The RouteViews Project

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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.

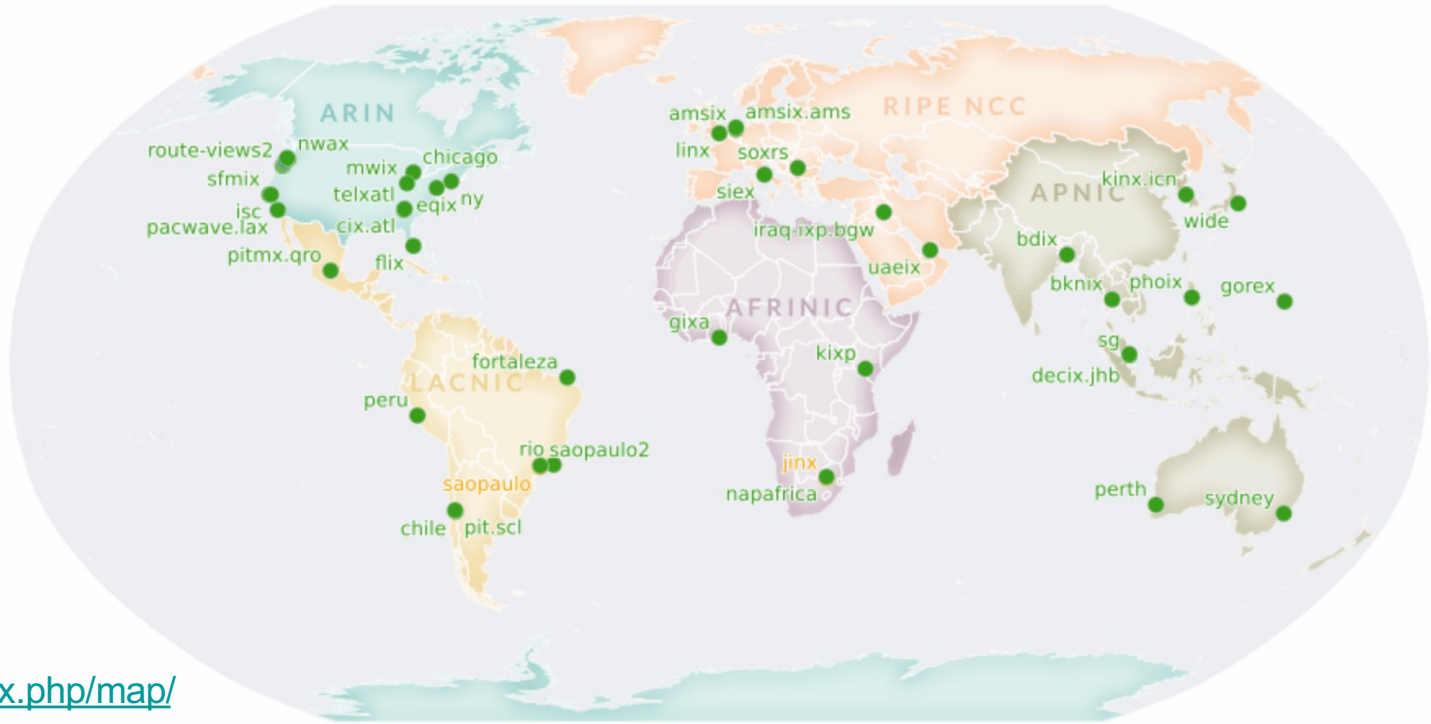
RouteViews Team Members

Hans Kuhn
Nina Bargisen
Owen Conway
Philip Smith

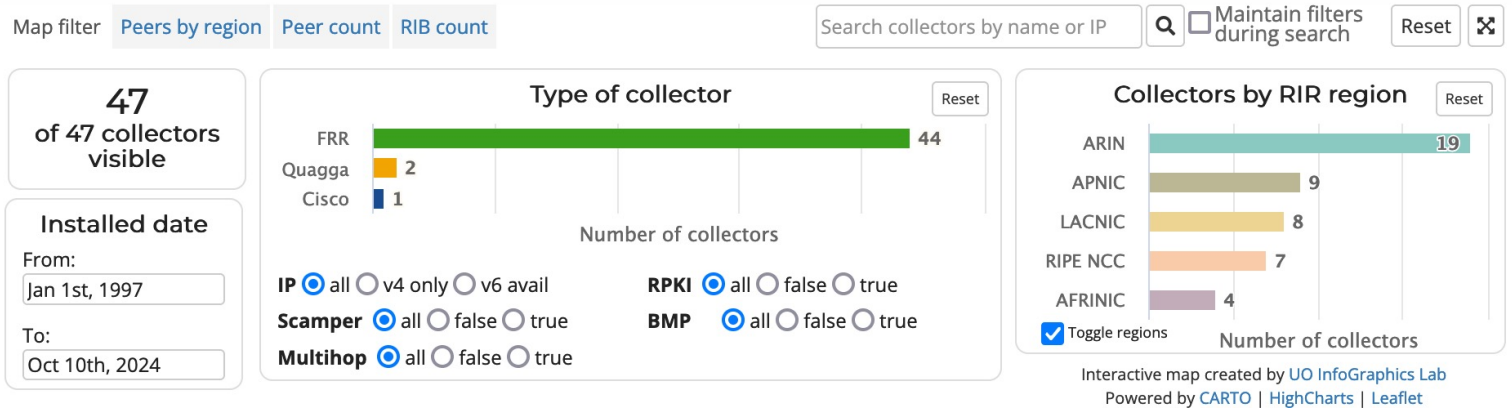
What is RouteViews

- 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.

RouteViews Collector Map



http://www.routeviews.org/routeviews/index.php/map/



What’s happening at RouteViews

ROUTEVIEWS NEWS

RouteViews News

- Collectors:
  - The majority use FRR[1] (either version 9.1 or 10)
  - One Cisco ASR1004 (as a tribute to the original!)
  - Moving collectors from metal to VMs (easier deployment & management)
- Location update:
  - Recent additions include KINX, CIX-ATL, PacWave LAX, Iraq IX, PIT Mexico & Santiago, DE-CIX Johor Bahru
  - Several new locations offered; resources required to fulfil those offers

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

RouteViews Development Projects

- API
  - Allow programmatic access to live RouteViews data
  - (our collectors currently allow telnet access, which 1000s of automated scripts hammer on a daily basis)
- LookingGlass
  - telnet access is unsustainable
  - Aim to making LookingGlass default access for each collector
    - telnet will remain available on one collector for legacy
- BMP
  - Live feed from collectors for BGP data consumers

RouteViews Behind the Scenes Projects

Months of ongoing effort:

- 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
  - Standardising on two latest releases, upgrading from old releases
  - “Badly behaving peers” (*aka* slow peers)

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
- Improved community support
  - Running this infrastructure costs money!
  - We hugely appreciate our generous supporters
    - https://www.routeviews.org/routeviews/index.php/supporters/
- Your suggestions are very welcome! 🙏

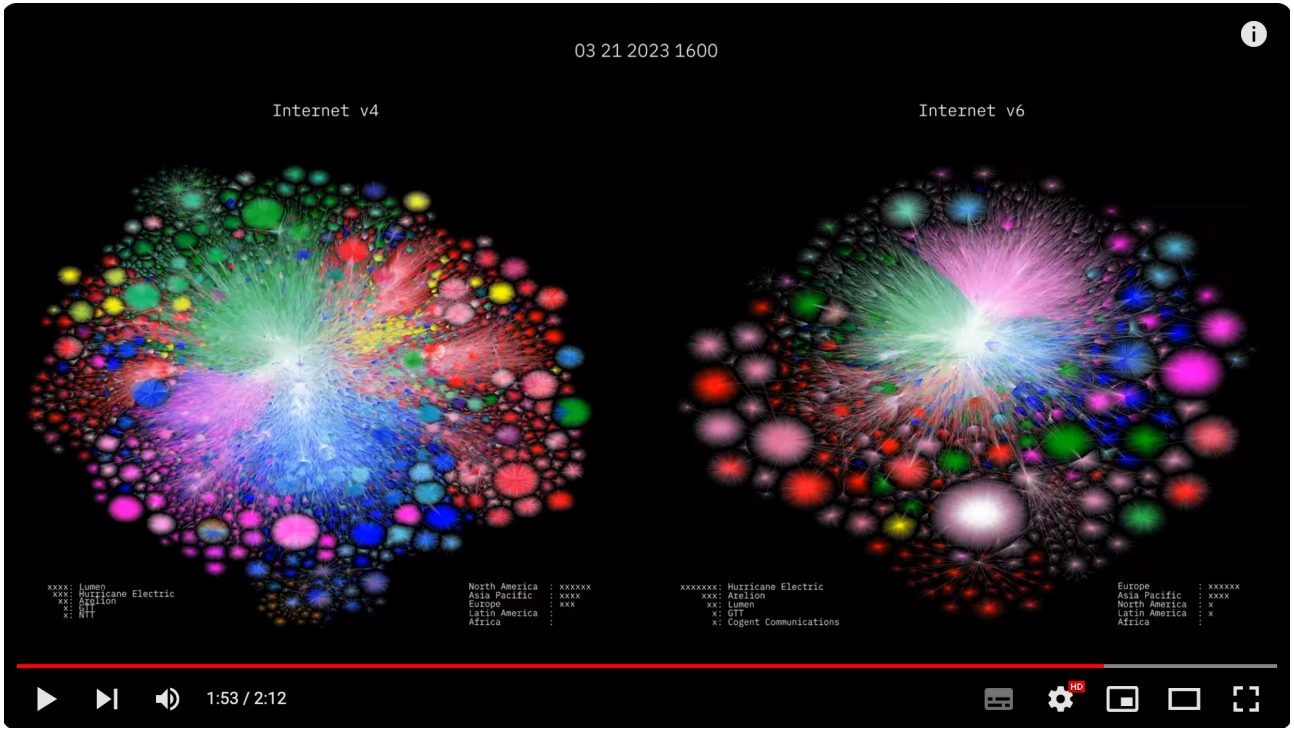
For network operators & researchers

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

RouteViews Impact



Barrett Lyon: https://www.youtube.com/watch?v=vo5glK9czIE

Use Cases – Multihop Collector

32 peers, multi-hop

Lots of full tables

```
route-views2.routeviews.org> sh bgp sum

IPv4 Unicast Summary (VRF default):
BGP router identifier 128.223.51.102, local AS number 6447 vrf-id 0
BGP table version 2376140
RIB entries 1842070, using 169 MiB of memory
Peers 32, using 644 KiB of memory

Neighbor        V         AS   MsgRcvd   MsgSent   TblVer  InQ OutQ  Up/Down State/PfxRcd   PfxSnt Desc
12.0.1.63       4       7018  17066420     49263 36133663    0    0 02w2d13h       942690        0 ATT
37.139.139.17   4      57866  13228029     98502 36133663    0    0 04w6d04h       945938        0 Fusix
45.61.0.85      4      22652  12042299     98502 36133663    0    0 04w6d04h       947568        0 FIBRENOIRE
62.115.128.137  4       1299 102692807     49257 36133663    0    0 02w1d11h       923085        0 Telia
64.71.137.241   4       6939  10290763     49253 36133663    0    0 04:43:44       965781        0 Hurricane Electric
77.39.192.30    4      20912  11473709    295482 36133663    0    0 04w0d08h       946247        0 PANSERVICE
87.121.64.4     4      57463   4455182     49210 36133663    0    0 6d03h38m       496561        0 NETIXLTD
89.149.178.10   4       3257  18633077     49261 36133663    0    0 17:21:15       943030        0 Tiscali
91.218.184.60   4      49788   9668054     49251 36133663    0    0 04w6d04h       946923        0 NEXTHOPNO
94.156.252.18   4      34224  19126013     49253 36133663    0    0 02w4d21h       971108        0 NETERRA
105.16.0.247    4      37100  15500333     98380 36133663    0    0 3d13h34m       945252        0 SEACOM
129.250.1.71    4       2914  14975638     98345 36133663    0    0 02w5d19h       943621        0 NTT-A
137.164.16.84   4       2152   7080942     49251 36133663    0    0 04w6d04h       944798        0 CENIC
140.192.8.16    4      20130  14056316     98515 36133663    0    0 2d04h56m       967769        0 DEPAULEDU
144.228.241.130 4       1239    180882     49225 36133663    0    0 2d11h39m        42763        0 Sprint
147.28.7.1      4       3130    226707     49253 36133663    0    0 04w0d22h           15        0 RGnet, LLC
147.28.7.2      4       3130   9976443     49255 36133663    0    0 04w0d22h       950154        0 RGnet, LLC
162.251.163.2   4      53767   1258983     98504 36133663    0    0 03w2d05h       165147        0 ICASTCENTER
163.253.3.14    4      11537    507926     49251 36133663    0    0 04w6d04h        24036        0 Internet2
168.209.255.56  4       3741   5581113     49251 36133663    0    0 04w6d04h       947709        0 INTERNETSOLUTIONS
194.153.0.253   4       5413   5774838     49252 36133663    0    0 04w6d04h       806463        0 DAISYCOMM
198.58.198.252  4       1403  14920886     98455 36133663    0    0 02w2d14h       945075        0 EBOX
198.129.33.85   4        293   6493053     98501 36133663    0    0 04w0d22h       968407        0 ESNet
```

Use Cases – Weird Announcements

```
route-views7.routeviews.org> sh ip bgp 45.181.4.0/24
BGP routing table entry for 45.181.4.0/24, version 54948963
Paths: (8 available, best #2, table default)
  Not advertised to any peer
...
924 835 16735 53062 262698 269289
    185.121.168.42 from 185.121.168.42 (10.20.30.40)
      Origin IGP, valid, external, best (Older Path), rpki validation-state: not found
      Community: 835:11103 924:90 924:601 924:690 16735:111 16735:7000 16735:7203 16735:53062 24115:16735 24115:24115 24115:65023
      53062:10020 53062:10021 53062:30004 53062:30007 53062:30009 53062:30011 53062:30013 53062:30045 53062:30049 53062:30058
      53062:30091 53062:30092 53062:30105 53062:30114 53062:30115 53062:30117 53062:30122 53062:30130 53062:30136 53062:30152
      53062:30156 53062:30161 53062:30168 53062:30182 53062:30183 53062:30184 53062:30185 53062:30186 53062:30187 53062:30188
      53062:30191 53062:30198 53062:30200 53062:30203 53062:30208 53062:30217 53062:30222 53062:30228 53062:30232 53062:30235
      53062:30239 53062:30244 53062:30250 53062:30255 53062:30263 53062:30274 53062:30278 53062:30287 53062:30291 53062:30296
      53062:30301 53062:30305 53062:30317 53062:30328 53062:30344 53062:30355 53062:30357 53062:30369
      Large Community: 924:1:90 924:600:90 924:601:101 24115:1000:2 24115:1001:1 24115:1002:1 24115:1003:26 24115:1004:16735
      53062:11:3692 53062:12:81 53062:13:48
      Last update: Thu Jun 20 04:03:53 2024
 37989 18106 263444 262316 269289 269289 269289 269289 269289 269289 269289 269289 269289 269289 269289 269289 269289 269289 269289
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    203.123.48.6 from 203.123.48.6 (203.123.48.6)
      Origin IGP, valid, external, rpki validation-state: not found
      Community: 13538:2000
      Last update: Sun Jun 16 10:17:30 2024
```

What is AS53062 trying to achieve with all these communities??

What is AS269289 trying to achieve by prepending 101 times??

Use Cases – Invalid ROAs

```
route-views2.routeviews.org> sh ip bgp rpki invalid
BGP table version is 36134957, 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, * 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
I*> 1.6.168.0/24     94.156.252.18            0             0 34224 6453 4755 9583 ?
I*> 1.6.169.0/24     94.156.252.18            0             0 34224 6453 4755 9583 i
I*> 1.6.183.0/24     94.156.252.18            0             0 34224 6453 4755 9583 i
I*> 1.6.219.0/24     94.156.252.18            0             0 34224 6453 4755 9583 137130 i
I*> 1.6.247.0/24     94.156.252.18            0             0 34224 6453 4755 9583 i
I*> 1.7.178.0/24     94.156.252.18            0             0 34224 6453 4755 9583 137130 i
I*> 1.7.191.0/24     94.156.252.18            0             0 34224 6453 4755 9583 137130 i
I*> 1.7.205.0/24     94.156.252.18            0             0 34224 6453 4755 9583 140202 i
I*> 1.7.228.0/24     94.156.252.18            0             0 34224 6453 4755 9583 137130 i
I*> 1.183.208.0/20   94.156.252.18            0             0 34224 6453 4134 141006 i
I*> 2.20.224.0/24    77.39.192.30                           0 20912 49367 6762 16625 i
I*> 2.20.225.0/24    77.39.192.30                           0 20912 49367 6762 16625 i
I*> 2.20.226.0/24    77.39.192.30                           0 20912 49367 6762 16625 i
I*> 2.20.227.0/24    77.39.192.30                           0 20912 49367 6762 16625 i
I*> 2.20.228.0/24    77.39.192.30                           0 20912 49367 6762 16625 i
I*> 2.20.229.0/24    77.39.192.30                           0 20912 49367 6762 16625 I
...
```

Use Cases – Valid ROAs

```
route-views.phoix.routeviews.org> sh ip bgp rpki valid
BGP table version is 15038644, local router ID is 198.32.172.137, 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*>  1.0.4.0/22       198.32.172.156           0             0 142271 135607 7545 2764 38803 38803 38803 i
V*>  1.0.4.0/24       198.32.172.156           0             0 142271 135607 7545 38803 i
V*>  1.0.5.0/24       198.32.172.156           0             0 142271 135607 7545 38803 i
V*>  1.0.6.0/24       198.32.172.156           0             0 142271 135607 7545 38803 i
V*>  1.0.7.0/24       198.32.172.156           0             0 142271 135607 7545 38803 i
V*>  1.0.64.0/18      198.32.172.156           0             0 142271 9299 7670 18144 i
V*>  1.6.0.0/22       198.32.172.156           0             0 142271 135607 9583 i
V*>  1.6.1.0/24       198.32.172.156           0             0 142271 135607 9583 i
V*>  1.6.2.0/24       198.32.172.156           0             0 142271 135607 9583 i
V*>  1.6.4.0/22       198.32.172.156           0             0 142271 135607 9583 i
V*>  1.6.7.0/24       198.32.172.156           0             0 142271 135607 6453 4755 9583 i
V*>  1.6.8.0/22       198.32.172.156           0             0 142271 135607 9583 i
V*>  1.6.9.0/24       198.32.172.156           0             0 142271 9304 9583 ?
V*>  1.6.10.0/24      198.32.172.156           0             0 142271 135607 9583 i
V*>  1.6.11.0/24      198.32.172.156           0             0 142271 135607 9583 i
V*>  1.6.12.0/22      198.32.172.156           0             0 142271 9304 9583 i
...
```

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 an Open 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)
  - Please do not use “add-path” or send us bogon routes
  - We do not send you any prefixes (please don’t ask)

Peering with RouteViews

- Presence in multiple IXP locations?
  - It can be interesting to peer; we will assess based on available capacity
- Will we peer with everyone?
  - If you peer with IXP Route Servers, you will be peering with AS6447
  - We are more selective about bi-lateral and multi-hop peerings (we would like to receive your view of the Global Routing Table)
  - We are interested in new, interesting, diverse peers all around the world

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 22.04 is RouteViews standard OS
  - We require a minimal Ubuntu Server install
  - Our deployment scripts do the rest
  - (We will move to Ubuntu 24.04 once we validate it with our deployment tools)
- 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
- 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!