CIS 410/510
Advanced Topics in Networking

Lecture 1
09/25/2017
Fall 2017
Welcome to CIS 410/510

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  • PhD from University of Wisconsin – Madison
  • Research interests: Computer Networking, Networked Systems, Future Internet paradigms and Cyber security

• About you
  • Your name? MS/PhD? Advisor?
  • Research interests?
  • What do you expect from this course?
  • One fun thing you did this summer?
Why is this course important?

• Internet is in a constant state of flux
  • Let’s see the Internet’s timeline
Internet timeline

- Only 4 nodes
- Everything was centralized!
- Goal: to test packet switching
Internet timeline

- Increased to 13 nodes
- Everything was centralized!
- Interface Message Processor ($82k)
Internet timeline

- Became International (to London and Norway)
- Satellite connection to Hawaii and others
- 40 nodes; everything was still centralized!
- Era of email and FTP
- About 100 nodes
- Usenet (long before FB and Twitter)
- Everything was still centralized!
Internet timeline

- Centralization was unmanageable
- Autonomous Systems
- TCP/IP (set of standards)
- CSNET (one of the first new Ases)
Internet timeline

- Truly global network
- Usenet
Internet timeline

- Commercialization and rise of ISPs
- Hell breaks loose!

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# Internet timeline

|-----|------|------|------|-------------|

How does the Internet look now?
Internet is a complex system

- Users, Apps and Data
- Datacenters and CDNs
- Cloud Services
- Mobile Devices
- SDNs and NFVs
- Internet of Things
Why is this course important?

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  • Let’s see the Internet’s timeline

• Evolution in architecture, topology, technologies, and applications
Why is this course important?

• Internet is in a constant state of flux
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• Course goals
  • Goal1: To understand the future envisioned by the various technologies
  • Goal2: To derive insights based on empirical measurements
  • Goal3: To conduct hands-on networking research
  • Goal4: To practice the art of reading, writing and critiquing research papers
  • Goal5: To publish the research outcomes in top-tier networking venues
Goal 1

- Goal 1: To understand the future envisioned by the technologies
  - Recent advances in networking
  - Internet cartography
    - Peering, layer 1, layer 3, colocation facilities, IXPs, etc.
  - Cyber attacks
    - Mirai botnet, DDoS, attack graphs, etc.
  - IPv6
  - Internet of Things
    - Security and Privacy
  - Big “Internet” Data
    - Network Analytics, Tensor Flow, Deep Learning, etc.
Goal 2

• To derive insights based on empirical measurements
  • “Measurement is the first step that leads to control and eventually to improvement. If you can’t measure something, you can’t understand it. If you can’t understand it, you can’t control it. If you can’t control it, you can’t improve it” --- H. James Harrington
  • Strategies for sound Internet measurement
  • Tools and techniques
Goal 3

• To conduct hands-on networking research
  • Course has a substantial project component: 60% of your grade
  • You’re welcome to work on your own ideas!
  • You’re welcome to work by yourself or in groups of two
    • Contribution should be substantial for group projects
  • Talk to me for ideas
    • I’ll present some ideas in the next class
  • We’ll meet every other week during office hours to discuss about your project
    • Next week (1) finalize group size and (2) submit a one paragraph description of your idea
  • Mid review (week of Oct. 30)
  • Final report and presentations (week of Nov. 27)
Goal 4

• To practice the art of reading, writing and critiquing research papers
  • We will (roughly) cover one emerging topic a week
  • You have to read papers before class
  • Writing a summary paragraph in canvas
    • Strengths, weaknesses, and how would *you* extend the idea
  • You will lead one lecture in a topic of your preference
• Rubrics
  • In-class discussion and posting summary in canvas: 10%
  • One in-class exam: 30%
Goal 5

• To publish the research outcomes in top-tier networking venues
  • This is optional!
Grading Policy

• Project: 60%
• In-class midterm exam: 30%
• Discussion and canvas: 10%
• Cheating policy: http://dos.uoregon.edu/conduct
• Extra credits/other options
  • In-class exam vs. publication in a workshop/conference
  • In-class exam vs. present 3 papers
I want you to learn and succeed!

• If you want to do good research, you have to
  • Do good research --- hands-on project
  • Articulate your ideas --- reading, writing, and presentations will help
Let’s get started!
Internet Measurements and Tools

• Overview
• What to measure?
• Types of measurements
Measurement and Analysis Overview

• Size, complexity and diversity of the Internet makes it very difficult to understand cause-effect relationships

• Measurement is necessary for understanding current system behavior and how new systems will behave
  • How, when, where, what do we measure?

• Measurement is meaningless without careful analysis
  • Analysis of data gathered from networks is quite different from work done in other disciplines

• Measurement/analysis enables models to be built which can be used to effectively develop and evaluate new techniques
  • Statistical, queuing and simulation
Determining *What* to Measure

• Before any measurements can take place one must determine *what* to measure

• There are many commonly used network performance characteristics
  • Latency - a time delay between the cause and the effect
  • Throughput - amount of data moved from a node to another in a given time
  • Response time - total time taken to respond to a request for service
  • Utilization - available time (usually a percentage) that a system is operating
  • Bandwidth - maximum amount of data that can be moved
  • Loss - one or more packets fail to reach destination
  • Routing - how packets are sent from one location to another
  • Reliability - ability of a system to perform its required functions
Measurement Introduction

• Internet measurement is done to either analyze/characterize network phenomena or to test new tools, protocols, systems, etc.

• Measuring Internet performance is easier said than done
  • What does “performance” mean?
  • Workload (what and where you’re measuring) selection is critical
    • Reproducibility is often essential

• Many tools have been developed to measure/monitor general characteristics of network performance
  • traceroute and ping are two of the most popular
    • These are examples of active measurement tools
  • Passive tools are the other major category

• Representative and reproducible workload generation will be a focus
Active Measurement

- Send probe packet(s) into the network and measure a response
  - Ping: RTT and loss
  - Zing: one way Poisson probes
  - Traceroute: path and RTT
  - Nettimer (Lai): latest bottleneck bandwidth using packet pair method

- Pathchar: per-hop bandwidth, latency, loss measurement
  - Pchar, clink: open-source reimplementations of pathchar

\[ T_{n+1} - T_n = \max(S/BW, T_1 - T_0) \]
Problems with active measurements

Additional traffic

Coverage problem

Occasionally blocked

Management difficulties
Passive Measurement

• Passive tools: Capture data as it passes by
  • Logging at application level
  • Packet capture applications (tcpdump) uses packet capture filter (bpf,libpcap)
    • Requires access to the wire
    • Can have many problems (adds, deletes, reordering)
  • Flow-based measurement tools
  • SNMP tools
  • Routing looking glass sites
Challenges

• LOTS and LOTS of data
• Privacy issues
  • PII leaks
• Getting packet scoped in backbone of the network