Computer Networks

COSC 6377
Lecture 1

Fall 2017

August 22, 2017

Course Goals

- Overview of the basics
- Principles and Philosophies
- Read research papers
- Hands-on experience with networked systems

Prerequisites

- Undergraduate level networking/OS course
- Some systems programming
- Familiar with Linux environment
- Access to a Linux environment
  - Use department server
  - Use your own machine
- Willingness to catch up if you don't have these experiences

Structure

- Lectures
- Paper discussions
- Homeworks
- Project
- Exams
- Class participation

Homeworks

- Several short assignments
- Concepts and calculations
- Some hands-on (incl. programming) work
- Allowed to discuss with other students, but you should turn in your own hw
- Submit online

Project

- One project with intermediate checkpoints
- Build a networked system

- Possible to propose your own project
  - Strongly encouraged for PhD students
  - Talk to the instructor

Exams

- No final exam!
- Open notes
- In-class scheduling

Grades

Exams	40%
Homeworks	15%
Project	40%
Class Participation	5%

- It is possible to get a C or lower grades
- No incompletes

Readings

- No required textbook
- Recommended texts
  - Computer Networks: A Systems Approach
  - Computer Networking: A Top-Down Approach
- Research papers
- Standards
- Wikipedia

Academic Honesty

- The work you turn in should be yours

- Acknowledge
  - Group discussions
  - Internet sources

- Plagiarism results in an F

Course Staff

- Instructor: Omprakash Gnawali
- Office Hours: TR 230-330

- TA: Milad Heydariaan

Communication

- Send questions and answers to Piazza
- Emails MUST have COSC6377 in the subject
- Check course website and Piazza regularly

http://www2.cs.uh.edu/~gnawali/courses/cosc6377-f17/

Some Questions

- How difficult is this course?

- What is the workload?

- Will I learn anything useful?

- Any other questions?

# Why are you taking this course?

What do you want to do?

The Internet: An Exciting Time

- One of the most influential inventions
  - A research experiment that escaped from the lab
  - … to be a global communications infrastructure
- Ever wider reach
  - Today: 3 billion+ users
  - Tomorrow: more users, computers, things, …
- Near-constant innovation
  - Apps: Web, P2P, social networks, virtual worlds
  - Links: optics, WiFi, cellular, WiMax, ...

With thanks to Jennifer Rexford

Transforming Everything

- The ways we do business
  - E-commerce, advertising, cloud computing, ...
- The way we have relationships
  - E-mail, IM, Facebook, virtual worlds, online dating
- How we think about law
  - Interstate commerce? National boundaries?
- The way we govern
  - E-voting and e-government
  - Censorship and wiretapping
- The way we fight
  - Cyber-attacks, including nation-state attacks

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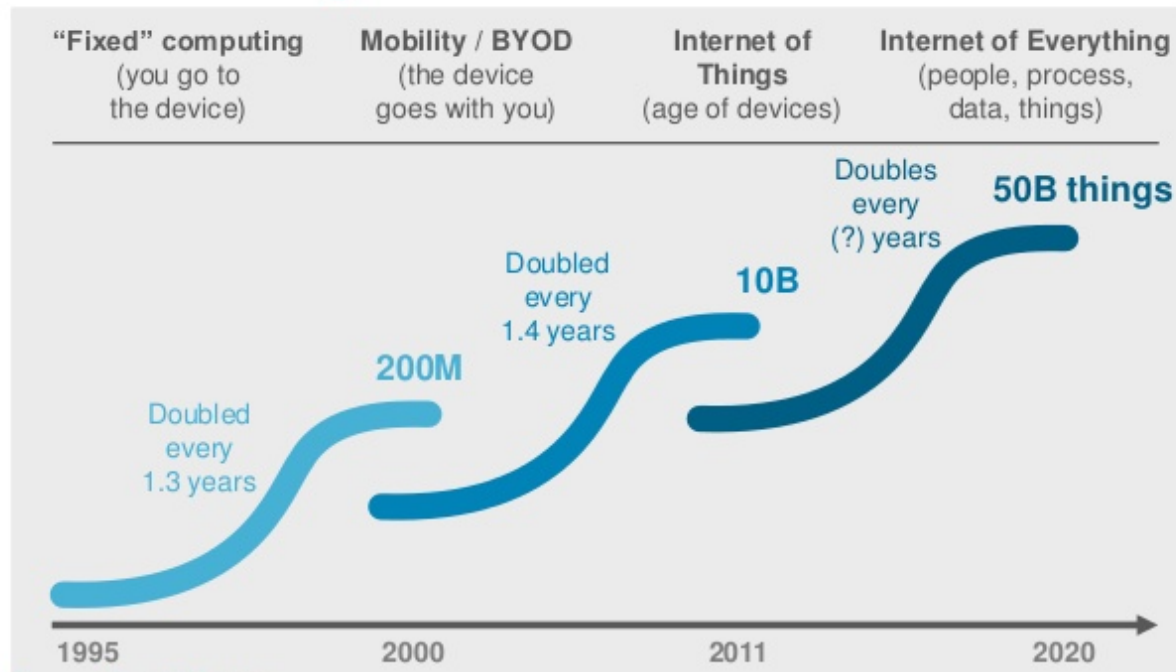
Cisco

The Study of Networking is Cool

- Tangible, relates to reality
  - Can measure/build things
  - Can truly effect far-reaching change in the real world
- Inherently interdisciplinary
  - Well-motivated problems + rigorous solution techniques
  - Interplay with policy, economics, and social science
- Widely-understood impact
  - Can discuss technologies with your grandfather!

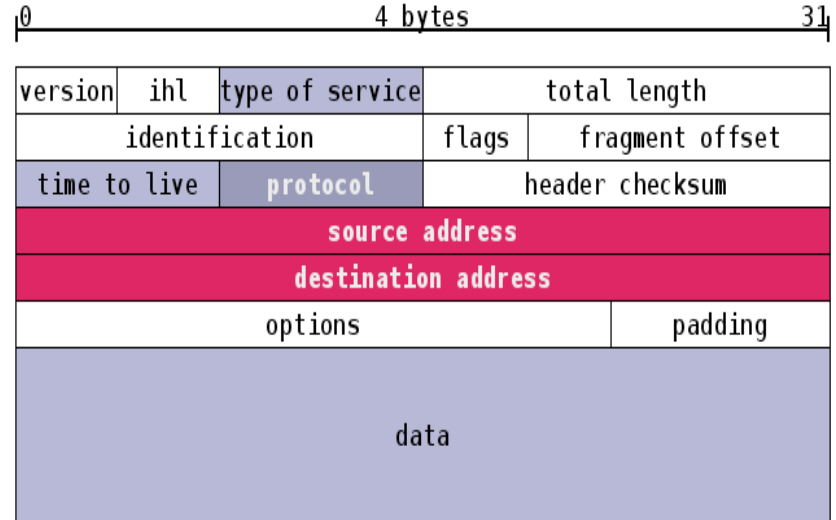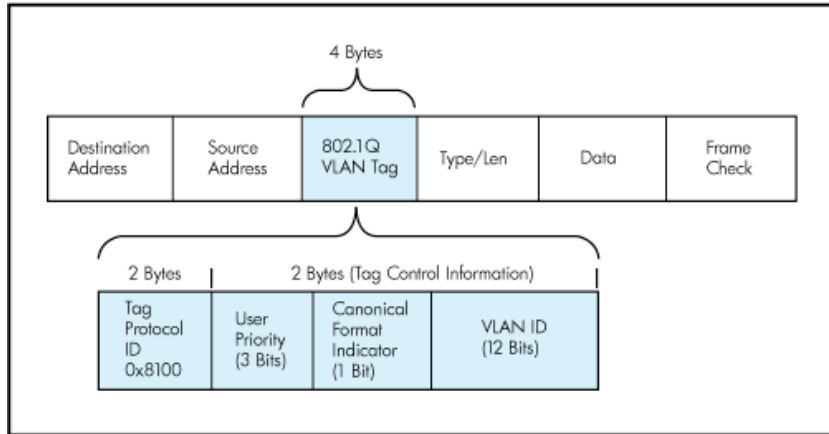# The Study of Networking is Cool

- Young, relatively immature field
  - Great if you like to make order out of chaos
  - Tremendous intellectual progress is still needed
  - *You* can help decide what networking really is
- Defining the problem is a big part of the challenge
  - Recognizing a need, formulating a well-defined problem
  - … is at least as important as solving the problem…
- Lots of platforms for building your ideas
  - Programmability: Click, OpenFlow, NetFPGA
  - Routing software: Quagga, XORP, and Bird
  - Testbeds: Emulab, PlanetLab, Orbit, GENI, …
  - Measurements: RouteViews, traceroute, Internet2, …

But, What *is* Networking?

A Plethora of Protocol Acronyms?

SNMP   WAP   SIP   PPP   IPX   MAC

LLDP   FTP   UDP

OSPF   RTP   ICMP   IMAP   IGMP   HIP

BGP   HTTP   ECN

PIM   RED   ARP

RIP   IP   MPLS   TCP   RTCP

SMTP   RTSP   BFD   CIDR

NNTP   TLS   NAT

SACK   STUN

DNS   SSH   DHCP

POP   VLAN   LISP   VTP   TFTP   LDP

A Heap of Header Formats?

A Big Bunch of Boxes?

Router

Label Switched Router

Load balancer

Switch

Scrubber

Repeater

Gateway

Intrusion Detection System

Bridge

Route Reflector

Deep Packet Inspection

DHCP server

Packet shaper

Firewall

NAT

Hub

Packet sniffer

WAN accelerator

DNS server

Base station

Proxy

23

A Ton of Tools?

arpwatch

syslog

tcpdump

wget

nslookup

traceroute

trat

snort

nmap

whois

ipconfig

rancid

ntop

net-snmp

bro

dig

ping

iperf

NDT

wireshark

dummynet

mrtg

But, That Doesn't Say What Networking Really *Is*

Or, What Will This Course is About

http://www.submarinecablemap.com/
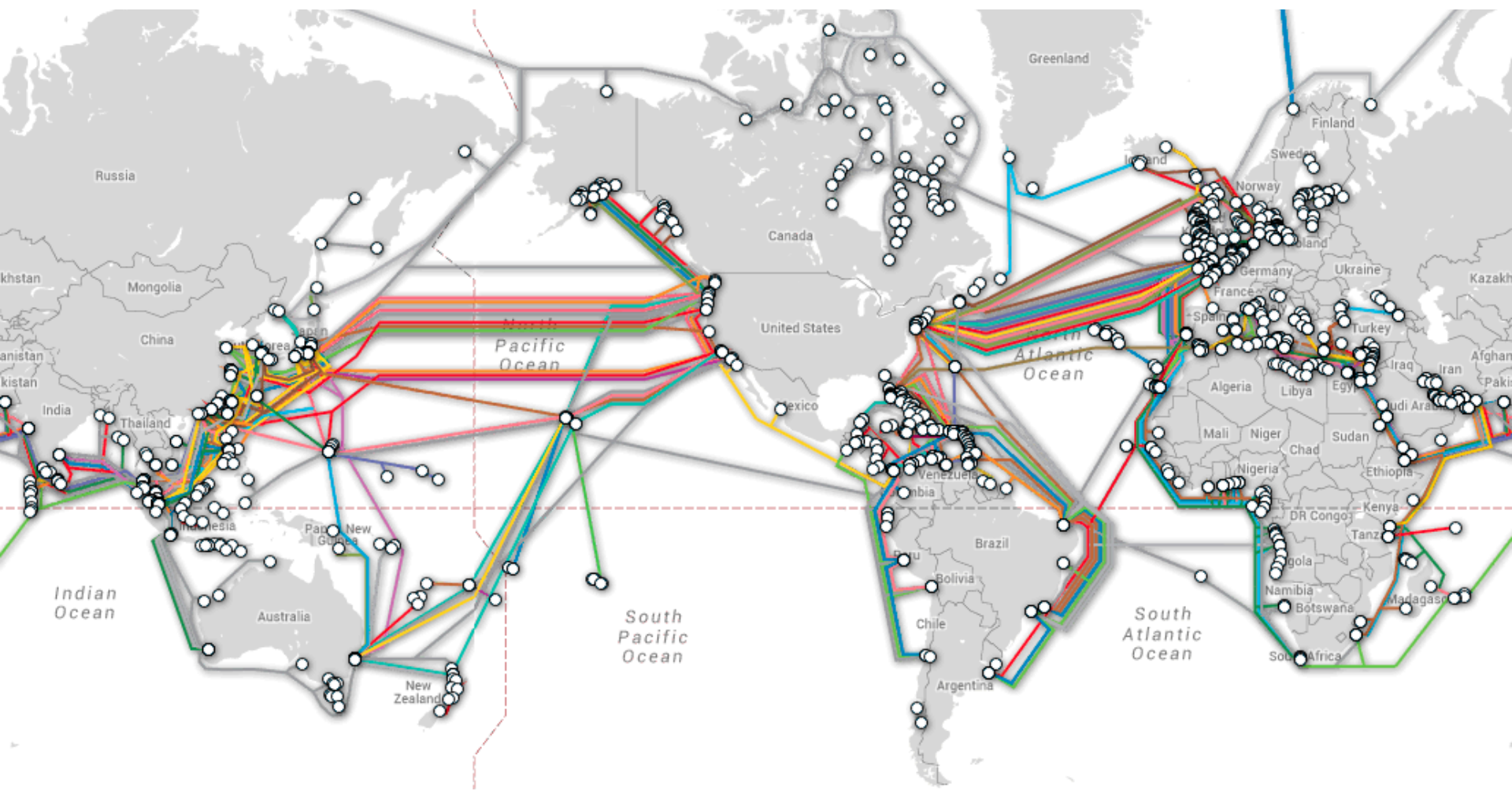
Nor does that…

We want to understand how the Internet works

Technical issues (protocols, architectures…)

Non-technical topics you will encounter (net-neutrality, access, rights…)

Internet as human right?

"The internet is essential to growing the knowledge we have and sharing it with each other. And for many of us, it's a huge part of our everyday lives. But most of the world does not have access to the internet. Internet.org is a Facebook-led initiative with the goal of bringing internet access and the benefits of connectivity to the two-thirds of the world that doesn't have them.

Imagine the difference an accurate weather report could make for a farmer planting crops, or the power of an encyclopedia for a child without textbooks. Now, imagine what they could contribute when the world can hear their voices. The more we connect, the better it gets."

Internet.org (part of Facebook)

"1.5 million people access the Internet via Google's free Wi-Fi at 19 Indian railway stations"

mashable.com

Types of things we will study

Internet Architecture

- How to
  - Design and manage *protocols*
  - That can be used and *combined in many ways*
  - To do *many things*
- Definition and placement of function
  - What to do, and where to do it
- The "division of labor"
  - Across multiple protocols and mechanisms
  - Across components (hosts, routers, administrators)
- Goal: search for general principles
  - Of protocol design, evaluation, and composition

Congestion

- How to know how much traffic is being used for what purpose?

- How to ensure we can service the competing traffic demand sharing the infrastructure

- How to design applications to run "fast"

Reliability

- How reliable is the Internet?
- How can we measure different aspects of reliability in networking?
- What causes it to break?

Security

- How secure is the Internet?
- Security challenges in the Internet (DDoS, bots, etc.)
- Technologies to make Internet secure and their limitations

- How to make your application secure?

Back to the two questions

Why are you taking this course?

What do you want to do?

Plan for next four weeks

- Rapid review of undergraduate material
  - Understand how the basic building blocks work
- Watch lectures/read slides from COSC4377
  - Cover approx. 5 lectures per week
- Discuss the material in the class
- Grab lectures from:
  http://www2.cs.uh.edu/~gnawali/courses/cosc4377-s12/