Week 12 – Review

COMP90007
Internet Technologies

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Final Exam Details

- Length: 3 hours in length, with 15 minutes reading time
- The exam will NOT be an open book exam
- I will be in attendance at the exam during reading time to answer any questions that may arise

Final Exam Structure

- Exam consists of 20 multiple choice questions (MCQs) and 10 short answer questions. You should attempt to answer all questions.
- MCQs → 1 mark each
- Short answer questions → 4 marks each
  - Questions should be able to be answered in a maximum of 2 short paragraphs (usually less).

Course Review

- "The objective for this subject is for students to develop an understanding of foundational network technologies and applications, and be able to demonstrate proficiency in internetworking."
- Major Goals
  - Develop an understanding of network technologies and applications
  - Be able to demonstrate proficiency in internetworking and its management
  - Be able to undertake problem identification, formulation and solution

Scope of Final Exam

- Questions can be originated from any topics covered in this subject:
  - Lecture slides
  - Workshops (i.e., labs and tutorial questions)
  - Assignments (Assignment 1, Assignment 2, and Network Analysis Assignment)
  - Relevant sections in the textbook

Introduction - summary

- Networks can provide connection-oriented or connectionless services
- The Internet is the most widely known network, it is a network of networks
- Standardisation of both hardware and software is important to ensure interoperability between different implementations

Computer Networks

- Different applications have different network requirements
- How many networks do you know?
- Can you tell the main characteristics of these networks?
- What kind of applications can run well/cannot run well in these networks?

Protocol Hierarchies

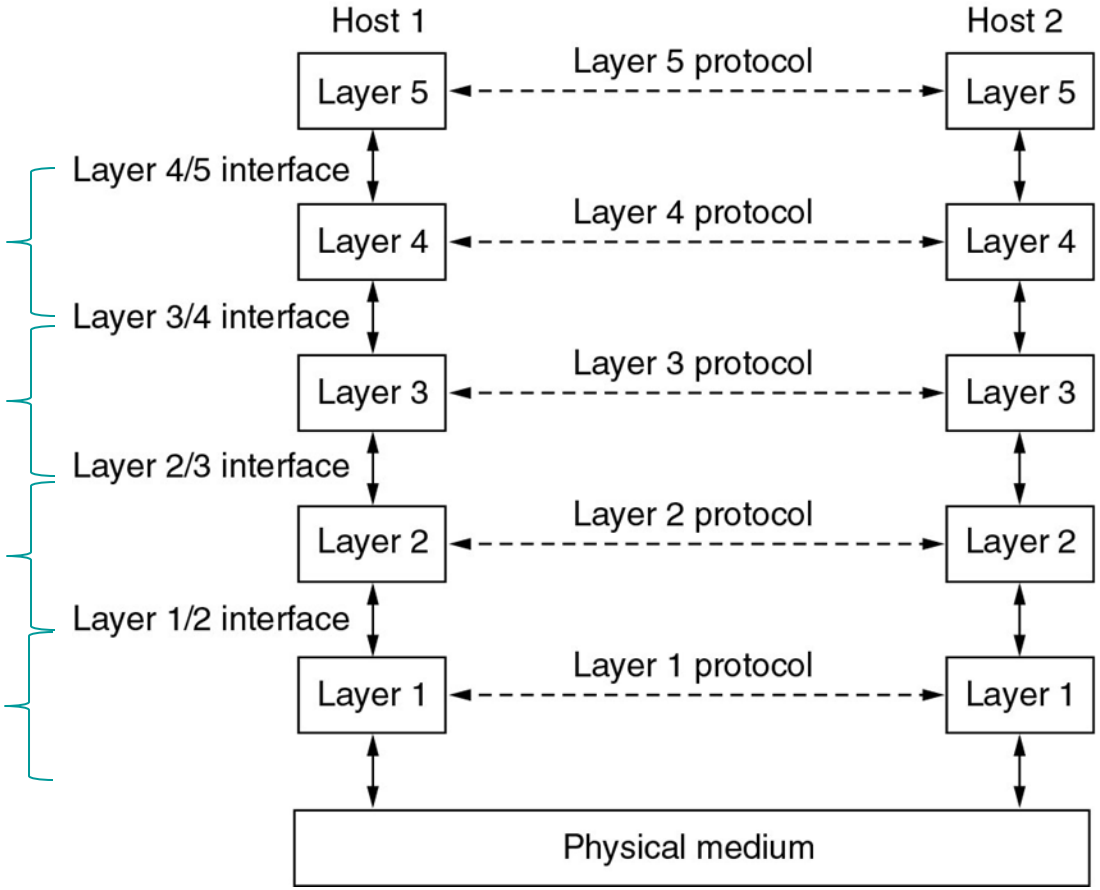
- Protocol, layers, and services

Multiplexing/demultiplexing applications

Connecting different networks (internetworking)

Framing, reliability and flow control (direct conn.)

Different cables, wireless signalling, digital to analogue



Physical Layer -summary

- Physical layer is the basis of all network technologies - natural limits on different types of channels and thus affect their bandwidth
- Message Latency (delay)
  - Putting the message on the line (Transmission Delay)
  - Travel time of a bit from one end to the other end of channel (Propagation delay)
- Transmission media can be guided (twisted pair, coaxial cable, fibre optics) or unguided (radio, infrared, lasers, microwaves)
- The PSTN network is a key element in many networks as it provides the local loop between the consumer and the network service provider

Physical Layer

- Data Communications Theory
  - Nyquist theorem
  - Shannon theorem
  - Characterise different guided media
    - Twised pair vs coaxial cable vs fibre optics
- Recognise different modulation types
- Wireless Data Transmission
  - Explain differences between wireless transmission types
  - Choose the appropriate type of satellite for an application

Data Link Layer - summary

- The data link layer converts a raw bit stream into a series of frames
- Various framing methods are used
- Protocols at the data link layer can provide error detection and control, as well as flow control - the sliding window mechanism is used to integrate these two concepts
- Sliding window protocols can be categorised based on the function which determines the size of the sender's and receiver's windows
- Many networks use a bit oriented protocol at the data link level – all use flag bytes to delimit frames and bit stuffing to prevent flag bytes occurring in the data

Data Link Layer

- Data Link Layer
  - Contrast types of services provided
  - Apply different framing methods
    - Character count, bit and byte stuffing
  - Explain methods for error detection / correction
- Data Link Layer Protocols
  - Characterise different protocols
  - Stop-&-wait, sliding window: go-back-N, selective repeat
  - Calculate efficiency of stop-and-wait

MAC Sublayer - summary

- In networks which have a single communication channel available, the design of the allocation mechanism for this channel is important, and many methods have been developed to achieve this
- The simplest allocation schemes are FDM and TDM - both best when traffic is continuous and number of nodes is small
- In larger systems, protocols derived from ALOHA are better choices
- Carrier sensing can be used by nodes to determine the state of the channel in advance of transmission
- Some protocols reduce or eliminate contention - binary countdown, tree walk
- Wireless LANs have unique problems and solutions for transmission management - MACA, MACAW
- Ethernet (dominant form of local area networking) is available in speeds from 10Mbps to 1Gbps using mostly twisted pair media
- Wireless LANs are becoming common, mostly using 802.11

MAC Sublayer

- MAC Sub-layer Compare different CSMA schemes
  - Understand collision free protocols
  - Understand why wireless is different to wired protocols
- Explain key features of Ethernet
  - Evaluate factors affecting Ethernet performance

Network Layer - summary

- The network layer provides services to the transport layer in either virtual circuit or datagram modes
- Main purpose of network layer is to route packets from source to destination
- Many routing algorithms are used in modern networks - static vs dynamic algorithms,
- Other routing variants - broadcast, multicast, hierarchical routing
- Congestion can occur in the network layer, necessitating mechanisms to resolve congestion including retransmission policies, flow control, load shedding, choke packets
- The Internet has a variety of protocols available at the network layer - IP as the primary data transport protocol, but also ICMP, ARP, RARP

Network Layer

- Internetworking – issues and solutions
- Routing
  - Differences between VC and Datagram subnetworks
  - Understand Distance Vector and Link State Routing protocols
  - Dijkstra's algorithm
- Internet Protocol
  - Explain principles of Internet design
  - Analyse structure of IP addresses – IP addresses allocation
  - Understand IPv4 frame structure
  - Explain roles of different Internet Control Protocols
- Quality of Service
  - Summarise effects on congestion of policies at different layers
  - Characterise QoS requirements of different applications

Transport Layer - summary

- The transport layer provides reliable, end to end connection oriented byte streams
- Primitives allow the establishment, use and release of connections
- Berkeley sockets are a common method for utilising the transport layer interface
- Transport protocols must also perform connection management over unreliable networks - mechanisms for handling lost or duplicate packets are important
- Three way handshakes are a common connection establishment mechanism
- The Internet has 2 main transport protocols - TCP and UDP

Transport Layer – summary (cont.)

- UDP is a connectionless protocol that mainly wraps IP packets with additional features of multiplexing using ports in addition to an IP address
- TCP is a reliable byte stream protocol, which allows segments to be disassembled and reassembled during transit
- Network performance is dominated by the need to reduce protocol and TPDU overhead - increasing problems at higher speeds – protocols should be designed to minimise the impact of increased traffic

Transport Layer

- Transport Layer Services
  - Discuss challenges in providing reliable services over unreliable network layer
  - Explain solutions for connection establishment and release
- Internet Transport Protocols
  - Characterise differences between TCP and UDP
  - Explain TCP congestion control
- Slow start procedure (to quickly increase the speed) and additive increase
  - Be able to explain step by step from the start

Core Applications - summary

- Foundational to the Internet architecture is the hierarchical naming scheme DNS
- DNS is implemented as a distributed database system which can be queried by clients to determine mappings between IP addresses, host names, and various other types of records
- Email is a dominant Internet application consisting of two components - the user agent and the mail transfer agent
- Email sent by SMTP, and alternatively received by POP3 or IMAP

Core Applications - summary (cont.)

- Email has been extended to allow the transmission of non-text objects through the use of MIME
- The WWW is actually an application that uses the Internet as a foundation
- Browsers are used to navigate the WWW, with the assistance of browser plugins and helper applications for rich content handling Information sources on the WWW can include both static and dynamic document types
- Web standards are continuously evolving

Core Applications

- DNS
  - Describe operation of DNS lookup
- HTTP & WWW
  - Types of connections
  - Describe the role of cookies
  - Describe the role of Web Cache

Emerging Applications - summary

- Multimedia on the web has become a feature of the Internet in the last 10 years
- Multimedia networks are characterised by higher bandwidth requirements and the need for Quality of Service in order to be accepted by end users
- Online audio requires compression in order to achieve efficient transmission
- Data networks are increasingly being used to carry voice traffic and this new traffic brings different perspectives to network design
- The dominant VOIP technologies are H.323 and SIP, which provide a number of core functions, with specialisation in different areas, both derive from different traditions of standards development
- Online video also requires compression in order to achieve efficient transmission

Emerging Applications

- Multimedia networks
  - Describe techniques for jitter management
    - How to manage media buffer
  - Handling errors in streaming stored media
  - Compression is necessary
- VoIP
  - Benefits of VOIP
  - Contrast H.323 and SIP
  - Explain steps in SIP call establishment

Security - summary

- Network security is an important issue to consider given our increased dependence on network transmission of data
- Cryptography is a method that can be used to protect confidential data
- Ciphers are used to convert plaintext into cipher text - many different types are available
- Cryptographic algorithms can be divided into symmetric and asymmetric types
- Public key algorithms are architecturally distinguished by the use of a widely distributed key for encryption, and a private key for decryption
- Digital signatures can be constructed to ensure the reliability and non-repudiation of data - message digests, digital certificates

Security - summary (cont.)

- Cryptographic tools can be used to secure network traffic - IPSec is the dominant model and is widely used to constructed encrypted streams between sources and destinations
- Firewalls are an important component of network security architectures, serving not only as a border between public and private networks but also as the termination points for virtual private networks
- Network security is a pervasive issue - existing at all layers of a network architecture

Security

- Cryptography
  - Contrast the strengths and weaknesses of different cipher modes
  - Understand the key issues of each cipher mode
    - Block chaining, stream ciphers, counter mode,
  - Explain the use of message digests
- Authentication
  - Understand basic concepts of authentication protocols
- Network Security
  - Key elements of IPSec VPNs
  - Summarise some of the challenges for wireless network security

Review

- Generic skills" to take away from this course:
  - be able to analyse the relationship between different components of computer networks;
  - be able to conceptually and practically differentiate the various layers in internetwork architectures;
  - be able to conduct research into emerging networking technologies;
  - be able to apply network security and network management concepts in today's networked environments

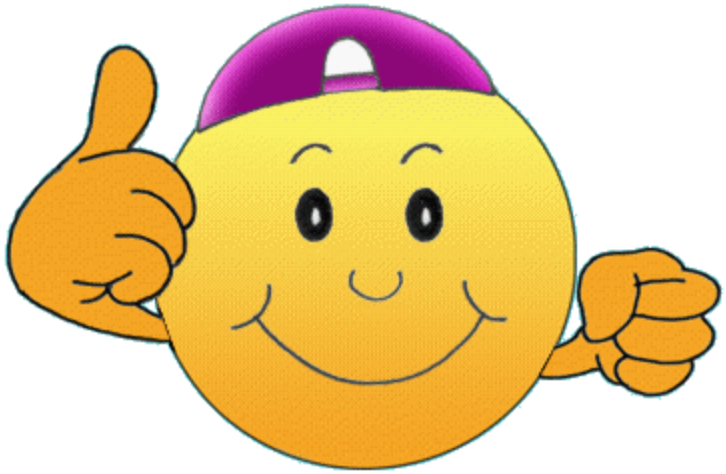
Exam Preparation: Practice Exam

- Practice Exam is available on LMS.
- Questions are indicative of the types of questions on this year's exam
- Suggest students take the practice exam as an exam

Exam Revision

- Identify the key concepts from each week's readings, lectures, tutorials and assignments
- Study and understand any of the lectures, tutorials, assignments and relevant sections from the textbook - examinable content may originate in any of them
- Look for recurring themes
  - Consider how key concepts from different topics could be related
  - E.g., jitter management for streamed media
- Try some questions from the end of chapter question sets, but don't spend all your time on them

GO FOR IT !



GOOD LUCK !