Open Map Generation for Heterogeneous Environments Based on Cloud Computing

SeungGwan Lee, Daeho Lee, Hyun Kim, Sanghyuck Ahn, and Sungwon Lee

***Abstract*—In Geographic Information System (GIS) areas, it accomplished by Open Application Programming Interface (OpenAPI) based map database (DB) construction approach. In this trend, multiple map DB providers try to reduce unknown map information in their own maps through their own capabilities. But, general map updating process is complicated and inconvenient. Also, the updated map information is just depend on the accuracy of the map DB provider's effort. Thus, in this paper, we propose the concept of Open Map generation for heterogeneous environments based on Cloud Computing for use between heterogeneous system providers or users for unknown map information.**

***Index Terms*—Navigation System, Cloud Computing, Map Updating, Open Map, mashup service.**

I. INTRODUCTION

Recently, Open Application Programming Interface (OpenAPI) enables the goal of Web 2.0 which are openness, sharing and participation cultures. This is simply not to share content, but through an open platform for various services and applications are to be shared. The key here is just an open data. In Geographic Information System (GIS) areas, it accomplished by the open source based map database (DB) construction approach.

Navigation systems have become an interesting research and industrial topic due to their wide deployment. However, the updating and distribution of the map DB is a complex and high-cost process. According to this issue, the real time map update methods using wireless communication technologies has not been widely considered for the map generation and updating processes. Thus, the updating cycle of a map DB is different according to the frequency at which the map DB provider and user update their map DBs.

If a user wants to update the map DB at the user's terminal equipment based on the provider's master map DB, the user connects to the Internet and manually checks the update status of the master map DB. Thus, the map generation and updating process is not an autonomous process, and real-time map generation and updating procedures are not supported. At present, navigation systems users should download the updated map DB by using a computer and memory card to store the updated map and then attach the memory card to the navigation systems. Thus, it takes up to ten minutes to update map data to the flash memory of the navigation systems device. This process is complicated and inconvenient. Also, the updated map information is just depend on the accuracy of the map DB provider's effort, which means that the user has no choice but relying on the map DB provider to keep their own map complete and reduce the unknown map information, before the user meet the problem.

So, some researches considered the shared-participation on the map using Open Map API [1, 2, 3, 4]. And, various researches have been done to update only the changed part of the map information [5, 6, 7, 8, 9].

However, these map DB updating architectures in real time have several problems. First, map DB updating is allowed between map DB users within the same provider. Second, the processing costs of extracting information for unknown map information are required for each provider. Third, the map information cannot be shared between providers due to provider's own proprietary map formats. Thus, to solve these problems, we propose the cloud-oriented open map generation between heterogeneous systems for unknown map information. Especially, the proposed method use cloud computing technology to solve the compatibility issues between map DB providers [10, 11, 12, 13].

In this paper, we review conventional methods for the updating of the map DB and unknown map information generation in Section 2. Section 3 describes the cloud-oriented open map generation concept and architecture between heterogeneous systems for unknown map information. And, we conclude this paper in Section 4.

II. MAP DB INFORMATION SERVICE

In the recent years various mash-up with open map APIs are proposed. Open Street Map (OSM) is a global road map production projects [14]. OSM is possible services that the voluntary participators enable rich services such as creation, deletion, and modification of the map on the web. Google's Google Map Maker provides the method to update information which is omitted in the Google map through the user's participation [15]. However, it can be shared between Google users. In Korea, Daum and Naver are providing the Open Map to enable mashup services using map in easy way [3][4]. Paran provides a openmap service which is the life-log open shared-participation on the map with a combination of map, content and community [16]. These

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openmap service can share the local contents which are created by users easily and freely. Through these, users can utilize the map service more convenient and useful. However, these Open Map services can be shared by only specific platform users.

According to the map DB generation and updating methods by using map information in car navigation, several works were done before. In the road *Map Air Update Server* (MAUS) project, researchers have developed a mobile spatial Database Management System (DBMS) to enable updates to the partial map data that could not be updated in the conventional navigation system [5][6]. *SK M&C* in Korea showed a service that can wirelessly update the navigation map information by using the *SK-DigitalHub* Service. Through the *DigitalHub* Service, the navigation map information and driver's safety driving information are updated by using the Bluetooth base station installed at the gas station [17]. *Toyota Motor Co., Ltd.*, announced the roadmap on Demand technology that it has developed to automatically deliver differential map data to car navigation systems [18]. *Honda Motor Co., Ltd.*, showed a demonstration of wireless updates to map information using mobile-phone networks, which is one of the services of *Inter-Navi Premium Club*, a communications service for automobiles, in conjunction with the announcement of a new model of its Inspire series [19]. In the *ActMap* project of Europe [20], the research regarding the interchange data format and the server-terminal system for partial map updates has progressed, and the prototype system has been developed since 2004, but this has failed to lead to commercialization. And, according to automated map DB generation and updating architecture in real time by using the Global Positioning System (GPS) information and detection of road images while driving unknown roads [21, 22, 23], when a user drives unknown roads that do not appear in the car's navigation map, the cloud-oriented car navigation system can effectively extract the GPS information and image information of the unknown roads. Subsequently, that extracted information is uploaded to the roadmap DB provider to enhance the master roadmap DB in the cloud. But, this method is that Internet Service Provider (ISP) and voluntary participators using mashup service were excluded. This is only updating method between the heterogeneous navigations.

III. Open Map Generation for Heterogeneous Environments

A. Network-Oriented Map Generation

First, we introduce the general network-oriented map generation concept for unknown map information extraction and map DB updating in the Cloud or Server on the Master Map as in Fig.1. It shows the concept of map generation based on cloud or server computing. The Cloud or Server is consisted of the Meta Info Generation Filter and Meta Info Aggregation Filter.

This scheme includes 1) the special purpose participators, voluntary participators, Internet Service Provider(ISP) and car navigation systems transfer the extracted map objects and attributes from the GPS and image information of the unknown map information to their map provider's Meta Info Generation Filter within the cloud or server through the wireless communication network, 2) The Meta Info Generation filter analyzes the reliability of the extracted information. If the extracted information is accurate, Meta Info Generation Filter transfer the accurate information of the unknown map information to Meta Info Aggregation Filter, 3) the Meta Info Aggregation Filter generates the metadata in the homogeneous map format available and update the master map DB, and 3) each provider update the there local system through synchronization with the updated master map DB.

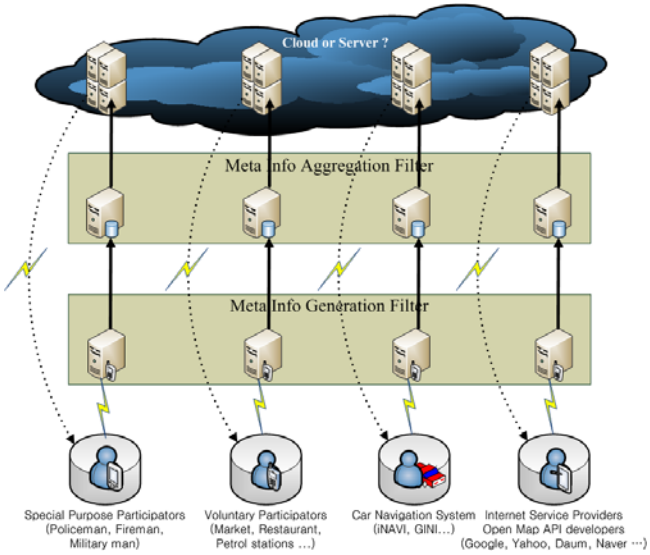

Fig. 1. Concept of network-oriented map generation based on cloud or server computing

B. Concepts of Open Map Generation based on Cloud Computing

We propose the cloud-oriented Open Map generation between heterogeneous systems for unknown map information extraction and map DB updating in the Intelligent Map Cloud as in Fig.2.

The Intelligent Map Clouds are consisted of the Meta Info Generation Filter and Meta Info Aggregation Filter.

When a user find unknown map information, if the user transfers the extracted map objects and attributes from the GPS and image information of the unknown map information to their provider within the Intelligent Map Clouds through the wireless communication network, the provider then transfers the information gathered from each user to the Meta Info Generation Filter and Meta Info Aggregation Filter within the Intelligent Map Clouds. The Meta Info Generation Filter and Meta Info Aggregation Filter then extracts the road attribute information and generates the metadata in the XML format available for heterogeneous systems, and the cloud provides this generated metadata in XML format to each map DB provider. Finally, the map DB providers change the received metadata to their provider DB formats and then update the map DBs of all navigation systems in real time.

In contrast with Network-Oriented Map Generation as in Fig.1, Fig.2 shows an concept of open map generation for heterogeneous environments based on cloud computing.

Looking briefly, the proposed scheme includes 1) the function of provider's Meta Info Generation Filter is same.

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But, Meta Info Generation filter transfer the accurate information of the unknown map information to the same Meta Info Aggregation Filter within the cloud, 2) the Meta Info Aggregation Filter generates the metadata in the XML format available for heterogeneous systems, and update the master map DB, and 3) the cloud update the all local system through synchronization with the updated master map DB.

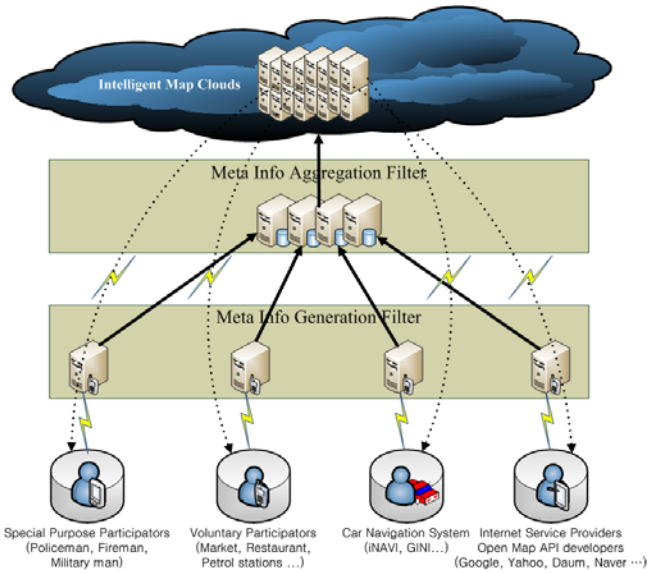

Fig. 2. Concept of open map generation for heterogeneous environments based on cloud computing

Fig. 3 shows the flowchart between Meta Info Generation Filter and Meta Info Aggregation Filter in the Intelligent Map Clouds.

In Fig. 3, procedures ❶, ❷ and ❸ are the steps to generate the map metadata in the cloud.

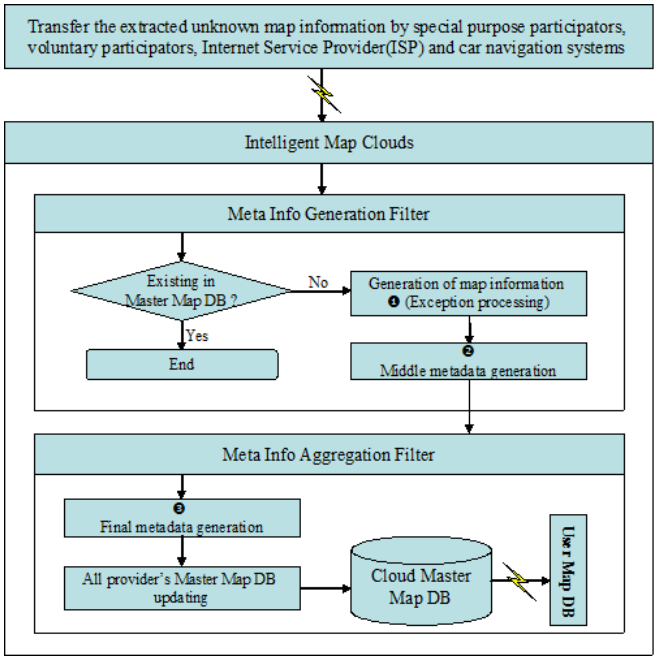

Fig. 3. Detail flowchart between Meta Info Generation Filter and Meta Info Aggregation Filter in the Intelligent Map Clouds

❶ is the step that each providers extract and analyze the transferred map information. Actually, because map DB providers do not evaluate new map information through actual traveling tests, it is not easy for these providers to analyze whether or not the map information are available for travel, using only the extracted information. However, the map DB provider can evaluate the validity of extracted map information with GPS position information of the location, with the images of the roads which can be extracted from car navigations.

❷ is the step that each providers generate the middle metadata of the map information using the existing information in a master map DB in the cloud.

❸ is the step that cloud generates the final metadata of the map information in XML format using the new map information from the all providers. But, all unknown map information should be updated to guarantee reliable final information after the actual traveling test, the final information must be updated in the cloud after the actual traveling test.

Instead of the traditional method of each provider updating the master map DB individually after the actual traveling test, the cloud fills out the actual traveling test and provides the 2nd final information that is the metadata in XML format.

IV. Conclusion

We proposed the cloud-oriented open map generation concept and architecture between heterogeneous systems for unknown map information in this paper. Mutual integration and sharing of map information through the cloud environment can provide accurate map information in real-time. When there is unknown map information or map attribute information that changes frequently, it is very expensive and requires duplication of effort for each provider to keep the master map DB current through the actual traveling test. However, this proposed method based on cloud computing can reduce the costs of the actual traveling test for each map DB provider and can reduce the maintenance costs of the map DB data center through the construction of the integration of server resources and the Green Data Center. Finally, the cloud-oriented map generation method can update the unknown map information in the users' map DBs more efficiently.

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