Limelight NETWORKS

Internet Measurements Tools and their usefulness

Gaurab Raj Upadhaya

Limelight Networks

Internet Measurements

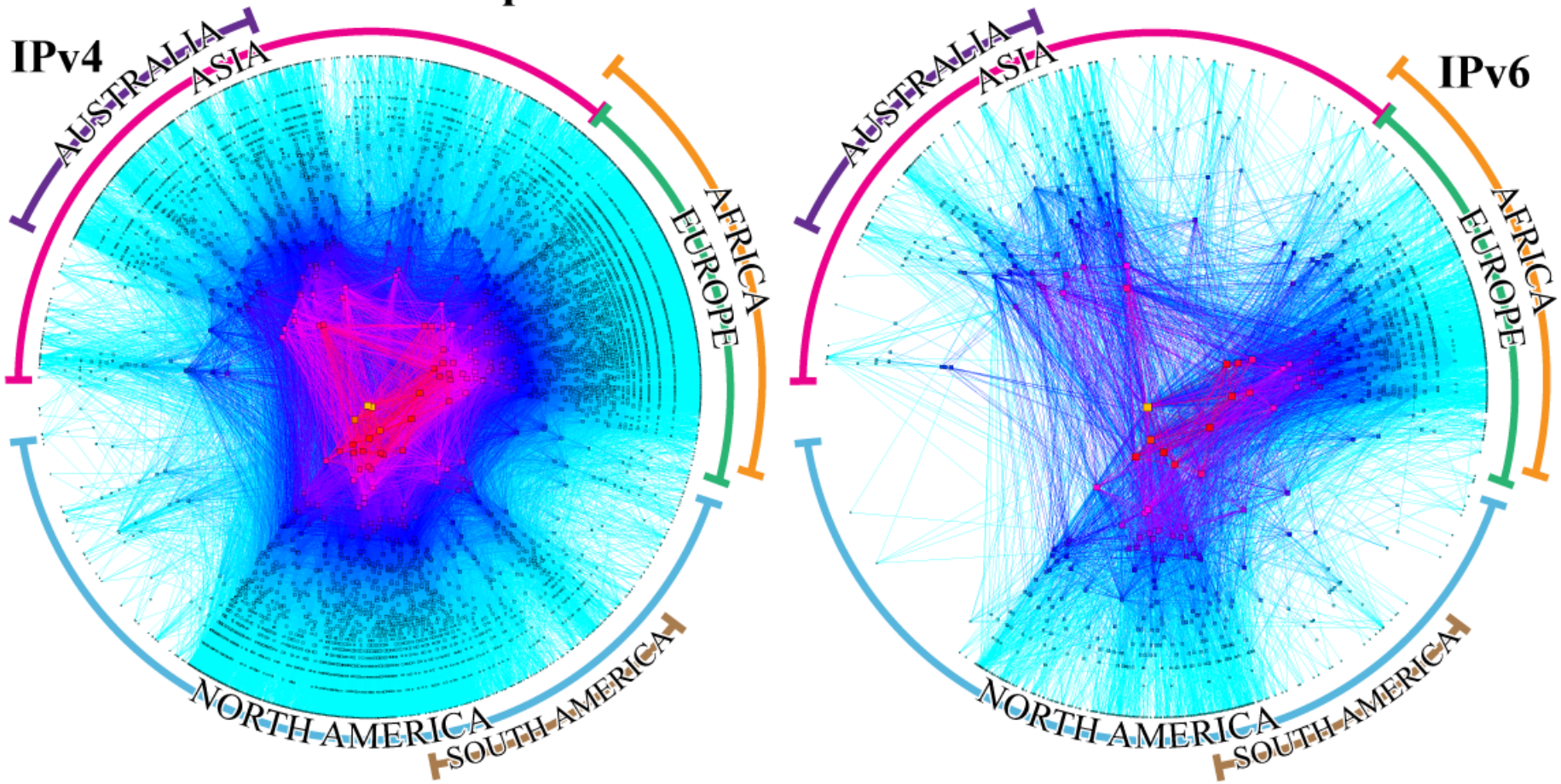
- There is a lot of measurements for various purposes on the Internet
  - Reachability and Latency Measurements
  - Routing Table measurements
  - Routing stability measurements
  - IPv6 / DNSSec / $VAR measurement
- These measurements may serve various purpose
  - We'll look at some common ones and 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)
    - CIDR-REPORT (and BGP Stability Report)
    - 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

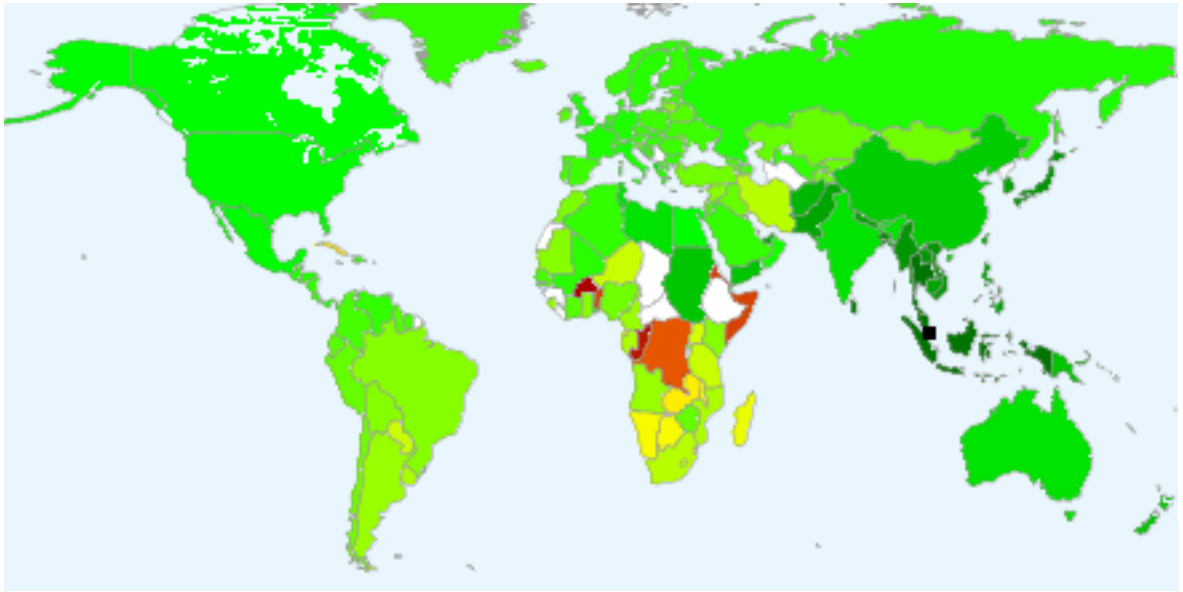
Archipelago
Jan 2013

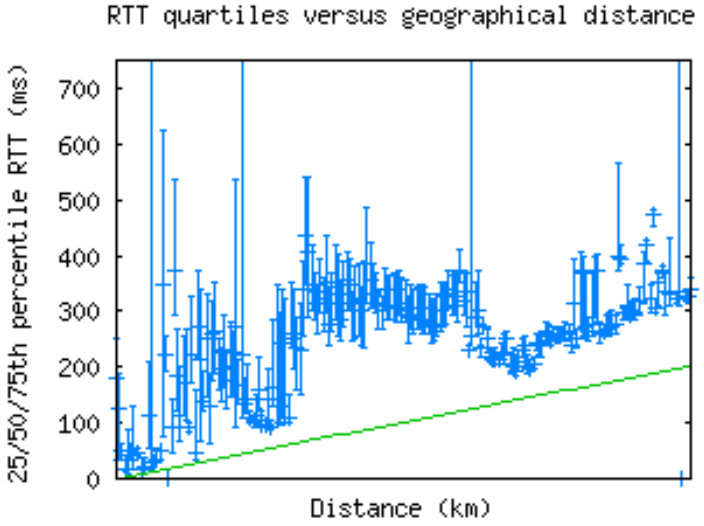


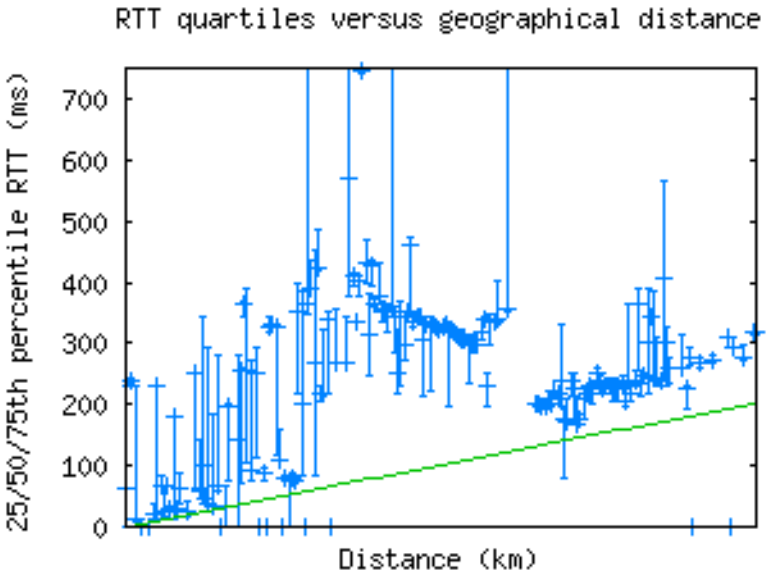
CAIDA ARK

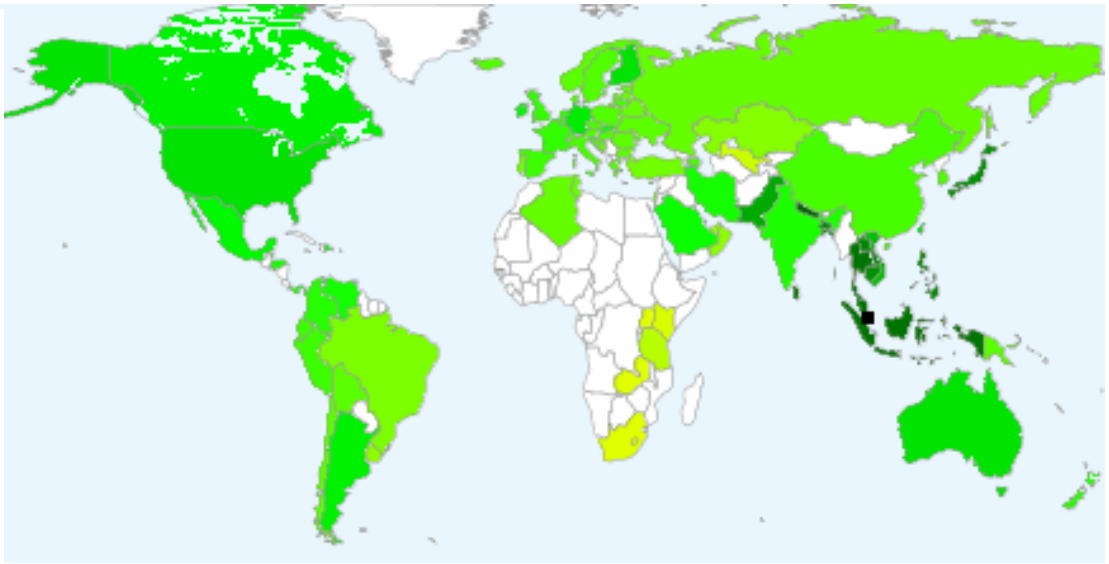
- CAIDA: The Cooperative Association for Internet Data Analysis (www.caida.org)
- CAIDA ARK is short form of the Archipelago Measurement Infrastructure
- Measures path and latency to ipv4/v6 address space visible on the global routing table.
- ARK data is used in lots of modeling and research. E.g AS-RANK

Reachability Report for v4/v6 from Equinix SG1 Singapore

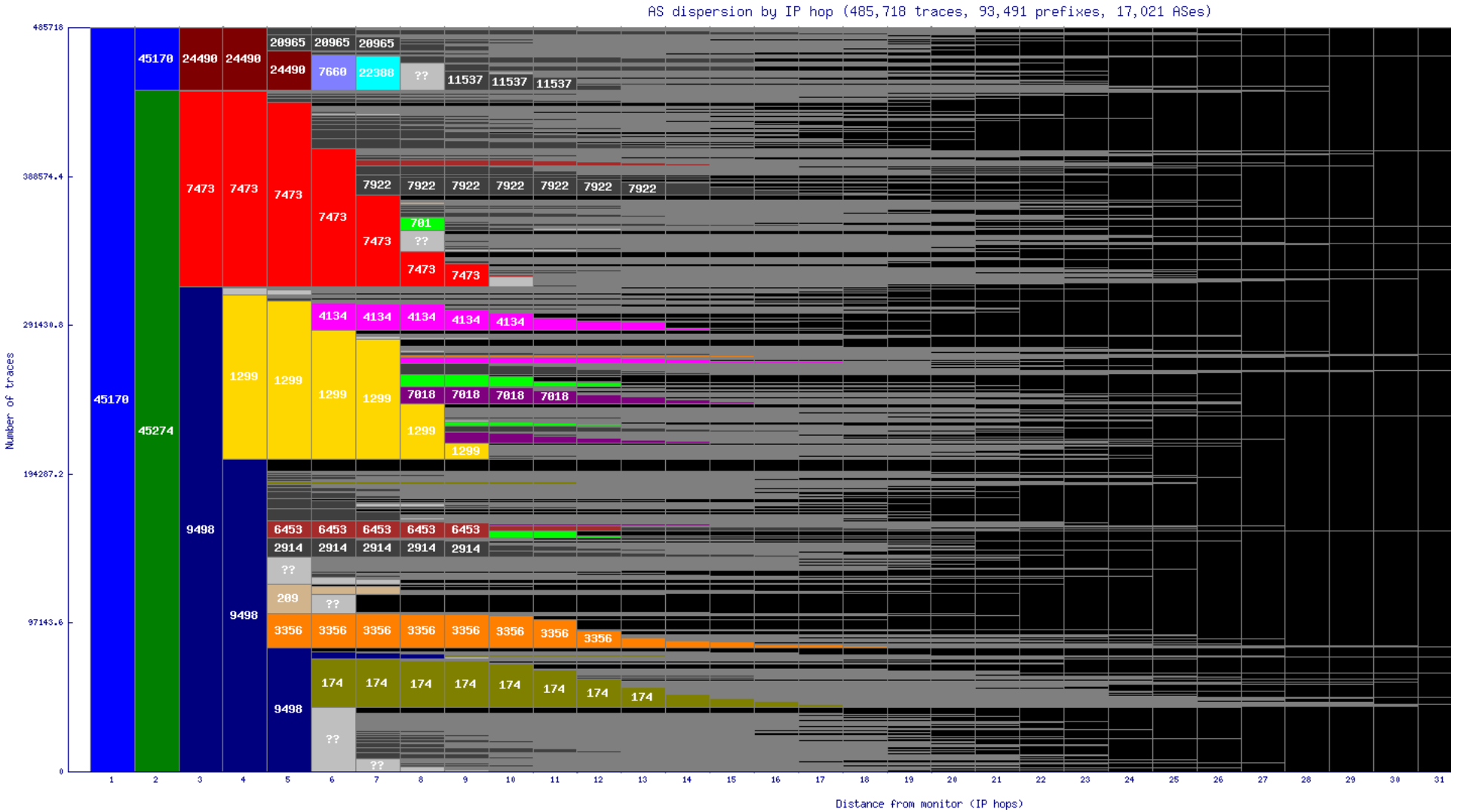








Connectivity from the Nepal Research and Education Network



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 NCC RIPE NETWORK COORDINATION CENTRE

Internet Coordination | Data & Tools | LIR Services | RIPE Community

Site Map | Contact | Help | RIPE Database Search

Sign In

RIPE stat

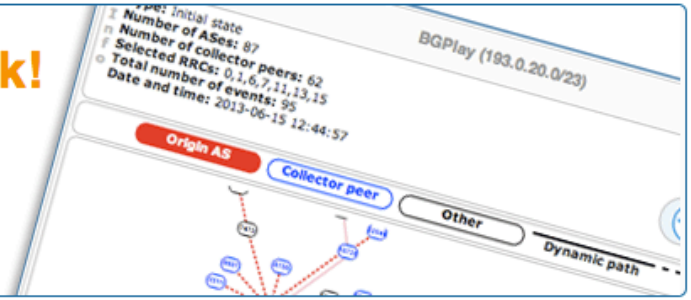
Your network: AS4755, 115.111.196.0/22 e.g.: IPv4 prefix/range, IPv6, ASN

RIPEstat is your source for Internet-related stats & status — stat! learn more...

Specials
- Multiple Widget & Resource Comparison
- Finding Internet-Abuse Related Contacts
- Country Comparison
- Syrian Network Outage (RIPE Labs article)
- Size Distribution of Registered IPv4 Prefixes
- Japanese Earthquake
- Egyptian Network Outage
- RIPEstat Mobile

RIPEstat Demos
- Tutorial: Abuse Contact Finder
- S2E06 (movie, article)
- S2E05 (movie, article)

BGPlay is back!



Quick links:

RIPEstat data API | Feedback/Contact | Changelog | Help

Videos about RIPEstat:

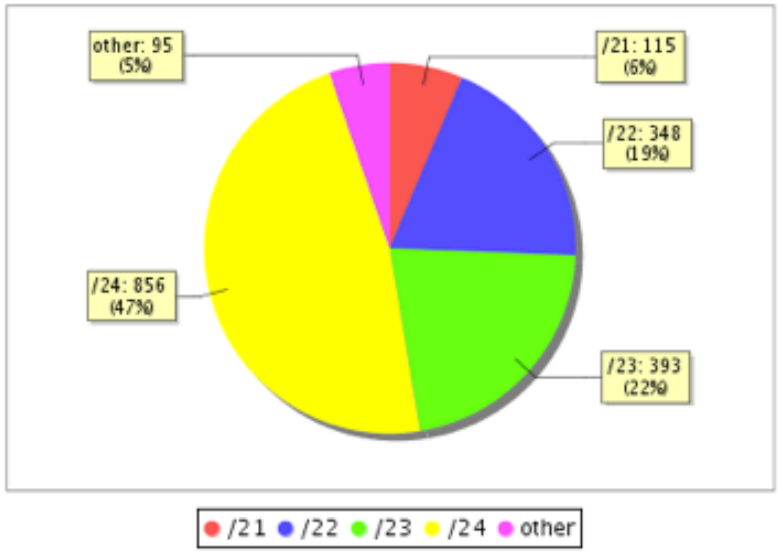
The current top queries
- 0.0.0.0-255.255.255.255
- vtigercrm/graph.php
- AS3320
- apple-touch-icon-precompo
- 10.0.0.0-10.255.255.255
- 192.168.0.0-192.168.255.2
- SY
- 1.2.0.0/22
- AS6830
- 94.168.92.0-94.168.99.255

Query for a different AS, or for a prefix: Query

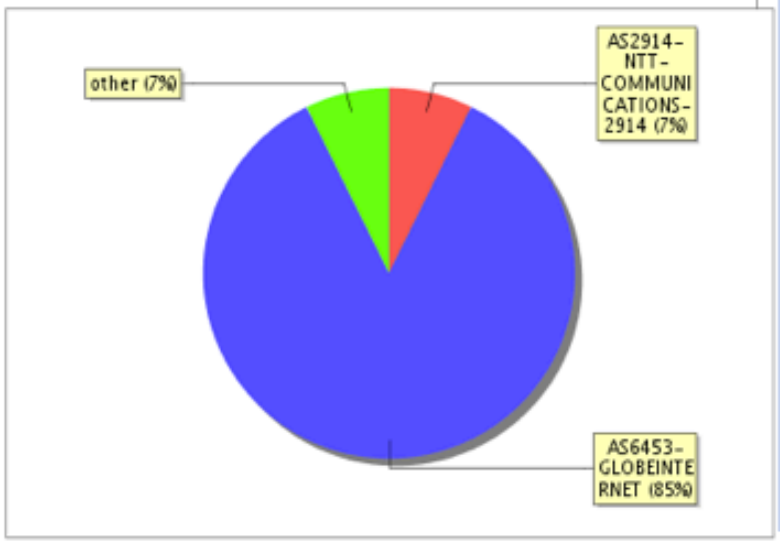
TATACOMM-AS TATA Communications formerly VSNL is Leading ISP [Whois data]

Overview | Prefixes | Transits | AS path lengths | Whois | Former bogon filtering

Prefix size distribution
AS4755

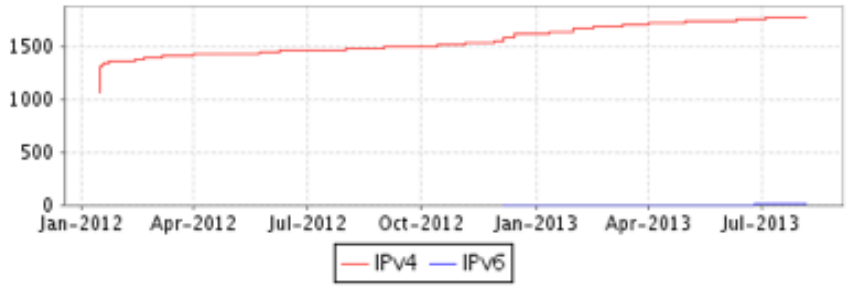


Transits distribution
AS4755

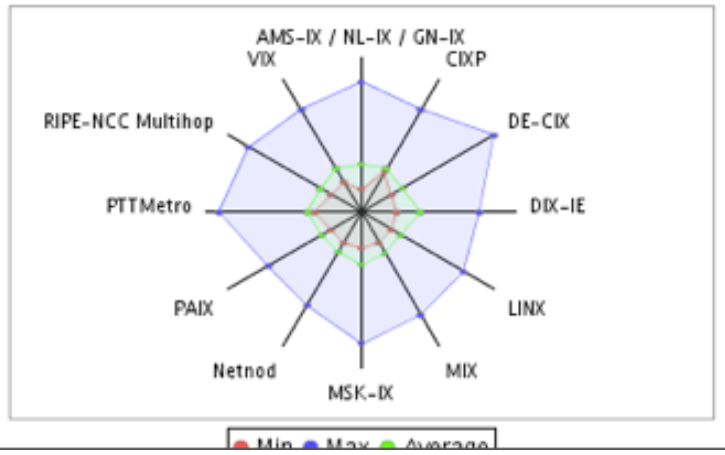


http://www.ris.ripe.net/dashboard/4755

Prefixes originated from AS4755 since 16/01/2012



AS path length to RIS collectors
AS4755



RIPE ATLAS

- New RIPE Measurements are using RIPE ATLAS
- A lot of stuff is reported by RIPE Labs
- A combination of TTM, DNSMON in a very tiny form factor
  - Can be installed in home broadband behind NATs
  - USB Powered and easy to install and forget.

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).

Location of RIPE ATLAS Probes

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 9498

Name

BBIL-AP BHARTI Airtel Ltd.

AS Adjacency Report

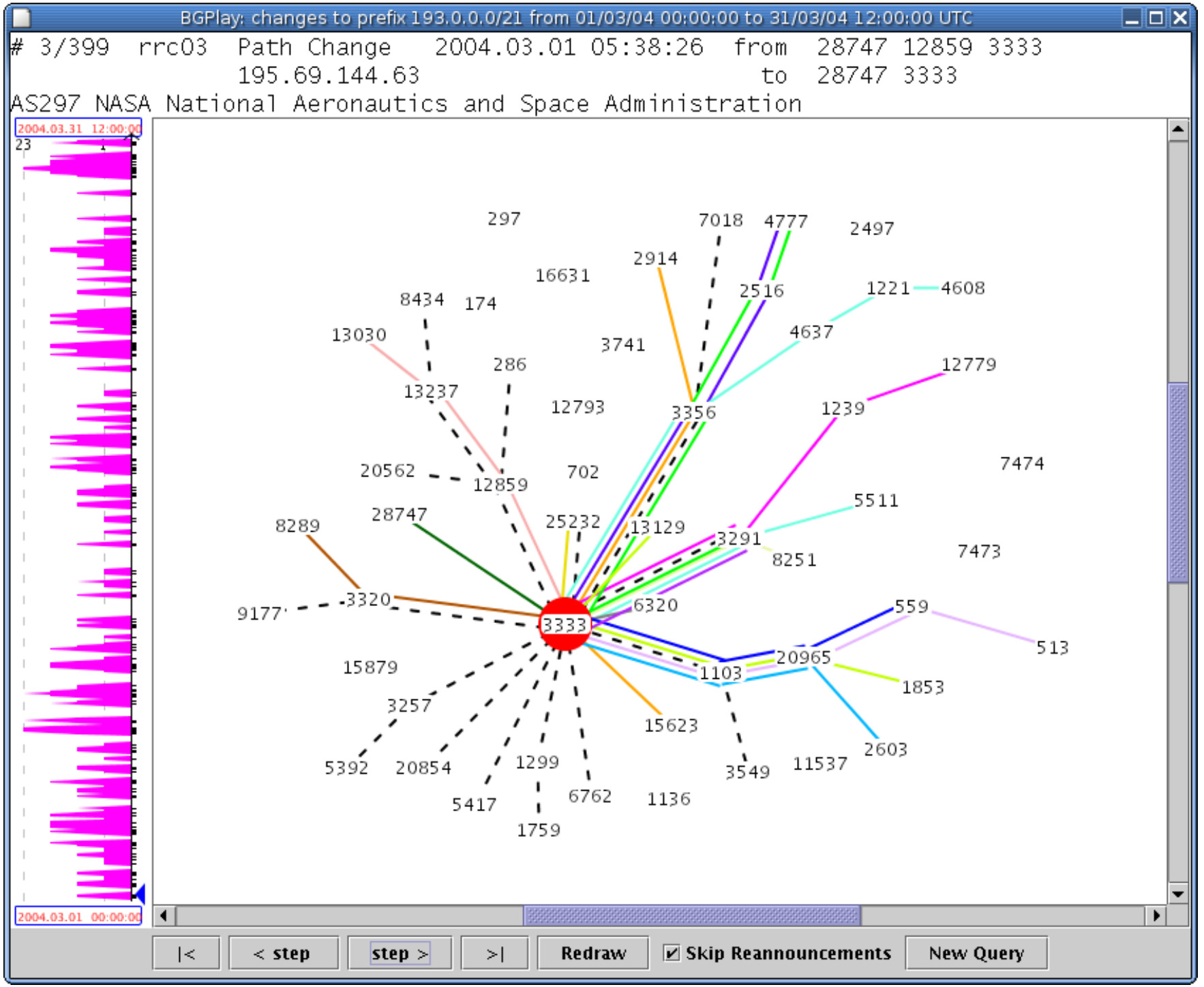
In the context of this report "Upstream" indicates that there is an adjacent AS that lines between the BGP table collection point (in this case at AS2.0) and the specified AS. Similarly, "Downstream" refers to an adjacent AS that lies beyond the specified AS. This upstream / downstream categorisation is strictly a description relative topology, and should not be confused with provider / customer / peer inter-AS relationships.

```
9498 BBIL-AP BHARTI Airtel Ltd.

  Adjacency:   298  Upstream:    13  Downstream:   285
  Upstream Adjacent AS list
    AS3320          DTAG Deutsche Telekom AG
    AS3356          LEVEL3 Level 3 Communications
    AS7473          SINGTEL-AS-AP Singapore Telecommunications Ltd
    AS6939          HURRICANE - Hurricane Electric, Inc.
    AS4635          HKIX-RS1 Hong Kong Internet Exchange--Route Server 1
    AS10026         PACNET Pacnet Global Ltd
    AS174           COGENT Cogent/PSI
    AS3561          SAVVIS-AS SAVVIS-AS3561
    AS3257          TINET-BACKBONE Tinet SpA
    AS3491          BTN-ASN - Beyond The Network America, Inc.
    AS3549          GBLX Global Crossing Ltd.
    AS6762          SEABONE-NET TELECOM ITALIA SPARKLE S.p.A.
    AS45274         WORLDLINK-INTERNATIONAL-TRANSIT-AS-AP Worldlink International Transit Services
  Downstream Adjacent AS list
    AS1310721036
    AS24448         NDSINDIA-AS NDS India Limited, Bangalore
    AS1310721072
    AS7991          SAVVISSTL - SAVVIS COMMUNICATIONS
    AS131072819
    AS1310721467
    AS1310721200
    AS1310721167
```

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
  - NIXI : http://www.nixi.in/lookingglass.php
- 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

HURRICANE ELECTRIC INTERNET SERVICES

Search

AS7473 Singapore Telecommunications Ltd

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.singtel.com

Country of Origin: Singapore

Prefixes Originated (all): 44
Prefixes Originated (v4): 43
Prefixes Originated (v6): 1

Prefixes Announced (all): 10,739
Prefixes Announced (v4): 10,476
Prefixes Announced (v6): 263

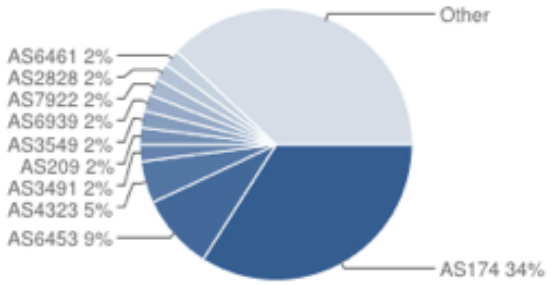
BGP Peers Observed (all): 309
BGP Peers Observed (v4): 301
BGP Peers Observed (v6): 107

IPs Originated (v4): 92,928
AS Paths Observed (v4): 33,049
AS Paths Observed (v6): 872

Average AS Path Length (all): 3.629
Average AS Path Length (v4): 3.636
Average AS Path Length (v6): 3.338

Like 2 people like this. Be the first of your friends.

AS7473 IPv4 Peers



ASN	Name
AS174	Cogent Communications
AS6453	Tata Communications
AS4323	tw telecom holdings, inc.
AS3491	PCCW Global
AS209	Qwest Communications Company, LLC
AS3549	Level 3 Communications, Inc. (GBLX)
AS6939	Hurricane Electric, Inc.
AS7922	Comcast Cable Communications, Inc.
AS2828	XO Communications
AS6461	Abovenet Communications, Inc

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

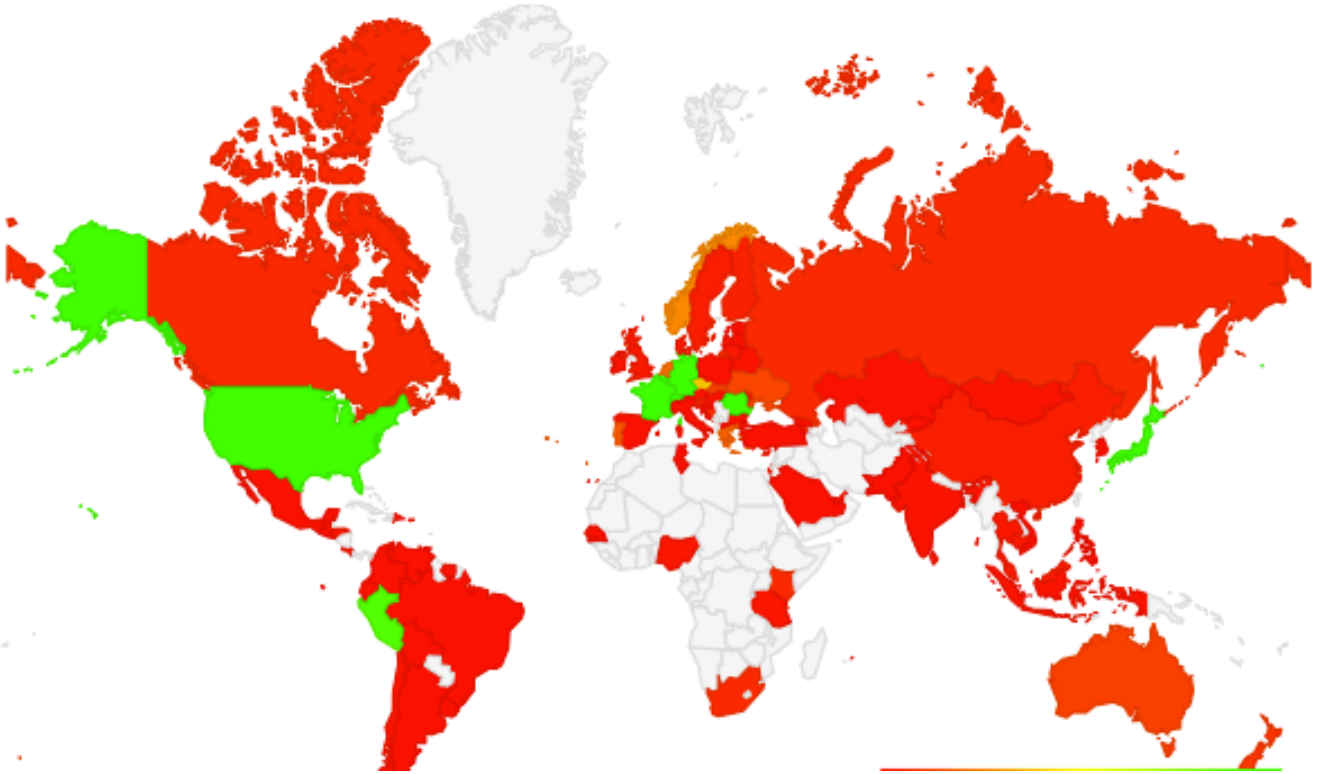
- Internet Measurement tools and activities are not just for academic purpose, but helps in operational troubleshooting
- Large datasets can help in modeling and planning exercises.
- Publicly available resources makes Internet a nicer place

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



Thank you!

Feedback welcome:
gaurab@llnw.com