# Research on Mobile E-commerce Information Search Approach Based on Mashup Technology

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**Abstract**

Mobile e-commerce information search will become popular with the mobile devices being widely used. Thus, how to provide content-rich and precise commerce information to mobile end-users becomes a challenge. The rise of mashup technology provides a promising solution for this challenge. In this paper the platform architecture of mobile e-commerce information search based on mashup technology is presented, and then the main components are described and discussed to illustrate how the platform facilitates mobile e-commerce information search. In section 4 a new approach of web search results processing adapted to mobile devices is proposed. An experiment is carried out to show the flow of web search results processing based on the presented approach. Mobile operators and internet operators can realize mutual benefits with the presented approach.

**Keywords:** Mashup, Mobile E-commerce, Mobile networks

## 1. Introduction

Mobile e-commerce allows customers to shop online at any time in any location. Consumers can browse or order products while using a cheap and secure payment method. Additionally, retailers will also be able to track customers at all times and notify them of discounts at local stores that the customer would be interested in.One report studied by Ministry of industry and Information Technology of the People's Republic of China showed that there are around 700-million mobile phone consumers in China. Mobile e-commerce is an emerging promising application in China with the mobile devices being widely used now.

Compared with PC-based web commerce information search, mobile e-commerce information search has its own characteristics in a number of ways: (1) the user interface and I/O are limited by small screen and tiny key pads, (2) mobile end-users prefer precise commerce information to tremendous returned search results, (3) limited bandwidth and costly connection time, (4) mobile contents and services are limited by the mobile operators' capability, by its concise nature, offers little content. So far, how to put web search results driven by users' initial queries, Internet data sources and Mobile Network's special sources together is crucial. In addition, how to provide commerce information that customers are interested in is another important issue.

The rise of mashup technology provides a promising solution for these problems. A mashup is a web page or an application that combines data or functionality from two or more external sources to create a new service. By combining data or services from Internet and Mobile Networks' capabilities, mobile end-users can enjoy a perfect commerce information search experience. As the "walled-garden" of content has been available, Mobile operators can encapsulate their business capability such as user information, SMS, MMS, and WAP et al to mashup services. Developing integrated services on the telecom has some natural advantages, such as operating and supporting capabilities, mobility of the terminal devices, user location information, and user online status

information etc. Muhammad Raza, and Farookh khadeer Hussain et al pointed out different mashup application methods in different domains and proposed a methodology for quality-based mashup of data source.To take advantage of Mobile Networks' special capability and Internet data sources to integrate web search results is real and feasible.

In this paper, we use the new technology mashup to provide content-rich and precise mobile e-commerce information to mobile end-users. The subsequent sections in this paper are organized as follows. In section 2, we present a description of related works about mashup and mobile e-commerce information search. In section 3, platform macro architecture of mobile e-commerce information search is proposed, and then three main components of the architecture are described and discussed in detail. In section 4, an approach of web search results processing adapted to mobile devices are discussed, and then an experiment was carried out to show the processing based on the presented approach.

## 2. Related Works

The research area we have identified above is most relevant to the research domain of mobile search. Mobile e-commerce stems from mobile search, and its development has much relevance to mobile search. With the development of advanced 3G networks and the wide usage of mobile devices, mobile search has come to researchers' attention. Feng Gui et al presented the personalization strategies which explicitly infer user search context from user current environment by analyzing the personalized search algorithms of PC-based web search. Karen Church and Barry Smyth provided an effective mobile search service by using content enrichment. A heuristic content enrichment framework that uses standard Web resources as a source of additional indexing knowledge was proposed. At the present time, the research on mobile search has mainly focused on mobile search technologies, mobile search business modes, and content enrichment etc. Especially, the research on content enrichment is a crucial issue. Lack of contents of Mobile Networks can't meet the mobile end-users' demand.

Mashup was a promising technology for the generation of lightweight service composition. Many existing technology can be used for assembling mashup application. Such technologies include XML which is used for data retrieving, web services such as simple object access protocol (SOAP), and web services description language (WSDL) for delivering data to the client. So far, the mashup technology mainly includes data resource acquiring technology, presentation component technology, server technology and merging technology. Screen scraping, Web Feed, REST AJAX, CSS, xHTML and Document Object Model (DOM) API etc technologies are also applicated for mashup application. AJAX technologies are applied in Google Maps API currently. In addition, ontology technology and semantic technology can be used in Mashup development and create a powerful user experience.

In the near future, mashup will become the primary technology to connect the Internet data sources and the data sources from Mobile Networks. It can enrich the contents of Mobile Networks and provide personalized commerce information based on mobile end-users' preference. In the domain of Mobile Networks, more and more research starts to focus on mobile applications based on mashup technology. School of Electronic Engineering in Beijing University of Posts and Telecommunications has done much research in this domain. Stuttgart University in Germany cooperated with Nokia and presented the Telar Mashup platform.University of Deusto in Spain made use of AJAX technology to achieve Mashup application in the mobile terminals. Ke Xu, and Xiaoqi Zhang et al presented the architecture of mobile Mashup platform based on SOA design principle. Additionally, this study shows the challenges and suggestions of mobile mashup.

## 3. Mobile e-commerce Information Search Platform Based on Mashup

In this section, we present the architecture of mobile e-commerce information search platform firstly. Then the functions of main components are detailed and how the platform facilitates mobile e-commerce information search is also discussed.

### *3.1 Platform Macro Architecture*

Figure 1 shows the macro architecture of mobile e-commerce information search platform based on mashup. This architecture contains three layers: presentation layer, logic layer and data source layer. The objective of this architecture is to provide content-rich and precise commerce information to mobile end-users.

- Presentation layer is the interface between the mobile e-commerce information search engine based on mashup and mobile end-users. This layer deals with issues of mobile search interface design and query results presentation on mobile devices. Mobile end-users can access to mobile networks through SMS, WAP, and IVR etc, they submit commerce request queries to mobile search engine. For the user interface and I/O are limited by

small screen, tiny key pads and limited bandwidth, so the query results presentation should adapt to show on mobile terminal devices.

- Logic layer is where the mashup execution of data and services from both Internet and Mobile Networks. Besides, the query request pre-processing and display process of web search results after aggregation are also executed in this layer. It is the most import layer of this architecture. Mashup manager provides effective services management and convenient service operation to mobile end-users. Mashup manager is responsible for a series of control strategies. With the contents or services from Internet and Mobile Networks, the mashup manager should select effective contents or services and query results to aggregate an effective result that the customer are interested in. The mashup manager selects the effective contents with user information, status information and interaction history etc from Mobile Networks.

- Data Source Layer provides contents or services to be mashed-up, or the web search results which adapted to customers' given situations. These contents or services are both from Internet or Mobile Networks. Web search results are the query results on Internet sources by users' initial query requests. They will processed by mashup manager with combing external sources. The user information from Mobile Networks can be divided into two parts: private user information and non-private user information. The mashup manager can only access part of them. Private information access should be permitted by users. Status information is the sources like user location, activities, user preferences and interaction history.

*3.2 Function Description of Main Components*

In this part, three main components of this architecture are described.

3.2.1 Mashup manager

The mashup manager is responsible for integrating of web search results and users' context with external information, and provides content-rich and precise commerce information search results to mobile end-users. The framework of mashup manager can be illustrated in Figure 2.

This component can be divided into two parts. One is mashup operation and management module, and the other one is mashup creation and execution environment module. To provide a high-quality service to mobile end-users, mashup operation and management is necessary. For example, due to the un-reliable sources from Internet, security management is need. Issues such as charging mode, registration and identification can be used for guarantying the services' quality. By the natural advantages of Mobile Networks such as operating and supporting capabilities, high security and identification etc, mashup operation and management will become easy. Additionally, mashup creation and execution is responsible for mashing-up service logic and invoking external resources based on user preference. It can create innovative search services adapted to changing needs and environments. As mobile end-users change activities, the mashup manager should select proper data or services to integrate. For example, if the user changed his or her location, the mashup manager can select different location information to integrate. This platform must be user's context awareness.

Data source for combination includes web search results, Internet APIs, Mobile Networks' special information such as user location, user status information, and user account etc. With the openness of mashup creation and operation, the security issue is crucial, so how to protect the users' information will come to mobile operator's attention.

From the technical perspective, this component can be illustrated in Figure 3.

APIs loading, rss, atom, and screen scraping are the technologies for data sources acquiring. Compared with PC-based Internet data sources acquiring, mobile contents acquiring needs which access to Mobile Networks. So APIs loading also includes APIs for which mobile SP provides. Based on the data transmission protocols such as SOAP, WSDL, REST etc, the integration platform can get the data sources conveniently. Then it can create innovative service with data integration platform.

3.2.2 Query Request Pre-processing

Mobile end-users submit their queries with mobile devices. Due to the limitations mentioned in the introduction, most mobile e-commerce information search queries are short and concise. In addition, most queries are submitted in nature language. Hence, query request pre-processing is necessary.

So far, a lot of technologies such as ontology, agent, and semantic process can be used to solve this problem. One approach called Query Expansion is a good method. Expanded query contains extra information which could facilitate web search engines and improve the topic relevance of returned result documents. Identifying the ambiguous queries and expanding these queries with user context is a crucial step. This component has much

relevance with the results veracity. Figure 4 illustrates the flow for pre-processing of mobile end-user's query request.

Here, take a scenario to describe this function. A mobile user typed "IBM computer" to mobile search interface. This query is ambiguous without specifying location or price. But the location information is included in the user context and the price information can deduced from user information. So the mobile search engine understands the real search intention and sends him or her satisfactory results.

3.2.3 Display process

There are so many mobile device producers and there is no standard interface now. To show query results in particular mobile device, we must design and analysis the differences. Additionally, how to show the query results on mobile device is another issue. Hence, web search results after aggregation should be processed to adapt to mobile devices. Display processing is necessary. The objective of this component is to provide personalized commerce information search results and improve mobile end-users' search experience. At the present time, this is a difficult task to address.

Mobile e-commerce information search has its own characteristics which have been mentioned in the introduction. This component deals with issues including: (1) The mobile devices are tiny and there is only a tiny pad, so the search results should not contain many big photos, flashes, or advertisements etc. Most of these contents in the search results should be cut off. (2) Limited bandwidth in heterogeneous network and limited capability of mobile devices make it need effective data exchange format to reduce transmission time and service performance. (3)Mobile device platform should be taken into consideration. The mobile devices can collect the hardware information such as memory, operating system, and display mode etc, then send the information to the mobile operator and meet the personalized commerce search service.

## 4. An Approach for Web Search Results Processing Based on Mashup

From the mobile end-users' perspective, there are mainly two disadvantages of web search results for purchase information search: (1) tremendous returned search results information, most of which was useless; (2) the returned result documents didn't consider users' preference; however, mobile end-users prefer precise purchase information. In this section, a new approach for web search results processing based on mashup is presented, and then an experiment is carried out to show the flow of web search results processing based on the presented approach.

### *4.1 Flow of Web Search Results Processing Based on Mashup*

In this part, flow of web search results processing adapted to mobile devices is discussed. Figure 5 shows the flow of web search results processing.

In order to describe the processing clearly, it is divided into a 2-stage process.

- Mobile end-user submits the purchase query request with mobile devices. Then the query request is pre-processed to adapt to user preference and sent to the particular Internet search engine or mobile operator's portal. Getting the search results by the pre-processed query, process such as result extraction, result selection, and result re-ranking are done. Then, users can get the search results of the first processing. The primary objective of this stage is to get the concise and precise search results based on user preference and wipe off contents which are not fit for mobile devices.
- Secondly, mashup processing is executed. The objective of this stage is combining the processed web search results with external sources, and then provide content-rich results. External sources mainly include mobile capabilities and Internet APIs.

### *4.2 Experiment*

Finally, an experiment is carried out on Amazon.com to show the web search results processing based on the presented approach. In order to describe the processing clearly, an example scenario is designed for illustration. According to the flow of processing, this experiment is divided into five stages as follows.

4.2.1 Mobile end-user's query pre-processing

This stage is responsible for query generation. Due to the factors mentioned above, the mobile end-user's query is usually short and in natural language. Information such as interaction history, location information, and status information that can help the system drive user's intention. The mobile end-user's query can be processed in the Amazon's server.

Suppose a user input "apple" with his mobile phone on Amazon.com. Different people may have different

intention in search context. With the user's interaction history before, the system can deduce that the user is an iPhone user rather than a fruit provider. The iPhone user may be interested in services or products related to iPhone, while a fruit provider may prefer to apple varieties and prices in regional places.

4.2.2 Search on internet data sources with the preprocessed queries

The mobile end-user's query then is sent to Website Amazon.com. Using the pre-processed query request, we can get the web search results from Amzon.com. Figure 6 shows the search results with the preprocessed query.

The search results above have several disadvantages as follows: (1) Tremendous information of search results, there are hundred pages of search results. (2) Contents such as large photos, flash, product's introduction etc are not fit for mobile terminals. Result extraction is one way to solve this problem. (3) The ranking of the search results doesn't take user preference into account. As shown in Figure 5, the high-ranking search results are desktop or laptop computers by Apple, while the mobile end-user prefers iPhone products. Hence, result re-ranking is also needed. The high quality results should have priority over others.

4.2.3 First Processing of web search results

This stage deals with issues of result extraction, result selection and result re-ranking. Result extraction is responsible for extracting the useful information from search results and cutting off search results that are not adapt to mobile terminal. Result selection is responsible for selecting proper search results based on user preference. Information which doesn't include user search intention should be cut off. Result re-ranking is responsible for re-ranking the search results with user intention. Then the top high-ranking search results with the highest quality should be the search results. One crucial principle in this stage is that all the processing should be based on user preference. In order to illustrate this stage, Figure 7 shows the imaginary web search results after first processing with manual selection.

As shown in Figure 6 above, the top 6 web search results with high quality from Amazon.com are selected. These results are based on user preference, and have much relevance to search precision.

4.2.4 Mashup process for mobile devices

This stage deals with issues of mashing-up the web search results in stage 3 and external data sources such as Internet APIs or mobile capabilities. One of the pieces of information that has the most potential value is location. As Google.com opens its "Google Map API" to public, integrating the search results above and map service is convenient.

In stage 3, we get the concise and precise search results from Internet. For the search results are with high quality and the items are of a limited number, so integrating these results with map service and displaying the final results on mobile terminal is feasible. Another factor that facilitates Location Service is that more and more intelligent mobile devices have the function of map service. Mobile end-users can browse search results clearly for concise and limited contents.

4.2.5 Display process

This is a difficult issue. The mobile terminal devices have limitations such as small screen, limited bandwidth and lack of computing capability. Hence, the final query results should be processed adapted to mobile terminal devices. Several approaches can be used for transmitting the final query results to mobile end-users. SMS, MMS were mostly used approaches in the past. With the development of Mobile Networks and mobile devices, WAP will be a promising solution in future. In this paper, we suggest that the final query results can be organized in WML (Wireless Markup Language) and displayed in WAP page. Additionally, if the terminal devices are not intelligent for WAP page, SMS or MMS will be another choice.

## 5. Conclusion

To provide search service with content-rich and precise information, this paper proposed a platform architecture of mobile e-commerce information search based on mashup technology. Three main components constitute this platform which facilitates mobile e-commerce information search. With the new approach presented in this paper, we can provide the search results adapted to mobile devices. By combining the external sources with web search results, users can enjoy a wonderful search experience. With the presented new approach, the mobile operators can provide search services by combing data source from Internet. Mobile operators should cooperate with Internet operators to realize mutual benefits.

Owing to the research work is being in progress so far, this paper just outlines architecture and involves less technology details. In our future work, we will focus on each component of this platform and conduct deep research on it.

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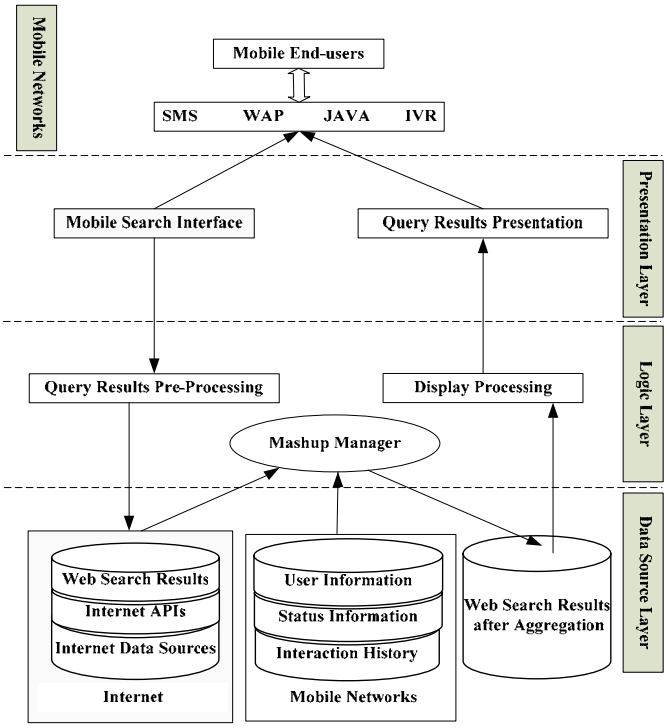


Figure 1. Macro architecture of mobile commerce information search

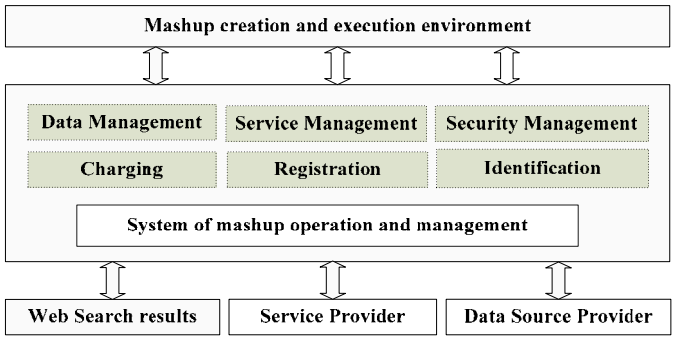


Figure 2. System architecture of mashup manager

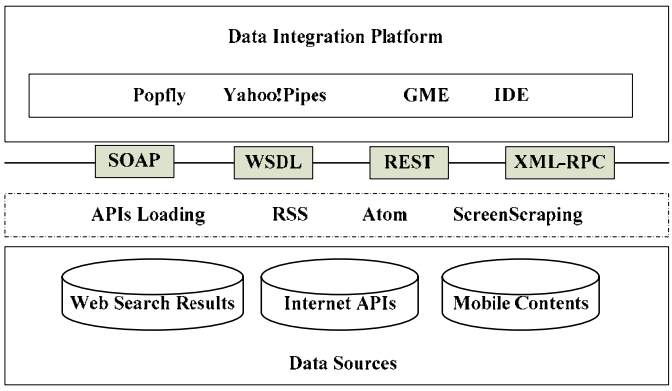


Figure 3. Technique realizing for mashup manager

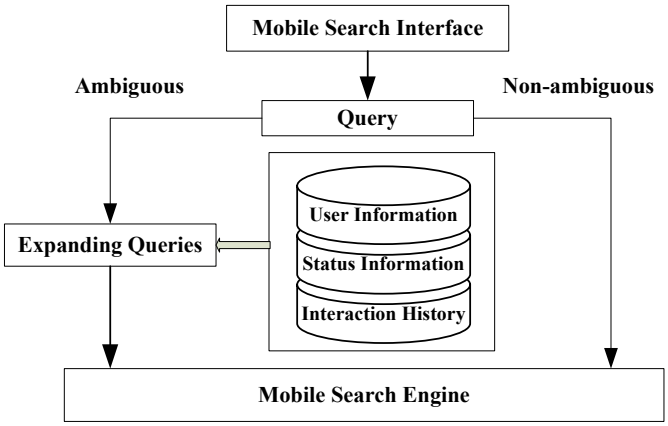


Figure 4. Pre-processing of mobile end-user's query

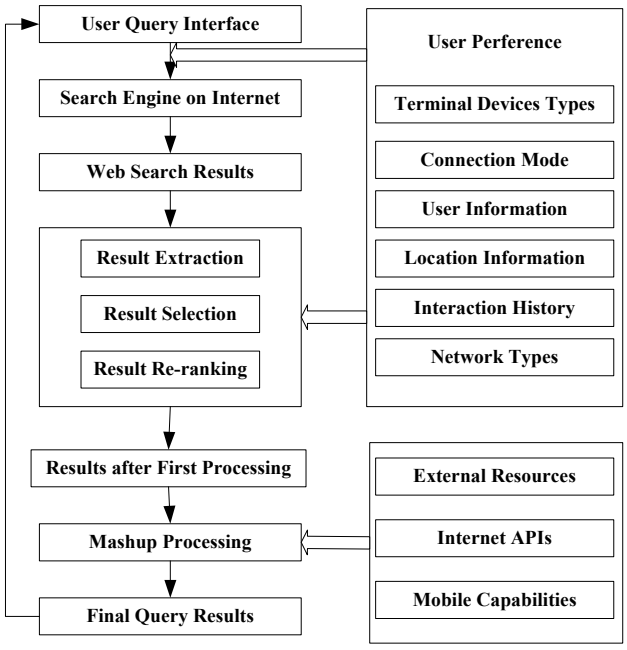


Figure 5. Flow of web search results processing


Figure 6. Search results from Amazon.com with the preprocessed query

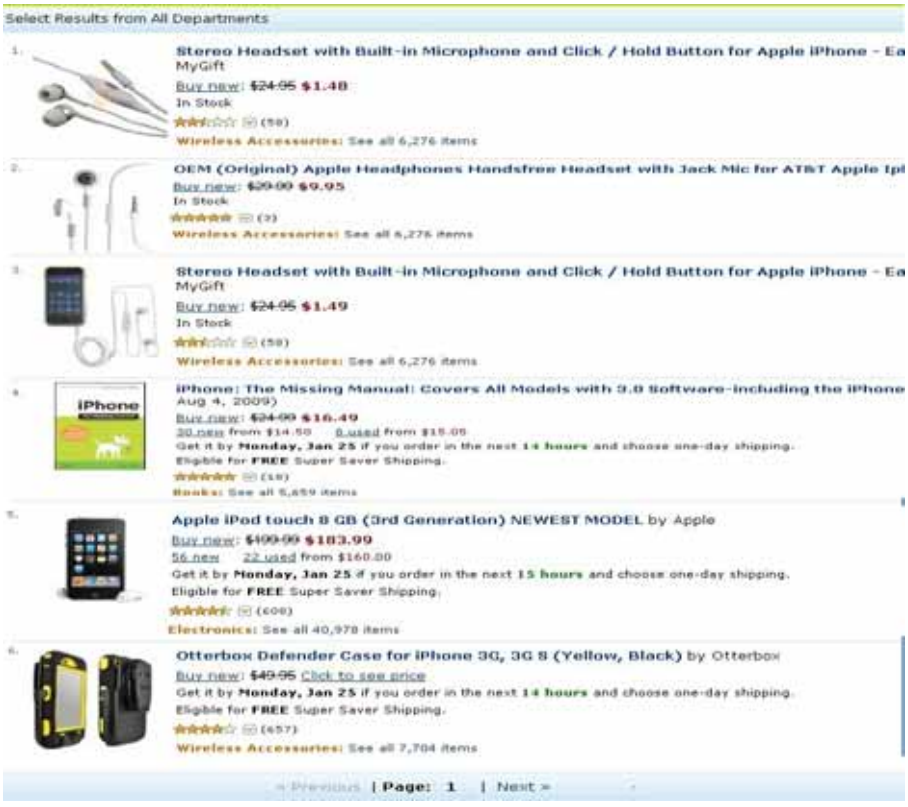


Figure 7. Web search results after first processing