IPv6 deployment: trends and tidbits of 4,800 dual-stack ASes

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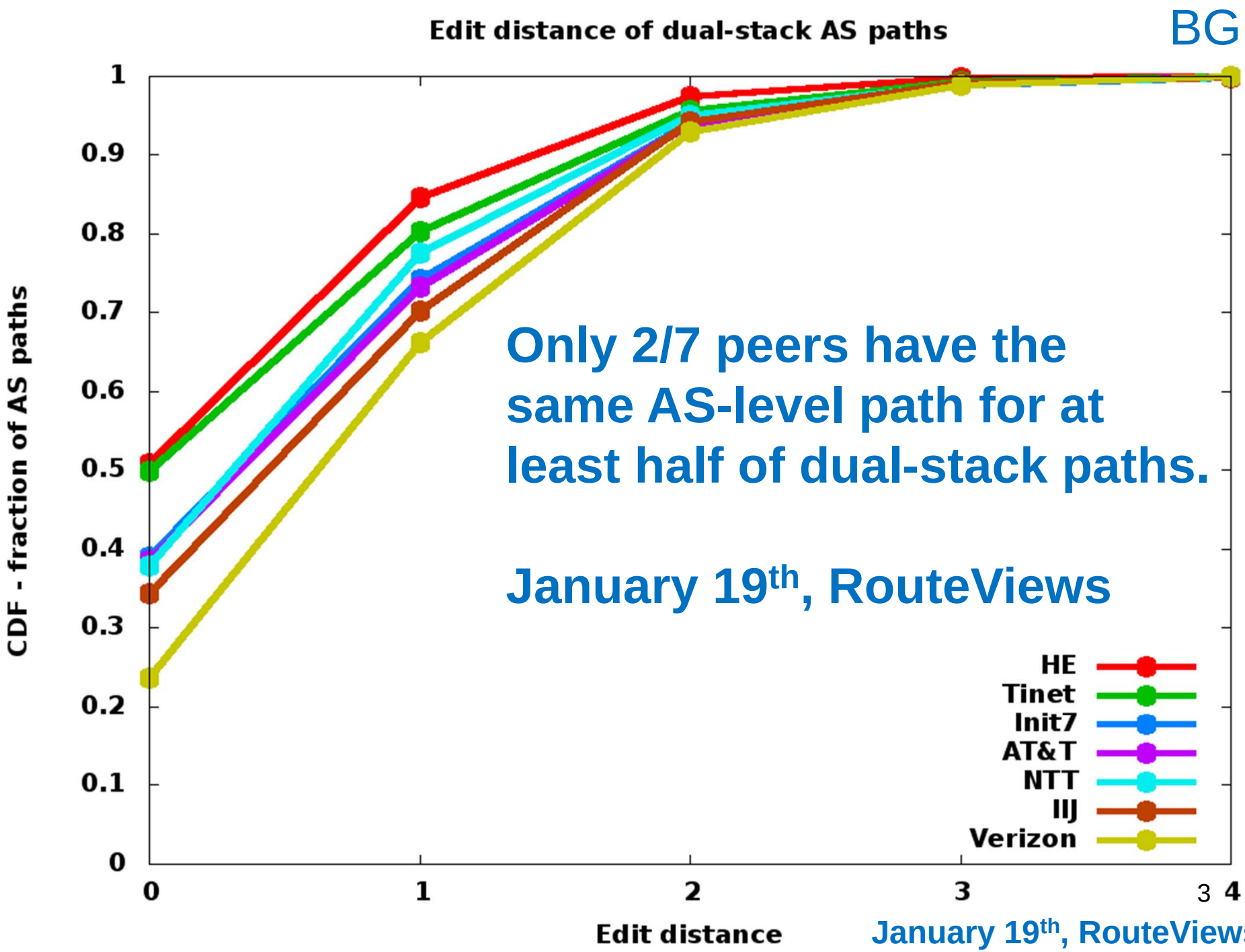
Hypothesis 1

- **In nearly all cases, IPv4 and IPv6 AS-level paths should be the same if the network is ‘mature’.**

- **Edit distance**: how many additions, subtractions, and substitutions are required to transform one string into another?
- IPv6 is ‘maturing’ if fraction of zero edit distance dual-stack paths increases over time

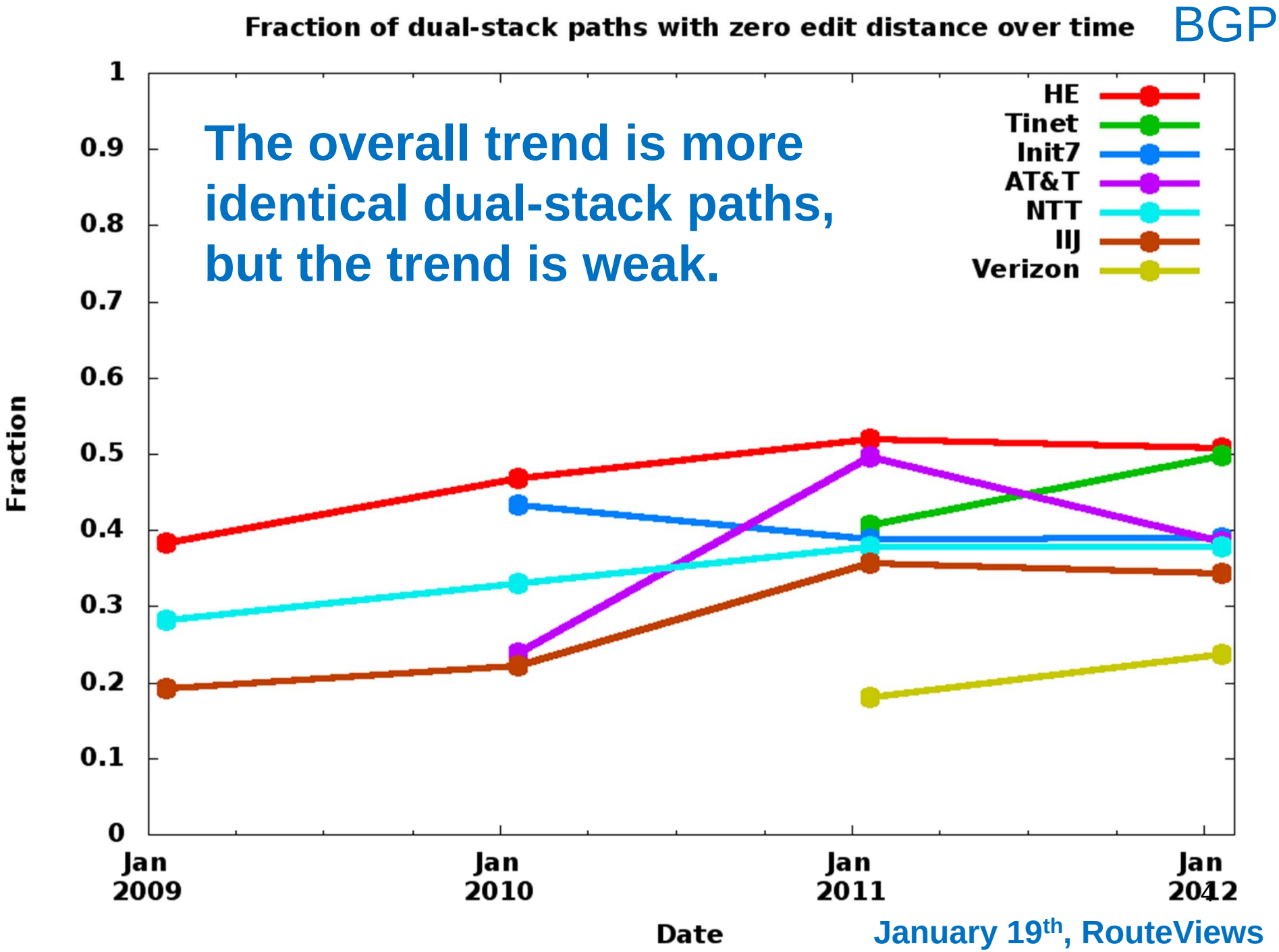


Only 2/7 peers have the same AS-level path for at least half of dual-stack paths.

January 19th, RouteViews

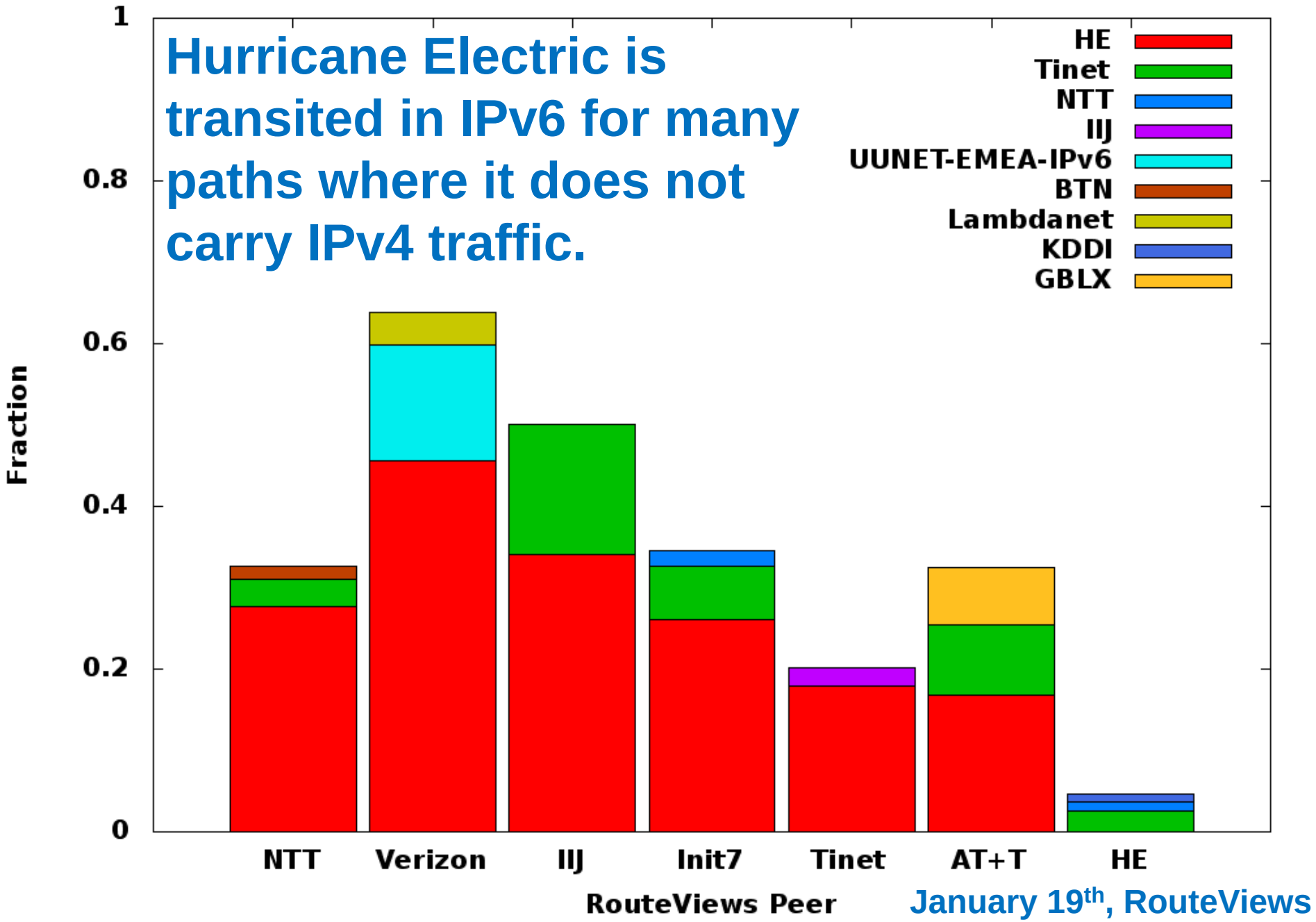
January 19th, RouteViews

BGP



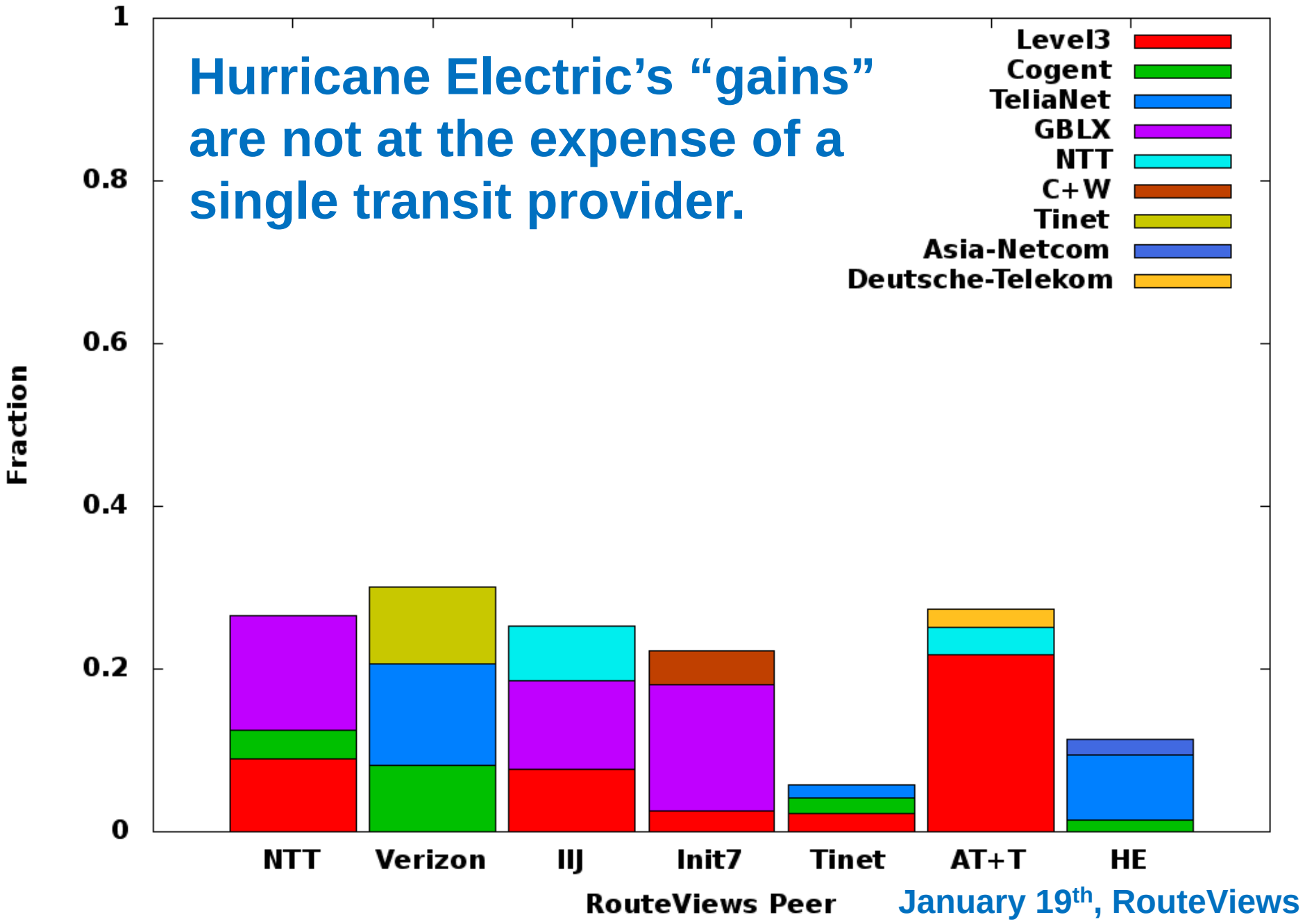
January 19th, RouteViews

BGP



January 19th, RouteViews

BGP



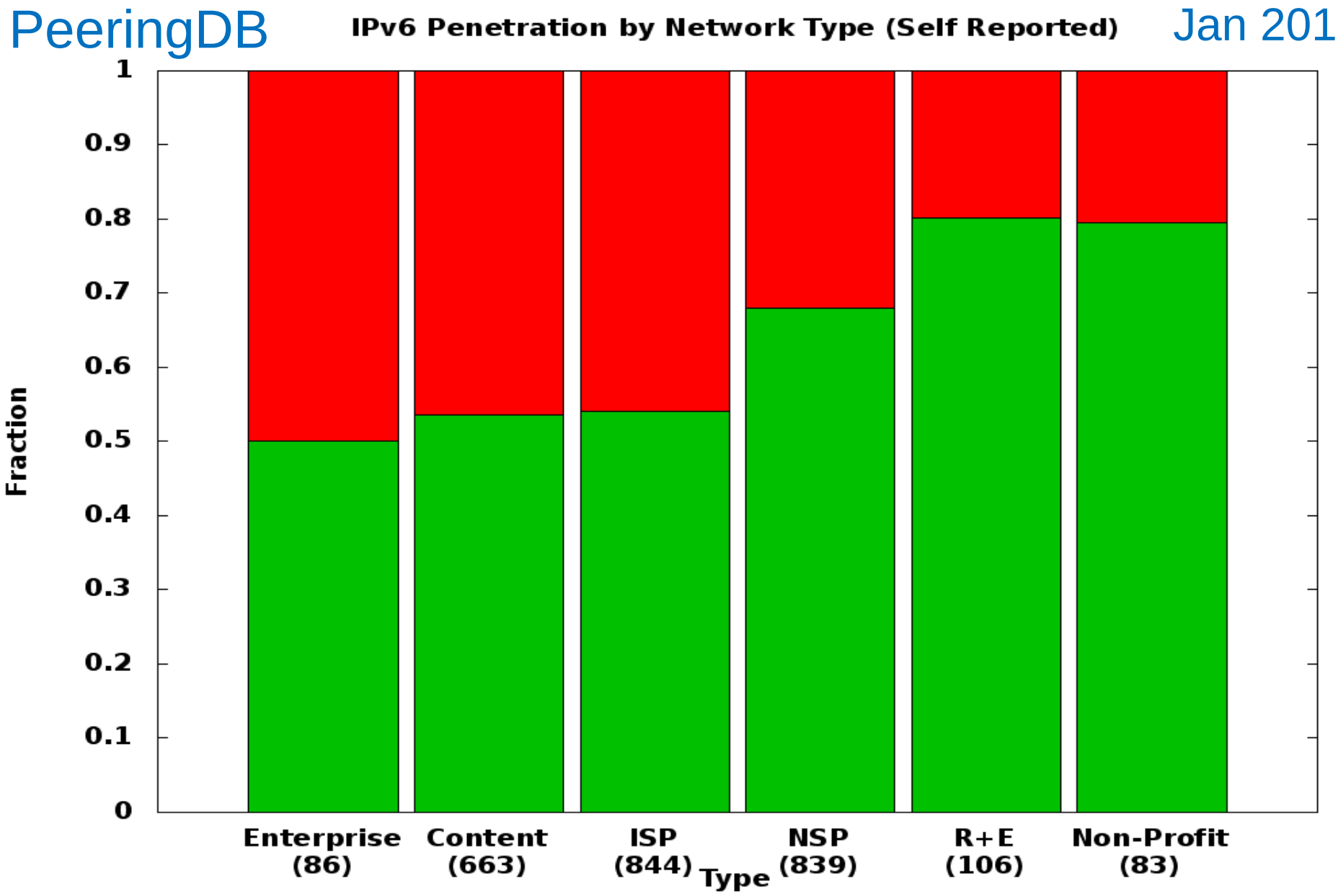
January 19th, RouteViews

Hypothesis 2

- **Does IPv6 capability correlate with network business type, bandwidth, geographic region, or RIR exhaustion?**

- **PeeringDB**: Self-selected set of ASes, large enough to want to peer and use it.
- Analyse 30th January 2012 snapshot
  - 2,622 ASes
  - 60% of networks in PeeringDB advertise themselves as “IPv6 capable”.

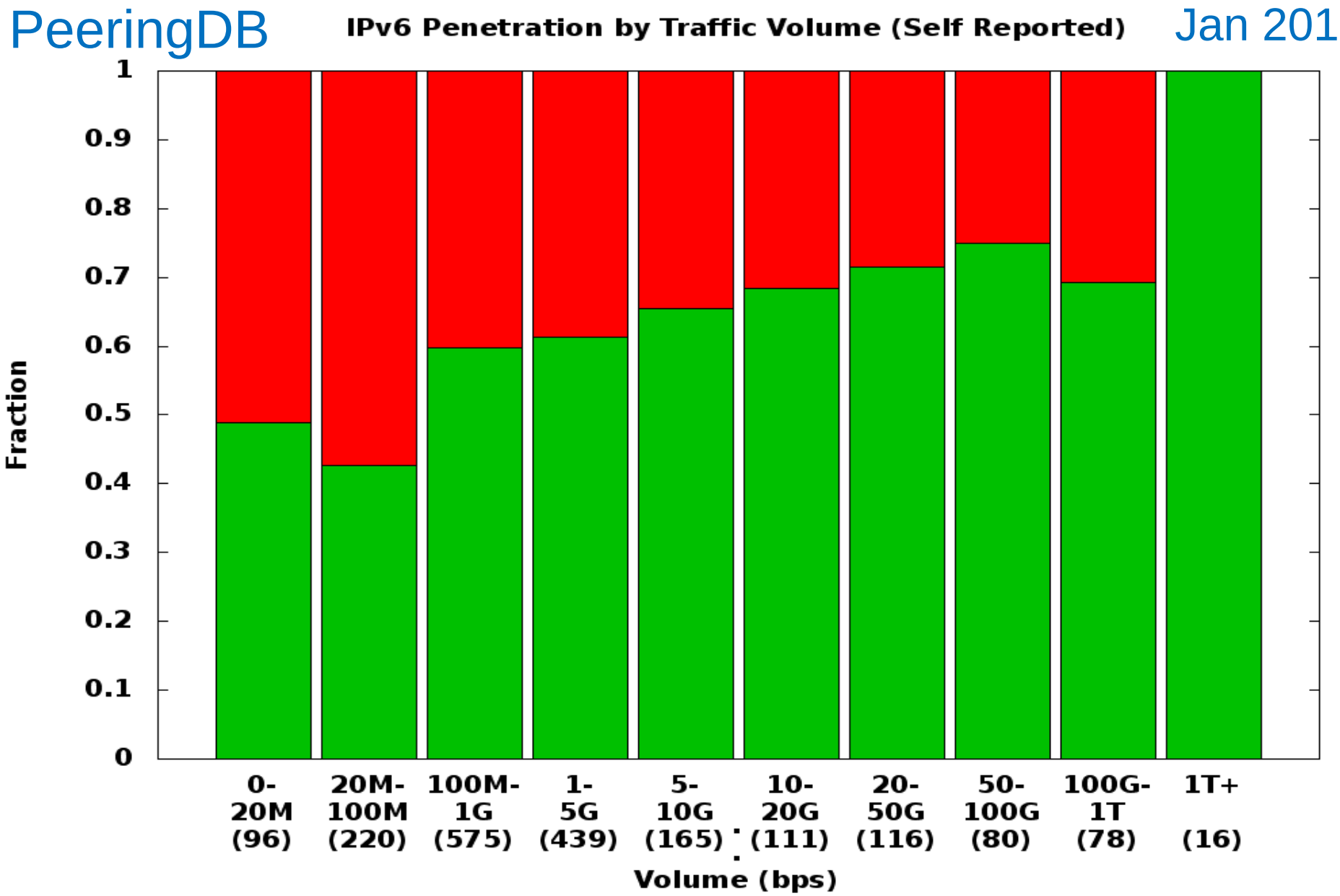
PeeringDB



Jan 2012

More NSPs than access ISPs are IPv6-capable.
Comparatively less capability in Content networks.

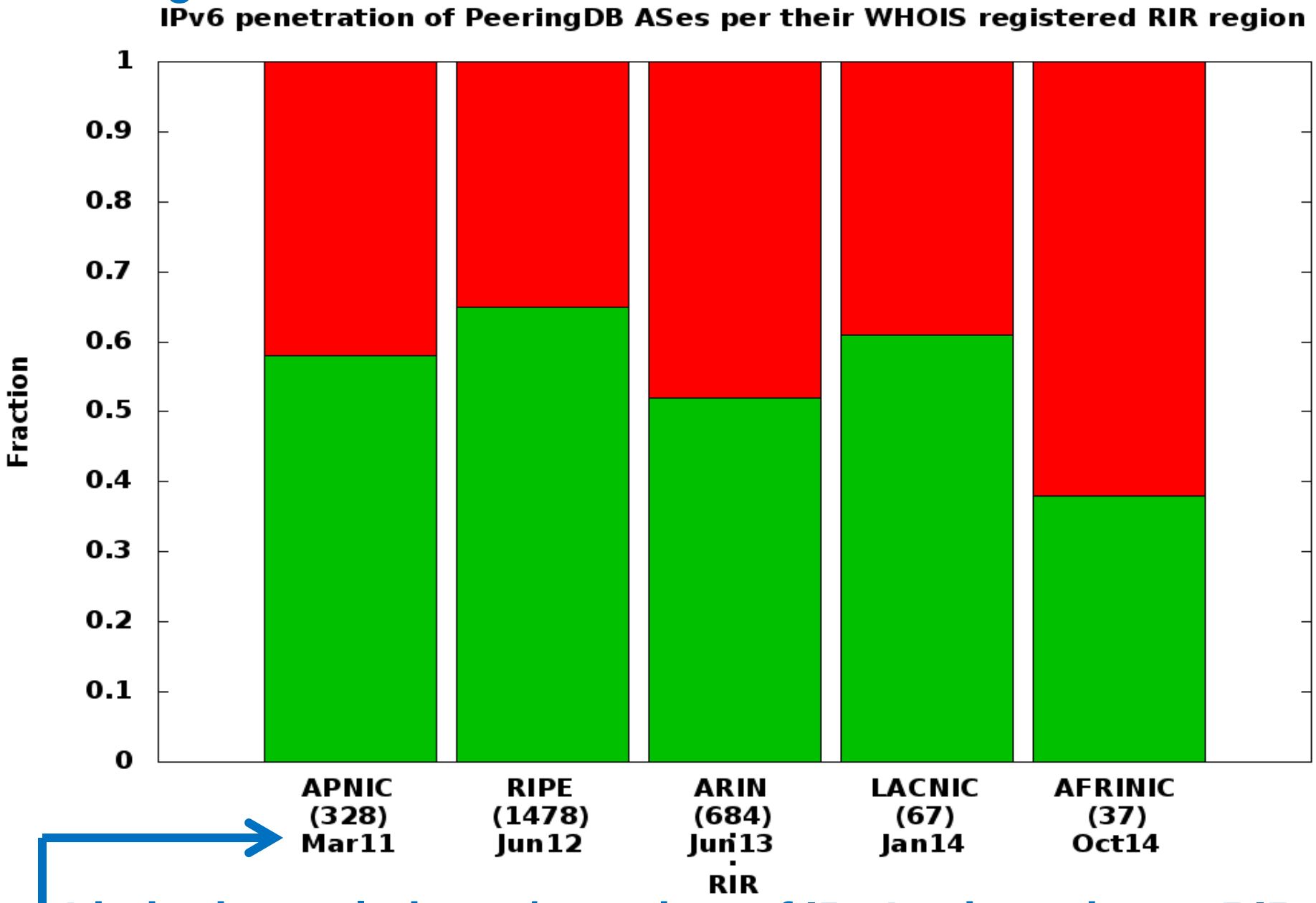
PeeringDB



The higher the reported traffic volume,
the more likely the network is to report IPv6 capability.

PeeringDB

Jan 2012



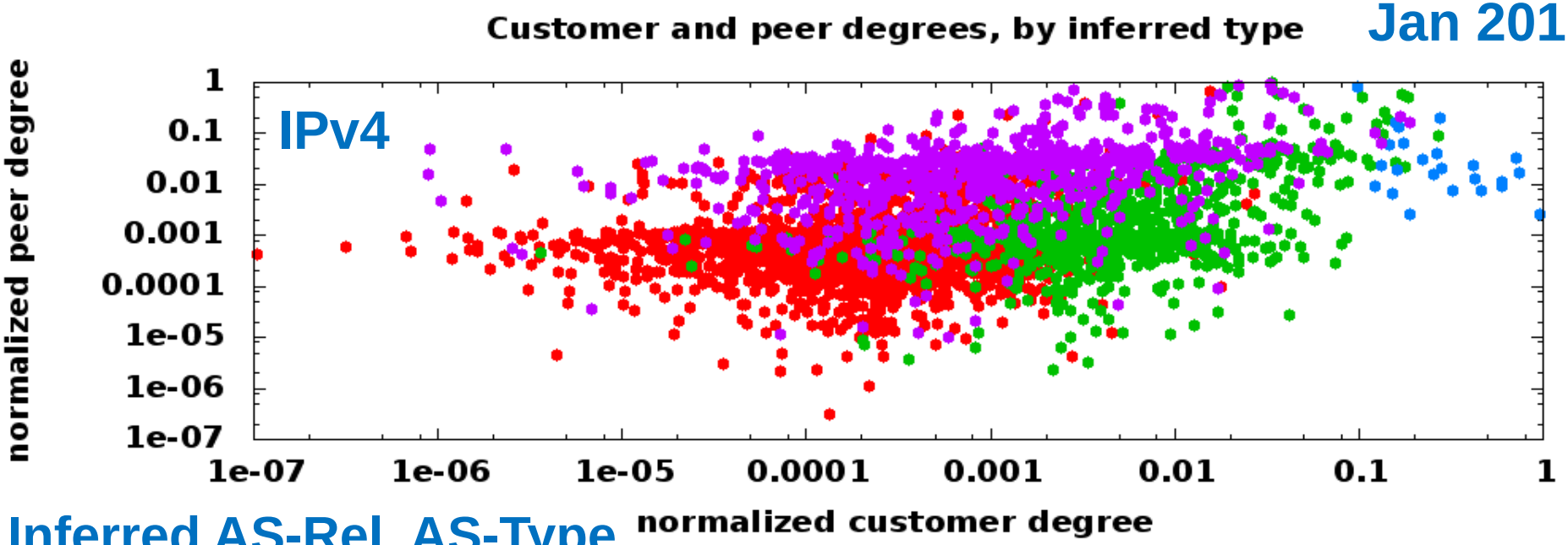
Limited correlation w/ est. date of IPv4 exhaustion at RIR.

Hypothesis 3

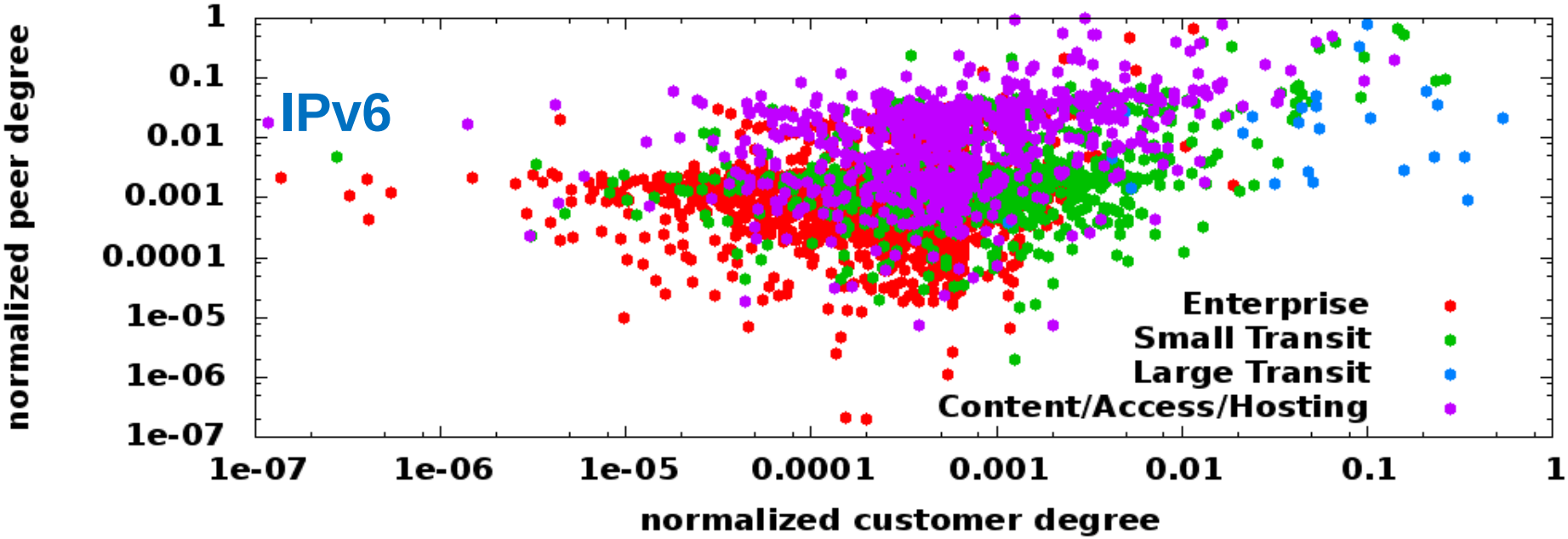
- **The profile of business relationships of dual-stacked ASes should be similar in IPv4 and IPv6.**

- **Infer relationships (p2p, p2c)** for IPv4 graph, apply those relationships to IPv6 graph -- use Gao's algorithm
- For each dual-stacked AS
  - **Infer type of AS (Enterprise, Content, Transit)**
  - Plot customer degree against peer degree in IPv4 and IPv6

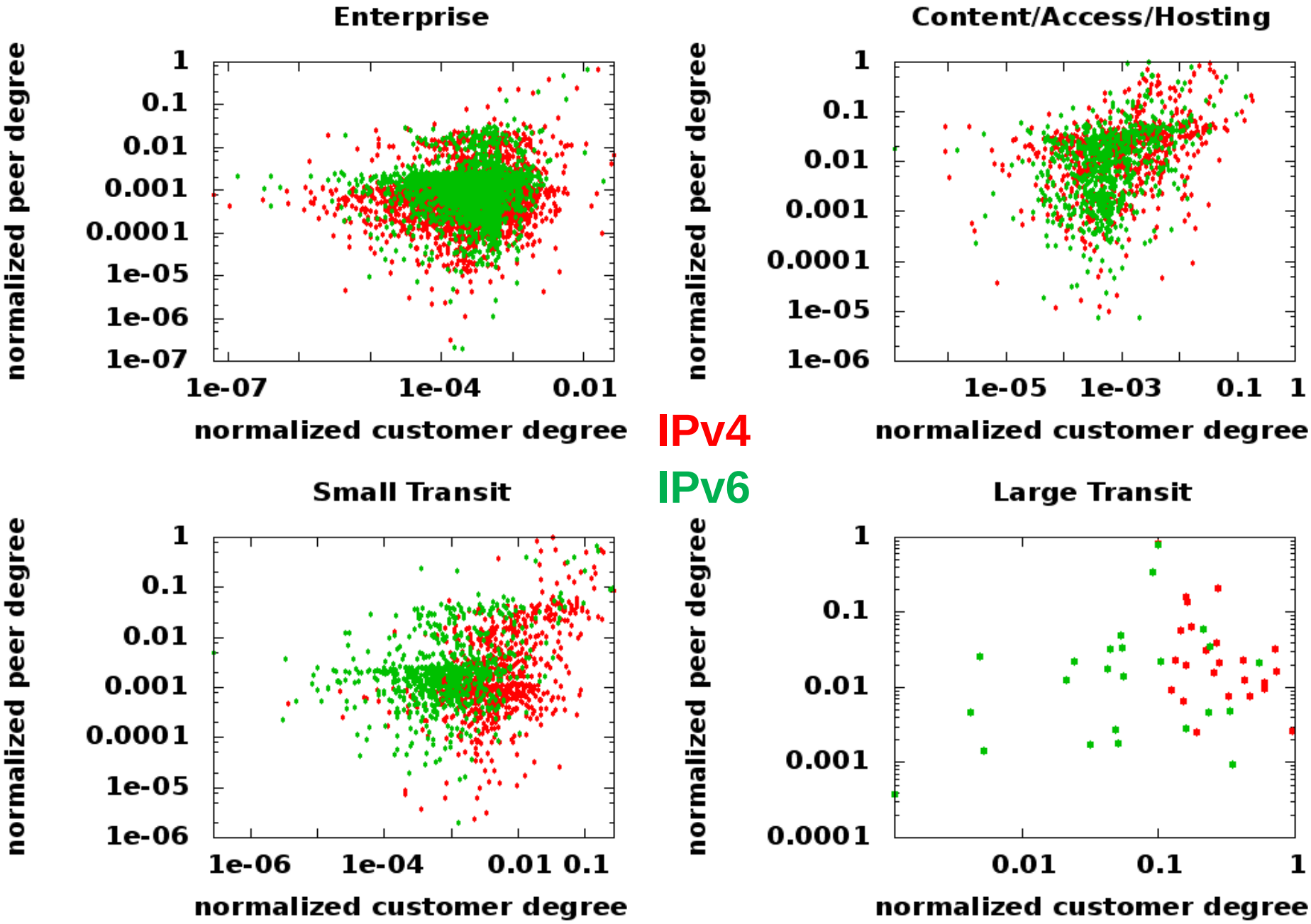
Jan 2012



Inferred AS-Rel, AS-Type



Dual-stack ASes have about the same profile for each protocol



Dual-stack Transit ASes have smaller customer degree in IPv6

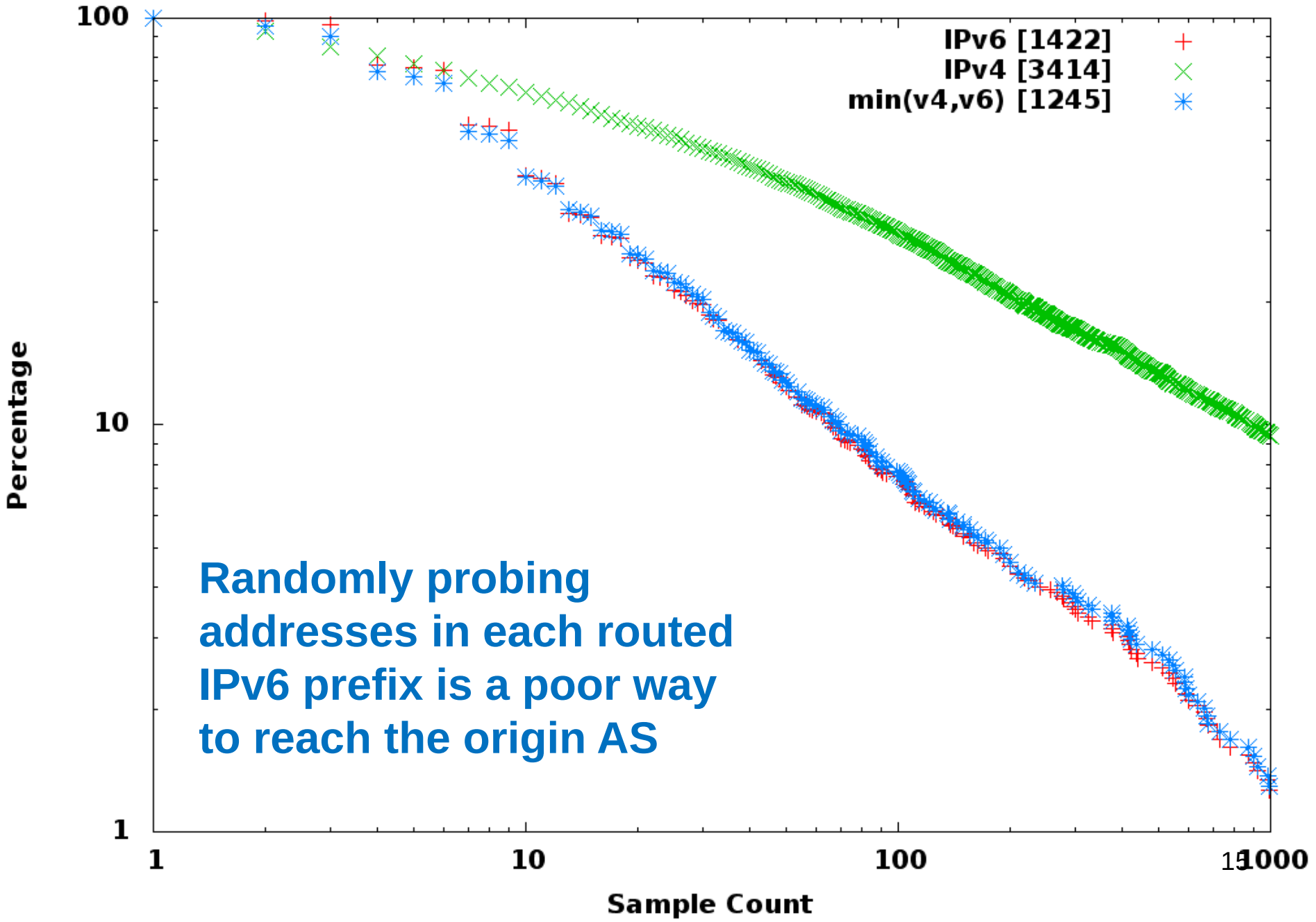
Hypothesis 4

- **IPv6 is maturing if the IPv4 and IPv6 RTTs for each AS are similar**

- **CAIDA Ark**: Use 20 dual-stacked boxes (used primarily for traceroute mapping)
- For each AS
  - determine median RTT values in IPv4 and IPv6 from traceroute responses
  - how different are the median RTT values for each AS?

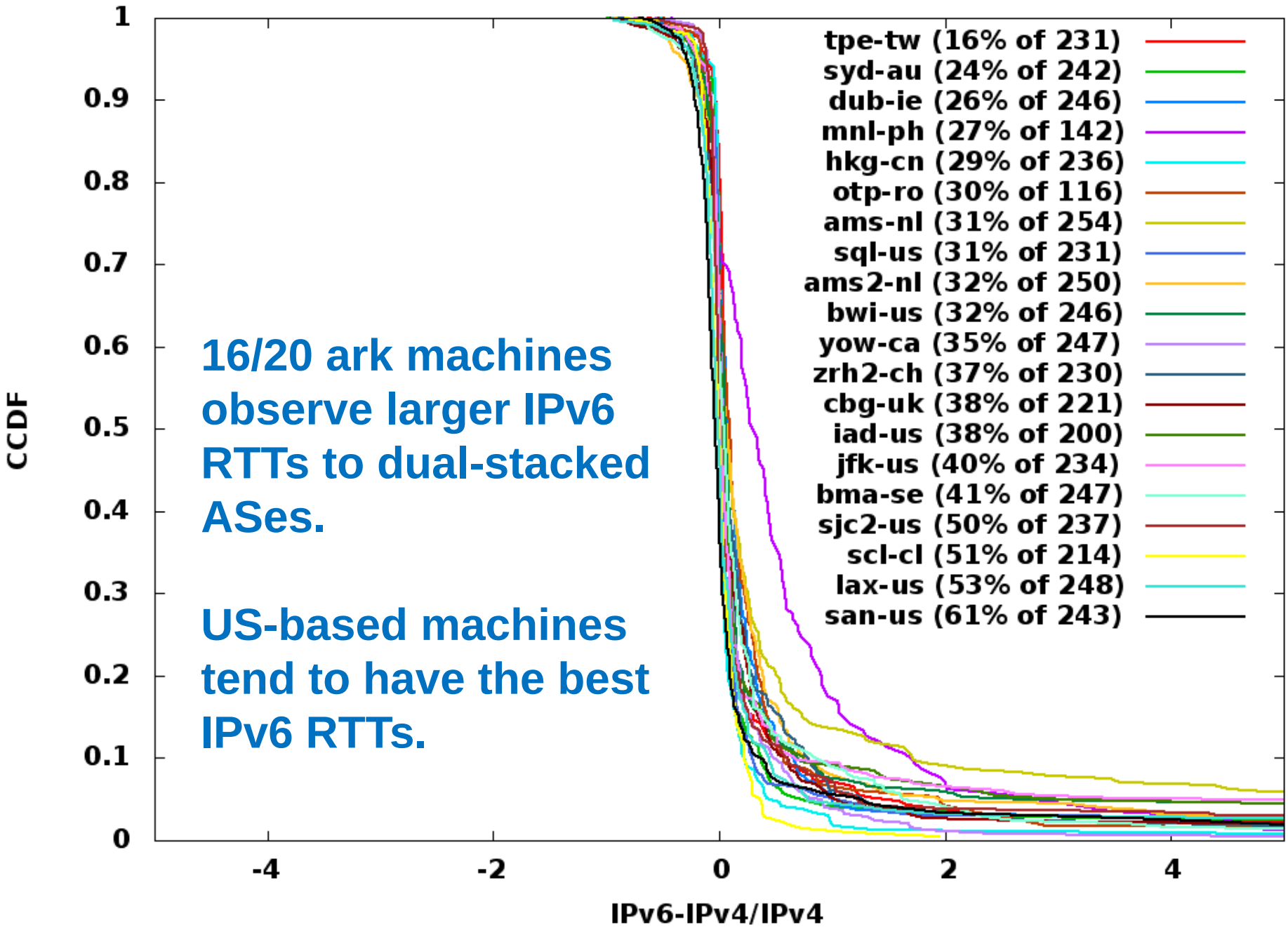
traceroute

Jan 2012



traceroute

Jan 2012



16/20 ark machines observe larger IPv6 RTTs to dual-stacked ASes.

US-based machines tend to have the best IPv6 RTTs.

Comments, Questions?

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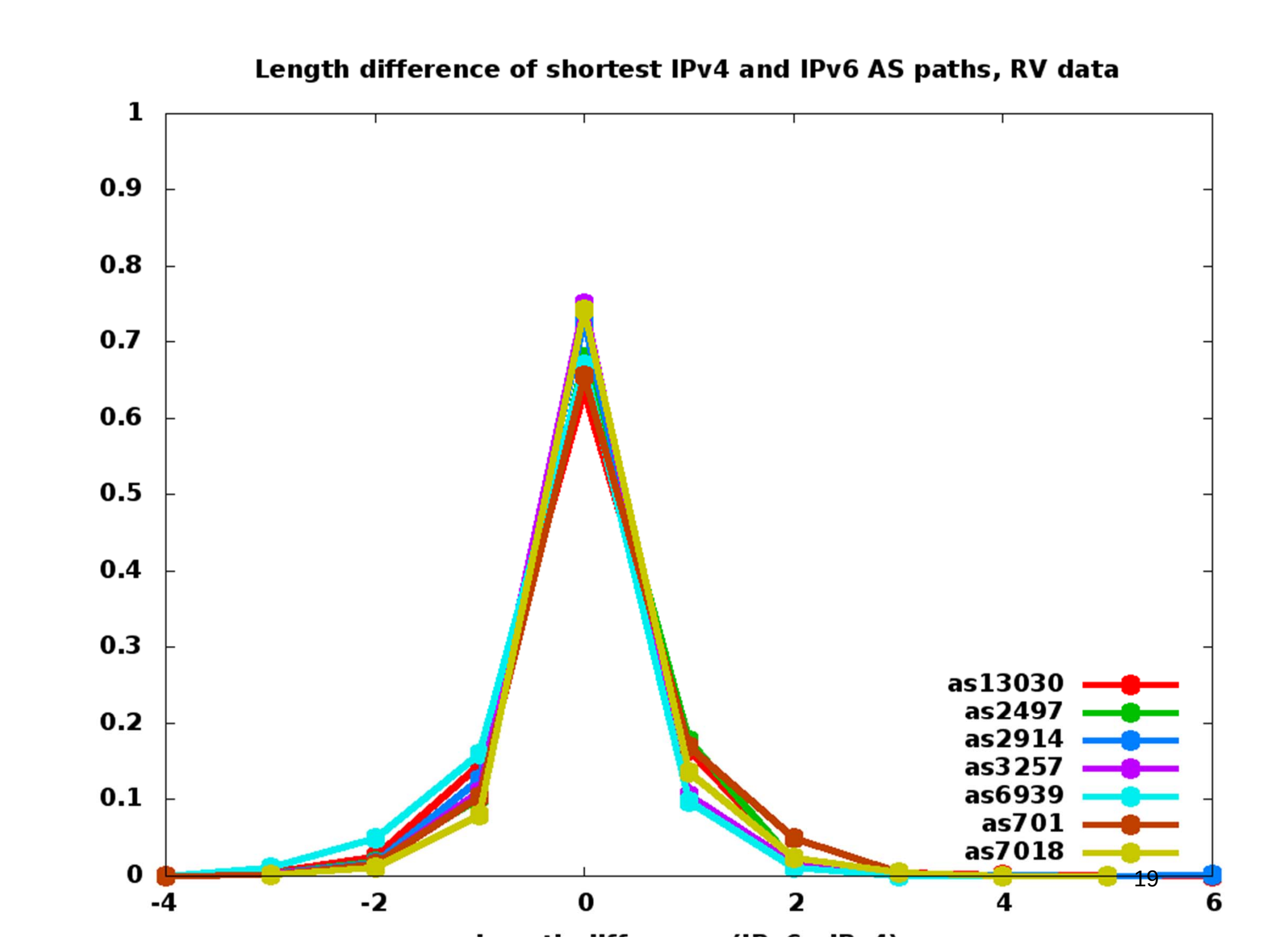
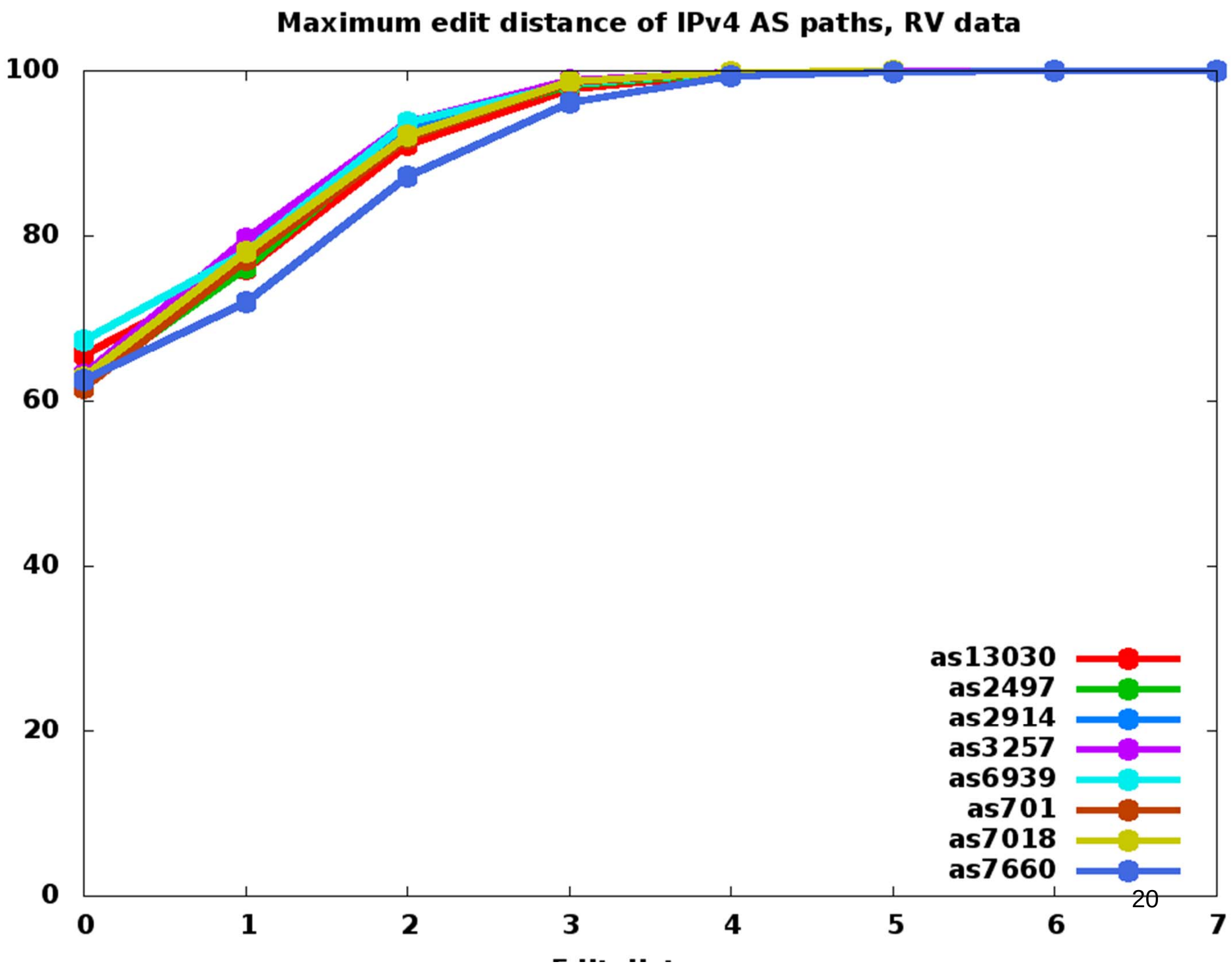
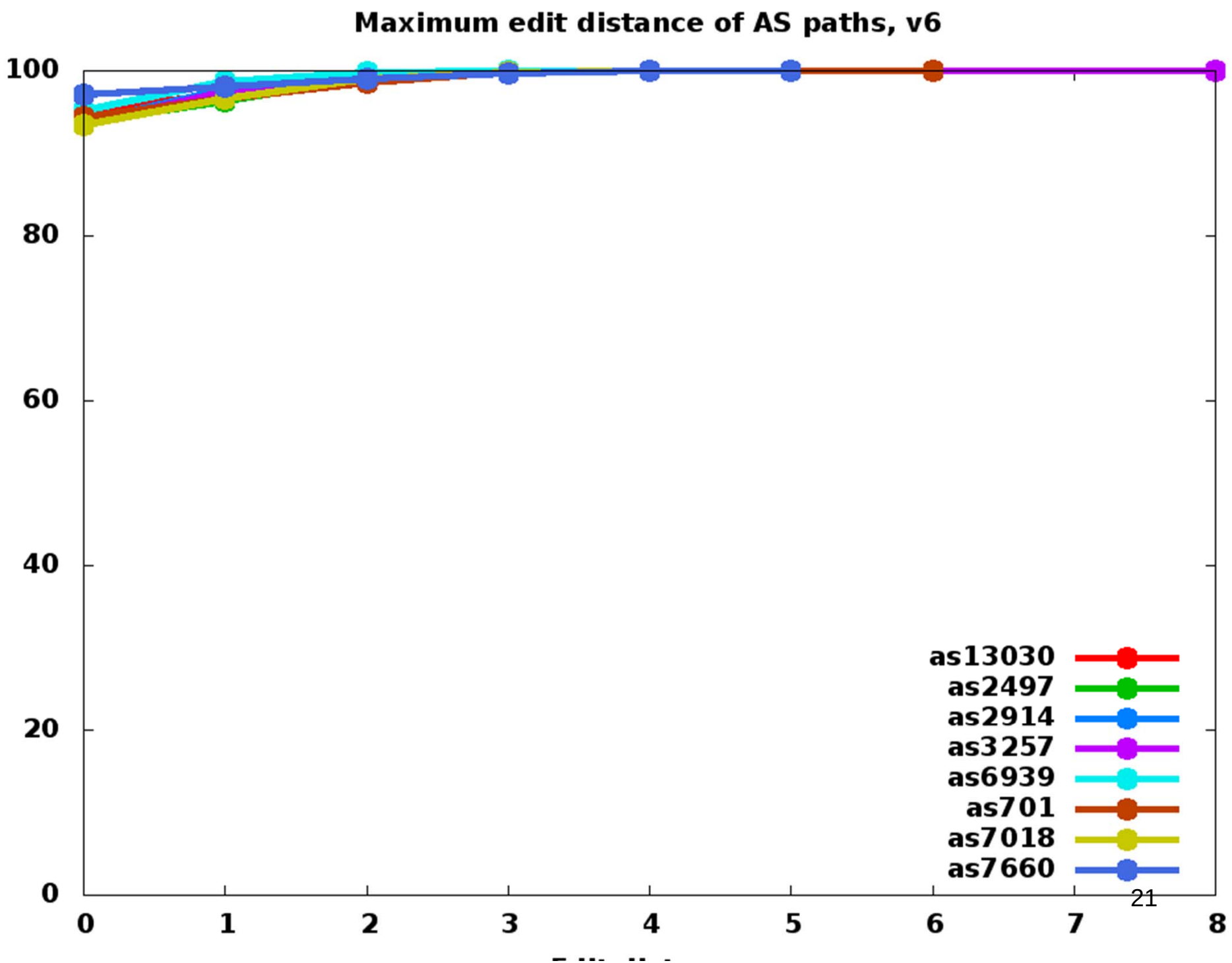
Spare Slides


Length difference of shortest IPv4 and IPv6 AS paths, RV data
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-4
-2
0
2
4
6
as13030
as2497
as2914
as3257
as6939
as701
as7018


Maximum edit distance of IPv4 AS paths, RV data
100
80
60
40
20
0
0
1
2
3
4
5
6
7
as13030
as2497
as2914
as3257
as6939
as701
as7018
as7660


Maximum edit distance of AS paths, v6
100
80
60
40
20
0
0
1
2
3
4
5
6
7
8
as13030
as2497
as2914
as3257
as6939
as701
as7018
as7660