



RIPE NCC

RIPE NETWORK COORDINATION CENTRE

Interconnectivity in Central Asia

2 years later

Alex Semenyaka | September 2024 | CAPIF 3



History

Then and now



- 2 years ago, in 2022, I already did this research
- I have presented the result on CAPIF-1
 - https://www.ripe.net/participate/forms/uploads/fobi_plugins/file/capif-1-presentation-upload/Interconnection%20in%20Central%20Asia%20-%20CAPIF%201_992d2182-cec4-481c-bb3a-998d5ccf0677.pdf
- This year, I repeated the research using the same methodology
 - Additionally, this time, results will be correlated with RIS data
- I am going now to present the new results and to make a comparison with what we saw 2 years ago



RIPE Atlas and RIS



What is RIPE Atlas?

RIPE Atlas is the RIPE NCC's main Internet data collection system. It is a global network of devices, called probes and anchors, that actively measure Internet connectivity. Anyone can access this data via Internet traffic maps, streaming data visualisations, and an API. RIPE Atlas users can also perform customised measurements to gain valuable data about their own networks.

Traceroute

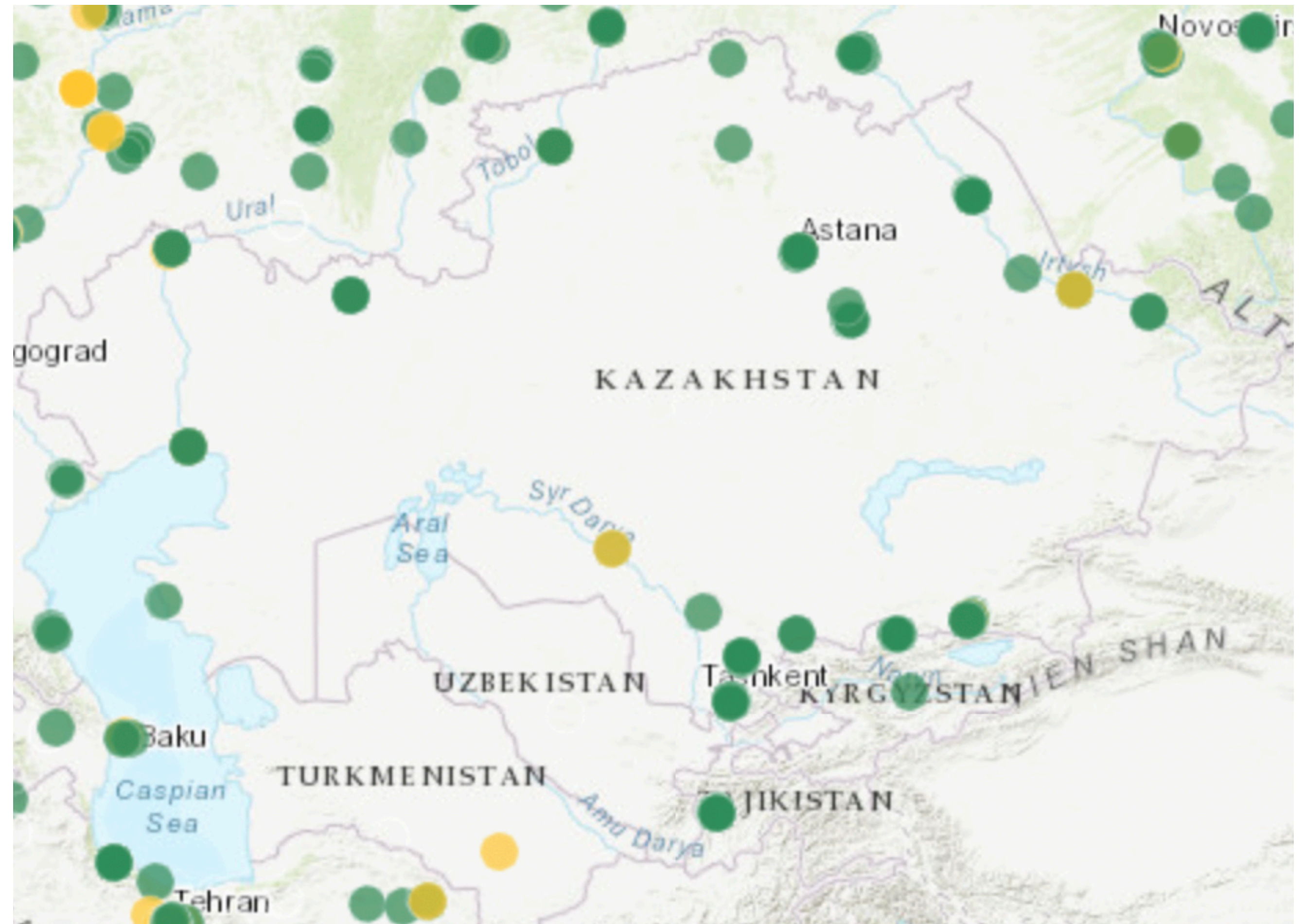


- Traceroute:
 - sends packets with increasing time-to-live/hop limit
 - analyses responses received from intermediate routers
 - returns their addresses and the time interval between sending the original packet and receiving the response
- RIPE Atlas traceroute
 - one of the basic measurement options in the RIPE Atlas system
 - is of “Paris” modification
 - originates UDP, TCP, ICMP packets on choice

RIPE Atlas probes in the region



- We have 90 probes in 4 countries (were 91 in 2022):
 - Kazakhstan: 53 (63 in 2022)
 - Kyrgyzstan: 8 (6 in 2022)
 - Tajikistan: 8 (9 in 2022)
 - Uzbekistan: 21 (13 in 2022)
- We can augment this set with some hosts from Turkmenistan
 - And get some results for this country too





Routing Information Service (RIS)



RIS is a routing data collection platform. It collects data on BGP, the protocol by which traffic is routed between networks on the Internet. By collecting this data, RIS improves our understanding of the global Internet routing system.

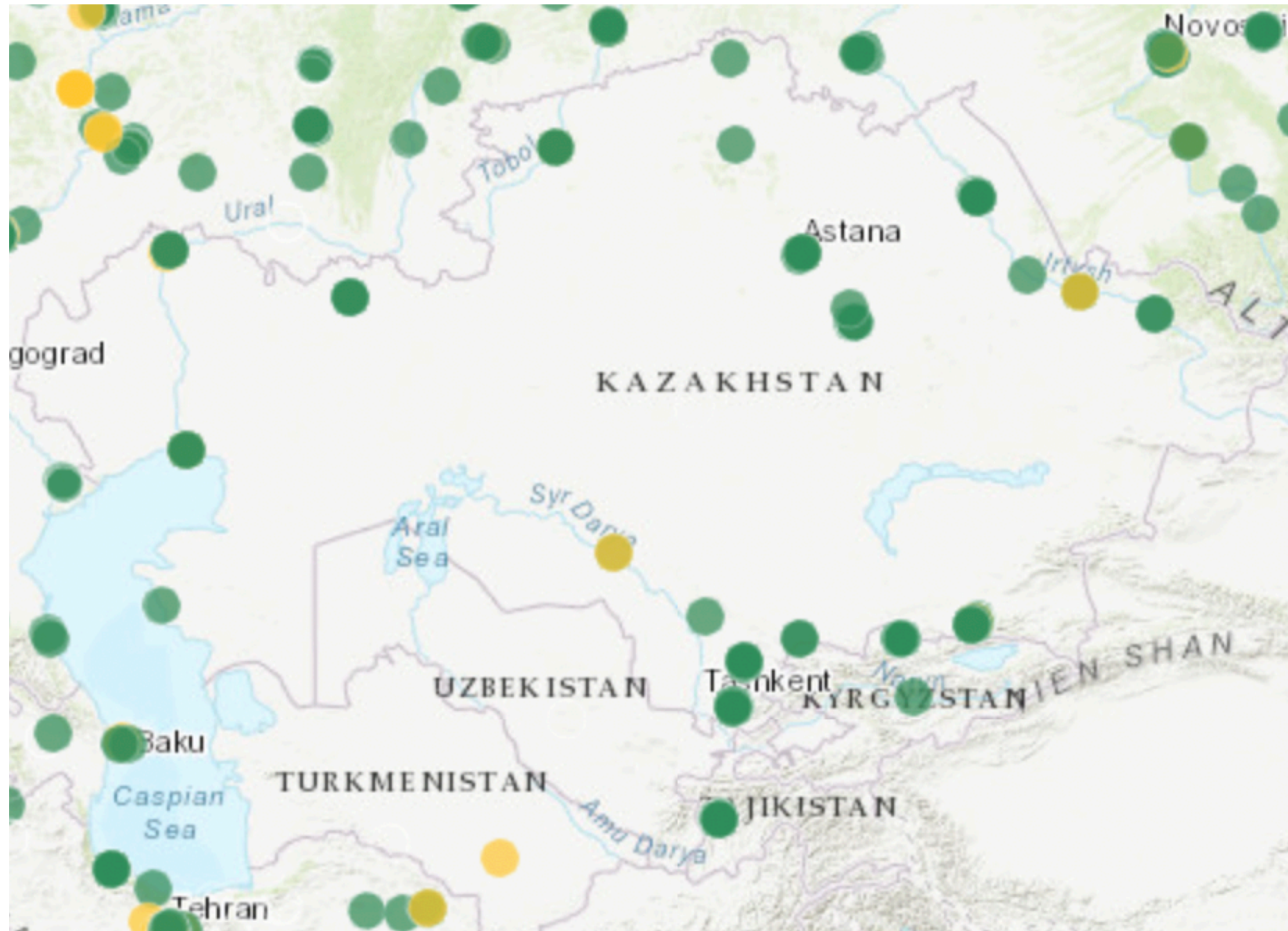
The Internet routing system has no built-in security mechanisms, so it's important to collect data to make this system observable and ultimately more secure. That's where RIS comes in. By collecting and displaying routing data, RIS lays bare the routing system, exposing malicious actors and allowing operators to identify and address security risks.

RIS also actively participates in the Internet routing system by periodically announcing and retracting Internet resources (using so-called "beacons") to collect even more data about the routing behaviour of different networks on the Internet.



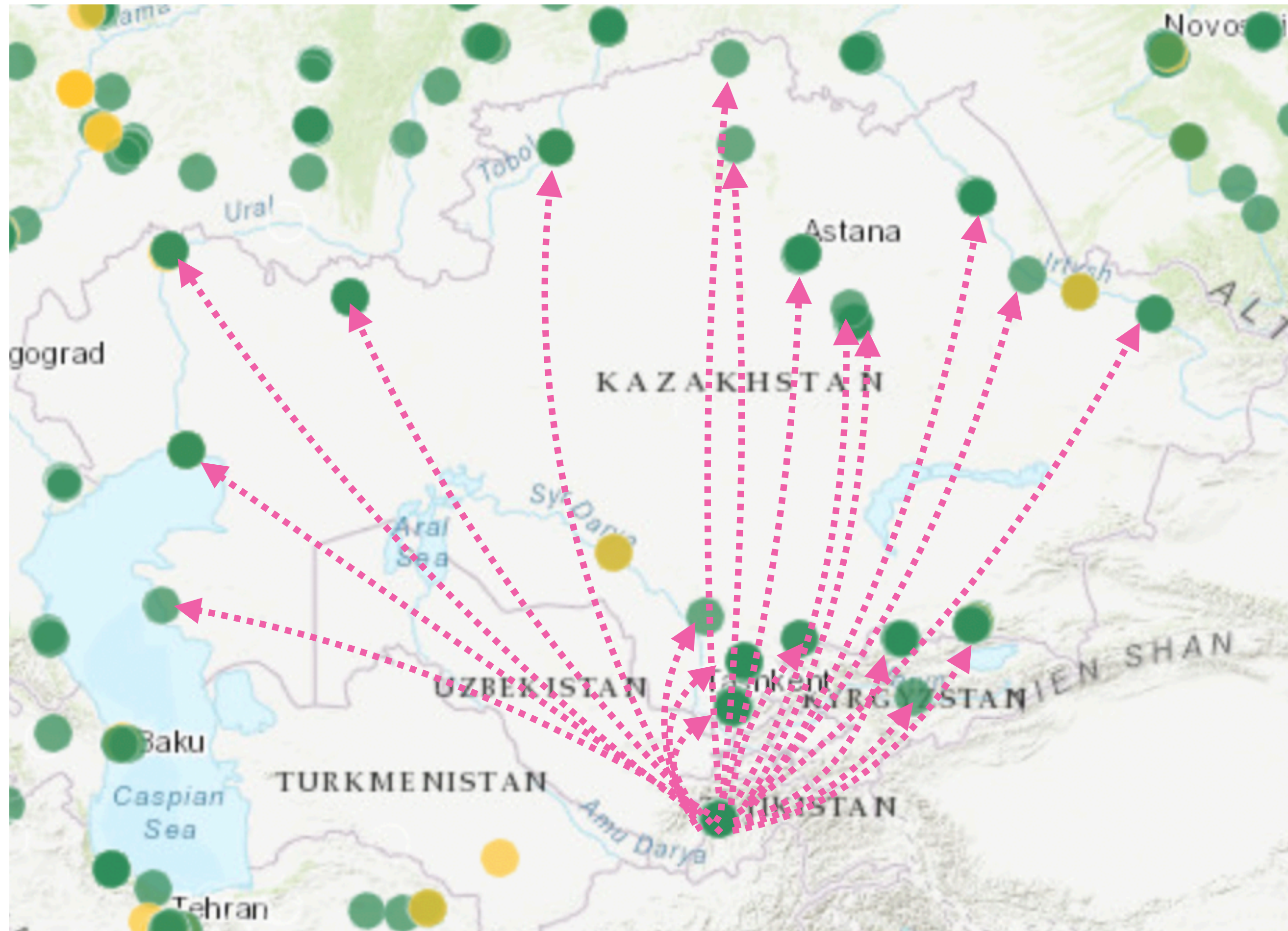
Methodology

What we do



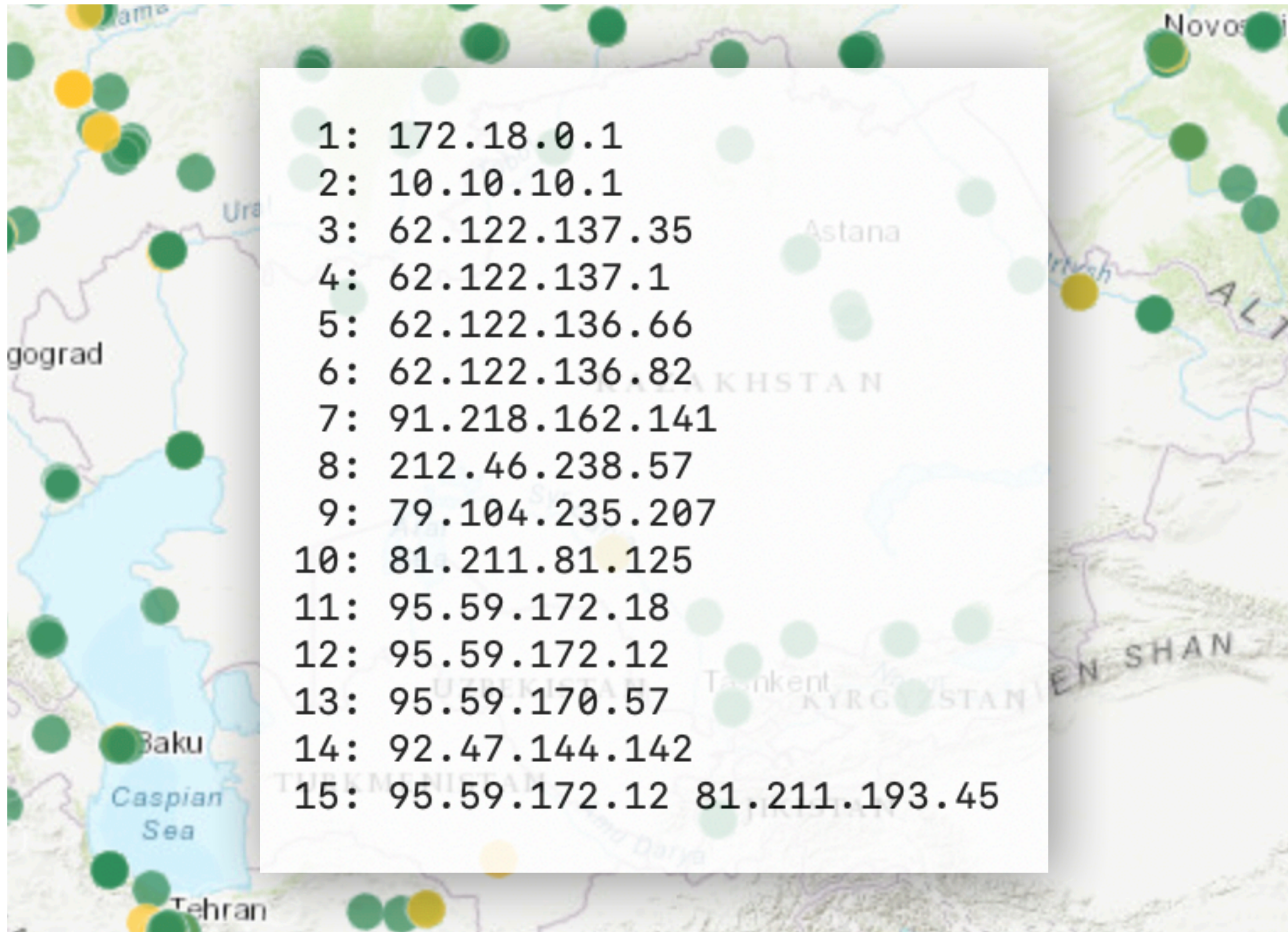
- Sources: all Atlas probes in a country

What we do



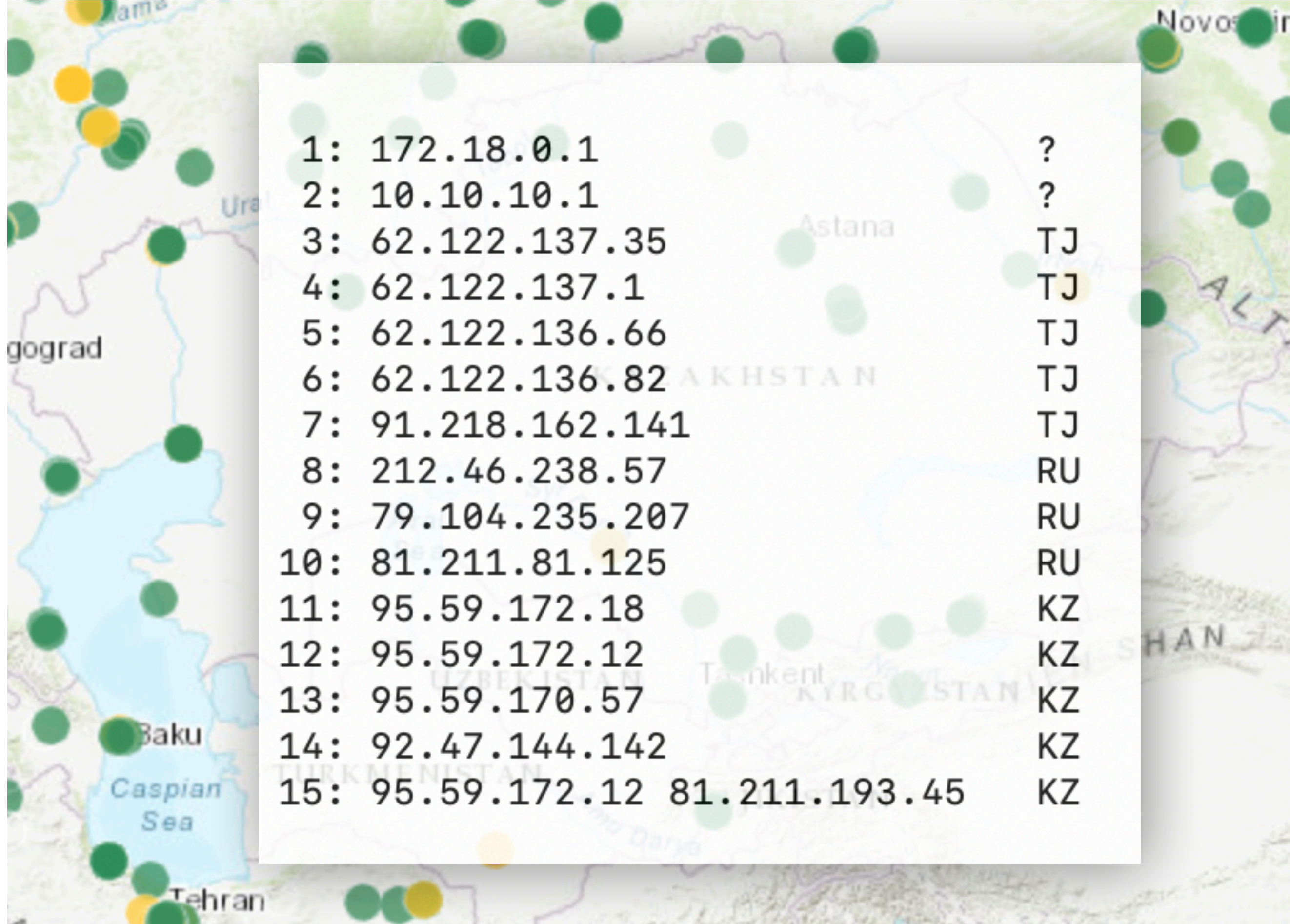
- Sources: all Atlas probes in a country
- Destination points: Atlas probes in other countries
 - Plus some additional hosts in Turkmenistan

What we do



- Sources: all Atlas probes in a country
- Destination points: Atlas probes in other countries plus some additional hosts
- We do traceroute and get a sequence of the hops
 - For each source and destination we use all options: UDP, TCP, ICMP over both IPv4 and IPv6

What we do



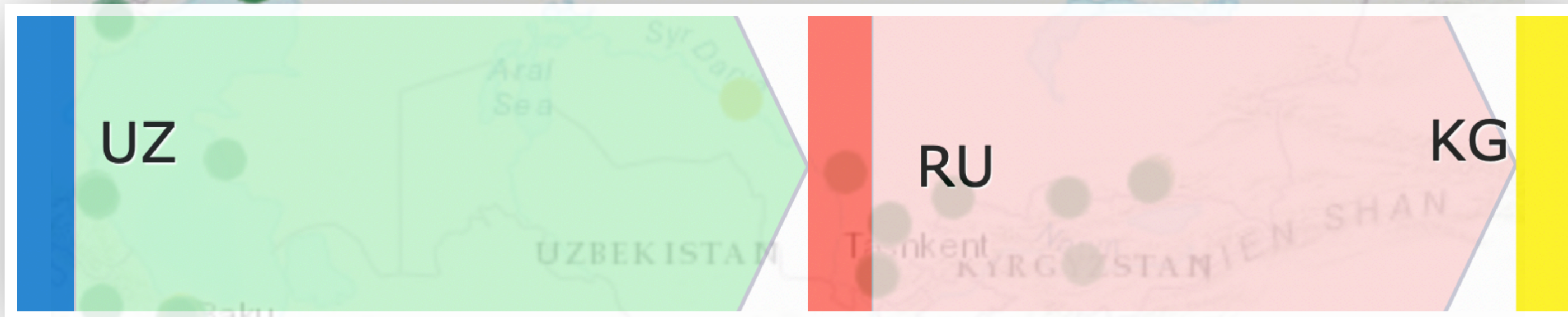
1:	172.18.0.1	?
2:	10.10.10.1	?
3:	62.122.137.35	TJ
4:	62.122.137.1	TJ
5:	62.122.136.66	TJ
6:	62.122.136.82	TJ
7:	91.218.162.141	TJ
8:	212.46.238.57	RU
9:	79.104.235.207	RU
10:	81.211.81.125	RU
11:	95.59.172.18	KZ
12:	95.59.172.12	KZ
13:	95.59.170.57	KZ
14:	92.47.144.142	KZ
15:	95.59.172.12 81.211.193.45	KZ

- Sources: all Atlas probes in a country
- Destination points: Atlas probes in other countries plus some additional hosts
- We do traceroute and get a sequence of the hops
- By associating each hop with a country we get a chain of countries

What we do



- Sources: all Atlas probes in a country
- Destination points: Atlas probes in other countries plus some additional hosts
- We do traceroute and get a sequence of the hops
- We get a chain of countries
- Results are aggregated by source and destination countries
- Finally, we correlate results with RIS data



Bias



- Not every network prefix has an Atlas probe
- The real weight of each route is unknown
- Traceroute works at the IP level: L1 and L2 geography is left out
 - Especially for multinational operators
 - And also, there can be IP tunnels
- The geographic location of intermediate routers is always questionable
 - They may not be known at all ("stars" in traceroute output)
 - They may have private addresses
- ECMP may still be displayed incorrectly (even with Paris traceroute)
- Routes might be unstable during even a single measurement
- Even stable routes tend to change over time

Eh... And can we believe results?



- An external observer **cannot be 100%** accurate in such a measurement
- The results give a **qualitative picture**, not a quantitative one
- **Data refinement** at each step significantly increases the validity of the results
- Thus they **can provide a basic understanding** of interconnectivity in the region
- Since the methodology does not change, **we can get valuable observations comparing the 2022 and 2024 results**

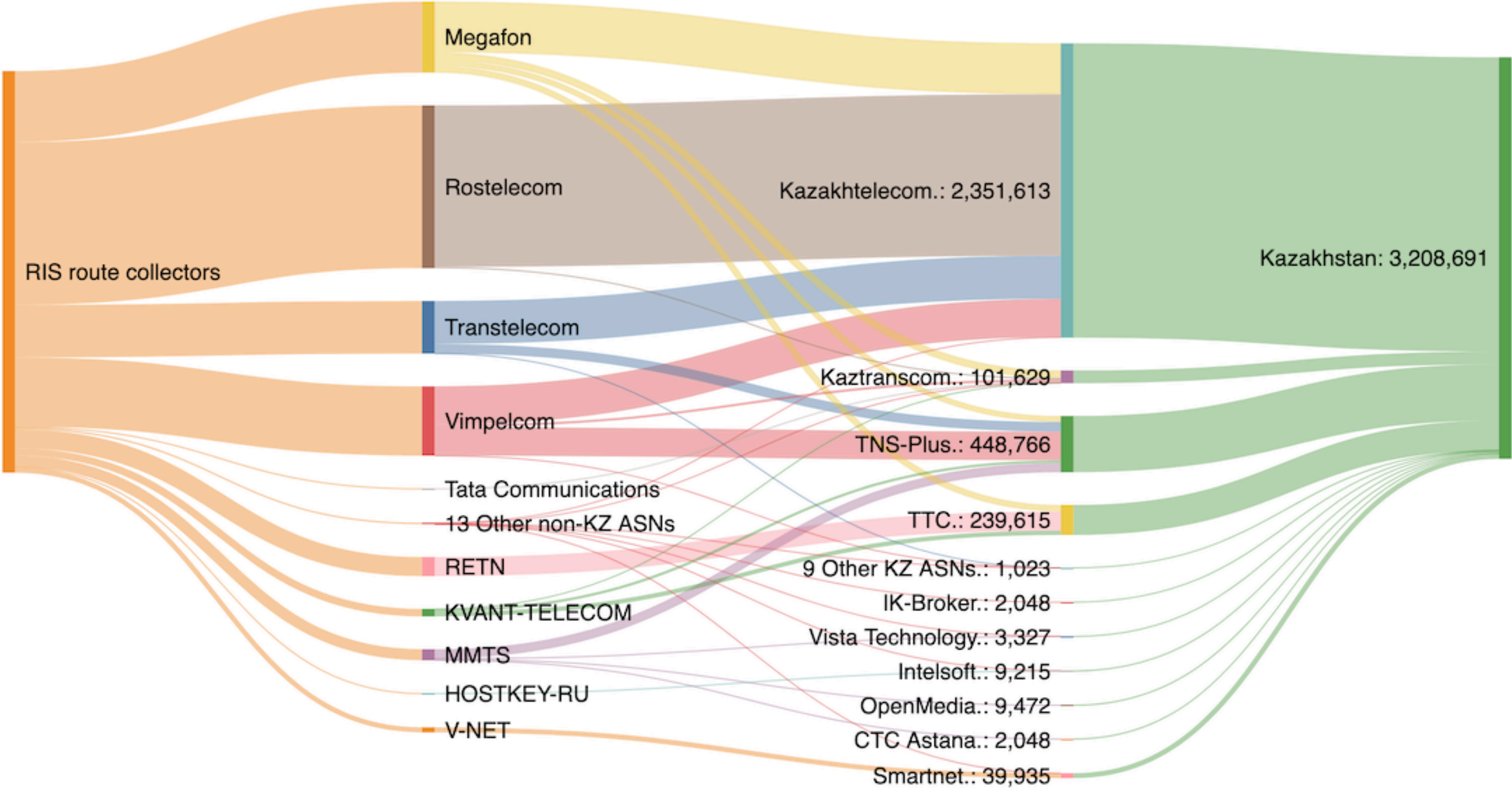


Results

Kazakhstan paths to outside, 2022



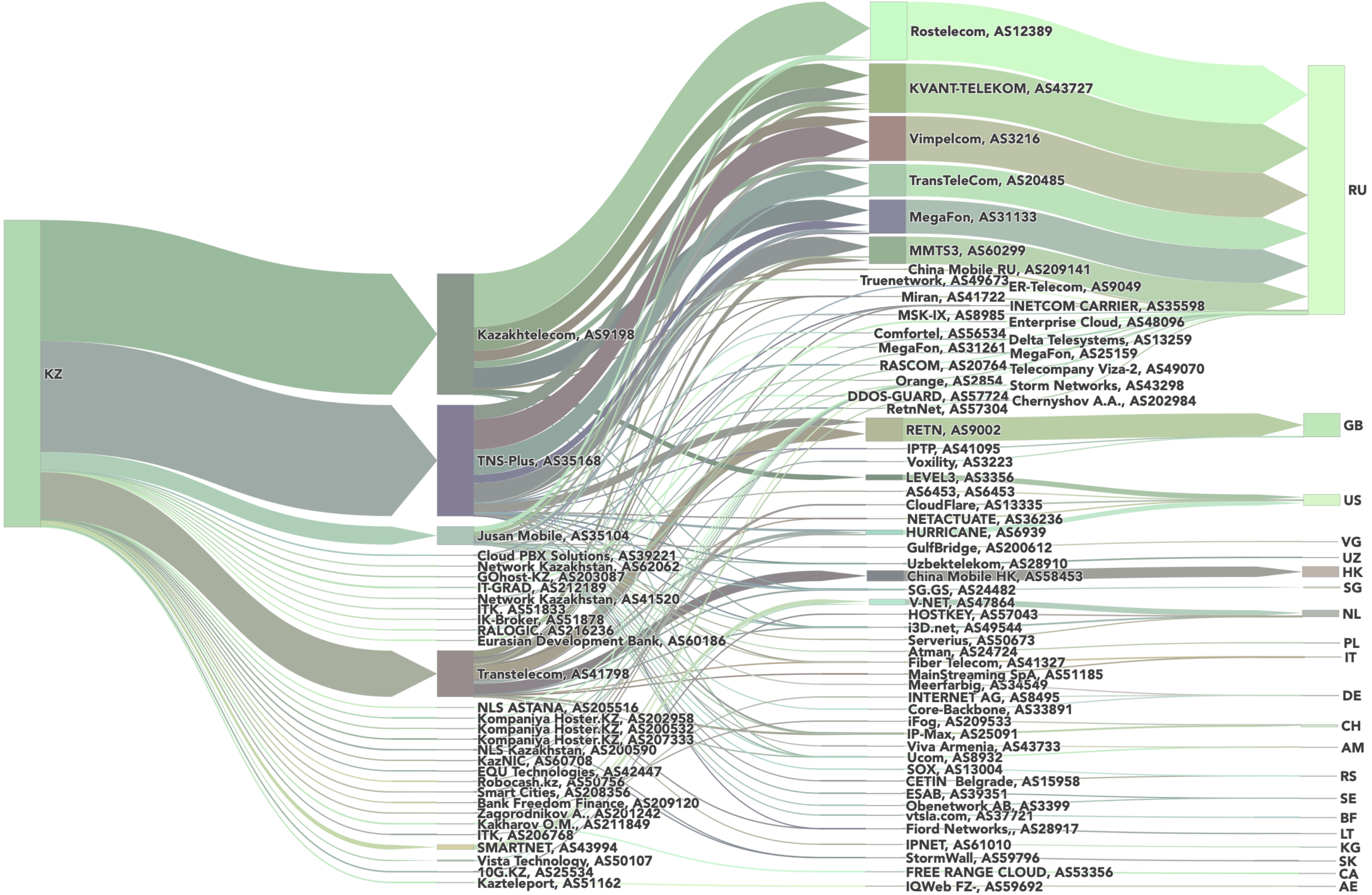
These measurements and diagrams are made by Rene Wilhelm, RIPE NCC



Kazakhstan paths to outside



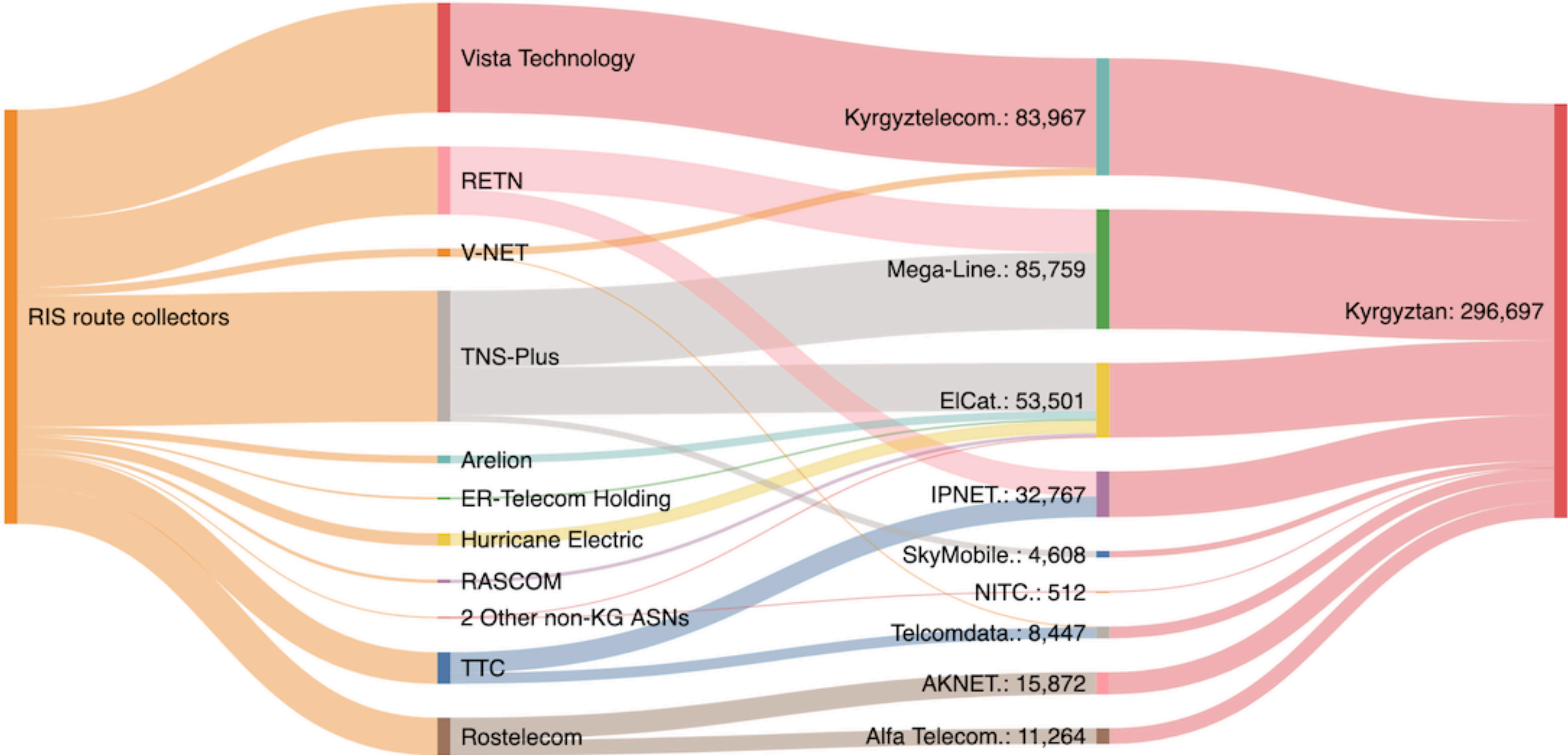
- 4 minor AS PATHs skipped
- Tata has left, while China Mobile appered
- Russia is the main transit country
- A lot of thin European connections appeared



Kyrgyzstan paths to outside, 2022



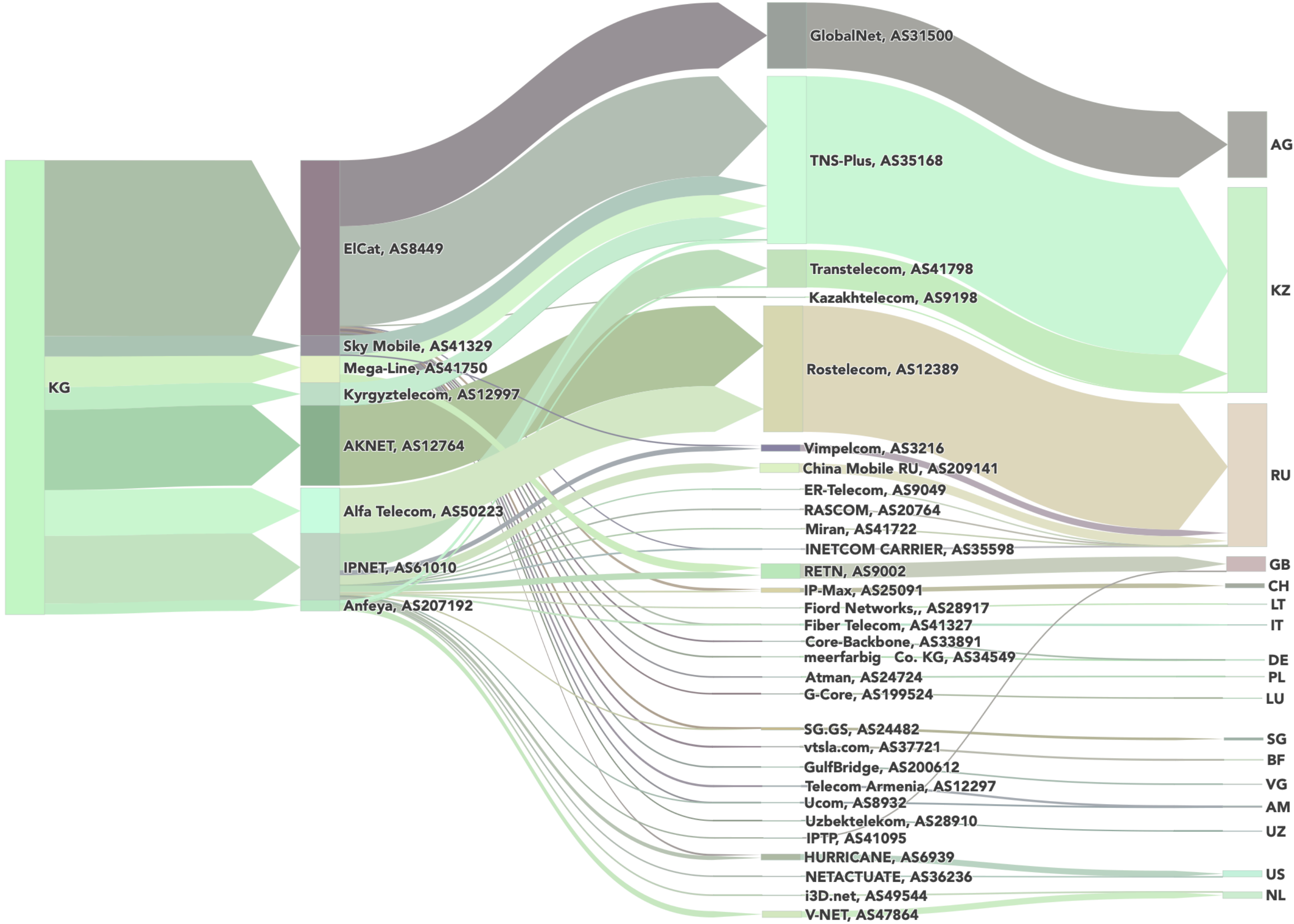
These measurements and diagrams are made by Rene Wilhelm, RIPE NCC



Kyrgyzstan paths to outside



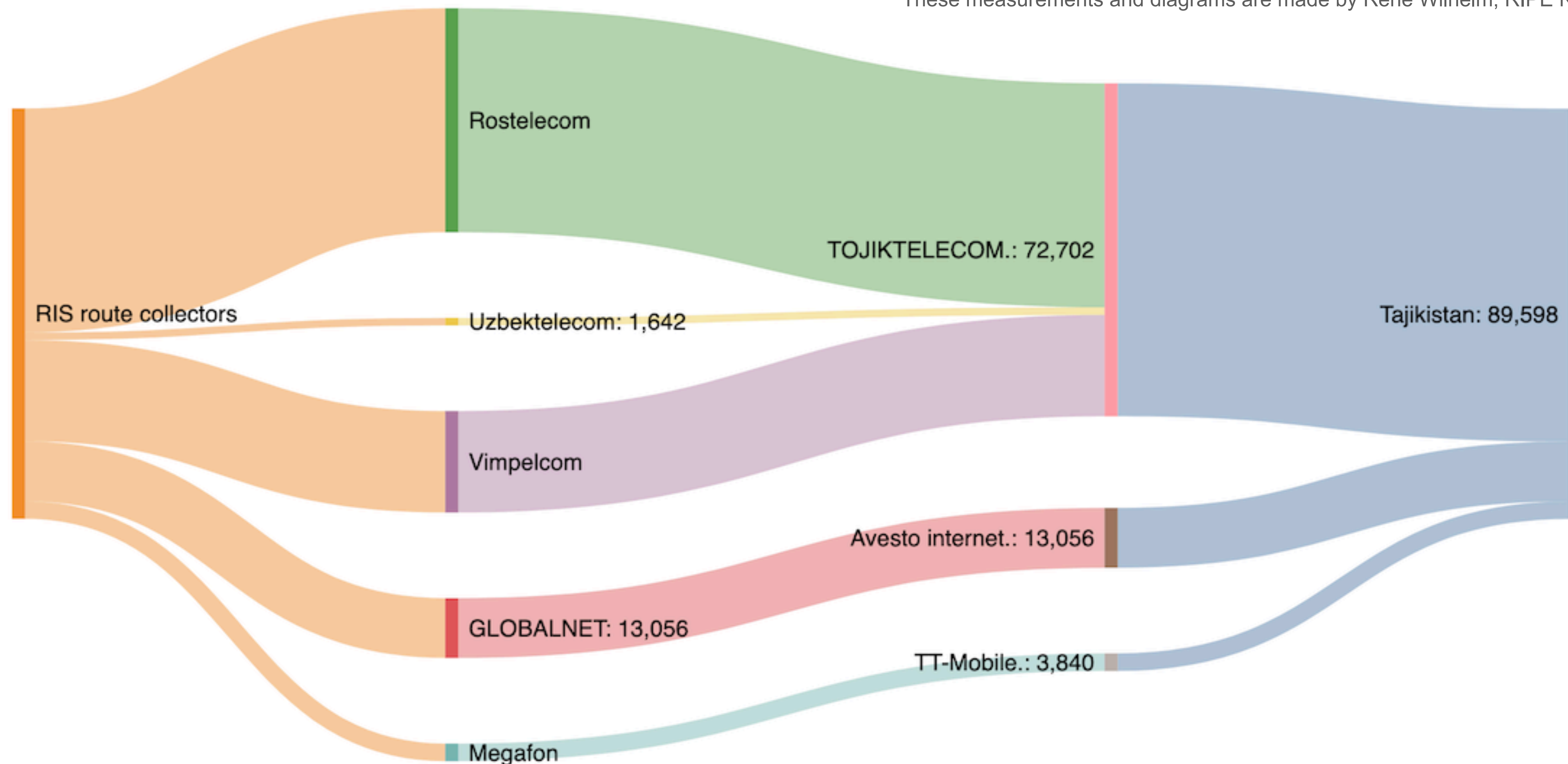
- 8 minor AS PATHs skipped
- There's been a huge increase in diversity
- Kazakhstan is the main transit country, Russia is on the second place



Tajikistan paths to outside, 2022



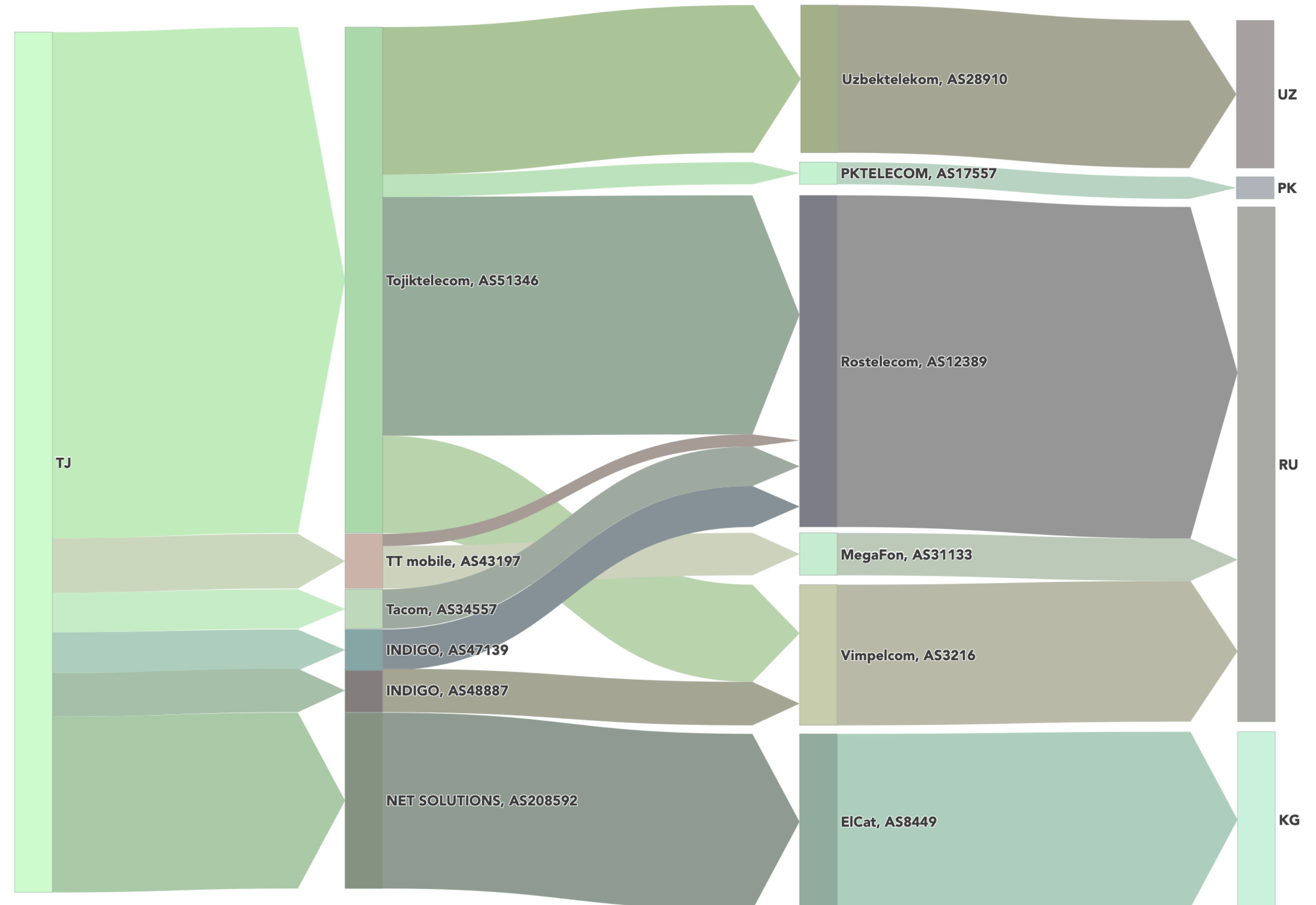
These measurements and diagrams are made by Rene Wilhelm, RIPE NCC



Tajikistan paths to outside



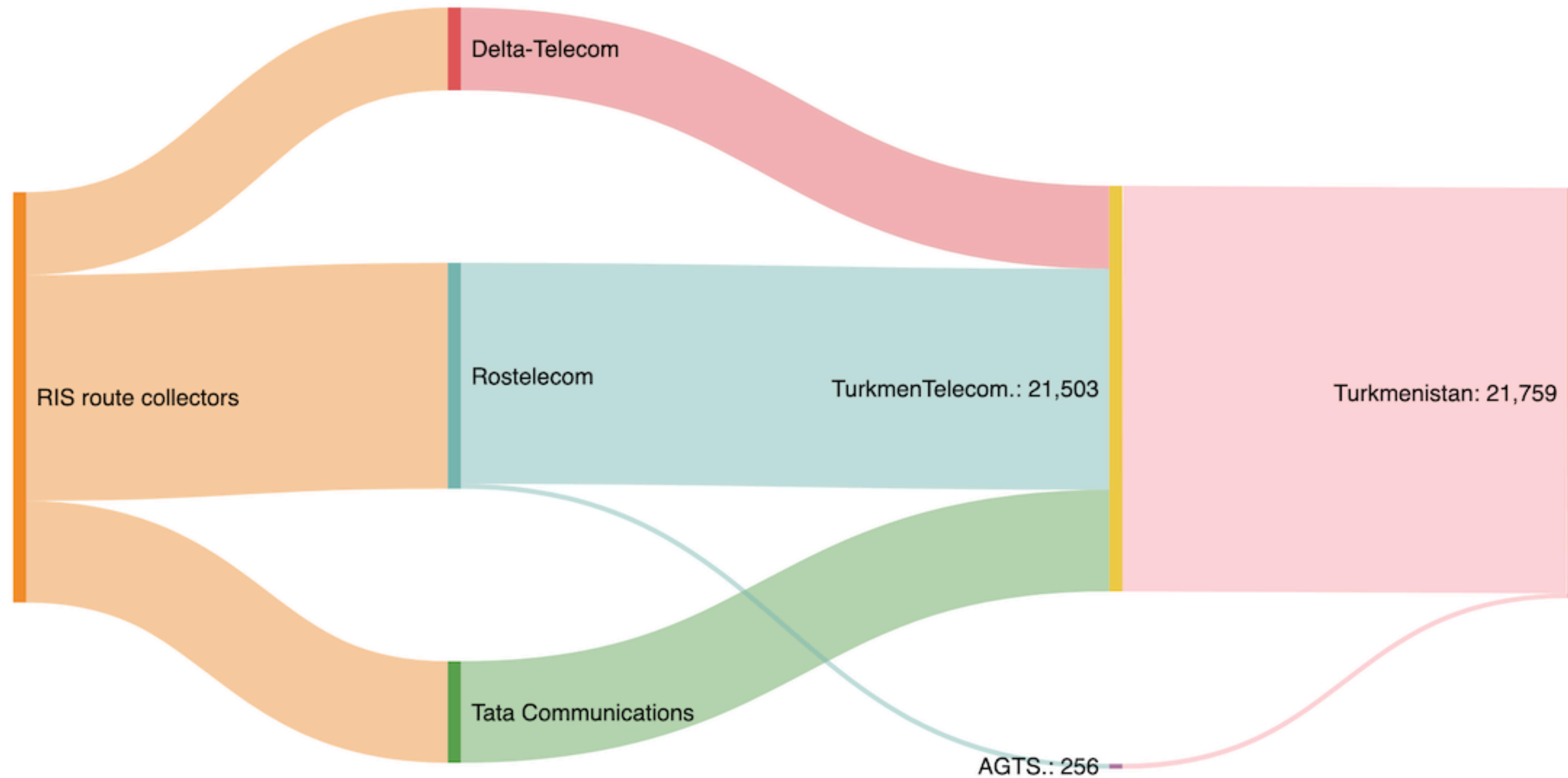
- Increase in the number of local players crossing the border
- Appeared:
 - Pakistan as a transit country
 - Uztelecom (UZ) and EICat (KZ) as transit providers



Turkmenistan paths to outside, 2022



These measurements and diagrams are made by Rene Wilhelm, RIPE NCC



Turkmenistan paths to outside



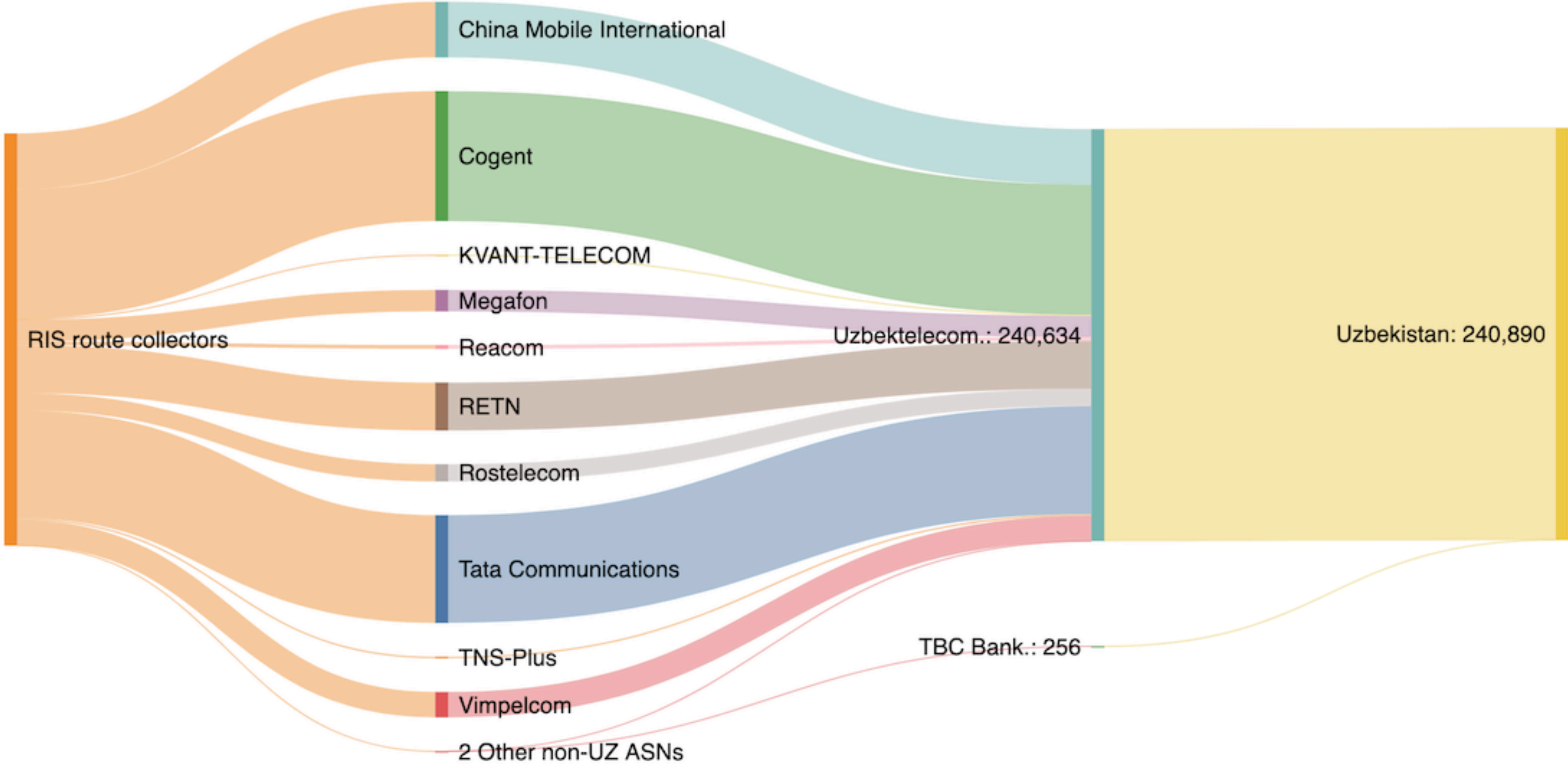
- Increase in the number of local players crossing the border
- Uztelecom replaces Tata



Uzbekistan paths to outside, 2022



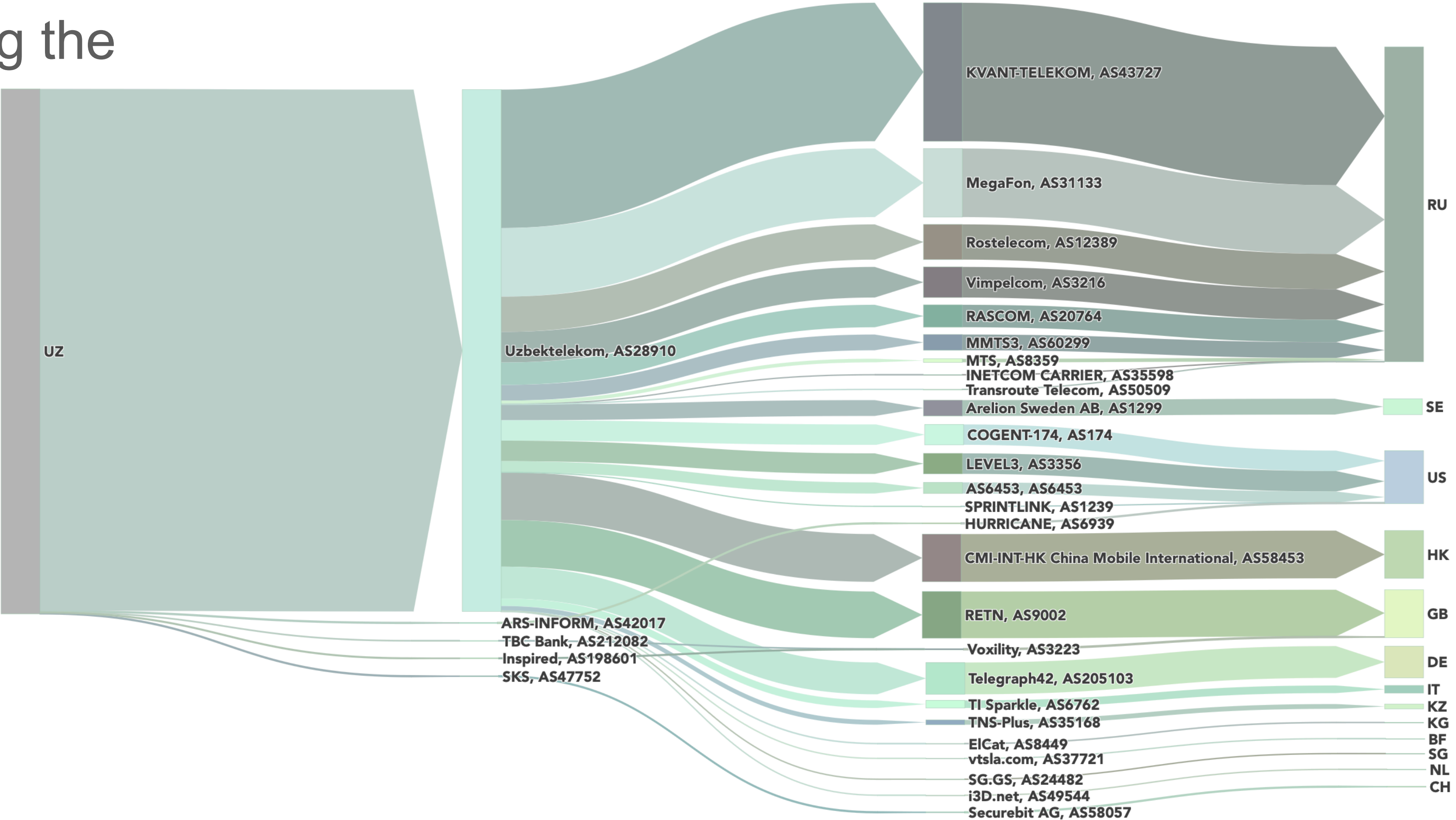
These measurements and diagrams are made by Rene Wilhelm, RIPE NCC



Uzbekistan paths to outside



- Increase in the number of local players crossing the border
- Tata has left
- Cogent's role decreased
- Kvant-Telecom's role increased
- Significantly more external peers





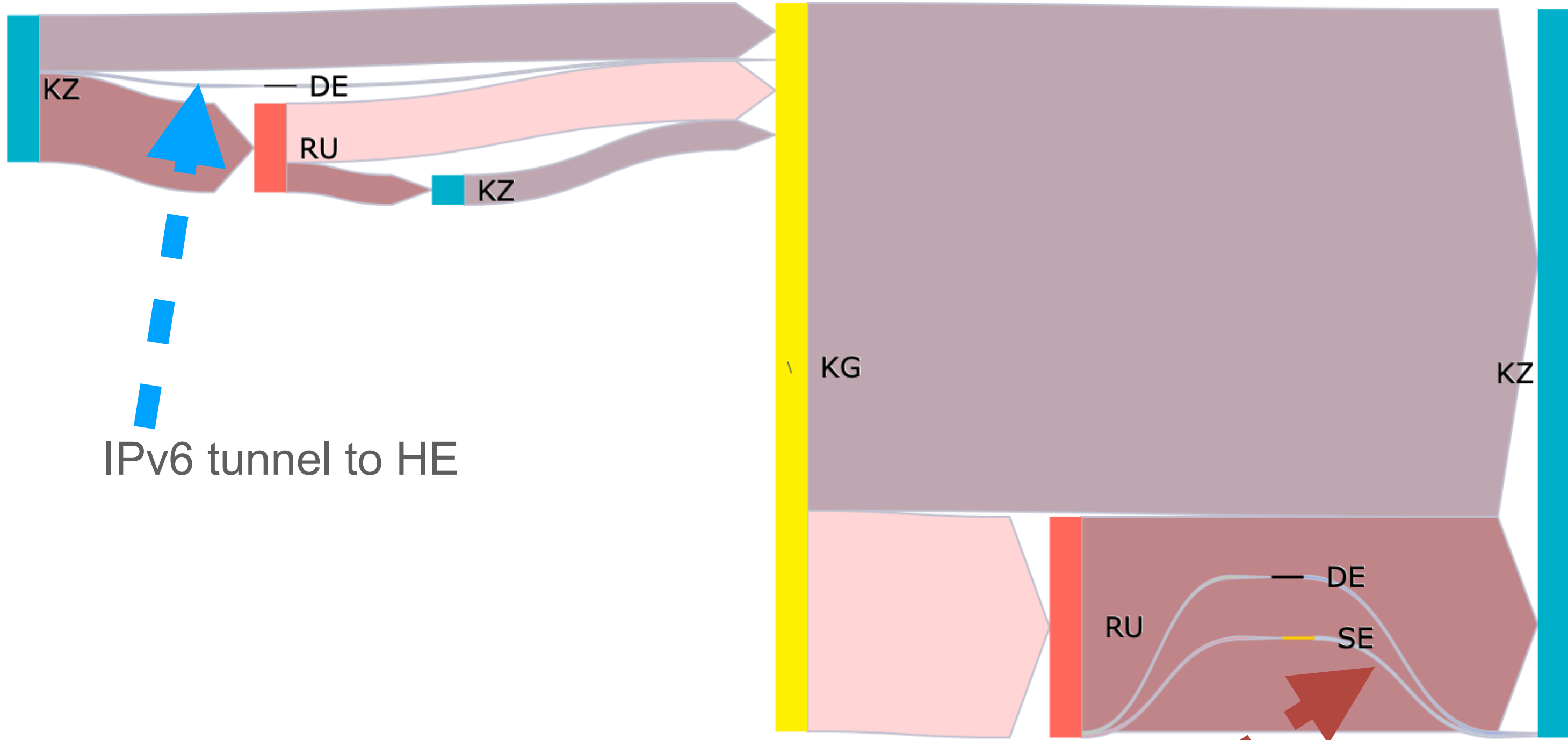
Data plane

Traceroutes
analysis



Kazakhstan ↔
Kyrgyzstan

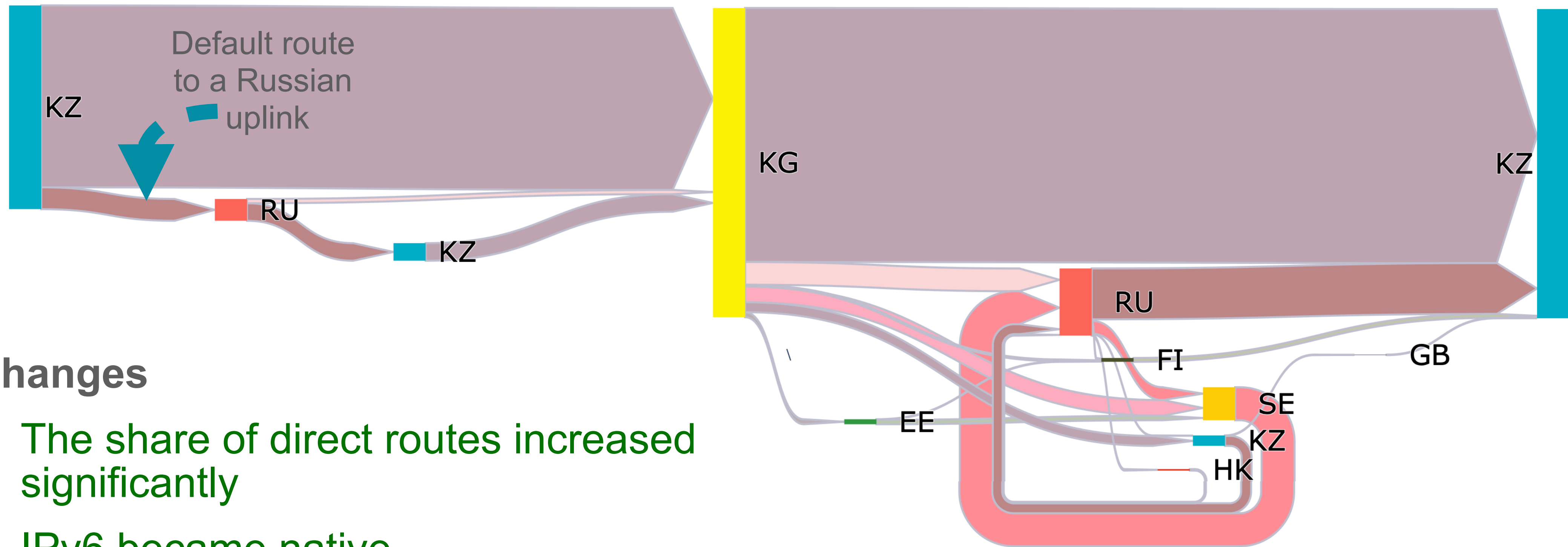
Kazakhstan ↔ Kyrgyzstan, 2022



IPv6 tunnel to HE

Real geography of traffic is hidden at the L1/L2 level

Kazakhstan ↔ Kyrgyzstan, 2024



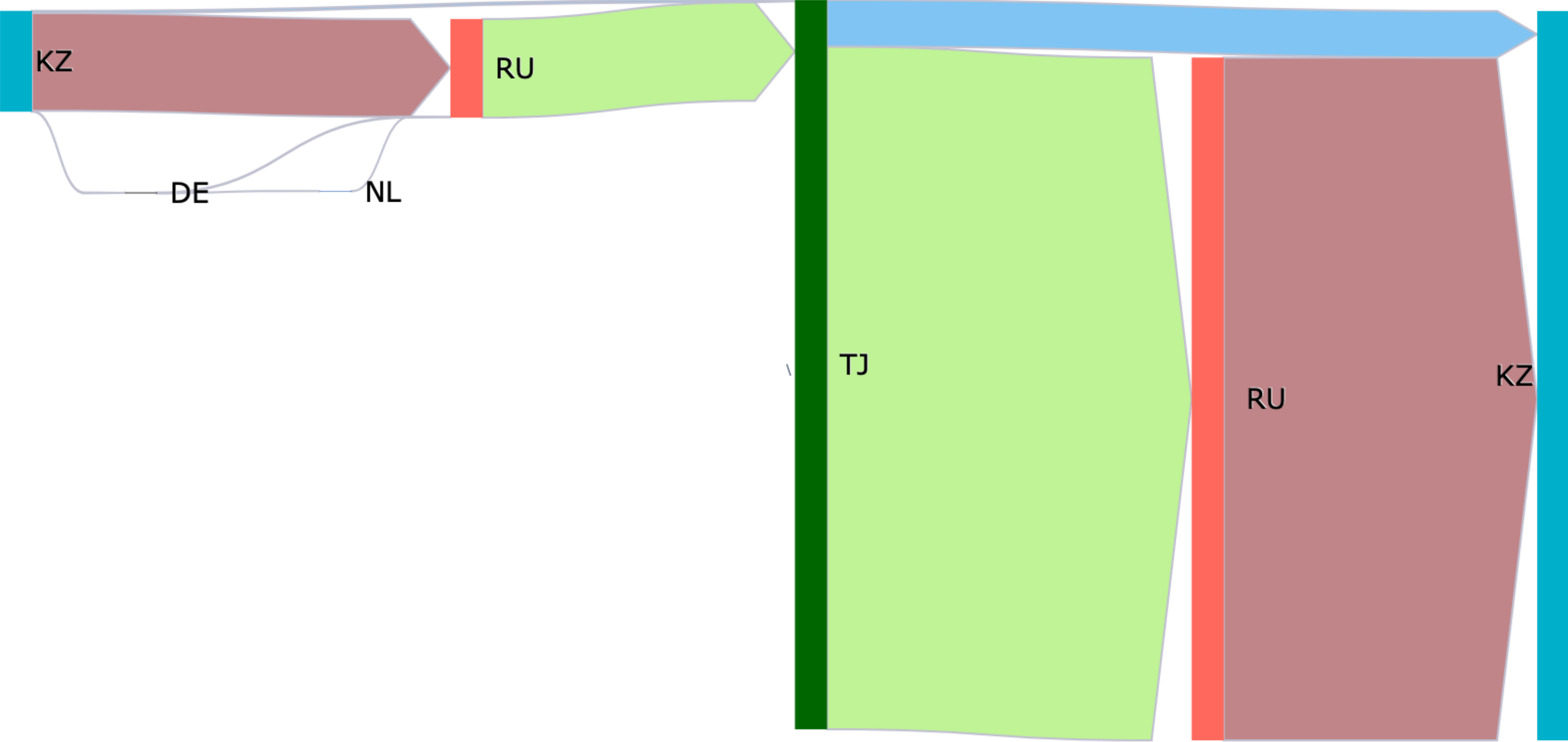
Changes

- The share of direct routes increased significantly
- IPv6 became native
- The variety of routes has increased significantly
 - Most often these routes are sub-optimal
- There's still a lot of traffic tromboning
 - Such as KZ-RU-KZ-KG
 - Standard behaviour of Transtelecom's "daughters"

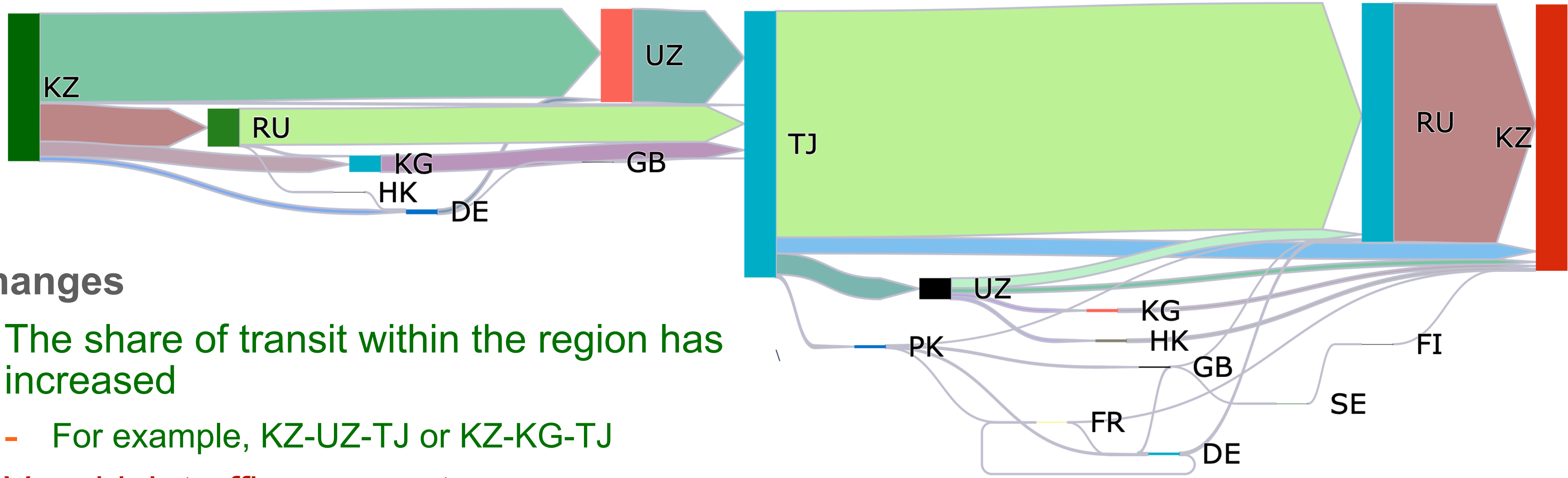


Kazakhstan ↔
Tajikistan

Kazakhstan ↔ Tajikistan, 2022



Kazakhstan ↔ Tajikistan, 2024



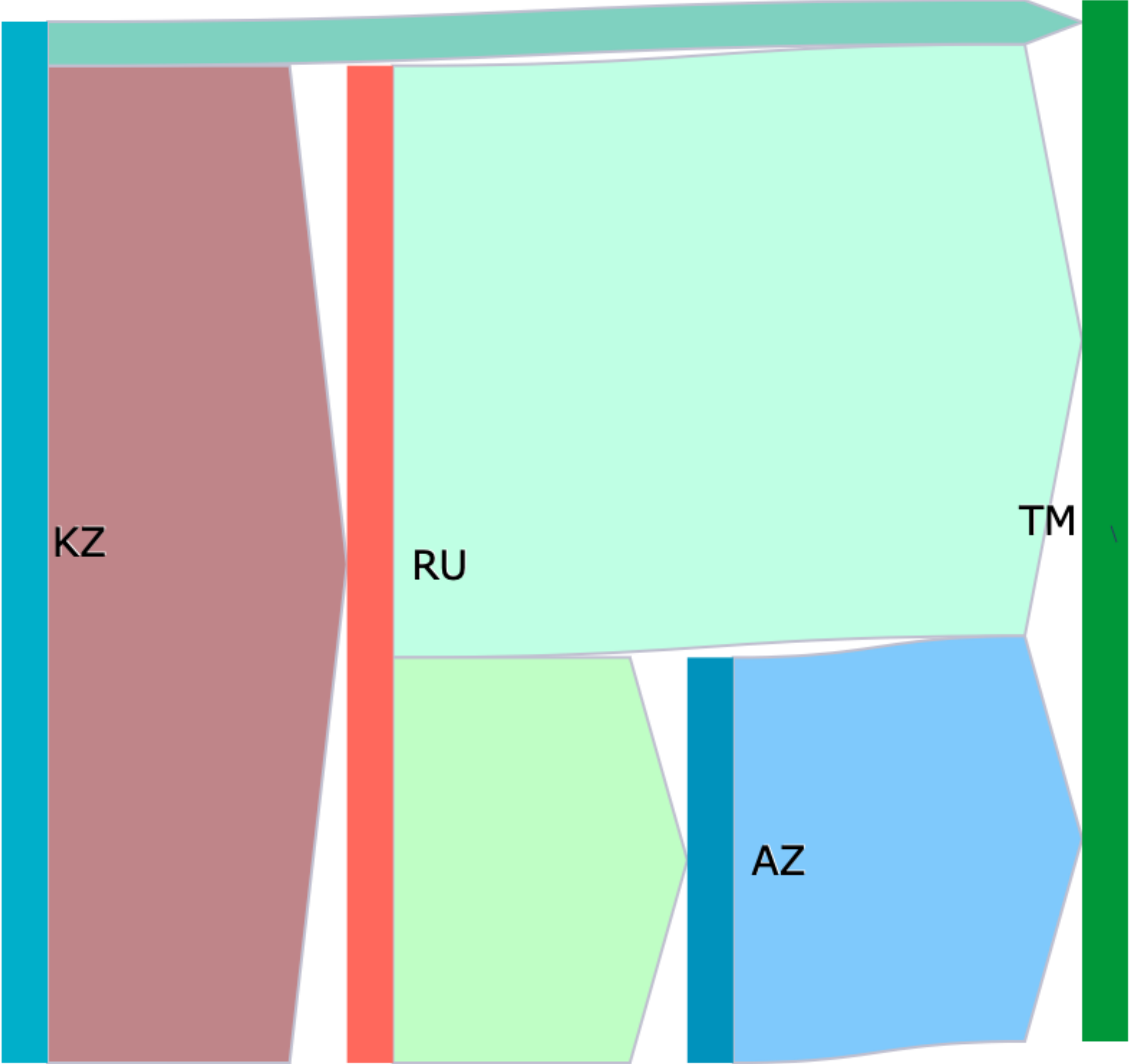
Changes

- The share of transit within the region has increased
 - For example, KZ-UZ-TJ or KZ-KG-TJ
- Very high traffic asymmetry
 - Most often these routes are sub-optimal
- Very high traffic asymmetry
 - Most often these routes are sub-optimal
- Very many minor, but substantially suboptimal routes
 - KZ-RU-HK-DE-GB-TJ or TJ-PT-GB-SE-FI-KZ
 - May be the result of routing instability



**Kazakhstan →
Turkmenistan**

Kazakhstan → Turkmenistan, 2022

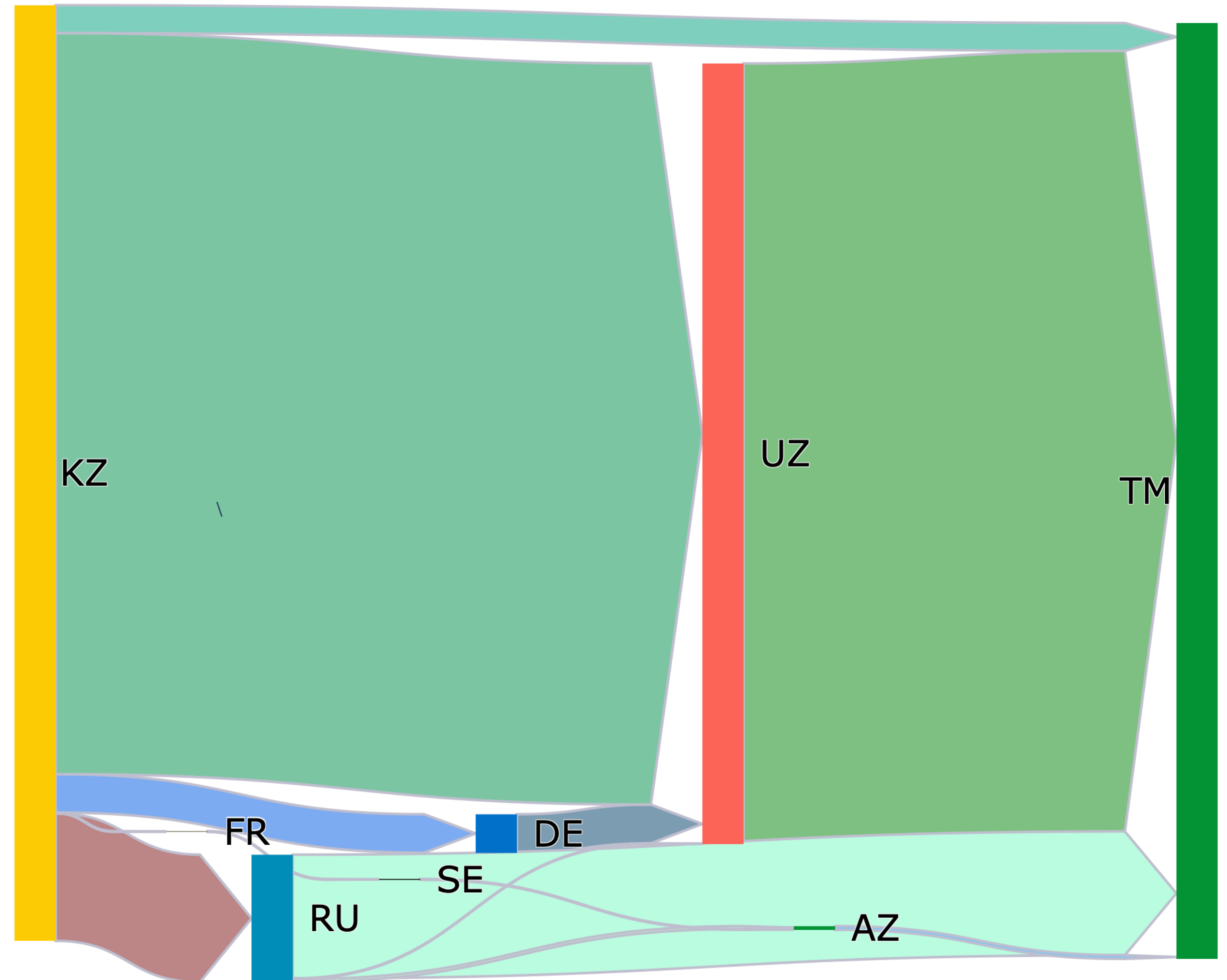


Kazakhstan → Turkmenistan, 2024



Changes

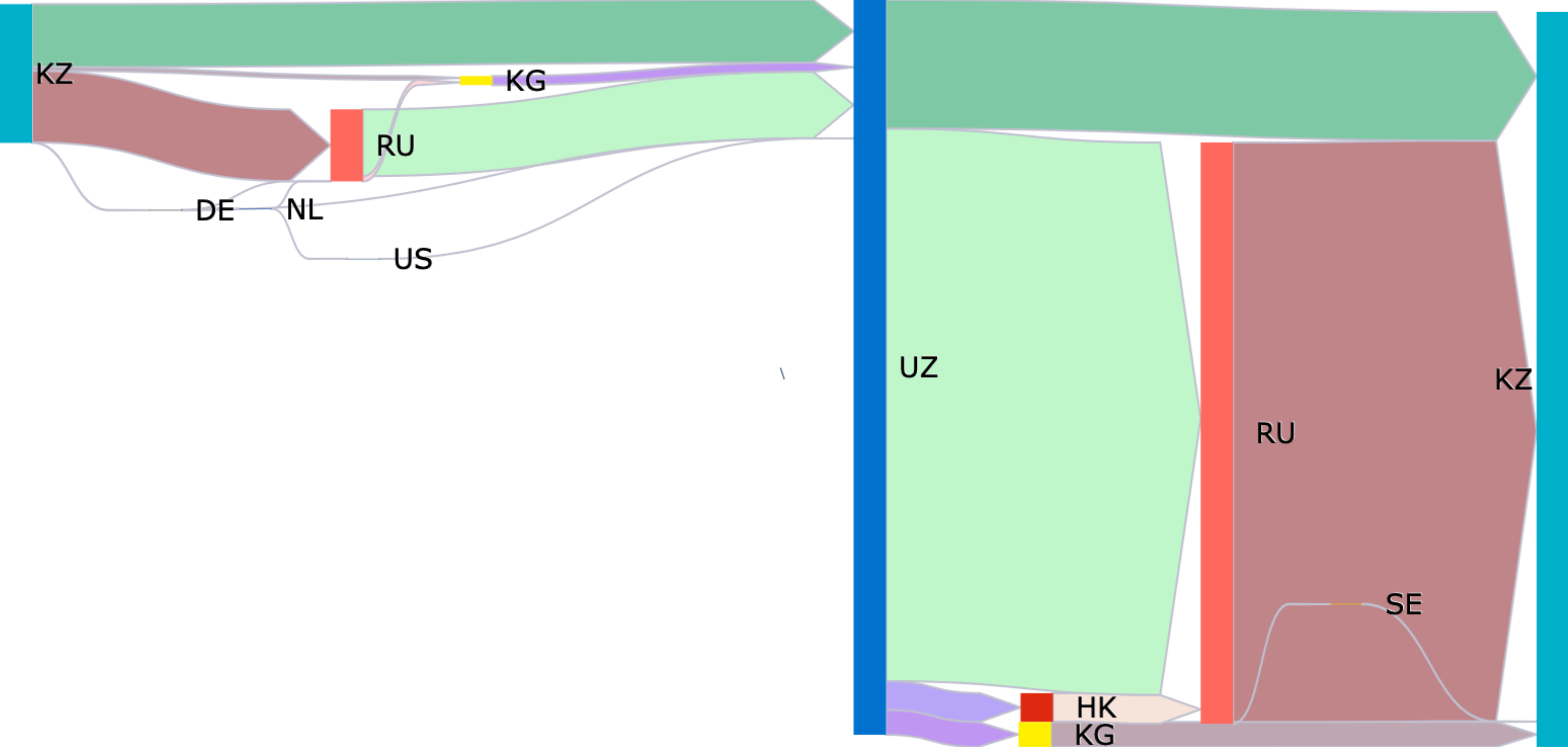
- To a large extent, Uzbekistan (a local player) has displaced Russia and Azerbaijan as transit countries
- Many minor but substantially suboptimal routes
 - Such as KZ-FR-SE-AZ-TM



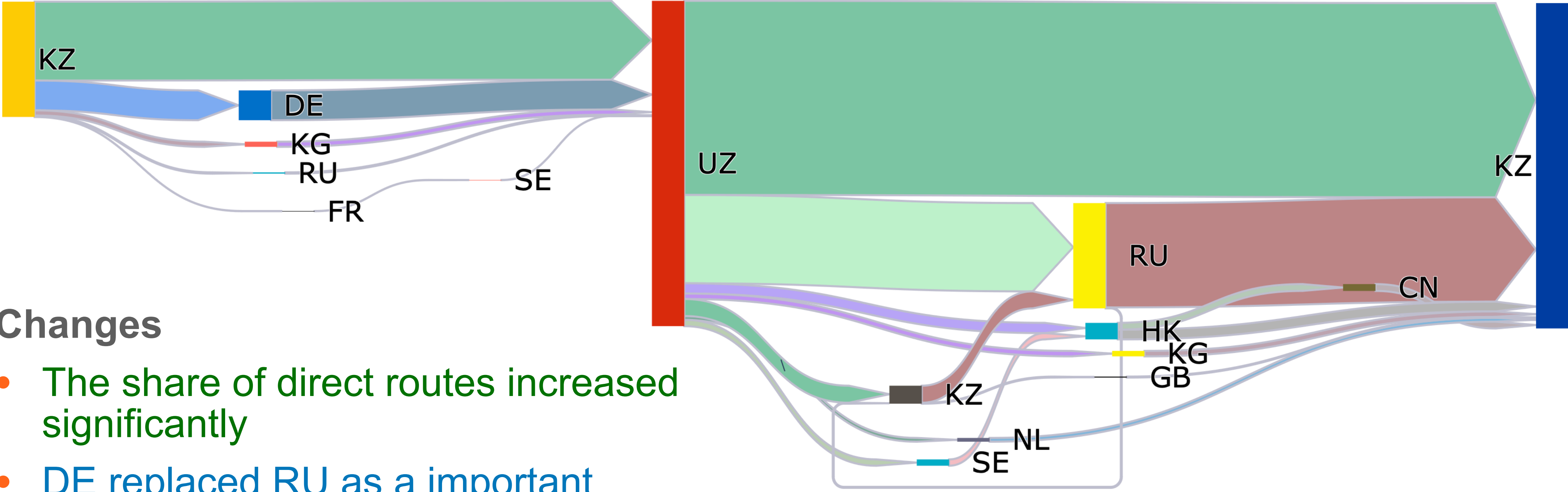


Kazakhstan ↔
Uzbekistan

Kazakhstan ↔ Uzbekistan, 2022



Kazakhstan ↔ Uzbekistan, 2024



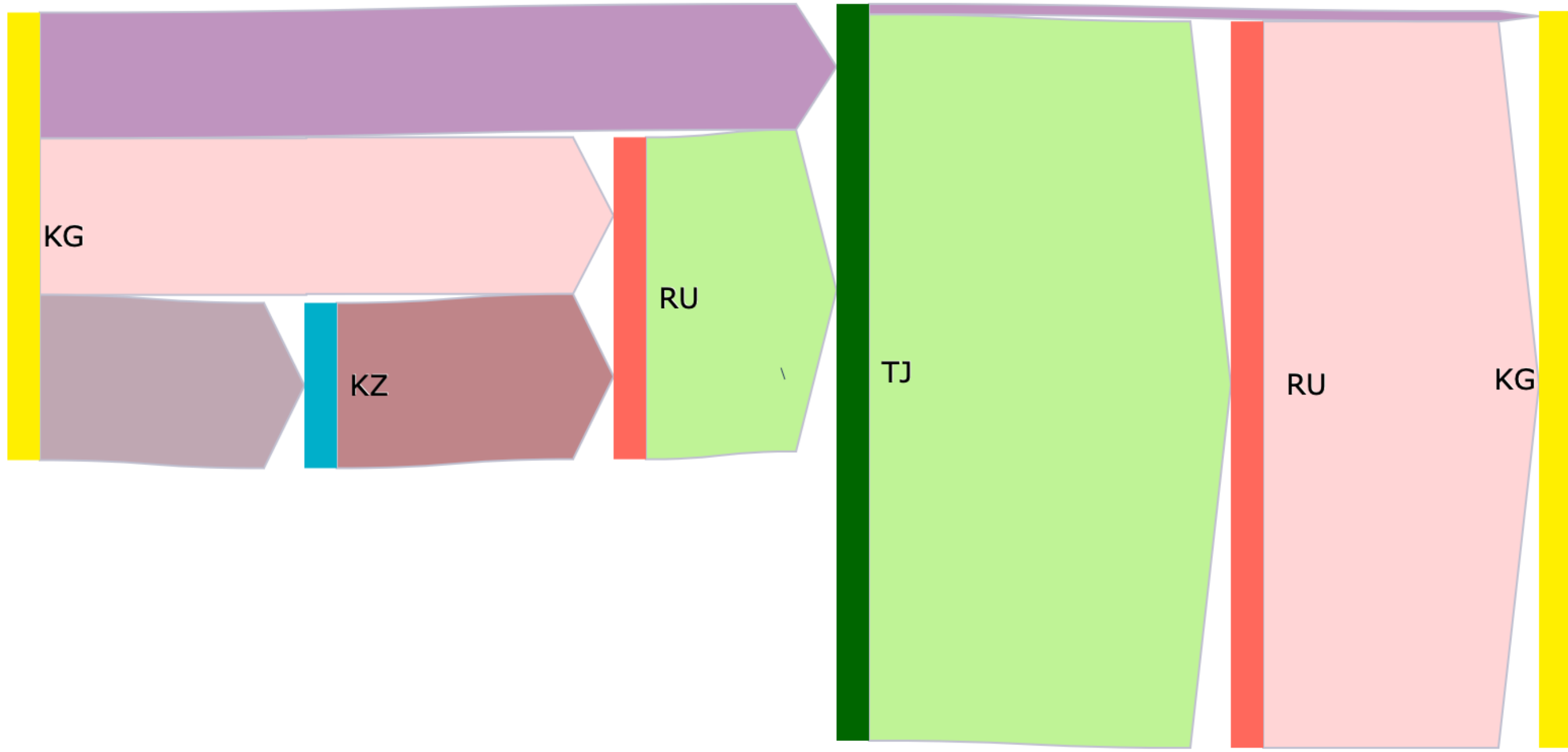
Changes

- The share of direct routes increased significantly
- DE replaced RU as a important transit country from KZ to UZ
- High traffic asymmetry
- A notable share of highly suboptimal routes
 - Such as UZ-SE-HK-CN-KZ or KZ-FR-SE-UZ
 - ➔ Distance SE-HK - about 8000 km!

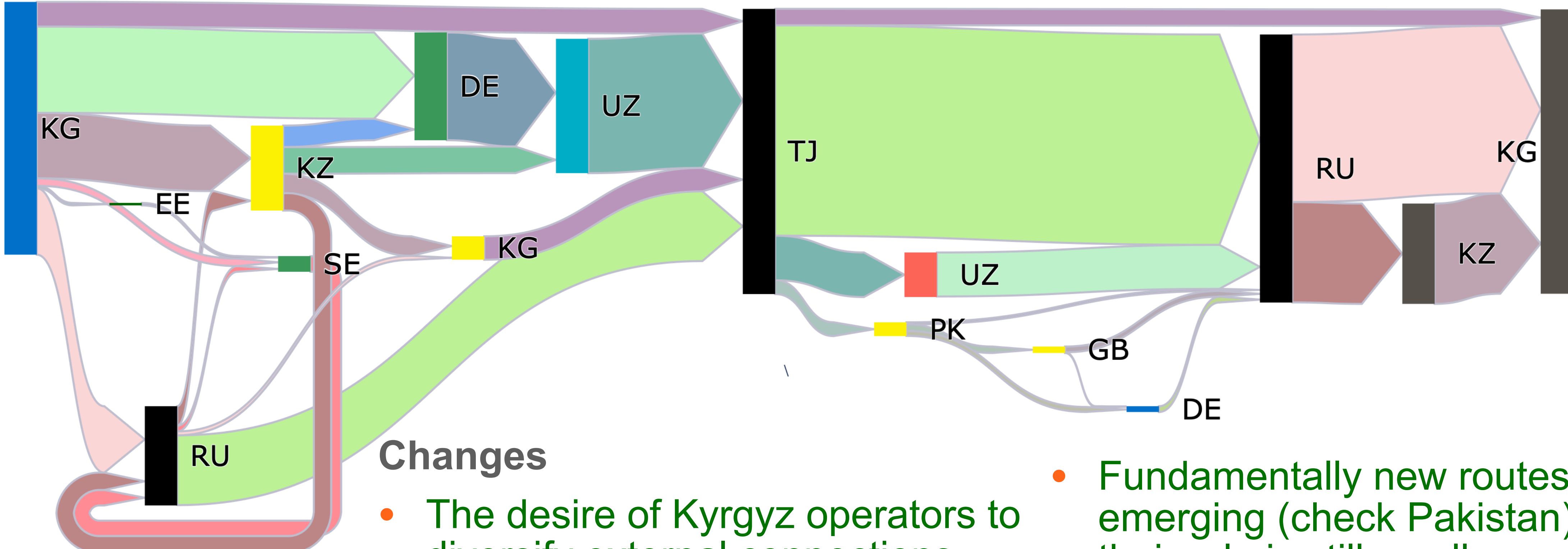


Kyrgyzstan ↔
Tajikistan

Kyrgyzstan ↔ Tajikistan, 2022



Kyrgyzstan ↔ Tajikistan, 2024



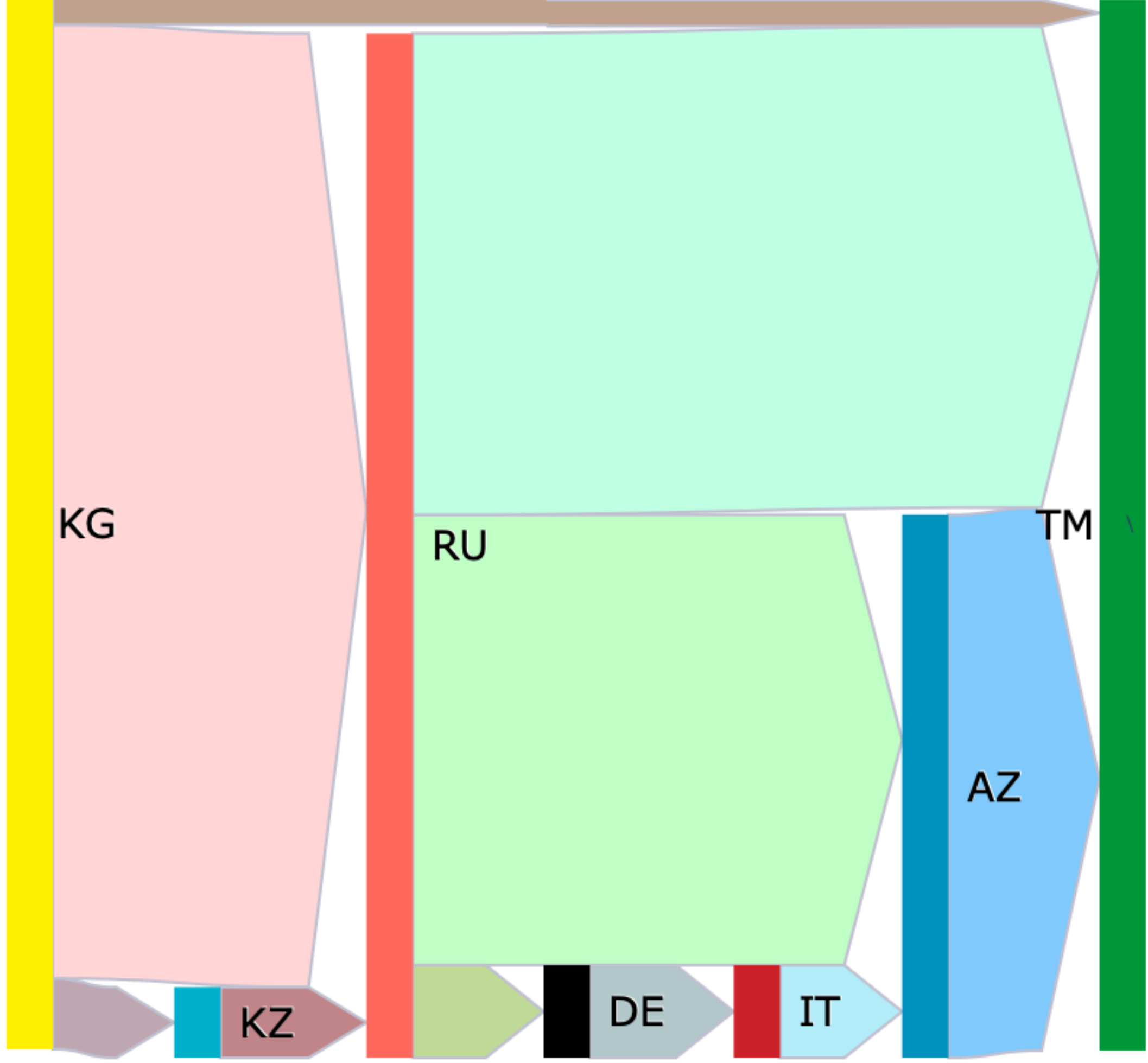
Changes

- The desire of Kyrgyz operators to diversify external connections is highly visible
 - However, the task of traffic optimization to Tajikistan did not appear at all
- Fundamentally new routes are emerging (check Pakistan), but their role is still small
- There are new inter-regional paths
 - Such as KG-KZ-UZ-TJ
- High traffic asymmetry



**Kyrgyzstan →
Turkmenistan**

Kyrgyzstan → Turkmenistan, 2022

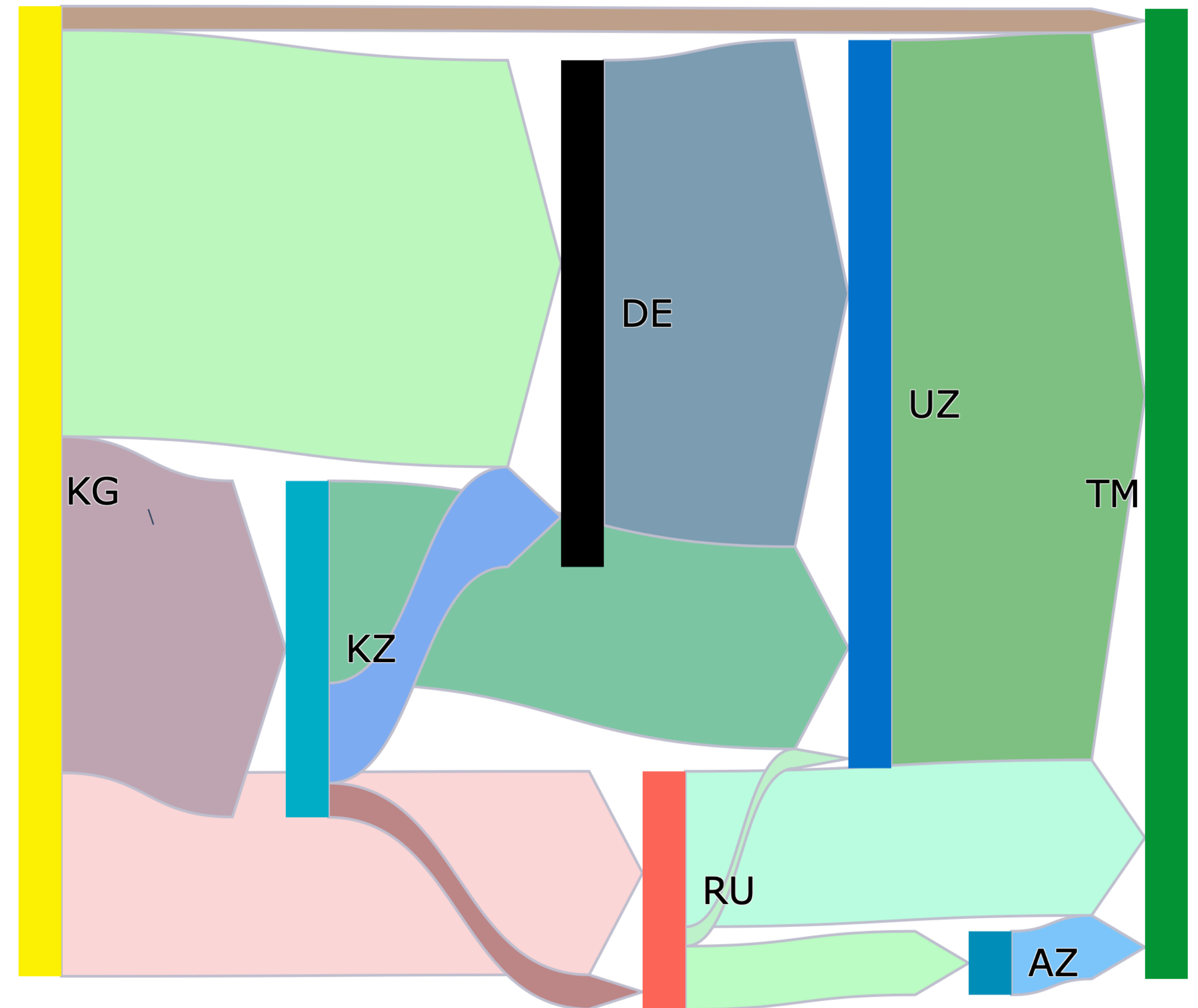


Kyrgyzstan → Turkmenistan, 2024



Changes

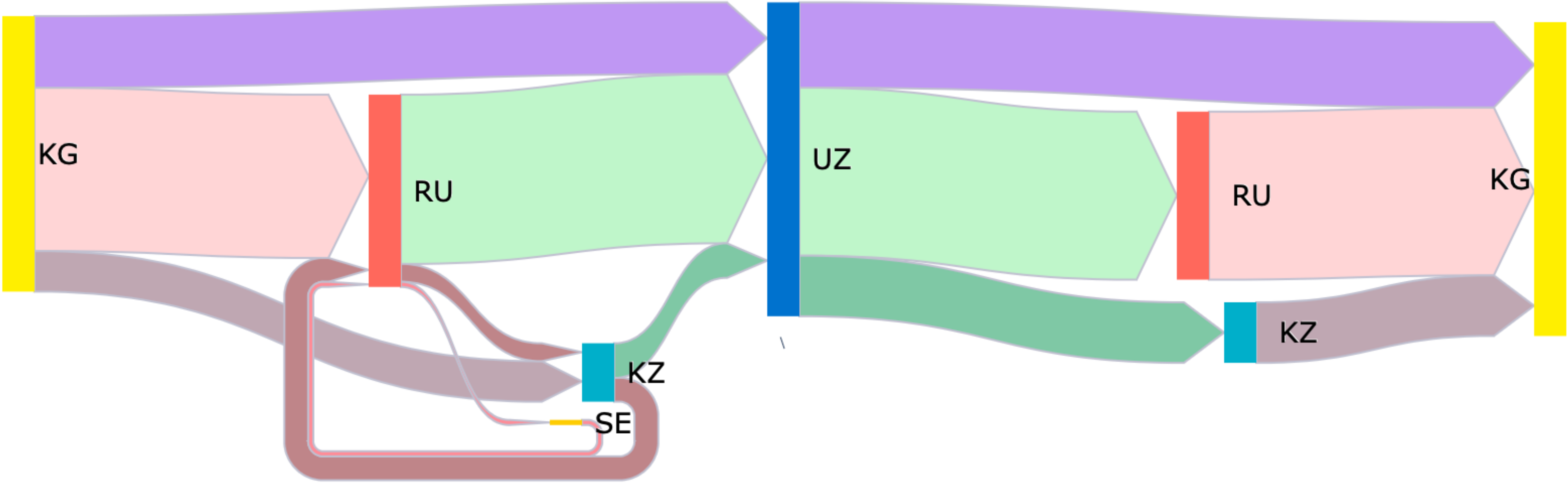
- Kyrgyzstan clearly tries to diversify external connections
 - Unfortunately, to the negative impact of connectivity with Turkmenistan
 - The role of Russia as a transit country has shifted to Germany (?!), Kazakhstan and Uzbekistan



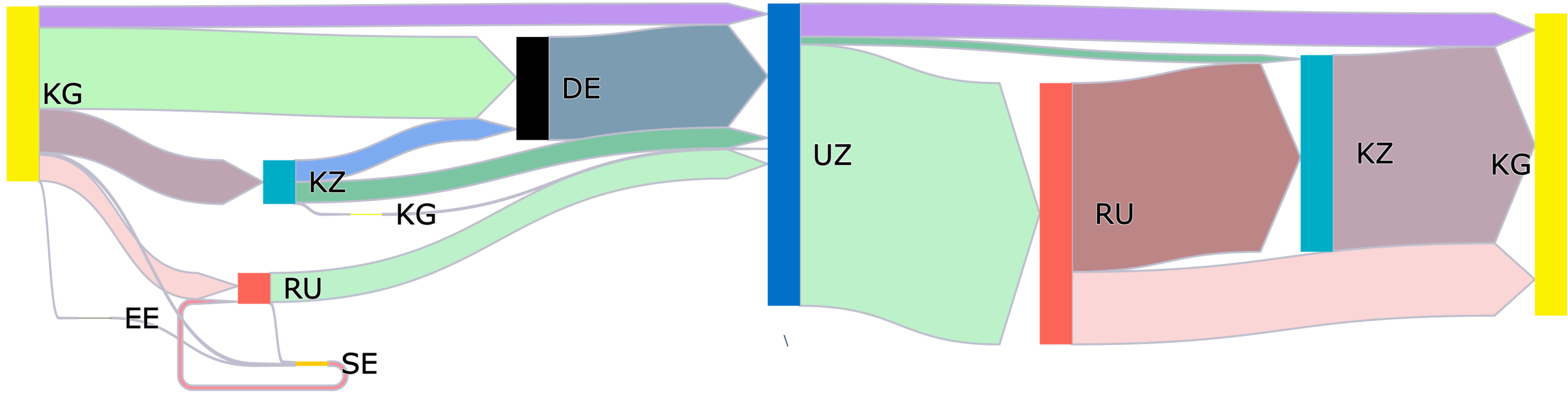


Kyrgyzstan ↔
Uzbekistan

Kyrgyzstan ↔ Uzbekistan, 2022



Kyrgyzstan ↔ Uzbekistan, 2024



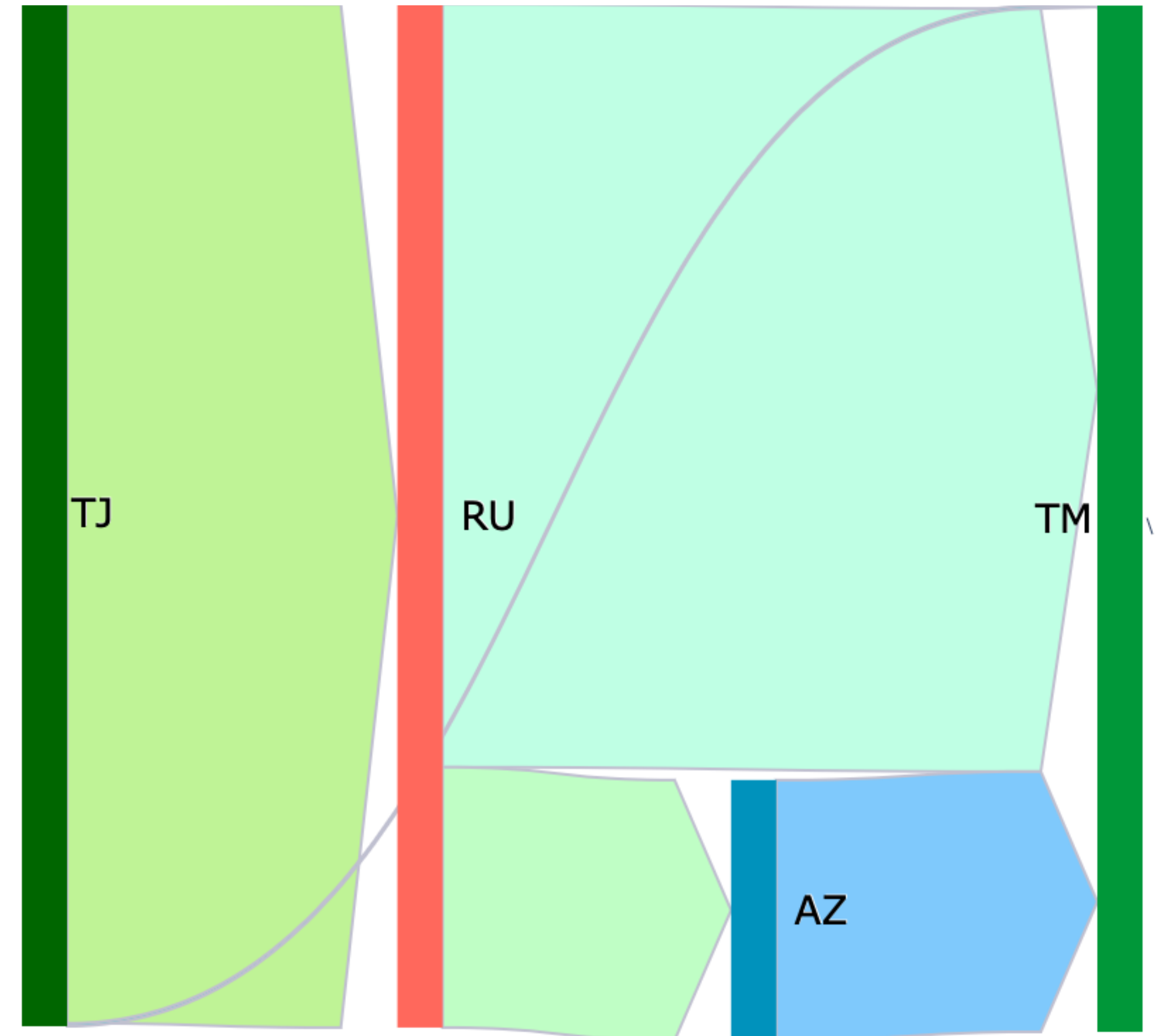
Changes

- The percentage of direct routes has dropped
- High traffic asymmetry
- Routes in both directions are still systemically suboptimal
 - Such as KG-DE-UZ and UZ-RU-KZ-KG
- Russian peer-to-peer clashes still also deteriorate connectivity between countries



**Tajikistan →
Turkmenistan**

Tajikistan → Turkmenistan, 2022

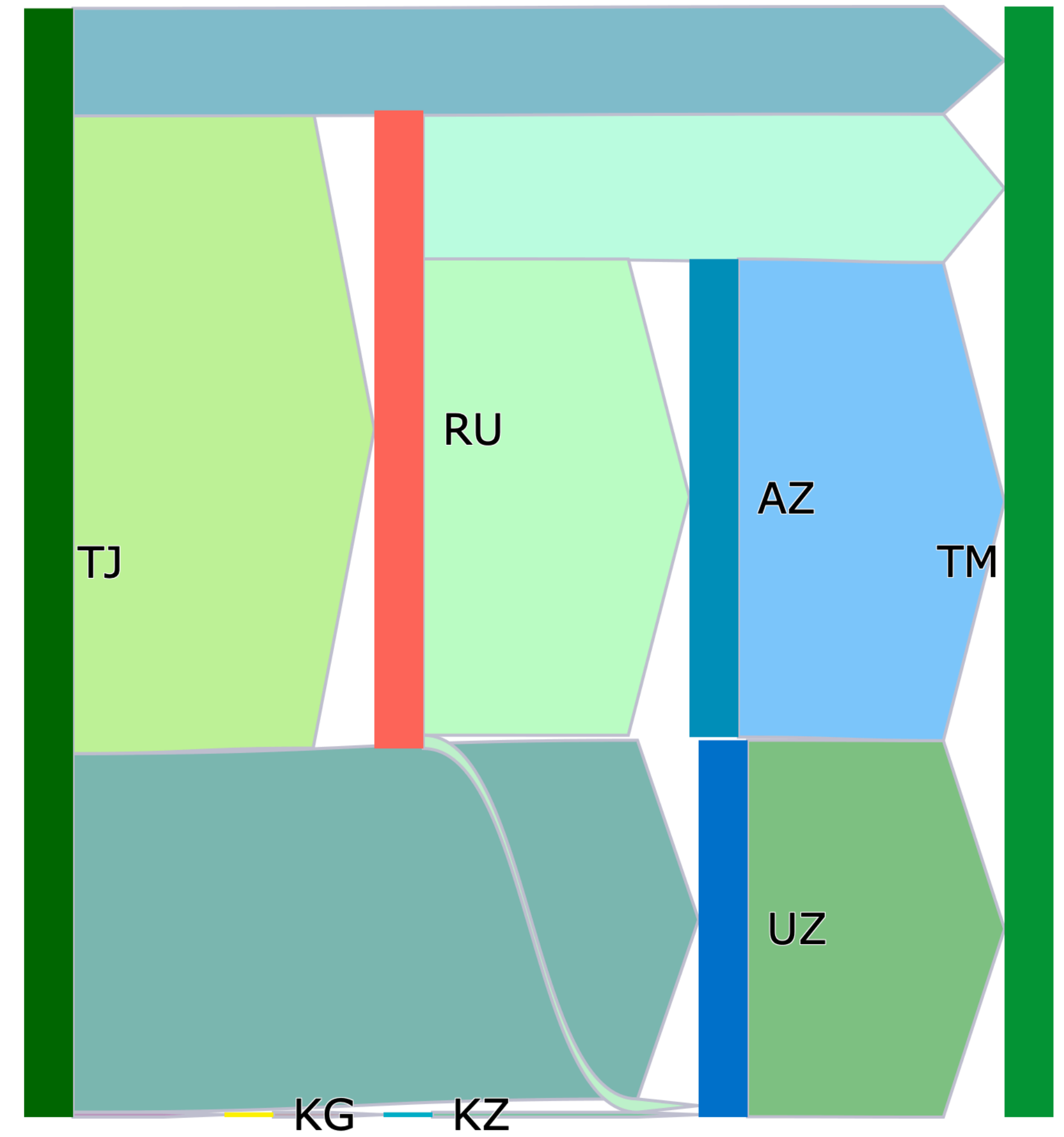


Tajikistan → Turkmenistan, 2024



Changes

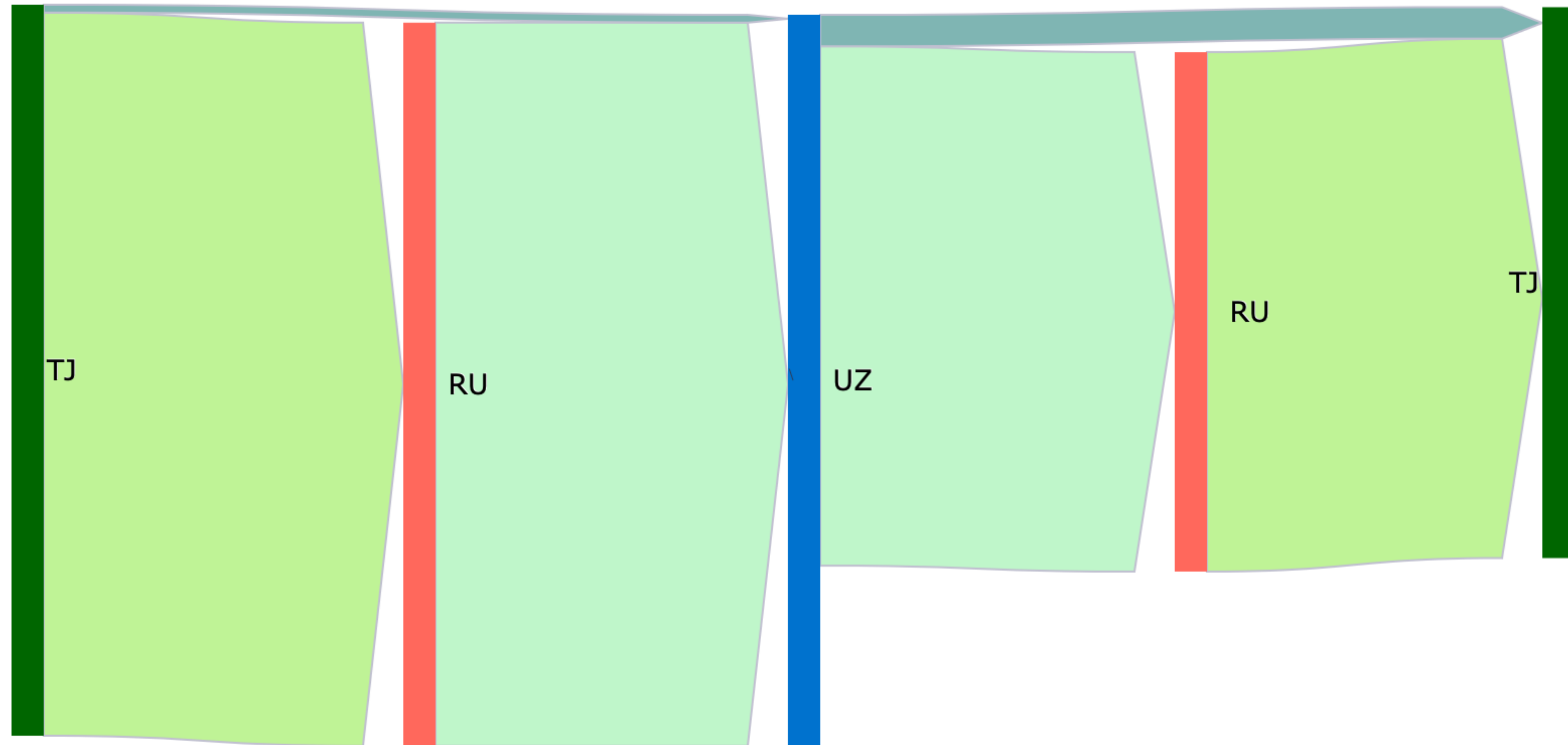
- There are fewer of them than between any other pair of countries
- A new intra-regional transit through Uzbekistan has emerged
- Transit through Russia more often went further through Azerbaijan



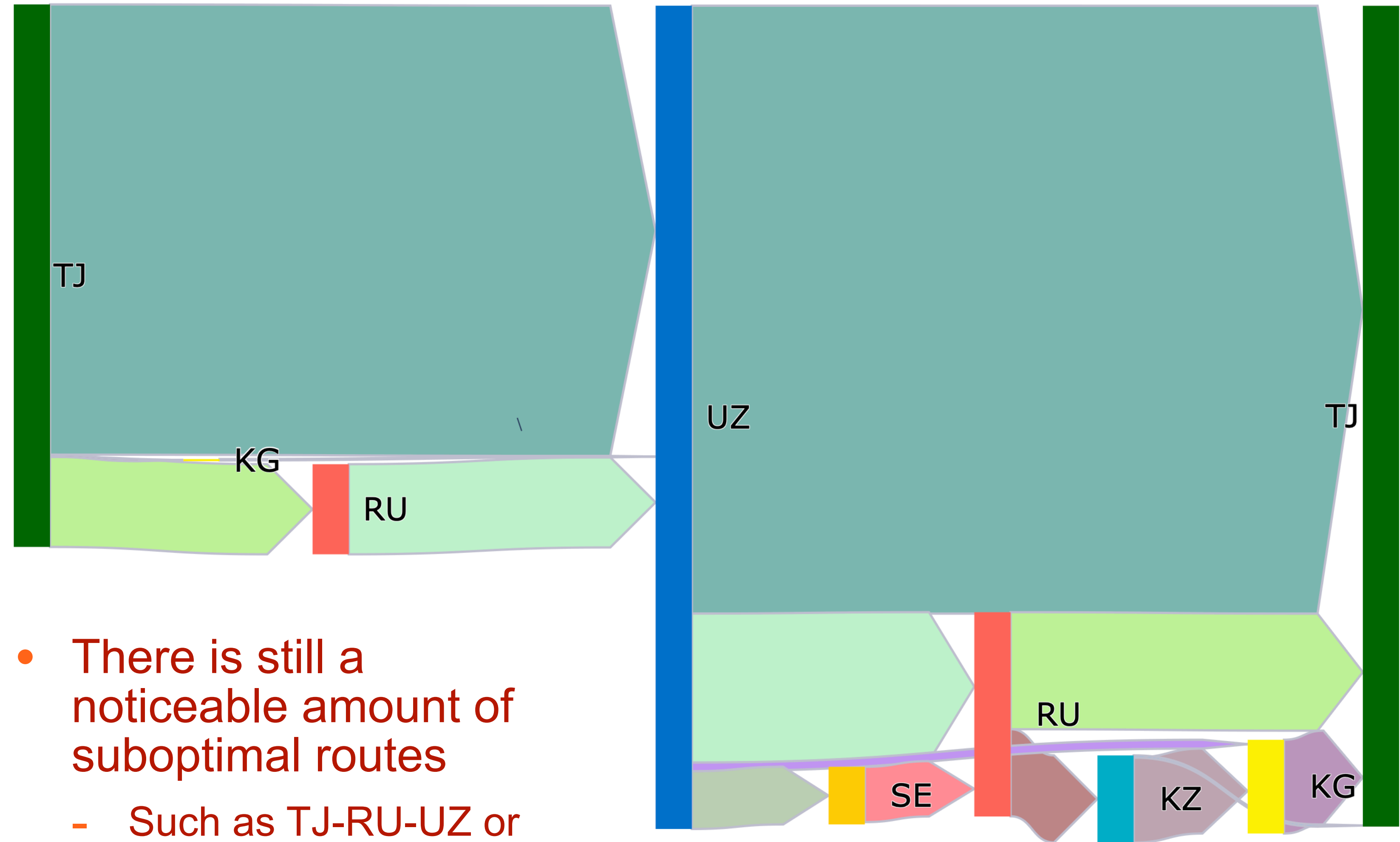


**Tajikistan →
Turkmenistan**

Tajikistan ↔ Uzbekistan, 2022



Tajikistan ↔ Uzbekistan, 2024



Changes

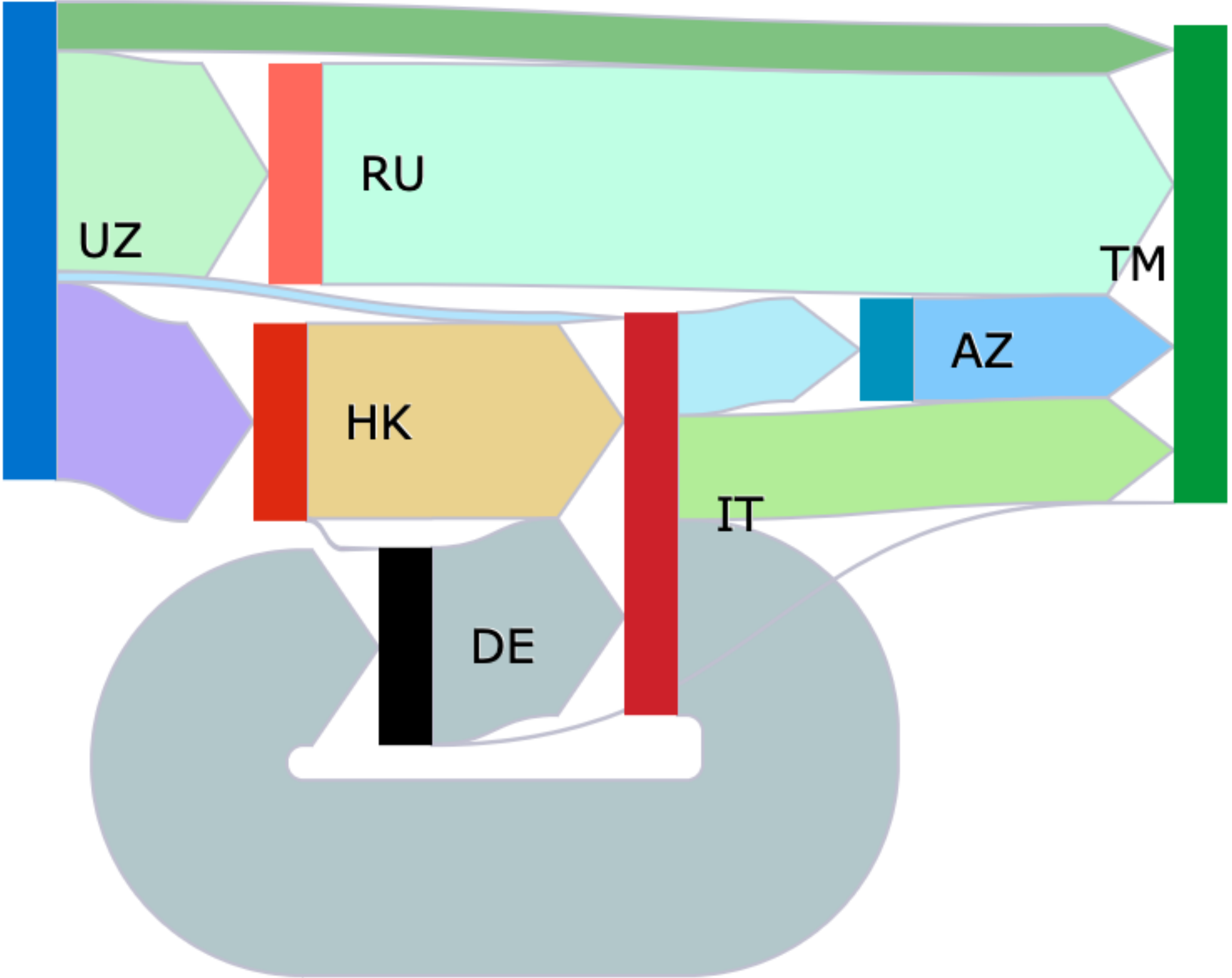
- Most routes are now direct
- High traffic asymmetry

- There is still a noticeable amount of suboptimal routes
 - Such as TJ-RU-UZ or UZ-SE-RU-KZ-KG-TJ



**Uzbekistan →
Turkmenistan**

Uzbekistan → Turkmenistan, 2022

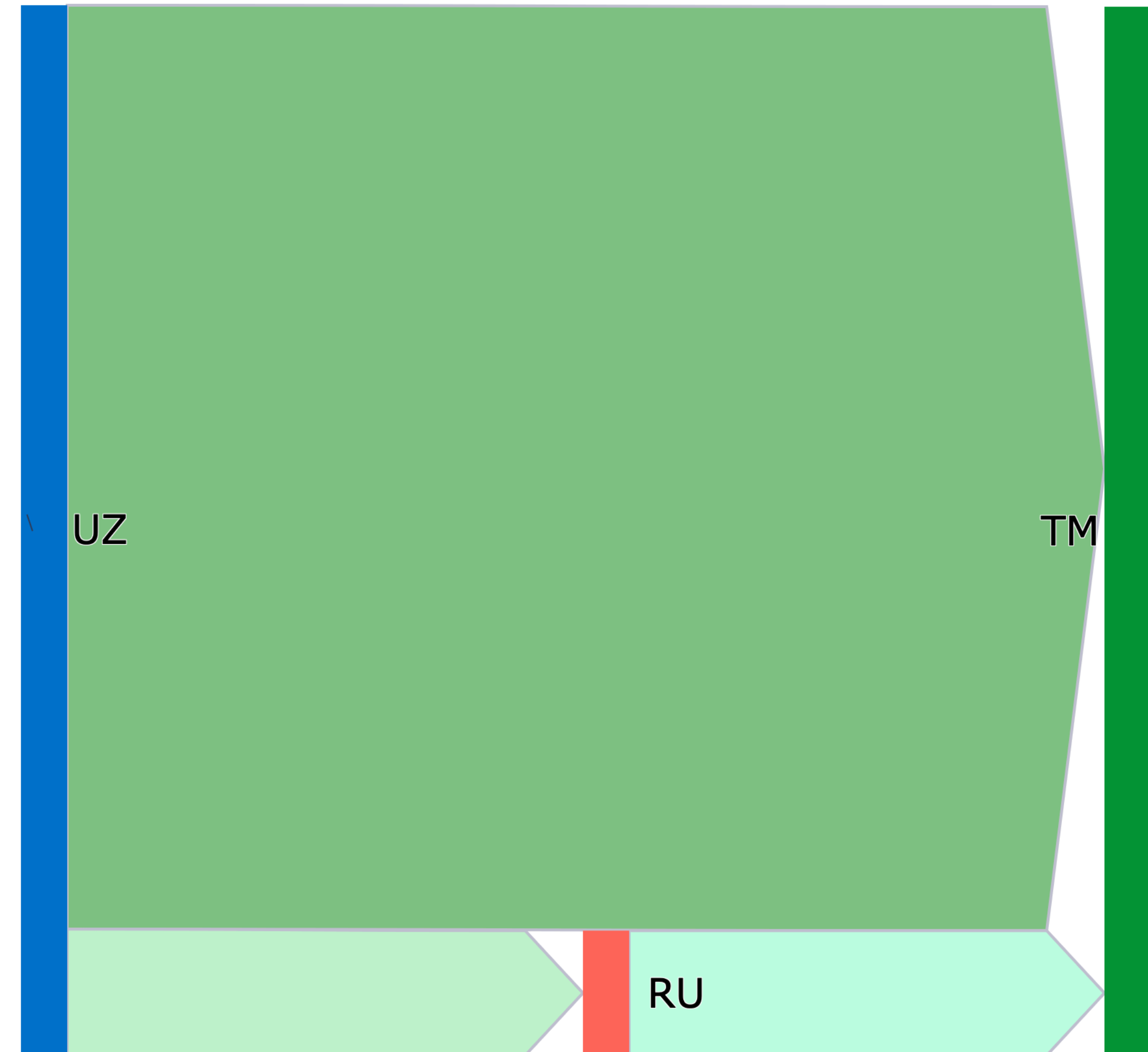


Uzbekistan → Turkmenistan, 2024



Changes

- Most routes are now direct
- The number of substantially suboptimal routes has decreased dramatically





Observations and conclusions

Observations and issues (1)



- Would be nice to have more probes: higher accuracy, better view
 - While the number for KG and UZ increased, KZ and TJ showed a decreasing
- Main players changes
 - Russia is no longer the major transit country of the region, which is logical
 - Now it looks like Uzbekistan is in first place
 - Kazakhstan is still in the second place
- The number of suboptimal traffic transit routes is still too high
 - And some of them are far too suboptimal
 - The global operators' internal decisions and peering wars of other players have a great impact on the region

Observations and issues (2)



- The regional telecom industry is active and developing fast!
 - One can see the active development of Kyrgyzstan
 - Uzbekistan's tremendous progress is visible
- Traffic between countries in the region is becoming more and more localized
 - As it should be
- Diversification of routes by countries has become much better!
 - But traffic asymmetry is still quite high

Observations and issues (3)



- Minor routes around the whole world are not a good thing
 - Significant RTT and jitter degradation
 - Unstable parameters of connections
- The list of global operators that carry intra-regional traffic of Central Asia around the whole world has increased
 - Now they are: RETN, Level3, China Mobile, and Cogent

Observations and issues (4)



- All countries increased the number of cross-border operators
- Tata has left the region
- Russia is much more noticeable on Control Plane than on Data Plane
 - Reasons to be studied separately
- Radically new routes have emerged (Pakistan)

Conclusion and proposal



- There is still tremendous room for improvement
- **Our Central Asia Peering and Interconnection Forum today is a great opportunity to agree on such improvements**
- If you'd like to hear a more detailed analysis or discuss the development of this project (or some part of it), we're here for you.
- And feel free to contact: **asemenyaka@ripe.net**



Questions



asemenyaka@ripe.net