

## **Development of Modern Mobile Web Applications Based on Three Logical Layers Schema**

**Dr. Mazin S. Al-Hakeem** 

Computer Science Department, University of Technology / Baghdad

Email: mazin\_ictc@yahoo.com

**Suhair M. Zeki**

Computer Science Department, University of Technology / Baghdad

**Sarah Y. Yousif**

Computer Science Department, University of Technology / Baghdad

**Revised on: 28/5/2012 & Accepted on: 31/1/2013**

### **ABSTRACT**

Smart mobile technology is increasingly being utilized as a tool for information dissemination and collection; in addition to support many services such as telephone calls, SMS and MMS messages, e-mail, Web access, etc. The open architecture of these devices is encourages for rapid application development and release. Most people who own smart mobile devices prefer to browse the Internet through these devices, the Mobile Web refers to the use browser-based access to the Internet application from a mobile device which connected to a wireless network. Despite that the Web applications suffer from the interoperability and usability problems.

In this paper, we design and implement a mobile web application for UOT (University of Technology) and mobile application server (MAS) based the three logical layers schema using Apple's Xcode IDE and SQLite database as an Independent on the mobiles operating system and Independent on the specifications of these devices by overcomes the interoperability and usability problems.

Also the implemented mobile web application for UOT enforces security sense when data transported across communication and provides encrypted communication and secure identification using built-in SSL/TLS protocol.

**Keywords:** Smart Mobile Device, Mobile Web, UOT, Apple's Products, Xcode, AppleScript. SQLite.

## تطوير تطبيقات الإنترنت المحمولة الحديثة على أساس مخطط ثلاث الطبقات المنطقية الثلاثة

### الخلاصة

ان استخدام تكنولوجيا الهاتف النقال الذكية بدأ يزداد كأداة لجمع ونشر المعلومات بجانب امكانياته لدعم العديد من الخدمات مثل المكالمات الهاتفية، الرسائل القصيرة، رسائل الوسائط المتعددة، البريد الإلكتروني، الوصول إلى شبكة الإنترنت، وغيرها. ان الهيكلية المفتوحة لهذه الاجهزة تشجع على تطوير واصدار التطبيقات بشكل سريع. وان معظم الناس الذين يمتلكون أجهزة الجوال الذكية يفضلون تصفح الإنترنت من خلال هذه الأجهزة، ان موبايل الويب يشير الى استخدام المتصفح التطبيقات المتصلة بالانترنت من اجهزة المحمول المتصلة بالشبكة اللاسلكية. على الرغم من ذلك فان تطبيقات الويب تعاني من مشاكل الاستخدام المتبادل وسهولة الاستخدام.

في هذه البحث، تم تصميم وتنفيذ تطبيق موبايل الويب للجامعة التكنولوجية و تطبيق الخادم المتنقل على اساس مفهوم الطبقات المنطقية الثلاثة وذلك باستخدام بيئة التطوير المتكاملة Xcode الخاص بشركة ابل وقاعدة البيانات SQLite كتطبيق ويب مستقل عن نظام تشغيل الاجهزة النقالة ومستقل عن مواصفات هذه الاجهزة من خلال تجاوز مشاكل الاستخدام المتبادل وسهولة الاستخدام. كما تم تعزيز تطبيق موبايل الويب للجامعة التكنولوجية المنفذ بفرض الاتصالات المشفرة عن نقل البيانات وكذلك التعريف الامن باستخدام بروتوكول SSL / TLS المدمج.

### INTRODUCTION

Since the mid of 2000s, mobile website has grown into what is now one of the most active areas of development activity in ICT fields. The Mobile Website refers to browse the website based access to the Internet from mobile devices, such as a smartphone or tablet computer which connected to a wireless network [1].

Most people who own smart mobile devices prefer to browse the Internet through these devices [2], worldwide sales of mobile devices totaled 440.5 million units in the third quarter of 2011, up 5.6 percent from the same period last year [3], all of these devices have different mobile platforms such as iOS from Apple Inc., BlackBerry OS from RIM and Windows Phone from Microsoft (all of them are closed source and proprietary), Android from Google Inc. (free and open source), webOS from HP (certain parts open sourced), and Symbian OS from Nokia and Accenture (open public license).

The worldwide main problems faced with mobile web are that browsing the websites varies from one device to another depending on the mobile operating system and the dependence on the specifications of devices. The closely related research to the mobile website and our work are addressing as the following:

In 2011, Kadhim Alaa and others [4] build a web application for UOT based on the mobile devices. The implemented application has been done by using MS Visual Studio 2008 as an environment and Visual Basic to implement the proposed application, and using Pocket PC 2003 SE emulator as a client smart device. The implemented work is suffers from the adaptation of display problem which has been override by account the specific features of the mobile device (Pocket PC 2003 SE specification) like the size and resolution of the non-touch screen and the nature of the OS, also the implemented work was not tested on the other smart devices.

In 2007, Al-Hakeem Mazin S. [5] presents a novel system ('WWRS' short for 'Web/WAP Recommendation System') for personalize and customize web content as a WML files for mobile devices. The WWRS has been based on mining of usage data and done by using Dot Net Mobile as a framework and ASP to implement the

proposed system, and using Pocket PC 2003 SE emulator as a client smart device. Despite the lack-of dependence on features of the mobile device, the implemented work is suffers from tested on the other smart devices like products of Apple (which grew-up at beginning of 2007), Android's devices, BlackBerry, Windows Phones, and others smart products.

In 2006, Riadh May Haikel [6], presents a system ('DWCRS' short for 'Developed Web Content Re-Authoring System') for bringing and parse Webpages as a WML files to mobile devices. The DWCRS has been based on HTML parser using XSTL files, but the render process is still working depending on the specification of the user device.

## **MOBILE WEB, APPLICATIONS, AND APPLICATION SERVERS**

### **Mobile Web**

The Mobile Web refers to (as shown in the above) the use of Internet connected applications, or browser based access to the Internet from mobile devices, such as a smartphone or tablet computer which connected to a wireless network (such as WiFi, 3G, 4G, ...)[1].

The first access to the mobile web was commercially offered by TeliaSonera (Sweden Mobile Network Operator in Northern and Eastern Europe), where requested from Nokia in 1996 to develop the mobile phone ability to access to the real internet [6]. And the first commercial launch of a mobile-specific browser-based web service was by NTT DoCoMo (Japanese Mobile Phone Operator) in 1999 [7].

Mobile Web access today still suffers from interoperability and usability problems. Interoperability issues stem from the platform fragmentation of mobile devices, mobile operating systems, and browsers. Usability problems are centered around the small physical size of the mobile phone form factors (limits on display resolution and user input/operating). Despite these shortcomings, many mobile developers choose to create apps using Mobile Web, and most 2011's researches on mobile development found Mobile Web the third most used platform [1].

### **Mobile Applications**

The Mobile Application (also known as Mobile App), is a term to describe Internet software that runs on smartphones; It's usually help users by connecting them to Internet services more commonly accessed on desktop or notebook computers [8].

Mobile Applications can be developed as "rich client applications" which support disconnected or occasionally connected scenarios or "thin client applications" (called also Web Application) which support connected scenarios only [9].

### **Mobile Application Servers**

Mobile Application Server (MAS) is a software program which runs in a server and provides functionality for the Mobile client devices. All Mobile Application Servers are divided into (at least) three logical layers as shown in figure (1), which contents: the Presentation Layer, Business Logic Layer, and Data Access Layer [10].

The objectives of the Mobile Application Server's Logical Layers are [11]:

- The objective of the "Presentation Layer" is to decouple the actual user interface design and implementation from the specialized business logic of specific mobile location services development process, and considering its presentation space characteristics and limitations.
- The objective of the "Business Logic Layer" is to partition the work into manageable, reusable, and discrete components to use by the presentation logic layer (which deliver content to clients), and should be concerned with

application issues (such as handling information requests and its integration with backend database or other business application function to solve domain-specific problems).

- The objective of the "Data Access Layer" is to provide functions to connect, management and session support of legacy information systems (from a relational database to a mainframe transaction processing system).

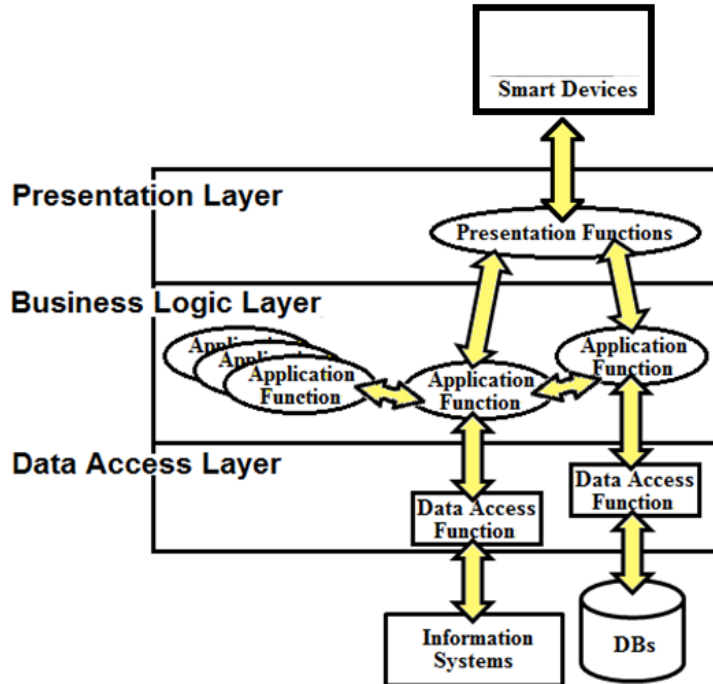


Figure (1) Mobile Application Server's Logical Layers.

**SMART DEVICES**

A smart device is an electronic device that is cordless, mobile (easily transportable), always connected (via WiFi, 3G, etc.) and is capable of voice and video communication, internet browsing, "geo-location" (for search purposes) and that can operate to some extent autonomously. Mobile devices are revolutionizing the way information can be disseminated. Contrast this with the older generation mobile devices such as Personal Data Assistants (PDAs) which primarily focused on data storage and display [12].

The most famous devices at time of writing are the Apple iPhone (Smart Phone) and iPad (Tablet) which based on iOS as a mobile operating system, and Samsung Galaxy tablet which based on Android OS, and Blackbary which based on RIM OS, etc. Smart devices can be designed to [12]:

- support a variety of form factors.
- support a range of properties pertaining to ubiquitous computing
- be used in any combination of three main system environments: physical world, human-centered environments and distributed computing environments.

All smart devices have a mobile browser (Wireless Internet Browser (WIB)), which optimized to display web content most effectively for small screens on smart devices [12].

All smart devices use Wireless Application Protocol (WAP) as a standard protocol for accessing information over a mobile wireless network, WAP support each of Web applications such like (E-Mail by mobile phone, Tracking of stock-market prices, Sports results, News headlines, and so on) [1].

The WAP Reference Model architecture (WAP Stack) is divided into 5 different levels [13]:

- Application Layer: Wireless Application Environment (WAE).
- Session Layer: Wireless Session Protocol (WSP).
- Transaction Layer: Wireless Transaction Protocol (WTP).
- Security Layer: Wireless Transport Layer Security (WTLS).
- Transport Layer: Wireless Datagram Protocol (WDP).
- 

### **XCODE IDE**

The Xcode programming suite is integrated development environment (IDE) developed by Apple Company for developing software for Mac OS and iOS (Operating System for Apple Smart Devices), first released was in 2003 [14].

The Apple's Xcode IDE includes [15]:

- Built-in Interface Builder, an application used to construct graphical user interfaces (GUI).
- Modified version of the GNU Compiler Collection for Apple, which supporting various programming languages.
- Apple's WebObjects tools and frameworks for building Java web applications and web services.

The Apple's Xcode IDE supports C, C++, Objective-C, Objective-C++, Java, AppleScript, Python and Ruby source code with a variety of programming models. More recent versions of Xcode added a second system (called Dedicated Network builds) which scales better to larger network configurations [15].

In this paper, the work was developed with AppleScript as a programming models and WebObject as a web application framework.

The AppleScript is a scripting language created by Apple Inc. and built into Macintosh operating systems since MAC System ver7 at 1991. While, AppleScript code is an inter-application processing system, designed to exchange data between and control other applications in order to automate repetitive tasks [16].

While the WebObjects is a web application server from Apple that ran on the server. It's also an object-orientation, database connectivity, and prototyping tools [17].

SQLite database is a C programming library to stored data. SQLite has many bindings to programming languages like AppleScript and others. However SQLite is a popular for client storage on web browsers [18].

### **THE IMPLEMENTED MOBILE WEBSITE FOR UOT**

In this paper, the Mobile UOT's Website was implemented and run over iPhone 4G and iPad II devices (smart mobile devices).

The implemented Mobile UOT's Website used Xcode IDE's WebObject as development tool for implementation the mobile web application, and the work

designed based on the 3 main mobile application server's logical layers schema. So the implemented work is content 3 Apple Layer Subsystem, as shown in figure (2).

The AppleScript was used as a programming model for implemented UOT's Website system and its functions and the information of UOT webpages is stored in SQLite database which completely compatible with AppleScript and Xcode objects. With wireless environment for this work, all traffic between smart devices and mobile application server will be sent via WAP-WDP registered port number 8081 or port number 443 to connect and logging to web application with confidential session. All of information of UOT webpages is stored inside SQLite database which based on B-Tree searching algorithm.

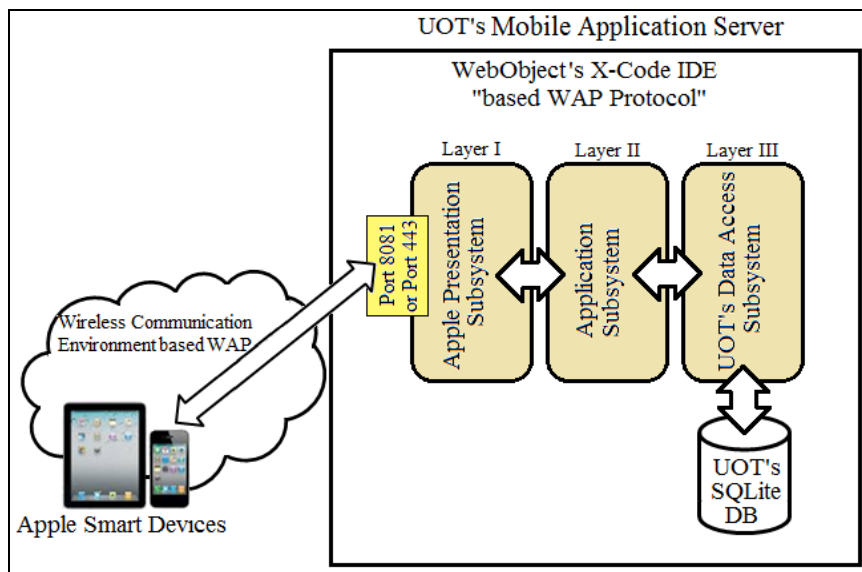


Figure (2) The Implemented Mobile UOT's Website Diagram.

The implemented work is published online in real world at the official address ([www.uotechnology.edu.iq](http://www.uotechnology.edu.iq)), and can be for everyone reaches through smart devices.

#### Architecture of Mobile UOT's Website

The architecture for the implemented Mobile UOT's Website, which shown in Figure (2), consists of the following elements:

1. Apple smart mobile devices (iPhone and iPad) as client devices which waving the mobile UOT's Website in real online at official address ([www.uotechnology.edu.iq](http://www.uotechnology.edu.iq)).
2. The implemented system which runs as mobile application server under Xcode IDE environment. The system has three AppleScript subsystems as describe bellow:
  - I. Subsystem I (Apple Presentation subsystem) based Presentation Layer schema, it's a layer I of the system which responsible for the following:
    - A. Controls the data exchange between the back-end subsystems and the connected smart devices. The subsystem I uses confidential ports to enforce the security sense when data transported across wireless communication environment, these ports are:
      - Port number 8081 (called blackice-logon Port) which based verification procedure depends on the receiving application.

- Port number 443(called HTTPS Port), it proposed as an alternative port, which applies the secure Web browser communication.
  - B. Customizes the features of the Apple smart device, like the size and the resolution of the multi-touch screen, and the nature of the operating system that the device operates in it, using WebObjects.
- II. Subsystem II (Application subsystem) based Business Logic Layer schema, it's a layer III of the system which use WebObjects to Logging, also to define request packet of individual mobile devices, and to determine the suitable webpages to be sent to the device (manipulation of data on mobile web server). It's the heart of the system.
- III. Subsystem III (UOT's Data Access subsystem) based Data Access Layer schema, it's a layer III of the system which run as an interface to the SQLite based B-Tree searching algorithm to select the suitable information from UOT's SQLite database that related to specific webpages.
  - 3. The UOT website has pages for all the university departments, centers, directorates and offices, central library, scientific activities, scientific and miscellaneous publications, conferences and symposia, these are 80 webpages with around 16Mbyte of file size. The information of all these pages is stored in UOT's DB in SQLite database format. The SQLite database is maintained using a separate B-tree which stored in the same disk file. B-tree is used for each table and index in the UOT's database.

#### **Waving the Implemented Mobile UOT's Website**

Figures below depict a typical interaction of Apple smart devices with the implemented system through waving the mobile UOT's website.

When the user clicks on a link to the website, the "Apple Presentation Subsystem" initially enforce security sense when data transported across communication when received the request by port:8081 to enforce verification level for login, or port:443 to provides encrypted communication and secure identification using built-in SSL/TLS protocol.

The "Apple Presentation Subsystem" also customizes the features (size and the resolution of the multi-touch screen, and version of iOS that the device operates in it) of the connected Apple smart device (either iPhone or iPad) using WebObjects.

The "Application Subsystem" use WebObjects to Logging, also to define request packet of individual connected mobile devices, and determine the suitable webpages to be sent to the device.

The "UOT's Data Access Subsystem" run B-Tree searching algorithm to select the suitable information from UOT's SQLite database that related to specific webpage.

Figure (3) shows the mobile UOT's home page using iPad and iPhone which initially display the main page. While Figure (4) shows the mobile UOT's Department and Center Pages, Figure (5) shows mobile UOT's Central Library Page and Scientific Magazine Page, and Figure (6) shows mobile UOT's Search Page. The same happens when the user uses Apple iPhone or iPad device as show in Figure (3).



Figure (3) Mobile UOT's Home Page Shown using iPad and iPhone.



Figure (4) Mobile UOT's Department and Center Pages.





Figure (5) Mobile UOT's Central Library Page and Scientific Magazine Page.



Figure (6) Mobile UOT's Search Page.

## DISCUSSION AND CONCLUSIONS

### Discussion

Firstly, there are some things must be discussed, these are as following:

1. The modern smart devices have full-featured web browsers and web technologies that are almost indistinguishable from desktop browsers; and a large number of people who own smart mobile devices prefer to browse the Internet through these devices, therefore it became important to develop mobile website for UOT and other official Iraqi institutes to keep up need users.

2. From market share view point [19]; the Apple's iOS (for Apple Smart Devices) market share up from 19% in fourth quarter of 2010 (Q4/2010) to 43% in Q4/2011, and forecast to arrive to more than 50% in Q1/2012. While the Android OS (for LG, Samsung, Google, and for more than 80 companies) market share down from 53% in Q4/2010 to 47% in Q4/2011, and forecast to arrive to less than 50% in Q1/2012. The market share of RIM OS (for Balckbary Devices) is 6%, and the Windows Phones OS (for Windows Smart Devices) is less than 4%. Therefore been selected the Apple Devices in this paper as a smart client devices and Xcode IDE as a development environment to develop the mobile web server depending on the popularity of these, unlike previous related research that depending on client devices began to disappear.
3. Because the mobile web applications are depending on continual network connectivity and speed Internet connection, so it's wrong to design rich interface for a mobile websites and applications.

### **CONCLUSIONS**

The following points represent the important conclusions which are drawing through the development of Mobile UOT's Website:

1. The implemented 3 Apple Layer Subsystem, which based on the mobile application server's three logical layers schema, completely recovered from interoperability and usability problems.
2. Xcode IDE, which includes WebObjects and AppleScript, is fully support distributed mobile applications and mobile web services; and Xcode IDE is a specialized framework and dedicated mobile web programming environment more than Pocket PC 2003 platform in Microsoft Visual Studio 2008 Which is still suffering from needs to compromise functions.
3. The implemented "Apple Presentation Subsystem" enforce security sense when data transported across communication when received the request by port:8081 to enforce verification level for login, and port:443 to provides encrypted communication and secure identification using built-in SSL/TLS protocol.
4. SQLite is a popular choice for mobile client storage on mobile web browsers, because its bindings to many programming languages, and it used by several widespread browsers, operating systems, and embedded systems, among others. Inverse to standard SQL which supported by some versions of some programming languages.

### **REFERENCES**

- [1].Patrick Collins, "Global mobile statistics 2012: all quality mobile marketing research", Available at: [mobithinking.com/mobile-marketing-tools/latest-mobile-stats](http://mobithinking.com/mobile-marketing-tools/latest-mobile-stats), 2012.
- [2].Christy pettey, Holly Stevens, "Gartner Says Sales of Mobile Devices Grew 5.6 Percent in Third Quarter of 2011; Smartphone Sales Increased 42 Percent", Available at: [www.gartner.com/it/page.jsp?id=1848514](http://www.gartner.com/it/page.jsp?id=1848514), 2011.
- [3].Kadhim Alaa, and others , " Design and Implementation Web Site for UOT Using Mobile Devices", Engineering & Technology Journal, Vol. 29, No.3, 2011.
- [4].Al-Hakeem Mazin S., "A Proposed System to Personalized and Customized Web Content for Mobile Devices", Computer Science Department - University of Technology, PhD Dissertation, 2007.

- [5].Riadh May Haikel, "Mobile Device Access Web Page Content", Informatics of Postgraduate Studies – Iraqi Commission for Computer and Informatics, PhD Dissertation, 2006.
- [6].Wikipedia Scientific Articles, "TeliaSonera", Available at: [en.wikipedia.org/wiki/TeliaSonera](http://en.wikipedia.org/wiki/TeliaSonera) , Last Modified on 6 January 2012.
- [7].Kothapalli S., and Agarwal P., "Mobile Commerce: A Survey on Underlying Technologies and Security Challenges", Computer Science Department, University of Victoria, Canada, 2004.
- [8].Website Available at: [www.webopedia.com](http://www.webopedia.com)
- [9].MedDb,"Comprehensive Solutions for Managing Data-Web Applications", Available at: [www.meddb.be/webapplications.aspx](http://www.meddb.be/webapplications.aspx), 2012.
- [10].J.D. Meier, Alex Homer and others, "Microsoft Application Architecture Guide", 3rd Edition, Patterns & Practices Developer Center, 2011.
- [11].Website Available at: [www.mobileinfo.com](http://www.mobileinfo.com)
- [12].Chet Hosmer and others, "Use of Mobile Technology for Information Collection and Dissemination", DAC Press, Data & Analysis Center for Software, 2011.
- [13].Protocols Website, WAP Wireless Communication, Available at: [www.protocols.com/pbook/wap.htm](http://www.protocols.com/pbook/wap.htm), 2012.
- [14].Official Mac App Store Preview, "Xcode", Available at: [itunes.apple.com/us/app/xcode/id497799835?mt=12](http://itunes.apple.com/us/app/xcode/id497799835?mt=12), 2012.
- [15].Apple Scientific Articles, "Xcode 4", Available at: [developer.apple.com/xcode/](http://developer.apple.com/xcode/), 2012.
- [16].Paul McFedries, "Mac OS X Snow Leopard in Depth Review", Que Publishing, 2009.
- [17].Official WebObjects Community Association "WOCCommunity", Available at: [www.wocommunity.org](http://www.wocommunity.org), 2012.
- [18].Official SQLite Website, Available at: [www.sqlite.org](http://www.sqlite.org)
- [19].Official Techcrunch Website, Market Share for iOS in Q3/2011, Available at: [techcrunch.com/2012/01/09/ios-marketshare-up-from-26-in-q3-to-43-in-octnov-2011/](http://techcrunch.com/2012/01/09/ios-marketshare-up-from-26-in-q3-to-43-in-octnov-2011/), 2011.