MOBILE COMPUTING

CSE 40814/60814
Spring 2021

Course Overview

- Instructor: Christian Poellabauer
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  - 574-631-9131
- Website:
  - https://www3.nd.edu/~cpoellab/teaching/cse40814/index.htm
  - Schedule, announcements, grading info, etc.
- Sakai:
  - Submissions, grading
- Zoom:
  - Link on website and Sakai
  - Used for office hours, Friday "LAB" sessions, remote attendance (quarantine, etc.), potential shut-downs, ...

Course Goals

- Fundamentals of **mobile computing**
- Fundamentals of **wireless networking**
- Topics from closely related areas:
  - Pervasive Computing
  - Wearables
  - Internet of Things
  - Real-Time Systems
  - Embedded Systems
  - Wireless sensor networks
- Acquire and practice development skills
  - Mini projects and course/group project

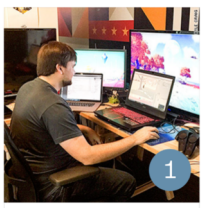
Mobile Computing & IoT Prospects

1. Mobile App Developer NEXT

Median Pay: $97,100
Top Pay: $133,000
10-year job growth: 19%

Whether you're Snapchatting with friends or catching Pokémon, you probably spend time every day using the creations of mobile app developers. They aren't necessarily saving the world, but mobile app developers get to create something that can reach millions of people on a daily basis.

That means growing demand for developers who build and update apps so they're secure, user-friendly, and sought after.



Kyle Craig, software developer at IBM's Mobile Innovation Lab

Why it's great: Mobile app developers are the first to test out the latest phones, tablets, and wearable devices. "If you like playing around with technology and exploring all the possibilities it offers, this can be a really fun job," says mobile app developer Kyle Craig.

CNN Money 2017

Internet of Things Engineer

Speaking of security and machine learning...the Internet of Things will need these new skills and more. It's almost impossible to talk about an IoT career because building and using embedded devices will take so many different skills. IoT is even more complex than most software now because of the complications of designing new hardware, integrating it with new software and managing new security concerns, not to mention storing and using the massive amount of data generated.

As always, companies are hoping to find a unicorn who possesses deep understanding of hardware, software, cloud, data, product and possibly dark magic, but more realistically, they're looking at hardware pros with some coding exposure, or software developers with a basic idea of how electronics work.

- **Average salary:** $96,000, according to Glassdoor
- **Baseline skills:** Wireless protocols, security, basic understanding of electrical circuits, programming (often Java, C and C#), understanding of networks and cloud, preferably domain expertise
- **Typical education:** Degree in computer science
- **Related careers:** Infosec analyst, business analyst, data scientist
- **Recommended MOOCs:** Internet of Things: Roadmap to a Connected World
- **Recommended books:** *The Second Machine Age: Work, Progress and Prosperity in a Time of Brilliant Technologies; The Silent Intelligence: The Internet of Things; Enterprise IoT*

TEKsystems 2017

Grading

• Midterm Exam	20%
• Final Exam	20%
• Mini Assignments	20%
• First Progress Report	5%
• Second Progress Report	5%
• Final Project Deliverables	10%
• Project Demonstration/Presentation	10%
• Class Participation	10%

Course Project

- Mini Projects:
  - Purpose: Learn/improve programming skills; learn Google Flutter
  - Individually, but collaboration encouraged!
- Class Project
  - Purpose: Develop innovative/unique “mobile computing solution”
  - Individually or in teams [1-3]
  - Collaboration across teams encouraged!

Questions?

Mobile Computing

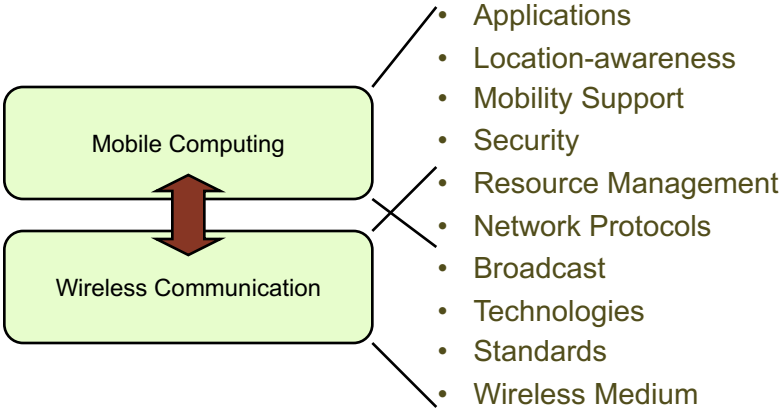
- **A simple definition could be:** Mobile Computing is using a computer (of one kind or another) while on the move
- **Another definition could be:** Mobile Computing is when a work process is moved from a normal fixed position to a more dynamic position
- **A third definition could be:** Mobile Computing is when a work process is carried out somewhere where it was not previously possible

- **Mobile Computing** is an umbrella term used to describe technologies that enable people to access services **anytime** and **anywhere**

Mobile Computing

- Many other names/overlapping computing paradigms:
  - Nomadic Computing (mobile computing)
  - Pervasive Computing (anytime and everywhere)
  - Ubiquitous Computing (anytime and everywhere)
  - Embedded Computing (embedded in a larger system)
  - Real-Time Systems (timing requirements)
  - Wireless Networks (wireless radios)
  - Wireless Sensor Networks (connected sensors)
  - (Mobile) Ad-Hoc Networks (dynamic network formation)
  - Internet of Things or IoT (“smart things” connected to the Internet)
  - …

Mobile Computing



Evolution

- Mobile computing can be categorized into **seven major categories of focus**
- These categories are the basis for the technology that is used today in research and design of mobile computing
- Each category or section is a different area that was focused on making mobile computing what it is today
- These seven categories are: Portability, Miniaturization, Connectivity, Convergence, Divergence, Apps, Digital Ecosystems

Miniaturization

- Creating new and significantly smaller mobile form factors that allowed the use of personal mobile devices while on the move

50mm x 50mm

35mm x 35mm

15mm x 15mm

Portability

- Reducing the size of hardware to enable the creation of computers that could be physically moved around relatively easily

Connectivity

- Developing devices and applications that allowed users to be online and communicate via wireless data networks while on the move

Convergence

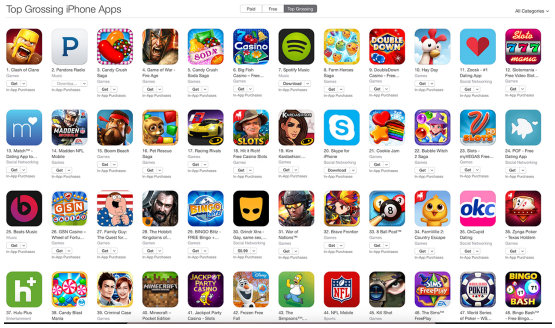
- Integrating emerging types of digital mobile devices, such as Personal Digital Assistants (PDAs), mobile phones, music players, cameras, games, etc., into hybrid devices

Divergence

- Opposite approach to interaction design by promoting information appliances with specialized functionality rather than generalized ones

Applications (Apps)

- The latest wave of applications (*apps*) is about developing matter and substance for use and consumption on mobile devices, and making access to this fun or functional interactive application content easy and enjoyable



Digital Ecosystems

- The emerging wave of *digital ecosystems* is about the larger wholes of pervasive and interrelated technologies that interactive mobile systems are increasingly becoming a part of

Example: Smartphone

- Portability: carry it anywhere you want
- Miniaturization: make it possible to build device to fit in your pocket
- Connectivity: Wi-Fi, LTE/4G, 5G, cellular, Bluetooth, RFID, NFC, …
- Convergence: phone, camera, gaming device, movie streaming, music player, …
- Divergence: ?
- Applications: “Rise of the Apps”
- Digital Ecosystem: social networks, distributed gaming, mobile cloud computing, shopping, banking/transfer, location-based services, …

App Store (iOS)

- 2003: iTunes Music Store
- 2008: iPhone App Store (500 apps)
- 2015: > 100 billion app downloads
- 2016: > 2 million apps
- 2016: App developers earned $20 billions
- 2020: Games accounted for ~40% of total app downloads

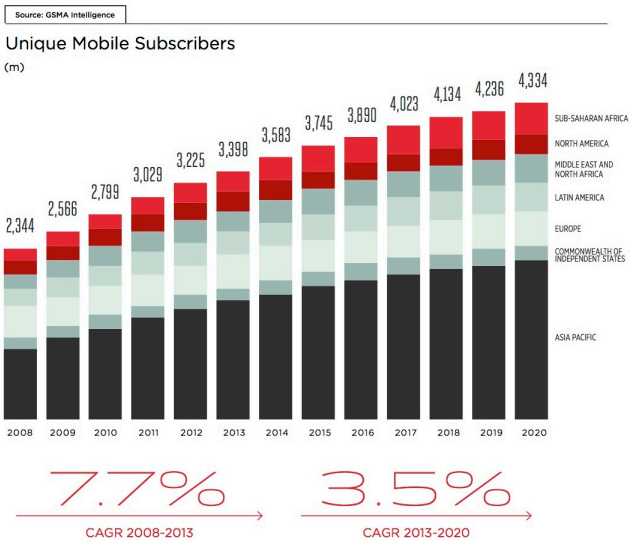
App Store (iOS): 2020 Free Apps

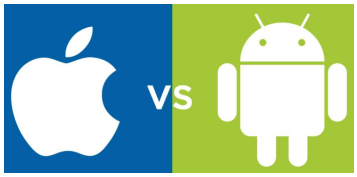
- Zoom
- TikTok
- Disney Plus
- YouTube
- Instagram
- Facebook
- Snapchat
- Facebook Messenger
- Gmail
- Cash App

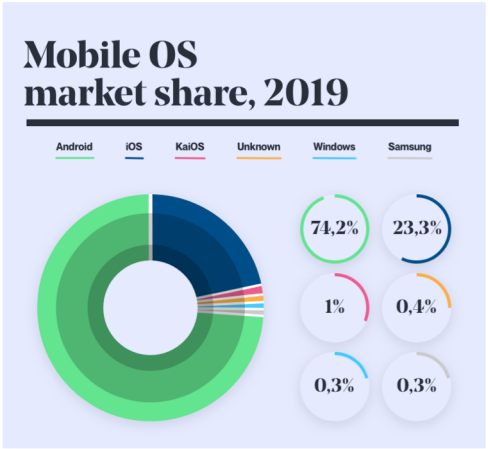
App Store (iOS): 2020 Paid Apps

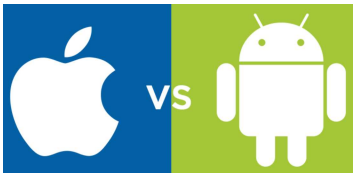
- TouchRetouch
- Procreate Pocket
- Facetune
- HotSchedules
- AutoSleep Track Sleep
- The Wonder Weeks
- SkyView
- Shadowrocket
- SkyGuide
- Forest – Stay Focused

Trends in Mobile: Phone Subscribers





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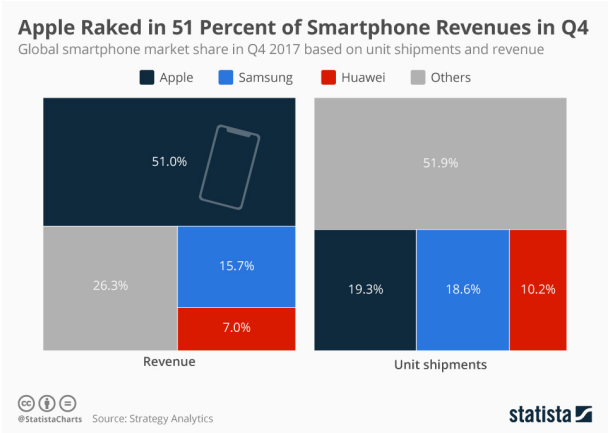
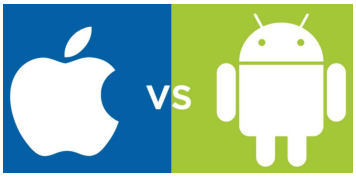

Apple Raked in 51 Percent of Smartphone Revenues in Q4
Global smartphone market share in Q4 2017 based on unit shipments and revenue
Apple
Samsung
Huawei
Others
51.0%
26.3%
15.7%
7.0%
Revenue
51.9%
19.3%
18.6%
10.2%
Unit shipments
@StatistaCharts
Source: Strategy Analytics
statista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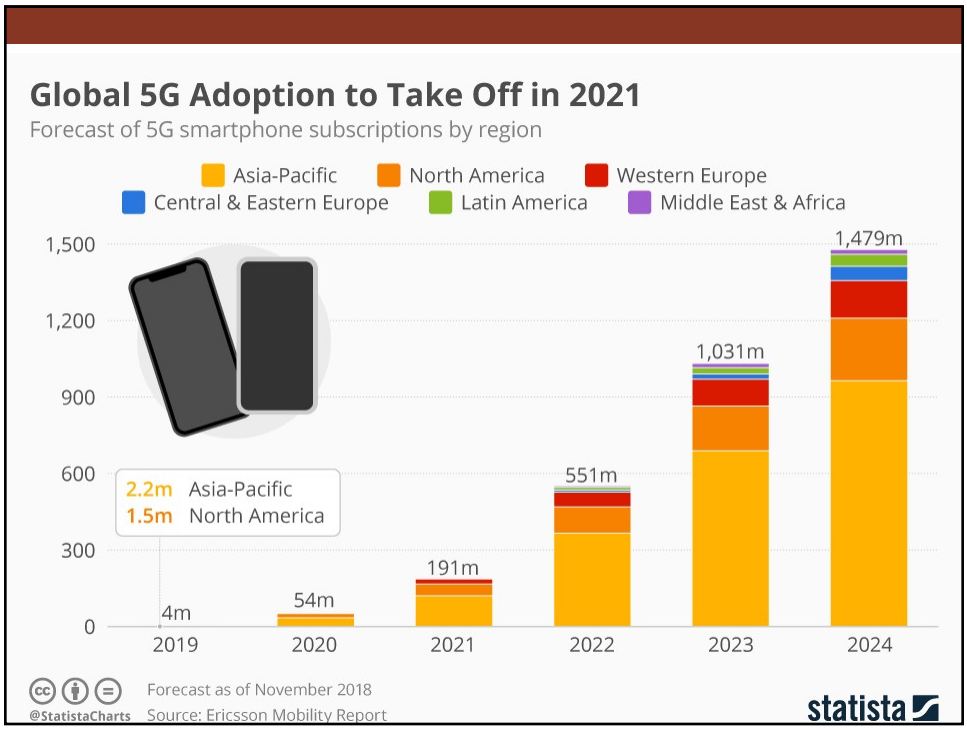
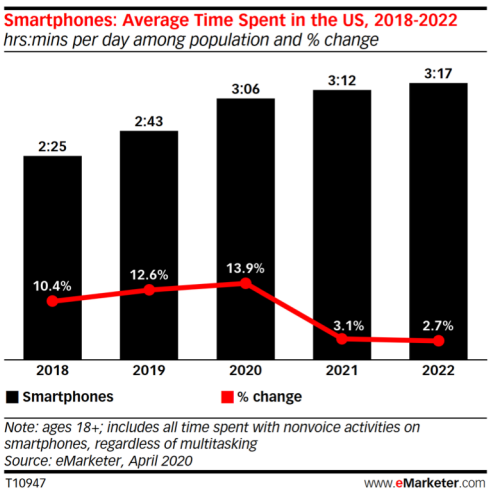
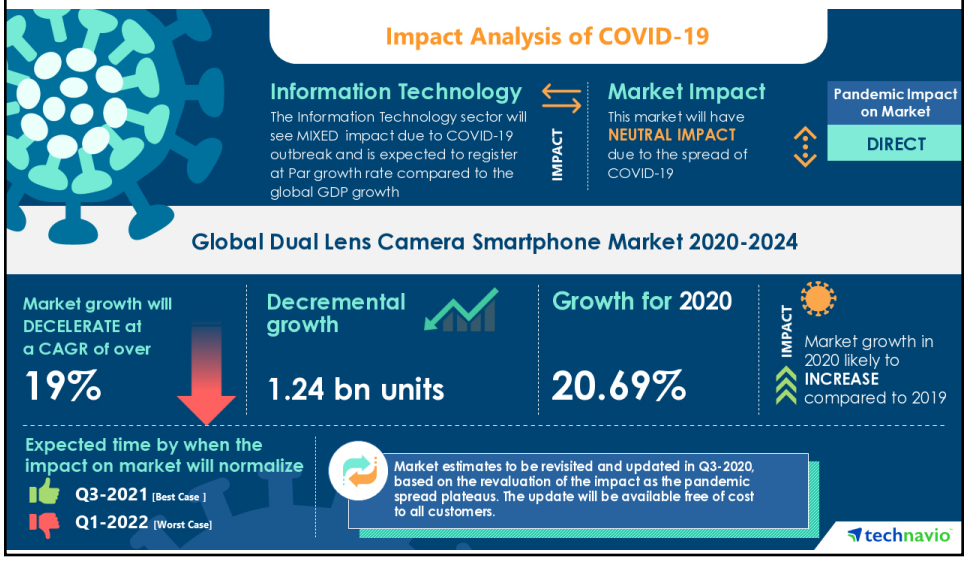


Time spent on Devices

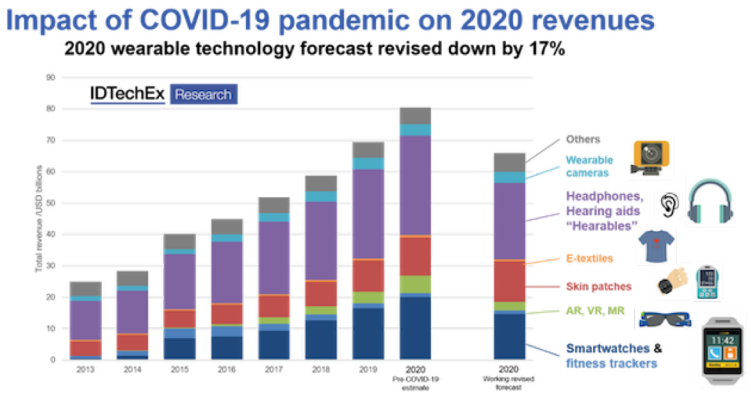


COVID-19 Impact

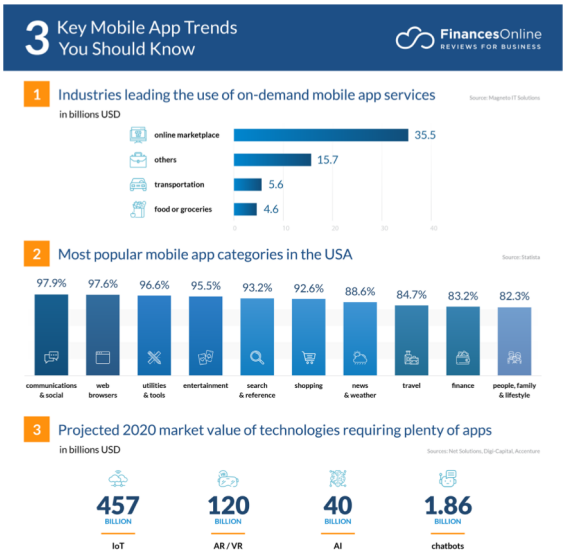


Trends in Mobile: Shopping

Trends in Mobile: Wearables



Trends in Mobile: Apps



That's it for today…

- Questions, comments, concerns, …?
- Up next: Project details/discussion/Q&A/etc. (Friday)