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Making smartphones brilliant:
Ten trends

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Making smartphones brilliant:
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The top-ten trends that will shape the future of mobile smart devices over the next five years put a premium on intelligent strategic planning for players across the value chain.

What makes smart devices so brainy, and will they become even more intelligent in the future? Beyond taking cues from current customers, smart device innovations also emerge from a deep understanding of how core component technologies, business models, and services will evolve. Apple's designers focused on targeted technologies such as multi-touch capability combined with a capacitive touch screen to create an entirely new user interface mode. In another case, Samsung bet heavily on active matrix organic light emitting diode (AMOLED) technology, assuming that consumers would pay a premium for high-contrast displays coupled with lower device power consumption.

Ten trends shaping the future of smart devices

Given the important role technology plays in driving smartphone innovations, McKinsey has identified the ten top mobile device hardware and software trends that will significantly impact these devices over the next five years.

Displays. With increased usage comes the need for more power-efficient and flexible displays. AMOLED – a power-efficient, flexible, and foldable display technology that will soon reach "retina resolution" (i.e., a higher display resolution density that boosts text and graphics clarity) – is emerging as the next standard. Following the lead of Samsung with their Galaxy phone (and now tablets), players such as Nokia and Motorola are offering this technology on their high-end handsets. Success among early adopters is driving widespread use across platforms. According to J.P. Morgan, AMOLED's display revenue market share should reach 50 percent by 2015. However, high capital investment requirements – up-front capital expen-

diture is higher for AMOLEDs than for liquid crystal displays (LCDs) – and short supply mean that only a handful of manufacturers will be able to produce this display at scale.

Processors. With Microsoft announcing support for ARM chipsets on Windows 8, a convergence across smartphones, tablets, and notebooks seems likely. ARM processors – with their low power consumption and compact size – will continue to dominate the smartphone market. As the power of ARM processors rises, they are likely to penetrate the notebook and server spaces as well, reaching an expected 23 percent penetration into the notebook market by 2015 according to iSuppli. Along with Intel's announced Medfield lineup, this will mean a significant step up in the portability of notebook PCs in the future. With ARM, for example, it is already possible to have a notebook with eight- to ten-hour battery life that weighs 500 to 600 grams – compared with five to six hours and over 1 kg on the current x86 platform.

Sensors. In terms of functionality, sensors continue to improve significantly. Future smart devices will incorporate new mobile sensor types, such as biometric, pressure, and environmental sensors, along with the ones currently in most smartphones. More sensors and the greater penetration of mobile devices will drive global sensor shipments to 6 billion units by 2015, one third of which will represent new sensor types. Particularly, the aggregation and

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analysis of environmental and user data collected through sensors will enable smarter applications and personalized advertisements adapted to user behavior and preferences.

Batteries. With increased mobile phone usage, satisfying power needs has become a priority. Innovations in battery technology, however, have lagged behind advances in processing power. Since 2000, battery capacity has only doubled, while processing speed has increased 12-fold. Current developments in lithium-sulfur and carbon nanotubes might increase battery capacity if they can be made commercially viable. Compared with lithium-ion technology, lithium-sulfur promises 80 percent more capacity, ten times the power density, and the ability to last four times longer. Carbon nanotubes can store much more electricity by weight than lithium-ion batteries, while maintaining their charge. They are also far more durable. Wireless battery charging, faster battery charging, and adaptive battery management are also in the development stages. Even though battery power is being used more efficiently and battery makers are experimenting with new technologies, capacity will continue to constrain the day-long use of smart devices in the short term.

Materials. Advances in nanotechnology are leading the way toward more adaptable and eco-friendly materials. If proven commercially viable, graphene will enable a new generation of lighter, more flexible, durable, and transparent form factors that are a hundred times stronger than steel and reduce the cost of materials for mobile devices. With competition among mobile device makers becoming fierce, sustaining operating margins will require such reductions in materials and operating costs. These new, cheaper alternatives will enable device makers to further reduce their "bill of materials" costs.

Operating system convergence. In order to present users with a unified experience, operating system providers have continued to converge their OS across devices. Apple's Lion OS for PCs, for instance, has features similar to its iOS 5 for iPads and iPhones. Microsoft's Windows 8 will also have similar traits to the Windows Phone 7. Along with the convergence of processors (i.e., the same processor will be used to power smartphones, tablets, and PCs), a true convergence is on the horizon – one that could be described as "one OS, one processor, but many form factors." Such true convergence would enable consistency of experience across different devices.

Web centricity. With HTML5 – the latest "open Web" version of the HTML language – and cloud services gaining traction, Web-based applications are moving computing power from devices to the cloud. As this takes place, browser technology will dominate over operating systems. Based on McKinsey's iConsumer survey, mobile activity via browsers already accounts for three quarters of non-talking time. Web centricity will enable a new set of consistent multiscreen experiences and drive advertising by providing a greater ability to achieve scale in devices. Web centricity, however, could also pose a serious threat to adjacent industries such as PC gaming as the cloud becomes the platform for many applications and games, using the browser as the middleware.

User interfaces. Current user interactions are limited to the touch screen, motion sensing, peripheral input devices, and voice recognition. The development of gesture and retina tracking, the infrared keyboard, and context-aware user interfaces (UIs) will accompany the emergence of new sensors, disrupting the mobile space and giving rise to a new generation of applications and form factors. Context-aware UIs would allow devices to adapt to the user's physical setting and preferences. The device screen could adjust itself to a user's location, for example, displaying work productivity

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applications when at the office. At home, it would show entertainment and social connectivity apps. Innovations in UI technology will help devices adapt independently to user contexts and preferences, optimizing productivity, while maintaining portability and enabling intuitive interactions.

Cloud services. From storing digital content online to synchronizing content across multiple devices, cloud services have become a major part of daily computing. With the rapid growth of this market, it is no surprise that major players are already staking out their own territories with very different monetization models to command ownership of customers.

- *Device lock-in model.* Apple's iCloud drives high-margin device sales by providing seamless multi-device synchronization.

- *Advertising model.* Google leverages its large cloud user base to drive advertising revenues by offering low-cost or free cloud services.

- *Content sales model.* Amazon drives content sales with cloud-based platforms that push digital content directly to users that have heavily subsidized devices.

- *OS lock-in model.* Microsoft leverages its Sky-Drive cloud services to let users synchronize their content, thus increasing customer reliance on Windows' platform and suite of applications.

Networks. As smart device penetration and data usage both increase, demands on mobile network capacity will continue to spike, leading to greater congestion. In response, operators have rapidly increased their adoption of long-term evolution (LTE) networks, accelerating from 126 commitments in August 2010 to 324 in October 2011. Enabled by LTE networks, next-generation application programming interfaces (APIs) will help drive innovations in mobile applications and tiered data pricing plans for operators. With these APIs in place, users will be able to dynamically control quality of service and bandwidth.
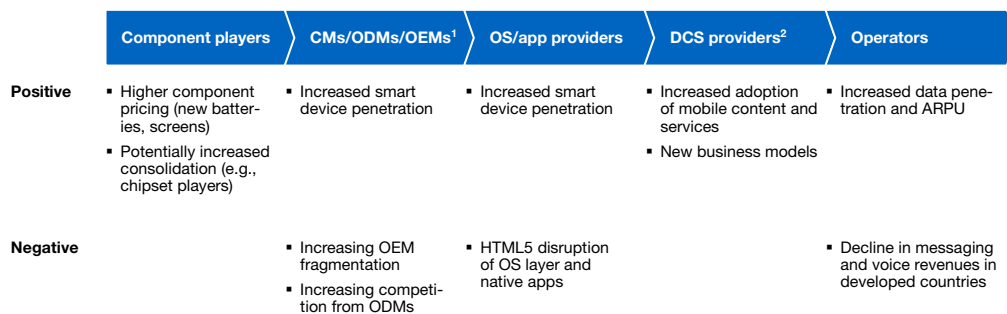
Trend-driven mobile functions of the future

Key developments in hardware, software, services, and networks are coming together to create promising opportunities for industry players and consumers alike. Potential growth areas include new form factors and UIX models, cognitive services, personal cloud, and new connectivity technologies.

Form factors and UIX models. Foldable, modular, hybrid devices combined with new UIX models will change the mobile device landscape. While current input methods are limited to touch and speech, users will be able to communicate with their devices with a wave of the hand or a directed glance in a few years. Pressure-sensing screens will also know exactly where the user intends to click, and advances in natural language processing and artificial intelligence – exemplified today by Apple's Siri digital personal assistant – will make voice recognition a truly interactive experience. One possibility is a device that users typically carry in their pockets as a smartphone. When they need a larger screen to watch a movie, they would unfold the device to become a tablet. Eliminating the need to carry multiple handsets, such hybrid devices have the potential to capture about 10 percent of the device market by 2015, reshaping the competitive landscape for OEMs in the process.

By eliminating the need to carry multiple handsets, hybrid devices could capture roughly 10% of 2015 device market

Cognitive and contextual services. With the advent of sensors and data analytics, mobile devices will know more about users, their preferences, and the environment than ever before. Imagine an application that checks the user's calendar, sees an upcoming business call, and automatically shows directions to a nearby coffee shop – that real-time noise sensors indicate is quiet. Other new sen-

The pervasive trends result in implications for mobile value chain players

	Component players	CMs/ODMs/OEMs[1]	OS/app providers	DCS providers[2]	Operators
Positive	▪ Higher component pricing (new batteries, screens) ▪ Potentially increased consolidation (e.g., chipset players)	▪ Increased smart device penetration	▪ Increased smart device penetration	▪ Increased adoption of mobile content and services ▪ New business models	▪ Increased data penetration and ARPU
Negative		▪ Increasing OEM fragmentation ▪ Increasing competition from ODMs	▪ HTML5 disruption of OS layer and native apps		▪ Decline in messaging and voice revenues in developed countries

Exhibit 1

sors will provide indoor positioning and biometric security. Beyond this, businesses will be able to monetize contextual advertisements, since personalized ads have demonstrated that they can provide a 40 percent lift in purchase intent. In sum, sensors and data analytics have the potential to reshape the USD 600 billion global advertising industry by shifting more spending to mobile markets.

Personal cloud. The mobile cloud will become an all-encompassing personal online identity that stores everything from user content, documents, calendar appointments, to-do lists, and personal preferences to financial information and sensor data. Social networks and online connections will become much easier to manage because one cloud will centrally store all user information. For instance, users could upload photos from a recent outing to a personal cloud, and social networks and photo-sharing Web sites could automatically access that cloud-based data.

Connectivity technologies. Handling the expected growth in mobile device usage will require critical improvements in network capacity. LTE networks

will soon be able to provide dynamic bandwidth control, which means that users can choose in real time when to increase their bandwidth (for a price), such as when streaming a high-definition video.

However, LTE networks might not be enough to alleviate the capacity problems. Many carriers will have to turn to alternative network technologies such as TV white space, software-defined radio (SDR), and cognitive radio (CR). SDR and CR in particular could help carriers to auction wireless spectrum in real time to reduce network capacity problems, trading spectrum from high-capacity to congested networks. Furthermore, the use of TV white space could allow operators to offload heavy bandwidth consumption services such as video streaming from carrier networks to the TV white space spectrum.

Implications for value chain players

Each of these opportunities will play a significant role in the future of mobile devices. As a result, they will have a potentially large impact on the bottom lines of mobile value chain players (Exhibit 1).

McKinsey's analysis of the trends and the players involved indicates that digital content and service (DCS) providers along with component manufacturers will capture much of the value shifts in the mobile value chain, since the trends highlighted are in their favor. Component manufacturers should see a greater increase than expected in value due to the higher penetration of smartphones and the evolution of new and innovative form factors. Each of these trends will drive demand for more and better components. The value share that DCS providers can capture will grow significantly thanks to higher content consumption and the greater value generated by very effective personalized advertisements.

For contract manufacturers (CMs), original design manufacturers (ODMs) and original equipment manufacturers (OEMs), significant shifts in value share are not expected. These players will benefit from launching new form factors driven by display, sensor, processor, and battery innovations – and from expanding into lucrative business segments such as productivity and special-use devices. Growing OEM fragmentation and competition from ODMs will, however, threaten OEM revenues.

For OS and app providers, the opportunities presented here will not have a disruptive impact on their value pools. Unlike the PC space – where OS players are strong – the mobile device industry requires simultaneous innovation and coordination in hardware and software to streamline the user experience. Thus, pure OS players are not equipped to make significant plays.

Mobile operators will capture a lower value share due to declining voice revenues in developed countries, the shift of content and advertisement revenues to DCS providers, and the migration of messaging revenues to IP services and social networks. Still, operators do have several potential plays that can help protect their value shares.

First, they can jointly develop mobile devices with key device OEMs. This would provide them with exclusive rights to device sales and give them the opportunity to redefine the retail experience for their products, as Apple stores have successfully achieved. Another move: mobile operators could launch next-generation IP services and network APIs that capture the benefits from all-IP LTE networks – and enable seamless user identity portability across devices via platform-independent mobile clouds. Such companies could also leverage new network models to alleviate frequency restrictions and spectrum congestion.

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As the trends, opportunities, and implications show, the smart device landscape is ripe for innovation and change. Room exists for players to make strategic moves and revolutionize the industry. Consumers will also benefit greatly from the rapidly improving user experience these trends foster. As smart devices evolve into brilliant ones over the next few years, industry players need to make sure their own strategies to capture value from this shift are equally intelligent.

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