



RIPE NCC

RIPE NETWORK COORDINATION CENTRE

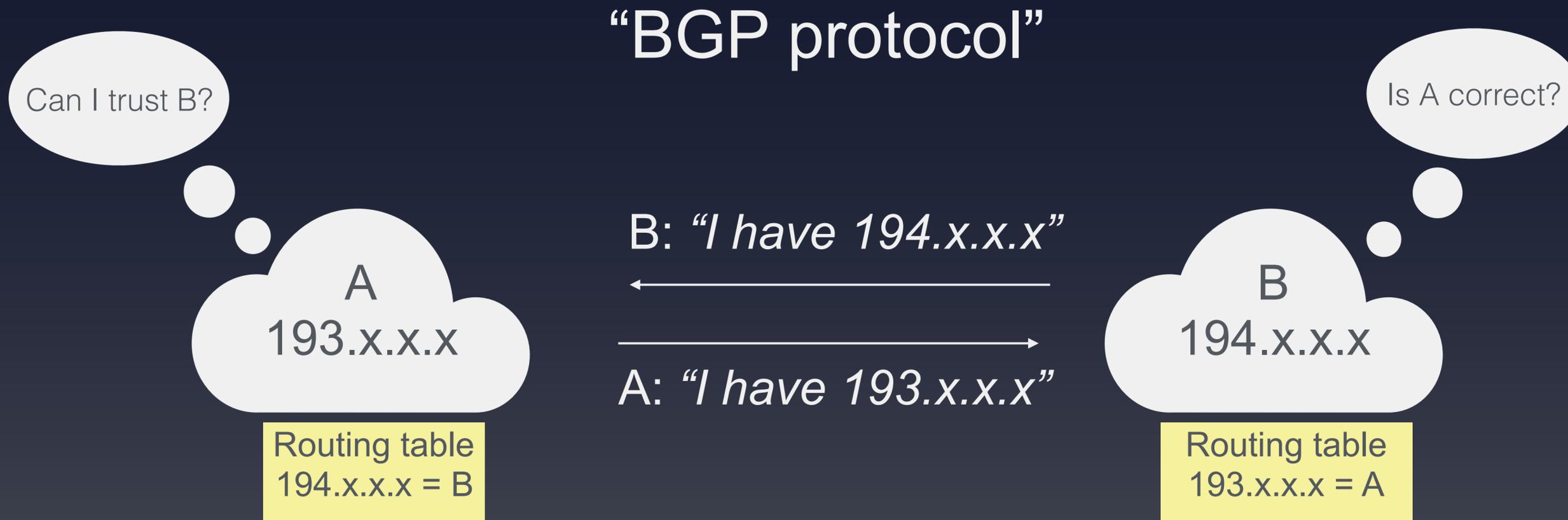
Developments in Routing Security

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

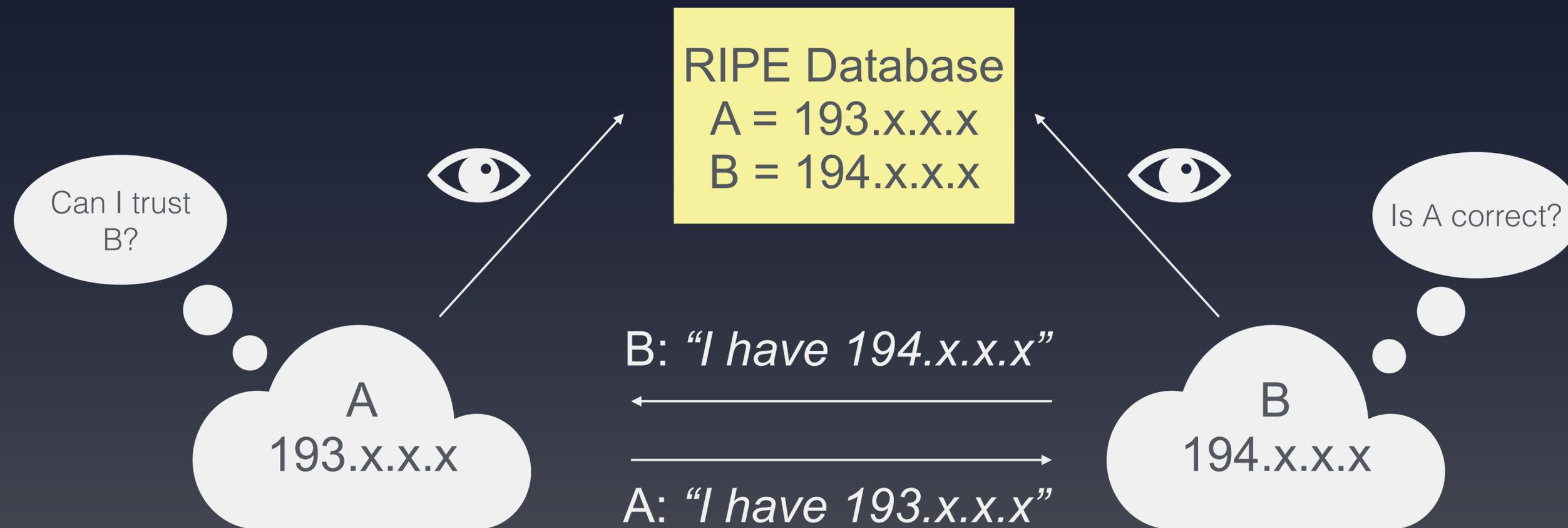
Routing on the Internet



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

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

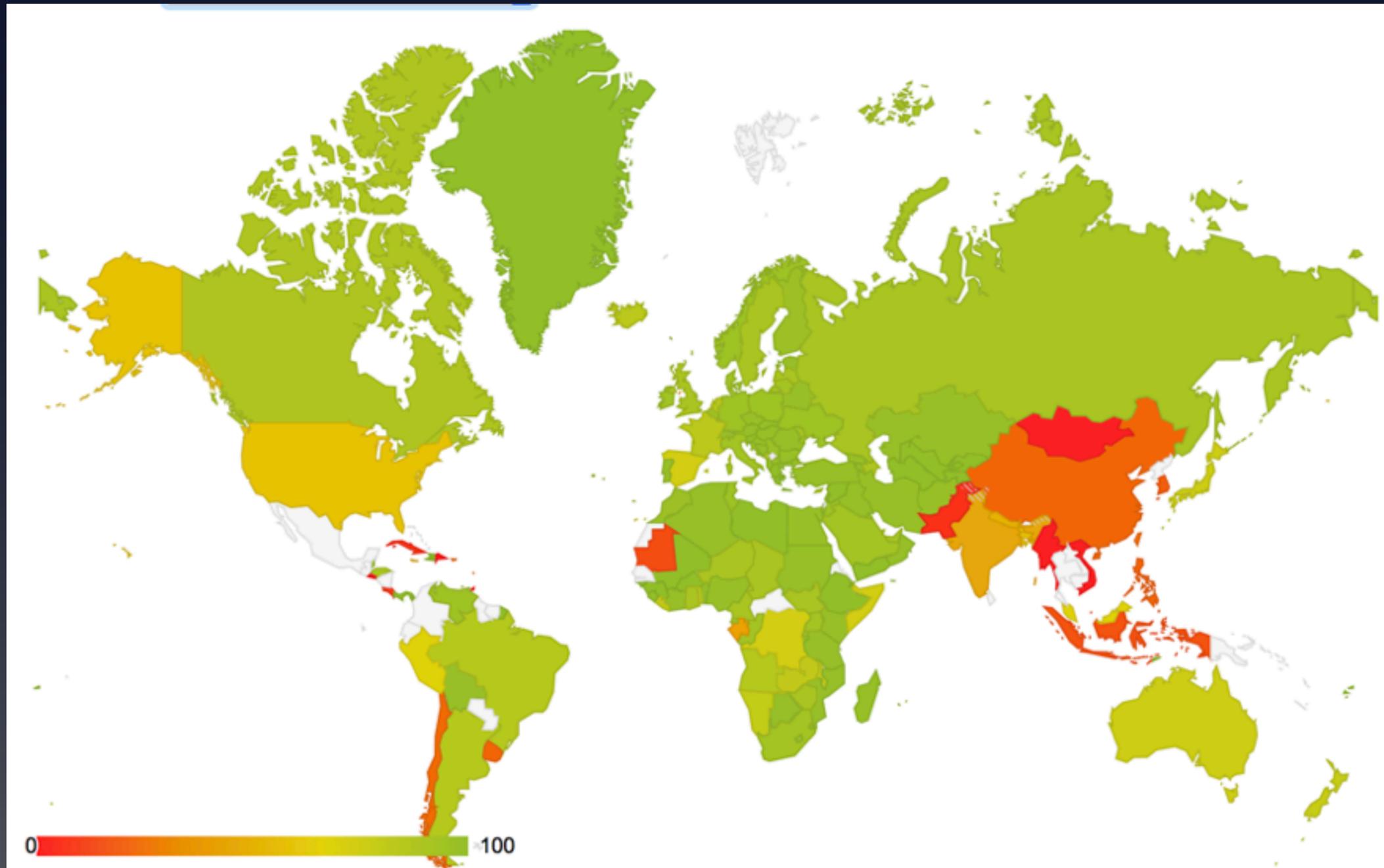
source: <https://www.bgpstream.com/>

Internet Routing Registry



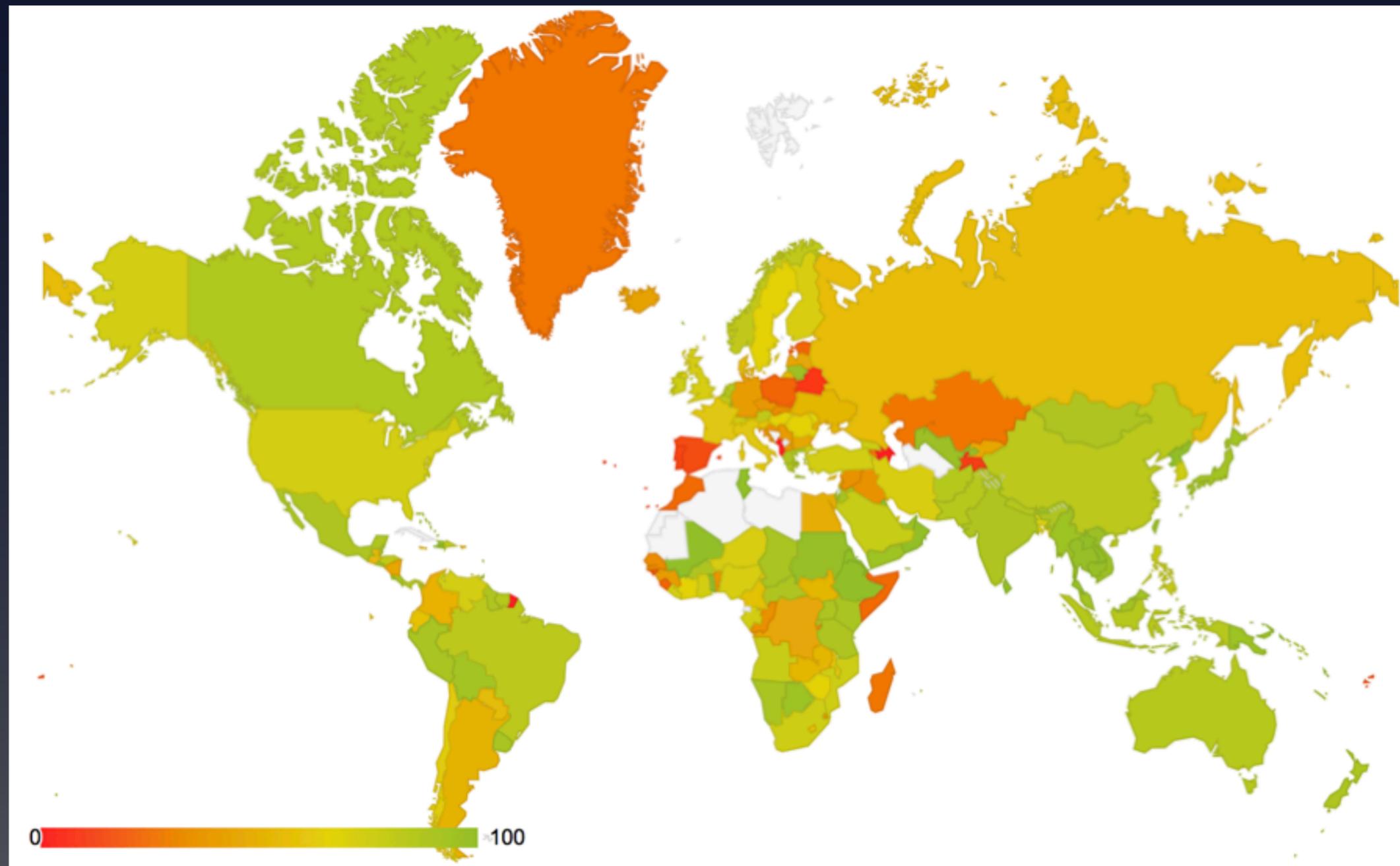
- Many exist, most widely used
 - RIPE Database
 - RADB
- Verification of holdership over resources
 - RIPE Database for RIPE region resources only
 - RADB allows paying customers to create any object
 - Lots of other IRRs do not formally verify holdership

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

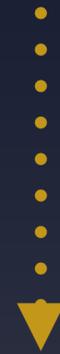


- Operated since 2008 by all RIRs
 - Community-driven standardisation (IETF)
 - IRR was not sufficient (incomplete, incorrect)
- Adds crypto-security to Internet Number Resources

Elements of RPKI



Signing



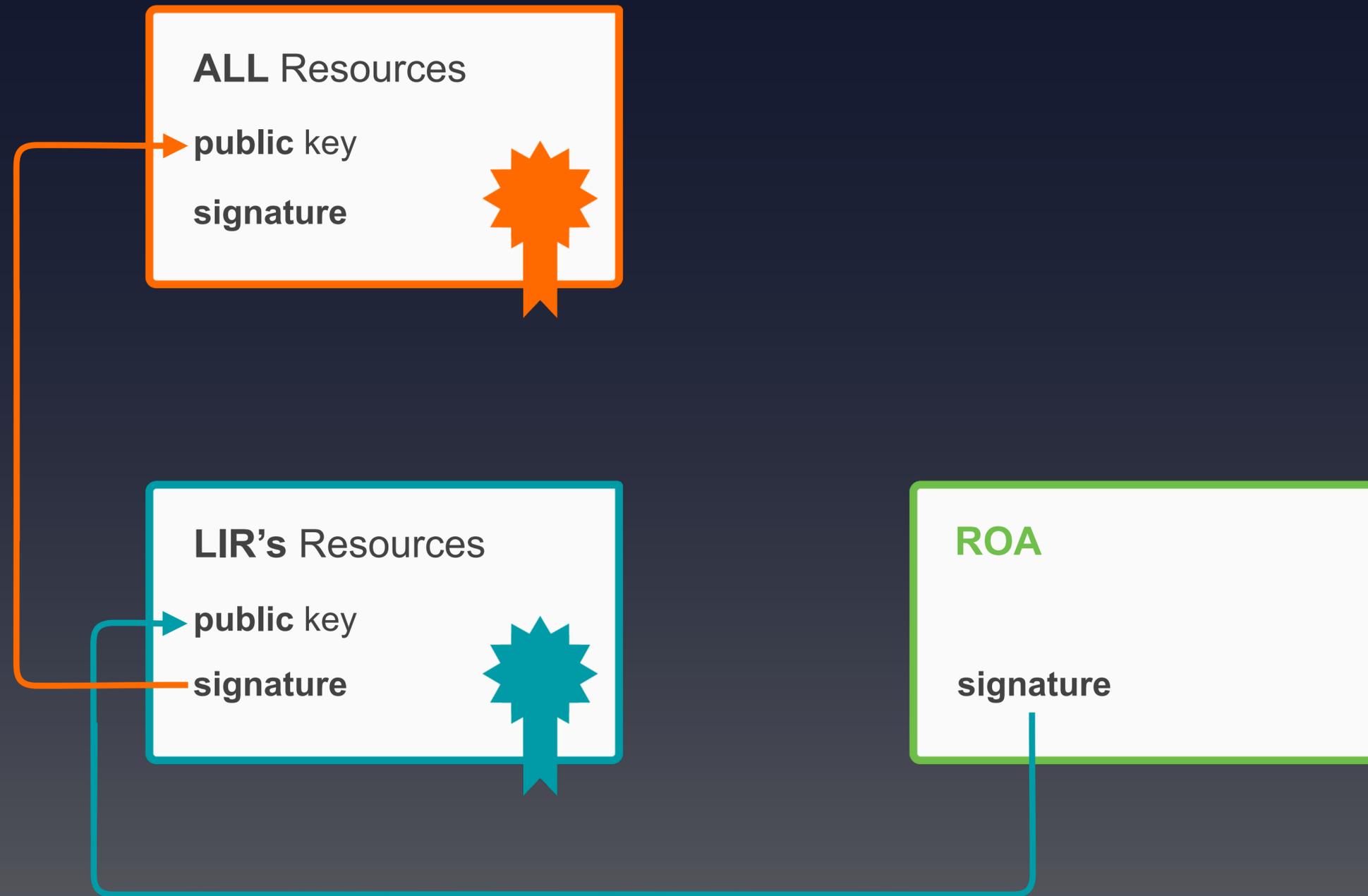
Create your ROAs

Validating

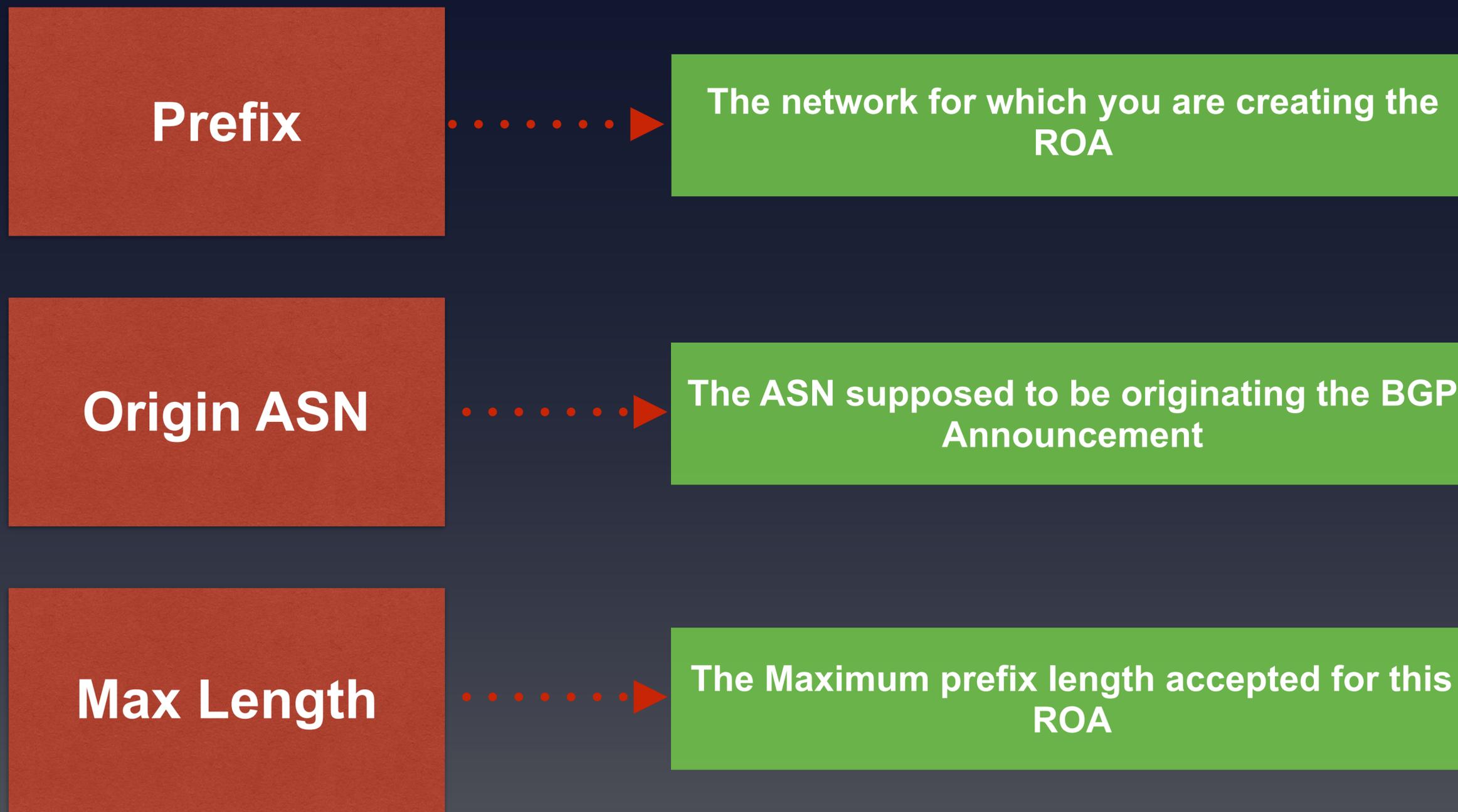


Verifying others

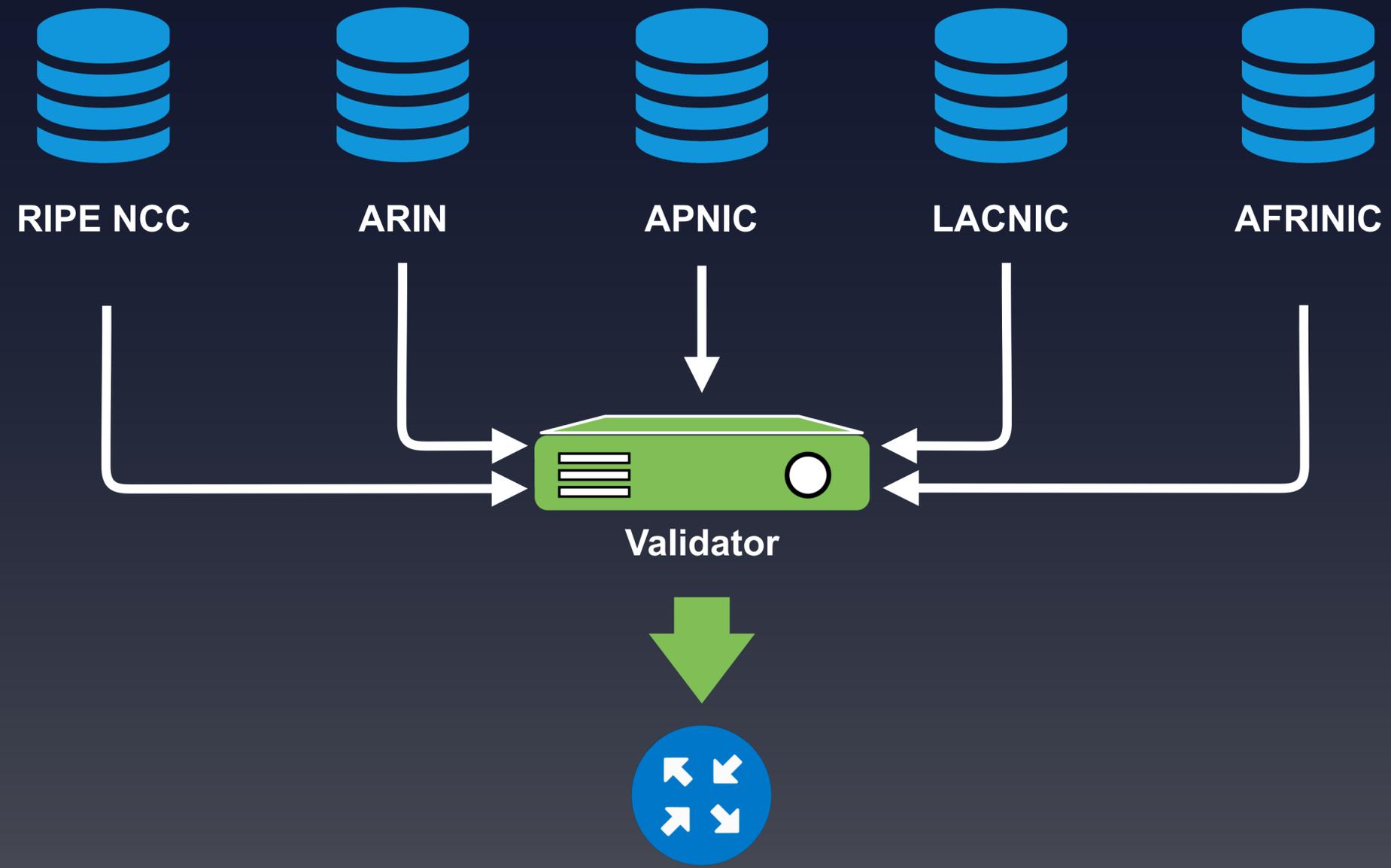
RPKI Chain of Trust



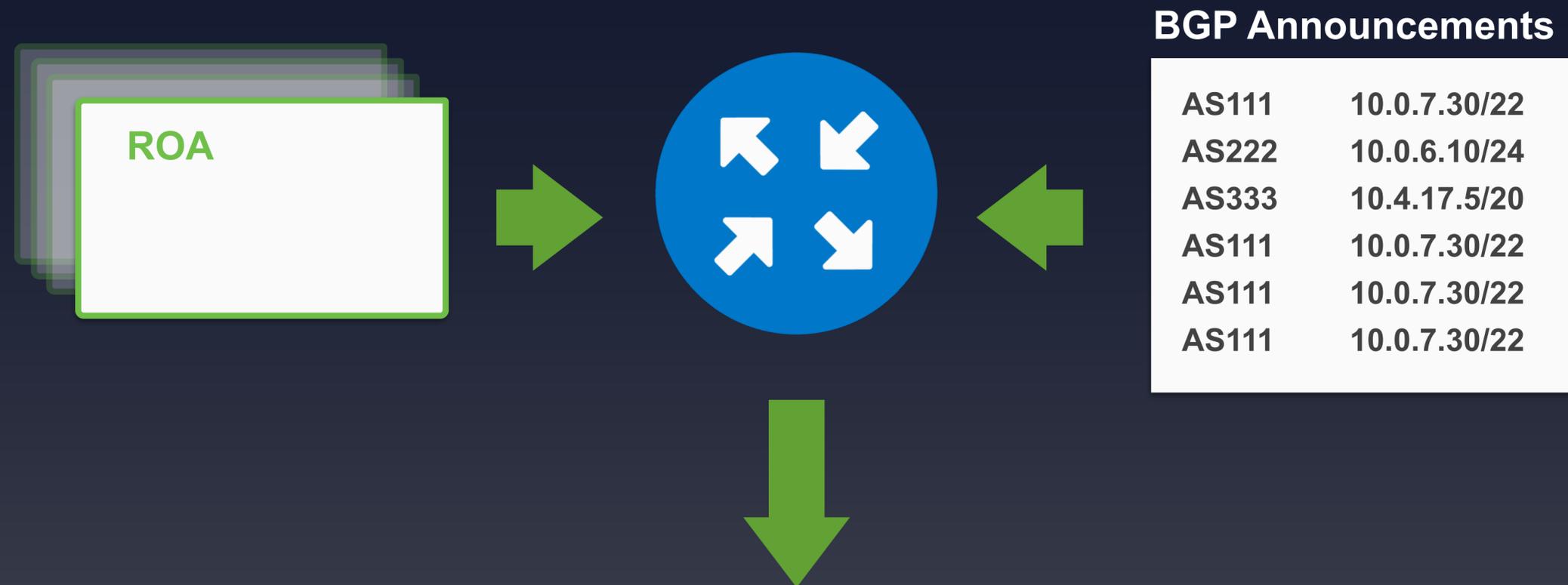
What's in a ROA



Route Origin Validation

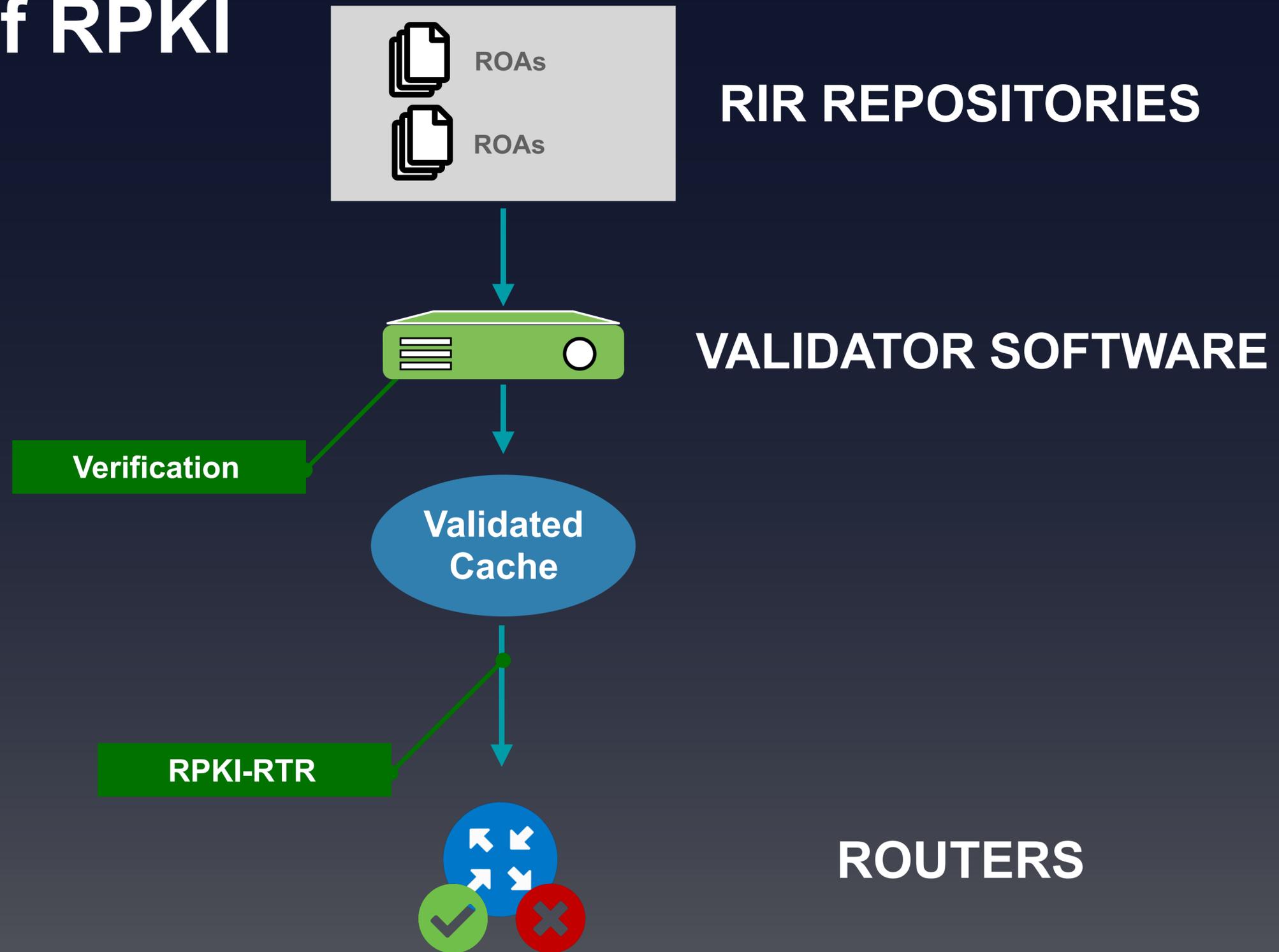


Route Origin Validation

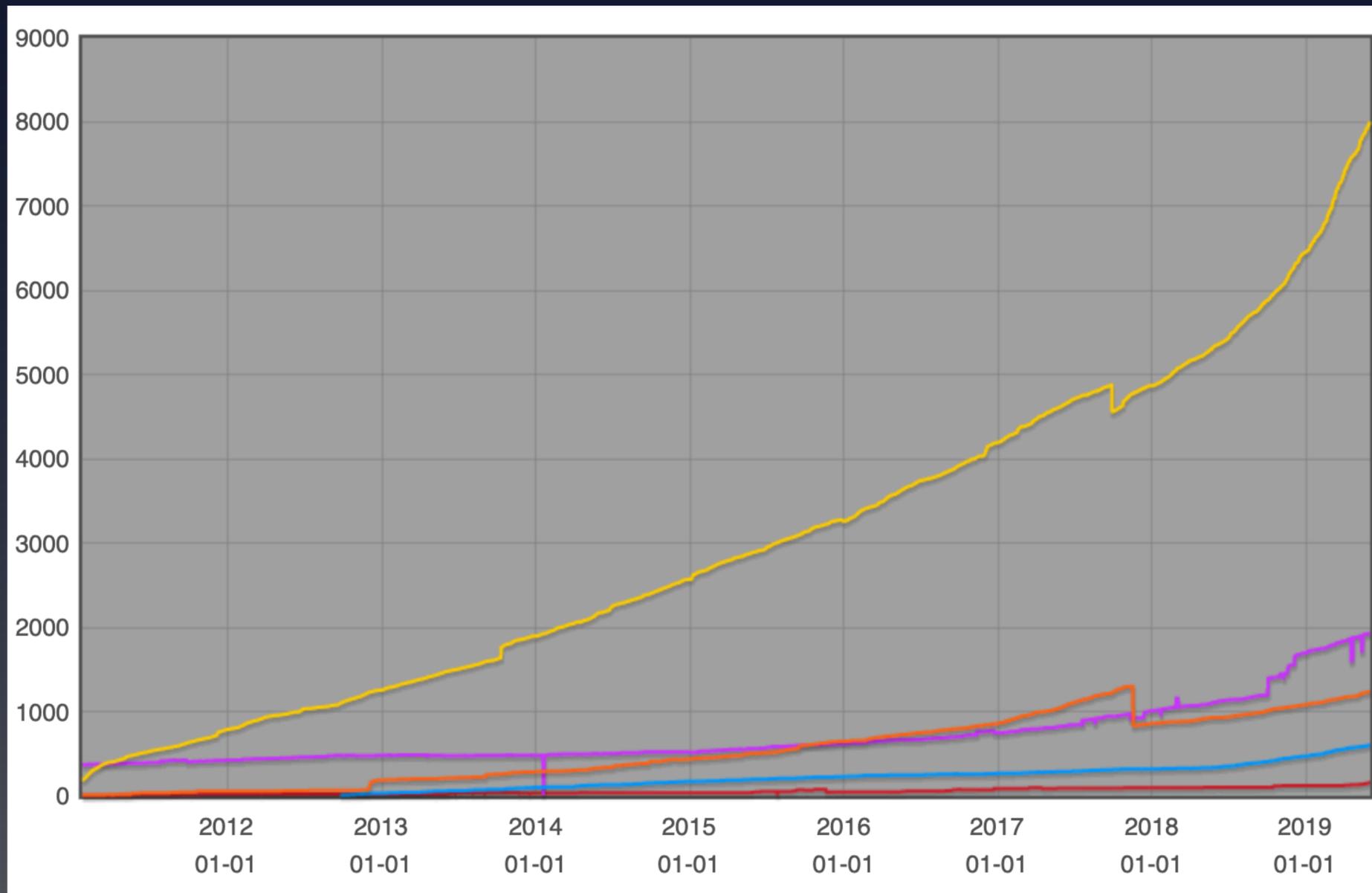


BETTER ROUTING DECISIONS

Elements of RPKI

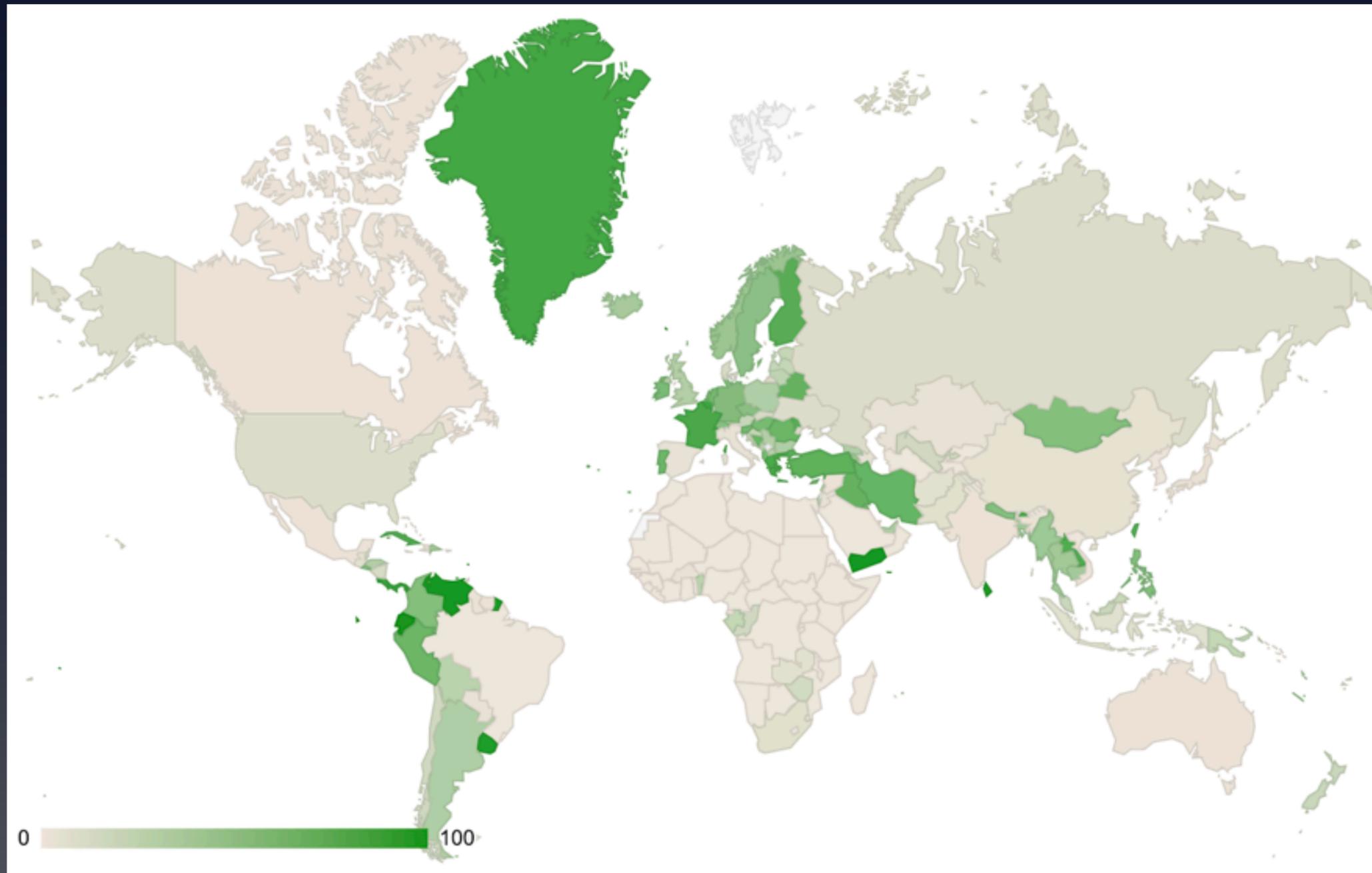


Number of Certificates

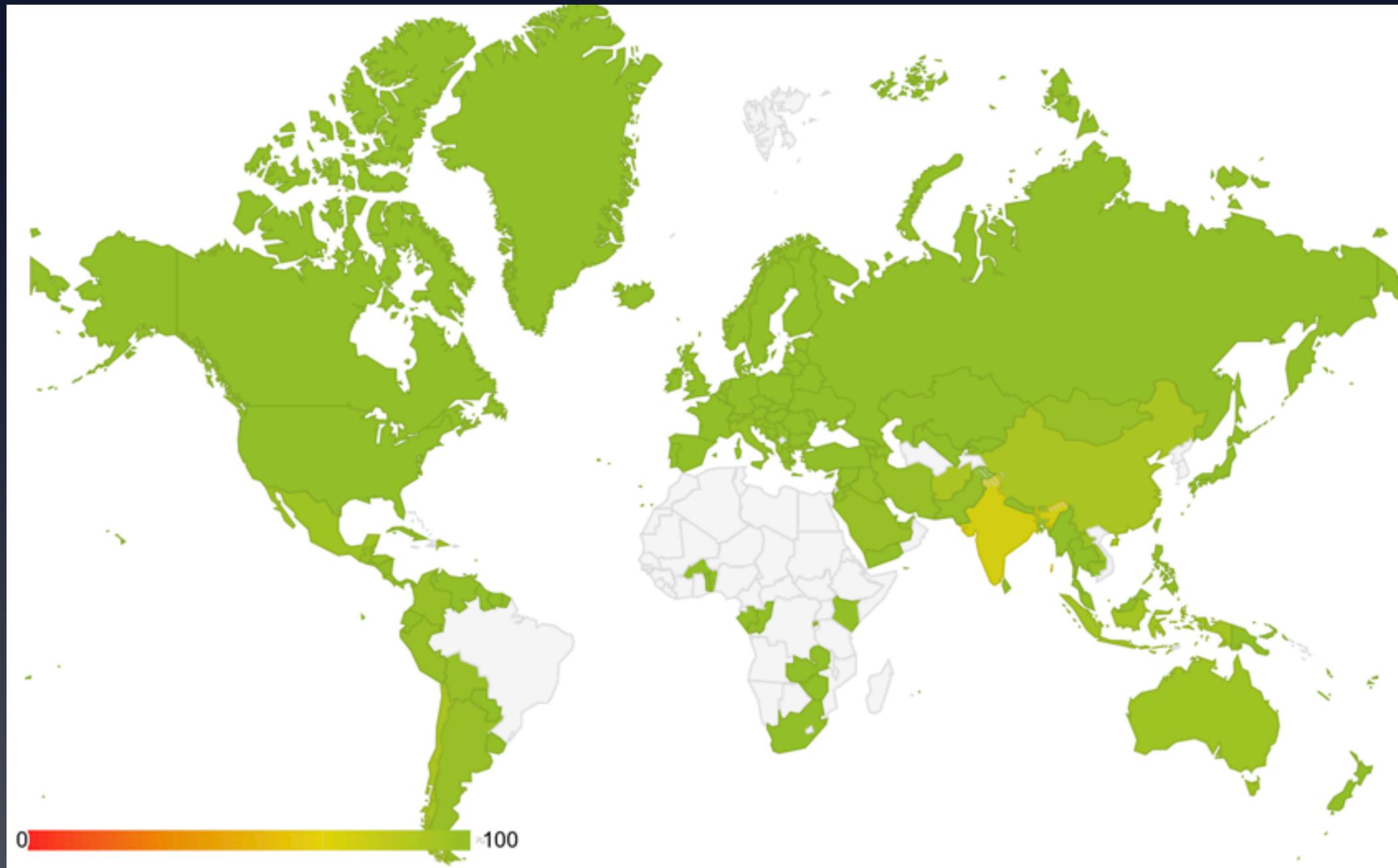


-  **RIPE NCC: 8003**
-  **APNIC: 1928**
-  **LACNIC: 1235**
-  **ARIN: 602**
-  **AFRINIC: 158**

Coverage - RPKI (all RIRs)



Accuracy - RPKI (all RIRs)



IPv4 addresses in valid announcements / covered announcements

RPKI in your region



Country	% Addreses	Accuracy
PT	59%	100,0%
ES	5%	99,8%
FR	74%	100,0%
IT	8%	99,9%
BG	54%	99,9%
AL	52%	99,5%
CZ	46%	99,9%
HR	18%	100,0%
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

Are you leading by example ?



Questions



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