# Smartphone's Hardware and Software Development Issues and Factors

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**Abstract:** *Smartphone's provides us the capability of a typical computer with absolute mobility and small form factor. But the hardware, software architecture of smartphone is significantly different from the conventional hardware and software architectures. The feature and architecture of the processors is totally different the traditional processors as these processors are developed to cope-up with less energy availability with Smartphone's or any other ultra portable devices.*

**Key-Words:** *Smartphone development issues, hardware, software development issues of Smartphones.*

## 1. INTRODUCTION

A smartphone is a mobile phone built on a mobile computing platform, with more advanced computing ability and connectivity than a feature phone. The initial Smartphone's were devices which mainly combined the functions of a personal digital assistant (PDA) and a mobile phone or a camera phone. Today's models also serve to combine the functions of portable media players, low-end compact digital cameras, pocket video cameras, and global positioning system (GPS) navigation units [1] [2]. Modern Smartphone's typically also include high-resolution touch screens, web browsers that can access and properly display standard web pages rather than just mobile-optimized web sites, and high-speed data access via Wi-Fi and mobile broadband.

There have been many issues regarding smartphone development and include hardware,-software, security, portability, cultural issues etc. and are discussed in following subsections in detail.

### 1.2 Hardware Performance

Hardware performance is of utmost importance for Smartphone's as they are battery powered and are supposed to run large complex applications, in addition to this modern day Smartphone's are supposed to run complex codes at par with desktop computers. Desktop and even laptop computers need large amount of power to work, but in contrary to this Smartphone's works with 3.7 to 4.2 Volt batteries, therefore huge gap exists in power requirements. So, only efficient hardware with maximal performance can bridge this gap.

### 1.3 Network Performance

Voice and data communication are the major functions that a phone has to perform, so the networks from which it fetches data/voice must be efficient otherwise power loss will occur. Network performance can be further categorized in following two ways namely network carrier performance and radio resource allocation performance.

#### 1.3.1 Network Carrier Performance

Different network carrier offer different network performance for the Smartphone's, even the same type of phone when used in different networks may perform differently. Since the main function of smartphone are surfing internet and getting network based services, the main evaluation object for smartphone network performance will be the data network.

Major parameters used in network performance analysis are: downlink/uplink, time of day and signal strength. The main metrics considered on the network side are: Throughput, round trip time (RTT), retransmission rate, local DNS lookup time, handshake time and Ping latency. Different types of network service workloads are: web browsing, email service, stream video and voice over internet protocol (VoIP) communication, etc. Several cellular

network measurement tools are currently available online to check speed, congestion and network performance. Current results show the real 3G network performance is much lower than the theoretical limitation, so large amount of work is still needed to improve current 3G network performance.

1.3.2 Radio Resources Allocation Performance

In current communication networks, the carrier's performance plays a major role. There exists a tradeoff between quick network response and battery power. Inefficient radio resources results in lot's of energy loss e.g. when connection breakdown occurs the mobile device have to repeatedly poll the carrier for sending data which wastes energy. If the breakdown occurs too frequently then lots of energy will be consumed in polling. Even different networks carriers have different protocols and different spectrum for communication, so the same device may behave differently with different network carriers.

Radio resource control (RRC) state mechanism is employed by the network service providers. RRC is responsible for effective utilization of phone and carrier. It controls the system when the phone is idle; doing data communication, voice communication, or when both voice and data communication are being done. This mechanism must be efficient for optimal performance.

1.3.3 Antenna Diversity Performance

Good antenna design could bring great power savings and high network performance to the smartphone. Right now most of the Smartphone's are still using Omni directional antenna, which wastes power and can also introduce interference among peers. Work is being done on improving antenna performance by applying two or more Omni-directional antennas for diversity. The new multi-directional antenna system uses accelerometer and compass (commonly existing in current Smartphone's) to assist orientation estimations. A complete smartphone antenna evaluation should consider different environment factors: outdoor/ line-of-sight indoor/non-line-of-sight indoor and different signal strength.

## 1.4 Keypad Input Performance

The styles of the keypads for smartphone have several different categories: traditional digital keypad, QWERTY keypad and on-screen keypad. The different keypads style could greatly influence the user experience for the smartphone. In order to increase the input speed of keypads and make users feel more comfortable to use smartphone, smartphone designers have designed many input methods and added user preference memory functions to the smartphone.

## 1.5 Additional Modules Performance

Comparing with normal mobile phones the Smartphone's also have many additional modules as such GPS, camera and Wi-Fi, which could help Smartphone's to possess new functions and improve performance. Performance of these additional modules matters a lot from energy consumption point of view. In many number of cases accelerators are used for implementing these functions. Accelerators actually implements code of these subsystems by hardware means and have lots of performance improvements. Following subsection briefly discusses theses additional modules in relation with smartphone.

## 1.6 GPS Module Performance

The GPS module can not only make the smartphone to become a GPS navigator, but it can also help the smartphone to provide location-based and context-aware services. Though the navigation function could also be realized by GSM/Wi-Fi based positioning system, the GPS can supply more precise information. The disadvantage of GPS is high power consumption. So a better GPS control mechanism is used with multiple different localization methods which achieve large power saving for the smartphone.

Code for GPS module must be compact and should be optimized to achieve power efficiency. With the help of localization methods significant improvements have been done in GPS module and its interface with the mobile phone.

## 1.7 Camera Module Performance

The camera is one of important part of the smartphone. Not only it can capture pictures, but also provide support for control or data collection of other applications in the smartphone system, like motion detection, face reorganization, visual

input for smartphone control, etc. Due to the power limitation of the phone battery, the imaging sensor with large number of pixels and high visual quality is hard to implement in a smartphone. Therefore, in current smartphone camera research, focus is on how to use vision based interaction to increase current camera capture efficiency. Beside this, research is being done to improve the speed of process execution. Different programming languages (C++, Python and Java, etc) are evaluated under the same smartphone operating system (OS) system.

Several metrics in image processing domain are applied to evaluate their performance e.g. frame per second: The number of full size bitmap frames captured from the camera and then saved to memory in one second. Read latency: the time interval between picture captured and shown on screen. Pixels skipping: image de-sampling processing (number of pixels are reduced in this process), Time to track: the time taken to track a small object from the background (example: a red dot in a white background) in the image.

In recent times accelerators have been used for performance improvement. These accelerator implement some part of the algorithm by hardware means to gain very fast computation speed. Present day Smartphone's comes with number of accelerator and includes display accelerator, camera accelerator, GPS accelerator and network accelerators.

### 1.8 Wi-Fi Data Communication

Wi-Fi network access is another important function of smartphone, because it could offer higher bandwidth and lower response latency comparing with cellular network. However, since Wi-Fi (wireless fidelity) doesn't have efficient RRC mechanism for smartphone, it could be power hungry in default mode for data communication and VoIP using Wi-Fi. Designing a better Wi-Fi control mechanism is critical for smartphone design. Moreover, though Wi-Fi is quite power consuming in the default mode, it consumes less power when doing VoIP communication than normal phone call using GSM/3G network. So mixing control for Wi-Fi and normal GSM/3G operation could provide large power saving. Some recent researches discussed the energy-delay tradeoff by seeking power saving for both Wi-Fi and GSM/3G network while maintaining the data transmission efficiency.

### 1.9 Software Performance

The software efficiency for smartphone largely influences the execution speed and power consumption of the smartphone. The software used for smartphone or any of the hand held device must be developed keeping in mind the underlying hardware on which the software has to work.

### 1.10 Security Performance

Since the Smartphone's are widely used in personal data service (e-mail, shopping, and bank service), company business and government work, the security issue has became an important issue for smartphone design [8]. Many security standards have been proposed to protect web safety and message encryption, such as Web Services Security (WSS) and Security Assertion Markup Language (SAML).

Due to the limitation of smartphone hardware and its power, the security standard for Smartphone's are still under developed, and it's especially lack of evaluation benchmarks and standards for different security standards performance in protecting information and detecting phone virus or spam. Various encryption methods have been implemented for Smartphone's which provide good security with minimum amount of code and still optimizations are being done to compact code to make them very useful for battery powered Smartphone's.

### 1.11 System Performance and Other Considerations

Due to commercial reasons and cell phone development history, the smartphone OS is quite isolated. So different smartphone operating systems show large performance differences even when they execute the same task. It's important to evaluate system performance of Smartphone's for better designing of future smartphone OS. The phone task organization and middleware design are two important aspects for smartphone system performance.

### 1.12 Phone Tasks Performance

Today's different Smartphone's can execute almost all tasks like phone call, messaging, email, web service, gaming, etc. But they show dramatically different performance when executing these tasks due to the different platforms which are used on them and different task models they use. Task performance must be good for Smartphone's.

### 1.13 Smartphone's Middleware Development and Performance

Middleware is the control management part between the OS, external sensors, wireless communication and various applications, as shown in Figure 1.1. It offers expansibility and compatibility for the smartphone to act as a pervasive computing device, which could be widely used in scientific research, medical care and daily life. Due to the isolation of smartphone OS and limited application programming interfaces (API) provided to the application developers, the traditional applications could not achieve the best performance and even poor power management occurs when applied to the smartphone.

With this both hardware and software implementation of middleware are being studied. Middleware can be implemented by software means if the underlying hardware is both powerful and energy efficient.

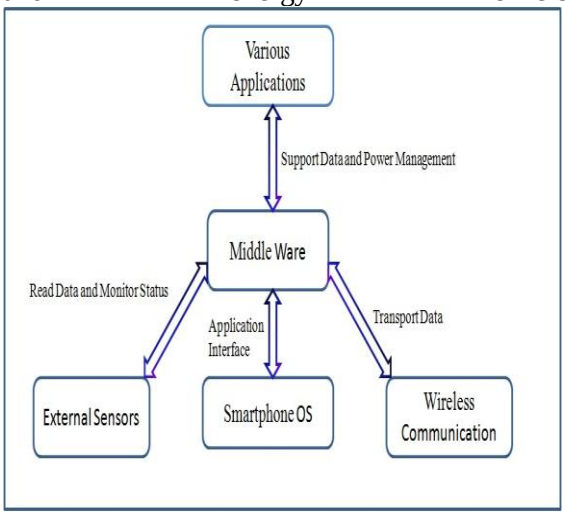


Figure 1.1: Middleware structure of smartphone [2]

Current research results show building up a generic middleware layer between the smartphone OS/external sensors and applications can greatly save power and increase the application execution efficiency while using smartphone as a pervasive computing device, and it also provide easy portability. The context-aware mechanism can offer good querying processing and accurate activity recognition. Tight integration between middleware and other software/hardware resources is mooted as it will provide more power efficiency.

Main metrics considered in middleware design are: data communication specifications (throughput, latency), power consumption, and execution speed for different programming languages and OS platforms, precision per recall.

### 1.14 Smartphone's Usage Performance

As a daily used equipment, the usage of smartphone is different among different groups of people and people from different parts of the world. The smartphone could perform poor to a user if it cannot satisfy the requirement of this specific user. Therefore, the usage diversity and cultural differences evaluation are important for smartphone design and performance.

### 1.15 Usage Diversity of Smartphone's

Different people use Smartphone's to accomplish different tasks. The capability of the smartphone to adapt to user behavior could largely affect the smartphone performance -and user experience. Comparing the user interaction activities with the smartphone can provide the smartphone designer more information on how to improve the smartphone configuration and its OS. Some recent works focused on analyzing user's behavior using statistical models for task diversity usages and battery consumption characteristics.

### 1.16 Cultural Differences Evaluation of Smartphone's

Cross-cultural factors have a great influence on how user experiences of people from different countries are. The smartphone performs different under different cultural environment. The main impacts of cultural differences can be divided into two categories: Objective issues (language, dates and number format convention, text directionality) and subjective issues (value systems, behavioral and intellectual systems, and

the cultural interactions with computers and websites).

### 1.17 Conclusion

As discussed in this paper, lots of factors which affects the development of Smartphone's. Each factors or issue has its own impact on the performance of the smartphone. Environment also affects lots of parameters which will be chosen during the development of Smartphone's. But usually optimal parameters are chosen for the smartphone development. We should be very careful during selecting these parameters.

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