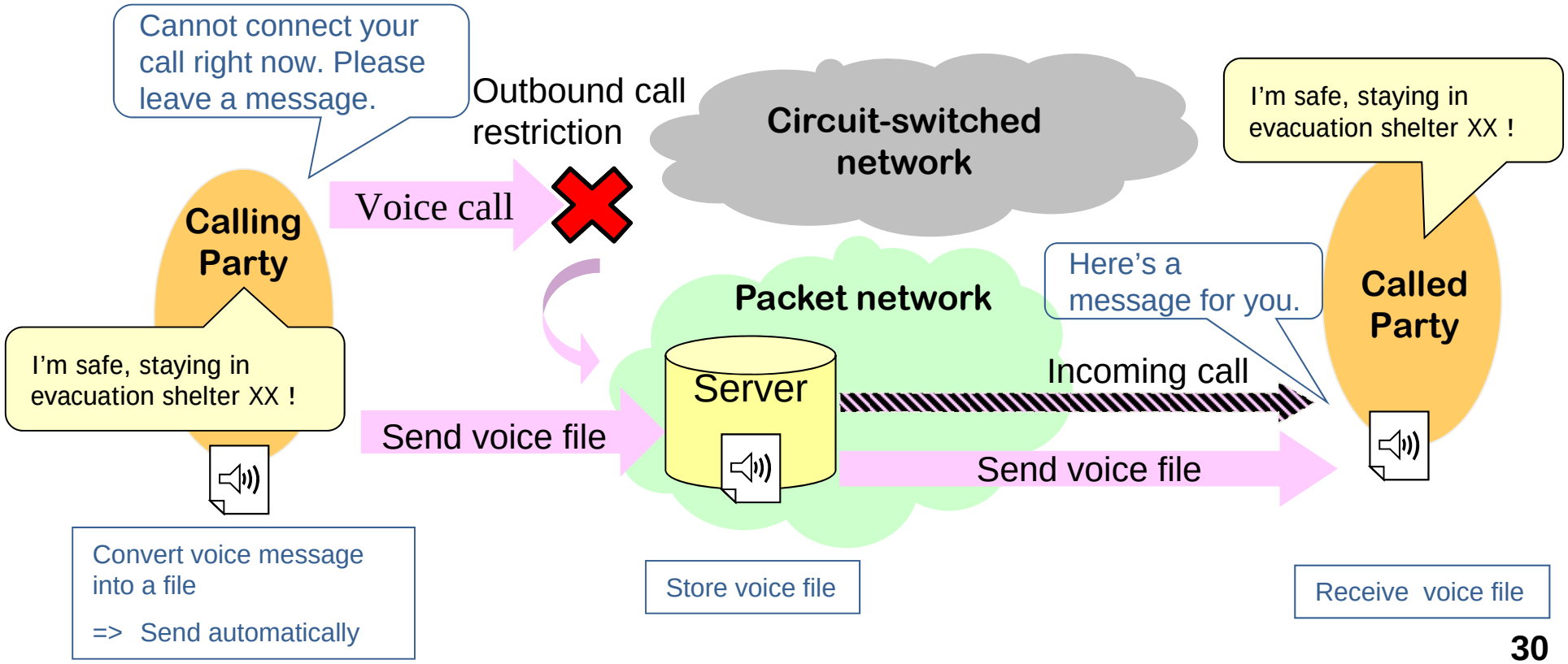
- Deployment in a total of approx. 100 locations across Japan
- Use of large-zone scheme with 7-km radius and 360-degree antenna directivity



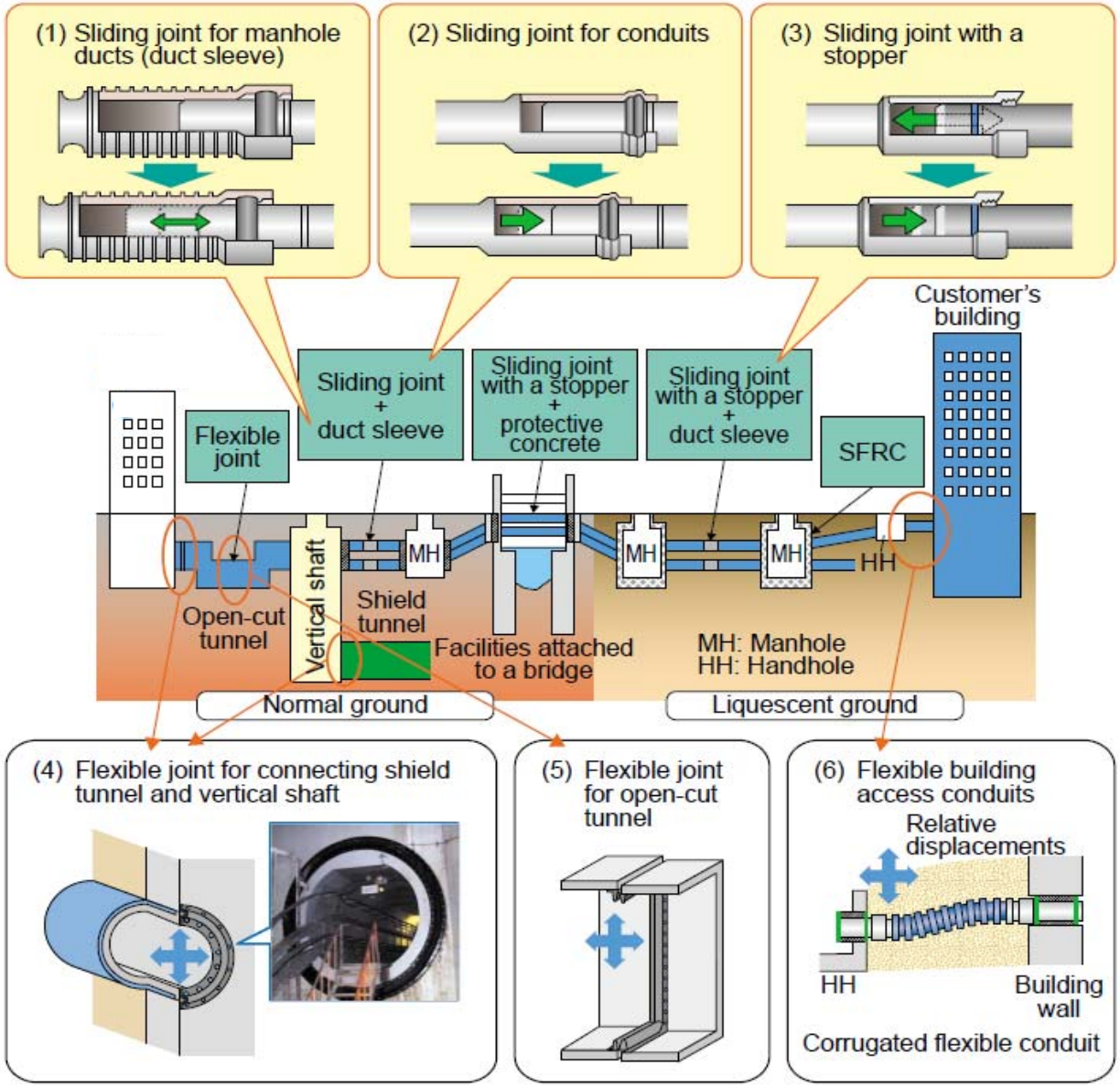
Disaster voice message service

Develop a service that carries voice messages to their destination by efficiently transmitting voice files over a packet network via a server, because voice calls are difficult to connect with circuit-switched networks in the event of a disaster due to the congestion caused by the massive number of outbound calls

Service image



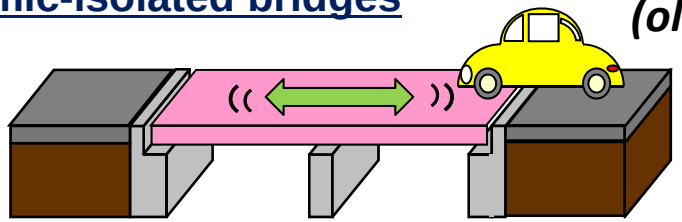
Earthquake countermeasures for underground facilities



Recent technologies for access infrastructure

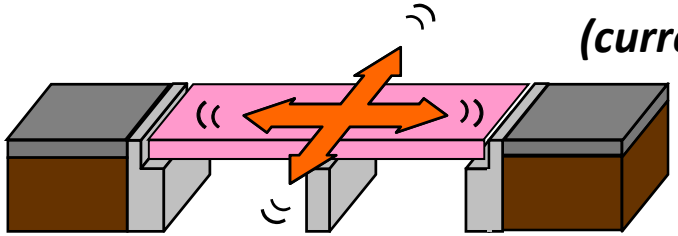
We developed technologies that combine traditional flexible joints with elastic parts to resist bridge vibration in all directions.

* Seismic-isolated bridges



(old)

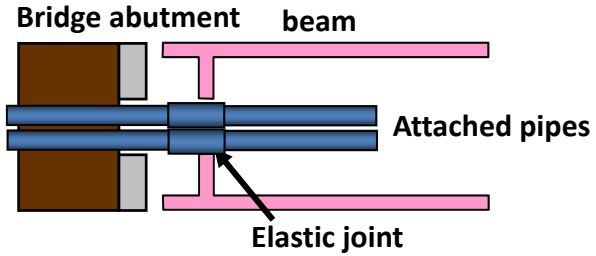
Vibrates in bridge-axial direction only

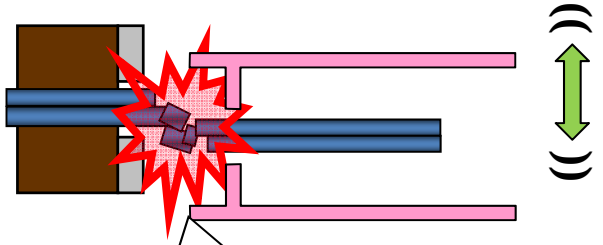


(current)

Vibrates in all directions

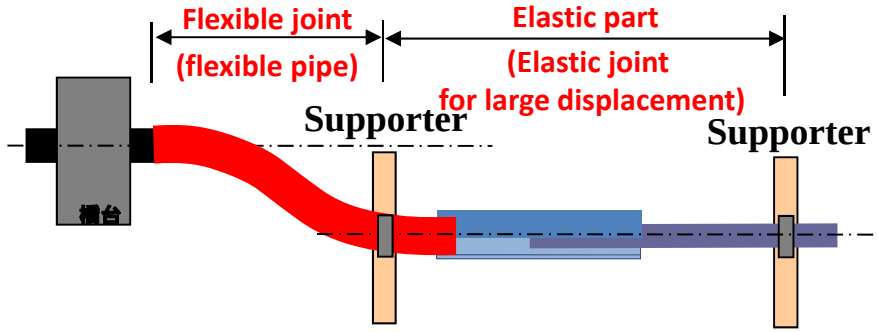
* Bridge-attached equipment



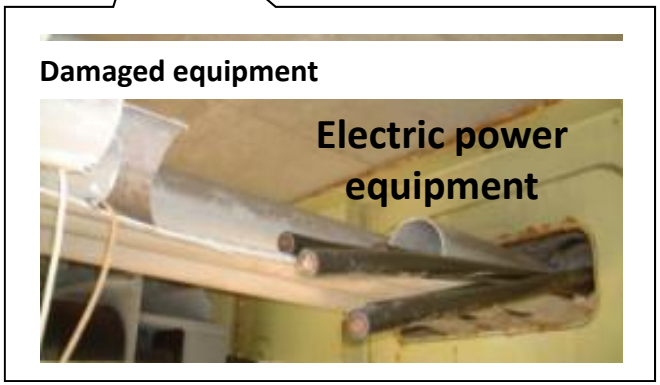


Traditional elastic joint cannot resist movement of seismic-isolated bridges

* Provision



Resistant to both right- and axis-angle large displacement



Summary

- **Overview of Great East Japan Earthquake**
  - **Telecommunication facilities were damaged and disrupted by earthquake and tsunami.**
  - **All communication services were stopped in the affected area.**
- **Research and development of telecommunication technologies for disaster relief and network resilience**

- **Reconfirm the importance and necessity of standardization studies in relation to disaster relief systems, network resilience and recovery**
- **Wide-range investigation of requirements for ICT systems that are utilized during a disaster**

Thank you!