Routing Security SIG
RPKI Data Results for APAC

https://About.Me/Terry.Sweetser

APRICOT 2024

APNIC 57
BANGKOK, THAILAND
21 February – 1 March 2024

#apricot2024

APNIC

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Boilerplate

- All data captured at 0400Z on February 7, 2024.

- It will be Open Source on GITHUB
  - https://github.com/tcsweetser/bcp185

- Lots of SQL, you get to see inside the Sausage Factory!

```
bcp185=# \d+
                                      List of relations
 Schema |          Name           |       Type        | Owner | Persistence | Access method |  Size   | Description
--------+-------------------------+-------------------+-------+-------------+---------------+---------+-------------
 public | overlapping_signed_routes | materialized view | apnic | permanent   | heap          | 8344 kB |
 public | rir_allocations         | table             | apnic | permanent   | heap          | 26 MB   |
 public | routes                  | table             | apnic | permanent   | heap          | 2121 MB |
 public | rpki_signed_routes      | table             | apnic | permanent   | heap          | 34 MB   |
(4 rows)
```

Data Sources

https://blog.apnic.net/2020/01/29/is-rpki-ready-for-the-big-screen/

https://www.routeviews.org/routeviews/
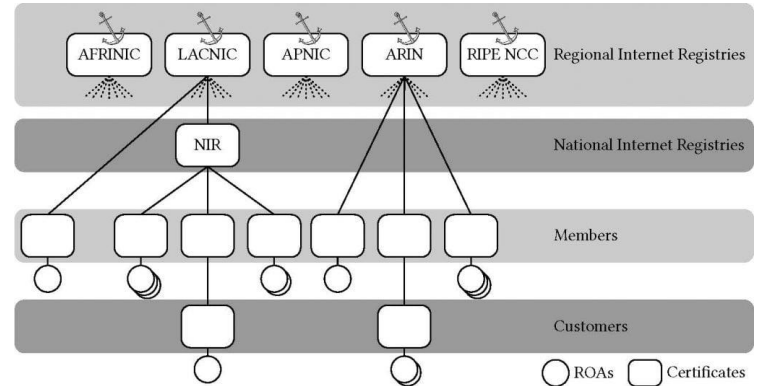
https://ftp.apnic.net/stats/

Simple Data Structures

```
bcp185=# \d+ rpki_signed_routes
                                    Table "public.rpki_signed_routes"
    Column     |   Type   | Collation | Nullable | Default |  Storage  | Compression | Stats target | Description
---------------+----------+-----------+----------+---------+-----------+-------------+--------------+-------------
 ASN           | text     |           |          |         | extended  |             |              |
 IP Prefix     | cidr     |           |          |         | main      |             |              |
 Max Length    | integer  |           |          |         | plain     |             |              |
 Trust Anchor  | text     |           |          |         | extended  |             |              |
 Expires       | bigint   |           |          |         | plain     |             |              |
Indexes:
    "rpki_signed_routes_ASN_idx" btree ("ASN")
    "rpki_signed_routes_IP Prefix_idx" gist ("IP Prefix" inet_ops)
    "rpki_signed_routes_Trust Anchor_idx" btree ("Trust Anchor")
    "rpki_signed_routes_masklen_idx" btree (masklen("IP Prefix"::inet))
Access method: heap
```

```
bcp185=# \d+ routes
                                    Table "public.routes"
   Column   |     Type     | Collation | Nullable | Default |  Storage  | Compression | Stats target | Description
------------+--------------+-----------+----------+---------+-----------+-------------+--------------+-------------
 dumptype   | text         |           |          |         | extended  |             |              |
 exported   | text         |           |          |         | extended  |             |              |
 protocol   | character(1) |           |          |         | extended  |             |              |
 nexthop    | inet         |           |          |         | main      |             |              |
 asn        | bigint       |           |          |         | plain     |             |              |
 prefix     | cidr         |           |          |         | main      |             |              |
 aspath     | text         |           |          |         | extended  |             |              |
 origin     | text         |           |          |         | extended  |             |              |
Indexes:
    "routes_prefix_idx" gist (prefix inet_ops)
Access method: heap
```

Same Basic Numbers

```
bcp185=# select count(*) from rpki_signed_routes;
 count
--------
 508414
(1 row)

bcp185=# select count(*) from routes;
  count
----------
 18535539
(1 row)
```

```
bcp185=# select family("IP Prefix"),"Trust Anchor",
count(distinct "IP Prefix")
from rpki_signed_routes
group by 1,2 order by 2,1;
 family | Trust Anchor | count
--------+--------------+--------
      4 | afrinic      |   8920
      6 | afrinic      |    647
      4 | apnic        |  92059
      6 | apnic        |  25952
      4 | arin         |  74949
      6 | arin         |  15991
      4 | lacnic       |  21594
      6 | lacnic       |   7915
      4 | ripe         | 174975
      6 | ripe         |  39003
(10 rows)
```

```
bcp185=# select family(prefix),count(distinct prefix) from routes group by 1;
 family | count
--------+--------
      4 | 982297
      6 | 204965
(2 rows)
```

RPKI in less than 1 minute …

ROA, are we there yet?

https://stats.labs.apnic.net/roas
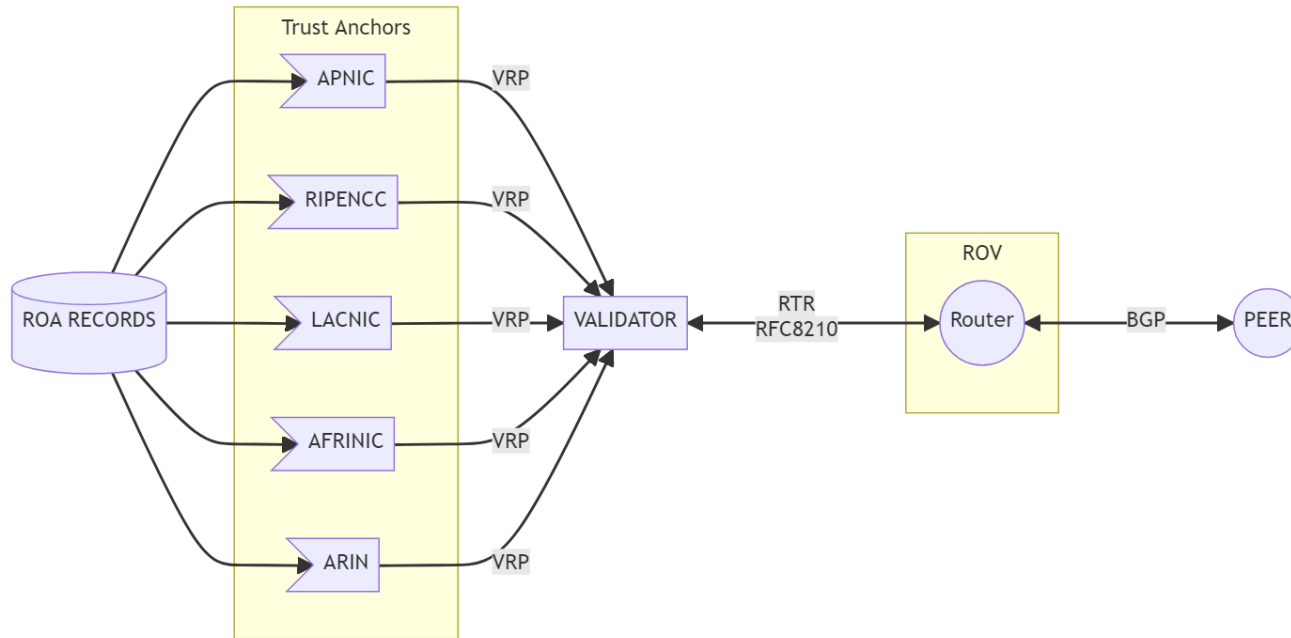
Lots of Green here, but…

CN
AU
PG
JP
NZ
TH

0   100

APNIC
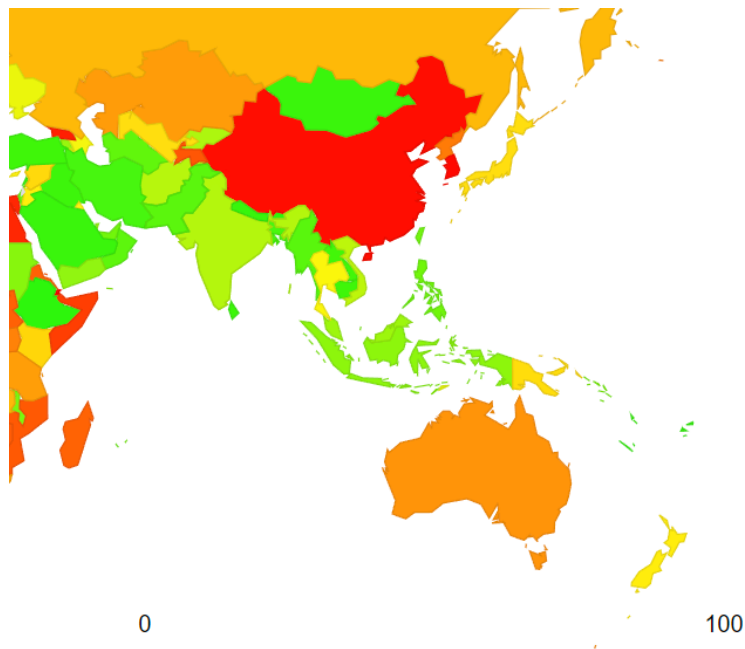
Progress ☺

Use of Route Object Validation for Asia (XD)

Display: **Addresses** (Advertised ROA-Valid Advertised Addresses), **Total** (IPv4 + IPv6), **Percent** (of Total)
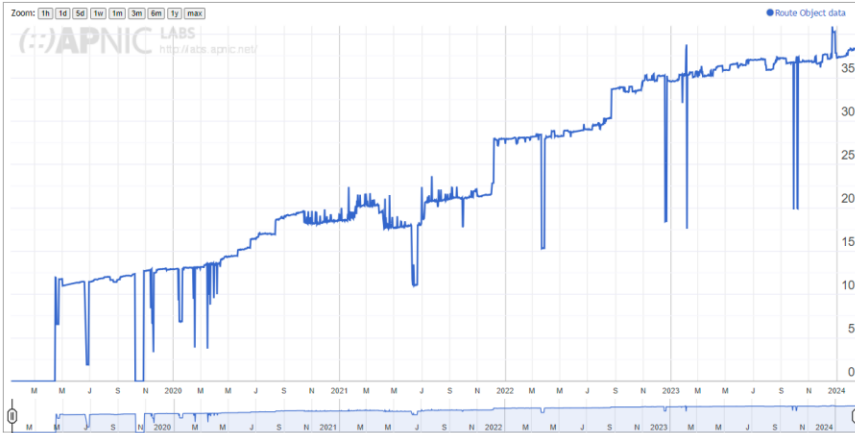
Use of Route Object Validation for Oceania (XF)

Display: **Addresses** (Advertised ROA-Valid Advertised Addresses), **Total** (IPv4 + IPv6), **Percent** (of Total)

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ROV, how is that going?

https://stats.labs.apnic.net/rpki
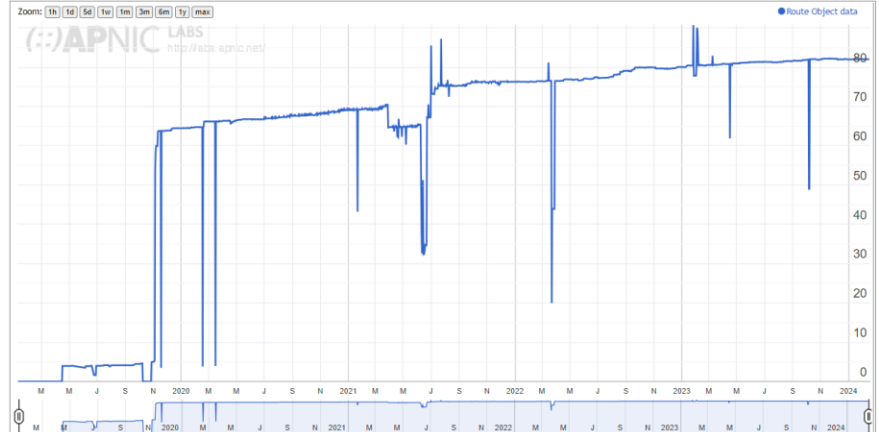
Great job by …

TW
AU
…
…
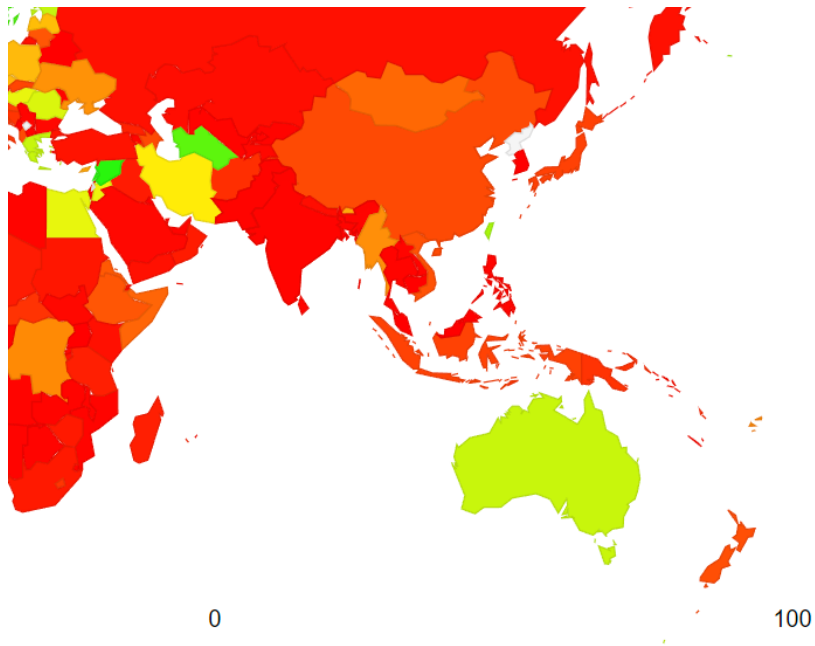
Validation: A Long Road Ahead

Use of RPKI Validation for Asia (XD)
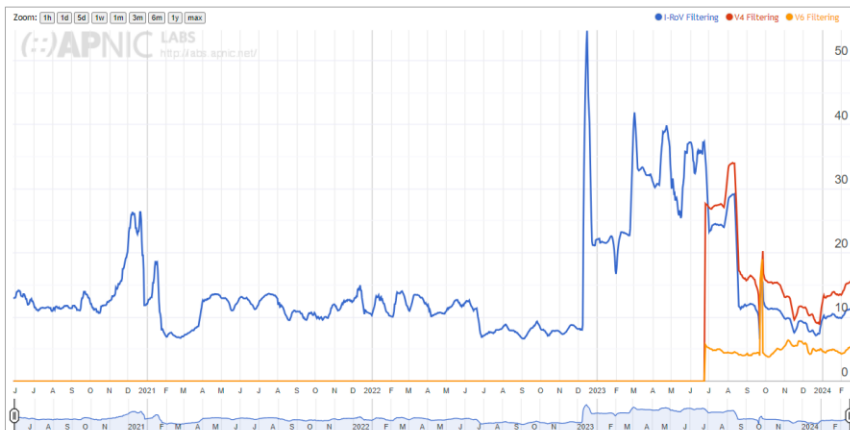
Use of RPKI Validation for Oceania (XF)

RFC7115 + RFC9319 = BCP185

> For this reason, this document recommends that, whenever possible, operators SHOULD use "minimal ROAs" that authorize only those IP prefixes that are actually originated in BGP, and no other prefixes. Further, it recommends ways to reduce the forged-origin attack surface by prudently limiting the address space that is included in ROAs. One recommendation is to avoid using the maxLength attribute in ROAs except in some specific cases. The recommendations complement and extend those in [RFC7115]. The document also

- Members of All the RIRs continue to "OVERSIGN"
  - Huge MAX LENGTHS with no matching ROUTES.
  - Largest and most connected economies are the WORST cases.
  - Highly questionable ROAs signed by those who should know better.

The Top 10 …

```
bcp185=# select * from report_bcp185_by_iso where
("Global Routes"/"ROA Coverage") < 0.00005
and economy_iso≠''
and "Global Routes" > 10
order by 2 desc;
 economy_iso | ROA Coverage | Global Routes | BCP185 Compliance
-------------+--------------+---------------+-------------------
 FR          |   1195134656 |         10450 | 000.00%
 TW          |    381642809 |         12649 | 000.00%
 JP          |    157727426 |          6087 | 000.00%
 MA          |     33835598 |           265 | 000.00%
 AL          |     32638327 |           927 | 000.00%
 IS          |      4457025 |           178 | 000.00%
 CD          |      2621515 |            69 | 000.00%
 LI          |      2228351 |            66 | 000.00%
 GD          |      1974818 |            34 | 000.00%
 GP          |      1180482 |            25 | 000.00%
(10 rows)
```

The Top 25 in APAC …

```
bcp185=#
bcp185=# select * from report_bcp185_combined where rir='apnic' order by 3 desc limit 25;
  rir  | economy_iso | ROA Coverage | Global Routes | BCP185 Compliance
-------+-------------+--------------+---------------+-------------------
 apnic | TW          |    380463099 |         12614 | 000.00%
 apnic | JP          |    155498452 |          6027 | 000.00%
 apnic | CN          |     36239128 |          2153 | 000.01%
 apnic | ID          |     29810247 |         17760 | 000.06%
 apnic | IN          |      4275225 |         38941 | 000.91%
 apnic | SG          |      3816797 |          5844 | 000.15%
 apnic | AU          |      3468345 |          7941 | 000.23%
 apnic | VN          |      2285508 |         22620 | 000.99%
 apnic | NZ          |      2105698 |          1802 | 000.09%
 apnic | HK          |      2059318 |          7349 | 000.36%
 apnic | US          |      1105124 |          1612 | 000.15%
 apnic | MY          |      1062999 |          3108 | 000.29%
 apnic | BD          |       958449 |         10300 | 001.07%
 apnic | MN          |       656210 |           514 | 000.08%
 apnic | PK          |       576198 |          7544 | 001.31%
 apnic | PH          |       416962 |          5387 | 001.29%
 apnic | KH          |       268386 |          2165 | 000.81%
 apnic | MM          |       263864 |          1071 | 000.41%
 apnic | MV          |       263226 |           281 | 000.11%
 apnic | NP          |       139692 |          1102 | 000.79%
 apnic | MO          |       132886 |           113 | 000.09%
 apnic | BT          |       131854 |           125 | 000.09%
 apnic | VU          |       131140 |            68 | 000.05%
 apnic | TH          |       117555 |          6822 | 005.80%
 apnic | LK          |        85615 |           743 | 000.87%
(25 rows)
```

Good News Everyone!

```
bcp185=# select * from report_bcp185_by_iso where
("Global Routes"/"ROA Coverage") > 0.80 and economy_iso≠''
order by 3 desc;
 economy_iso | ROA Coverage | Global Routes | BCP185 Compliance
-------------+--------------+---------------+------------------
 SY          |          163 |           163 | 100.00%
 YE          |          127 |           121 | 095.28%
 BW          |           73 |            64 | 087.67%
 TJ          |           46 |            42 | 091.30%
 GU          |           26 |            23 | 088.46%
 GL          |           24 |            21 | 087.50%
 TM          |           20 |            20 | 100.00%
 TD          |           24 |            20 | 083.33%
 PM          |           18 |            18 | 100.00%
 SM          |           17 |            16 | 094.12%
 MH          |           18 |            15 | 083.33%
 AX          |           16 |            15 | 093.75%
 NR          |           15 |            14 | 093.33%
 FO          |           14 |            13 | 092.86%
 IO          |           12 |            12 | 100.00%
 CW          |           13 |            12 | 092.31%
 DM          |            7 |             7 | 100.00%
 TT          |            7 |             7 | 100.00%
 AI          |            5 |             5 | 100.00%
 GG          |            6 |             5 | 083.33%
 CU          |            5 |             5 | 100.00%
 NU          |            5 |             5 | 100.00%
 BB          |            4 |             4 | 100.00%
 VA          |            2 |             2 | 100.00%
 VI          |            1 |             1 | 100.00%
(25 rows)
```

CAUTION

SARCASM DETECTED

Overlapping Signed Routes …

```
bcp185=# select * from overlapping_signed_routes limit 10;
 asns_subnet | asns_supernet |   subnet     | subnet_maxlen |   supernet    | supernet_maxlen
-------------+---------------+--------------+---------------+---------------+----------------
 {AS132215}  | {AS9583}      | 1.6.228.0/24 |            24 | 1.6.228.0/22  |             24
 {AS4755}    | {AS9583}      | 1.6.229.0/24 |            24 | 1.6.228.0/22  |             24
 {AS132215}  | {AS9583}      | 1.7.142.0/24 |            24 | 1.7.140.0/22  |             24
 {AS132215}  | {AS9583}      | 1.7.151.0/24 |            24 | 1.7.148.0/22  |             24
 {AS132215}  | {AS9583}      | 1.7.161.0/24 |            24 | 1.7.160.0/22  |             24
 {AS132215}  | {AS9583}      | 1.7.162.0/24 |            24 | 1.7.160.0/22  |             24
 {AS132215}  | {AS9583}      | 1.7.180.0/24 |            24 | 1.7.180.0/22  |             24
 {AS396421}  | {AS9583}      | 1.7.225.0/24 |            24 | 1.7.224.0/22  |             24
 {AS4755}    | {AS9583}      | 1.7.229.0/24 |            24 | 1.7.228.0/22  |             24
 {AS65037}   | {AS4788}      | 1.9.12.0/24  |            24 | 1.9.0.0/16    |             24
(10 rows)

bcp185=# select count(*) from overlapping_signed_routes;
 count
-------
 63296
(1 row)
```

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Please Stop Doing …

Max Max Length IPv4	Max Max Length IPv6

```
bcp185=# select "Trust Anchor",count(distinct "ASN")
 from rpki_signed_routes
 where family("IP Prefix")=4 and "Max Length" = 32
 group by 1 order by 2 desc;
 Trust Anchor | count
--------------+-------
 ripe         |   572
 lacnic       |   281
 arin         |   162
 apnic        |    67
 afrinic      |    20
(5 rows)
```

```
bcp185=# select "Trust Anchor",count(distinct "ASN")
 from rpki_signed_routes
 where family("IP Prefix")=6 and "Max Length" = 128
 group by 1 order by 2 desc;
 Trust Anchor | count
--------------+-------
 lacnic       |   276
 ripe         |   130
 arin         |    33
 apnic        |    28
 afrinic      |    15
(5 rows)
```

APNIC

Please stop doing …

```
bcp185=# select array_agg("ASN") as asns,"IP Prefix" as subnet, "Max Length" as maxlen,
split_cidr_count("IP Prefix","Max Length") from rpki_signed_routes
where family("IP Prefix")=4
group by 2,3 order by 4 desc limit 10;
             asns             |     subnet     | maxlen | split_cidr_count
------------------------------+----------------+--------+------------------
 {AS21928}                    | 100.128.0.0/9  |     24 |            65535
 {AS6253}                     | 48.0.0.0/9     |     24 |            65535
 {AS8987,AS14618,AS16509}     | 3.128.0.0/10   |     24 |            32767
 {AS16509,AS8987,AS14618}     | 44.192.0.0/10  |     24 |            32767
 {AS8987,AS14618,AS16509}     | 3.192.0.0/10   |     24 |            32767
 {AS14618,AS8987,AS16509}     | 3.0.0.0/10     |     24 |            32767
 {AS6253}                     | 48.128.0.0/10  |     24 |            32767
 {AS14618,AS8987,AS16509}     | 34.192.0.0/10  |     24 |            32767
 {AS14618,AS8987,AS16509}     | 3.64.0.0/10    |     24 |            32767
 {AS17676}                    | 126.64.0.0/10  |     24 |            32767
(10 rows)
```

Please explain …

```
bcp185=#
bcp185=# select * from _route_rpki_subnet_counts where subnet ⋘ '100.128.0.0/9'::cidr;
    subnet      | maxlen | expanded_count | routed_count | rir  | economy_iso
----------------+--------+----------------+--------------+------+-------------
 100.128.0.0/9  |     24 |          65535 |            1 | arin | US
(1 row)

bcp185=# select * from _route_rpki_subnet_counts where subnet ⋘ '48.0.0.0/9'::cidr;
   subnet     | maxlen | expanded_count | routed_count | rir  | economy_iso
--------------+--------+----------------+--------------+------+-------------
 48.0.0.0/9   |     24 |          65535 |            0 | arin | US
(1 row)

bcp185=# select * from _route_rpki_subnet_counts where subnet = '3.0.0.0/10'::cidr;
   subnet     | maxlen | expanded_count | routed_count | rir  | economy_iso
--------------+--------+----------------+--------------+------+-------------
 3.0.0.0/10   |     24 |          32767 |          243 | arin | US
(1 row)
```

Wait, there's more …

```
ocp185=# select * from rpki_signed_routes where "ASN" = 'AS7473'
and "IP Prefix" << '2001:c10::/32'::cidr order by 3 limit 25;
  ASN   |       IP Prefix       | Max Length | Trust Anchor |  Expir
--------+-----------------------+------------+--------------+--------
 AS7473 | 2001:c10:8000::/34    |         34 | apnic        | 170784
 AS7473 | 2001:c10:4000::/34    |         34 | apnic        | 170784
 AS7473 | 2001:c10:c000::/35    |         35 | apnic        | 170784
 AS7473 | 2001:c10:2000::/35    |         35 | apnic        | 170784
 AS7473 | 2001:c10:e000::/36    |         36 | apnic        | 170784
 AS7473 | 2001:c10:1000::/36    |         36 | apnic        | 170784
 AS7473 | 2001:c10:f000::/37    |         37 | apnic        | 170784
 AS7473 | 2001:c10:800::/37     |         37 | apnic        | 170784
 AS7473 | 2001:c10:400::/38     |         38 | apnic        | 170784
 AS7473 | 2001:c10:200::/39     |         39 | apnic        | 170784
 AS7473 | 2001:c10:fc00::/39    |         39 | apnic        | 170784
 AS7473 | 2001:c10:100::/40     |         40 | apnic        | 170784
 AS7473 | 2001:c10:fe00::/40    |         40 | apnic        | 170784
 AS7473 | 2001:c10:ff80::/41    |         41 | apnic        | 170784
 AS7473 | 2001:c10:c0::/42      |         42 | apnic        | 170784
 AS7473 | 2001:c10:40::/42      |         42 | apnic        | 170784
 AS7473 | 2001:c10:ff40::/42    |         42 | apnic        | 170784
 AS7473 | 2001:c10:a0::/43      |         43 | apnic        | 170784
 AS7473 | 2001:c10:20::/43      |         43 | apnic        | 170784
 AS7473 | 2001:c10:ff20::/43    |         43 | apnic        | 170784
 AS7473 | 2001:c10:10::/44      |         44 | apnic        | 170784
 AS7473 | 2001:c10:90::/44      |         44 | apnic        | 170784
 AS7473 | 2001:c10:ff10::/44    |         44 | apnic        | 170784
 AS7473 | 2001:c10:8::/45       |         45 | apnic        | 170784
 AS7473 | 2001:c10:88::/45      |         45 | apnic        | 170784
(25 rows)
```

```
85=# select * from rpki_signed_routes where "ASN" = 'AS7473'
"IP Prefix" << '2001:c10::/32'::cidr order by 3 limit 25 offset
N |       IP Prefix       | Max Length | Trust Anchor |  Expi
--+-----------------------+------------+--------------+------
473 | 2001:c10:80:1::2c0/126 |        126 | apnic        | 17078
473 | 2001:c10:80:1::1f0/126 |        126 | apnic        | 17078
473 | 2001:c10:80:1::16c/126 |        126 | apnic        | 17078
473 | 2001:c10:80:1::164/126 |        126 | apnic        | 17078
473 | 2001:c10:80:1::144/126 |        126 | apnic        | 17078
473 | 2001:c10:80:1::f8/126  |        126 | apnic        | 17078
473 | 2001:c10:80:1::e8/126  |        126 | apnic        | 17078
473 | 2001:c10:80:1::e0/126  |        126 | apnic        | 17078
473 | 2001:c10:80:1::5c/126  |        126 | apnic        | 17078
473 | 2001:c10:80:1::20/126  |        126 | apnic        | 17078
473 | 2001:c10:0:1::64/126   |        126 | apnic        | 17078
473 | 2001:c10:0:1::60/127   |        127 | apnic        | 17078
473 | 2001:c10:0:1::116/127  |        127 | apnic        | 17078
473 | 2001:c10:0:1::136/128  |        128 | apnic        | 17078
473 | 2001:c10:0:1::132/128  |        128 | apnic        | 17078
473 | 2001:c10:0:1::122/128  |        128 | apnic        | 17078
473 | 2001:c10:0:1::115/128  |        128 | apnic        | 17078
473 | 2001:c10:0:1::63/128   |        128 | apnic        | 17078
473 | 2001:c10:0:1::103/128  |        128 | apnic        | 17078
473 | 2001:c10:0:1::62/128   |        128 | apnic        | 17078
473 | 2001:c10:0:1::57/128   |        128 | apnic        | 17078
473 | 2001:c10:0:1::16/128   |        128 | apnic        | 17078
473 | 2001:c10:0:1::60/128   |        128 | apnic        | 17078
473 | 2001:c10:0:1::33/128   |        128 | apnic        | 17078
473 | 2001:c10:0:1::24/128   |        128 | apnic        | 17078
rows)
```

One Billion Routes!

```
bcp185=# select array_agg("ASN") as asns,"IP Prefix" as subnet, "Max Length" as maxlen,
split_cidr_count("IP Prefix","Max Length") from rpki_signed_routes
group by 2,3 order by 4 desc limit 25;
            asns            |      subnet      | maxlen | split_cidr_count
----------------------------+------------------+--------+------------------
 {AS5511}                   | 2a01:c000::/19   |     48 |       1073741823
 {AS26810}                  | 2601:9000::/20   |     48 |        536870911
 {AS7303}                   | 2800:2000::/20   |     48 |        536870911
 {AS3462}                   | 2001:b000::/21   |     48 |        268435455
 {AS3462}                   | 2001:b000::/23   |     64 |         67108863
 {AS17676}                  | 2400:2100::/24   |     48 |         33554431
 {AS8987,AS14618,AS16509}   | 240f:8000::/24   |     48 |         33554431
 {AS17676}                  | 2403:9900::/24   |     48 |         33554431
 {AS6939}                   | 2600:7000::/24   |     48 |         33554431
 {AS8987,AS14618,AS16509}   | 2600:1f00::/24   |     48 |         33554431
 {AS8987,AS14618,AS16509}   | 2406:da00::/24   |     48 |         33554431
 {AS17676}                  | 2400:2200::/24   |     48 |         33554431
 {AS17676}                  | 2400:2300::/24   |     48 |         33554431
 {AS7155}                   | 2600:6800::/24   |     64 |         33554431
 {AS14618,AS8987,AS16509}   | 2600:f000::/24   |     48 |         33554431
 {AS36925}                  | 2c0e:6000::/24   |     48 |         33554431
 {AS14618,AS8987,AS16509}   | 2a05:d000::/25   |     48 |         16777215
 {AS22927}                  | 2802:8000::/25   |     48 |         16777215
 {AS15557,AS198949}         | 2a02:8400::/25   |     48 |         16777215
 {AS3215}                   | 2a01:cb00::/26   |     48 |          8388607
 {AS51964}                  | 2a01:ce80::/26   |     48 |          8388607
 {AS4780,AS9919}            | 2401:8000::/26   |     48 |          8388607
 {AS17709}                  | 2404::/26        |     48 |          8388607
 {AS4780}                   | 2001:4580::/26   |     48 |          8388607
 {AS43754}                  | 2a05:1a00::/26   |    128 |          8388607
(25 rows)
```

What is MY ASK here?

BCP185

- Sign your routes, but limit that to only what you advertise to the Global Internet.

- Don't use Public Sources of data for bizarre and non-sensical experiments.

- Don't know? Ask!

https://About.Me/Terry.Sweetser

Questions?

THANK YOU
FOR YOUR ATTENION