An analysis of the Internet interconnection density in IPv6 compared to IPv4

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So what is the issue?

- IPv6 latency / speed is not the same as on IPv4
- Because of:
  - MTU, tunnels, hardware, etc.
  - The peering interconnection density in v6
- The amount of interconnection density seems different in v4 and V6 for various reasons:
  - V6 is still in a test phase
  - Just new peering sessions are dual stacked
  - Etc…

How to measure density?

- Count all BGP sessions in V4 and V6 for all networks
- Unrealistic approach
- Alternatives
  - Looking Glasses
  - Route view servers
  - Etc
- To view of them and they just show the best BGP path -> incomplete view

My approach…

- Network latency is measured with ping and traceroute.
- Lets take a lot of them from a lot of sources in IPv4 and IPv6 to common destinations
  - RIPE ATLAS as the weapon of choice
  - 500 sources to 500 destinations
  - For v4 and v6
  - Use traceroutes instead of ping to get more info
  - Measuring RTT, IP Hops and ASN Hops
  - 500x500x2x3 = 1.500.000 Data Points

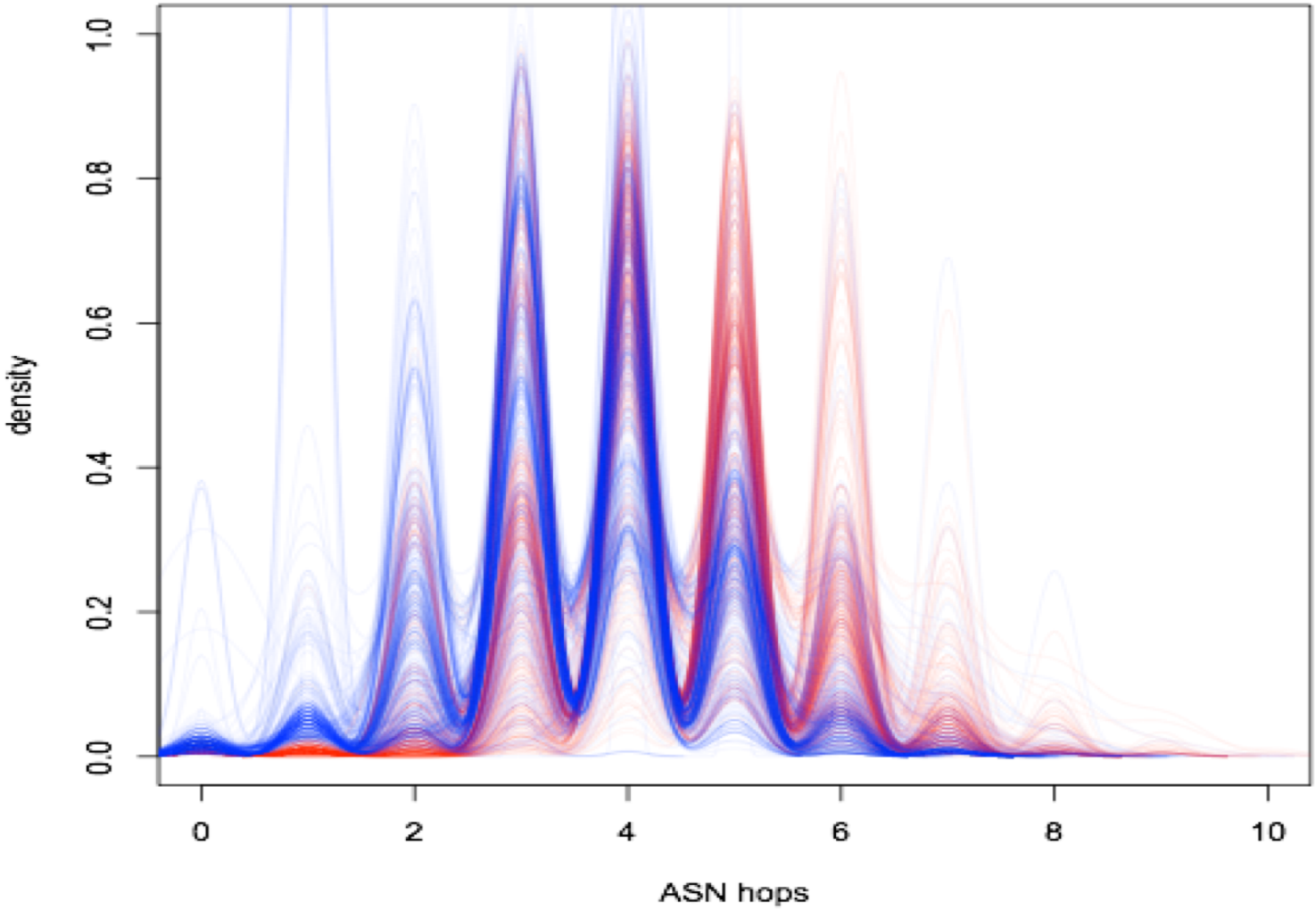
Atlas Usage

- Conducted study utilizing “random” probes in the worldwide geo scope.
  - Compiled list of 500 probes that showed v4 & v6 connectivity.
  - These same 500 probes are used measure connectivity to our 500 sites (repeatability)
  - Chosen 500 non CDN or Anycasted destinations from Alexa
- Python script invokes Atlas API to run v4 & v6 traceroutes from each probe to all 500 destinations
- Results stored on RIPE Atlas in JSON format
- Script downloads 1,000 JSON files (v4/v6 separated)

Data Crunching

- Python post-processing script
  - Fetches the ASN for each hop in traceroute
    - Enables us to determine full AS path
    - Used Team Cymru's IP to ASN database ☺
  - Records last hop RTT
  - Creates matrix report displaying Site by Probe
    - v4 & v6 RTT
    - v4 & v6 IP Hop Count
    - v4 & v6 ASN Path Count

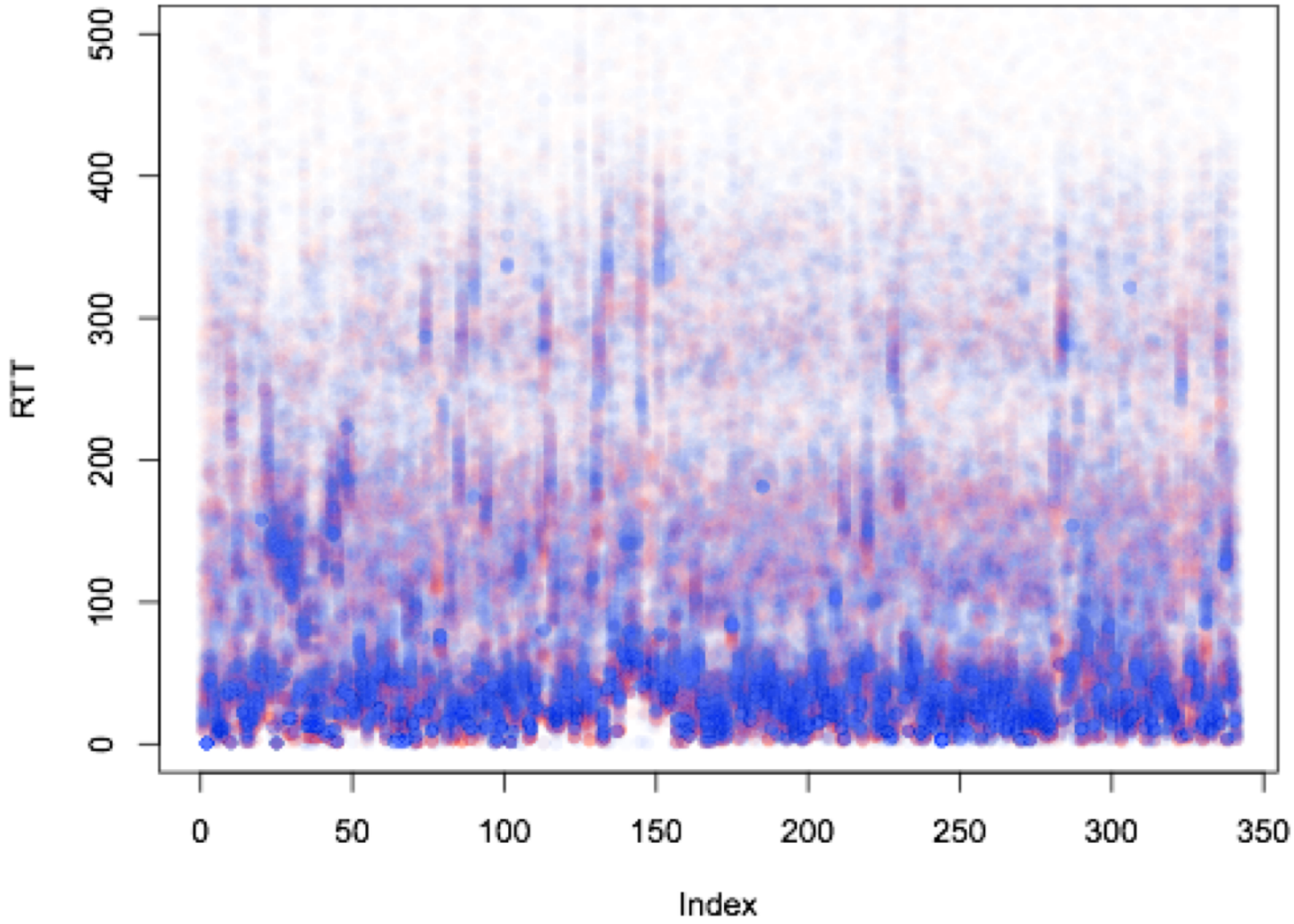
Results: ASN hop diversity



Results: ASN hop diversity

- Anomalies at hop 0 and 1 - which mainly occur in IPv6 and seem to be the result of the IPv6 over IPv4 tunnels
- IPv6 has lower ASN hop counts than IPv4. The majority of all ASN hop counts is between 2 and 6.

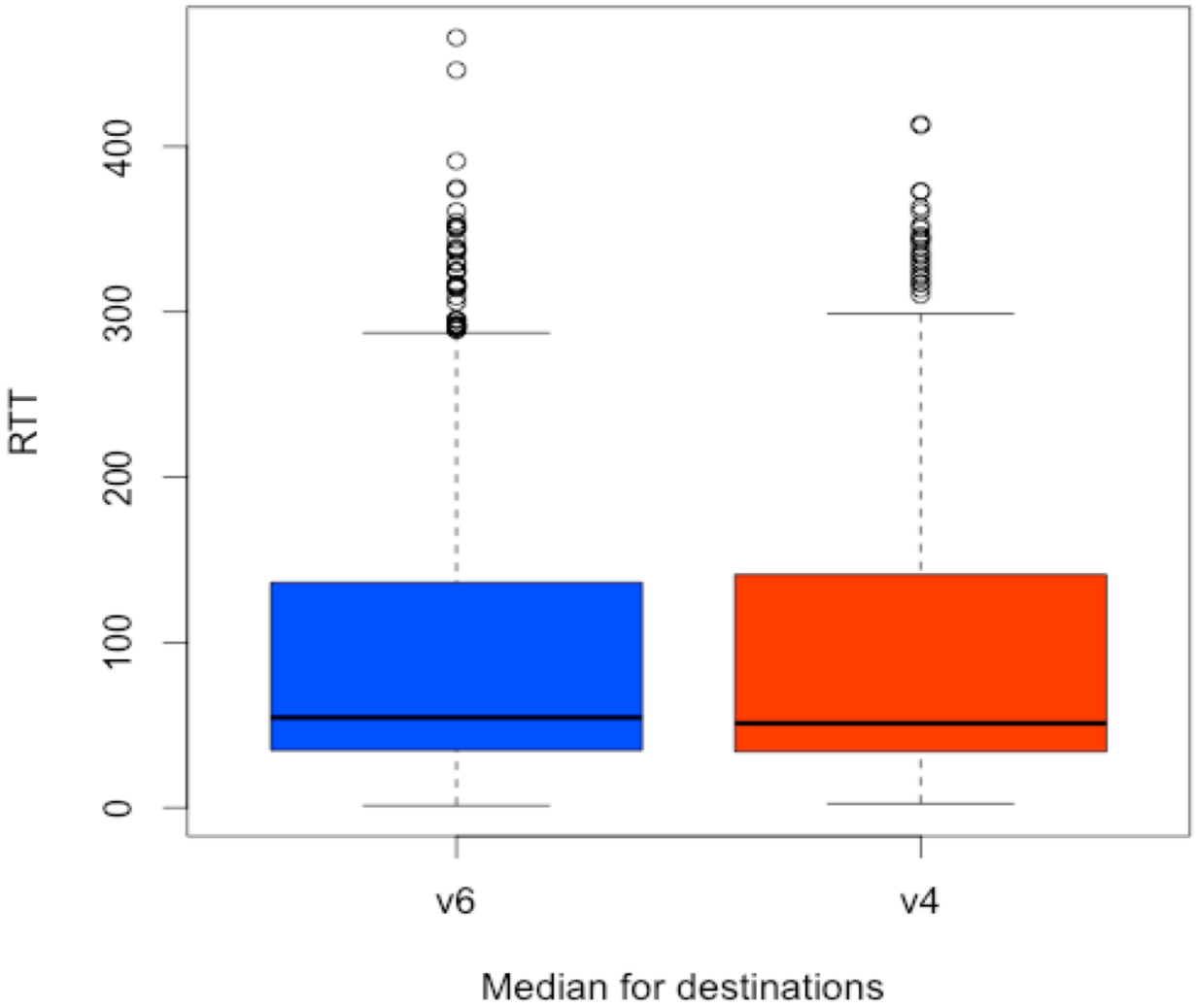
Results: RTT for all probes



Results: RTT for all probes

- The RTT diversity does not show any clustering and is widely spread over all probes
- The RTT values show a strong clustering from 0 to 75ms on the y-axis and fade then out to an arbitrarily chosen max of 500ms.

Results: Median RTT



Results: Median RTT

- The IP and ASN hop comparisons are compromised by IPv6 over IPv4 tunnels
- RTT figures on the other side are not susceptible to tunnels and will therefore show better comparable data
- The RTT results show more outliers for IPv6 but slightly less RTT spread and a slightly higher median value

Traceroute scenarios:

	ASN Path	IP Hops	Occurrence in %
Scenario 1	same	same	6
Scenario 2	same	different	24
Scenario 3	different	different	62
Scenario 4	different	same	8

Summary:

- Overall result of my Master Thesis:

-> IPv6 is not much slower – but less interconnected and less redundant then IPv4.

Questions and Comments?

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