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Your personalized technology hub

Interconnectivity, intelligence, and identity in tomorrow's smartphones

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Introduction

Do you have a smartphone? This may be a silly question—most of us do. Years after clothing designers began incorporating special pockets into jackets and cargo shorts, smartphones are so ubiquitous[1] that retailers can safely assume that most consumers are carrying them. According to Deloitte's Global Mobile Consumer Survey, 42 percent of respondents check their smartphones within five minutes of waking up.[2]

It's that ubiquity that makes smartphones so valuable, both to users who benefit from an expanding universe of apps and to developers of other smart devices. As the preferred portable technology device of citizens around the world, the smartphone is becoming the default interface for wearable and proximity devices[3] (WPDs)—and the core of a growing WPD ecosystem.

Using smartphones today, anyone can wake up to an alarm, remotely track her health, select a favorite show or music video, adjust the temperature or lighting in her home, monitor her home security, start her car, and maintain remote connections with a plethora of independent connected devices. No wonder consumers are increasingly integrating WPDs into their lives, especially as Internet of Things (IoT) technology connects ever more users and devices.[4] WPDs are showing explosive growth, with ownership rates doubling from 2014 to 2015 for smartwatches and fitness bands, creating new opportunities for providers to capture enterprise and consumer data to drive demand and influence customer decision making.[5]

Businesses are also looking to benefit from the high level of coordination among interconnected systems, from customer prospecting and demand generation to order fulfillment and supply chain logistics, from payments and accounting to customer service programs. App and software developers have only begun to explore the ways in which our smartphones can interface with WPDs to broaden the connections, choices, and experiences in our personal and professional lives. Other players—chipset manufacturers, original equipment manufacturers (OEMs), operating system (OS) vendors, security solution providers, content developers, mobile network operators (carriers) and analytics, information management and cognitive computing players—also have much at stake.

The smartphone's unique position at the center of our everyday lives, consolidating information and connections, promises to drive greater adoption and integration of WPDs. Currently, in our increasingly linked world, the connections are generally point-to-point—individual relationships forged from secure connections between our smartphones and single-user WPDs. Few apps are truly interconnected or smart, grounded in personalization and cognitive computing algorithms. A user's smartphone or wearable wake-up morning alarm does not, yet, automatically adjust the thermostat, trigger the coffeemaker, turn on a favorite morning news show, and map the fastest route to the day's first meeting based on real-time traffic patterns. Sure, an ambitious and savvy smartphone or WPD user can manually configure individual programs or apps to perform some of those tasks, but they don't function interdependently; in this sense, our devices are not yet truly smart, digitally observing, learning, and implementing changes congruous with our lifestyle, choices, and needs.

The wide gap between current market offerings and the potential for life-altering connected technology provides ample space for developers, manufacturers, and retailers—and it all begins with the smartphone. In this article, we examine smartphones' role—both present and future—as the critical technology hub to enable WPDs with the combination of interconnectivity, intelligence, and identity to facilitate consumer insights and decisions.

How to catalyze the leap forward in personalized technologies? We envision products that create a tailored experience for enterprise and end consumers, allowing a single device to communicate with multiple WPDs, compiling data to aid users' decision making. Central to this environment will be each individual's personal circle of WPDs communicating with each other, generating data and sharing insights.

We define three I's as critical to the future of personalized technology: *interconnectivity, intelligence, and identity*.[6] Interconnectivity enables instant connection and communication across all of a user's WPDs, intelligence aggregates and analyzes data gathered from multiple devices and presents actionable insights to the consumer, and identity provides security, adjustments, and learnings from WPD-generated data, enhancing users' daily decision making.

This vision of personalized technologies mediated by this singular device hinges on several complementary factors: the explosion in sensor-based information, real-time customer interaction, and data storage and access, along with IoT-driven integration with other actionable data traffic.[7] To meet the need for technology complementarity, technology companies have increasingly turned to mobile operating systems, embedded applications, and software solutions, with obvious implications for developers and manufacturers of devices, operating systems, and applications. The smartphone-mediated personalized technology experience will involve integration and connection with wearables, connected cars, automated home appliances, and more.

We also anticipate that some or all of the three I's may be distributed across multiple devices and into the cloud. While companies involved in making and selling smartphones—and developing apps for those phones—would be wise to continue making investments to promote this future, multiple alternate technology approaches and consumer preferences may shift toward alternative architectures.

With that uncertainty in mind—not to mention rapid and unpredictable shifts in prevailing technology—is it prudent to focus on the smartphone as the hub of the future, rather than another of the plethora of interconnected devices, or even one not yet on the market? Our view is that the smartphone's place at the center of the personalized technology ecosystem is secure for at least the near term. Most people already carry and trust smartphones[8] and are reasonably proficient with their applications and use; Deloitte's Digital Democracy Survey finds that respondents across the age spectrum value smartphones above all other devices,[9] ranking ahead of computers, laptops, tablets, and gaming devices.[10] Still, with the landscape largely uncharted, the path ahead is hazy, and we aim to explore and elaborate on the complex factors that will drive or deter the vision of the smartphone as a personalized technology hub.

Navigating the future of personalized technology

THE market for WPDs is established and growing rapidly: US analysts expect today's estimated 75 million connected devices to grow exponentially, with some 15 to 60 billion connected devices installed by 2020.[11] WPDs, both personal and shared, are already integral to any number of aspects of our lives: health and fitness, entertainment, safety, transportation, home security and controls, and much more.

While personalized technology described by the integration of the three I's relies on a one-to-one relationship with the smartphone and WPDs, a particular WPD may also be sharable. This is important for the shared economy: the growing marketplace of economic agreements between two (or more) parties, usually enabled by a digital platform that enables use of consumption of a product, service, or activity without full ownership.[12] Consider that a significant proportion of consumers prefer a shared family mobile data plan to share data across many devices,[13] an example of the WPD relationship moving from one-to-one to one-to-many or many-to-many. In a home with a smart refrigerator installed, each family member will expect tailored functionality, with the appliance aware of preferences and anticipating desires. Similarly, connected cars are typically a shared resource and need to distinguish based on identity and intelligence to personalize the experience for multiple end consumers. Hubs—that is, smartphones—are essential to manage individuals' WPD ecosystems and help all those WPDs navigate the complexities of multiple identities and users.

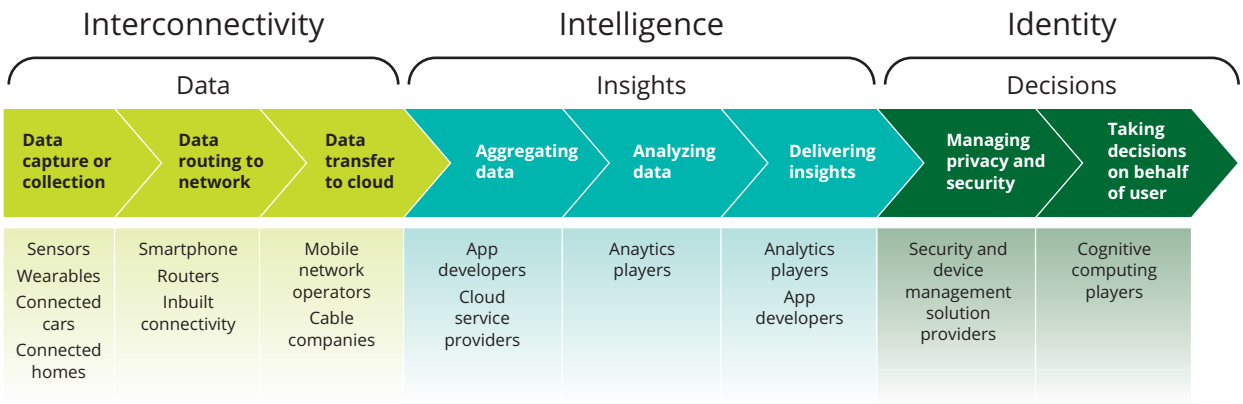
This diversity and growth in WPDs—and the IoT-based information traffic they generate—threatens to overwhelm the consumer as well as the infrastructure for capturing and analyzing this information, especially as a user's shifting locations (home, vehicle, office, etc.) continually change the components of her personalized technology ecosystem. The smartphone, tucked in a purse or docked in a car, therefore provides a mobile technology hub for WPDs to automatically capture, process, and synthesize information in real time, which in turn requires the three I's of interconnectivity, intelligence, and identity (figure 1).

Interconnectivity: With IoT technology's growing ubiquity, interconnectivity is the means by which each connected device operates as part of a coordinated ecosystem. This interconnection can be either directly from the WPD via a cellular network (the standalone model) or a low-power link (Wi-Fi, Bluetooth, etc.) that then connects through a paired cellular link (the hub model).

Intelligence: The second "I" refers to the processing power and storage that is used to understand the collected information, how it should be used, and what actions need to be taken. Intelligence can be in the device itself, in the hub, in the cloud, or disseminated across all these locations.

Identity: The final "I" securely identifies the user and personalizes the technology experience to match her preferences, with a smartphone or other wearable hub device most likely owning and maintaining the information. Identity is important to au-

Figure 1. From data to decisions



Source: Deloitte analysis.[14]

Graphic: Deloitte University Press | DUPress.com

tomate technology interactions by mediating interactions with other devices such as communicating preferences, authorizing secure transactions, and charging for record data or services.

The personalized technology ecosystem is likely to evolve as two parallel technology architectures. The **first architecture** is an extrapolation of the current paradigm, in which consumers' smartphones take on all three roles of interconnectivity, intelligence, and identity, supplemented by cloud-based learning and analytics. In this architecture, the smartphone plays the most critical role: the central hub for communicating to and from smart devices, establishing user identity, and providing most decision-making intelligence. The market dynamics supporting this architecture include:

- Smartphones are highly valued by all age demographics, are already in nearly everyone's possession, and undertake many of these functions today
- Major OS providers are building application-based ecosystems around their smartphones
- Centralizing power and processing in the smartphone means that developers can streamline other devices—an important consideration for size-constrained wearables.

On the other hand, the smartphone-as-a-hub architecture does present several complications and hurdles:

- Multiple consumers' smartphones accessing the same device(s). Any user's WPD ecosystem will inevitably overlap others'—with a shared vehicle, office equipment, home refrigerator, or other devices. In these situations, peripheral devices must respond to and work with multiple smartphones and consumers, creating potential issues of interconnectivity, identity, and security
- Devices that need to operate and be powered even in the absence of proximal smartphone controls. For example, home devices must remain functional when no one is in the house
- Secure connections requiring a "locked down" system with standalone three I capabilities, such as medical devices and home security systems
- Interoperability conflicts among different OS standards

In the first architecture, the three I's create a singular smartphone-as-a-hub. By contrast, the **second architecture** requires only identity for a device to become a hub, with intelligence and interconnec-

tivity located in the device (figure 2). For example, connected cars have sufficient power and processing capabilities to include advanced functionalities such as machine learning; they come fully equipped with interactive consoles and sensors that provide real-time insights about weather, traffic conditions, and navigation routes. Most connected cars also allow stand-alone connectivity to link directly to mobile networks. Audi, for example, has partnered with AT&T to turn its cars into high-speed, mobile Wi-Fi hotspots for multiple devices.[15] Audi Connect acts as a one-stop hub for information on traffic, weather, and the car's internal controls, along with search functionality and social media integration. This exemplifies how a shared resource—in this case, the connected car—can create a new business model to coexist with smartphones. This model may also extend to enterprises or enable the next generation in the shared economy.

Physical distance to WPDs can complicate the process of converting data to insights. Of course it's simpler to control systems from a smartphone on the same local Wi-Fi network, but most WPD ecosystems will involve a wider geographical range, and remote or wireless management involves new challenges such as multiple levels of connectivity, data, and interfaces. Navigating mobile networks and home broadband, while taking care of differing operating system standards, presents challenges to interconnectivity and intelligence. Remotely managing a large number of connected devices and concurrent sessions is an even more daunting hurdle to personalizing technology.

Figure 2. The three I's: The two architectures for tomorrow's personalized technology hub

Source: Deloitte analysis.[16]

Graphic: Deloitte University Press | DUPress.com

REMAINING NIMBLE: ADAPTING TO ALTERNATIVE DEVICES AND PLATFORMS

While we believe smartphones are the natural choice to serve as hubs for individual users' ecosystems of wearable devices, many mobile industry experts expect smartphones to face competition within the next five years. The leading contenders for the technology hub role: artificial intelligence (AI) and mixed reality interfaces, both of which may be in a position to disrupt existing screen-based systems. According to an Ericsson ConsumerLab survey of 5,000-plus smartphone customers across nine countries,[17] many believe that "AI will take over many common activities, such as searching the net, getting travel guidance and as personal assistants."[18] AI enthusiasts foresee intelligent wearable electronic assistants and holographic icons becoming commonplace within five years, reducing the need for touchscreen interfaces.[19] Within the same timeframe, half of the consumers believe they will be able to communicate directly to their household appliances. Growing consumer interest in alternate interaction technologies such as virtual reality and augmented reality sets the foundation for a system that is more powerful and interactive than the modern smartphone, particularly in visually limiting situations, including driving and cooking.

The recent rise of mixed reality (XR) as a novel medium for interactivity also presents a potential alternative to smartphones. XR uses the combination of augmented reality, virtual reality, headsets, and holographic images to merge real and virtual worlds, enabling a user to freely interact with physical and virtual elements in real time. XR advocates believe smartphones may become redundant if XR voice-activation commands can call up holographic screens blended with the real world, augmenting visual reality with real-time information.[20] Right now, though, XR faces a surprisingly high hurdle: the social stigma associated with wearing headsets in a humanized world; indeed, initial trials with XR headsets have met with skepticism and backlash.[21] Despite the coolness and novelty associated with XR, smartphones are well positioned to hold the edge over alternate reality-based interaction methods, due to prevailing social mores and acceptance. Furthermore, through new innovations such as Google's Tango,[22] smartphone companies are trying to incorporate elements of XR in smartphones themselves.

Connecting the dots and sensors: Linking the three I's

THE volume and density of personalized data that smartphones can capture, analyze, and synthesize is both technologically daunting and overwhelming. Rendering this influx of data actionable for enterprise customers and consumers alike requires the personalized smartphone to embody all three I's. Wi-Fi and Bluetooth allow smartphones to interconnect with diverse WPDs; meanwhile, mobile applications have the intelligence to connect, tune, and capture information from other devices; and, finally, technology developers are working diligently to enhance identity-related features through cognitive computing and other advanced methods. To accelerate progress, players in the smartphone ecosystem need to scale up and build capabilities in all three I's.

Interconnectivity

A diverse and rich set of wireless interconnectivity technologies are already available to enable connectivity of personal and professional devices, including Bluetooth, Bluetooth Low Energy (BLE), Bluetooth Smart, Zigbee, NFC, and Wi-Fi. New technologies to enhance interconnectivity are continually emerging as well. For instance, Li-Fi, which uses the electromagnetic spectrum's visible-light portion to transmit information, potentially offers speeds up to 100 times faster than Wi-Fi.[23] Rapid improvements in speed, signal quality, and signal processing enable better syncing between smartphones and their local WPD environments. These higher speeds facilitate geotagging combined with secure authorization to obtain WPD locations more quickly and accurately via a larger number of cells and automatic syncing with specific environments based on permissions. Faster speeds also improve interoperability and backhaul continuity versus discrete short-range connectivity standards such as Wi-Fi, BLE, Z-wave, and ZigBee. Next-generation mobile networks such as 5G will potentially have the capability to provide data speeds of up to 20 Gbps, 20 times faster than 4G.[24]

Developers are rapidly bringing forth open-source applications and architecture to connect with a smartphone hub. TapHOME's home automation system uses the open Z-Wave wireless standard to integrate any Z-Wave-compatible device into the connected home,[25] while Greenpeak's ZigBee-based hybrid chip connectivity solution offers both smartphone-based direct and cloud connectivity to provide home control of appliances and lighting with or without Internet connectivity.[26]

Intelligence

Technology players that work with smartphones are in a unique perch for big-data analytics: They can capture, analyze, and synthesize valuable data from WPDs to generate insights to help consumers and enterprises make actionable choices in business, lifestyle, health, and security. Some strategies for these players include:

- Capture processing and decision-making capabilities, as well as filtering and contextual awareness
- Capture as wide and diverse a range of data as possible to create linkages between systems
- Develop a simple and intuitive graphical user interface for consumers to interact with and generate engagement with WPDs
- Build open platforms to offer seamless connectivity and interoperability across proximity devices
- Invest in targeted platforms and applications that are interoperable, faster to load, and energy-efficient to conserve WPD battery life

One recent example is Google's Android Wear, launched in 2015 to extend the company's Android operating system to wearables. Initially focused on smartwatches, Google is expanding to a wide range of body-fitting devices. Android Wear enables developers to build applications for smaller screens,[27] enabling new forms of voice interactions[28] and tapping into cellular connectivity for cloud services (by interacting with larger devices such as smartphones and tablets).[29] Google's preference for open platforms in its Android ecosystem is well documented—also in 2015, the company launched Brillo, an open IoT platform with four key elements: an embedded OS, core platform services, developer kit, and developer console.[30] Developers designed the Android-derivative OS to run with low onboard memory and minimal power consumption. Core services include Weave, which helps devices to securely connect and seamlessly communicate across a network, and the developer kit accelerates third-party development and creation of customized applications on the platform.[31]

Intelligent technologies and designs have expanded to wearables, transportation, and home control. Apple Inc. released WatchKit® developer software in 2014 to provide third-party developers a set of tools to create innovative and customized applications for Apple Watch® wearable devices.[32] In transportation, Automatic has developed a connected-car adapter that plugs into a vehicle's diagnostics port and sends insights about a car's performance via a mobile app.[33] Automatic has also forged alliances within its ecosystem to share intelligence—for instance, it communicates with the Nest thermostat (acquired by Google in 2014), which preemptively raises or lowers the temperature in the home as the homeowner's car approaches or departs.[34] In another example of home control, Domus offers an iOS/Android application to control all home appliances with a single finger swipe on smartphones; the app allows consumers to easily set rules and customize schedules for appliances, automatically turning off power when devices are fully charged.[35]

Identity

Identity is designed to provide secure authorization and access for consumers to set their preferences and personalize their experiences. Ideally, identity applications should be built on learning algorithms that become more sophisticated and context-sensitive with time and experience. Intelligence and identity intersect where the smartphone-as-a-hub gathers data from WPDs to learn consumers' needs. Ideally, the system becomes so context-sensitive that it can generate recommendations or, in specific identified situations, make decisions on the consumer's behalf.

In line with concerns about potential IoT-related data breaches,[36] protecting identity-related information and preferences is a top security priority. Looking to thwart intrusion and attacks, smartphone-related players are already focused on enhancing security by using multifactor authentication, advanced encryption, and biometric features to build proactive counterdefense and self-healing capabilities in both home and work environments. Some cutting-edge security technologies also offer filtering and contextual awareness, making decisions on customers' behalf, and differentiating and customizing professional and personal identity and usage, as well as offering advanced privacy and permission management tools so consumers can customize privacy rules for different applications. Atlas is an example of an application that uses a machine learning algorithm to make decisions for consum-

ers; it combines a traditional fitness band and intelligence platform, powered by the Motion Genome Project database of movements, with learning algorithms that automatically classify exercise routines in 3D vectors.[37]

The power to bring machine learning to WPDs introduces a new dimension to identity, potentially shifting intelligence from the cloud to real-time transpiring (also called "intelligence on the edge"). Processing information directly on a smartphone offers the benefit of running deep learning applications more rapidly in specific situations. One key to consider is making power-efficient smartphone-ready AI processors. For its Android smartphones, for example, Google is purchasing processor chips from Movidius, due to that firm's expertise in making low power machine-learning processors for connected devices.[38] Another semiconductor chipmaker, Qualcomm, in 2013 launched its Zeroth Machine Intelligence Engine SDK, in an effort to give developers and devices machine learning capabilities even when offline.[39]

The way forward

FOR each of the three I's, there are different ways to move forward and embrace the role of smartphones as a personalized technology hub of WPDs—whether selecting the first or the second architecture leads to difficult strategic choices for ecosystem players. For some players, there are advantages in the second architecture, or to a stripped-down handset that would be one of many connected devices dependent on the cloud for storage and intelligence. For companies with successful business models focused on the smartphone, leaders will aim to invest in the first architecture: having stand-alone interconnectivity, intelligence, and identity. The questions, then, are how to hedge investments and how many resources should be allocated to such hedges. Examples of the different choices for each of the three I's:

Interconnectivity: Does the smartphone act as a hub for other short-range WPDs, or do most devices have their own network connections?

Intelligence: Does the smartphone handle the bulk of the processing and storage for the devices and act as a gateway to any additional cloud-based resources, or do individual devices have a mix of local and cloud-based storage and processing?

Identity: Does the smartphone confirm the user's identity, set her preferences, and provide the context for interaction with WPDs, or do biometric sensors identify the user to local devices?

The various ecosystem players will have particular preferences across the three I's in terms of how they evolve (figure 3). While mobile OS providers—and, in general, mobile operators and handset/device OEMs—will likely prefer the first architecture, the second architecture will probably be the choice of software vendors and, to a lesser extent, content providers. Interestingly, however, nearly every player would like to see more devices that follow the first architecture—having stand-alone interconnectivity, intelligence, and identity. The exception might be mobile OS providers, especially where they lack a closed ecosystem to protect their devices.

All ecosystem players will likely face key decisions, including:

- Should carriers promote the handset as a hub and risk losing customer loyalty to OEMs and mobile OS players, or should they endorse a direct connection approach and accept that this will strengthen the power of cloud-based players?
- Should OEMs promote the handset as the source of intelligence and identity in order to preserve high average selling prices, or should they endorse device proliferation in the hope that the increased volume of devices will give them leverage against mobile OS players and offset reductions in handset prices?
- Should app developers and content providers promote a world of stand-alone devices interfacing with the cloud and accept significant com-

Figure 3. Preference of personalized technology hub architectures, by ecosystem players

3 I's	Interconnectivity		Intelligence		Identity	
Architecture	First	Second	First	Second	First	Second
Industry segment	Via smartphone*	Stand-alone	Via smartphone*	Stand-alone	Via smartphone*	Stand-alone (biometric)
Chipset designer/ manufacturer	Acceptable	Preferred	Preferred	Preferred	Acceptable	Preferred
Handset/device OEM	Acceptable	Preferred	Preferred	Potentially undesirable	Preferred	Acceptable
Mobile OS vendor	Preferred	Potentially undesirable	Preferred	Potentially undesirable	Preferred	Potentially undesirable
Applications software vendor	Acceptable	Preferred	Potentially undesirable	Preferred	Acceptable	Preferred
Content provider	Acceptable	Acceptable	Acceptable	Preferred	Acceptable	Acceptable
Mobile network vendor	Acceptable	Preferred	Preferred	Acceptable	Preferred	Acceptable

Preferred · Acceptable · Potentially undesirable

Source: Deloitte analysis.[40]

Graphic: Deloitte University Press | DUPress.com

plexity and SKU increases, or should they remain focused around the major mobile OS platforms?

- Should mobile OS players strengthen their hold on the smartphone through including more functionality, or should they partner with emerging players to expand their dominance to WPD platforms?
- Should chipset manufacturers rely on smartphone chips to provide cellular connectivity to WPDs, or should they embed cellular connectivity directly within WPD chipsets?

Until ecosystem players make the above strategic choices and test the benefits of stand-alone architecture and new technologies (such as VR and XR), smartphones are uniquely suited to serve as an interconnector, intelligent interface, and identity validator for consumers and enterprise customers alike.

In the near future, smartphones' mobility advantage could enable them to extend beyond personal devices to households and small and midsized businesses. The "personalized future" concept will likely be driven by proliferation of personal devices and accessories; technological advancements in hardware, exponential increases in processing power, battery life, and networking speeds; and a growing marketplace of third-party-developed open-source applications.

That said, in a fast-changing world of technology, companies currently invested in smartphones—building them, selling them, developing apps, handling communication linkages, working on security, etc.—can't afford to be complacent. To stay relevant in the longer term, and to remain central to users' WPD ecosystems, they will have to keep pace with evolving technologies.

METHODOLOGY

Deloitte's Global Technology, Media, and Telecommunications practice commissioned the 2015 Global Mobile Consumer Survey. An independent research firm fields the survey, based on an online poll of consumers, with responses weighted to reflect the US population (based on 2011 Census data). The survey offers insights into US consumer habits, wants, and trends, with a focus on smartphones and wearable and proximity devices and services.

The 10th edition of Deloitte's Digital Democracy Survey was fielded by an independent research firm in November 2015 and employed an online methodology among 2,205 US consumers. All data is weighted back to the most recent US Census to give a representative view of what consumers are doing. The survey offered insights into consumer trends related to product and device ownership and value, mobile app usage, and advertising insights.

Primary research for this article also included in-depth interviews with subject matter experts in the field of smartphone technologies and telecommunication services.

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