Mobile Technology

Lecture 4.2

Mobile Computing

Slides by Dr. Tami Meredith

General characteristics of mobile technology

- Small / Compact / Light
- Low power usage (typically battery)
- Useful “on the go” (within limits)
- Multiple resources in one package
  - E.g., Browser, Clock, Phone, TV, Music Player
  - How does the user benefit from multiple different information sources/resources/tools in one package?

Multiple tools in one package:

- Terminology: A mobile phone is usually called a “cell phone” in Canada/USA.

We use cell phones:

- To make phone calls
- As a text messaging device
- To watch movies (i.e., T.V.)
- To listen to music (i.e., radio/C.D.)
- As a calendar
- To check email
- As an alarm clock, timer, or stopwatch
- To take photos/videos
- As a compass or GPS
- To read or scan documents
- As a flashlight
- To pay bills (i.e., credit or debit card)
- To monitor our heart rate.
- As a portable modem (i.e., hotspot)
- To browse the web
- For online shopping
- To play games

- **What else can you use it for?**

Mobile Technology

Introduces new opportunities for:

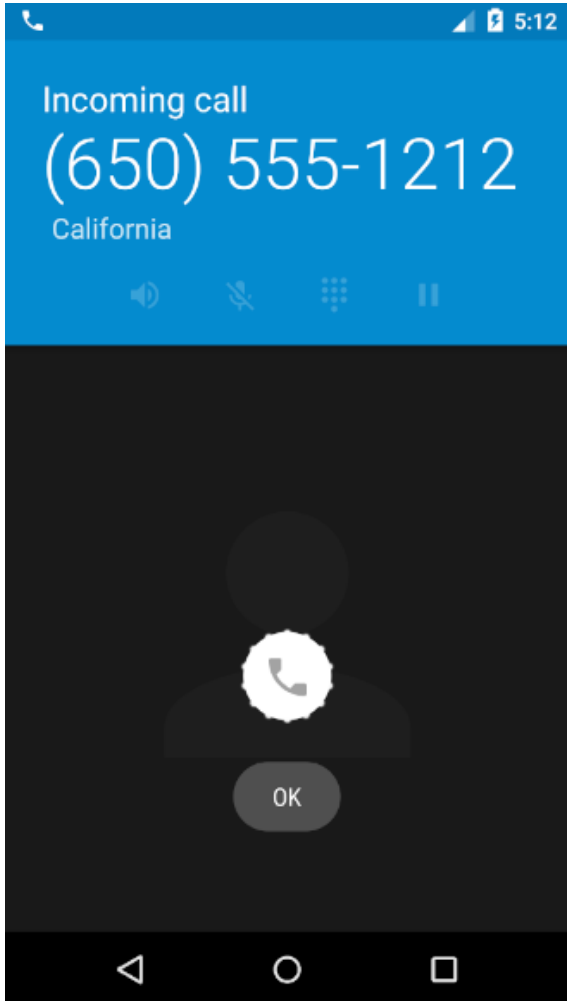
- Assistance (aiding, recommendations, guiding, informing),
- Communication, and
- Commerce (advertising, services, sales).

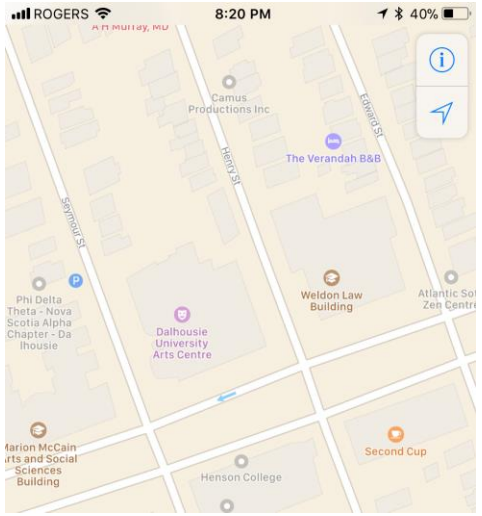
Question: What enables these capabilities?

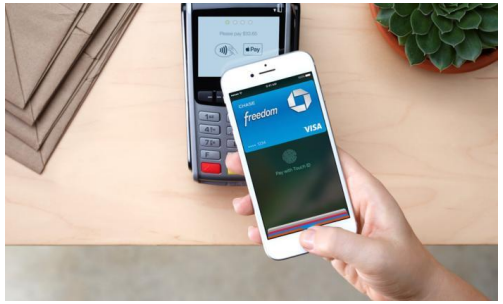
Components: Communication

Ordered by decreasing distance (longest to shortest distance)

- Satellite
- GPS (Global Positioning System)
- Cellular
- WiFi
- Bluetooth
- NFC (Near Field Communication)
- Serial Connectivity (USB Cable)

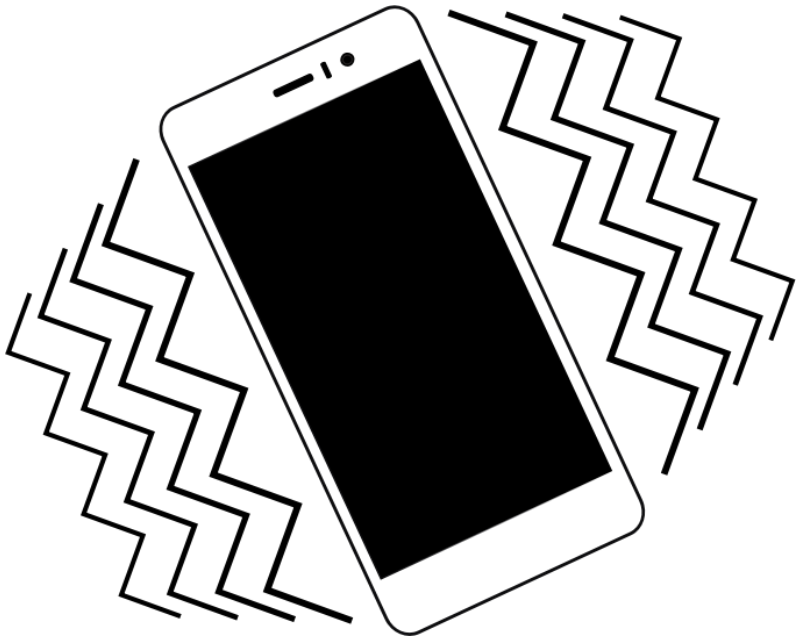






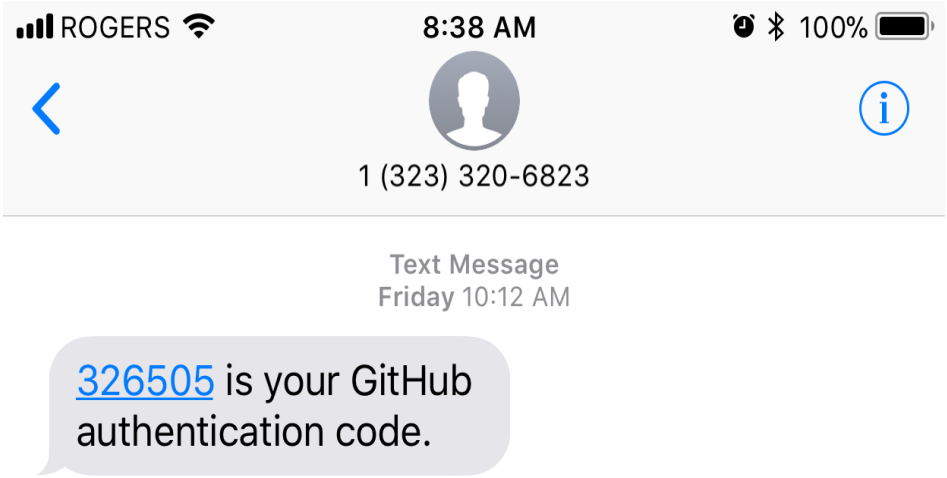
Components: Output

- Visual: Screen (different sizes)
  - Screen size will define the purpose of the device (tablet vs. phone vs. watch)
- Audio: Speaker or headphones/headset
- Touch: Haptic feedback
- Projection, connected devices (wireless headset, speakers)
- Light (e.g., camera flash)



Two-Factor Authentication

Two-factor authentication or (2FA) is used to confirm the user's identity using two different components. For example, the password in the browser and a code sent through SMS.



A Thought:
Many developers like 2FA while their users find it irritating. Who is more important and how necessary is "security?"

Two Factor Authentication

- There are 4 factors we can use;
  1. Knowledge: Something the user knows (password)
  2. Possession: Something the user has (card)
  3. Inheritance: Something the user is (biometrics)
  4. Location: Where the user is (network address)
- Two factor authentication uses two of these (as opposed to just one).
- E.g.,: A bank card with a PIN uses possession of the card and knowledge of the PIN
- It is NOT simply the use of an SMS message with a code sent to your phone.

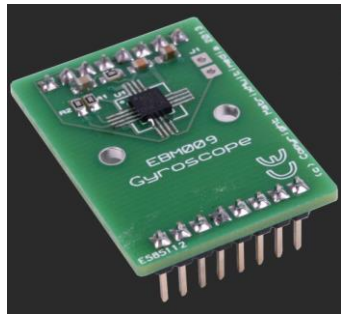
Components: Input

- Touch screen / gesture recognition
- Physical buttons (e.g., volume)
- Keyboards (BlackBerry or Bluetooth)
- Camera (also light sensors)
- Microphone (also external headsets)
- Thermometer
- Accelerometer
- IMU (Inertial Measurement Unit)
  - Measures linear & angular momentum using gyroscopes & accelerometer (6DOF)
  - Measures a reference vector to earth magnetic field (+3DOF)

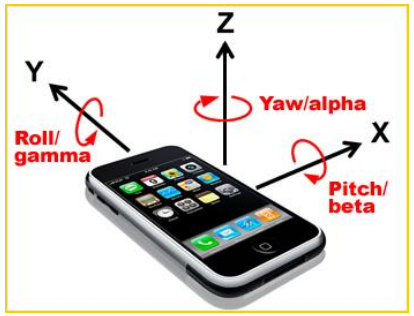
Google Pixel 2 XL Teardown

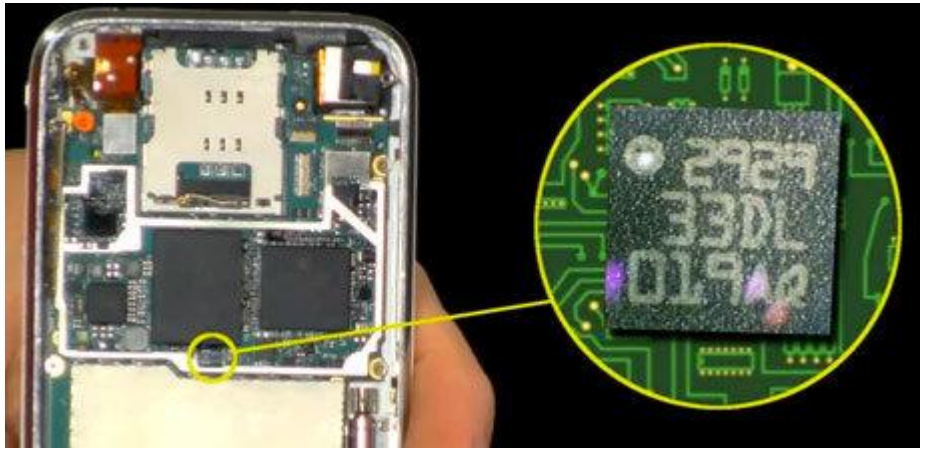
Physical keyboard on a BlackBerry

Aside: Gyroscope vs. Accelerometer



- An accelerometer is a device designed to measure non-gravitational acceleration (change in motion) using microscopic crystals that go under stress when acceleration occurs. It provides a 3D vector referencing gravity.
- A gyroscope is a device designed to measure changes in angular velocity





Components:
Storage & Computation

- Flash RAM (long term, nonvolatile)
- P-SRAM / SRAM (short term, volatile)
- DRAM (volatile)
- Access to external services:
  - Remote servers
  - Cloud services
- Mobile CPU
- Mobile GPU
- Communications processors
  - e.g., System on a Chip

SRAM vs. DRAM (volatile)

BASIS FOR COMPARISON	SRAM	DRAM
Speed	Faster	Slower
Size	Small	Large
Cost	Expensive	Cheap
Used in	Cache memory	Main memory
Density	Less dense	Highly dense
Construction	Complex and uses transistors and latches.	Simple and uses capacitors and very few transistors.
Single block of memory requires	6 transistors	Only one transistor.
Charge leakage property	Not present	Present hence require power refresh circuitry
Power consumption	Low	High

Components: Power

- Power Management Unit
- Battery
- External Power
  - Wall socket or portable battery via:
    - Lightning (Apple devices)
    - USB-C
- Wireless Charging
  - Qi standard
  - Governed by the *Wireless Power Consortium*

Components: Software

Firmware (built-in, hardware oriented)

Operating System

- Plays a key role in mobile computing
- Hardware architecture dependent;
- Native development requires developers to learn different frameworks
- What are potential solutions to this “problem?”
  - Cross-platform native development; e.g. Xamarin, Flutter, React Native

Applications (Apps)

- Application stores

What is Android?

Android Architecture

Android is layered.

1. The bottom layer is all in C. It is a complete Linux Kernel with all the usual O/S components.
2. The next layer (HAL) is much more complex than it first seems.
3. After that we have:
   a. The Android Runtime
   b. A lot of C/C++ libraries which are used by the Java API Framework

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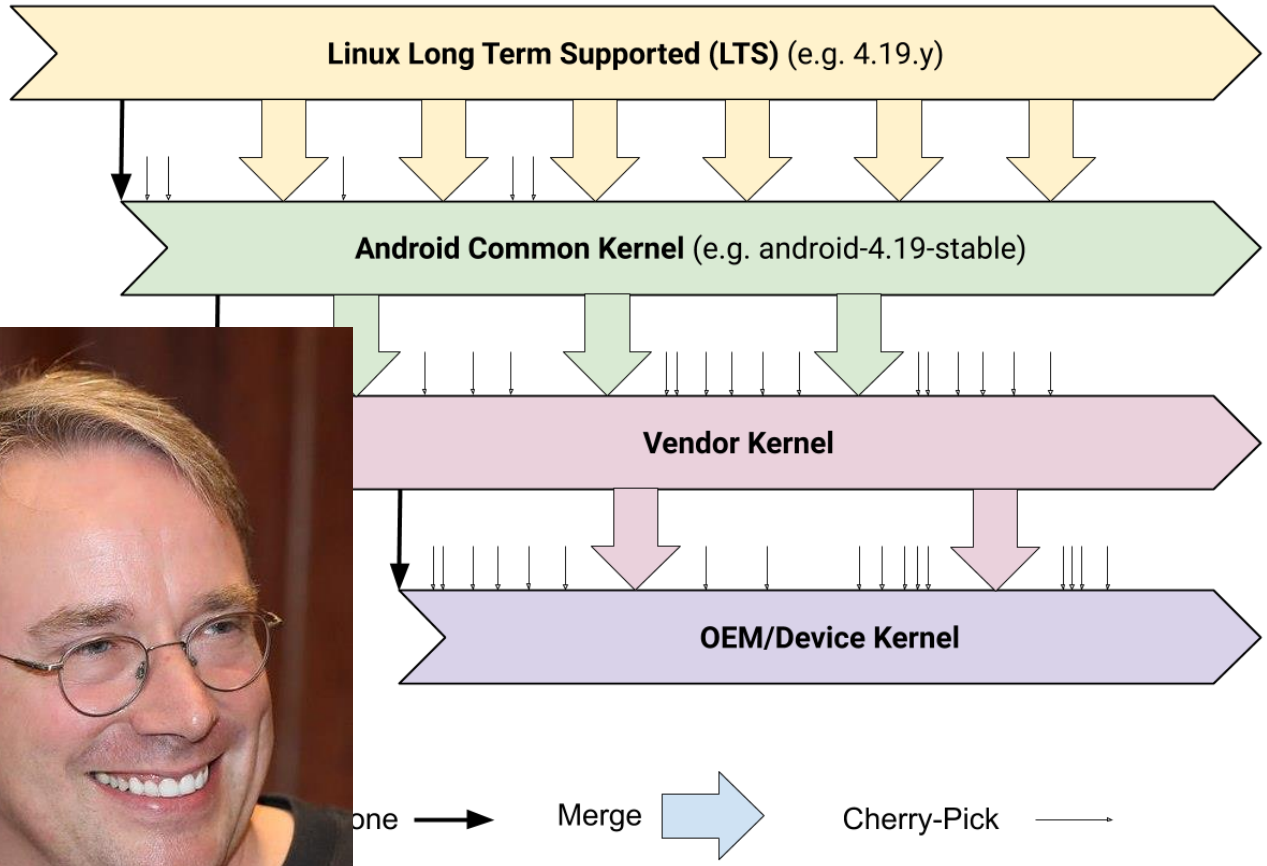
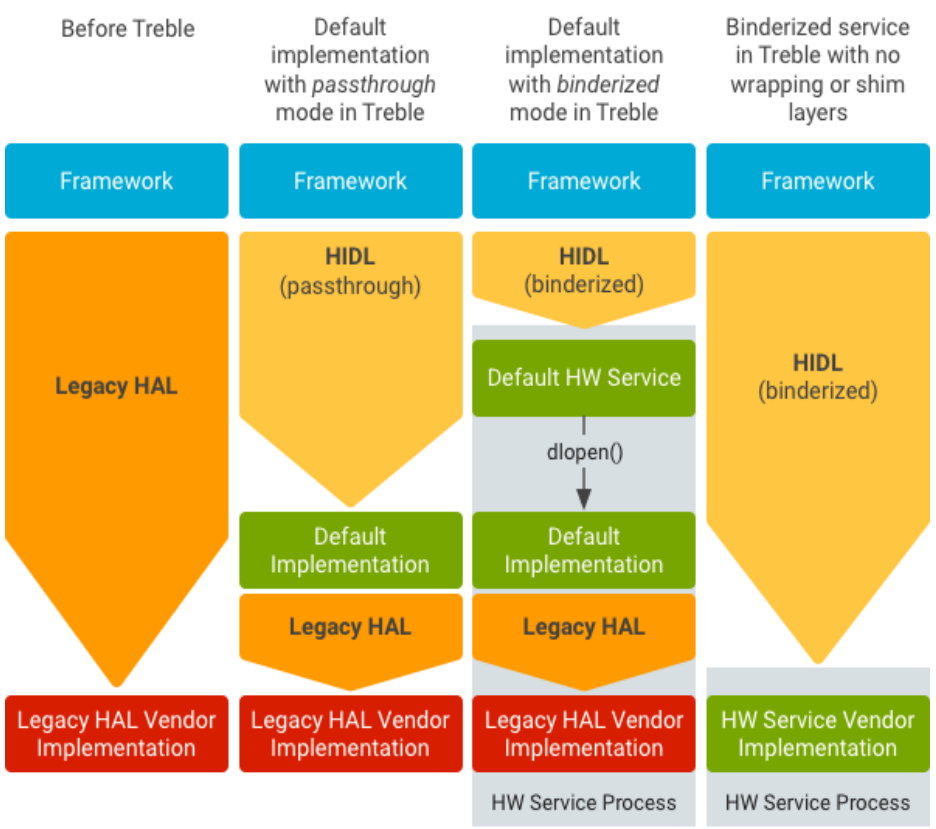
4. Above this are all the internal APIs to assist application developers.
5. Finally, we have the applications sitting at the top level.

The Linux Kernel

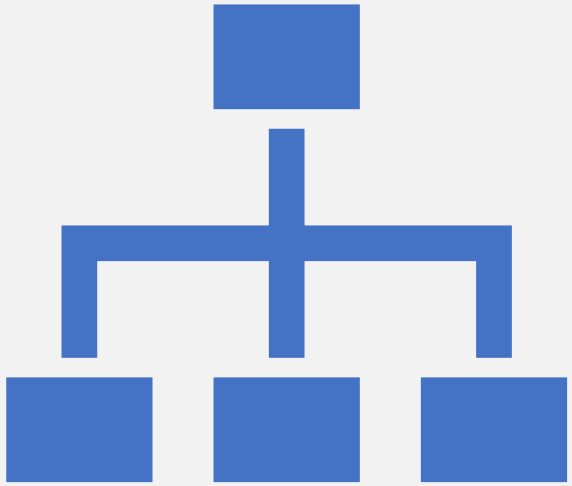


- Largest collaborative open-sourced project known
- 4000 developers, 450 countries, 56K files, 22 MLOC
- Google identifies the Android Common Kernel (ACK) for use with each Android release – nobody uses these
- Every device has a custom kernel (up to 50% non-ACK code)

The Hardware Abstraction Layer (HAL)



- HAL is a set of libraries stored as .so files. They are usually written in C/C++ with assembly support and provided by hardware manufacturers (most of them are written by engineers).
- HAL libraries are hidden beneath HIDL (Hardware Interface Description Language). This system is constantly changing.



High Level API Framework

- This is the level that you will predominantly work with.
- There are a lot of packages you can access to create applications:

see:
https://developer.android.com/reference/packages

- There are packages to work with PDF, hardware (e.g., camera), math, TV, music, USB, gestures, NFC, O/S services (e.g., IPC, message passing), SMS, time, and …
- PERSISTENCE. All android phones have a built-in SQL database: SQLite (now there is Room)

Six forms of vendor lock-in

A. **DISINCENTIVES TO COMBINE OFFERINGS FROM VARIOUS VENDORS**
   1) **UX and technical compatibility**: two or more tools from the same vendor work more smoothly among themselves than with other tools, because ...
      a. ... [soft:] they have the same feel and easy, prominent, dedicated, named connections
      b. ... [hard:] they use data formats or connections that are not compatible with open formats or broad standards
   2) **Sales combinations and package deals:**
      a. ... [soft:] each additional product bought from the same vendor makes the entire package cheaper
      b. ... [hard:] products are only available in combination with another product from the same vendor

B. **DISINCENTIVES TO SWITCH TO ANOTHER VENDOR**
   1) **Knowledge investments:** the product requires investing in deep and product specific knowledge/training
   2) **Data/procedure adaptation:** the product requires the user/client to adapt its own data/procedures in order to be able to work successfully with the product; those adaptations only pay off for (all) the products of that vendor, not for others
   3) **Data applicability:** data generated in the product can only be meaningfully used within the product
   4) **Collaboration opportunity**: switching would mean fewer or more difficult opportunities to collaborate with other clients