Flexible Communication Infrastructure Using Existing Systems and Terminals

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OVERVIEW: In the aftermath of the Great East Japan Earthquake that inflicted tremendous damage over a wide range of areas, disruptions in communications caused functional failures in a variety of different systems, which in turn complicated and caused confusion in the exchange of information. This led to a renewed awareness of the importance of communication infrastructures in securing the ability to share identical information between civil services. In response, Hitachi is providing a wide-area communication system that is being realized as a part of the Great East Japan Earthquake recovery projects. This system is designed to "integrate information via an IP network" as the desired communication infrastructure, and has been adopted as versatile joint communication equipment at Matsushima Air Base of Japan Air Self-Defense Force.

INTRODUCTION

THE communication infrastructures used by civil services are comprised of regular work wireless, disaster control wireless, internal telephone networks, security systems, and other systems, and are independently constructed and utilized by each civil service. Since these communication systems have been independently developed, operated, and maintained over many years, the mutual exchange and sharing of information between communication systems have been lacking. This has made it difficult to implement the seamless exchange of information between various

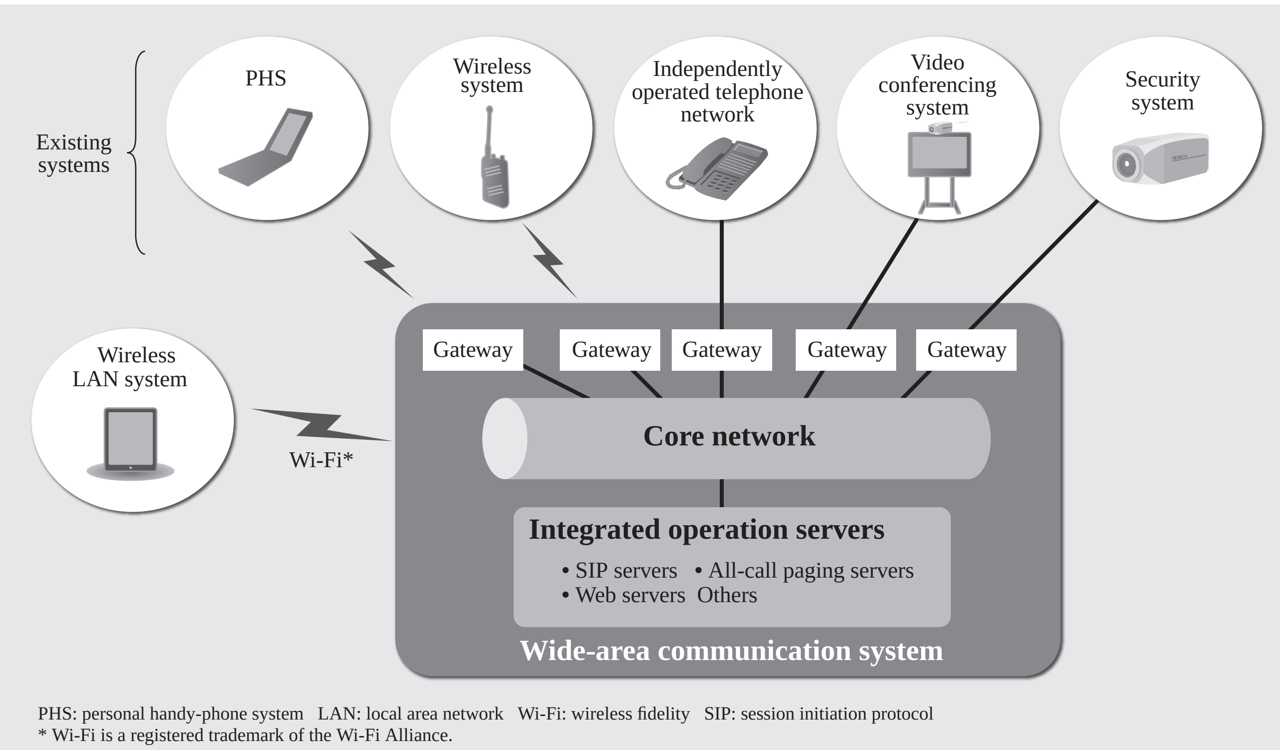

Fig. 1—Connection between Wide-area Communication Systems and Existing Systems.
The construction of systems centered on a core network makes it possible to seamlessly share information.

systems used by civil services and departments, or to implement automation processes that work over multiple systems, and in many cases information has been shared manually through the use of memos, messages, and other methods that require human intervention. It is essential, however, that during a major disaster, each civil service can collaborate in their response to situations by rapidly securing shared access to information that is both unified and identical. This is why "information integration" must be achieved in order to enable the sharing of information across the barriers between communication systems independently developed by each civil service.

The most important issue in the realization of information integration is a lack of compatibility between communication protocols. When information is exchanged between an existing communication system using an old communication protocol and a new system using a new communication protocol, functions must be made to match the existing system. For instance, when an existing system running under an old protocol is connected to a system running under a new protocol, the additional functions that one might expect the new system to provide may be restricted due to differences between the protocols of the new and old systems.

In order to resolve this problem, an information and communication infrastructure must be built that can seamlessly exchange information with existing communication systems, and which allows for the easy addition and expansion of new functions and operations.

This article describes the system technologies that can be used to achieve this interconnectivity through the application of new efforts at supporting communication infrastructures, by promoting a concept of seamlessness in the adoption of a variety of different communication terminals and media in order to respond to changes in the technological environment.

ACHIEVING INFORMATION INTEGRATION WITH A WIDE-AREA COMMUNICATION SYSTEM

Objectives of Development

A wide-area communication system is to be achieved that will enable information sharing and collaboration over the barriers between regions and organizations by linking the various communication systems developed separately in the past. Development is aimed at the following three objectives:

(1) Improved interconnectivity utilizing existing communication infrastructures

In the past, mutual communication was only possible between terminals inside each separate communication system. This development work is aimed at enabling communication and the sharing of information between terminals belonging to different communication systems, and will make it possible to implement new functions without the need to replace existing systems. No troublesome procedures are required, and the users can use systems without being aware of differences between them. In addition, it is also possible to link with new terminals that offer new functions added to the wide-area communication system.

(2) Addition of new functions

New functions are to be easily added in order to support new operations. New functions must be executable using terminals connected to existing communication systems, not just new terminals. Furthermore, not only is communication possible between terminals connected to different communication systems, new functions can be added to create new value based on the connection of both types of terminals.

(3) Strengthened responses to contingency situations

Ordinary communication infrastructures are often unavailable for use during emergency situations such as when a disaster has occurred. Even when this happens, the configuration of available terminals and communication infrastructures is to be changed dynamically in order to provide a bare minimum of functionality.

Basic Architecture

In order to achieve the objectives described above, a core network that can connect multiple existing communication systems is provided along with integrated operation servers providing new functions to support new operations (see Fig. 1).

(1) Core network

The core network is an Internet Protocol (IP) network that connects existing communication systems such as personal handy-phone systems (PHS), wireless systems, independently operated telephone networks, video conferencing systems, and security systems. The use of an IP network means that advances in network technology can be easily followed, and benefits are also afforded in terms of cost and functionality.

The unique communication protocols used by existing communication systems are converted to a protocol that allows IP connection by gateways. This enables communication and the sharing of information between the terminals of different types of communication systems, which used to be impossible.

(2) Integrated operation servers

A group of integrated operation servers is able to implement new operations and services by linking different types of communication systems. By sifting through the data flowing from terminals through the core network, converting the data and sending it to the target terminals, the servers enable communication and the sharing of information between different types of subsystems, all of which was not possible before. By putting a different server in charge of each function to be implemented, independence is heightened between functions, and this makes it possible to flexibly support the modification or addition of functions.

Function Implementation

The specific functions implemented in a wide-area communication system are as follows:

(1) Function for communicating between different types of terminals

This function enables terminals connected to different terminals to connect to each other on an equal footing and seamlessly communicate. This function expands the functionality of a session initiation protocol (SIP)* server by implementing communication with terminals that have been designed without considering the concept of a session.

(2) Function for conferencing between different types of terminal

In the past, specialized equipment was necessary for using conferencing, and a conferencing system involved connecting dedicated terminals to a dedicated network. With a wide-area communication system, any terminal connected to the core network can participate in a conference.

Any terminal can participate in a conference, with the state of every terminal in the system displayed in such a way as to allow for the selection of the terminals to participate, as well as the specification of audio mixing method, calling method, and other settings. The system also offers features such as the ability to remove restrictions on the terminals that can participate, for instance by allowing an audio-only terminal to participate in a video conferencing system.

* A protocol that controls the sessions necessary for exchanging audio, video, and text messages between two or more parties in the application layer.

(3) Sensor linkage function

This function notifies each terminal regarding abnormal information detected by any of the different types of sensors connected to the system. By updating and modifying the correspondence table listing abnormal information and terminals that must be notified, it is easy to maintain an up-to-date state along with any new terminals.

(4) Forced connection and simultaneous broadcast functions

These functions are used by the commander to force a connection and initiate a call with specified terminals, or to simultaneously broadcast to all specified terminals, especially during a disaster situation (see Fig. 2).

(5) Core network extension function

This function extends the core network, which is the backbone of the system. When a contingency situation occurs, this function is designed to support activities in a location that has been cut off from the network. By extending the core network using portable wireless transmission equipment, the use of public address systems, PHS, video conferencing systems, and other types of equipment is enabled at remote locations. This makes it possible to use the same wide-area communication system at remote locations as in the center of the network (see Fig. 3).

Operational Examples

In addition to operations during ordinary times, the wide-area communication system was also developed with the objective of automatically providing rapid support during disasters and emergency situations. Specific examples of how this works are described below.

(1) Remote public addresses

Public addresses, which are ordinarily broadcast from a dedicated microphone, can now be broadcast from an easily portable terminal via a separate system, such as a wireless system, PHS, or smart phone. This makes it possible to take refuge and broadcast from a safe location during a disaster. In this example, the following conversion process is executed in order to broadcast audio: audio via two-way radio, telephone line, IP packets, SIP server, IP packets, IP speaker, and finally an audio broadcast.

(2) Alarm notifications

When alarm information is detected by the sensor system, abnormal situation information and alarm announcements are automatically broadcast to telephone terminals and public address terminals.

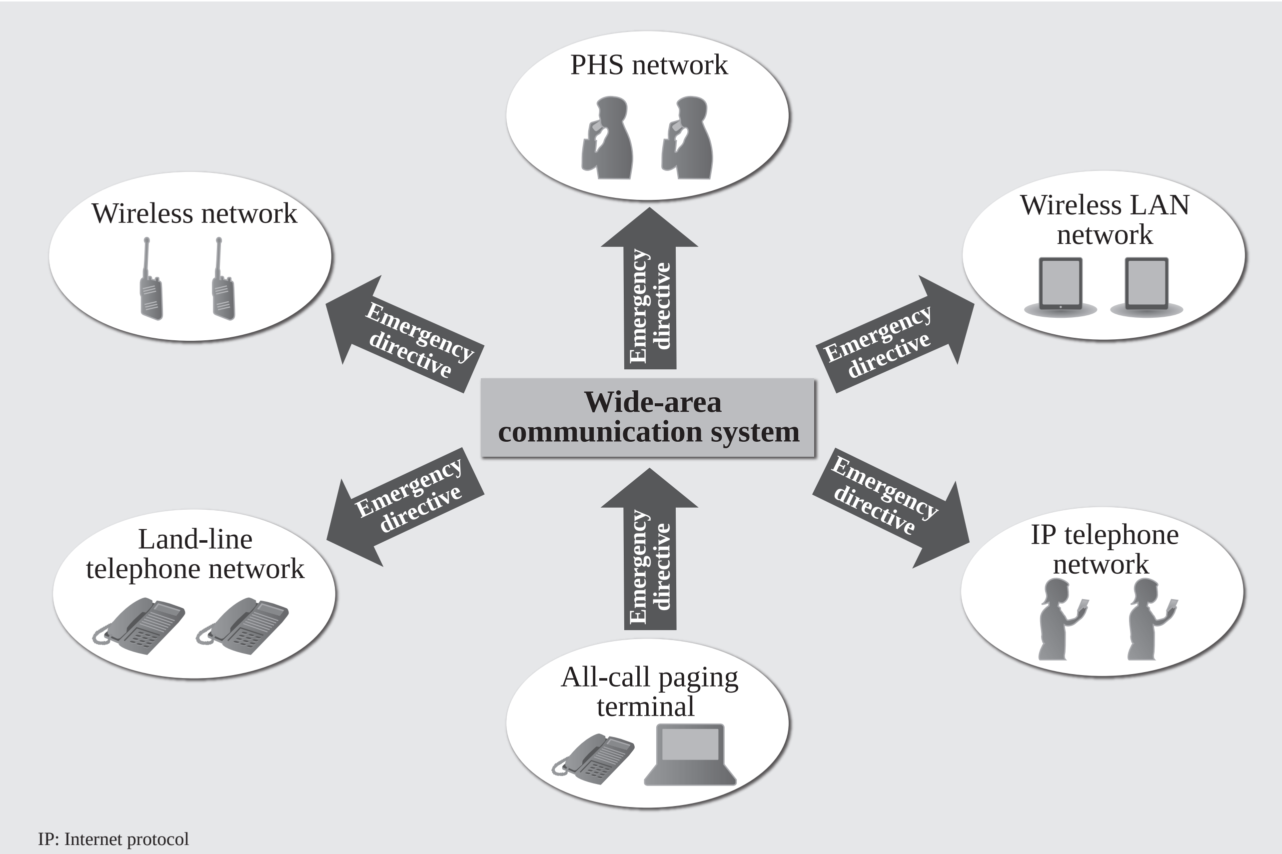

Fig. 2—All-call Paging.
An all-call paging terminal can be used to call specified terminals during an urgent or emergency situation.

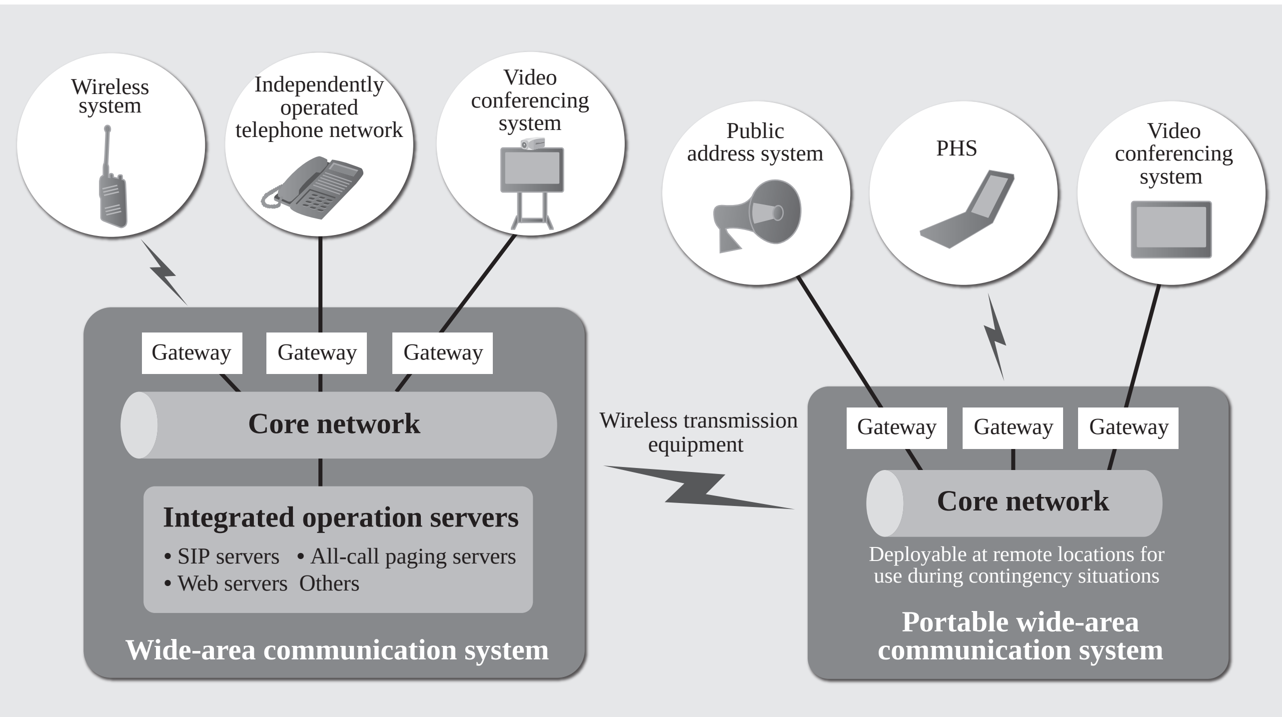

Fig. 3—Configuration of System for Contingency Situations.
A portable wide-area communication system is deployed to remote locations for use in contingency situations, and information can be shared via wireless transmission equipment.

Alarm information is also sent to PHS telephones and other devices via text-based e-mail.

APPLICATION AT MATSUSHIMA AIR BASE

Matsushima Air Base of Japan Air Self-Defense Force, which is located on the Pacific coast side of Miyagi Prefecture, was completely flooded with tsunami water approximately two meters deep after the Great East Japan Earthquake, causing the base to lose some of its functions. A large number of airplanes and facilities were submerged and damaged to the extent that they became unusable. In order to deal with this crisis, Japan Air Self-Defense Force quickly switched to business-use mobile phones with waterproofing features and used them during recovery operations.

In response to this situation, the Communications Section of the C4 Systems Division in the Japan Ministry of Defense's Air Staff Office took the initiative in deciding to introduce versatile joint communication equipment [Japan Air Self-Defense Force Joint IP Communication System (AJICS)] as part of the recovery of Matsushima Air Base, adopting Hitachi's wide-area communication system.

The most important function of the communication system at Matsushima Air Base was the sharing of voice-based information, and so the versatile joint communication equipment was used to implement joint communication and broadcast functions. This system can use the previously adopted business-use mobile telephones as internal extension telephones, utilizing PHS cards for on-site use. In addition, seamless communication with existing communication equipment including private branch exchanges, various types of wireless systems, and public address systems was established by connecting to the core network via gateways. Also, the all-call paging server that is one of the features of the wide-area communication system can be used to connect to equipment without the need for the user to be aware, which makes it possible to communicate with all types of media in the same way one would place a telephone call.

Representative examples of operation are described below.

(1) Operational example #1

When the commander at the command post wants to verify on-site information for carriers of wireless mobile devices, he/she can use the all-call paging terminal to connect commander, wireless mobile devices and broadcast equipment in order to grasp the situation while monitoring details of conference calls with all personnel inside the indoor broadcast facilities.

(2) Operational example #2

By connecting the commander's IP telephone and public address equipment, on-base broadcast facilities can be used to convey weather, disaster, and other information.

(3) Operational example #3

During a contingency situation, a portable wide-area communication system can be deployed to the municipality through the nearby mountain region for the sharing of information. Microwave wireless transmission equipment is used for nearby communication extensions in order to enable communication with regions that lack communication infrastructure facilities.

The exterior of the main versatile joint communication equipment is shown in Fig. 4.

By using versatile joint communication equipment as described above, it was possible to use a wide range of equipment that had escaped damage from the tsunami by linking it with equipment adopted during recovery operations, thereby achieving unified operations.

CONCLUSIONS

This article described a new approach towards supporting communication infrastructures by responding to changes in the technological environment while promoting a concept of seamlessness that can be

Photograph courtesy of Japan Air Self-Defense Force

Fig. 4—Versatile Joint Communication Equipment.
Exterior of main equipment for versatile joint communication installed at Matsushima Air Base of Japan Air Self-Defense Force.

applied to a wide range of different communication terminals and communication media, as well as system technology that can be used to implement this concept.

In the future, Hitachi will continue working to improve the sophistication of system technology through application to every type of communication infrastructure, both domestic and international, while contributing to the achievement of social systems that offer both flexibility and sustainability.

Finally, the authors would like to acknowledge their heartfelt gratitude to the members of the Communications Section of the C4 Systems Division in the Japan Ministry of Defense's Air Staff Office for providing their generous time and invaluable advice regarding the contents of this article.

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