

ROUTEVIEWS: The BGP Collector for Today's Network Operator & Researcher





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A collaborative router looking glass to share BGP views among network operators and researchers.



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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 and Google with other contributions from public and private organizations.

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UNIVERSITY OF OREGON

The University of Oregon is a public research institution in Eugene, Oregon, USA founded in 1876. UO is renowned for its research prowess and commitment to teaching. Both NSRC and RouteViews are based at the UO.

ROUTEVIEWS

The Team

DAVID TEACH



ERIC SMITH



FOOTPRINT



FOOTPRINT

COLLECTOR LOCATIONS

- ✓ Atlanta (digital realty)
- ✓ Chicago (equinix)
- ✓ Chile
- ✓ DC (eqix)
- ✓ Eugene (Multi-hop)
- ✓ Indianapolis (MWIX)
- ✓ Johannesburg (JINX, NAPAfrica)
- ✓ London (LINX)
- ✓ Miami (flix)
- ✓ Nairobi (kixp)
- ✓ Palo Alto (PAIX)
- ✓ Perth (WAIX)
- ✓ Portland (NWAX)
- ✓ Sao Paulo (IX.br x4)
- ✓ San Francisco (sfmix)
- ✓ Singapore (Equinix SG)
- ✓ Serbia (sox)
- ✓ Stockholm (AMSIX)
- ✓ Sydney (equinix)
- ✓ Tokyo (DIX-IE)
- ✓ Cape Town

A complete list of current RouteViews locations is at <https://as6447.peeringdb.com>

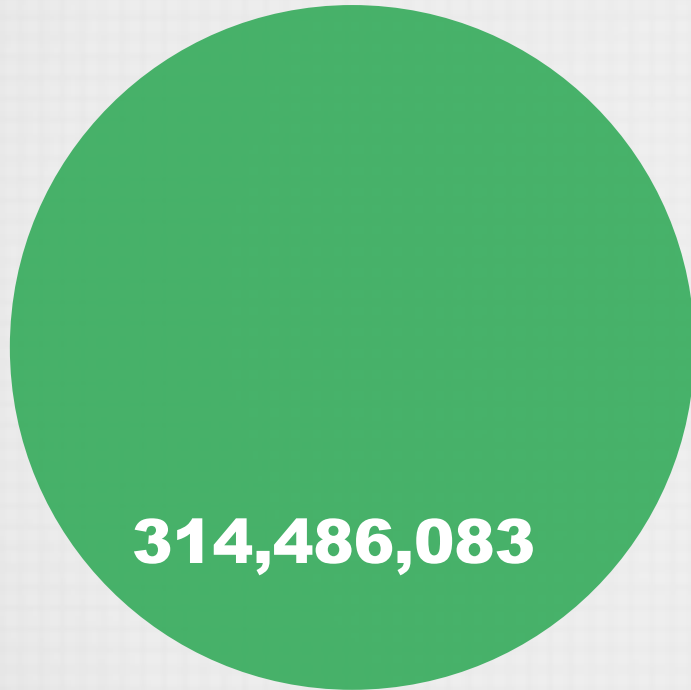


PEERING STATS

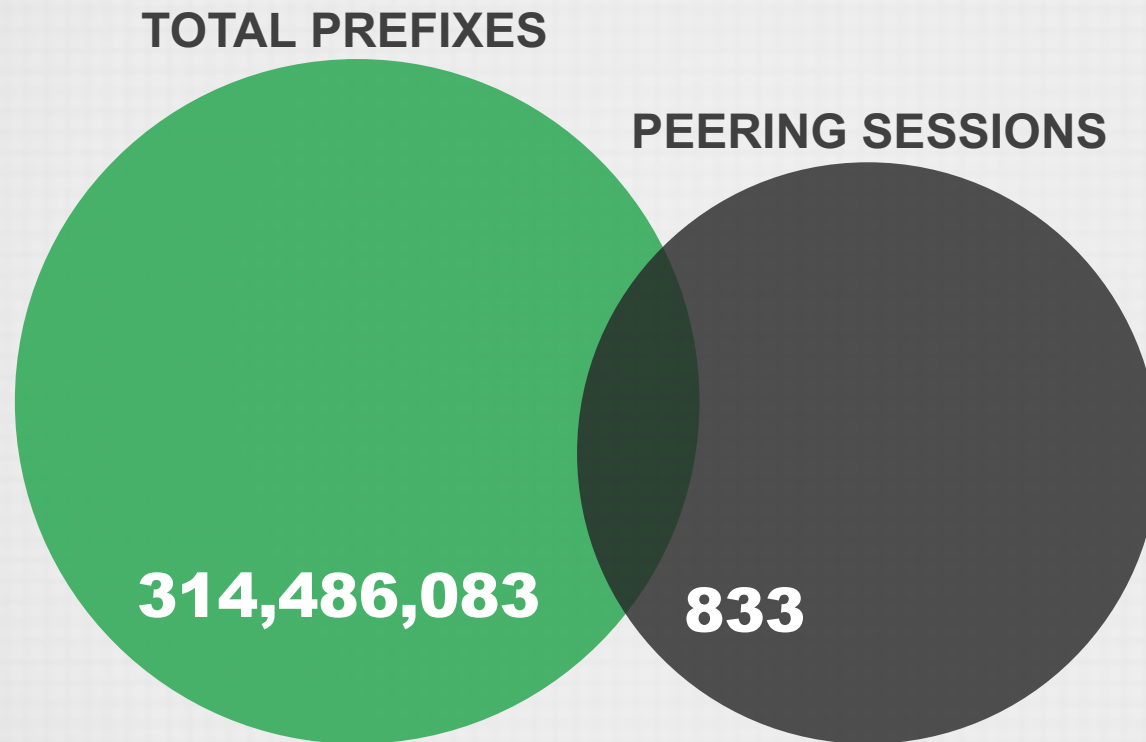


PEERING STATS

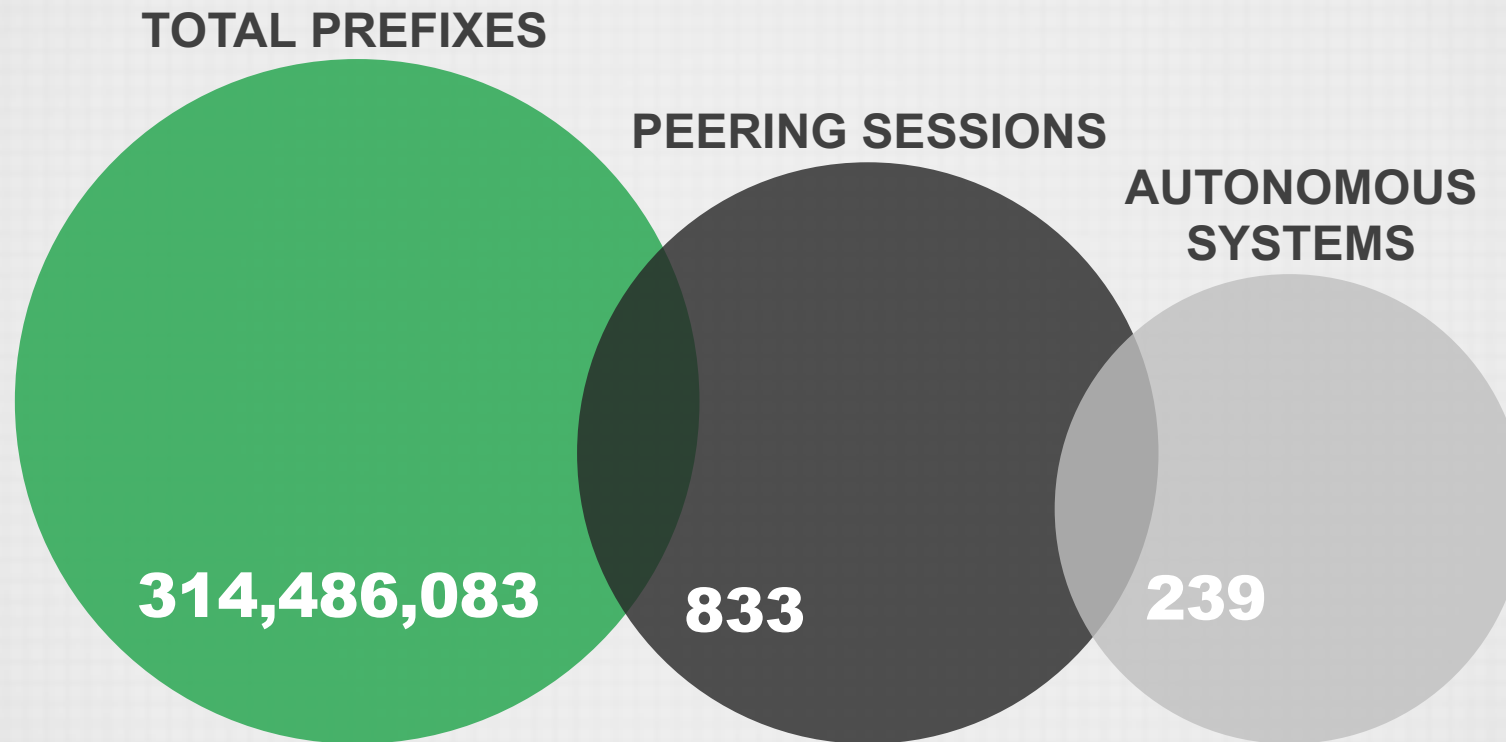
TOTAL PREFIXES



PEERING STATS



PEERING STATS



More peering information: www.routeviews.org/peers/peering-status.html

COLLECTORS

HARDWARE

Commodity

- 8-16 Cores
- 32G-64G Ram
- 400GB-1TB SSD
- 1/10 GB eth

Vendor

- ASR 1004

SOFTWARE

OpenSource

- Linux/Centos and...
- Quagga – bgpd
- FRR – bgpd

Vendor

- IOS XE

COLLECTORS OPERATIONS

MULTI-HOP

Pros

- If you can reach the collector, you can peer

Cons

- Peerings are subject to the routing anomalies that RouteViews seeks to observe and collect

INTERNET EXCHANGE

Pros

- Better positioned to address multi-hop issues
- Geographic diversity
- Peering diversity

COLLECTOR DATA

MRT

Multi-Threaded Routing Toolkit

- <https://tools.ietf.org/html/rfc6396>
- MRT provides a standard for parsing or dumping routing information to a binary file.
- RouteViews Dumps consist of BGP RIBs and UPDATES.
 - RIBs are dumped every 2 hours
 - UPDATES are dumped every 15 minutes

DATA ACCESS

- MRT files are bziped and rsynced back to <http://archive.routeviews.org/> regularly
- They can be accessed via, http, ftp and rsync.

MRT TOOLS

Isolario, RIPE libBGPdump, UCLA BGP Parser, NTT BGPdump2, etc:



- <https://gitlab.com/Isolario>
- <https://bitbucket.org/ripenc/bgpdump/wiki/Home>
- <https://github.com/cawka/bgpparser>
- <https://github.com/yasuhiro-ohara-ntt/bgpdump2>
- <https://github.com/t2mune/mrtparse> (Python)
- <https://github.com/rfc1036/zebra-dump-parser> (Perl)
- <https://github.com/CAIDA/libparsebgp>

COLLECTOR ACCESSIBILITY

telnet://route-views*.routeviews.org

- No username necessary.
- Users are able to run show commands, e.g. show ip bgp x.x.x.x/x.

GOTCHAS

- Why not SSH?!
 - RouteViews data is publicly available. We've got nothing to hide.
 - We use ssh for host management.
- show ip route x.x.x.x next-hop is incorrect!
 - Remember, this is a collector. There's no data-plane, thus no true FIB.

USE CASES

OPERATIONS

- BGP is the backbone of the Global Routing Infrastructure.
- To ensure its stability, it needs to be constantly monitored.
- RouteViews provides:
 - Command-Line/ Looking Glass
 - Prefix Visibility, Verify Convergence, Path Stability
 - Comparing Local/Regional/Global Views
 - Troubleshooting Reachability

USE CASES

OPERATIONS

- Worldwide CLI access – how to access a collector
- `telnet://route-views.routeviews.org`
 - *route-views, route-views{2,3,4,6}* are all housed at University of Oregon in the United States, and each collector has eBGP Multihop sessions with peers from around the world
- `telnet://route-views.linx.routeviews.org`
 - Other collector locations accessible via these 3rd level domains (replace “linx”): *saopaulo, saopaulo2, telxatl, jinx, napafrica, perth, soxrs, eqix, nwax, sg, sfmix, flix, amsix, chicago, chile, isc, sydney, mwix, kixp, & wide*

USE CASES

OPERATIONS

```
route-views>sh ip bgp 194.126.81.35
BGP routing table entry for 194.126.64.0/19, version 143916617
Paths: (32 available, best #29, table default)
  Not advertised to any peer
  Refresh Epoch 1
  57866 2914 5413, (aggregated by 5413 62.72.136.6)
    37.139.139.0 from 37.139.139.0 (37.139.139.0)
      Origin IGP, localpref 100, valid, external, atomic-aggregate
      Community: 2914:420 2914:1206 2914:2203 2914:3200 57866:11 57866:100 57866:103
  Refresh Epoch 1
  8283 5413, (aggregated by 5413 62.72.136.6)
    94.142.247.3 from 94.142.247.3 (94.142.247.3)
      Origin IGP, metric 0, localpref 100, valid, external, atomic-aggregate
      Community: 6777:65011 6777:65023 8283:1 8283:101
      unknown transitive attribute: flag 0xE0 type 0x20 length 0x18
        value 0000 205B 0000 0000 0000 0001 0000 205B
              0000 0005 0000 0001
```

Setting aggregator attribute

Communities set by peers

Unsupported BGP attribute

USE CASES

OPERATIONS

```
route-views>sh ip bgp 194.126.81.35
BGP routing table entry for 194.126.64.0/19, version 143916617
Paths: (32 available, best #29, table default)
  Not advertised to any peer
```

...

Refresh Epoch 1

```
4901 6079 1299 5413 5413, (aggregated by 5413 62.72.136.161)
  162.250.137.254 from 162.250.137.254 (162.250.137.254)
  Origin incomplete, localpref 100, valid, external, atomic-aggregate
  Community: 65000:10100 65000:10300 65000:10400
```

Refresh Epoch 1

```
101 101 3356 5413 5413 5413, (aggregated by 5413 62.72.136.7)
  209.124.176.223 from 209.124.176.223 (209.124.176.223)
  Origin IGP, localpref 100, valid, external, atomic-aggregate
  Community: 101:20100 101:20110 101:22100 3356:2 3356:22 3356:100 3356:123
3356:500 3356:2064 65001:0
  Extended Community: RT:101:22100
```

AS4901 communities?

Extended BGP community

USE CASES

OPERATIONS

```
route-views>sh ip bgp 194.126.81.35 | i aggregated
 701 1299 5413 5413, (aggregated by 5413 62.72.136.161)
57866 2914 5413, (aggregated by 5413 62.72.136.6)
 8283 5413, (aggregated by 5413 62.72.136.6)
3333 5413, (aggregated by 5413 62.72.136.6)
53767 3257 1299 5413 5413, (aggregated by 5413 62.72.136.161)
58901 51167 8220 5413, (aggregated by 5413 62.72.136.161)
 7660 2516 3356 5413 5413 5413, (aggregated by 5413 62.72.136.7)
4901 6079 1299 5413 5413, (aggregated by 5413 62.72.136.161)
 101 101 3356 5413 5413 5413, (aggregated by 5413 62.72.136.7)
 7018 1299 5413 5413, (aggregated by 5413 62.72.136.161)
3277 3267 5413, (aggregated by 5413 62.72.136.6)
3267 5413, (aggregated by 5413 62.72.136.6)
49788 12552 5413, (aggregated by 5413 62.72.136.6)
53364 3257 1299 5413 5413, (aggregated by 5413 62.72.136.161)
54728 20130 6939 5413, (aggregated by 5413 62.72.136.6)
 286 1299 5413 5413, (aggregated by 5413 62.72.136.161)
 852 1299 5413 5413, (aggregated by 5413 62.72.136.161)
3549 3356 3356 5413 5413 5413, (aggregated by 5413 62.72.136.7)
20912 1267 5413, (aggregated by 5413 62.72.136.6)
1403 6461 5413, (aggregated by 5413 62.72.136.161)
1403 6461 5413, (aggregated by 5413 62.72.136.161)
2497 1299 5413 5413, (aggregated by 5413 62.72.136.161)
1221 4637 5413, (aggregated by 5413 62.72.136.6)
1351 6939 5413, (aggregated by 5413 62.72.136.6)
3561 209 1299 5413 5413, (aggregated by 5413 62.72.136.161)
6079 1299 5413 5413, (aggregated by 5413 62.72.136.161)
6079 1299 5413 5413, (aggregated by 5413 62.72.136.161)
1239 1299 5413 5413, (aggregated by 5413 62.72.136.161)
3303 5413, (aggregated by 5413 62.72.136.6)
4826 6939 5413, (aggregated by 5413 62.72.136.6)
6939 5413, (aggregated by 5413 62.72.136.6)
19214 174 1299 5413 5413, (aggregated by 5413 62.72.136.161)
```

All the paths to this destination

USE CASES

OPERATIONS

```
route-views>sh ip bgp 202.4.32.0 lo
* 202.4.32.0      195.208.112.161
*                140.192.8.16
*                212.66.96.126
*                162.250.137.254
*                203.62.252.83
*                134.222.87.1      700
*                193.0.0.56
*                208.51.134.254      0
*>                64.71.137.241
*                12.0.1.63
*                198.58.198.255
*                198.58.198.254
*                202.93.8.242
*                194.85.40.15      0
*                162.251.163.2
*                37.139.139.17      0
*                114.31.199.1
*                91.218.184.60      0
*                154.11.12.212      0
*                209.124.176.223
*                207.172.6.1      0
*                94.142.247.3      0
*                207.172.6.20      0
*                137.39.3.55
*                206.24.210.80
*                217.192.89.50
*                144.228.241.130      80
*                173.205.57.234
*                132.198.255.253
*                202.232.0.2
0 3277 39710 6939 17993 i
0 54728 20130 6939 17993 i
0 20912 6939 17993 i
0 4901 6079 6939 17993 i
0 1221 4637 6939 17993 i
0 286 6939 17993 i
0 3333 6939 17993 i
0 3549 3356 6939 17993 i
0 6939 17993 i
0 7018 6939 17993 i
0 1403 6939 17993 i
0 1403 6939 17993 i
0 24441 6939 17993 i
0 3267 6939 17993 i
0 53767 6939 17993 i
0 57866 6762 6939 17993 i
0 4826 38456 6939 17993 i
0 49788 6939 17993 i
0 852 6939 17993 i
0 101 101 6939 17993 i
0 6079 6939 17993 i
0 8283 6939 17993 i
0 6079 6939 17993 i
0 701 6939 17993 i
0 3561 209 6939 17993 i
0 3303 6939 17993 i
0 1239 6939 17993 i
0 53364 3257 1299 6939 6939 17993 i
0 1351 6939 17993 i
0 2497 6939 17993 i
```

All the paths to this destination

USE CASES

OPERATIONS

```
My traceroute [vUNKNOWN]
pfs-mbp.ws.blueskypacificgroup.com (192.168.1.220) 2019-06-24T10:58:29+1300
Keys: Help Display mode Restart statistics Order of fields quit
          Packets          Pings
Host      Loss%  Snt  Last  Avg  Best  Wrst  StDev
1. 192.168.0.217 0.0%   9   4.2  4.5  2.5   8.2   1.7
2. tw.mfu.samoatel.ws 0.0%   9   4.9  6.9  3.9  12.8   2.8
3. 202.4.37.1 0.0%   9   4.8  4.9  3.2   7.6   1.5
4. 202.4.37.2 0.0%   9   4.0  6.5  3.3  13.4   3.3
5. 202.4.37.5 0.0%   9   5.2  5.3  4.1   7.7   1.1
6. 202.4.37.6 0.0%   9   2.4  4.3  2.4   6.5   1.3
7. 202.4.37.10 0.0%   9   6.0  6.3  3.1  10.4   2.6
8. 10.254.250.6 0.0%   9 140.5 140.4 136.9 146.8   3.3
9. bluesky-samoa-ltd.10gigabitethernet1-1-6 0.0%   9   4.2  6.1  3.4   9.5   2.0
10. v406.core1.sjc1.he.net 0.0%   9 138.4 141.3 137.7 148.8   4.5
11. tpg-internet-pty-ltd.100gigabitethernet1 0.0%   8 299.4 297.7 293.3 302.2   3.1
12. syd-apt-ros-crt2-he-0-3-0-2.tpgi.com.au 0.0%   8 349.1 350.3 347.6 355.3   2.4
13. bri-pow-que-crt2-po30.tpgi.com.au 0.0%   8 359.7 360.4 358.7 361.8   1.1
14. 203-219-166-146.static.tpgi.com.au 0.0%   8 359.9 360.1 359.1 362.3   1.0
15. ppp217-120.static.internode.on.net 0.0%   8 376.4 368.6 366.1 376.4   3.3
```

USE CASES

OPERATIONS

```
route-views>sh bgp ipv6 uni 2001:44B8::/32 lo | i 2001:44B8
* 2001:44B8::/32 2606:6D00:EB0::254
* 2001:44B8:24::/48
* 2001:44B8:25::/48
* 2001:44B8:26::/48
* 2001:44B8:27::/48
* 2001:44B8:28::/48
* 2001:44B8:29::/48
* 2001:44B8:2A::/48
* 2001:44B8:2B::/48
* 2001:44B8:2C::/48
* 2001:44B8:2D::/48
* 2001:44B8:2E::/48
* 2001:44B8:2F::/48
* 2001:44B8:30::/48
* 2001:44B8:31::/48
* 2001:44B8:32::/48
* 2001:44B8:33::/48
* 2001:44B8:34::/48
* 2001:44B8:35::/48
* 2001:44B8:36::/48
* 2001:44B8:37::/48
* 2001:44B8:38::/48
* 2001:44B8:39::/48
* 2001:44B8:60:2300::/56
* 2001:44B8:60:2500::/56
* 2001:44B8:1058::/48
* 2001:44B8:1059::/48
* 2001:44B8:105A::/48
```

Lots of /48s out of /32 covering aggregate, why??

USE CASES

OPERATIONS

```
route-views>sh ip bgp 202.144.128.0/19
BGP routing table entry for 202.144.128.0/19, version 143910183
Paths: (32 available, best #30, table default)
  Not advertised to any peer
  Refresh Epoch 1
  701 6461 17660
    137.39.3.55 from 137.39.3.55 (137.39.3.55)
      Origin IGP, localpref 100, valid, external
  Refresh Epoch 1
  3277 3267 6461 17660
    195.208.112.161 from 195.208.112.161 (194.85.4.13)
      Origin IGP, localpref 100, valid, external
      Community: 3277:3267 3277:65100 3277:65320 3277:65326 3277:65331
  Refresh Epoch 1
  3267 6461 17660
    194.85.40.15 from 194.85.40.15 (185.141.126.1)
      Origin IGP, metric 0, localpref 100, valid, external
```

32 paths to this aggregate,
but look at next slide...

USE CASES

OPERATIONS

```
route-views>sh ip bgp 202.144.128.0/20
BGP routing table entry for 202.144.128.0/20, version 129174671
Paths: (5 available, best #4, table default)
Not advertised to any peer
Refresh Epoch 1
1351 6939 17660 18024
  132.198.255.253 from 132.198.255.253 (132.198.255.253)
    Origin IGP, localpref 100, valid, external
Refresh Epoch 1
58901 51167 8220 17660 18024
  178.238.225.14 from 178.238.225.14 (178.238.233.155)
    Origin IGP, localpref 100, valid, external
Refresh Epoch 1
54728 20130 6939 17660 18024
  140.192.8.16 from 140.192.8.16 (140.192.8.16)
    Origin IGP, localpref 100, valid, external
Refresh Epoch 1
6939 17660 18024
  64.71.137.241 from 64.71.137.241 (216.218.252.164)
    Origin IGP, localpref 100, valid, external, best
Refresh Epoch 1
4826 17660 18024
  114.31.199.1 from 114.31.199.1 (114.31.199.1)
    Origin IGP, localpref 100, valid, external
Community: 4826:5101 4826:6570 4826:51011 24115:17660
```

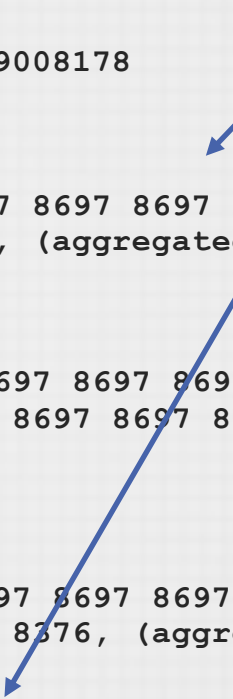
This /20 is only announced at one IXP - so who is **leaking**?

USE CASES

OPERATIONS

```
route-views>sh ip bgp 37.202.76.0/24
BGP routing table entry for 37.202.76.0/24, version 149008178
Paths: (31 available, best #7, table default)
  Not advertised to any peer
  Refresh Epoch 1
    701 3356 8697 8697 8697 8697 8697 8697 8697 8697 8697 8697 8697 8697 8697 8697 8697 8697 8697 8697
8697 8697 8697 8697 8697 8697 8697 8697 8697 8697 8376, (aggregated by 8376 10.50.253.13)
  137.39.3.55 from 137.39.3.55 (137.39.3.55)
    Origin IGP, localpref 100, valid, external
    Refresh Epoch 1
      24441 3491 3491 3356 8697 8697 8697 8697 8697 8697 8697 8697 8697 8697 8697 8697 8697 8697 8697 8697
8697 8697 8697 8697 8697 8697 8697 8697 8697 8697 8697 8697 8376, (aggregated by 8376
10.50.253.13)
    202.93.8.242 from 202.93.8.242 (202.93.8.242)
    Origin IGP, localpref 100, valid, external
    Refresh Epoch 1
      7018 3356 8697 8697 8697 8697 8697 8697 8697 8697 8697 8697 8697 8697 8697 8697 8697 8697 8697 8697
8697 8697 8697 8697 8697 8697 8697 8697 8697 8697 8697 8376, (aggregated by 8376 10.50.253.13)
    12.0.1.63 from 12.0.1.63 (12.0.1.63)
    Origin IGP, localpref 100, valid, external, best
    Community: 7018:5000 7018:37232
```

What is AS8697 trying to achieve with 26x prepend?



USE CASES

OPERATIONS – HIJACK or MISCONFIGURATION ?

```
route-views>sh ip bgp 202.134.24.0/21 | i 9241
 3267 174 9241 38201
 49788 174 9241 38201
 57866 1299 174 9241 38201
 3333 1257 174 9241 38201
 3277 3267 174 9241 38201
 54728 20130 6939 1299 174 9241 38201
 852 174 9241 38201
 8283 38930 174 9241 38201
 4826 174 9241 38201
 6079 3257 174 9241 38201
 101 101 174 9241 38201
 24441 3491 3491 174 9241 38201
 1403 174 9241 38201
 1403 174 9241 38201
 6079 3257 174 9241 38201
```

etc

The aggregate

Correctly originated
by AS38201

202.134.24.0/21 and its two subnets,
202.134.24.0/22 and 202.134.28.0/22

USE CASES

OPERATIONS – HIJACK or MISCONFIGURATION ?

```
route-views>sh ip bgp 202.134.24.0/22 | i 9241
 3267 1299 4648 9241 38201
 49788 1299 4648 9241 38201
 57866 2914 4648 9241 38201
 3333 1257 1299 4648 9241 38201
 3277 3267 1299 4648 9241 38201
 54728 20130 6939 4648 9241 38201
 852 1299 4648 9241 38201
 6079 1299 4648 9241 38201
 1403 1299 4648 9241 38201
 1403 1299 4648 9241 38201
 101 101 11164 4648 9241 38201
 4826 38456 4648 9241 38201
 24441 3491 3491 1299 4648 9241 38201
 286 1299 4648 9241 38201
 6079 1299 4648 9241 38201
```

etc

The first subnet

Correctly originated
by AS38201

202.134.24.0/21 and its two subnets,
202.134.24.0/22 and 202.134.28.0/22

USE CASES

OPERATIONS – HIJACK or MISCONFIGURATION ?

```
route-views>sh ip bgp 202.134.28.0/22 | i 9241
 3267 1299 4648 9241
 49788 1299 4648 9241
 57866 2914 4648 9241
 3333 1257 1299 4648 9241
 3277 3267 1299 4648 9241
 54728 20130 6939 4648 9241
 852 1299 4648 9241
 1403 1299 4648 9241
 1403 1299 4648 9241
 101 101 11164 4648 9241
 24441 3491 3491 1299 4648 9241
 6079 1299 4648 9241
 4826 38456 4648 9241
 6079 1299 4648 9241
 286 1299 4648 9241
```

etc

The second subnet

Originated by the
Transit AS ?!

202.134.24.0/21 and its two subnets,
202.134.24.0/22 and 202.134.28.0/22



HURRICANE ELECTRIC
INTERNET SERVICES

 Search

AS9241 Fiji International Telecommunications Ltd

- Quick Links**
- [BGP Toolkit Home](#)
 - [BGP Prefix Report](#)
 - [BGP Peer Report](#)
 - [Exchange Report](#)
 - [Bogon Routes](#)
 - [World Report](#)
 - [Multi Origin Routes](#)
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 - [Looking Glass](#)
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 - [IPv6 Certification](#)
 - [IPv6 Progress](#)
 - [Going Native](#)
 - [Contact Us](#)

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

Prefix		Description	
110.35.88.0/21		KIDANET Internet Service Provider	
113.20.64.0/19		KIDANET ISP	
113.20.86.0/24		KIDANET ISP	
124.108.24.0/23		ITC Services	
124.108.26.0/24		ITC Services	
124.108.28.0/22		ITC Services	
202.62.0.0/21		Asia Pacific Network Information Centre	
202.134.28.0/22		Tonga Communications Internet Network	
202.170.32.0/20		Fiji International Telecoms Ltd	
202.170.33.0/24		Fiji International Telecoms Ltd	
202.170.36.0/24		Fiji International Telecoms Ltd	
202.170.38.0/24		Fiji International Telecoms Ltd	
203.202.235.0/24		BSP Fiji	

Sure enough:
invalid ROA

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USE CASES

RESEARCH

- BGP anomalies and dynamics are critical as well.
- RouteViews Provides:
 - Network Topology Monitoring
 - Route Leaks/Hijacks (ex. Artemis, Cyclops)
 - Network Optimization
 - Growth, Aggregation, etc. in AS/v4/v6
 - Address Provenance
- ~500 research publications have used RouteViews data
- More info: <http://www.routeviews.org/routeviews/index.php/papers/>

THANK YOU

COMMUNITY SUPPORT

- RouteViews would not be possible without:
 - Hosts like IX.br, Netflix, 31173.ab, Equinix, and many many more, who host the collectors and provide free power, cooling, transit connectivity, IX connectivity, and so on
- RouteViews is a beacon of the collaboration successes of the global network engineering community



THANK YOU

Questions?