Technology Institute

Mobile Technologies Index

Mobile operating system: Smartphones will just get smarter

By Raman Chitkara, Global Technology Industry Leader

The smartphone seems to acquire more cognitive capabilities with each major product release—regardless of the OEM. PwC expects this trend to continue.

Many of these cognitive improvements will be enabled by the technologies that comprise the PwC Mobile Technology Index—device connectivity speed, network speed, application processor, memory (DRAM), storage, image sensor and display. The mobile operating system (OS) is not included in the Index because there is no comprehensive metric for it, but we do anticipate continuous innovation, especially in the user interface (UI) layer and the core services layer (capabilities that make life easier for application developers) of the OS, to support the new cognitive capabilities of mobile devices.

Cognition is defined as 'the mental action or process of acquiring knowledge and understanding through thought, experience, and the senses.'[1] Propelled by sensor technology, more powerful processors, better connectivity, cloud data sources and increasingly sophisticated data analysis on and off the device, smartphones, tablets and other mobile devices are on track to acquire ever more of this capability. "The smartphone, in particular, appears destined to become a true digital assistant, capable of self-learning based on the user's behaviours, then personalising both the active and passive ways the device can engage with the user, the environment and network," says Daniel Eckert, PwC director for Mobile Computing.

Daniel Eckert
PwC Director for Mobile Computing

The role of the OS will only grow in importance as the orchestrator of all the components and services on the device and those that reside in the cloud. The OS is the enabler of the enablers, if you will.

Although there is no comprehensive metric for the OS, we see incremental improvement over time similar to DRAM, storage and the other mobile building blocks. Unlike the other components, it is difficult to define metrics for OS performance. Instead of more bits transferred per second, or more bytes stored per dollar, OS improvements come in qualitative enhancements: better security, multi-tasking capability, support for more media protocols, etc.

One reasonable approach to forecasting change in the OS is to examine the history of these incremental improvements and look for patterns likely to continue. Specifically, we examined the number of material enhancements to the iOS and Android operating systems over the period covering the last four major releases from Apple and Google. This includes iOS3 through iOS6 and Android's Gingerbread, Honeycomb, Ice Cream Sandwich and Jelly Bean releases. We chose these two platforms because, at the time of this writing (Spring 2013), they account for more than 90 percent of the mobile OS smartphone market.

1 New Oxford American Dictionary

2 http://techcrunch.com/2012/11/02/idc-android-market-share-reached-75-worldwide-in-q3-2012/ http://www.idc.com/tracker/showproductinfo.jsp?prod_id=37

While we focused on these two platforms to forecast changes in the OS, we expect continuing innovation in all significant operating systems. Advances in one operating system will fuel accelerated innovation from others.

Our source of data is the documentation that Apple and Google supply developers to inform them of the major additions to the OS in each release.[3] Thus we allow the OS vendors themselves to tell us which additions and enhancements to the OS they considered worthy of note. Because, in reality, there are hundreds of changes to the OS in each major release, but only a few broadly indicative of innovation.

The specific items called out by Apple and Google were then placed into one of four architectural layers in the OS, and we counted the number in each layer.

The results of this content analysis of notable enhancements are shown in Figures 1, 2 and 3. Figure 1 combines the data for iOS and Android. There is remarkable consistency in the total number of enhancements to the mobile OS (between 30 and 32) in each new generation, and a fairly consistent number in each layer. The UI and core services layers account for 91 of the 125 or about three-fourths of all enhancements.

Figure 1: Combined iOS and Android innovation pattern

	iOS3 & Gingerbread	iOS4 & Honeycomb	iOS5 & Ice Cream Sandwich	iOS6 & Jelly Bean	Total layer innovations
User interface layer	11	10	12	12	45
Media layer	6	6	7	3	22
Core services layer	11	11	11	13	46
Core OS layer	4	3	2	3	12
Grand total	**32**	**30**	**32**	**31**	**125**

Source: Apple Inc. and Google Inc.

Figures 2 and 3 show the same data for iOS and for Android. The first distinctive pattern here is in the total enhancements across all layers of the OS. iOS starts with more, but has trended down over time, concluding with 11 enhancements Apple considered significant enough to signal to the developer community in iOS6. Android starts with fewer, but has trended up concluding with 20 enhancements Google brought to developers' attention in its Jelly Bean release.

Figure 2: Apple iOS innovation pattern

	iOS3	iOS4	iOS5	iOS6	Total layer innovations
User interface layer	8	6	4	4	22
Media layer	3	4	4	1	12
Core services layer	4	7	5	6	22
Core OS layer	2	1	1	0	4
Grand total	**17**	**18**	**14**	**11**	**60**

Source: Apple Inc.

3 https://developer.apple.com/library/ios/#documentation/Miscellaneous/Conceptual/iPhoneOSTechOverview/Introduction/Introduction.html#//apple_ref/doc/uid/TP40007898-CH1-SW1 http://developer.android.com/about/index.html

Both the iOS and Android enhancement patterns show a preponderance of activity in the UI and core services layers. Most of the differences between iOS and Android are explained by an increase in enhancements in the UI layer, from three in the Gingerbread release versus eight in Jelly Bean, its most recent release. Over the same number of generations, iOS has gone from eight UI enhancements in iOS3 to four in iOS6.

(For more details that summarise the actual enhancements we counted for the preceding tables, see our footnote 3 on page 2.)

Figure 3: Android innovation pattern

	Gingerbread	Honeycomb	Ice Cream Sandwich	Jelly Bean	Total layer innovations
User interface layer	3	4	8	8	23
Media layer	3	2	3	2	10
Core services layer	7	4	6	7	24
Core OS layer	2	2	1	3	8
Grand total	**15**	**12**	**18**	**20**	**65**

Source: Google Inc.

This view of enhancement patterns over time suggests a forecast pattern for the two currently dominant mobile OSes, and possibly any others.

For example, don't expect much to happen at the core OS layer, although a few fundamental developments could arise in response to the needs for greater information security, especially in the enterprise context. Beyond that, we are likely to only see improvements required to keep up with incremental advances in the seven enabling technologies—more powerful processing; larger storage on board; higher image resolution, and the like. OS improvements to match those are necessary, not innovative.

Likewise, we do not anticipate multiple major innovations within the media layer. One exception would be a one-time bump in new capabilities as ultra high definition video becomes incorporated in high-end smartphones over the forecast period.

The two layers likely to see the most enhancements over the next five years are the core services and UI layers. Precise predictions are not possible, but we can hypothesise the anticipated vectors of innovation in these layers.

Enhancements in the core services layer will target the developer community directly by exposing advanced hardware features such as sensor data and making it easier to move between applications and social networks or other cloud access points. Two specific areas likely to see innovation, requiring parallel innovation from the OS, are ubiquitous high-speed connectivity and tighter integration.

Ubiquitous, high-speed connectivity will be essential for many of the proactive always-on monitoring we anticipate from some sensor-driven apps. Next generation wireless starts with the widespread availability of LTE networks that enable the mobile OS to keep the device continuously connected.

But to achieve truly high speed connectivity carriers will introduce hundreds of thousands of self-configuring micro-, pico- and nano-cell base stations, all in service of moving connectivity speeds ever closer to 1 Gibabit (Gb) per second. Only by creating smaller cells connecting fewer users per call will the desired speeds be possible. This introduces additional challenges for the network and the device for managing interference and dealing with multi-cell connectivity.

The LTE environment won't be everywhere by the end of our forecast period. So the OS will need to be able to figure this out, and find ways to adjust for always-on proactive apps—determining optimal refresh cycles, for example.

Figure 4: Patterns of innovation in the OS through 2016

Core layer – Better security and improvements to keep up with incremental advances in the seven enabling technologies.

Media layer – Innovations associated with ultra high definition video.

Core services layer – Enhancements that target the developer community directly by exposing advanced hardware features and making it easier to move between applications and social networks or other cloud access points; specific areas likely to include ubiquitous high-speed connectivity and tighter integration.

User interface layer – Innovations to enhance the growing cognitive capabilities of mobile devices, including more instructions to the device coming from sensors and the web without human intervention.

Source: PwC

As connectivity improves, the OS will need to be able to more thoroughly integrate and orchestrate the mobile device with the cloud, managing the balancing act of native apps on the device with apps, data and services in the cloud and the interplay amongst them; and continuous connection with other devices with which it is federated and has the ability to exchange information. Federated devices might be a desktop computer, a tablet computer and devices belonging to family members or friends with whom the user wishes to interconnect. Or the smartphone might have to federate with wearable computers, acting as the hub and integration point that connects wearable sensors to the cloud.

The desire of users to federate devices could pose a big challenge to OS developers for several reasons. Users tend to have devices from different OEMs, each with its own OS. Sensors are increasingly available with embedded Bluetooth, but standards for data transfer are only beginning to emerge as new sensor applications appear almost daily. While there's already this kind of integration for a user of all Apple products, the situation is vastly different when the proliferation of intelligent sensors is considered.

We also expect many more enhancements over the next five years in the UI layer. "This is due in part to the opportunity for mobile OS vendors to continue to try to differentiate on the basis of user experiences," adds Eckert.

The mobile OS has already changed the basic paradigm for how the user interacts with mobile computers, through the capacitive touch sensor just beneath the screen—the swiping, tapping and pinching to manipulate on-screen objects we're all familiar with.

More recently, voice has become an increasingly important way to literally tell the device what to do. On the horizon is touch-free gesture control, which will require a mobile OS to decide if the movement of a finger was or was not an instruction. We already see wearable computing devices[4] that sense the subtle muscle movements associated with the changing positions of individual fingers and translate them into instructions to the OS and any other federated devices.

These are still just variations on how the user can give the smartphone instructions. Through 2015, we expect more instructions to come automatically from sensors and the Web without human intervention. The very definition of 'user' and 'UI' is likely to expand to include the inanimate pieces of the device that sense, know, and figure things out or scan on behalf of the human but without her intervention.

The mobile OS will acquire the capabilities to orchestrate the services that use the sensors, process the data they capture, and turn it into actionable information. Think of this as making technology 'people literate' rather than requiring people to become technology literate.

We already see sensors that act on their own, often with support from some of the standard enabling components on the device (sensor-based apps that work together with the image sensor, for example).

Google Now and its Card metaphor on Android devices are already demonstrating the potential for smartphones to act autonomously on behalf of the user. Early services include tracking the timing and locations of a daily commute by a smartphone owner to 'learn' where the user's home and office are located, then proactively

4 http://news.idg.no/cw/art.cfm?id=F75697A1-CE91-D930-2D7D3A8FA64F60DA

flagging a traffic jam on the user's standard route to work, and suggesting alternatives. It is still early days, but the many patterns of behaviour and information interaction in our daily lives offer a plethora of additional ways a digital companion style OS can add value.

Clearly, the evolving mobile OS is beginning to integrate situational information in the service of building a more complete context of the smartphone user, including specific patterns of user behaviour and implied preferences. These broadly come from three sources: the components on the device itself; the surrounding physical environment outside the device as understood by various sensors; and the needs, traits, desires, and preferences of the user derived algorithmically from an individual user's application data that builds over time. These cognitive capabilities are also known as contextual awareness.

By contextual awareness we mean that a mobile device understands a user's relationships to people, places, objects and information, and is able to infer certain needs, intents and goals of the user. Armed with this knowledge, a mobile device can meet a user's needs and wants with minimal requirement for that person to state them explicitly. In Phase II of the Mobile Innovation Forecast, we will explore contextual awareness in depth, and the role of the OS in providing it.

Let's talk

If you have any questions about the Mobile Innovations Forecast or would like to discuss any of these topics further, please reach out to us.

Raman Chitkara
Global Technology Industry Leader
PricewaterhouseCoopers LLP
raman.chitkara@us.pwc.com

Daniel Eckert
Mobile Computing Director
PricewaterhouseCoopers LLP
daniel.eckert@us.pwc.com

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