Homework assignment

1. Consider routing in a network with 180 routers, and on average every router is connected to 5 other routers. Routing information is exchanged every 120 msec. How much network bandwidth is used under link-state and distance vector routing to exchange this information. Assume sequence numbers are used to damp flood packets for link-state. Please explain any assumptions you make about the size of routing table entries.
   - 6 pts

Assumptions:

- **Size of Routing Table Entries**: We assume each entry for both protocols has an approximate size of **40 bytes**. This size is reasonable for typical network routing entries, which include an IP address, sequence number (for link-state), cost metric, and necessary headers.
- **Link-State Routing Updates**: Every router sends information about its directly connected neighbors to all other routers in the network. Each entry (link-state advertisement or LSA) includes each neighbor, so for 5 neighbors, each router generates 5 entries.
- **Distance Vector Routing Updates**: Each router sends its entire routing table to its immediate neighbors, not the entire network. We assume every router's table has an entry for each router (180 entries) in the network.

Link-State Routing

1. **Total Entries per Router**: Each router sends information about its 5 links.
2. **Size of LSA Update Packet**: Each LSA entry is 40 bytes, so a router's update is $5 \bullet 40 = 200$ bytes.
3. **Flooding Frequency**: Routing information is exchanged every 120 ms.
4. **Total Data Sent Across the Network**:
   - Since the protocol floods the network, every router's LSA is sent across every link.
   - For 180 routers, the total LSA data per exchange is:

     $$180 \times 200 = 36,000 \text{ bytes}$$

5. **Bandwidth per Second**:

$$\text{Bandwidth} = \frac{36\ 000\ bytes}{0.12\ sec} = 300,000\ bytes/sec = 300\ KBps$$

Distance Vector Routing

1. **Routing Table Size**: Each router's table has 180 entries, one for each router.
2. **Size of Distance Vector Update**: For each router, the update size is

   $180 \times 40 = 7,200\ bytes.$

3. **Updates Sent per Neighbor**: Each router sends its distance vector to its 5 neighbors, so the total data sent per router per exchange is:

   $5 \times 7,200 = 36,000\ bytes$

4. **Total Data Sent Across the Network**:

   $180 \times 36,000 = 6,480,000\ bytes$

5. **Bandwidth per Second**:

$$\text{Bandwidth} = \frac{6{,}480{,}000\ bytes}{0.12\ sec} = 54,000,000\ bytes/sec = 54\ MBps$$

- **Link-State Routing**: 300 KBps
- **Distance Vector Routing**: 54 MBps (significantly higher due to each router sending the entire routing table to each neighbor)

2. How can flooding and broadcast be said to be similar to each other? How do they differ? Name *one* way in which they are similar/different.
   - 2 pts

Similarity:

- Both flooding and broadcast aim to distribute information to multiple recipients. In both methods, the message is spread across the network, potentially reaching every node.

Difference:

- Flooding: Packets are forwarded indiscriminately, potentially causing duplicates, as each router forwards to all its neighbors except the one it received the packet from.
- Broadcast: A controlled method where each packet is forwarded once per node or link, often leveraging spanning trees to avoid duplicates.

3. Split horizon does not always help in avoiding the count-to-infinity problem. Illustrate a case where it fails (make routing tables - show 2 iterations).
   - 2 pts

Example Scenario: Consider a network with three routers, A, B, and C, connected in a line as follows:

- Router A <-> Router B <-> Router C

Initially:

- A has a route to C through B with a distance of 2.
- B has a direct route to C with a distance of 1.
- C is directly connected to B.

Routing Tables after Initial Setup:

1. **Router A**:
   - C via B, distance 2
2. **Router B**:
   - C directly, distance 1
   - A directly, distance 1
3. **Router C**:
   - B directly, distance 1

Step 1 - Link Break between B and C:

- Now, B loses its direct link to C, so B sets its distance to C as infinity.

Step 2 - Exchange After Split Horizon:

- **Router A** (still has C through B at distance 2):
  - A will not inform B about the route to C (due to split horizon).
- **Router B**:
  - B assumes C is unreachable and starts updating its table.

After several iterations without split horizon help, A and B may start believing that a route to C exists again (falsely incrementing distances).