



RIPE NCC

RIPE NETWORK COORDINATION CENTRE

CGN in Europe?

An Analytical Approach
to Policymaking

Marco Hogewoning | December 2017

What Is This About



- Statistical data is only useful within a context
 - Most of the value comes by combining data sources
 - Need to understand some of the inner mechanisms
- Going to give an example using CGN
 - Disclaimer: these are all estimates and predictions
 - There is a significant error margin:
 - Not every RIPE NCC member offers Internet access
 - Enterprise, SME and other business are ignored
 - There is always overhead in IPv4 pool management



Rule #1:

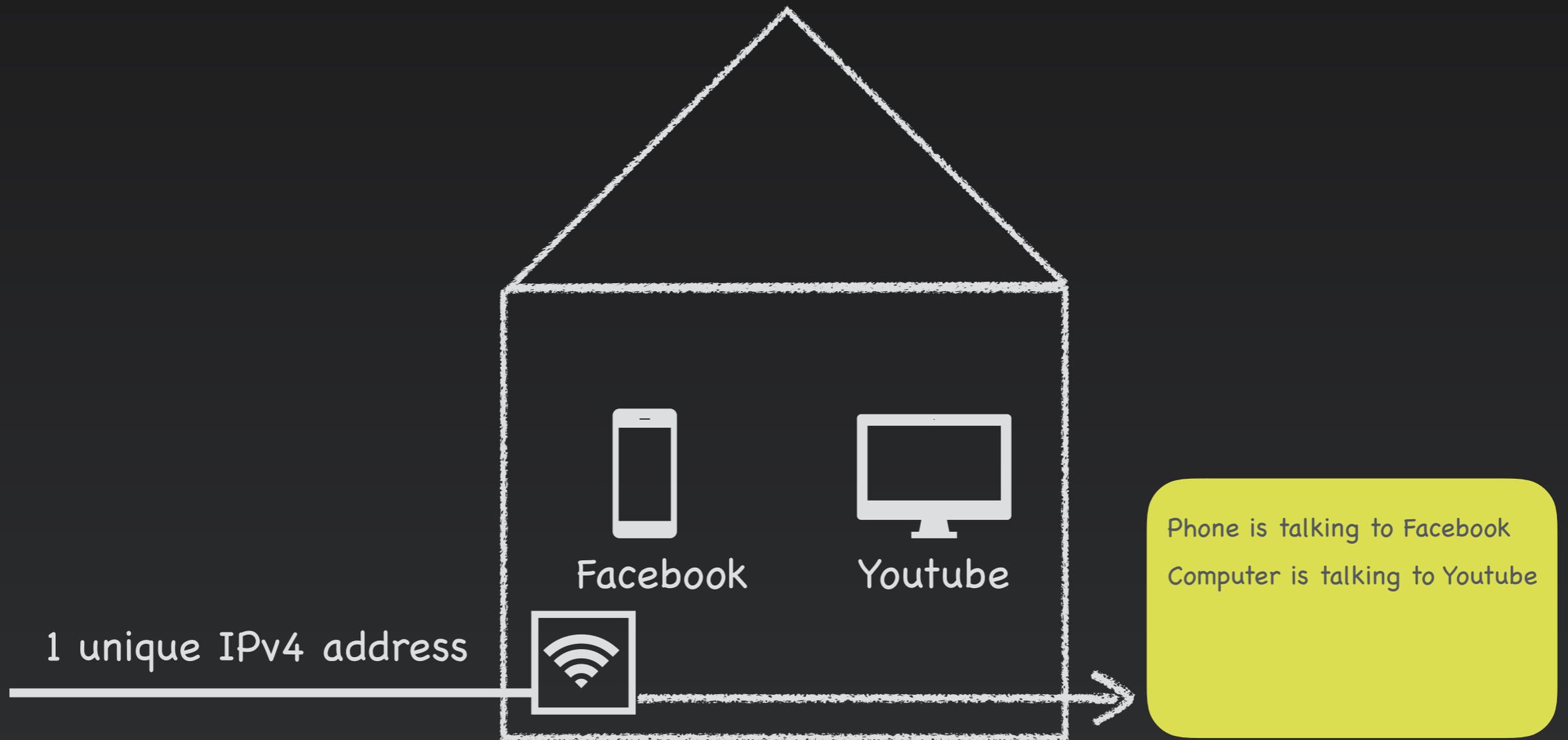
“You can only connect to the Internet if you have an IP address”



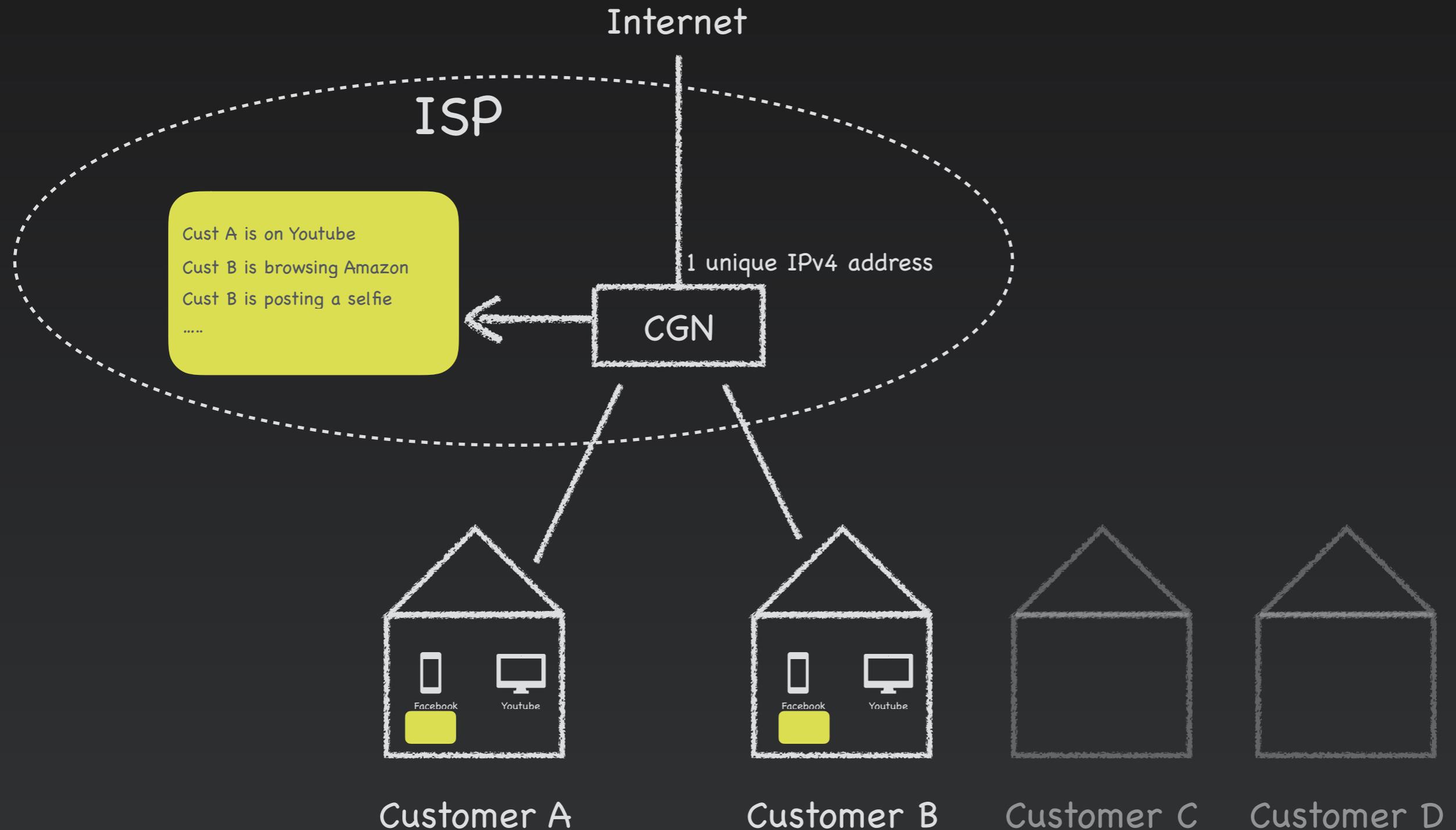
Rule #2:

“If you can't have your own IP address, you need to share one”

Network Address Translation



Carrier Grade NAT (CGN)





“Do you have enough addresses for every customer?”



1

"magic number"



Internet Registry Structure

- Focussed on networks
 - Usually a network operator (ISP) is a member
 - Operationally, networks are defined by their ASN
- Networks are sized by number of end points
 - Usually the number of subscribers or websites
 - Number of IP addresses proportional to size
 - “Needs based allocation” fundamental in policy



To receive traffic, you must
“announce” the IP address ranges
in the global routing table

Example: Magyar Telekom (Hungary)



"Size: 1,4 million IPv4 addresses"

Whois Matches (AS5483)

aut-num	5483	(+)
as-name	HTC-AS	
descr	Magyar Telekom Nyrt.	
descr	Public Internet Access Provider	
descr	Budapest, Hungary	
descr	HU	
org	ORG-HTM1-RIPE	
status	ASSIGNED	
mnt-by	RIPE-NCC-END-MNT	
mnt-by	AS5483-MNT	
mnt-by	TCOM-MNT	
mnt-by	MTELEKOM-MNT	
source	RIPE	

Last updated less than 5 days ago
Showing results for AS5483 as of 2017-12-04 10:47:00 UTC

source data embed code permalink info

Routing Status (AS5483)

At 2017-12-04 08:00:00 UTC, AS5483 was visible to 100% of 156 IPv4 and 100% of 157 IPv6 RIS full peers.

First ever seen as origin announcing 145.236.150.0/24, on 2000-08-18 08:00:00 UTC.

Originated IPv4 prefixes: 104
Originated IPv6 prefixes: 18
Observed BGP neighbours: 160
Address space announced (IPv4): 1389312 IPs
Address space announced (IPv6): equiv. to 1048577 /48s

Advanced Settings

Showing results for AS5483 as of 2017-12-04 08:00:00 UTC

Results exclude routes with very low visibility (less than 3 RIS full-feed peers seeing).

Given query time (2017-12-04 08:00:00 UTC) has been changed because it is earlier than the time there is data available for!

source data embed code permalink info

How Big Is Magyar Telekom?



- 1 million fixed Broadband
 - Growing 4.3% over last 12 months
- 5,4 million mobile users
 - Growing 1,9% over last 12 months
 - Caveat: maybe not all mobile subscribers have data

Operational statistics – access numbers	Sep 30, 2016	Sep 30, 2017	Change (%)
Number of mobile customers (RPC)	5,301,049	5,400,966	1.9%
Postpaid share in the RPC base	58.9%	62.6%	n.a.
Total fixed voice access	1,437,116	1,420,725	(1.1%)
Total retail fixed broadband customers	1,018,564	1,062,528	4.3%
Total TV customers	978,692	1,016,192	3.8%

Source: Maavar Telecom Plc. Q3 2017 Interim Financial Report



High Level Analysis

- Magyar is reporting 6,4 million connections
 - With only 1,4 million IPv4 addresses visible
 - Likely scenario, common in market
 - Fixed broadband to use “regular” IPv4
 - Mobile broadband uses CGN
- They are reporting growth
 - How long is this still sustainable?
 - How many customers need to share a single IP address?



A1/Telekom Austria

- Appears to be using three networks
 - AS 1901 (former EUNET AT)
 - Announcing 600k IPv4 addresses
 - AS 8447
 - Announcing 2,3 million IPv4 addresses
 - AS 12793 (former eTel Austria)
 - Announcing 74k IPv4 addresses

A1 Austria Telekom Group



- Q2 2017 financial report
 - 5,3 million mobile subscribers
 - 900k reported as “mobile broadband”
 - 3,4 million wireline RGUs (revenue generating unit)
 - 1,5 million reported as fixed broadband
- Estimate between 2,4 and 6,8 million connections
 - 3 million IPv4 addresses in the network

Wireless indicators	Q2 2017 reported	Q2 2016 proforma	% change	1-6 M 2017 reported	1-6 M 2016 proforma	% change
Wireless subscribers (thousands)	5,364.0	5,441.3	-1.4	5,364.0	5,441.3	-1.4
thereof postpaid	3,684.3	3,709.2	-0.7	3,684.3	3,709.2	-0.7
thereof prepaid	1,679.8	1,732.1	-3.0	1,679.8	1,732.1	-3.0
MoU (per Ø subscriber)	253.1	254.9	-0.7	254.1	253.1	0.4
ARPU (in EUR)	15.5	15.6	-0.7	15.5	15.7	-1.2
Churn (%)	1.7%	1.5%		1.7%	1.6%	
Wireline indicators	Q2 2017 reported	Q2 2016 proforma	% change	1-6 M 2017 reported	1-6 M 2016 proforma	% change
RGUs (thousands)	3,435.1	3,513.2	-2.2	3,435.1	3,513.2	-2.2

*) Including other operating income



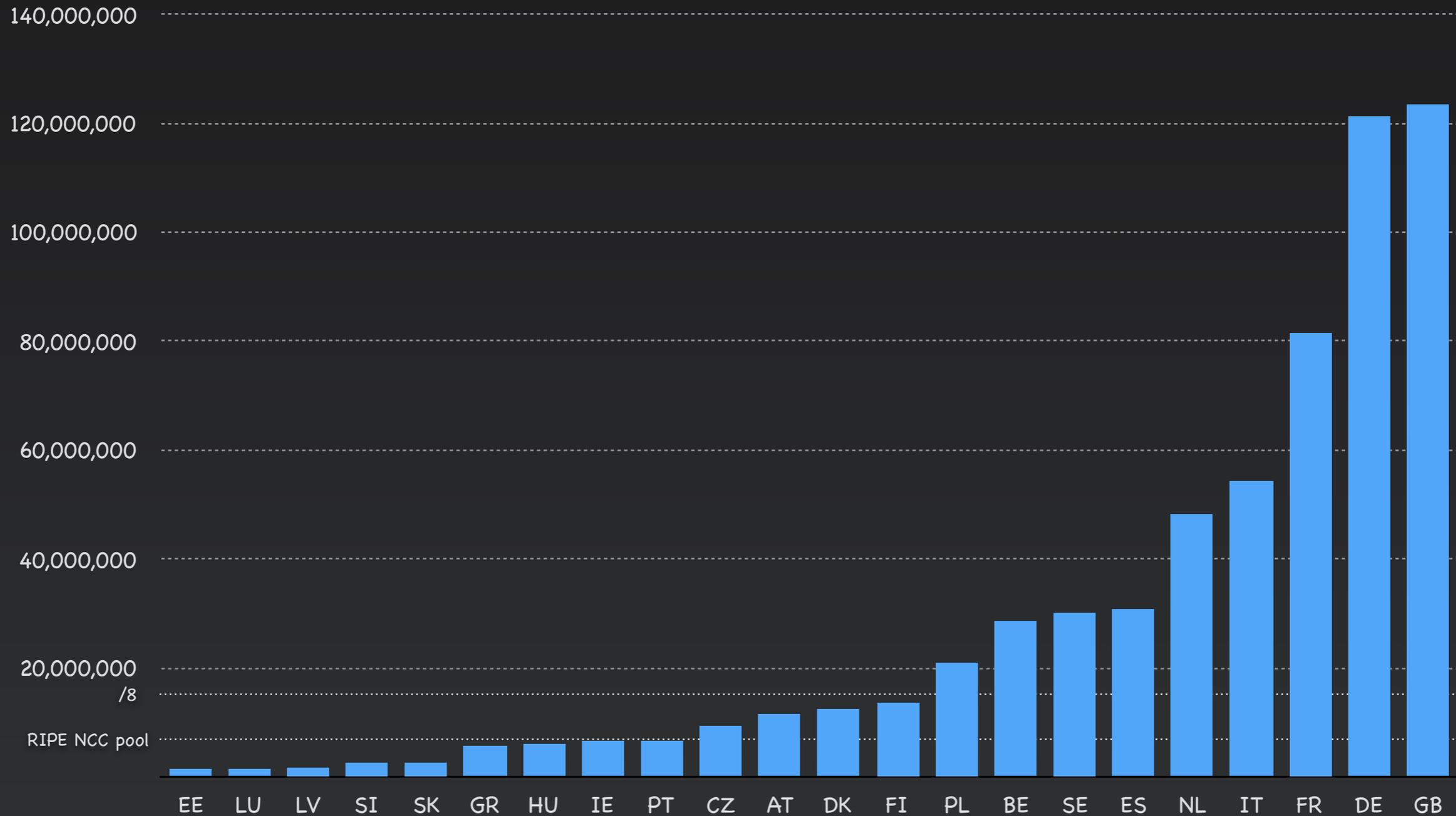
Pressure on IPv4 is significant even
for long established companies



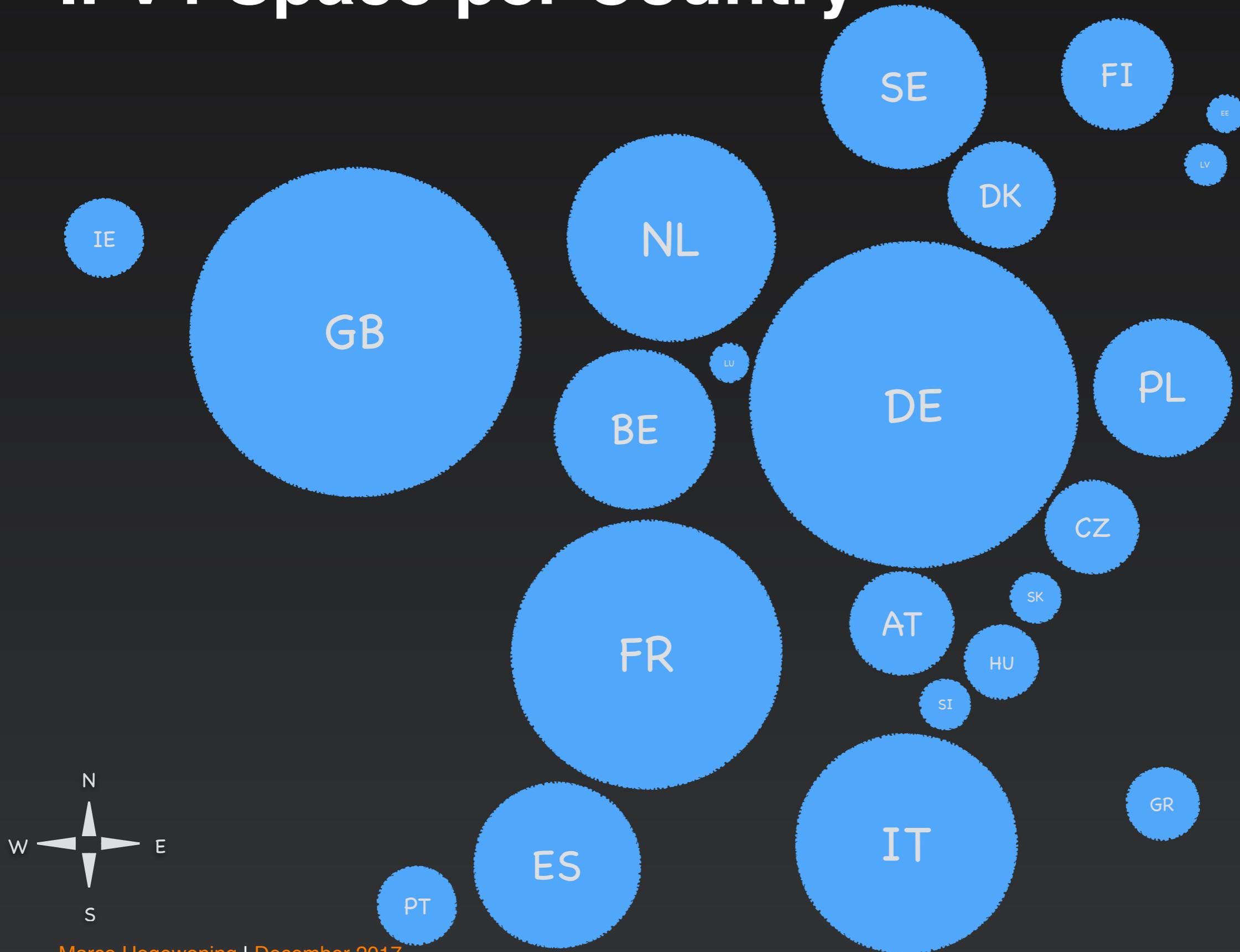
Country Level

taking a step back

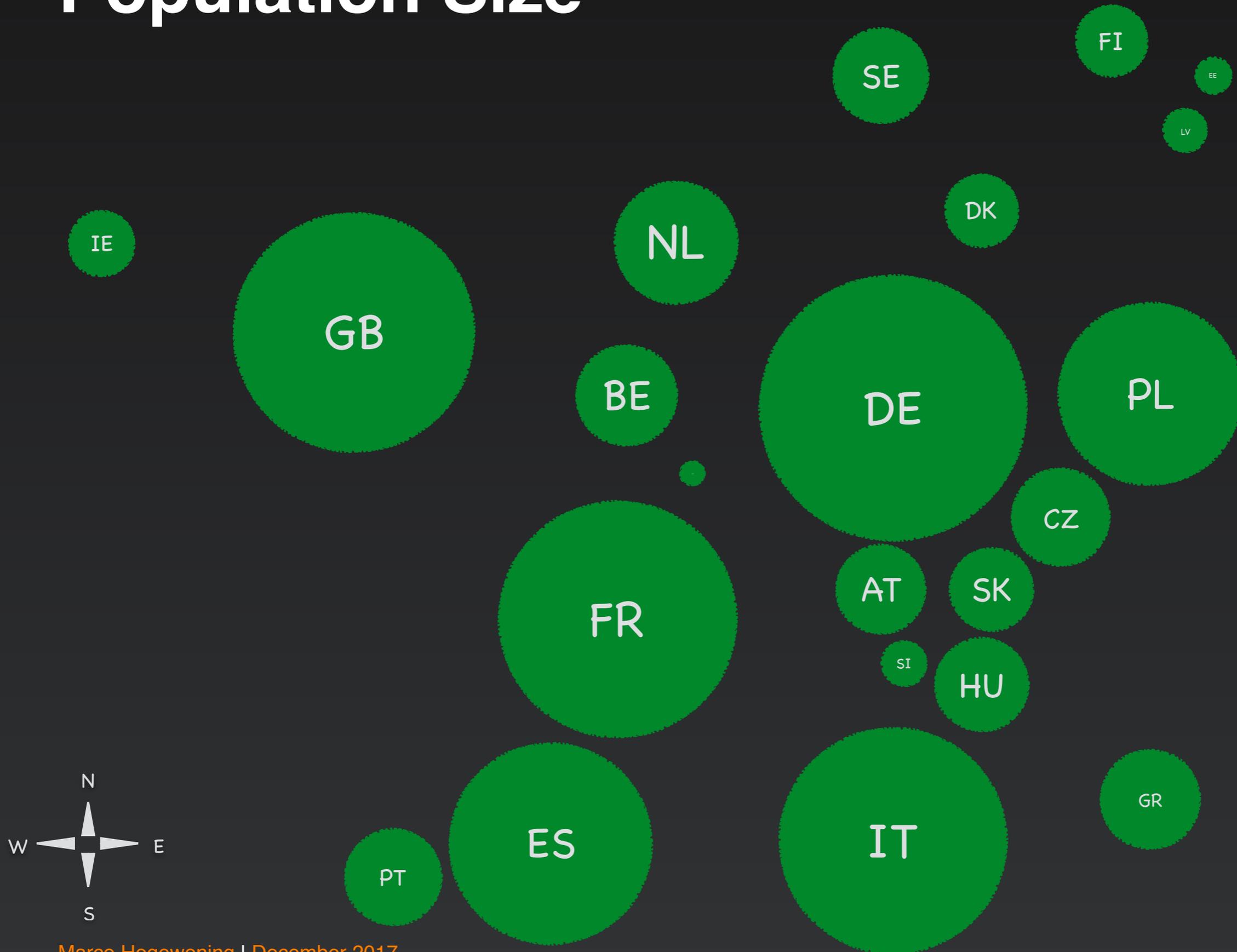
IPv4 Addresses per Country



IPv4 Space per Country



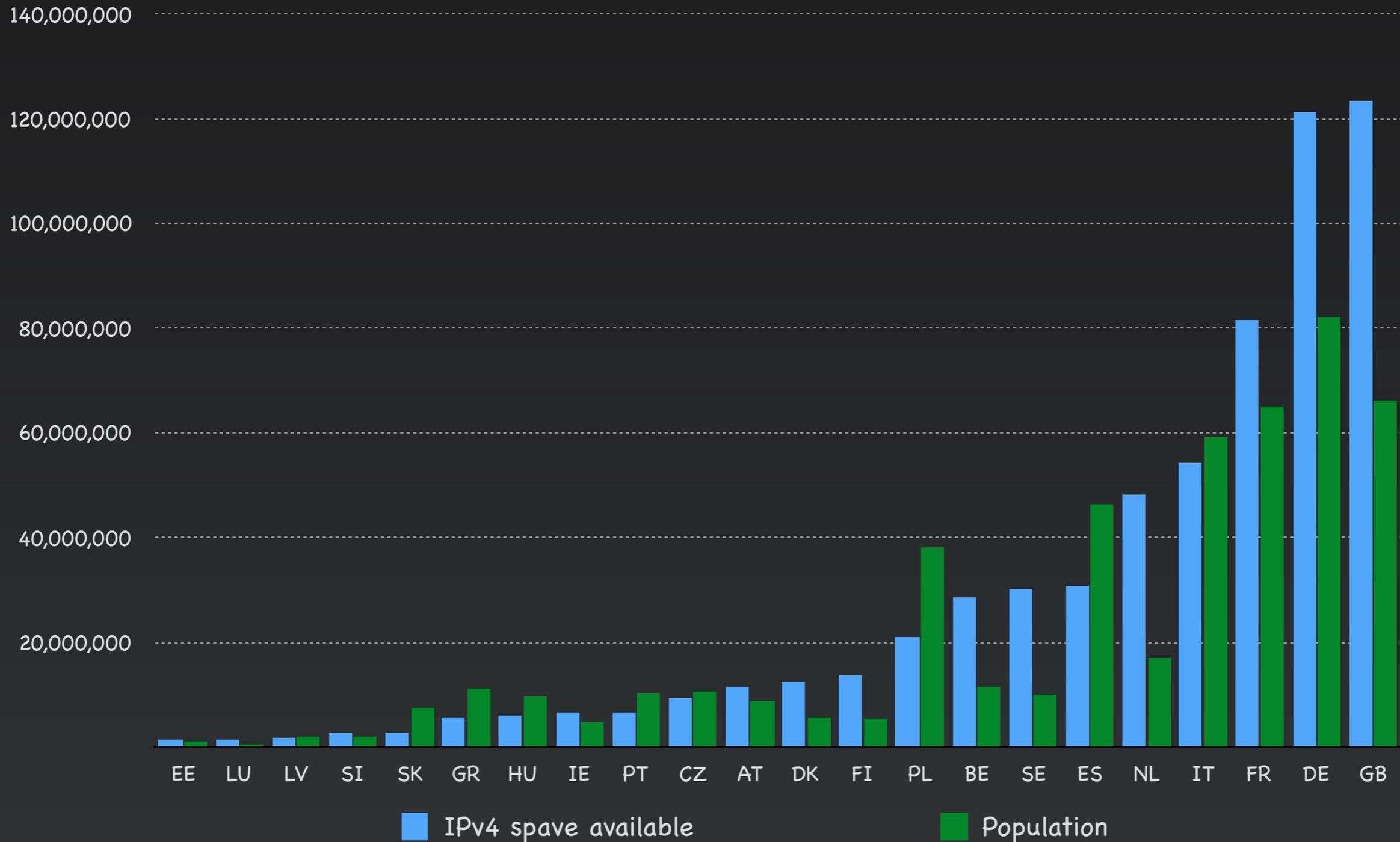
Population Size



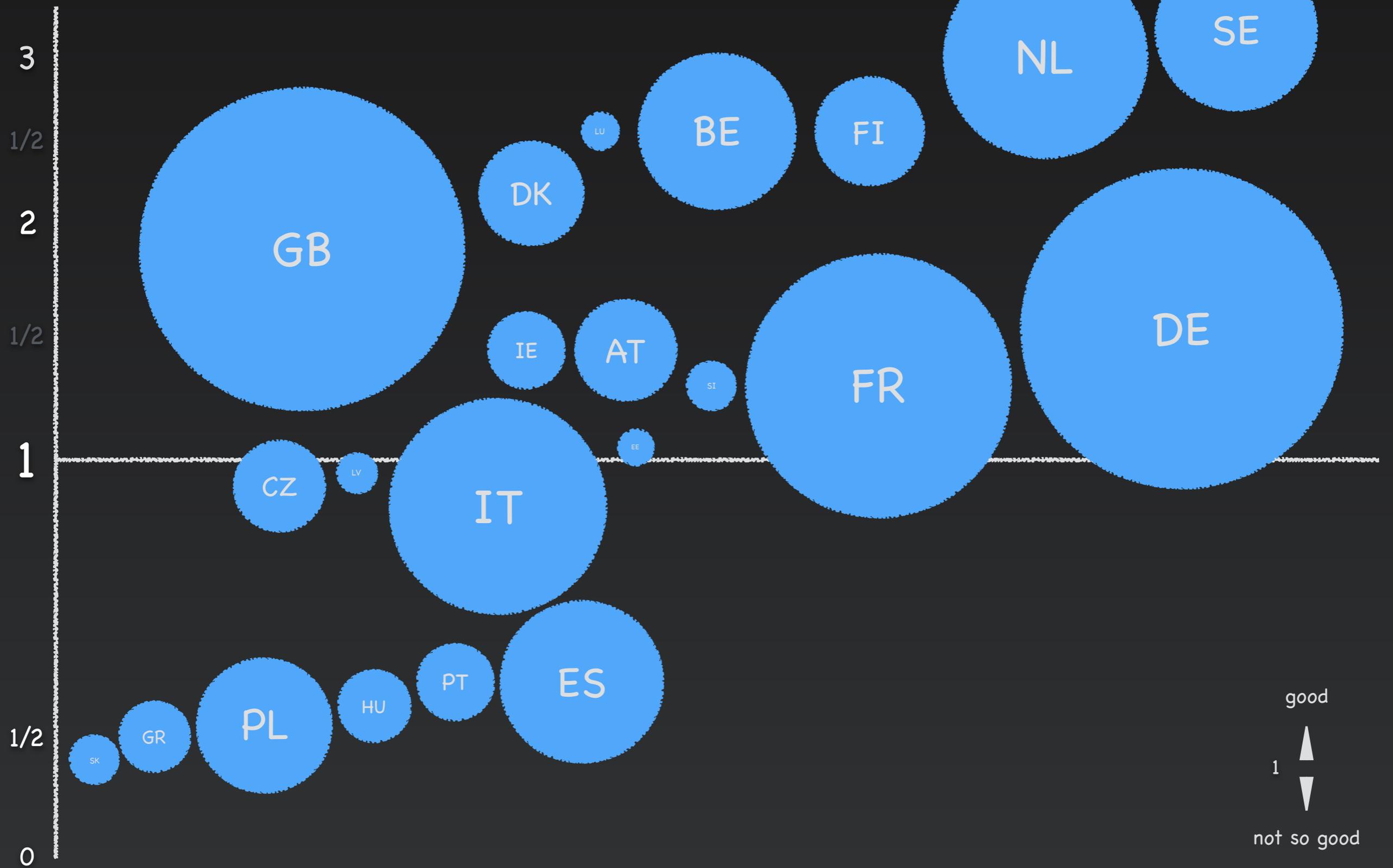
IPv4 and Population



IPv4 and Population



IPv4 per Capita



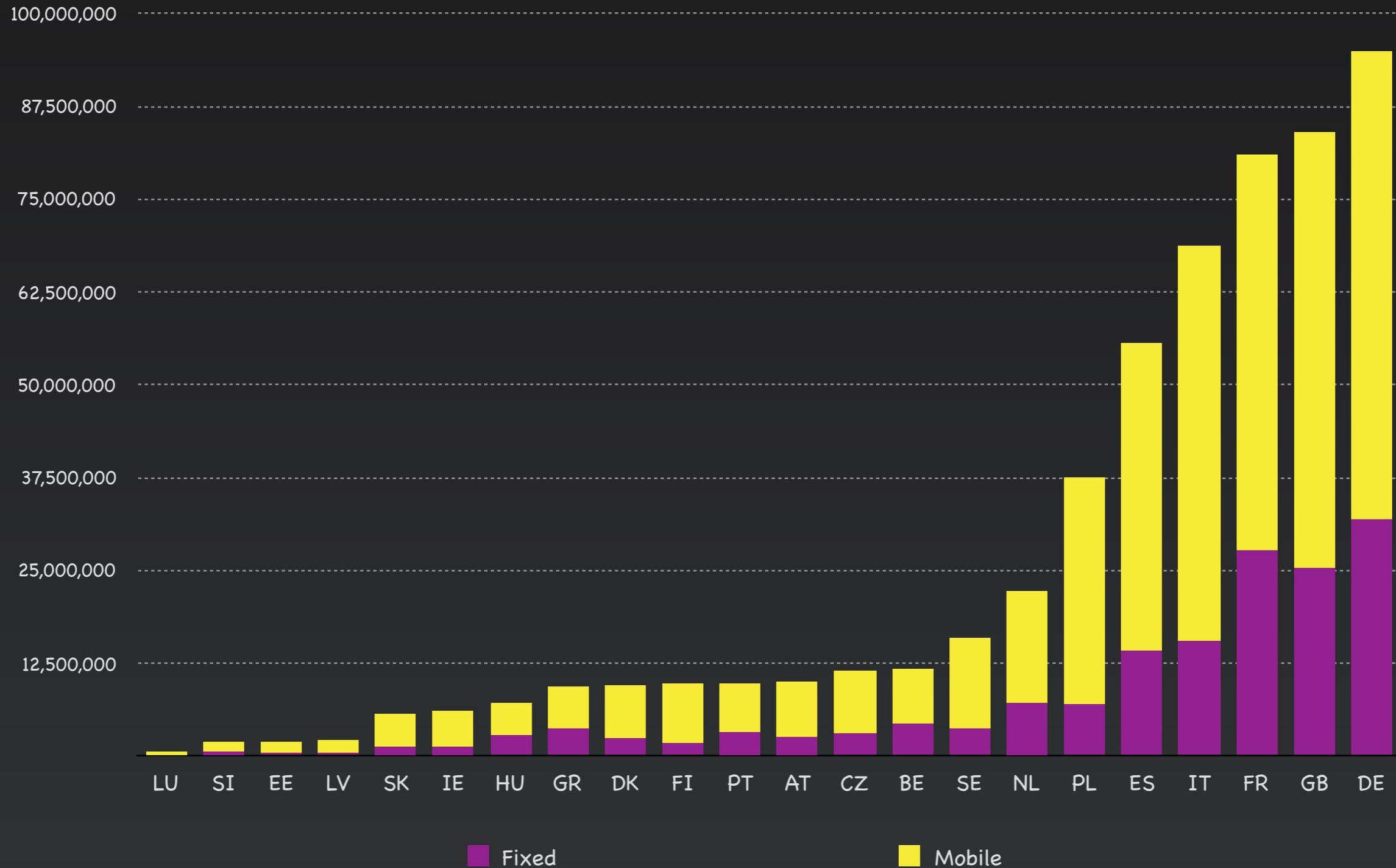




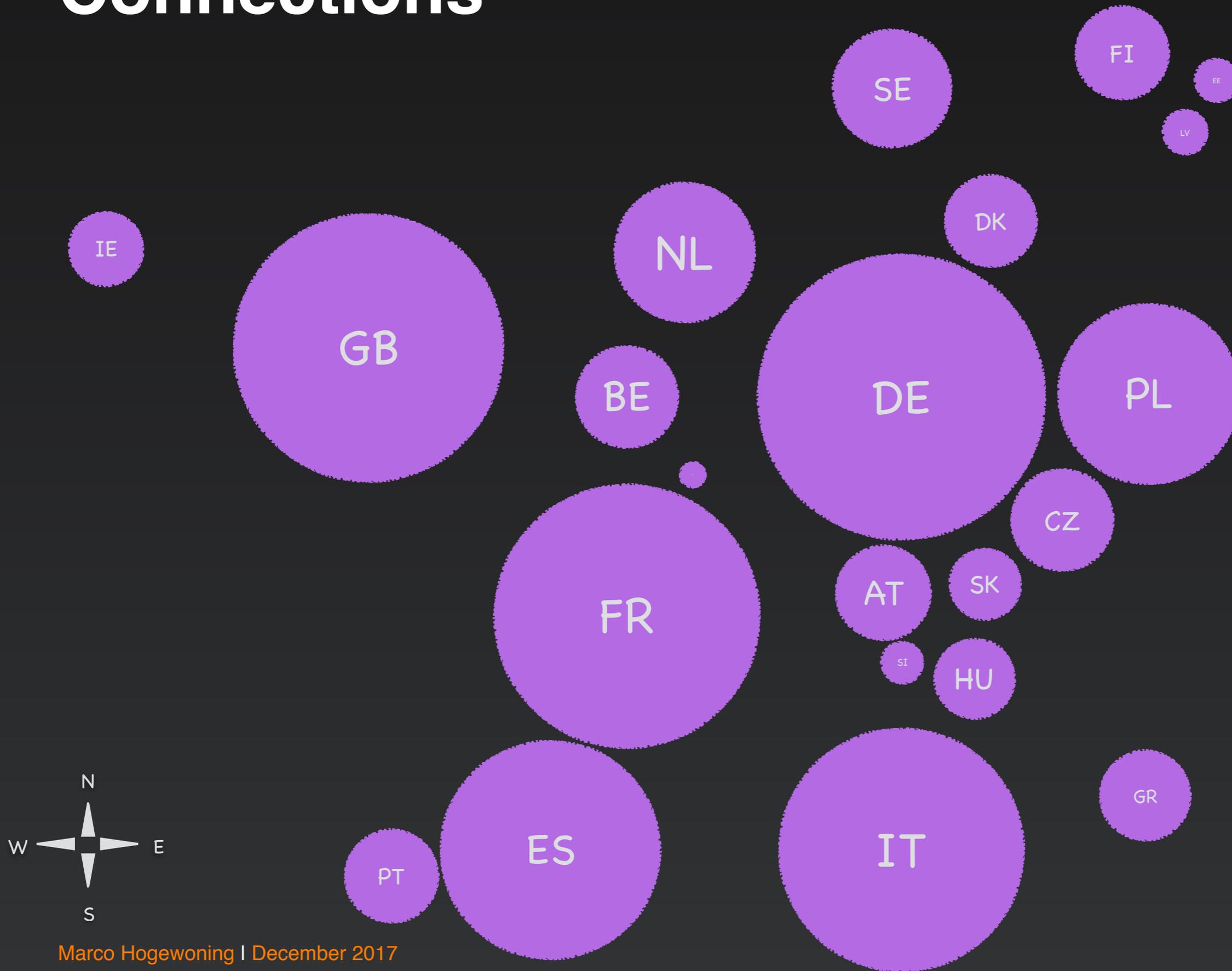
Sizing the Market

How many connections are there?

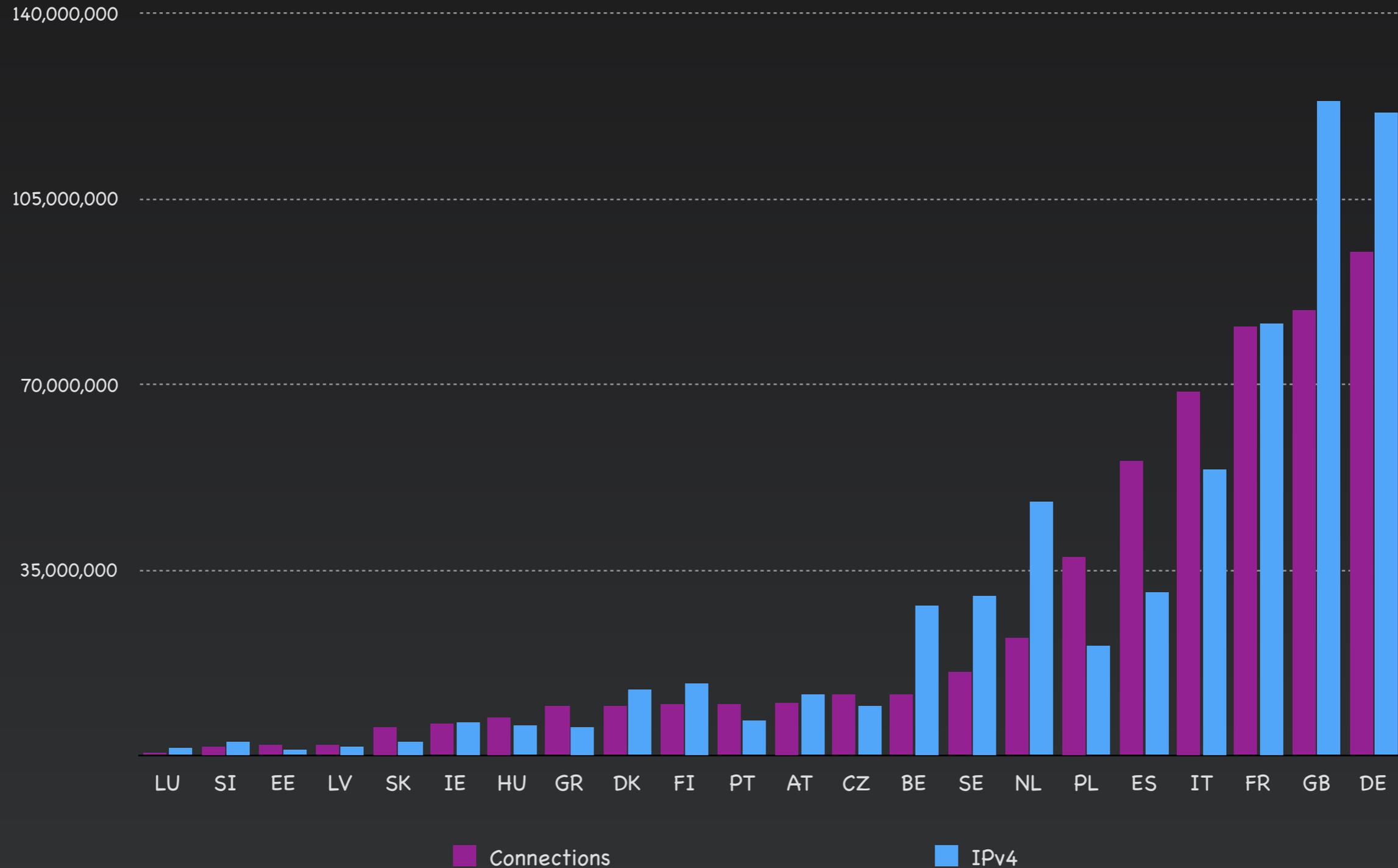
Number of Broadband Connections



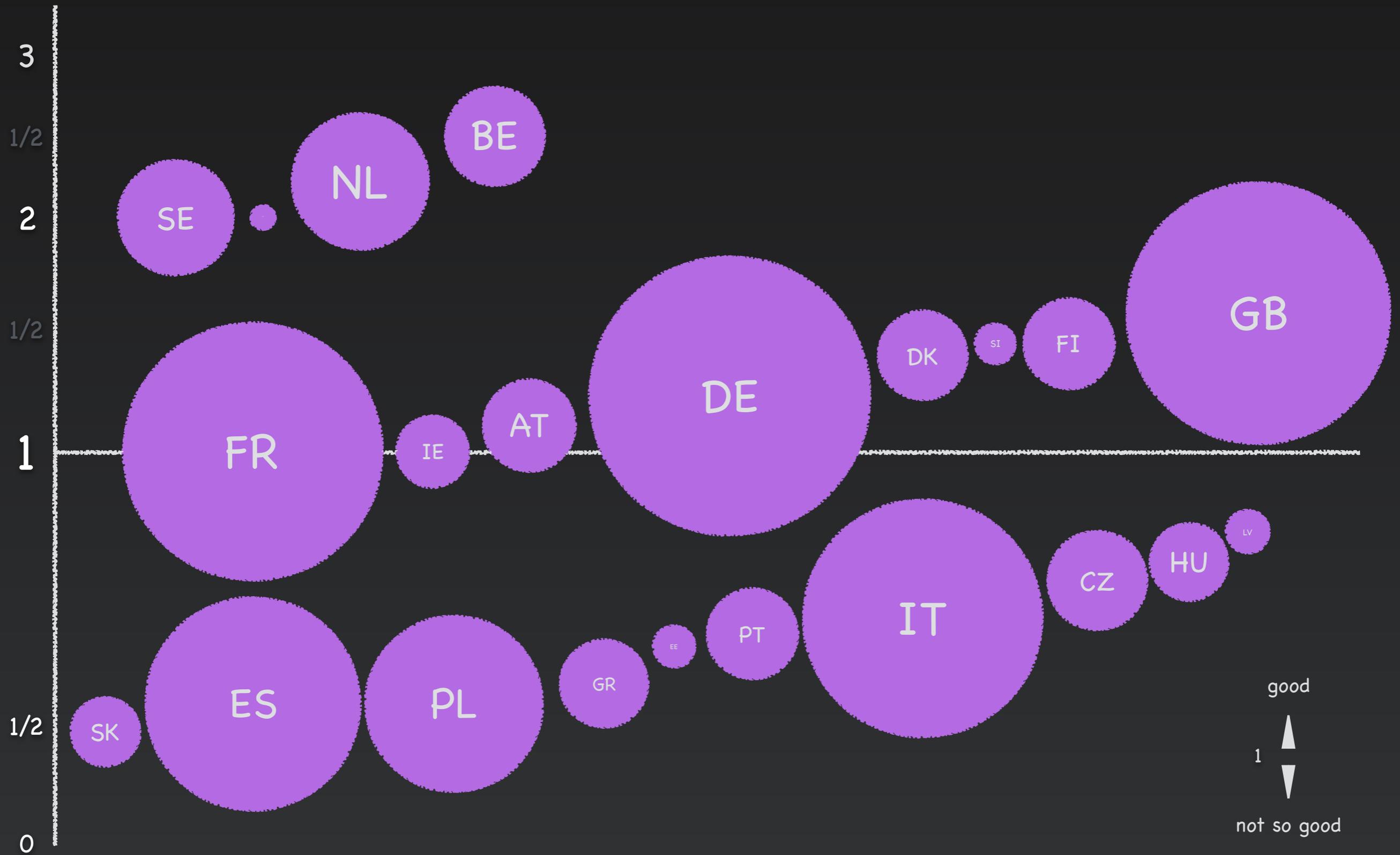
Connections

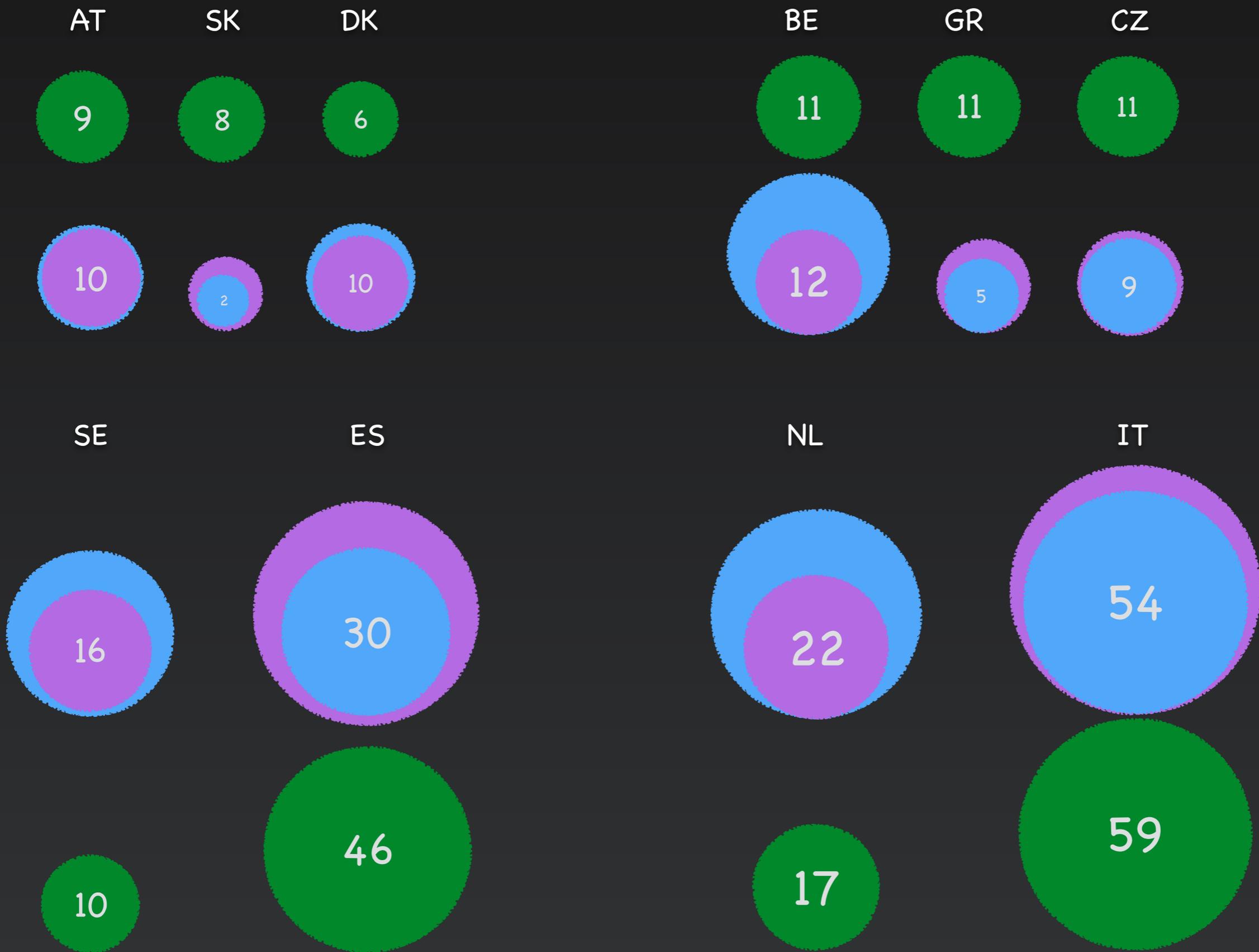


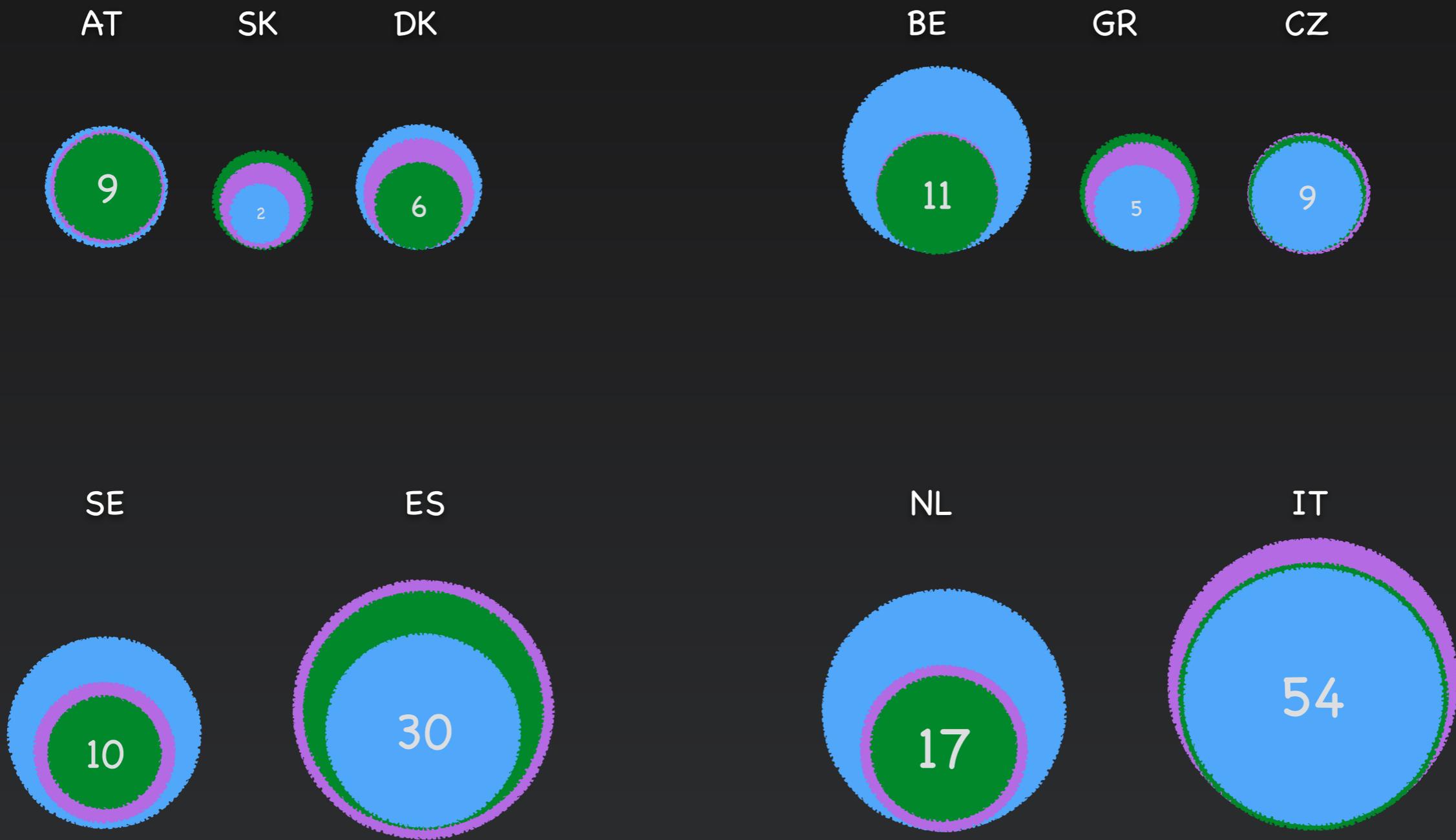
Connections and IPv4



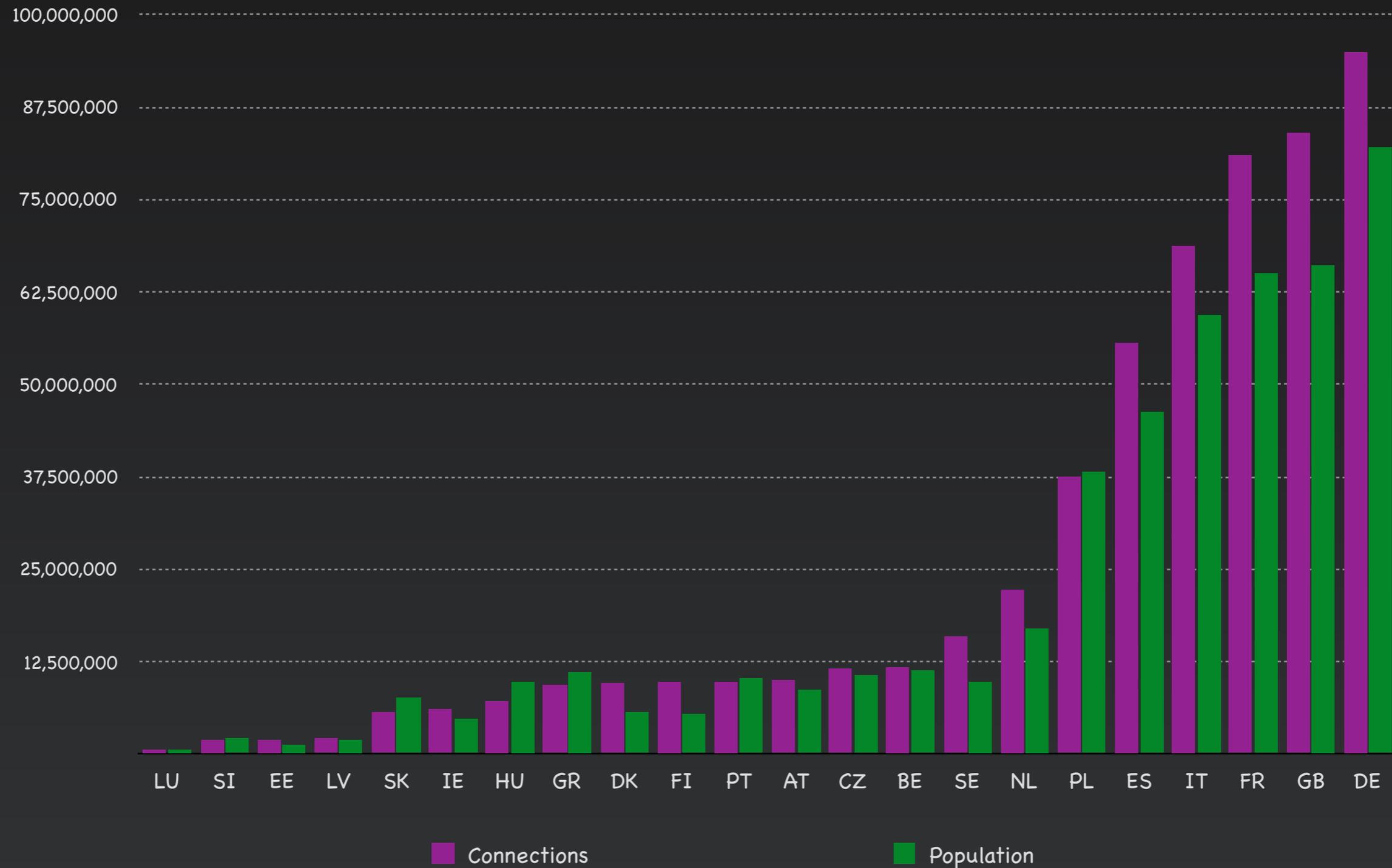
Connections per IPv4







Connections and Population





Peeking into the Future

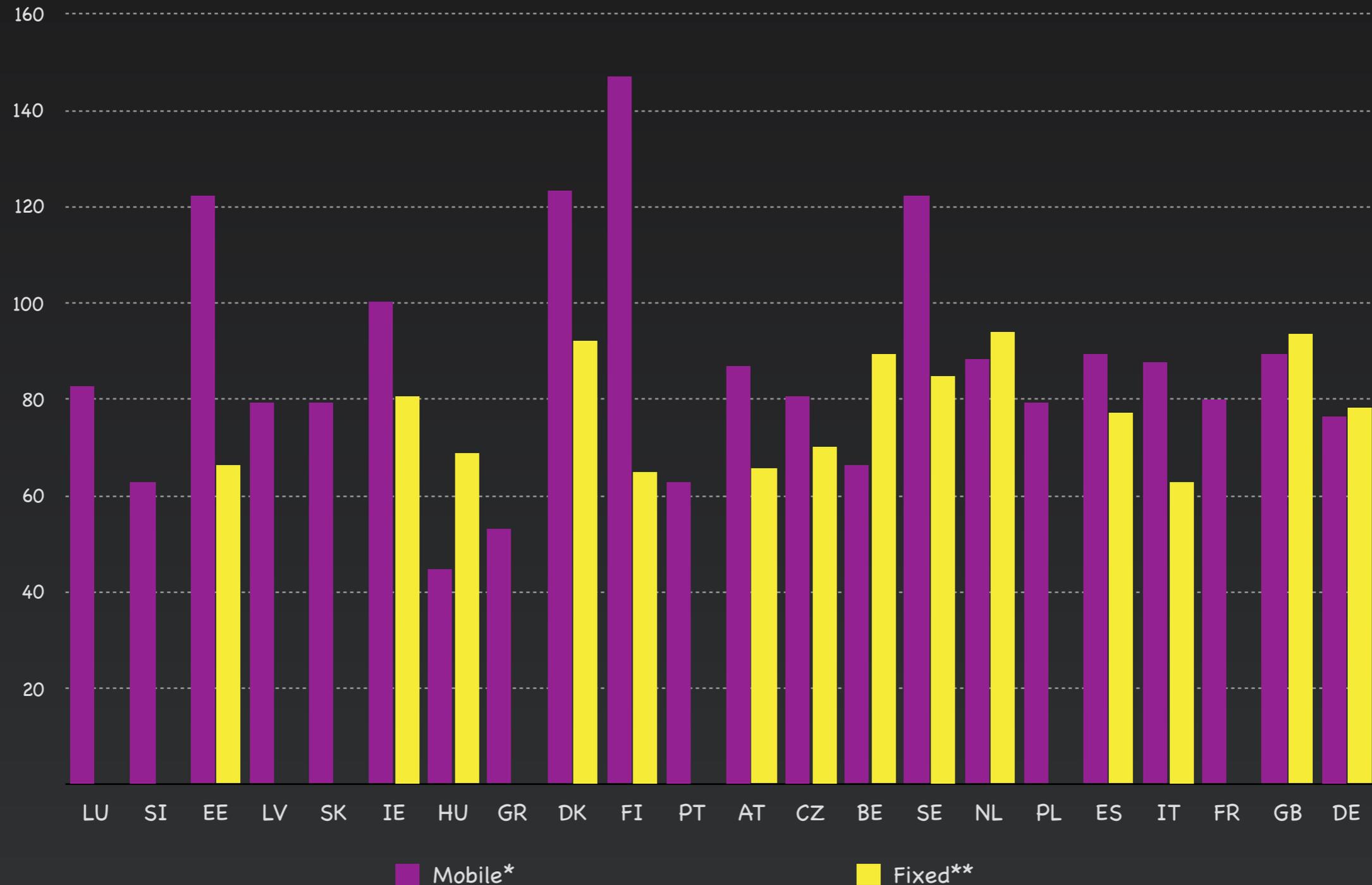
Exploring with Extrapolation

Ubiquitous Internet

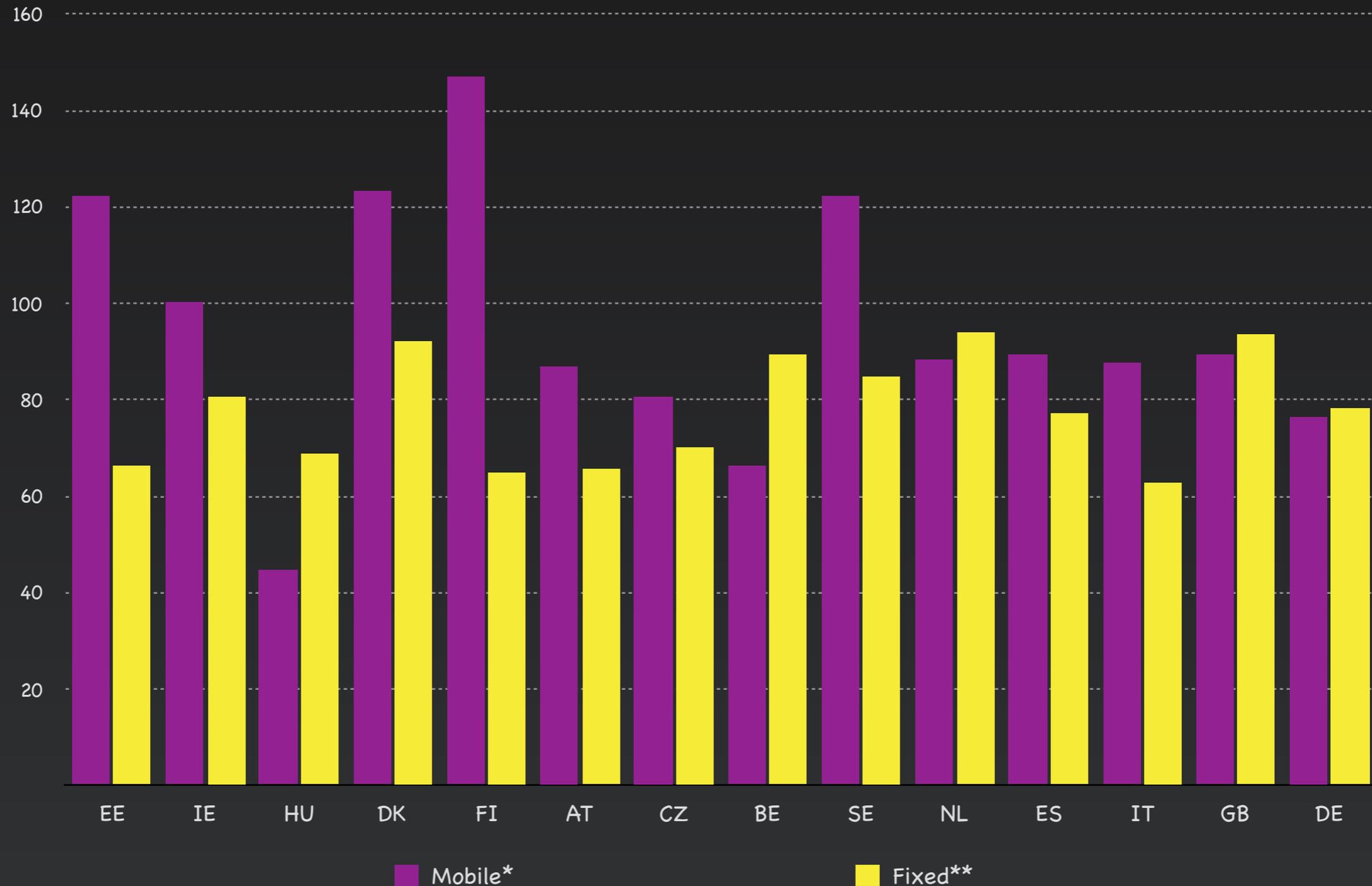


- What if everybody gets an Internet connection
 - You are likely to share the home (fixed) connection
 - “One fixed line per household”
 - Everybody gets a mobile phone (maybe two)
- Going to ignore some parts of the market:
 - Enterprise and SME
 - Machine-to-machine
 - Datacentre and public/utility networks

Adding Market Coverage Data



Adding Market Coverage Data

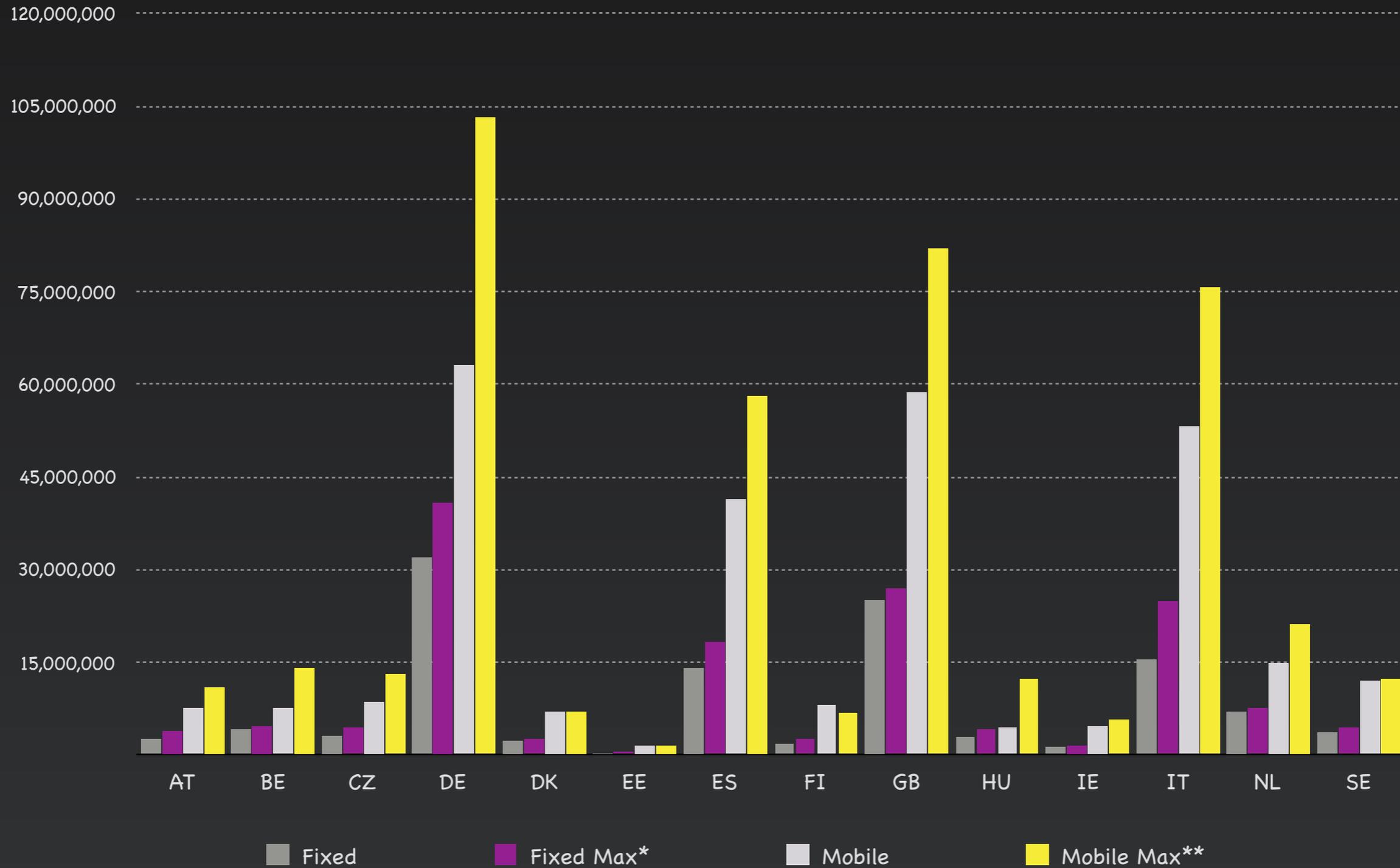




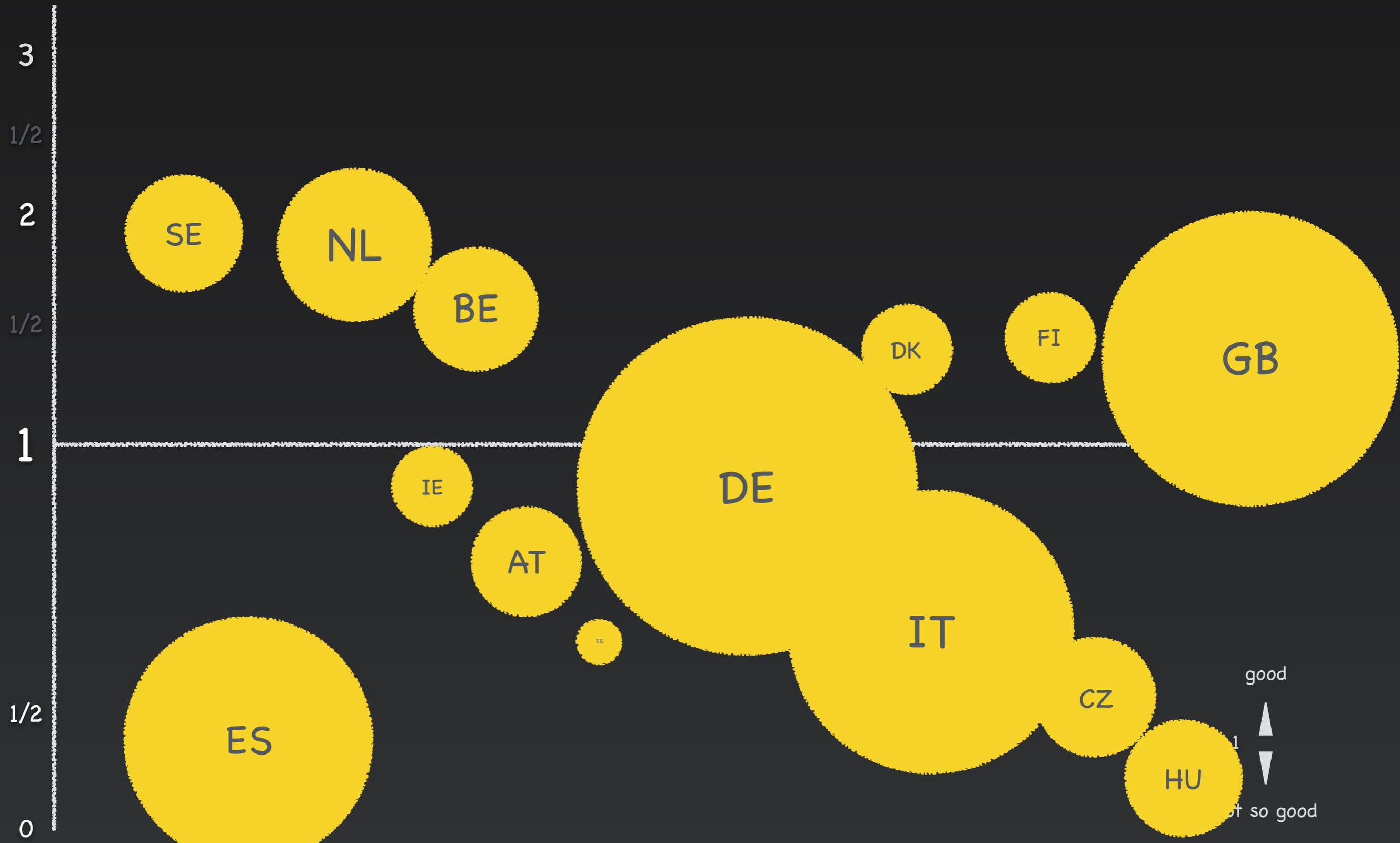
What Can We Expect?

- Every household will get a fixed line
 - Extrapolating current market to 100% penetration
 - Number of households probably relatively stable
- Mobile between 146% and 122% peak
 - Taking 125% as “saturated” for now
 - Developments in M2M could be significant
 - Impact of using 4G/5G to replace wireline unknown

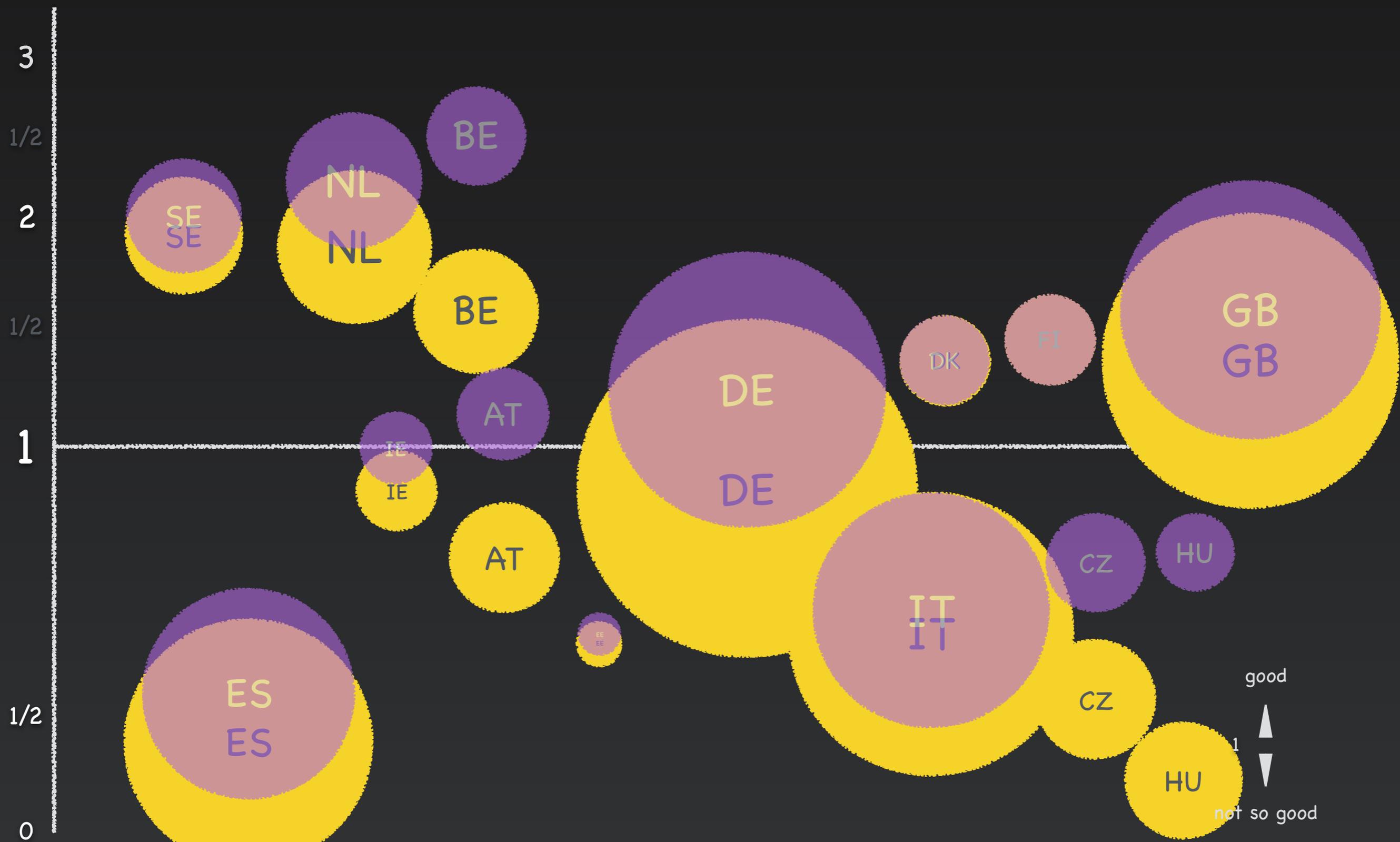
Theoretical Saturated Market



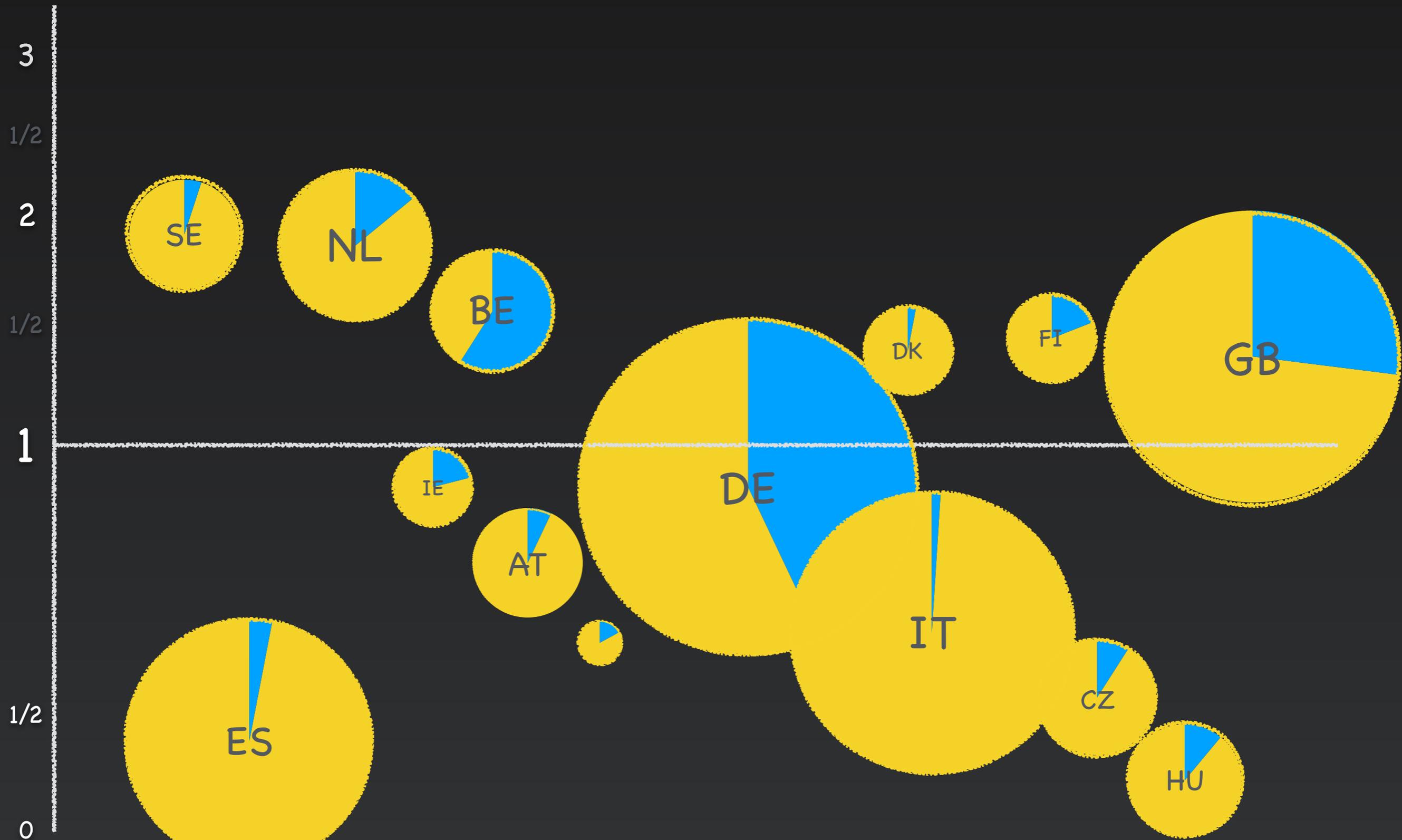
Max Connections per IPv4



Current and Future



Percentage of IPv6



Soft Conclusions



- Many markets already have more connections than they have IP addresses available
 - Which means that they are using CGN somewhere
 - This situation is not expected to improve over time
- Some markets likely to fall below the threshold
 - Introduction of address sharing should be expected
- Not sure CGN is driving IPv6 adoption
 - No large pressure on IPv4 in Belgium



Is this useful?



Open Data is Important

- Data sources used in this
 - Regional Internet Registry data (IPv4 and IPv6)
 - Financial reporting information (company numbers)
 - OECD Broadband portal (connections per country)
 - UN stat (population, households)
- Manually processed
 - APIs are missing or not standardised
 - Not all data is current (households from 2011)



Questions?

marcoh@ripe.net





	Fixed BB (OECD 2016)	Fixed BB penetration (households)	Mobile BB (OECD 2016)	Mobile BB penetration (OECD 2016)	Total connections	Population (Huston)	Number of Households (UN 2013-2015)	Total IPv4 (Huston)	IPv4/capita (Huston)	IPv4/connection (current)	Top number mobile connections (125%)	Top number of connections (125% mobile + 100% fixed)	Worst case IPv4/connection
Austria	2.510.500	65,77	7.585.400	86,80	10.095.900	8.735.453	3.816.800	11.685.984	1,338	1,157	10.923.675	14.740.475	0,793
Belgium	4.265.026	89,55	7.480.397	66,37	11.745.423	11.429.336	4.762.737	28.517.504	2,495	2,428	14.088.438	18.851.175	1,513
Czech Republic	3.038.394	70,26	8.534.191	80,79	11.572.585	10.618.303	4.324.650	9.311.872	0,877	0,805	13.204.281	17.528.931	0,531
Denmark	2.430.002	92,16	7.058.216	123,20	9.488.218	5.733.550	2.636.586	12.541.288	2,187	1,322	7.161.339	9.797.925	1,280
Estonia	384.787	66,26	1.607.838	122,19	1.992.625	1.309.632	580.708	1.316.152	1,005	0,661	1.644.813	2.225.521	0,591
Finland	1.712.000	64,99	8.070.000	146,87	9.782.000	5.523.231	2.634.339	13.599.936	2,462	1,390	6.868.319	9.502.658	1,431
France	27.683.000		53.361.000	79,81	81.044.000	64.979.547		81.492.528	1,254	1,006	83.575.053		
Germany	31.867.148	78,16	63.094.865	76,50	94.962.013	82.114.224	40.774.000	121.260.416	1,477	1,277	103.096.185	143.870.185	0,843
Greece	3.616.705		5.709.261	52,94	9.325.966	11.159.773		5.625.600	0,504	0,603	13.480.499		
Hungary	2.814.523	68,65	4.397.417	44,80	7.211.940	9.721.559	4.100.000	5.901.056	0,607	0,818	12.269.579	16.369.579	0,360
Ireland	1.360.309	80,53	4.697.555	100,30	6.057.864	4.761.657	1.689.300	6.520.144	1,369	1,076	5.854.381	7.543.681	0,864
Italy	15.563.279	62,75	53.076.750	87,55	68.640.029	59.359.900	24.803.000	54.188.608	0,913	0,789	75.780.625	100.583.625	0,539
Latvia	519.154		1.555.566	79,34	2.074.720	1.949.670		1.746.688	0,896	0,842	2.450.791		
Luxembourg	203.100		482.000	82,59	685.100	583.455		1.423.360	2,440	2,078	729.507		
Netherlands	7.135.000	94,00	15.017.000	88,18	22.152.000	17.035.938	7.590.228	48.060.392	2,821	2,170	21.287.423	28.877.651	1,664
Poland	7.042.470		30.499.198	79,37	37.541.668	38.170.712		20.910.664	0,548	0,557	48.033.259		
Portugal	3.372.571		6.477.160	62,71	9.849.731	10.329.506		6.625.568	0,641	0,673	12.910.939		
Slovak Republic	1.336.541		4.300.524	79,19	5.637.065	7.557.212		2.654.464	0,487	0,471	6.788.300		
Slovenia	583.540		1.294.534	62,70	1.878.074	2.079.976		2.596.352	1,248	1,382	2.580.809		
Spain	14.163.442	77,20	41.471.985	89,25	55.635.427	46.354.321	18.346.200	30.786.112	0,664	0,553	58.084.013	76.430.213	0,403
Sweden	3.679.768	84,98	12.140.358	122,34	15.820.126	9.910.701	4.330.401	30.195.560	3,047	1,909	12.404.322	16.734.723	1,804
United Kingdom	25.250.011	93,54	58.706.343	89,53	83.956.354	66.181.585	26.994.000	123.383.064	1,864	1,470	81.964.625	108.958.625	1,132
	160.531.270	77,77	396.617.558	86,51	557.148.828	475.599.241		620.343.312	1,304	1,113			
Total		Average	Total	Average	Total	Total		Total	Average	Average			

Raw data (selection of EU/OECD member states)