Computer Networks – Lab 07 (NS3) – Concept + Practical Q&A; Revision

■ Objective

Understand NS3 network simulator, basic network simulation setup, and TCP congestion control mechanism with practical graph plotting.

■ Conceptual Questions and Answers

Q1: NS3 kya hai aur iska use kya hai?

NS3 ek discrete-event network simulator hai jo virtual environment mein networking protocols (TCP, UDP, Routing, Wireless) simulate karta hai bina real hardware ke. It is used for testing and research in networking.

Q2: Point-to-Point link kya hota hai?

Ye ek direct wired connection hoti hai do nodes ke beech – jaise ek tar jo sirf 2 computers ko connect karti hai. Isse data directly dono ke darmiyan transfer hota hai. In NS3: PointToPointHelper use karke link banate hain aur DataRate & Delay set karte hain.

Q3: NodeContainer kya karta hai?

NodeContainer multiple nodes (computers) create aur manage karta hai. Example: nodes.Create(2) do virtual computers banata hai.

Q4: InternetStackHelper ka role kya hai?

Ye TCP/IP stack install karta hai nodes pe taake wo internet protocols use kar saken (jaise TCP aur UDP).

Q5: Ipv4AddressHelper ka role kya hai?

Ye har node ko unique IP address assign karta hai. Example: address.SetBase('10.1.1.0', '255.255.255.0');

Q6: Simulator::Run() aur Simulator::Destroy() ka kaam kya hai?

Simulator::Run() simulation start karta hai aur scheduled events execute karta hai, jabke Simulator::Destroy() memory free karke simulation end karta hai.

Q7: UdpEchoClientHelper aur UdpEchoServerHelper kya karte hain?

Ye do applications simulate karte hain jahan ek server data receive karta hai aur ek client data send karta hai.

■ TCP Congestion Control Mechanism

- 1■■ **Slow Start:** TCP apni speed exponential tarike se badhata hai (1, 2, 4, 8...).
- 2■■ **Congestion Avoidance:** Jab ssthresh cross karta hai to window size linearly increase karta hai.
- 3■■ **Congestion Detection:** Jab packet loss hoti hai to CWND (congestion window) half ho jata hai (multiplicative decrease).

■ TCP Variants

TCP Tahoe: Packet loss hone par CWND = 1 kar deta hai aur slow start se restart karta hai.
TCP Reno: Fast Recovery use karta hai – loss ke baad CWND = ssthresh (half) hota hai, jisse speed recover fast hoti hai.
TCP NewReno / Cubic: Reno ke improved versions hain, jisme better performance aur stability hoti hai.

■ Common Exam Questions (with Answers)

Q1: TCP ke 3 phases kya hain?

Slow Start (exponential growth), Congestion Avoidance (linear growth), aur Congestion Detection (multiplicative decrease).

Q2: TCP Reno aur Tahoe mein kya difference hai?

Tahoe har loss ke baad CWND = 1 karta hai, jabke Reno Fast Recovery use karta hai aur CWND = ssthresh (half) karta hai, isliye Reno zyada efficient hai.

Q3: ssthresh kya hota hai?

ssthresh ka matlab Slow Start Threshold. Jab CWND isse cross karta hai, TCP exponential se linear growth par chala jata hai.

Q4: CWND kya represent karta hai?

CWND yaani Congestion Window represent karta hai ki TCP ek time mein kitna data bhej sakta hai bina ACK ke.

■ Practical / Code Based Tasks

- DataRate aur Delay modify karo in PointToPoint link.
- Ek extra node add karo aur usko connect karo.
- UDP client ke Packet Size ya Interval change karo.
- TCP variant (Tahoe, Reno, NewReno) implement karo aur output observe karo.
- AnimationInterface use karke XML animation output generate karo.
- Congestion Window (CWND) trace enable karo aur graph plot karo.

■ Steps to Apply TCP Congestion Control and Plot CWND Graph

- 1■■ NS3 folder open karo aur terminal mein enter karo.
- 2■■ Run karo built-in example: ./waf --run 'tcp-variants-comparison --transport_prot=TcpNewReno --tracing=1'
- 3■■ Ye cwnd trace file generate karega (e.g., cwndTraceNewReno).
- 4■■ Graph plot karne ke liye gnuplot use karo:
- plot 'cwndTraceNewReno' using 1:2 with linespoints title 'CWND Graph'
- 5■■ Optional: Custom C++ script likh ke cwnd_trace.txt log karo aur plot banao.

■ Tip: Exam mein mostly code modification aur conceptual mix questions aayenge. Commands, TCP phases aur attributes yaad rakho (DataRate, Delay, PacketSize, Interval, ssthresh, CWND).