

COMP 3331/9331:
Computer Networks and
Applications

**Announcements + Final Exam + Review +
Sample Problems**

Feedback

- myExperience On-line Survey
 - You should have received email
 - Active till 3rd November
 - Accessible via Moodle
 - Please enter answers for both parts – (i) Course and (ii) Teacher
- I would greatly appreciate 5-10 minutes of your time
- I need to hear from you about your experience with this course and my teaching
 - Helps us improve the quality for future sessions
- Written comments are encouraged
- Feedback is anonymous



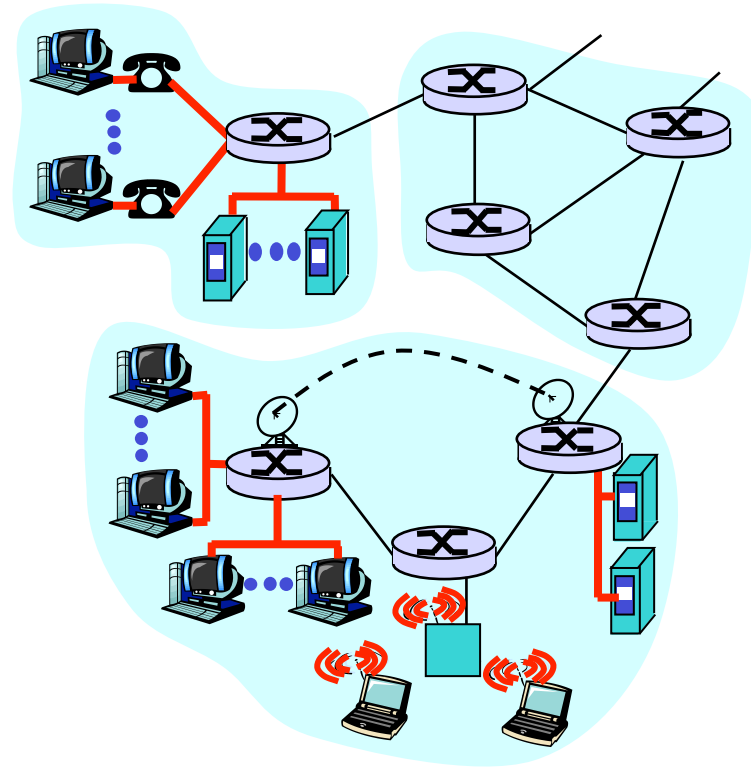
Course Announcements

- Assignment 2
 - Deadline – midnight, Friday, Week 13 (28th June)
 - **Remember to test your programs on a CSE machine before submitting**
 - We won't be lenient as with the first assignment if your code cannot be executed
 - Submission instructions provided in spec
- Solutions to all sample questions posted
 - Attempt to answer them yourself before examining answers
- Several other questions on the lecture content page
 - Please discuss the solutions

Recap from Week 1: A top-down approach

We've covered networking using a top-down

- ❑ **end-system** applications, end-end transport
- ❑ **network core**: routing, hooking nets together
- ❑ **link-level** protocols, e.g., Ethernet
- ❑ **other stuff**: security, wireless networks



What you have accomplished

- Comprehensive overview of the entire protocol stack with a particular focus on the Internet
- Key principles
 - Layering, scale, hierarchy, etc.
- Key design issues
 - Application architectures, reliability, congestion control, routing, medium access, etc.
- Hands-on practical laboratory experiments using several diagnostic tools and ns-2
- Two “real-world” assignments
 - Stripped down implementation of TCP
 - Link state routing protocol

Key topics (1)

- Organisation principles
 - Layering, hierarchy, encapsulation
 - Some researchers speculate that layering is also useful in biological systems/evolution
- Application layer
 - Protocol design, P2P, socket programming
- Transport layer
 - Error detection, reliable data transfer, flow control, congestion control
 - TCP and UDP

Key topics (2)

- Network layer
 - Network addressing, scalability, hierarchical addressing
 - Fragmentation as an example to deal with heterogeneous link layer technologies
 - Routing protocols and algorithms: link state, distance vector
- Link layer
 - Addressing, ARP
 - Medium access control, especially random access
 - Interaction between link and network layers

Key topics (3)

- Wireless Networks
 - 802.11, CDMA
- Security
 - Symmetric key and public key cryptography
 - Confidentiality, message integrity, authentication
 - The role of encryption in these
 - Firewalls

What next?

- COMP 9332: Network Switching and Routing
- COMP 9334: System Capacity and Planning
- COMP 4336/9336: Mobile Data Networks
- COMP 3441/9441: Security Engineering (+ new security courses to be launched)
- COMP4337/9337: Wireless Network Security
- COMP6337: IoT Experimental Design Studio
- Undergraduate/Postgraduate Projects and Thesis –
Come work with us (Networked Systems and Security Research Group)

Final Exam (1)

- Friday, 16th November, Wednesday 13:45 – 17:00
- Check seating arrangement
- Time: 3 hours + 10 minutes (reading time)
- Maximum Marks: 35
- Recall that, to pass the course, one requirement is that you must score ≥ 14 marks (40%) in the final exam

```
lab = marks for lab exercises (scaled to 20)
assign = marks for the two programming assignments (scaled to 25)
midExam = mark for the mid-semester exam (out of 20 marks)
finalExam = mark for the final exam (out of 35 marks)
mark = lab + assign + midExam + finalExam
grade = HD|DN|CR|PS if mark  $\geq$  50 && finalExam  $\geq$  14
      = FL          if mark < 50 || finalExam < 14
```

- Allowed to carry forward max 3 bonus marks (2 from assignment 1 and 1 from assignment 2) to final score

Final Exam (2)

- Closed book
- What to bring
 - Student ID
 - Calculator will NOT be provided. BYO - GET THEM APPROVED (CSE STUDENT OFFICE)
 - Pen, Pencil, etc.

Final Exam (3)

- Not a memory test, questions will examine your understanding of concepts
- Tests your understanding
- Tests whether you can apply the principles in a situation that you haven't seen before
- You can use the mid-session exam as a guide on what the expectations are

Final Exam (4)

- **Syllabus: Comprehensive**
 - See the next few slides for content on the exam
 - More focus on the material after the mid-semester exam
 - Self-study material is examinable
 - External links, News Items and Research Items discussed in lectures not covered
 - Questions may also examine multiple layers at the same time
 - No questions on programming or lab exams
 - However reading through the lab exercise solutions may be instructive for understanding certain concepts
- You are asked to show your steps and tell us your arguments in answering questions

Final Exam (5)

- How to prepare?
 - Read and thoroughly understand all content
 - **Practice, Practice, Practice**
 - Go through all the sample questions, sample exam papers, lecture Q&A, textbook questions, etc. for practice
- Don't panic and get stressed if you come across a hard question

NOTE: Sample final exam paper has been posted on the Final Exam Page linked to course webpage

Examinable Content (1)

❑ Introduction and Overview

- No specific questions but the general concepts may be examined in some questions
- No questions on circuit/packet switching

❑ Application Layer

- No specific questions but some applications may be referenced in some questions
- General understanding of applications should be sufficient
- No questions on DHT or peer to peer networks

Examinable Content (2)

❑ Transport Layer

- All content is examinable
- No questions on finite state machines

❑ Network Layer

- All content is examinable excluding the following:
 - IPv6
 - ICMP
 - Specific routing protocols such as BGP, RIP, OSPF (was not covered in the lectures)
 - Broadcast and Multicast Routing (was not covered in the lectures)

Examinable Content (3)

□ Link Layer

- All content is examinable excluding the following:
 - DOCSIS: Link layer for Cable Internet Access
 - Virtual LANs
 - Link Virtualisation
 - Data Center Networking

□ Wireless Networks

- Wireless Links and Network characteristics, CDMA, WiFi, 802.11 MAC are all included

Examinable Content (4)

□ Network Security

- Symmetric and Public key cryptography
 - General questions only, no math questions, you don't need to know details of AES/DES
- Message Integrity and Digital Signatures
- End-Point Authentication
- Firewalls
- No specific questions on Secure E-mail

How do I seek help?

- Post any questions on the course forum
- Engage in discussions (peer learning)
- I will arrange for consults in the days leading to the exam

Practice Problem (1)

- Consider a TCP connection with initial congestion window of one segment and a constant RTT of 1 second. The ssthresh parameter is initially set to 32,000 bytes. All segments carry 1,000 bytes of data. The receiver's advertising window is 64,000 bytes. Suppose that the connection does not experience any losses or queuing delays. How long will it take to transfer a 200,000 bytes file? You may ignore the connection establishment latency.

Practice Problem (1)

Practice Problem (2)

- Consider a TCP Reno connection between two hosts with a large amount of data packets flowing in only one direction. Assume a malicious router along the path drops every other data segment of this connection (i.e. it drops 2, 4, 6, etc.). Assume that the receiver's advertised window is 256 MSS. Also assume that there is plenty of bandwidth available on the path, so as to accommodate a TCP window size of 64 MSS in the absence of the malicious router.
 - (a) What is the maximum window size achieved on this connection?
 - (b) Repeat (a) for the case when the malicious drops every eight packet (say 8, 16, 24, etc.)

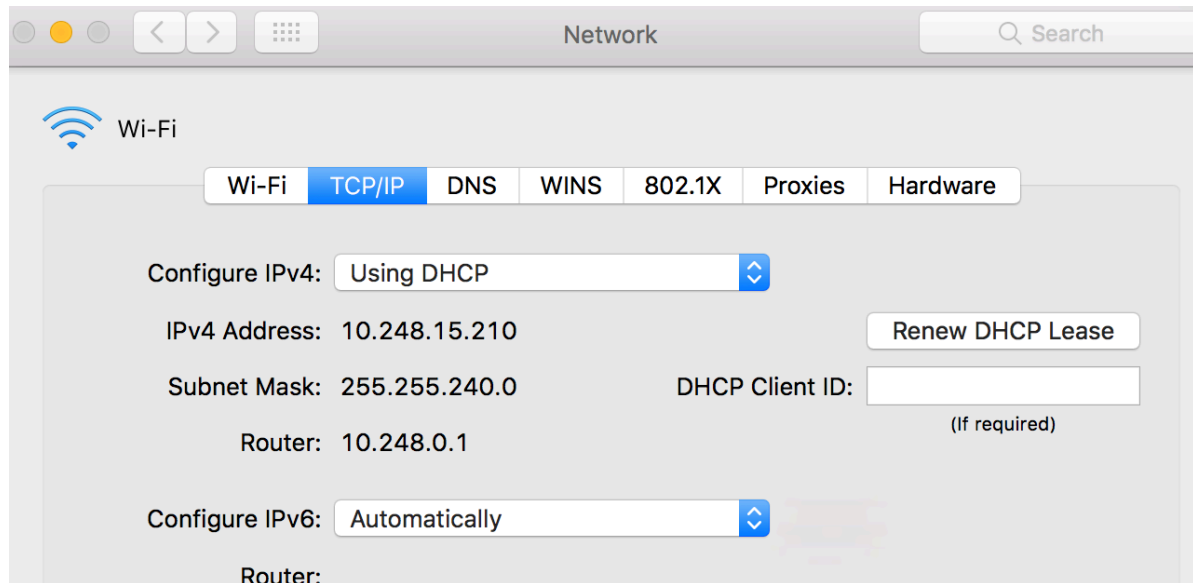
Practice Problem (2)

- Answer:

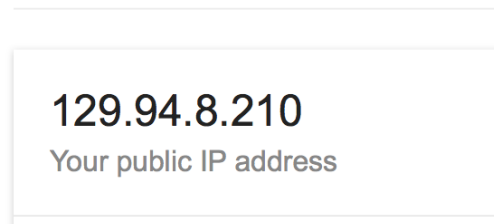
Practice Problem (2)

Practice Problem (3)

- The picture below shows you the IP address of my machine connected to the uniwide wireless network.



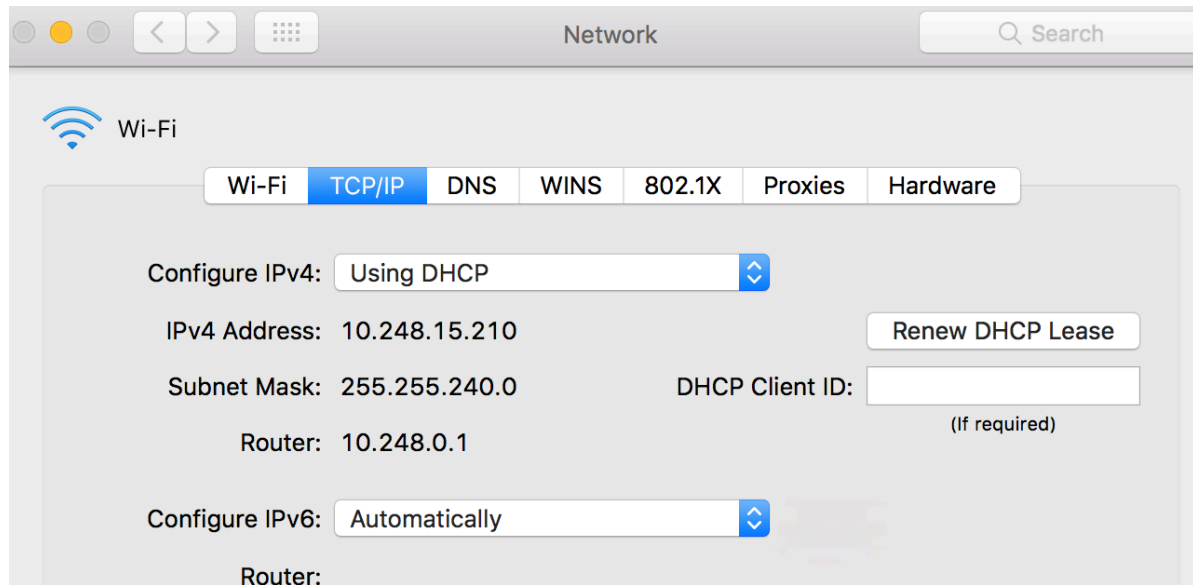
- However when I ask Google it says my IP address is as noted below. Can you explain the discrepancy?



Practice Problem (3)

- Answer:

Practice Problem (4)



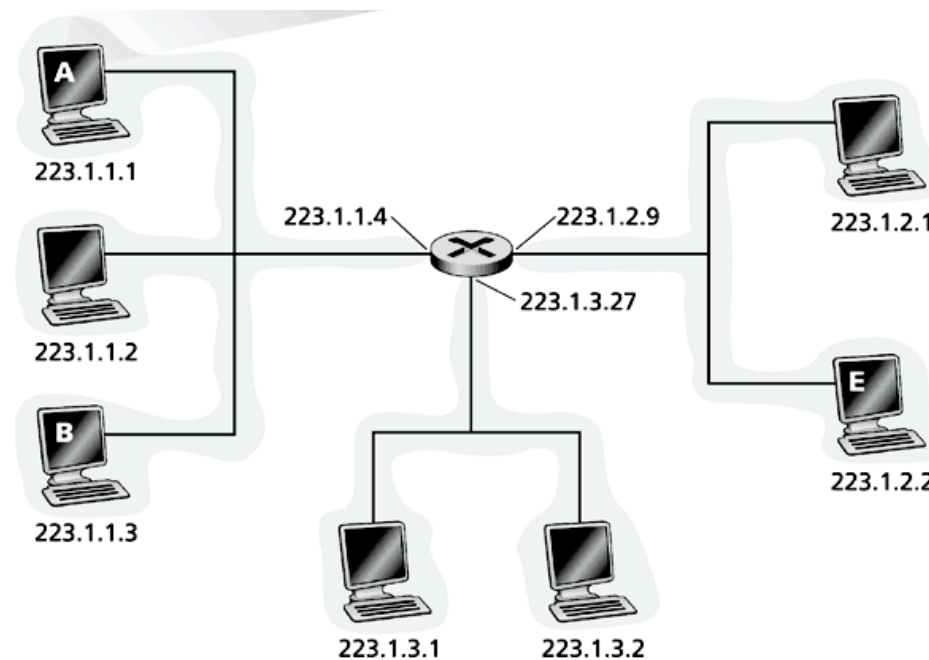
- Can you express the subnet address for the subnet that my machine belongs to (see picture above) in the CIDR format (i.e. a.b.c.d/x) ?
- What is the broadcast address for this subnet?
- How many hosts can be part of this subnet?

Practice Problem (4)

- Answer:

Practice Problem (5)

Describe the complete sequence of steps involved for getting data sent from the network layer of host A to the network layer of host E. Be sure to include all steps involved at the network layer and data link layers.



Practice Problem (5)

□ Answer:

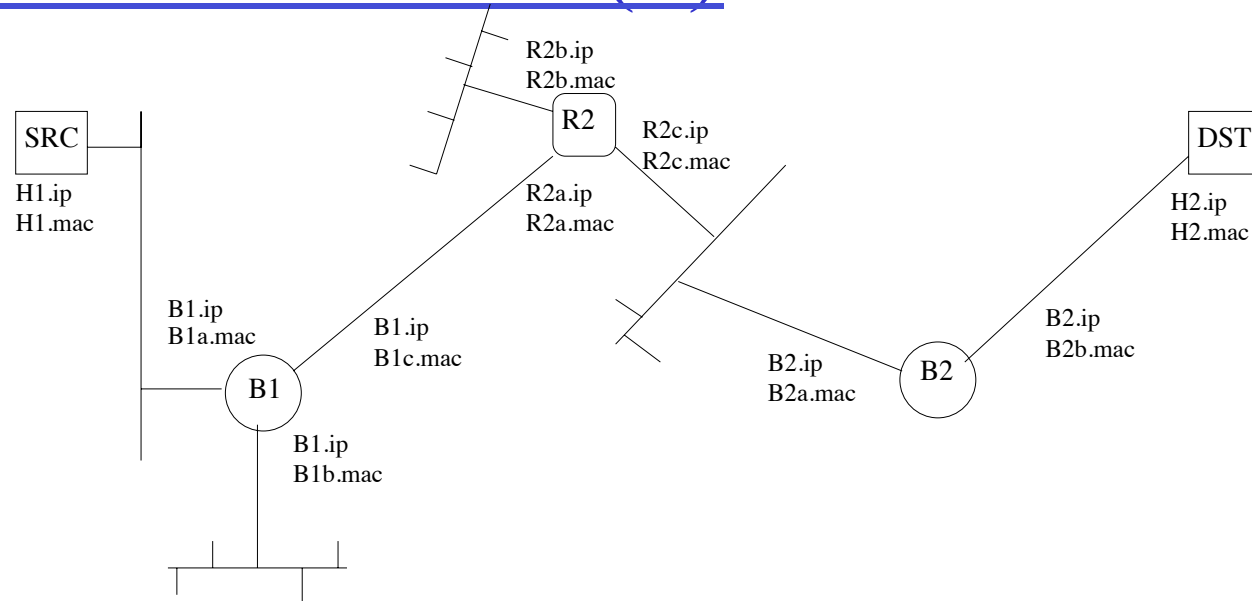
Practice Problem (6)

Q: Suppose Ethernet was the only existing LAN technology, so every host in the Internet was part of a local Ethernet and thus had a globally-unique Ethernet address. Would you recommend getting rid of IP addresses by simply using Ethernet addresses instead of IP addresses? Why or why not?

Practice Problem (6)

□ Answer:

Practice Problem (7)



Above is a picture of a network with 2 switches (bridges) and 1 router. Each interface is labeled with an IP address and a MAC address. Imagine that host H1 is sending packet to host H2. Answer the following:

- How many subnets in the above topology?
- Just before the packet reaches bridge B1, what is the destination MAC address in the Ethernet frame?
- Just before the packet reaches bridge B2, what is the source MAC address in the Ethernet frame?
- Just after the packet leaves router R2, what is the source IP address in the datagram?

Practice Problem (7)

□ Answers:

Practice Problem (8)

- Consider the following 3 applications over a wireless network
 - Voice-over-IP, where packets are very small and the send rate is constant
 - MPEG movie streaming, where the packet size is large and the send rate is variable
 - Instant messenger chat, where packet size is small and send rate is variable
- For each application, list and explain which of the following MAC protocols you would use – (i) TDMA, (ii) plain CSMA/CA (iii) CSMA/CA + RTS/CTS

Practice Problem (8)

- Answer:

Practice Problem (9)

- Assume that a group of 10 people wishes to communicate securely with each other. Each member of the group needs to send secret data to the other 9 people within the group. All communication between any two people p and q is visible to all other people in this group and no other person in the group should be able to decode their communication.
 - (a) If the group decides to use symmetric key encryption, how many keys are required in the system as a whole?
 - (b) Instead if public key encryption is chosen, how many keys would be required?

Practice Problem (9)

- Answer:

Last Goodbye :(

- Hope you enjoyed the course
- Hope you learnt a lot
- Hope you know more about computer networks than you did 3 months ago
- Good Bye !!
- Good luck for the exam and the future
- Have a great break
- **Please fill in feedback**

