CS 179i: Project in Computer Science (Networks)

Jiasi Chen
Lectures: Monday 3:10-4pm in Spieth 1307

TA: Shikhar Garg
Lab: Wednesday 6:10-9pm in Winston Chung 132

http://www.cs.ucr.edu/~jiasi/teaching/cs179i_winter16/
Outline

• Why networks?

• Course Organization

• Project
Why Networks?

Supports the applications that we use today...

Social media

Number of Internet users
• 97% of Americans between 18-29
• 40% of the world population → scope for more users

Why Networks?

But also a source of conflict.

Cyber security

A Look Back at the Target Breach

Network neutrality


A new plan from T-Mobile USA to allow unlimited streaming of some video services may become the first test of the federal government’s rules to prevent favoritism on the Internet.

On Tuesday, T-Mobile, the nation’s third-largest wireless carrier, said customers could stream as many videos as they want — regardless of their data plan limits — from more than two dozen video providers, including Hulu and Netflix.

http://www.huffingtonpost.com/eric-dezenhall/a-look-back-at-the-target_b_7000816.html
Major Areas in Networking

• **Wireless**
  • How to provide a one-to-one communication pipe in an inherently broadcast environment?

• **Layering**
  • How to modularize the design to enable easy innovation?

• **Protocols**
  • How to interact within each layer, and talk to other layers?

• **Resource allocation**
  • How to share limited resources between competing users?

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**OSI 5-layer model of the Internet**

<table>
<thead>
<tr>
<th>Layer</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
<td>(e.g. video streaming)</td>
</tr>
<tr>
<td>Transport</td>
<td>(e.g. TCP, UDP)</td>
</tr>
<tr>
<td>Network</td>
<td>(e.g. routing)</td>
</tr>
<tr>
<td>Link</td>
<td>(e.g. scheduling)</td>
</tr>
<tr>
<td>Physical</td>
<td>(e.g. OFDM)</td>
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</table>
How to design the network to best support these applications?

How to design applications that make the best use of the network?
Course Organization
What You Will Learn in this Course

• **Knowledge:** Common networking tools/protocols, depending on your choice of project
  - Android programming
  - MPEG-DASH video streaming
  - Kernel and socket programming

• **Skills**
  - How to work in teams
  - How to lead your own project
  - How to learn on your own
Logistics

- Lecture: Jiasi Chen
  - Slides available on course website
  - Office hours: Thursday 3-5pm, or by appointment

- Lab: Shikhar Garg
  - Office hours: TBA

- Required to attend lectures and labs
  - No lab session this week (1/6)

- Submit assignments on iLearn

- Check class website for latest updates
  - http://www.cs.ucr.edu/~jiasi/teaching/cs179i_winter16/
Grading

- **Project: 75% total**
  - Proposal: 10%
  - Progress update: 10%
  - Final report: 20%
  - Final presentation: 15%
  - Technical merit and originality: 20%

- **4 essays: 15%**
  - ABET requirement
  - One free late day during the quarter

- **Participation: 10%**
  - Attending lecture and lab
  - Giving feedback during other teams’ final presentations
## Calendar

<table>
<thead>
<tr>
<th>Date</th>
<th>Lecture</th>
<th>Assignment Due</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan. 4</td>
<td>Introduction</td>
<td></td>
</tr>
<tr>
<td>Jan. 11</td>
<td>Project details I</td>
<td>Group formation</td>
</tr>
<tr>
<td>Jan. 18</td>
<td>(holiday)</td>
<td>Project proposal</td>
</tr>
<tr>
<td>Jan. 25</td>
<td>Project details II</td>
<td></td>
</tr>
<tr>
<td>Feb. 1</td>
<td>Ethics</td>
<td>New trends essay</td>
</tr>
<tr>
<td>Feb. 8</td>
<td>Progress update</td>
<td>Brief oral presentation from each team</td>
</tr>
<tr>
<td>Feb. 15</td>
<td>(holiday)</td>
<td></td>
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<tr>
<td>Feb. 22</td>
<td>Guest lecture</td>
<td>Ethics essay</td>
</tr>
<tr>
<td>Feb. 27</td>
<td>Final presentations</td>
<td></td>
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<tr>
<td>March 7</td>
<td>Final presentations</td>
<td>Presentation essay</td>
</tr>
<tr>
<td>March 14</td>
<td>(exams week)</td>
<td>Teamwork essay, final report due</td>
</tr>
</tbody>
</table>

If the class agrees, we may combine Feb. 27 + March 7 final presentations onto a single day, e.g., one day during the weekend of March 5/6.
Project
Project Outline

• Form groups of 3

• I will provide some project ideas, or design your own
  1. Google Cardboard
  2. Adaptive video streaming
  3. Download booster

• Goal: open-ended projects and the relevant resources to succeed

• Suggestion: choose your project with your future career/job interviews in mind
1. Google Cardboard

• Virtual reality (VR) using commodity hardware
  • $20 cardboard viewer to use your smartphone as a VR display

• Demo
  • https://www.youtube.com/watch?v=29uXoePowzQ

• Existing apps are rudimentary
  • E.g., White House Christmas tour, find the ball
  • Single user, single view
1. Google Cardboard

- **Street View**
  - Single view → multiple views
  - User interface for navigation
  - Tour of a location of your choice
  - Request views from server with low latency

- **Periscope**
  - Single user → multiple users
  - Simple version: Copy the currently viewed screen to another user, with audio voiceover (e.g., campus tour)
  - More challenging: live streaming with camera passthrough

- **Your imagination?**

- **Requires Android phone (emulation doesn’t work 😞)**

- **Resources**
  - Cardboard Android API: [https://developers.google.com/cardboard/android/](https://developers.google.com/cardboard/android/)
2. Adaptive Video Streaming Using MPEG-DASH

- **MPEG-DASH**
  - Application-layer protocol for adapting video quality to network conditions
  - Client-driven: client estimates network conditions and requests appropriate video quality
  - Standard doesn’t specify adaptation algorithm, just the communication protocol between client and server

- Who uses it? [YouTube](#), [Netflix](#), [hulu](#), [Apple](#)
2. Adaptive Video Streaming Using MPEG-DASH

• Current approaches
  • Numerous approaches proposed in research literature and in practice
  • Need a apples-to-apples comparison under common set of test conditions

• Resources
  • MPEG-DASH video player: https://github.com/Dash-Industry-Forum/dash.js/wiki
3. Download Booster Using Multiple Interfaces

- Want to speed up downloads of large files by using multiple interfaces simultaneously (e.g., WiFi, 4G, Ethernet)

- Samsung introduced Download Booster, but it got blocked by major carriers

- Multipath-TCP is another major standardization effort to enable multiple networks
3. Download Booster Using Multiple Interfaces

- **Transport layer: multipath-TCP**
  - Extension to TCP to split a single flow into multiple subflows
  - Each subflow can use a different interface
  - Problems: requires server and client kernel modifications, difficult for widespread deployment

- **Application layer: HTTP client proxy**
  - Implement in the application layer using common HTTP protocol
  - Use HTTP GET requests to request different pieces of the content over different interfaces

- **Transport vs application layer**
  - Which version is better? What are the pros and cons?
  - What improvements can be made to either protocol?

- **Resources**
Do-It-Yourself

• Have a cool idea for a project? Pursue it!

• Potentially more points for technical merit and originality (20%)

• Please schedule a meeting with me and the TA as soon as possible to discuss this

• Resources
  • Datasets of wireless traces: http://www.crawdad.org/
  • Previous senior design projects at Stanford: http://web.stanford.edu/class/cs210/2013SoftwareFaireProgramDraft.pdf
Conclusions

• Next lecture: Tips about suggested projects

• To do by next class (1/11)
  • Form groups and send one email per group to myself and TA, CC-ing all group members

• Questions?