RIPE NCC
RIPE NETWORK COORDINATION CENTER

SEE Operational Insights and Updates

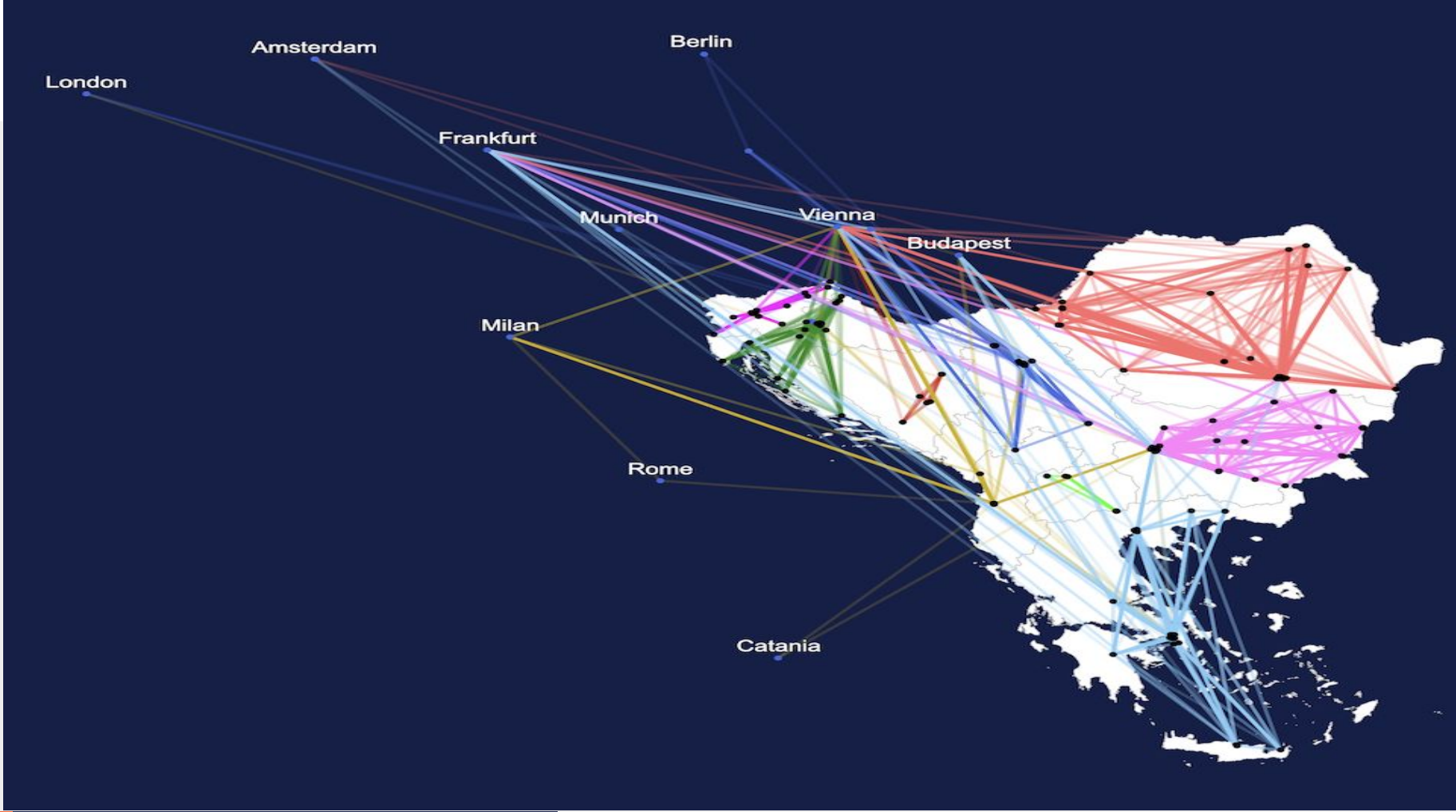
5th SEE Roundtable for Governments and Regulators

Desiree Miloshevic | RIPE | 7 April 2025, Sofia

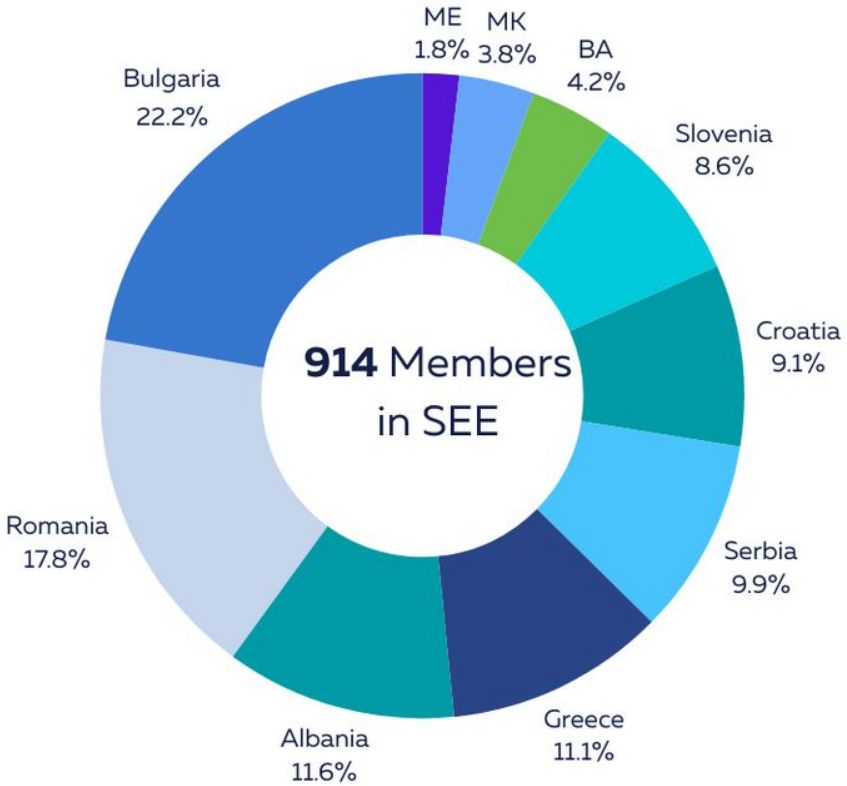
Agenda

1.	SEE Regional Overview
2.	IP allocations per country
3.	Enhancing Routing security with RPKI
4.	IPv6 Uptake in SEE
5.	Q&A

SEE Regional Overview


Amsterdam
Berlin
London
Frankfurt
Munich
Vienna
Budapest
Milan
Rome
Catania

RIPE NCC Members in South East Europe

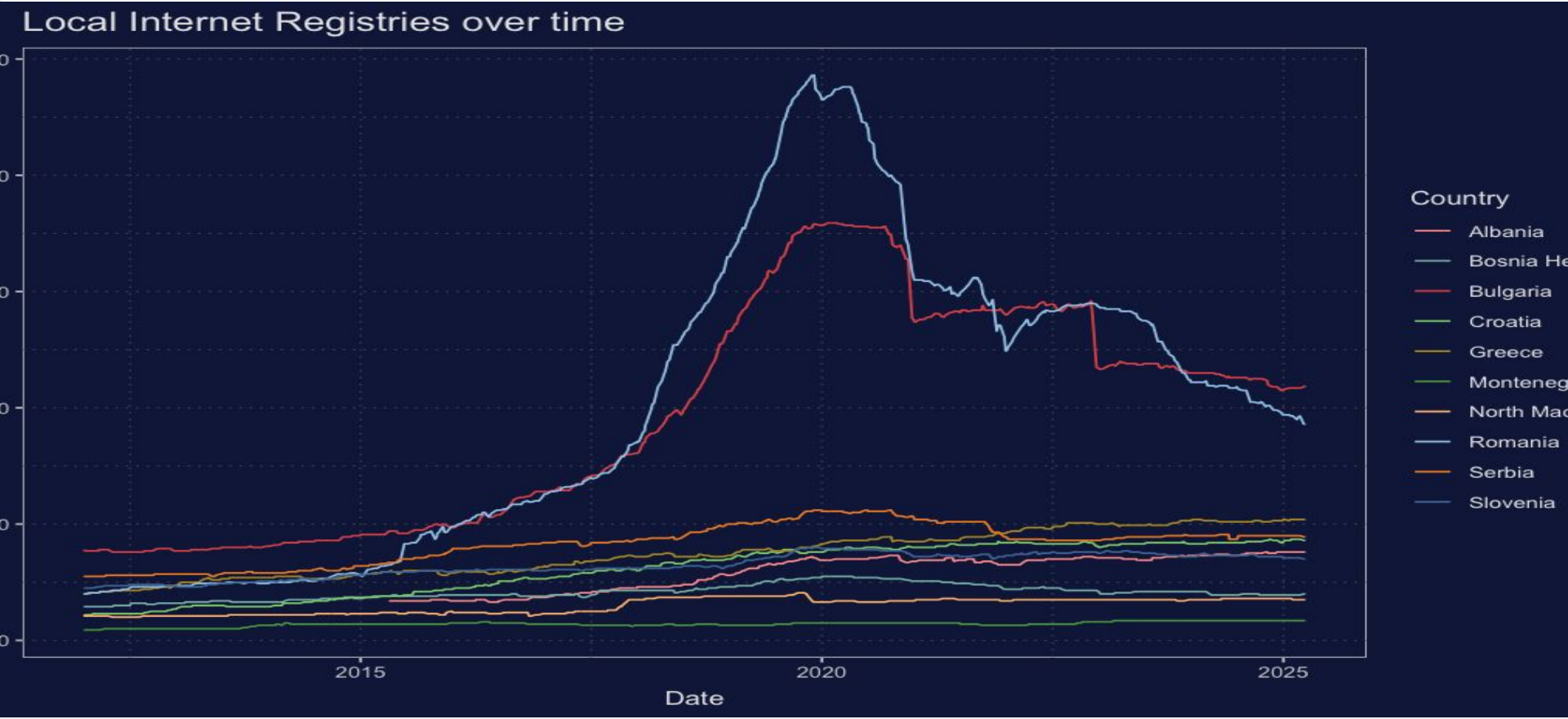


Country	Members	Population (thousands)
Montenegro (ME)	17	616
North Macedonia (MK)	35	2,058
Bosnia and Herzegovina (BA)	39	3,234
Slovenia	70	2,109
Croatia	84	3,854
Serbia	91	6,760
Greece	102	10,567
Albania*	107	2,776
Romania	164	18,957
Bulgaria	205	6,465

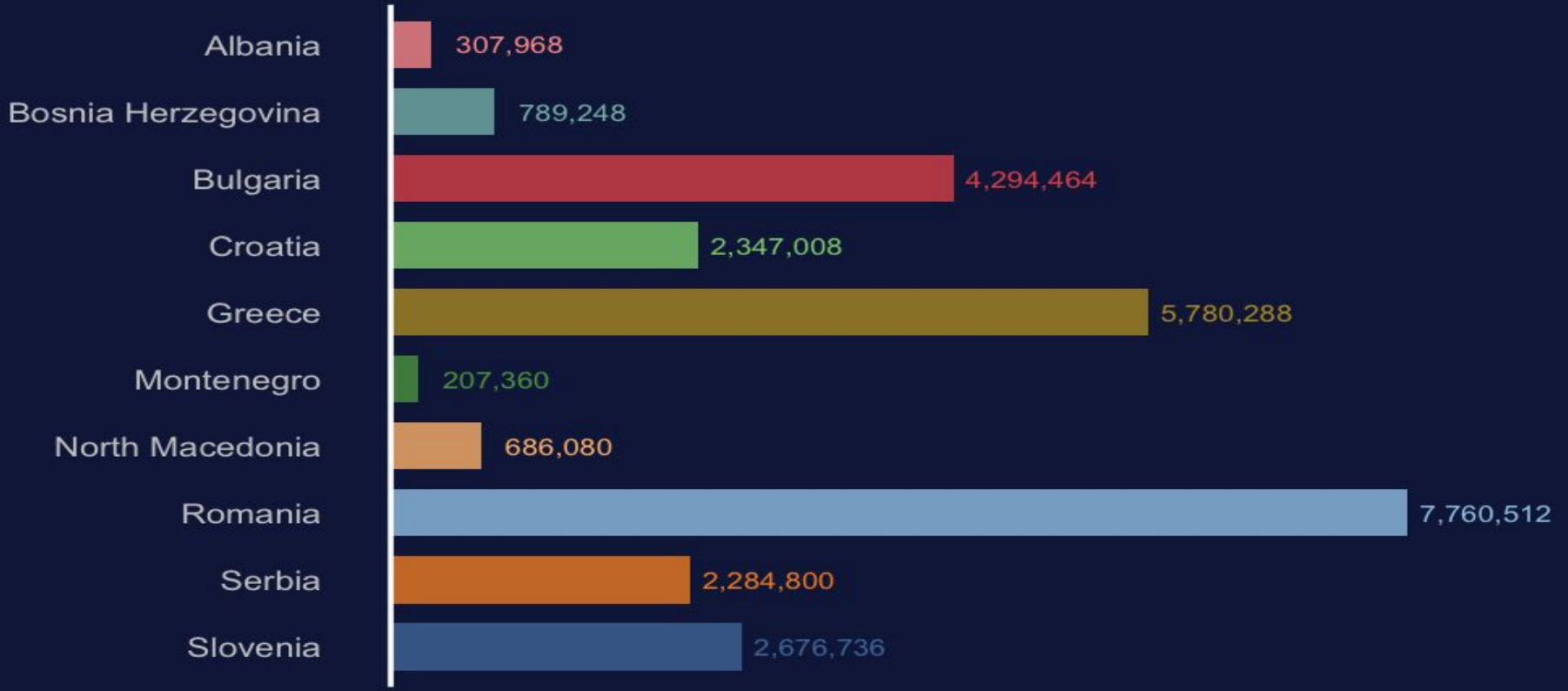
*Members in Kosovo are registered under Albania or Serbia country codes

Registry data as of March 2025
Populations source: World Bank, 2022

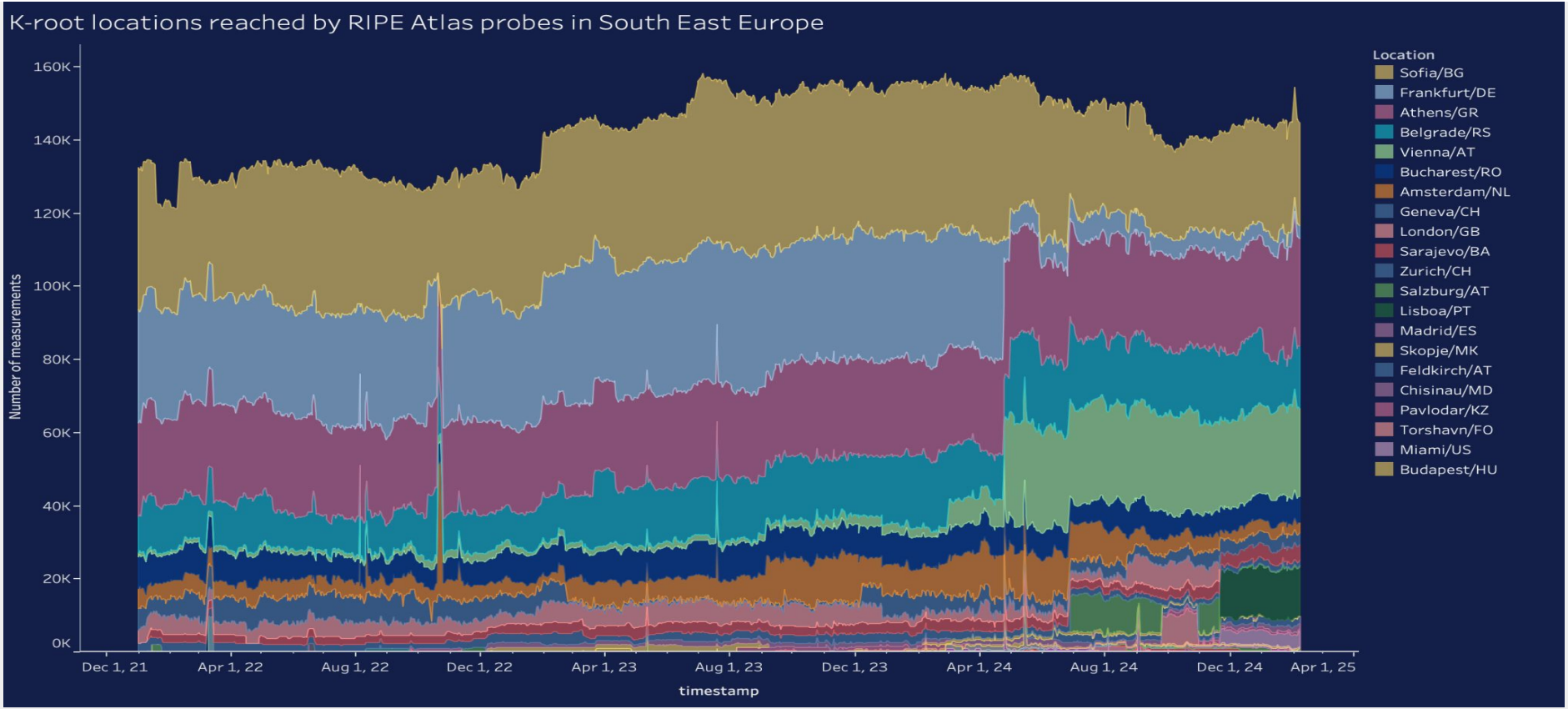
Local Internet Registries over time



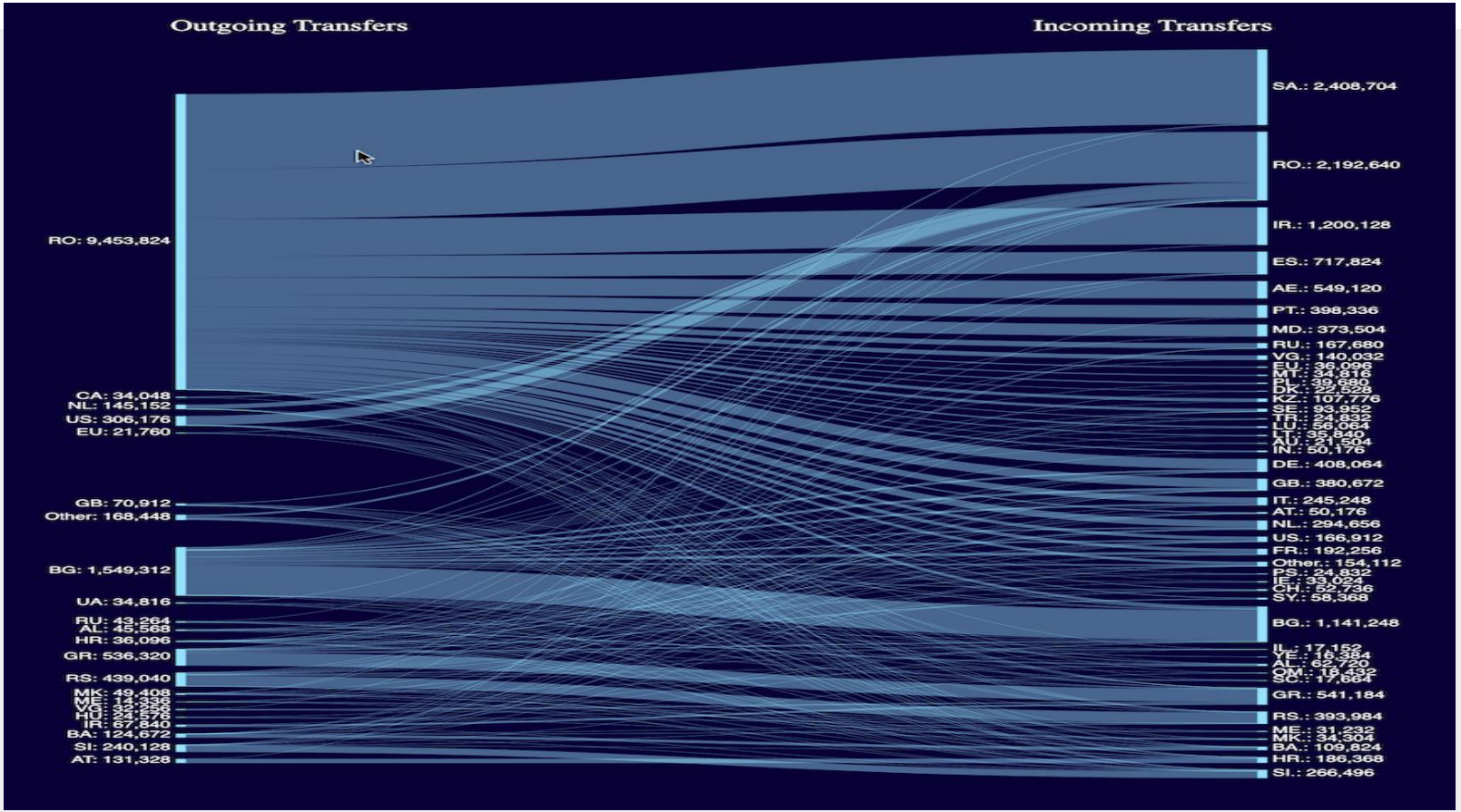
IPv4 address holdings by country



K-root locations reachec by RIPE Atlas probes in SEE



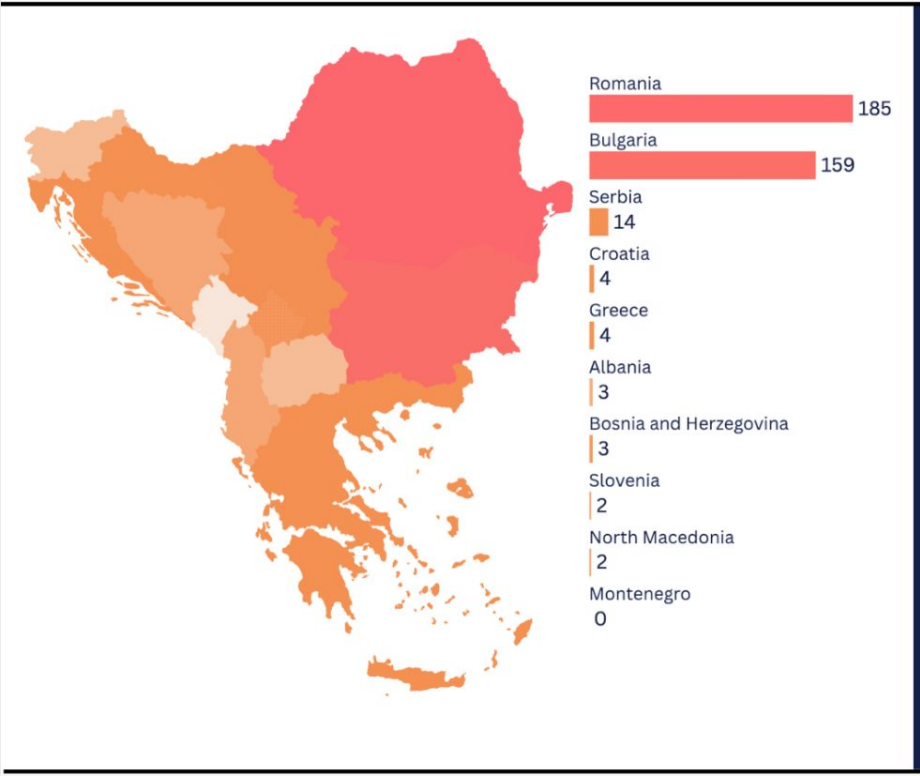
IP Transfers

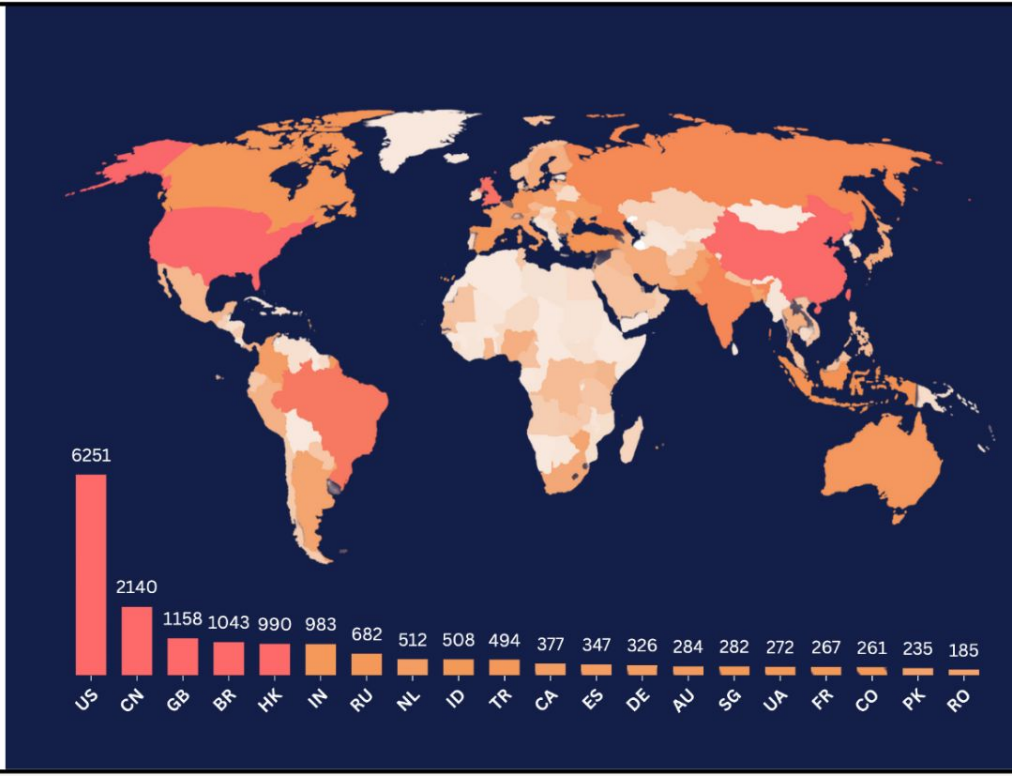


Enhancing Routing Security with RPKI

BGP Incidents in the Region

March 2024 - March 2025, source: Cloudflare





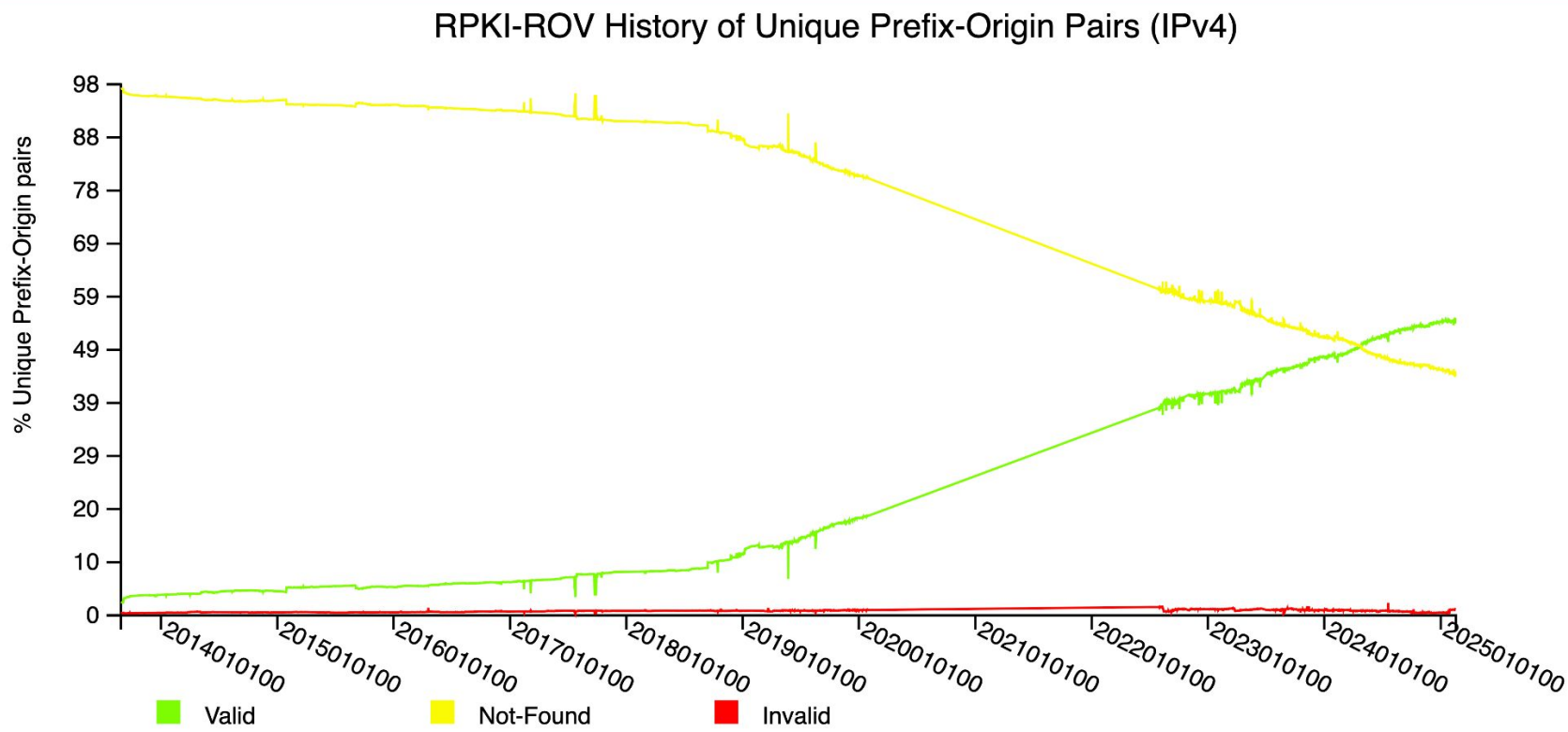
The Need for RPKI

Background info

- **Border Gateway Protocol**
  - Extremely trustful, “routing by rumour”
  - Attackers or misconfigurations can redirect traffic and cause outages or data theft
  - Can we get rid of it? Can we update it? Can we add something out of band?

- **Why RPKI?**
  - Resource Public Key Infrastructure
  - Initially introduced to make informed routing decisions (by verifying the legitimacy of BGP announcements with digitally signed statements)
  - Helps mitigate both accidental and malicious BGP incidents

Global RPKI Adoption (NIST)



NIST RPKI Monitor: RPKI-ROV Analysis **Protocol:** IPv4 **RIR:** All **URL:** https://rpki-monitor.antd.nist.gov/ROV#div2

Conclusion – RPKI Adoption

Examples

- Growing recognition of RPKI importance at government level:
  - White House roadmap advocating RPKI as mature solution for BGP vulnerabilities
  - US government aims to have 60% of advertised IP space under ARIN RSA, explicitly paving the way to ROAs for federal networks

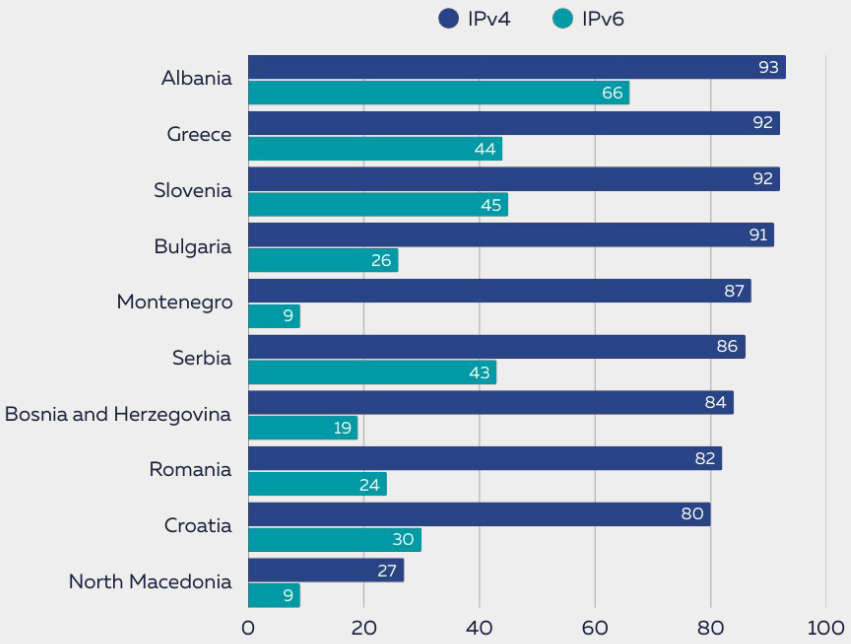
- Regulatory bodies taking action:
  - FCC (in US), proposing annual BGP security risk management plans for ISPs
  - Forum Standaardisatie (in NL), “apply or explain” by the end of 2024 for all governmental entities, both ROAs and ROV

- Implications for South East Europe:
  - Opportunity for operators and policymakers to enhance routing security
  - Potential to establish guidelines and timelines for RPKI adoption

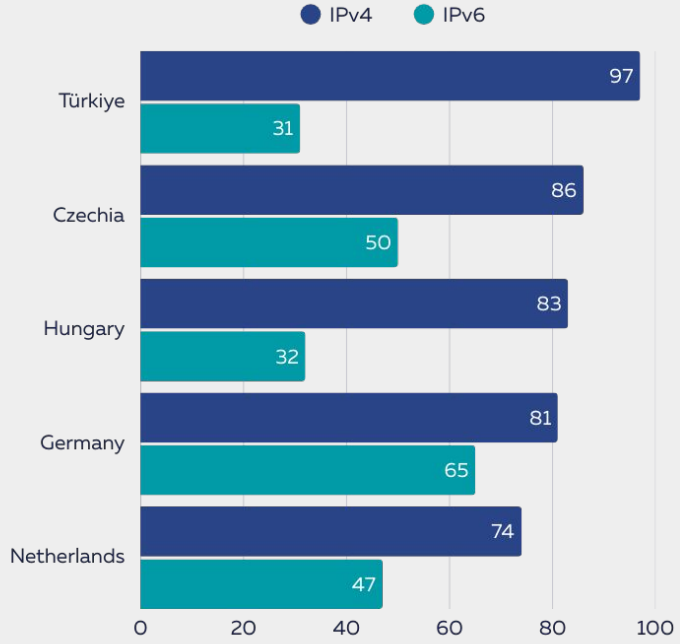
ROA Coverage in the region and beyond (IPv4 and IPv6, %)

x

X



South East Europe

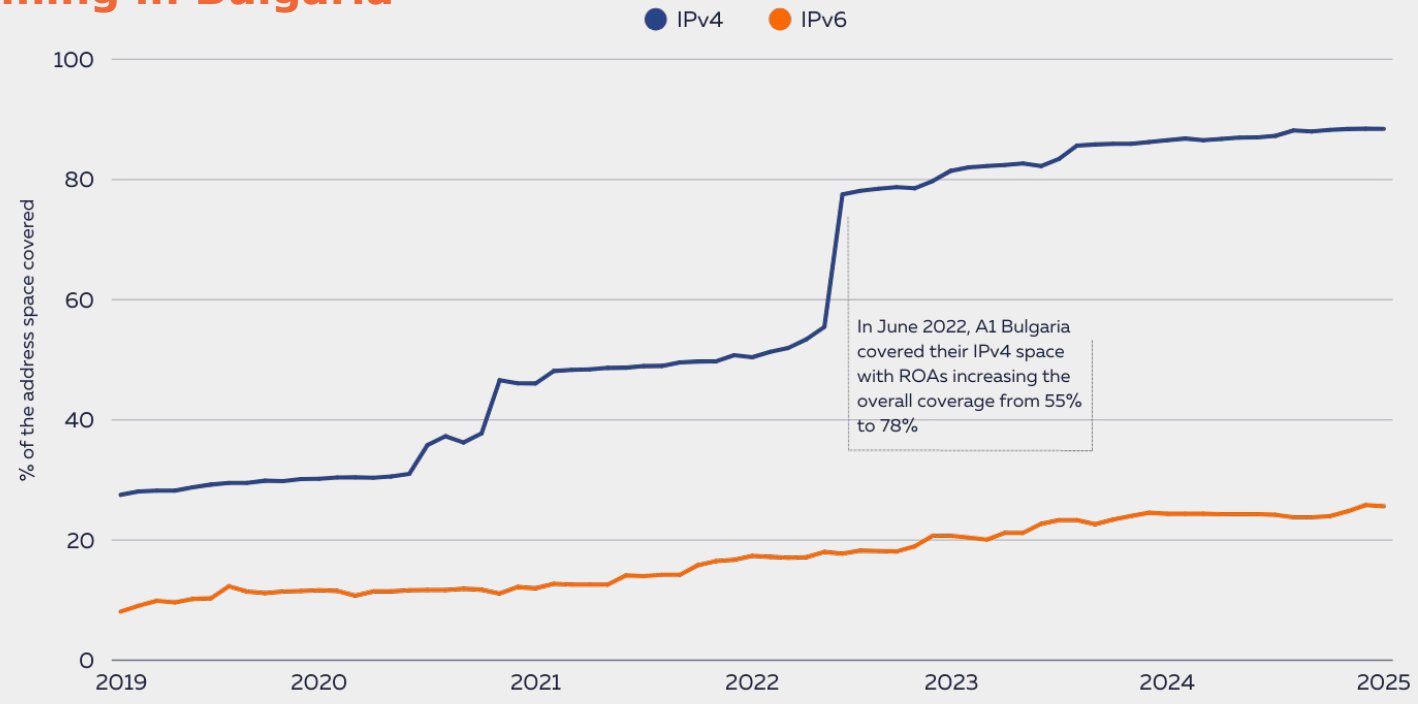


Other Countries

Source: RIPE NCC
Snapshot from March 2025

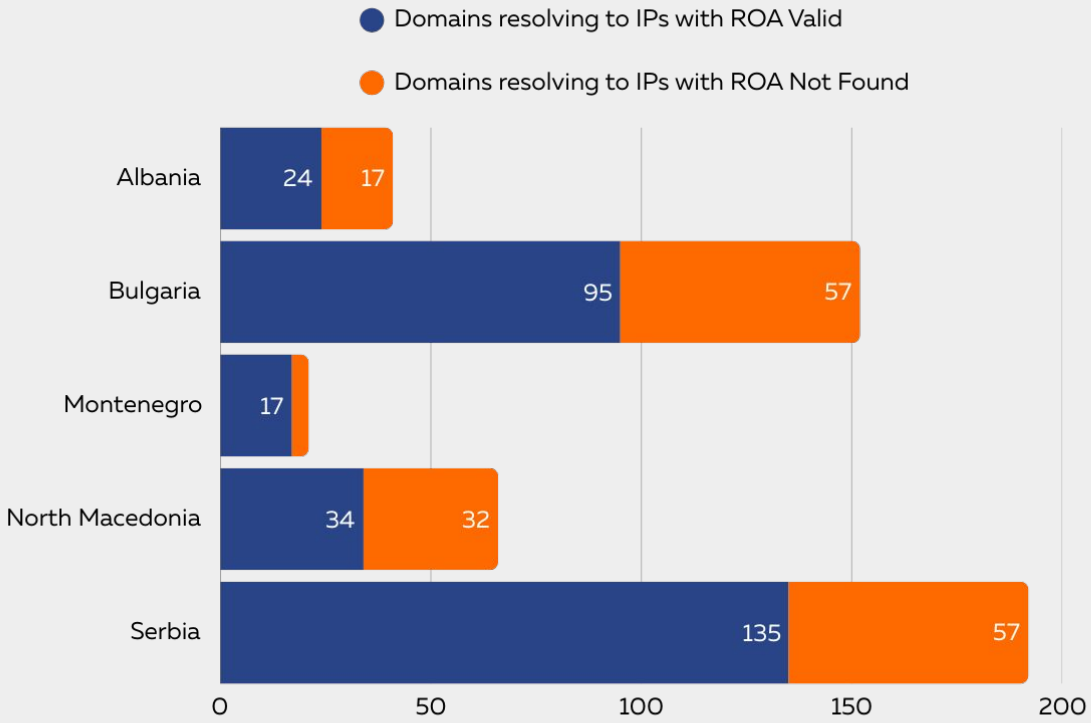
ROA Coverage in the region (IPv4)

Zooming in Bulgaria



Source: RIPEstat, RIPE NCC

ROA Coverage: Government Domains in SEE



Source: RIPE NCC, RIS

We analysed whether IP addresses resolved to the government domains in certain SEE countries are covered by ROAs. We chose a sample of countries that experienced cyber attacks on government websites in the past few years.

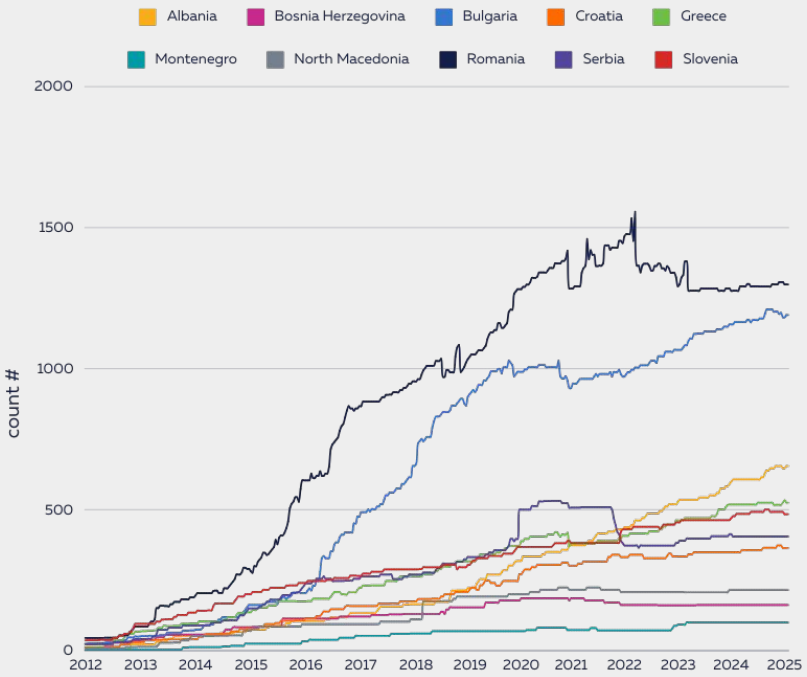
The methodology involves extracting BGP routing data from RIS and then validating against RIPE NCC's RPKI Validator, categorising each prefix as Valid (properly authorised), Invalid (violating a ROA), or Not-Found (lacking RPKI protection).

IP addresses that fell under Invalid or Not-Found prefixes, and were not concurrently covered by a more specific Valid ROA, were classified as being associated with IP addresses under RPKI Invalid or Not-Found prefixes.

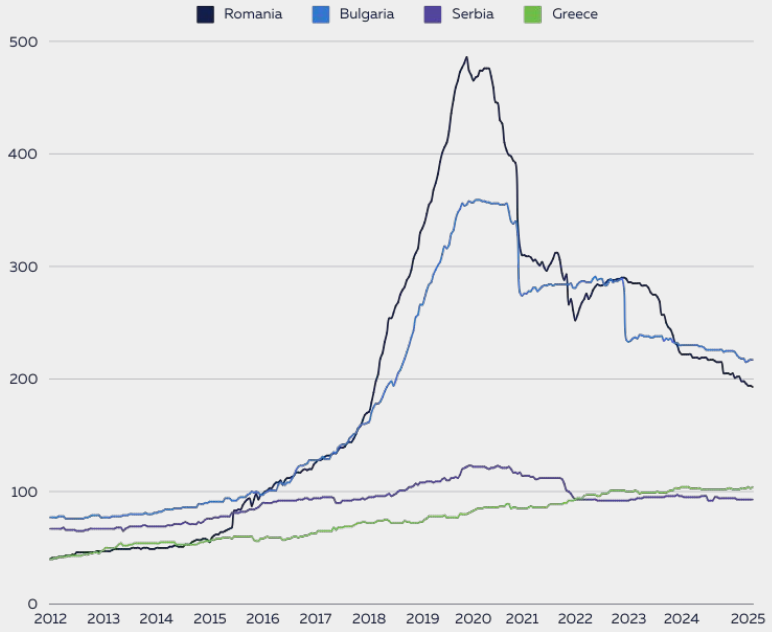
Help us make the domain lists comprehensive!

IPv6 Uptake in South East Europe

South East Europe: Internet Resources



IPv6 Space (/32s) in SEE



Active LIRs
(Bulgaria, Greece, Romania, Serbia)

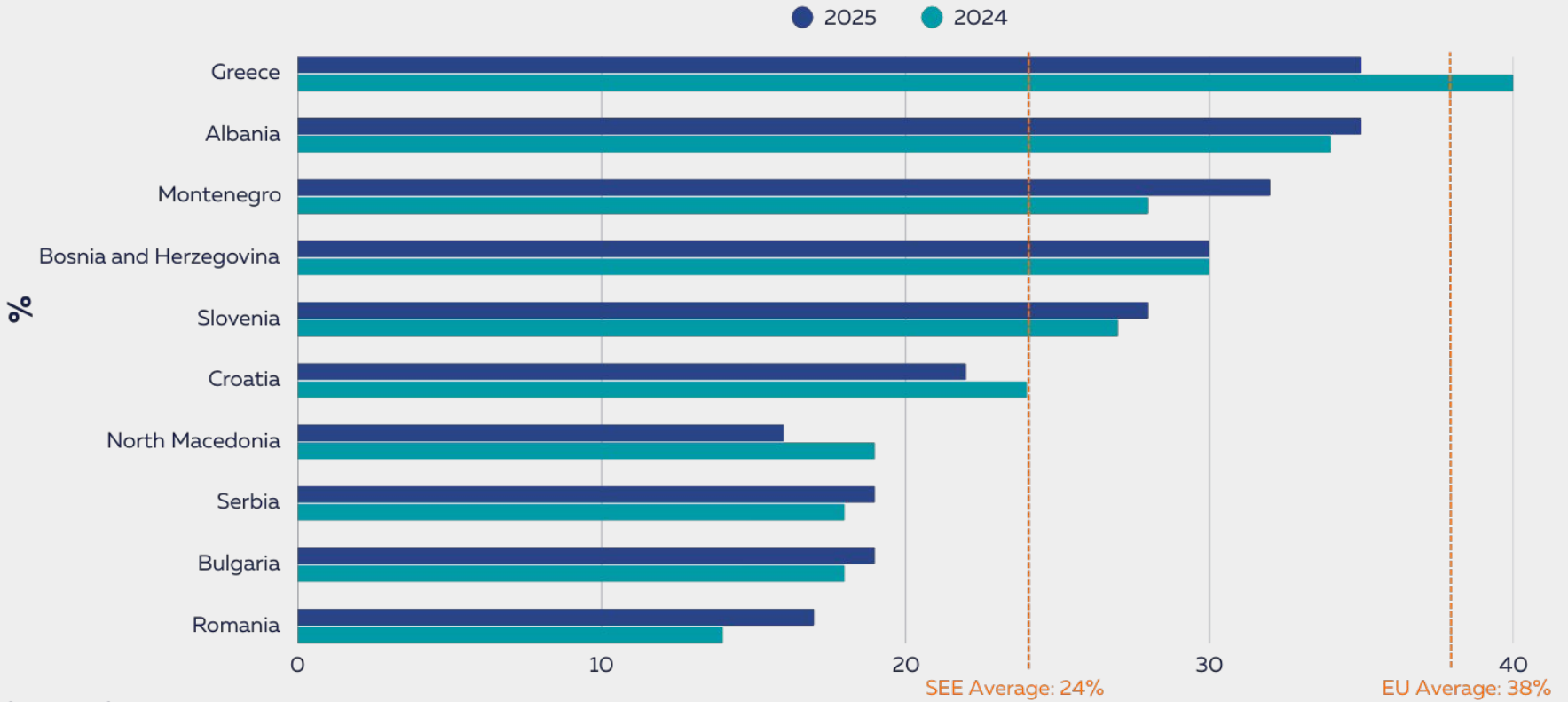
Source: RIPE NCC

IPv6 Capability

Capability & Adoption

- Given the vast size of the IPv6 address space, counting individual addresses is not an effective metric.
- We calculated (IPv6 capability) the percentage of ASes in each country that announce both IPv4 and IPv6 addresses, as well as those that announce only IPv6, compared to those that announce only IPv4
    - IPv6 capability indicates that addresses are being routed, this does not necessarily equate to adoption.
    - IPv6 capability should be viewed as an initial step toward broader adoption.

% of IPv6-capable ASNs in South East Europe



Snapshot from March 2024 and March 2025

Source: RIPE NCC

IPv6 Adoption in the South East Europe, %

Country	IPv6 adoption (Google)	IPv6 adoption (Facebook)	IPv6 adoption (Cloudflare)
Greece	63	56	38
Romania	32	33	18
Bulgaria	21	15	6
Slovenia	14	13	8
Albania	10	8	1
Bosnia Herzegovina	10	15	6
Croatia	9	5	4
Serbia	6	7	5
Montenegro	0	0	0
North Macedonia	0	0	0
Kosovo	0		18

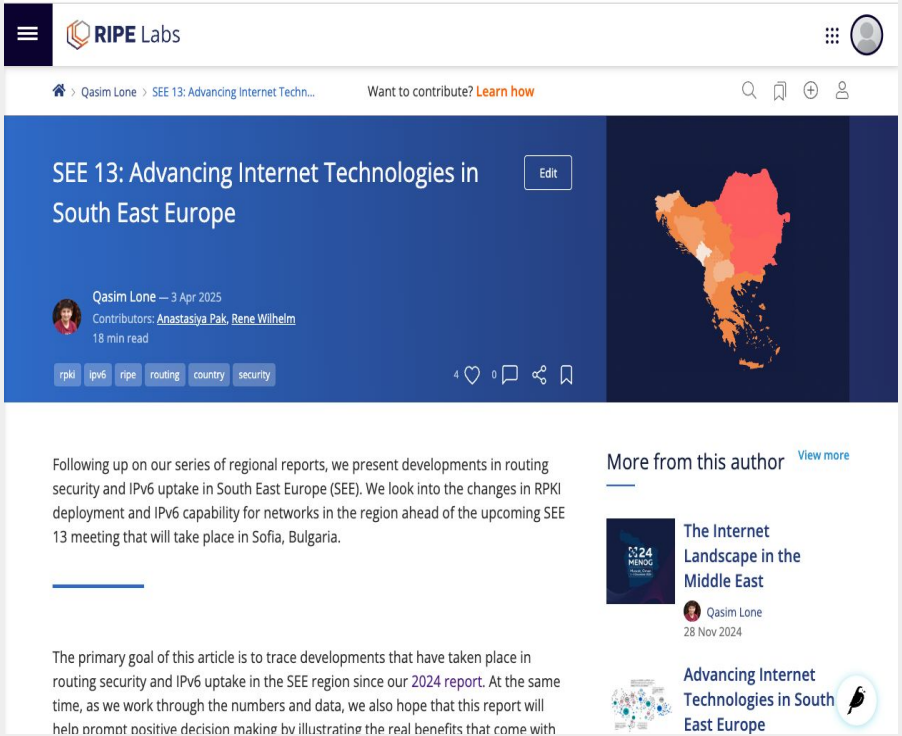
- IPv6 adoption measures if users can actually use IPv6 on their networks.
- We used Content Delivery network (CDN's) (Google, Facebook, Cloudflare) traffic statistics to measure adoption across the region.
- Generally, low level of IPv6 adoption in the region except Greece. Romania and Bulgaria also have relatively higher level of adoption in comparison to the rest of the region.

Presentation Tuesday, 8 April or Read More on RIPE Labs!

For broader context see

RIPE Lab's article &

Advancing Internet Technologies in South East Europe - live @ SEE13



Questions & Comments

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THANK YOU!