Comparison of Concurrent Mobile OS Characteristics

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***Abstract*- It is challenging for the mobile industry to supply the best features of the devices with its increasing customer requirements. Among the progress of technologies, the mobile industry is the fastest growing; as it keeps pace with rapidly changing market demands. This paper compares between the currently available mobile devices based on its user interface, security, memory utilization, processor, and device architecture. The mobile products launched from 2015-19 are used for comparison. Current results after comparison with earlier study found that many mobile devices and features became obsolete in a short time span supporting the aggressive growth of mobile industry.**

***Keywords*- Mobile OS, Security, GUI, Mobile Architecture, Processor, Memory Utilization**

I. INTRODUCTION

Today's life is more connected than a few years back. Mobile phones are essential and we cannot think of life without it today. With availability of powerful mobile operating system, and considering the unprecedented fast growth in mobile communication technology, mobile computing is projected to have the most potential for future growth. The technology growth rate of mobile industry has surpassed the growth rate of all other industries setting a mark in human evolution. One needs to keep up with the rapid evolution of new mobile phones. The challenging demand requirement by its wide spread customer base has mobile phone manufacturers produce mobile phones with multiple useful features. Given the broad choice of selectable feature with their issues, and multiple vendors, currently it has become difficult for a customer to decide which mobile phone is best for their own use. This work provides a tabular comparison of five features of different phones across major vendors to give a helpful insight about concurrent mobile phones. This work uses the mobile products launched between the years 2015-2019. Current results were compared with the earlier work [1] and found that many mobile devices and features which ranked high in consumer attraction at one time became obsolete in a short time span indicating the aggressive growth of mobile industry.

1.1 Motivation

Mobile operating system allows a user to effectively utilize their time by being in constant touch with their official work while utilizing their commuting and travelling time. Hundred of frequency bands and different operating systems providing thousands of features to the customers seem to be a mind boggling market. This creates confusion for the customers to choose the right mobile and operating system to fulfil their requirements. An operating system is the soul of the mobile device, and every mobile industry want to provide best features in their mobile devices. This paper intends to explore different OS perspectives, features & suitability for mobile devices and compares between Android, iOS, KaiOS, Windows, Sailfish OS, and Fire OS.

1.2 Background

The mobile operating system models are used to provide various interfaces of communication between the software components at the application layer, middleware layers, and hardware devices. The operating system models were compared based on the parameters like user interfaces, processors, memory utilization, security, power management, connectivity, cross plat-forming, cloud readiness and, execution of software on diversified hardware components and as a development platform. These parameters are indicative for exploring a mobile operating system, which is user friendly and helpful for the developer. Features like camera, global positioning system (GPS), browser, messaging, and music are also gaining popularity in mobile operating systems. However, in the present study, emphasis has been given to the operating system features. Among different operating systems, Android and iOS has taken over the market largely because of their uniqueness.

II. MATERIALS AND METHODS

In this method of mobile OS comparison, we took mobiles with different OS, and compared their user interfaces, processors, memory utilization, security, power management, connectivity, cross plat-forming, cloud readiness, performance of software on diversified hardware components, and as a development platform.

2.1 Processor (System On Chip (SOC))

A SOC is a chip that integrates all components of a computer or other electronic system. These components typically include a CPU, memory, I/O ports and secondary storage. All these devices are on a single substrate or microchip. SOC are very common in the mobile computing (such as in Smartphone) and edge computing markets.SOC are typically fabricated using metal–oxide–semiconductor (MOS) technology, and are commonly used in embedded systems and the Internet of Things.

Android OS: Qualcomm Snapdragon 855 plus is having octa core CPU (Clock Speed 2.96GHz) &Adreno 640 GPU having on chip graphics memory of 1024 kb

iOS: A13Bionic processor is having Dual Cluster **HexaCore** (2.66 Ghz) and a quad core GPU (Graphics Processing Unit). Apart from it an octa-core NPU (Neural Processing Unit) is also added to it.

KaiOS:HTML 5 based firefox OS is used in KaiOS which is having Dual core (Clock Speed 1.1 GHz) in Jio Phone and Quad Core(Clock Speed 1 GHz) in Jio Phone 2.

Windows: Qualcomm Snapdragon 810 is having octa-core CPU (Clock Speed 1.8 Ghz) which is being used in Nokia Lumia 950 XL having Adreno 430 GPU having Graphics memory of 1536 kb.

Sailfish OS: Sailfish OS is being used in Sony Xperia mobile sets which used to run on Android OS and it is based on Linux.

2.2 Operating System (OS)

A program that acts as an interface between the user and computer hardware is the Operating System. It controls the execution of all types of programs. Some of important functions of an operating System are Memory Management, Processor Management, Device Management, File Management, Security, Control over system performance, Job accounting, Error detecting aids, Coordination between other software and users. A mobile OS is software which drives the SOC or the main hardware.

Android OS : It is based on Linux.

iOS: It is based on Unix.

KaiOS: It is based on Linux.

Windows OS: It is based on Windows Kernel NT.

Sailfish OS:It is based on Meego OS which is again based on Linux.

2.3 User Interface (UI)

The user interface (UI) is the space where interactions between humans and machines occur. The goal of user interface design is to produce a user interface which makes it easy, efficient, and user-friendly to operate a machine in the way which produces the desired result. In a Mobile Unit, the UI helps the OS to take the commands from the user and drive the SOC or main hardware as per the user requests.

Android OS: Android provides variety of **pre-built UI components** such as structured layout objects and UI controls that allow you to built graphical user interface for your app (Figure 1). Android also provides other UI modules for special interfaces such as **dialogues, notifications and menus**.

(Example – ASUS ROG Phone 2, Black Shark 2 pro)

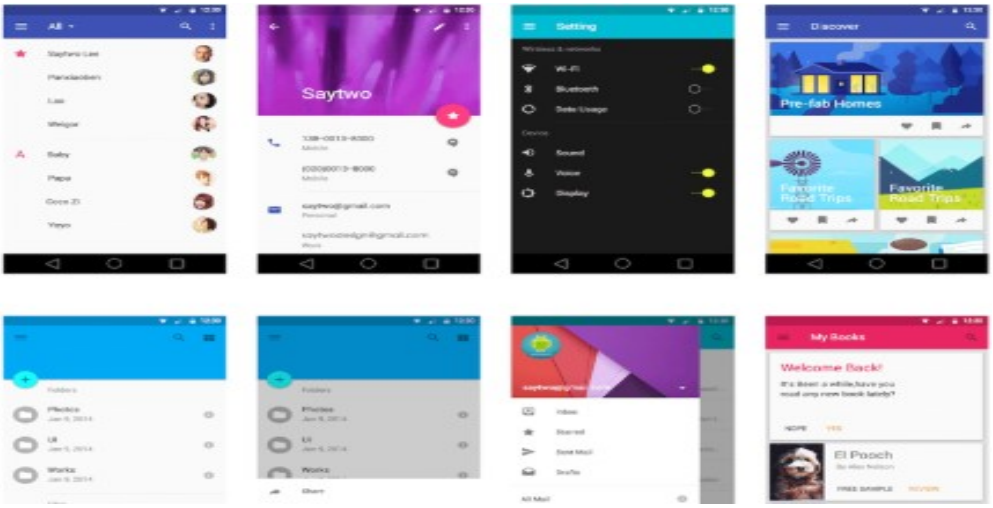

Figure 1. Shows Android's several contact GUI[2].

iOS: Throughout the system, text is legible at every size, icons are precise and lucid, adornments are subtle and appropriate, and a sharpened focus on functionality motivates the design. Content typically fills the entire screen, while translucency and blurring often hint at more(Figure 2). Minimal use of bezels, gradients, and drop shadows keep the interface light and airy, while ensuring that content is paramount. Touch and discoverability heighten delight and enable access to functionality and additional content without losing context. Transitions provide a sense of depth as you navigate through content.

Figure 2. Represents iOS 13 User Interface (Supports human healthcare app too) [3]

KaiOS: KaiOS apps are created from UI Components which define common interface elements. By following UI components, apps achieve a consistent appearance across the system. The units of spacing defined in KaiOS are specified in rem. On a screen with density of 140, 1 rem is equal to 10 pixels which is a baseline QVGA resolution on a 2.8 inch display.

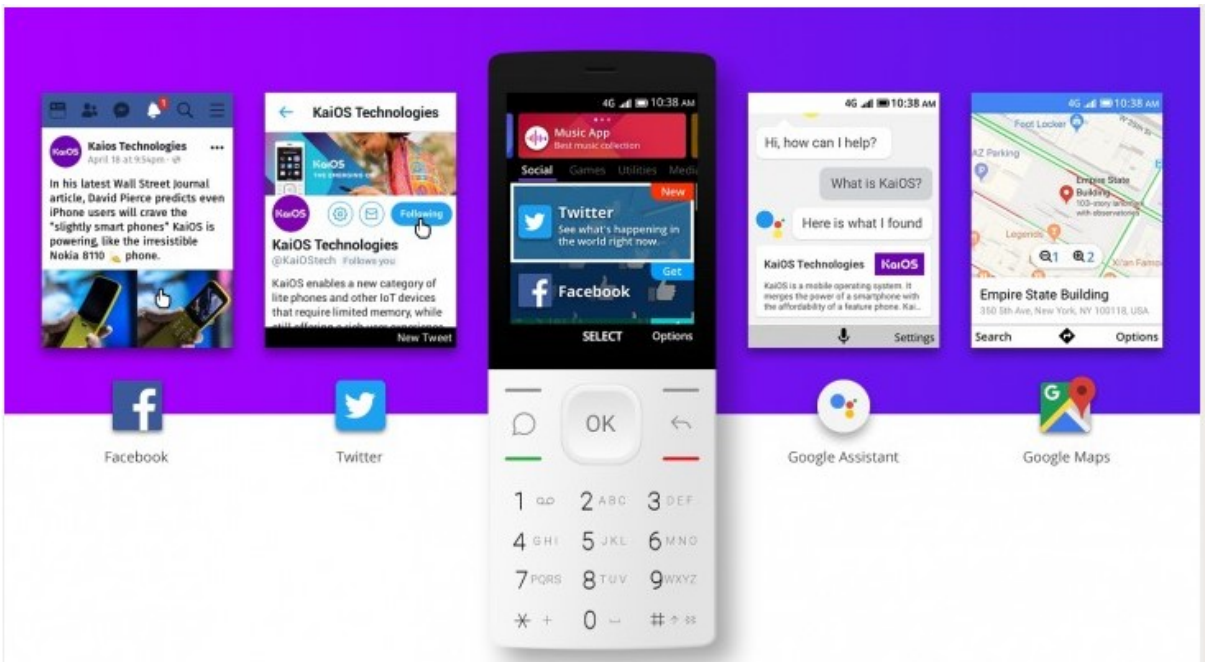

Figure 3. Nokia 8110 4G having KaiOS User Interface [4]

Windows: The Microsoft **Windows** Resource Compiler is an application development tool used to add **UI** and other resources to a **Windows**-based application (Figure 4). A resource is any non-executable data used by an application, and includes such things as dialog boxes, menus, strings, cursors, icons, bitmaps, and so on.

Figure 4. Representing Windows 10 User Interface [5].

Sailfish: Sailfish OS works with natural hand movements via gestures. Everything is always under thumb. Sailfish UI are user friendly, simple, and fast (Figure 5). It can change the way people interact with their devices. It uses gestures, user interactions, the UI framework and more.

Sailfish OS is a Linux based mobile operating system.

Figure 5. Representing the user interface of Sailfish OS

2.4. Connectivity

Connectivity refers broadly to the social connections constructed through mediated communications systems.One aspect of this is the ability of the social media to accumulate economic capital from the user's connections and activities on social media platforms by using certain mechanisms in their architecture. Mobile connectivity is essential as it brings people and technologies together.

Android OS (having Qualcomm Snapdragon 855 plus as an SOC): In addition to providing standard network

connectivity, Android provides APIs to let an app connect and interact with other devices with protocols such as Bluetooth 5.0 (Speed till 2Mbps and having range 100 meter), NFC (Near Field Communication), WiFi6 (Speed of 0.6-9.6Gbps at a frequency of 2.4/5 GHz), P2P, USB 3.1 (Speed till 10Gbps),SIP (System Integrity Protocol).

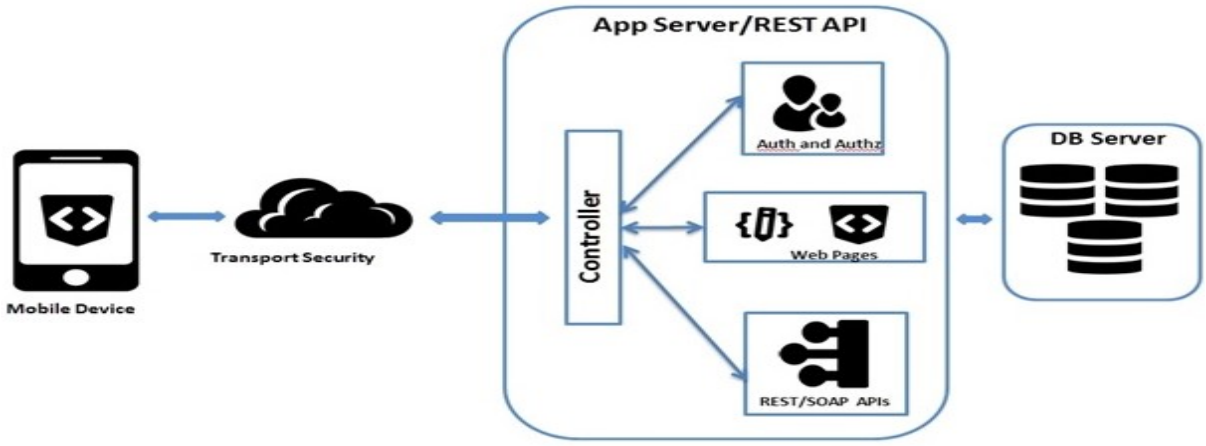

Figure 6: Android application connectivity with server.

iOS: A13 Bionic provides Bluetooth 5.0 which provides a speed of 48 Mbps at a frequency of 2.4 to 2.485MHz. Wifi6 802.11ax is also added to SOC providing a maximum speed of 9.6Gbps.

KaiOS: KaiOS does offer all the connectivity options including 4G/LTE (Long Term Evolution) which is 10 times faster than 3G, NFC for payments (Near Field Communication), Dual-SIM compatibility, and Wi-Fi 802.11b/g/n providing speed upto 54Mbps and uses higher frequency till 5GHz for higher speed. It also provides Bluetooth 4.1 (Speed 24Mbps) and USB 2.0 (480 Mbps).

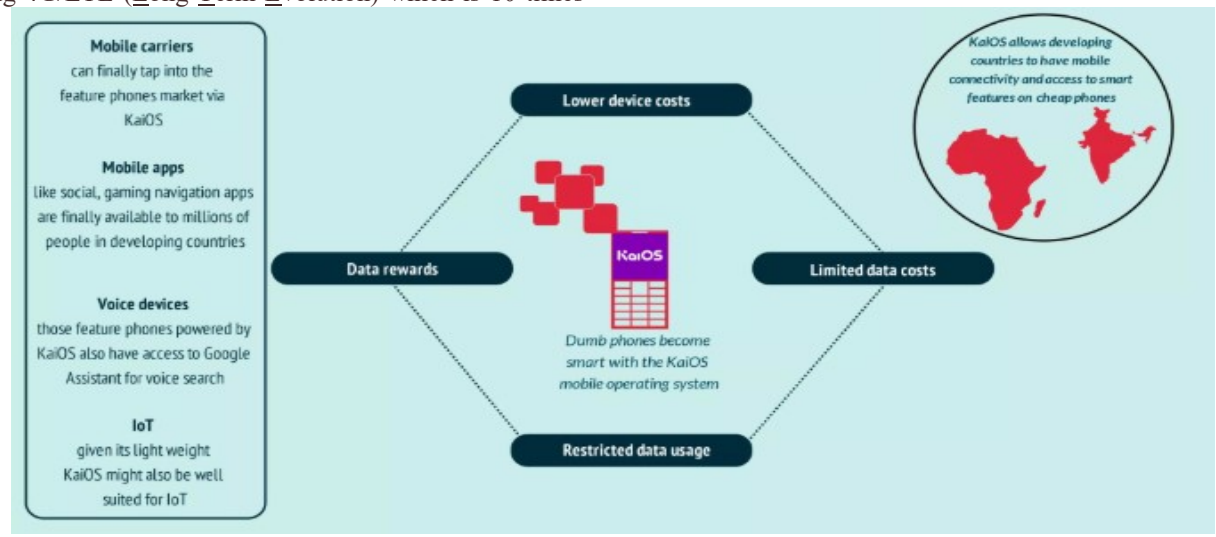

Figure 7: KaiOS feature phone connectivity [6].

- **Windows**: Wi-Fi 802.11 a/b/g/n/ac(Speed 433 – 6933Mbits/sec), GPS, Bluetooth v4.10, NFC, FM radio, 3G, and 4G with support for Band 40 used by some LTE (Long Term Evolution) networks in India.
- **SailFish:**
  - Wi-Fi and cellular mobile data scanning and connections.
  - WLAN hotspot connection sharing.
  - Flight mode handling for disabling/restoring connectivity
  - Cellular network registration
  - Operator queries.
  - Core modem management.
  - Phone calls, SMS and MMS.

- Bluetooth connections for making calls via the Bluetooth HandsFree Profile (HFP).
- SIM operations, including PIN and PUK codes and SIM ToolKit (STK) access.
- Supplementary service code handling including USSD/GSM Codes.
- Audio Gateway for Headset Profile (HSP) and HandsFree Profile (HFP) for making calls via Bluetooth headsets.
- Advanced Audio Distribution Profile (A2DP) for playback of multimedia audio over a Bluetooth connection.
- SyncML client & server (SyncML) for synchronization of contact data.
- OBEX Object Push (OPP) for file exchange services.
- Phone Book Access Profile (PBAP) for exchanging phonebook data with a car kit[7].

2.5. Memory Utilization

The memory utilization of OS basically defines the amount of RAM used by a system at a particular time and it is not managed as a single unit as a disk and it is not as a single component like CD or floppy but it is rather than a collection of small components called page where each page consumes a memory of about 1 to 8 kb. Memory utilization means to provide the efficient way to give the proper storage and provide it back to the user in the best time as required. Smart phones SOCs mostly use LPDDR2 SDRAM, where the "LP" stands for low-power and DDR stands for "double data rate".

Android: LPDDR4X (Low Power Double Data Rate 4X) is used here, which is 15% more efficient than LPDDR4 More android manufacturers include more RAM in their smart-phones than Apple does. If you use multiple apps each day then RAM usage won't hit much more than 2.5-3 Gb. Each Android smart-phone comes with fixed amount of RAM. It is part of phone's motherboard and it is not upgradable.

iOS: App should use little as little as memory as possible making more memory available to other apps and system services. iOS monitor apps total memory usage at run time and if the amount exceeds predetermined limit, the system terminates that app.

KaiOS: 3G/4G LTE, 256M/512M RAM/ROM or 512M/4G RAM/ROM, Wi-Fi, GPS, Single/Dual Sim, NFC support for mobile payments, Single Camera (back), Dual Camera (front & back).

Windows: Windows 10 still uses a page file when it has to. However, now when computer's memory tarts to fill up, Windows 10 will start *compressing* old pages of memory so they take up less space, similar to what happens when you create a ZIP archive of multiple files. So, for example, if you have an app running that you haven't touched in a while, rather than copying the information about that app to your hard drive, Windows will simply make it smaller, but keep it in memory.

2.6. Architecture

Architecture consists of multiple layers of hardware, software, and firmware interface with the help of which the upper layer which is user interface is linked to core layer that is the main hardware (SOC). The information received at the upper layer and the main core layer (hardware) is not directly linked but they are linked with various types of connectivity layers. Mobile architecture is basically the path which connects the activities done by the user in the UI (applications) with the SOC through various types of layers inbuilt.

Android: Consist of 4 layers and 5 sections. Linux Kernel, Libraries, Android Libraries, Android Runtime, Application Framework.

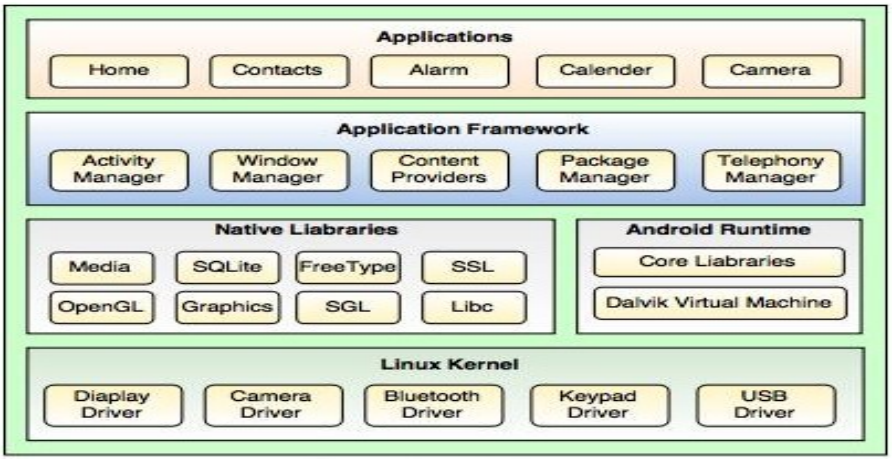

Figure 8. Android Architecture Representation

IOS: Consists of 4 layers**- Cocoa Touch, Media Layer, Core Services, Core OS** (Figure 9).

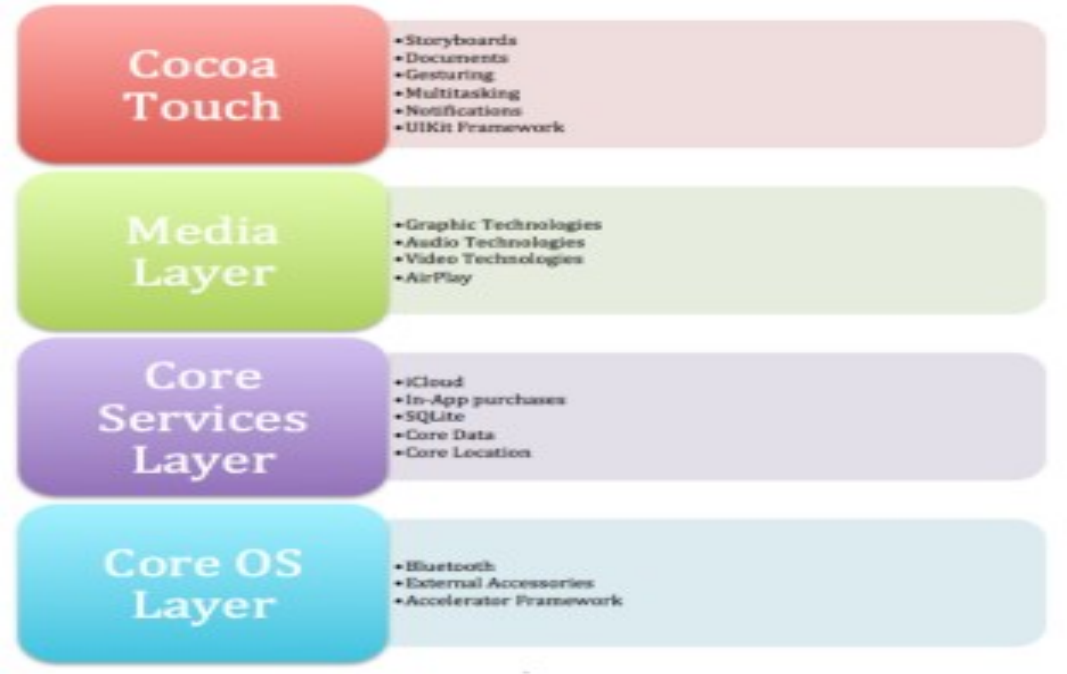

Figure 9. iOS Architecture Representation[8].

KaiOS: Consists of 3 layers- Front End, Gecko, Gonk (Figure 10).

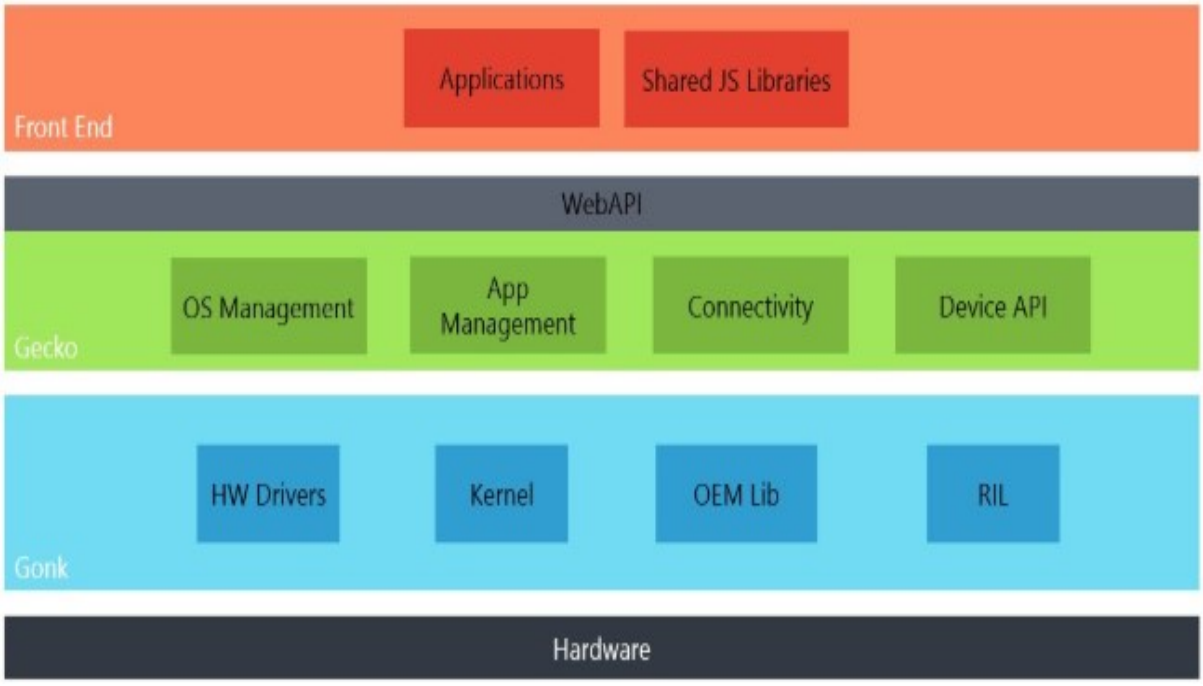

Figure 10. KaiOS Architecture Representation[9].

Windows: 2 main components- User Mode, Kernel Mode (Figure 11).

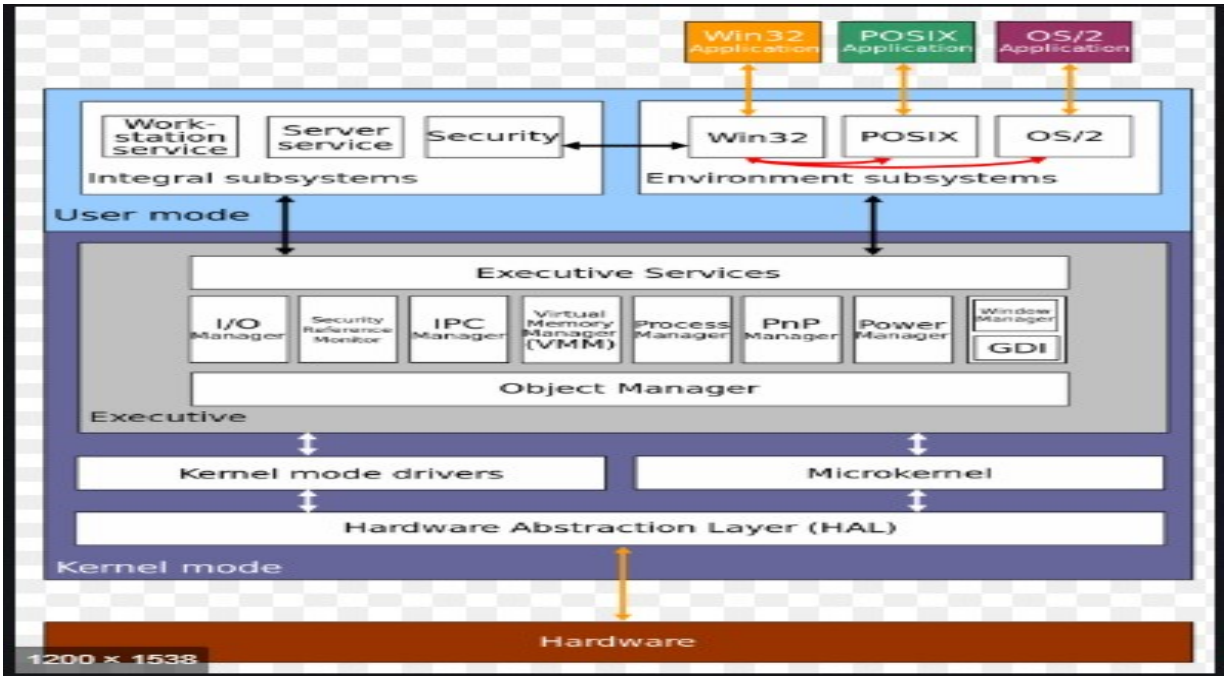

Figure 11. Windows OS Architecture Representation [10].

SailFish: Consists of 3 layers – Base Kernel Layer, Middle Ware Layer, App/UI layer (Figure 12).

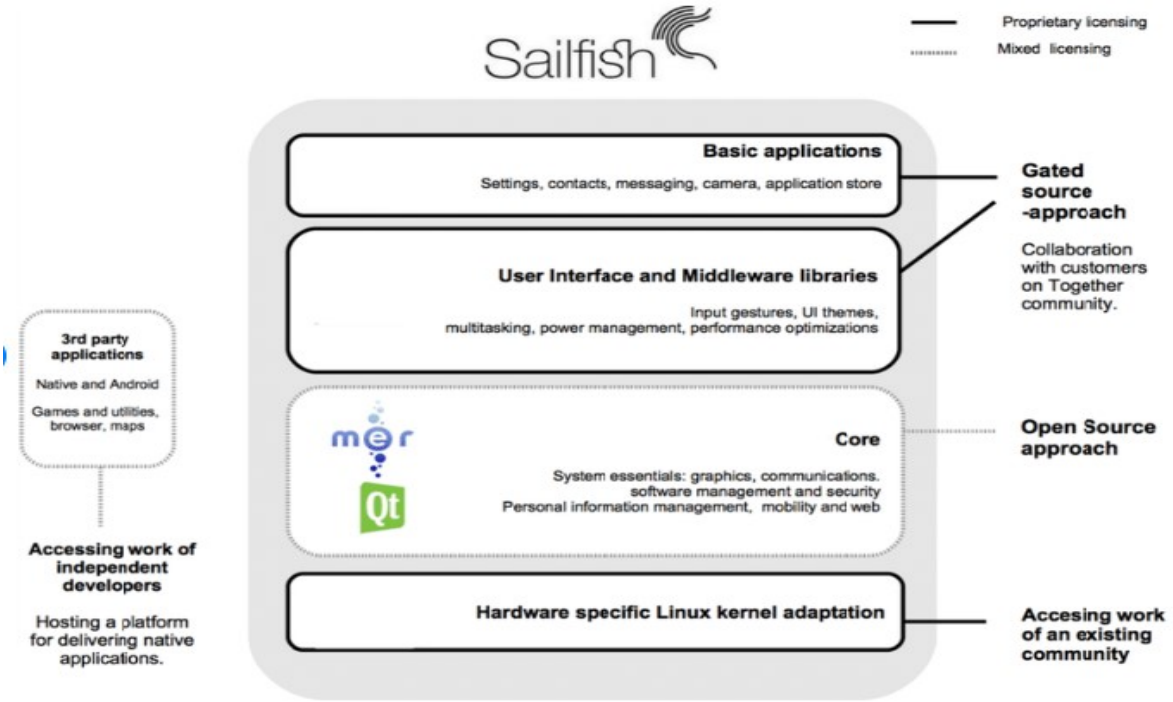

Figure 12. Sailfish OS Architecture Representation[11].

2. 7. Security

Security of OS means the specified steps required to keep the OS secure from various types of malware, threats, viruses or hacking from remote places. It is basically a process of ensuring OS confidentiality. Mobile device security in OS is the most essential part of the software as it provides the most secure way to protect the data of the users.

Android: The **Linux Kernel** provides android with a set of security measures. It grants the operating system user based permission model, process isolation, a secure mechanism for IPC, and the ability to remove any unnecessary or insecure parts of Kernel (Figure 13).

Mobile security application for **Google's android platform** help android smartphone and tablet mobile devices from malware threats as well as unauthorized access following accidental loss or theft of the device.

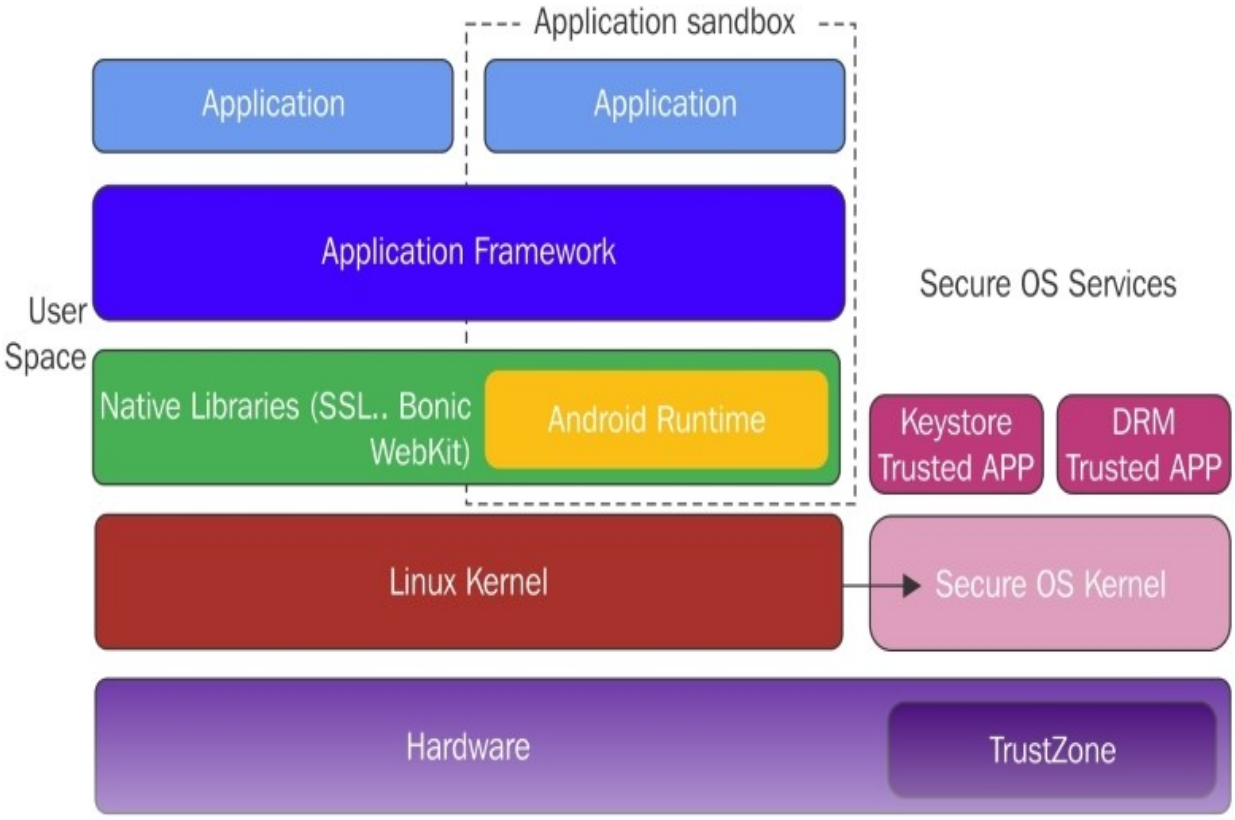

Figure 13. Represents Android Security Layer showing 5 different layers as Application, Application Framework, Android Runtime, Linux Kernel and Hardware layer [12]

Linux Kernel has direct link to Hardware Section. Application layer has no direct access to hardware layer. Application layer has to move through application framework, android runtime and Linux Kernel to access hardware section.

iOS: The integrated and secure software and hardware that are platform for iphone, ipad, ipod touch. Encryption and Data protection- the architecture and design that protects user data if the device is lost or stolen, or if an unauthorized person attempts to use or modify it. Apps provided with device like Safari and Mail are signed by Apple (Figure 14). Third party apps must also be validated and signed using an Apple-issued certificate. Mandatory code signing extends the concept of chain of trust from the OS to apps, and prevents third part app from loading unsigned code resources or using self-modifying codes.

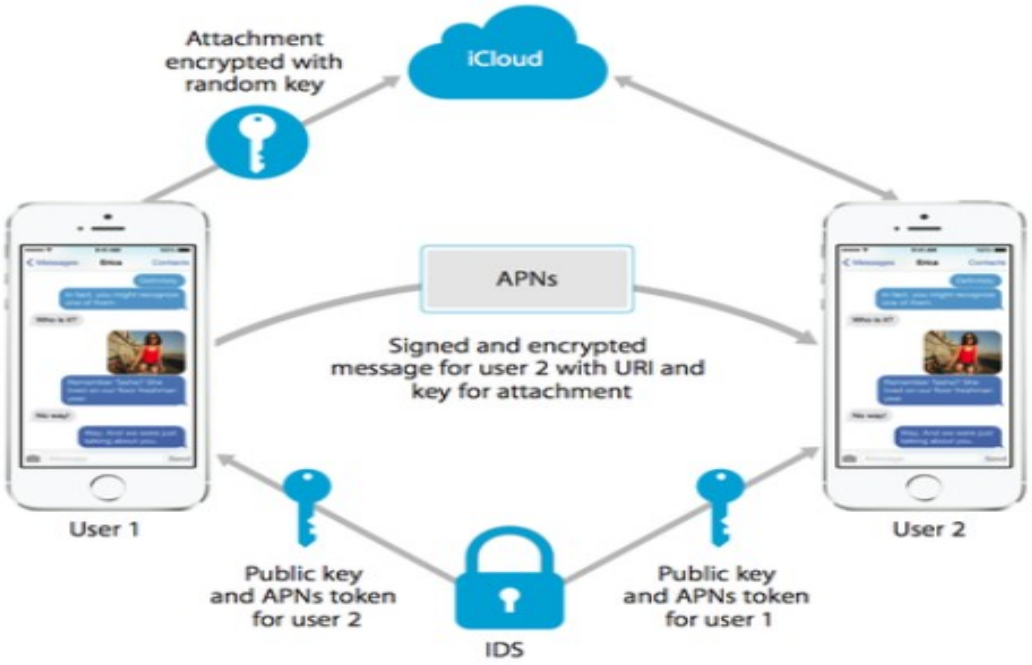

Figure 14. Represents iOS connection with server Security Layer uses IDS (intrusion detection system) as well as iCloud. IDS provides better security as it has separate APN tokens and public key for different users but icloud provides only single encryption key.

KaiOS: The KaiOS uses multi layered security model that is designed to mitigate exploitation risks at every level (Figure 15). Front level counter measures are combined with a defence-in-depth strategy that provides comprehensive protection against threats.

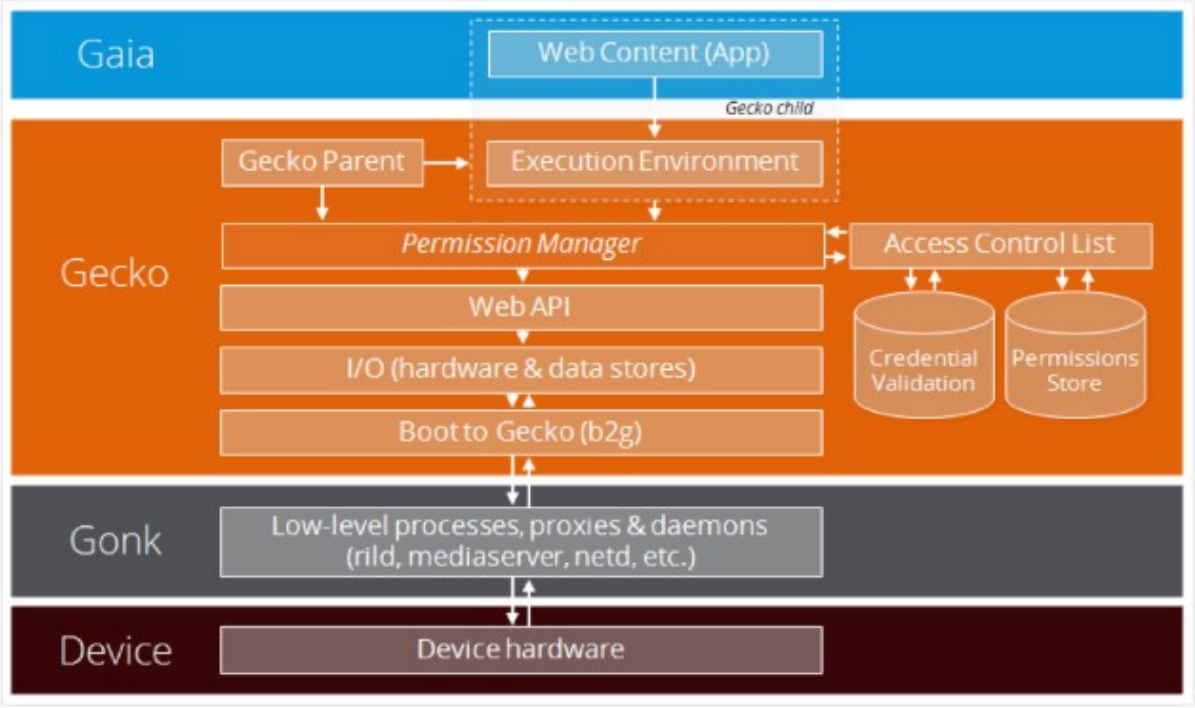

Figure 15. Represents KaiOS Security Layer. Gaia layer (web content) is connected to device layer through Gecko and Gonk[13].

Gonk having low- level processes is directly connected to Device layer whereas the upper layer (user interface layer) that is Gaia is connected to Gecko layer(having web api) first , then Gonk and at last it is connected to main device.

Windows: Windows Security continually scans for malware (malicious software), viruses, and **security** threats (Figure 16). The built-in security automatically prevents viruses and other threats from running on your device, and will receive **s**ecurity updates automatically.

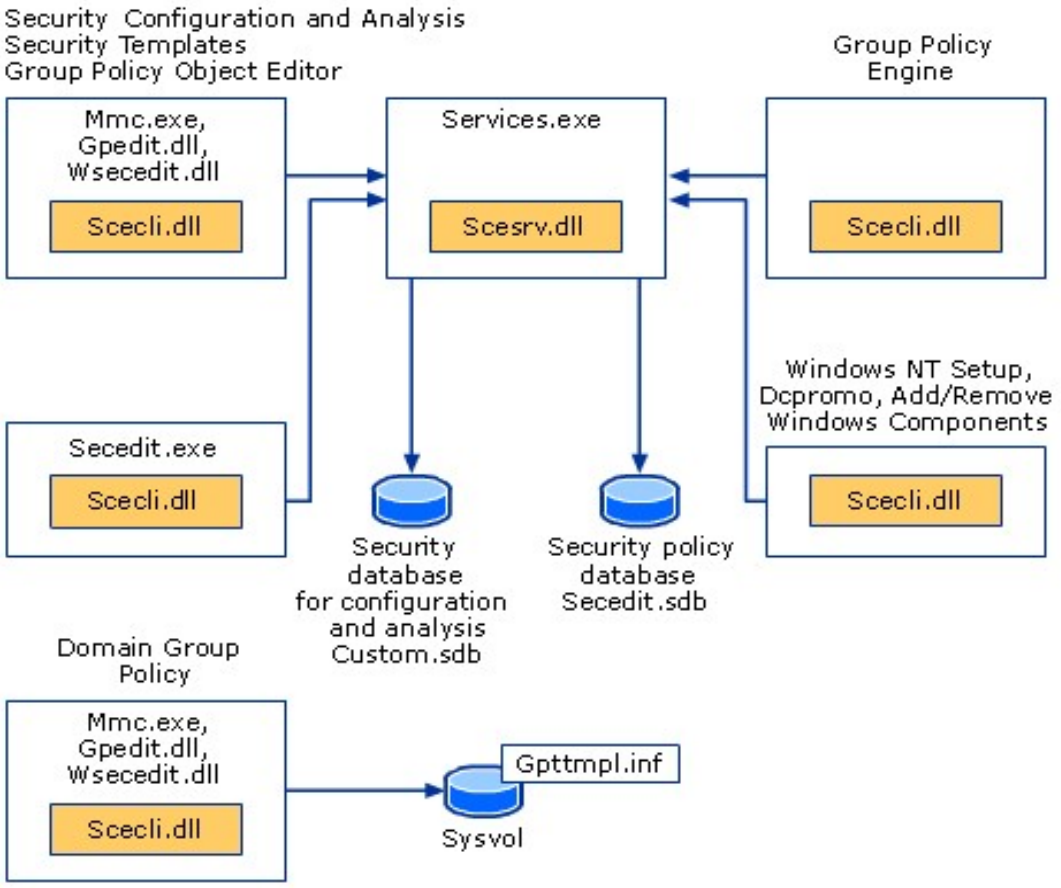

Figure 16.Represents Windows Security layer [14].

SailFish OS: Sailfish OS currently uses a two-level security architecture. Applications available in the Harbour are rigorously tested to ensure that no malicious applications are installable by end users. Furthermore, applications available in the Harbour run at a lowered privilege level, so that they do not have access to the user's data.Sailfish OS devices can be updated with so called "hotfixes" for specific security issues outside of the normal release update cadence. This allows vendors to provide users with security updates as they become available, with minimal delay. These fixes are provided as package updates via the normal package management systems, and are fully versioned and delivered securely with end-to-end encryption to avoid man-in-the-middle or other contamination attacks [15].

2.8 Power Management

Mobile Power management is basically the inbuilt software which provides the best way to run the device having the least power consumption so that it can be made run for longer time.

Android: Falls into 2 categories- App standby: The system limits app access to resources like CPU or

battery based on user's usage pattern (Figure 17). Battery Saver Improvements: When the battery saver is turned on, the system places restrictions on all apps.

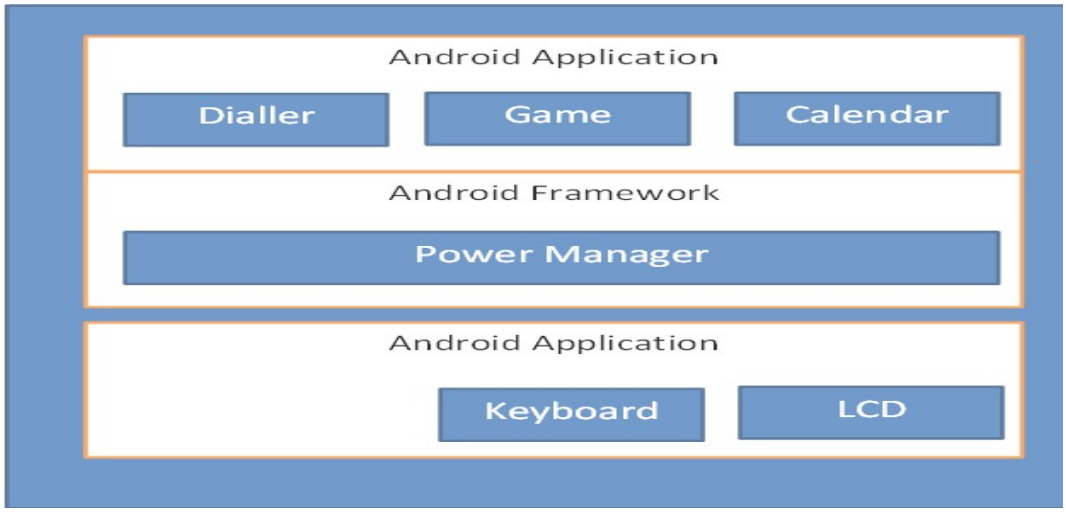

Figure 17. Android Security Power Management Layer

iOS: For iPhone 6, iPhone 6 plus, iPhone 6s, iPhone 6s plus, iPhone SE, iPhone 7, iPhone 7 plus, iOS dynamically manages performance peaks to prevent the device from unexpectedly shutting down so that iPhone can still be used by the user. This performance management works by looking at the combination of device temperature, battery state of charge as well as battery impedance. It dynamically manages the maximum performance of some system components such as CPU and GPU, in order to prevent unexpected shutdowns (Figure 18).

Figure 18. iOS Battery Charge Level [16].

KaiOS: It brings support of 4G/LTE, GPS, and Wi-Fi, as well as HTML5-based apps and longer battery life, to non-touch devices.

Windows: Its power management makes computers instantly accessible to users at the touch of a button or key (Figure 19). The Windows operating system uses power-management hardware to put the computer into a low-*power* sleep state instead of shutting down completely, so that the system can quickly resume working.

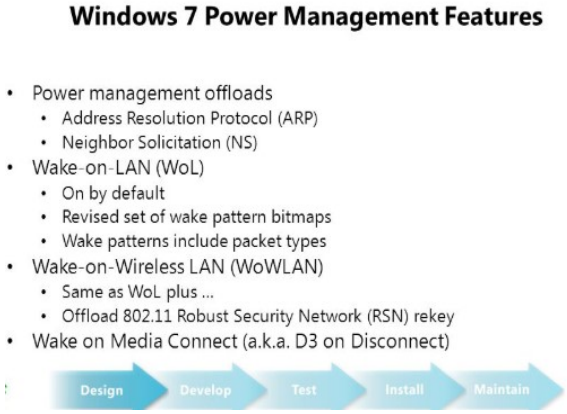

Figure 19. Windows Power Management[17].

SailFish OS: Sailfish OS 3.0.2. Oulanka comes with a battery saving mode, which is enabled by default when the battery goes lower than 20%. Additionally, users can also specify the battery saving threshold themselves by going to the "Battery" section in the settings menu.

Cross Platform

Phone Gap is now being used as cross platform for Android and IOS (BLACKBERRY OS is isolated)

Android:Phone Gap now owned by adobe is a cross platform development tool that relies on web technologies to create for **Android** and **IOS**. You can use **HTML, CSS** and **JavaScript** to build a mobile app with a native look and feel, without needed to write the same code twice for different platform.

Figure20: Phone Gap is used as cross platform for Android and IOS.

IOS: Phone Gap now owned by adobe is a cross platform development tool that relies on web technologies to create for **Android** and **IOS** [18].

Kai OS: Its cross platform availability is its best feature and that is not ending soon. Platform of Firefox os can be used.

SailFish: Sailfish OS SDK is a collection of tools for developing SailfishOS applications. It includes:

Qt Creator integrated development environment (IDE).

Sailfish OS build engine for cross compilation.

The Sailfish OS Emulator.

Tutorial, Design and API Documentation.

Repositories for additional libraries and open source code.

Table I

Researchable Issues	Android OS	iPhone OS (Apple)	Windows	Sailfish(OS)	Kai(OS)
Architecture	Consist of 4 layers and 5 sections. 1. Linux Kernel 2. Libraries 3. Android Libraries 4. Android Runtime 5. Application Framework 6. Applications	Consist of 4 layers. 1. Cocoa Touch 2. Media Layer 3. Core Services 4. Core OS	2 main components 1. User Mode 2. Kernel Mode	Consist of 3 layers 1. Base Kernel Layer 2. Middle Ware Layer 3. App/UI Layer	Consist of 3 layers 1. Front End 2. Gecko 3. Gonk
Processor	Qualcomm Snapdragon 855 plus Ex- One Plus 7, Pixel 4 (2.84GHz)	A13- Hexa Core 2.65 GHz ex-iPhone 11 Pro iPhone 11 Pro max	Qualcomm Snapdragon 808 1.8 GHz Hexacore Ex- Nokia Lumia 950	1.4 GHz dualcore (Sony Xperia) Version v3.1.0.11	1.1 GHz dualcore (JioPhone 2)/ 1.2 GHz dualcore (JioPhone)
User Interface	Pre built UI components such as UI controls and structured layer objects	UI supports human health care app	Includes dialog box menus, strings, cursors, icons, bitmaps	Sailfish OS works via gestures too	Provides a baseline QVGA resolution on 2.8 inch display
Security	Secure mechanism for IPC, process isolation, user based permission model	Third party apps must be must be validated and signed by Apple issued certificate	Built in security prevents viruses and other threats	Access to SSH restrict. Crypto API implemented for Sailfish OS	Security 4 layers 1. Gaia 2. Gecko 3. Gonk
Connectivity features					
Bluetooth	Bluetooth 5.0 Band 2.4 - 2.485 GHz Range-300 mtr Speed-48 Mbps	Bluetooth 5.0 Band 2.4 - 2.485 GHz Range - 300 mtr Speed -48Mbps	Bluetooth 4.1 Band 2.4 - 2.485GHz Range - 100 mtr Speed- 24Mbps	Sailfish OS which is based on Meego OS is being offered to the Sony Xperia constumers by the SONY, if they want to upgrade their Android OS version	Bluetooth 4.1 Range -100mtr Speed - 24 Mbps
WiFi version	WiFi 6 (802.11 ax) Speed 600 -9608 Mbits/s 2.4/5 GHz 1-6 GHz (ISM)	WiFi 6 (802.11 ax) Speed 600 - 9608 Mbits/s 2.4/5 GHz 1-6 GHz (ISM)	WiFi 5 (802.11 ac) Speed 433-6933 Mbits/s 5 GHz	to Sailfish OS , They can upgrade it on a paid package. All these properties depends on the SOC version which were used on the Sony Xperia Models.	WiFi 802.11 b/g/n Speed 1-54 Mbit/s 2.4 GHz - 5GHz

USB version	USB 3.1 Speed- 10Gbps	No USB
NFC	Support NFC (Near Field Communication) Usefull for online payments	Support NFC

USB 3.0, 2.0	USB 2.0
Speed - 480 Mbps (for 2.0) Speed - 5 Gbps (for 3.0)	Speed - 480 Mbps
Support NFC	Support NFC

Table 1. Comparison table on OS various parameters

III. PERFORMANCE ANALYSIS

Performance analysis on the basis power efficiency. Here we have used mobiles of different OS and have played a movie "Train to Busan" on You Tube. Here at first we made the cell phones 100% charged and then played the movie on individual "You Tube" having same version, and noted down its power efficiency after 15mins, 30mins and 1 hour and made a graph of the power consumed. The slope of the graph can be used to compare performance between two independent mobile OS.

Android OS (Redmi Note 5 Pro)

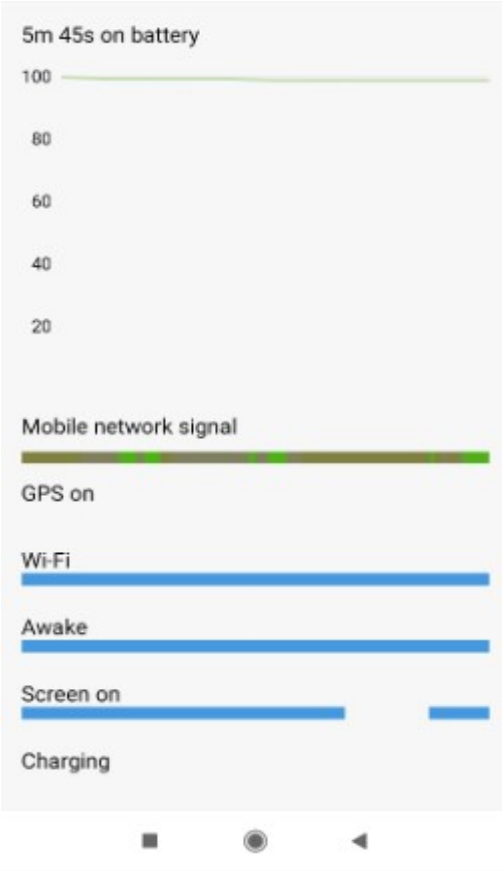

Figure 21 : 100% charge (Redmi Note 5 Pro). Since, it is fully charged, so Wi-fi, Awake and Screen on shows a continuous blue line in the above figure.

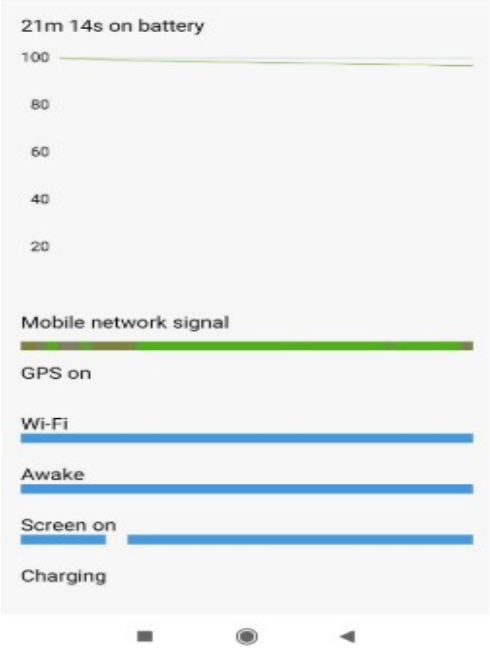

Figure 22: Power remained after video playing of 15 minutes. Since, movie was going on Youtube continuously for 15 minutes, so Wi-fi, Awake and Screen on shows a continuous blue line in the above figure.

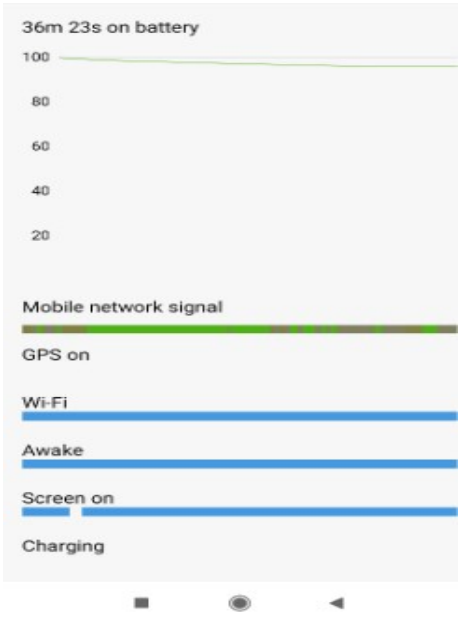

Figure 23: Power remaining percentage after video playing of 30 minutes. Since, movie was going on Youtube continuously for 30 minutes, so Wi-fi, Awake and Screen on shows a continuous blue line in the above figure.

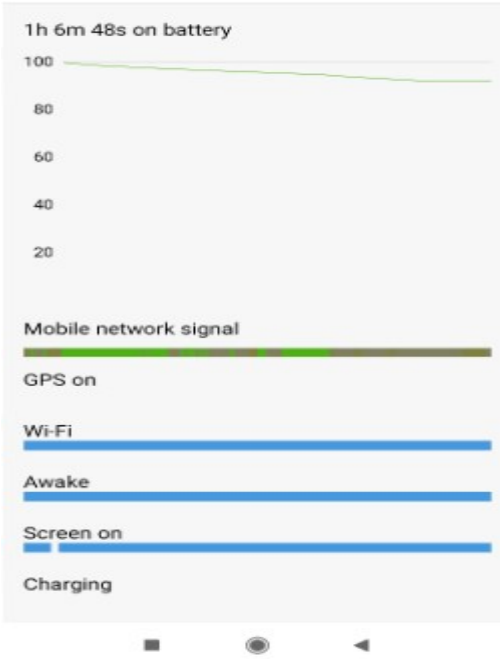

Figure 24: Power remaining percentage after video playing of 1 hour. Here, movie was going on Youtube continuously for 1 hour, so Wi-fi, Awake and Screen on shows a continuous blue line in the above figure.

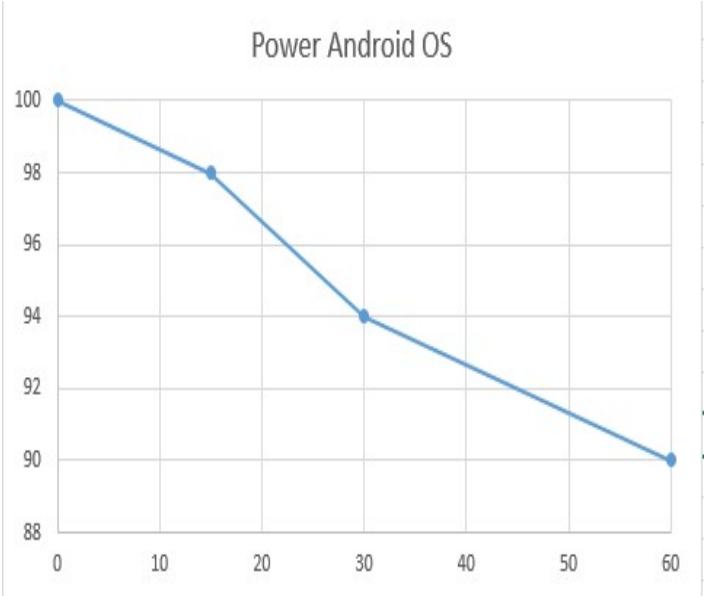

Figure 25: ANDROID OS power efficiency graph

iPhone 6s

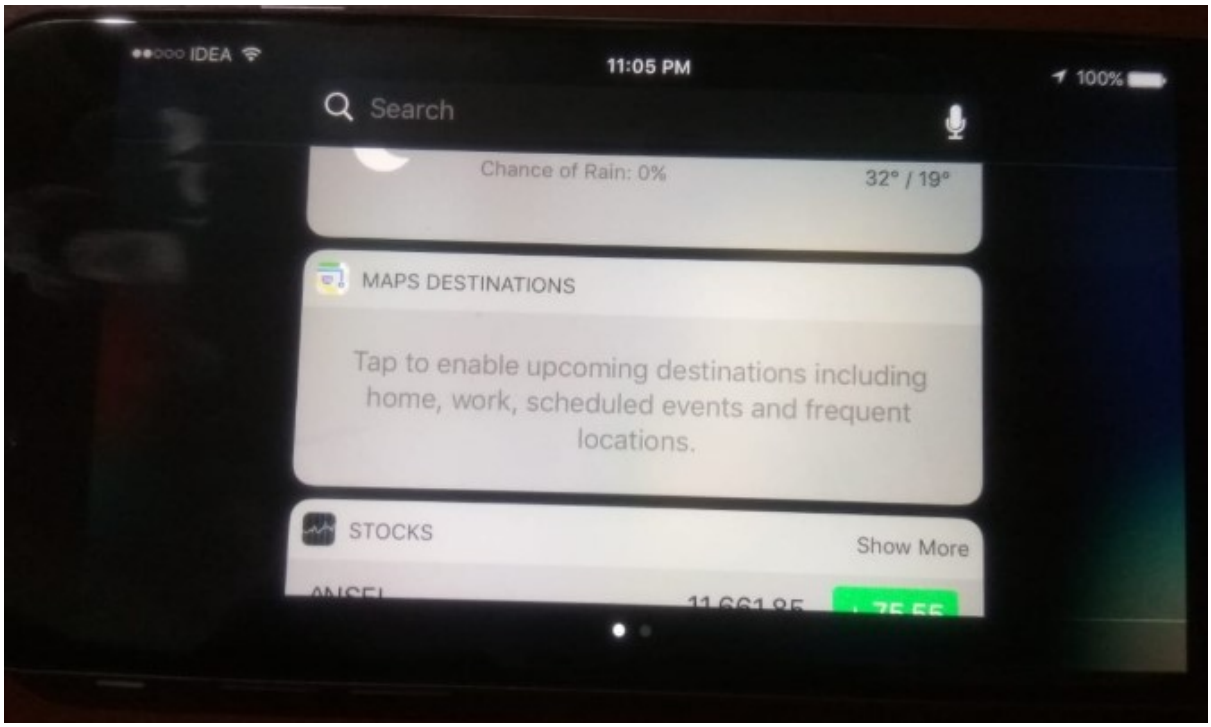

Figure 26: 100% Charge (iPhone 6S).

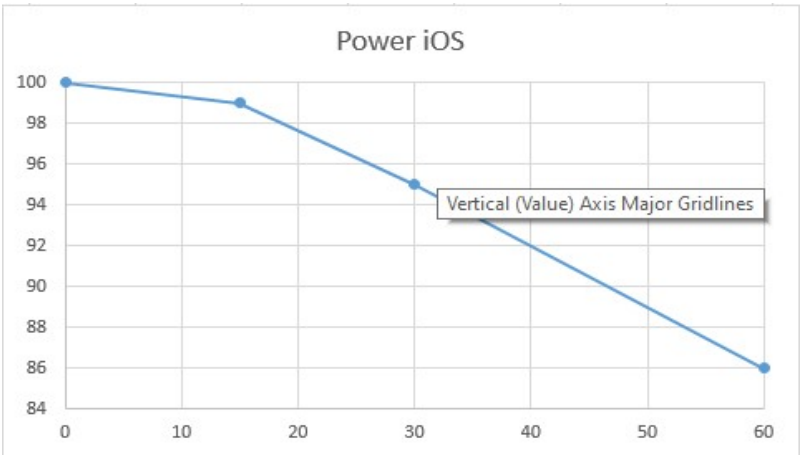

Figure 27: Power efficiency graph of iPhone 6s.

KaiOS (Jio Phone, INDIA)

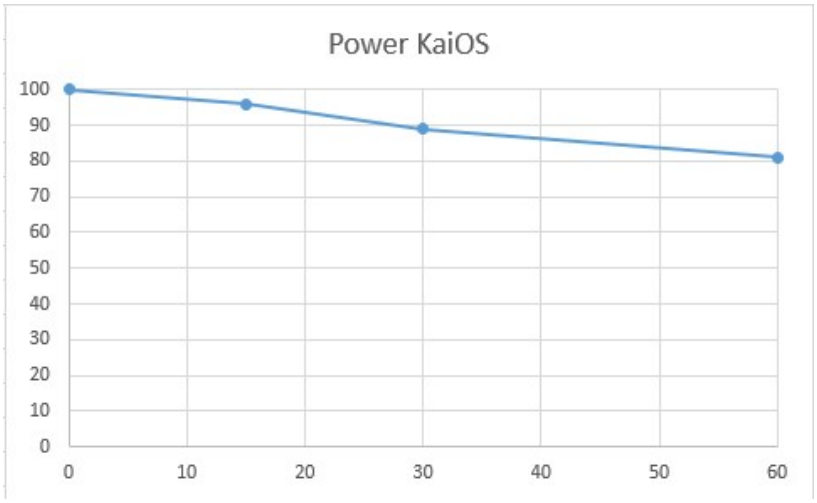

Figure 28: Power efficiency of Jio Phone (INDIA)

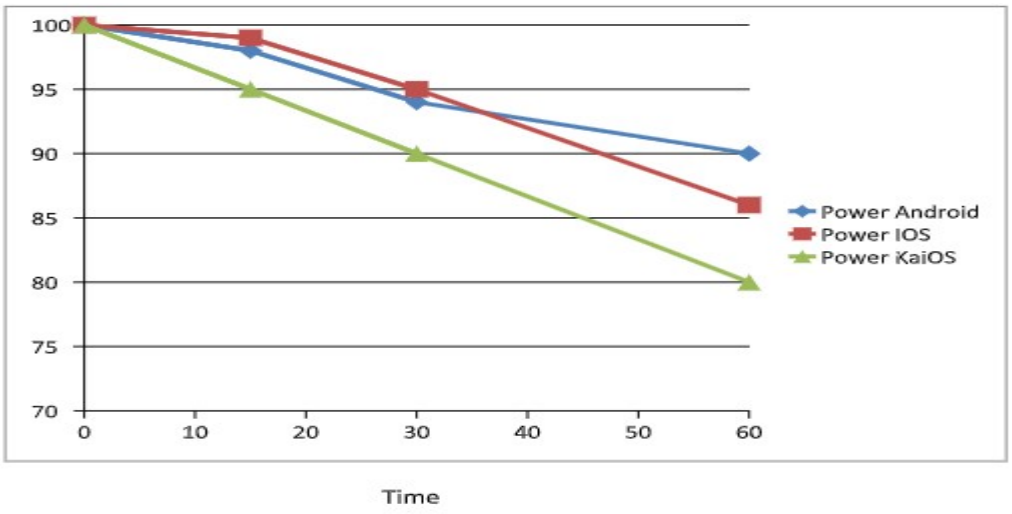

Figure 29: Overall power efficiency graph of Android OS, IOS, KaiOS.

IV. CONCLUSION

User Interface: Android and IOS provides the best UI, but android is preferred more as it is pocket friendly as compared to IOS.

Security: IOS provides the best security as in third party apps are also validated and signed using an Apple-issued certificate.

Power Management**:** Linux is the most efficient OS for servers. Windows is the most efficient for desktops when MS software is required or the software is only available on Windows.

Memory Utilization: LPDDR 5 is used in IOS A13 Bionic, while LPDDR4x is used in Android OS (Qualcomm, Snapdragon 855 plus), while in Windows, LPDDR4 is used. So IOS is having the best memory utilization in terms of speed as well as memory storage.

SOC: IOS A13 Bionic processor provides the best speed as well as efficiency due to its dual cluster hexa-core (2.66 GHz) and quadcore GPU, while Android OS (Qualcomm, Snapdragon 855 plus) octa-core CPU is having speed of 2.96 GHz.

Current results were compared with the earlier work [1] and found that many mobile devices and features which earlier ranked high in consumer attraction at one time had became obsolete in a short time span indicating the aggressive growth of mobile industry. The list includes mobile OS as BLACKBERRY, Bada, Meego. All these didn't continue because of sudden fall in the world market share, due to which they didn't update their OS features and further stop using advanced SOC's in their ongoing production of cell phones. This at last results in the shutdown of their existence in the world market.

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