IT@Intel White Paper

Intel IT
IT Best Practices
Cloud Computing and Compute Continuum
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Building a Mobile Application Development Framework

Executive Overview

Intel IT created a mobile application development framework—a set of specific capabilities, tools, and resources that together enable mobile applications to be successfully planned, developed, and delivered into production. This framework augments Intel's existing approach to IT projects and standards to fully support the development of mobile applications.

With our framework, Intel's development teams can evaluate the suitability of mobile applications for mobile use cases, follow governance standards, and identify the correct project deliverables for mobile deployment.

We created this framework in response to Intel's employees' expectations to use mobile devices, such as smartphones and tablets, to access web-based and native line-of-business applications in the corporate environment. And, like users everywhere, Intel employees want both mobility and usability.

Until recently, project teams have developed applications primarily for Windows*-based PCs. Now with our mobile application development framework, Intel's development teams can more easily accomplish the following:

- Evaluate the suitability of mobile applications for mobile use cases
- Follow governance standards
- Identify the correct project deliverables for mobile deployment

The framework includes a decision matrix that explores questions relating to application content, existing user base, use cases, and costs. The matrix helps application development teams establish the business value of mobile development.

After completing the framework, Intel IT deployed a number of mobile enterprise applications, including customer relationship management, social media, travel tools, and a paystub application. We are currently developing and deploying several more applications, such as online collaboration and document sharing, factory worker applications, facility services, and expense reporting. We anticipate extending the mobile application development framework to include new devices and new capabilities, supporting Intel's vision of a compute continuum model of seamless, consistent experience across devices.

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BUSINESS CHALLENGE

At Intel, we have thousands of existing PC applications, and new PC-focused applications are continuously being developed. In contrast, we have developed only a small number of applications for mobile devices. Actively supporting the consumerization of IT, we recognize the business value of letting employees select the form factor they need to accomplish certain tasks—thereby increasing employee productivity as well as job satisfaction. Our security model protects Intel's intellectual property (IP) and infrastructure while still providing Intel employees with a broad choice of mobile devices.

Currently, Intel enterprise applications are generally targeted to Microsoft Windows*-based laptops with 15-inch screens and one primary screen resolution for web-based application delivery. Although existing application development guidelines prompt developers to verify the compatibility of their solutions with different browsers, we now needed to extend the compatibility concept so developers also consider OS versions and form factor levels.

Our goal is for many applications to be available and usable on mobile devices as well as on laptops, but we have found that not all applications are suitable for mobile deployment. As we worked to expand the availability of mobile applications, we found we needed a reliable way to decide which applications and individual functionalities made most sense to mobilize and would deliver value on a smaller device.

In our experience, the key attributes of applications benefitting from mobile delivery include the following:

- Provide support for tasks using a small number of steps and real-time action requirements
- Offer critical status updates

Because we support multiple mobile OSs, our mobile application development landscape is complex: each mobile OS has its own security features, hardware, and other unique capabilities that affect application behavior and performance. Applications must also work well on smaller screen sizes and different screen resolutions, with varying connectivity models and speeds.

Developing mobile applications represents major changes in both technical skill sets and in the approach to balancing functionality and usability. Application developers must be aware of the differences between mobile OSs, able to perform cross-platform development with ease, and adept at developing for varying screen resolutions and taking advantage of device-specific features such as device sensors and touch screens, while adhering to mobile standards.

Other areas of consideration during application development include:

- Understanding that designing for simplicity and usability are key factors
- Choosing an appropriate application deployment method, such as platform-independent HTML5 or platform-dependent native coding
- Understanding mobile security issues, including portals, gateways, mobile virtual private networks (VPNs), and one-time passwords
- Determining the user base for each mobile OS
- Following established governance, path to production, and deployment models

We needed a way to communicate with and support Intel's application development teams—both within Intel IT and in other business groups—in order to raise awareness about the importance of targeting mobile devices and to foster effective code development skills for mobile devices. In this way, teams—which include project managers, analysts, developers, and business

stakeholders—can initiate projects by using established best-known methods.

Beyond initial application development, we also needed to implement changes to other processes associated with the project life cycle (PLC), including testing and quality assurance, support, and deployment and distribution, because aspects of these processes are different for mobile devices, compared with desktop or laptop PCs.

SOLUTION

Intel IT created a mobile application development framework—a set of specific capabilities, tools, and resources that together enable mobile applications to be successfully planned, developed, and launched. This framework augments Intel's existing approach to IT projects and standards to fully support mobile application development.

Our ability to build such a framework depended on having several IT infrastructure prerequisites in place, as well as having a thorough understanding of the mobile application development process. Then after the framework was completed we needed to encourage developers to use it.

Prerequisites for Mobile Application Development

We found that properly addressing security and legal challenges added a layer of complexity to delivering applications in the mobile space, which many enterprises may not have considered. Not only was it necessary to learn how to use a significant amount of new technology, but because most of the mobile devices in use at Intel are personally owned, it was also critical that we balance Intel's legal requirements to protect IP with our employees' right to privacy and respect their rights to choose which enterprise services to use on their devices.

Before we began work on the framework, we also identified the following prerequisites:

- **Strong demand.** We needed to demonstrate sufficient demand for mobile applications and a critical mass of devices. At Intel we currently support about 33,000 mobile devices, and most existing mobile applications are approved for use with two of the five mobile OSs we support. We expect the number of mobile devices to continue to grow, especially as new solutions are approved for use with additional mobile OSs. Therefore, investing in mobile application development has the potential to provide a significant return on investment (ROI).
- **A solid foundation.** For Intel IT, as for most IT shops, our starting point for delivery of mobile applications was a mechanism for delivery of push email, calendar information, and contacts. We focused on these in the early phases of our integration of mobile devices into the enterprise architecture.
- **Mobile device management.** We initially used a secure container to deliver services such as email and calendar. As our solutions matured and platforms became certified for use with a mobile device management (MDM) solution, we then replaced those containerized solutions. Now we use MDM to deliver services and push security policies to mobile devices.
- **Service-oriented architecture (SOA).** Our mobile application development activities depend on effectively implementing SOA because mobile applications access business logic and data through an abstracted service layer.
- **Adequate security.** For secure delivery of mobile applications, we needed the ability to encrypt data in transit and to develop web portal gateways for mobile devices. We have also significantly redesigned our security model to support non-IT managed systems.

Mobile Application Development Process

We employ a two-step process when developing a mobile application.

1. We use a defined decision matrix to first determine whether the application is a good candidate for mobile development.
2. We then determine how the application should be delivered.

IDENTIFYING APPLICATIONS SUITABLE FOR MOBILE DEVELOPMENT

Our decision matrix helps establish the business value of mobile development. By asking key questions, the matrix helps identify applications that are task-oriented and specific in nature—functions that on-the-go employees need. Because it is not generally feasible to port every application capability to mobile devices, we focus on defining the appropriate use cases, optimizing the user experience, and addressing connectivity and security requirements.

The following sections describe our mobility development decision matrix.

Case

The project team examines whether there is a use case for having the content on the target device. For example, if the application manipulates large amounts of spreadsheet data, it might make more sense to target a tablet instead of a smartphone. Through thoughtful analysis and business process optimization, developers can design and develop an optimal user experience that leverages device capabilities while providing a familiar user interface.

Employees use PCs and small form factor devices in different ways. In our experience, applications that enable small tasks or key updates to be performed within a short time period, such as while walking to the next meeting or waiting in line, are the best targets for mobile deployment. In many circumstances, this means that not all functionalities of

a legacy enterprise PC application will be reflected in its mobile application.

Consumer

The project team determines whether a substantial user base already exists on the target platform, which helps to define which platforms and deployment methods make the most sense to develop. The mobile development analysis should also determine if there is a currently deployed base of devices as, for example, in a factory environment that has chosen to limit mobile devices to a single device.

We also encourage project teams to ascertain the likeliness of the targeted user base to use a particular mobile application. In general, as a result of Intel's Bring-Your-Own-Device (BYOD) initiatives, we've found that eventually there is a sufficient user base for most mobile applications.

Content

The project team determines whether the application is supported by existing services such as authentication and device management. The team also determines whether the application can be transferred to a mobile device without adversely affecting the device's performance and user experience. These concerns can arise when converting legacy applications or off-the-shelf solutions that do not have previously published mobile services.

Scope and Cost

Much of the work in building a mobile application exists outside the boundaries of developing a basic desktop or traditional browser-based solution. To successfully develop a mobile application, project teams need to expand project scope and consider the additional costs of including SOA efforts, the extra support necessary for possible multiple interfaces, and appropriate team training. Project teams must calculate the ROI for the mobile application to determine whether there will be sufficient use of the application to warrant its development.

DECIDING ON A DEPLOYMENT MECHANISM

Mobile applications can be deployed several ways. Figure 1 summarizes our available deployment mechanisms and outlines their advantages and disadvantages.

Whenever possible, we prefer to deploy applications using either a hybrid combination of native HTML5 code and web browser or the web browser. Our goal is to use these deployment mechanisms for about 80 percent of mobile applications.

Other deployment options are mobile native, using a Mobile Enterprise Application Platform (MEAP); and a virtualized deployment mechanism for some applications, especially those needed within a short time frame. Our goal is to use these deployment mechanisms for about 20 percent of mobile applications.

Intel's current strategy is to support all these deployment mechanisms for mobile development, depending on business need and targeted device. For example, if the factory decides to use only a single tablet model,

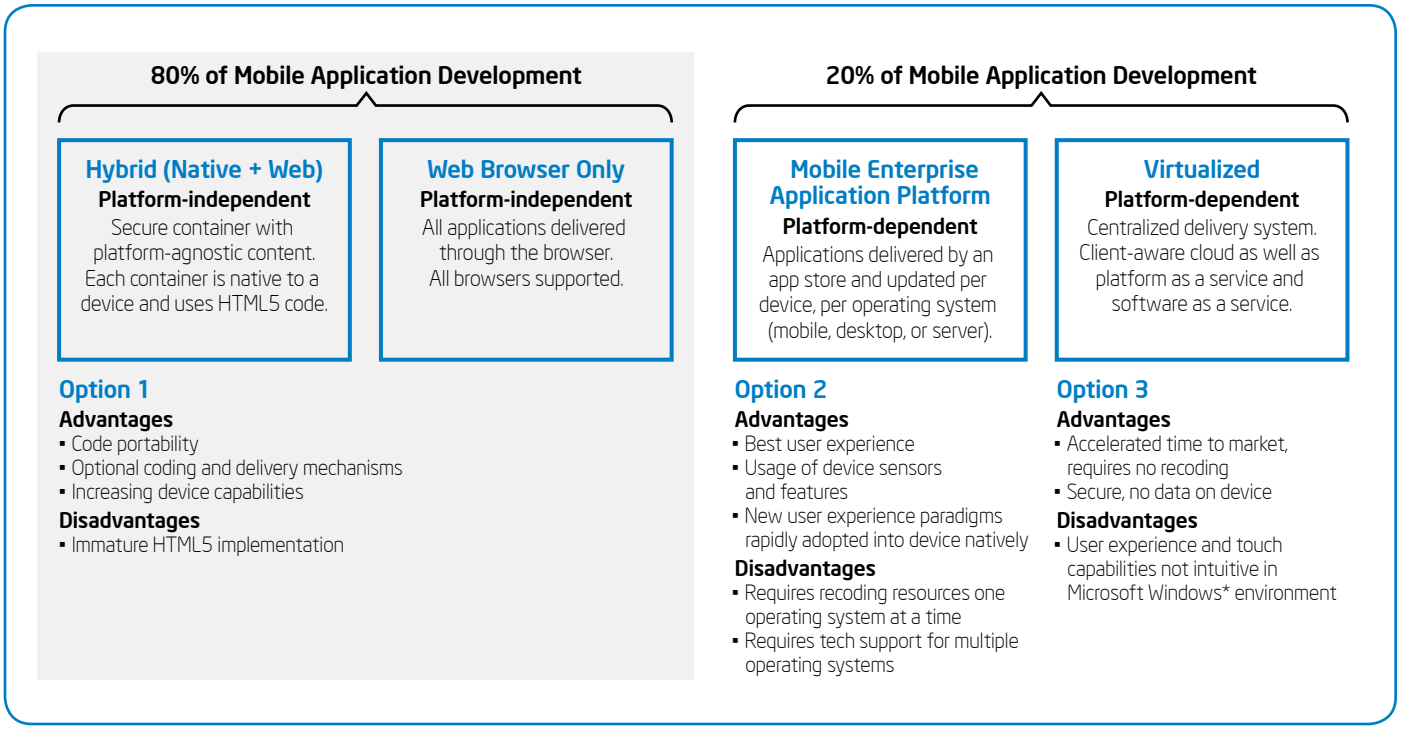

Figure 1. Mobile application deployment mechanisms are determined by business needs and targeted devices.

MEAP may be the best deployment method, because there is only one platform to target and support. However, if an off-the-shelf application is not available for a particular OS, virtualization may be the best approach.

TRANSITIONING TO THE END STATE

Because Intel is targeting more than one mobile device type and mobile OS for application development and deployment, we need to carefully plan our building blocks and recommended options. We want the end result to be a flexible and versatile mobile ecosystem that adds business value. But enabling that robust mobile ecosystem takes time.

To expedite our implementation of mobile application development, we took some informed risks. We knew that employees tend to prefer an optimal user experience over extended capability, but we sometimes found it necessary to launch an application or piece of infrastructure before it was 100 percent ready, while continuing to work on an improved version for a later release. For example, a virtual session might be temporarily needed to run some applications while a more user-friendly approach that provides better performance without sacrificing security was developed.

We also took this incremental approach with infrastructural items such as VPNs, realizing that current functionality, although not perfect, enabled us to move toward better solutions.

Using this approach led to the following outcomes:

- Employees could use social media, such as discussion forums, and surveys to articulate the functionality they wanted in a particular application.
- Application owners realized that the demand was high enough to warrant making their applications user-friendly for mobile users.
- We used these early projects to validate the infrastructure components and generate excitement for mobile applications among developers and users.

We also conducted pilot projects that explored the effectiveness of the mobile application development framework so that developers could provide feedback about what guidance worked best. This enabled us to improve our framework before opening its use to a wider number of developers.

How the Mobile Application Development Framework Works

The mobile application development framework is designed to outline development options, provide guidance on choosing which options and approaches to use, encourage use of a governance process, deliver the technical IT building blocks required, and provide structure and assistance in using those building blocks.

By using the framework, projects can better adhere to standards and best practices, helping to deploy applications faster and thereby helping to increase business velocity.

As shown in Figure 2, the mobile application development framework provides the following:

- **Guidance documentation.** Offers technical and project management tasks to help project managers and developers understand how mobile applications differ from traditional applications.
- **Enabling capabilities.** Includes new infrastructure building blocks that enable mobile devices to connect to the enterprise services and the applications running on them to take advantage of network resources.
- **Supporting resources.** Provides access to various groups and resources that can help navigate the unique aspects of developing for the mobile environment. Examples include specialist developers who can provide assistance with mobile application development, external suppliers, and engineering roadmaps and hardware for testing.

GUIDANCE DOCUMENTATION

Intel's mobile application development framework provides five documents that help application developers successfully develop mobile applications with the highest possible business value.

- **Governance.** Describes the existing processes and approval gates that must be navigated to get a mobile application to production.

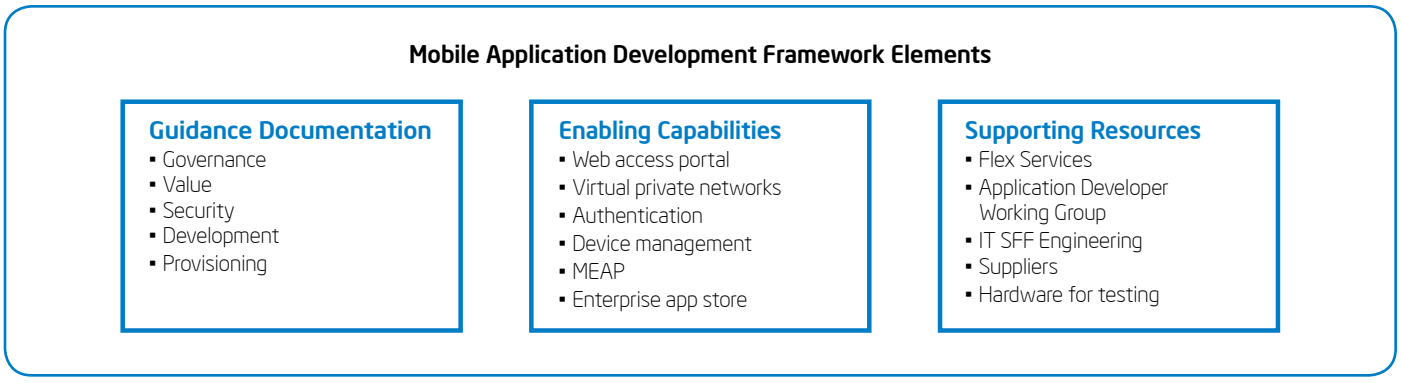

Figure 2. Mobile components and building blocks complement our existing IT processes and standards.

- **Value.** Describes the internal mobile markets, their segments, and other elements to consider when determining the value of a project.
- **Security.** Defines specific and mandatory security policies that must be followed to ensure success. This includes the data classifications, how to authenticate users, and how to obtain access to data and services through the firewalls.
- **Development.** Covers the high-level concepts to consider when designing a mobile application, such as which OS to target and which deployment mechanism to choose.
- **Provisioning.** Explains how a mobile application and subsequent updates can be delivered to devices using an app store and device management capabilities.

ENABLING CAPABILITIES

We provide six IT mobile building blocks that support efficient mobile application development.

- **Web access portal.** This is the gateway capability that is hosted in the demilitarized zone (DMZ). It allows authenticated trusted devices to obtain access to a list of predefined mobile applications.
- **VPN.** The VPN has a client-side software capability that directly interfaces with a gateway in the DMZ, authenticating the user and encrypting all network traffic between the device and the gateway. This allows web services on the network to be utilized by client devices in a secure manner.
- **Authentication.** Depending on the data being accessed, various levels of authentication are required. Both the VPN and web access portals verify user identity.
- **Device management.** Some devices must be registered and managed by the MDM solution in order to receive certain services, although not all devices must be registered, and not all services require registration. We automate the determination of how much MDM is required so developers can focus on other aspects of application development.
- **Enterprise app store.** Our mobile app store interfaces with the MDM solution to allow users to download applications. The MDM solution enables us to provision device profiles and certificates, and install client applications. One of the profiles delivers access to an Internet portal gateway that shows a list of web resources available to the user. There are a number of web applications available in this portal, in addition to the available client applications.
- **MEAP.** This middleware capability consists of multiple components on the infrastructure side and also has a client component that interfaces with the infrastructure. The advantage is that applications can be delivered to any client supported by the client component without having to develop for multiple OSs.

SUPPORTING RESOURCES

Intel has a variety of resources to help application project teams connect with peers in the development world to share information and best practices, and to help expand their skill sets.

- **Flex Services.** This Intel group is a global pool of specialist developers that provide assistance with mobile application development.
- **Application Developer Working Group.** This is a weekly forum, with membership across all major IT organizations, using a wiki to communicate content useful to development teams.
- **IT Small Form Factor (SFF) Engineering.** This group is responsible for some of the capability building blocks and can usually help with hardware for testing.
- **Engineering roadmaps.** This resource enables developers to view the current state of various projects and plans, as Intel's mobile development ecosystem continues to evolve.
- **Suppliers.** Many suppliers are willing to help Intel's application developers with specific concerns. The SFF Engineering team can provide contact information to connect directly with suppliers.

Access to these supporting resources can be found on various web sites.

INTEGRATING THE FRAMEWORK WITH INTEL'S PROJECT LIFE CYCLE

The mobile application development framework is integrated with and complements components of Intel's PLC methodology, although there are differences specific to mobile applications. For example, the framework governance uses existing PLC processes while the model for provisioning applications and patching through an app store is different for mobile clients.

Table 1 lists some of the questions we encourage application developers to consider during the exploration phase of the PLC and outlines applicable mobile application development framework resources.

Encouraging Mobile Application Development at Intel

To maximize our investment in creating Intel's mobile application development framework, we needed to encourage project teams to use the framework. We also wanted to support the project teams by helping them expand their skill sets.

To begin familiarizing project teams with the mobile application development framework, we asked each general manager for a list of five people—leaders in their respective areas—to participate in a forum. We knew that these thought-leaders would share what they learned about developing mobile applications with their teams, essentially evangelizing mobile application development.

After project teams used the framework to complete a few projects, we conducted a review of the process. The feedback received from the project teams was invaluable in

helping us modify our methods to make them more usable—and more successful.

We publicized our mobile application development framework to application owners, developers, and various business application project teams, including participants in Intel's Handheld program.

We also captured best practices from applications already deployed and in many cases incorporated those best practices into libraries for other mobile applications to reuse.

CLOSING THE GAP

Many of the development issues raised in this paper apply only to mobile applications and are not relevant in the development environment for Windows*-based laptops and desktops. Examples of these considerations include the following:

- The use of service-oriented architecture as the primary method for data and business logic interaction must be pervasive in all mobile development.
- On-device radio use—data transfer rate and volume, time connected, and frequency of updating—must be optimally sized to improve user battery life and user experience.
- Context switching—the ability for users to switch rapidly between applications—must be removed. Instead, the flow of interaction should be focused on the screen that is in front of the user. The use of menus and complex navigation and switching methods should be avoided.
- Developers also need to consider features of mobile devices that are not part of the laptop or desktop experience, such as gesture, voice, the Global Positioning System, and camera.

Our goal is for Intel's developers to create applications that behave like the consumer applications employees already have on their mobile devices and that employees want to use. These enterprise applications must be intuitive and task-oriented.

We initially hired design specialists to assist with UI design. These specialists helped properly validate and design application UIs to take full advantage of device capabilities. These designers also collaborated with and helped train application developers in the principles of mobile application development.

The unique features of mobile devices meant that testers needed to learn new skills and processes. For example, mobile devices have more input methods than just the keyboard and mouse. Other development platform constraints also required consideration when developing for mobile devices; some applications that are targeted to certain mobile OSs cannot be coded from a Windows*-based PC, but instead must be developed from an Apple Mac*. The test and QA teams also needed access to multiple devices for accurate validation of application functionality.

RESULTS

Intel IT's mobile application development framework is now complete. The supporting architecture is in place, and the necessary processes and systems are defined. In the first year of using this framework, we have successfully deployed a number of mobile enterprise applications. These include customer relationship management, social media, travel tools, and a paystub application. We are in various stages of development and deployment for several more mobile applications.

- Online collaboration and document sharing
- Expense reporting
- Applications for factory workers and facility technicians

Our goal is to further streamline the development process by creating more reusable code, well-documented

Table 1. Mobile application development framework resources answer project life cycle exploration questions.

Project Life Cycle Exploration Question	Mobile Application Development Framework Resource
What is the application's purpose? Who will use the application?	Value guidance document
Which devices do the users have? Which markets make sense to target?	
What data will be sent to the device? What are the security requirements for this data?	Security guidance document
What is the supporting infrastructure for security requirements? What does that mean to the type of application to develop?	Development guidance document and Application Developer Working Group
Is there a workable off-the-shelf solution or must one be developed?	
Do we have the necessary development skills or resources?	If the answer is "no," consult with Flex Services or provide the project team with the necessary training
Who will test the application and how? How will we deploy and tell employees about the application, and how will we provide training?	Provisioning guidance document or small form factor testing wiki

procedures, and more efficient path-to-production processes. For example, using security coding modules that are already approved streamlines Information Security Group review. Procedure documentation should include contact information and detailed information on the PLC. Similarly, the path to production information should include contact names, how to obtain approvals, and the minimum requirements for landing an application in production.

We are also shifting governance to a self-help support model so that review committee inputs can be efficiently addressed throughout the path to production, and anticipate enabling new devices and new capabilities with our framework.

CONCLUSION

Our mobile application development framework, which augments Intel's existing approach to IT projects and standards, raises awareness of the importance of targeting mobile devices, provides guidance and resources for application development teams to help them create effective mobile applications, and connects developers with a community of experts. By using this framework, teams can use best-known methods to develop mobile applications.

Our goal is for Intel's application development teams to create enterprise applications that behave like consumer applications: They must be easy to use, task-oriented, and intuitive. We have already used the framework to successfully deploy several mobile enterprise applications and are using the framework to develop additional mobile applications.

We anticipate extending the mobile application development framework to include new devices and new capabilities to support Intel's vision of a compute continuum model of seamless, consistent experience across devices.

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- "Pre-Evaluating Small Devices for Use in the Enterprise"
- "Rethinking Information Security"
- "The Future of Enterprise Computing: Preparing for the Compute Continuum"
- "Why the Device Matters in a Cloud-Centric World"

ACRONYMS

BYOD	bring-your-own-device
DMZ	demilitarized zone
IP	intellectual property
MDM	mobile device management
MEAP	Mobile Enterprise Application Platform
PLC	project life cycle
ROI	return on investment
SFF	small form factor
SOA	service oriented architecture
VPN	virtual private network

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