Advanced Unidirectional Route Assessment

draft-amf-ippm-route-00

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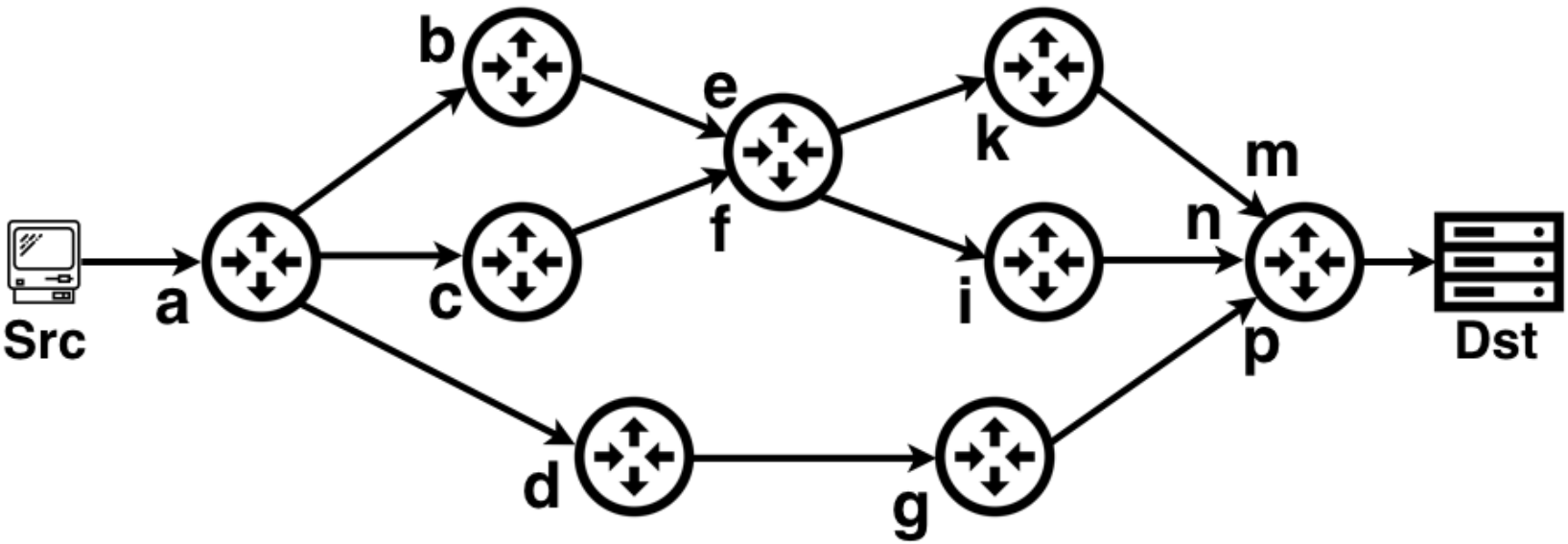
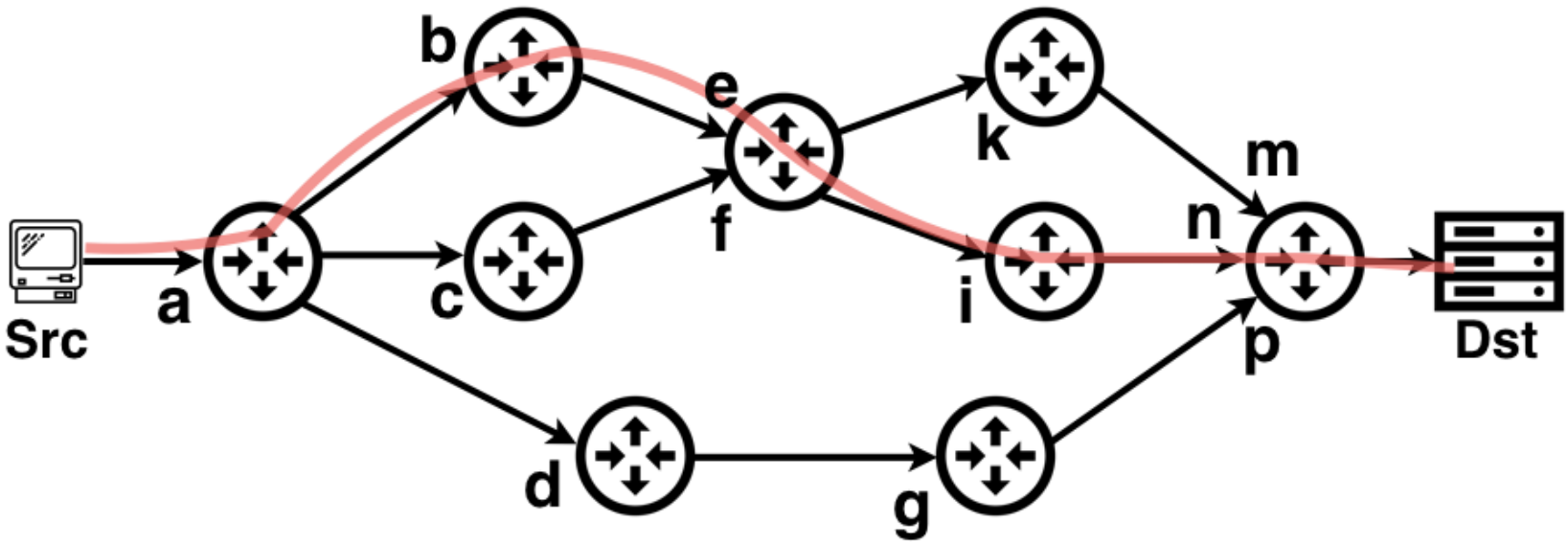
Objectives

1. new route metric (updates the section 5 of RFC2330)
2. framework for active and hybrid active-passive methods (Type I of RFC7799)
3. RTD measurements statistics

Metric Definitions



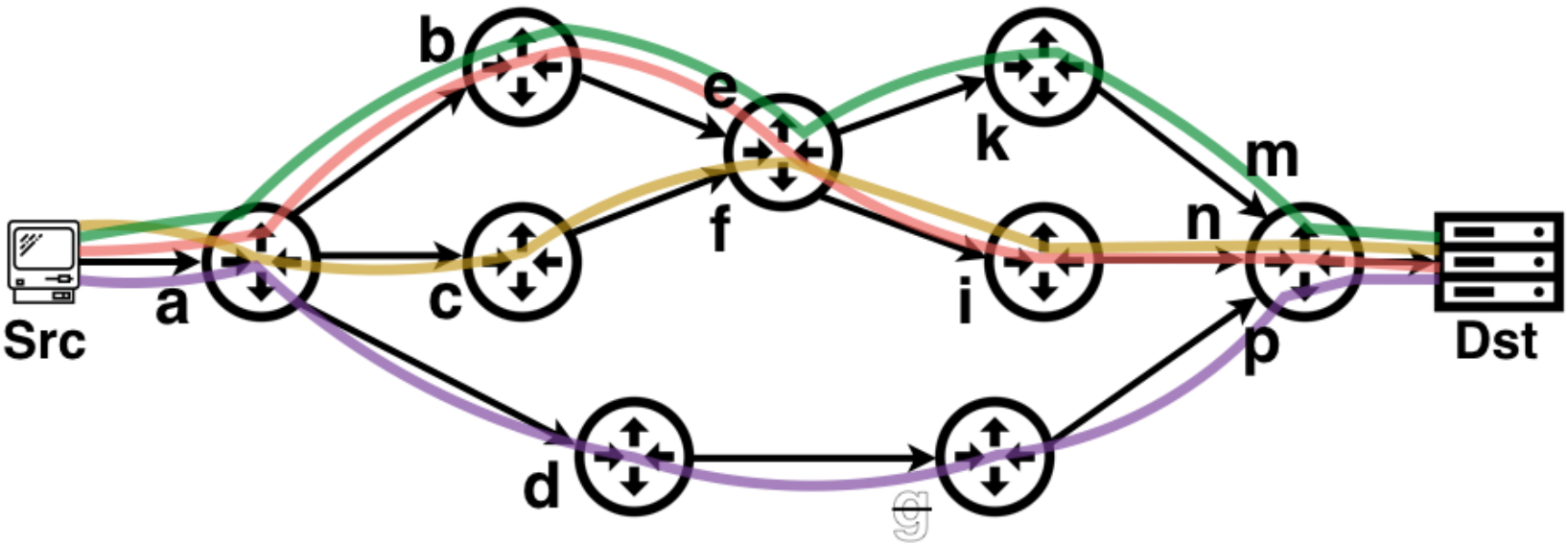
Metric Definitions II



A particular flow from the **Src** to **Dst**:

`IP@Src, IP@Dst, port-Src, port-Dsc, protocol {TCP,UDP,other}`

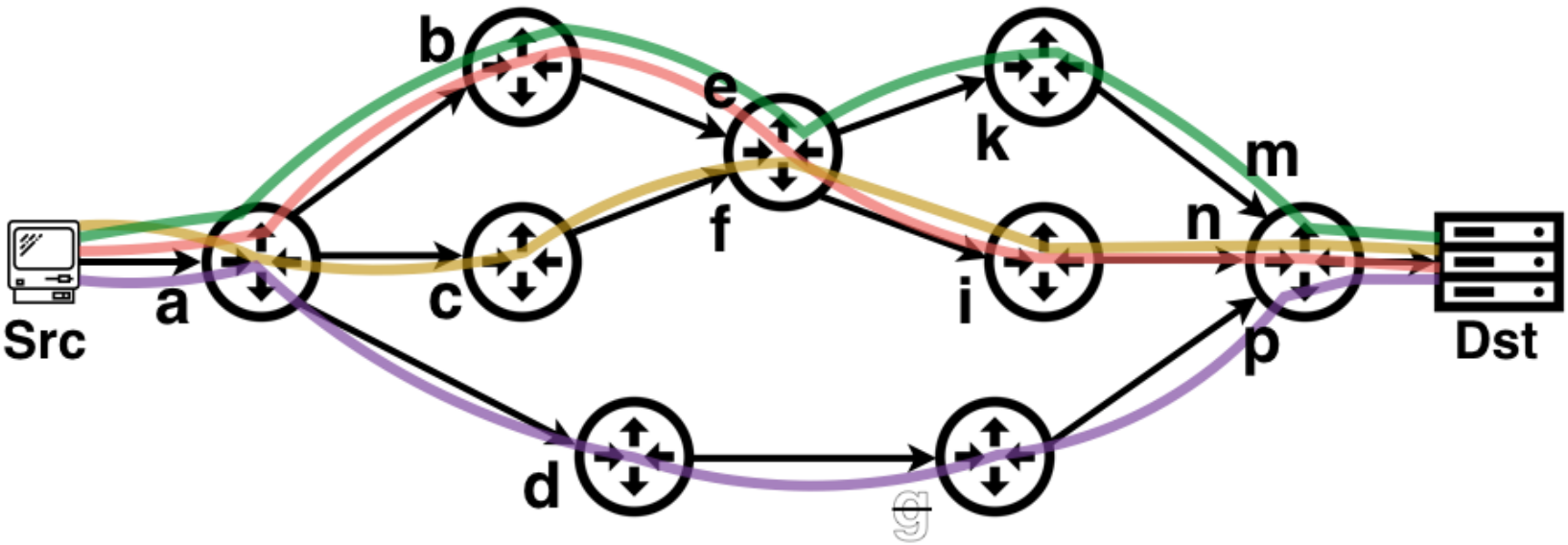
Metric Definitions III



Basic concepts:

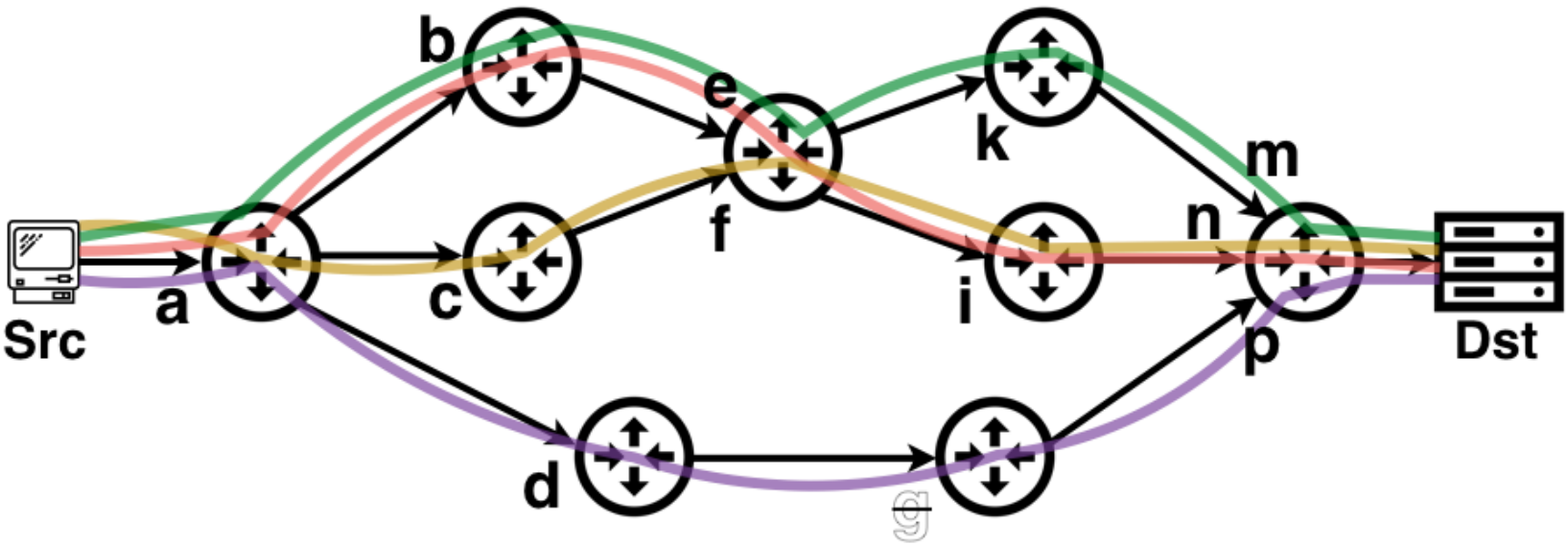
- Different flows from **Src** to **Dst**
- To measure round trip delay from **Src** to every intermediate hop i: $T(i)$
- **Host identification**: IP (ingress interface for active measurements) or alternate identifier (ioam)
- Discoverable: host identifies himself according to RFC1122 (g does not decrement TTL, not discoverable)

Metric Definitions IV



$$\begin{aligned}
\textit{Route Member} &= \Big\{T(a), T(b), T(e), T(k), T(m), Dst\} \\
\textit{Route Ensemble} &= \Big\{\{T(a), T(b), T(e), T(i), T(n), Dst\}, \\
&\quad \{T(a), T(b), T(e), T(k), T(m), Dst\}, \\
&\quad \{T(a), T(c), *^{1}, T(i), T(n), Dst\}, \\
&\quad \{T(a), T(d), T(p), Dst\}\Big\}
\end{aligned}$$

Metric Definitions V



$$\begin{aligned}
\textit{Route Member} &= \Big\{h(1,i), h(2,i), h(3,i), \ldots, h(Ni,i) = Dst\} \\
\textit{Route Ensemble} &= \Big\{\{h(1,1), h(2,1), h(3,1), \ldots, h(N1,1) = Dst\}, \\
&\quad \{h(1,2), h(2,2), h(3,2), \ldots, h(N2,2) = Dst\}, \\
&\quad \vdots \\
&\quad \{h(1,m), h(2,m), h(3,m), \ldots h(Nm,m) = Dst\}\Big\}
\end{aligned}$$

Route Assessment Methodologies

- Active Methodologies (`traceroute`)
  - **Paris traceroute** (2006): flow-wise tool
  - **Scamper** (2010): CAIDA's traceroute tool[2]
- Hybrid Methodologies
  - `draft-brockners-inband-oam-data-05`: nodes can add timestamps and route information

[2] Scamper also includes many other features.

Route Assessment Methodologies II

Type-P-Route-Ensemble-Method-Variant packets should verify:

- `TCP`: (DSCP, Src, Dst, port-Src, port-Dst) constant ⇒ same flow
- `UDP`: (DSCP, Src, Dst, port-Src, port-Dst) constant ⇒ same flow
  backward path: (UDP checksum) constant ⇒ ICMP time-exeeded
- `ICMP`: (data field) compensates TTL and IP checksum

Route Round-Trip Delay Measurement Goals

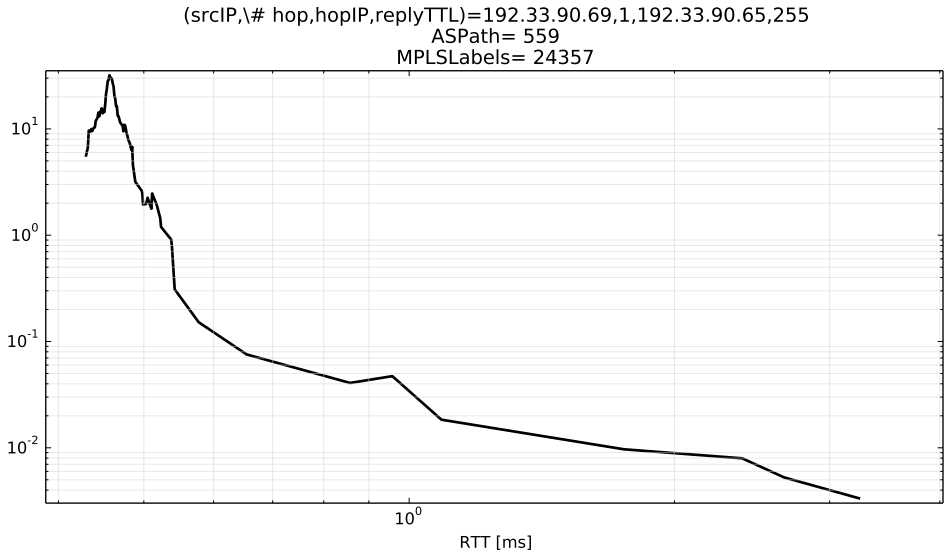
- Intercontinental submarine links[3]
- Satellite communications[2]
- Congestion[4]
- Interdomain paths [5]

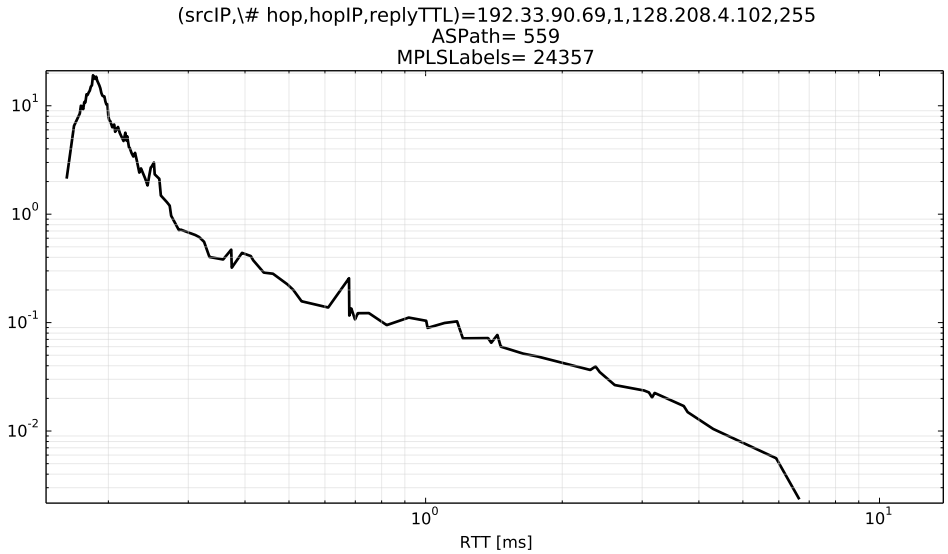
[3] Bischof, Z., Rula, J., and F. Bustamante, "In and out of Cuba: Characterizing Cuba's connectivity", In Proceedings of the 2015 ACM Conference on Internet Measurement Conference, pp. 487-493. ACM, 2015

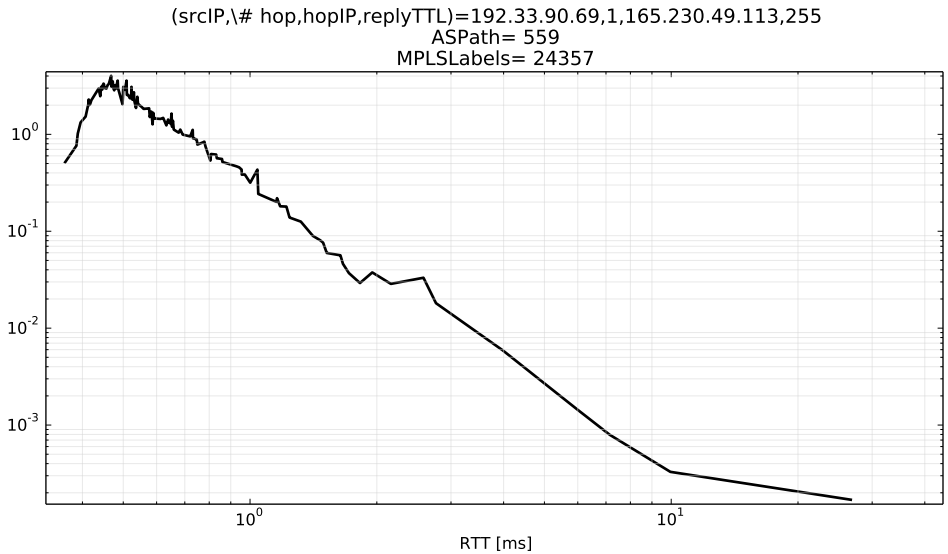
[4] Luckie, M., Dhamdhere, A., Clark, D., and B. Huffaker, "Challenges in inferring internet interdomain congestion", In Proceedings of the 2014 Conference on Internet Measurement Conference, pp. 15-22. ACM, 2014.

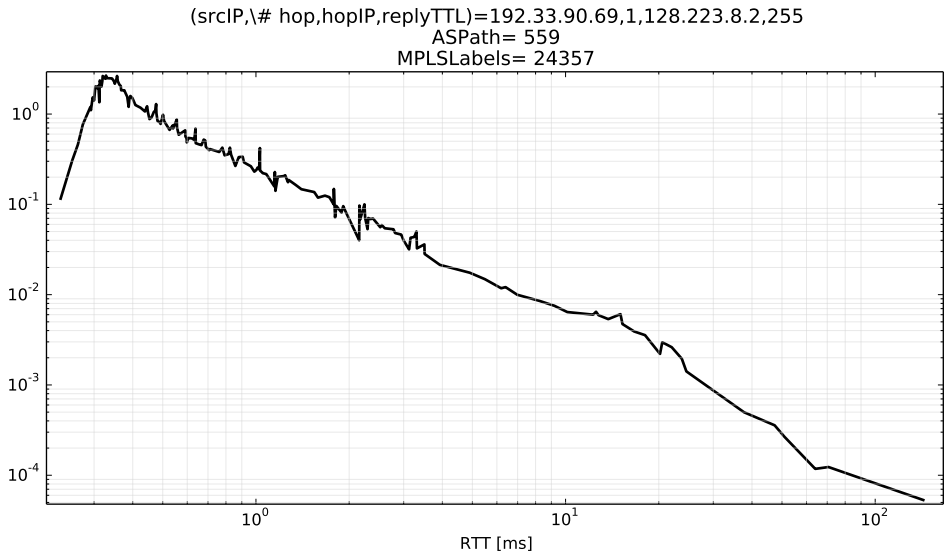
[5] Luckie, M., Dhamdhere, A., Huffaker, B., Clark, D., and KC. Claffy, "bdrmap: Inference of Borders Between IP Networks", In Proceedings of the 2016 ACM on Internet Measurement Conference, pp. 381-396. ACM, 2016.

RTD Measurements Statistics









Heavy tailed queues!

RTD Measurements Statistics II

- `traceroute`: a Paris-traceroute[6]-like tool
- quantiles for each hop (min, Q1, Q2, Q3, max)
- The P2[7] algorithm computes quantiles online

[6] Augustin, Brice, et al. "Avoiding traceroute anomalies with Paris traceroute." Proceedings of the 6th ACM SIGCOMM conference on Internet measurement. ACM, 2006.

[7] Jain, Raj, and Imrich Chlamtac. "The P 2 algorithm for dynamic calculation of quantiles and histograms without storing observations." Communications of the ACM 28.10 (1985): 1076-1085.

RTD Measurements Statistics III

```
 1  input:  W (window time of the measurement)
 2          i_t (time between two measurements)
 3          E (True: exhaustive, False: a single path)
 4          Dst (destination IP address)
 5  output: Qs (quantiles for every hop and alt in the
             path(s) to Dst)
-------------------------------------------------------
 6  T <? start_timer(W)
 7  while T is not finished do:
 8  |       start_timer(i_t)
 9  |       RTD(hop,alt) = advanced-traceroute(Dst,E)
10  |       for each hop and alt in RTD do:
11  |       |     Qs[Dst,hop,alt] <? ComputeQs(RTD(hop,alt))
12  |       done
13  |       wait until i_t timer is expired
14  done
15  return (Qs)
```

Todo

Feedback on ippm mailing list (Rüdiger Geib - thank you)!

1. **Incorporate** Standards terms from RFC 2119
2. **Define** the term Discoverable Host (RFC 1122 to start)
3. **Methodologies**: make clear what parallelism can be detected (e.g., parallel hosts at same hop) and what parallelism cannot (e.g., parallel links).
4. **Distinguish** methods by their coverage (single/multi-domain)
5. More on **how** different **methods** can be combined
6. Security considerations of **changing fields to keep checksum constant**[8], and in-situ OAM.
7. Several areas to **discuss** between the route metric and in-situ OAM teams: primarily impact on checksum after in-situ headers have been removed.
8. More feedback welcome.

[8] not seen as an issue for active measurements

http://tools.ietf.org/html/draft-amf-ippm-route-00

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