Towards Flexible Mobile Payment via Mediator-based Service Model

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ABSTRACT

Applications and digital goods for mobile devices have been around for more than a decade. Recent technology development has also driven the use of mobile commerce technology. Mobile commerce is another form of payment but it has the ability to embrace new ideas concerning digital money as mobile device have grown to become an essential personal needs. A range of businesses have already been thinking along these lines and tried to gear their ideas towards using the mobile phone as a payment device with the aim of making life simpler for consumer. Some applications are already driving the use of mobile phone as payment device with the purchase of digital goods such as ring-tones and games but this is just the beginning, as long as the technologies can iron out their differences and formulate a more cohesive technology platform. This paper suggests a mobile web services concept framework solution which allows mobile payment with flexible payment options for mobile consumers.

Categories and Subject Descriptors

C.2.4 [**Distributed Systems**]

General Terms

Design

Keywords

Mobility, web services, mobile payment, middleware, agents

1. INTRODUCTION

Digital goods such as ringtones and mobile games normally go through media such as websites, newspapers and TV advertisements to promote their sales. For instance, ring-tone providers will have to publish their advertisements in local new papers and television channels to attract mobile subscribers to

download their ring-tone content such as polyphonic tunes and true tunes.

Typically, the content will be delivered to mobile subscriber using premium SMS charging method where subscribers will be charge a premium rate for the content received through SMS. By implementing revenue sharing model, content or service provider will share the revenue with mobile operators. Hence, , revenue collection is a difficult task as it needs to go through various reconciliation processes with the mobile operators. Furthermore, this revenue sharing model has caused a large chunk of the revenue to be ripped by mobile operators. As a result, a large portion of the revenue is distributed between mobile operators and media advertisers, causing service providers to gain a trivial profit out of the value chain.

With these problems, we propose a Mediator-based Payment Service (MPS) model to allow flexible payment mechanisms for mobile consumers and service providers by keeping service providers from solely relying on mobile operators to implement their service or sell their content to mobile consumers. Whilst mobile consumers will have alternative payment options through our proposed payment service model.

This paper is organized as follow. We give a brief description on related work in next section. In section 3, we explain the model framework and the logical components of our proposed Mediated-based Payment Service model. In section 4, we present the system implementation of the proposed model. Section 5 explains the analysis and discussion of our work and finding. We conclude this paper in section 6.

2. RELATED WORK

A number of works to improve the current service level of transaction and service delivery platforms have been proposed. However, most of their focus is either on transaction platform or service delivery platform but not both.

[13] proposed a M-Payment architecture which links up operator, service providers and banking institution. The architecture generally allows mobile consumers to purchase content/services using SMS, WAP or Web through mobile device. This solution has introduced the alternative payment concept but does not provide sufficient study on the service delivery. For instance, the usage of web services as mean of

communication between the architecture and service provider is not included in this study.

Chang, Chen and Tseng [15] proposed a Mobile Commerce Framework based on web services architecture that adopts the concepts of *publish*, *find* and *bind* operation. The study focuses mainly on the use of web services in different stages of mobile commerce operation. *Publish* operation allows content and service providers to publish their contents and services while *find* operation allows mobile consumers to locate the required service or content. *Bind* operation binds both the parties together to complete the retail cycle of mobile commerce. This study provides architecture on content and service matching but does not consider the interaction between financial institute and service providers.

McKitterick [14] proposed a web service based mobile payment framework. The framework consists of a web service flow between device client and payment server. However, the author did not emphasize on the communication between content or service provider with mobile consumer.

Our solution proposes a mediator-based payment service (MPS) model which considers mobile commerce services from mobile consumer, merchant and mobile operators perspectives to provide a more comprehensive web service based mobile commerce framework for the above-mentioned parties.

3. MPS MODEL FRAMEWORK
The proposed MPS model is a 3-tier model, which involves system components such as Payment Service Gateway server (PSG), Client application, Payment Service Providers server (PSP) and 3rd party content/service provider server (CP). The implementation of a multi-tier model allows better scalability and security control for the payment service platform. One of the advantages of multi-tier platform is its flexibility in deploying new functional features by introducing a new tier-ring into the existing structure. Figure 1 presents the framework of the proposed Mediator-based Payment Service (MPS) model.

3.1 Payment Service Gateway Server (PSG)
The Payment Service Gateway server (PSG) provides the business logic and interfaces to remote systems, i.e. Payment Service Providers server (PSP) and Content/Service Providers server (CP).

The PSG connects mobile consumers to multiple types of services without the constraint of mobile operator's limitation. The PSG server acts as mobile web services "payment facilitator" that provides the mechanisms for managing order request (can be either sent by mobile consumer or content/service provider), payment authentication processes and consumer profiles/sessions. It performs the authentication of transaction parties and the authorization of the payment settlement. The results of authentication and consumer profiles/session verification are then sent back to the CP. For an authorized mobile consumer, the request content/service URL (Uniform Resource Locater) is sent to the consumer through HTTP (Hyper Text Transfer Protocol) connection.
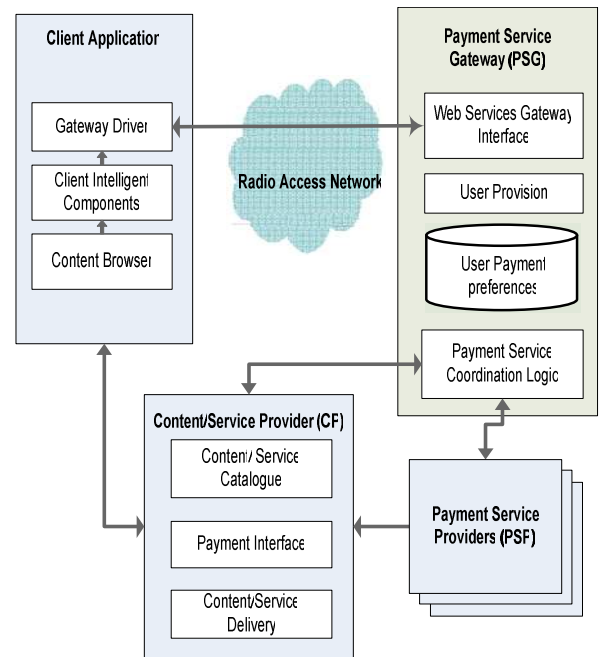

Figure 1. Payment Service Agency Architecture

When a mobile consumer makes an order request, the PSG will authenticate and verify consumer profiles such as preferred payment mode and payment details. A mobile consumer will need to register with PSG which offers federated Identity service capabilities in order to avoid repetition of keying payment details into the mobile device, such as credit card details. Federated Identity management capability allows consumers to use the same consumer name, password or other personal identification to sign on to the networks of more than one platform in order to conduct payment transactions. This will allow companies to share applications without needing to adopt the same technologies for directory services, security and authentication.

User provisioning capability is provided to enable system consumers to be granted access to the system and for day to day monitoring and management to be performed. This is provided in the form of an administration portal.

3.2 Client Component
The client application resides on the mobile device and communicates to the servers using web services invocation method [24]. The client browser component enables XML (Extensible Markup Language) compliant format message to be delivered to the client. The handling of all XML messages is done by using generic XML parsing method [16]. However, the client in this system is designed to handle two types of XML messages, generic web service and proprietary Really Simple Syndication (RSS) [17] document which is updated by content providers.

When the mobile consumer chooses a particular service offered by a specific content/service provider, the URL (Uniform Resource Locator) of the RSS document is sent to the mobile client. Given ringtone service as an example, the list of ringtone offered by a particular content/service provider is sent to the mobile client in RSS document format. The RSS parsing engine in client will parse the RSS Document.

This RSS document contains proprietary fields which are needed for multiple format content aggregation. The RSS format displays text-based content aggregation, which can be supported by most of the device clients. The RSS document contains information such as provider information and the service/content details. An example of the RSS document is shown as follow.

```
<?xml version="1.0" encoding="ISO-8859-
1"?>
<rss version="2.0">
<merchant>
<provider>
     <name> World News </name>
     <id>10002</id>
     <rsscat>
          International News
     </rsscat>
     <rsscatid>20008</rsscatid>
     <lastupdated>
     Tue, 28 Jun 2005 17:11:30 GMT
     </lastupdated>
</provider>
<item>
     <name>
     U.S Chopper Down in Afghanistan
     </name>
     <itemid>30024</itemid>
     <type> Digital </type>
     <desc> U.S Army today announced
     that one of its chopper has been
     shot down by Afghanistan rebellion
     troops. </desc>
     <currency> USD </currency>
     <price>0.03</price>
     <pubdate>
     Thu, 23 Jun 2005 08:21:00 GMT
     </pubdate>
</item>
</provider>
</merchant>
```

Figure 2. Example of RSS Document

The client intelligent component provides the core business logic such as providing the presentation of the GUI to the mobile consumer, handling consumer's request and corresponding server response such as PSG or CP. If the consumer opts to purchase any content or service, the request will be sent to CP and the payment process will be handled at the PSG which communicates with the PSP.

3.3 Communications Between PSG and Client

In order to allow PSG to monitor transactions closely as to ensure the payment transactions are delivered securely, we proposed multi-staging approach which multiple agents are placed in respective stage to perform specific functions. In this approach, agents are placed in mobile client (device stage) and PSG (transactions stage). The agents are responsible to feedback the device client information from device stage to transaction for further processing. This information includes CPU (Central Processing Unit) speed, execution memory, storage space and Java Virtual Machine (JVM) version information.
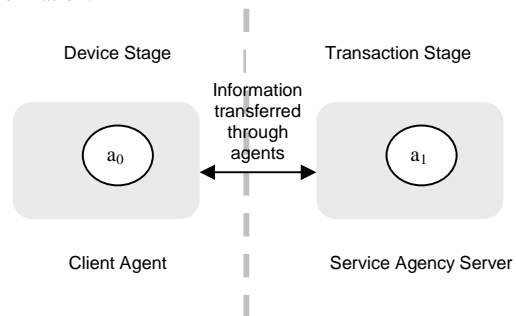

Figure 3. Multi-staging Process for Transactions Monitoring

Figure 3 presents the multi-staging approach process. After receiving feedback information such as network bandwidth, speed, device compatibility and security from agent, a_0, in device stage, transaction stage will plan for necessary actions and transfer the information, through agent a_1, for further executions. The problems encountered during the execution of the transaction will be tracked within the stage itself.

With multiple agents in different stages, the system will have better control on transaction delivery assurance as problems can be identified in local environment. There are two mechanisms we applied for the client agents to handle the transaction problems that might be encountered, namely time-out handling and information caching.

3.3.1 Time-Out Handling
Time-out technique mainly handles the network issues which might arise due to unstable mobile network conditions. Timeout technique deals with uncertain situations where systems cannot communicate with each other due to failures. We incorporate the time-out technique to deal with system or network failure. In this technique, a variable time-out value is set by mutual agreement of the respective agents before the execution of a transaction. The PSG will be responsible to negotiate with the transaction operations to reach the agreement.

After the expiry of the timeout interval, transaction operations are free to perform the necessary actions such as rollback, compensation or replacement. In such case, if the mobile data network is extremely slow, the agents in device stage will inform

the transaction stage server to extend the time-out period for the transaction. This will avoid unwanted time-out operations where consumer will need to repeat their transaction process again.

3.3.2 Information Caching

The purpose of applying caching mechanism is to reduce the rate of broken and roll-back transaction by optimizing and breaking up large data chunks into smaller pieces to be transferred over mobile environment. Caching mechanism also cache necessary information needed for the transaction in the case of network unavailability. This technique will reduce the rate of broken transaction and hence enable mobile network to increase their data network efficiency. When the transaction is disconnected in the middle of delivering transaction, the caching system will store the required information to be transacted accordingly.

The caching system also estimates the battery life and decide on the total amount of information needs to be cached for secured and assured transactions. For instance, if the agent in device stage detected that the transaction file size is huge and the battery life is short, caching techniques will be applied to slice the file size and sent to the transaction server part by part. If the transaction is halted due to battery life, the consumer will only need to re-perform the transaction by sending the remaining data to the transaction server.

3.4 Payment Service Provider Server (PSP)

The Payment Service Provider server (PSP) is responsible for the payment charging and transaction controls. The PSP controls the payment charging between the mobile consumer and the content/service provider. A PSP could be a network operator, a financial institution, a credit card company or an independent payment vendor.

The PSG interacts with the PSP through its web service or API (Application Program Interface). The PSG will interface with different payment providers such as banking direct debit system, credit card payment system as well as online payment provider such as Paypal [18]. The API of each provider will be interpreted by PSG and be exposed as a single API to content/service provider as payment collection option. For instance, a mobile consumer who downloads content from a particular provider can opt for any of the payment method describe as above. This eliminates the limitation of making mobile payment using single payment option such as premium SMS.

The PSP is connected directly to PSG through its coordination logic interface for charging and billing purposes. Once the mobile consumer is authenticated, the charging flow will go through the PSP component to perform real-time online payment. In this case, the PSP is connected to PSG that implements federated identity management functions to manage authentication of consumer. The PSP is also connected to CP to distribute the payment to content/service providers. Upon completing a payment transaction, the payment will be debited to content/service provider account on a real-time basis.

3.5 Content/Service Provider Server (CP)

The Content/Service Provider server (CP) contains the digital content or services requested by the mobile consumer. The roles of CP involve forwarding order requests to the PSG, relaying authorization requests back to the consumer and delivery of the content/service. There are 3 key elements in the components namely content catalogue generator, content delivery mechanism and payment interface.

Content catalogue generator plays a role in generating the catalogue of various contents provided by the provider themselves. The generator sits in content provider's server and generates content catalogue in RSS document format periodically. The RSS document will be parsed by mobile device client software which reorganizes the data and represents them in device compatible format.

Content delivery mechanism functions to deliver the service/content upon the completion of the payment transaction. CP's payment interface allows PSG to acquire pricing information from the server for specific content/services. The pricing information will be used to calculate the amount charged to mobile consumer for purchasing the specific content or services.

4. IMPLEMENTATION

We implemented a simple prototype to evaluate the concept of our proposed mediated-based payment model framework. The process flow of the model framework is presented in Figure 4.

The PSG is developed using JBoss 4.0 application server components that exposes a range of mobile web services to the device based client. The PSG functional components are developed according to the standard use in Apache [19] Axis [20] web service engine along with a security domain to enable authentication of consumer requests.

The web services architecture communications are based on SOAP 1.1 [21], the field definitions of RSS documents are proprietary at this stage for the purpose of aligning and feeding them into standards where appropriate. We adopt basic authentication approaches for web services security such as WS-Security [22] and SSL [28] encryption of the server.

The client application component is developed as a J2ME MIDlet application that offers the GUI interfaces, client business logic and the ability to support secure dialogues with the server. The PSG components provide web service connectivity to the outside world and are implemented using KSOAP-2 [23] that provides SOAP 1.1 and authentication capabilities.

The PSG supports heterogeneous devices ranging from PDA, mobile phones, PCs or set top box. The consumer can first log in into the PSG using single-sign-on mechanism allowing him/her to be authenticated throughout the whole process without the need of multiple identity verifications. Following that, the consumer will request service from the service provider list downloaded through web service invocation method [24].

For PSP, we have chosen PayPal[TM] as the payment provider in this prototype. Any other payment providers such as PLUS [25], Visa [26] or MasterCard [27] can be added into the payment

provider list by service agency operator. As for service providers, we have chosen news content and music content service provider as sample service providers in this prototype.
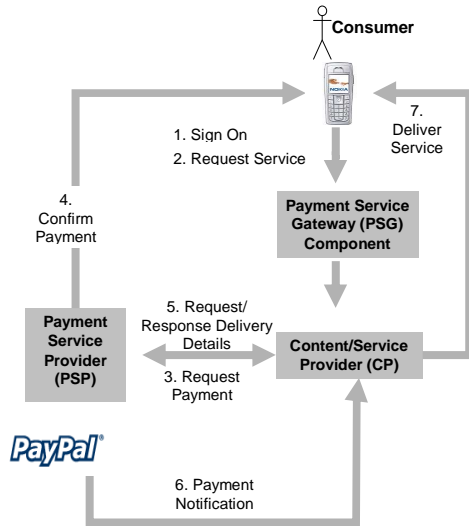

Figure 4. Prototype Service Process Flow

The screenshots in appendices show the content displayed and user interfaces of our implementation work on the device client written using J2ME program.

5. DISCUSSION

Our proposed framework is generic, highly scalable and modular. With our proposed model, the Payment Service Provider server (PSP) can be connected to any payment operator ranging from financial institutes to payment vendor such as PayPal^{TM}. The use of web services architecture and RSS technology in providing updated provider catalogues greatly reduce the overheads of data transfer as compared to normal WAP or web pages. The use of RSS technology also eases devices in formatting the data according to different device display capabilities.

From the perspective of payment, content providers are able to collect the payment almost instantly as opposed to the current premium SMS billing scenario. Micro payment is still preferred over macro payment currently as mobile operator is not willing to bear the risk of payment debts. As our system is flexibility enough to distribute the risk to payment operator, it will spur up more macro payment activities among mobile consumers.

6. CONCLUSION

We have proposed a framework for mobile payment based on mediated-based payment service model. A prototype has been implemented to visualize and proof the concept of the model framework. Mobile payment based on the proposed model provides flexible payment methods in offering mobile content or services to consumers. Web services architecture play an important role in designing the framework. As the proposed model enables multiple services to interact with each others using web services, the presented framework is designed in such

a way that web services are used as the core communication protocol. Since mobile consumers have time and device constraints in wireless environment, the use of web services is crucial in delivering dynamic information. such as news and information catalogue menus.

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8. APPENDICES

Figure 5: User selects RSS Catalogue

Figure 6: List of content provider is returned to user's mobile device through web service protocol communications.

Figure 7: User selects content provider "World News" and list of news content is returned to user in RSS format.

Figure 8: User selects "World News" (from Figure 5). The summarized content and pricing information is displayed on user mobile device.