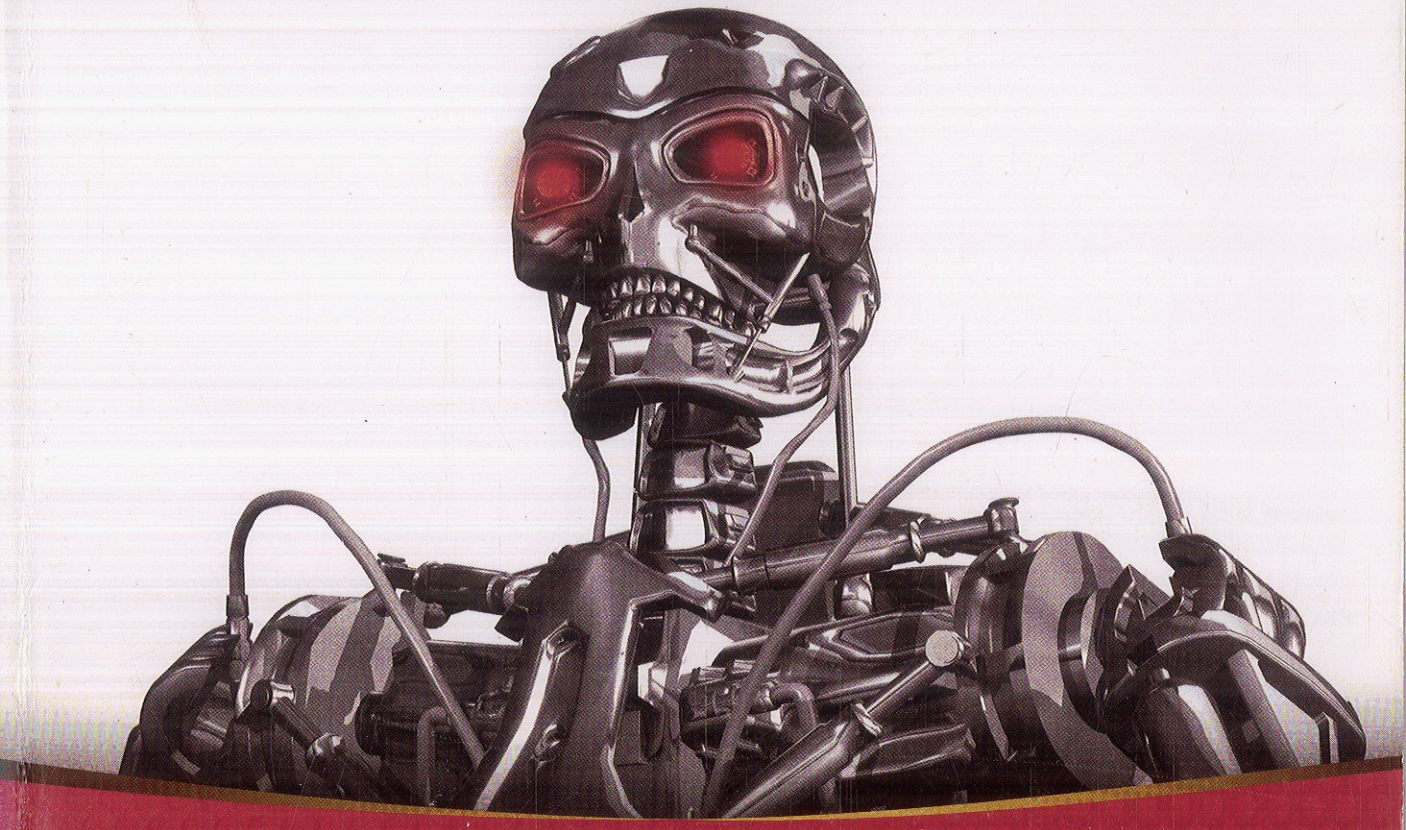

Professional Android™ 2 Application Development

Reto Meier

CONTENTS

INTRODUCTION *xxvii*

CHAPTER 1: HELLO, ANDROID 1

A Little Background 2
The Not-So-Distant Past 2
The Future 3
What It Isn't 3
Android: An Open Platform for Mobile Development 4
Native Android Applications 5
Android SDK Features 6
Access to Hardware, Including Camera, GPS, and Accelerometer 6
Native Google Maps, Geocoding, and Location-Based Services 7
Background Services 7
SQLite Database for Data Storage and Retrieval 7
Shared Data and Interapplication Communication 7
Using Widgets, Live Folders, and Live Wallpaper to Enhance the Home Screen 8
Extensive Media Support and 2D/3D Graphics 8
Optimized Memory and Process Management 8
Introducing the Open Handset Alliance 9
What Does Android Run On? 9
Why Develop for Mobile? 9
Why Develop for Android? 10
What Has and Will Continue to Drive Android Adoption? 10
What Does It Have That Others Don't? 11
Changing the Mobile Development Landscape 11
Introducing the Development Framework 12
What Comes in the Box 12
Understanding the Android Software Stack 13
The Dalvik Virtual Machine 14
Android Application Architecture 15
Android Libraries 16
Summary 16

CHAPTER 2: GETTING STARTED 17

Developing for Android 18
What You Need to Begin 18
Downloading and Installing the SDK 18
Developing with Eclipse 19
Using the Eclipse Plug-In 20
Creating Your First Android Application 23
Starting a New Android Project 23
Creating a Launch Configuration 24
Running and Debugging Your Android Applications 26
Understanding Hello World 26
Types of Android Applications 29
Foreground Applications 29
Background Services and Intent Receivers 29
Intermittent Applications 30
Widgets 30
Developing for Mobile Devices 30
Hardware-Imposed Design Considerations 30
Be Efficient 31
Expect Limited Capacity 31
Design for Small Screens 32
Expect Low Speeds, High Latency 32
At What Cost? 33
Considering the Users' Environment 34
Developing for Android 35
Being Fast and Efficient 35
Being Responsive 36
Developing Secure Applications 37
Ensuring a Seamless User Experience 37
To-Do List Example 38
Android Development Tools 43
The Android Virtual Device and SDK Manager 44
Android Virtual Devices 44
SDK Manager 45
The Android Emulator 46
Dalvik Debug Monitor Service (DDMS) 47
The Android Debug Bridge (ADB) 47
Summary 48

CHAPTER 3: CREATING APPLICATIONS AND ACTIVITIES 49

What Makes an Android Application? 50
Introducing the Application Manifest 51
Using the Manifest Editor 56
The Android Application Life Cycle 57
Understanding Application Priority and Process States 58
Externalizing Resources 59
Creating Resources 60
Creating Simple Values 60
Styles and Themes 62
Drawables 63
Layouts 63
Animations 64
Menus 66
Using Resources 67
Using Resources in Code 67
Referencing Resources within Resources 68
Using System Resources 69
Referring to Styles in the Current Theme 70
To-Do List Resources Example 70
Creating Resources for Different Languages and Hardware 71
Runtime Configuration Changes 72
Introducing the Android Application Class 74
Extending and Using the Application Class 74
Overriding the Application Life Cycle Events 75
A Closer Look at Android Activities 76
Creating an Activity 77
The Activity Life Cycle 78
Activity Stacks 78
Activity States 79
Monitoring State Changes 80
Understanding Activity Lifetimes 82
Android Activity Classes 84
Summary 84

CHAPTER 4: CREATING USER INTERFACES 85

Fundamental Android UI Design 86
Introducing Views 86

Creating Activity User Interfaces with Views 87
The Android Widget Toolbox 88
Introducing Layouts 89
Using Layouts 89
Optimizing Layouts 91
Creating New Views 91
Modifying Existing Views 92
Customizing Your To-Do List 93
Creating Compound Controls 96
Creating Custom Views 99
Creating a New Visual Interface 99
Handling User Interaction Events 104
Creating a Compass View Example 105
Using Custom Controls 110
***Drawable Resources* 111**
Shapes, Colors, and Gradients 111
Color Drawable 111
Shape Drawable 111
Gradient Drawable 113
Composite Drawables 114
Transformative Drawables 114
Layer Drawable 116
State List Drawables 116
Level List Drawables 116
NinePatch Drawable 117
Resolution and Density Independence 117
The Resource Framework and Resolution Independence 118
Resource Qualifiers for Screen Size and Pixel Density 118
Specifying Supported Screen Sizes 119
Best Practices for Resolution Independence 119
Relative Layouts and Density-Independent Pixels 120
Using Scalable Graphics Assets 120
Provide Optimized Resources for Different Screens 121
Testing, Testing, Testing 121
Emulator Skins 122
Testing for Custom Resolutions and Screen Sizes 122
Creating and Using Menus 123
Introducing the Android Menu System 123
Defining an Activity Menu 124
Menu Item Options 126

Dynamically Updating Menu Items 127
Handling Menu Selections 127
Submenus and Context Menus 128
Creating Submenus 128
Using Context Menus 128
Defining Menus in XML 130
To-Do List Example Continued 131
Summary 136

CHAPTER 5: INTENTS, BROADCAST RECEIVERS, ADAPTERS, AND THE INTERNET 137

Introducing Intents 138
Using Intents to Launch Activities 138
Explicitly Starting New Activities 139
Implicit Intents and Late Runtime Binding 139
Returning Results from Activities 140
Native Android Actions 143
Using Intent Filters to Service Implicit Intents 144
How Android Resolves Intent Filters 146
Finding and Using the Launch Intent Within an Activity 147
Passing on Responsibility 147
Select a Contact Example 148
Using Intent Filters for Plug-Ins and Extensibility 152
Supplying Anonymous Actions to Applications 153
Incorporating Anonymous Actions in Your Activity's Menu 154
Introducing Linkify 155
The Native Linkify Link Types 155
Creating Custom Link Strings 156
Using the Match Filter 157
Using the Transform Filter 157
Using Intents to Broadcast Events 157
Broadcasting Events with Intents 158
Listening for Broadcasts with Broadcast Receivers 158
Broadcasting Sticky and Ordered Intents 161
Native Android Broadcast Actions 161
Introducing Pending Intents 162
Introducing Adapters 163
Introducing Some Native Adapters 163
Customizing the Array Adapter 163
Using Adapters for Data Binding 164

Customizing the To-Do List Array Adapter 165
Using the Simple Cursor Adapter 169
Using Internet Resources 170
Connecting to an Internet Resource 170
Using Internet Resources 171
Introducing Dialogs 172
Introducing the Dialog Classes 172
The Alert Dialog Class 173
Specialist Input Dialogs 174
Using Activities as Dialogs 174
Managing and Displaying Dialogs 175
Creating an Earthquake Viewer 176
Summary 184

CHAPTER 6: FILES, SAVING STATE, AND PREFERENCES 187

Saving Simple Application Data 188
Creating and Saving Preferences 188
Retrieving Shared Preferences 189
Creating a Settings Activity for the Earthquake Viewer 189
Introducing the Preference Activity and Preferences Framework 197
Defining a Preference Screen Layout in XML 198
Native Preference Controls 199
Using Intents to Import System Preference Screens 200
Introducing the Preference Activity 200
Finding and Using Preference Screen Shared Preferences 201
Introducing Shared Preference Change Listeners 201
Creating a Standard Preference Activity for the Earthquake Viewer 202
Saving Activity State 203
Saving and Restoring Instance State 203
Saving the To-Do List Activity State 205
Saving and Loading Files 207
Including Static Files as Resources 207
File Management Tools 208
Summary 208

CHAPTER 7: DATABASES AND CONTENT PROVIDERS 209

Introducing Android Databases 209
Introducing SQLite Databases 210
Introducing Content Providers 210

Introducing SQLite 210
Cursors and Content Values 211
Working with SQLite Databases 211
Introducing the SQLiteOpenHelper 214
Opening and Creating Databases without SQLiteHelper 215
Android Database Design Considerations 215
Querying a Database 215
Extracting Results from a Cursor 216
Adding, Updating, and Removing Rows 217
Inserting New Rows 217
Updating a Row 218
Deleting Rows 218
Saving Your To-Do List 218
Creating a New Content Provider 224
Exposing Access to the Data Source 225
Registering Your Provider 227
Using Content Providers 227
Introducing Content Resolvers 227
Querying for Content 228
Adding, Updating, and Deleting Content 228
Inserts 228
Deletes 229
Updates 229
Accessing Files in Content Providers 230
Creating and Using an Earthquake Content Provider 230
Creating the Content Provider 230
Using the Provider 236
Native Android Content Providers 238
Using the Media Store Provider 239
Using the Contacts Provider 240
Introducing the Contacts Contract Content Provider 240
Reading Contact Details 240
Modifying and Augmenting Contact Details 243
Summary 244

CHAPTER 8: MAPS, GEOCODING, AND LOCATION-BASED SERVICES 245

Using Location-Based Services 246
Configuring the Emulator to Test Location-Based Services 246
Updating Locations in Emulator Location Providers 246

Selecting a Location Provider **247**
Finding the Available Providers 248
Finding Location Providers Using Criteria 248
Finding Your Location **249**
'Where Am I?' Example 250
Tracking Movement 252
Updating Your Location in 'Where Am I?' 253
Using Proximity Alerts **255**
Using the Geocoder **256**
Reverse Geocoding 257
Forward Geocoding 258
Geocoding 'Where Am I?' 259
Creating Map-Based Activities **260**
Introducing Map View and Map Activity 260
Getting Your Maps API Key 261
Getting Your Development/Debugging MD5 Fingerprint 261
Getting your Production/Release MD5 Fingerprint 262
Creating a Map-Based Activity 262
Configuring and Using Map Views 263
Using the Map Controller 264
Mapping 'Where Am I?' 265
Creating and Using Overlays 268
Creating New Overlays 268
Introducing Projections 269
Drawing on the Overlay Canvas 269
Handling Map Tap Events 270
Adding and Removing Overlays 271
Annotating 'Where Am I?' 271
Introducing My Location Overlay 275
Introducing Itemized Overlays and Overlay Items 275
Pinning Views to the Map and Map Positions 278
Mapping Earthquakes Example **279**
Summary **284**

CHAPTER 9: WORKING IN THE BACKGROUND **285**

Introducing Services **286**
Creating and Controlling Services 287
Creating a Service 287
Registering a Service in the Manifest 289
Self-Terminating a Service 289

Starting, Controlling, and Interacting with a Service 290
An Earthquake Monitoring Service Example 290
Binding Activities to Services 297
Prioritizing Background Services 299
Using Background Threads 300
Using AsyncTask to Run Asynchronous Tasks 301
Creating a New Asynchronous Task 301
Running an Asynchronous Task 302
Moving the Earthquake Service to a Background Thread Using AsyncTask 303
Manual Thread Creation and GUI Thread Synchronization 304
Creating a New Thread 304
Using the Handler for Performing GUI Operations 304
Let's Make a Toast 306
Customizing Toasts 306
Using Toasts in Worker Threads 308
Introducing Notifications 309
Introducing the Notification Manager 310
Creating Notifications 310
Creating a Notification and Configuring the Status Bar Icon 310
Configuring the Extended Status Notification Display 311
Triggering Notifications 313
Adding Notifications and Toasts to the Earthquake Monitor 314
Advanced Notification Techniques 316
Using the Defaults 317
Making Sounds 317
Vibrating the Phone 317
Flashing the Lights 318
Ongoing and Insistent Notifications 319
Using Alarms 320
Setting Repeating Alarms 322
Using Repeating Alarms to Update Earthquakes 323
Summary 325

CHAPTER 10: INVADING THE PHONE-TOP 327

Introducing Home-Screen Widgets 328
Creating App Widgets 328
Creating the Widget Layout 329
Widget Design Guidelines 329
Supported Widget Views and Layouts 330
Defining Your Widget Settings 331

Creating Your Widget Intent Receiver and Adding It to the Application Manifest 332
Introducing Remote Views and the App Widget Manager 333
Creating Remote Views and Using the App Widget Manager to Apply Them 333
Using a Remote View within the App Widget Provider's onUpdate Handler 334
Using Remote Views to Modify UI 335
Making Your Widgets Interactive 335
Refreshing Your Widgets 337
Using the Minimum Update Rate 337
Listening for Intents 338
Using Alarms 339
Creating and Using a Widget Configuration Activity 340
Creating an Earthquake Widget 341
Introducing Live Folders 346
Creating Live Folders 346
Live Folder Content Providers 347
Live Folder Activity 348
Creating an Earthquake Live Folder 349
Adding Search to Your Applications and the Quick Search Box 351
Adding Search to Your Application 351
Creating a Search Activity 352
Responding to Search Queries from a Content Provider 353
Surfacing Search Results to the Quick Search Box 355
Adding Search to the Earthquake Example 355
Creating Live Wallpaper 358
Creating a Live Wallpaper Definition Resource 359
Creating a Wallpaper Service 359
Creating a Wallpaper Service Engine 360
Summary 361

CHAPTER 11: AUDIO, VIDEO, AND USING THE CAMERA 363

Playing Audio and Video 364
Introducing the Media Player 364
Preparing Audio for Playback 365
Packaging Audio as an Application Resource 365
Initializing Audio Content for Playback 365
Preparing for Video Playback 366
Playing Video Using the Video View 367

Setting up a Surface for Video Playback 367
Initializing Video Content for Playback 369
Controlling Playback 370
Managing Media Playback Output 370
Recording Audio and Video 371
Using Intents to Record Video 371
Using the Media Recorder 372
Configuring and Controlling Video Recording 373
Previewing Video Recording 374
Using the Camera and Taking Pictures 375
Using Intents to Take Pictures 375
Controlling the Camera and Taking Pictures 377
Controlling and Monitoring Camera Settings and Image Options 377
Monitoring Auto Focus 379
Using the Camera Preview 379
Taking a Picture 381
Reading and Writing JPEG EXIF Image Details 381
Adding New Media to the Media Store 382
Using the Media Scanner 382
Inserting Media into the Media Store 383
Raw Audio Manipulation 384
Recording Sound with Audio Record 384
Playing Sound with Audio Track 385
Speech Recognition 386
Summary 388

CHAPTER 12: TELEPHONY AND SMS 389

Telephony 390
Launching the Dialer to Initiate Phone Calls 390
Replacing the Native Dialer 390
Accessing Phone and Network Properties and Status 392
Reading Phone Device Details 392
Reading Data Connection and Transfer State 392
Reading Network Details 393
Reading SIM Details 394
Monitoring Changes in Phone State, Phone Activity, and Data Connections 395
Monitoring Incoming Phone Calls 396
Tracking Cell Location Changes 396
Tracking Service Changes 397
Monitoring Data Connectivity and Activity 398

Introducing SMS and MMS 398
Using SMS and MMS in Your Application 399
Sending SMS and MMS from Your Application Using Intents and the Native Client 399
Sending SMS Messages Manually 400
Sending Text Messages 400
Tracking and Confirming SMS Message Delivery 401
Conforming to the Maximum SMS Message Size 402
Sending Data Messages 403
Listening for Incoming SMS Messages 403
Simulating Incoming SMS Messages in the Emulator 405
Handling Data SMS Messages 406
Emergency Responder SMS Example 406
Automating the Emergency Responder 415
Summary 423

CHAPTER 13: BLUETOOTH, NETWORKS, AND WI-FI 425

Using Bluetooth 425
Accessing the Local Bluetooth Device Adapter 426
Managing Bluetooth Properties and State 427
Being Discoverable and Remote Device Discovery 430
Managing Device Discoverability 430
Discovering Remote Devices 431
Bluetooth Communications 433
Opening a Bluetooth Server Socket Listener 434
Selecting Remote Bluetooth Devices for Communications 435
Opening a Client Bluetooth Socket Connection 437
Transmitting Data Using Bluetooth Sockets 438
Bluetooth Data Transfer Example 439
Managing Network Connectivity 448
Introducing the Connectivity Manager 448
Reading User Preferences for Background Data Transfer 449
Monitoring Network Details 450
Finding and Configuring Network Preferences and Controlling Hardware Radios 451
Monitoring Network Connectivity 451
Managing Your Wi-Fi 452
Monitoring Wi-Fi Connectivity 452
Monitoring Active Connection Details 453
Scanning for Hotspots 453

Managing Wi-Fi Configurations 454
Creating Wi-Fi Network Configurations 455
Summary 455

CHAPTER 14: SENSORS 457

Using Sensors and the Sensor Manager 458
Introducing Sensors 458
Supported Android Sensors 458
Finding Sensors 459
Using Sensors 459
Interpreting Sensor Values 461
Using the Compass, Accelerometer, and Orientation Sensors 462
Introducing Accelerometers 462
Detecting Acceleration Changes 463
Creating a G-Forceometer 464
Determining Your Orientation 467
Determining Orientation Using the Orientation Sensor 468
Calculating Orientation Using the Accelerometer and Magnetic Field Sensors 468
Remapping the Orientation Reference Frame 470
Creating a Compass and Artificial Horizon 470
Controlling Device Vibration 474
Summary 475

CHAPTER 15: ADVANCED ANDROID DEVELOPMENT 477

Paranoid Android 478
Linux Kernel Security 478
Introducing Permissions 478
Declaring and Enforcing Permissions 479
Enforcing Permissions for Broadcast Intents 480
Using Wake Locks 480
Introducing Android Text to Speech 481
Using AIDL to Support IPC for Services 483
Implementing an AIDL Interface 484
Passing Class Objects as Parcelables 484
Creating the AIDL Service Definition 486
Implementing and Exposing the IPC Interface 487
Using Internet Services 488
Building Rich User Interfaces 489

Working with Animations 489
Introducing Tweened Animations 490
Creating Tweened Animations 490
Applying Tweened Animations 492
Using Animation Listeners 492
Animated Sliding User Interface Example 493
Animating Layouts and View Groups 498
Creating and Using Frame-by-Frame Animations 500
Advanced Canvas Drawing 501
What Can You Draw? 501
Getting the Most from Your Paint 502
Improving Paint Quality with Anti-Aliasing 507
Canvas Drawing Best Practice 507
Advanced Compass Face Example 508
Bringing Map Overlays to Life 516
Introducing the Surface View 517
When Should You Use a Surface View? 517
Creating a New Surface View 517
Creating 3D Controls with a Surface View 519
Creating Interactive Controls 520
Using the Touch Screen 520
Using the Device Keys, Buttons, and D-Pad 524
Using the On Key Listener 525
Using the Trackball 526
Summary **526**

INDEX ***529***