

IMT-2000 Reverse-Billing Service

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This article reviews the reverse-billing service launched for the FOMA i-mode service and its functions.

1. Introduction

NTT DoCoMo launched the i-mode service based on Freedom Of Mobile multimedia Access (FOMA) in May 2001, and introduced the reverse-billing service in the International Mobile Telecommunications-2000 (IMT-2000) network in the summer of 2002. Reverse-billing is a service that imposes the packet transmission charges associated with browsing sites on the information provider while charging nothing to users. While reverse-billing service had already been offered for i-mode on the PDC mobile Packet data communication system (PDC-P), the launch makes it possible to offer sites without imposing packet transmission charges to FOMA users also.

Since the launch of the FOMA in May 2001, more services harnessing the high-capacity, high-speed communication properties have been offered in FOMA i-mode than in PDC-P i-mode. The reverse-billing service introduced lately targets all users subscribing to FOMA i-mode, and is designed to offer the i-mode service in a more user-friendly manner with no charge at various sites.

This article reviews the reverse-billing service in FOMA i-mode.

2. Service

2.1 Overview

In the i-mode service, a wide range of information is offered by various information providers. Users can browse sites using an i-mode mobile phone, and the information provider can distribute information to users' i-mode mobile phones via an i-mode server. Conventionally, users were charged a fee depending on the sites browsed and the volume of information distributed (packet volume) as a packet-transmission charge. The

introduction of the reverse-billing service in FOMA i-mode has made it possible to specify the payer of the packet transmission charges by content accessed by an i-mode mobile phone, and enabled information providers to offer services and information without burdening users.

Also, reverse-billing accelerates the invoice process, which is executed in such a manner that packet transmission charges would not be imposed on the user when they have arisen despite communication failure due to fault or congestion in the Gateway service Representative Internet Market Mobile access exchange (GRIMM).

Services using reverse-billing currently offered in FOMA i-mode are described below.

(1) Reverse-billing for PULL type*¹ Information Providing Services

The payer of the packet transmission charges can be specified by content when a user selects one of the links on a website using an i-mode mobile phone and browses a site. For example,

sites such as “iMenu,” “Weekly i-guide,” “Option Setup,” “Notice & Help” can be registered as reverse-billing sites, so that the packet transmission charges associated with browsing these sites will be imposed on the information provider rather than the user (**Figure 1**). For example, the Weekly i-guide encourages the use of new services by giving information on new sites made available every week without any communication charges.

(2) Reverse-billing for PUSH type*² Information Distribution Services

The reverse-billing mechanism is also applied to PUSH type information distribution services in which messages are sent from the network to specific users’ i-mode mobile phones (“Message Free Service”) to distribute information from the information provider to users (this service is not currently avail-

*1 PULL type: A service that requires some kind of action to be taken by the user to acquire information.

*2 PUSH type: A service that distributes information automatically even if the user does not take any action to acquire information.

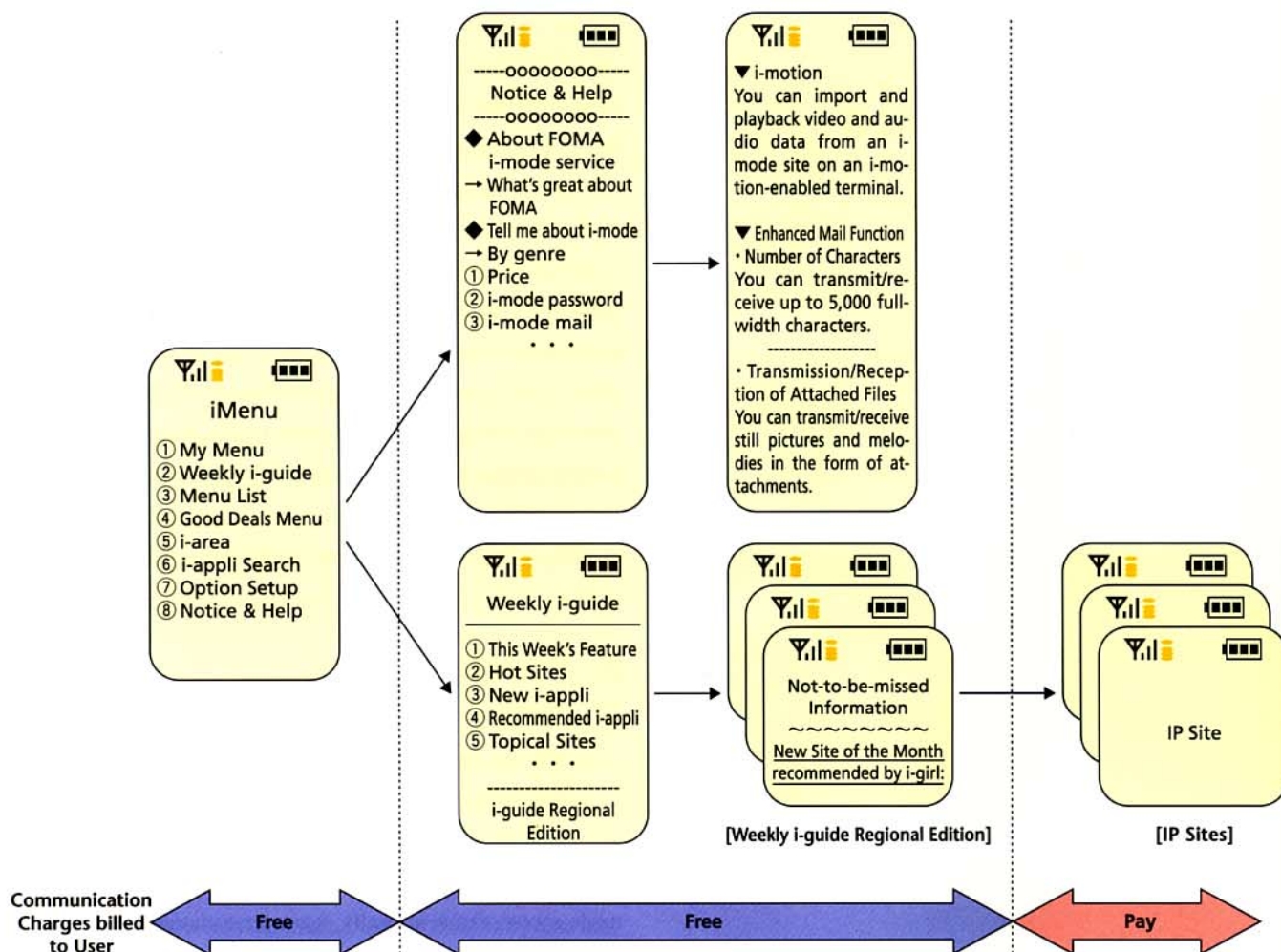


Figure 1 iMenu

able in FOMA i-mode). For example, an information provider who wishes to distribute advertisements based on user demographic information will be able to distribute information easily to specific users when the free message service becomes available in FOMA i-mode in the future by using the reverse-billing mechanism, which imposes the packet transmission charges on the information provider rather than the users.

2.2 Service Functions

The mechanism of the reverse-billing service is described briefly below, using the PULL type information providing service as an example.

In the current i-mode service, the “iMenu” page serves as the portal to the i-mode site, offering links to notices from NTT DoCoMo and pages provided by various information providers. When a user accesses one of such sites using an i-mode mobile phone, packet transmission charges determined by the volume of each page are imposed on the user every time they browses. As explained previously, all packet transmission charges used to be imposed on users before the launch of the reverse-billing service. The reverse-billing service enables information providers to specify zero packet transmission charges to users for downloading a page, on a page-by-page basis. This means that downloading a HyperText Markup Language (HTML) page involves at least one set of a HyperText Transfer Protocol (HTTP) request and HTTP response. The payer is decided by determining in the NTT DoCoMo network, on HTTP basis, as to whether the requested URL requires the user or the information provider to pay.

3. Development Concept and Network Functions Division

The following is a description of the development concept considered when implementing reverse-billing in the FOMA network and the division of network functions based on the development concept.

3.1 Development Concept

Based on the Core Network (CN) layer and the independent Application (AP) layer, the FOMA network offers a service AP function as a network so as to accelerate the introduction of Internet-related services in mobile communications and to improve the efficiency of system development.

The FOMA network introduces the gateway system, as a

system in the AP layer to offer AP functions within the network. The functions are provided by a different gateway system according to the way in which the terminal is used (whether the mobile station (MS) is used independently or in combination with a PC) and the connection destination (whether it is connected to the Internet or user LAN).

In consideration of various services that might be added in the future, it is conceivable to introduce the Multimedia Service Agent (MSA) as a device that realizes the functions within the network according to the service, in addition to the gateway system. The potential merits of this arrangement are as follows.

- Development can be simplified and made more efficient by consolidating the AP-unique functions according to the service.
- New functions and services can be introduced easily by reducing the number of functions that need to be added to the gateway system. Moreover, centralized management can be performed even after the commencement of operation.

In order to implement reverse-billing in the IMT-2000 network, NTT DoCoMo introduced an MSA for providing the billing service over the network, called the multimedia Service Agent for aCcounting (SAC).

3.2 NetWork (NW) Functions Division and Configuration

As explained above, the reverse-billing service is distinctive in that it can switch the payer on HTTP basis. Such billing arrangement requires the measurement of the data volume at the HTTP level. In the gateway system, the Wireless Protocol Conversion Gateway (WPCG) is equipped with the HTTP protocol (**Figure 2**).

WPCG collects the billing data for generating a bill. SAC generates the bill based on this billing data. The functions are divided in this manner so that the performance of the protocol conversion function between the MS and IMT-GRIMM would not be affected (**Figure 3** and **Table 1**).

In the case of PULL type information providing services, IMT-GRIMM determines the payer in response to the HTTP request from an MS and informs WPCG of the payer together with the HTTP content. WPCG sends to SAC, as the billing data, the collected packet information and the HTTP information, as well as the payer information notified from IMT-GRIMM. SAC transmits to the Customer Cell record Collector_IMT (CCC_I) the bill in which the payer information

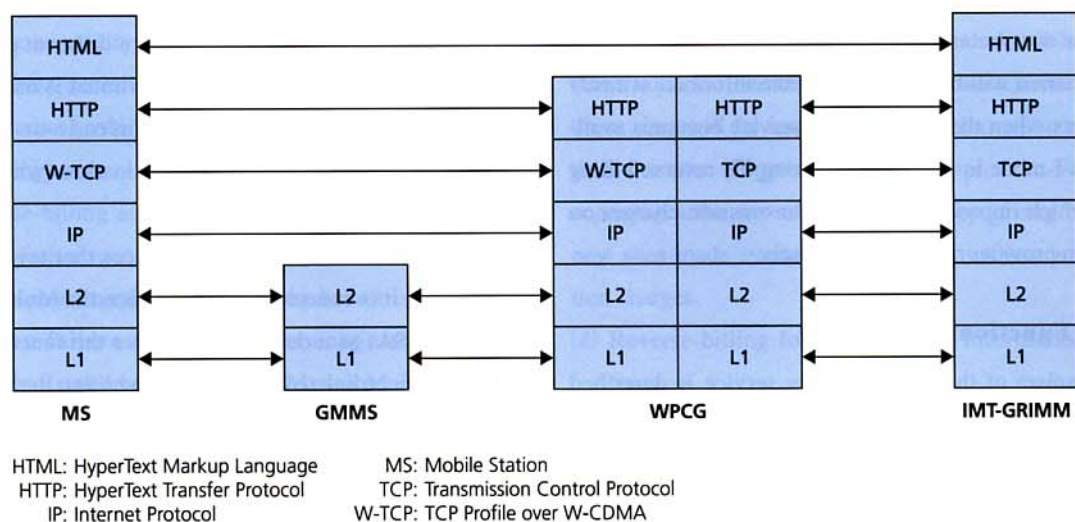


Figure 2 i-mode Service User Data Protocol

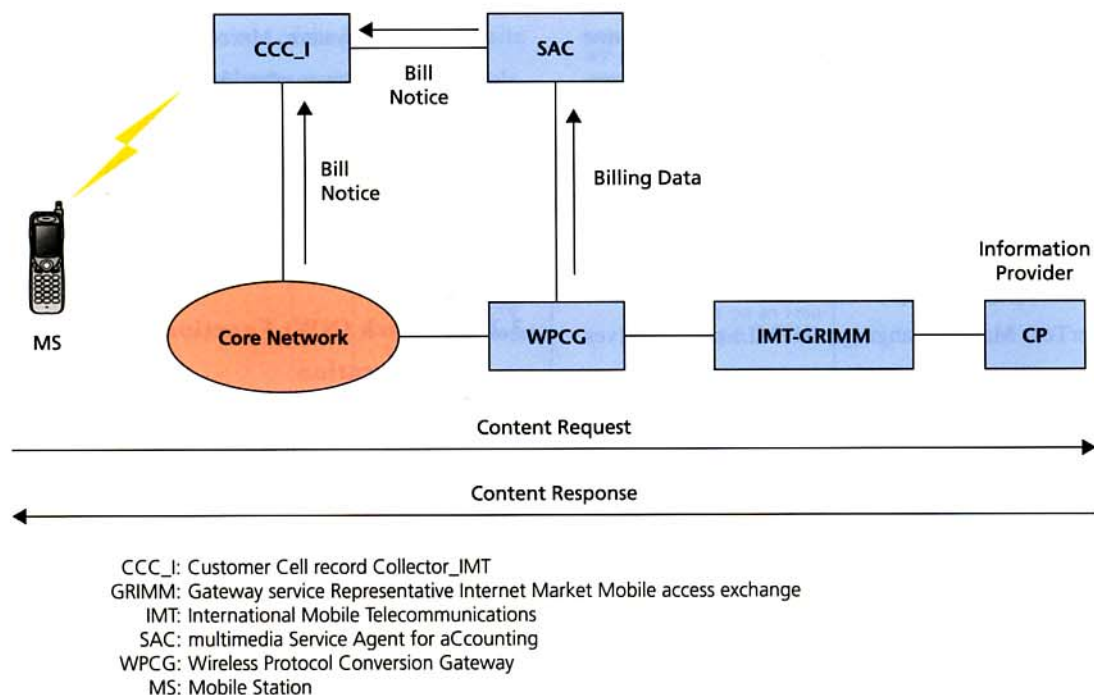


Figure 3 Functions divided between Nodes to realize Reverse Billing

Table 1 Functions between Nodes to realize Reverse Billing

Node Name	Functions
GRIMM	Notification of payer (user or information provider) according to content
WPCG	Collection of packet information Notification of billing information to SAC
SAC	Production of bill for reverse billing
CCC_I	Process to merge CN bill with SAC bill

CCC_I: Customer Cell record Collector_IMT
 GRIMM: Gateway service Representative Internet Market Mobile access exchange
 SAC: multimedia Service Agent for aCcounting
 WPCG: Wireless Protocol Conversion Gateway

is set forth based on the billing data sent from WPCG. CCC_I merges the bill from CN with the bill from SAC, and generates detailed statement information (**Figure 4**).

In the case of PUSH type information providing services, the payer information is notified simultaneously as IMT-GRIMM informs WPCG of call termination. This is followed by a sequence similar to PULL type information providing services, and detailed statement information is produced in compliance with the payer information (**Figure 5**).

4. Functions realized in Each Node

4.1 IMT-GRIMM Functions

(1) Accounting Management

IMT-GRIMM maintains the accounting information provider list that contains information on whether the provider will be the payer or not. An administrator can always maintain the accounting information provider list by using the maintenance terminal. When an administrator changes the accounting information provider list, IMT-GRIMM checks it to make sure

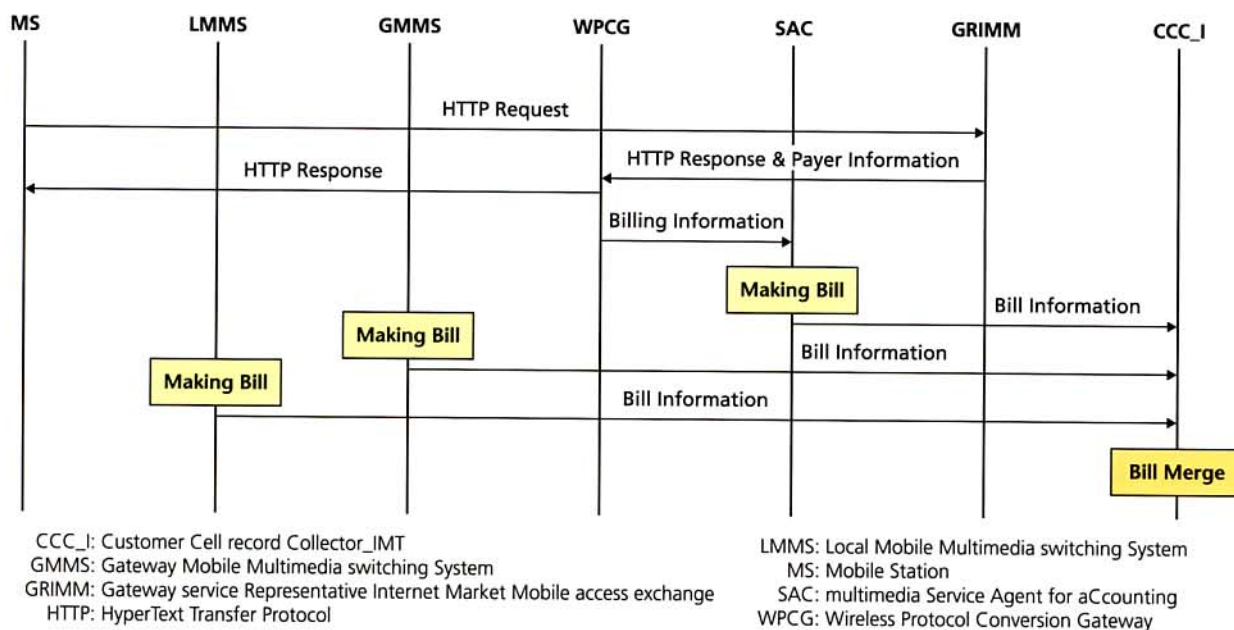


Figure 4 Reverse-billing Service Sequence (PULL Type)

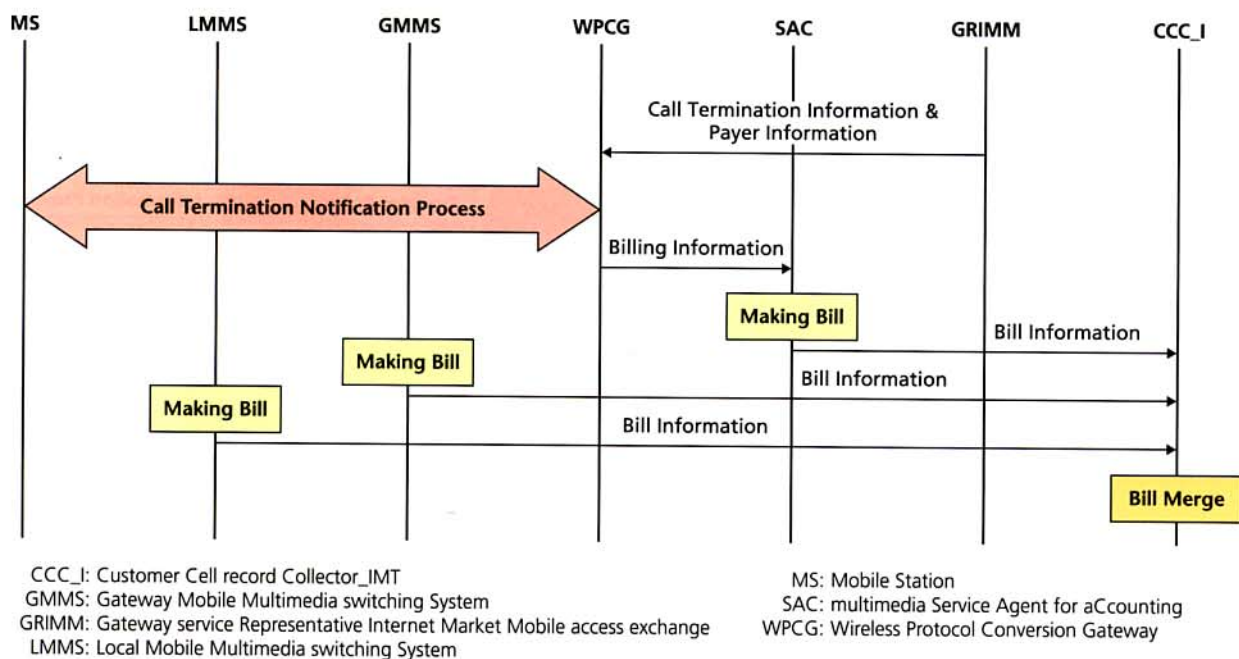


Figure 5 Reverse-billing Service Sequence (PUSH Type)

that there are no inconsistencies with the information provider list so that the payer is not “nonexistent.” The information provider list contains information on the provider’s up and running services. An administrator can resister or change the accounting information provider list only if the provider’s contents service is running; otherwise, its accounting information will not be available (**Figure 6**).”

(2) Payer Modification

In the case of PULL type information providing services, when an HTTP request is received from WPCG, the requested URL and the accounting information provider list are matched with each other in order to determine the payer. The HTTP response to the request received from the Web server with the determined payer information is forwarded to WPCG.

If there is no response to the request from the Web server for a certain period of time, IMT-GRIMM generates an HTTP response stating that there has been no response, and notifies it together with the retained payer information.

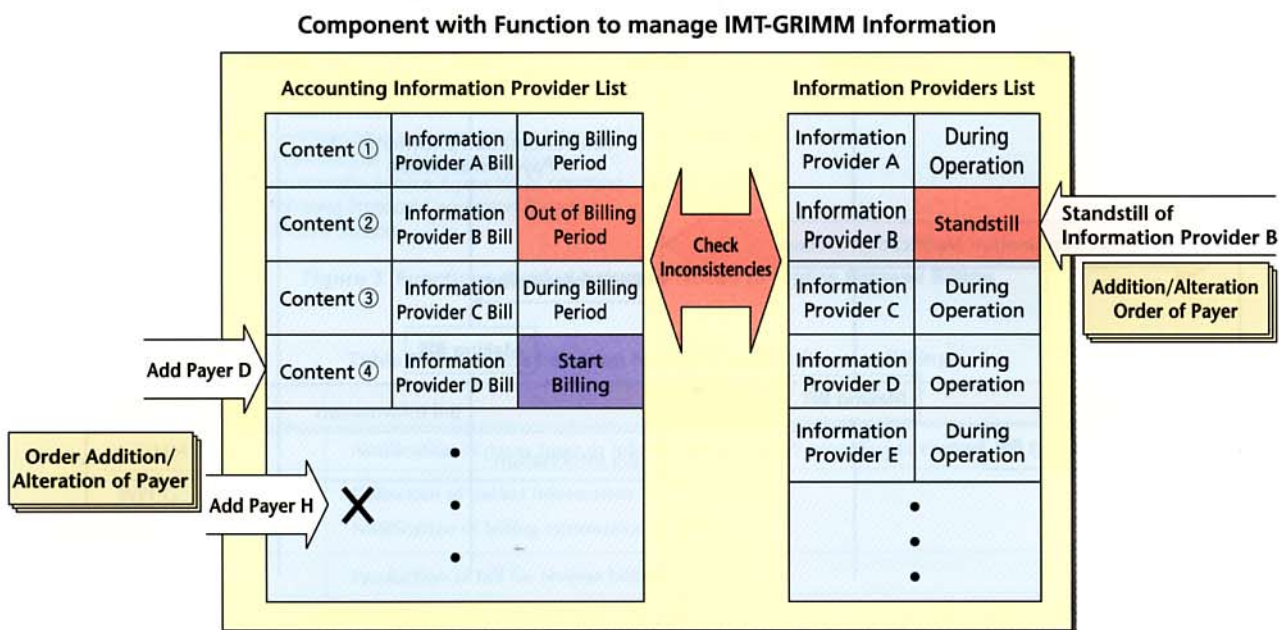
In the case of PUSH type information providing services, the packet transmission charges concerning the arrival notification will be charged to the payer informed from IMT-GRIMM. Its information will be informed with arrival notification signal to WPCG from IMT-GRIMM. After MS receives the arrival notification, it will get the message from IMT-GRIMM. Its packet transmission charge is specified in the same manner as in PULL type information providing services.

4.2 WPCG Functions

(1) IP Packet Capture Process

In FOMA i-mode, call origination by MS triggers the Gateway Mobile Multimedia switching System (GMMS) to send a connection notice to WPCG. Triggered by the reception of the connection notice, WPCG secures tables to store the billing data. Specifically, there are two tables: the packet capture table, which collects and stores Transmission Control Protocol/Internet Protocol (TCP/IP) packet information; and the content access information table, which collects and stores the user data information in the HTTP layer (**Figure 7**).

The IP packet capture function is informed of the TCP/IP packet information received by WPCG when an HTTP request is received from the MS or an HTTP response is transmitted to the MS. The IP packet capture function searches the corresponding packet capture table based on the source IP address of the notified packet, and sets the packet type and the length of the packet information. When transmitting an HTTP response, the user data in the HTTP layer, which is in the upper layer, is notified to the content access information collection function. The payer information notified to IMT-GRIMM together with the HTTP response is stored in the corresponding place in the content access table based on the content access information collection function. The payer information constitutes information required between IMT-GRIMM and WPCG for implementing reverse-billing, and is deleted at WPCG when the HTTP



GRIMM: Gateway service Representative Internet Market Mobile access exchange
 IMT: International Mobile Telecommunications

Figure 6 Payer Information Management

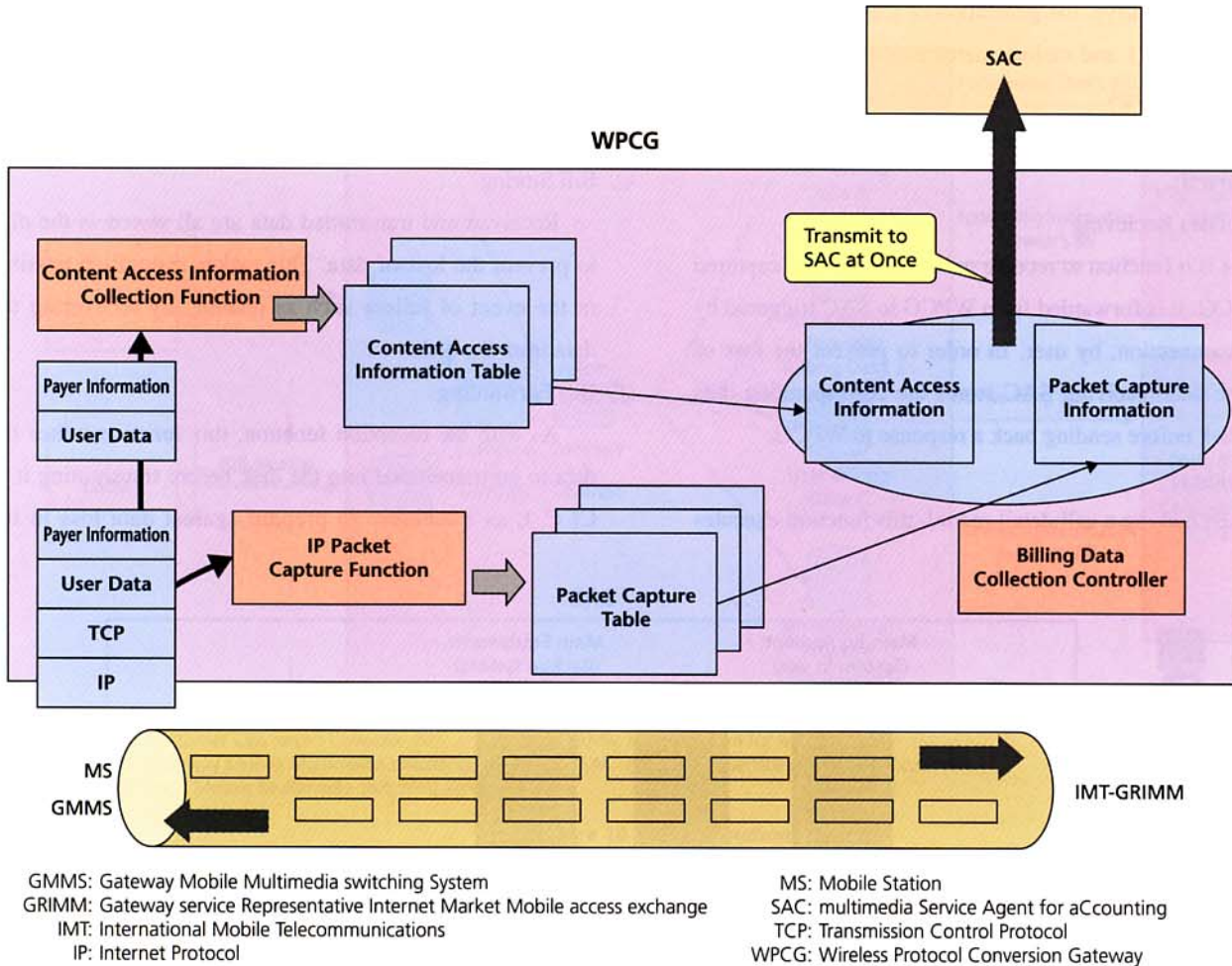


Figure 7 WPCG Functions

response is passed on to the MS.

In addition to the above, WPCG collects various data to produce billing information and stores them in their respective tables.

(2) Billing Data Forwarding

When the user ends a call, GMMS sends a call release notice to WPCG. WPCG informs the billing data collection controller of the end of the call in the event of receiving such call release notice. The billing data collection controller searches the packet capture table and the content access information table, extracts the corresponding user information and forwards both of them to SAC in the form of one piece of billing data (Figure 7).

4.3 SAC Functions

The following is a description of the hardware configuration, the software configuration and the functional profile of SAC, which has just been newly introduced to offer the service.

(1) Hardware Configuration

The main equipment that constitutes SAC consists of the

server and a disk drive that stores billing information. Attached equipment consists of the maintenance terminal that monitors and maintains the main equipment, the router and the hub, which are required for connecting with other nodes serving as network equipment (Figure 8).

SAC itself is based on a redundant configuration, in which two servers form a cluster. This helps avoid any interruption to the service by switching to a backup system, in the event of halt in processing due to the failure of one of the servers. The route to connect with other nodes is based on a redundant configuration, so that in the event of network failure, communication can be sustained by taking an alternative route.

(2) Software Configuration

The software of SAC consists of three layers: the Operating System (OS), middleware layer and the application layer.

The OS runs on the system, and the middleware layer is in charge of cluster management, disk-drive management and hardware management of the main equipment. The application layer is in charge of the reception of data transmitted from WPCG,

storage in the disk drive, the generation of Call Detail Records, forwarding to CCC_I, and various maintenance functions.

(3) Functions overview

SAC functions associated with the billing process are as follows (**Figure 9**).

① Billing Data Recieving

This is a function to receive packet information captured by WPCG. It is forwarded from WPCG to SAC triggered by call disconnection, by user. In order to prevent the loss of data, the data-receiving SAC stores the corresponding data in the disk before sending back a response to WPCG.

② Bill Making

When making a call detail record, this function executes

arrival confirmation based on TCP signals and imposes a charge with respect to the data volume of the corresponding packets. It makes bills by switching the payer based on the payer information transmitted from WPCG.

③ Bill Storing

Received and transmitted data are all stored in the disk to prevent the loss of data. This makes restoration possible in the event of failure such as resume, by recovering the data from the disk.

④ Bill Forwarding

As with the reception function, this function writes the data to be transmitted into the disk before transmitting it to CCC_I, as a measure to prepare against data loss in the

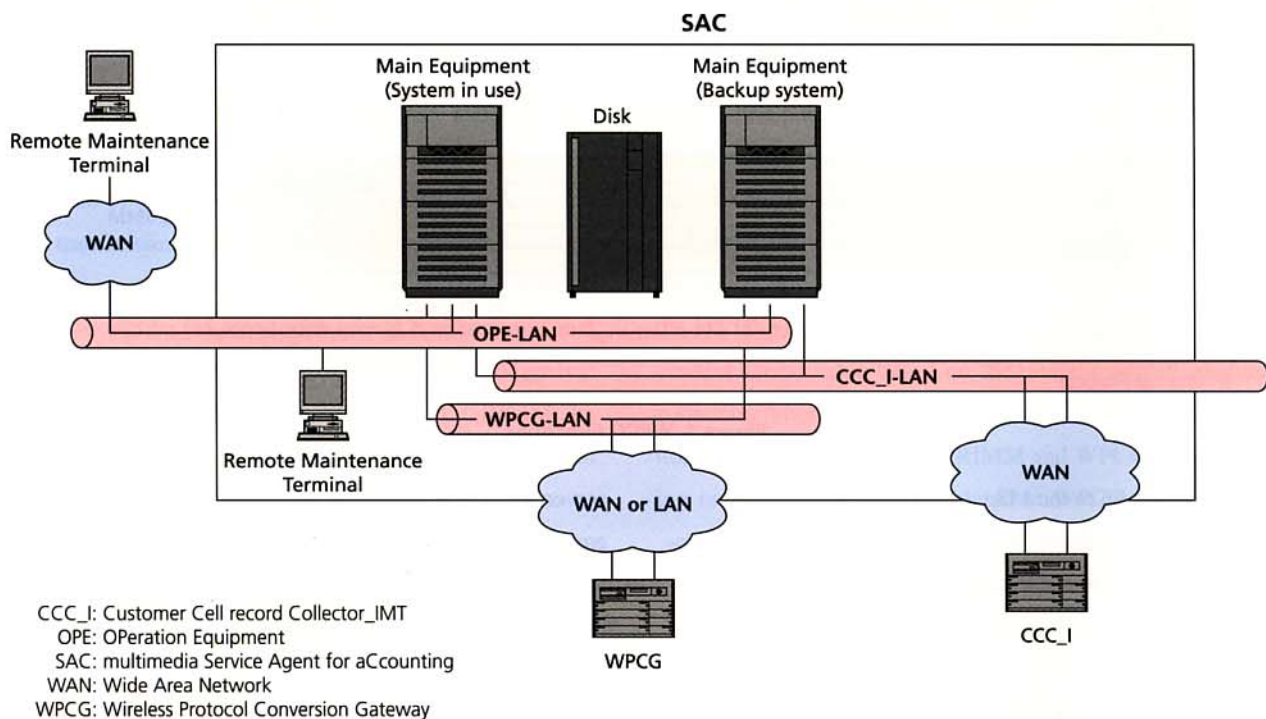


Figure 8 SAC Hardware Configuration

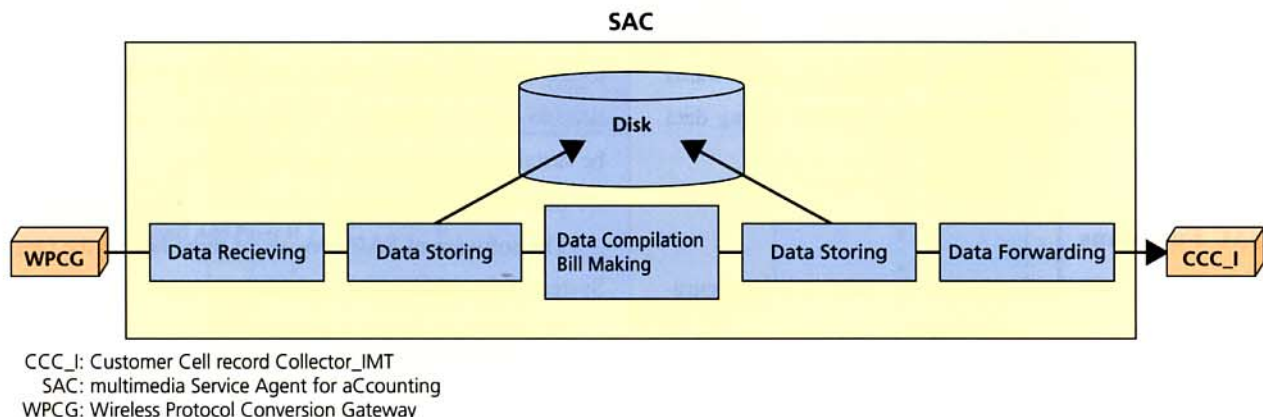


Figure 9 SAC Billing Process Functions

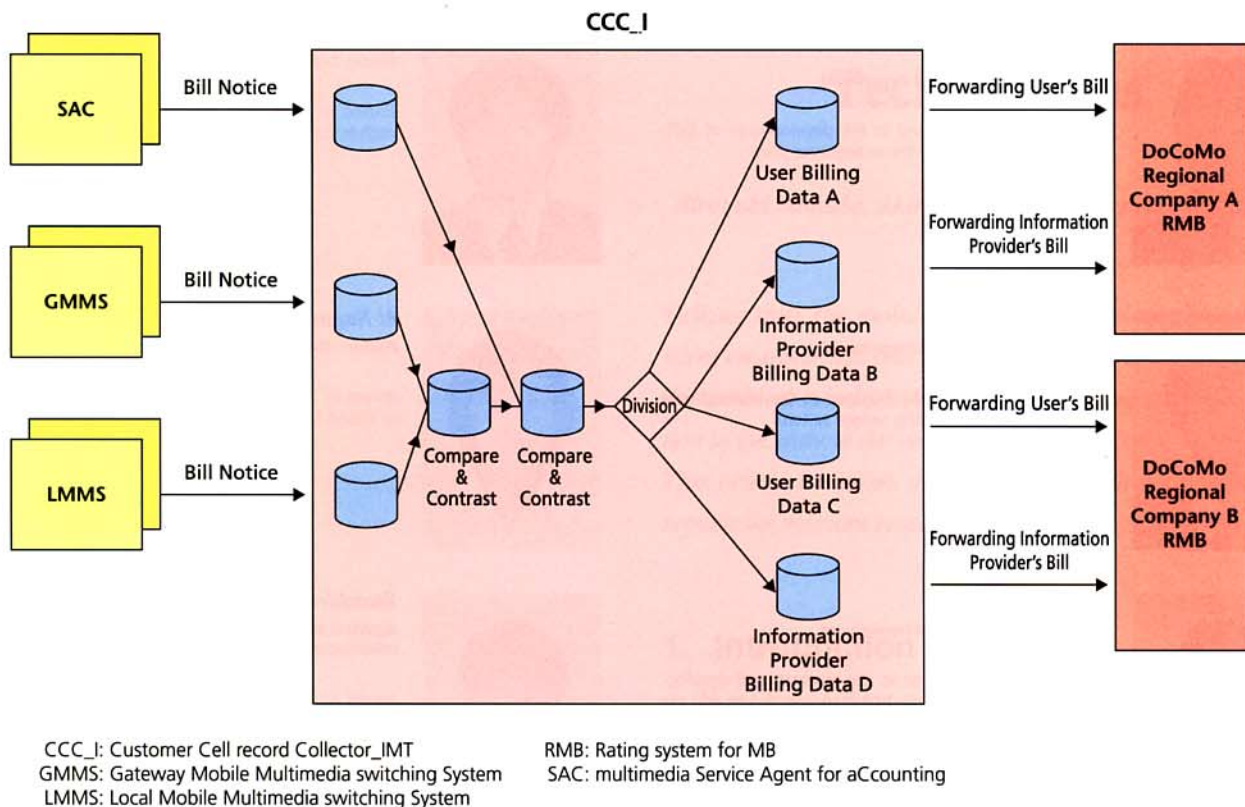


Figure 10 CCC_I Functions

communication channel. The data is treated as transmission-confirmed data following the confirmation that it has been accumulated according to a response from CCC_I. Until the confirmation is made, it repeatedly retransmits the data to prevent data loss in the transmission line.

4.4 CCC_I Functions

CCC_I is one of NTT DoCoMo's Mobile communication Billing systems (MoBills). Its main task is to collect Call Detail Record information for FOMA from CN and SAC. In FOMA i-mode, CCC_I compares and contrasts the Call Detail Record information collected from CN and SAC, extracts the necessary data from each bill and consolidates them into one bill. Then, this is divided into the data volume to be billed to the MS user, and the data volume to be billed to the reverse content side, and divided and forwarded to the Rating system for MB (RMB) of the FOMA MS-subscribing NTT DoCoMo regional company and content provider-subscribing NTT DoCoMo regional company (Figure 10).

5. Conclusion

The reverse-billing service makes it possible to charge information providers for sites such as "iMenu" and "Notice &

Help."

In the future, we intend to continue adding services using reverse billing, in consideration of market trends and user needs.

REFERENCES

- [1] Jinguji, et al: "Gateway Technologies: WPCG, TCPGW, ExGW," NTT DoCoMo Technical Journal, Vol.9, No.3, pp.49-60, Oct.2001.

GLOSSARY

CCC_I: Customer Cell record Collector_IMT
 FOMA: Freedom of Mobile multimedia Access
 GMMS: Gateway Mobile Multimedia switching System
 GRIMM: Gateway service Representative Internet Market Mobile access exchange
 HTML: HyperText Markup Language
 HTTP: HyperText Transfer Protocol
 IMT, IMT-2000: International Mobile Telecommunications-2000
 IP: Internet Protocol
 LMMS: Local Mobile Multimedia switching System
 MoBills: Mobile communication Billing systems
 MS: Mobile Station
 MSA: Multimedia Service Agent
 OPE: Operation Equipment
 PDC-P: PDC mobile Packet data communication system
 RMB: Rating system for MB
 SAC: multimedia Service Agent for aCcounting
 TCP: Transmission Control Protocol
 W-TCP: TCP Profile over W-CDMA
 WAN: Wide Area Network
 WPCG: Wireless Protocol Conversion Gateway