

## Chapter 9

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# Mobile Internet Devices and the Cloud

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### 9.1 Chapter Overview

A December 2008 Informa Telecoms & Media study<sup>1</sup> estimated that there are over 4 billion connections to mobile devices worldwide—an astounding number when you realize that this figure represents 60% of the global population today. Of course, this does not mean that two out of every three people on Earth have a mobile phone. It is common in more than 60 countries, however, for one person to have two or more devices, even while there are no phones at all in some parts of the globe. In some countries, millions of people are now experiencing connectivity to the world for the first time through wireless technologies. It is changing their economic, social, and political fortunes forevermore.

The number of wireless users on 3G services continues to rise daily. Informa estimates that there are nearly 415 million 3G subscriptions to date, with 77% share of the 3G market on UMTS/HSPA1 networks or 320 million connections, and the remaining 95 million subscribed to the older CDMA EV-DO2 technology. The number of commercial UMTS/HSPA networks has risen to 258 in more than 100 countries, including 41 networks in 20 countries in the Latin America and Caribbean region. It is a foregone conclusion that HSPA and HSPA+3 will compete with all prevailing mobile wireless technologies available today. Telstra's recent commercial launch of HSPA+, reports peak theoretical downlink speeds of 21.6 Mbps. The 3G technology is more than capable of delivering the high-speed bandwidth that customers demand.<sup>2</sup>

If the cloud is becoming increasingly pervasive and mobile browsers are getting better every day, you may be asking yourself if you need anything

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1. [http://www.unstrung.com/document.asp?doc\\_id=169641](http://www.unstrung.com/document.asp?doc_id=169641).
  2. [http://www.unstrung.com/document.asp?doc\\_id=169641](http://www.unstrung.com/document.asp?doc_id=169641).

more on your mobile device beyond a browser that can access the cloud. Can browser widgets provide enough functionality that you don't need applications on your device? What if you could get everything you need accomplished using simple widgets that leverage your mobile device-based browser to access the cloud? The potential impact on enterprise mobility is huge. While organizations are deploying more and more Software-as-a-Service (SaaS) applications, there is no reason mobile workers can't access those applications from their mobile devices, assuming they have enough bandwidth (i.e., 3G- or 4G-capable devices). All that is really required beyond such bandwidth is a browser that can actually handle all of the various SaaS-associated web standards. Imagine a future environment in which mobile device manufacturers will partner with multiple SaaS vendors to provide enterprises complete cloud-based computing solutions that work anywhere.

## 9.2 What Is a Smartphone?

The definition of a smartphone is not standardized and varies depending on who you ask. For most users, the consensus is that a smartphone is a mobile device that offers advanced capabilities beyond those offered by a typical mobile phone. Modern versions come with PC-like functionality. Many of the newer models have customized operating systems and associated software that provides a standardized interface. Nearly all smartphones have advanced features such as email, Internet access, instant messaging, etc. Smartphones are much more than just another cell phone. They provide instant access to the web, which translates into immediate collaboration capability. Whether you are researching financial news to predict the stock market or looking for the perfect golf course to treat your client, it's on the Internet. Most smartphones allow you to sync data with your desktop computer. You can store and work on documents from your smartphone, and you can receive and reply to emails as they arrive in your inbox using real-time push email.

Smartphone applications may be developed by the manufacturer of the device or by any other third-party provider or developer capable of accessing the open source operating system. Other functionalities might include an additional interface such as a miniature QWERTY keyboard on the touch screen, built-in video and camera features, contact management, built-in navigation software, office document processing capability, and software for playing music and viewing video clips. Such smartphone capabilities transform the common cell phone into a mobile multimedia platform for your

entertainment. They can store and display pictures, videos of friends and family, or even play live broadcasts of sports or movies.

## 9.3 Mobile Operating Systems for Smartphones

Many regard the smartphone as a minicomputer with a phone. Most smartphones use an identifiable and open source operating system, often with the ability to add user applications. This is a major factor differentiating smartphones from traditional mobile phones, which only support dedicated, proprietary applications. In the next few sections, we will take a look at several popular mobile devices and the operating systems used with them.

### 9.3.1 iPhone

The Apple iPhone uses 3G technology, and its operating system (OS) is based on the Darwin OS. Darwin forms the core set of components on which both the Mac OS X and iPhone OS are based. Darwin is compatible with Single UNIX Specification version 3 (SUSv3) and POSIX UNIX applications and utilities. The iPhone touts features such as Global Positioning System (GPS) mapping, support for enterprise applications such as Microsoft Exchange, the new App Store, etc. The iPhone is a wide-screen mobile device very much like the iPod. It provides users a rich interface with HTML email and an outstanding web browser. The iPhone home screen is shown in Figure 9.1.

The iPhone lets you customize your home screen with applications and web clips of your choosing. You can arrange the icons any way you want or even create as many as nine home screens, each customizable to your needs. For example, if you check the same web site every day, you can create a web clip to access it directly from your home screen using a single tap of a finger. You can always press the home button to go back to your main home screen. iPhone supports rich HTML email which allows you to see email attachments in their original format. The iPhone supports more than a dozen file and image formats, including PDF, Microsoft Word, Excel, PowerPoint, and iWork attachments. Support for Microsoft Exchange ActiveSync gives you push email that arrives automatically to your inbox, as shown in Figure 9.2.

### 9.3.2 Google (Android)

Android is a software platform and operating system for mobile devices that is based on the Linux kernel. It was originally developed by Google and



Figure 9.1 The iPhone home screen.

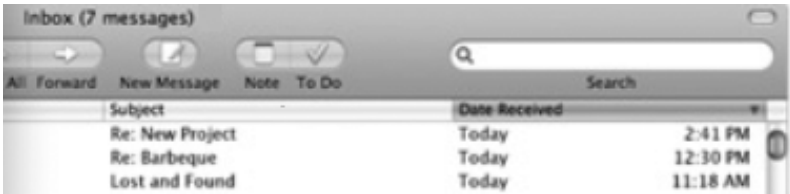


Figure 9.2 The message inbox for iPhone.

later with the Open Handset Alliance (which is a group of more than 30 technology and mobile companies). The Android operating system is the first complete, open, and free mobile platform. An Android Software Development Kit is available to help developers get started on new applications. Android allows developers to write managed Java code to control a mobile device. Developers can distribute their applications to users of Android mobile phones. There is a marketplace called Android Market that enables developers to easily publish and distribute their applications directly to users of Android-compatible phones. The T-Mobile G1, shown in Figure 9.3, is one of the better-known commercial offerings using Android.



Figure 9.3 The T-Mobile G1.

Google has now released most of the Android code under the Apache license, a free software and open source license. Figure 9.4 shows the major components of the Android operating system.

Android developers have full access to the same framework application programming interfaces (APIs) used by the core applications. The architecture is designed to simplify reuse of components, so any application can publish its capabilities and any other application may then make use of those capabilities (subject to security constraints enforced by the framework). This same mechanism allows framework components to be replaced by the user. Underlying all applications is a set of services and systems, including:

1. A rich, extensible set of views that can be used to build an application (i.e., lists, grids, text boxes, buttons, and an embedded web browser)
2. Content providers that allow applications to access data from other applications or to share their own data

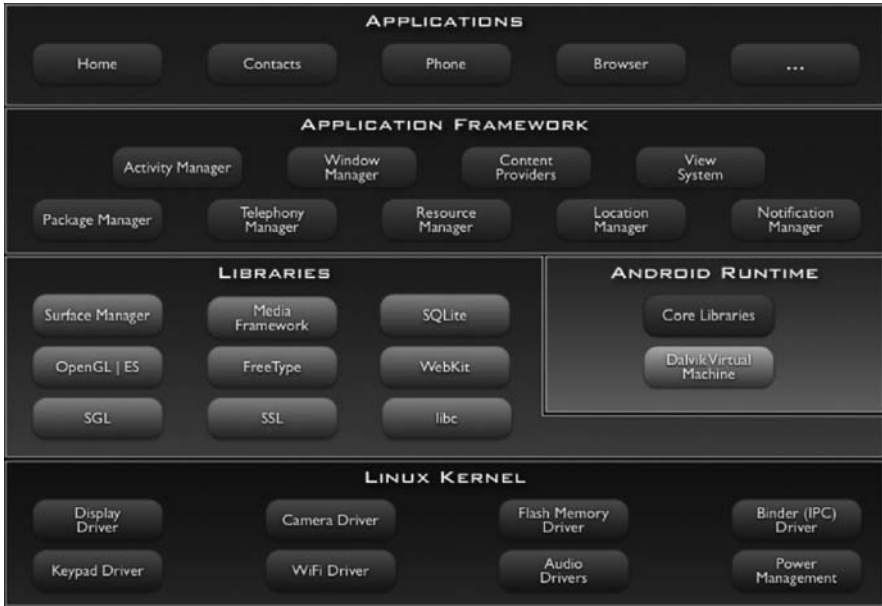


Figure 9.4 Major components of the Android operating system. (Source: <http://d.android.com/guide/basics/what-is-android.html>.)

3. A resource manager to manage access to noncode resources such as localized strings, graphics, and layout files
4. A notification manager that enables all applications to display custom alerts in the status bar
5. An activity manager to manages applications and provide a common navigation stack

Every Android application runs in its own process, with its own instance of the Dalvik virtual machine (VM). The Dalvik virtual machine is a major piece of Google's Android platform for mobile devices. It runs Java platform applications which have been converted into a compact Dalvik Executable (.dex) format suitable for systems that are constrained in terms of memory and processor speed.<sup>3</sup> Dalvik has been written so that a device can run multiple VMs efficiently. The Dalvik VM relies on the Linux kernel version 2.6 for underlying functionalities such as threading, low-level memory management, and core system services such as security,

3. "Dalvik Virtual Machine," Wikipedia, retrieved 8 Mar 2009.

memory management, process management, network stack, etc. The kernel acts as an abstraction layer between the hardware and the rest of the software stack.

### 9.3.3 Blackberry

The BlackBerry solution consists of smartphones integrated with software that enables access to email and other communication services. Developed by the Canadian company Research In Motion (RIM), the BlackBerry is a wireless handheld device originally introduced in 1999 as a two-way pager. In 2002, RIM released their version of the smartphone, named BlackBerry. It supported push email, mobile telephony, text messaging, internet faxing, web browsing, and other wireless information services. BlackBerry first made progress in the commercial marketplace by concentrating on enterprise email. The BlackBerry has a built-in QWERTY keyboard, optimized for “thumbing” (the use of only the thumbs to type). System navigation is primarily accomplished by a scroll ball in the middle of the device (older devices used a track wheel on the side). Their current solution gives mobile users access to email, phone, data, applications, games, and the Internet from a state-of-the-art smartphone, as shown in Figure 9.5.

The BlackBerry offers an end-to-end encryption solution with two transport encryption options, Advanced Encryption Standard (AES) and Triple Data Encryption Standard (Triple DES) for all data transmitted between their BlackBerry Enterprise Server and licensed BlackBerry smartphones. Private encryption keys are generated in a secure, two-way authenticated environment and are assigned to each BlackBerry smartphone user. Each secret key is stored only in the user’s secure enterprise email account and on the user’s BlackBerry smartphone. Data sent to the BlackBerry is encrypted by the BlackBerry Enterprise Server using the private key retrieved from the user’s mailbox. Next, the encrypted information is transported securely across the network to the smartphone, where it is decrypted using the key stored on the smartphone. Data remains encrypted in transit and is never decrypted outside of the corporate firewall.

### 9.3.4 Windows Mobile

Windows Mobile is a compact operating system offering a set of basic applications commonly found on mobile devices. It is based on the Microsoft Win32 API. Devices that run Windows Mobile include pocket PCs, smartphones, portable media centers, and on-board computers for certain automobiles. Windows Mobile is designed to appear similar to desktop versions



Figure 9.5 The Blackberry.

of Microsoft Windows. The platform supports third-party software development. Originally, Windows Mobile appeared as the pocket PC 2000 operating system, then known as Windows Compact Edition (CE). Since then, Windows Mobile has been updated several times. The next planned release, Windows Mobile 7.0, is slated for the latter part of 2009. Figure 9.6 shows what it is expected to look like.

Microsoft had projected in 2008 that it would see an increase of devices shipping with Windows Mobile from 11 million to 20 million units. It missed its initial goal, selling only 18 million licenses, but even that number indicates the phenomenal growth of this market. Microsoft attributed the shortfall in its prediction to the delayed launch of some smartphone devices. Since then, Windows Mobile's market share as an operating system for smartphones worldwide has fallen from 23% in 2004 to 12% in 2008.<sup>4</sup> Windows Mobile now has a worldwide smartphone market share of 14%. It is interesting to note that Microsoft licenses its Windows Mobile platform





Figure 9.6 Windows Mobile

to four of the world's five largest mobile phone manufacturers—a strong testament to its popularity in the marketplace.

### 9.3.5 Ubuntu Mobile Internet Device (MID)

Ubuntu MID Edition is designed specifically for mobile internet devices (MIDs). Ubuntu MID is based on the popular Linux distribution Ubuntu. Ubuntu MID is highly flexible and customizable. It is an open source platform that is best suited to the kind of product differentiation that reaches target users in the mobile marketplace. MIDs generally have the following common features and attributes:

1. Small size/form factor, typically a 4- to 7-inch touch screen
2. Physical and/or virtual keyboard
3. Wi-Fi, 3G, Bluetooth, GPS, WiMAX
4. 2- to 8-GB Flash or disk storage

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4. Prince Mclean, "Microsoft Plans "Skymarket" Apps Store for Windows Mobile 7 in 2009," <http://www.roughlydrafted.com/2008/09/01/microsoft-plans-%E2%80%9Cskymarket%E2%80%9D-apps-store-for-windows-mobile-7-in-2009>, RoughlyDrafted Magazine, San Francisco, CA, 1 Sept 2008, retrieved 9 Mar 2009.

5. 256 to 512 MB RAM (the more the better)



Figure 9.7 Clutter user interface.

6. OpenGL 3D graphics support
7. USB, camera, headphone jack, speakers, microphone
8. Customizable (Flash or Clutter<sup>5</sup>-based) user interface (see Figures 9.7 and 9.8).

Ubuntu MID Edition has a suite of applications that work seamlessly to meet the needs of mobile users. Web applications such as Facebook, MySpace, YouTube, and Dailymotion are easily supported. Ubuntu MID needs no stylus—you navigate using a touchscreen. Just tap the screen or drag a finger for navigation and control. To launch applications, tap the application icon with your finger or tap menus and buttons to use them. You can swipe a web page to pan up, down, or sideways, and you can swipe a video, photo, song, or thumbnail page to move to the next or the previous one. Figure 9.9 shows the home screen of Ubuntu MID.

In the next few pages we highlight some of the applications found in the default distribution of Ubuntu MID, to give you a feel for what capabilities exist on modern mobile devices and how they can enhance daily life, simply by facilitating collaboration via the Internet. When you first get the device running, it is important to set preferences such as time and date (see Figure

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5. Clutter is an open source software library for creating fast, visually rich, and animated graphical user interfaces.



Figure 9.8 Flash user interface.



Figure 9.9 Ubuntu MID home screen.

9.10) and to perform any system updates to bring the version current with any releases or updates since your particular version was made available.

To update your system, simply tap the System menu and select the Update Manager. The application will start and display the “Starting Update Manager...” message as shown in Figure 9.11.

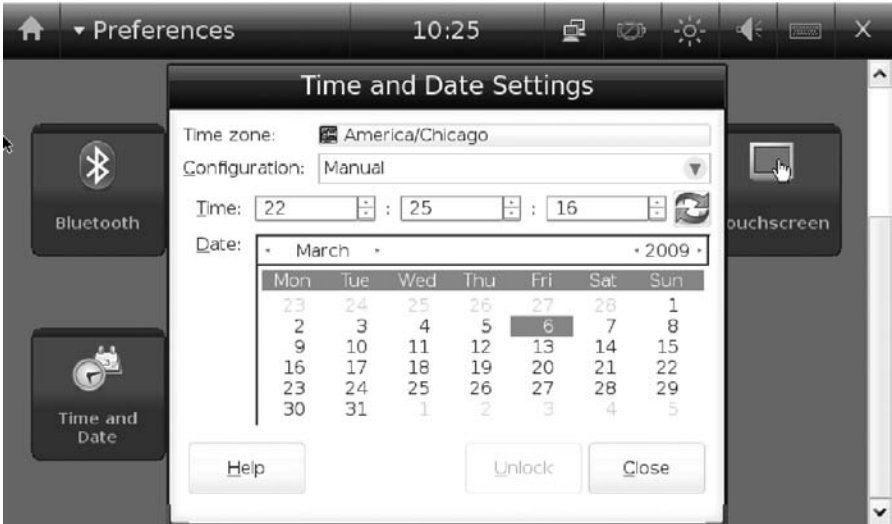


Figure 9.10 Setting the time and date on Ubuntu MID.



Figure 9.11 The Ubuntu MID Update Manager.

Once the update manager starts, it will use your existing Internet connection and check with the update server to determine which applications on your system may need to be updated. You can even update the system

itself using this tool. After checking with the server to see what may have changed, you will be presented with the screen shown in Figure 9.12.



Figure 9.12 Installing updates.

Simply click the green checkmark button to install updates. For the example in Figure 9.12, five updates will be installed. The first part of the installation downloads the updates, as shown in Figure 9.13.

The download will proceed and, depending on your connection speed, may take anywhere from a few seconds to minutes to complete. After the downloads complete, installation proceeds automatically. You may be asked to reboot the device to complete the install process.

Mobile users deal with office documents on a daily basis. Ubuntu MID offers an office document reader to read various document types such as .doc, .pdf, .xml, etc. The reader is shown in Figure 9.14 displaying a .pdf file.

For users who need more than a read-only display of a document, Ubuntu MID also offers a complete mobile office solution, OpenOffice version 2.4 (see Figure 9.15), which allows you to build presentations, spreadsheets, documents, etc. It is a very popular solution in the open source community.

Figure 9.16 shows the editing of an .html document using OpenOffice. OpenOffice is the leading open source office software suite for word pro-

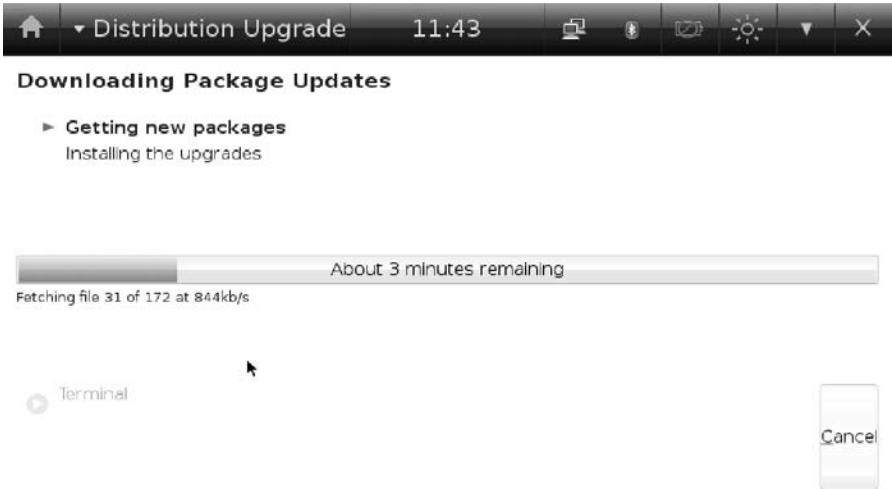


Figure 9.13 Downloading updates.

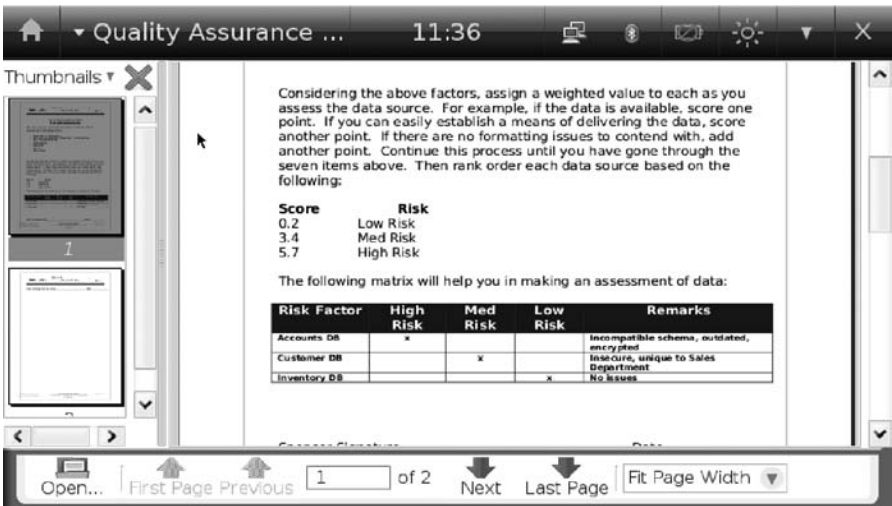


Figure 9.14 The Ubuntu MID document reader.

cessing, spreadsheets, presentations, graphics, databases, etc. It is available in many languages and works on all common computer platforms. It stores data in an international open standard format, the ISO-approved Open Document Format (ODF), and it can read and write files from other common commercial office software packages. It can be downloaded from the official web site<sup>6</sup> and used completely free of charge for any purpose.

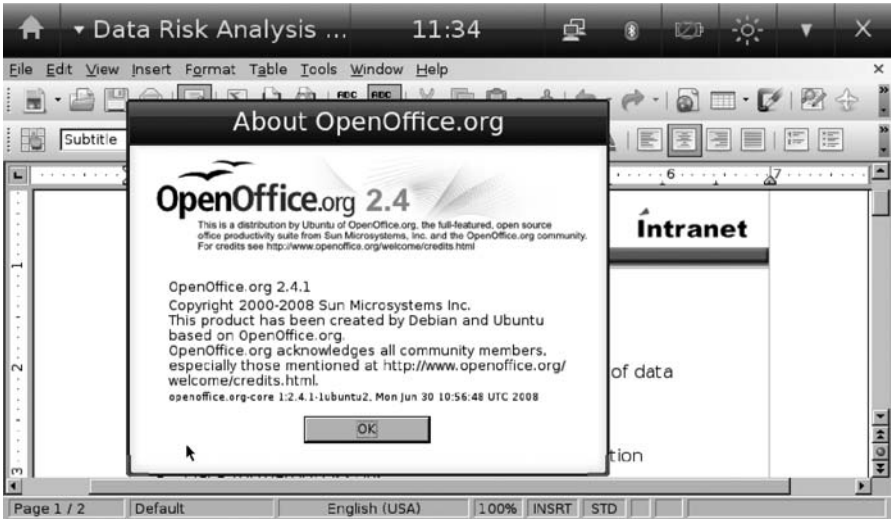


Figure 9.15 Ubuntu MID OpenOffice.

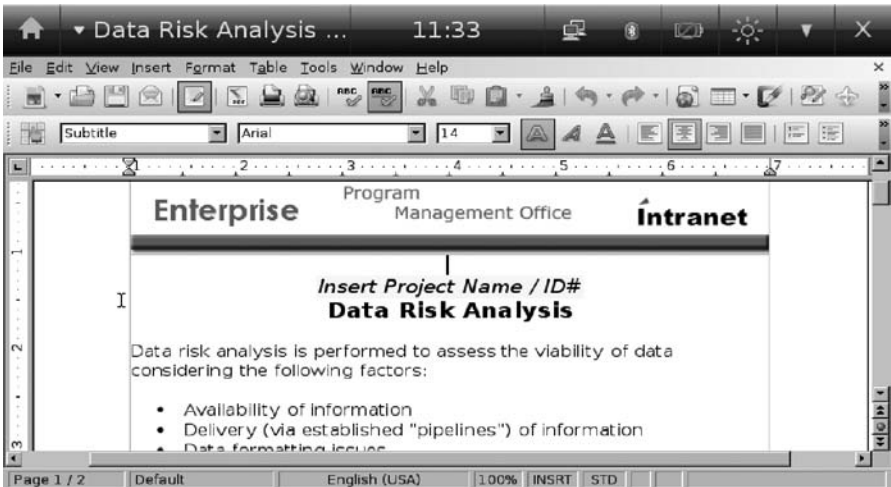


Figure 9.16 Editing a document using OpenOffice.

The most recent versions of OpenOffice (version 3.0 and later) provide support for integrated email and calendaring, using Thunderbird 2.0 for email and Lightning for calendaring. Both of these products are available

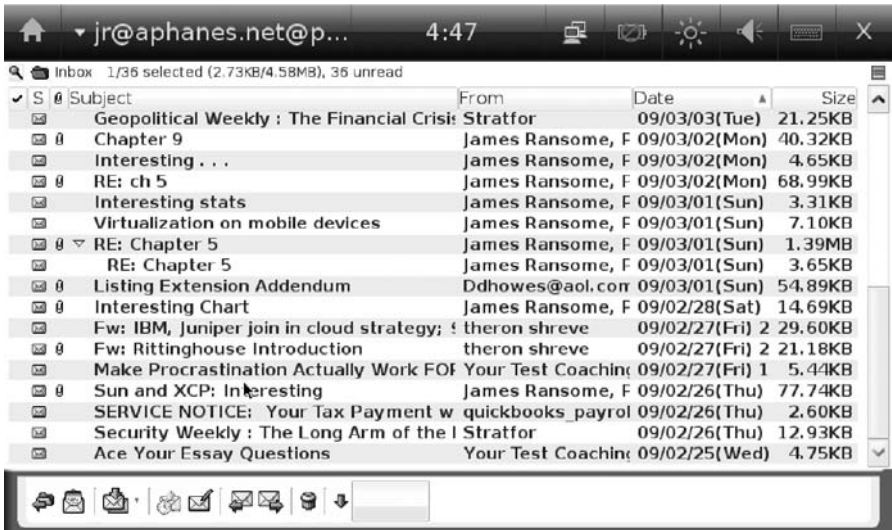


Figure 9.17 OpenOffice email in Ubuntu MID.

from mozilla.org and are also open source. Figure 9.17 shows an inbox in OpenOffice email.

For mobile users, traveling often involves downtime, sitting on a plane or in an airport or hotel lobby. FBReader is an ebook reader included with Ubuntu MID. FBReader works on Linux, Windows XP/Vista, FreeBSD, and various other Linux-based mobile operating systems. FBReader is distributed under the terms of the GNU GPL. It supports many ebook formats, such as fb2 ebook format, HTML, CHM, plucker, Palm doc, zTxt, TCR, RTF, OpenReader, and plain text format. Direct reading from tar, zip, gzip, and bzip2 archives is also supported. FBReader can perform automatic library building, and automatic language and character encoding detection is also supported. Other features include:

1. Automatically generated contents table
2. Embedded images support
3. Footnotes/hyperlinks support
4. Position indicator
5. Keeps the last open book and the last read positions for all opened books between runs



6. List of last opened books
7. Automatic hyphenation
8. Text search and full-screen mode, including screen rotation by 90, 180, and 270 degrees

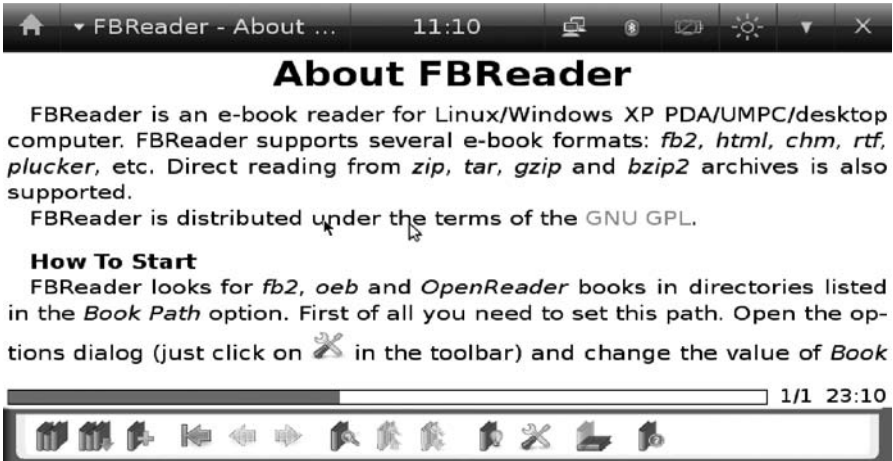


Figure 9.18 FBReader.

An FBReader screen is shown in Figure 9.18.

For those more inclined to chat using instant messaging, a full-featured IM client is provided, as illustrated in Figure 9.19.

If you cannot find anyone to chat with, you can always use the Internet browser to visit your favorite web sites, listen to the radio, or watch videos on YouTube, Hulu, etc. The browser is very capable, supporting the most recent standards for a rich user interface. See Figure 9.20.

## 9.4 Mobile Platform Virtualization

Smart phones with rich and open operating systems are growing in popularity, resulting in a market that is undergoing tremendous innovation and change. The pressure to reduce development costs and get phones to market faster has increased competitive pressure to deliver feature-rich phones to market faster and to migrate from proprietary operating systems to open operating systems without compromising the security of trusted services.

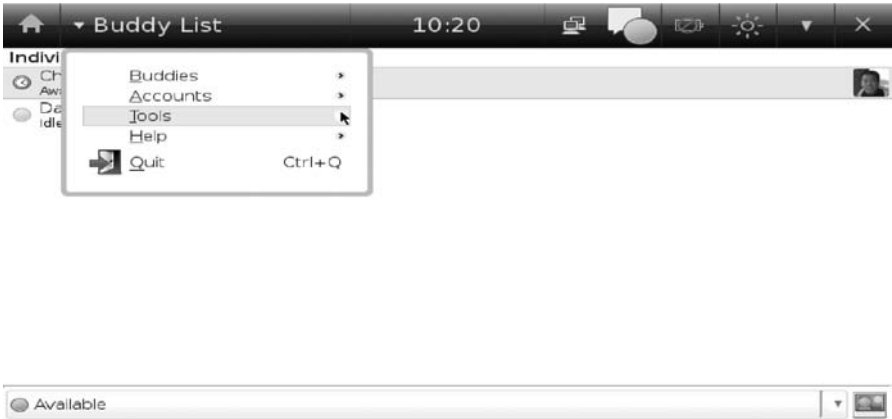


Figure 9.19 Ubuntu MID instant messenger.



Figure 9.20 Internet browsing on Ubuntu MID.

As mobile phones have become more powerful, beyond their basic phone functionality, phones now offer music, video, cameras, and built-in GPS capabilities. Rich applications are being built every day by a vibrant developer community utilizing the open operating systems. As these capabilities have been developed, the mobile phone user's ability to include applications, pictures, videos, music, emails, bank and credit card information, and personal information management (PIM) have all been combined to provide a much richer and more valuable experience into a persona that is

portable and can be transferred seamlessly when upgrading to a new phone. The ability to protect and migrate personas will become an important purchasing decision. The risk of not securing and managing employee-owned devices if they contain confidential information is significant, and managing a wide variety of devices is complex in terms of both cost and security. Virtualization is a key enabling technology to address these issues.

Security is a serious issue for mobile handsets running an open source operating systems. There are already a significant number of known viruses, and their numbers are growing fast for mobile phones but still lag far behind the number of known PC viruses. The mobile handset user is a roving agent in a wireless IT world, and security is every bit as important as it is in the fixed-wire IT world. The frequent emergency security upgrades and patches common in the PC world, however, would be unacceptable to the average user of a mobile handset. Such an approach to security could stall the proliferation of smart and feature phones. Consequently, security must be designed in from day one of the handset's life cycle. Real-time virtualization solutions offer robust security via hardware-enforced memory isolation of partitions, isolating each operating system from the others and preventing cross-corruption. In addition, specific partitions may be added and used to execute secure applications in small certifiable environments protected from the larger open environment or real-time operating system (RTOS) executing in other partitions. Security cannot be an afterthought.

A virtualization solution may be used to ease introduction of smart phone software functionality to an existing feature phone hardware platform, with minimal effort and cost. Virtualization-based solutions open up the phone software architecture to bring added functionality to both feature phones and smartphones in terms of service availability, security, and device management. Two examples of virtualization software being used on smartphones are discussed in the following.

#### **9.4.1 KVM**

Kernel-based Virtual Machine (KVM) is open source software that is a full virtualization solution for Linux on x86 hardware containing virtualization extensions (Intel VT or AMD-V). KVM consists of a kernel module, `kvm.ko`, which provides the core virtualization infrastructure, and a processor-specific module, `kvm-intel.ko` or `kvm-amd.ko`, depending on the CPU manufacturer (Intel or AMD). KVM also requires a modified QEMU,<sup>7</sup> although work is underway to get the required changes upstream. Multiple

virtual machines running unmodified Linux or Windows images can be run using KVM. A wide variety of guest operating systems work with KVM, including many versions of Linux, BSD, Solaris, Windows, Haiku, ReactOS, and the AROS Research Operating System. Each virtual machine has private virtualized hardware: a network card, disk, graphics adapter, etc. The kernel component of KVM is included in Linux, as of the 2.6.20 kernel version.

KVM's performance is good, but not as good as that of some of the more mature products, such as VMware or VirtualBox. For example, network and graphics speeds are noticeably slower with KVM. In general, KVM performance can offer near-native speed, thanks to its use of Intel VT or AMD-V extensions. As an open source product, it is being very actively developed and is constantly improving.

### 9.4.2 VMWare

VMware Mobile Virtualization Platform (MVP) is a thin layer of software that is embedded on a mobile phone to separate the applications and data from the underlying hardware. It is optimized to run efficiently on low-power, low-memory mobile phones. MVP is planned to enable handset vendors to bring phones to market faster and make them easier to manage.<sup>8</sup> VMware inherited the MVP software when it bought Trango Virtual Processors in October 2008. The technology serves much the same function as VMware's flagship server product, adding a flexible software layer onto hardware and making it easier to move applications from device to device.<sup>9</sup> MVP currently supports a wide range of real-time and rich operating systems, including Windows CE 5.0 and 6.0, Linux 2.6.x, Symbian 9.x, eCos, μITRON NORTi, and μC/OS-II.

VMware MVP benefits end users by being able to run multiple profiles (e.g., one for personal use and one for work use) on the same phone. Increasingly, handset vendors and carriers are migrating from proprietary operating systems to rich open operating systems so that their customers can choose from the widest selection of applications. With this transition to open operating systems, however, protection of trusted services such as digi-

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7. According to Wikipedia, "QEMU is a processor emulator that relies on dynamic binary translation to achieve a reasonable speed while being easy to port on new host CPU architectures," QEMU, Wikipedia, <http://en.wikipedia.org/wiki/QEMU>, retrieved 9 Mar 2009.
  8. <http://www.vmware.com/company/news/releases/mvp.html>.
  9. <http://bits.blogs.nytimes.com/2008/11/10/vmware-lends-virtual-hand-to-mobile-phone-crowd>.

tal rights management, authentication, billing, etc., is becoming of increasing concern. VMware MVP allows vendors to isolate these important trusted services from the open operating system and run them in isolated and tamper-proof virtual machines so that even if the open environment is compromised, the trusted services are not affected.

With VMware solutions, desktop and IT security administrators get the control and visibility they need to protect mobile data and prevent malicious code intrusion, while end users get the freedom and flexibility of “anytime, anywhere” access to their own familiar desktop environment. For virtual teams and telecommuters with a steady Internet connection, VMware View (formerly VMware Virtual Desktop Infrastructure, VDI) can be used to deliver remote access to server-based virtual desktop PCs through a secure network connection. Using VMware View, an organization can keep desktop images and sensitive information stored on servers behind the corporate firewall, eliminating the risk of a security breach as a result of laptop theft, allow remote access through a Web browser for maximum flexibility, or keep access limited to PCs with VMware View client software installed for maximum control, and can prevent data leakage and network intrusions with strong encryption, multifactor authentication, and access control policies for client-side USB devices.<sup>10</sup>

Mobile users with intermittent access to the Internet can use VMware ACE to deploy “assured computing environments” (ACEs) that workers can use on corporate-owned laptops, employee-owned PCs, or even iPods and USB memory sticks without putting sensitive corporate information at risk. VMware ACE clients are encapsulated inside a single file or “package,” and ACE packages can be secured with strong encryption to protect the entire virtual desktop environment, not just specific files and folders. Administrators can set and enforce granular policies governing the lifespan of each ACE client package, the networks it can access, and the peripheral devices that can interface with it, with Active Directory integration for unified user authentication. The result is a scalable solution that helps enhance the mobility of users while protecting access to valuable corporate information assets.<sup>11</sup>

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10. <http://www.vmware.com/solutions/desktop/mobile.html>.

11. <http://www.vmware.com/solutions/desktop/mobile.html>.

## 9.5 Collaboration Applications for Mobile Platforms

The growing popularity and power of mobile devices and the demand for business solutions and collaboration tools on mobile devices, along with Web 2.0 as a new platform for developing interactive applications across devices, has ushered in a new era for collaboration technologies—as can be seen in the advent of devices such as the Apple iPhone, the BlackBerry Storm touchphone, and the Google phone. The adoption of mobile collaboration services is not just a matter of design but also depends on factors such as mobile network coverage and pricing structures, all of which have been leveraged by these three phones, and others are on the way.

Mobile phones have evolved rapidly in the past few years, from specialized devices for voice communication to a general-purpose computing devices that are able to run a rich variety of data applications. The latest mobile phones also provide a variety of networking options such as cellular, Bluetooth, Wi-Fi, and WiMAX, which serve a range of coverage and bandwidth requirements. Mobile phones have now become the device of choice for people to keep in touch with family members, friends, and business partners. Current mobile phones allow people not only to make telephone calls but also to access email and short messages, play games, share information, run video conferences, and coordinate business actions. Mobile phones are now equipped with faster processors, larger memory, and longer-life batteries. Many mobile phones today come with integrated position-tracking and camera features. Many of the software tools previously available in personal digital assistants (PDAs), tablets, laptops, and desktop PCs have been ported to mobile phones, such as office and multimedia applications. Today, many collaboration technologies are widely used, such as email, instant messaging, data conferencing, workflow, wiki, and social networking systems.

Collaboration technologies based on mobile phones have unique advantages over laptops and desktop systems because they are lightweight and can fit into pockets or purses. They are truly mobile and can be connected all the time, which means you can take your desktop with you: Collaboration software on mobile hand-held devices provides the ability to be productive wherever you are. In this new era of mobile computing, the next generation of collaboration technologies on mobile phones is being developed to enable consumers to collaborate anytime, anywhere, using just their mobile phones. Although mobile collaboration technologies are still in their infancy and there is still significant room for progress, there

have been several significant recent developments, such as the Cisco WebEx collaboration software, which currently has over 60% of the web collaboration conferencing software market,<sup>12</sup> being ported over to the iPhone<sup>13</sup>; the IBM Lotus Notes Traveler being extended to support a range of S60-based Nokia mobile phones built on the S60 third edition of the Symbian operating system and providing a major alternative to Windows Mobile device support<sup>14</sup>; and Unison Technologies recently announcing its free unified communications software offering in a direct challenge to industry giants Microsoft and Google.<sup>15</sup>

## 9.6 Future Trends

The real value of cloud computing is that it makes software and data available transparently and everywhere—include the mobile environment. Consumers of cloud computing services purchase computing capacity on demand and need not be concerned with the underlying technologies used to achieve server capabilities. Computing resources are being accessed which are typically owned and operated by a third-party provider on a consolidated basis in data center locations. This stateless model facilitates much greater scalability than conventional computing and can be used in conjunction with virtualization to achieve maximum data center and computing resource utilization. One of the key elements of a stateless computing environment is a networked storage system that enables ubiquitous availability of software, making the cloud the ideal environment to enable mobile smartphone users to access its powerful computing power remotely.

Each day, more and more users connect to the Internet using their mobile devices. The mobile operating system as an extension to the cloud is emerging as a value-added alternative to sophisticated and complex operating systems such as Windows. New players such as Apple and Google are developing their mobile operating systems to challenge Symbian and Windows Mobile. Mobile device hardware is currently too weak to run fully capable hardcore software such as Adobe Photoshop or Microsoft Office natively on a smartphone, which is why cloud computing will likely be the future model for of mobile computing. Cloud computing may prove to be

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12. <http://www.pcmag.com/article2/0,4149,1418533,00.asp>.

13. <http://www.webex.com/iphone>.

14. <http://www.itwire.com/content/view/21856/1154>.

15. <http://www.channelinsider.com/c/a/Messaging-and-Collaboration/Unisons-Free-Unified-Communications-Software-Challenges-Microsoft-and-Google>.

an ideal strategy for reaping the full benefit of mobile devices, by allowing companies to essentially push their IT environment out to employees, rather than employees having to get access to the IT environment. In the future, cloud computing will also reduce the need for unnecessary full application overhead by using the mobile smartphone as a “dumb terminal” to leverage the powerful computing power of the cloud.

## 9.7 Chapter Summary

Cloud computing for mobile devices is taking off with the expansion of high-speed wireless networks around the world. Mobile devices take data out of homes and offices and put them in our pockets, increasing the attractiveness of cloud computing as a model to connect end users with more than just the Internet and email while they roam. This means that much of your vital data will be available not just at home, at the office, or in your wallet, but can easily be accessed by hooking up to the huge memory of the Internet cloud with a mobile device. Consumers are beginning to demand not only access to hotel and restaurant directions, airline reservations, weather reports, social networking sites, personal email and instant messaging, but also full and secure access to their business applications at work or a business partner’s site as well.

The cloud is becoming increasingly pervasive and mobile browsers are getting better every day, providing the ability to access the cloud and its applications. Organizations are deploying more and more SaaS-based applications and, assuming they have enough bandwidth, there is no reason that mobile workers cannot access those applications on their devices with a browser that can actually fully handle web and cloud standards. In this chapter we described the mobile smartphones platforms, their operating systems, virtualization of these platforms, mobile collaboration applications, and future trends.

## 9.8 Closing Comments

Cloud computing is in a period of strong growth, but cloud technology is still somewhat immature and will take another few years to mature. Development will probably be dominated by a select group of vendors, mostly technologically aggressive application development organizations. There will likely be proliferation of new vendors and then subsequent consolidation as cloud computing becomes appealing to more mainstream develop-



ment organizations. As with any other technology going through a period of rapid growth, the stronger small players will survive and the weaker players will be driven out of the market. In the meantime, demand for interoperability and integration will likely drive a widely supported fabric of "intracloud" application programming interfaces that will be developed to link cloud-based systems across vendor platforms. This consolidation and integration, along with improved security, privacy, and governance enhancements, will broaden the appeal of cloud computing while building the trust of consumers, who will increasingly offload large portions of their IT infrastructure to third parties such as the SaaS providers described throughout this book. The cloud is going to be the hot topic in the next few years and probably beyond, and it is not just IT personnel who will need to understand the benefits of cloud computing, but personnel across the entire business continuum. Many consumers and companies are missing out on the benefits of cloud computing because they do not fully grasp the concept of cloud computing; we hope this book has improved your grasp.