Resilient ICT Research Center

National Institute of Information and Communications Technology

Building disaster-resilient information and communications technology

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Implementing R&D achievements in society and contributing to restoration of disaster-hit areas

The Great East Japan Earthquake and subsequent tsunami of March 11, 2011 resulted in widespread failure of telecommunication networks, which greatly hindered information gathering and recovery efforts. Telecommunication networks were damaged in the earthquake affected areas, and also suffered outages across wider areas not directly affected by the earthquake. These effects had a major impact on society.

A lesson learned from the earthquake is that telecommunication networks are now recognized as a major element of the infrastructure in modern society, and it is vital to ensure they are resilient against disasters. The Ministry of Internal Affairs and Communications (MIC) initiated a study on increasing the disaster resiliency of Japan's telecommunication networks, and with this study, the National Institute of Information and Communications Technology (NICT), together with Tohoku University, has worked to build a new research center with the mission of enhancing cross-sectoral collaboration among industry, academia and government, and to set up a test bed to promote the research. The Resilient ICT Research Center was established in April 2012.

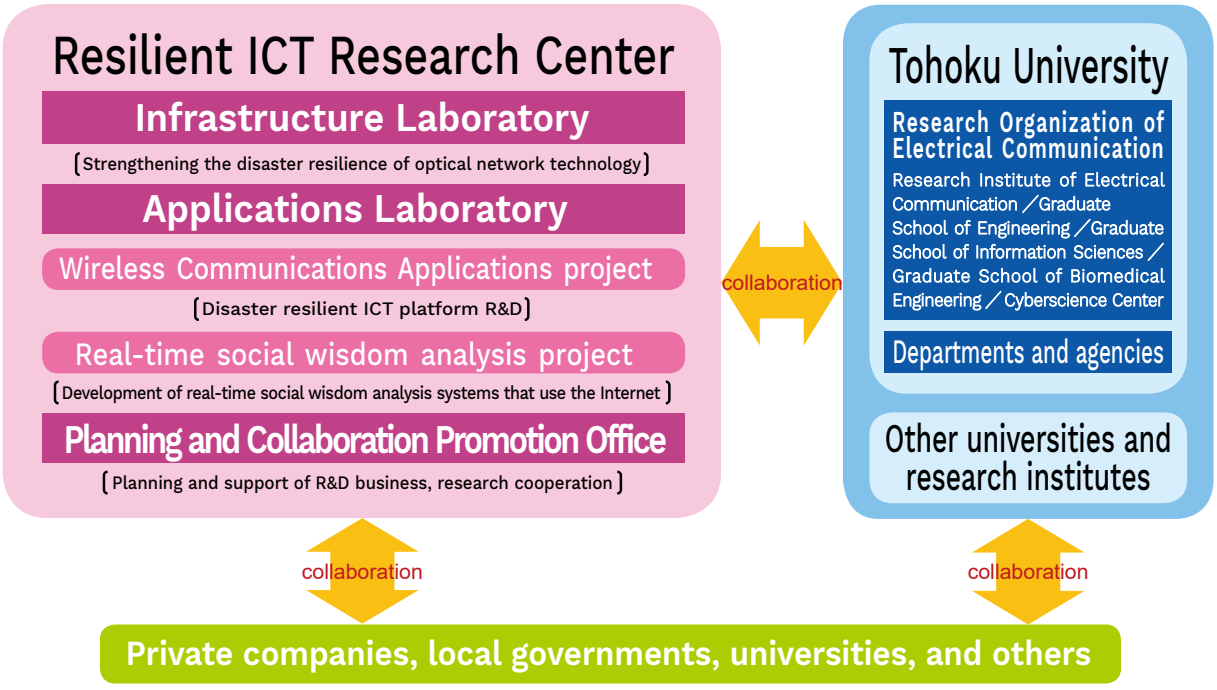
The research center promotes industry-academia-government collaborations with a goal of sharing the social benefits of research results quickly. To this end, we operate a test bed and conduct research centered on three research fields: optical communication technology, wireless technology and information technology. We also engage in joint research with industrial and academic institutions, including Tohoku University. We have set up a Resilient ICT Forum for collaboration with industry and a Resilient ICT Regional Cooperation Committee to liaise with local governments and learn their needs.

The fourth phase of NICT medium-to-long-term plan started in April 2016. NICT has been working on basic research, as well as implementing its research achievements in society and strengthening its role as a core center of collaboration. In addition to ongoing work on the collaborative framework that it has established so far, the Resilient ICT Research Center also works within the Social Innovation Unit of the Open Innovation Promotion Headquarters, to maximize the outcomes from our activities. We remain grateful for the continued support and encouragement of academic institutes, local governments, and industry.

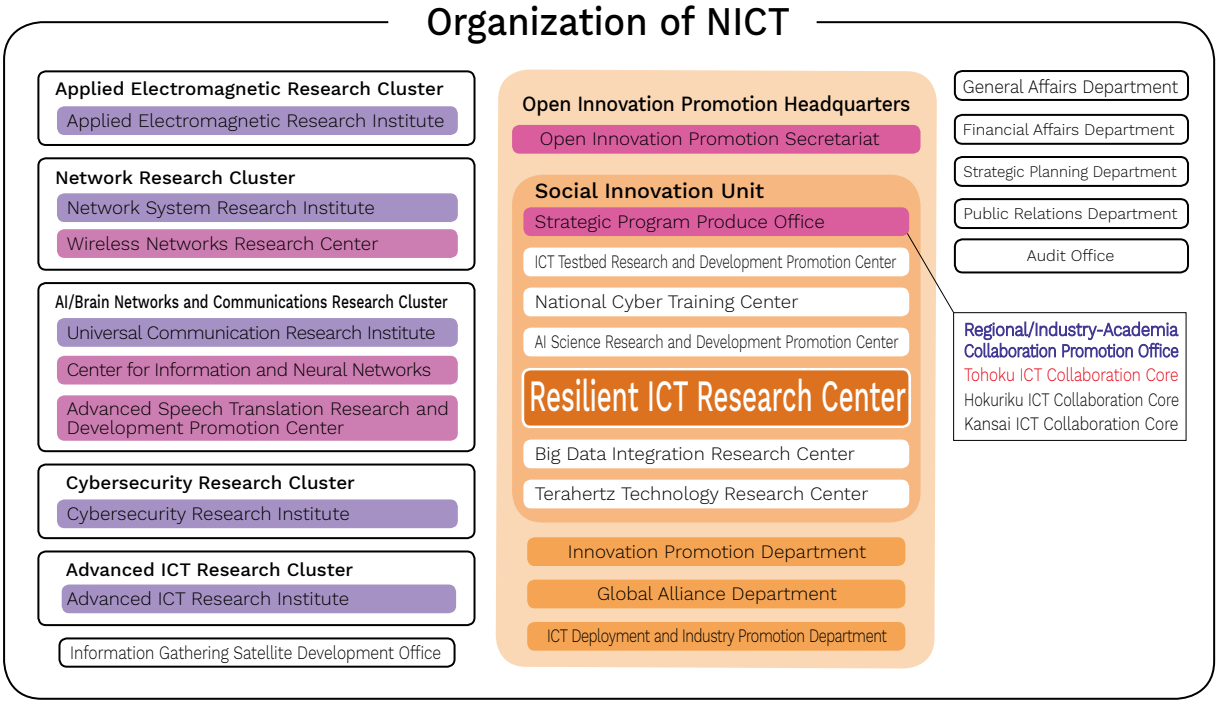
Organization

The Resilient ICT Research Center comprises a Planning and Collaboration Promotion Office and two laboratories—the Infrastructure Laboratory and the Applications Laboratory—where research is carried out in close cooperation with other NICT organizations: the Network System Research Institute, the Wireless Networks Research Center and the Universal Communication Research Institute.

We also collaborate closely on research with the Research Organization of Electrical Communication, the Research Institute of Electrical Communication and other departments of Tohoku University, and work on collaborative studies with the private sector, local governments and other universities.



Organization of NICT



Infrastructure Laboratory

Further strengthening of disaster-resilient optical network technology

Overview

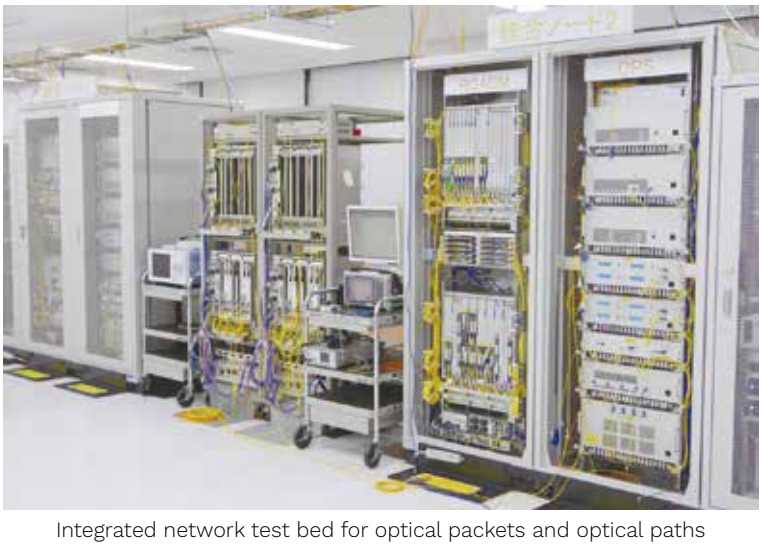
The most important feature of optical networks is their ability to transmit large quantities of data over long distances using low-loss optical fibers. At the time of a large-scale disaster, it can be said that next-generation optical networks will play a crucial role in the two main roles of this property; i.e., alleviating the sudden congestion of traffic, and rapidly establishing a fast-response emergency optical network that meets most of the communication needs in the affected area. So far, we have been working towards the practical technologies for the introduction of several new technologies that have been proven in principle through basic experiments, simulations and the like.

Research and development of elastic optical network

It is known from experience that packet switching networks are resilient to disasters because the packet only uses networks for a very short period of time. A corresponding unit of traffic in an optical network is called an optical packet, and by using optical packets in next-generation networks, it will be possible to alleviate the large-scale congestion that can occur over a wide area. Furthermore, by incorporating new technologies such as elastic communication for highly efficient optical communication, we will work on the basic technology of optical networks that are much more robust even compared with networks using optical packets alone.

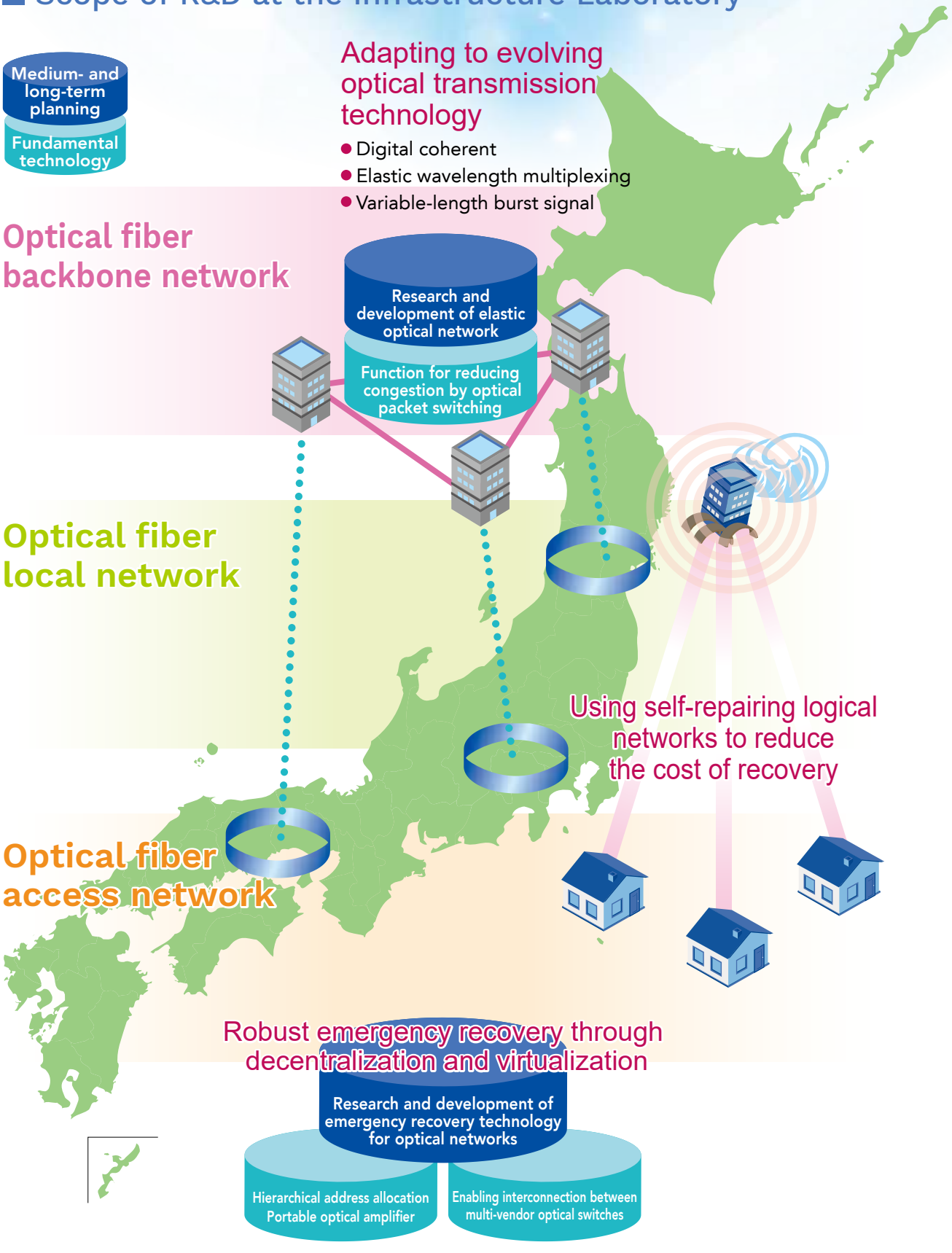
Research and development of emergency recovery technology for optical networks

From a proof-of-principle study to construct a tentative optical network by interconnecting surviving multi-vendor optical communication equipment with optical fibers, we have enhanced the emergency recovery technology for responding flexibly and rapidly to diverse situations such as local networks and subscriber networks, and we have accelerated the recovery of telecommunication environments centered on disaster areas through synergy with normal restoration procedures.



Integrated network test bed for optical packets and optical paths

Scope of R&D at the Infrastructure Laboratory



Applications Laboratory
[Wireless Communications Applications project]

Disaster resilient ICT platform R&D

Overview

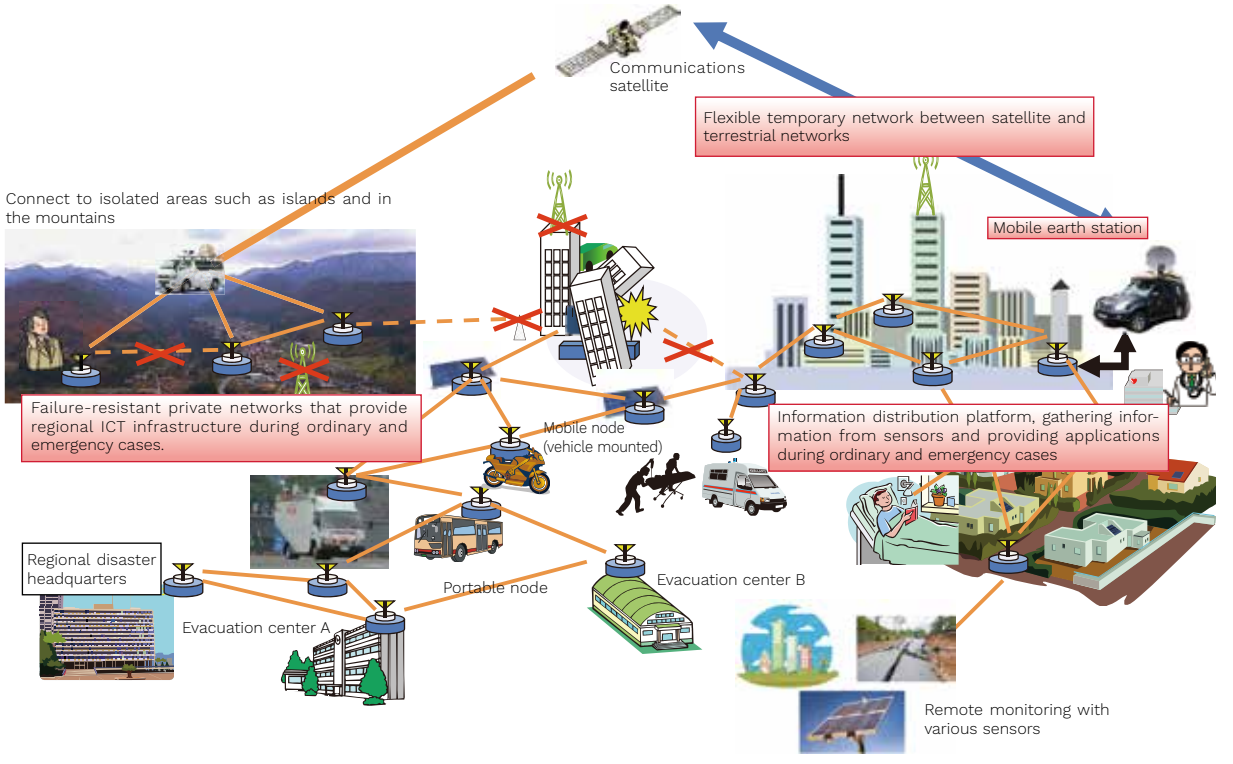
To realize a disaster-resilient ICT platform, the Applications Laboratory's Wireless Communications Applications Project conducts research on technologies and applications of mesh networks that operate autonomously and cooperatively over wide areas, and technologies for flexible wireless networks that are resistant to interruption, even when communicating from mobile objects moving widely such as automobiles and communication satellites.

Research Targets

◎ To develop technology that can minimize the out-of-service area, even when functionality stops in part of the mesh network, maintaining as much network functionality as possible through links with the rest of the network resources, satellites, automobiles and other components, and to demonstrate this capability in events such as disaster preparation drills.

◎ To conduct demonstrations of mobile earth station developed to implement a satellite communications system that is reliable and easy to operate, and to conduct research and development on related technologies.

◎ To develop energy saving communication systems through efficient utilization of radio resources and to conduct research and development toward regional ICT utilization through sensors installed in a mesh network.

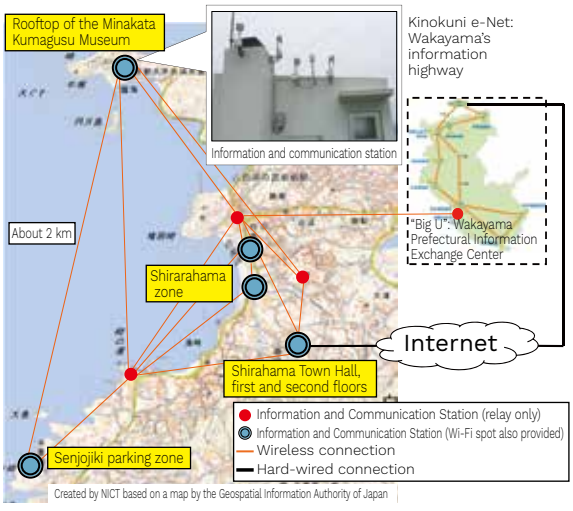


Demonstration in Shirahama, Wakayama Prefecture

We have installed a mesh network in Shirahama, Wakayama Prefecture, and conducted tests to demonstrate its performance as a communications network. The system consists of data communication stations connected by wireless links with mesh topology. This prevents concentration of communication at any one point, so communication can be maintained by the remaining stations if a connection is lost or some equipment is damaged. Connection to the Internet is made possible in Wi-Fi areas established at four locations: Shirahama, Senjojiki, the Minakata Kumagusu Museum, and the Shirahama Town Hall. Usually, these data communication stations can be used for various regional social infrastructure purposes, such as distribution of local information using signage, Internet access for residents and tourists, and monitoring children or elderly people using cameras and other sensors.

Regional ICT test bed in the town of Onagawa, Miyagi Prefecture

We have installed a mesh network in Onagawa, Miyagi Prefecture, to demonstrate a private network used by local industries. With the town hall as a base, the network connects the regional medical center, the youth employment center, and the Tohoku University, Onagawa Field Center, which are important locations during a disaster. We have also installed hydrophones near the water intake facility of the Field Center, to monitor sounds emitted by ships and promote research on automatic detection of traffic that is suspected of activities such as poaching.



Mesh network set up in Shirahama

Regional mesh network built in Onagawa

Mobile earth station for satellite communication

As we learned from the Great East Japan Earthquake, satellite links that are normally used for local government networks or as backup connections can be utilized to avoid interruption of communication during a disaster. As such, we have developed a mobile earth station that can gather and transmit the latest information in real time while the disaster-response organization moves through the disaster-affected region. We are also conducting tests to demonstrate the effectiveness of these technologies, participating in disaster drills and the like held by local governments.

Compact mobile earth station

Equipped with 65 cm antenna, 20 W solid-state power amplifier (SSPA), capable of data communication while moving at high speed

Applications Laboratory
[Real-time social wisdom analysis project]

Development of real-time social wisdom analysis systems that use the Internet

Overview

During the Great East Japan Earthquake, we learned that it is very difficult to obtain relevant information quickly when a disaster occurs. According to interviews with relief organizations working in disaster-hit areas, it was also difficult to share information about rescue and reconstruction efforts, which lead to many complications. In the Real-time Social Wisdom Analysis project of the Applications Laboratory, we are developing a real-time social-wisdom analysis system that gathers large amounts of disaster-related information in real time when a disaster occurs and uses information analysis techniques that we have been developing to provide relevant information to assist users in grasping the situation and perform correct decision making.

Technical issues and objectives

DISAANA (DISAster information ANAlyzer) is a system that analyzes disaster-related information on Twitter. It has been made publicly available by the NICT Resilient ICT Research Center and the Universal Communication Research Institute since April 2015 at https://disaana.jp. DISAANA extracts answers to simple questions such as “What is in short supply in ...?” or “Where have people been buried alive in ...?” from a vast number of Tweets and outputs an overview of the damage on a map. It also automatically searches for contradictory information in tweets, to help reducing confusion caused by false rumors. This service can be accessed by anyone using a browser on a smartphone or a PC. Since making DISANNA available to the public, we continued to improve it and introduce new features based on feedback from users, with the goal of realizing a real-time social wisdom-analysis system that can visualize exchange of information on social media and support appropriate decision-making based on that information.

Example of DISAANA output during the 2016 Kumamoto earthquakes
“What is in short supply in Kumamoto Prefecture?”

Disaster conditions in Kumamoto Prefecture before and one hour after the Kumamoto earthquake summarized by D-SUMM

DISAANA functions and features

- Extracts a wide range of answers to disaster-related questions from a vast number of tweets in real-time.
- Automatically extracts related problems by just specifying a location
- Searches for contradictory information and displays it if found, to reduce confusion caused by false rumors.
- Automatically detects measures being taken corresponding to reported issues and presents them together.
- Handles place names properly. For example, recognizes that Shimomashiki Jonan middle school is situated in Jonan-machi Miyaji, Minami-ku, Kumamoto city, Kumamoto prefecture. Thus, even if a tweet does not contain the word “Kumamoto”, it should still be searchable using a phrase such as “In Kumamoto prefecture...”.
- Displays answers and related locations on a map, based on the results of place-name handling.
- Can be accessed using a Web browser from a PC, tablet or smartphone, without requiring a specialized application.
- Freely accessible at https://disaana.jp.

D-SUMM functions and features

- Extends the features of DISAANA, automatically extracting damage reports for a specified area, organizing and summarizing then to show what has happened and where in an easy to understand way. Helps workers gain an overall understanding of disaster conditions.
- Able to display on a map, as with DISAANA, but allowing the types of disasters displayed to be selected and combined freely.
- Can be accessed by anyone free-of-charge at https://disaana.jp/d-summ/

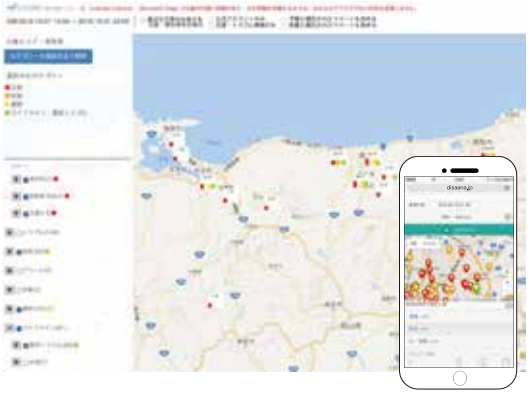
Deployment of resilient ICT technologies in society

Resilient ICT Research Center
National Institute of Information and Communications Technology

NICT's fourth medium-to-long-term plan, which began in April 2016, promotes deployment of research and results in society in the Social Innovation Unit of the newly established Open Innovation Promotion Headquarters.
Our activities to promote basic and applied research on resilient ICT technologies and deployment of results of this research in society include: consolidating collaboration systems within our institute, strengthening collaboration with external universities and research facilities, forming networks among industry, academia and government including regional governments, understanding and responding to the needs of disaster-related users through events such as conferences, participating in demonstrations in society, disaster preparedness drills and exhibitions, and initiatives to create guidelines for when disasters occur. We are actively promoting such activities to deploy and use technology in society, and contribute to mitigate damage and accelerate recovery when disaster occurs.

Utilization of DISAANA and D-SUMM

We have made these disaster information provision systems that use Twitter data available to the public on a trial basis, and are appealing to public institutions, regional governments, NPOs, and other organizations to use them.

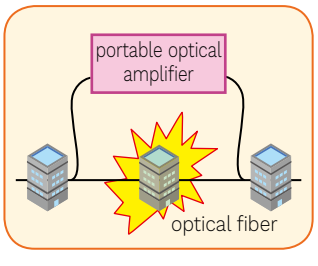


Promoting practical use of NerveNet

We are promoting use of the "NerveNet" regional distributed wireless network system, as a disaster resilient network for connecting bases during disaster, as a temporary measure when communication is interrupted, and for borrowed use by public institutions, regional governments, NPOs and other organizations. We are also participating in training to connect these bases together during NerveNet system at disaster drills of the central government disaster response headquarters in the Tachikawa area, Tokyo, and also contributing to building networks in rural areas in the ASEAN region. Moreover, we are promoting use of NerveNet in communications systems for monitoring equipment in remote areas and as an IoT platform.
NerveNet technologies have been transferred to a private company and have already been commercialized.

Emergency recovery of optical fiber networks using portable optical amplifiers

In order to quickly recover optical fiber networks broken during a disaster, we developed a portable optical amplifier with low power consumption and environmental robustness. We are promoting deployment of this equipment, mainly in telecommunications and related enterprises.



Packaging of disaster response technologies available to disaters by NICT

We are packaging technologies available during disasters from among R&D results at NICT, providing the resilient technologies by our jusdgement according to the each disaster.

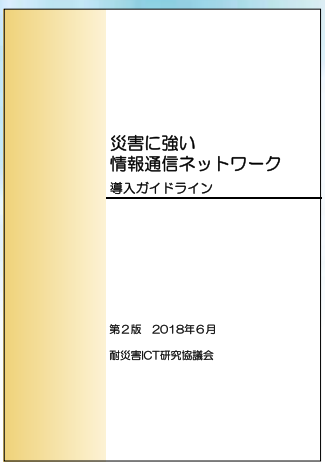
◆Technologies that are always being provided and can be used any time:
- The "VoiceTra" multilingual speech translation application
- The "KoeTra" and the "SpeechCanvas" support application for the communication through writing is usual between those with normal hearing and those with hearing impairments

◆Technologies that may be provided upon request during a disaster:
- Pi-SAR2 (Airborne synthetic aperture radar)
- NerveNet, portable IP-PBX
- WINDS satellite communication
- Distribution of aerial imagery from disaster areas using unmanned aircraft

Committees and other activities

○ Resilient ICT Forum (established May 2012)

This Fourum was established to promote cooperation and coordination among the Ministry of Internal Affairs and Communications (MIC), the NICT, Tohoku University, and private enterprise and university affiliated persons conducting research on disaster resilient ICT, and to maximize use of research results in society. This was based on awareness that the resilient ICT research plays an extremely great role when disasters occur, in the preservation of life and property and in the restoration and recovery after the disaster. “Guidelines for the Introduction of Disaster-Resilient Information and Communications Networks,” was created and published in June 2014. The second edition was created and published in June 2018, covering the rapid progress enhancing disaster resilient ICT. NICT performs the executive functions for this Forum.



“Guidelines for the Introduction of Disaster-Resilient Information and Communications Networks” 2nd Edition (June 30, 2018)

○ Resilient ICT Regional Cooperation Committee

In order to realize reconstruction in the disaster areas affected by the Great East Japan Earthquake and create new city that is resistant to disasters, the Resilient ICT Regional Cooperation Committee aims to promote regional cooperation by exchanging knowledge, information, and opinions from various perspectives based on experience in disaster-stricken areas, and to promote the development of ICT research.

Publication of R&D results

We are conducting demonstrations and disaster drills that actually use R&D results related to satellite communications, mesh networks, and DISAANA/D-SUMM, with cooperation from government agencies and regional governments. We also hold symposia and technology expositions to promote these results.

March 2018: Resilient ICT Research Symposium (TKP Garden City)

May 2015: Flood-fighting drill at upstream of the Kitakami River (Morioka City)

“Disaster-resilient ICT symposium” organized by NICT as a public forum event (TKP Garden City)

MIC exhibition booth at the main conference venue(Sendai International Center)

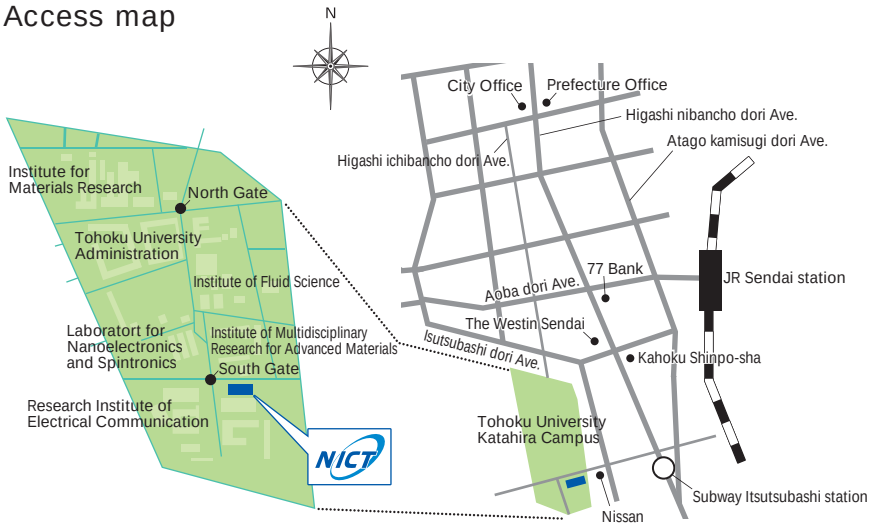
March 2015: Third United Nations World Conference on Disaster Risk Reduction (Sendai City)

Establishing the Tohoku ICT Collaboration Core

In April 2017, the Social Innovation Unit of the Open Innovation Promotion Headquarters established the Tohoku ICT Collaboration Core and is working on planning and promotion of the collaboration among industry, academia and government in the Tohoku region.

External appearance of Resilient ICT Research Center

Access map



Transportation guide

On foot : About 20 minutes from Sendai Station
Subway : Get off at Itsutsu-bashi station on the Namboku line.
About an 8-minute walk from the North exit No. 2.
Taxi : About 5 minutes from JR Sendai station

National Institute of Information and Communications Technology

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