

A REVIEW ON THE EVOLUTION OF 1KG RED CLAY BRICK DEVICE INTO COOPERS LIGHTWEIGHT SMARTPHONES

C.R.Kavitha

Assistant Professor Senior,
Sri Lakshmi Narasimha College of Pharmacy,
Chittoor, Andhra Pradesh, India.

Abstract: The history of the mobile phone is both an interesting and mysterious one, because how come it's possible a 1kg Brick of handled Radio device in early 40's has become a Lightweight Smart phone. The earliest phones were massive pieces of machinery that steadily developed into smaller and smaller as portable and easy to handle one. Smartphone has become a part and parcel of living things to most people of this Cellphonic world. But very few of the Smartphone users can truly make out, how the evolution of this technology happened. In this article we are going to see the journey of Smartphone, how it's differ from the cellphone, who made and introduced the face of smart to the world, what are all the early models of Smartphones. The Physical size of the phone has shrink into small, but the logical view has become grown like stuffing a large things (Software's/Operating System) into a small hole.

Keywords: *Cellphone, iphone, Mobilephone, Operating Systems, Personal Digital Assistant, Smartphone*

I. INTRODUCTION

Smartphone can be seen as the latest revolution in Information and Communication Technology. Today Smart phones are considered to be powerful tool like notebook PCs/Mini Computers. It was 40 years over the cell phones and mobile phones became smart and increased their technical specifications [2]. Cellphone is a starter to find out the Smartphone, and processing of these Cellphone has become Mobile phone, at last the processing of Mobile phone gave Smart phone. The Lightweight Smartphone started its life from a weight of 1Kg Brick device. The very first mobile weighed half as much as red clay brick and was barely to handle and hard to trusted for long phone conservation. To make a conclusion for past two decades work in communication field, where the Chicago-based Laboratory was trying to beat the Legend of Communication at AT&T Bell Labs at making the first phone call through handled mobile device [1].

In simple Smartphone means 'a mobile phone with an advanced mobile operating system, which combines the features of a cellphone with other popular mobile devices' [3]. On other hand 'is able to perform many of the functions of a computer, typically and an operating system capable of running general-purpose applications' [4].

II. COOPERS FIRST CELL-PHONIC WORD

Alexander Graham Bell made a first phone call nearly a century before. But on April 3rd 1973 has become a lucky day to Martin Cooper, because it's lab at Chicago had beaten Graham's first phone call. Cooper, a Motorola Researcher and an executive made the first Mobile phone call from a handled device to his friend Rival Joel S.Engel at Bell Labs and said "Joel, this is Marty. I'm calling you from a Cellphone, a real Handheld Portable device". The conversation was really very short, but it has become a base to get a light weight Smartphone. In his 2012 interview Cooper reported that, he looks back on all that happened in the lab in Chicago and what really motivated the "little

company in Chicago" to take on the biggest company in the world. The idea behind to made a handheld device is much more sense of pride than first Cellphone call. That was to beat AT&T Bells Lab and to beat monopoly in Cellphone field and at last it was happened. Cooper also mentioned the reason why they built the phone was "to prove the world that you didn't have to have domination over the business; you didn't have to have those resources to make cellular reality" [1].

III. GROWTH HISTORY OF SMARTPHONES

1940s'

Handheld radio devices were available in the early 40s, and used for communication in World War II [1].

July 1946

AT&T commercialized Mobile Telephone Service (MTS), a VHF radio system that was linked to a switched telephone network. All calls were placed through a telephone operator [1].

Nov'1946

Motorola carried the first calls on Illinois Bell Telephone Company's new car radiotelephone service in Chicago [1].

1950s'

Commercial networks were deployed in Europe, Germany and Norway [1].

1960s'

IMTS was launched, Here 'I' standard for "Improved". The major improvement here was that though it linked to the switched network, it eliminated the role of an operator and allowed direct dial-in [1].

1970s'

1. The very first concept of a smartphone is said to have been visualized in the mid of 1970s', but that idea did not come onto culmination, almost 20 years later when IBM's Simon personal communicators first showed its face in 1992 [4].

2. Cellular telephones began in the 1970s' with the expansion of AT&T into the mobile telephone service market. Cellular telephones used analog technology at that time. This changed in mid 1995 when IBM developed technology that digitized information transmitted over the cellular telephone network and then became capable for transmitting both voice and data [13].

1971

In 1971 *Theodore Paraskevakos* merged the two concepts telephony and computing as one in a device. He was the first who introduced the current application at present we are using in the Smartphones like intelligence, data processing and visual display screen. His device was patented in 1974 and offered for sale in the beginning of 1993 [3].

1973

Till now, mobiles were basically car phones. The first handheld mobile phone was tested on April 3rd 1973. Motorola researcher "Martin Cooper" made a call to rival research laboratory at AT&T Bell Labs, informing them they had been beaten to it. The device weighed around 1Kg, and took 10 hours to recharge and was 9 inches long 5 inches deep and 1.75 inches wide. The charge lasted for just 20 minutes [1].

1979 (1G)

The First Commercially automated cellular network (known as 1G) was launched in Tokyo, Japan. Five years later, Japan had the first nationalized network. Later, Nordic Mobile Telephone launched fully automatic systems in Sweden, Norway, Denmark and Finland [1].

1983

It took nearly a decade for this invention to leave lab. Motorola's DynaTac 8000X sold for \$4,000. The charge lasted 30 min.(talk time), Six hours standby, and could store 30 phone numbers [1].

1990s (2G)

The 1990s saw cellular networks go digital. The European GSM standard and US CDMA standard both used digital transmission speeding up the signaling process. This led to the cell phone explosion [1].

1992

The first SMS was sent over Vodafone's GSM network in the UK on December 3rd 1992. Short and jolly, it read 'Merry Christmas'.

1993

1. Over the 90s, the phones got thinner, packed on more features and crunched more data; in effect, got 'smarter'.

2. IBM introduced Simon, and advertised as the world's first "smart phone". It had a phone, pager, touch-screen, QWERTY keyboard and basic applications that we now take for granted such as the calendar, clock, calculator and notepad. It also had a stylus and had predictive typing [1].

1995

The very magical and gigantic word 'Smartphone' that connecting people where ever they are and the universe on their palm was printed and pronounced in 1995, as describing AT&T's 'Phone Writer Communicator' as 'Smartphone'[3].

Mobile phones arrived in India on 30th July. The late Communist party (Marxist) leader Jyoti Basu and then Union Communications Minister Sukh Ram, made history when they exchanged pleasantries in the first mobile phone call in India [1].

1998

First 3G network launched by NTT DoCoMo in Japan. It used Packet switching networks. But as phones got hungrier and consumption increased, networks had to upgrade. 3G technology, which used packet switching rather than circuit switching for data transmission, was introduced [1].

2000

Ericsson R380 was released by Ericson Mobile Communications and it was marketed as a first smartphone [3].

2001

3G was made available commercially in Japan by DoCoMo on 1st October with wideband CDMA standard network [1].

4G

The first two commercially available 4G technologies were the LTE(offered by Scandinavia's TeliaSonera) and WiMax (offered in the US by sprint). Moving ahead from circuit switching 4G is an all IP network [1].

IV. SMARTPHONE ASSESSMENT

The Smartphones are evaluated on the same set of criteria which is used to compare computers (Laptops, Tablets) – Input devices, Battery life, Storage capacity, Performance, Physical factors, Price and Computer usage [5].

- **Input devices**
The physical keyboards provided by some Smartphones are small, designed for typing short phrase used in while searching text and electronic messages on Internet. Touch screens are easier to handle.
- **Battery Life**
The usage of battery on smartphone varies significantly depend on user activities. The call/talk time capacity of battery ranges for 7 to 17 hours,

the usage battery capacity on internet ranges from 4 to almost 5 hours and the charging time ranges from around 2 to 4 hours.

- **Storage Capacity**
Smartphones use solid-state drivers to store data, with capacities of 16 to 64 GB. Samsung and BlackBerry include slots for microSD cards that can hold up to 64 GB of data.
- **Performance**
Smartphone pack a lot of processing power into small space. Most of the smartphone possess 2GB RAM and multicore processors to handle most of the smartphone task efficiently. These performance features allow us to multitask as much as the operating system.
- **Physical Factors**
Smartphones are lightweight, designed to carry for long periods, about 4-6 oz. Their screens are much smaller than tablet screens, usually around 5 inches measured diagonally, though some approach in 7 inches. To compensate for small screens, smartphones increase the screen resolution, which is measured in pixels per inch (ppi). Resolutions higher than 300 ppi produce sharp, crisp images and easy-to-read text.
- **Price**
According to International Data Corp. the average price of a smartphone may fall into \$300 in 2017, because 80% of people ages from 18 to 24 had a smartphone. Smartphone manufacturers must compete on prices as well as other factors to win new customers and retain current ones.
- **Computer Usage**
Instead of using computer only to access the Internet and Communicate with others, then smartphone will be the best to replace the computer. Software for smartphone is limited by screen size and RAM. If you need to use more productive or full-featured software, purchase a smartphone as a supplement to another personal computer.

V. TECHNICAL SPECIFICATION OF SMARTPHONES

In today's mobile world, the Consumer Electronics serve multipurpose mobile devices to the mobile lovers. Cellular phones (also called Cell phone or Mobile phone) served for one purpose only. That is, they let you to send and receive voice communications. But the revolution in communication devices, the mobile phones and similar devices are equipped with customized Software, Internet access, Digital cameras; Portable music players, Global Positioning System (GPS) functions and many more options like send and receive calls, e-mail messages and text messages [5]. The technological advancement makes common terminology such as Mobile phone, Smartphone, PDA(Personal Digital Assistant) phone to difficult to understand as each type of device changes its traditional features constantly, belonging to one type of devices are now found on others. Here the popular categories of mobile communications devices and

its similarities, differences between some of the products are explored.

1. PERSONAL DIGITAL ASSISTANT (PDA)

A Personal digital assistant is probably the most commonly used small mobile computing device or handheld PC or personal information manager next to a cellular telephone. PDAs are lightweight and small enough to fit in a pocket and they run essential applications. PDA is a generic name that applies to simple digital telephone directory and to more elaborate mobile computing devices that run a spreadsheet, word processor, email and a variety of customized program [13].



Figure1. Personal Digital Assistant

All PDA devices are small computing devices that contain an operating system, processor memory and a port to connect the PDA to peripherals and external computing devices. There are three commonly used operating systems on PDA : EPOC, Palm OS and Windows CE. EPOC is used in the Psion product line, Palm OS in the PALM OS in the PALM PDS and Windows CE on Various pocket PC devices [13].

Memory is precious in a PDA. A PDA does not have permanent storage, therefore all the applications and data running in a PDA must reside in memory. PDA use ROM and RAM. ROM is used to store bundle applications like: word processor, spreadsheet, diary, telephone directory and other kinds of programs that you expect to find a PDA. Applications that are not bundle with the PDA and data for all applications including those that reside in ROM, are stored in RAM.

PDAs use one of three types of RAM: Dynamic RAM (DRAM). Enhanced Data Output (EDO) and Synchronous Dynamic RAM (SDRAM). DRAM is the least expensive RAM. EDO is found in some PDAs and SDRAM is rarely used. The amount of RAM that affects performance depends on the PDA's operating system [13].

Some PDAs have an expansion slot for Compact Flash(CF+) cards that contain components such as modem, cellular telephone, network card used to connect to a local area network or additional memory that slips into an expansion slot on the PDA to enhance PDA's family. PDAs have the same problem as all mobile devices. They need batteries to operate and they drain batteries quickly. And it also don't have a user-friendly keyboard to enter data [13].

2. IBM SIMON (1993)

IBM developed a prototyped first mobile phone in 1992 and introduced in market with the name 'Simon Personal

Communicator' in 1994 by BellSouth [3]. The word 'Smartphone' was predated by IBM Simon (coined by Ericsson's GS88 prototype), but it's widely considered as the first true Smartphone. Simon had a monochrome touch screen, a stylus and a charging base station [4]. This device can run familiar applications like: Email, Calendar, and Address book, calculator, notepad and a stylus input for handwritten notes [2].

Dimensions	: 8 inches by 2.5 inches by 1.5 inches thick
Weight	: 18 ounces
Processor	: 16 MHz Vadem processor
Memory	: 1 MB
Storage	: 1MB
Battery Life	: 1 hr



Figure2. IBM Simon Personal Communicator

3. NOKIA 9000 COMMUNICATOR (1996)

In 1996 Nokia entered into the competition of developing an all purpose handset, where smart phones are not yet developed [4]. Today it's not considered as an innovative model, but there was a time when the finished mobile device maker pushed the envelope like: the Nokia 9000 communicator was the first Smartphone to feature a full QWERTY keyboard with an outward facing dial pad, navigation keys, and monochromatic display [4]. It requires a touch screen like IBM's Simon, but the Smartphone features included email, calendar, contacts and notepad widgets [2].

Dimensions	: 6.8 inches by 2.5 inches by 1.5 inches
Weight	: 14 ounces
Processor	: 24MHz Intel 386EX processor
Memory	: 8MB
Storage	: 0
Battery Life	: 3 hrs. of talk time



Figure3. Nokia 9000 Communicator

4. PALM KYOCERA 6035(2001)

Kyocera's Palm-powered device is considered to be the "First modern, Mass-Marketed Smartphone". The Kyocera 6035 was released in the 2001 and ran on Palm 3.5 operating system. The device had phone, PDA and pager functionality, web browser capability and email, address book, Scheduler Memo pad and even voice recording. It can run hundred of Palm device was novel at the time because it introduced the model of installable software on a phone [2]. Vertically oriented cell phones with hinges at the bottom of the phone which allowed the dial pad to flip down and expose a much larger touch screen beneath [4].

Dimensions	: 5.6" by 2.5" by 0.86 inches
Weight	: 7.34 ounces
Processor	: 33MHz Free scale Dragon ball processor
Memory	: 8MB
Storage	: 0
Battery Life	: 5 hrs. of talk time



Figure4. Palm Kyocera 6035

5. BLACKBERRY 6210(2003)

Blackberry formerly known as "Research in Motion"- the very first device is Black Berry 850 a two way pager released in 1999. The globally popular devices of this series are monochrome 6200 and color 7200. Due to heavy focus on email with spacious keyboards, Black Berry became a well know brand in the market [4]. It started out making email devices and two-layer pagers and then added cell phone technology later. After two years of Kyocera's 6015, the processor speed and memory size of Smartphone are increased. It's the first "Smartphone with integrated", stand-alone phone capabilities was 6210 [2]. Black Berry peral8100 and curve 8300 series were designed to accommodate to the mass consumer market [4]. Black Berry latterly gained popularization in America and users of this country popularized it as 'CrackBerry' in 2006 due to its addictive nature. The company released BlackBerry 6210, BlackBerry 6220 and BlackBerry 6230 devices in 2003[3].

Dimensions	: 4.40" by 2.90" by 0.80 inches
Weight	: 4.8 ounces
Processor	: 75-100MHz ARM7EJ-S core Processor
Memory	: 2MB
Storage	: 16 MB
Battery Life	: 5 hrs. of talk time



Figure5. BlackBerry 6210

Dimensions	: 4.88" by 2.49" by 0.43 inches
Weight	: 4.9 ounces
Processor	: 1GHz Nvidia Tegra2(dual Core Processor)
Memory	: 512MB
Storage	: 8GB
Battery Life	: 8 hrs. of talk time

6. APPLE IPHONE(2007)

Apple launched its iphone in the smartphone market in june 2007. It combined powerful multimedia functions with the same email and web browsing features as all other Smartphones previously had. It is a finger- friendly user interface with digitizer display. Like before phone it had only one button ot its face, a home button and three around its edges, two for volume up/down and one for power/standby [4]. The first generation iPhone didn't break many technical barriers, but it would become popularized because of its touch screen technology. "This is the first Smartphone offered 16GB of Internal Storage and lash out the trend of faster processors, more memory and higher storage capacity". The resolution of touch screen display is 320 x 480. The concept of tick, light and sleek smartphone took off, and the rest is in history [2].

Dimensions	: 4.5" by 2.4" by 0.46 inches
Weight	: 4.75 ounces
Processor	: 412MHz Samsung RISC ARM Processor
Memory	: 128MB
Storage	: 4, 8 or 16 GB
Battery Life	: 8 hrs. of talk time



Figure6. Apple Iphone

7. LG OPTIMUS X2 (2011)

After the arrival of iPhone, as soon as a torrent of new Smartphone hit the market and pushed the technical specifications further advanced. The bigger achievement is, found of Nvidia's Tegra2 'System-on-a-chip' (SoC), the first Dual-core mobile processor. The first benefit of found of dual core processor is invention of LG's Optimus X2, an Android super-phone with some attractive features. This kind of Smartphone's camera also supported HD video recording. LG's device supported 1080p HD video playback and came with a mini-HDMI port. To support the dual-core processor the Optimus X2 received a sizeable increase in memory [2].



Figure7. LG Optimus X2

8. SAMSUNG GALAXY S4 (2013)

"Samsung Galaxy S4 is the first Smartphone with an Octo-core processor". The International version of this device runs Samsung on Exynos octa chip, with two categories: Faster 1.6 quad-core ARM Cortex-A15 cluster for heavy lifting and, the second category is Slower 1.2 quad-core Cortex-A7 cluster for more energy efficiency. This means the battery life is very longer and the processing power is double the RAM of most phone have. The touch screen of this king of phone is super AMOLED with 1080 x 1920 resolution and full HD video support [2].

Dimensions	: 5.38" by 2.75" by 0.31 inches
Weight	: 4.6 ounces
Processor	: 1GHz Nvidia Tegra2(dual Core Processor)
Memory	: 2GB



Figure8. Samsung Galaxy S4

VI. OTHER MOBILE DEVICES

Other than Laptops, Tablets smartphone include Electronic book readers (e-reader), Media players and handheld game devices. Many of these mobile devices provide wireless connections to the Internet, but do not include other features or capabilities that mobile computer have. For example you cannot install productivity applications or other software on a handheld game device. Instead, each of these devices is dedicated to a particular purpose, and only les you to perform task related to that purpose. Features of these other mobile devices include the following [5]:

- E-book readers (e-reader)

E-book readers are used to down-load and read electronic versions of printed books, magazines and newspapers. Most e-book readers have touchscreens, instead some have buttons and a small touchpad to navigate to digital media. E-book readers are usually smaller than a tablet, but larger than a smartphone, and include a hard driver with up 4 GB of storage capacity. When using LCD screen e-book readers use electronic paper display, which consume less power and provide higher contrast than LCDs. Many e-book readers also offer backlight to improve readability when the light is low.



Figure9. E-book reader

- Portable media player

A portable media player is a mobile device that can store digital media such as songs, videos and photos, typically on a small hard driver. IT is also called as MP3 player, a term that refers to the MP3 file format used for many digital audio files. Some portable media player, such as the iPod also plays audio files in other formats.



Figure10. Portable media player

- Handheld game device

A handheld game device is a mobile device designed for a single video game player to use at one time. Many handheld game devices can connect to the Internet and to other game devices so that the user can play against others who are using their game device at the same time. In smartphone, these devices include built-in screens, speakers, batteries and controls in one unit. Recent models provide touch screens and up to 16 GB of data storage.



Figure11. Handled Game Device

VII. OPERATING SYSTEM OF SMARTPHONES

A mobile operating system is designed for a small handheld computing device such as a smartphone or tablet. Operating systems may fall into four major categories, which depend on the types of device for which they are designed like Personal Computers, Mobile computing devices, Servers and devices other than computers. When you purchase a mobile device or personal computer the operating system is already installed. A mobile operating system is designed for a system includes features similar to a personal operating system, but is significantly simple and smaller. Mobile operating systems are designed to fit into the limited memory of mobile devices and work well with mobile hardware features [5].

Smartphone is a Mobile phone that operates on an Operating System, similar to a mini computer. The most important software in any Smartphone is an Operating System. An operating system manages both the Hardware and Software resources of the Smartphone. It offer a variety of features such as, calling capabilities, computing capabilities, video conferencing, online surfing, cameras, media players, GPS navigation units, etc. Any mobile phone that lets you to do the work of a computer is considered as a Smartphone [1].

The following figure 12. depict how mobile operating systems are classified based on their rapid usage among smartphone users. In continued at present movable mobile operating systems are given, at the same time the operating system which are not at present in the mobile market usages are listed.



Figure12. Types of Mobile Operating System

Smartphone's are powered by operating systems such as Android, iOS, Windows Mobile, Nokia's Symbian, RIM's BlackBerry, Samsung's Bada, Microsoft's Windows Phone, Hewlette-Packard's webOS, and embedded Linux distributions such as Maemo and MeeGo. Such operating systems can be installed on many different phone models, and typically each device can receive multiple OS software updates over its lifetime. A few other upcoming operating systems are Mozilla's Firefox OS, Canonical Ltd.'s Ubuntu Phone, and Tizen Worldwide sales of Smartphone's overtook those of feature phone in early 2014 [1].

7.1. CONTINUED

7.1.1. Android

The ruler of at present mobile word is Android operating systems founded by Andy Rubin in October 2003 and owned by Google [3]. Millions of people are using mobile devices, smart phone and tablet computers. Android Inc. Google purchased this Android operating system from its initial developer in 2005 [6]. Android is running on Linux kernel and mainly used in mobile devices. It was bought by Google on August 17, 2005 and constituted on November 5, 2007[7]. The first Android operating system mobile was launched in October 2008 with the name 'HTC Dream' (also called as T-Mobile G1) and populared in 2010 and mobile market has been dominated by this operating system [3].



Figure13. Android insignia

More than 80 hardware, software and telecommunication companies joined with Google and formed a consortium called as 'Open Handset Alliance (OHA)'. The OHA is a consortium of big companies like Broadcom Corporation, Google, HTC, Inel, LG, Marvell Technology Group, Motorola, Nvidia, Qualcomm, Samsung Electronics, Sprint Nextel, T-Mobile and Texas Instruments [6]. The source code of Android was released by Google in the authorized way of Apache free open source license [7].

The Android Open Source Project (AOSP) led by the Google is responsible to maintains, develops and updates Android from time to time. The main goal of AOSP is to provide a really useful and successful real-world system for the mobile and the smart phone user. The Application Programming Interface (API) for Android is written in C and the application software has Java-compatible libraries [6].

Android Application Components and architecture:

Android System architecture uses a layered architecture to form a very clear hierarch. The following illustrates the Android system architecture, it has five layers namely: Application layer(Applications), the Application

frame(Application Framework), System Runtime layer (Libraries and Android Runtime) and the Linux Kernel Layer (the Linux Kernel) from high level to low level [7].

Android applications are composed of components and its classified into four types: Activities, Services, Content Providers and Broadcast receivers [6]

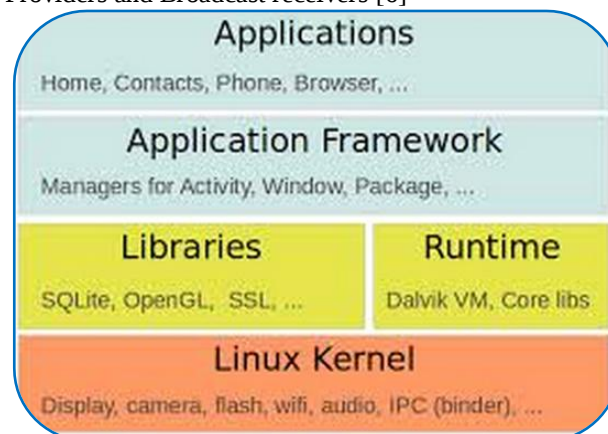


Figure14. Architecture of Android Operating System

Activities: single screen with an user interface example, email application- this activity of this application can be listing newly received emails or writing an email or reading an email. Each activity is independent of the other one.

Services: It's performed in the background, while writing or executing long running user programs. Example- fetching data from a network without coming in the way of user current activity.

Content Provider: It's deal with shared set of application data. Using this other applications can access your data and can even modify it, if permission is granted.

Broadcast Receivers: This is used respond to system-wide broadcast announcements and responds accordingly.

7.1.2. iOS

It stands for iPhone Operating System (iPhone OS). The first multi-touch interface 'iphone' was introduced and developed by Apple firm in 2007. In 2005, Steve Jobs had two choices to launch the iPhone, either shrink the Mac OS or enlarge the iPod. The decision enabled the success of the iPhone as platform for the third party [9].

In June 2010, Apple rebranded iPhone OS as 'iOS'. This trademark 'IOS' had been used by Cisco for over a decade for its operating systems on routers. Apple licensed the IOS trademark for Cisco [9].

Apple iOS has still not allowed any other manufacturer to put down hands on its operating system. [Unlike Android, Apple has concentrated more on the platform rather than appearance. This is the reason that the basic appearance of iOS is almost the same as it was born in 2007 [10].

Instead of its stylus, iOS was useful for its large touch screen through direct fingering inputs. In June 2007 Apple announced that the iPhone would support third-party "web 2.0 applications" running in its web browser that share the look and feel of the iPhone interface [3].

The user interface of iOS is based on the concept of direct manipulation, using multi-touch gestures. Multitasking implementation in iOS has been first released in June 2010 along with the release of iOS4.0.. In iOS, there are four abstraction layers, they are Core OS layer, Core Services layer, Media layer and the Cocoa Touch layer. Major versions of iOS are released annually. The current release of iOS 8.4 was released on June 30, 2015 [9].



Figure15. iOS insignia

iOS and OS X are based on the NeXTSTEP Operating System by NeXT Computer Inc., which was founded by Steve Jobs after he left Apple in 1985. iOS was later derived from OS X, and it is Apple's OS for mobile devices and at that time it was called as iPhone OS and latterly renamed to iOS to better reflect the fact that it runs on other mobile devices, such as iPod Touch, the iPad and Apple TV. iOS was built specially for mobile device with touch interfaces [12].

iOS Architecture

Major versions of iOS are released annually. In iOS, there are four abstraction layers: the core OS layer, the Core Services layer, The Media Services layer and the Cocoa Touch layer [9].

The iPhone OS is a variant of Apple's Mac OS X operating system that has been adapted to run on the iPhone. It is built upon a 'UNIX-like' foundation called Darwin and consists of the Mach Kernel, core services and media layers and the Cocoa Touch interface [11]. iOS shares some framework with OS X such as, Core Foundations, Cocoa Touch rather than OS's Cocoa [9].

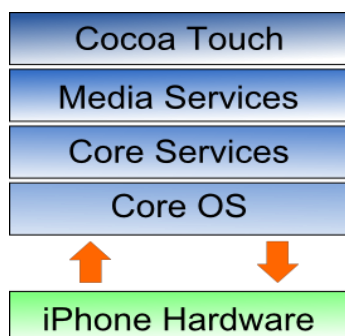


Figure16. Architecture of iOS Operating System

Cocoa Touch Layer:

The Cocoa Touch layer is placed at the top of the iPhone OS stack and contains the frameworks that are most commonly used by iPhone application developers. Cocoa Touch is primarily written in Objective-C, and it is based on the

standard Mac OS X Cocoa API and has been extended and modified to meet the needs of the iPhone [19].

Media Service Layer:

The role of the Media layer is to provide audio, video, animation and graphics capabilities. As with the other layers comprising the iPhone OS stack, the Media layer comprises a number of frameworks that can be utilized when developing iPhone apps [20].

Core Service Layer:

The iPhone Core Services layer provides much of the foundation on which the above layers are built [21].

Core OS Layer:

The Core OS Layer is the bottom layer of the iPhone OS stack and placed directly on top of the device hardware. The layer provides a variety of services including low level networking, access to external accessories and the usual fundamental operating system services such as memory management, file system handling and threads [22].

7.1.3. Windows Phone/ Windows OS

Windows Phone (WP) is family of mobile operating system developed by Microsoft for smartphones as the replacement successor to Windows Mobile. It introduced a new features of user interface derived from Metro design language [14]. In 2003 the Pocket Pc, are renamed to Windows Mobile [4]. The next generation mobile operating system 'Windows Phone' was released in February 15th 2010. This operating system includes completely over lifted 'Metro Design Language' of Microsoft services such as: Microsoft SkyDrive and office, Xbox Music, Xbox Video, Xbox Live games and Bing and also the non-Microsoft services such as Facebook, Twitter and Google accounts. On October 28th 2012 Microsoft released the next generation OS Windows Phone-8 which replaces its previously windows based architecture based on the Windows NT Kernel [3].



Figure17.Windows Phone insignia

Microsoft started a new operating system from scratch, named Windows Phone. Nokia abandoned Symbian and partnered with Microsoft to use Windows Phone on its smartphones and this operating system became the third most popular OS. In February 2011, Nokia announced that it would replace Symbian with Windows Phone as the operating system in all of its future smartphones, with the platform abandoned throughout the following years [3].

The familiar window operating system is used in computers all over the world. Microsoft and Nokia joined their hands together to give very powerful devices. Nokia Lumia series is completely windows based. Some of the latest windows phones are Nokia Lumina 800, Nokia Lumina 900, Samsung Focus and HTC Titan 2 [10].

7.1.4. RIM's BlackBerry

Blackberry is a line of wireless mobile devices developed by a Canadian company RIM which stands for 'Research In Motion'. Black Berry Operating System is a proprietary Mobile operating system developed by BlackBerry Ltd., for its BlackBerry Smartphone handheld devices. The very first RIM device was the Interactive Pager 900, a clamshell type device that allowed two-way paging announced on September 18, 1996 [17].

RIM released its first BlackBerry device in 1999, as a two-way pager in Munich Germany. to secure real-time e-mail communications on wireless devices. RIM changed its platform and releasing out new devices in the name of 'BlackBerry'. The name BlackBerry was coined by the marketing company Lexicon Branding. The updated version of Black Berry OS are: version 3.6, released in March 2002 on Black Berry 5810 series and version 5.0 in August 2008 and versions 6.0, 7.0 and 7.1 in Jan' 9th 2011. The original BlackBerry devices RIM 850 and 857 used the DataTAC network [17].

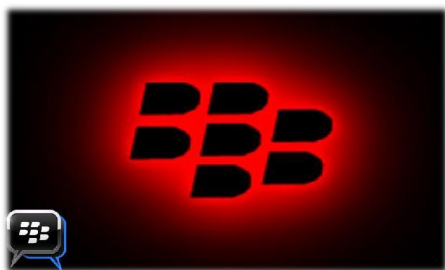


Figure18. BlackBerry insignia

Every BlackBerry device has a globally unique personal identification number (PIN) that identifies the devices for both messaging and management. Unlike a bank account PIN, the BlackBerry PIN is public. Users employ PIN to find each other over BlackBerry Messenger and administrators can use PIN to identify the devices they are managing [18].

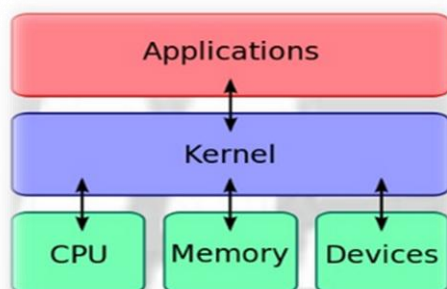


Figure19. Architecture of BlackBerry Operating System

The BlackBerry OS is a modern Operating System with features such as multitasking, interprocess communication (IPC) and threads. All OS and device features are accessed using RIM and J2ME APIs. Each BlackBerry has two

different types of memory: falsh and SRAM. Flash memory is nonvolatile and persists even when the devices power runs out. The BlackBerry OS, applications and long lived data such as e-mail anre stored within flash memory. SRAM is used to store runtime object data and holds slots for external flash memory cards [18]. Black Berry is much different from other operating systems. Like Apple, BlackBerry OS is a close source OS and is not available for any other manufacturer [10].

7.1.5. Firefox OS

Firefox OS is designed to provide a complete, community-based alternative system for mobile devices using open standards and approaches such as HTML 5 applications. On July 25, 2011, Andreas Gal, Director of Research at Mozilla Corporation, announced the "Boot to Gecko" Project (B2G) on the Mozilla platform mailing list. The proposal of project was to 'pursue the goal of building a complete, standalone operating system for the open web' in order to "find the gaps that keep web developers' [27].

Firefox OS was demonstrated by Mozilla in February 2012. The first commercially available Firefox OS phones were ZTE Open and Alcatel One Touch Fire. As of 2014 more companies have partnered with Mozilla including Panasonic (which is making a smart TV with Firefox OS) and Sony. In July 2012 Boot to Gecko was rebranded as 'Firefox OS' after Mozilla as became well-known desktop browser [3]. On July 2, 2013, Telefonica launched the first commercial Firefox OS based phone. Mozilla has also partnered with T2Mobile to make a Firefox OS reference phone christened as "Flame" which is designed for developers to contribute to Firefox OS and to test apps.



Figure20. Screen shot of Firefox

The current set of Firefox OS is completely open standards and there is no proprietary software or technology involved because the software stack is entirely HTML 5. This OS contains three major software layers in its architecture:

Gonk: platform denomination for a combination of the Linux Kernel and the HAL from Android. Gecko: the web browser engine and application run-time service layer. Gaia: an HTML 5 layer and user-interface system [27].

7.1.6. Sailfish OS

Sailfish Operating System is a Linux-based general-purpose operating system, widely known as a mobile operating system and combining the Linux kernel for a particular hardware platform use, the open source Mer core middleware, contributed by Jolla. Sailfish is being developed by Jolla in permanent cooperation with the Sailfish community and the Mer project and its community and corporate members of the Sailfish Alliance and various open community members. Sailfish is used in the Jolla smartphone, the upcoming Jolla Tablet.



Figure21. sailfish insignia

The Sailfish OS and the Sailfish software development kit (SDK) are based on the Linux kernel and Mer. Sailfish OS includes a multi-tasking graphical shell called "Lipstick" built by Jolla. Jolla uses free and open-source graphics device drivers but the Hybris library allows use of proprietary graphics device drivers for Android. Jolla's stated goal is for Sailfish to be open source eventually. It can run on Android applications through a proprietary compatibility layer [28].

7.1.7. Tizen OS

On January 1, 2012, the LiMo Foundation was renamed Tizen Association. The Tizen Association is led by a Board of Directors from Samsung, Intel, Huawei, Fujitsu, NEC, Panasonic Corporation, Sprint SK Telecom, Orange, NII DoCoMo and Vodafone. The Tizen Association works closely with the Linux Foundation, which supports the Tizen open source project. On April 30, 2012, Tizen released version 1.0, code-named Larkspur.



Figure22. Screen shot of Tizen

Tizen is an operating system for devices including smartphones, tablets, in-vehicle infotainment (IVI) devices, and smart TVs. It is an open source system that aims to offer a consistent user experience across devices. Tizen's main components are the Linux kernel and the WebKit runtime. Tizen believe that the "future belongs to HTML5-based applications, outside of a relatively small percentage of apps, and we are firmly convinced that our investment needs to shift toward HTML5." Tizen will be targeted at a variety of platforms such as handsets, touch pc, smart TVs and in-

vehicle entertainment. Tizen provides application development tools based on the JavaScript libraries jQuery and jQuery Mobile [29].

7.1.8. Ubuntu OS

Ubuntu Touch (also known as Ubuntu Phone) developed by Canonical UK Ltd and Ubuntu Community. It is a mobile version of the Ubuntu operating system and it is designed primarily for touch screen mobile devices such as smartphones and tablet computers. The first version of was Ubuntu Touch 1.0 was released by Canonical on 17 October 2013. Followed by Ubuntu 13.10 that primarily supports the Galaxy Nexus and Nexus 4 phones were released on 17 April 2014 along with Ubuntu 14.04 [30].

When Ubuntu Touch is turned on no lock screen is necessary as applications will unlock if needed. The center of the "Welcome Screen" is a visualization of activity on the device. It shows your status and recent events on the welcome screen, completed with an animated design around the circle



Figure23. Ubuntu 13.04 Galaxy Nexus welcome screen

Ubuntu Touch was released to manufacturers on 16 September 2014. Ubuntu Touch uses the Qt 5-based touch user interface and various software frameworks originally developed for Maemo and MeeGo [30].

7.2. DIS-CONTINUED

7.2.1. Symbian

In 1998, Senior management and product architects from Ericsson, Motorola and Nokia decided to initiate the development of a new operating systems running on cellular phones from Ericsson, Motorola and Nokia were designed for simple user interfaces and telephony protocols. The aim was to create a next generation cellular phone operating system that would be an open standard to be adopted by the entire industry. EPOC (Electronic Piece Of Cheese), an operating system developed by Psion Software was selected as the baseline for Symbian OS. In February 2005 Symbian launched the latest version of Symbian OS, Symbian OS v9.1 [23].

Latterly passed and managed by Symbian Ltd., but currently maintained by Accenture. The first Symbian Smartphone with touch screen of Ericsson R380 model was released in 2000. And it was the first device marketed as Smartphone as well as world's most widely used Operating System. In 2010 Nokia released Nokia-N8 Smartphone, it is the first

device to run on the Symbian3 mobile operating system and the first Smartphone to feature a 12megapixel autofocus lens[3].



Figure24. Symbian insignia

From 1996 onwards Symbian was the number one Smartphone platform in market share but it was dropped into second place when Google's Android OS was released in 2011. In February 2011, Nokia announced that it would replace Symbian with Windows-Phone as the operating system on all of its future Smartphone's. On January 24th 2013, Nokia officially confirmed that '808 Pure-view' would be the last Symbian Smartphone. Symbian S60 is still remained as a popular operating system for business purpose in Nokia's Communicator series (E90) and Navigator series (N73, N93, N95, N97).

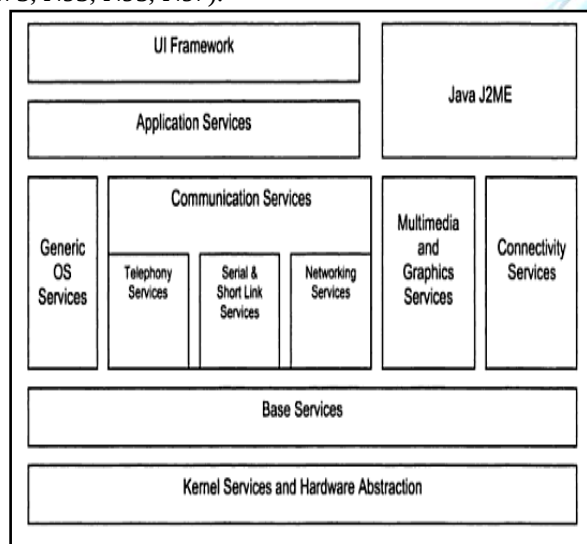


Figure25. Architecture of Symbian OS

7.2.2. Windows mobile

Windows Mobile OS was based on Window CE Kernel and appeared as the first Pocket PC Operating System in 2000 and it was renamed to Windows Mobile in 2003. On February 12, 2007, Microsoft exposed Windows Mobile 6, the latest version of the software platform. Much of the strength of this OS lies in the compatibility of Microsoft Office suite programs and somewhat similar to desktop version of Windows. This Operating System is available in both touch-screen and non-touch screen formats. A key software feature of Windows Mobile was ActiveSync- a data synchronization technology and a protocol developed by Microsoft was originally released in 1996. Windows Mobile is still in use to this day in the enterprise market by supermarket chains and courier companies [24].



Figure26. Windows Mobile 2003 Screen Shot

Windows Mobile 2003 was named as 'Ozone' and it was the first release under the Windows Mobile banner on June 23, 2003. It came four editions: 'Windows Mobile 2003 for Pocket PC Premium Edition, Windows Mobile 2003 for Pocket PC Professional Edition, and 'Windows Mobile 2003 for Smartphone' and Windows Mobile 2003 for Pocket PC Phone Edition'.

Windows Mobile 5.0, originally coded as "Magneto", was released at Microsoft's Mobile and Embedded Developers Conference 2005 in Las Vegas, May 2005.



Figure27. Windows Mobile 5.0 Screen Shot

Windows Mobile 6, formerly named as 'Crossbow', was released on February 12, 2007 at the 3GSM World Congress 2007. The three different versions are: 'Windows Mobile 6 Standard' for Smartphones (phones without touch screens), 'Windows Mobile 6 Professional' for Pocket PCs with phone functionality and 'Windows Mobile 6 Classic' for Pocket PCs without cellular radios.



Figure28. Windows Mobile 6 Screen Shot

Windows Mobile 6.1 was announced on April 2008. It is a minor upgrade to the Windows Mobile 6 platform with various performance enhancements and a redesigned *Home* screen featuring horizontal tiles that expand on clicking to display more information, although this new home screen is featured only on Windows Mobile Standard edition. Windows Mobile 6.5 was a stopgap update to Windows Mobile 6.1 intended to bridge the gap between version 6.1 and the then yet-to-be released Windows Mobile 7, that arrived in 2010 [24].

7.2.3. Bada

Bada is an operating system for mobile devices such as smartphones and tablet computers. Its name is derived from Korean Language with the meaning "ocean" or "sea" and developed by Samsung Electronics [25]. Like other developers Samsung also owns an Operating System with name Bada. It's designed for midrange and high end smartphones. Bada is a quiet user friendly and efficient operating system but unfortunately Samsung did not use it on a large scale for unknown reasons [10].



Figure29. Bada insignia

The Bada operating system for smartphone was released by Samsung on 10th November 2009. The first Bada based smart phone was released in June 1st 2010 with the name of Samsung Wave S8500. On 25 February 2013, Samsung announced that it will stop developing Bada, and moving to develop Tizen operating system. All Bada-powered devices are branded under the name 'Wave', where as Samsung's Android-powered devices are branded under the name 'Galaxy'. On April 2010, the first Bada based phone was released with the bearer name of Samsung Wave S8500 [25]. The latest version Bada 2.0.5 was released on March 15th 2012. There are only 3 phones which are operating on Bada. These three smartphones are Samsung Wave, Samsung Wave 2 and Samsung Wave 3 [10].

7.2.4. Palm OS (Garnet OS)

Palm OS was a proprietary Mobile Operating System, also called as 'Garnet Operating System'. Initially developed by Jeff Hawkins at Palm Computing Corporation in 1996 for Personal Digital Assistants (PDA). But in September 2005, Palm Source announced that it was acquired by ACCESS Corporation. On January 25, 2007 ACCESS announced that their Operating System Palm name was changed and titled as 'Garnet OS'. The version of this operating system was starting from Palm OS 1.0 to Palm Os 5. Palm OS versions earlier than 5.0 run on Motorola/Freescale DragonBall processors. From version 5.0 onwards, Palm OS runs on ARM architecture-based processors [26].



Figure30. Palm Insignia

Palm OS was originally designed to work on touch screen GUI. Unfortunately it could not make a mark on the market and currently is not being used by any of the latest top devices. Palm OS was used by many companies including Lenovo, Legend Group, Kyocera and IBM [4].

7.2.5. Web OS

WebOS was also known as 'LG WebOS, Open WebOS or Palm WebOS. WebOS is a proprietary mobile operating system running on the Linux Kernel based multitasking operating system for smart devices like TV and smart watches. It was initially developed by Palm, which was acquired by Hewlett-Packard, HP made the platform open source and it became Open WebOS. The operating system was later sold to LG Electronics. Various versions of WebOS have been featured on Several devices, including Pre, Pixi and Veer smartphones, the HP Touchpad tablet and LG smart TVs. The owners of this operating system stylized named all iterations of the operating systems (Palm, HP and LG) as WebOS.

In January 2009 Palms launched WebOS and call it as 'Palm WebOS' as the successor to Palm OS. The first WebOS device was the original Palm Pre, released by Sprint in June 2009 followed by Palm Pixi.



Figure31. Palm WebOS insignia

In April 2010 HP acquired Palm WebOS and described it as a key asset and motivation for the purchase. HP indicated its intention to develop the WebOS platform for use in multiple new products, including smartphones, tablets, and printers



Figure32. HP WebOS insignia

On August 18, 2011 HP announced that webOS hardware was to be discontinued but would continue to support and update webOS software and develop the webOS ecosystem. HP released webOS as open source under the name Open WebOS, and plans to update it with additional features. And in February 2012 HP released Isis, a new web browser for Open WebOS.



Table.1 Comparison of Mobile operating systems

Figure33. Open WebOS insignia

On February 25, 2013 HP announced the sale of WebOS to LG Electronics, who planned to use the operating system for its "smart" or Internet-connected TVs. However HP retained patents underlying WebOS as well as cloud-based services such as the App Catalog.



Figure34. LG WebOS insignia

VIII. ANATOMY OF MOBILE OPERATING SYSTEMS

Mobile Operating Systems

Continued

Dis-Continued

Chara cteriza tions	Android	iOS	Windo ws Phone	Black Berry	Firefox OS	Sailfish OS	Tizen	Ubuntu Touch	Symbian	Windo ws Mobile	Bada	Palm OS	Web OS
Develo per	Google, Open Handset Alliance	Apple Inc.	Microso ft Corpora tion	BlackB erry Limited	Mozilla	Jolla	Linux Founda tion, Tizen	Canonic al Ltd., Ubuntu commu nity distribut ors	Accentur e on behalf of Nokia (basically from Symbian Ltd, and Foundati on)	Microso ft	Samsu ng Electr onics	Palm Inc., ACC ESS (Gar net OS)	LG Elect ronic s
Writte n Langu age	C (core), C++, Java (UI)	C, C++, Object ive-C, Swift	C, C++		HTML 5, CSS, Javascr ipt, C++	-	HTM L 5, C, C++	-	C++	-	C++	C++	C++
OS Family	Like Unix	Unix- like, based on Dar win(B SD), O S X	Microso ft Windo ws	BlackB erry 10	Firefox OS/Open Web (based on Kernel)	GNU/Li nix	Linux	Like Unix	RTOS	Microso ft Window s	Posix	Palm OS	Web OS (base d on Linu x)
Kernel Type	Monolith ic (modif ied Linux kernel)	Hybrid (XNU)	Hybrid (Monoli thic in Windo ws Phone 7)		Monolith ic (Linux)	Monolit hic (Linux)	Monolit hic (Linux)	Monolit hic (Linux kernel)	Real time Microker nel, EKA2	Hybrid	RTOS or Linux kernel	AM X,pla n to port on Linu x	Mon olithi c (Linu x kerne l)
Platfor ms	32 and 64 bits, ARM architec ture, x86- 64 MIPS	64- and 32- bit ARM architec tures	Qualco mm Snapdra gon (ARMv 7)	Mukti- platfor ms (android ,ios,w in dowph one)	ARM, x86, MIPS	ARM and ARM 64-bit, x86	ARM and x86	ARM and x86	ARM, x86	Hardwar e platform was not created	Bada	ARM archit ectur e	ARM

Initial Release	Sep'23, 2008	June 29, 2007	Oct'2010	1999	April 23, 2013	Nov' 27, 2013	Jan'5, 2013	Oct'17 2013	June 1997	Apr'19 2000	June 2012	1996	Jan' 2009
Latest Release	April 2015, 5.1.1 Lollipop	June 30, 2015	June 2, 2015	2015	Jan' 12, 2015	July 15, 2015	Feb' 13, 2015	2015 (Vivid Vervet)	Oct' 2, 2012	Feb 2, 2015	Feb' 28, 2013	Jan' 2013	Jan' 12, 2012
Working Status	Current	Current	Current	current	Active	Current	Current	Released	Discontinued	Succeeded by Windows Phone	Stopped (Replaced by Tizen)	Active from Nov' 2012	-
Source Model	Open Source	Closed Source	Closed Source	Open source	Open source	Open source with third parties components	Operating System: Open source SDK: closed source	Open source	Closed source, previously open source	Open source	Mixed : Proprietary and Open source	Active source	Open source
No. of Available Languages	70	34	130	-	-	-	-	Multilingual	Multilingual	-	-	English, French, Japanese and more	5
License	Apache License 2.0 GNU GPL v2 for the Linux kernel modifications	Proprietary software expect to open source	Commercial Proprietary software	RIM	Free Software (MPL2.0)	For end user the EULA, used open source and other licenses components with a components origin.	OS: GPLv2, LGPL, Apache License, BSD, Flora License	Mainly the GPL and various other open source licenses	Proprietary, previously licensed under EPL	Proprietary software licensed to OEMs	Proprietary	Proprietary EULA	Apache
Default User Interface	Graphical (Multi-touch)	Cocoa Touch (multitouch, GUI)		Varies by model	Graphical	Graphical	Graphical (Native and web applications)	Graphical (Native and web applications)	Avkon	Graphical	Touch Wiz, Graphical	Graphical	Graphical (Luna)
References	[8]	[9]	[14]	[16]	[26]	[27]	[28]	[29]	[31]	[23]	[24]	[25]	[30]
Official website	www.android.com	www.apple.com/ios/	www.windowsphone.com	www.blackberry.com	Mozilla.org/firefox/oss	Sailfishos.org	www.tizen.org	ubuntu.com/phone	Symbian.nokia.com	-	www.bada.com	garnet/index.html	hpwebos.com

IX. CONCLUSION

The Smartphone is an incredible technology that has transformed our world in a variety of different ways. To think that one small device holds someone's entire world. It has revolutionized the activity of communication between people and allowed instant access to information in the palm of our hands. In future the Smartphone is going to occupy every human's hand. The opportunities available for the future of a Smartphones are endless. It will only take time to see which of these innovations will be a part of our everyday lives. Applications can give Smartphone's an extra edge that ordinary phones do not have.

X. ACKNOWLEDGMENT

I would like to thank my family members for their valuable support for completing this journal. Last, and most obvious but not least, I would like to thank the IJCRCT for their valuable guidance to rectify mistakes in my article.

XI. REFERENCES

- [1] Deepa Krurp, From 1kg Brick to Lightweight Smartphones. The Hindu', April,10,2013, Chennai Edition.
- [2]<http://www.crn.com/slide-shows/mobility/240152197/the-evolution-of-the-smartphone-in-7-releases.htm>
- [3] <https://en.wikipedia.org/wiki/Smartphone>
- [4] <http://pocketnow.com/2014/07/28/the-evolution-of-the-smartphone>
- [5] Connie Morrison, Dolores Wels, Lisa Ruffolo, Computer Literacy BASICS:A Comprehensive Guide to IC3,Cengage Learning, 2014, pp.1-12,172-174.
- [6] I.Chandra Mohan, Operating Systems PHI Learning Ltd, 2013, pp.40-42.
- [7] Peiyu Ren, Zhenyu Du, Information Technology and Industrial Engineering (set), WIT Press, 2014, pp. 641-643.
- [8] [https://en.wikipedia.org/wiki/Android_\(operating_system\)](https://en.wikipedia.org/wiki/Android_(operating_system))
- [9] <https://en.wikipedia.org/wiki/IOS>
- [10] www.shoutmeloud.com/top-mobile-os-overview.html
- [11] http://www.techotopia.com/index.php/The_Anatomy_of_an_iPhone
- [12] Ole Henry Halvorsen, Douglas Clarke, OS X and iOS Kernel Programming, Volume 36; Volume 76 Apresspod Series, Apress, 2011, pp. 16-21.
- [13] Jamesh Keogh, The complete Reference – J2ME, Tata McGraw Hill, 2003, pp.30-31.
- [14] https://en.wikipedia.org/wiki/Windows_Phone
- [15] <https://cseweb.ucsd.edu/classes/sp00/cse221/reports/luc-ngu-tam-wan.pdf>
- [16] <https://en.wikipedia.org/wiki/BlackBerry>
- [17] Himanshu Dwivedi, Chris Clark, David Thiel, Mobile Application Security, Tata McGraw Hill,2010,pp.123-135.
- [18] http://www.techotopia.com/index.php/The_iPhone_OS_Cocoa_Touch_Layer

[19] http://www.techotopia.com/index.php/The_iPhone_OS_Media_Layer

[20] http://www.techotopia.com/index.php/The_iPhone_OS_Core_Services_Layer

[21] http://www.techotopia.com/index.php/The_iPhone_OS_Core_OS_Layer

[22] Mohammad Ilyas, Syed A.Ahson, Smartphone Research Reports, IEC Publications, 2006, pp.17-20.

[23] https://en.wikipedia.org/wiki/Windows_Mobile

[24] <https://en.wikipedia.org/wiki/Bada>

[25] https://en.wikipedia.org/wiki/Palm_OS

[26] https://en.wikipedia.org/wiki/Fire_OS

[27] https://en.wikipedia.org/wiki/Sailfish_OS

[28] <https://en.wikipedia.org/wiki/Tizen>

[29] https://en.wikipedia.org/wiki/Ubuntu_Touch

[30] <https://en.wikipedia.org/wiki/WebOS>

[31] <https://en.wikipedia.org/wiki/Symbian>

AUTHOR PROFILES



C.R.Kavitha received the B.Sc. (Chemistry) in University of Madras in 1999 and MCA in Indira Gandhi National Open University in 2004. And Completed M.Phil in Thiruvalluvar University in 2008. She now works as an Assistant

Professor in Sri Lakshmi Narasimha College of Pharmacy, Andhra Pradesh, India. She already published three articles in an International Journals.