INEX

INEX's RPKI Implementation

RIPE78, Reykjavik
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RPKI

ROAs - Route Origin Authorisations

- A cryptographically secure replacement for route[6] objects
- Adds maximum prefix length
- Yields route origin triplets that have been validated

```
( Origin AS, Prefix        ,  Max Length )
( AS65500,   2001:db8::/32,  /48          )
( AS65501,   192.0.2.0/24,   /24          )
```

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NEW ROUTE SERVERS

Route Server Refresh at INEX

- RPKI just one element
- Upgrade configuration from Bird v1.6 to Bird v2.0
- Complete rewrite of filtering workflow
  - Large communities used extensively within the route server
- Upgrade Bird's Eye[1] for Bird v2 BGP
- Overhaul IXP Manager looking glass

1. A secure micro service for querying Bird - https://github.com/inex/birdseye

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NEW ROUTE SERVERS

Bird v1 to v2 Changes

- RPKI-RTR supported
- Collapsed separate daemons for IPv4 and IPv6 into a single daemon
  - master route table becomes master4 / master6
  - new protocol blocks: ipv4 { ... } / ipv6 { ... }
- Other very minor configuration changes

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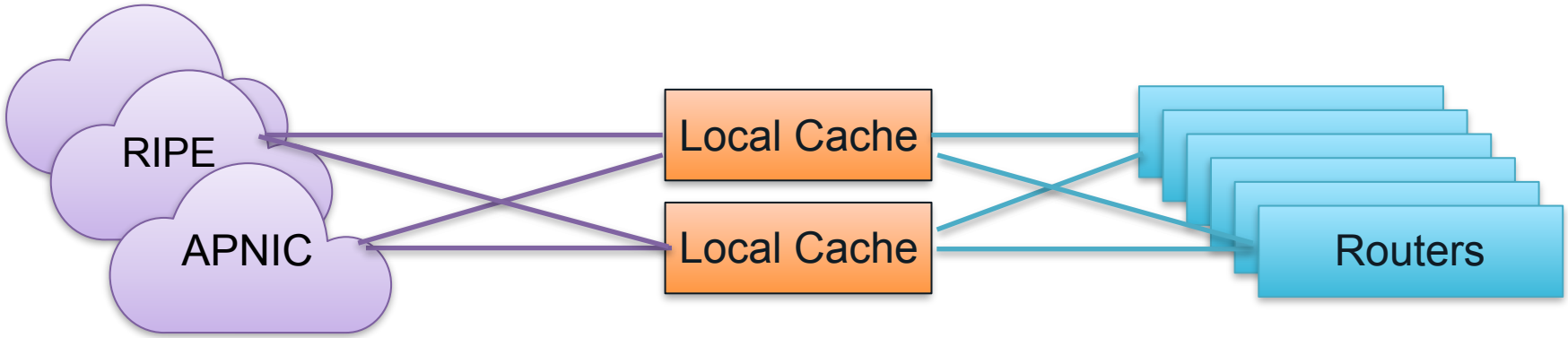
RPKI

Validating BGP Routing with RPKI-RTR

- A cache server *(validator)* does the cryptographic heavy lifting
- Routers receive and maintain the set of ROAs via RPKI-RTR from the cache
- RPKI gives three validation results: VALID, INVALID, UNKNOWN



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NEW ROUTE SERVERS

IXP Manager v5 Route Server Filtering

1. Small prefixes (default is > /24 / /48 for ipv4 / ipv6)
2. Martians / bogons
3. Ensure at least 1 ASN and <= 64 ASNs in path
4. Ensure peer AS is the same as first AS in the prefix's AS path
5. Prevent next-hop hijacking
6. Filter known transit networks
7. Ensure origin AS is in set of ASNs from member AS-SET
8. RPKI:
    - Valid -> accept
    - Invalid -> drop
9. RPKI Unknown -> revert to standard IRRDB prefix filtering

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NEW ROUTE SERVERS

Filter Known Transit Networks

These do not peer at IX's and they aren't typically customers of IX participants

```
14  define TRANSIT_ASNS = [ 174,          # Cogent
15                          209,          # Qwest (HE carries this on IXPs IPv6 (Jul 12 2018))
16                          701,          # UUNET
17                          702,          # UUNET
18                          1239,         # Sprint
19                          1299,         # Telia
20                          2914,         # NTT Communications
21                          3257,         # GTT Backbone
22                          3320,         # Deutsche Telekom AG (DTAG)
23                          3356,         # Level3
24                          3549,         # Level3
25                          3561,         # Savvis / CenturyLink
26                          4134,         # Chinanet
27                          5511,         # Orange opentransit
28                          6453,         # Tata Communications
29                          6461,         # Zayo Bandwidth
30                          6762,         # Seabone / Telecom Italia
31                          7018 ];       # AT&T
```

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NEW ROUTE SERVERS

Ensure Origin AS is in member's AS-SET

```
as-set:      AS-HEANET
descr:       Autonomous Systems routed by HEAnet
members:       AS1213, AS2128, AS112, AS42310, AS2850, AS-IEDR
remarks:     Group ASs routed by HEAnet together
mnt-by:      HEANET-NOC
source:      RIPE
```

No ability to create AS sets in RPKI

draft-ietf-grow-rpki-as-cones will resolve this

This is a regression over static IRRDB filtering

1. BGP filtering automation tool: https://github.com/snar/bgpq3

NEW ROUTE SERVERS

IXP Manager v5 Route Server Filtering

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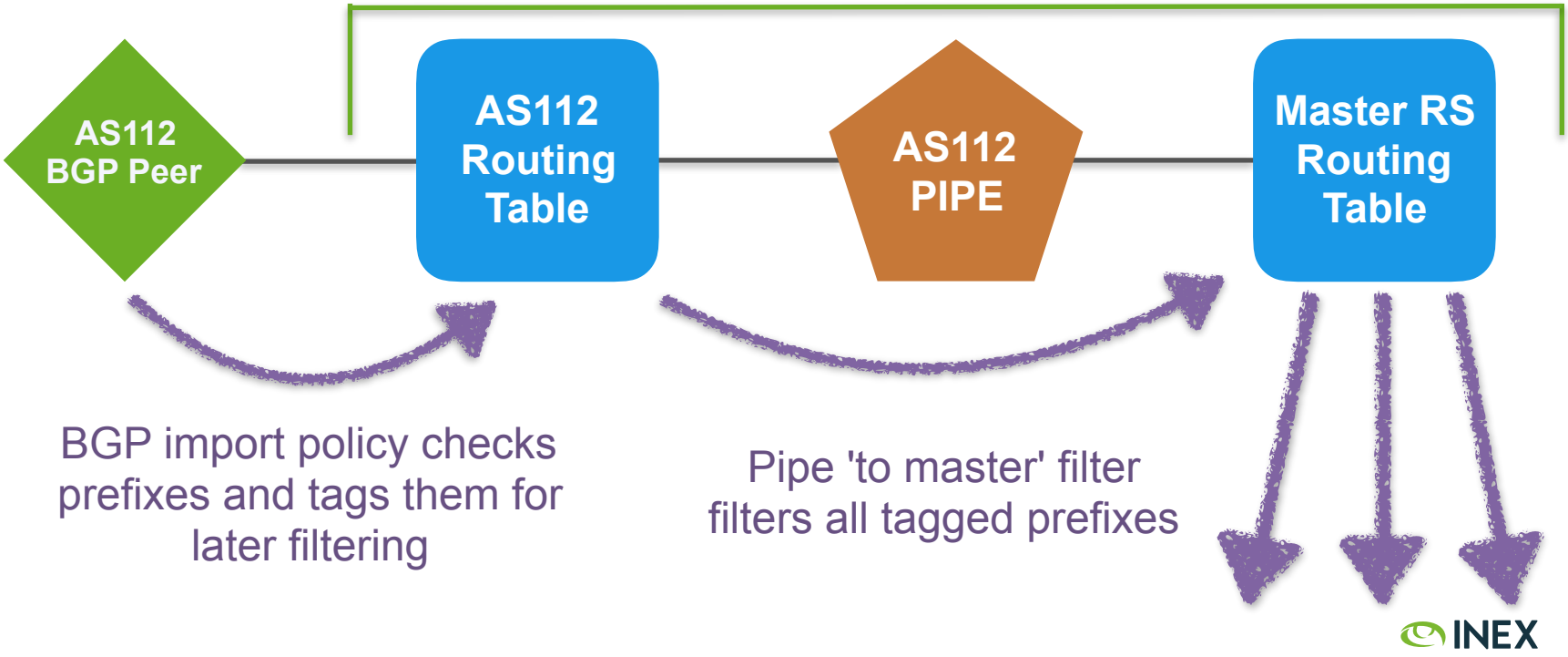
NEW ROUTE SERVERS

IXP Manager v5 Bird Topology - Import From Member



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NEW ROUTE SERVERS

Route Server BGP Community Usage

43760:1101:* are filtered

Side note

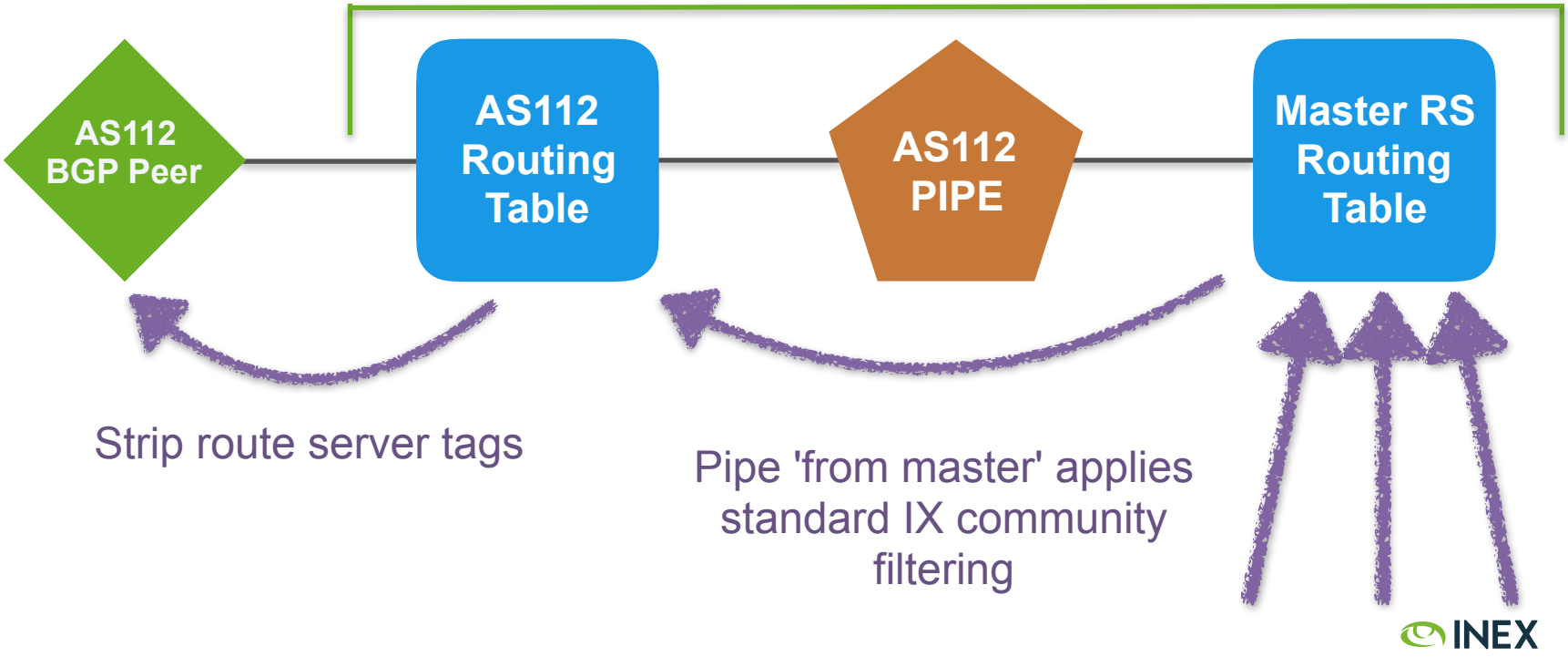
Description	Large Community
RPKI Valid	43760:1000:1
RPKI Unknown	43760:1000:2
IRRDB Valid	43760:1001:1
…	…

Description	Large Community
Bogon Prefix	43760:1101:3
IRRDB Invalid	43760:1101:9
RPKI Invalid	43760:1101:13
…	…

1. https://github.com/euro-ix/rs-workshop-july-2017/wiki/Route-Server-BGP-Community-usage

NEW ROUTE SERVERS

IXP Manager v5 Bird Topology - Export To Member



Side note

NEW ROUTE SERVERS

Standard IX Route Server Community Filters

Description	Community	Large Community
Prevent announcement of a prefix to a certain peer	0:peer-as	43760:0:peer-as
Announce a prefix to a certain peer	43760:peer-as	43760:1:peer-as
Prevent announcement of a prefix to all peers	0:43760	43760:0:0
Announce a prefix to a all peers	43760:43760	43760:1:0

RPKI Implementation Notes

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Validator Software - RIPE NCC RPKI Validator 3

- RIPE NCC RPKI Validator 3 released in 2018
  - https://github.com/RIPE-NCC/rpki-validator-3
- Dramatically reduces installation complexity
- Modest VM requirements, runs on standard OS distributions
- Requirement to download ARIN TAL separately

```
$ wget https://ftp.ripe.net/tools/rpki/validator3/rc/generic/rpki-validator-latest-dist.tar.gz
$ tar zxf rpki-validator-latest-dist.tar.gz
$ ./rpki-validator-3.0-x/rpki-validator-3.sh
$ open http://localhost:8080

$ wget https://ftp.ripe.net/tools/rpki/validator3/rc/generic/rpki-rtr-server-latest-dist.tar.gz
$ tar zxf rpki-rtr-server-latest-dist.tar.gz
$ ./rpki-rtr-server/rpki-rtr-server-3.sh
```

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Validator Software - Routinator

- Routinator by NLnet Labs
  - https://github.com/NLnetLabs/routinator
- First impressions: low overheard, installation simplicity, stable, "just works"
- Requirement to download ARIN TAL separately

```
$ curl https://sh.rustup.rs -sSf | sh
$ source ~/.cargo/env
$ cargo install routinator
$ routinator rtrd -al 127.0.0.1:3323
```

RPKI @ INEX

Validator Software - RPKI-RTR and Bird

```
roa4 table t_roa;

protocol rpki rpki1 {

    roa4 { table t_roa; };

    remote "192.0.2.67" port 3323;

    retry keep 90;
    refresh keep 900;
    expire keep 172800;
}
```

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Validator Software - RPKI-RTR and Bird

```
# RPKI check
rpki_result = roa_check( t_roa, net, bgp_path.last_nonaggregated );


if( rpki_result = ROA_INVALID ) then {
    ...
}


# or ROA_VALID / ROA_UNKNOWN
```

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Implementation Process at INEX

- INEX has two route servers and a route collector per LAN
- Upgrade route collector to Bird v2 + RPKI first
  - identify members who peer on the route server with RPKI invalid prefixes
  - found 4 members of ~80 with issues
    - 1 x more specific advertised than ROA allowed for
    - 1 x origin AS not matching ROA
    - 1 x member still advertising transferred space, new owners had ROAs
    - 1 x member created ROA for upstream peer-as rather than origin-as
  - members alerted to this on a "FYI basis" (i.e. non-blocking for INEX)
- Route server #1 completed Feb 7th
- Route server #2 completed Feb 14th

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Implementation Process at INEX

- Outside of the four members with issues, no other member issues
- No issues to date with Bird v2
- Some issues with RIPE NCC Validator (crashing, disk space)
- No issues with Routinator 3000
- There's a lot in this:
  - Bird v2
  - 24 route collectors and route servers
  - Large community tagging and filtering
  - RPKI vs IRRDB
  - etc

IXP MANAGER INEX Member Information Peering Statistics Support

Looking Glass INEX Cork - Route Collector - IPv4

INEX Cork - Route Collector - IPv4

This is the public looking glass. Uncached results and additional routers available when logged in.

Bird v2 2.0.3 | API: 1.2.0 | Router ID: 185.1.69.126 | Uptime: 11 days. | Last Reconfigure: 2019-02-16 15:12:02 | JSON: [status] [bgp]

Search:

Neighbor	Description	ASN	Table	PfxLimit	State/PfxRcd	PfxExp	Actions
185.1.69.6	AS112 - AS112 Reverse DNS	112	master4		2	0	Details
185.1.69.24	AS714 - Apple Distribution International	714	master4		596	0	Details
185.1.69.26	AS714 - Apple Distribution International	714	master4		597	0	Details
185.1.69.11	AS1213 - HEAnet	1213	master4		23	0	Details
185.1.69.12	AS5466 - Eir	5466	master4		77	0	Details
185.1.69.17	AS15405 - East Cork Broadband	15405	master4		5	0	Details
185.1.69.14	AS16171 - Strencom	16171	master4		4	0	Details
185.1.69.16	AS20940 - Akamai Technologies	20940	master4		1	0	Details
185.1.69.23	AS25152 - RIPE NCC k-root server	25152	master4		1	0	Details
185.1.69.10	AS31122 - Viatel	31122	master4		90	0	Details
185.1.69.19	AS41736 - Nova Telecom	41736	master4		3	0	Details
185.1.69.21	AS42090 - Rapid Broadband	42090	master4		6	0	Details

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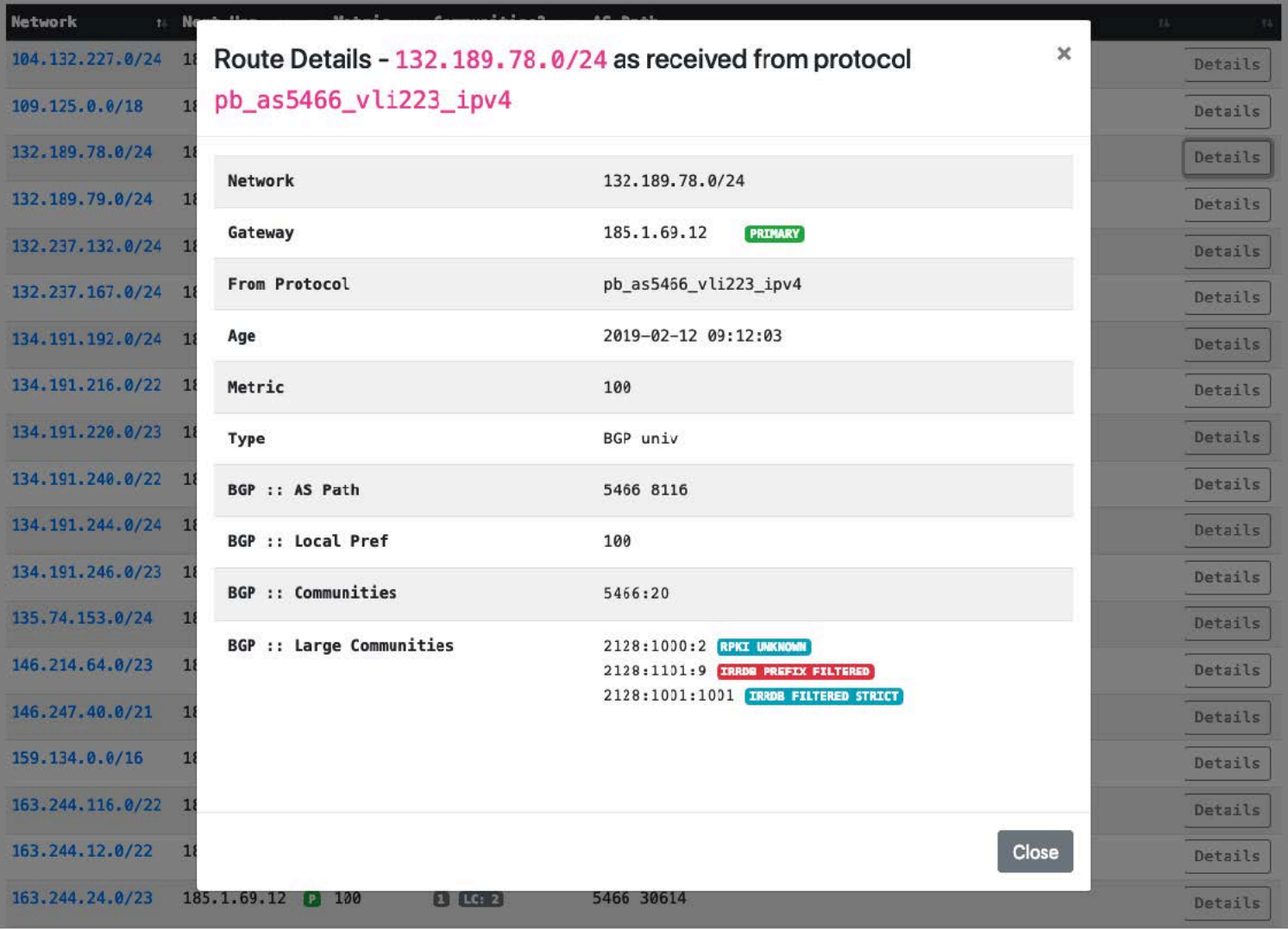
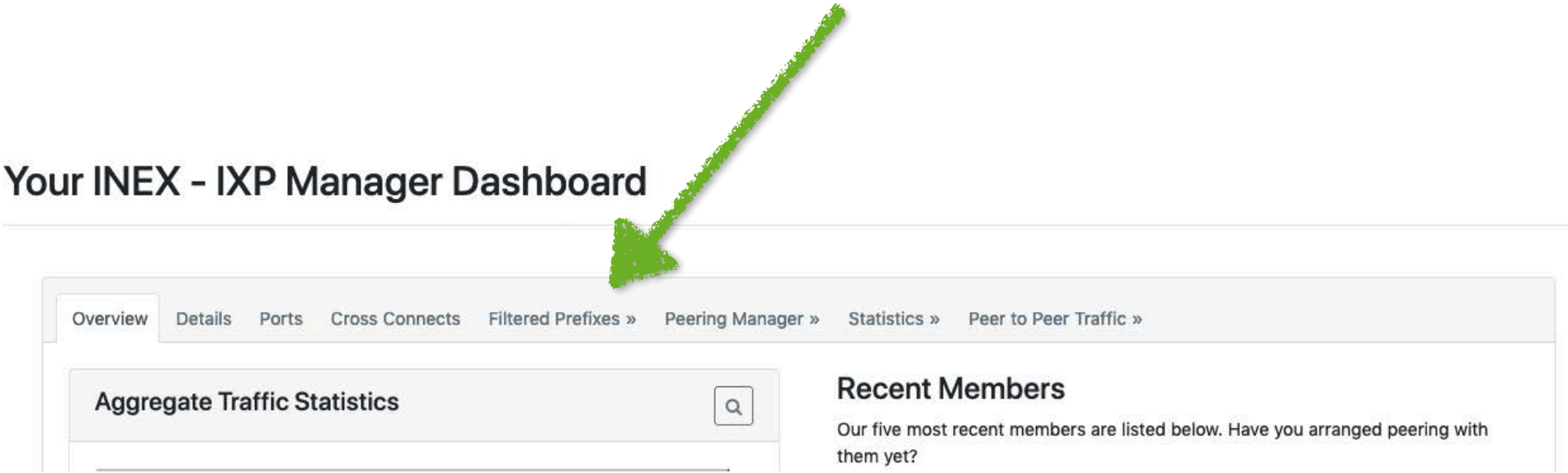
Network	Next Hop		Metric	Communities?	AS Path	
104.132.227.0/24	185.1.69.12	P	100	1 LC: 2	5466 41264	Details
109.125.0.0/18	185.1.69.12	P	100	1 LC: 2	5466 15751	Details
132.189.78.0/24	185.1.69.12	P	100	1 LC: 3 ⚠	5466 8116	Details
132.189.79.0/24	185.1.69.12	P	100	1 LC: 3 ⚠	5466 8116	Details
132.237.132.0/24	185.1.69.12	P	100	1 LC: 2	5466 30614	Details
132.237.167.0/24	185.1.69.12	P	100	1 LC: 2	5466 30614	Details
134.191.192.0/24	185.1.69.12	P	100	1 LC: 2	5466 4983	Details
134.191.216.0/22	185.1.69.12	P	100	1 LC: 2	5466 4983 4983 4983 4983 4983 4983 4983 4983 4983	Details
134.191.220.0/23	185.1.69.12	P	100	1 LC: 2	5466 4983 4983 4983 4983 4983 4983 4983 4983 4983	Details
134.191.240.0/22	185.1.69.12	P	100	1 LC: 3 ⚠	5466 4983	Details
134.191.244.0/24	185.1.69.12	P	100	1 LC: 3 ⚠	5466 4983	Details
134.191.246.0/23	185.1.69.12	P	100	1 LC: 2	5466 4983	Details
135.74.153.0/24	185.1.69.12	P	100	1 LC: 3 ⚠	5466 18676	Details
146.214.64.0/23	185.1.69.12	P	100	1 LC: 3 ⚠	5466 42213	Details


Network
104.132.227.0/24
109.125.0.0/18
132.189.78.0/24
132.189.79.0/24
132.237.132.0/24
132.237.167.0/24
134.191.192.0/24
134.191.216.0/22
134.191.220.0/23
134.191.240.0/22
134.191.244.0/24
134.191.246.0/23
135.74.153.0/24
146.214.64.0/23
146.247.40.0/21
159.134.0.0/16
163.244.116.0/22
163.244.12.0/22
163.244.24.0/23
185.1.69.12 P 100 1 LC: 2 5466 30614
Details
Route Details - 132.189.78.0/24 as received from protocol pb_as5466_vli223_ipv4
Network 132.189.78.0/24
Gateway 185.1.69.12 PRIMARY
From Protocol pb_as5466_vli223_ipv4
Age 2019-02-12 09:12:03
Metric 100
Type BGP univ
BGP :: AS Path 5466 8116
BGP :: Local Pref 100
BGP :: Communities 5466:20
BGP :: Large Communities 2128:1000:2 RPKI UNKNOWN
2128:1101:9 IRRDB PREFIX FILTERED
2128:1001:1001 IRRDB FILTERED STRICT
Close

RPKI @ INEX

New *Route Server Filtered Prefixes* Tool



Route Server Filtered Prefixes

Bad news! We found 9 prefix(es) that are currently being filtered.

These are listed below with the reason for the filtering and the route server where filtering has been applied.

Prefix	Filtered Because	Filtered On Router(s)
87.232.5.0/24	IRRDB PREFIX FILTERED	rs1-lan1-ipv4 rs2-lan1-ipv4
87.232.128.0/21	RPKI INVALID	rs1-lan1-ipv4 rs2-lan1-ipv4
87.232.64.0/18	NEXT HOP NOT PEER IP	rs1-lan1-ipv4 rs2-lan1-ipv4
87.232.32.0/19	RPKI INVALID	rs1-lan1-ipv4 rs2-lan1-ipv4
91.197.36.0/22	TRANSIT FREE ASN	rs1-lan1-ipv4 rs2-lan1-ipv4

THANK YOU

Any Questions?