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# 5-2 Space Environment Information Service System

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CRL provides a daily space environment report via an automatic telephone information service and an Internet web server. A daily summary and forecast of solar and geomagnetic activity, proton events, and ionospheric disturbances are included in this report. A daily editing routine is done by a forecaster on duty with computer processing: a dataset of pre-formed sentences with selective terms registered in a dedicated computer for the system can be handled on demand and used to arrange the report. However, since this editing style has several restrictions regarding text expressions themselves, forecasters cannot always make routine reports properly. Furthermore we are planning to introduce a more sophisticated style of routine space environment forecasts, in which more multiple forecasters will cooperate together and work as a group. This means that more flexible functions that help forecasters edit more accurate and informative space environment content should be developed and implemented in the space environment information service system.

## *Keywords*

Space environment information, Space weather

## 1 Introduction

The space-environment information service of the Communications Research Laboratory has continued to expand its functions in line with the evolution of information communication technologies and of information communication media[3]. As part of this evolution, popularization of the worldwide web and electronic mail have brought dramatic changes to the space-environment information service, enabling a new network-based data-sharing mode of operation that goes beyond the limitations of the conventional operation mode, which consisted primarily of one-way transmission from a provider to users.

The Space-Environment Realtime Data Intercommunication Network (SERDIN/WWW)[3], which now incorporates webpage functionality is designed to facilitate sharing and cross-referencing of data, and is operated even now as a tool for supporting staff engaged in space-environment forecasting as well as for

members involved the space-environment information service. This database allows users to grasp the current state of the space environment precisely and rapidly. Successive online databases based on the same concept as SERDIN/WWW were established at around the time of development of SERDIN/WWW, and are now in operation on the Internet.

Electronic mail, which previously served as the only means of exchanging URSIGRAM code data between regional warning centers (RWCs) and the like, has been reevaluated as an information media highly adapted to the web, through the popularization of mailing lists and the development of e-mail programs that support HTML e-mail and clickable URLs.

In addition, in the space-environment information service, a web server and an automatic mailing-list operating system have been introduced as a newly structured solar/terrestrial environmental forecast system[1]. The solar/terrestrial environmental forecast is a

plaintext report that is issued once a week (on Friday). Upon occurrence of an abnormal event, the forecast describes the current state and future development for the applicable regions, based on results of analysis performed by a forecaster on a wide area of the space environment—from the surface of the photosphere to the vicinity of the earth.

After its reconstruction, the configuration of the solar/terrestrial environmental forecast system presented seemingly irreconcilable problems; namely, the improvement of operating efficiency and the expansion of the media through which information is offered (to include a total of three media: the web, e-mail, and fax). Nevertheless these problems have been resolved, rendering possible a significant expansion of the text-based distribution of forecast reports.

The plaintext report handled by the space-environment information service that presents the solar/terrestrial environmental forecast is offered in addition to the daily updated space-environment "telephone service." Originally this service was provided via telephone; hence the name. Currently the report is converted to an HTML document and is available on the web as well as via telephone. However, although both reports are plaintext reports, the solar/terrestrial environmental forecast has no restrictions in terms of sentence expressions, whereas the space-environment telephone service can only handle sentences composed of words and phrases registered in the system in advance (hereinafter referred to as "standardized sentences") and hence presents a problem in that information to be transferred to the user cannot necessarily be phrased in correct sentences.

Meanwhile the Communications Research Laboratory is pursuing a transition from the conventional "one person on-duty" scheme to one in which researchers form groups in order to make the most of their collective expertise and to increase the sophistication and professionalism of the space-environment information service. Detailed space-environment forecasting analysis is performed by each

group for its respective region (this scheme is hereinafter referred to as the "group on-duty" scheme).

If the transition is properly executed, the plaintext report distributed by the space-environment information service will be required to support distributed cooperation; i.e., cooperative editing by multiple groups; this is necessary in consideration of the network configuration of the Communications Research Laboratory and the arrangement of the relevant staff. This paper presents a brief report on the development of the space-environment information distribution service initiated to address these requirements in fiscal 2002, before the transition to the group on-duty scheme.

## 2 Development policy

- (1) Continuity of the communication system between master station and slave stations of the space-environment telephone service
- (2) Development of remote operation of the space-environment telephone service

As for the existing space-environment telephone service, the automatic answering service will be carried over to the new scheme without interruption.

At present, the space-environment telephone service handles the following six items.

- 1) General conditions and forecast
- 2) Solar activity
- 3) Geomagnetic activity
- 4) Proton event
- 5) Ionosphere
- 6) Activity index

Each message corresponding to the above items is made up of standardized sentences, and is updated every day based on the results of a forecasters' meeting. The space-environment telephone service consists of "slave station PCs" installed at six sites nationwide (Wakkanai, Sendai, Hiraiso, Koganei, Osaka, Okinawa); these PCs control an automatic answering service. The system also includes a "master station PC" to edit telephone service

messages and to distribute the message data to the slave station PCs. The master station PC is installed at the Hiraiso Solar Terrestrial Research Center. The master station PC manages the following three principal processes.

- 1) Telephone-service message editing
- 2) Communication between master station PC and slave station PCs
- 3) Transfer of space-environment information to a platform for information collection and distribution

The space-environment forecasting operation has, from fiscal 2002, developed into a cooperative operation of researchers based at Hiraiso Solar Terrestrial Research Center and at the Koganei Headquarters; however, the conventional message editing process of the master station PC did not support remote operation over a network. Therefore, in order for the staff at both sites to perform message-editing work without concern about the installation site of the master station PC, the space-environment telephone service became required to support remote editing over a network.

Further, in order to secure expandability of the space-environment information service and to overcome the technical restrictions of the telephone service, it will be necessary to solve at least the two problems below.

### (3) Introduction of free sentences

If the degree of freedom in message composition and editing is high, system convenience will increase for the forecaster. However, continuity of the space-environment telephone service is also important. Therefore, it was determined that the message editing function will support the following two formats 1) and 2); the telephone service as is will handle only 1), distribution of information via the web and e-mail will support both 2) and 1).

- 1) Standardized sentence: Messaging supported by the existing telephone service (words and phrases are selected from a given set to constitute a message)
- 2) Free sentence: Messages are composed by a forecaster on duty, without limitations on format

Free-sentence messaging will be able to be applied to each of the six above-mentioned items included in the service. Introduction of free sentences will enable the construction of diverse and detailed reports allowing for a range of expression not available with standardized sentences; for example, the free-sentence format may allow the forecaster on duty to cite sources of information (such as various on-line databases), or to present a specialized analysis of a given physical process.

### (4) Support for cooperative editing by multiple operators

It is expected that after the transition to the group on-duty scheme, both standardized sentences and free sentences will be edited cooperatively by multiple operators on the Communications Research Laboratory computer network. Given that content service requires daily distribution at an appointed time, in order to prevent confusion and improve editing efficiency in the group on-duty scheme, it is necessary to ensure that the operators understand the operation code thoroughly; it is also essential to provide operational system support functions, such as cooperative network processing, exclusive control of file handling, and the like.

## 3 System outline

A conceptual diagram of the space-environment information distribution service is shown in Fig.1. With this service, the existing space-environment telephone-service master station PC is replaced with a PC with an OS that supports multiple processes (Windows NT Server 4.0), and a new message-editing PC (hereinafter referred to as the "editing PC"). This represents a client-server processing system composed of a master station PC and an editing PC, in which new functions have been implemented while all the functions of the space-environment telephone service have been taken over. That is, telephone-report editing function and the user interface for the slave-station updating function, which were conventionally managed by the master

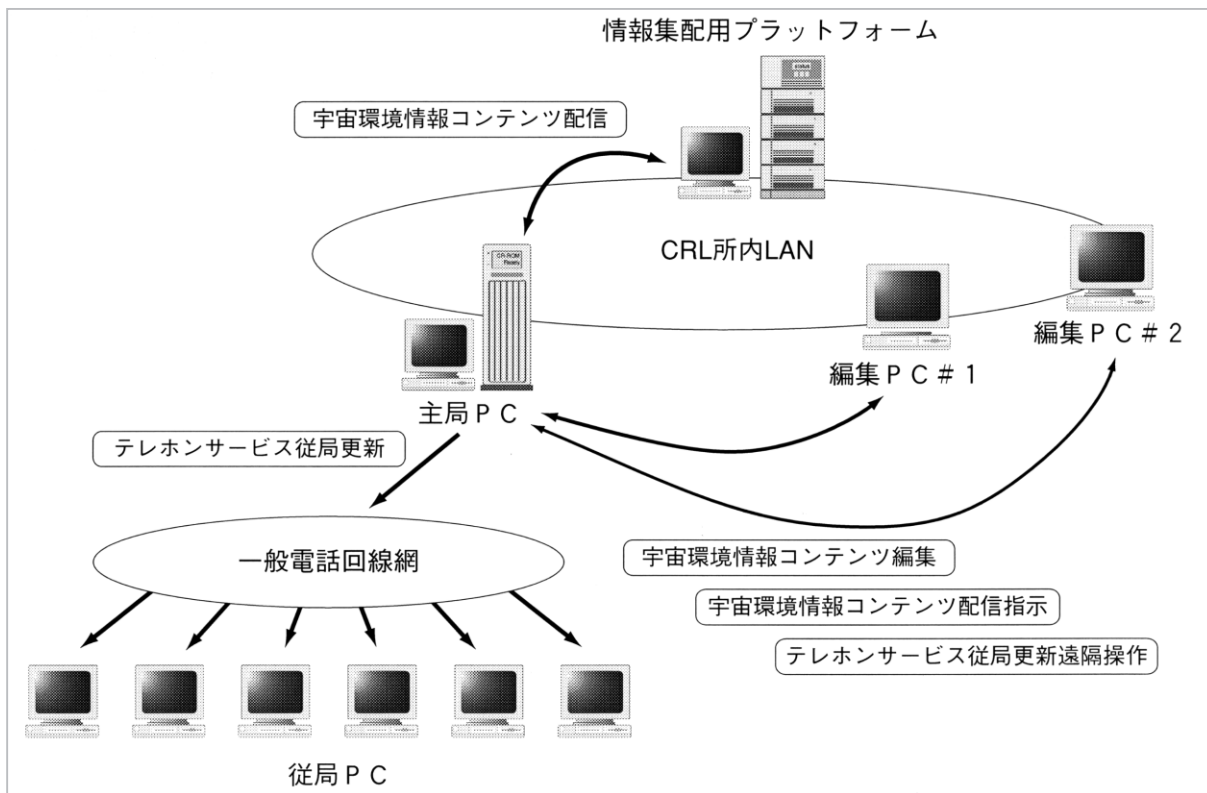


図1 宇宙環境情報コンテンツ配信システム概念図

station PC, were transferred to the editing PC, while server functions were consolidated in the master station PC. Individual editing PCs capable of cooperative processing can be added and linked to the system as the need arises. Moreover, it is also possible to modify the master station PC and the editing PC separately.

On the whole, the system as configured represents a highly expandable support tool in the group on-duty scheme. This system has now been implemented through the installation of one editing PC at the Hiraiso Solar Terrestrial Research Center and one at the Koganei Headquarters.

The interface between the editing PC and the master station PC is described in the appendix hereto. Each process of the editing PC side transmits a processing request to the master station server by socket communication; in turn the master station PC responds to the editing PC by sending processed results by socket communication. The editing PC is provided with three kinds of client programs: editing, distribution processing, and statistical

processing, which programs are launched as the need arises. The main processing functions of the master station PC and the editing PC will be described in the next chapter.

## 4 Processing Outline

### 4.1 Standardized-sentence editing

Editing of standardized sentences is conducted with an editing program on the editing PC. Although the user interface has followed the conventional telephone-report editing program, it offers additional functions: transfer of standardized-sentence editing data to the master station PC over the network, and exclusive control of data-file handling for each message item, allowing for remote operation of standardized-sentence editing and for distributed cooperation.

When a message item to be edited is selected (or when multiple items are selected), the master server assigns an editing status to the message, preventing editing of the same message by another editing PC.

Upon receipt by the master server of a pro-

cessing request from the editing PC, the standardized-sentence data is allotted a file name by the master station server according to a unified file-name code based on predetermined classifications of regions between the Sun and Earth and based on date and is subsequently stored in a prescribed directory of the master station PC. At the same time, updating date and the updating operator's name—items registered in the requesting editing PC—are stored in the master station PC within a message-updating status file. The message-updating status file is then used to notify editing PCs of the standardized-sentence updating status via a distribution program installed on the editing PC, as described later.

## 4.2 Free-sentence editing

The concept behind standardized-sentence editing emphasizes continuity with the conventional telephone-report editing and support of cooperative work by multiple operators, whereas free-sentence editing attaches more importance to securing greater freedom for the forecaster on duty in the composition and submission of free-sentences. Accordingly, we designated free-sentence composition as work to be performed by the forecaster strictly on his/her computer, separated from the network system. Thus, unlike with standardized-sentence editing, the network system is not equipped with a client application for free-sentence composition. Instead, we stipulated a free-sentence file name code, in which free-sentence file names are assigned to each message item, with file names entered by the free-sen-

表1 定型文・自由分ファイル名規約

ファイル名	名称	説明
telyyyyymmdd. 1	定型文/概況ファイル	概況 yyyyymmdd は作成日を示す
telyyyyymmdd. 2	定型文/太陽活動ファイル	太陽活動 yyyyymmdd は作成日を示す
telyyyyymmdd. 3	定型文/地磁気活動ファイル	地磁気活動 yyyyymmdd は作成日を示す
telyyyyymmdd. 4	定型文/プロトン現象ファイル	プロトン現象 yyyyymmdd は作成日を示す
telyyyyymmdd. 5	定型文/電離層ファイル	電離層 yyyyymmdd は作成日を示す
telyyyyymmdd. 6	定型文/活動度指数ファイル	活動度指数 yyyyymmdd は作成日を示す
freeyyyymmdd. 1n	自由文/概況ファイル	概況 yyyyymmdd はコンテンツが配信されるべき日付 n はメッセージ項目ごとの通し番号 (0~9)
freeyyyymmdd. 2n	自由文/太陽活動ファイル	太陽活動 yyyyymmdd はコンテンツが配信されるべき日付 n はメッセージ項目ごとの通し番号 (0~9)
freeyyyymmdd. 3n	自由文/地磁気活動ファイル	地磁気活動 yyyyymmdd はコンテンツが配信されるべき日付 n はメッセージ項目ごとの通し番号 (0~9)
freeyyyymmdd. 4n	自由文/プロトン現象ファイル	プロトン現象 yyyyymmdd はコンテンツが配信されるべき日付 n はメッセージ項目ごとの通し番号 (0~9)
freeyyyymmdd. 5n	自由文/電離層ファイル	電離層 yyyyymmdd はコンテンツが配信されるべき日付 n はメッセージ項目ごとの通し番号 (0~9)
freeyyyymmdd. 6n	自由文/活動度指数ファイル	活動度指数 yyyyymmdd はコンテンツが配信されるべき日付 n はメッセージ項目ごとの通し番号 (0~9)

tence author into the network system interface.

The free-sentence unified file name code is described in Table 1. Each file name is determined based on date and telephone-service message category. Moreover, the free-sentence author can register up to ten different free-sentence message files for each message item using a file extension. Although the master station PC receives the free-sentence data, currently only an ftpd program is installed on the master station PC for the receipt of these data files (using WarFTPd software).

As of the preparation of this report, the (extremely loose) system operation constraints imposed on the free-sentence authors are as follows.

- (1) Conformity of file names to the unified file name code
- (2) Data transmission to the master station PC via ftpd
- (3) Certain loose restrictions on transmission time limits and the like

Free sentences registered in the master station PC, merged with standardized sentences for the same message items, can be perused by the editing program on the editing PC. Moreover, simple additions/corrections can also be conducted.

### 4.3 Space-environment information distribution processing

The standardized-sentence data edited with the editing program is used for slave-station update processing of the telephone report and is supplied via the distribution program; it is then combined in the master station PC with the free-sentence data previously registered by a free-sentence author; this combined data comprises the space-environment information for each message item. The data is then transferred to an existing platform for collection and distribution as a file over the web and via e-mail. The method of arrangement of standardized sentences and free sentences is as shown in Fig.2.

For standardized sentences, the master station PC searches for files that correspond to the distribution date of a given standardized

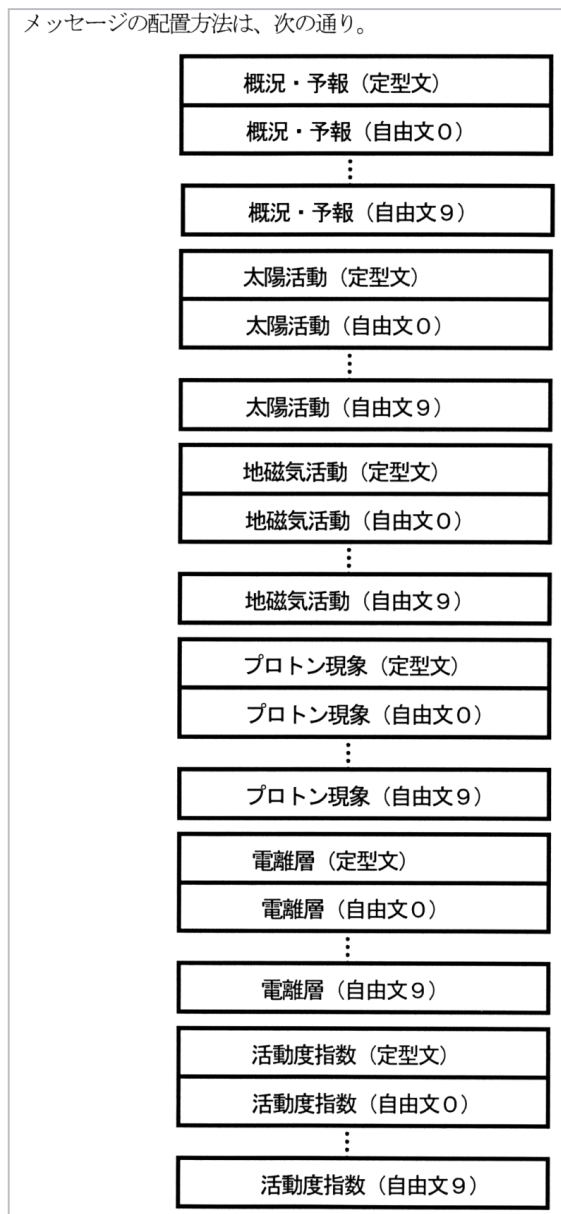


図2 宇宙環境情報コンテンツにおける定型文、自由分の配置方法

sentence within a standardized-sentence storage directory and merges any files found with the free sentence. Similarly, a free-sentence storage directory is also searched for free sentences corresponding to the message item. However, since up to ten free sentences may be assigned to any given message item, these are searched for one by one, starting from serial number 0. If no file corresponds to a given serial number, the serial number is increased by one and the search is resumed for a corresponding file.

While transfer processing to the platform

for information collection and distribution is completed in a short time, slave-station update processing of the telephone report is carried out via a common telephone circuit using tone signals; hence it takes nearly 20 minutes for processing to complete (even though only information relating to the clause combinations of the standardized sentence is transmitted, in order to shorten transfer time). Therefore, in order to conduct trouble-free slave-station update processing of the telephone report when multiple editing PCs are working simultaneously, the editing PC or the distribution program must permit monitoring of detailed slave-station updating status by the master station PC (including recognition of the editing PC issuing a slave-station distribution command) and must provide an interface capable of informing the user of current event processing, through review by the master station PC of slave-station updating information and processing status. Among other factors, this user interface is important in establishing the practicability of cooperative editing by multiple editing PCs.

We have adopted a method whereby three modes are set in the distribution program; the user is informed of the current mode or of mode transition by means of displayed combinations of four indication items.

The three modes are as follows.

- 1) Idling Mode: The state of the distribution program when distribution processing for slave stations is not being conducted.
- 2) Master Mode: The state of the distribution program when distribution processing for slave stations is being conducted further to issuance of a slave-station distribution command.
- 3) Monitor Mode: The state of the distribution program when distribution processing for slave stations is being conducted without issuance of the slave-station distribution command.

Mode transition occurs, as the need arises, in response to various events that may occur during operation of the distribution program

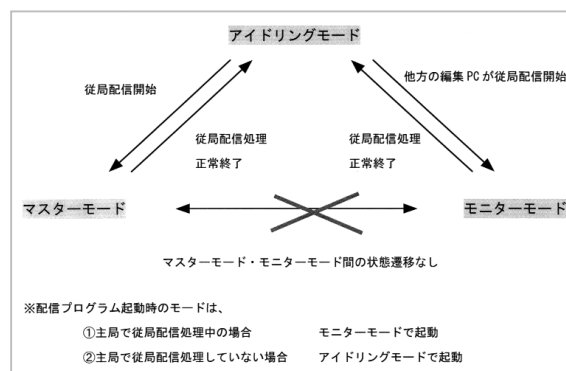


図3 配信プログラム稼働中のモード遷移

(Fig.3). The following four events trigger mode transition.

- Issuance of the slave-station distribution command
- Issuance by another distribution program of the slave-station distribution command
- Completion of the distribution processing for slave stations (normally/abnormally)
- Pressing of a button to terminate slave-station distribution processing

Following initiation, distribution program modes proceed as follows, according to the distribution processing state of the slave stations assigned in the master station PC.

- During distribution processing for slave stations: Processing begins in the monitor mode, and
- Without distribution processing for slave stations: Processing begins in the idling mode.

#### 4.4 Slave-station update processing of space-environment information telephone report

- (1) Transmission of the telephone report between master station and slave stations
- (2) Slave-station message data updating of telephone report
- (3) Use of statistical data acquisition function of the telephone report

The three functions cited above have been taken over from the old master station PC, and are implemented in the new master station PC as a line control process, to be used during slave-station update processing. Slave-station update processing is executed upon reception

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of a processing request from the editing PC via the master station server during space-environment information distribution, as will be described later.

## 5 Concluding remarks

The present paper reported on the status of development of the space-environment information distribution system. This system was introduced as a forecasting operation, in the context of the existing "one man on-duty" scheme in March 2002, and preliminary operations began with the exception of free-sentence editing, for which guidelines have yet to be established. In view of the transition to the "group on-duty" scheme, trial standardized-sentence editing is being conducted through cooperation between the Hiraiso Center and the Koganei Headquarters, with an eye to the transition to the group on-duty scheme. Initial setting of the editing PC is extremely easy, and hence additional editing PCs can be installed as the need arises.

In order to make the most of the forecast and lessen the workloads of researchers in charge, we are planning to install an exclusive editing PC to edit content as a routine processing operation and to assign a new full-time operator to this task. Furthermore, we intend

to develop a system for automatically distributing space-environment information via e-mail over the Internet using the platform for information collection and distribution; this will serve as a third form of information media, following the telephone service and the web-based service.

Two months have passed (as of April 2002) since test operations began. It can be said that the space-environment information distribution service is performing as expected, and is moving toward the transition to the group on-duty scheme. The use of free sentences has markedly increased the freedom of expression of the content provider. Accordingly, we are considering commencing official operation of the space-environment information distribution service as soon as the operational guidelines governing free sentences are established, in order to better support a smooth transition from the existing one-man on-duty scheme to the group on-duty scheme.

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