



RIPE NCC
RIPE NETWORK COORDINATION CENTER

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

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DNS Root Servers

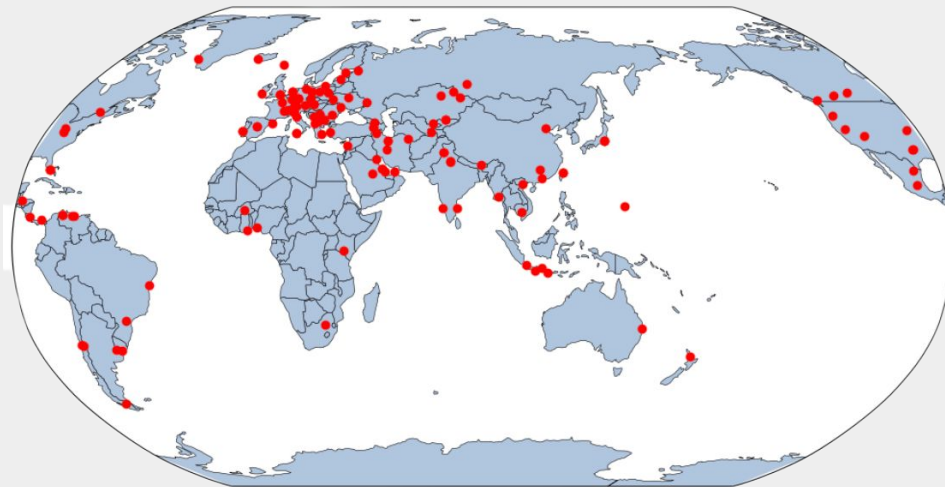
The DNS Root Servers Form a Global Community



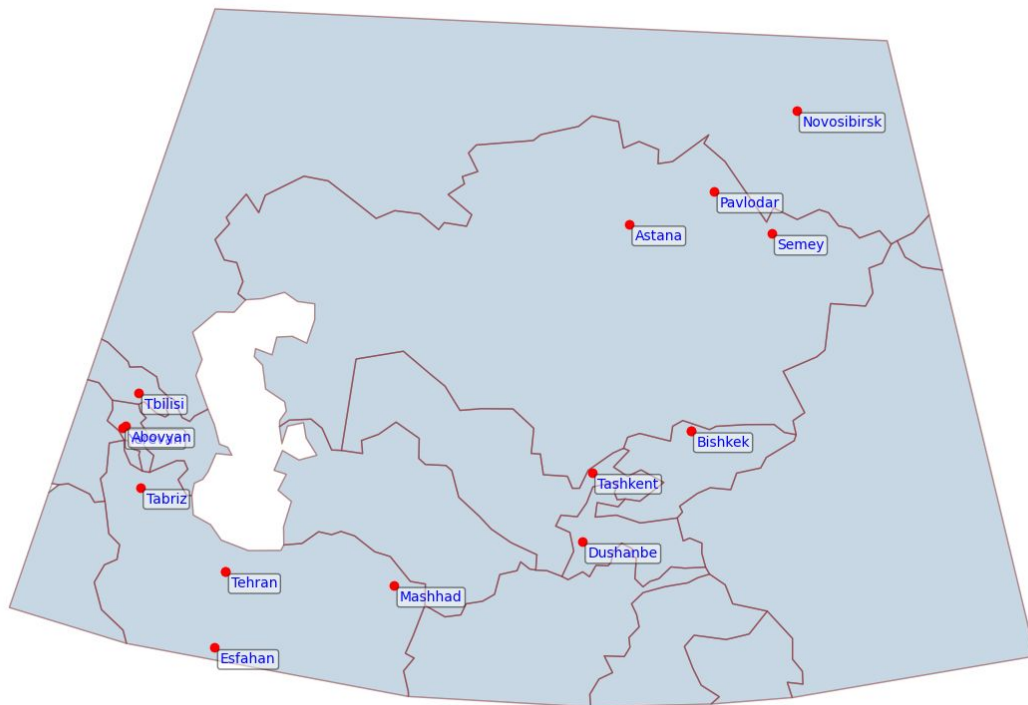
13 root servers (A-M) are coordinated by 12 organisations

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**



Central Asia's K-Root Instances Are Part of this Community



Seven Central Asian K-Root Instances (Sep 2025)



Kazakhstan

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

Kyrgyzstan

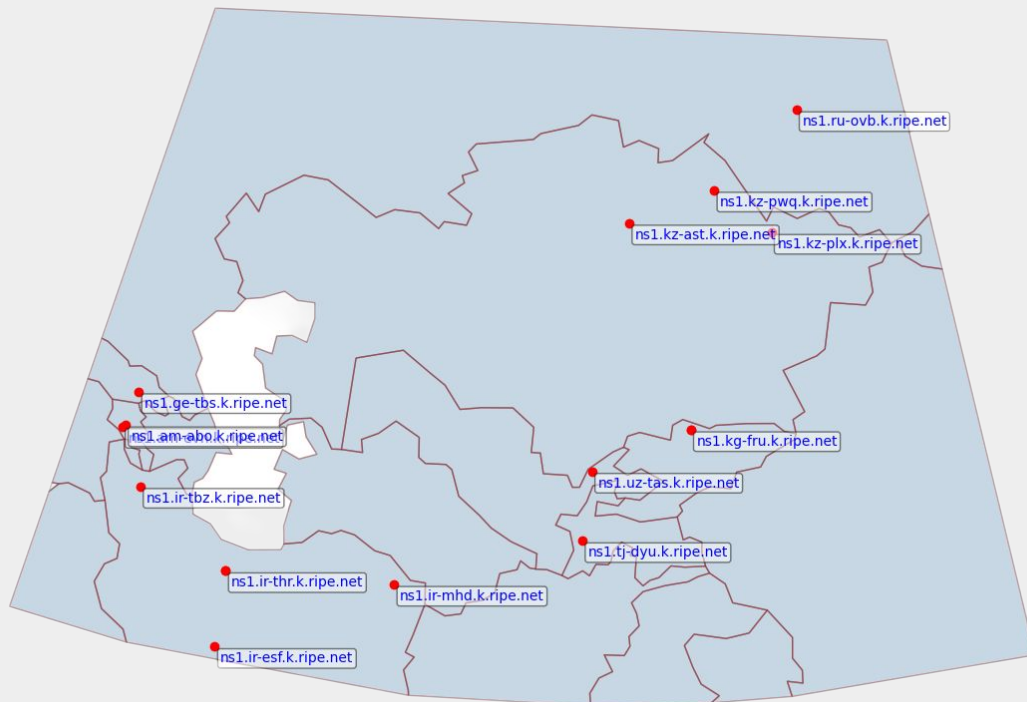
- Bishkek-1 (KG-IX)
- Bishkek-2 (NUR Telecom)

Uzbekistan

- Tashkent (UZINFOCOM)

Tajikistan

- Dushanbe (Eastera Ltd)



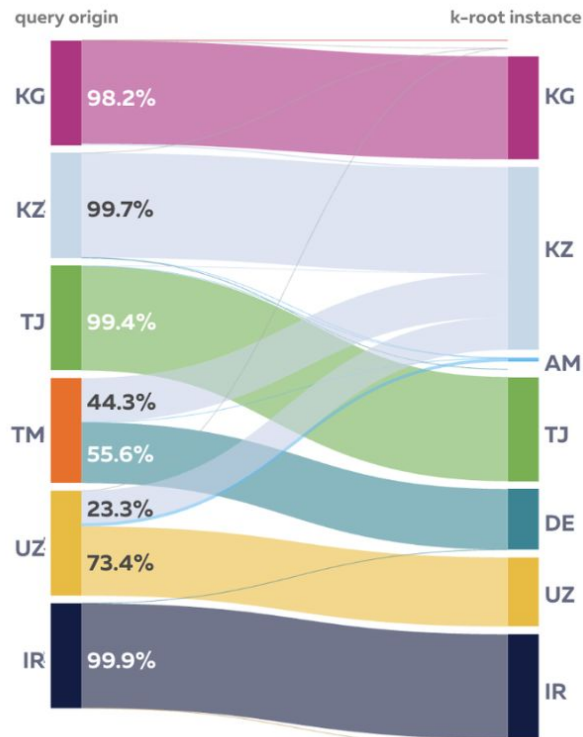
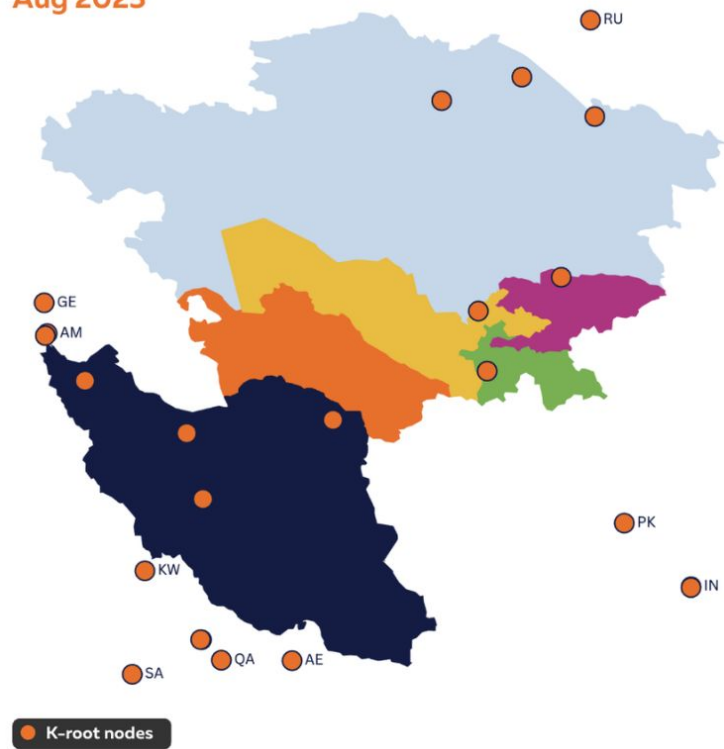


Where Do Central Asian DNS Resolvers Send Most K-Root Queries?

What Percentage of K-Root Queries Reach Each Country?



Aug 2025



- **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



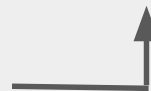
K-root instance	City	% of queries	% of resolver IPs
ns1.pwq-kz.k.ripe.net	Pavlodar, KZ	85.9%	56.4%
ns1.plx-kz.k.ripe.net	Semey, KZ	12.0%	36.7%
ns1.ast-kz.k.ripe.net	Astana, KZ	1.8%	5.4%

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

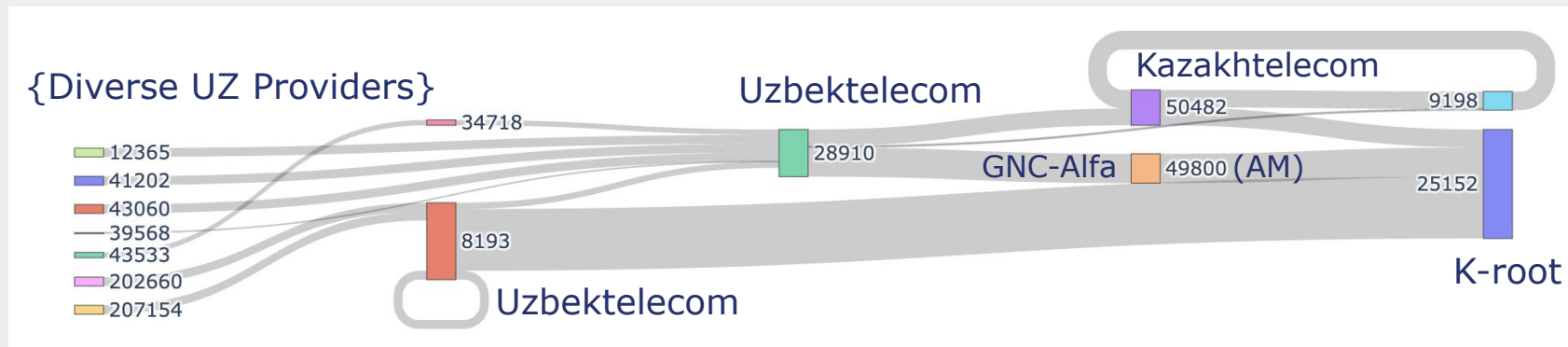


ATLAS Probes Reveal Diversity of Received Anycast Routes



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



Source: RIPE Atlas traceroutes
collected 31 July 2025



Latencies Can Tell a More Complex Story

Median Daily Latencies to K-Root from Kazakhstan, 2025



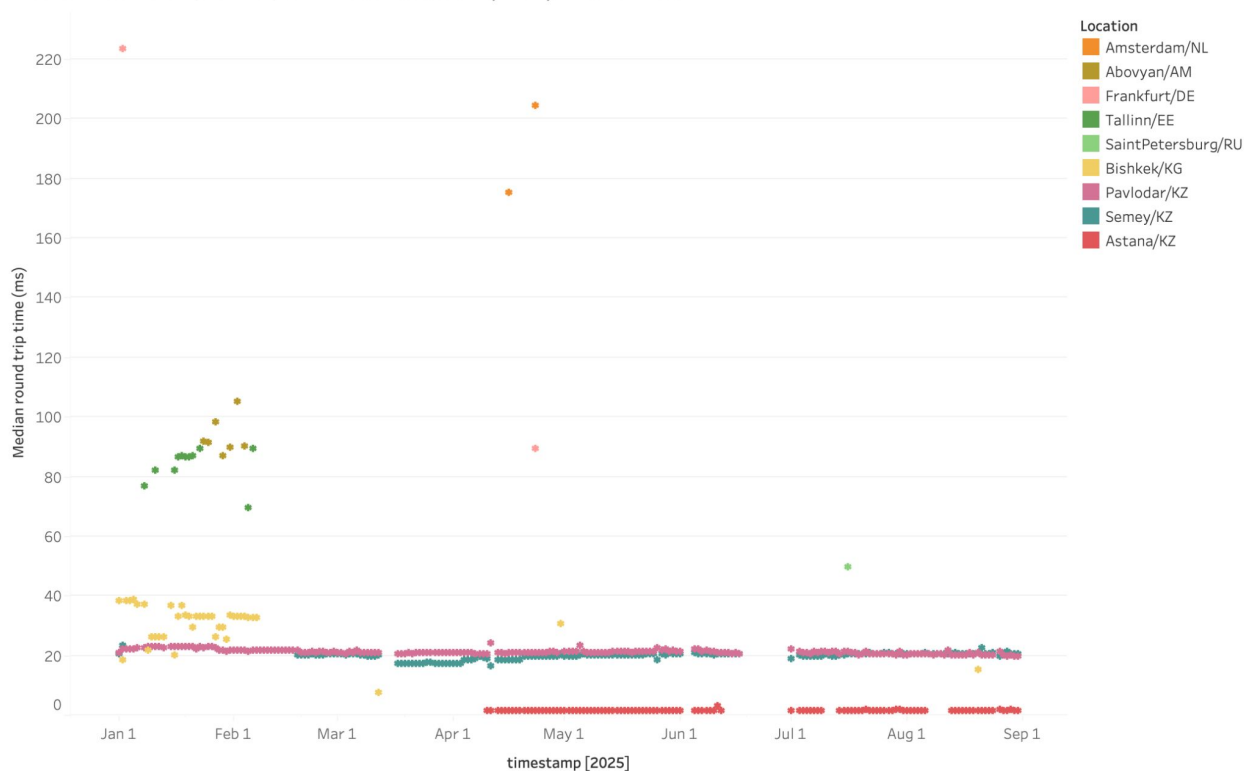
This is good:
Kazakhstan's
ATLAS probes see
consistent low
latencies to mostly
domestic instances
of K-Root.

30ms: Bishkek/KG

20ms: Pavlodar, Semey/KZ

<10ms: Astana/KZ

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



Median Daily Latencies to K-Root from Uzbekistan, 2025



120-160ms: Pavlodar/KZ

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

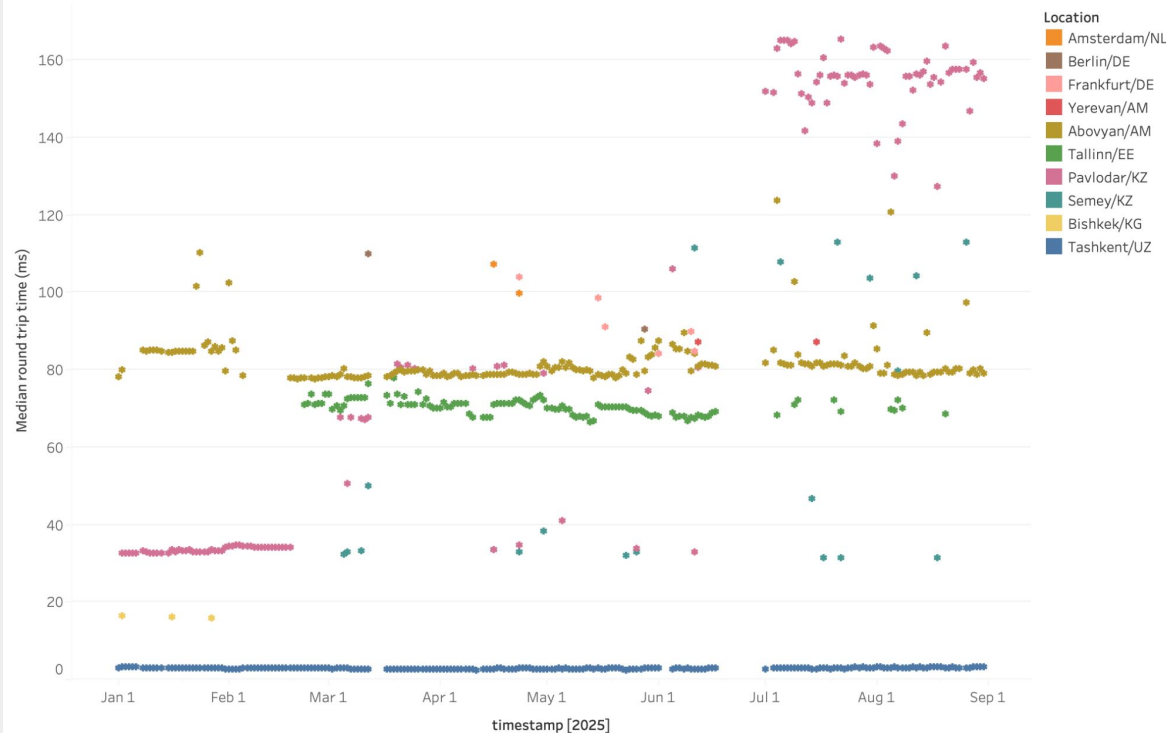
80ms: Abovyan/AM

70ms: Tallinn/EE

...Pavlodar used to be faster?

<10ms: Tashkent/UZ

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



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	<u>192.168.12.200</u>	*		0.991 ms	0.792 ms	0.759 ms
2	<u>94.158.57.0</u>	*	 <u>43060</u>	1.736 ms	1.347 ms	1.417 ms
3	*	*	 *	*	*	*
4	<u>195.69.189.178</u>	*	 <u>28910</u>	2.307 ms	1.533 ms	2.549 ms
5	<u>195.69.189.39</u>	*	 <u>28910</u>	2.685 ms	2.022 ms	1.601 ms
6	<u>185.1.153.206</u>	kaztel.spb.piter-ix.net		55.65 ms	54.662 ms	55.31 ms
7	<u>92.47.151.207</u>	*	 <u>50482</u>	123.652 ms	123.18 ms	123.21 ms
8	<u>95.59.172.8</u>	95.59.172.8.static.telecom.kz	 <u>9198</u>	136.441 ms	136.765 ms	136.214 ms
9	<u>82.200.243.207</u>	*	 <u>9198</u>	105.228 ms	103.218 ms	103.21 ms
10	<u>92.47.150.89</u>	*	 <u>50482</u>	157.293 ms	157.625 ms	158.225 ms
11	<u>193.0.14.129</u>	k.root-servers.net	 <u>25152</u>	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×tamp=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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