



HURRICANE ELECTRIC
INTERNET SERVICES

Intercountry BGP As Topology

Pretty diagrams are good!

RIPE65

Amsterdam, Netherlands

27th September 2012

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Hurricane Electric

Agenda

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- Methodology
- Visualizing IPv4 & IPv6 BGP adjacency
- Summary

* A reference to Dorothy's ruby slippers from The Wizard of Oz

VISUALIZING IPV4 & IPv6 GLOBALLY AND WITHIN EUROPE

Checking global IPv6 routing – graphically!

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Showing IPv4/IPv6 route propagation in a graphical form

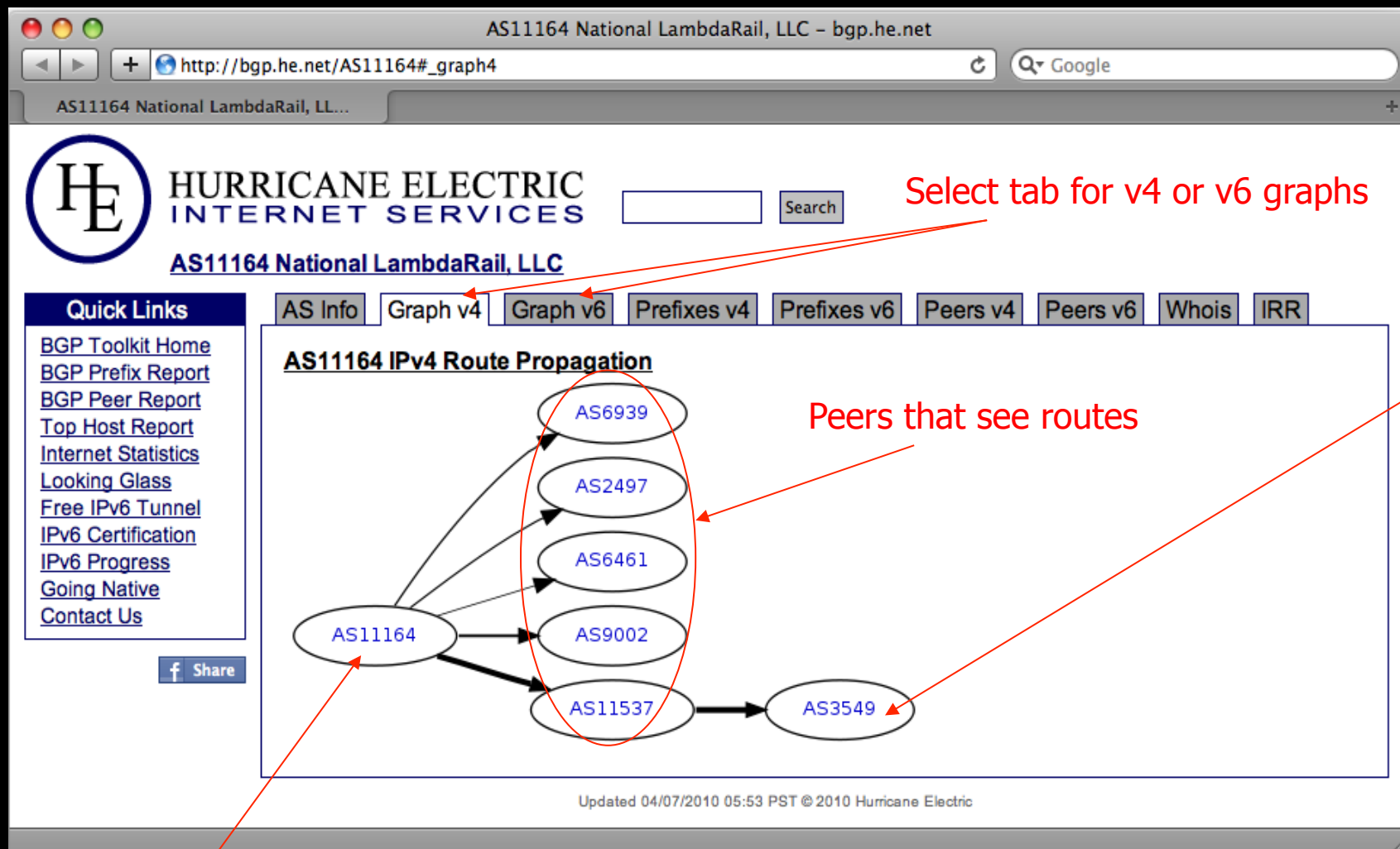
<http://bgp.he.net/>

Caveat:

- This tool is only as good as its source data.
- IP information is uploaded from RIPE RIS & Oregon routeviews.
- Some views are missing; not all routes and paths are visible.
- NOT based on the Hurricane Electric routing tables.

http://bgp.he.net/ – Route propagation graphs

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Routes see downstream of peers

Peers that see routes

ASN originating routes

Can regional IPv6 routing be measured?

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■ Question:

- ❑ Is there enough IPv6 routing between ISPs?
- ❑ Can IPv6 BGP routing tables provide insight?

■ Methodology:

- ❑ Lots of BGP routing tables collected globally
- ❑ Data from <http://bgp.he.net/> processed further
- ❑ Graphical view on a country-to-country basis

Measuring BGP routing by collecting tables

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- Build on exceptional work by others
 - ▣ RIPE/RIS & Oregon routeviews collect BGP tables
 - ▣ A hearty “*thank you*” to RIPE & University of Oregon
- Use Hurricane Electric’s <http://bgp.he.net/> site and it’s database
 - ▣ Daily processing of those BGP tables
 - ▣ Results are user-friendly visualization of routing
- Take the data one step further ...

Measuring BGP routing by collecting tables

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- Take the data one step further ...
- Only look at BGP peer data (v4 & v6)
 - ❑ It's only interesting to look at BGP adjacency
 - ❑ Map ASN to country-codes
 - ❑ Search for adjacencies where CCs are different
- Process resulting data to search for in-region connections
 - ❑ Clean up the data
 - ❑ Display the data

Example processing – CC & ASN

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<http://bgp.he.net/country/MY>

ASN	Name	Adjacencies v4	Routes v4	Adjacencies v6	Routes v6
AS4788	TM Net, Internet Service Provider	145	562	45	35
AS38182	Extreme Broadband - Total Broadband Experience	53	73	6	1
AS24218	Global Transit Communications - Malaysia	42	314	16	25
AS9930	TIME dotCom Berhad	22	90	7	1
AS2042	JARING Communications Sdn Bhd.	18	66	7	2
AS9534	Binariang Berhad	14	71	2	1
AS45352	IP ServerOne Solutions Sdn Bhd.	11	57	2	7
AS24514	Malaysian Research & Education Network	11	69	4	5
AS10204	Arcnet NTT MSC ISP	8	8	2	3
AS10030	Celcom Internet Service Provider	8	15	5	2
AS23678	MyKRIS Asia Sdn Bhd	6	46	2	4
AS17666	Free Net Business Solutions Sdn Bhd	6	16	0	0
AS86111	Agarto Sdn Bhd	5	8	3	1
AS55799	Hostemo Technology Sdn Bhd	5	10	3	1
AS55720	THEGIGABIT.com - Dedicated Server & Server Co-Location	5	19	0	0
AS4818	DiGi Telecommunications Sdn. Bhd.	5	6	3	1
AS45839	PIRADIUS NET AS45839	5	18	1	2
AS45785	Techavenue Data Center, Global IP Transit, KL, Malaysia	5	13	1	1
AS55482	Level 12 Menara Sunway, Jalan Lagoon Timur	4	4	0	0

Process each ASN within each country

Note the ASNs within the country ...

http://bgp.he.net/AS24514#_peers

Rank	Description	IPv6	Peer
1	Level 3 Communications, Inc.		AS3356
2	TELECOM ITALIA SPARKLE S.p.A.		AS6762
3	Singapore Telecommunications Ltd	X	AS7473
4	Tata Communications		AS6453
5	NTT America, Inc.	X	AS2914
6	Hutchison Global Communications		AS9304
7	Hong Kong Internet Exchange--Route Server 1	*	AS4635
8	Measat Transit, Measat Teleport and Broadcast Centre Cyberjaya		AS38891
9	Freescale Semiconductor, Inc.		AS14857
10	e-Genting Sdn Bhd		AS55520
11	Office Squared		AS45331
12	SHTech, City Broadband Service		AS45410
13	VNPT Global JSC		AS45896
14	BRUHAAS		AS55724

Remove all peers within CC

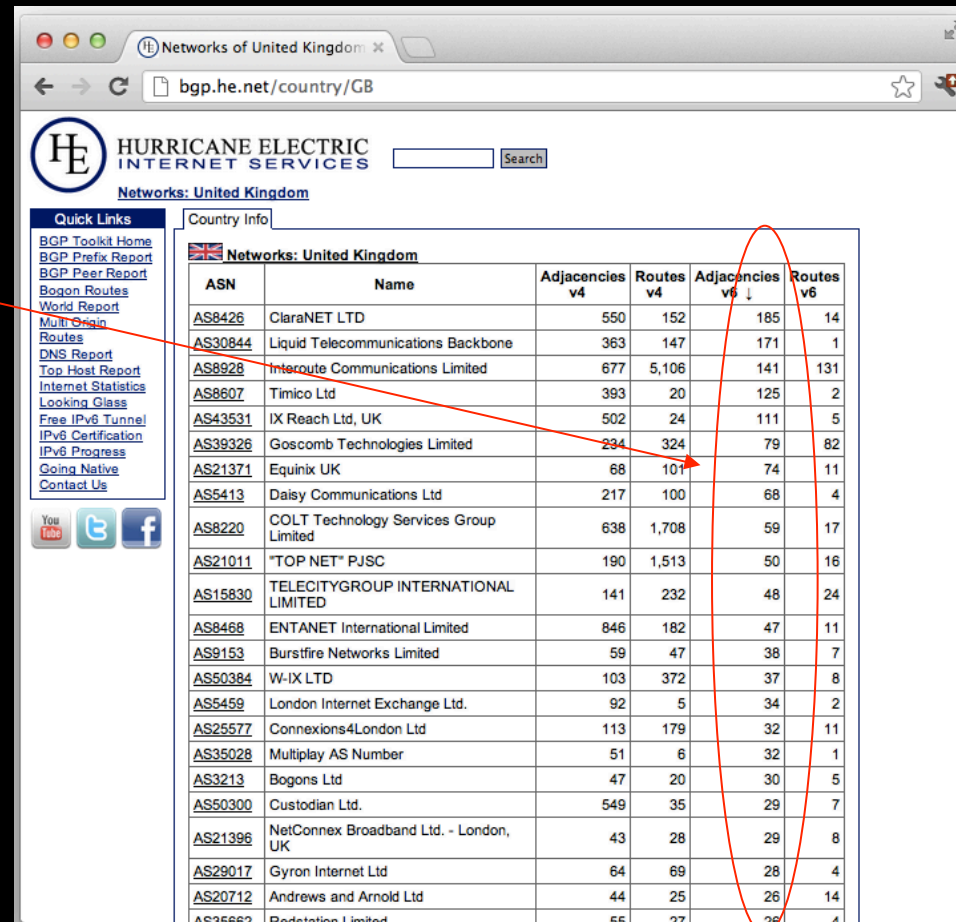
Note the peer connections that are outside the country ...

Visualizing IPv6 routing within the UK

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- Full country listing at <http://bgp.he.net/country/GB> (not UK)
 - Assuming that the ASN is listed as “GB” within RIPE database

ASNs sorted by Adjacency count



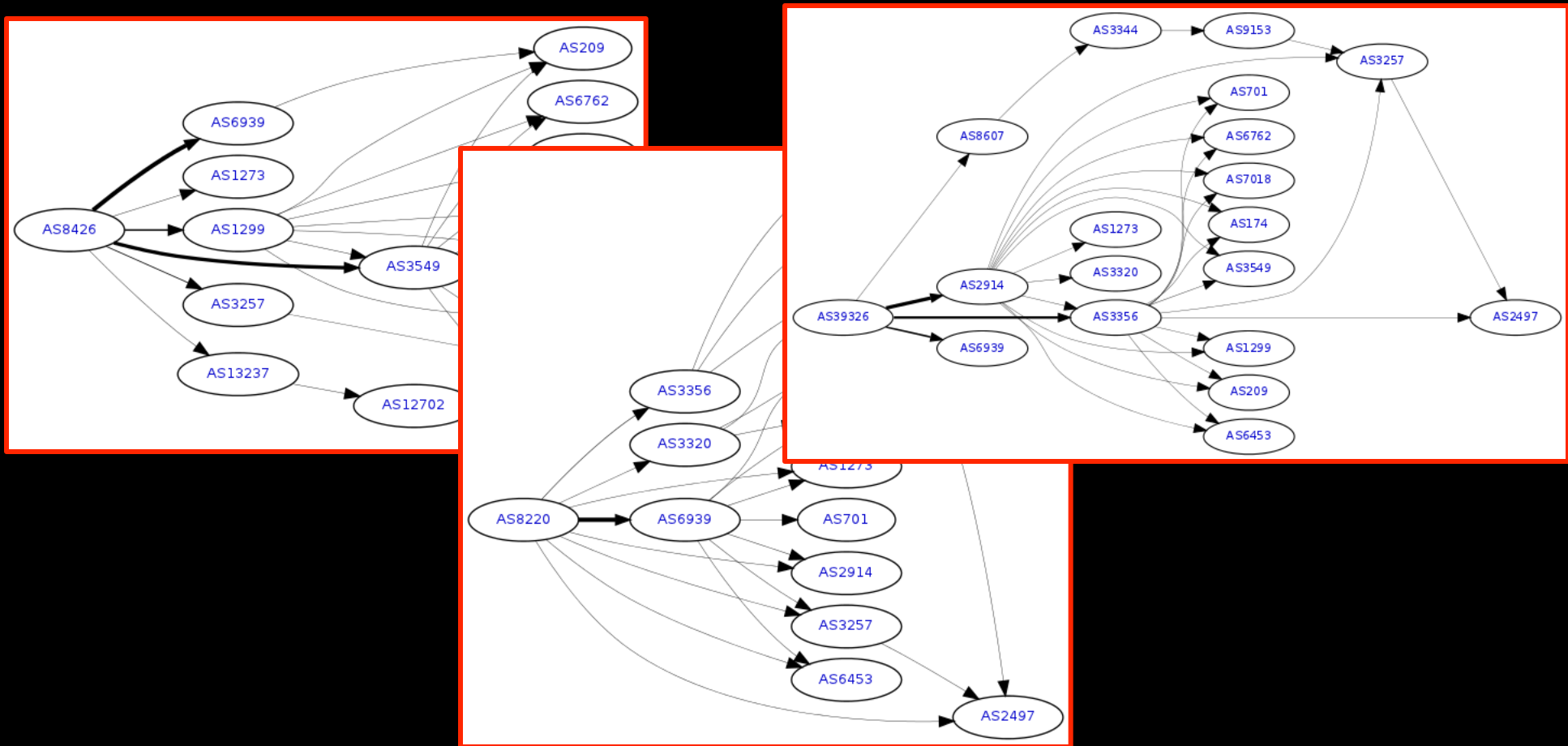
ASN	Name	Adjacencies v4	Routes v4	Adjacencies v6	Routes v6
AS8426	ClaraNET LTD	550	152	185	14
AS30844	Liquid Telecommunications Backbone	363	147	171	1
AS8928	Interoute Communications Limited	677	5,106	141	131
AS8607	Timico Ltd	393	20	125	2
AS43531	IX Reach Ltd, UK	502	24	111	5
AS39326	Goscomb Technologies Limited	234	324	79	82
AS21371	Equinix UK	68	101	74	11
AS5413	Daisy Communications Ltd	217	100	68	4
AS8220	COLT Technology Services Group Limited	638	1,708	59	17
AS21011	"TOP NET" PJSC	190	1,513	50	16
AS15830	TELECITYGROUP INTERNATIONAL LIMITED	141	232	48	24
AS8468	ENTANET International Limited	846	182	47	11
AS9153	Burstfire Networks Limited	59	47	38	7
AS50384	W-IX LTD	103	372	37	8
AS5459	London Internet Exchange Ltd.	92	5	34	2
AS25577	Connexions4London Ltd	113	179	32	11
AS35028	Multiplay AS Number	51	6	32	1
AS3213	Bogons Ltd	47	20	30	5
AS50300	Custodian Ltd.	549	35	29	7
AS21396	NetConnex Broadband Ltd. - London, UK	43	28	29	8
AS29017	Gyron Internet Ltd	64	69	28	4
AS20712	Andrews and Arnold Ltd	44	25	26	14
AS35682	Redstation Limited	55	27	26	4

<http://bgp.he.net/country/GB>

Visualizing IPv6 routing within the UK

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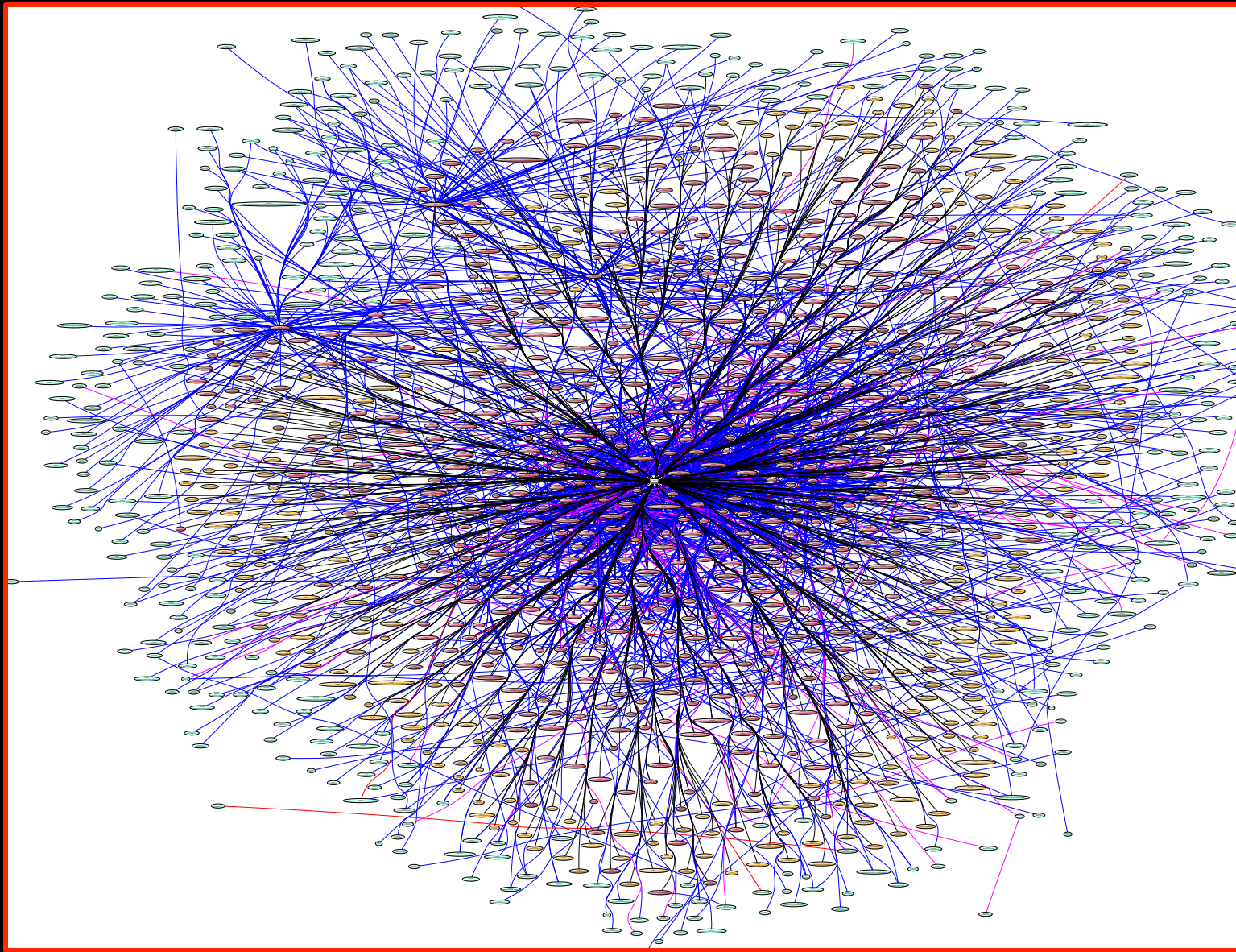
- Routing propagation graphs for three providers in the UK
 - These change all the time; it's best to look online for latest BGP propagation



Caveat: Not all links will show within these graphs

Visualizing IPv6 routing within the UK

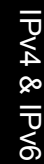
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IPv4 & IPv6

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**NATIVE IPv6
EVERYWHERE**



27 Sept 2012

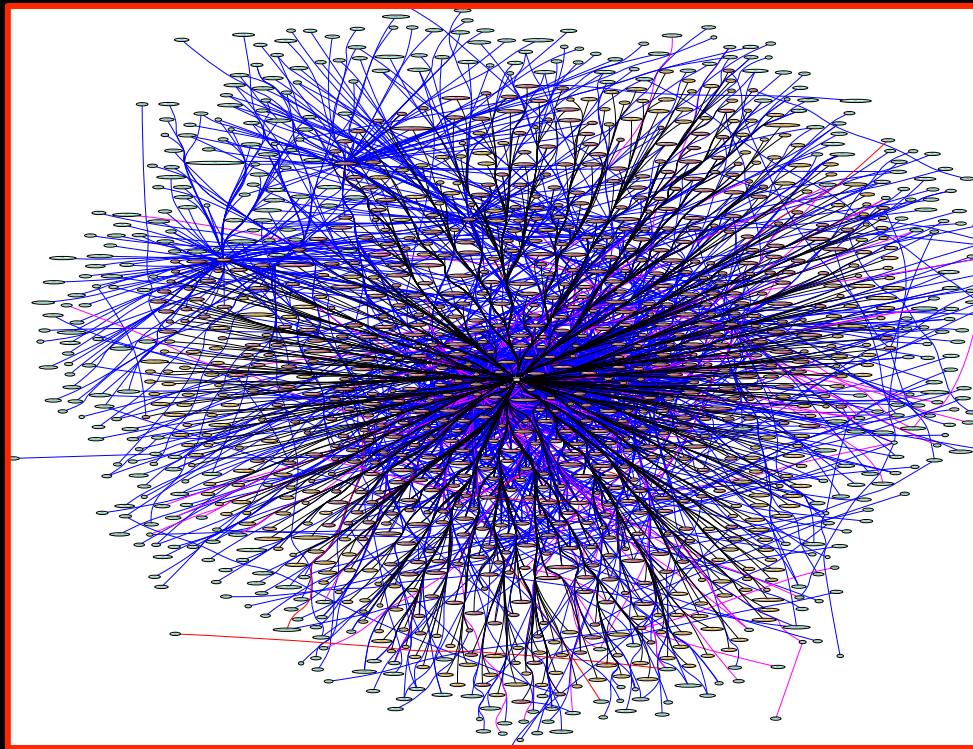
13



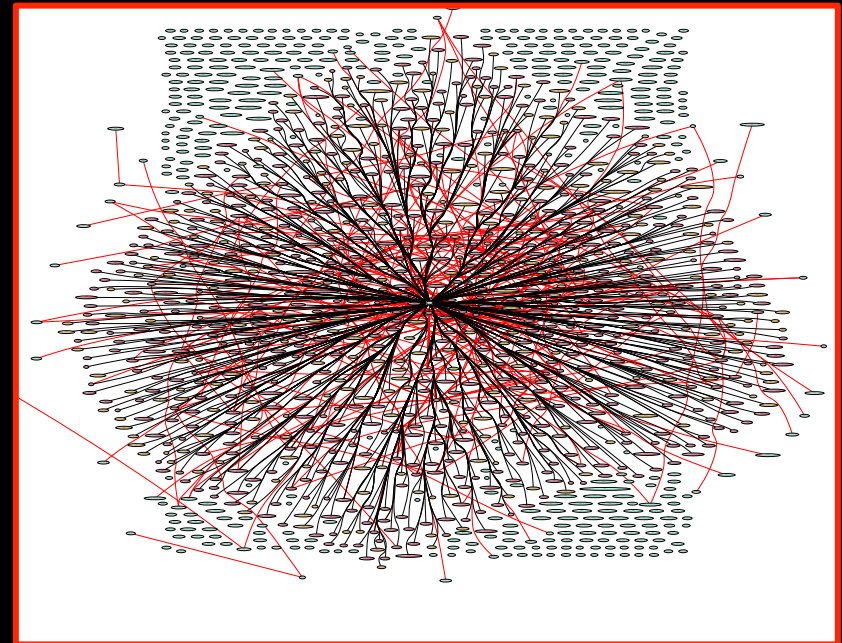
Visualizing IPv4 & IPv6 routing within the UK

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IPv4 & IPv6



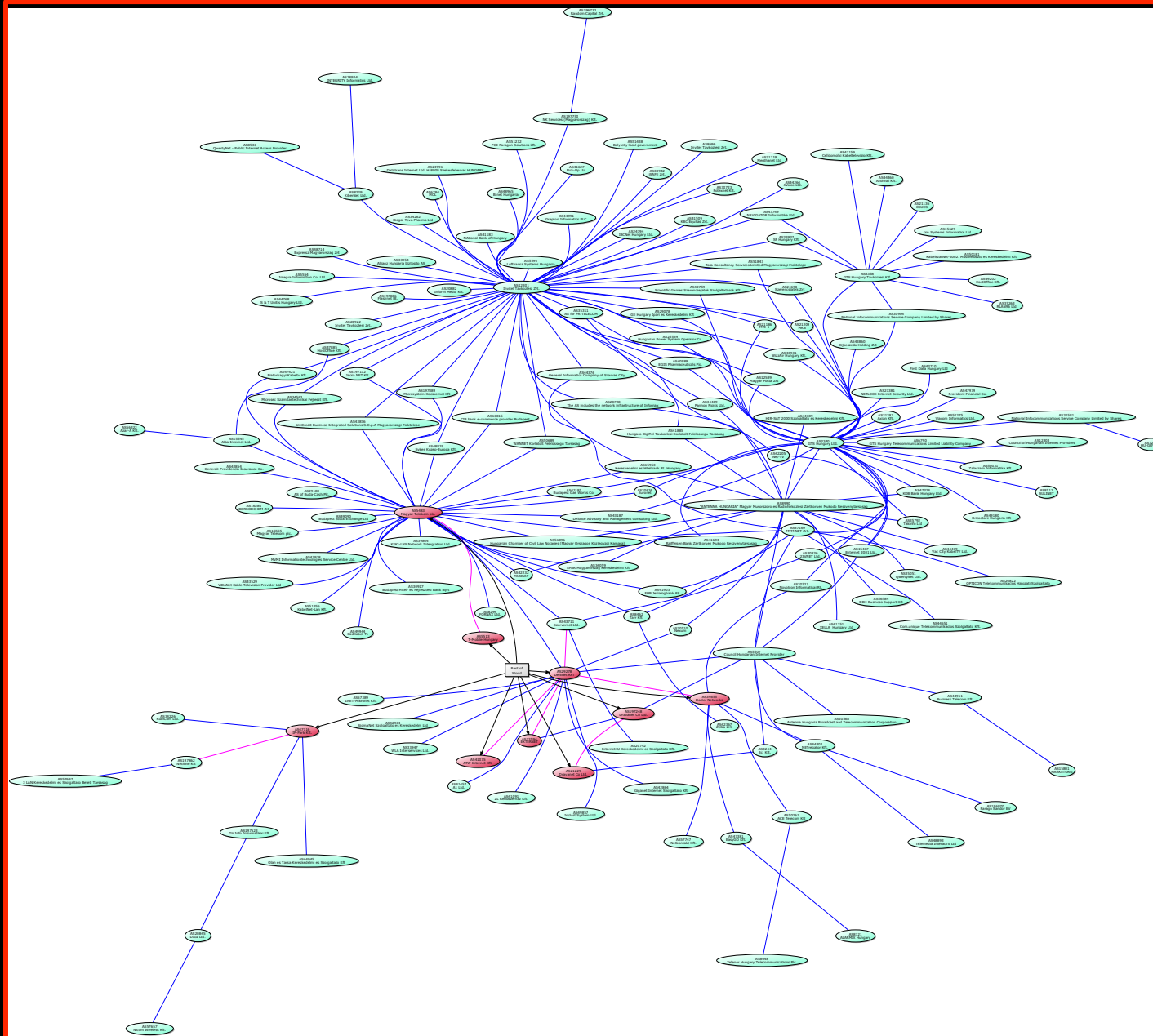
IPv6



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Visualizing IPv6 routing within Hungary

NATIVE **IPv6**
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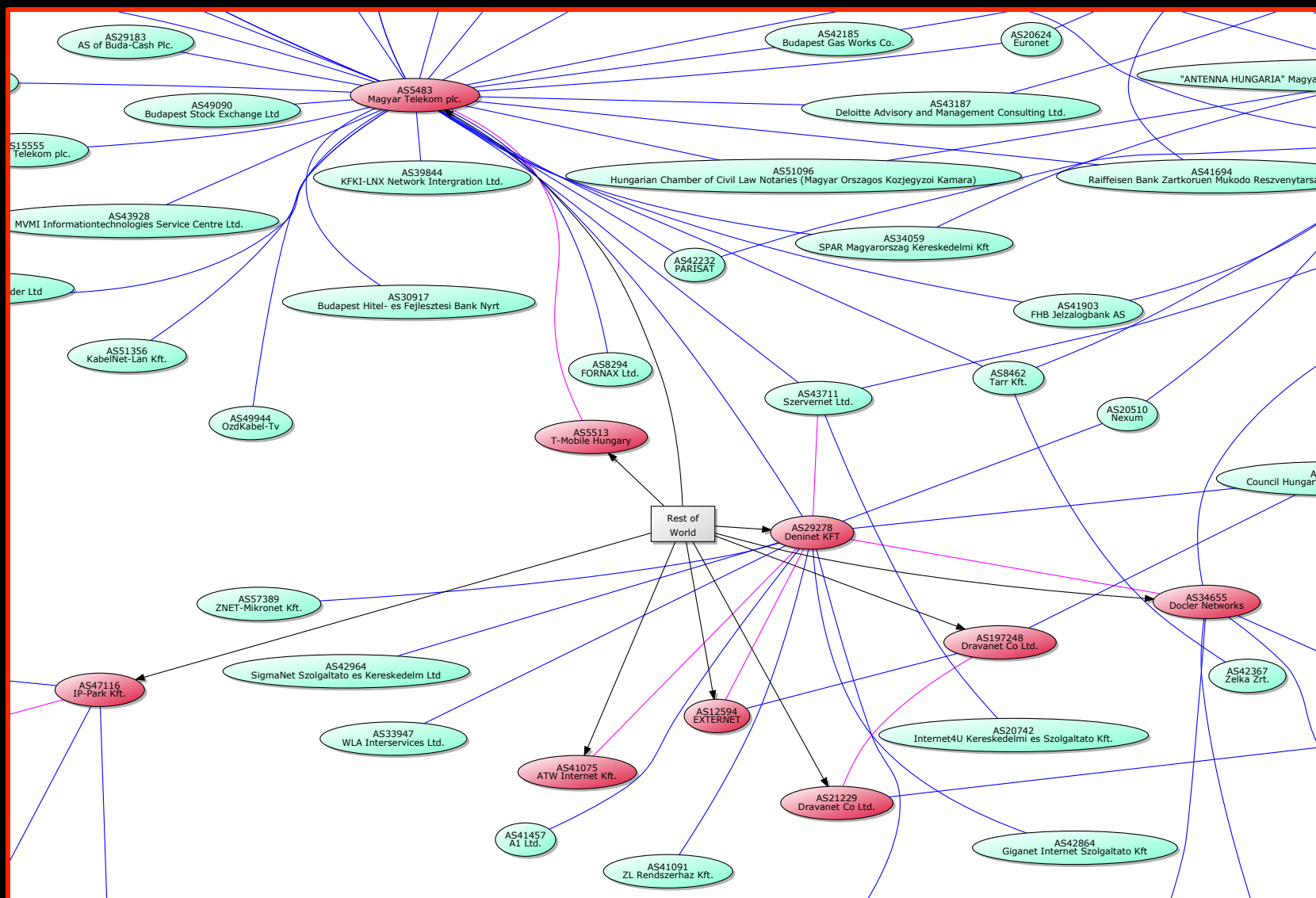


IPv4 & IPv6

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Visualizing IPv6 routing within Hungary (cont)

NATIVE IPv6
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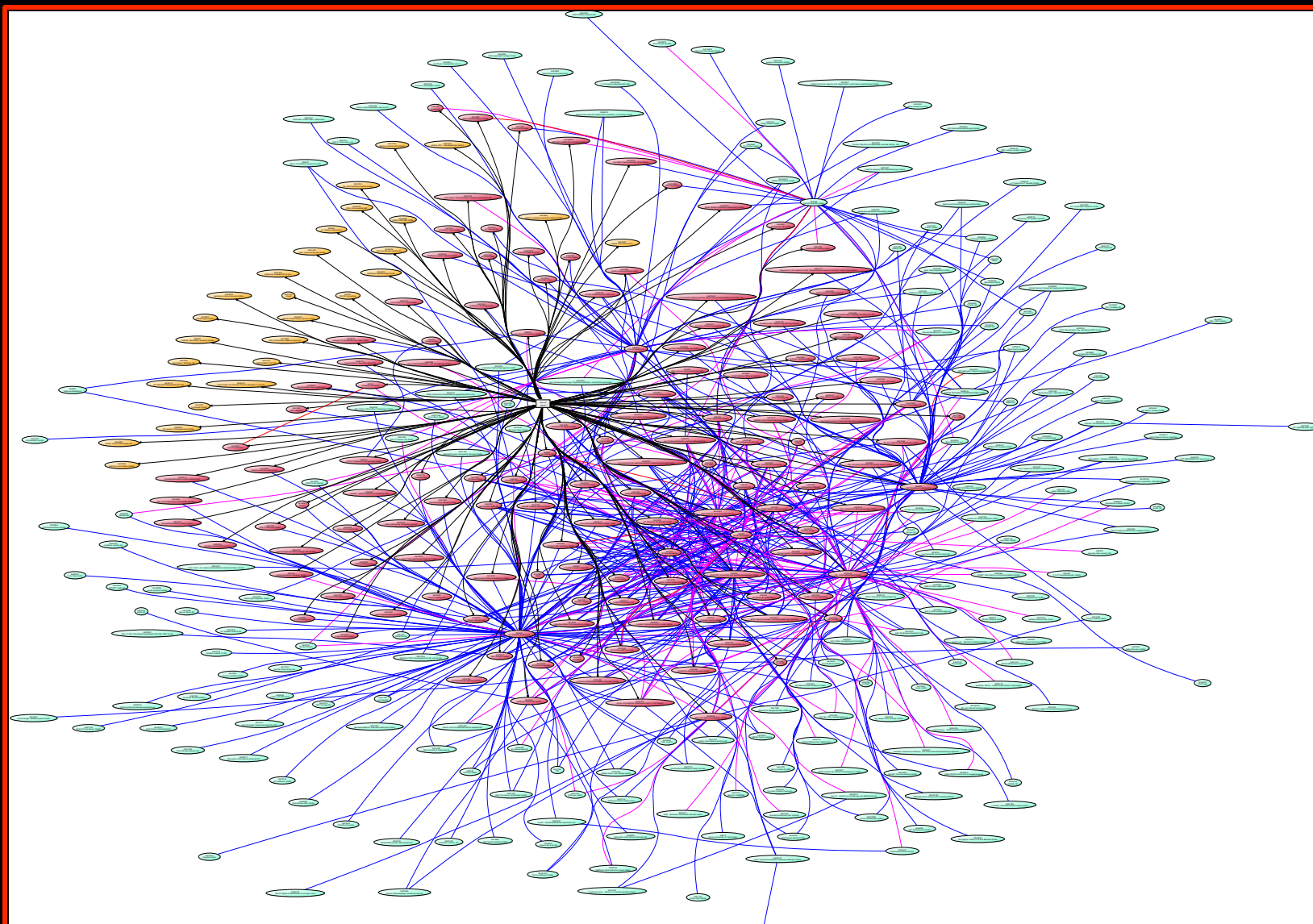


IPv4 & IPv6

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Visualizing IPv6 routing within Austria

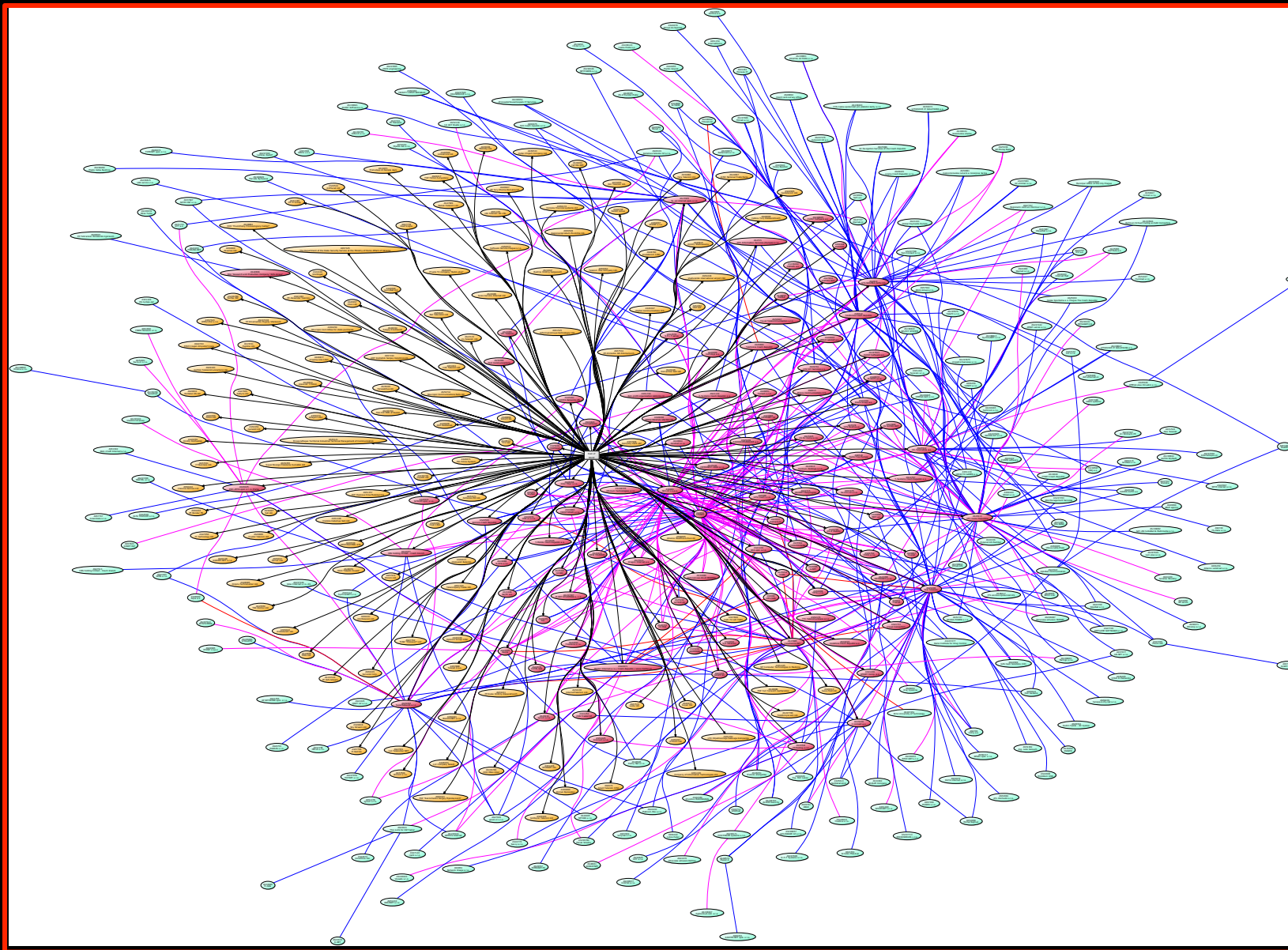
NATIVE **IPv6**
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Caveat: Not all links will show within these graphs

Visualizing IPv6 routing within Czech Republic

NATIVE **IPv6**
EVERYWHERE



IPv4 & IPv6

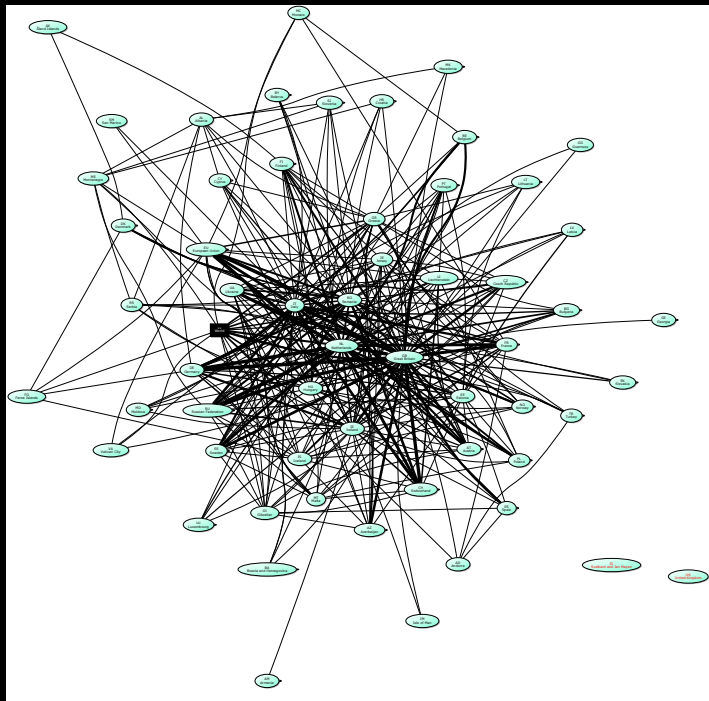
Caveat: Not all links will show within these graphs

Visualizing IPv4/IPv6 routing within Europe

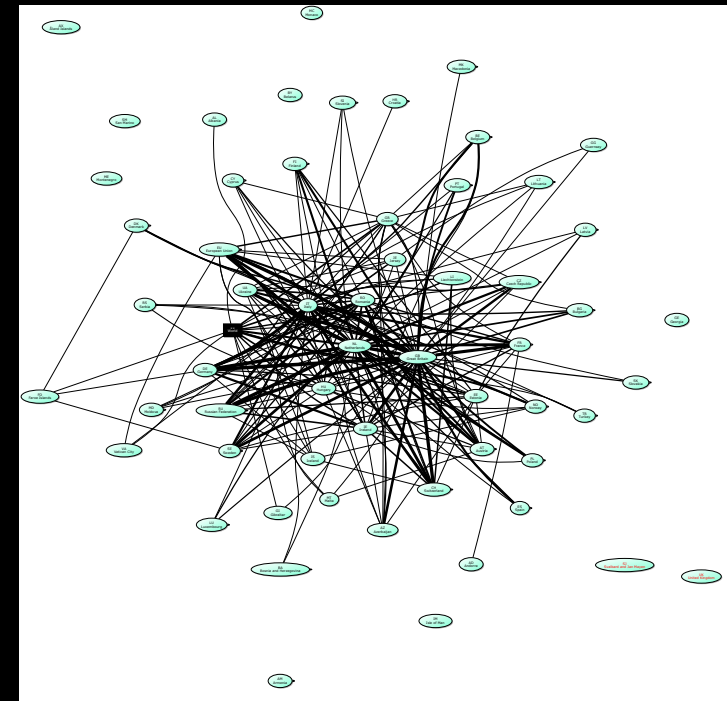
NATIVE **IPv6**
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■ Methodology:

- Look at all ASNs within one country and map ASN-to-ASN connections seen between countries
- Thickness of lines shows number of adjacencies seen between countries
- Only countries that have in-continent IPv4/IPv6 interconnections are shown



IPv4

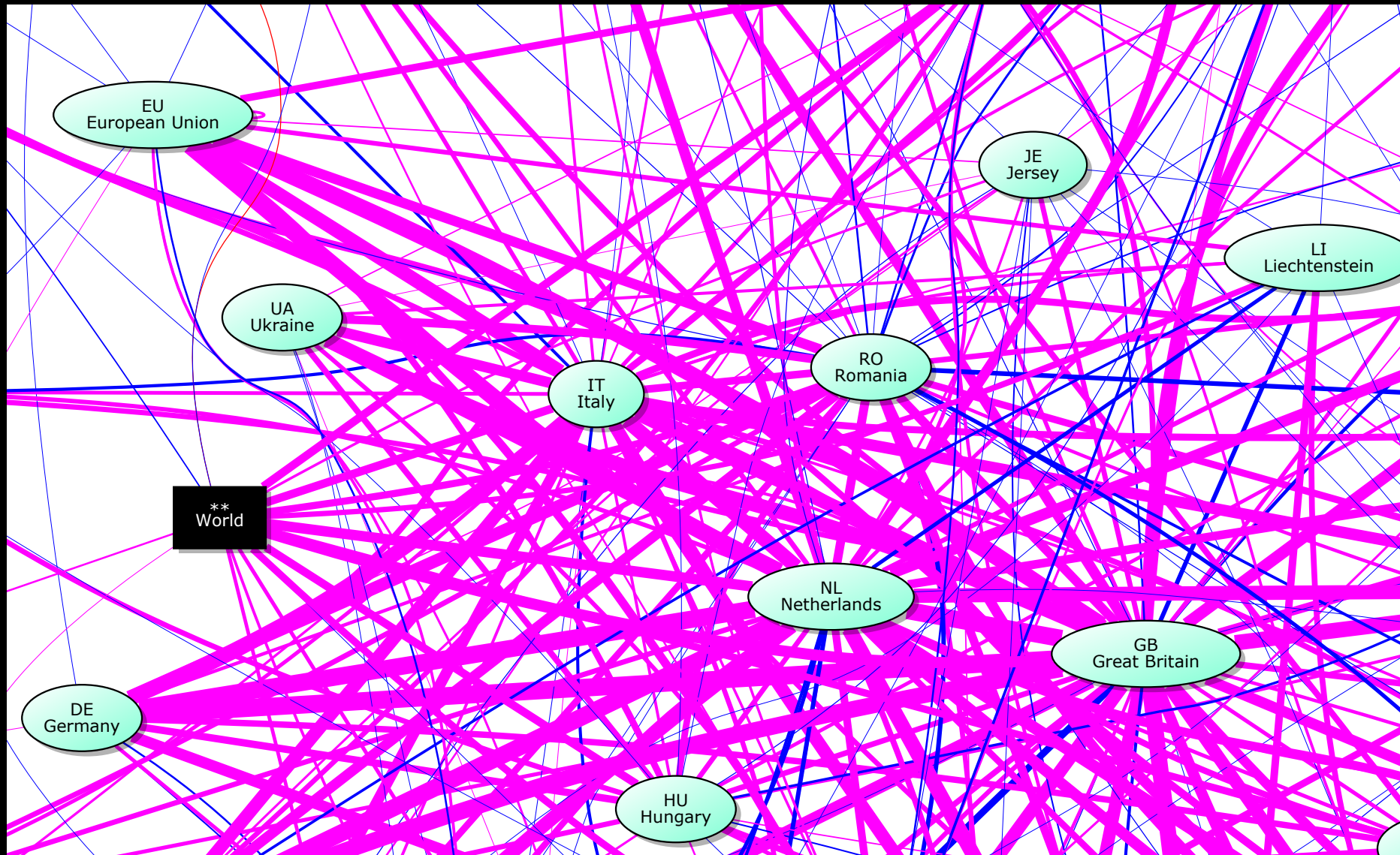


IPv6

Caveat: Not all links will show within these graphs

Visualizing IPv4/IPv6 routing within Europe

NATIVE **IPv6**
EVERYWHERE



IPv4 & IPv6

Caveat: Not all links will show within these graphs

However; data cleanup is needed ...

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- RIPE has “EU” listed as country code for many ASNs; but they are really “somewhere”
- Some examples ...

AT	AS1109	University of Salzburg
AT	AS1110	University of Innsbruck
AT	AS1111	University of Klagenfurt
AT	AS1113	Technische Universitaet Graz, AT
AT	AS1114	Universitaet Graz
AT	AS1117	Universitaet fuer Bodenkultur, Wien
AT	AS1120	ACOnet Services @ Vienna Internet eXchange
AT	AS1205	Johannes Kepler University
AT	AS1776	Wirtschaftsuniversitaet Wien
AT	AS1901	eTel Austria Gesmbh u. CO KG
AT	AS1921	NIC.at head office Salzburg

SI	AS2107	ARNES
SI	AS6764	Perftech d.o.o.

IS	AS1850	Internet Iceland Inc. (ISNIC)
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FI	AS375	Tieto Oyj
FI	AS565	Technical Research Centre of Finland
FI	AS719	Elisa Oyj
FI	AS764	Prime Minister's Office
FI	AS790	Elisa Oyj
FI	AS1234	Fortum
FI	AS1248	Nokia Internet
FI	AS1342	Fujitsu Invia Finland IP-network
FI	AS1738	OP-Pohjola Group Central Cooperative
FI	AS1739	TUT
FI	AS1741	FUNET
FI	AS1759	TeliaSonera Finland IP Network

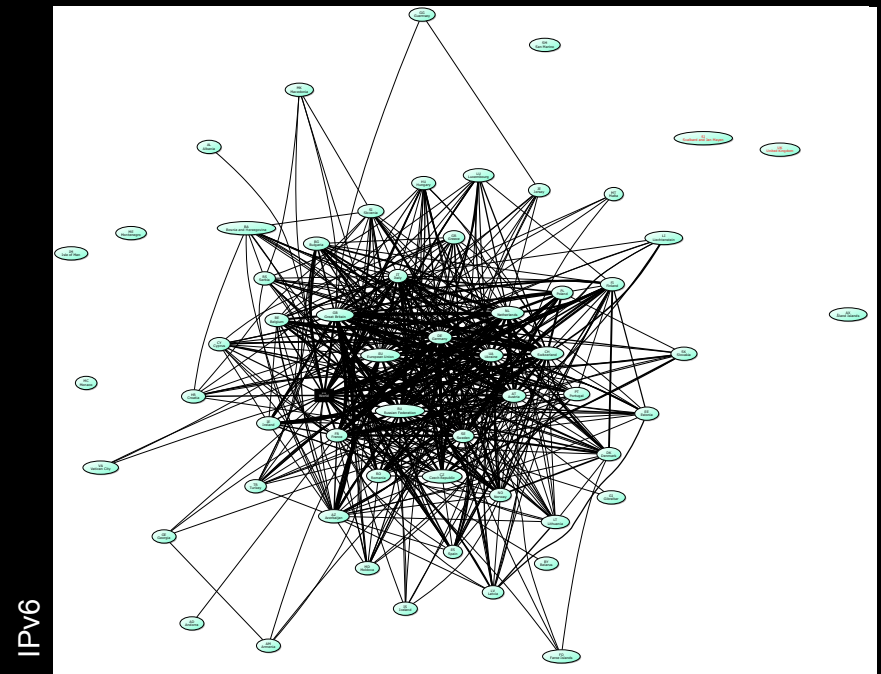
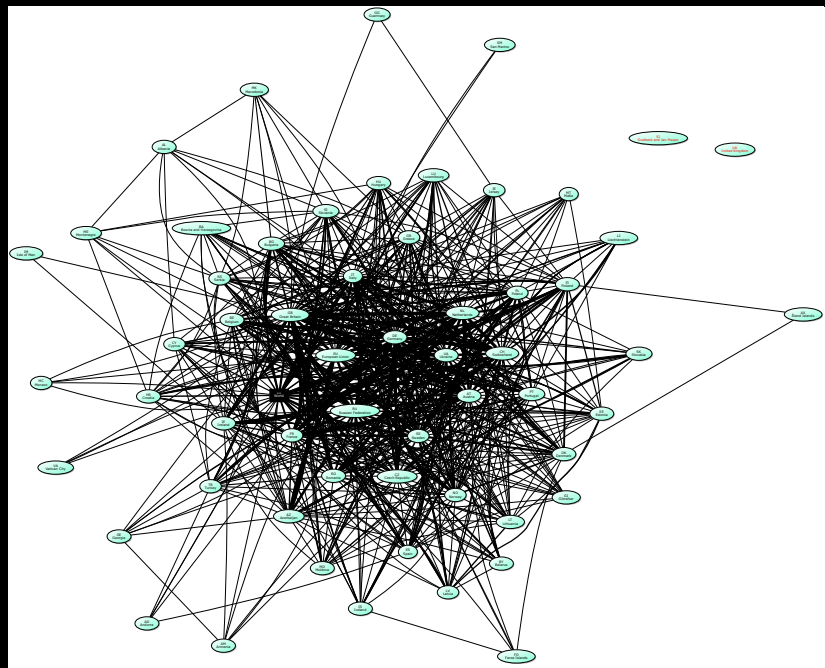
IT	AS1267	WIND Telecomunicazioni S.p.A.
IT	AS137	GARR Italian academic and research network

Visualizing IPv4/IPv6 routing within Europe

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■ Methodology:

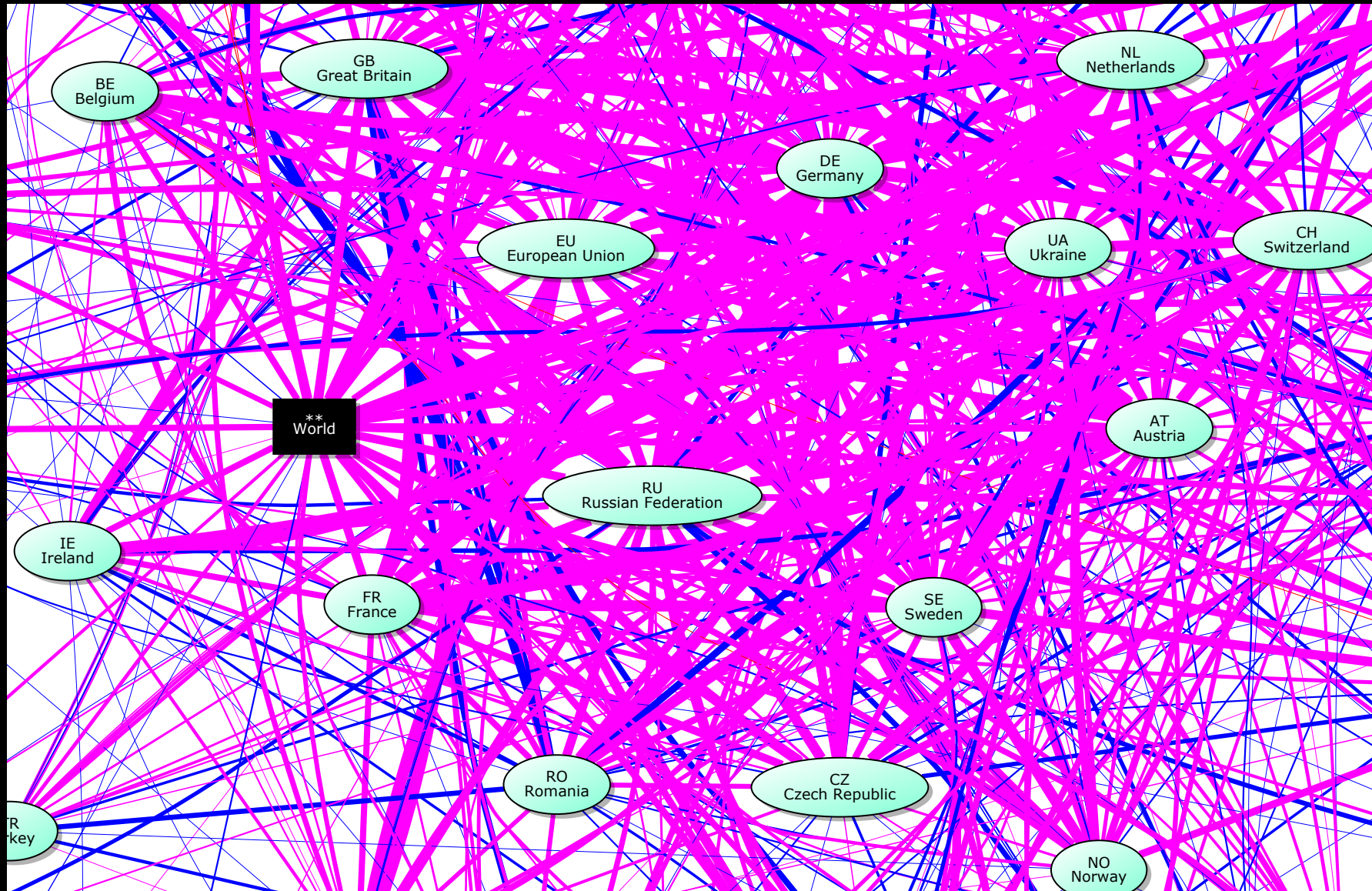
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Visualizing IPv4/IPv6 routing within Europe

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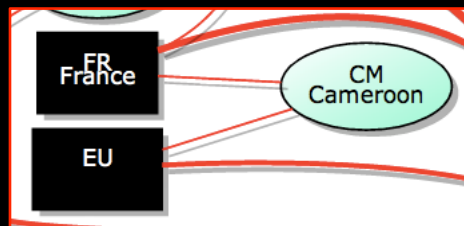
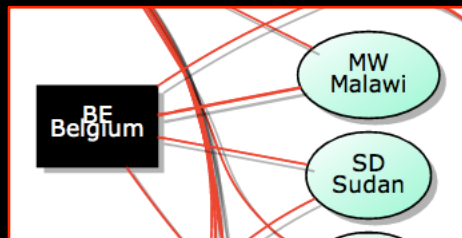
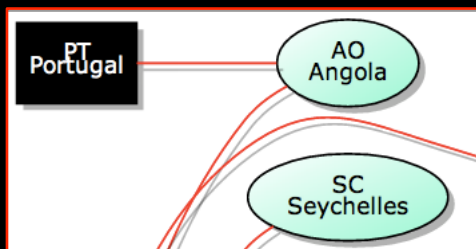
IPv4 & IPv6

Caveat: Not all links will show within these graphs

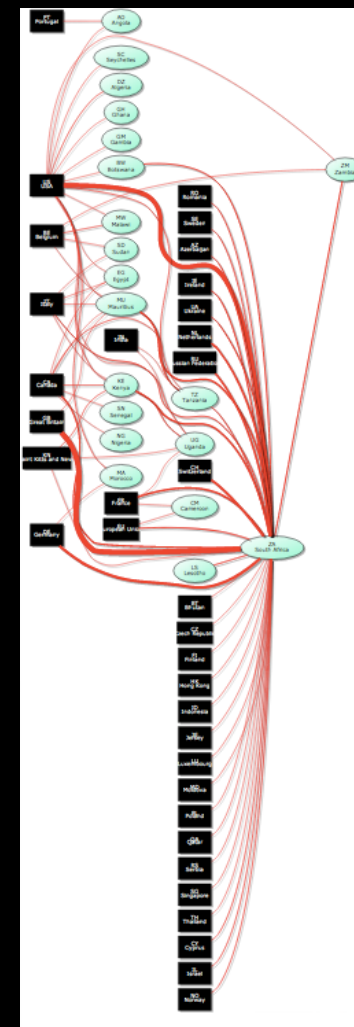
Examples from elsewhere in the world

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- Adding an example of showing each country as a separate node
 - Now you see country-to-country relationships



Zoom in and view specific countries



Impossible to read (need to zoom)!

Caveat: Not all links will show within these graphs

Does this produce valid BGP diagrams?

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- Can you question the collected BGP data?
 - ▣ Yes - There's a need for more participating ASNs
- Can you question the quality of the data?
 - ▣ Yes - BGP is BGP – it's only “best path”
- Can you question the processing?
 - ▣ Yes - It only takes one route to show an adjacency exists
- Can you question a connection from CC_1 to CC_2 ?
 - ▣ Yes – in some cases peering could be in CC_3 (ie: USA)



Every Day is v6 Day
at Hurricane Electric

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