RIPE NCC
RIPE NETWORK COORDINATION CENTRE

BGP Routing Security: Hijacks vs RPKI

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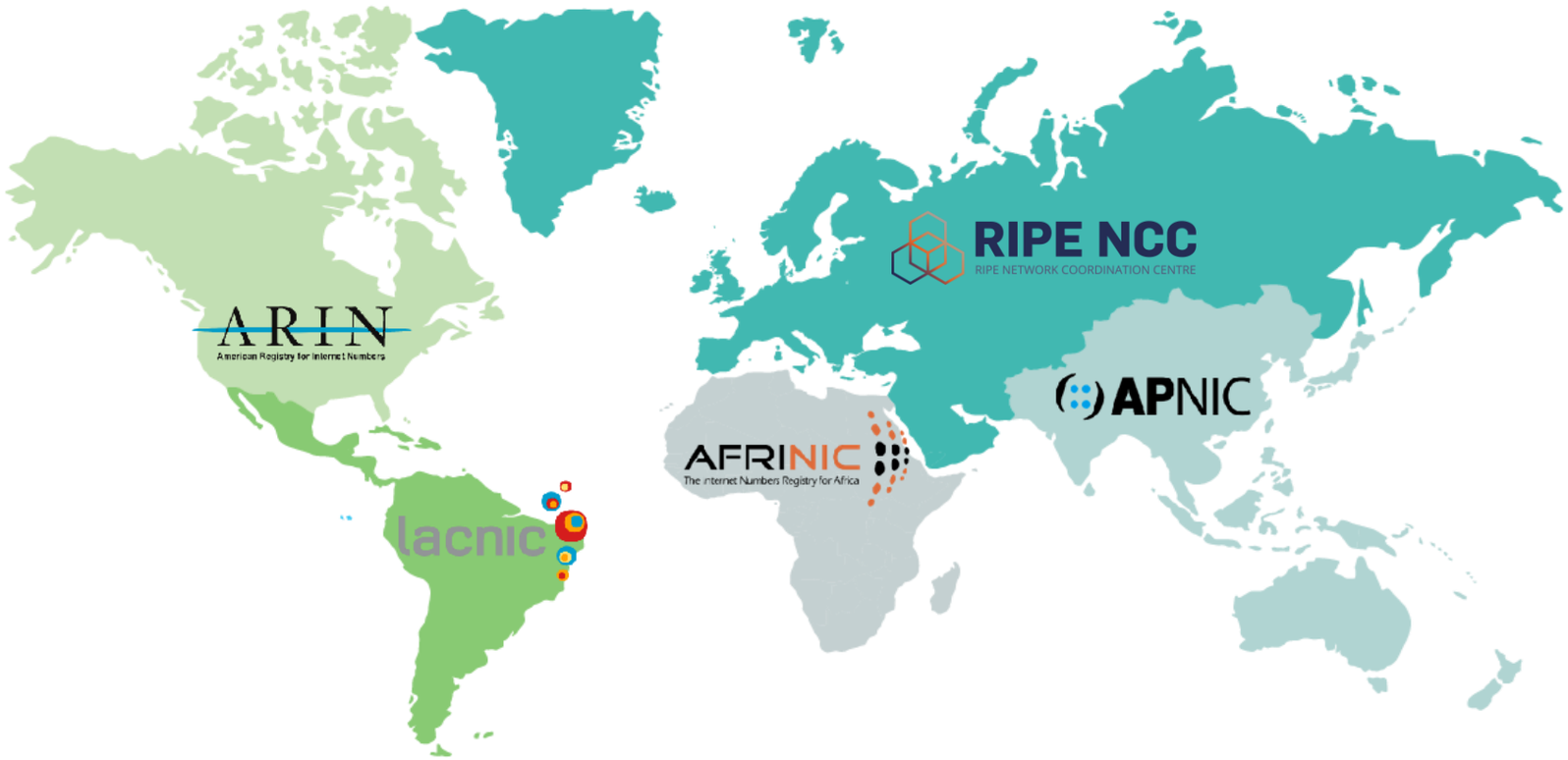
RIPE NCC

What is the RIPE NCC?

Internet Assigned Numbers Authority



RIR = Regional Internet Registry

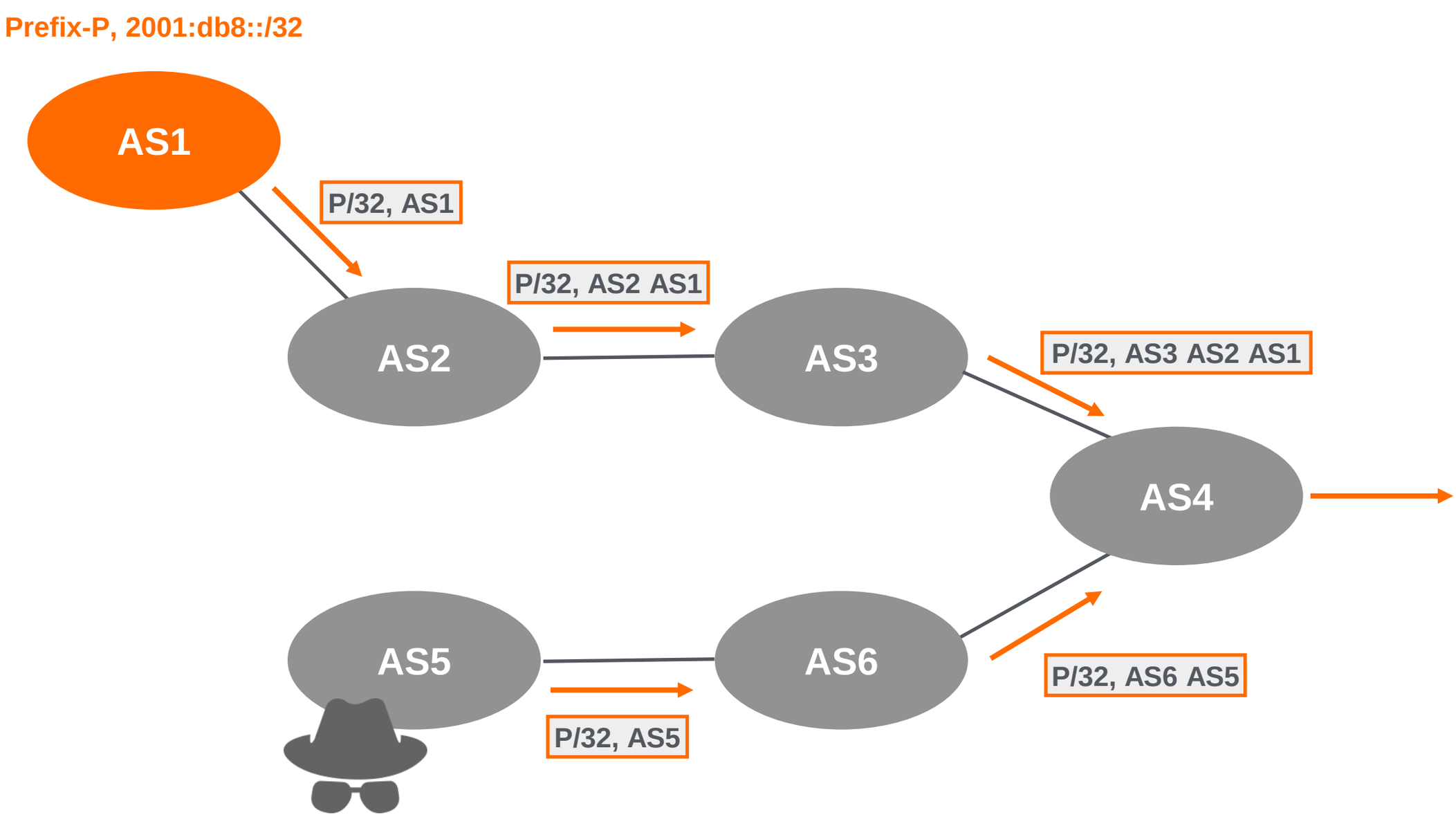
- Not-for-profit organisation
- Funded by membership fees
- Policies developed by regional communities
- Neutral, impartial, open, and transparent

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?

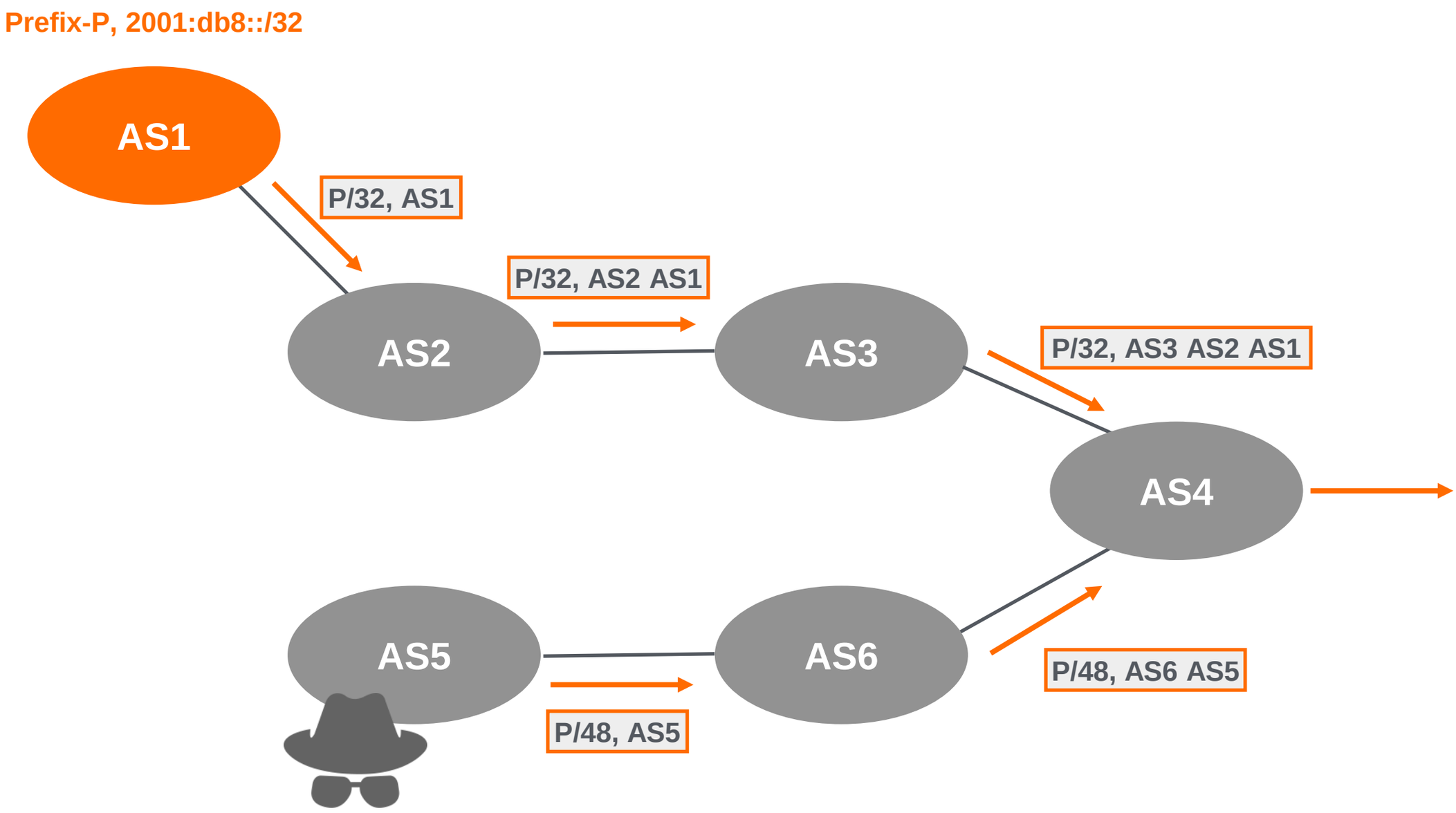
Resource
Public
Key
Infrastructure

Origin Hijack: Same Prefix



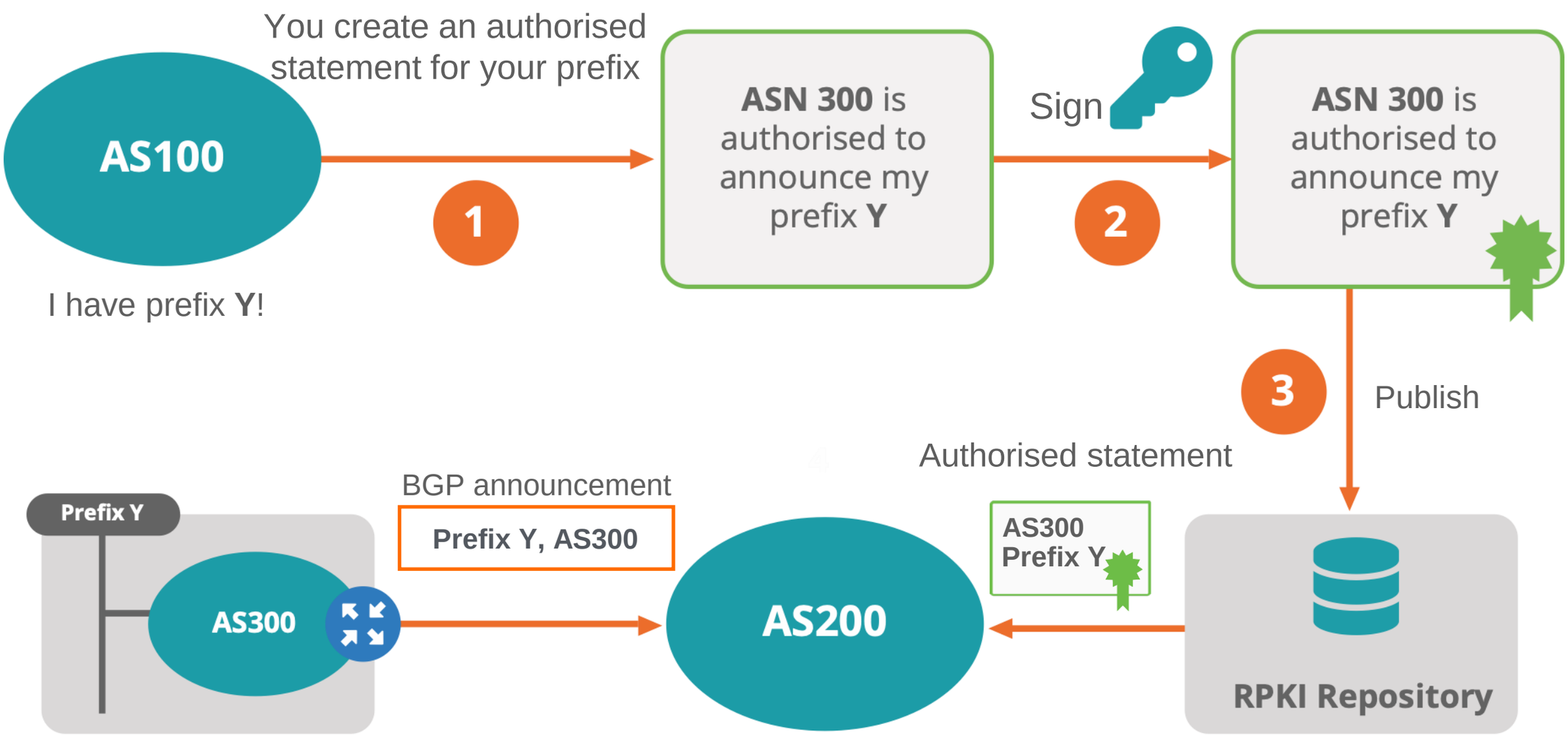
This is a **local hijack!**
Only some networks are affected based on BGP path selection process.

Origin Hijack: More Specific Prefix



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

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

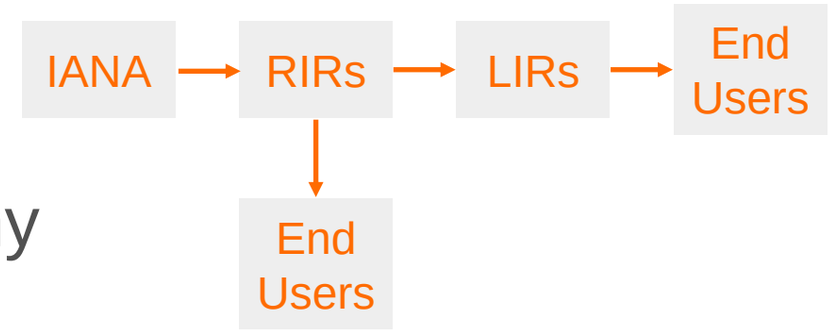
+

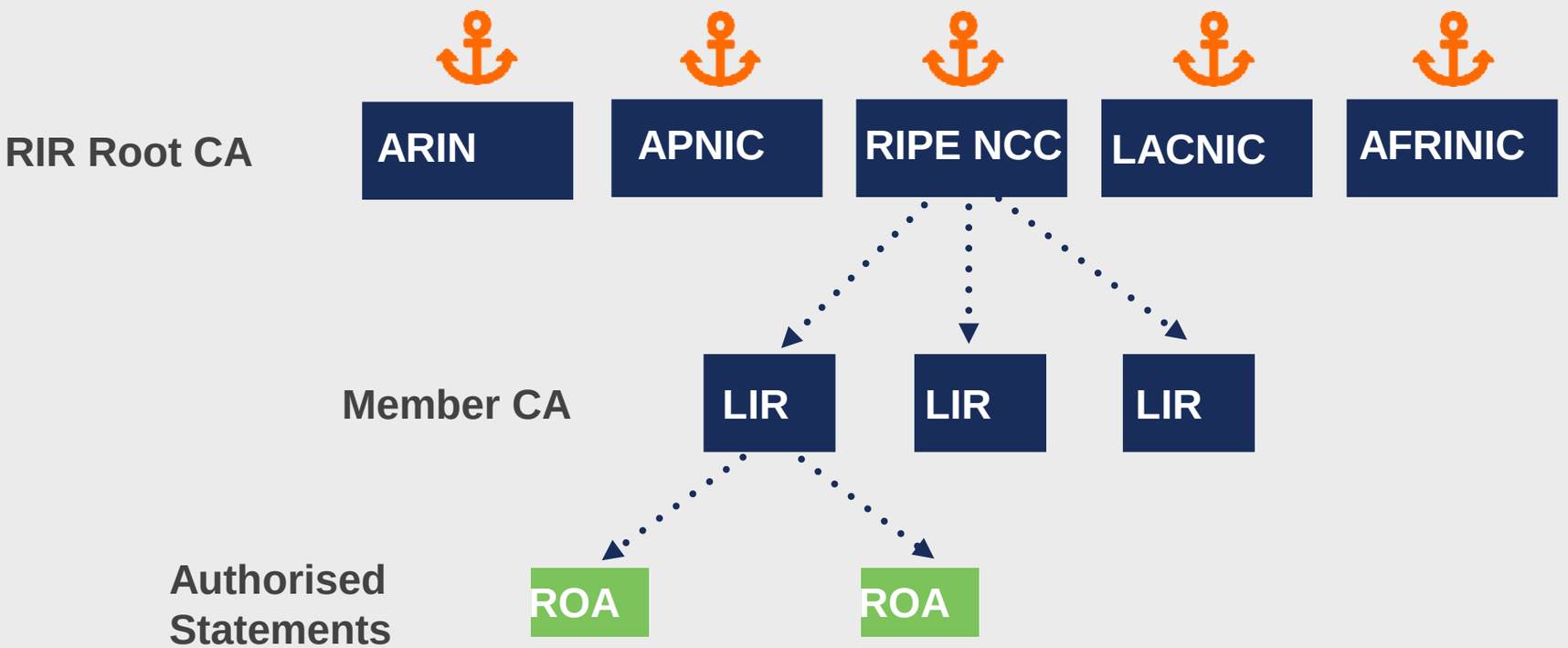
VALIDATION

Verify the information provided by others

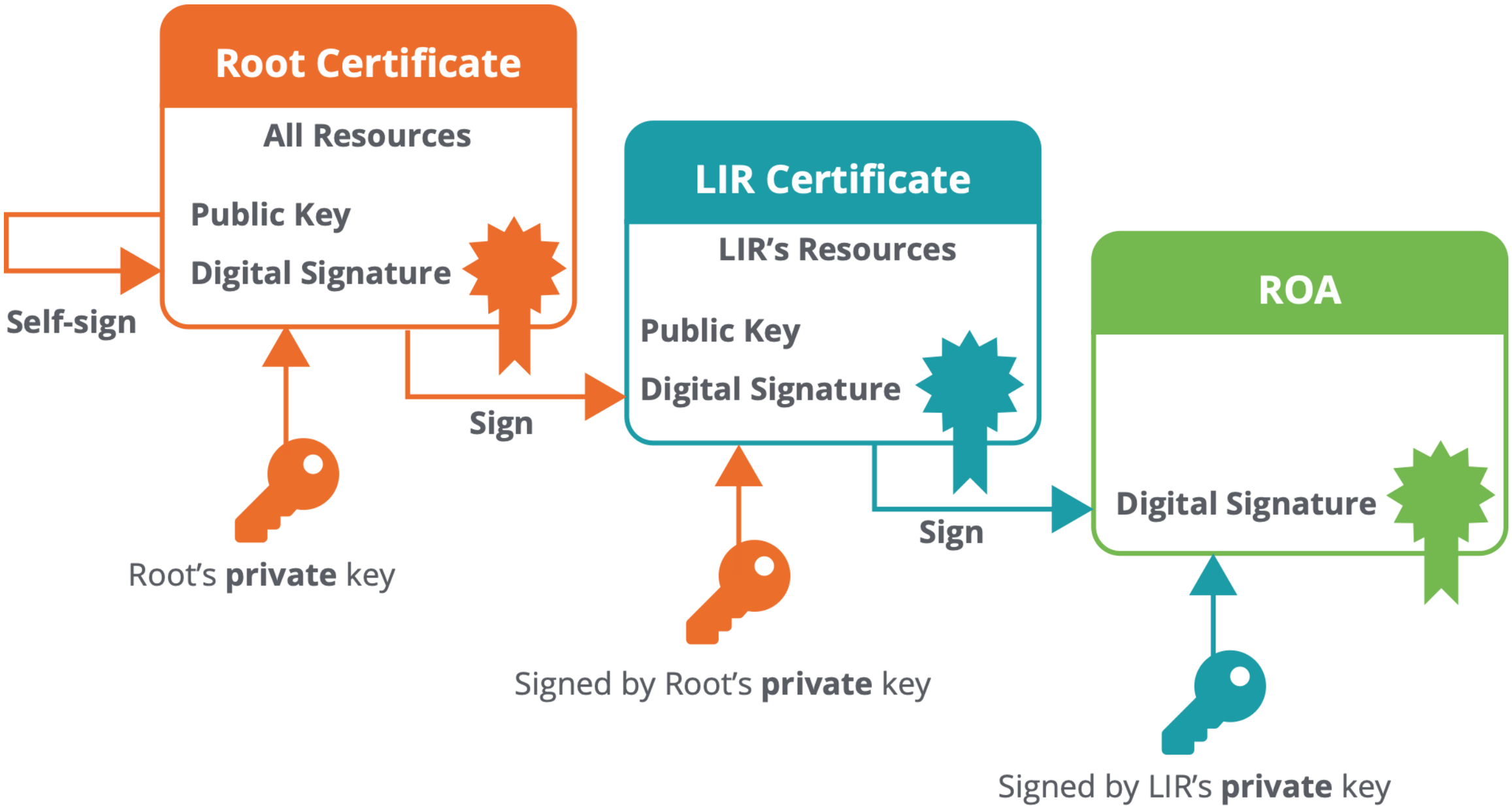
Trust in RPKI

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



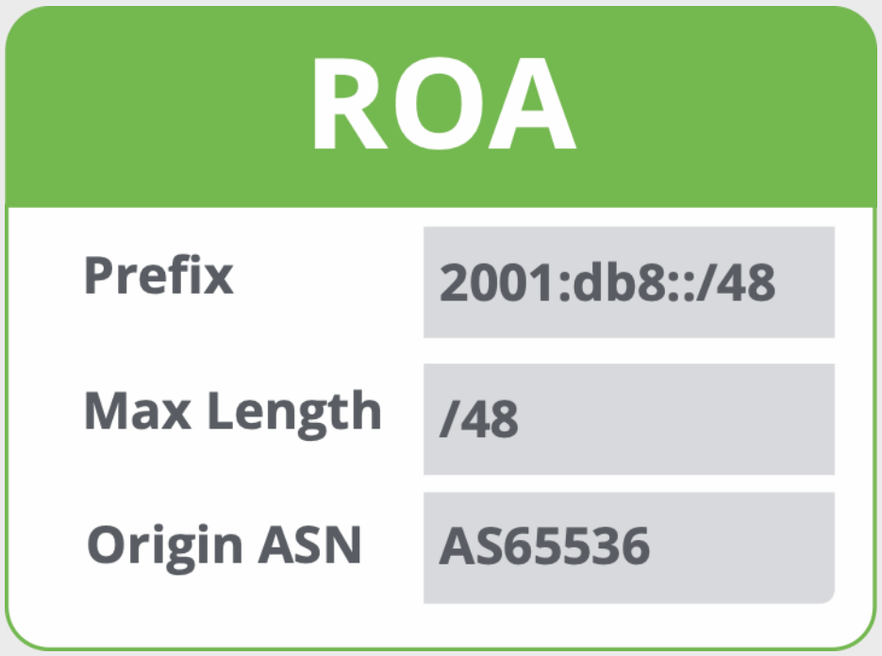


RPKI Chain of Trust



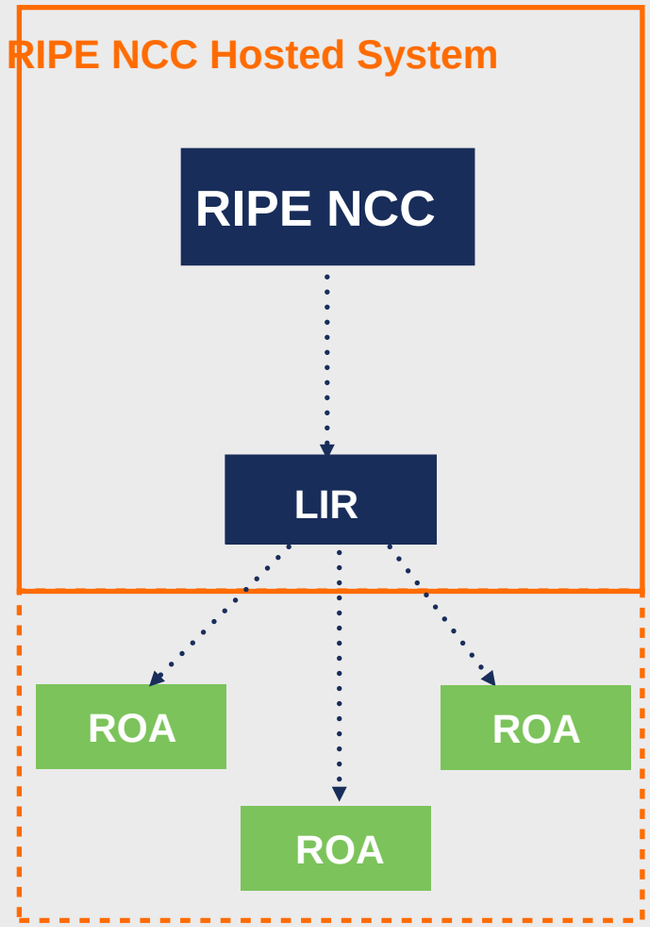
What are ROAs?

- 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



Hosted RPKI

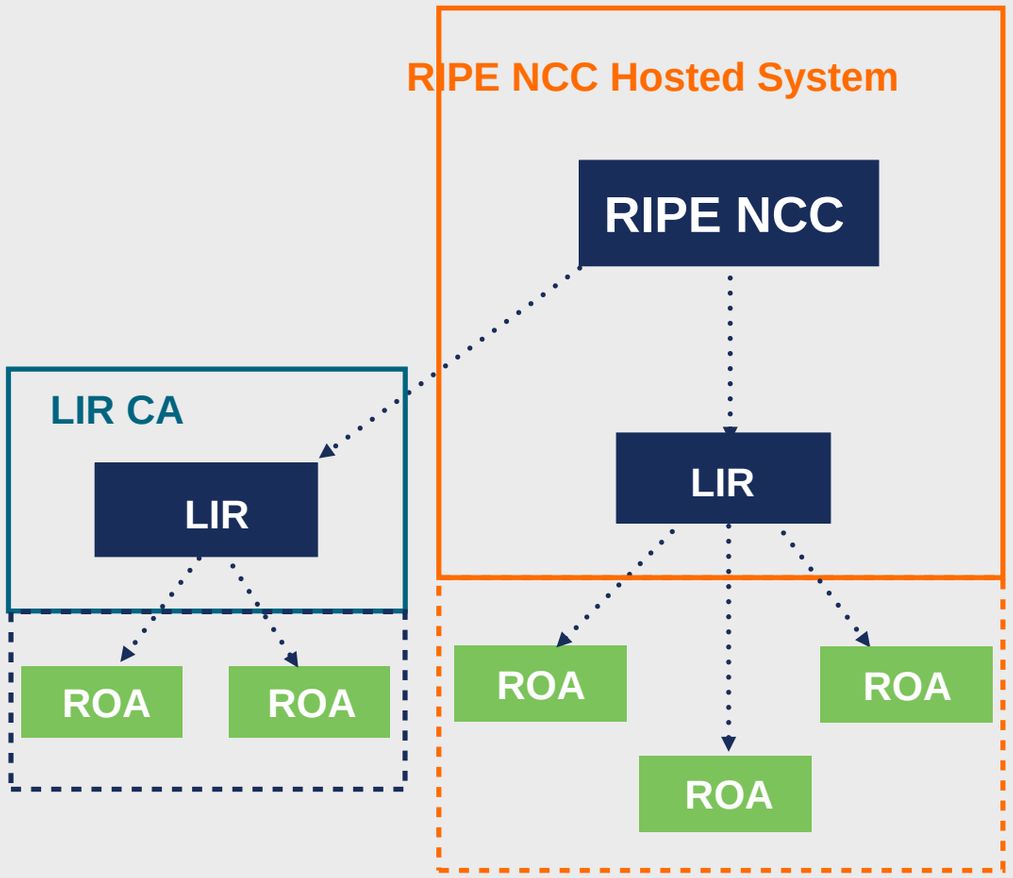
- ROAs are created and published using the **RIR’s member portal**
- RIR hosts a CA (Certification Authority) for LIRs and signs all ROAs
- Automated signing and key rollovers



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

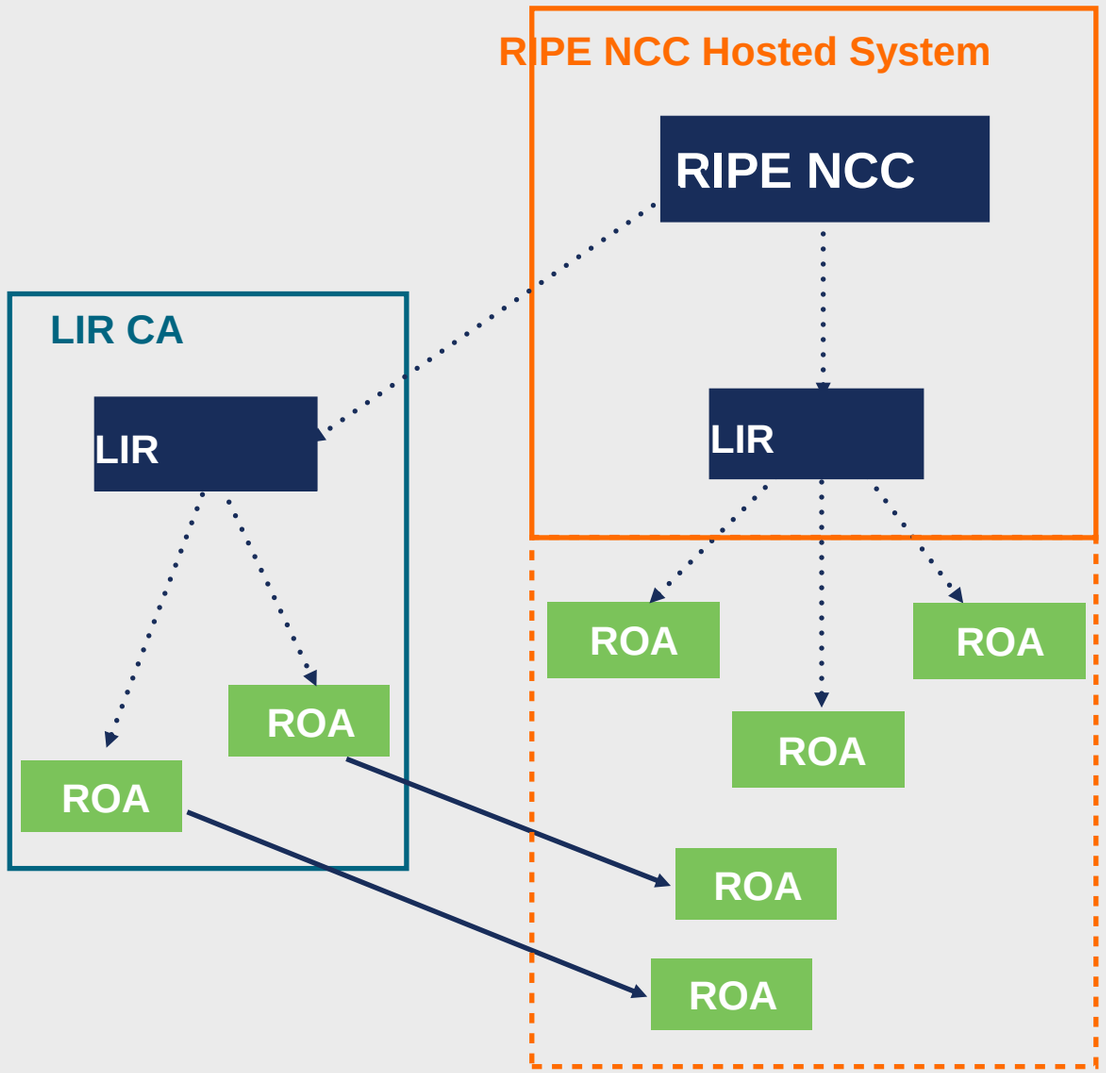
- Certificate Authority (CA) Software
  - **Krill** (NLnet Labs)
  - **rpkid** (Dragon Research Labs)



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

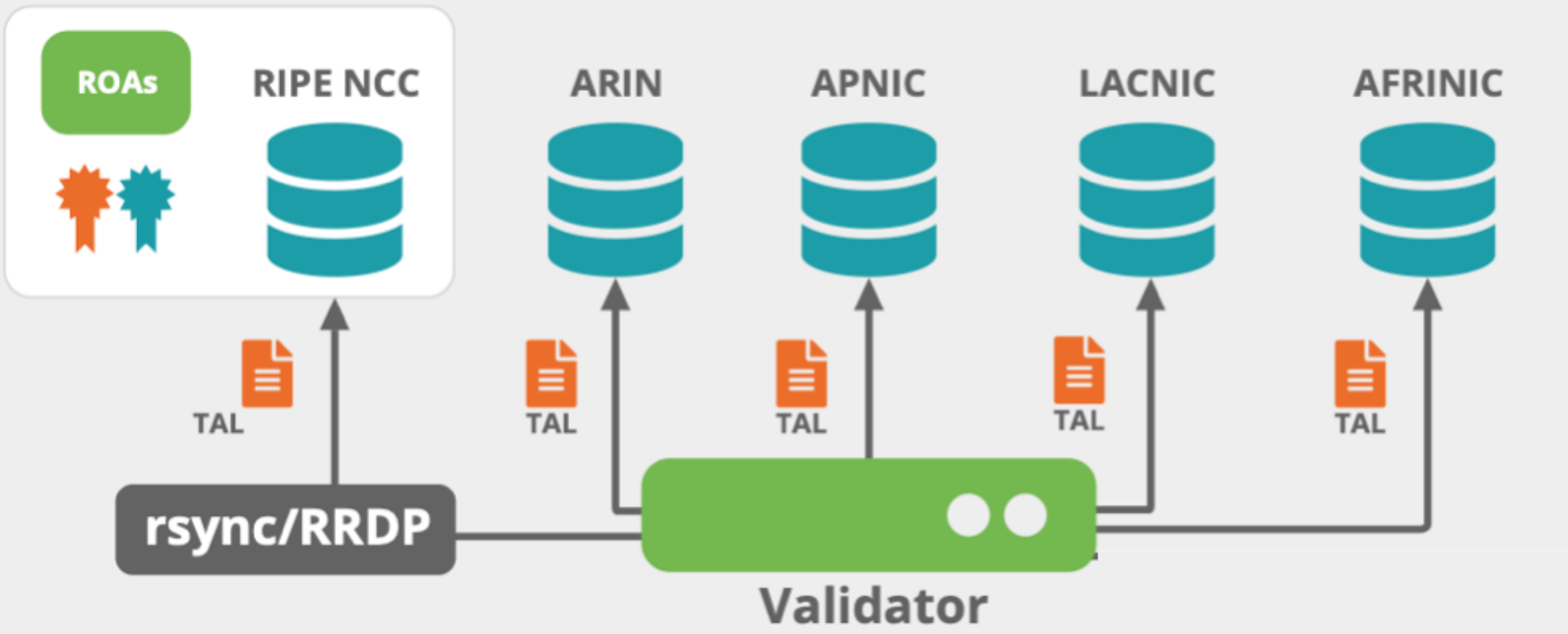
- RPKI system consists of two parts…

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

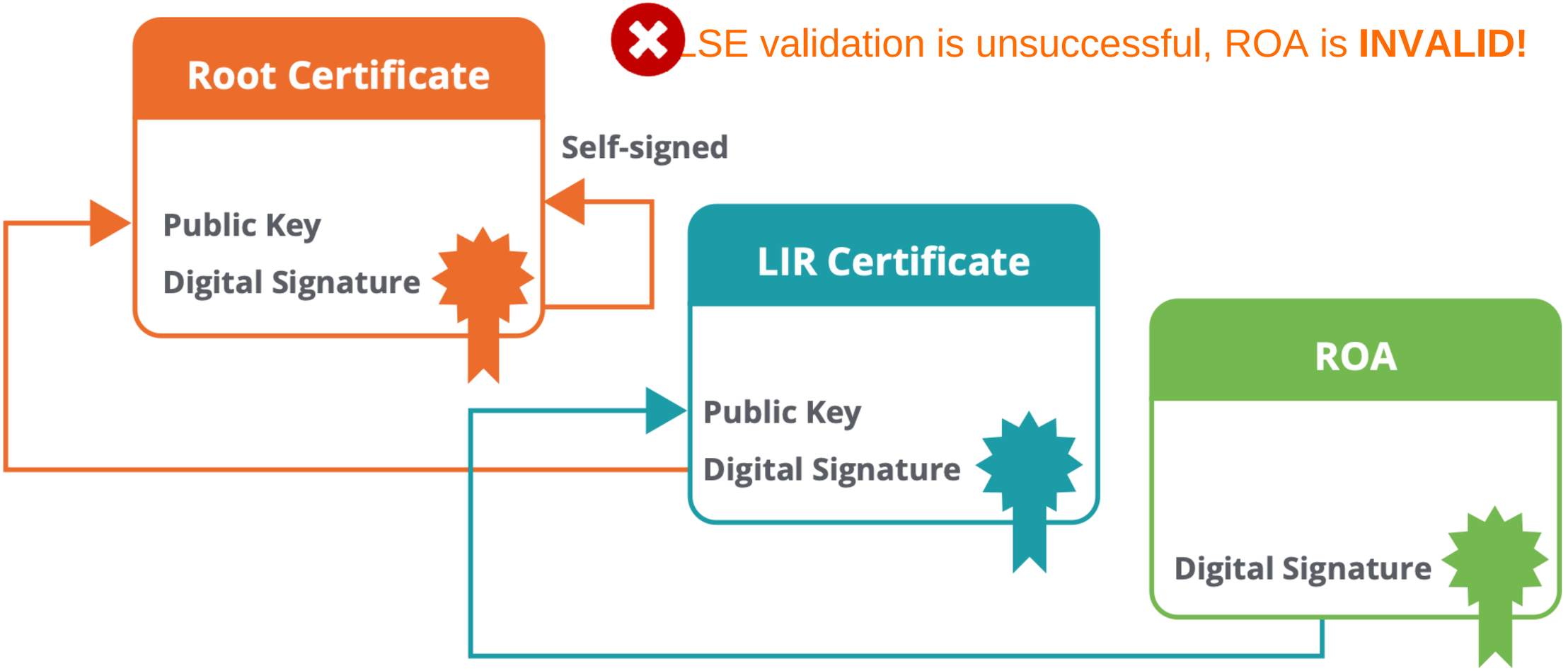
- Connects to RPKI repositories via rsync or RRDP protocol
- Uses TALs to connect to the repositories and download ROAs
- Validates chain of trust for all ROAs and associated CAs
- Creates a local “validated cache” with all the valid ROAs



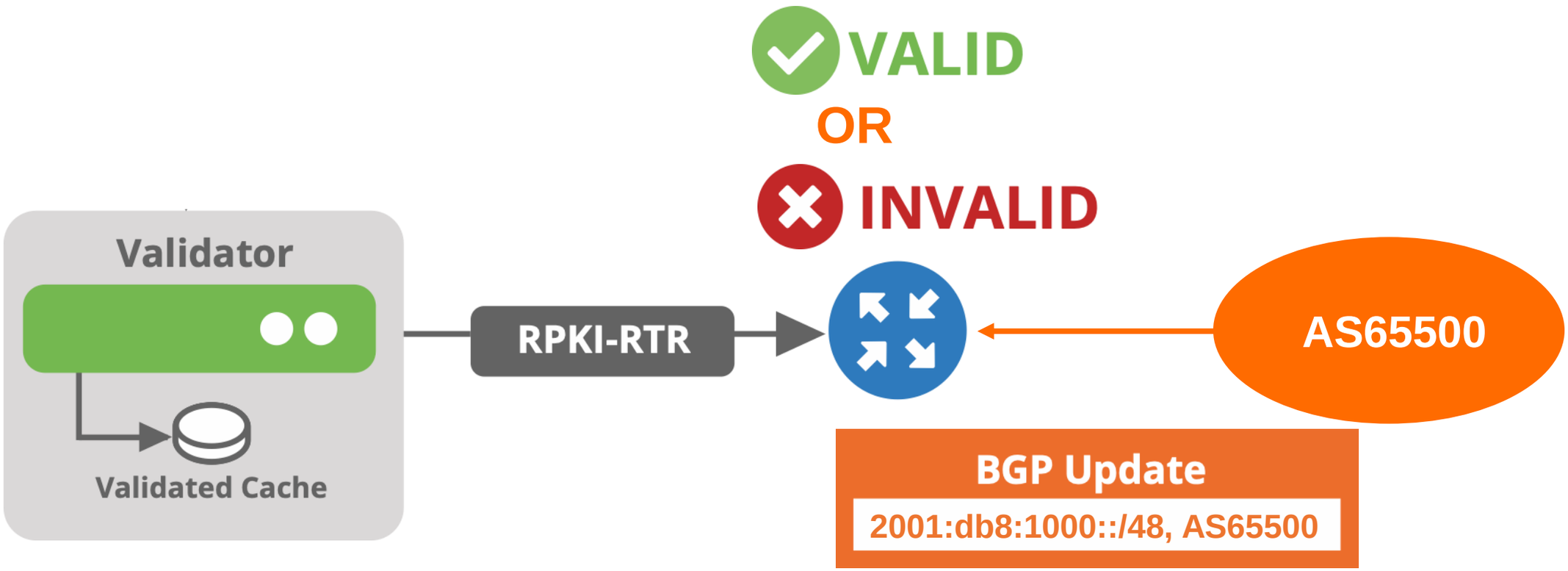
ROA Validation Process

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

LSE 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

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…

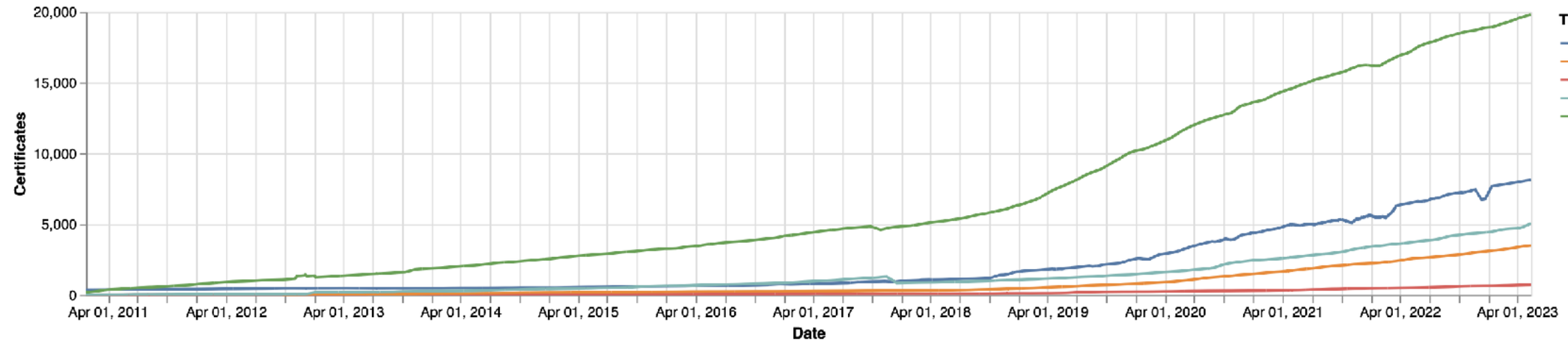
https://rpki.readthedocs.io

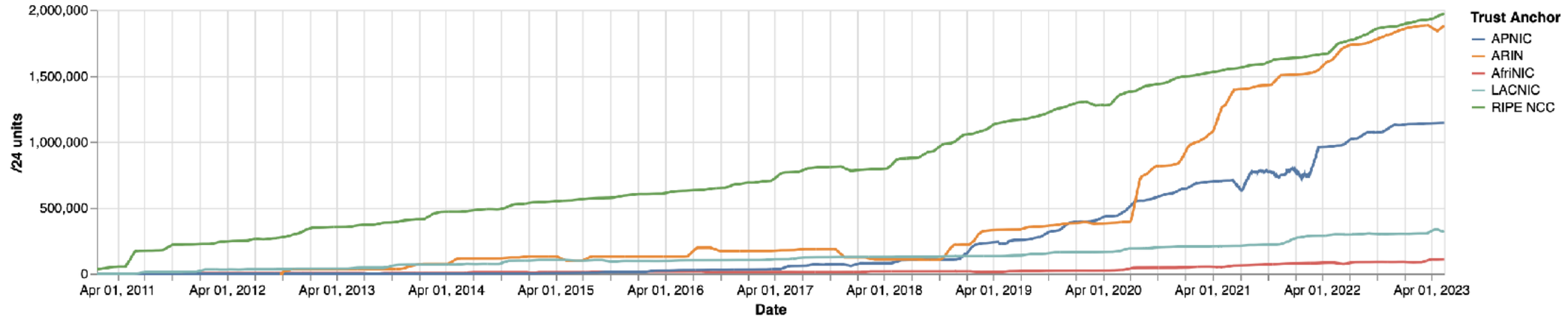
Run Different Validators

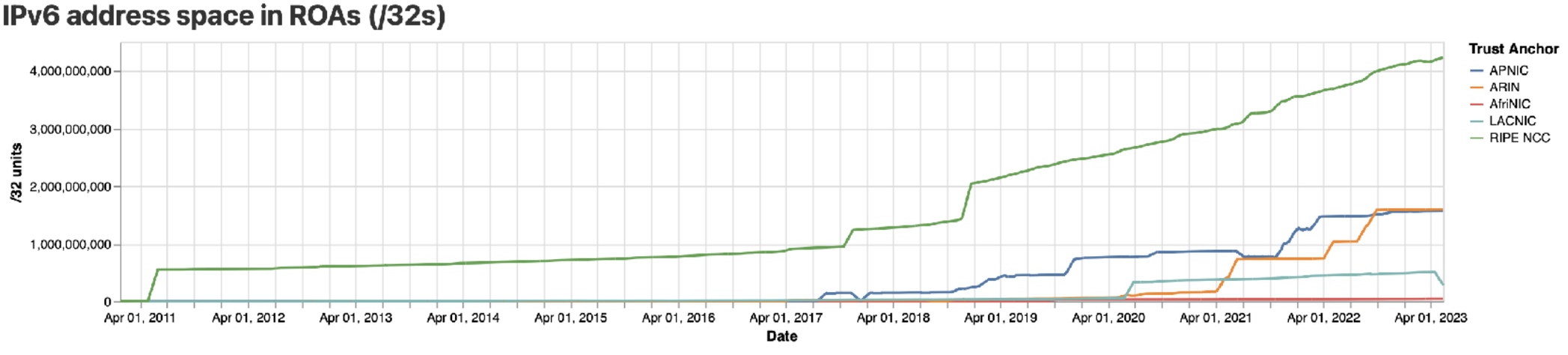
Validator	Number (13/5/23)	%
Routinator	2297	79%
rpki-client	253	9%
OctoRPKI	181	6%
FORT	91	3%
Validator	**87**	**3%**
Other	6	0%

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

Steady growth: Adoption and ROAs







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

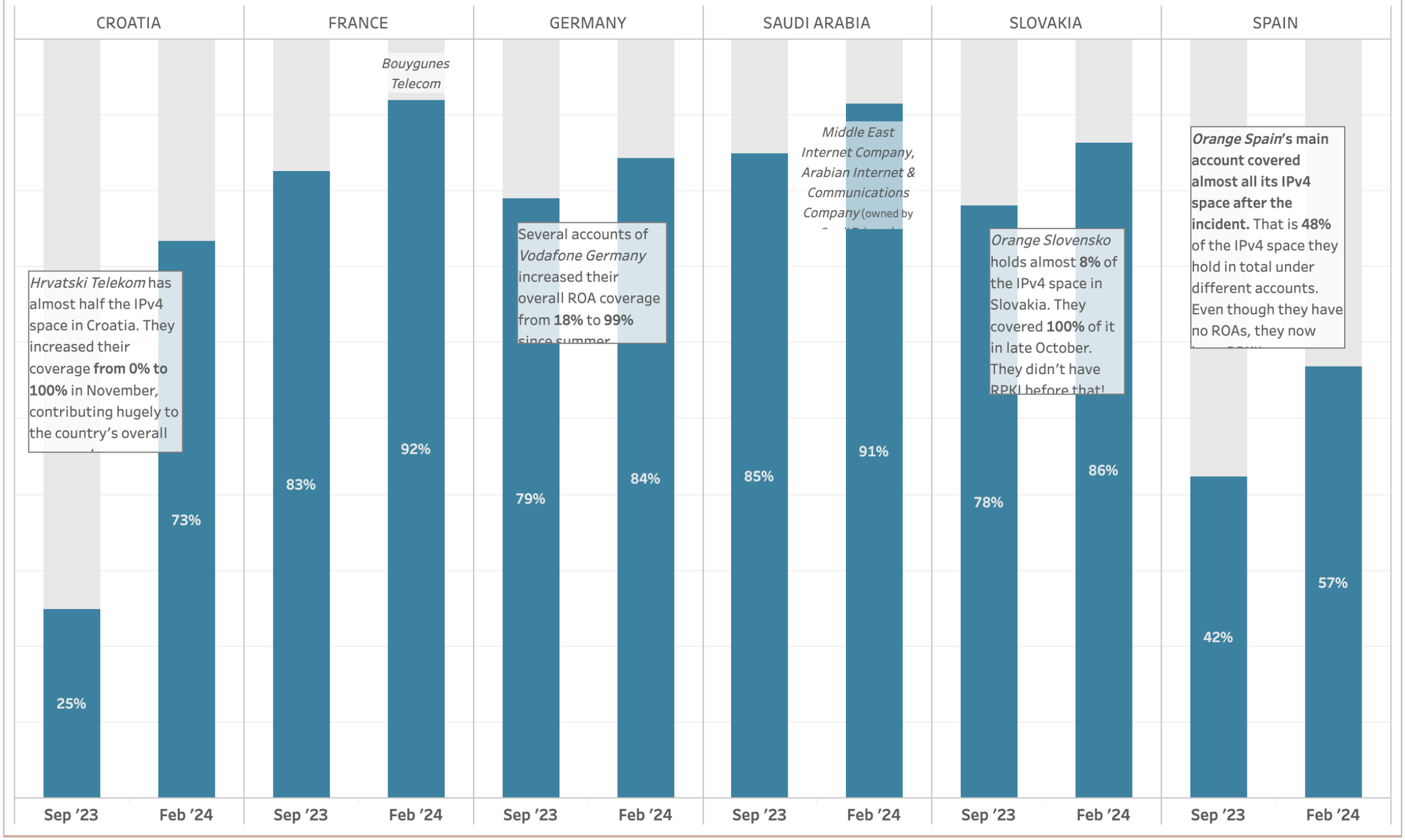
Adoption per RIR

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

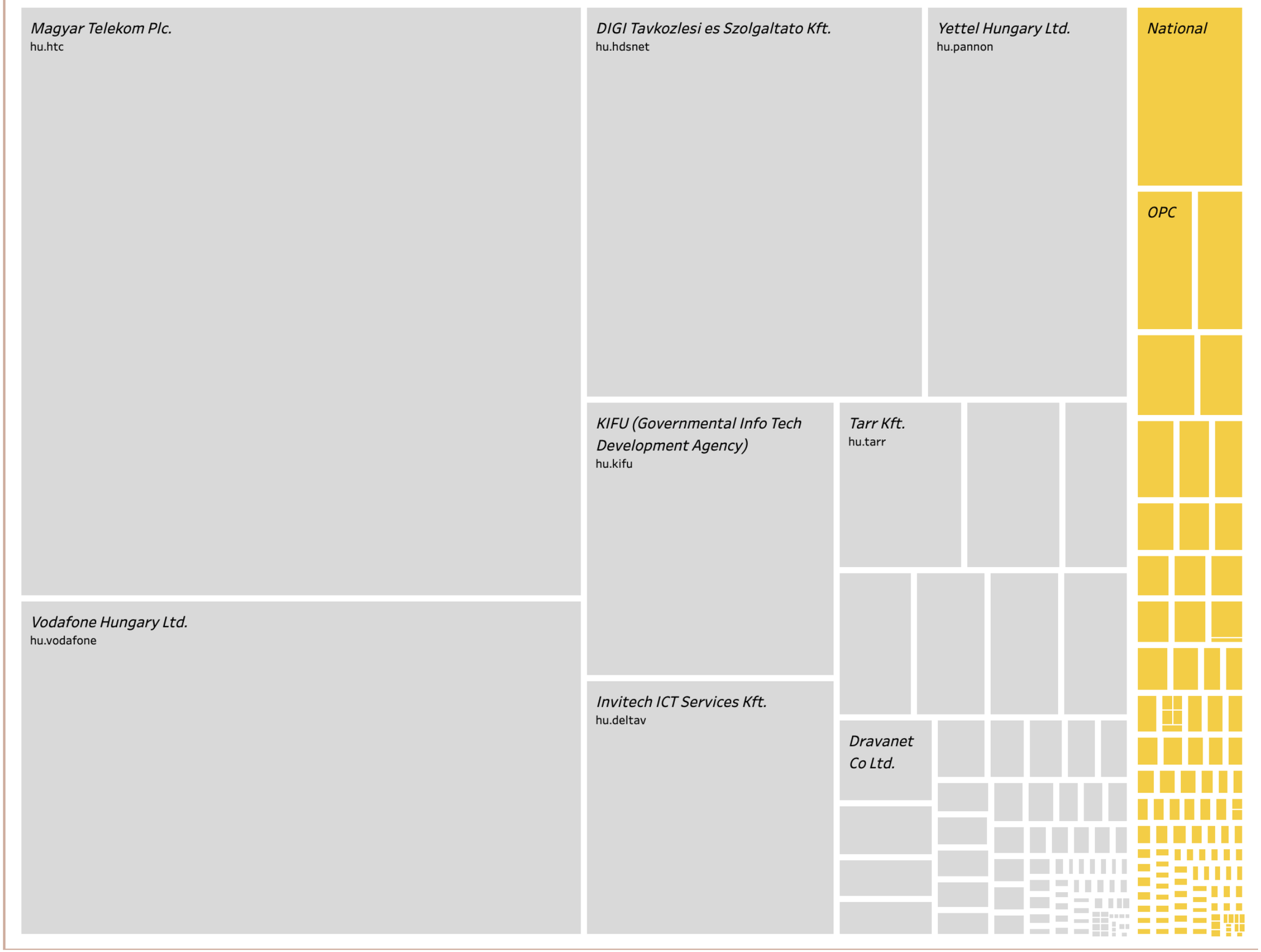
Source (14/5/23): https://ftp.ripe.net/pub/stats/ripencc/nro-adoption/latest/

Countries with significant change in IPv4 ROA Coverage

September 2023 vs February 2024



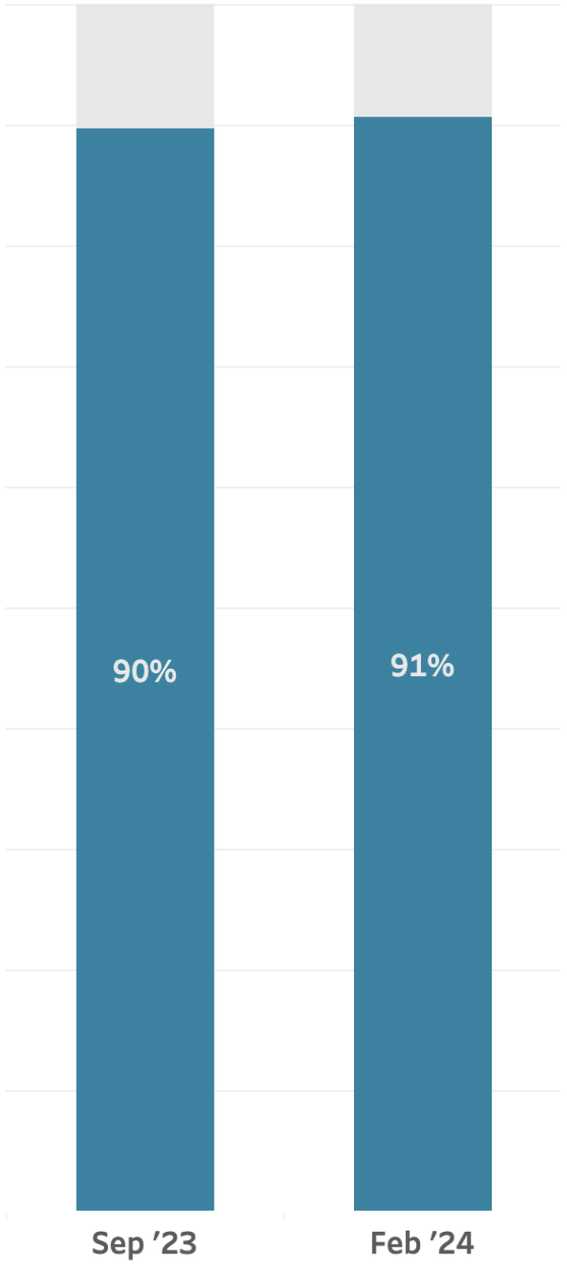
IPv4 Covered vs Uncovered: Hungary



Changes in IPv4 ROA Coverage

IPv4 ROA Coverage in HUNGARY

Sept 2023 vs Feb 2024



Change

Country Name: HUNGARY

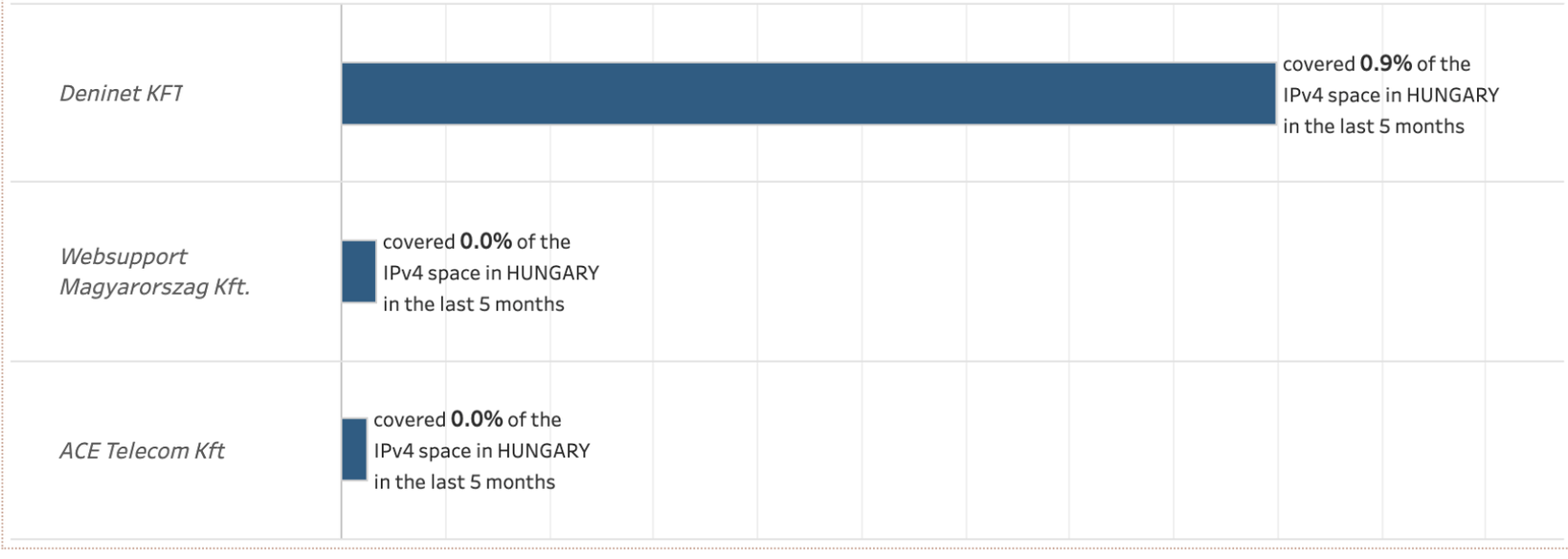
1.0% increase
in ROA covered IPv4 space

1% increase
in IPv4 ROA coverage

0.1% decrease
in IPv4 space

Who to thank??

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



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