

# Native libraries

## Lecture 4

Android Native Development Kit

18 March 2014

SQLite

SSL

WebKit

Surface Manager

Audio Manager

Media Framework

OpenGL ES

Keywords

Bionic

SQLite

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WebKit

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Media Framework

OpenGL ES

Keywords

- ▶ Custom C library
- ▶ Replacement for glibc
- ▶ Not POSIX compliant
- ▶ Goals
  - ▶ BSD license
    - ▶ Avoid GPL and LGPL in userspace
  - ▶ Small size
    - ▶ glibc is very large
  - ▶ High speed
    - ▶ Designed for low CPU frequencies

- ▶ Bionic routines do not throw, pass and handle C++ exceptions
  - ▶ Support for exceptions adds a great overhead
  - ▶ Exceptions can be used internally in C++ code, if they do not cross the libc routine
- ▶ No C++ Standard Template Library
  - ▶ You can use the free SGI implementation
- ▶ New *pthread* implementation
- ▶ No *wchar\_t* and no support for LOCALE

- ▶ A shared memory region is used for configuration
  - ▶ Also used by the applications through *property\_get()* and *property\_set()*
- ▶ No *openlog()* or *syslog()*
  - ▶ *\_\_libc\_android\_log\_print()* used for logging
- ▶ Specific malloc implementation
  - ▶ A hash table used for tracking allocations to discover leaks
- ▶ No pty support

- ▶ No AIO (*aio\_read()*, *aio\_write*)
- ▶ No *crypt()*
  - ▶ Includes MD5 and SHA1
  - ▶ Use OpenSSL for crypto
- ▶ Android has its own account management
  - ▶ Does not use */etc/passwd*, no *getpwent()*
  - ▶ *getpwnam()* and *getpwuid()* wrappers that use Android ID service
- ▶ *getprotobyname()* only prints "FIX ME! implement *getprotobyname()*"
  - ▶ Bionic not finished

- ▶ Mutexes, rwlocks, condvars implemented using kernel futexes
- ▶ No pthread\_cancel()
  - ▶ Threads cannot kill other threads
- ▶ No pthread\_atfork()
- ▶ Thread local storage (TLS) implemented
  - ▶ Max 64 keys
  - ▶ Id and errno reserved
  - ▶ Mapped at 0xffff0ff0 in the process (on ARM)
- ▶ pthread\_attr\_{set,get}inheritsched and pthread\_attr\_{set,get}scope not implemented



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Keywords

- ▶ Developed for embedded systems
- ▶ Used by Android, Apple iOS, Blackberry
- ▶ Low memory consumption
  - ▶ Starts from 50 KB, reaches few hundred KB
- ▶ Ease of use
  - ▶ No configuration files or complex commands
- ▶ Free
  - ▶ Released under public domain
  - ▶ Supported by Google, Adobe, Mozilla
  - ▶ Active maintenance

- ▶ Is serverless
  - ▶ No process
  - ▶ Access database through library
  - ▶ No port configuration, no user adding, no access levels
- ▶ All data in a single file
  - ▶ Indices, triggers, metadata
  - ▶ Journal file added
- ▶ Fewer datatypes
  - ▶ INTEGER, REAL, TEXT, BLOB
  - ▶ No datetime -> string
  - ▶ No boolean -> 0 and 1
  - ▶ Blob not recommended on Android -> files in the file system

- ▶ Does not use static typing
  - ▶ Type depends on the inserted value
  - ▶ Not on the definition in CREATE TABLE
  - ▶ Create INTEGER column and insert TEXT
  - ▶ Manifest typing -> between static and dynamic typing
- ▶ No fixed column length
  - ▶ No limit to the inserted value
  - ▶ Constraints in the code
- ▶ Database files are cross-platform
  - ▶ Pull file from device, use it on laptop
  - ▶ Open file with GUI tools
  - ▶ Populate file on laptop, push on device

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Keywords

- ▶ Generated from OpenSSL external project
- ▶ Includes libcrypto and libssl libraries
- ▶ Libcrypto implements cryptographic algorithms
  - ▶ Symmetric ciphers
  - ▶ Public key crypto
  - ▶ Certificates
  - ▶ Authentication codes, hashes
- ▶ Libssl implements SSL/TLS for secure communications
- ▶ Cryptographic routines from libcrypto are used by libssl

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Keywords

- ▶ Open source web browser engine
- ▶ BSD license but WebCore and JavaScriptCore under LGPL
- ▶ From 2013, WebKit is a trademark of Apple
- ▶ Contributors: Apple, Nokia, Google, Samsung, Adobe, Intel, etc.
- ▶ Ports: Safari, Chrome, Android, Blackberry, Tizen, etc.
- ▶ Originally forked from KHTML and KJS libraries from KDE
- ▶ Google forked WebCore (WebKit component) into Blink



- ▶ Speed, power and versatility
- ▶ Support for new features in CSS3, HTML5 and JavaScript
- ▶ WebCore
  - ▶ LGPL license
  - ▶ C++ based
  - ▶ Layout, rendering, DOM library for HTML and SVG
  - ▶ Creates HTML visualisations based on DOM markup and CSS
- ▶ JavaScriptCore
  - ▶ JavaScript engine
  - ▶ Derived from KJS library in KDE and PCRE regular expression library
  - ▶ High performance interaction engine

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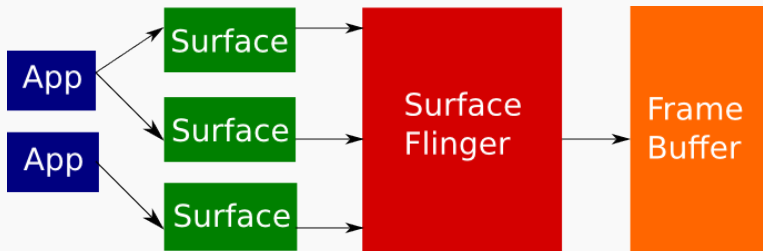
Audio Manager

Media Framework

OpenGL ES

Keywords

- ▶ a.k.a. Surface Flinger
- ▶ Part of System Server
- ▶ System-wide surface composer
- ▶ Handles surface rendering to frame buffer device
- ▶ Combines 2D and 3D surfaces, surfaces from multiple apps
  - ▶ Each app generates 1 or more surfaces
  - ▶ The Surface Flinger composes these surfaces
  - ▶ The result is stored in the Frame Buffer



- ▶ Surfaces passed as buffers using Binder IPC calls
  - ▶ Surface instances written to or restored from Parcels
- ▶ Use OpenGL ES or 2D hardware accelerator for the composition
- ▶ Double buffering using page flip
  - ▶ Front buffer (primary surface) and back buffer
  - ▶ Change primary surface pointer and back buffer pointer
  - ▶ Screen never flickers or displays artifacts

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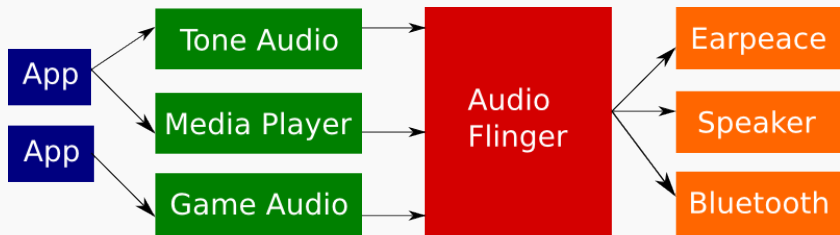
**Audio Manager**

Media Framework

OpenGL ES

Keywords

- ▶ a.k.a. Audio Flinger
- ▶ Part of Media Server
- ▶ Manages the audio output devices
- ▶ Receives and combines multiple audio streams (tone, media player, games)
- ▶ Directs audio to various outputs (Headphones, Speaker)





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**Media Framework**

OpenGL ES

Keywords

- ▶ Uses StageFright engine for audio/video recording and playback
- ▶ Default software codecs
- ▶ Implement your own hardware codec
  - ▶ Using OpenMAX Integration Layer (IL)
- ▶ OpenMAX IL
  - ▶ Standardized way for Stagefright to recognize and use hardware codecs
  - ▶ OpenMAX plugin - shared library
  - ▶ Implemented according to the standard
- ▶ Accessed through *android.media* API

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Keywords

- ▶ Manage 2D and 3D graphics on embedded systems
- ▶ Interface between software and graphics acceleration hardware
- ▶ Low-level, lightweight API
- ▶ Subset of OpenGL
- ▶ Display complex 3D graphics on mobile
- ▶ Easy porting

- ▶ Industry standard
  - ▶ Open, vendor-neutral, multi-platform
  - ▶ Anyone can implement OpenGL ES based on the specification
- ▶ Small footprint, low power consumption
  - ▶ Minimum data storage requirements
  - ▶ Small binary
- ▶ Works with both hardware and software rendering
  - ▶ Calls to hardware, to software routines or combination of both

- ▶ NDK includes both OpenGL ES 1.x and 2.0 libraries (eventually 3.0)
- ▶ Differ significantly
  - ▶ Different Graphics Rendering Pipelines
    - ▶ Processing stages taken by the graphics hardware to produce graphics
    - ▶ Accepts object description (vertices, primitives, color values)
  - ▶ 1.x fixed function pipeline
    - ▶ Input primitive, texture data, lightning
  - ▶ 2.0 programmable pipeline
    - ▶ Write vertex and fragment shaders using the Shading Language (GLSL)

	<b>1.x</b>	<b>2.0</b>
<b>Performance</b>	Fast 2D and 3D graphics	Faster 2D and 3D graphics
<b>Compatibility</b>	Almost all Android devices	Many Android devices
<b>Ease of coding</b>	Fixed pipeline with convenient functions, easy to use for simple 3D apps	No built-in basic functions, more effort to use for simple 3D apps
<b>Graphics control</b>	Difficult or impossible to create some effects (fixed pipeline)	More direct control of the graphics processing pipeline (programmable pipeline)

- ▶ Use OpenGL ES directly from Android app
- ▶ Create a view container
- ▶ Implement a *GLSurfaceView* and *GLSurfaceView.Renderer*
- ▶ *GLSurfaceView*
  - ▶ View container for the graphics
  - ▶ Draw and manipulate objects using OpenGL API
- ▶ *GLSurfaceView.Renderer*
  - ▶ Controls what is drawn in the view
  - ▶ Defines methods required for drawing
  - ▶ Attach it to the *GLSurfaceView* instance
  - ▶ *GLSurfaceView.setRenderer()*



- ▶ Call OpenGL API
- ▶ OpenGL ES 1.0/1.1 API
  - ▶ *android.opengl* (static interface, better performance)
  - ▶ *javax.microedition.khronos.opengles* (standard implementation)
- ▶ OpenGL ES 2.0 API
  - ▶ *android.opengl.GLES20* (starting with Android 2.2, API level 8)
- ▶ OpenGL ES 3.0 API
  - ▶ *android.opengl.GLES30* (starting with Android 4.3, API level 18)
  - ▶ Requires an implementation of the pipeline provided by the manufacturer
  - ▶ Not all 4.3 devices support 3.0 API
- ▶ Declare version requirement in the manifest
  - ▶ `<uses-feature android:glEsVersion="0x00020000" android:required="true" />`

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