ROUTEVIEWS

Global BGP Collector for Operators and Research

Presented by Greg Shepherd
shep@routeviews.org

ROUTEVIEWS

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

RouteViews was founded at the University of Oregon's Advanced Network Technology Center (ANTC) in 1995. Data archives began in 1997 and amount to 50TBs (compressed) today.

The group is currently led by the Network Startup Resource Center (NSRC) group engineering team at the University of Oregon

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 and Google with other contributions from public and private organizations.

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.

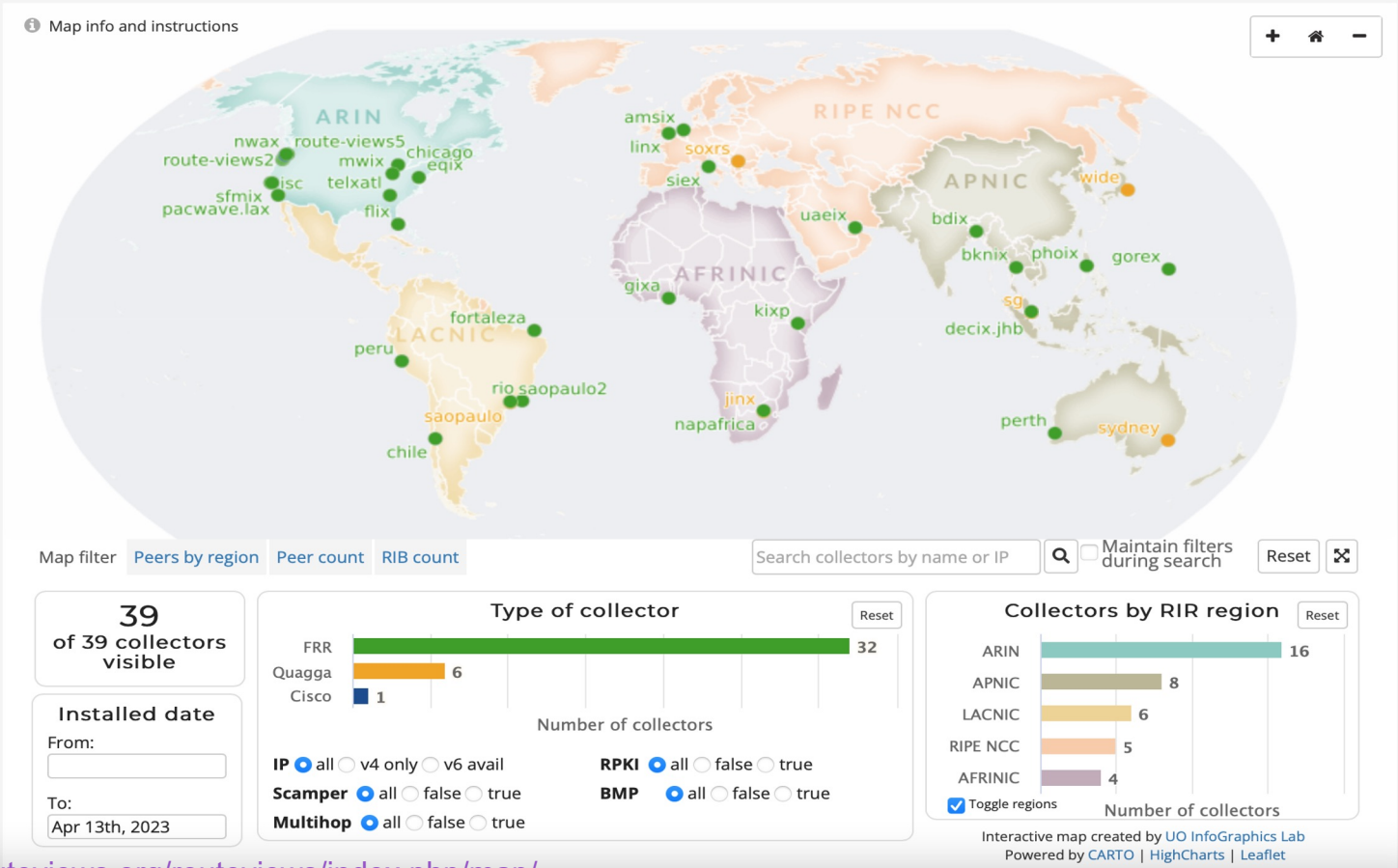
Why Routeviews?

IT'S YOUR INTERNET

- Originally conceived in 1995 as a tool for Internet operators to look at the BGP table from different backbones and locations around the world to troubleshoot and to assess:
  - reachability, hijacks, peer visibility, mass withdrawals, and RPKI status
- Operators who find it a valuable tool also peer to contribute to the value

- The 26-year data-set of BGP information archived by RouteViews since 1997 has become an invaluable research resource
  - RouteViews data has been used in over 1000 research papers.
  - http://www.routeviews.org/routeviews/index.php/papers/

Routeviews Collector Map



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

COLLECTOR DEPLOYMENT

Physical

- Off the shelf hardware.
- Shipped to the IX.
- Least preferred.

Virtual

- Much quicker deployment time.
- Easier to upgrade.

Collectors

HARDWARE

Commodity

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

SOFTWARE

OpenSource

- Linux/Centos and…
- Quagga – bgpd
- FRR – bgpd
- Gobgpd
- OpenBMP
- GoBMP

Collector Deployment

MULTI-HOP

- Pros:
  - If you can reach the collector, you can peer.
- Cons:
  - Multi-hop peerings are subject to the routing anomalies RouteViews seeks to observe and archive.

IX-HOSTED/CO-LOCATED

- Pros:
  - Better positioned to address multi-hop issues.
  - Geographic diversity.
  - Peering diversity.
  - Scalable.
- Cons:
  - More infrastructure to manage.

Collector Data

Multi-Threaded Routing Toolkit (MRT)

- 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 archived every 2 hours
  - UPDATEs are archived every 15 minutes

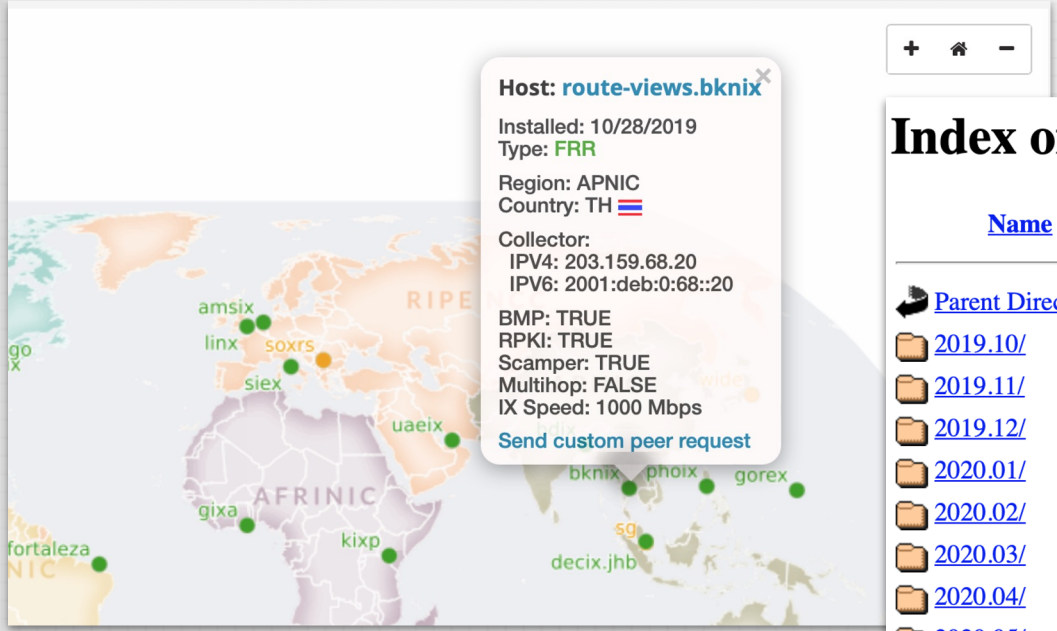
Data Access

- MRT files are bzipped and rsynced back to http://archive.routeviews.org/ on above schedule
- They can be accessed via, http, ftp and rsync
- Map view tool is interactive

Direct BMP Feed

- New Model
- BMP upstream from collectors, not FROM peers

Collector Data



Index of /route-views.bknix/bgpdata

Name	Last modified	Size	Description
Parent Directory		-	
2019.10/	2019-10-28 23:01	-	
2019.11/	2019-10-28 23:01	-	
2019.12/	2019-11-28 23:01	-	
2020.01/	2019-12-28 23:01	-	
2020.02/	2020-01-28 23:01	-	
2020.03/	2020-02-28 23:01	-	
2020.04/	2020-03-28 23:01	-	
2020.05/	2020-04-28 23:01	-	
2020.06/	2020-05-28 23:01	-	
2020.07/	2020-06-28 23:01	-	

http://archive.routeviews.org/route-views.bknix/bgpdata/

PEERING HowTo

BGP CONFIGURATION

- Send full-table if you can
- Remove default route
- Remove NULL routes
- Remove RFC-1918 addresses
- We don’t accept ADD-PATH TX/RX
- We don’t send any routes back
- When peering with multi-hop collectors, set ebgp-multihop

MRT Tools

BGPKIT, RIPE LIBBGPDUMP, NTT BGPDUMP2, ETC

- https://bgpkit.com/ (BGP toolkit written in Rust)
  - https://bgpkit.com/parser
- https://github.com/bgpkit
  - https://github.com/bgpkit/bgpkit-parser
  - https://github.com/bgpkit/peer-stats
  - https://github.com/bgpkit/pybgpkit

- https://github.com/RIPE-NCC/bgpdump (Last updated 2020)
- https://github.com/cawka/bgpparser (Last updated 2015 ☹)
- https://github.com/yasuhiro-ohara-ntt/bgpdump2
- https://github.com/t2mune/mrtparse (python)
- https://github.com/rfc1036/zebra-dump-parser (perl) (Last updated 2014 ☹)

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
  - Access to historical BGP data, ie “When did this happen??”

Use Cases

Accessing a Collector

- `telnet://route-views*.routeviews.org`
- No username necessary.
- Users are able to run show commands, e.g. `show ip bgp x.x.x.x/`
- Telnet access is rate-limited to prevent automation overuse
- PLEASE don't script. There is an API for that.

Gotchas

- Why not SSH?!
  - RouteViews data is publicly available. We've got nothing to hide.
- `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
  - Kernel default-route points to transit provider next-hop

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

- Legacy Naming Scheme
  - telnet://route-views.bknix.routeviews.org
  - Other collector locations accessible via these 3rd level domains (replace “bknix”): saopaulo, saupaulo2, telxatl, jinx, napafrica, perth, soxrs, eqix, nwax, sg, sfmix, flix, amsix, chicago, chile, isc, sydney, mwix, kixp, & wide

- New Naming Scheme
  - (exchange).(closest airport).routeviews.org
  - ie: decix.jhb.routeviews.org - Malaysia IX, Johor Bahru airport

Use Cases

NEW(ER) COLLECTOR FEATURES

BMP

- BMP data will feed tools like BGPStream and ARTEMIS.
- Or write your own Kafka consumer for raw BMP data.
- Limited access at first.
- Wider availability to follow.

RPKI

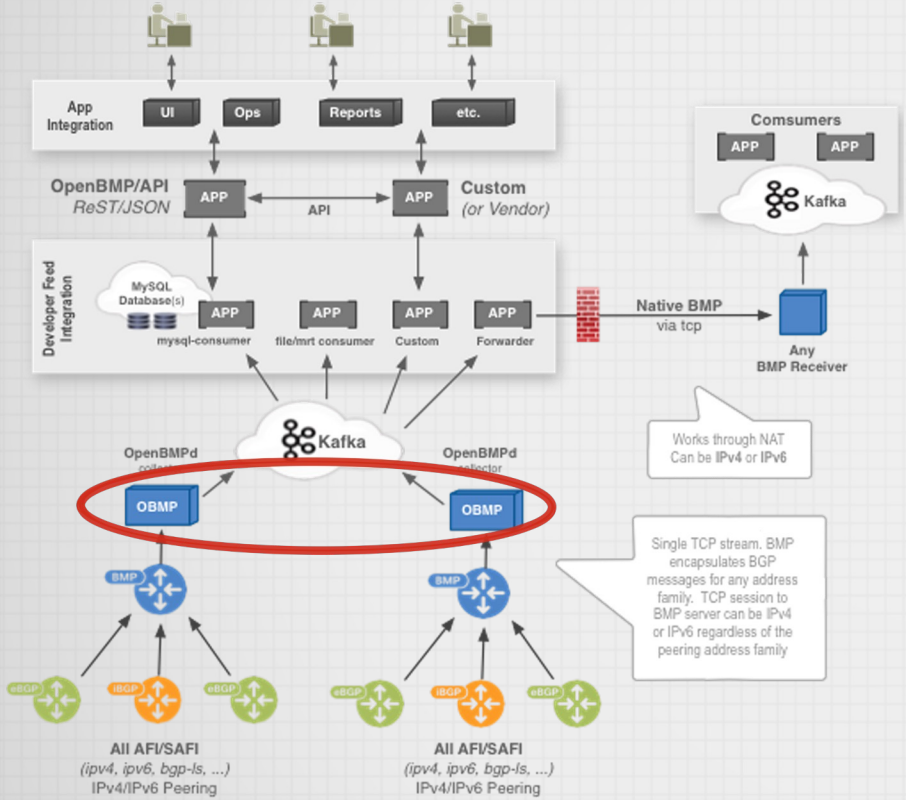
- RPKI data will be accessible directly from the collectors.
- We also are establishing an archive of RPKI ROA data.
- Working on back-filling that data set from the RIR/CAs.

Use Cases

BGP DATA DISTRIBUTION

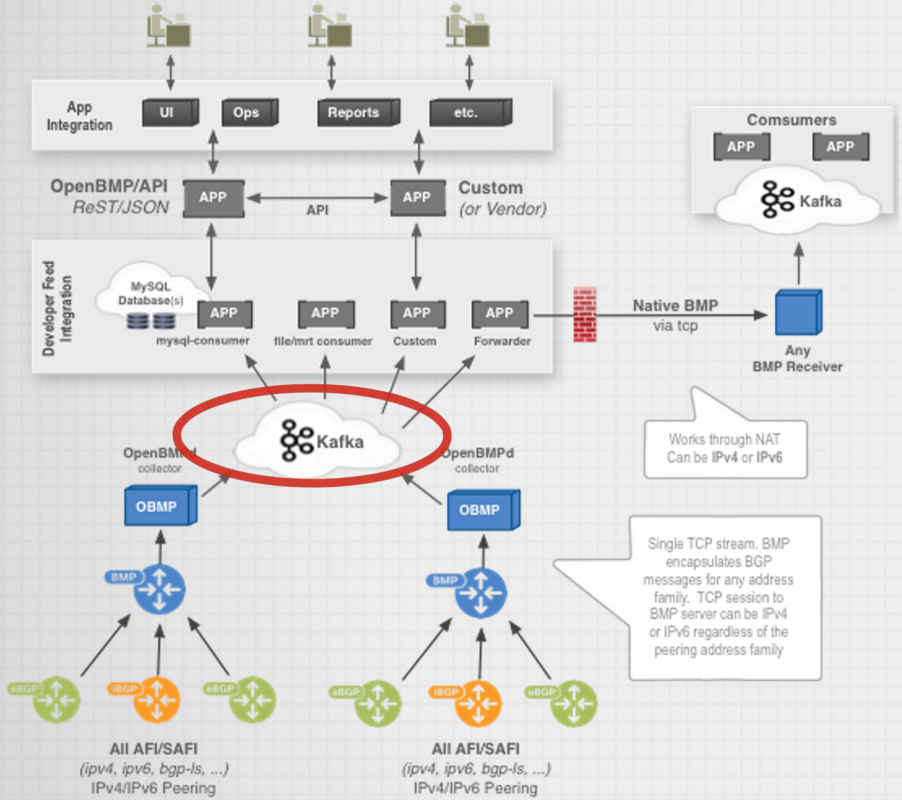
- “Message-based” data distribution (Kafka)
  - Real-time streaming telemetry
    - Per-message timestamps, with meta-data
    - Middle-layer abstraction, multi-client access (facilitates analysis and services)
    - Automated consolidating and sequencing
- RPKI validation and archival

BMP & Open/GOBMP



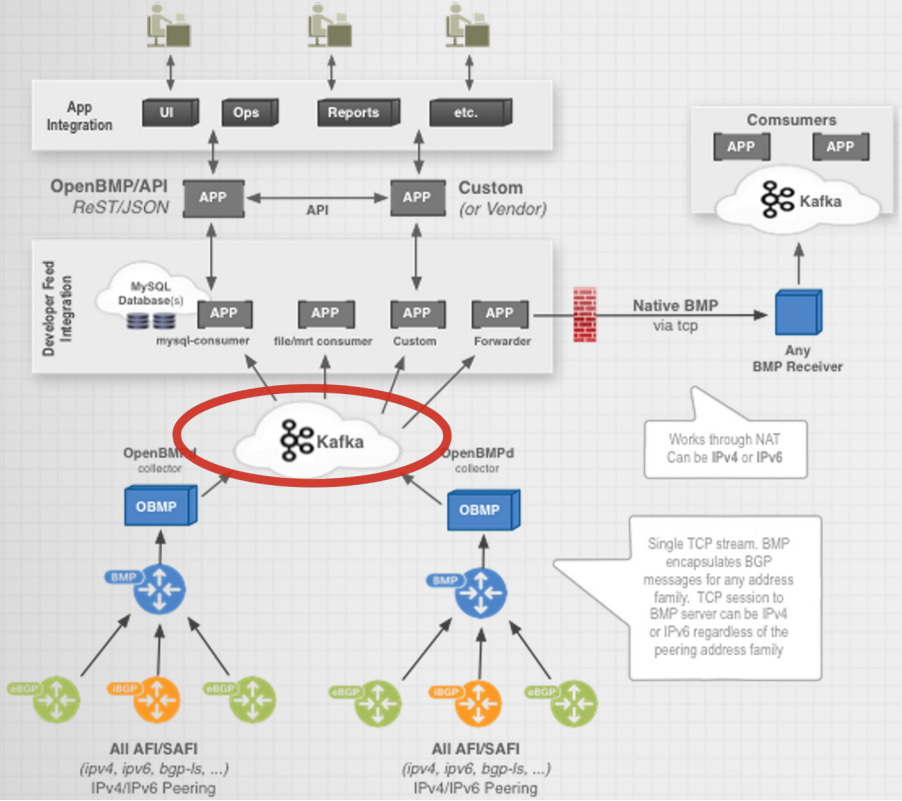
- BGP Monitoring Protocol (BMP) is an IETF standard rfc7854
  - Available now - (Cisco, Juniper, Arista & FRR)
  - Consolidates peers/collectors
  - Splits collector, peer and update messages into separate streams
- OpenBMP is OpenSource (under the Linux Foundation)
  - Latest update: 2018.. :(
- GoBMP
  - Latest update: 3 weeks ago! :)

Apache Kafka



- Apache Kafka comprises the message bus for OpenBMP
  - Proven to scale
  - Mature client API
    - Clients in 16 different programming languages

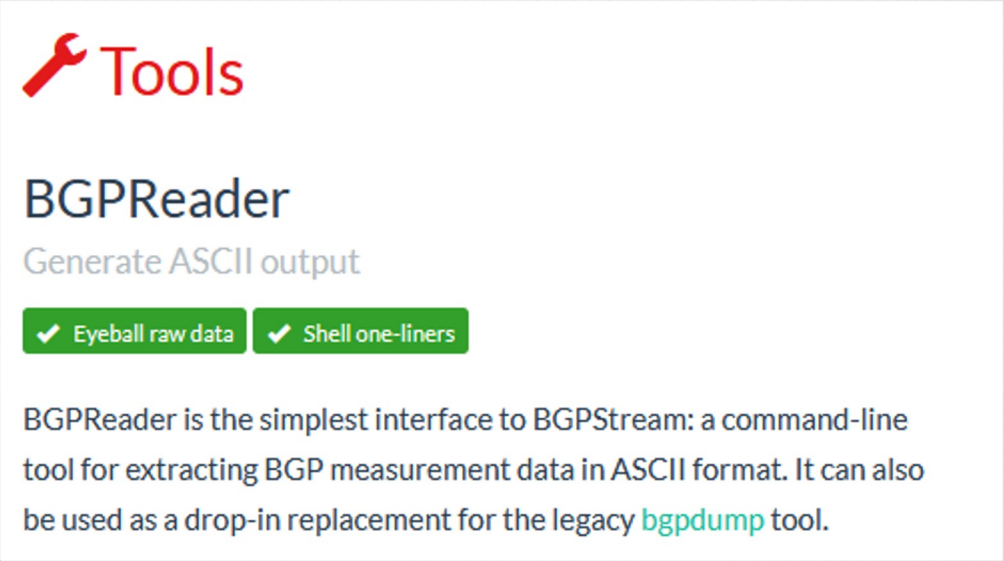
Apache Kafka



- Send email to:
  - help@routeviews.org

Use Cases

BGPStream a project of CAIDA group at UC San Diego:
https://bgpstream.caida.org



Use Cases

BGPStream a project of CAIDA group at UC San Diego
https://bgpstream.caida.org

APIs

libBGPStream

Develop C/C++ code

✔ Build efficient tools ✔ Build complex infrastructure

libBGPStream is the central library of the BGPStream framework. It is written in C and presents a simple API for configuring and reading a stream of BGP measurement data. All BGPStream tools as well as the PyBGPStream API make use of libBGPStream.

PyBGPStream

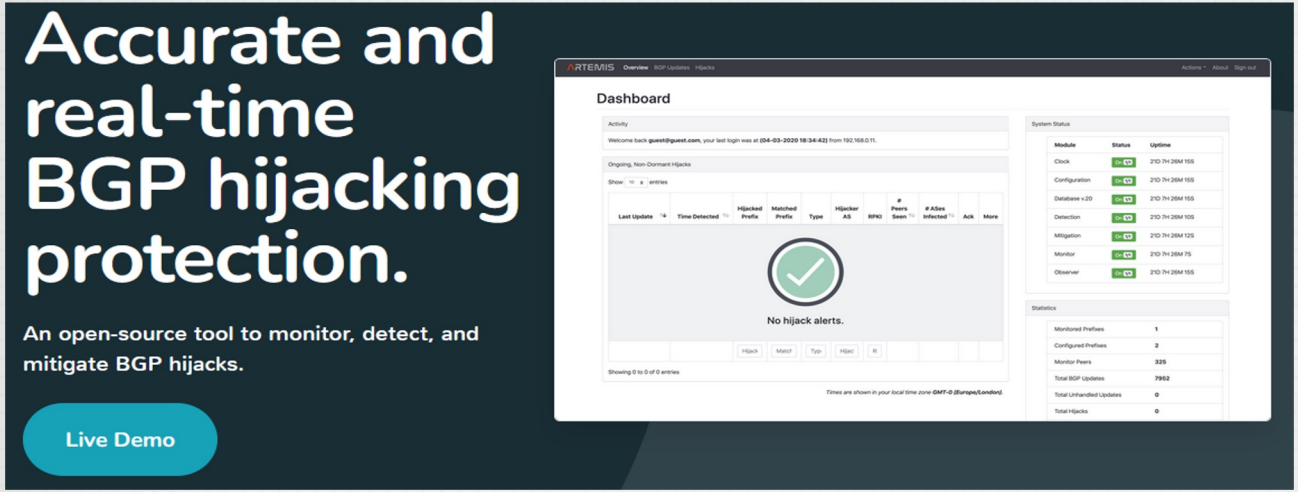
Develop Python code

✔ Rapid prototyping ✔ Ad-hoc analysis

PyBGPStream is Python package that provides bindings to the libBGPStream library, allowing Python scripts to configure and read a stream of BGP measurement data.

Use Cases

OTHER OPEN-SOURCE TOOLS: ARTEMIS



- **ARTEMIS**
  - An open-source tool to monitor, detect, and mitigate BGP hijacks
  - Real-time detection and notifications of BGP prefix hijacking attacks/events
  - https://bgpartemis.org

Use Cases

OTHER OPEN-SOURCE TOOLS: BGPKIT

- BGPKIT Parser
  - Rust-based MRT/BGP Data Parser
- BGPKIT Broker
  - REST API for searching archive files across public data collection projects. Data updated in real-time.
- BPPKIT Monocle
  - A commandline application to search, parse, and process BGP information in public sources

https://bgpkit.com/

Use Cases

NOT-SO OPEN-SOURCE TOOLS...

TECH

Cisco acquires ThousandEyes for around $1 billion to make deeper push into software

PUBLISHED THU, MAY 28 2020•4:38 PM EDT | UPDATED THU, MAY 28 2020•5:51 PM EDT

Ari Levy
@LEVYNEWS

Jordan Novet
@JORDANNOVET

SHARE

Use Cases

OPERATIONS

77 peers, multi-hop

Not all peers are up..

```
route-views2.routeviews.org> sh ip bg sum

IPv4 Unicast Summary (VRF default):
BGP router identifier 128.223.51.102, local AS number 6447 vrf-id 0
BGP table version 14375055
RIB entries 1786807, using 327 MiB of memory
Peers 77, using 54 MiB of memory

Neighbor        V         AS   MsgRcvd   MsgSent   TblVer  InQ OutQ  Up/Down State/PfxRcd  PfxSnt Desc
4.68.4.46       4       3356         0     15732        0    0    0    never       Active        0 Level3
5.101.110.2     4      14061         0         0        0    0    0    never      Connect        0 DIGITALOCEAN
12.0.1.63       4       7018   9318817     31942        0    0    0 03w1d04h       909294        0 ATT
37.139.139.17   4      57866   9727660     63869        0    0    0 03w1d04h       911576        0 Fusix
43.226.4.1      4      63927         0         0        0    0    0    never      Connect        0 Rise
45.61.0.85      4      22652   8018158     63869        0    0    0 03w1d04h       913095        0 FIBRENOIRE
62.115.128.137  4       1299  31136526     31866        0    0    0 01w3d16h       892007        0 Telia
64.71.137.241   4       6939   7260005     31935        0    0    0 03w1d04h       936399        0 Hurricane Electric
64.71.255.61    4        812         0         0        0    0    0    never      Connect        0 Sprint
66.185.128.1    4       1668         0         0        0    0    0    never      Connect        0 AOL
67.219.192.18   4      19653         0         0        0    0    0    never       Active        0 CTSTelecom
68.67.63.245    4      22652         0         0        0    0    0    never       Active        0 FIBRENOIRE
80.241.176.31   4      20771         0         0        0    0    0    never      Connect        0 CAUCASUS
85.114.0.217    4       8492  13486557     63875        0    0    0 01w4d01h       924556        0 OBITRU
87.121.64.4     4      57463  13008288     32486        0    0    0 01w3d12h       413863        0 NETIXLTD
89.149.178.10   4       3257   8721640     31936        0    0    0 03w1d04h       909050        0 Tiscali
91.209.102.1    4      39756         0         0        0    0    0    never      Connect        0 HOSTWAY-RO
91.218.184.60   4      49788  17361887     31939        0    0    0 01w3d15h       915046        0 NEXTHOPNO
...

Total number of neighbors 77
```

Lots of full tables

Use Cases

OPERATIONS

```
route-views2.routeviews.org> sh ip bgp  45.235.208.0/22
BGP routing table entry for 45.235.208.0/22, version 1474520
Paths: (30 available, best #25, table default)
  Not advertised to any peer
  11686 52320 22381 22381 22381 22381 11432 11432 11432 11432 11432 11432 11432 11432 11432 11432 11432
11432 11432 11432 11432 11432 11432 11432 11432 11432 11432 11432 11432 268214
            96.4.0.55 from 96.4.0.55 (96.4.0.55)
            Origin IGP, valid, external, rpki validation-state: not found
            Community: 11686:294
            Last update: Tue May  9 04:34:01 2023
  22652 4230 11432 268214
            45.61.0.85 from 45.61.0.85 (184.95.245.30)
            Origin IGP, valid, external, rpki validation-state: not found
            Community: 4230:11 4230:30 4230:511 4230:5101
            Last update: Sat May  6 08:05:45 2023
  8492 31133 3356 268214 268214
            85.114.0.217 from 85.114.0.217 (85.114.0.104)
            Origin IGP, valid, external, rpki validation-state: not found
            Community: 8492:1104 8492:1601
            Last update: Thu May  4 05:57:42 2023
...
```

WHAT IS ASN:11432 TRYING TO ACHIEVE BY PREPENDING 23 TIMES??

Use Cases

OPERATIONS

```
route-views2.routeviews.org> sh ip bgp rpki invalid
...
I*  212.193.8.0/24    168.209.255.56           0 3741 5511 6453 8551 203905 i
I*                    194.153.0.253            0 5413 8551 203905 i
I*                    45.61.0.85               0 22652 6453 8551 203905 i
I*                    91.218.184.60            0 49788 12552 8551 203905 i
I*                    198.129.33.85     710    0 293 6453 8551 203905 i
I*                    212.66.96.126            0 20912 49367 6762 61135 61135 60446 204843 204843 204843 i
I*                    202.232.0.3              0 2497 6453 8551 203905 i
I*>                   85.114.0.217             0 8492 8551 203905 i
I*                    203.189.128.233          0 23673 23764 8551 203905 i
I*                    94.156.252.18       0    0 34224 6453 8551 203905 i
```

ASN: 203905 ??

ASN: 204843 ??

TWO ASN: OF ORIGIN ??

Use Cases

OPERATIONS

WHOIS Lookup (212.193.8.0)

```
inetnum:          212.193.8.0 - 212.193.8.255
netname:          AjyalFiCompanyLLC
country:          PS
admin-c:          KB5060-RIPE
tech-c:           KB5060-RIPE
status:           ASSIGNED PA
abuse-c:          AR68281-RIPE
mnt-by:           lir-ae-rcstechnologies-1-MNT
mnt-by:           interlir-mnt
created:          2023-01-12T18:31:35Z
last-modified:    2023-01-12T18:31:35Z
source:           RIPE
```

PALESTINE

Use Cases

OPERATIONS

WHOIS Lookup (AS204843)

```
...
organisation:   ORG-SVMY1-RIPE
org-name:       STERLY VERI MERKEZI YAZILIM VE SIBER GUVENLIK HIZMETLERI A.S.
country:        TR
org-type:       OTHER
address:        KONAK MAH. BARIS(120) SK. OFIS ARTI BLOK NO:3 IC KAPI NO:10 NILUFER/BURSA
abuse-c:        ACRO48320-RIPE
mnt-ref:        ulasatakan
mnt-ref:        bggroupittelecom-mnt
mnt-by:         lir-tr-teknosos-1-MNT
mnt-by:         Teknosos-TR
created:        2022-05-27T09:14:49Z
last-modified:  2022-12-01T17:27:16Z
source:         RIPE # Filtered
```

FROM TURKEY ??

Use Cases

OPERATIONS

WHOIS Lookup (AS203905)

```
...
as-block:       AS196608 - AS207419
...
admin-c:        KB5060-RIPE
tech-c:         KB5060-RIPE
status:         ASSIGNED
mnt-by:         RIPE-NCC-END-MNT
mnt-by:         DigiComm-MNT
created:        2015-10-06T13:35:54Z
last-modified:  2023-02-04T17:55:17Z
source:         RIPE # Filtered

organisation:   ORG-DCL18-RIPE
org-name:       Digital Communication Company for Telecommunications and Information Technology LTD
country:        PS
org-type:       LIR
address:        Omar Al-Mokhtar st., Khaduir Building Floor #2
address:        9990300
address:        Gaza Al-Remal
address:        PALESTINE, STATE OF
```

FROM PALESTINE

Use Cases

OPERATIONS

```
route-views2.routeviews.org> sh ip bgp rpki invalid
...
I*  212.193.8.0/24    168.209.255.56           0 3741 5511 6453 8551 203905 i
I*                    194.153.0.253            0 5413 8551 203905 i
I*                    45.61.0.85               0 22652 6453 8551 203905 i
I*                    91.218.184.60            0 49788 12552 8551 203905 i
I*                    198.129.33.85     710    0 293 6453 8551 203905 i
I*                    212.66.96.126            0 20912 49367 6762 61135 61135 60446 204843 204843 204843 i
I*                    202.232.0.3              0 2497 6453 8551 203905 i
I*>                   85.114.0.217             0 8492 8551 203905 i
I*                    203.189.128.233          0 23673 23764 8551 203905 i
I*                    94.156.252.18       0    0 34224 6453 8551 203905 i
```

ASN: 203905

ASN: 204843 NOT VALID ORIGIN ?

MIS-CONFIGURATION? PREFIX HIJACK??

OTHER BITS..

RouteViews email list

- https://lists.nsrc.org/listinfo/routeviews-users
- Also available on the Contact page at routeviews.org
- A place to ask question and receive updates on RouteViews activities.
- Hosted by the wonderful folks at NSRC.

RouteViews Impact

Geoff Huston wrote in his report, "BGP in 2022 – the routing table":

"I should take a moment to mention the Route Views Project. It was originally intended to offer a multi-perspective real-time view of the inter-domain routing system, allowing network operators to examine the current visibility of route objects from various points in the inter-domain topology.

What makes Route Views so unique is that it archives these routing tables every two hours and has done so for more than two decades. It also archives every BGP update message. ***This vast collection of data is a valuable research data source in its own right****, and here we are just taking a tiny slice of this data set to look at longer-term routing growth trends.*

The folk at the Route Views Project, with support from the University of Oregon and the US National Science Foundation, should be commended for their efforts here. This is a very unique data set if you are interested in the evolution of the Internet over the years."

RouteViews Impact

Aftab Siddiqui:

"The MANRS Observatory relies heavily on BGPStream and GRIP for the detection of BGP related incidents such as BGP Leakss and BGP mis-origination. It is also very critical to verify that any incident highlighted by these services can be verified independently and to do that ***we require raw BGP data which is made available by 2 sources: RIPE RIS and Route Views.*** *Diversity of data sources is once again very important to verify any such incidents. NSRC, which manages the Route Views project, ensures that the routing data they provide is accurate and they have promptly addressed any issues or concerns raised by the MANRS team, whether it is related to changes in the MRT format causing problems in data parsing or helping with BMP data.* ***Actively maintaining Route Views provides community service by NSRC.***

MANRS has gained a lot of good reputation in the community due to the support and expertise provided by its partners such as NSRC. NSRC included MANRS Action explanation and implementation guidelines in their training courses for network operators and R&E networks, in their technical video content, and has been promoting various MANRS programs to respective communities specifically in Asia Pacific and Africa where the MANRS participation is low as compared to other regions."

Route Views

“The Internet works because a lot of people cooperate to do things together.”

Jon Postel

Route Views

“This is your Internet.”

Greg Shepherd

THANK YOU

Questions?