

Unit 1:

Introduction to Mobile Application Technology and Development



Mobile Application Development (MAD)
CCIT4059, 2025-2026 S2

Outline

- Mobile Applications and Devices
- Technology of Mobile Devices
- Multilayer Mobile System
- Mobile Operating Systems
- Mobile App Development Environments
- Developing Mobile Applications
- Developing Android App
 - Android Studio

Mobile Applications and Devices

- **Mobile applications (apps)** are application software developed to run on mobile devices, including smartphones, tablets, and wearable devices
- Different types of mobile apps, including:
 - Games and Entertainment,
 - Social networking, Information and News,
 - Business and Finance,
 - Education and Training,
 - Utility and Monitoring, and more...

Mobile Applications and Devices

- Mobile device is often defined as an electronic device with ***ability to work in 'mobile' environments***
 - Mobile: able to ***operate with changing locations***
 - Possibly and preferably portable:
 - hand-held, pocket sized, light (e.g. < 200 grams for mobile phone), etc.
- Various types of mobile devices provide functions for different purposes
 - PDA, handheld game console, mobile phone, tablet, wearable smart glasses and watch

Technology of Mobile Devices

- Looking backwards, **mobile phone** is an extension of telephone, one of the greatest inventions
 - Telephone enables us to reach across distances, and share thoughts and ideas verbally with others
 - It “shrinks” the world and “enlarges” our personal reachable scope



Technology of Mobile Devices

- Nowadays, mobile phone is also a device for communication, information, business, entertainment, sports, etc.
 - Nearly always connected to the Internet, even if you don't have a web browser open
 - Send and receive voice and text messages
 - Purchase goods and services
 - Have fun with others via online games
 - Take photos or videos
 - Locate which street corner you are standing on
 - Keep track on how long you have been running
 - And more...



Technology of Mobile Devices

(Evolution of Mobile Phone)

- **Brick Era (1973~1988)**

- Large size and weight



- **Candy Bar Era (1988~1998)**

- A thin, rectangular form of mobile devices
- Network shifted to 2nd-generation (2G)



- **Feature Phone Era (1998~2008)**

- More complex, with more functions in a device:
- Phone, camera, media player, etc.



- **Smartphone Era (2002~)**

- Include all capabilities of a feature phone
- Use a common (more general) operating system: (e.g. iOS, Android)
- Often provide SDK (Software Development Kit) and tools for application developers



Technology of Mobile Devices

- **Tablet Computers**

- A mobile computer with display, circuitry and battery in a single unit
- Equipped with various sensors, including cameras, microphone, accelerometer and touchscreen, with finger or stylus gestures replacing computer mouse and keyboard



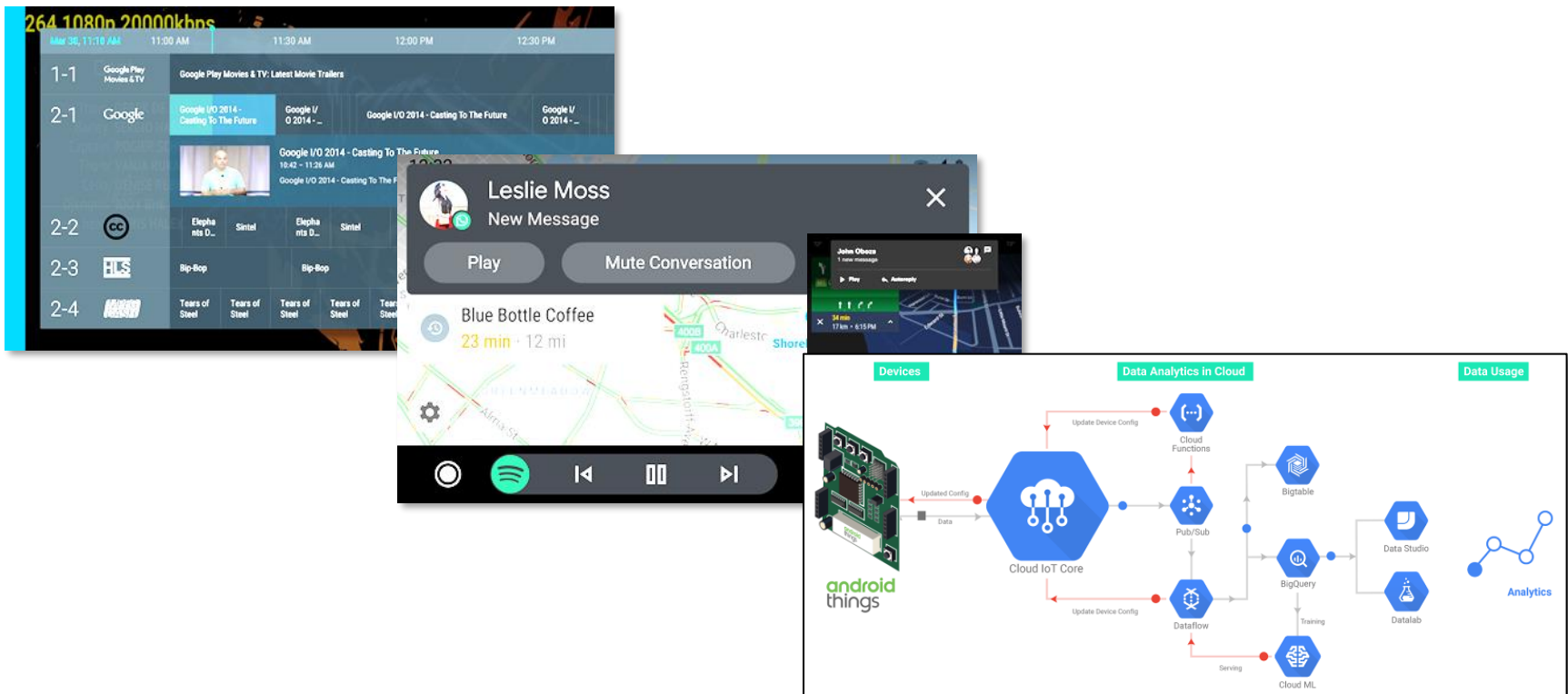
- **Wearable Computers**

- Miniature electronic devices that are worn by the bearer under, with or on top of clothing
- “Wearable computing” is currently a topic of active research, with areas of study including user interface design, augmented reality, pattern recognition
- Use of wearables for specific applications or for compensating disabilities as well as supporting elderly people steadily increases



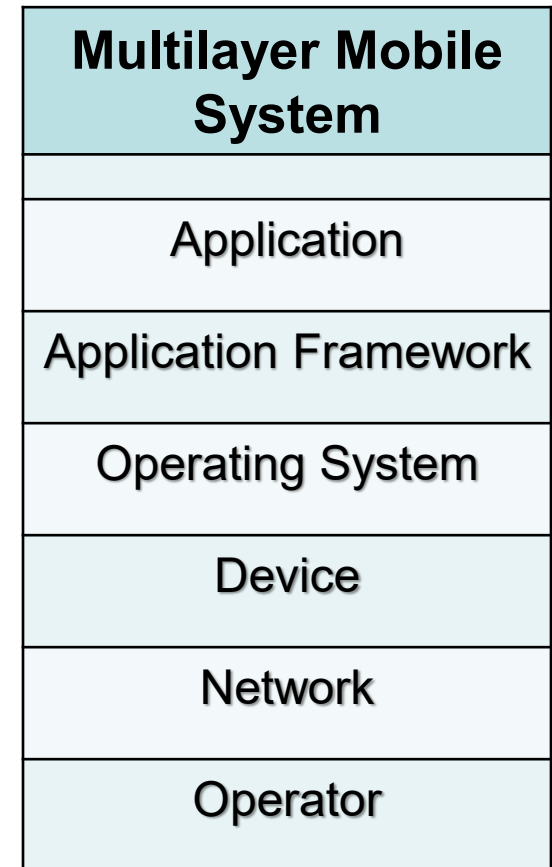
Technology of Mobile Devices

- Other Types of Mobile Devices
 - Smart Television (TV), e.g. with Android TV
 - Automobile, e.g. with Android Auto
 - Internet of Things, e.g. Android Things



Multilayer Mobile System

- Mobile devices are typically connected to the world of mobile system, which could be realized as *a mobile ecosystem with 6 level multi-layers*
- Each layer in this Multilayer Mobile System relies on the others to create a seamless, end-to-end experience to end users



Multilayer Mobile System (Operator Layer)

- The base layer in the mobile system is the **Operator Layer**, the providers of *mobile system infrastructure*
- Its role is to create and maintain a specific set of *wireless services over a reliable cellular network*
- Operators can be referred to as mobile service providers, carriers; mobile phone operators; or cellular companies
 - E.g. China Mobile, PCCW Mobile, and AT&T

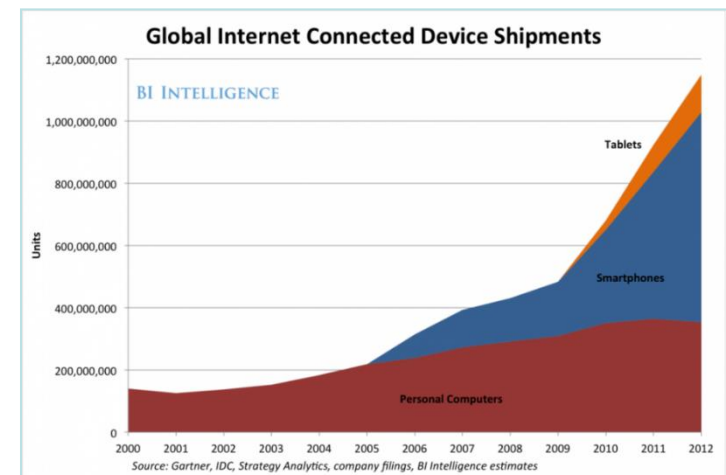
Multilayer Mobile System (Network Layer)

- While operators operate wireless networks, **network layer** is related to the type of *radio and antenna which determines the capability of the network and the services* under the cellular technology
- Types of networks around the world, e.g.:
 - 2G / 2.5G (GSM / GPRS)
 - 3G / 3.5G (W-CDMA / HSPA)
 - 4G (LTE)
 - 5G (NR)



Multilayer Mobile System (Device Layer)

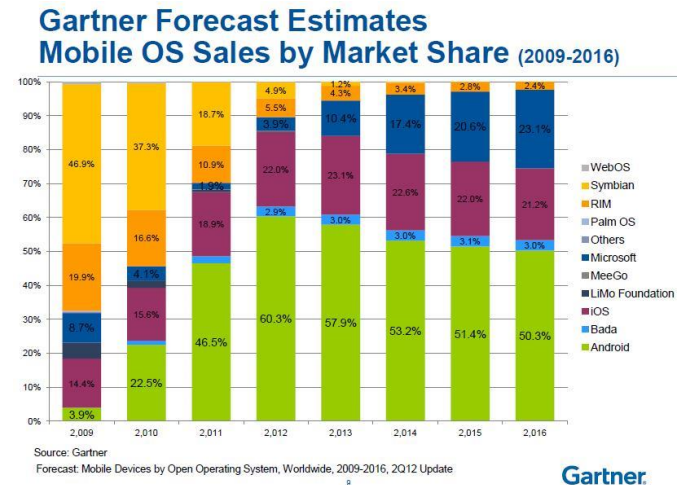
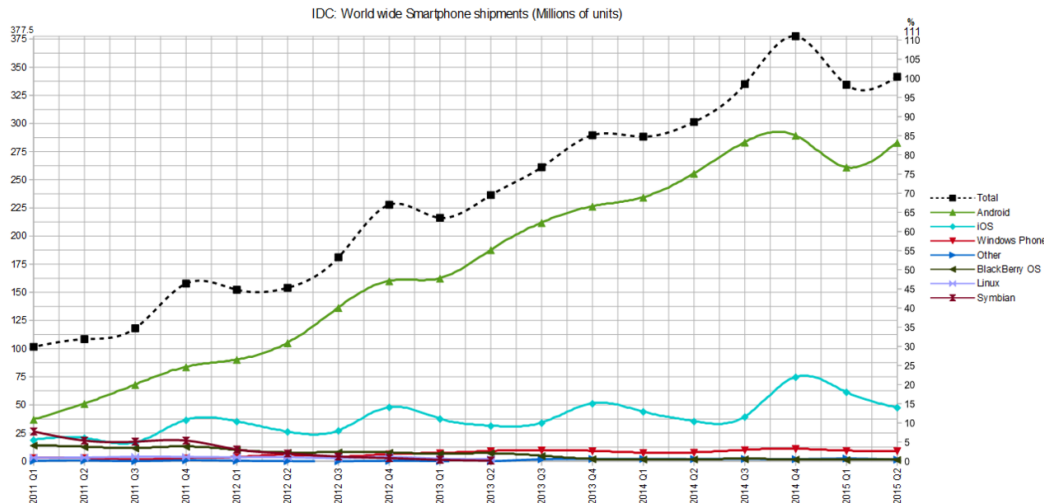
- **Device layer** contains the *hardware devices for mobile users*
 - There are various types of devices (the hardware) in the mobile world, e.g.:
 - PDAs, mobile phones, smart watches, and tablets
 - Mobile phones still dominate the markets
 - Smart watches and Tablets are getting popular these days



* Figures for reference only.

Multilayer Mobile System (Operating System Layer)

- **Operating System (OS) Layer** provides *the operating system running on mobile devices*
 - The *most important system software*, including functions of managing the computer's resources such as CPU and memory, handling proper user interface, and providing services for applications software
- Used to be smartphone which has mobile Operating System (OS) at the beginning. As technology advanced, a broader set of devices supports mobile operating systems, including tablets and smart watches.



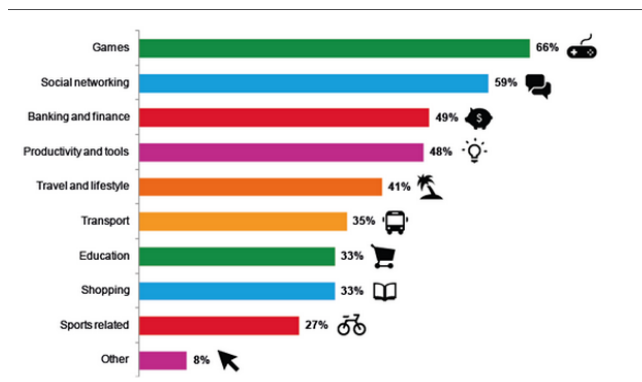
Multilayer Mobile System (Application Framework Layer)

- Often the first layer a developer accesses is the application framework (or Application Programming Interface, API), e.g.
 - Android (Java API) Framework, for Android
 - Cocoa Touch Framework, for iOS
- **Application frameworks** often run on top of operating systems, sharing core services such as communications, graphics, location, security, and many others



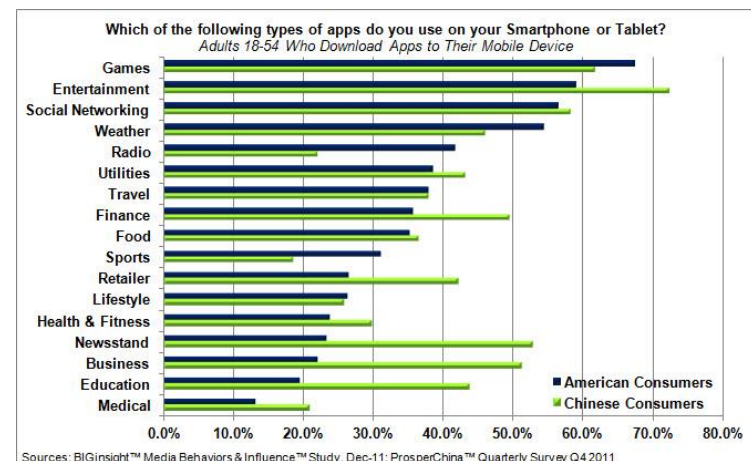
Multilayer Mobile System (Application Layer)

- In the top **Application Layer**, different apps (application software) could be created, e.g.
 - Game, web browser, photo editor, or media player
- One challenge of deploying applications is knowing the specific device attributes and capabilities



Per cent of people who downloaded an app in the six month to May 2013

Source: ACMA-commissioned survey, May 2013.



Sources: BIGinsight™ Media Behaviors & Influence™ Study, Dec-11; ProsperChina™ Quarterly Survey Q4 2011

*Percents add up to more than 100% because respondents could select more than one answer.

Multilayer Mobile System

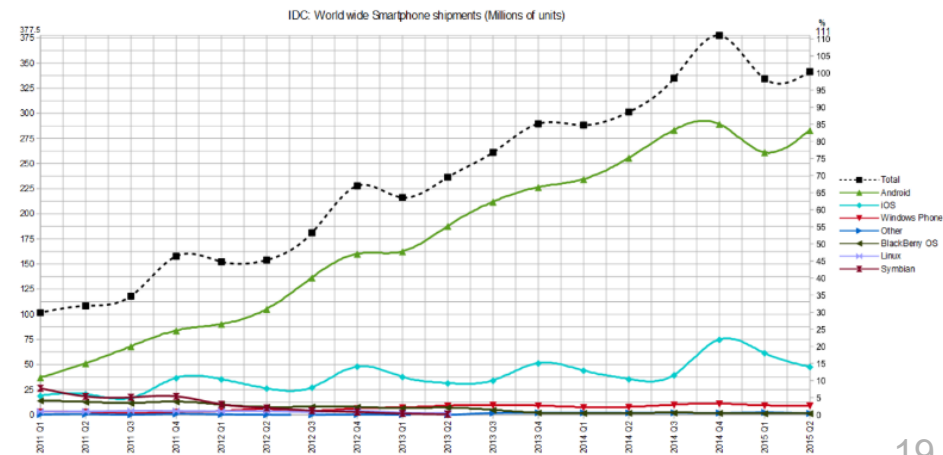
- Above all these layers are situated with various types and styles of *“end users”*
- What makes a mobile application operate successfully relies on designing and developing right for the actual “end users”
 - “User-centred” approach in design and development

Mobile Operating Systems

- Mobile OS controls a mobile device, similar in principle to an operating system (OS) such as Windows, Mac OS X, or Linux that controls a desktop computer or a laptop
- They are comparatively simpler, which deal more with the wireless versions of broadband and local connectivity, mobile multimedia formats, and different input methods

Mobile Operating Systems

- Major mobile operating systems on smartphones, mobile OS-powered tablets, and other mobile devices
 - Google's Android
 - Apple's iOS / iPadOS
 - HomonaryOS
 - KaiOS
 - ~~Microsoft's Windows 10 (Mobile Edition, Discontinued)~~
 - ~~Nokia's Symbian (Outdated)~~



* Figures for reference only.

Mobile Operating Systems (Other than Mobile OS)

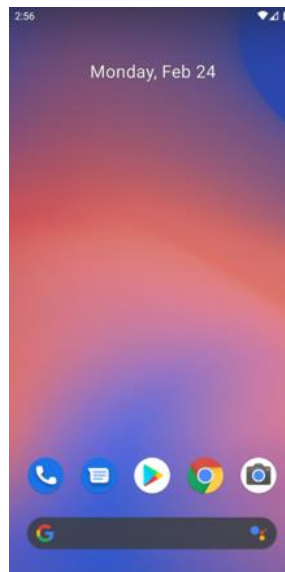
- Java ME (Micro Edition) is not a mobile OS, but a Java platform designed for embedded systems, particularly for mobile devices
 - Once a promising approach, for supporting cross-platforms on different brands of mobile devices (with Java Virtual Machine)
 - *“write once, run anywhere”*



Mobile Operating Systems (Android, Google)

Reference
Only

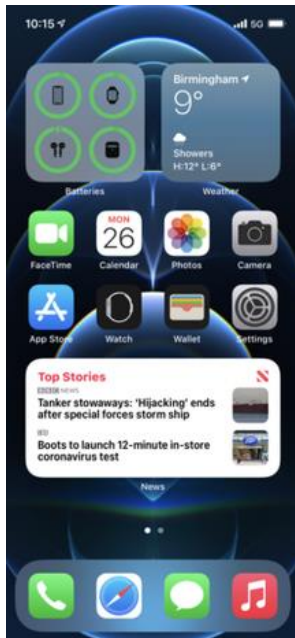
- Linux based mobile OS
- Consist of a kernel based on the Linux, with libraries and APIs written in C
- Use process virtual machine (Android Runtime / ART, or Dalvik virtual machine in older versions) to execute applications written for Android, often with programming languages Java or Kotlin



Mobile Operating Systems (iOS / iPadOS, Apple)

Reference
Only

- iOS / iPadOS are used in Apple's iPhone, iPod Touch, iPad, and Apple TV
- Derived from Mac OS X
 - Unix-like operating system by nature



App Development Environments

- Types of software development environment for mobile apps are related to the types of mobile apps to be created
- Three major types of mobile applications: *Native mobile apps*, *Web-based mobile apps* (or simply web apps), and *Hybrid mobile apps*



ANDROID WEAR



PHONES



TABLETS



ANDROID TV



ANDROID AUTO

App Development Environments

- ***Native mobile apps***

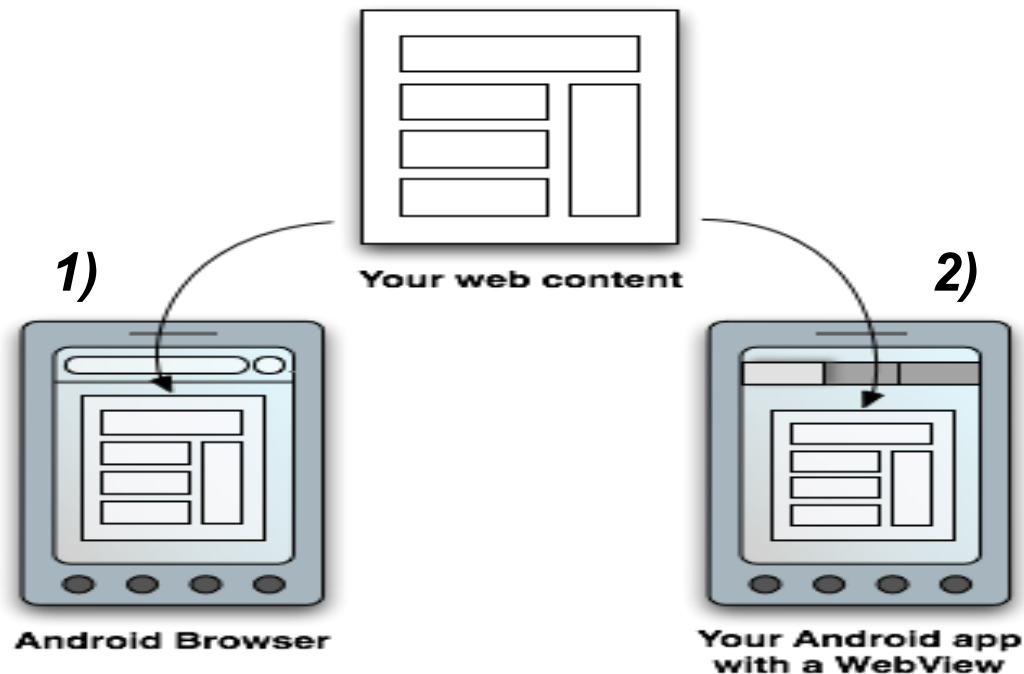
- Native mobile applications are usually developed using higher level programming languages, such as Java/Kotlin for Android, C# for Windows 10, or Objective-C/Swift for iOS
- The native APIs are provided to the developer as part of the platform SDK
- The platform APIs are usually designed to provide native apps optimal access to hardware capabilities, such as the device's camera and Bluetooth stack

App Development Environments

- Native mobile apps
 - Go for native, if we need to take advantage of the features of a device that a mobile web-browser does not allow
 - Common cases of likely going native than web
 - Create games that require instant response
 - Require specific locations or file systems
 - Require hardware/sensors: cameras, accelerometer
 - Work for offline users: if the user is likely to be offline or out of range of a mobile network

App Development Environments

- Apart from native mobile apps, the other two types of mobile apps involve delivering some contents in a web format:
 - 1) **Web-based apps**: use mobile web-browsers
 - 2) **Hybrid apps**: use browser-like web viewer component (such as `WebView` in Android, a component in an application framework that displays web contents)



App Development Environments

- ***Web-based mobile apps***

- Web-based mobile apps (or simply web apps) use web technology to implement mobile applications as websites designed for web-enabled mobile phones, and present content in a web format and work with a web server
- Cross-platform: user needs only a web browser that displays web content
- Common technologies: PHP, HTML, CSS, JavaScript

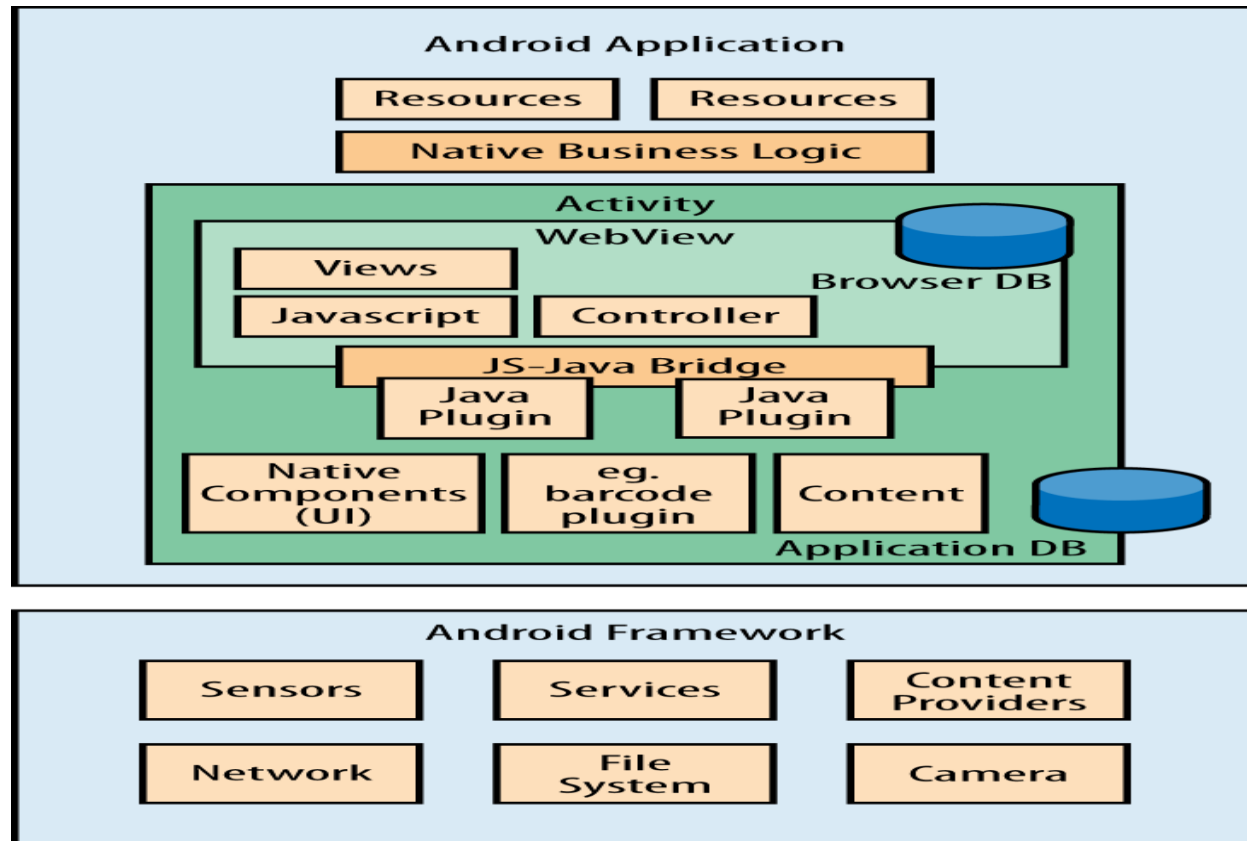
App Development Environments

- ***Hybrid mobile apps***

- Hybrid apps, like native apps, run within a native process environment on the device
- These apps typically wrap the HTML content within a web viewer component in full screen mode, without a visible address bar or other browser controls

App Development Environments

- Hybrid mobile apps
 - Example of a hybrid application architecture in Android platform



App Development Environments

- Major mobile operating systems provide software development kit (SDK) for third-parties to develop mobile apps



- Google's Android SDK (e.g. in Android Studio)



- Apple's iOS SDK (Xcode)



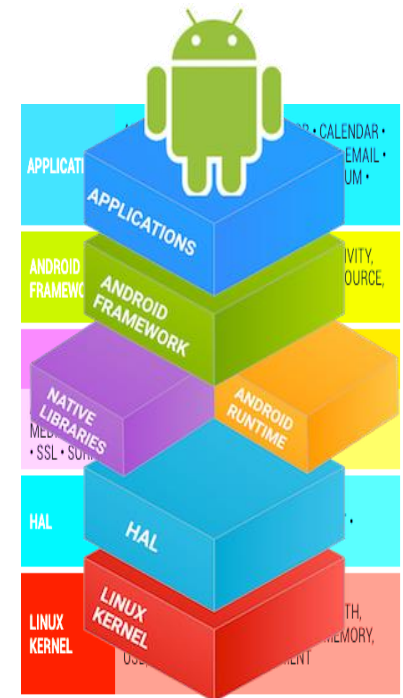
- Microsoft's Windows 10 SDK (Visual Studio)

- Nokia's Symbian SDK

- SDK is also available for Java ME platform
 - E.g. Java ME SDK for NetBeans or Eclipse

App Development Environments

- Android apps are often written in Java and compiled to .class bytecode file, then converted to Dalvik-compatible .dex files before installation
- Android architecture consists of 5 layers
 - Application (including System Apps)
 - Android (Java API) Framework
 - Native (C/C++) Libraries and Runtime
 - Hardware Abstraction Layer (HAL)
 - Linux Kernel



* Further details will be given in later unit(s).

Developing Mobile Application

- Developing mobile apps (applications) goes through the similar process of typical software development life cycle: including planning, design, implementation, evaluation and maintenance
- While on what platform(s) the mobile apps will run heavily determines how the apps are implemented, however, the overall design and development process is basically the same

Developing Mobile Application

- In general, development process of a mobile application project involves 5 stages:
 - Initiation, Requirement and Planning
 - Design
 - Implementation
 - Evaluation and Distribution (Deployment)
 - Operation and Maintenance
- Apart from issues related to typical software development process, concerns should also be given to those specific to mobile apps when developing mobile applications, including:
 - Operational environment of mobile applications,
 - Hardware and software constraints

Developing Mobile Application

- Two important design aspects in developing mobile apps:
 - Visual Design
 - User Interface Design
- Features and techniques in developing mobile applications also include:
 - Object-Oriented Programming Approach
 - Data Structure and Algorithm
 - Design pattern, e.g. Model View Controller
- Implementing mobile apps often includes:
 - Programming & Using Software Tools
 - E.g. For developing Android mobile apps: Java or Kotlin programming languages, Android Studio (with Android SDK), IntelliJ IDEA IDE (with Android SDK)

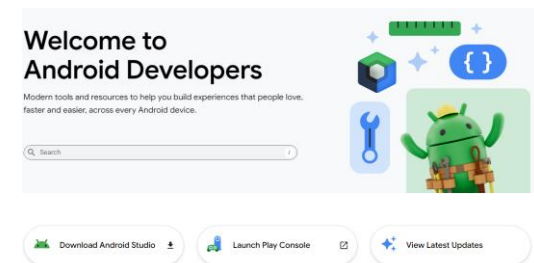
Developing Mobile Application

- In particular, implementing mobile apps with Java and Android SDK for Android platform requires further knowledge in:
 - Concepts of Object-Oriented Programming
 - Class and Object, Field and Method
 - Encapsulation, Inheritance, Polymorphism
 - Interface, Event Handling, Collection and Generic, Thread
 - Android OS Environment
 - Graphical User Interface

Developing Android App (Android Studio)

- Android Studio (AS) is the official Integrated Development Environment (IDE) for Android app development, based on IntelliJ IDEA.
 - Latest Version: **Android Studio Otter Feature Drop | 2025.2.1**
- Android Studio offers a set of project templates to create Android apps, e.g.: Empty Activity, No Activity, and Basic Activity
- Each project in Android Studio contains one or more modules with source code files and resource files, including Android app modules
- Android app module contains 3 important folders:
 - manifests: Contains the `AndroidManifest.xml` file.
 - java: Contains the Java source code files.
 - res: Contains all non-code resources, such as XML layouts, UI strings, and bitmap images.

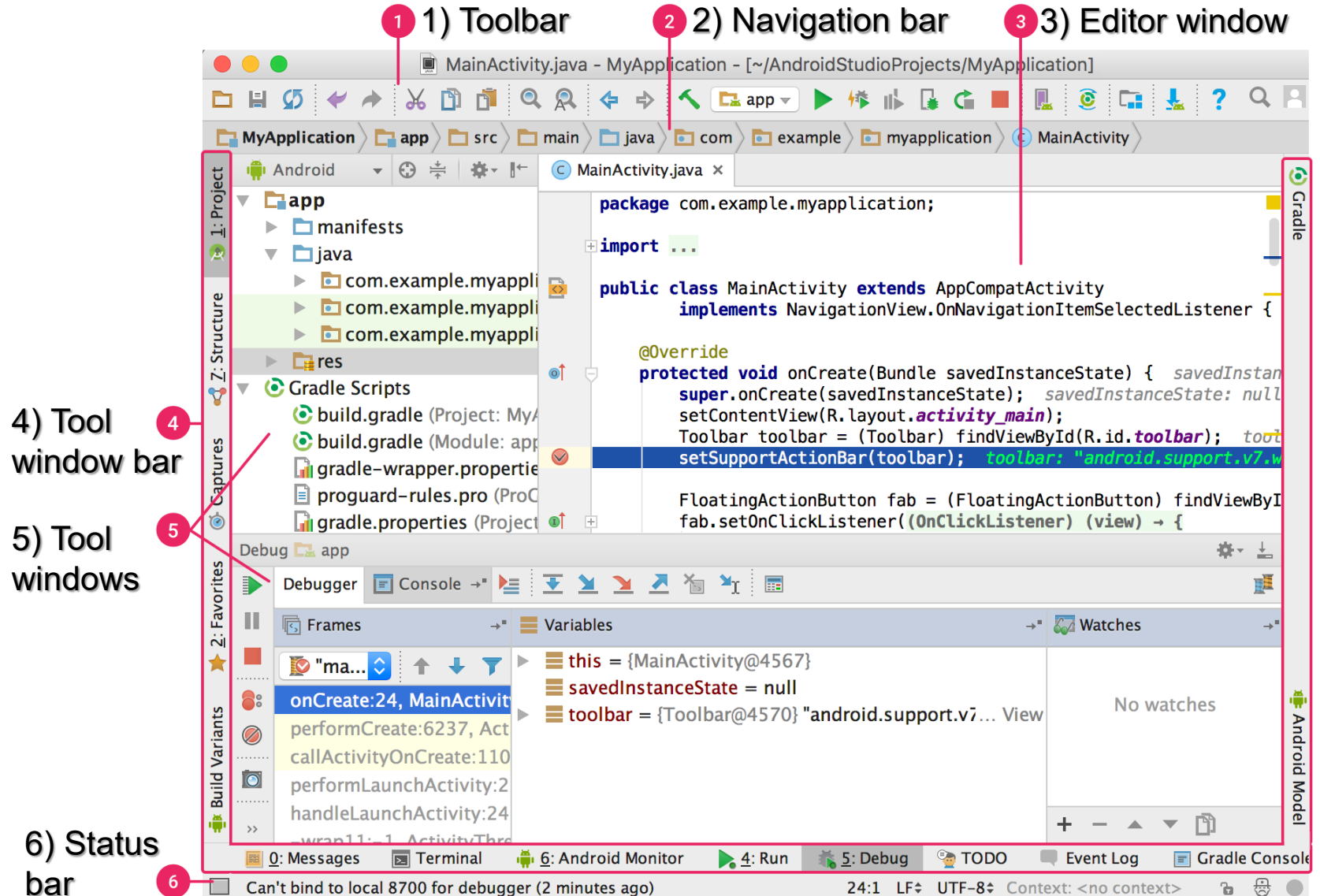
** Remark: For details, check the AS user guide and the web:
<https://developer.android.com/studio>*



Developing Android App (Android Studio)

- Android Studio working space is made up of several panel areas:
 - 1) The **toolbar** lets you carry out a wide range of actions, including running your app and launching Android tools.
 - 2) The **navigation bar** helps you navigate through your project and open files for editing. It provides a more compact view of the structure visible in the **Project** window.
 - 3) The **editor window** is where you create and modify code. Depending on the current file type, the editor can change. For example, when viewing a layout file, the editor displays the Layout Editor.
 - 4) The **tool window bar** runs around the outside of the IDE window and contains the buttons that allow you to expand or collapse individual tool windows.
 - 5) The **tool windows** give you access to specific tasks like project management, search, version control, and more. You can expand them and collapse them.
 - 6) The **status bar** displays the status of your project and the IDE itself, as well as any warnings or messages.

Developing Android App (Android Studio)



Developing Android App (Android Studio)

- For better handling and distributing an Android Studio Project, we should create 1) an apk for installation and 2) a complete project zip file after completing the implementation of an Android app with Android Studio Project.
1. Build the app to apk file for installation (e.g. into a physical device):
 - From menu: **Build > Rebuild Project**
 - Locate the apk file, in **<ASProjectFolder>\app\build\outputs\apk\debug\app-debug.apk**
 - Extract and properly rename the app-debug.apk file, e.g. **appName.apk**
 2. Export the project to zip, e.g. for distribution:
 - From menu: **File > Export > Export to Zip File...**
 - May name the project zip file, e.g. **appName.zip**

References

- Part of this slide set is prepared and extracted from the followings:
 - Fling, B. (2009) *'Mobile Design and Development: Practical techniques for creating mobile sites and web apps'*, O'Reilly Media, Inc.
 - Gok, N. and Khanna, N. (2013) *'Building Hybrid Android Apps with Java and JavaScript'*, O'Reilly Media, Inc.
 - Google Inc. 'Website for Android Developers', <http://developer.android.com/>
 - Google Inc. 'Website for Android Sources', <https://source.android.com/>
 - Apple Inc. 'Website for Apple Developers', Website: <https://developer.apple.com/>
 - Microsoft Corp. 'Website for Windows Developers', <https://developer.microsoft.com/en-us/windows>
 - Wikipedia Website: <http://en.wikipedia.org>
- This set of slides is for teaching purpose only