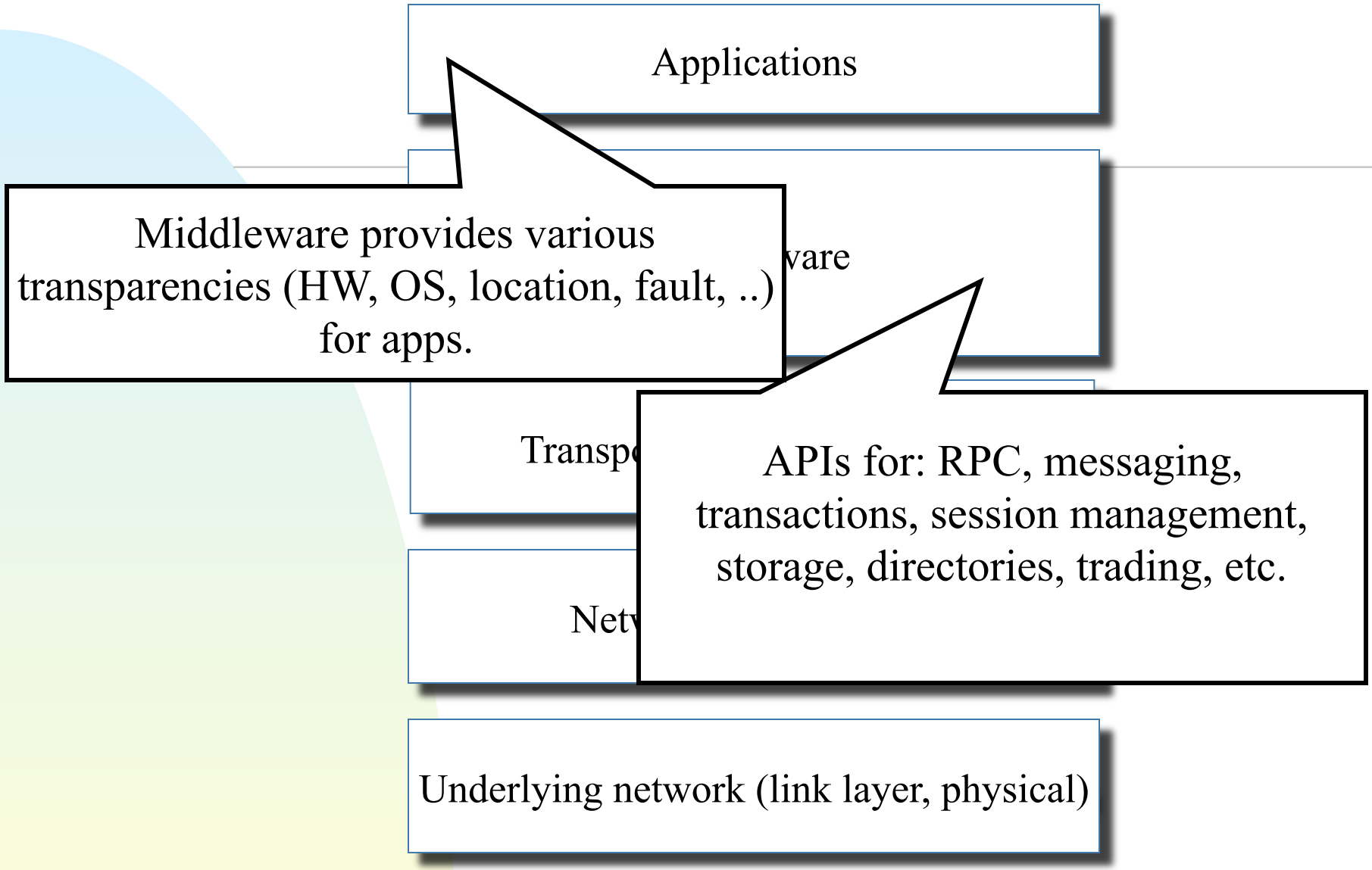
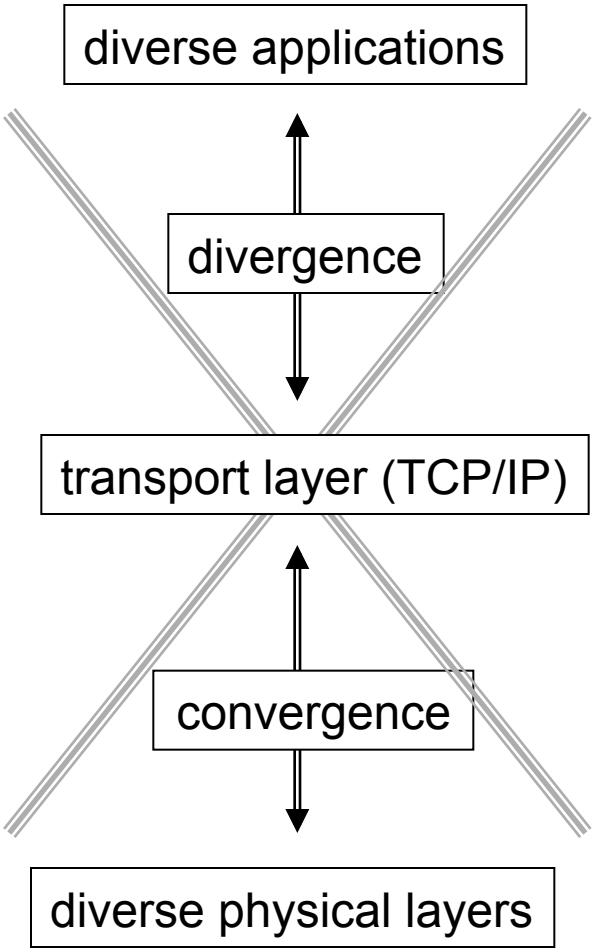
Mobile Middleware Course

Mobile Platforms and Middleware

Sasu Tarkoma


Applications
Middleware provides various transparencies (HW, OS, location, fault, ..) for apps.
APIs for: RPC, messaging, transactions, session management, storage, directories, trading, etc.
Underlying network (link layer, physical)

The Hourglass



Mobile Platforms

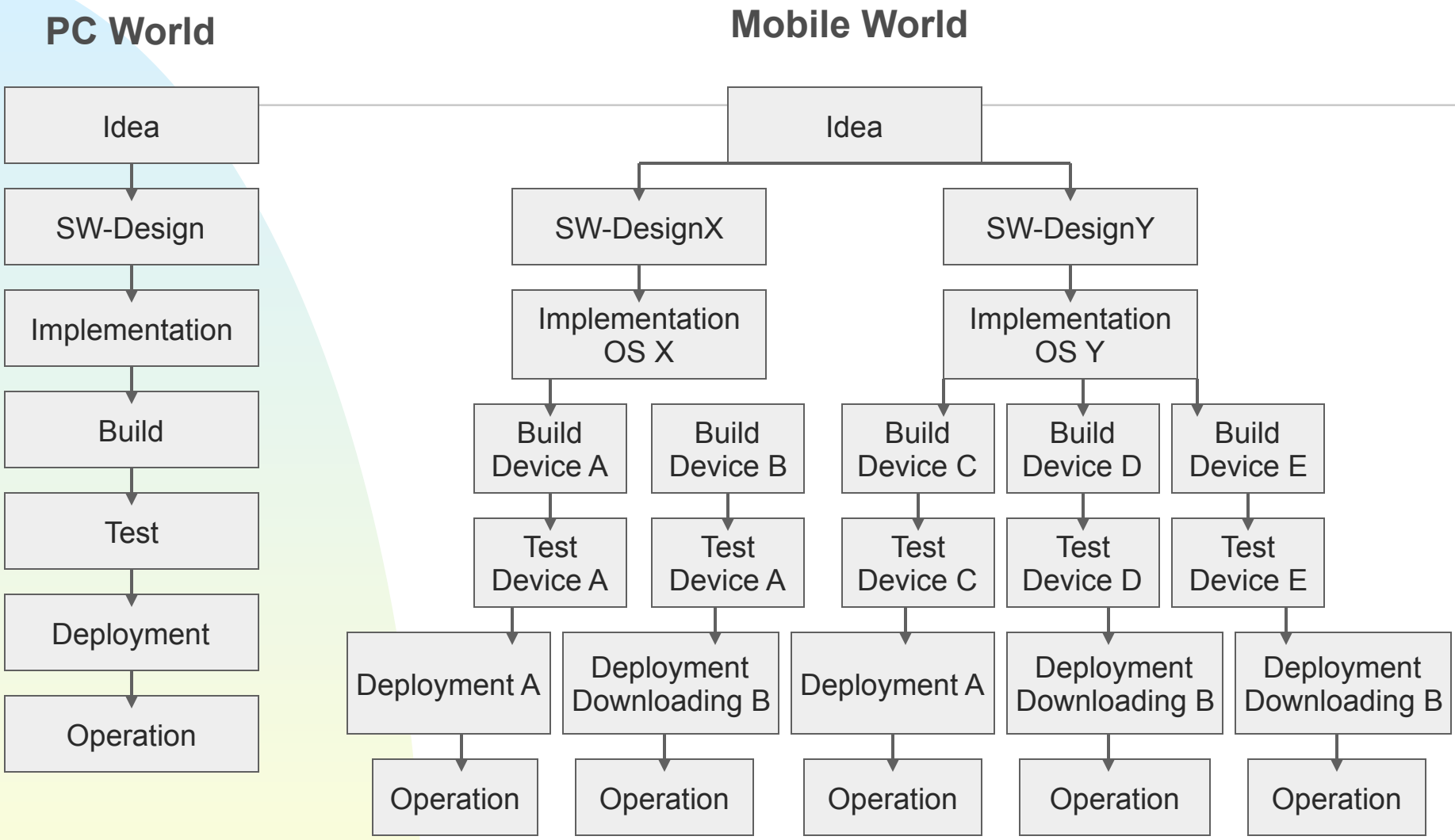
- Collections of central services and libraries with both reactive and proactive functions
- APIs typically logically centralized
- Distributed between elements of the environment
  - Multi-tier client-server
  - Peer-to-peer
  - Hybrids
- The platform running on the mobile terminal and the characteristics of the device determine how service is rendered for the end user

Wireless and Cloud

- Wireless hop is the limiting factor
  - Bandwidth, connectivity, reachability, tail energy, costs
- Server side scalability can be achieved by using traditional solutions:
  - clusters, caching, geographical distribution, load balancing, data centers
- Cloud computing
  - Integration, offloading
  - Web apps vs. native apps

Mobile Service Development

- The mobile landscape is fragmented
  - Heterogeneous device base
  - Many different wireless technologies
- The situation is challenging for the developer
  - Many APIs
    - Open vs. private APIs
  - Many middleware platforms
  - APIs evolve over time
- Current challenge of the industry pertains to improving the development processes


PC World
Idea
SW-Design
Implementation
Build
Test
Deployment
Operation
Mobile World
Idea
SW-DesignX
SW-DesignY
Implementation OS X
Implementation OS Y
Build Device A
Build Device B
Build Device C
Build Device D
Build Device E
Test Device A
Test Device A
Test Device C
Test Device D
Test Device E
Deployment A
Deployment Downloading B
Deployment A
Deployment Downloading B
Deployment Downloading B
Operation
Operation
Operation
Operation
Operation

Introduction to Platforms

- Mobile middleware aims to support the development, deployment, and execution of distributed applications in the heterogeneous and dynamic mobile environment.
- The goals for mobile middleware include adaptability support, fault-tolerance, heterogeneity, scalability, and context-awareness.
- The industry solution to these challenges has been to create middleware *platforms*.
- A platform collects frequently used services and APIs under a coherent unified framework.

Platforms

- 2009
  - Java Micro Edition (Java ME)
  - iOS
  - Symbian and Series 60
  - Windows Mobile
  - Linux Maemo (MeeGo)
  - Android
  - BREW
  - WAP
- 2012
  - iOS
  - Android
  - Windows Phone 8
  - HTML5 web apps

Application Trends

- WP8
  - Native apps, cloud integration
- iOS
  - Native apps, cloud integration
  - Potential for Web apps
- Android
  - Native apps, cloud integration
- WebOS
  - Web apps with HTML5
  - Obsolete (open source)
- Blackberry
  - Native and Web apps

Challenges

- Fragmentation is a major problem
  - device-level fragmentation
  - standard fragmentation
  - implementation fragmentation
- Energy consumption
  - Modelling: where is the energy going
  - Optimization: how to improve things
- Security is also a problem
  - Sandboxed environments and privileged operations require certification
  - Certification is difficult for developers
  - Current trend is towards application stores and more lightweight certification processes
  - No malware for iOS, plenty for Android

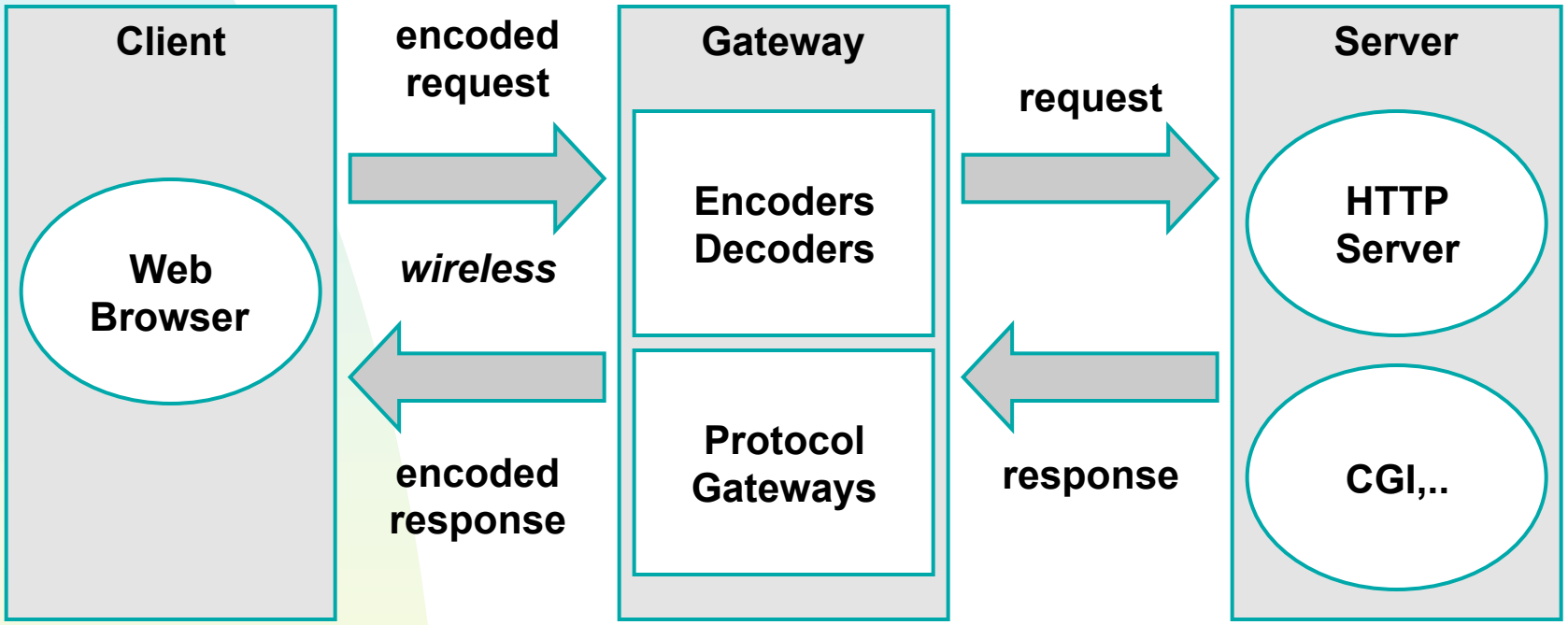
Examples

- Classical examples
  - WAP
  - Java ME
  - Symbian
  - MAEMO / MeeGo
- Current Platforms
  - Windows Phone 8
  - iPhone
  - Android
  - Web apps

WAE

- Wireless Application Environment (WAE)
  - A suite of protocols and specifications for optimizing data transfer for wireless communication
- WAP stack
  - Focus on binary transmission
  - WSP (Wireless Session Protocol)
    - HTTP replacement, “compressed”
  - WTP (Wireless Transaction Protocol)
    - Request/response, more efficient than TCP
  - WTLS (Wireless Transport Layer Security)
    - Based on TLS, may not be end-to-end with a gateway
  - WDP (Wireless Datagram Protocol)
    - UDP replacement

Web Access with Gateway



Web Access

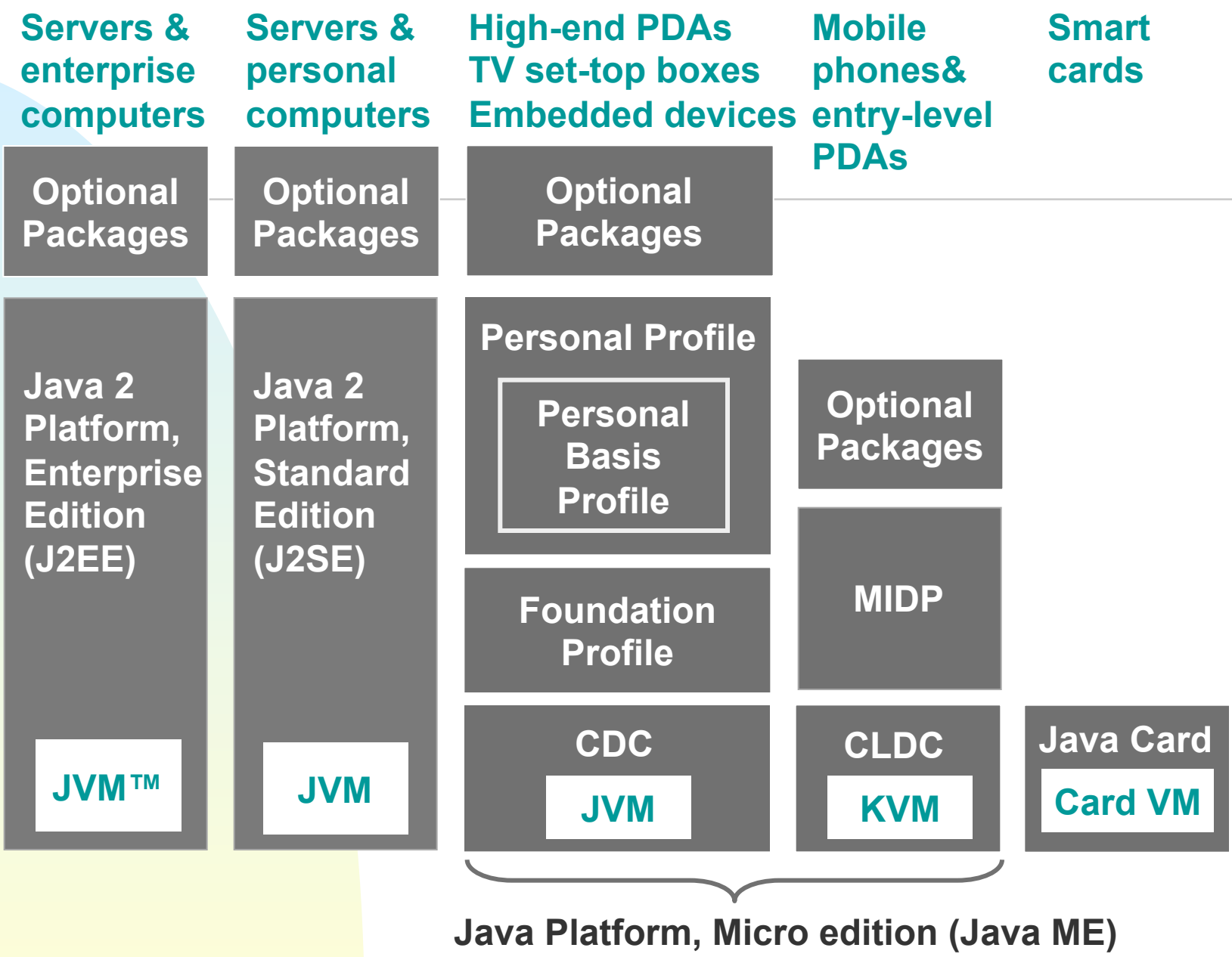
- Data transformation
  - WAP gateway performs data transformation between WML (or XHTML) and HTML
- Data compression
  - Technique are used for dealing with images and other graphics
- Adaptability
  - User profile and device characteristics are stored in the WAP gateway
- Security
  - Secure Enterprise Proxy (SEP) using 128-bit encryption in WAP 1.2
- Service discovery and mobility support
  - WAP’ s “walled garden” – WAP gateways are provided by ISP such as AOL

WAE: current status

- WAP Forum now in OMA (Open Mobile Alliance)
- WAP 2.0, is a re-engineering of WAP using a cut-down version of XHTML with end-to-end HTTP
- Gateway and custom protocol suite is optional.
- WAP used by many handsets
  - 1.2 version introduced WAP Push (typically using an SMS message)
- Typically versatile networking stacks with also IPv6 support

Java Micro Edition (Java ME)

- Java for consumer electronics and embedded devices
- A virtual machine and a set of APIs
- Configurations and profiles
  - Configurations
    - two-low level APIs and optimized VMs
      - CDC, CLDC
  - Profiles
    - API specification on top of a configuration for complete runtime
    - CLDC: MIDP
    - CDC: Foundation, Personal Basis, Personal
    - Profiles defined using Java Community Process (JCP)


Servers & enterprise computers
Servers & personal computers
High-end PDAs TV set-top boxes Embedded devices
Mobile phones& entry-level PDAs
Smart cards
Optional Packages
Optional Packages
Optional Packages
Java 2 Platform, Enterprise Edition (J2EE)
JVM™
Java 2 Platform, Standard Edition (J2SE)
JVM
Personal Profile
Personal Basis Profile
Foundation Profile
CDC
JVM
Optional Packages
MIDP
CLDC
KVM
Java Card
Card VM
Java Platform, Micro edition (Java ME)

Important JSRs

- 75 File Connection and PIM
- 82 Bluetooth
- 120 Wireless Messaging API (WMA)
- 135 Mobile Media API (MMAPI) Audio, video, multimedia
- 172 Web Services
- 177 Security and Trust Services
- 179 Location API
- 180 SIP API
- 184 Mobile 3D Graphics
- 185 Java Technology for the Wireless Industry (JTWI) General
- 205 Wireless Messaging 2.0 (WMA)
- 211 Content Handler API
- 226 SVG 1.0
- 229 Payment API
- 234 Advanced Multimedia Supplements (AMMS) MMAPI extensions
- 238 Mobile Internationalization API
- 239 Java Bindings for the OpenGL ES API
- **248 Mobile Service Architecture General**
  - **Collects useful specifications**
- 256 Mobile Sensor API
- 287 SVG 2.0

MIDP 3.0

- MIDP 3 specified in JSR 271 will specify the 3rd generation mobile APIs.
  - AMS (Application Management System)
  - Multitasking
  - Provisioning and OTA
  - Shared libraries
  - Security and access control
  - Service framework
  - Inter-MIDlet communication
  - User Interface improvements
- A key design goal of MIDP3 is backward compatibility with MIDP2 content
- Approved in Dec, 2009. Not supported by current phones.

Symbian

- OS for handheld devices with limited resources
- User interface framework
- APIs (C++)
- Tools
- Operating System
  - Pre-emptive, multitasking, multithreading, memory protection
  - Event-based, active objects
  - Memory conservation, reliability, CPU optimizations

Software Components

- Kernel
  - Manages and controls access to hw
  - Hw-supported privileges, kernel mode
- Application
  - Program with a user interface
  - Runs in user mode in its own process
- Server
  - Program without a user interface
  - Manages resources, provides interface to clients
  - File server, window server, comms, ..
- Engine
  - Application part that manipulates data, typically separate DLL

Key layers

- The Symbian OS System Model contains the following layers:
  - UI Framework Layer.
  - Application Services Layer.
  - Java ME.
  - OS Services Layer: generic OS services, communications services. multimedia and graphics services, connectivity services.
  - Base Services Layer.
  - Kernel Services and Hardware Interface Layer.

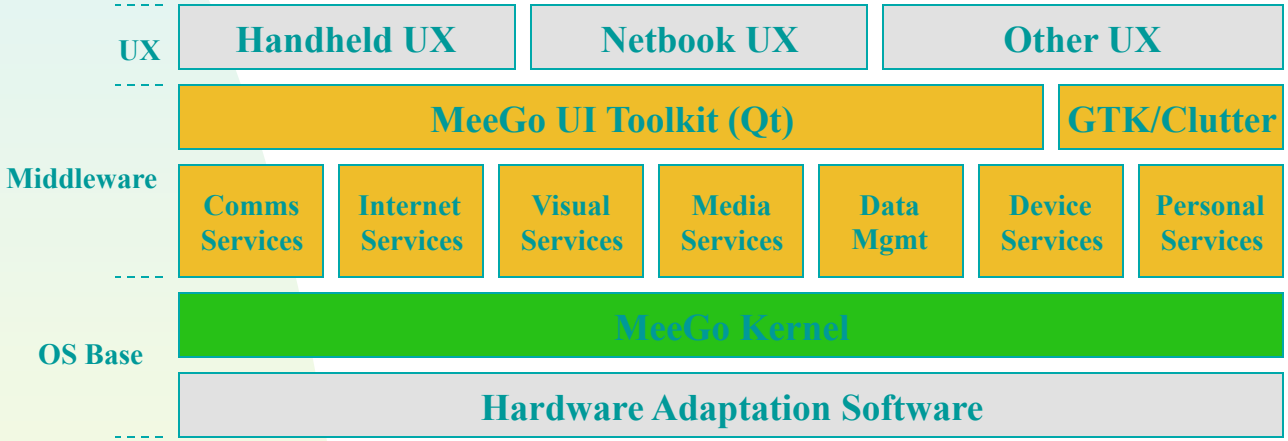
MAEMO and MeeGo

- Open Source development platform for Nokia Internet Tablets and other Linux-based devices
- Previously MAEMO, integrated with Intel's Moblin to create MeeGo
- MeeGo 1.1 for Atom and ARM
- Nokia is no longer developing MeeGo
- www.meego.com

MeeGo

- Versatile platform for mobile computing
- Linux-based, Qt is the key development environment
- The MeeGo includes a set of components called the content framework to gather and offer user metadata to application developers

MeeGo


UX
Handheld UX
Netbook UX
Other UX
MeeGo UI Toolkit (Qt)
GTK/Clutter
Middleware
Comms Services
Internet Services
Visual Services
Media Services
Data Mgmt
Device Services
Personal Services
OS Base
MeeGo Kernel
Hardware Adaptation Software

Qt

- Qt is a cross-platform application framework
  - Rapid creation of GUIs
- For Linux and Symbian application development
- The Qt API is implemented in C++ and most Qt developers use C++ (bindings for other languages)
- Extensions for using mobile functionality from within Qt code
  - access points, alarms, audio, calendar, camera, contacts, installer, landmarks, location, media, messaging, profile, resource access, sensor, settings, system information, telephony, vibration, other utilities etc.

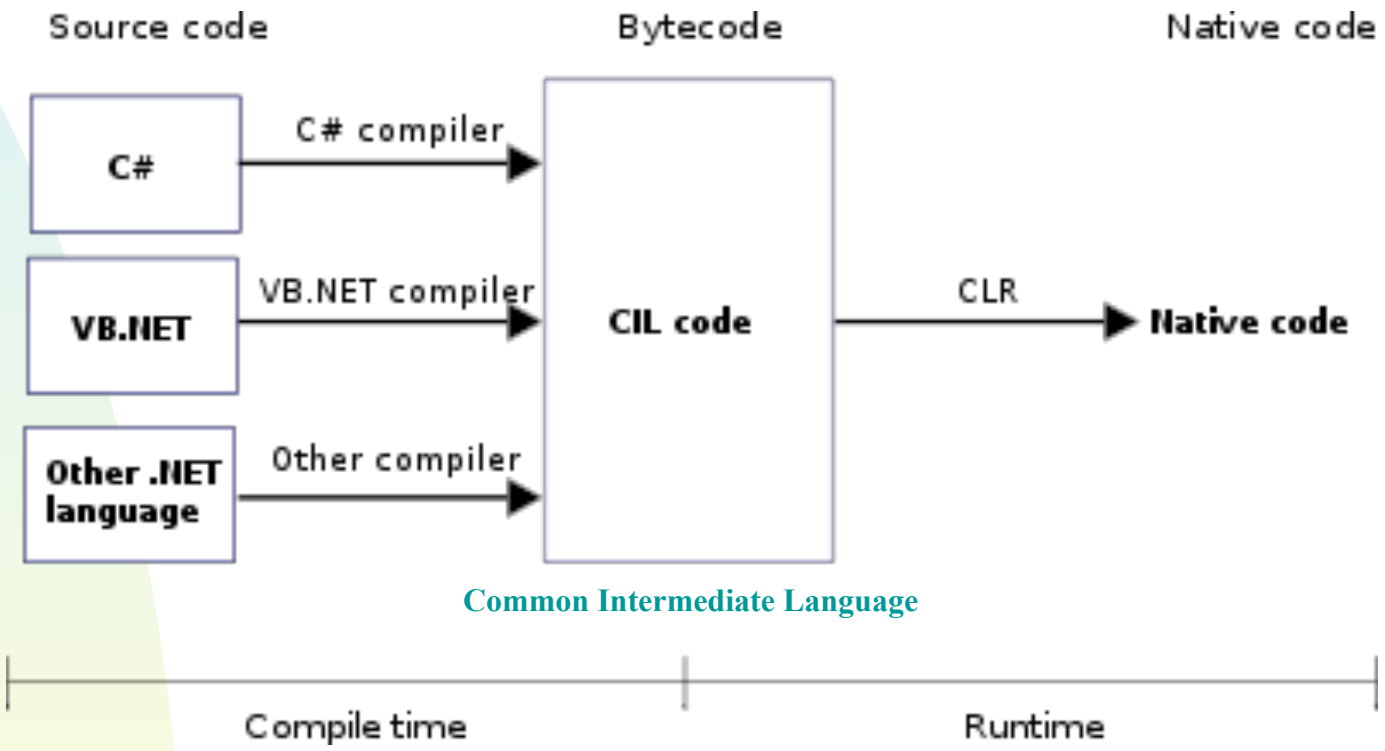
Windows Mobile

- Windows Mobile 6 was released by Microsoft at the 3GSM World Congress 2007 and it came in three flavours
  - standard version for smartphones
  - a version for PDAs with phone functionality
  - a classic version for PDAs without phone features.
- Based on the Windows CE 5.0 operating system and has been designed to integrate with Windows Live and Exchange products.
- Software development for the platform is typically done using Visual C++ or .NET Compact Framework.

Runtime

- The .NET Compact Framework CLR is made up of the following three component:
  - class libraries
  - execution engine
  - platform adaptation layer
- The purpose of the class libraries is to provide a basic set of classes, interfaces, and value types
  - the foundation for developing applications in .NET.
- The execution engine is the core component of the CLR. It provides the fundamental services needed for executing managed code.
  - The execution engine includes components such as a JIT compiler, a class and module loader, and a garbage collector..
- The PAL layer maps calls from the execution engine to the functions of the underlying operating system.

CLR



Source: http://en.wikipedia.org/wiki/Common_Language_Runtime

WP7 and WP8

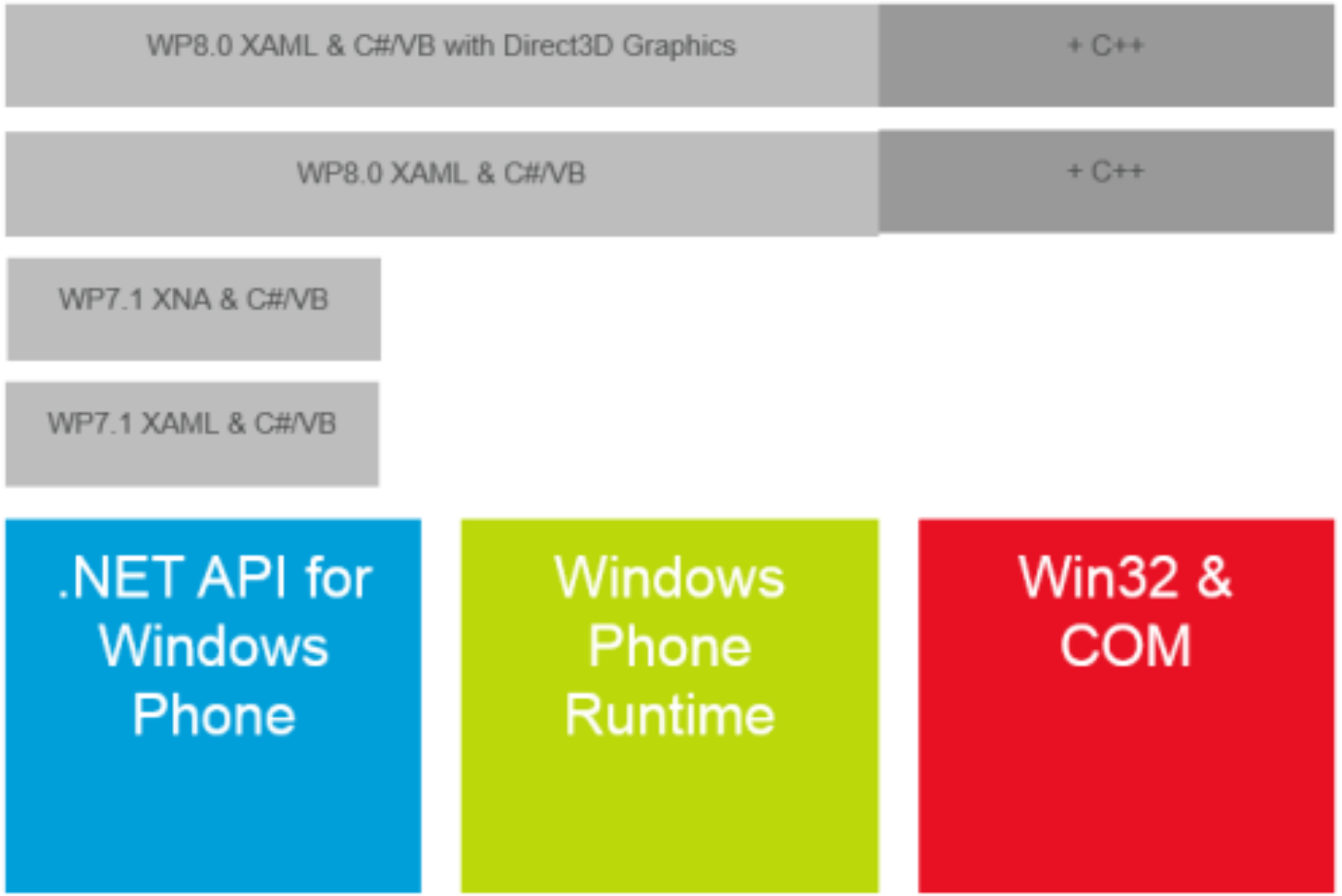
- Windows Mobile 7 was announced in 2010
- Limited APIs for third party applications
- WP store for applications
- Development: C# and XNA, Silverlight 4, VB, on-going API work

- WP7 used CE kernel, WP8 uses NT kernel

Development

- Simple applications with Silverlight
  - XML-based UI declaration and C# code
  - Executed in .NET CLR
  - UI widgets, event based input
  - Similar to Android Java and XML
- Games with XNA (WP7)
  - C# code executed in .NET CLR
  - Direct 3D
  - Xbox
- SDK is free of charge
  - Microsoft Windows Phone Developer Tools
  - Windows 7 required
  - Add-on for Visual Basic

Windows Phone



Source: http://fiercedesign.wordpress.com/2012/12/

Android

- Mobile OS and application platform from Google
- Open Handset Alliance
- Linux kernel
- Open Source
- Uses Java to build applications (Java SE class library parts from Apache Harmony project)
- Optimized virtual machine called ”Dalvik”
  - Runs .dex files (derived from .class or .jar)
  - Relies on underlying system for process isolation, memory mng, and threading
- Independent of Sun and JCP
- Java APIs for basic comms, location, SQLite, OpenGL, SyncML

Android History

- 2005
  - Google acquires startup Android Inc.
  - Work on Dalvik VM starts
- 2007
  - Open Handset Alliance announced
  - Early work on Android SDK
- 2008
  - SDK 1.0 released
  - Android released open source (Apache License)
- 2009
  - SDK 1.5-2.1
- 2010
  - Nexus One
  - SDK 2.2 (Froyo)
    - Flash support, tethering
  - SDK 2.3 (Gingerbread)
    - UI update, system-wide copy-paste
- 2011
  - SDK 3.0-3.2 (Honeycomb) for tablets only
    - New UI for tablets, support multi-core processors
  - SDK 4.0.x (Ice Cream Sandwich), 4.1/4.2 (Jelly Bean)
    - Changes to the UI, Voice input, NFC

Android II

- Android includes a set of C/C++ libraries used by various components of the Android system. The capabilities of these libraries are exposed to developers through the Android application framework APIs.
- The core libraries include:
  - System C library, a BSD-derived implementation of the standard C system library (libc), adapted for embedded Linux-based devices.
  - Media Libraries based on PacketVideo's OpenCORE.
  - Surface Manager that manages access to the display subsystem and seamlessly renders 2D and 3D graphic layers from multiple applications.
  - LibWebCore, a web browser engine which powers both the Android browser and an embeddable web view.
  - SGL, the underlying 2D graphics engine.
  - 3D libraries, an implementation based on OpenGL ES 1.0 APIs.
  - FreeType, bitmap and vector font rendering.
  - SQLite, a lightweight relational database engine available to all applications through the framework API.

Android Fragmentation

- For example: 7 API levels in active use starting from Android 1.6 to 3.0
- APIs are forward compatible
- Device features vary
- App must specify requirements

Application model

- Application components classes
  - Activity: UI view
  - Service: background component
  - Content provider: shared app data
  - Broadcast receiver: reacting to system events
  - Component-level garbage collection

Android SDKs

- Java SDK
- Native SDK

- Eclipse IDE for Linux, Mac, Windows
- Visual UI builder

- More information:
- developer.android.com/sdk/index.html

Android: Key Components

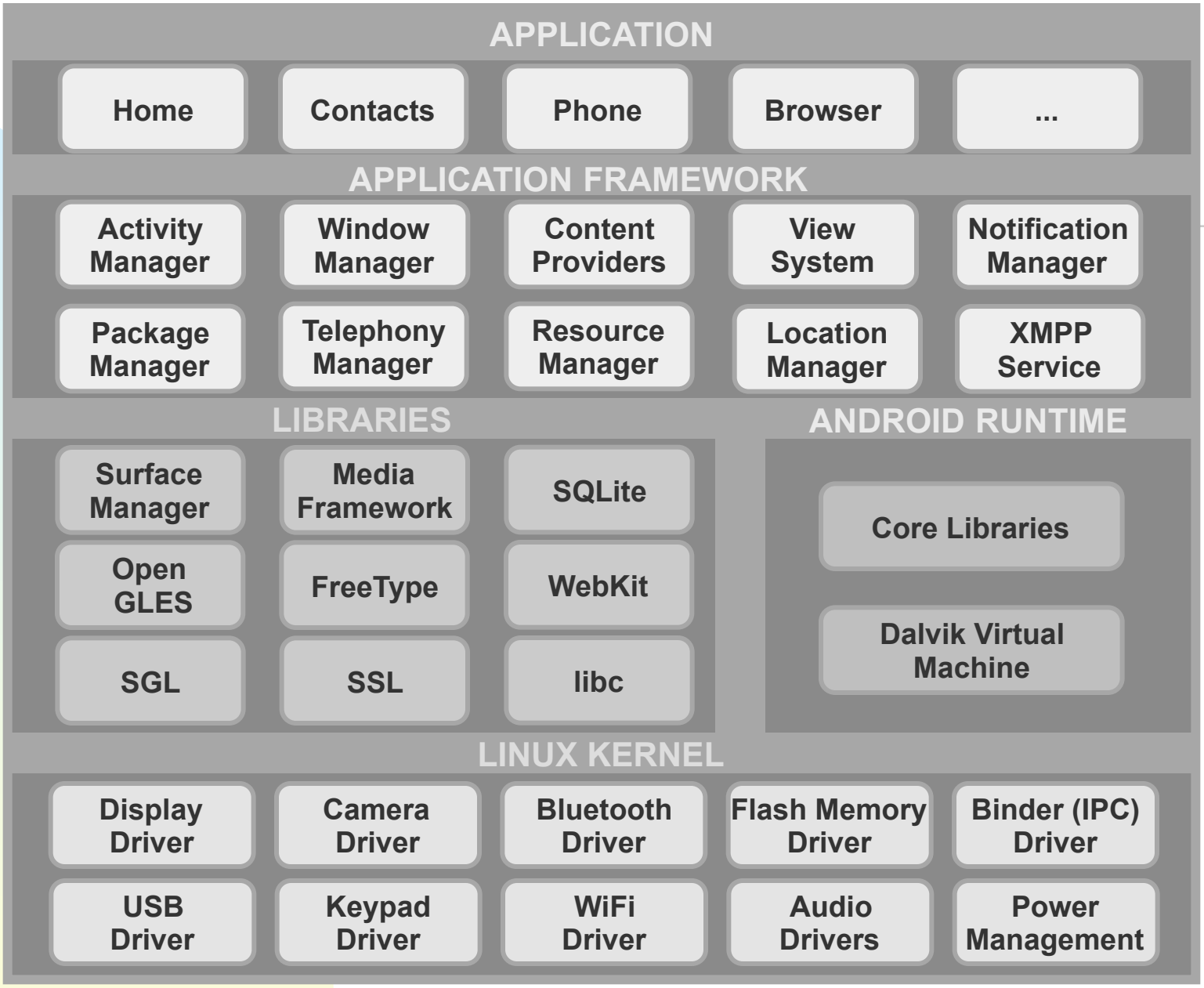
- **AndroidManifest.xml**. This XML document contains the configuration that tells the system how the top-level components will be processed.
- **Activities**. An activity is an object that has a life cycle and performs some work. An activity can involve user interaction. Typically one of the activities associated with an application is the entry point for that application.
- **Views**. A view is an object that knows how to render itself to the screen.
- **Intents**. An intent is a message object that represents an intention to perform some action.
  - In Android terminology, an application has an intent to view a Web page, and generates an Intent instance in order to view the Web page using a URL. The Android system then decides how to implement the intent. In this case, a browser would be used to load and display the Web page.
- **Services**. A service is code that runs in the background. The service exposes methods for to components. Other components bind to a service and then invoke methods provided by using remote procedure calls.
- **Notifications**. A notification is a small icon that is visible in the status bar. Users can interact with this icon to receive information.
- **ContentProviders**. A ContentProvider provides access to data on the device.

Manifest

- AndroidManifest.xml defines the app
  - Activities and components
  - Device features
  - Intent filters, actions to associate with
  - Permissions needed / required
  - Minimum API support

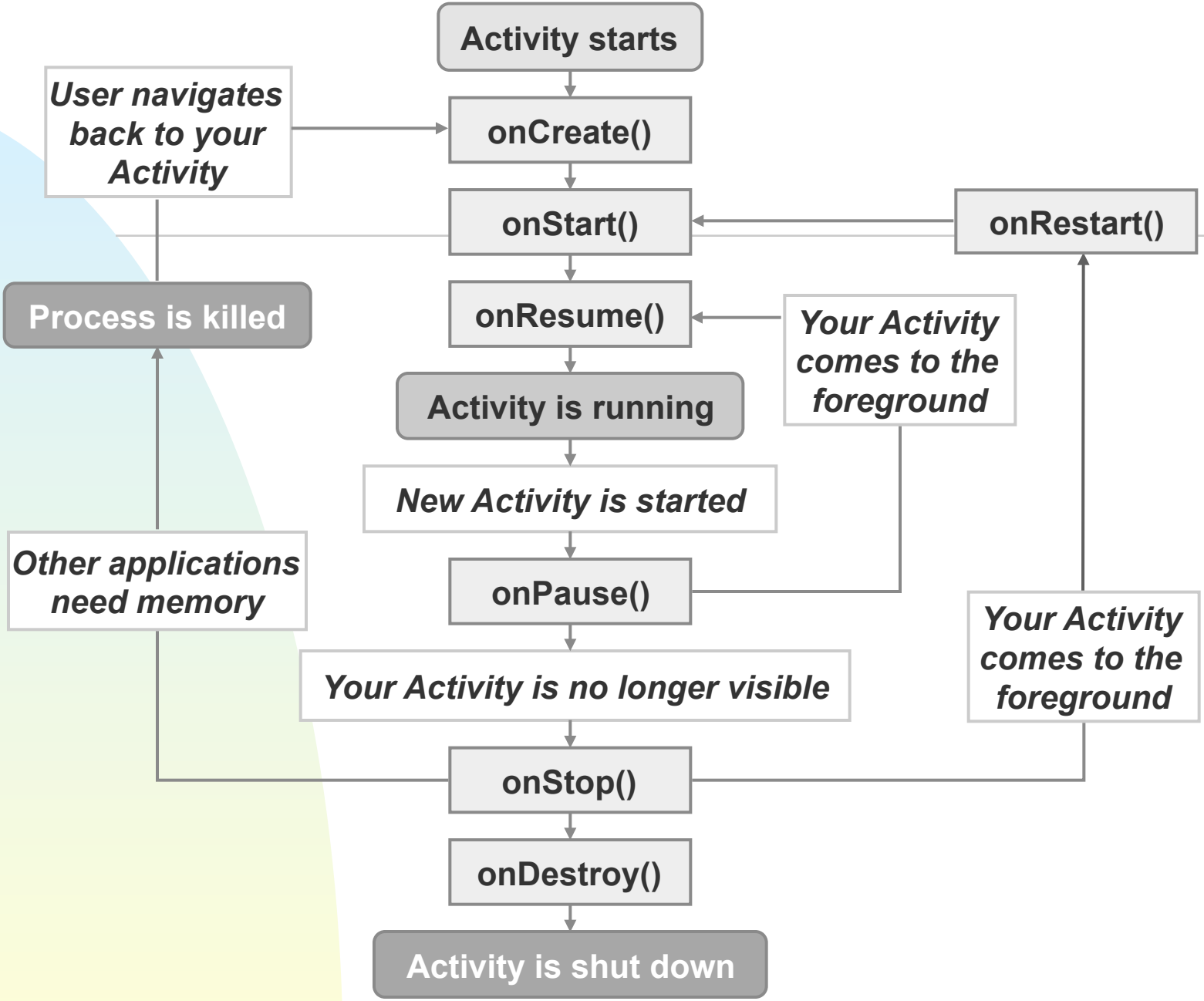
Processes and Threads

- When the first of an application's components needs to be run, Android starts a Linux process for it with a single thread of execution.
- Can spawn additional threads
  - Thread class, Looper, Handler, ...
- RPC for interprocess communications
  - Java-based IDL: AIDL


APPLICATION
Home
Contacts
Phone
Browser
...
APPLICATION FRAMEWORK
Activity Manager
Window Manager
Content Providers
View System
Notification Manager
Package Manager
Telephony Manager
Resource Manager
Location Manager
XMPP Service
LIBRARIES
Surface Manager
Media Framework
SQLite
Open GLES
FreeType
WebKit
SGL
SSL
libc
ANDROID RUNTIME
Core Libraries
Dalvik Virtual Machine
LINUX KERNEL
Display Driver
Camera Driver
Bluetooth Driver
Flash Memory Driver
Binder (IPC) Driver
USB Driver
Keypad Driver
WiFi Driver
Audio Drivers
Power Management

Activity states

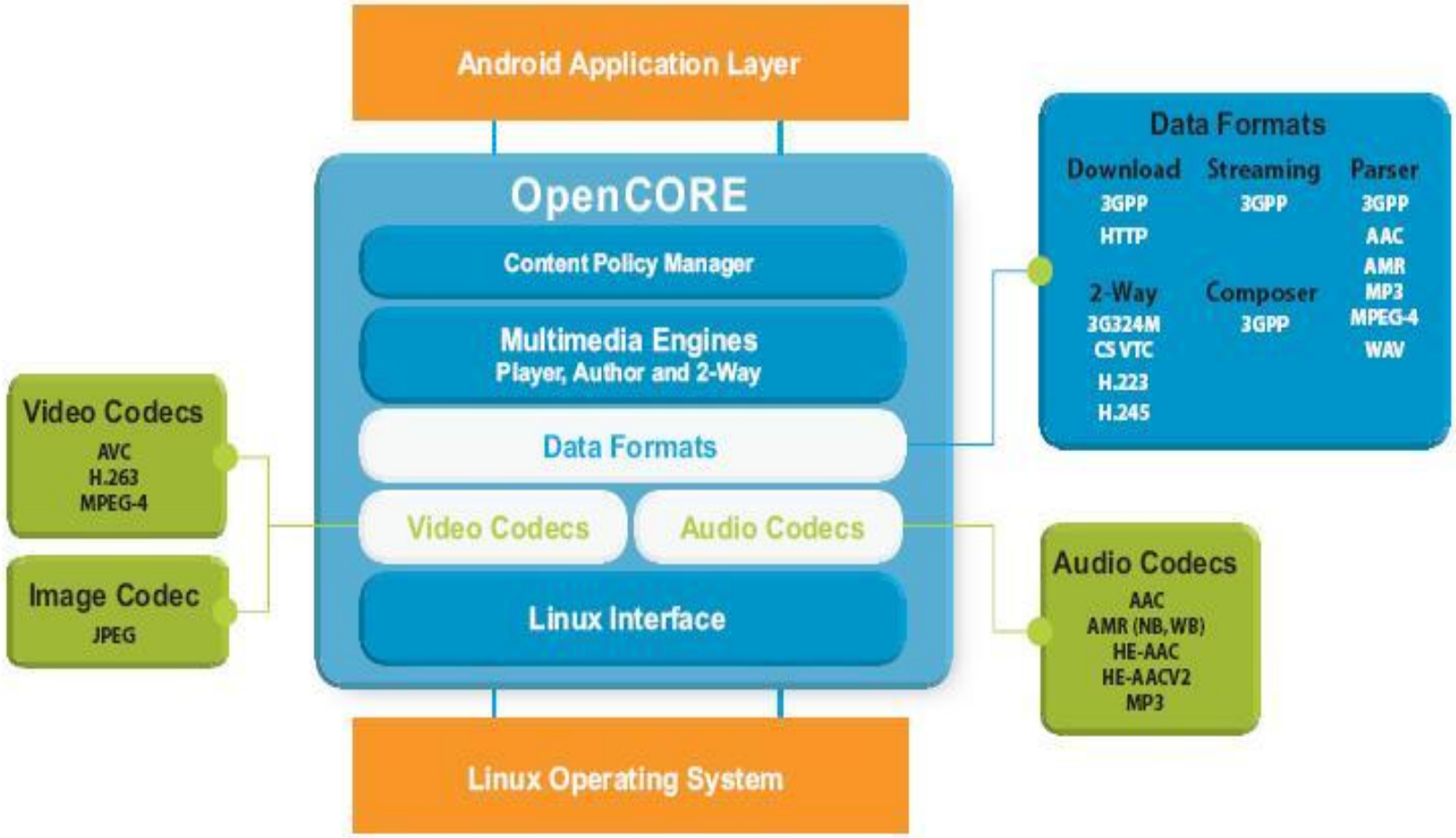
- An activity has four main states:
  - Active. An activity is active when it is in the foreground of the screen and at the top of the activity stack.
  - Paused. An activity is paused when it has lost focus, but is still visible. A paused activity is alive, but can be destroyed by the system if memory needs to be freed.
  - Stopped. An activity is stopped when it is obscured by another activity. The stopped activity retains its state, but it is no longer visible and can be destroyed by the system when memory is needed.
  - Destroyed/Inactive.
- If an activity is paused or stopped, the system can remove the activity from memory. This can happen in two ways, the system can ask the application to finish or simply destroy the process.


Activity starts
User navigates back to your Activity
onCreate()
onStart()
onRestart()
Process is killed
onResume()
Your Activity comes to the foreground
Activity is running
New Activity is started
Other applications need memory
onPause()
Your Activity comes to the foreground
Your Activity is no longer visible
onStop()
onDestroy()
Activity is shut down

Media Framework

- Android use OpenCore as core component of Media framework
- OpenCore supports MP3, AAC, AAC+, 3GPP, MPEG-4 and JPEG,

Media Framework

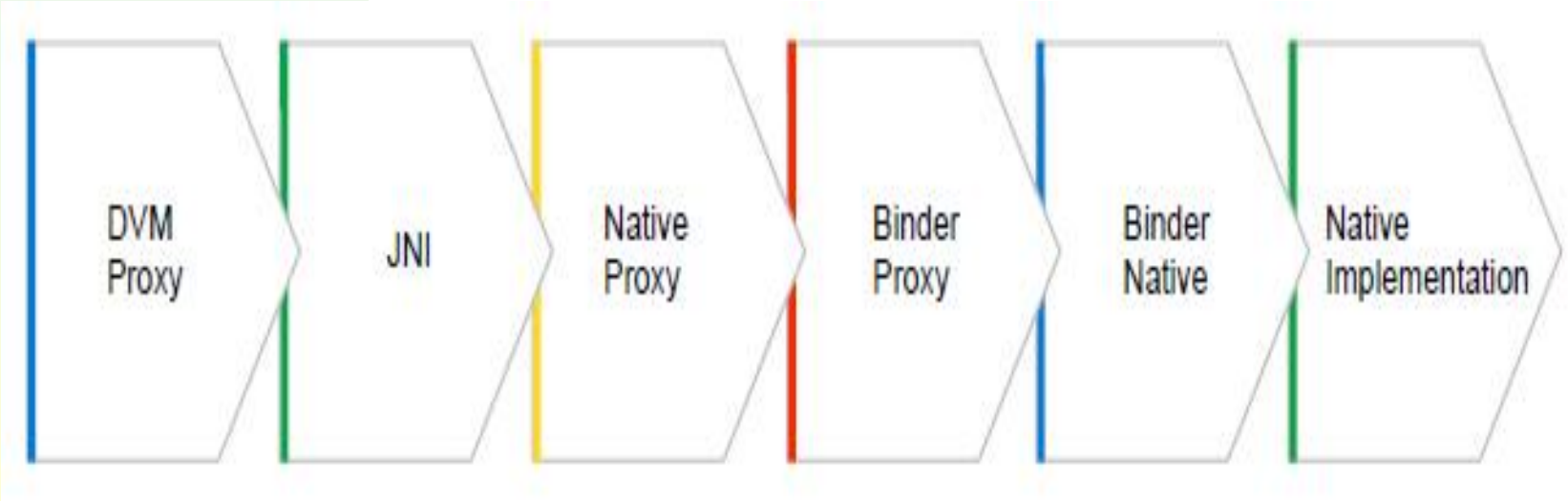


Media Framework

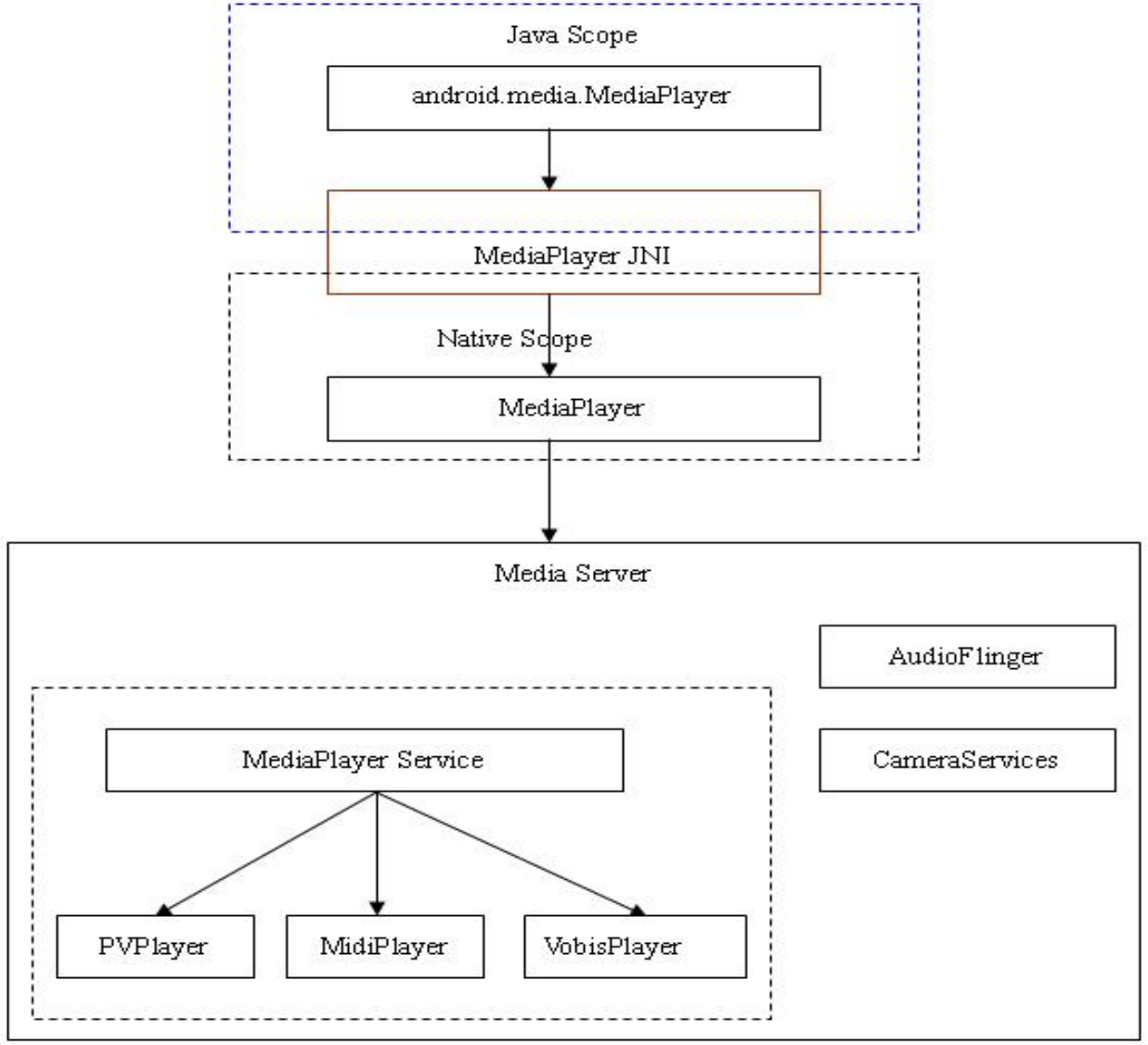
- Example:
- MediaPlayer mp = new MediaPlayer();
- mp.setDataSource(PATH_TO_FILE);
- mp.prepare();
- mp.start();

Media Framework

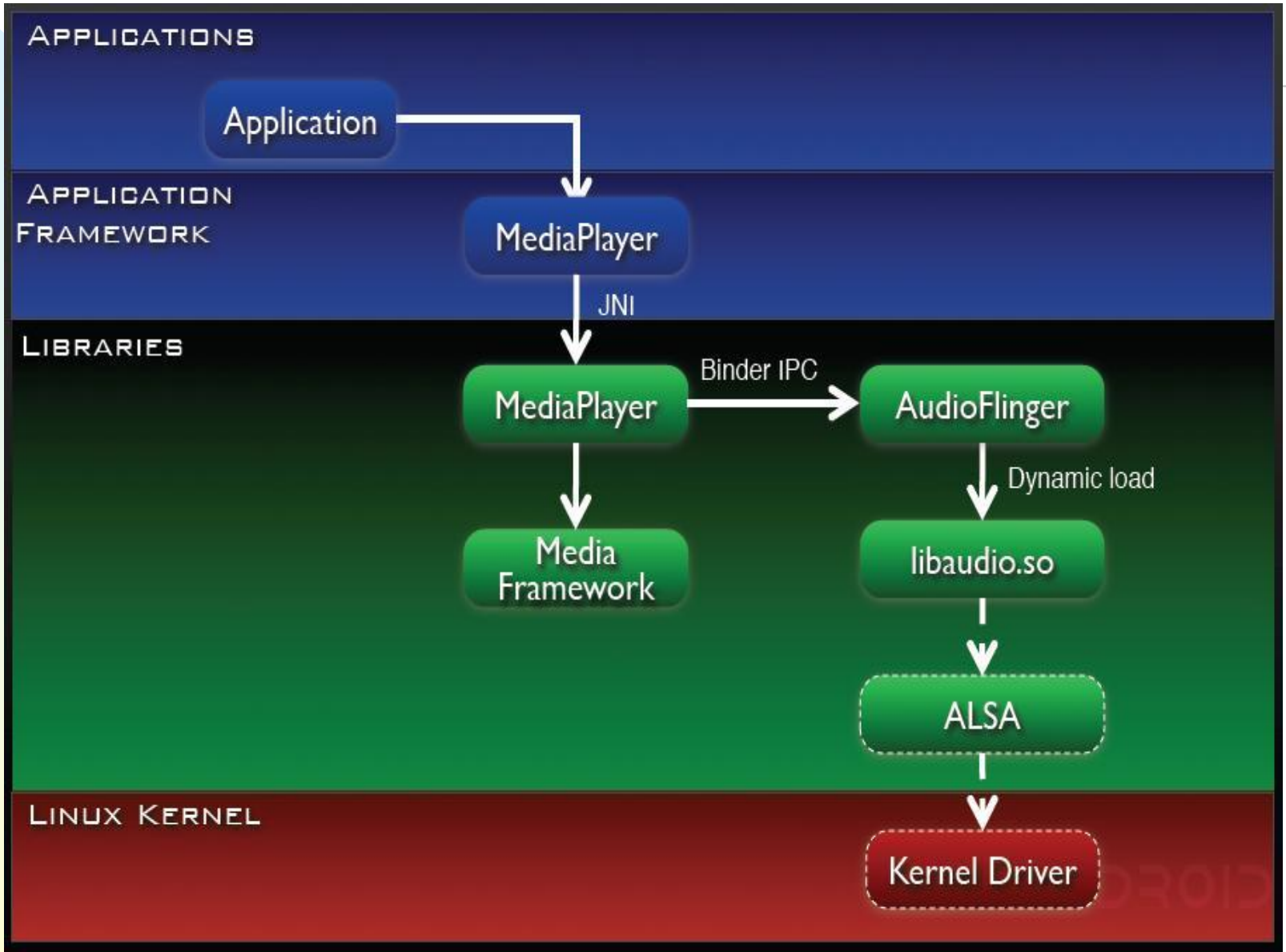
- OpenCore lib has a C/S Architecture.
- MediaPlayer invoke JNI to manipulate client.
- The client request to the server to control hardwares.



Media Framework



Media Framework



Activity Manager

- Each user interface screen is represented by an Activity class.
- Each activity has its own life cycle.
- Activity uses Intent object to jump between them.

Intent and Intent filters

- Intent activates activities, services, and broadcast receivers.
- Intent can be used in explicit way or implicit way.
- The implicit way depends on parameters: **Action, Data**(url and MIME type) , **Category**

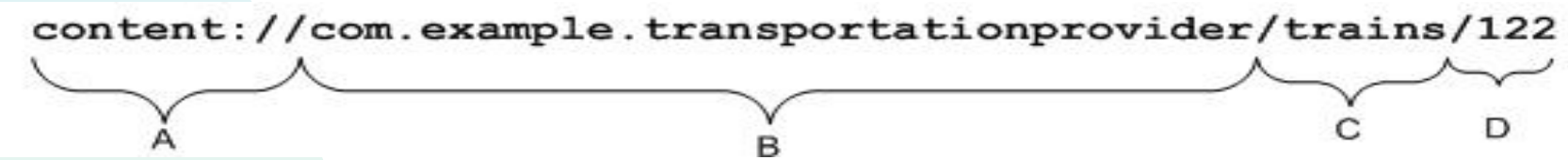
Content manager

- Manage data
- Client+server architecture.
- **Content Resolver** provides API interface for applications.
- **Content Providers** is the server managing the DB tables and database content with different application.

Content manager

Source: Google

- URI identifies the data or the table



- A: Standard prefix indicating that the data is controlled by a content provider.
- B: The authority part of the URI; it identifies the content provider.
- C: The path that the content provider uses to determine what kind of data is being requested.
- D: The ID of the specific record being requested.

Security and permissions

- Security between applications and the system is enforced at the process level through standard Linux facilities
- Inter-component communications security enforced with a reference monitor (in Android mw)
  - Manifest file, intent permissions
- Application cannot disrupt other applications, except by explicitly declaring the *permissions* for it
- Each Android package is given its own unique Linux user ID

Summary

	Android Linux
Development	Java, native code with JNI and C/C++
Network scanning	Yes
Network interface control	Limited
Background processing	Yes (services)
Energy and power monitoring and control	Yes
Memory management	Yes
Persistent storage	Yes
Location information	Yes
HTML 5	Yes, support depends on version
SIP API support	Limited
Open Source	Yes
3rd party application installation	Certificate, Android store
Level of fragmentation	Some fragmentation

iOS

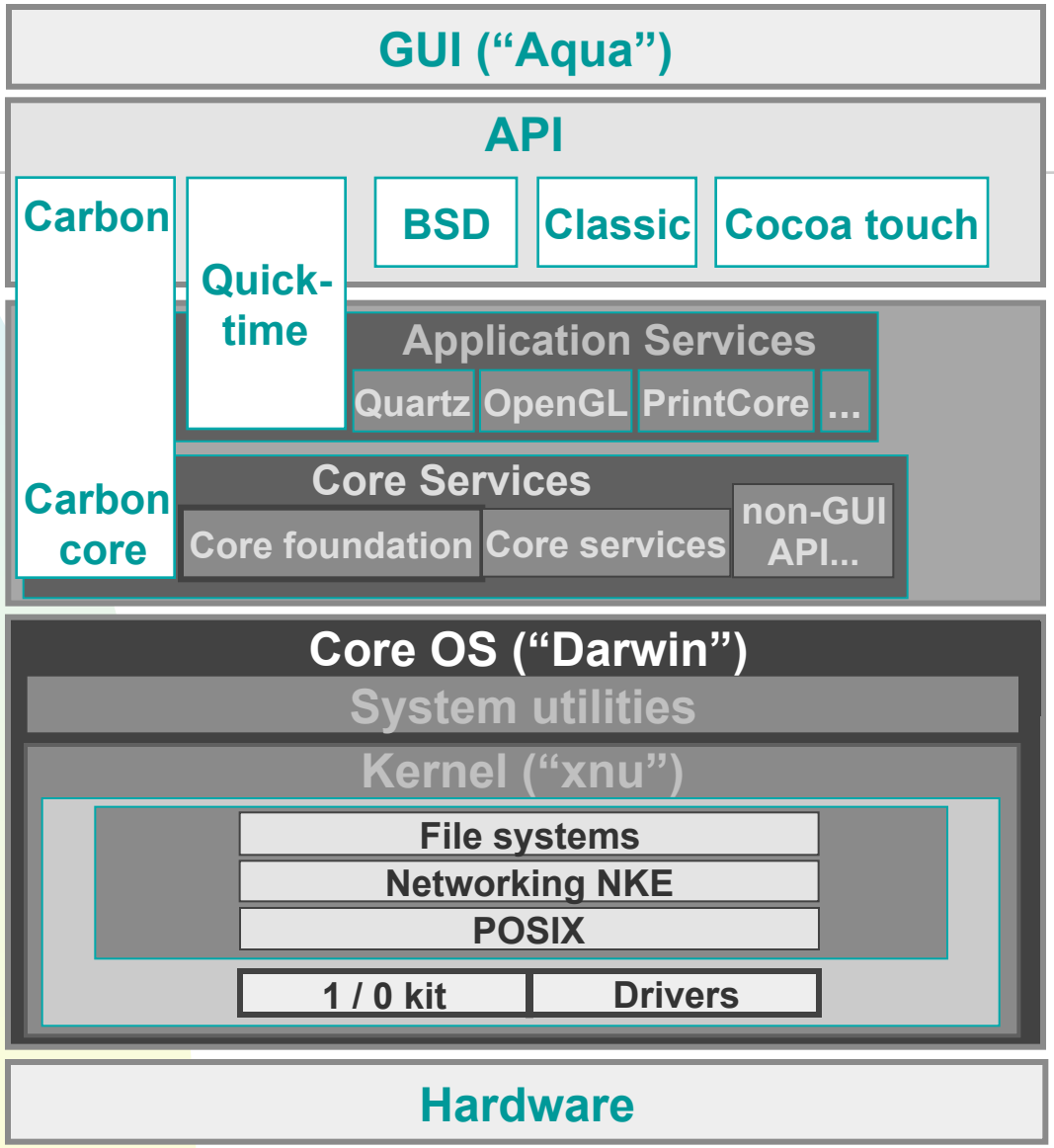
- iOS is a mobile operating system developed by Apple Inc. for their iPhone, iPod touch, and iPad products.
- The OS is derived from Max OS X and uses the Darwin foundation.
- Darwin is built around XNU, a hybrid kernel that combines the Mach 3 microkernel, various elements of Berkeley Software Distribution (BSD) Unix, and an object-oriented device driver API (I/O Kit).

iOS development

- The iPhone OS is based on four abstraction layers, namely the *Core OS layer*, the *Core Services layer*, the *Media layer*, and the *Cocoa Touch layer*.
- Objective C and Cocoa Touch are used by developers
- An universal application determines the device type and then uses the available features based on conditional statements.

iPhone OS

- The iPhone OS's user interface is based on *multi-touch gestures*. Interface control elements consist of sliders, switches, and buttons.
- Interaction with the OS includes gestures such as swiping, tapping, pinching, and reverse pinching.
- Additionally, using internal accelerometers, rotating the device on its y-axis alters the screen orientation in some applications.


GUI (“Aqua”)
API
Carbon
Quick-time
BSD
Classic
Cocoa touch
Application Services
Quartz
OpenGL
PrintCore
...
Carbon core
Core Services
Core foundation
Core services
non-GUI API...
Core OS (“Darwin”)
System utilities
Kernel (“xnu”)
File systems
Networking NKE
POSIX
1 / 0 kit
Drivers
Hardware

Versions

- iOS 1 Web apps
- iOS 2 introduced the App Store
- iOS 3 single tasking, new features
- iOS 4 multitasking, FaceTime videoconferencing, iBooks, iAd, in-app purchases (apps can run in the background)
- iOS 5 cloud integration

iPhone OS 4

- The iPhone OS 4.0 was announced in April 2010 and it supports multitasking for 3rd party applications.
- The key design principle is to offer APIs for specific background operations in order to be able to optimize overall system performance.
- For example VoIP applications will be able to receive calls in the background.
- Third party push servers are supported for sending notifications to applications.

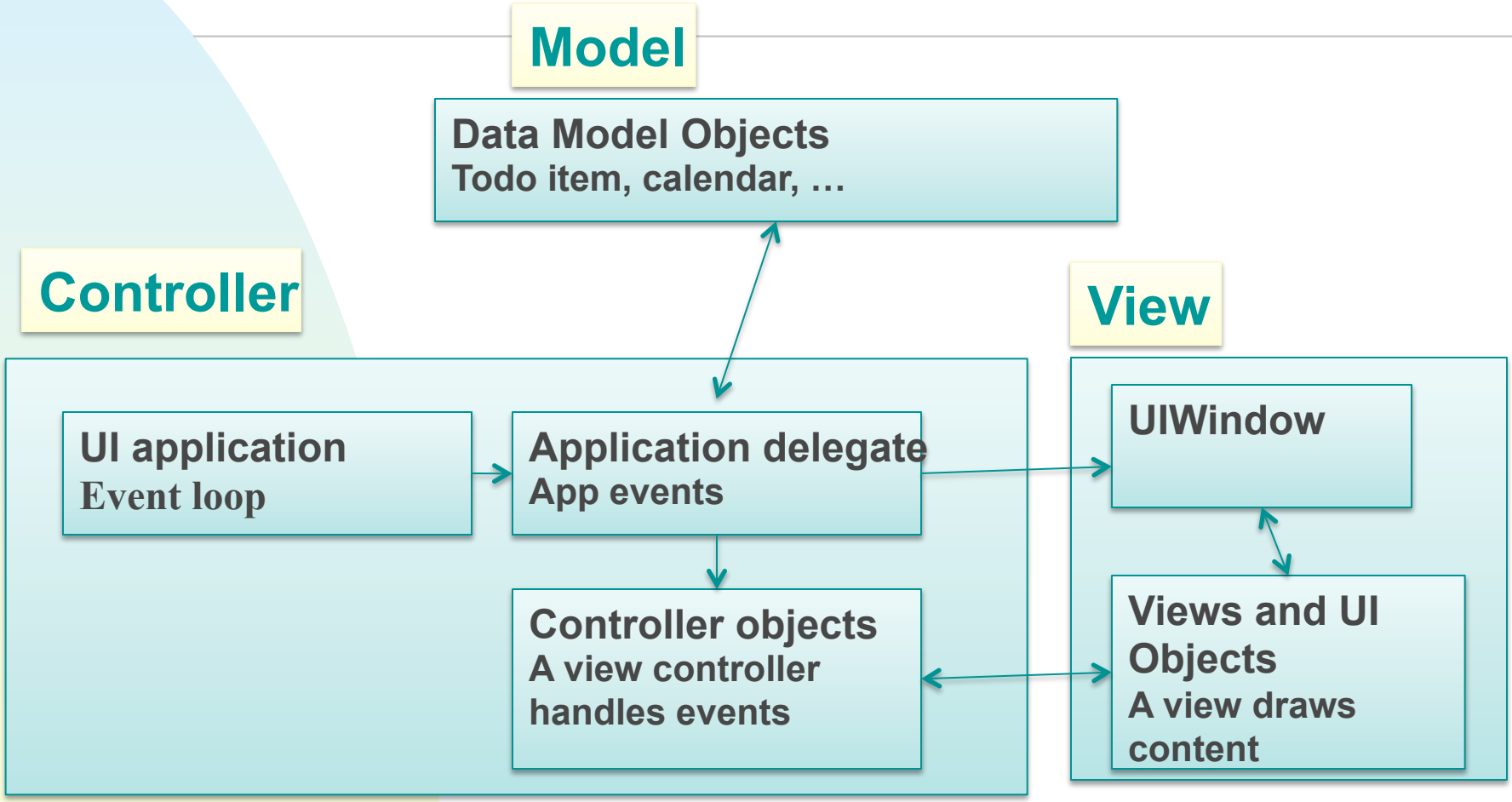
iOS4 multitasking

- The new iPhone multitasking-specific APIs includes
  - support for background audio play
  - VoIP
  - location services
  - task completion, and
  - fast application switching
- If you know the task then you can optimize scheduling

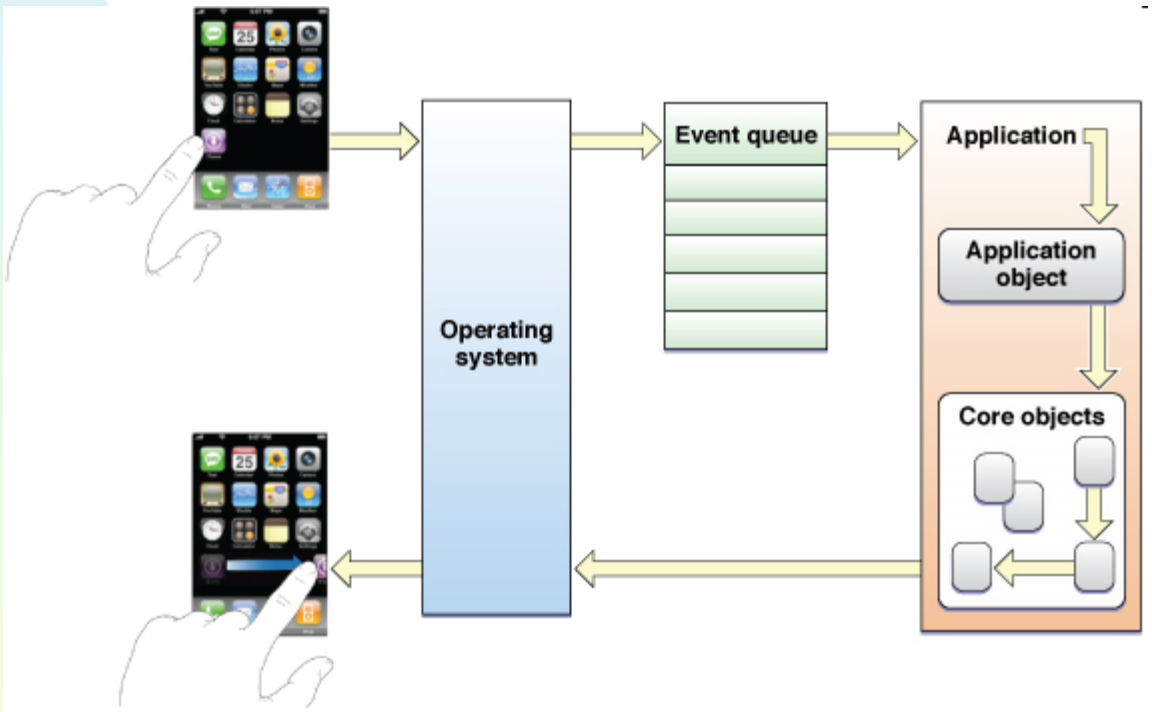
Application model

- Mac OS X model
  - Traditional main() starts UI event loop
  - View controller reacts to events
  - View objects manage visible objects
  - View controller unserializes views from a .nib file (UI builder)
  - All code is native
  - Patterns
    - Model-View-Controller
    - Delegate
      - Implement application specific logic

Structure


Model
Data Model Objects
Todo item, calendar, …
Controller
View
UI application
Event loop
Application delegate
App events
Controller objects
A view controller
handles events
UIWindow
Views and UI
Objects
A view draws
content

iPhone Events



Source: http://developer.apple.com/iphone/library/documentation/iPhone/Conceptual/iPhoneOSProgrammingGuide/Art/app_interruptions.jpg

XCode

- Xcode is Apple's IDE for iOS development
- Interface Builder
  - XML view definitions, .nib files
- Emulator for testing

- Pointer: developer.apple.com

Summary

	iPhone OS
Development	Objective-C
Network scanning	No
Network interface control	No
Background processing	No (Yes for 4.0)
Energy and power monitoring and control	Monitoring since 3.0
Memory management	Yes
Persistent storage	Yes
Location information	Yes
HTML 5	Yes
SIP API support	Limited
Open Source	No
3rd party application installation	Certificate, Apple AppStore
Level of fragmentation	Minor fragmentation

	Android Linux	Blackberry OS 5.0	iPhone OS	Java ME MIDP	Kindle SDK	MeeGo Linux	HP WebOS Linux	Symbian Series 60	Windows Mobile .NET and Windows Phone
Development	Java, native code with JNI and C/C++	Java MIDP, Blackberry APIs	Objective-C	Java ME	Java, Personal Basis Profile	C/C++, Qt APIs, various	Applications with Web tech. (HTML 5), C/C++	C++, Qt, Python, various	C# and .NET, various
Network scanning	Yes	Yes (hotspot API)	No	No	No	Yes	Limited (Web apps)	Limited	Yes
Network interface control	Limited	Limited (hotspot API)	No	No	No	Yes	Limited (Web apps)	Yes	Yes
Background processing	Yes (services)	Yes	No (Yes for 4.0)	Yes (multi-tasking support in MIDP 3.0)	No	Yes	Yes	Yes	Yes, not supported for third party applications in WP7
Energy and power monitoring and control	Yes	Limited (battery info)	Monitoring since 3.0	No	No	Yes	Yes (battery status, inform duration of activity)	Yes	Yes
Memory management	Yes	Yes (low-memory events)	Yes	Limited	Limited	Yes	Yes (no for Web apps)	Yes	Yes
Persistent storage	Yes	Yes	Yes	Limited, exension	Limited secure storage	Yes	Yes (HTML 5 storage)	Yes	Yes
Location information	Yes	Yes	Yes	Extension	No	Yes	Yes	Yes	Yes
HTML 5	Yes, support depends on version	Yes, support depends on version	Yes	N/A	N/A	Depends on WebKit version	Yes	No (Widgets and Javascript API)	No
SIP API support	Limited	No	Limited	Extension	No	Yes	No	Yes	No
Open Source	Yes	No	No	No	No	Yes	No (some parts are Open Source)	Yes	No
3rd party application installation	Certificate, Android store	Certificate	Certificate, Apple AppStore	Certificate	Kindle DRM	Certificate	Certificate	Certificate	Certificate, app store (WP7)
Level of fragmentation	Some fragmentation	Minor fragmentation	Minor fragmentation	Fragmented	Not fragmented	Not fragmented	Not fragmented	Some fragmentation	Some fragmentation

Discussion

- The current state is fragmented
- Difficult to achieve portability
- Certain patterns are pervasive (model view control and others)
- Solutions?

Web Apps

- Emerging as an alternative to native applications
- Hybrid usage: Web content to native application interfaces
- Web content can partially solved portability issues
- **Survey: Android Programmers Shifting Toward Web Apps**
  - *CNet (03/20/12) Stephen Shankland*
  - http://news.cnet.com/8301-30685_3-57400136-264/survey-android-programmers-shifting-toward-web-apps/

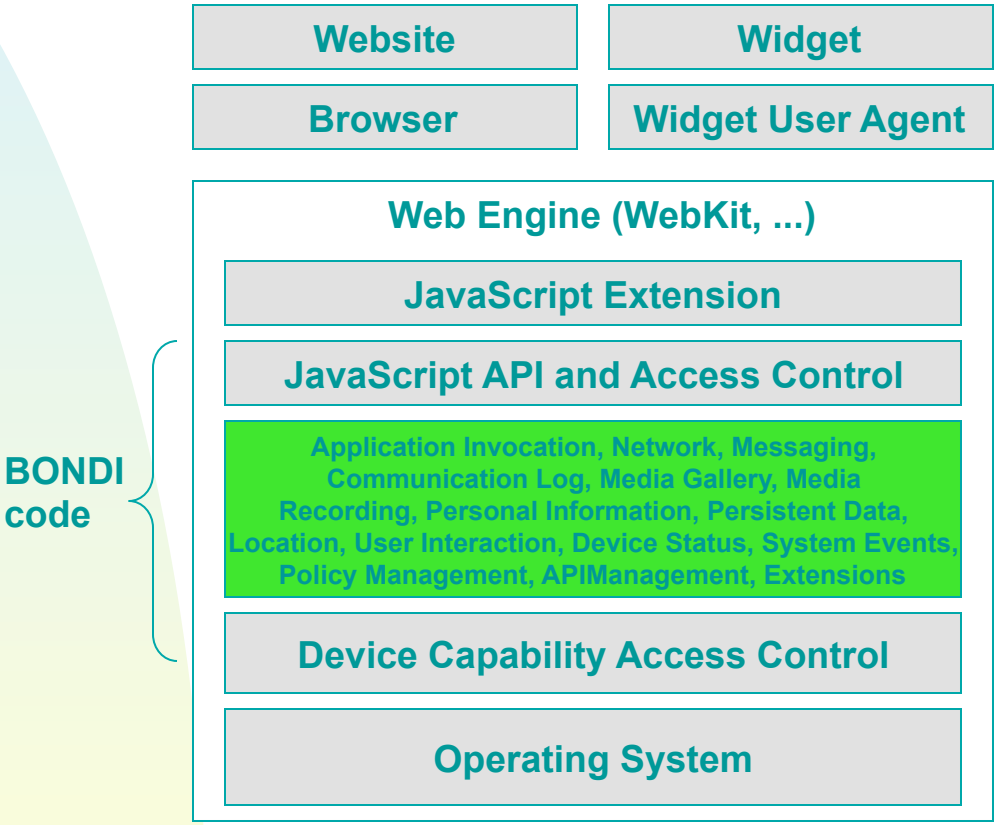
HTML5

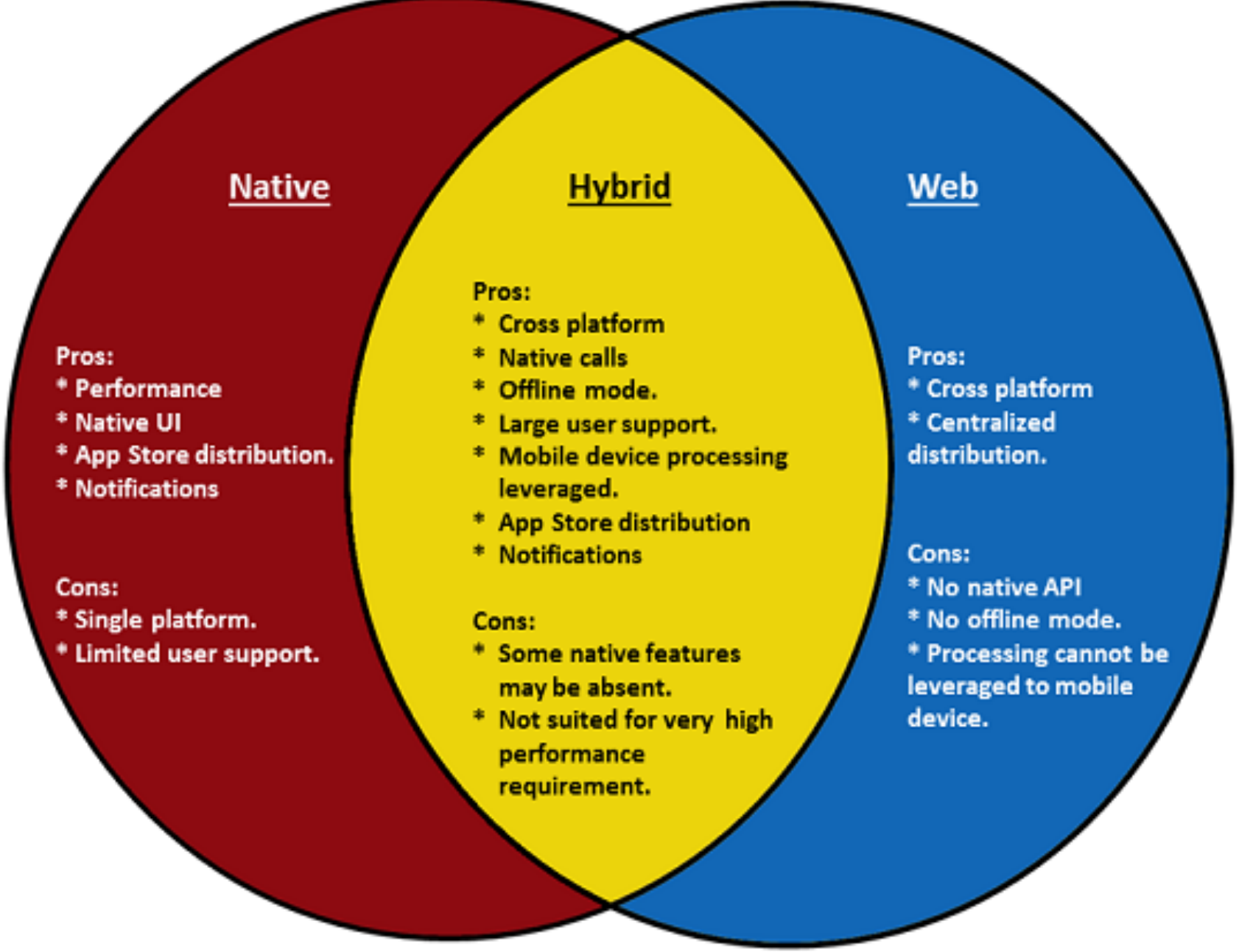
- HTML 5 is the next version of HTML
  - The first public working draft of the specification available in January 2008 and completion expected around 2012
- Improvements
  - Web Socket API, advanced forms, offline application API, and client-side persistent storage (key/value and SQL).
- HTML 5 support divides the platforms.
  - The iPhone platform has a very good support for HTML 5
  - Also Windows Phone and Android support it
  - http://mobilehtml5.org/

JavaScript access

- The Open Mobile Terminal Platform (OMTP) group defines requirements and specifications that aim towards simpler and more interoperable mobile APIs
- BONDI defines requirements governing Device Capability access by JavaScript APIs to promote interoperability and security of implementations
- The 1.1 release of BONDI is compliant with the W3C Widgets: Packaging and Compliance specification

BONDI Architecture





Source: http://www.developer.nokia.com/Community/Wiki/Cross_Platform_Mobile_Architecture

Libraries/frameworks for Portability

- Apache Cordova (former PhoneGap)
  - Use JavaScript to access a native API, like geolocation, camera, storage, etc. using a single API call irrespective of the mobile platform
- Sench Touch
  - An HTML5 framework and native api wrappers
- Xamarin
  - Xamarin compiler bundles the .NET runtime and outputs a native executable, packaged as an iOS or Android app

System bus

- An asynchronous system-wide event bus is a basic solution for interconnecting various on-device components
- There is no single standard for this.
  - Android and Java ME use Java-specific events (Android Intent filtering)
  - MeeGo uses D-BUS
  - Palm's WebOS W3C Events
- One particular trend is to utilize URI-based conventions for naming system resources and services.
  - This is extensively used in Android, WebOS and the BONDI architecture. Can be used for iOS as well (URL handlers)

Summary

- Three current smartphone platforms
  - iOS, Android, WP8
- Fragmentation is a current problem
  - Device, standard, implementation
- Closed vs. Open platforms
  - Trust in apps, API access, privileges
- Cross-platform development
  - HTML5, native, or hybrid
  - Middleware support
  - Hybrid is a viable alternative