



RIPE NCC
RIPE NETWORK COORDINATION CENTRE

Routing Security Toolset

The challenges of origin
validation

RIPE NCC



- Members organisation founded in 1992
- Manages IP and ASN allocations in Europe, Middle East and former Soviet Union
 - Ensure unique holdership
 - Document holdership in RIPE Database (whois)
 - Facilitate operators to document use of their addresses

Inter-Domain Routing



- Border Gateway Protocol
 - IETF Standard, RFC1105, 1989
 - BGPv2, 1990
 - BGPv3, 1991
 - BGPv4, 1994
 - Many other extensions...
- Problem remains
 - Any network (ASN) can announce any IP prefix
 - No built-in security in BGP protocol

Accidents Happen



Accidents Happen



- Fat Fingers
 - 2 and 3 are really close on our keyboards..
- Policy violations (leaks)
 - Oops, we didn't mean this to go the public internet
 - Infamous incident Pakistan Telecom blackholed YouTube, for the world..

Or worse..

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



<https://pixabay.com/en/burglar-crime-criminal-theft-thief-157142/>

Incidents are common



- 2017 Routing Security Review by Internet Society
 - 14k incidents
 - 10% of all ASNs affected
 - 3k ASN victim of at least one incident
 - 1.5k ASN caused at least one incident

<https://www.internetsociety.org/blog/2018/01/14000-incidents-2017-routing-security-year-review/>

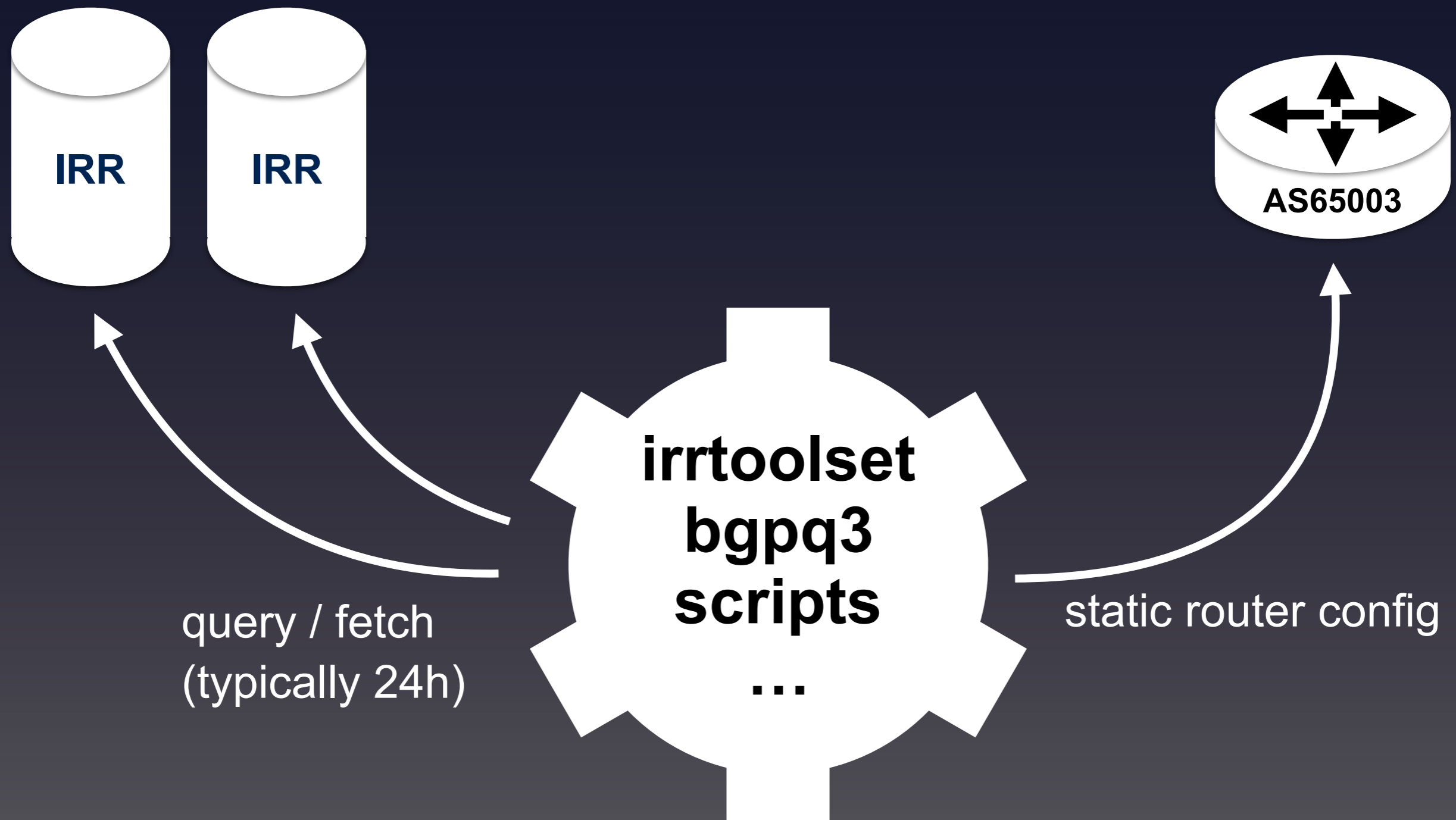


Internet Routing Registry



- Many exist, most widely used
 - RIPE Database
 - RADB
- Verification of holdership over resources
 - RIPE Database for RIPE region resources only
 - RIPE Database allows anyone to create out-of-region (deprecated)
 - RADB allows paying customers to create any object
 - Lot of other IRR don't formally verify holdership

Automate using IRR

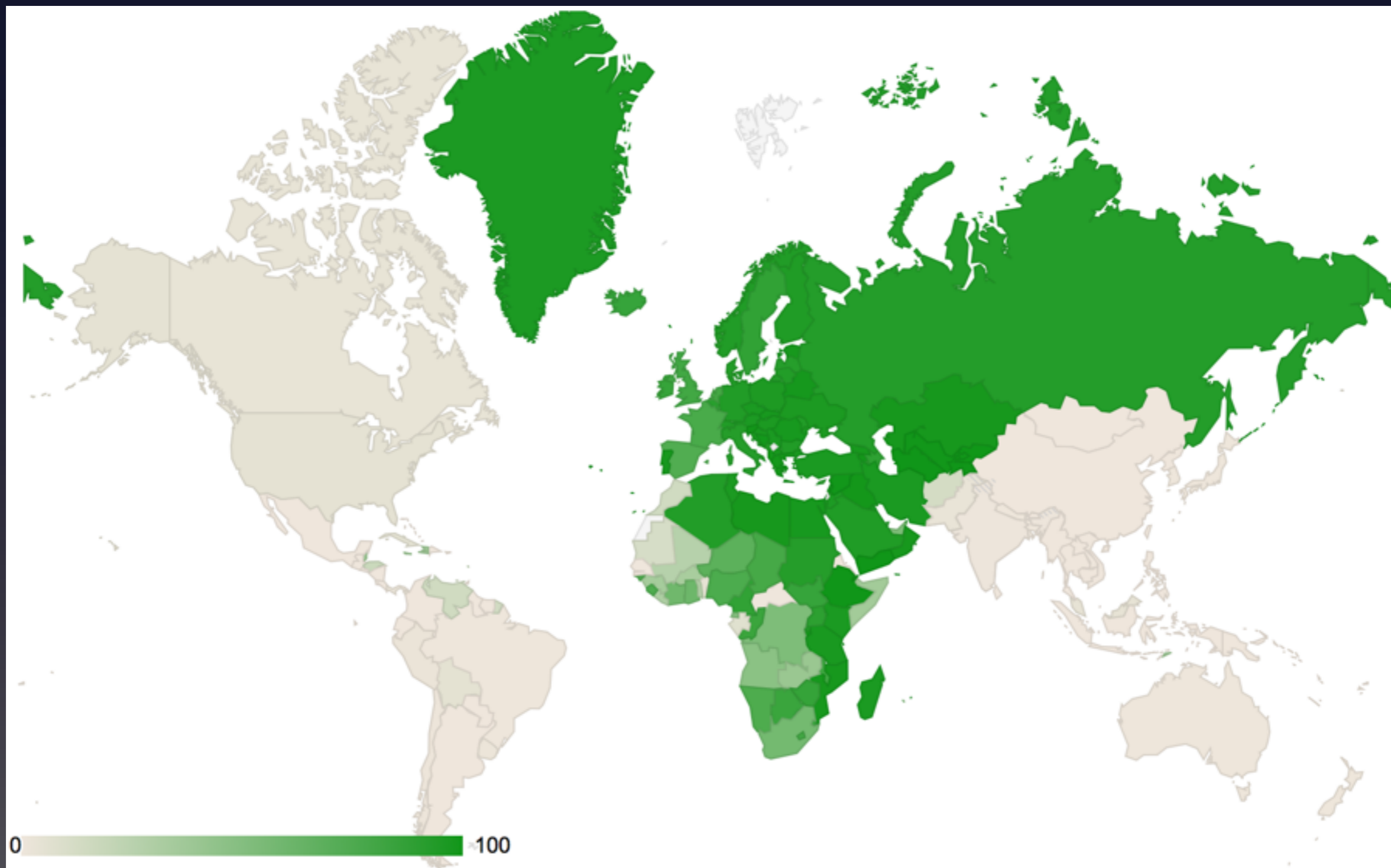


Filtering Value Proposition



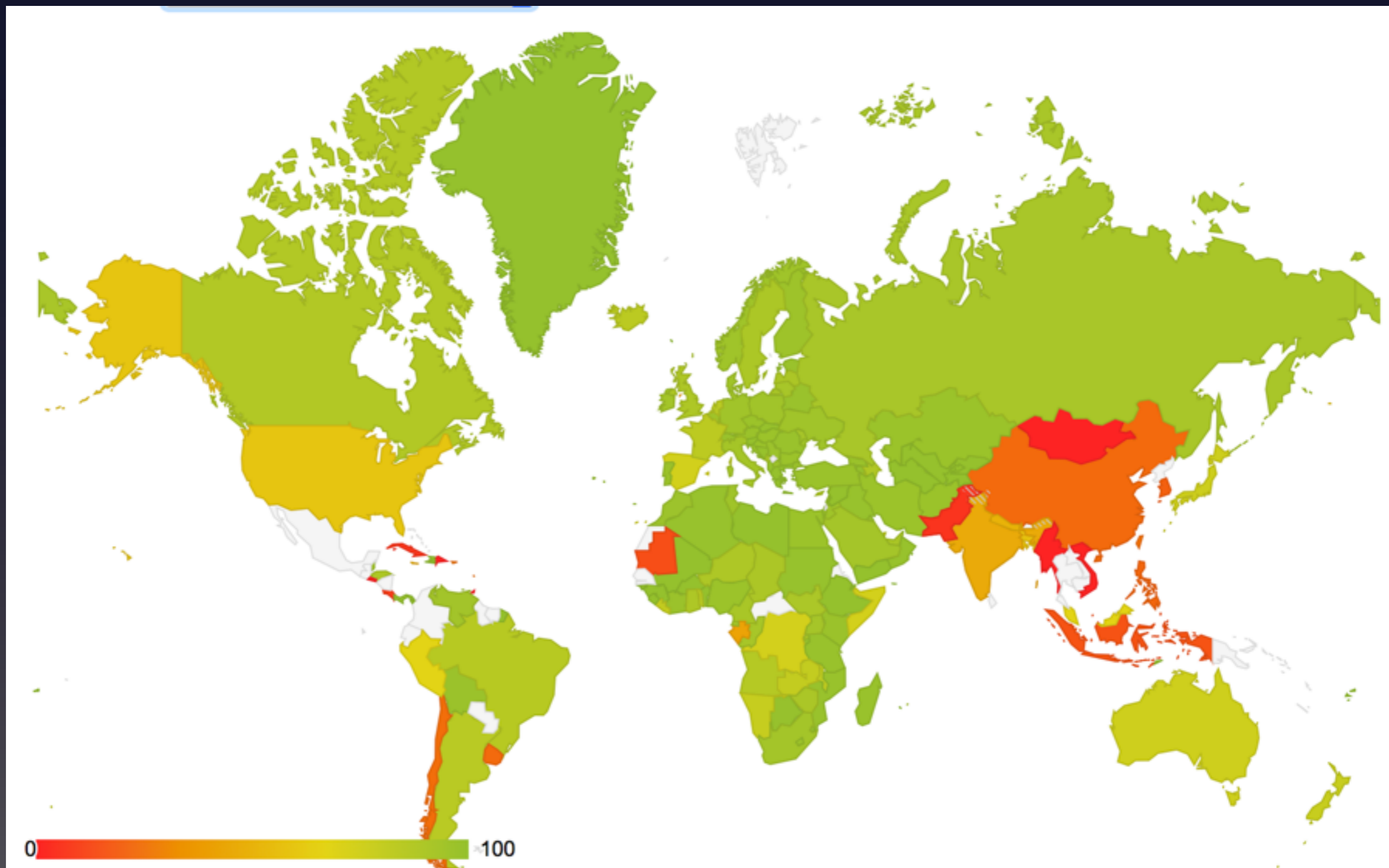
- Most commonly done by providers
- Internet Exchange points have started offering filtering as a service
- Transit providers usually do not filter
- Stub networks may filter because they want to block poisonous traffic

Coverage - RIPE IRR



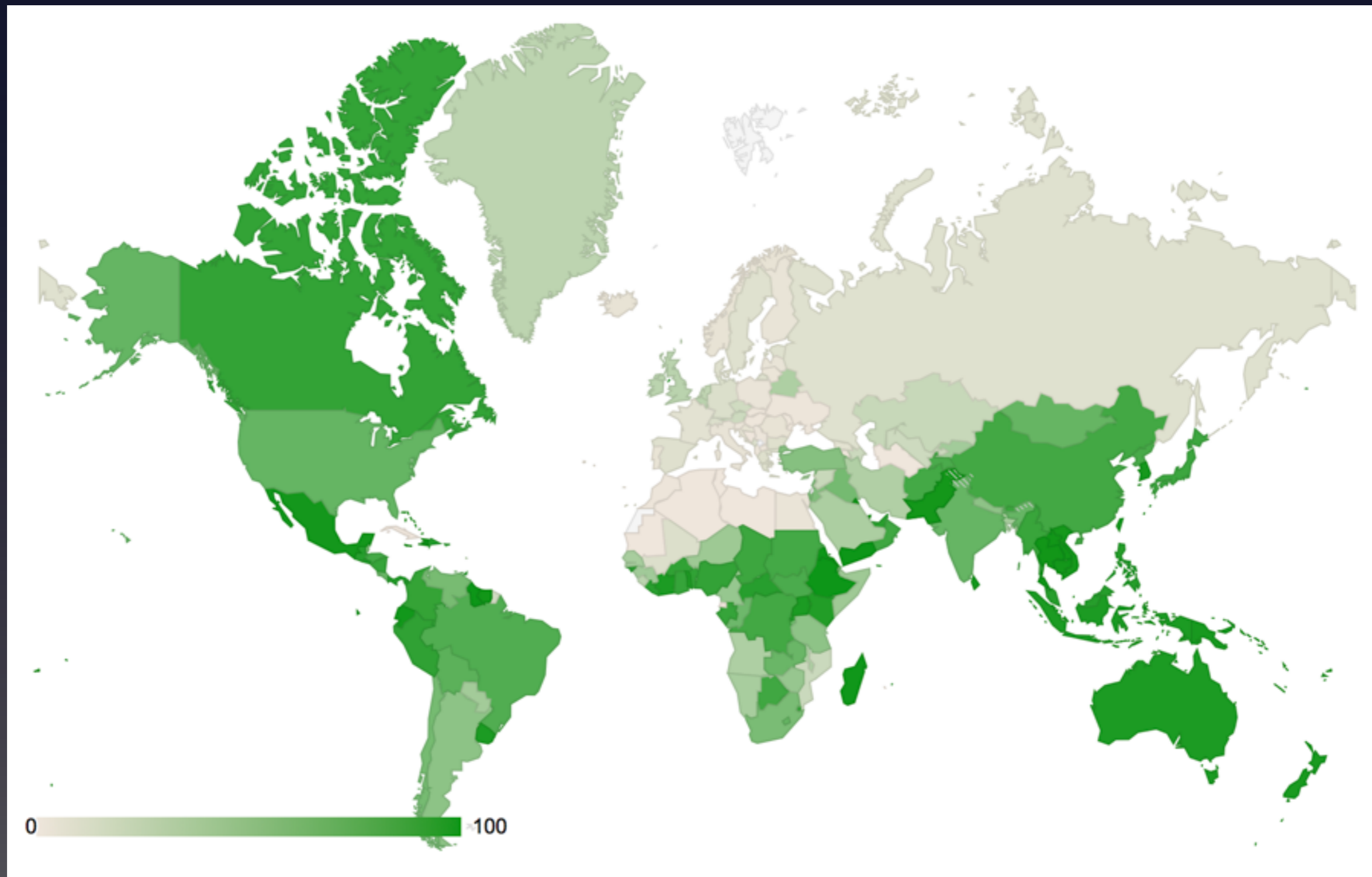
Fraction of IPv4 announcements valid according to ROUTE objects

Accuracy - RIPE IRR



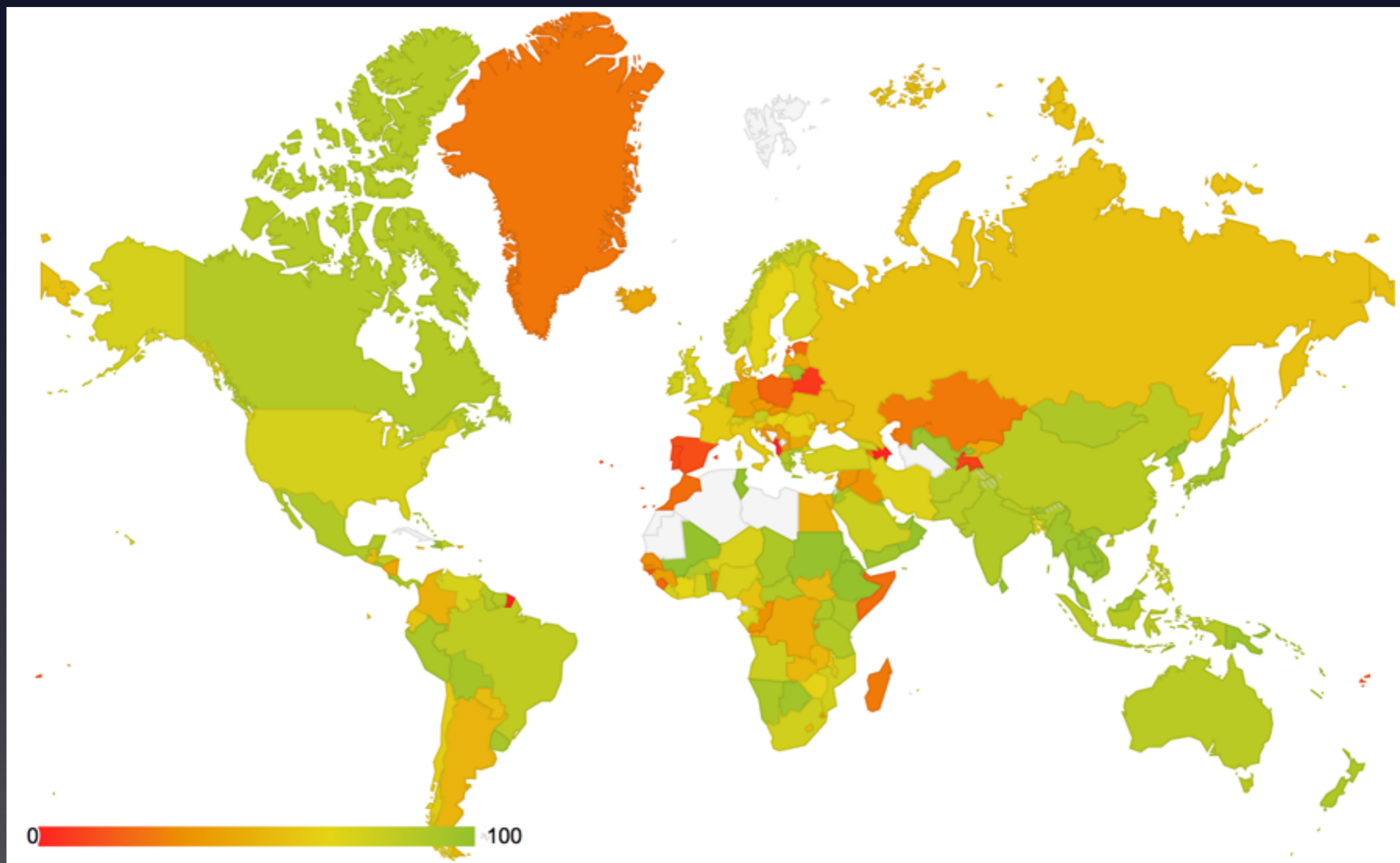
Accuracy - Valid announcements / covered announcements

Coverage - RADB IRR



Fraction of IPv4 announcements valid according to ROUTE objects

Accuracy - RADB IRR



Accuracy - Valid announcements / covered announcements



Resource Public Key Infrastructure



- Resource Public Key Infrastructure
 - 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

Give me a button! — When I authorise



- We show members announcements
 - Member chooses to authorise, or not
 - No need to worry about the crypto
 - It's there, but let the machines handle it..
- APNIC and Lacnic also have easy to use portals
 - Uptake and quality of data is a function of the interface

How to set up ROAs



RPKI Dashboard

11 CERTIFIED RESOURCES

ALERTS ARE SENT TO 1 ADDRESS

63 BGP Announcements

87 ROAs

59 Valid 0 Invalid 0 Unknown

87 OK 0 Causing problems

BGP Announcements

Route Origin Authorisations (ROAs)

History

Search...

↓ Create ROAs for selected BGP Announcements

Valid Invalid Unknown

<input type="checkbox"/>	Origin AS	Prefix	Current Status	
<input type="checkbox"/>	AS3333	193.0.0.0/21	VALID	
<input type="checkbox"/>	AS3333	193.0.10.0/23	VALID	
<input type="checkbox"/>	AS3333	193.0.12.0/23	VALID	
<input type="checkbox"/>	AS3333	193.0.18.0/23	VALID	
<input type="checkbox"/>	AS3333	193.0.20.0/23	VALID	
<input type="checkbox"/>	AS3333	193.0.22.0/23	VALID	
<input type="checkbox"/>	AS3333	2001:67c:2e8::/48	VALID	
<input type="checkbox"/>	AS12654	2001:7fb:fd02::/48	VALID	
<input type="checkbox"/>	AS12654	2001:7fb:fd03::/48	INVALID ASN	
<input type="checkbox"/>	AS12654	2001:7fb:fe03::/48	VALID	

Show 10 of 63 items

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BGP Announcements

Route Origin Authorisations (ROAs)

History

Search...

Fix announcement

Affected Announcement

AS number: AS12654, Prefix: 2001:7fb:fd03::/48, Max Length: 48

Create ROA

ROAs currently invalidating this announcement

AS number: AS196615, Prefix: 2001:7fb:fd03::/48, Max Length: 48

INVALID ASN

Manual fix

AS Number	Prefix	Max length	Add ROA
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☐ AS12654

2001:7fb:fd02::/48

VALID

☐ AS12654

2001:7fb:fd03::/48

INVALID ASN

MUTED

☐ AS12654

2001:7fb:fe03::/48

VALID

Show 10 of 63 items

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0 Invalid

0 Unknown

87 ROAs

87 OK

0 Causing problems

BGP Announcements

Route Origin Authorisations (ROAs)

History

Search...

Create ROAs for selected BGP Announcements

Valid

Invalid

Unknown

<input type="checkbox"/>	Origin AS	Prefix	Current Status	Future Status
<input type="checkbox"/>	AS3333	193.0.0.0/21	VALID	
<input type="checkbox"/>	AS3333	193.0.10.0/23	VALID	
<input type="checkbox"/>	AS3333	193.0.12.0/23	VALID	
<input type="checkbox"/>	AS3333	193.0.18.0/23	VALID	
<input type="checkbox"/>	AS3333	193.0.20.0/23	VALID	
<input type="checkbox"/>	AS3333	193.0.22.0/23	VALID	
<input type="checkbox"/>	AS3333	2001:67c:2e8::/48	VALID	
<input type="checkbox"/>	AS12654			
<input type="checkbox"/>	AS12654			
<input type="checkbox"/>	AS12654			

Show 10 of

Review and publish changes

1

Staged ROAs

AS12654 2001:7fb:fd03::/48 48

Affected announcements

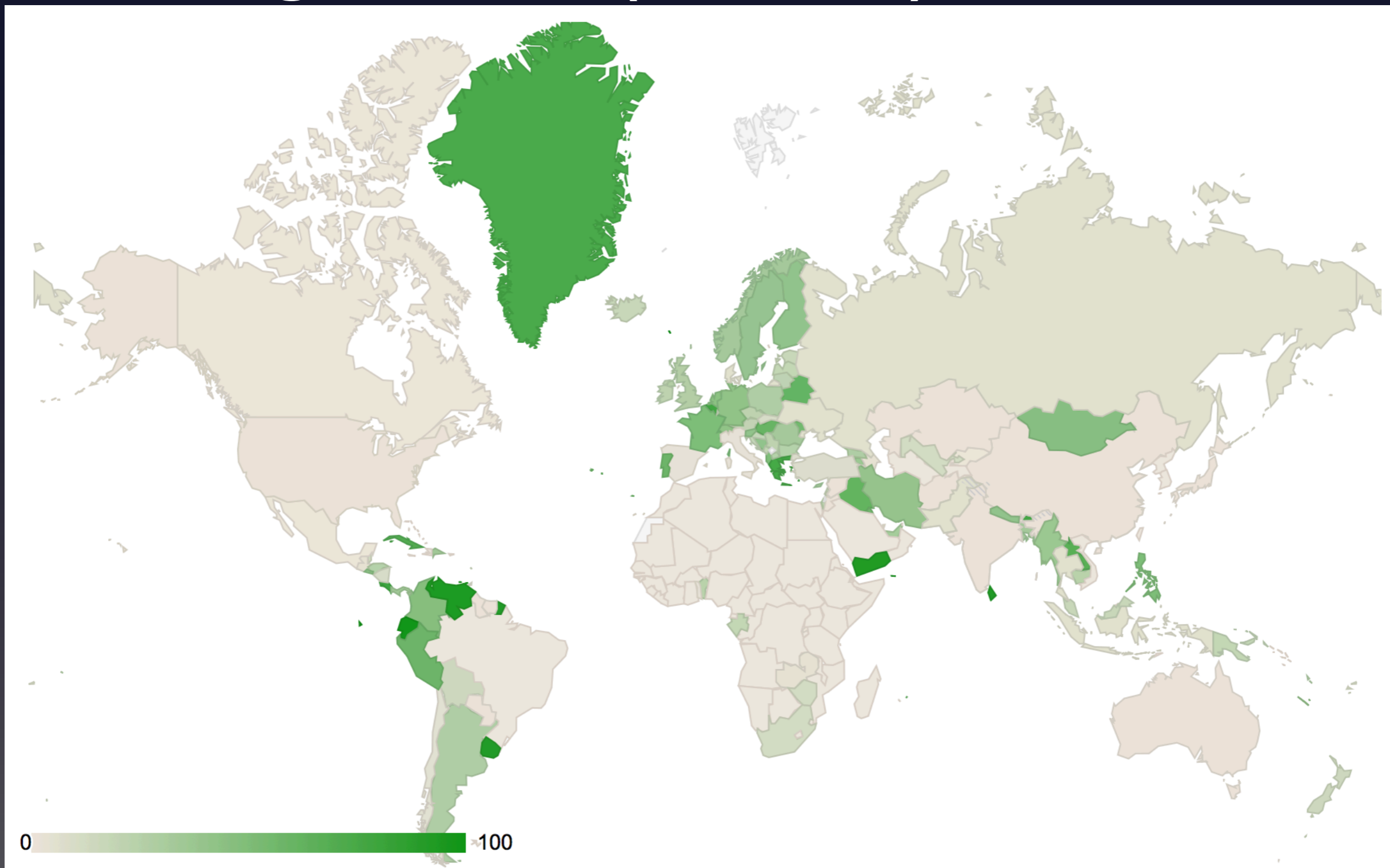
AS12654 2001:7fb:fd03::/48 INVALID ASN VALID

Publish!

Continue making changes

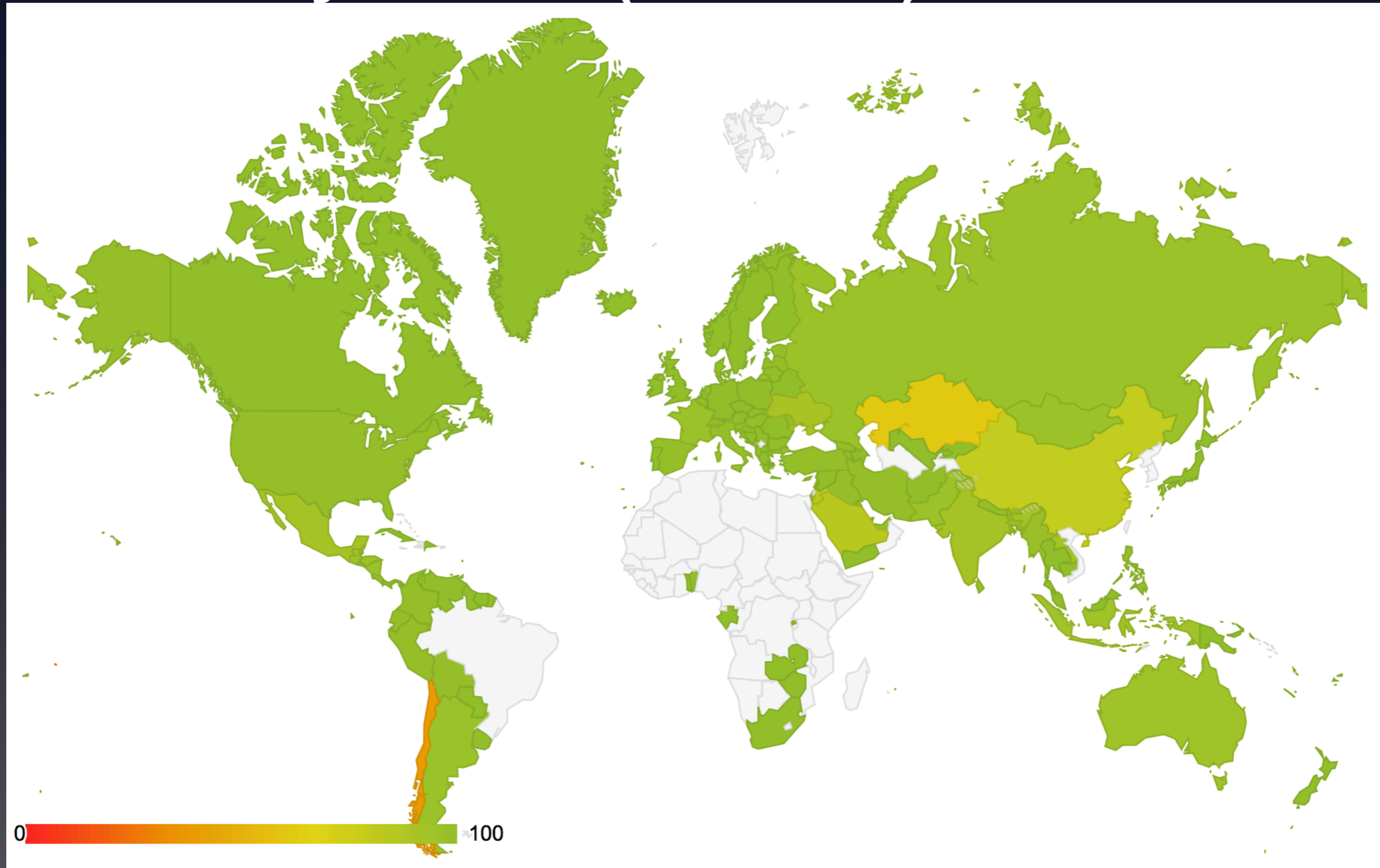
Discard changes

Coverage - RPKI (all RIRs)



Fraction of IPv4 announced addresses valid according to ROAs

Accuracy - RPKI (all RIRs)



IPv4 addresses in valid announcements / covered announcements

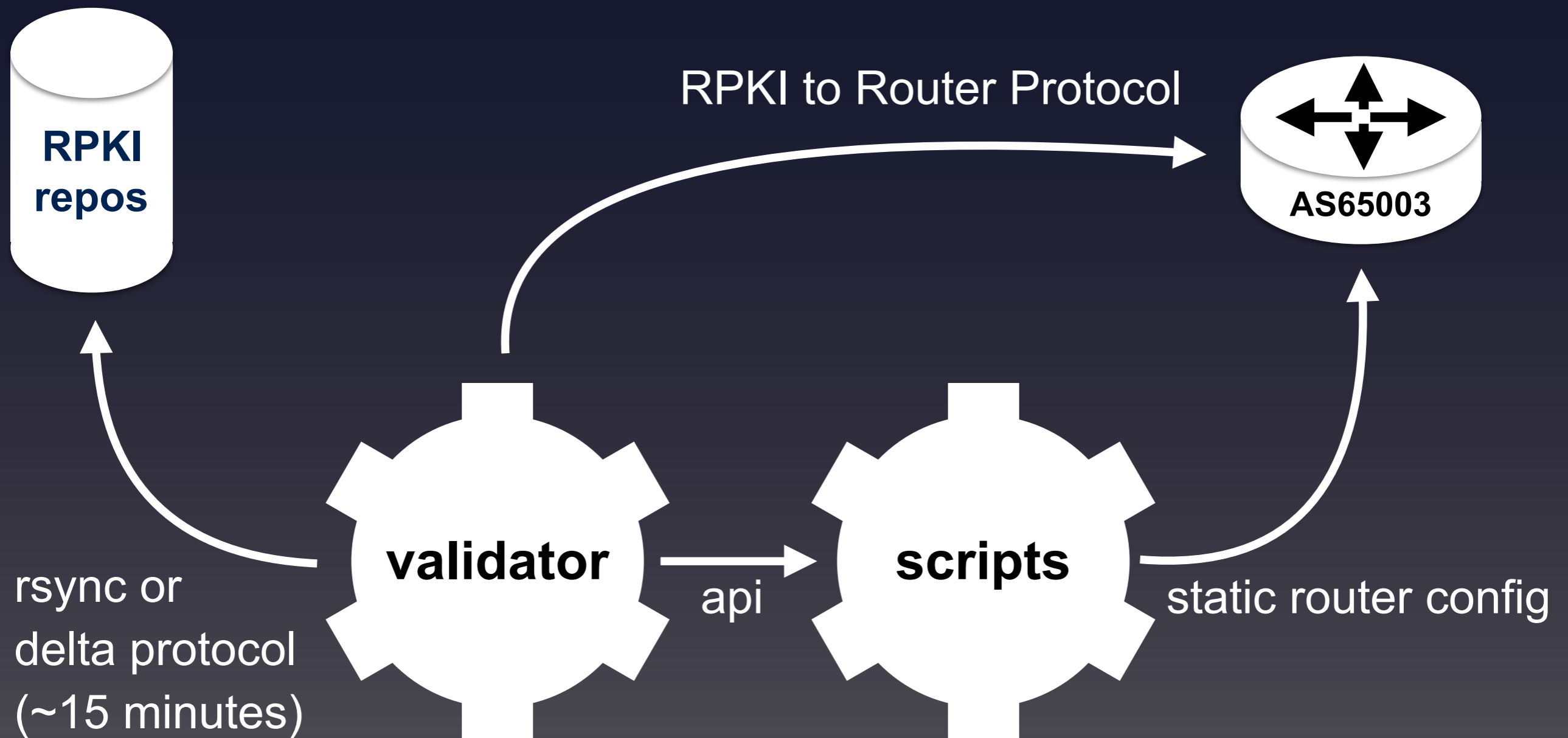
RPKI in some European countries



Country	% Prefixes	% Addresses	Accuracy
NL	25%	44%	99,9%
BE	27%	78%	100,0%
DE	17%	42%	100,0%
FR	26%	50%	96,9%
GB	14%	26%	99,9%
IE	20%	21%	99,9%
FI	20%	40%	100,0%
SE	12%	38%	100,0%
GR	46%	75%	100,0%
CZ	13%	23%	99,9%
SK	13%	10%	100,0%

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

Give me a button! — When I validate



Search through validated ROAs



RPKI Validator Trust Anchors ROAs Ignore Filters Whitelist BGP Preview Announcement Preview

Validated ROAs

Show 10 entries

Search:

ASN	Prefix	Max Length	Trust Anchors	URI of ROA
AS13335	1.0.0.0/24	24	APNIC RPKI Root	🔗
AS13335	1.1.1.0/24	24	APNIC RPKI Root	🔗
AS4788	1.9.0.0/16	24	APNIC RPKI Root	🔗
AS65037	1.9.12.0/24	24	APNIC RPKI Root	🔗
AS24514	1.9.21.0/24	24	APNIC RPKI Root	🔗
AS65120	1.9.23.0/24	24	APNIC RPKI Root	🔗
AS65077	1.9.31.0/24	24	APNIC RPKI Root	🔗
AS24514	1.9.65.0/24	24	APNIC RPKI Root	🔗
AS4760	1.36.0.0/16	16	APNIC RPKI Root	🔗
AS4760	1.36.0.0/19	19	APNIC RPKI Root	🔗

« « 1 2 3 4 5 » »

Showing 1 to 10 of 52137 entries

Export

Here you are able to export the complete ROA data set for use in an existing BGP decision making workflow. The output will be in CSV or JSON format and consist of all validated ROAs, minus your ignore filter entries, plus your whitelist additions.

Get CSV

Get JSON

Manage local exceptions



RPKI Validator Trust Anchors ROAs Ignore Filters **Whitelist** BGP Preview Announcement Preview

Whitelist

By adding a whitelist entry you can manually authorise an ASN to originate a prefix in addition to the validated ROAs from the repository. Please note that whitelist entries may **invalidate** announcements for this prefix from other ASNs, just like ROAs. This may be intentional (you are whitelisting ASN A, ASN B is hijacking), or not (ASN B should also be authorised, or you made a mistake). When you create a whitelist entry here, make sure to check the table below for a report on prefixes validated / invalidated by this entry and verify that no unintentional side effects occurred.

Add entry

Prefix	Origin	Maximum prefix length	
<input type="text" value="IPv4 or IPv6 prefix"/>	<input type="text" value="ASN"/>	<input type="text" value="Number"/>	<input type="button" value="Add"/>
Comment <input type="text"/>			

Current entries

Show 10 entries

Search:

Prefix	ASN	Maximum prefix length	Validates	Invalidates	Comment	
193.0.0.0/21	1		0 announcement(s)	1 announcement(s)	Want this to be valid here	

« « 1 » »

Showing 1 to 1 of 1 entries

SLURM

Download or upload SLURM file.

Analyse any announcement



RPKI Validator Trust Anchors ROAs Ignore Filters Whitelist BGP Preview Announcement Preview

Announcement Preview

ASN: AS3333

Prefix: 193.0.0.0/21

Status: **INVALID ASN**

Relevant Validated ROAs

ASN	Prefix	Max Length	Source	URI	Status
AS1	193.0.0.0/21		Whitelist		INVALID ASN
AS3333	193.0.0.0/21	21	RIPE NCC RPKI Root	🔗	FILTERED VALID



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RPKI Validator references



- RIPE NCC RPKI Validator 2.24
<https://www.ripe.net/manage-ips-and-asns/resource-management/certification/tools-and-resources>
- RIPE NCC RPKI Validator 3
<https://github.com/RIPE-NCC/rpki-validator-3/wiki>
 - Release Candidate out NOW
 - Please try it! Your feedback is much appreciated
- Rcynic
<https://github.com/dragonresearch/rpki.net/>
- RPSTIR
<https://github.com/bgpsecurity/rpstir>



Questions



awolski@ripe.net
@taihen