Internet Measurements Tools and their usefulness

Gaurab Raj Upadhaya

Limelight Networks

Internet Measurements

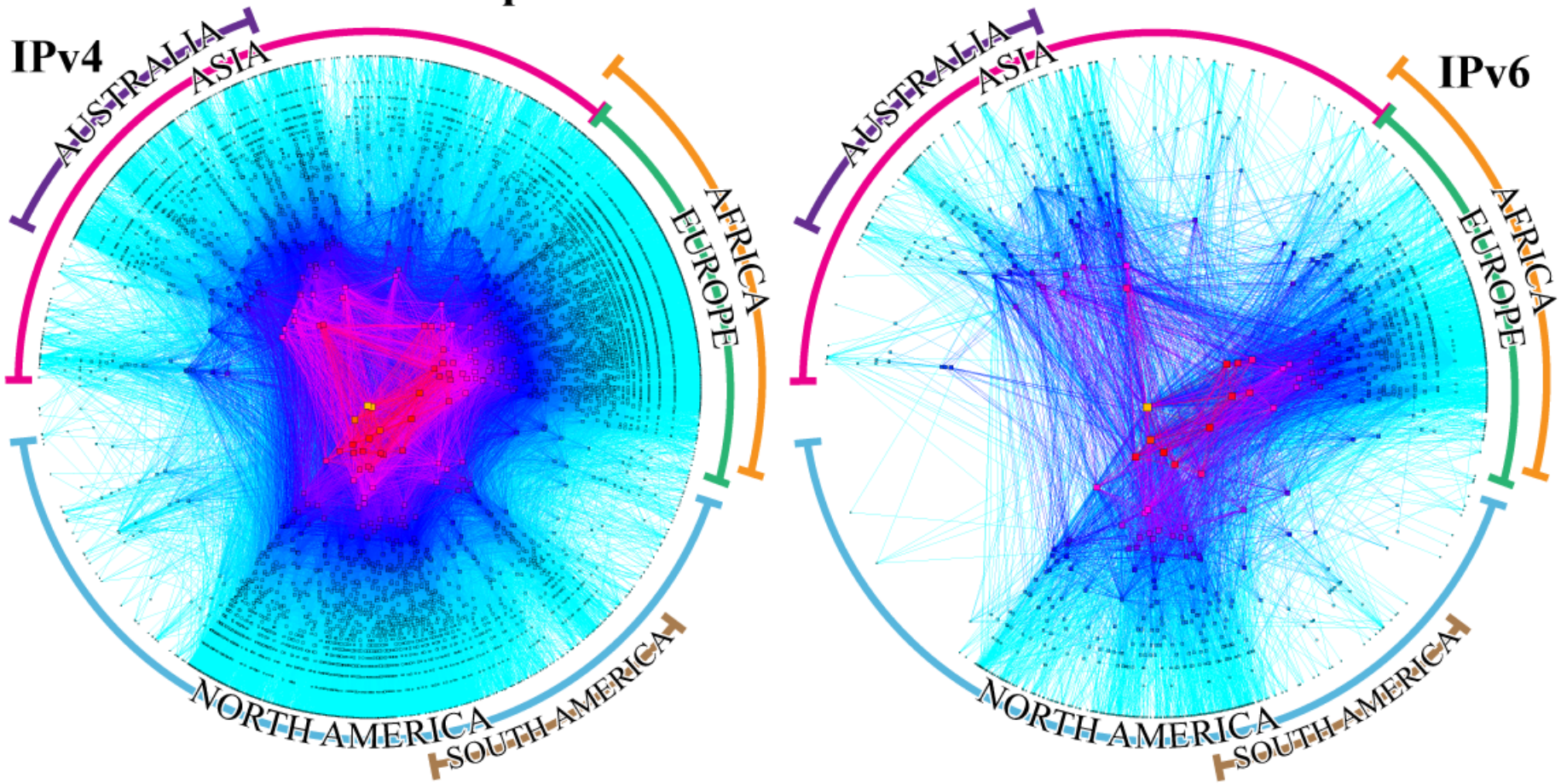
- There is a lot of measurements for various purposes on the Internet
  - Reachability and Latency Measurements
  - Routing Table measurements
  - Routing stability measurements
  - IPv6 / DNSSec / $VAR measurement
- These measurements may serve various purpose
  - We'll look at some common ones and how Network engineers can utilize them.

Measurement Models

- There are a lot of one-off measurements, we won't dwell into those.
- Continuous measurements can be categorized in three main groups
  - Academic Study
    - CAIDA (www.caida.org)
    - Planet Lab
    - Lots of others smaller ones out there
  - Community/Industry Run
    - RIPE LABS (ATLAS, TTM, DNSMON et al)
    - APNIC Research (CIDR-REPORT, BGP Stability Report, APNIC Measurements)
    - Routeviews (www.route-views.org)
    - Looking Glasses
    - HE BGP Toolkit (bgp.he.net)
  - Commercially run
    - Renesys
    - Arbor

CAIDA's IPv4 & IPv6 AS Core
AS-level INTERNET Graph

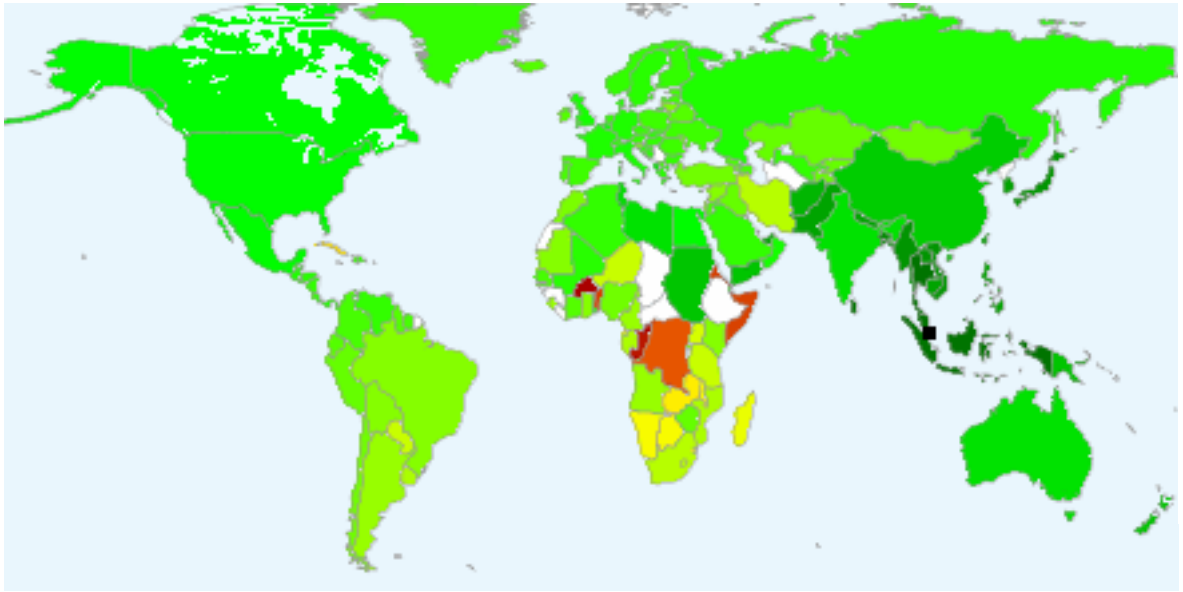
Archipelago
Jan 2013

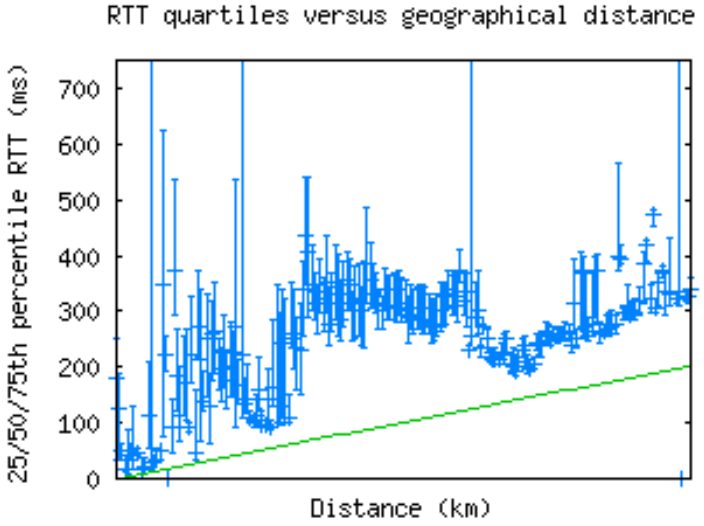


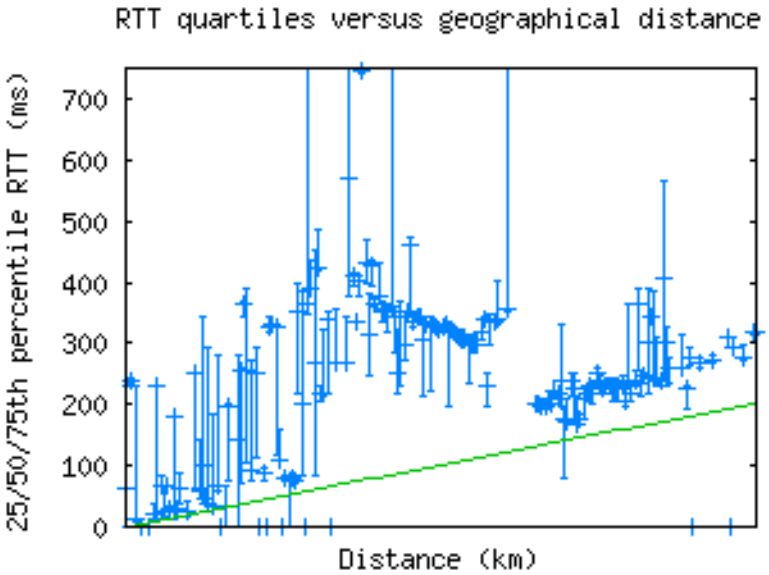
CAIDA ARK

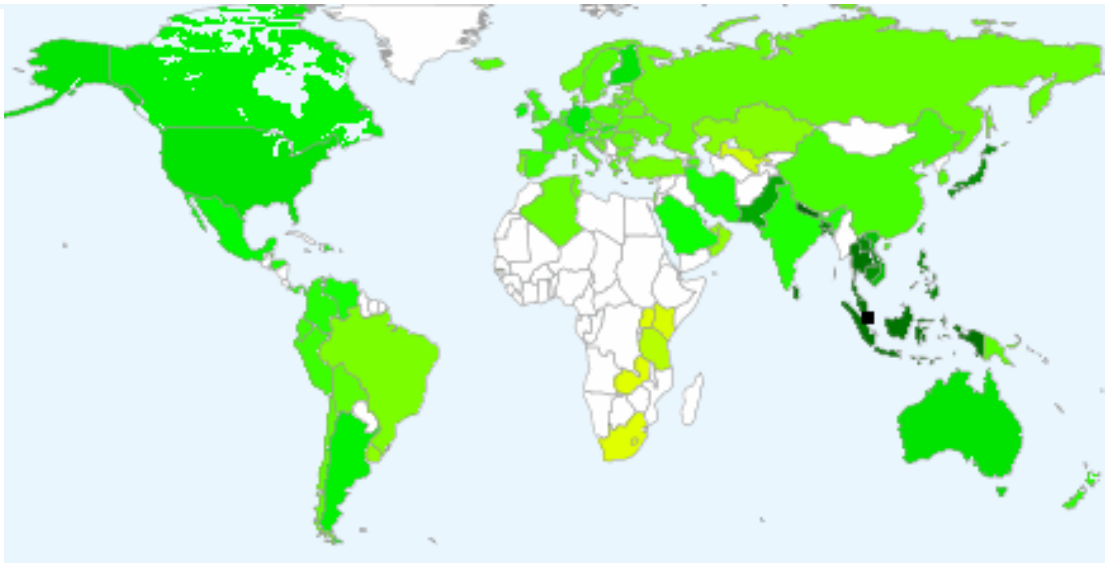
- CAIDA: The Cooperative Association for Internet Data Analysis (www.caida.org)
- CAIDA ARK is short form of the Archipelago Measurement Infrastructure
- Measures path and latency to ipv4/v6 address space visible on the global routing table.
- ARK data is used in lots of modeling and research. E.g AS-RANK

Reachability Report for v4/v6 from Equinix SG1 Singapore

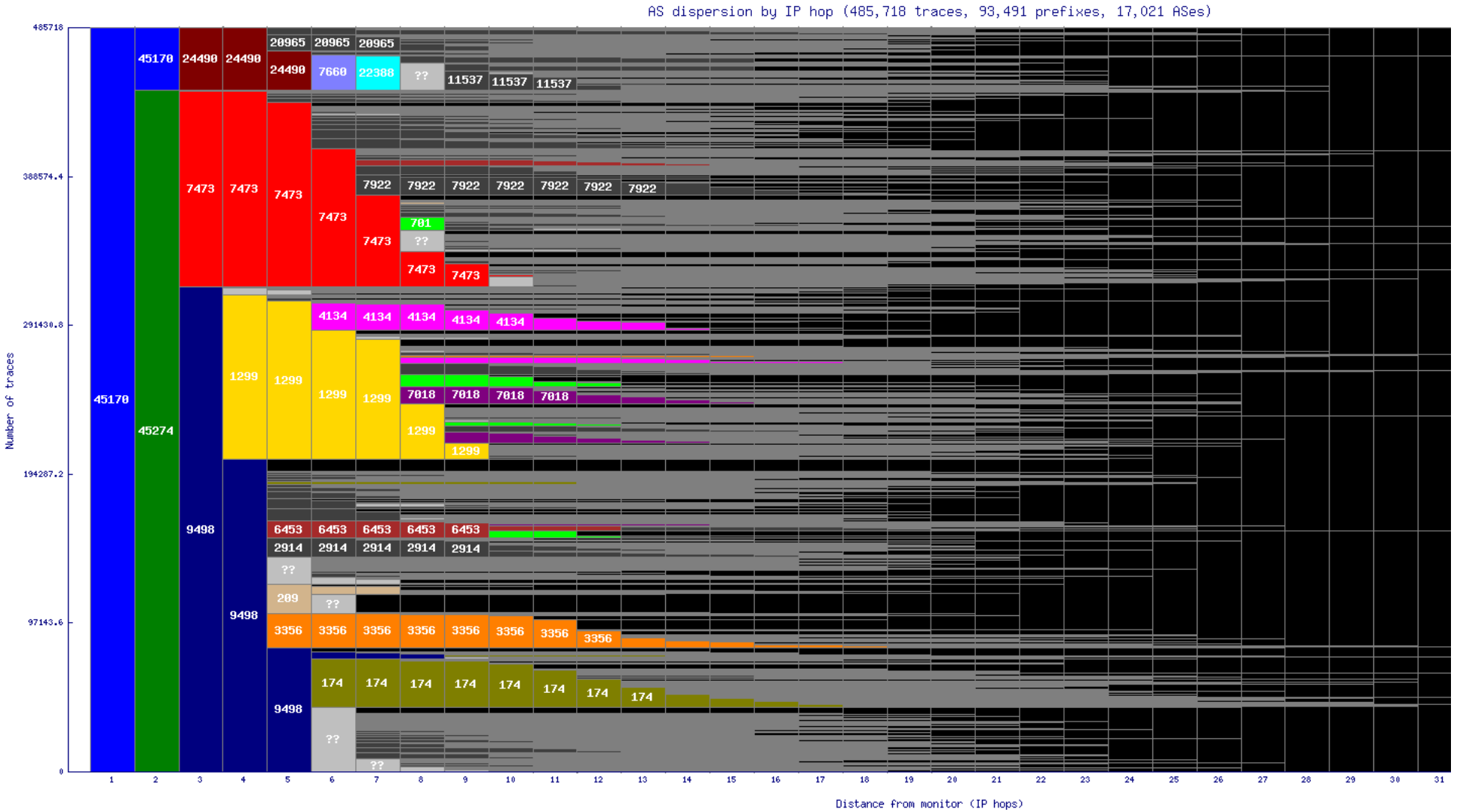








Connectivity from the Nepal Research and Education Network



Locations of the CAIDA ARK Measurement Nodes

Raspberry Pi based ARK Node

RIPE

- RIPE NCC – the Regional Internet Registry has a long history of running measurements
- All the RIPE data is available through http://stat.ripe.net
  - Routing Information Service (RIS)
    - Collects BGP Data
    - http://www.ripe.net/ris
  - DNSMon
    - Monitors critical DNS Servers
    - http://dnsmon.ripe.net
  - Test Traffic Measurement (TTM)
    - Measures latency and path, stores trace-routes between all TTM nodes
    - Gradually being replaced by RIPE ATLAS

RIPE ATLAS

- RIPE ATLAS does a pre-defined set of measurements
  - ICMP Ping /Trace with v4/v6 to participating root servers
  - To selected other Authoritative servers
- User Defined Measurements
  - If you host a RIPE ATLAS probe, you get credits
  - You can use your credit to run your own measurements (one off or ongoing).

APNIC Research

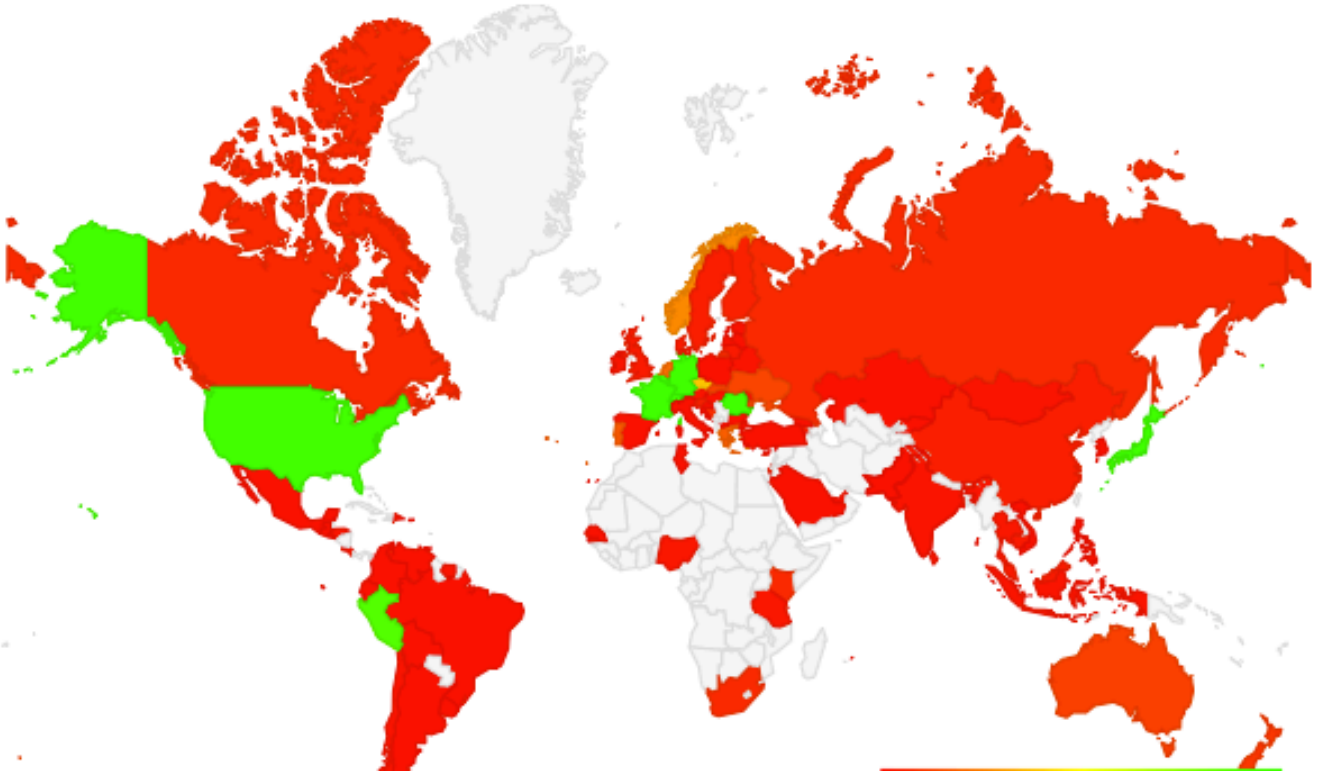
- Structuring Geoff Huston's works
  - LABS
    - Measurements using different techniques
      - IPv6 measurement using Google ads
      - Measurement on 1.1.1.0/24, 1.2.3.0/24
  - CIDR Report
  - BGP Updates report
  - Other reports as things pop up
    - NTP
    - DNSSec.

Labs.APNIC.NET

World IPv6 Adoption

As a continuing activity following on from the World IPv6 Launch we report on the levels of IPv6 deployment measured by client end-to-end capability. This is reported by economy, AS, and by regional and organizational breakdowns. These can be found at labs.apnic.net/ipv6-measurement.

Click on an Economy to jump to its graphs



IPv6 measurement by AS Number

back

- IPv6 preference by UN Geographic/Political Region
- IPv6 preference by Economy
- IPv6 preference by Organization

This page lists the IPv6 measurement per AS number, with a 30 day average on the ranking to reduce the impact of occasional-measurement AS such as conference shownets, and collections of few points but with relatively high IPv6 preference ratio.

The ranking is based on the IPv6 preference for IPv4 addresses with the given AS as origin-AS, based on the BGP data for the period of the sample. Where insufficient samples exist to reliably plot the AS for a given period, is considered to have no samples. This exclusion limit is currently set at 200 samples.

The iso3166 economycode of each AS based on its registration is also listed.

Columns for numeric and alphabetic fields are sortable.

A non-truncated list of all ASN seen in the experiment is also available at index.all.html as a paginated index. The .csv and .json data is available for all seen ASN below.

CSV JSON

Economy	ASN	AS Name	# samples	v6 capable	v6 preferred	csv	json
US	AS32934	FACEBOOK - Facebook; Inc.	157	100.00%	98.73%	csv	json
CN	AS37944	CNNIC-CSTNET-AP CHINA SCIENCE AND TECHNOLOGY NETWORK	194	100.00%	100.00%	csv	json
CN	AS23910	CNGI-CERNET2-AS-AP China Next Generation Internet CERNET2	1332	100.00%	100.00%	csv	json
US	AS19782	INDIANAGIGAPOP - Indiana University	637	99.53%	99.53%	csv	json
RU	AS13238	YANDEX Yandex LLC	1544	98.19%	51.30%	csv	json
AU	AS38083	CURTIN-UNI-AS-AP Curtin University	345	95.36%	94.20%	csv	json
US	AS15169	GOOGLE - Google Inc.	10134	93.92%	4.96%	csv	json
SG	AS10091	SCV-AS-AP StarHub Cable Vision Ltd	18810	90.85%	63.91%	csv	json
AU	AS4608	APNIC-SERVICES Asia Pacific Network Information Centre	536	87.31%	85.45%	csv	json
US	AS6621	HNS-DIRECPC - Hughes Network Systems	1159	85.16%	84.73%	csv	json
US	AS16591	GOOGLE-FIBER - Google Fiber Inc.	218	84.86%	78.90%	csv	json
US	AS2698	IASTATE-AS - Iowa State University	187	75.94%	72.19%	csv	json
GB	AS786	JANET JISC Collections And Janet Limited	190138	68.07%	66.81%	csv	json
CZ	AS197451	VUTBR-AS Brno University of Technology	301	66.78%	64.45%	csv	json
RO	AS12675	UAIC-NETWORK Alexandru Ioan Cuza University	160	66.25%	53.13%	csv	json
BR	AS22548	N\xfacleo de Inf. e Coord. do Ponto BR - NIC.BR	214	64.95%	61.68%	csv	json

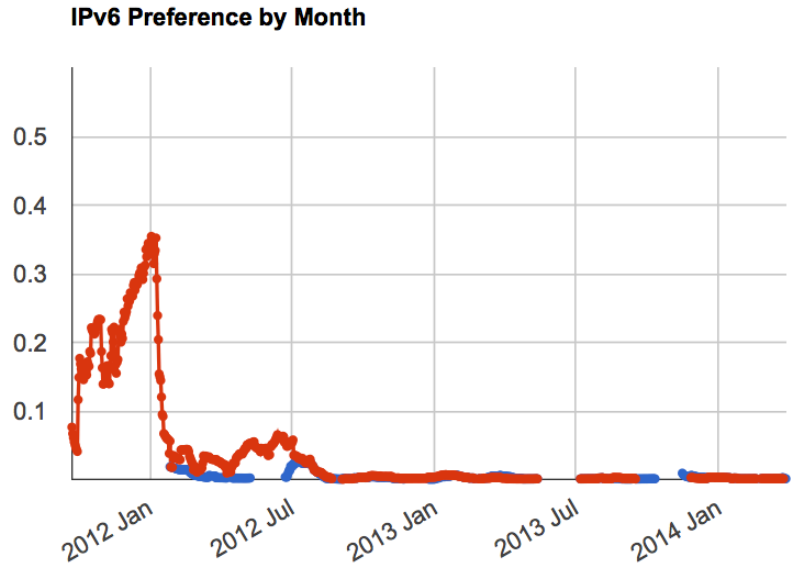
IPv6 measurements for Saudi Arabia

back

- IPv6 preference by AS Number
- IPv6 preference by Economy
- IPv6 preference by UN Geographical/Geopolitical Region
- IPv6 preference by various Organizations

image size: small medium large
data type: IPv6 Preferred IPv6 Capable datasource: flash js both
sample accumulated over: 30 day 7 day interval

IPV6 Capability by Interval | Select an Economy | Sample Count by Month | ASN in this Economy



30 day JSON 30 day CSV 7 day JSON 7 day CSV

CIDR Report

- CIDR report is at www.cidr-report.org
  - Original Concept: Tony Bates, Revised by: Philip Smith, Further Revised: Geoff Huston
  - If you don't get a copy of it every week, you probably are not on the right mailing lists ☺
  - The weekly reports on BGP Routing Tables reports on de-aggregation
  - A second report on BGP updates reports on the number of BGP Updates received
- The Website is something you should bookmark

CIDR Report

Report for 8966

Name

ETISALAT-AS Emirates Telecommunications Corporation,AE

AS Adjacency Report

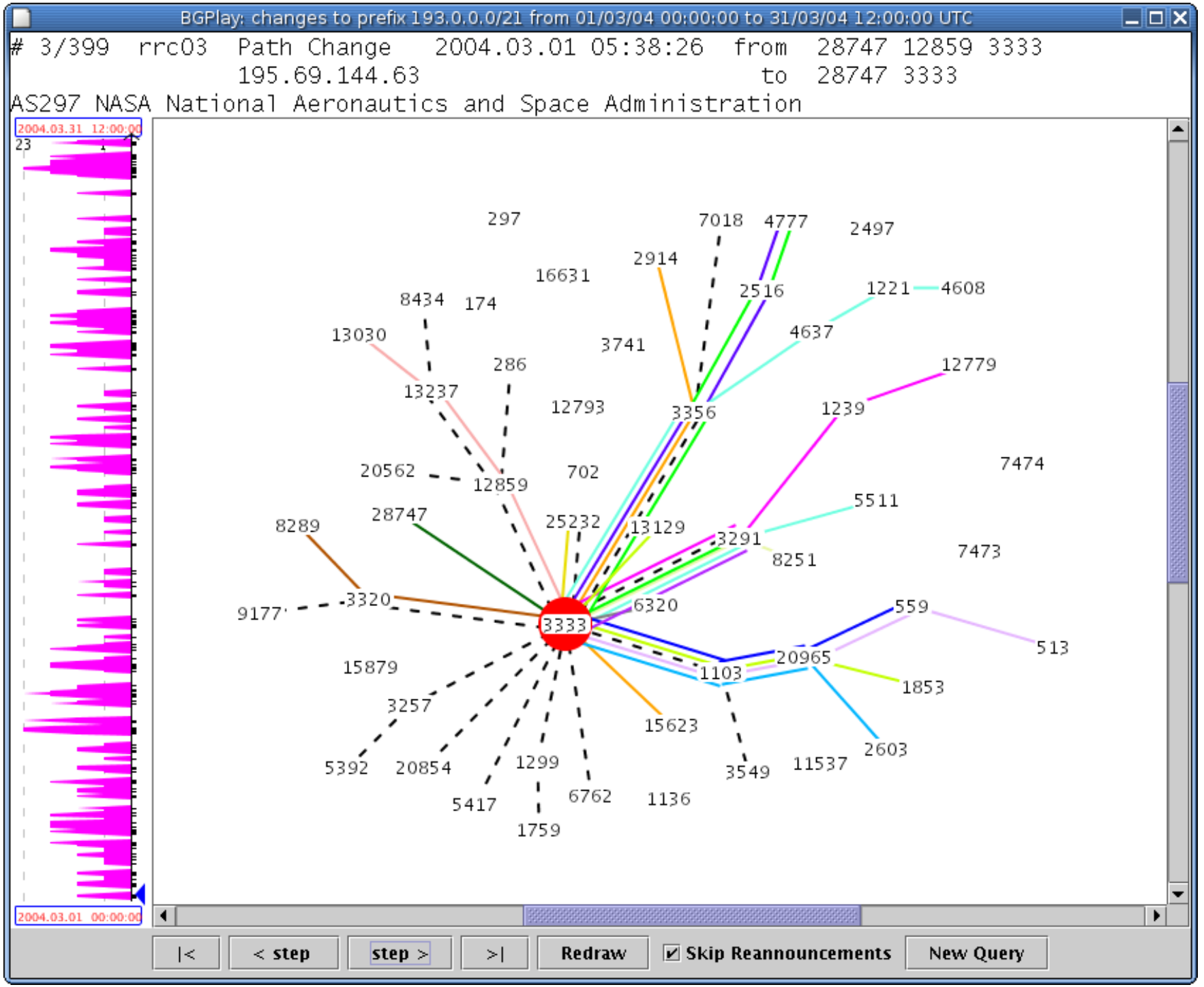
In the context of this report "Upstream" indicates that there is an adjacent AS that lines between the BGP table collection point (in this case at AS
"Downstream" refers to an adjacent AS that lies beyond the specified AS. This upstream / downstream categorisation is strictly a description relat
confused with provider / customer / peer inter-AS relationships.

```
8966 ETISALAT-AS Emirates Telecommunications Corporation,AE

  Adjacency:    32  Upstream:     8  Downstream:    24
  Upstream Adjacent AS list
    AS3561          SAVVIS - Savvis,US
    AS4323          TWTC - tw telecom holdings, inc.,US
    AS3257          TINET-BACKBONE Tinet SpA,DE
    AS3356          LEVEL3 - Level 3 Communications, Inc.,US
    AS6453          AS6453 - Tata Communications,CA
    AS6762          SEABONE-NET TELECOM ITALIA SPARKLE S.p.A.,IT
    AS7473          SINGTEL-AS-AP Singapore Telecommunications Ltd,SG
    AS2516          KDDI KDDI CORPORATION,JP
  Downstream Adjacent AS list
    AS12076         MICROSOFT - Hotmail Corporation,US
    AS23880         YAHOO-AEA Internet content provider,US
    AS36040         YOUTUBE - Google Inc.,US
    AS35753         ITC ITC AS number,SA
    AS15399         WANANCHI-KE,KE
    AS12455         JAMBONET,KE
    AS37273         BCS,UG
    AS36930         Zantel-AS,TZ
    AS36866         JTL,KE
    AS60261         LLNW-AE Limelight Networks, INC.,EU
    AS9155          QNET QualityNet General Trading & Contracting Co.,KW
    AS30125         ISC-F-AS - Internet Systems Consortium, Inc.,US
```

Route-Views and BGPlay

- Routeviews is at www.routeviews.org
  - Operated by the University of Oregon Route Views Project
  - While the Route Views project was originally motivated by interest on the part of operators in determining how the global routing system viewed their prefixes and/or AS space, there have been many other interesting uses of this Route Views data. (from routeviews.org)
- Route Views collector Peers with very large number of ASNs either directly at IXPs or through eBGP multihop.
- BGP visualization tool BGPlay uses Routeviews


BGPlay: changes to prefix 193.0.0.0/21 from 01/03/04 00:00:00 to 31/03/04 12:00:00 UTC
3/399 rrc03 Path Change 2004.03.01 05:38:26 from 28747 12859 3333
195.69.144.63 to 28747 3333
AS297 NASA National Aeronautics and Space Administration
2004.03.31 12:00:00
2004.03.01 00:00:00
297
7018
4777
2497
2914
16631
2516
1221
4608
8434
174
13030
4637
3741
286
12779
13237
12793
3356
1239
20562
702
7474
12859
5511
28747
25232
13129
3291
8289
8251
7473
3320
6320
559
9177
3333
513
15879
20965
1103
1853
3257
15623
2603
5392
20854
1299
3549
11537
5417
6762
1136
1759
|<
< step
step >
>|
Redraw
Skip Reannouncements
New Query

Multi Network Looking Glasses

- Packet Clearing House route-collector AS3856 peers at a large number IXPs and looking glass is available at http://lg.pch.net
- Many of the IXPs have visible looking glasses on their websites.
  - HKIX : http://www.hkix.net/hkix/hkixlg.htm
  - LINX : https://www.linx.net/pubtools/looking-glass.html
- There is a list available at www.traceroute.org (but not all of them are current).
- Historical archives of the data is also available on request from most of these.

More Resources

- Hurricane Electric BGP Toolkit. http://bgp.he.net/
  - Uses HE internal BGP data, and data from routeviews, and other sources
  - It's the packaging that is immensely useful with the HE BGP toolkit.
- Peering DB (www.peeringdb.com) : For the peering co-ordinators by the peering co-ordinators
  - Lists the Network ASNs,
  - IX it's present at,
  - the colocation facilities for private peering,
  - Peering Policies
  - Contact Addresses

AS15802 Emirates Integrated Telecommunications Company PJSC (EITC-DU)

Quick Links

- BGP Toolkit Home
- BGP Prefix Report
- BGP Peer Report
- Bogon Routes
- World Report
- Multi Origin Routes
- DNS Report
- Top Host Report
- Internet Statistics
- Looking Glass
- Free IPv6 Tunnel
- IPv6 Certification
- IPv6 Progress
- Going Native
- Contact Us

AS Info | Graph v4 | Graph v6 | Prefixes v4 | Prefixes v6 | Peers v4 | Peers v6 | Whois | IRR

Company Website: http://www.du.ae

Country of Origin: United Arab Emirates

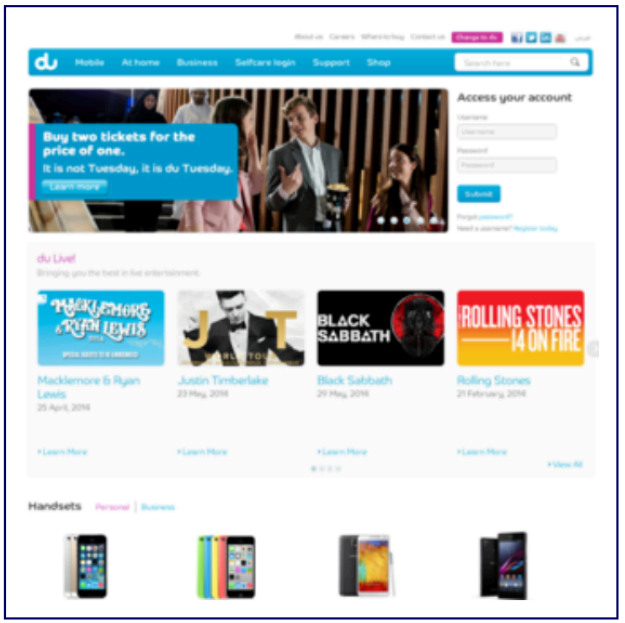
Prefixes Originated (all): 161
Prefixes Originated (v4): 159
Prefixes Originated (v6): 2

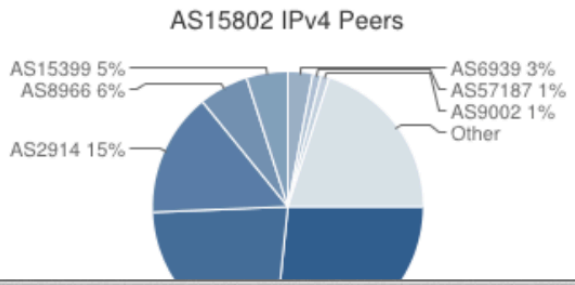
Prefixes Announced (all): 227
Prefixes Announced (v4): 225
Prefixes Announced (v6): 2

BGP Peers Observed (all): 90
BGP Peers Observed (v4): 90
BGP Peers Observed (v6): 2

IPs Originated (v4): 1,091,840
AS Paths Observed (v4): 482
AS Paths Observed (v6): 193

Average AS Path Length (all): 3.616
Average AS Path Length (v4): 3.608
Average AS Path Length (v6): 3.637





ASN	Name
AS3356	Level 3 Communications, Inc.
AS15412	Flag Telecom Global Internet AS
AS2914	NTT America, Inc.
AS8966	Etisalat - Emirates Telecommunications Corporation
AS15399	Wananchi Group
AS6939	Hurricane Electric, Inc.
AS57187	Emirates Integrated Telecommunications Company PJSC (EITC-DU)

Peering DB entry for AS22822

Company Information	
Company Name	Limelight Networks
Also Known As	llnw.net
Company Website	http://www.limelightnetworks.com/
Primary ASN	22822
IRR Record	AS-LLNW
Network Type	Content
Approx Prefixes	600
Traffic Levels	1 Tbps+
Traffic Ratios	Mostly Outbound
Geographic Scope	Global
Looking Glass URL	
Route Server URL	
Notes	
Protocols Supported	Unicast IPv4 ☑ Multicast ☐ IPv6 ☑
Date Last Updated	2013-07-16 22:18:55 UTC

Peering Policy Information	
Peering Policy URL	http://www.as22822.net/
General Policy	Selective
Multiple Locations	Required - US
Ratio Requirement	No
Contract Requirement	Not Required

Contact Information

Role	Contact Name	Telephone	E-Mail
Technical	Peering		peering-team@llnw.com
NOC	NOC	+1-602-850-6400	noc@llnw.com
Policy	Scott Leibrand	+1-360-419-5185	sleibrand@llnw.com
Technical	Brad Raymo	+1-602-850-5716	braymo@llnw.com
Policy	Gaurab Upadhaya	+65-9851-2037	gaurab@llnw.com

Public Peering Exchange Points

Exchange Point Name	ASN	IP Address	Mbit/sec
AMS-IX	22822	2001:7f8:1::a502:2822:1	60000
AMS-IX	22822	195.69.145.133	60000
AZIX	22822	206.223.120.9	20000
AZIX	22822	2001:504:18:a5:0:2:2822:1	20000
CoreSite - Any2 Chicago	22822	206.51.43.4	10000
CoreSite - Any2 Chicago	22822	2001:504:13:4::4	10000
CoreSite - Any2 Los Angeles	22822	2001:504:13::16	20000
CoreSite - Any2 Los Angeles	22822	206.223.143.16	20000
DE-CIX Frankfurt	22822	80.81.192.221	60000
DE-CIX Frankfurt	22822	80.81.193.221	50000
DE-CIX Frankfurt	22822	2001:7f8::5926:0:2	50000
DE-CIX Frankfurt	22822	2001:7f8::5926:0:1	60000

1 2 3 4 5 of 8 Next > Last >>

Private Peering Facilities

Facility Name	ASN	City	Country	SONET	Ethr	ATM
151 Front Street West Toronto	22822	Toronto	CA	☐	☑	☐
40 Hashacham St	25804	Petach Tikva	IL	☐	☑	☐
CANIX 3 (Cologix)	22822	montreal	CA	☐	☑	☐
CoreSite Los Angeles (One Wilshire)	22822	Los Angeles	US	☐	☑	☐
CoreSite Washington DC (1275)	22822	Washington	US	☐	☑	☐
Equinix Amsterdam (AM1)	22822	Amsterdam	NL	☐	☑	☐
Equinix Ashburn (DC1-DC11)	22822	Ashburn	US	☐	☑	☐
Equinix Atlanta (AT2/3)	22822	Atlanta	US	☐	☑	☐
Equinix Chicago	22822	Chicago	US	☐	☑	☐
Equinix Chicago (CH1/CH2)	22822	Chicago	US	☐	☑	☐
Equinix Dallas (DA1)	22822	Dallas	US	☐	☑	☐
Equinix Dallas (DA3)	22822	Dallas	US	☐	☑	☐

1 2 3 4 5 of 6 Next > Last >>

Common Use Cases

- Routing Trouble
  - Put the IP addresses in the HE BGP Toolkit and you'll get the associated ASNs and upstream
  - Check to see if there has been any topology changes on the source and destination ASN in BGPlay
  - Cross verify it through ARK or CIDR-REPORT
  - Use your RIPE ATLAS access to run trace from other locations around the world
  - Routing Trouble may originate inside your networks as well, so it's useful to see your own routes as seen by route-views or other looking glass.

Network Expansion

- When you need to expand to locations outside of your primary operations area, how can the data help
  - CAIDA Data can show you where the ‘hubs’ are near you.
  - Peering DB can tell you where the largest number of networks are, and which colocation points are the most dense in the city you are looking at.
  - Peering DB will also tell you the peering policy of the ASNs you are interested in peering with. In many cases e-mailing in advance asking for peering potential is acceptable.
  - The PCH/IX/HE looking glass tells you which routes are easily available.
  - These tools help you narrow down your options before you start looking at commercials.

Hosting Probes / Contributing Data

- CAIDA ARK footprint is pretty small, but still prefers a public IP. If you like to host one, talk to me (and I'll put you in touch)
- RIPE ATLAS is available by request on their website. RIPE Staff also hands them out at different NOG conferences, so do APNIC staff.
- Routeviews is at IXPs only, but as an network, do eBGP Multi-hop peer with them.
  - Internet Routing data is publicly visible, so you don't loose by sharing directly, but contribute to the richness of it.

Conclusion

- Internet Measurement tools and activities are not just for academic purpose, but helps in operational troubleshooting
- Large datasets can help in modeling and planning exercises.
- Publicly available resources makes Internet a nicer place

Thank you!

Feedback welcome:
gaurab@llnw.com