



G5 - Android for Industrial System Control

Building friendly interfaces for industrial systems with Android

Objectives

- Discover the Android system architecture.
- Learn to configure and compile the Android sources to get a working system.
- Understand the Android SDK and NDK
 - Learn how to build a simple application
 - Learn the basics of man-machine Interface with Android
 - Discover how to interface Java code and native code
- Explore the Android source code architecture
 - The Android init process
 - System services
 - The Android Hardware Abstraction Layer

Labs are conducted on i.MX6 or i.MX8 boards

We use the last open source version of Android, as available on the board.

For on-site trainings, if suitable Linux workstations are not available, we provide virtual machine images for VirtualBox; the only requisite is then a recent 64bit PC with at least 8Gb of RAM and 100Gb of free disk space.

Who should attend this course?

- Engineers that must develop Android applications to control industrial systems.
- Architects that want to understand the benefit they may obtain from using Android in their products.

What you will be able to do after the training

- Install Android on an embedded platform
- Interface an Android platform with an external system
- Create a typical Android Embedded application.

Prerequisite

- Basic Linux user experience
- Basic C (or C++) programming skills
- Due to the high degree of advanced Java techniques being used, good Java development skills are mandatory
 - See our [L4G - Java for Android](#) course for quickly learning the necessary Java techniques

Course environment

- Printed course material (in English).
- One Linux PC for two trainees.
- One target Android platform (dual Cortex/A9) for two trainees
- External sensor hardware on an Arduino board connected in USB with the Android platform

Target Audience

- Any embedded systems engineer or technician with the above prerequisites.

Course Outline

First Day

Android Architecture Overview

- Linux and Android
- Android licensing

The Android Build System

- The Android code base
- Building Android
 - The Android build environment
 - The Android build system
 - The Android.mk files
- Adding new components to the build system
 - Java components
 - Native components
 - Applications

Exercise: Compiling the Android platform

Android Application Structure

- Structure of an Android Application
- Android application components
 - Activity
 - Service
 - Broadcast receiver
 - Content provider
- Manifest file
 - Application components declaration
 - Permissions

Exercise: Hello world application

- User interface configuration
 - Depending on the language
 - Depending on screen characteristics (dimensions, orientation&)

Exercise: Multilingual Hello world (Deutsch-English-Français)

The Android System Initialization

- Android properties
- The Android initialization
 - Structure of the init process
 - The Android initialization language
- The Dalvik Java virtual machine
 - The Dalvik machine structure
 - The Dalvik bytecodes
 - The Dalvik zygote process

Exercise: Tailoring Android initialization to start additional system daemons

Second Day

Activities and user interface

- Activities life cycle
- Activity callbacks
 - onCreate
 - onStart&
- Intents and Intents filter
 - The Intent class Intent
 - Declaring Intent filters in manifest files
- Activity invocation with and without results
 - startActivity
 - startActivityForResult
- Tasks (activities stack) and navigation between activities

Exercise: Writing a simplified parameter entry application

Defining user interface layout

- Layouts
 - Layout kinds
 - Components properties related to layouts
- Resources
 - Strings
 - images
 - layouts&
- Views
 - Buttons, labels and edition fields
 - View instantiation from a resource
- Specialized views
 - ListView
 - Data binding (Adapter class and subclasses)
- User Input
 - Touch screen and keyboard
 - Software keyboard management
- Dialogs and User notifications
 - Dialog box
 - Status Bar
 - Toast

Exercise: Writing a simple Command and Control application

The Android Sensors

- Sensors in Android
 - The sensor types
 - The Sensor Manager
 - Accessing Sensors
- Framework Architecture
 - Sensor discovery
 - Sensor Calibration

Exercise: Getting and displaying a sensor value (temperature...)

Third day

Android as a Distributed System

- The Android Binder architecture
- Binder implementation
 - The AIDL language
 - The AIDL tool
 - Binder Java classes
- Writing Application Services
- System services
 - What is a system service
 - Static and context-dependent services
 - Structure of a system service
 - Adding a new system service
 - The system ServiceManager process

Exercise: Coding a service to control an external device

Android Native Interface

- The Android NDK
 - Defining Java methods in C++
 - JNI for Android
- Integrating native code in a package
 - Using the NDK from Eclipse
 - Debugging native code

Exercise: Displaying data fetched from an external device

Advanced User Interface

- User interface and multithreading
 - Accessing views from another thread

Exercise: Multi-threaded user interface with buttons and progress bars

- Custom control creation
 - By deriving directly the View class
 - By deriving an existing view
- 2D Drawing
 - Canvas and Shapes
 - Drawing from the main thread
 - Drawing from another thread

Exercise: Displaying a graph of sensor values

Data management

- Storage
 - Shared preferences
 - Internal storage
 - External storage
 - SQLite
- Content provider
 - Communication with a content provider
 - Implementing a content provider

Exercise: Logging data fetched from the external device and displaying historical data

Fourth Day

Broadcast Receivers

- Installing a Broadcast Receiver
 - Static creation of broadcast receivers
 - Dynamic instantiation and registration
- Broadcasting intents
 - Normal broadcast
 - Ordered broadcast
- Using PendingIntent in broadcast receivers
- System broadcasted events

Exercise: Handling process alarms in a custom broadcast receiver

Networking

- Connections management
- Sockets
- HTTP requests
- WebView control
- Web Services

Exercise: Socket communications with a distant management application

The Hardware Abstraction Layer

- Why a HAL?
- HAL Component Structure
 - Defining HAL components
 - Loading and using HAL component
- The standard HAL components
 - Graphics
 - Audio
 - Camera
 - Bluetooth
 - GPS
 - Sensors

Exercise: Create a simple HAL component