# MOBILE COMMERCE

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## Mobile Devices and Operating Systems

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# Learning Objectives

- The relevant mobile devices, their properties and interfaces, how to classify them and assess their possible uses.
- Know the current development of the smart phone market.
- Operating systems for mobile devices and assess their possible uses based on their advantages and disadvantages.

# Mobile Devices and Operating Systems

What is a mobile device?

- The characteristics form the conception for mobile use

Types of Devices

- Mobile phone, Personal Digital Assistant (PDA), Smartphone
- Other mobile devices - Examples: Tablet PC (depending on the application), Smart watch, mobile NFC-Reader
- Devices for special purposes - Example: Parcel service has special hardware developed that is designed for the special requirements, of its delivery drivers are connected via mobile radio
- By definition, no mobile devices are: Laptop-PC (even it is light ...) - Stationary use : although the location changes sometimes. - Mobile devices: single user - multi task

# Interfaces of Mobile Devices

Mobile devices typically provide a set of interfaces:

- Sending / Receiving short messages (SMS, EMS, MMS)
- Voice function, use of Interactive Voice Response (IVR)
- Internet Browser (formerly: WAP, today: Mobile Browser)
- Data transmission via WLAN, IR, Bluetooth, RFID, NFC,...
- Execution of programs (also “native apps”), programmed in higher programming languages (Java, C++, ...)
- Localization function (GPS), radio cell localisation

# Interface: SMS

GSM service for sending short messages (160 characters) Sequence of several messages possible.

Benefits:

- "Store-and-Forward" service: If the message cannot be delivered directly, it will be delivered later by means of intermediate storage
- Device independence
- Different billing models possible (e.g. premium SMS)

Disadvantages:

- Very limited functionality
- Few interaction options

Consequence: outdated!

- Usage has dropped dramatically
- Messenger services have taken over

# Interface: MMS

Service for sending messages with image, video and audio data (in GPRS and UMTS networks)

- Extension of the SMS service

Benefits:

- Offers obviously some more options than conventional SMS
- Can be sent to email addresses, too

Disadvantages:

- Compatibility problems between different mobile devices
- But also little interaction and little functionality
- Just an intermediate step towards media flexibility
  Pretty outdated as well!

# Interface: Transmission via IR, Bluetooth, RFID, NFC

Possibility of transaction processing through data connection over short ranges (almost direct contact)
Benefits:

- Directly and automatically use of location/context-specific services
- Identification function (e.g. for access control, billing)

Disadvantages / Risks:

- Data protection
- Limited distribution so far, keyword: “killer application”

# Interface: Internet Browser

Presentation of conventional websites as a “mobile” version

- Also called “Web Apps”

Benefits:

- Quite low additional development effort compared to the conventional website offer
- Outsourcing of the computation load to the server side

Disadvantages:

- Some special display problems on different browser types and the huge amount of different mobile device types
- Need for (almost) permanent internet access (hidden costs ?)

# Interface to Application: Native Apps

Provision of various applications via one-time download in an online shop ("App Store")

- Native Apps are often developed for a special operating environment and a special runtime version

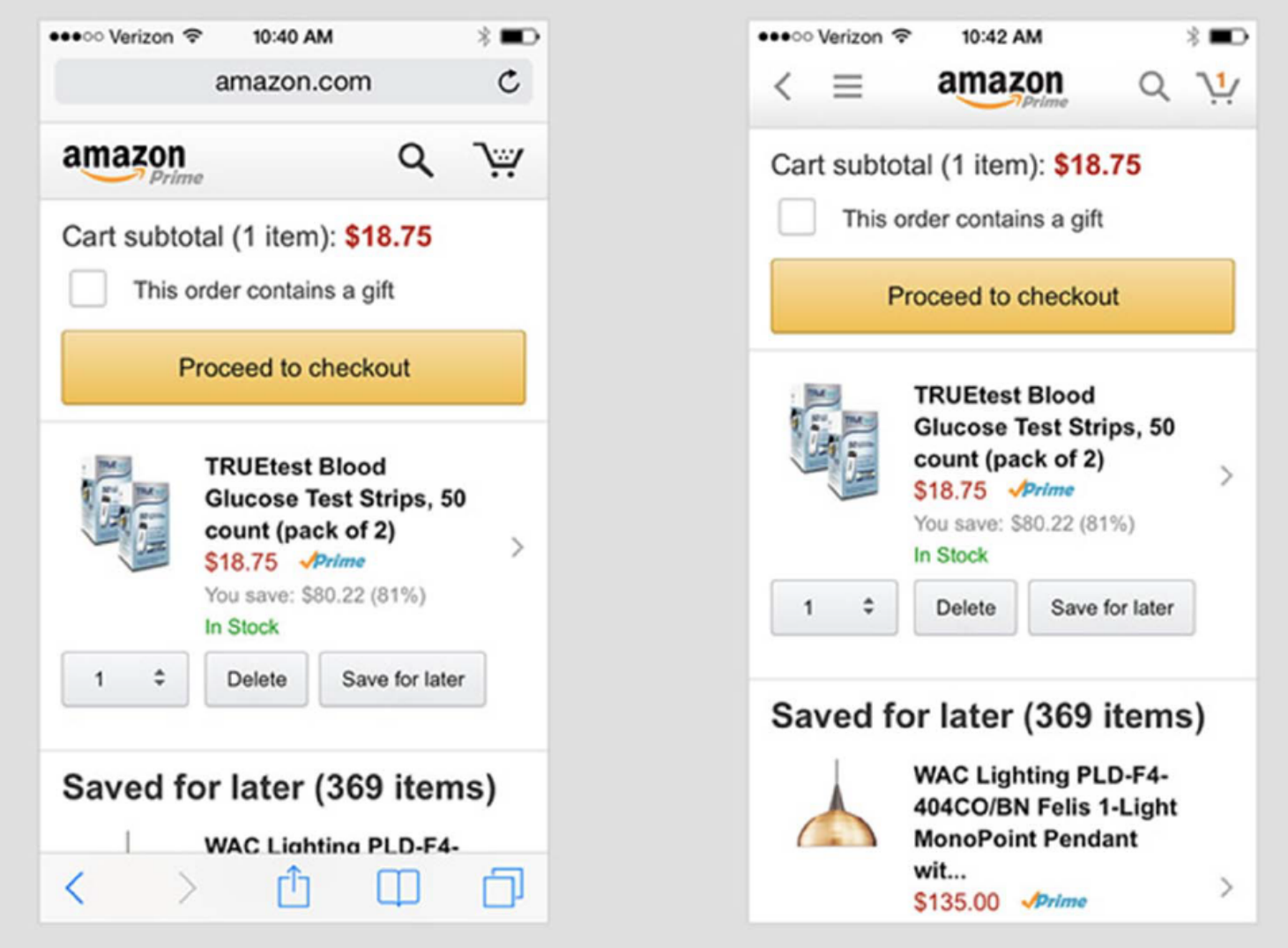
Benefits:

- One-time download, then no internet access required - for the program itself! Most apps still need data access via internet
- Any application possible (large developer community)

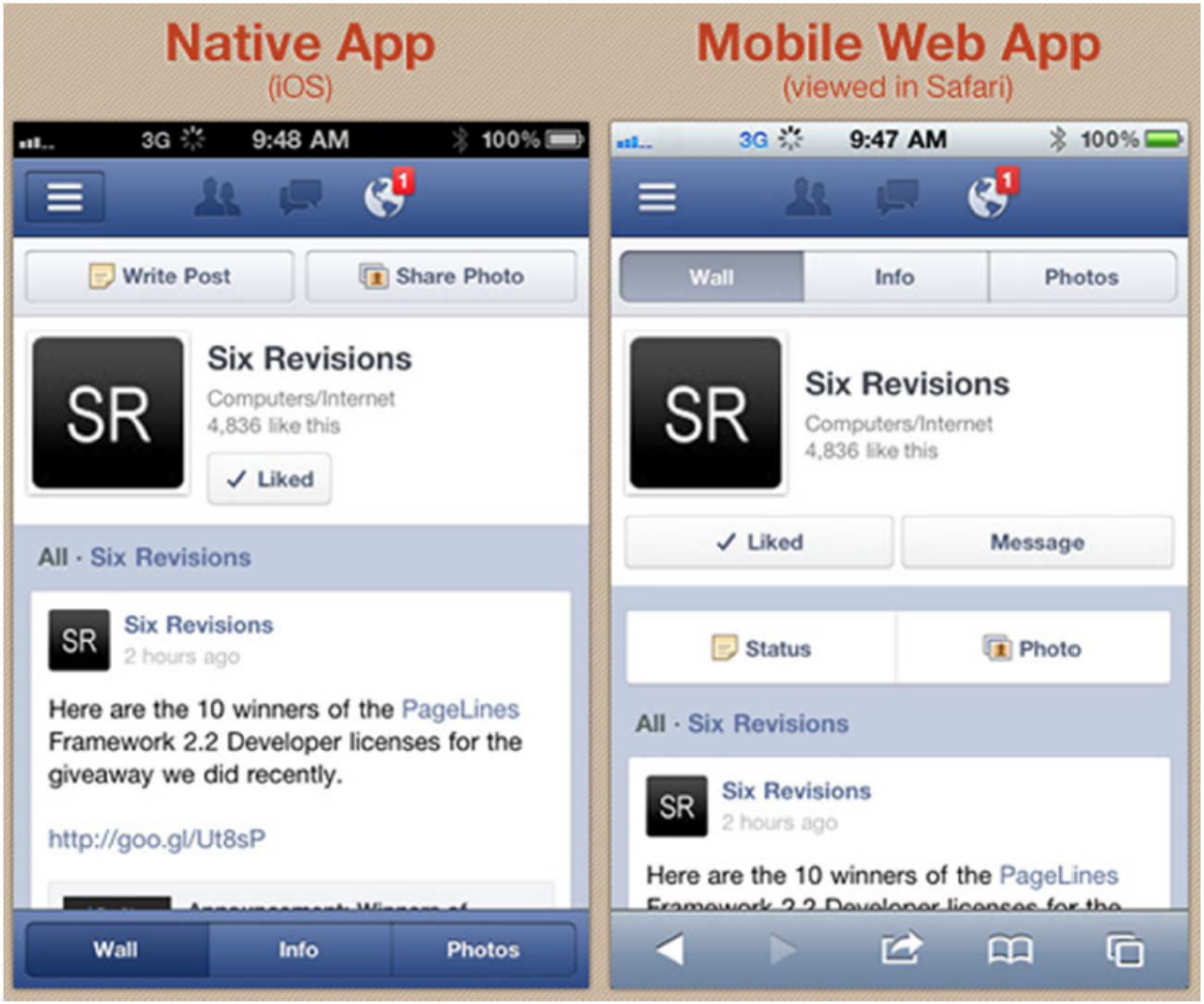
Disadvantages:

- Strict operating system dependency
- Relative high costs for development and maintenance - Entire software development lifecycle

# Example “Amazon”



# Example “Facebook”



# Class Discussion

From your perspective:

- What are the pros and cons for
  - Web Apps compared to Native Apps?

# Web-App Vs. Native-App (1/2) - “Pros”

What are the arguments in favour of “web apps”?
“Pros”:

- No download of the application necessary
- Compatible with all operating systems
- Live updates
- Web apps content can be found via search engines
- Via interfaces to existing offers (websites, CMS systems), content can be generated quickly and easily for web apps
- Lower development and maintenance costs than “native apps”

# Web-App Vs. Native-App (2/2) - “Cons”

What are the arguments against “web apps”?
“Cons”:

- Restricted access to hardware of the mobile device
- Permanent internet connection necessary (possibly higher costs)
- Operation and display are often less convenient
- “Native apps” are presented by a central contact point (app store) (e.g. through reviews)
- No integration into the operating system services used e.g. push notifications, controls, “Bookmark” on the home screen, access to contacts, address data, etc.

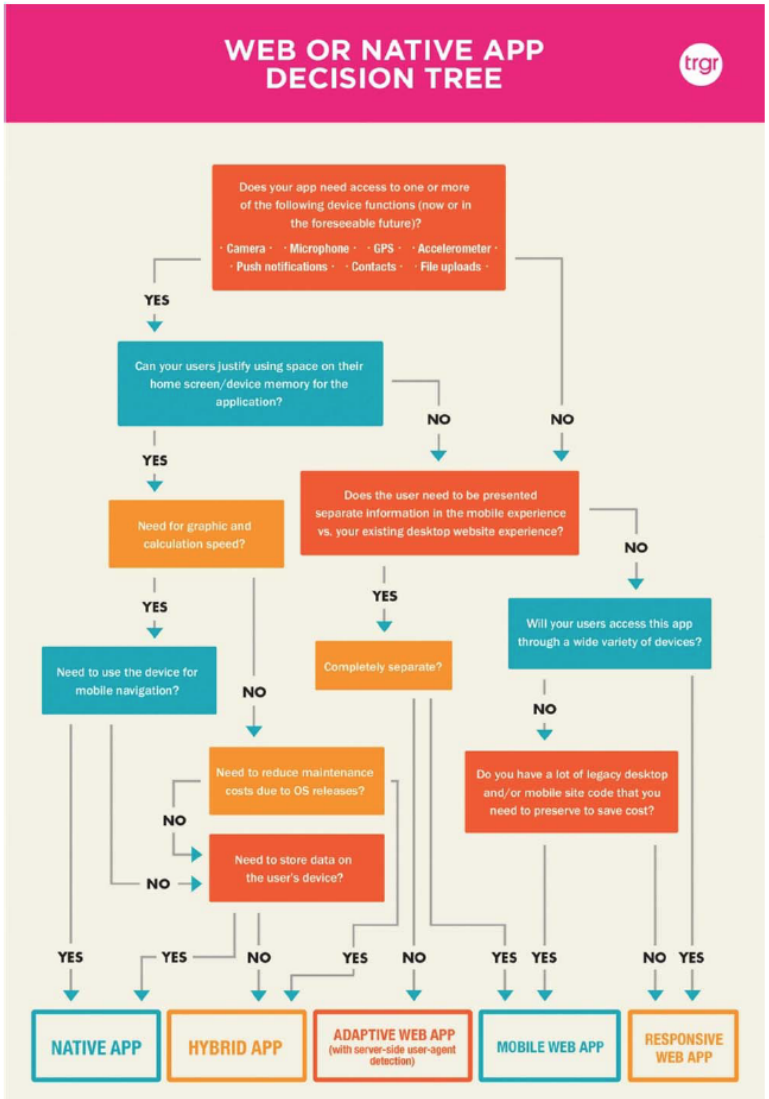
# Somewhere in the Middle: Hybrid Apps

A hybrid mobile app ...

- ...contains a web view (essentially an isolated browser instance) to run a web application inside of a native app.
- ...uses a native app wrapper that can communicate with the native device platform and the web view
- ...can run on a mobile device and have access to the device, such as the camera or GPS features

| Hybrid App | Native App |
|---|---|
| Developed using HTML, CSS, and Javascript | Developed in platform specific language, Objective-C or Swift for iOS, Java for Android, etc. |
| Write Once, Run Anywhere | Separate code for each platform |
| Medium performance comparable to Native apps | Fastest and most responsive experience to users |
| Save Time and Money | Higher investment of time, talent and resources |
| Faster development cycle | Higher costs and development time |
| Eg. Baskin Robbin, Sworkit, Untappd | Eg. PayPal, Gmail |

# Web-App vs. Native-App



# Mobile phone, Voice Function Only

- 1G or very old 2G devices
- Today (2021) almost irrelevant
  - Voice function IVR (V)
  - SMS / MMS (X / X)
  - WAP / Internet (X / X)
  - IR / Bluetooth / RFID (X / X)
  - Higher Programming Languages (X)

NOTE: (V) = Yes, (X) = No and (0) = Partly

# Mobile phone, Java Capable

2G devices

- Voice function IVR (V)
- SMS / MMS (V / V)
- WAP / Internet (V / 0)
- IR / Bluetooth / RFID (V / V / 0)
- Higher Programming Languages (0)

NOTE: (V) = Yes, (X) = No and (0) = Partly

# Personal Digital Assistant (PDA) - Intermediate Step to Smartphones (1/2)

Functionality

- Organizer with PIM functionality
- Devices with a PC-like operating system

Communication

- Offline synchronization
- Connection via modem-compatible mobile phone
- Mobile phone as a plug-in card
- Integrated mobile radio

# Personal Digital Assistant (PDA) - Intermediate Step to Smartphones (2/2)

- Voice function IVR (V)
- SMS / MMS (V / V)
- WAP / Internet (V / 0)
- IR / Bluetooth / RFID (V / V / 0)
- Higher Programming Languages (0)

NOTE: (V) = Yes, (X) = No and (0) = Partly

# Today: Smartphones (1/2)

Integration of multiple functionalities Okay, it's still a telephone, too, but ...

- PDA: Personal Digital Assistant
- PIM: Software "Personal Information Manager"
- Camera
- Navigator
- General purpose computer ...

# Today: Smartphones (2/2)

- Voice function IVR (V)
- SMS / MMS (V / V)
- WAP / Internet (X / V)
- IR / Bluetooth / RFID (V / V / 0)
- Higher Programming Languages (V)

NOTE: (V) = Yes, (X) = No and (0) = Partly

# iPhones

A matter of money and “personal style”

# Android Phones

Stylish assessor and - by the way - a phone ...

# Properties of Mobile Devices / Smartphones (1/2)

Basic properties:

- Ensuring permanent mobility
- Requirements: small, light, shockproof and “robust”

Power supply

- Use of optimized processors
- Trade-off : power consumption vs. computing power

“Sufficient” storage

- Flashcards (e.g. MMC, SD, CF, MicroSD, ...)

“User friendly” interface (whatever that means ...)

- Options, options, options, options, options, options, options,..

# Properties of Mobile Devices / Smartphones (2/2)

Running a specific operating system

- Installation of (almost) any program - if it fits to the OS

Providing a touchscreen

- Manual entry with your fingers or special stylus
- Gesture control
- Mostly provided: typing AND voice input

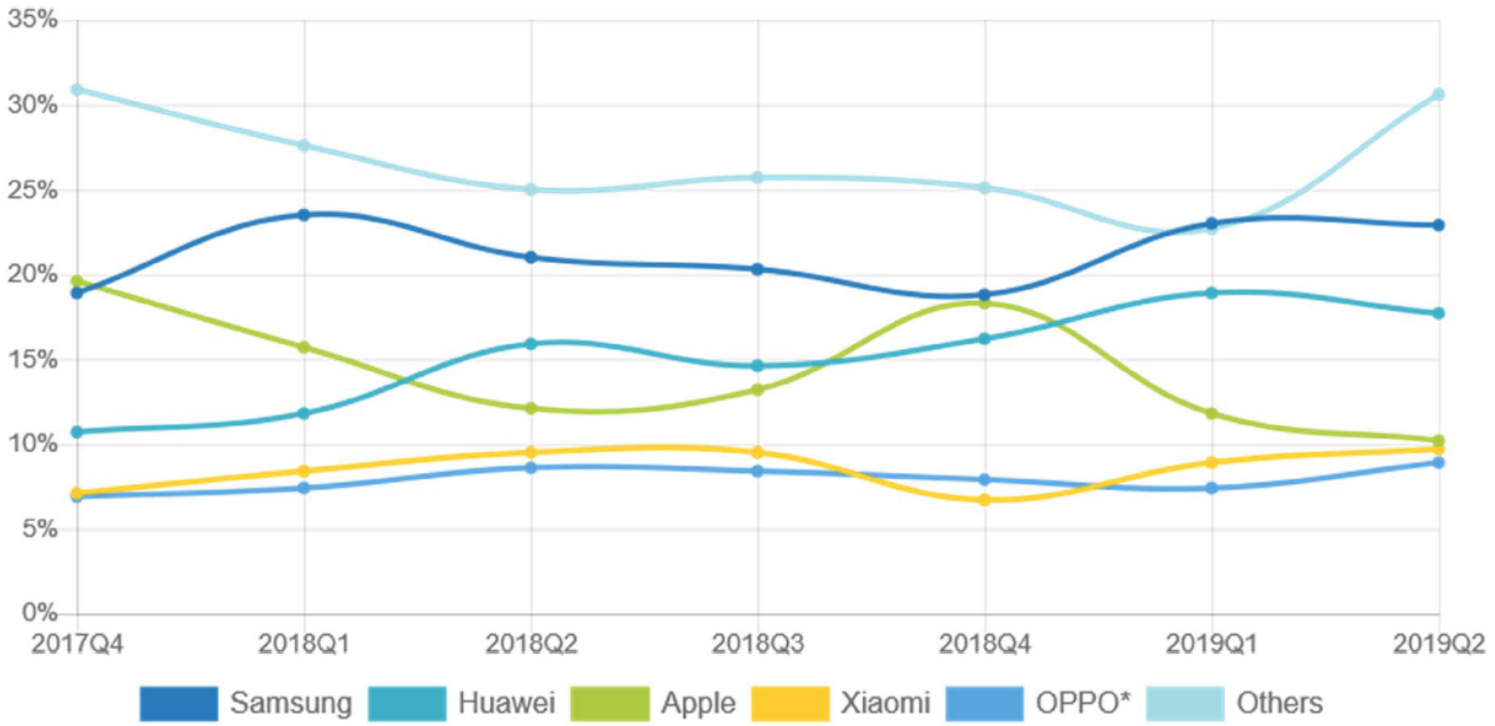
Additional features

- Digital camera, GPS receiver, MP3 player, Gyroscope, many kinds of additional sensors

If sufficient bandwidth is available

- Internet telephony (VoIP), Video conferences via LTE-A

# Worldwide Top 5 Smartphone Shipment Company Market Share




Source: IDC 2019

# Briefly: Generations of Operating Systems (1/2)

Batch Operating Systems (main frames)

- Programs were executed “quasi parallel” independently from each others
- Processes could be interrupted waiting for resources to become ready
- Shared resources (memory, tape storage) managed by the OS

Operating Systems supporting user dialogs

- User interaction at exact defined points in the program
- Execution pauses while waiting for user to complete the input
- Synchronous Dialogs (exception: some keys ...)

BIG Change: OS with Graphical User Interfaces (GUI)

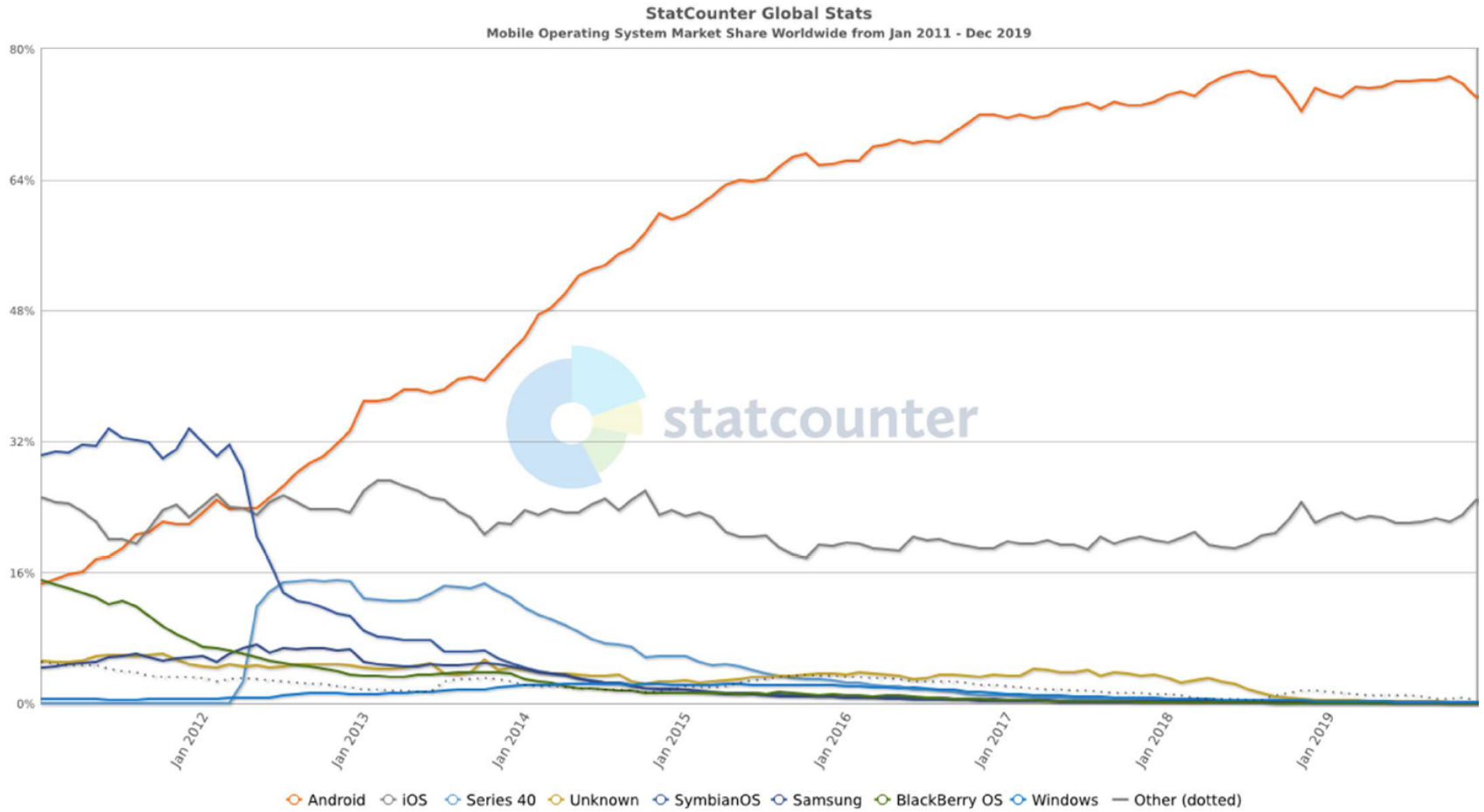
- Direct manipulative user interaction: mouse (1963) or light-pen
- Asynchronous Interrupts by user: mouse or keyboard
- Reactive while many processes execute in parallel
- Programming Concepts: Input focus, callbacks, threads ...

# Briefly: Generations of Operating Systems (2/2)

Additional challenge: Mobile Operating System

- Much more asynchronous user interaction
- New kinds of interaction: touch screen, gesture control
- Communication between different Apps
- Numerous sensors with different return data and interrupts
- More communication with (background-) services: music, time events, events from sensors or network
- Programs with multiple program entry points (not only “main”)
- More complex process lifecycle
- Complex permission control
- Dynamic binding between processes ...

# Worldwide Smartphone Operating System Market




Source: statCounter 2020

# Android Versions

| Version | Code name | Release date | API level | Runtime | |
|---|---|---|---|---|---|
| **10** | 10 | September 3, 2019 | **29** | ART | Pixel, Pixel XL, Pixel 2, Pixel 2 XL, Pixel 3, |
| **9** | Pie | August 6, 2018 | 28 | ART | Essential Phone, Pixel, Pixel XL, Pixel 2, F Xiaomi Mi Mix 2S[378] |
| **8.1** | Oreo | December 5, 2017 | 27 | ART | Pixel, Pixel XL, Nexus 6P, Nexus 5X |
| **8.0** | Oreo | August 21, 2017 | 26 | ART | N/A |
| **7.1** | Nougat | October 4, 2016 | 25 | ART | Pixel, Pixel XL |
| **7.0** | Nougat | August 22, 2016 | 24 | ART | Nexus 5X, Nexus 6P |
| **6.0** | Marshmallow | October 5, 2015 | 23 | ART | Nexus 5X, Nexus 6P |
| **5.1** | Lollipop | March 9, 2015 | 22 | ART | Android One |
| **5.0** | Lollipop | November 3, 2014 | 21 | ART 2.1.0 | Nexus 6, Nexus 9 |
| **4.4** | KitKat | October 31, 2013 | 19 | Dalvik (and ART 1.6.0) | Nexus 5 |
| **4.3** | Jelly Bean | July 24, 2013 | 18 | Dalvik | Nexus 7 2013 |
| **4.2** | Jelly Bean | November 13, 2012 | 17 | Dalvik | Nexus 4, Nexus 10 |
| **4.1** | Jelly Bean | July 9, 2012 | 16 | Dalvik | Nexus 7 |
| **4.0** | Ice Cream Sandwich | October 19, 2011 | 15 | Dalvik | Galaxy Nexus |
| **2.3** | Gingerbread | February 9, 2011 | 10 | Dalvik 1.4.0 | Nexus S |

**Legend:** Old version | Older version, still supported | **Latest version** | Latest preview version | Future release

# Acknowledgment

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VERY LARGE
BUSINESS APPLICATIONS