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 Androidcourse 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

Plan

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

Exercice: *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

Exercice: *Hello world application*

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

Exercice: *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

Exercice: *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

Exercice: *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

Exercice: *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

Exercice: *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

Exercice: *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

Exercice: *Displaying data fetched from an external device*

Advanced User Interface

- User interface and multithreading
  - Accessing views from another thread

Exercice: *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

Exercice: *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

Exercice: *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

Exercice: *Handling process alarms in a custom broadcast receiver*

Networking

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

Exercice: *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

Exercice: *Create a simple HAL component*

Renseignements pratiques

Duration : 4 days
Cost : 3060 € HT