RIPE NCC
RIPE NETWORK COORDINATION CENTER

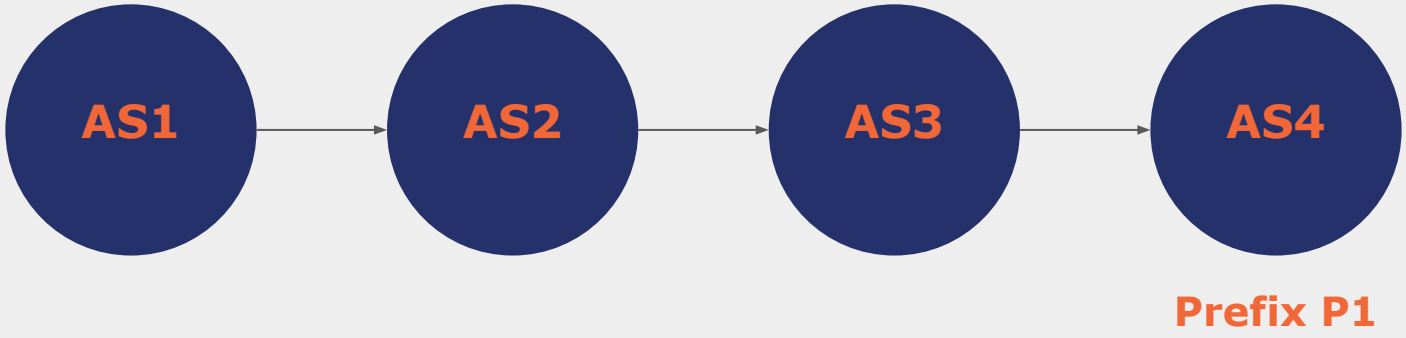
Advancing Internet Connectivity in Central Asia

The Role of IPv6 Uptake, ROAs and ROV

Qasim Lone | RIPE NCC | 25 September 2024

Routing Security

Route Hijack



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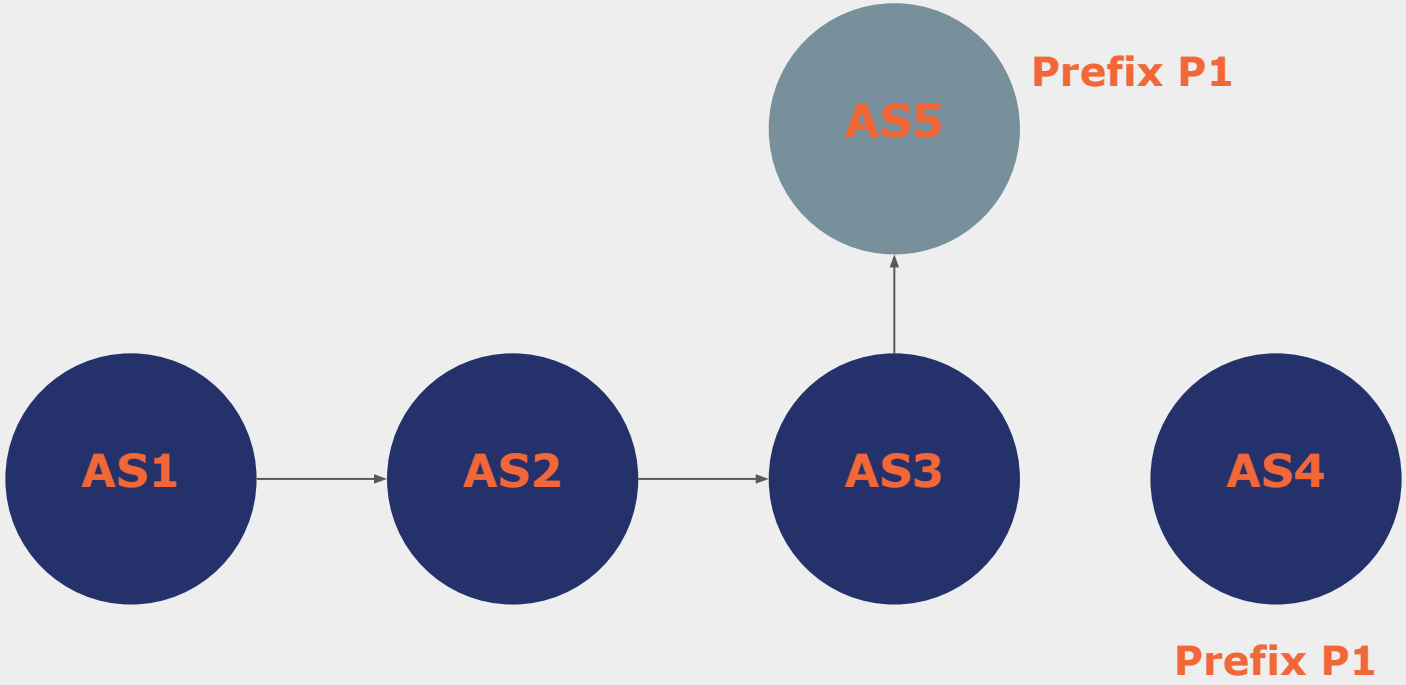


The Need for RPKI

- Attackers or misconfigurations can redirect traffic, causing outages or data theft.
    - **Example**: Pakistan Telecom (2008) accidentally hijacked YouTube's IPs, resulting in a global outage.
- Why RPKI?
    - Prevents such incidents by cryptographically verifying the legitimacy of route announcements.
    - Helps mitigate both accidental and malicious BGP misconfigurations.

Enhancing Routing Security

- Used to validate the origin of BGP announcements
  - Is the originating ASN authorised to originate this particular prefix?

- Has two parts:

  - **Route Origin Authorisation (ROA):** Defines which ASes are authorised to announce specific IP prefixes

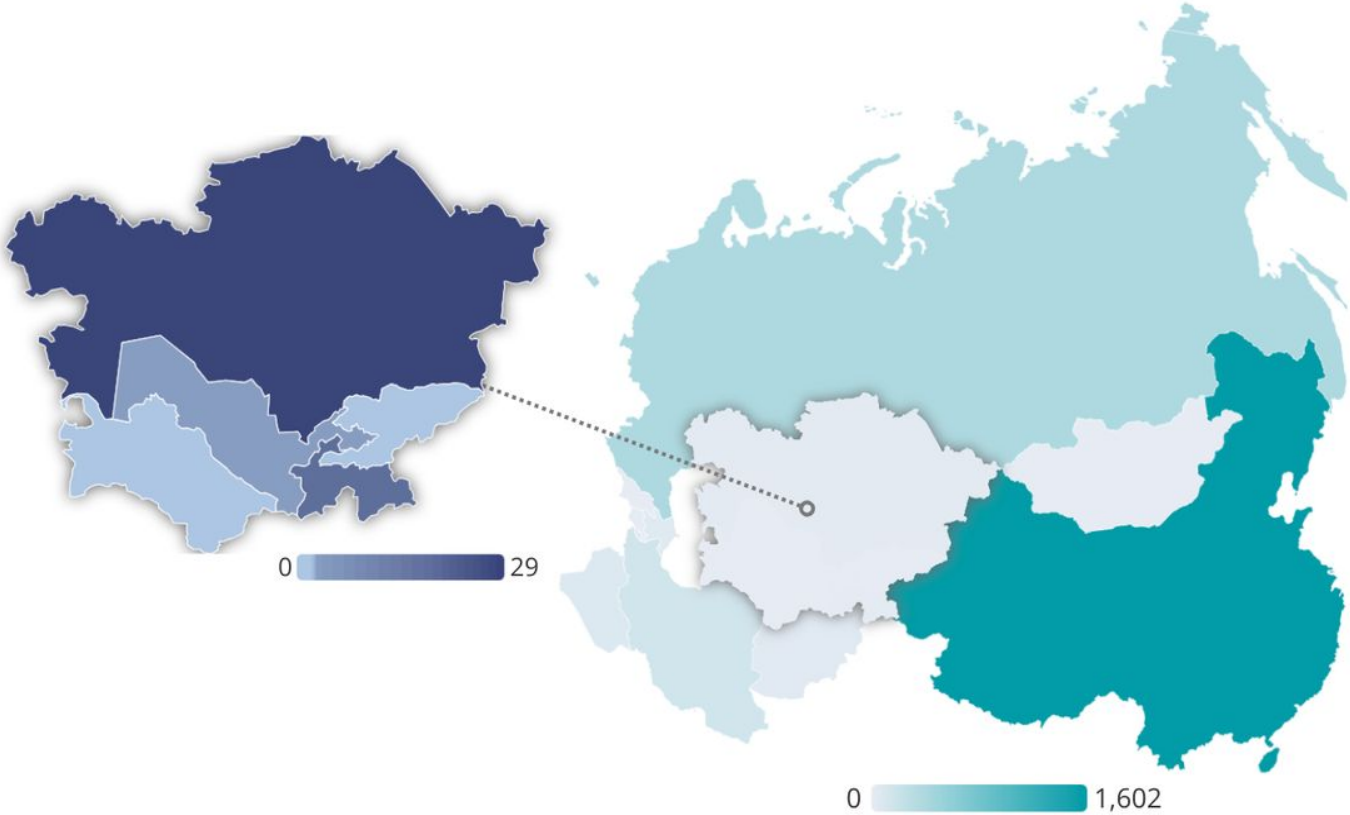
  - **Route Origin Validation (ROV):** Validates routes based on ROAs, ensuring only legitimate routes are accepted.

The RPKI Era – Enhancing Routing Security

- Iraq's Telegram Block Attempt (July 2023):
  - Misconfigured BGP advertisement blackholed global traffic Networks with ROV rejected incorrect routes Telegram's ROAs allowed automatic rejection of hijacks
- Cloudflare 1.1.1.1 Incident (June 27, 2024):
  - Routing misconfiguration caused service disruption ROV could have prevented incorrect route propagation

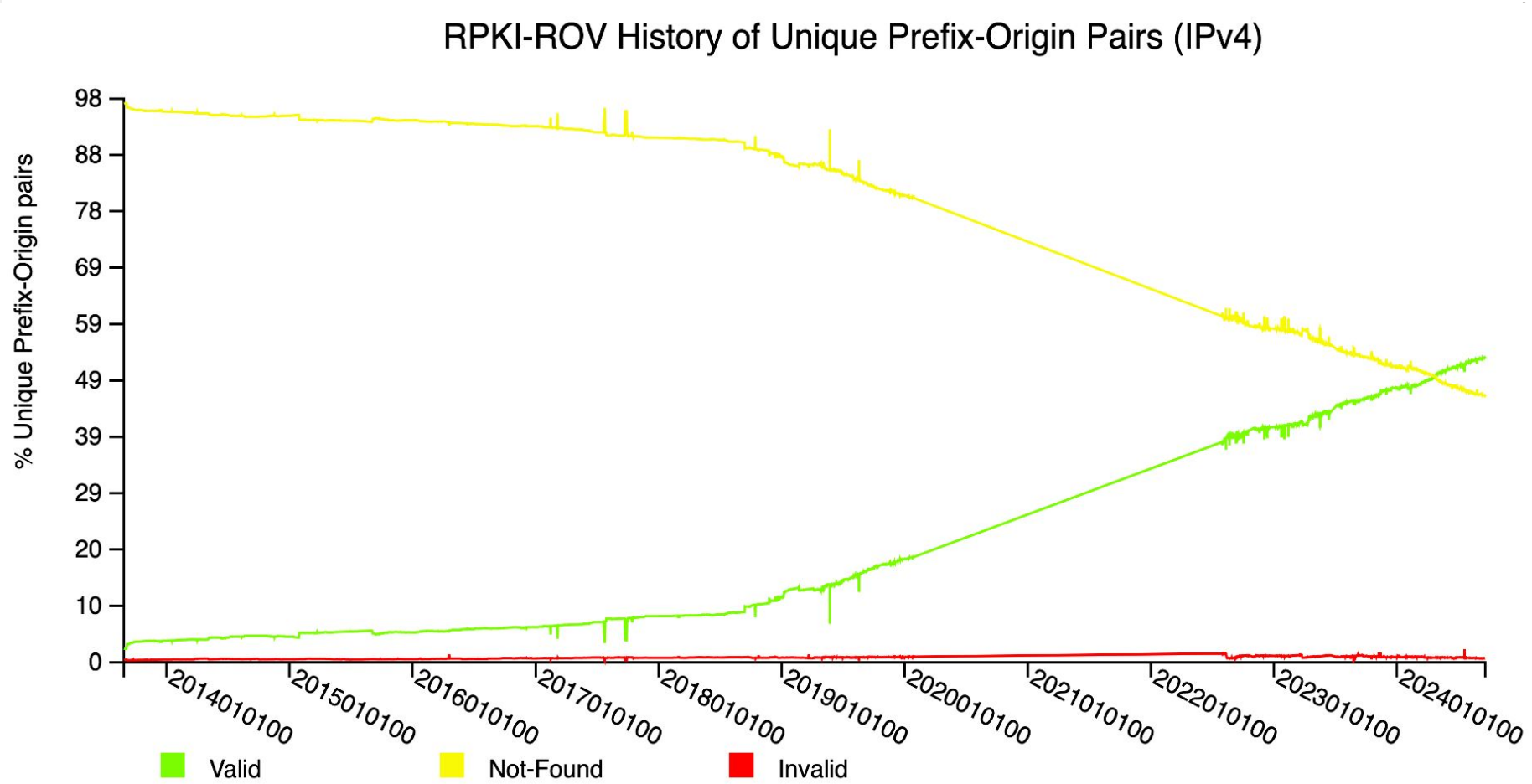
BGP Incidents in Central Asia and Neighbouring Regions (1 Aug 2023 - 1 Aug 2024)

China	1602
India	1558
Russia	399
Iraq	68
Azerbaijan	48
Afghanistan	35
Kazakhstan	**29**
Tajikistan	**18**
Armenia	7
Uzbekistan	**2**
Turkmenistan	**1**
Kyrgyzstan	**0**
Mongolia	0
Georgia	0



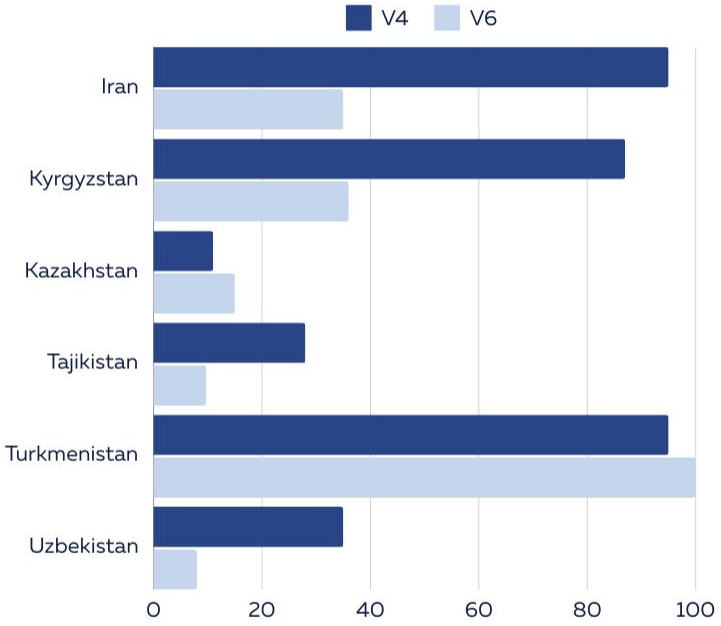
Source: Cloudflare

Route Origin Authorisation

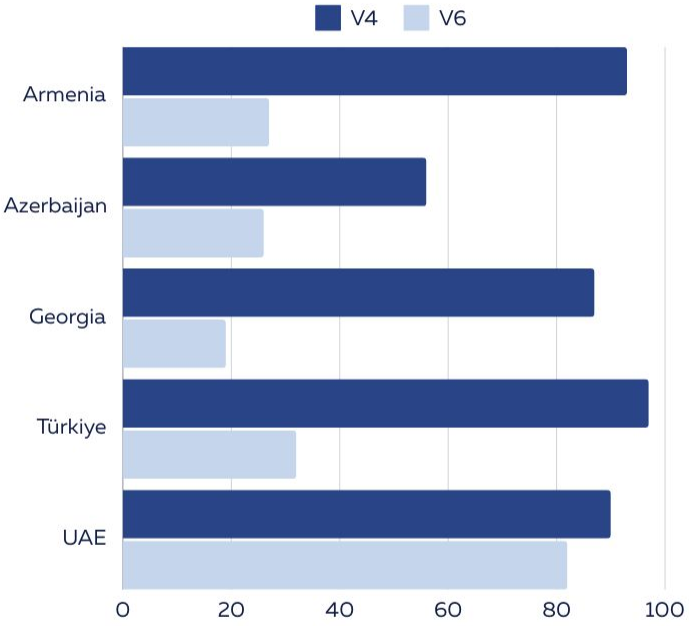


NIST RPKI Monitor: RPKI-ROV Analysis **Protocol:** IPv4 **RIR:** All **URL:** https://rpki-monitor.antd.nist.gov/ROV#div2

ROA Coverage



Central Asia & Iran



Other Countries

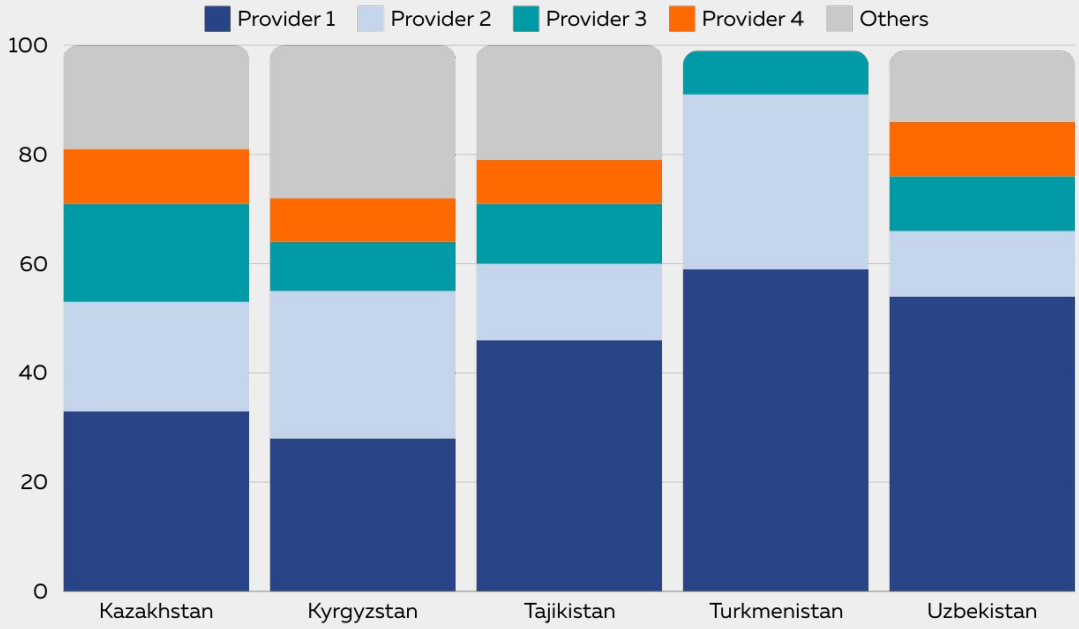
Snapshots from 1 August 2024

Central Asia Market Dynamics

Central Asian markets show increasing concentration

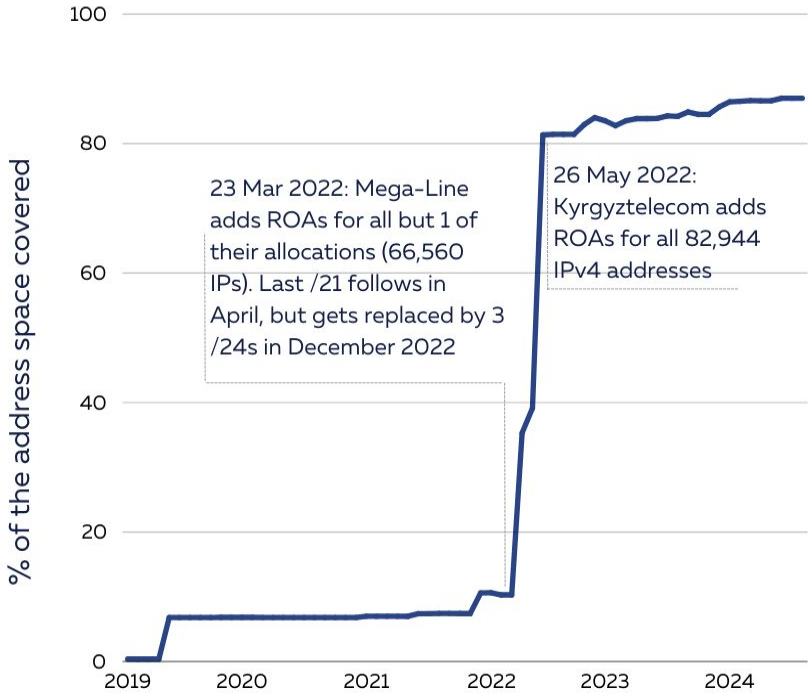
Fewer players can drive faster tech changes region-wide

Tradeoff: Less competition, but quicker innovation potential

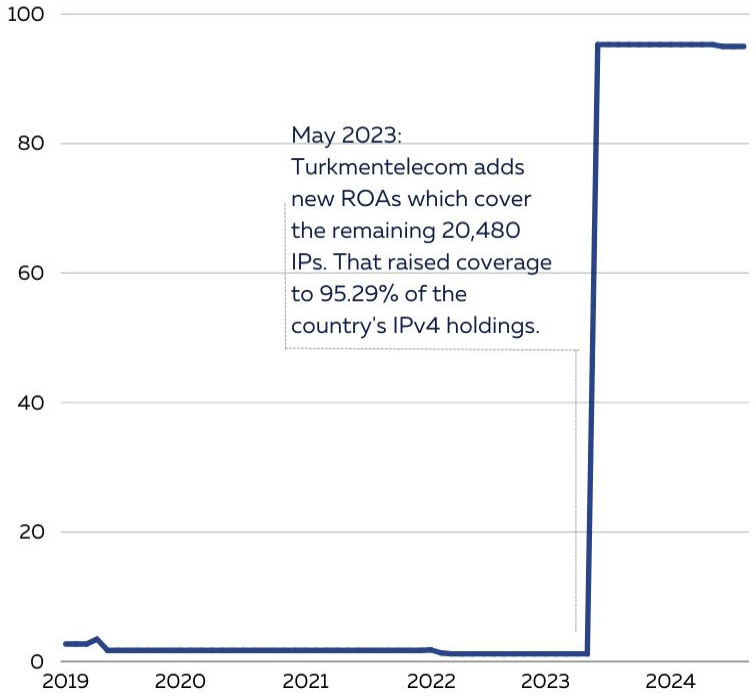


Source: APNIC

ROA Coverage in Central Asia (IPv4)

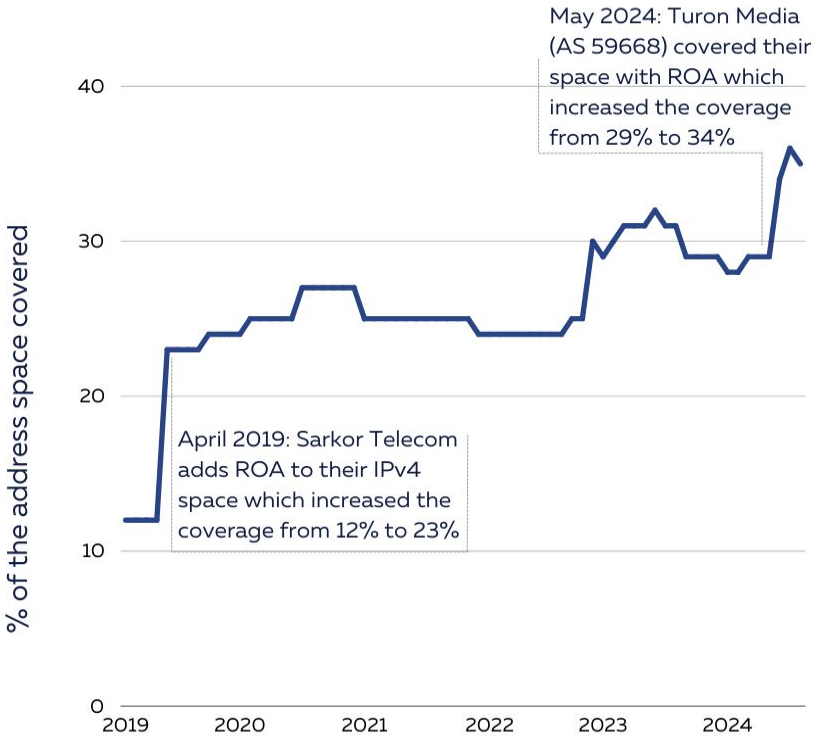


Kyrgyzstan

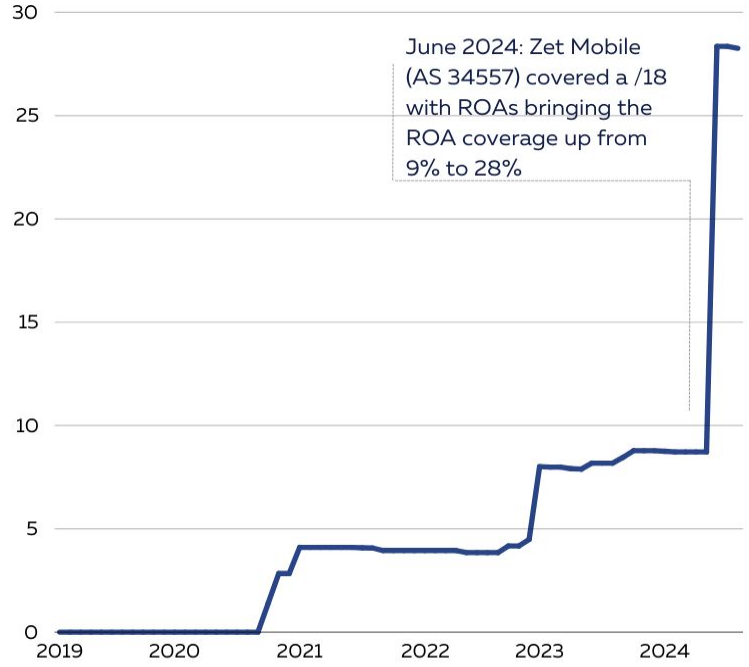


Turkmenistan

ROA Coverage in Central Asia (IPv4)



Uzbekistan



Tajikistan

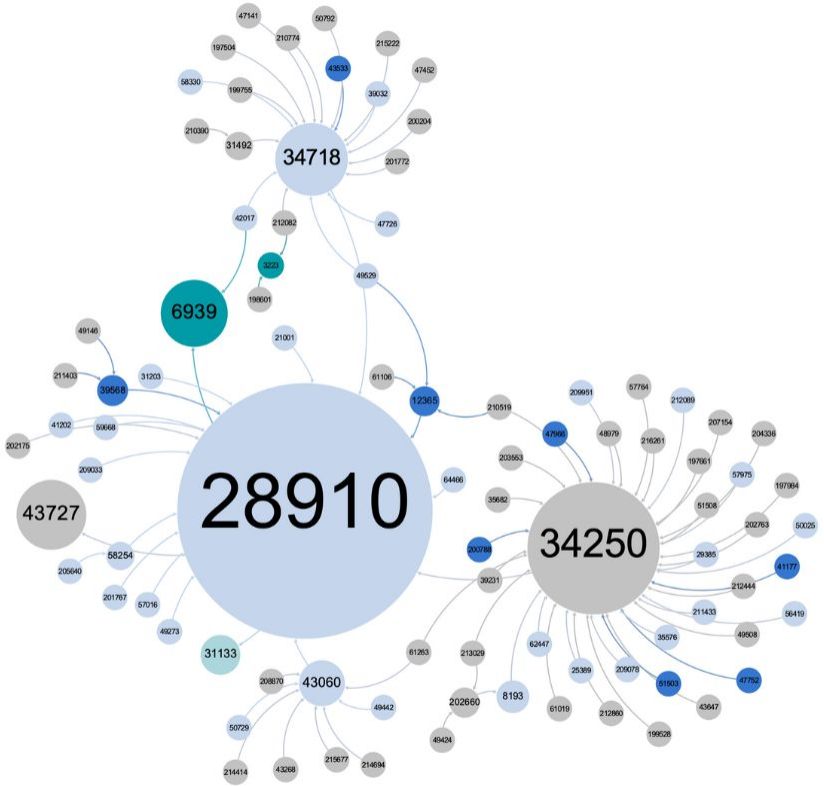
Route Origin Validation

Measuring ROV

- We used RoVISTA to analyse deployment of ROV across Central Asian region
  - RoVISTA calculates the scores based on the number of RPKI-invalid prefixes that an AS can reach. We used a more inclusive approach where we classify an AS as having implemented ROV if its score is greater than 0, indicating any level of ROV deployment.

- **Collateral benefit**
  - We assessed ROV impact from the perspective of network centrality, utilising the AS Hegemony 2 methodology, which measures the centrality of autonomous systems within a country.
  - The methodology measures the common transit networks to a local AS and how much this AS relies on these transit networks based on BGP data. AS hegemony values range between 0 and 1 and indicate the fraction of paths crossing a node.

Interconnectivity ‘map’ in Central Asia



Local AS Foreign AS

ROV

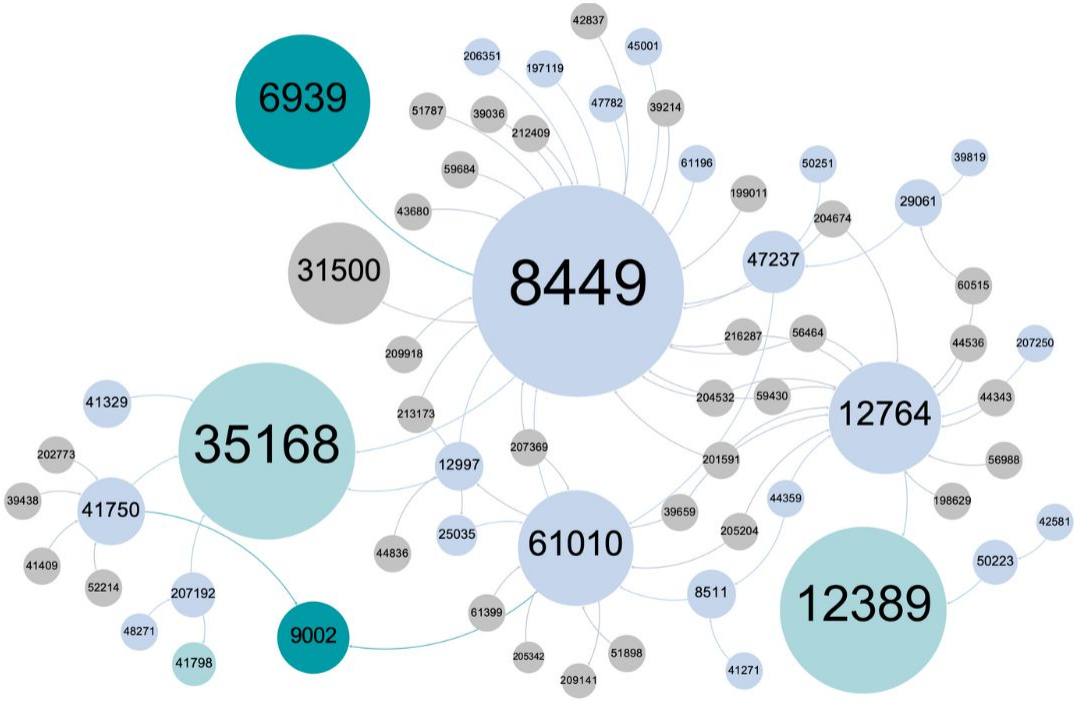
No ROV

No data

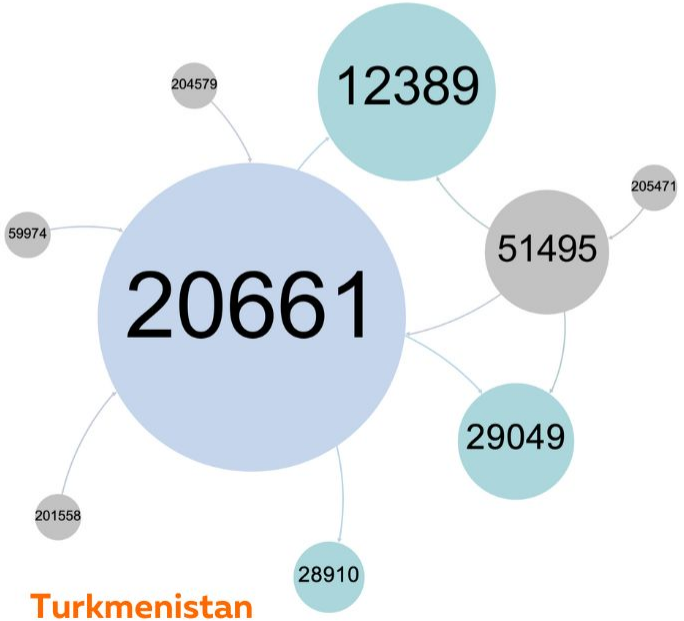
Uzbekistan

Tajikistan

Interconnectivity ‘map’ in Central Asia



Kyrgyzstan



Turkmenistan

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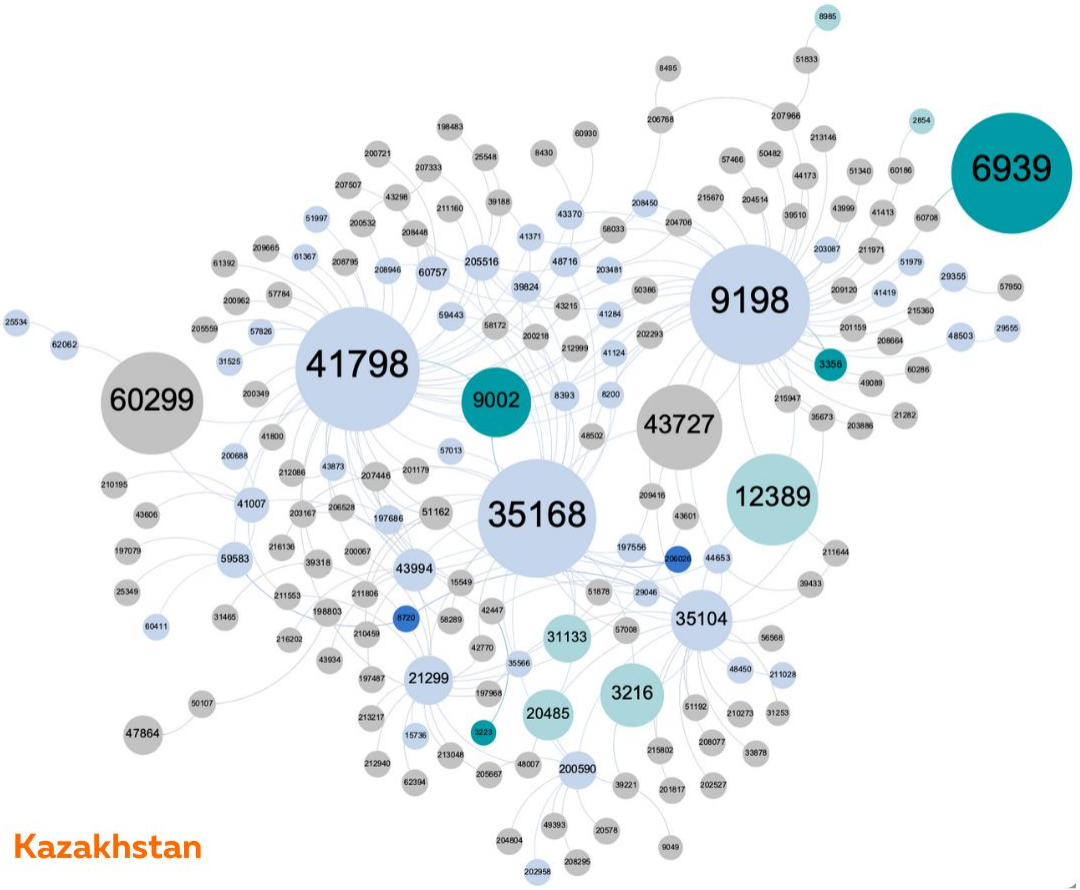


Local AS Foreign AS

ROV

No ROV

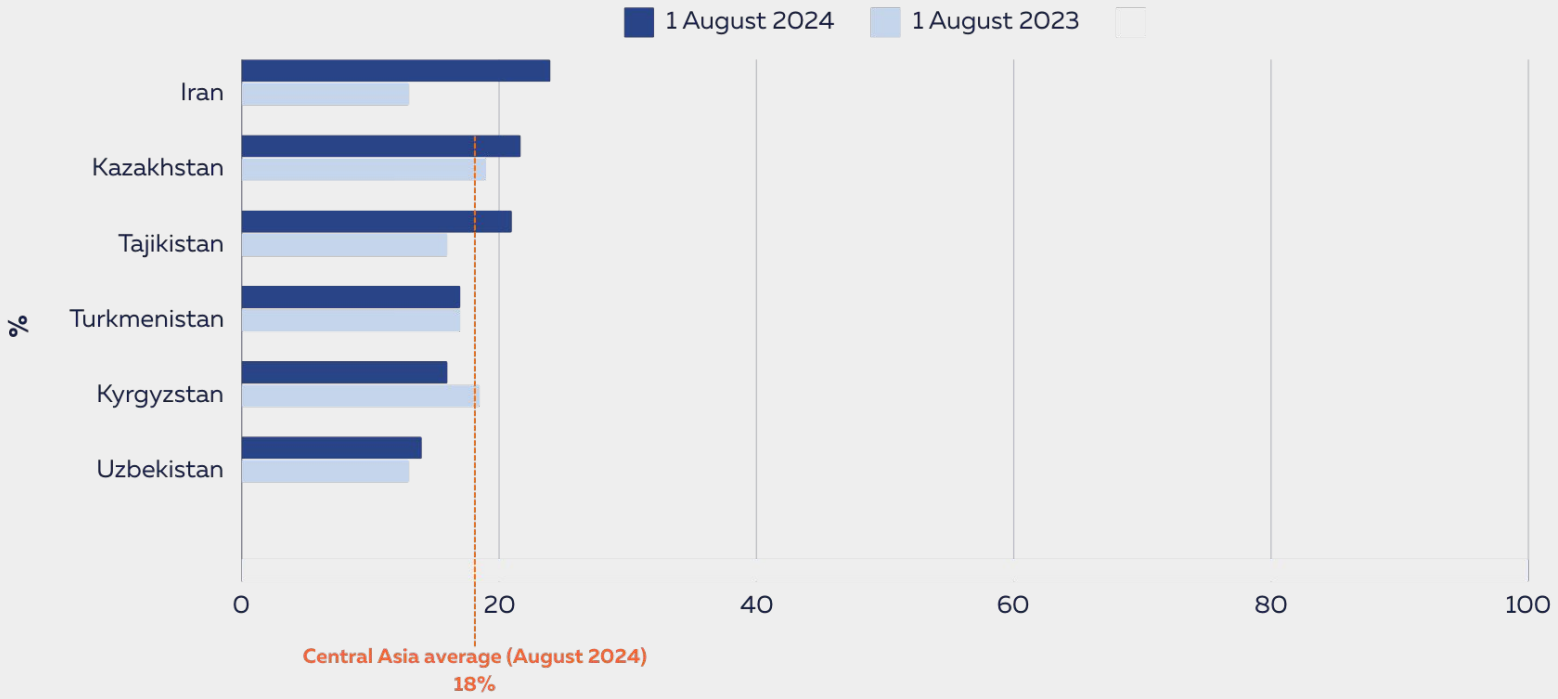
No data

IPv6 Uptake in Central Asia

IPv6 Capability

- 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 Central Asia and Iran



Snapshots from 1 August 2023 and 1 August 2024

IPv6 Adoption

- IPv6 adoption measures if users can actually use IPv6 on their networks.
- We use Content Delivery network (CDN's) (Google, Facebook, Cloudflare) traffic statistics to measure adoption across the region.
    - Kazakhstan: 13-17%
    - Kyrgyzstan: ~4%
    - Uzbekistan: ~3%
    - Iran (neighboring country) shows higher but inconsistent adoption: 76% (Facebook), 22.6% (Cloudflare), 16% (Google)

IPv6 Adoption

- Despite different measurement approaches, data consistently shows low IPv6 adoption across Central Asia.
- **Key Challenges (RIPE NCC 2023 Survey):**
    - 46%: Ensuring IPv4-IPv6 feature parity
    - 41%: Changing IPv4 mindset in organisations
    - 40%: Gathering implementation knowledge

Conclusion – RPKI Adoption

- Growing recognition of RPKI importance at government level
  - White House roadmap advocating RPKI as mature solution for BGP vulnerabilities
  - U.S. government aims to secure 60% of advertised IP space under RSA by year-end

- Regulatory bodies taking action
  - FCC proposing annual BGP security risk management plans

- **Implications for Central Asia**
  - Opportunity for policymakers to enhance routing security
  - Potential to establish guidelines and timelines for RPKI adoption

Conclusion – IPv6 Adoption

- Need for policy initiatives and infrastructure investments
- Increased awareness and education is crucial

- **Learning Resources**
  - RIPE NCC Academy courses (New: IPv6 Fundamentals in Russian)

  - Upcoming trainings in Bishkek post-CAPIF 3

Questions & Comments

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References

- [1] RoVista https://rovista.netsecurelab.org
- [2] AS Hegemony, https://labs.ripe.net/author/romain_fontugne/as-hegemony-measuring-as-interdependence/
- Find this research at (also in Russian): https://labs.ripe.net/author/anastasiya-pak/securing-internet-infrastructure-in-central-asia/