CMPE 220

Class 27 – Mobile Operating Systems

Types of Operating Systems

- Batch / Single-Process (early computers – 1940s-50s)
- Multi-Programming Systems ("modern" computers – last 1960s)
- Multi-Processor Systems
- Distributed Operating Systems
- Network Operating Systems
- Embedded Systems
- Real-Time Systems
- Cloud Systems
- Mobile Systems

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What is a Mobile Operating System?

- An operating system for smartphones, tablets, smartwatches, smartglasses, or other non-laptop personal mobile computing devices
- Mobile operating systems combine features of a desktop computer operating system with other features useful for mobile or handheld use

Popularity of Mobile Operating Systems

- An estimated *6.84 billion* mobile phones in use
- Compare to:
  - 2.5 billion computers (desktops, servers, laptops)
    - Windows
    - MacOS
    - Linux (multiple variants)
    - Cloud Operating Systems
  - 15.2 IoT devices
    - Linux
    - Dozens of dedicated operating systems

Mobile Operating Systems Market Share

Q1 2023	Worldwide Market Share
Android*	71%
iOS	29%
All others (combined): • Windows • Symbian • Ubuntu	< 1%

*** <u>Android Variants</u>**

- Each manufacturer produces their own customized version of Android
- Mostly variations in User Interface and pre-loaded apps

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History: iOS

- First released by Apple Computer in June 2007
- Based on BSD Unix
- Originally called iPhone OS
- Renamed iOS (version 4) in April 2010 to expand support to iPad

History: Android

- Developed in 2003 by Android, Inc. as an operating system for cameras
- Based on Linux
- Purchased by Google in 2005
- First Android-based phone - the HTC Dream - shipped in September, 2008

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Is Android Open Source?

- The core OS is developed and released by the Android Open Source Project – through a consortium managed by Google
- Most of the Android application software is not open source
- Most code comes from Google
- Google licenses its own version to hardware vendors

- Amazon Kindle operating system – FireOS - is based on the Android Open Source Project

The Android OS Release Pipeline

- New version of Android is “frozen” in open source
- Google releases a new version of its proprietary Android with Google apps
- Manufacturers “port” the system to their hardware
- Manufacturers release the new version

- Typical delay: several weeks to several months
  - Major releases take longer

- Security risk!

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Update Rates

- Good statistics are hard to find, but iOS users are much more likely to be running the “current” OS
  - An estimated 60% or more of iPhone users are up-to-date
  - Less than 20% of Android users are up-to-date

Android Version	Market Share
13	12%
12	17%
11	23%
Older	49%

iOS Version	Market Share
16	61%
15	28%
14	3%
Older	8%

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Problems Due to Slow Adoption

- Security Risks
  - Hackers target known vulnerabilities
- Slow feature adoption
  - App vendors don’t take advantage of new features

Comparison of Operating Systems

- All provide a means of sharing resources across a communications network
- **Network Operating System:** access to remote resources is explicit
- **Distributed Operating System:** access to remote resources is implicit – programs may not know about locality of references
- **Cloud Operating system:** manages the operation, execution and processes of *virtual machines*, virtual servers and virtual infrastructure, as well as the back-end hardware and software resources.

Mobile OS Differences

File System

- Mass Storage
  - No disk drive
  - Solid-state storage (file system)
  - System doesn’t need to deal with disk latency
  - Supports virtual memory

- RAM: 4-16 GB
- Mass Storage: 16GB – 1TB

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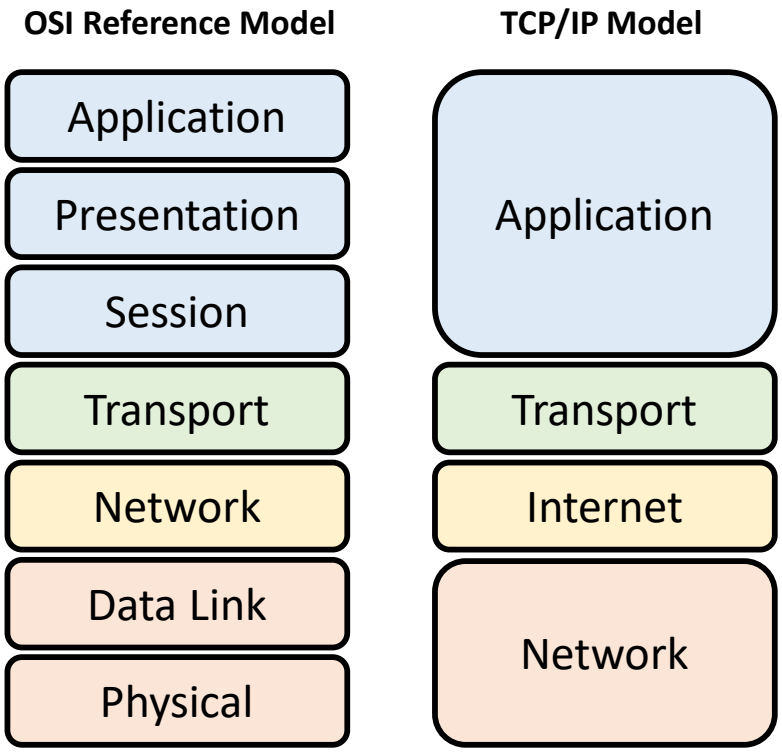
Networking: OSI Versus TCP/IP Models



- OSI model provides a clear distinction between application, presentation, and session services.
- TCP/IP groups these as a single *Application* layer

- In the OSI model, the data link layer and physical are separate layers.
- TCP/IP groups these as a single *Network* layer

Networking

Layer	Smartphone Implementation
Application	HTTP, HTTPS, POP, IMAP, SMTP, SMS, etc
Transport	UDP, TCP
Internet	IP
Network	Wifi Cellular

I/O

- Device I/O: keyboards, printers, etc
- Drivers:
  - Bluetooth
  - USB
- Camera
- Audio input & output
- Location services
- Touchscreen

User Interface

- Screen interface / Window system
- User Interface API
  - Event-driven framework

Power Management

- Charging
- Smart charging algorithms
- Charge monitoring
  - CPU throttling (Apple “scandal”)
  - Task management
  - Instruction selection
- Battery monitoring
  - Health assessment and reporting

Additional Characteristics

- **Resiliency and Availability** - the ability of a service to recover quickly from any disruption
- **Critical Phone Service** – service disruptions can be life-threatening

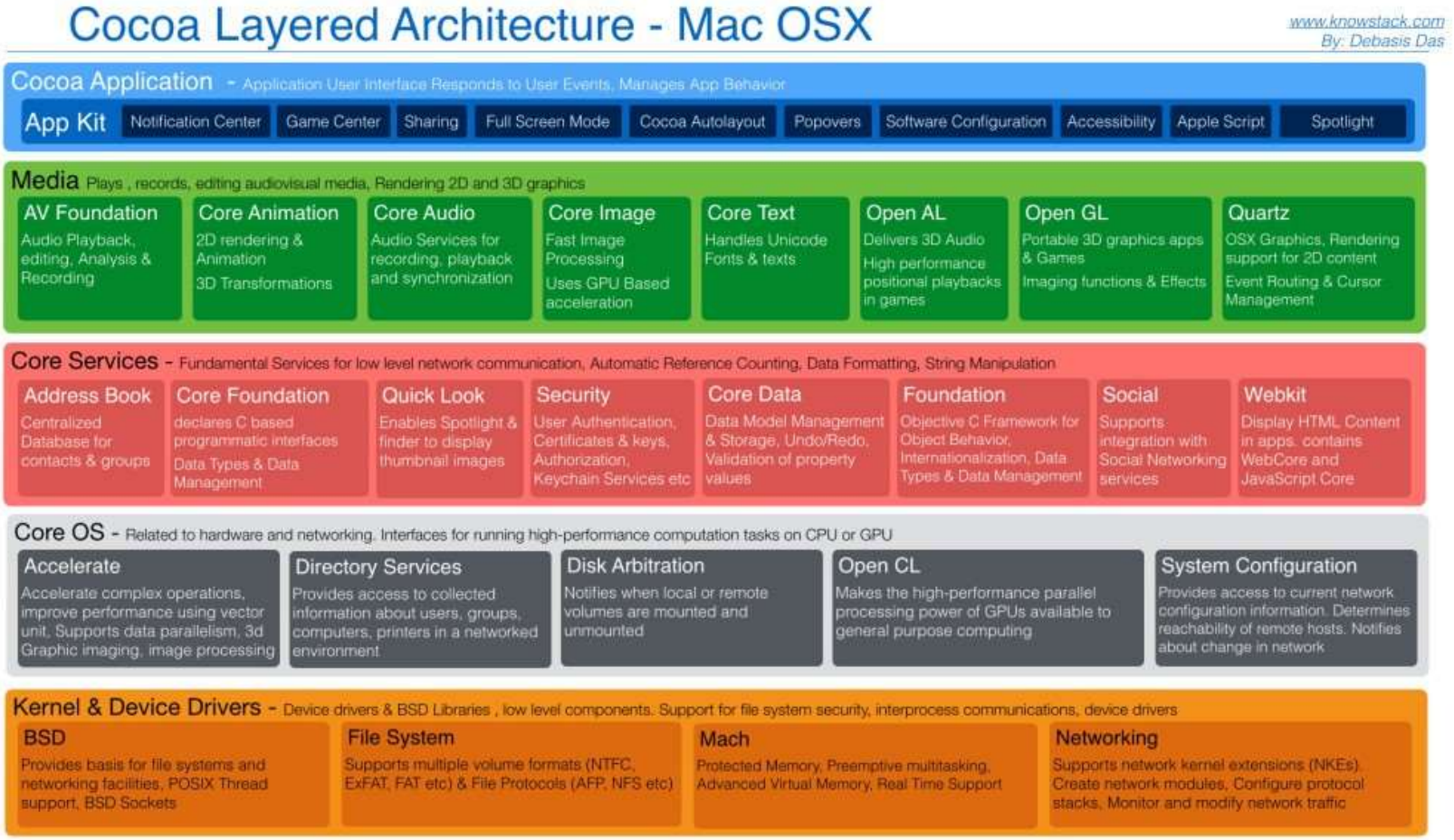
Android Architecture

- Linux based
  - C/C++ OS Code
- Java Virtual Machine
  - Application Framework

Development

- Android SDK
- Java Virtual Machine (JVM)
- Multiple application frameworks
- Applications can be written in Kotlin, Java, and C++
- Kotlin is a modern, statically-typed language used by over 60% of Android developers

iOS Architecture



Based on BSD-Unix

Development

- An object-oriented application framework
- Cocoa for iOS and MacOS
- Cocoa is written in Objective-C, C++, and C
- Applications are written in Swift and Objective C

Security

- Android is an open system
  - Applications may be distributed through the Google Play Store or private exchanges
  - Google inspects and verifies applications in Play Store
- iOS is a closed system
  - Applications *must* be distributed through the Apple Store
  - Apple inspects and verifies apps in App Store

- Security Implications
  - Theft of data

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Estimated Prevalence of Malware

- Android: 0.25% to 4% of devices may have malware
- Apple: < 0.05% of devices may have malware

- In 2017, Nokia's 2017 **Threat Intelligence Report** revealed that:
  - 68 percent of all mobile devices infected with malware in the past year were running Android
  - 28 percent were running Microsoft Windows
  - 3 percent were running iOS

Privacy

- Apple restricts application tracking
  - Apps must ask users before tracking and reporting usage
  - Apple enforces tracking restrictions through the App Store
- Google currently has no restrictions on tracking
  - Restrictions – if any – cannot be enforced

Anti-malware

- Major vendors support aps on both Android and iOS
  - BitDefender
  - McAfee
  - Norton
  - SmartCleaner