Department of Computer Science and Engineering
National Sun Yat-sen University
First Semester of 2026 PhD Qualifying Exam

Subject： COMPUTER NETWORK

Answer all 10 questions. Each question is worth 10 points. The total score is 100 points.

1. (10 points) Compare circuit switching and packet switching in terms of resource allocation, connection establishment behavior, and performance guarantees (e.g., bandwidth, delay, and packet loss). Clearly state the fundamental design trade-off between the two approaches.
2. The Internet uses a layered architecture to provide a modular framework for communication.
   (a) (5 points) Describe the five-layer Internet protocol stack. For each layer, briefly state its primary responsibility.
   (b) (5 points) Explain the process of protocol encapsulation as a message moves down the sender's protocol stack. Describe how header fields added at each layer enable the receiver to perform demultiplexing and correctly deliver the data to the intended application.
3. The Domain Name System (DNS) is a critical Internet application.
   (a) (5 points) Explain why DNS is implemented as a distributed, hierarchical database rather than a centralized system.
   (b) (5 points) Analyze how caching in DNS improves performance and scalability, and discuss one potential drawback of DNS caching.
4. In digital video streaming, compression and adaptive delivery are fundamental to maintaining Quality of Service (QoS). Answer the following questions regarding video coding and Dynamic Adaptive Streaming over HTTP (DASH):
   (a) (4 points) Explain how spatial coding and temporal coding reduce the required coding rate.
   (b) (6 points) In the context of DASH, describe the operations for the following:
   - Server-side: How does the server store the video content?
   - Client-side: How does the client initiate a streaming session and subsequently "pull" data? What specific information does the client use to determine which video segment to request next?
5. In TCP congestion control, the sender maintains a state variable called the Congestion Window (*cwnd*) to limit the amount of unacknowledged data in the network.
   (a) (5 points) Contrast the evolution of *cwnd* during the Slow Start and Congestion Avoidance phases. Specifically, (i) describe the mathematical growth rate of *cwnd* in each phase, and (ii) define the role of the slow start threshold (*ssthresh*) and state the exact condition that triggers the transition from Slow Start to Congestion Avoidance.
   (b) (5 points) TCP interprets different loss events as signals of varying congestion severity.

Explain the sender's reaction to the following events, focusing on the resulting values of *cwnd* and *ssthresh*: (i) Triple duplicate ACKs, and (ii) timeout event

6. Answer the following regarding Dynamic Host Configuration Protocol (DHCP).
   (a) (5 points) Describe the DHCP address allocation process, clearly explaining the purpose of each message exchanged during initial host configuration.
   (b) (5 points) Explain why DHCP is implemented as an application-layer protocol over UDP rather than TCP.
7. The End-to-End principle is a foundational design principle of the Internet.
   (a) (5 points) State and explain the End-to-End principle. In your explanation, describe its original motivation and the types of network functions it argues should reside at the endpoints versus the network core.
   (b) (5 points) With the integration of HTTP/3 over QUIC, features like connection migration and encryption are implemented above IP at the endpoints. Analyze how this evolution impacts the End-to-End principle. Does it strengthen or weaken the transparency of the network core?
8. Software-Defined Networking (SDN) replaces destination-based forwarding with generalized forwarding using match-action rules.
   (a) (6 points) Describe destination-based forwarding and generalized forwarding in terms of (i) packet header fields examined, (ii) forwarding actions supported, and (iii) control-plane implications.
   (b) (4 points) Explain how a single OpenFlow flow table can simultaneously function as (i) a router, and (ii) a NAT (Network Address Translation) device. Your answer should refer to match-action rules.
9. Routing protocols are generally classified into global (link-state) and decentralized (distance-vector) algorithms.
   (a) (5 points) Using link-state routing as an example, explain how routers obtain and maintain a consistent view of the network topology. In your answer, discuss: (i) the dissemination mechanism for topology information, (ii) the role of shortest-path computation, and (iii) one limitation that arises when link costs depend on dynamic traffic load.
   (b) (5 points) Using distance-vector routing as an example, explain how routing information is computed and exchanged in a decentralized manner. In your answer, describe: (i) the role of the Bellman-Ford equation, (ii) the iterative update process, and (iii) the cause of the count-to-infinity problem, including a concrete scenario.
10. Multiple access protocols are used to share a broadcast communication channel among multiple nodes.
    (a) (5 points) Briefly describe the operating principles of TDMA, FDMA, and slotted ALOHA.
    (b) (5 points) Under what specific traffic conditions does TDMA outperform Slotted ALOHA, and vice versa?