

(when the equipment and supplies were removed), providing satellite channels in Tsukuba Space Center, Ofunato and Otsuchi in Iwate Prefecture and Onagawa in Miyagi Prefecture.

These channels were used to collect a variety of information in line with the requirements of the disaster areas, which ranged from governmental needs (such as the capacity for information gathering by disaster countermeasures offices) to those of the general public (such as the capacity for information collection to confirm people's safety at evacuation sites). JAXA offered flexibility in response to requests for the hours of communication line provision to be extended.

Although the data transfer rates of KIKU No. 8 are limited, the high mobility and operability of related communication terminal equipment highlighted the satellite's important role in securing post-disaster communication lines as part of initial response efforts. It was also clarified that the top priority for people in disaster areas was the provision of telephone and Internet functions rather than disaster-management application. The provision of Internet connections over a long period further highlighted that usage patterns shifted over time from operation to collect information on damage in the immediate aftermath of the disaster to gathering daily living information toward recovery.

The provision of communication lines using KIKU No. 8 (an R&D satellite) went smoothly even though this was the first time it had been used to support disaster-related measures. It enabled the provision of ongoing stable communication environments, except when operations were interrupted by bad weather (strong winds), over a period of approximately two months with almost daily aftershocks. There were no personnel accidents or major issues with the satellite and related communication equipment/supplies during this period.

The support sites fully tested the functions and performance of KIKU No. 8, and its high potential was demonstrated and utilized at the support sites as a result.

2.2.3 Summary

A digital divide issue emerged in northeastern coastal areas in the immediate aftermath of the Great East Japan Earthquake. To help bridge this divide, JAXA provided the disaster countermeasures offices in Iwate Prefecture and Onagawa Town in Miyagi Prefecture with communication lines using KIZUNA and KIKU No. 8. Changes in the overall state of damage to commercial communication lines and findings gained through JAXA's support activities for disaster areas and other matters are summarized below.

2.2.3.1 Communication infrastructure damage caused by the Great East Japan Earthquake

Communication infrastructure damage and related influences are summarized in *Damage to Information and Communications Infrastructure Caused by the Great East Japan Earthquake and the Present Status of Restoration* (Reference Material No. 37-1-10) in the handout given at the 37th meeting of the Information and Communications Council's Information and Communications Policy Committee under the Ministry of Internal Affairs and Communications. The statistics below are from this source.

Figure 2.2-30 shows the status of damage and congestion relating to fixed-line and mobile communications. A total of 1.9 million landlines and 15,000 mobile phone base stations were damaged.

Figure 2.2-31 shows changes in the numbers of disconnected landlines and suspended mobile phone base stations between March 11 and May 6. It can be seen that immediately after the quake, both landline and mobile phone communications were possible in many areas. However, the problem worsened thereafter because private generators at relay and base stations (i.e., control stations) were used due to power failures after the quake, and disruption to landlines and base stations peaked once these units ran out of fuel (see

Figure 2.2-32).

Figure 2.2-33 shows changes in the status of damage to communication lines in Iwate Prefecture 2 weeks, 1 month and 1.5 months after the disaster. At the two-week stage, lines were yet to be restored in 10 municipalities, including Kamaishi, Ofunato and Otsuchi, where JAXA provided communication facilities. A month after the disaster, recovery still had not been achieved in parts of five municipalities, including Kamaishi, Ofunato and Otsuchi Town. All lines were finally restored 1.5 months after the disaster.

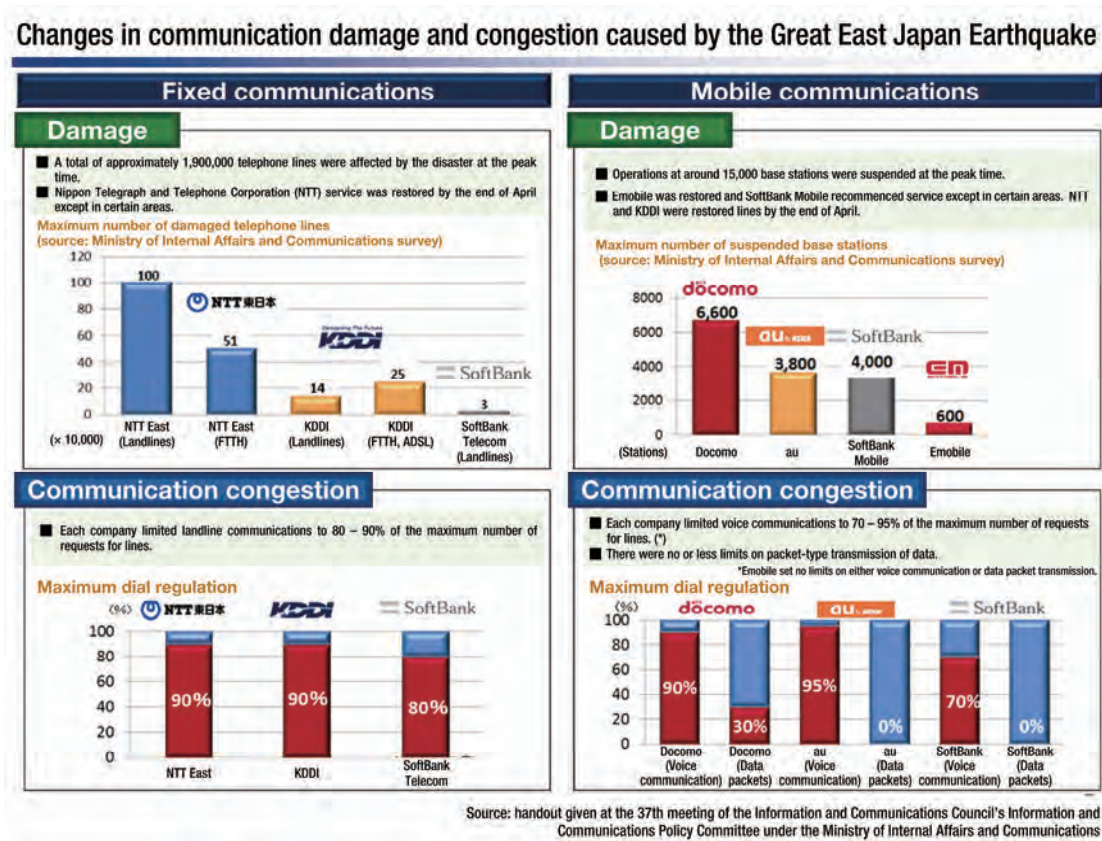


Figure 2.2-30 Changes in communication damage and congestion caused by the Great East Japan Earthquake

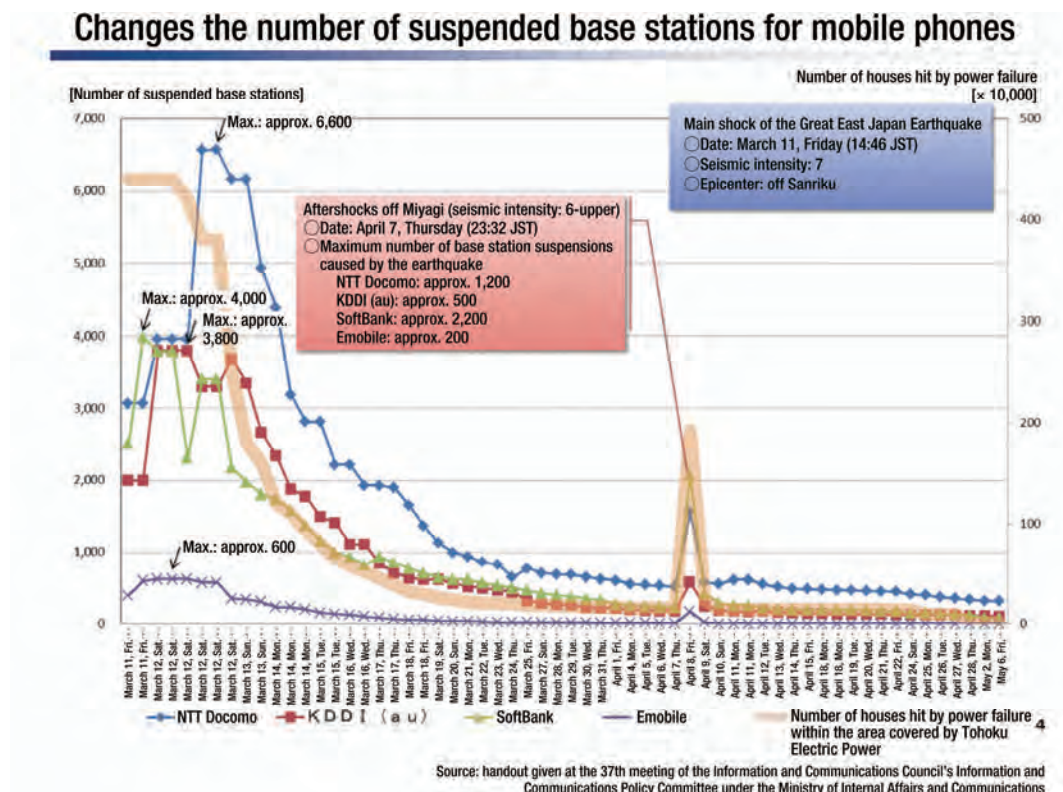
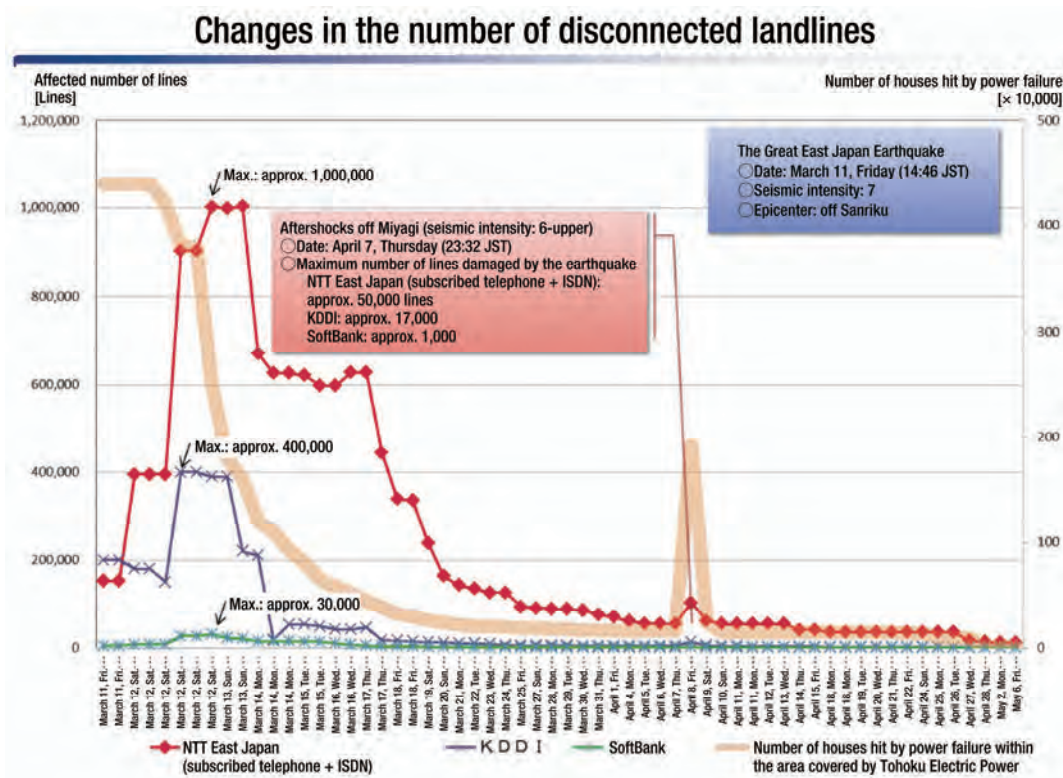


Figure 2.2-31 Changes in numbers of disconnected landlines and suspended mobile phone base stations

Damage to mobile phone networks

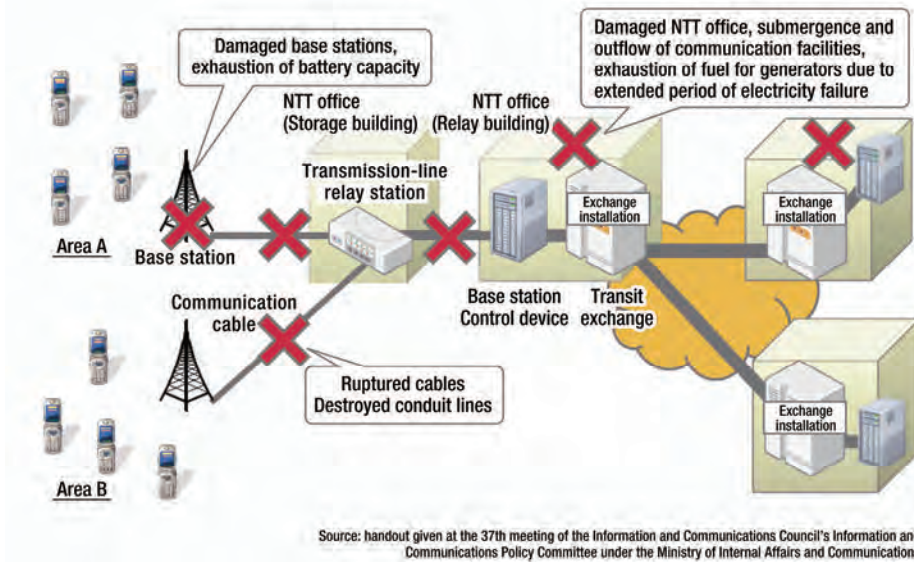


Figure 2.2-32 Locations of damage to mobile phone networks

Changes in the situation of damage caused by the Great East Japan Earthquake (geographical distribution)

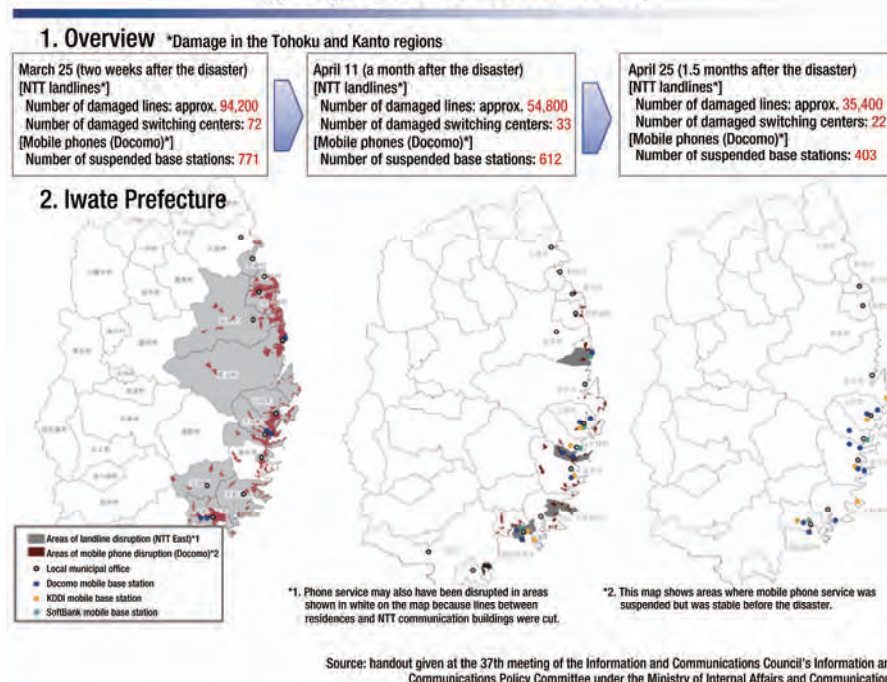


Figure 2.2-33 Changes in damage to communication lines in Iwate Prefecture

2.2.3.2 Findings from communication line provision work in disaster areas

Findings made through direct interaction with representatives of prefectural/local disaster countermeasures offices, disaster victims at these offices and staff dispatched from national/local government bodies are summarized below.

- Ideally, the quality of telephone and Internet services provided should match that of pre-disaster levels.
 - Immediately after the disaster, facilities to communicate the need for emergency medical assistance and to request help were considered more important than food, gas and water.
 - In Iwate Prefecture, a lack of communication facilities delayed rescue work.
 - Many survivors had mobile phones on their person, but PCs were mostly located in washed-away/damaged houses and buildings. As a result, electronic communications were difficult regardless of the status of Internet service recovery. In Kamaishi and Otsuchi in Iwate Prefecture and Onagawa in Miyagi Prefecture, government buildings sustained tsunami damage, and the number of PCs available was limited as a result.
- In tsunami-ravaged coastal areas, damage to base stations and overland cables caused an immediate digital divide. In this regard, it is important for local governments to share information and broadcast prompt reports on aftershocks, tsunamis and similar.
 - Municipalities that could not be contacted immediately after the earthquake and tsunami had suffered serious damage, and faced the worst conditions.
 - In coastal areas of Iwate Prefecture, information on aftershocks and accompanying tsunami could not be broadcast to local residents after the initial tsunami damage.
- Information and communication lines in various forms are required depending on time, place and usage. Generally, disaster victims and local government staff used telephones for different purposes. Meanwhile, disaster victims used the Internet mainly to download information, while local government staff used it to upload information from disaster areas.
 - Earthquake/tsunami – 2nd week: Phone and Internet lines were disrupted.
 - ✓ Disaster victims
Used phone services to let people know they were safe and accessed the Internet to e-mail, locate other affected people and obtain information on the extent of the devastation. The phone line capacity provided approximately matched the demand for the service.
 - ✓ Teams dispatched from municipalities and other organizations outside disaster areas
Used phone services to communicate with their activity bases and accessed the Internet to send images of disaster areas to their home organizations and to check maps and road conditions at their dispatch destinations.
 - ✓ Local government staff in disaster areas
Used phone services and the Internet to clarify situations and share information. Communication lines were also used for videoconferencing between prefectural and local disaster countermeasures offices. KIZUNA provided upload speeds of up to about 6 Mbps at Kamaishi's local countermeasures office (Iwate Coastal Regional Development Bureau).
 - 2nd week after the disaster onward: Most phone networks were restored. Internet connections with speeds matching those of communication cards provided by telecommunications carriers (i.e., several hundred Kbps or more) were achieved.
 - ✓ Disaster victims and evacuation sites

Used Internet services to collect information on everyday living (e.g., procedures for disaster victim certificate issuance, evacuation sites, insurance coverage, cancellation of contracts for essential utilities, job openings, schools and used cars). KIKU No. 8 provided connection speeds of up to about 768 Mbps at the evacuation site in Onagawa.

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These usage details are summarized in Table 2.2-4 below.

Table 2.2-4 Summary of communication line usage in disaster areas

Target	Details	Purpose	Circuit capacity	Notes
Victims		Phone calls and e-mails to support confirmation of people's safety	Double-digit kbps upward (upload and download)	Phone service is essential for victims to confirm people's safety and make emergency calls.
Evacuation sites		Phone calls and Internet service to support confirmation of people's safety and collection of information on damage and everyday living	KIKU No. 8 provision: 768 kbps upward	Evacuation sites in Otsuchi Town, Iwate and Onagawa Town, Miyagi
Dispatched teams		Release of local information and sharing with organizations dispatching teams, delivery of images and collection of map information	Several Mbps upward	The circuit capacity between evacuation sites and local municipalities is used to deliver local images.
Municipalities in disaster areas	Local disaster countermeasures office organized	Internet service to collect, share and release information, videoconferencing to share information	KIZUNA provision: 6 Mbps upward	Iwate Prefecture Disaster Countermeasures Office and local countermeasures offices in Kamaishi and Ofunato (Coastal Regional Development Bureau)
	No local disaster countermeasures office organized	Internet service to collect, share and release information	KIKU No. 8 provision: 768 kbps upward	Ofunato City Hall, Iwate

The successful provision of communication lines using KIZUNA and KIKU No. 8 demonstrated the direct applicability of results from previous related JAXA experiments and training programs. The satellite network provided by KIZUNA and KIKU No. 8 along with commercial communications satellites served government bodies and other organizations in disaster areas. This is a clear indication that satellite networks are a necessary supplement to terrestrial lines, which by themselves may be inadequate. Terrestrial networks are vulnerable to major disasters like the March 11 calamity due to possible disconnection of communication cables and destruction of base stations. To protect human life and property, satellite network systems and the supplementary connections they provide are essential. In light of the serious damage and extreme hardships suffered in areas where communications were cut off immediately after the disaster, there is an urgent need to examine the future of information and communications technologies for improved disaster-preparedness in Japan.