Routing Security Roadmap

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Why are we doing any of this?

• Creating filters based on public data, forces malicious actors to leave a trail in IRR, WHOIS or other data sources: **auditability**

• **Bugs happen!** – your router may suddenly ignore parts of your configuration, you’ll then rely on your EBGP peer’s filters

• **Everyone makes mistakes** – a typo is easily made
Average view on routing security
Perception: it is hopeless, too many holes..
But really, there is a only a finite amount of hurdles...
Exhaustive list of issues in the current ecosystem

• IRRdb / database inaccuracy (stale, autopiloted, non-validated)
• IXPs not filtering
• Lack of Path Validation
• Lack of sufficient and good enough software
IRR – what is broken what can be fixed?

• Some IRRdbs do not perform validation
  • Meaning that virtually anyone can create virtually any route/route6 object and sneak those into the prefix-filters

• Eleven relevant IRRs not validating: RIPE, NTTCOM, RADB, ALTDB, ARIN IRR, BBOI, BELL, LEVEL3, RGNET, TC, CANARIE

• Two solutions:
  • Lock the database down (RIPE / RIPE-NONAUTH)
  • Filter on the mirror level
RIPE NWI-5 proposal & implementation

- RIPE NCC’s IRR previously allowed anyone to register any non-RIPE-managed space if it had not yet been registered. *DANGER*
- The “RPSL” password & maintainer was used for this

Three steps were taken:
- Cannot register non-RIPE-managed space any more
- All non-RIPE space moved to separate “RIPE-NONAUTH” database
- Route/route6 ASN authorization rules have been improved

More info: https://www.ripe.net/manage-ips-and-asns/db/impact-analysis-for-nwi-5-implementation
OK – so current status

• Ten relevant IRRs not validating: NTTCOM, RADB, ALTDB, ARIN IRR, BBOI, BELL, LEVEL3, RGNET, TC, CANARIE

• Done: RIPE
ARIN IRR allows anyone to register anything

```
hanna:~ job$ whois -h rr.arin.net 2001:67c:208c::
% This is the ARIN Routing Registry.
% Note: this output has been filtered.
%       To receive output for a database update, use the "-B" flag.

% Information related to '2001:67c:208c::/48AS15562'

route6:         2001:67c:208c::/48
descr:          2001:67c:208c::/48 - Job's net
remarks:        Job asked me to steal his net. Honest!
origin:         AS15562
mnt-by:         MNT-ATTW-Z
source:         ARIN # Filtered
```
ARIN community also recognized this is an issue

- Consultation at NANOG and through ARIN-Consult mailing list
- https://teamarin.net/2018/07/12/the-path-forward/

“Improve, or kill it”
OK – so current status

• Nine relevant IRRs not validating: NTTCOM, RADB, ALTDB, BBOI, BELL, LEVEL3, RGNET, TC, CANARIE

• Done: RIPE, ARIN IRR

• How to deal with the remaining nine .... ?

• Not all of these are so easily communicated with, not all are really actively managed
Using RPKI to clean up the IRR
The “IRR” system access

• The IRR is access through predominantly two “gateways”
  • whois.radb.net (the bgpq3 and peval default)
  • rr.ntt.net

• All mirroring is essentially done with one software: IRRd

Solution: Let’s use the hegemonic duopoly for good!
Improving security at the "aggregator"?

Data sources
- RIPE IRR
- NTTCOM
- RADB
- APNIC
- ...

Aggregators
- whois.radb.net
- rr.ntt.net

Clients
- bgpq3
Proposal: Let RPKI “drown out” conflicting IRR

• RPKI can be used for *BGP Origin Validation* – but also for other things!

• A RPKI ROA is sort of a route-object
  - It has a “prefix”, “origin” and “source” (the root)
  - We can [use RPKI ROAs for provisioning BGP prefix-filters](Github)

• Extend IRRd so that when IRR information is in direct conflict with a RPKI ROA – the conflicting information is suppressed ([Github](Github))
RPSL filter at the aggregators

Data sources
- RIPE IRR
- NTTCOM
- RADB
- APNIC
- ...

Aggregators
- whois.radb.net
- rr.ntt.net

Clients
- bgpq3
How are IRR and RPKI different?

• IRR route/route6 objects are statements:
  • About what Prefix/Origin ASN combinations can exist
  • Not necessarily made by the owner of the resource
  • Doesn’t tell us anything about the validity of other route objects, or other non-matching BGP announcements
  • Unsuitable for filtering your upstream, OK-ish for peers and downstreams
  • Not exclusive

• RPKI on the other hand:
  • Objects are only created by resource holders
  • RFC 6811 is game changer – RPKI based BGP Origin Validation allows for non-authorized BGP announcements to be rejected
  • Exclusive
RPKI suppressing conflicting IRR advantages

• Industry-wide common method to get rid of stale proxy route objects – by creating a ROA you hide old garbage in IRRs

• By creating a ROA – you will significantly decrease the chances of people being able to use IRR to hijack your resource
OK – so current status

• IRRs not validating: no longer relevant

• Done: RIPE, ARIN IRR, NTTCOM, RADB, ALTDB, BBOI, BELL, LEVEL3, RGNET, TC, CANARIE

NTT & Dashcare have started a full rewrite of IRRd to make this possible: https://github.com/irrdnet/irrd4
“Filtering at IXPs is hard”

- Many IXPs have come to realize their responsibilities to the Internet ecosystem and the commercial benefits of a more secure product.
- [http://peering.exposed/](http://peering.exposed/)
  - 9 out of top 10 IXPs are filtering, tenth will later this year. [IX.br](https://www.ixpmanager.org/) making good progress
- IXP filtering has become much easier, there are multiple fully featured configuration generators:
  - [https://www.ixpmanager.org/](https://www.ixpmanager.org/) version 5 has RPKI support!
  - [http://arouteserver.readthedocs.io/](http://arouteserver.readthedocs.io/)
Not everyone needs to do RPKI

• Because of the centralization of the web, if a select few companies deploy RPKI Origin Validation – millions of people benefit

• (google, cloudflare, amazon, pch/quad9, facebook, akamai, fastly, liberty global, comcast, etc...)

• I think only 20 companies or so need to do Origin Validation for there to be big benefits...

• https://dyn.com/blog/bgp-dns-hijacks-target-payment-systems/
Issue: “RPKI Origin Validation is useless without Path Validation aka BGPSEC...”
The internet keeps connecting directly

**Average AS Path Length**

Source: https://labs.ripe.net/Members/mirjam/update-on-as-path-lengths-over-time
Hijack / misconfiguration scenario

Paths from AS 13335 perspective:

185.25.28.0/23 13335_XXX_15169
185.25.28.0/23 13335_YYY_15169
185.25.28.0/24 13335_ZZZ_15562 (wins)
Hijack / misconfiguration scenario – direct peering

Paths from AS 13335 perspective:

185.25.28.0/23 13335_15169

185.25.28.0/24 13335_15562 (wins)
Enter RPKI ROAs

Prefix: 185.25.28.0/23
Prefix description: Google
Country code: CH
Origin AS: 15169
Origin AS Name: GOOGLE - Google LLC, US
RPKI status: ROA validation successful
MaxLength: 23
First seen: 2016-01-08
Last seen: 2019-02-26
Seen by #peers: 40
Cloudflare applying “invalid == reject”

Paths from AS 13335 perspective:

185.25.28.0/23 13335_15169 (wins)
185.25.28.0/24 13335_15562 (rejected, wrong prefix length)
Cloudflare applying “invalid == reject”

Paths from AS 13335 perspective:

185.25.28.0/23 13335_15169 (wins)
185.25.28.0/23 13335_15562 (rejected, wrong Origin ASN)
Change of tactics: spoof origin – NOT EFFECTIVE!

Cloudflare applying “invalid == reject”

Paths from AS 13335 perspective:

185.25.28.0/23 13335_15169 (wins)
185.25.28.0/23 13335_15562_15169 (not shortest AS_PATH)
“There is no healthy software ecosystem”

• RIPE NCC Validator v3 is works and actively maintained
• NLNetlabs is released a RPKI Cache Validator (Routinator 3000)
• Dragon Research RPKI Toolkit
• RPSTIR
• OpenBSD close to releasing a new RPKI validator implementation

• Almost all serious routing vendors have RPKI support (Cisco, Juniper, BIRD, Nokia, FRR – and more are on the way)

• Solution: more users results in better software, start using!
RPKI based traffic analysis with pmacct
Pmacct RPKI capabilities

• RFC 6811 Origin Validation procedure is applied
• Mark traffic based on ROA status, without deploying RPKI in your network
• This helps us understand the effects of dropping RPKI Invalid announcements
• Version 1.7.3 - https://github.com/pmacct/pmacct
Timeline

• All ISPs, create RPKI ROAs now - it’s easy!
• IXPs – start doing RPKI Origin Validation on your route servers now
• In 2019 RPKI data will be used to clean up IRR
• Hopefully the ARIN RPKI TAL situation will improve
Deployment update

- Cloudflare
- YYCIX

Good news! On Oct 7, the YYCIX route servers started filtering prefixes which are RPKI ROA invalid. We are among the leaders in performing this validation -- probably the first #IXP in North America!

As of today, 75% of the @cloudflare PoPs (116/155) have RPKI strict validation enabled on all peering sessions. That’s about 17,000 RPKI enabled peerings. Great work from @lpoinsig!
RPKI Deployment

• AT&T rejects invalids on peering sessions
• Nordunet rejects invalids on all EBGP sessions
• KPN / 286 rejects invalids on customer sessions
• Seacomm & Workonline will drop invalids per April 2019
• INEX
• AMS-IX
• DE-CIX
• France-IX
• Netnod (soon!)
Conclusion