U.S. DEPARTMENT of ENERGY

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# Autonomous System Provider Authorization (ASPA) in R&E

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GNA-G Routing WG
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# Routing Security ecosystem

- IRR
- RPKI
- ROV
- OTC
- ASPA

# 'ASPA', not the K-Pop group 'aespa'

kpop.fandom.com/wiki/Aespa

RE ARTISTS MEDIA DECADES (YEARS) COMMUNITY & HELP

—*aespa*

**aespa** (에스파; also stylized as **æspa**) is a four-member girl group under SM Entertainment. They debuted on November 17, 2020 with the digital single "Black Mamba".

Their name is a combination of "æ", which means 'Avatar X Experience', and "aspect", which means double-sided. Together it means that you would being able to experience a new world through an avatar of yourself.[3]

**aespa**

Contents [hide]

# Problem: Route leaks

- The origin AS is legitimate.
- The prefix can be valid under RPKI ROA.

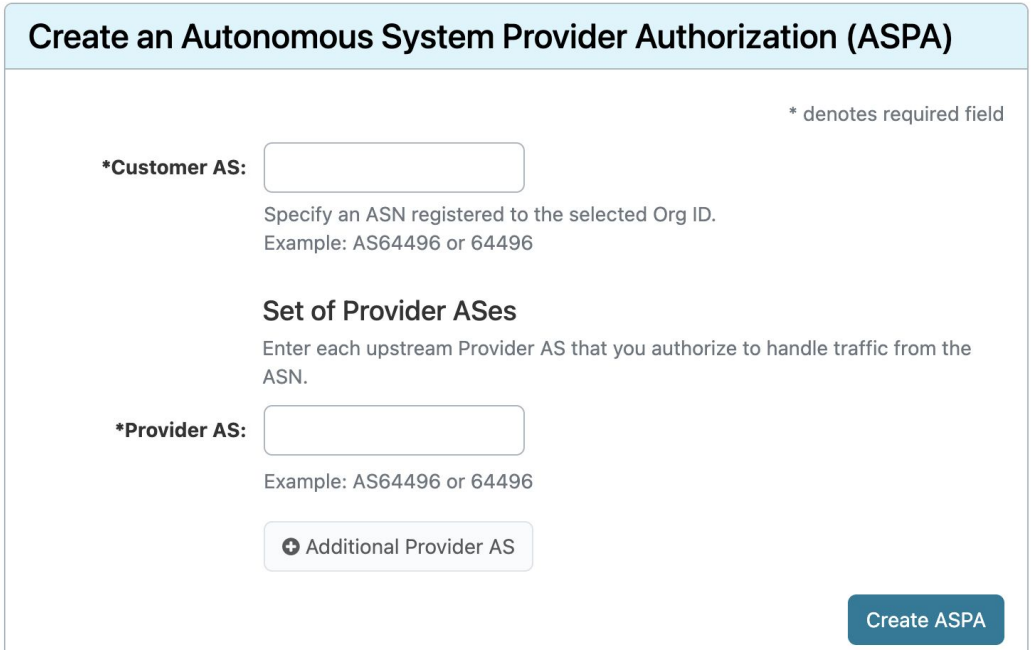
The route can be propagated through an unexpected as-path.

# Where ASPA fits in

- Autonomous System Provider Authorization (ASPA) objects are created and distributed the same way as Route Origin Authorizations (ROAs) in the RPKI
- ROAs state which ASNs are authorized to announce given prefixes
- **ASPAs state which ASNs are allowed to propagate their routes.**
  - Only specifies "Upstream" ASNs
  - Does not differentiate between IPv4 and IPv6
  - Does not disclose lateral peering relationships

# What does it look like?

- Customer (you) specifies the Provider(s) ASN.
- Only 1 record per customer AS
- Multiple provider ASNs ok
- List of providers once set must be complete and maintained over time.

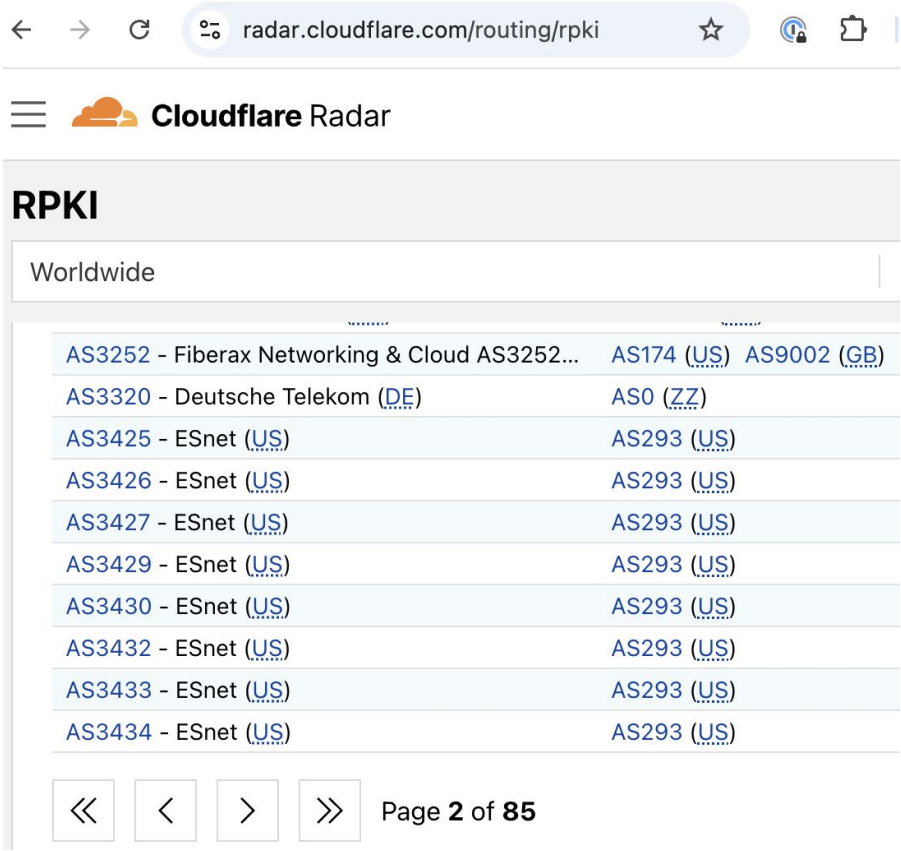


# ASPA Records for Networks

Very straightforward

- Go to your RIR portal (RIPE, ARIN, APNIC, etc)

- Not dependent on your customers or providers having records or not.



# Special case: AS0 - No upstreams

| Customer | Providers |
|---|---|
| AS174 - Cogent Communications, Inc. (US) | AS0 (ZZ) |
| AS1299 - Arelion (Twelve99) (SE) | AS0 (ZZ) |
| AS3320 - Deutsche Telekom (DE) | AS0 (ZZ) |
| AS4492 - Antonios A. Chariton (GR) | AS0 (ZZ) |
| AS5426 - Sunrise GmbH (CH) | AS0 (ZZ) |
| AS6777 - AMS-IX Route Servers (NL) | AS0 (ZZ) |
| AS6830 - Liberty Global (NL) | AS0 (ZZ) |
| AS7018 - AT&T US - 7018 (US) | AS0 (ZZ) |
| AS8231 - Sunrise GmbH (CH) | AS0 (ZZ) |
| AS8608 - EspritTelecom (NL) | AS0 (ZZ) |
| AS9143 - Vodafone-Ziggo (NL) | AS0 (ZZ) |

# What is an 'Upstream' Network?

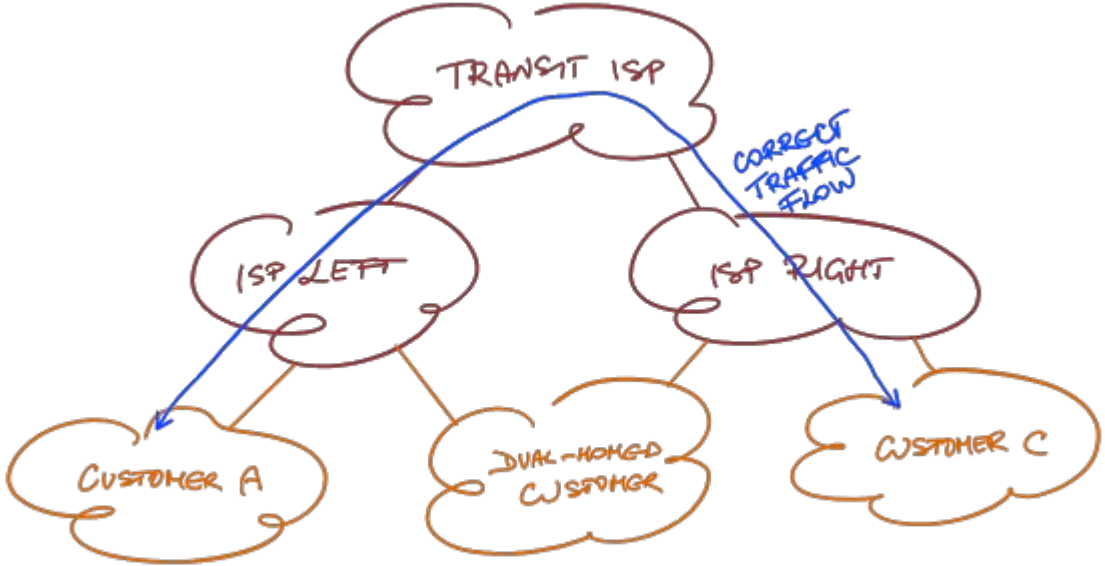
Easy to consider in monetary terms

- If you are paying them, they are your upstream
- If they pay you, they are your downstream (customer)
- Includes both Commercial and R&E networks

Valley-free principle

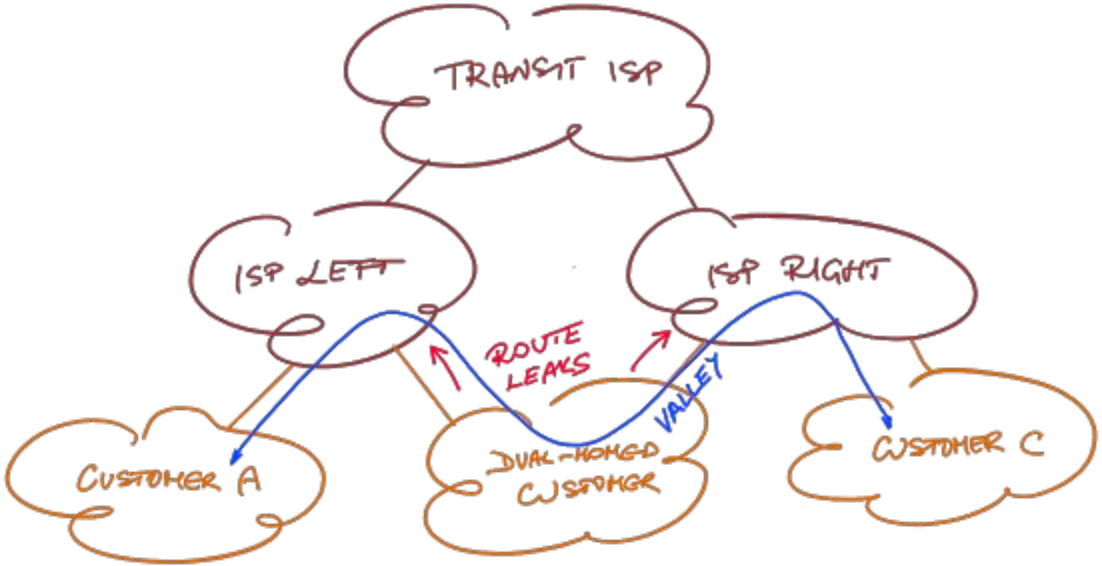
- Routes from an upstream provider can't go downstream and then back up again
- Peers don't transit customer routes learned from one peer to another peer

# Valley-free principle




https://blog.ipspace.net/2018/09/valley-free-routing/

# Valley-free principle




https://blog.ipspace.net/2018/09/valley-free-routing/

# Difficulties applying ASPA to R&E Networks

- Criticism: "Valley-free" is a essentially a commercial construct
  - Not limited nor enforced by the BGP protocol
  - Implies a hierarchy which may not exist
- R&E Networks are at times not valley-free
  - Mutual backup arrangements are not uncommon
    - especially for subsea cable diversity
  - R&E exchange points provide needed reach
    - and at times, include their ASN in the AS-PATH
- Some of the paths are not routinely visible
  - If a path is only used in an outage condition, it may not always be seen, depending on your vantage point
  - Be very wary of tools that try to guess your upstreams for you

# Clarifications for R&E

- All Relationships between networks need to be formalized
  - Upstream, Customer, or Peer
- Where we have a Peer--Peer--Peer topology,
  - For ASPA, these middle networks are an upstream
- Where a NREN has a mutual backup with another NREN
  - they both upstreams of each other
- Where a NREN offers a route exchange service to reach other NRENs
  - it is an upstream
- If it's in any way complicated,
  - It's probably an upstream

# Example R&E ASPA records in production

- Upstreams will be both commercial and R&E networks

| | |
|---|---|
| AS553 - BelWü (DE) | AS174 (US) AS559 (CH) AS680 (DE) AS1299 (SE) AS2914 (US) AS3320 (DE) |
| AS559 - SWITCH (CH) | AS174 (US) AS513 (CH) AS553 (DE) AS1299 (SE) AS3257 (US) AS3356 (US) AS20965 (NL) AS21320 (NL) |
| AS589 - University of North Texas (US) | AS7459 (US) AS16905 (US) AS22645 (US) AS62728 (US) |
| AS680 - DFN Deutsches Forschungsnetz e.V. (DE) | AS1299 (SE) AS2914 (US) AS3320 (DE) AS3356 (US) AS20965 (NL) AS21320 (NL) |

https://radar.cloudflare.com/routing/rpki

# Validation

- ASPA extends the same toolchain already used for RPKI:
  - An AS publishes an ASPA object listing its upstream providers.
- RPKI validators fetch and validate the object.
- Routers
  - receive validated ASPA payloads via the RPKI-to-router protocol.
  - perform AS_PATH verification locally.
  - (No new cryptography is required inside the router.)
- Verification produces three possible states:
  - Valid
  - Invalid
  - Unknown



https://fastnetmon.com/2026/02/25/aspa-the-next-layer-of-routing-security/

# How ASPA Finds Valleys

- Customer to Provider path from the origin is “UP” ramp
- Provider to Customer path from the reverse end is “DOWN” ramp

Then UP and DOWN must either

- meet at adjacent peers
- meet in a shared Provider
- overlap with multiple hops (partial adoption or complex relations)

A gap between UP and DOWN means there is a valley: mark invalid

Good overview w/ diagrams:
https://www.ripe.net/manage-ips-and-asns/resource-management/rpki/aspa/

# Validation

Recommended validation pattern mirrors RPKI ROV:

- Reject 'invalid' routes.
- Accept 'valid'
- Always Accept 'unknown'

# Deployment status

RIRs

- RIPE - done
- ARIN - done
- APNIC - July?
- LACNIC - end of year?
- AFRINIC - ... ?

Validators - mostly in flight

- ex: https://routinator.docs.nlnetlabs.nl/en/stable/advanced-features.html

IX route servers - early deployments

Routers - expected next year

# Standardization Effort

IETF SIDROPS WG

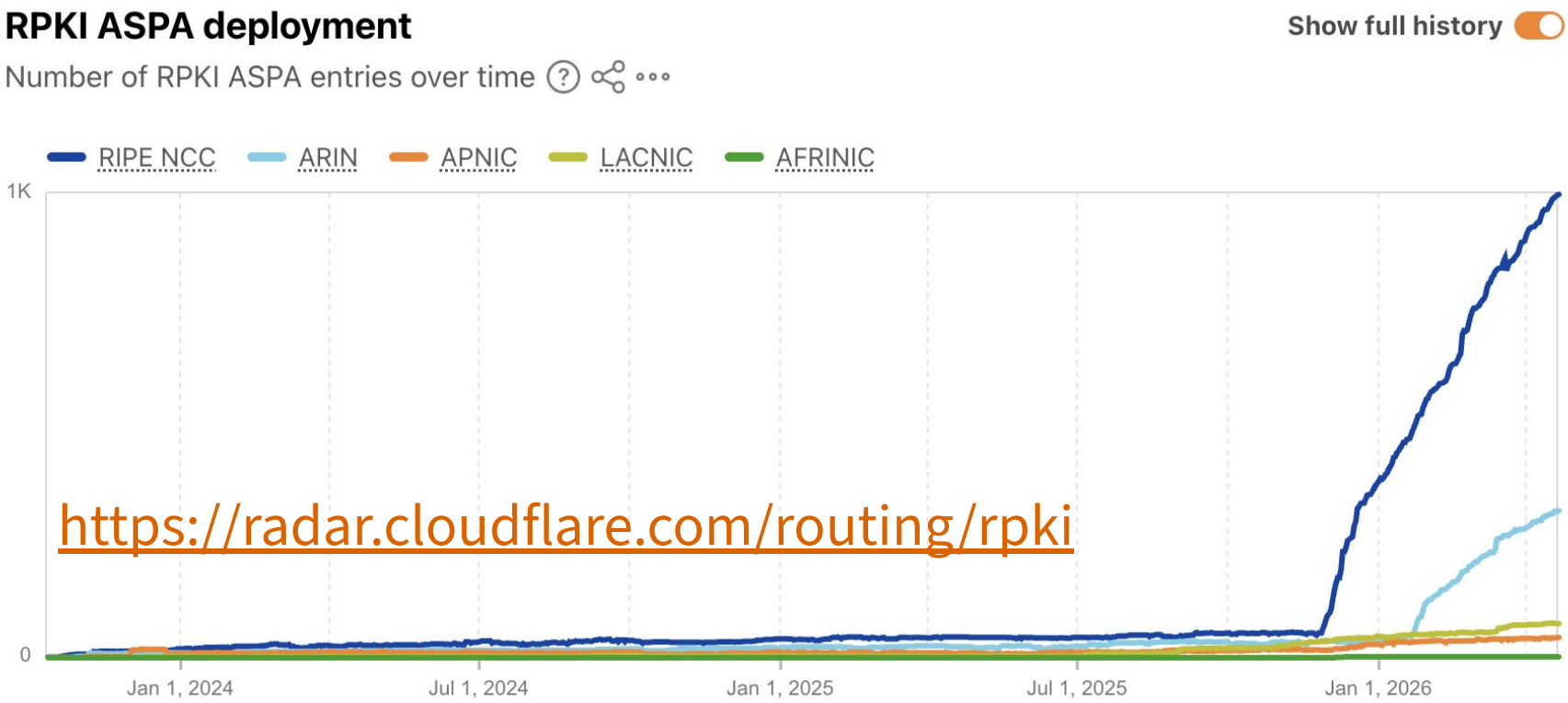
- Very close to the finish line

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

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

https://datatracker.ietf.org/doc/draft-ietf-sidrops-8210bis/

# Adoption Curve




https://radar.cloudflare.com/routing/rpki

# Resources

- https://rootbeer.internet2.edu/global-report#mode=aspa
- https://radar.cloudflare.com/routing/rpki
- https://bgp.tools/
- https://bgp.nsrc.org/REN/index.html
- RIR pointers
  - https://www.arin.net/resources/manage/rpki/aspa/
  - https://www.ripe.net/manage-ips-and-asns/resource-management/rpki/aspa/
  - https://blog.apnic.net/2026/04/20/strengthening-your-network-security-with-apnics-products-and-tools/

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