

## Location Information Functions for Smartphone Terminals

*With the spread of smartphones, there is a demand to enhance safety and security services making use of location functions on smartphones, to a level equivalent to i-mode terminals. To achieve this, NTT DOCOMO has developed functions for smartphones that provide location information to third-party applications. These functions allow a smartphone to provide detailed location information using its GPS functionality to emergency facilities when it places an emergency call. They also allow services already available on i-mode terminals to be provided on smartphones, including the imadoco Search, imadoco Simple Search and Keitai-Osagashi services.*

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### 1. Introduction

Many smartphone terminals now are equipped with a function to determine the current location of the terminal using GPS[1]. i-mode terminals also have a similar current-location function[2], as well as location providing functions such as one that specifies the current location to emergency-response facilities when an emergency call is placed, and another that can indicate a child's location to his/her parents[3]. NTT DOCOMO also provides third-party location-related services such as

imadoco Search, imadoco Simple Search and Keitai-Osagashi Search, which use these functions.

With the recent rapid proliferation of smartphones in society, there is increasing need for smartphones to provide location information to emergency-response facilities when an emergency call is placed as well. Accordingly, NTT DOCOMO has developed smartphone functions that provide this location information to third-party applications, as are available for i-mode terminals.

i-mode terminals have a location

function implemented using the Control Plane (C-Plane)<sup>\*1</sup>. However, Android<sup>TM\*2</sup> and other smartphone terminals generally have location functions that use the User Plane (U-Plane)<sup>\*3</sup>, which is easier to use while roaming out, so it is difficult to provide NTT DOCOMO's C-Plane positioning function on these terminals as is. Smartphone terminals use the Secure User Plane Location (SUPL)<sup>\*4</sup> location function standardized by the Open Mobile Alliance (OMA)<sup>\*5</sup> [4], but for this development, we have used a combination of SMS<sup>\*6</sup> and location functions in order

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\*1 **C-Plane**: The transmission path for control signals, such as establishing and disconnecting communications.

\*2 **Android<sup>TM</sup>**: An open source platform targeted mainly at mobile terminals and promoted by Google Inc., in the United States. Android<sup>TM</sup> is a trademark or registered trademark of Google Inc. in the United States.

to support third-party location-based services on a larger range of smartphone terminals. This not only allows location to be provided to emergency-response facilities with emergency calls, but currently available i-mode services, including imadoco Search imadoco Simple Search and Keitai-Osagashi can also be provided for smartphones.

In this article, we provide an overview of these location-provision functions for third-party smartphone location services, together with a description of the implementation.

## 2. Third-party Location Service for Smartphones and Network Control

### 2.1 Service Overview

#### 1) Location Functions for When Emergency Calls are Placed

Providing location when emergency calls are placed includes both notifying emergency response facilities of the sender's location when placing an emergency call from a mobile terminal, and allowing emergency-response facilities to retrieve the location of the caller. As a first step, an initial reference location<sup>\*7</sup>, taken from measurements at the base station, is sent to emergency-response organizations and in a second step, they are sent a detailed position determined using GPS. Till now, since there has not been a way to obtain the detailed GPS position from

smartphones, the same reference position used in the first step was retrieved for the second step. With development of these new functions, the detailed GPS location results on smartphones can also be sent to emergency-response facilities.

Emergency response facilities can also retrieve location information by specifying the originator of an emergency call. Till now, only the reference position was available for smartphones, but the new functions allow the detailed GPS position to be retrieved for smartphones as well.

#### 2) imadoco Search and imadoco Simple Search

The imadoco Search and imadoco Simple Search services allow i-mode terminal users to check the location of someone else on a map using their i-mode terminal, such as a parent looking for their child. NTT DOCOMO has only been offering this service to search for i-mode terminals, as demand for smartphone terminals has increased, it is now also possible to search for smartphones, as of October, 2011. With the development of these new functions, search can be done from both i-mode terminals and smartphone terminals as well.

#### 3) Keitai-Osagashi Service

The Keitai-Osagashi service enables users to detect the location of the terminal itself when it has been lost. Till now, it was only offered for i-mode

terminals, but with development of the new smartphone location functions, the Keitai-Osagashi service can also be used to find smartphone terminals if they are lost.

### 2.2 Network Control of Location Functions for Smartphone Terminals

As an overview of the location provision scheme for smartphone terminals, we describe the example of the location notification function for emergency calls.

When responding to a third-party positioning request on a SUPL Enabled Terminal (SET)<sup>\*8</sup>, the smartphone must support the NETWORK INITIATED (positioning) function (**Figure 1**) standardized by the OMA. On the other hand, most current smartphones only support the SET INITIATED (self positioning) function (**Figure 2**). This has led to an issue that only a limited number of terminals support third-party location services that use the NETWORK INITIATED function. For this reason, NTT DOCOMO has developed location provision functions that utilize SMS, which is generally available on smartphones, and the SET INITIATED function, which is already supported on many smartphones. This approach removes the limitation on applicable smartphones and allows third-party location services to be used on many more terminals.

\*3 **U-Plane**: The transmission path for transferring user data.

\*4 **SUPL**: A positioning scheme that uses the U-Plane for exchange of positioning signals between terminal and server.

\*5 **OMA**: An industry standardization organization that aims to standardize service and application technology and achieve interoperability

in mobile communications.

\*6 **SMS**: A service for sending and receiving short text-based messages, mainly between mobile terminals. It can also be used for sending and receiving control signals for mobile terminals.

\*7 **Reference location**: One element of the GPS-assist data specified by the 3GPP. It

includes elements such as latitude and longitude coordinates and a radius of error that expresses likely distance from the true location. Generally, the more accurate this information is, the better GPS positioning performs.

\*8 **SET**: A mobile communication terminal capable of SUPL communication.

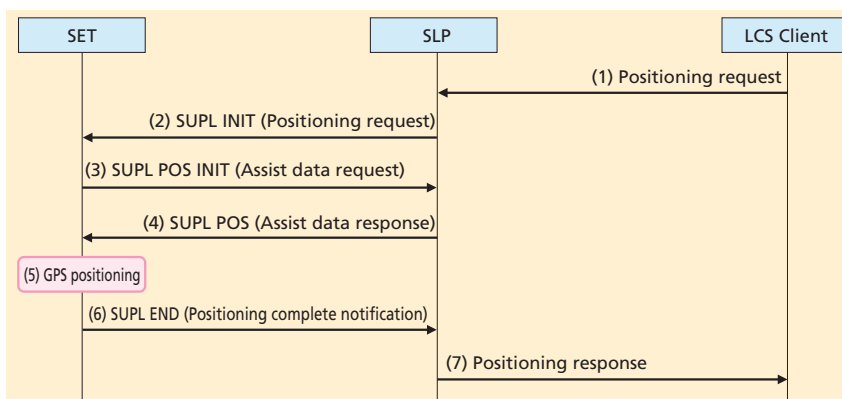


Figure 1 NETWORK INITIATED function

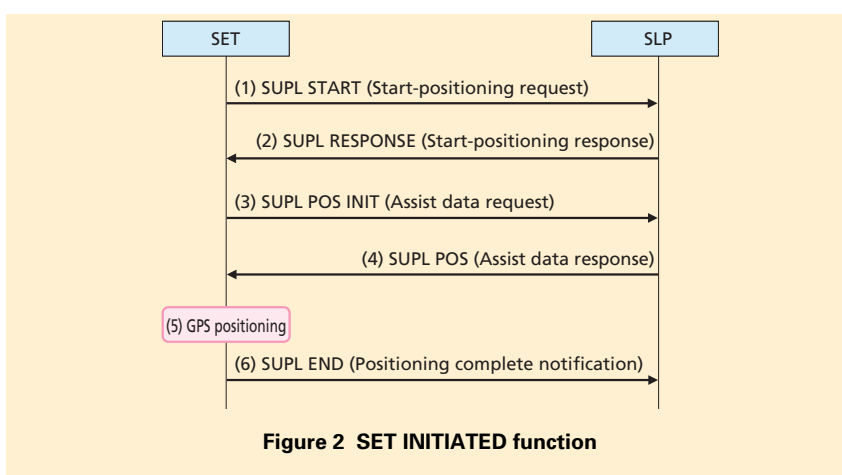


Figure 2 SET INITIATED function

The location function utilizing the SET INITIATED function and SMS is shown in **Figure 3**. An LCS Client<sup>\*9</sup> using the location function first sends a location request to the SUPL Location Platform (SLP)<sup>\*10</sup> (Fig. 3 (1)). After receiving the location request, the SLP sends a request to launch the location application to the smartphone (Fig. 3 (2)-(3)). When the smartphone receives the SMS, it launches the pre-installed location application (Fig. 3 (4)). The location application then operates the

SET INITIATED function and completes the location processing with SUPL (Fig. 3 (5)-(10)). The location application then notifies the SLP of the GPS measurement result through HTTP (Fig. 3 (11), (12)).

The above description shows how location information can be provided to third-party applications using SMS and the SET INITIATED function (Fig. 3 (13)).

### 2.3 Location Measurements for Third-party Location Functions

When a searching party, such as an emergency-response agency, requests third-party location information, the terminal and network perform the following two measurement methods.

- Base station positioning

Base station positioning derives an approximate reference location using the position of the base station where the smartphone is currently located.

- GPS positioning

GPS positioning uses the SET INITIATED function. The assist data<sup>\*11</sup> required for GPS positioning is obtained through SLP.

The capabilities of the terminal determine which method(s) are used. For example, if the smartphone (a) has the location application installed or (b) does not, determines which is chosen. Determination of the handset type can be done on the network side using the eight-digit Type Allocation Code (TAC), which is part of the International Mobile Equipment Identifier (IMEI) and indicates device type. The IP Service Control Point (IPSCP)<sup>\*12</sup> is notified of the IMEI when the terminal registers its location, so the IPSCP maintains a record of the type of terminal being used by a user with a given phone number. Thus, the decision can be made for

\*9 **LCS Client**: A generic name for systems providing location notification and location provision functions. In this article, refers to entities such as application service providers or corporate users.

\*10 **SLP**: The server which performs SUPL communication tasks such as distributing assist data (see \*11) to SET.

\*11 **Assist data**: A collection of parameters widely used for positioning by GPSs. Mobile terminals receive assist data distributed through a network and use it together with signals from GPS satellites to increase the accuracy of GPS positioning calculations.

\*12 **IPSCP**: IP Service Control Point. A node with functions to manage subscriber service information (contract and configuration information) and for service control.

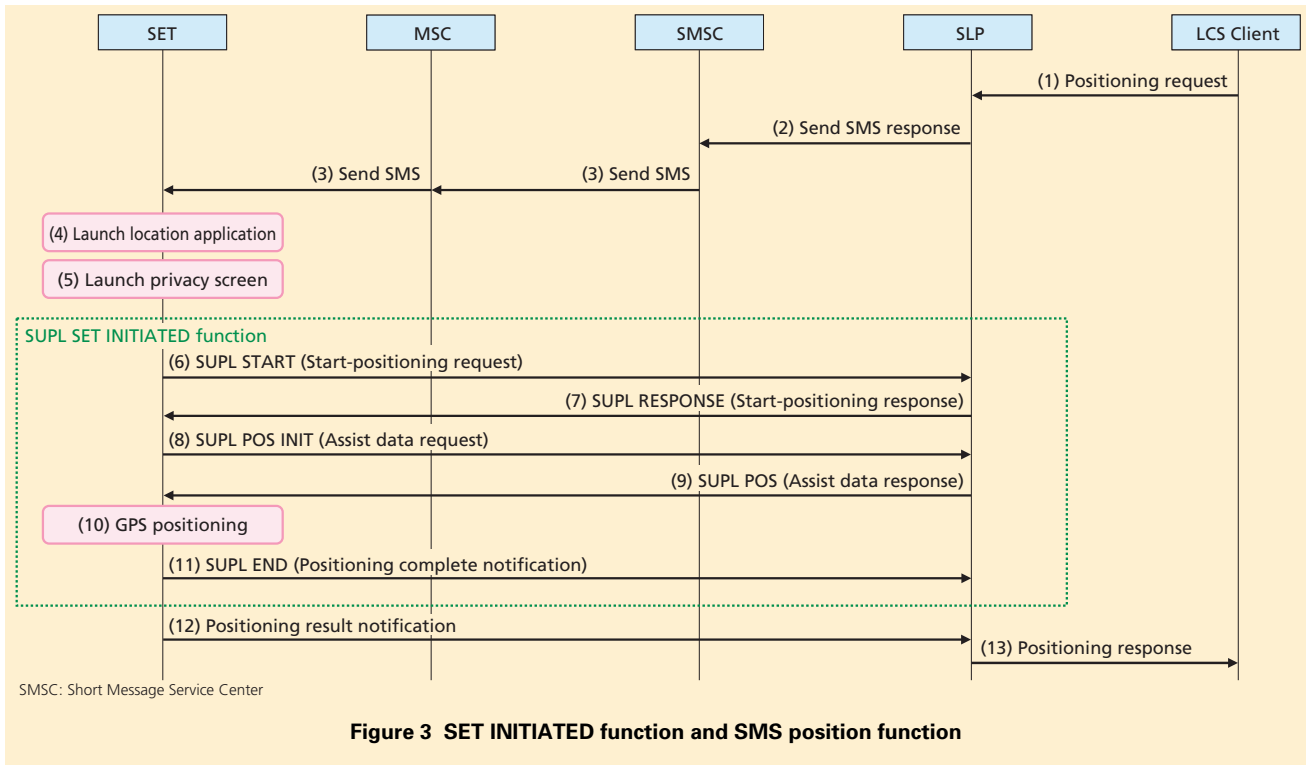


Figure 3 SET INITIATED function and SMS position function

each terminal by querying the IPSCP. The criteria for deciding may be different for other services, but here we describe the method used for the location function used in the emergency call example.

Figure 4 shows the configuration for providing positioning information when an emergency call is placed. When a smartphone places an emergency call (Fig. 4 (1)), the Mobile Switching Center (MSC)<sup>\*13</sup> determines that it is an emergency call (Fig. 4 (2)). In such cases, the MSC also determines the type of the originator’s terminal (Fig. 4 (3)). If the sender’s terminal does not have the location application installed (case (b)), the MSC performs

base station positioning (Fig. 4 (4)), and then notifies the emergency response facilities of the base-station-positioning result through an External Business-user Service Control Point (EBSCP)<sup>\*14</sup> (Fig. 4 (5)).

If the sender has the location application installed (case (a)), the MSC performs base station positioning and then notifies the EBSCP of the result, also setting a flag indicating that the terminal supports third-party positioning. The EBSCP notifies the emergency response facilities of the base-station-positioning result and also requests third-party positioning through the SLP. Upon receiving the third-party positioning request, the SLP sends an SMS to

the smartphone terminal (Fig. 4 (6)). The smartphone receives the SMS, launches the location application (Fig. 4 (7)) and performs GPS positioning (Fig. 4 (8), (9)). The location application then notifies the SLP of the positioning result (Fig. 4 (10)), and the SLP notifies emergency response facilities of the GPS result through the EBSCP (Fig. 4 (10)).

In this way, the searcher can be notified of the search result, switching positioning methods on the network side appropriately based on the terminal type of the person being searched for. Also, for services such as imadoco Search, imadoco Simple Search and Keitai-Osagashi, the system determines

\*13 MSC: A logical node having CS functions, specified by 3GPP.

\*14 EBSCP: A device that maintains profile data, such as the name and IP address, of each provider, handles authentication with each provider, and manages connections in the FOMA network.

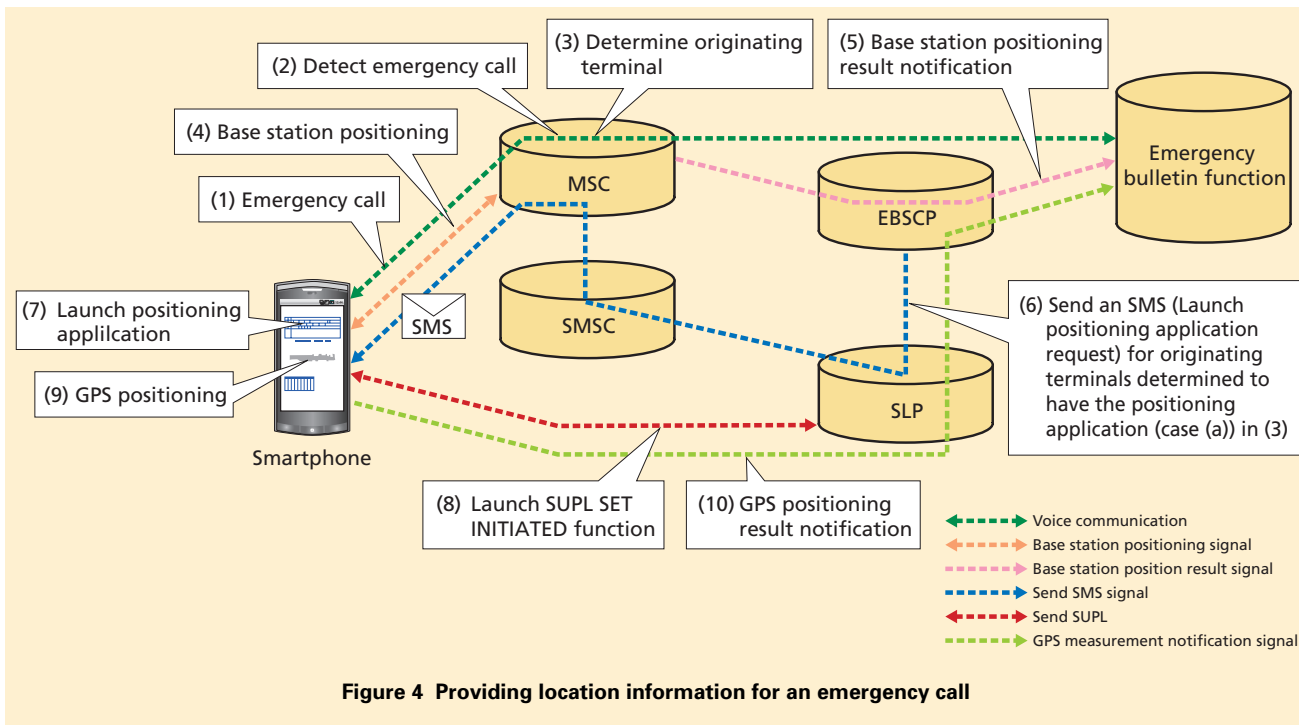


Figure 4 Providing location information for an emergency call

whether the location application is installed or not, but also whether the terminal supports DOCOMO SUPL (c) or not (d), determining terminal specifications and positioning conditions according to the service requirements.

### 3. Functions and Features Provided by the Location Application for Smartphones

#### 3.1 Application Launch Control Function

The location application is equipped with a function to prevent launching it if it is installed on a terminal that does not support it, or if it is using an access point where it cannot be used. Even if it can be used on the terminal, except for the emergency response

functions, it will not provide location information unless the user has agreed to the software consent agreement. Whether the user has agreed to the consent agreement or not is also linked to the Subscriber Identity Module (SIM)<sup>\*15</sup> currently inserted in the terminal. Consent from the user is requested when the location application is launched if consent has not already been given. Launch of the application could occur at the following times:

- The application icon is tapped on the Android HOME screen.
- The widget icon is tapped
- It is launched after receiving an SMS

The user can select to agree or

refuse to agree on the software consent agreement screen. If the user selects to agree, a flag is set indicating that the user has agreed, and the main menu function is called. Thereafter, when the consent function is called, consent has already been given, so the function simply calls the main menu.

If the user refuses consent, the location application exits.

#### 3.2 Privacy Protection

To implement privacy protection according to guidelines from the Ministry of Internal Affairs and Communications (MIC), we have provided the following functions in the current development for smartphone terminals. Specifically, an icon pictogram<sup>\*16</sup> is dis-

\*15 SIM: An IC card which stores mobile-phone subscriber information.

\*16 Pictogram: Icons and other display images other than characters. Pictograms such as the i-mode and antenna symbols are used in DOCOMO's mobile terminals.

played on the screen giving clear indication to the user that permission to provide location information has been given to avoid providing the terminal owner's location to others without the owner's authorization. This implements the required protection of privacy.

### 3.3 SMS Analysis

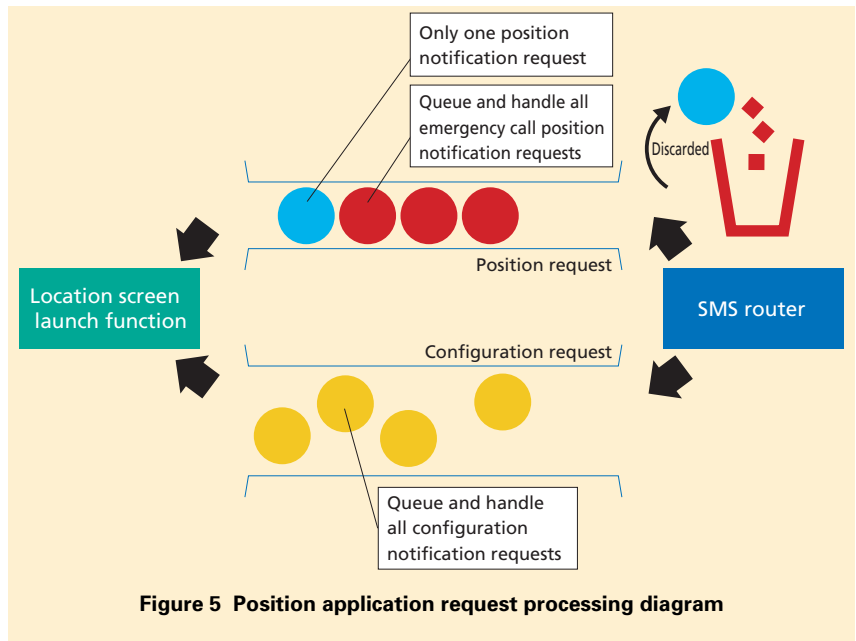
The location application for smartphones provides analysis of SMS messages. This function is able to pick out requests arriving in the request queue and launch the location screen depending on the request.

**Figure 5** shows the organization of request processing in the location application. Internally, the location application processes all of the requests in order when launching the location screen. Processing of one request cannot be interrupted by any other request.

While location requests received in SMS messages are processed in order, configuration requests are processed immediately. The settings screen can overlap the location screen, but the reverse is not permitted.

## 4. Conclusion

We have enabled third-party loca-



**Figure 5** Position application request processing diagram

tion services to be provided without restriction to many different types of smartphone terminals by providing smartphone location functions using a combination of SMS and SET INITIATED functions. This has enabled us to provide NTT DOCOMO's safety and security services on smartphone terminals at a level equivalent to that on i-mode terminals.

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