

# Mobile Information Systems

## Lecture 01 – Introduction & Technological Basics

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# Topics

- Introduction & technological basics
  - Device classification
  - Device hardware & software
  - Key features & issues

# Classification: size (1)

- Mobile computer (e.g. laptop)
  - Capabilities similar to desktop computer
  - Extensible/modular (USB, plug-in cards)
- Handheld (e.g. tablet, mobile phone)
  - Reduced capacity (CPU, RAM, storage) compared to standard mobile computer
  - Data often synchronized with a desktop PC or server (“cloud”)
- On-board computer
  - Specialized devices for time-critical control tasks



# Classification: size (2)

Source (CC): <http://ksimgs.s3.amazonaws.com/PebblePressPack1.zip>

- Wearables
  - Worn on body: e.g. clothing, ring, watch, ...
  - Minimal manual interaction possible
- Chip card (e.g. SIM)
  - Special reader/adapter is required
  - Chip can store data and is often programmable
- NFC tags
  - Similar to chip card, but wireless power & data transmission



# Classification is getting blurry

Source (CC): [Flickr \(11741149766\)](#), [Flickr \(16129709460\)](#), Wikimedia

- Convertibles
  - Tablets with attach-/foldable keyboard, big CPU
- „Project Ara“
  - Smartphone platform: "spine" plus extension modules
- Dual-Display Devices
  - Galaxy Fold (problems with screen cracking)
  - Display on both sides of phone (OLED + e-Ink)



# Classification: purpose

- Orthogonal to the size:
  - General purpose device
    - Installation & execution of various applications possible
    - Needs a flexible operating system and well defined interfaces
  - Special purpose devices
    - Developed to run/support a certain application
    - Mostly not programmable (at least not by user)
    - Specialized hardware

# Classification: Examples

Category	General Purpose	Special Purpose
Mobile standard computer	Notebook, convertible	e.g. for cartography, surveying and alignment, archaeology
On-board computer	-	e.g. in cars, airplanes or drones
Handheld  Primary lecture topics	Smartphones, tablets, PDAs	E-book reader, "dumbphone", pager, game console (e.g. 3DS), calculator, car navigation
		Programmable wearables, e.g. smartwatches
Wearable		Watch, medical devices (measuring pulse, etc.)
Chip card	Smart Card	SIM card, phone card, EC card with cash chip

# Classification: summary

- Two major dimensions: size and purpose
- Size: broad spectrum from ~ 1 mm to ~ 50 cm
- Purpose: general or special (with overlap)

# Hardware: Comparison (1)

- Desktop & laptop PC:
  - High-end multi-GHz CPU & GPU
    - Modular design
    - Significant power consumption
    - Thermal design / heat issues
    - (Mostly) x86/AMD64 architecture
  - Few high-performance I/O channels
    - Screen: at least Full HD (1920x1080) or beyond
    - Keyboard & Mouse: up to 300 APM (actions per minute), see  
<https://www.youtube.com/watch?v=YbpCLqryN-Q>

# Hardware: Comparison (2)

- Mobile devices:
  - Energy-efficient, lower-performance SOCs
    - System-On-Chip with integrated CPU/GPU/bridge chips
    - RAM/ROM usually still separate (why?)
    - (Mostly) ARM architecture, many vendors
  - many different low(er) performance I/O channels
    - Touchscreen, camera, vibration, light sensor, accelerometer/IMU, GPS, proximity sensor, LED, ...
    - Why are 300 APM probably not possible with a touchscreen?

# Hardware: Convergence?

Source (FU): <https://www.indiegogo.com/projects/neptune-suite-one-hub-infinite-possibilities#gallery>

- Vision: only one device + accessories
  - "Project Neptune" (IndieGogo, never actually produced)
  - Powerful smartwatch + wireless screens (why infeasible?)

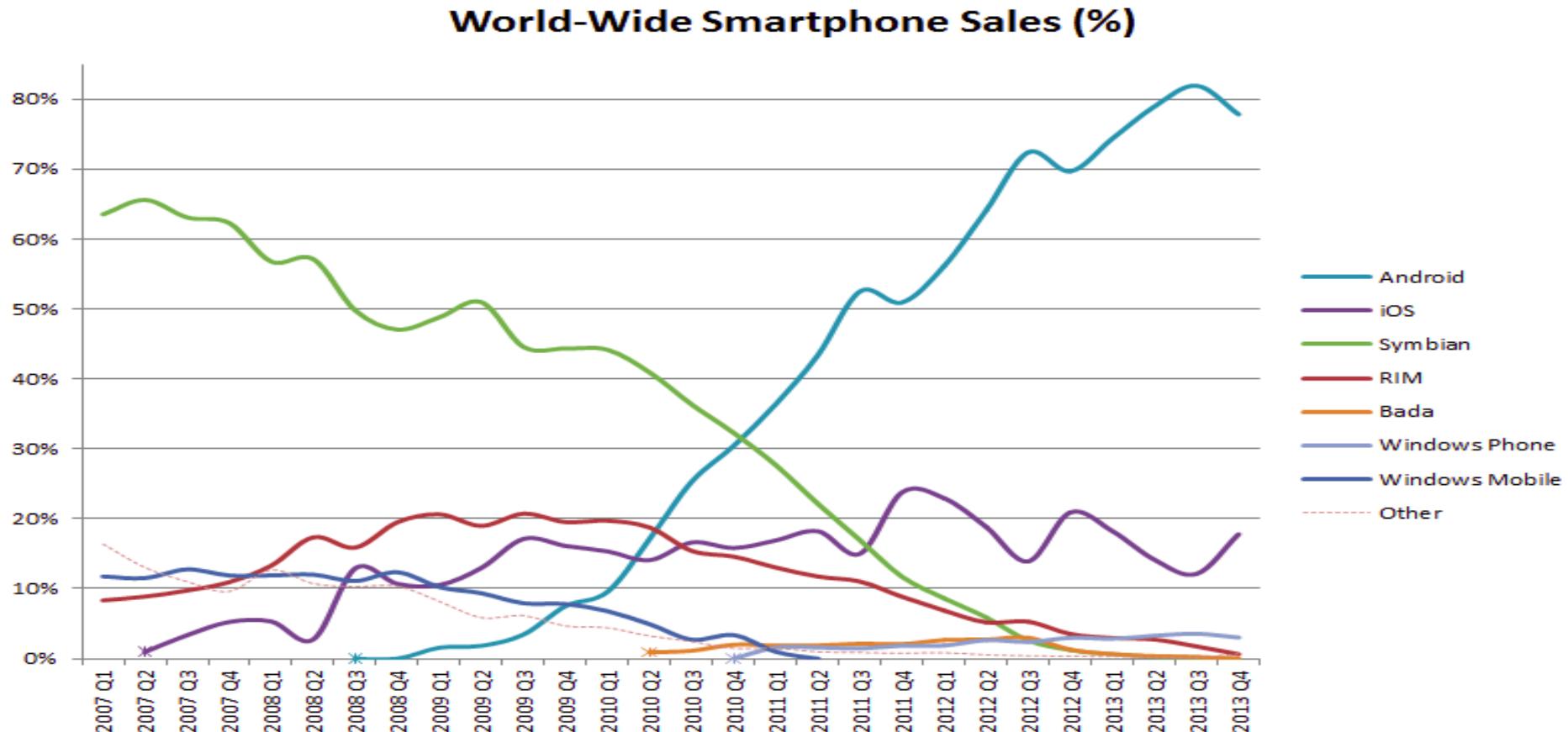


# Operating Systems: Overview

- 2007/08: “Smartphone revolution”
- Current state (2024): duopoly
  - 10 – 20 % market share (high-end): iOS
  - 80 – 90 % market share (whole spectrum): Android
- Android took ~ 2 years to overtake and ~ 4 years to completely displace Symbian
- Past challengers: Windows 10, Ubuntu Touch, Bada, Tizen, Firefox OS, ...
- Usually centralized “app stores” for software

# Operating Systems: Sales history

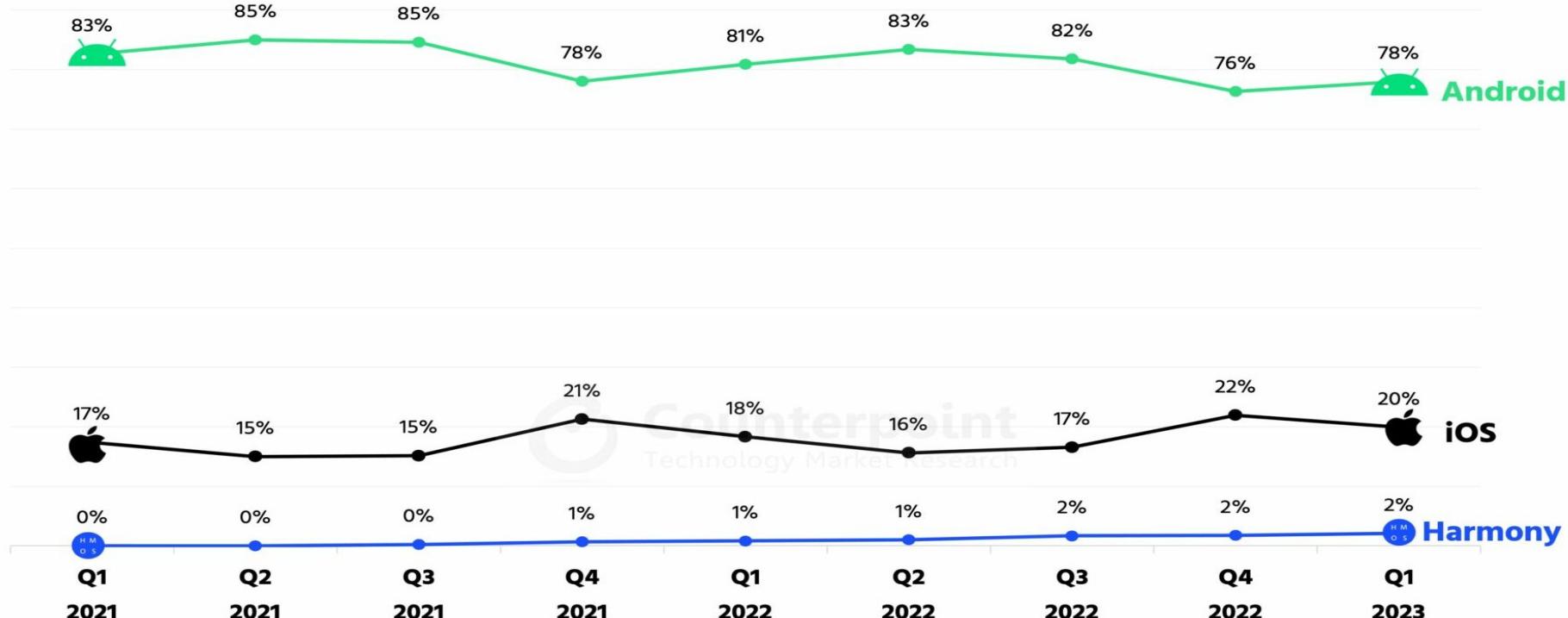
Image source (CC): [https://commons.wikimedia.org/wiki/File:World\\_Wide\\_Smartphone\\_Sales\\_Share.png](https://commons.wikimedia.org/wiki/File:World_Wide_Smartphone_Sales_Share.png)



# Operating Systems: Market share

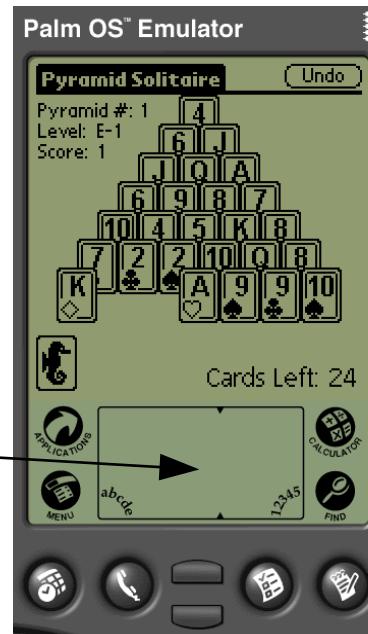
Image source (FU): IDC, Counterpoint Research

Global Smartphone Sales Share by Operating System

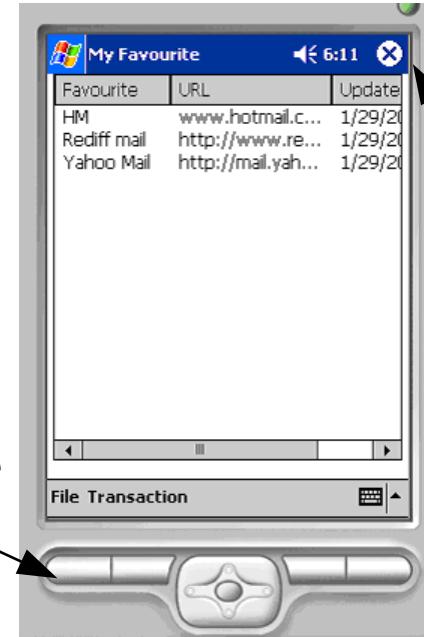


# Operating Systems: Legacy gallery

Image sources (CC/FU): [Flickr \(PalmOS\)](#), [Codeproject \(WinCE\)](#), [Wikipedia \(Symbian\)](#)



PalmOS (Palm/HP)  
(stylus-based)



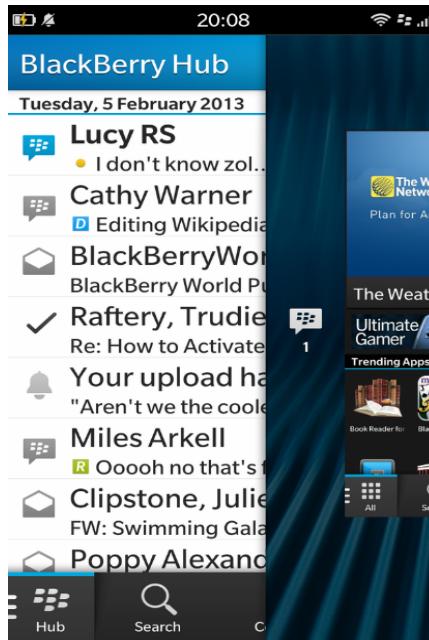
Windows CE  
(stylus, Win95 clone)



Symbian (Nokia)  
(1st "smartphone" OS)

# Operating Systems: Legacy gallery (2)

Image sources (CC): [Wikipedia \(Blackberry\)](#), [Wikipedia \(Firefox OS\)](#), [Wikipedia \(Ubuntu Touch\)](#)



Blackberry (RIM)  
(business-focused)



Firefox OS  
(webtech-based)

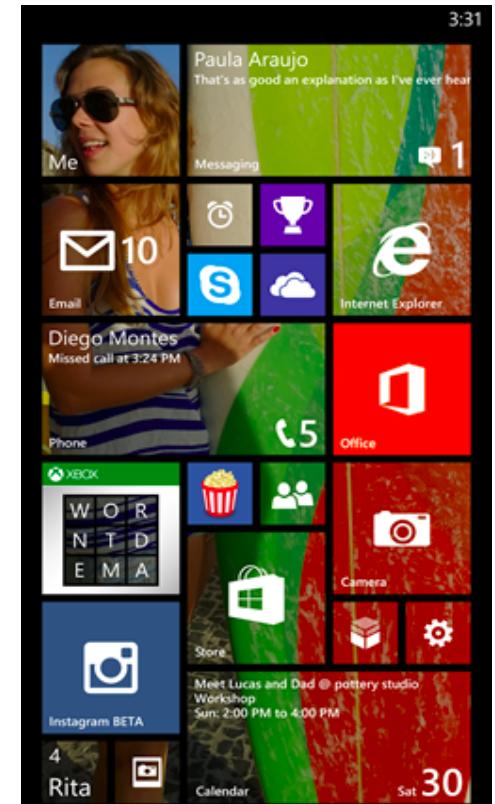


Ubuntu Touch  
(Linux-based)

# Operating Systems: Windows 10/11

Image source (FU): [https://en.wikipedia.org/wiki/Windows\\_Phone#/media/File:WP8.1\\_Start\\_Screen.png](https://en.wikipedia.org/wiki/Windows_Phone#/media/File:WP8.1_Start_Screen.png)

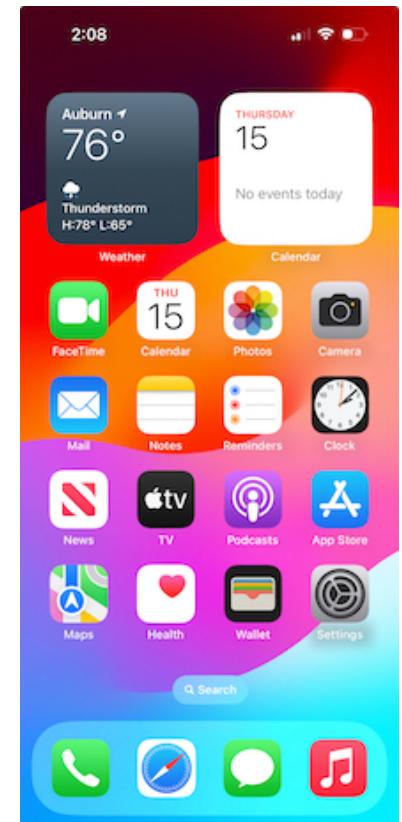
- Successor of Windows CE/Windows Mobile
- Last standalone version: Windows 10 Phone
  - New tile-based graphical user interface („Modern“/„Metro“)
  - Partnership with Nokia (R.I.P. Symbian)
  - Development with C#/.NET
  - Support for dedicated mobile version has ended, merged into “regular” Windows 10/11



# Operating Systems: iOS

Image source (FU): [https://en.wikipedia.org/wiki/IOS#/media/File:IOS\\_17\\_Homescreen.png](https://en.wikipedia.org/wiki/IOS#/media/File:IOS_17_Homescreen.png)

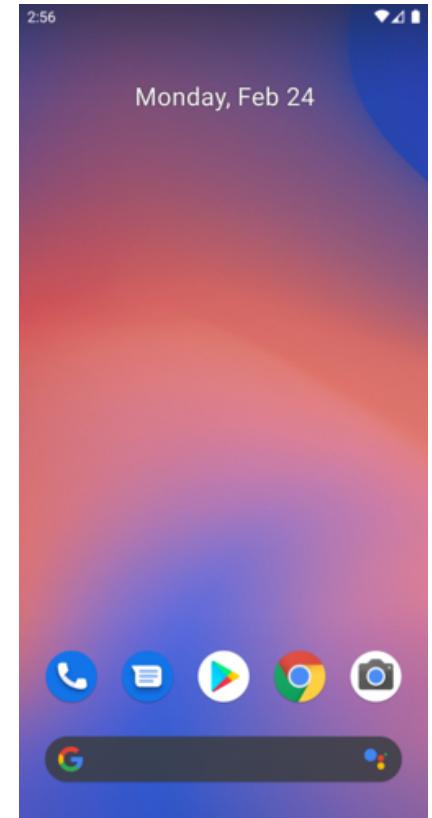
- Initially released as iPhone OS in 2007
- Multitasking / background activities since iOS 4 (still more limited than Android)
- Development using Objective C & (more recently) Swift
- Based on Darwin/BSD kernel, but not open-source



# Operating Systems: Android

Image source (CC): [https://en.wikipedia.org/.../File:Android\\_R\\_\(Developer\\_Preview\\_1\)\\_screenshot.png](https://en.wikipedia.org/.../File:Android_R_(Developer_Preview_1)_screenshot.png)

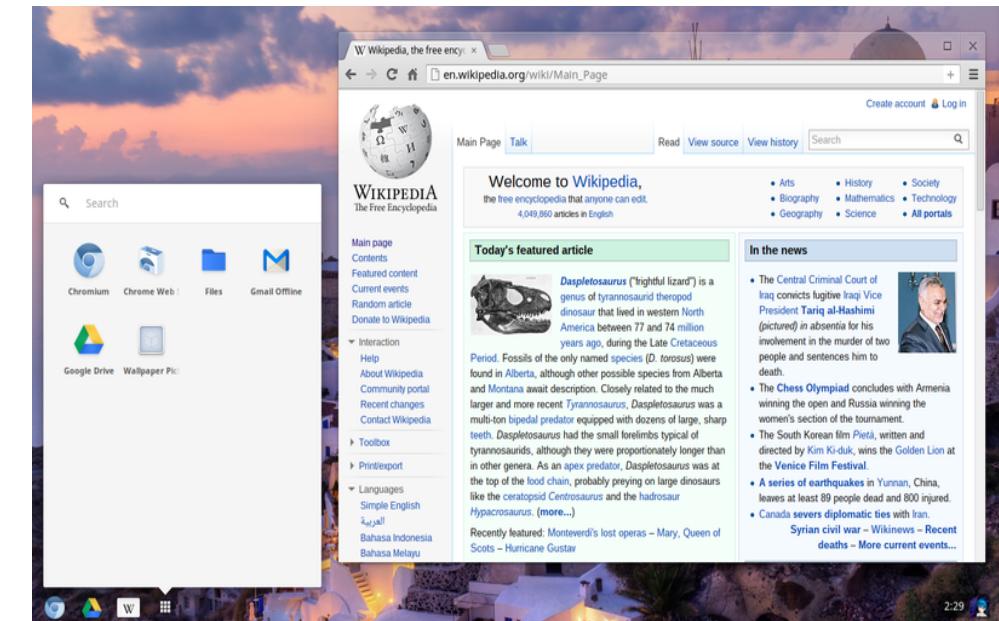
- Released by Google in 2008
- (mostly) Open Source
  - Based on Linux kernel
  - Many derivatives, e.g. LineageOS
- Development with Java & (recently) Kotlin
- No „traditional“ JavaVM
  - Dalvik Virtual Machine
  - Optimized for mobile HW



# Operating Systems: Chrome OS

Image source (PD): [https://de.m.wikipedia.org/wiki/Datei:Chromium\\_OS\\_\(updated\).png](https://de.m.wikipedia.org/wiki/Datei:Chromium_OS_(updated).png)

- Hybrid between desktop Linux and Android
- Originally only web applications supported
- Now also supports Android apps and Linux desktop applications
- Somewhat inconsistent UI
- Expected to merge with Android in the future (?)



# Operating Systems: Convergence?

- Slow progress towards unified OS for desktop and mobile
  - Windows 10/11 (roots in desktop)
  - Android, Chrome OS (roots in mobile)
  - Ubuntu Touch (based on Ubuntu Linux)
  - maru os, Pure OS (based on Android, alpha/beta state)
- Hardware issues (power consumption, heat, volume/weight)

# Hardware/Software: summary

- Mobile hardware: more “monolithic” than regular PCs (why?)
  - Side effect: tighter connection between hardware and OS, porting usually difficult (driver issues)
- Mobile software: 2 major OS (Android/iOS), 2 minor OS (ChromeOS + Windows 11), many small contenders
  - Common aspect: centralized “app stores” (censorship?)
  - Fragmentation issues (esp. for Android, see Samsung/Huawei)

# Key features of MIS

- Communication
  - Voice, video, text across many platforms
- Accessing data anytime/anywhere
  - „Intelligence Amplification“ (or at least „knowledge amplification“)
- Location-based services
  - Mapping, route guidance, nearby facilities
- Context-sensitive systems
  - User may be in the car, at home, in a meeting, sleeping, talking, ...

# Key issues of MIS

- Most central aspect: *mobile* hardware
  - Needs to be portable & lightweight
  - No fixed location, moves with user
  - Raises additional issues:
    - Limited power supply & storage
    - Wireless communication channels
    - Limited/different I/O capabilities
    - Unpredictable usage context
    - Sustainability/long-term support
  - Many potential *tradeoffs*

# Key issues of MIS: power & storage

Image source (CC): <https://www.flickr.com/photos/intelfreepress/10190082395/>

- Limited power supply
  - Tradeoff: capacity ↔ size/weight/portability
  - Energy consumption becomes important
- Limited storage
  - Data (partially) stored in „cloud“ services
  - Requires network connection for access
  - Tradeoff: bandwidth ↔ storage



# Key issues of MIS: wireless communication

- Wireless data transfer
  - Coverage: area-wide vs. hotspot-based
  - Available bandwidth
  - Cost aspects
  - Unpredictable availability
    - Cell sharing (capacity)
    - Shielding effects (zones without coverage)
  - Moving device ↔ static routing not possible
  - Tradeoff: bandwidth ↔ energy consumption

# Key issues of MIS: I/O

Image source (FU): The Simpsons (S21E11), Fox Broadcasting Company

- Different I/O capabilities
  - Small screens, no physical keyboard
  - Text entry/precision work much slower
  - “Fat finger problem”
  - Use other channels ...
    - For input: motion, camera, location, ...
    - For output: vibration, sound, speech, ...
  - Tradeoff: size/weight ↔ I/O features?



# Key issues of MIS: context

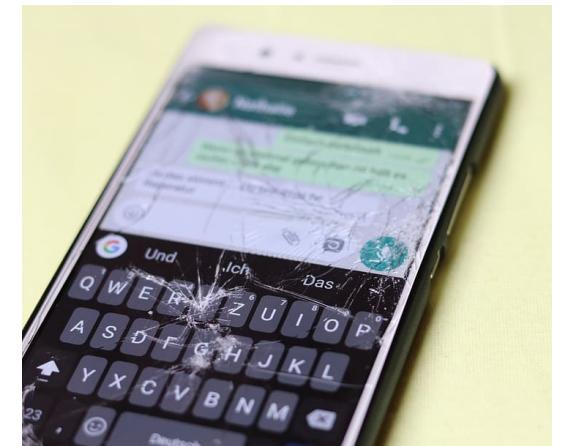
Image source (CC): [https://en.wikipedia.org/.../File:Cell\\_phone\\_use\\_while\\_driving.jpg](https://en.wikipedia.org/.../File:Cell_phone_use_while_driving.jpg)

- Unpredictable usage context – user can be ...
  - Sitting
  - Standing (no support)
  - Walking (into things?)
  - Lying on the sofa
  - Driving in a car (shaking)
  - Talking to other people (noisy)
  - Some (sensible) combination of the above
  - ... ?



# Key issues of MIS: sustainability

- Current: ~ 2 year lifecycle of mobile phones
- Fundamental feature set hasn't change since ~ 2015
- Mostly due to lack of software updates (on Android)
- Alternatives: FairPhone, LineageOS, etc.
- “Right to Repair”?



# Features & issues: summary

- Main feature: *mobile* data access & processing
- Main issue: *mobility* → leads to ...
  - Power & storage issues
  - Connectivity issues
  - I/O issues
  - Context issues
  - Long-term support?

# The End

