

# Computer Networks

COSC 6377

Lecture 1

Spring 2022

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# 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/AWS server
  - Use your own machine
- Willingness to catch up if you don't have these experiences

# Structure

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

# Homework

- 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 on Blackboard

# Project

- One project with one mid-term checkpoint
- Build a networked system
- Individual project
  
- 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%
Homework	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: M230-330
  
- TA: Alireza Ansaripour
  - Expert in networking
  - Office hour: R3-4

# Communication

- Teams for discussions
- Personal message for private matters
  - Examples...
- Emails **MUST** have COSC6377 in the subject if you **MUST** send email.
- Do not use Teams personal message to the instructor or the TA unless it is an emergency
- Check course website regularly

<http://www2.cs.uh.edu/~gnawali/courses/cosc6377-s22/>

# Logistics

- In-person instruction
- Lectures will be available also on Teams

# 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

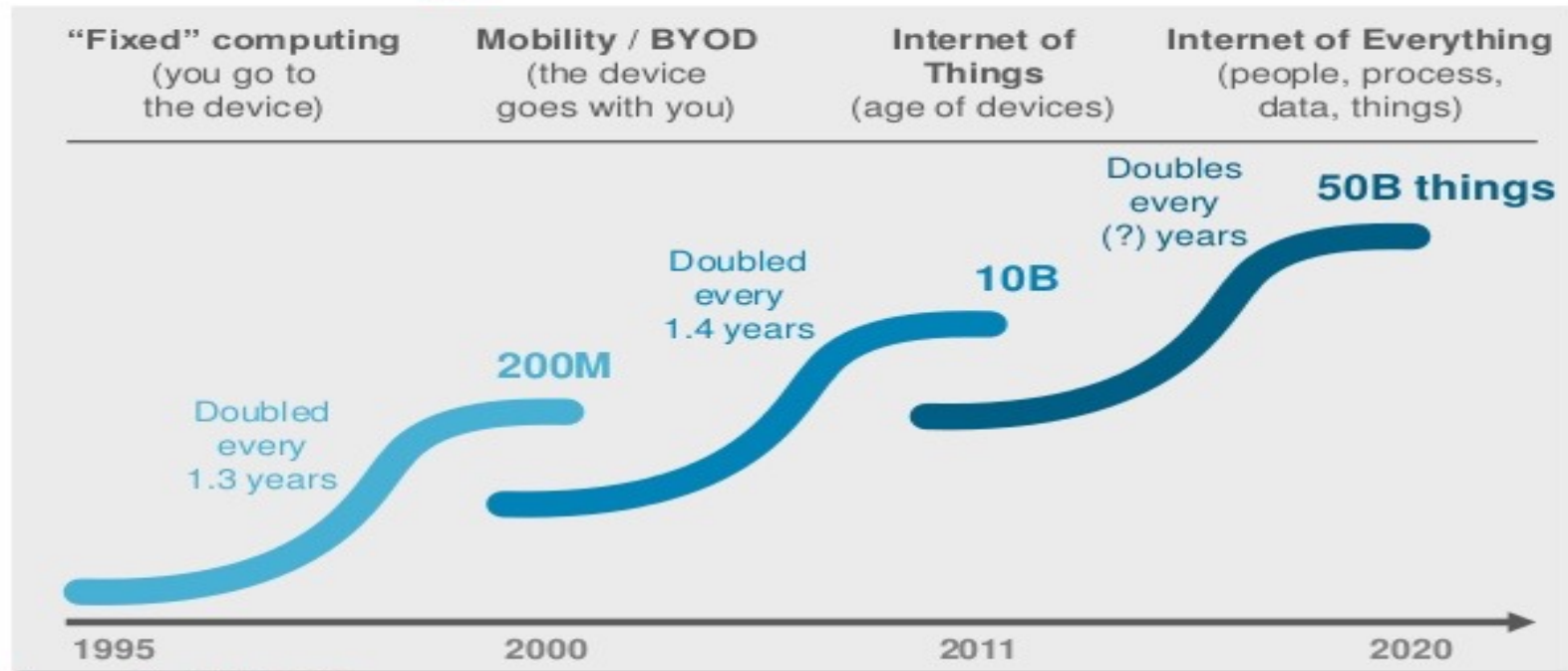
- One of the most influential inventions
  - A research experiment that escaped from the lab
  - ... to be a global communications infrastructure
- Ever wider reach
  - Today: 5 billion users
  - Tomorrow: more users, computers, things, ...
- Near-constant innovation
  - Apps: Web, P2P, social networks, virtual worlds
  - Links: optics, WiFi, cellular, 5G, ...



# 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

# Internet Growth Occurring in Accelerating Waves



Source: Cisco IBSG, 2012

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Cisco Public 2

# The Study of Networking is Cool

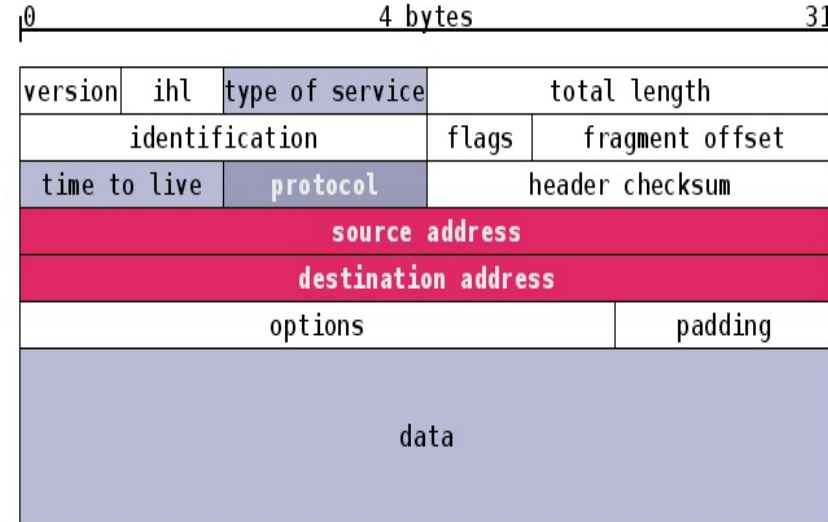
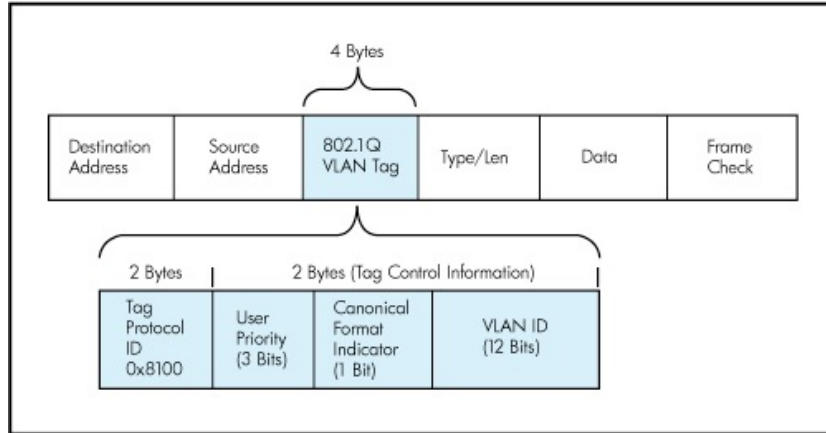
- Tangible, relates to reality
  - Can measure/build things
  - Can truly effect far-reaching change in the real world
- Inherently interdisciplinary
  - Well-motivated problems + rigorous solution techniques
  - Interplay with policy, economics, and social science
- Widely-understood impact
  - Can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

But, What *is* Networking?

# A Plethora of Protocol Acronyms?

SNMP WAP SIP PPP IPX MAC  
LLDP FTP UDP ICMP IMAP IGMP HIP  
OSPF RTP BGP HTTP ARP ECN  
PIM RED BGP HTTP ARP ECN  
RIP IP MPLS TCP RTCP  
SMTP RTSP BFD CIDR  
NNTP SACK TLS NAT STUN  
DNS SACK TLS NAT STUN  
POP VLAN LISP VTP DHCP LDP

# A Heap of Header Formats?



<b>Source Port</b>		<b>Destination Port</b>						
<b>Sequence Number</b>								
<b>Acknowledgment Number</b>								
<b>Data Offset</b>	<b>Reserved</b>	<b>URG</b>	<b>ACK</b>	<b>PSH</b>	<b>RST</b>	<b>SYN</b>	<b>FIN</b>	<b>Window</b>
<b>Checksum</b>				<b>Urgent Pointer</b>				
<b>Options</b>				<b>Padding</b>				

## HTTP Response Header

Name	Value
HTTP Status Code: HTTP/1.1 200 OK	
Date:	Thu, 27 Mar 2008 13:37:17 GMT
Server:	Apache/2.0.55 (Ubuntu) PHP/5.1.2
Last-Modified:	Fri, 21 Mar 2008 13:57:30 GMT
Etag:	"358a4e4-56000-ddf5c680"
Accept-Ranges:	bytes
Content-Length:	352256
Connection:	close
Content-Type:	application/x-msdos-program

# 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

NAT      Firewall      Hub

Packet sniffer

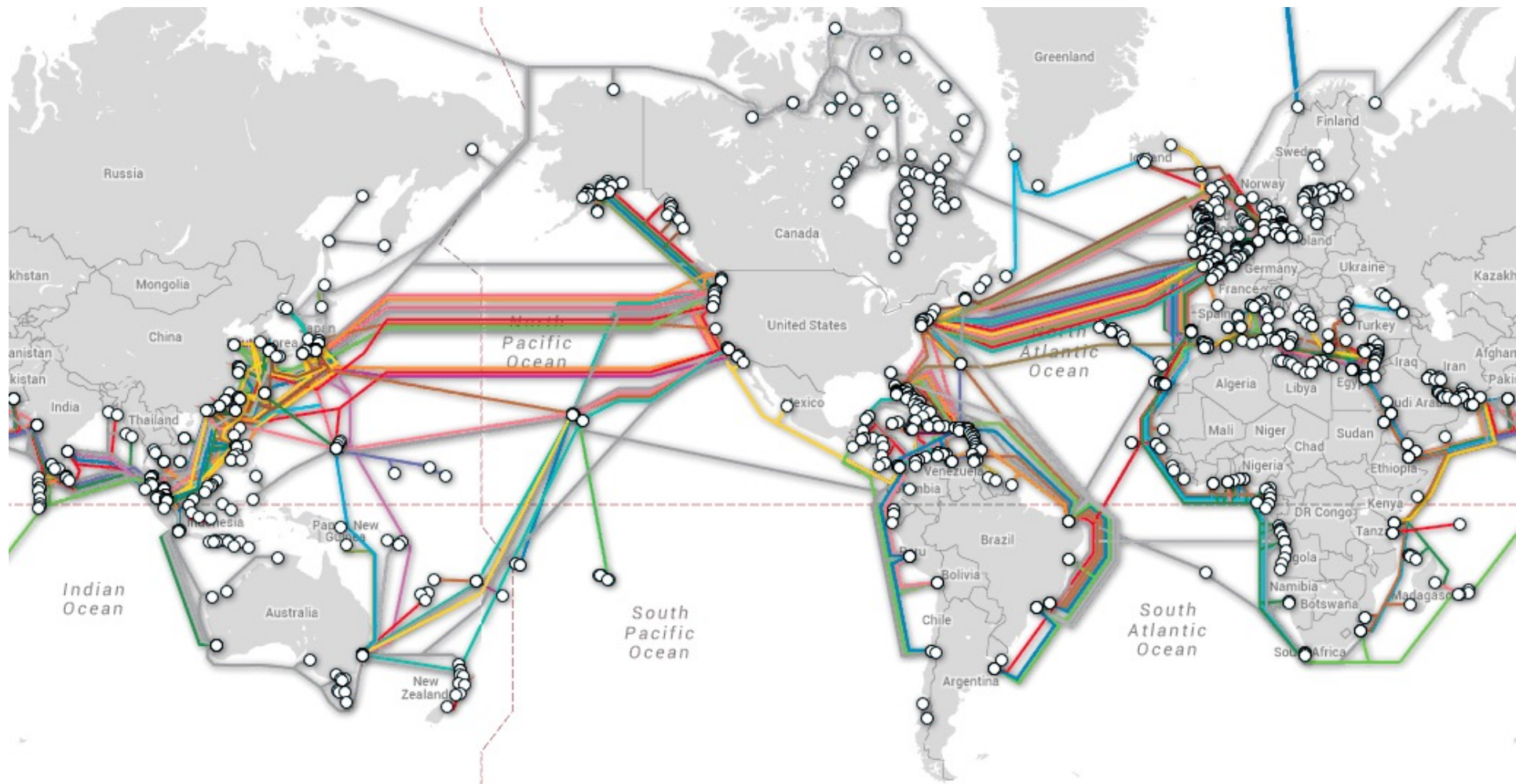
WAN accelerator      DNS server      Base station      Proxy





**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?

Politics

Business

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?

# Wireless

- Wireless networks are pervasive
- Mobile, phones, IoT devices
- 5G

# Online services at scale

- Internet-scale networking
- Cloud
- Data centers
- Content distribution

Back to the two questions

Why are you taking this course?

What do you want to do?

# Will I learn anything useful?

- Architect data communication
  - IoT
  - Online software
  - Apps on different platforms
  - Information consumption and production
- Some general skills
  - Presentation
  - Project formulation
  - Checkpoints
  - Code review

# Project Ideas

- Study Wireless, Internet, ... adoption, use
- Extend existing technology
- Explore new and popular ideas
  - IoT
  - Blockchain
- Create impact using Internet or Wireless
  - Low-resource setting (edu, health, etc.)
  - Access to information

# Plan for next four weeks

- Rapid review of undergraduate material
  - Understand how the basic building blocks work
- Watch lectures/read slides from COSC4377
  - Cover 3-5 lectures per week
- Discuss the material in the class
- Grab lectures from:  
<http://www2.cs.uh.edu/~gnawali/courses/cosc4377-s12/>