# Introduction to Computer Networks

COSC 4377

Lecture 1

Spring 2012

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# Textbook

Computer Networks: A Top-Down Approach

Kurose and Ross

Fifth Edition

- Library has two copies on reserve
- 4th edition also ok

# Teaching Staff

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# Topics Covered

- How does the Internet work?
- Learn to design and analyze network infrastructure, applications and services
- Build several networked programs
  - Lots of programming!

- NOT
  - System administration
  - Network configuration

How does a message travel from me to my friend?

# Homeworks

- Most of them programming assignments, approximately one per week
- C in Linux/Unix environment
- Discuss in groups, submit your own work
- Submit on Blackboard
- Late submission
  - Two days late: max(80%, your score)
  - More than two days late: 0

# Exams

- Two in-class exams
- No final exam!

# Grades

| Component | Percentage |
|---|---|
| Homeworks and Projects | 55 |
| Exams | 40 |
| Participation | 5 |

Final grade curved, but modified to take into account your mastery of material

# Getting Help

- General questions on Piazza
- Come to office hours
- Wikipedia / Google / YouTube

- Put COSC 4377 in subject in emails
  - Email not preferred for technical discussion

# Why Study Networks?

- Critical Infrastructure for everyday life
  - How does it work?
  - What are its shortcomings?
- Most applications are networked
  - Designing and building
  - Debugging and understanding
- Internet as human right?

# Disclosure

- Material will be liberally taken from the textbook, Wikipedia, and other online sources

- Some material taken from slides that come with the textbook, Rodrigo Fonseca, and many others

# Course Website

http://www2.cs.uh.edu/~gnawali/courses/cosc4377-s12/

When should we have
a C-programming tutorial?

Wednesday evening

Thursday evening

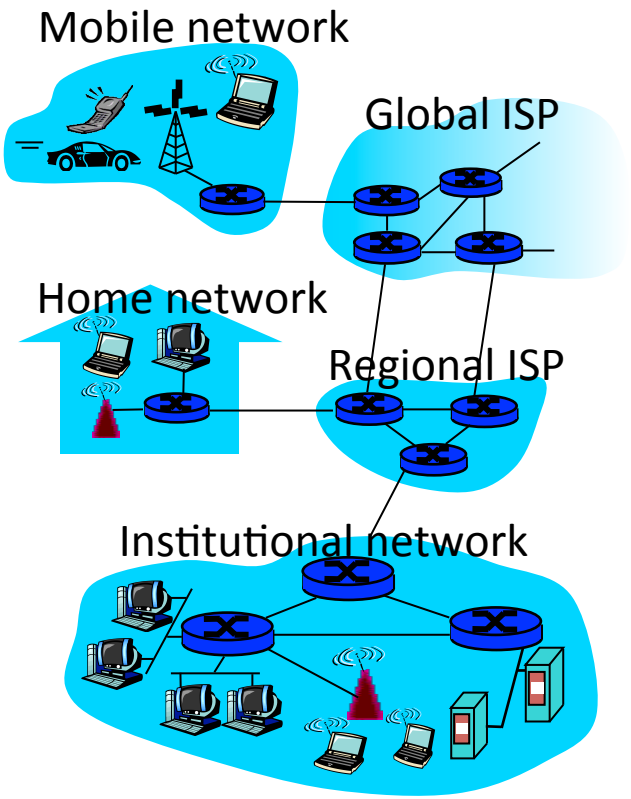
# Today’s topics

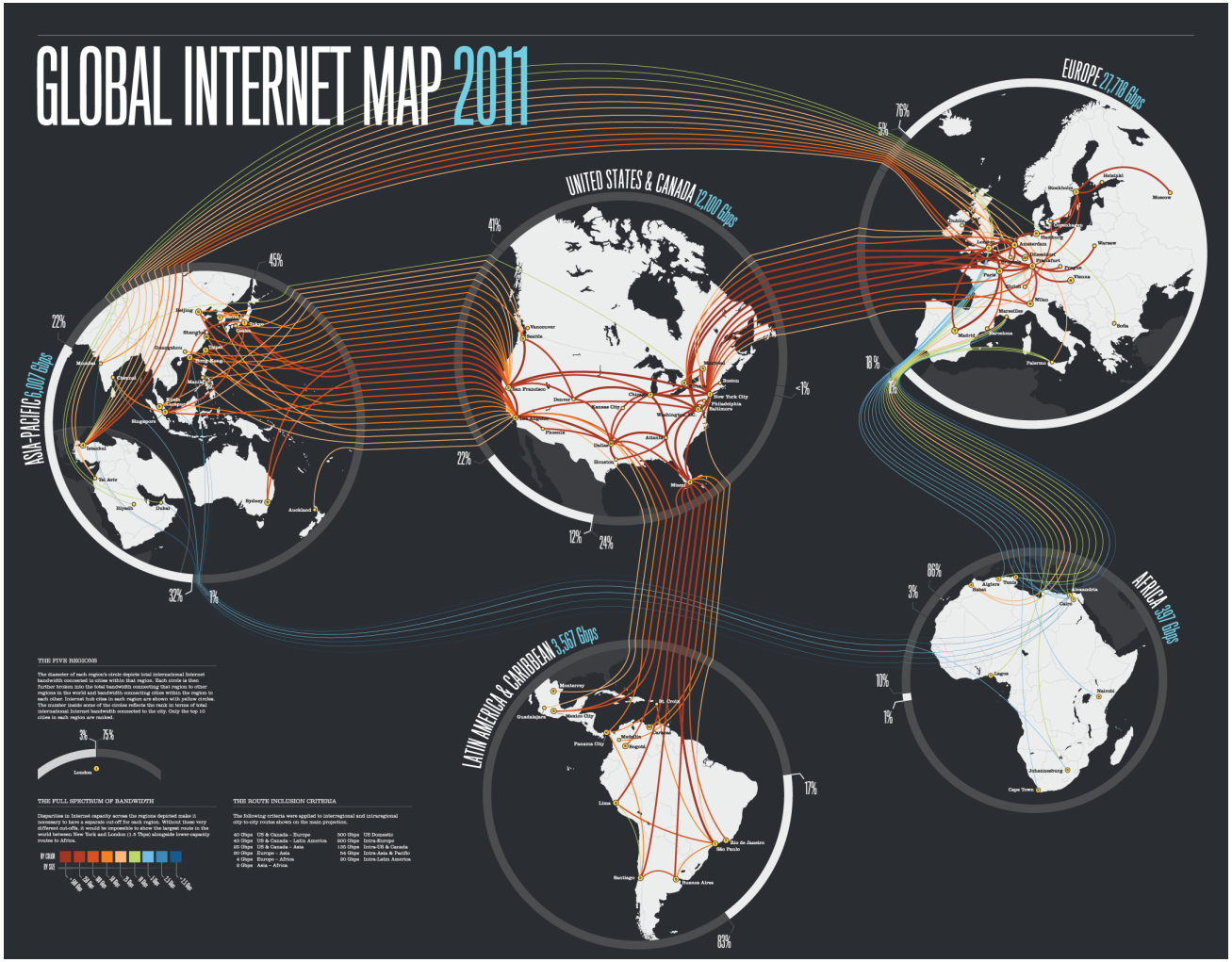
- Networking the nodes
- Network metrics
- Protocols

# The Internet

- Collection of nodes, wire and wireless technology connecting those nodes, applications and services

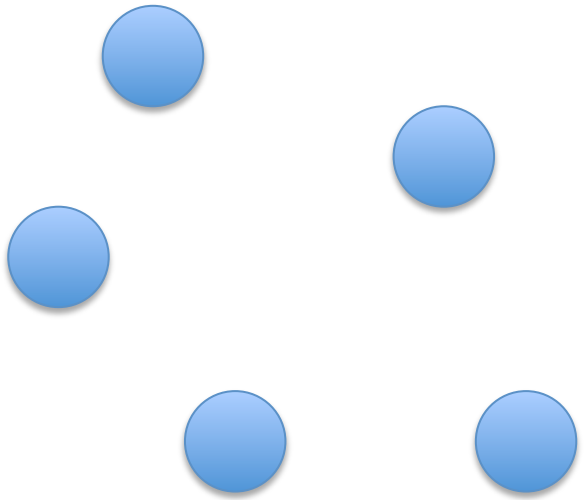
- Types of nodes
  - Desktops and Laptops
  - Servers
  - TV / Refrigerator
  - Cellphones





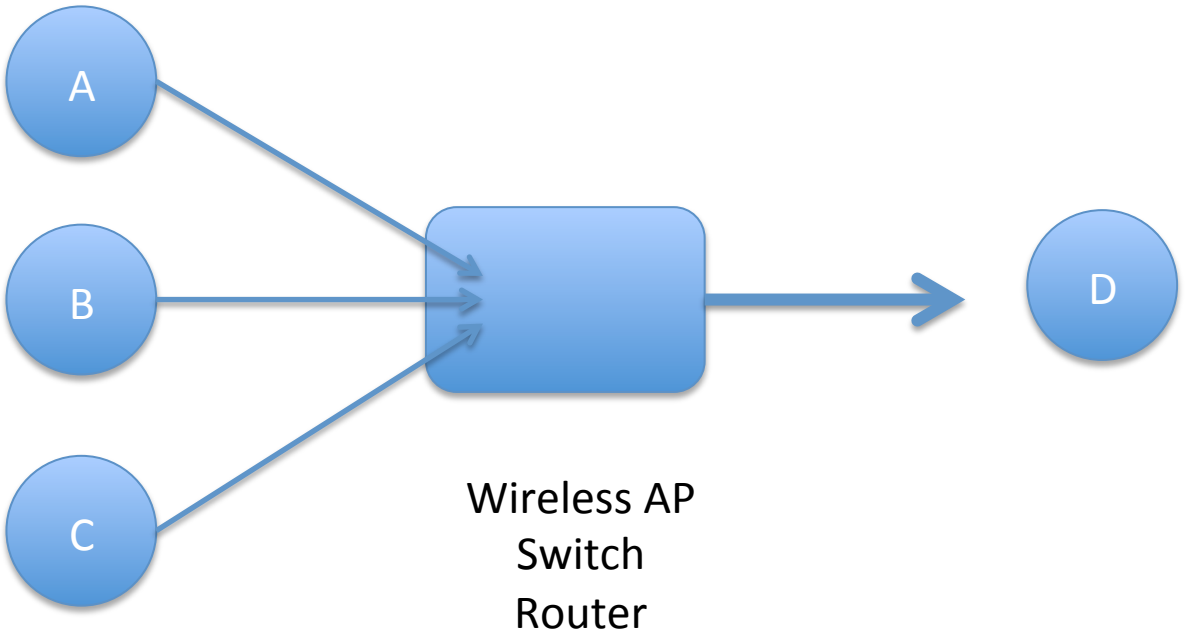

http://www.telegeography.com/telecom-resources/map-gallery/global-internet-map-2011/index.html

- Goal: Connect all the nodes to each other
- Solutions
  - $N^2$ cables
  - Sharing the links
    - Circuit Switching
    - Packet Switching



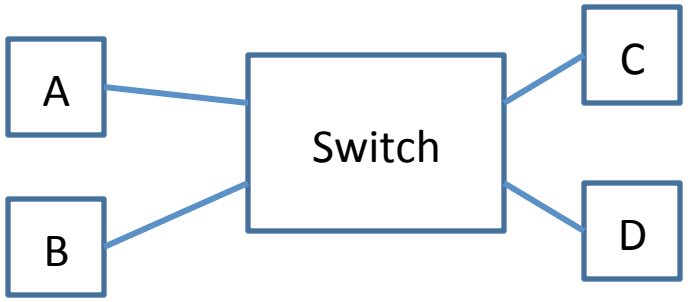
- Packet
  - Collection of bits to transfer across a network
  - Think: envelope and its content
- Circuit
  - Pre-allocated path/resource

# Packet vs Circuit Switching



# Circuit Switching

- Setup the connection or resource
  - Schedule (e.g., TDMA)
  - State in the network




| Time | Circuit |
|---|---|
| T, 3T, 5T, … | A-D |
| 2T, 4T, 6T, … | B-C |

# Circuit Switching

- Natural for predictable data rates
- Can guarantee certain level of service
- Can be inefficient for many applications

http://en.wikipedia.org/wiki/Circuit_switching

# Some Circuit Switching Techniques

- Time
  - Reserve to use the link at a given schedule
  - Read: http://en.wikipedia.org/wiki/Time-division_multiplexing
- Frequency
  - Reserve to use certain frequencies (channel)
  - Read: http://en.wikipedia.org/wiki/Frequency-division_multiplexing

# Packet Switching

- Wire is selected for each packet
- No network **state**
- Supports unpredictable / bursty traffic pattern
- Higher link utilization
- No guarantees but good enough for most applications

http://en.wikipedia.org/wiki/Packet_switching

# Packet vs Circuit Switching

- Packet Switching
  - Plus: More sharing (more efficient)
  - Minus: No service guarantee
- Circuit Switching
  - Plus: Service Guarantee
  - Minus: Less sharing (less efficient)
- Every day examples
  - Road network

We will study these topics in greater detail when we study switching and routing later in the semester

# Describing a Network

- How to describe how well a network is working?
  - metrics
- Performance metrics
  - Throughput
  - Latency
  - Reliability

# Throughput

- How many bytes can we send through in a given time?
  - Bytes per second
  - How many bits/s in kbps?
  - Read: http://en.wikipedia.org/wiki/Data_rate_units
- Useful bytes transferred vs overhead
  - Goodput
  - Everyday example: car vs passenger
- How do you measure throughput?

http://en.wikipedia.org/wiki/Throughput

# Latency

- How long does it take for one bit to travel from one end to the other end
  - ms, s, minutes..
- Typical latencies
  - Speed of light
  - Why is web browsing latency in seconds?

# Relation between Latency and Throughput

Characterize the latency and throughput of

Oil tanker

Aircraft

Car

Tractor Trailer

- Which metrics matter most for these applications?
  - Netflix
  - Skype
  - Amazon
  - Facebook

# Reliability

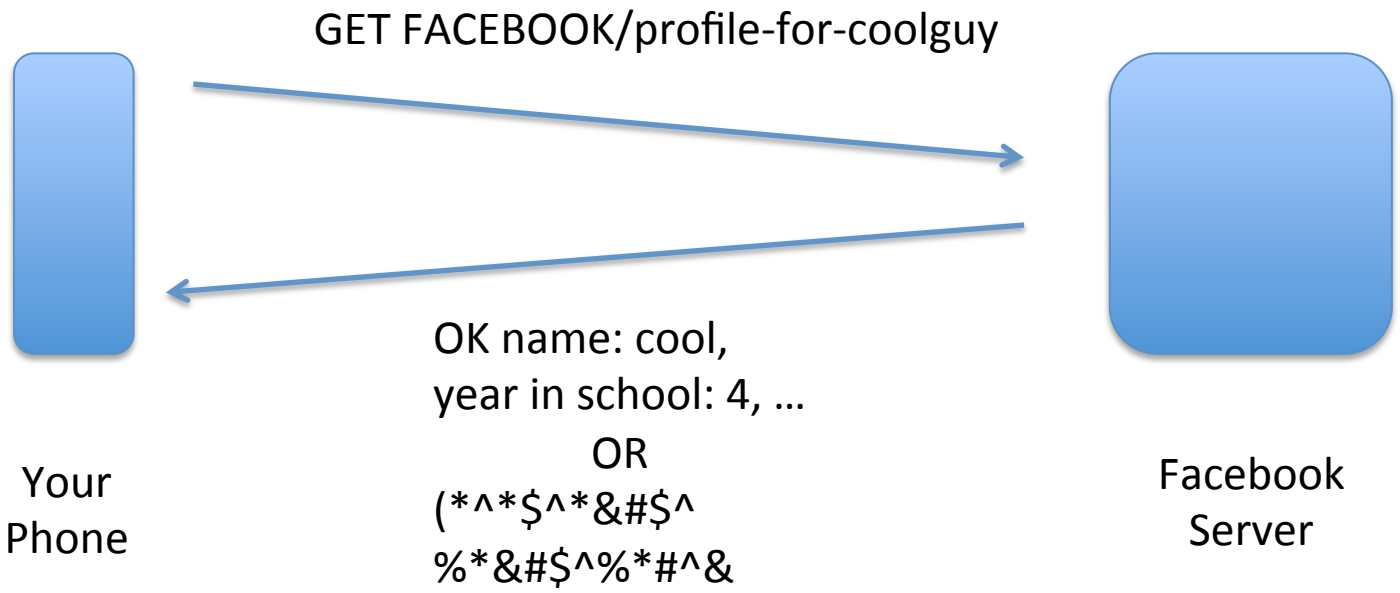
- How often does a network fail?
- How often do packets drop?
  - Damage (corruption)
  - Drops in the queues
- How persistent are failures?
- Typical metrics
  - uptime percentage
  - packet or bit loss rates

# Protocols

- Agreed-upon rules, format, and meaning for message exchange
- Lets examine this sequence:
  - Hello
  - How are you?
  - Fine.

http://en.wikipedia.org/wiki/Communications_protocol

# Network Protocols




What are the rules, format, and meaning in this message exchange?

# Protocols and Standards

- How can your phone (HTC running Android?) access Facebook (runs on UNIX-like OS on big servers)?
- Using standard protocol enables inter-operation
- Who standardizes the protocols?

# Protocol Layers

- Lower level to higher level message exchange
  - Organize the functionalities
  - Abstractions in services used and provided
- 5-7 layers depending on who you talk to
  - Physical, Link, Network, Transport, Application
- Should a smartphone app developer worry about
  - Voltages being applied on the wire
  - If the underlying media uses packet or circuit switching

http://en.wikipedia.org/wiki/Protocol_stack

# Encapsulation

- Think of how paperwork is processed in a university
  - Each person processes and adds some information to it and passes it along
- On the transmitter: the lower layers include the message from upper layers, add their own information and send it along
- On the receiver: reverse

# Encapsulation