

SEMESTER 1 EXAMINATIONS 2019/20

EMBEDDED NETWORKED SYSTEMS

Duration 120 mins (2 hours)

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This paper contains 3 questions

Answer **ALL** questions

Only University approved calculators may be used.

A foreign language dictionary is permitted ONLY IF it is a paper version of a direct 'Word to Word' translation dictionary AND it contains no notes, additions or annotations.

**8 page examination paper**

## Question 1

- (a) In the context of networking systems, **define** the terms *protocol layering* and *standardisation*. **Explain** one advantage and one disadvantage of each. [6 marks]
- (b) A CRC is calculated for the bit string  $10011101_2$ , appended to the end, and transmitted. The generator  $G(x) = x^3 + 1$ .
- (i) **Calculate** the actual transmitted bit string. [5 marks]
  - (ii) The most-significant-bit (MSB) is inverted during transmission. **Show** whether the receiver detects this and, if so, **explain** the steps it might take to rectify it. [6 marks]
  - (iii) **State** an example of a bit error in the transmitted bit string that will not be detected, and **explain** why. [3 marks]
- (c) 10 frames of size 110 bits are transmitted in quick succession, using the go-back-N protocol with a transmitter window of size 16. One bit in the 4th frame is inverted during transmission. **Calculate** which error control mechanism is more efficient: the CRC used in question 1b (calculated over the entire frame), a (15,11) Hamming code, or a single even parity bit? Your answer should include a sequence diagram for each, showing all frames. **Explain** whether this is true for *any* errors that could occur during transmission. [9 marks]
- (d) Referring to the *Access Code* and *Address Bits* fields in Figure 1, **explain** whether or not a Bluetooth device can be:
- (i) A master of two piconets at the same time;
  - (ii) A slave in two piconets at the same time.
- [4 marks]

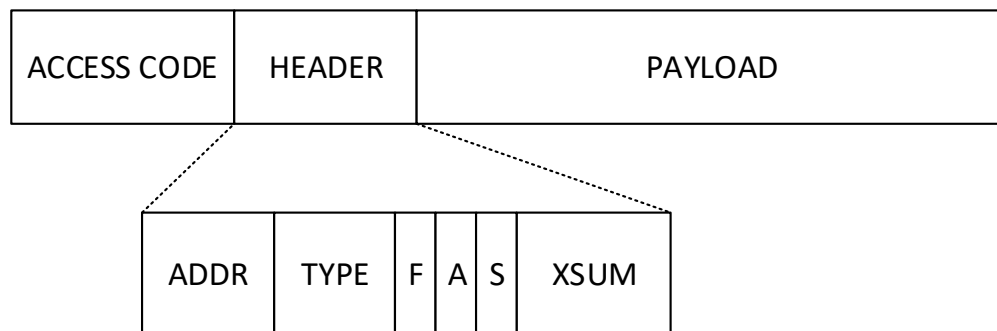


Figure 1 – a Bluetooth frame structure, for Question 1(d)

**TURN OVER**

## Question 2

- (a) In the network described by Table 1, distance vector routing is used. The following distance vectors arrive at B:

from A(0,6,4,7,10,10);

from D(7,5,3,0,4,3);

from E(10,4,7,4,0,2).

B measures delays to A, D and E as 6, 5 and 4 respectively.

**Construct** the new routing table at B, listing the outgoing lines to use and the expected delays.

[6 marks]

Node	Is connected to
A	A,B
B	A,D,E
C	A,D
D	B,D,E,F
E	B,D,F
F	D,E

Table 1 – connection of the network, for Question 2(a)

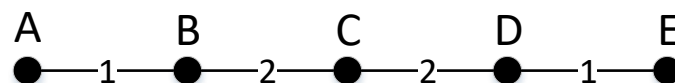


Figure 2 – linear network, for Question 2(b)

- (b) A linear network has the delays shown in Figure 2.
- (i) **Construct** a table to show how news of connections to node A propagate through the network at each exchange.
  - (ii) The link between A and B is interrupted. Following on from the table from part (i), **show** how the change propagates through the network over the next 5 exchanges. **Comment** on this performance.
- [6 marks]
- (c) An excerpt of a DNS resource record is shown in Table 2.
- (i) A sender wishes to transmit an email to `bob@soton.ac.uk`. **Explain** how the name server returns the address(es), and what may happen if the chosen mail server later fails.
  - (ii) **Explain** what happens if an email is sent instead to `bob@ecs.soton.ac.uk`
  - (iii) A user attempts to access `www.soton.ac.uk`  
**Explain** how the name server computes the address to return. What is the advantage of defining it in this way?
- [5 marks]

soton.ac.uk.	86400	IN	SOA	admin@company.com (20191022, 3600, 1800, 604800, 86400)
soton.ac.uk.	86400	IN	NS	alpha
soton.ac.uk.	86400	IN	MX	1 beta
soton.ac.uk.	86400	IN	MX	2 gamma
alpha	86400	IN	A	152.78.130.111
beta	86400	IN	A	152.78.130.251
gamma	86400	IN	A	131.41.231.180
delta	86400	IN	A	152.78.130.102
www	86400	IN	CNAME	delta
ecs.soton.ac.uk	86400	IN	CNAME	soton.ac.uk

Table 2 – excerpt of a DNS resource record, for Question 2 (c)

**Question continues on following page**

- (d) **List** the three distinct and worldwide unique identifiers that many business computers have.  
[3 marks]
- (e) **State** which transport protocol is used by DNS servers, and **explain** why this is a good choice for this type of communication. **Explain** what happens if a request (or response) is lost.  
[3 marks]
- (f) A TCP congestion window is set to 32 kB and a timeout occurs. Assume that the maximum segment size is 2 kB.
- (i) **State** how large the window will be for the next burst.
  - (ii) A further four transmission bursts are sent successfully. **State** how large the window will be for each of these bursts.
- [4 marks]
- (g) **Explain** the role of CAs in public key encrypted communications. Why are they necessary?  
[3 marks]
- (h) Alice wishes to send Bob a signed unencrypted message, using a message digest. **Explain** what would happen if an attacker:
- (i) Replaced the content of the message.
  - (ii) Replaced both the message and the message digest.
- [3 marks]

## Question 3

- (a) The following are sources of inefficiency/energy wastage in the Data Link Layer: overhearing; idle listening; control overheads; and collisions.
- (i) **Define** each of these terms.  
[4 marks]
  - (ii) **Explain** how the X-MAC protocol reduces these sources of inefficiency.  
[4 marks]
- (b) The IEEE 802.15.4 Link Layer offers both beacon-enabled and non-beacon modes of operation. **Describe and compare** the operation of both, commenting on the advantages and disadvantages of each. Your answer should include a diagram of the superframe structure.  
[8 marks]
- (c) **Explain** the main difference between connection-oriented (virtual circuit) and connectionless (datagram) based transmission. **State**, and **briefly explain**, a major benefit and drawback of each method.  
[6 marks]
- (d) A ZigBee network may be built from RFDs and FFDs.
- (i) **State** what RFD and FFD stands for;
  - (ii) **Explain** what network roles are supported by each type of device;
  - (iii) **State** which type of device is suitable for powering from a small battery, and **explain** why.  
[7 marks]

Question continues on following page

- (e) Websites often use cookies to identify users and keep small amounts of data, up to 4kB, on the local machine.
- (i) A website keeps a list of customer preferences in a cookie. For a complex website with lots of options, it is possible that the 4kB limit may be exceeded. Briefly **explain** how this problem could be avoided.
  - (ii) A banking website uses the technique you proposed in part (i) to provide an automated login facility. **Explain** whether there are any security issues with this and, if there are, **suggest** how they could be avoided.
- [4 marks]

**END OF PAPER**