Shane Conder
Lauren Darcey

Second Edition

Android™ Wireless Application Development

Developer's Library

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Introduction

Pioneered by the Open Handset Alliance and Google, Android is a hot, young, free, open source mobile platform making waves in the wireless world. This book provides comprehensive guidance for software development teams on designing, developing, testing, debugging, and distributing professional Android applications. If you're a veteran mobile developer, you can find tips and tricks to streamline the development process and take advantage of Android's unique features. If you're new to mobile development, this book provides everything you need to make a smooth transition from traditional software development to mobile development—specifically, its most promising new platform: Android.

Who Should Read This Book

This book includes tips for successful mobile development based on our years in the mobile industry and covers everything you need to run a successful Android project from concept to completion. We cover how the mobile software process differs from traditional software development, including tricks to save valuable time and pitfalls to avoid. Regardless of the size of your project, this book can work for you.

This book was written for several audiences:

- **Software developers who want to learn to develop professional Android applications.** The bulk of this book is primarily targeted at software developers with Java experience but not necessarily mobile development experience. More seasoned developers of mobile applications can learn how to take advantage of Android and how it differs from the other technologies of the mobile development market today.
- **Quality assurance personnel tasked with testing Android applications.** Whether they are black box or white box testing, quality assurance engineers can find this book invaluable. We devote several chapters to mobile QA concerns, including topics such as developing solid test plans and defect tracking systems for mobile applications, how to manage handsets, and how to test applications thoroughly using all the Android tools available.
- **Project managers planning and managing Android development teams.** Managers can use this book to help plan, hire, and execute Android projects from start to finish. We cover project risk management and how to keep Android projects running smoothly.

- **Other audiences.** This book is useful not only to a software developer, but also for the corporation looking at potential vertical market applications, the entrepreneur thinking about a cool phone application, and hobbyists looking for some fun with their new phone. Businesses seeking to evaluate Android for their specific needs (including feasibility analysis) can also find the information provided valuable. Anyone with an Android handset and a good idea for a mobile application can put this book to use for fun and profit.

Key Questions Answered in This Book

This book answers the following questions:

1. What is Android? How do the SDK versions differ?
2. How is Android different from other mobile technologies, and how can developers take advantage of these differences?
3. How do developers use the Eclipse Development Environment for Java to develop and debug Android applications on the emulator and handsets?
4. How are Android applications structured?
5. How do developers design robust user interfaces for mobile—specifically, for Android?
6. What capabilities does the Android SDK have and how can developers use them?
7. How does the mobile development process differ from traditional desktop development?
8. What development strategies work best for Android development?
9. What do managers, developers, and testers need to look for when planning, developing, and testing a mobile development application?
10. How do mobile teams design bulletproof Android applications for publication?
11. How do mobile teams package Android applications for deployment?
12. How do mobile teams make money from Android applications?
13. And, finally, what is new in the second edition of the book?

How This Book Is Structured

This book is divided into seven parts. The first five parts are primarily of interest to developers; Parts VI and VII provide lots of helpful information for project managers and quality assurance personnel as well as developers.

Here is an overview of the various parts in this book:

- **Part I: An Overview of Android**

  Part I provides an introduction to Android, explaining how it differs from other mobile platforms. You become familiar with the Android SDK and tools, install the development tools, and write and run your first Android application—on the emulator and on a handset.

- **Part II: Android Application Design Essentials**

  Part II introduces the design principles necessary to write Android applications. You learn how Android applications are structured and how to include resources, such as strings, graphics, and user interface components in your projects.

- **Part III: Android User Interface Design Essentials**

  Part III dives deeper into how user interfaces are designed in Android. You learn about the core user interface element in Android: the `View`. You also learn about the basic drawing and animation abilities provided in the Android SDK.

- **Part IV: Using Common Android APIs**

  Part IV is a series of chapters, each devoted to a deeper understanding of the most important APIs within the Android SDK, such as the data and storage APIs (including file and database usage as well as content providers), networking, telephony, Location-Based Services (LBS), multimedia and 3D graphics APIs, and the optional hardware APIs available.

- **Part V: More Android Application Design Principles**

  Part V covers more advanced Android application design principles, such as notifications and services.

- **Part VI: Deploying Your Android Application to the World**

  Part VI covers the software development process for mobile, from start to finish, with tips and tricks for project management, software developers, and quality assurance personnel.

- **Part VII: Appendixes**

  Part VII includes several helpful quick-start guides for the Android development tools: the emulator, ADB and DDMS, Eclipse tips and tricks, and a SQLite tutorial.

An Overview of Changes in This Edition

When we began writing the first edition of this book, there were no Android devices on the market. One Android device became available shortly after we started, and it was available only in the United States. Today there are dozens of devices shipping all over the world. The Android platform has gone through extensive changes since the first edition of this book was published. The Android SDK has many new features, and the development

tools have received many much-needed upgrades. Android, as a technology, is now on solid footing within the mobile marketplace.

Within this new edition, we took the opportunity to do a serious overhaul on book content—but don't worry, it's still the book readers loved the first time, just bigger, better, and more comprehensive. In addition to adding newly available content, we've retested and upgraded all existing content (text and sample code) for use with the newest Android SDKs. Here are some of the highlights of the additions and enhancements we've made to this edition:

- Coverage of the latest and greatest Android tools and utilities
- Updates to all existing chapters, often with some entirely new sections
- Complete overhaul of sample code and applications—many more of them, too—organized by topic
- Nine new chapters, which cover new SDK features, including web APIs, the Android NDK, extending application reach, managing users, data synchronization, backups, advanced user input, and compatibility
- Topics such as Android Manifest files, content providers, designing apps, and testing each now have their own chapter
- Updated 3D graphics programming, including OpenGL ES 2.0
- Coverage of hot topics such as Bluetooth, gestures, voice recognition, App Widgets, Live Folders, Live Wallpapers, and global search
- Even more tips and tricks from the trenches to help you design, develop, and test applications for different device targets, including an all-new chapter on tackling compatibility issues
- A new appendix full of Eclipse tips and tricks

As you can see, we cover many of the hottest and most exciting features that Android has to offer. We didn't take this review lightly; we touched every existing chapter, updated content, and added many new chapters as well. Finally, we included many additions, clarifications, and, yes, even a few fixes based upon the feedback from our fantastic (and meticulous) readers. Thank you!

Development Environment Used in This Book

The Android code in this book was written using the following development environments:

- Windows 7 and Mac OS X 10.6.4
- Eclipse Java IDE Version 3.5 (Galileo)
- Eclipse JDT plug-in and Web Tools Platform (WTP)
- Java SE Development Kit (JDK) 6 Update 20

- Android SDK Version 2.2, API Level 8 (FroYo)
    1. ADT Plug-in for Eclipse 0.9.9
    2. NDK Tools Revision 4b
    3. SDK Tools Revision 7
- Android Handsets: T-Mobile G1, HTC Nexus One, HTC Evo 4G, Motorola Droid, ARCHOS 5 internet tablet

Supplementary Materials Available

The source code that accompanies this book for download on the publisher website: http://www.informit.com/title/9780321743015.

We also run a blog at http://androidbook.blogspot.com, which covers a variety of Android topics and presents reader feedback, questions, and further information. You can also find links to our various technical articles.

Where to Find More Information

There is a vibrant, helpful Android developer community on the Web. Here are a number of useful websites for Android developers and followers of the wireless industry:

- **Android Developer Website:** The Android SDK and developer reference site: http://developer.android.com/
- **Stack Overflow:** The Android website with great technical information (complete with tags) and an official support forum for developers: http://stackoverflow.com/questions/tagged/android
- **Open Handset Alliance:** Android manufacturers, operators, and developers: http://www.openhandsetalliance.com/
- **Android Market:** Buy and sell Android applications: http://www.android.com/market/
- **Mobiletuts+:** Mobile development tutorials, including Android: http://mobile.tutsplus.com/category/tutorials/android/
- **anddev.org:** An Android developer forum: http://www.anddev.org
- **Google Team Android Apps:** Open source Android applications: http://apps-for-android.googlecode.com/

- **FierceDeveloper:** A weekly newsletter for wireless developers: http://www.fiercedeveloper.com/
- **Wireless Developer Network:** Daily news on the wireless industry: http://www.wirelessdevnet.com/
- **Developer.com:** A developer-oriented site with mobile articles: http://www.developer.com/

Conventions Used in This Book

This book uses the following conventions:

- ➥ is used to signify to readers that the authors meant for the continued code to appear on the same line. No indenting should be done on the continued line.
- Code or programming terms are set in `monospace` text.

This book also presents information in the following sidebars:

Tip

Tips provide useful information or hints related to the current text.

Note

Notes provide additional information that might be interesting or relevant.

Warning

Warnings provide hints or tips about pitfalls that you might encounter and how to avoid them.

Contacting the Authors

We welcome your comments, questions, and feedback. We invite you to visit our blog at
http://androidbook.blogspot.com
or email us at
androidwirelessdev+awad2e@gmail.com

1

Introducing Android

The mobile development community is at a tipping point. Mobile users demand more choice, more opportunities to customize their phones, and more functionality. Mobile operators want to provide value-added content to their subscribers in a manageable and lucrative way. Mobile developers want the freedom to develop the powerful mobile applications users demand with minimal roadblocks to success. Finally, handset manufacturers want a stable, secure, and affordable platform to power their devices. Up until now a single mobile platform has adequately addressed the needs of all the parties.

Enter Android, which is a potential game-changer for the mobile development community. An innovative and open platform, Android is well positioned to address the growing needs of the mobile marketplace.

This chapter explains what Android is, how and why it was developed, and where the platform fits in to the established mobile marketplace.

A Brief History of Mobile Software Development

To understand what makes Android so compelling, we must examine how mobile development has evolved and how Android differs from competing platforms.

Way Back When

Remember way back when a phone was just a phone? When we relied on fixed landlines? When we ran for the phone instead of pulling it out of our pocket? When we lost our friends at a crowded ballgame and waited around for hours hoping to reunite? When we forgot the grocery list (see Figure 1.1) and had to find a payphone or drive back home again?

Those days are long gone. Today, commonplace problems such as these are easily solved with a one-button speed dial or a simple text message like "WRU?" or "20?" or "Milk and?"

Our mobile phones keep us safe and connected. Now we roam around freely, relying on our phones not only to keep in touch with friends, family, and coworkers, but also to

tell us where to go, what to do, and how to do it. Even the most domestic of events seem to revolve around my mobile phone.

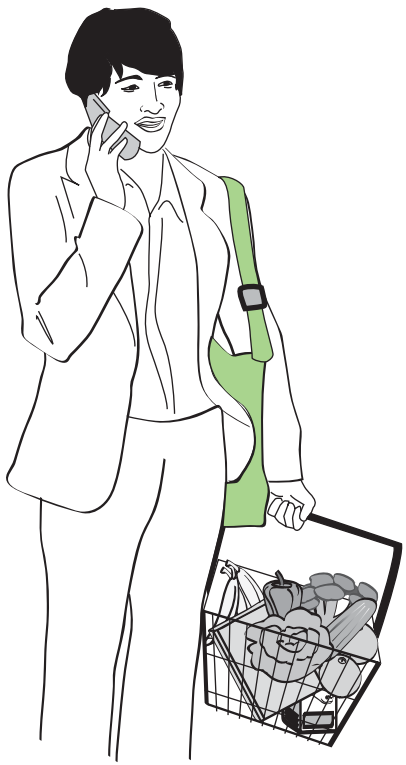

Figure 1.1 Mobile phones have become a crucial shopping accessory.

Consider the following true story, which has been slightly enhanced for effect:

Once upon a time, on a warm summer evening, I was happily minding my own business cooking dinner in my new house in rural New Hampshire when a bat swooped over my head, scaring me to death.

The first thing I did—while ducking—was to pull out my cell phone and send a text message to my husband, who was across the country at the time. I typed, "There's a bat in the house!"

My husband did not immediately respond (a divorce-worthy incident, I thought at the time), so I called my dad and asked him for suggestions on how to get rid of the bat.

He just laughed.

> Annoyed, I snapped a picture of the bat with my phone and sent it to my husband and my blog, simultaneously guilt-tripping him and informing the world of my treacherous domestic wildlife encounter.
>
> Finally, I googled "get rid of a bat" and then I followed the helpful do-it-yourself instructions provided on the Web for people in my situation. I also learned that late August is when baby bats often leave the roost for the first time and learn to fly. Newly aware that I had a baby bat on my hands, I calmly got a broom and managed to herd the bat out of the house.
>
> Problem solved—and I did it all with the help of my trusty cell phone, the old LG VX9800.

My point here? Mobile phones can solve just about *anything*—and we rely on them for *everything* these days.

You notice that I used half a dozen different mobile applications over the course of this story. Each application was developed by a different company and had a different user interface. Some were well designed; others not so much. I paid for some of the applications, and others came on my phone.

As a user, I found the experience functional, but not terribly inspiring. As a mobile developer, I wished for an opportunity to create a more seamless and powerful application that could handle all I'd done and more. I wanted to build a better bat trap, if you will.

Before Android, mobile developers faced many roadblocks when it came to writing applications. Building the better application, the unique application, the competing application, the hybrid application, and incorporating many common tasks such as messaging and calling in a familiar way were often unrealistic goals.

To understand why, let's take a brief look at the history of mobile software development.

"The Brick"

The Motorola DynaTAC 8000X was the first commercially available cell phone. First marketed in 1983, it was 13 × 1.75 × 3.5 inches in dimension, weighed about 2.5 pounds, and allowed you to talk for a little more than half an hour. It retailed for $3,995, plus hefty monthly service fees and per-minute charges.

We called it "The Brick," and the nickname stuck for many of those early mobile phones we alternatively loved and hated. About the size of a brick, with a battery power just long enough for half a conversation, these early mobile handsets were mostly seen in the hands of traveling business execs, security personnel, and the wealthy. First-generation mobile phones were just too expensive. The service charges alone would bankrupt the average person, especially when roaming.

Early mobile phones were not particularly full featured. (Although, even the Motorola DynaTAC, shown in Figure 1.2, had many of the buttons we've come to know well, such as the SEND, END, and CLR buttons.) These early phones did little more than make and receive calls and, if you were lucky, there was a simple contacts application that wasn't impossible to use.

Figure 1.2 The first commercially available mobile phone: the Motorola DynaTAC.

The first-generation mobile phones were designed and developed by the handset manufacturers. Competition was fierce and trade secrets were closely guarded. Manufacturers didn't want to expose the internal workings of their handsets, so they usually developed the phone software in-house. As a developer, if you weren't part of this inner circle, you had no opportunity to write applications for the phones.

It was during this period that we saw the first "time-waster" games begin to appear. Nokia was famous for putting the 1970s video game Snake on some of its earliest monochrome phones. Other manufacturers followed suit, adding games such as Pong, Tetris, and Tic-Tac-Toe.

These early phones were flawed, but they did something important—they changed the way people thought about communication. As mobile phone prices dropped, batteries improved, and reception areas grew, more and more people began carrying these handy devices. Soon mobile phones were more than just a novelty.

Customers began pushing for more features and more games. But there was a problem. The handset manufacturers didn't have the motivation or the resources to build every application users wanted. They needed some way to provide a portal for entertainment and information services without allowing direct access to the handset.

What better way to provide these services than the Internet?

Wireless Application Protocol (WAP)

As it turned out, allowing direct phone access to the Internet didn't scale well for mobile.

By this time, professional websites were full color and chock full of text, images, and other sorts of media. These sites relied on JavaScript, Flash, and other technologies to enhance the user experience, and they were often designed with a target resolution of 800x600 pixels and higher.

When the first clamshell phone, the Motorola StarTAC, was released in 1996, it merely had an LCD 10-digit segmented display. (Later models would add a dot-matrix type display.) Meanwhile, Nokia released one of the first slider phones, the 8110—fondly referred to as "The Matrix Phone" because the phone was heavily used in films. The 8110 could display four lines of text with 13 characters per line. Figure 1.3 shows some of the common phone form factors.

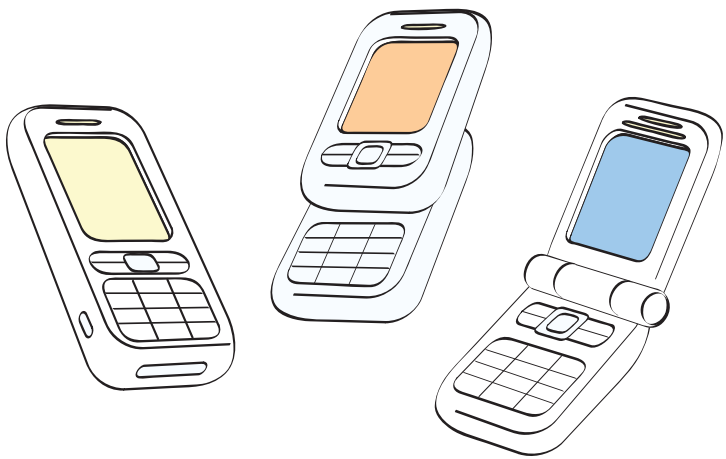

Figure 1.3 Various mobile phone form factors: the candy bar, the slider, and the clamshell.

With their postage stamp-sized low-resolution screens and limited storage and processing power, these phones couldn't handle the data-intensive operations required by traditional web browsers. The bandwidth requirements for data transmission were also costly to the user.

The Wireless Application Protocol (WAP) standard emerged to address these concerns. Simply put, WAP was a stripped-down version of HTTP, which is the backbone protocol of the Internet. Unlike traditional web browsers, WAP browsers were designed to run within the memory and bandwidth constraints of the phone. Third-party WAP sites

served up pages written in a markup language called Wireless Markup Language (WML). These pages were then displayed on the phone's WAP browser. Users navigated as they would on the Web, but the pages were much simpler in design.

The WAP solution was great for handset manufacturers. The pressure was off—they could write one WAP browser to ship with the handset and rely on developers to come up with the content users wanted.

The WAP solution was great for mobile operators. They could provide a custom WAP portal, directing their subscribers to the content they wanted to provide, and rake in the data charges associated with browsing, which were often high.

Developers and content providers didn't deliver. For the first time, developers had a chance to develop content for phone users, and some did so, with limited success.

Most of the early WAP sites were extensions of popular branded websites, such as CNN.com and ESPN.com, which were looking for new ways to extend their readership. Suddenly phone users accessed the news, stock market quotes, and sports scores on their phones.

Commercializing WAP applications was difficult, and there was no built-in billing mechanism. Some of the most popular commercial WAP applications that emerged during this time were simple wallpaper and ringtone catalogues that enabled users to personalize their phones for the first time. For example, a user browsed a WAP site and requested a specific item. He filled out a simple order form with his phone number and his handset model. It was up to the content provider to deliver an image or audio file compatible with the given phone. Payment and verification were handled through various premium-priced delivery mechanisms such as Short Message Service (SMS), Enhanced Messaging Service (EMS), Multimedia Messaging Service (MMS), and WAP Push.

WAP browsers, especially in the early days, were slow and frustrating. Typing long URLs with the numeric keypad was onerous. WAP pages were often difficult to navigate. Most WAP sites were written one time for all phones and did not account for individual phone specifications. It didn't matter if the end user's phone had a big color screen or a postage stamp-sized monochrome screen; the developer couldn't tailor the user's experience. The result was a mediocre and not very compelling experience for everyone involved.

Content providers often didn't bother with a WAP site and instead just advertised SMS short codes on TV and in magazines. In this case, the user sent a premium SMS message with a request for a specific wallpaper or ringtone, and the content provider sent it back. Mobile operators generally liked these delivery mechanisms because they received a large portion of each messaging fee.

WAP fell short of commercial expectations. In some markets, such as Japan, it flourished, whereas in others, such as the United States, it failed to take off. Handset screens were too small for surfing. Reading a sentence fragment at a time, and then waiting seconds for the next segment to download, ruined the user experience, especially because every second of downloading was often charged to the user. Critics began to call WAP "Wait and Pay."

Finally, the mobile operators who provided the WAP portal (the default home page loaded when you started your WAP browser) often restricted which WAP sites were accessible. The portal enabled the operator to restrict the number of sites users could browse and to funnel subscribers to the operator's preferred content providers and exclude competing sites. This kind of walled garden approach further discouraged third-party developers, who already faced difficulties in monetizing applications, from writing applications.

Proprietary Mobile Platforms

It came as no surprise that users wanted more—they will always want more.

Writing robust applications with WAP, such as graphic-intensive video games, was nearly impossible. The 18-year-old to 25-year-old sweet-spot demographic—the kids with the disposable income most likely to personalize their phones with wallpapers and ringtones—looked at their portable gaming systems and asked for a device that was both a phone and a gaming device or a phone and a music player. They argued that if devices such as Nintendo's Game Boy could provide hours of entertainment with only five buttons, why not just add phone capabilities? Others looked to their digital cameras, Palms, BlackBerries, iPods, and even their laptops and asked the same question. The market seemed to be teetering on the edge of device convergence.

Memory was getting cheaper, batteries were getting better, and PDAs and other embedded devices were beginning to run compact versions of common operating systems such as Linux and Windows. The traditional desktop application developer was suddenly a player in the embedded device market, especially with smartphone technologies such as Windows Mobile, which they found familiar.

Handset manufacturers realized that if they wanted to continue to sell traditional handsets, they needed to change their protectionist policies pertaining to handset design and expose their internal frameworks to some extent.

A variety of different proprietary platforms emerged—and developers are still actively creating applications for them. Some smartphone devices ran Palm OS (now Garnet OS) and RIM BlackBerry OS. Sun Microsystems took its popular Java platform and J2ME emerged (now known as Java Micro Edition [Java ME]). Chipset maker Qualcomm developed and licensed its Binary Runtime Environment for Wireless (BREW). Other platforms, such as Symbian OS, were developed by handset manufacturers such as Nokia, Sony Ericsson, Motorola, and Samsung. The Apple iPhone OS (OS X iPhone) joined the ranks in 2008. Figure 1.4 shows several different phones, all of which have different development platforms.

Many of these platforms have associated developer programs. These programs keep the developer communities small, vetted, and under contractual agreements on what they can and cannot do. These programs are often required and developers must pay for them.

Each platform has benefits and drawbacks. Of course, developers love to debate about which platform is "the best." (Hint: It's usually the platform we're currently developing for.)

The truth is that no one platform has emerged victorious. Some platforms are best suited for commercializing games and making millions—if your company has brand

backing. Other platforms are more open and suitable for the hobbyist or vertical market applications. No mobile platform is best suited for all possible applications. As a result, the mobile phone has become increasingly fragmented, with all platforms sharing part of the pie.

Figure 1.4 Phones from various mobile device platforms.

For manufacturers and mobile operators, handset product lines quickly became complicated. Platform market penetration varies greatly by region and user demographic. Instead of choosing just one platform, manufacturers and operators have been forced to sell phones for all the different platforms to compete in the market. We've even seen some handsets supporting multiple platforms. (For instance, Symbian phones often also support J2ME.)

The mobile developer community has become as fragmented as the market. It's nearly impossible to keep track of all the changes in the market. Developer specialty niches have formed. The platform development requirements vary greatly. Mobile software developers work with distinctly different programming environments, different tools, and different programming languages. Porting among the platforms is often costly and not straightforward. Keeping track of handset configurations and testing requirements, signing and certification programs, carrier relationships, and application marketplaces have become complex spin-off businesses of their own.

It's a nightmare for the ACME Company that wants a mobile application. Should it develop a J2ME application? BREW? iPhone? Windows Mobile? Everyone has a different kind of phone. ACME is forced to choose one or, worse, all of the platforms. Some platforms allow for free applications, whereas others do not. Vertical market application opportunities are limited and expensive.

As a result, many wonderful applications have not reached their desired users, and many other great ideas have not been developed at all.

The Open Handset Alliance

Enter search advertising giant Google. Now a household name, Google has shown an interest in spreading its vision, its brand, its search and ad-revenue-based platform, and its suite of tools to the wireless marketplace. The company's business model has been amazingly successful on the Internet and, technically speaking, wireless isn't that different.

Google Goes Wireless

The company's initial forays into mobile were beset with all the problems you would expect. The freedoms Internet users enjoyed were not shared by mobile phone subscribers. Internet users can choose from the wide variety of computer brands, operating systems, Internet service providers, and web browser applications.

Nearly all Google services are free and ad driven. Many applications in the Google Labs suite directly compete with the applications available on mobile phones. The applications range from simple calendars and calculators to navigation with Google Maps and the latest tailored news from News Alerts—not to mention corporate acquisitions such as Blogger and YouTube.

When this approach didn't yield the intended results, Google decided to a different approach—to revamp the entire system upon which wireless application development was based, hoping to provide a more open environment for users and developers: the Internet model. The Internet model allows users to choose between freeware, shareware, and paid software. This enables free market competition among services.

Forming the Open Handset Alliance

With its user-centric, democratic design philosophies, Google has led a movement to turn the existing closely guarded wireless market into one where phone users can move between carriers easily and have unfettered access to applications and services. With its vast resources, Google has taken a broad approach, examining the wireless infrastructure from the FCC wireless spectrum policies to the handset manufacturers' requirements, application developer needs, and mobile operator desires.

Next, Google joined with other like-minded members in the wireless community and posed the following question: What would it take to build a better mobile phone?

The Open Handset Alliance (OHA) was formed in November 2007 to answer that very question. The OHA is a business alliance comprised of many of the largest and most

successful mobile companies on the planet. Its members include chip makers, handset manufacturers, software developers, and service providers. The entire mobile supply chain is well represented.

Andy Rubin has been credited as the father of the Android platform. His company, Android Inc., was acquired by Google in 2005. Working together, OHA members, including Google, began developing a nonproprietary open standard platform based upon technology developed at Android Inc. that would aim to alleviate the aforementioned problems hindering the mobile community. The result is the Android project. To this day, most Android platform development is completed by Rubin's team at Google, where he acts as VP of Engineering and manages the Android platform roadmap.

Google's involvement in the Android project has been so extensive that the line between who takes responsibility for the Android platform (the OHA or Google) has blurred. Google hosts the Android open source project and provides online Android documentation, tools, forums, and the Software Development Kit (SDK) for developers. All major Android news originates at Google. The company has also hosted a number of events at conferences and the Android Developer Challenge (ADC), a contest to encourage developers to write killer Android applications—for $10 million dollars in prizes to spur development on the platform. The winners and their apps are listed on the Android website.

Manufacturers: Designing the Android Handsets

More than half the members of the OHA are handset manufacturers, such as Samsung, Motorola, HTC, and LG, and semiconductor companies, such as Intel, Texas Instruments, NVIDIA, and Qualcomm. These companies are helping design the first generation of Android handsets.

The first shipping Android handset—the T-Mobile G1—was developed by handset manufacturer HTC with service provided by T-Mobile. It was released in October 2008. Many other Android handsets were slated for 2009 and early 2010. The platform gained momentum relatively quickly. Each new Android device was more powerful and exciting than the last. Over the following 18 months, 60 different Android handsets (made by 21 different manufacturers) debuted across 59 carriers in 48 countries around the world. By June 2010, at an announcement of a new, highly anticipated Android handset, Google announced more than 160,000 Android devices were being activated each day (for a rate of nearly 60 million devices annually). The advantages of widespread manufacturer and carrier support appear to be really paying off at this point.

The Android platform is now considered a success. It has shaken the mobile marketplace, gaining ground steadily against competitive platforms such as the Apple iPhone, RIM BlackBerry, and Windows Mobile. The latest numbers (as of Summer 2010) show BlackBerry in the lead with a declining 31% of the smartphone market. Trailing close behind is Apple's iPhone at 28%. Android, however, is trailing with 19%, though it's gaining ground rapidly and, according to some sources, is the fastest-selling smartphone platform. Microsoft Windows Mobile has been declining and now trails Android by several percentage points.

Mobile Operators: Delivering the Android Experience

After you have the phones, you have to get them out to the users. Mobile operators from North, South, and Central America; Europe, Asia, India, Australia, Africa, and the Middle East have joined the OHA, ensuring a worldwide market for the Android movement. With almost half a billion subscribers alone, telephony giant China Mobile is a founding member of the alliance.

Much of Android's success is also due to the fact that many Android handsets don't come with the traditional "smartphone price tag"—quite a few are offered free with activation by carriers. Competitors such as the Apple iPhone have no such offering as of yet. For the first time, the average Jane or Joe can afford a feature-full phone. I've lost count of the number of times I've had a waitress, hotel night manager, or grocery store checkout person tell me that they just got an Android phone and it has changed their life. This phenomenon has only added to the Android's rising underdog status.

In the United States, the Android platform was given a healthy dose of help from carriers such as Verizon, who launched a $100 million dollar campaign for the first Droid handset. Many other Droid-style phones have followed from other carriers. Sprint recently launched the Evo 4G (America's first 4G phone) to much fanfare and record one-day sales (http://j.mp/cNhb4b).

Content Providers: Developing Android Applications

When users have Android handsets, they need those killer apps, right?

Google has led the pack, developing Android applications, many of which, such as the email client and web browser, are core features of the platform. OHA members are also working on Android application integration. eBay, for example, is working on integration with its online auctions.

The first ADC received 1,788 submissions, with the second ADC being voted upon by 26,000 Android users to pick a final 200 applications that would be judged professionally—all newly developed Android games, productivity helpers, and a slew of location-based services (LBS) applications. We also saw humanitarian, social networking, and mash-up apps. Many of these applications have debuted with users through the Android Market—Google's software distribution mechanism for Android. For now, these challenges are over. The results, though, are still impressive.

For those working on the Android platform from the beginning, handsets couldn't come fast enough. The T-Mobile G1 was the first commercial Android device on the market, but it had the air of a developer pre-release handset. Subsequent Android handsets have had much more impressive hardware, allowing developers to dive in and design awesome new applications.

As of October 2010, there are more than 80,000 applications available in the Android Market, which is growing rapidly. This takes into account only applications published through this one marketplace—not the many other applications sold individually or on other markets. This also does not take into account that, as of Android 2.2, Flash applications can run on Android handsets. This opens up even more application choices for Android users and more opportunities for Android developers.

There are now more than 180,000 Android developers writing interesting and exciting applications. By the time you finish reading this book, you will be adding your expertise to this number.

Taking Advantage of All Android Has to Offer

Android's open platform has been embraced by much of the mobile development community—extending far beyond the members of the OHA.

As Android phones and applications have become more readily available, many other mobile operators and handset manufacturers have jumped at the chance to sell Android phones to their subscribers, especially given the cost benefits compared to proprietary platforms. The open standard of the Android platform has resulted in reduced operator costs in licensing and royalties, and we are now seeing a migration to open handsets from proprietary platforms such as RIM, Windows Mobile, and the Apple iPhone. The market has cracked wide open; new types of users are able to consider smartphones for the first time. Android is well suited to fill this demand.

Android Platform Differences

Android is hailed as "the first complete, open, and free mobile platform":

- **Complete:** The designers took a comprehensive approach when they developed the Android platform. They began with a secure operating system and built a robust software framework on top that allows for rich application development opportunities.
- **Open:** The Android platform is provided through open source licensing. Developers have unprecedented access to the handset features when developing applications.
- **Free:** Android applications are free to develop. There are no licensing or royalty fees to develop on the platform. No required membership fees. No required testing fees. No required signing or certification fees. Android applications can be distributed and commercialized in a variety of ways.

Android: A Next-Generation Platform

Although Android has many innovative features not available in existing mobile platforms, its designers also leveraged many tried-and-true approaches proven to work in the wireless world. It's true that many of these features appear in existing proprietary

platforms, but Android combines them in a free and open fashion while simultaneously addressing many of the flaws on these competing platforms.

The Android mascot is a little green robot, shown in Figure 1.5. This little guy (girl?) is often used to depict Android-related materials.

Android is the first in a new generation of mobile platforms, giving its platform developers a distinct edge on the competition. Android's designers examined the benefits and drawbacks of existing platforms and then incorporated their most successful features. At the same time, Android's designers avoided the mistakes others suffered in the past.

Since the Android 1.0 SDK was released, Android platform development has continued at a fast and furious pace. For quite some time, there was a new Android SDK out every couple of months! In typical tech-sector jargon, each Android SDK has had a project name. In Android's case, the SDKs are named alphabetically after sweets (see Figure 1.6).

The latest version of Android is codenamed Gingerbread.

Figure 1.5 The Android mascot and logo.

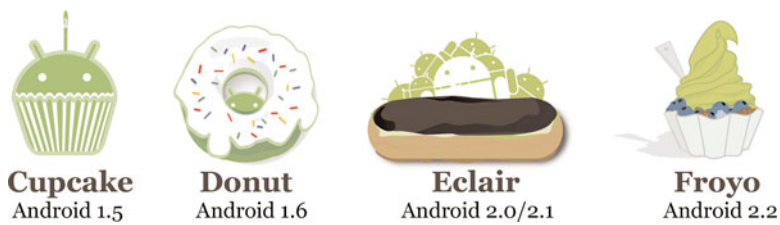

Figure 1.6 Some Android SDKs and their codenames.

Free and Open Source

Android is an open source platform. Neither developers nor handset manufacturers pay royalties or license fees to develop for the platform.

The underlying operating system of Android is licensed under GNU General Public License Version 2 (GPLv2), a strong "copyleft" license where any third-party improvements must continue to fall under the open source licensing agreement terms. The Android framework is distributed under the Apache Software License (ASL/Apache2), which allows for the distribution of both open- and closed-source derivations of the source code. Commercial developers (handset manufacturers especially) can choose to enhance the platform without having to provide their improvements to the open source community. Instead, developers can profit from enhancements such as handset-specific improvements and redistribute their work under whatever licensing they want.

Android application developers have the ability to distribute their applications under whatever licensing scheme they prefer. Developers can write open source freeware or traditional licensed applications for profit and everything in between.

Familiar and Inexpensive Development Tools

Unlike some proprietary platforms that require developer registration fees, vetting, and expensive compilers, there are no upfront costs to developing Android applications.

Freely Available Software Development Kit

The Android SDK and tools are freely available. Developers can download the Android SDK from the Android website after agreeing to the terms of the Android Software Development Kit License Agreement.

Familiar Language, Familiar Development Environments

Developers have several choices when it comes to integrated development environments (IDEs). Many developers choose the popular and freely available Eclipse IDE to design and develop Android applications. Eclipse is the most popular IDE for Android development, and there is an Android plug-in available for facilitating Android development. Android applications can be developed on the following operating systems:

- Windows XP (32-bit) or Vista (32-bit or 64-bit)
- Mac OS X 10.5.8 or later (x86 only)
- Linux (tested on Linux Ubuntu 8.04 LTS, Hardy Heron)

Reasonable Learning Curve for Developers

Android applications are written in a well-respected programming language: Java.

The Android application framework includes traditional programming constructs, such as threads and processes and specially designed data structures to encapsulate objects commonly used in mobile applications. Developers can rely on familiar class libraries, such as `java.net` and `java.text`. Specialty libraries for tasks such as graphics and database

management are implemented using well-defined open standards such as OpenGL Embedded Systems (OpenGL ES) or SQLite.

Enabling Development of Powerful Applications

In the past, handset manufacturers often established special relationships with trusted third-party software developers (OEM/ODM relationships). This elite group of software developers wrote native applications, such as messaging and web browsers, which shipped on the handset as part of the phone's core feature set. To design these applications, the manufacturer would grant the developer privileged inside access and knowledge of a handset's internal software framework and firmware.

On the Android platform, there is no distinction between native and third-party applications, enabling healthy competition among application developers. All Android applications use the same libraries. Android applications have unprecedented access to the underlying hardware, allowing developers to write much more powerful applications. Applications can be extended or replaced altogether. For example, Android developers are now free to design email clients tailored to specific email servers, such as Microsoft Exchange or Lotus Notes.

Rich, Secure Application Integration

Recall from the bat story I previously shared that I accessed a variety of phone applications in the course of a few moments: text messaging, phone dialer, camera, email, picture messaging, and the browser. Each was a separate application running on the phone—some built-in and some purchased. Each had its own unique user interface. None were truly integrated.

Not so with Android. One of the Android platform's most compelling and innovative features is well-designed application integration. Android provides all the tools necessary to build a better "bat trap," if you will, by allowing developers to write applications that seamlessly leverage core functionality such as web browsing, mapping, contact management, and messaging. Applications can also become content providers and share their data among each other in a secure fashion.

Platforms such as Symbian have suffered from setbacks due to malware. Android's vigorous application security model helps protect the user and the system from malicious software.

No Costly Obstacles to Publication

Android applications have none of the costly and time-intensive testing and certification programs required by other platforms such as BREW and Symbian.

A "Free Market" for Applications

Android developers are free to choose any kind of revenue model they want. They can develop freeware, shareware, or trial-ware applications, ad-driven, and paid applications. Android was designed to fundamentally change the rules about what kind of wireless applications could be developed. In the past, developers faced many restrictions that had little to do with the application functionality or features:

- Store limitations on the number of competing applications of a given type
- Store limitations on pricing, revenue models, and royalties
- Operator unwillingness to provide applications for smaller demographics

With Android, developers can write and successfully publish any kind of application they want. Developers can tailor applications to small demographics, instead of just large-scale money-making ones often insisted upon by mobile operators. Vertical market applications can be deployed to specific, targeted users.

Because developers have a variety of application distribution mechanisms to choose from, they can pick the methods that work for them instead of being forced to play by others' rules. Android developers can distribute their applications to users in a variety of ways:

- Google developed the Android Market (see Figure 1.7), a generic Android application store with a revenue-sharing model.

Figure 1.7 The Android market.

- Handango.com added Android applications to its existing catalogue using their billing models and revenue-sharing model.
- Developers can come up with their own delivery and payment mechanisms.

Mobile operators are still free to develop their own application stores and enforce their own rules, but it will no longer be the only opportunity developers have to distribute their applications.

A New and Growing Platform

Android might be the next generation in mobile platforms, but the technology is still in its early stages. Early Android developers have had to deal with the typical roadblocks associated with a new platform: frequently revised SDKs, lack of good documentation, and market uncertainties.

On the other hand, developers diving into Android development now benefit from the first-to-market competitive advantages we've seen on other platforms such as BREW

and Symbian. Early developers who give feedback are more likely to have an impact on the long-term design of the Android platform and what features will come in the next version of the SDK. Finally, the Android forum community is lively and friendly. Incentive programs, such as the ADC, have encouraged many new developers to dig into the platform.

Each new version of the Android SDK has provided a number of substantial improvements to the platform. In recent revisions, the Android platform has received some much-needed UI "polish," both in terms of visual appeal and performance. Although most of these upgrades and improvements were welcome and necessary, new SDK versions often cause some upheaval within the Android developer community. A number of published applications have required retesting and resubmission to the Android Marketplace to conform to new SDK requirements, which are quickly rolled out to all Android phones in the field as a firmware upgrade, rendering older applications obsolete.

Some older Android handsets are not capable of running the latest versions of the platform. This means that Android developers often need to target several different SDK versions to reach all users. Luckily, the Android development tools make this easier than ever.

The Android Platform

Android is an operating system and a software platform upon which applications are developed. A core set of applications for everyday tasks, such as web browsing and email, are included on Android handsets.

As a product of the OHA's vision for a robust and open source development environment for wireless, Android is an emerging mobile development platform. The platform was designed for the sole purpose of encouraging a free and open market that all mobile applications phone users might want to have and software developers might want to develop.

Android's Underlying Architecture

The Android platform is designed to be more fault-tolerant than many of its predecessors. The handset runs a Linux operating system upon which Android applications are executed in a secure fashion. Each Android application runs in its own virtual machine (see Figure 1.8). Android applications are managed code; therefore, they are much less likely to cause the phone to crash, leading to fewer instances of device corruption (also called "bricking" the phone, or rendering it useless).

The Linux Operating System

The Linux 2.6 kernel handles core system services and acts as a hardware abstraction layer (HAL) between the physical hardware of the handset and the Android software stack.

Some of the core functions the kernel handles include

- Enforcement of application permissions and security
- Low-level memory management

- Process management and threading
- The network stack
- Display, keypad input, camera, Wi-Fi, Flash memory, audio, and binder (IPC) driver access

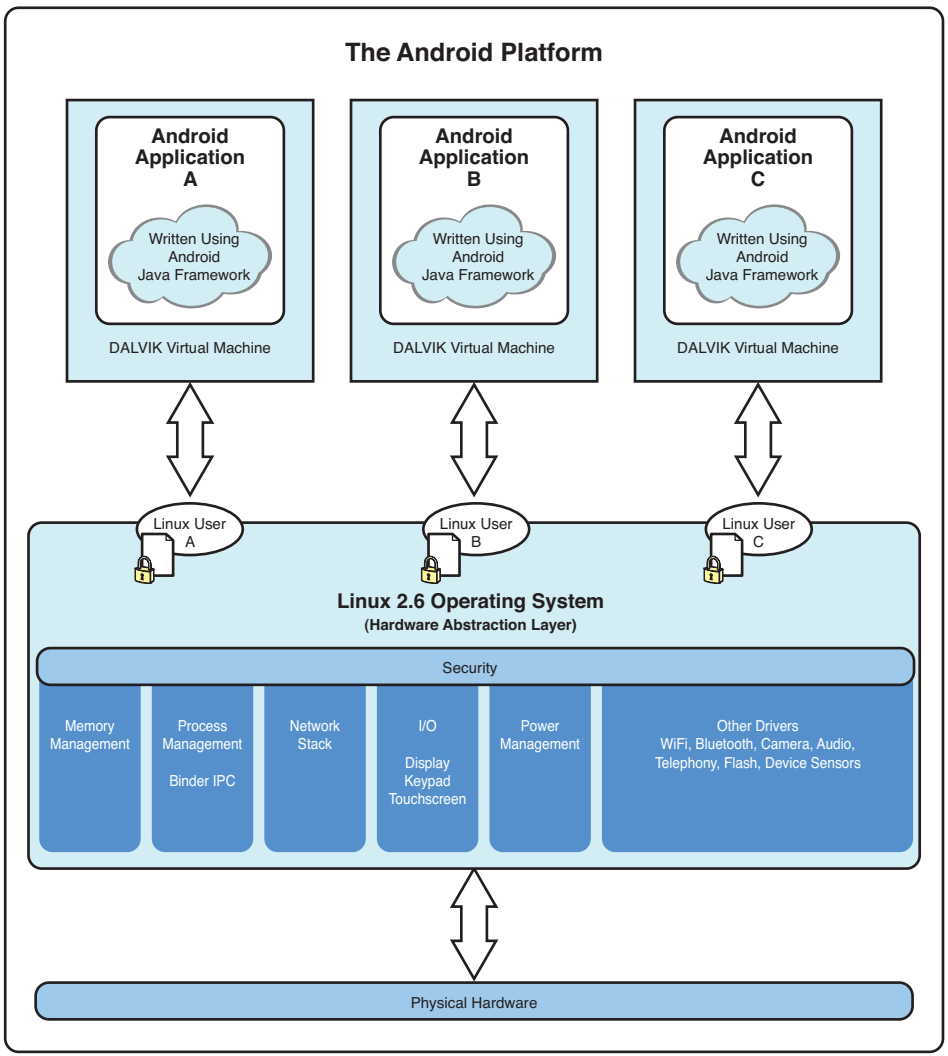

Figure 1.8 Diagram of the Android platform architecture.

Android Application Runtime Environment

Each Android application runs in a separate process, with its own instance of the Dalvik virtual machine (VM). Based on the Java VM, the Dalvik design has been optimized for mobile devices. The Dalvik VM has a small memory footprint, and multiple instances of the Dalvik VM can run concurrently on the handset.

Security and Permissions

The integrity of the Android platform is maintained through a variety of security measures. These measures help ensure that the user's data is secure and that the device is not subjected to malware.

Applications as Operating System Users

When an application is installed, the operating system creates a new user profile associated with the application. Each application runs as a different user, with its own private files on the file system, a user ID, and a secure operating environment.

The application executes in its own process with its own instance of the Dalvik VM and under its own user ID on the operating system.

Explicitly Defined Application Permissions

To access shared resources on the system, Android applications register for the specific privileges they require. Some of these privileges enable the application to use phone functionality to make calls, access the network, and control the camera and other hardware sensors. Applications also require permission to access shared data containing private and personal information, such as user preferences, user's location, and contact information.

Applications might also enforce their own permissions by declaring them for other applications to use. The application can declare any number of different permission types, such as read-only or read-write permissions, for finer control over the application.

Limited Ad-Hoc Permissions

Applications that act as content providers might want to provide some on-the-fly permissions to other applications for specific information they want to share openly. This is done using ad-hoc granting and revoking of access to specific resources using Uniform Resource Identifiers (URIs).

URIs index specific data assets on the system, such as images and text. Here is an example of a URI that provides the phone numbers of all contacts:

```
content://contacts/phones
```

To understand how this permission process works, let's look at an example.

Let's say we have an application that keeps track of the user's public and private birthday wish lists. If this application wanted to share its data with other applications, it could grant URI permissions for the public wish list, allowing another application permission to access this list without explicitly having to ask for it.

Application Signing for Trust Relationships

All Android applications packages are signed with a certificate, so users know that the application is authentic. The private key for the certificate is held by the developer. This helps establish a trust relationship between the developer and the user. It also enables the developer to control which applications can grant access to one another on the system. No certificate authority is necessary; self-signed certificates are acceptable.

Marketplace Developer Registration

To publish applications on the popular Android Market, developers must create a developer account. The Android Market is managed closely and no malware is tolerated.

Developing Android Applications

The Android SDK provides an extensive set of application programming interfaces (APIs) that is both modern and robust. Android handset core system services are exposed and accessible to all applications. When granted the appropriate permissions, Android applications can share data among one another and access shared resources on the system securely.

Android Programming Language Choices

Android applications are written in Java (see Figure 1.9). For now, the Java language is the developer's only choice on the Android platform.

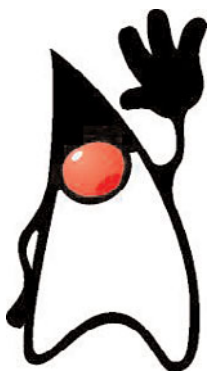

Figure 1.9 Duke, the Java mascot.

There has been some speculation that other programming languages, such as C++, might be added in future versions of Android. If your application must rely on native code in another language such as C or C++, you might want to consider integrating it using the Android Native Development Kit (NDK). We talk more about this in Chapter 18, "Using the Android NDK."

No Distinctions Made Between Native and Third-Party Applications

Unlike other mobile development platforms, there is no distinction between native applications and developer-created applications on the Android platform. Provided the application is granted the appropriate permissions, all applications have the same access to core libraries and the underlying hardware interfaces.

Android handsets ship with a set of native applications such as a web browser and contact manager. Third-party applications might integrate with these core applications, extend them to provide a rich user experience, or replace them entirely with alternative applications.

Commonly Used Packages

With Android, mobile developers no longer have to reinvent the wheel. Instead, developers use familiar class libraries exposed through Android's Java packages to perform common tasks such as graphics, database access, network access, secure communications, and utilities (such as XML parsing).

The Android packages include support for

- Common user interface widgets (Buttons, Spin Controls, Text Input)
- User interface layout
- Secure networking and web browsing features (SSL, WebKit)
- Structured storage and relational databases (SQLite)
- Powerful 2D and 3D graphics (including SGL and OpenGL ES)
- Audio and visual media formats (MPEG4, MP3, Still Images)
- Access to optional hardware such as location-based services (LBS), Wi-Fi, Bluetooth, and hardware sensors

Android Application Framework

The Android application framework provides everything necessary to implement your average application. The Android application lifecycle involves the following key components:

- Activities are functions the application performs.
- Groups of views define the application's layout.
- Intents inform the system about an application's plans.
- Services allow for background processing without user interaction.
- Notifications alert the user when something interesting happens.

Android applications can interact with the operating system and underlying hardware using a collection of managers. Each manager is responsible for keeping the state of some underlying system service. For example, there is a `LocationManager` that facilitates interaction with the location-based services available on the handset. The `ViewManager` and `WindowManager` manage user interface fundamentals.

Applications can interact with one another by using or acting as a `ContentProvider`. Built-in applications such as the Contact manager are content providers, allowing third-party applications to access contact data and use it in an infinite number of ways. The sky is the limit.

Summary

Mobile software development has evolved over time. Android has emerged as a new mobile development platform, building on past successes and avoiding past failures of other platforms. Android was designed to empower the developer to write innovative applications. The platform is open source, with no up-front fees, and developers enjoy many benefits over other competing platforms. Now it's time to dive deeper and start writing Android code, so you can evaluate what Android can do for you.

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http://developer.android.com
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http://www.openhandsetalliance.com

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