CS 179i: Project in Computer Science (Networks)

Jiasi Chen
Lectures: Monday 1:10-2pm in Sproul 2343
TA: Ryan Holt
Lab: TBD

http://www.cs.ucr.edu/~rholt002/cs179i_winter17/
Outline

• Why networks?

• Course Organization

• Project
Why Networks?

Supports the applications that we use today...

Social media

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

Number of Internet users

Why Networks?

But also a source of conflict.

Cyber security

A Look Back at the Target Breach

Network neutrality


By CECILIA KANG  NOV. 11, 2015

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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</tbody>
</table>
How to design the network to best support these applications?

How to design applications that make the best use of the network?
Project Ideas
Project Outline

• Form groups of 2+

• I will provide some project ideas, or come up with your own
  1. Virtual reality
  2. Adaptive video streaming
  3. Download booster
  4. Smart home
  5. Kids learning

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

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

- Different types of hardware
  - Low-end: Google Cardboard
  - High-end: Oculus Rift, HTC Vive

- Demo
  - [https://www.youtube.com/watch?v=29uXoePowzQ](https://www.youtube.com/watch?v=29uXoePowzQ)

- Existing apps are rudimentary
  - E.g., White House Christmas tour, Fantastic Beasts promo
  - Single user, single view
1. Virtual Reality

• Indoor Street View
  • Single view → multiple views
  • Tour a virtual location
  • Challenge: storing the content on the server (long latency) vs client (high storage)

• Social VR
  • Single user → multiple users
  • Interact with others’ avatars
  • Challenge: synchronizing the users over the network

Resources:
Cardboard Android API: https://developers.google.com/cardboard/android/
Unity programming
2. Adaptive Video Streaming

- **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

• Current approaches
  • Numerous approaches proposed in research literature and in practice
    • Current buffer level
    • Predicted bandwidth
  • 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**
4. Smart Home

• Measurement study
  • How much do these devices use the network?
  • What protocols do they use?

• Control household appliances
  • Complex logic to integrate different devices
5. Helping Kids Learn

• Creating games for to help young kids learn

• Understanding how well children learn from realistic vs fantastical environments
  • For example, cartoon animals vs human figures

• Can the learning experience be improved through:
  • Virtual reality?
  • Virtual assistants like Alexa?

• Collaboration with a psychology professor
  • User study in the psychology department
  • Potential for real impact!
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
Wait... How does this relate to my networking class?

• What about your favorite networking topics?
  • ALOHA
  • TCP retransmission
  • 802.11 backoff
  • ...

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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 2-4pm, or by appointment

• Lab: Ryan Holt

• Submit assignments on iLearn

• Check class website for latest updates
  • http://www.cs.ucr.edu/~rholt002/cs179i_winter17/
Grading

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

• 4 essays: 10%
  • ABET requirement
  • One free late day during the quarter

• Participation: 15%
  • Attending lecture and lab
  • Giving feedback during other teams’ final presentations
# Calendar

<table>
<thead>
<tr>
<th>Week</th>
<th>Lecture</th>
<th>Assignment Due</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>(holiday)</td>
<td>Group formation</td>
</tr>
<tr>
<td>3</td>
<td>Project details I</td>
<td>Project proposal</td>
</tr>
<tr>
<td>4</td>
<td>Project details II</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Ethics</td>
<td>New trends essay</td>
</tr>
<tr>
<td>6</td>
<td>Progress update</td>
<td>Brief (10 minute) presentation</td>
</tr>
<tr>
<td>7</td>
<td>(holiday)</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Guest lecture</td>
<td>Ethics essay</td>
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<tr>
<td>9</td>
<td>Final presentations</td>
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<tr>
<td>10</td>
<td>Final presentations</td>
<td>Presentation essay</td>
</tr>
<tr>
<td>Finals week</td>
<td>(exams week)</td>
<td>Teamwork essay, final report due</td>
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</table>
Conclusions

• Next lecture (in 2 weeks): Project details

• To do by next Monday
  • Form groups and send one email per group to myself and TA
  • Sign up for lab time availability

• Questions?