Course Overview

• Instructor: Christian Poellabauer
  • 323B Cushing Hall
  • cpoellab@cse.nd.edu
  • 574-631-9131
  • Office hours: Tue 10-11, Wed 11-12 and by appointment
  • TA: Justin Benedetto, office hours/location TBD
• Website: schedule, grading, project info, ...
Grading

- Midterm Exam 15%
- Final Exam 25%
- Mini Project 10%
- Project Progress Reports 15%
- Project Presentation 15%
- Final Project Deliverables 20%

Mini Project

- Choose a mobile platform: iOS or Android (no web, hybrid, etc.!)S
- Develop a simple app that can perform the following functions (at a minimum):
  - Display a map and your location on the map (GPS, map)
  - Reads accelerometer/gyroscope and does “something” when device is moved in certain way (e.g., shaking) (sensors)
  - Has at least two “views” where you can navigate back and forth:
    - map view
    - table/list view (with “subview”)
- Submit code & instructions/report via AFS dropbox
- To be done individually
- TA may request meeting if problems arise when compiling/running your code
- Can be re-used for main project as you see fit
- Deadline: 9/23 11.59pm
Main Project

- Semester-long development project in broad area of mobile computing
- Team-based (1-3; 3+ only after approval)
- If help needed identifying team members, let me know!
- Project proposal due: 9/9 11.59pm
- Platforms/devices of your choice:
  - SW: Android, iOS, Windows, Blackberry, TinyOS, …
  - HW:
    - Smartphones, tablets
    - Embedded devices & development boards
    - Sensor devices
    - Wearables
    - Robots, UAVs
    - …

Project Characteristics

- Portable solution/app
- Context/location awareness
- Mobile – cloud integration
- Sensors on mobile devices
- Device embedded into mobile system
- Wireless network technology
- Communication-oriented (should talk to something/body else)
Project Structure

- 2 written progress reports
- Final report, delivered with code
- In-class demo/presentation of project

- Resources:
  - B30 Lab & other Engineering labs
  - Plenty of mobile/sensing/embedded devices (can purchase if needed)
  - Collaboration is encouraged!!

Course Goal

- To understand what are the fundamental concepts & challenges in Mobile Computing and what are some of the solutions towards solving these fundamental challenges
- But also:
  - To get you a high-paying job
  - To enrich you with new ideas
  - To train you in (mobile) systems oriented thinking
  - To provide you with skills in mobile development
Mobile Developer Jobs

  - **1. Mobile applications developer**
    - 2012 salary range: $85,000-$122,500
    - 2013 salary range: $92,750-$133,500
    - Net: 9% increase

- “Best Computer Jobs For the Future”:
  - #1: Mobile App Developer Employment Projections | 2010 - 2020
    - **10-Year Growth Pct**: 32% (much faster than avg.)
    - **10-Year Growth Volume**: 292,000 new jobs
    - **Average Salary**: $95,000

Mobile Computing

- Computing enabled by presence of wireless enabled portable devices (PDAs, cell phones etc.):

- Many other names/overlapping computing paradigms:
  - Pervasive Computing
  - Ubiquitous Computing
  - Wireless Computing
  - Embedded Computing
  - Nomadic Computing
  - Wireless Sensor Networks
  - Ad-Hoc Networks
  - Mesh Networks
  - Vehicular Networks
  - …
Mobile Computing

- Applications
- Location-awareness
- Mobility Support
- Security
- Resource Management
- Network Protocols
- Broadcast
- Technologies
- Standards
- Wireless Medium

Trends in Mobile

Source: GSMA intelligence

Unique Mobile Subscribers (M)

- 2,204
- 2,569
- 3,123
- 3,225
- 3,398
- 3,745
- 3,698
- 4,023
- 4,326
- 4,334

CAGR 2008-2013: 7.7%
CAGR 2013-2020: 3.5%
Trends in Mobile

- Forrester: “US consumers will make $52 billion in mobile payments in 2014 and ramp up their mobile spending to $142 billion by the end of 2019.”
- Gartner: “By year-end 2016, more than $2 billion in online shopping will be performed exclusively by mobile digital assistants.”
- IDC: “Difficulties linking mobile platforms to existing databases will cause 45% of mobile enterprise app initiatives to be delayed or go over budget in 2015.”
- Gartner: “Through 2015, more than 75% of mobile applications will fail basic security tests.”
- IBM: “81% of companies have employee owned devices accessing their networks, but only 48% claim to have a well-defined mobile security strategy.”
Trends in Mobile

In stores, 82% of smartphone users turn to their devices to help them make a product decision.


91% growth in B2B researchers using smartphones throughout the path to purchase
Trends in Mobile

**Global Wearable Device Unit Shipments Forecast**

![Graph showing the forecast for global wearable device unit shipments.](image)

**Why Aren't You Interested In A Smartwatch?**

<table>
<thead>
<tr>
<th>Reason</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Don't See The Point</td>
<td>51%</td>
</tr>
<tr>
<td>I Don't Like Wearing A Watch</td>
<td>13%</td>
</tr>
<tr>
<td>Price: They Are Too Expensive</td>
<td>8%</td>
</tr>
<tr>
<td>I Just Don't Want To Spend A Lot Of Money On A Watch</td>
<td>6%</td>
</tr>
<tr>
<td>All Smartwatches I Have Seen Are Ugly</td>
<td>7%</td>
</tr>
<tr>
<td>Other</td>
<td>15%</td>
</tr>
</tbody>
</table>

Source: BI Intelligence Smartsheet Survey, October 2014; n = 1,206
Trends in Mobile

HEALTHCARE MARKET TRENDS
The web is crucial for healthcare

VIDEO INSIGHTS
Health information has never been so easy to access

SEARCH INSIGHTS
Search trends are evolving as more people use mobile devices

PATH TO PURCHASE
88% of users looked for health information online using mobile devices

SEARCH TRENDS BY DEVICE

CONSUMER INSIGHTS

HOSPITAL ADMINISTRATORS
Contact a patient directly after an initial visit

57%
of B2B SELLERS have placed their company’s information online

HEALTHCARE SERVICES
75%
of patients are using mobile apps for health-related information

GOOGLE SOLUTIONS DRIVE RESULTS

Trends in Mobile

Trends in Mobile

How Apps Are Used

Source: Statista

Mobile App Revenue = Still Trumps Mobile Ad Revenue...
68% of Mobile Monetization

Source: Statista

Mobile App Revenue = Still Trumps Mobile Ad Revenue...
68% of Mobile Monetization

Global Mobile App + Advertising Revenue, 2008 – 2013

Crabby

Crispycodes

crispycodes.com

Email: info@crispycodes.com
Trends in Mobile

- Cellphone vs. Smartphone
- More than 10T SMS in 2013
- [https://en.wikipedia.org/wiki/App_Store_%28iOS%29#Most_downloaded_apps](https://en.wikipedia.org/wiki/App_Store_%28iOS%29#Most_downloaded_apps)
Trends in Mobile

iOS App Statistics
In addition to announcing iOS 8, the newest OS X, and a new streaming music service at their annual developer conference WWDC, Apple this week announced some pretty staggering statistics from the App Store. Here’s a summary:

- 100 billion apps downloaded since 2008
- 1.5 million apps in the App Store
- 119 apps downloaded per iOS user
- 850 apps downloaded per second

 Universities and the Mobile Revolution

NEARLY ALL STUDENTS TEXT EVERYDAY...
Send texts everyday
YES 94% NO 06%

MUCH MORE THAN MAKE CALLS EVERYDAY.
Make calls everyday
YES 73% NO 27%

TECH ADDICTION? MANY STUDENTS EXPERIENCE IT.
Sometimes feel ‘addicted’ to phone
YES 60% NO 40%
Universities and the Mobile Revolution

Enablers

- **Wireless communication networks**
  - multiple networks “covering” the globe
  - world-wide deregulation and spectrum auctions
  - standard communication systems and air link interfaces

- **Portable information appliances**
  - laptops, notebooks, sub-notebooks
  - hand-held computers, tablets
  - smartphones

- **Internet:**
  - TCP/IP & *de-facto* application protocols
  - ubiquitous web content
Wireless Networks

• The edge of the Internet becoming wireless
  • Single hop networks
  • Multi-hop networks

Wireless versus Fixed Networks

• Higher loss-rates due to interference
  • emissions of, e.g., engines, lightning
• Restrictive regulations of frequencies
  • frequencies have to be coordinated, useful frequencies are almost all occupied
• Low transmission rates
  • local some Mbit/s, regional currently, e.g., 53kbit/s with GSM/GPRS or about 150 kbit/s using EDGE
• Higher delays, higher jitter
  • connection setup time with GSM in the second range, several hundred milliseconds for other wireless systems
• Lower security, simpler active attacking
  • radio interface accessible for everyone, base station can be simulated, thus attracting calls from mobile phones
• Always shared medium
  • secure access mechanisms important
Advantages of Wireless

• Significantly lower cost
  • No cable, low labor cost, low maintenance

• Ease
  • Minimum infrastructure - scatter and play

• Unrestricted mobility
  • Unplugged from power outlet

• Ubiquity
  • Available like water/electricity - holy grail

The Future
The Future

RFID and Sensor Networks
Citywatchers, Walmart, Intel, Philips, Bosch ...

Personal Area Networks
Motorola, Intel, Samsung ...

Mesh Networks and Wireless Backbones
Microsoft, Intel, Cisco ...

Internet

Mobile + Wireless

Applications that exploit ubiquity and mobility. Challenges underlying such applications

Ubiquitous Services
Incentives
Loss Discrimination
Energy Savings
Spatial Reuse
Application
Security
Transport
Network
MAC / Link
PHY

Privacy
Eavesdropping
Mobility
Interference Mgmt.
Channel fluctuations

Enabling wireless ubiquity. Showing what is feasible, and what is not …