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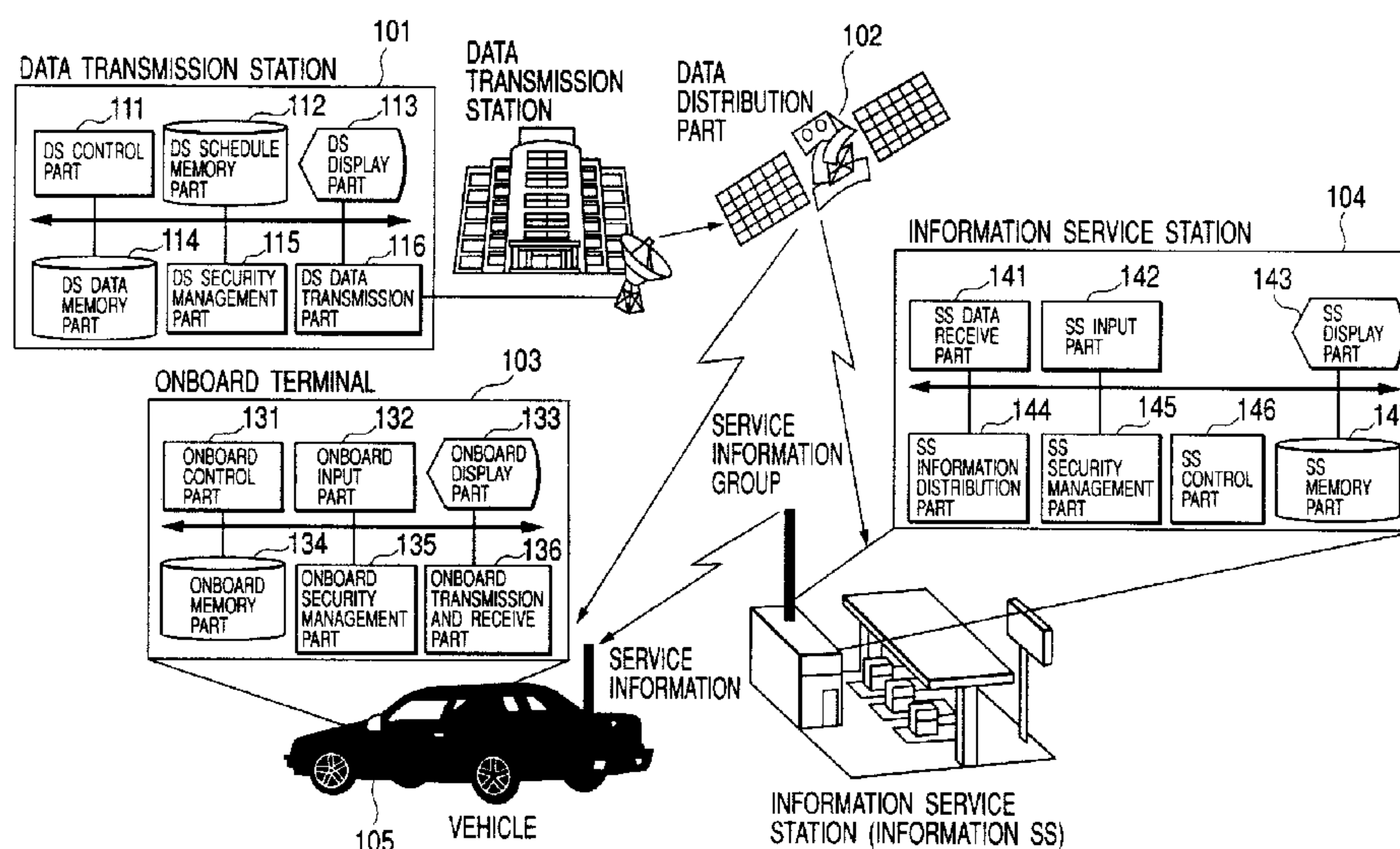
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(54) **SYSTEME DE RADIODIFFUSION NUMERIQUE, TERMINAL
MOBILE ET STATION DE SERVICE D'INFORMATION**

(54) **DIGITAL BROADCASTING SYSTEM, MOBILE TERMINAL
AND INFORMATION SERVICE STATION**



(57) Ordinary data groups and index information indicating data names and memory locations of broadcasted data are transmitted in multiplex mode from a data broadcasting station, and received by an onboard terminal and/or an information service station through a data distribution part. The onboard terminal detects the information, which it does not hold, by referring to the index information, and presents a list of data names at the onboard display part. The service station separately stores the data groups and the index information provided from the broadcasting station. In response to the download request from the onboard terminal, the service station examines whether the required data is located in SS memory part by referring to the index data, and captures the required data from external memory locations defined in the index information if the required data is not stored. The download data is encrypted with the cipher key provided by the requester and transmitted through a radio wave.

ABSTRACT

Ordinary data groups and index information indicating data names and memory locations of broadcasted data are transmitted in multiplex mode from a data broadcasting station, and received by an onboard terminal and/or an information service station through a data distribution part. The onboard terminal detects the information, which it does not hold, by referring to the index information, and presents a list of data names at the onboard display part. The service station separately stores the data groups and the index information provided from the broadcasting station. In response to the download request from the onboard terminal, the service station examines whether the required data is located in SS memory part by referring to the index data, and captures the required data from external memory locations defined in the index information if the required data is not stored. The download data is encrypted with the cipher key provided by the requester and transmitted through a radio wave.

DIGITAL BROADCASTING SYSTEM, MOBILE TERMINAL AND INFORMATION SERVICE STATION

BACKGROUND OF THE INVENTION

5 The present invention relates to the field of digital broadcasting systems.

It is well known for an information system used on a vehicle to use a map navigation system. However, upgrading the software of the map navigation system requires technical knowledge, making such an action difficult for general users. Often, the
10 onboard navigation systems are designed with a general purpose OS, and various programs are executed on it.

An information service to a moving vehicle is provided actively in a next generation onboard information system, Intelligent Transportation System (ITS). Under the
15 present circumstance, only transient traffic information such as traffic jam status and expected travel time is presented by such a service.

In order to meet the user's needs mentioned above and transfer information efficiently to plural targets in such a way that the user can service the data and
20 software of the navigation system in the onboard terminal, broadcasting the data though digital broadcasting and/or FM broadcasting is introduced (Japanese Patent Application Laid-Open number 8-87234 (1996), and Japanese Patent Application Laid-Open number 8-195690 (1996)). By integrating the network represented by GPS and Internet and data broadcasting, a navigation system enabling various

services including upgrading of the map data at the onboard terminal with a computer is proposed (Japanese Patent Application Laid-Open number 10-153440 (1998)).

- 5 As described above, there are some proposals found that enables registration of a new version of the software and controls versions in the onboard terminal by using multiplexed data broadcasting. However, as the current information transmitted from the broadcasting station is transient (or intermittent), the user cannot obtain the necessary data when the data broadcasting is not on air. A data distribution part of
- 10 the satellite and beacon systems has a limited transmission capacity. For example, the communication satellite for digital television has 20 to 30 Mbps per 1 channel. When trying to transmit massive data and programs in such a circumstance, it is impossible to transfer all the data in a short period. In trying to repeat data broadcasting including past data, the transmission efficiency is reduced, resulting in
- 15 various data services not being provided.

Owing to this circumstance, even when the user needs a new program for the onboard terminal or tries to upgrade the version of the data in order to obtain the services provided for the onboard terminal, data is reluctantly transmitted from the

20 data distribution parts. This means that it is difficult for the user to obtain the necessary data when the user needs it. On the other hand, since electric power is not applied to the onboard terminal when the vehicle stops, data cannot be received. As a result, whether the required broadcasting data has been broadcasted cannot be recognized, and the data cannot be obtained.

What is proposed in Japanese Patent Application Laid-Open number 8-87234 (1996) is a system where the data is stored in plural repeater stations and the onboard terminal of the individual vehicle picks up the data from its neighboring
5 repeater station if required. However, if the name of the unreceived broadcasting data is not recognized by the onboard terminal, the user cannot request the unreceived broadcasting data.

There is no consideration in the prior art for the onboard terminal that knows what
10 data was broadcasted in past and what data could not be received. A mechanism for providing the name of the broadcasted data and without increasing the amount of data is desired. If the name of the data (and preferably the location of the data) that should be transmitted again can be found in the repeater station the efficiency in the transmission processing and the storage processing can be increased and the
15 service provided in response to the request for the broadcasting data name from the onboard terminal can be realized.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a digital broadcasting system and a
20 mobile terminal that allows software revisions at the mobile terminal by using a multiplex data broadcasting, and provides an information service station for storing data by relaying the digital broadcasting contents and for distributing the mobile terminal requesting those contents.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram of a mobile information service system of one of the
5 embodiments of the present invention;

FIG. 2 is a structure diagram of broadcast data to be multiplexed from a data
transmission station;

FIG. 3 is an explanatory drawing of memory and management operations of
information receipt on the onboard terminal;

10 FIG. 4 is an explanatory drawing showing an example of screen image of the
onboard terminal;

FIG. 5 is an explanatory drawing of memory and management operations of
information receipt at the information service station;

FIG. 6 is a system block diagram including structures required for download added
15 on the information service station and the onboard terminal;

FIG. 7 is a data structure diagram showing an example of data in the IC card;

FIG. 8 is a transition diagram of operation screens when servicing information from
the information service station; and

FIG. 9 is an explanatory drawing of operation screens when downloading information
20 directly from the onboard terminal.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Now, the preferred embodiment of the present invention is described in detail by
referring to the attached figures. It is difficult for users to obtain their necessary data

and programs at their preferential time from the data distribution part with the onboard terminal in the prior art. In order to solve this problem, there is such a solution that the data distribution part is configured so as to enable interactive communication with and accept requests from the onboard terminal. There are
5 10,000,000 or more vehicles in Japan, and thus, it is difficult to broadcast massive data to the individual vehicles simultaneously. Though it is possible in practice to make the onboard terminal connect to the Internet through PDC interface of cellular phone systems and download data, it is not easy for public users to install data and programs and revise their software versions.

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In the mobile terminal information service system of the present invention, an information service station for storing programs and data served to the onboard terminal through digital broadcasting and distributing (selling) them to the onboard terminal is provided. The information service station stores massive programs and
15 data which cannot be loaded only on a single onboard terminal, and downloads them onto the onboard terminal in response to the request by the user through radio wave communication in the similar manner to the purchase of gasoline for the vehicle. It will be appreciated that the user can obtain his or her necessary data at his or her preferential time even when the data distribution part does not distribute the data in
20 real time.

FIG. 1 illustrates a schematic diagram of a mobile information service system according to an embodiment of the present invention. The mobile information service system is composed of three major parts: an onboard terminal 103, a data

transmission station 101 and an information service station 104. The onboard terminal 103 is mounted on a mobile body such as vehicle 105 for providing service information to people in a vehicle 105. The data transmission station 101 distributes the information (display data and programs for the onboard terminal) directed to the
5 onboard terminal 103 to the ground station (onboard terminal 103 and information service station 104) through the data distribution part 102 such as satellite and vehicle-to-road communication path (beacon) on the road. The information service station 104 sells the data (map data, music data, etc) and the programs (navigation programs, etc.) used in the onboard terminal 103, and updates the versions of this
10 data and programs.

The data transmission station 101 is composed of DS control part 111 for controlling the data transmission station 101, DS memory part 114 for storing the information to be distributed including the program used in the onboard terminal 103, the program
15 difference information used for version upgrade, and the data (map information, shopping information, etc.) used by the programs in the onboard terminal 103. The data transmission station 101 also has DS schedule memory part 112 for storing the transmission timing (transmission schedule) for those service information, DS security management part for encrypting data for distributing data with security
20 protection, and DS data transmission part 116 for modulating and transmitting encrypted data on a designated radio wave.

DS data control part 111 reads a time schedule stored in DS schedule memory part 112 defining what information of program files and data files in DS data memory part

114 should be sent at each time slot. The time schedule is examined with finer time mesh and the information file to be sent is searched and extracted from DS data memory part 114 at a designated time before the information file is to be transmitted. The information file to be sent is encrypted with a designated cipher key at DS security management part 115 and the encrypted transmission information and the transmission time are coupled together and sent to DS data transmission part 116. DS data transmission part 116 searches a pair of the encrypted transmission information and the transmission time sent from DS control part 111. When the scheduled transmission time is detected then DS data transmission part 116 modulates the encrypted transmission information scheduled to be sent at this time at a designated frequency and sends it in radio wave forms.

The data distribution part 102 is composed of a data receive part, a data amplifier part and a data transmission part (not shown in the figure.) The encrypted transmission information sent from the data transmission station 101 is received and modulated at the data receive part. The modulated signal is amplified by the data amplifier part and then, the data transmission part modulates again the amplified signal at a designated frequency and resends it via radio waves.

The onboard terminal 103 is composed of an onboard control part 131 for controlling the onboard terminal 103, an onboard transmission and receive part 136 for receiving transmission information (programs and data used in the onboard terminal 101) from the data distribution part 102 and the information service station 104, and a onboard security management part 135 for managing the overall security. The

onboard terminal 103 also has an onboard input part 132 for capturing the input operation by the user and programs and data through an IC card and removable media such as CD-ROM and DVD into the onboard terminal 103, an onboard memory part 134 for storing programs and data used in the onboard terminal 103
5 from the onboard input part 132 and the onboard transmission and receive part 136, and an onboard display part 133 for displaying the execution result of programs (for example, car navigation screens) and operation screens to the user.

The programs and data used in the onboard terminal 103 are read out from the
10 removable media driver such as CD-ROM and DVD in the onboard input part 132 and stored as program files in the onboard memory part 134 by a command for requesting the execution of an install program in the media from the onboard input part 132 to the onboard control part 131. The user requests the execution of the program files from the onboard input part 132, the onboard control part 131 extracts
15 the program file corresponding to the program requested to be executed by the user from the onboard memory part 134 and executes it. The programs and data used in the onboard terminal to be stored in the onboard memory part 134 are obtained from the information transmitted as a radio wave from the data distribution part 102 and/or the information service station 104. The onboard transmission and receive part 136
20 always detects a radio wave having a designated frequency like digital TV, and extracts encrypted transmission information from the data distribution part 102 and/or the information service station 104. When a set of logical information is established, The encrypted transmission information is transferred from the onboard transmission and receive part 136 to the onboard security management part 135.

The onboard security management part 135 holds a key for decoding the encrypted transmission information received at the onboard transmission and receive part 136 and decodes the encrypted transmission information into the original transmission information with this key and transfers it to the onboard control part 131. If the
5 onboard security management part 135 cannot decode the encrypted transmission information, that is, it has no encoding key, the received information is abandoned.

The onboard memory part 131 temporarily holds the decoded transmission information in the onboard memory part 134. As the area for storing the decoded
10 transmission information inside the onboard memory part 134 is limited, if the volume of the decoded transmission information exceeds the size of this area, older decoded transmission information stored in this area is deleted sequentially according to its access history. Furthermore, the onboard control part 131 displays a small icon on the onboard display part 133 the label of which is named after the name of the
15 program captured by the onboard transmission and receive part 136. With this user interface, the user can be made recognize that new information has arrived and is stored in the onboard memory part 134.

The information service station 104 is composed of SS control part 146 for
20 controlling the information service station 104, SS data receive part 141 for receiving the encrypted transmission information from the data distribution part 102 SS memory part 147 for storing the received data, SS input part 142 for capturing the user input through an IC card and/or a touch panel into the information service station 104, and SS information distribution part 144 for distributing the information

in SS memory part 147 to the onboard terminal 103 of the vehicle 105 through a radio wave in response to the user input. The information service station 104 also has , SS security management part 145 for encoding the information from SS data receive part 141 and encrypting the information in SS memory part 147 to be distributed from SS information distribution part 144, and SS display part 143 for displaying the execution status of the information service station 104 and its user operation menu.

SS control part 146 inside the information service station 104 captures the download target and the encryption code for permitting the download operation in response to user input (which may be allowed through an IC card as described later) from SS input part 142. A list of software available for download for the user is displayed on SS display part 143, and the user is allowed to select data for download. When the user specifies the data for download, SS control part 146 extracts the specified data from SS memory part 147, and the data is encrypted by the encryption code assigned to the individual download operation defined as described above. The encrypted data is modulated at a predefined frequency for the individual download operation and distributed to the onboard terminal 103 by SS information distribution part 144.

As the onboard transmission and receive 136 in the onboard terminal 103 is staying in the download operation under the control of the onboard input part 132, it does not detect a radio wave from the data distribution part 102, but detects a radio wave having a frequency assigned for the information service station 104, and thus, can

receive the data from SS information distribution part 144. In addition, the data received at the onboard transmission and receive part 136 is decoded by the onboard security management part 136 as described above and stored in the onboard memory part 134.

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As described above, by using the information service station 104, the onboard terminal 103 can download necessary information anytime the user requests it. However, as the information transmission rate (bandwidth) of the artificial satellite and the on-road communication apparatus (beacon) provided as the data distribution part 102 is limited, it is difficult to transmit all the requested data all the time. In addition, it is difficult for the onboard terminal 103 and/or the information service 104 station as a receiver to receive all the channel corresponding to a single frequency or a single channel if a single frequency is used and multiplied in a time division mode like digital TV. This means that the onboard terminal 103 cannot obtain the information name required for allowing the user to specify the download information only by the above described architecture. In addition, the information service station 104 cannot efficiently store various information for the onboard terminal 103 and provide the information service to be distributed.

20 In the system of this embodiment, the name of data already broadcasted and to be broadcasted in the future and the index information related to their memory locations are transmitted in a time division multiplex so as to be accessible and downloadable from the remote sites.

FIG. 2 illustrates data formats of broadcast data in this embodiment. As shown in FIG. 2 (a), in addition to the ordinary data 212 and 216 broadcasted at the present time, the index information 202 is inserted in a time division multiplex. As shown in FIG. 2 (b), in the index information 202, the memory location 223 for the individual data is defined in terms of FTP (File Transfer Protocol) file directory, and its data number 221 and data name 222 are also described. The index information 202 also includes the amount of money charged 224 to the user for the individual download operation, the comment 225 for the individual data and the broadcast time 226 of the data, which are stored in the data memory part 114 of the data transmission station 101.

In the schedule data in DS schedule memory part 112, information for transmitting the index information 202 as well as programs and data used in the onboard terminal 103 is defined. DS control part 111 transmits data in obedience to this index information 202. For example, if there is such a schedule data defined in DS schedule memory part 112 that the program (1) 212 is transmitted first, the index information 202 is transmitted next, and then the program (2) 216 is transmitted, DS control part 111 extracts the data related to the program (1) 212 from DS data memory part 114 first, and this data is encrypted by DS security part 115 and then transferred to DS data transmission part 116. Next, DS control part 111 extracts the index information 202 from DS data memory part 114, and this data is encrypted also by DS security part 15 and then transferred to the data transmission part 116. This procedure is applied similarly to the program (2) 216.

On the other hand, DS data transmission part 116 sequentially applies frequency modulation to the encrypted data transmitted from DS control part 111 and transmits it. Thus, the index information 202 is inserted between the ordinary data 212 and 216 broadcasted at the moment in the data supplied from the data transmission station as shown in FIG. 2 (a). At this time, the data transmission part 111 adds the identifiers 211, 213 and 214 to the data and transmits them. The identifiers 211, 213 and 214 contain a data number 221 represented in 62 bits. A number 0 is assigned in the identifier 213 for the index information 202. Thus, whether the transmit data contains the index information 202 or the ordinary data can be recognized easily by the receive side.

As described above, by means of multiplex broadcasting of the current broadcasting program as well as the index information 202 with a smaller transmission volume, the user can recognize the existence of necessary programs and/or data and their location. The user can obtain necessary information not stored in the information service station 104 owing to its circumstances or not broadcasted yet by accessing the location directed by the memory location 223 if the information is not stored in the information service station 104.

FIG. 2(c) illustrates a format of the data number in the index information. The version of programs and data executed in the onboard terminal 103 is upgraded with time. Therefore, a version upgrade of data is not definitely recognized only by means of marking serial numbers to programs and data sequentially as the broadcast programs are distributed on schedule. In this embodiment, the data

number 221 is defined with a revision number 2212 coded in 16 bit as well as a source data number 2211 coded in 32 bits. In addition, an associated operating system (OS) number 2213 coded in 12 bits is allowed to be assigned in order to handle a single program title associated with different OSs.

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With this format, the information service station 104 and/or the onboard terminal 103 can recognize the source data and its version associated with the received data only by referring to the data number 221. If the version upgrade data of the source data is transmitted as difference data, all the difference data associated with the source data can be obtained by using its source data number 2211 and associated-OS number 2213 as search keys.

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Next, the operation of the onboard terminal in this embodiment is described. As the onboard terminal 103 of the mobile information service system receives the information from the data transmission station 101 as the data and its index information 202 broadcasted thorough the data distribution part 102, the user can understand what programs have been already broadcast and what programs are to be broadcasted in the future, and even what programs were not watched.

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FIG. 3 illustrates a structure of memory and management operations of information receipt at the onboard terminal. The onboard memory part 134 is composed of the onboard data management table 301 and the onboard data memory part 302. When the onboard control part 131 receives the information originated from the data distribution part 102 from the onboard transmission and receive part 136, the

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received information is decoded with the decode key in the onboard security management part 135, decomposed into parts each corresponding to the individual data, and stored the onboard memory part 134. At the same time, the following procedures are applied to the onboard data management table 301.

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As if with the index information 202, what is stored on the onboard data management table 301 includes the data number 321 and the data name 322 uniquely assigned to the individual data, the remote file name 323 directing the remote location in which the data files are stored, the local file name 324 with which the data file is stored
10 locally inside the onboard terminal 103, the amount of money charged 325 for the individual download operation, the broadcast time 326 of the individual data and the access time 327 by the user.

When the onboard control part 131 receives individual data, it confirms the identifiers
15 211, 213 and 214. When the index information 202 with its identifier 0 is received, by making a comparison between the data number 221 and the data number 321 arrival of new data is detected and a data number 221, a data name 222, a remote file name 223, a charge 224, a comment 225 and a broadcast time 226 of the new data are extracted from the index information 202 and added on the onboard data
20 management table 301. At this time, NIL is put into the corresponding local file name 324 and the time .327.

If the index of the received data is not 0 (for receiving the data), the onboard terminal 131 searches the onboard data management table 301 by using the data number

- 221 in the received data for the search key, to determine if there is a local file corresponding to the data number 321. If there is a local file name 324 (not NIL), the received data is abandoned. On the other hand, if the local file name 324 is NIL, the received data is stored in the onboard data memory part 302 as data, and the file
- 5 name (generated from the data name) stored in the onboard data memory part 301 is made stored as the local file name 324 in the onboard data management table 301. In addition, the value of the time 327 in the onboard data management table 301 is the time when the data is stored.
- 10 If the empty area of the onboard data memory part 302 is so small that the received data cannot be stored, the onboard control part 134 deletes the data already stored and reserves the memory area on the onboard data memory part 302 for storing the next received data. At this time, the onboard control part 134 refers to the time 327 in the onboard data management table 301, and deletes older data in order of their
- 15 time stamps in order to reserve the memory area for the new download data. Then, the received data is installed. The time when the user downloads the individual data is recorded as the time 327. Thus, the older data in the onboard data memory part 302 to which the user accessed in the past are deleted in order of access history.
- 20 FIG. 4 illustrates an example of the screen image of the onboard terminal. In responding to the user's selection of the data tabulation button 414 from the onboard input part 132 of the onboard terminal 103, a data table 415 including a data broadcasting menu as shown in FIG. 4 is displayed. When the data tabulation button 414 is selected by the user, the onboard control part 131 searches the

onboard data management table 301, and recognizes the individual data status (for data No 321 judged from data number 221, for name 322 judged from data name 222, for broadcast time 326 judged from broadcast time 226, and whether the individual data is already downloaded or not judged with local 324 being NIL or not, respectively), and then displays the data table 415 shown in FIG. 4. The data already downloaded and the data not yet downloaded are classified with their status as "settled" or "unsettled", which can be recognized explicitly by the user. With this representation, the user can understand what data has been downloaded and what data has not been downloaded.

The user can delete, download and reserve the data in the onboard terminal 103 by using the buttons of the onboard input part 132 shown in FIG. 4. For example, suppose that the user select the data already received shown in the data table 415. If the user select the data deletion button 402 next, similarly as if of the data overflow described above, the onboard control part 131 deletes the data (for example, the program 303) of the selected data, and initializes the local file 324 and the time 327, both corresponding to this data in the onboard data management table 301 so as to be NIL. If the user selects the data already received and selects the download button 413, the selected data from the information service station 104 can be downloaded.

Next, the structure and operation of the information service station 104 are described. At first, the method for storing and controlling the information in the information service station 104 is described. The information service station 104

receives the information from the data transmission station 101 through the data distribution part 102. ss control part 14 receives the information transmitted by the data distribution part 102 at SS data receive part 141, and then encodes the information with the decoding key in SS security management part 145, and
5 decomposes the encoded information into parts each corresponding to the individual data and stores them into SS memory part 47.

FIG. 5 illustrates the structure of SS data memory part. SS memory part 147 is composed of SS data management table 501 and SS data memory part 502. As if of
10 the index information 202, what are stored in SS data management table 501 includes the data number 512 and the data name, both uniquely assigned to the individual data, the remote file name 523 directing the remote location in which the data files are stored, the local file name 524 with which the data file is stored locally inside the information service station 104, the amount of money charged 526 or the
15 individual download operation, the user's access time 526 and comments 527 for the individual data.

When SS control part 146 receives the index information 202, it compares the data number 221 with the data number 521 presently stored in SS data management
20 table 501 and if it is judged that there is new data, SS control part 146 extracts the data number 221, the data name 222 the remote file name 223, the charge 224 and the comment 225 of the new data from the received data and adds those to SS data management table 501. At this time, the entities for the corresponding local file name 524 and time 525 are set to be NIL. When SS control part 146 receives the

data, it searches SS data management table 501 by using the data number 221 in the received data for the search key, and whether there is a local file corresponding to the data number 221 (=521) is determined. If there is a local file name 524 (not NIL), the received data is abandoned. On the other hand, if the local file name 524 is NIL, the received data is made stored in SS data memory part 502 as data (for example, program (1) 503), and the file name generated from the data name stored in SS data memory part 147 is stored as the local file name 524 in SS data management table 501. In addition, the time when the data is stored is the time 526 in SS data management table 501.

If the empty area of the onboard data memory part 502 is so small that the received data cannot be stored, SS control part 146 deletes the data already stored and reserves the memory area on SS data memory part 502 for storing the next received data. At this time, SS control part 146 refers to the time 526 in SS data management table 501, and deletes older data in order of their time stamps in order to reserve the memory area for the new download data. The time when the user download the individual data is recorded as the time 526. Thus, the older data in SS data memory part 502 are deleted in order of history with reference to the time 526.

Next, methods for downloading data from the information service station 104 and data maintenance are described. FIG. 6 illustrates a structure for downloading the data from the information service station 104 to the onboard terminal 103.

As shown in FIG. 6, the onboard input part 132 of the onboard terminal 103 has a

download button 435 and an IC card reader 436. The onboard transmission and receive part 136 is composed of a channel selection part 431 for selecting a frequency with which information the user requires is provided and/or a channel provided by multiplying a designated frequency in a time division mode like digital TV, a radio wave receive part 432 for receiving a radio wave, and an antenna 433 for transmitting and receiving the radio wave.

When the user inserts the IC card 437 into the IC card reader 436, all the information in the IC card 437 is stored in the onboard memory part 134. At this time, if the user pushes the download button 435, the IC card 437 is ejected from the IC card reader 436. At the same time, the onboard control part 131 of the onboard terminal 103 is switched into download mode. That is, the onboard control part 131 temporarily saves the channel number currently selected by the user in the onboard memory part 134. The onboard control part 131 requests the channel selection part 431 to switch the communication channel established in advance to the information service station 104 into receive channel mode. With this operation, the onboard terminal 103 can receive an information transmitted from the information service station 104.

FIG. 7 illustrates a data structure inside an IC card 437. IC card 437 has a customer data management table 601 and a registration data management table 603, and an onboard terminal number 611, a user number 612, a vehicle number 614, a credit number 616, a download public-key 620 and so on are registered in the customer data management table 601. On the other hand, the registration data management table 603 administrates the data representing the contents of programs and data

groups currently downloaded in the onboard terminal 103 such as a data number 631 (321) and a data name 632 (322).

On the other hand, as shown in FIG. 6, SS input part 142 of the information service station 104 has an IC card reader 444 and a touch screen 443 on SS display part. SS data receive part 141 has SS wire communication part 442 for communicating an information through the network 402 as well as SS radio wave communication part 441 for communicating information via a radio wave from the data distribution part 102 as described so far. The network 402 is connected to a remote information distribution part 401 represented as a memory location (remote file name) 223 defined in the index information 202. The remote information distribution part 401 stores the source data from the data distribution part 102 and distributes the data in response to the request by the information service station 104.

FIG. 8 illustrates procedures (1) to (7) for screen operations when providing information from the information service station 104 to the onboard terminal 103. As shown above, when the IC card 437 ejected from the onboard terminal 103 with its mode switched to a download mode is inserted into the IC card reader 444 of the information service station 104, a procedure for providing information by the information service station 104 is started.

When the IC card 437 is inserted into the IC card reader 444 of SS input part 142, its insertion event is reported to SS control part 146. SS control part 146 receiving this report extracts the user name 613, the vehicle number 614 and the password 619

from the customer data management table 601 stored in the IC card 437 thorough the IC card reader 444. A start-up screen (1) generated by using the user name 613 and the vehicle number 614 is displayed on SS display part 143, and the user's input of his or her password is expected. When the user inputs his or her password requested on the start-up screen (1) from SS input part 142, SS control part 146 compares the input password and the password 619 extracted from the IC card 437. If those passwords match each other, the top menu (2) is displayed. If those passwords do not match each other, the start-up screen (1) is displayed again and the user is requested to input his or her password.

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At the top menu (2), a selection menu including "install new software", "version-up", etc., is displayed. In addition, recommendation announcements may be displayed for the user. In order to prepare those display contents, SS control part 146 refers to the registered data management table 603 representing the contents of programs and data groups stored in the IC card (403) and currently downloaded in the onboard terminal 103. The source data number 2211 and the revision number 2212 are obtained in the data number 321 on the registered data management table 605. In order to determine whether there is any data in the onboard terminal 103 that can be upgraded, SS data management table 501 in the information service station 104 is searched by using the individual source data number 2211 for the search key. If new data is found in SS data management table 501 with its version higher than the version of the data in the onboard terminal 103, the information indicating that "the version of program is upgraded" in the onboard terminal 103 is displayed and the user is advised to download its new version.

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When the user touches the menu indicating "new software installation" on the top menu (2), the coordinate of the position at which the user specifies on the touch panel 433 at SS input 142 is captured. SS control part 146 judges from the input
5 coordinate that the menu indicating "new software installation" is selected, and a new software installation screen (3) is displayed in the following procedure.

Data other than the data with their data number 321 read out from the IC card 437 and downloaded in the onboard terminal 103 are searched with their source data
10 number 2211 corresponding to the data number 521 stored on SS data management table 501 in the information service station 104. In addition, the searched data is sorted for the individual source data number 2211, and the largest revision number 2212 is found in the sorted data. Thus, program names with their revision numbers as candidates to be newly installed are displayed at SS display part (143) as shown
15 in the screen (3.)

Collecting the individual data numbers 521 having an identical source data number 2212 and referring to the charge 525, which is amount of money charged for upgrading a version from its previous version for the individual data, a base charge
20 for the program is defined for the charge for the version 0, in SS data management table 501, the total amount of money for the data from the first version 0 to the current version is displayed for the total charge at SS display part 143.

If a comment 527 is stored for the latest version for the source data number 2211 in

SS data management table 501, SS control part 146 displays its comment on the comment field on the screen (3). In the illustrated example, a comment indicating "3D image generation" is displayed on the comment field for "Navigation 1" as the first software.

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The user can select necessary software by touching the title of the software on the new software installation screen (3), that is, through the touch screen 443 on SS display part 143. SS control part 146 identifies the software to be installed on the basis of the position on which the user touched. For example, in case of the screen (3), it is assumed that the user selects the title of "Navigation 1". As a matter of course, the user is allowed to select plural titles of software. When the user selects plural titles of software and presses "OK" button, SS input part 142 recognizes from the position on the touch panel that the user presses "OK" button, and displays a list of selected titles of software as shown in the download start screen (5).

15

In order to display the screen (5), SS control part 146 searches SS data management table 501 with the title of software selected by the user, and calculates the individual download charge for the individual software and their total charge by the above described method. In the illustrated example, "Navigation 1 is ¥ 3,000", "WWW is ¥ 100" and the total charge is ¥ 3,100 is displayed on SS display part 146. When the user selects "Download" button, a download-on-go screen (6) is displayed next.

20

When the user selects "Download" button on the screen (5), SS control part 146

refers to SS data management table 501 and obtains the memory locations for designated software (for example, "Navigation 1" and "WWW".) At this time, if the memory location is already stored in SS memory part 147, the local memory location 524 can be obtained. On the other hand, if the memory location is not yet stored in SS memory part 147 or the program content has not broadcasted yet, the local memory location cannot be obtained, and hence, SS control part 146 can obtain the remote memory location 523 broadcasted as the index information 202. If there is information to be downloaded at the local memory location 524, SS control part 146 extracts an information to be downloaded from a designated location (with a designated file name) at SS data memory part 502.

On the other hand, if there is information to be downloaded at a remote site, SS control part 146 directs SS data receive part 141 to get the information from the location 523 defined in SS data management table 501. SS data receive part 141, receiving the receive request and the remote site location from the SS control part 146, obtains the information to be download from the remote site, for example, the remote information distribution part 401 through the network 402 with FTP protocol at SS wire communication part 442 inside SS data receive part 141. The source data already broadcasted as well as the source data to be broadcasted are ordinarily stored in the remote information distribution part 401 so as to be ready for distribution.

Furthermore, SS control part 146 downloads the file received from the remote site and/or the local file into the user's onboard terminal 103. When SS control part 146

obtains the information specified by the user so as to be downloaded from SS memory part 147 and/or SS data receive part 141, a verification and administration number (64bit fixed-length record) uniquely assigned to the data is added onto the header of the data and encrypted with a download public-key 620 read out from the IC card 437 at SS security management part 145. The encrypted information is modulated with a predefined download frequency and broadcasted at SS information distribution part 144. In order to present the progress status of the download operation, SS control part 146 generates, for example, a slide bar as the screen (6) with the amount of data to be downloaded and the amount of data already downloaded and displays it on SS display part 143.

As the channel selection part 431 in the onboard transmission and receive part 136 is tuned to the download frequency in the onboard terminal 103, the onboard terminal 103 receives the broadcasted data through the antenna 433, the radio wave receive part 432 and the channel selection part 431 when the broadcast program is broadcasted from SS information distribution part 144 of the information service station 104. The onboard control part 131 decodes the downloaded encrypted information at the onboard security management part 135 by using the user's download cipher key 620. If the cryptanalysis is successfully completed, the onboard control part 131 determines that the downloaded data is for its onboard terminal and stores the downloaded data in the onboard memory part 134, and return its terminal number and verification management number indicating that the download data is received at the information service station 104 through the onboard transmission and receive part 136.

The information service station 104 receives verification information (including the number of the onboard terminal downloading the data and its verification management number) from SS information distribution part 144, and transfer it to SS control part 146. SS control part 146 examines whether the verification management number is identical to that of the information when downloading, and judges that the download operation is completed if the onboard terminal number 611 in the IC card matches the transmitted onboard terminal number. If these numbers do not match each other or that there is no reply for verification in a definite period of time, an error message is displayed on SS display part 143, and the screen (5) is displayed. When completing the download operation, SS control part 146 displays the download completion screen (7) on SS display part 143.

When the user selects the verification key on the screen (7), SS control part 146 judges that the download operation was successfully completed, and executes the accounting operation, and then, adds the contents of the download information to the registered data management table 603 of the IC card 437 and ejects the IC card 437 from SS input part 444.

When the user returns the ejected IC card 437 to the onboard terminal 103, the onboard control part 131 judges that the download operation is completed, and then, sets the previous channel number stored in the onboard memory part 131 into the channel selection part 431 in order to switch back to the memorized channel before the downloading operation.

If the user select "Version Upgrade" on the top menu (2) shown in FIG. 8, SS input part 142 captures the coordinate of the input position on the touch panel 443. SS control part 146 judges from the input coordinate that the menu indicating "Version Upgrade" is selected, and a version-up screen (4) is displayed in the following procedure.

SS control part 146 finds all the same data as the data with their data number 631 (321) read out from the IC card 437 and downloaded in the onboard terminal 103 among the data corresponding to the data number 521 stored on SS data management table 501 in the information service station 104. In addition, the found data are sorted for the individual source data number 2211, the individual data numbers 521 having an identical source data number 2212 are collected and the charge 525 (which is amount of money charged for upgrading a version from its previous version for the individual data, a base charge for the program is defined for the charge for the version 0) in SS data management table 501 is referred to. The total amount of money for the data from the first version 0 to the current version is displayed for the data download charge at SS display part 143.

As shown in the screen (4), the program name, the version number and the charge of the data as candidates for version upgrade. In addition, if a comment 527 is stored for the latest version for the source data number 2211 in SS data management table 501, SS control part 146 displays its comment on the comment field. For example, a comment indicating "3D image generation" is displayed on the

comment field for "Navigation 1" as the first software.

The user can select necessary software by touching the title of the software on the version upgrade screen (4). SS control part 146 identifies the software to be
5 installed on the basis of the position on which the user touch. For example, in case of the screen (4), it is assumed that the user selects the titles of "Navigation 1" and "WWW". The user is allowed to select plural titles of software. When the user selects plural titles of software and presses "OK" button, SS input part 142 recognizes from the position on the touch panel that the user presses "OK" button,
10 and displays a list of selected titles of software as shown in the screen (5). Later screen operations (5) to (7) and the operation of the service station 104 are the same as those in case for installing new software.

In the above embodiment, what is described is a method such that, the user visits
15 the information service station 104 and interactively operates the screens in the information service station 104, and downloads necessary information into the onboard terminal 103. As for another method, the user can download necessary information directly from the information service station 104 by operating the onboard terminal 103 while inside the vehicle. A method for downloading an information by
20 means that the user operates the onboard terminal 103 is described below.

FIG. 9 describes screen operations for downloading a necessary information directly from the onboard terminal. In FIG. 9 (a), when the user selects the data already downloaded (for example, WWW and Navigation 1) on the operation screen

including the broadcast menu list shown in FIG. 4, and specifies the download button 413, the onboard terminal 103 and the information service station 104 executes the following procedures and downloads the designated data.

- 5 When the user selects the download button 413 at the onboard input part 132, the onboard control part 131 directs the channel selection part 431 through the onboard transmission and receive part 135 to switch to the dedicated download channel. In addition, the onboard control part 131, by using this dedicated channel, a communication request for asking whether there is an information service station 104
- 10 able to respond in the neighborhood. Broadcasts the public-key 620 for the onboard terminal stored in the onboard security management part 135 and the onboard terminal number 611 of the onboard control part 131 with a radio wave through the radio wave transmission and receive part 432.
- 15 When the information service station 104 in the neighborhood receives the request from the onboard terminal 103 at SS radio wave communication part 441 of SS data receive part 141, if the information service station in the neighborhood is occupied by the execution of the service for another user, the information service station 104 encrypts the data indicating that the information service station 104 is busy and the
- 20 unique number of the information service station 104 in SS control part 146 with the open key 620 received from the onboard terminal 103 and transmits the encrypted information from SS information distribution part 144. On the other hand, if the information service station 104 the neighborhood is not occupied by the execution of the service for another user, the information service station 104 encrypts the

message indicating that the information service station 104 is ready to serve for the user and the unique number of the information service station 104 in SS control part with the open key 620 received from the onboard terminal 103 and transmits the encrypted information with a radio wave from SS information distribution part 144.

5

The onboard terminal 103 requesting the communication receives the information from several information service stations 104 at the onboard transmission and receive part 36, and encodes the received information with its own public-key 620, and then initiates the communication with the information service station 104 transmitting the message indicating that its service is available. The onboard terminal 103 encrypts the credit card number 616 used in payment in the onboard control part 131 and/or the IC card 437 and the data name (for example, WWW and Navigation 1) of the data which the user specifies on the screen shown in FIG. 9 (a) for download by using the open key provided by the information service station 104 with which the onboard terminal wants to communicate, and encrypts again the unique number of the information service station 104 the user want to use with the public-key 620 of the onboard terminal 103 and transmits it.

When SS control part 141 of the information service station 104 answering the message indicating that it can be used for service receives the data from the onboard terminal 103 in response to the communication request from the onboard terminal, at first, SS control part decodes the received data with the public-key 620 which is obtained from the onboard terminal 103 with a radio wave previously, and next judges whether the unique number of the information service station in the

20

encoded data is that for the information service station 104 itself. If the information service station 104 number is not for that station the SS control part 146 does not proceed the further procedure. On her other hand, If this unique number is that for the information service station 104 itself, SS control part 146 further decodes the data from the onboard terminal 103 with its own public-key, and extracts the credit number 616 provided from the onboard terminal 103 and the data name which the user wants to download.

SS control part 146 searches SS data management table 501 by the title of the software the user selects, and calculates the download charge of the individual software and the total charge by using the method described above. And then, an information 'indicating such a user's selection defined as "Navigation 1 is ¥ 3000", "WWW is ¥ 100" and the total charge is ¥ 3100 is encrypted with the public key of the onboard terminal and transmitted to the onboard terminal 103.

The onboard terminal 103 decodes the data from the information service station 104 with the public-key 620 and displays a download-on-go message shown in FIG. 9 (b).

Furthermore, when the information service station 104 receives the request for download from the onboard terminal 103, SS control part 146 refers to SS data management table 501 and obtains the memory locations for the software corresponding to be downloaded (for example, "Navigation 1" and "WWW".) At this time, if the software to be downloaded is already stored in SS memory part 147, the

local memory position 524 can be obtained. If the local memory position 524 cannot be obtained, the remote memory position 523 broadcasted as index information 202 can be obtained.

- 5 If there is information to be downloaded at the local memory location 524, SS control part 146 gets out information to be downloaded from a designated location (file name) in SS memory part 504. On the other hand, if there is information to be downloaded at a remote site, SS control part 146 directs SS data receive part 141 to get the information at the remote memory location 523. When SS data receive part 10 141 receives a remote location 523 and a data receive request from SS control part 146, SS data receive part obtains, from its internal SS wire communication part 442, the information to be downloaded from a remote location (remote information distribution part 401) with FTP protocol through the network 402.
- 15 SS control part 146 downloads the file received from the remote site and/or the file stored locally onto user's onboard terminal 103. When SS control part 146 obtains the information specified by the user so as to be downloaded from SS memory part 147 and/or SS data receive part 141, it adds a verification and administration number (64bit fixed-length record) uniquely assigned to the data to be downloaded onto the 20 header of the data and SS security management part 145 encrypts it with a download public-key 620 provided from the onboard terminal. In addition, the encrypted information is modulated in a predefined download frequency and broadcasted at SS information distribution part 144.

In the onboard terminal 103, as the channel selection part 431 of the onboard transmission and receive part 136 is turned for the download frequency, when broadcasting from SS information distribution part 144 at the information service station 104 begins, the onboard terminal receives the data broadcasted through the antenna 433, the radio wave receive part 432 and the channel selection part 431. The onboard control part 131 decodes the downloaded information by using its own cipher key at the onboard security management part 135. At this time, if decoding is successfully completed, the onboard control part 131 judges that the downloaded information is the data directed to itself and stores the data into the onboard memory part 134, and replies its own onboard terminal number and a verification and administration number indicating that the designated data is surely received to the information service station 104 through the onboard transmission and receive part 136.

The information service station 104 receives the verification information (the onboard terminal number and the verification and management number for the download operation) from SS information distribution part 144, and transfers it to SS control part 146. SS control part 146 checks whether the verification and management number is identical to the information provided when downloading, and if the onboard terminal number 611 transmitted from the onboard terminal 103 coincides the transmitted onboard terminal number, it concludes that the download operation is completed, and transmits a termination report to the onboard terminal 103. In the onboard terminal 103, when completing the download operation, the onboard control part 146 displays the download completion screen as shown in FIG. 9 (c) on the

onboard display part 143.

When the user selects the verification key 903 on the download completion screen (c) with the onboard input part 13, the onboard control part 146 reports the user's verification to the information service station 104. The information service station 104 recognizes the successful download operation with the receipt of this user's verification, and applies the charge to the credit number 616 from the onboard terminal 103, and terminates the communication with the onboard terminal 103. The onboard control part 131 of the onboard terminal 103 also recognizes the termination of the download operation when selecting the verification key 903, and sets the previous channel number stored in the onboard memory part 131 to the channel selection part 431.

According to the present invention, the program currently broadcasted and information groups including its related data and the individual data name and index data of the information group already broadcasted and to be broadcasted in the future are broadcasted as digital broadcasting data in multiplex broadcasting. It will be appreciated that a list of data which cannot be received by the mobile terminal can be viewed. With this approach, there is such an effect that the data name and its version to which the user cannot access easily can be easily obtained and the user can request to download necessary data among the available data. In addition, as the volume of the index data is smaller compared with the source data, various data service can be established without reducing the transmission efficiency of the data broadcasting station.

According to the present invention, as the information service station which receives and stores the data group and index, and distributes them in response to the user's request stored can be realized, there is such an effect that the user does not need to
5 memorize all the broadcasting data and the user can download necessary data when needed.

As the information service station encrypts the data to be downloaded with the cipher key obtained through the communication or the IC card provided by the user there is
10 such an effect that the download data is not heard by unintended people and the user can download the data with security from the information service station through radio waves.

WHAT IS CLAIMED IS:

1. A digital broadcasting system comprising:

a digital broadcasting transmission apparatus for broadcasting data groups;

5 and

a digital broadcasting receive apparatus for receiving said data groups directly or indirectly through a data distribution part;

wherein said digital broadcasting transmission apparatus has a transmission means for multiplexing and broadcasting a data group comprising ordinary data
10 composed of programs and index data composed of identification information of ordinary data broadcast in past or to be broadcast in future.

2. The digital broadcasting system of claim 1 wherein said index data includes data identifiers of the ordinary data broadcast in past or to be broadcast in future,

15 and a remote memory location from which the ordinary data can be downloaded.

3. The digital broadcasting system of claim 1 or 2, wherein said digital broadcasting transmission apparatus adds distinctive identifiers individually to said ordinary data and said index data.

20

4. The digital broadcasting system according to one of claims 1, 2 or 3, wherein said digital broadcasting receive apparatus has a data separation means for identifying said ordinary data and said index data separately among the received data groups.

5. The digital broadcasting system of claim 4 wherein said digital broadcasting receive apparatus has a judge means for determining if an ordinary data having an associated data identifier has been downloaded in the digital broadcasting receive apparatus by referring to the data identifiers in said received index data.

5

6. The digital broadcasting system of claim 5, wherein said digital broadcasting receive apparatus is a mobile terminal and has a download request means for allowing selection of ordinary data for downloading by displaying index data of ordinary data not yet downloaded.

10

7. The digital broadcasting system of claim 6, wherein said mobile terminal has a transmission means for sending a download request and a receive means for receiving data groups and requested ordinary data.

15

8. The digital broadcasting system of claim 7, wherein said transmission means adds and sends out said requested ordinary data with a public-key used exclusively for an individual digital broadcasting receive apparatus.

20

9. The digital broadcasting system according to one of claims 1, 2 or 3, wherein said digital broadcasting receive apparatus is an information service station, and has a data receive means for receiving said data groups and a data memory means for storing said ordinary data and said index data separately among said received data groups.

10. The digital broadcasting system of claim 9, wherein said information service station has an input means for accepting a download request for requested ordinary data from a requester; a data management means for referring to index data corresponding to requested ordinary data if said data memory means does not
5 contain said requested ordinary data and directing said requested ordinary data to be retrieved from a remote memory location specified by said index data; and a distribution means for transmitting said requested ordinary data to said requester.
11. The digital broadcasting system of claim 10, wherein said information service
10 station has a security management means for encrypting said requested ordinary data by using a cipher key specified by said requester.
12. The digital broadcasting system of claim 10 or 11, wherein said information service station transmits verification information for verifying that said requester
15 obtains distributed information along with said requested ordinary data, acknowledges a response to said verification information, and processes a billing operation.
13. A mobile terminal comprising:
20 an embedded computer executing plural installed software programs;
a communication means for receiving digital broadcasting contents, said digital broadcasting contents comprising programs and related data;
an input means for accepting an operation input by a user;
an information memory means for storing said programs and related data;

a display means for displaying an execution result of programs and a
operation screen; and

a control means for managing said programs and related data captured from
said communication means and said input means;

5 wherein said information memory means stores management information
independent of said programs and related data, said management information
comprising information identifiers of said programs and related data.

14. The mobile terminal of claim 13, wherein when said control means receives
10 index data including data identifiers of the programs and related data already
broadcast or to be broadcast in the future as time division multiplex data of said
digital broadcasting contents through said communication means, said control
means extracts data identifiers of programs and related data not yet downloaded by
referring to management data stored in said information memory means, and
15 displays said index data and data identifiers with said display means.

15. The mobile terminal of claim 13 or 14, wherein said input means has an
external media input means allowing an integrated circuit (IC) card and/or an
external memory media to be inserted, and when a designated memory media is
20 inserted and a download operation is requested by said input means, said
management data stored in said information memory means are read out and stored
in an inserted memory media.

16. The mobile terminal of claim 15, wherein said designated memory media is an

IC card, and stores a mobile terminal number or user number, and a cipher key. for download operation.

17. The mobile terminal of claim 14 or 15, wherein said communication means
5 has a receive channel corresponding to a transmission from a download request and a receive channel for said digital broadcasting, in which those channels are switched in response to an insert operation of said designated memory media.

18. An information service station in communication with a mobile terminal, said
10 information service station comprising:

a data storage for storing data groups received in a digital broadcast, said data groups comprising ordinary data to be broadcast as programs and index data defined as information of ordinary data broadcast in past or to be broadcast in future;

a distributor for distributing requested ordinary data in response to a download
15 request said mobile terminal; and

wherein said information service station obtains an individual cipher key for said mobile terminal, encrypts said requested ordinary data by said cipher key and sends said encrypted requested ordinary data to said mobile terminal.

20 19. The information service station of claim 18, further including a management information storage for storing management information; said management information comprising data identifiers of stored data, an internal memory location, and index data; wherein said index data and data identifiers have external data memory locations for ordinary data already broadcast or to be broadcast in the

future.

20. The information service station of claim 19, wherein said cipher key is
obtained from an output of a transmission means of a mobile terminal as a cipher
5 key described in Claim 8.

21. The information service station of claim 19, wherein said cipher key is
obtained from an integrated circuit (IC) card for a mobile terminal as a cipher key
described in Claim 16.

10

22. The information service station of claim 21, wherein data identifiers of ordinary
data already downloaded by said mobile terminal and stored in said IC card and said
management information are compared with each other, and the data not
downloaded yet or its version are displayed selectively.

15

23. The information service station of claim 22, wherein if a download request in
terms of selection is issued for ordinary data or its version displayed, a download
charge is displayed so as to enable to verify a download operation.

20 24. The information service station according to one of claims 19, 20, 21, 22 or
23, wherein if ordinary data requested for download is not located in said internal
memory location, said requested ordinary data are captured from said external
memory location indicated by an index data and downloaded onto a requester.

FIG. 1

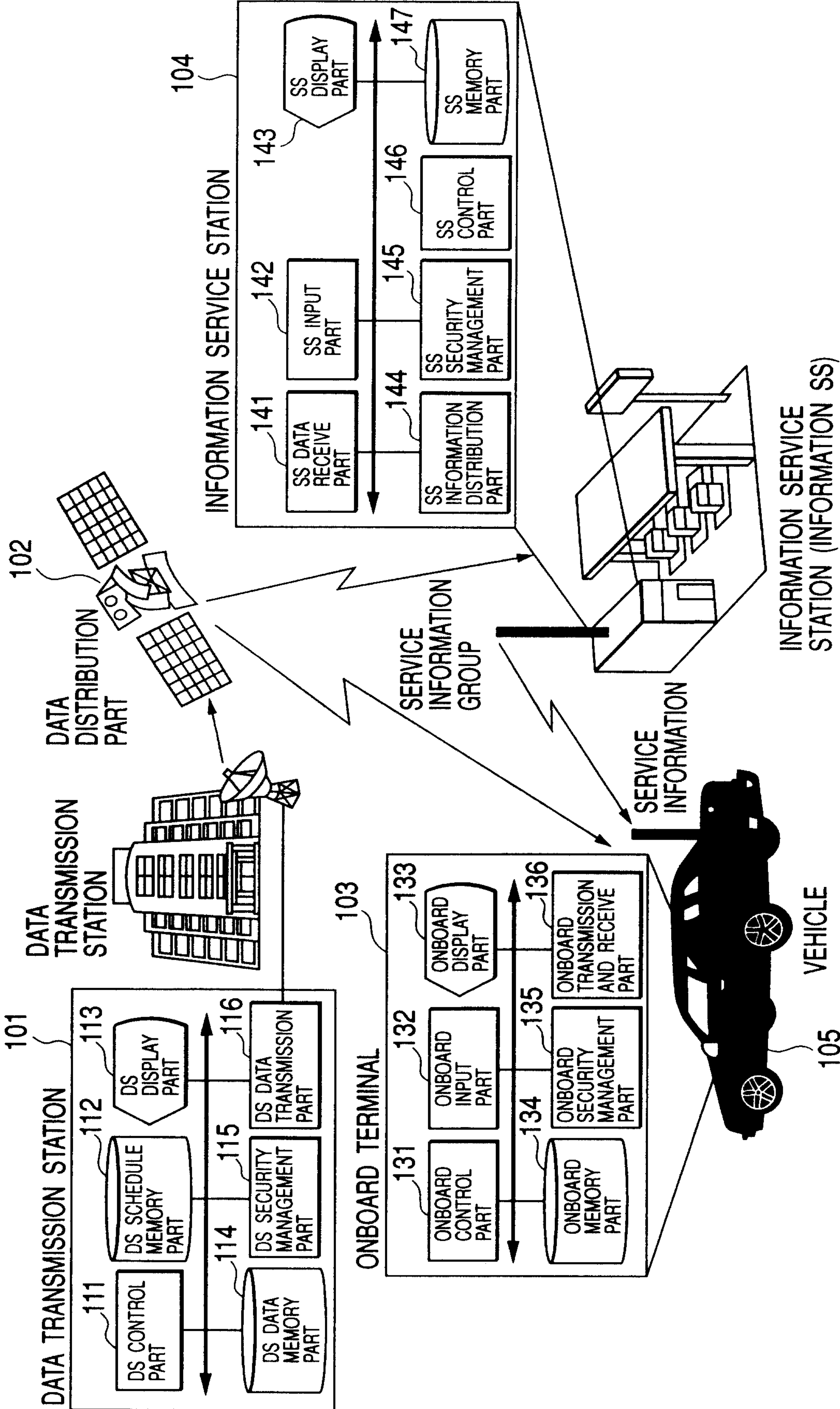


FIG. 2(a)

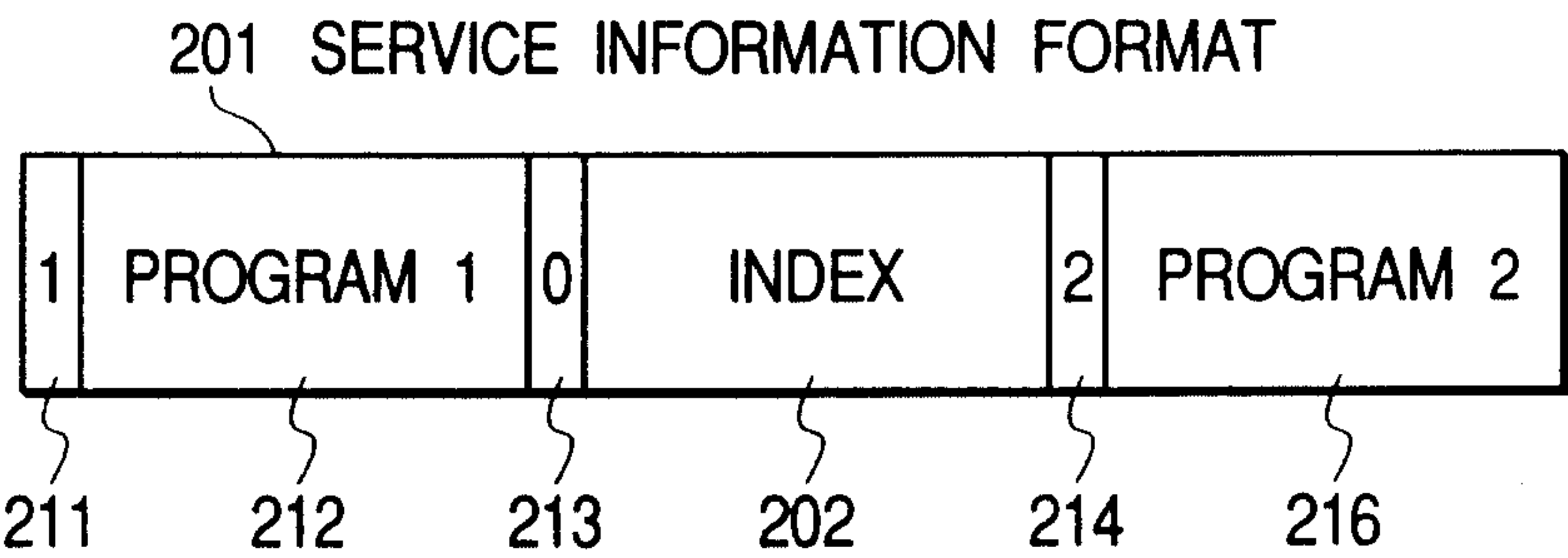


FIG. 2(b)

202 INDEX INFORMATION

DATA NO.	DATA NAME	MEMORY LOCATION	CHARGE	COMMENT	TIME
1	PROGRAM 1	ftp://H/prog1			
⋮	⋮	⋮			
N	PROGRAM n	ftp://H/progn			

221 222 223 224 225 226

FIG. 2(c)

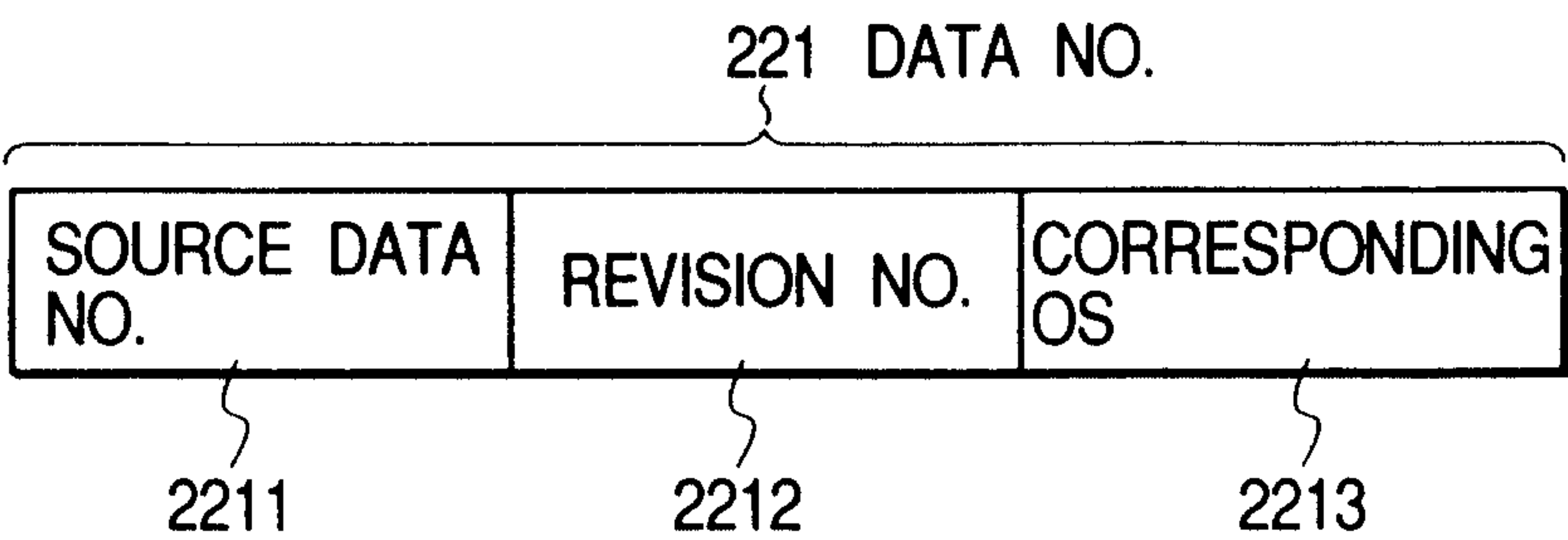


FIG. 3

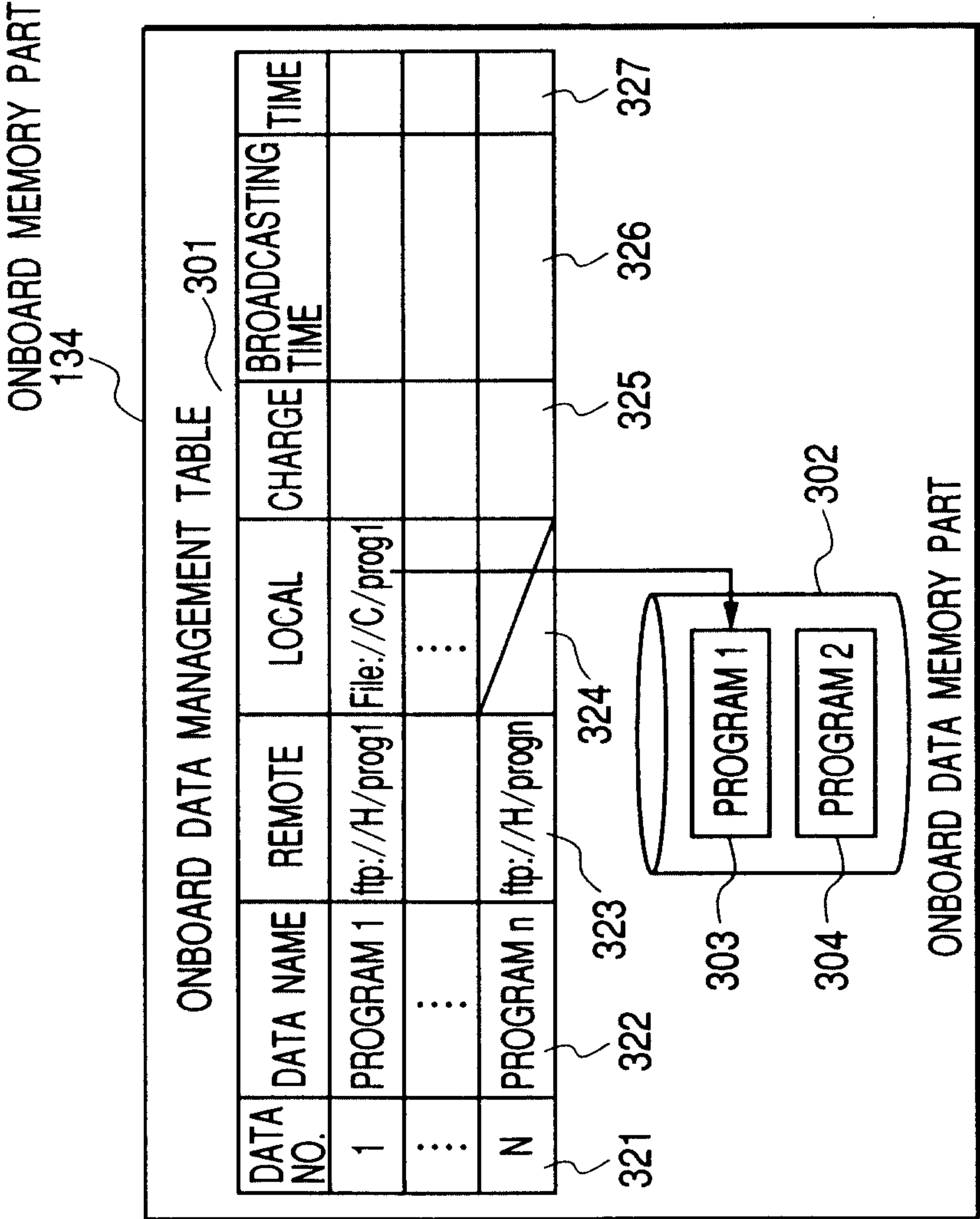


FIG. 4

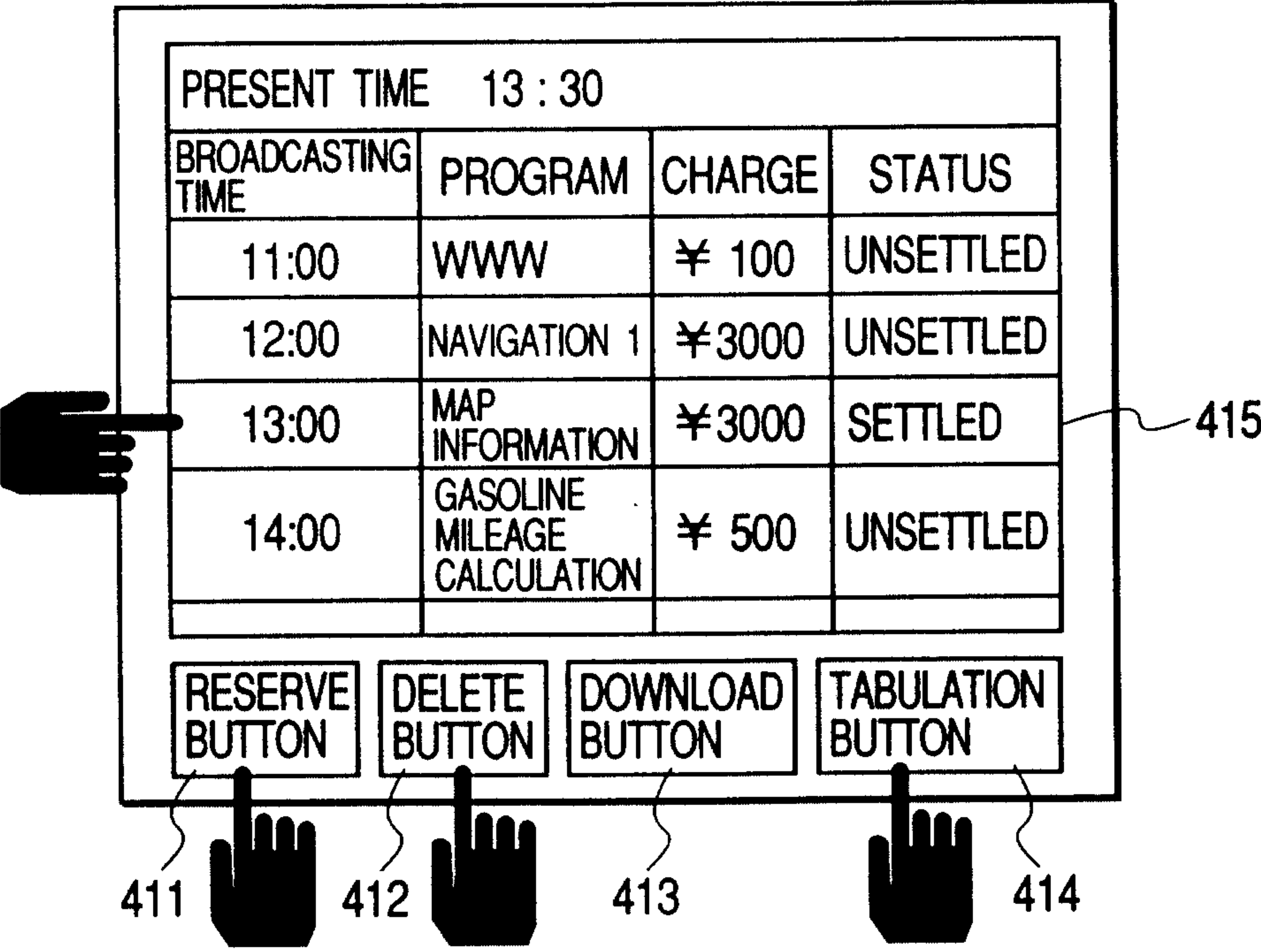


FIG. 5

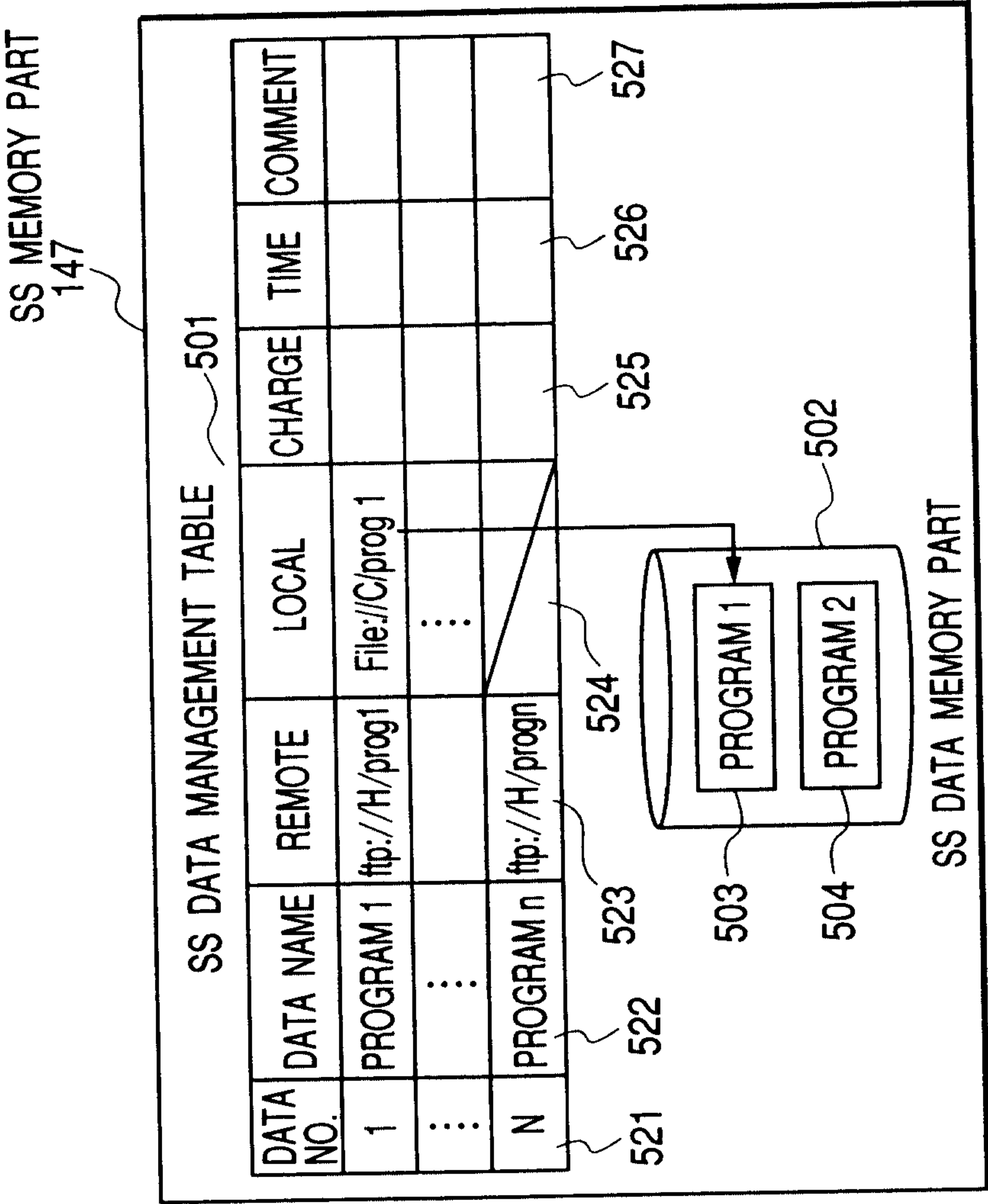


FIG. 6

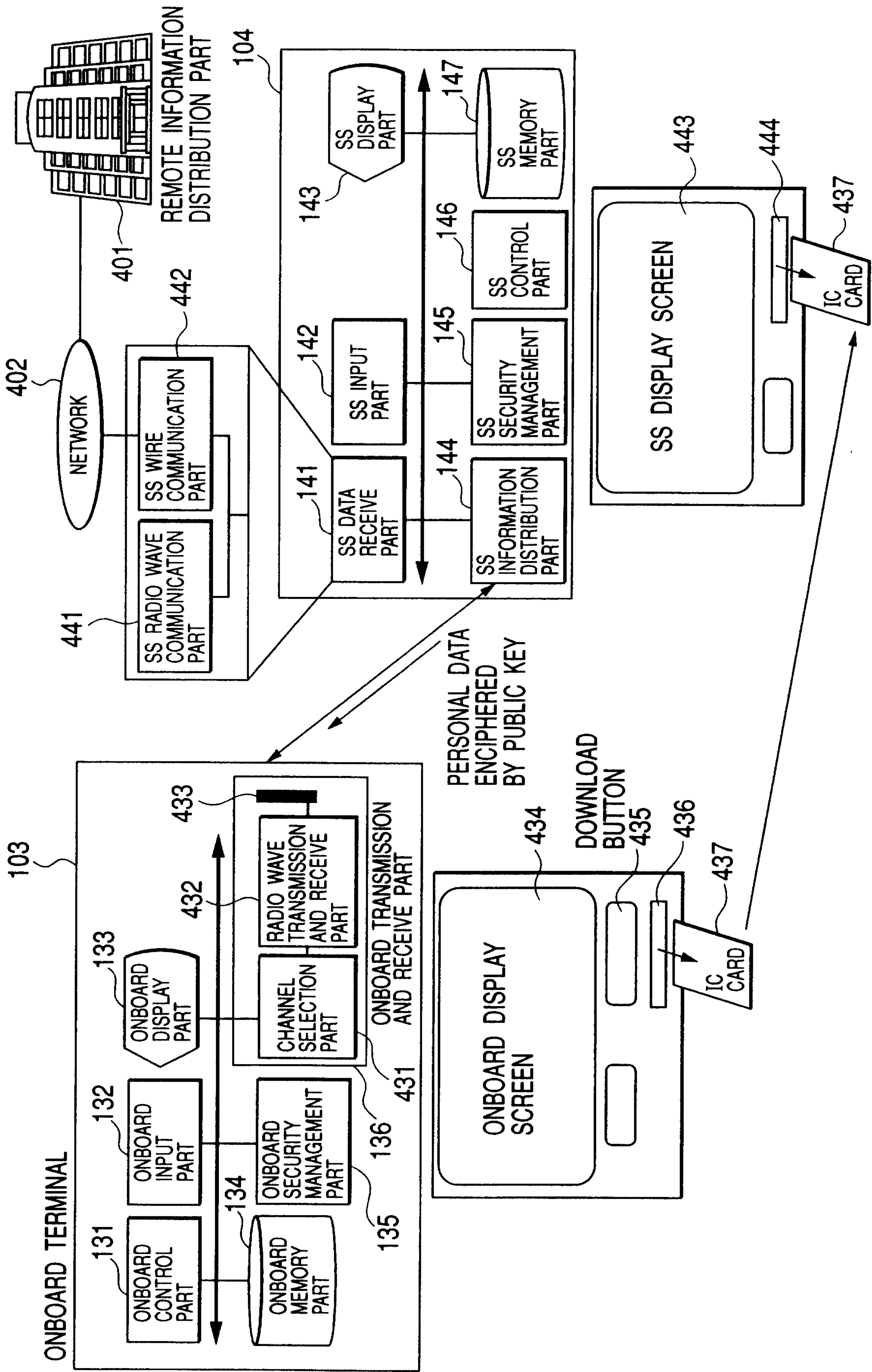


FIG. 7(a)

601

CUSTOMER DATA MANAGEMENT TABLE

611	ONBOARD TERMINAL NO.	
612	USER NO.	
613	USER NAME	
614	VEHICLE NO.	
615	RENEWAL DATE	
616	CREDIT NO.	
617	USER KEY	
618	ACCESS KEY	
619	ACCESS PASSWORD	
620	DOWNLOAD PUBLIC KEY	
621	NUMBER OF REGISTERED DATA	

FIG. 7(b)

603

REGISTERED DATA MANAGEMENT TABLE

DATA NO.	DATA NAME	Ver.	ACCESS CODE	DATA POINTER

631
(321)

632
(322)

633

634

635

FIG. 8

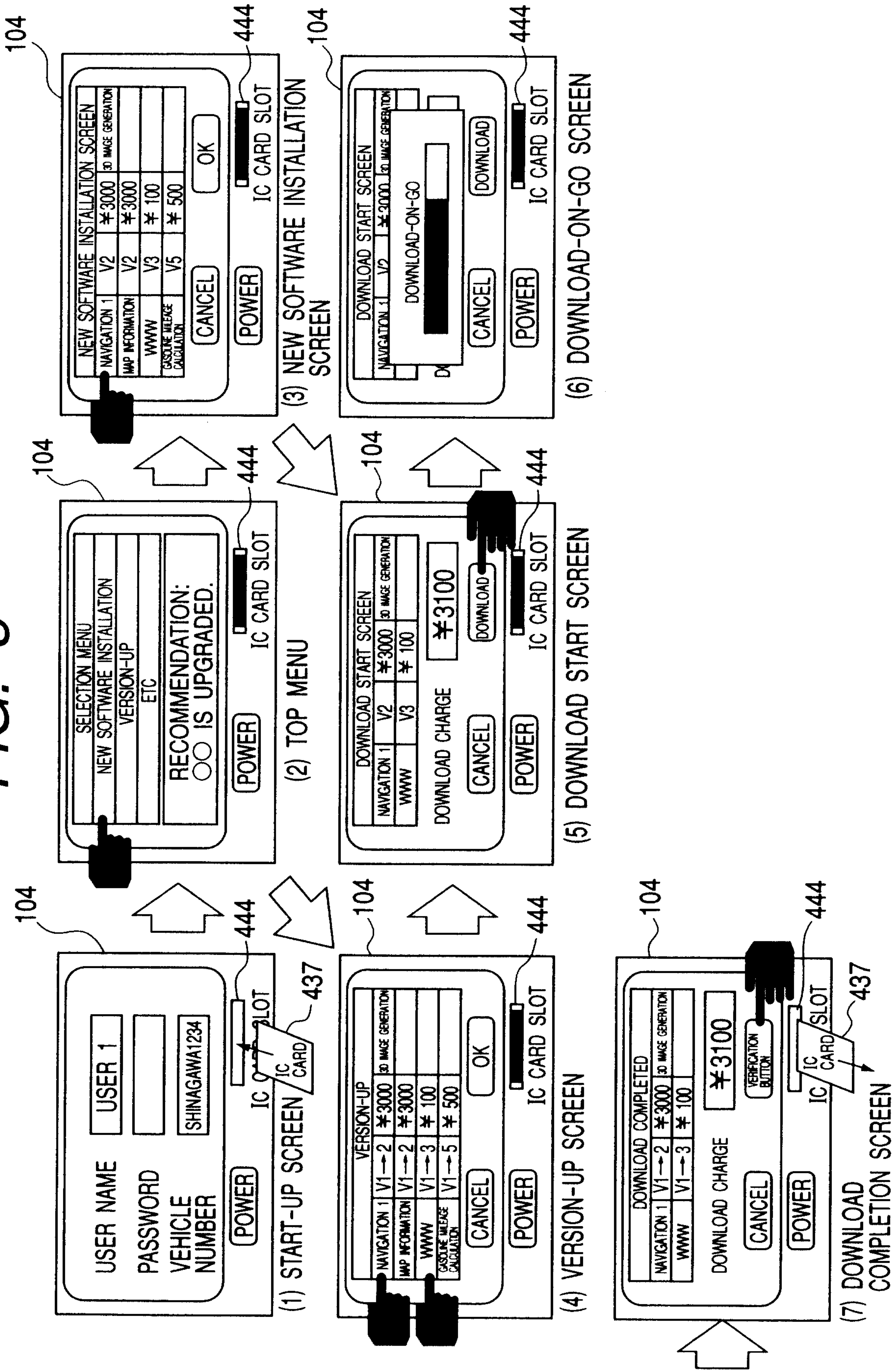


FIG. 9(b)

FIG. 9(c)

