

Database Integration via Mediator Approach for Integrated Applications with NFC Technology

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Abstract— Automated application using the integration of Near Field Communication (NFC) technology via mobile phone seems to be cost effective without the need to invest on expensive device reader. Some of the applications that utilized NFC technology have been explored and its data sources need to be managed. This paper proposed a suitable approach to integrate databases for application using NFC technology. Mediator approach was chosen as a bridge for application using NFC technology and data sources. Five components in mediator based: user layer, presentation layer, mediator layer, wrapper layer and database layer. Two core components in mediator approach are mediator and wrapper. S-Library is an example application using NFC technology. Three different data sources which are library database, book supplier database, student information system database as an example different data sources. The conceptual integration of these three different data sources using mediator approach is explained and the reason why mediator approach is better compared to other approaches are discussed in this paper.

Index Terms— Database Integration, Near Field Communication (NFC), Mediator Approach

I. INTRODUCTION

A database is a collection of structured, interrelated information units [1]. Information units can be described as a package of information at various levels of granularity. Collection of data from experiments such as a string of letters form is one of the example information units. The information units will keep increasing from time to time and at the same time affecting the database size. Dealing with the unlimited and continuous growth of database size definitely requires a Database Management System (DBMS) to manage the data in the database. The DBMS is set of programs that enables administrator to store, modify, and extract the information from a database [2]. DBMS provides other

functions such as to add, delete, access, and analyze data in one location [2].

Most mobile applications used DBMS to easily manage the data in a database. The mobile application is a software application designed to run on smart phones, tablet computer and other mobile devices. The different mobile phone use different mobile operating system (OS) [3] which can be divided into six types; Android, Symbian, BlackBerry OS, iOS, Microsoft and other OS [10]. Android OS supports communication with Near Field Communication (NFC) reader embedded in many Smartphone [4].

The NFC is a combination of contact-less identification and interconnection technologies that enables wireless short-range communication between mobile devices, consumer electronics, PCs and smart objects [4]. The usage of embedded NFC reader is to allow mobile phone to scan and read NFC tag data before submitting the data into database. Such data may not only be applicable to a single application, since different applications might be using the same technique to store data.

This paper will discuss and propose a suitable approach for database integration using NFC technology. Database integration means merge two or more databases in different sources and providing users with a unified view of these data [5]. It is to allow users from different applications make any data transaction such as search, view or send the data through a “suitable bridge”. A suitable bridge allows any processes from different users access or send the data to the right destination (a database). There are four types of current approaches in database integration; hyper-linked, absorb locally, query internal and mediator [5]. Hyperlink is widely used but it cannot support massive data in other databases which otherwise would be totally separate. In absorb locally approach, data from the public or external databases are

formatted and absorbed into a local database, there were some issues when dealing with import or update process. Query internal provides a local system but not data is actually stored in the local system. This approach also experiences problems such as the current implementation is very complex and some are hardware is dependent [5]. The mediator is another approach for database integration. The mediator is a collection of functionality that is designed to have functionality added and removed with minimal changes in layers above and below [6][7].

II. OVERVIEW OF NFC TECHNOLOGY

Nowadays, the mobile phone becomes more important not only for communication purpose but also for other functions such as taking a picture, recording video, managing appointments, and etc. In some of mobile phone, there are built in functions, which make the mobile phone ready to integrate with other devices. For instance Nokia mobile phone (Samsung Galaxy Mini 2) has a function to integrate with NFC tag. NFC is an extension of Radio Frequency Identification (RFID). NFC is issued in 2003 and the purpose of this technology is to provide short-range data communication with frequency band of 13.56MHz [8].

In the NFC, two devices are used for communications which are active and passive [8]. Active role is called initiator and passive part is called the target. Coupling and radio signals are used for data exchange. Fig.1 shows three types of interaction supported by NFC technology. In fig.1 (a), an NFC chip embedded into mobile phone can read a tag’s information. In this case, the NFC-chip is a reader where it can read information and send it via the mobile phone. In Fig.1 (b), NFC-chip read data from the reader. In this case, reader already read the data, so NFC-chip just extracts the data from the reader. In Fig.1 (c) shows the communication between two devices/readers.

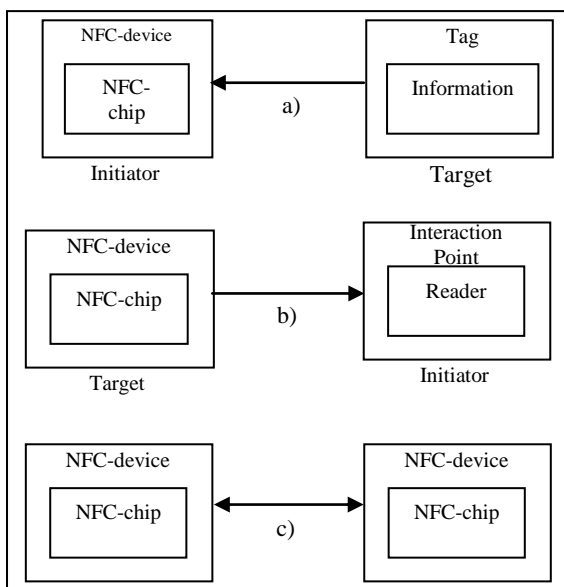


Fig. 1: Types of interaction supported by NFC [8]

NFC technology provides some advantages such as very fast set-up time, better usability, more use cases and better consumer experience. In terms of connection speed, NFC is in the between compared to WiFi and RFID technology [9]. Table 1 shows three types of NFC operating mode and their advantages.

Table 1: Benefits for different NFC operating modes [9]

	Card emulation mode	Reader/writer mode	Peer-to-peer mode
Benefits	Physical object elimination	Increase mobility	Easy data exchange between devices
	Access control	Decreases physical effort	Device pairing
		Ability to be adapted by many scenarios	
		Easy to implement	

Table 2 has demonstrated that NFC technology is also usable in different demands and has proven to be successful and employable in different areas as explained in the Table 2. The next section of this paper, will describe details about system design of mediator.

Table 2: Applications using NFC technology

Applications	Explanation
Smart Poster	NFC tag is located on the poster. The tag consists of information on a URL or icon. User can use mobile phone to read the NFC tags, and automatically being redirected to the website of the read URL. From this website, users can read the information about the poster.
Hot in City	NFC devices are located in selected areas. The user needed to touch the NFC devices using their mobile phone. Then the NFC reader will extract the location while the application will automatically update the location to their friends.
Navigation system	Offer visitor location services with maps and text information. Main function in this application is to provide travelers with information on their location and directions.
Restaurant ordering system	The restaurant provides NFC device. Customers go to the restaurant and tag mobile phone to the NFC tag. Then, select type of food for instance vegetarian. This application will send only their vegetarian menu.

III. SYSTEM DESIGN OF MEDIATOR

A mediator based integration system was proposed to integrate all related databases. This approach was chosen because its' high level of transparency to the user. Meanwhile, users can query the mediated system without knowing the detail of the actual location and structure of the data sources. The purposes of this mediator approach is to translate the global query into an execution query for each wrapper to search data from databases, reconcile different data source schemas and integrate them into a coherent global schema. A mediator approach has two main components which are the mediator and the wrapper. The main responsibility of a mediator is to receive the formulated query from the global mediated schema. Then, the mediator will decompose the query into sub-queries that can map each data source's execution based on individual database. In the second step, the mediator will reformulate the queries into the respective execution plan based on the local models and schemas. Then, the reformulated queries will send to the respective wrapper by the mediator. Meanwhile, the main function of a wrapper is to convert these queries into an expected execution format depending on the data source. The wrapper is hidden technical and local implementation from the mediator. In fig 2, five components forming the mediator-based system: user layer, presentation layer, mediator layer, wrapper layer and database layer.

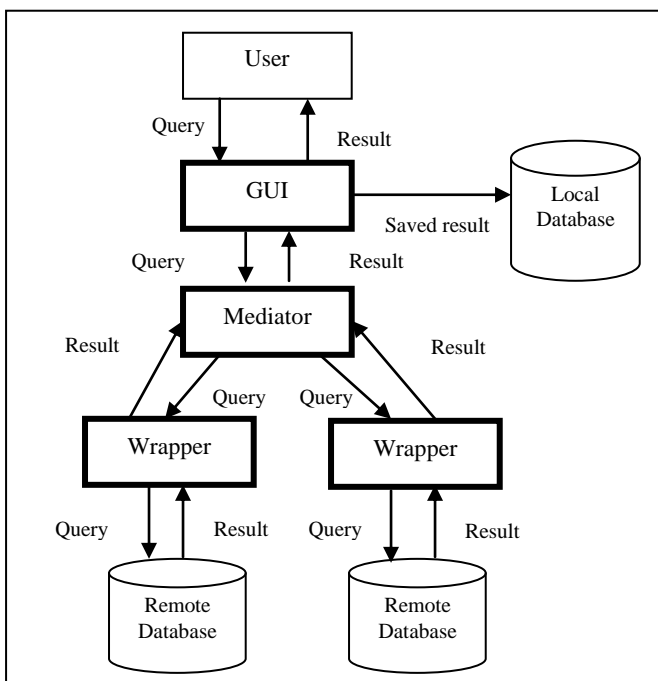


Fig. 2 System Architecture

A. Presentation Layer

The purpose of the presentation layer is to provide a mechanism for interaction between users and the system. It is important for users to create the query so that it will provide the user the opportunity to construct meaningful query. In fig. 2, Graphical User Interface (GUI) is provided to help users construct meaningful queries and avoid ambiguous queries. Users are given the choice to

select only useful data to be viewed as the results. A filter is used to filter only related data that will be displayed to users. Three inputs are required to perform filtering process:-

- i. Restriction collection – keywords, author, ISBN, Etc.
- ii. Target sources – the remote databases to be searched (Library Apps, Supplier Database, Student Information System Database, etc)
- iii. Projection – output fields a user wants to be returned.

B. Mediator

A Fig 3 shows the architecture of mediator approach. Mediator received the constructed query from presentation layer. The query will be rewritten (transformed) into a series of dependent queries. The mediator will apply mapping concept that maps the independent queries with the specific dependent queries by using local schema. Then, a mediator is needed to map these sources-dependent queries with the specific data source information before passing all the relevant information to the concerning wrapper. The detail of data source schema contains the specific data source information such as name of the data source, the URL of the data source, sequence of navigational queries that lead to the result and a set of rules to interpret the result. After all the processes in mediator are completed, the output will be passed to the wrapper.

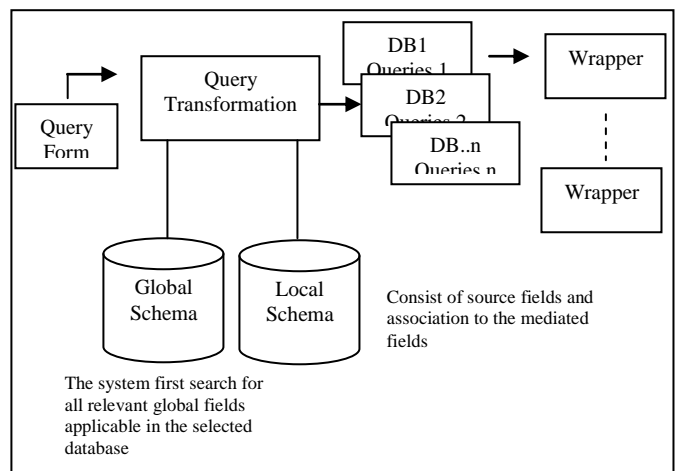


Fig.3 Mediator Architecture

C. Wrapper

The functionality of the wrapper is shown in fig. 4. The first function is to facilitate the physical execution of query and the second is to handle communication with the data sources. The wrapper is responsible to fetch data and response from a specific data sources. Technical and data sources are hidden from mediator.

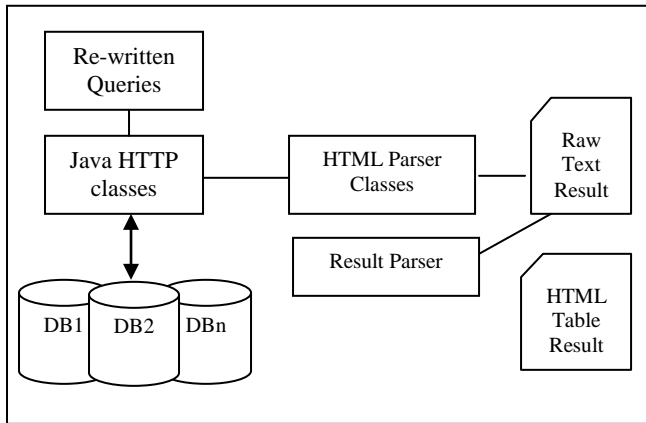


Fig. 4 Wrapper Architecture

IV. APPLICATION USING NFC TECHNOLOGY

Library application using NFC technology was used as a case study to visualize the concept of mediator approach.

A. S-Library App

There are three components in this communication which are mobile phone (with NFC reader), NFC tag and library application/system shows in fig 5.

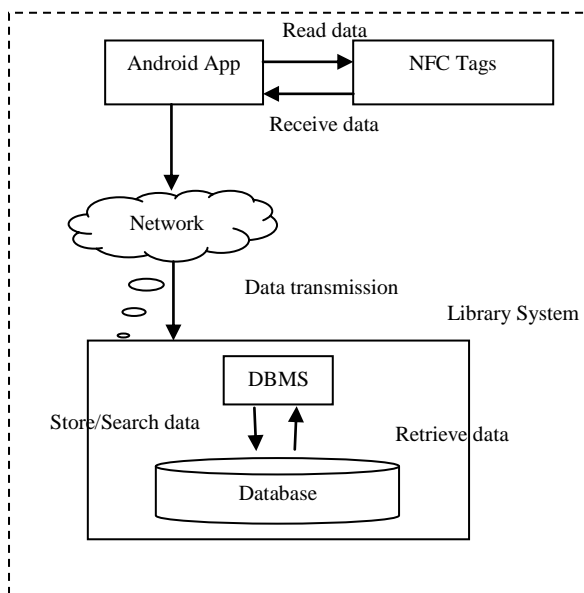


Fig.5 Data transmission process flow

Android application (library app) is needed to install into a mobile phone that supported by NFC reader. NFC tag is required to be tagged on the book. The NFC tag keeps information such as ISBN, book title, author, year, etc.

The transaction of borrowing the processes involved in this application is as follows:

- i. The user is needed to activate a library application on a mobile phone
- ii. Touch the mobile phone onto the selected book
- iii. NFC Reader on the mobile phone will automatically scan and read the book information from the NFC tag.
- iv. The application will submit this information together with other required information to library system such as ISBN, transaction date, transaction time, user id, etc.

Based on Fig 5, library application for mobile phone for Android OS will connect to current library system. The purpose of this integration is to ensure all transactions using a mobile phone will update automatically into the library system. All transactions must be executed on the real time and internet connection is required.

B. Sample of Database Integration

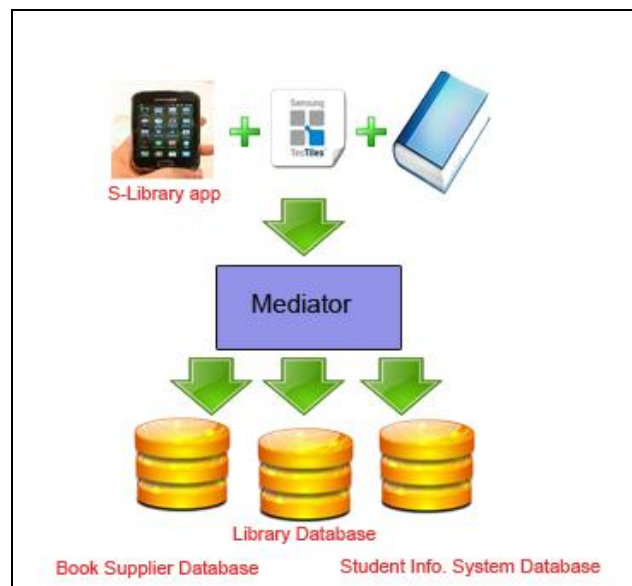


Fig. 6 Sample of Database Integration

In Fig. 6, there are three different data sources are connected to the mediator. The three data sources are "Book Supplier Database", "Library Database" and "Student Information System Database". NFC technology is proposed to implement for S-Library application. NFC tag is allocated at the book. The NFC tags keep the information such as ISBN, book name, year, etc. Meanwhile, S-Library application is needed to be installed into a mobile phone. In this case, Samsung Galaxy Mini 2 is chosen as a test case because this mobile device supported by NFC reader. Once the users request to borrow the book, the users touch their mobile phone onto the book. Then, the NFC reader from a mobile phone will read the information such as ISBN, authors, year, etc. from NFC tag on the book. This information will be sent to a mediator. The mediator will

check the current status either the book can be borrowed or not from “*Library Database*”. If the status is available, the user can borrow the book. But if the status is not available (the books are already booked by others), the mediator will search the data from “*Book Supplier Database*”. If the record is available, the user can suggest to library to book this book based on user request. At the same, the mediator will check the status of users from “*Student Information System Database*” either this user is active or not. If the status is active, the user can proceed to the book borrowing process. If the status is not active, the user cannot proceed to the next steps in the book borrowing process.

V. DISCUSSION

This paper has described about why mediator approach is proposed to integrate databases for application with NFC technology compared to others approaches. The mediator based approach is used to translate the queries from the user and understood by the data source. The detail architecture and explanation about mediator approach was explained in the previous section. The mediator solves the updating problem because the query directly goes to the original source. A mediator can be locked as a cheap and effective approach since it involves schema or view integration, rather than to have huge storage to store copied data from all the involved data sources.

VI. CONCLUSION AND FUTURE WORK

This paper begins with overviews of description of the database, NFC technology, database integration and mediator approach. Then, it describes more details about types of NFC interaction and some of example applications using NFC technology. The three approaches for database integration that have been discussed are hyperlink, absorb locally, query internal and mediator approach. Mediator approach has been selected as a proposed approach to integrate a database for application using NFC technology. The architecture and implementation about mediator approach was proposed in section III. The two important components in mediator approach are mediator and wrapper. An example of integration among different data source library database, book supplier database and student information system database as explained in section IV.

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