Wrapping up Phase 1 of the Mobile Innovations Forecast

New data bolster the general direction of innovation over the next five years

By Raman Chitkara, Global Technology Industry Leader

With this article, PwC concludes Phase 1 of its Mobile Innovations Forecast, in which we have examined trends in the performance of core components of mobile devices and infrastructure. Based on new data for these components, our fundamental assessment is that the rate of performance increases for these seven enabling components of mobile innovation—memory, application processor, storage, infrastructure speed, device speed, imaging and display technology—is expected to decelerate only slightly between 2011 and 2016, relative to 2007 to 2011.

We do see a potential trouble spot with the coming introduction of ultra high definition (UHD) video. Will the massive data streams produced by UHD overwhelm the other components? We explore that issue below. On the other hand, we are enthused by the early breakthroughs demonstrated by smartphones that use contextual information to deliver new value to owners. And a major question as we move into Phase 2 of our exploration of mobile innovation is how many mobile operating systems (OS) and associated app store ecosystems will survive to relevancy by 2016?

For new readers of the Mobile Innovations Forecast, some brief scene setting before we proceed. This forecast exists within PwC's framework for understanding various dynamics driving the broader technology sector today, a framework that suggests ways technology companies might navigate disruptions that are rich in opportunity.

Mobile innovation is one of four market forces in this framework that are redefining customer demand, expectations and business opportunity for technology companies. The others are cloud computing, social networking and the emergence of intelligent devices. Individually, each is turning the rules of the broader technology sector upside down. Collectively, they are co-mingling in ways that paint a forward-looking picture that is starkly, even radically, unlike the past.

Our coverage of the vast mobile ecosystem is an ongoing project comprising four phases. Phase 1 examined the performance improvements of existing technology components. Phase 2, launching soon, covers new capabilities being added to mobile devices. Phase 3 will review compelling new use cases. And Phase 4 will cover new business models.

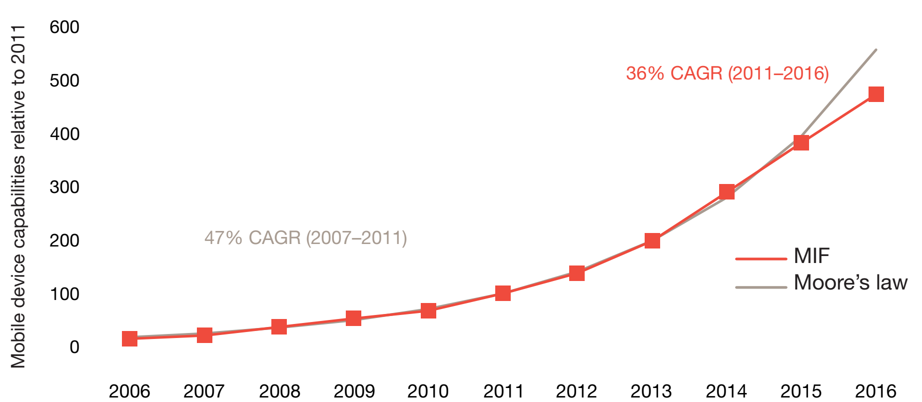
One purpose of Phase 1 has been to track the recent performance history of the core platform on which mobile delivers value and to forecast its trend line. For this purpose, PwC developed its Mobile Technologies Index, comprised of a metric for each of the seven enabling components. As part of this conclusion to Phase 1 we are reporting new data acquired from our supplier, IHS. Based on this data, we are publishing an updated version of our Mobile Technologies Index and forecasts for each of its seven technologies. Using this new data we can extend our forecast from 2015 to 2016.

In our revised forecast, the compound annual growth rate (CAGR) for the Index, 2011 through 2016, is 36 percent [Figure 1], compared to the earlier forecast of a CAGR of 41 percent for the period 2011 through 2015 [Figure 2].

The five-point reduction in the CAGR for 2011–2016 versus 2011–2015 is mainly due to the extra year. However, three components—application processor, display technology and infrastructure speed—have downward revisions of five percentage points or more in their improvement rates between the two forecast periods. [See sidebar on page 5]

PwC remains optimistic that the price-performance metrics for these basic enablers of mobile innovation will continue to improve at rates sufficient to inspire and support inventors. For the most part, these components are evolving in parallel; for example, app processors meet the data crunching needs of the OS as it delivers new gesture-sensing capabilities to users.

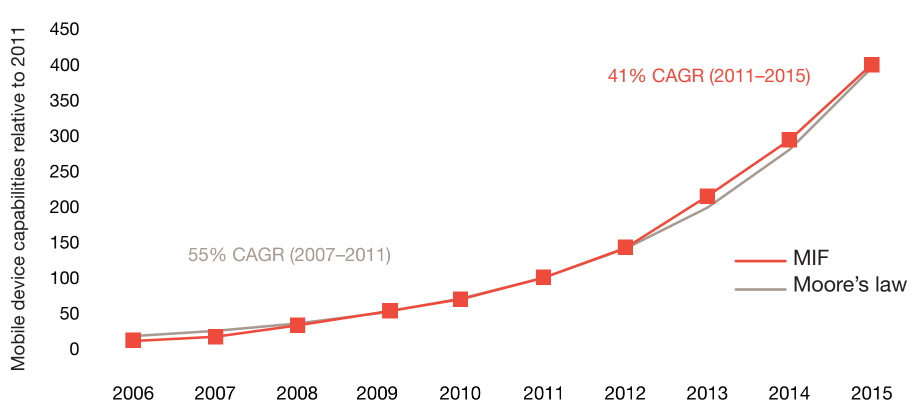
Figure 1: Revised Mobile Technologies Index



The red line represents a performance improvement trajectory that would match Moore's law.

Source: IHS iSuppli Mobile and Wireless Communications Service

Figure 2: Original Mobile Technologies Index



The red line represents a performance improvement trajectory that would match Moore's law.

Source: IHS iSuppli Mobile and Wireless Communications Service

The OS and the ecosystems they spawn

Although the Index does not include a metric for the OS, we cannot say often enough how key its evolution will be to future use cases involving the new technologies to be examined in Phase 2. At present, however, there are a number of questions about how the OS will evolve to support these use cases, especially across disparate mobile platforms.

Historically, desktop and server OS innovation originated from individual OEMs. The mobile ecosystem has been more complicated, making OS innovation itself more chaotic and, so far, a major source of innovation. That's because there are different types of mobile OS environments. At present, we see three models:

- Total control—a single vendor has complete and total control of closed source code, with no relicensing and a highly coherent application ecosystem driven by the vendor;
- Shared control—a community open-source approach driven by a few large vendors where variations and extensions are managed through commercial agreements that include validation testing to limit application incompatibilities;
- Hybrid—a go-it-alone approach by a large or small vendor using an open-source code base as a starting point but making changes that introduce incompatibilities, usually in support of a different business or monetisation model.

Each type has implications for the path, or vector, of innovation. Whilst we cannot accurately predict which vector will have the greatest impact on mobile innovation, we can suggest patterns of innovation that could be more likely in each model.

The total control approach offers the vendor strong brand recognition, a track record and a critical mass of users associated with some initial groundbreaking innovation. The challenge comes later. Once a mass of users has been established, it creates a dead weight of backward compatibility requirements. This dead weight can limit innovation to capabilities consistent with the existing ecosystem. Even if the existing ecosystem was initially launched by an earlier disruptive innovation, vendors can find it difficult later to 'break the eggs' by introducing a new disruptive innovation to their installed base.

In the shared control model, the core common platform offers a foundation, but introduces some freedom to build new capabilities on top that suit particular user communities. However, this potential for the OS to fork in different directions prohibits against broad adoption of any significant innovation from one fork. As such, and given network effects in technology, it is unclear if the end game of shared control is, in fact, a continuation of the model or an evolution to the total control approach.

On the other hand, depending on the nature of the open-source community and licensing terms, the most successful forks can be repatriated into the core, shared platform. This model could support a larger number of innovation initiatives, not all of which would survive but those that did could be more impactful than what a single, closed-source vendor might produce.

In the hybrid approach the level of innovation is least constrained—it is effectively a blank canvas for the most disruptive capabilities. The challenge is that a new device would need an innovation so valuable that people would be willing to carry a second device or willing to give up access to their current ecosystem of apps, or tap into an entirely new market—say in regions of the world where smartphones are not yet widely adopted.

Mobile innovation in general is about seeing what everyone sees but interpreting it differently—fighting on new ground, not on the same ground. But it is also about gaining enough traction to become widely adopted. This is an old story in innovation, and one not likely to change in the next few years.

The big takeaway

As we look at the entire picture we have painted in Phase 1, certain components stand out more than others as crucial to mobile innovation in the next few years. Although we have always held that all seven for which we have metrics, plus the OS, are enablers, and that no component alone drives innovation, especially not the disruptive variety, we now understand better that some might incite innovation more than others.

Without rehashing previous articles, let's just note that continuing advances in display technology, imaging, infrastructure speed and application processors (quad versus single-purpose strategy more than performance per se) appear more closely tied to mobile innovation bursts.

Consider sensing technologies, to be explored more fully in Phase 2. Display and imaging will be crucial to all kinds of sensors that lead to the context-aware[1] smartphones we expect. The application processer must be optimised and robust enough to handle all the additional data harvested by sensors, without quickly draining the battery or burning the user's hand. Infrastructure speeds will need to be robust enough to move all that data back and forth to the cloud because much of the contextual awareness capabilities will reside in the cloud. Finally, the OS will be the primary manager of all this stuff on and off the device going on in some sensing application.

We expect that the metrics for the enabling components singled out in the previous paragraph will improve fast enough to keep up with the sensing-based contextual awareness capability about to explode on the scene (in ways we will explore in Phase 2).

In contrast, there are other new capabilities to be explored in Phase 2 for which realising the full capability of the new technology may have to wait on one or more enablers (which reemphasises why we designate them as enablers).

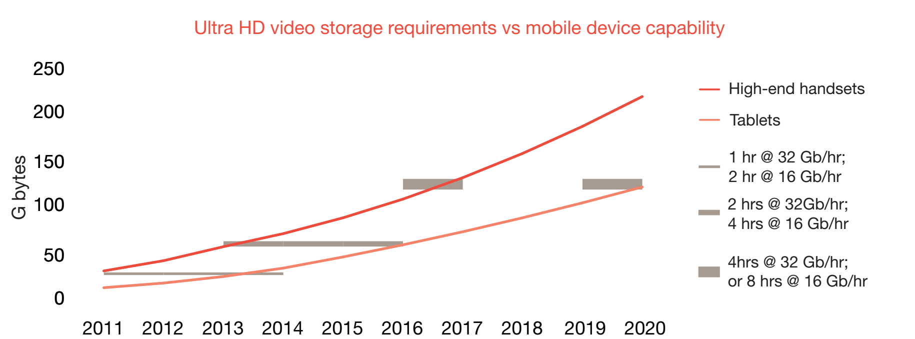
One example is UHD. UHD image sensors may be moving faster to market than the ability of the surrounding enabling technologies to keep up. UHD-capable smartphones and tablets are just on the horizon, but what do OEMs mean when they say 'capable.' That conceivably spans a wide spectrum from simple UHD capture of short video segments on a smartphone to watching a two-hour UHD movie that resides on a tablet.

We expect the initial use cases for UHD will be relatively modest, mostly the former example, and within the boundaries of whatever the enabling components are capable of handling. As for storing and watching or streaming a feature movie in UHD on your device, that is farther off, perhaps not within our forecast period, which is now extended to 2016. [See Figure 3]

Farther down the road there are likely to be contextual awareness applications that will need or benefit from UHD image capture. Fine-grained gesture recognition such as 'typing in the air' with your fingers could be one example.[2] The enabling components might not be up to processing, storing and transferring the heavy quantities of data involved.

One thing that is exceedingly clear is how data centric (as opposed to voice centric) mobile is and will continue to be. The mobile device remains all about communication, but now communication extends beyond the simple phone call or text message. The amount of data collected, stored, transmitted and recovered after analysis in the cloud continues to explode. And future development, such as UHD imaging, only makes that clearer.

Figure 3: UHD video requirements



UHD video is a realistic future application for mobile devices, but how much, how soon and in what form? As Figure 3 shows, UHD video will require significant amounts of storage for the content to actually reside on the device itself. Other enablers such as streaming technology, compression and playback on the device will require even further development before mobile UHD reaches full fruition. UHD is likely to drive the inclusion of more storage on smartphones and tablets, and is also likely to accelerate improvements in other technologies that might turn a tablet into a full UHD viewer. But most of that will take place outside the 2016 timeframe of our mobile innovation forecast

Source: PwC estimates

[1] 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.

[2] http://www.sci-tech-today.com/news/HP-To-Offer-Leap-Controllers-on-PCs/story.xhtml?story_id=10000B60T69O&full_skip=1

More detail about the new forecast

As explained in the Phase 1 Introduction, the Mobile Technologies Index is a broad composite of the seven enabling components that underlie the power of the mobile device to sense, analyse, store and connect information. We created the Index as a starting point for our broader examination of mobile innovation, and have spent the preceding months looking at each of the technologies, and their metrics, component by component.

Our forecast began with these components because they are key to understanding the evolutionary curve of technological innovation, and the developments that might lead to a disruptive product that transforms an entire ecosystem. Since mobile phones appeared in the 1970s, disruptive breakthroughs have been made possible, in part, by the continuous progress of these components at predictable price points.

For this quantitative analysis, we partnered with IHS, an Englewood, Colorado-based global information and analytics provider with comprehensive databases of each sector of the high technology value chain. Using IHS data and collaborating with IHS analysts, we constructed the Index and the individual metrics we have now reported in the series of Phase 1 articles.

We now offer a revised forecast, based on data from the second half of 2012, approximately a year after the initial forecast. Individual 2011 and 2012 forecasts for each component are compared in Figure 4. A more visually illustrative way of looking at their relative improvement is the spider diagram. [Figure 5]

In the original forecast and the revised version, the comparison period of 2007–2011 was a period of even faster rates of improvement than 2011–2015 or 2011–2016. This is due largely to the disruptive nature of the first Apple iPhone, which debuted in 2007. With its huge initial popularity, followed by the immense popularity of competing smartphones, production volumes of components greatly accelerated. Higher volumes drove innovation and accelerated rates of improvement in the individual price-performance curves.

The most striking change in the new data from IHS is the 5-point slowdown in the overall CAGR of the Index, from 41 percent for 2011–2015 to 36 percent for 2011–2016. This is mainly due to the additional year in the forecast period, bringing the total now to six. The 2011–2015 CAGR recalculated with the new data is only one point different—40 percent—well within any margin of error.

That said, five individual CAGRs for components are revised downward in the new forecast: memory (DRAM) down 3 percent; imaging, 4 percent; applicationprocessors, 5 percent; display, 6 percent and infrastructure speed, 9 percent. The downward corrections are based on new data that are improved estimates of shipments, average sales prices, etc. Forecasting is, after all, a predictive endeavour susceptible to revision as estimates change.

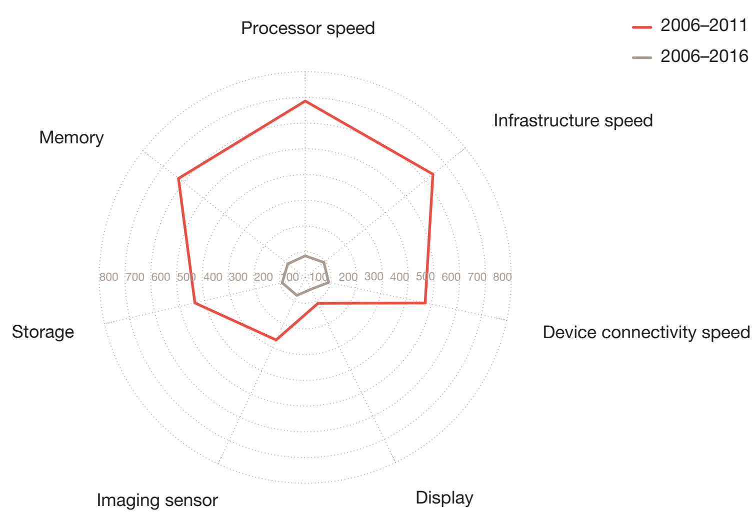
Take application processors, for example. The CAGR for 2011–2015 in the first forecast was 53 percent in Gigahertz per dollar (GHz/$). The new CAGR, based on the IHS data for 2011–2016, dropped to 48 percent. The price-performance curve tapers off in the new forecast due to a number of factors.

Figure 4: Comparison of two forecasts

	Original forecast		Updated forecast		
Index component	**CAGR (2007–2011)**	**CAGR (2011–2015)**	**CAGR (2007–2011)**	**CAGR (2011–2015)**	**CAGR (2011–2016)**
Application processor	43%	53%	43%	54%	48%
Device speed	75%	37%	71%	41%	37%
Memory	49%	48%	48%	49%	45%
Storage	76%	35%	62%	39%	35%
Imaging	37%	20%	29%	24%	24%
Display technology	26%	16%	17%	10%	10%
Infrastructure	77%	54%	79%	52%	45%
Full Index	55%	41%	47%	40%	36%

Source: IHS iSuppli Mobile and Wireless Communications Service

Figure 5: Index component changes



Source: IHS iSuppli Mobile and Wireless Communications Service

One is that, despite a race to build and install quad-core application processors, the sales of quad-cores has slowed because the industry now recognises that quad core is not always ideal for a mobile device the way it nearly always has been for personal computers. A dual core may run certain applications just as effectively but use less power and produce less heat—two key design factors critical for smartphones and tablets.

Meanwhile, optimisation techniques are making possible special purpose cores devoted to specific tasks now handled by identical, general-purpose multicore processors. Image processing is one example. The point is, wide adoption of quad cores by OEMs would improve the price-performance faster, but since fewer are likely to be used in mobile devices than initially predicted, quad-core price-performance slows a bit, impacting the overall metric.

Display technology is another example of products evolving in ways not anticipated in our first set of data. At the time of our initial forecast, the screen size segments ended at 3 inches. With the increased adoption of larger screens for smartphones, we can track more segments—4 inches and 5 inches—each with its own pricing dynamics. This greater granularity allows us to track more accurately what is happening with the price-performance metric for display on an aggregate basis.

The new data also provide an opportunity to validate our forecast accuracy. The first version of our Index used actual market data for the years 2007–2010 but forecasts for 2011–2015. This new version uses actual market data for 2011, allowing us to compare it to the earlier 2011 forecast. Figure 6 shows this comparison.

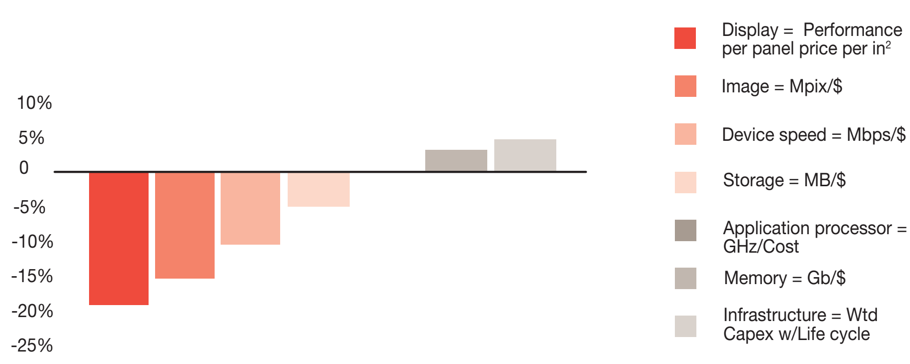
Four of the seven metrics are within a five percent variance. The three with greater variance were all revised downward: device speed down 10 percent, imaging down 15 percent and display technology down 19 percent.

In addition to the standard explanation of more accurate data and volatile new technologies, here are reasons these three components evolved in unexpected ways:

- Device speed, in megabits per second per dollar, is slower than forecast because LTE is rolling out more slowly than we expected, specifically outside the US.
- Imaging, in megapixels per dollar, is slower because there is greater demand for higher resolution sensors in advanced smartphones, a dynamic that is presently driving average selling prices in the seller's direction, not in the buyer's.
- Display technology, in performance per dollar per square inch, is lower than expected because of the shift in the technologies in use is rather volatile.

Overall, considering the dynamism of any technology market when measured on a performance-per-dollar basis, which involves unanticipated changes in demand and supply in both primary and related markets, we find the forecast accuracy for 2011 to be good. With each succeeding year of data we will continue to benchmark our accuracy, both to enhance it, and to learn more about the drivers of change in the mobile ecosystem. ■

Figure 6: Variances in two forecasts



Source: IHS iSuppli Mobile and Wireless Communications Service

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.

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