RIPE NCC
RIPE NETWORK COORDINATION CENTRE

BGP Routing Security: Update and Stats

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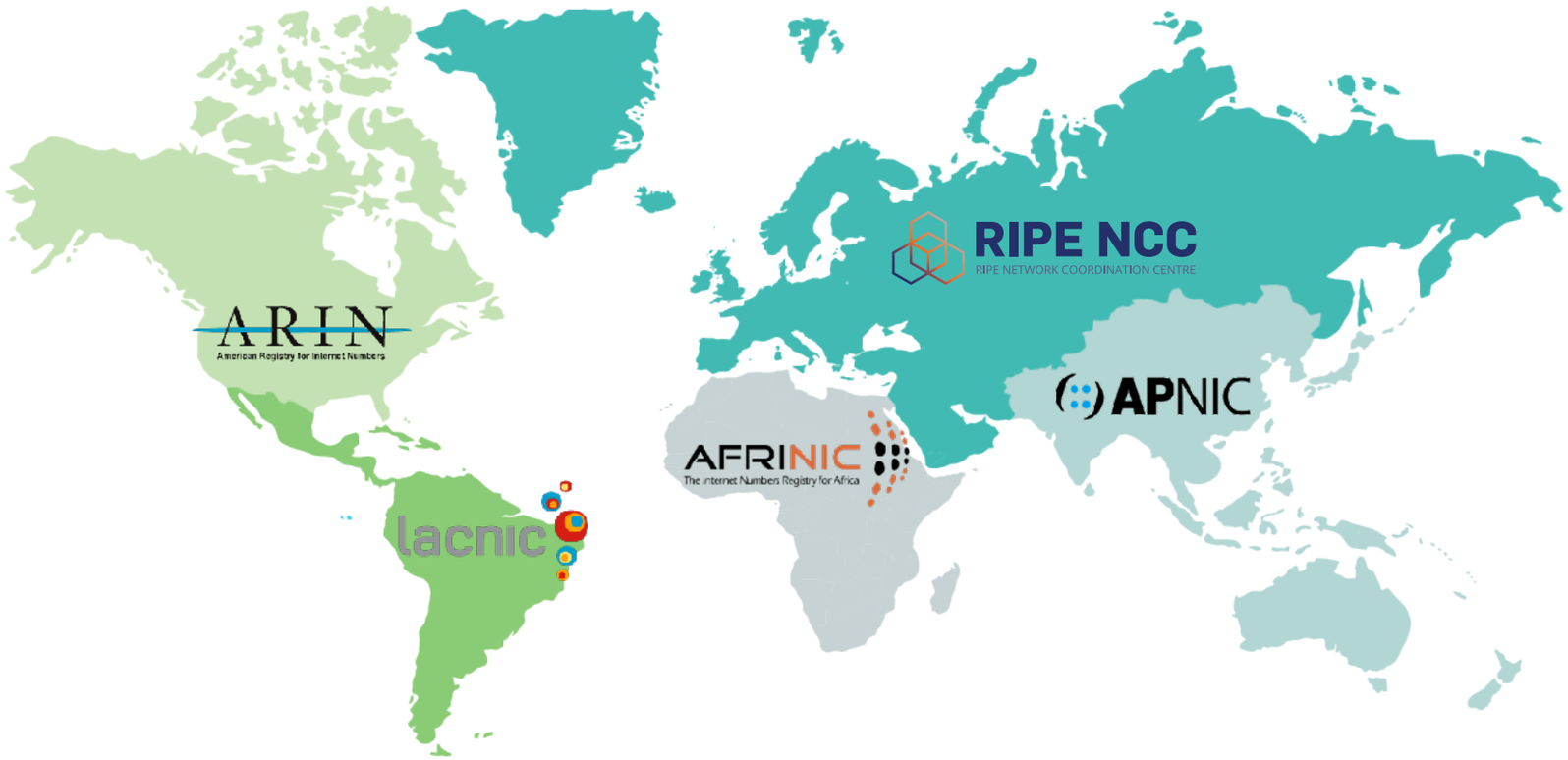
RIPE NCC

ESNOG 29 | 19 May 2023

What is the RIPE NCC?

Internet Assigned Numbers Authority



RIR = Regional Internet Registry

- Not-for-profit organisation
- Funded by membership fees
- Policies developed by regional communities
- Neutral, impartial, open, and transparent

- Origin Hijack
- RPKI
- Stats for Spain

RIPE NCC
ACADEMY

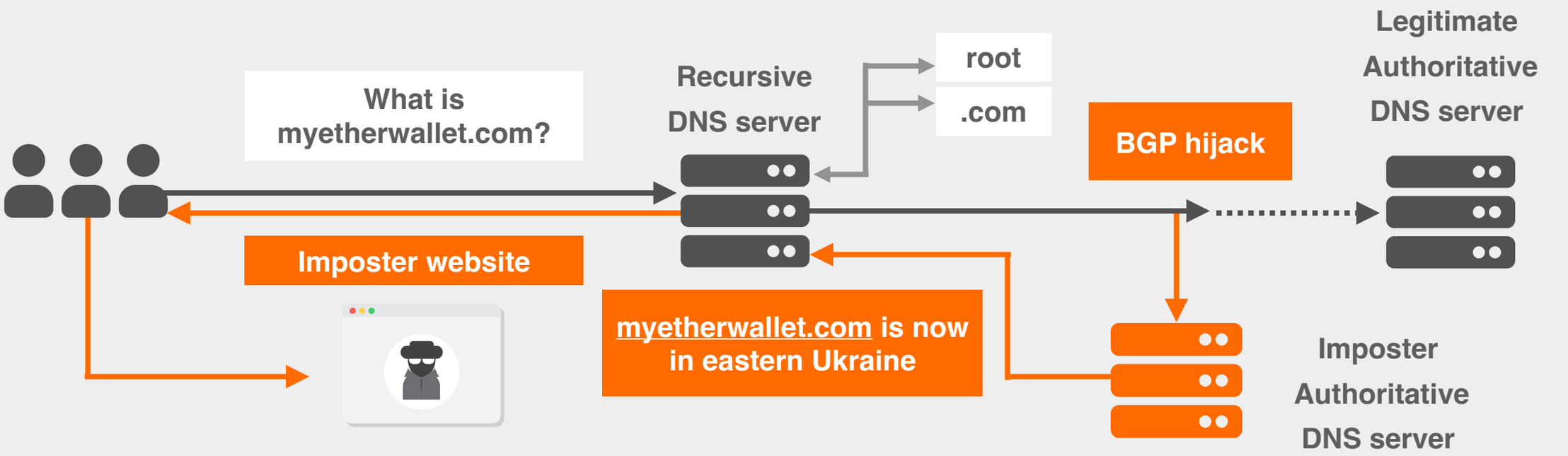
BGP Security E-learning Course

- Free online course
- Interactive, you can study at your own pace
- Practical lab environment and activities

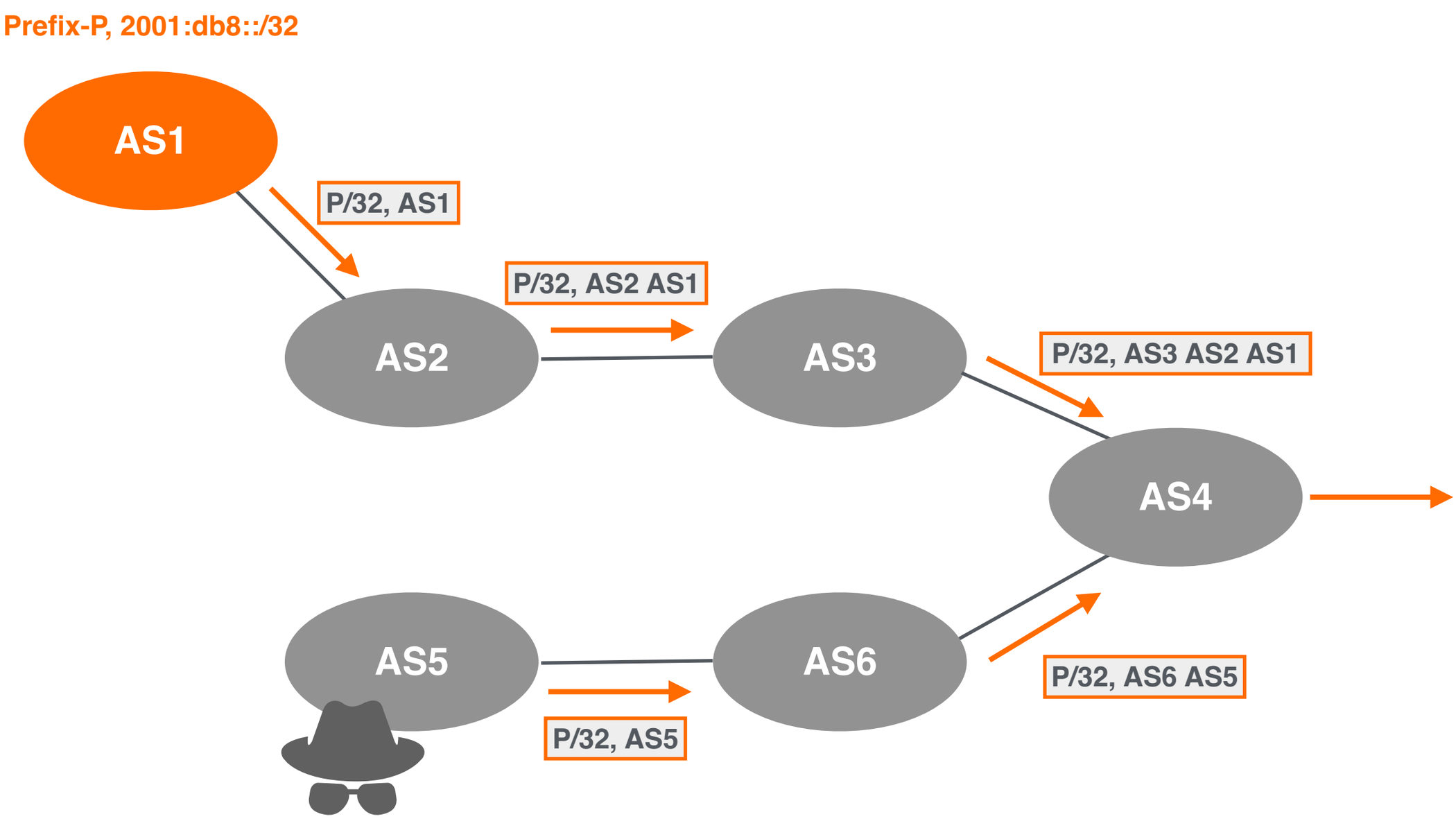
academy.ripe.net/bgp-security/

April 2018: Amazon-MyEtherWallet

- BGP hijack of Amazon DNS
- How did it happen?
- Why? To steal cryptocurrency

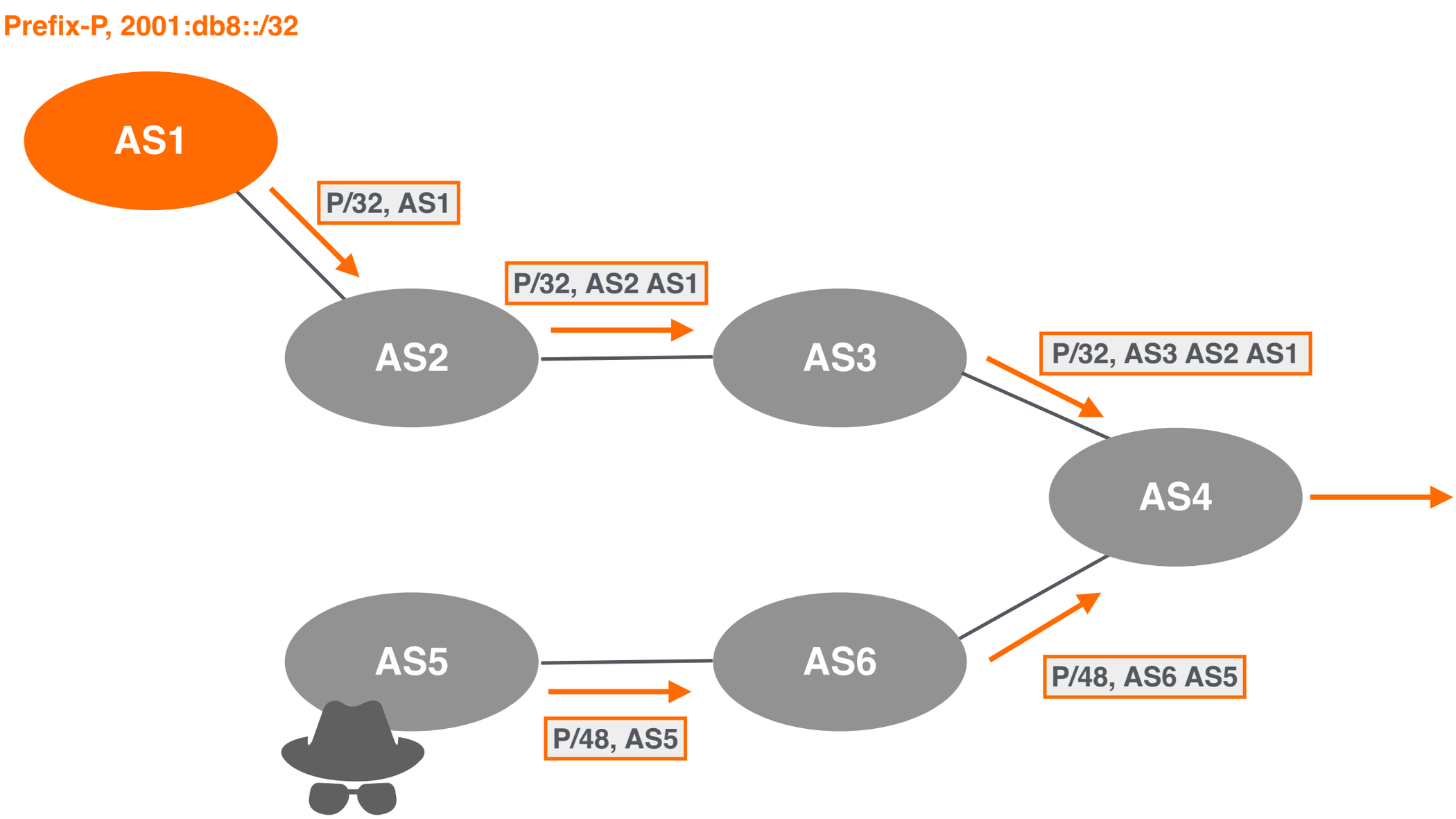


Origin Hijack: Same Prefix



This is a **local hijack!**
Only some networks are affected based on BGP path selection process.

Origin Hijack: More Specific Prefix

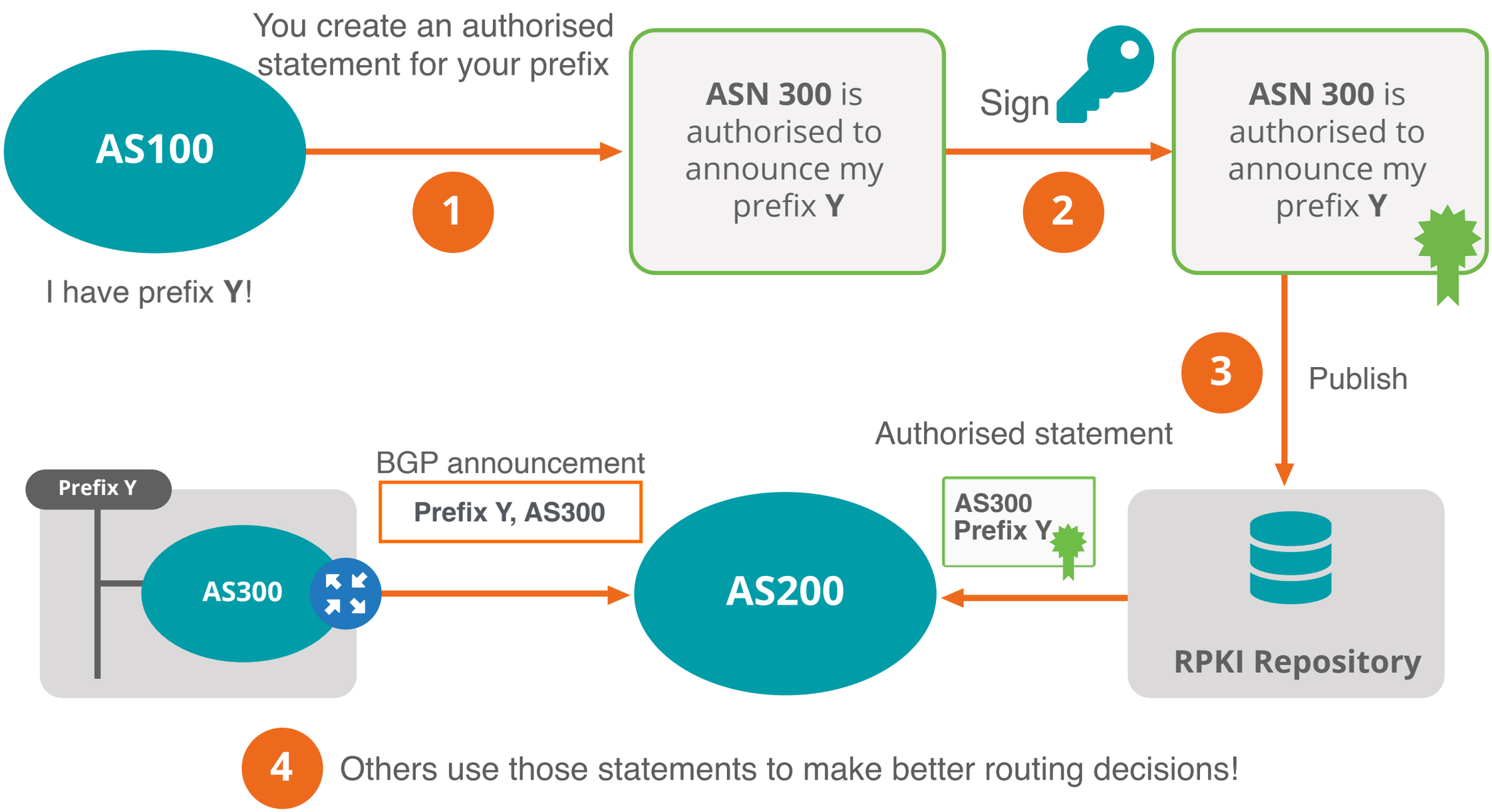


This is a **global hijack!**
All traffic for more specific will be forwarded to the attacker's network network.

What is RPKI?

- A security framework using Public Key Infrastructure and **Resource certification** (X.509 PKI certificates) for BGP route origin validation (ROV)
- Allows resource (IPs) holders to prove ownership, and create authorisations (ROAs)
- ASNs can use ROAs to validate the origin of BGP announcements
  - Is the originating ASN authorised to originate a particular prefix?

How does it work?



4 Others use those statements to make better routing decisions!

Elements of RPKI

- RPKI system consists of two parts…

SIGNING

Create ROAs for your prefixes in the RPKI system

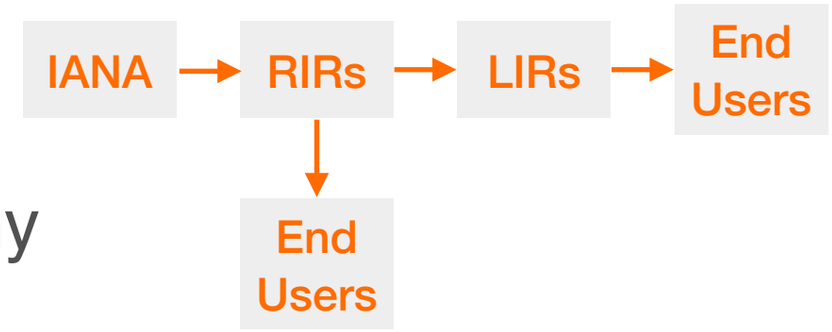
+

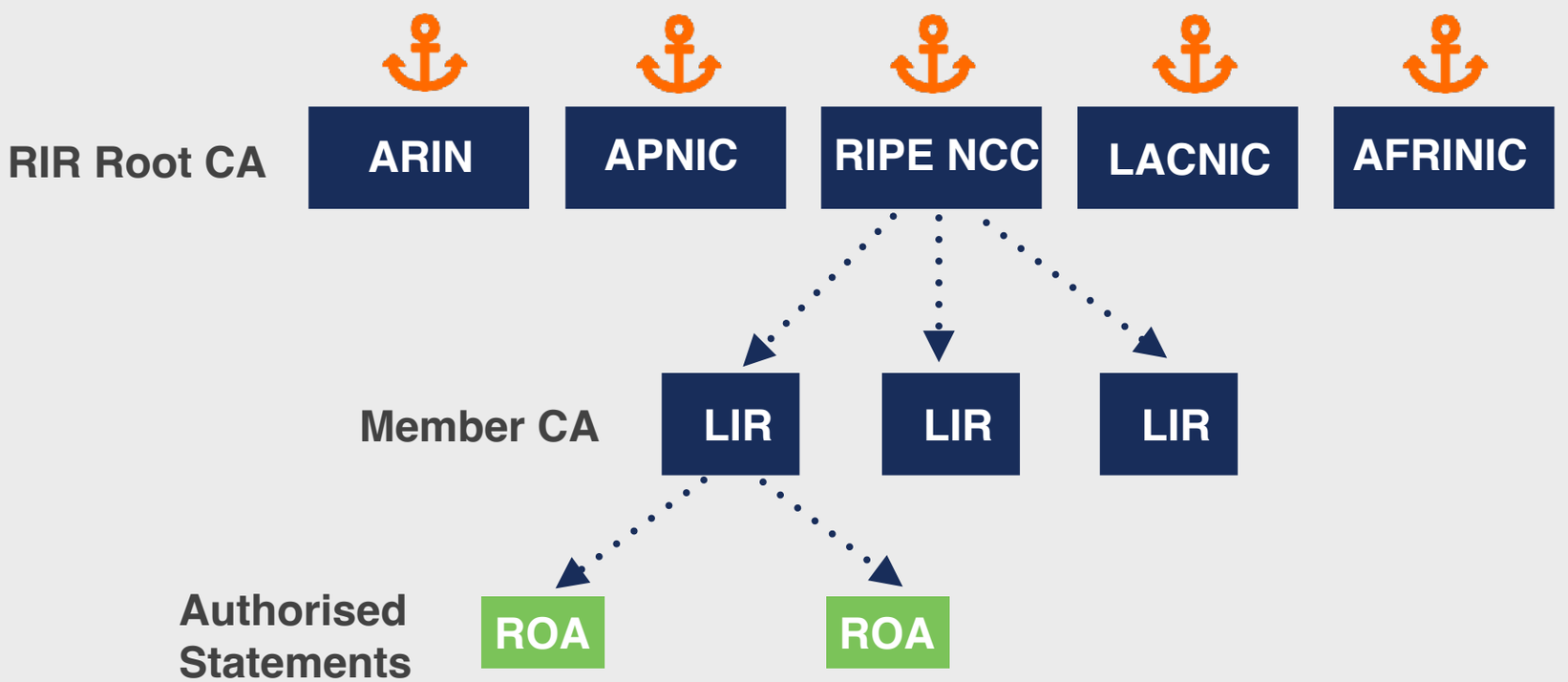
VALIDATION

Verify the information provided by others

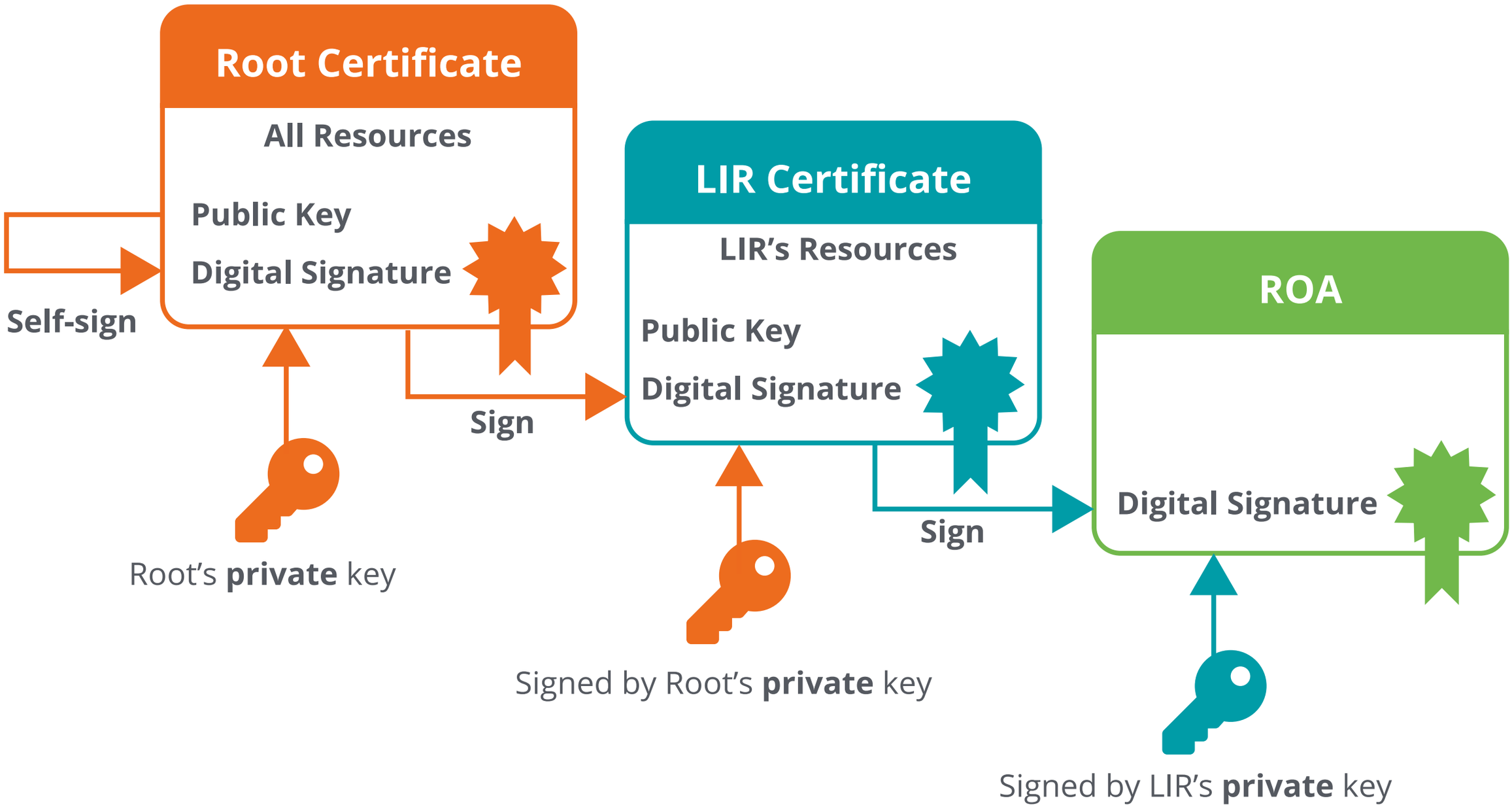
Trust in RPKI

- RPKI relies on five RIRs as Trust Anchors
- Certificate structure follows the RIR hierarchy
- RIRs issue certificates to resource holders



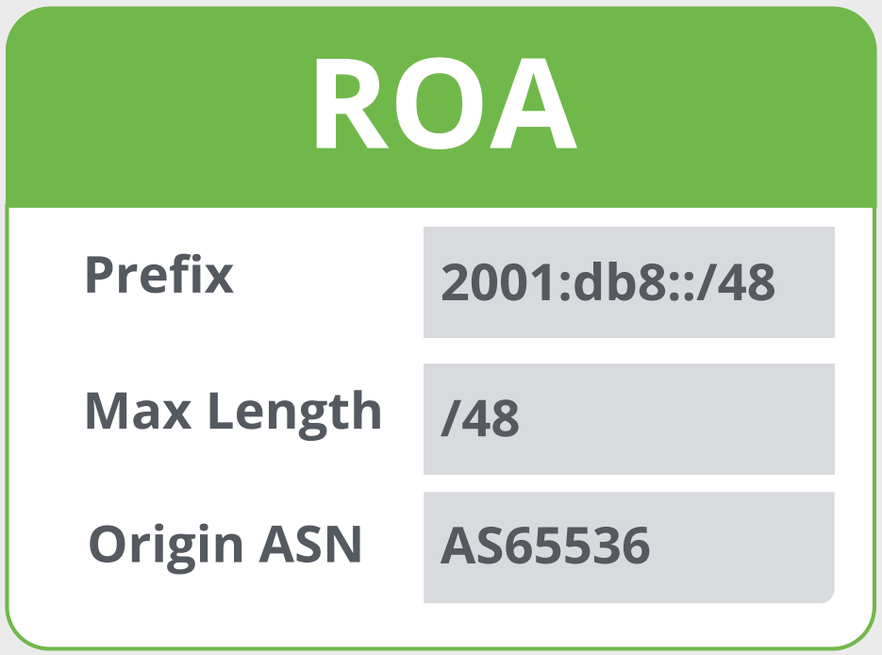


RPKI Chain of Trust



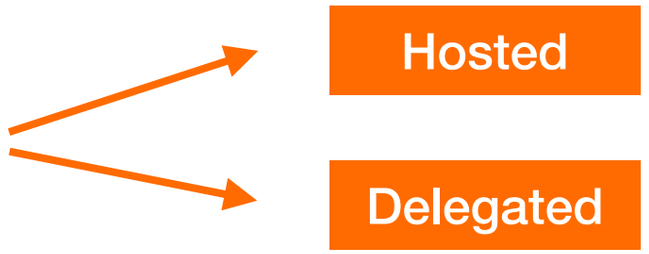
What are ROAs?

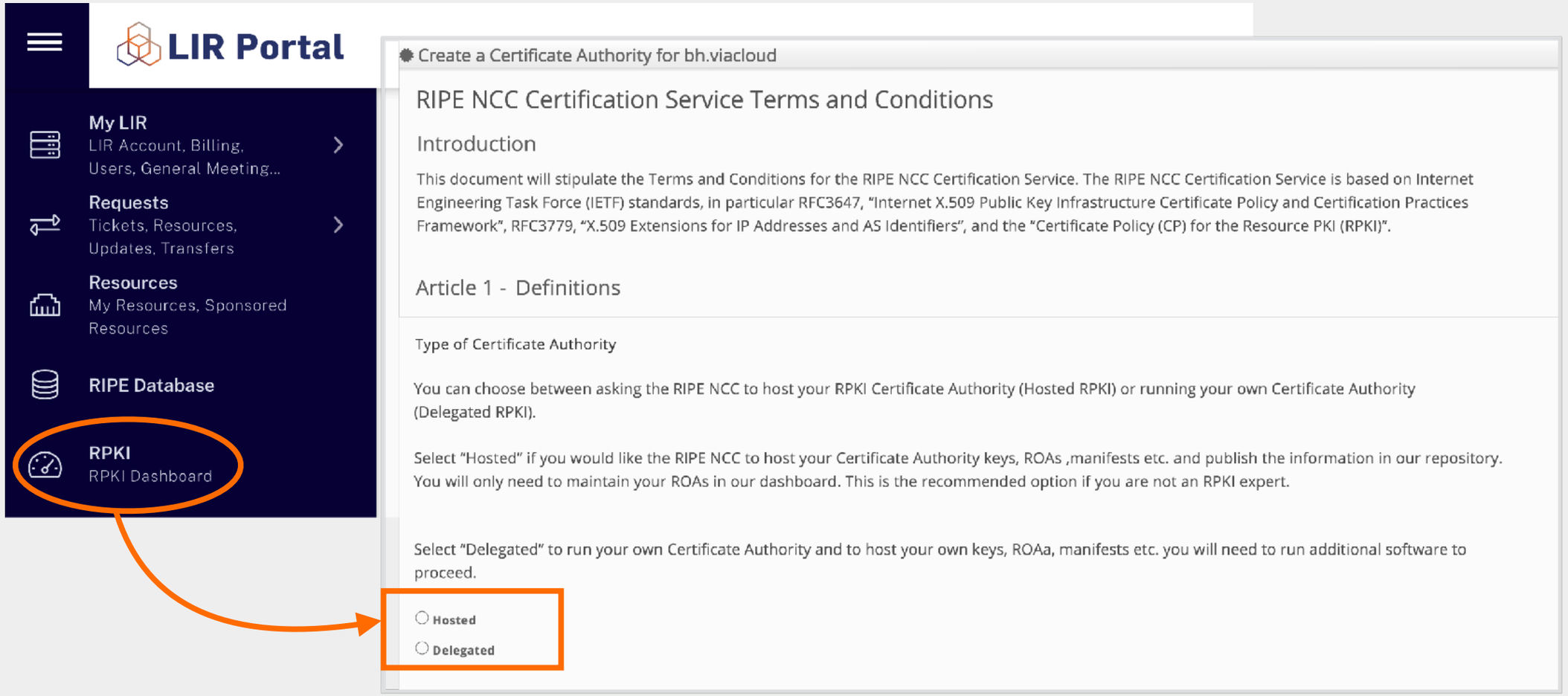
- An **authorised statement** created by the resource holder
- States that a certain prefix can be originated by a certain AS
- LIRs can create ROAs for their resources
- Multiple ROAs can exist for the same prefix
- ROAs can overlap



How to create a ROA?

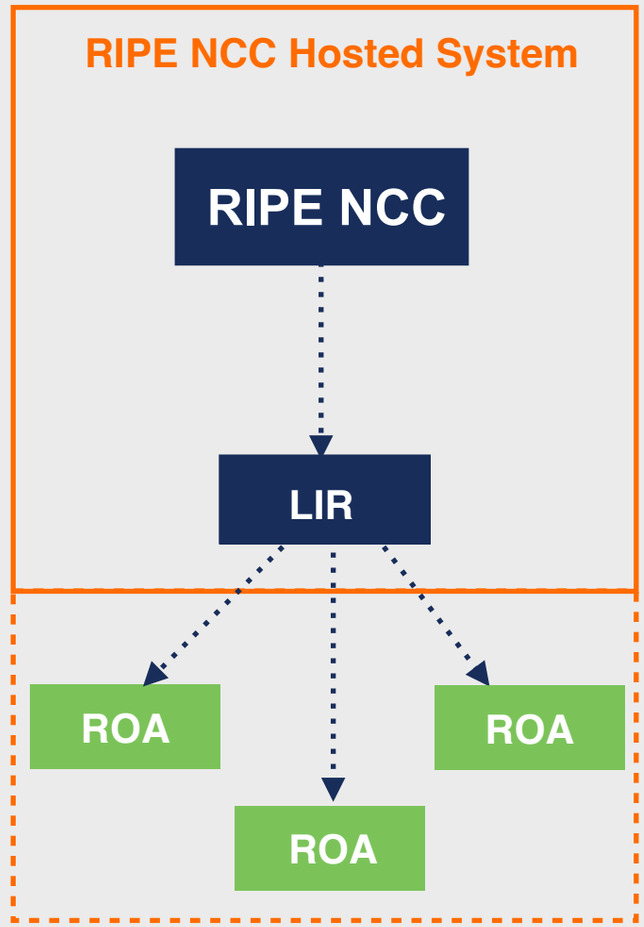
- Login to LIR Portal (my.ripe.net)
- Go to the RPKI Dashboard
- Choose which RPKI model to use





Hosted RPKI

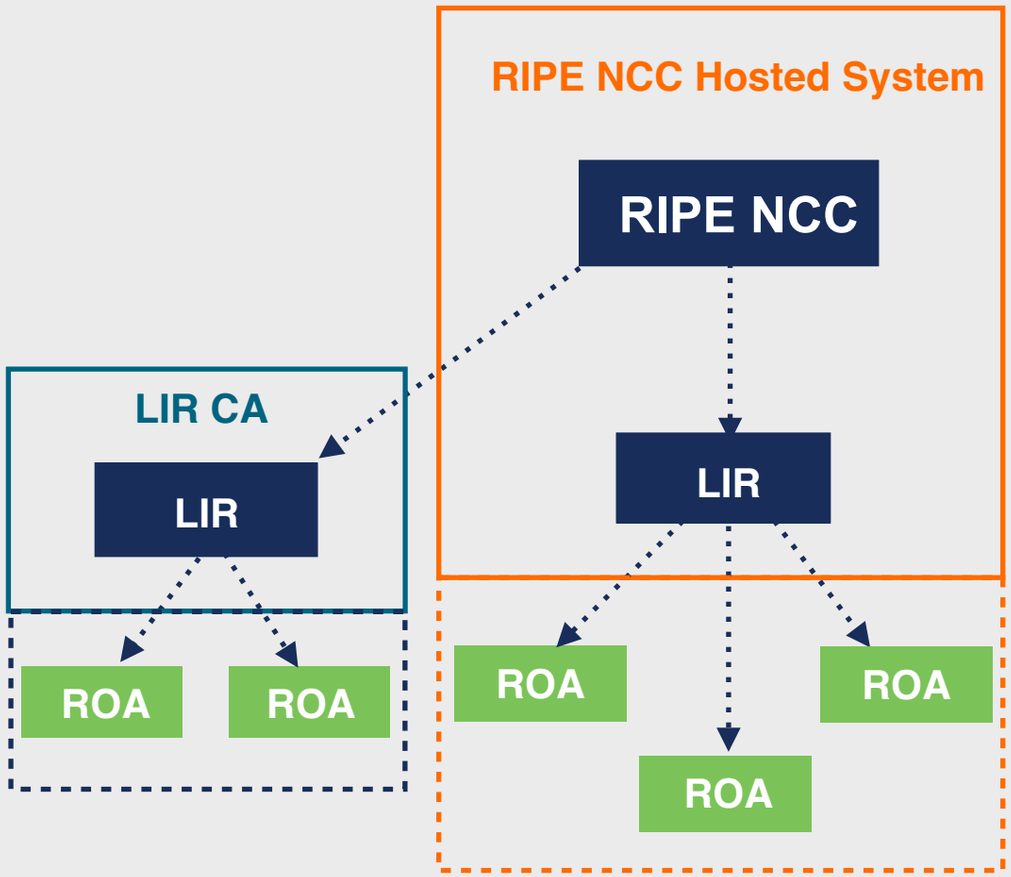
- ROAs are created and published using the **RIR's member portal**
- RIR hosts a CA (Certification Authority) for LIRs and signs all ROAs
- Automated signing and key rollovers



Delegated RPKI

- Each LIR manages its part of the RPKI system
  - Runs its own CA as a child of the RIR
  - Manages keys/key rollovers
  - Creates, signs and publishes ROAs

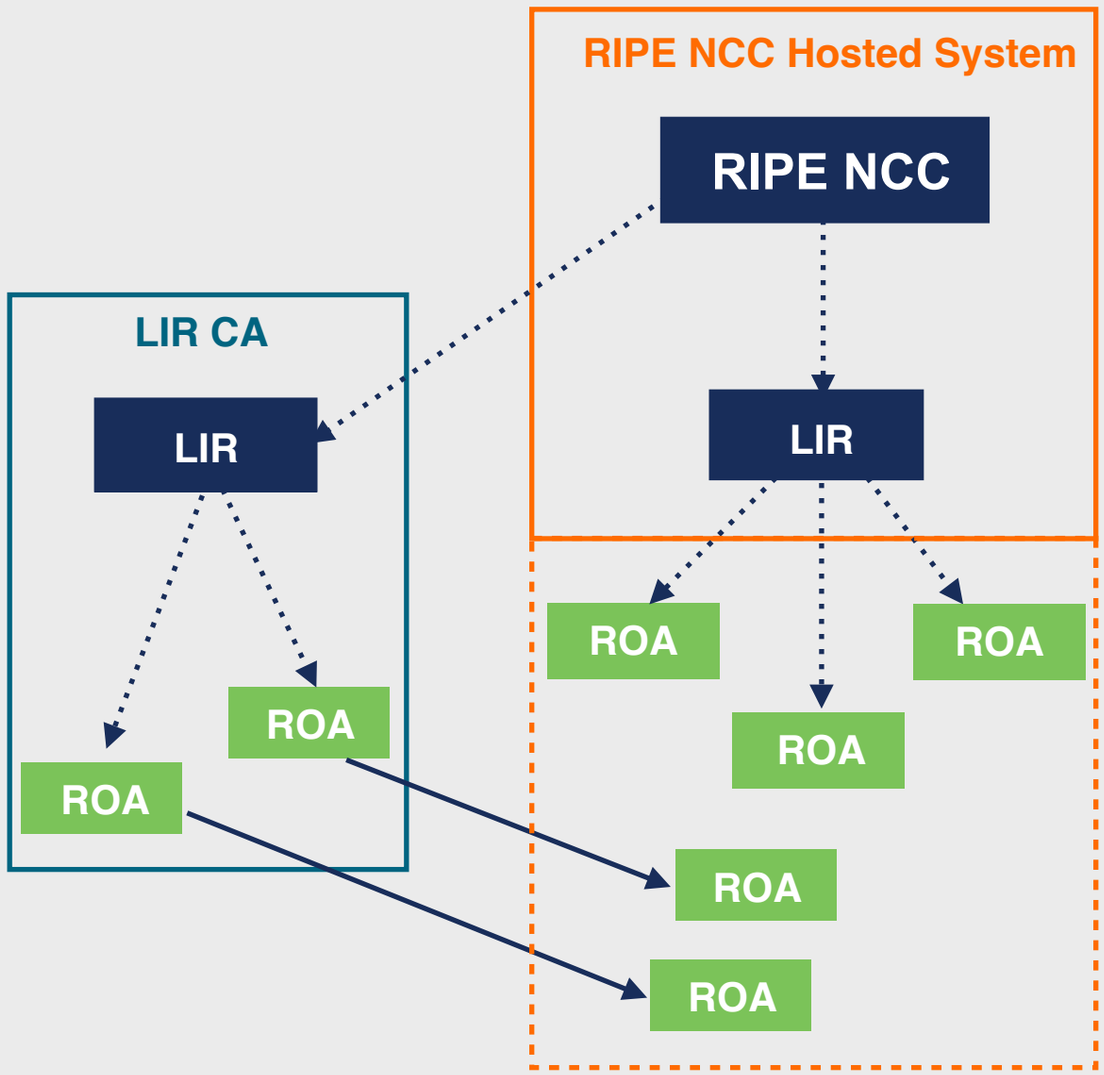
- Certificate Authority (CA) Software
  - **Krill** (NLnet Labs)
  - **rpkid** (Dragon Research Labs)



Publication as a Service

NEW!

- In-between Hosted and Delegated
  - Runs its own CA as a child of the RIR
  - Manages keys/key rollovers and ROAs
  - Maintain key pairs and objects and send them to RIR
  - RIR publishes ROAs on behalf of LIR
- Also APNIC, ARIN, RIPE NCC, NIRs
- AKA “Publication in parent” or “Hybrid RPKI”



Elements of RPKI

- RPKI system consists of two parts…

SIGNING

Create ROAs for your prefixes in the RPKI system

+

VALIDATION

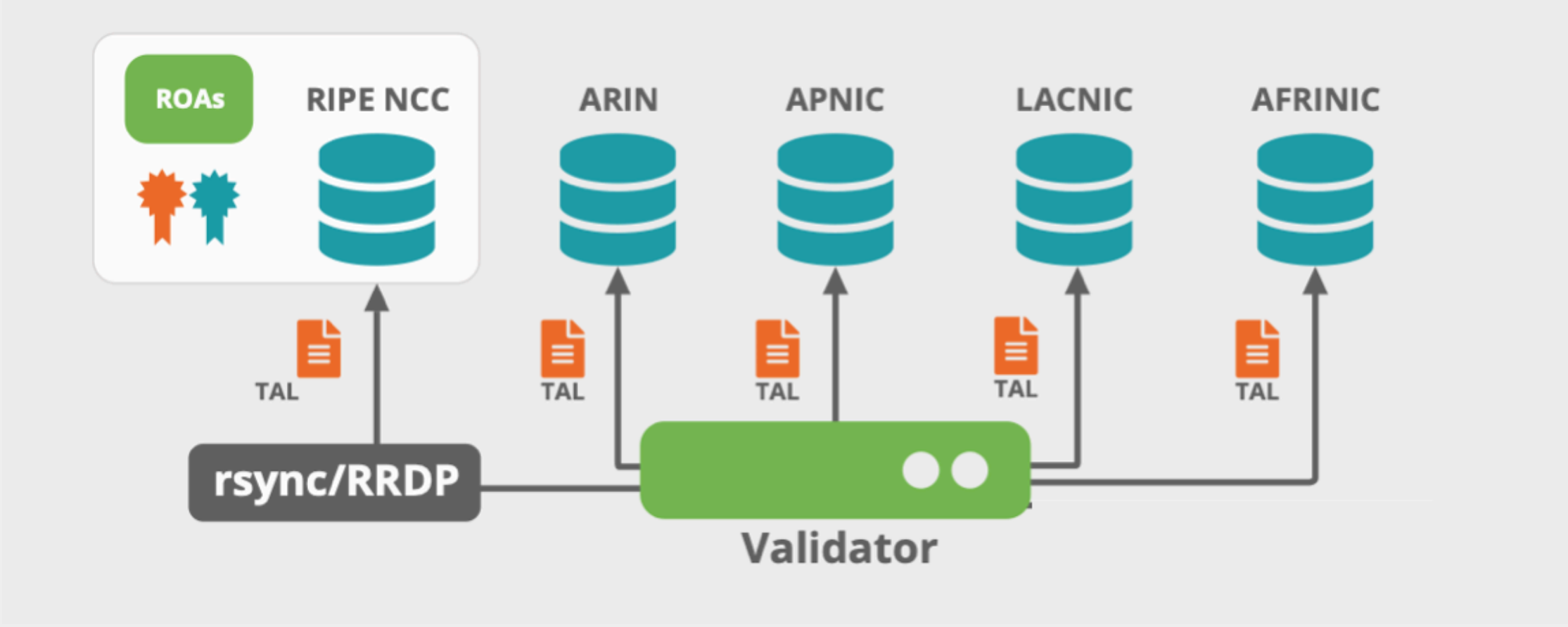
Verify the information provided by others

RPKI Validation

- Verifying the information provided by others
  - Proves holdership through a public key and certificate infrastructure
- In order to validate RPKI data, you need to …
  - install a validator software locally in your network
- Goal is to validate the “origin of BGP announcements”
  - Known as BGP Origin Validation (BGP OV) or Route Origin Validation (ROV)

RPKI Validator

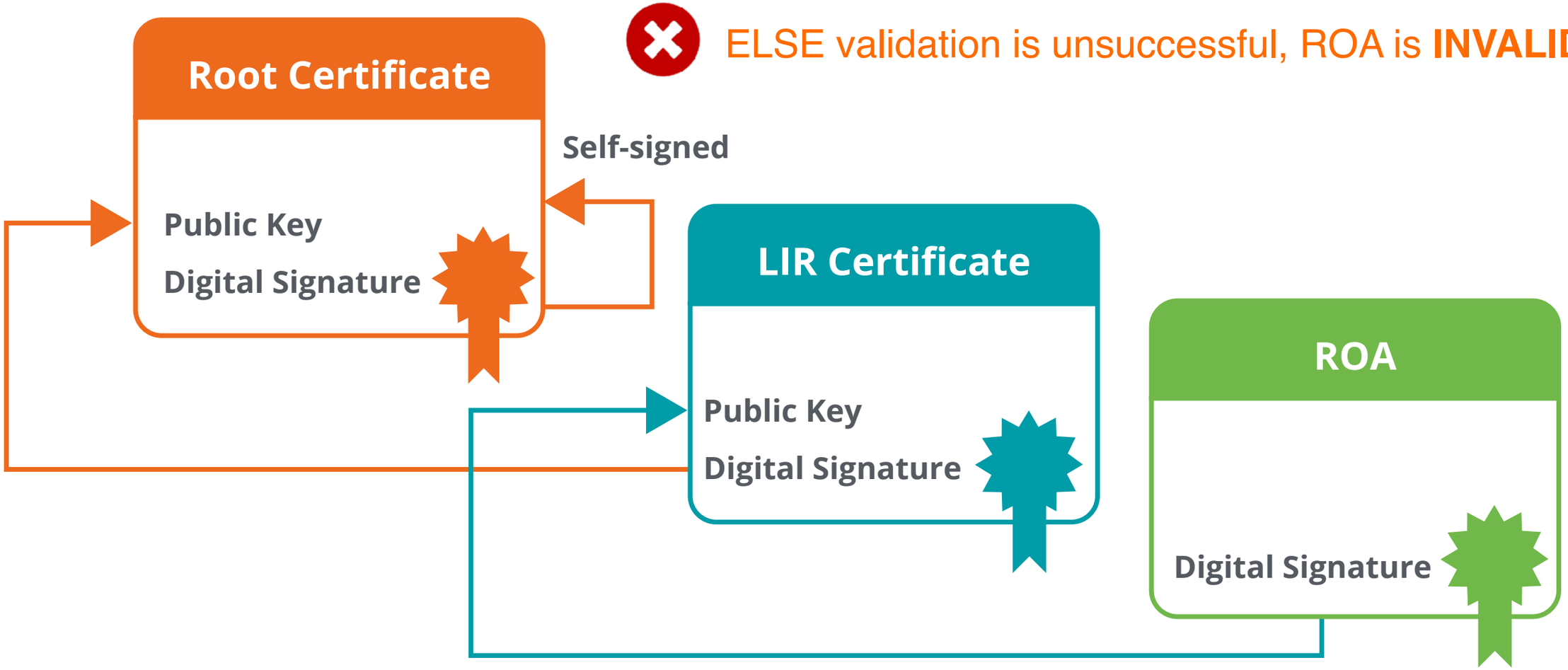
- Connects to RPKI repositories via rsync or RRDP protocol
- Uses TALs to connect to the repositories and download ROAs
- Validates chain of trust for all ROAs and associated CAs
- Creates a local “validated cache” with all the valid ROAs



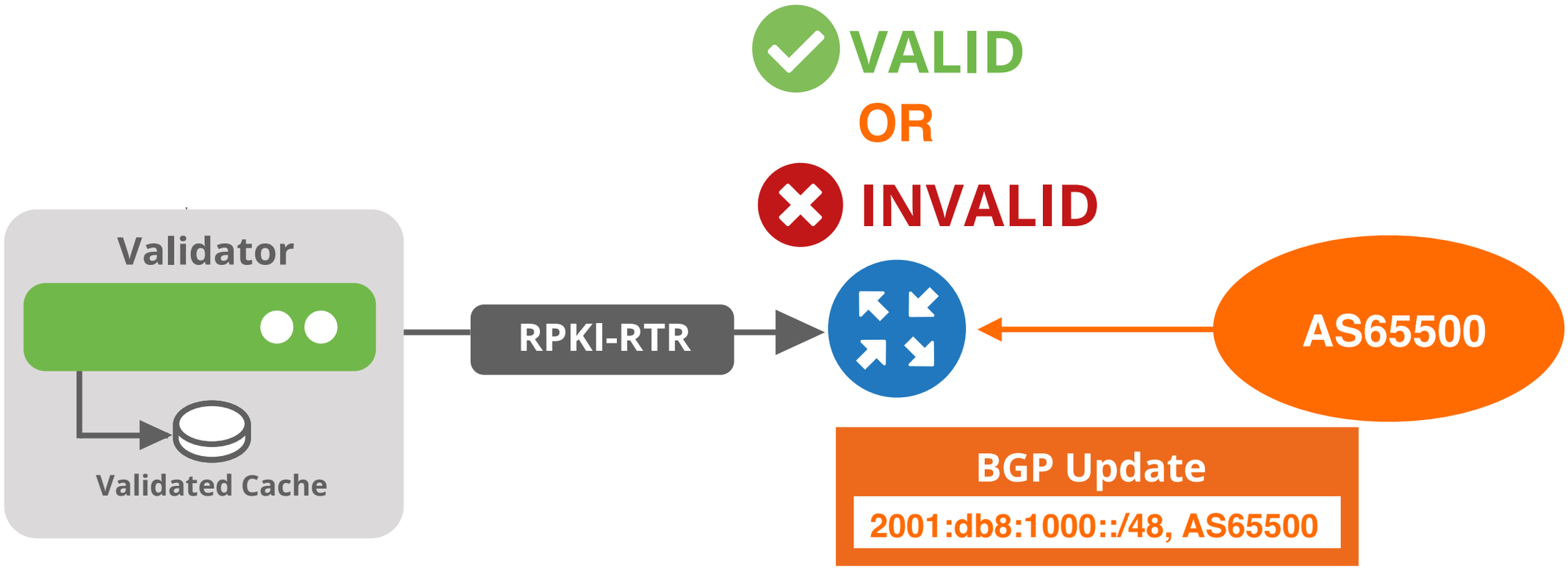
ROA Validation Process

IF chain is complete, it means ROA is **VALID!**

ELSE validation is unsuccessful, ROA is **INVALID!**



Valid ROAs Are Sent to the Router!



Router uses this information to make better routing decisions!

What's New?

RPKI Validators are Mature

- Much better than 5 years ago
- Installation, configuration, documentation is way better
- Big research work on vulnerabilities in 2021
  - Multiple fixes in all validators, mostly addressing potential DoS attacks
  - Source: https://arxiv.org/pdf/2203.00993.pdf

Run Different Validators

Validator	Number (13/5/23)	%
Routinator	2297	79%
rpki-client	253	9%
OctoRPKI	181	6%
FORT	91	3%
Validator	**87**	**3%**
Other	6	0%

Source (13/5/23): https://rov-measurements.nlnetlabs.net/stats/

RPKI Validator Options

- **Routinator**
  - Built by NLNetlabs
- **OctoRPKI**
  - Cloudflare’s relying party software
- **FORT**
  - Open source RPKI validator
- **rpki-client**
  - Integrated in OpenBsd

Links for RPKI Validators

https://github.com/NLnetLabs/routinator.git

https://github.com/cloudflare/cfrpki#octorpki

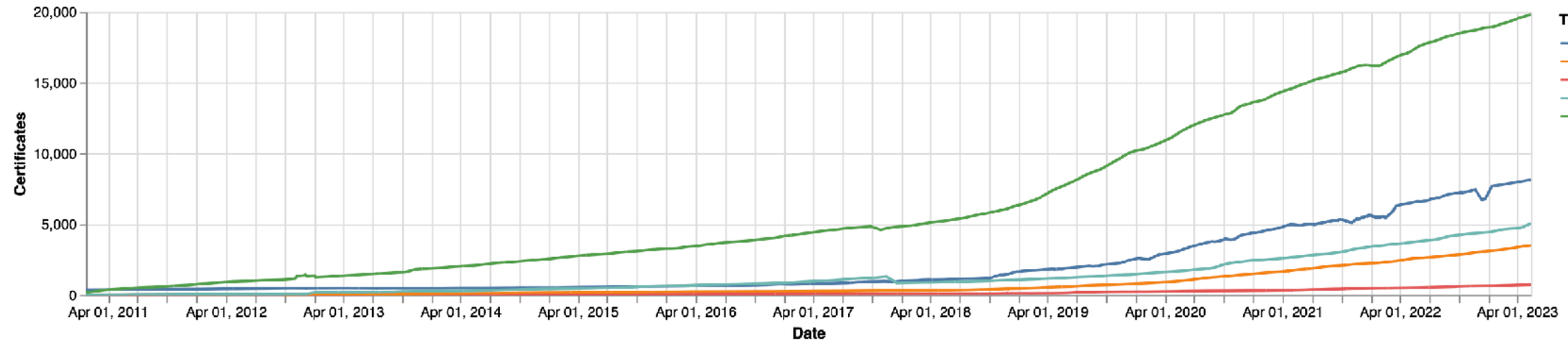
https://github.com/NICMx/FORT-validator/

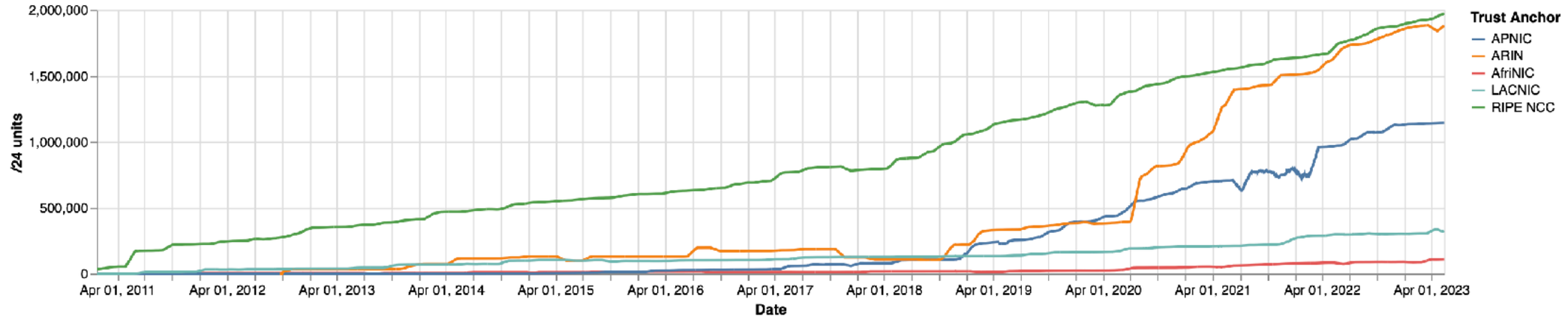
https://www.rpki-client.org/

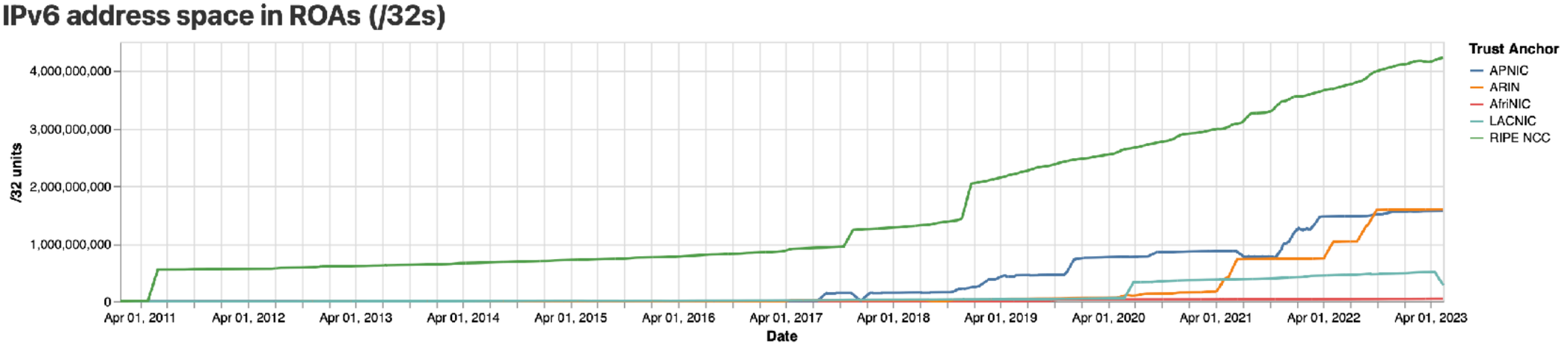
For more info…

https://rpki.readthedocs.io

Steady growth: Adoption and ROAs





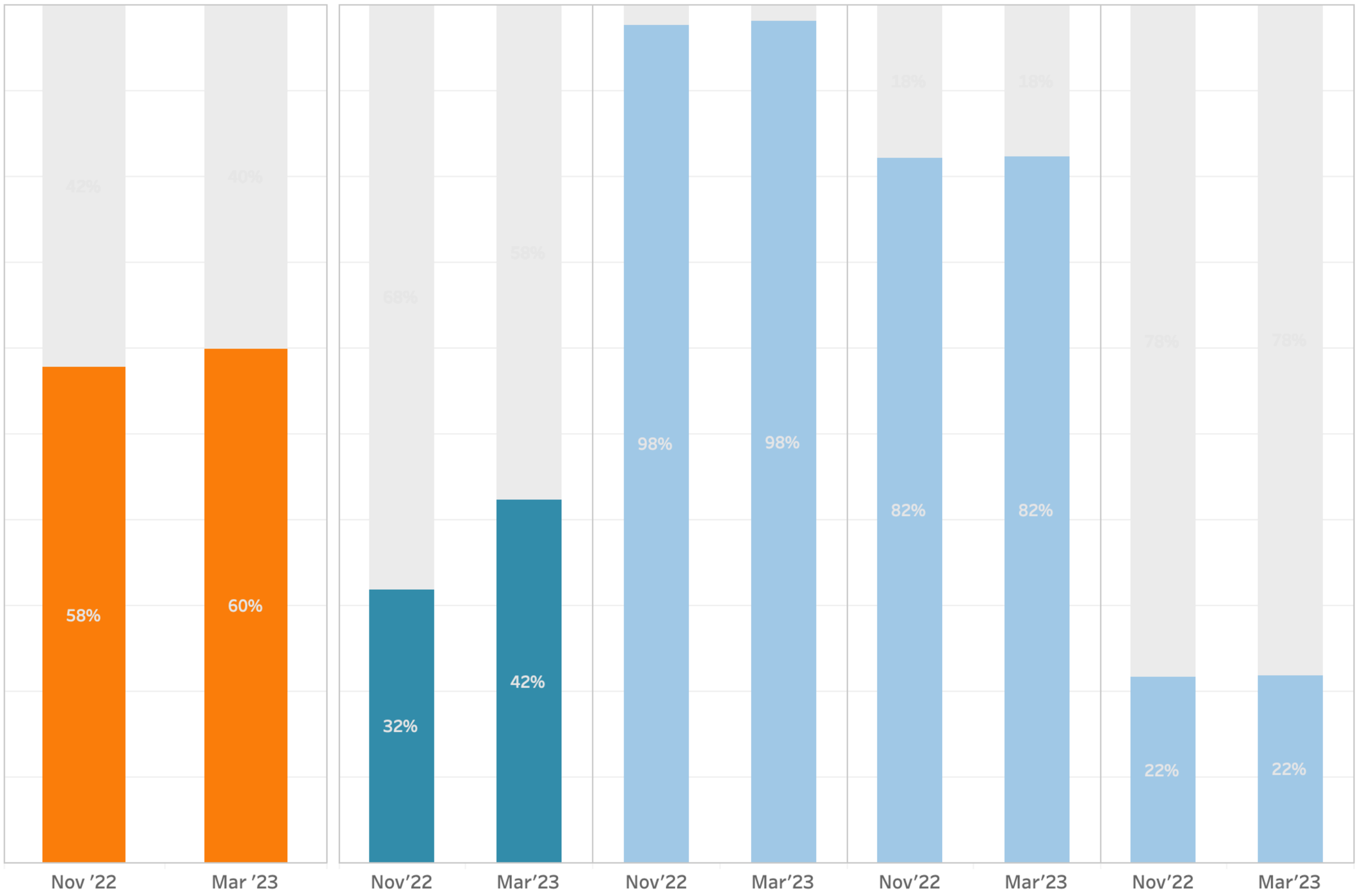


Source (14/5/23): https://certification-stats.ripe.net/

Adoption per RIR

RIR	IPv4 Addr. Space	IPv6 Addr. Space
APNIC	33%	23%
RIPE NCC	61%	37%
LACNIC	42%	23%
ARIN	29%	35%
AFRINIC	25%	7%

Source (14/5/23): https://ftp.ripe.net/pub/stats/ripencc/nro-adoption/latest/


RIPE NCC
SPAIN
PORTUGAL
FRANCE
ITALY
42%
40%
58%
60%
68%
58%
32%
42%
98%
98%
98%
98%
18%
18%
82%
82%
78%
78%
22%
22%
Nov '22
Mar '23
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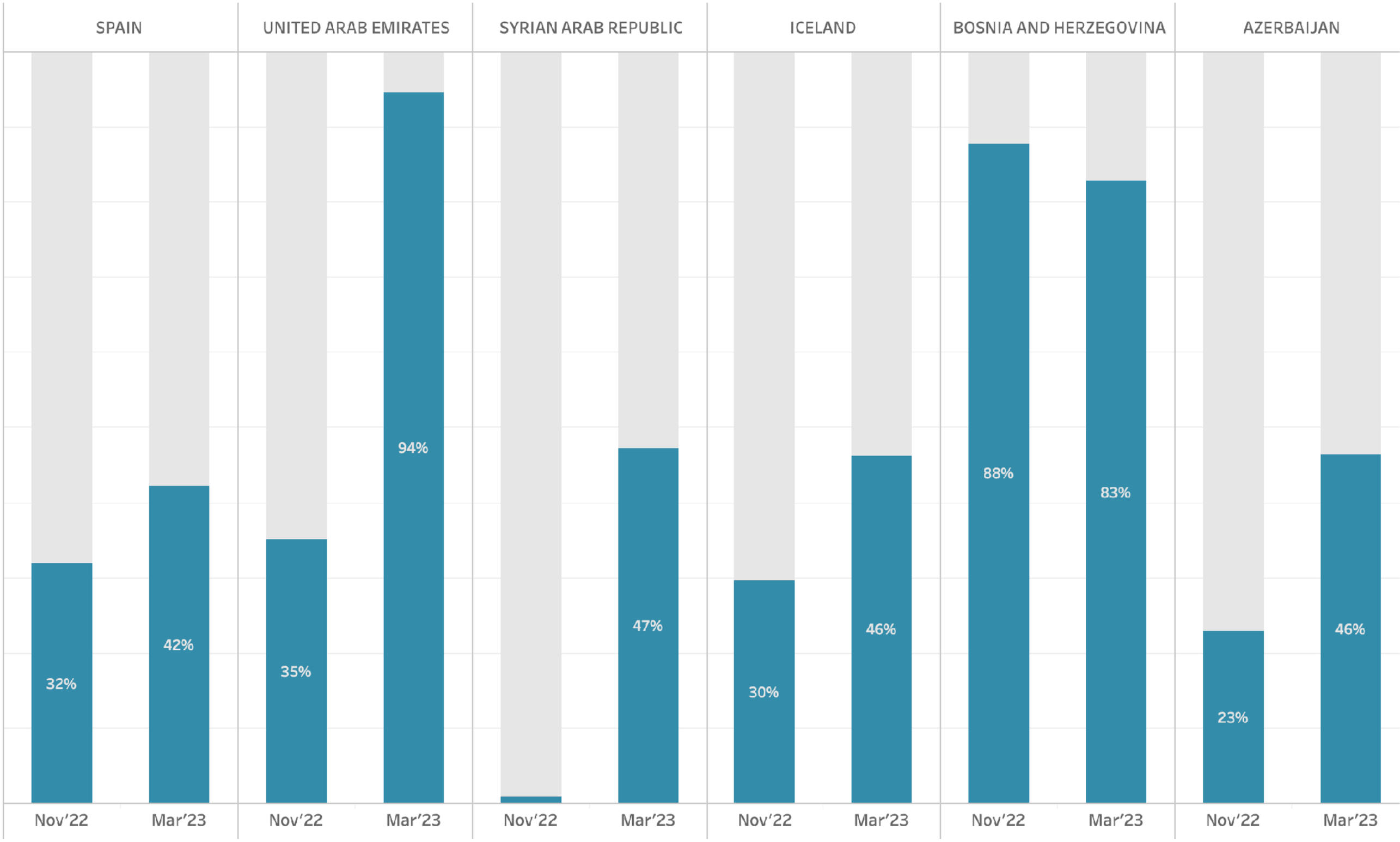
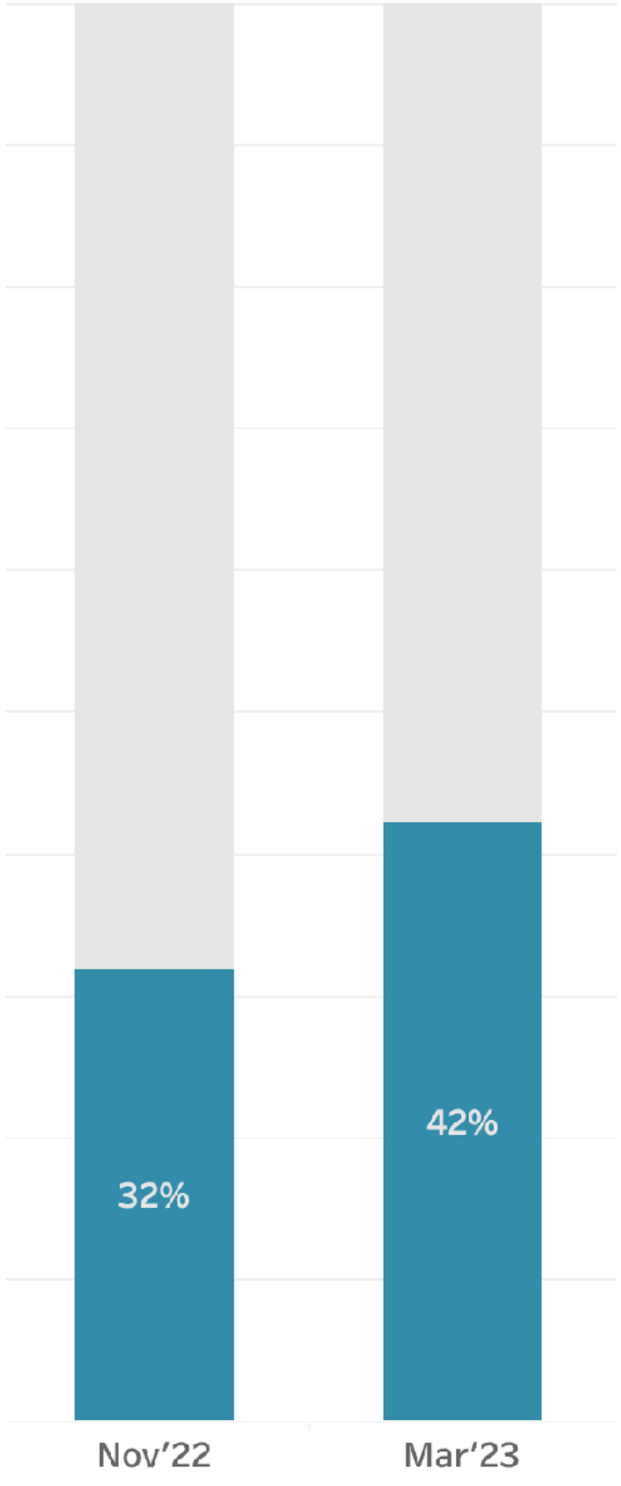
Countries with the most change in IPv4 ROA Coverage

November 2022 vs March 2023



IPv4 ROA Coverage in SPAIN

November 2022 vs March 2023



Change

Select Country

SPAIN

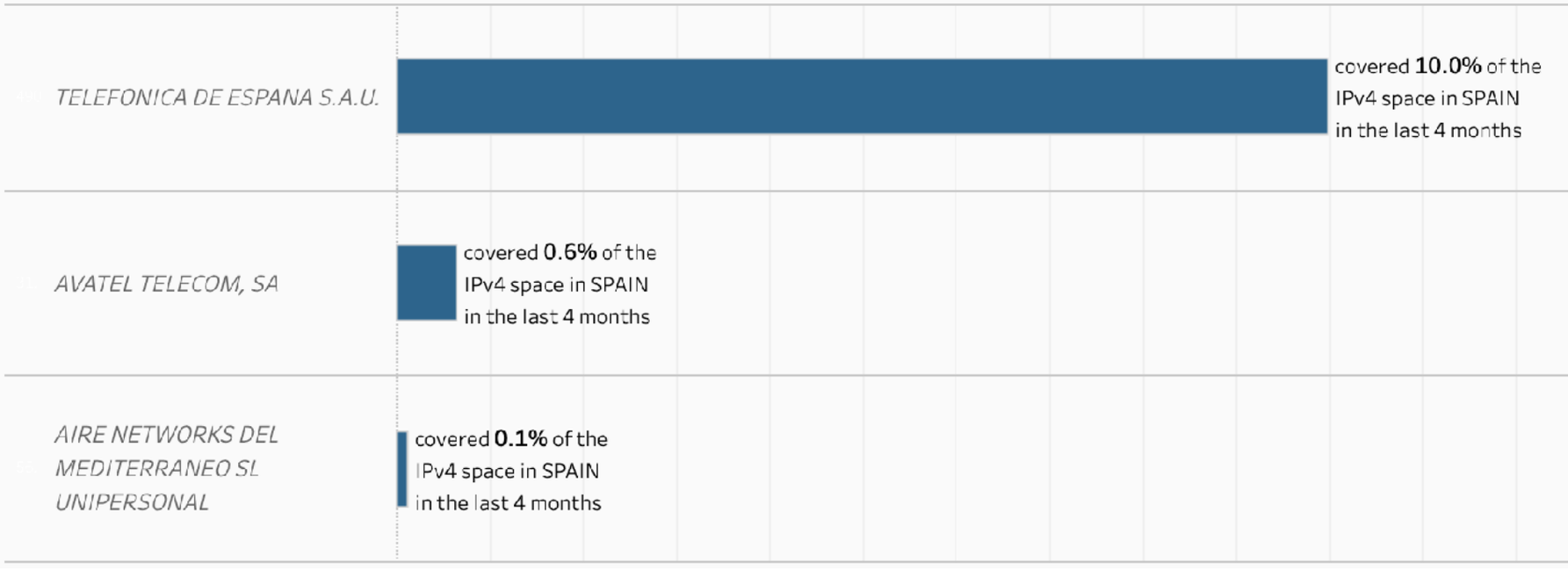
10% increase
in IPv4 ROA coverage

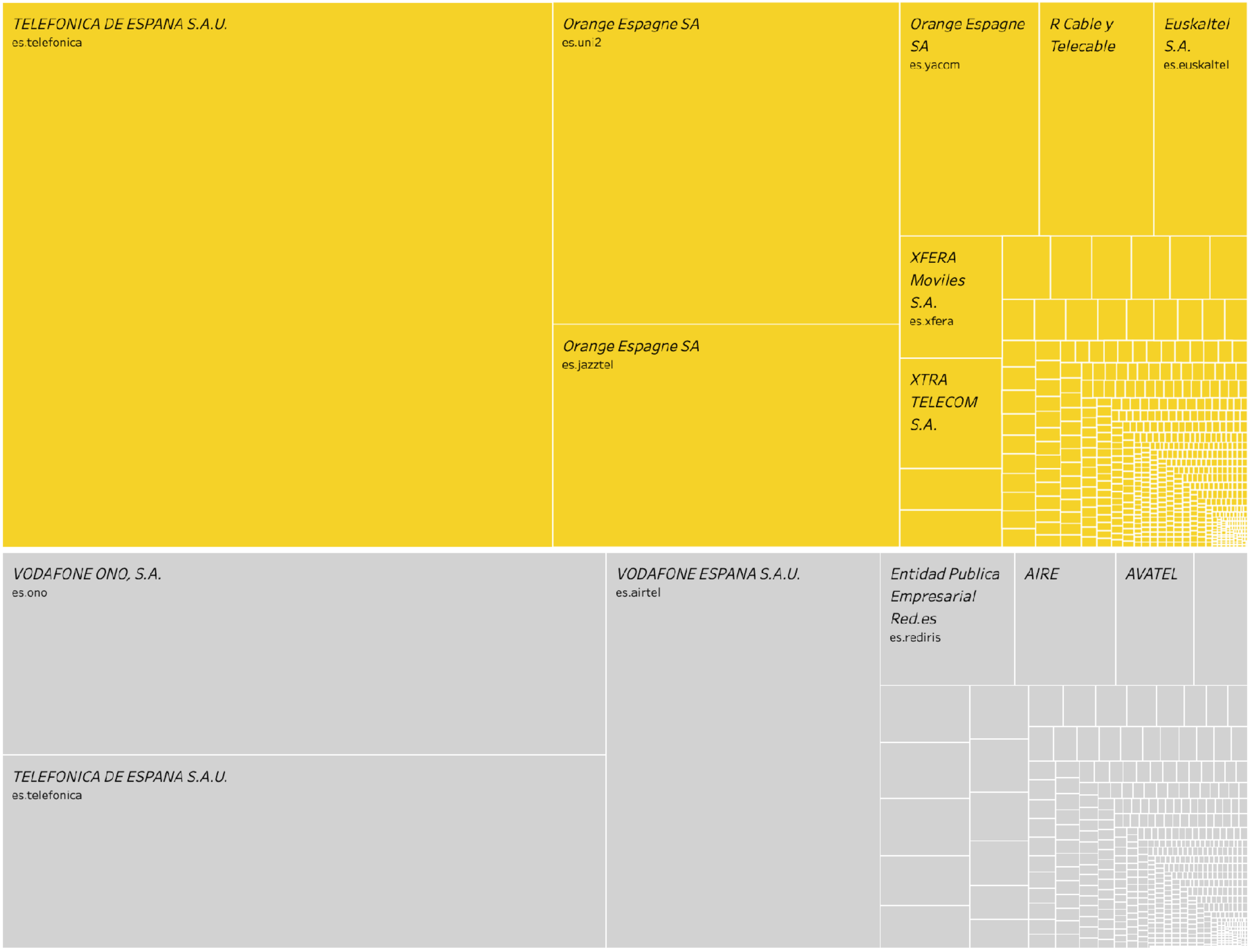
32.4% increase
in ROA covered IPv4 space

0.1% decrease
in IPv4 space

Who to thank??

Top 3 contributors to the increase in IPv4 ROA coverage in SPAIN




TELEFONICA DE ESPANA S.A.U.
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Orange Espagne SA
es.un!2
Orange Espagne SA
es.jazztel
Orange Espagne SA
es.yacom
R Cable y Telecable
Euskaltel S.A.
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XFERA Moviles S.A.
es.xfera
XTRA TELECOM S.A.
VODAFONE ONO, S.A.
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TELEFONICA DE ESPANA S.A.U.
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VODAFONE ESPANA S.A.U.
es.airtel
Entidad Publica Empresarial Red.es
es.rediris
AIRE
AVATEL
covered
uncovered


Ënn
Соңы
An Críoch
پایان
Y Diwedd
Vége
Endir
Finvezh
վերջ
Ende
Koniec
Son
დასასრული
Amaia
הסוף
Кінець
Finis
Lõpp
Tmiem
Sfârşit
Loppu
Liðugt
Kpaj
Slutt
Kraj
النهاية
Конец
Konec
Fund
Fin
Fí
Край
Τέλος
Fine
Einde
Pabaiga
Slut
Fim
Beigas
END

Questions