R&D and International Expansion of Portable Local ICT Systems for Disaster Response

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1. Introduction

The rapid, widespread expansion of Internet services in recent years has made our lives easier and increasingly prosperous. On the other hand, the occurrence and scale of natural disasters such as earthquake, typhoons, and flooding are on an upward trend throughout the world. These events can degrade the quality of communication services or even disrupt them including Internet-based services as communication facilities become damaged or power supplies are cut off. At the same time, the demand for communications in the aftermath of a disaster often increases sharply, for example when confirming the safety of others, checking disaster conditions, and coordinating disaster-response activities. Such a large gap between the supply and demand of communication functions can stall disaster-response activities or delay recovery in the stricken area.

To deal with such a communications interruption or gap in the supply and demand of communication functions at the time of a disaster, we have been proposing portable local information and communications technology (ICT) systems for disaster response and have been conducting research and development toward their implementation and international expansion. In this article, we provide an overview of our activities to date in this area.

2. Background and Overview of Research and Development

The Great East Japan Earthquake that struck in March 2011 affected 1.5 million NTT fixed-line telephone circuits due to damage sustained by telecom buildings, the severance of communication cables, and other problems. It took several months to recover from this damage[1]. Since then, disaster victims and agencies responsible for recovery activities have not been able to sufficiently grasp conditions in many disaster-stricken areas giving them no choice but to grope for evacuation services and rescue/recovery activities in a trial-and-error manner.

To prevent such a situation from occurring again, we proposed a portable local ICT system named Moveable and Deployable Resource Unit (MDRU) and began its research and development[2]. Figure 1 outlines the MDRU system. This system accommodates communications processing equipment, access network equipment, and communication equipment within a portable box for connecting to the existing network. It can be brought into an area having a demand for communications such as a disaster-stricken area and used for forming an immediate access network so that local communication services can be provided in a short time. In addition, when connected to an existing network such as the Internet, the MDRU can function as an edge node to meet the locally confined demand for communications on-site. The MDRU system became an ITU-T Recommendation (L.392) in 2016 as a system from Japan following the Great East Japan Earthquake[3].

After proposing MDRU and recommending its international standardization, we continued to research and develop portable

Figure 1: Conceptual diagram of MDRU system

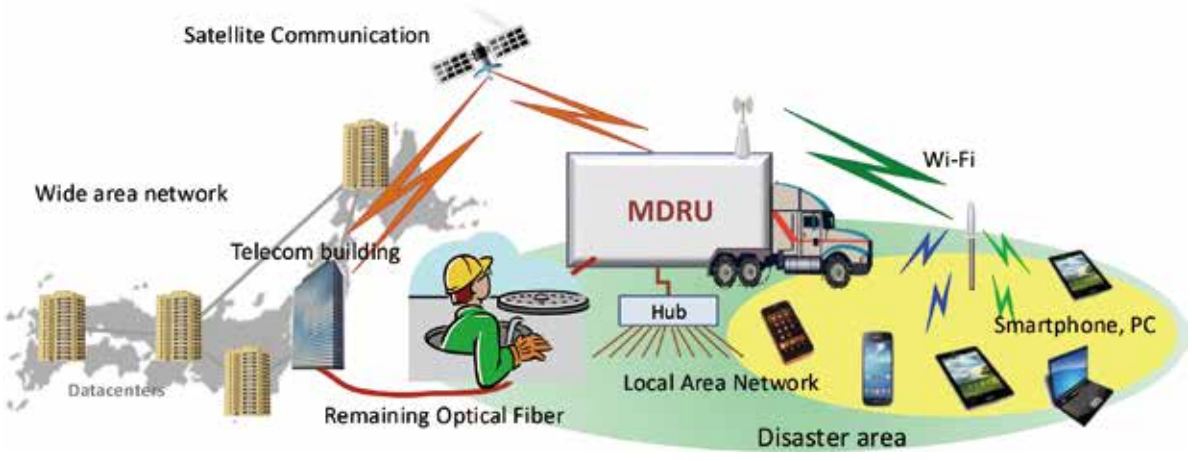
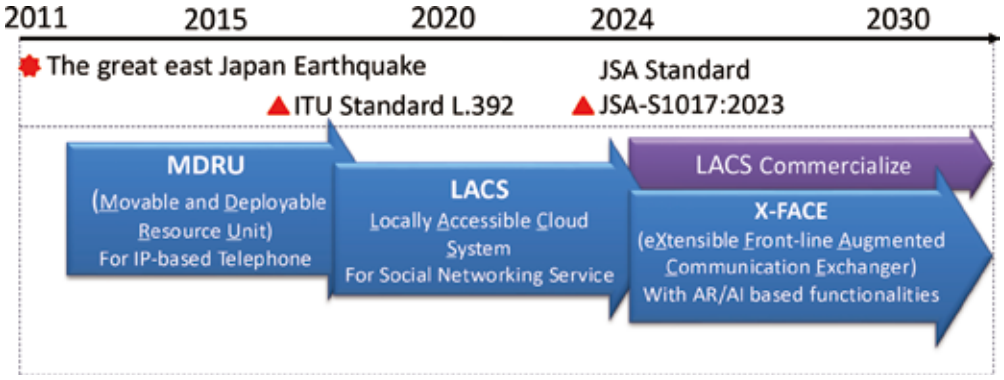


Figure 2: R&D transitions in portable local ICT systems



local ICT systems. Figure 2 shows the transitions in this research and development following our proposal of the MDRU system. Building on the MDRU, we proposed and promoted the research and development of a Locally Accessible Cloud System (LACS)[4] from 2018 and an eXtensible Front-line Augmented Communications Exchanger (X-FACE)[5] from 2023. Either of these services accommodates an access network device, server, battery, etc. within a portable case enabling the impromptu launch and provision of local ICT services. Both conform to the L.392 standard but each differs in the primary service functions provided. The initial MDRU provided telephone service, but LACS features SNS service functions of the Internet era while X-FACE features artificial intelligence (AI) and augmented reality (AR) functions such as voice recognition. In this way, the research and development of portable local ICT systems have been evolving along with the ongoing progress in technology and Internet companies.

3. R&D of Portable Local ICT Systems

The following gives an overview of existing development work in portable local ICT systems using X-FACE as an example. Figure 3 shows the X-FACE usage concept. The portable case accommodates a compact server, Wi-Fi access point, battery, and peripheral devices. To make use of services, the user accesses the X-FACE server via Wi-Fi from a handheld smartphone, tablet, AR device, etc. The compact server provides the user with a variety of functions such as chat and voice/video calls as provided by an ordinary Social Networking Service (SNS) as a Web service. Figure 4 shows examples of screen shots when accessing the X-FACE service via a Web browser. The screen on the left of the figure is the page displaying a list of provided functions while that on the right is what the user might see when viewing SNS-posted messages or images. In short, the X-FACE service features a user interface the same as an ordinary SNS making it easy for even first-time users to begin using it.

The main use envisioned for X-FACE is to enable disaster responders (police department, fire department, Japan Self-Defense Forces, Disaster Medical Assistance Team (DMAT), etc.) to share and record information within a team at a disaster-stricken site or to make contact with upper-level organizations. For this reason, the aim here is to enable information input/output and other operations to be performed in a hands-free manner without hindering the user through the use of AI technology such as voice recognition. Research and development are also proceeding with a view to making disaster response activities more efficient by superimposing disaster-related information on the video seen from a camera using AR technology.

Figure 3: X-FACE usage concept

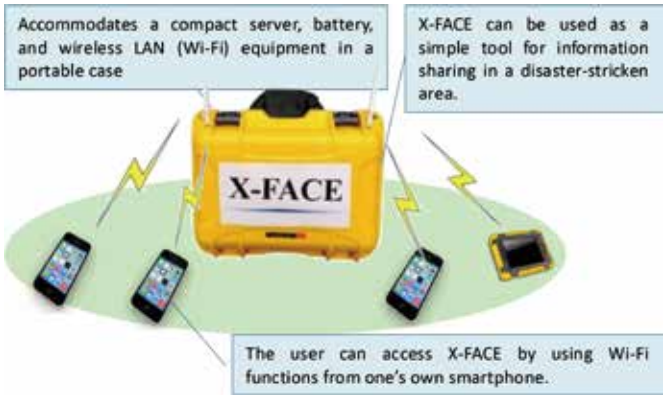


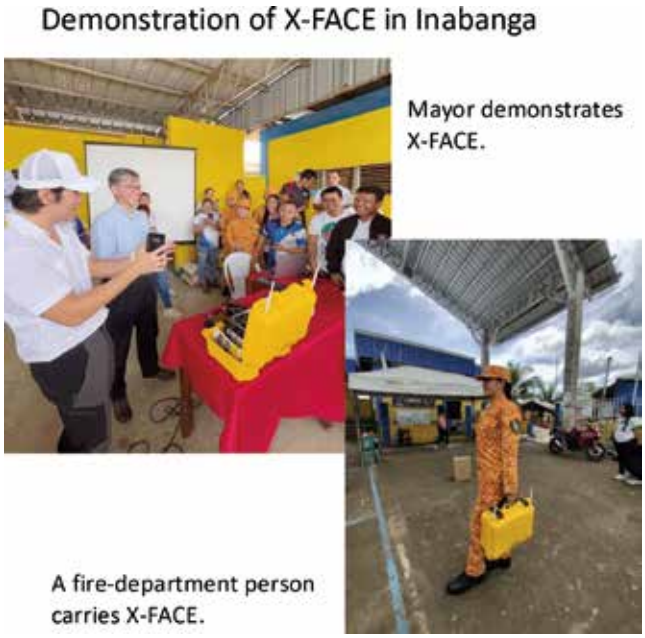
Figure 4: Examples of screen shots of X-FACE services

4. International Expansion Activities of R&D Results

We have been proposing and researching and developing portable local ICT systems to eliminate the significant supply-and-demand gap in information-communication services that occurs when communications are disrupted at the time of a disaster. Knowing that such a supply-and-demand gap is particularly noticeable in developing countries that are prone to natural disasters, we have been conducting a variety of demonstrations using developed systems at overseas locations such as the Philippines as part of our R&D work[4].

Figure 5 shows examples of demonstrations conducted in Cebu Island, Philippines from 2019 to 2023 using a LACS prototype. In the demonstrations, we carried prototype units into Cordova City located in the southern part of Mactan Island in the Cebu region and into Gilutongan Island located about 6 km off the coast of Cordova City and conducted multiple use cases. We mention here that schools around the country were closed due to the impact of the worldwide pandemic during this period forcing all education to be provided online. As a result, many students were unable to receive an education especially in areas that lacked a sufficient Internet infrastructure, which created a major social problem. Under these conditions, we conducted a demonstration using LACS for remote education. Furthermore, in cooperation with local governments, we conducted a LACS-based demonstration simulating the time of a disaster and a demonstration of managing residents under disaster conditions using a local server temporarily. Through these series of demonstrations, we were able to verify the usefulness of portable local ICS systems.

Figure 6: X-FACE demonstration in Inabanga City, Philippines



Next, Figure 6 shows a demonstration conducted in Inabanga City, Bohol Island, Philippines in 2025 using an X-FACE prototype to simulate the use of X-FACE at the time of a disaster. In the demonstration, we asked members of disaster responding agencies such as fire departments to try using a variety of functions some of which used voice recognition such as information input. We received good feedback on the usefulness of the X-FACE system.

Figure 5: Examples of demonstrations in Cebu Island, Philippines

Category	Activity	Main participants
e-Education	Trial of downloading the contents to student's smartphone and work out with the contents and then upload the reports by local students.	Local teacher/student, University Processor
Disaster response	Demonstration of LACS application in searching for a missing person	Municipal Official Stakeholders Community Residents
Platform as a service	Demonstration of a residents management system	Municipal Official Stakeholders Community Residents

Simultaneously with these demonstrations centered on the Philippines, we were also involved in publicizing activities for portable local ICS systems at forums sponsored by the United Nations with a view to international expansion of our developed systems. Figure 7 shows booth exhibits of developed systems at UN-sponsored Internet Governance Forum (IGF) events. Figures 7(a) and 7(b) show our exhibits at IGF 2023 held in Kyoto and IGF 2024 held in Riyadh, respectively. Through exhibits like these, the value of our developed systems can be recognized as tools for accelerating the elimination of gaps between regions originating in a lack of Internet availability, which is also a worldwide issue hindering the achievement of Sustainable Development Goals (SDGs). Global recognition is growing as reflected by inquiries that we have been receiving from African regions, the United States, and elsewhere on use cases of these systems.

5. Conclusion

This article introduced the research and development of portable local ICT systems that we have been promoting and associated international activities. These series of activities have led to international standardization, higher level of system completeness, and improved and advanced functions. Going forward, in addition to conducting further research and development and promoting international standardization, we aim to deploy the developed systems in disaster-prone countries and in areas where the Internet has not yet been restored so that they can be widely used as a tool for immediately launching a local network environment and accelerating the restoration of the Internet at the time of a disaster.

Acknowledgements

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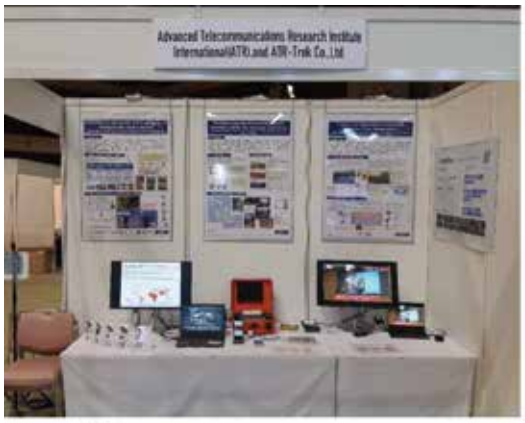
References

[1] NTT-East. (2012) "Recovering from the Great East Japan Earthquake: NTT East's Endeavors", https://www.ntt-east.co.jp/info/detail/pdf/shinsai_fukkyu_e.pdf.
[2] Toshikazu Sakano, Zubair Md. Fadlullah, Thuan Ngo, Hiroki Nishiyama, Masataka Nakazawa, Fumiyuki Adachi, Nei Kato, Atsushi Takahara, Tomoaki Kumagai, Hiromichi Kasahara, and Shigeki Kurihara (2013). "Disaster-Resilient Networking: A New Vision Based on Movable and Deployable Resource Units", IEEE Network, vol. 27, no. 4, pp. 40-46.
[3] ITU-T Recommendation L.392: Disaster management for improving network resilience and recovery with movable and deployable information and communication technology (ICT) resource units (April 2016).
[4] Sakano T, Ojetunde B, Llanto J, Jangir SK, Sharma C (2023) Locally Accessible Cloud System (Lacs) as a portable communication tool in disaster situations. Asia-Pac Tech Monit 40(2): 37-47.
[5] T. Sakano, B. Ojetunde, M. Suzuki, K. Temma, A. Nakamura and T. Fukada, "A Portable and Elastic Edge Computing Network for Disaster First Responders," 2025 27th International Conference on Advanced Communications Technology (ICACT), Pyeong Chang, Korea, Republic of, 2025, pp. 357-363, doi: 10.23919/ICACT63878.2025.10936663.

Figure 7: Booth exhibits of developed systems at Internet Governance Forum (IGF) events



(a) IGF2023 in Kyoto

(b) IGF2024 in Riyadh