Coláiste na Tríonóide, Baile Átha Cliath
Trinity College Dublin
Ollscoil Átha Cliath | The University of Dublin

Faculty of Science, Technology, Engineering and Mathematics

School of Computer Science and Statistics

Integrated Computer Science Programme **Semester 1 2023**
Joint Honours
CSLL
Year 3

Computer Networks

13th December 2023 **RDS SIM COURT** **14.00-16.00**

Prof. Stefan Weber

Instructions to Candidates:
Answer 2 questions.
All questions carry equal marks (50 marks).
Answer each question in a separate answer book.

Materials permitted for this examination:
Calculator (non-programmable)

Question 1)

a) One of the tasks of the Link layer in the OSI stack is called "flow control".
   i) Define the term "flow control" and describe a transfer of a number of frames with and without flow control mechanisms.
   ii) Explain a "Stop-and-Wait ARQ" mechanism and a "Selective Repeat ARQ" mechanism, including the state that needs to be kept at the sender- and receiver-side of a transfer, the reaction of each mechanism to transmission errors in the transfer of the various frames and the advantages and disadvantages of each mechanism. Assume that the mechanisms use 4 bits to encode the sequence numbers of packets and that packets may be corrupted during the transmission. The explanation of each mechanism should be accompanied by flow diagrams that visualise the transfer of the frames over time.
   iii) Discuss the trade-offs in the design of flow control mechanisms, the fields in protocol headers that are involved and the effect that the choice for a flow control mechanism has on the state has to be kept at the sender- and receiver-side of a transfer.

[25 marks]

b) Approaches such as Cyclic Redundancy Checksums (CRCs) and Hamming Code are used for error detection.
   i) Assume that a station intends to transmit the following bit sequence of 13 bits: 1110111011011. It will employ CRC as error detection mechanism with the following polynomial: $x^4+ x^3+x+1$. Explain and demonstrate the process that the station will calculate the bit sequence that is to be transmitted and the process the receiver would employ to detect in the case a number of bits have been modified in the transmission. Discuss the advantages and disadvantages of the use of CRC for error detection in comparison to a checksum used in the Internet Protocol version 4 (IPv4) header.
   ii) Assume that a station intends to transmit the following 2 7-bit sequences: 1101110 0011001. It will use Hamming Code as error detection mechanism. Explain and demonstrate the process that the station will follow to determine the bits to transmit and the process a receiver would follow to detect potential changes in the transmission. Discuss the advantages and disadvantages of the use of Hamming Code for error detection in comparison to 2-dimensional parity checks.

[25 marks]

[Total 50 marks]

© Trinity College Dublin, The University of Dublin 2023

Question 2)

a) Code Division Multiple Access (CDMA) and Carrier Sense Multiple Access / Collision Detection (CSMA/CD) provide two mechanisms for medium access control.
   i) Discuss the approach that CDMA takes to the coordination of access to the medium by giving an example of 3 stations communicating with a base station. The example should include the process that a station follows in transmitting 3 bits and the process that a base station would follow when receiving a transmission.
   ii) Contrast the allocation of the medium using CDMA in i) against using CSMA/CD for a similar communication. Use diagrams to visualize the chronological exchange of the information in both cases.
   iii) Discuss the effect of a large number of nodes competing for a medium using CSMA/CD and the effect that a binary exponential back-off method will have as reaction to collisions.

[25 marks]

b) IEEE 802.11 defines two methods for medium access control, the Distributed Coordination Function (DCF) and the Point Coordination Function (PCF).
   i) Assume that six stations S1 to S6 use 802.11 radios and are within each other coverage area. Station S4 completed communicating with Station S3. Station S2 intends to transmit to station S1 and station S5 intends to transmit to station S6. The stations will use 802.11 DCF to get access to the medium. Describe the frames that will be exchanged by the stations and the inter frame spaces that are involved in these exchanges. Use diagrams to visualise the chronological exchange of the frames and the inter-frame spaces that are involved in these exchanges.
   ii) Assume that the communication laid out in i) would use 802.11 PCF instead of 802.11 DCF and that an access point AP is present as point coordinator. Describe the frames that will be exchanged by the stations and the inter-frame spaces that are involved in these exchanges. Use diagrams to visualise the chronological exchange of the frames and the inter-frame spaces that are involved in these exchanges.

[25 marks]
[Total 50 marks]

© Trinity College Dublin, The University of Dublin 2023

Question 3)

a) Assume that a node A intents to communicate with a node E over a number of intermediate nodes, B to D, as shown in figure 3. The nodes use IEEE 802.3 Ethernet as Link layer protocol for the connections between them and node B acts as a NAT gateway for the local network that includes node A. Define IPv4 addresses, Ethernet addresses and routing information as you see appropriate

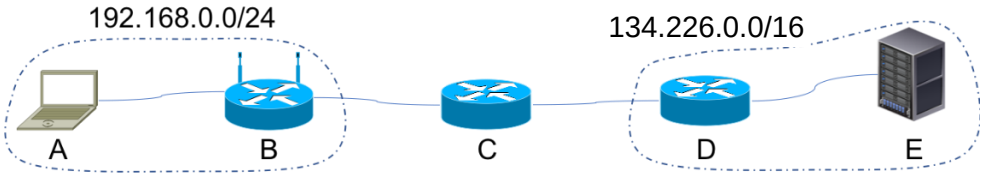

Figure 1: A Topology of two networks connected by a router

i) Describe the information that node B will keep in order to act as NAT gateway and how this information is used by B to process incoming and outgoing IPv4 packets.

ii) Describe the IPv4 packet that A would issue and the routing process of the IPv4 packet from A to E at the intermediate hops.

iii) Describe the Link layer frames encapsulating the IPv4 packet assuming that all links use Ethernet and the resolution of the IPv4 addresses to Ethernet addresses at every hop.

[25 marks]

b) Link State Routing (LSR) consists of two steps, the establishing of a view of the topology and the computation of Dijkstra's Shortest Path.

i) Explain the process of establishing a routing table using the two steps of LSR for node A of the topology shown in figure 2. The numbers on the edges indicate the cost or weight for communicating over the connection between the two nodes that the edge connects.

ii) Describe the reaction of node B, E and H to a failure of node G and how node A would process this change to the topology.

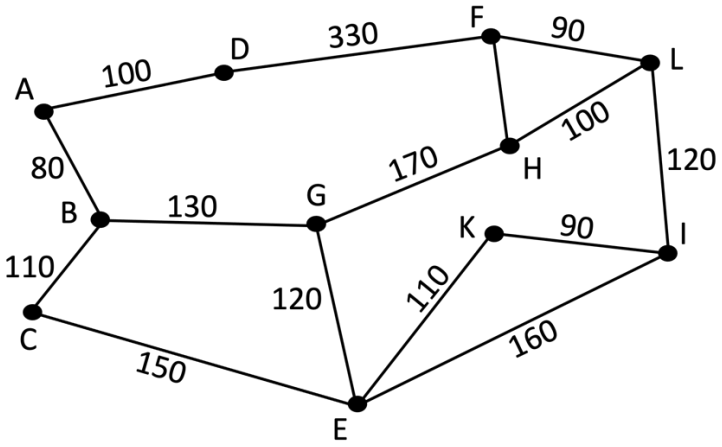

Figure 2: Topology of interconnected routers

[25 marks]

[Total 50 marks]

© Trinity College Dublin, The University of Dublin 2023