● New Technology Report ●

Special Article on Information Distribution Services

Location Information Services
–mopera Location Service and Enhanced Functions of Ima-DoCo Service–

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Location information services are expected substantial progress in the future. DoCoMo launched a new location information service called mopera Location Service in February 2001, and at the same time, enhanced the functions of the Ima-DoCo Service. This article explains the outlines of these two services.

1. Introduction

Location information services are infrastructure services that have the potential to generate a various business opportunities harnessing the characteristics of mobile communications, and are expected substantial progress in the future.

DoCoMo has been providing two location information services in recent years: Ima-DoCo Service, which uses PHS cell station information; and DoCo-Navi Service, which uses the Global Positioning System (GPS). In addition to these, DoCoMo launched a new location information service called mopera Location Service in February 2001. At the same time, it enhanced the functions of Ima-DoCo Service, improvement in positioning accuracy, nationwide roaming and other enhanced functions, as well as more convenient features for end users.

This article reviews the newly introduced mopera Location Service and the enhanced functions of Ima-DoCo Service.

2. mopera Location Service

2.1 Service Overview

mopera Location Service uses DoCoMo's mobile information service called the Mobile OPEration Radio Assistant (mopera) as a common platform so as to provide a wide range of location-related content through Application Service Providers (ASP) connected to mopera. When mopera receives a request for loca-

tion-related content from an end user, it sends his/her location information to the ASP, so that the ASP can send back location-related content that are relevant to the end user in that location. Currently, the service is only available in PHS; only some of the Paldio models with the browsing function (e.g. 641S, hereinafter referred to as "compatible PHS terminals") can use the service. However, DoCoMo is planning to make it available to terminals gradually for PDC mobile Packet data communication system (PDC-P).

mopera gives much consideration to the protection of privacy, as it handles the location information of end users. For example, the end user's location information will not be sent to the ASP unless the end user deliberately takes the following three steps.

(1) Set the compatible PHS terminal. (Set the "Add Location Information" (ON/OFF) in "Browser Settings" to ON.)

(2) Connect to mopera from the compatible PHS terminal, and set the network. (Set the "Location Information Settings" (DISCLOSE/NOT DISCLOSE) in "User Information Settings" to DISCLOSE.)

(3) Accept the transmission of location information to the ASP. (Accept to the terms and conditions which will be displayed when using the location-related content for the first time.)

This system prevents the careless transmission of end users' location information.
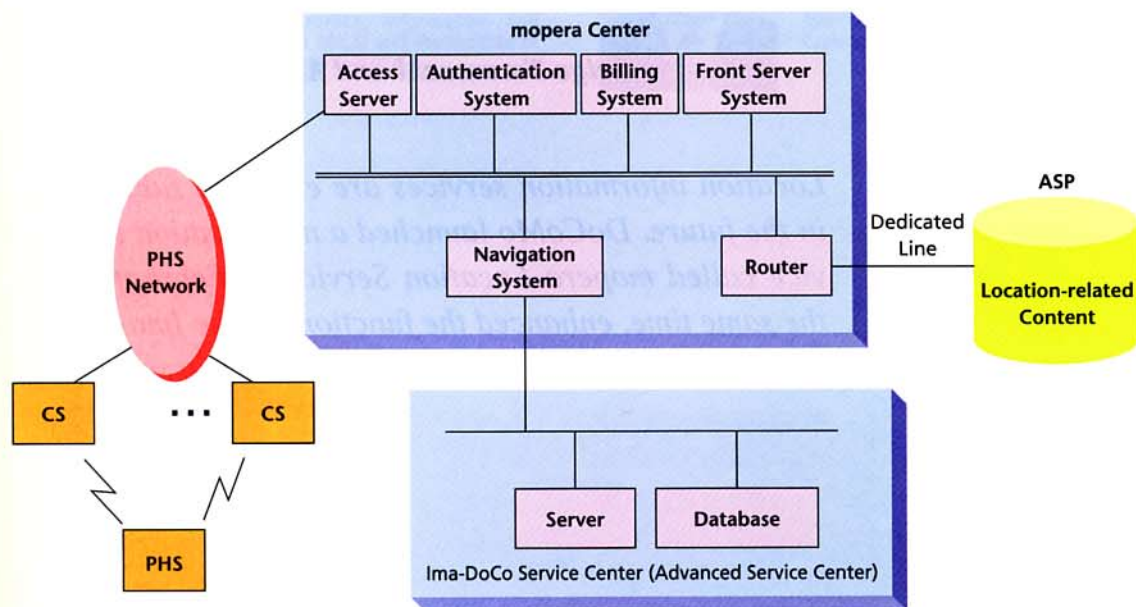
ASP: Application Service Provider
CS: Cell Station
mopera: Mobile OPEration Radio Assistant

Figure 1 System Configuration of mopera Location Service

2.2 System Configuration

Figure 1 illustrates the system configuration of mopera Location Service.

The compatible PHS terminal stated above has the function to receive control signals sent by surrounding PHS Cell Stations (CS) upon transmission, measure the Cell Station IDentification (CS-ID) in control signals (CS-ID is unique to each CS) and the signal level which represents the strength of the received control signals, and transmit the information to mopera.

On the other hand, mopera is a complex system consisting of an authentication system, front server system, navigation system, etc. The authentication system authenticates compatible PHS terminals and stores the CS-ID and signal level sent by compatible PHS terminals as user-in-range information. The front server system first displays the terms and conditions relating to the transmission of location information when the end user is to use location-related content, and sends the end user's actual location information to the ASP. The navigation system uses the Ima-DoCo Service Center to convert the user-in-range information—information when users are in a specific range—(CS-ID and signal level) into user location information (latitude, longitude, etc.)

2.3 Service Sequence

Figure 2 illustrates the service sequence of mopera Location Service. The operation is as follows.

It should be noted that users are required to activate mopera quick start and acquire a user ID and a password before using mopera Location Service. The following steps need to be taken after acquiring the user ID and password.

(1) Select "Menu" from the browser screen of the compatible PHS terminal, and request connection to the mopera access server. In this process, the compatible PHS terminal sends to the access server CS-IDs and signal levels accounting for up to 10 stations using control signals.

(2) As the access server recieves a connection request, it requests the authentication system to authenticate the connection in response. At the same time, it hands over the received CS-IDs and signal levels to the authentication system as user-in-range information.

(3) If there are no problems with connection authentication, the connection will normally be established.

(4) After connection, if the user wishes to request contents other than location-related content, he/she must directly send a "Content Request" to the ASP from the browser of the compatible PHS terminal. In return, "Content Response" is sent back from the ASP.
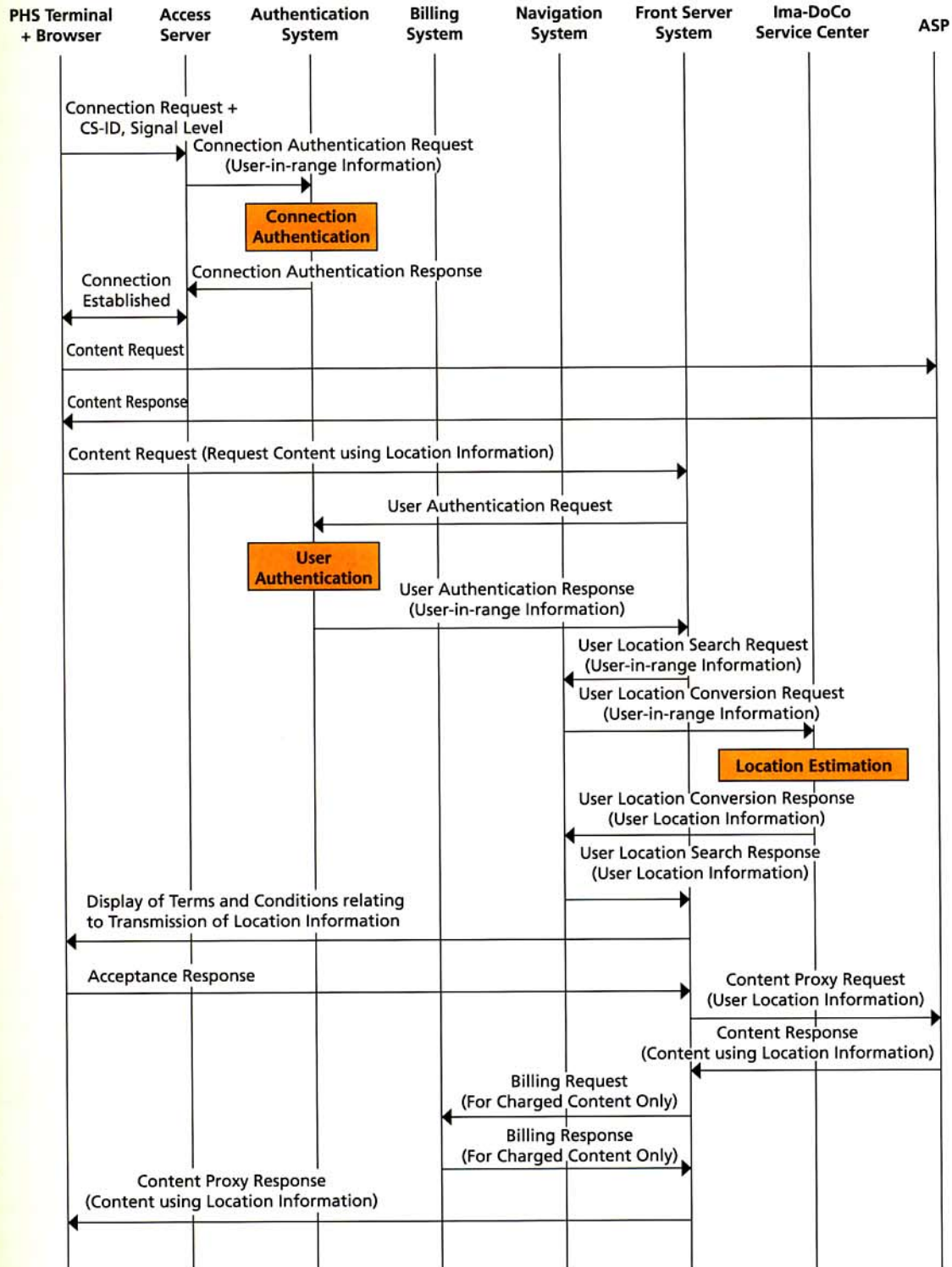
(5) If the user wishes to request location-related content, he/she must send a "Content Request" to the front server system from the browser of the compatible PHS terminal.

(6) When the front server recieves the "Content Request", it requests the authentication system to authenticate the user.

(7) The authentication system authenticates the user. If there are no problems, it passes on the user-in-range information to the front server system.

(8) The front server system requests the navigation system to convert the user-in-range information.

(9) The navigation system uses the Ima-DoCo Service Center to convert the user-in-range information (CS-ID and signal level) into latitude, longitude and other user location information, and sends it back to the front server system.

(10) If the location-related content are new to the user, the front server system sends the acceptance confirmation screen associated with the transmission of location information (for charged content, the confirmation of purchase will also be involved.) to the compatible PHS terminal. If the location-related content are not new to the server, skip to step (12).

(11) The browser of the compatible PHS terminal displays the acceptance confirmation screen associated with the transmission of location information. If the user accepts this, the terminal will send an acceptance response to the front server system.

(12) The front server system sends a "Content Proxy Request" to the ASP, with the user location information attached to the request.

(13) The ASP sends the location-related content based on the user location information to the front server system as a "Content Response".

(14) For charged content, the front server system requests the Billing System to process the billing.

(15) The front server system sends the location-related content to the compatible PHS terminal as a "Content Proxy Response". The location-related content are displayed on the compatible PHS terminal as a result.

2.4 Available Content

Major content available from mopera Location Service

include:

- Weather forecast at the user's current location;
- Local restaurant finder and route guidance based on a simplified map;

- Information on events at department stores and other invitations; and
- Search information relating to the nearest train station, and find the best route to the next destination based on timetable

| PHS Terminal + Browser | Access Server | Authentication System | Billing System | Navigation System | Front Server System | Ima-DoCo Service Center | ASP |

Connection Request +
CS-ID, Signal Level

Connection Authentication Request
(User-in-range Information)

Connection Authentication

Connection Authentication Response

Connection Established

Content Request

Content Response

Content Request (Request Content using Location Information)

User Authentication Request

User Authentication

User Authentication Response
(User-in-range Information)

User Location Search Request
(User-in-range Information)

User Location Conversion Request
(User-in-range Information)

Location Estimation

User Location Conversion Response
(User Location Information)

User Location Search Response
(User Location Information)

Display of Terms and Conditions relating
to Transmission of Location Information

Acceptance Response

Content Proxy Request
(User Location Information)

Content Response
(Content using Location Information)

Billing Request
(For Charged Content Only)

Billing Response
(For Charged Content Only)

Content Proxy Response
(Content using Location Information)

ASP: Application Service Provider
CS-ID: Cell Station IDentification

Figure 2 Service Sequence of mopera Location Service

information.

In addition to the above, various types of content can be offered depending on the applications. For example, by using location information, an application may enable users to access local information easily at places where they have never been before. DoCoMo plans to expand the range of location-related content in pursuit of convenience.

3. Enhanced Functions of Ima-DoCo Service

Ima-DoCo Service harnesses the micro-cell zone structure, which is a radio zone arrangement unique to PHS. It is a PHS network service that locates PHS terminals within a margin of error of a few hundred meters, and makes the location findings available. Ima-DoCo Service was launched in May 1998; its functions were enhanced in February 2001.

3.1 Overview of Enhanced Functions

Conventional Ima-DoCo Service is able to roughly identify the positioning of PHS terminals as long as they are in the PHS service area, unless they are relayed by a home/office antenna, the user setting is OFF, the power is turned off, the terminal is out of range, or the line is engaged. However, users have been demanding (1) better positioning accuracy (approx. 100m-500m), and (2) the service to be available across different companies rather than being limited to certain DoCoMo service areas. Also, claims have been made that (3) the concentration of periodical search might stall call traffic.

Enhanced functions of Ima-DoCo Service are aimed at solving these problems. Key functional improvements were made in the form of (1) improved positioning accuracy and (2) nationwide roaming, both of which are merits to the user, and (3) reduction of call traffic, which is a merit to operators.

(1) Improved Positioning Accuracy

Conventional Ima-DoCo Service (hereinafter referred to as "conventional service") presumed that the terminal is located in the middle of a straight line drawn between two CSs that transmit the highest signal levels to the terminal. Also, it estimated the margin of error based on the transmission power of the CS that transmitted a higher signal level. **Figure 3**(a) illustrates how the conventional service positions the terminals.

In contrast, Ima-DoCo Service with enhanced functions (hereinafter referred to as "advanced service") is able to use up to 10 CSs for positioning and does not use the same approach to
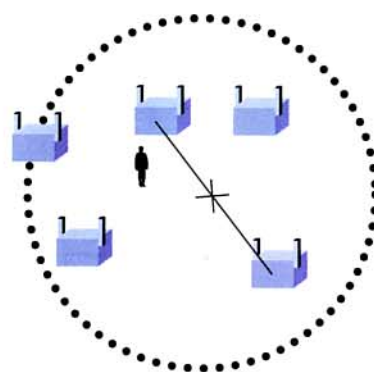
(a) **Positioning by Conventional Service**
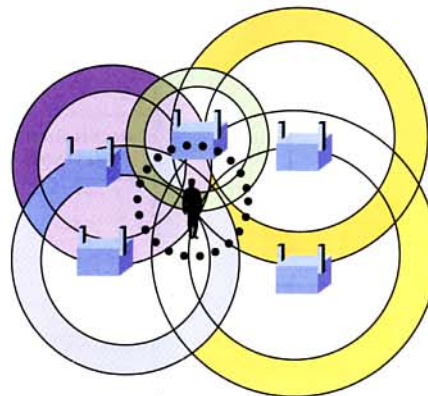
(b) **Positioning by Advanced Service**

Figure 3 Positioning Scheme

locate the terminal as the conventional service. It works out the probability distribution of the location of the PHS terminal with reference to the signal level from each CS received by the terminal, in addition to the location and transmission power of each CS. The positioning result is the expected value. The estimated margin of error is calculated based on the idea that the PHS terminal is more likely to be inside a circle with a certain radius, where the estimated location is in the middle. **Figure 3** (b) shows how the advanced service positions the terminals. The advanced service has radically improved the accuracy of positioning based on this technique, which is also used when the mopera Location Service converts location information.

(2) Nationwide Roaming

The conventional service was imperfect since the users could not access the service outside service areas of companies subscribing to the Ima-DoCo Service (DoCoMo companies). In contrast, the advanced service is available in all PHS service areas nationwide, regardless of the companies subscribing to the Ima-DoCo Service.

(3) Reduction of Call Traffic
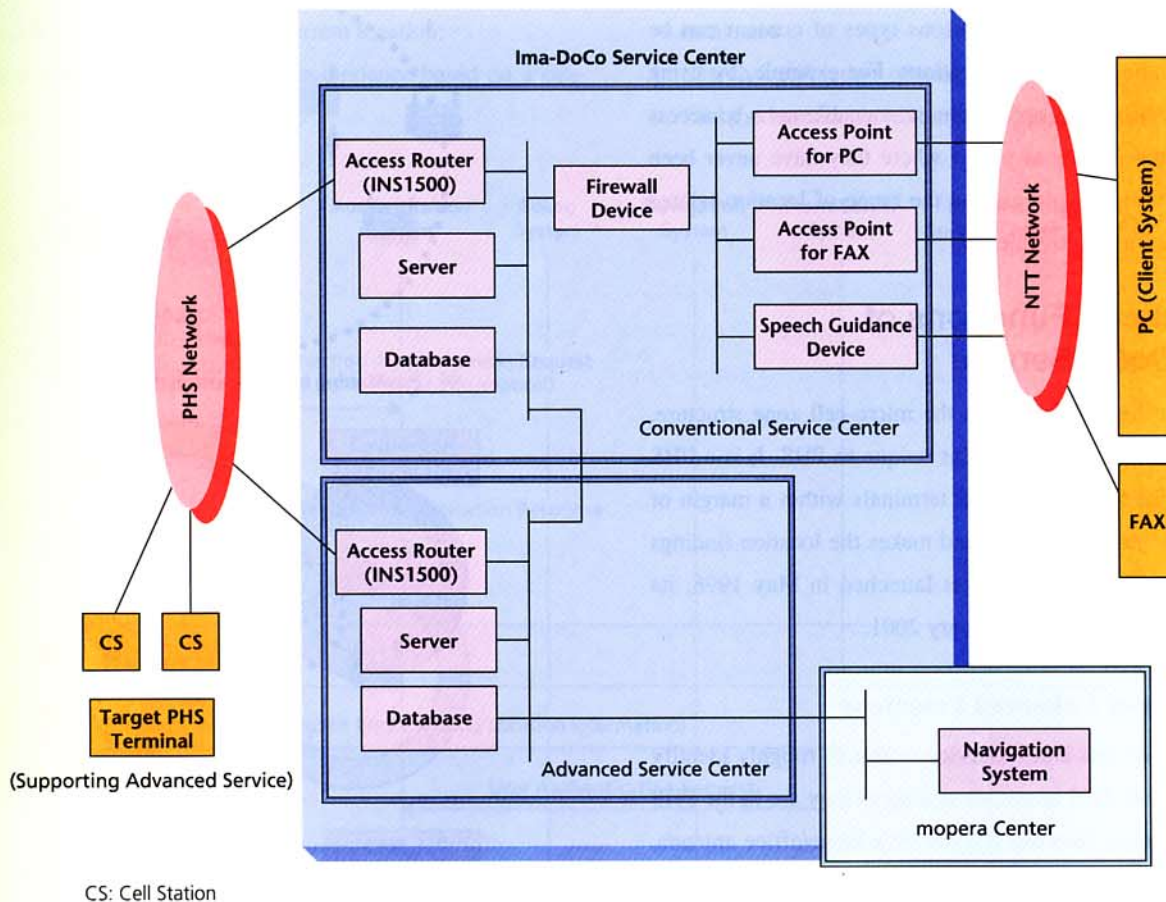
The conventional service was based on a periodical search

Ima-DoCo Service Center

Figure 4　System Configuration of Advanced Service

CS: Cell Station

system in which the Ima-DoCo Service Center call out the PHS terminals. This system is prone to call traffic congestion when PHS terminals requiring a call concentrate in a particular location-registered area. The advanced service does not rely on such a periodical search system; instead, the PHS terminals make a declaration to the Ima-DoCo Service Center. This reduces call traffic, as no call traffic is generated by transmissions from PHS terminals, in contrast with the conventional service that generates call traffic in the entire location-registered area as a result of calling out a PHS terminal.

(4) Other Functional Improvements

The advanced service improves the positioning accuracy by using up to 10 CSs to locate the terminals. An increase in the number of CSs also raises the transmission volume of information. DoCoMo has further improved the functions by exchanging essential information between PHS terminals and Ima-DoCo Service Center, through User-to-User Information (UUI) which is an optional service of Integrated Services Digital Network (ISDN).

3.2　System Configuration

Figure 4 illustrates the system configuration of the advanced service.

The advanced service shares part of the system with the conventional service. Specifically, it shares the FAX access point, PC access point, voice guidance device and firewall device. This configuration was developed to make sure that users of the conventional service could use the same equipment (FAX, computer) and the same access point even when they decided to receive the advanced service.

The advanced service and the conventional service have their own servers, access routers and databases.

For the advanced service, PHS terminals compatible with the advanced service (641S, P-doco?mini, etc.) must be used.

3.3　Service Sequence

Applications of the advanced service can be broadly divided into two groups by searching method: non-periodical search type and periodical declaration type. The operation of each type is described below.

CS-ID: Cell Station IDentification
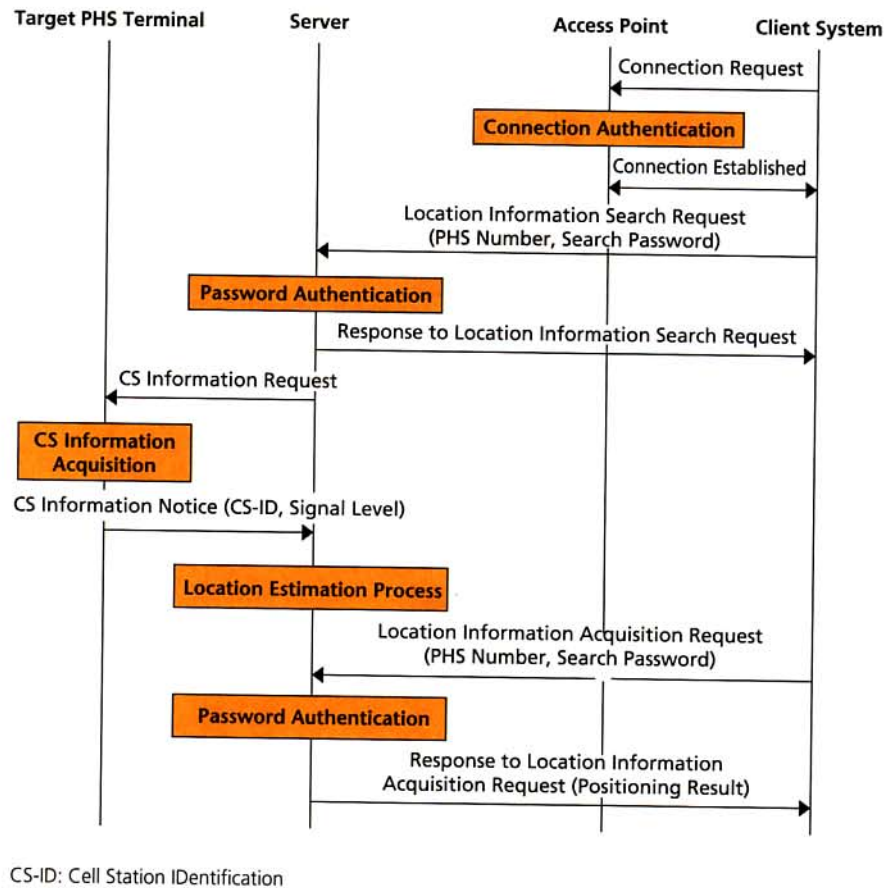
Figure 5 Service Sequence of Advanced Service (Non-periodical Search Type)

(1) Non-periodical Search Type

Non-periodical search type searches the positioning of the PHS terminal immediately after receiving a search request. The sequence of the service is described below, with reference to **Figure 5**, when a non-periodical search is executed from a client system, such as a managing computer in a company.

① The client system accesses the access point (for PC) for connection authentication. If there are no problems with connection authentication, the connection will normally be established.

② After connection, the "Location Information Search Request" will be sent to the server. The "Location Information Search Request" includes the PHS number (phone number) of the target PHS terminal and the search password as parameters.

③ The server inquires the database and authenticates the password. If there are no problems with authentication, it will send back a response to the location information search request to the client system, and transmit a CS information request to the target PHS terminal.

④ The target PHS terminal receives control signals from surrounding CSs, and sends a "CS Information Notice" to the server, including the parameters of CS-IDs and signal levels accounting for up to 10 CSs.

⑤ The server works out the probability distribution of the location of the target PHS terminal, with reference to the signal level from each CS received by the terminal, in addition to the location and transmission power of each CS. The positioning result is the expected value.

⑥ The server subsequently receives a "Location Information Acquisition Request", and executes password authentication. If there are no problems with authentication, the server will send back a "Response to Location Information Acquisition Request" with parameters which are set according to the positioning result (location capture time, estimated location, and estimated margin of error).

(1) Periodical Declaration Type

Periodical declaration type captures the positioning automatically, according to a schedule registered to the Center in advance. The schedule may be registered via a voice guidance
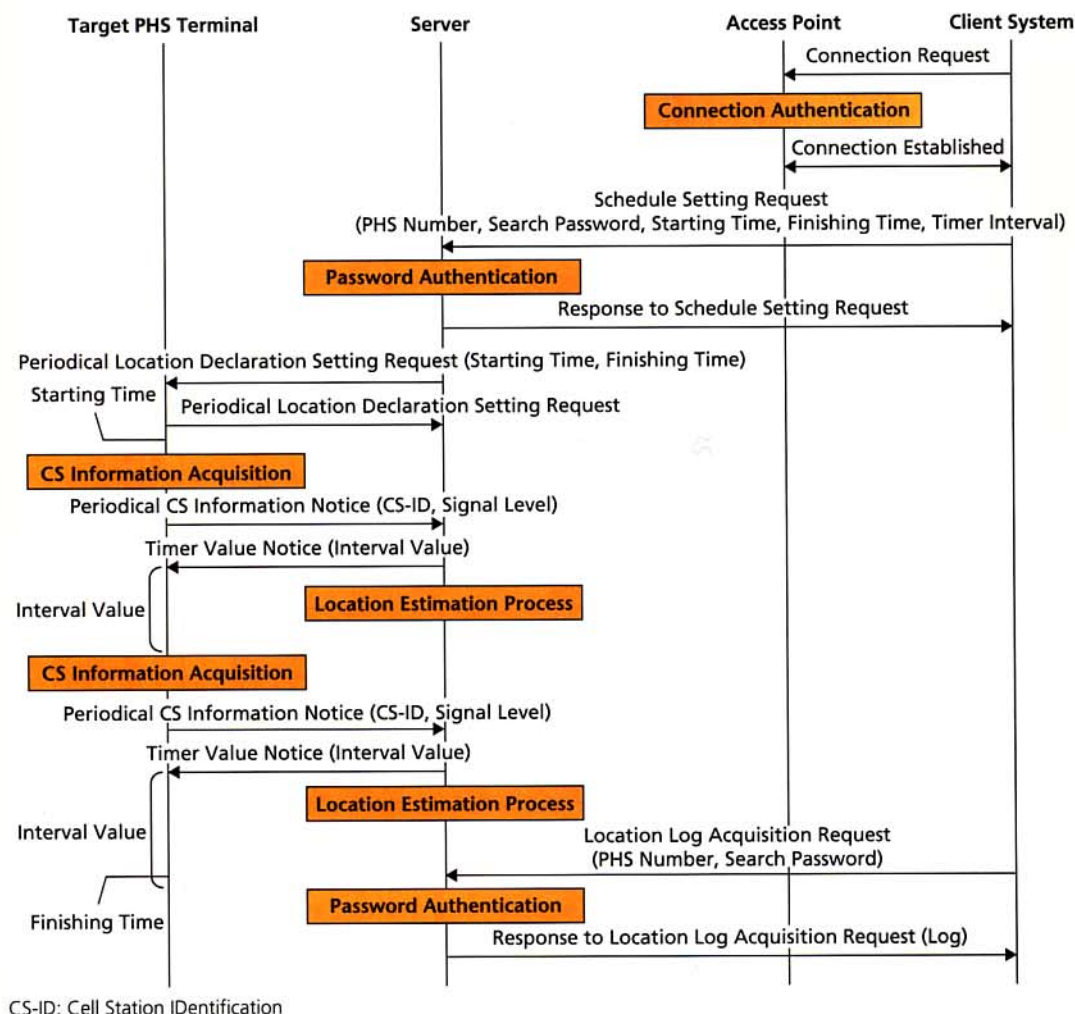
Figure 6 Service Sequence of Advanced Service (Periodical Declaration Type)

device which is an automated voice responding device, or from a client system. The sequence of the service is described below, with reference to **Figure 6**, when a periodical declaration is executed from a client system, such as a managing computer in company.

① The client system accesses the access point (for PC), and connection is established in the same manner as in the non-periodical search type.

② After connection, a "Schedule Setting Request" is sent to the server. The "Schedule Setting Request" includes the PHS number (phone number) of the target PHS terminal, the searching password, the starting and finishing time, as well as the time interval in parameters.

③ The server executes password authentication. If there are no problems with authentication, it will send back a "Response to Schedule Setting Request", and transmit a "Periodical Location Declaration Setting Request" to the target PHS ter-

minal, including the starting time and the finishing time in parameters.

④ The target PHS terminal receives a "Periodical Location Declaration Setting Request", and sends back a "Response to Periodical Location Declaration Setting Request" to the server, and goes into the standby mode until the starting time.

⑤ After standby, the target PHS terminal receives the control signals from CSs, and sends a "Periodical CS Information Notice" to the server, including parameters of CS-IDs and signal levels accounting for up to 10 CSs.

⑥ The server sends back a "Timer Value Notice" to the target PHS terminal, including an interval value (timer interval) in parameters, and estimates the positioning of the terminal with reference to the received CS-IDs and signal levels.

⑦ The target PHS terminal goes into standby mode again during the interval. After the interval, steps ⑤ through ⑦ are

repeated until the finishing time.

⑧ The server subsequently receives a "Location Log Acquisition Request", and executes password authentication. If there are no problems with authentication, the server will send back a "Response to Location Log Acquisition Request" with parameters set according to the positioning results stated above (log).

4. Conclusion

Location information services take advantage of the characteristics of mobile communications. It is possible to make mobile communications more attractive by linking them with various types of applications. DoCoMo will add more bearers of location information services and make other enhancements to the services, and at the same time, endeavor to improve the location-related content.

GLOSSARY

ASP: Application Service Provider
CS: Cell Station
CS-ID: Cell Station IDentification
GPS: Global Positioning System
ISDN: Integrated Services Digital Network
PDC-P: PDC mobile Packet data communication system
UUI: User-to-User Information
mopera: Mobile OPEration Radio Assistant