

# Using hopcount to measure IMRS server placement



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# What are we studying

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- We want to measure how topologically close ASes are to IMRS
- We want to derive that value from IMRS traffic, passively
  - as per contract between ICANN and hosting providers:
  - instances must be used for serving DNS traffic only, i.e. no active measurement from instances
- We measure topological network distance, not latency
  - Distance relates to placement, while latency depends on many factors, including distance.

# What are we studying

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- Distance can be measured in two ways
  - IP hop count
    - Measures number of hops between client and server
    - Easily derived from incoming queries
    - `_actual_traffic_`
  - AS path length
    - Measures number of AS on the path between server and client
    - Easily derived from route tables
- The two are not directly comparable
  - Both measure topological distance
  - In opposite direction
  - In different units

# Hop-count, (1/3)

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- Modern operating systems have a default IP-TTL (IPv4) or Hop Limit (IPv6) value that is a multiple of 32
- These are decreased by every intermediate system.
- For each query, we record the 5 least significant bits (values 0-31) and subtract it from 31,
- That gives us the hop distance between the source address and the IMRS instance.
  - (we record the original value as well to check if values have not overflowed, i.e. traversed more than 31 hops)

# Hop-count, (2/3)

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- Routing happens by announcing a prefix
- The minimum prefixes in the default-free zone are /24 (v4) and /48 (v6)
  - (i.e. the prefixes may be shorter, but often not longer)
- Different addresses within a prefix may have different hop distance
  - While they share the path outside their AS to the instance, they may have a different internal route.
- We use the lowest hop count of an address in a prefix as the default hop distance, for that entire prefix.
- Default-free zone: The collection of AS that don't require a default rout

# Hop-count, (3/3)

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- Prefixes can be mapped to an AS.
- Prefixes within an AS may have different default hop distances
  - While they share part of the path outside their AS to the instance, they may have a different internal routes.
- We use the lowest hop count of any prefix in an AS as the default hop distance, for the entire AS.

# What can we do with this metric

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- We assume that the closest an instance can get to an AS is to be served from within that AS.
  - There are about 100.000 ASes, and about 130 IMRS instances, so only 0.13% would have (a theoretical) hop distance of 1.
  - Most ASes are therefor more than 1 hop away.
- With this in mind, we can rank prefixes, ASes, and IMRS instances as to how close instances are to their catchments.

# Some statistics

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- 16.2 Billion Queries received
- 60 B: number of hops travelled by all queries combined
- Average number of hops per query: 3.717



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# Some statistics

Instance Name	Hops Counted	Query Count	Average Hop Count
AA-IN-BOM	4.51 B	1.273 B	3.543
AA-CN-PVG	4.50 B	0.918 B	4.904
AA-CN-CGO	4.46 B	1.020 B	4.376
AA-CZ-XUY	4.04 B	1.201 B	3.362
AA-US-RTV	2.83 B	0.535 B	5.284
AA-KR-ICN	2.73 B	0.502 B	5.432
AA-US-LAX	2.29 B	0.512 B	4.466
AA-FR-PAR	2.00 B	0.708 B	2.826
AB-PK-LHE	1.99 B	0.342 B	5.809
AA-ID-JOG	1.92 B	0.442 B	4.350
AB-RU-MOW	1.73 B	0.333 B	5.204
AA-TW-NTC	1.72 B	0.508 B	3.386
AA-MX-MTY	1.33 B	0.309 B	4.292
AA-KZ-PLX	1.32 B	0.305 B	4.336

# What can we do with this information

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- We can produce this automatically and continuously
- We can generate rankings over time
- We can also use this to determine changes when new instances become active or old instances are switched off
- We can use these rankings to see what prefixes or ASes are underserved by IMRS

# Some more statistics

ASN	Hops Counted	Query Count	Hop Count	% Queries	Instance
X796X	2638984239	293220471	9	32	AA-CN-PVG
X079X	626849181	69649909	9	13	AA-US-RTV
X723X	387483108	32290259	12	11	AA-KZ-PLX
X30X	368612849	33510259	11	10	AA-UY-MVD
X53X	323458074	35939786	9	7	AA-US-LAX
X516X	236839284	26315476	9	10	AA-BR-SAO
X413X	223595810	22359581	10	4	AA-CN-BJD
X011X	214622112	26827764	8	5	AA-US-RTV
X580X	205720515	15824655	13	5	AB-RU-MOW
X12X	192838144	24104768	8	29	AA-US-ILG
X116X	188974100	18897410	10	6	AB-RU-MOW
X142X	188283616	23535452	8	4	AA-US-RTV
X135X	152059792	19007474	8	4	AA-US-RTV
X515X	145511510	14551151	10	4	AB-RU-MOW



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