RIPE NCC
RIPE NETWORK COORDINATION CENTRE

IPv6 in the Nordics

(and why it's important)

Suzanne Taylor | 7 December 2022 | ICANN Training Series

Topics

- The RIPE NCC
- IPv6 basics
- Why IPv6 is important
- IPv6 in the Nordics
  - 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

iana
Internet Assigned Numbers Authority

ARIN
American Registry for Internet Numbers

lacnic

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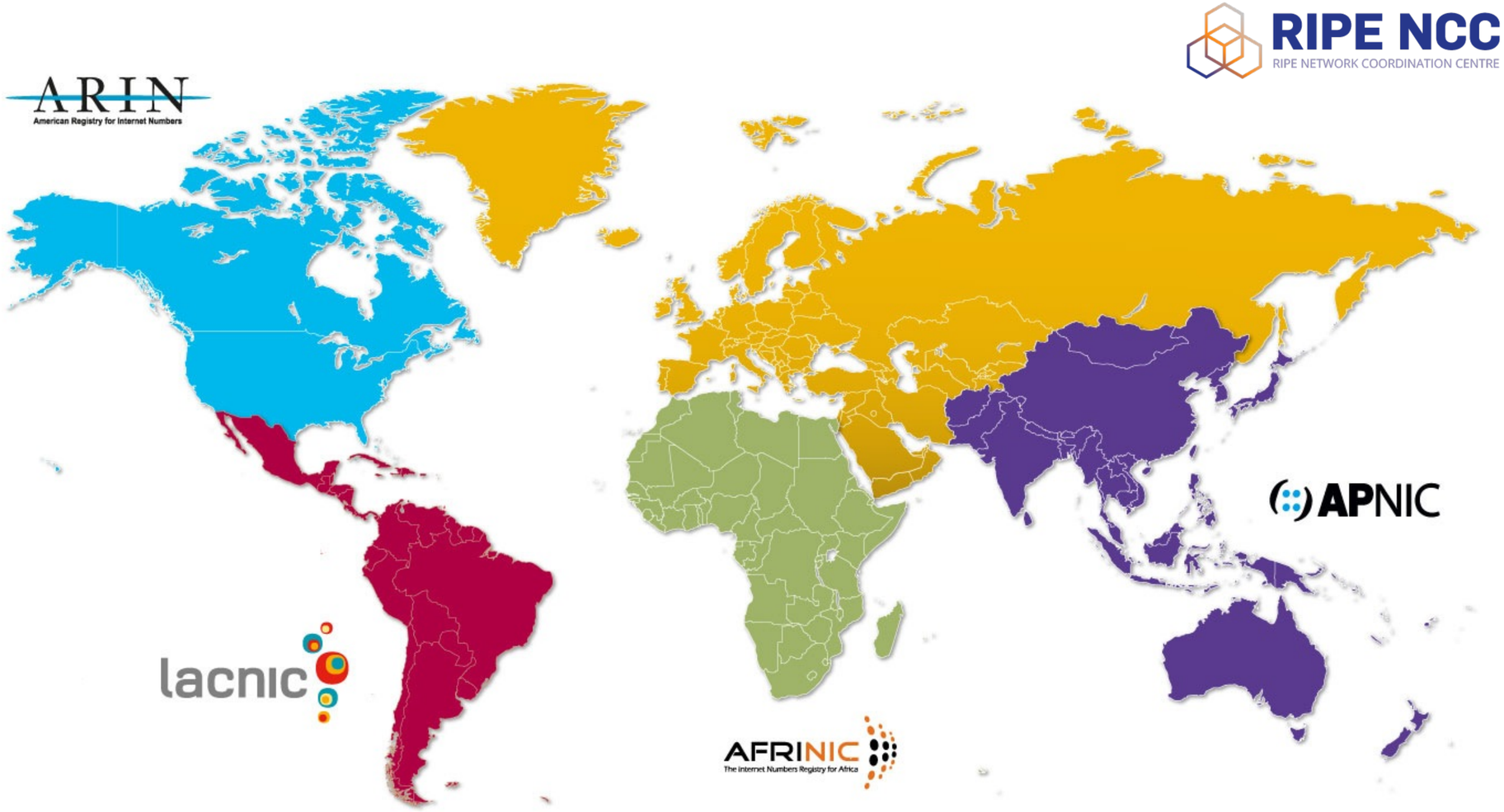
AFRINIC
The Internet Numbers Registry for Africa

APNIC

Local Internet Registries

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

Regional Internet Registries (RIRs)



RIPE NCC

- Provides 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
- Involved in 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

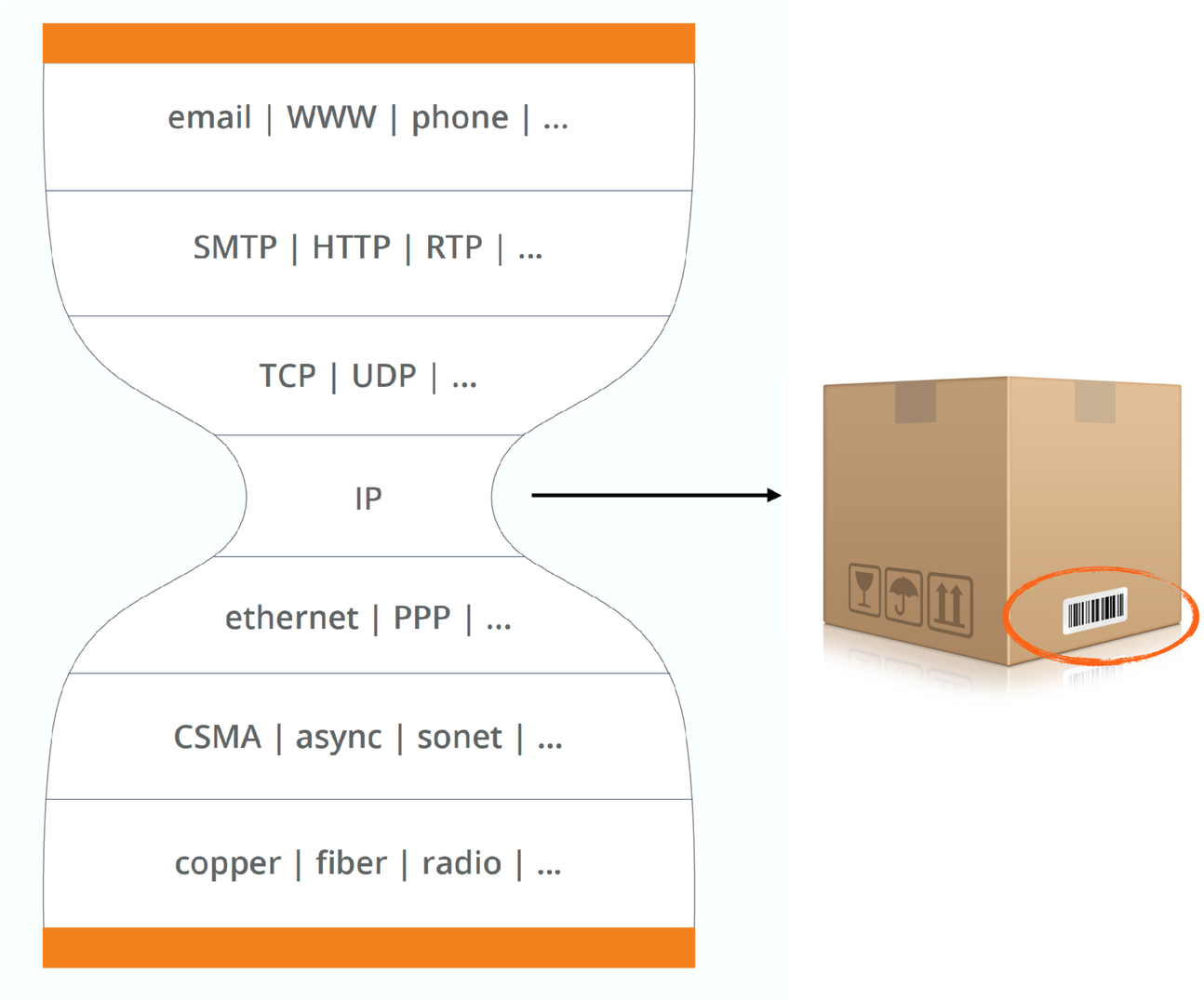
IPv6

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 small players out

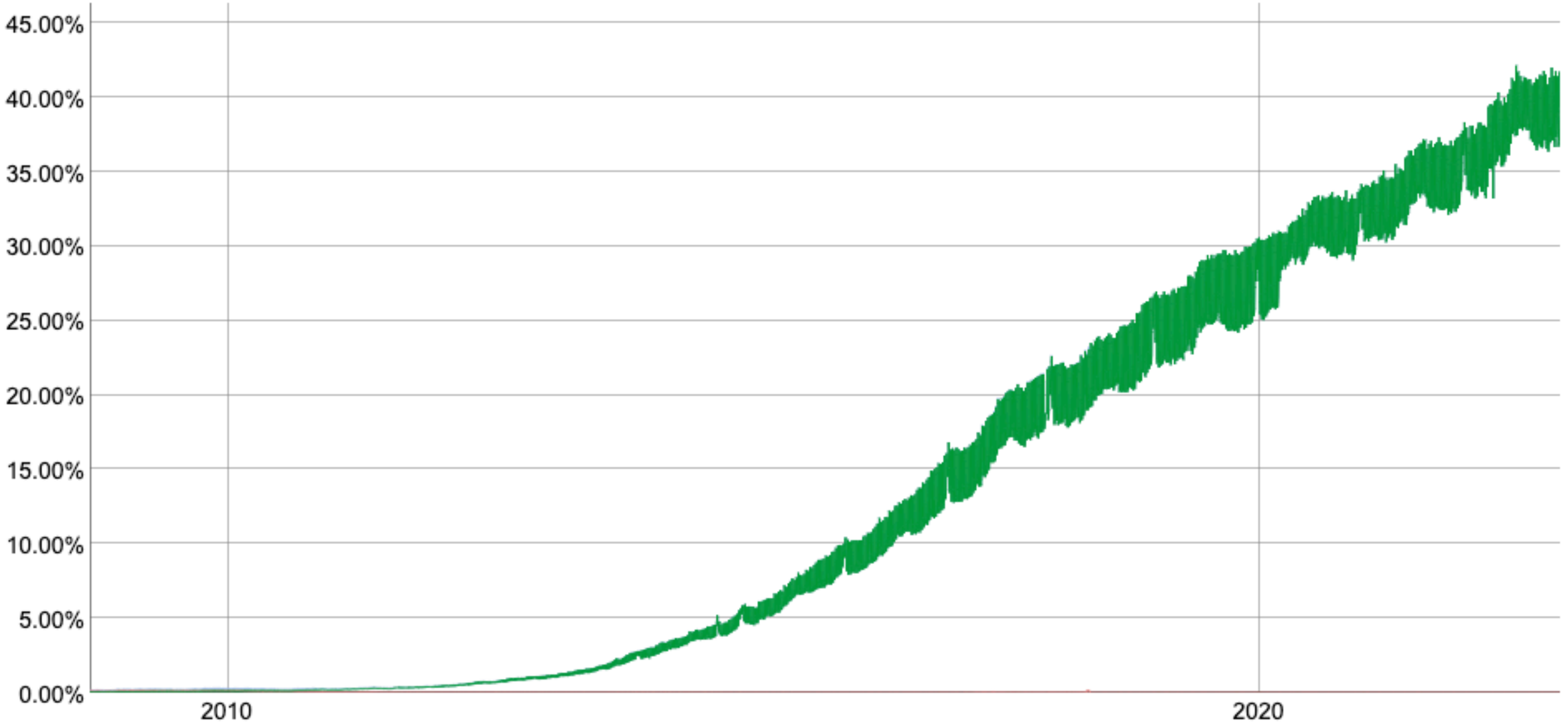
The Problem: Not Enough Addresses

- 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
- 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

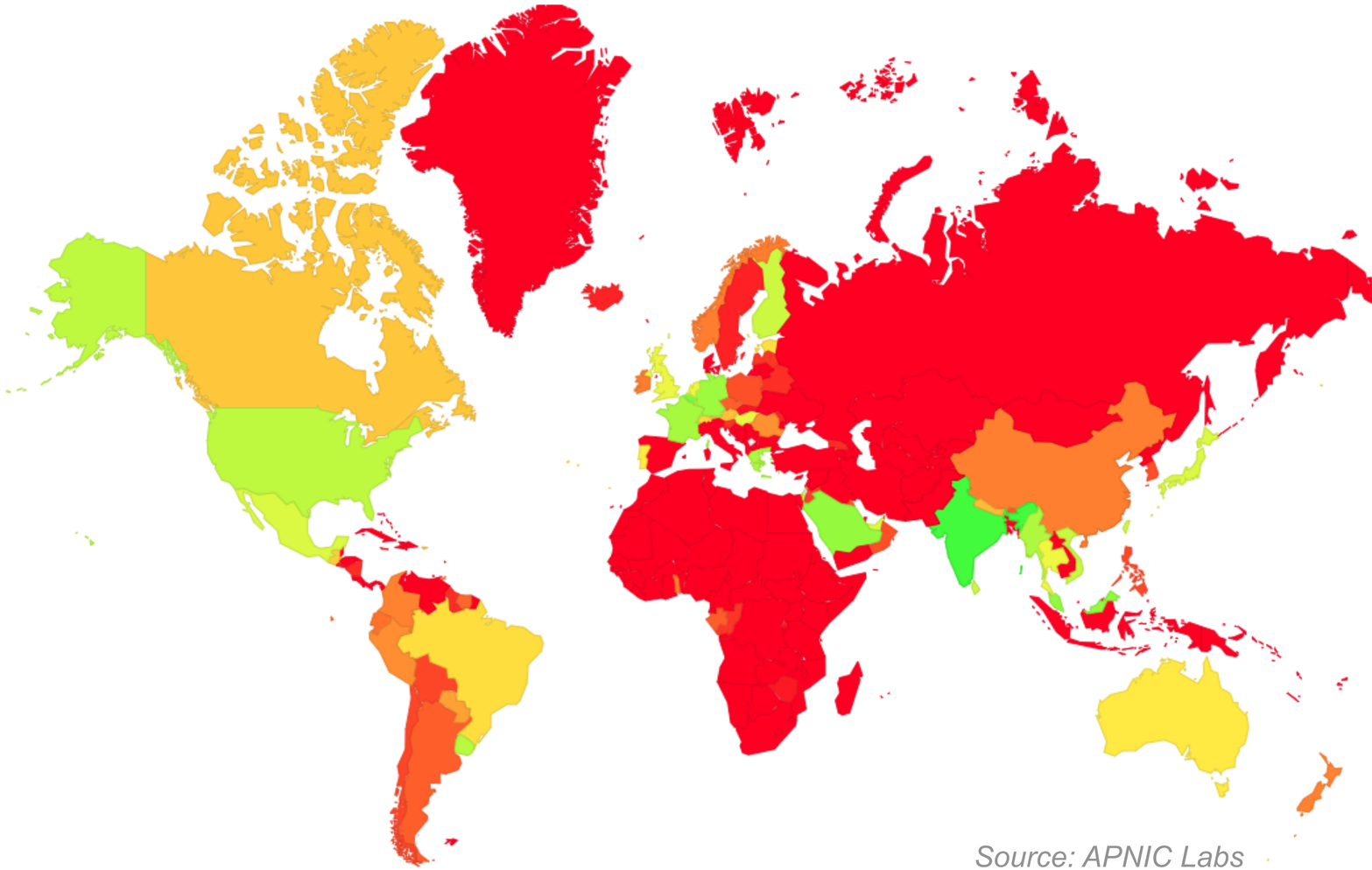
Current State of IPv6 Use



Source: Google

Current State of IPv6 Use

- World average: 30%
- Leaders:
  - Saint Barthélemy: 85%
  - India: 79%
  - Belgium: 67%
  - Malaysia: 62%
  - Saudi Arabia: 61%
  - Germany: 60%
  - France: 58%
  - Greece: 57%



Source: APNIC Labs

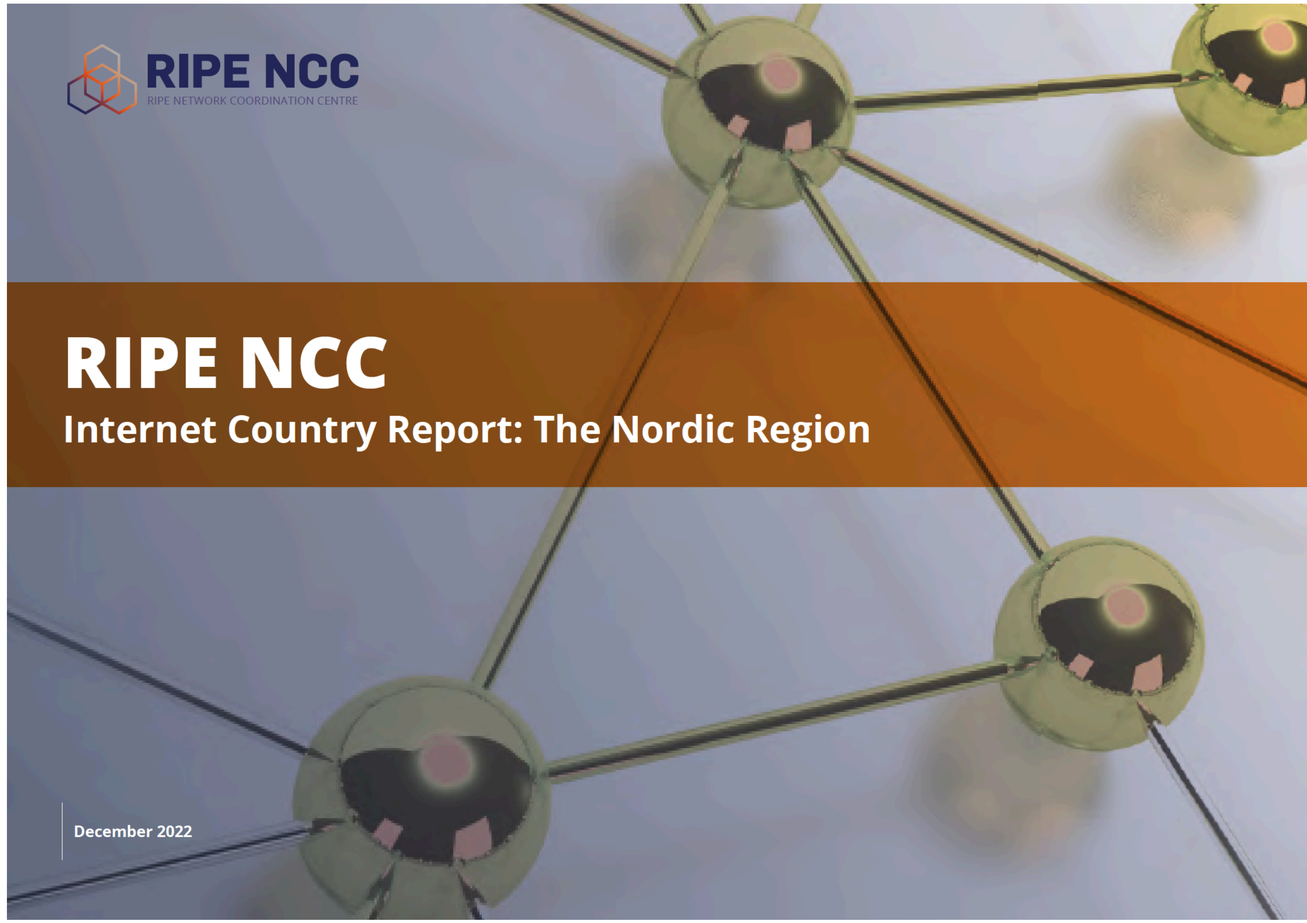
IPv6 in the Nordics

As Seen from the RIPE NCC

RIPE NCC Internet Country Report

- Nordic Region country report published yesterday

  https://labs.ripe.net/country-reports/
- Covers IPv4 and IPv6



RIPE NCC Internet Country Reports

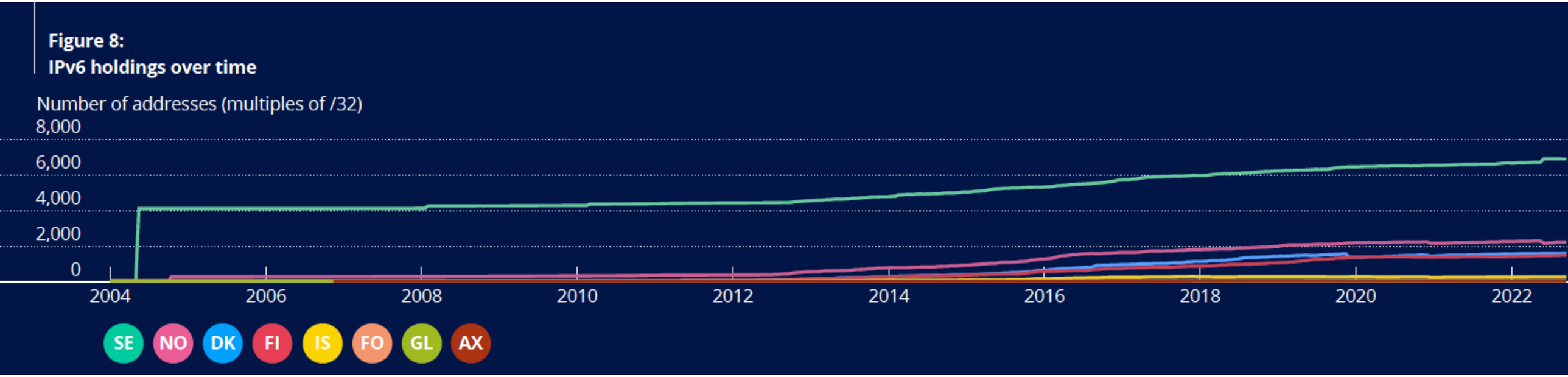
- Showcase RIPE NCC data and measurement platforms
- Bring value to local technical communities
- Support Internet development throughout service region
- Inform public policymaking

Highlights

- Advanced Internet development
- Large amounts of IPv4 in the region
- IPv6 capability ranges from 0-50%
- Routing is generally optimised (but some long paths)
- Good diversity in international connectivity

IPv6 Holdings and Use

Figure 8:
IPv6 holdings over time



Top IPv6 Holders

- Not much consolidation in Denmark, Norway, Finland, Iceland
- Faroe Islands:
  - 32% each: Føroya Tele and P/F Electron (ISPs), Kringvarp Føroya (public broadcaster)
- Åland:
  - 42% each: Ålands Penningautomatförening (gambling operator owned by regional government), Carus (software company)
- Sweden:
  - 60%: Telia Company (some went to Telia in Sweden, Denmark and Finland)
- Greenland:
  - 80%: Nanoq Media (tv, radio and broadband Internet)

IPv6 Holdings vs Use

- Having IPv6 space doesn’t mean it’s in use
- In the Nordic Region, 64% of IPv6 space is actually routed
- Without Telia’s large holding, it’s only 46%
- Even being routed doesn’t mean it’s being used…

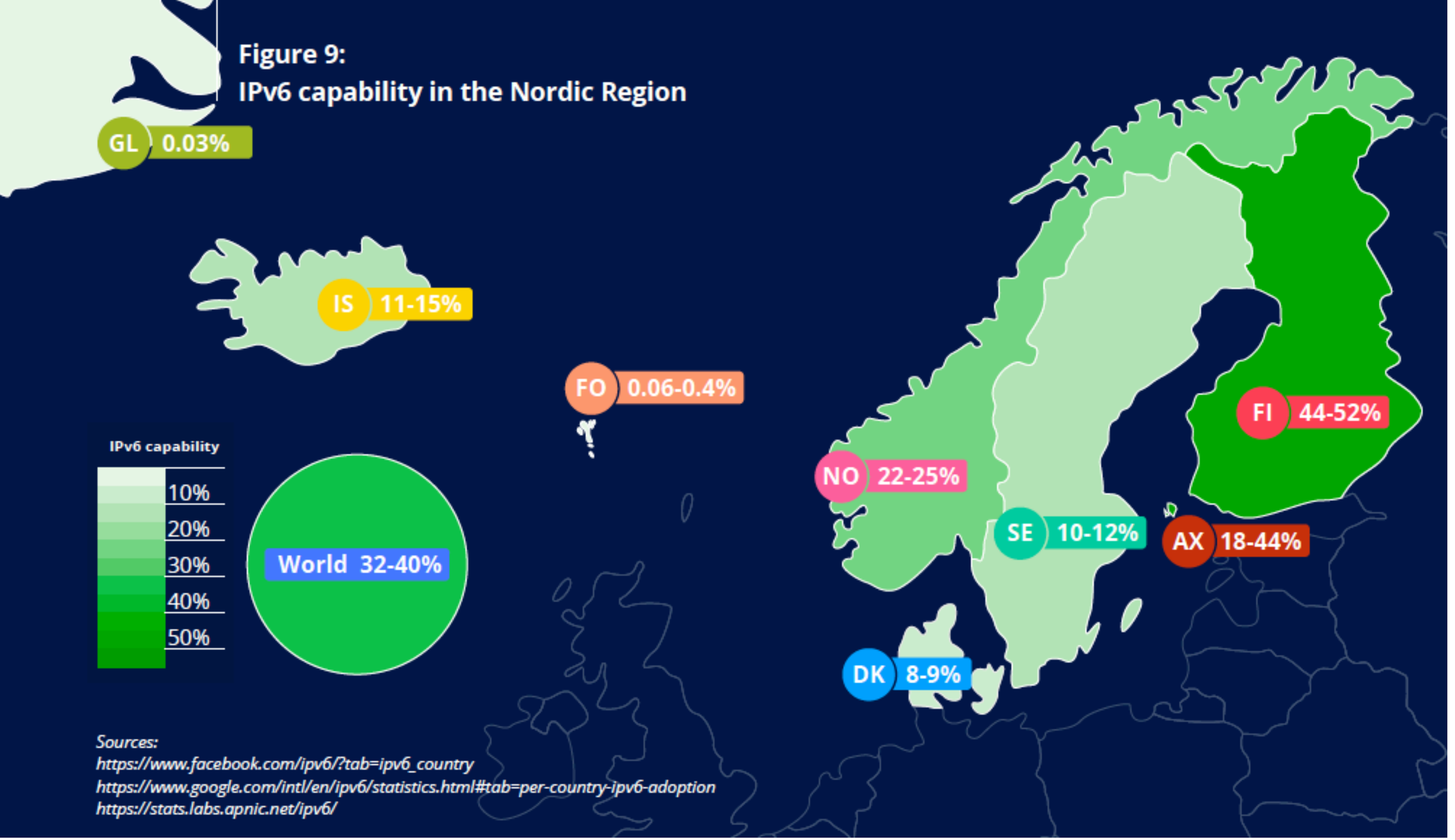


Figure 9:
IPv6 capability in the Nordic Region
GL 0.03%
IS 11-15%
FO 0.06-0.4%
FI 44-52%
NO 22-25%
SE 10-12%
AX 18-44%
DK 8-9%
World 32-40%
IPv6 capability
10%
20%
30%
40%
50%
Sources:
https://www.facebook.com/ipv6/?tab=ipv6_country
https://www.google.com/intl/en/ipv6/statistics.html#tab=per-country-ipv6-adoption
https://stats.labs.apnic.net/ipv6/

IPv6 Capability of Major Providers

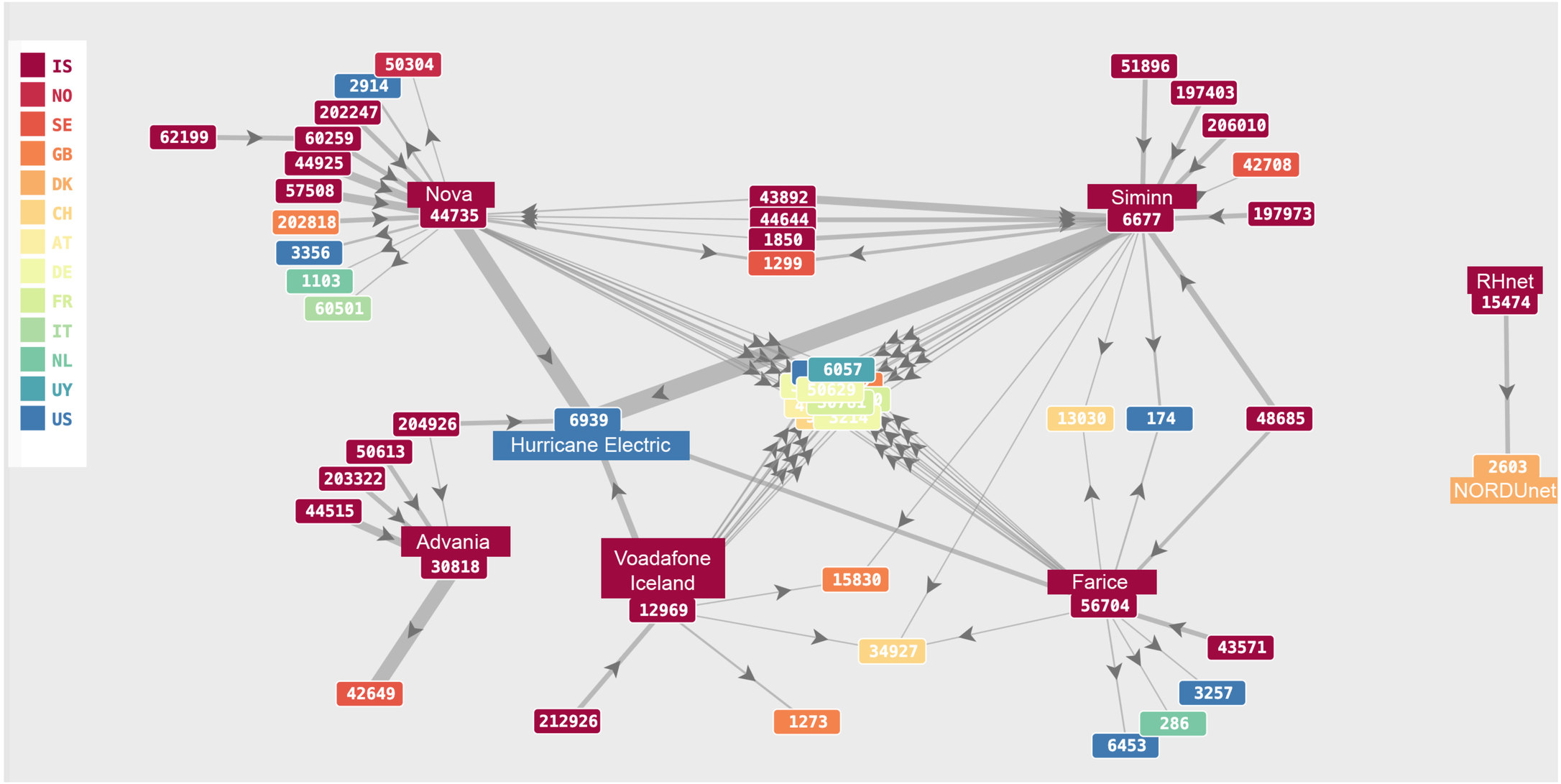
- Major providers in the Nordics with more than 50% capability:
  - Elisa
  - DNA
  - Ålcom
  - Hi3G
  - Telenor
  - Nova
- Despite Telia's large holding, only 5% capable

IPv6 Challenges

- RIPE NCC Survey 2019: 250 respondents from Nordic Region
  - 36% said they would need more IPv4 space in next 2-3 years
    - Compared to 46% of all respondents
  - Top challenge in Nordic Region was IPv6 deployment
    - Compared to top challenge among all respondents being dependency on IPv4
  - Mixed reasons for not deploying > most common was lack of business need
- Swedish regulator report identified two main obstacles:
  - Low demand for IPv6 in public sector
  - Limited IPv6-compatible access in public networks
- Governments regulators, IXPs, ISPs, NOGs all have a role

Domestic Connectivity

Iceland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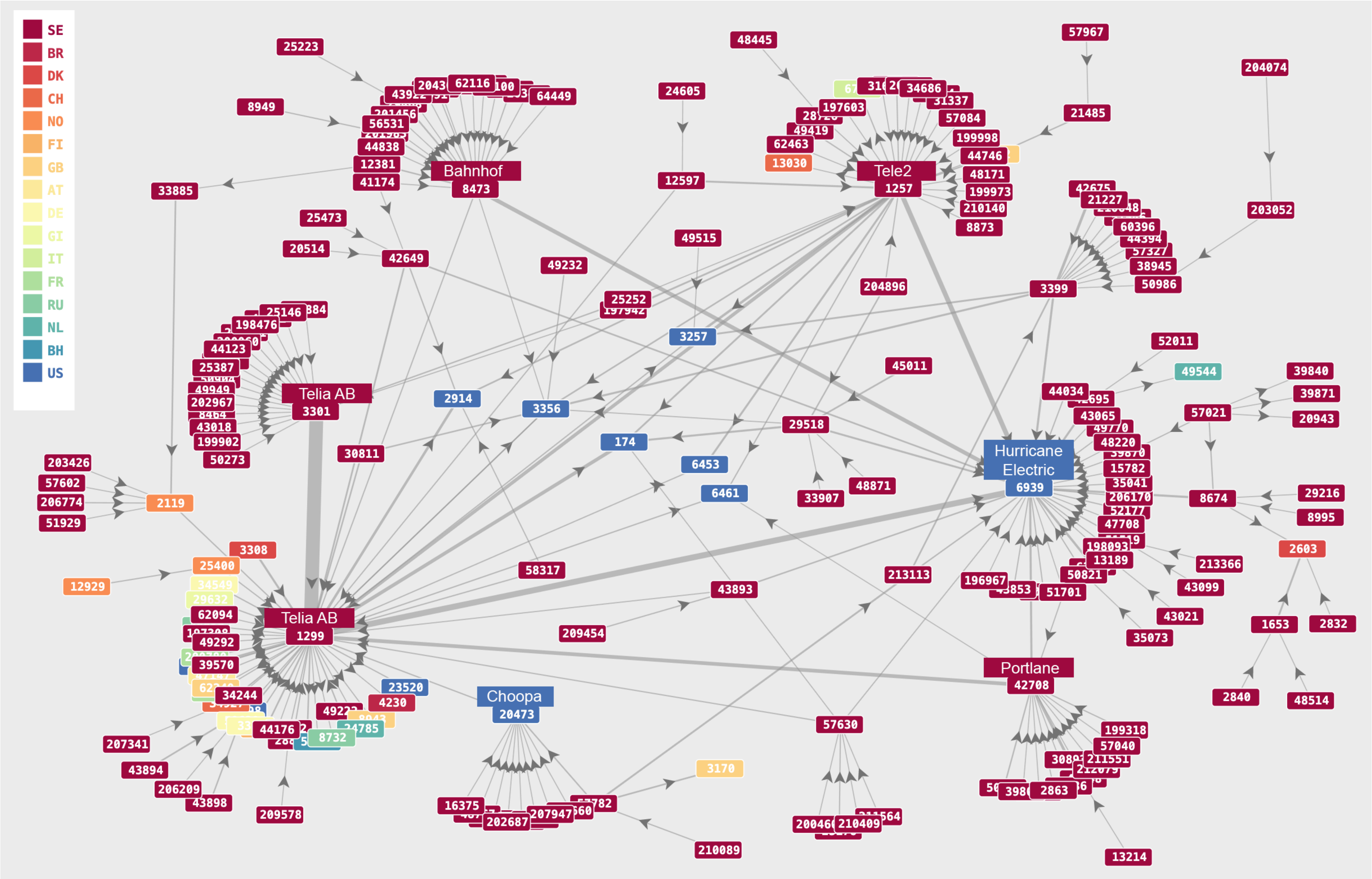
Sweden



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Telia AB
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Telia AB
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Hurricane Electric
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Portlane
42708
Choopa
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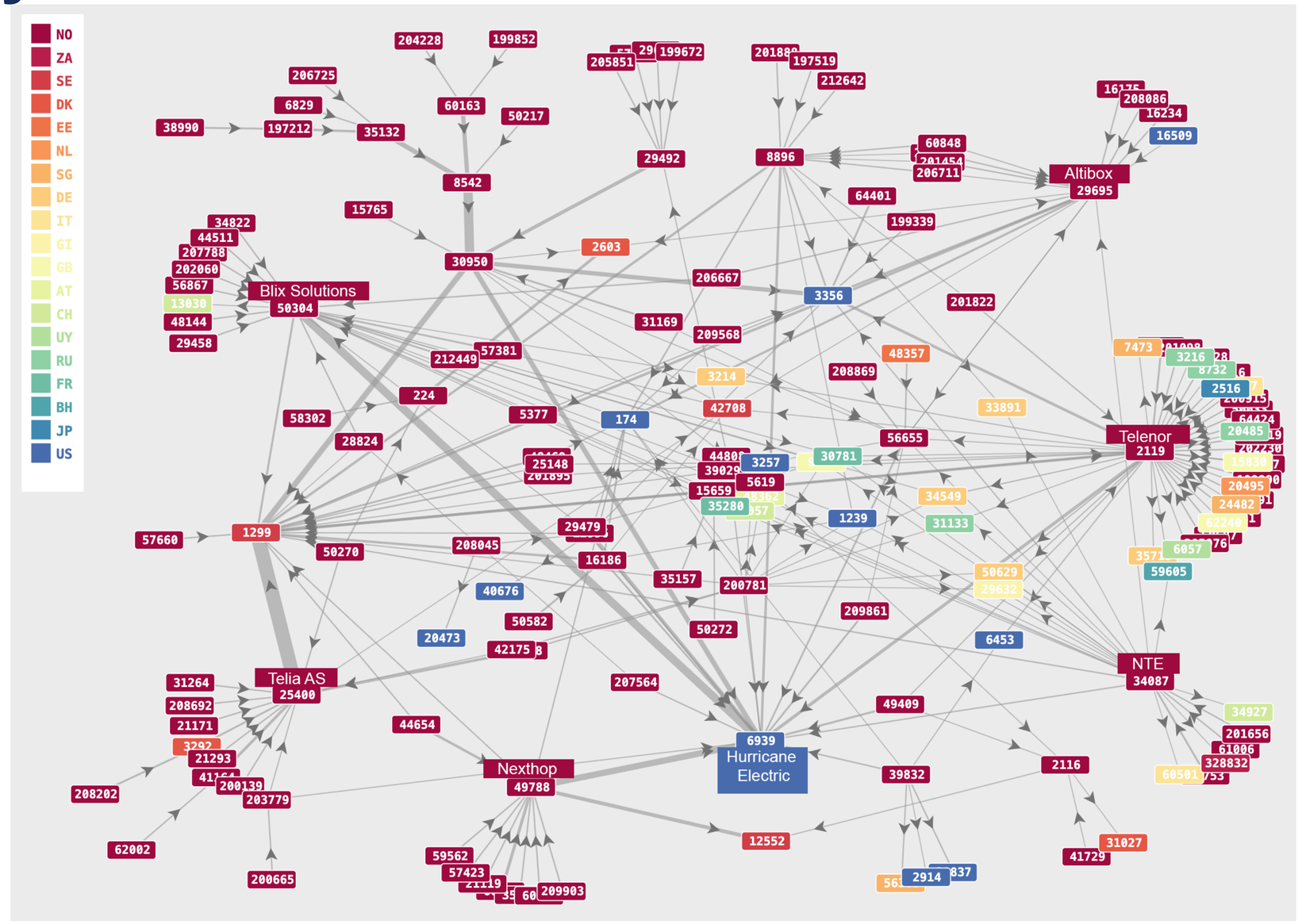
Norway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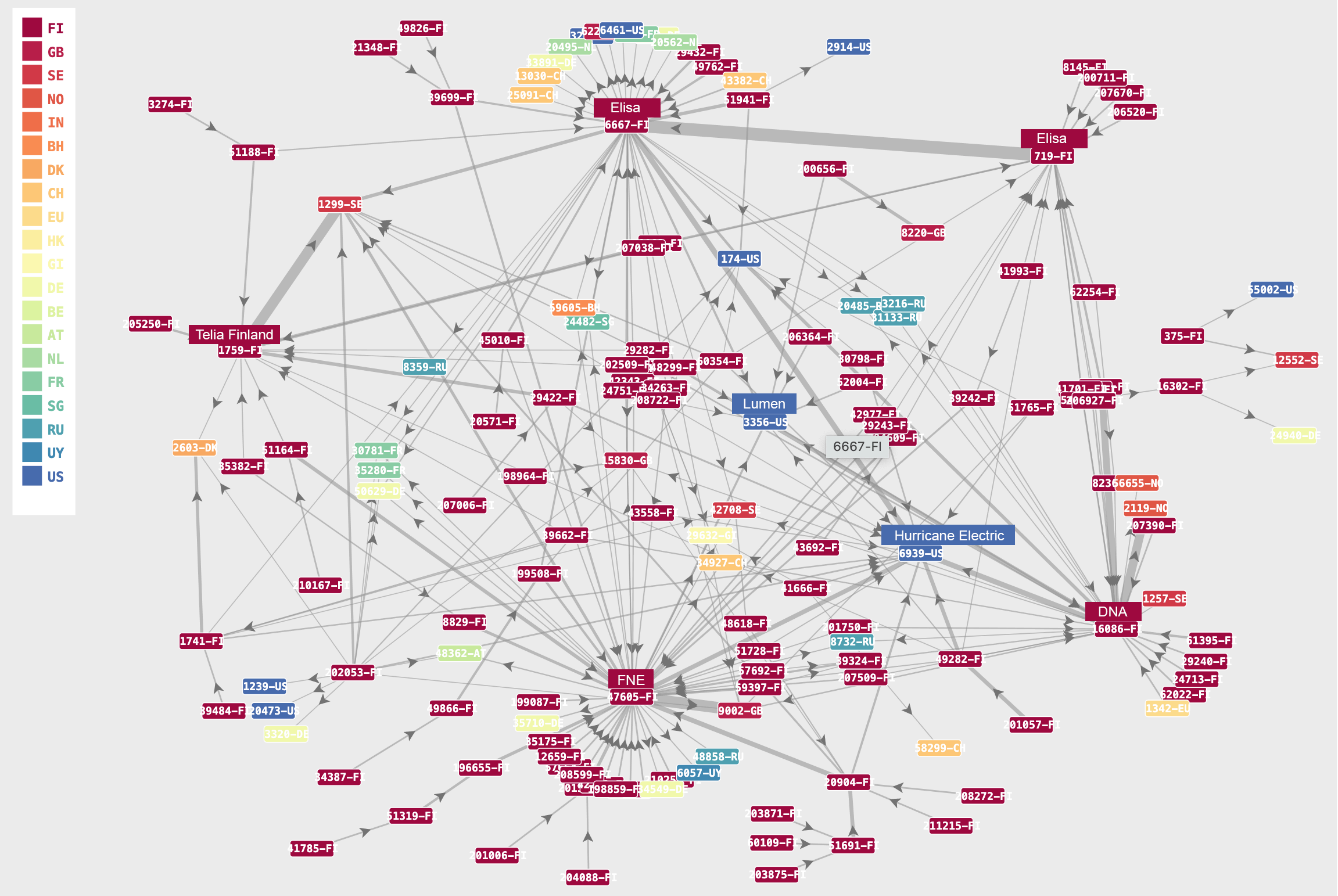
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Hurricane Electric
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DNA
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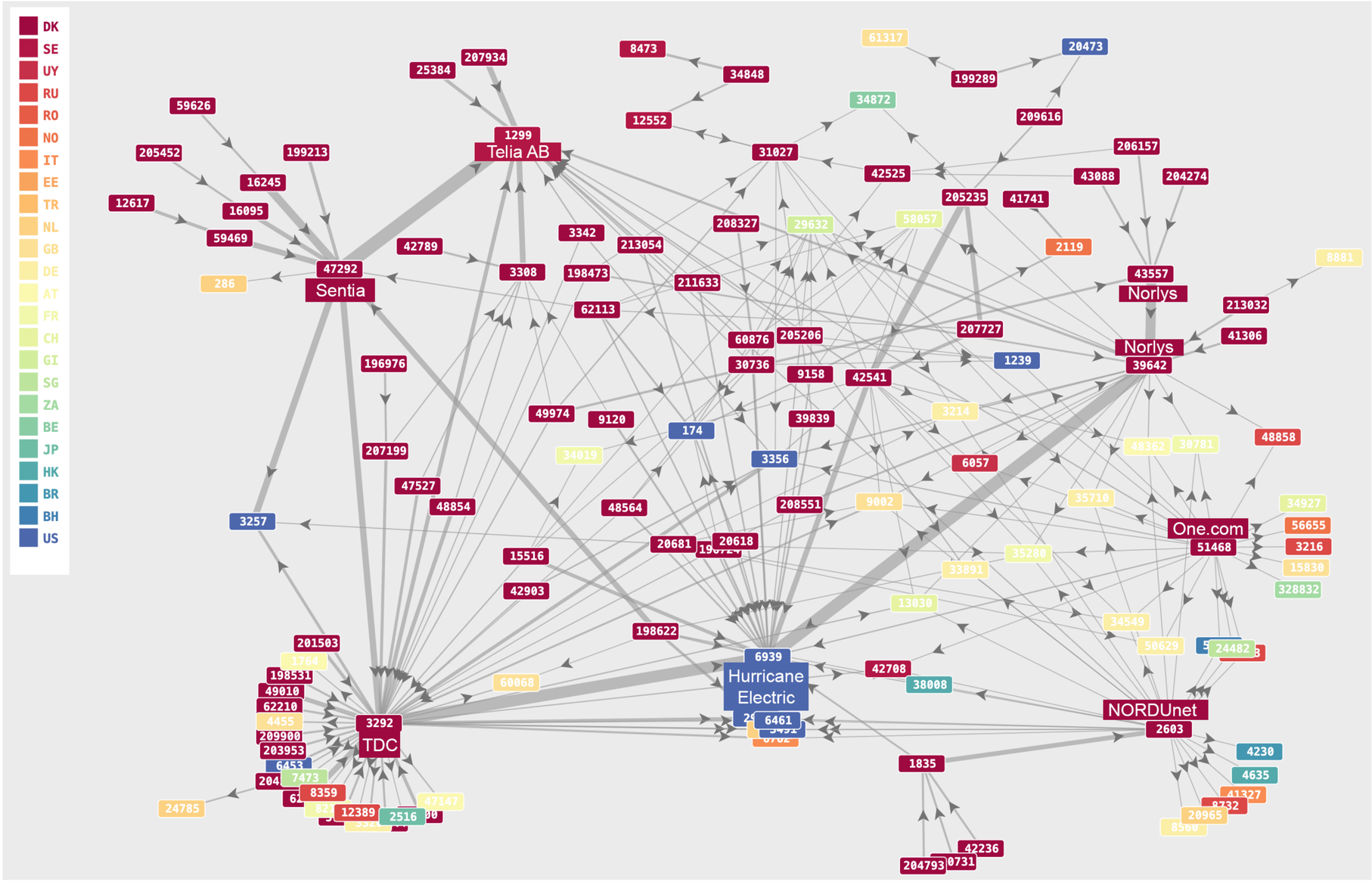
Denmark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Hurricane Electric
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Norlys
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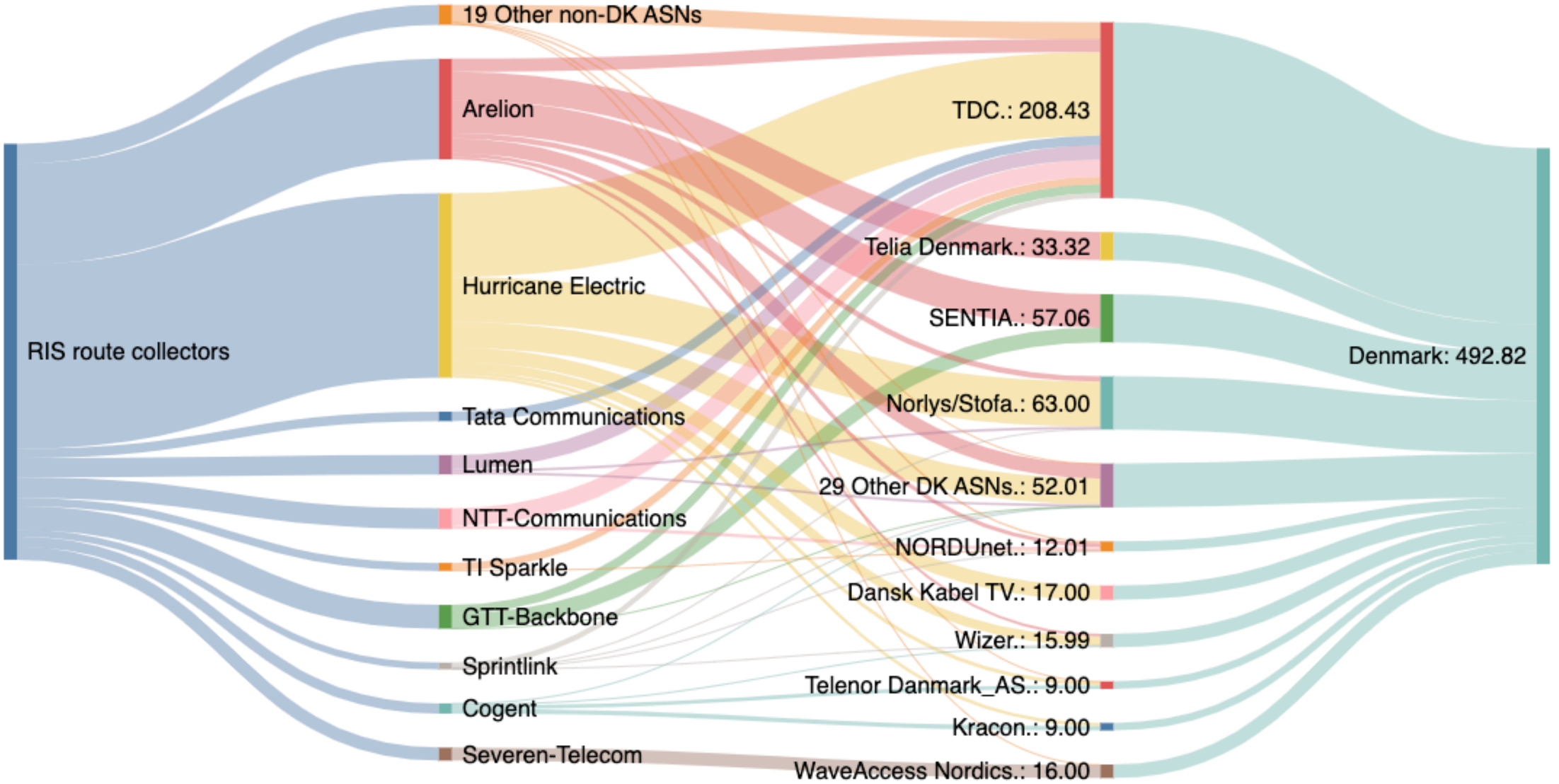
Norlys
51468
One.com
2603
NORDUnet

Domestic Connectivity

- Ideally, a visualisation of domestic connectivity should look like a deeply interconnected web
- That’s generally what we see in the Nordic Region, with a lot of interconnection between domestic networks in the five countries
- This provides the overall system with redundancy and, therefore, resilience

International Connectivity


RIS route collectors
19 Other non-DK ASNs
Arelion
Hurricane Electric
Tata Communications
Lumen
NTT-Communications
TI Sparkle
GTT-Backbone
Sprintlink
Cogent
Severen-Telecom
TDC.: 208.43
Telia Denmark.: 33.32
SENTIA.: 57.06
Norlys/Stofa.: 63.00
29 Other DK ASNs.: 52.01
NORDUnet.: 12.01
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Wizer.: 15.99
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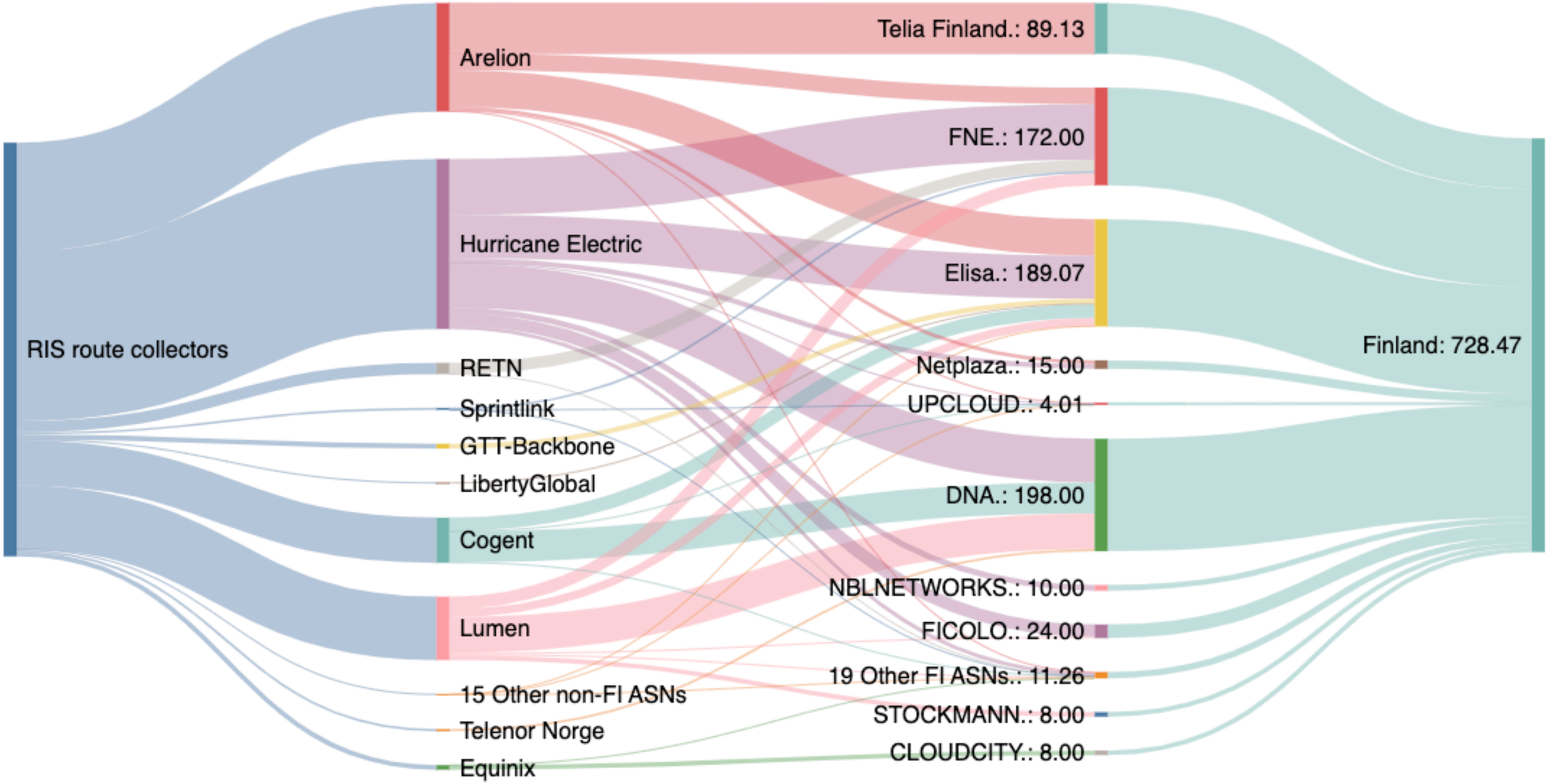
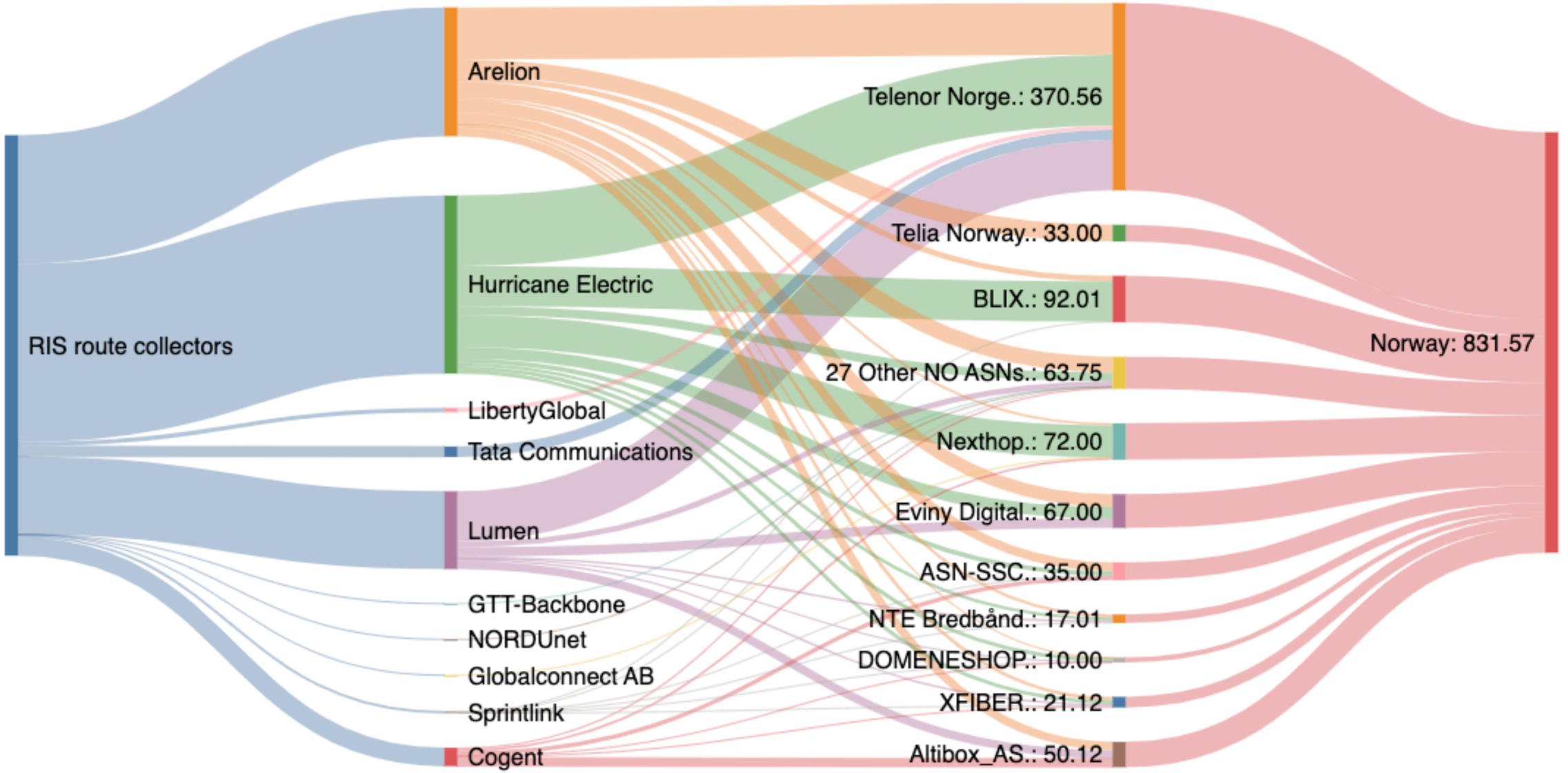
Kracon.: 9.00
WaveAccess Nordics.: 16.00
Denmark: 492.82


RIS route collectors
Arelion
Hurricane Electric
RETN
Sprintlink
GTT-Backbone
LibertyGlobal
Cogent
Lumen
15 Other non-FI ASNs
Telenor Norge
Equinix
Telia Finland.: 89.13
FNE.: 172.00
Elisa.: 189.07
Netplaza.: 15.00
UPCLOUD.: 4.01
DNA.: 198.00
NBLNETWORKS.: 10.00
FICOLO.: 24.00
19 Other FI ASNs.: 11.26
STOCKMANN.: 8.00
CLOUDCITY.: 8.00
Finland: 728.47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Lumen
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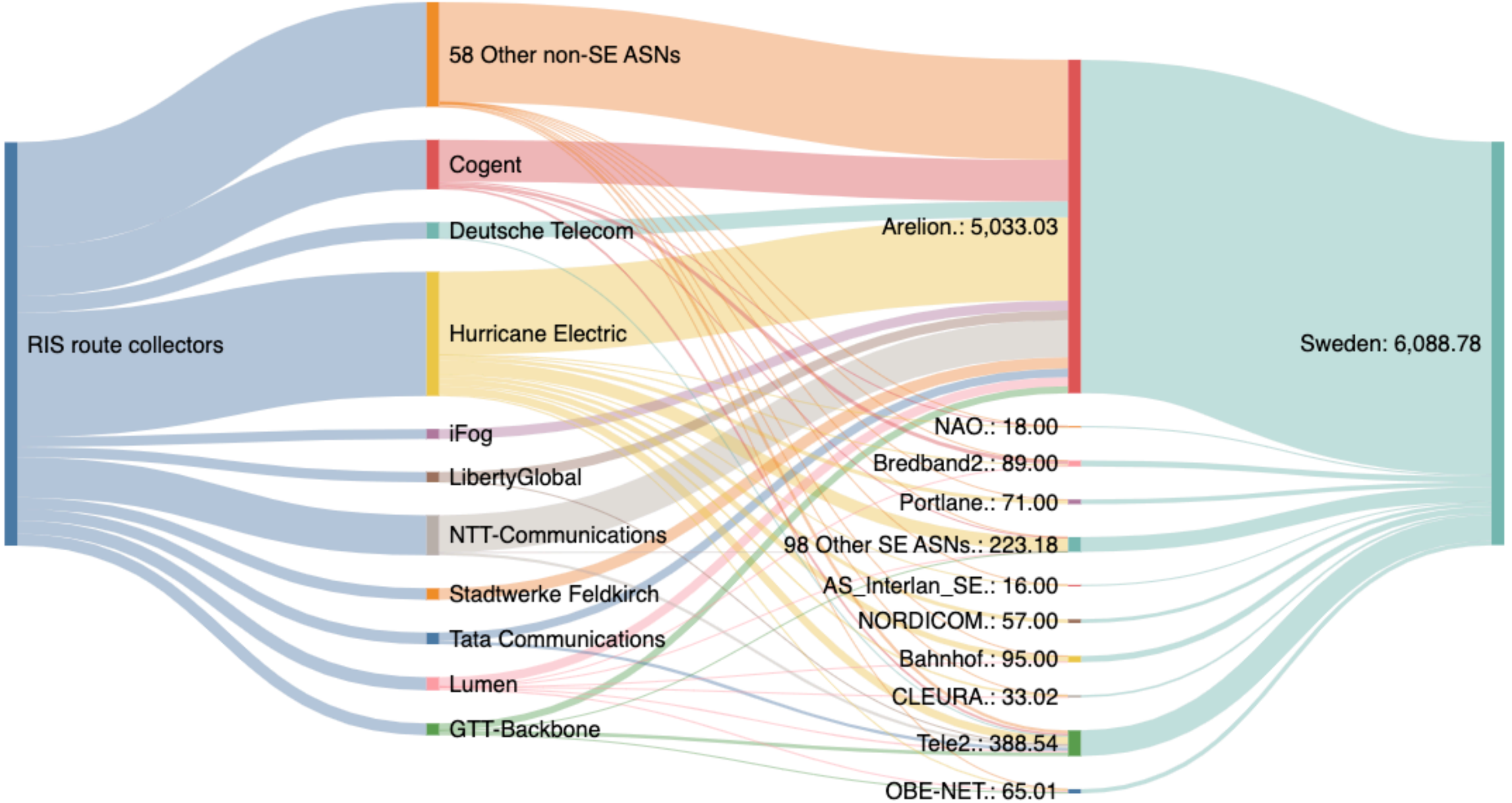
NORDUnet
Globalconnect AB
Sprintlink
Cogent
Telenor Norge.: 370.56
Telia Norway.: 33.00
BLIX.: 92.01
27 Other NO ASNs.: 63.75
Nexthop.: 72.00
Eviny Digital.: 67.00
ASN-SSC.: 35.00
NTE Bredbånd.: 17.01
DOMENESHOP.: 10.00
XFIBER.: 21.12
Altibox_AS.: 50.12
Norway: 831.57


RIS route collectors
58 Other non-SE ASNs
Cogent
Deutsche Telecom
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NTT-Communications
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Tata Communications
Lumen
GTT-Backbone
Arelion.: 5,033.03
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Portlane.: 71.00
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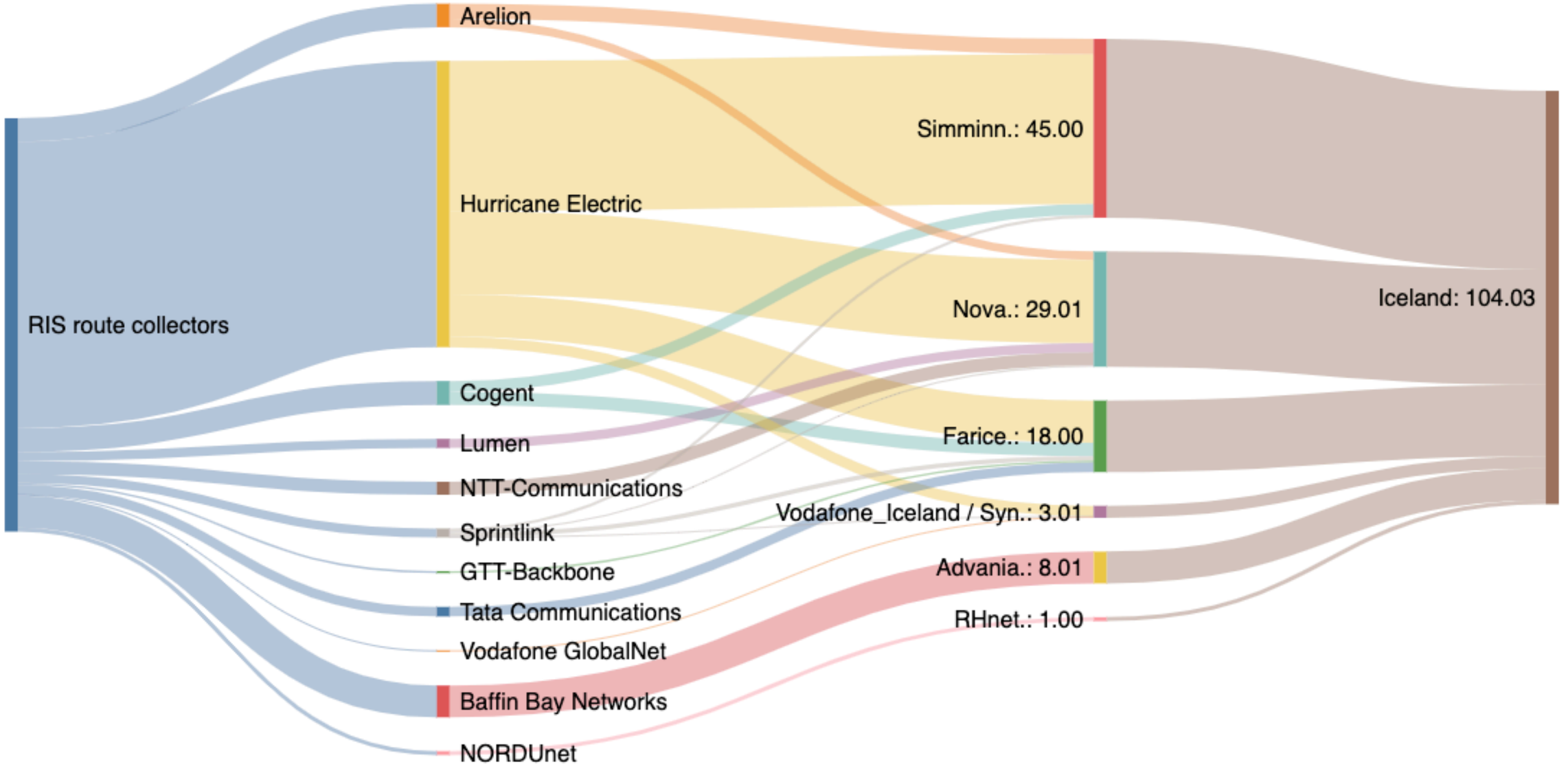
RIS route collectors
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Baffin Bay Networks
NORDUnet
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Nova.: 29.01
Farice.: 18.00
Vodafone_Iceland / Syn.: 3.01
Advania.: 8.01
RHnet.: 1.00
Iceland: 104.03

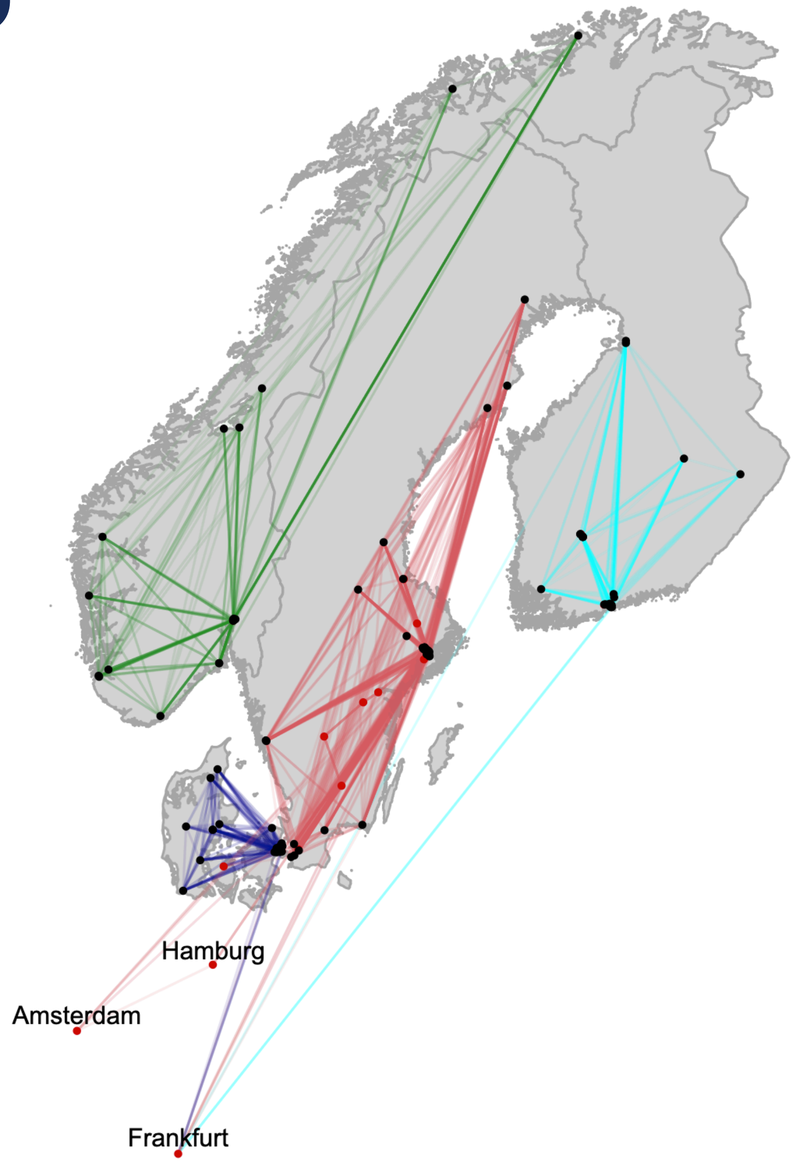
International Connectivity

- Hurricane Electric is the dominant upstream in the Nordics over IPv6
- Overall, there’s a lot of diversity in upstream providers
  - Major providers in the countries have more than one upstream
  - This provides redundancy and resilience

Traffic Paths

Traffic Paths over IPv6

- Most paths stay fairly local
  - Although some major foreign IXPs used
- Paths extended much farther over IPv4
  - As far as New York and Los Angeles



Routing Security

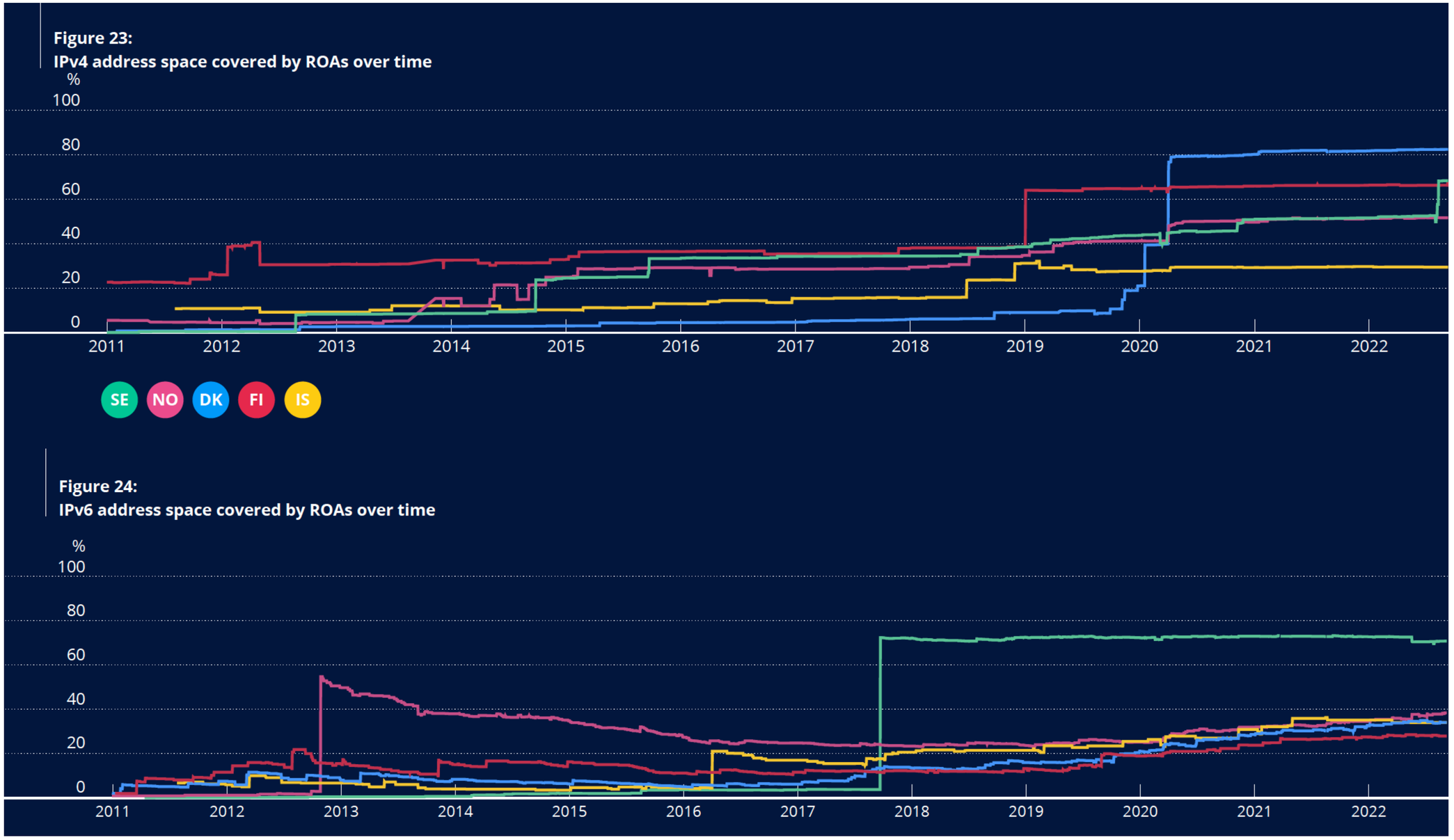


Figure 23:
IPv4 address space covered by ROAs over time
%
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SE
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Figure 24:
IPv6 address space covered by ROAs over time
%
100
80
60
40
20
0
2011
2012
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2017
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2020
2021
2022

The Nordic Region: Conclusions

- Highly developed Internet landscape
  - Early development
  - Large amounts of IPv4 address space
  - Open market with government support
- Good level of interconnection
  - Both domestically and internationally > stable, resilient Internet
- BUT it is 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

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
  - 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

staylor@ripe.net