Looking upwards – Smartphone stack

As we all agree, business value chain of smartphones are becoming highly competitive and complex day by day. In less than two years time, all smartphones are transforming from its high profile task master status to just something more than a paper weight. Beyond wear and tear, mal functioning, damage, transformation from task master to paper weight is being accelerated by the technology obsolescence wherein technology being projected as the state of the art at the time of device launch becomes outdated in a short span of time. In the above context, let us look at the technology stack of smart phones spread across hardware, firmware and application stack and the kind of transformation each piece that forms the smartphone stack are undergoing.

Dissecting the smart phone hardware

Let us look at the hardware first. Almost all smart phone devices available in the market are using ARM processor based Systems on Chip (SoC) that incorporate memory, interfaces, radios, etc. Let us first look at why ARM processor based SoCs for smart phones. ARM processors with RISC-based computer design require significantly fewer transistors than typical CISC x86 processors in most personal computers. RISC based architecture and instruction set reduces costs, heat and power use that are desirable traits for light, portable, battery-powered smart phone devices. Simpler design comprising of instruction sets and architecture of ARM cores

helps OEMs to come up with efficient multi core CPUs and SoCs. Major SoC vendors in the smartphone market include Qualcomm, Samsung, Apple, Nvidia, MediaTek, Broadcom, Atmel, TI etc.

ARMv8-A ARM core used in Apple A7 chipset used in Apple iPhone 5S has support for 64-bit address space and 64-bit arithmetic. From ARMv7 onwards, ARM core also includes a robust hardware Floating Point Units (FPUs), with improved speed compared to software based floating-point. Performance of the SoCs used in smart phones will be varying based on the number of cores and properties of each ARM cores used within SoCs such as address space, register size support for general cores and FPU within the cores, depth of pipeline, out of order execution capability, presence of Floating Point Units (FPUs) within ARM core, caching levels and of course speed per core. On top of all of the above, the GPU (Graphics Processing Unit or media processor core) core used within the SoC and its capabilities such as video CODEC (hardware CODEC) support, Graphical library support, clock speed, number of ALUs etc. will make a big difference in the performance, especially when we evaluate the performance of smart phone for playing 720p or 1280p videos.

Peripheral capabilities and the capabilities of communication components such as GPRS radio, Wi-Fi radio, Bluetooth radio and their specifications also will be key evaluation factors while doing the hardware evaluation. Usage characteristics would be a key decision factor for the communication capability evaluation. As traditional voice communication still works over he older network infrastructure, the decision on the communication capabilities have to be looked from what the device hardware has to offer for data communication. While advanced radio support for 3G/ 4G (different variants –LTE, WiMAX, HSPA) will be looking very attractive from a device capability angle, the decision should be based on the network capability and regulatory authority's network upgrade roadmap for the next two years where our device has its life span.

Screen type and screen resolution data also have to be verified and compared as part of peripheral capability evaluation. Super AMOLED displays comes with built in touch sensors on the display itself, as opposed to creating a separate touch sensitive layer. This makes it the thinnest display technology on the market. Retina display offered by Apple for its iPhones has high resolutions as well. Gorilla glass with exceptional damage resistance is becoming the display glass choice for many leading OEMs who are in competition to deliver superior quality smart phones to its customers.

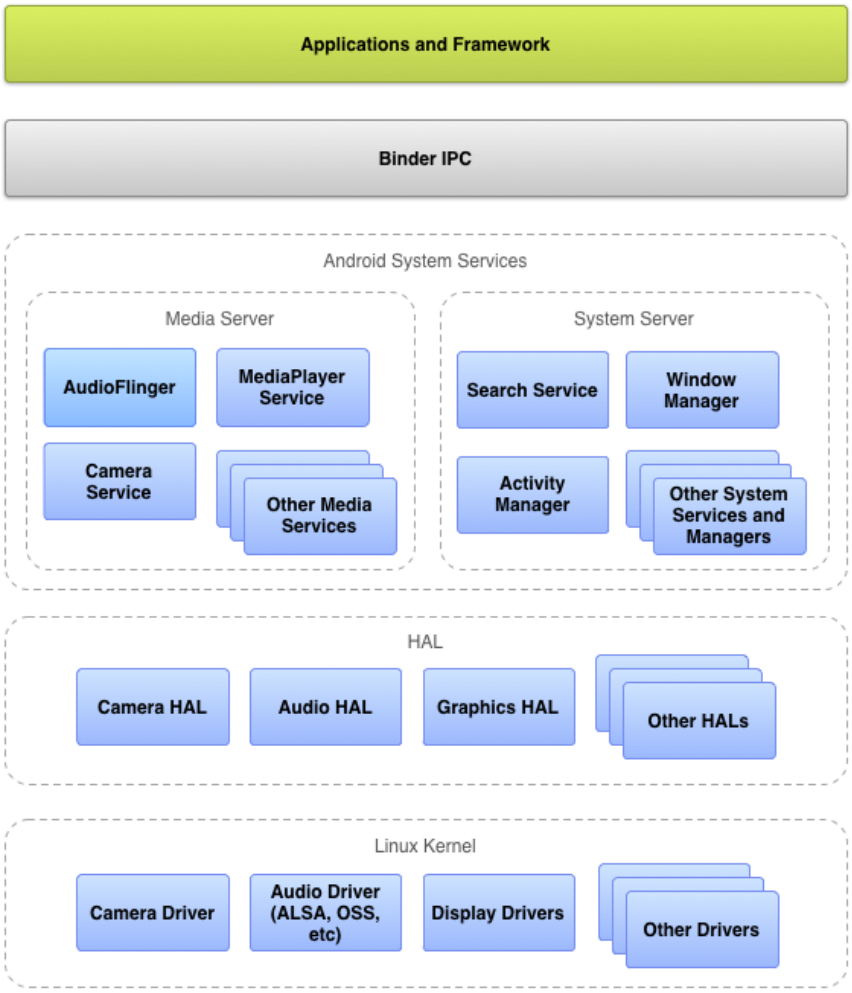
Dissection of Firmware – Operating System

Now let us look at the next segment that sits on top of the smart phone hardware, firmware.

The primary and important criteria before we look at the integration interfaces exposed by the firmware are the robustness and performance optimality of the operating system from the functional capabilities angle. Apart from the traditional functions like management of hardware, processes, memory, scheduling and users, its real time nature and multi-tasking capabilities have to be analysed and compared against other options available in the market.

As with any other layered architecture that we talk about for software systems, the integration between hardware layer and the hardware platform dependent firmware (Hardware Abstraction Layer – HAL) has to be very tight and optimal for smart phone firmware to make the best use of the hardware capabilities. Firmware also should have the optimal hooks to ensure that the application layer that sits on top of the firmware has the best seating on top of firmware. Platform vendors are adopting different approaches for the firmware design taking into account the various non-functional aspects while keeping the functional aspects same across platforms and their versions. Certain platforms are adopting several layers of abstractions as the transactions move from one layer to another to take into account the maintainability. Volume of native code execution from the API call through the HAL layer till driver and back and the number of abstractions in between layers will be the key factors deciding the firmware performance for the APIs it is offering for the application layer.

Let us look at Android firmware as an example. The below given system architecture shows the different Android firmware layers and the system level components in each of the layers. Application developers will be confining their firmware level interaction at the Application framework level.



The Hardware Abstraction Layer (HAL) serves as a standard interface that allows the Android system to call into the device driver layer while being agnostic about the implementations of the drivers and hardware. Android does not mandate a standard interaction between our HAL implementation and the device drivers, so firmware developers have freedom to do what is best for their situation. As HAL layer is directly interacting with device drivers and actual hardware, it is always safe to assume that the firmware provided by the actual OEMs will be the best one suited for our hardware from the functional and performance context rather than experimenting with firmware for the same SoC from other parties. But the challenge that tech savvy device users face every time, especially in the context of Android is that OEMs selling their devices fall short of their firmware update release commitments. Google has announced Android Update Alliance to ensure latest mandatory timely firmware update delivery for the next 18 months for all the Android based smart phones released in the market, but it is yet to become a reality and actual practice.

Dissection of Applications and Framework layer

Now let us look at the Applications and Framework layer that provides the required API support for developers to leverage the hardware and firmware capabilities. While improved and advanced hardware components and tightly integrated performance optimized HAL layer are expected to deliver far superior performance for the smart phones, the actual performance outcome depends on the performance and compatibility of the API layer offered by the applications and framework layer. For example, a smartphone having a hardware spec that is equivalent to that of latest Samsung Galaxy S5 when embedded with any Android versions prior to 4.4 (Kitkat) would have ended up delivering below par performance from the usability and interactivity response angle. Such devices wouldn't be able to make use of the state of the art Android applications built on top of Android API level 19. Platform vendors while releasing the latest versions of their smart phone operating system will evaluate the competitive landscape and their competitive positioning in terms of the market share trend, volume of the applications getting launched through their app stores, user and developer adoption of the operating system etc. As a result more and more APIs that were kept private in the previous API levels integrated with previously released OS versions will be made public to redefine their application business eco system. Also APIs for exposing peripheral capabilities and communication hardware integrated with smart phone hardware will undergo further fine tuning for the leading SoC platforms making use of the previously released version of the operating system. Another important aspect to look into from the application framework standpoint is the device OEM's commitment in releasing the new firmware updates as and when platform vendors releases major platform releases and minor patch releases. For example for Android smart phone operating system, the last major release officially made by Google is Kitkat (Android version 4.4). This major release happened on 31st October 2013. All leading OEM vendors selling Android based smart phones have made use of this version while launching their flagship products to market. But post 4.4 release, Google has made three more patch releases till date for the Kitkat version. The latest release 4.4.3 was made on 2nd June 2014. All these patch releases were primarily targeted for launching the improved APIs for enhancing the device peripheral performance, security enhancement etc. Hence it would be ideal to analyze the past

trends of the OEM vendors in releasing the firmware updates once platform vendors launch major and patch releases.

Exploring the smart phone applications eco system

Applications and the intuitiveness of the business models defined around them forms the face and external appearance of a smart phone device. If it is not that impressive when compared with the application eco system of competitive products, no one would prefer to further explore the internal and inherent platform and device capabilities since the layer that users are exposed to is not reflecting the inherent platform and device capabilities. We are seeing two different trends in this area from the two leading smartphone operating system platforms iOS and Android. While iOS app eco system ensures quality control for the applications on top of the operating system capabilities through its completely closed loop certification program and process, Android app eco system irrespective of its operating system capabilities doesn't offer such a tight control for ensuring quality compliance of its application eco system. Closed loop app eco system ensures consistency and predictability in device performance, application performance, system resource usage etc. While open-ended application GTM approach for app launching through App store will attract a wider developer and business audience for the app eco system, the chances for quality deterioration and user adoption deterioration is quite high, especially while also considering the fact that there is no qualification mechanism for onboarding developer profiles to the app eco system. Certification process based application eco system will ensure consistency and predictability of the performance.

Physical packaging – another key decision factor for selection

Last but not the least is the quality of the physical packaging, its ruggedness and the ergonomics of the device. As smart phones are exposed consistently to adverse environments, it is always advisable to provide certain weightage for devices that offer physical packaging that are having industry recognized packaging certifications. For example the latest launch from Samsung, Galaxy S5 has an IP67 rating indicating that it is dust proof and waterproof.

With multiple user interactivity options (touch, keypad, voice, gesture etc) and the standard practices being followed across smart phone platforms for ensuring effective

user engagement, ergonomics factors will boil down to cultural and individual perceptions mostly.

Conclusion

While analyzing the capabilities of each of the individual blocks mentioned above and benchmarking them against the best for that segment, we need to keep in mind about the dependencies of each of the blocks and analyze how each blocks when stacked together collectively delivers the best intended performance results for the users.

About Attinad Software

Attinad Software is a software company specializing in new generation technology driven solutions around Social, Mobile, Analytics and Cloud (SMAC) across various industry verticals. Attinad Software's key objective is to become the right technology and IT solutions partner for its clients by delivering them the best in class software products and solutions that best suits their context. Our products, proven solution frameworks and the implementation methodologies have helped our clients rollout the best fit solution that suits their business contexts, both from functional workflow context and non-functional growth, sustainability and scalability angle.

Attinad Software, one of the fastest growing company has won several prestigious awards and accolades since its inception for its unique differentiators and state of the art solution deliverables. Attinad has been bestowed with the prestigious Red Herring Global 100 award in the year 2013. Red Herring is a prestigious award given to technology companies who bring differentiation in converging and transforming technologies into business solutions. In the year 2012, it has been selected as the EMERGE 50 companies in India by NASSCOM, the association of software companies from India. The mobile patient management solution developed by Attinad has been chosen for the final round of NASSCOM Innovation Award for the year 2013. It has also figured out in other leading technology magazines such as IDG Channel World, Silicon India as one of the hot 50 companies with unique market differentiators.

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