

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
 - $500 \times 500 \times 2 \times 3 = 1.500.000$ Data Points

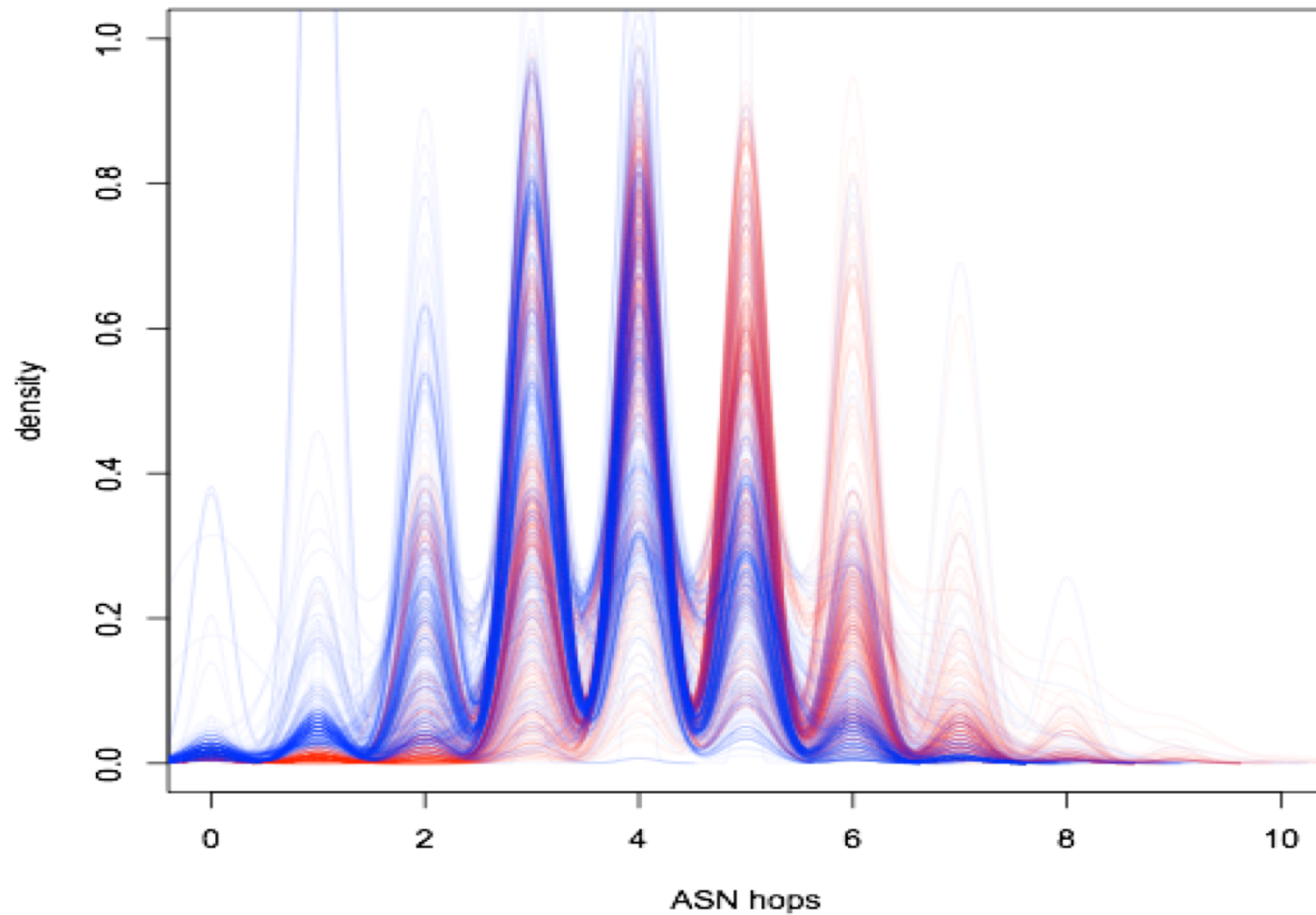
Atlas Usage

- 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)
- Python script invokes Atlas API to run v4 & v6 traceroutes from each probe to all 500 sites
- 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

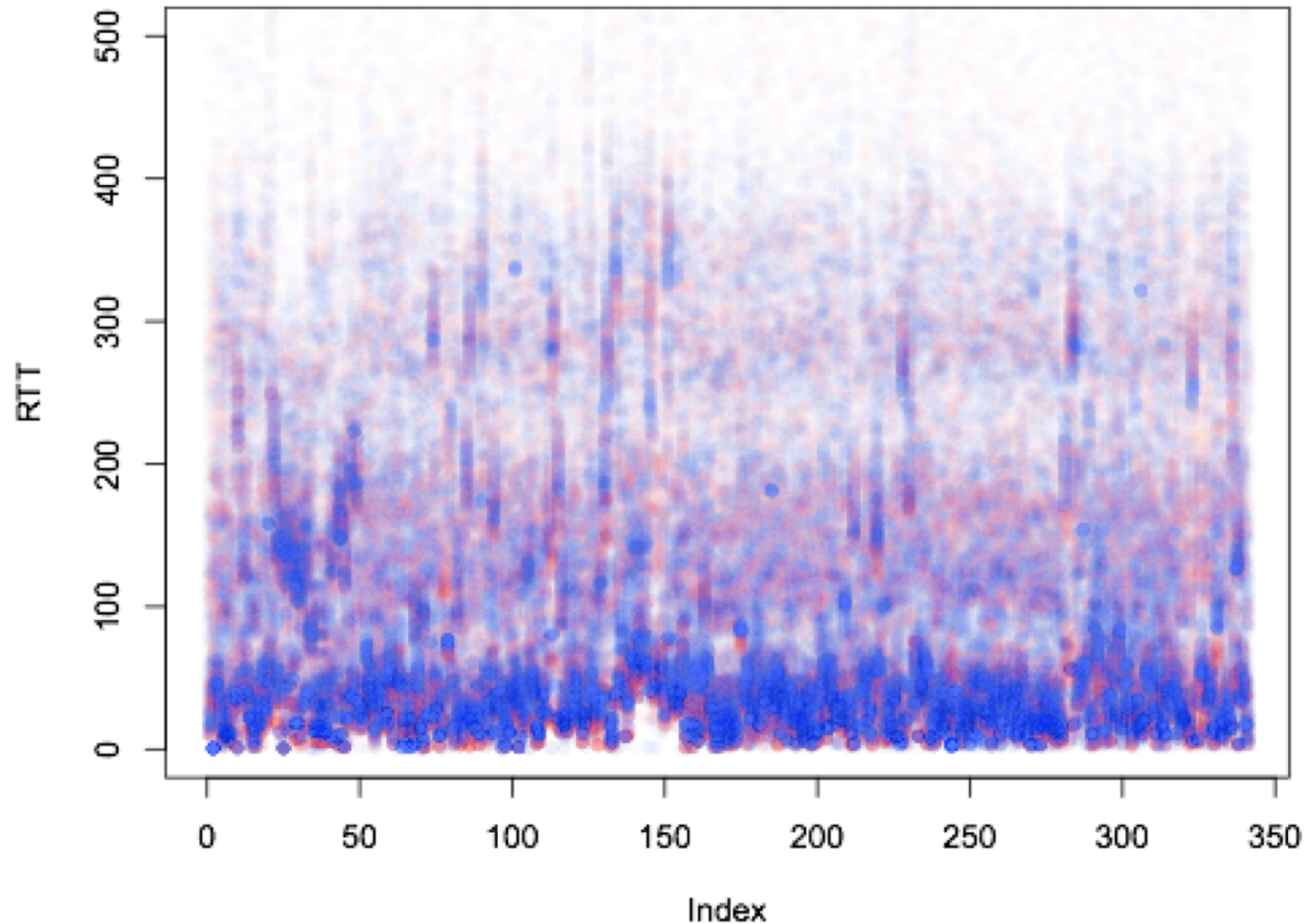
Results: ASN hop diversity



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- 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.

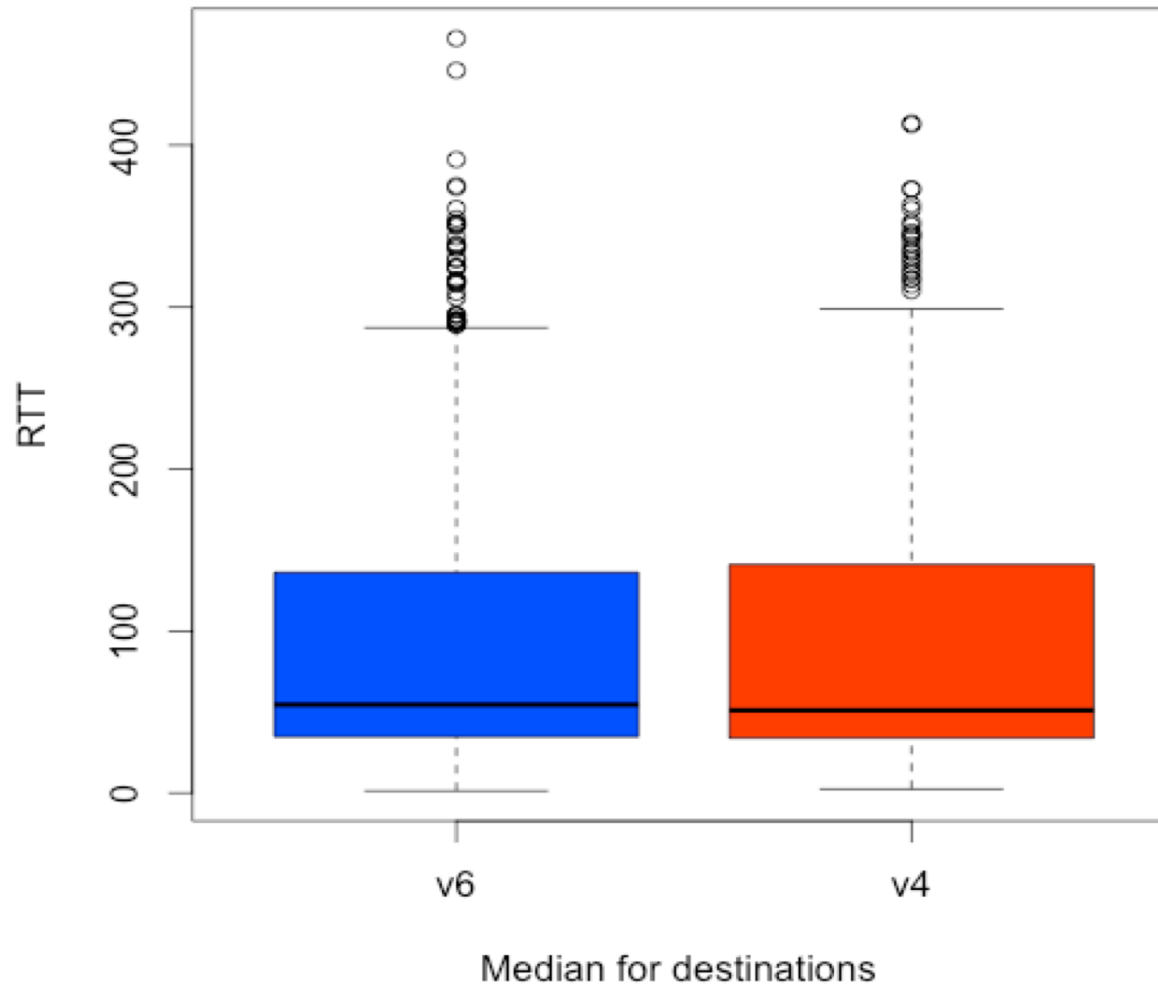
Results: RTT for all probes



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- 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



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- 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 than IPv4.

Questions and Comments?

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