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

Faculty of Engineering, Mathematics & Science

School of Computer Science and Statistics

Integrated Computer Science Programme **Semester 1 2022**
Ba (mod) Computer Science and a Language
Computer Science (Joint Honours)
Year 3 Annual Examinations

Computer Networks

12th December 2022 **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". The High-Level Data Link Control (HDLC) protocol defines a number of types of frames shown in figure 1. Assume that node A, address 10000011, uses HDLC to send 5 frames to node B, address 11011111. The code in the S-Frame for an acknowledgement is 00 and for a negative acknowledgement is 11. The flag byte consists of the bit-sequence 01111110.

   i) Draw the exchange of the frames in much detail as possible for a Stop-and-Wait approach and for a Selective-Repeat approach. Your diagram should be accompanied by an explanation of the process and of assumptions in case you made any.

   ii) Explain the process that takes place when the information that is being transferred includes the same bit-sequence as the flag byte.

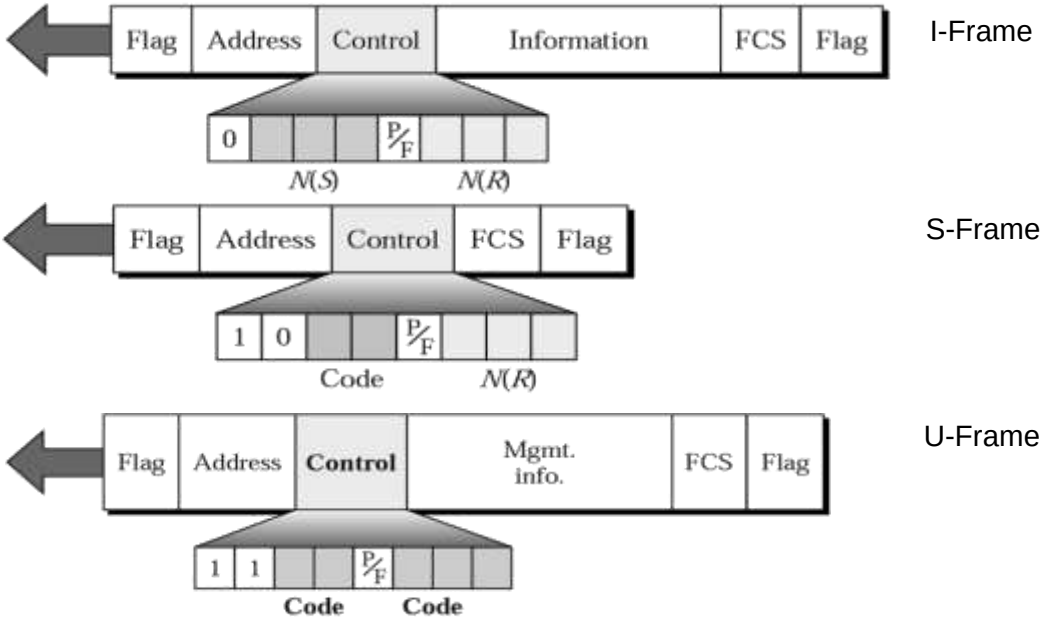

Figure 1: Types of HDLC frames

[30 marks]

b) A variety of mechanisms are used in telecommunication to provide error detection.

   i) Discuss the difference between Checksums as used in the IPv4 header and Hamming Code. As part of this discussions, explain the suitability of Checksums for IP headers and the suitability of Hamming Code for bit-sequences in link layer implementations.

   ii) Demonstrate the use of a Checksum and of Hamming Code on the following bit-sequence "1001001 0100010 1000011".

   iii) Discuss the difference of CRC to Checksums and Hamming Code and why CRC is suitable for the Ethernet frames while Checksums and Hamming Code would be less suitable in the context of Ethernet frames.

[20 marks]

[Total 50 marks]

Question 2)

a) A number of medium access protocols have been proposed that can be used to determine the access to the medium for a set of stations.

   i) Assume that the wired network of your company currently uses a Time-Division Multiple Access (TDMA) approach that is configured to accommodate 6 stations. Explain how stations in this network gain access to the medium and the advantages and disadvantages of this approach. Your explanation should be accompanied by diagrams that visualise the behaviour of the protocol and its limitations.

   ii) Assume that your manager asks you to propose a protocol that could be used instead of TDMA in i) and that would be suitable to accommodate a varying number of stations. Suggest a suitable protocol, explain the procedure by which stations would gain access to the medium by competing with each other and discuss the advantages and disadvantages of this protocol. Your explanation should be accompanied by diagrams that visualise the behaviour of the protocol and its limitations.

[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 S2 intends to transmit to station S4 and station S6 intends to transmit to station S1. 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]

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

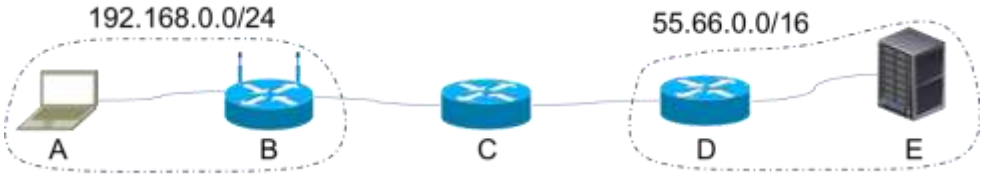

Figure 2: A Topology of two networks connected by a router

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) Distance Vector Routing and Link State Routing describe two fundamental types of routing protocols.

i) Give a short description of both Distance Vector and Link State Routing in your own words and discuss the difference of both approaches to routing.

ii) Describe the concept of Distance Vector Routing on the example of the computer network in Trinity College. Assume that 15 Schools of TCD, such as “Computer Science and Statistics (CSS)”, “Electronic Engineering (EE)”, “Genetics (G)”, “Chemistry (C)”, etc., have each an individual router and that these routers are partially connected to one another e.g. the router from CSS may be connected to the router from EE but not to the router from G and so on. The description should include diagrams that visualise the process that the concept follows to establish routing tables at the individual routers.

iii) Explain the problem of “Count to Infinity” in your own words on the network described in ii)

[25 marks]

[Total 50 marks]