CS2105
An Awesome Introduction to Computer Networking
Office Hour
Monday 4-6pm
2 programming assignments
1 written assignment
9 problem sets
4 practical exercises
Important Dates
Midterm: 10 March 2014
Final Exam: 30 April 2014
Midterm & Final are Semi-Open Book
(one double-sided A4 crib sheet allowed)
Slides to be posted 1-2 days before the lecture
Slides $\neq$ Notes
You are expected to **take notes** during lecture
You are expected to **read** the assigned readings
No model answer will be posted
Light a Fire
``No mercy'' policy against plagiarism
``No mercy'' policy against violation of naming convention
http://blog.nus.edu.sg/cs2105
Check for updates frequently and subscribe via email or RSS
Use your real name when commenting online
Screencast will be posted
You need an SoC UNIX account. Get one here:
https://mysoc.nus.edu.sg/~newacct/
Questions?
Introduction
14 January, 2014
After this class, you are expected to:

- understand the basic terms, including host, packet, protocol, throughput, bottleneck link, store-and-forward, and autonomous system.

- know about the logical (the five layers) and physical architecture (as a network of ASes) of the Internet.

- know about the pros and cons of packet switching versus circuit switching.

- understand the different components of end-to-end delay and their relations to bandwidth, packet size, distance, propagation speed, and queue size.
The complexity involved in engineering the Internet will make your head explode, but this one incredibly simple trick keeps the complexity manageable.
What is CS2105 about?
Concepts and principles behind computer networking

Introduction to networked application programming
The Internet is a network of connected computing devices.
Hosts or end systems
996,230,757
as of July 2013
996,230,757
as of July 2013

Data obtained from Internet Systems Consortium: http://www.isc.org/solutions/survey/history
The hosts run distributed applications
Web: browsers, Web servers
WoW: clients, game servers
Skype: clients, supernodes
BitTorrent: peers, trackers
Applications exchange messages and communicate according to protocols
Protocol: the **type** and **order of** messages exchanged and the **actions** taken after messages are sent or received
Examples:
HTTP, SMTP, FTP, TCP
The hosts access the Internet through access network
WiFi, Ethernet, 3G, LTE, DSL, Cable, Fiber, Dial-Up, Satellite
You can read up more about these different access network technologies in Section 1.2.1. We will cover Ethernet and WiFi in more details in CS2105.
Hosts can communicate over different **physical** media
twisted pair
coaixial cable
fiber optic
Consider two hosts connected directly through a physical medium.
The hosts communicate by sending information to each other.
Information can be represented by a sequence of bits -- 0 or 1.
Modulation/Demodulation: Conversion between bits and signals
Error Detection/Correction: Ensuring that bits are received correctly
Packetization/Segmentation:
Dividing data into chunks (called *packets*) so that only erroneous packets need to be retransmitted.
Consider multiple hosts connected through a shared physical medium
Addressing:
Identify the source and destination
Medium access control:
Regulate who sends
Consider multiple hosts connected through intermediate packet switches, which store and forward the packets.
The Internet is a packet switching network
Packet switching:
Resources used on demand;
best effort services
Circuit switching:
Resources are reserved, guaranteeing services
Packet vs. Circuit Switching: Which is more efficient?
Packet vs. Circuit Switching:
Which is more efficient?

Details about packet switching and circuit switching is explained in Sections 1.3.1 and 1.3.2
Who owns the intermediate packet switches on the Internet?
The Internet is a "network-of-networks", organized into autonomous systems (AS), each is owned by an organization.
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To learn more about the architecture of the Internet, read Section 1.3.3. The Internet topology figure is taken from http://www.caida.org/research/topology/as_core_network/
traceroute
You can also try to traceroute from other locations on the Internet at http://www.traceroute.org
Routing: Decide which path/route to take
Reliability: Recover from packet losses
Link Rate/Bandwidth: How many bits can be "pushed" onto a link per unit time.
Delay:
Time between send and receive
To send a packet in a packet switch network, for each link in the path

1. transmit packet onto the link as bits
2. propagate bits to next node
3. store and process the packet
4. wait to be transmitted
End-to-end packet delay consists of:

1. transmission delay
2. propagation delay
3. processing delay
4. queueing delay
Throughput: How many bits can be communicated per unit time.
Multiple applications can run on each host
Demultiplexing: Determine which packet belongs to which application
Many issues to consider, to support different applications running on large number of hosts through different access technology and physical media.
Layering:
Common CS trick to deal with large and complex systems
Each layer provides a service; Simple interfaces btwn layers; Hide details from each other.
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The five layers of the Internet are described in Section 1.5.
Applications (or processes) treat the Internet as a black box, sending and receiving messages through a socket.
Transport layer provides process-to-process message delivery services.
TCP
reliable, in-order delivery, with congestion and flow control
UDP
best-effort delivery
Network layer
host-to-host delivery
Link layer
node-to-node delivery
Physical layer
``bits over physical media"