5-3 Development of Telephone Service System

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We have provided the various space environment information for users by a telephone service system. The telephone service system have been altered and enlarged from first-generation to second-generation system. As a result, the current system have improved the amount of information and usability for users.

Keywords
Telephone service, Space weather forecast, Information service

1 Introduction

The solar system, including the Earth, is constantly subject to the forces of the Sun. In a phenomenon known as solar wind, the Sun constantly blows plasma out into the solar system; these solar winds reach Earth at a distance of about 150 million km from the Sun. Additionally, the Sun occasionally displays sunspots on its surface, which appear as areas of discoloration on the Sun's surface. Complex magnetic fields form around a sunspot. From time to time, the energy produced by these magnetic fields is ejected into space as solar flares. The X-rays, high-energy particles, and solar wind plasma accompanying flares have various effects on the space environment around the Earth.

Through the Tokyo Regional Warning Center (RWC Tokyo), the CRL forecasts and issues daily warnings on the space environment of its International Space Environment Services (ISES).

Forecasts and warnings from RWC Tokyo are exchanged with local warning centers and the World Warning Agency (WWA). RWC Tokyo provides an automated telephone service to the public as part of its space environmental information services.

This paper reviews the history of CRL's telephone service.

2 History of the telephone service

CRL's telephone service was launched April 1, 1986, in accordance with a recommendation of the Ionosphere Observation/Radio Forecast/Warning Committee. In the early stages of the telephone service, CRL offered voice-synthesized messages via a telephone network using automatic answering machine installed at six sites nationwide: Wakkanai Radio Observatory (Hokkaido), Akita Radio Observatory (Akita), Hiraiso Branch (Ibaraki), CRL headquarters (Tokyo), Yamagawa Radio Observatory (Kagoshima), and Okinawa Radio Observatory (Okinawa), with a host computer installed at the Hiraiso Branch (now the Hiraiso Solar Observatory).

Later, on January 1, 1988, another access point was established at the Kinki Bureau of Telecommunications of the Ministry of Posts and Telecommunications (in Osaka, now the Kinki Bureau of Telecommunications of the Ministry of Public Management, Home Affairs, Posts and Telecommunications). Seven service sites were then available to public users.

On April 1, 1994, CRL introduced a second-generation telephone service system, replacing its conventional audio-tape-based automatic answering machine with a PC-based machine utilizing a voice synthesizer.

On July 1, 1995, the Akita Observation Information Site (formerly the Akita Radio

Observatory) ceased operations. The access point for the Tohoku District moved to the Tohoku Bureau of Telecommunications of the Ministry of Posts and Telecommunications (Miyagi, now the Tohoku Bureau of Telecommunications of the Ministry of Public Management, Home Affairs, Posts and Telecommunications). On February 1, 2002, the Okinawa Subtropical Environment Remote-Sensing Center (formerly the Okinawa Radio Observatory) moved from Nakagusuku, Nakagami to Onna, Kunigami.

3 System Configuration

3.1 First-generation telephone service system

The first-generation telephone service system incorporated an automatic answering machine using a looping audio tape.

The information that could be provided was limited by tape capacity (a little less than three minutes). The capacity of this recording device restricted the service to the minimum of information on anomalous phenomena. Unfortunately for the caller, if the information of interest appeared at the end of the recording, the user had to wait while all the other information played, paying phone charges during this time. The call counter was read manually at the end of each month to collect statistical data on user access and calls.

The messages for the telephone service were prepared with an office computer at the Hiraiso Branch (now the Hiraiso Solar Observatory).

Fig.1 *First-generation automatic answering machine*

Fig.2 *First-generation message editing terminal*

A voice synthesizer unit and telephone line control unit were connected to the office computer. Data required for voice synthesis was held as phrase data in the semiconductor memory of the voice synthesizer unit, and voice messages were prepared by combining phrase data. Since revising the phrase data involved rewriting data in semiconductor memory, revisions were difficult to perform. Moreover, since voice data was sent to each automatic answering machine over the public telephone network, the updating of voice data was time-consuming and costly.

One feature of the first-generation telephone service system was an automated switching function for Warnings (N, U, W) on Radio Propagation that was transmitted over the Standard Frequency and Time-Signal Station (JJY) in accordance with the category and state of short-wave propagation selected when

the message was prepared. The Warnings (N, U, W) on Radio Wave Propagation, which were conveyed on JJY, were automatically switched by dialing a specific telephone number for access to CRL headquarters and sending a command encoded in tone signals.

The messages for the telephone service were prepared after daily discussions at the Space Weather Forecast Meeting at 10:30 a.m. (JST). On holidays, the weatherperson on duty prepared messages based on personal experience.

This system remained in place until March 31, 1994.

3.2 Second-generation telephone service system

The second-generation telephone service system was developed to provide information on the Sun-Earth environment and to contribute to the space weather forecast program, following a review of the shortcomings of the first-generation system. The second-generation automatic answering machine used PC-based voice synthesizing technology, which was becoming widely available at the time.

Fig.3 *Second-generation automatic answering machine*

We began by trying to reduce the intervals of data updates in the automatic answering machine, an issue with the first-generation service system. In those days, voice synthesis from textual data was not yet feasible. As with the first-generation system, we converted recordings of human voices into digital data and combined the digital data for use. Later, as inexpensive PCs and voice synthesizers designed for PCs became widely available, we replaced the conventional audio-tape-based automatic answering machine with a new PC-based machine. Because each automatic answering machine now held its own phrase data for voice synthesis, it became possible to update the messages stored by the automatic answering machine by sending phrase combination data created in a message editing terminal to the PC. As before, data transmission was performed via the public telephone network. One of the numbers assigned in advance to individual messages was transmitted via dial-tone signals along with the message. The second-generation telephone service system made it possible to reduce the intervals between message updates in the automatic answering machine. Using dial-tone signals, we were able to collect detailed statistical information on call volumes.

The PC-based automatic answering machine also allowed users to skip past uninteresting messages. The second-generation telephone service system organized messages into one of several categories.

Table 1 *List of service codes*

Service Code	Item
0	Summary and Forecast
1	Solar Activities
2	Geomagnetic Activities
3	Proton Events
4	Ionosphere
5	Indices
6	Announcements

With this system, any user with access to a dial-tone telephone could obtain information of interest by entering a service code via dial-tone signal. For users who lacked dial-tone phones, we added a DP-PB converter (a unit that converts dial pulse signals into dial tone signals) to the system.

A PC was used to prepare telephone serv-

ice information to be disseminated via telephones. In the first-generation system, the voice synthesizer and telephone line controller had been separate. In the second-generation system, an expansion card (Fig.5) integrated voice synthesizer and telephone line controller functions onto a single circuit board. All data for voice synthesis was now stored on the PC's hard disk. This made changing a single phrase, a difficult task with the first-generation system, relatively easy.

Fig.4 *Second-generation message editing terminal*

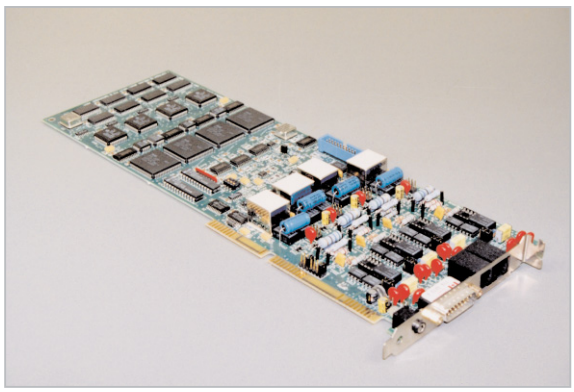

Fig.5 *Voice data processing board*

The "Warnings on Radio Wave Propagation" automated switching function for JJY incorporated into the first-generation system was dropped from the second-generation system. This function was rarely used, and its removal streamlined the system structure. In its place, the person on duty manually switches the warning function.

As PCs became increasingly widespread, the distribution of weather messages shifted to PC communications, starting February 1995. With the growth and expansion of the Internet, the Sun-Earth environment information service was made available on a website.

The messages provided in the telephone service were prepared from discussions at the Space Weather Forecast Meeting held at 10:30 a.m. (JST). After ISES changed the time of RWC Tokyo's forecast announcements from 11 a.m. (JST) to 3 p.m. (JST), the starting time of the Space Weather Forecast Meeting was changed to 2:30 p.m. (JST). On holidays, the weatherperson on duty prepared messages based on personal expertise.

Table 2 *Components of the second-generation telephone service system*

Automatic answering machine	
Computer	IBM PC/AT compatible (i486DX-33MHz)
Operating System	OS/2
Voice data processing board	VBX400
Voice data storage format	ADPCM

Message editing terminal	
Computer	IBM PC/AT compatible (i486DX-33MHz)
Operating System	PC-DOS 5.0/V
Voice data processing board	VBX400
Voice data storage format	ADPCM

Table 2 shows the major components of the second-generation telephone service system.

The second-generation automatic answering machine ran on OS/2. This was because OS/2 permitted multi-tasking greater compatibility and future prospects. At this time, Windows 3.1 was dominant; no driver software for our voice data processing board was available for Windows NT.

4 Summary

For some years, CRL has provided a telephone-based information dissemination service to the public as a service providing information on the space environment. In its early years, the system involved an automatic answering machine based on audio tape, to which users had 24-hour access. With the second-generation system, the amount of available data increased, while operating costs were reduced.

Information on the space environment is

useful in various contexts. Much like the daily weather forecasts provided on television, forecasts of space weather will becoming increasingly significant in the near future for the general public. CRL's telephone service is used by many as their primary source of space weather forecasts.

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Space Weather Forecast