RIPE NCC
RIPE NETWORK COORDINATION CENTRE

IPv6 in Central Europe and the Baltics

(and why it's important)

Suzanne Taylor | 9 November 2023 | ICANN Training Series

Topics

- The RIPE NCC
- IPv6 basics
- Why IPv6 is important
- IPv6 in Central Europe and the Baltics
  - Address space holdings and use
  - Domestic and international connectivity
  - Traffic exchange
  - Routing security

The RIPE NCC

Regional Internet Registries (RIRs)

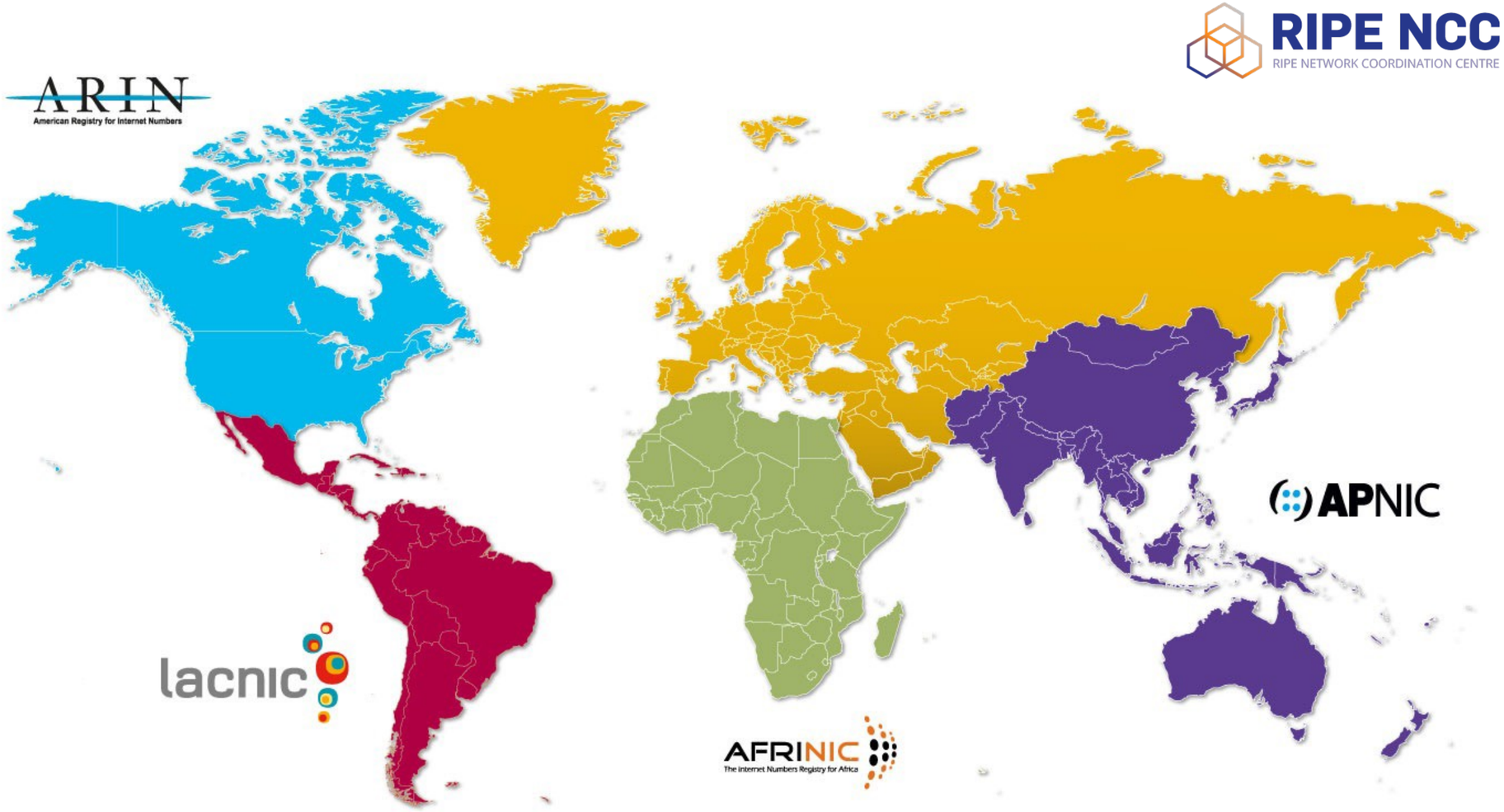
- There are five Regional Internet Registries (RIRs)
  - All are not-for-profit, membership-based organisations
  - Each RIR covers a geographical service region
- We manage the IP address pool
  - Distribute IPv4, IPv6 and Autonomous System Numbers
  - Maintain registries of these allocations
- We operate on behalf of the global Internet community
  - We operate under the principle of multistakeholder governance
  - Our communities decide on the policies under which we operate the registry
  - Open, transparent, consensus-based, bottom-up process

IP address distribution

Local Internet Registries

ISPs / CDNs / SMEs / Academic institutions / Banks / Governments

Regional Internet Registries (RIRs)



RIPE NCC

- Technical services and tools:
  - K-root / RIPE Altas / RIPEstat / Routing Information Service (RIS)
- Community development and capacity building
  - In-person and online training courses
  - Regional workshops, meetings, events, NOGs
- Public policy and Internet governance
  - Input on legislative and regulatory proposals
  - Involved in global Internet Governance Forum, EuroDIG and others
  - Participate in International Telecommunication Union (ITU) and UN processes

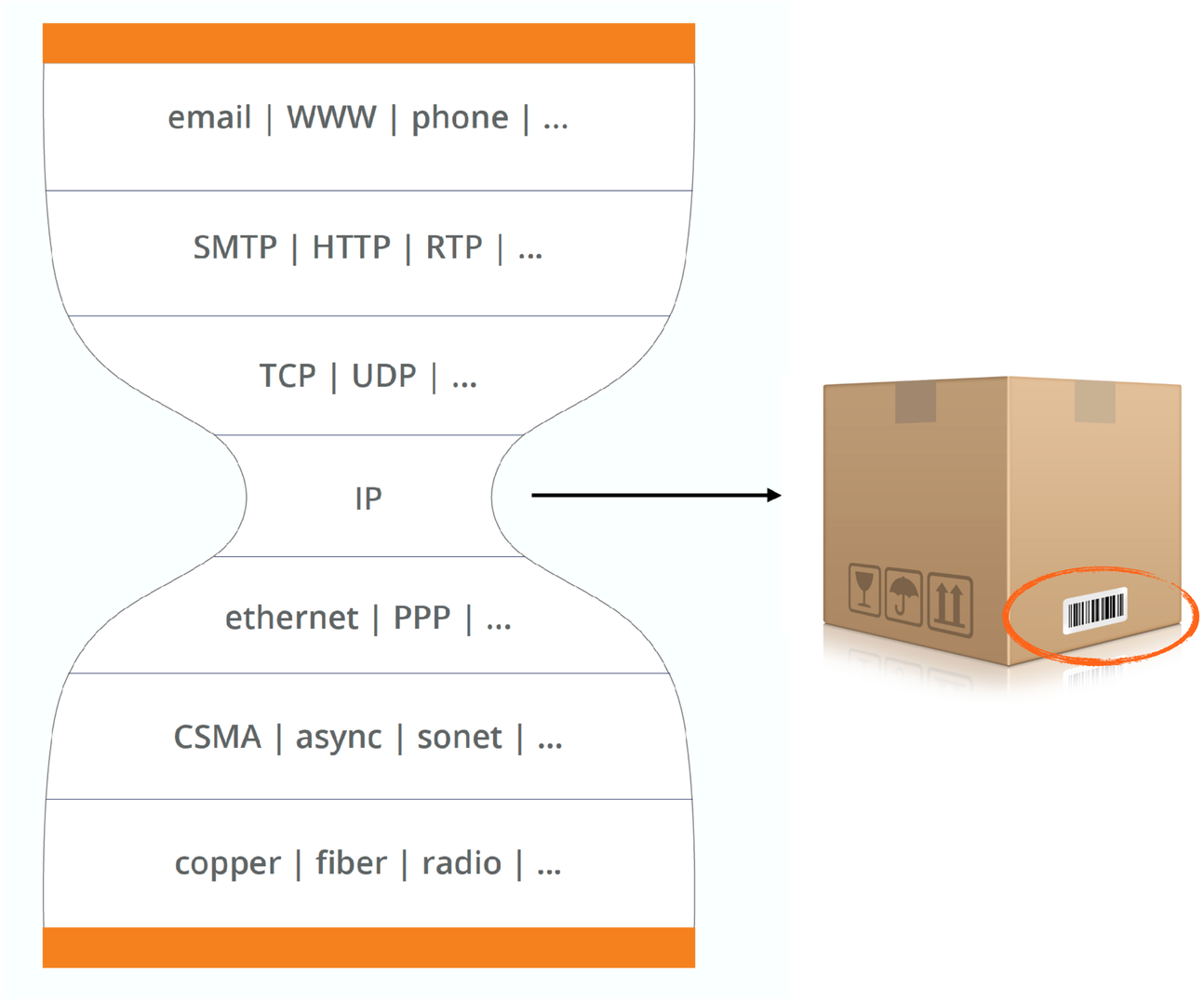
IPv6

Internet Protocol (IP) Address

- It needs to be globally unique
- It is an address, not an identity
  - Represents a location in a network
  - When you move, your address changes

- IPv4 (32 bits): 192.0.2.17
- IPv6 (128 bits): 2001:db8:0:1234:0:567:8:1

Internet Layers



The Problem: Not Enough Addresses

- Each connection point needs its own unique address
  - Internet is set up to behave as one global, un-fragmented network
- IPv4 has run out
  - There are 4.2 billion IPv4 addresses, but more connections than that on the Internet today

The Problem: Not Enough Addresses

- Some temporary fixes
  - Policy changes in IPv4 address allocation
  - Sharing addresses among devices (NAT)
  - Secondary/transfer IPv4 market developed

… and problems

> Remaining pool can only stretch so far

> Quality of service, law enforcement issues

> Prices keep new and small players out

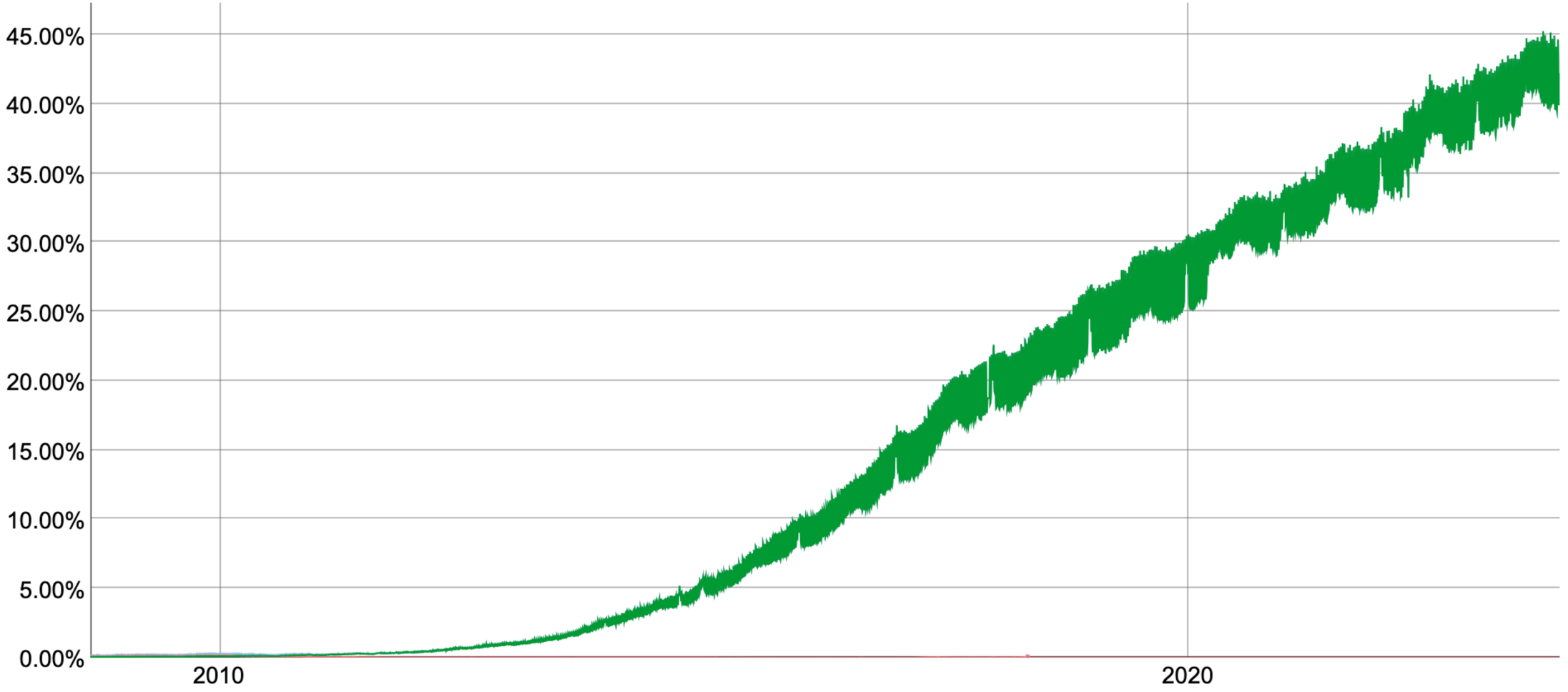
The Problem: Not Enough Addresses

- More and more IP addresses are needed for:
  - Sustained market competition
  - Connecting more of the global population
  - New and emerging technologies
    - 5G, IoT, smart cities…

The Solution: IPv6

- Everybody knew this moment would come
  - IPv6 standard developed in the nineties as the Internet expanded
  - RIPE NCC reached last /8 block of IPv4 in 2012 and allocated last of it in 2019
- The only long-term solution is IPv6
  - IPv6 has 2^128 unique addresses
  - IPv4 and IPv6 are not directly interoperable, but can run side-by-side
  - The original idea was for the industry to transition before IPv4 ran out

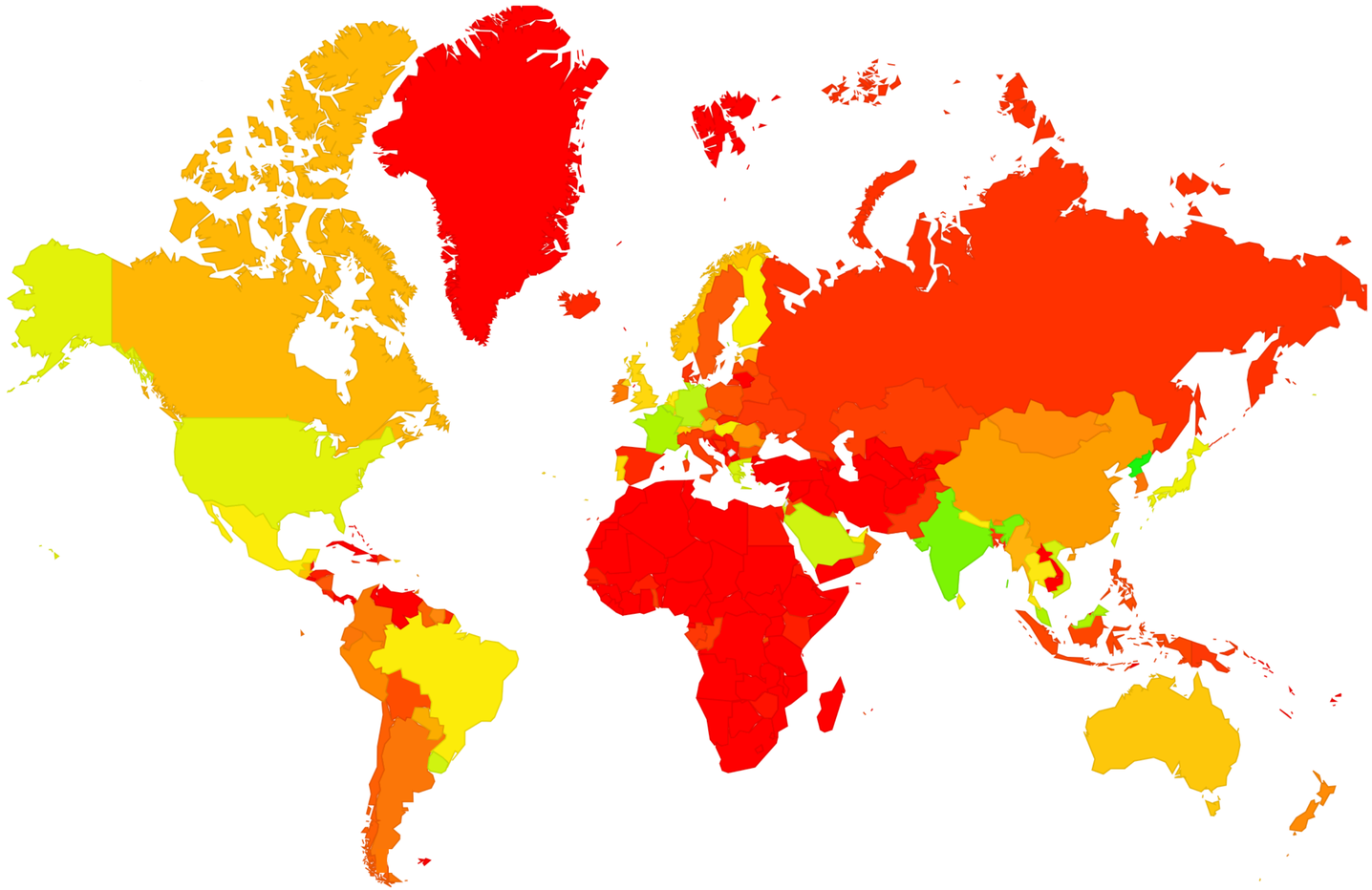
Current State of IPv6 Use



Source: Google

Current State of IPv6 Use

- World average: 36%
- Leaders:
  - India: 79%
  - Malaysia: 68%
  - France: 68%
  - Belgium: 67%
  - Åland Island: 66%
  - Germany: 64%
  - Saudi Arabia: 61%
  - Greece: 58%



Source: APNIC Labs

IPv6 in Central Europe and the Baltics

As Seen from the RIPE NCC

RIPE NCC Internet Country Report

- Central Europe country report published in June

  https://labs.ripe.net/country-reports/
- Czechia, Hungary, Poland and Slovakia
- Covers IPv4, IPv6 and much more
- Added more IPv6 and Baltics for this presentation

RIPE NCC Internet Country Reports

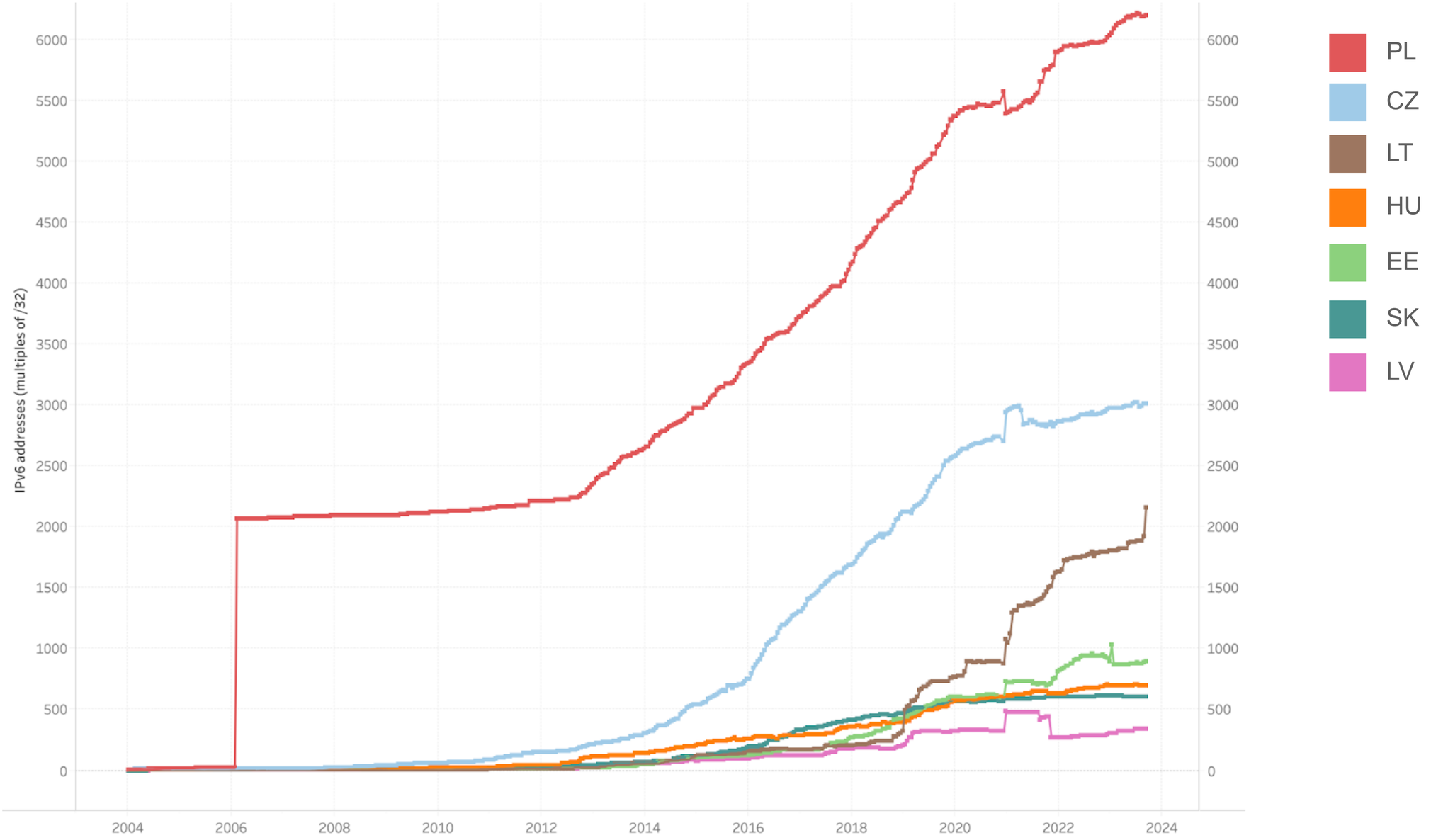
- Showcase RIPE NCC data and measurement platforms
- Bring value to local technical communities
- Support Internet development throughout service region
- Inform public policymaking

Highlights from Central Europe

- Well developed, competitive markets
- Modest amounts of IPv4 in the region
- Low IPv6 capability rates, except for Hungary
- Routing is generally optimised
- Good diversity in international connectivity

IPv6 Holdings and Use

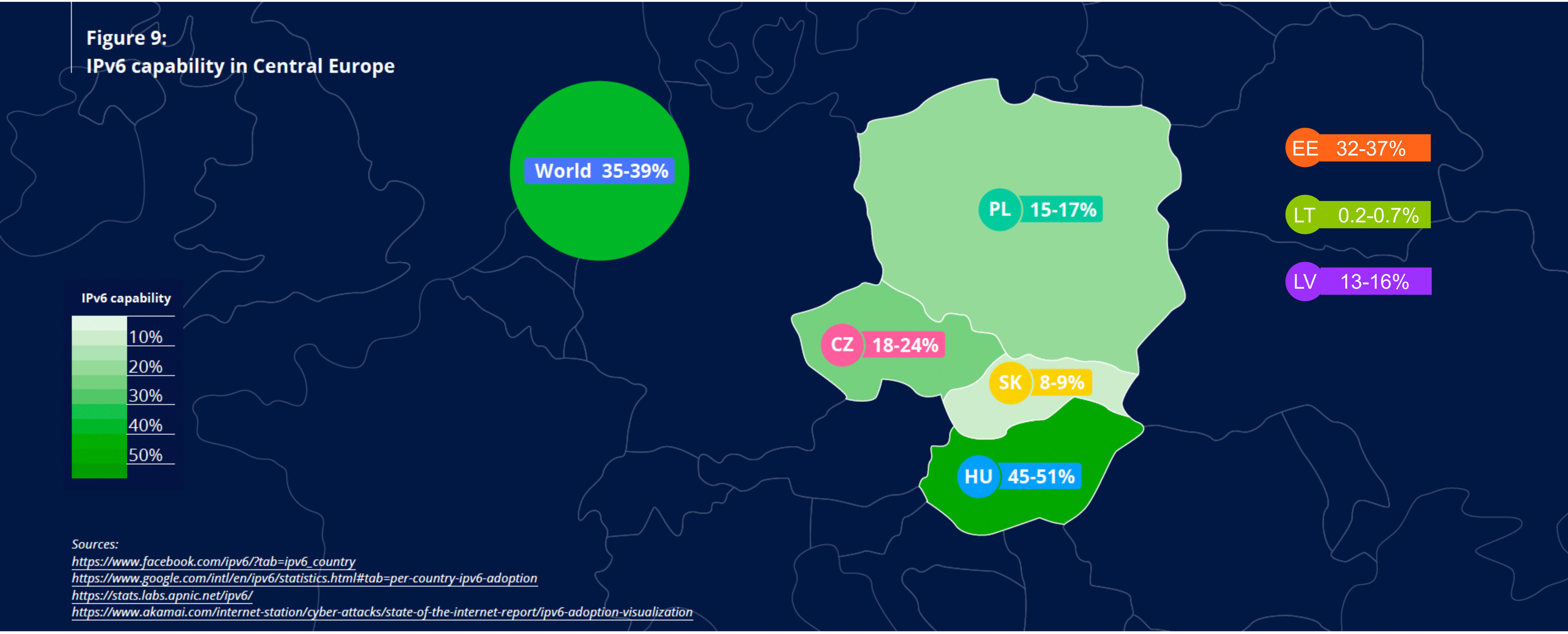
IPv6 Holdings Over Time



IPv6 Holdings vs Use

- Having IPv6 space doesn’t mean it’s in use
- Percentages of IPv6 space being routed:
  - CZ 59%
  - HU 41%
  - PL 59%
  - SK 47%
  - EE 22%
  - LT 22%
  - LV 43%
- Even being routed doesn’t mean it’s being used…

Figure 9:
IPv6 capability in Central Europe



Sources:
https://www.facebook.com/ipv6/?tab=ipv6_country
https://www.google.com/intl/en/ipv6/statistics.html#tab=per-country-ipv6-adoption
https://stats.labs.apnic.net/ipv6/
https://www.akamai.com/internet-station/cyber-attacks/state-of-the-internet-report/ipv6-adoption-visualization

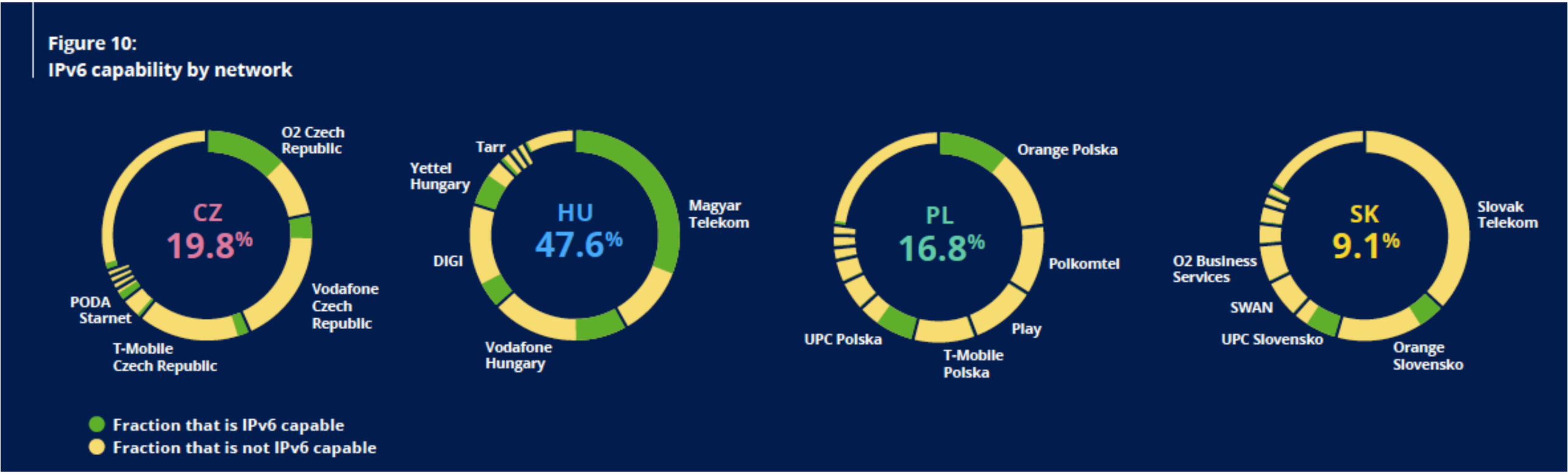
Top IPv6 Holders

- Not much consolidation in Central Europe or the Baltics

- Top IPv6 holders and percentage of country's IPv6 space:
  - CZ: ISP Alliance 4%
  - HU: VIVACOM 4%
  - PL: Orange Polska 33%
  - SK: CDicon 4%
  - EE: IT Hosting Group 7%
  - LT: UAB Linama 14%
  - LV: Baltcom 7%

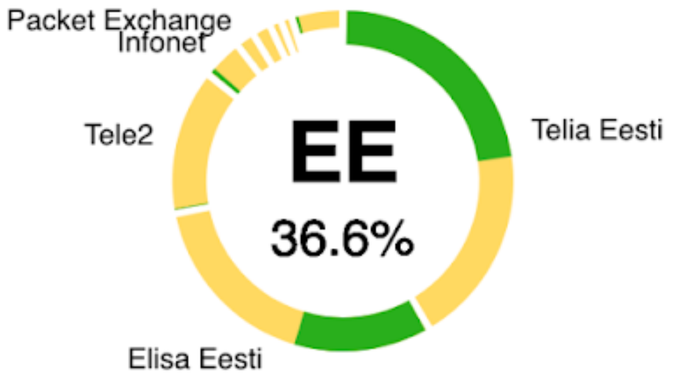
- Don't see hoarding with IPv6 like we do with IPv4, where there is much more consolidation among the big providers

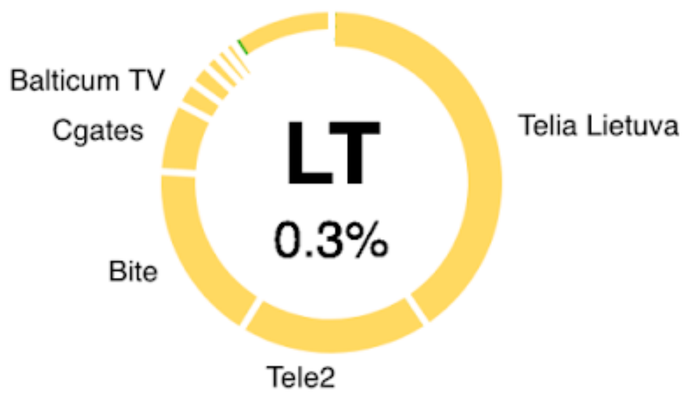
IPv6 Capability of Major Providers

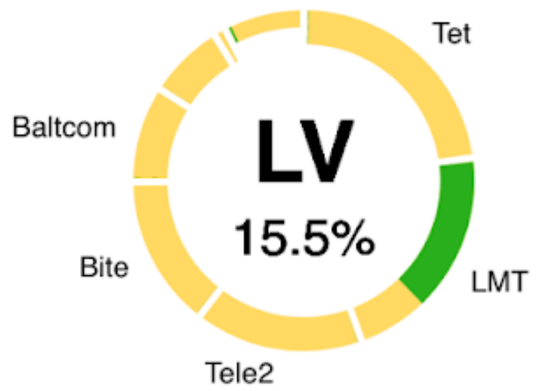


Source: APNIC

IPv6 Capability of Major Providers







Source: APNIC

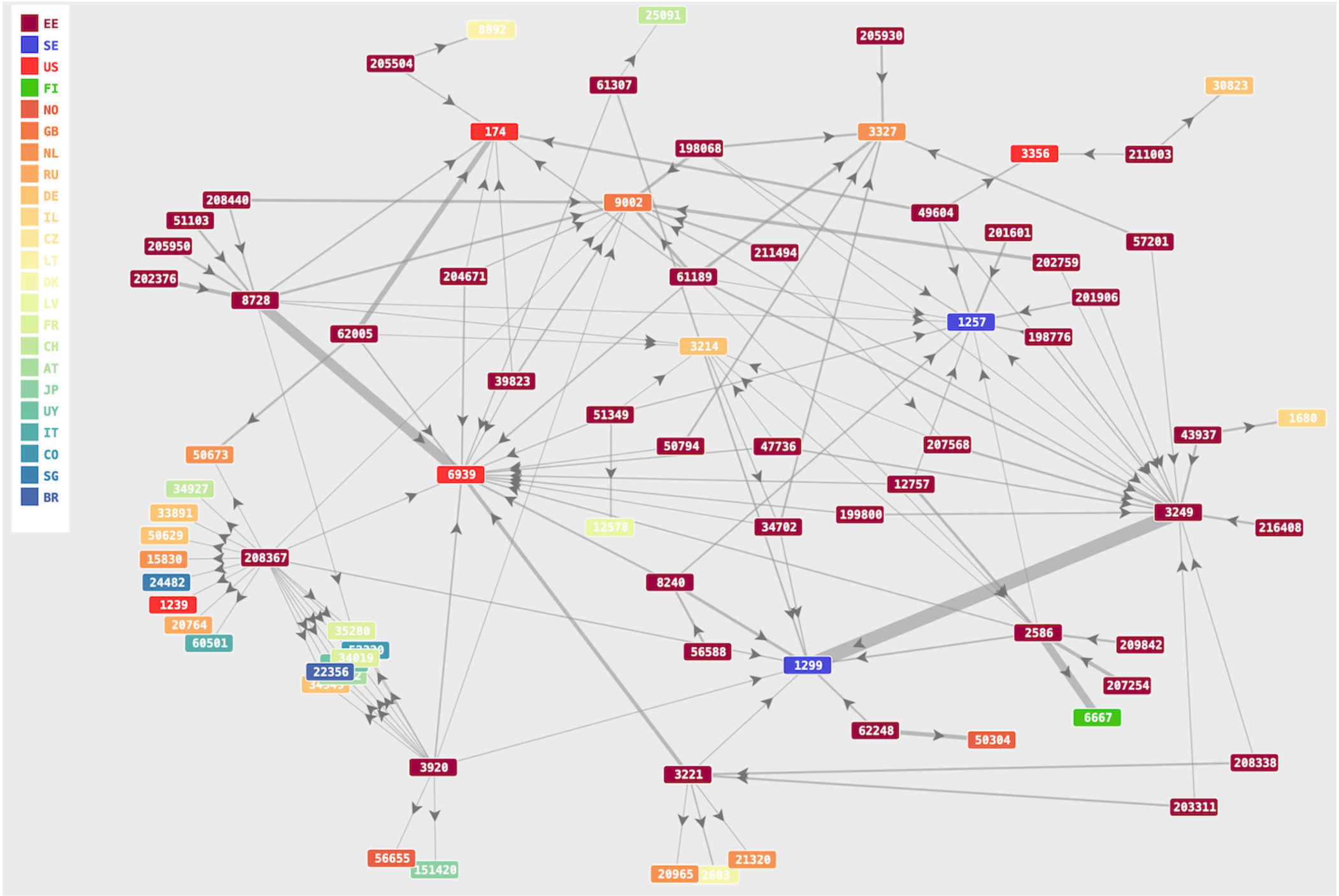
IPv6 Challenges in Central Europe

- RIPE NCC Survey 2019: 273 respondents from Central Europe
  - 52% said they would need more IPv4 space in next 2-3 years
    - Compared to 46% of all respondents
  - 27% said they had fully deployed IPv6 / 52% had at least started / 12% had no plans
  - Top reasons for not deploying:
    - Lack of business need
    - Lack of time
    - Lack of technical expertise

IPv6 Efforts in Central Europe

- Hungary:
  - Hungarian IPv6 Forum established in 2012
  - IPv6 Education Lab established at Budapest University of Technology and Economics in 2011
  - Magyar Telekom started deploying IPv6 at the end of 2016.
- Czechia:
  - Government resolution in 2009 that all new networking equipment must be IPv6 compatible
  - In 2013, Czechia ranked first among European countries in having the most websites available over IPv6
  - The ccTLD for Czechia, administered by NIC.CZ, is active in IPv6 promotion

Domestic Connectivity over IPv6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208367
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56588
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6667
62248
50304
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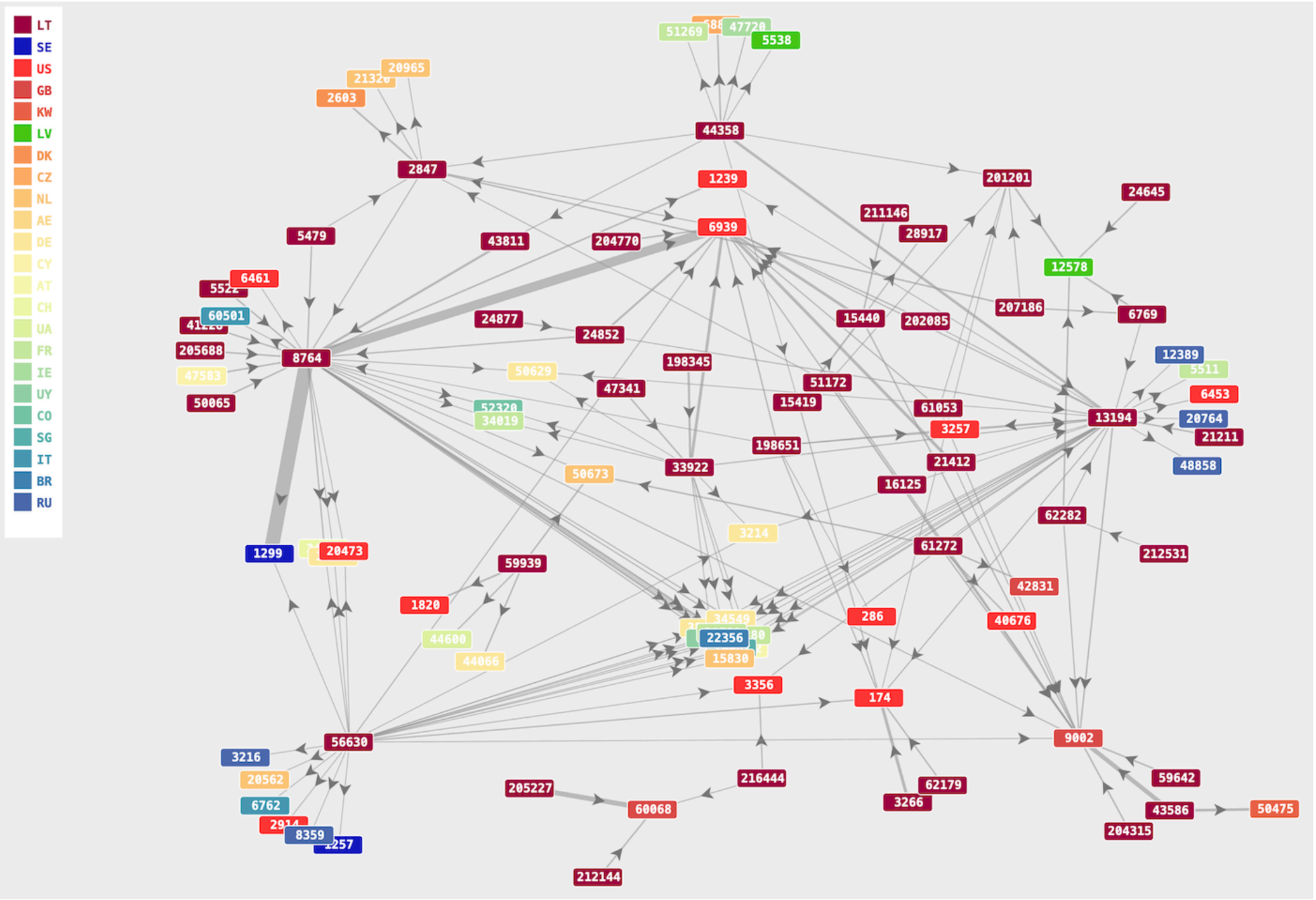
Estonia

Estonia

- Domestic networks connecting four or more other Estonian networks:
  - 8728 Infonet
  - 3249 Telia Eesti
  - 2586 Elisa Eesti
- Notable foreign networks:
  - 174 Cogent
  - 9002 RETN
  - 3327 CITIC Telecom
  - 1257 Tele2
  - 6939 Hurricane Electric
  - 3214 xTom (German Infrastructure as a Service provider)
  - 1299 Arelion
  - 6667 Elisa (parent of Elisa Eesti)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34019
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198651
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21412
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1820
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44066
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174
56630
9002
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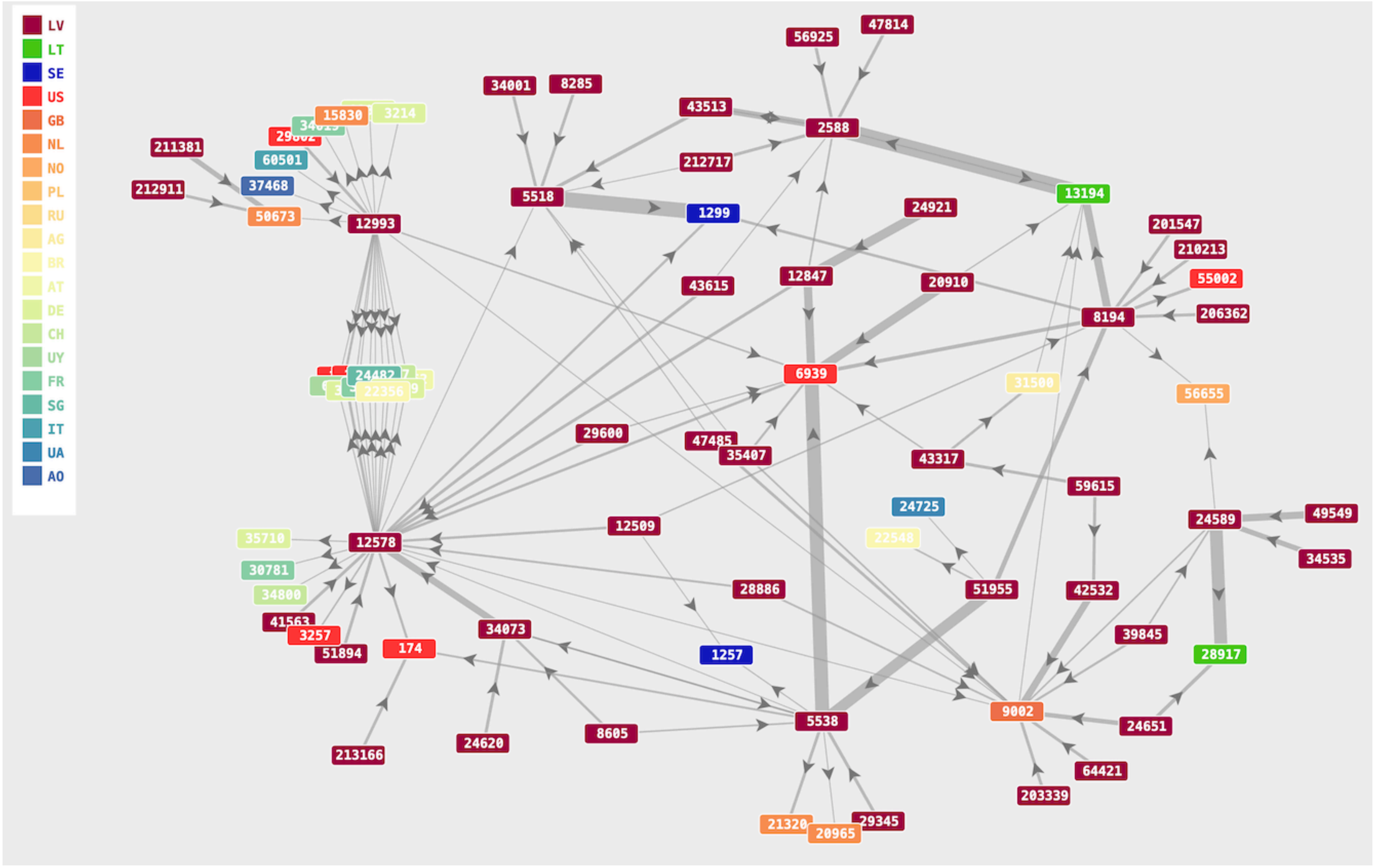
20562
216444
59642
205227
62179
6762
60068
3266
43586
50475
8359
204315
212144

Lithuania

Lithuania

- Domestic networks connecting four or more other Lithuanian networks:
  - 8764 Telia Lietuva
  - 2847 LITNET (NREN)
  - 201201 Duomenu logistikos
  - 13194 Bite Lietuva
- Notable foreign networks:
  - 6639 Hurricane Electric
  - 174 Cogent
  - 9002 RETN
  - 1299 Arelion
  - 12578 Tet (main Latvian fixed network provider)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5518
1299
13194
24921
201547
210213
55002
206362
43615
12847
20910
8194
6939
31500
56655
29600
47485
35407
43317
59615
24725
22548
12509
35710
12578
30781
34800
41563
3257
51894
174
34073
28886
51955
42532
49549
24589
34535
39845
28917
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9002
24651
8605
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213166
64421
203339
21320
20965
29345

Latvia

Latvia

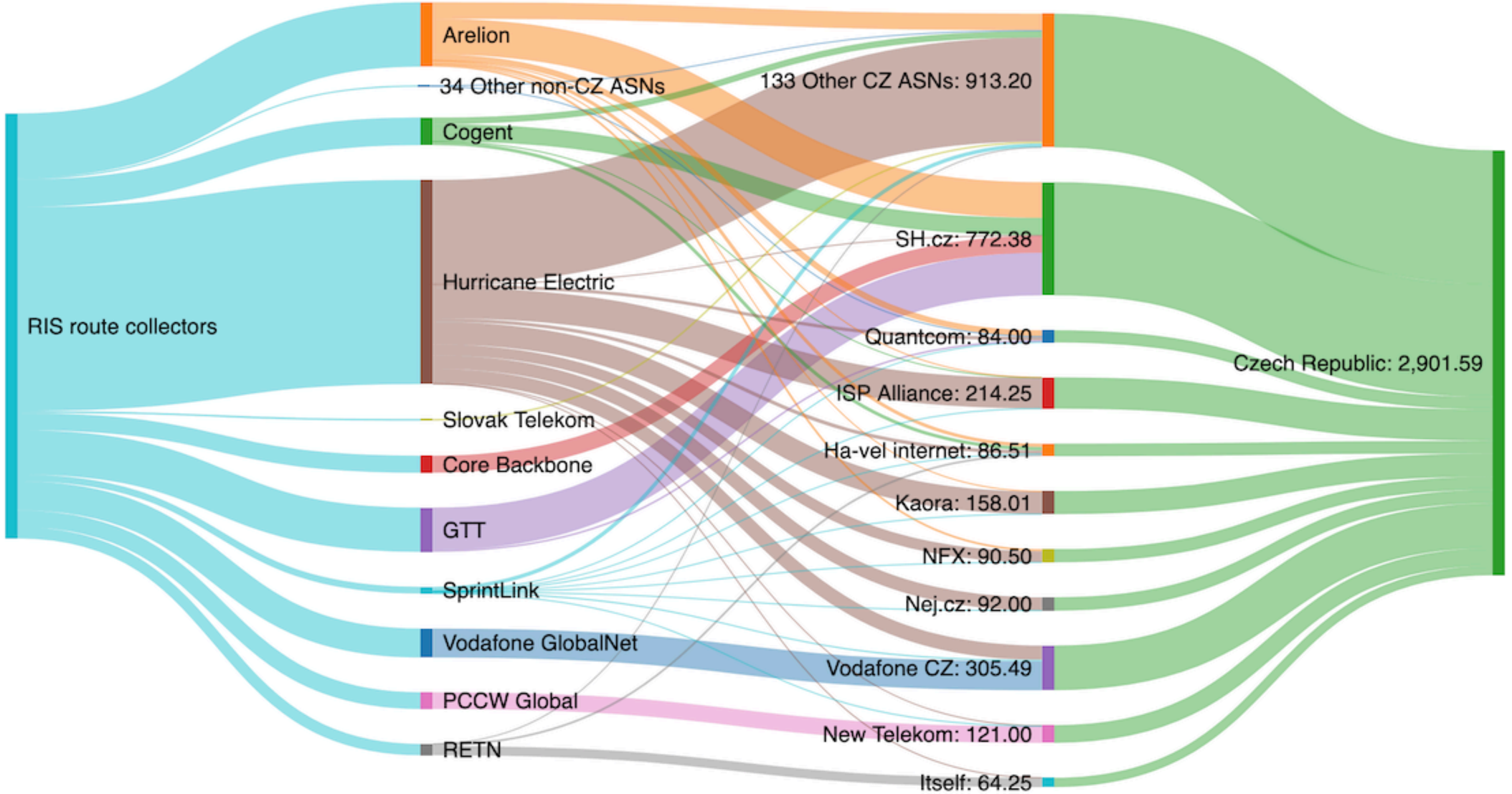
- Domestic networks connecting four or more other Latvian networks:
  - 12578 Tet
  - 5518 Tet (former Telia Latvija net)
  - 2588 Bite Latvija
  - 8194 VITA
  - 5538 SigmaNet-NIC (NREN and ccTLD)
- Notable foreign networks:
  - 6939 Hurricane Electric
  - 1299 Arelion
  - 9002 RETN
  - 13194 Bite Lietuva
  - 28917 Fiord Networks (main upstream for Telenet)

Domestic Connectivity

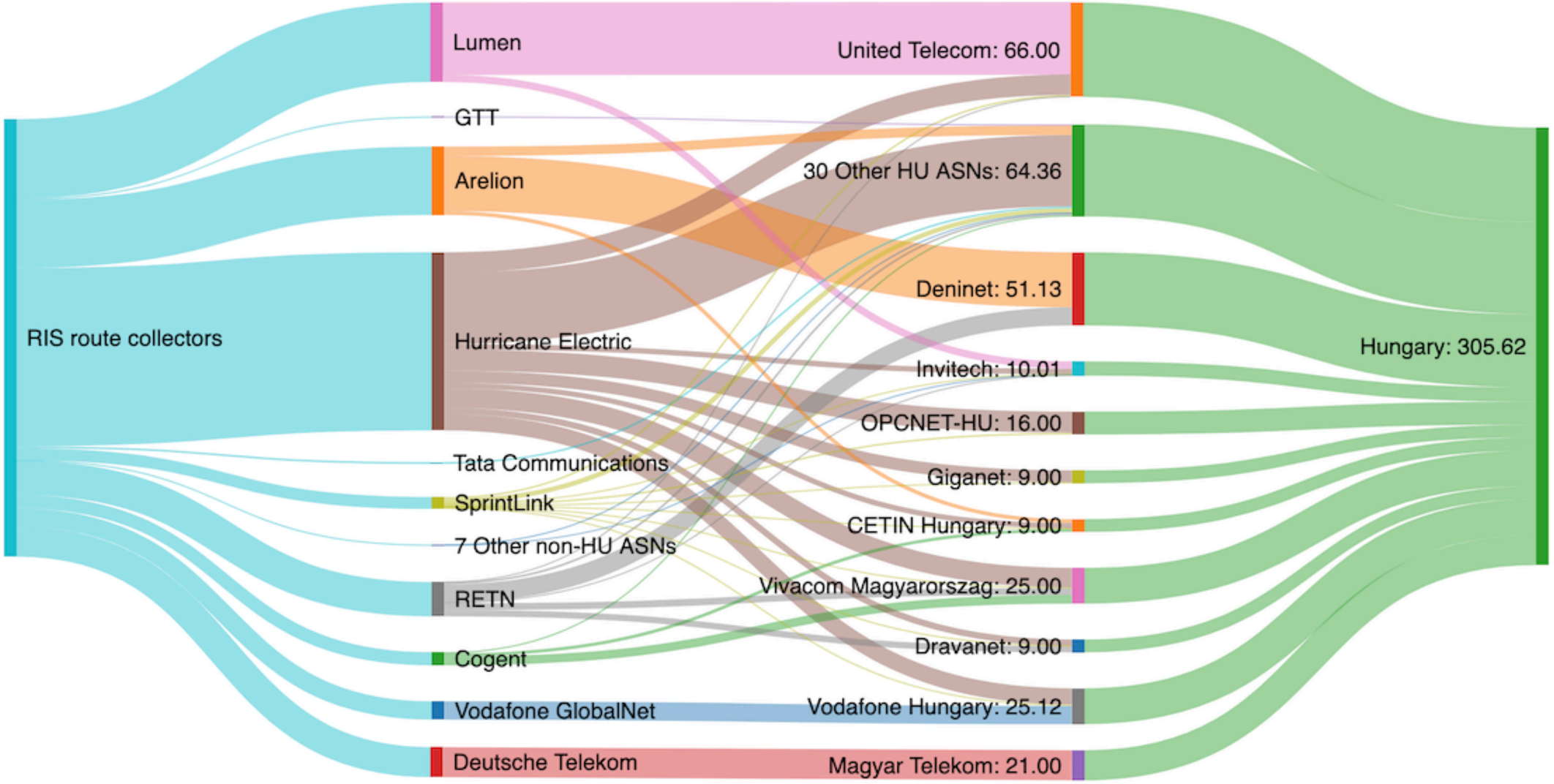
- Ideally, a visualisation of domestic connectivity should look like a deeply interconnected web
  - This provides the overall system with redundancy and, therefore, resilience
- That's generally what we see in the Baltics, with a lot of interconnection between domestic networks in the countries
- But also see relatively high number of networks with direct connections to foreign networks (compared to IPv4)
  - May be side effect of ongoing transition to IPv6 > smaller networks that usually connect to a local provider may just not have IPv6 in BGP yet

International Connectivity over IPv6

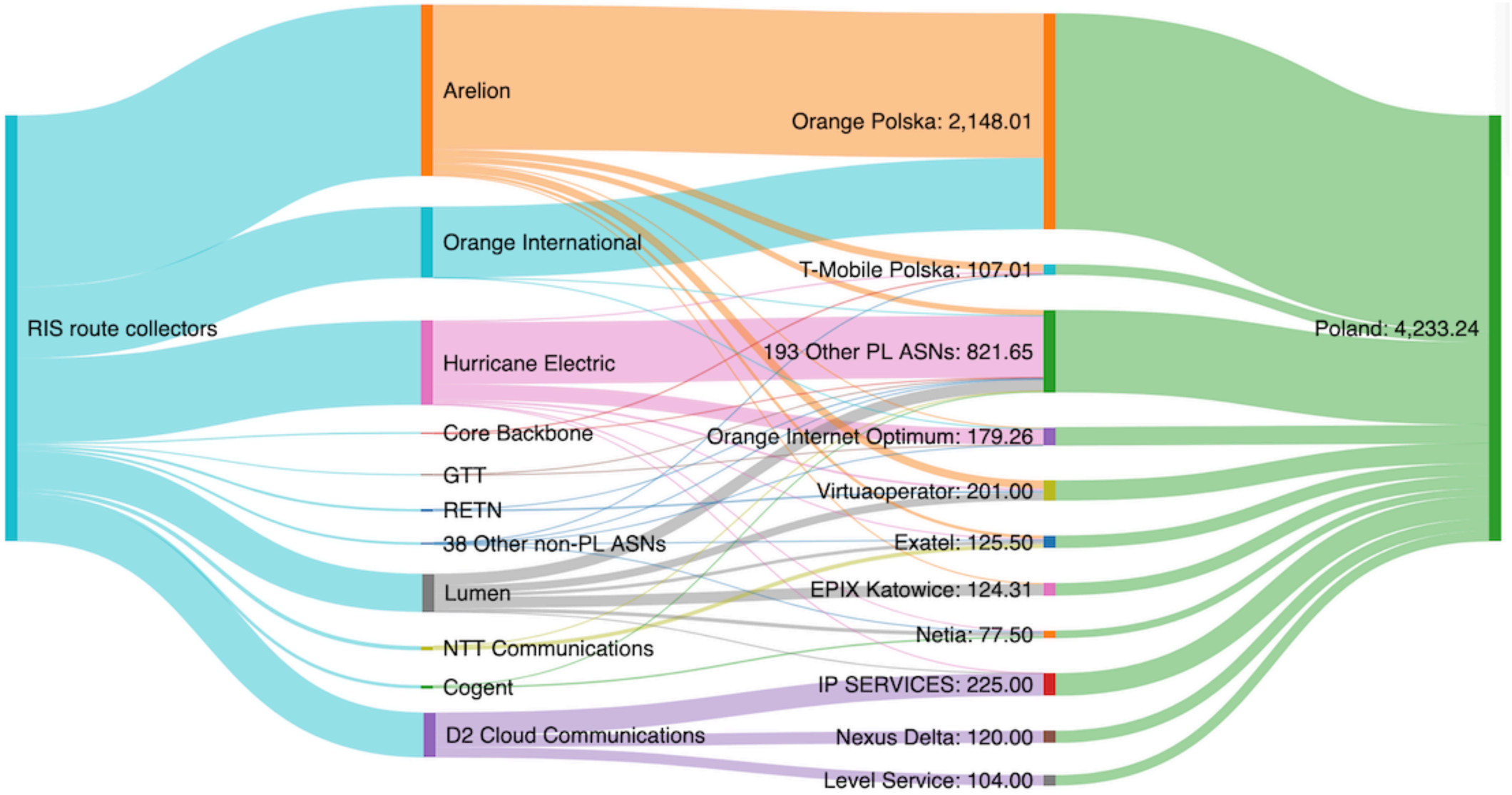
Czechia


RIS route collectors
Arelion
34 Other non-CZ ASNs
Cogent
Hurricane Electric
Slovak Telekom
Core Backbone
GTT
SprintLink
Vodafone GlobalNet
PCCW Global
RETN
133 Other CZ ASNs: 913.20
SH.cz: 772.38
Quantcom: 84.00
ISP Alliance: 214.25
Ha-vel internet: 86.51
Kaora: 158.01
NFX: 90.50
Nej.cz: 92.00
Vodafone CZ: 305.49
New Telekom: 121.00
Itself: 64.25
Czech Republic: 2,901.59

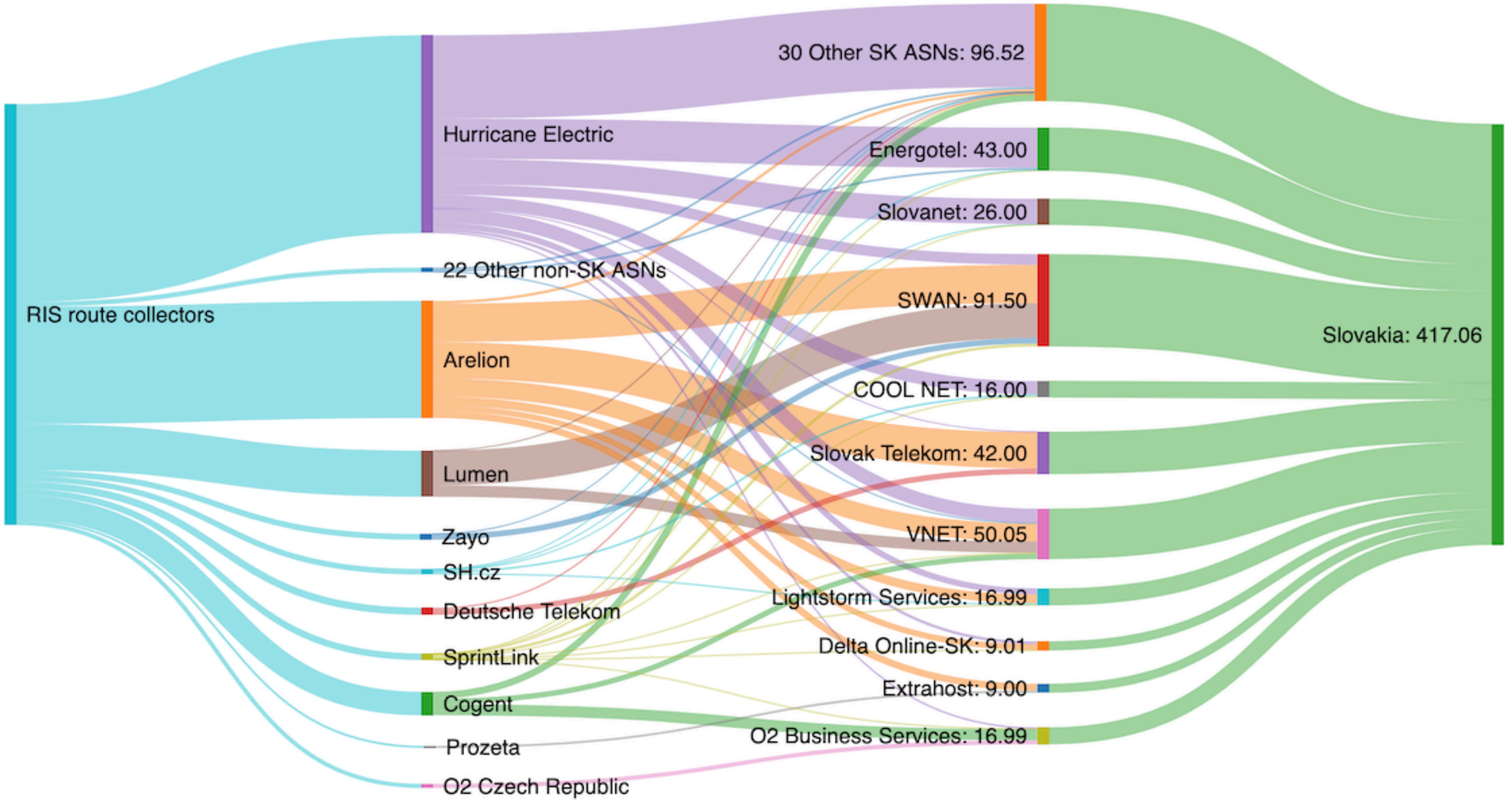
Hungary


RIS route collectors
Lumen
GTT
Arelion
Hurricane Electric
Tata Communications
SprintLink
7 Other non-HU ASNs
RETN
Cogent
Vodafone GlobalNet
Deutsche Telekom
United Telecom: 66.00
30 Other HU ASNs: 64.36
Deninet: 51.13
Invitech: 10.01
OPCNET-HU: 16.00
Giganet: 9.00
CETIN Hungary: 9.00
Vivacom Magyarorszag: 25.00
Dravanet: 9.00
Vodafone Hungary: 25.12
Magyar Telekom: 21.00
Hungary: 305.62

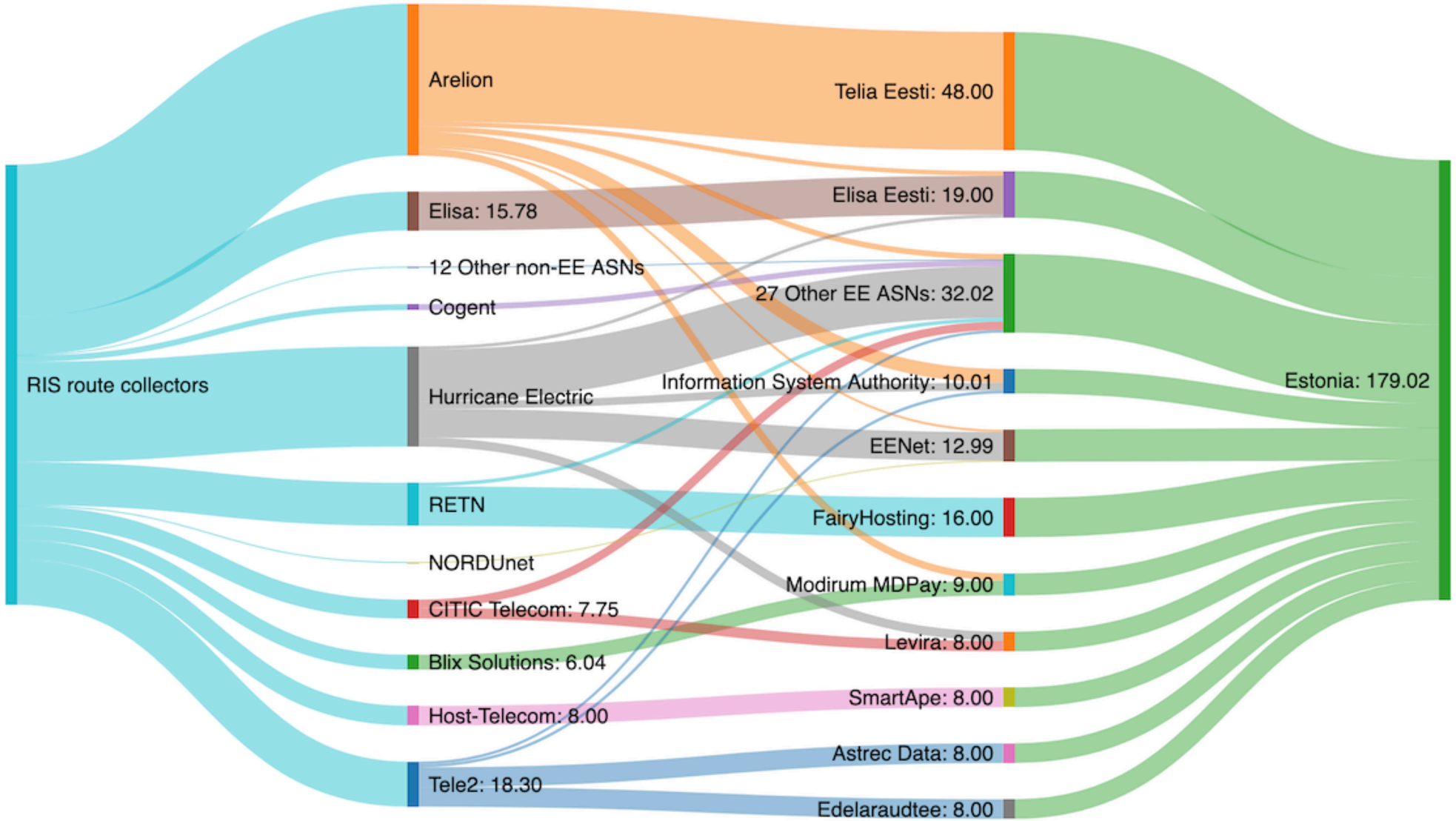
Poland


RIS route collectors
Arelion
Orange International
Hurricane Electric
Core Backbone
GTT
RETN
38 Other non-PL ASNs
Lumen
NTT Communications
Cogent
D2 Cloud Communications
Orange Polska: 2,148.01
T-Mobile Polska: 107.01
193 Other PL ASNs: 821.65
Orange Internet Optimum: 179.26
Virtuaoperator: 201.00
Exatel: 125.50
EPIX Katowice: 124.31
Netia: 77.50
IP SERVICES: 225.00
Nexus Delta: 120.00
Level Service: 104.00
Poland: 4,233.24

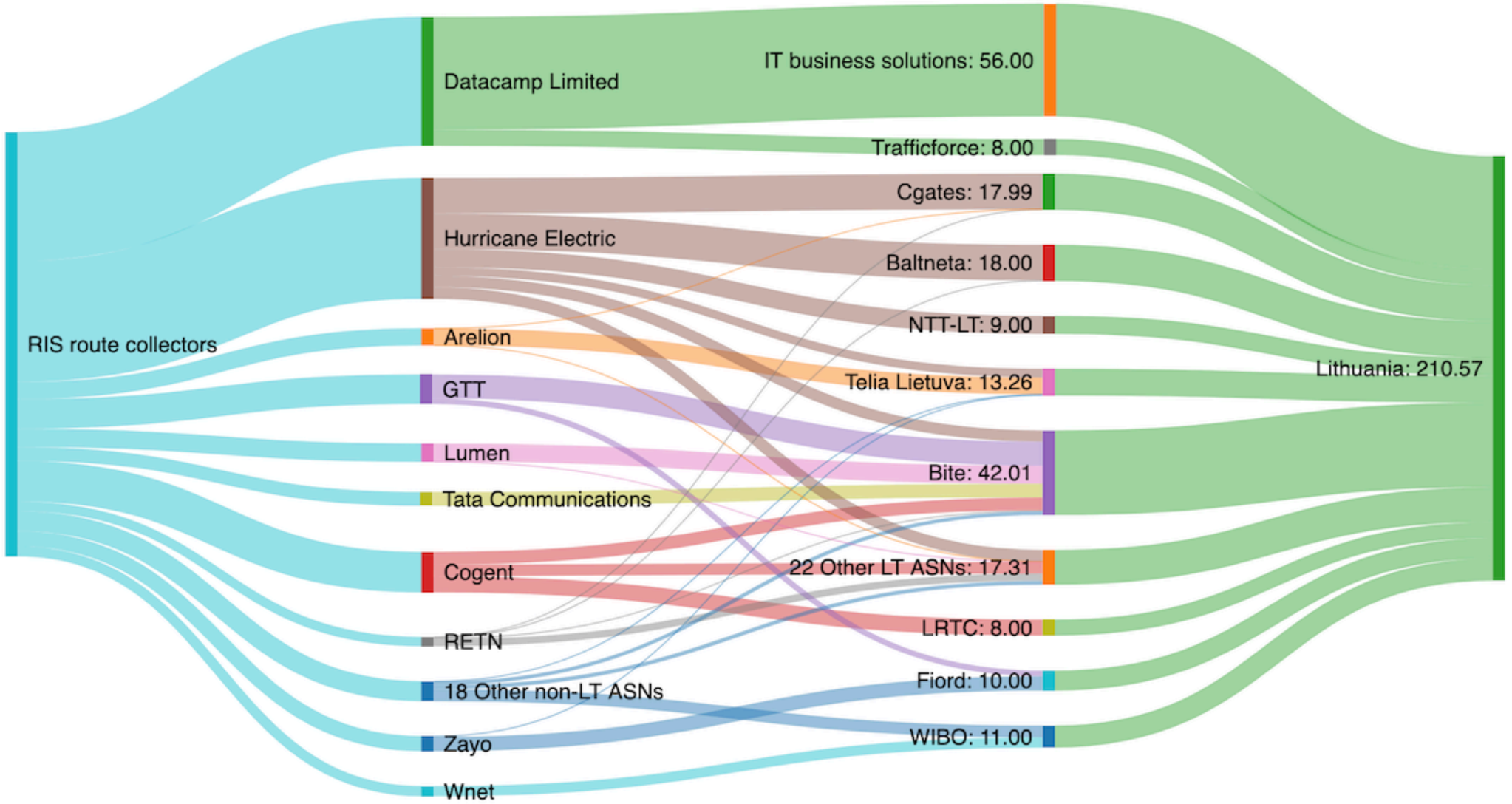
Slovakia


RIS route collectors
Hurricane Electric
22 Other non-SK ASNs
Arelion
Lumen
Zayo
SH.cz
Deutsche Telekom
SprintLink
Cogent
Prozeta
O2 Czech Republic
30 Other SK ASNs: 96.52
Energotel: 43.00
Slovanet: 26.00
SWAN: 91.50
COOL NET: 16.00
Slovak Telekom: 42.00
VNET: 50.05
Lightstorm Services: 16.99
Delta Online-SK: 9.01
Extrahost: 9.00
O2 Business Services: 16.99
Slovakia: 417.06

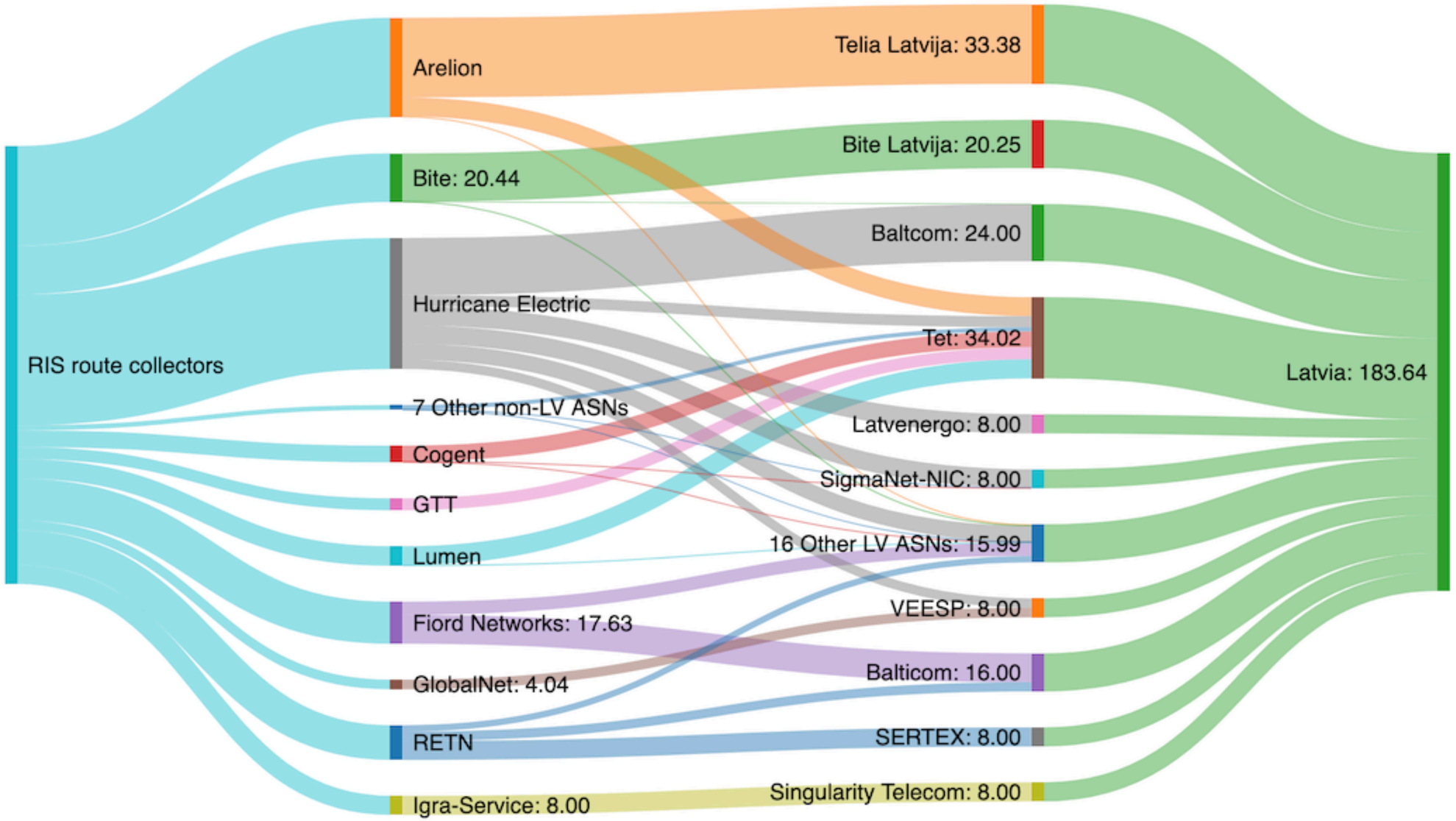
Estonia


RIS route collectors
Arelion
Elisa: 15.78
12 Other non-EE ASNs
Cogent
Hurricane Electric
RETN
NORDUnet
CITIC Telecom: 7.75
Blix Solutions: 6.04
Host-Telecom: 8.00
Tele2: 18.30
Telia Eesti: 48.00
Elisa Eesti: 19.00
27 Other EE ASNs: 32.02
Information System Authority: 10.01
EENet: 12.99
FairyHosting: 16.00
Modirum MDPay: 9.00
Levira: 8.00
SmartApe: 8.00
Astrec Data: 8.00
Edelaraudtee: 8.00
Estonia: 179.02

Lithuania


RIS route collectors
Datacamp Limited
Hurricane Electric
Arelion
GTT
Lumen
Tata Communications
Cogent
RETN
18 Other non-LT ASNs
Zayo
Wnet
IT business solutions: 56.00
Trafficforce: 8.00
Cgates: 17.99
Baltneta: 18.00
NTT-LT: 9.00
Telia Lietuva: 13.26
Bite: 42.01
22 Other LT ASNs: 17.31
LRTC: 8.00
Fiord: 10.00
WIBO: 11.00
Lithuania: 210.57

Latvia


RIS route collectors
Arelion
Bite: 20.44
Hurricane Electric
7 Other non-LV ASNs
Cogent
GTT
Lumen
Fiord Networks: 17.63
GlobalNet: 4.04
RETN
Igra-Service: 8.00
Telia Latvija: 33.38
Bite Latvija: 20.25
Baltcom: 24.00
Tet: 34.02
Latvenergo: 8.00
SigmaNet-NIC: 8.00
16 Other LV ASNs: 15.99
VEESP: 8.00
Balticom: 16.00
SERTEX: 8.00
Singularity Telecom: 8.00
Latvia: 183.64

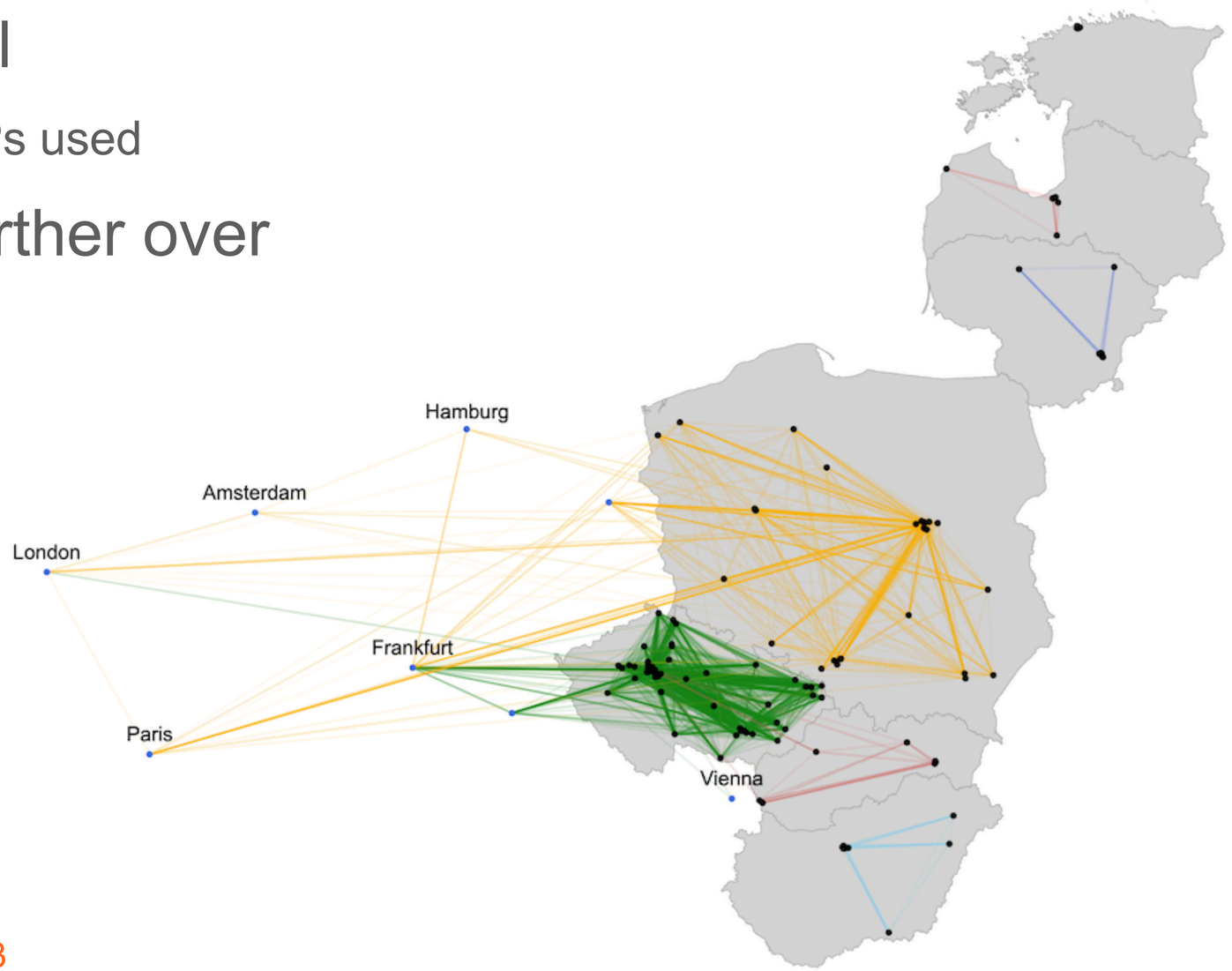
International Connectivity

- Hurricane Electric and Arelion are the dominant upstream providers in Central Europe and the Baltics over IPv6
  - Hurricane Electric plays a larger role over IPv6 than IPv4 (in Central Europe)
- Overall, there’s good diversity in upstream providers
  - Major providers in the countries have more than one upstream
  - Not a lot of dependencies on single providers
  - This provides redundancy and resilience

Traffic Paths

Traffic Paths over IPv6

- Most paths stay fairly local
  - Although some major foreign IXPs used
- Paths extended slightly farther over IPv4 in Central Europe
  - Moscow, Dublin, Istanbul, Madrid



Routing Security

Figure 22:
IPv4 address space covered by ROAs over time

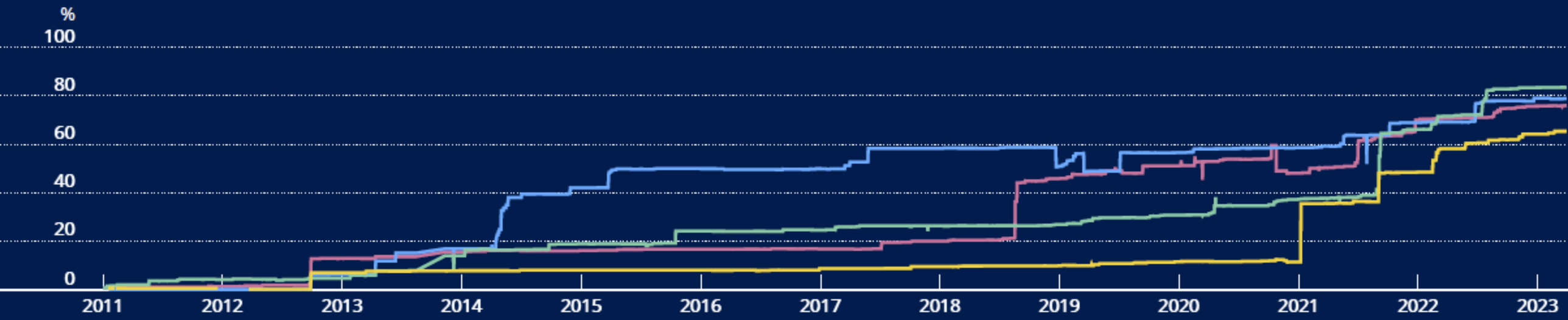
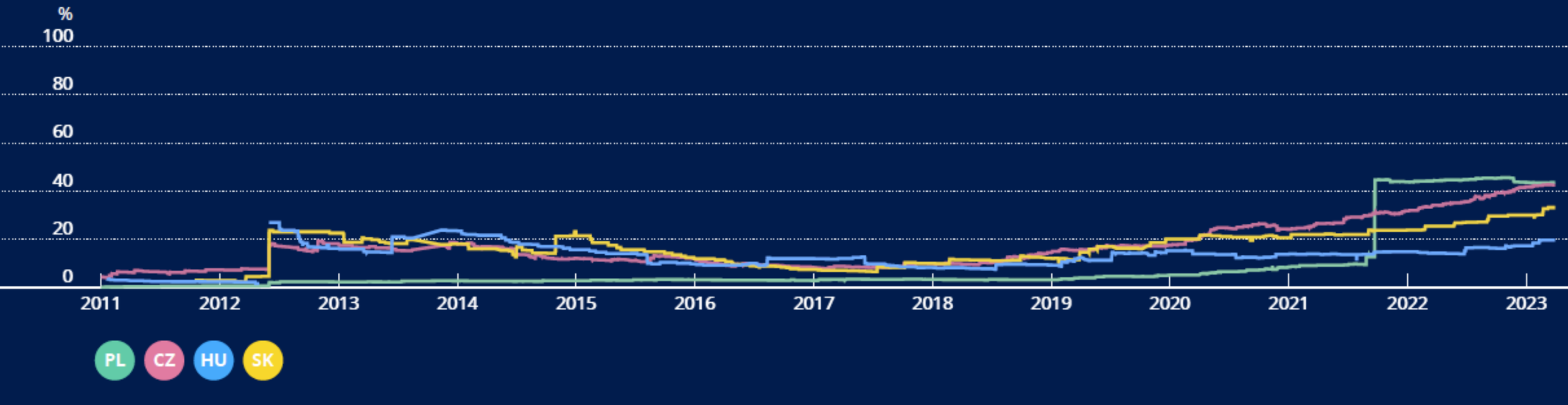
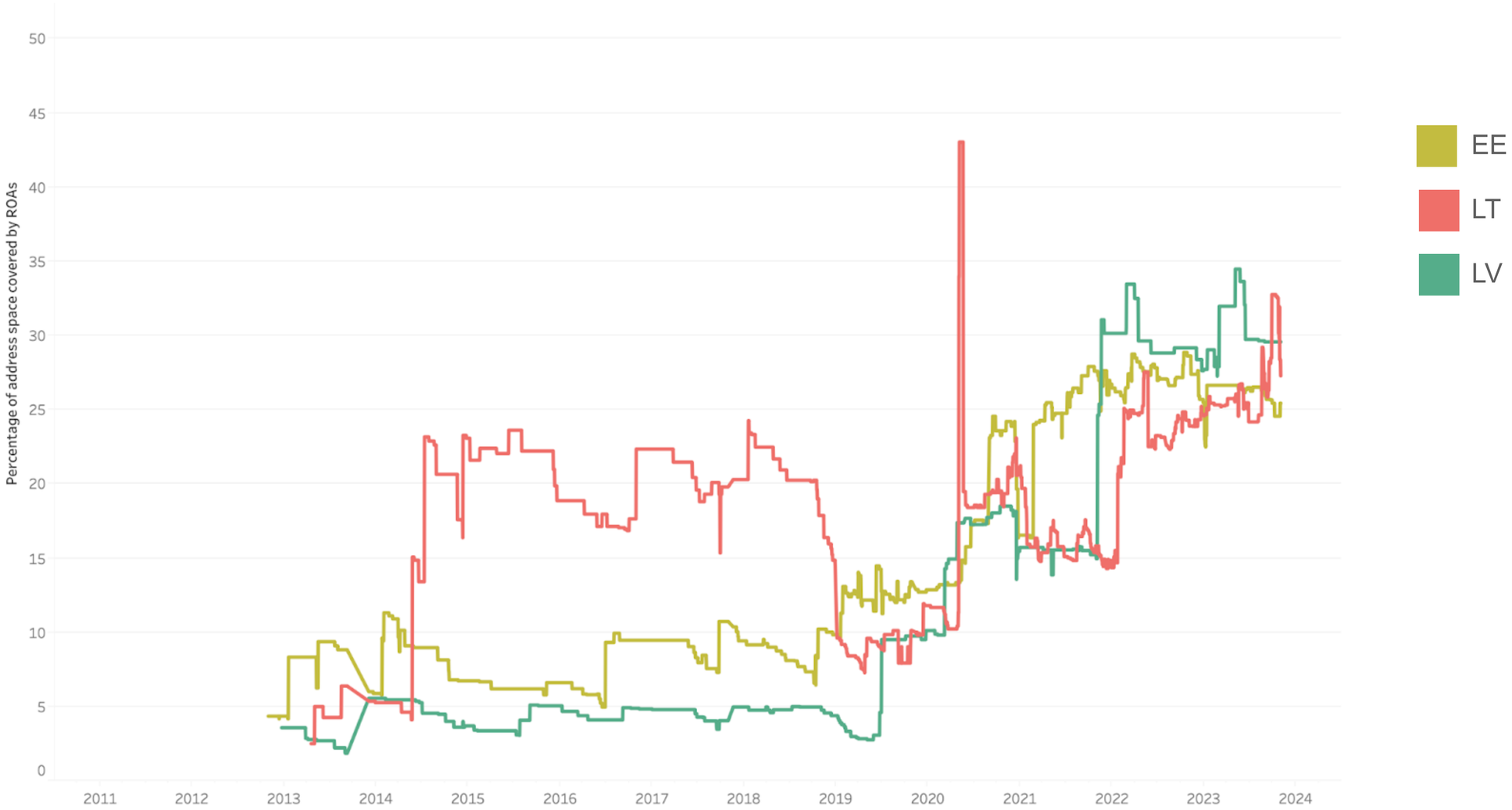


Figure 23:
IPv6 address space covered by ROAs over time



IPv6 Address Space Covered by ROAs in the Baltics



Central Europe and the Baltics: Conclusions

- Good level of interconnection over IPv6
  - Both domestically and internationally
  - Stable, resilient Internet landscapes
- BUT falling behind on IPv6 deployment
  - IPv6 is the only long-term solution to support future growth and new technologies
  - Everyone has a role to play
    - Governments, regulators, IXPs, ISPs, operators, decision makers, NOGs

Data Sources

- RIPE Registry
  - Record of all IP address and ASN allocations and resource holders
  - Public information available via the RIPE Database: https://www.ripe.net
- RIPE Atlas
  - Globally distributed network of thousands of probes collecting information about Internet connectivity
  - Public data available via maps, visualisations and API: https://atlas.ripe.net
- Routing Information Service (RIS)
  - Collecting Internet routing data from locations around the world since 2001: https://www.ripe.net/ris

RIPE NCC Training

- We offer a lot of different training courses
  - Range of technical and non-technical topics - including IPv6!
  - Courses for both members and others free and open to anyone

    https://www.ripe.net/support/training

A few parting thoughts…

- These reports are always evolving
- Please get in touch and tell us what you want!

  ppig@ripe.net
- YOU can use this data, too

  https://labs.ripe.net

Questions

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