Current and Future Mobile Platforms

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Abstract—This paper gives the reader overview about nowdays most used platform for smartphone such as iPhone OS, Blackberry OS, Android OS, Symbian OS, and Windows mobile OS. This paper will also observe both the technical and market areas. Questions like "Which is required for the developers to develop an application in certain platform or how can the developers publish their application" will be here explained. At the very end will also the future mobile platforms such as iOS 4 and Windows Phone 7 be discussed.

I. INTRODUCTION

A. Motivation

With the progress of the internet , 3G and the introduction of 4G networks is the using of smartphones and its services become more and more popular. People can easily access their mailbox and answer emails with their phone. A lot of useful services e.g Location Based Services, weather services, or transport informaton services which can give many useful information to the user are developed and offered nowdays and in the future.

Mobile Services make life easier, simpler, and more effective. People can access internet services everywhere and everytime they want. But services or applications for mobile purposes such as applications in smartphone are still behind compare to applications on PC or laptop because of the limited hardware, computation power, battery, etc. Therefore making applications/services running in smartphone faster, more convenient, more secure are todays challenges for mobile applications and mobile operating system developers.

There are several mobile platforms that developed and play an important roles in telecommunication. After read this paper, readers will have knowledges about technical design of the platforms and have the comparison in technical and business area. We will know how to develop applications on certain platforms and how to publish our applications.

B. Smartphone definition

Smartphone is a device that combine the ability from cell phone and Personal Digital Assistent (PDA). Cell phones were used for making calls, sending SMS, and not much else. While PDA could store contact information, send and receive email with wireless connectivity, and syncronize with computer. A smartphone run complete operating system software providing a platform for application developers and allows the user to install and run applications.

II. CURRENT MOBILE PLATFORM

Customers and users that use smartphone have changed pretty dramatically over the last few years. If we looked at late 1990s and early 2000s, it was only the business people that can afford it. The first smartphone was IBM simon and lauched in 1993 in 15 US states. It was originally prices at $899. With such a high price was the use of smartphone was limited to certain people. And then Nokia introduced its first smartphone which called Nokia Communicator in 1996.

With the progress of internet and the benefit of intelligent network[1] in the late 1990 has the development of smartphone grown rapidly. People become to think that they can use their phone more just only to make a call, send SMS or to read emails. iPhone that released on June 2007 made the big breaktrough in smartphone development. And then the introduction from application store on July 2008 become the use of smartphone more and more popular. Many developers started to develop mobile application and therefore many services can be provided by the smartphone nowdays. With access to the internet, we can know the schedule of public transportation in our city. We can buy online ticket and even we can know whether there is a delicious restaurant around us.

Like our personal computer at home, every smartphones need operating system and can't work without it. The common feature of operating system is for example process management, interrupts handling, memory management, file system management, graphical user interface, etc.

If we look at the Figure 1 and 2 from Gartner[2], we know that Symbian OS, Blackberry OS (RIM), iPhone OS, Android OS, and Windows Mobile OS are the most used mobile operating system for smartphone nowdays. Symbian is losing its market share from 47% to 44%. Even though Symbian is losing its market share, with 44% it is still far above most used OS compare with the othe OSs. RIM and Windows Mobile lost also a little bit of their share. Only iPhone and Android made a progress especially for Android with 6% increase.

In the next subsection we will see quick overview about the history and layer structure of all these OS.

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[1]Intelligent Network (IN) is a network architecture for both fix and mobile network that allow provider to create and deploy services quicker and easier.

[2]Gartner is an information technology research and advisory firm headquartered in Stamford, Connecticut
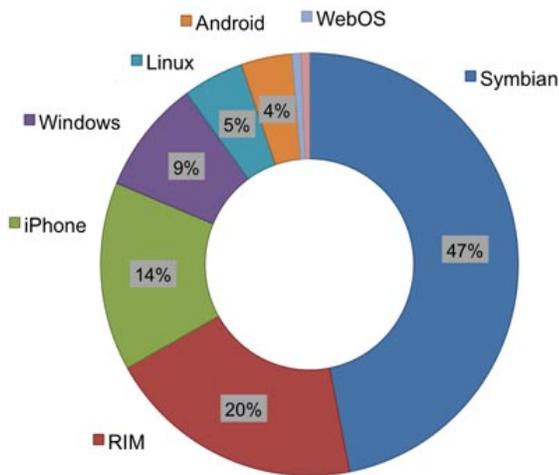
Figure 1. Share of 2009 smartphone shipments by operating system, by Gartner
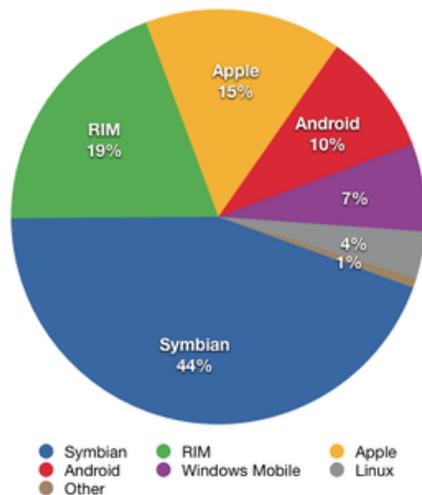

Figure 2. Share of 2010 Q1 smartphone shipments by operating system, by Gartner

A. Symbian OS

Symbian is the most used operating system for smartphone even though symbian is losing its market share lately. It was originally developed by Symbian Ltd. and then by Symbian Foundation. Symbian runs on several smartphone like Nokia, Samsung, Sony Ericson, etc. Most of Nokia's handy run Symbian and Nokia is the biggest phone's manufacturer. Therefore Symbian is the most used mobile OS until now. There are currently three layers within the Symbian platform[1]:

- OS Layer
- Middleware Layer
- Application Layer

The OS layer includes the hardware adaptation layer (HAL) required to support a specific hardware platform and which abstracts all higher layers from actual hardware and the Symbian kernel including physical and logical device drivers. It also includes low-level OS services such as frameworks, libraries and utilities, which turn the abstracted hardware and OS mechanisms into a programmable interface. It also provides all higher-level OS services across a full range of technology domains such as communications, networking, graphics, multimedia,etc.

The middleware layer represents the functionality that is independent of UI and applications. It provides services to applications (that is, programs with which the user can interact through a user interface) and other higher-level programs. It is independent of hardware and uses the hardware-abstracted services provided by the OS layer. Services in this layer can be specific application technology such as messaging and multimedia, or more general device services such as web services, security, device management, IP services.

Application layer contains all the applications available as part of the Symbian platform, such as the organizer application suite, multimedia applications, telephony and IP applications, and applications for controlling device settings. Many applications also provide programmatic interfaces to allow other applications programs to access their functionality, to support extensibility or customization.

B. Blackberry OS

Blackberry is the second most used mobile operating system after Symbian. It was developed by Canadia firm Research in Motion(RIM). This is a propietary OS and run only on Blackberry device. Blackberry is familiar with its supporting software like Blackberry Enterprise Server(BES), Blackberry Internet Service(BIS), and Blackberry Messenger. Every BlackBerry has an ID called BlackBerry PIN, which is used to identify the device to the Blackberry Messenger, BES, and BIS.

C. iPhone OS

iPhone OS is the operating system that developed by Apple Inc. The first iPhone OS was released on June 2007. This OS is programmed in C, C++, and Objective-C. The latest stable is 4.0. If we look at figure 3, there are four abstraction layer from this OS [2]:

- Core OS Layer
- Core Service Layer
- Media Layer
- Cocoa Touch Layer

The lowest layer is Core OS. This layer work with kernel environment, drivers, and basic operating system on iPhone. It manage memory, networking, file system and interprocess communication. In this layer we have the access to LibSystem library. LibSystem library provide access to the low level of the system :

- Threading (POSIX threads)

Figure 3. iPhone architecture

- Networking (BSD Sockets)
- File system access
- Standard I/O
- Bonjour and DNS Services
- Locale Information
- Memory Allocation
- Math Computation

Above the Core OS layer is Core services layer. This layer provides fundamental system services that all applications use and use frameworks such as Core Foundation framework, CFNetwork framework, and Security framework. Core Foundation framework manage :

- Collection data types
- Application Bundle support
- Data & time management
- Raw Data management
- Preferences management
- URL & Stream services
- Thread & Run-loop
- Port & Socket communication

CFNetwork framework manage:

- BSD Sockets
- FTP & HTTP(S) communication
- Bonjour Network services
- DNS Host resolution
- Encrypted SSL or TLS

And Security framework manage :

- Certificate & Key management
- Generate Pseudo-random numbers
- Keychain

iPhone OS use SQLite Library for database support and XML Library

The third layer is media layer. Media layer contain audio, video and graphic technology. The graphics technologies are Quartz, Core Animation, and OpenGL ES. The audio technologies are Core Audio & Audio ToolBox frameworks ad OpenAL. The video technology is MediaPlayer framework.

The toppest layer is Cocoa Touch Layer. This layer provides the primary classes for implementing graphical and event application on the iPhone. The most important framework in this layer is UIKit framework.

D. Android OS

Android OS is an open source mobile operating system that developed by Google and lately by Open Handset Alliance(OHA). Android has been available as open source since 21 October 2008. The entire source code is under an Apache License. The first phone that run Android was HTC Dream and released on October 22, 2008. The latest stable version 2.2 just came out on May 20, 2010 with the name Froyo based on Linux Kernel 2.6.32. The core of this OS is programmed in C and the User Interface(UI) is in Java. Some of the third party libraries are programmed in C++.
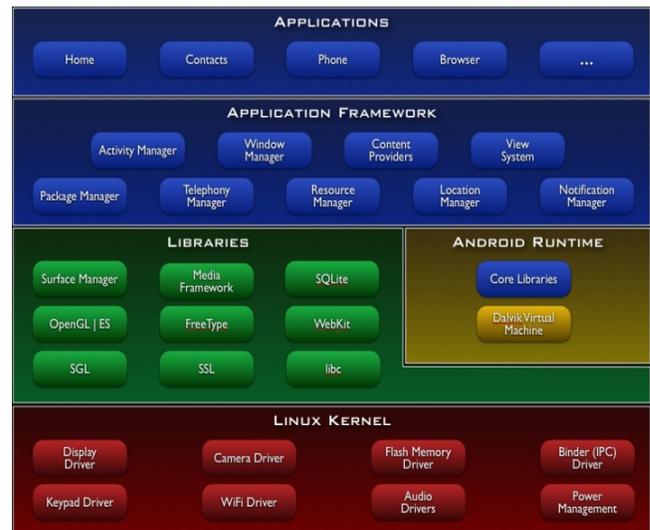

Figure 4. Android Architecture

If we see figure 4, Android OS consist of 4 layers [3]:
1) Linux Kernel
2) Libraries and Android Runtime
3) Application Framework
4) Applications

Android relies on Linux version 2.6 for core system services such as security, memory management, process management, network stack, and driver model. The run time environment is not in the pure java runtime environment but in Dalvik virtual maschine [3]. Dalvik has been written so that a device can run multiple VMs efficiently.The Dalvik VM executes files in the Dalvik Executable (.dex) format which is optimized for minimal memory and processor speed.

Android has a set of C/C++ libraries used by various components of the system. Examples of these libraries are SQLite, Media Framework and Webkit. SQLite support for database system. The media framework are based on PacketVideo's openCore which support playback and recording of many popular audio format. WebKit is open source library for the basic of creating a web browser.

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[3]Dalvik is the virtual maschine on Android mobile devices

The applications framework consist of classes and services that needed to create an applications. All Android applications are written in Java. Android offers developers to build various applications with an open development. The application layer is designed to simplify the reuse of components. Any applications can publish its capabilities and any other application may then make use of those capabilities. The applications including views that can be used to build an applications, including lists, grids, text boxes, buttons, and even an embeddable web browser. Content providers enable applications to access data from other applications or to share data with others. The resource manager providing access to non-code resources such as localized strings, graphics and layout files. The notification manager enable all applications to display custom alter in the status bar. The activity manager manages the lifecycle of applications and provides a common navigation backstack.

E. Windows Mobile OS

Windows Mobile is propietary mobile operating system developed by Microsoft. Windows Mobile run on several smartphone devices like Acer, Asus, HP, HTC, LG, Samsung, Sony Ericson, and Toshiba. The latest stable version is 6.5 based on Windows CE 5.2 kernel.

III. DEVELOPMENT

A. Hardware and Programming Language

1) Symbian OS: Most today PC are suitable for Symbian development. There are several development environment suitable like Visual C++, Visual Studio, Borland C++, or Carbide.c++ . The latest thing is to install the SDK from the manufacturer e.g Nokia SDK or Sony Ericson SDK.

2) Blackberry OS: RIM supports the developers in all level of experience. They offer several programs for developers to know and enhance their skills around Blackberrry application and functionality. These programs are categorized to free program, Blackberry Academic Program, Blackberry Independent Software Vendor Alliance Program, and Blackberry Solution Provider and System Integrators Alliance Programs.

Apps are written in Java language. RIM provides SDK for the developers that called Blackberry Java Development Environment (Blackberry JDE). BlackBerry JDE is a fully integrated development environment and simulation tool for building Java Platform, Micro Edition (Java ME) applications for Java based BlackBerry smartphones.The installation for JDE run only in Windows maschine. Technical requirements for the installation are [4]:

1) Windows 2000 SP1 or later, or Windows XP
2) Windows Vista (BlackBerry JDE v4.2.1 and higher)
3) BlackBerry JDE v4.5+: Java SE JDK v6.0
4) BlackBerry JDE v4.2.1 and v4.3.0: Java SE JDK v5.0 or v6.0
5) BlackBerry JDE v4.1 and v4.2: Java SE JDK v5.0
6) BlackBerry JDE v4.0 and v4.0.2: Java SE SDK v1.4

3) iPhone OS: In order to develop applications based on iPhone OS 3.2, the developer need following requirement [2]

- Mac maschine with an Intel-based Mac running Mac OS X Snow Leopard or later and iPhone
- iPhone SDK 3.2 that contains XCode IDE and iPhone Emulator
- The knowledge of Objective C Programming[4].

If they want to publish their applications in Apple app store, they have to join the iPhone developer program and purchase $99/year for membership. We will talk about this topic more detail in the section Apps Store.

There are 3 main sensors built into the iPhone that can perform several advantages :

- Proximity sensor : This sensor can determine how close the iPhone is to our face. With helps of this sensors, the iPhone can turn off its screen automaticaly if we hold the iPhone near to our ear. This can prevent accidental button clicks by the side of our head when talking and can extend the battery's life.
- Motion sensor / accelerometer : This sensor enables the iPhone's screen to automatically switch from landscape to portrait modes and back again based on whether we are holding the phone up or down or sideways.
- Ambient light sensor : This sensor can determine how much light is available in the surrounding area in order to extend the battery's life.

iPhone has also moisture sensor which capable to detect whether the device has been affected or damaged by water. The other sensors are assisted GPS and digital compass.

4) Android OS: Android applications can be developed in Windows, Mac, or Linux maschine. It gives the developer more choices unlike to develop applications on iPhone. But there are also limitations. Android SDK can be installed on Windows XP(32-bit), Windows Vista(32- or 64-bit), Mac OS X 10.5.8 or later(x86 only) and Ubuntu linux Hardy Heron[3]. Unfortunately it does't work on the earlier version.

The latest Android that has been released is Android 2.2. Java Development Kit(JDK) should first be installed on the maschine. The most easiest way to write, run and debug the code is with Eclipse IDE(3.4 or newer is recommended) with the Android Development Tools (ADT) plugin. The Android emulator is all included in the SDK.

If we look into the SDK, android.hardware.SensorManager is the class that permits access to the sensors available within the android platform. Not every Android device will support all of the sensors in the SensorManager. This class contains several contansts, which represent different aspects of Androids sensor system namely orientation sensor, accelerometer, light sensor, magnetic field sensor, proximity sensor, temperature sensor, pressure sensor, and gyroscope sensor.

5) Windows Mobile OS: In order to create Windows Mobile applications developers need Visual Studio 2005 or 2008. It will allow developers to author, debug, and package the

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[4]Objective-C is a reflective, object-oriented programming language which adds Smalltalk-style messaging to the C programming language

application. Microsoft provide also Windows Mobile SDK. The latest version is 6.0. And the latest things is developers need to have ActiveSync or Windows Mobile Device Center in order to deploy applications to Windows Mobile Device or to an Emulator. The supported operating systems for this development are Windows Server 2003 Service Pack 2, Windows Vista, Windows XP Service Pack 2[9].

B. Apps Store

1) Blackberry App World: Blackberry Ap World is application online store that provided by RIM in order to distribute Blackberry's applications from 3rd party developers to the users. This store was opened in April, 2009. In order to have applications published in Blackberry App World, developers must create a vendor account and submit the application for evaluation by RIM.

There is $200 administration fee to complete registration and submit applications[5]. Developers can publish their apps as free or paid apps. With initial fee of $ 200 developers will be allowed to submit 10 applications. If all 10 apps submissions have been done, they have to pay another $ 200 in order to be able to submit another 10 applications.

RIM will review a submitted application for content suitability and perform technical testing to ensure the application meets the BlackBerry App World Vendor Guidelines. Developers will get 70% of the applllication price and the rest 30% goes to vendor.

2) Apple App Store: Apple App Store is an online shop created by Apple Inc. which allows user to browse and download applications for iPhone from iTunes Store. This store is also accessible from iPhone application by the same name. In order to download applications from Apple apps store, users must have first iTunes store account that needs credit card number or Click-and-Buy acccount.

As of June 7, 2010 there are 225.000 apps in total on the apple store and has the number of downloads over 5 billion apps since its opening 2 years ago[6]. The developers can also publish their apps in apple store for free or paid. Apple allows 70% of sales revenues from the store to the seller and 30% go to Apple[7]. To get applications into apps store, developers are required to submit their apps and wait for approval or rejection. This process can take several weeks. The two most common reasons for application rejection are issues with core functionality and crashing. A large percentage of applications are rejected due to various types of crashes, including crashes on launch, which would have been found and dealt with if they had been tested on an actual device[8]. Apple prove not only the technical but also the content. If the applications contains adult material, they will reject this applications. This rule make the publishing apps in apple store stricter rather than android market. Before this process, they have to join the Apple Developer Program and pay 99$/year for membership for standard developer[2].

3) Android App Market: The biggest application store for androids is Android App Market . In order to download application by Android Market, android users have to register by

google checkout and have an google mail account. Developers can publish their applications on Android Market or in every website. Android Market is opener rather than Apple App Store. Applications are not controlled before they go to the market. Developers who want to publish their applications by Android Market have to pay 25$ one time as a membership and have google mail and google checkout account. They receive 70% of the application price and the remaining 30% distributed between carriers(5). By 8 June 2010, there were over 70.000 applications available for download in the Android Market.

Unlike Apple that has only one store, people who develop Android apps can publish their apps in more than one store. There are others market areas for Android apps such as AndSpot, SlideMe, AndroLib, AppBrain, etc. Apps that are published in Android Market are not controlled by authorized people and therefore all of these market can grow rapidly in the next few year and of course there will be also bad applications in Android market compare to others like Apps Store or Blackberry App World.

4) Windows Mobile Marketplace: Microsoft allows the third party developers to put their Windows Mobile applications to the store called Windows Mobile Marketplace. This store began on operation on 6 October, 2009. Developers can submit their apps as paid or free applications. They have to pay $99 for annual fee in order to be able to submit the apps. And the submissions are limited to 5 applications within 1 year[10]. The sales revenue split is 70 to 30 where the developers get 70% and the other 30% goes to the carriers.

5) Nokia Ovi Store, Samsung Application Store, Sony Ericson PlayNow Arena: Symbian applications can be downloaded from its phone manufacturer e.g Symbian that run on Nokia can download the applications from Nokia Ovi Store. The biggest app store for Symbian is Ovi Store. Ovi Store was released in May, 2009 by finnish firm Nokia. The other 2 big app stores for Symbian are called Samsung Application Store from Samsung and Sony Ericson PlayNow Arena from Sony Ericson.

The rules from each market are different each other such developers have to pay 50 euro for registration fee in Ovi Store, 1 euro in PlayNow Arena, and does not have to pay in Samsung Application Store. But the sales revenue split is for all these store is the same where developers get 70% and the rest 30% go to carriers.

C. Comparison

	iPhone	**Android**	**Blackberry**	**Symbian**	**Windows Mobile**
Developer	Apple	OHA	Blackberry	Symbian Foundation	Microsoft
Manufacturer	Apple	HTC, LG, Samsung, Sony Ericson, Motorola	RIM	Nokia, Samsung, Sony Ericson	Acer, Asus, HP, HTC, LG, Palm, Samsung, Sony Ericson, Toshiba
Programming language for apps developer	Objective-C	Java	Java	C++	C++, C#, VB.Net
Latest stable release	4.0	2.2	5.0.0		6.5.3
Application store	Apple App Store Release : July 10, 2008	Android Market Release : Oct 22, 2008 Others : AndSpot, SlideMe, AndroLib, AppBrain	Blackberry App World Release : April 1, 2009	Nokia Ovi Store Samsung Application Store Sony Ericson PlayNow Arena	Windows Mobile Marketplace Release : Oct 6, 2009
Available Apps	April 2010 : 225.000+	June 2010 : 70.000+ in Android Market			
Sales Revenue	70% to developers 30% to apple	70% to developers 30% to carriers in Android Market	70% to developers 30% to RIM	70% to developers 30% to carriers in Nokia Ovi Store, Samsung Application Store, Sony Ericson PlayNow Arena	70% to developers 30% to carriers
Apps developer charge	Standard program : $99/year Enterprise program : $299/year	$25/one time	$200/10 apps	Nokia Ovi Store : 50EUR registration fee Sony Ericson PlayNow Arena : free Samsung Application Store : $1 registration fee	$99/year which covers five application submissions to Windows Marketplace for Mobile.
Multitasking	no start with iOS 4: yes	yes	yes	yes	yes
Open Source	no	yes	no	yes	no
Latest SDK	iPhone SDK 3.2	Android SDK 2.2	Blackberry JDE 5.0	Carbide.C++	Windows Mobile SDK 6.0
supporting OS for development	Mac OS	Windows, Mac OS, Linux	Windows	Windows	Windows

IV. Future and Use of Mobile Platforms

A. iOS 4

iOS 4 is the newest mobile operating system from Apple that released on June 21 2010. iOS 4 works with iPhone 3G, 3GS, and the new iPhone 4. It does not work unfortunetely for the previous version. . Not all features are compatible with all devices. For example, multitasking is available only with iPhone 4 and iPhone 3GS. One of the new feature is multitasking. Multitasking is supported through the use of 7 background APIs namely : background audio, voice over IP, background location, push notifications, local notifications, task finishing, and fast app switching. iOS 4 does not support Flash or java but support HTML 5 and JavaScript as an alternative to Flash. Apple has also released iPhone 4 on June 24, 2010 that run iOS 4 as its OS. iPhone 4 is delivered with following hardware specification:

- 1 GHz Apple A4 Processor
- Retina display which is 3.5-inch widescreen multi-touch display that has 960-by-640-pixel resolution at 326 ppi.
- 512 RAM and 16GB or 32 GB flash drive
- 5-megapixel back camera with LED flash
- Camera records HD 720p video
- front facing camera
- Gyro sensor

The iPhone 4 adds another new sensor namely Gyro sensor. When combining the gyro sensor with accelerometer, this gives iPhone 4 six axes on which it can operate. This is designed to make iPhone 4 more sensitive, responsive, and powerful for gaming.

B. Windows Phone 7

Windows Phone 7 will be the future mobile operating system from Microsoft. Microsoft announced that the newest OS will be released in later 2010. There will be also new app store separate from previous store with name Windows Phone Marketplace. All applications that run must be first approved by Microsoft.

This new OS require at minimum hardware :

- 4-point multitouch screen
- 1 GHz ARM v7 Cortex/Scorpian or better processor
- Direkt X9 rendering-capable GPU
- 256MB of RAM with at least 8GB of Flash Memory
- Accelerometer with compass, light, proximity sensor and A-GPS
- 5-megapixel camera with flash; dedicated camera button required.

Upgrade from Windows Mobile 6 to Windows Phone 7 is not possible because there are not devices that run Windows Mobile 6 fulfil those hadware requirements.

C. Use of mobile platforms

1) Mobile Marketing: If we look at figure 5, in the future people will use mobile broandband more than fixed broadband. It means that mobile platform will be used to deliver more and more services and applications. And we look at figure 6 and
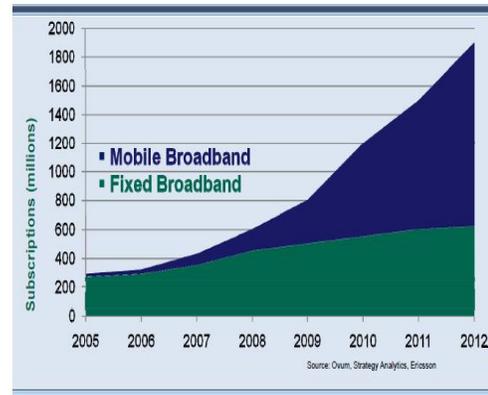
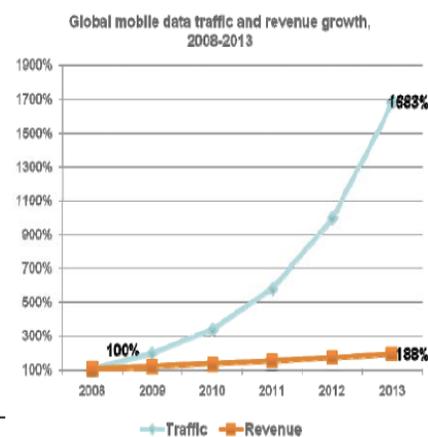

Figure 5. Mobile broadband growth 1

Figure 6. Mobile broadband growth 2

7, a huge mobile traffic data will be generated. The examples that will be given here are in the area of mobile marketing and mobile commerce. With the number of huge smarphone's users can advertisements be delivered to the consumers.

Mobile marketing can be described as all the activities required to communicate with the customer through the use of mobile devices in order to promote the selling of products or services. Two examples that will be given here is iAd and mobile couponing.

iAd is a advertising platform that provided by Apple. iAd allows developers to embed ads within apps. This method is used to help developers monetize free iPhone,iPod, and iPad applications. iAd advertisement ist different from the normal web advertisement . People create and use native application ofter rathen than web application in iPhone. Therefore adds will be displayed in native applications unlike in general web application. The app developer will get to keep 60% of gross revenue while Apple will get the rest 40%.

In general coupons and rebates are used to increase sales and promote consumer loyalty. The goals of coupons and rebate programs are usually the same and can include: encouraging
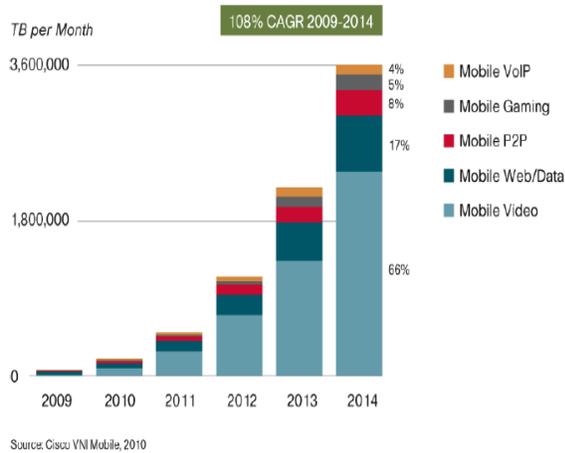
Mobile Traffic Forecast

Figure 7. Source: Cisco VNI Mobile, 2010

repeat purchase, increasing product awareness, getting consumers to try a new product, moving overstocked inventory, targeting specific markets, launching a new marketing campaingn, and responding to competitive pressure. A Mobile coupon is an electronic ticket solicited and delivered by mobile phone that can be exchanged for a financial discount or rebate when purchasing a product or service[11]. Mobile coupon has several advantages compare to traditional coupon namely the cost for printing and transport are for sure smaller and it can be delivered much faster to the client. Example for this approach is Coupies[12]. Coupies is platform for mobile couponing. Coupies is available in several mobile platforms like Android, iOS, and Windows Mobile. The prosedure is the user with the help of coupies's application can get several coupons rebate near from user's locations. Then the coupons can be downloaded and showed on the phone's screen. The consumer just have to show the coupon with the smartphone and get rebates.

2) Mobile Commerce: Mobile commerce is defined by the ability to conduct transactions using a mobile device. Telephone calls and emails are not only services that can be offered by smartphone. Transactions through the mobile phone such us mobile online banking, mobile payment, etc are the challenge topic in the future. E-commerce firm like Ebay, Amazon, etc have already built their own native application on the iPhone or Android.

V. Conclusion

As we have already seen that in the future the number of people who use mobile broadband is growing rapidly. It is implied that the use of smartphones and its services will be more popular. More and more interesting, useful applications will be developed. All of the mobile platforms that we have seen above offer SDK to the third party developers where developers can create and submit their applications. The differents are only the fee for the applications submission and the

policy of each store regarding acceptance or rejections of the applications. Apple with its apps store offer for now the most various applications compared to the other stores. But Android will make a strong competition with iOS and dominate the market share in the future because of its open development. Android apps can be developed in all of maschines unlike others. This advantage can draw more developers in the future and java is also the most used programming language nowdays and have a bright future. A huge number of new applications will be seen in Android market in the future because of less strict policy of acceptance compare to other stores. But there will be a lot of bad applications that will be appear in Android market and this will bring disadvantage for the users.

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