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...





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
- Lack of operator experience

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-RIPEmanaged 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: <u>https://www.ripe.net/manage-ips-and-asns/db/impact-analysis-for-nwi-5-implementation</u>

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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.

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- % 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. Hone	st!
origin:	AS15562	
mnt-by:	MNT-ATTW-Z	
source:	ARIN # Filtered	

ARIN community recognized this is an issue

- Consultation at <u>NANOG</u> and through <u>ARIN-Consult</u> mailing list
- <u>https://www.arin.net/vault/resources/routing/2018_roadmap.html</u>
- <u>https://teamarin.net/2018/07/12/the-path-forward/</u>

"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

The "IRR" system access

- The IRR is access through predominantly two "gateways"
 - whois.radb.net (bgpq3 and peval default)
 - rr.ntt.net
- All mirroring is essentially done with one software: <u>IRRd</u>

Solution: Let's use the hegemonic duopoly for good!

Improving security at the "aggregator"?



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
- Extend IRRd so that when IRR information is in direct conflict with a RPKI ROA – the conflicting information is suppressed (<u>Github</u>)

RPKI filter at the aggregators



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: <u>https://github.com/irrdnet/irrd4</u>

"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.
- <u>http://peering.exposed/</u>
 - 9 out of top 10 IXPs are filtering, tenth will later this year
- IXP filtering has become much easier, there are multiple fully featured configuration generators:
 - <u>https://www.ixpmanager.org/</u>
 - <u>http://arouteserver.readthedocs.io/</u>
- BIRD's hegemony in the route server software is being challenged: OpenBGPD is funded to be able to compete

Many invalid RPKI routes in DFZ

- Ben / Niels talked a bit about this about 6,000 prefixes in DFZ are "invalid"
- Only subset of those become unreachable (because of valid or unknown less-specific)
- List: https://as286.net/data/ana-invalids.txt (grep for **NONE**)
- How to get that number down?
 - IXPs should take a leading role to support their members/customers
 - Route servers can start

Route servers must begin dropping RPKI Invalids

- Route servers by definition provide partial Internet tables
- No guarantees whatsoever that a given route will be available via RS
- When a route server drops a prefix, **worst case scenario is rerouting** not an outage.



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...
- <u>https://dyn.com/blog/bgp-dns-hijacks-target-payment-systems/</u>

"RPKI Origin Validation is useless without Path Validation aka BGPSEC"

- The lack of path validation can be resolved through two methods:
 - Densely peer with each other (Example: Google & Akamai have 126+ facilities in common with each other)
 - An AS_PATH blocking mechanisms like "peerlock"
- Both effectively are "path validation for 1 hop"
- \bullet Perhaps "1 hop" already is good enough $\textcircled{\odot}$

"There is no healthy software ecosystem"

- RIPE NCC Validator v3 is works and actively maintained
- NLNetlabs is writing a RPKI Cache Validator (Routinator 3000)
- A company I can't name is secretly writing one too
- 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!



Timeline

- IXPs start doing RPKI Origin Validation on your route servers now
- ISPs / CDNs
 - if you are pointing default somewhere, do it **now**
 - If your market is mostly West-Europe, do it now
 - If you are transit-free, wait a bit

We aren't done yet - Future work

- Use the RPKI to publish "peerlock" rules about who are authorized upstreams and who aren't
 - https://tools.ietf.org/html/draft-azimov-sidrops-aspa-verification
 - <u>https://tools.ietf.org/html/draft-azimov-sidrops-aspa-profile</u>
- Extend the RPKI to replace IRR AS-SETs (IRR / RPKI feature parity)
 - <u>https://tools.ietf.org/html/draft-ss-grow-rpki-as-cones</u>
- ARIN TAL issue needs addressing

Conclusion



