



Using Mobile Apps in Government



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Foreword

On behalf of the IBM Center for The Business of Government, we are pleased to present this report, *Using Mobile Apps in Government*, by Sukumar Ganapati, Florida International University.

In less than a decade, the way Americans communicate has changed dramatically. More than 90 percent now own a cell phone, and three-quarters of those are smartphones. Mobile apps—first introduced in 2008—have become an essential tool for commercial services, such as music, weather, and shopping. In fact, the average smartphone user has about 40 apps on their device.

Apps are increasingly becoming an essential tool for how citizens interact with their government. Government-created or supported mobile apps offer a wide range of opportunities for delivering services, such as finding parking spaces and paying for them, as well as engaging citizens in co-producing services, such as reporting potholes and damaged streetlights. Creative ways of using mobile apps for government continue to multiply, as can be seen through the many examples described in this report.

In this report, Dr. Ganapati documents the state of mobile apps at the federal, state, and local levels. He offers insights to government leaders on where trends are headed and which strategies government organizations might employ to both better serve and engage citizens, and their own employees, in the mobile world ahead. The report focuses on two types of apps which governments at all levels are now developing:

- **Enterprise-focused apps** aimed internally to improve a government organization's mission efficiency and effectiveness
- **Citizen-oriented apps** aimed to foster real-time public engagement for innovative services.



Daniel J. Chenok



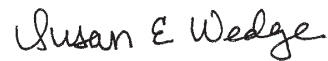
Susan Wedge

He concludes with three recommendations on the need to standardize data, data formats, and data standards that, he believes, will help further the growth of the use of mobile apps in government in years to come.

We hope this report serves as a useful overview of mobile apps, as well as an inspiration to leverage the use of mobile apps in the service of better government.



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Executive Summary

Apps are programs designed specifically for mobile devices like smartphones, tablets, and wearables. With the explosive growth of mobile devices, apps have become commonplace since Apple introduced them for iPhones in 2008. There are close to 4 million apps available through major gateways such as the App Store (for Apple's iOS devices) and Google Play (for Android devices). The app economy has burgeoned with billions of downloads. Nearly 90 percent of a mobile user's time is spent on apps (Khalaf, 2015).

The growth of mobile devices and apps presents new opportunities in the public sector. Schadler, Bernoff, and Ask (2014) argue that there is a mind shift in the mobile environment, in which a person expects that "I can get what I want in my immediate context and moments of need."

The proliferation of mobile phones is also narrowing the digital divide in terms of access to online services. The ownership of smartphones, and dependence on them for Internet access, is especially high among minority groups. African Americans and Hispanic adults spend more time on apps than the average user. Low-income households are also more likely than high-income households to depend on smartphones for online access. The greater accessibility of smartphones to traditionally underserved populations raises the prospects of delivering social services through apps.

There are two broad types of government apps that are discussed in the report:

- **Enterprise-focused apps** are mainly for internal use within a public organization. They are accessible only to employees and operate within secure firewalls established by the organizations.
- **Citizen-oriented apps** are intended for external use. They are accessible to anyone who seeks to use government services.

The State of Mobile Apps in Government

Mobile Apps in the Federal Government

The Obama administration's 2012 Digital Government Strategy laid out a broad digital plan to harness information technology in federal agencies. The strategy explicitly envisaged doing mobile "right" from the beginning. It was premised on four principles to:

- Create an information-centric government that focuses on open data and content
- Establish a shared platform within and across agencies
- Take a customer-centric approach in presenting data
- Build required security and privacy measures upfront

The federal strategy required agencies to expose high-value data and content of at least two existing major customer-facing systems through Application Programming Interfaces (APIs), which are online methods for apps to access data from public agencies in order to provide value-added services in real time and place. The core strength of the federal digital strategy is that government data is a resource that can be leveraged to spur customer service innovation. All new federal agencies' systems, underlying data, and content have to comply with the open data and API policy.

Mobile Apps in State and Local Government

State and local (county/city) governments vary in their adaptation to the mobile environment because they follow their own mandates and policies. Customer service improvements are very important at the state and local levels as they are the direct service providers to citizens on a day-to-day basis (e.g., schools, hospitals, law enforcement, public works, transportation, etc.). Hence, state and local governments have created apps to facilitate citizen engagement.

State government apps. State governments are increasingly adapting to the mobile environment. According to the NASCIO (2014) survey, about 60 percent of the state CIOs considered mobile devices and apps to be essential or high priority; yet, nearly half considered their mobility management to be mostly or totally fragmented. About 36 of the 50 states' main portals are mobile friendly (Ziadeh, 2015).

Local government apps. Local governments vary greatly in their adaptation to the mobile environment. Large cities and counties often have mobile apps; their websites, however, may not be mobile friendly. About half of the 10 largest city and county governments' root websites passed the Google Mobile-Friendly test. The Vision Internet (2015) survey of local governments also showed that about half of the respondents provide mobile-friendly citizen services.

Enterprise-Focused Apps

In the federal government. Customized agency-developed enterprise-focused apps for internal organizational use are in their very early stages of emergence. Early federal government enterprise use of mobile devices (which pre-dated subsequent mobile apps) is the Computer Aided Personal Interview (CAPI) solution implemented since 2012 by the U.S. Department of Agriculture's (USDA) National Agricultural Statistics Service (NASS). The use of mobile devices in CAPI increased field-work efficiency while maintaining a high level of data quality and security.

In state and local governments. Similar to the federal government, enterprise-focused apps are not prominent—but rather emerging—among state and local government agencies. Routine human resource functions lend themselves to mobile optimization. Employees can also use informational apps in real time. Such apps include directory searches, organizational operating procedures, and other content management systems that can be accessed spontaneously (e.g., the City of Los Angeles's *InsideLA* mobile app).

The transformational use of mobile devices is in re-engineering field processes, so there is greater degree of integration between line workers in the field and back-office workers. Field case management, road and rail infrastructure maintenance, vehicular fleet management, inventory control, and supply chain management are all areas that have potential efficiency gains with mobile use. The Pennsylvania Department of Transportation's *Posted and Bonded Road* mobile app, for example, replaced manual paper-based reports, reducing the field workers' administrative duties.

The road ahead for enterprise-focused apps. Enterprise-focused apps are still in the nascent stages of growth in federal, state, and local government agencies. Indeed, enterprise-focused

apps represent a lucrative growth area in private businesses as well, especially among the sales force (Columbus, 2015; Kerschberg, 2015). There is much opportunity for transforming internal operations with location-based services available anywhere in real time.

Enterprise-focused apps could enhance government productivity in several ways:

- Aid in managing mobile assets
- Increase employees' productivity, especially among routine and simple tasks that require cursory examination
- Reduce field workers' administrative onus in the back office
- Provide opportunities for collaboration and networking between public agency field offices

Citizen-Oriented Apps

Citizen-oriented apps are more prevalent than enterprise-focused apps in the federal, state, and local governments. These apps are used as additional innovative mechanisms of delivering public services, and to engage the public in decision-making processes.

Citizen-oriented apps in the federal government. As a result of the 2012 Digital Strategy, most federal agencies have at least one type of citizen-oriented app. There are five categories of federal citizen-oriented apps:

- **Information and news service apps** provide information about the agency's services, latest news, or use agency data (e.g., the *White House* app and the Department of Commerce's *BusinessUSA* mobile app).
- **Client services apps** for "on the go" services (e.g., the Internal Revenue Service's *IRS2go* app, the GSA's *per diem* app, the Transportation Security Agency's *myTSA* app).
- **Crowdsourcing apps** are used to obtain volunteered information from users, which the agencies could not have obtained by themselves. Examples include the *myTSA* (crowd-sources the wait time in security lines from passengers), the Department of Energy's *Lantern Live* app (crowdsources gas fueling stations during an emergency), and the Federal Communications Commission's *Speed Test App* (crowdsources broadband speed).
- **Health and safety information apps** are now being used by the Federal Emergency Management Agency (FEMA), Food and Drug Administration (FDA), the Department of Health and Human Services (HHS), and other agencies to provide information on disaster assistance, drug shortages, and HIV/AIDS, respectively.
- **Educational apps** are fun and explore aspects of a theme, aiming toward gamification. Such apps include NASA's *Comet Quest*, the Library of Congress's *Aesop for Children*, the National Archives and Records Administration's *DocsTeach*, and the Smithsonian Institution's *Access American Stories*.

Citizen-oriented apps in the state and local government. Citizen-oriented apps provided by state and local governments can be classified into four categories:

- **Information on parks, recreation, and leisure activities** is oriented to tourists (e.g., park guides developed by ParksByNature Network in many states). Innovative apps utilize Quick Reader (QR) codes for interactive park navigation and augmented reality to overlay virtual reality to enrich the park experience.
- **Traffic and transit information apps** are provided in real time and place. The 511 apps by state departments of transportation (DOTs) give traffic conditions on the highways, so drivers can adjust their driving routes accordingly.

- **Public engagement apps** include 311 apps, which are apps for citizens to obtain non-emergency services (e.g., fixing a pothole or a streetlight). Open 311 has enabled the 311 apps to be used in cities without 311 centers and through third party vendors such as Accela's *PublicStuff*, *CitySourced*, *QScend*, *SeeClickFix*, and others.
- **Third party civic apps** for government are developed by citizen groups, nonprofit agencies, and private sector entities using local government data. Public agencies have held app competitions and hackathons to develop such apps.

The road ahead for citizen-oriented apps. In the years ahead, government at all levels will move toward:

- **Increased support of citizen-oriented apps to enhance public services.** Government agencies should assist in developing and supporting citizen-oriented apps that enhance the public services they provide. Mobile service provision has the potential to reduce an agency's costs.
- **Increased embedded approach for citizen-oriented apps.** Public agencies should take an embedded approach to citizen-oriented apps by providing a public service contextually. In this approach, public agencies would embed their service in conjunction with other mobile services commonly being used by citizens.
- **Increased availability of APIs for third-party citizen-oriented apps.** Providing APIs is another frontier of mobile app development. Public agencies have a strong role to play because they are repositories of vast data in the public domain. APIs are standard protocols for accessing public data, which can be used in apps for providing value-added services.

Mobile App Design Considerations

The type of device (wearable, smartphone, or tablet) is a primary consideration in designing an app. Small devices allow greater portability, but have limited screen space for presentation and user interaction. Wearables are appropriate for personalized user needs. Smartphones are used for a range of communications and social networking activities, including location-based services. Tablets are useful devices for performing field-based activities. Apps have to be customized to the specific features of the various devices. Because operating systems vary among mobile devices, different versions of an app need to be developed for each system.

There are three types of app designs from a software perspective:

- **Native apps** are downloaded onto the device and take maximum advantage of the device's hardware features (e.g., camera, etc.).
- **Web apps** are websites using responsive web design features so the same web app can be optimized and accessed from different types of devices.
- **Hybrid apps** combine the features of native and web apps. Similar to native apps, hybrid apps are accessed through the app gateways and installed onto a device. However, these apps are developed with cross-mobile device features so they can work across different platforms.

The road ahead for mobile app design. With the proliferation of mobile devices, public agencies need to explicitly adopt a "mobile first" strategy. Government agencies at the federal, state, and local levels should strategically assess their existing online services and engage the public in identifying those which would be most valued on various mobile devices. Because there are various mobile devices and app design considerations, apps need to be offered appropriately. Every device has its strengths and limitations.

Recommendations

The report concludes with the following three recommendations:

- **Recommendation One: Optimize Online Services for Mobile Devices.** Government agencies should strategically assess their online services for mobile optimization. The mobile devices are ubiquitous and are accessible to populations that were traditionally underserved. Hence, the mobile devices offer additional opportunities for government agencies to provide public services.
- **Recommendation Two: Provide Open Data Based on Common Standards.** Public agencies are treasure troves of public domain data that they collect in order to fulfill their mission. Proactive open data policies make the data available in machine readable formats based on common standards. The proactive approach assists in creating a range of mobile apps that are socially useful.
- **Recommendation Three: Assess Feasibility of Standard Data Structures Across and Within Agencies.** The standardization of the structure of data enables different public agencies to provide their data in a consistent way. The apps can then use the data from different agencies, with little or no customization across jurisdictions. The Local Inspector Value-Entry Specification and the General Transit Feed Specification are examples of data standardization for restaurant inspections and transit agency data feeds. They have enabled several value-added apps for food safety and transit.

Introduction to Mobile Apps

The Growth of Mobile Apps

Mobile devices have become commonplace over the last decade. They include mobile phones, tablets, e-readers, wearables, and other hybrid devices. They use wireless communications, over-the-telephone (cellular), or broadband (e.g., wi-fi) connections. Mobile devices around the world number about 7.4 billion, which exceeded the global population of 7.2 billion in 2014 (CISCO, 2015). The adoption of mobile devices has grown remarkably during a short period:

- The share of Americans owning cell phones rose from 83 percent to over 91 percent between 2011 and 2014 (Pew Research Center, 2015).
- Smartphone (i.e., phone with Internet access) ownership went up from 35 percent to 64 percent (Pew Research Center, 2015). comScore reported a 77 percent smartphone subscriber market share in 2015 (Lella, 2015a).
- Mobile phone-only households (i.e., those with no landlines at home) have steadily increased, from 34 percent to over 45 percent between 2011 and 2014 (Blumberg and Luke, 2015).
- Tablet ownership increased from 8 percent in 2011 to over 42 percent in 2013; e-reader ownership went up from 12 percent to 32 percent during the same period (Zickuhr and Rainee, 2014).

Wearables represent the next frontier for mobile device growth. Apple began selling the Apple Watch in 2015. Google Glass is being re-introduced for workplaces (e.g., healthcare, energy, manufacturing) after its first version was withdrawn from the marketplace in early 2015 (Barr, 2015). In addition, a range of biometric and location-aware wearables (such as badges, bands, etc.) also has emerged.

Mobile apps are programs designed specifically for mobile devices that typically combine both communications and computing capabilities. Mobile apps are distinctive as a result of mobile device portability and Internet connectivity. Apps take advantage of a mobile device's hardware features such as the camera and geographical positioning system (GPS).

Apps first emerged for the Apple's iPhones, which were introduced in 2007. The app market burgeoned with the Apple's App Store in 2008. Since then, apps are used for smartphones, tablets, hybrid devices (e.g., phablets), and wearables (such as the Apple Watch). Two operating systems—Apple's iOS and Google's Android—run on over 97 percent of the mobile devices in the United States (Figure 1). Windows phones emerged in 2011 and account for less than two percent of the share of the mobile market; Blackberry comprises less than one percent.

The world of mobile apps is still evolving, albeit at a very fast pace. Apps are available for download in app gateway stores. The major gateways include:

- Google Play

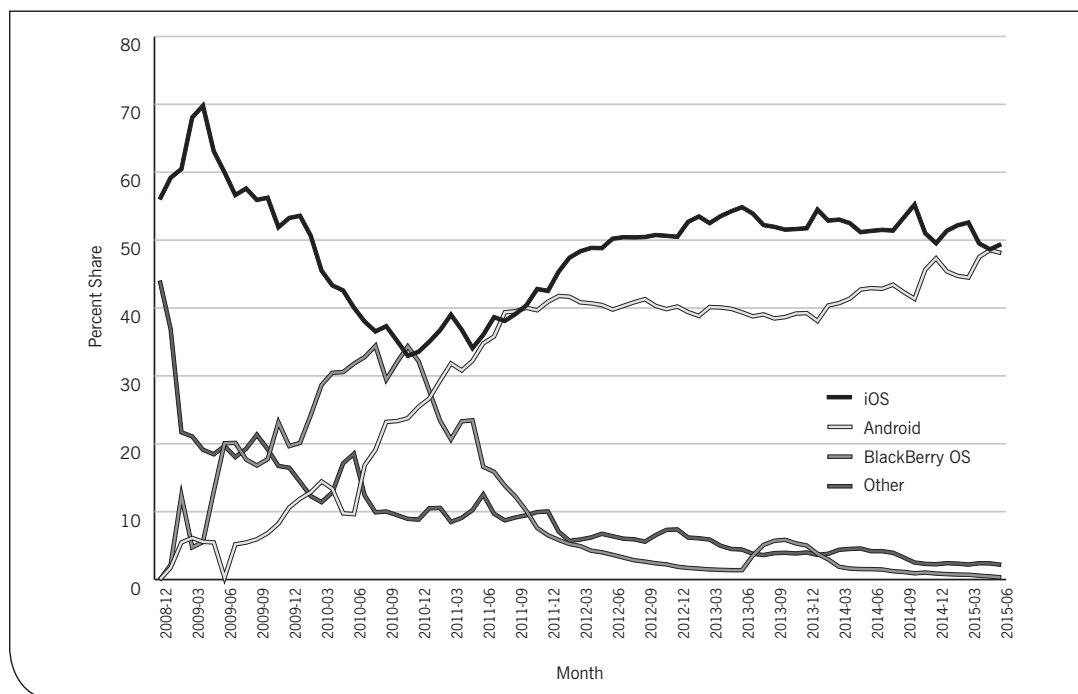
- Apple’s App Store
- Microsoft Windows Store
- Amazon

Together, they house nearly 3.97 million apps. Google Play (with 1.6 million apps) and the Apple’s App Store (1.5 million apps) are the two largest gateways, accounting for about 78 percent of apps. The Microsoft Windows Store and Amazon host about 19 percent of apps, and Blackberry accounts for three percent. App downloads are projected to grow from nearly 64 billion in 2012 to nearly 268.7 billion in 2017. Associated revenues from apps are expected to grow from \$18 billion to \$77 billion during the same period (Shen and Blau, 2013).

App gateways are crucial to how apps are discovered, distributed, and used. Besides the aforementioned four prominent gateways, there are a few others that are proprietary to the manufacturer’s operating system (e.g., Blackberry World, Mozilla’s Firefox Marketplace, Palm’s WebOS apps, Samsung’s Galaxy and Tizen stores).

App use has increased significantly since their introduction. Culturally, the app phenomenon has become so predominant that it spawned Apple’s mantra of “there’s an app for that,” implying the ubiquitous use of apps for problem solving. The average smartphone owner has 36 (as per Google, 2015) to 42 apps (as per Nielsen, 2014b) on the device, and accesses about 26.7 apps per month (Nielsen, 2015). According to comScore (2014), more than half of the digital media time (which includes both mobile and desktop use) is spent on apps. Apps are used as pastimes for social networking (e.g., Facebook, Instagram), playing games, and entertainment (e.g., YouTube for videos, Pandora for music), although time is also spent on communication apps (e.g., e-mail, instant messenger) and location-based apps (e.g., Google Maps) (Beard, 2014; comScore, 2014).

Figure 1: Share of Mobile Operating Systems in the U.S., 2008–2015



Source: Global Stats, http://gs.statcounter.com/#mobile_os-US-monthly-200812-201506

On average, nearly 90 percent of a mobile user's time is spent on apps (Khalaf, 2015). As comScore (2015) reports, "Mobile app usage exploded on its way to becoming the majority of all digital media activity." While apps have been principally oriented toward smartphones and tablets (and hybrids, such as phablets), apps also hold good prospects for wearables as the market grows. For example, the Apple watch debuted in April 2015 with over 3,000 apps; by June 2015, the number of apps for the watch had grown to over 6,300 (App Annie, 2015a).

The Emergence of Government Apps

The growth of mobile devices and apps presents new opportunities in the public sector. Mobile-specific functions can be distinguished as a subset of e-government functions, premised on electronic delivery of services. Whereas e-government enables anytime access to public e-services, mobile government enables "anytime, anywhere" government services on demand from any location. Citizens require government services on demand from public agencies, highly contextualized to the person and the location. Citizens need information on the go, affecting how public agencies deliver the information.

Mobile devices have transformed consumer behavior into a series of *intent-rich micro moments*, when "we reflexively turn to a device to act on a need we have in that moment, to learn, discover, find, or buy something" (Forrester Research, 2015). Location-based service apps harness the device's real-time location information to give customized personal services in the immediate vicinity.

In 2015, mobile users surpassed computer users for the first time in terms of Google searches in the U.S. (Dischler, 2015; Lella, 2015). Google changed its search algorithm in April 2015 to include mobile-friendly sites and relevant app content (through app indexing) in its search results (Makino, Jung, and Phan, 2015).

Mobile devices now account for over one-third of the traffic on U.S. government websites—about 28 percent from smartphones and 7.5 percent from tablets.¹ According to Pew Internet Research, 40 percent of smartphone users employ the device to look up government services or information (Smith, 2015). Smartphones are significant for public employees as well—

Types of Government Apps

There are two broad types of government apps, according to their use: enterprise-focused apps and citizen-oriented apps.

- **Enterprise-focused apps** are mainly for internal use. They are accessible only to a public organization's employees and operate within a secure firewall established by that organization. The apps could be restricted to employer-provided devices, although a bring your own device (BYOD) approach requires these apps to be compatible with the employee-owned devices as well. Enterprise-focused apps could potentially transform an organization through revised processes and procedures, especially in an agency's field operations.
- **Citizen-oriented apps** are intended for external use. They are accessible to anyone who seeks to use public services. Hence, these apps need to be compatible across different devices citizens commonly use. These apps facilitate "anytime, anywhere" citizen engagement (e.g., through crowdsourcing, social media) with government organizations for innovative services and decision-making processes.

1. <https://analytics.usa.gov/>, accessed on July 31, 2015

nearly two-thirds of federal agency leaders indicated agency-issued smartphones would have the greatest impact on improving workplace performance (NAPA and ICF, 2015).

It is important to note that government agencies have embarked on new strategies for government mobile device use. A popular mantra is to be “mobile first,” meaning access to government information and services is based on the use of mobile devices from the beginning, rather than adapting traditional computer-based access for mobile device use.

Mobile apps provide a particularly exciting area of growth for a range of public sector functions by government employees. Apps are distinctive to mobile devices and are arguably among the core elements of mobile government. Mobile apps enable new mechanisms for providing public services. The transformational use of mobile lies in taking electronic processes into the field. In the future, mobile access could replace paper-based processes that could not be made electronic with e-government. Such processes are fieldwork activities conducted outside the office. Mobile devices also hold the promise to re-engineer field processes creating a greater degree of integration between office and field processes.

Mobile-specific tools—such as the Quick Response (QR) codes, which are two-dimensional matrix bar codes that can be read with a mobile app—provide new modes of interactivity and communications with the public. Lorenzi, et al. (2014) show that QR codes enable park navigation, incentivize park use through gamification, increase safety for park goers, disseminate information more effectively and accurately, and improve feedback. The ubiquity of mobile devices has facilitated volunteered geographic information (Goodchild, 2007), in which citizens are sensors reporting through social media networking events on real-time events in the immediate vicinity (e.g., Twitter). According to Pew Research, 67 percent of smartphone owners utilized their phone to share pictures, videos, or commentary about events happening in their community (Smith, 2015). Such information crowdsourcing enables government services to effectively target the contextual needs of the place (e.g., in transportation management, public works).

Mobile apps also hold the promise of becoming a key part of a “smart city” ecosystem, enabling city services through information and communication technologies and location-based sensors (e.g., radio-frequency identification systems) (Townsend, 2013). The smart city is characterized by the Internet of Things (IoT), in which objects are Internet-connected (machine-to-machine connections). In terms of internal city operations, smartphone apps and the IoT can facilitate new

Privacy and Security Concerns with Mobile Apps

Caveats must be recognized in the public sector use of mobile devices and apps. Individual privacy is a major concern. For example, map and navigation apps on mobile devices collect data to provide consumers with location-based services (e.g., car companies collect location data to provide turn-by-turn directions, which could also be shared with traffic information providers). While consumers benefit from location-based services, information sharing could also compromise their individual privacy. Consumer tracking, identity theft, threats to personal safety, and surveillance are potential problems. Adequate safeguards need to be in place for protecting privacy (Government Accountability Office, 2012; 2014).

Mobile security is another area of concern. Wireless Internet connections traditionally have not been as secure as wired connections. Mobile apps are subject to the same set of security concerns as those of other online connections. Vulnerable coding of mobile apps, accessing sensitive data over insecure wireless connections, and lost mobile devices could compromise enterprise security. Mobile apps need to be vetted and the devices need to be subject to the enterprise security measures.

ways of managing city services (e.g., automated meter reading for water supply). In terms of citizen usage, a smartphone can help navigate within a “smart city” through location-based services (Clarke, 2013).

Location-Based Services

Location-based services harness real-time location information to give customized personal and neighborhood-level services. Popular location-based services provide turn-by-turn navigation in cars or locate businesses near the user. These services, which support how apps operate in multiple ways given the users’ location, use the Geospatial Web 2.0 platforms (e.g., ArcGIS online, Microsoft’s Bing Maps, Google Maps, Nokia’s Here, Mapquest, Yahoo Maps, Open Street Map) to provide local services. For example, *FourSquare* and *Yelp* have become popular apps to locate businesses of interest (e.g., restaurants, bars, etc.) in a neighborhood. These apps crowdsource reviews about quality and other aspects of the business through a community of users. The apps could overlay advanced technologies such as augmented reality to provide additional location-specific information about the physical environment. Augmented reality is the combination of virtual reality and real world (e.g., overlaying a picture or video with virtual information in real time); platforms for such mobile apps include *Layar*, *Wikitude*, and *Metaio*. Although still evolving, augmented reality techniques could be useful for tourists (e.g., getting information about points of interest), infrastructure maintenance, public works, zoning, and other activities (Graham, Zook, and Boulton, 2013; Liao and Humphreys, 2014; Lin et al., 2014).

Location-based services offer essential features for the new sharing economy, whereby mobile apps are used to facilitate the new shared services. People living in the same geographical community can share various services, such as rides, shopping, obtaining domestic help, etc. The services are hyperlocal, often focusing on the neighborhood level; consumers directly engage with each other in the neighborhood (Fowler, 2015; Botsman and Rogers, 2010; Gansky, 2010). Prime examples of a sharing economy are *Uber* and *Lyft*, which are platforms allowing riders and drivers to connect with each other. A person requiring a ride makes the request through an app and it is routed to a nearby willing *Uber* or *Lyft* driver who provides the ride. Similar types of location-specific on-demand services have arisen across a range of other economic activities: ordering food delivery from local restaurants (e.g., *DoorDash*, *GrubHub*, *Sidecar*, *SpoonRocket*); getting assistance with daily chores such as cleaning, handyman jobs, shopping, delivery, etc. (e.g., *Clutter*, *Instacart*, *Postmates*, *TaskRabbit*); peer-to-peer car rental (e.g., *Getaround*); booking accommodations (e.g., homes or apartments) from independent hosts (e.g., *Airbnb*, *Couchsurfing*, *Homeaway*); and arranging a local experience with independent insiders (e.g., *Vayable*) at a destination.

Mobile Devices Help Bridge the Digital Divide

The proliferation of mobile phones is also narrowing the “digital divide” in terms of access to the Internet. Households have become increasingly mobile-dependent, using phones for both communications and Internet access. Smartphone ownership, and dependence on them for Internet access, is especially high among minority groups. According to Pew Internet (Lopez, Gonzalez-Barrera, and Patten, 2013), about 86 percent of Hispanics and 90 percent of African Americans owned a cell phone in 2012, compared to 84 percent for whites. Smartphone penetration was 49 percent, 50 percent, and 46 percent, respectively, among the three groups. African American and Hispanic adults spend more time on apps than the average user (Nielsen, 2014b).

Smartphones have reduced the digital divide across income categories, too. Low-income groups depend on smartphones for online access at significantly higher rates than those of high-income groups. Nearly 60 percent of poor households were wireless-only in 2014, compared to 41 percent of non-poor households (Blumberg and Luke, 2015). About 13 percent of Americans from low-income households (earning less than \$30,000 per year) are smartphone dependent for Internet access, compared to only one percent of those in high-income households (earning more than \$75,000 per year) (Smith, 2015). The greater smartphone accessibility for low-income households raises the prospects of delivering social services through apps. Of course, a digital divide still exists in terms of age: 77 percent of seniors own cell phones, only 18 percent of those seniors own a smartphone. About 27 percent of seniors use social networking sites (Smith, 2014).

Application Programming Interface (API): A Key Ingredient of Mobile Apps

An API is a set of software codes that enables computers to exchange information between different software programs. Using an API, an organization can expose its data to any user over the Internet. A user (e.g., computer programmer) needs to obtain an API key from an organization to access the specific information. Mobile apps use APIs to access data from several organizations to provide value-added services in real time and place. Private firms benefit because the added value attracts more customers. Public agencies benefit through citizen co-production (e.g., additional services created by civic groups using the agency's data). There are three types of APIs:

- Private (organization limits the users)
- Open (organization does not restrict the users)
- Hybrid (combining elements of both private and open APIs)

Public sector APIs are generally open because the data are in the public domain. The JavaScript Object Notation (JSON) is a commonly accepted format for APIs to return data. Other formats include comma delimited (CSV) and eXtensible Markup Language (XML). APIs have become the next growth frontier for interoperability between devices and systems. There are over 14,000 APIs, according to programmableweb.com (<http://www.programmableweb.com/apis/directory>).

The State of Mobile Apps in Government

Mobile Apps in the Federal Government

The Obama administration's 2012 Digital Government Strategy laid out a broad digital plan to harness information technology in federal agencies. The strategy explicitly laid a path for adopting emerging digital technologies, including doing mobile "right" from the beginning. It stressed that high-quality digital government information and services should be available from anywhere, anytime, on any device.

The Policy Framework

The federal government's digital strategy is organized around four principles:

- Create an information-centric government that focuses on open data and content. The data would be made freely available in device-agnostic ways through APIs for interoperability and openness. Decoupling data from the presentation paved new ways to harness the data for various devices.
- Establish a shared platform within and across agencies. Much of the task fell on the General Services Administration (GSA) to establish a central resource for sharing source code (the "build once, use many times" model), solutions, and training across various technologies (e.g., open content management systems, APIs, etc.). The federal Chief Information Officers Council (CIOCC) and the Office of Management and Budget (OMB) assisted in the process.
- Take a customer-centric approach in presenting data. Federal agencies were required to optimize at least two existing priority customer-facing services for mobile, and expose high-value data and content of at least two *existing* major customer-facing systems through APIs. The customer orientation implied improving customer-facing mobile services and implementing performance and customer satisfaction measuring tools.
- Build in security and privacy upfront when adopting new technologies. The federal strategy recognized the unique challenges of the mobile world:
 - Mobile devices elevate the risk of being misplaced.
 - Wireless connectivity poses security challenges.
 - Bring your own devices (BYOD) may not be compliant with enterprise security systems.
 - Public open data made available also need to conform to federal legal privacy requirements.

The core strength of the federal digital strategy is that it presumes government data as a resource that can be leveraged to spur customer service innovation. All *new* federal agencies' systems and underlying data and content have to comply with the open data and API policy. Subsequent policies such as the *Making Open and Machine Readable the New Default for Government Information* (President's Executive Order of May 9, 2013) provided additional

guidelines to make open data a default policy. The U.S. Digital Services Playbook, released in 2014, outlined 13 key “plays” drawn from private and public-sector best practices that agencies can follow to effectively build digital services, including mobile apps.

The Governance Framework

The federal government also established a support structure within GSA for building a digital government:

- **Office of Citizen Services & Innovative Technologies (OCSIT)** plays a leadership role in identifying and applying new technologies.
- **18F Program** is an in-house “tech startup” that serves as a consulting service internal to the government to create digital services and public-facing applications.
- **Digital Government Division (digitalgov.gov)** houses mobile-oriented solutions as a part of its suite of support systems, which include:
 - Content management systems
 - Digital analytics program
 - Crowdsourced mobile testing
 - Mobile apps registry
 - Social media registry
 - Negotiated terms of service agreements that are federally compatible

Current Use of Apps in the Federal Government

Federal apps are catalogued on Github, an open source repository (they were previously located in the now-defunct Federal Mobile Apps Directory under usa.gov, the federal government-wide portal). The Github catalog lists 289 mobile apps (as of July 2015). Of the 76 federal agencies that have developed apps, 58 had developed one to four mobile apps, and 19 had developed five to 15 apps.

10 agencies had 10 or more apps:

- Animal and Plant Health Inspection Service
- Centers for Disease Control and Prevention
- Department of Defense
- Department of Education
- Department of Health and Human Services
- National Center for Telehealth and Technology
- National Institutes of Health
- National Aeronautics and Space Administration
- Department of Veterans Affairs
- Smithsonian Institution

Their apps cover a range of platforms, with 84 iOS-only apps, 69 mobile web apps, and 13 Android-only apps; 77 apps are developed for both iOS and Android, and 35 apps are for multiple platforms (across Android, Blackberry, iOS, and Windows platforms).

In addition to the apps, federal agencies have also made progress with respect to development of APIs. About 96 agencies have API developer hubs with about 420 public APIs.² However, there are 1,927 federal APIs as per data.gov, the central repository for all agency APIs. The Environmental Protection Agency accounts for about 75 percent of the APIs in the data.gov inventory.³

Overall, federal agencies are still in the infancy stage in adopting digital tools in general, and the mobile environment in particular (GBC, 2015; Fiorenza, 2013). Although federal agencies have their individual websites, they are not all mobile optimized. Fretwell (2015) reports that the four federal websites with most traffic—Internal Revenue Service’s IRS.gov, National Oceanic and Atmospheric Administration’s Weather.gov, Office of Personnel Management’s USAJobs.gov, and National Park Service’s NPS.gov—were not mobile friendly. (Since that article was published, the NPS.gov has been mobile optimized.) In a test conducted by the author on 15 federal executive departments’ domain root websites in July 2015, six did not pass the Google Mobile-Friendly test: Departments of Defense, Homeland Security, Housing and Urban Development, Transportation, Treasury, and Veterans Affairs.

About 17 percent of federal agencies have a presence in the app world and 22 percent of them have public APIs (there are about 438 federal agencies as per the *Federal Register*). According to a Government Business Council (GBC, 2015) survey of federal managers, only 23 percent of respondents indicated they use mobile apps to serve their customers. In addition, 81 percent said they have at least one digital-related skill deficit in their agency; mobile app development was one of them. The GBC (2014) study also showed slow progress toward the implementation of a digital government strategy. Federal agency officials expressed very limited use of apps: about 37 percent of the respondents agreed that their agency uses mobile apps to serve their external customers (i.e., citizen-oriented apps), and the share fell to 30 percent for their internal customers (i.e., enterprise-focused apps).

According to another survey by Fedscoop (2014), only one-third of respondents acknowledged that their agencies provide online access to high-quality digital government information on mobile devices. Their APIs are also not of uniformly high quality (see Lane (2014) for a review of the quality of federal agency APIs). Although agencies are required to post their APIs on data.gov, there are inconsistencies among the agencies.

Barriers to Rapid Adoption

The top barriers for incorporating digital tools are:

- Limited or declining IT budgets
- Security and privacy concerns (GBC, 2015)

In addition, there are the following organizational barriers:

- Lack of digital skills in the agency
- Limitations of legacy systems
- Cultural resistance
- Unclear long-term vision impediments in achieving the digital strategy goals (GBC, 2014)

Many agencies do not have the budget or staffing resources to develop enterprise mobile apps and stores to distribute them (Fiorenza, 2013). Organizationally, a 2015 GAO study revealed

2. <http://18f.github.io/API-All-the-X/pages/status>, accessed on July 31, 2015.

3. http://catalog.data.gov/dataset?res_format=api, accessed on July 31, 2015.

lack of centralized mobile device and service management. Of the 15 agencies having the highest-reported annual telecommunications spending, only five agencies had a complete inventory of mobile devices and associated services and only one agency (GSA) had documented procedures for monitoring its spending on mobile strategies. Despite the challenges, federal agencies are steady in their progress toward adopting new mobile technologies, because there is a broad federal policy framework and support structure.

Mobile Apps in State Government

State governments are increasingly adapting to the mobile environment, although progress is not as steady. About 36 of the 50 states' main portals are mobile friendly (Ziadeh, 2015). According to the National Association of State Chief Information Officers (NASCIO) survey of state CIOs in 2014, nearly 60 percent of the state CIOs considered the mobile devices and apps to be essential or high priority in their strategic agenda and IT operational plans. At the same time, nearly half considered their mobility management to be mostly or totally fragmented (NASCIO, 2014). The share with such opinion about fragmentation had not changed since the 2012 survey (NASCIO, 2012). Thus, there is little progress in enterprise-focused mobile management. Moreover, only 30 percent of the CIOs considered their organizations to be ready to deploy and support mobile devices and applications, although 72 percent of them said that their agencies allow BYOD (NASCIO, 2012).

All states have at least one mobile app. The NASCIO catalog shows 327 apps, of which 299 are iOS-enabled apps and 242 are Android-enabled apps. Twenty-eight states have one to five apps; 22 states have between six and 14 apps; and three states—California, Utah, and Virginia—have 15 or more apps.

State governments have created innovative apps to facilitate citizen engagement. Utah was the first state to create an app for iPhone in 2009 to let users check the licensure status of professionals in the state; it also created the first app for Google Glass to send transit notification on the spot (Newcombe, 2014). Arkansas launched the first government app for the Apple Watch, epitomizing the personalized delivery of government services. Called *Gov2Go*, the app provides customized digital government information, allowing the user to set reminders and receive notifications for government transactions, such as property tax payments, vehicle registration renewals, etc. (Williams, 2015).

States have developed a range of citizen-oriented apps. The most common types of apps are for parks (89), traffic (60), and safety (34), which together account for 56 percent of the total apps. The pattern reflects the results of a state CIO survey in 2012, where nearly four in five CIOs thought that the parks and traffic apps were most popular with citizens (NASCIO, 2012). The next five most common types of apps are: wellness (19), development (15), comprehensive (12), benefits (11), and legislature (10). There are also apps for state agency (9), voting (6), taxes (5), employment (5), and the state economy (5). The "other" category encompasses a broad range of apps, including business, license, tax, etc.

A few state governments have made important strides in making available public APIs. According to the federally sponsored *data.gov* website, there are over 3,000 state government-sponsored datasets that can be accessed through APIs (nearly 98 percent of the datasets are available in JSON format).⁴ These datasets, however, originate only from five states (Hawaii,

4. http://catalog.data.gov/dataset?organization_type=State+Government&q=-aapi+api+OR++res_format+percent3Aapi, accessed on July 31, 2015.

Illinois, Maryland, New York, and Oregon). Most of the other state governments have yet to offer the APIs at the state level. California and Utah are interesting exceptions. California offers the API data as Google Fusion tables for some demographic, healthcare, and industrial data. Utah offers three types of APIs that can be used across the Utah.gov database (search, location, and public notices).

Mobile Apps in Local Government

The top 10 most populated cities in the country—Los Angeles, Houston, Phoenix, New York City, San Jose, Chicago, Dallas, Philadelphia, San Antonio, and San Diego—have at least one mobile app (the average is about four apps). The author’s mobile friendliness test in July 2015 (using the Google tool) showed that the first five cities’ root domains are mobile optimized; the rest are not. Similarly, the top 10 most populated counties—Los Angeles County, CA; Cook County, IL; San Diego County, CA; Riverside County, CA; Dallas County, TX; Harris County, TX; Maricopa County, AZ; Miami-Dade County, FL; Orange County, CA; and San Bernardino County, CA—have at least one app each. The mobile-friendliness test showed that websites of the first five are mobile optimized.

A recent survey of local governments by Vision Internet (2015) also shows a similar finding: nearly half of respondents said their organization provides mobile-friendly citizen services. About one-third of the respondents rated their organization websites to be effective. Thus, there is much scope for local governments to become mobile-friendly. Local government officials do recognize the significance of adapting to the mobile world. According to the Vision Internet (2015) survey, local government respondents considered the top three advantages of mobile to be:

- Citizen convenience
- Expanded communications outreach
- Savings on time and human resources

At the same time, they indicated budgetary, security, and usability challenges in using mobile apps as a tool for delivering government services.

Mobile apps at the local level are principally citizen-oriented; enterprise-focused apps for internal employee use are in the emergent phase. County and city apps are commonly related to transit and requests for public services. Transit apps provide information about the schedule of the buses and trains in real time. Public service request apps allow citizens to initiate a service request and follow through on it (e.g., reporting graffiti, street maintenance, broken streetlights, etc.). Several cities and counties also provide tourism and recreational information, detailing the leisure and entertainment activities that visitors can enjoy. These types of apps are hyperlocal in nature, aimed toward improving citizen service experiences. Cities and counties are closer to the communities they serve and have to be responsive to the immediate needs of the communities. These apps feature location-based services to provide information specific to the mobile user’s context.

Several cities have been at the forefront of the open data movement, making their data publicly accessible. Cities such as Boston, Chicago, Houston, New York, Philadelphia, Portland, San Francisco, and Washington, D.C. provide such datasets. Similar to the state governments, some cities and counties provide APIs for accessing these public datasets online. According to the data.gov, there are over 3,085 datasets that can be accessed through the APIs (nearly 88

percent of the datasets are in JSON format).⁵ Most of these datasets, however, originate from only five cities (Chicago, Los Angeles, New York, San Francisco, and Seattle) and three counties (Cook County, IL; Montgomery County, MD; and King County, WA).

5. http://catalog.data.gov/dataset?organization_type=X+Government&q=-aapi+api+OR++res_format+percent3Aapi (where X is City or County), accessed on July 31, 2015.

Enterprise-Focused Apps

The goal of enterprise-focused apps is to achieve an organization's mission efficiently and effectively. These apps could streamline existing practices and have the potential to transform internal administrative processes. The apps are securely operated within the organization's firewall, and they need to meet the enterprise's security standards. While enterprise-focused apps could operate across a range of functions, their use is more significant in streamlining internal field operations. Smartphones and tablets can be used in the field, interacting with the organization's database systems directly. These apps are particularly useful for front-line workers to obtain and report information in real time directly from the field. First responders (firefighters and other emergency workers), foster care caseworkers, law enforcement officials, field inspectors (e.g., planning and zoning, health, etc.) benefit from such enterprise-focused apps.

Enterprise-Focused Apps in the Federal Government

Customized agency-developed enterprise-focused apps for internal organizational use are in their nascent stages of adoption among federal agencies. The Department of Agriculture, NASA, State Department, and GSA have been among the early government leaders in enterprise-focused apps.

Fieldwork Apps at the Department of Agriculture

The early enterprise-focused use of mobile devices in the federal government is the Computer Aided Personal Interview (CAPI) solution implemented since 2012 by the U.S. Department of Agriculture's (USDA) National Agricultural Statistics Service (NASS). Although not a mobile app, CAPI illustrates the use of tablets for fieldwork. NASS, which compiles agricultural data from all states, employs thousands of field enumerators to conduct annual surveys. Tablets ease the data collection process, as enumerators do not have to carry paper and manually upload data. The agency-provided tablets upload data in a secure manner to the NASS's Electronic Data Reporting System; the data are available for review within a few hours (Kleweno and Hird, 2012). The mobile use of CAPI increased fieldwork efficiency while maintaining a high level of data quality and security.

Productivity, Utility, and Reference Apps at the National Aeronautical and Space Agency (NASA)

NASA is a leader in the development of enterprise-focused apps (as well as citizen-oriented apps). The Center for Internal Mobile Applications (CIMA), an in-house mobile application management system, manages the apps@NASA app store. The store hosts internal mobile apps and NASA data for use on both agency-issued devices and personal devices. The 20 internal apps in the store are enterprise-focused, comprising:

- **Productivity apps** that allow mobile, collaborative working (e.g., *ExplorNet*) and conferencing (e.g., *Extended Voice System*)

- **Utility apps** that facilitate teleworking (e.g., *WebTADS*) and remote job monitoring (e.g., *myNAS*)
- **Reference apps** that include emergency procedures handbooks, human resource policies, NASA employees' contacts, buildings on campus, etc.

Food Inspection Apps at the Food and Drug Administration (FDA)

The Food and Drug Administration's *Field Investigator Tool with Mapping (FIT-MAP)* is an exemplary enterprise mobile app that enhances field investigators' efficiency. Investigators can directly report on agricultural products from the farm. The app is aimed towards reducing the occurrence of food-borne illnesses (Cheeseman and Trujillo, 2014). The Food Safety Modernization Act of 2011 directed the creation of a proactive early warning system for preventing food-borne diseases. Recent episodes warranted the need for an effort to contain the outbreaks: the 2006 E. Coli outbreak due to spinach contamination, the 2011 *Listeria monocytogenes* outbreak due to cantaloupe contamination, and the 2013 *Cyclospora cayotensis* outbreak due to salad mix/cilantro contamination.

FIT-MAP allows FDA inspectors to report directly from the farm through Personal Identification Verification (PIV)-enabled Windows mobile devices. Inspectors can upload photos, site documents and geo-code data about the farm's product (Otto, 2014). The tool can be utilized for surveys, inspection, and/or tracking of any FDA regulatory investigation information. The data enable FDA to monitor food products from across the country in real time. The app can support predictive analytics for proactive interventions across the agency to contain the occurrence of food-borne diseases. The app received the Best Business Investment Award in the 2015 Mobile Application Fair hosted by the American Council for Technology and Industry Advisory Council (ACT-IAC).⁶ *FIT-MAP* completed the pilot test phase and is currently under evaluation by the agency as a field inspection tool.

Fleet Management Apps at the State Department

The enterprise-focused apps for fleet management used by the U.S. Department of State (e.g., *Mobile Driver*) are a good example of how apps can be used to manage mobile assets in real time. Mobile apps benefit vehicle fleet management, assisting both drivers and fleet managers (Ziadeh, 2014). The State Department has developed apps that allow flexible use of the vehicles, including the Integrated Logistics Management System (ILMS), which tracks the department's fleet of 14,000 vehicles spread over 176 countries. Employees can use the *Mobile Driver* app to record trip information, review assigned trips, and manage reassignments and transfers in real time. They do not have to carry a clipboard and additional paperwork. The app improves fleet management data quality, and also allows consulate personnel to rate their satisfaction and digitally sign for deliveries.

Fleet Management Apps at the General Services Administration (GSA)

Similar to the State Department, the GSA's *FMS2GO* app extends the agency's Fleet Management System (FMS) capacity, which manages over 200,000 vehicles in real time. *FMS2GO* connects with the FMS database using an API. The app facilitates drivers in managing and recording their inventory on site and at delivery locations, thus improving the supply-chain management. The mobile device's camera and microphone enable barcode scanning and voice recognition. All the communications through the mobile app are secured via secure socket layer (SSL) connections.

6. <https://actiac.org/custom-links/14853/69677/70998>

Enterprise-Focused Apps in State and Local Government

Enterprise-focused apps are still emerging among state and local government agencies. Routine human resource functions, such as electronic approvals, provide opportunities for mobile optimization. Employees can use informational apps in real time on the location. These apps include directory searches, organizational operating procedures, and other content management systems that can be accessed instantly. Such content is typically already accessible online through desktop computers, but it needs to be optimized for mobile devices.

The City of Los Angeles's *InsideLA* provides a good example of an enterprise-focused mobile app. Accessible only to city employees via a secure login system, the app features an employee directory (CityFone), an IT ticketing system to request and administer IT issues, and connects to other internal web apps.

The transformational use of mobile devices is in the re-engineering of field processes, such that there is a greater degree of integration between line-workers in the field and back-office workers. Mobile asset and employee management provide good opportunities in this regard. The typical limitation is in the availability of broadband network connections in the field, which can be overcome by an asynchronous connection (e.g., upload data when a broadband connection is available).

Field case management, road and rail infrastructure maintenance, vehicular fleet management, inventory control, and supply chain management are all areas that have potential efficiency gains with mobile use. The Pennsylvania Department of Transportation's (PennDOT) *Posted and Bonded Road (PBR)* mobile application provides an illustration. Timely surveys and audits of the posted and bonded roads are required for their timely repair and maintenance. The mobile process replaced manual paper-based reports, reducing field workers' administrative duties. The *PBR* app also allows the user to record and upload photos of road conditions. The electronic process reduced intervening human errors, increasing the survey data quality. The data are also uploaded and available in real time over wireless broadband (if a wireless connection is not available, the data are synchronized with the PennDot database when a connection becomes available).

The Road Ahead for Enterprise-Focused Apps

Government Needs to Prioritize Enterprise-Focused Apps

Enterprise-focused apps that concentrate on internal organizational process and productivity improvements are now underdeveloped, yet show great potential. Enterprise-focused apps are still in the nascent stages of growth in federal, state, and local government agencies, yet they can benefit agencies' internal operations and potentially transform them. There is much opportunity for developing enterprise-focused apps to streamline public agencies' field activities, with location-based services in real time.

Many organizations have already begun to use cloud-based mobile solutions for communications tasks such as e-mail, file sharing, and other daily tasks. Enterprise-focused apps are aimed toward enhancing the performance of organizational tasks and collaboration in making productivity improvements. Enterprise-focused apps act as an interface to access the organization's proprietary (and secure) data and content information from different locations. Enterprise-focused apps are lucrative growth industries in the private sector as well, as businesses are adopting them for productivity gains, especially among the sales force (Columbus, 2015; Kerschberg, 2015)

Enterprise-focused apps could enhance public sector organizational productivity in several ways:

- The apps can aid in managing mobile assets. In transit agencies, the apps can assist in managing the vehicular fleet, deploying and routing them in real time with greater flexibility (such as the Department of State and GSA apps discussed above). In addition, remote sensor technologies to evaluate the conditions of the vehicle could provide cost savings for fleet repair and maintenance.
- Enterprise-focused apps can assist in increasing employees' productivity. The apps allow employees to work from anywhere, anytime, behind secure firewalls. Routine and simple human resource tasks that require cursory examination (e.g., some of the approval processes in payroll and benefits transactions) are amenable to being performed on mobile devices.
- Enterprise-focused apps are crucial for field workers to reduce their administrative onus (such as PennDOT's *PBR* app). In the past, employees would need to return to their home office to file field reports on their activities (e.g., case management workers, law enforcement officers, surveyors, etc.). Enterprise-focused apps allow employees to file their data and reports directly from the field, reducing the additional time spent on back-office work. Even if a broadband network connection is not available in the field to enable such direct filings, the field data synchronization can be done once the connection is available. Such direct filing not only increases efficiency, but also increases the data integrity and quality.
- Enterprise-focused apps provide opportunities for collaboration and networking between the field offices of the public agency. Employees working on the same issue at the different branches use the same app. The app can assist the employees in getting the information in real time to the field, which can be crucial, especially in emergency management and law enforcement.

Enterprise-focused apps should be role-based to facilitate user needs, and task-oriented toward solving a specific issue, or a set of issues. These apps would be installed on a mobile device, because employees would use them often to conduct their tasks. The apps also allow employees to work offline though this introduces security vulnerabilities that should be addressed. Custom-made apps could assist in addressing an organization's specific needs; in addition, generic commercial off-the-shelf solutions may be available for addressing a general task.

As enterprise-focused apps are still uncharted territories for public organizations, their development requires new approaches. The agile method is a well-regarded approach in this respect (Kyte, Norton, and Wilson, 2014). The agile method emphasizes a small team-based approach with incremental steps and multiple iterations, and it places high value on user interface and interactivity of the apps. Frontline workers should ideally be involved in app development. End users' early involvement in the design and development is critical for an app to be user-friendly and helpful in solving tasks. Hackathons, which are used for developing customer apps, typically entail teams of software developers and designers competitively engaging in producing apps over short time periods. Internal hackathons with teams of software developers and operational teams could assist in creating enterprise-focused apps that are customized to the organizational tasks. A facilitated internal hackathon can stimulate collaboration for app development. Organizational leaders could provide a supportive environment for facilitating an internal hackathon (Altringer, 2013).

Government Organizations Need to Develop Policies for Enterprise-Focused Apps and App Management

As discussed previously, security and privacy are the topmost concerns of agency officials when dealing with mobile devices. Mobile devices pose security risks for several reasons.

Agencies often allow a BYOD plan, which is beneficial for the employees, but it may not meet enterprise security standards. If the device is lost, the privacy of the agency's records could be adversely affected. Mobile wireless systems could also be susceptible to security breaches if security protocols are not followed. An enterprise mobile device and app management strategy is a key requirement for ensuring organizational security and privacy of the records. At the federal level, the Federal Risk and Authorization Management Program (FedRAMP) provides a central, standardized approach to security assessment, authorization, and monitoring of the devices. However, federal departments and agencies manage their employees' devices and apps. As the GAO (2015) report showed, agencies lack centralized mobile device and service management. Agencies at the state and local government levels, too, show a fragmented approach toward mobile device and app management.

Finding and downloading apps is another challenge for government users. The iOS App Store and Google Play are two major app gateways; most apps are developed for iOS and Android devices. Commercial app gateways have their own policies on hosting a government-sponsored app—the iOS App Store has more stringent requirements than Android for approving apps. Apps developed by an agency need to be hosted in an app store for employees to download and install. (Mobile devices are distinctive from desktop computers in this respect—users cannot install applications directly; apps need to be downloaded from the appropriate store.) With the large number of apps available, the discovery of the best enterprise-focused apps becomes a challenge.

Using an enterprise approach to mobile device and app management (MDAM) addresses the challenges of app security and discovery. An MDAM system entails that all the different devices are brought under one umbrella system of device management which can ensure the security of the device, while maintaining the privacy of the agency's data. An MDAM system can also host agency apps that would assist employees in discovering the apps and trust that they meet enterprise security standards. There are many commercial MDAM vendors that provide such solutions.

Citizen-Oriented Apps

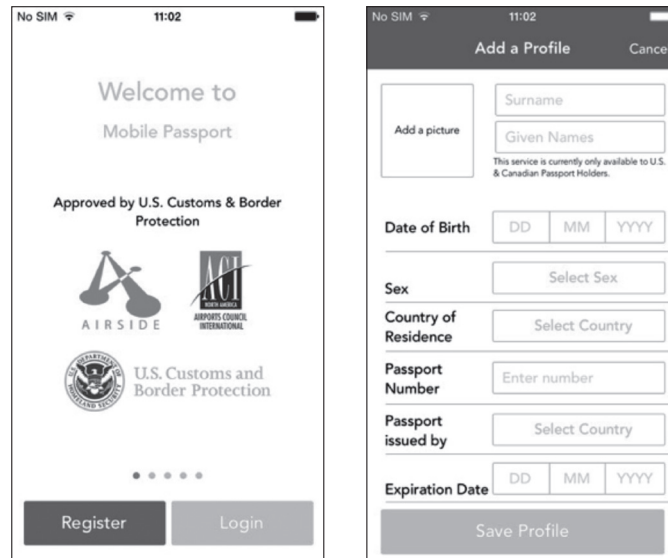
Many government organizations use citizen-oriented apps to foster real-time public engagement for innovative services and decision-making processes. Often, the citizen-oriented apps provide real-time information that is useful to the immediate task of a person in a location (e.g., a transit-oriented app to provide information on transit schedule). Apps typically draw on information available through the public agency's data sources; government data are therefore a crucial feature for enhancing citizen services. These apps are often co-produced in collaboration with citizen groups and civic organizations.

Citizen-Oriented Apps in the Federal Government

Citizen-oriented apps are more prevalent than enterprise-focused apps in the federal government. As a result of the 2012 Digital Strategy, most federal agencies have at least one citizen app. Five distinctive categories of citizen-oriented federal apps can be identified:

- **Information and news services.** The first type of citizen-oriented apps provides information, covering agency news or using agency data. The *White House* app, for example, provides the latest news from the blog and newsroom, featured videos and photos, and live video streaming of White House events with the president. The Department of Commerce's *BusinessUSA* mobile app consolidates the U.S. federal government's business information and resources for small businesses. The Census Bureau developed three apps using census data:
 - *dwellr* app provides neighborhood-level statistics for individuals to explore where they want to live, using the Census's American Community Survey.
 - *America's Economy* app provides real-time updates for 20 key economic indicators from the U.S. Census Bureau, Bureau of Labor Statistics, and Bureau of Economic Analysis.
 - *Census Pop Quiz* app tests knowledge about the states, drawing on the Census's American Community Survey.
- **Client services.** The second type of citizen-oriented app provides client services on the go. The *IRS2go* app from the Internal Revenue Service lets individuals check their refund status, find free tax preparation assistance, and sign up for helpful tax tips. The GSA's *per diem* app allows users to verify per diem of different locations. Many federal agencies also provide information about client services regulated by the agency. Examples include the Federal Motor Carrier Safety Administration's *QCMobile* (provides the safety performance for all commercial motor carriers) and *SaferBus* (provides safety performance of motor coach and bus companies). The Transportation Security Agency's *myTSA* app provides real-time operating statuses for U.S. airports.

The Customs and Border Patrol's *Mobile Passport* App



The Customs and Border Patrol's *Mobile Passport* app is an exemplary app that benefits users because they have shorter wait times, and it benefits the agency by providing efficiency gains due to a streamlined process and lower operational costs.

The agency launched its *Mobile Passport* app to streamline the traveler inspection process by allowing travelers to submit passport information electronically with a smartphone. Using the app, qualified travelers create a profile with their passport information (e.g., name, gender, date of birth, and country of citizenship). Travelers then complete the declaration form by selecting the arrival airport and airline, taking a self-picture, and answering the customs declaration questions. Once travelers submit the declaration form, they get an electronic receipt with an encrypted QR code to show to airport agents (along with their passports) before exiting.

The app supports CBP's mission to process travelers safely and efficiently while enhancing security and reducing operational costs; at the same time, it provides valuable customer service by reducing customers' wait times. It is also a mobile-centric solution that is indicative of the "anytime, anywhere on-demand" government. The app was first piloted in Atlanta's airport in 2014, and it then expanded to Chicago's O'Hare, Miami, and Seattle airports (Sampson, 2015). The app's success has prompted the CBP to further expand the program to 20 airports by 2016 (CBP, 2015).

- **Crowdsourcing.** The third type of citizen-oriented app is a crowdsourcing app, which is used to obtain volunteered information from users. Examples include:
 - *myTSA* allows passengers to crowdsource the wait time in security gate lines helping other passengers who have to board airplanes.
 - The Department of Energy's *Lantern Live* app allows people to crowdsource gas fueling stations during an emergency, which can also be used by others to locate open gas stations.
 - The Federal Communications Commission's (FCC's) *Speed Test* app automatically measures the broadband speed of a communications network, and it uploads the information to the FCC for evaluating the country's broadband performance.

- NOAA's National GeoPhysical Data Center *CrowdMag* app records the magnetic field data in the background and uploads the information, so that NOAA can track the earth's changing magnetic fields. NOAA's apps empower citizens to become scientists: the *Meteorological Phenomena Identification Near the Ground* (mPING) app allows people to submit a weather observation to the National Severe Storms Laboratory database and the *Dolphin and Whale 911* app allows one to report the location of dead or stranded sea creatures. Crowdsourcing assists in generating information the agencies could not have gathered by themselves.
- **Health and Safety Information.** The fourth type of citizen-oriented app provides health and safety information. The Federal Emergency Management Agency (FEMA), the Food and Drug Administration (FDA), the Department of Health and Human Services (HHS), and other agencies have developed apps to provide information on disaster assistance, drug shortages, and HIV/AIDS respectively. The FEMA app, for example, gives customized emergency safety information, safety tips, and alerts from the National Weather Service; users can also use it to report damage and recovery efforts (called the Disaster Reporter) by uploading and sharing photos, and to apply for assistance through Disaster Assistance.
- **Educational Services.** A fifth type of citizen-oriented app is educational, which often includes fun and exploratory aspects of a theme, and aims toward gamification. These apps draw on the popularity of game apps among users. This category includes apps developed by NASA—*Comet Quest*; Library of Congress—*Aesop for Children*; National Archives and Records Administration—*DocsTeach*; and the Smithsonian Institution—*Access American Stories*.

Citizen-Oriented Apps in State and Local Government

Just like with the federal government, citizen-oriented apps are more prominent than enterprise-focused apps in state and local governments. The citizen-oriented apps could be classified into four categories:

- Apps providing information on parks, recreation, and leisure activities
- Traffic and transit information apps
- Public engagement apps
- Third-party apps for government

Apps Providing Information on Parks, Recreation, and Leisure Activities

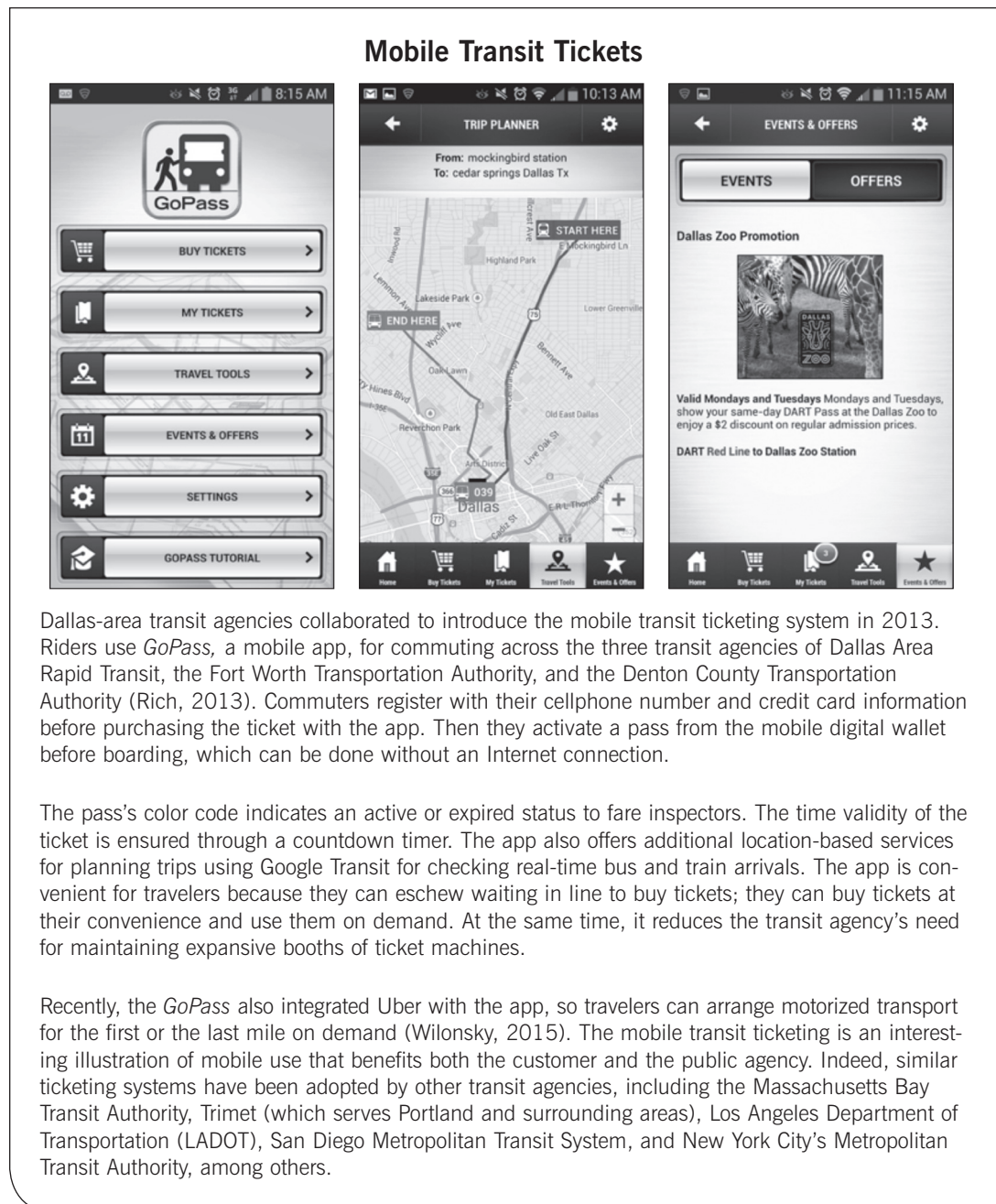
These apps are mainly oriented toward tourists, giving a background on the historical features of a place, directions, amenities, and a schedule of activities. Almost every state has an app focused on providing such information about state parks. The ParksByNature Network, for example, has developed official park guides for several states.

Citizen-oriented apps are also provided by local governments for guiding tourists (e.g., San Antonio Official Travel Guide), active recreation (e.g., Utah County *Trail Guide*, Summit County's *To the Trails*), and providing information on public art and spaces (e.g., Portland's Public Art PDX). Exceptional apps, however, combine QR codes and/or augmented reality for park visitors to enhance their park experience. The app for Camp Lawton, Georgia, is a good illustration. Visitors can scan QR codes of exhibits using a smartphone or tablet and get additional information, which includes multimedia presentations, interactive tables, and external links. The QR code can also be used as a waypoint system for park navigation, and to make a game out of the historical sites to improve the user experience (Lorenzi et al., 2014). Augmented reality is a technique by which virtual reality can be overlaid on the smartphone's visual display through the camera. Thus, using the smartphone camera, visitors can get a 3D

reconstruction of the Camp Lawton prison stockade situated in the real world (Georgia Department of Natural Resources, 2014).

Traffic and Transit Information Apps

The second category is traffic and transit information apps, which are commonly developed by state and local agencies. The state-level departments of transportation (DOTs) are vanguards of traffic and transportation information on state and other highways (Transit Cooperative Research Program, 2011). State DOTs have traditionally provided traffic information through the 511 systems; hence, they already have the data readily available to provide to customers. Indeed, in many states, traffic apps are called 511 apps (e.g., *Iowa 511*, *Kentucky 511*, *Minnesota 511*, etc.). Many county and city governments also feature similar transit- and traffic-oriented apps.



An innovative approach is to use mobile apps as a means of providing boarding tickets by public transit agencies. The mobile approach increases a transit agency's efficiency by reducing the need for installing and maintaining ticket booths for paper tickets; it also increases flexibility for the passenger to acquire and use the tickets on demand.

Often, transit apps are provided by third-party vendors, building on a city government's transit data feeds and APIs (e.g., Chicago's *TransitGenie*). The transit feeds are in a standard format—General Transit Feed Specification (GTFS)—used by Google Transit. The standardization has enabled third-party developers to create customized apps for the location. Portland's transit agency (TriMet), for example, showcases 56 apps that are developed using the agency's GTFS data. Additional creative endeavors include apps for custom travel such as Boston's *Where's My School Bus* app that helps parents track their children's school bus in real time. In addition, parking apps provide the ability to find the nearest parking facility and to pay for such facilities.

Public Engagement Apps

These apps have been developed both by public agencies and commercial vendors. The most common type of app in this category is related to 311, which is a centralized number for local governments to field non-emergency service requests (e.g., fixing a pothole or a streetlight). Over 300 local governments have such 311 centers. They are crucial one-stop service centers in large cities: New York City had over 28 million customer contacts through 311 in 2014. The service requests can be made electronically via mobile apps, social media, online chats, e-mails and text messages or via in-person visits and phone calls. The use of mobile apps has particularly grown with Open 311, a standardized protocol for customer service request data. Over 30 cities have adopted an Open 311 service. The Open 311 protocol has enabled the rise of third-party commercial vendors to provide "311 mobile apps"—including *SeeClickFix*,

311 Citizen-Oriented Apps for Public Engagement and Citizen Relationship Management

To report non-emergency issues:

- *Accela's PublicStuff*
- *CitySourced*
- *Connected Bits*
- *Fix311*
- *Qscend*
- *SeeClickFix*

Others include:

- *CityVoice*, a location-based call-in system for collecting, sharing and understanding community feedback
- *Citizeninvestor*, a digital platform that specializes in a crowdfunding approach to support government projects and engage its citizens
- *Streetmix* allows citizens to mock-up areas as future plans for city officials and planners
- *Textizen* and *YouTown* offer civic dialogue and customer relationship management-type digital platforms

PublicStuff, *CitySourced*—that could be used for making service requests from any location. Private sector vendors have contractual arrangements with cities that do not necessarily have 311 centers to make the online service requests (e.g., *SeeClickFix* serves 290 cities, *Accela's PublicStuff* about 200, *CitySourced* about 100 cities).

Third-Party Civic Apps for Government

Third-party apps are not produced by public agencies directly; they are location-based services that are useful for civic engagement and idea generation at the local level. Such apps are co-produced in conjunction with other citizen efforts. The availability of open data in some communities has spurred civic innovation by encouraging citizens and nonprofit groups to develop leading-edge mobile solutions. Several cities, such as Portland, New York, and Washington, D.C., have held civic competitions and challenges premised on the use of open data and APIs; the competitions yielded a wide range of innovative apps. Public agencies have also held civic hackathons where designers, data specialists, programmers, and project managers collaboratively work on specific thematic issues relating to the local government, drawing upon the agency's data. The hackathons are also supported by social enterprises such as Code for America, MindMixer (now mySidewalk), and Open Knowledge Foundation. Code for America Brigades are local volunteer groups that bring together community members to solve local issues using technology. Although creative, the principal limitation of hackathons is that the solutions are not sustainable without continued support (Gordon-McKeon, 2013; Schrier, 2013). Solutions need to be useful to the local governments, and the civic groups need to provide continued support. Code for America has catalogued about 30 apps for local services and civic engagement.

Local governments could also take advantage of commercial location-based services to provide innovative value-added services. San Francisco and New York began collaborating with Yelp in 2012 to put the safety inspection ratings of local restaurants on its mobile platform; Los Angeles, California; Evanston, Illinois; and Raleigh, North Carolina have also followed up to post their restaurant safety inspection scores on the *Yelp* app (Hickey, 2015). A collaboration among these communities resulted in Local Inspector Value-Entry Specification (LIVES), an open data standard for municipalities to publish restaurant inspection information. The data standardization has since helped spur additional apps for food safety in public eating places using inspection data. The *HDScores* app provides restaurant scores in 27 states, and the *What the Health* app grades restaurants in 10 states (Shueh, 2015).

Some social networking groups are geographically organized, which could benefit the local community and their public agencies. Nextdoor, for example, is an online platform that provides services to neighborhoods that are organized geographically (there are over 54,000 such neighborhoods). Only verified residents within specified neighborhood boundaries can view Nextdoor postings. Over 750 local government agencies, such as police, public works and utilities, provide community-specific information with the online neighborhoods. Location-based social media engagement also provides information that is critical for law enforcement and public safety purposes (Crump, 2011; Grimmelikhuijsen and Meijer, 2015).

The Road Ahead for Citizen-Oriented Apps

Increased Support of Citizen-Oriented Apps to Enhance Public Services

Government agencies should assist in developing and supporting citizen-oriented apps that enhance the public services they provide. Mobile access to the service provides an added convenience to citizens. Providing a service through multiple channels has the potential to reduce an agency's administrative burdens, as online transactions can result in cost savings for an

agency. With mobile phones reducing the digital divide, smartphones can potentially be used to serve different socio-economic segments in society. Minority and low-income individuals depend on smartphones for their Internet access, which raises the prospects of smartphone use for e-benefits, healthcare, social security, and other services. With their deeper penetration into the market, smartphones can be effective devices for real-time public engagement in order to inform government policy and decision-making processes. Crowdsourcing can assist in gathering valuable information that a public agency would have otherwise spent resources to obtain.

Many state and local governments have begun to use smartphone apps to provide innovative services. Transit agencies, as we reviewed in this report, are using apps in place of issuing paper tickets to commuters. Utah launched the *Utah Hunting and Fishing* mobile app in 2014 for obtaining licenses. It allows citizens to purchase, download, store, and display hunting and fishing licenses for game wardens from a mobile device. The app has been downloaded by nearly one-third of the total licensees in the state. Mobile phones are evolving into a personal credential (using digital wallets such as Apple Pay or Google Wallet). States including Alabama, Delaware, California, and Iowa have begun, or are in the process of, implementing the use of smartphones as a form of personal identification (Marshall, 2015; Whitney, 2015).

Increased Embedded Approach for Citizen-Oriented Apps

When using apps to provide citizen-oriented services, public agencies should take an embedded approach by providing a service contextually. Typically, citizens do not use government apps to the same extent as their personal apps for social networks and other forums. Yet, when citizens do need a government service, they need ready access. In the embedded approach, a public agency would embed its service in conjunction with other services already being used by citizens. The emphasis is on the service to be provided, rather than the organization that is the provider. For example, the Dallas DART transit system and Uber have joined together to provide access to Uber reservations in conjunction with DART's transit *GoPass* mobile app.

Public agencies can similarly collaborate with other private and public agencies to embed their services synergistically. Zillow, for example, offers a popular real estate app for finding homes. However, while finding the home, citizens may also look for additional information, such as local school quality, crime rate, demographics, amenities, etc. Public agencies can embed the data with popular apps in order to deliver value-added information requested by the citizens.

Increased Availability of APIs for Third-Party Citizen-Oriented Apps

APIs advance the layering concept to provide information in context. Providing APIs is another frontier of the mobile app development. They are standard protocols for accessing data from an external source (i.e., the public agency). Using an API, an app can dynamically query the external dataset. The public agency needs to assign a key for the app to access the data. Along with open data, public agencies have also stepped up to provide their own APIs. There is significant growth potential for the APIs as public agencies begin to provide the data. Federal agencies are required to provide access to their data through APIs, and state and local government agencies can also provide access to their data through APIs. APIs offer an unobtrusive way for the public agency to provide the data and service.

Making available APIs for agency data would help leverage citizen co-production of civic apps. Citizen co-production is key to building the value-added services. Innovation in mobile apps has been spurred by citizen co-production, which harnesses creative ideas for innovative apps. Public agencies have developed citizen-oriented apps through challenge competitions, hackathons, and other creative mechanisms. The U.S. Census Bureau's City Software Development Kit (CitySDK) is a good illustration of how APIs provide value-added solutions. The CitySDK Data Solutions Challenge (conducted during the time of this writing, June 6 to August 3,

2015) was an open civic challenge to create an app prototype using the Census Bureau's APIs for its data to improve local city conditions (e.g., economy, environment, housing, education, social justice). CitySDK featured guides for using the data and a gallery of datasets besides the Census Bureau's, to which participants can link. It also held a *Hack for Diversity and Social Justice* hackathon in Baltimore. The project was hosted on Github, an open source platform. Over 20 teams participated to provide creative solutions to local issues. Nonprofit organizations such as Code for America and Sunlight Foundation have supported similar hackathons that have resulted in apps for government transparency (e.g., following government spending, tracking bills), economic development, environment, and so on.

Mobile App Design Considerations

Three Types of App Design

In developing mobile apps, the type of device (wearable, mobile phone, or tablet) is a primary consideration. App security and user interactivity vary with the devices. App security is a fundamental concern for public agencies. It is further complicated by BYOD arrangements, which allow government employees to use their personal devices for work purposes. These devices require enterprise-level security, at least for the enterprise-focused apps installed on personal devices. User interactivity is also different with the devices. Unlike the smartphones' *mobile* moments, wearables like watches are characterized by even briefer *glanceable* moments (Schadler, 2015).

Smaller devices allow greater portability, but have limited screen space for presentation and user interaction. Wearables are appropriate for personalized user-based needs, such as information updates, biometric readings, and location-based activities in real time and can be adapted based on user's role and goal. Smartphones are used for a range of communications and social networking activities, including location-based services. Both smartphones and tablets have become useful devices for performing field-based activities (e.g., law enforcement, code enforcement, etc.). Intermediate devices such as "phablets" bridge the functionalities across smartphones and tablets.

Apps have to be customized to the specific features of the various devices. Because operating systems vary among mobile devices, the same mobile app may not work across the different systems; different versions of an app need to be developed for each system. Interoperability of apps across different devices and apps poses a major concern. Customization of apps for each device increases development costs; user experience could also vary across the devices. The problem is allayed to a great measure with responsive web design, by which the same content can be adjusted for display and interaction across different devices. Technologically, the responsiveness is enabled by using HTML5 (a version of hypertext markup language), in combination with Cascading Style Sheets (a formatting style for presentation) and Javascript (executable programs within HTML files for interactivity).

Three types of apps have evolved from a software perspective: native, web, and hybrid (Crowe, 2013; Heitkötter, Hanschke, and Majchrzak, 2013).

- **Native apps** are device-specific, they are downloaded onto the device and take the maximum advantage of the device's hardware features (e.g., camera, etc.). Apps are hosted on one of the app gateways for download. They are technically complex, because the apps need to be customized to each different mobile operating system. Because the apps reside on the device, they could function offline.
- **Web apps** are websites using responsive web design (i.e., HTML5) features, so that the same web app can be optimized and accessed from different types of devices (e.g., the user interface will change based on the device). Web apps do not require customization, as

they are not specific to an operating system (“develop once, run many” apps). As a result, the development of web apps costs less than native apps. There is no requirement to have an app gateway, since the web apps are not downloaded and installed onto the device. Web apps must be accessed over the Internet; hence, an Internet connection is necessary. They, however, may not take advantage of all the features of the mobile device.

- **Hybrid apps** combine the features of native and web apps (Barney, 2009). Like native apps, hybrid apps are accessed through the app gateways and installed onto a device. However, these apps are developed with cross-mobile device features, so that the apps can work across different platforms. Cross-device compatibility is enabled by the web app features of HTML5. APIs allow access to a device’s specific features. Hybrid apps are often conflated with native apps, because they are made available through an app gateway as well.

Which Type of App Should Governments Develop?

As there are no clear guidelines on which type of app to develop, public agencies undergo a learning process as they adapt to the mobile environment. Mobile devices have also been quickly evolving, so guidelines can hardly be static. Yet, it would be strategic for agencies to consider a few key criteria in the app development process. These are:

- Task complexity
- Frequency of app use
- Security
- Interoperability
- Integration with mobile’s hardware features
- Need for Internet connectivity
- Total cost of ownership

Table 1 summarizes the major elements of these considerations.

Table 1: Criteria for Considering Type of App

	Native app suitable for:	Web app suitable for:	Hybrid app suitable for:
Task complexity	Very complex tasks	Moderately complex tasks	Very complex tasks
Frequency of use	Very frequent use	Occasional use	Very frequent use
Security	Device-level security	Server-level security	Device- and server-level security
Interoperability	Device-specific use	Device-agnostic use	Device-agnostic use
Hardware integration	Full device feature integration	Very little device feature integration	Partial device feature integration
Internet connectivity	Use without Internet connection	Use with Internet connection	Partial use without Internet connection
Total cost of ownership	Lower costs with device-specific use	Lower costs across different devices	Lower costs across different devices

Task complexity. Task complexity relates to the time and intensity of human interaction with a device for completing a task. Simple tasks (e.g., information updates) require minimal time and device interaction. Moderately complex tasks require more time and device interaction (providing inputs on forms). Very complex tasks require longer time and involved device inter-

action (e.g., creating or editing a document, multimedia, etc.). Users could switch devices when carrying out more complex tasks. According to Gartner (2014), when conducting online activities, the “smartphone [use is] first as a device that is carried when mobile, followed by the tablet that is used for longer sessions, with the PC increasingly reserved for more complex tasks.” Simple information updates (e.g., status of IRS filing, a license application, etc.) could be sent as a message on a wearable or mobile phone. Enterprise-focused apps have a high-to-moderate level of task complexity and are often native or hybrid apps (e.g., field tasks), ideally used with tablets. Customer apps for moderate-to-simple tasks could be implemented as web apps (e.g., forms).

Frequency of app use. Users are typically constrained by a device’s available memory for downloading and storing apps. A user is unlikely to download apps that are not frequently used. If not useful or helpful, an app is deleted eventually (Purcell, Entner, and Henderson, 2010). Native and hybrid apps, which require downloading and memory space, would be appropriate for frequently used apps. Enterprise-focused apps used by employees on a regular basis for fulfilling specific tasks lend themselves to such native or hybrid apps. Web apps do not require downloading and can be used by an infrequent user who needs the service occasionally.

Security. The ability to control security features differs among apps. Native and hybrid apps are installed on the device. App security is device-centric and security updates depend on the device user. Native enterprise-focused apps, however, require enterprise-level security. Hence, a public agency needs enterprise-level security management that is enforced through a mobile application management process. Since web apps are accessed online and not installed on the device, their security can be implemented at the enterprise level (i.e., a web server).

Interoperability. Citizens seeking public services use a range of different mobile devices to access them, including desktop and laptop computers. Customer service apps thus need to be interoperable across a range of devices. Web apps provide a great deal of interoperability in this context. Public agencies that have BYOD schemes also cannot control employees’ devices. While the BYOD schemes allow employee flexibility, the enterprise-focused apps would need to function across the devices. Enterprise-focused apps requiring flexibility could be web or hybrid apps. However, certain specialized enterprise-focused apps requiring high levels of security are designed for specific platforms; employees need to use agency-issued devices for accomplishing a task.

Integration with the mobile’s hardware features. Mobile devices are equipped with a range of hardware features, such as the camera, GPS, and accelerometer (to sense movement and tilt of the device). Smartphones take advantage of voice commands and functions. Devices are also increasingly equipped with Near Field Communication (NFC), which is used for contactless transactions (e.g., mobile payments) and access control. Native apps developed for specific devices could take advantage of these mobile hardware features for value-added functionality. Web apps do not have the same degree of capacity to use hardware features. Hybrid apps provide an intermediate method for using device-specific features and maintaining flexibility.

Need for Internet connection. Because native apps are installed onto a device, they do not need Internet connectivity for their functioning. They can function offline, so they can be used in places with limited or no Internet connections. Enterprise-focused apps lend themselves to native apps, as they can be used in the field where the Internet cannot be accessed. Hybrid apps and web apps typically require an Internet connection for them to function, although HTML5 allows a greater degree of offline capacity.

Total Cost of Ownership. The total cost of ownership refers to the comprehensive costs of apps over their lifetime of use, which include the production costs, operational costs (e.g., security, maintenance, and updates), software and hardware (e.g. servers) costs, and user training and support costs. Native apps typically incur more production and operational costs than web apps, especially since they need to be customized to the devices. The higher costs of native apps may be justified for enterprise-focused apps where the organization can control the devices (and involve complex tasks). The web apps could be appropriate for citizen-oriented apps, where the citizens could use different types of devices. Similar tasks may incur comparable software and hardware requirements to support the apps; hence, such costs may not vary much across native, web, and hybrid apps. User training and support would be required especially for enterprise-focused apps in the initial stages; citizen-oriented apps may not require similar intensity of user support.

Federal, state, and local government agencies have developed all three types of apps. As mobile devices diversify, however, apps need to be responsive to the devices, providing specific on-demand services that are suited to individual users. In such a context, public sector agencies need to adopt mobile apps in a strategic way. Broadly, from an organizational perspective, apps need to assist in fulfilling an organization's mission more effectively and efficiently. From a user perspective, the apps need to be contextually useful and helpful in fulfilling a task. Government agencies are typically the only source for key citizen services such as licenses, benefits, social security, etc. Citizens benefit when services are provided through multiple channels. Online transactions benefit agencies through costs savings, improved speed in delivery, and greater accuracy.

The Road Ahead for Mobile App Design

In the future, organizations should also consider the impact of the Internet of Things in general, and mobile in particular, as part of organizational transformation. The rapid growth of sensors and machine-to-machine connections will have an impact on organizational routines. Just as electronic government initiatives streamlined routine jobs, organizations should continue streamlining field processes. At the base level, mobile will replace paper-based processes in the field. At a more advanced level, mobile will further blur the distinction between back-office operations and front-line field activities.

Federal agencies are already poised for mobile optimization in terms of adopting responsive design features, because recent federal policies require all new online offerings to be mobile optimized. Recent organizational initiatives within GSA (such as 18F and Digital Government) provide support structures to federal agencies in adopting mobile-centric features. State and local government agencies are also on an evolutionary path toward adopting the mobile environment. For example, the state of Utah, which provides an exemplary model for state governments, has explicitly adopted a "mobile first" strategy and made responsive web design the default.

Recommendations for Government Mobile Apps

Recommendation One: Optimize Online Services for Mobile Devices

Government agencies at the federal, state, and local levels should strategically assess their existing online offerings and engage the public in identifying those which would be most valued on various mobile devices. Smartphones are ubiquitous; tablet penetration is also increasing; and wearables like the Apple watch and Google Glass are the next frontier. Each of these devices has its strengths and limitations. People spend much time on their smartphones, but in a series of brief mobile moments. Each mobile moment is critical to shape consumer decisions and preferences instantaneously (Forrester Research, 2015). Smartphones are used for social networking, communications (e-mail, text, video, chat), online searches, and following news (Smith and Page, 2015). Wearables are used for even briefer glanceable moments. Tablets lend themselves to more complex tasks that require longer engagement. Public agency online offerings need to be sympathetic to the use and capability of the devices. Furthermore, with smartphones reducing the digital divide, it is even more imperative that public agencies use mobile devices to offer appropriate services to meet the needs of different population groups. In adopting a mobile-first approach, organizations should optimize their online content offerings, interactions, and transactions for mobile devices.

Mobile optimization implies that agencies use responsive web designs to make their online offerings mobile friendly. Responsive design allows for the same content and service to adjust to the different modes of human interactions with the devices. Reading content or watching video on a computer and a smartphone has distinctively different experiences. With the high use of smartphones to access the Internet from anywhere, it is imperative for public agencies to respond. Google⁷ and the W3 consortium⁸ provide methods to verify the mobile friendliness of a site. Wearables lend themselves to short messages that require instantaneous action in a specific geographic location.

Recommendation Two: Provide Open Data Based on Common Standards

The core strength of a public agency is its data. Public agencies are typically treasure troves of data that they collect from their customers or to meet their mission. At the same time, government data are public data that should be in the public domain. The open data movement has gathered much momentum in the United States across federal, state and local agencies. Federal policy requires that all federal agency data be open by default and provided in machine-readable format. State and local governments make their data available through their portals. Proactive open data policies are useful, because these data do not have to be obtained through requests under the Freedom of Information Act (FOIA). More

7. <https://www.google.com/webmasters/tools/mobile-friendly/>

8. <http://validator.w3.org/mobile/>

importantly, making government data available publicly has broader social benefits. Data can be the foundation of socially useful apps. As of mid-2015, the federally sponsored data.gov portal catalogued over 158,500 datasets from federal, state, and local government agencies.

While the open data movement is commendable, public agencies also have to move to the next phase of providing data in useful formats based on common standards. Standards-based approaches that are adapted by government would ensure that data are of high quality that can be used reliably for analysis. The quality of data can be partly ascertained from metadata. Metadata includes information about elements that describe the data (e.g., title, abstract, author, and keywords), structure of the data, and administrative aspects (e.g., version, rights, preservation) of the data. Technically, standardization facilitates interoperability of data across different platforms. Standardization is useful for further development of mobile apps, since external users can access data through APIs. While there are different formats of data, JSON has become a popular format for publishing the data; XML and CSV formats are also often used. These machine-readable formats are more valuable than data made available in other forms (such as .pdf files) that are not amenable to reliable machine reading.

Recommendation Three: Assess Feasibility of Standard Data Structures Across and Within Agencies

While technical standardization is important for interoperability, the more fundamental issue is to create a standardized *structure* of data. For example, government budgeting and financing is an important aspect of government transparency. Budgeting and finance data would be useful for analysis if data were available in a standardized structure across different jurisdictions and over time. The eXtensible Business Report Language (XBRL) provides a standardized structure by which business and financial information is reported by public agencies. The Federal Bureau of Investigation's Uniform Crime Reporting and the North American Industrial Classification System (NAICS) are other illustrations of how crime and industrial data are structured. Making data available in structured formats enables them to be used for apps across different agencies. Crime mapping apps across jurisdictions are typically based on FBI UCR standards. Similarly, economic development apps analyzing industrial trends use NAICS standards.

Reviewing whether or not to standardize the data structure across different agencies is arguably the next big step for government data. Even though the federal government has established standards in the aforementioned areas within agencies, there is considerable scope for standardizing data structures across agencies. For example, the U.S. Census Bureau (2013) acknowledges, "Lack of Census Bureau-wide standardized data creates challenges for comparing and integrating domain data across different surveys and censuses, impedes streamlining the survey line and producing new data products." The Census Bureau is the principal source of demographic and economic data for the country. Several mobile apps use census data, and making this data available in a standardized structure would jumpstart a range of apps that give historical and comparative analyses.

Two examples, one each at the state and local government levels, help to further illustrate the significance of standardization of data structures across levels and units of government. At the state government level, the emergence of the Local Inspector Value-Entry Specification (LIVES) is significant for apps to provide value-added service. LIVES was the result of the collaborative effort of Yelp and the cities of San Francisco and New York, in order to put the health ratings of the restaurants on the *Yelp* app. LIVES describes a standardized data structure for how

states and municipalities should publish restaurant inspection information.⁹ LIVES helped add value to the *Yelp* restaurant locator service, because users can now view a restaurant's health inspection grade before choosing a restaurant. As more states adopted the standard, LIVES spurred additional apps for food safety, such as the *HDScores* and *What the Health* apps (Shueh, 2015).

At the local government level, the General Transit Feed Specification (GTFS) has become an important standard for transit agency data feeds. The GTFS was an outcome of the partnership between Google and Portland TriMet in 2005 to standardize transit data (McHugh, 2013). The GTFS provides a standard format for public transportation schedules and associated geographic information (e.g., stops, timing, etc.).¹⁰ The information is provided in the CSV format. Over 900 transit agencies have adopted the standard since then. Transit apps also take advantage of the standardized data structure. Similar standardization of data across other public agencies would jump-start further value-added apps.

9. See <http://www.yelp.com/healthscores> for the specification

10. See <https://developers.google.com/transit/gtfs/?hl=en> for the standard

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Dr. Ganapati obtained his PhD in Planning in 2003 from the School of Policy, Planning, and Development at the University of Southern California. Before he joined FIU in 2004, he taught at California State University, Northridge; California Polytechnic State University, Pomona; and University of Southern California, Los Angeles.



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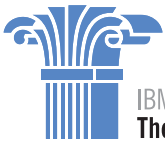
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