Who We Are

• We manage IP and ASN allocations in Europe, the Middle East and parts of Central Asia
  - Ensure unique holdership
  - Document holdership in the RIPE Database (whois)
  - Enable operators to document use of their address spaces
Routing Security is in Our DNA

- In 1994, RIPE-181 was the first document published that used a common language to describe routing policies
- We co-developed standards for IRR and RPKI
- We are one of the five RPKI Trust Anchors
- Our Validator tool was, until recently, the only production-grade tool to do Origin Validation
Routing on the Internet

"BGP protocol"

A: 
193.x.x.x

Routing table
194.x.x.x = B

B: 
194.x.x.x

Routing table
193.x.x.x = A

Can I trust B?

B: “I have 194.x.x.x”

A: “I have 193.x.x.x”

Is A correct?
How to Secure Routing?

“Internet Routing Registry”

RIPE Database
A = 193.x.x.x
B = 194.x.x.x

Can I trust B?

Is A correct?

A: “I have 193.x.x.x”
B: “I have 194.x.x.x”
Accidents Happen

• Fat Fingers
  - 2 and 3 are really close on our keyboards…

• Policy violations (leaks)
  - Oops, we did not want this to go to the public Internet
  - Infamous incident with Pakistan Telecom and YouTube
Or Worse…

- April 2018
  - BGP and DNS hijack
  - Targeting MyEtherWallet
  - Unnoticed for 2 hours
Incidents Are Common

- **2018 Routing Security Review**
  
  - 12.6k incidents
  - 4.4% of all ASNs affected
  - 3k ASNs victims of at least one incident
  - 1.3k ASNs caused at least one incident

source: [https://www.bgpstream.com/](https://www.bgpstream.com/)
Internet Routing Registry

• Many exist, most widely used
  - RIPE Database
  - RADB

• Verification of holdership over resources
  - RIPE Database for RIPE region resources only
  - RADB allows paying customers to create any object
  - Lots of other IRRs do not formally verify holdership
Accuracy - RIPE IRR
Accuracy - RADB IRR

Accuracy - Valid announcements / covered announcements
Resource Public Key Infrastructure

• RPKI
  - Ties IP addresses and ASNs to public keys
  - Follows the hierarchy of the registry

• Authorised statements from resource holders
  - ASN X is authorised to announce my IP Prefix Y
  - Signed, holder of Y
Resource Public Key Infrastructure

• Operated since 2008 by all RIRs
  - Community-driven standardisation (IETF)
  - IRR was not sufficient (incomplete, incorrect)

• Adds crypto-security to Internet Number Resources
Elements of RPKI

Signing

Create your ROAs

Validating

Verifying others
RPKI Chain of Trust

ALL Resources
- public key
- signature

LIR’s Resources
- public key
- signature

ROA
- signature
What’s in a ROA

Prefix

The network for which you are creating the ROA

Origin ASN

The ASN supposed to be originating the BGP Announcement

Max Length

The Maximum prefix length accepted for this ROA
Route Origin Validation

RIPE NCC  ARIN  APNIC  LACNIC  AFRINIC

Validator

Mirjam Kühne | September 2019 | BCIX
Route Origin Validation

BGP Announcements

<table>
<thead>
<tr>
<th>AS</th>
<th>Prefix</th>
</tr>
</thead>
<tbody>
<tr>
<td>111</td>
<td>10.0.7.30/22</td>
</tr>
<tr>
<td>222</td>
<td>10.0.6.10/24</td>
</tr>
<tr>
<td>333</td>
<td>10.4.17.5/20</td>
</tr>
<tr>
<td>111</td>
<td>10.0.7.30/22</td>
</tr>
<tr>
<td>111</td>
<td>10.0.7.30/22</td>
</tr>
<tr>
<td>111</td>
<td>10.0.7.30/22</td>
</tr>
</tbody>
</table>

BETTER ROUTING DECISIONS
Elements of RPKI

- **RIR REPOSITORIES**
  - ROAs
  - Validated Cache
  - RPKI-RTR
  - ROUTERS

**VALIDATOR SOFTWARE**

Verification
How to create a ROA

RPKI Dashboard

2 BGP Announcements
- 2 Valid
- 0 Invalid
- 0 Unknown

3 ROAs
- 3 Valid
- 0 Causing problems

BGP Announcements

<table>
<thead>
<tr>
<th>AS number</th>
<th>Prefix</th>
<th>Most specific length allowed</th>
<th>Affected announcements</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS21222</td>
<td>193.0.24.0/21</td>
<td>21</td>
<td>0</td>
</tr>
<tr>
<td>AS2121</td>
<td>2001:57c:64:48</td>
<td>48</td>
<td>1</td>
</tr>
<tr>
<td>AS2121</td>
<td>193.0.24.0/21</td>
<td>21</td>
<td>1</td>
</tr>
</tbody>
</table>

Show 25 of 3 items
Number of Certificates

RIPE NCC: 8948
APNIC: 2135
LACNIC: 1322
ARIN: 705
AFRINIC: 218
Coverage - RPKI (all RIRs)
Accuracy - RPKI (all RIRs)

IPv4 addresses in valid announcements / covered announcements
## RPKI in your region

<table>
<thead>
<tr>
<th>Country</th>
<th>% Addresses</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>DE</td>
<td>50%</td>
<td>99.9%</td>
</tr>
<tr>
<td>NL</td>
<td>72%</td>
<td>99.8%</td>
</tr>
<tr>
<td>FR</td>
<td>74%</td>
<td>100.0%</td>
</tr>
<tr>
<td>IT</td>
<td>8%</td>
<td>99.9%</td>
</tr>
<tr>
<td>BE</td>
<td>78%</td>
<td>99.9%</td>
</tr>
<tr>
<td>AL</td>
<td>52%</td>
<td>99.5%</td>
</tr>
<tr>
<td>CZ</td>
<td>46%</td>
<td>99.9%</td>
</tr>
<tr>
<td>HR</td>
<td>18%</td>
<td>100.0%</td>
</tr>
<tr>
<td>AT</td>
<td>18%</td>
<td>100.0%</td>
</tr>
<tr>
<td>SK</td>
<td>10%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Source: [https://lirportal.ripe.net/certification/content/static/statistics/world-roas.html](https://lirportal.ripe.net/certification/content/static/statistics/world-roas.html)
Recommendations to Get Started

- Create your ROAs in the LIR Portal
- Pay attention to the Max Length attribute
- Download and run a Validator
- Check validation status manually, which routes are invalid?
- Set up monitoring, for example pmacct
  - https://github.com/pmacct/
Invalid == Reject

- What breaks if you reject invalid BGP announcements?
  - “Not all vendors have full RPKI support, or bugs have been reported”
  - “Mostly nothing” - AT&T
  - “5 customer calls in 6 months, all resolved quickly” - Dutch medium ISP
  - “Customers appreciate a provider who takes security seriously” - Dutch medium ISP
  - “There are many invalids, but very little traffic is impacted” - Very large cloud provider
Making the Difference

- Is routing security on your agenda?
- Initiate the conversation with providers and colleagues

https://www.ripe.net/rpki

Are you leading by example?
Questions

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