

Standards Analysis on Korean Positioning System for Public Safety

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Abstract— In public safety, the position information of the rescue requester is an important element to provide public safety services to the rescue requester in time. Usually mobile network operators acquire the position information of the rescue requester through their positioning system and provide it to the national public safety agency using their own interfaces. Since each mobile operator implements and operates their own proprietary platform, an interoperability of the system among mobile operators is not assured and it sometimes causes system errors. Thus the stable and interoperable positioning system is required for the public safety.

In US and EU, the standard on the positioning system for public safety is being discussed and tested due to reasons described above. In Korea, the discussion to create standards on the positioning system for public safety was initiated in 2015 as well, and recently a standard work on system interfaces is finalized.

In this paper, requirements, architecture and interfaces of the positioning system for public safety standardized in Korea are analysed. And also the solution to develop the positioning system to ensure a system interoperability among mobile operators is proposed.

Keywords— Public Safety, Positioning System, Standard, Interoperability, Mobile LBS

I. INTRODUCTION

A position information of a rescue requester is very important element in public safety since the national public safety agency(e.g. police department, fire department) can provide more efficient rescue services through an accurate position information of the rescue requester. The position information of the rescue requester is generally provided by mobile operators which operate their own positioning systems in their networks.

In mobile network services, positioning systems supporting popular positioning methods such as cell based positioning methods(cell-ID positioning method) and A-GNSSs(Assisted-GNSS) are already deployed in the market using de facto standards defined by 3GPP(3rd Generation Partnership Project)[1] or OMA(Open Mobile Alliance)[2]. In case of emerging positioning technologies such as Wi-Fi based positioning methods, BT based positioning methods, etc., importance and needs are recently increasing, and new emerging positioning technologies are continuously unveiled. However each service provider implements their own

solutions or platforms due to a lack of related standards. Because of an above reason, an interoperability among positioning systems is not assured and the positioning accuracy is different. According to a recent research on the positioning system for public safety in Korea, the test results of a request-response rate are not good since there is an interoperability problem among operators' positioning systems. In Korea, the national public safety agency acquires position information of a rescue requester through the positioning system deployed and operated by mobile network operators as well. However since each operator deploys their own positioning platform and provides different interfaces to the national public safety agency, an interoperability among them is not assured and a complexity of the platform increases. Beside since some mobile virtual network operators do not deploy a positioning system, the national public safety agency may not acquire an accurate position information of a rescue requester who is a customer of mobile virtual network operators. Thus needs on standardized positioning system for public safety is increasing.

US and EU lead making regulations and standards for public safety. In 2015, US FCC(Federal Communications Commission) determined the regulation on a position accuracy for public safety[3], and standards on a positioning system for public safety are being discussed in ATIS(Alliance for Telecommunications Industry Solutions) ELOC TF(Emergency Location Task Force)[4]. In EU, requirements on a positioning accuracy and standards on a positioning system for public safety are being discussed in EENA(European Emergency Number Association)[5]. In Korea, a discussion to make standards on a positioning system for public safety was initiated from 2015. Until now, requirements, architecture and interfaces are discussed and defined.

The aim of this paper is to introduce and analyse the Korean standards on the positioning system for public safety and propose a method to solve the problem issue on an interoperability among positioning systems.

II. POSITIONING SYSTEM REQUIREMENTS

In this section, requirements defined in the Korean standards to develop the interoperable positioning system for

public safety are described. Fig. 1 shows a reference model of the positioning system for public safety.

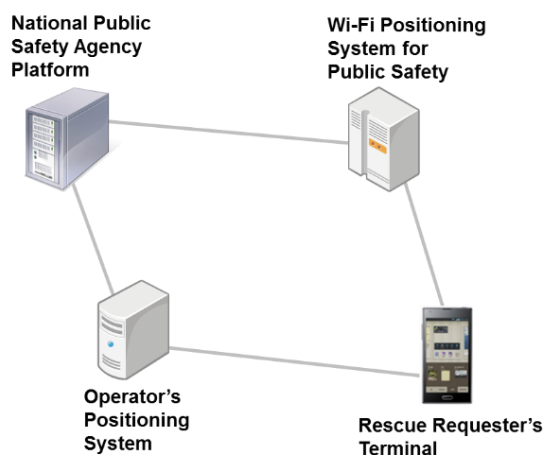


Figure 1. Reference model of positioning system for public safety

The main purpose of standards is to make the positioning system for public safety that provides the accurate positioning information of the rescue requester to the national public safety agency quickly and stably. And the standardized positioning system shall support an interoperability between various public safety agencies and positioning systems operated by mobile network operators, and provide the method to acquire position information of cell phones including unlocked cell phones or prepaid phones that do not provide accurate position information to operators. The aim of standardized requirements is to achieve the goal mentioned above. In below sections, detailed requirements are described.

A. System Overall Requirements

In order to establish the interoperable and stable positioning system, main requirements are as below:

- The positioning system shall support A-GNSS, Wi-Fi based positioning method, cell-ID based positioning method.
- The positioning system shall support WCDMA and LTE network.
- Positioning servers are different according to the positioning method
- In the positioning system, the position information shall be stored and exchanged securely.

B. Interface Requirements

There are various interfaces among entities of the positioning system. The main requirements of interfaces are as below:

- The national public safety agency can choose the positioning method to be used during the positioning session.
- The position information to be provided to the national public safety agency is in the form of the latitude/longitude and optionally altitude, and/or the civic address.

- The positioning session shall be performed in the mobile network user plane.
- The network initiated service is only supported.
- When an error occurs, detailed error information shall be reported to the national public safety agency.

III. POSITIONING SYSTEM ARCHITECTURE

Fig. 2 shows an architecture diagram of the positioning system for public safety.

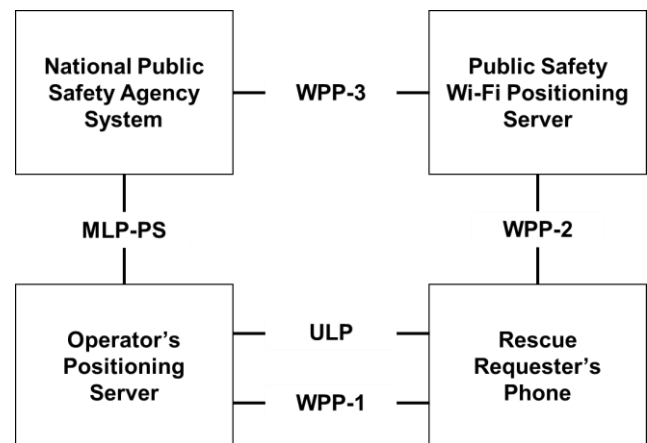


Figure 2. Architecture diagram of positioning system for public safety

A. System Entities

The positioning system for public safety consists of 4 entities. Main features of each entity are as below:

- National public safety agency system: the system operated by the national public safety agency. An aim of this system is to request and receive the position information of the rescue requester.
- Operator's positioning server: the positioning server operated by the mobile network operator. The positioning server receives the positioning request from the national public safety agency system. In case that the requested positioning method is A-GNSS or cell-ID based positioning method, the operator's positioning server acquires the position information of the rescue requester's phone, and then sends it to the national public safety agency system. In case that the requested positioning method is Wi-Fi based positioning method, the operator's positioning server sends a request to the rescue requester's phone to initiate the Wi-Fi based positioning procedure.
- Public safety Wi-Fi positioning server: the positioning server to perform the Wi-Fi based positioning method based on received Wi-Fi AP information scanned and sent by the rescue requester's phone. After the position information is calculated, the public safety Wi-Fi positioning server sends the positioning result to the national public safety agency. This server is operated by the government and opened to the public for the public safety purpose.
- Rescue requester's phone: the target phone providing the position information. In case that the requested

positioning method is A-GNSS, the rescue requester's phone performs the positioning procedure with the operator's positioning server. In case that the requested positioning method is Wi-Fi based positioning method, the rescue requester's phone scans the Wi-Fi AP information at the current position, and then sends the scanned information to the public safety Wi-Fi positioning server.

B. System Interfaces

Main features of each interface between entities of the positioning system are as below:

- MLP-PS(Mobile Location Protocol-Public Safety): the interface between the national public safety agency system and the operator's positioning server. This interface is based on MLP[6] interface standardized by OMA with some modification for Korean public safety requirements. This interface is used to request and response the position information of the rescue requester.
- ULP(User-plane Location Protocol): the interface between the operator's positioning server and the rescue requester's phone. ULP[7] interface standardized in OMA is applied in this interface. This interface is used for the A-GNSS positioning procedure between the operator's positioning server and the rescue requester's phone.
- WPP-1(Wi-Fi Positioning Protocol-1): the interface between the operator's positioning server and the rescue requester's phone. The operator's positioning server uses this interface to send the request to initiate the Wi-Fi positioning procedure to the rescue requester's phone.
- WPP-2(Wi-Fi Positioning Protocol-2): the interface between the rescue requester's phone and the public safety Wi-Fi positioning server. Through this interface, the rescue requester's phone sends the scanned Wi-Fi AP measurements for positioning to the public safety Wi-Fi positioning server.
- WPP-3(Wi-Fi Positioning Protocol-3): the interface between the national public safety agency system and the public safety Wi-Fi positioning server. Using this interface, the public safety Wi-Fi positioning server sends the positioning result to the national public safety agency system.

In case of MLP-PS and ULP interfaces, the MLS(Mobile Location Services)[6] and SUPL(Secure User Plane Location)[7] standardized by OMA are applied since they are widely deployed and used in the mobile network service market. Through a reuse of standards which are well-defined and implemented, the reliability and stability of the positioning system would increase and the development cost and time would decrease when the positioning system is implemented and deployed.

IV. POSITIONING PROCEDURE

In this section, brief positioning call flows are briefly described according to the positioning method.

A. Positioning Procedure for A-GNSS Positioning Method

Fig. 3 show the call flow for A-GNSS positioning procedures.

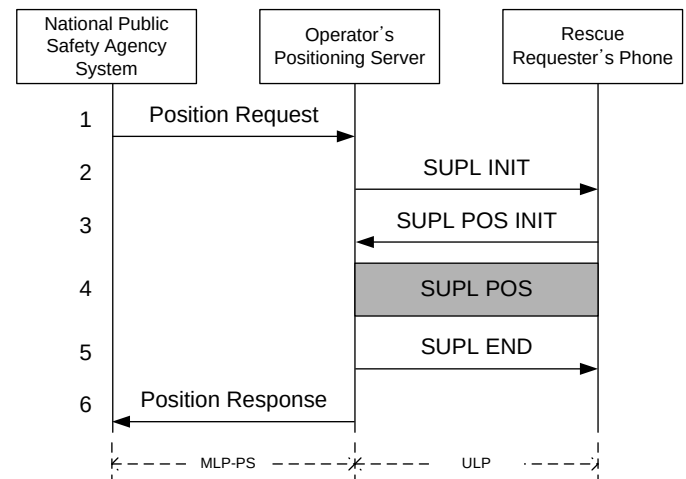


Figure 3. Positioning procedure for A-GNSS positioning method

- Step 1. The national public safety agency system sends the position request message to the operator's positioning server including the target ID, the requested positioning method(= A-GNSS).
- Step 2. The operator's positioning server sends the SUPL INIT message to initiate the positioning session with the rescue requester's phone including the server address, the requested positioning method.
- Step 3. The rescue requester's phone sends the SUPL POS INIT message to the operator's positioning server including the capabilities of phone for positioning.
- Step 4. The operator's positioning server and the rescue requester's phone exchange several messages to calculate the position of the rescue requester's phone.
- Step 5. After the calculation of the position, the operator's positioning server sends the SUPL END message to terminate the positioning session with the rescue requester's phone.
- Step 6. The operator's positioning server sends the position response message to the national public safety agency system including the positioning result.

In this call flow, step 2 to step 6 are identical with the network initiated emergency location service defined in the OMA SUPL 2.0[7].

B. Positioning Procedure for Wi-Fi based Positioning Method

Fig. 4 show the call flow for Wi-Fi based positioning procedures.

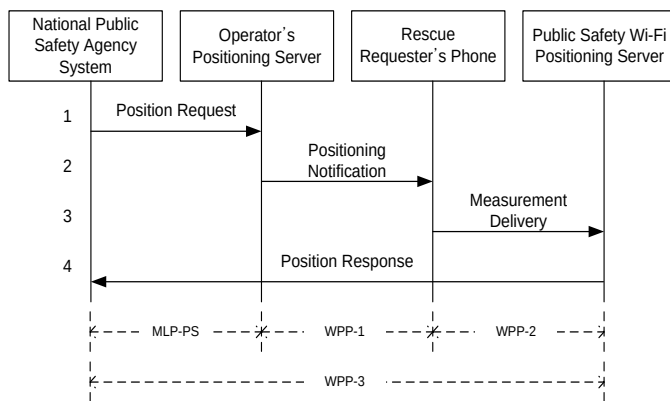


Figure 4. Positioning procedure for Wi-Fi based positioning method

- Step 1. The national public safety agency system sends the position request message to the operator's positioning server including the target phone ID, the requested positioning method(= Wi-Fi based positioning method).
- Step 2. The operator's positioning system sends the request message to the rescue requester's phone to initiate the Wi-Fi positioning procedure.
- Step 3. After receiving the request, the rescue requester's phone scans the Wi-Fi AP information at the current position. And then the rescue requester's phone sends the measurement delivery message to the public safety Wi-Fi positioning server including the scanned Wi-Fi AP measurements for positioning.
- Step 4. The public safety Wi-Fi positioning server calculates the position of the rescue requester's phone using the received measurement in step 3, and then sends the position response message to the national public safety agency system including the positioning result.

Between step 1 and step 2, the national public safety agency system may send the notification message to the public safety Wi-Fi positioning server to inform that the Wi-Fi positioning will be requested by the target rescue requester's phone.

V. INTEROPERABILITY OF POSITIONING SYSTEM

In case of A-GNSS positioning method, an interoperability of positioning system among mobile network operators is assured by OMA SUPL 2.0[7] standard. However in case of Wi-Fi based positioning method, there is an interoperability problem since each mobile operator deploys and operates their own proprietary solution. Locked cell phones perform the Wi-Fi based positioning procedure with the operator's positioning server since an agent for positioning provided by the operator is pre-installed including an address of the operator's positioning server. However unlocked cell phones cannot perform the positioning procedure with the operator's positioning server since an agent for positioning does not installed in the terminal and unlocked cell phones do not know an address of the operator's positioning server in general. Consequently the position information of unlocked cell phone

users cannot be provided to the national public safety agency since unlocked cell phones cannot perform the Wi-Fi based positioning procedure when the national public safety agency requests the Wi-Fi positioning information. It is a serious problem in public safety. In this paper, the solution to overcome the problem mentioned above is proposed.

A. Solution

The proposed solution is using a data SMS and a common agent for positioning. The data SMS is a kind of the SMS standardized in 3GPP[1]. Thus all mobile operators can send the data SMS and the mobile terminal can receive it. The data SMS is not visible to the user but it is operated internally in the mobile terminal. The common agent is an application installed in the terminal to perform the Wi-Fi positioning method. The common agent can be installed and used regardless of subscribed mobile operator and terminal model. In this solution, it is assumed that the common agent is pre-installed in the terminal.

The detailed solution is that the operator's positioning server sends the data SMS to the terminal including the address of the public safety Wi-Fi positioning server to execute the common agent in the terminal when the operator's positioning server receives the positioning request from the national public safety agency. After the terminal receives the data SMS, the terminal OS triggers the common agent to perform the Wi-Fi positioning. Finally the common agent accesses the public safety Wi-Fi positioning server and sends Wi-Fi AP measurements for positioning to the public safety Wi-Fi positioning server.

B. Validation Test

The public safety Wi-Fi positioning server and the common agent are developed for the validation test. Fig. 5 shows the public safety Wi-Fi positioning server developed for the validation test, and Fig. 6 shows the screen of the common agent developed for the test.

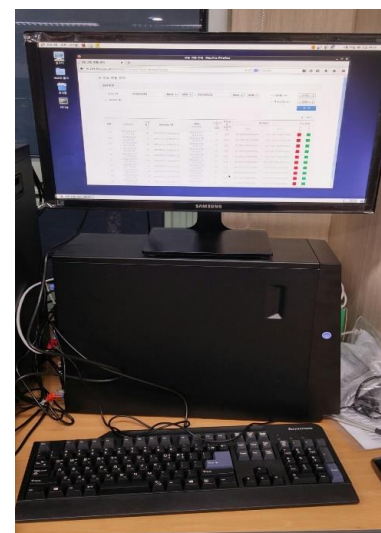


Figure 5. Public Safety Wi-Fi positioning server for test

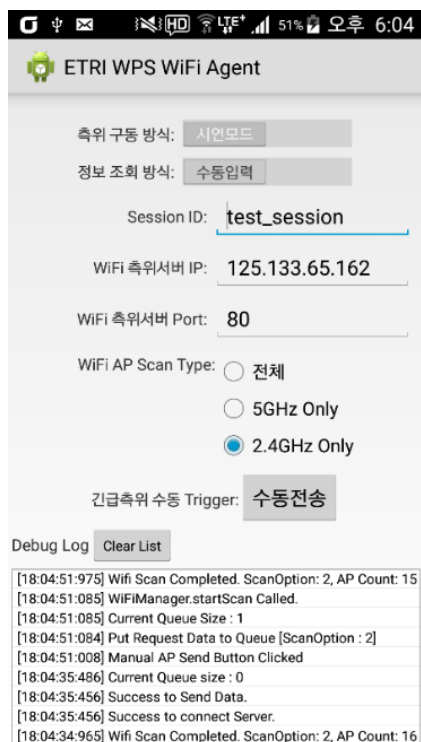


Figure 6. Common agent for positioning

Two tests are performed. The first test is to validate the common agent, and the second test is to validate resolving interoperability problem between a locking cell phone and an unlock cell phone. Fig. 7 shows the test scenarios performed.

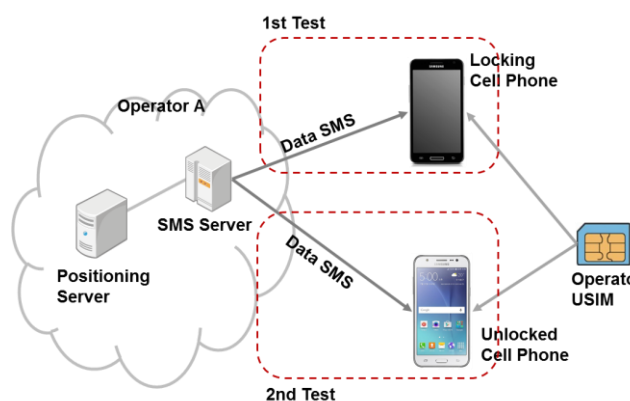


Figure 7. Validation Test Scenarios

In the first test, the operator A sends the data SMS to the locking cell phone equipping operator A's USIM. In this test, the positioning procedure is performed successfully. In the second test, the operator A sends the data SMS to the unlock cell phone equipping operator A's USIM. In this test, the positioning procedure is also performed successfully and the positioning result is acquired successfully.

VI. CONCLUSIONS

In this paper, the Korean standard on the positioning system for public safety is analysed and the solution to resolve the

interoperability problem is proposed including the validation test result. Since the interfaces standard has finalized, the test will be performed to validate the solution to resolve the interoperability issue among mobile operators as well.

ACKNOWLEDGMENT

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- [5] EENA, European Emergency Number Association, <http://www.eena.org>
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- [7] OMA SUPL v2.0 ULP TS, <http://www.openmobilealliance.org>



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