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?

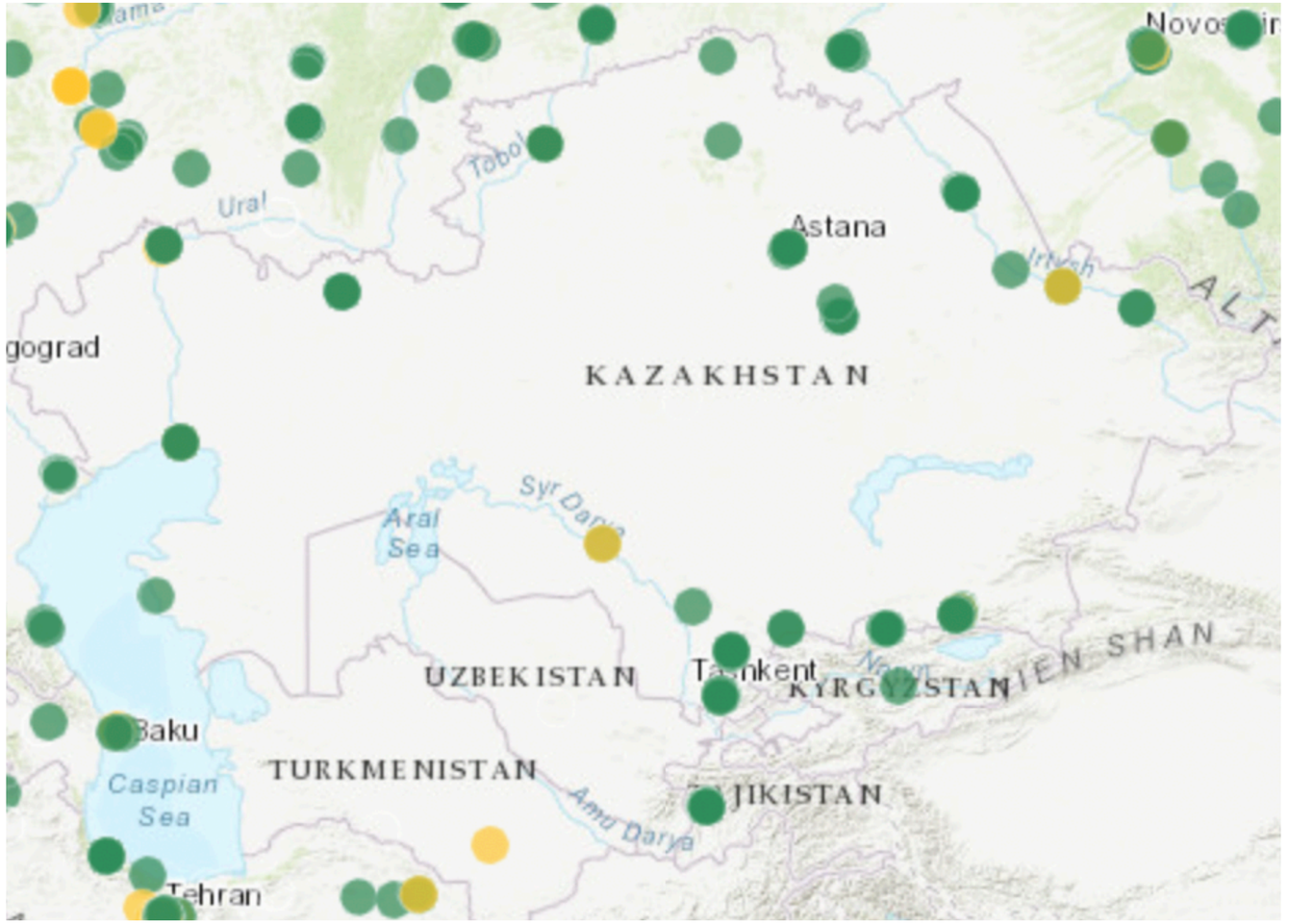
RIPE Atlas is the RIPE NCC's main Internet data collection system. It is a global network of devices, called probes and anchors, that actively measure Internet connectivity. Anyone can access this data via Internet traffic maps, streaming data visualisations, and an API. RIPE Atlas users can also perform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

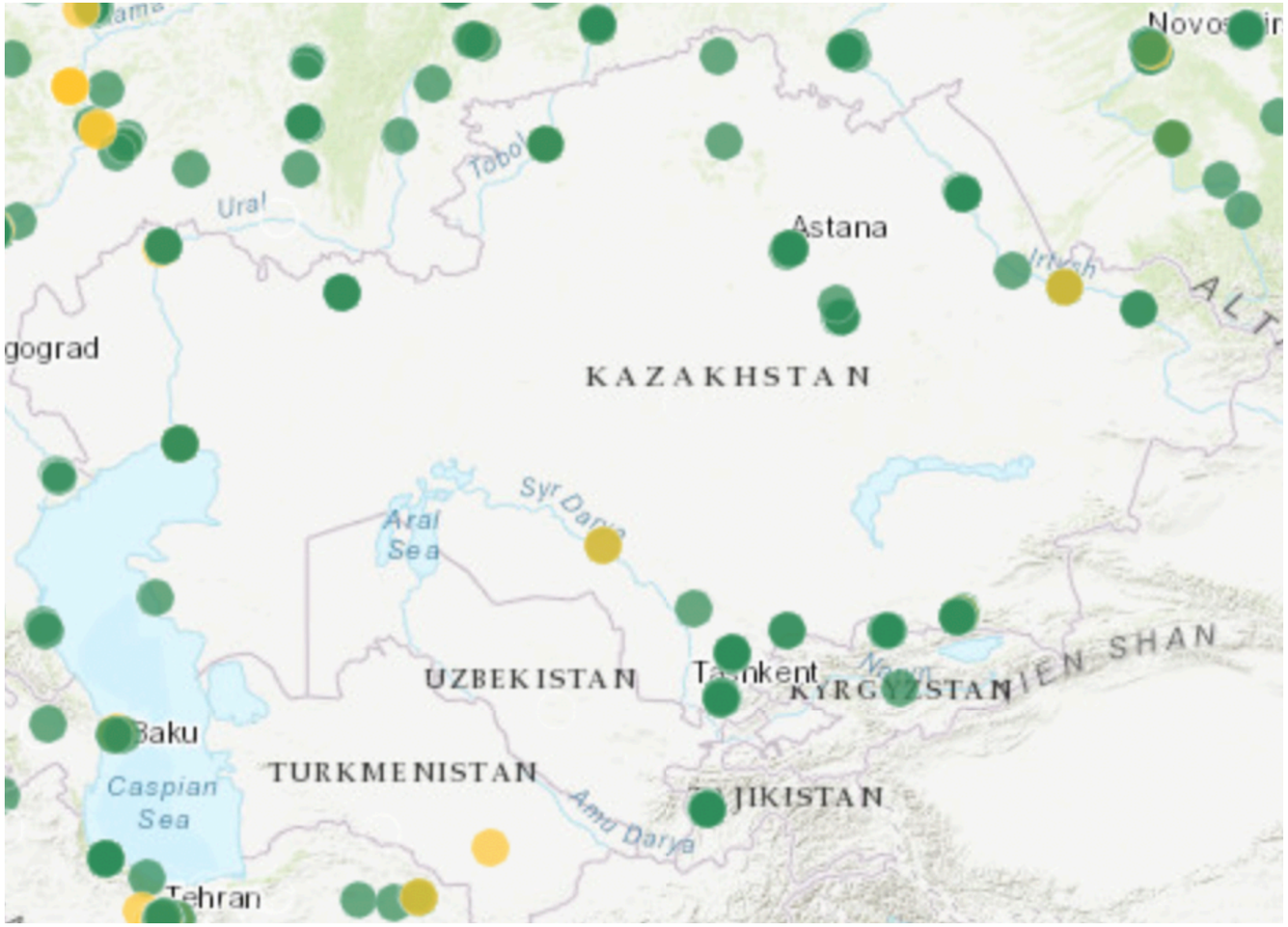
RIS is a routing data collection platform. It collects data on BGP, the protocol by which traffic is routed between networks on the Internet. By collecting this data, RIS improves our understanding of the global Internet routing system.

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.

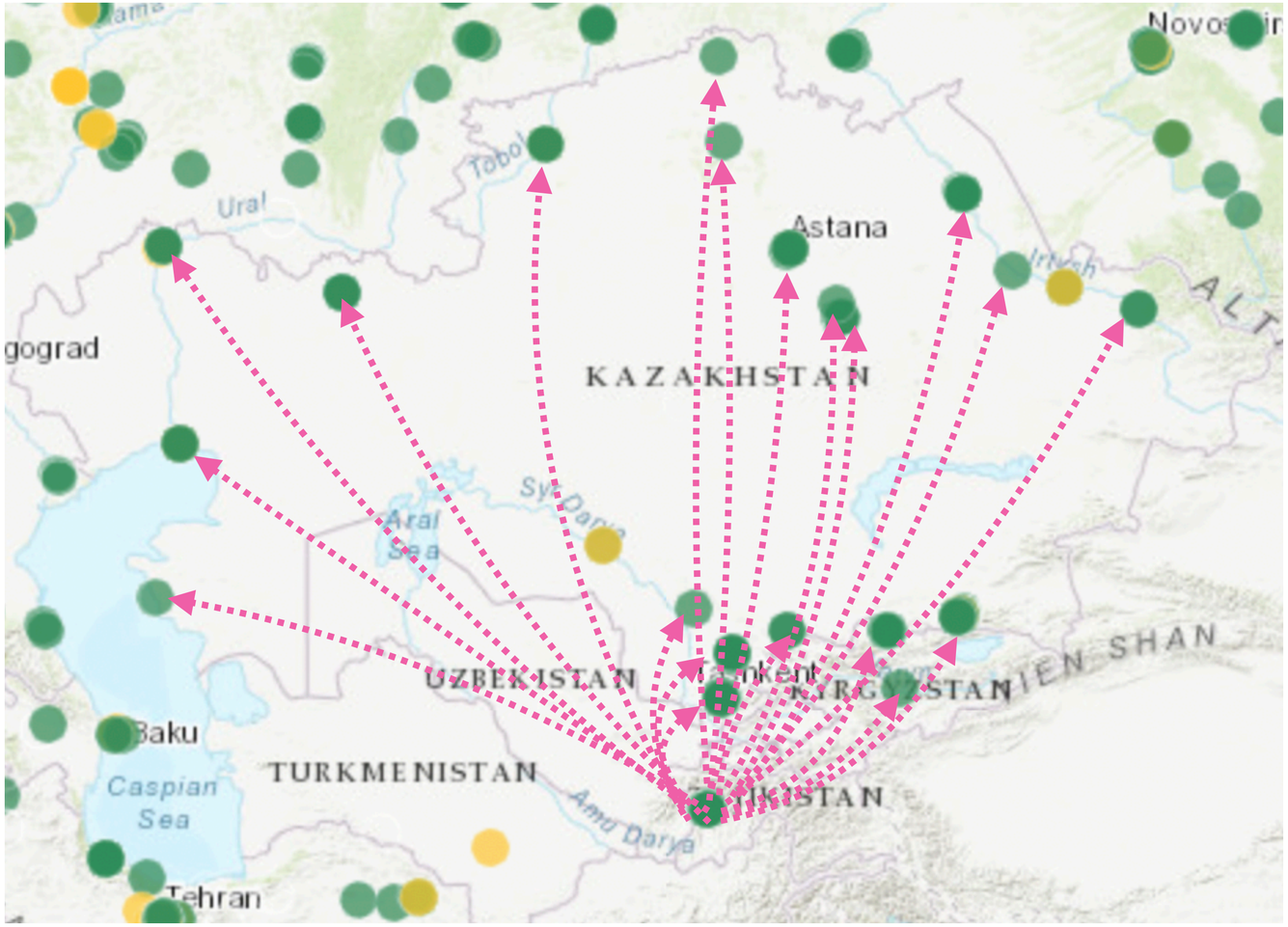
# Methodology

# What we do



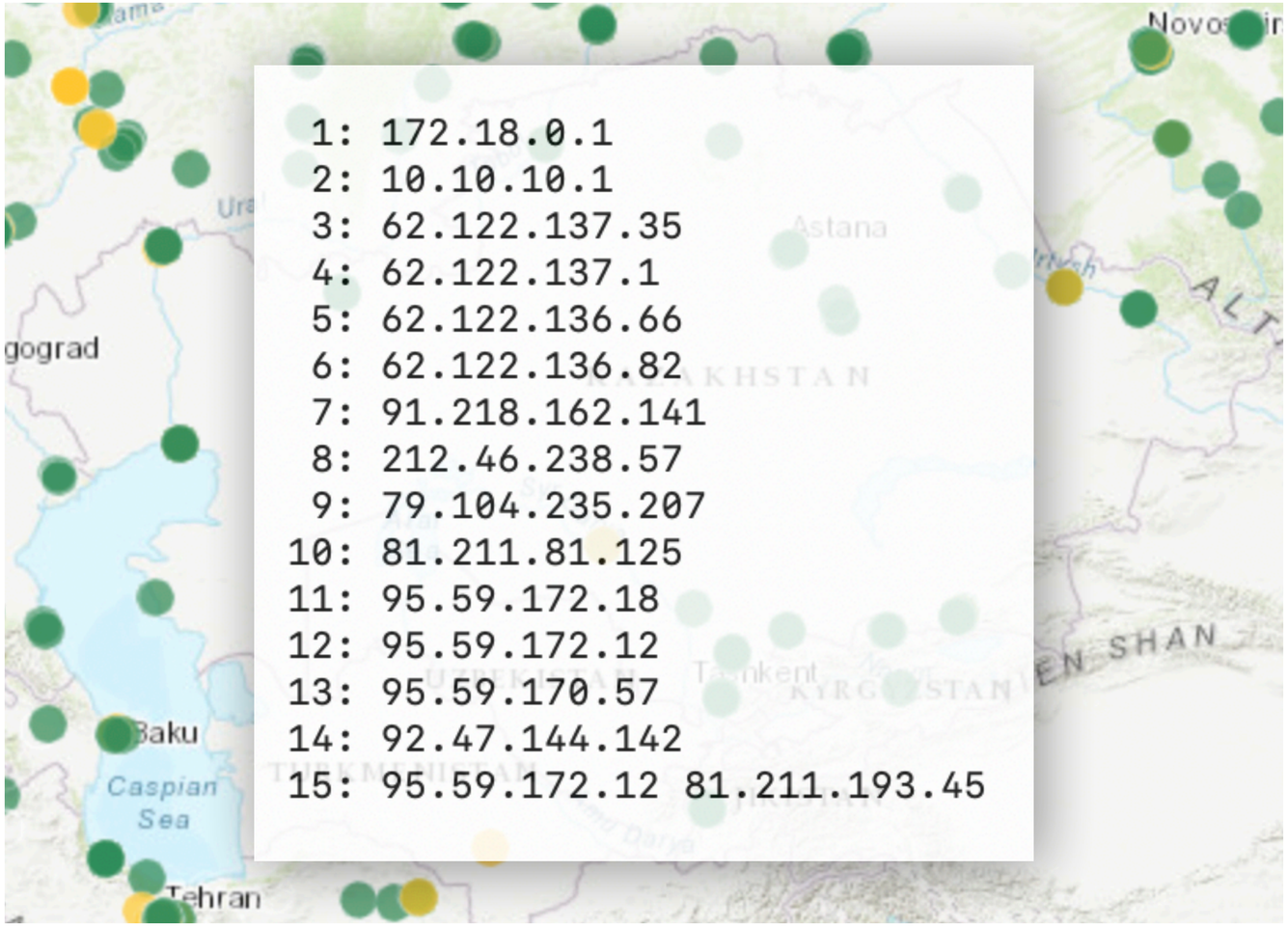

- Sources: all Atlas probes in a country

# 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

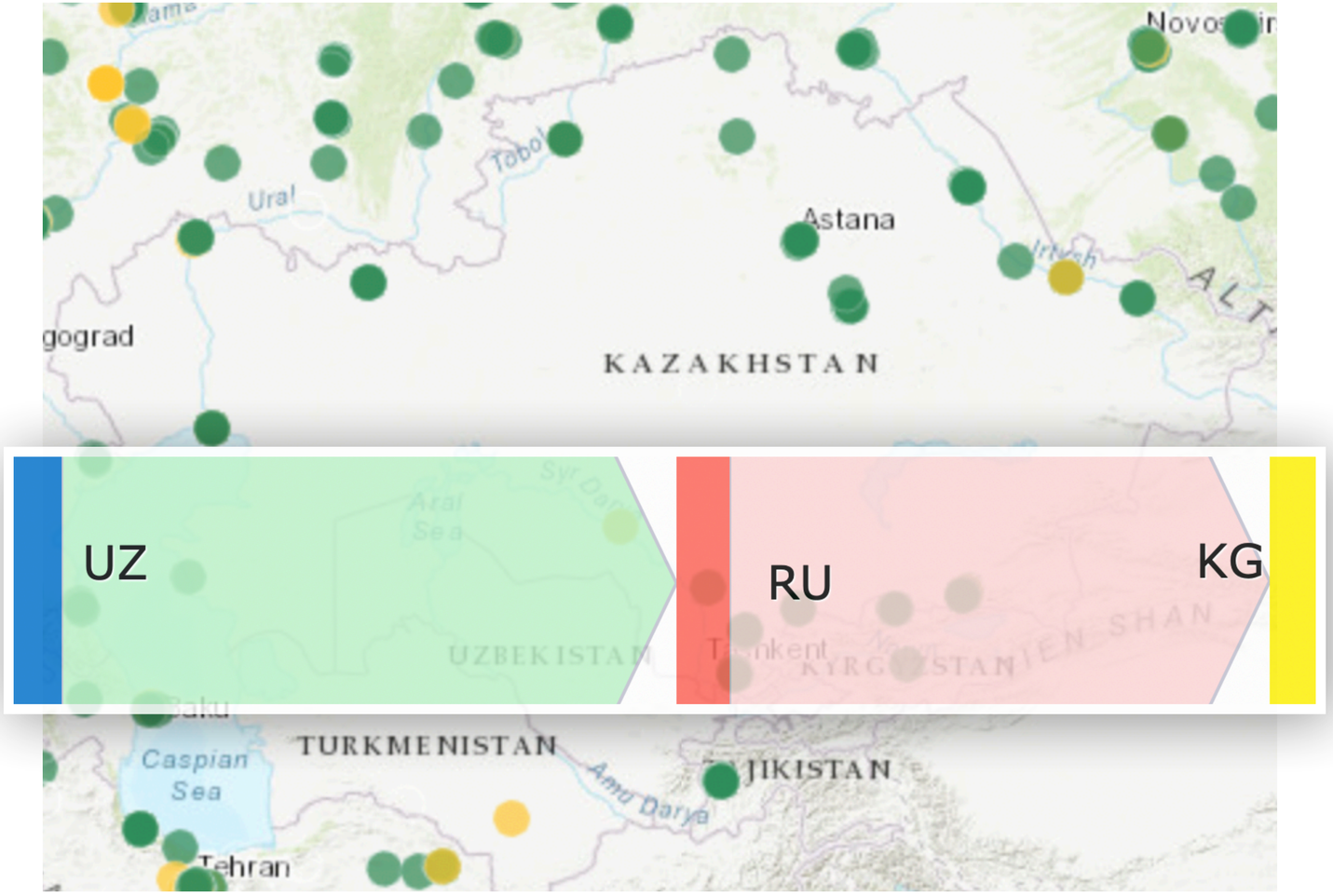



- Sources: all Atlas probes in a country
- Destination points: Atlas probes in other countries plus some additional hosts
- We do traceroute and get a sequence of the hops
  - For each source and destination we use all options: UDP, TCP, ICMP over both IPv4 and IPv6

# What we do

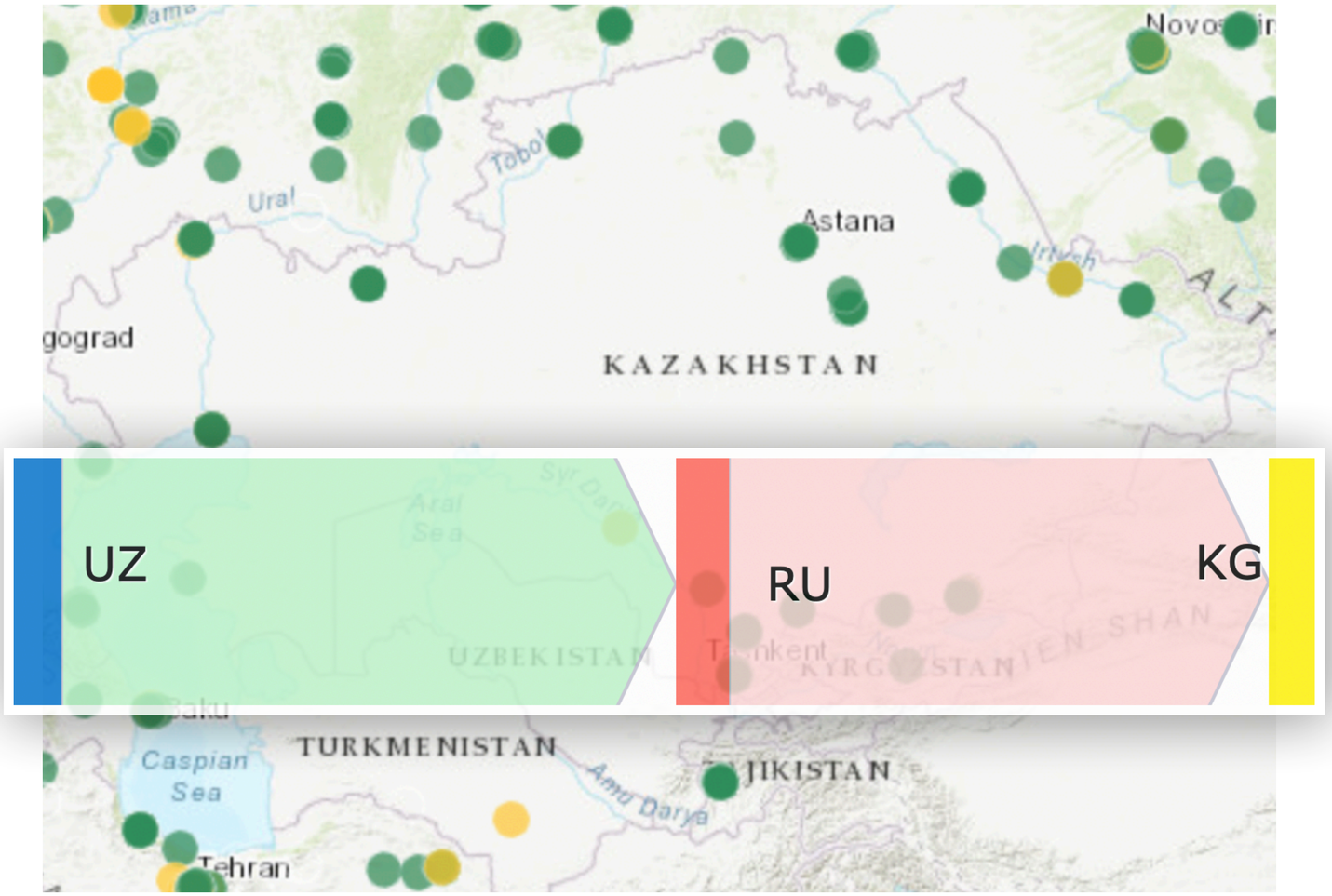

- Sources: all Atlas probes in a country
- Destination points: Atlas probes in other countries plus some additional hosts
- We do traceroute and get a sequence of the hops
- By associating each hop with a country we get a chain of countries

# 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

# 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

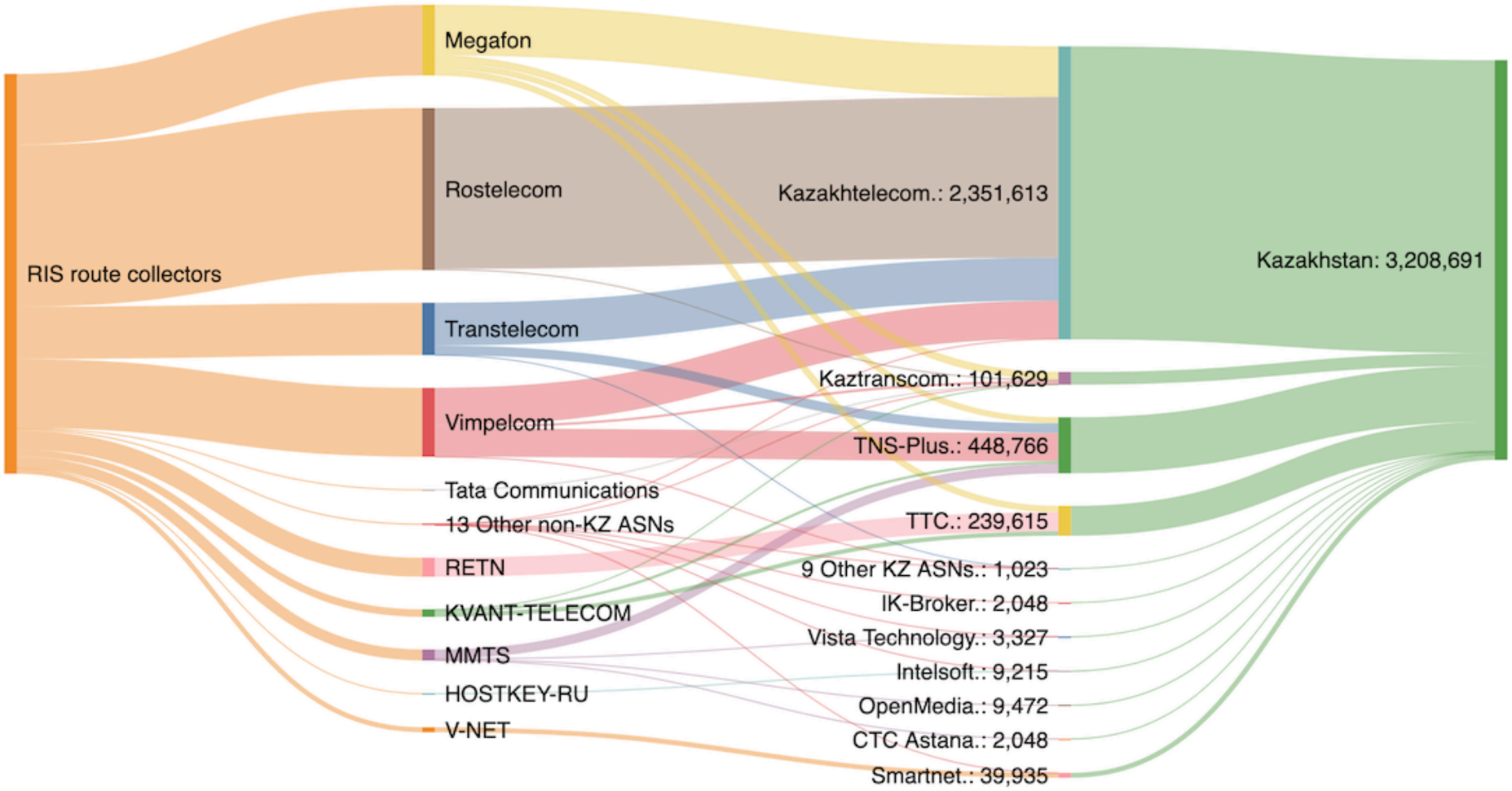
# Eh… And can we believe results?

- 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

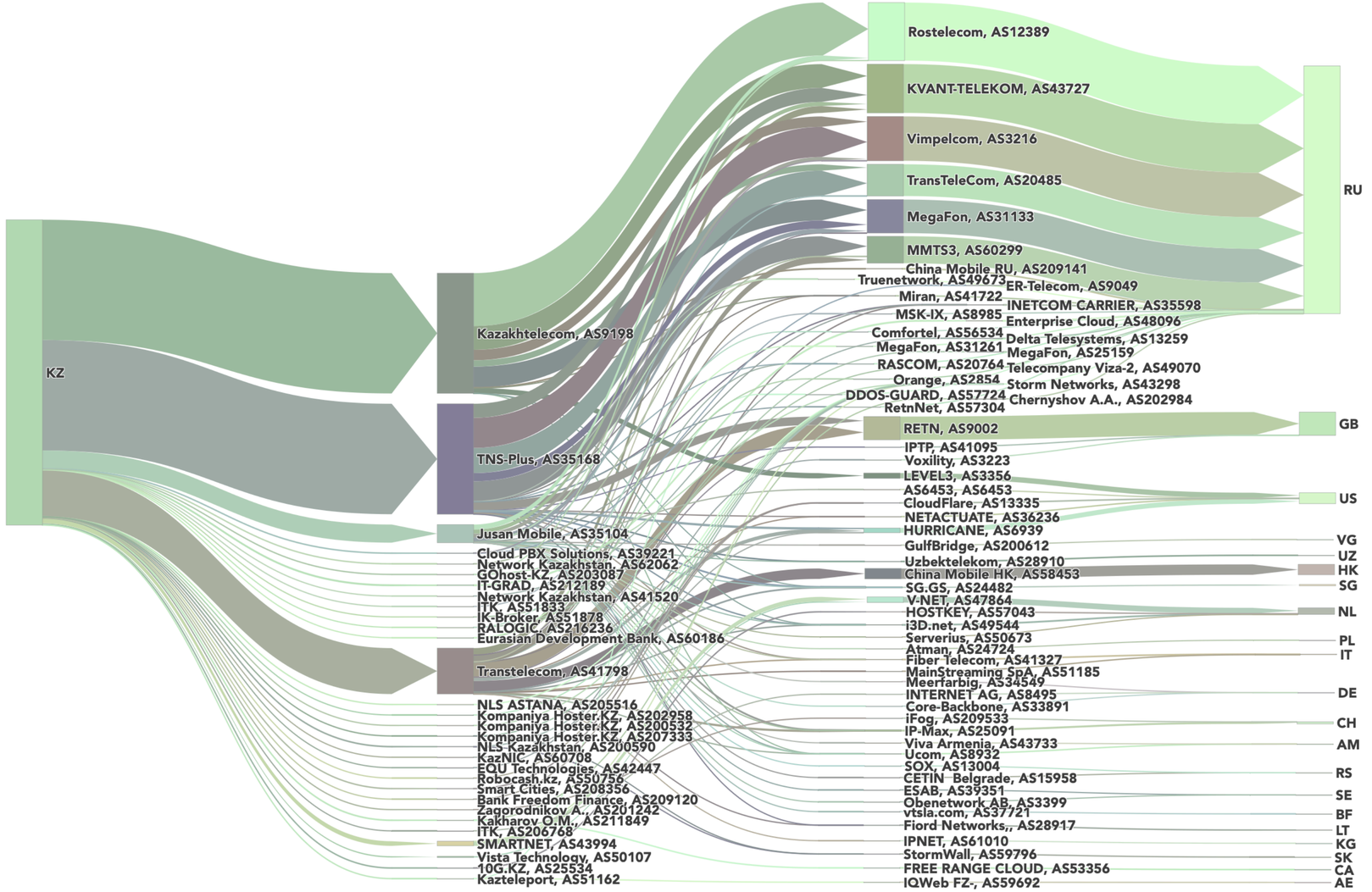
# Kazakhstan paths to outside, 2022

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

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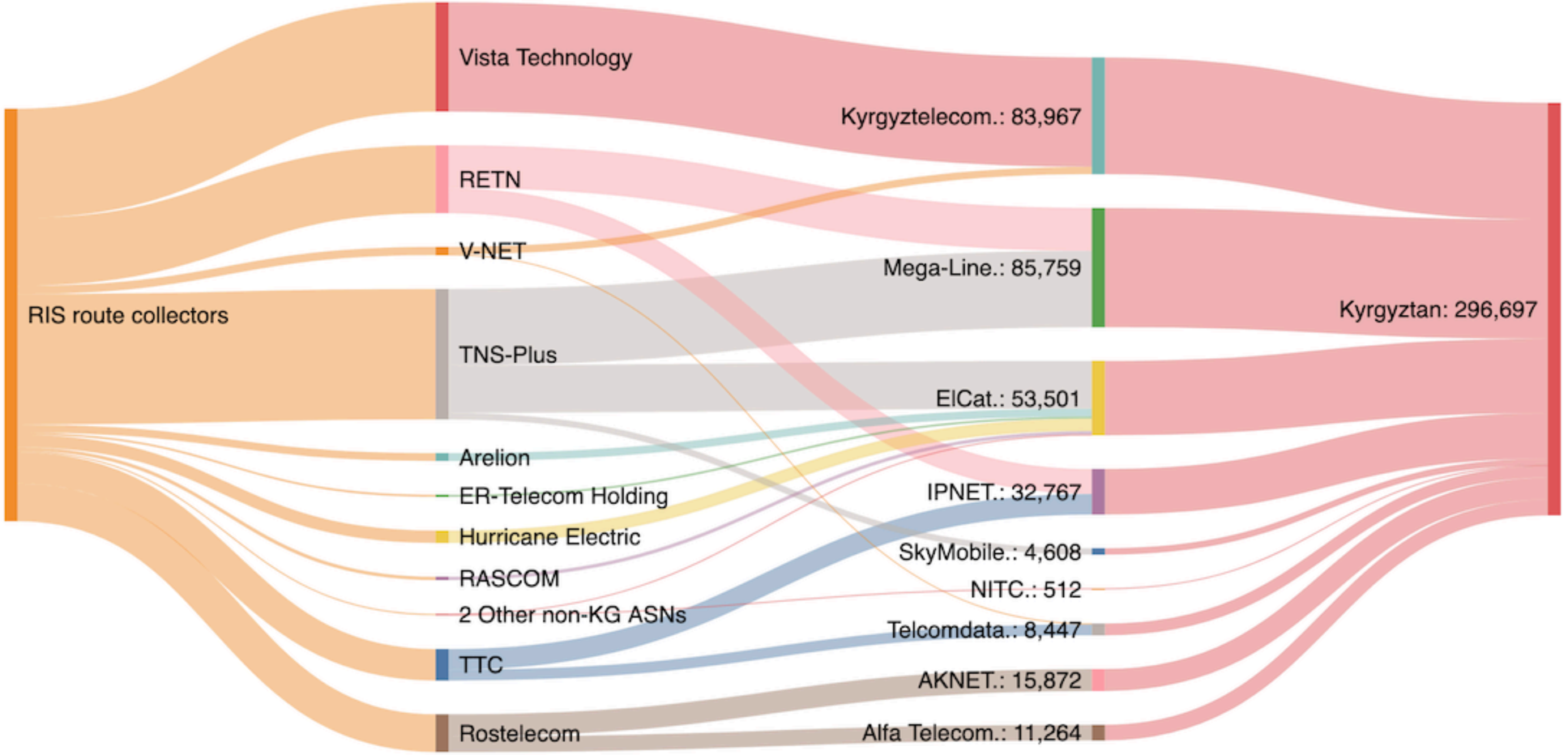
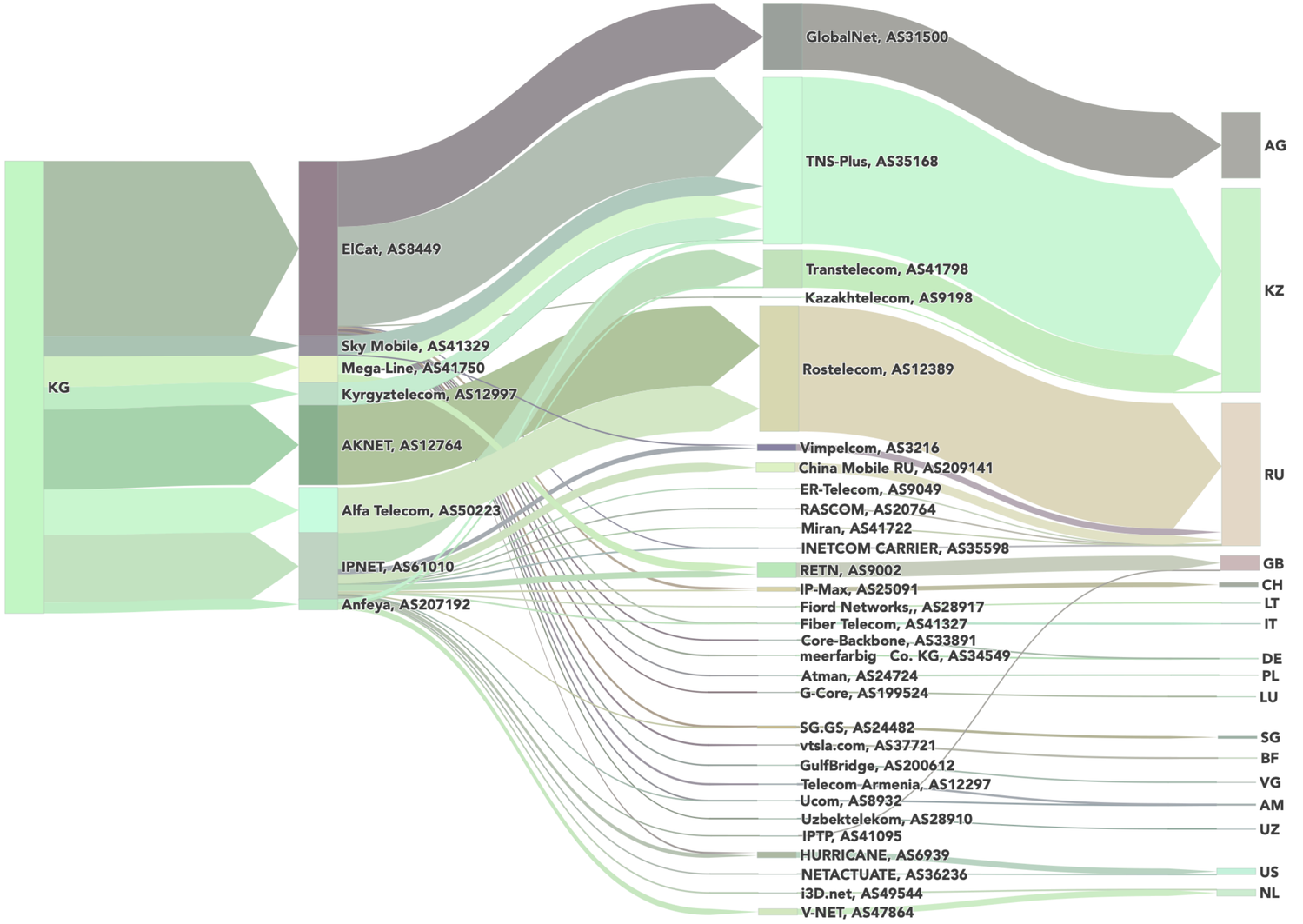


# Kyrgyzstan paths to outside

- *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

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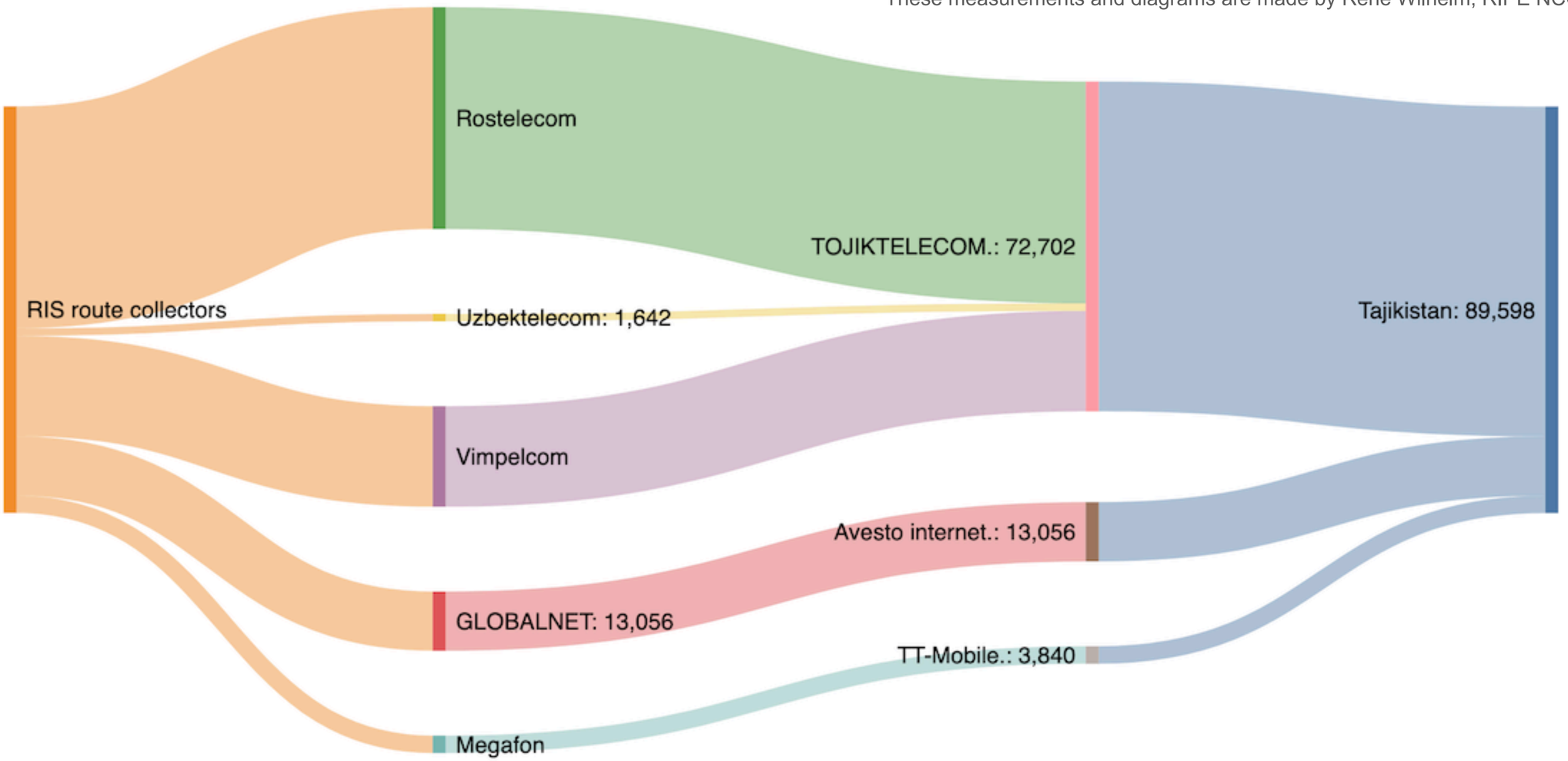
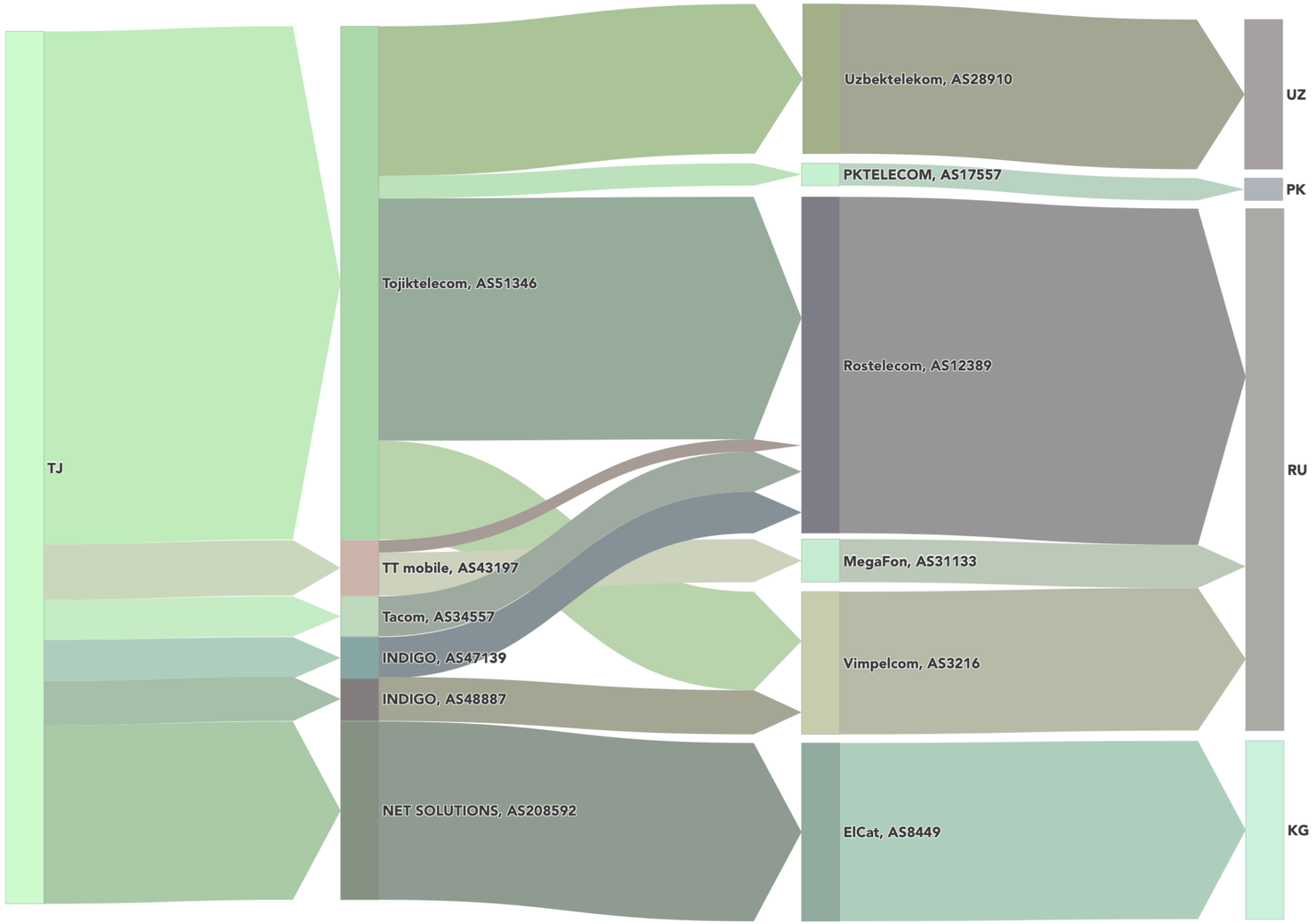


# Tajikistan paths to outside

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



# Turkmenistan paths to outside, 2022

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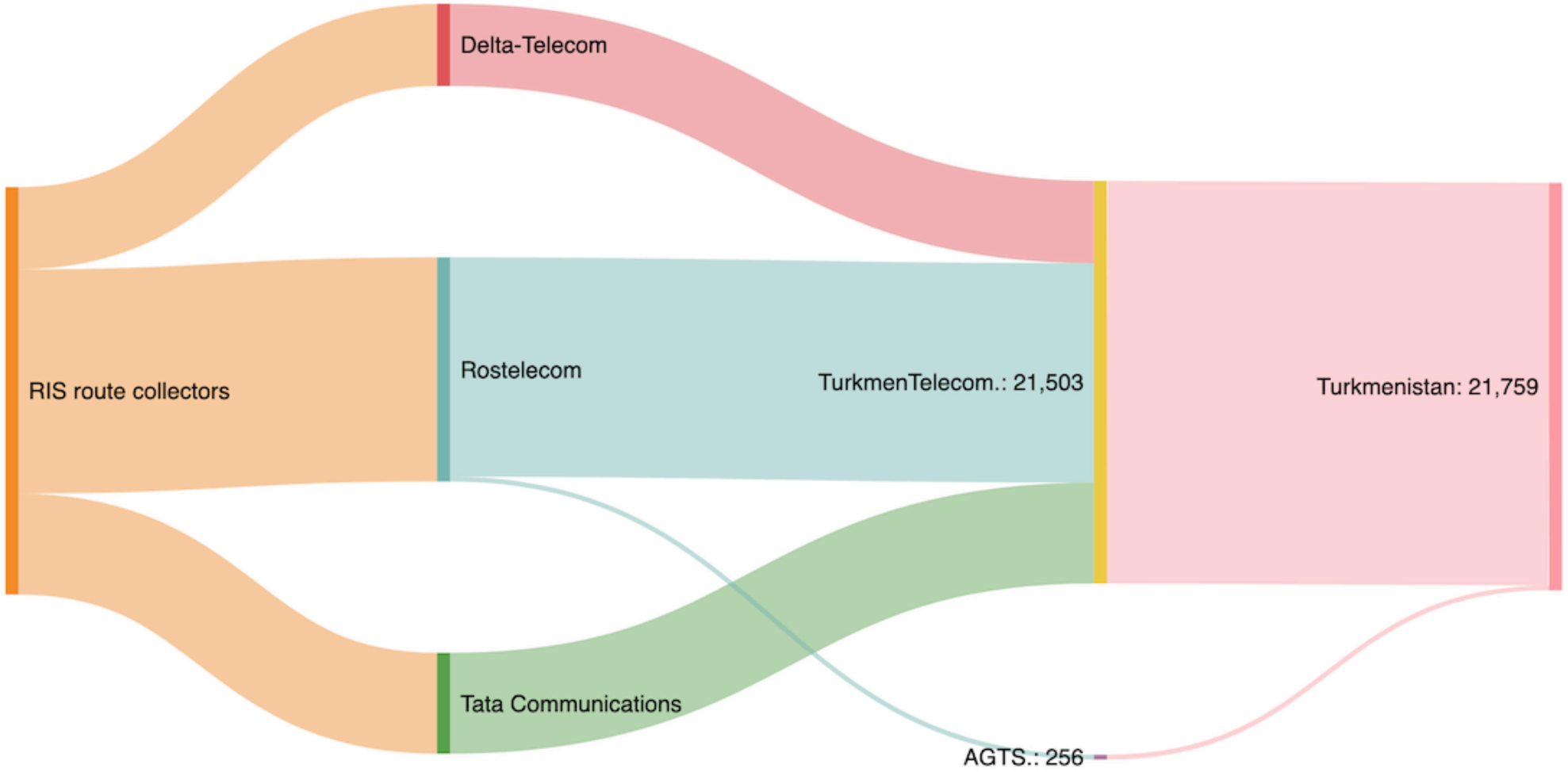
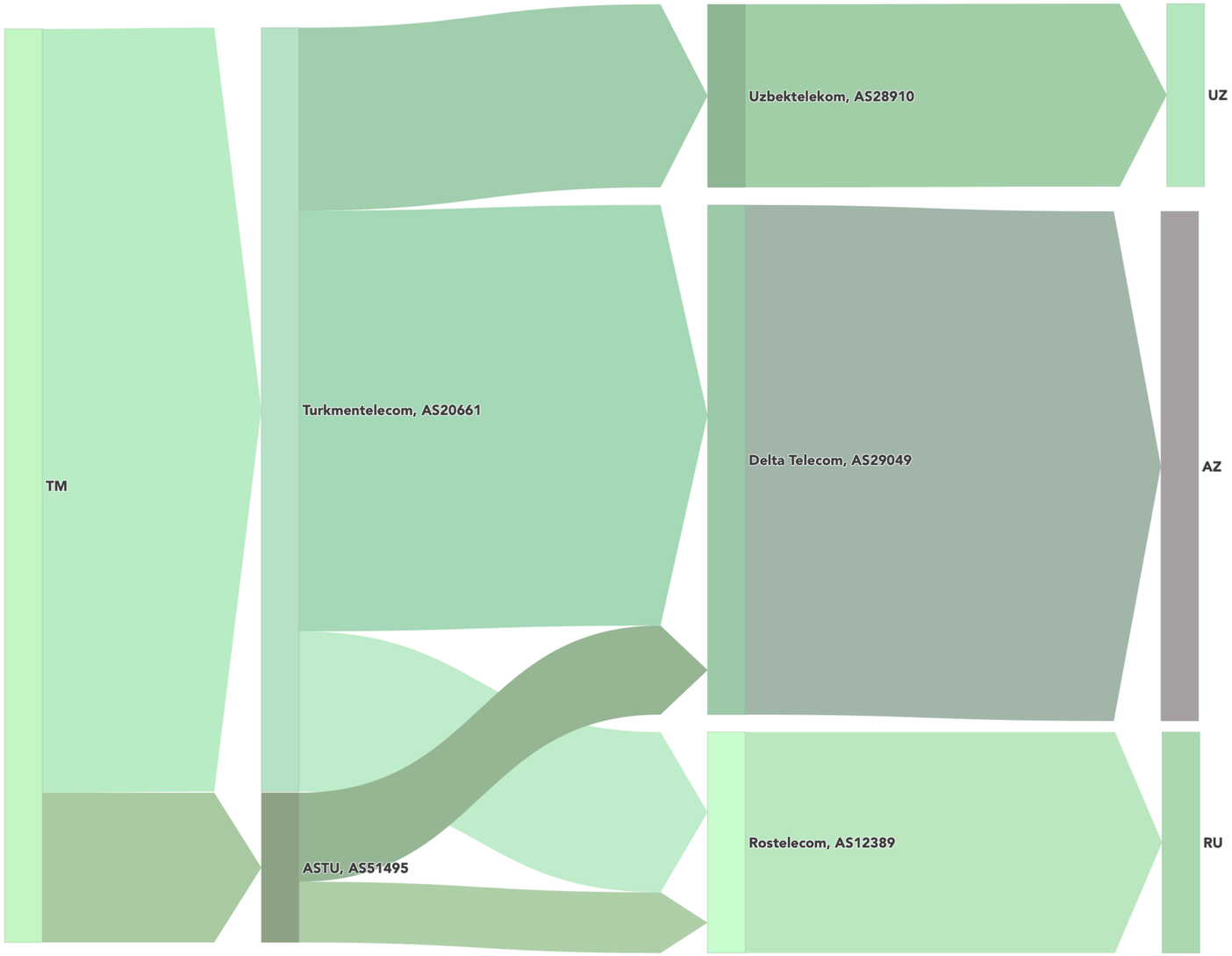


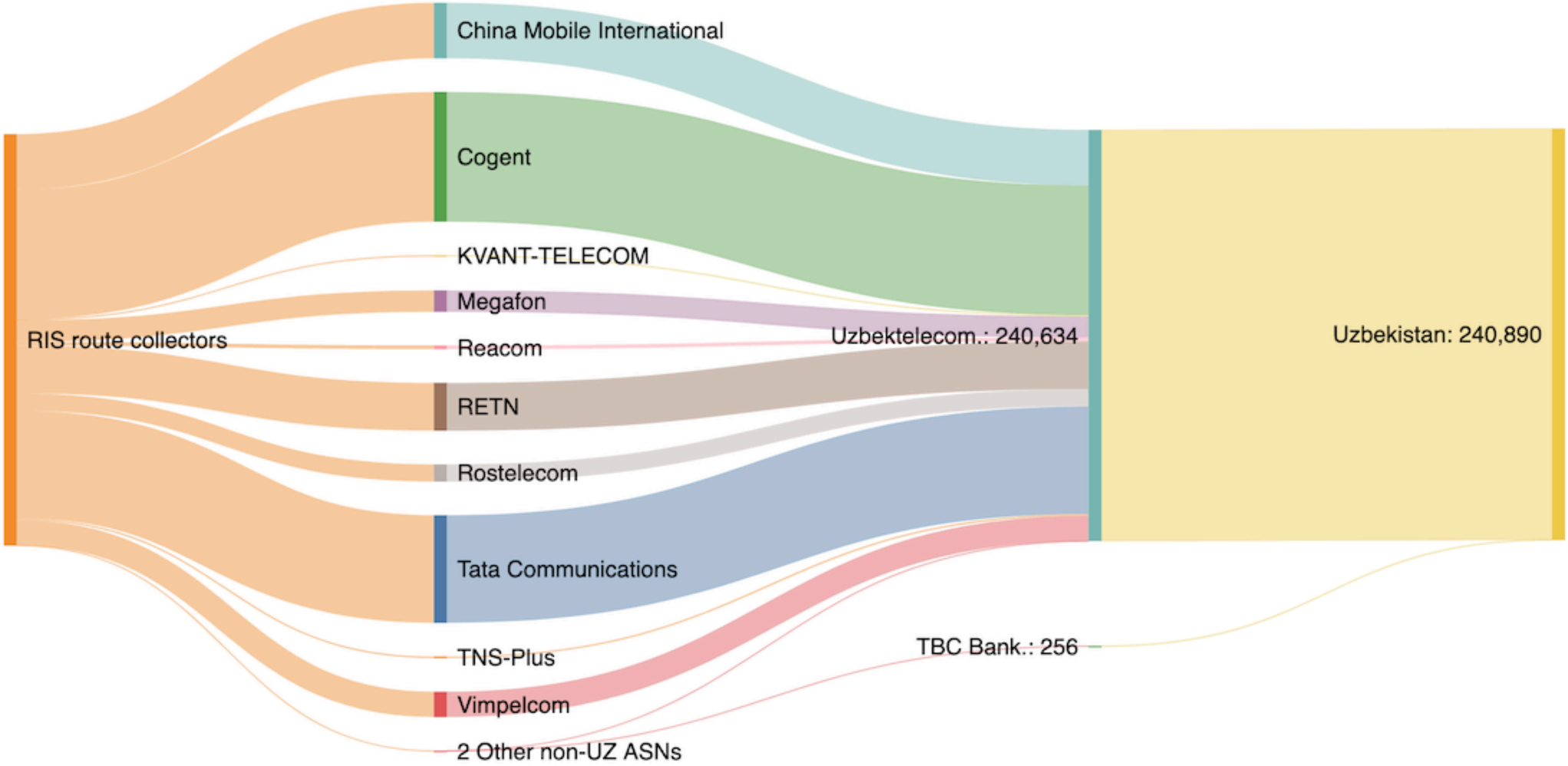
# Turkmenistan paths to outside

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



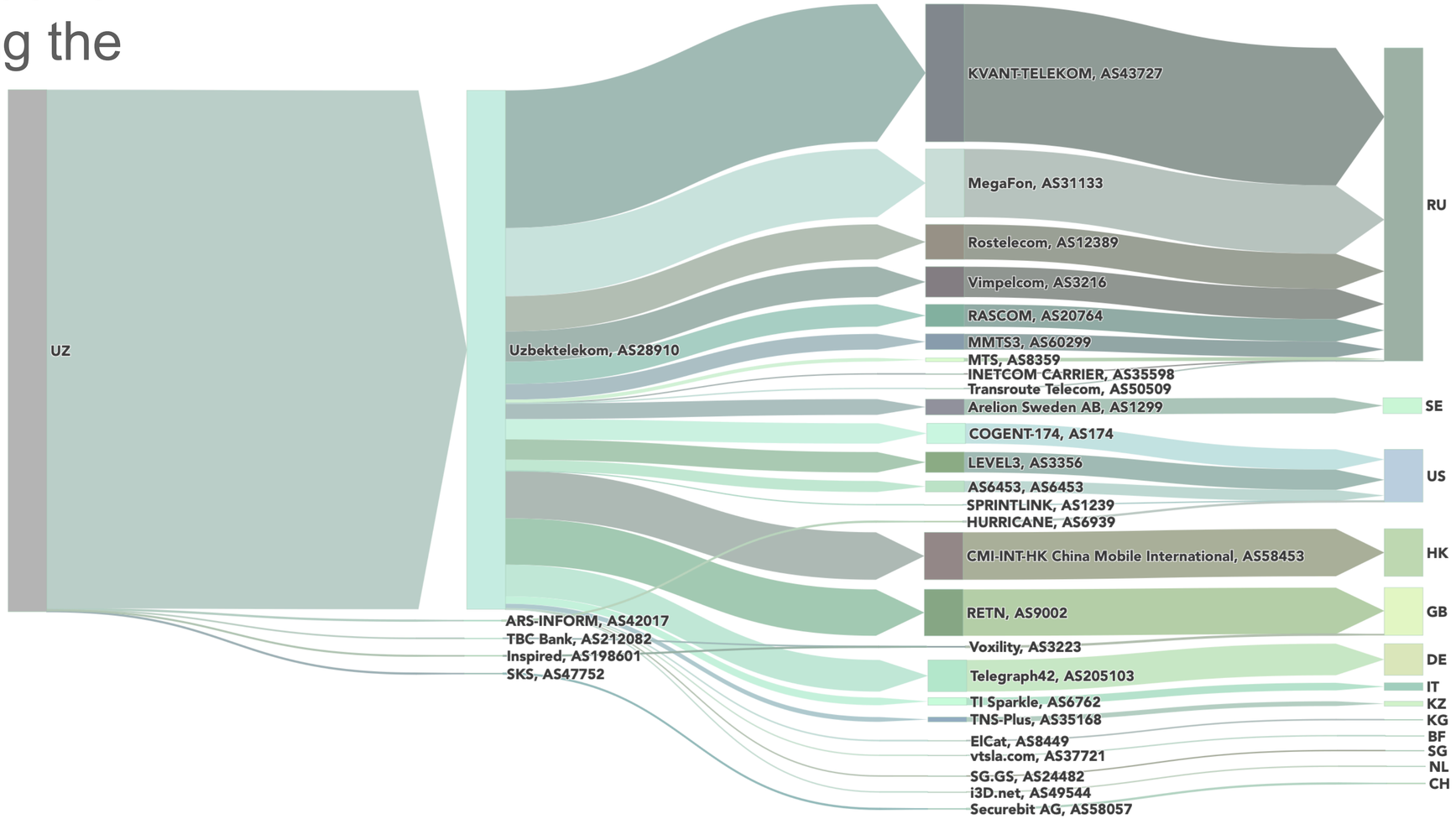
# Uzbekistan paths to outside, 2022

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

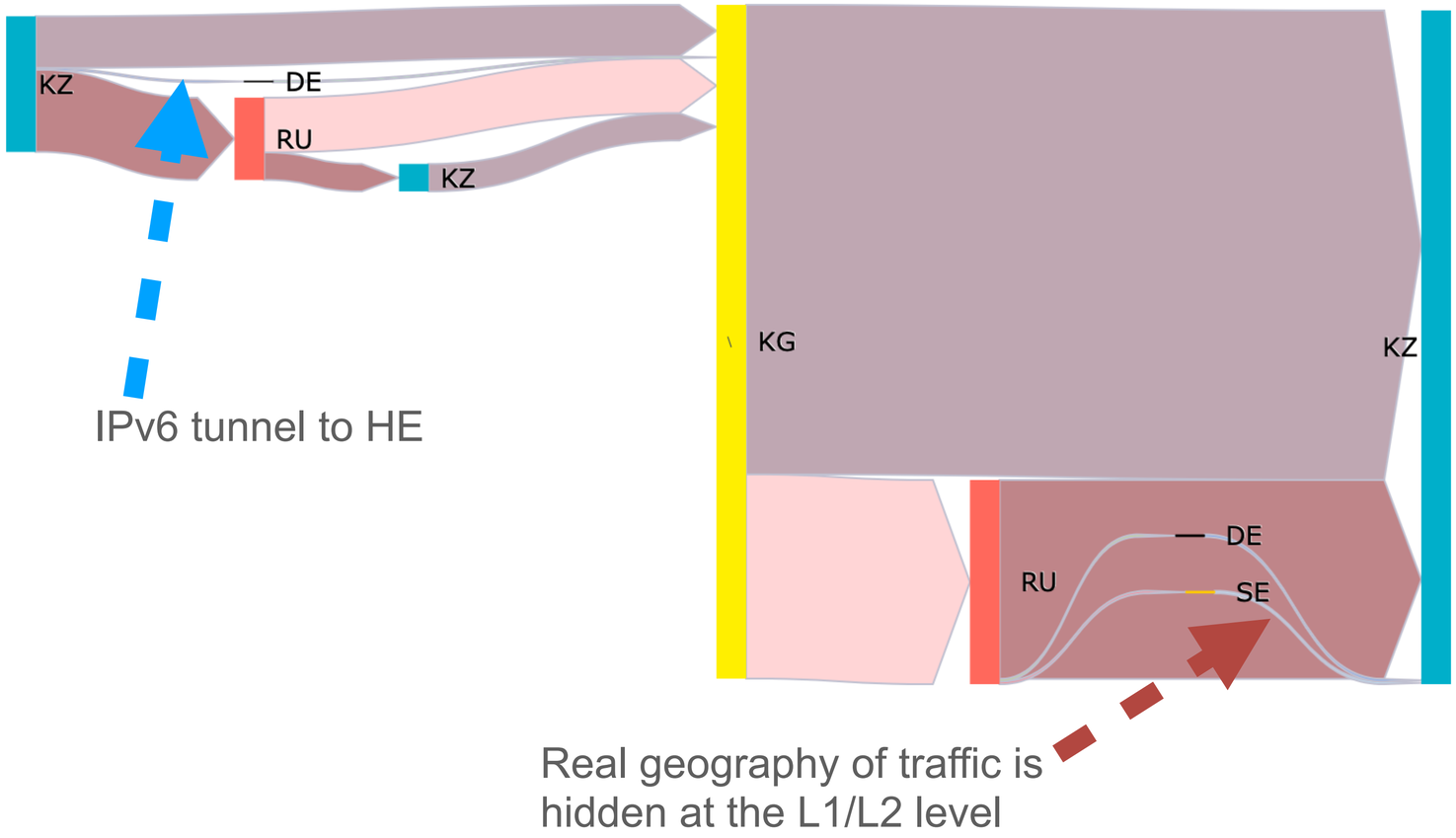


# Data plane

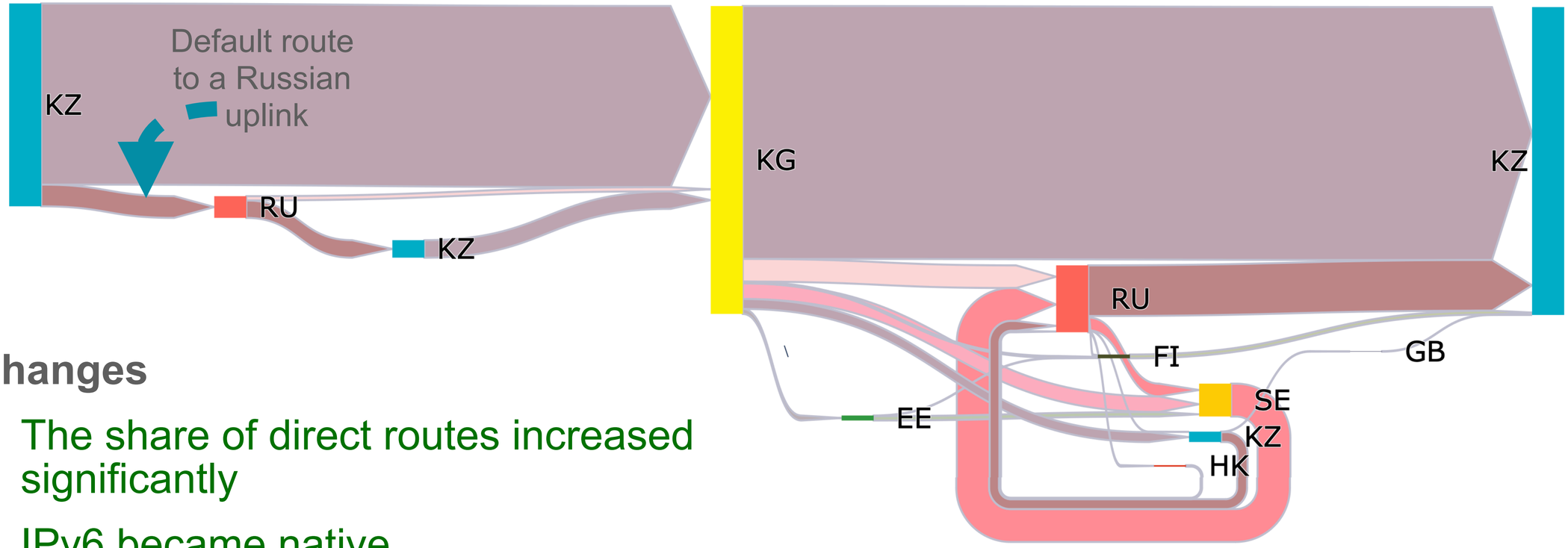
## Traceroutes analysis

# Kazakhstan ⇿ Kyrgyzstan

# Kazakhstan ⇿ Kyrgyzstan, 2022



# Kazakhstan ↭ Kyrgyzstan, 2024



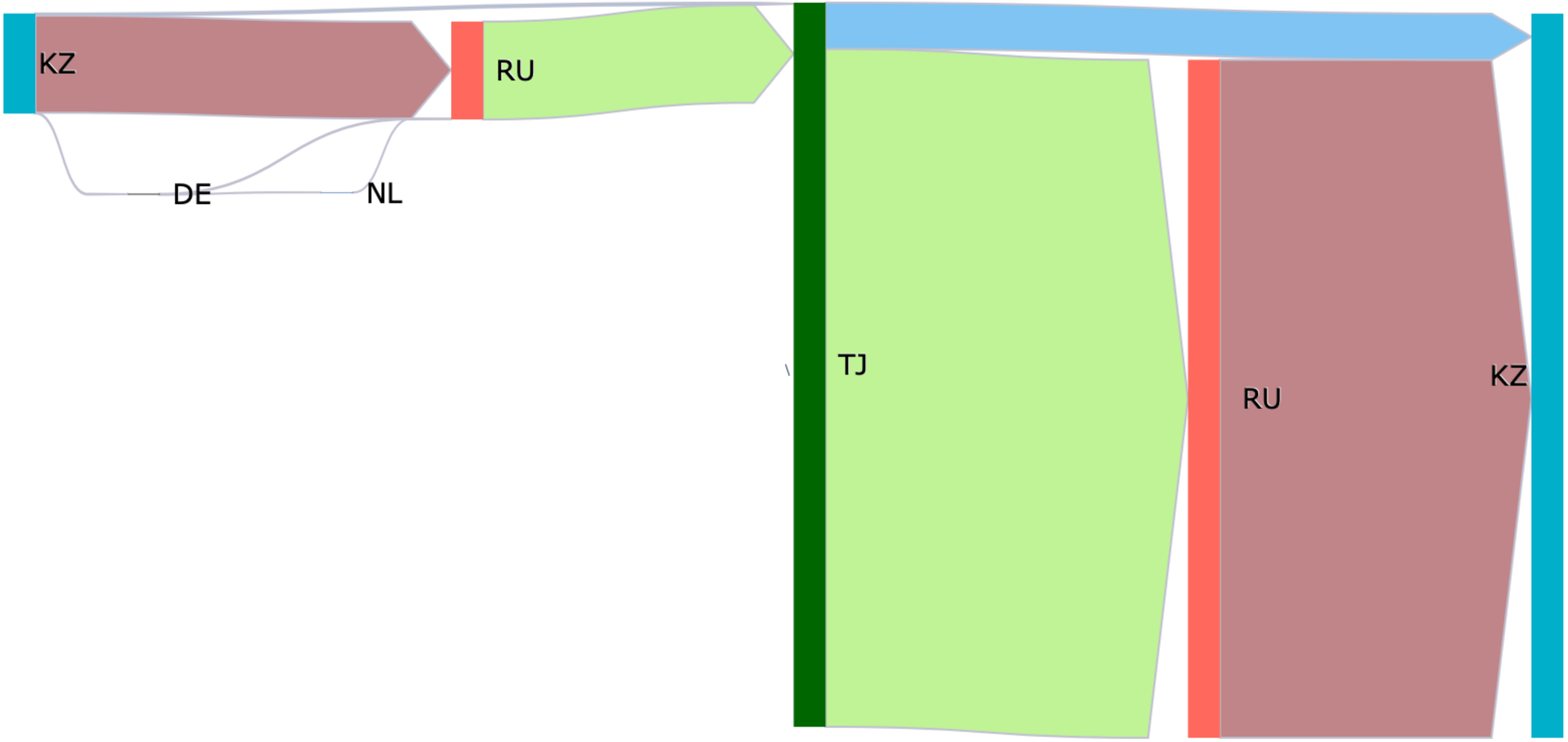

**Changes**

- The share of direct routes increased significantly
- IPv6 became native
- The variety of routes has increased significantly
  - Most often these routes are sub-optimal

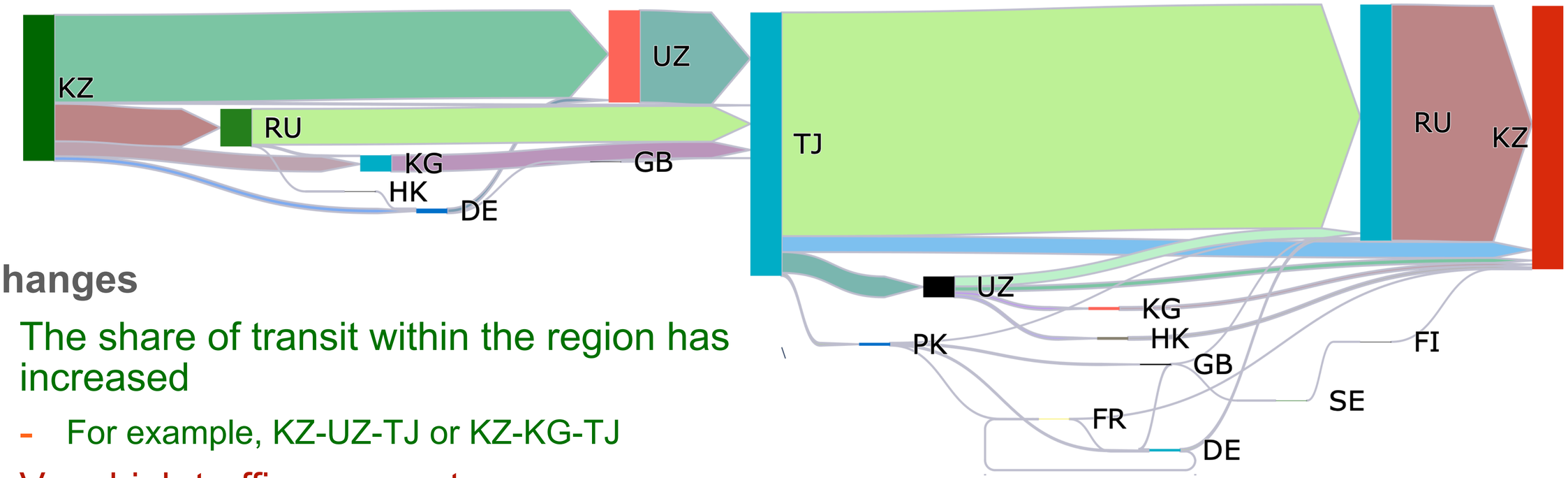
- There's still a lot of traffic tromboning
  - Such as KZ-RU-KZ-KG
  - Standard behaviour of Transtelecom's "daughters"

# Kazakhstan ⇿ Tajikistan

# Kazakhstan ⇿ Tajikistan, 2022



# Kazakhstan ⇿ Tajikistan, 2024

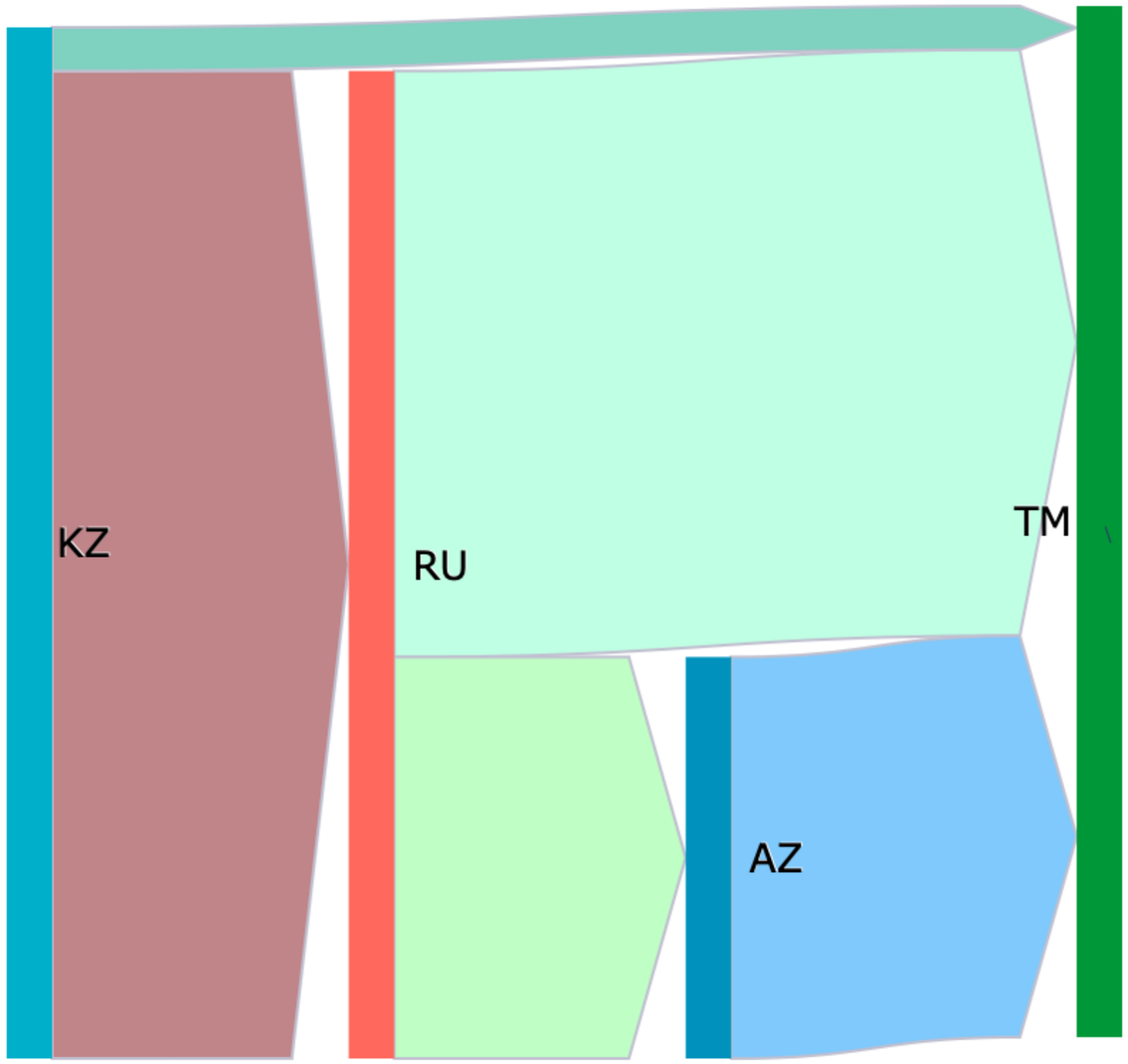



## Changes

- 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

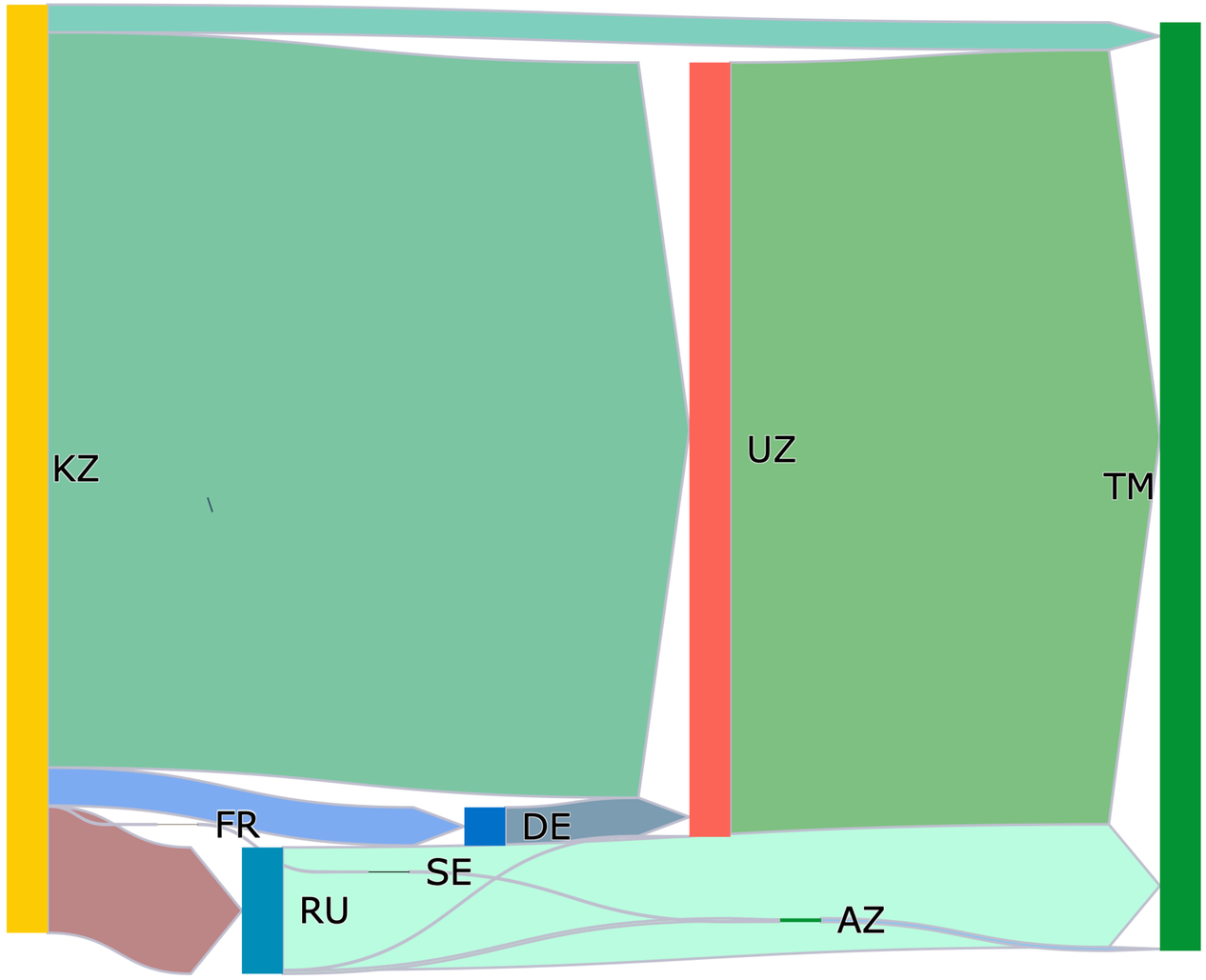
# Kazakhstan → Turkmenistan, 2022



# Kazakhstan → Turkmenistan, 2024

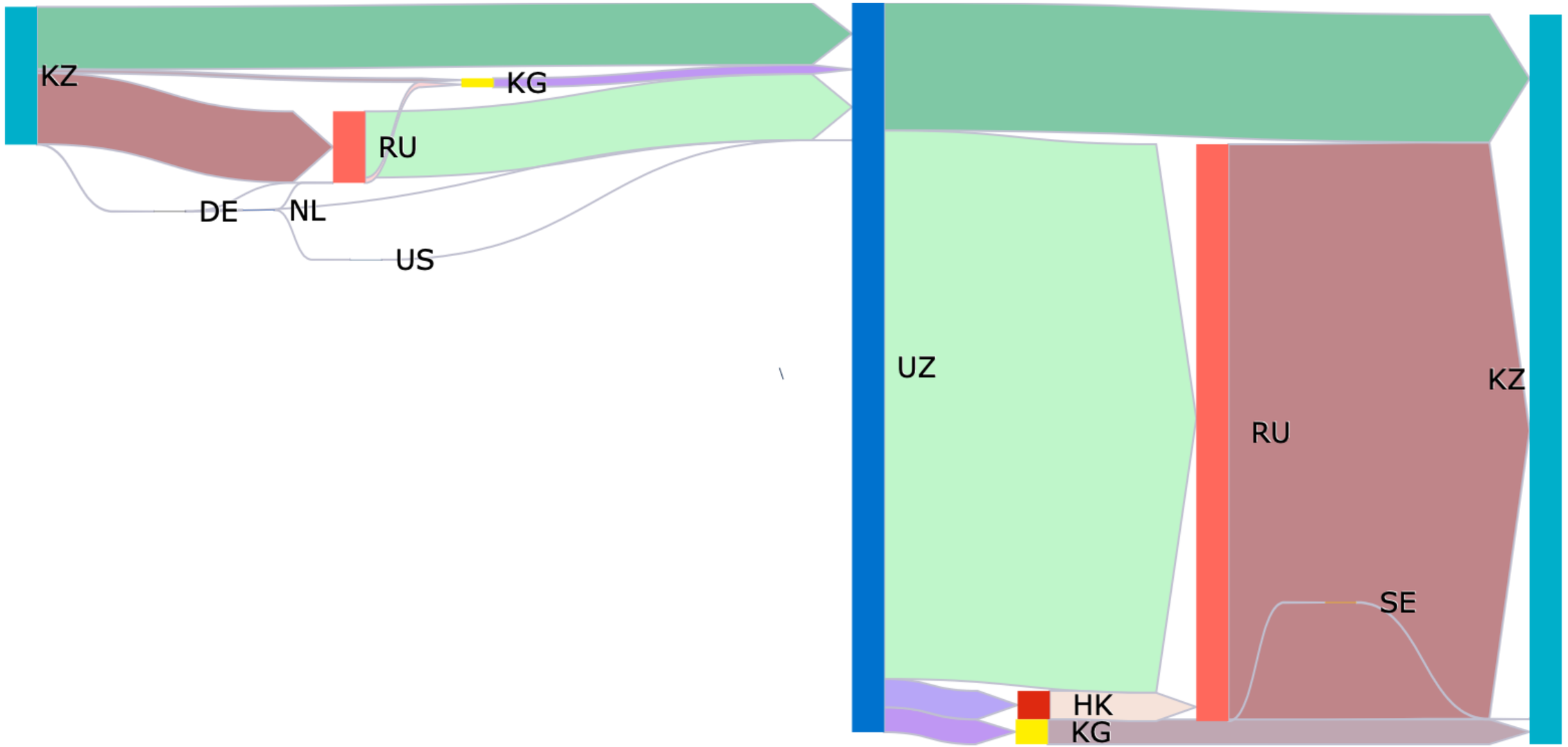
## Changes

- 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

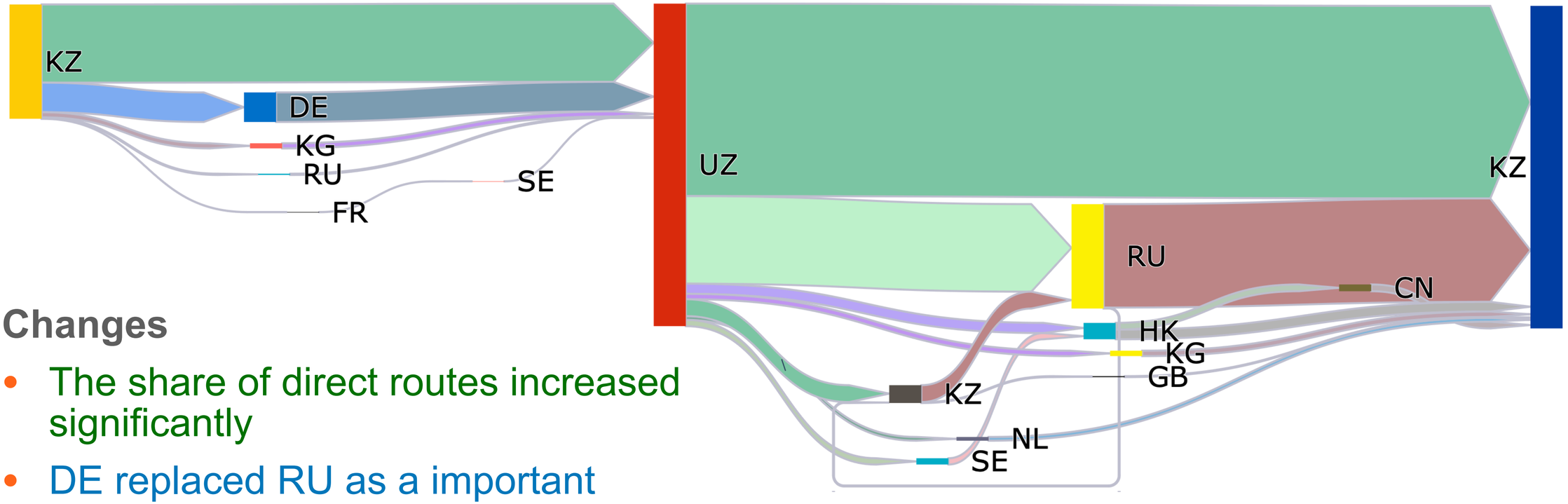


# Kazakhstan ⇿ Uzbekistan

# Kazakhstan ↭ Uzbekistan, 2022



# Kazakhstan ⇿ Uzbekistan, 2024



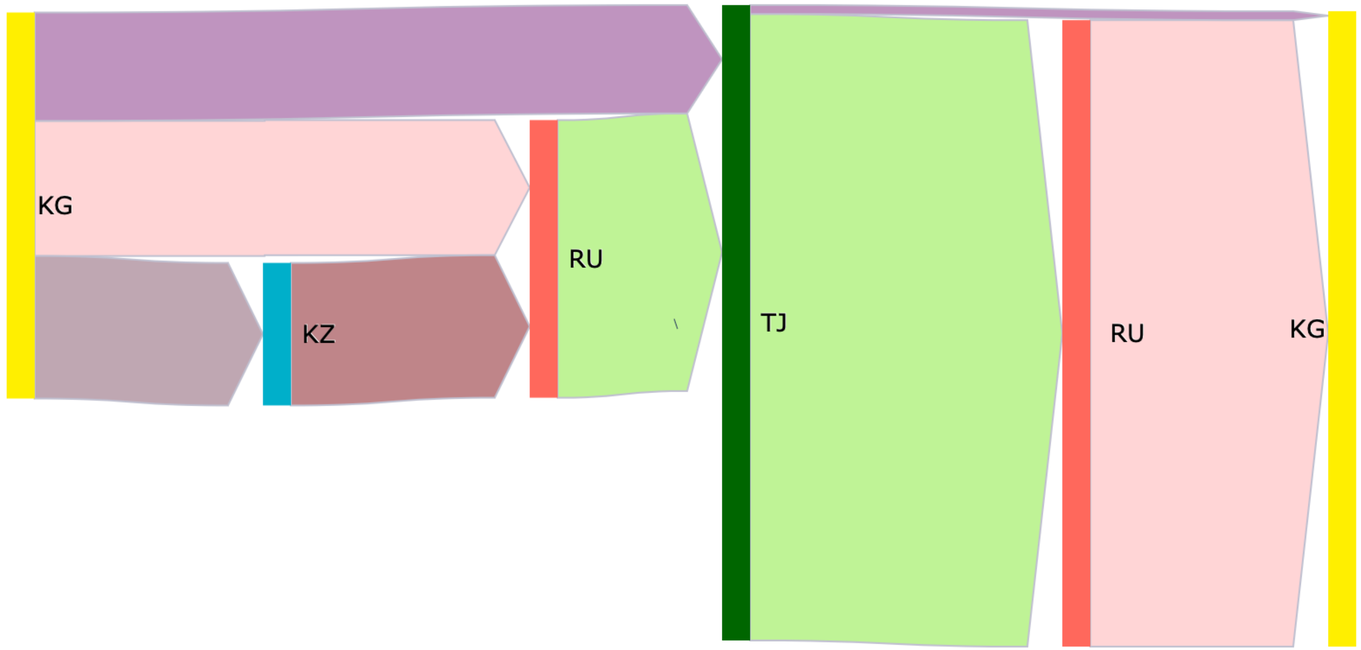

**Changes**

- The share of direct routes increased significantly
- DE replaced RU as a important transit country from KZ to UZ
- High traffic asymmetry

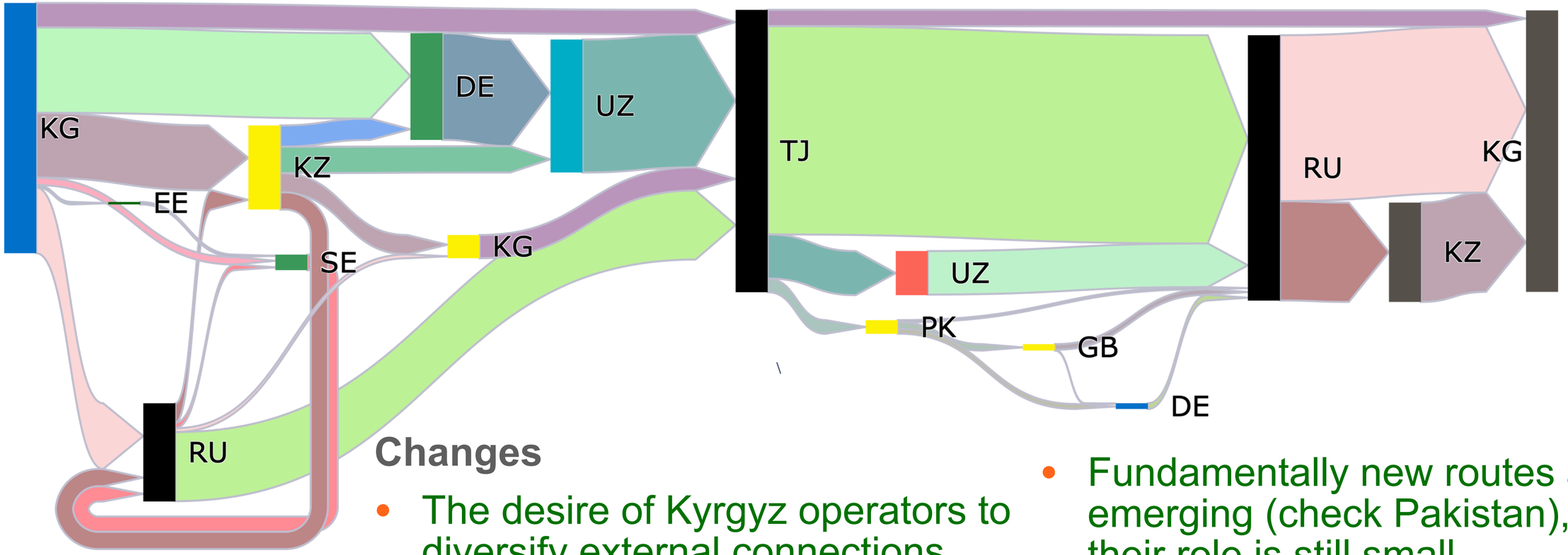
- A notable share of highly suboptimal routes
  - Such as UZ-SE-HK-CN-KZ or KZ-FR-SE-UZ
    - ➡ Distance SE-HK - about 8000 km!

# Kyrgyzstan ⇿ Tajikistan

# Kyrgyzstan ⇿ Tajikistan, 2022



# Kyrgyzstan ⇿ Tajikistan, 2024

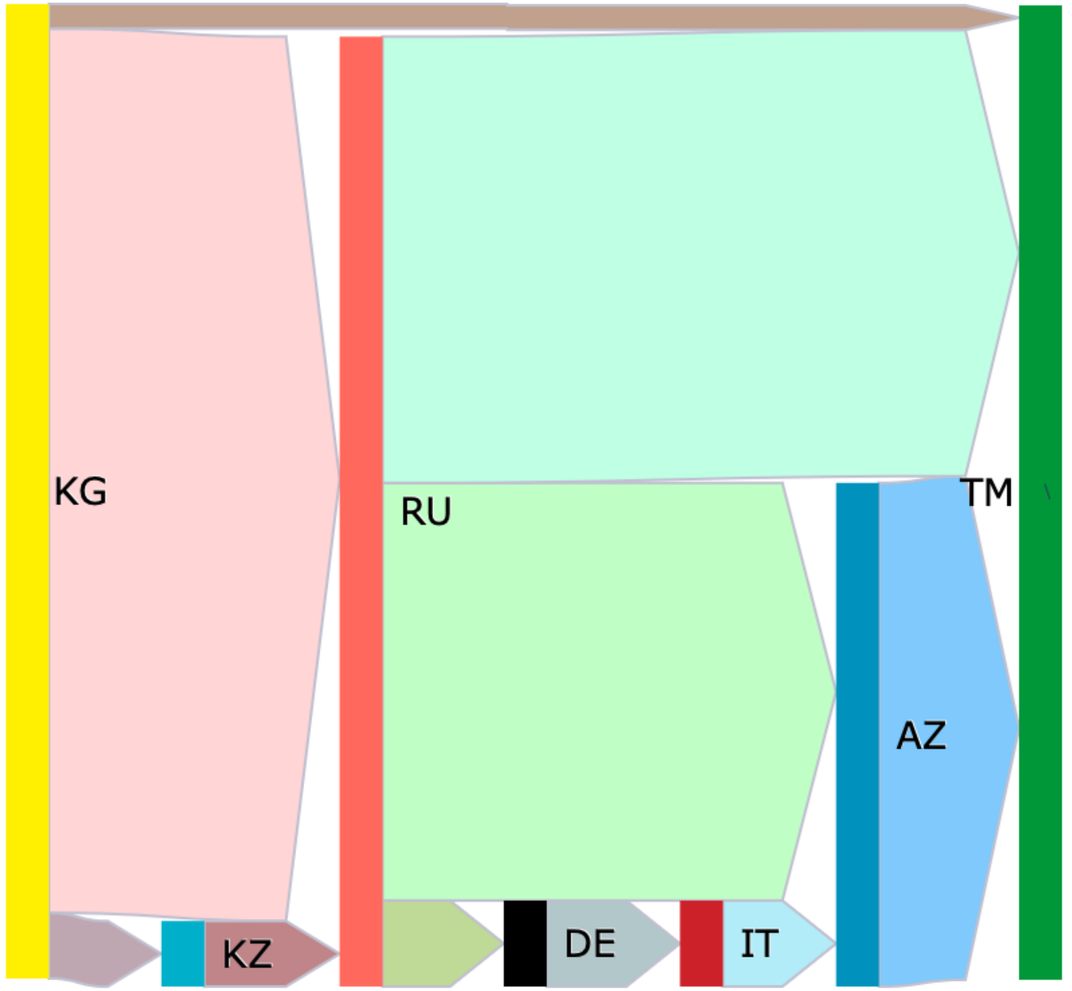



## Changes

- 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

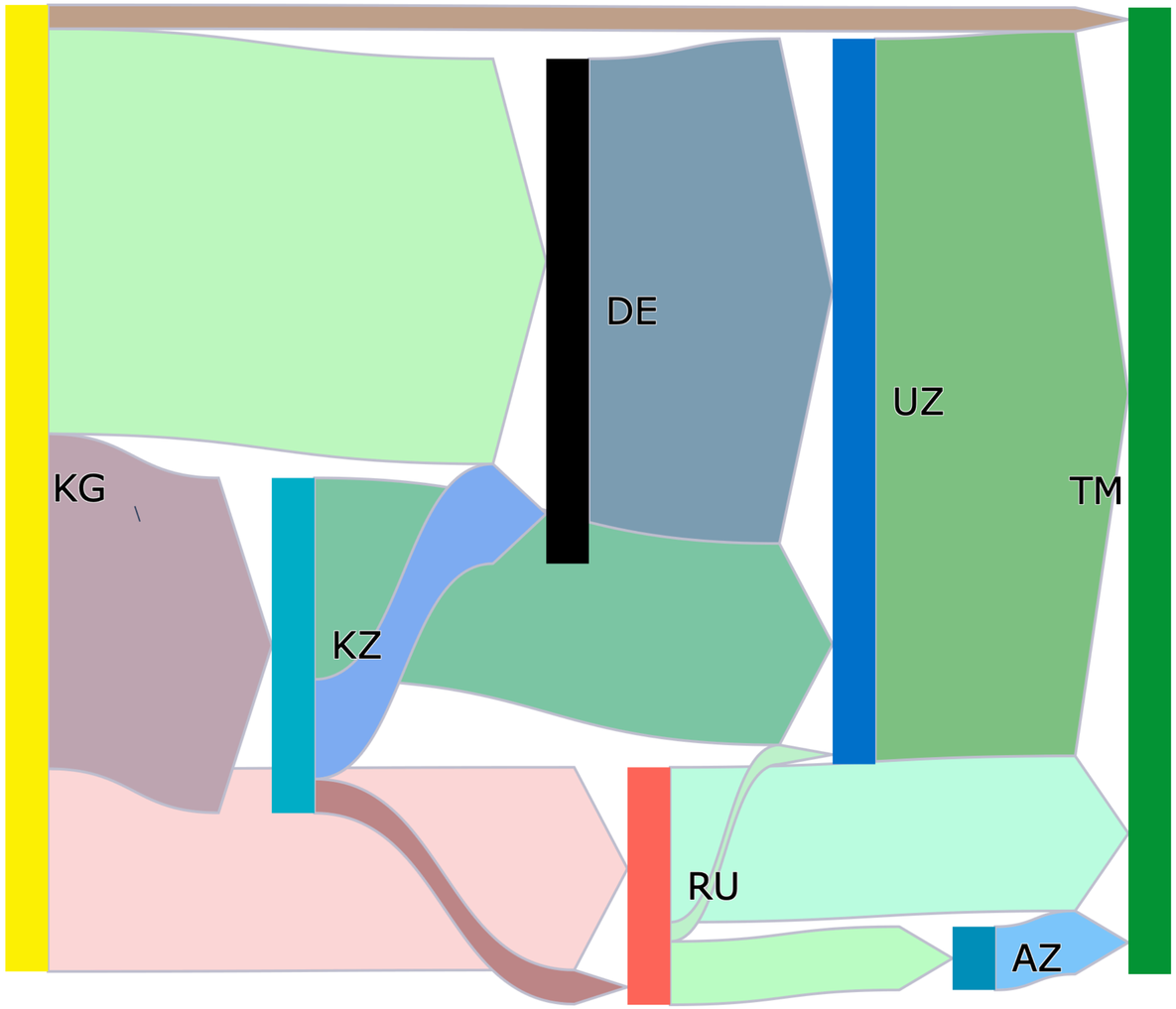
# Kyrgyzstan → Turkmenistan, 2022



# Kyrgyzstan → Turkmenistan, 2024

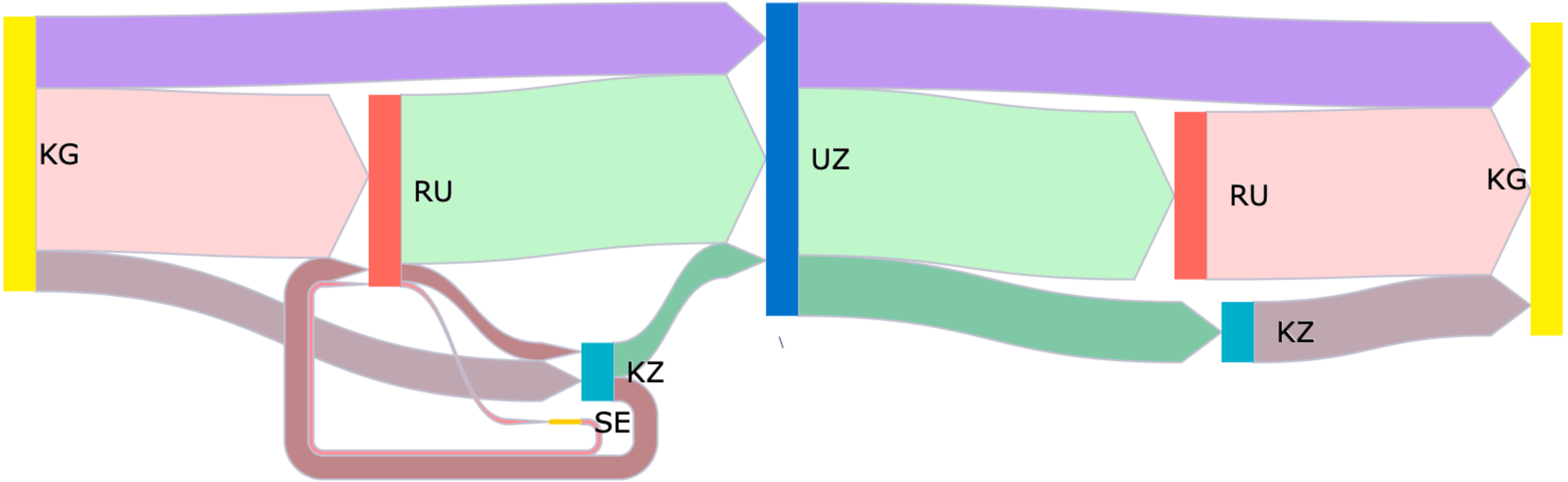
## Changes

- 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

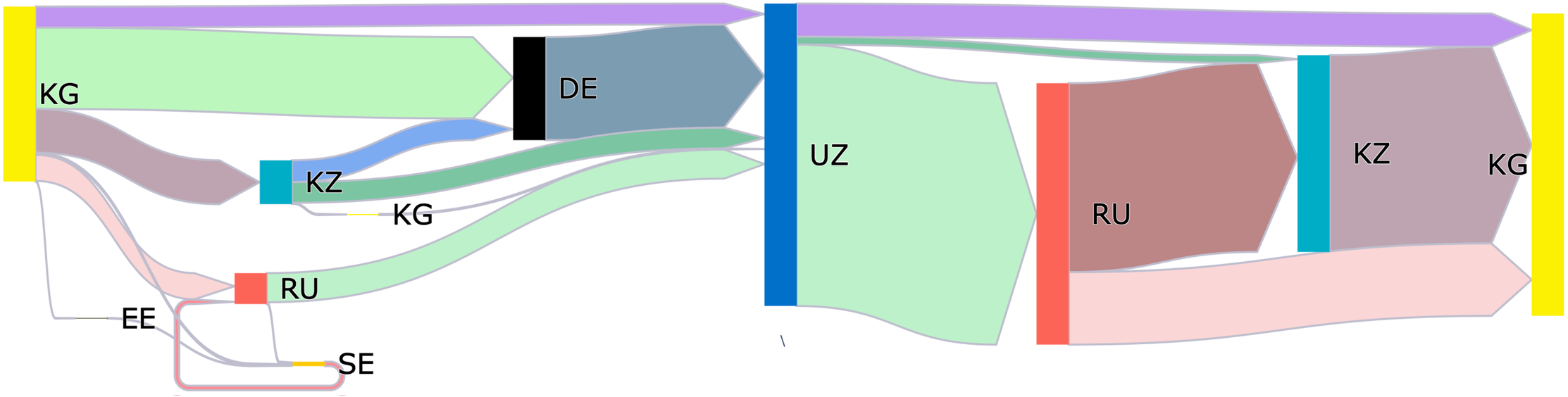


# Kyrgyzstan ⇿ Uzbekistan

# Kyrgyzstan ⇿ Uzbekistan, 2022



# Kyrgyzstan ⇿ Uzbekistan, 2024



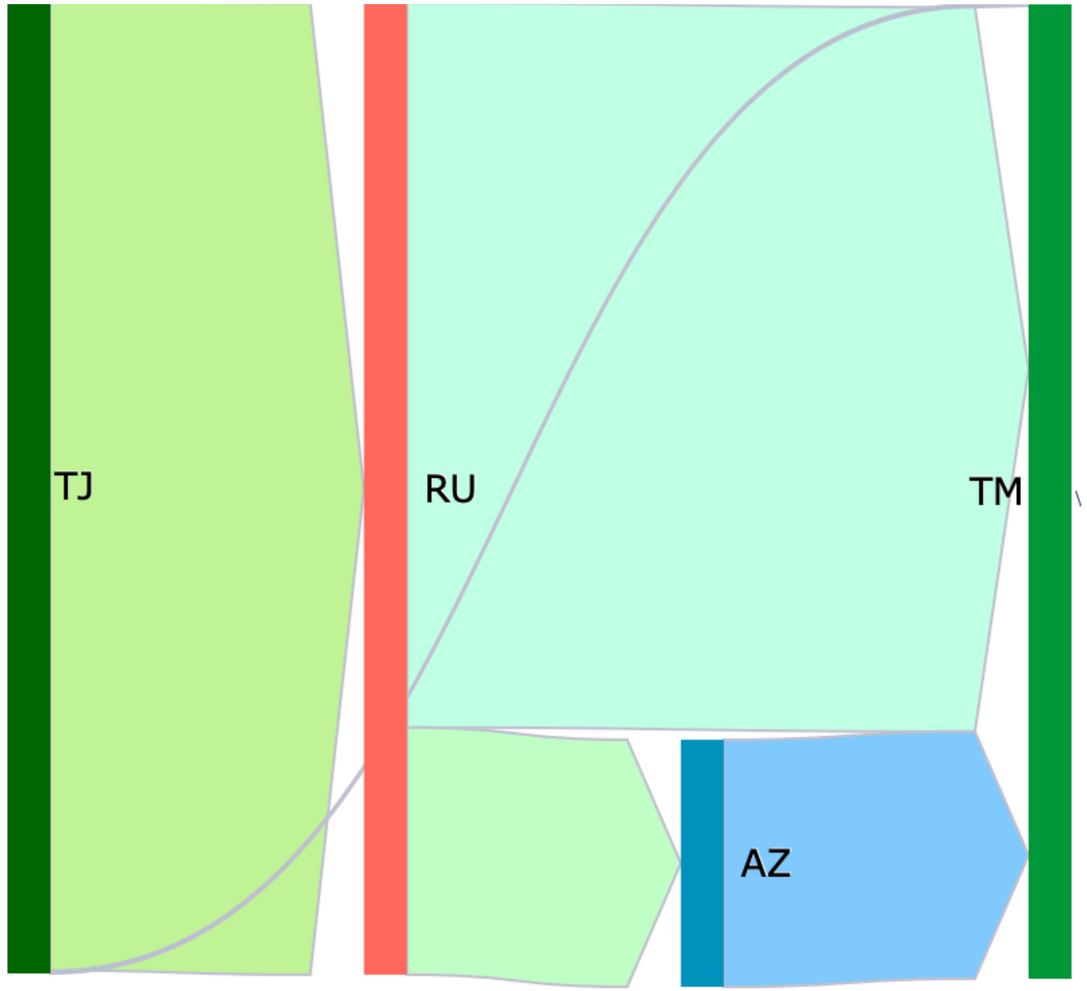

**Changes**

- 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

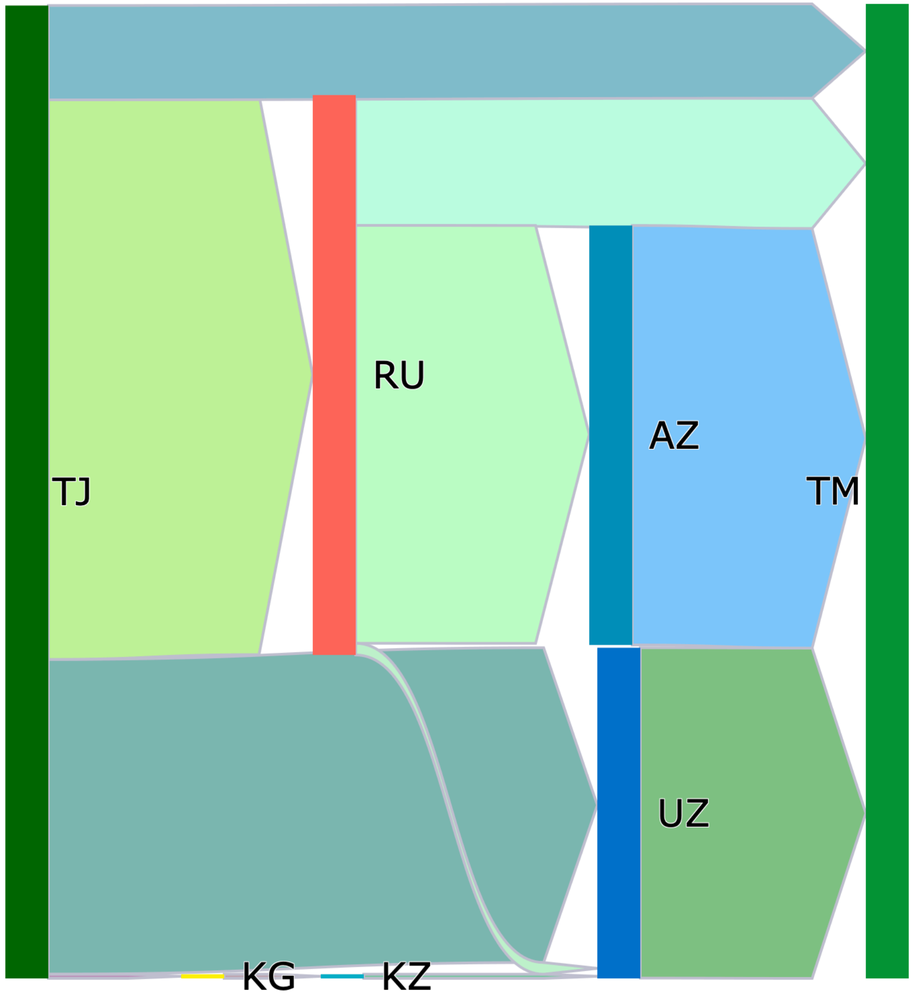
# Tajikistan → Turkmenistan, 2022



# Tajikistan → Turkmenistan, 2024

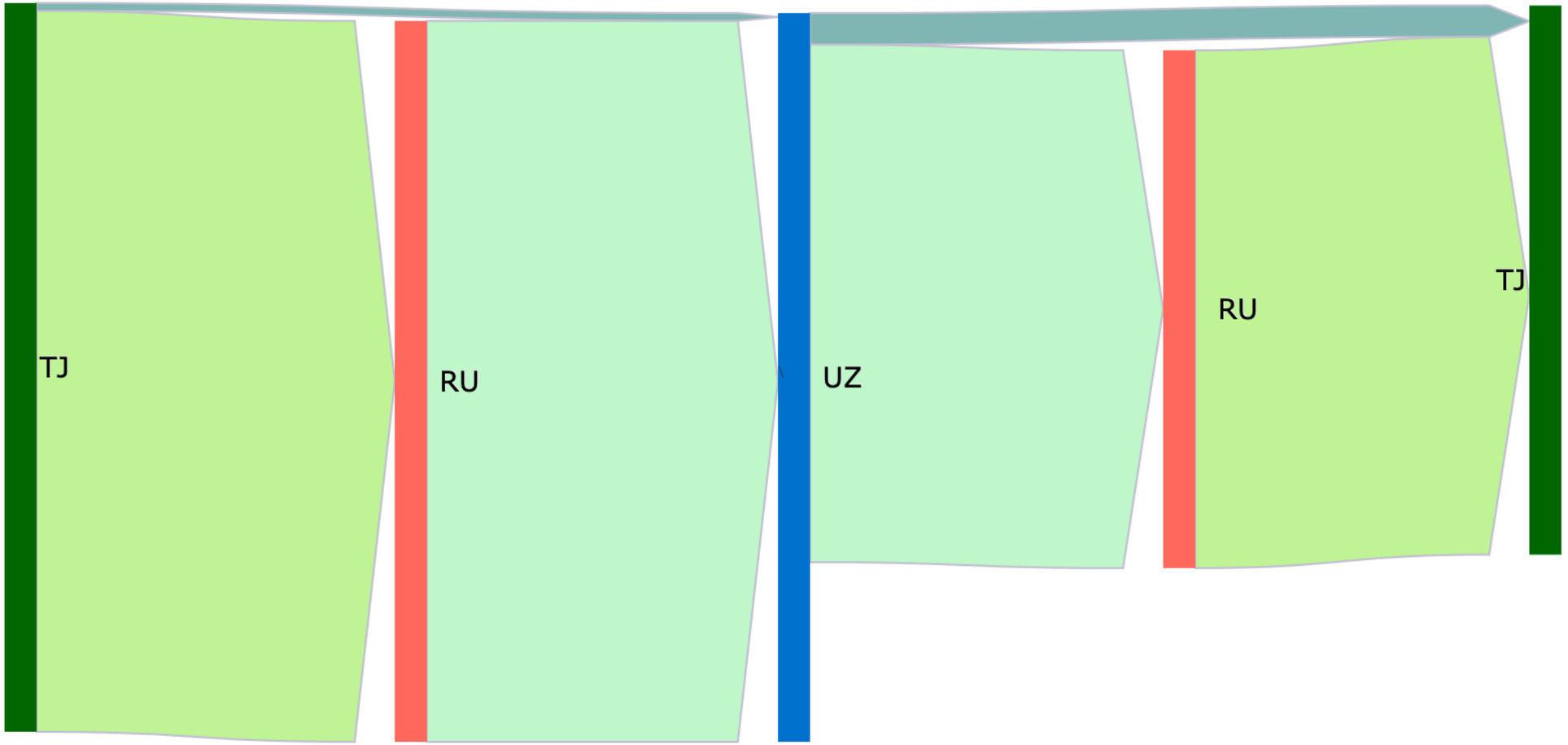
**Changes**

- 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

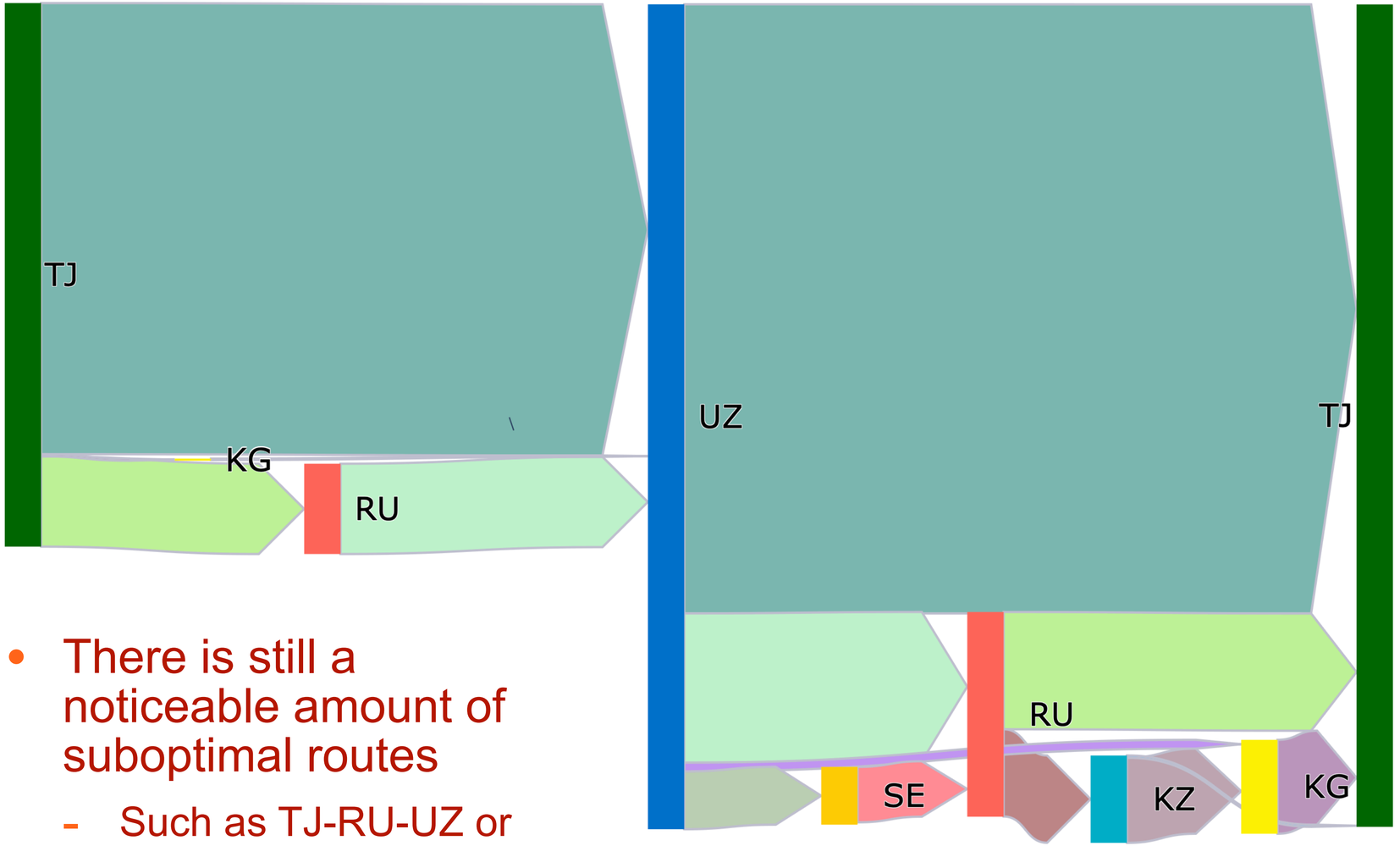


# Tajikistan → Uzbekistan

# Tajikistan ⇿ Uzbekistan, 2022



# Tajikistan ⇿ Uzbekistan, 2024



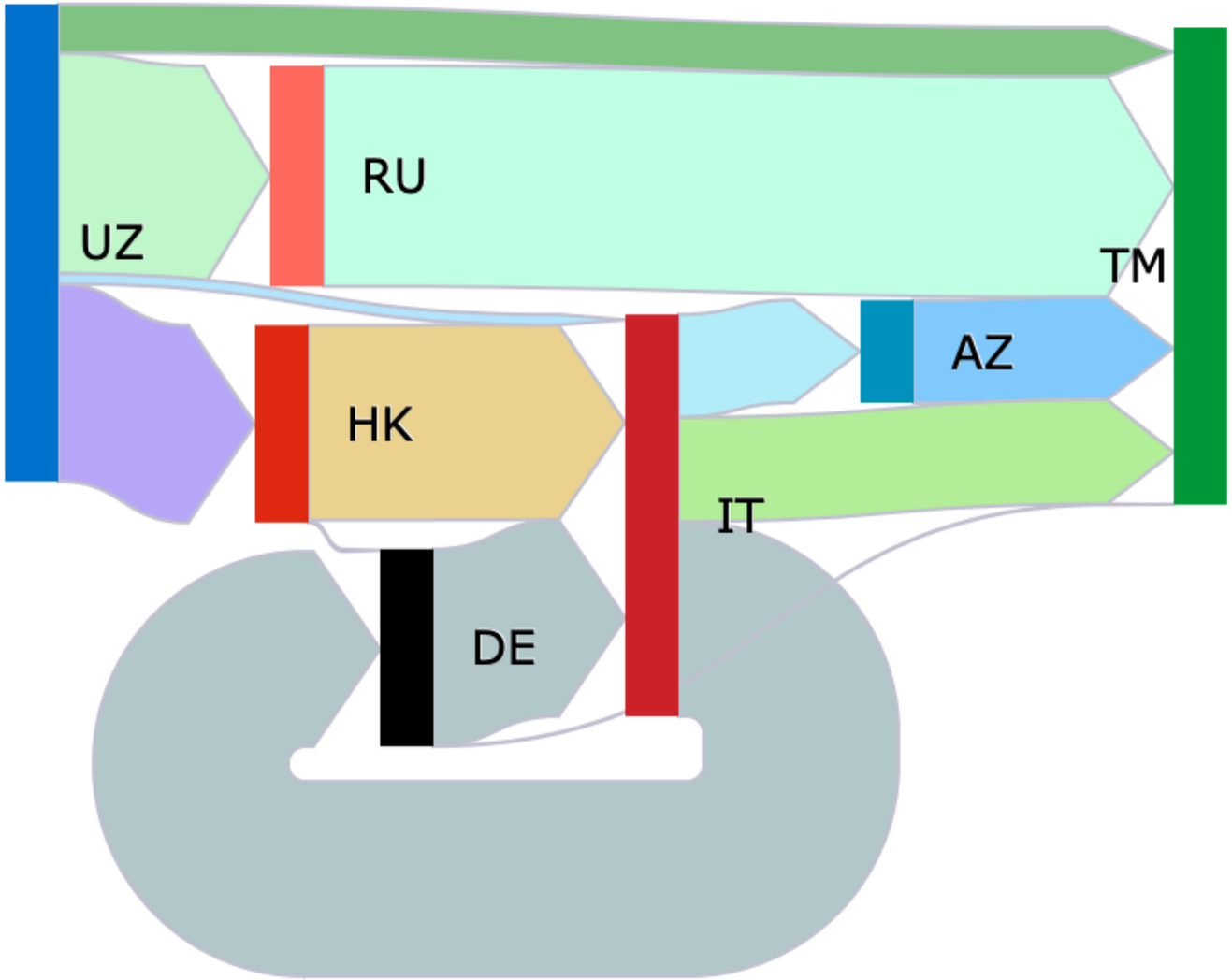

**Changes**

- 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

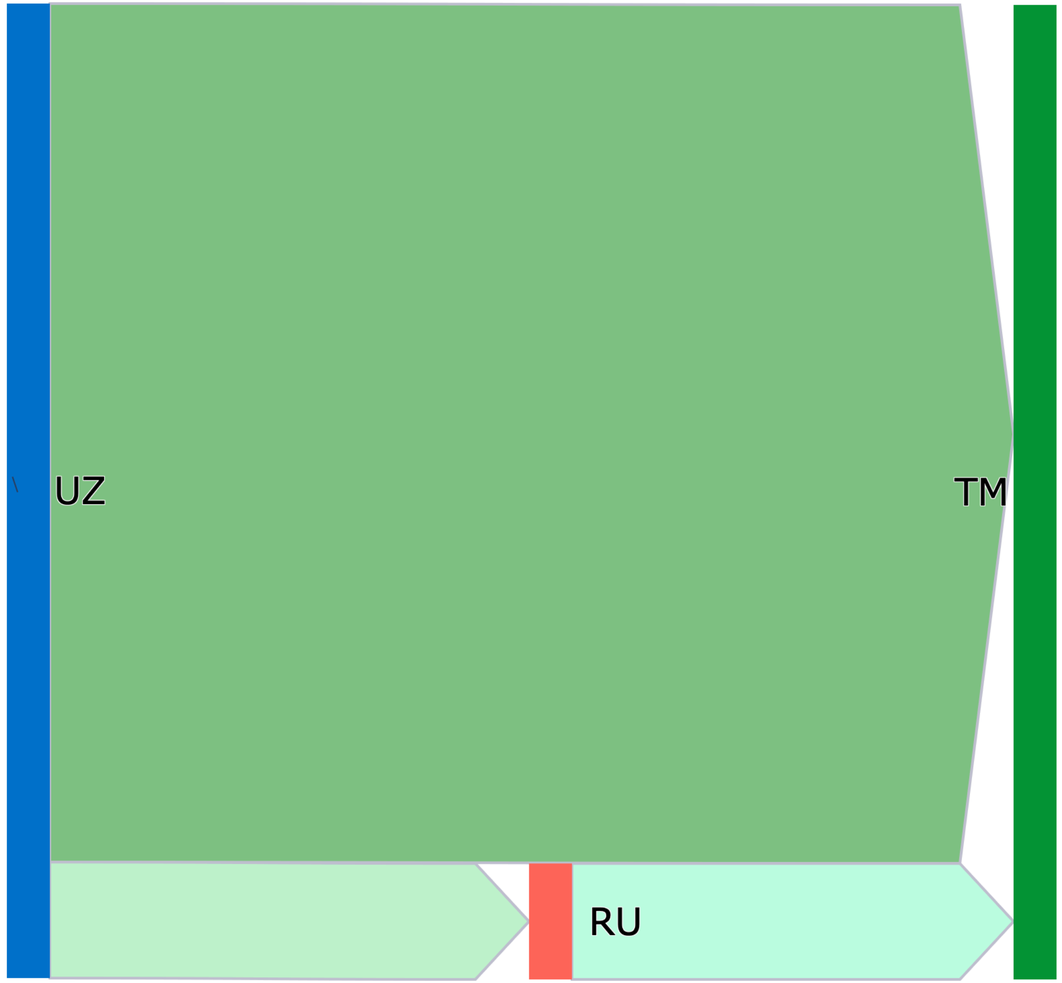
# Uzbekistan → Turkmenistan, 2022



# 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
- Russia is much more noticeable on Control Place than on Data Plane
  - Reasons to be studied separately

# 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
- All countries increased the number of cross-border operators
- Radically new routes have emerged (Pakistan)

# Observations and issues (3)

- 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
- 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
  - Tata has left the region

# Conclusion and proposal

- There is still tremendous room for improvement
- **Our Central Asia Peeing 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