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AN EVENT-BASED MOBILE ADVERTISING SERVICE MODEL CONSOLIDATING DECOUPLED SERVICES

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ABSTRACT

To support the collaborations of distributed services in mobile advertising, this study proposes a model with event-driven architectural style that can accommodate distributed loosely coupled services. The proposed model employees QR code scanning as a bridge between separated service domains. Also, to initialize events in this model by QR code scanning launched by users on their demands can alleviate the tense concerns on privacy. The major contribution of the proposed model is to provide a practical approach to achieve agility for compositions of web services.

KEYWORDS: *Event-driven Architecture, Mobile advertising, QR code, Web Services Composition*.

I. INTRODUCTION

Along with the rapid progresses in wireless communication, the technological advances have also produced a sharp increasing population of mobile devices including laptops, netbook and tablet computers, mobile phones and smart phones that altogether have magnified the strong demands for emerging mobile applications and services. Due to the emerging tremendous benefits to business in the forthcoming era of mobile Internet, the issues about mobile commerce and mobile advertising have become hot subjects in both research and application fields in recent years. The competitive market changes rapidly. Specially, it usually accompanies with loosely coupled web services which also create magnified demands of agility. Since the agility is regarded as one of the core competencies to keep the dominating position in the market, the businesses have to react quickly in response to impulses [1]. The purchases for agility are still going on. Therefore, the approach to achieve the required agility becomes a valuable concern. How to meet the needs aforementioned above from changing business timely has being an essential struggle in the competitive market [2].

As to service provision on the Internet, the required agility can be achieved efficiently by accommodating the existed appropriate supporting services among the various distributed decoupled services online. However, how to consolidate the distributed and decoupled supporting services on the Internet is still lack of efficient approaches. The Event-Driven Architecture (EDA) is the approach for incorporations of distributed services to build efficient and agile applications [3]. Both researches and applications of event-driven architecture have been gaining momentum [4] and also promised enhanced responsiveness in recent years. Therefore, the event-driven architectural style is regarded as a viable approach for services compositions due to its featured characteristics of adoptions of asynchronous communication and loosely coupled services.

The event-based communication has been widely used to integrate various forms of system and software [5]. Event-driven applications allow processes to be modified rapidly and to respond to errors and exceptional conditions that disrupt conventional processes [6]. As the stronger needs for mobile advertising which have emerged in recent years, the corresponding service providers must be with high agility to cope with the changes timely. Therefore, the event-driven architectural style is a suitable approach for orchestrating the distributed supporting systems and services. Besides, the

mobile advertising message propagation is the same to the push/pull mechanism of the event-based approach therefore has being considered to be widely applied in mobile advertising services.
However, the value of event-based approaches highly depend on recognizing the significant events on a given business context, and identifying the efficient responses to the events [6]. It is an essence of the event-based approach to recognize the significant events. Furthermore, privacy is also a key issue for advertisers as they attempt to gather more detailed information to deliver tailored, personalized messages [7]. Concerns on issues of privacy have been always discussing around the subjects of mobile advertising. How to recognize the significant events and how to alleviate the tense concerns on privacy of mobile advertising are as important as its increasing value. In the proposed model, all messages are supposed to be published under user's permissions and activations by QR code scanning, since QR code has the ability to bridge the gap between the virtual world and reality[8], connects the online and offline.
This research addresses the practical issues to consolidate and to leverage the benefits of the mobile advertising systems. The aim of this research is to propose a model which enables event-driven service providing and consuming in mobile Internet based on light weight REST (Representational State Transfer) [9] web services. The proposed mobile advertising service model with event-driven architecture provides two significant contributions. The first one is to encourage an event-based approach for provisioning of agile services that can be composed by decouples supporting system from distributed providers on the Internet. The second is that applying Quick Response code scanning triggered by users to alleviate the tense concerns of privacy preservation.
This paper is organized as follows. The second section provides a brief overview of the related works and some background on mobile event-driven architectural style software designing and mobile advertising. Section 3 introduces the new mobile advertising service model by presenting its system architectures and technical stacks. Section 4 presents the examples of the illuminating scenario and discussions. Finally, the remarkable conclusions are presented in Section 5.

II. RELATED WORK

2.1. Event-Driven Architecture

Event-driven architecture (EDA) [10] is regarded as a methodology or a model promoting the practices of compositions of distributed services. The "event" is defined as "a meaningful change in state". It is the change of state that triggers the emerging message and generates an event. From the formal perspective, the change of messages and information are the production, publication, propagation, detection and consumption of the events. From the perspectives of industry, the meaningful changes of states are the relevant business that happened notably and need to be dealt with. An event can trigger the invocation of a service, the initiation of a business process, and/or the publication or syndication of further information [6]. The overall EDA can be viewed as a virtual channel of events logically. In practice, the event channel represents the applied protocols of messaging backbone and formats of transports standard between event generators, event processing engines, and downstream subscribers. The event generations, processing and downstream subscribers are mapping to the tasks of generation, handle and action that regarded as the essential components of event-driven architecture.
Event producers generate the events that draw the concerns of related parties inside or outside the business. The sources might be an application, data base system, we services, business process, sensors, or communication tools. In EDA, only the notable meaningful events can trigger the pre-defined actions. A raised event may be evaluated for notability by a router or filter in its way to the processor according to the pre-defined rules. The generated events could come from the internal and external resources. Only those events that meet the requirements will go into the queue for event processing in the event channel. The basic concept of the event processing system is exhibited on Figure 1 below.

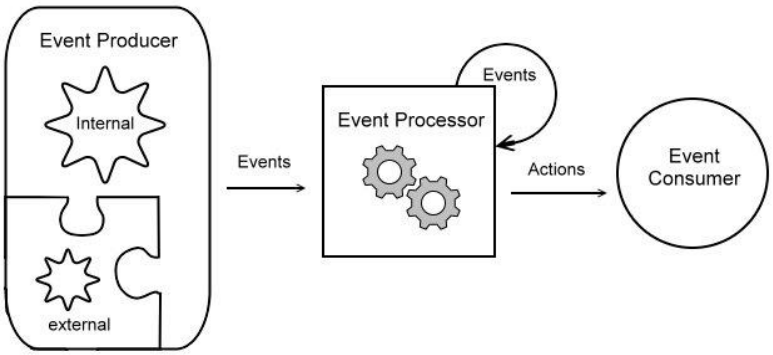

Figure 1. Basic concept of an event processing system

In the event processing, events are evaluated against rules from the business logics to decide whether and which actions are need to be initiated. The event processing rules and actions are defined in accordance to the needs of the interested parties. The actions include invoking a service, initiating a business process, publishing the event out to a subscription hub, directly notifying humans or systems, generating a new event, and/or capturing the event for historical purposes. Events are processed by engines. A simple engine processes each event occurrence independently [11].
Since the event-driven architecture is suitable to deal with asynchronous tasks/information flows, EDA technologies provide a viability for achieving promises enhanced responsiveness and asynchronous communication which is also fit to the developments of mobile advertising system.

2.2. Mobile Advertising

Mobile advertising refers to advertisements sent to and received by mobile devices which people carry with them [12]. Basically, mobile advertising can be divided into two categories; push and pull advertising [13]. The pushed advertising to the users is generally used in mobile advertising [14]. To access the vast amount of information on the mobile phones and the locations of interest to the user in order to provide personalised ads is the key advantage of mobile advertising. Since that, preservation of user privacy is become essential for successful deployment of a mobile advertising service [15].
The five Cs mobile advertising value chain is the significant one among many related reports. 5 Cs are referred as content, cross-media marketing, campaign management, customer database, and carrier cooperation [14]. To sum up the viewpoints of 5Cs model, mobile advertising is to create advertising campaign interaction with advertisers and producing/delivering permission-based advertising messages to the customers via mobile channel. It's notable that the content is considered as a key factor in creating a mobile service that attracts the users.

2.3. RESTful Architectural Style

The term "REST" was proposed by Fielding [9] which represents "Representational State Transfer" and is the principles of software design style for network-based distributed systems. The coordinated set of architectural constraints that are principles of REST that attempts to minimize latency and network communication while at the same time maximizing the independence and scalability of component implementations.
First of these REST principles is that the building blocks of the Web are referred to resources should be identified. A resource, e.g., a file, an image or a script should be named as the format of URI (Universal Resource Identifier) which is defined on the Internet. And then, resources are manipulated via messages based on the HTTP methods. In response to a request for a resource, the client receives a representation of that resource, which may have a different format than the resource owned by the server. The messages are self-descriptive and the state of any client–server interaction is kept in the hypermedia they exchange, i.e., links, or URIs. Any state information is passed between the client and the server in each message, thus keeping them both stateless [16].
As a programming approach, REST is a lightweight alternative to Web Services. A RESTful service can easily be used in the presence of firewalls since REST is platform-independent, language-independent and runs on top of HTTP as standards-based approach. REST has emerged as a

predominant Web service design model. Subsequently, the extended term "RESTful" is to describe the design style building the Web Services that are according to the principles of REST.

2.4. Quick Response Code

QR stands for "Quick Response" as the creator intended the code to allow its contents to be decoded at high speed. QR Code is two-dimensional barcode which is categorized in matrix barcode that can store data information which is introduced in Japan by Denso Corporation in 1994 with the features of large capacity, small printout size and high speed scanning. Nowadays, due to its convenient, QR code has been widely applied to mobile devices equipped with built-in camera. A QR Code can hold a considerably greater volume of information: 7,089 characters for numeric, 4,296 characters for alphanumeric data, 2,953 bytes of binary (8 bits) and 1,817 characters of Japanese Kanji/Kana symbols. QR Code also has the vary capabilities of error correction. Data can be restored even when substantial parts of the code are distorted or damaged. Furthermore, there are some shared code libraries on the Internet saving the efforts of QR code deployments.

III. EVENT-BASED MOBILE ADVERTISING SERVICE MODEL

3.1. Model Overview

One of the principles of event processing is that events are sent to all interested scribers who might need to act on it. In the scenarios of EDA, an event can be the center of the communication and be used to control the components which act autonomous even though those components are fully decoupled. In [17], the author presents an event-based approach for bridging the decoupled functional boundaries. This idea provides the valuable inspiration to this research. The distinct extra enforcements are this research adopts the technology of QR code as the activators and tokens of events to build up an event channel. QR code has been regarded as a bridge between virtual computing and real world can also play the roles of moderating decoupled services effectively.

In Event-Based Mobile Advertising (EBMA) service model, the special interest groups (SIGs) represent the parties which need to response to emergent events for business benefits. The SIG might be a functional department or a business organization which compromises correlated processes with respect to a given event. Basically, the SIGs are also defines the boundaries of data and services reuse domain. Every SIG owns distinct business logics and unshared data but more or less them have built and released some web services on Internet that providing the viability for collaborations with the supporting online services from the other interest parties to complete a given business process. The proposed mobile advertising service model aims to address the problem of how to consolidate the existing decoupled web services among the services cloud. The system overview is presented as Figure 2.

3.2. Benefits of using QR code Technology

In the proposed Mobile Advertising service model, referred as EBMA, information/messages are supposed to be activated by user's QR code scanning in the channel of propagation. Only the activated information/messages have the chance to emerge up as an event. Besides, in EBMA service model, QR code scanning is not only the event launchers but also the communicators to bridge the decoupled supporting services into practice.

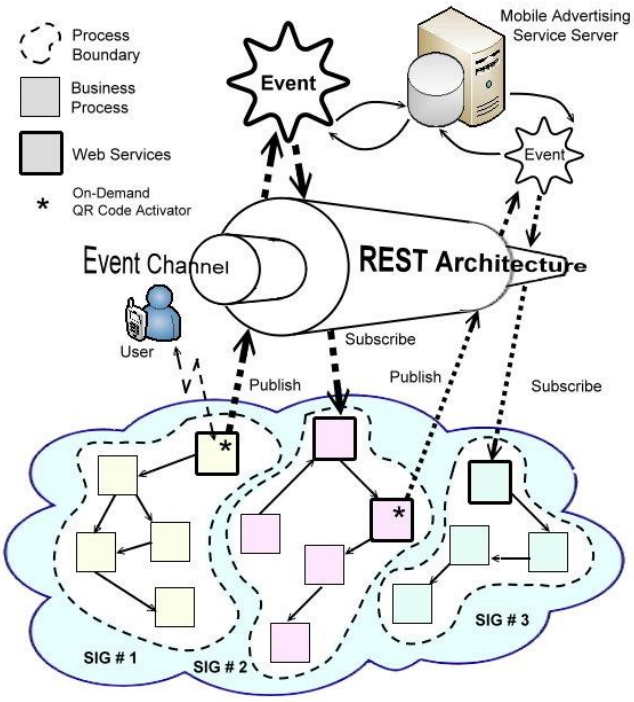

Figure 2. Event-based mobile advertising service model

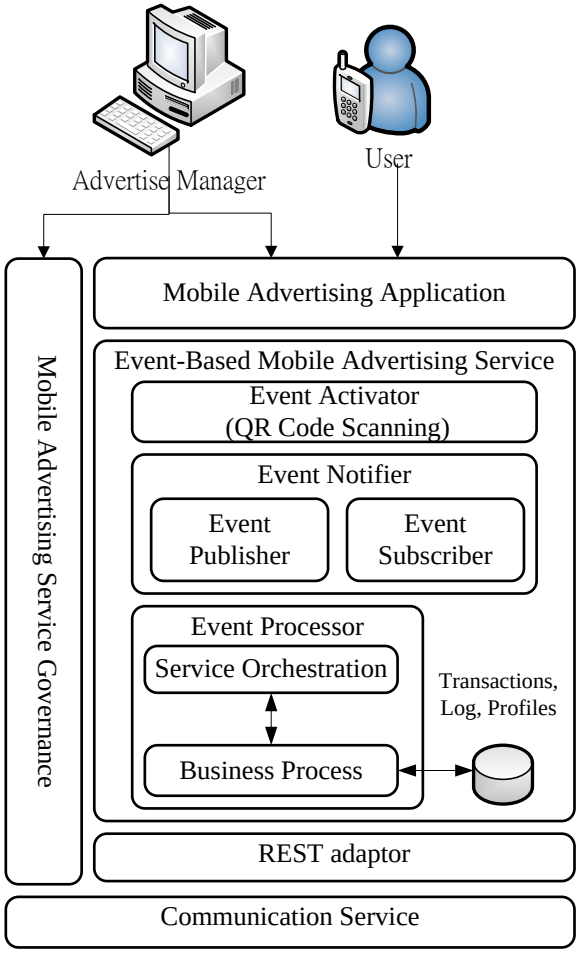

Figure 3. Architectural stacks of mobile advertising service model

Since the scanning of QR codes are supposed to be initialized by users, they always own the chance to decide whether to activate a message publishing or not. The users can choose initialized the mobile advertising services which interested them on their demand. Thus, the scanning of QR codes also act as a filter that a user can recognize the valuable message on themselves and free from the overwhelming annoyed and unexpected message. Nevertheless, EBMA service model can alleviate the tense concerns of users' privacy preservation since the users can decide whether to scan the QR code or not. They can only receive or activate the message which they needed by on-demand QR code scanning without the continuous location invoking and tracking of the user from system.

IV. SCENARIOS OF USING MOBILE ADVERTISING SERVICE MODEL

The value of mobile advertisement is increased by the use of context-aware computing technology as information becomes adaptive and thus more relevant to consumers' needs [18]. This goal is achieved in the proposed mobile advertising service model that merging some context information into location-based QR code encoding.

4.1. Scenario Descriptions

Bob installed EBMA service client software onto his smart phone and register an account with his e-mail. As Bob was going on his business trips, EBMA services provided some handy aids on the way. In the beginning, Bob scanned EBMA QR code when he reached to the airport. Having this EMBA QR code scanning, Bob can take a vacancy from the available rooms with free buffet coupon provided by hotels. And then Bob rent a taxi to the downtown from the associated pop-up selection boxes which are presented based on the prior process and QR code scanning.
On the way to the downtown, Bob scanned another EBMA QR code on the taxi. EBMA service model lists the featured stores, cafeterias, restaurants also with special discounts associated to the prior QR code scanning. Bob keeps those coupons on his EBMA service app on smart phone and start to his visiting to customers. All the correlated services and special discounts are presented because Bob has booked a room through EBMA QR code.

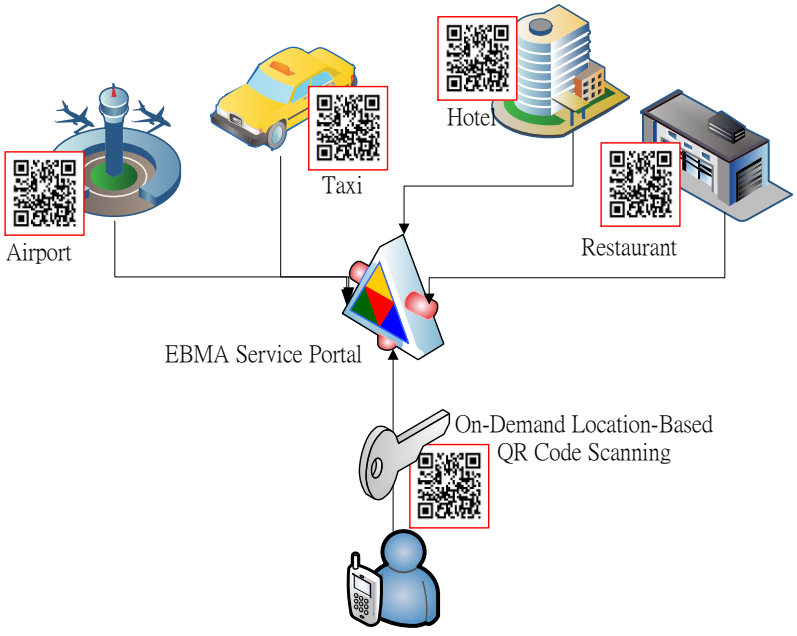

Figure 4. User's view of EBMA service model

When business visits are completed, Bob returned to hotel and scanned another EBMA QR code in the lobby of hotel. EBMA service was initialized and published another event message with respect to Bob's scanning. EBMA service responds with a list of products that may be of interest to Bob on the neighbourhood around the hotel. Bob went around some shops casually. EBMA lists products that are

currently on sale when he scanned the attached QR code in front of the shopping windows. Thus, Bob is spared from having to browse through the shop.

In general, a mobile advertising usually fuse the location information as location-based or personalized advertising. The location information and some essential contextual data, such as: time stamps, associated processes, transaction logs, are able to blend into the QR code and provide context-aware mobile advertising services in EBMA service model. Figure 4 exhibits this scenario with event processing of using EBMA service model. Figure 4 presents the scenarios from user's view. In user's view, the EMBA services provide services among varying businesses. Users can pick required services by scanning the corresponding QR codes. The EBMA service model can provide location-based serveries (LBS) without tracking location of users via global position system. The required location information is blended into the corresponding QR codes for LBS. This approach can achieve location-aware with the least degree of worry about privacy preservation.

4.2. EBMA RESTful URIs and Http Methods

The URI of EBMA represents a resource returned when a response is invoked. The response returned to the end-user represents a snapshot of the state of the requested resource. Four basic HTTP methods that can be applied to a URI: GET, POST, PUT, and DELETE represent the methods/actions that can be invoked for each URI. Briefly speaking, if services want to create a new resource, use POST. Use GET while services want to retrieve a representation of a resource. To update a current resource, use PUT method. Finally, to delete a resource, use DELETE method. The actions of HTTP methods are shown as Table 1.

Table 1. Http method actions

HTTP Method	CRUD Action	Description
POST	Create	Create a new resource
GET	Retrieve	Retrieve a representation of a resource
PUT	Update	Update a resource
DELETE	Delete	Delete a resource

Table 2. Http status codes

Code	Status
200	OK
201	Created
204	No Content
301	Moved Permanently
400	Bad Request
404	Not Found
410	Gone

The first step to build a RESTful web service is to defined resources. The root is the starting point to invoke the proposed event-based mobile advertising (EBMA) portal service REST API. Among the various HTTP status codes to be returned, the following will be used for the EBMA portal RESTful URIs. The following are the EBMA portal RESTful URIs as resources. All URI schemes specified are relative URIs relative to the service root URI. The EBMA RESTful resource hierarchy is presented as Figure 5.

Once the URIs have been defined, the next step is to decide representations with respect to the corresponding response of HTTP method. You need to enumerate the typical HTTP status codes that could be returned. In a perfect situation, this step wouldn't be necessary since a good implementation would handle every status code correctly. In practice, you should list all the status codes that are expected to return for test on varying conditions which are shown as Table 2. The HTTP methods of EBMA service model with corresponding status and representations are list on Table 3 and Table 4.

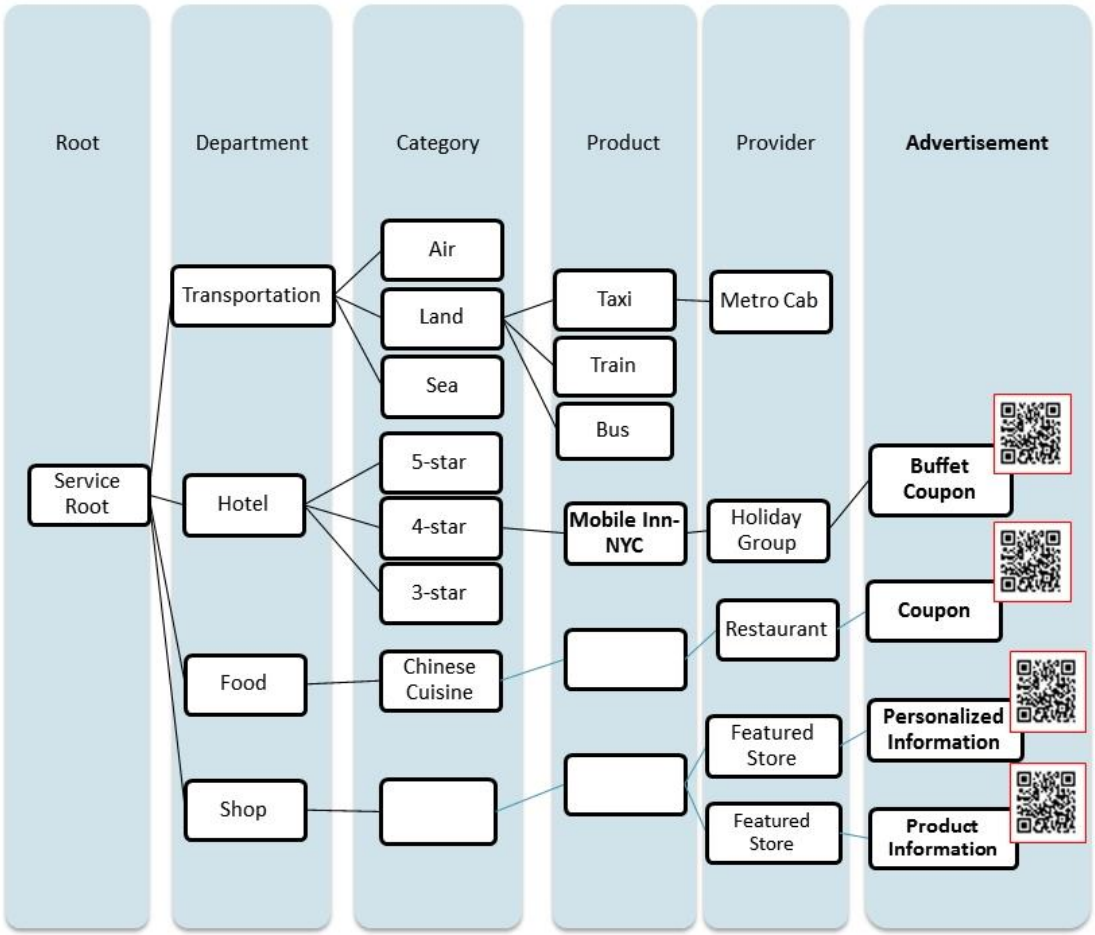

Figure 5. EBMA RESTful resource hierarchy

Table 3. RESTful services of EBMA model (partial)

Resource	URI	Method	Representation	Status Codes	Description
Provider	/*category_id* /*provider_id*	GET	Provider	200, 301, 410	Get provider
		POST	N/A	404	N/A
		PUT	Provider	200, 204	Update provider
		DELETE	None	200, 301, 400, 410	Delete provider
All products	/*category_id*/*provider_id*/products	GET	Products List	200, 301	Get the list of all products
		POST	None	201, 400	Create a product
		PUT, DELETE	N/A	404	N/A
Product	URI: /*category_id* /*provider_id*/*product_id*/	GET	Product	200, 301, 410	Get specific product
		POST	Products	201, 400	Create a product
		PUT	Product	200, 204	Update product
		DELETE	None	200, 301, 400, 410	Delete provider
Order	URI: /*category_id* /*provider_id*/*product_id*/*order_id*	GET	Order	200, 301, 410	Get specific order
		POST	Order	201, 400	Place an order
		PUT	Order	200, 204	Update an order
		DELETE	None	200, 204	Delete provider

Table 4. RESTful search service of EBMA model (partial)

Resource	URI	Method	Representation	Status Codes	Description
Product List	/search/product/ item?***product_attribute***= XXX	GET	Product List	200, 301, 410	Get a specified list of product
		POST, PUT, DELETE	N/A	404	N/A

4.3. An Example of EBMA Service Model

This section illustrates an example of EMBA service model according to the aforementioned scenario. In the beginning, Figure 6 Illustrates the aforementioned example to more detailed technologically by parsing and explaining the message flows of EBMA service model.

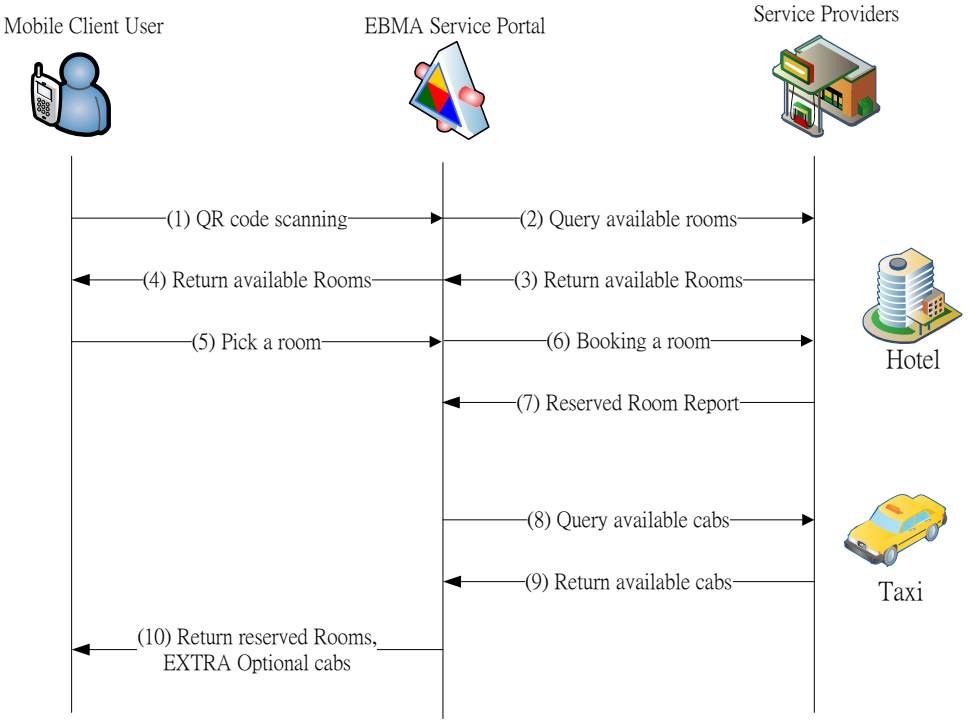

Figure 6. Message flows of EBMA service model

For concise expressions, the messages are expressed in the format as below:

(Node 1, Node 2): → Text 1, ← Tex2, ….

(Node 1, Node 2) in paired are the communicating nodes, symbol → and ← represent the direction of message flow, Tex1 and Text 2 are contents of messages.

Below are the messages that to be sent between mobile client users, EBMA service portal and product/service providers in example. The message flows are: The message #1 launch an event by QR codes scanning. And then, the following messages complete a simple services composition which is divided into 3 parts for explanations and shown as Figure 7.

Stage A:

Flow #1 as: (Client, EBMA): → Query a room in airport

Flow #2, #3 as: (EBMA, Hotel): → Query available rooms, ← 25 rooms available

Flow #4, #5 as: (EBMA, Client): ←25 rooms available, →Pick a room

Stage B:

Flow #6, #7 as: (EBMA, Cabs): → place an order, ← Order completed

Stage C:

Flow #8, #9 as: (EBMA, Cabs): → Query free cabs on airport, ← 3 cab available

Flow #10 as: (EBMA, Client): → 3 available Cabs

The contents of RESTful processing are shown as below.

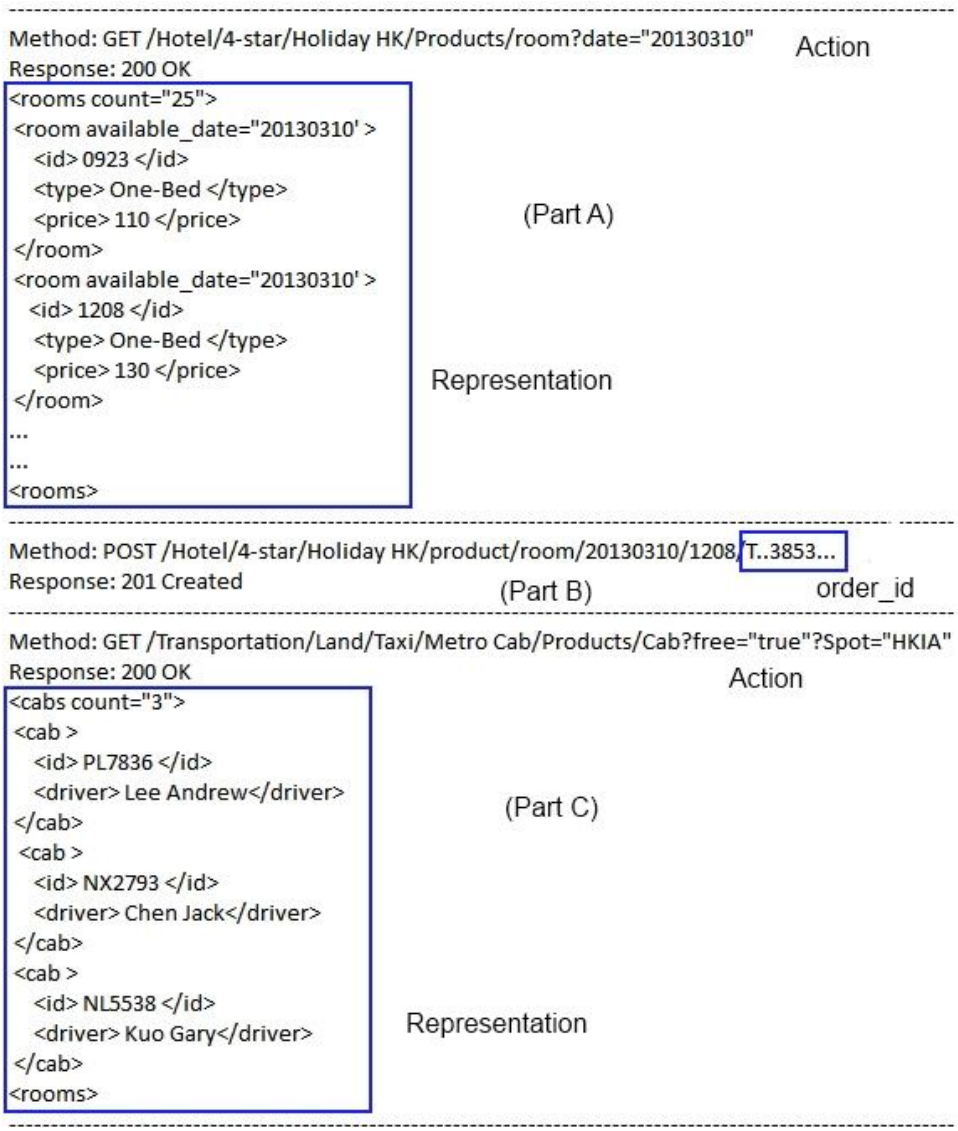

Figure 7. Service results of EBMA model

4. 4. Limitations and Discussions

The proposed EMBA service model may encounter two major problems in practice. The first issue is about security. REST architectural style does not have predefined security methods. RESTful services work on top of HTTP and rely on security add-ons based upon HTTP such as HTTPS. It is notable that the main driver for creating REST is simplicity. Since that, it is reasonable that REST does not defined security methods, developers have to work for their own. Often, developers in a hurry to just

get their services deployed without treating issues of security as the same level of diligence as their projects. Consequently, lead to web services with serious vulnerabilities. Nevertheless, security is definitely an issue should be built up for your RESTful services though the memory and processing power of mobile devices are extremely limited. The compact and efficient frameworks to secure the m-commerce are still a developing topic. For example, [19] proposed a SMS-based secure framework provides a viable approach for REST services. The new SMS-based secure scheme with suitable encryption/decryption algorithms is suit to RESTful service architects that worth further efforts.
The second issue is about complexity of business integrating. Implementing transactions with CRUD messages requires exchanging many HTTP messages, which can get complex quickly [16]. Current framework is not mature enough to commit/roll back the transactions to all or none. However, transactions are required essentially in enterprise business. To build up a more complicated model to compromise the handling of transactions is worthy to endeavour in. Besides, to enable the composition of RESTful web services and traditional web services is also an attractive topic for both research and practice [20].

V. CONCLUSIONS

A new services model for mobile advertising with technologies of QR code and event-driven architecture is proposed to consolidate the existing distributed decoupled supporting service into practice. From the customer's view, mobile advertising with unsolicited push message may produce overwhelming garbage messages and make users feel annoyed. EBMA service model solves this problem by means of on-demand QR code scanning. Addition to that, on-demand QR code scanning also provides leverage to recognize the value of single mobile advertising service. In conclude, EBMA model providing an effective approach to achieve a context-aware and personalized advertising which are two of the most valuable characteristics of mobile advertising.
On the other hand, from the industrial's view, it is easy and inexpensive to deploy a QR code project. Therefor the center concerns for building an event-based mobile advertising service architecture consolidating existing decoupled services should focus on the specifications of event channel. This problem is more practical than theoretical instead. Some services should be registered into the EBMA server in advance. Besides, a standard and well-defined format for propagations in the event channel should be discussed and defined. A well-defined and efficient event channel can produce huge benefits to the collaborated parties on the mobile service cloud. This field of research is valuable and still open to researches.

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