Adaptive Source Routing and Packet Replication in Wide-area Networks

Oliver Michel, University of Vienna

ADVISORS: Ashish Vulimiri and P. Brighten Godfrey

Background

- Today’s routing techniques on the Internet rely completely on decisions made within the network.
- Lacking an end-to-end view, today’s strategies often react slowly to dynamics and do not take into account the type of traffic routed.
- Let sources define the path along which a packet traverses the network!
- Source routing offers a range of opportunities for optimization of today’s Internet routing and traffic engineering, e.g., multi-path routing, path selection, and packet replication.

Path Selection

- Make routing decisions based on continuous end-to-end measurements to optimize end-to-end performance.
- Simple heuristics can be applied to select the best from a set of end-to-end paths.
- Sources can optimize different metrics such as latency, loss rate, or throughput.

More is Less

- Low latency is critical for interactive networked applications.
- Replicate packets over multiple best performing paths simultaneously to reduce the latency-tail.
- Use whichever packet arrives first.
- Overhead for certain use-cases reasonable (e.g., TCP handshakes, DNS requests, API calls).
- Live run experiments on PlanetLab/ProtoGENI using overlay routing over 3 different topologies (two continental U.S., one transatlantic).

Results

- Depending on the distribution of flow-sizes, the increase in network load caused by replication can be low (Figure 1).
- Intelligent path selection reduces experienced latency considerably; when multiple paths are used concurrently, previous wrong path decisions often get “corrected” (Figure 2).
- When sending multiple copies of actual payload packets over the best selected paths, the latency tail can be cut down significantly (Figure 3, Figure 4).
- Packet replication and intelligent path selection can be beneficial in a future Internet setting in which traffic sources have control over routing decisions.

Future Work

- Verification of results in a larger-scale overlay experiment on PlanetLab or using OpenFlow in the GENI meso-scale experimental facility.
- Implementation of this technique for a specific use-case or application (e.g., TCP connection establishment, DNS, critical mobile connectivity).

Figures:

- Figure 1: Total load increase for different degrees of traffic duplication.
- Figure 2: Performance of a simple moving average heuristic for path selection in a PlanetLab measurement without sending actual data compared to best path in retrospect.
- Figure 3: Latency Distribution in representative topology at a data-rate of 56kbit/s and replication over up to 3 distinct paths.
- Figure 4: Measured RTT’s in 56kbit/s experiment for 1 path and reduction when using replication (packets later than 4.5 seconds were considered lost).