Mobile Handsets: A Panoramic Overview

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Outline

• Introduction
• Mobile Handset Architecture
• Mobile Handset Operating Systems
• Networking
• Applications
Mobile Handset Definition

- Mobile handsets (*mobiles*): electronic devices that provide services to users:
  - Internet
  - Games
  - Contacts
- Form factors: tablets, *smartphones*, consoles?
- Mobile: your next (primary?) computer system

Sources: Apple, Google, Samsung, Nintendo
Mobile Handsets: Business

• Meteoric sales and growth:
  – ITU: worldwide mobile phone/cellular subscriptions exceeds world population*
  – Some people have *multiple* phones!
  – Mobile handsets & industries: $5 trillion [3]

• Mobile phones are replaced every 6 months in S. Korea (just *phones*) [4]

• We can’t ignore these numbers

• Note: mobiles are *computer systems*

* [https://www.itu.int/en/mediacentre/Pages/2018-PR40.aspx](https://www.itu.int/en/mediacentre/Pages/2018-PR40.aspx)
What’s Inside a Mobile Handset?

Figure D.17 Circuit board from a Nokia cell phone. (Courtesy HowStuffWorks, Inc.)

Source: [5]
Handset Architecture (1)

- Handsets use several hardware components:
  - Microprocessor
  - ROM
  - RAM
  - Digital signal processor
  - Radio module
  - Microphone and speaker
  - Hardware interfaces
  - LCD display
Handset Architecture (2)

• Handsets store system data in electronically-erasable programmable read-only memory (EEPROM)
  – Mobile operators can reprogram phones without physical access to memory chips
• OS is stored in ROM (nonvolatile memory)
• Most handsets also include subscriber identity module (SIM) cards
Handset Microprocessors

• Handsets use *embedded processors*
  – ARM architectures dominate market. Examples include:
    • iPhone XS CPU: 6-core, 64-bit ARM (Apple A12 SoC; 2 cores @ 2.5 GHz + 4 cores @ 1.59 GHz)
    • Pixel 3 CPU: 8-core, 64-bit ARM (Qualcomm 845 SoC; 4 cores @ 2.5 GHz + 4 cores @ 1.8 GHz)
  – Low power use and code size are crucial [5]
  – Microprocessor vendors often package *all* the chip’s functionality in a single chip (*package-on-package (PoP)*) for maximum flexibility
Example: Samsung Exynos 9 Chip

- Samsung’s Exynos 9: 8-core system on a chip (SoC) [25]
  - Designed for high-end mobile devices
    - USB 3.0
    - 4K UHD display (4096 × 2160)
    - On-board neural network accelerator
  - Highly modular architecture

Source: Samsung, [25]
Mobile Handset OSes (1)

- Key mobile OSes:
  - Google Android
  - Apple iOS
- Others include:
  - Windows 10 mobile
  - Tizen
  - Ubuntu Touch

U.S. market share. Source: DeviceAtlas, [27]
Mobile Handset OSes (2)

- **iOS (ARM only)**
  - Proprietary (Apple)
  - Multitasking
  - Multi-touch interface
  - Programming: *Swift*, Objective-C

- **Android (ARM, x86, …)**
  - Open-source
  - Multitasking
  - Programming: Java/Kotlin, C/C++

- **Other OS features**
  - Most require app code signing
  - ARM is predominant instruction set arch.
Mobile Handset Networking

• Handsets communicate with each other and with service providers via many networking technologies

• Two “classes” of these technologies:
  – Cellular telephony
  – Wireless networking

• Most handsets support both, some also support physical connections such as USB
Many mobile handsets support cellular services

Cellular telephony is radio-based technology, radio waves propagated by antennas

Most cellular frequency bands: 800, 850, 900, 1800, 1900, 2100 MHz

Source: [5]
Cellular Telephony Basics (2)

• Cells, base stations
  – Space divided into *cells*, each has *base station* (tower, radio equipment)
  – Base stations coordinate so mobile users can access network
  – Move from one cell to another: *handoff*
Cellular Telephony Basics (3)

• Statistical multiplexing
  – Time Division Multiple Access (TDMA)
    • Time & frequency band split into time slots
    • Each conversation gets the radio a fraction of the time
  – Frequency Division Multiple Access (FDMA) analogous
Wireless Networking (1)

• Bluetooth (BT)
  – Frequency-hopping radio technology: hops among frequencies in 2.4 GHz band
  – Nearly ubiquitous on mobile handsets
  – Personal area networking: master device associate with ≤ 7 slave devices (piconet)
  – Pull model, not push model:
    • Master device publishes services
    • BT devices *inquire* for nearby devices, *discover* published services, *connect* to them
  – Latest version: 5.0; latest mobiles 4.0+ [12]
Wireless Networking (2)

• Wi-Fi (IEEE 802.11)
  – Variants: 802.11b, g, n, ac, ad, ah, etc.
  – Radio technology for WLANs: < 1, 2.4, 5, 60 GHz
  – Mobile handsets after 2007 support Wi-Fi
  – Two modes: infrastructure and ad hoc
    • Infrastructure: mobile stations communicate with access points, e.g., OSU Wireless
    • Ad hoc: mobile stations communicate with each other without infrastructure
  – Most mobiles support infrastructure mode; ad hoc Wi-Fi requires specialized tools
Mobile Handset Applications

- Mobile apps span many categories, e.g.:
  - Games: Minecraft, Fortnite, Candy Crush Saga, etc.
  - Multimedia: YouTube, Netflix, Spotify, etc.
  - Utilities: Kindle, 1Password, etc.
- Many apps are *natively* developed for one mobile OS, e.g., iOS, Android
  - *Cross-platform* native mobile apps are developed via middleware, (Flutter [28], Titanium [14], Xamarin [29])
  - Can also build HTML 5 Web apps
- We’ll discuss mobile app development next
Native Mobile App Development

- Mobile apps can be developed *natively* for particular mobile handset OSes
  - iOS: Xcode; Mac only
  - Android: Android Studio; Windows/Mac/Linux
Other Mobile App Development

• Hybrid app development
  – Flutter: Dart + Swift/Kotlin compiled for iOS, Android
  – Xamarin: C# compiled for both platforms
  – Titanium: HTML/JS + APIs compiled for both
  – Still dependent on native SDK restrictions

• SMS/cellular promotions
Business Opportunities

- Mobile OSes support app sales via app stores (App Store, Google Play)
- Devs sign up for accounts, download SDKs
  - Costs: $99/yr (iOS), $25 once (Google Play)
- Many apps free to download; sell in-app purchases/subscriptions
Discussion and Questions

Thank you
References [2]


15. Ibis Reader LLC, http://ibisreader.com

