RIPE NCC
RIPE NETWORK COORDINATION CENTER

DNS Without Borders: Uncovering Regional Hubs and Dependencies in K-Root Traffic

**Jim Cowie, Qasim Lone, Rene Wilhelm | CAPIF4 Almaty** | 24 September 2025

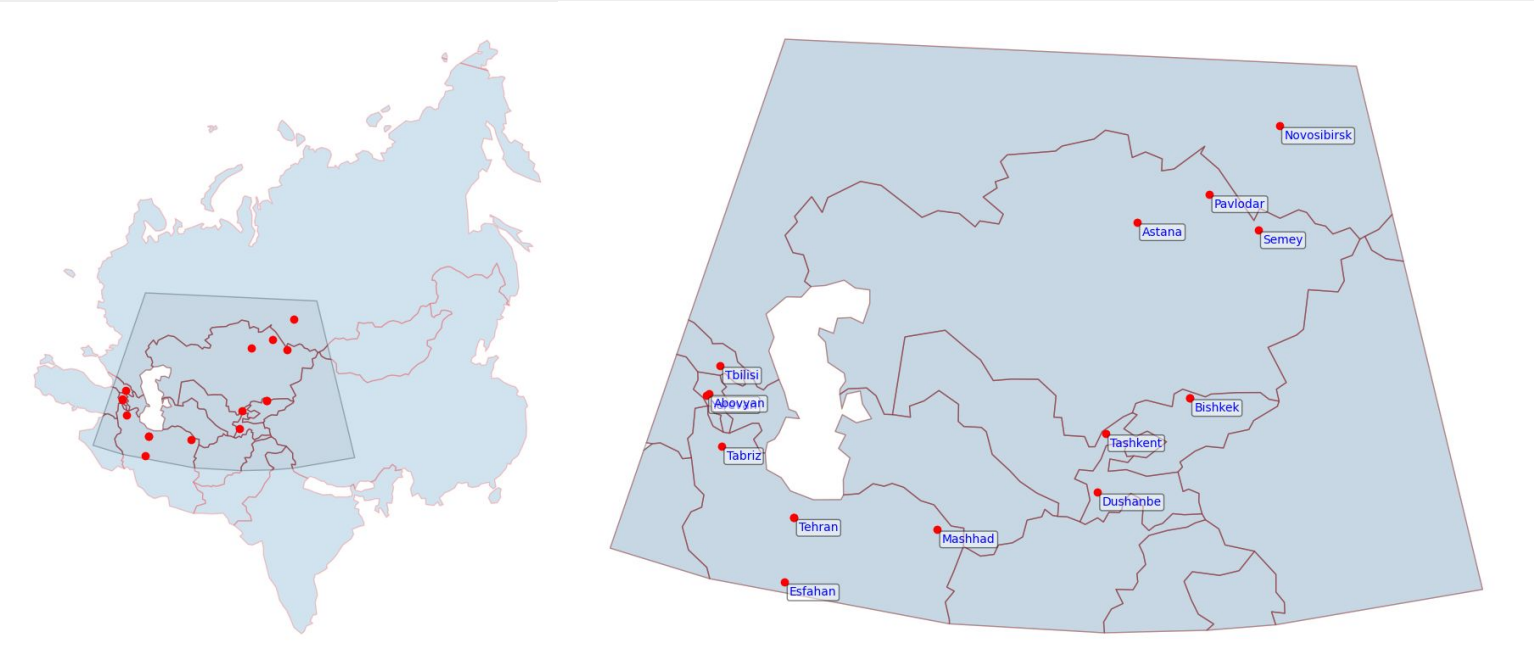# DNS Root Servers

The DNS Root Servers Form a Global Community

13 root servers (A-M) are coordinated by 12 organisations

K-root (one of the 13, operated by RIPE NCC) is effectively **its own global community**

- **140 instances** in cities worldwide

- Anycast routes to **193.0.14.0/23** (IPv4) or **2001:7fd::/32** (IPv6)

- k.root-servers.net
    - **193.0.14.129**
    - **2001:7fd::1**
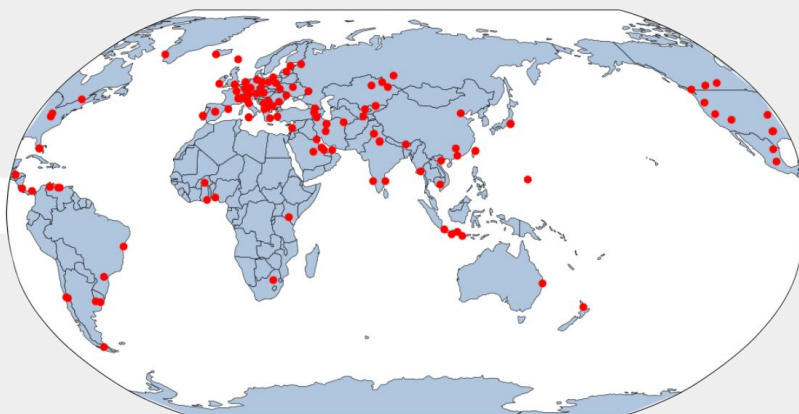
Kazakhstan

- Semey (KZNIC)
- Pavlodar (Kazakhtelecom)
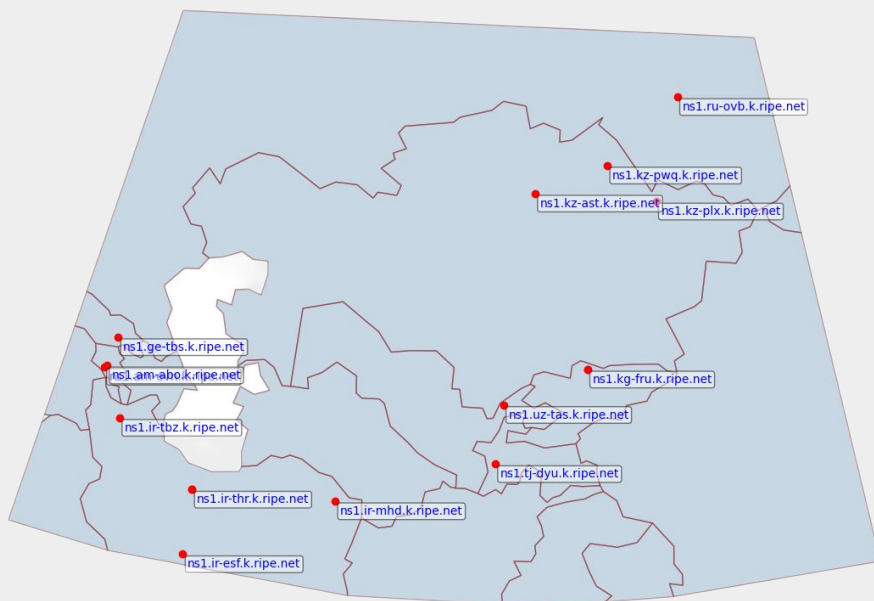- Astana (State Technical Service, **new** in April 2025)

Kyrgyzstan

- Bishkek-1 (KG-IX)
- Bishkek-2 (NUR Telecom)

Uzbekistan

- Tashkent (UZINFOCOM)

Tajikistan
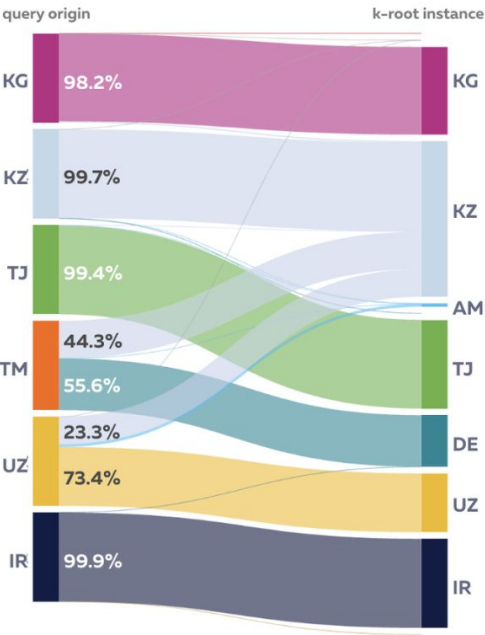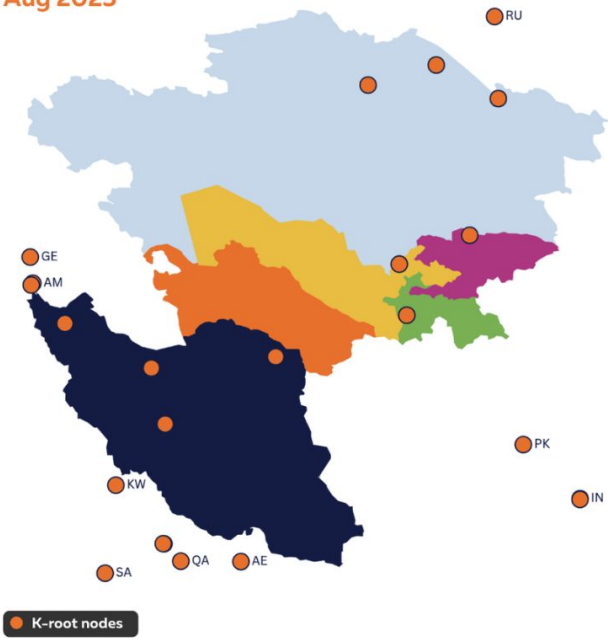
- Dushanbe (Eastera Ltd)

Where Do Central Asian DNS Resolvers Send Most K-Root Queries?

What Percentage of K-Root Queries Reach Each Country?

Aug 2025

K-root nodes

query origin — k-root instance

KG 98.2%
KZ 99.7%
TJ 99.4%
TM 44.3% / 55.6%
UZ 23.3% / 73.4%
IR 99.9%

- **Kyrgyzstan, Kazakhstan, Tajikistan,** and **Iran** now handle >98% of K-root queries from their domestic resolver populations
- **Uzbekistan** stays regional, sending 23.3% of queries to neighbor Kazakhstan
- **Turkmenistan** has no K-root instance, and exports queries to Kazakhstan, Germany

Kazakhstan's Resolver Population: Top Mappings

K-root instance	City	% of queries	% of resolver IPs
ns1.pwq-kz.k.ripe.net	Pavlodar, KZ	**85.9%**	**56.4%**
ns1.plx-kz.k.ripe.net	Semey, KZ	**12.0%**	**36.7%**
ns1.ast-kz.k.ripe.net	Astana, KZ	**1.8%**	**5.4%**

Uzbekistan's Resolver Population: Top Mappings

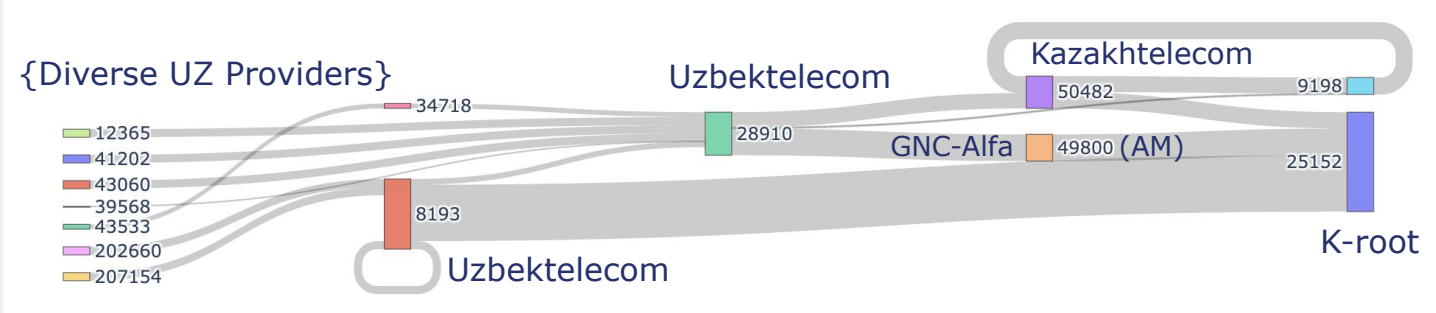| K-root instance	City	% of queries	% of resolver IPs
ns1.tas-uz.k.ripe.net	Tashkent, UZ	**73.4%**	**33.8%**
ns1.pwq-kz.k.ripe.net	Pavlodar, KZ	**23.3%**	**14.6%**
ns1.abo-am.k.ripe.net	Abovyan, AM	**3.2%**	**47.3%**

Different providers learn different anycast routes
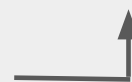
Many providers learn routes to Armenia and Kazakhstan via Uzbektelecom's AS28910

...But most *K-root queries* will still remain in Tashkent through Uzbektelecom's AS8193

{Diverse UZ Providers}

12365
41202
43060
39568
43533
202660
207154

34718

Uzbektelecom
28910

8193

Uzbektelecom

Kazakhtelecom
50482

GNC-Alfa
49800 (AM)

9198

25152

K-root

Source: RIPE Atlas traceroutes collected 31 July 2025

Latencies Can Tell a More Complex Story

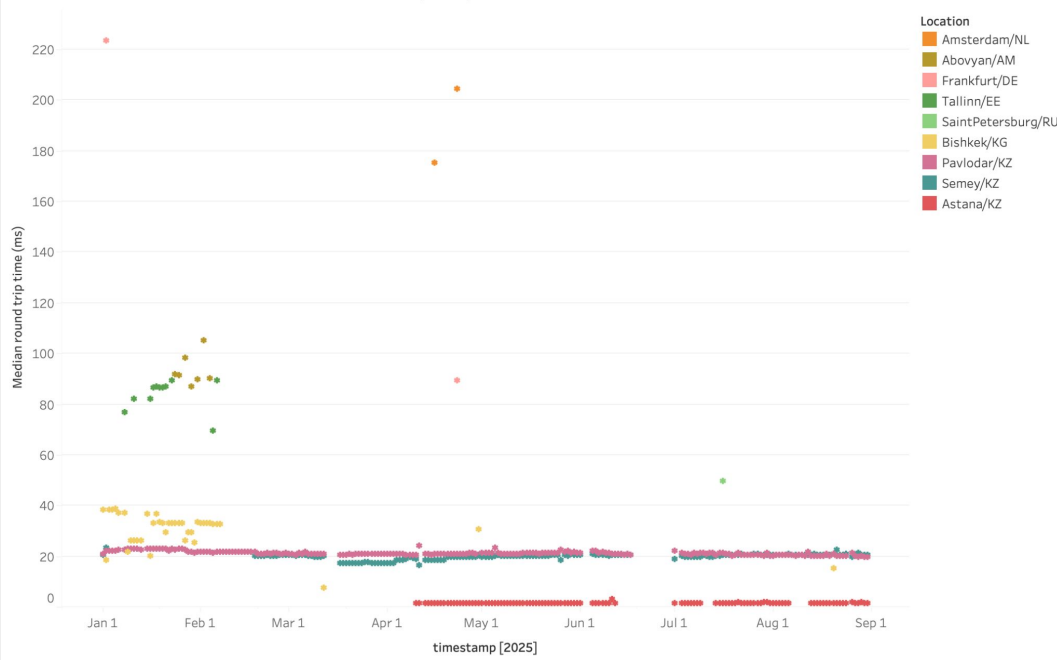# Median Daily Latencies to K-Root from Kazakhstan, 2025

This is <u>good</u>:
Kazakhstan's
ATLAS probes see
consistent low
latencies to mostly
domestic instances
of K-Root.

30ms: Bishkek/KG

20ms: Pavlodar,Semey/KZ

<10ms: Astana/KZ

Median round trip time per k-root location (IPv4) - Kazakhstan

Location
- Amsterdam/NL
- Abovyan/AM
- Frankfurt/DE
- Tallinn/EE
- SaintPetersburg/RU
- Bishkek/KG
- Pavlodar/KZ
- Semey/KZ
- Astana/KZ

Median round trip time (ms)
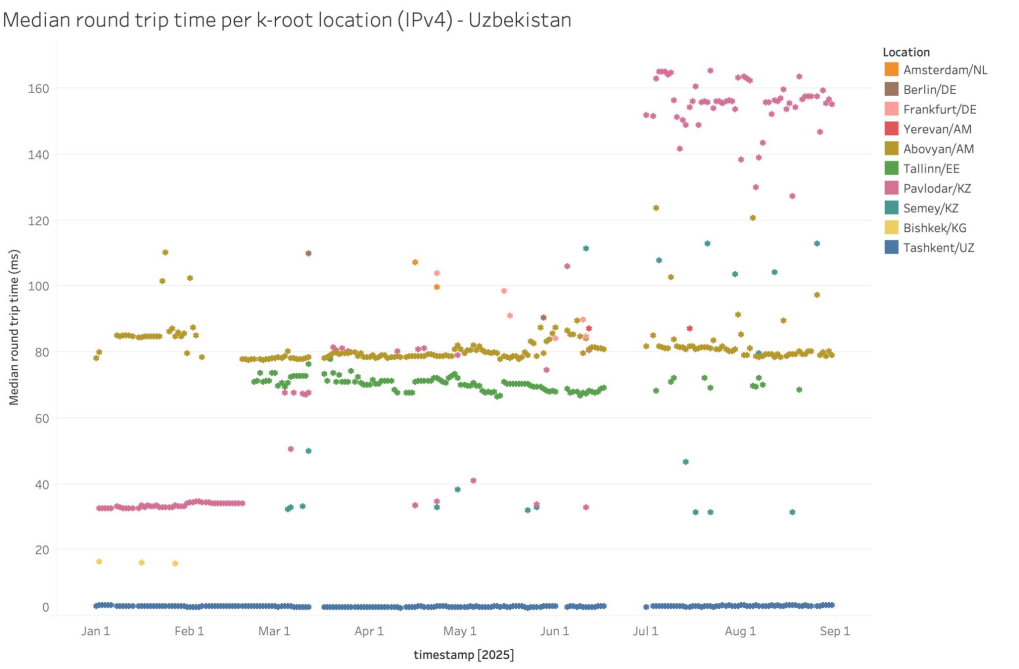
timestamp [2025]

120-160ms: Pavlodar/KZ

Why is the UZ-KZ path to Pavlodar such high latency?

80ms: Abovyan/AM

70ms: Tallinn/EE

…Pavlodar used to be faster?

<10ms: Tashkent/UZ

Median round trip time per k-root location (IPv4) - Uzbekistan

Location
- Amsterdam/NL
- Berlin/DE
- Frankfurt/DE
- Yerevan/AM
- Abovyan/AM
- Tallinn/EE
- Pavlodar/KZ
- Semey/KZ
- Bishkek/KG
- Tashkent/UZ

Uzbekistan Often Reaches Kazakhstan K-Root via Russia.

- Uzbektelecom 28910 passes along a route to K-root that it has learned via Kazakhtelecom's peering at Piter-IX in St. Petersburg, instead of a route to the local on-net instance preferred by Uzbektelecom 8193.

- Traceroutes then go from Tashkent to Russia and then **return** to K-root in Pavlodar: a **100ms+** detour

Hop	IP Address	Reverse DNS		ASN	RTT 1	RTT 2	RTT 3
1	192.168.12.200	*	🇺🇿		0.991 ms	0.792 ms	0.759 ms
2	94.158.57.0	*	🇺🇿	43060	1.736 ms	1.347 ms	1.417 ms
3	*	*	🇺🇿	*	*	*	*
4	195.69.189.178	*	🇺🇿	28910	2.307 ms	1.533 ms	2.549 ms
5	195.69.189.39	*	🇺🇿	28910	2.685 ms	2.022 ms	1.601 ms
6	185.1.153.206	kaztel.spb.piter-ix.net	🇷🇺		55.65 ms	54.662 ms	55.31 ms
7	92.47.151.207	*	🇰🇿	50482	123.652 ms	123.18 ms	123.21 ms
8	95.59.172.8	95.59.172.8.static.telecom.kz	🇰🇿	9198	136.441 ms	136.765 ms	136.214 ms
9	82.200.243.207	*	🇰🇿	9198	105.228 ms	103.218 ms	103.21 ms
10	92.47.150.89	*	🇰🇿	50482	157.293 ms	157.625 ms	158.225 ms
11	193.0.14.129	k.root-servers.net	🇰🇿	25152	123.568 ms	122.882 ms	122.758 ms

Who *Else* Relies on Central Asia's K Root Instances?

Many Other Countries Learn Routes to Kazakhstan's K-root!

Over 3 days of observation (31 July 2025 - 2 August 2025):

- **Russia** sent Kazakhstan more than 186M queries

    - *Kazakhstan is actually the #1 destination for Russian resolver traffic to K-root*

- **China** sent Kazakhstan more than 94M queries

    - *China resolves 99% of its own K-root traffic, but ranks KZ #2*

- **Pakistan** sent Kazakhstan more than 5M queries

    - *This is 26% of Pakistan's K-root traffic, also ranking KZ #2*

- KZ's anycast instances attract at least 1000 queries per day from at least **30 countries**

    - …as far away as Hong Kong, Eritrea, Morocco, and the Philippines

You Can Examine the Catchment of Any K-root Server!

For example, here's the most recent set of probes that chose Pavlodar, KZ

https://atlas.ripe.net/maps/root-instances?root=01&question=103&protocol=0&timestamp=1758240000&minRTT=0&maxRTT=300&tags=kz-pwq

In Conclusion...

- **Central Asia** provides resiliency and diversity as an important part of the K-root global service network.
- **Kazakhstan**, in particular, resolves root queries for ISPs far beyond the region who learn about its anycast routes.
- **Everyone in the region succeeds** in sending the bulk of their domestic K-root query traffic to domestic K-root instances, with very low latency, with the exception of Turkmenistan (no instance yet!)
- **It's still important to monitor latencies** in order to detect suboptimal routing out-of-region, even between neighbors.

Questions
& Comments

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