



RIPE NCC

RIPE NETWORK COORDINATION CENTRE

Routing Security and RPKI

Who We Are

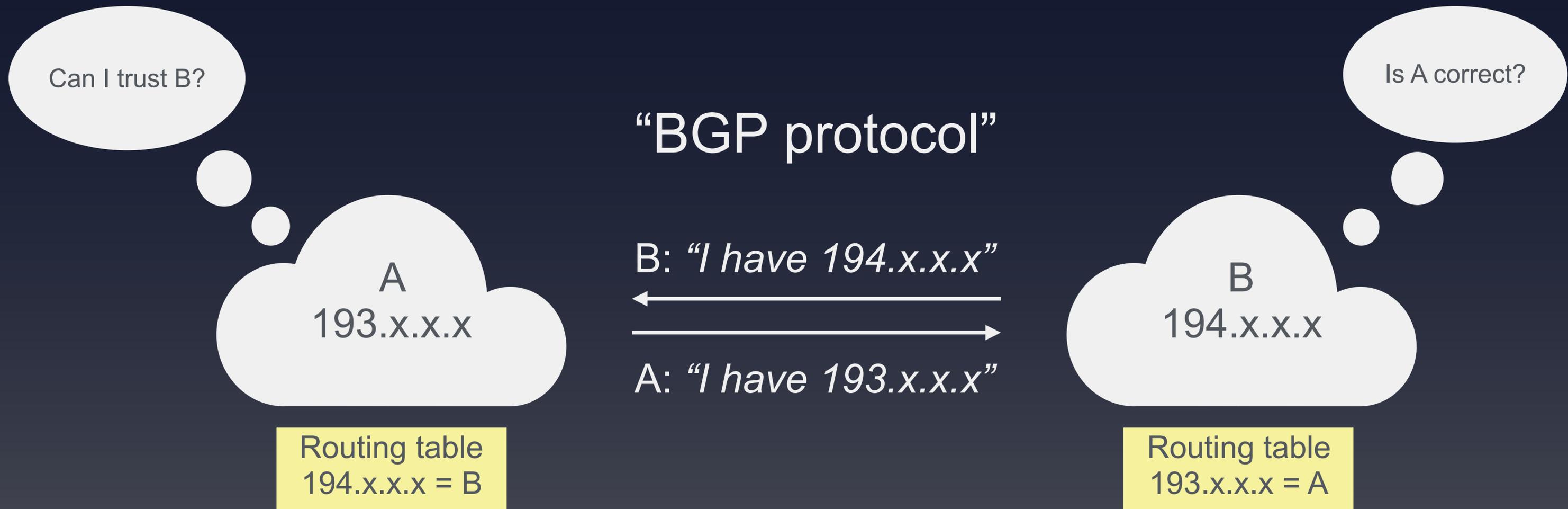


Who We Are



- 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)

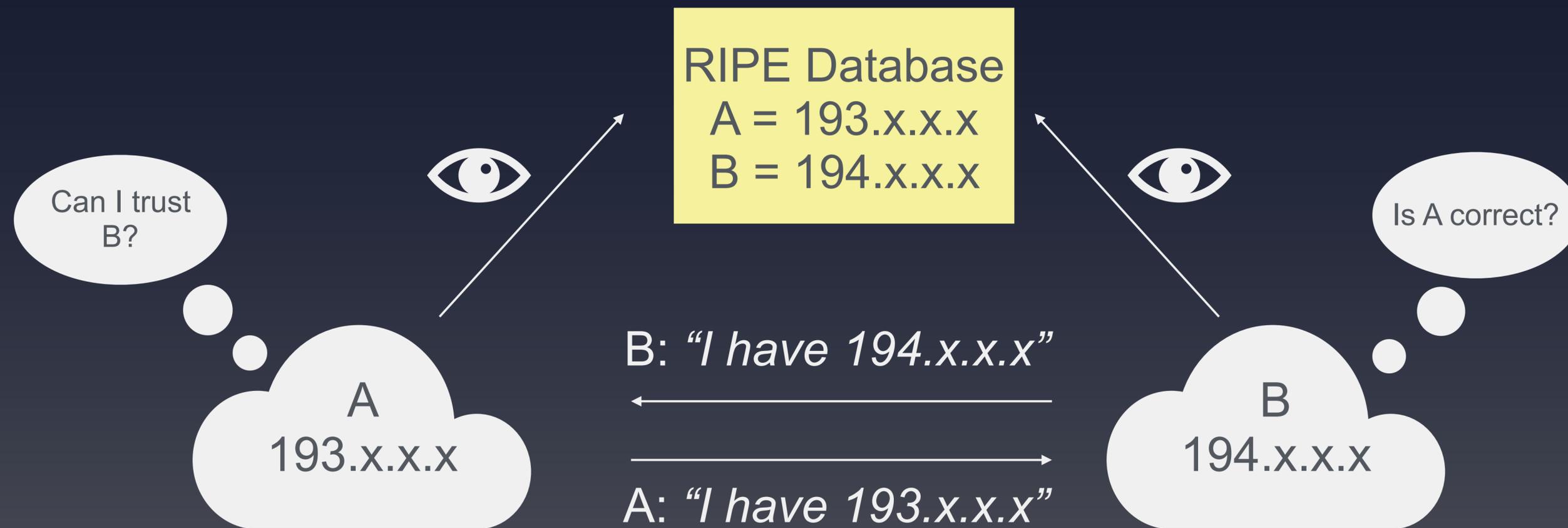
Routing on the Internet



How to Secure Routing?



“Internet Routing Registry”



Internet Routing



- Border Gateway Protocol
 - BGPv4, 1994
- The problem remains
 - No built-in security in BGP Protocol

Accidents Happen



- Fat Fingers
- Policy violations (leaks)

Or Worse...

- BGP and DNS hijack



Incidents Are Common



- **2018 Routing Security Review**
 - 12,600 incidents
 - 4.4% of all ASNs affected
 - 3,000 ASNs victims of at least one incident
 - 1,300 ASNs caused at least one incident

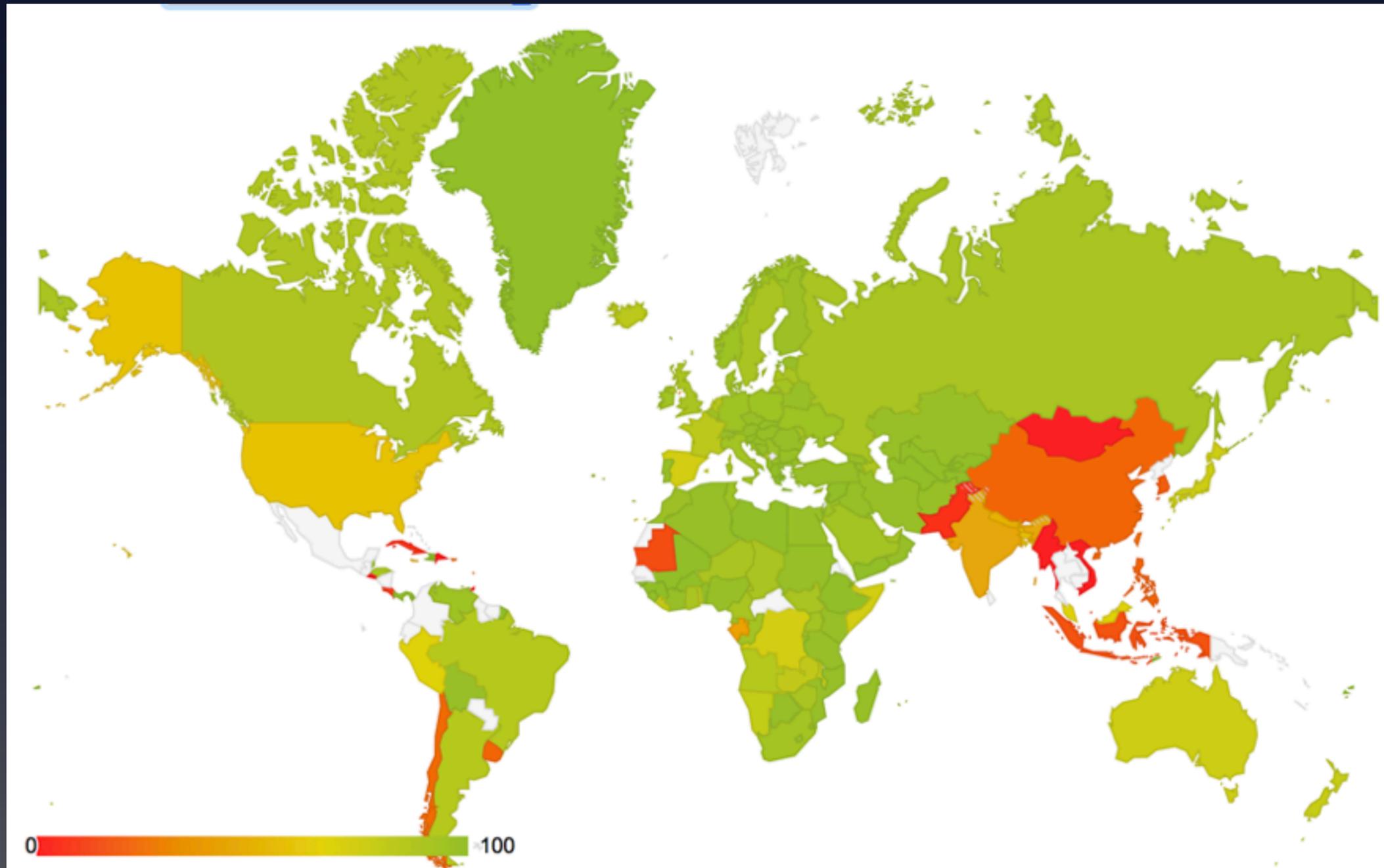
(Source: <https://www.bgpstream.com/>)

Internet Routing Registry



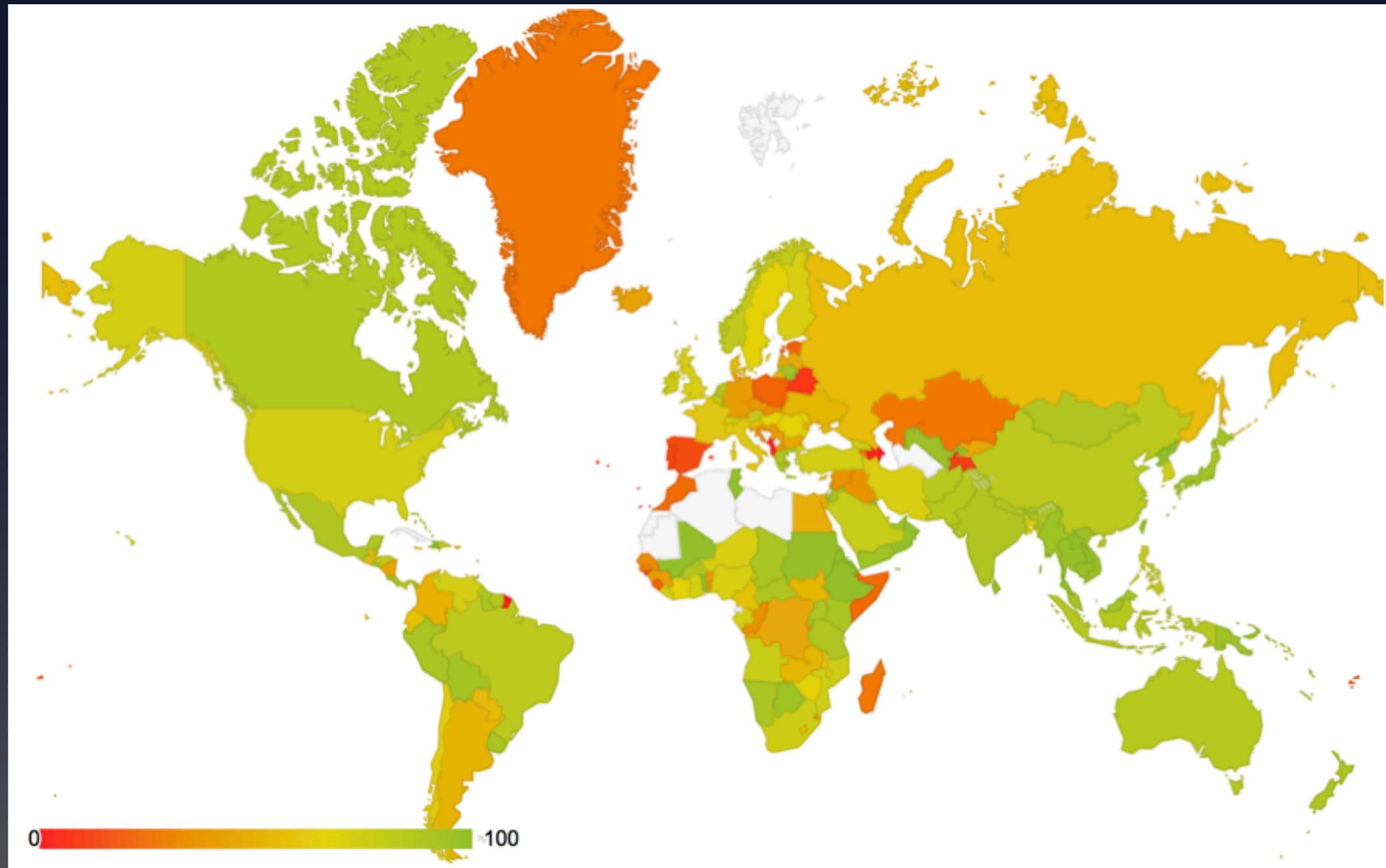
- Many exist, most widely used
 - RIR Databases (e.g. RIPE Database)
 - Private Databases (e.g. RADB)
- Verification of holdership over resources
 - RIR Databases for the respective service region only
 - RADB allows paying customers to create any object
 - Lots of other IRRs do not formally verify holdership

Accuracy - RIPE IRR



Accuracy - Valid announcements / covered announcements

Accuracy - RADB IRR



Accuracy - Valid announcements / covered announcements

Resource Public Key Infrastructure



- RPKI
 - Ties IP addresses to ASNs with certificates
 - Follows the hierarchy of the registry
- Certified statements from resource holders
 - ASN X is authorised to announce my IP Prefix Y
 - Signed, holder of Y

RPKI in a Slide



RIPE NCC Root Certificate



LIR Certificate



ROA

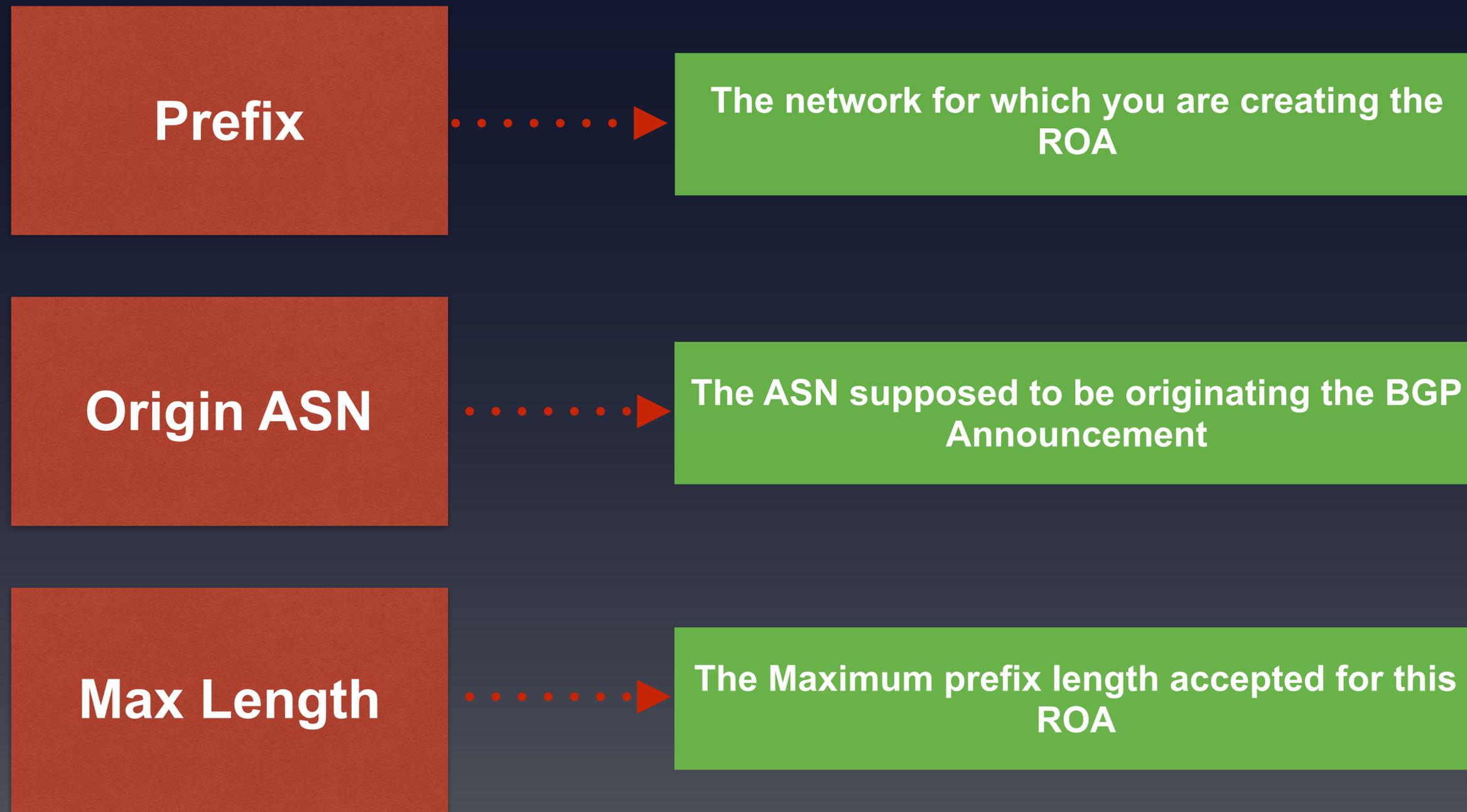
IP Range	
AS Number	AS65551
Max Length	/24
Signature	

ROA (Route Origin Authorisation)

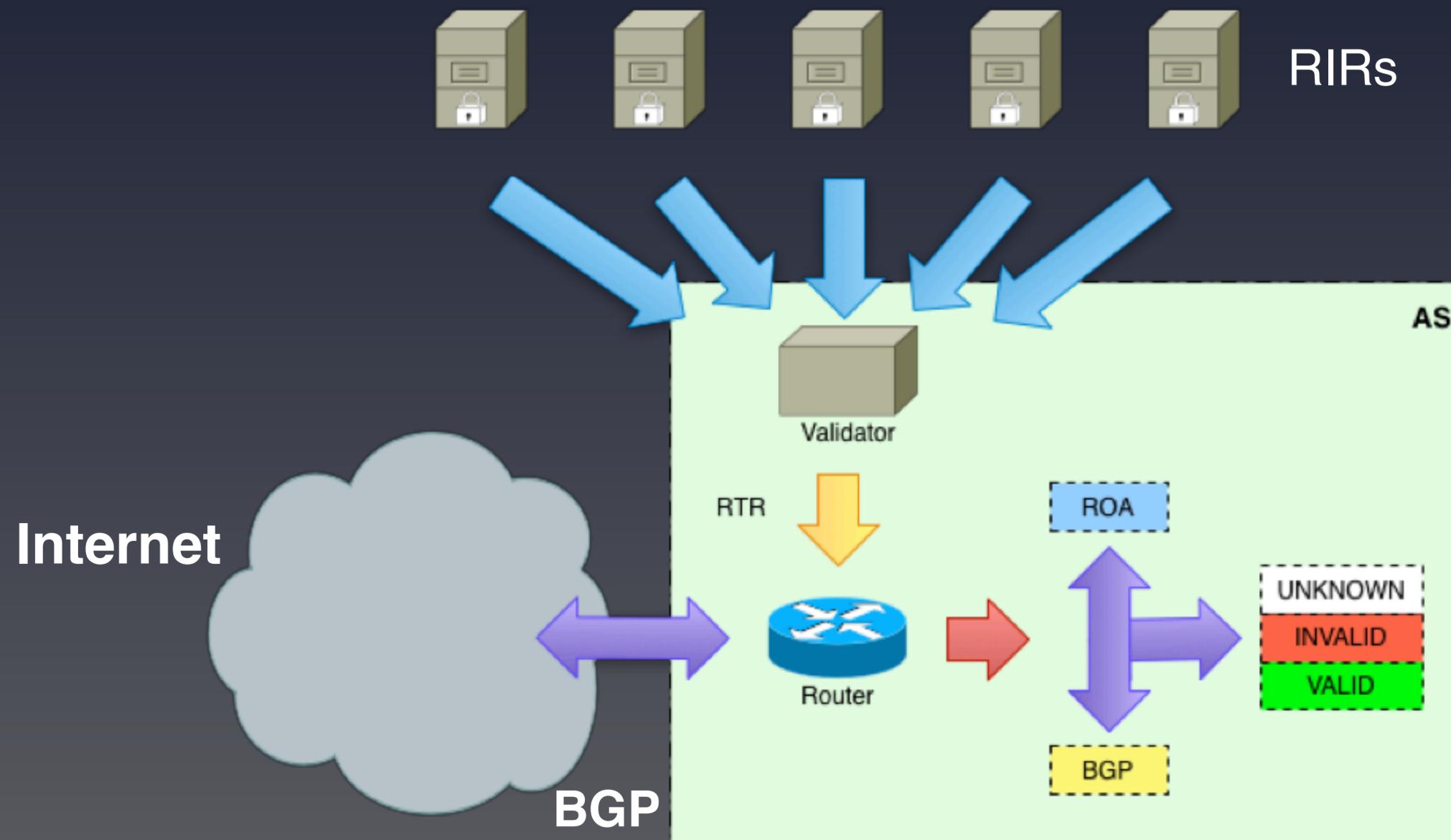


- LIRs can create a ROA for each one of their resources (IP address ranges)
- Multiple ROAs can be created for an IP range
- ROAs can overlap

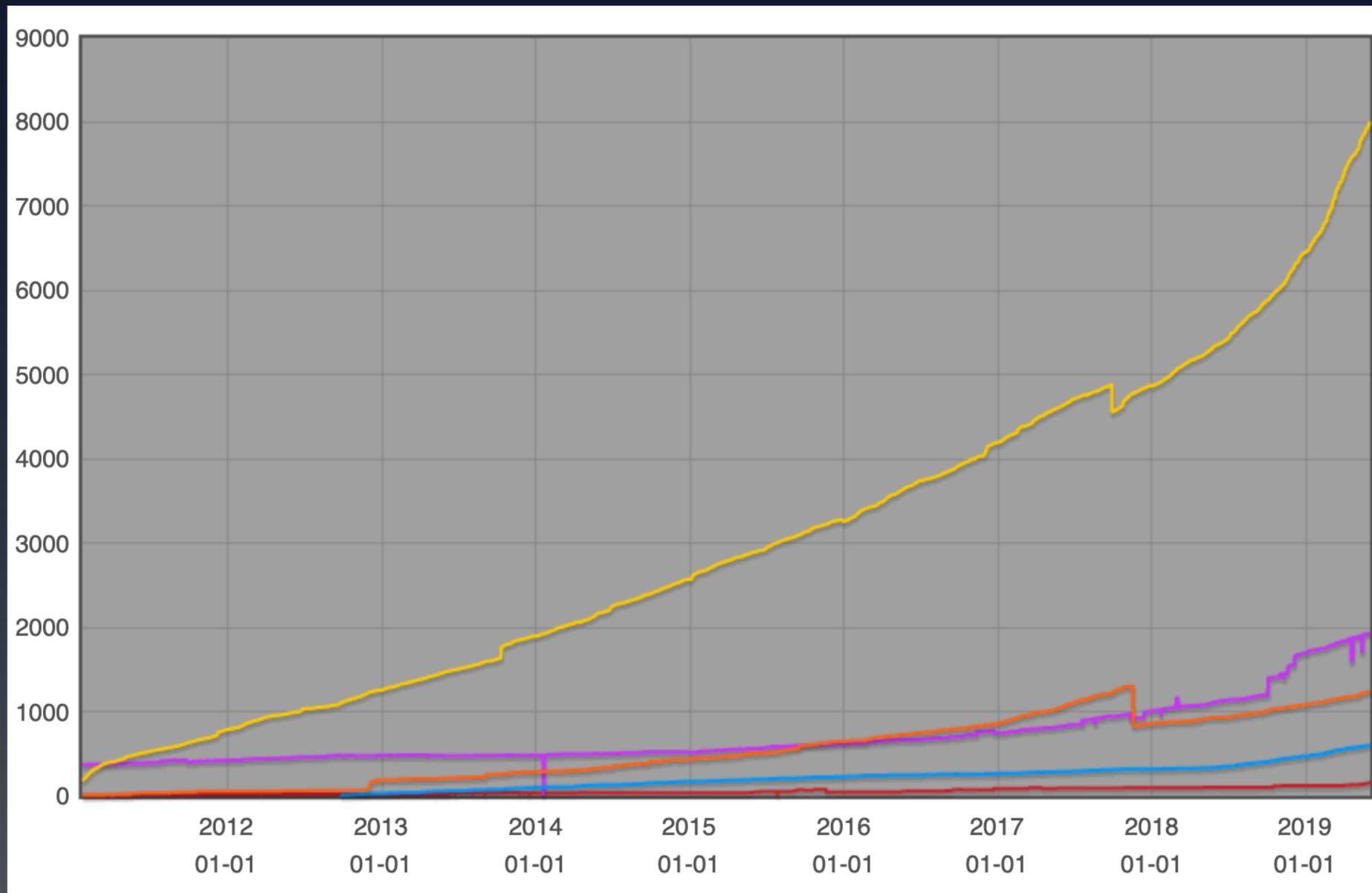
What's in a ROA



RPKI in a Slide...Part 2

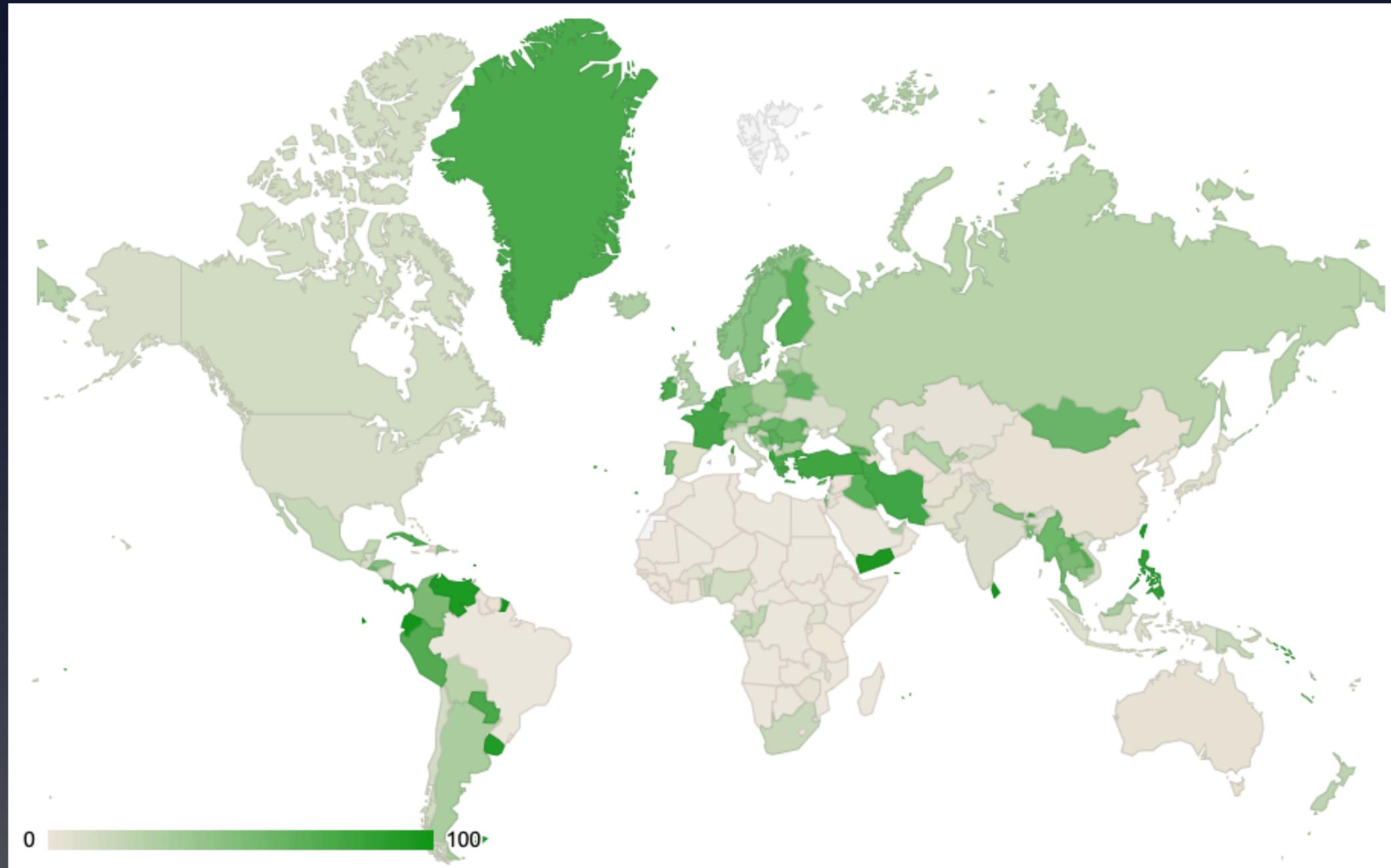


Number of Certificates

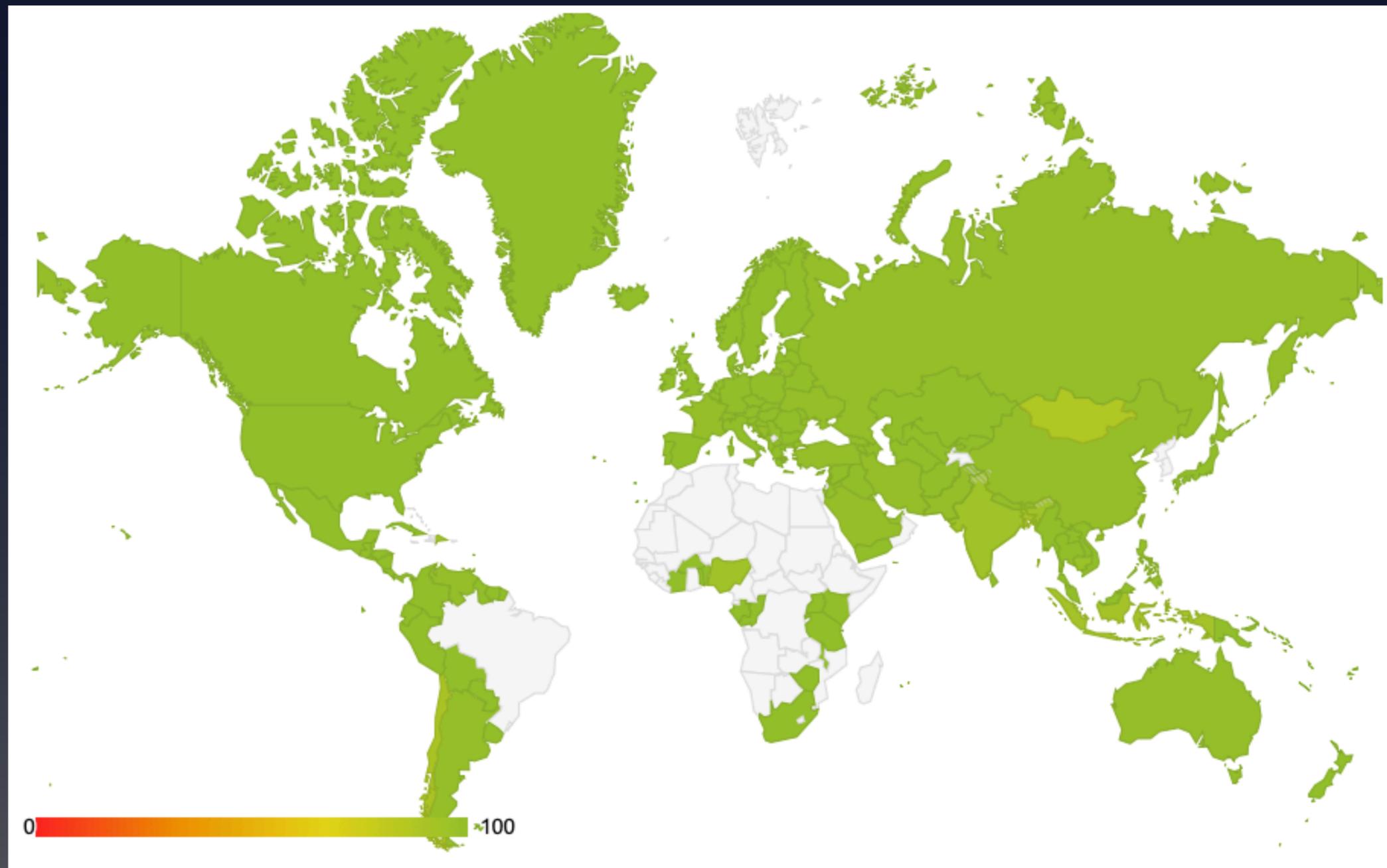


-  **RIPE NCC: 8003**
-  **APNIC: 1928**
-  **LACNIC: 1235**
-  **ARIN: 602**
-  **AFRINIC: 158**

Coverage - RPKI (all RIRs)



Accuracy - RPKI (all RIRs)



IPv4 addresses in valid announcements / covered announcements

Routing on the Internet



Country	% Addreses	Accuracy
NL	74,45%	99,9%
BE	79,83%	100 0/
FR	76,26%	99,5%
DE	50,54%	99,9%
IT	11,35%	100,0%
SE	48,64%	100,0%
DK	11,03%	100,0%
RU	24,27%	99,8%
CH	51,95%	100,0%
AT	19,75%	99,9%

(Source: <https://lirportal.ripe.net/certification/content/static/statistics/world-roas.html>)

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



Questions



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