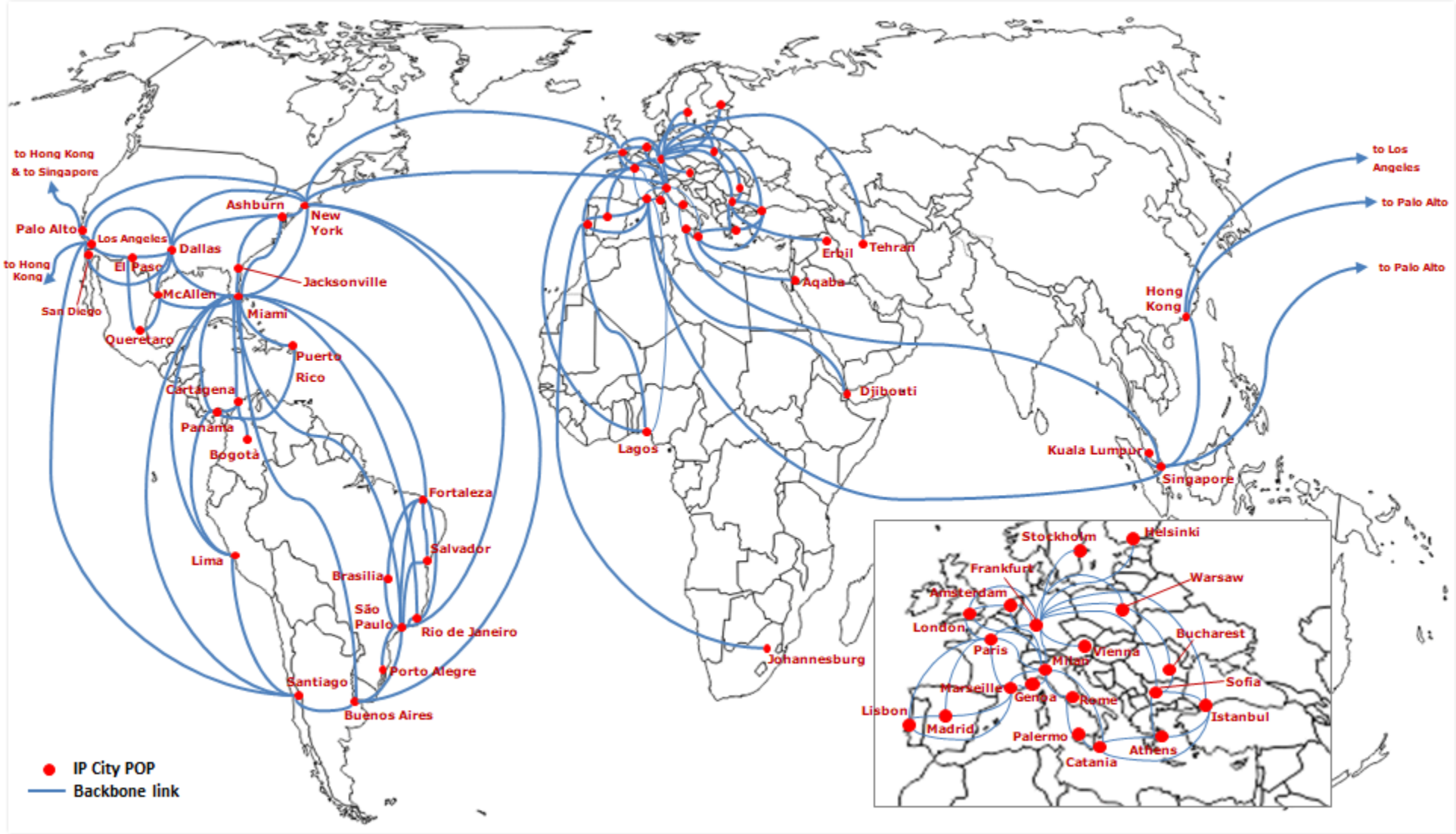

SPARKLE
Inside Seabone
Experiences of a Tier-1
Backbone

Sparkle Seabone Tier-1 footprint

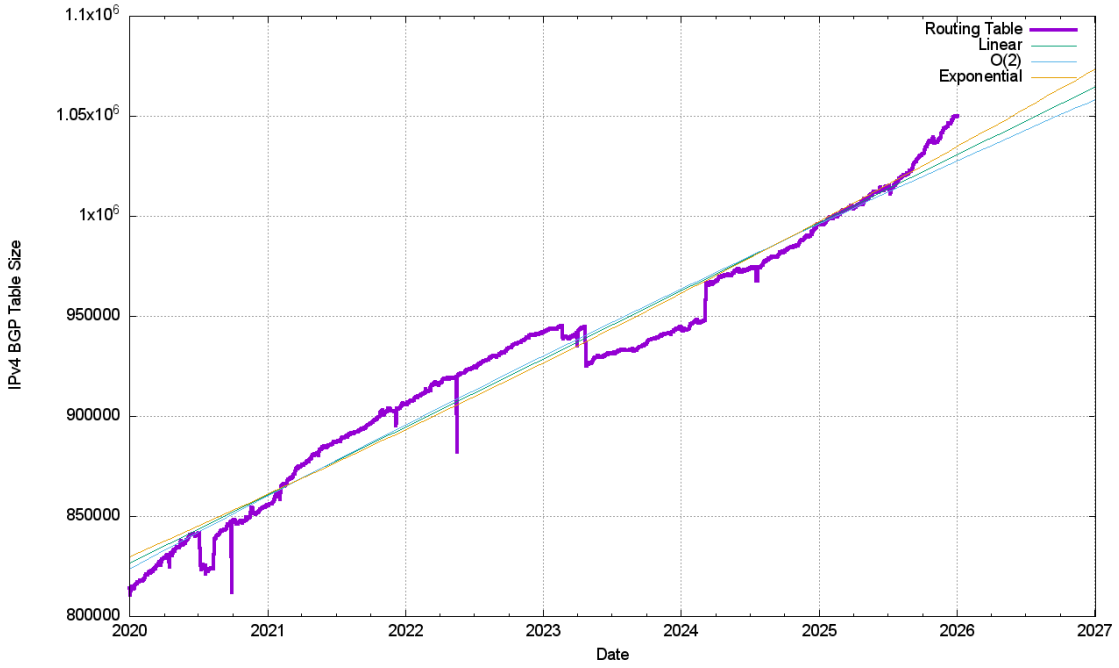
- Multi Tb/s overall capacity
- Dual stack IPv4/v6 network
- RPKI worldwide coverage



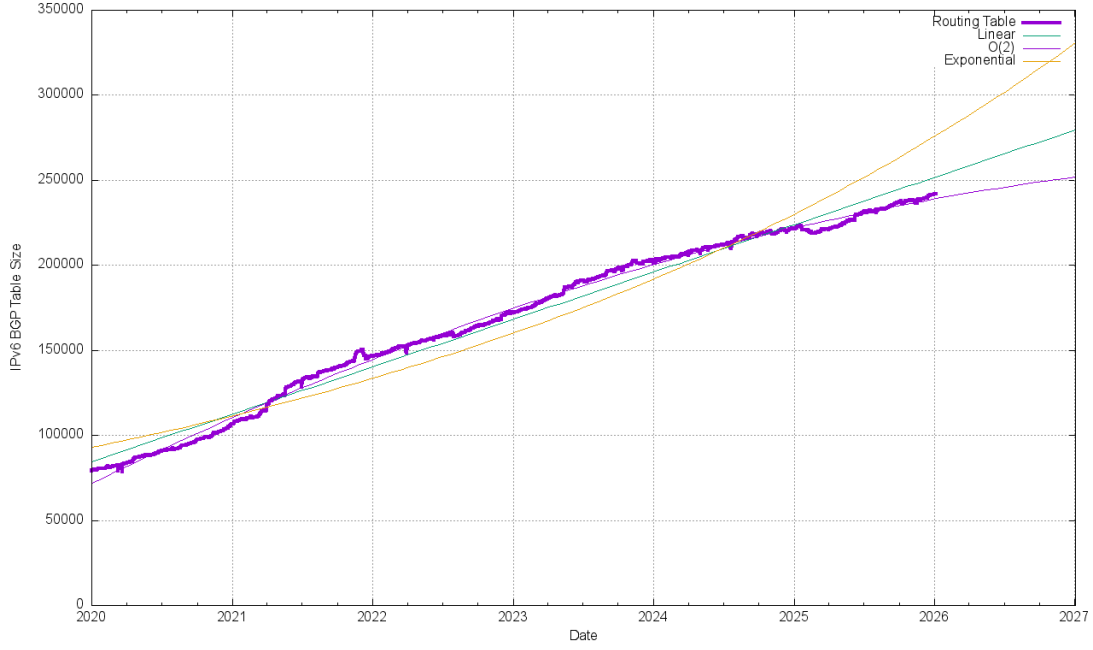
Internet Data (1/2)

- Global size of the internet IP address forecast APNIC data
- IPv4 BGP prefix full routing table size forecast for end ‘25 > 1 M
- IPv6 BGP prefix full routing table size forecast for end ‘25 > 250 k
- “While a number of access providers and service platforms have made significant progress in public IPv6 deployments for their respective customers, the majority of the Internet user base (some 57% the Internet’s user base) is still exclusively using IPv4 as of the end of 2025 ”

IPv4 routes growth



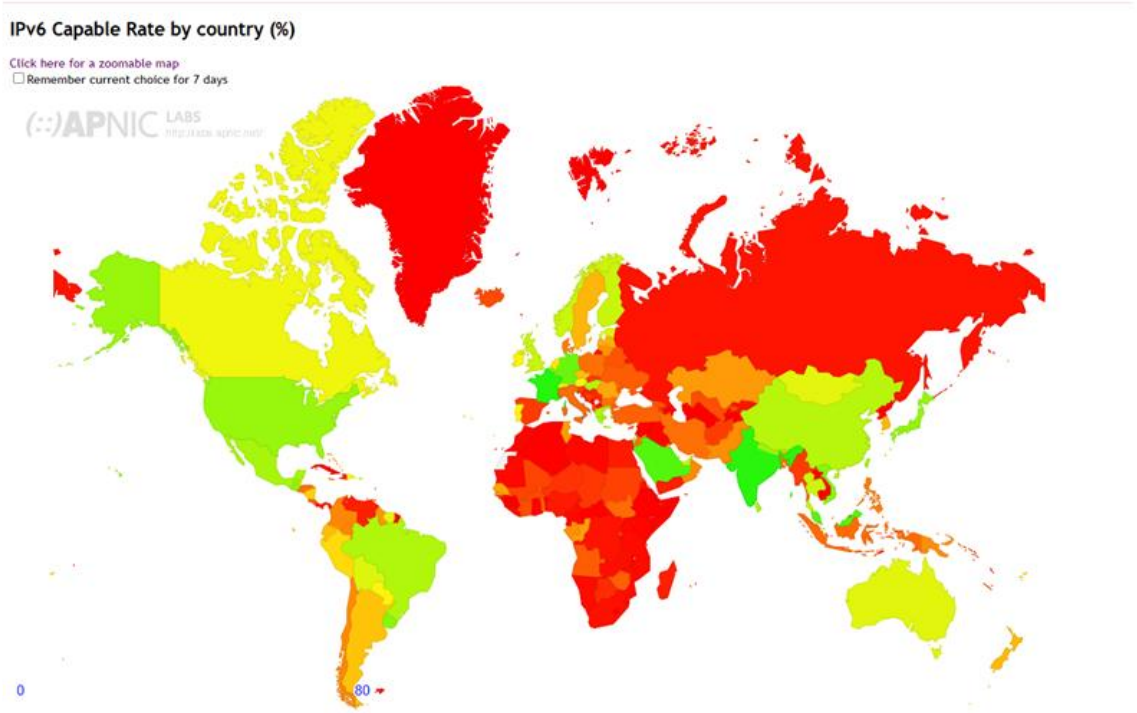
IPv6 routes growth

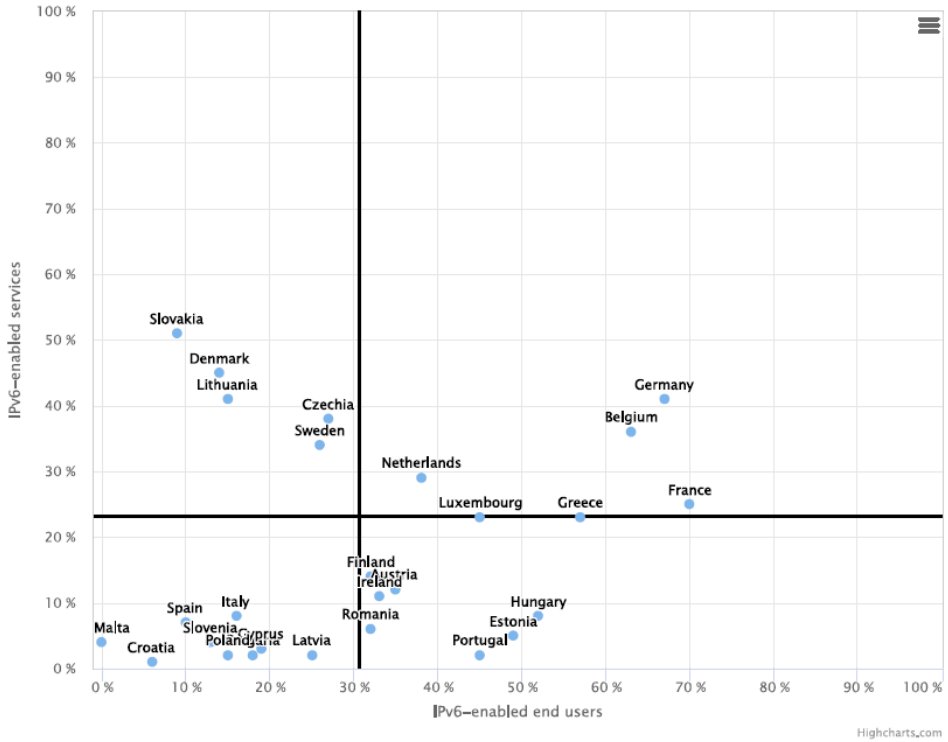


https://labs.apnic.net/index.php/2026/01/06/bgp-in-2025/
https://blog.apnic.net/2025/01/06/bgp-in-2024/

Internet Data (2/2)

- Access service provider focus: IP hostname – end customers
- Transit service provider focus: IP transited from Access provider





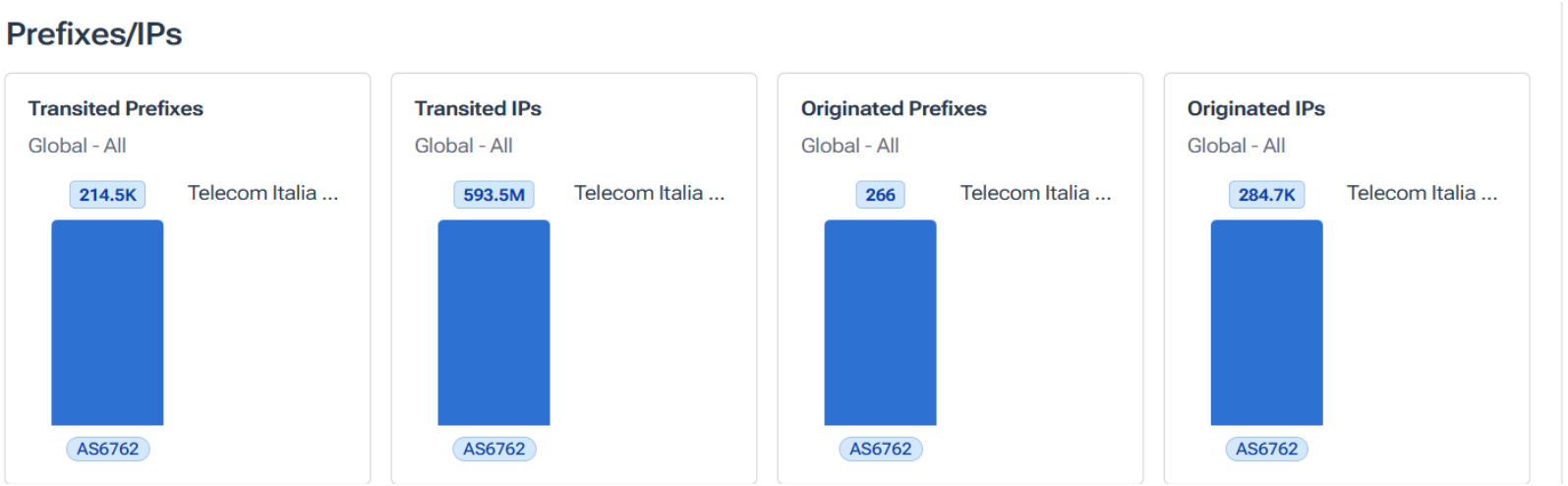
https://stats.labs.apnic.net/ipv6/

https://ec.europa.eu/internet-standards/ipv6.html

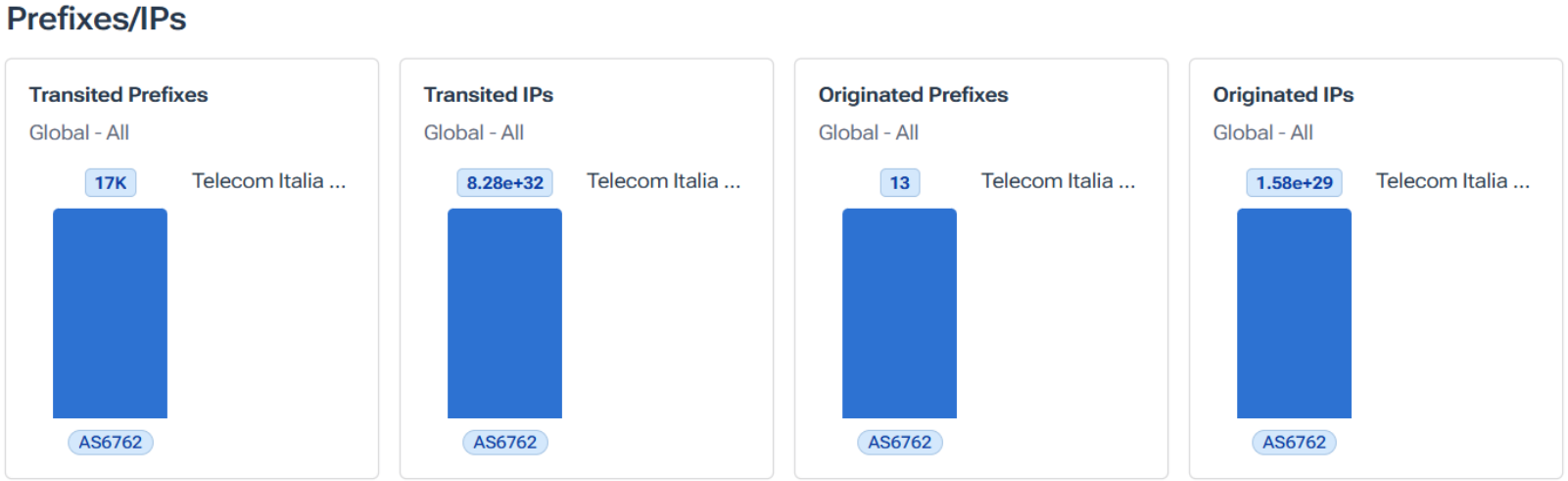
Seabone Tier-1 sizing and numbers

- IPv4 prefix transited: **214 k** (1 M global – 21,4 %)
- IPv6 prefix transited: **17 k** (200 k global – 8,5 %)
- IPv4 hostname addresses transit: **600 M**
- IPv6 statistics: **10 %** of the total traffic transited

IPv4



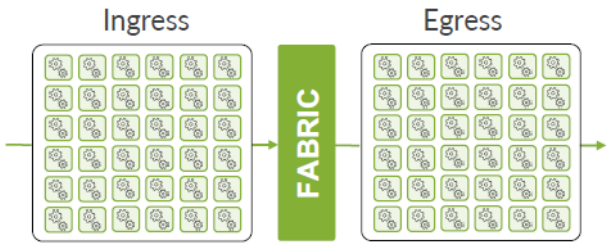
IPv6

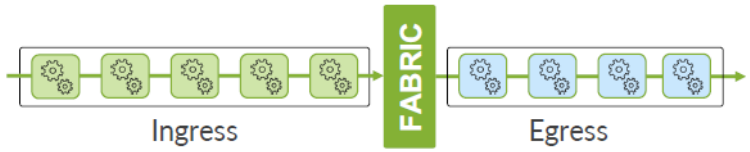


Source: Kentik info-provider

Focus on the technology

- Packet Processing Architectures choice has an high impact on Tier 1 in order to manage 8 – 16 Tera in 2 or 3 Rack Unit
- As explained in NANOG 93 & NANOG 95 by HPE Juniper contribution n. 2 option are availabe and our choice converged towards routers in Pipeline Architecture





Multiple Packet Processing Engines (PPE) Architectures

Multiple PPEs

- Infinite programmability
  - **All features** can be supported
- Highest level of flexibility
  - Each PPE can access a fungible memory
- Can't get the Power/Speed that pipelines offer

Pipeline Architectures

Pipeline

- Higher performance
  - Higher Speed / Lower power
- Lower latency
- Covers "most" of the major use-cases
- Can't reach the flexibility a multiple PPE architecture offers

Router capacity needed in Seabone

- Max RIB (Routing Information Base) size: 60 M routes
- Max FIB (Forwarding Information Base) size: 4 M routes
- 8 - 16 T wirespeed routers

IPV6 implementation in Seabone Network

Based on Intra-AS 6PE, both native IPv6 and dual-stack configurations are available.
IPv6 packets are seemlessly carried along the backbone

```
xe-3/1/0:2 {
    unit 0 {
        description "[CUSTOMER] TIS-100000XXXXXX";
        family inet {
            rpf-check {
                mode loose;
            }
            filter {
                input-list [       -IPv4 Border-IPv4 Accept-IPv4 ];
            }
            address XXX.XXX.XXX.6/31;
        }
        family inet6 {
            filter {
                input-list [       -IPv6 Border-IPv6 Accept-IPv6 ];
            }
            address 2001:41a8:YYYY:YYYY::YYYY/127;
        }
    }
}
```

```
xe-X/Y/W:Q {
    unit 0 {
        description "[CUSTOMER] TIS-100000XXXXXX";
        family inet6 {
            filter {
                input-list [ -IPv6 Border-IPv6 Accept-IPv6 ];
            }
            address 2001:41a8:YYYY:YYYY::YYYY/127;
        }
    }
}
```

RPKI configuration in Sparkle network (HPE/Juniper environment)

RPKI Validator Connection

Policy Configuration

BGP Community Configuration

E-BGP peering Application

```
@J10003A-yyy> show validation session detail
Session xxx.xxx.xxx.xxx, State: up, Session index: 3
  Group: in-SPARKLE, Preference: 100
  Local address: xxx.xxx.xxx.xxx, Port: 3323
  Refresh time: 600s
  Hold time: 1500s
  Record Life time: 900s
  Serial (Full Update): 2219
  Serial (Incremental Update): 2220
  Session flaps: 7
  Session uptime: 2w3d 20:33:31
  Last PDU received: 00:05:06
  IPv4 prefix count: 639923
  IPv6 prefix count: 189842
```

In Cisco environment, RPKI configuration includes TCP session with the RPKI Validator and BGP configuration

BGP announcements «External Security»

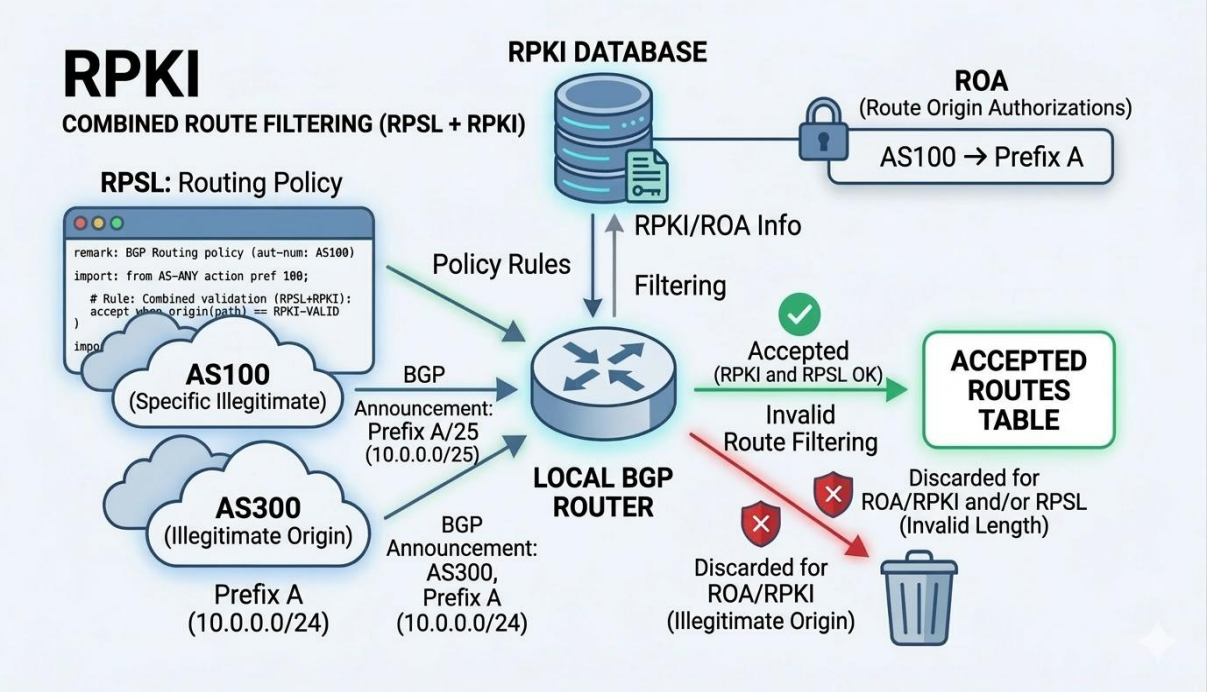
- To protect against fraudulent BGP announcements, a two-layer filtering approach is applied to external sessions:

RPSL validation:

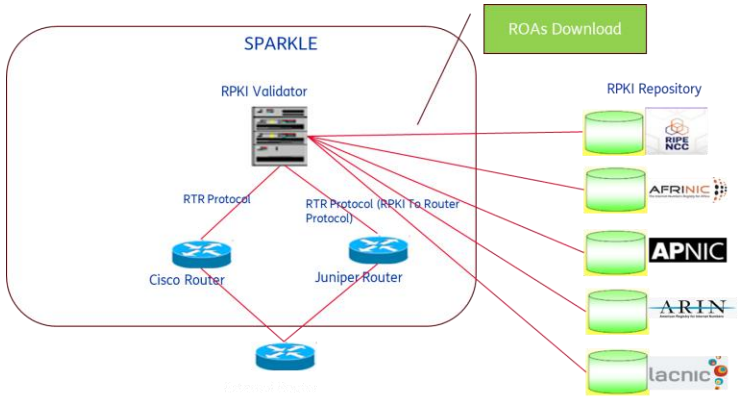
- This procedure verifies the authenticity of route origin data by comparing it against the Routing Policy Specification Language database, ensuring route announcements adhere to declared policies. For customers lacking an AS-SET or Route-set, only directly connected prefixes are accepted.

Filtering of RPKI invalid routes:

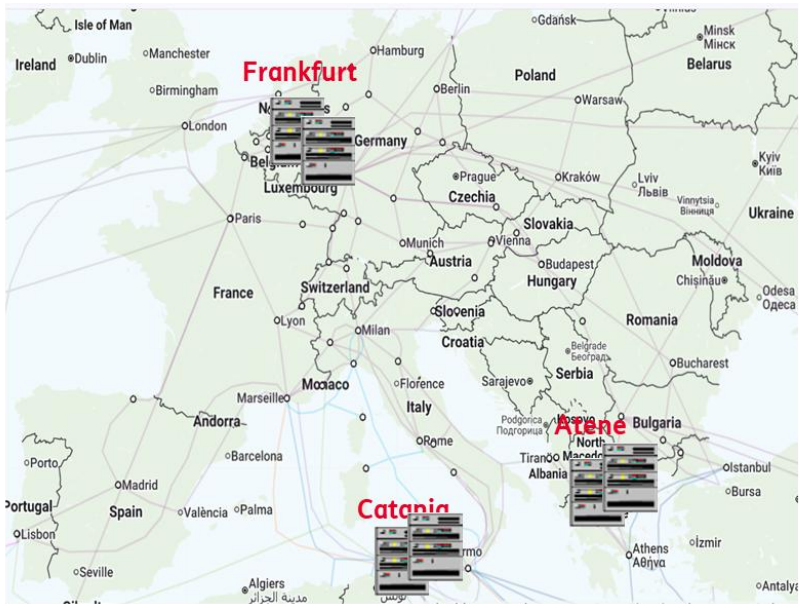
- This measure rejects any route announcements that do not pass validation via the Resource Public Key Infrastructure, thereby blocking potentially unauthorized or malicious routes from any eBGP session.



Spreading RPKI platform in Seabone network



- Expanding the RPKI platform worldwide
- Differentiating the software distribution (e.g. Routinator & RPKI-client)



Status of RPKI implementation

- MANRS guidelines implemented seems not enough: the community has other on-field tools to verify conformance and test the network
- Take a look to https://manrs.org/netops/participants/
- Is BGP safeyet is a must https://isbgpsafeyet.com/
- ROVISTA score too is a must https://rovista.netsecurelab.org/

We've been in touch with 3 different entities very helpful and collaborative to have the work done and still in continuous improvement (MANRS, Cloudflare and Virginia Tech)

Status

Displaying 31 major operators + Show all + Show ASN column

NAME	TYPE	DETAILS	STATUS
Lumen	transit	signed + filtering	safe
Arelion (formerly Telia)	transit	signed + filtering	safe
Cogent	transit	signed + filtering	safe
NTT	transit	signed + filtering	safe
Sparkle	transit	signed + filtering	safe
Hurricane Electric	transit	signed + filtering	safe
GTT	transit	signed + filtering	safe
TATA	transit	signed + filtering	safe
Zayo	transit	signed + filtering	safe
PCCW	transit	signed + filtering	safe
Vodafone	transit	signed + filtering	safe
RETN	transit	partially signed + filtering	safe
Orange	transit	signed + filtering	safe

ASN Search

Rank	ASN	Country	Organization	ROV-Score	Last updated on
1	3356	United States	Level 3 Parent, LLC	100.0%	2026-03-10
2	1299	Sweden	Arelion Sweden AB	100.0%	2026-03-10
3	174	United States	Cogent Communications	100.0%	2026-03-10
4	3257	United States	GTT Communications Inc.	100.0%	2026-03-10
5	2914	United States	NTT America, Inc.	100.0%	2026-03-10
6	6939	United States	Hurricane Electric LLC	100.0%	2026-03-10
7	6453	United States	TATA COMMUNICATIONS (AMERICA) INC	100.0%	2026-03-10
8	6762	Italy	Telecom Italia S.p.A.	100.0%	2026-03-10
9	6461	United States	Zayo Bandwidth	100.0%	2026-03-10
10	3491	United States	PCCW Global, Inc.	100.0%	2026-03-10