CSE824 Final Exam, Fall 2020

Due time: 11:59pm, Wednesday, November, 25th 2020

Name: _____

Student ID: _____

Notes:

1. Be **brief** and **concise** in your answers.
2. If you wish to be considered for partial credit, show all your work.
3. You are expected to uphold the highest degree of academic honesty.

PROBLEM	MAX SCORE	YOUR SCORE
1	51	
2	24	
3	8	
4	8	
5	9	
TOTAL	100	

YOU ARE EXPECTED TO WORK ON IT INDEPENDENTLY !!

Problem 1 (51 points): Multiple choices (3 points each). Select all correct answers from the given five choices (there *may* be multiple correct answers).

1. Which of the design guidelines the Internet TCP/IP protocol suite follows?

   - Your answer ____ (A) protocols are integrated across layers (cross-layer design). (B) design and operational complexity is kept at each router. (C) Internet provides performance guarantees for voice and video flows as cellular networks do. (D) end-to-end argument. (E) end hosts have minimal design (Smart CORE, Dumb Terminal).

2. Which of the following statements about Ethernet 802.2 MAC CSMA/CD are NOT true?

   - Your answer ____ (A) Supports random multiple access (B) Bursty data is the main traffic source (C) Assumes that transmitter can send/listen concurrently (D) The signal is identical at Tx and Rx (E) Can be seamlessly applied to supporting wireless environment.

3. If we know that mutual interference between wireless nodes is severe, but the data corruption percentage due to environmental noise is small and negligible, then which signaling or control component in MACAW can be eliminated?

   - Your answer ____ (A) RTS (B) CTS (C) ACK (D) DS (E) random backoff

4. Which is NOT a characteristic of wireless transmissions?

   - Your answer ____ (A) rate diversity perceived at the receiver; (B) multipath fading; (C) location-dependent contention; (D) signal attenuation over distance; (E) transmission can be performed over any radio frequency without any constraint.

5. Which statement about packet scheduling is correct?

   - Your answer ____ (A) Fair share of wireless channel cannot be achieved through distributed packet scheduling. (B) Location-dependent wireless channel errors make it possible to schedule wireless packets to achieve fairness and high throughput at the same time. (C) Wireless fair queueing can achieve short-term fairness even under error-prone channel conditions. (D) Wireless scheduling can only work with same packet size. (E) Wireless scheduling cannot work with bursty packet arrivals.

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7. Which of the following statements about WiFi standards are NOT true?

   - Your answer ____ (A) roaming is an Access Point-initiated solution while the DCF mode is used (B) Only supports passive scanning functions (i.e., listening for Beacons) (C) Distribution System (DS) interconnect a set of BSSs and integrated LANs to create an ESS (D) A WiFi MAC frame only uses two addresses: sender address and receiver address (E) A WiFi MAC frame can carry up to 2312-byte data.

8. Which of the following statements about WiFi security are NOT true?

- Your answer ____ (A) WEP uses RC4 steam cipher algorithm (B) Since RC4 has been proven insecure, WPA discontinues to support RC4 (C) WPA2 improves WPA by adopting AES block cipher rather than RC4 stream cipher (D) In 802.11i, it requires AP (access point)'s MAC address, a nonce selected by AP, station's MAC address, a nonce selected by station, and PMK to calculate PTK (E) PTK is a key that encrypts user data and PMK is a key that provides user data with integrity protection.

9. Which of the following statements about WiFi rate adaptation that we discussed in class are true?

   - Your answer ____ (A) To achieve the maximum throughput, we should always select the highest rate (B) If packet losses caused by hidden terminals/stations, we should decrease rate (C) using deterministic patterns to increase/decrease rate can improve the throughput with a high probability (more than 50%) (D) Adaptive RTS aims to reduce the overhead of using RTS and CTS (RTS and CTS will not be always enabled) (E) How to select rates is fully defined in 802.11 standards.

10. Which of the following statements about Mobile IP are true?

    - Your answer ____ (A) In TCP/IP, the host IP address is used for IP routing but not as TCP connection identifier. (B) Even though you use mobile IP on each host, the standard TCP protocol can only run on the mobile host with changes. (C) The Mobile IP protocol needs the home agent for Mobile IPv4. (D) The location directory in mobile IP has to be ONE centralized database for all mobile hosts on the global Internet to ensure correct operations. (E) When a mobile host is back to its home network from a visited network, its home agent still intercepts packets on behalf of the mobile host.

11. Which of the following statements about Mobility Support the at Transport Layer is/are NOT true?

    - Your answer ____ (A) Mobility is per connection, not just per host. (B) Locates hosts through existing DNS. (C) Maintains standard IP addressing model. (D) connection migration is not required to ensures seamless connectivity. (E) TCP Connection Migration does not deploy any security defenses against TCP connection hijacking attacks (i.e., adversaries can migrate a TCP connection between a victim and a server to their malicious hosts).

12. Which of the following statements about Wireless TCP is/are true?

    - Your answer ____ (A) In wireless mesh networks, optimal TCP window size W* is network topology dependent. (B) Buffer overflow-induced congestion loss (intermediate nodes cannot buffer more packets and discards new packets) happens before contention losses (C) Snoop can improve both uplink and downlink throughput. (D) Snoop can be applied to supporting UDP and IPSec packets. (E) Explicit Loss Notification is a Split-connection-based solution improving the performance of wireless TCP.

13. Which of the following statements about 4G LTE security is/are true?

    - Your answer _____ (A) 4G LTE security uses asymmetric cryptography. (B) The shared key is maintained at both user (SIM) and infrastructure (authentication center). (C) AS security enables the ciphering and integrity protection of user data transmitted over the air. (D) NAS Security enables ciphering and integrity protection of NAS signaling transmitted between user equipment (e.g., phones) and controllers (i.e., MMEs). (E) 4G LTE does not support mutual authentication, whereas 5G does.

14. Which steps are not needed when setting up data service in 3G/4G networks?

    - Your answer _____ (A) set up radio connectivity ; (B) device needs to register (i.e., attach) to the carrier network; (C) sending device needs to explicitly obtain the receiver's permission before sending data; (D) set up connectivity context such as IP address and routing path.

15. Which of the following statements on LTE call support is/are true?

    - Your answer ____ (A) CSFB uses the 3G data service to support voice calls. (B) VoLTE uses packet switching and ensures quality of service for call message delivery. (C) Both CSFB and VoLTE support best-effort voice call quality similar to Skype. (D) CSFB can ensure guaranteed call quality but VoLTE cannot. (E) Neither CSFB nor VoLTE uses circuit-switched delivery.

16. Which is true for mobile data charging?

    - Your answer _____ (A) It can never incur inaccurate charging; (B) Users may be over-charged due to wireless link losses; (C) Users can be under-charged due to wireless link losses;(D) Users can be undercharged during roaming.

17. Which statement is true for VoLTE?

    - Your answer _____ (A) It uses the legacy 3G for voice call; (B) Data sessions are migrated to 3G during VoLTE calls; (C) It never uses SIP for call signaling; (D) The voice packets for VoLTE are delivered with higher priority than data from Web browsing.

Problem 2 (24 points; 3 points each): Answer the following questions. Be brief and concise.

1. In wireless transmission (Lecture 3), the collision occurs at the receiver side rather than the transmitter side. Please briefly explain why.

2. Identify a usage scenario why wireless TCP needs to take different congestion control actions compared with the wired TCP.

3. Assume the 4G LTE network is always faster than the 3G network. Suppose you are downloading a large movie file over your LTE network when a voice call is coming. Which case has faster file downloading speed during your call, CSFB or VoLTE? Briefly justify your answer.

4. In the Distributed Fair Scheduling, how to ensure wireless hosts will not select the same backoff interval? Briefly justify your answer.

5. In the telecommunication networks, a design principle, "Smart CORE, Dumb Terminal", is adopted. Please discuss advantages of this design principles. Hint: Cost.

6. Adversaries can increase the monthly bill of smartwatche users by launching a great number of unestablished VoLTE call attempts to them? Hint: volume-based charging and time-based charging methods for bearers in 4G LTE networks.

7. Why is challenging for cellular IoT service operators to accurately identify the user device by RF-fingerprinting based approaches? Hint: please refer to the reading assignment.

8. In IMS-based SMS security paper, 3GPP2 allows operators to disable IPSec for IMS services and only enable radio network security (i.e., enabling secure wireless communications between mobile devices and base stations), whereas 3GPP stipulates that IPSec MUST be always enabled for IMS services. Assume that there exists no malicious software installed on mobile devices. Please discuss the benefits when IPSec is disabled.

Problem 3: MAC Protocol (8 points) You are asked to design a wireless MAC for broadcast video streaming services (one sender and multiple receivers) in a restricted setting: The network setting has no AP infrastructure deployed, and a single wireless channel is shared among all nodes. If there is only a single sender and 30 receivers. Assume that the receiver needs to reply with with an individual ACK upon each DATA transmitted by the sender. The sender thus will receive multiple ACKs for each DATA transmission. With a large number of receivers, the ACK explosion problem will occur (i.e., the sender will receive many ACKs). However, these ACKs are important information for the sender to adjust the video transmission rate. For example, if the sender knows that most receivers have successfully received DATA at the rate of X Mbps, the sender can further increase the transmission rate and provide receivers the video in a higher resolution (e.g., 8K). Please design a mechanism that allows the sender to determine whether the transmission rate should be decreased or increased, while preventing the ACK explosion problem. Assume that the sender knows the number of receivers in advance. You are allowed to use any signaling message you know.

Problem 4: Power Save for 802.11 wireless networks (8 points) An 802.11 wireless interface consumes significant amount of power when it transmits/receives frames, while its consumption is minimized when it is in sleep mode. Design a simple Power Save algorithm for 802.11 devices that operate in the ad-hoc mode, which means that the 802.11 devices need to determine when they can go to sleep mode by their own. Consider factors such as frames available for transmission, frame losses. State clearly your assumptions.

Problem 4: 4G LTE Data and Voice (9 points) The 4G LTE network provides universal coverage, but the signal can be bad in the indoor environments and it is charged (based on the usage volume); WiFi is free and fast, but is not available in every place. You are asked to design a solution for your smartphone, so that it can intelligently select the right network given the current setting where the user is staying. Note that once users' packets arrive at 4G P-GW, users need to pay for these packets no matter users receive these packets or these packets are successfully transmitted to recipients.

1. (4 points) If Wi-Fi is not available in the outdoor environment, Can the user be overcharged by the LTE operator? Which of the following settings can incur unbounded overcharging? (1) UDP flows; (2) TCP flows. Briefly justify your answer. Assume that UDP flows are for broadcasting video services.

2. (3 points) Under what conditions should you switch your phone from LTE to Wi-Fi? Under what conditions should you switch your phone from Wi-Fi to LTE?

3. (2 points) Can the switching between LTE and Wi-Fi lead to overcharging to users?