UNIVERSITY OF HERTFORDSHIRE

Academic year: 2019/20

Exam Session: Semester A

School/Dept: Engineering and Computer Science

Module code: **7COM1076 Solutions from page 6**

Module title: Wireless Mobile and Multimedia Networking

Duration of Exam: 180 minutes

THE FOLLOWING IS PROVIDED FOR THIS EXAMINATION:

ONE Answer book

Continuation answer sheets can be requested from an invigilator.

INSTRUCTIONS TO CANDIDATES:

This paper consists of FOUR questions on FIVE pages including this page.

Answer ALL FOUR questions.

Ensure you write your exam number on any sheets which are to be handed in.

University approved calculators allowed? YES

Are question papers allowed to be taken at the end of the exam? **YES**

QUESTION 1

(a) Figure 1 shows two ad hoc networks in a 5G cellular network. What features make ad hoc networks useful in 5G? (4 marks)

Discuss how the DSR routing protocol is used in the upper ad hoc network of Figure 1 (the one containing 4 relaying devices) to find a route from the source device (Source) to the destination (Destination), and the route maintenance procedure in case one of the relaying devices is not functional any more. (8 marks)

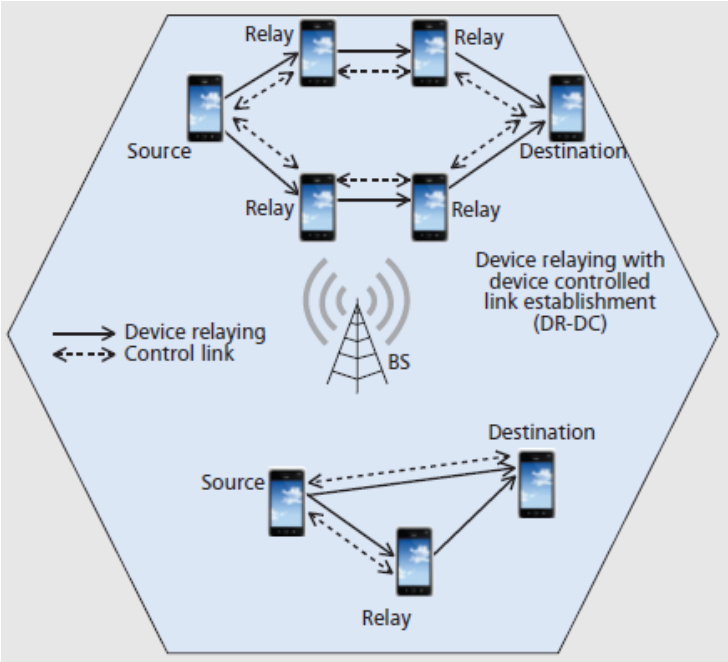


Figure 1: Ad hoc networking in 5G

(b) In the Mobile IP registration procedure, a mobile node sends a registration request to its home agent and the home agent sends back a registration reply message. The registration request and registration reply messages both contain two fields called lifetime and identification.

- What is the lifetime field used for? Does the lifetime in a registration reply have to be the same as the value in the corresponding registration request? Explain why or why not. (3 marks)

- What is the identification field used for? On one occasion the home agent receives a registration request with the identification field as 915. The home agent returns a message "registration error" to the mobile node, followed by a registration reply containing an identification field of 327. Explain and justify what attack may be happening in this registration occasion and what the mitigations are. (7 marks)

- Someone suggests using TCP to send out registration request message instead of UDP. Do you agree with them nor not? Justify your answers. (3 marks)

QUESTION 2

(a) Figure 2 below presents the elements in IoT. Explain the meaning of each element using examples where necessary such as WiFi, Mobile IP, cellular networks, etc.

Figure 2: IoT Elements

- Identification
- Sensing
- Communication
- Computation
- Services
- Semantics

(9 marks)

Analyse why cloud computing plays an important role in addressing the challenges in IoT big data analysis. (3 marks)

(b) A WiFi network is shown in Figure 3. Nodes A, B, C, and D are within the transmission range of their neighbours and the access point (AP). Assume that node A is transmitting to node AP, in the meantime node D wants to transmit to node AP. Analyse how MACAW resolves the hidden terminal problem in this scenario.

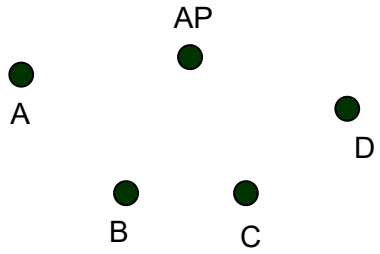


Figure 3: A WiFi Network (5 marks)

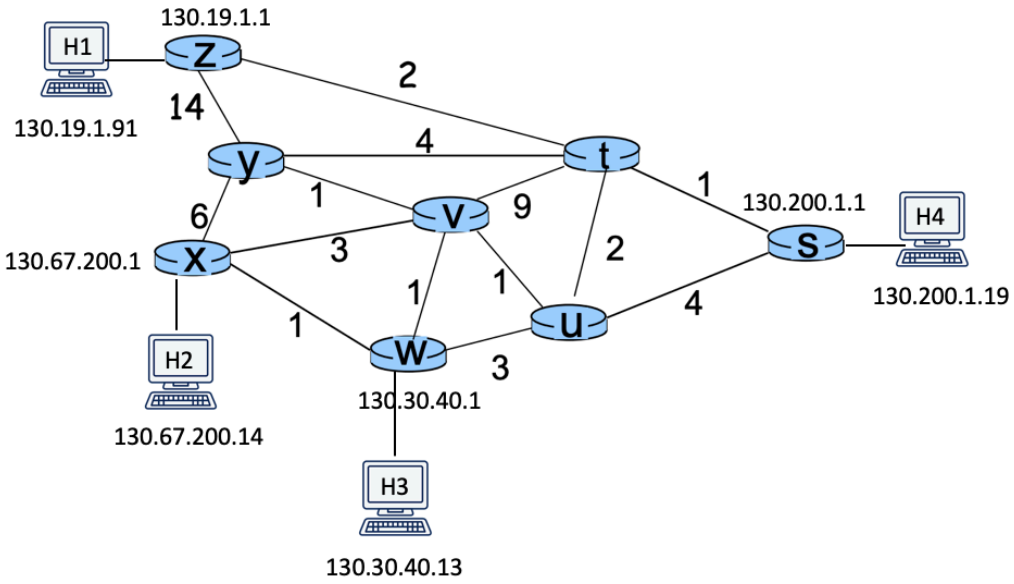
(c) Illustrate how MACAW outperforms MACA in terms of network utilization and fairness by the following designs. You may choose any TWO designs and accompany your illustration by using examples and diagrams if that is helpful. Maximally 5 marks are for the illustration of each design and maximally 10 marks for this part of Question 2.

- ACK control message
- DS control message
- RRTS control message
- Backoff copy
- MILD algorithm in backoff

(8 marks)

QUESTION 3

In the network scenario given below, the end node H4 is the source node for a multicast service that has the group identification of 226.17.30.197. Node H1 and H3 are in the multicast group. The costs for each link and the IP addresses for some nodes are annotated as shown. Answer the following questions.



(a) If IGMPv2 is used in the given scenario, devise the solutions for the following purposes. Also illustrate the field settings for the datagram such as relevant address fields and TTL.

- H2 wishes to join the group.
- H1 wishes to exit the group.
- Router W wishes to find out if any end notes belong to this multicast group.

(10 marks)

(b) Explain how RPF is used to establish the distribution tree for this multicast group. In particular, illustrate how the route is established for node H2.

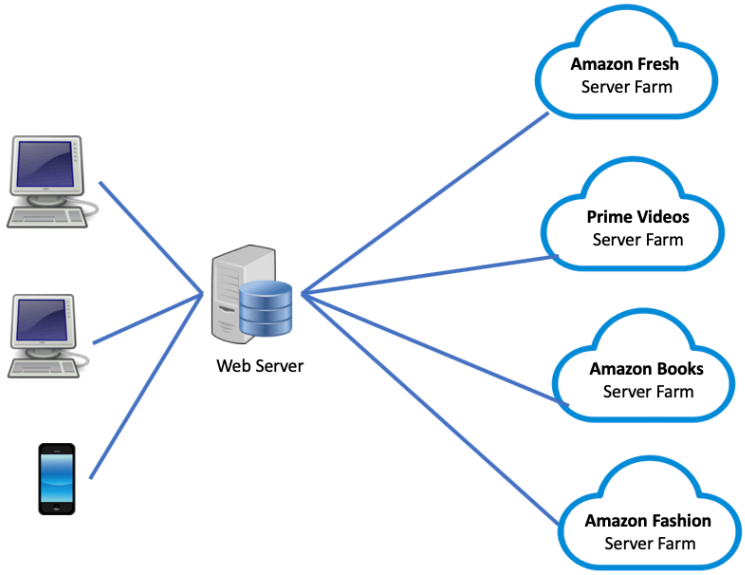
(10 marks)

(c) Use source-based tree to devise a multicast solution and explain how the data are delivered through the network.

(5 marks)

QUESTION 4

The diagram below shows a simplified version of Amazon network scenario. Answer the following questions.



(a) Explain the critical roles that the web server plays in the given network architecture.

(5 marks)

(b) The average size of an Amazon webpage is about 100kb. Surveys have shown that internet users will start to lose interests if the web page is not displayed after 10 seconds; and after 20 seconds if the page is still not displayed properly, most users will give up and close the page connection. Comment on the ETE delay standard for maintaining an acceptable service and a best service respectively.

(6 marks)

(c) Propose a solution to optimise existing cache algorithms on Amazon Prime Videos server. The solution should include the traffic capture technique and parameter of interest.

(10 marks)

(d) If Amazon is to host a MMORPG in the future, suggest a transport protocol to support this application and give your reasons.

(4 marks)

QUESTION 1 Answers:

(a) Features of ad hoc networking: no centralised administrator, no pre-defined infrastructure, limited bandwidth, contention-based channel access, easy to set up, scalable

(maximally 4 marks)

Route request message to be flooded. Show the working. (2-3 marks)

Route reply message coming back. Show the working (2-3 mark)

Route maintenance: (2-3)

Maximally 8 marks, marks are given to clearly illustrated diagrams

(b) Lifetime shows the valid time of a requested/successful registration after which the registration becomes expired. No. Because the home agent may think a shorter lifetime value should be granted.(3 marks) :

Identification field is used for security protection (1) against reply attack (1) Previously the identification field of 915 was used by the mobile node (1). This time the registration request may come from an attacker who uses this old registration request (1) The home agent realizes the identification field does not contain the expected value. Issue "registration error", (1) and then reissue a new identification value in the next registration reply.(1)

Mitigations can be using MD5 algorithms to provide authentication and integrity check (2-3) marks.

Maximally 7 marks for this part.

No, UDP should be used instead of TCP. Because registration request messages are replied by registration reply message anyway so it does not need TCP to provide reliability at transport layer. (3 marks)

QUESTION 2 Answers

(a) 1 mark for explaining each concept, and 1-2 marks for examples. Maximally 9 marks for part (a) of the questions.

Identification: Identity of IoT object, crucial for the IoT to name and match services with their demand, Electronic product codes (EPC), IPv4 addresses and IPv6 addresses

Sensing: Gather data from related objects and send it back to a data warehouse, database, or cloud. Different sensors.

Communication: transfer the data through various technologies, such as Wi-Fi, Bluetooth, RFID, NFC, 5G, various systems and protocols

Computation: The brain's computational ability. May mention Hardware: Microcontrollers, microprocessors, SoCs, FPGAs, Arduino, Raspberry PI, Gadgeteer. Operating systems: RTOS such as Contiki, TinyOS, LiteOS, Cloud Platforms such as the free tier of Google Cloud Platform and AWS (Amazon Cloud Platform)

Services: Various applications we already talked about. Smart vehicles, smart school, smart market, smart industry, smart transportation, smart healthcare, smart agriculture, smart home, smart building, etc.

Semantics: Extract knowledge smartly by different machines to provide the required services. Discover and use resources, model information, Recognise and analyse data for decision making, Represent the brain by sending demands to the right resources

IoT Big data challenge

Storage -- big data needs smart and efficient storage (1)

Computation -- big data needs computation resources to process them and extract knowledge (1)

Cloud computing provides such storage and computation requirements (1)

(b) No (1). MACAW (multiple access collision avoidance for wireless networks) (1) uses RTS-CRS-DATA-ACK as a round of transmission.(2-3 depending on how much details are given) A sends out RTS (1), AP replies CTS to A, heard by D. Thereby node D knows AP is receiving data. D will defer its transmission. (1) marks also be given to pure descriptions of MACAW.(maximally 5 marks)

(c) ACK improves utilization (1) more details up to 4 marks

DS (data sent) improves fairness (1) more details up to 4 marks

RRTS (request to send) improves fairness (1) more details up to 4 marks

Backoff Copy improves fairness (1) more details up to 4 marks

MILD in Backoff improves utilization (1) more details up to 4 marks

(maximally 10 marks)

Question 3 Answers:
(a)

When H2 joins the group, it sends this message:

IGMP group join
IGMP group address = 226.17.30.197
Destination IP address = 224.0.0.2
Source IP address = 130.67.200.14

(3 marks)

When H1 leaves the group, it sends this message:

IGMP group leave
IGMP group address = 226.17.30.197
Destination IP address = 224.0.0.2
Source IP address = 130.19.1.91

(3 marks)

When router W wishes to find out if anyone is in this group, it sends this message:

Group-specific query
IGMP group address = 226.17.30.197
Destination IP address = 224.0.0.2
Source IP address = 130.30.40.1

(3 marks)

TTL should also set to 1.
(1 marks)

(b)

RPF (Reverse Path Forwarding) builds a shortest path tree in a distributed fashion by taking advantage of the unicast routing tables.
(2 marks)

Given the address of the root of the tree (e.g., the sending host), a router selects as its upstream neighbor in the tree, which is the next-hop neighbor for forwarding unicast packets to the root. This concept leads to a reverse shortest path from any router to the sending host.
The union of reverse shortest paths builds a reverse shortest path tree.
(2 marks)

For H2, using link state algorithm for instance, the routing table is updated as follows.
(Note that the demonstration of the routing process does not have to match the following format.)
(1 mark)

Step	N'	D(s),p(s)	D(t),p(t)	D(u),p(u)	D(v),p(v)	D(w),p(w)	D(y),p(y)	D(z),p(z)
0	x	∞	∞	∞	3,x	1,x	6,x	∞
1	xw	∞	∞	4,w	2,w		6,x	∞
2	xwv	∞	11,v	3,v			3,v	∞
3	xwvu	7,u	5,u				3,v	∞
4	xwvuy	7,u	5,u					17,y
5	xwvuyt	6,t						7,t
6	xwvuyts							7,t

(3 marks)

The route from H4 to reach H2 is the reversed order of:

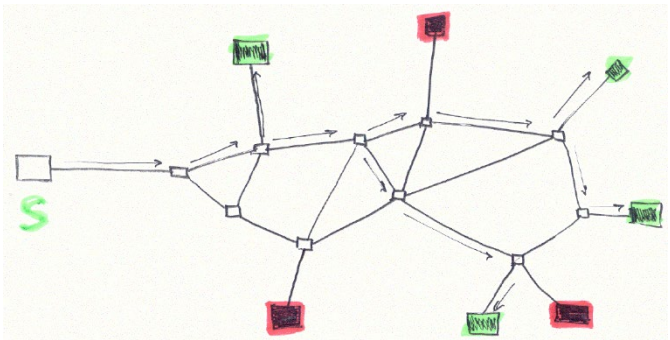
- X W V U Y T S

(2 marks)

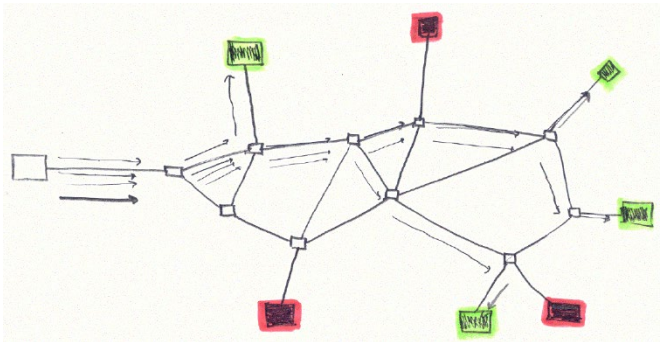
(C)

Multicast allows many applications to transmit the same data at one time to multiple receivers, which is technically feasible to achieve via unicast as well. But unicast will use point-to-point link for every pair of sender and receiver, and therefore duplicate data will be delivered through the network.
(2 marks)

(The example can be any scenario or using the given scenario.)



Attempting with multicast: A packet is sent over a link 12 times.


Attempting with unicast: A packet is sent over a link 22 times: 3 + 6 + 7 + 6 = 22.

(3 marks)

QUESTION FOUR answers

(a)

The given scenario is a three-tier structure. The web server functions as the terminal server (TS).
TS will be the web server that directly interfaces with the users, and other servers (e.g. database server, user profile server, login server maybe) are hiding behind the TS.'

(3 marks)

Terminal server delivers applications to the clients, where each user sees only its own session, which is managed transparently by the server operating system.
The terminal server also functions as the client of other servers.

(2 marks)

(b)

Best performance threshold:

10/100000 = 0.1ms

(3 marks)

Acceptable performance threshold:

20/100000 = 0.2ms

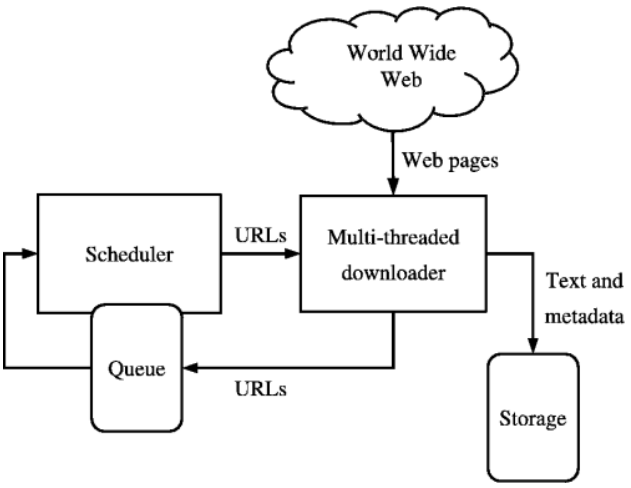
(3 marks)

(c)

The study and evaluation of video content features can benefit network traffic engineering by supporting the development of sustainable video delivery services and regulation of network traffic. Such evaluations are particularly useful to network operators who aim to refine and optimize existing cache algorithms to better adapt to video traffic patterns.

(3 marks)

Web Crawling Technique:
(1 mark)



(Either using words or diagram to explain is fine.)

(3 marks)

The measurement in question for the video capture is the average file size.

If the average file size is discovered as A, then to cache a total of B amount of videos, a disk space of A*B is required.

However, it may be interesting to investigate the video resolution as well. The analysis of video resolutions is important because it not only gives a definitive indication of video qualities in the system, but also offers an indicative reflection of users' uploading capabilities.

(3 marks)

(d)

MMORPGs provide higher tolerances for network delays.

(2 marks)

TCP as a reliable transmission protocol is an ideal transport platform for MMORPGs as it can prevent error propagation during long play sessions.

(2 marks)