May 2024

Internet Resilience and Efficiency in Central Asia

A review of and recommendations to improve infrastructure, security, and content hosting in the region

Internet Society

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Executive Summary

Central Asia has historically played an important role in connecting the world. Comprising Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan, the region is home to around 80 million people from diverse cultures, religions, languages, and economic backgrounds.

While the Caspian Sea borders some of these countries, it and the region are landlocked. This means all the region's Internet connectivity is provided by terrestrial fiber from neighboring countries Afghanistan, China, Iran, and Russia.

Given the questionable current and future status of the Internet in three of these four countries, Central Asia has quickly become an isolated road to nowhere and an equally important bastion to uphold the merits of an open, globally connected, secure, and trustworthy Internet.

In this report, we will examine the resilience profile of each country in the region using open data sources, most of which are collated and presented in Internet Society Pulse.

This includes examining each country's:

- Resource allocations, including the distribution and management of IPv4 and IPv6 addresses and Autonomous System Numbers (ASNs). The number of resources allocated to businesses and individuals in each country and the number announced in the routing table (that is, they are connected to the Internet) provide insight into the maturity of the Internet in a country.
- Cross-border terrestrial cable connectivity, based on ITU Broadband Maps data. Given that these countries rely solely on land-based telecommunications infrastructure (except for a very small percentage of satellite connectivity), these maps highlight each country's redundancy and the robustness of its broadband backbone.
- Routing security posture, including the implementation of Resource Public Key Infrastructure (RPKI), Route Origin Authorizations (ROA), and Route Origin Validation (ROV). These security frameworks are essential for preventing routing incidents such as hijacking or leaks and ensuring that only authorized and validated routes are used within the network.
- Reliance on internal and external hosts to serve its top 1,000 websites (based on the Tranco list). Hosting data closer to its end users means they can access it faster and, in many cases, more affordably, as they don't need to contribute to the cost of international transit. It can also help to continue to serve locally created and cached content if an outage or shutdown in a neighboring country compromises international Internet connectivity.

This analysis can help measure the impact of development in the region and guide where to focus further research and resources.

As you review the specifics of each country's Internet infrastructure, it is important to keep in mind the regional context—both the challenges and the opportunities—and the holistic nature of the Internet in that it should not necessarily be defined by national borders but a network or networks spanning the globe.

Central Asia Ranks Lowest for Resilience in Asia

A resilient Internet connection maintains an acceptable level of service despite faults and challenges to normal operation.

Unfortunately, not all countries have reliable Internet infrastructure. Low-income countries often have under-provisioned networks and lack robust cable infrastructure and redundant interconnection systems. The likelihood of Internet outages occurring is in these countries and regions is much higher than elsewhere.

The Internet Society tracks and indexes open-source Internet resiliency metrics using the Pulse Internet Resilience Index (IRI). Our overall measure of Internet resilience is based on the following pillars:

Infrastructure	Performance	Security	Market Readiness
The existence and availability of physical infrastructure that provides Internet connectivity.	The ability of the network to provide end-users with seamless and reliable access to Internet services.	The ability of the network to resist intentional or unintentional disruptions through the adoption of security technologies and best practices.	The ability of the market to self-regulate and provide affordable prices to end-users by maintaining a diverse and competitive market.

Central Asia's overall IRI score of 39% (Figure 1) is well below the overall average for Asia (46%) and the lowest of its neighboring sub-regions: Southern Asia (43%), Western Asia (47%), Eastern Asia (49%) and South-Eastern Asia (49%).

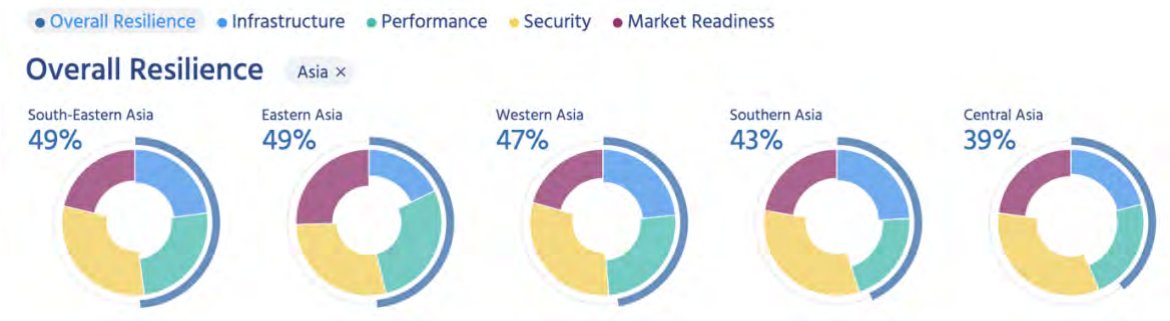

Figure 1 — Central Asia's overall Internet resilience ranks last among the five sub-regions in Asia Pulse Internet Resilience Index scores. Source: Internet Society Pulse.

Looking at each country in the sub-region (Figure 2), we can see a wide range of resilience, from 49% in Kazakhstan to 29% in Turkmenistan.

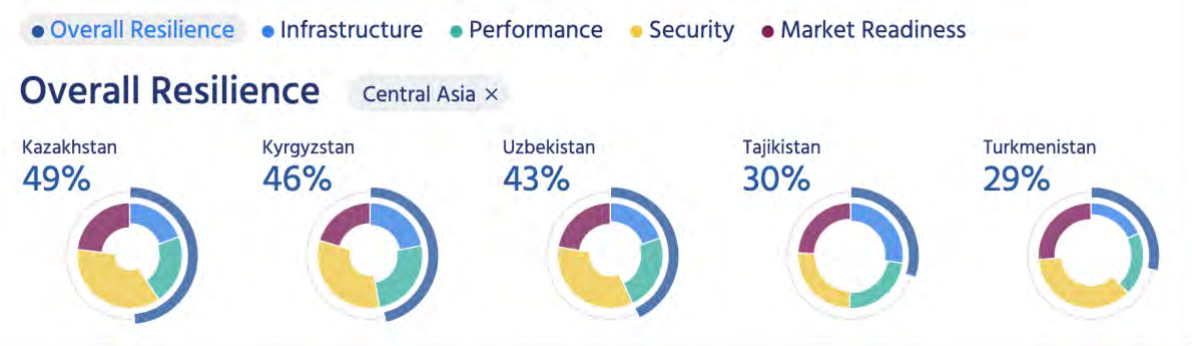

Figure 2 — The overall Internet Resilience Index score for each country in Central Asia. Source: Internet Society Pulse.

If we compare the scores for the pillars of each country (Figure 3), we can see that Turkmenistan's resiliency is consistently low across all areas. In the other countries, there have been varying degrees of effort to increase resilience, most notably security resilience, which is the number one ranking pillar for Kazakhstan (71%), Kyrgyzstan (60%), Tajikistan (60%), and Uzbekistan (42%).

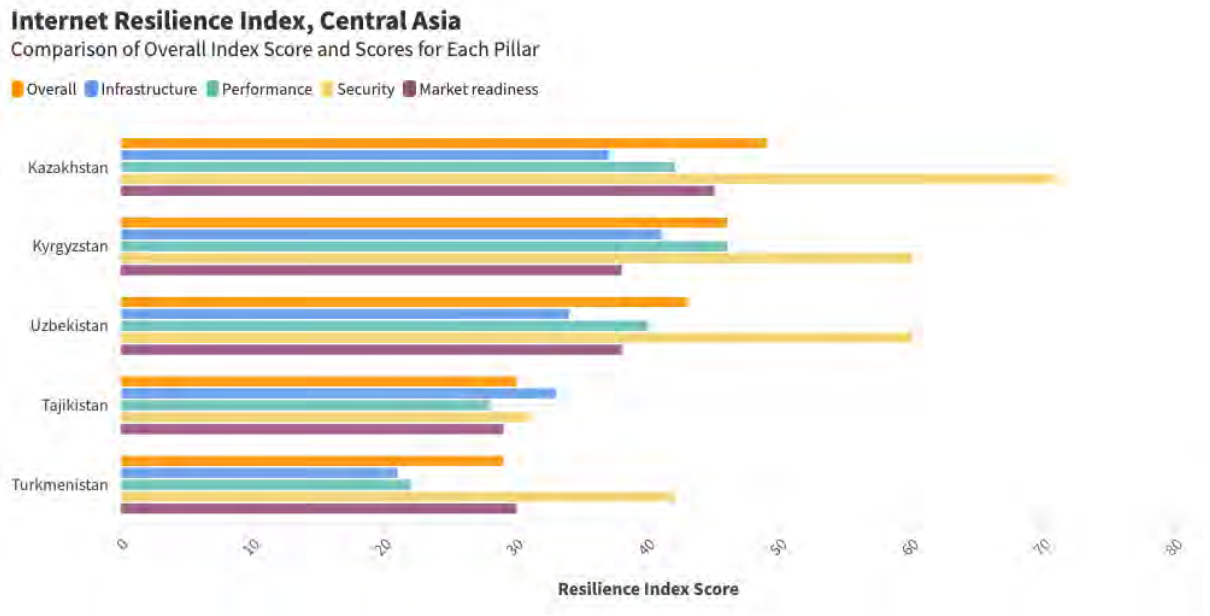

Figure 3 — A comparison of each country's overall Internet Resilience Index score and the individual scores for each of the four pillars contributing to the overall score. Source: Internet Society Pulse.

As mentioned, the region relies on Internet connectivity via several cable links to its neighbors, Afghanistan, China, Iran, and Russia (Figure 4).

Figure 4 — Broadband terrestrial map for Central Asia. Source: ITU

Three of these countries (China, Iran, and Russia) have been actively censoring and blocking access to the global Internet for decades, making them unviable. In effect, the connectivity they provide to Central Asia is or will be their own version of the Internet or, at the very least, limited.

Kazakhstan

Kazakhstan is the largest country in Central Asia by land mass and has the second largest population (around 19 million), of which 92% use the Internet.

Kazakhstan has the most developed Internet ecosystem and ranks highest in all three of the four IRI pillars out of the five countries in the region. Its overall IRI score of 49% is well above the subregional average of 39% and comparable with the average for Asia (46%).

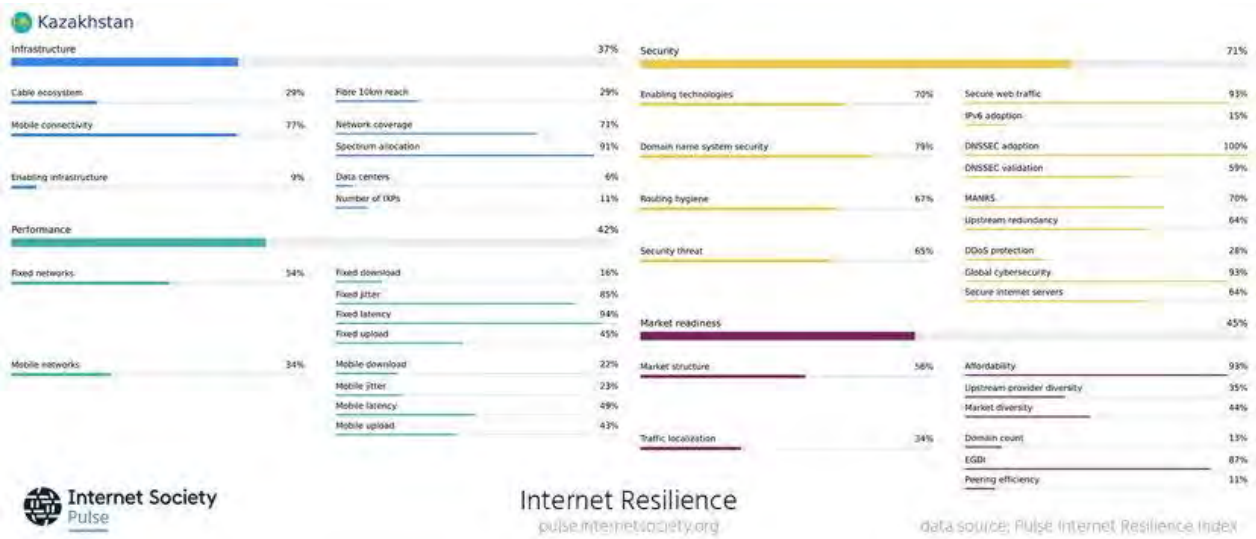

Figure 5 — The Pulse Internet Resilience Index profile for Kazakhstan. Source Internet Society Pulse.

Resource Allocation/Market Diversity

The market is dominated by providers such as Kazakh Telecom, Kcell, and Beeline. More than 200 ASNs (networks) are assigned to network operators in the country (Figure 5), but only 135 of them appear in the global routing table (Figure 6).

Figure 6 — The number of resources assigned to Kazakhstan. Source: Pulse Country Report.

Figure 7 — Of the 205 ASNs and the 3.3M IPv4 and 26M IPv6 addresses originating from the ASNs assigned to the country, only 135 ASNs are announcing 3,794 IPv4 and 339 IPv6 prefixes. IPv4 network addresses can have a prefix length between 1 and 32. IPv6 network addresses can have a prefix length between 1 and 128. Source: RIPEstat.

Terrestrial Cable

Being a landlocked country, it is not surprising that Kazakhstan has a robust terrestrial cable network (Figure 8) that forms the backbone of its telecommunications infrastructure. The country's strategic location has made it a key hub in the Eurasian Internet network, linking major networks between Europe and Asia.

The primary cable systems include the Trans Kazakhstan (TRANSKZ), which connects major cities across the country and extends to neighboring China and Russia and onward to Western Europe. This line is the backbone for regional connectivity and supports national and international data transit.

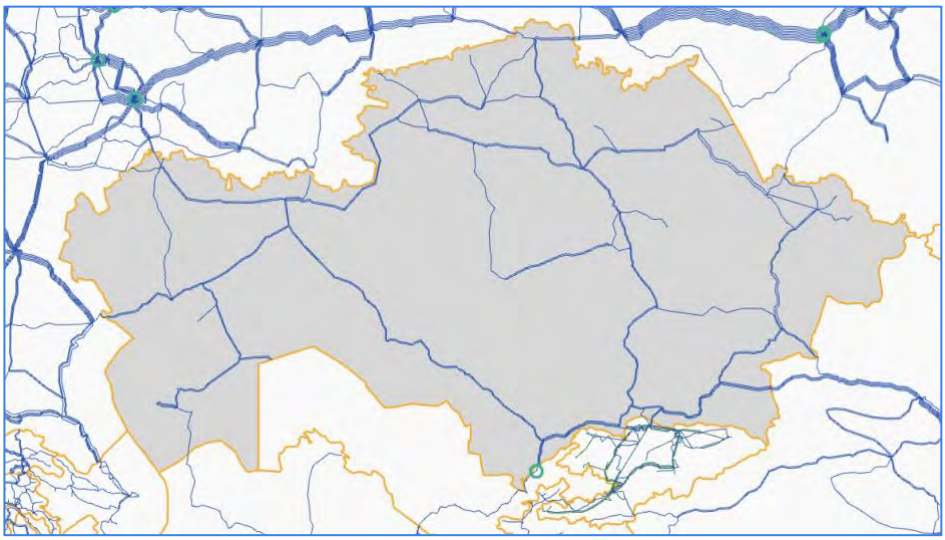

Figure 8 — The Trans Kazakhstan cable forms the country's main broadband backbone. Source: ITU.

Kazakhstan has several cross-border cable links with Russia and at least one link with China, Kyrgyzstan, Uzbekistan, and Turkmenistan.

RPKI ROA/ROV Coverage:

Kazakhstan has yet to make any progress in implementing RPKI to enhance the security and stability of its Internet routing. The total number of address spaces covered by valid ROA is very low, and few networks are doing ROV (Figure 8).

Figure 9 — Routing Security Adoption (15%) and Coverage (IPv4, 13% and IPv6, 63%) in Kazakhstan is below the Asia average (15%, 73%, and 73%, respectively). Source: Pulse Country Report.

Local/External Content

Figure 9 shows the distribution of local and external hosting by different content delivery providers (CDNs) for the country's top 1,000 domains (websites). We selected the top 1,000 domains from the Tranco country list and examined the Content Distribution Network (CDN) they are hosted at, the locations they are served from, and whether the content providers have a local presence.

It is promising to see that more than 50% of these domains are served locally, with Cloudflare providing most of the content.

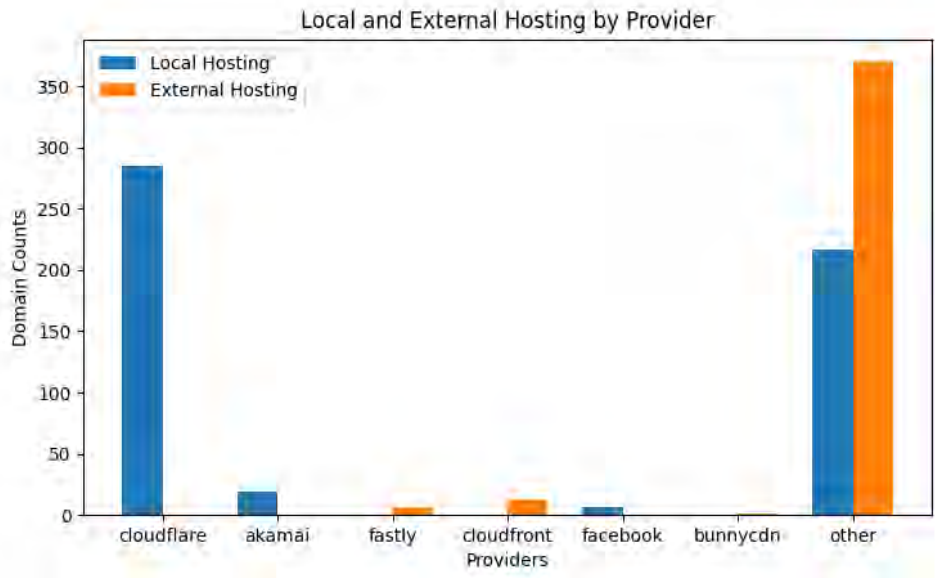

Figure 10 — The number of top 1,000 websites (domains) hosted by local (blue) and external (orange) providers. Data Source: Tranco.

Uzbekistan

Uzbekistan is the most populated country in Central Asia, with a population of almost 35 million. Nearly 80% of the population uses the Internet.

The overall Pulse IRI score for Uzbekistan (43%) is slightly above the overall average for Central Asia (39%) and just below the average for Asia (46%).

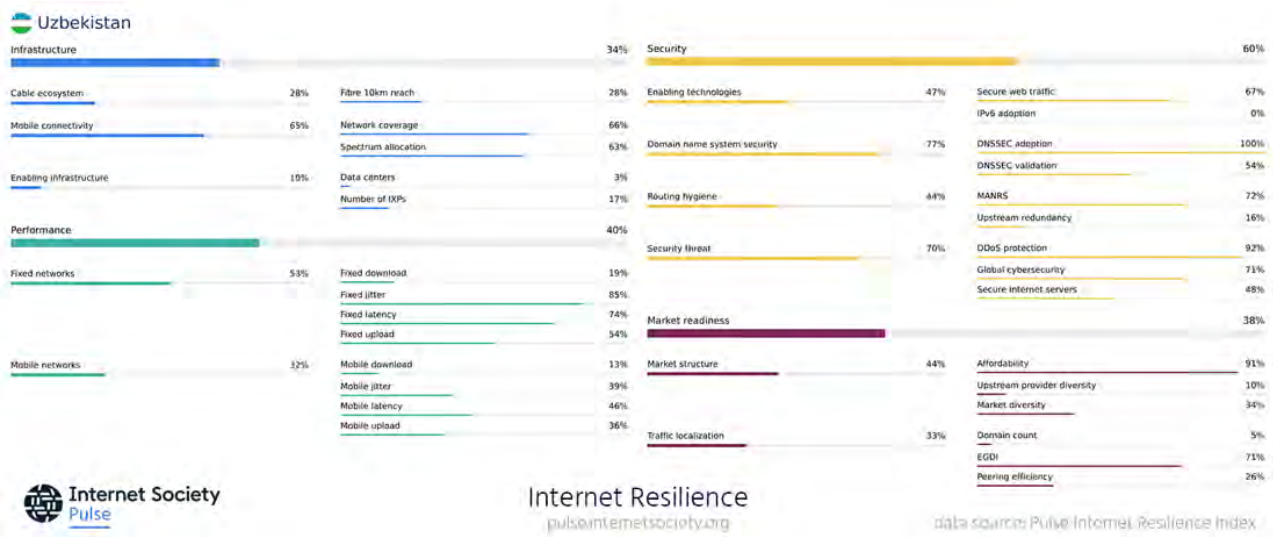

Figure 11 — The Pulse Internet Resilience Index profile for Uzbekistan. Source Internet Society Pulse.

It has the highest Infrastructure (34%) and Performance (40%) resilience of any country in the region, though fixed and mobile download and upload speeds rank very low in OOKLA's speed test.

Resource Allocation/Market Diversity

Despite its large population, Uzbekistan only has 56 active networks (out of 100 assigned networks) in the global routing table (Figure 11). Uztelecom and Ucell are the leading ISPs. The country's lack of ISPs contributes to its low upstream provider diversity index score (see Figure 10).

Figure 12 — The number of resources assigned to Uzbekistan. Source: Pulse Country Report.

Figure 13 — Of the 100 ASNs and the 278K IPv4 and 15M IPv6 addresses originating from the ASNs assigned to the country, only 56 ASNs are announcing 370 IPv4 and 33 IPv6 prefixes. Source: RIPEstat.

Terrestrial Cable

Figure 13 shows the grim reality of terrestrial cable infrastructure in Uzbekistan, with only one operational cable — Transit Europe-Asia (TEA) Terrestrial Cable Network — providing backbone and international connectivity for the country.

Figure 14 — The Transit Europe-Asia (TEA) Terrestrial Cable Network is the only cable transiting through Uzbekistan. Source: ITU.

Consequently, Uzbekistan has very low upstream provider diversity (10%) and peering efficiency (26%). This, along with the low number of local websites using country-code Top-Level Domain names (Domain Count, 5%), is severely impacting its overall Market Readiness IRI score (38%) (Figure 14).

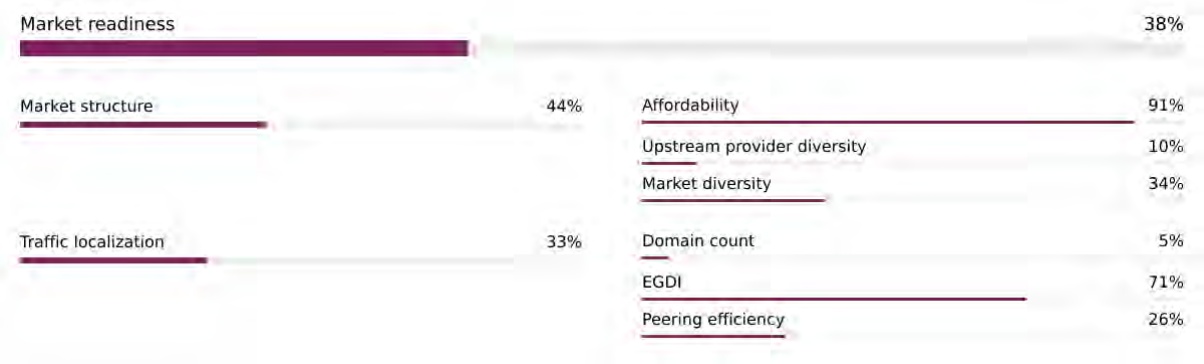

Figure 15 — Market readiness Internet resilience index profile for Uzbekistan. Source: Internet Society Pulse.

RPKI ROA/ROV Coverage

Compared to Kazakhstan, Uzbekistan has made slightly more progress in implementing RPKI to enhance the security and stability of its Internet routing. However, once again, with a small number of active networks, the total number of address spaces covered by valid ROA could easily be very high, but it is still below the regional average, and very few networks are doing ROV.

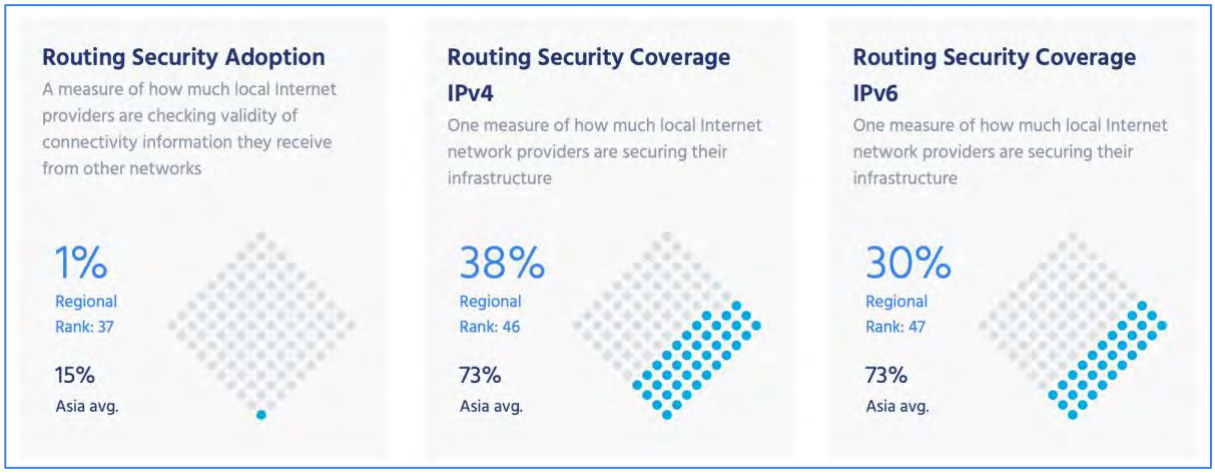

Figure 16 — Routing Security Adoption (1%) and Coverage (IPv4, 38% and IPv6, 30%) in Uzbekistan are well below the Asia average (15%, 73%, and 73%, respectively). Source: Pulse Country Report.

Local/External Content

Figure 16 shows that more than 75% of the top 1,000 most popular websites (domains) in Uzbekistan are served by external hosts (orange). Even though Cloudflare has a Point-of-Presence (PoP) in Tashkent, the traffic is re-routed to other PoPs for some reason.

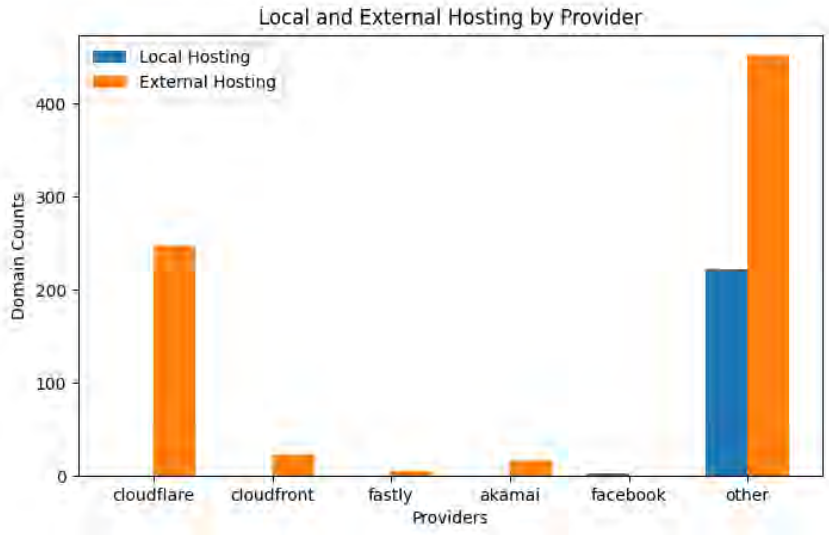

Figure 17 — The number of top 1,000 websites (domains) hosted by local (blue) and external (orange) providers. Data Source: Tranco.

Like Kazakhstan, Cloudflare's dominance shows the over-reliance on a single provider, which can be a potential risk if said provider ever has an outage.

Turkmenistan

Turkmenistan has one of the most restricted Internet environments in the region and, accordingly, has the lowest overall IRI score of the five countries (29%).

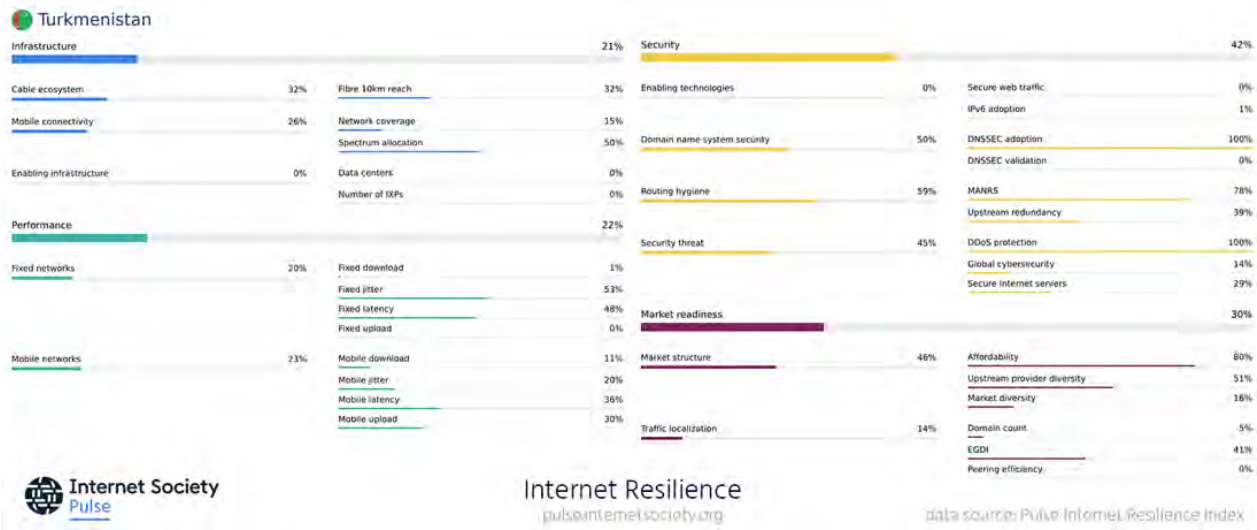

Figure 18 — The Pulse Internet Resilience Index profile for Turkmenistan. Source Internet Society Pulse.

With a limited number of network and telecom operators in the country, Internet penetration is very low — one in five people use the Internet. The state-owned Turkmentelecom is the primary provider, with limited competition.

Geographically, Turkmenistan's land size is compared to Uzbekistan, but it has 80% fewer residents, who are widely dispersed.

Resource Allocation/Market Diversity

Turkmenistan has five active networks in the global routing table (Figure 19). All networks are connected to Turkmentelecom for transit. This lack of upstream transit provider diversity significantly impacts the country's Market Readiness IRI score (30%).

Figure 19 — The number of resources assigned to Turkmenistan. Source: Pulse Country Report.

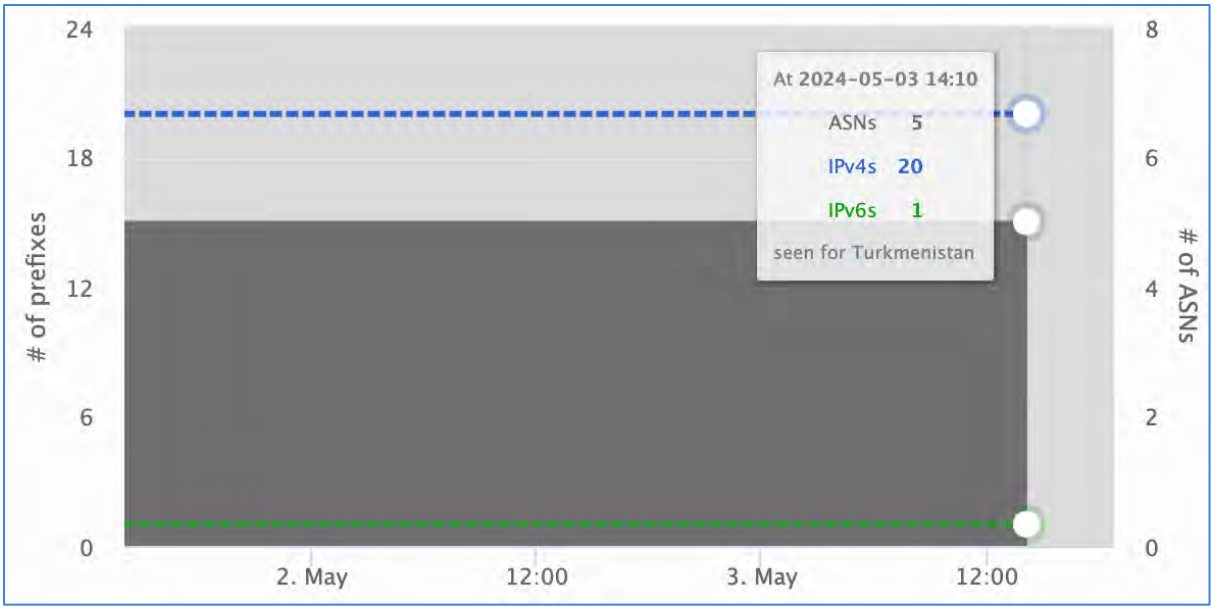

Figure 20 — Of the 7 ASNs and the 22K IPv4 and 1M IPv6 addresses originating from the ASNs assigned to the country, only 5 ASNs are announcing 20 IPv4 and 1 IPv6 prefix/es. Source: RIPEstat.

Terrestrial Cable

Figure 15 shows Turkmenistan's terrestrial connectivity. The Trans Asia-Europe Line connects Turkmenistan to Afghanistan, Iran, and Uzbekistan. **Turkmentelecom** and **Kazakhtelecom** installed a link to Kazakhstan as well.

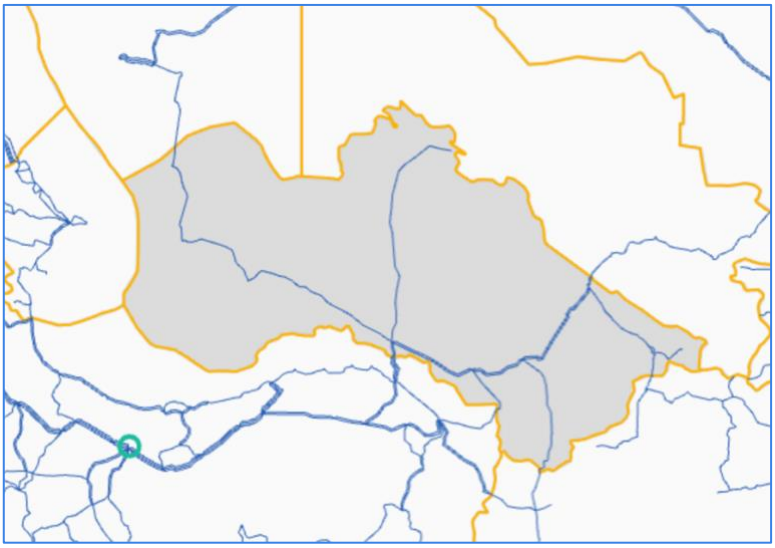

Figure 21 — Turkmenistan is connected to its neighboring countries via the Transit Europe-Asia (TEA) Terrestrial Cable Network and a link operated by Turkmen and Kazakh telecom. Source: ITU.

Turkmenistan does have a shoreline on the Caspian Sea, but, unfortunately, there is no submarine cable (or underwater cable, as the Caspian Sea is not an actual sea). There have been ongoing discussions about an Azerbaijan-Turkmenistan underwater cable, but nothing is in production.

RPKI ROA/ROV Coverage

Given Turkmenistan's small number of active networks, the total number of address spaces covered by valid ROA is very high (88% for IPv4 and 100% for IPv6 address space), and ROV adoption is 94%, among the highest in the world!

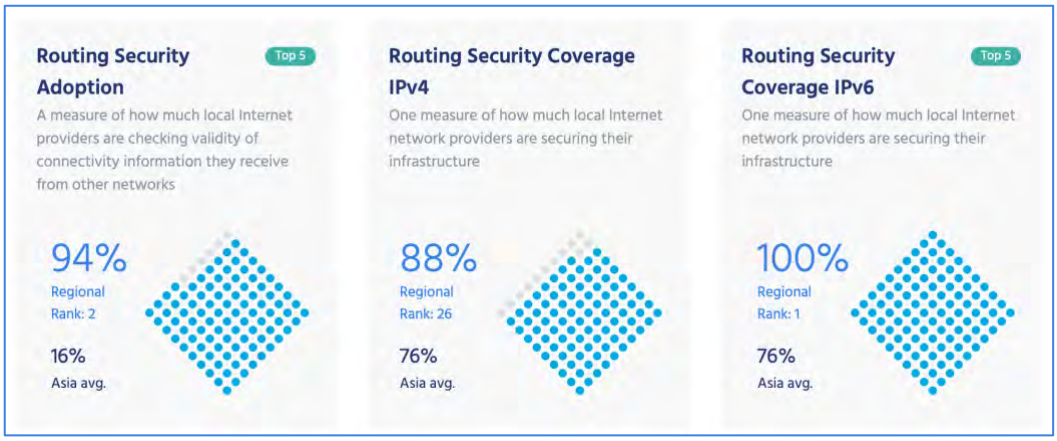

Figure 22 — Routing Security Adoption (94%) and Coverage (IPv4, 88% and IPv6, 100%) in Turkmenistan are well above the Asia average (15%, 73%, and 73%, respectively). Source: Pulse Country Report.

Local/External Content

Figure 22 shows Turkmenistan's extraordinary reliance on cross-border connectivity to serve content for more than 85% of the country's top 1,000 most popular websites (domains).

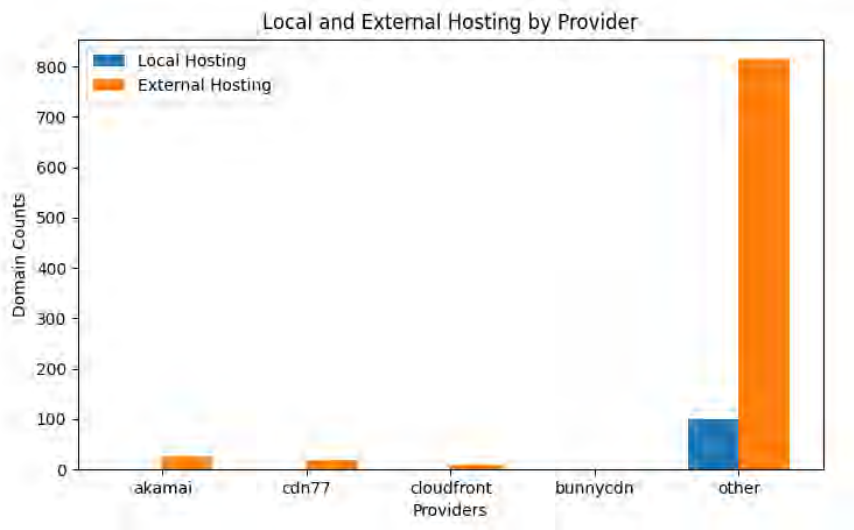

Figure 23 — The number of top 1,000 websites (domains) hosted by local (blue) and external (orange) providers. Data Source: Tranco.

The small portion of content being served locally shows that there is infrastructure available, but it is either not used properly or is not competitive enough to encourage local businesses to host content locally.

Kyrgyzstan

Kyrgyzstan is situated between China, Kazakhstan, Tajikistan, and Uzbekistan and has strategically worked on extending its terrestrial cable networks to connect with its neighboring countries. Because of this, it has one of the highest Infrastructure IRI scores (45%) compared to other Central Asian countries.

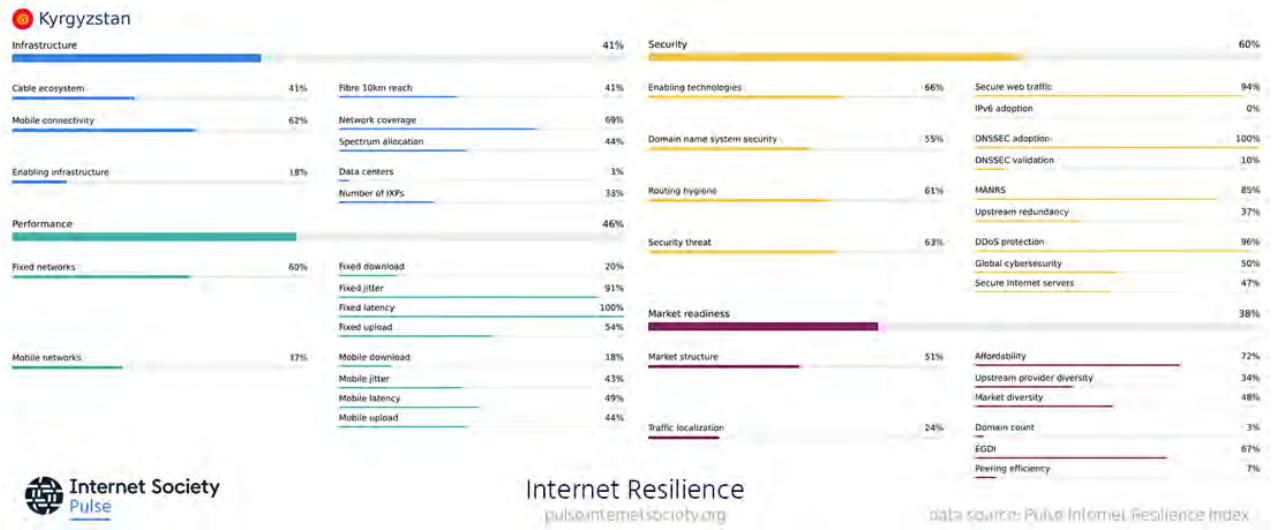

Figure 24 — The Pulse Internet Resilience Index profile for Kyrgyzstan. Source Internet Society Pulse.

Resource Allocation/Market Diversity:

Roughly 80% of Kyrgyzstan's 7 million people use the Internet. Even though it has a population similar to Turkmenistan's, it has more than six times more networks assigned (Figure 24), of which more than half (n=38) are announced on the global routing table (Figure 25).

Figure 25 — The number of resources assigned to Kyrgyzstan. Source: Pulse Country Report.

Figure 26 — Of the 62 ASNs and the 267K IPv4 and 6.4M IPv6 addresses originating from the ASNs assigned to the country, only 38 ASNs are announcing 385 IPv4 and 10 IPv6 prefixes. Source: RIPEstat.

Terrestrial Cable:

Kyrgyzstan is linked to the Trans Asia-Europe Line via a ring connecting Kazakhstan, Tajikistan, and Uzbekistan (Figure 26). Local ISPs operate other cables connecting China, Kazakhstan, Tajikistan, and Uzbekistan.

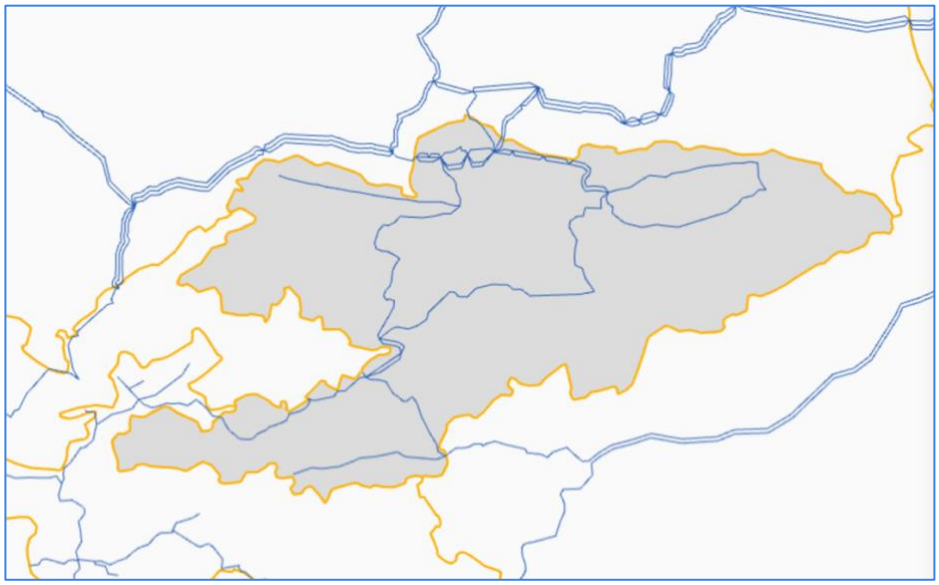

Figure 27 — Kyrgyzstan has several terrestrial connections to its neighboring countries, including via the Transit Europe-Asia (TEA) Terrestrial Cable Network and several locally operated links with China, Tajikistan, Uzbekistan and Kazakhstan. Source: ITU.

RPKI ROA/ROV Coverage:

With a decent number of active networks in the country compared to its neighboring countries, the total number of address spaces covered by valid ROA is relatively high (87% for IPv4 and 100% for IPv6 address space). However, ROV adoption is nonexistent (Figure 27).

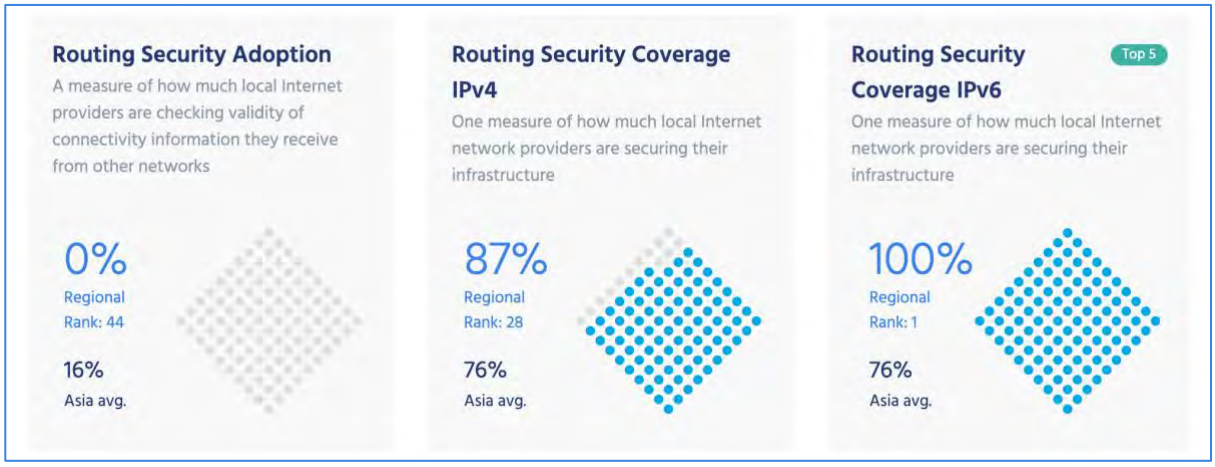

Figure 28 — Routing Security Adoption (0%) and Coverage (IPv4, 87% and IPv6, 100%) in Kyrgyzstan are well below and above the Asia average (15%, 73%, and 73%, respectively). Source: Pulse Country Report.

Local/External Content

Like Turkmenistan, Kyrgyzstan also relies heavily on cross-border connectivity, given that more than 80% of its top 1,000 most popular websites (domains) are hosted outside the country (orange). Again, the locally served content shows that local businesses can host their content locally.

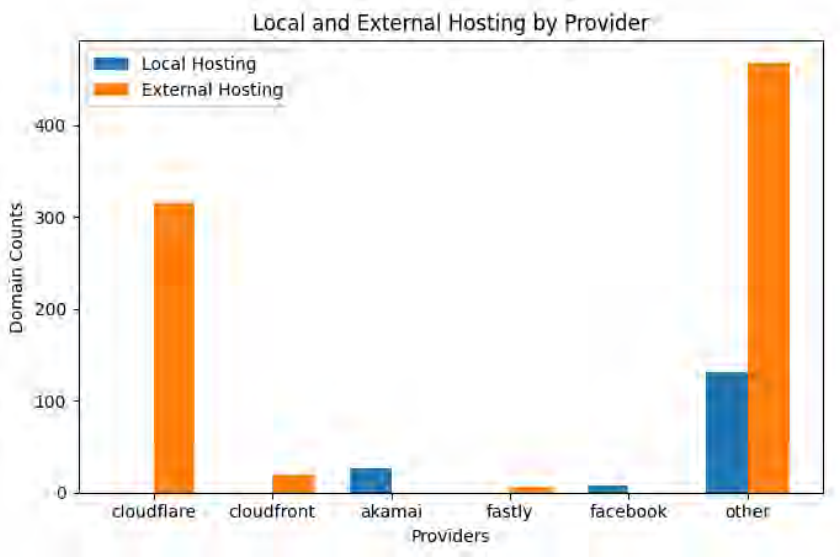

Figure 29 — The number of top 1,000 websites (domains) hosted by local (blue) and external (orange) providers. Data Source: Tranco.

Tajikistan

Tajikistan's Internet infrastructure faces several challenges due to its geographic constraints. Its largely mountainous terrain makes deploying and maintaining telecommunications infrastructure difficult and expensive.

It is the smallest country in Cental Asia regarding land mass but has a larger population than its neighbor, Kyrgyzstan. Around 22% of its 10 million population uses the Internet.

Figure 30 29 — Terrestrial map of Tajikistan. Source: Google Maps.

Despite these challenges, the country's overall IRI score (30%) is slightly better than Turkmenistan's (29%).

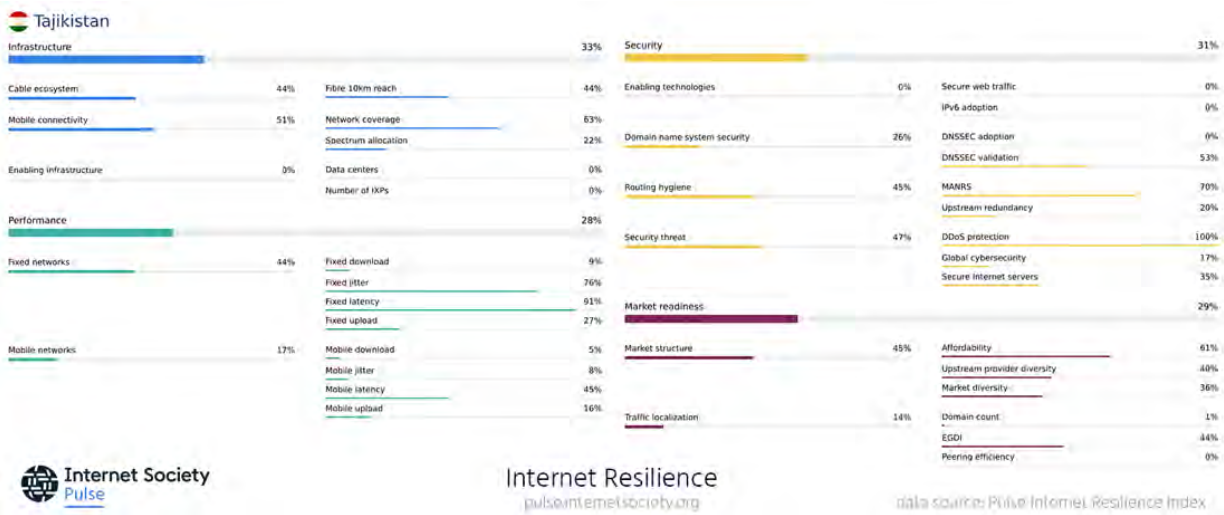

Figure 31 — The Pulse Internet Resilience Index profile for Tajikistan. Source Internet Society Pulse.

Resource Allocation/Market Diversity

Tajikistan also has a small number of active networks (22 out of 31), showing that its market for Internet services is small and somewhat saturated with a few dominant players. Major ISPs in the country are Tajik Telecom, Babilon Mobile, and Tcell. Due to the challenging terrain, each mainly focuses on mobile broadband instead of fiber broadband.

Figure 32 — The number of resources assigned to Tajikistan. Source: Pulse Country Report.

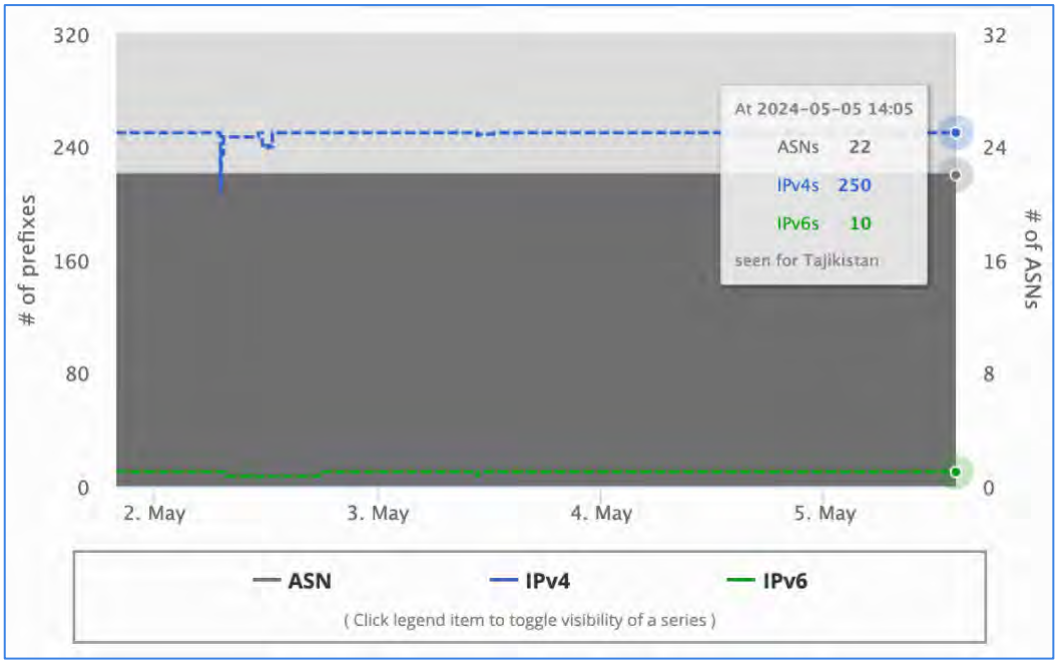

Figure 33 — Of the 31 ASNs and the 82K IPv4 and 5.4M IPv6 addresses originating from the ASNs assigned to the country, only 22 ASNs are announcing 250 IPv4 and 10 IPv6 prefixes. Source: RIPEstat.

Terrestrial Cable

Tajikistan has cross-border fiber optic links with Afghanistan, Kyrgyzstan, and Uzbekistan. Despite the challenging terrain and economic hurdles, the country has, to some degree, developed a decent terrestrial network of cables, achieving a certain level of resilience.

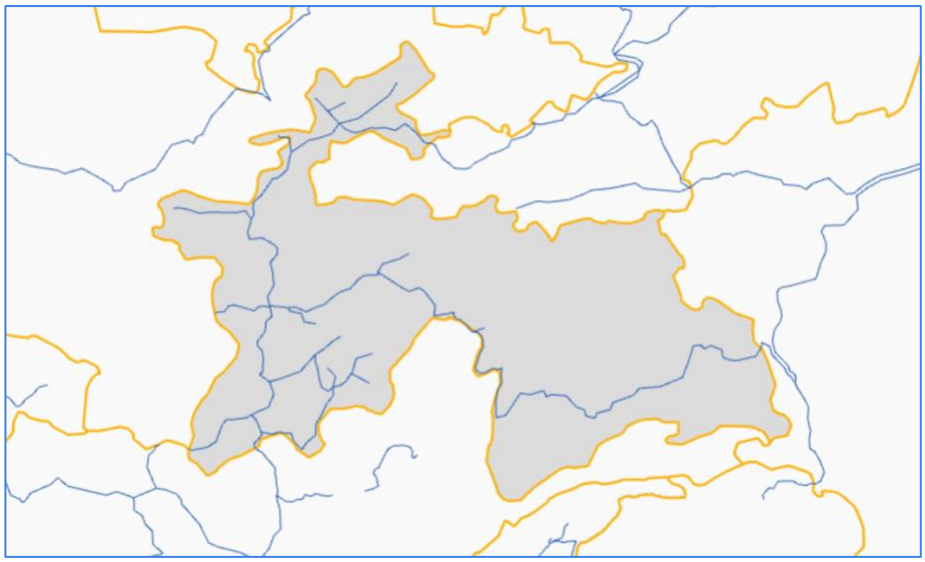

Figure 34 — OJSC Tajik Telecom operates several terrestrial cables connecting to its neighboring countries, Afghanistan, China, Kyrgyzstan, and Uzbekistan. Source: ITU.

RPKI ROA/ROV Coverage

With 22 active networks operators in the country, the total number of address space covered by valid ROA is very low (14% for IPv4 and 6% for IPv6 address space). Route Origin Validation adoption is 1%.

Figure 35 — Routing Security Adoption (1%) and Coverage (IPv4, 14% and IPv6, 6%) in Tajikistan are well below the Asia average (15%, 73%, and 73%, respectively). Source: Pulse Country Report.

Local/External Content

Like Turkmenistan and Kyrgyzstan, Tajikistan relies heavily on cross-border connectivity. More than 90% of its top 1,000 most popular websites (domains) are hosted outside the country.

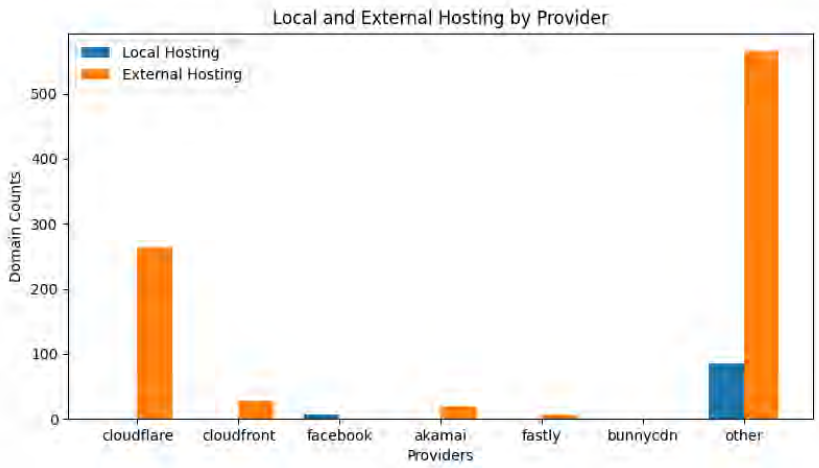

Figure 36 — The number of top 1,000 websites (domains) hosted by local (blue) and external (orange) providers. Data Source: Tranco.

Central Asia's Overall Infrastructure Resilience Challenges

Central Asia's geographical challenges make developing its terrestrial cable network infrastructure difficult. Major neighbors border the region — Russia to the north, China to the east, and Afghanistan and Iran to the south — and the Caspian Sea provides a natural boundary with Eastern European countries.

From the perspective of terrestrial cable resiliency, each Central Asian country has undertaken basic measures to establish connections with all its neighboring countries and participate in the Trans-European cable networks. However, the following challenges complicate these efforts:

- **Difficult Terrain**: Much of Central Asia is characterized by rugged landscapes, including significant mountain ranges like the Tien Shan and Pamir. This terrain complicates the laying and maintenance of terrestrial cables, increasing costs and technical challenges.
- **Landlocked Geography**: The lack of direct access to seas/oceans, besides the inland Caspian Sea, makes it impossible to connect directly to submarine cables, which are crucial for high-capacity, international bandwidth. As a result, these countries rely solely on terrestrial links that are often longer and more vulnerable to political and physical disruptions.
- **Long Distances**: The large distances between major urban centers within these countries and across the region also create significant challenges. Building infrastructure over such distances requires substantial investment and coordination.
- **Political and Economic Instability**: Political and economic issues can impede infrastructure development. Investment in telecommunications infrastructure often requires stable political conditions and economic predictability, which can be lacking in some areas of Central Asia.

- **Security Concerns**: Central Asia's proximity to neighbors that some global entities might not consider trustworthy for data sharing can pose significant challenges in providing secure and reliable Internet services. Concerns about data privacy and the risk of cyber threats may necessitate additional security measures and protocols when establishing and managing cross-border data flows, which may add more hurdles to seamless connectivity.

The landlocked nature of Central Asian countries significantly contributes to lower Internet speeds and higher transit costs, affecting Internet adoption and usage rates in the region. Since approximately 95% of global Internet traffic is carried by submarine cables and not having access to submarine cables puts heavy reliance on terrestrial cables, which often traverse long distances and multiple borders, increasing the potential for higher latency and additional costs associated with securing transit agreements. These factors combined can deter widespread Internet use and slow digital development.

Recommendations

It's challenging to identify any single factor that could enhance the resilience of infrastructure (and reduce the cost of Internet services) in any of the countries or region collectively. Instead, multiple strategies need to be considered, including:

- **Local Traffic Sharing**: One proven and important strategy to reduce Internet costs, increase reliability, and decrease latency is to maximize the sharing of local traffic within the same country or region. Traffic originating and destined within a country should never cross international borders. This is only possible by establishing Internet Exchange Points (IXPs) in each country in the region. IXPs can significantly reduce costs and improve reliability by facilitating more efficient local data exchange.
- **Cross-Border Data Sharing**: To improve Internet sustainability and reliability, transparent and inclusive policies for cross-border data sharing must be developed. Such policies should prioritize direct data exchange with neighboring countries, which is typically more cost-effective than routing traffic through multiple countries. This approach not only reduces transit costs but also improves the resilience and speed of connections.
- **Encouraging Local Data Hosting**: Promoting data hosting locally is another effective method to keep Internet costs low. Traffic can be confined locally by ensuring that content and services consumed within a country are hosted within the same country or at least within the region. This reduces the reliance on international bandwidth and decreases costs while improving access speeds.
- **Building Local Content and Infrastructure**: Alongside encouraging local data hosting, developing infrastructure to support local content creators and service providers is critical. This is an after-effect of having robust local peering and data-sharing infrastructure. This infrastructure can include data centers, cloud services, and content delivery networks that

are physically closer to the users within the region, thus enhancing the overall user experience and fostering the digital economy.

- **Government and Regulatory Support**: Governmental support and appropriate regulatory frameworks are necessary to facilitate these initiatives. Policies encouraging investment in telecommunications infrastructure support establishing and operating IXPs and incentivize local data hosting. These can significantly increase the resiliency of the country's infrastructure and drive down costs for providing essential Internet services.

Low-earth Orbit (LEO), Medium-Earth Orbit (MEO), and Geostationary Orbit (GEO) Internet satellite services such as HughesNet, Intelsat, O3b, OneWeb, Project Kuiper, and Starlink continue to increase availability in Central Asia. Though licenses have not been granted in all countries, satellite connectivity presents an alternative to fiber connectivity in the region, especially as prices continue to fall. However, it should be seen more so for redundancy reasons, with more emphasis on local infrastructure.

Ultimately, more investment in locally hosted content and Internet service infrastructure in Central Asia will help mitigate the challenges it currently and potentially faces as its neighboring countries disassociate themselves from the global Internet.

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