Computer Networks
COSC 6377
Lecture 1

Fall 2016

August 22, 2016

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

- 3-4 homeworks
- Concepts
- Calculations
- Some hands-on work
- Allowed to discuss with other students, but you should turn in your own writeup
- Submit through Moodle

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
  - UNIX Network Programming
- Research papers
- Standards
- Wikipedia

Academic Honesty

- The work you turn in should be yours

- Acknowledge
  - Group discussions
  - Internet sources

- Plagarism results in an F

Course Staff

- Instructor: Omprakash Gnawali
- Office Hours: MW 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-f16/

Some Questions

- How difficult is this course?

- What is the workload?

- Will I learn anything useful?

- Any other questions?

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
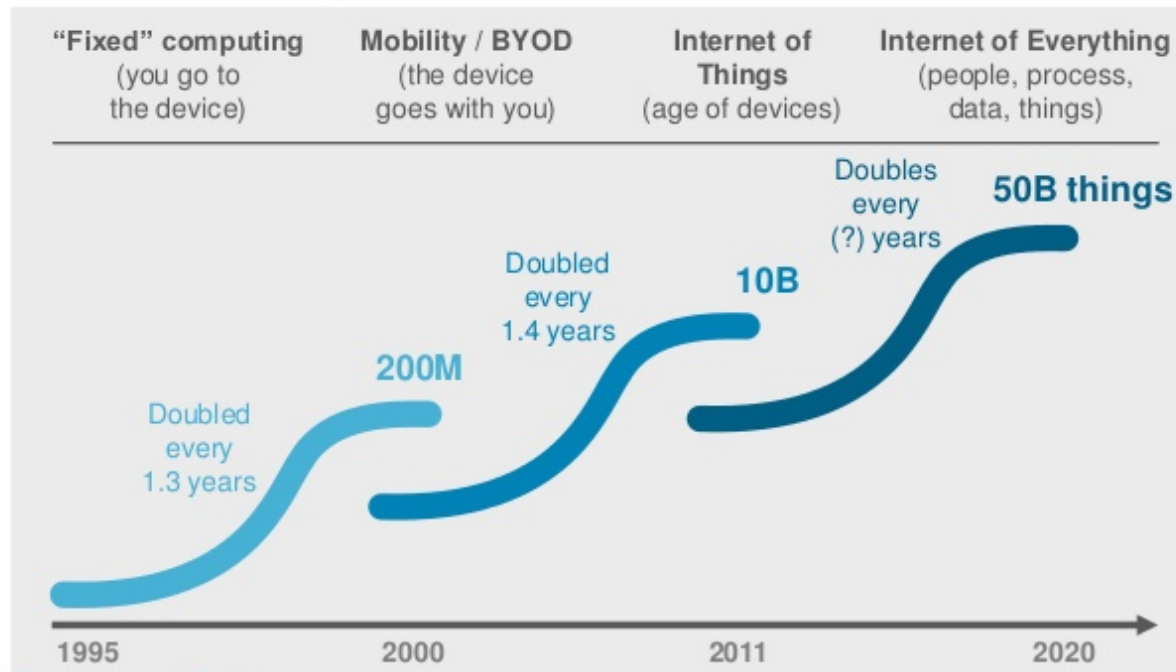
Cisco

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-read papers
  - Many of the most cited papers in CS are in networking

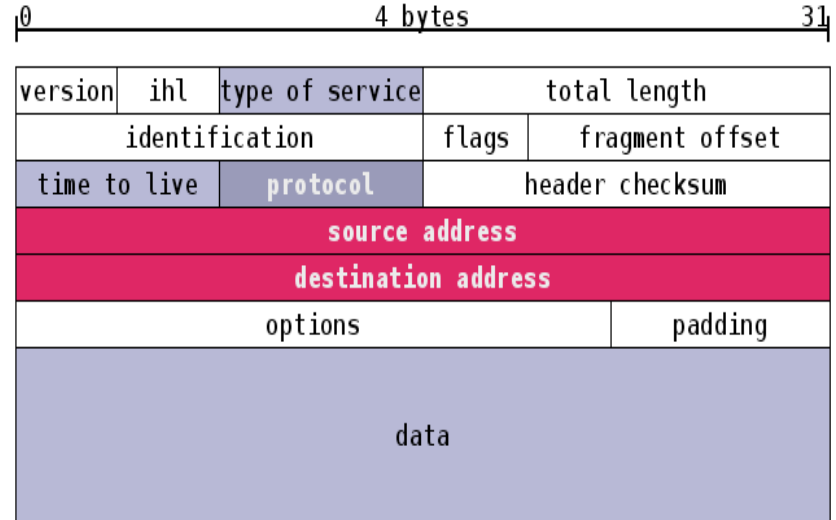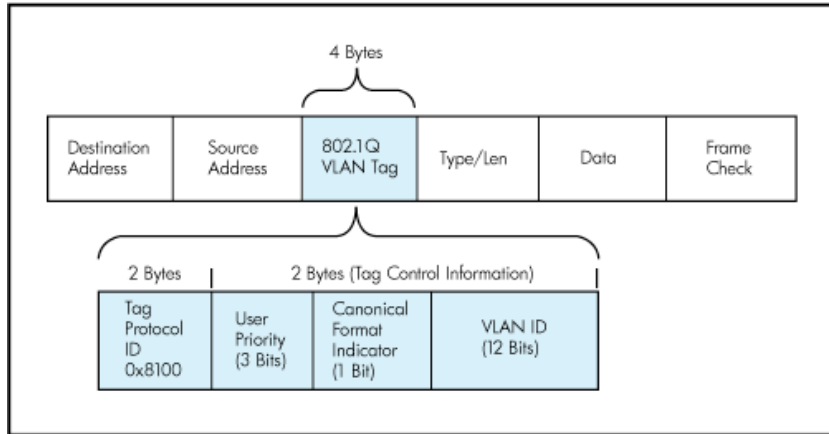# The Study of Networking is Cool

- 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
IPX
PPP
MAC

LLDP
FTP
UDP

OSPF
RTP
ICMP
IMAP
IGMP
HIP

BGP
HTTP
ECN

PIM
RED
ARP

RIP
IP
TCP
RTCP

MPLS

SMTP
BFD
CIDR

RTSP

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

A Ton of Tools?

arpwatch

syslog

tcpdump

wget

nslookup

traceroute

trat

snort

nmap

whois

ipconfig

rancid

ntop

bro

net-snmp

dig

ping

iperf

wireshark

NDT

dummynet

mrtg

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

Or, What Will This Course is About

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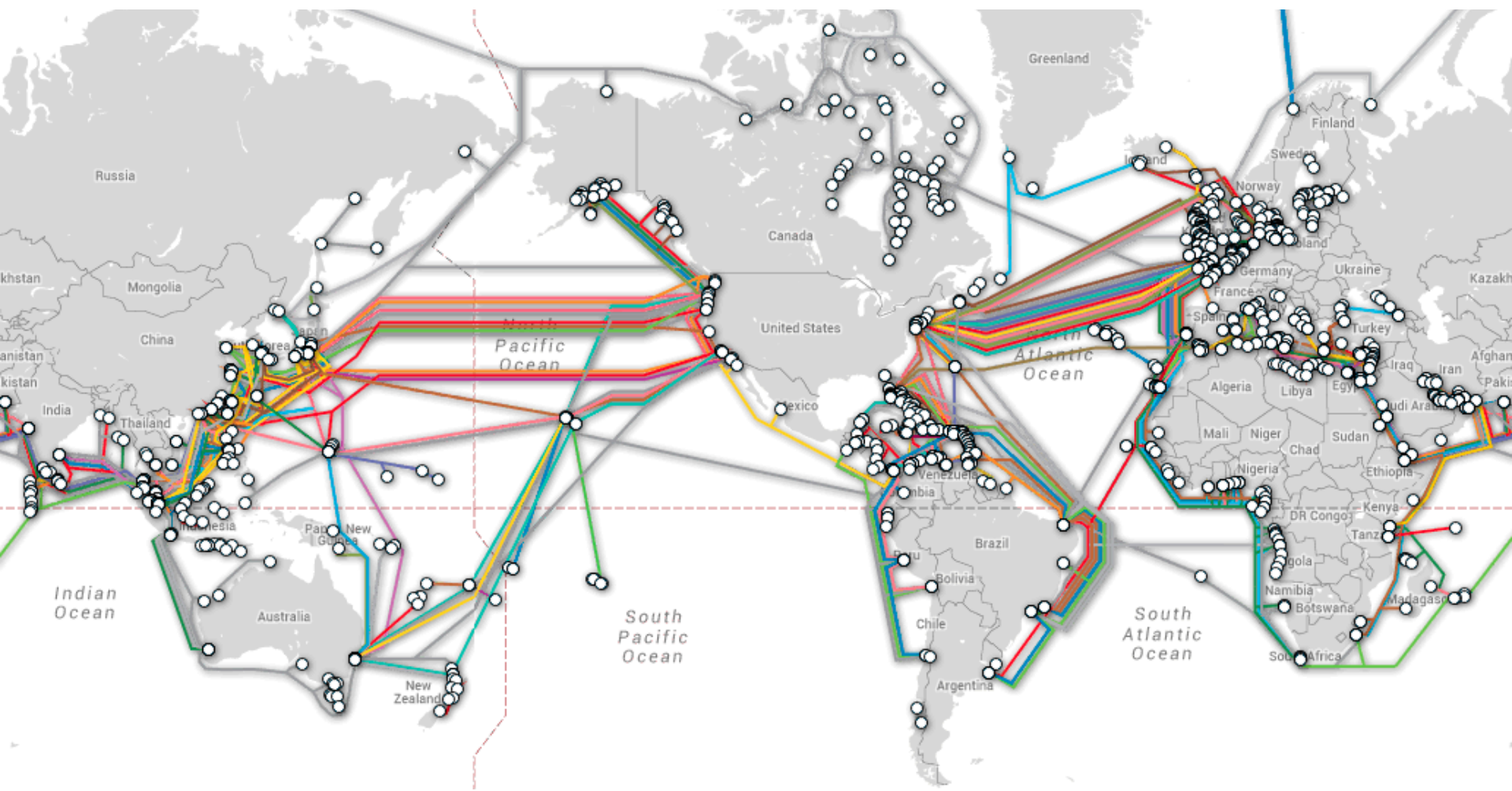
Nor does that…

We want to understand how the Internet works

Technical issues (protocols, architectures…)

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

One Take on Defining Networking

- 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

"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

Of the over 7 billion people in the world, fewer than half are connected to the Internet. And for many who are online, inadequate or nonexistent infrastructure offers slow and unreliable connections.

Google launched Project Link to bring faster, more reliable Internet to the people and places that need it. We first built a metro fiber network in the city of Kampala, Uganda, a dense urban center that was limited to pre-broadband speeds. Since then, we have expanded Project Link to Ghana, where we expect to build over 1,000 kilometers of fiber in Accra, Tema and Kumasi.

In Uganda, we also offer wholesale last-mile Wi-Fi access. Internet Service Providers (ISPs) and Mobile Network Operators (MNOs) can leverage our network to bring high-quality Wi-Fi to homeowners, small businesses and mobile users on-the-go. We continue to explore opportunities for expanding Project Link Wi-Fi networks to future markets.

https://www.google.com/get/projectlink/

Plan for next four weeks

- Rapid review of undergraduate material
- 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/