Internet Measurements with Prespecified Timestamps

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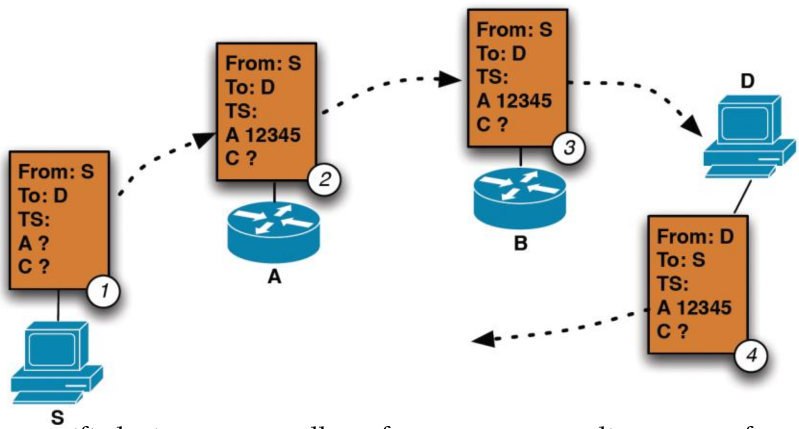
Conventional Wisdom: IP Options like the Prespecified Timestamp Option are rarely supported, and even when supported, are implemented in unusable and inconsistent ways.

Reality: IP Prespecified Timestamps are <u>supported by over 25% of IP addresses</u> on the Internet, with a limited set of easily-identifiable implementations. IP Prespecified Timestamps provide <u>unique measurement insights</u> with multi-address queries in a single probe, timestamp clock values, and reverse path visibility. <u>Timestamps are a valuable asset to the measurement toolkit.</u>



Prespecified timestamps allow for a source to list up to four IP addresses in order. If a router recognizes it's own IP address as the first unstamped address, it will provide a timestamp before forwarding.

Are addresses responsive to timestamp requests?

- **56%** respond with timestamp values
- **17%** respond, but without timestamps
- **27%** drop the packet or encounter filters

*Values from **ping-responsive** IP addresses discovered in a day's iPlane traceroutes*

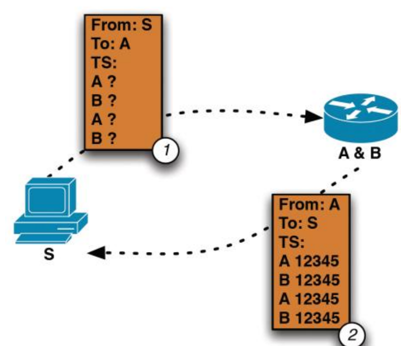
Practical Uses of Prespecified Timestamps

IP Alias Resolution

How do we identify when two IP addresses belong to the same router?

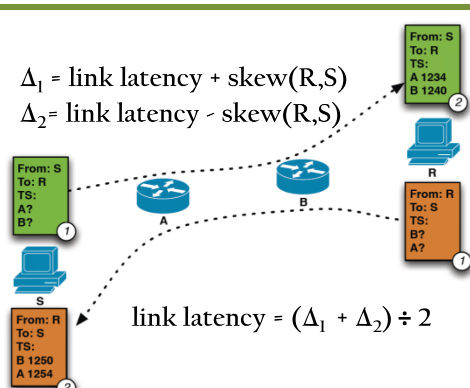
Why? IP aliases are necessary for generating accurate maps of Internet topologies.

Solution: Send probes combining prespecified timestamp requests to two IP addresses A,B suspected to belong to the same machine. Infer alias pairs from identical clock values (a shared clock) and implied looped forwarding between A and B (generally impossible under destination-based routing).



One-Way Latency

How long will it take a packet to traverse a single backbone link one way?



Δ_1 = link latency + skew(R,S)
Δ_2 = link latency - skew(R,S)

link latency = $(\Delta_1 + \Delta_2) \div 2$

Why? Many applications, such as IP geolocation, depend on fine grained latency measurements.

Solution: Send probes forward and reverse across the same link. Calculate delta by subtracting first timestamp from the second. After using algebraic manipulation to cancel out clock skew, we are left with one-way latency of the link.