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# MuBike: Cloud Communication Service Composition Platform for Automatic Renting Bikes

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***Abstract***

*Recently, bicycle culture is more and more active due to the environment consciousness and healthful life concept. This paper proposes an event-driven based cloud communication service composition technology to provide automatic renting bike system with smart phones which is tested and verified at ITRI MuBike Platform. With a unique interface on smart end-point devices and collecting lots of user's location-based information, the user requests and the huge location-based information are processed by Complex Event Processing (CEP) which is used to trigger suitable SIP-based Telecom services and Internet/Cloud services at smart mobile devices. Therefore, our platform provides richer and dynamic information and location-based services combined with Telecom services and Internet/Cloud services architecture. With the more usage of smart end-point devices, the more plentiful users' present status will be retrieved and recorded, this platform can provide more convenient and helpful Telecom services and Internet/Cloud service environment for users.*

***Keywords:*** *Location-based Service; Cloud Communication Service Composition; Event-driven*

## 1. Introduction

In recent years, visiting the city through bike riding has become a fashionable green life. So far, many cities have built up the related automated bicycle rental system and the bike riding environment in the world. One of the famous cities is Amsterdam capital of Netherland. This city is the world's largest bike city. With the constructions of both bike automatic service machines and the cycle paths, it can courage people to bike instead of taking the public transport or private cars. Also, more and more tourists can get close to the corners of the cities through the public bike rental services while promoting the tourist trade.

Take Taipei city and Kaohsiung city in Taiwan for examples, the public bike system-YouBike [1] has provided 500 bikes and 43 rental point from March 2008 in Taipei city. For Kaohsiung city, after the public bike system been constructed in March 2009, it has already

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provided 74 rental points for these years. Basically, such kind of public bike rental system provides user for a self-service operating environment by the constructions of automatically bike services machine and the web information services. However, with the establishment of ALL-IP network environment and the growing popularity of the smart phone, all kinks of advanced technologies on communication and network services have been published. Thus, how to integrate these technologies into the automatic bike rental system and provide a friendlier and efficient service for tourists becomes an important topic.

Basically, service composition is intended to meet the requirements of user to achieve complete services. The services will compose at least two kinds of different services. Unfortunately, two major network services provider, Telecom and Internet, face lots of difficulties to do the service composition due to their technological development background. The traditional Telecom service station can provide communication service immediately and reliably. However, it can only provide the basic Telecom services, and has less adjustment and variety on services. Thus, the traditional Telecom service is not able to provide more actual services according to users' localization. It is also not table to provide Location-Based Services real-time.

On the other hand, the Voice-Over-IP (VoIP), which provides services based on network technology, can compose varied network services. However, it also cannot provide Location-Based Services real-time. Users who use VoIP services cannot even call out with emergency while the network is disconnected. This is because that user may connect to the Internet on different places and the IP address will be changed while roaming.

In order to improve the mentioned problem, a cloud communication service system based on smart devices is proposed. Basically, the service system can operate on both of Telecom service or Internet (also cloud network) service. Thus, the system can provide smooth services. The main contributions are listed as follow:

- Provide an Event-Driven structure to integrate three kinds of technologies, including: Telecom, Internet and cloud network.
- Construct a MuBike platform to verify the availability of Event-Driven structure. MuBike platform is constructed based on the automatic bike rental system of ITRI (Industrial Technology Research Institute of Taiwan) u-Bike. By using MuBike system, users can get real-time Telecom/Internet/cloud network services, such as Real-Time Locating, Parking Guidance and Information, emergency roadside assistance, and Car Rental services, with a mobile application (also called APP, which is constructed based on MuBike System).

The remainder of this paper is organized as follows. Section 2 introduces the related works. Section 3 presents the detail of the Cloud communication platform. Finally, Section 4 provides the conclusion.

## 2. Related Works

In order to reduce the environment pollution bring by the public transportations, many countries start to construct public bike paths. Furthermore, more and more people seem bike riding as a natural sport for health. All these will push the development of bike riding with higher speed.

So far, both of the public bike rental system or Exercise bike system can only provide single type of services based on the APP installed on the smart devices. Take bike rental system in Taiwan for example, in addition to the hardware construction of the bike automated service machines; the system provides users with relevant Internet service to find out the rental point based the inquiry location [1] [2]. Take another common APP service about bike sport for example, the main functions about the system is providing the cloud service with

recording the time , distance and calorie of users. The related APP include: kadaGo[3], Antphero Bike[4], My Tracks[ 5]. There have some APP that can provide the information about the route on map by surfing the Internet, for example: Bicycle_Ing[6], bicycle route[7].

The above APPs can only provide the Internet service or cloud service at the same time. In this paper, the MuBike will provide bike rider an APP service window. Through the system, users can get the overall services on Telecom/ Internet/ cloud services which are all composed to the cloud communication integration platform.

In this paper, the system will apply the single user interface and collect the real-time information about the current state of user. Basically, through the use of the large amount of information flow, the system will be triggered to handle the logical service technology with the massive data analysis services exchange activity. The logical service technology include: real-time cloud computing and service information warehouse management. However, how to filter and retrieve the required information to achieve efficient service management under such a big data environment is an eager topic to be discussed.

Complex Event Processing (CEP) technology can be applied to handle the big data for services management. CEP can detect the event within the big data in real-time, and then trigger the related response mechanisms. Furthermore, CEP technology can be used in Internet intrusion, Radio-frequency identification (RFID) application, and management of aviation transportation, financial management (such as risk management and fraud detection). Recently, the common CEP technologies include: Tibco Business Events、Oracle CEP、Sybase Aleri、Streambase, and ESPER. In this paper, the event of CEP will be triggered to the related integration technologies among Telecom, Internet and cloud services.

In the integration logic technology of triggering network / cloud service, the server or the message sender will automatically send message to client by using the push technology. This is different from the pull technology in which the client-side (or client) requires to propose a request for getting the information from server-side (or server). The push technology not only can save the power of the smart mobile devices, but also can save the network connection bandwidth. In 1996, PointCast company provide a service of subscribe and collect the related network data through personal preference settings automatically. This is the beginning of the push technology been used [8] [9]. The most common push technology applications include: the first generation of mobile phone short message service, the second generation of actively notification for users to receive the update mail service, and the third generation of the initiative to send update information or advertisements to users through the push data technology under smart phone. In the growing popularity of smart phones, C2DM push mechanism that Google disclosed become both lightweight and elastic network message update mode.

In the integration logic technology of triggering Telecom / cloud service, based on the locating information which is provided by the mobile devices, the cloud server will find the most appropriate means of communication number accord to the location. After that, the system will create or transfer this communication channel through the communications system. Basically, this channel not only needs to send the voice, but also needs to transmit the information about the stores or parking spaces around the users. Hence, the global system for mobile communications (GSM) is unsuitable for the services. On the other side, the Voice over IP (VoIP) [10] [11] [12] can meet this requirement. Recently, the most common system of VoIP includes: Skype, MSN, Google talk and Session Initiation Protocol (SIP) [13]. Among the VoIP systems, SIP has the standardized permeability and is relatively easier to control and transfer for communication. Thus, SIP is the first choice for Telecom system.

## 3. The Cloud Communication Platform-Itri Mubike

In order to provide a more healthy and friendly working environment for workers, Administrative Service Center of ITRI proposed an automatic bike rental platform: ITRI u-Bike in 2009. Workers can use the identification (which is embedded with RFID) to rent a public bike by themselves. This can reduce the time while ply between different buildings. It can also achieve for the purpose of Carbon reduction. So far, ITRI u-Bike provides twelve parking spaces (This place also has the automatic bike rental machine) and web based information services [14]. In this paper, a MuBike platform is constructed based on the ITRI u-Bike services environment for verifying the availability about the cloud communication integration services technology. The purpose of the MuBike platform is letting user to operate and use the cloud/ Telecom/ Internet services by using the APP in the smart devices while moving. The structure of MuBike platform is introduced in Section 3.1. Section 3.2 shows the services module construction technology and its application situation for client.

### 3.1 MuBike platform

In this paper, users' location information (such as: longitude and latitude information) and real-time services information will be collect by the smart device based on the Event-Driven cloud communication integration technology. The related Telecom/ Internet/ cloud integration services system will be trigged by the event definition. Based on the ITRI cloud platform [15], the related services technologies will be constructed on the virtual machine. It will bring more convenience about the related services, such as: increasing the service points flexibly while the information flow is expanding, transforming services in different real machines, having the backup service points in different places and so on. The system structure is shown in Figure 1.

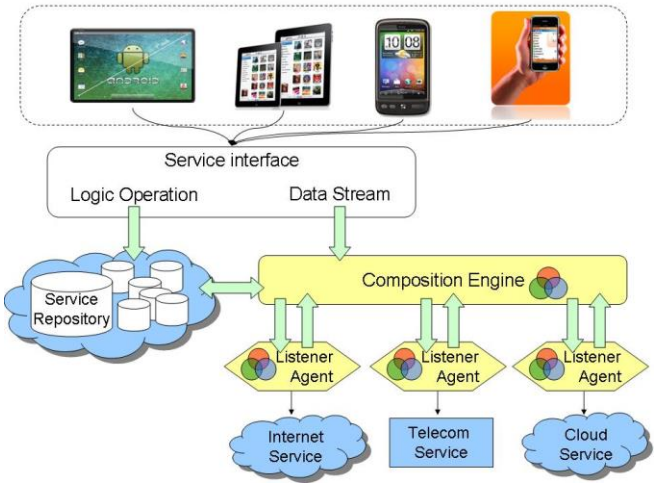



**Figure 1 The System Structure.**

While doing implement design, the system need to provide a variety of user interfaces due to the users' end devices are highly diversified. Thus, in this paper, the system will adopt the RESTfull WEB Service interface for the client. Through this interface, the system can utilize HTTP communication protocol to get related services easily, whether users use tablet, smart phone (iOS/Android) or notebook. Furthermore, the server will be programmed in JAVA

language and TOMCAT server. The server system will also adopt Object-Relation Mapping Framework (O/R Framework) to accelerate the development process. Basically, the O/R Framework can connect to all kinds of relational database management system (RDBMS) and can help developer to construct the system more flexible. Such kind of multi-level server structure not only can support for various kinds of hardware of the server, but also can support for most of the operation system, such as: Windows, Linux, UNIX, and BSD. This will be helpful while doing the promotion activities for the services.

In the message stream processing, as shown in Figure 1: The Composition Engine will be constructed with the JAVA development environment. The Engine will also use ESPER to be the message stream processing engine which is the open source CEP engine for JAVA language [16]. Via real-time process of mining data streams from a massive of complex event patterns, the system can trigger the corresponding event handling mechanism. The definition of the pattern can use JAVA Beans, XML or a simple Name Value Pairs.

To make ESPER able to listen to the stream system, the system must to define all event classifications by using JAVA Bean. All of the statement will be defined by the Event Processing Language (EPL), and will be registered into the ESPER engine. After that, the statements will be implemented into the ESPER UpdateListener class listening device (Listener). Thus, when there has qualified event among the data stream been detected, the Listener will be trigger to perform the corresponding action, and the ESPER engine will deploy the real-time resources according to the event. Through this process, the engine can handle various kinds of service definition events, and register the corresponding activities and services for the events.

Basically, the system can execute the corresponding activities for the events and then notice users to update the system by using the cloud push notification platform. Here, the push notification platform can be used on both of the C2DM in Android system [17] or the push notifications function in iOS system. For example, after obtaining a user's real-time geographic information, the system can find out that there has no parking space where user is going to. At the same time, the system can give users some services information and suggestions through C2DM push notification platform. This can achieve the goal to integrate services real-time.

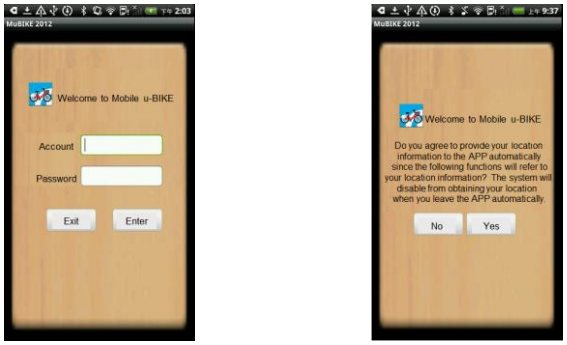
For the Telecom services, when users start to dialing Telecom services, the mobile devices also required to be SIP Client and perform the request for establishing a call connection initiatively. The SIP Server is responsible for verifying the identification of a caller to accept the call and then broker a SIP network communications for the parties. Furthermore, when establishing a call communication encounter a system busy, the SIP Server can help to transfer the call automatically. System can eliminate the time of manual check and re-establish call connection. Hence, this is an intelligent services integration system.

### 3.2 The technology of service module and the context of the application

For client, user can operate the mobile cloud and Telecom service modules by using the APP which is installed on the smart mobile device. Currently, the service modules are supported upon the version of Android 2.3.3 and above. After login into the system through a single user interface (The login diagram is shown in Figure 2(a)), the system can verify the identification of users by using the Lightweight Directory Access Protocol (LDAP) [18]. Upon successful verification, system will ask for user's authentication for getting the information about the location and the diagram is shown in Figure 2(b). The service server will automatically retrieve the latitude and longitude information while users are moving and then start the following service module (The service menu is shown in Figure 3).

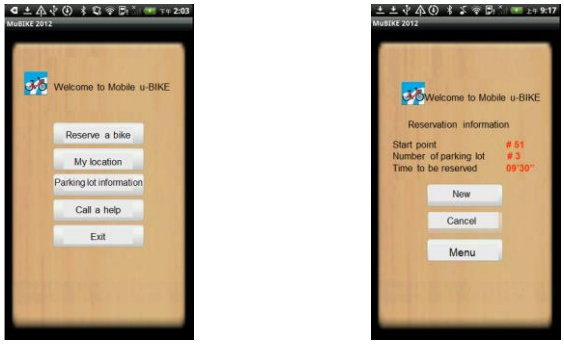
- Bike Reservation service module

After users propose a bike reservation service requisition, ESPER server will provide the information about the available parking spaces through the cloud information for users. At the same time, the back-end bike machine controller will be triggered to provide a specific user to pick up the bike. In the context of the application, the user can added bike reservation and use the identification card to pick up the car, or cancel the reservation within the prescription. For example, the reservation rule shows that user must pick up the car within 10 minutes after making a reservation. The system will launch a picking up care message for users before the reservation is getting expire to prevent users from picking bike or return the bike overdue. The diagram is shown in Figure 3(b).




(a) Login interface (b) GPS authentication

**Figure 2. The Diagram of Login and Authentication**




(a) Service menu (b) Bike reservation

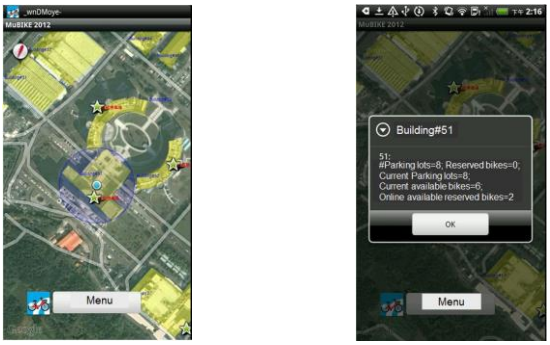
**Figure 3. The Service Menu**

- Real-Time Locating Information service module

In ITRI, there are 35 buildings and 12 u-Bike parking space which have latitude and longitude separately. Basically, the information of the latitude and longitude will be built on a layer and then stacked on the top of the Google Map. Here, the information about the latitude and longitude of each buildings and parking space will never be changed; hence when Google update the content of Google Map layer, users can keep utilizing the layer constructed by ITRI. Besides, the real-time locating information service module is constructed based on the API package: com.google.android.maps which is provided by Google Android Maps [19]. In the context of the application, users need to agree on opening the locating service for using the real-time locating information service module. Users can know their current location

through the smart devices which will retrieve the information of the position and shows the results with the IRTI map layer. After that, user can know the relative position of each parking space and buildings while zoom in or zoom out the map. Finally, users can select the appropriate path to avoid getting lost or detour. The related diagram is shown in Figure 4(a).




(a) Real-Time Locating (b) Parking Space Information

**Figure 4. The Service Modules**

- Parking Space Information Query Service Module

In addition to follow the map on the real-time locating information service module, the parking space information query service module will be integrated with the Cloud to Device Messaging (C2DM) push mechanism on the cloud. Basically, Android C2DM [17] is a cloud service architecture provided by Google. It provides the Android application developers to send the information to the application on the Android devices through cloud server and application server. Here, the application server will use the ESPER server. Besides, C2DM cloud message push mechanism is mainly to provide a lightweight information notification mechanism to notify the application about the updated data on the application server, hence, when ESPER server gets the updated information about the parking spaces from database, it will push the updated information to the mobile devices of the registered user who are using the application through the C2DM cloud server.

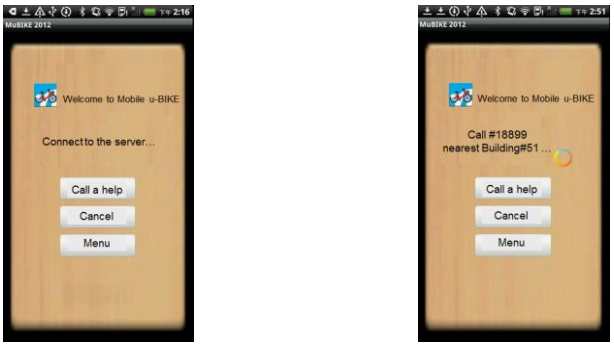
In the context of the application, whether the users agree to turn on the locating service or not, they are able to use the parking space information query service module. Users can click on the marked parking space on the map to get the overall information about the parking space, such as: the remaining number of parking space, the number of bike that still can be borrowed, and the number of bike that can be reserved et cetera. Furthermore, users can query the real-time information about the parking space dynamically to avoid the dilemma of no bike to rent when they arrive the destination. This can also help to reduce the time for finding a parking space. The diagram is shown in Figure 4(b). In addition, users who use the platform can instantly receive the updated information about the parking space and the bike that still can be rent through C2DM message push mechanism.

- Immediate Roadside Assistance Service Module

In addition to build a SIP server, the platform also uses the android.net.sip package [20] to make the smart mobile devices be a role of SIP client. The smart mobile devices can get the users locating information and then the ESPER server will trigger the cloud service to obtain

the assistance of immediate rescue call. Here, the SIP client will request a connection from the SIP server. The server will decide to accept the call request.

In the context of the application, when users face the situations occurring while dynamic travel, such as: flat tire and malaise, and requires immediate rescue services, users only need to click on a button of rescue to get quick and effective rescue communication. If users do not agree to turn on the locating services, ESPER server will automatically transfer the call to the customer service line. Thus, users are no longer to query or call the customer service line by themselves. On the other hand, if users agree to turn on the locating services, ESPER server will call the nearest rescue station according to the result compared with the location of the users. For the general VoIP, users may surf the Internet at any location and it is difficult to trace the IP address, hence, VoIP system cannot trace the callers' locations readily. This is the problem that the MuBike wants to solve. The related immediate roadside assistance service module is shown in Figure 5.




(a) Immediate rescue call (b) Nearest rescue station

**Figure 5. Immediate Roadside Assistance Service Module**

## 4. Conclusion

In this paper, a composition scheme to Telecom/ Internet/ cloud services based on Event-Driven has been proposed. In the system, the users' real-time geographic information and the related required information will be collected, and then be used to handle the process and activate the corresponding event handling by using the complex event processing technology. A MuBike platform is also ben constructed to verify the related availability of cloud communication integration services result. The overall system can help users to get some services through the APP in the smart devices. Basically, the services include: vehicle reservations, real-time geographic information, parking information, and real-time road rescue of the cloud/ Telecom/ Internet services system. Furthermore, the APP is embedded with the real-time dynamic competitive weights scheme. This can help to provide the bike parking spaces competitive information and to reduce the time to find any available parking space dynamically while users are moving.

With the advancement and popularity of smart mobile devices, more information about users' status will be retrieved and recorded. Through the prosed cloud communication integration services platform, users can get more conveniences about the Telecom, Internet and Cloud services.

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