R2

Group 1 Observations

Probe Distribution by TTL:

Upon examining TTL-specific packets using Wireshark filters (e.g., `ip.ttl == 1`, `ip.ttl == 2`, etc.), it is confirmed that each TTL value consistently corresponds to three probes in all five trace files. This triple-probing method ensures redundancy and allows for more accurate path reconstruction and RTT measurements.

Summary of Probe Counts per TTL:

- All Traces (1–5): 3 probes per TTL

Path Variations in Final Hops:

Focusing on routers from hop 12 onward, we identify discrepancies in IPs across traces, especially in hops 12–16. This indicates dynamic routing behavior.

Hop	T1	T2	T3	T4	T5
12	74.125.37.91	72.14.237.123	74.125.37.91	74.125.37.91	72.14.237.123
13	72.14.237.123	74.125.37.91	72.14.237.123	72.14.237.123	209.85.249.153
14	209.85.249.155	209.85.249.109	209.85.247.63	209.85.246.219	209.85.250.59
15	209.85.250.121	209.85.250.57	209.85.245.65	209.85.250.123	209.85.247.61
16	209.85.249.153	209.85.246.219	209.85.249.155	209.85.245.65	-

Possible Reasons for Variations:

- Load balancing across multiple routers.

- Temporary congestion rerouting.

- Backend routing policy updates.

Group 2 Observations

Probe Frequency:

Mirroring Group 1, every TTL in Group 2 traces sees exactly three probe packets. This uniformity confirms the same methodology was used in both groups.

Path Consistency:

Unlike Group 1, Group 2 paths remain identical across all five traces. The routing path to the final destination (8.8.8.8) remains constant.

Stable Hop-by-Hop Path:

- 1. 192.168.0.1
- 2. 24.108.0.1
- 3. 64.59.161.197
- 4. 66.163.72.26
- 5. 66.163.68.18
- 6. 72.14.221.102
- 7. 108.170.245.113
- 8. 209.85.249.249
- 9. 8.8.8.8 *(Final Destination)*

Latency (RTT) Measurements by TTL:

TTL	T1 (ms)	T2 (ms)	T3 (ms)	T4 (ms)	T5 (ms)
1	3.33	2.71	7.85	3.42	1.75
2	15.81	17.12	11.84	13.25	16.15
3	18.87	20.10	22.58	21.67	21.60
4	22.84	19.42	19.46	19.75	18.56
5	26.50	21.56	20.32	35.77	20.72
6	24.26	19.98	21.85	22.67	43.47
7	18.41	51.66	22.76	18.34	26.92
8	22.97	108.74	20.59	24.57	25.62
9	18.10	21.91	23.14	19.94	21.44

Analysis of High-Latency Hops:

- Hop 8 (209.85.249.249): Extremely high delay in Trace 2 (108.74 ms), suggesting temporary congestion.

- Hop 7 (108.170.245.113): Also showed elevated RTT in Trace 2 (51.66 ms).

Likely Causes of Delay:

- Queuing delays due to congestion.

- Route instability or failover mechanisms.

- Load balancing triggering alternate processing paths.