ICT Answer

Q1 Throughput, Delay, and Packet Loss

Q2 HTTP

Q3 hierarchical (or similar)

Q4 UDP

Q5 all packets not yet acked (or similar)

Q6 doubling or increasing exponentially

Q7 Forwarding and Routing

Q8 port

Q9:

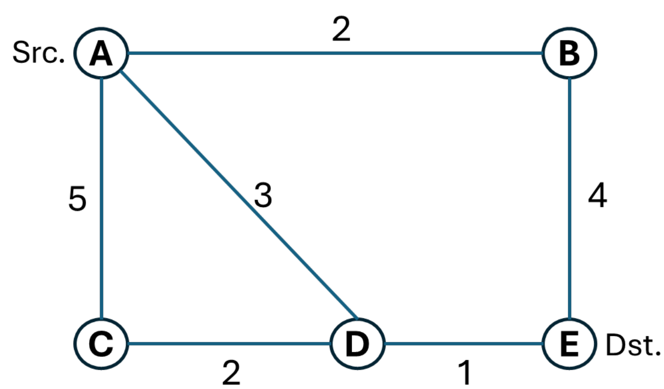

Fig. 1: Network topology.

(a) The network topology above illustrates the link costs between routers (nodes) A, B, C, D, and E, where node A is the source (Src.) and node E is the destination (Dst.). Each number on the link represents the cost (or distance) between two directly connected nodes. Assume all links are bidirectional and all nodes initially know the direct link costs of their neighbors.

i. Explain the main principle behind the Distance Vector algorithm and how each node updates its routing table.

Answer

The Distance Vector (DV) routing algorithm is a distributed routing protocol in which each router maintains a table (distance vector) that stores the minimum cost to reach every destination and the next hop to use.

Main principle:

- Each router knows only:
  - The cost to its directly connected neighbors
  - The distance vectors received from those neighbors
- Routers periodically exchange their distance vectors with neighbors.
- Routing decisions are made using the Bellman–Ford algorithm.

Routing table update rule:

For each destination d, a router x computes:

$$D_x(d) = \min_{v \in \text{Neighbors}(x)} [c(x, v) + D_v(d)]$$

where:

- $D_x(d)$= cost from router $x$to destination d
- $c(x, v)$= cost of the link between $x$and neighbor v
- $D_v(d)$= neighbor v's advertised distance to d

If a lower-cost path is found, the routing table is updated with:

- The new minimum cost
- The next-hop neighbor that provides that cost

This process continues iteratively until all routers converge to stable shortest paths.

ii. Using the Bellman-Ford equation, compute the minimum cost path from source node A to destination node E.

Answer:

Using the Bellman-Ford (BF) equation, node A computes the minimum cost to reach destination E by evaluating all possible paths via its neighbors.

At node A:

$$D_A(E) = \min[c(A, B) + D_B(E),\ c(A, C) + D_C(E),\ c(A, D) + D_D(E)]$$

$$D_A(E) = \min[2 + 4,\ 5 + 3,\ 3 + 1]$$

$$D_A(E) = \min[6,\ 8,\ 4]$$

Minimum cost $D_A(E) = 4$

Minimum cost path = A → D → E

Q10:

(b) A national government network (AS-Gov) connects to a large telecommunication ISP (AS-ISP) that provides upstream Internet access. A nearby university campus network (AS-Uni) also connects to the same ISP for Internet access. The AS-Gov must securely exchange data with AS-Uni for research collaboration, but both must keep their internal routing policies private. Using this scenario:

i. How do AS-Gov and AS-Uni establish eBGP sessions with AS-ISP to advertise their reachability information?

Answer:

To exchange routing information while preserving internal policies:

- AS-Gov establishes an eBGP session with AS-ISP via their gateway routers
- AS-Uni also establishes a separate eBGP session with AS-ISP via their gateway routers

How eBGP works here:

- AS-Gov advertises its own reachability information to AS-ISP using its gateway router
- AS-Uni advertises its own reachability information to AS-ISP using its gateway router
- AS-ISP acts as a transit AS, forwarding routes between the two using its gateway routers
- Internal routing policies and topologies of AS-Gov and AS-Uni are not exposed

This ensures:

- Secure inter-domain connectivity
- Policy control at AS boundaries
- Scalability and administrative independence

ii. How does each domain/AS use iBGP internally to disseminate learned routes to routers inside its own network?

Answer:

Within each AS:

- iBGP (internal BGP) is used to distribute routes learned via eBGP
- Routes received from AS-ISP are propagated to all internal routers via each of AS-Gov and AS-Uni's gateway routers
- iBGP does not modify AS-PATH attributes
- This ensures all routers within each AS have a consistent view of external routes

This ensures:

- Internal routers can forward traffic correctly to external destinations
- Internal routing policies remain private and controlled