The RouteViews Project: Update

Nina Bargisen

Apricot, Jakarta

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Background

- **RouteViews was first started in 1995**
- Now a growing network of 40+ collectors positioned strategically at Internet Exchange Points around the world
- RouteViews collaborates with the Center for Applied Internet Data Analysis (CAIDA) working with NSF grants that support Designing a Global Measurement Infrastructure to Improve Internet Security, GMI3S (OAC-2131987), and an Integrated Library for Advancing Network Data Science, ILANDS (CNS-2120399).
- RouteViews is supported with financial and in-kind donations by multiple organizations

- **RouteViews is based at the University of Oregon and operated by NSRC**
- NSRC supports the growth of global Internet infrastructure by providing engineering assistance, collaborative technical workshops, training, and other resources to university, research & education networks worldwide.
- NSRC is partially funded by the IRNC program of the NSF (OAC-2029309) and Google with other contributions from public and private organizations.
- The University of Oregon is a public research institution in Eugene, Oregon, USA founded in 1876.

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ROUTE VIEWS 6447

NSRC Network Startup Resource Center

RouteViews Team Members

Hans Kuhn
Nina Bargisen
Owen Conway
Philip Smith
Philip Paeps
Anton Berezin






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Network Startup Resource Center

What is RouteViews

- A tool that allows Internet network operators to look at the BGP table from different backbones and locations around the world to troubleshoot and to assess:
  - Reachability, hijacks, bugs, peer visibility, mass withdrawals, RPKI status,…
- Operators who find it a valuable tool also peer to contribute to the value
- RouteViews operates collectors strategically positioned at IXPs around the world.
  - It also hosts a few multi-hop collectors at UO for those operators who are not present at IXPs.

What is RouteViews

- Many free and commercial tools used by network engineers every day include data from RouteViews
  - CAIDA ASRANK
  - CAIDA BGP Reader
  - HE BGP Tools
  - Kentik Market Intelligence
  - Kentik BGP monitoring
  - Catchpoint
  - BGPMon
  - And many more

RouteViews Collector Map

https://www.routeviews.org/routeviews/map/

What's happening at RouteViews

ROUTEVIEWS NEWS

RouteViews News

- Collectors:
  - All software collectors use FRR[1] (version 10.5)
  - One Cisco ASR1004 (as a tribute to the original!)
  - Moving collectors from metal to VMs (easier deployment & management)
- Location update:
  - Most recent additions include Jakarta (IIX Jakarta), Puerto Rico (CRIX) and Lagos (IXPN)
  - Several new locations offered; resources required to fulfil those offers

[1]FRRouting Project: https://frrouting.org/

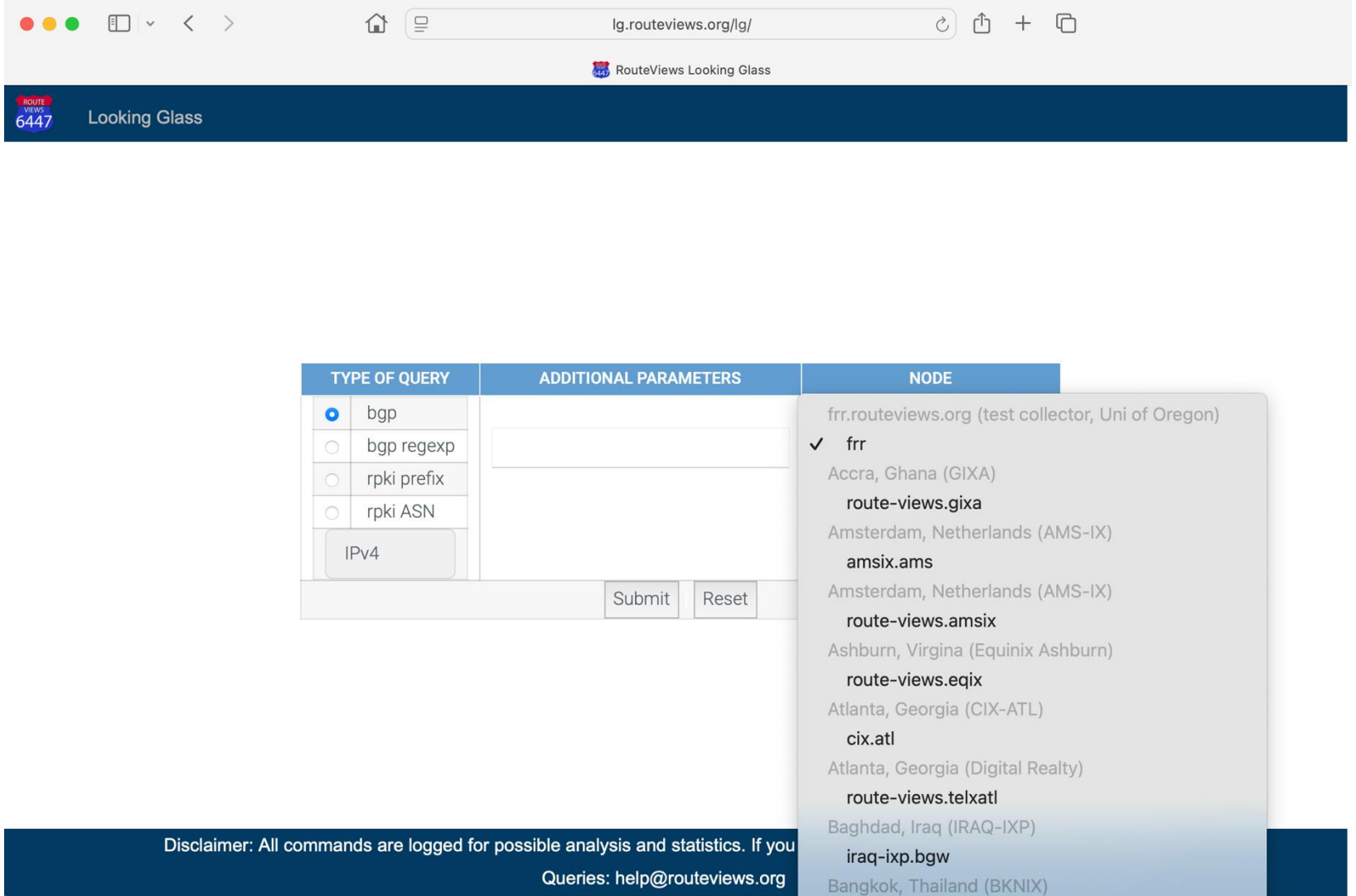
RouteViews Development Projects: API

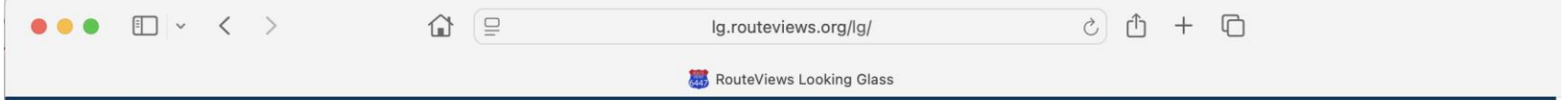
- API allows programmatic access to live RouteViews data
  - (our collectors currently allow telnet access, which 1000s of automated scripts hammer daily)
- Two access levels:
  - Unauthenticated for casual (infrequent queries)
  - Authenticated access (using verified PeeringDB users) for more serious research
- API currently supports ten collectors
  - More will be added as resources become available
- Please consult the docs on how to use the API
  - https://api.routeviews.org/docs/

Exchange	collector
AMS-IX Amsterdam, Netherlands	route-views.amsix.routeviews.org
LINX, London, United Kingdom	route-views.linx.routeviews.org
NAPAfrica, Johannesburg, South Africa	route-views.napafrica.routeviews.org
Equinix SG1, Singapore, Singapore	route-views.sg.routeviews.org
Equinix SYD1, Sydney, Australia	route-views.sydney.routeviews.org
SAOPAULO (PTT Metro, NIC.br), Sao Paulo, Brazil	route-views2.saopaulo.routeviews.org
Multi-hop at U of Oregon	route-views3.routeviews.org
Multi-hop at U of Oregon	route-views4.routeviews.org
Multi-hop at U of Oregon	route-views5.routeviews.org
Multi-hop at U of Oregon	route-views6.routeviews.org

RouteViews Development Projects: LG

- telnet access is unsustainable
  - Gives open access to the collector command line interface to run “show” commands
- Looking Glass will soon become the default access for each collector
  - Permits the most commonly used BGP diagnostic commands
  - telnet remains available on route-views.routeviews.org (the Cisco ASR1004) for legacy access
- Looking Glass can be found on https://lg.routeviews.org/lg/
  - telnet access will be removed after due notice to the community


lg.routeviews.org/lg/
RouteViews Looking Glass
Looking Glass
TYPE OF QUERY
ADDITIONAL PARAMETERS
NODE
bgp
bgp regexp
rpki prefix
rpki ASN
IPv4
Submit
Reset
frr.routeviews.org (test collector, Uni of Oregon)
frr
Accra, Ghana (GIXA)
route-views.gixa
Amsterdam, Netherlands (AMS-IX)
amsix.ams
Amsterdam, Netherlands (AMS-IX)
route-views.amsix
Ashburn, Virgina (Equinix Ashburn)
route-views.eqix
Atlanta, Georgia (CIX-ATL)
cix.atl
Atlanta, Georgia (Digital Realty)
route-views.telxatl
Baghdad, Iraq (IRAQ-IXP)
iraq-ixp.bgw
Bangkok, Thailand (BKNIX)
Disclaimer: All commands are logged for possible analysis and statistics. If you
Queries: help@routeviews.org



ROUTE VIEWS 6447 Looking Glass

Router: frr

Command: show bgp ipv4 unicast 23.56.154.116

```
frr.routeviews.org> show bgp ipv4 unicast 23.56.154.116
BGP routing table entry for 23.56.144.0/20, version 50831
Paths: (2 available, best #1, table default)
  Not advertised to any peer
  3582 3701 6939 4651 20940 16625
    128.223.253.10 from 128.223.253.10 (128.223.253.10)
      Origin IGP, valid, external, multipath, best (Older Path), rpki validation-state: valid
      Community: 3701:10200 3701:10204 3701:30003
      Last update: Tue May  6 21:45:58 2025
  3582 3701 6939 4651 20940 16625
    128.223.253.9 from 128.223.253.9 (128.223.253.9)
      Origin IGP, valid, external, multipath, rpki validation-state: valid
      Community: 3701:10200 3701:10204 3701:30003
      Last update: Tue May  6 21:45:58 2025
```

ROUTE VIEWS 6447 Looking Glass

Router: frr

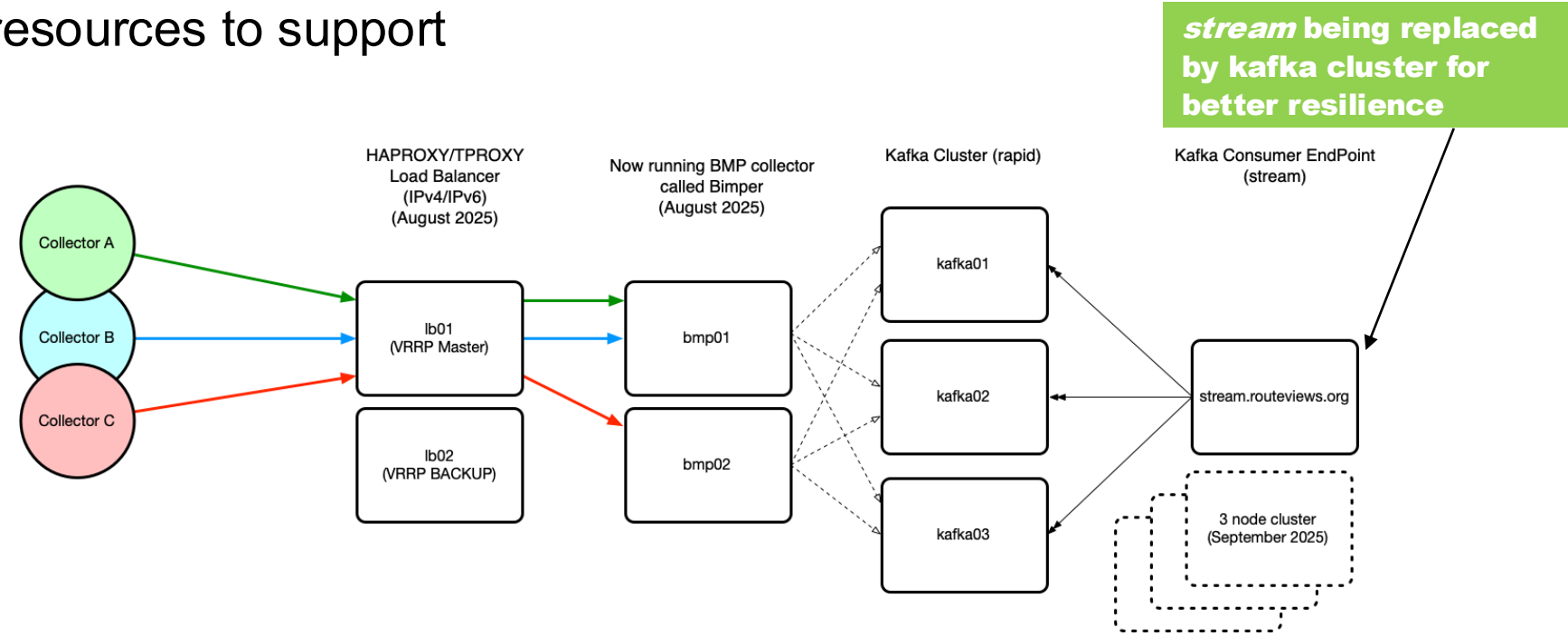
Command: show bgp ipv4 unicast 23.56.0.0/16 longer-prefixes

```
frr.routeviews.org> show bgp ipv4 unicast 23.56.0.0/16 longer-prefixes
BGP table version is 21483649, local router ID is 128.223.51.23, vrf id 0
Default local pref 100, local AS 65123
Status codes:  s suppressed, d damped, h history, u unsorted, * valid, > best, = multipath,
               i internal, r RIB-failure, S Stale, R Removed
Nexthop codes: @NNN nexthop's vrf id, < announce-nh-self
Origin codes:  i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
V*>  23.56.0.0/24     128.223.253.10                         0 3582 3701 2152 2516 20940 20940 i
V*=                   128.223.253.9                          0 3582 3701 2152 2516 20940 20940 i
V*>  23.56.1.0/24     128.223.253.10                         0 3582 3701 11164 20940 i
V*=                   128.223.253.9                          0 3582 3701 11164 20940 i
V*>  23.56.2.0/24     128.223.253.10                         0 3582 3701 2152 3356 20940 i
V*=                   128.223.253.9                          0 3582 3701 2152 3356 20940 i
V*>  23.56.3.0/24     128.223.253.10                         0 3582 3701 11164 20940 i
V*=                   128.223.253.9                          0 3582 3701 11164 20940 i
V*>  23.56.4.0/24     128.223.253.10                         0 3582 3701 11164 20940 i
V*=                   128.223.253.9                          0 3582 3701 11164 20940 i
V*>  23.56.5.0/24     128.223.253.10                         0 3582 3701 2152 3356 20940 i
V*=                   128.223.253.9                          0 3582 3701 2152 3356 20940 i
```

RouteViews Development Projects: BMP

- Live feed from collectors for BGP data consumers
- Challenge is to make this scale and provide the infrastructure resources to support



RouteViews Development Projects: Bimper

Bimper is a specialised high-performance BGP Monitoring Protocol (BMP) message processor that receives BGP routing data from network routers and forwards it to Kafka for downstream analysis and storage. It provides real-time monitoring of BGP routing events with Prometheus metrics integration for operational visibility.

The system includes bimperctl, a control utility for managing and monitoring bimper instances, allowing administrators to interact with the service and view connection status information, and manage router connections

Bimper replaces OpenBMP and Bimper messages are compatible with OpenBMP’s raw bmp

RouteViews Behind the Scenes Projects

- Upgrading archive infrastructure and storage
  - RouteViews stores BGP data from 1997 – around 50 TBytes (compressed)
- Tooling
  - Automation tools for managing the whole infrastructure and deploying new peers
- Collector OS (from CentOS to Ubuntu)
  - CentOS end-of-life – half the collectors still running CentOS
- FRR performance
  - Tuning Linux TCP parameters to improve BGP peer performance
    - https://fasterdata.es.net/host-tuning/linux/
  - “Badly behaving peers” (*aka* slow and/or noisy peers)

Slow and noisy peers

- Bimber enables us to monitor bgp and bmp more closely
- Much time was spent chasing stalled bgp and bmp sessions
- upgrade to FRR 10.5.1 greatly improve queing and processing of updates and means the live stream platform is much more stable now

RouteViews Future Planning

- Collectors & hosts in new locations outside North America
  - Large IXPs with dense interconnection
  - Unique or specialist environments (e.g. R&E exchanges)
- Scalable and diverse archiving
- RouteViews Peering Portal
- Improved community support
  - Running this infrastructure costs money!
  - We hugely appreciate our generous supporters
    - https://www.routeviews.org/routeviews/index.php/supporters/
- Your recommendations are welcome! 🙏

For network operators & researchers

USING ROUTEVIEWS

Using RouteViews

- Network Operators use the live data to analyse how their routes appear on the Global Routing System
- Researchers use the 27-year-old data archive to study trends, route hijacks, and changes such as:
  - Origin change
  - Next-hop change
  - New prefix / more specifics
  - New neighbours
  - Operator ASN appearing in a new transit path
  - Bogons

Looking Glass

TYPE OF QUERY	ADDITIONAL PARAMETERS
bgp	
bgp regexp	summary
rpki prefix	
rpki ASN	
IPv4	

Submit Reset

route-views.daeix
Fortaleza, Brazil (IX.br (PTT.br) Fortaleza)
route-views.fortaleza
Guam, US Territories (GOREX)
route-views.gorex
Indianapolis, Indiana (FD-IX)
route-views.mwix
Johannesburg, South Africa (NAPAfrica)
route-views.napafrica
Johor Bahru, Malaysia (DE-CIX Malaysia)
decix.jhb
Lima, Peru (Peru IX)
route-views.peru
London, United Kingdom (LINX)
✓ route-views.linx
Los Angeles, California (Pacific Wave)
pacwave.lax
Miami, Florida (FL-IX)
route-views.flix
Nairobi, Kenya (KIXP)
route-views.kixp
New York, NY (DE-CIX New York)
route-views.ny
Palo Alto, California (PAIX)
route-views.isc
Perth, Australia (WA-IX)
route-views.perth
Portland, Oregon (NWAX)
route-views.nwax
Querétaro, Mexico (PIT Chile MX)
pitmx.qro
Quezon City, Philippines (PhOpenIX)

Disclaimer: All commands are logged for possible analysis and statistics. If you

Queries: help@routeviews.org

ROUTE VIEWS 6447 Looking Glass

Router: route-views.linx

Command: show bgp ipv4 unicast summary

```
route-views.linx> show bgp ipv4 unicast summary
BGP router identifier 195.66.225.222, local AS number 6447 VRF default vrf-id 0
BGP table version 309367728
RIB entries 1960257, using 239 MiB of memory
Peers 59, using 1402 KiB of memory

Neighbor        V         AS   MsgRcvd   MsgSent   TblVer  InQ OutQ  Up/Down State/PfxRcd   PfxSnt Desc
195.66.224.12   4      47957  12686566    175336 309367728    0    0 08w4d21h       429688        0 Ingenico Solutions
195.66.224.21   4       6939  13824625     87669 309367728    0    0 08w4d21h       998128        0 Hurricane Electric
195.66.224.25   4      37497  13990578    108820 309367728    0    0 08w4d21h       978133        0 Network Platforms
195.66.224.29   4       5413    178038    175336 309367728    0    0 08w4d21h            0        0 Daisy Corporate
195.66.224.32   4       3257  39273641    175478 309367728    0    0 08:15:53       973113        0 GTT Communications
195.66.224.51   4       6453  20849985    175336 309367728    0    0 08w4d21h       973415        0 TATA Communications
195.66.224.64   4       3292    181363    175336 309367728    0    0 08w4d21h          645        0 Tele Danmark
195.66.224.66   4       8426    103378     87669 309367728    0    0 08w4d21h          118        0 Claranet
195.66.224.83   4       5511   1926542    175336 309367728    0    0 08w4d21h       143805        0 Orange S.A.
195.66.224.89   4       6830  25270342    175044 309367728    0    0 03w4d06h       973086        0 Liberty Global B.V.
195.66.224.99   4      13237  91674008     87669 309367728    0    0 08w4d21h       977005        0 euNetworks Group
195.66.224.114  4       6667  42436550    174822 309367728    0    0 04w5d08h       974317        0 Elisa Corporation
195.66.224.118  4      14537  28534432    175336 309367728    0    0 08w4d21h       977143        0 Continent 8
195.66.224.138  4       2914  21709483    175044 309367728    0    0 03w4d06h       973489        0 NTT Global IP
195.66.224.153  4       6762   5153973    175341 309367728    0    0 02w6d21h       212040        0 Telecom Italia
195.66.224.157  4      16552  26255740    175336 309367728    0    0 08w4d21h       974632        0 Tiggee LLC
195.66.224.165  4      38880  21790409     87669 309367728    0    0 08w4d21h      1014829        0 Micron21 Datacentre
195.66.224.167  4       3491  10385507     87669 309367728    0    0 08w4d21h       970203        0 PCCW Global
195.66.224.175  4      13030  29719579     87669 309367728    0    0 08w4d21h       974063        0 Init7 (Switzerland)
195.66.224.193  4       9002  14866344    175336 309367728    0    0 08w4d21h       974480        0 RETN
195.66.224.215  4      31500    140603     87594 309367728    0    0 04w3d15h         3585        0 Global Network
```

59 peers

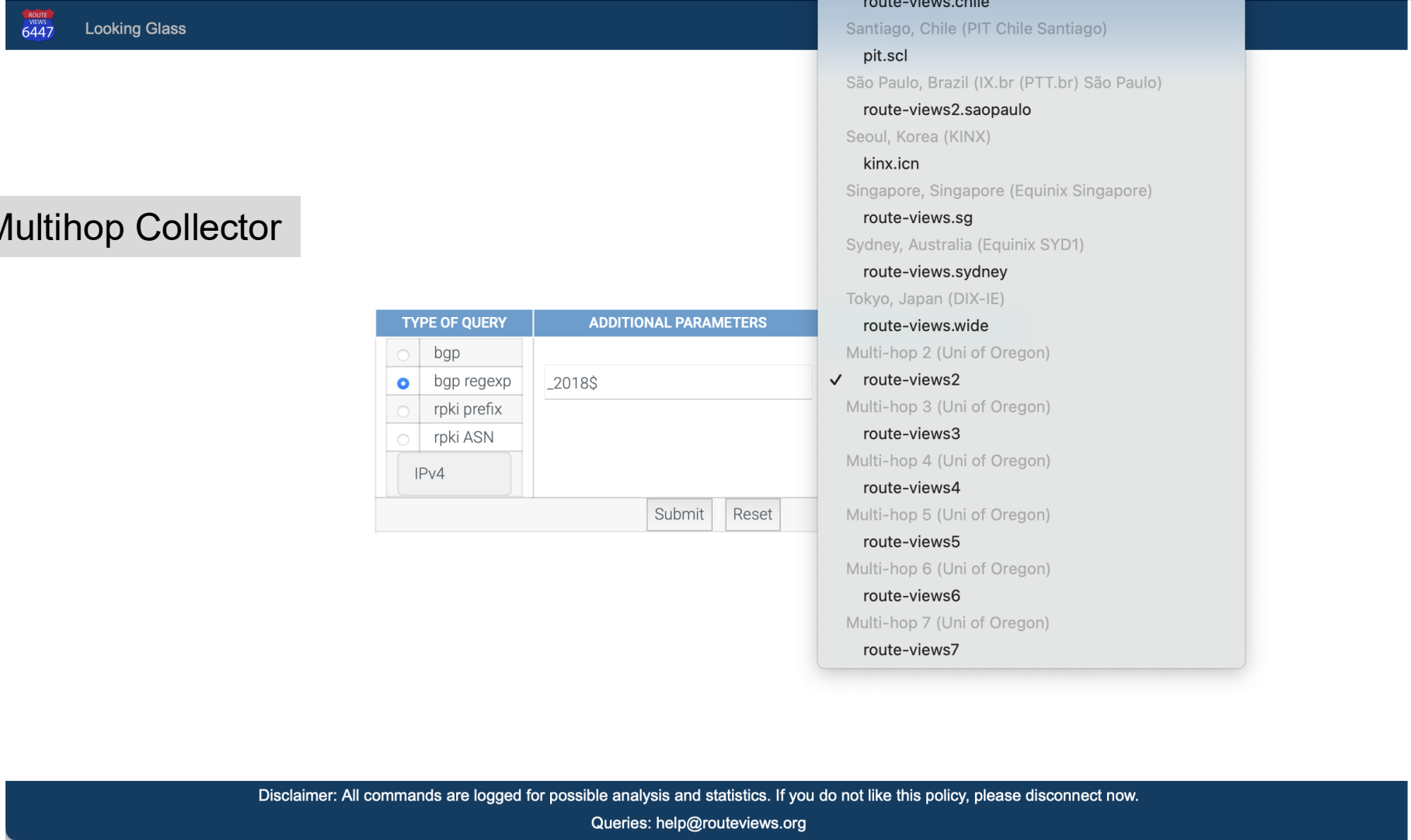
Lots of full tables

RouteViews Use Cases: Peering Negotiation

- Understanding your prospects connectivity can be key to a good negotiation
  - Who are the upstreams?
  - Who are the peers?
  - Who are the customers?

- Let's have a look at AS2018 as an example

Multihop Collector



ROUTE VIEWS 6447 Looking Glass

Router: route-views2

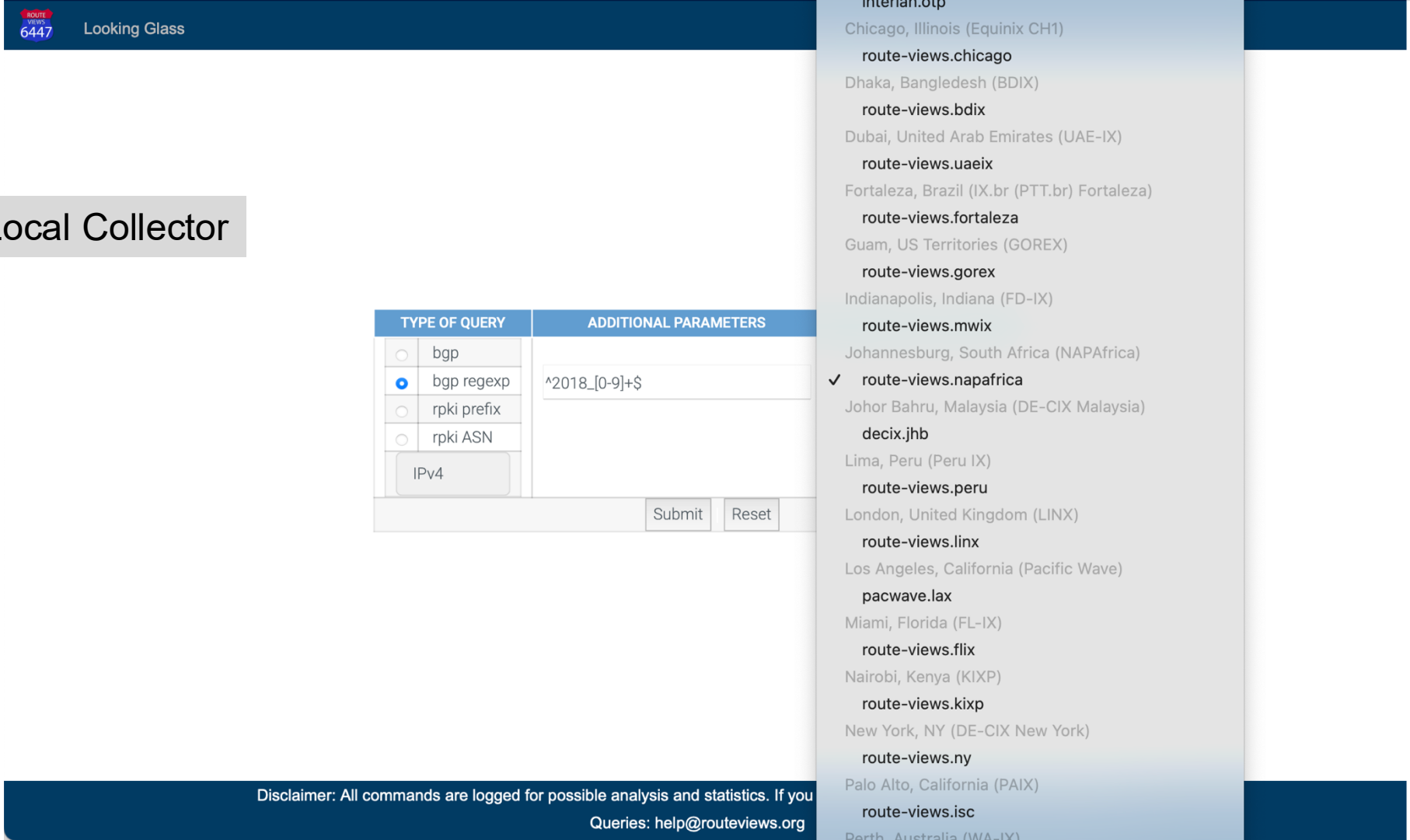
Command: show bgp ipv4 unicast regexp _2018$

```
route-views2.routeviews.org> show bgp ipv4 unicast regexp _2018$

BGP table version is 38730963, local router ID is 128.223.51.102, vrf id 0
Default local pref 100, local AS 6447
Status codes:  s suppressed, d damped, h history, u unsorted, * valid, > best, = multipath,
               i internal, r RIB-failure, S Stale, R Removed
Nexthop codes: @NNN nexthop's vrf id, < announce-nh-self
Origin codes:  i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
N*>  137.214.0.0/16   94.156.252.18            0             0 34224 2018 i
N*                    105.16.0.247                           0 37100 2018 i
N*                    198.129.33.85         9000             0 293 2018 i
N*                    217.192.89.50                          0 3303 2018 i
N*                    163.253.3.14                           0 11537 2018 i
N*                    168.209.255.56                         0 3741 2018 i
N*                    87.121.64.4                            0 57463 2018 i
N*                    202.73.40.45                           0 18106 2018 i
N*                    64.71.137.241                          0 6939 2018 i
N*                    203.181.248.195                        0 7660 11537 2018 i
N*                    91.218.184.60                          0 49788 12552 2018 i
N*                    129.250.1.71         29078             0 2914 20080 2018 i
N*                    140.192.8.16                           0 20130 6939 2018 i
N*                    12.0.1.63                              0 7018 2914 20080 2018 i
N*                    37.139.139.17            0             0 57866 2914 20080 2018 i
N*                    202.232.0.3                            0 2497 2914 20080 2018 i
N*                    137.164.16.84                          0 2152 2153 11537 2018 i
```

Local Collector



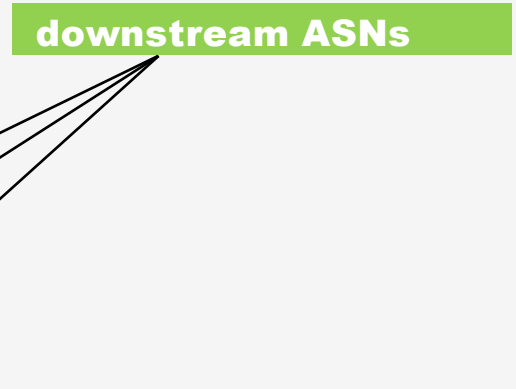
ROUTE VIEWS 6447 Looking Glass

Router: route-views.napafrica

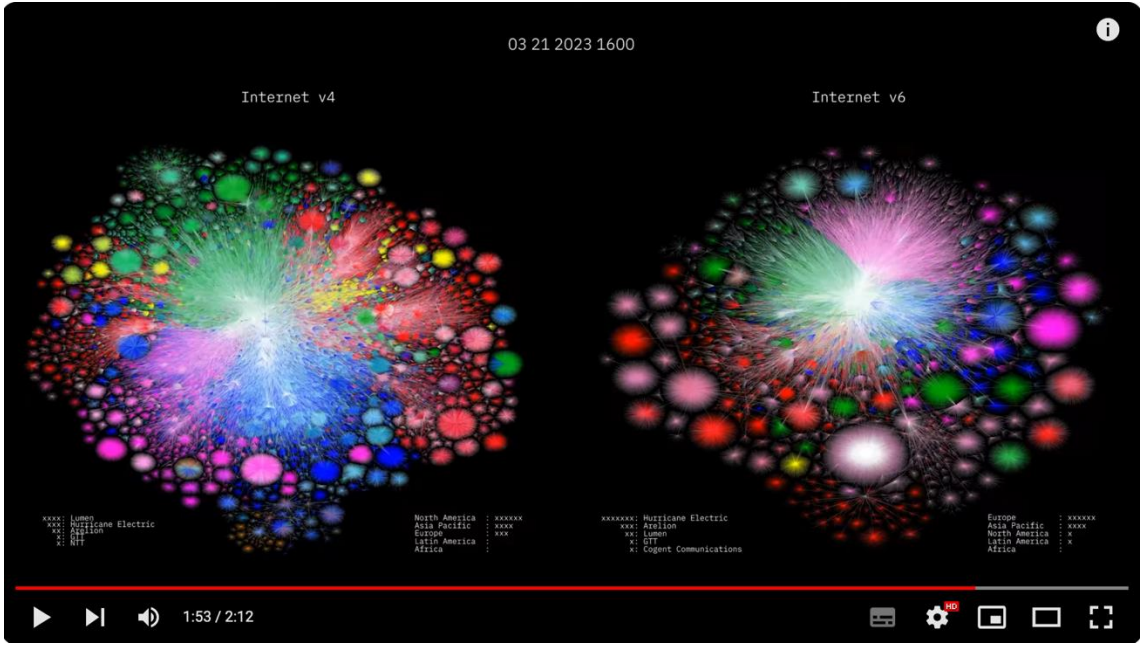
Command: show bgp ipv4 unicast regexp ^2018_[0-9]+$

```
route-views.napafrica> show bgp ipv4 unicast regexp ^2018_[0-9]+$
BGP table version is 439885622, local router ID is 196.60.9.68, vrf id 0
Default local pref 100, local AS 6447
Status codes:  s suppressed, d damped, h history, u unsorted, * valid, > best, = multipath,
               i internal, r RIB-failure, S Stale, R Removed
Nexthop codes: @NNN nexthop's vrf id, < announce-nh-self
Origin codes:  i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
V*>  41.74.144.0/23   196.60.8.216                           0 2018 329522 i
V*>  41.74.146.0/23   196.60.8.216                           0 2018 329522 i
V*>  41.74.156.0/23   196.60.8.216                           0 2018 329522 i
V*>  41.74.158.0/23   196.60.8.216                           0 2018 329522 i
N*>  137.158.0.0/16   196.60.8.216                           0 2018 36982 i
N*>  143.160.0.0/24   196.60.8.216                           0 2018 8094 i
N*>  143.160.1.0/24   196.60.8.216                           0 2018 8094 i
N*>  143.160.2.0/24   196.60.8.216                           0 2018 8094 i
N*>  143.160.3.0/24   196.60.8.216                           0 2018 8094 i
N*>  143.160.4.0/22   196.60.8.216                           0 2018 8094 i
N*>  143.160.8.0/22   196.60.8.216                           0 2018 8094 i
N*>  143.160.12.0/22  196.60.8.216                           0 2018 8094 i
N*>  143.160.16.0/20  196.60.8.216                           0 2018 8094 i
N*>  143.160.32.0/22  196.60.8.216                           0 2018 8094 i
N*>  143.160.36.0/22  196.60.8.216                           0 2018 8094 i
N*>  143.160.40.0/21  196.60.8.216                           0 2018 8094 i
N*>  143.160.48.0/22  196.60.8.216                           0 2018 8094 i
N*>  143.160.52.0/22  196.60.8.216                           0 2018 8094 i
```



RouteViews Impact



Barrett Lyon: https://www.youtube.com/watch?v=vo5glK9czlE

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ROUTE VIEWS 6447

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Network Startup Resource Center

Consumers of RouteViews data

If you use RouteViews data for your products or services:

- Please acknowledge the source!
  - Your product or service likely would not work without our data!
- Please do *NOT* send your customers of your products or services to us for technical support:
  - We simply collect what is seen in the global routing table
  - We cannot fix mistakes made by network operators
  - We cannot fix bugs in BGP implementations
  - We cannot remove BGP announcements we receive
  - We cannot change what is seen in the global routing table

For Peering Coordinators

PEERING WITH ROUTEVIEWS

Peering with RouteViews

- RouteViews has a Selective peering policy
  - PeeringDB: https://www.peeringdb.com/asn/6447
- We require all peers to have a PeeringDB entry
  - Our tools build peering options (for IXP based collectors) and configurations from PeeringDB
- Peering:
  - Over IPv4 (for IPv4 prefixes) and IPv6 (for IPv6 prefixes)
  - We want to receive the entire BGP table (if operationally possible)
  - We do not send you any prefixes (please don't ask)

Peering with RouteViews: General Requirements

- Peer must operate stable equipment
  - RouteViews will shutdown BGP sessions that impact the stability of the RouteViews platform
- Peer must have a public routable ASN
- Peer must not be a hobby network
- Peer's full view of the global routing table is preferred
- Routes should be aggregated as much as possible
  - (no longer than /24 for IPv4 and /48 for IPv6)
- Peer must have up-to-date information in PeeringDB, including the NOC email address
- Peer must filter RFC6890 space and must not send default routes
- RouteViews does not accept addpath-RX or TX

Peering with RouteViews: IXP & Multihop

IXP Peering

- We happily accept everyone's routes from the route servers.
- We will set up bilateral sessions with anyone who meets the general requirements and will send us their full table.
- We will peer at all mutual exchanges if requested.

Multihop Peering

- We will accept multihop peers who are not on any mutual IXPs.
- Peers must provide their full view of the Internet as they see it.
- We accept two sessions for redundancy; more than two sessions can be set up if the feeds are sufficiently different.

Why a Selective Peering policy?

- Balancing operational overhead, scale and information from the data
- Hobby Networks
- Full View of the Internet
- What makes a peering interesting?
  - Networks in regions where we have limited visibility
  - Networks demonstrating new interconnection patterns
  - Networks using innovative routing practices
  - Networks that help us understand emerging market dynamics
  - Or maybe something we haven't thought about yet

For potential hosts of collectors

HOSTING ROUTEVIEWS

Hosting RouteViews

- RouteViews is interested in new locations
  - Especially in regions or economies we have no collector
  - Where there are IXPs with large numbers of peers (>100)
- Hosting a RouteViews collector
  - Hosts can be IXPs themselves
  - Hosts can be members of IXPs
  - Hosts sponsor the IXP port and the (~10Mbps) transit required
  - Hosts sponsor the VM needed for the collector
    - Physical hardware is less preferred due to being harder to manage
    - VMs sometimes may not be possible due to operational requirements

Collector Specifications

- Virtual Machine:
  - 16GB RAM min (prefer 32GB)
  - 100GB disk
  - 4 vCPUs
  - 1 transit interface (management and public CLI access, low traffic)
  - 1 peering interface on the IX
- Physical Hardware:
  - 32GB – 64GB RAM
  - 400GB – 1TB SSD
  - 4+ CPUs
  - Ethernet port for transit interface (1Gbps is enough)
  - Ethernet port for IX peering (10Gbps is the standard now)

Collector Software

- Ubuntu 24.04 is RouteViews standard OS
  - We require a minimal Ubuntu Server install
  - Our deployment scripts do the rest

- Routing daemon we install is FRR
  - MRT[1] used for BGP RIBs (archived every 2 hours) and BGP updates (archived every 15 minutes)

[1] Multi-Threaded Routing Toolkit: https://datatracker.ietf.org/doc/html/rfc6396

Collector Host

- Acknowledged on RouteViews website as a sponsor
- Contact details kept up to date with RouteViews team
  - An up-to-date PeeringDB entry helps 😀

How you can help

SUPPORTING ROUTEVIEWS

Supporting RouteViews

- The project was started in 1995 because network operators wished to see what their BGP announcements looked like from an external viewpoint
  - Thousands of network operators & researchers all around the world now rely on RouteViews
  - Many everyday tools we all rely on use RouteViews data
  - Many commercial products and services rely on RouteViews data

Supporting RouteViews

Please consider supporting RouteViews:

- By peering with one of our collectors
- By publicly acknowledging the value of the information we have collected
  - For citations, our DOI is *10.7264/1y7v-2d90*
- If your product or service is commercially successful, we look forward to receiving your support to keep your product or service that way!
- In any other way that helps keep this community service going

Thank you!