



**RIPE NCC**

RIPE NETWORK COORDINATION CENTRE

# Developments in Routing Security

**Slides by Nathalie Trenaman**

# Who We Are



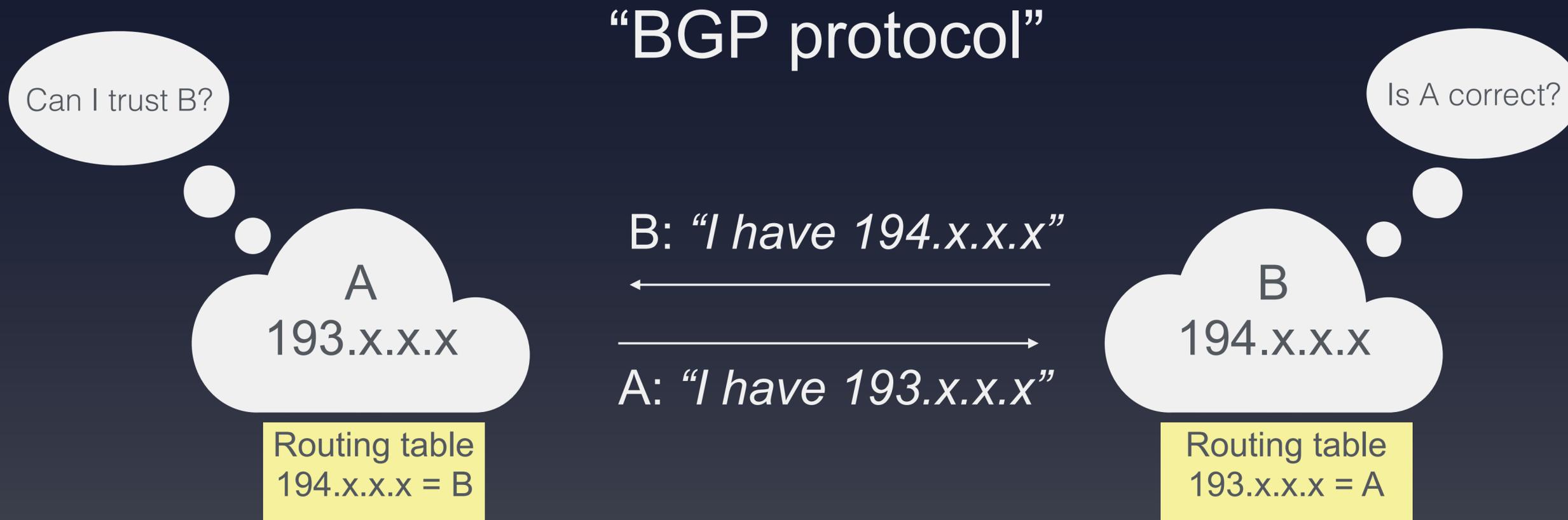
- We manage IP and ASN allocations in Europe, the Middle East and parts of Central Asia
  - Ensure unique holdership
  - Document holdership in the RIPE Database (whois)
  - Enable operators to document use of their address spaces

# 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

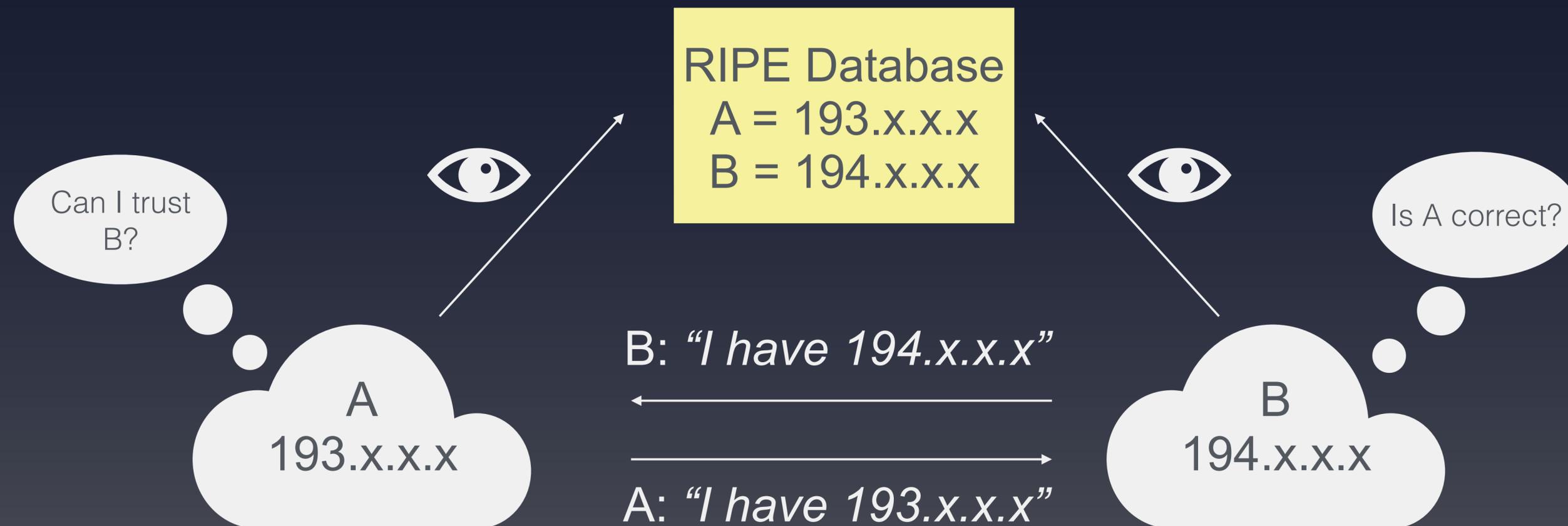
# Routing on the Internet



# How to Secure Routing?



## “Internet Routing Registry”



# 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
- <https://www.ripe.net/publications/news/industry-developments/youtube-hijacking-a-ripe-ncc-ris-case-study>

# 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

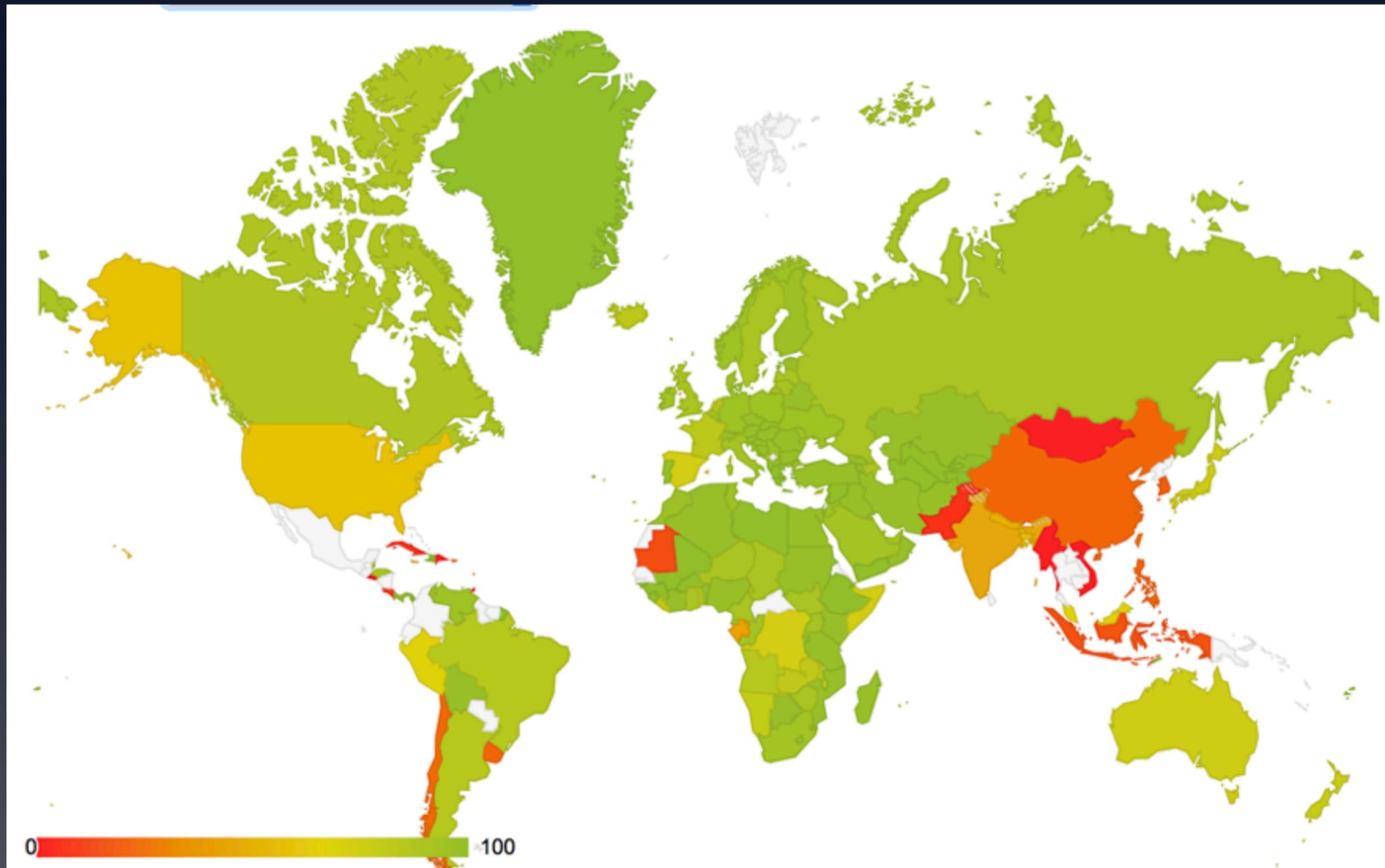
source: <https://www.bgpstream.com/>

# Internet Routing Registry



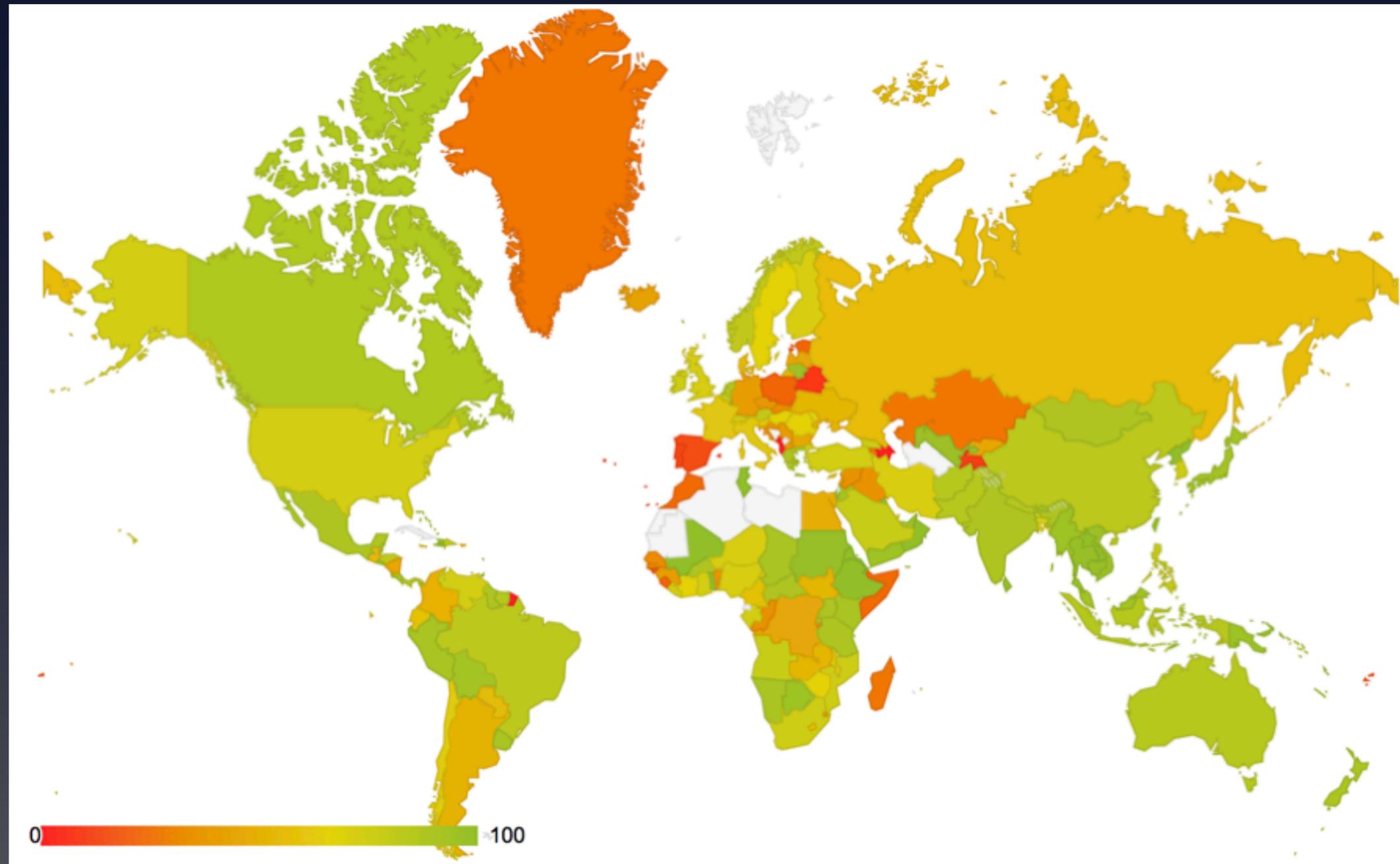
- Many exist, most widely used
  - RIPE Database
  - RADB
- Verification of holdership over resources
  - RIPE Database for RIPE region resources only
  - RADB allows paying customers to create any object
  - Lots of other IRRs do not formally verify holdership

# Accuracy - RIPE IRR



Accuracy - Valid announcements / covered announcements

# 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

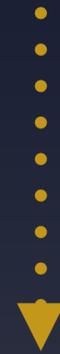


- Operated since 2008 by all RIRs
  - Community-driven standardisation (IETF)
  - IRR was not sufficient (incomplete, incorrect)
- Adds crypto-security to Internet Number Resources

# Elements of RPKI



**Signing**



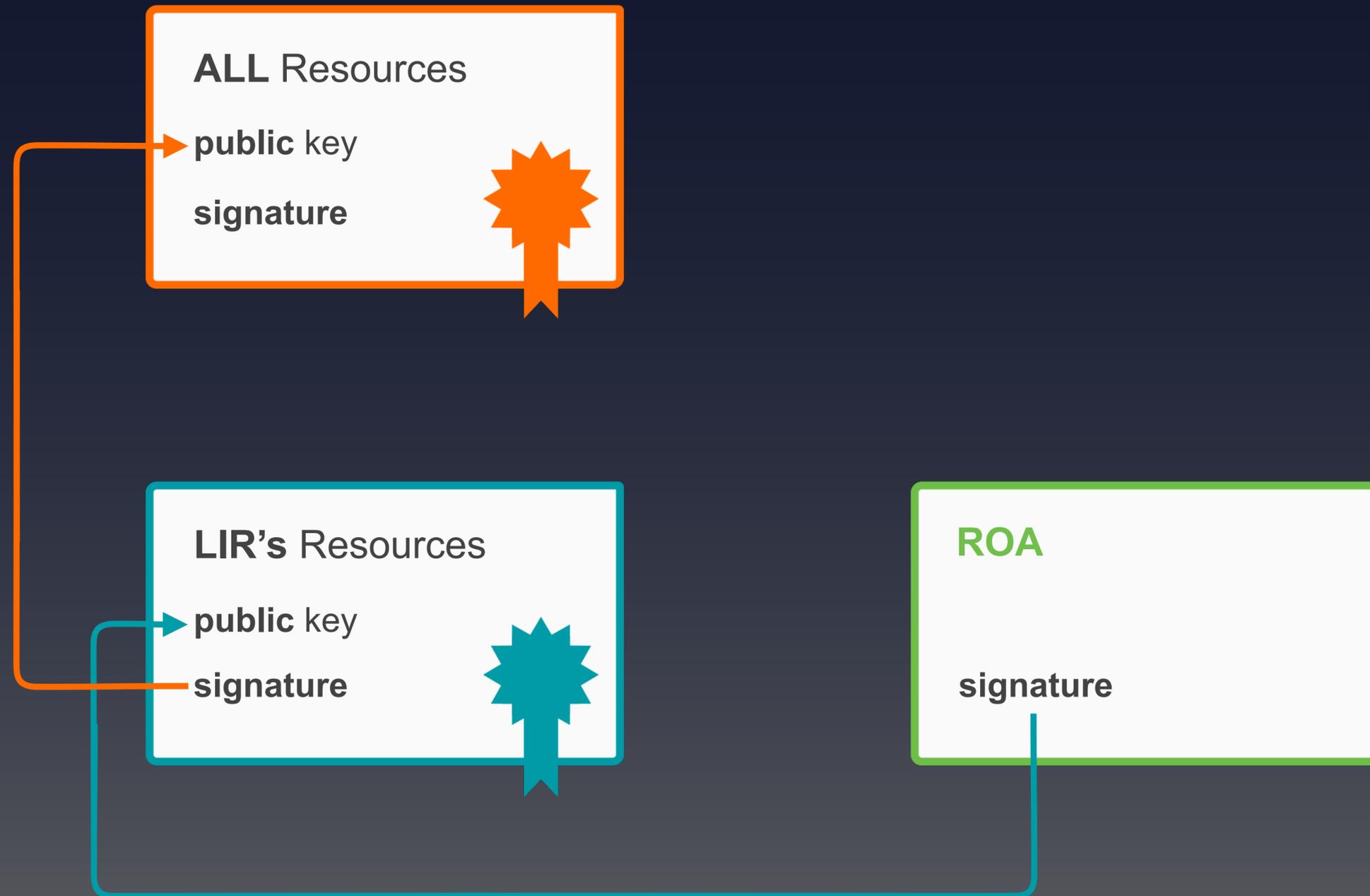
**Create your ROAs**

**Validating**

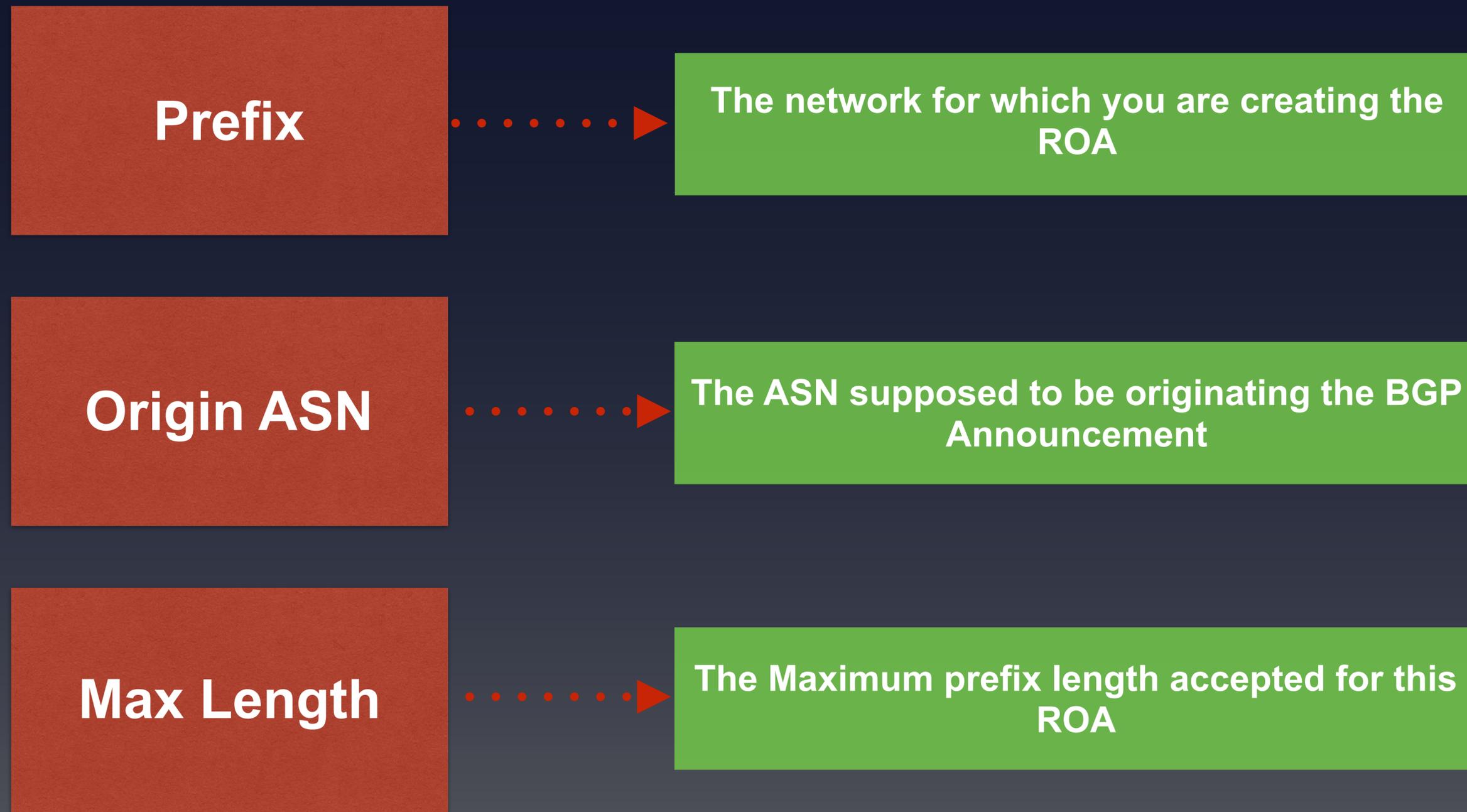


**Verifying others**

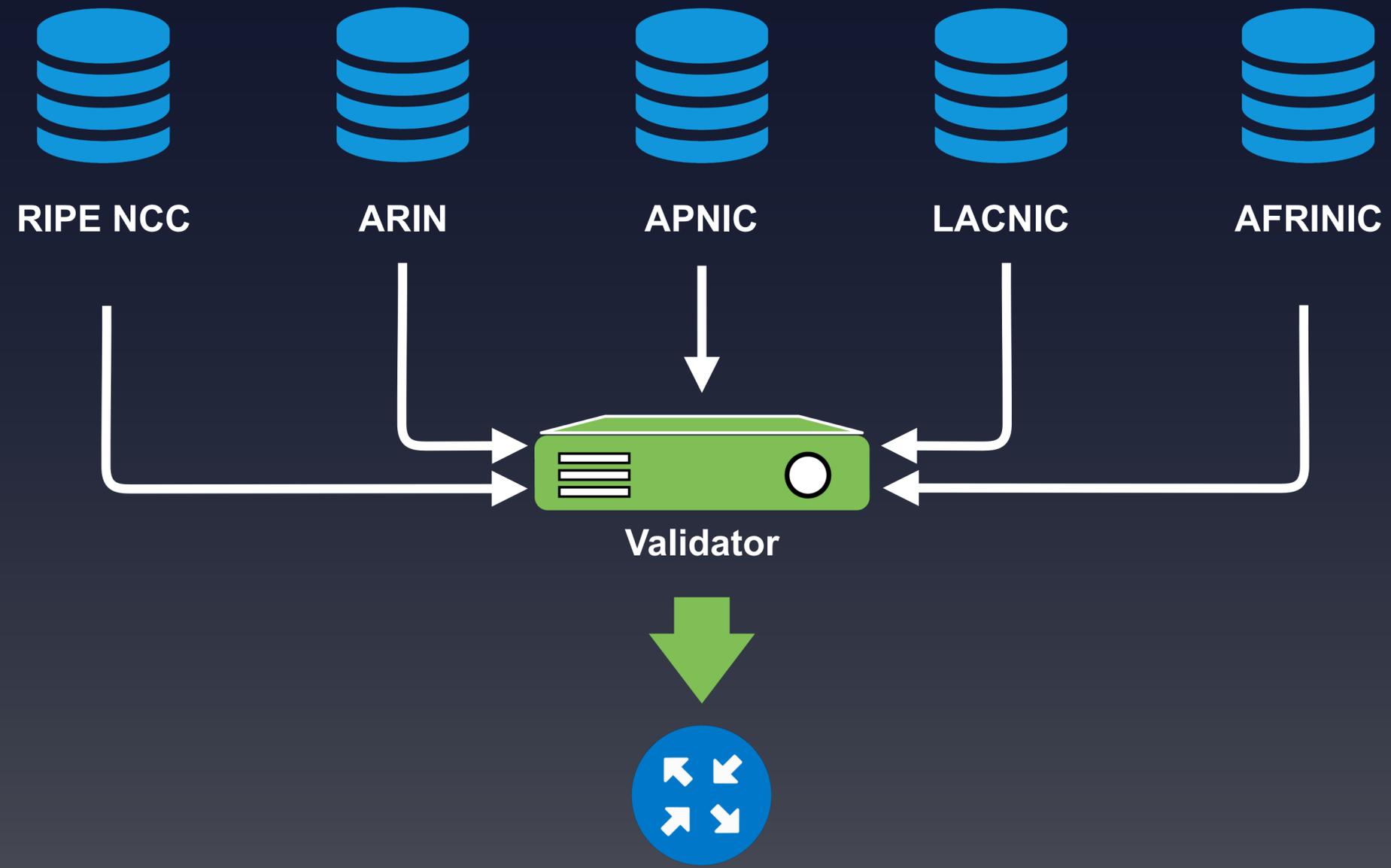
# RPKI Chain of Trust



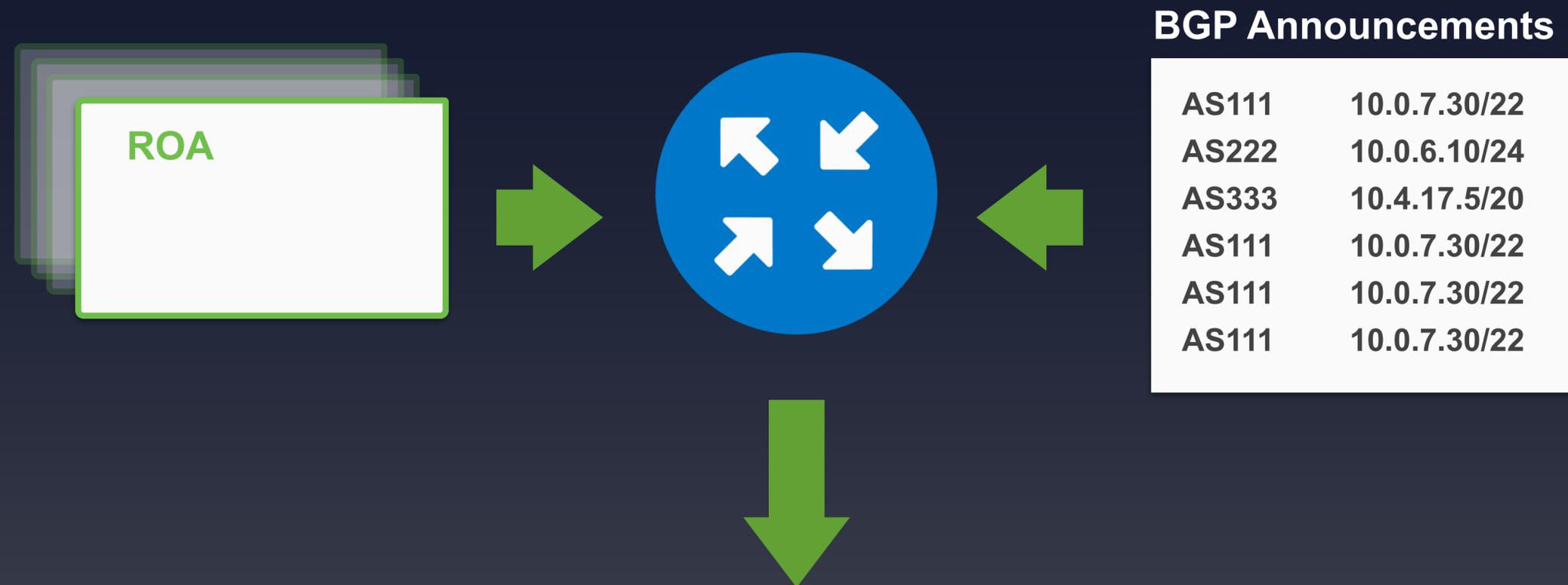
# What's in a ROA



# Route Origin Validation

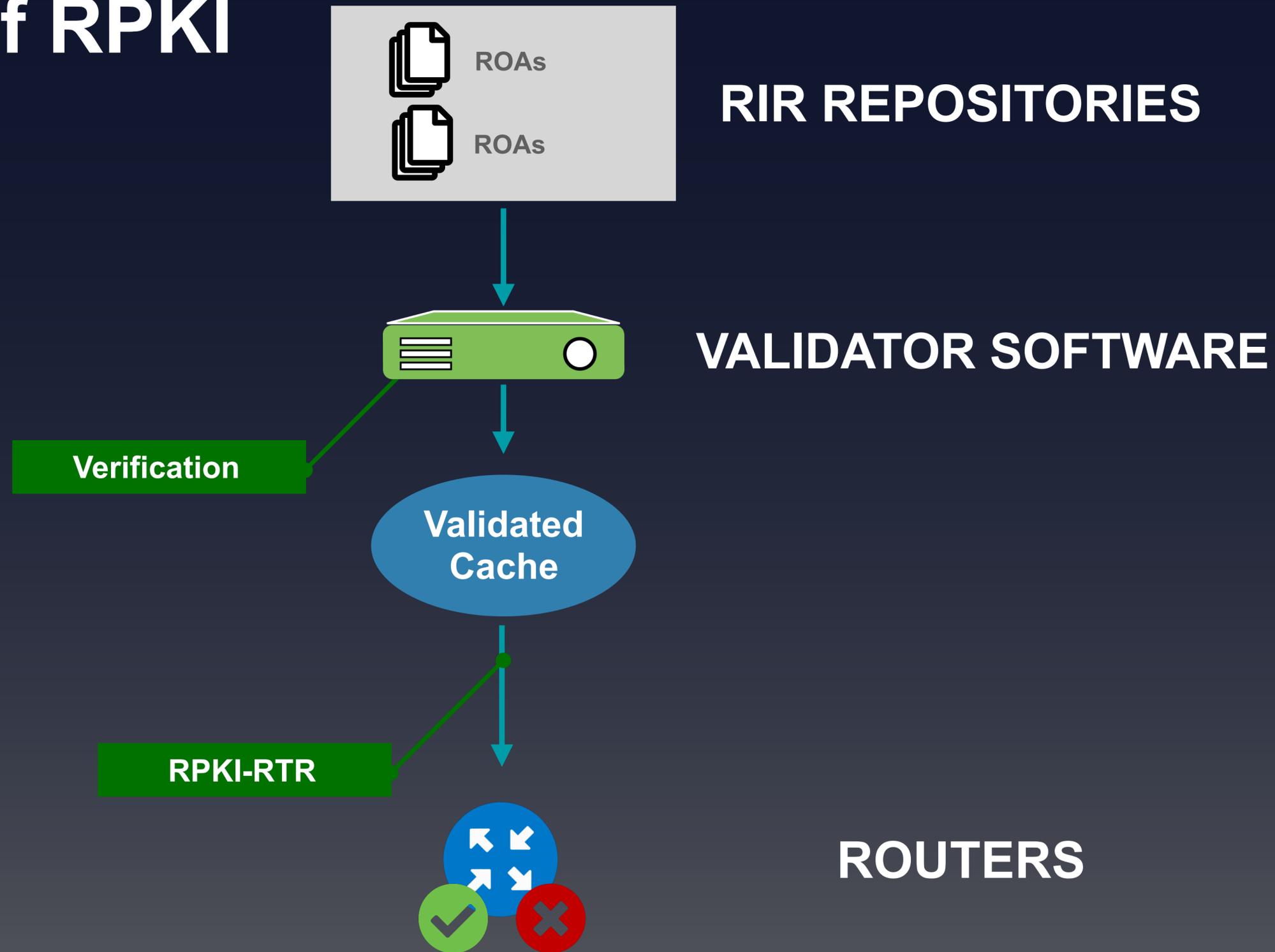


# Route Origin Validation



**BETTER ROUTING DECISIONS**

# Elements of RPKI



# How to create a ROA



Manage IPs and ASNs > Analyse > Participate > Get Support > Publications > About Us >

You are here: [Home](#) > [Manage IPs and ASNs](#) > LIR Portal

You are editing: [Reseaux IP Europeens Networ...](#)

My Account >

**Resources** ▾

- My Resources
- Sponsored Resources
- Request Resources
- Request Transfer
- IPv4 Transfer Listing Service
- [RPKI Dashboard](#)

RIPE Database >

## RPKI Dashboard

2 CERTIFIED RESOURCES    ALERTS ARE SENT TO 1 ADDRESS

**2 BGP Announcements**      **3 ROAs**

2 Valid    0 Invalid    0 Unknown      3 OK    0 Causing problems

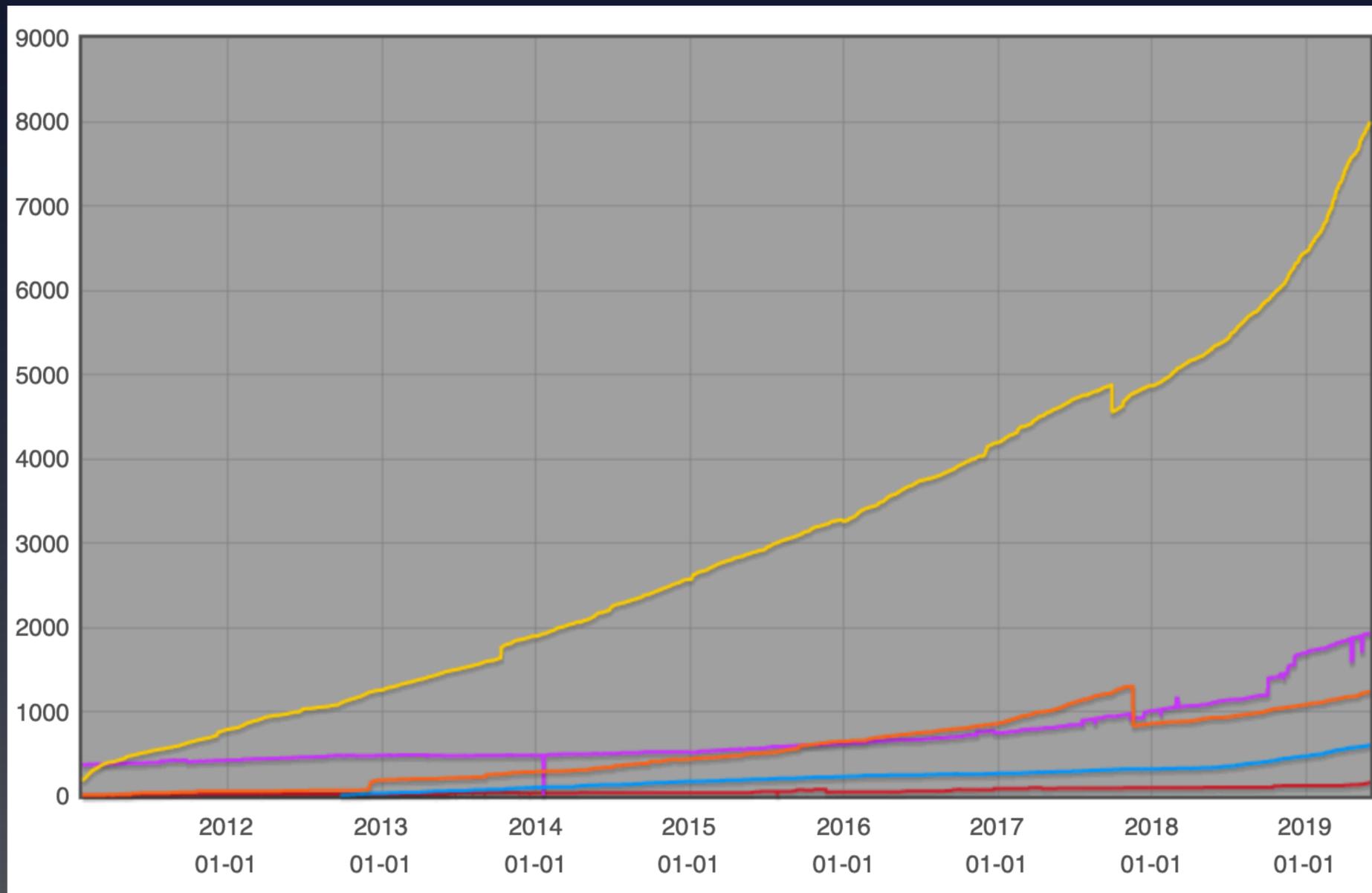
**BGP Announcements**    **Route Origin Authorisations (ROAs)**    **History**    Search...

Discard Changes    Delete ROAs    Causing Problems    Not Causing Problems    + New ROA

<input type="checkbox"/>	AS number	Prefix	Most specific length allowed	Affected announcements	
<input type="checkbox"/>	AS Number	Prefix	Max length		📄 ↺
<input type="checkbox"/>	AS21222	193.0.24.0/21	21	0	✎ 🗑
<input type="checkbox"/>	AS2121	2001:67c:64::/48	48	1	✎ 🗑
<input type="checkbox"/>	AS2121	193.0.24.0/21	21	1	✎ 🗑

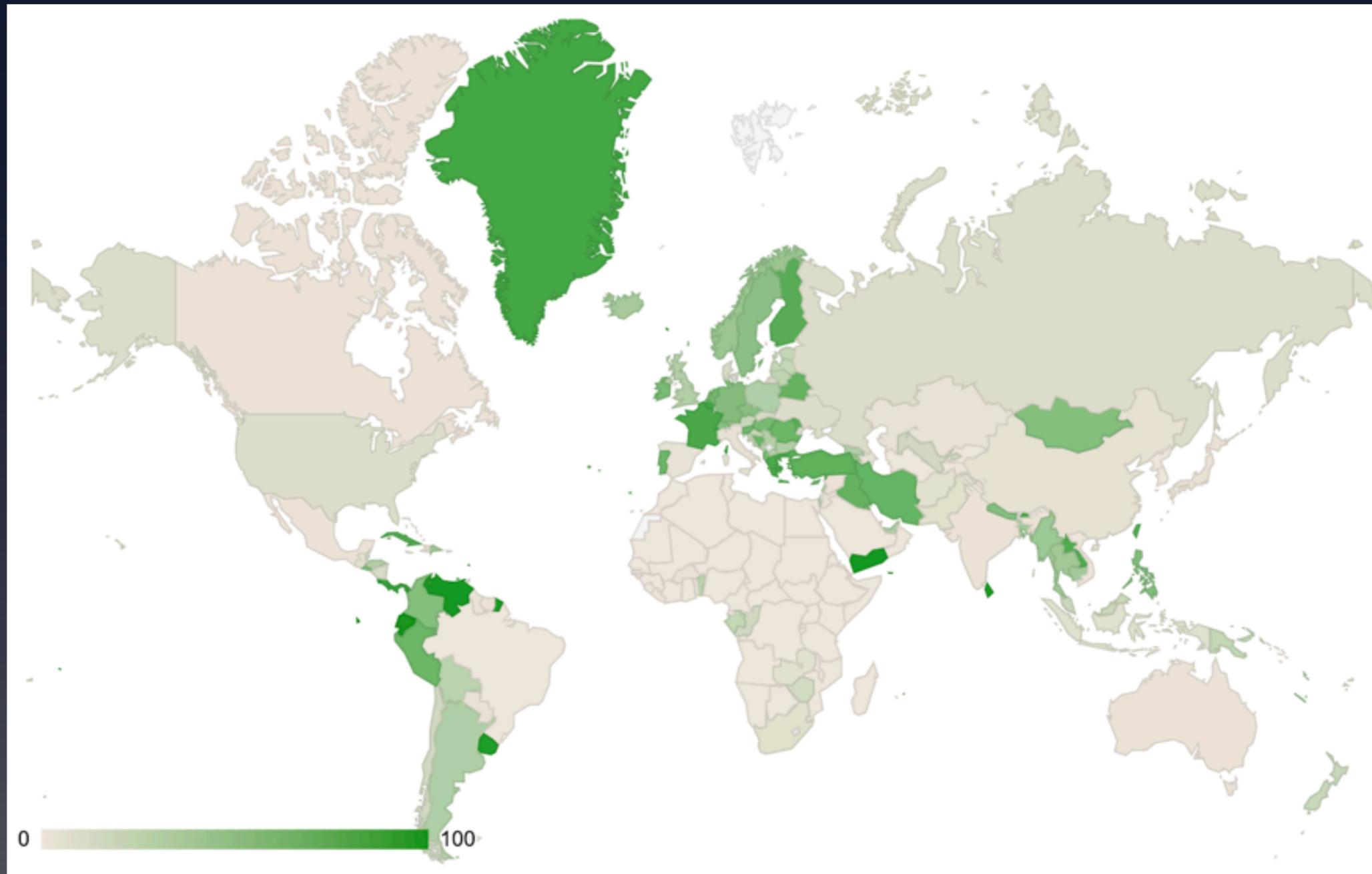
Show 25 of 3 items

# Number of Certificates

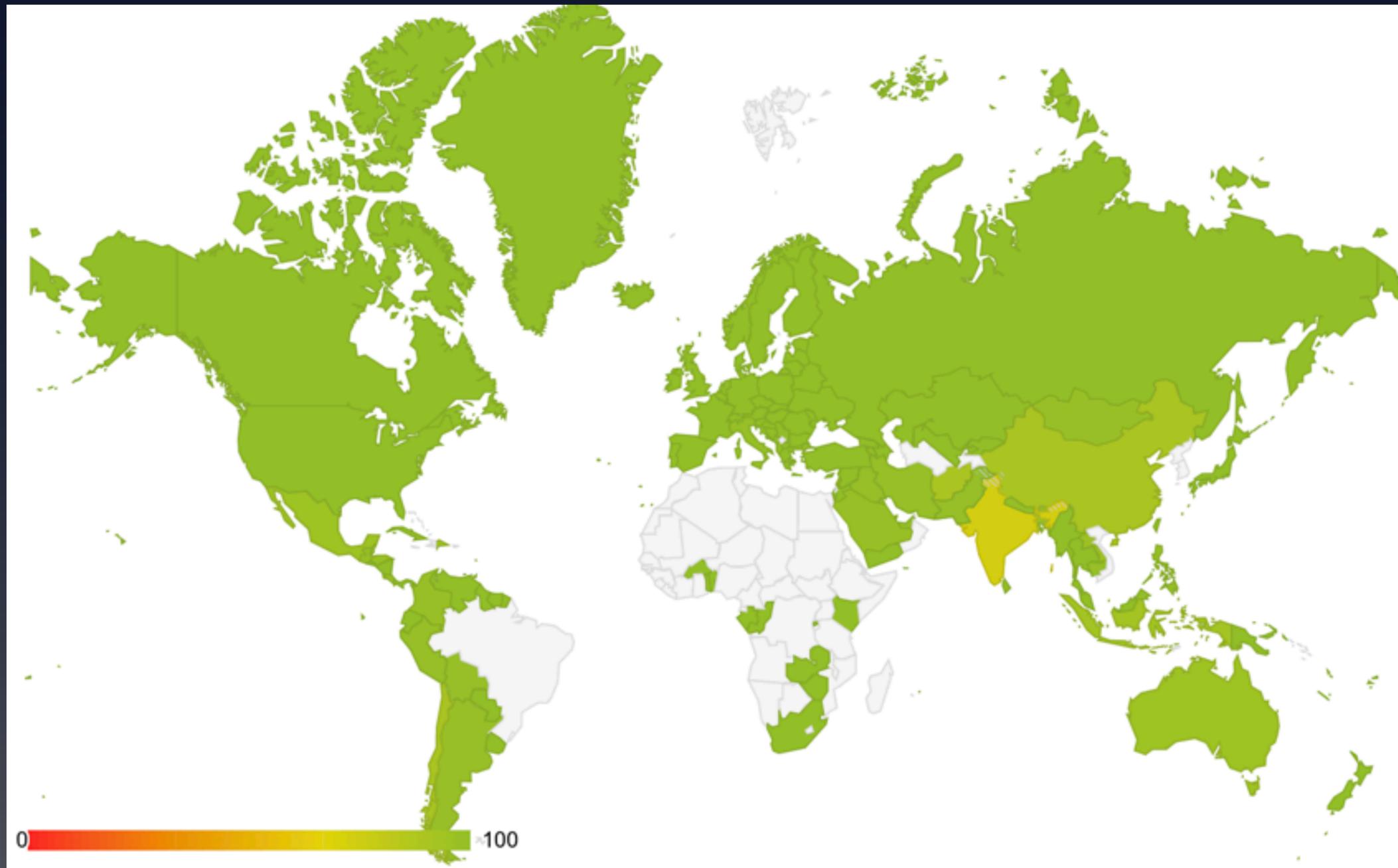


-  **RIPE NCC: 8948**
-  **APNIC: 2135**
-  **LACNIC: 1322**
-  **ARIN: 705**
-  **AFRINIC: 218**

# Coverage - RPKI (all RIRs)



# Accuracy - RPKI (all RIRs)



IPv4 addresses in valid announcements / covered announcements

# RPKI in your region



Country	% Addresses	Accuracy
<b>DE</b>	<b>50%</b>	<b>99,9%</b>
NL	72%	99,8%
FR	74%	100,0%
IT	8%	99,9%
BE	78%	99,9%
AL	52%	99,5%
CZ	46%	99,9%
HR	<b>18%</b>	<b>100,0%</b>
AT	18%	100,0%
SK	10%	100,0%

# 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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