RIPE NCC
RIPE NETWORK COORDINATION CENTER

RIPE NCC RPKI Features 2025

Tim Bruijnzeels | RIPE 90 | 15 May 2025

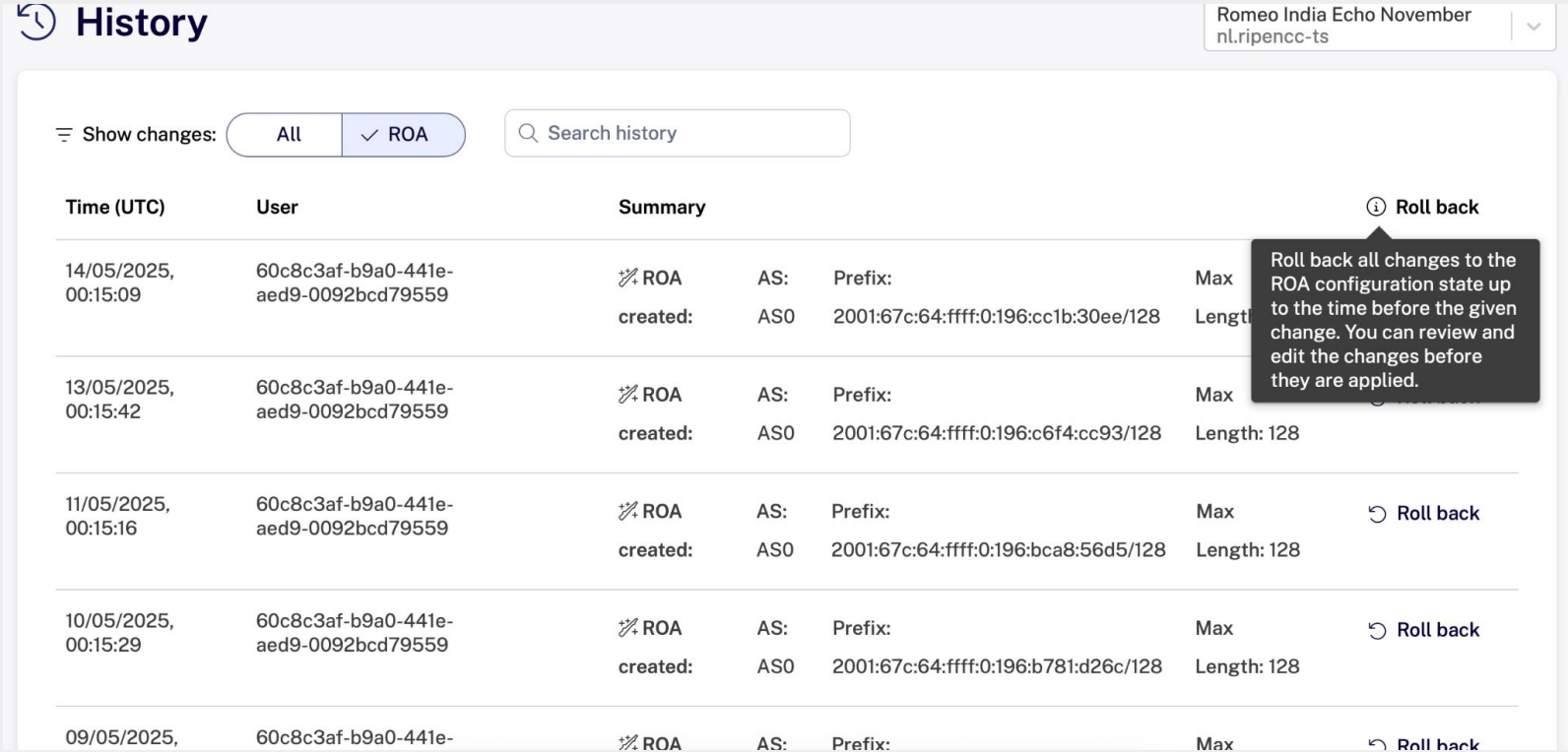
RPKI Features at RIPE NCC in 2025

1. Now
    a. ROA History Improvements
    b. ROA Config Change Alerts
    c. Revert to point in time

2. Next
    a. BGPsec Signing
    b. ASPA

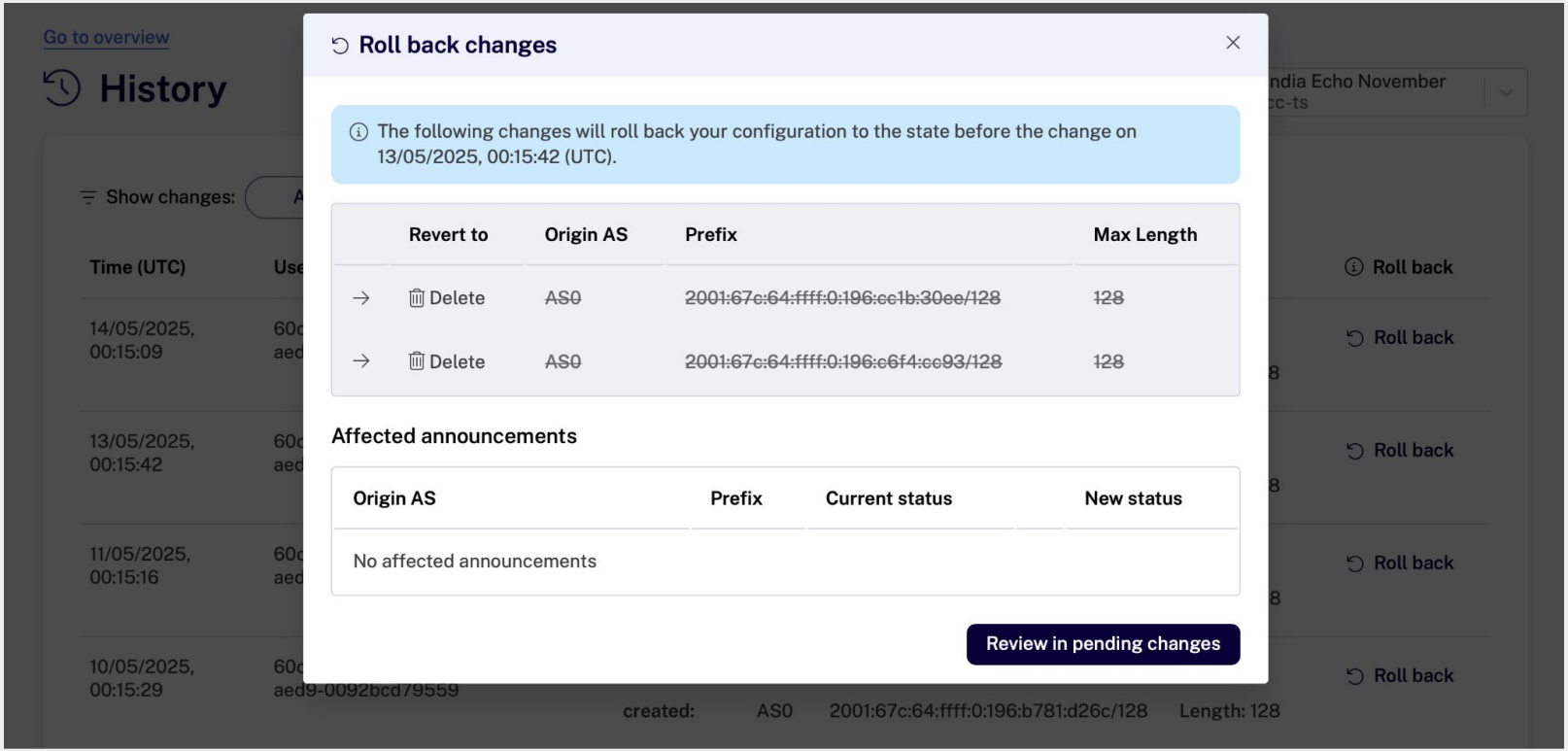
Features Done So Far in 2025

ROA History Improvements

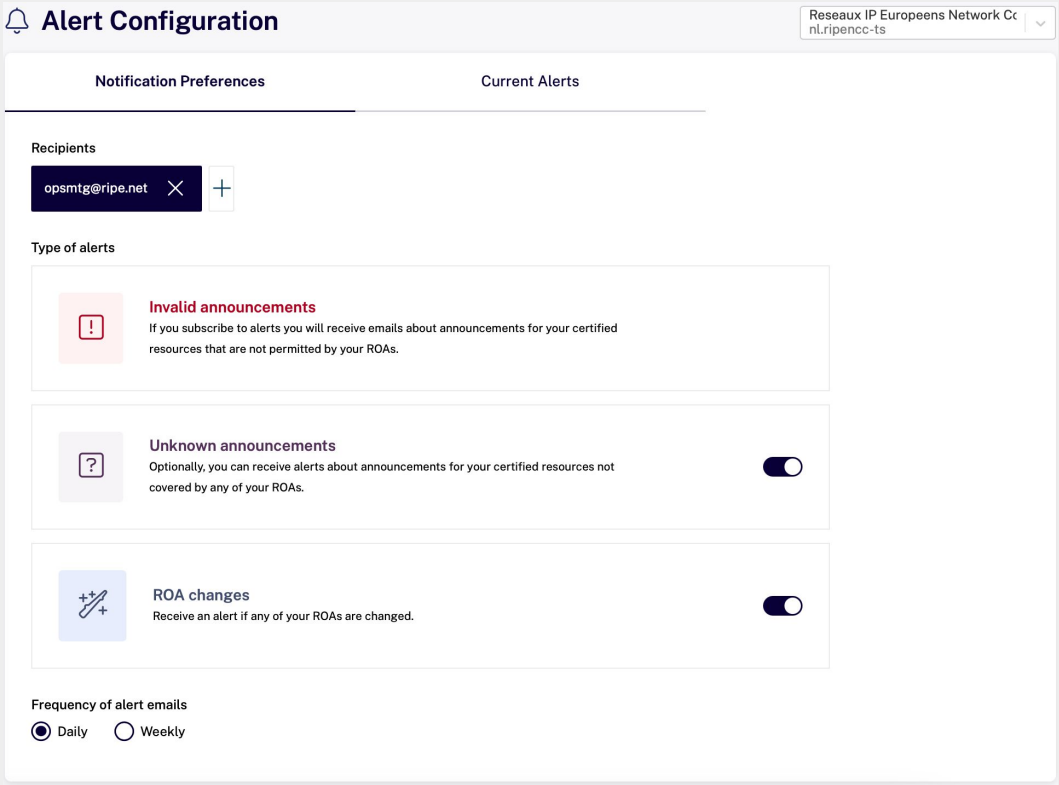


- Filter
- Search
- Formatting
- Roll back

ROA Roll Back and Review



ROA Change Alerts



Receive alerts when ROA configurations change.

BGPsec
Verifiable Paths

BGPsec Router Certificate Signing

- BGPsec
  - Signed paths
  - Detect path spoofing
  - RPKI CA signs Router Certificate
    - Associate AS number with Router Key
  - Routers sign and validate

- Challenges
  - Performance, see “A Look at BGPsec Performance” by Ignas Bagdonas @RIPE84
  - Downgrades
  - Fail closed

- Why support signing BGPsec Router Certificates now?
  - Signing is the easy part
  - Support in API only
  - Help implementers improve standards

AS Provider Attestations (ASPA)
Plausible Paths

AS Provider Authorisations (ASPA)

ASPA Object Structure (simplified)

```
EE Certificate
     Public Key
     AS Number
     Signed by CA Private Key
     Not Before
     Not After

eContent
     Customer AS Number
     Provider AS Numbers

Signature
     SHA256 Hash
     Signed by EE Private Key
```

- RPKI Signed Object Template (RFC 6488)
- Intermediate End-Entity (EE) Certificate
  - Customer AS used in content
  - MUST be included in CA certificate
  - Signed by CA certificate private key
- eContent
  - Specific format for ASPA
  - One Customer AS (held by signer)
  - One or more Provider AS

The holder of *Customer AS number* declares that listed *Provider AS* numbers may be seen after it in BGP paths

Plausible Paths from Customer to Provider

Plausible, well… *Not Implausible* Paths

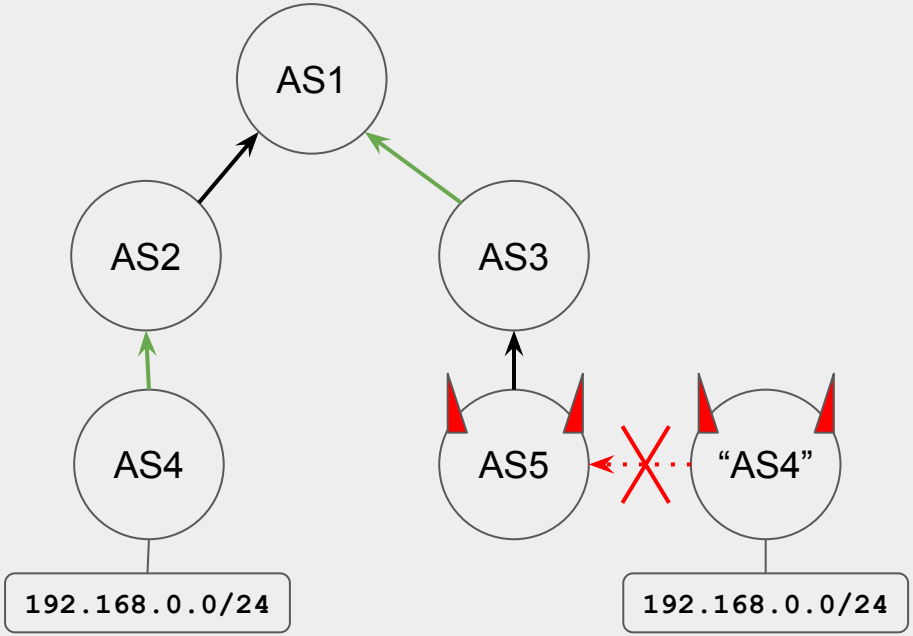
- Each AS - to - AS hop is *verified* as:
  - Provider
  - Not Provider
  - No Attestation
    (no ASPA exist for customer AS)

- A path from origin is plausible as long as no “Not Provider” is encountered
  - Proven unexpected hop
  - Support partial deployment
  - Fail open in case of an issue with RPKI *validation* itself

Routes learned from Customer AS networks MUST NOT have Not Provider

ASPA Verification - Routes from Customers

Partial Deployment From Customer



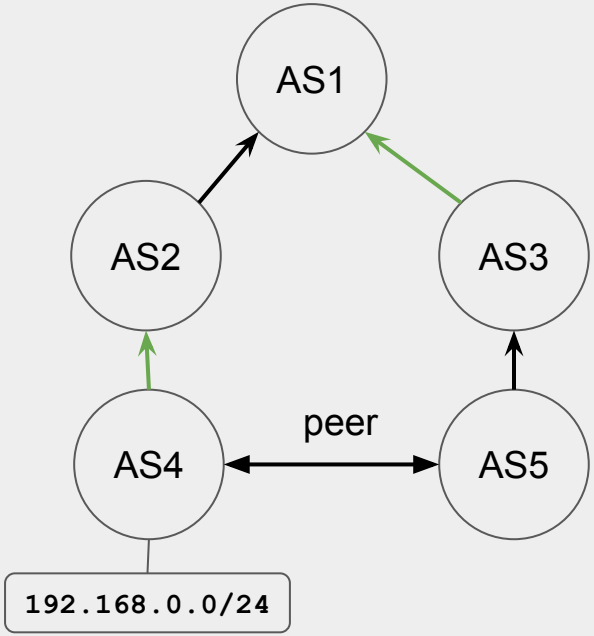
Consider:

```
192.168.0.0/24 => AS4
AS3 => [ AS1 ]
AS4 => [ AS2 ]

PATH 4->5->3->1
ASPA 4->X

PATH 4->2->1
ASPA 4->2->1
```

AS1 knows that AS3 is a customer, and therefore paths MUST NOT have NOT Provider towards them.

ASPA Verification - Routes from Customers

Partial Deployment From Customer



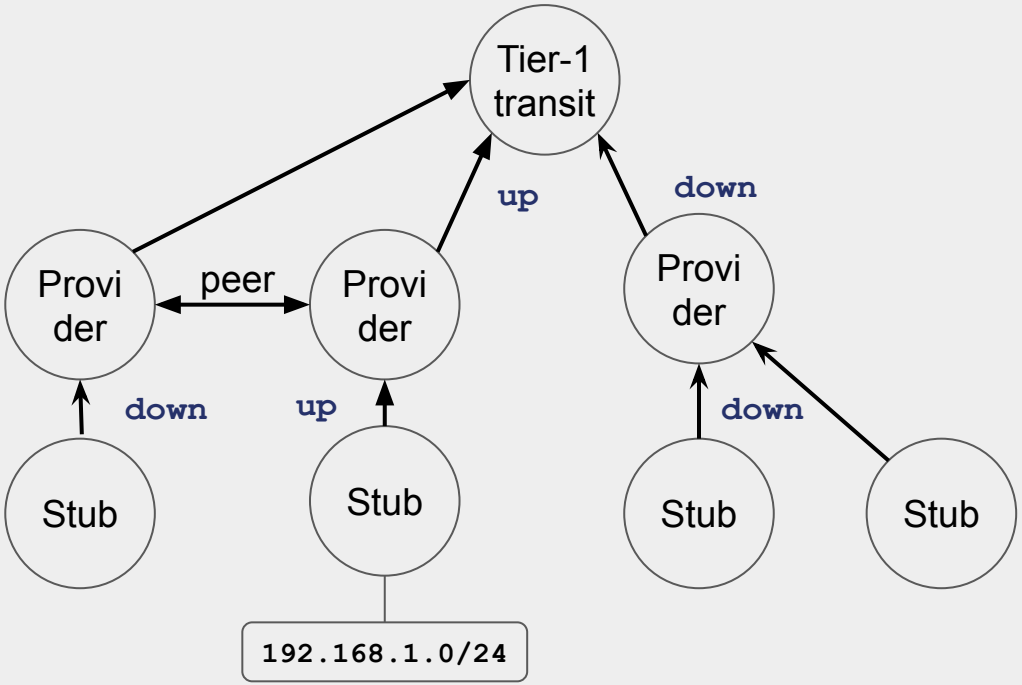
Consider:

```
192.168.0.0/24 => AS4
AS3 => [ AS1 ]
AS4 => [ AS2 ]

PATH 4->5->3->1
ASPA 4->X

PATH 4->2->1
ASPA 4->2->1
```

AS1 can detect leak by AS5

ASPA Verification - Route From Providers

Topology - "Up and Down Ramps"



The announcement for 192.168.1.0/24 goes:

- **"up"**

  customer to provider

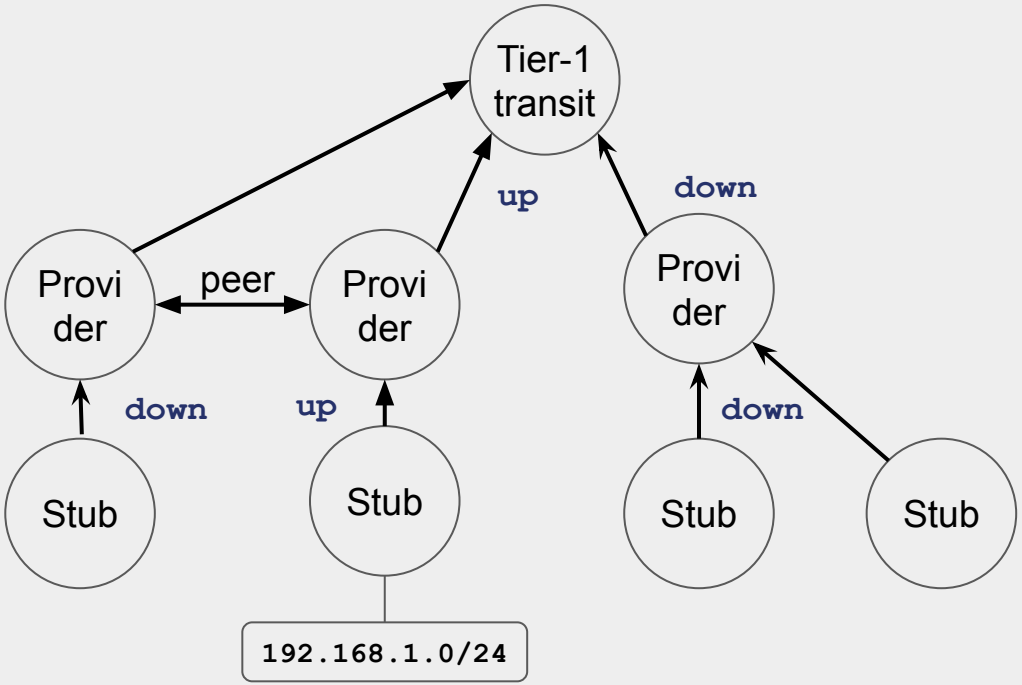
- to a common provider apex, or peer pair

- **"down"**

  reverse provider to customer

ASPA Verification - Route From Providers

Verification: Combine Up and Down



Find the longest possible up and down ramps by looking at plausible c2p hops in the path from both ends

Valid in case up and down ramps:

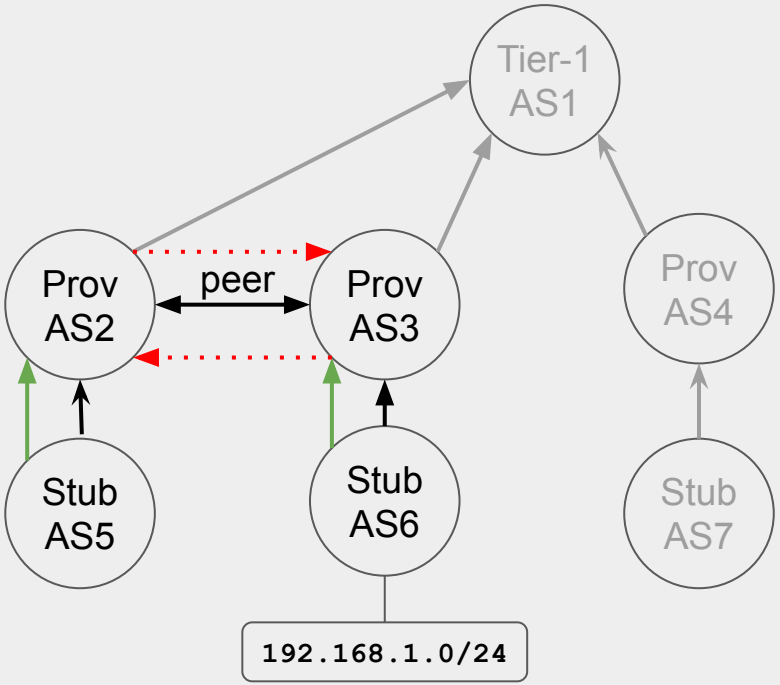
- overlap (partial deployment) - or
- meet at an apex provider - or
- meet at a peer pair (1 hop)

Invalid in case up and down ramps:

- are separated by more than 1 hop

ASPA Verification - Peers

AS5 Verifies



Consider:

```
192.168.0.0/24 => AS6
AS6 => [ AS3 ]
AS3 => [ AS1 ]
AS2 => [ AS1 ]
AS5 => [ AS2 ]

PATH 6->3->2->5

UP    6->3->X
DOWN     X<-2<-5
```

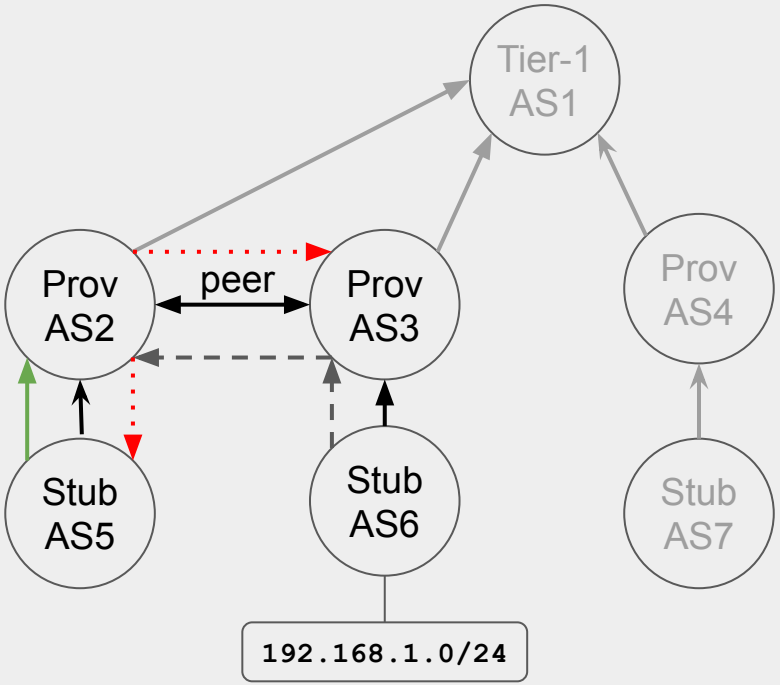
Meet at pair AS2-AS3

Accept :D

NOTE: Think IX peers

ASPA Verification - Peers - Partial Deployment

AS5 Verifies



Consider:

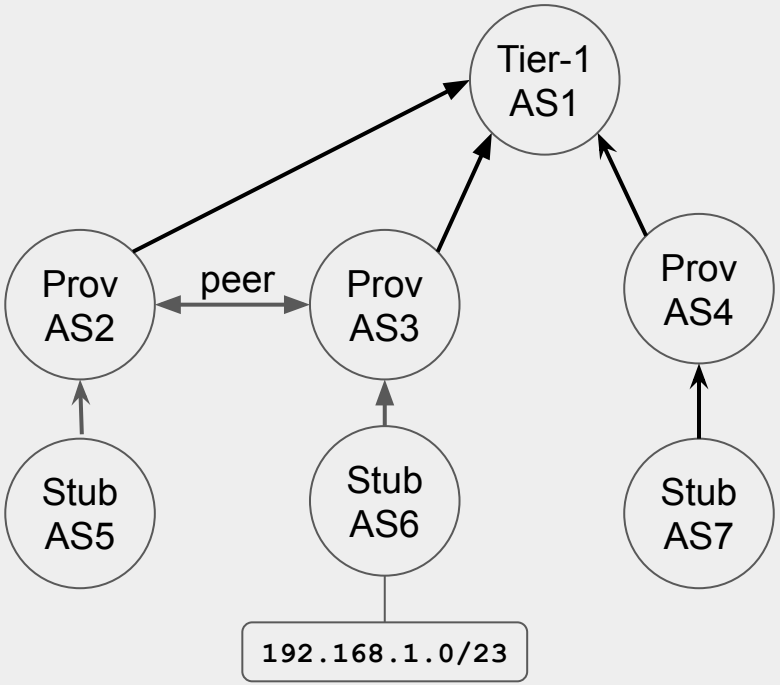
```
192.168.0.0/24 => AS6
AS6 => [ AS3 ]
AS5 => [ AS2 ]
AS2 => [ AS1 ]
AS3 => [ AS1 ]

PATH 6->3->2->5

UP    6->3->2->X
DOWN     X<-2<-5
```

Meet at AS2

Accept :D

ASPA Verification - Peers - Little Deployment

AS5 Verifies



Consider:

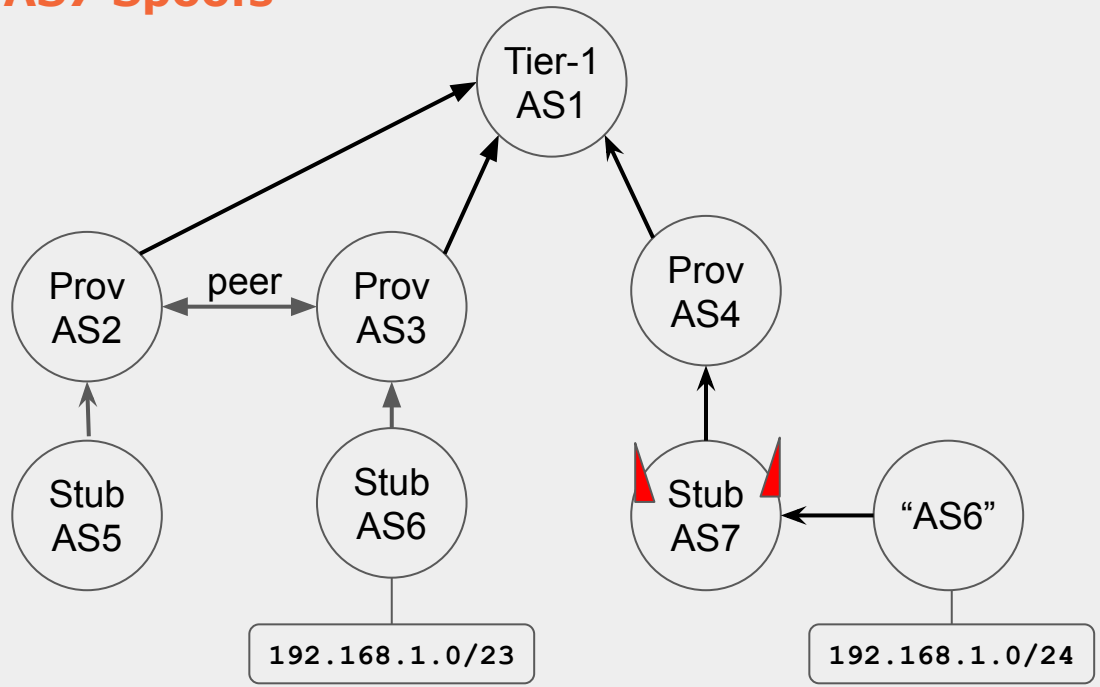
```
192.168.0.0/23-24 => AS6
AS5 => [ AS2 ]

PATH   6->3->2->5

UP     6->3->2->5
DOWN   6<-3<-2<-5
```

Paths overlap
(no conflicting attestations)

Accept :D

ASPA Verification - Provider - Little Deployment

AS5 Verifies
AS7 Spoofs



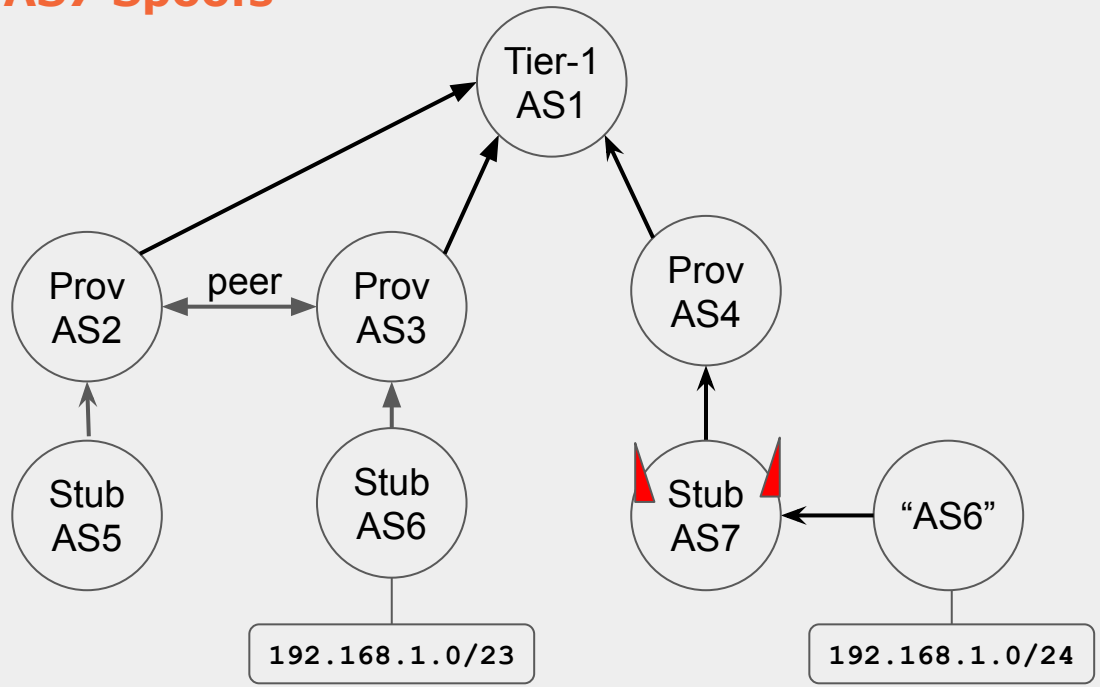
Consider:

```
192.168.0.0/23-24 => AS6
AS5 => [ AS2 ]

PATH   192.168.0.0/24
       6->7->4->1->2->5

UP     6->7->4->1->2->5
DOWN   6<-7<-4<-1<-2<-5

(no ASPAs disagree)
```

Accept more specific hijack :(

ASPA Verification - Provider - More Deployment

AS5 Verifies
AS7 Spoofs



Consider:

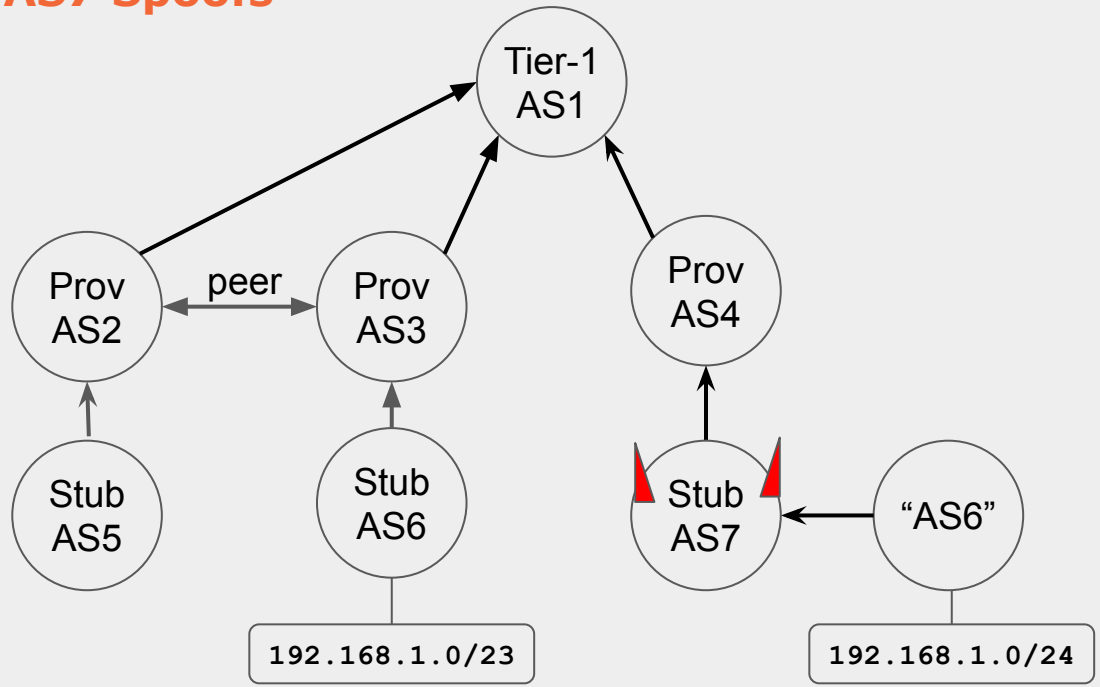
```
192.168.0.0/23-24 => AS6
AS5 => [ AS2 ]

+ AS6 => [ AS3 ]

PATH   192.168.0.0/24
       6->7->4->1->2->5

UP     6->X
DOWN   6<-7<-4<-1<-2<-5
```

Accept, despite AS6 ASPA

Also, do not use max length lightly!

ASPA Verification - Provider - More, More Deployment

AS5 Verifies
AS7 Spoofs



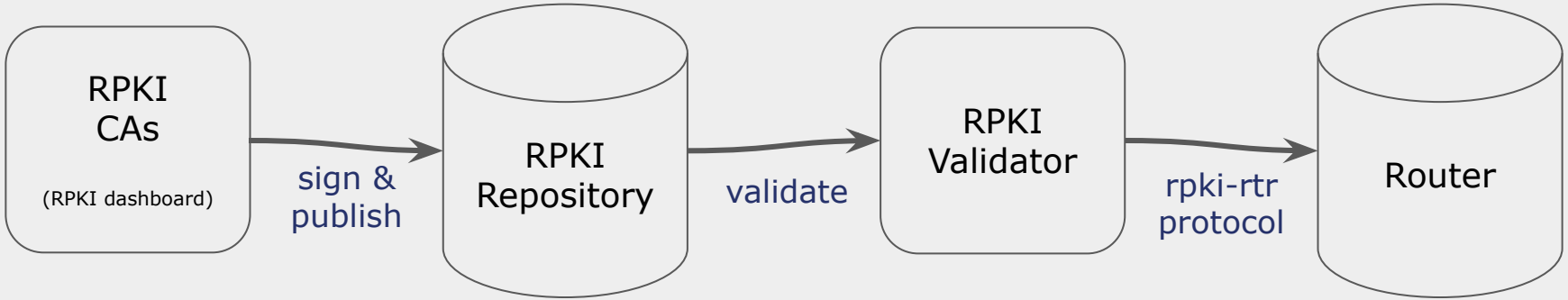
Consider:

```
192.168.0.0/23-24 => AS6
AS5 => [ AS2 ]
AS6 => [ AS3 ]

+ AS1 => [ AS0 ] (PROVIDER FREE)

PATH   192.168.0.0/24
       6->7->4->1->2->5

UP     6->X
DOWN          X<-1<-2<-5
```

REJECT

Provider/Tier-1 ASPA helps, but AS3 should also deploy to stop AS7 spoofing -3-6-PFX

ASPA Deployment Model



- ➔ Same deployment model as ROAs
- ➔ Crypto handled by RPKI CAs and Validators
- ➔ Router gets table with validated ASPA content (could run on modest hardware)
- ➔ IETF drafts very close to last call

ASPA Implementations

- Signing
  - Krill (e.g. delegated CA under RIR)
  - RIPE NCC
    - At the moment API only test environment
- Validation
  - Routinator
  - rpki-client
- Routers
  - OpenBGPd
  - BIRD
  - Cisco is working on it

ASPA Support in RIPE NCC Hosted RPKI CA

- Support in UI
- No ASPA suggestions yet
  - But planned for the future
- Talk to me or Antonella de Bellis about UX ideas!
- Plan to implement this summer
  - Testbed first (feature flag)
  - Enable in prod after IETF LC?
  - ARIN and APNIC also plan test implementations in 2025

ASPA Validation - More Reading

- ASPA Verification Draft:

  https://datatracker.ietf.org/doc/html/draft-ietf-sidrops-aspa-verification

- ASPA Examples:

  https://github.com/ksriram25/IETF/blob/main/ASPA_path_verification_examples.pdf

- Formal Proof:

  https://datatracker.ietf.org/meeting/110/materials/slides-110-sidrops-sriram-aspa-alg-accuracy-01

Questions & Comments

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