Kazakhstan's Internet Landscape: Infrastructure, Geopolitical Dependencies, and Pathways to Digital Sovereignty

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Introduction

The Internet has become an indispensable element of modern life, fostering economic development, social interaction, and access to information. In Kazakhstan, a nation positioned at the crossroads of Europe and Asia, the Internet's evolution mirrors the country's broader aspirations[1] toward digital transformation and integration into the global economy.

However, debates in Kazakhstan are polarized over the risk of being completely cut off from the global Internet as a result of potential future geopolitical tensions with Russia. While human-rights activists point to Kazakhstan's complete dependence on Russia,[2] industry experts—such as the President of the

[1] "Accessible Internet National Project: Kazakhstan Residents to Be Provided with High-Speed Internet Access of at Least 100 Mbit/s." *Official Information Source of the Prime Minister of the Republic of Kazakhstan,* https://primeminister.kz/en/news/accessible-Internet-national-project-kazakhstan-residents-to-be-provided-with-high-speed-Internet-access-of-at-least-100-mbits-23858/, accessed on 31 Jan. 2025.

[2] Daniyar Akmetov, "Digital Slavery or Technical Dependence : How Kazakhstan Becomes a Hostage to Russian Internet (Цифровое рабство или техническая зависимость: как Казахстан стал заложником российского интернета)", *Taspanews*, (29/08/2024), https://taspanews.kz/novosti-kazakhstana/tsifrovoe-rabstvo-ili-tekhnicheskaya-zavisimost-kak-kazakhstan-stal-zalozhnikom-rossiyskogo-Interneta-746612452884, accessed on 20 Nov. 2024.

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Internet Association of Kazakhstan—state the exact opposite,[3] saying that Kazakhstan has independent access to the Internet and that there will be no disruption to local Internet access due to actions on the Russian network. One of the objectives of this paper is to shed light on this debate with qualitative and quantitative data on Kazakhstan's Internet connectivity, its links to Russia, and the existing alternatives. Kazakhstan is primarily concerned not only because most of its international connectivity has to go through Russia, but also because it plays a key role in redistributing Russia-bound international bandwidth to other landlocked countries in Central Asia.

This paper explores the current state of the Internet in Kazakhstan and the areas for continued development, examining its infrastructure, resilience, regulatory and policy environment, and emerging trends. Despite significant investments in connectivity and digital services, challenges remain, including uneven access across rural and urban areas, regulatory constraints, and cybersecurity concerns.

By analyzing key metrics, such as Internet penetration rates, and the impact of governmental policies, this study aims to provide a comprehensive overview of Kazakhstan's Internet landscape. It also highlights opportunities for growth and the role of Internet technologies in advancing Kazakhstan's ambition to become a regional digital hub.

This paper is the result of an extensive survey of the relevant literature and supporting Internet measurements performed during fall 2024 (unless stated otherwise). It first provides an overview of Kazakhstan's Internet architecture, starting with an analysis of both the physical infrastructure and the connectivity landscape. It reveals how the USSR's legacy still conditions the way Central Asian countries gain access to the Internet.

Kazakhstan: A Transit-Crossroad in Central Asia

Central Asia's Telecommunications Network

With the rise of Internet traffic, satellite connectivity quickly reached its limits, creating the need for landline connections. Following the independence of Kazakhstan and its Central Asian neighbors, the main regional ISPs capitalized on the dense railway network to lay fiber optic cables. Therefore, the Central Asian backbone physical network distribution follows the historical railway lines organized around the south-to-north axis towards the Russian border. As in many countries, including Kazakhstan, national railway companies established a telecommunications subsidiary at the beginning of the 2000s,

[3] Artem Volkov (Артем Волков), "Optolf axe: can Russia leave Kazakhstan without the Internet? (Топором по оптоволокну: может ли Россия оставить Казахстан без интернета?)", *Orda*, (09/09/2024), https://orda.kz/toporom-po-optovoloknu-mozhet-li-rossija-ostavit-kazahstan-bez-Interneta-391521/, accessed on 20 Nov. 2024.

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to surf the new wave of a nascent Internet industry. The railway network's integration made it easy for these companies to build cross-border connections and explore business opportunities.

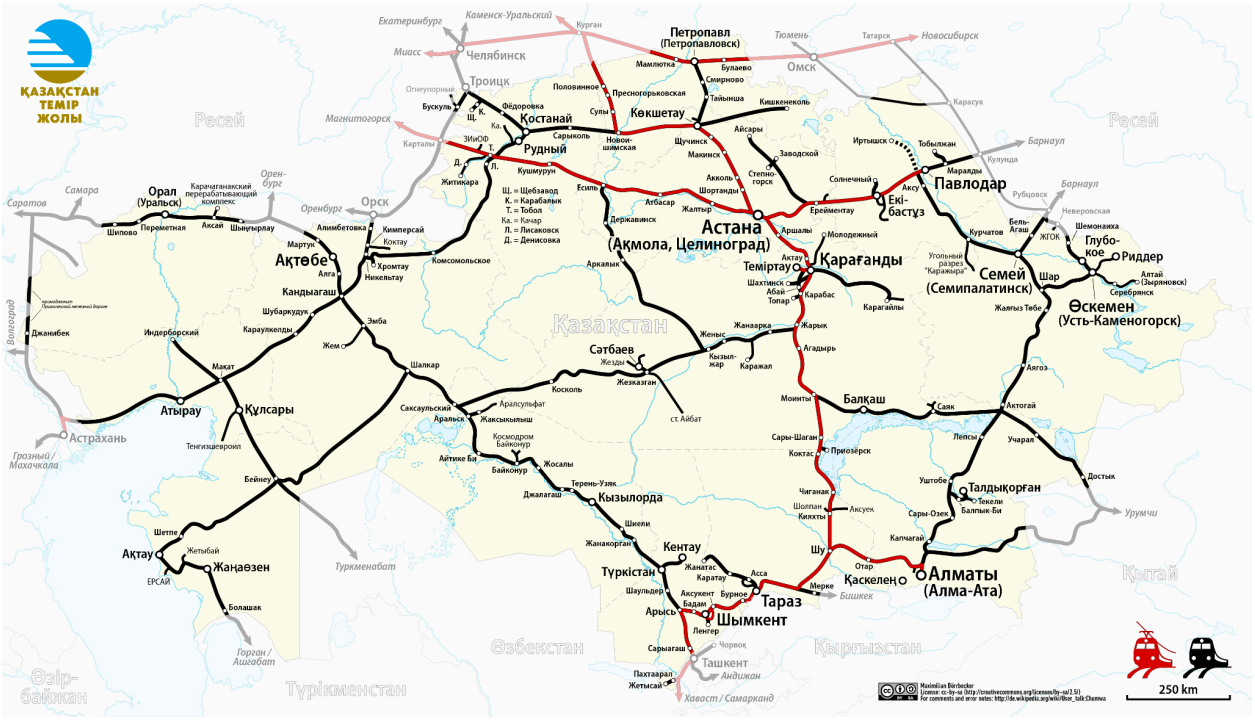

Figure 1. KZ Railway system[4] (June 2024)

A Telecommunication Sector Undergoing Diversification

Kazakhstan's telecom sector is organized around two major groups: KazakhTelecom (which includes fixed-line operations under the same brand name, as well as the mobile operator Kcell) and VEON (which owns the mobile operator Beeline and the fixed-line provider TNS-Plus). These two groups own Kazakhstan's two major fixed-line ISPs and the country's main mobile service providers.

Two other major players also operate long-distance fiber backbones: Transtelecom and KazTransCom. In terms of long-haul coverage, KazakhTelecom has the most extensive network, followed by TNS-Plus, as well as Transtelecom and KazTransCom who also sell to end-users, mostly corporate customers. Other minor ISPs provide niche services such as FTTx services in Almaty for AlmaTBV or VSAT connectivity for ASTEL.

[4] "Category:Rail Transport Maps of Kazakhstan." Wikimedia Commons, https://commons.wikimedia.org/wiki/Category:Rail_transport_maps_of_Kazakhstan, accessed 31 Jan. 2025.

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Concerns over monopolistic practices intensified after KazakhTelecom's subsidiaries secured key 5G frequencies[5] in 2022. The Antitrust Agency (APDC) and the Digital Ministry (MDDIA) proposed reforms, including barring subsidiaries from future auctions and divesting assets. Figure 2 provides an overview of the ownership structure of Kazakh ISPs.

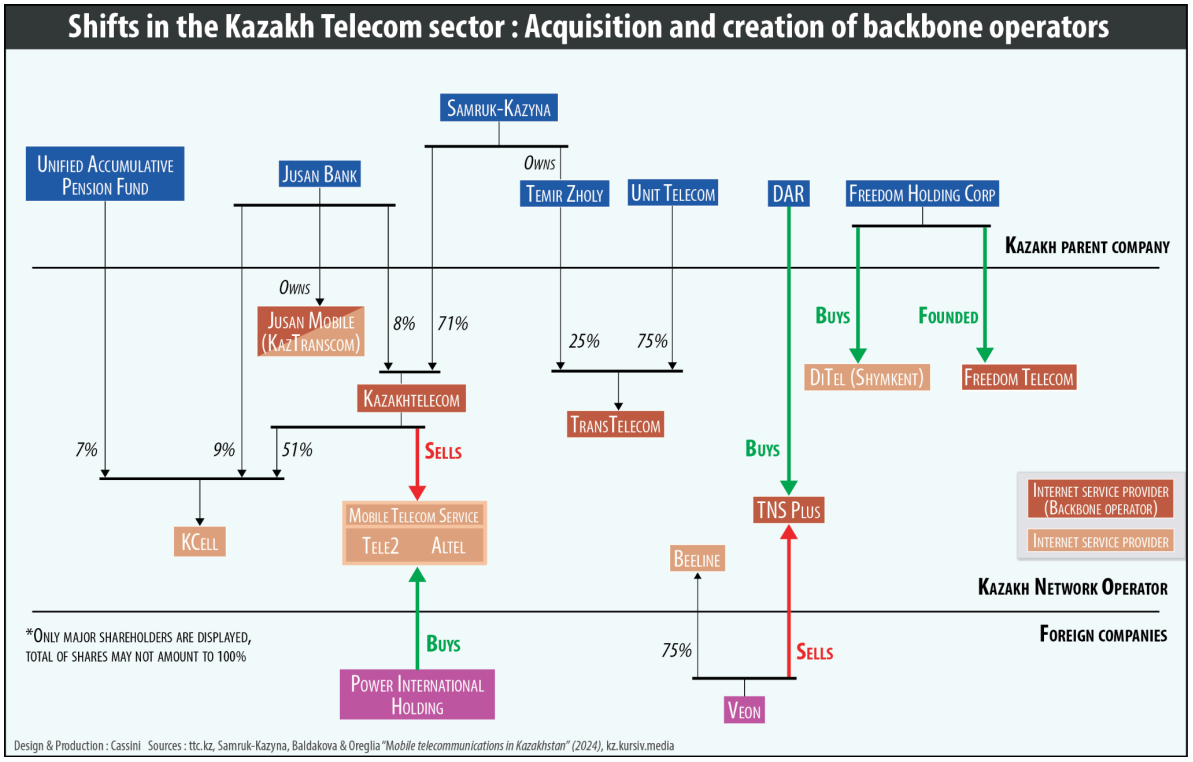

Figure 2. Ownership structure of telecommunication operators[6]

Current Market Structure

KazakhTelecom operates a nationwide network connecting its current and former subsidiaries to the Internet. About 58% of Kazakhstanis access the global Internet via KazakhTelecom or via its customers. Kar-Tel/Beeline, on the other hand, relies on the TNS-Plus transit network (recently sold by VEON), making this network quite centralized despite the fact that it does not contract directly with end users. These results highlight KazakhTelecom's monopoly in connecting users of different ISPs and, to a lesser extent, the importance of the TNS-Plus backbone network.

Current market share information (December 2024):

- The incumbent ISP, KazakhTelecom, is serving 29.1% of the Kazakhstani users from its main

[5] Albert Fahrutdinov, "Kazakhstan worries about risks associated with KazakhTelecom's success at 5G bids", *Kursiv*, 27/12/2022, https://kz.kursiv.media/en/2022-12-27/kazakhstan-worries-about-risks-associated-with-its-biggest-operator-success-at-5g-bids/, accessed on 20 Nov. 2024.

[6] Sources: "TTC." TTC Transtelecom, 22 Jan. 2025, ttc.kz; Samruk-Kazyna; Baldakova & Oreglia (2024); "Mobile telecommunications in Kazakhstan"; "Kursiv." Kursiv Media Kazakhstan, 31 Jan. 2025, https://kz.kursiv.media/en/, accessed on 14 Mar. 2025.

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Autonomous System[7] (AS9198) and an additional 8.73% from the mobile network KCell (a subsidiary of KazakhTelecom).

- Kar-Tel (a.k.a Beeline, part of VEON) is the second largest, with 17.8% (AS206026) and 10.7% (AS21299).
- The Mobile Telecom Service (MTS) (sold to Qatari holding by KazakhTelecom) is the third largest group. It is made of two mobile operators: Altel, which has a 3.67% market share (AS39824)—therein registered as MTS LLP—and the mobile operator Tele2 (AS48503), which has a 16.8% market share.

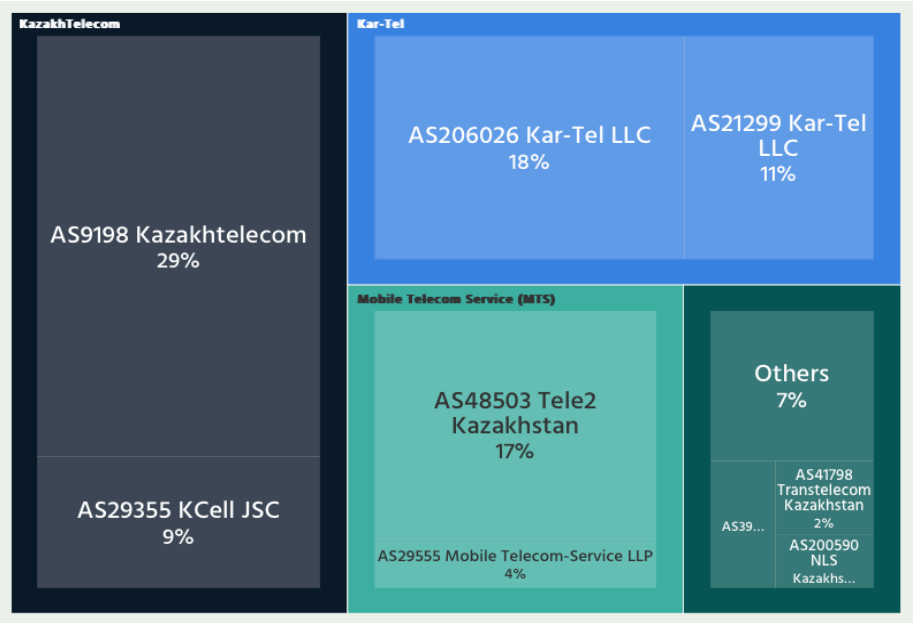

Figure 3. Estimated market share of Kazakh networks (Source: APNIC[8])

Using Border Gateway Protocol (BGP[9]) paths, this study investigates the routes used for reaching all networks registered in Kazakhstan and identifies the most important transit providers. As shown in Figure 4, three main networks emerged in this analysis: KazakhTelecom (AS9198), TNS Plus (AS35168), and Transtelecom (AS41798). As discussed above, KazakhTelecom and TNS Plus connect residential and mobile networks to the Internet. Transtelecom Kazakhstan appears to connect other types of networks, notably Transtelecom and KazakhTelecom, which provide transit to Yandex Cloud Kazakhstan (AS208795).

[7] An **Autonomous System (AS)** is a collection of IP networks and routers under the control of a single entity, such as an Internet service provider (ISP), enterprise, or university, which presents a unified routing policy to the global Internet. Autonomous Systems are the building blocks of the Internet's structure.

[8] Data provided by APNIC: Huston, Geoff. "How We Measure: ISP User Counts." APNIC Blog, 11 Nov. 2024, https://blog.apnic.net/2024/11/11/how-we-measure-isp-user-counts/, accessed on 14 Mar. 2025.

[9] The **Border Gateway Protocol (BGP)** is the principal routing protocol used to exchange routing information across the Internet, allowing Autonomous Systems (ASes) to communicate and determine the best paths for data packets to travel.

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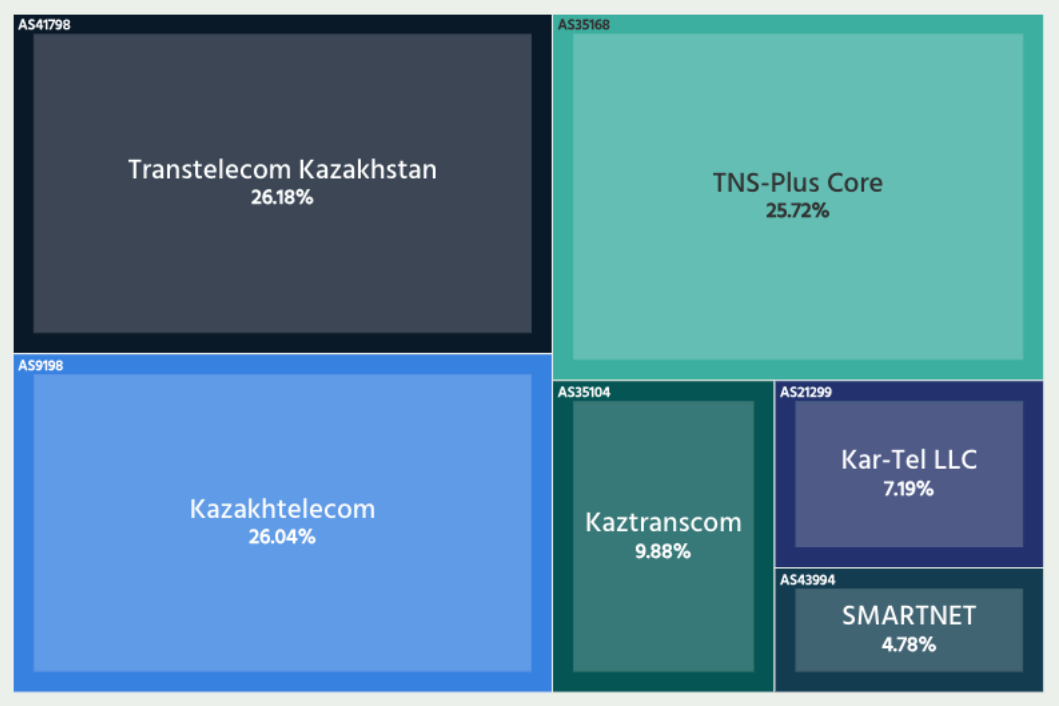

Figure 4. The top 6 transit providers in Kazakhstan and the percentage of Kazakh networks reachable through them. (Internet Health Report)

Central Asia's Largest Domestic Market

Kazakhstan has the largest number of Autonomous System Numbers (ASNs) and Internet Protocol (IP)[10] prefixes allocated to its domestic market. In September 2024, 212 ASNs were allocated to organizations registered in Kazakhstan. Most of these ASNs (171) are active at the BGP level, especially in IPv4 (169), but only a very small fraction is using IPv6 (38). All other countries in the region have less than 100 assigned ASNs.

Kazakhstan has one of the most complex and diversified networks within the region. Compared to Uzbekistan, Kazakhstan has twice as many ASNs despite the fact that Uzbekistan's population is much larger (36.4M compared to 19.9M). Although ASNs allocated to Kazakhstan are significantly fewer than Russia and China which both have over 5,000 active networks, these results reveal that Kazakhstan has the most competitive market in Central Asia.

Figure 5 provides a breakdown of ASNs per country (registered and active for both IPv4 and IPv6) and the number of stub networks. A stub network refers to an end-site such as a company or university network, which does not provide connectivity to other networks.

[10] An IP prefix refers to a range of Internet Protocol (IP) addresses, which come in two versions, IPv4 and IPv6, allocated to an entity such an Internet Service Provider (ISP) or any organization running a public network (e.g., a university).

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Figure 5. Number of networks registered in Central Asia and active on the Internet

About 3.2 million IPv4 addresses are allocated to Kazakhstan (Figure 6), and almost all of them (3.1M) are actively announced in BGP. Hence, Kazakhstan manages by far the largest number of IPv4 addresses in the region. Most of the IPv4 space allocated to KZ is active in BGP, but for IPv6, only a small fraction of the allocated space is active. The more IP addresses allocated to a country directly correlates to the country's demand in terms of Internet resources. Despite the growing IPv6 demand around the world, Central Asia and Kazakhstan's transition to IPv6 is relatively slow. Around 20% of IPv6 prefixes are currently announced on the global Internet. As per APNIC Labs[11]22.46% of users are currently served over IPv6, which is much larger than the regional average (9.98%). The two operators leading the chart for IPv6 are Kar-Tel (Beeline) and Tele2.

[11] APNIC IPv6 Statistics—https://stats.labs.apnic.net/ipv6/KZ, accessed on 14 March 2025.

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Figure 6. Number of IPv4 and IPv6 prefixes registered in Kazakhstan and the number of these addresses that are globally reachable on the Internet (Source: NRO, RouteViews, RIPE RIS)

Concentrated Yet Competitive Local Market

Kazakhstan has the best affordability rate, measured in the percentage of GNIpc (Gross National Income per capita), as opposed to other countries in the subregion (Figure 7). While Kazakhstan's telecom sector is concentrated, competition among a few major ISPs (KazakhTelecom, Beeline, Transtelecom, and KazTransCom) helps keep prices competitive. The presence of multiple mobile operators (Beeline, Kcell, Tele2, and Altel) creates a price-sensitive environment where operators offer competitive pricing to retain market share.

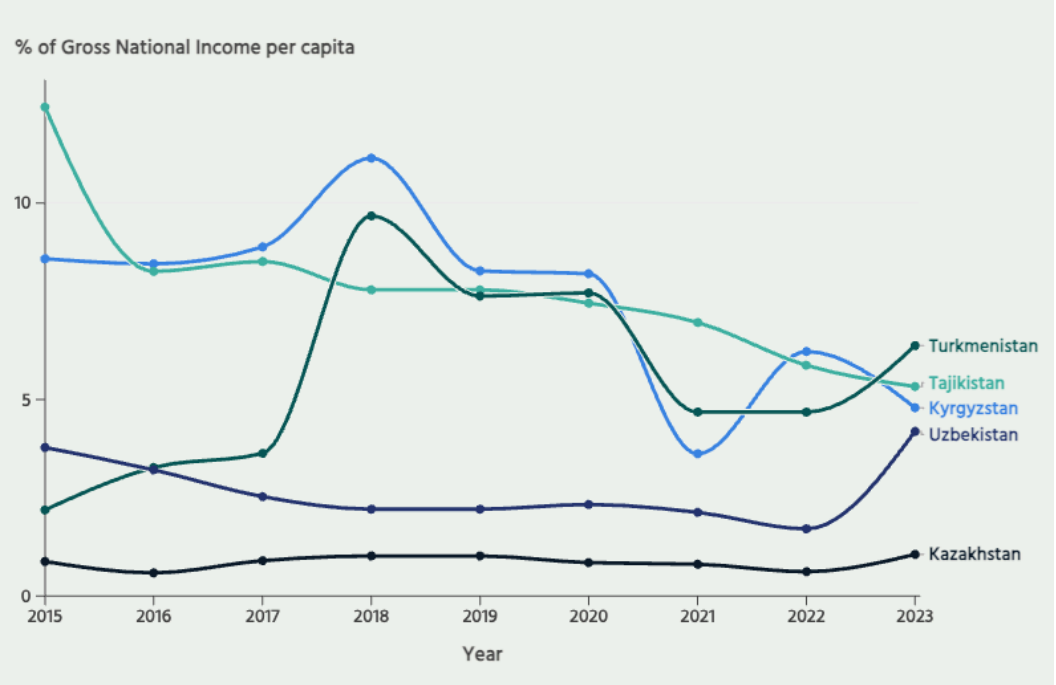

Figure 7. Internet Affordability measured using % of the Gross National Income per capita for Fixed Broadband (Source: ITU)

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Another reason is because Kazakhstan sources a large portion of its Internet transit from Russian providers, which offer cheaper bandwidth compared to alternative transit routes. This reduces the cost of international bandwidth and helps keep end-user prices lower.

Kazakhstan: A Gateway Towards Russian Networks

Kazakhstan Sits at the Crossroads of Regional Terrestrial Fiber Lines

Kazakhstan's fiber optic network features multiple links to Russia in the northern and northwestern regions. Additionally, other international connections primarily support the integration of neighboring Central Asian states with the global Internet via Kazakhstan (mainly in the south) or provide a direct route linking China, Russia, and Europe.

As illustrated in Figure 8, Kazakhstan has up to 16 cross-border connectivity points, which seems to amount to a high degree of physical path diversity. However, most of these interconnections are located at the border with Russia (n=10). Other than Russia, path diversity is less significant. Kyrgyzstan has two active land connection points and one under construction with Kazakhstan, whereas connectivity with China is served through only two points, and connections towards Uzbekistan and Turkmenistan are limited to a single physical gateway.

Kazakhstan sources the majority of its international bandwidth from Russia, with most ISPs routing their traffic through Russian networks. This makes Russia Kazakhstan's largest supplier[12] of international bandwidth by a significant margin.

Within Central Asia, the Kyrgyz Republic relies heavily on Kazakhstan for connectivity to Russian networks and beyond. This dependence is driven by Kazakhstan's competitive pricing and the highest available capacities in the region.[13] Similarly, Uzbekistan depends on Kazakhstan for its international connectivity, as most Uzbek ISPs use transit providers based in Russia, resulting in the majority of Uzbekistan's traffic being routed through Kazakhstan to Russia.

[12] Also see: RIPE NCC, "Internet Country Report—Central Asia", september 2020, https://labs.ripe.net/media/documents/RIPE_NCC_Internet_Country_Report_Central_Asia_Sept_2020_1.pdf, accessed on 03 Dec. 2024.

[13] 24.kg, ""The Internet will not rise in price—the head of "Kyrgyztelecom" dispelled the fears of operators (Интернет не подорожает—глава «Кыргызтелекома» развеял опасения операторов)", 21/11/2024, https://24.kg/biznes_info/311775_Internet_nepodorojaet_glava_kyirgyiztelekoma_razveyal_opaseniya_operatorov/, accessed on 03 Dec. 2024.

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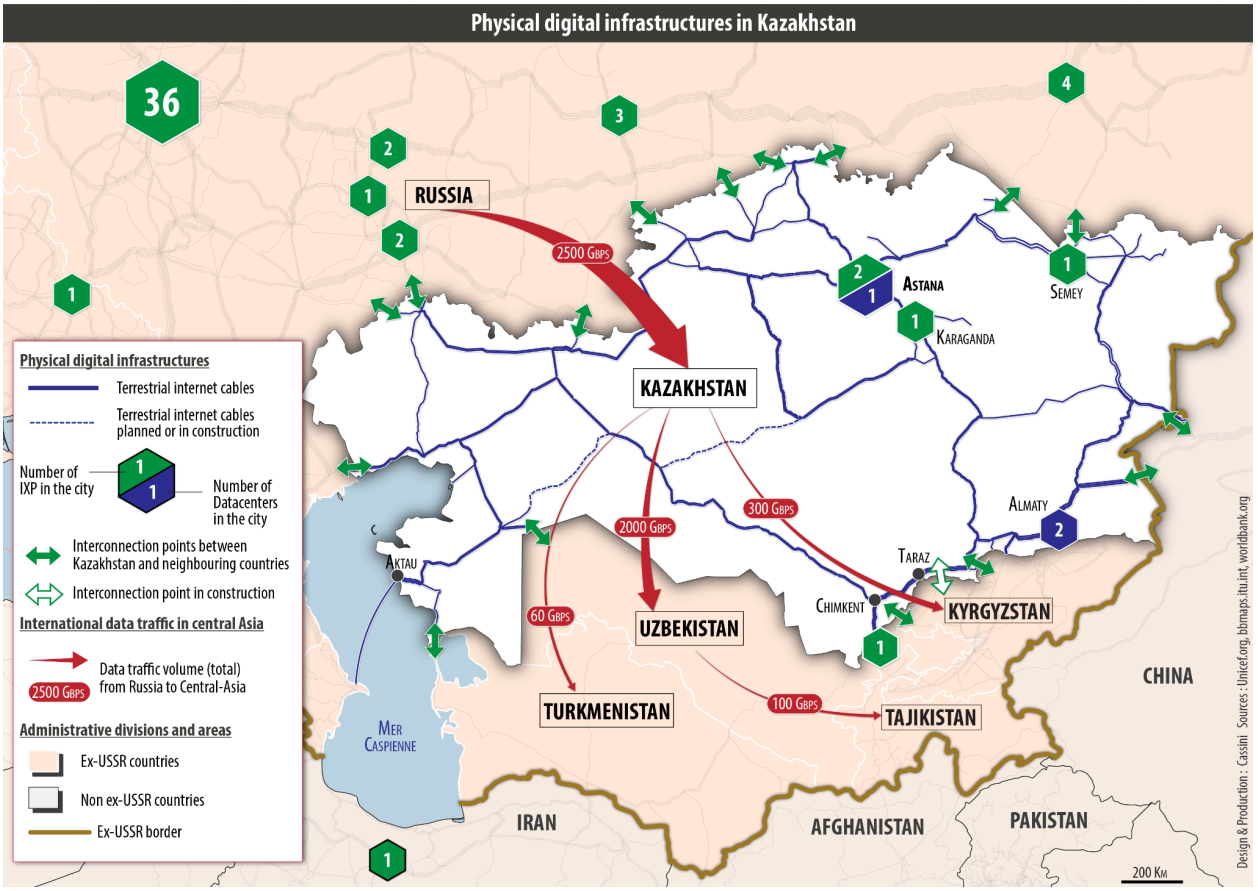

Figure 8. Kazakhstan's physical Internet connectivity map[14]

Turkmenistan, while a smaller consumer of Kazakh bandwidth, has a more diverse set of connectivity options. Although it relies heavily on Rostelecom for transit, it also has agreements with regional providers such as the Azerbaijani ISP Delta Telecom and Uzbektelecom.[15]

[14] Sources : UNICEF, www.unicef.org/. Accessed 31 Jan. 2025; "Empowering Connectivity through Broadband Mapping." ITU, bbmaps.itu.int/. Accessed 31 Jan. 2025; worldbank.org.

[15] Hurricane Electrics, "AS20661 State Company of Electro Communications Turkmentelecom", https://bgp.he.net/AS20661#_peers; Internet Health Report, "AS20661", https://www.ihr.live/en/network/AS20661?af=4&last=3&date=2024-11-04&active=routing, accessed on 30 Jan. 2025.

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Understanding Strategic Dependencies on the Russian Internet

Prominence of Russian-based content

Central Asia's connectivity historically depended on Russian services, which provided first-move advantages to Russian content providers. Before the Trans Europe Asia (TEA) cable in 2005, the region suffered poor connectivity and limited foreign investment. Russian services like Yandex, Mail.ru, and VKontakte became dominant in both Russia and Kazakhstan due to early infrastructure advantages.

Russian platforms remain significant in Kazakhstan, offering social media, video, and streaming services. For example, VKontakte (social media platform), has two points of presence (POPs) in Kazakhstan, in Almaty and Astana. Yandex provides a good case study having relocated all `yandex.kz` servers within Kazakhstan and having opened a data center within the country. Their advantage over U.S. and Chinese competitors stems from local cache distribution, enabling lower latency. VKontakte has points of presence in Almaty and Astana, while Yandex relocated `yandex.kz` servers within Kazakhstan. Meanwhile, U.S. cloud services are scarce—Cloudflare has a presence in Almaty, but AWS, Azure, and Google do not. Chinese providers like Alibaba, Huawei, and Tencent also lack local infrastructure.

Kazakhstan's Dependence on Russia for Transit

After Russia's invasion of Ukraine in March 2022, major US-registered Tier-1 providers Cogent[16] and Lumen (operating Level-3)[17] ceased to provide transit in Russia, disrupting their access to global networks. Cogent announced it has ceased to serve major Russian ISPs such as Rostelecom, Transtelecom, VEON, and MegaFon. London Internet Exchange (LINX) has also disconnected Megafon and Rostelecom from its peering facilities.[18] However, it is worth noting that in the case of Cogent, peering data shows that overall, the number of Russian networks it connects to has vastly increased since 2022, going from about 20 early in the year, to nearly 40 in September 2024.

At the time of the disconnection, Russian ISPs had to connect via many intermediaries to reach their final destination, bringing more latency and cost to their customers. At the time, KazakhTelecom was getting its international bandwidth or transit through five Russian companies: Rostelecom, Transtelecom, MegaFon, VEON, and China Mobile (Russia).[19] As such the sanction taken against Russian

[16] *Reuters*, "U.S. firm Cogent cutting Internet service to Russia", 04/03/2022, https://www.reuters.com/technology/us-firm-cogent-cutting-Internet-service-russia-2022-03-04/, accessed on 20 Nov. 2024.

[17] Lumen, "Lumen's Readiness to Meet Global Events", 07/03/2022, https://news.lumen.com/RussiaUkraine; accessed on 20 Nov. 2024.

[18] Sebastian Moss, "London Internet Exchange disconnects Megafon and Rostelecom", *Data Center Dynamics*, 14/03/2022, https://www.datacenterdynamics.com/en/news/london-Internet-exchange-disconnects-megafon-and-rostelecom/, accessed on 20 Nov. 2024.

[19] Elnur Alimova (Ельнур АЛИМОВА), "It will be a disaster. Where will Kazakhstan get the Internet if Russia is disconnected from the global network? («Это будет катастрофа». Где Казахстан возьмет интернет, если Россию отключат от

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transit providers at a routing level might affect their downstream clients located in Central Asia, such as Kazakhstan, Tajikistan, and Uzbekistan.[20]

According to Kentik, if Russia cuts itself from the Global Internet, Kazakhstan could be left offline. Since Kyrgyzstan, Tajikistan, and Uzbekistan are connected to the global Internet through Kazakhstan, these countries will also be disconnected from the global Internet. This will also affect Turkmenistan and Mongolia, but not to the same extent as other Central Asian states, given that these countries also receive Internet transit through Iran and China and therefore have alternatives.[21] According to Talgat Nurlybaev, Chairman of the Kazakhstani Chapter of the Internet Society, 95% of Kazakhstan's Internet traffic goes through Russia.[22]

KazakhTelecom has declared that it is using different Internet backup routes independent from Russia.[23] According to PeeringDB, JSC KazakhTelecom (AS9198) is connected to three Public exchanges: DATIX, PITER-IX Moscow, PITER-IX St. Petersburg, and three interconnection facilities: Equinix FR5 (Frankfurt), Equinix HK2—Hong-Kong, Moscow M9.[24]

Additionally, KazakhTelecom officials have declared that even if Russia builds an autonomous Internet (analogous to China), it will not affect Kazakhstan's own access since Internet service is provided to Kazakhstan through transit, which crosses the Russian territory towards Europe (it does not enter the Russian network itself).[25] Reportedly, KazakhTelecom is presently increasing its presence abroad to minimize the risks. It is building a resilient connectivity architecture that could sustain external Internet cuts, using other alternatives.[26]

глобальной Сети?)", *Radio Free Europe*, 24/03/2022, https://rus-azattyq-org.translate.goog/a/31767819.html?_x_tr_sl=auto&_x_tr_tl=fr&_x_tr_hl=fr&_x_tr_pto=wapp, accessed on 21 Nov. 2024.

[20] Doug Madory, "Updated: Cogent and Lumen curtail operations in Russia", *Kentik*, 07/03/2022, https://www.kentik.com/blog/cogent-disconnects-from-russia/, accessed on 20 Nov. 2024.

[21] Elnur Alimova. 22/03/2024. *Ibid.*

[22] Dosimzhan Naukhanov (Досымжан Науханов), "If Russia is off the Internet, what will happen to Kazakhstan?—review of the Kazakh media (Если Россию отключат от интернета, что будет с Казахстаном?—обзор казСМИ)", 29/03/2022, https://365info.kz/2022/03/esli-rossiyu-otklyuchat-ot-Interneta-chto-budet-s-kazahstanom-obzor-kazsmi, accessed on 20 Nov. 2024.

[23] Elnur Alimova. 22/03/2024. *Ibid.*

[24] PeeringDB is a public database of Internet data: *PeeringDB*, https://www.peeringdb.com/net/2585, accessed 31 Jan. 2025.

[25] Artem Volkov (Артем Волков), "Optolf axe: can Russia leave Kazakhstan without the Internet? (Топором по оптоволокну: может ли Россия оставить Казахстан без интернета?)", *Orda*, (09/09/2024), https://orda.kz/toporom-po-optovoloknu-mozhet-li-rossija-ostavit-kazahstan-bez-Interneta-391521/, accessed 31 Jan. 2025.

[26] *Profit*, "KazakhTelecom summed up the results of activities for 2023", 09/02/2024, https://profit.kz/news/65393/Kazahtelekom-podvel-itogi-deyatelnosti-za-2023-god/, accessed on 03 Dec. 2024.

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Upstream connectivity

According to BGP[27] data the most prominent upstreams for Kazakh networks are still Russian ISPs, meaning that routes to the broader Internet are more likely to go through Russian ISPs. However, this does not mean that all traffic terminates in Russia, but Russia is used as a connection point towards Europe and Asia.

Table 1 shows that peering agreements with Russian networks continue to dominate Kazakhstan's connectivity landscape. This analysis reveals 525 AS links originating from 26 different Kazakh networks connected to 474 Russian networks. In comparison, links with American networks are limited to 50, stemming from 11 Kazakh networks. The total number of AS links with Europe reaches 118 from 13 Kazakh networks, placing the region as a whole below Russia in terms of logical paths connected to Kazakh networks.

Table 1. Number of international routes per country (Source: NRO, RouteViews, RIPE RIS)

Number of KZ networks	Number of routes	Going to	Number of Networks
26	525	Russian Federation	474
13	118	Europe	90
10	50	United States of America	37
3	9	Kyrgyzstan	7
2	2	Uzbekistan	1
15	132	Other	107

In Asia, Kazakhstan's ISPs maintain only a few links, including seven with Singapore, two with Hong Kong, and one with China. Within Central Asia, Kyrgyzstan has the highest number of Internet routes with Kazakhstan (n=9), followed by Uzbekistan (n=2).

Figure 9 gives an overview of the most common networks seen on routes from the Internet to Kazakhstan in September 2024. The size of nodes conveys the likelihood of an AS to be present on a route towards networks managed by Kazakh organizations. The Kazakh ISPs, KazakhTelecom (AS9198), TNS-Plus (AS35168), Transtelecom Kazakhstan (AS41798) have most of their international routes transiting via Russian transit providers such as Rostelecom (AS12389), VimpelCom (AS3216), KVant (AS43727), Transtelecom Russia (AS20485), Megafon (AS31133), and MMTS (AS60299), except for routes transiting via Tier-1 networks (Cogent, PCCW, Lumen) and a few ISPs registered in Europe such as V-net (AS47864).

[27] **BGP (Border Gateway Protocol)** is the protocol used for networks to exchange routing information on the Internet. BGP data is collected via Route Collectors, placed in strategic locations around the world.

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To understand whether announced sanctions[28] against Russian networks from Tier-1 providers Cogent and Level-3 had an impact on Kazakhstan's international connectivity the relationships of these Tier-1 networks with Kazakh networks were examined. As per the data collected, KazakhTelecom has direct connectivity with Cogent and Level-3 in Frankfurt and Hong Kong and shall not be impacted by disruptions happening at the Russian transit providers' end. According to the Internet Routing Registries[29] (IRR), connections with U.S. content providers (Amazon, Apple, META, Microsoft, Google, and Twitch) mainly happen in Hong Kong and Frankfurt.[30] A peering with Google is also visible in Moscow. Moreover, according to the measurements, Cogent and Level-3 have stopped their blockade of Russian ISPs and are re-connected with them as per their routing announcements seen in BGP.

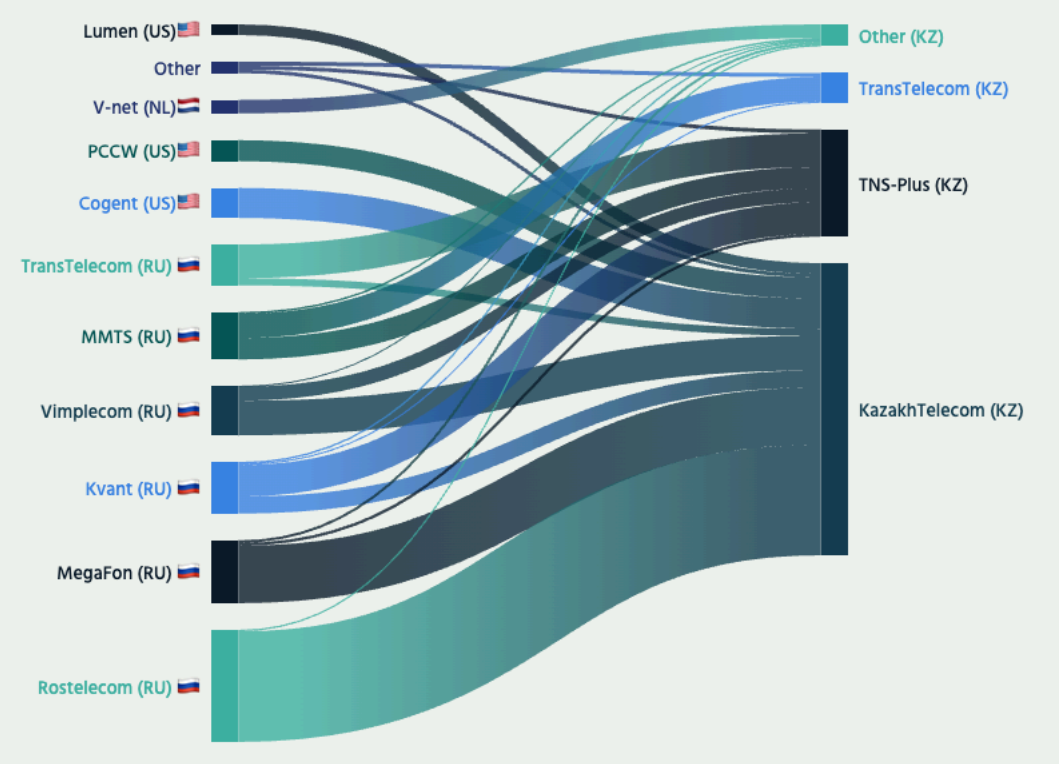

Figure 9. Kazakhstan International connectivity in September 2024. (Source: RouteViews, RIPE RIS).

From a longitudinal perspective, KazakhTelecom's (AS9198) outgoing routes showed better international diversity in September 2024 than in September 2021. In 2021, Kazakhstan's primary ISP relied heavily on Russian providers for international connectivity. By 2024, while Rostelecom remains its primary partner, KazakhTelecom has significantly improved its connectivity to global networks such as Cogent, PCCW, and Lumen. Similarly, in 2021, Kazakhstan's second backbone provider, TNS-Plus

[28] The Impact and Limits of Sanctions on Russia's Telecoms Industry, https://dgap.org/en/research/publications/impact-and-limits-sanctions-russias-telecoms-industry, accessed on 14 Mar. 2025.

[29] **Internet Routing Registries**: A public database to disclose routing operations and policies.

[30] "AS9198 JSC Kazakhtelecom." *Hurricane Electric*, https://bgp.he.net/AS9198#_irr, accessed 31 Jan. 2025.

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(AS35168), primarily depended on Russian ISPs, including its parent company VEON, Vimpelcom (AS3216). As of 2024, its international routes continue to be dominated by Russian ISPs.

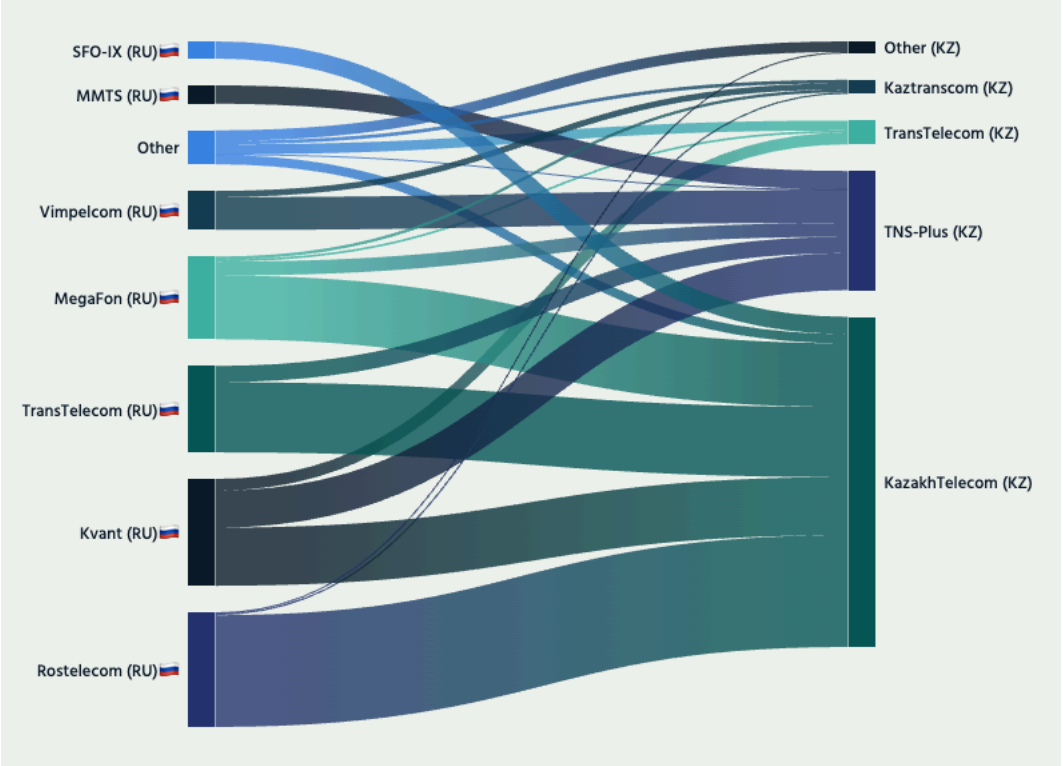

Figure 10. Kazakhstan International connectivity in September 2021 (Source: RouteViews, RIPE RIS)

Based on the analysis of logical routes, Kazakhstan has slightly reduced its reliance on Russian networks since 2021. Kazakh ISPs now have marginally better connectivity to major American networks, while their peering with Europe has remained stable, with no significant changes observed. This effort, mainly driven by KazakhTelecom, should be pursued by all large transit networks in Kazakhstan to further diversify the country's international connectivity.

Kazakhstan's Peering Landscape

There are currently four active Internet Exchange Points (IXPs) in Kazakhstan (Figure 11, blue) where 7.21% of local networks are peering. As is generally the case in Central Asia, the coverage is relatively low in Kazakhstan. This is because the local IXPs are highly controlled by the government. This is the case for KAZ-GOV-IX, Kazakhstan's main public IXP, managed by the State Technical Service (STS).

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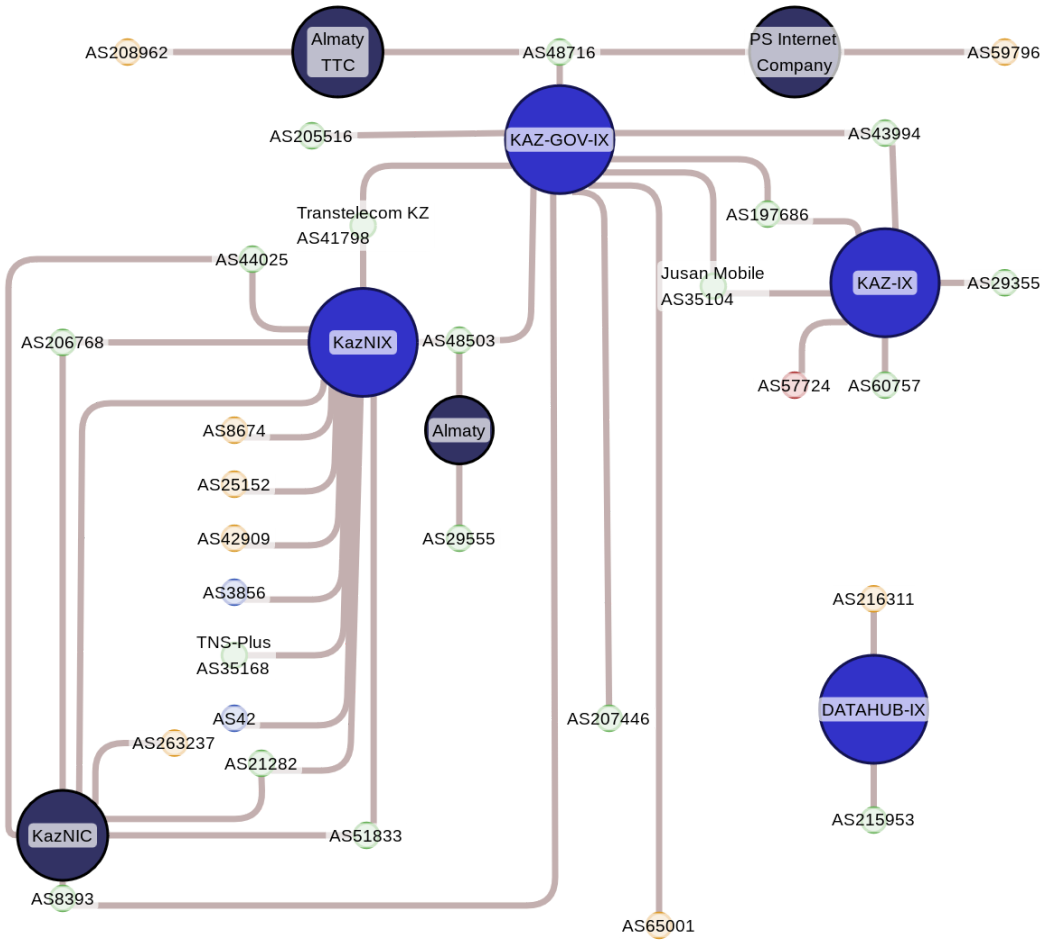

Figure 11. Peering ecosystem in Kazakhstan. Co-location facilities (black), IXPs (blue), Kazakh networks (green), international networks (blue: US, red: Russia, orange: Others).

According to the KAZ-GOV-IX's official website, it is currently connecting all the major national ISPs together. In Almaty, 21 ISPs are interconnected, including KazakhTelecom, TNS+, Transtelecom et KazTransCom[31]. STS is managing exchange facilities in 18 cities of Kazakhstan (Astana, Almaty, Aktau, Aktobe, Atyrau, Zhezkazgan, Karaganda, Kokshetau, Kostanay, Kyzylorda, Pavlodar, Petropavlovsk, Semey, Taldykorgan, Taraz, Uralsk, Ust-Kamenogorsk, and Shymkent). KAZ-GOV-IX concentrates all IXP-routed traffic of the country (over 350GBps) (Figure 12).

[31] KAZ GOV-IX, "Looking Glass", https://lg-ix.sts.kz/, accessed on 18 Nov. 2024.

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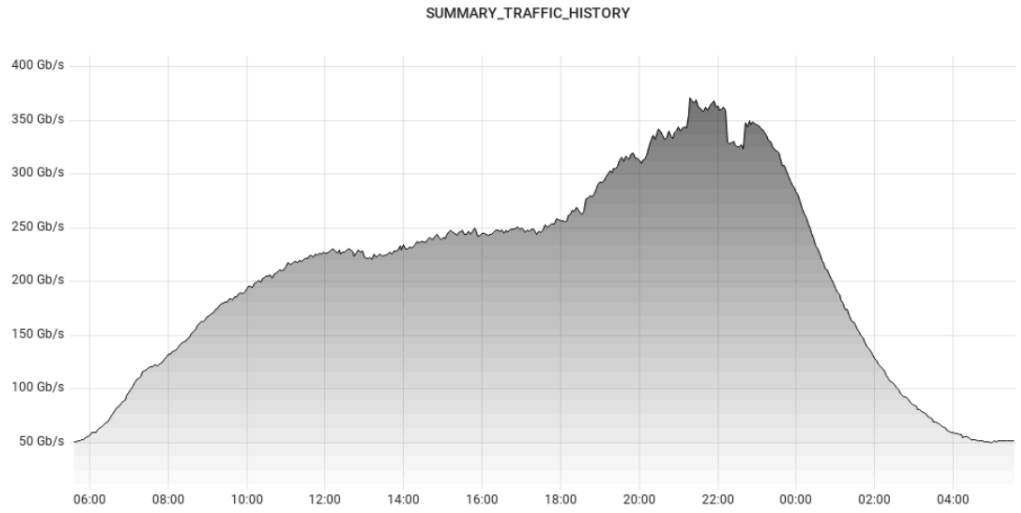

Figure 12. Typical KAZ GOV-IX daily traffic (Source: KAZ GOV-IX)

In comparison, KazNIX, an independent IXP, launched in February 2019 in Semey, only receives 1 Gbps of traffic during peak times (Figure 13). KazNIX describes itself as 'neutral,' and as an exchange platform for "IP traffic between networks and the globally distributed networks of DNS servers for support of root domain zones."

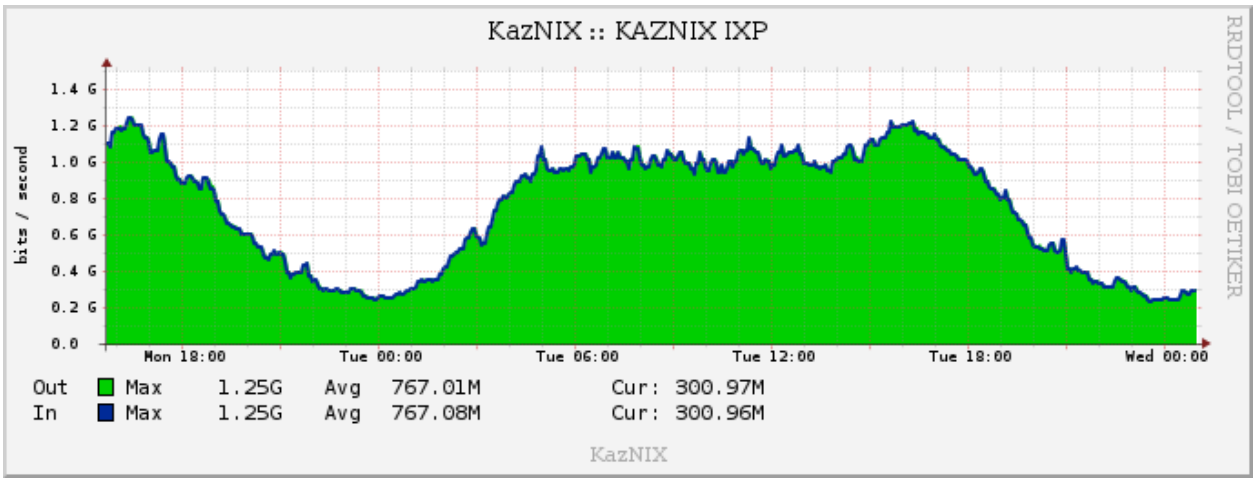

Figure 13. Typical KazNIX daily traffic (Source: KazNIX)

The networks participating at both IXPs convey a key difference between these IXPs. KAZ GOV-IX members are solely domestic operators, while KazNIX has a mix of foreign and domestic operators. For example, DNS root providers (Netnod, PCH, and RIPE NCC) are at KazNIX but not KAZ-GOV-IX. It is recommended to host anycast DNS servers at IXPs not only to increase the overall user experience by reducing DNS resolution latencies, but it adds to the overall resilience of the DNS ecosystem.

The concentration of the traffic at the government-managed IX jeopardizes resilience as it creates a single point of failure which could be vulnerable to operational mishaps and disruptions.

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Content Locality: A Contrasted Picture

The previous section focuses on Kazakhstan's international connectivity. This section provides an overview of where most Internet users in Kazakhstan fetch their content.

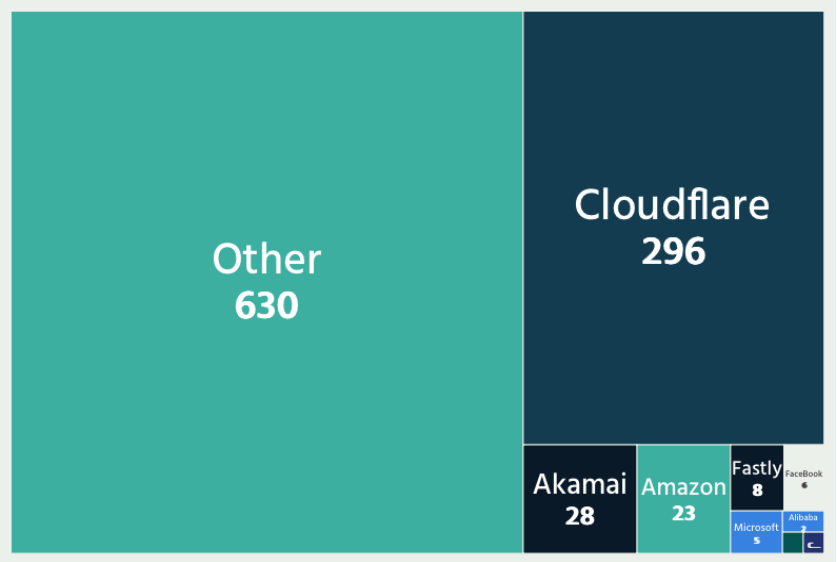

Figure 14. Distribution of host providers for the top 1,000 websites in Kazakhstan.

To understand the extent of popular content in Kazakhstan, it is important to know the localization of the infrastructure hosting the top 1,000 most popular websites reported in Google's CRuX[32] dataset. Out of 1,000 websites, 308 websites are served by Cloudflare, 25 by Amazon, 26 by Akamai, and the rest are hosted either natively or on private clouds (Figure 14).

Figure 15 shows the countries and networks hosting the most popular content accessed by Kazakh Internet users: Almost two-thirds are hosted in Kazakhstan. The Anycast[33] category (33% of websites) represents servers that are located in various places worldwide, but as most of these websites are hosted by Cloudflare and given the presence of Cloudflare at multiple places in Kazakhstan, the vast majority of the websites in the Anycast category are indeed hosted within the country. An additional 27% of websites are clearly identified in Kazakhstan; these are typically hosted by Kazakh networks, including KazakhTelecom, PS cloud services, and Hoster.kz. Over 17% of the studied websites are located in Russia which supports the need for Internet capacity in Russia. The rest are spread out worldwide and include popular American and European hosting providers such as Google, OVH, and Hetzner.

[32] "Overview of Crux: Chrome UX Report : Chrome for Developers." *Chrome for Developers,* https://developer.chrome.com/docs/crux, accessed on 8 Feb. 2025.

[33] **Anycast** is a network addressing and routing method in which incoming requests can be routed to a variety of different locations (usually to the closest location).

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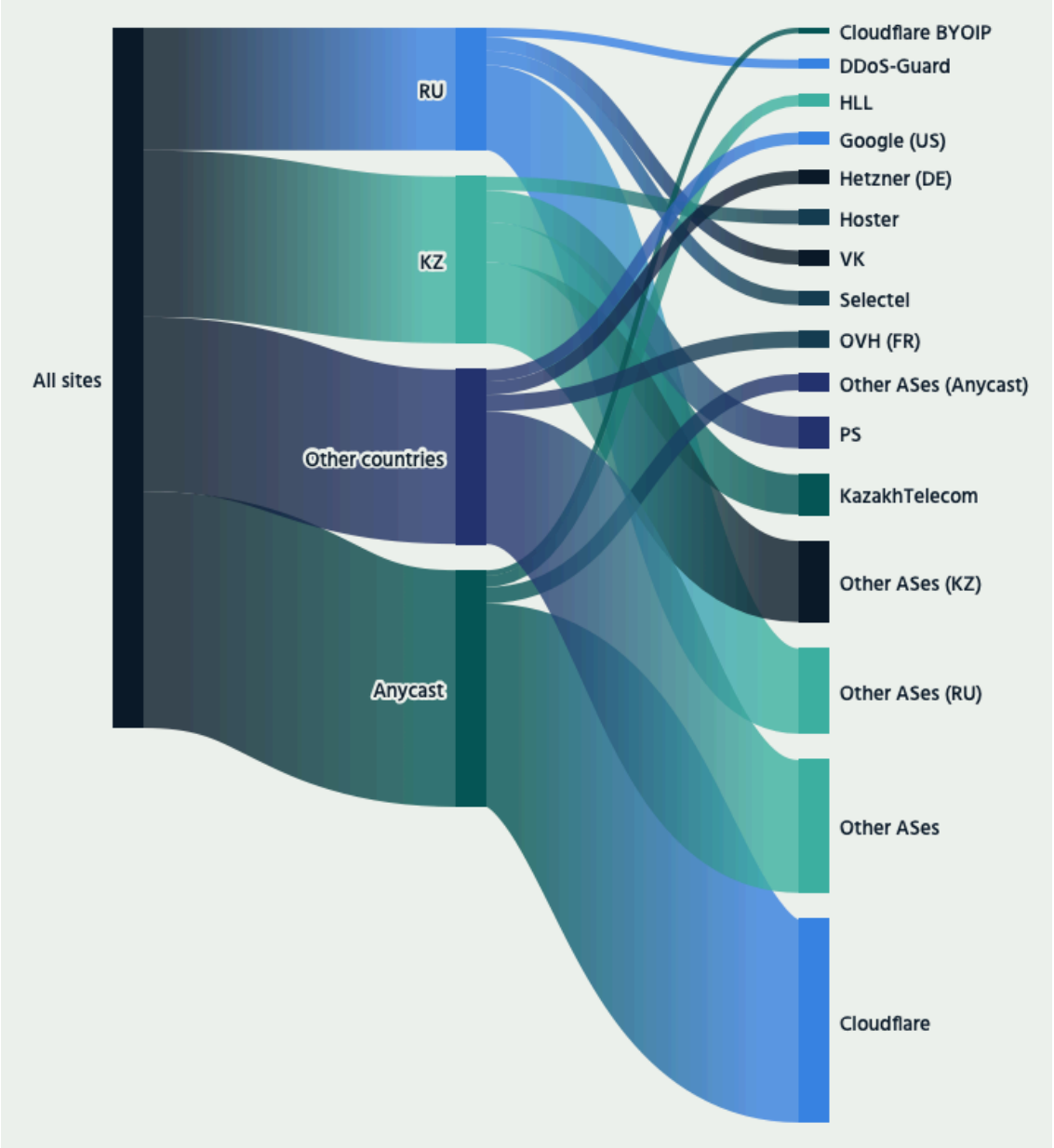

Figure 15. Geographical and topological localization of the top 1,000 websites in Kazakhstan.

Internet Society's Pulse Content Locality Tracker[34] also supports the above results and confirms the local Cloudflare traffic. The chart below shows that almost two-thirds of caches are located inside the country. That is the case of Akamai, Cloudflare, and Facebook. However, other U.S. cloud providers such as Amazon, Fastly, and Microsoft are served from outside of Kazakhstan. As mentioned above, some of these networks are directly connected to KazakhTelecom in Frankfurt and Hong Kong, hence do not require transit via a third-party network, but the distance from the content to the users inevitably causes higher latencies (i.e., ~100ms) compared to content hosted domestically (i.e., <60ms).

[34] "Country Report for Kazakhstan." *Pulse,* pulse.internetsociety.org/en/reports/kz/. Accessed 13 Mar. 2025.

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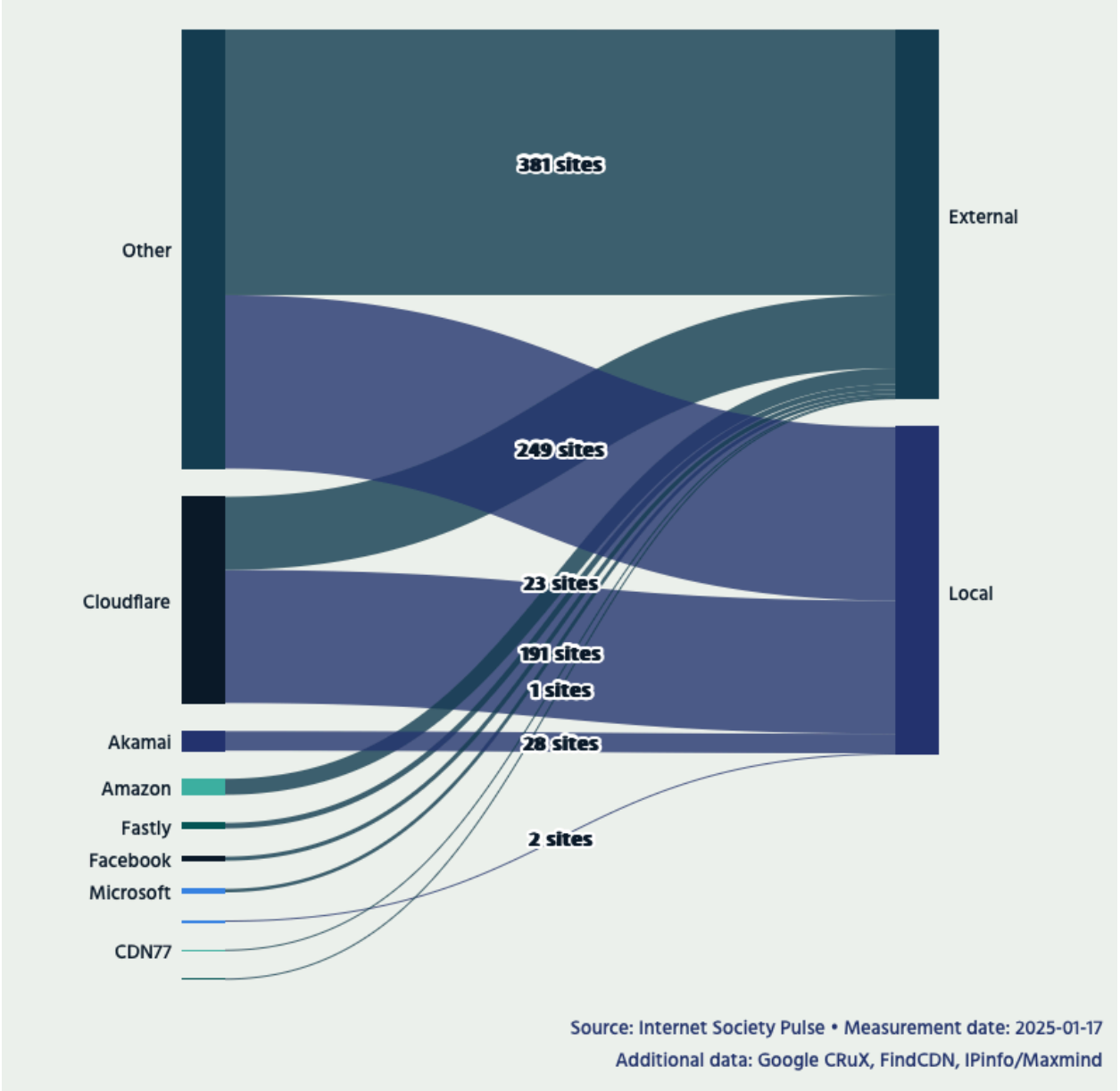

Figure 16. Number of websites (out of 1,000) hitting either a local or external cache.

This study also investigated the location of governmental websites (`.gov.kz`) and found that all of them are hosted by Kazakh networks (Table 2). Unlike many European and North American countries,[35] Kazakhstan is not relying on any of the popular third-party cloud providers. This reveals a distinctive strategy from the Kazakh government to avoid external dependencies in their web infrastructure.

Furthermore, the different e-services offered by the government are distributed over different networks hence avoiding centralization. Since 2021 and the enactment of the "Rules for registration, use, and distribution of domain names in the space of the Kazakhstani segment of the Internet" (adopted in

[35] Of Choices and Control - A Comparative Analysis of Government Hosting, Rashna Kumar, Esteban Carisimo, Lukas De Angelis Rivas, Mauricio Buzzone, Fabián E. Bustamante, Ihsan Ayyub Qazi, Mariano G. Beiró, ACM IMC 2024.

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2018), all the websites registered under a ".kz" domain name are supposed to be hosted within national boundaries.[36]

According to these rules, the use of a domain name can be suspended if the associated Internet resources are hosted on hardware and software complexes outside the territory of the Republic of Kazakhstan. Yet, there is no piece of legislation enforcing ".kz" domain names to be hosted specifically on local cloud providers, as long as an international provider has physical servers located within Kazakhstan it can provide hosting services to local websites.

Table 2. List of government websites and their host providers.

Websites	Host Provider
adilet.gov.kz, did.gov.kz, egov.kz, eotinish.gov.kz, kostanay.gov.kz, mfa.gov.kz, pavlodar.gov.kz, pki.gov.kz, root.gov.kz	National Information Technologies (AS15549)
bkogov.kz, edugov.kz, invest.gov.kz	PS Cloud Services (AS48716)
bolashak.gov.kz, goszakup.gov.kz, orda.gov.kz, qamqor.gov.kz	KazakhTelecom (AS9198)
edu.gov.kz, law.gov.kz, sud.gov.kz, zan.gov.kz	Kar-Tel (AS21299)
election.gov.kz, eqyzmet.gov.kz, esf.gov.kz, kgd.gov.kz, minfin.gov.kz, stat.gov.kz	TransTelecom (AS41798)
mgw.gov.kz	State Technical Service (AS207966)

Finally, we also look at the DNS infrastructure for the 1,000 most popular websites (as reported by Google's CrUX). Figure 17 shows the country where organizations managing DNS authoritative servers for popular content are registered. A large fraction (46%) are managed by American companies, half of these using Cloudflare DNS services. Russian companies are also managing the DNS for a significant number (16%) of the top 1,000 websites which is slightly higher than the number of websites managed by Kazakh DNS servers (15%), acknowledging again the popularity of Russian services in Kazakhstan. Other DNS providers are mainly spread out through different countries of Europe.

[36] Ministry of Defense and Aerospace Industry of the Republic of Kazakhstan, "On approval of rules for registration, use and distribution of domain names in the space of the Kazakhstani segment of the Internet (**Интернеттің қазақстандық сегментінің кеңістігінде домендік аттарды тіркеу, пайдалану және бөлу қағидаларын бекіту туралы**)", 27/03/2018, https://nic.kz/docs/main-rules-kaz.pdf, accessed on 31 Jan. 2025.

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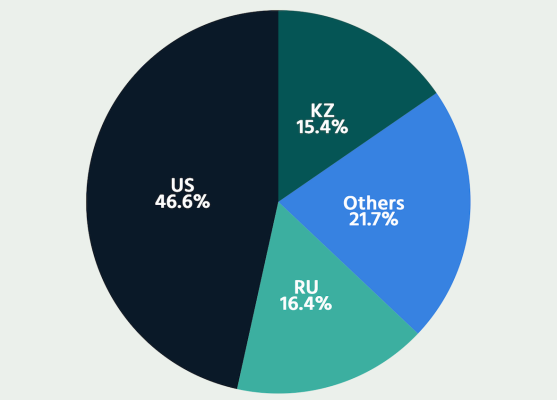

Figure 17. Registered country for networks hosting authoritative name servers of the top 1,000 websites.

Finding Alternative Paths: Emerging Initiatives

The Transcaspian Fiber-Optic Cable Project

The idea of building new telecommunications bridges across the Caspian Sea is not new. It dates back to the 1990s, and since then several projects have followed one another without major breakthroughs due, in part, to the Caspian Sea's disputed legal status. Figure 18 provides an overview of Kazakhstan's digital constraints and opportunities in the wider Eurasian region.

Azerbaijan has the ambition of becoming a "digital hub" and has integrated the Trans-Caspian fiber optic project into its national strategy[37]. AzerTelecom signed an agreement with KazakhTelecom in June 2023 to establish a joint venture for the construction and operation of the Trans-Caspian Fiber Optic Communication Line. The project is currently under tender and scheduled to be completed by the end of 2025. The cable will connect Sumgait, Azerbaijan, to Aktau, Kazakhstan. AzerTelecom has negotiated projects with Georgian, Turkmen, and Turkish providers in tandem, potentially connecting Kazakhstan to new networks for routing.

AzerTelecom has branded its fiber-optic line as the "Digital Silk Way," drawing upon the same historic images of the ancient Silk Road that China also used for its One-Belt-One-Road initiative. Azerbaijan has promoted this vision, particularly through institutions such as the Organization of Turkic States.

[37] See: "Azerbaijan Digital Hub", https://www.adh.az/, accessed on 21 Nov. 2024.
Ayaz Museyibov, "Azerbaijan's Latest Steps Toward Becoming a Regional Digital Hub", *Eurasian Daily Monitor*, Vol. 19, n°93, (23/06/2022), https://jamestown.org/program/azerbaijans-latest-steps-toward-becoming-a-regional-digital-hub/, accessed on 21 Nov. 2024.

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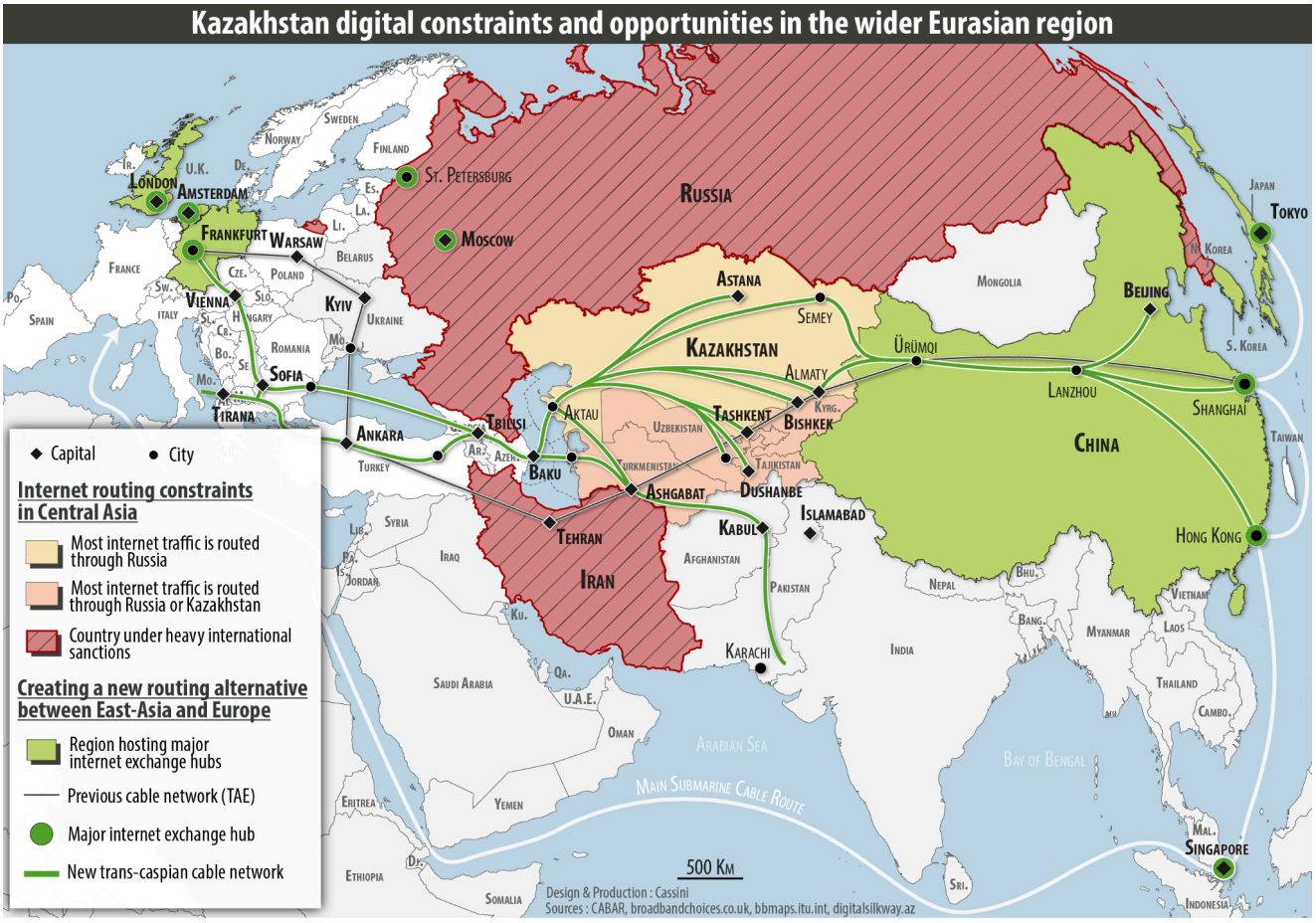

Figure 18. Map of Kazakhstan's digital constraints and opportunities in the wider Eurasian region[38]

Similarly, Kazakhstan has emphasized the project's importance, with President Tokayev directly mentioning the Transcaspian fiber-optic project, calling for its completion by the end of 2025. He stressed the project's "[importance] for our country in terms of creating a digital infrastructure associated with international corridors and cross-border data flows."[39] On 4 March 2025, the Chairmen of AzerTelecom and KazakhTelecom, Emil Masimov and Bagdat Musin, signed an agreement to construct fiber-optic cables across the Caspian Sea.[40]

[38] Sources : cabar.asia; *Broadband, TV, Landline & Mobile Comparison | Broadbandchoices*, https://www.broadbandchoices.co.uk/, accessed 31 Jan. 2025., "Empowering Connectivity through Broadband Mapping." *ITU*, bbmaps.itu.int/, accessed 31 Jan. 2025.; "Connectivity beyond Borders." *Digital Silk Way*, digitalsilkway.az/, accessed 31 Jan. 2025.

[39] *Tengri News*, "Fiber-optic cable on the bottom of the Caspian Sea: Tokayev called the timing of the completion of the project (Оптоволокно по дну Каспия: Токаев назвал сроки завершения проекта)", 02/09/2024, https://tengrinews.kz/kazakhstan_news/optovolokno-dnu-kaspiya-tokaev-nazval-sroki-zaversheniya-546614/, accessed on 21 Nov. 2024.

[40] Mammadov, Seymur. "Strategic Breakthrough: Undersea Cable across the Caspian to Link Continents | News.Az." *News.AZ*, 10 Mar. 2025, https://news.az/news/-strategic-breakthrough-undersea-cable-across-the-caspian-to-link-continents

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China-Europe route via Kazakhstan

Since 2005, China has established cross-border fiber-optic links with Russia, Mongolia, Kazakhstan, Tajikistan, and Kyrgyzstan,[41] all of which also provide access to Europe. China Telecom has established international branches and a regional bandwidth bureau in Xinjiang, allowing traffic to bypass traditional hubs in Beijing, Shanghai, and Guangzhou.

Kazakhstan views China as a possible alternative transit route especially if Russia isolates its Internet, but this would introduce challenges. The geographical distance to Europe would cause higher latency, and China's strict Internet controls could increase filtering-related delays and costs. Currently, Internet transit from China to Kazakhstan is minimal, requiring increased traffic flow before it can be a viable alternative to Russian transit.

Kazakh ISPs, such as KazakhTelecom, are now peering with transit providers in Hong Kong (China's main Internet hub), potentially making China a more attractive option. Additionally, the growing influence of Chinese content providers like AliCloud, ByteDance (TikTok), and Tencent may drive higher demand for Kazakhstan-China connectivity, further shaping the region's telecom landscape.

Nevertheless, China is increasingly interested in transiting its own traffic through Kazakhstan. Since the beginning of the 2000s it has tried to balance its international bandwidth between submarine cables and land connections for security reasons. Building trans-Eurasian fiber-optic links with Russia was part of this long-term goal. International sanctions against Russia have added new urgency to these goals, with Chinese ISPs again interested in investing in fiber links circumventing Russia towards Europe, adding redundancy and resiliency to the existing channels.

A Business Opportunity for Kazakh ISPs

As stated previously, Kazakh ISPs such as KazTransCom, Transtelecom, and KazakhTelecom are already earning revenue from Europe-Asia transit services. The new Trans-Caspian route to Azerbaijan has created new business opportunities, as some Europe-to-Asia bandwidth customers are reluctant to use Russian transit. In the near future, Kazakhstan could become a digital crossroad between Europe, East Asia, and South and Southeast Asia. The three main Kazakh backbone operators all operate multi-terabit Europe-to-Asia networks and are already gaining significant revenue from their cross-continental data transit operations.

According to Kazakh government data, in 2023, 5% of traffic between Europe and East Asia is transiting through land communication channels in 2023, with 3.5% directly crossing Russia, and 1.5% transiting through Kazakhstan. Astana wants to raise Kazakhstan's share of data traffic in this direction to 5% by

[41] Yang Jie (杨杰), "Connecting the Eurasian Information Corridor (贯通欧亚信息通道)", *People's Post and Telecommunications Daily*, 03 Sep. 2013.

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2027. In other words, Kazakhstan does not only wish to attract more traffic but also to compete with Russia in that domain, the geopolitical context brings business opportunities for Kazakh stakeholders.

Additionally, the Kazakh authorities are considering establishing domestic Internet traffic exchange points. This move aims to keep Internet traffic within the country's borders, avoiding the need for it to travel through international communication networks. This initiative suggests a growing focus on resilience and reduced reliance on international transit.

Satellite Internet: A Possible Alternative Encountering Limitations

Low Earth Orbit (LEO) satellites offer great promise in helping to connect the unconnected. They could be used to help bridge the digital divide in rural, un-served, and under-served regions, provide relief during natural or human disasters, and reduce infrastructure dependencies, improving Internet resiliency. At the same time, they could also introduce new security and privacy concerns.[42]

The Government of Kazakhstan has shared its "2027 Accessible Internet National Project" which, among other things, seeks to provide 95% of the country's households with high-speed Internet access and bring the Internet to 97% of rural residents. LEO satellites have been identified as a potential solution, with the government of Kazakhstan rolling out new connectivity projects. A partnership with Starlink seeks to connect rural schools[43], while a deal with Eutelsat-OneWeb, seeks to connect rural villages.[44] Most recently, Spacesail Kazakhstan Limited, a subsidiary of the Chinese low-earth orbit satellite provider Spacesail International Limited, was registered for operation in Kazakhstan.[45]

[42] "Perspectives on LEO Satellites—Using Low Earth Orbit Satellites for Internet Access." *Internet Society*, Nov. 2022, https://www.internetsociety.org/wp-content/uploads/2022/11/Perspectives-on-LEO-Satellites.pdf, accessed on 14 Mar. 2025.

[43] Kemelova, Fatima. "Starlink Expands Internet Coverage to 1,731 Schools in Kazakhstan." *The Astana Times*, 8 Aug. 2024, https://astanatimes.com/2024/08/starlink-expands-Internet-coverage-to-1731-schools-in-kazakhstan/, accessed on 14 Mar. 2025.

[44] Kemelova, Fatima. "Kazakhstan Tests Eutelsat-OneWeb to Expand Internet Coverage to Remote Areas." *The Astana Times*, 23 Oct. 2024, https://astanatimes.com/2024/10/kazakhstan-tests-eutelsat-oneweb-to-expand-internet-coverage-to-remote-areas/, accessed on 14 Mar. 2025.

[45] Zhazetova, Zhanel. "Chinese Rival of Starlink Enters Kazakhstan's Market." *Kursiv Media Kazakhstan*, Kursiv Media Kazakhstan, 22 Jan. 2025, https://kz.kursiv.media/en/2025-01-22/engk-tank-chinese-rival-of-starlink-enters-kazakhstans-market/, accessed on 14 Mar. 2025.

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The government of Kazakhstan has described these projects as trials and has emphasized that the use of these services by private citizens is illegal. Individuals found using Starlink using illegal equipment face fines.[46] Despite this, the black market for terminals and equipment has only grown.[47]

Due to the lack of ground stations within the territory of Kazakhstan, Starlink and other international private-sector LEO satellite providers exist outside of the content detection and moderation system developed by the government of Kazakhstan and implemented by domestic telecom providers. In addition to enforcement of content monitoring and blocking obligations, the government of Kazakhstan has shut down Internet access multiple times in recent years in the name of national security. The government of Kazakhstan would likely lack the levers needed to compel international providers like Starlink to comply with any future shutdowns.

In December 2024, an official order[48] from the Kazakh government imposed a total ban on the import into the territory of the Republic of Kazakhstan of certain types of telecommunications means of communication networks, for which the control center is located outside the Republic of Kazakhstan (this directly applies to Starlink-operated services in the country).

At the same time, the Internet Society has identified the domination of the LEO satellite Internet market by a small number of players as a concern. By licensing multiple satellite providers in all orbits (low earth, medium earth, and geostationary), the government of Kazakhstan can reduce monopoly effects and power imbalances. Recent reporting indicates that the government of Kazakhstan is already doing this by licensing services from multiple LEO satellite providers, including Amazon's Project Kuiper and Eutelsat OneWeb, and China's SpaceSail.

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[46] Pannier, Bruce. "Central Asia in Focus: Kazakh Authorities Send Mixed Signals on Using Spacex's Starlink." *Radio Free Europe/Radio Liberty*, 26 June 2024, https://about.rferl.org/article/central-asia-in-focus-kazakh-authorities-send-mixed-signals-on-using-spacexs-starlink/, accessed on 14 Mar. 2025.

[47] Einhorn, Bruce, et al. "Elon Musk's Starlink Terminals Are Falling into the Wrong Hands." *The Japan Times*, The Japan Times, 27 Mar. 2024, https://www.japantimes.co.jp/news/2024/03/26/world/politics/elon-musk-starlink-terminals/, accessed on 14 Mar. 2025.

[48] Import regulations, see: "О Некоторых Вопросах Регулирования Ввоза На Территорию Республики Казахстан Отдельных Видов Средств Телекоммуникаций Сетей Связи, Центр Управления Которых Расположен За Пределами Республики Казахстан." *Открытые НПА*, legalacts.egov.kz/npa/view?id=15333399. Accessed 31 Jan. 2025.

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Government Internet Control and Monitoring

The Internet Cut of January 2022: Implications

Following political unrest in the country over rising energy prices, authorities in Kazakhstan cut off access to the Internet starting at 11:00 UTC on 5 January 2022. The access appeared to be briefly and partly restored for a few hours each day before being cut again. As per the Internet Society Pulse Netloss Calculator, the outage continued until 11 January 2022 and cost the Kazakhstan economy over $32 million USD.[49]

During the January 2022 shutdown, Kcell and Beeline explained that authorities had taken actions over their network as a counter to alleged "terrorism activities." According to media reports, the Kazakh government first tried to use a Russian deep packet inspection (DPI) technology to precisely filter Internet resources, yet the attempt failed. They therefore resorted to a last-resort complete blockade of Internet access.[50]

According to The Diplomat, the week-long Internet shutdown of January 2022 may have led to a loss of up to $410 million for the Kazakh economy. Besides, amendments from 2014 and 2016 to communication laws now allow the Prosecutor General's Office to cut the Internet without a court decision and the National Security Committee picks government actors that can restrict Internet access and other communication services[51]. As Cloudflare reports, mobile traffic represents about 75% of total Internet traffic in Kazakhstan, leading to massive disruption when mobile traffic stopped in January.[52]

Different hypotheses can be explored to better understand how the Internet was shut down and what it means for the future development of communications in Kazakhstan. Cybersecurity expert Konstantin Korsun notes that blocking the Internet is more easily done if the exchange of international traffic is mostly handled by one carrier (monopolistic situation) or if the state has a monopoly over the communication sector.[53] Korsun points at KazakhTelecom and TransTelecom as such monopolists, providing broadband Internet access, interactive television, cellular communications, and local and

[49] Internet Shutdown in Kazakhstan, ISOC Pulse, https://pulse.internetsociety.org/shutdowns/kazakhstan-cuts-off-internet-access, accessed 02 Feb. 2025.

[50] Exclusive.kz, "The authorities tried to block the Internet with the help of DPI technology (Власти пытались заблокировать интернет с помощью технологии DPI)", (12/01/2022), https://www.exclusive.kz/expertiza/daily/127157/, accessed on 21 Nov. 2024.

[51] Catherine Putz, "Internet Shutdown Pushback in Kazakhstan", *The Diplomat*, 30/08/2023, https://thediplomat.com/2023/08/Internet-shutdown-pushback-in-kazakhstan/, accessed on 21 Nov. 2024.

[52] João Tomé, "Internet shut down in Kazakhstan amid unrest", *Cloudflare*, 07/01/2022, https://blog.cloudflare.com/Internet-shut-down-in-kazakhstan-amid-unrest/, accessed on 21 Nov. 2024.

[53] "В Казахстане Отключили Интернет: Может Ли Подобное Случиться в Украине." *ФОКУС*, 6 Jan. 2022, https://focus.ua/digital/502522-v-kazahstane-otkluchili-internet-mozhet-li-podobnoe-sluchitsya-v-ukraine, accessed on 21 Nov. 2024.

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long-distance telephone services. He adds that they could restrict access to the Internet using Deep Packet Inspection technology (DPI).

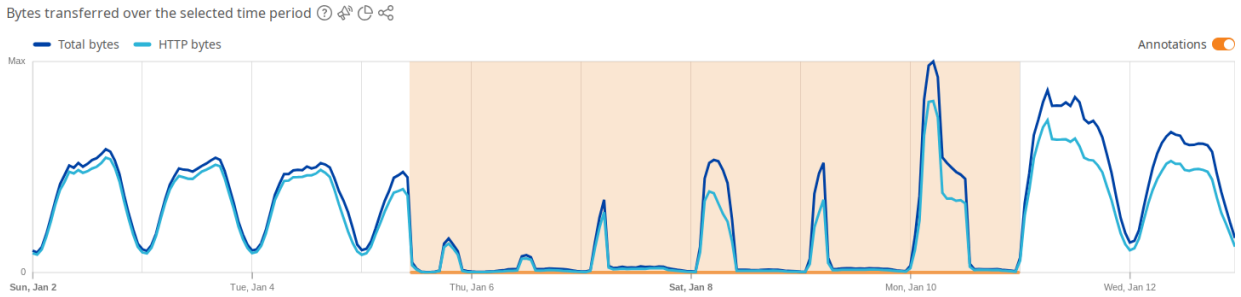

Figure 19. Cloudflare Traffic in Kazakhstan from 2 to 12 January 2022. (Source: Cloudflare Radar)

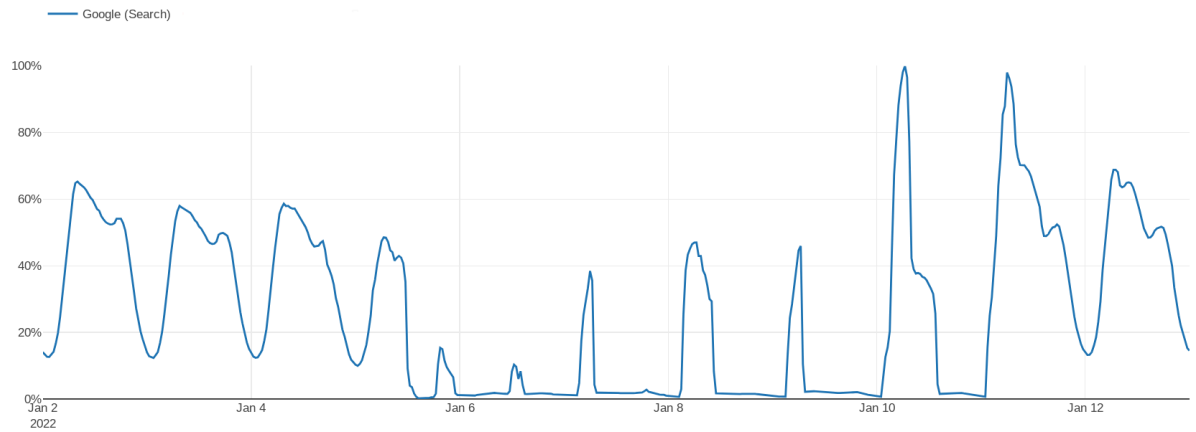

Figure 20. Google search traffic in Kazakhstan, 2 to 12 January 2022. (Source: Google transparency report)

We recommend that the government of Kazakhstan remove obligations to route traffic through the Unified Gateway to Internet Access. Decentralization of routing will increase Internet resiliency by removing single points of failure that could be misused for Internet shutdown purposes.

Encryption for Web Traffic: Machine-in-the-Middle Attacks

Encryption is the process of scrambling or enciphering information so it can be understood only by someone with the means to return it to its original state. It protects the confidentiality of stored or transmitted data by making it unintelligible so that even if a third party gains access to the data, it would not be able to make sense of it.

Over 95% of web traffic in the world is protected using the encryption protocol TLS (transport layer security). This protocol is what keeps Internet traffic safe and usable for citizens, protecting data as it is transmitted between a website and the user's browser. When browsing the web, the "S" in HTTPS lets Internet users know that the encryption protocol is being used.

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In previous years, the Kazakh government has made various efforts to bypass the protection offered by TLS using machine-in-the-middle (MITM) attacks. MITM attacks work by positioning the attacker, in this case the government authority, in between the two endpoints of an encrypted transmission. Criminals use this approach to intercept valuable data, for example, sensitive banking information, or to impersonate another party for the purpose of fraud or blackmail. Government-led MITM attacks could similarly intercept data for the purpose of surveillance, the monitoring of Internet user activities, or blocking users from accessing certain content on the Internet.

The government of Kazakhstan has developed root certificates, which it has periodically pressured Kazakhstani residents to install on their devices. Amendments to Kazakhstan's Law "On Communications" facilitated the creation of government root certificates,[54] and in late 2015, the government announced that all citizens should install the root certificate on their devices.[55] However, pressure from Internet users and businesses in Kazakhstan delayed the roll-out of the certificate.[56]

In 2019 the Internet Society issued a statement[57] in reaction to news[58] that the government of Kazakhstan was again coercing the users of Kazakh mobile operators to download government-issued root certificates on their mobile and desktop devices. As a result, the government could see, monitor, record, and even block interactions between Kazakh users and any website, including banks, email providers, social networks—and critical public services like electricity, elections, hospitals, and transportation.

Apple, Google, Microsoft, and Mozilla have responded to these events by blocking the use of the government root certificate within their browsers. In the case of Mozilla, this means that Internet users in Kazakhstan who have downloaded the certificate will face error messages notifying them that the certificate should not be trusted.[59]

OONI research identified that between 2021 and 2024, four distinct government root certificates and seven distinct intermediate certificates were deployed for MITM attacks. The root certificate was used

[54] *Internet Freedom—Kazakhstan*, https://ifkz.org/ru, accessed 31 Jan. 2025.

[55] "Kazakhtelecom JSC Notifies on Introduction of National Security Certificate from 1 January 2016." *Kazakhtelecom*, https://web.archive.org/web/20151202203337/telecom.kz/en/news/view/18729, accessed 31 Jan. 2025.

[56] "Kazakhstan Government Is Now Intercepting All HTTPS Traffic." *ZDNET*, https://www.zdnet.com/article/kazakhstan-government-is-now-intercepting-all-https-traffic/, accessed 31 Jan. 2025.

[57] "The Internet Society's Concerns on the Recent Government Action in Kazakhstan Regarding Encrypted Internet Traffic ." *Internet Society*, www.Internetsociety.org/news/statements/2019/Internet-society-concerns-kazakhstan-encryption/, accessed on 26 Nov. 2024.

[58] "Kazakhstan Government Is Now Intercepting All HTTPS Traffic." *ZDNET*, www.zdnet.com/article/kazakhstan-government-is-now-intercepting-all-https-traffic, accessed 31 Jan. 2025.

[59] "Continuing to Protect Our Users in Kazakhstan." *Mozilla: Open Policy & Advocacy*, 18 Dec. 2020, https://blog.mozilla.org/netpolicy/2020/12/18/kazakhstan-root-2020/, accessed on 29 Feb. 2024.

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to carry out MITM attacks on 19 different networks and 14 distinct domain names.[60] The large number of networks suggests that ISPs are highly compliant with government directives.

In February 2024, nongovernmental organization the Cyber Attacks and Analysis Center claimed that an allegedly Chinese state-sponsored espionage operation had gained full access to the critical infrastructure of Kazakhstani telecommunications operators, public service providers, and private companies in the country.[61] It is unclear to what extent Kazakhstani web browsing data intercepted by Kazakhstani telecom operators using the government root certificate may have been compromised during this time.

Kazakhstan's Geopolitical Connectivity Challenges and Opportunities

Kazakhstan faces ongoing geopolitical challenges in its immediate environment, with tensions in neighboring Russia and China shaping its international connectivity strategy. The uncertainty surrounding Russia's Internet policies, particularly the potential isolation of the Russian Internet through the sovereign RuNet initiative, could disrupt Kazakhstan's reliance on Russian transit routes. At the same time, while China offers an alternative, its strict Internet controls and filtering mechanisms introduce technical and political complexities. Given the potential for further regional instability, Kazakhstan must proactively diversify its connectivity options to maintain robust and resilient Internet access.

One of the key opportunities for Kazakhstan lies in increased global interest in Central Asia. With geopolitical shifts and supply chain realignments, international investors and tech companies are looking to expand their presence in the region. This provides an opportunity for Kazakhstan to attract foreign direct investment (FDI) into its digital infrastructure, improving network redundancy and resilience. Investment from global telecom providers, hyperscalers (such as AWS, Google Cloud, and Microsoft Azure), and IXPs could help Kazakhstan strengthen its Internet backbone while reducing dependency on a small number of transit providers. Similarly, the government should lower the barriers to entry for locally-grown cloud providers and encourage sound competition by diversifying the market.

Another significant opportunity is Kazakhstan's alignment with Azerbaijan and China's digital expansion strategies. Azerbaijan, which sits at a strategic crossroads between Europe, the Caucasus, and Central Asia, is actively expanding its fiber and transit capacity as part of the Middle Corridor. Closer

[60] Kabyshev, Yelzhan. "Kazakhstan: TLS MITM Attacks and Blocking of News Media, Human Rights, and Circumvention Tool Sites." *OONI,* https://ooni.org/post/2024-kazakhstan-report/, accessed on 21 Nov. 2024.

[61] "Хакерская Группировка Более 2 Лет Имела Полный Доступ к Критической It Инфраструктуре Казахстана—ЦАРКА." *Аналитический Интернет-Журнал Власть*, Интернет-журнал Власть, https://vlast.kz/novosti/59025-hakerskaa-gruppirovka-bolee-2-let-imela-polnyj-dostup-k-kriticeskoj-it-infrastrukture-kazahstana-carka.html, accessed on 21 Feb. 2024.

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cooperation with Azerbaijan could allow Kazakhstan to develop alternative routes to Europe that bypass Russia, improving network resilience. Similarly, China's growing role as a data transit hub offers Kazakhstan a potential eastward alternative, despite concerns over Internet filtering and geopolitical risks. By negotiating favorable transit agreements with China, Kazakhstan can benefit from improved access to Chinese content and cloud services, particularly as demand for platforms like AliCloud, ByteDance (TikTok), and Tencent grows in the region.

Finally, Kazakhstan should embrace emerging technologies such as low Earth orbit (LEO) satellite broadband to enhance connectivity in remote and underserved areas. Companies like Starlink, OneWeb, and China's Guowang are deploying LEO satellite networks, offering high-speed Internet access without relying on terrestrial fiber or traditional geostationary satellites. By partnering with satellite providers and facilitating regulatory approvals for LEO operations, Kazakhstan can rapidly expand broadband coverage in rural areas, reducing its digital divide and improving access to online services.

Recommendations for Improving Internet Access, Security, and Freedom in Kazakhstan

The following recommendations can help Kazakhstan improve its Internet resilience, expand access to underserved populations, and foster a more open and secure digital environment:

1. Strengthening Regional Cooperation: Kazakhstan should enhance regional cooperation to improve Internet resilience and diversify its connectivity options. One way to achieve this is by encouraging Kazakh network operators and other stakeholders to participate in forums such as the Central Asia Peering and Interconnection Forum (CAPIF). By improving coordination on international infrastructure projects, Kazakhstan and its neighbors can develop alternative routes to Europe and Asia, reducing dependency on any single transit provider.
2. Encouraging Alternative Connectivity Solutions: Given the geopolitical risks associated with heavy reliance on Russian transit networks, Kazakhstan must diversify its Internet routes. Investments in fiber-optic connections through Azerbaijan and the Caspian Sea should be prioritized. At the same time, Kazakh Internet users should consider satellite providers as a useful source of additional connection diversity, but overreliance on any single form of Internet transport has the potential to create single points of failure, surveillance, and control.
3. Connecting Remote Areas: Kazakhstan should continue to explore the potential of low Earth orbit (LEO) satellite Internet as a backup connectivity option, particularly in remote areas. While fiber remains the superior long-term solution due to its speed and reliability, LEO satellite Internet can provide temporary solutions for underserved communities and during emergency

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situations.

4. Enhancing Internet Security and Privacy: Kazakhstan must take steps to protect Internet users from surveillance and cyber threats. The government should formally discontinue its root certificate program, which has been used to intercept encrypted Internet traffic. This program undermines trust in online services and exposes users to security risks. Internet Service Providers (ISPs) and regulatory authorities should work together to restore public confidence by ensuring that user data remains private and secure. Additionally, encryption should be endorsed as a key component of national security, protecting users from cyberattacks and foreign espionage.
5. Promoting an Open and Competitive Market: Kazakhstan's Internet market remains highly concentrated, with KazakhTelecom playing a dominant role. To encourage competition, the government should implement policies that make it easier for new ISPs and content providers to enter the market. This includes reducing barriers to entry for international cloud providers and content distribution networks such as removing the requirement for majority local ownership to increase competition and open up the market.
6. Developing more Internet Exchange Points (IXPs): The Kazakh government should implement policies to promote greater participation in IXPs to enhance network resilience, reduce latency, and lower transit costs. This includes incentivizing all ISPs, content providers, and enterprises to peer at IXPs by ensuring a neutral, transparent, and competitive environment. Privatization or public-private partnerships for the government-owned IXP could encourage wider adoption. Additionally, investment in infrastructure such as in carrier-neutral data centers will help improve local traffic exchange, reducing reliance on costly international transit.
7. Preventing Internet Shutdowns and State Control Over Content: Government-led Internet shutdowns have had serious economic and social consequences. To ensure stability, the government should remove obligations that require ISPs to route traffic through the Unified Gateway to Internet Access, which acts as a centralized control mechanism. Instead, Kazakhstan should adopt policies that support an open and globally connected Internet, ensuring that businesses, media, and civil society can operate without disruptions.

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Conclusion

This report analyzes Kazakhstan's digital connectivity landscape, identifying potential infrastructure dependencies, the impact of government policy on Internet quality, and opportunities to address these challenges.

The digital connectivity landscape in Kazakhstan is largely robust though issues persist. Efforts to reform the telecom market and increase competition in the sector have been successful, but more work is needed to reduce market concentration further. KazakhTelecom, the incumbent, continues to play a central role at both the domestic and international connectivity levels.

Kazakhstan's connectivity to the global Internet is largely dependent on Russia, which could prove problematic if geopolitical relations between the two countries were ever to be strained. Efforts to reduce these dependencies are evident with government-backed initiatives to create new, diversified routes towards Europe. Such efforts are expected to increase Internet resiliency both for Kazakhstan and its downstream Central Asian neighbors including Kyrgyzstan, Tajikistan, and Uzbekistan.

Kazakhstan's telecom sector remains highly concentrated, dominated by KazakhTelecom (which also owns Kcell) and VEON (Beeline/TNS-Plus). Other players like Transtelecom and KazTransCom have some influence, but overall, market concentration is a concern. With only two major players controlling the majority of the market, competition is weak. This could lead to higher Internet prices and lower service quality, as consumers have few alternative providers. The government should provide incentives (tax breaks, grants) for new ISPs to enter the market and create a healthy and competitive ecosystem.

Furthermore, Russian content is heavily consumed by Internet users in Kazakhstan, solidifying consumer demand for connectivity to Russia. The development of local content over time would likely increase local consumption and increase the proportion of local traffic.

New Internet connectivity projects via the Caspian Sea seek to create alternative paths to Europe. Investment in the Europe-East Asia transit line would reduce dependencies on Russia and could also be lucrative for Kazakh ISPs in the long run as they would be able to extract transit revenue. Meanwhile, government trials of low-earth orbit satellite options offer short-term solutions to dependency concerns but should not be seen as a full substitute for terrestrial infrastructure in terms of quality and reliability.

Government interventions in recent years have damaged Internet trustworthiness and reliability. The use of root certificates to bypass website encryption risks putting Kazakh Internet users at risk. Internet shutdowns and heavy-handed content blocking harm Kazakh society, economy, and the global Internet infrastructure. It is vital that the Kazakh government supports the open, globally connected, secure, and trustworthy Internet to ensure that the Internet works for everyone in Kazakhstan.

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