
2.2 Communications satellite-based activities

2.2.1 KIZUNA (WINDS)

2.2.1.1 Overview and characteristics of KIZUNA

The KIZUNA Wideband InterNetworking engineering test and Demonstration Satellite (WINDS) was jointly developed by JAXA and the National Institute of Information and Communications Technology (NICT) and launched on February 23, 2008. It is designed to support the development and demonstration of technologies and to perform related demonstration testing, thereby contributing to the formation of an advanced information and communications network society without disparities in data availability through operation in conjunction with ground-based infrastructure.

KIZUNA follows an orbit above the equator at 143 degrees east longitude, and is equipped with multi-beam antennas (MBAs) featuring fixed multi-spot beams covering Japan and Southeast Asia and an active phased array antenna (APAA) that covers a wide area with scanning beams (see Figure 2.2-1). Its switching equipment enables signal switching on board the satellite itself.

KIZUNA features the following characteristics of ordinary geostationary communications satellites:

- Wide coverage area: Covers almost a third of the earth's surface without geographical restriction.
- Broadcast: Information is simultaneously received within the coverage area.
- Disaster resistance: Networks are not affected by disasters, and line setting is easy.

KIZUNA also has the following characteristics that make it superior to conventional communications satellites:

- Ultra-high-speed satellite communications (155 Mbps for the 45 cm ϕ small antenna and 1.2 Gbps for the 5 m ϕ antenna):

Its small antennas supporting ultra-high-speed communications are especially useful in setting up temporary lines. For this purpose, JAXA operates portable VSAT and portable USAT user terminals (see Figure 2.2-2).

- Communications without links to a hub station with half the conventional delay time:

By halving the delay time of conventional satellites that use a hub station for communications, KIZUNA allows videoconferences to be conducted with minimal interference.

- IP (Internet Protocol) interface highly compatible with ground equipment:

The interface with the earth station is IP-based, and the ability to use commercially available devices as ground equipment allows the adoption of inexpensive modern instruments. By way of example, videoconferences, wireless LAN, IP telephones and PCs can be connected with no special interface arrangement.

- KIZUNA's own communication specifications provide outstanding data security and make interception difficult:

Existing communications satellites frequently use the Ku band or lower, whereas KIZUNA uses the high-frequency Ka band. The unique communication protocol specifications used provide outstanding data security.

JAXA utilized these characteristics and conducted basic experiments to analyze the fundamental performance of the communication network system and on-board equipment and to perform demonstration tests. The results indicated that KIZUNA is suitable for use in a variety of fields such as emergency communications, the bridging of digital divides, distance learning and telemedical services.

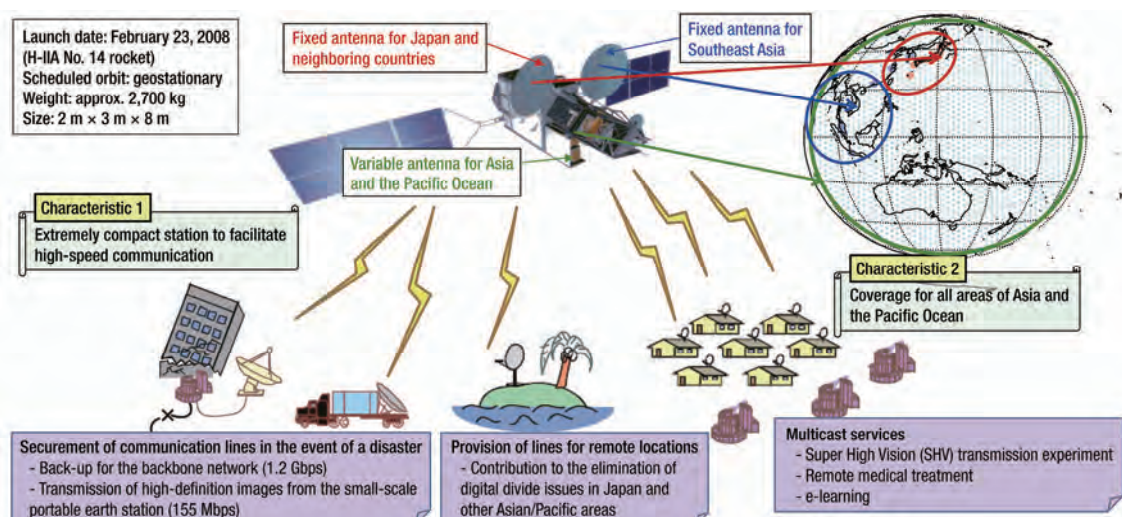


Figure 2.2-1 Image of KIZUNA in orbit and coverage areas

Earth station equipment	HDR-VSAT	Portable very-small-aperture terminal (VSAT)	1.2-m portable VSAT	Portable USAT
Antenna diameter	1.2m	1.0m	1.2m	45cm
Output from transmitter (Rated capacity)	250W (TWTA)	40W (SSPA)	40W (SSPA)	10W (SSPA)
Data transfer rate				
Upload	1.5/6/24/51/155Mbps	1.5/6/24/51 Mbps	1.5/6/24/51 Mbps	1.5/6 Mbps
Download	155Mbps	155Mbps	155Mbps	155Mbps
Service areas (MBA or APAA)	MBA/APAA	MBA	MBA/APAA	MBA
Weight (standard)	442kg	97kg	More than 90kg	53kg
Images				

Figure 2.2-2 Examples of KIZUNA experimental stations

2.2.1.2 Background to the provision of communication lines in affected areas

- March 11, 2011: JAXA scheduled disaster drills involving the use of KIZUNA on March 12 and 13 on Sado Island in Niigata along with NPO Aichi Net, Ibaraki Rescue Support Bike and Kanagawa Rescue Support Bike in conjunction with Sado City. The Great East Japan Earthquake hit when JAXA staff were near the ferry terminal in Niigata on the way to Sado Island, and the drills were cancelled.
- March 12: In response to an earthquake with a seismic intensity of 6 upper in the Chuetsu area of Niigata, an arrangement for the provision of communication lines using KIZUNA was discussed with the prefectural staff in charge of disaster management at the Niigata Prefecture Disaster Countermeasures Office (Niigata Prefectural Government Disaster Prevention Center). However, it was found that no areas had been left without communication lines in the prefecture, and JAXA asked them to contact municipalities in coastal Tohoku instead. It was possible to reach the Fukushima Prefecture Disaster Countermeasures Office, but not the corresponding offices in the prefectures of Iwate and Miyagi. Plans to provide communication lines to Fukushima Prefecture were abandoned due to the unpredictable safety situation brought about by the nuclear power plant accident in the region.
- March 15: A request was received from the Iwate Prefecture Disaster Countermeasures Office (Morioka) for the provision of communication lines using KIZUNA to support information sharing and Internet usage, as telephone and other communication systems were congested at the Kamaishi on-site disaster countermeasures office (Wide-area Coastal Promotion Bureau). After consultation with JAXA and the Ministry of Education, Culture, Sports, Science and Technology (MEXT), the Chief of the Disaster Management Office at the Department of General Affairs in Iwate Prefecture asked the Director-General of MEXT's Research and Development Bureau to support the securement of communication lines using KIZUNA.
- March 15: The Director-General of MEXT asked the President of JAXA to fulfill this request. In response, safety in field activities was confirmed with the staff in charge from the Disaster Management Office of the Department of General Affairs at the Iwate Prefecture Disaster Countermeasures Office, and the Tsukuba City Disaster Countermeasures Office was asked to issue emergency passes because the Tohoku Expressway was closed to the public. JAXA also asked Iwate Prefecture to secure accommodation, provide official vehicles and issue certificates that would give the Agency priority in purchasing gasoline.
- March 16: At a meeting of JAXA's Disaster Countermeasures Office, a decision was made to provide KIZUNA services to Iwate Prefecture.
- March 17: Communications equipment and five staff members were dispatched to the field.
- March 18: Equipment was transported to the Prefecture Disaster Countermeasures Office (Morioka), and earth station facilities and communications equipment were installed.
- March 19: Earth station facilities and communications equipment were installed at the on-site disaster countermeasures office (Kamaishi). Connection between the two offices was confirmed.
- March 20: Communication service was started using the line of communication between the Prefecture Disaster Countermeasures Office (Morioka) and the on-site disaster countermeasures office (Kamaishi).
- March 22: Due to problems with communication lines for the on-site disaster countermeasures office (Wide-area Coastal Promotion Bureau) in Ofunato City, the Prefecture Disaster Countermeasures Office asked JAXA to provide communication lines using KIZUNA in order to support information sharing and Internet usage. After consultation with JAXA and MEXT, Chief of the Disaster Management Office of the Department of General Affairs in Iwate Prefecture asked the Director-General of MEXT's Research and Development Bureau to support the securement of communication lines using KIZUNA.
- March 22: The Director-General of MEXT asked the President of JAXA to fulfill this request.
- March 23: Communications equipment and one staff member were dispatched to the on-site disaster countermeasures office (Wide-area Coastal Promotion Bureau) in Ofunato City.

- March 24: The staff member dispatched to provide communication lines in Kamaishi joined in with work at the on-site disaster countermeasures office (Wide-area Coastal Promotion Bureau) in Ofunato City, installing earth station facilities and communications equipment. The provision of communication lines to connect the three offices started.
- April 24: As business communication lines for the on-site disaster countermeasures offices (Wide-area Coastal Promotion Bureaus) in the cities of Kamaishi and Ofunato were mostly restored, the provision of communication lines using KIZUNA was ended in coordination with the Prefecture Disaster Countermeasures Office and MEXT.
- April 25: Earth station facilities and communications equipment were removed from the three offices.

2.2.1.3 Communication modality and results of communication line usage

Figure 2.2-3 shows a schematic representation of support offered by JAXA to disaster areas in Iwate Prefecture through the provision of communication lines using KIZUNA. A portable VSAT unit installed at the Iwate Prefecture Disaster Countermeasures Office (part of the Iwate Governor's Office) was connected using KIZUNA with portable USAT and VSAT units installed at the local disaster countermeasures offices in the cities of Kamaishi and Ofunato. Additionally, the High Data Rate VSAT (HDR-VSAT) at the Tsukuba Space Center was designed to connect with public Internet networks, and connections were established from these support bases.

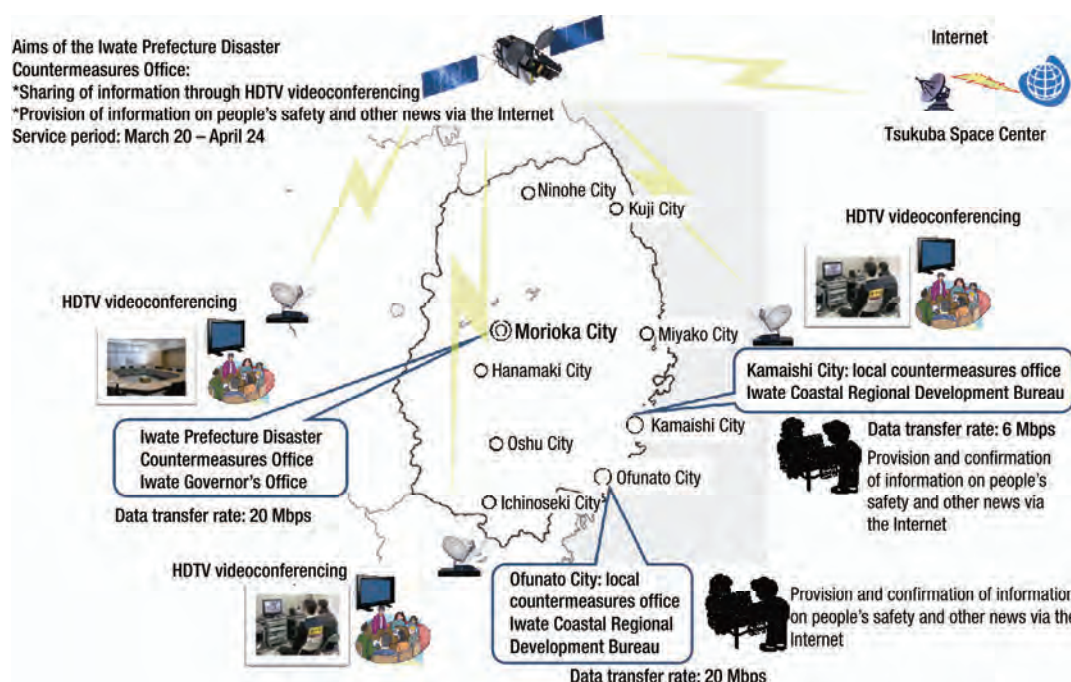


Figure 2.2-3 Schematic representation of support offered by JAXA to disaster areas in Iwate Prefecture through the provision of communication lines using KIZUNA

In addition to the portable VSAT/USAT experimental stations, the support bases were also equipped with an all-in-one unit of disaster-related equipment and supplies (peripheral communication equipment, including an L3 switch and a TCP accelerator, housed in a general-purpose rack), a videoconferencing system, application equipment for wireless LAN access points and other items. These were used for videoconferencing, Internet services and other purposes. Photos and schematic representations of antenna installation locations at the support bases are shown below.

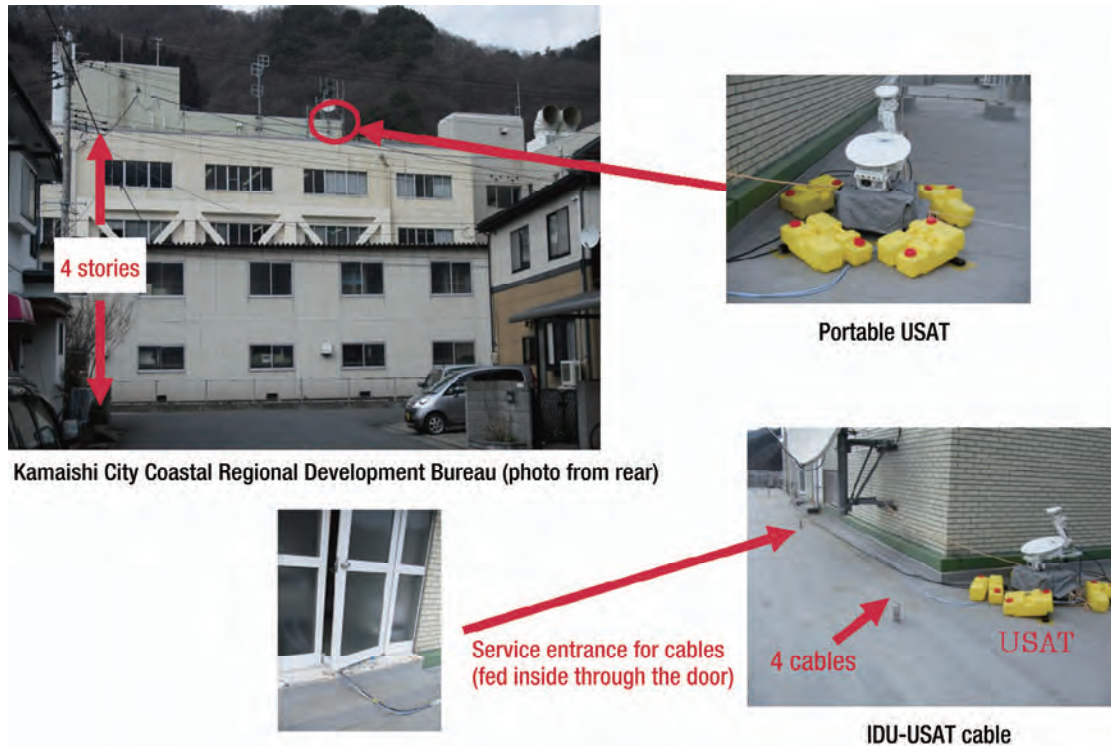


Figure 2.2-6 Outdoor unit (ODU) installed at the Kamaishi Coastal Regional Development Bureau

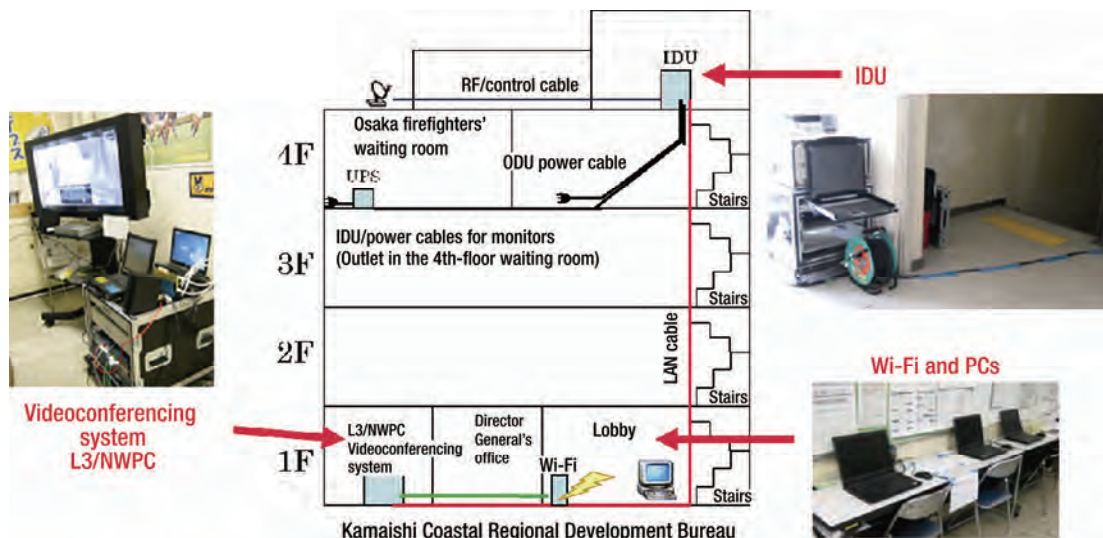


Figure 2.2-7 Schematic representation of equipment installed at the Kamaishi Coastal Regional Development Bureau

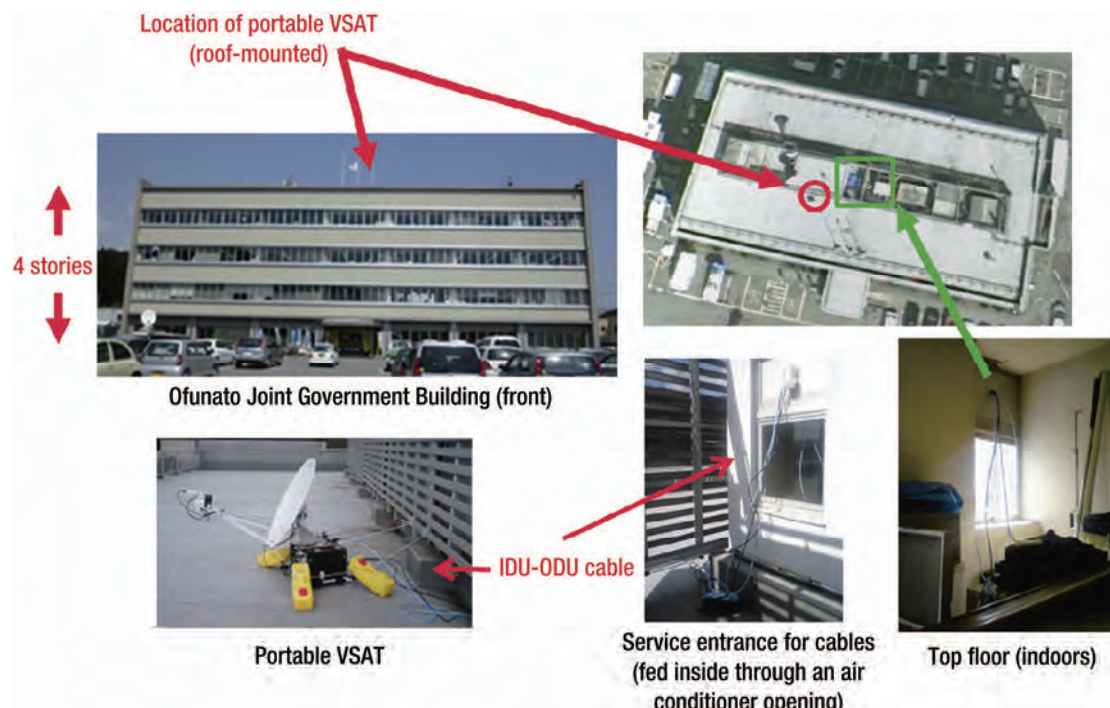


Figure 2.2-8 Outdoor unit (ODU) installed at the Ofunato Coastal Regional Development Bureau

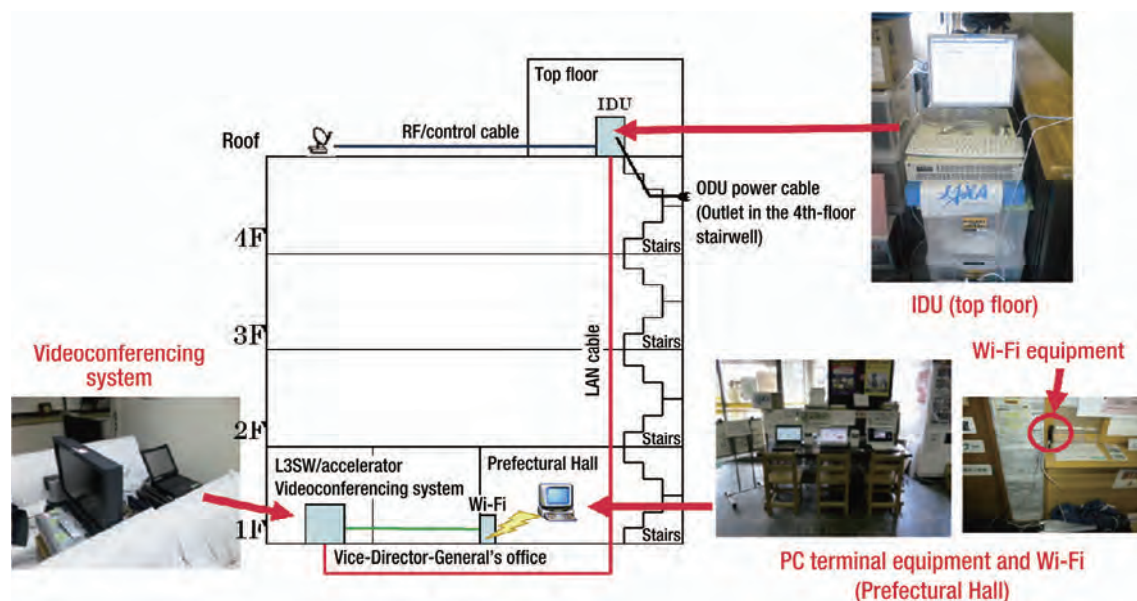


Figure 2.2-9 Schematic representation of equipment installed at the Ofunato Coastal Regional Development Bureau

Videoconferencing

As part of JAXA's support activities, the videoconferencing systems installed at the support bases were used for information sharing by disaster countermeasures offices. The details of their usage are outlined below.

At the Prefecture Disaster Countermeasures Office, support activities were engaged in not only by prefectural government employees but also by staff dispatched from other prefectural governments, government ministries and agencies (e.g., the Cabinet Office, the Ministry of Health, Labour and Welfare, the Ministry of Land, Infrastructure, Transport and Tourism, the Ministry of Internal Affairs and Communications, the Fire and Disaster Management Agency, and the Japan Self-Defense Forces (JSDF)) and other organizations. Accordingly, liaison and coordination meetings were held almost daily at the Prefecture Disaster Countermeasures Office for two purposes: 1. to share information on sanitary conditions at evacuation sites, the living conditions and needs of disaster victims, the status of search operations for missing people, and other considerations; and 2. to solve problems toward expedited recovery and reconstruction efforts. The information shared and the decisions made by the prefectural government at these meetings and other gatherings took time to reach local disaster countermeasures offices in coastal areas, and much more time was needed until the information was shared with smaller local countermeasures offices.

To address this delay issue, local disaster countermeasures offices and the Prefecture Disaster Countermeasures Office were connected by a videoconferencing system via KIZUNA so that local office representatives could participate in the liaison and coordination meetings held by the prefectural government from their own offices. In this way, the videoconferencing system supported real-time information sharing and opinion exchanges with the prefectural government.

The system was well received by staff at local disaster countermeasures offices, who highlighted its usefulness for promptly communicating the state of devastation in coastal areas to the prefectural government. Specific advantages mentioned include superior voice and image clarity (of a level that allowed small print on the screen to be read) compared to the web conference system previously used by the Iwate Prefectural Government, and the capacity for real-time transmission of videos captured from helicopters above coastal areas and other resources.



Figure 2.2-10 Liaison and coordination meeting held by the prefectural government
(center: videoconferencing system)

Internet services

As part of JAXA's support activities, wireless LAN access points were set up at support bases to connect to public Internet lines by linking to HDR-VSAT installed/operated in Tsukuba using KIZUNA. At the Prefecture Disaster Countermeasures Office in Morioka City, a wireless LAN access point was set up in the room next to the disaster countermeasures office (where the videoconferencing system was installed) for use

by staff dispatched from supporting organizations. In particular, pre- and post-earthquake images from the Daichi satellite (PALSAR and AVNIR) showing coastal areas of Iwate were downloaded at high speed from the Daichi Bousai WEB via KIZUNA for use in planning debris removal work and to help visualize the status of removal progress.

At the local disaster countermeasures offices in Kamaishi and Ofunato, a wireless LAN access point and three Internet-enabled laptops were installed in the entrance lobby, which was open to the public. These units were used by disaster victims and individuals dispatched to coastal areas by various organizations to assist with support activities.

During the period of provision from March 20 to April 24, these Internet services were used by 538 people at the disaster countermeasures office in Kamaishi and by 1,252 in Ofunato. Changes in the number of Internet users are shown in Figure 2.2-11. On average, 18.6 people per day used the services in Kamaishi, and 43.1 in Ofunato. The laptop usage rates at the support bases exceeded 50 percent almost all day long, indicating high demand for Internet services.

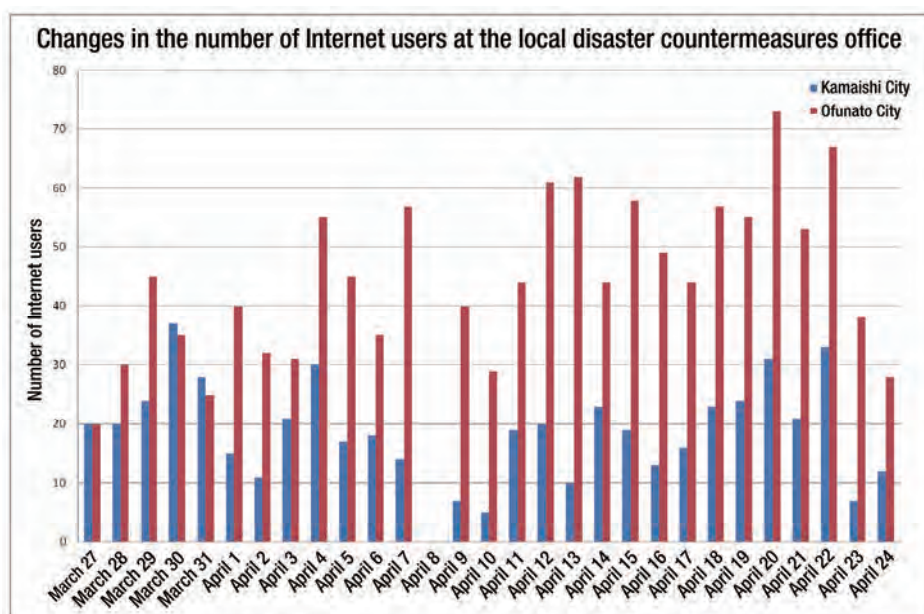


Figure 2.2-11 Changes in the number of Internet users

Usage of the Internet services by staff who were dispatched by organizations to coastal areas to assist in support activities included accessing web-based e-mail to report to their organizations and checking restoration conditions of available means of transportation and roads to destination, and routes to take. Usage by the general public until about two weeks after the disaster was generally to check people's safety and obtain information on disaster-related matters such as evacuation sites, evacuees and the extent of the devastation. In particular, city government website lists showing the names of those affected by the disaster were heavily accessed every day, despite the availability of the same lists in paper form. The prompt information updates and powerful search capabilities of the Internet are believed to have been behind the large user numbers seen. Two weeks after the disaster onwards, Internet usage was more to collect information on everyday living, such as that relating to the issuance of disaster victim certificates, the status of restoration efforts for daily utilities like electricity, gas and telephone lines, applications for temporary housing, housing units for rent, used cars, hospitals/schools and job openings. This usage demonstrates how the type of information sought by disaster victims changes with time from matters relating to the disaster itself to those concerning living environments.