

# A review of current worldwide IPv6 deployment (HKNOG edition)

George Michaelson

ggm@apnic.net

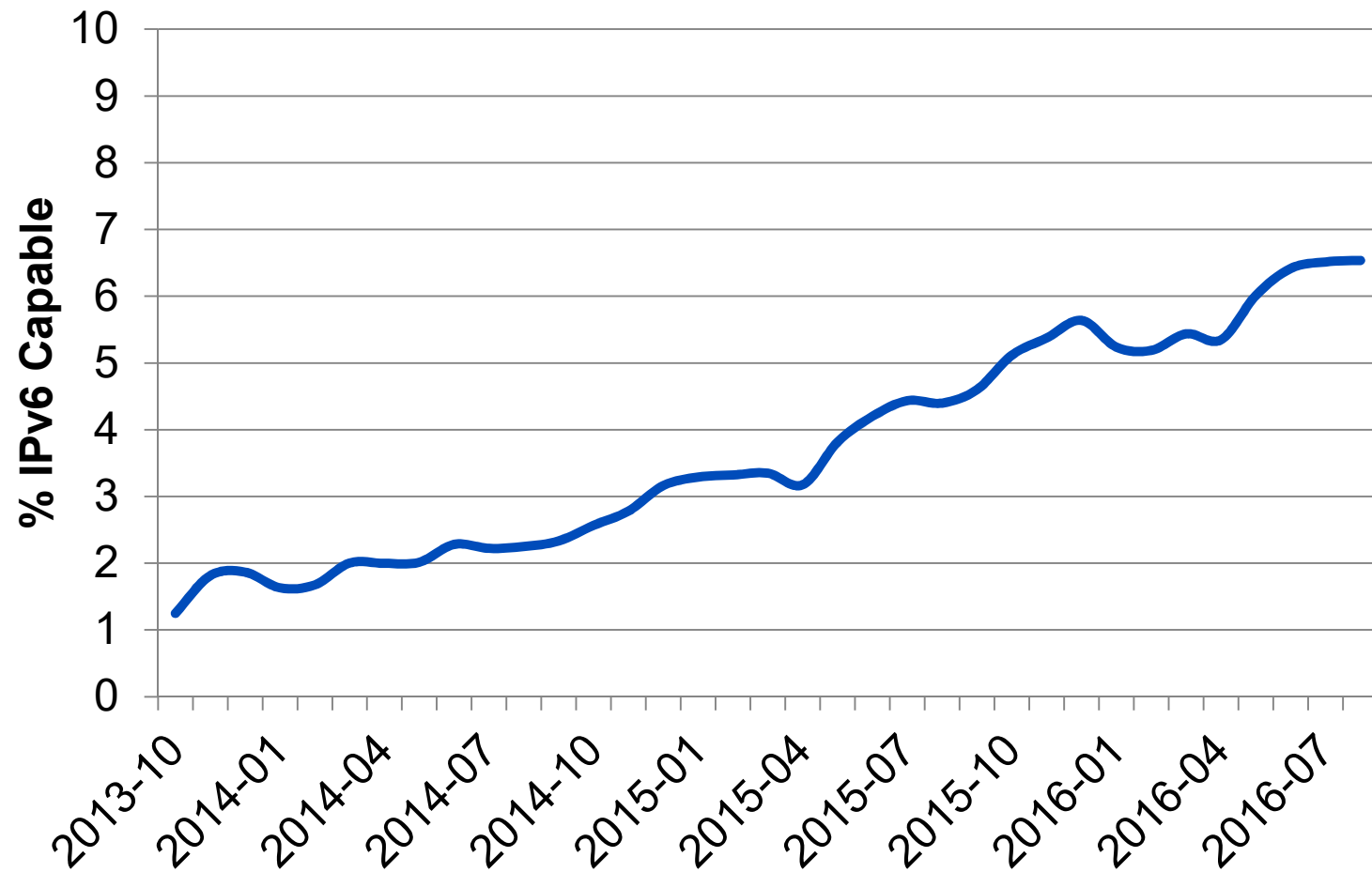
**APNIC**

Issue Date:

Revision:



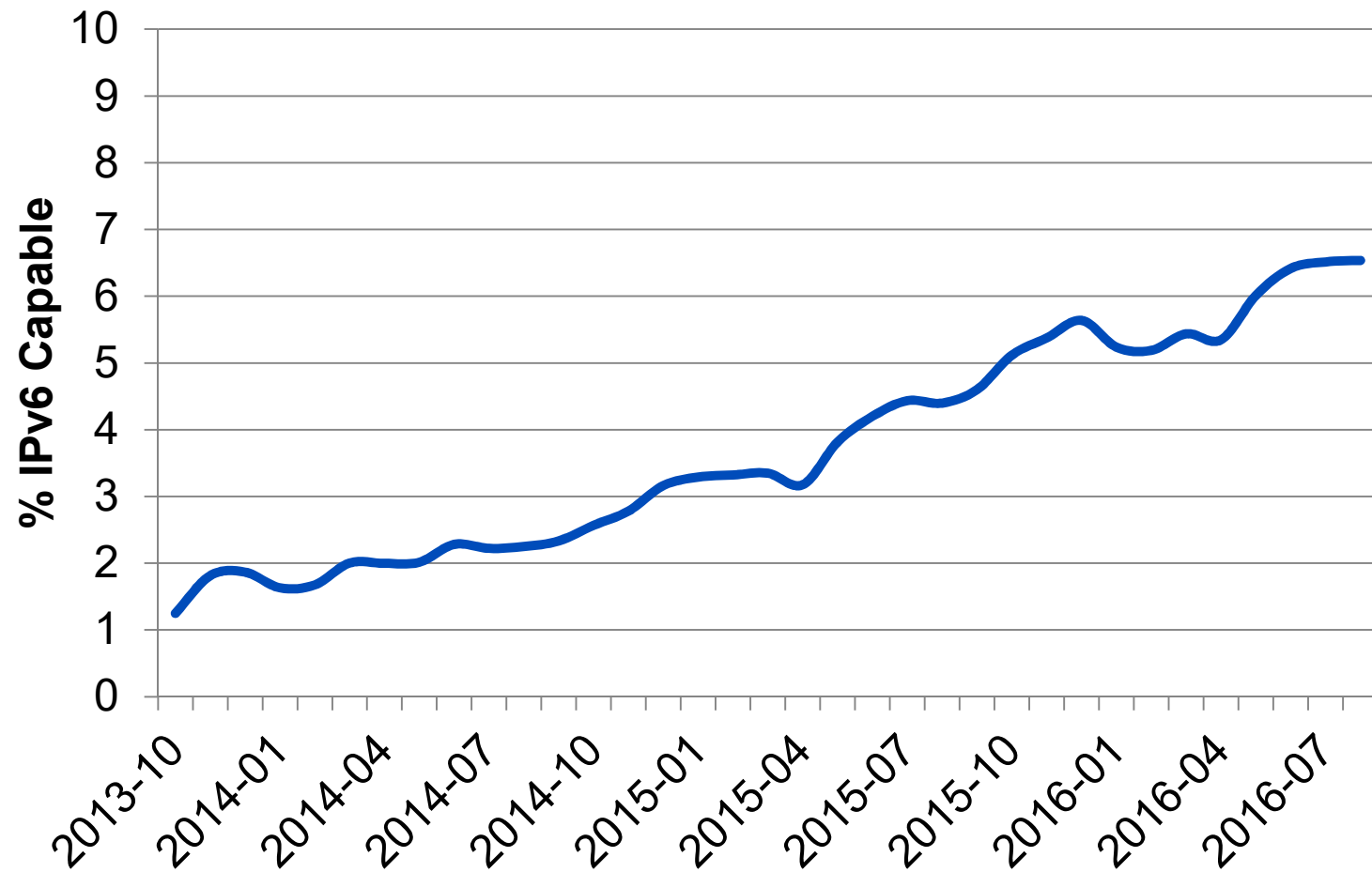
# IPv6 capability, worldwide (weighted)



## 6.5%? Google says 10+?

- APNIC applies a weighting function to sum the measurements,
  - based on ITU internet population data, to adjust for sample size anomalies worldwide.
- If you like, consider this worldwide figure as a low-side count
  - and the Google (and other) measures as a high-side count:
- Its probably somewhere inbetween the two

# IPv6 capability, worldwide (weighted)



CC	IPv6 %	CC	IPv6 %	CC	IPv6 %	CC	IPv6 %	CC	IPv6 %	CC	IPv6 %
BE	55.47%	US	33.96%	CH	31.30%	GR	28.66%	DE	28.28%	PT	25.62%
LU	23.02%	EC	19.59%	GB	19.51%	PE	18.96%	EE	17.18%	JP	16.99%
FR	14.63%	MY	14.30%	FI	13.88%	CA	12.75%	BR	9.99%	NO	9.83%
CZ	9.54%	TT	8.29%	SG	8.05%	NL	7.74%	IE	7.47%	AU	7.37%
RO	6.59%										

Above and

Below the Line:

C	IPv6 %	C	IPv6 %	C	IPv6 %	C	IPv6 %	C	IPv6 %	C	IPv6 %
AT	5.38%	BO	5.10%	SA	4.87%	HU	4.63%	SE	4.39%	TR	3.65%
IN	3.42%	BA	3.35%	NZ	2.69%	PL	2.35%	HK	2.31%	LK	2.16%
AX	1.64%	SI	1.59%	RU	1.51%	KR	1.25%	TW	1.06%	TH	0.96%
DK	0.82%	IL	0.77%	IT	0.69%	BG	0.68%	VN	0.66%	LV	0.48%
LR	0.35%	MD	0.33%	CN	0.32%	BT	0.29%	SK	0.25%	SD	0.21%
MT	0.19%	UA	0.19%	ID	0.16%	KN	0.14%	IS	0.14%	BW	0.12%
LT	0.11%	RE	0.10%	ZA	0.08%	CY	0.07%				

# Emerging problem in AP region

- Few economies in the AP region are above world-grade IPv6 capability (green)
- Of the economies below the line, many are stagnant (red), some are moving upward (yellow)
- Hard to quantify what quality determines ranking:
  - Its not just about economic size, diversity of ISP
  - Is it about capital investment?

# Two kinds of Internet?

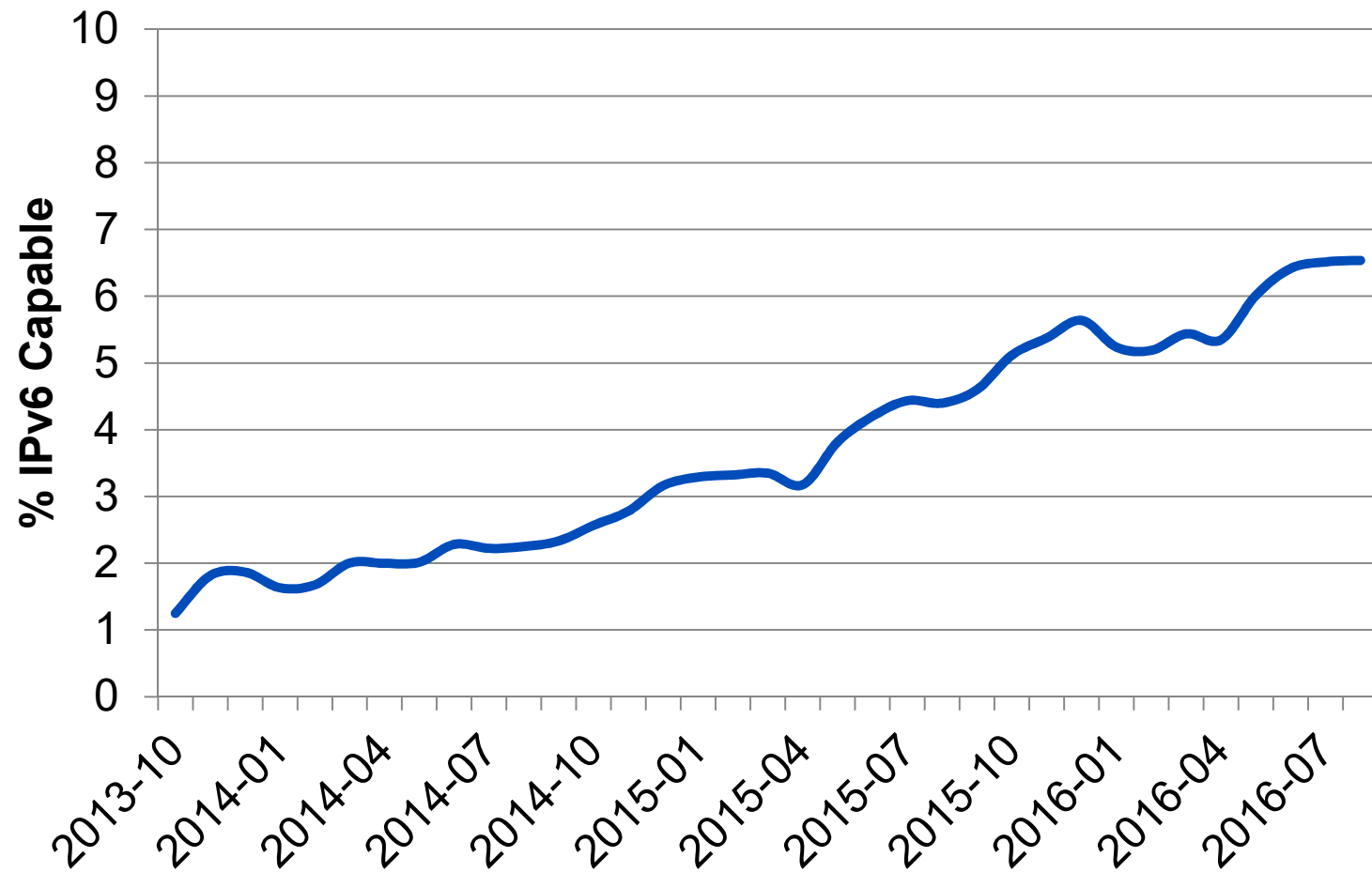
- IPv4 and IPv6 can't directly inter-operate as protocols
  - You can tunnel, and you can gateway but you can't send IP packets directly from
    - 2000::/3 to 10.0.0.0/8
  - The decision to proceed with IPv6 deployment implies dual-stack operations, short or long term
  - The decision to remain in IPv4 implies increasing use of CGN and other techniques to maximise address re-use
- There is no avoidance of extra technology cost to continue to grow the Internet.

# It looks like it on macro scale

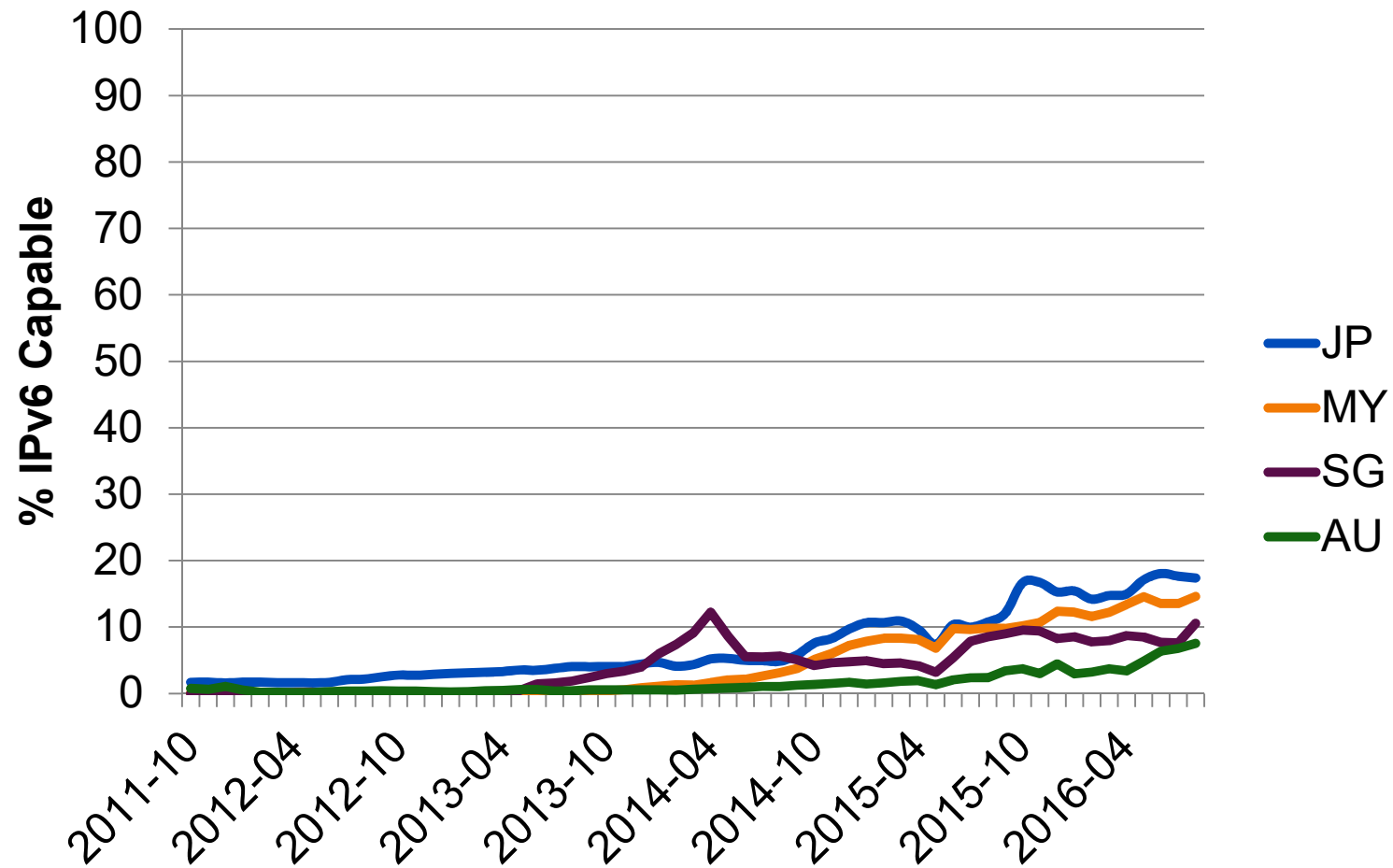
- There are signs that at a high-level view, the economies investing in IPv6 are now diverging from the ones who are staying in IPv4
  - Its not just about size, or economic capacity
- Lets review some of the players in each 'camp'
  - Some economies with signs of significant IPv6 deployment
  - Some economies with little or no sign of significant IPv6 deployment



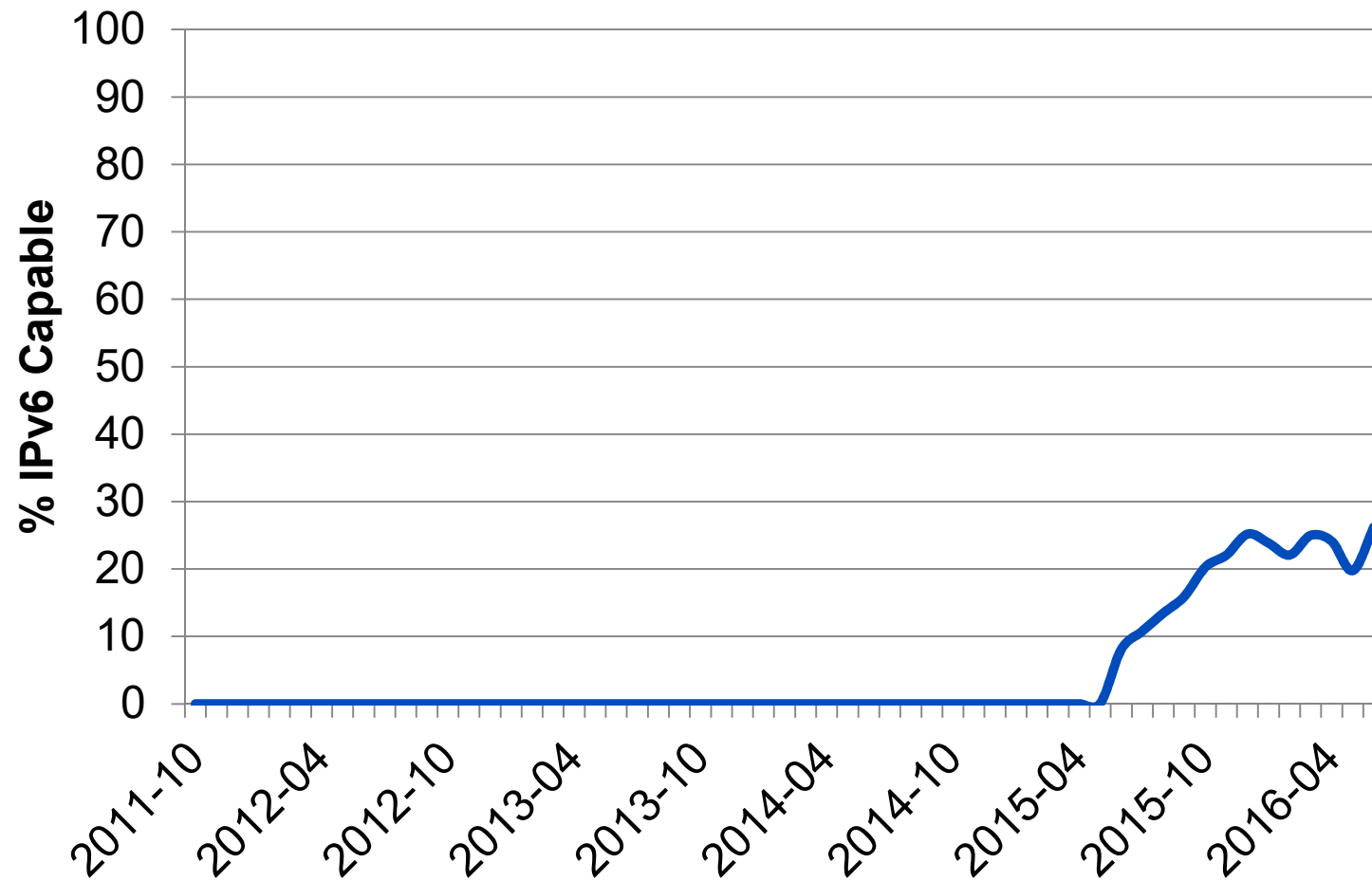
# IPv6 capability, worldwide (weighted)



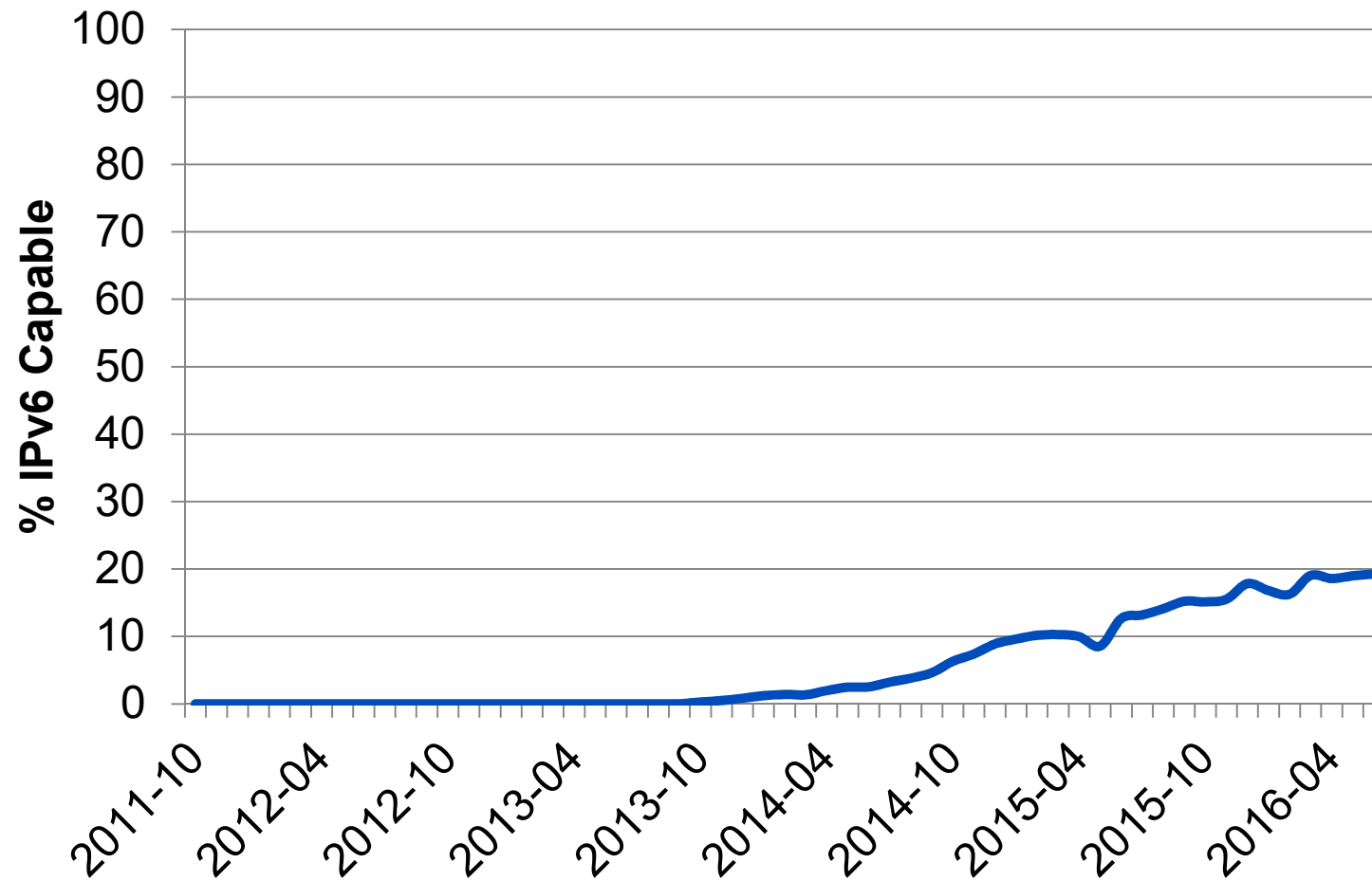
# Higher IPv6 capability in Asia-Pacific



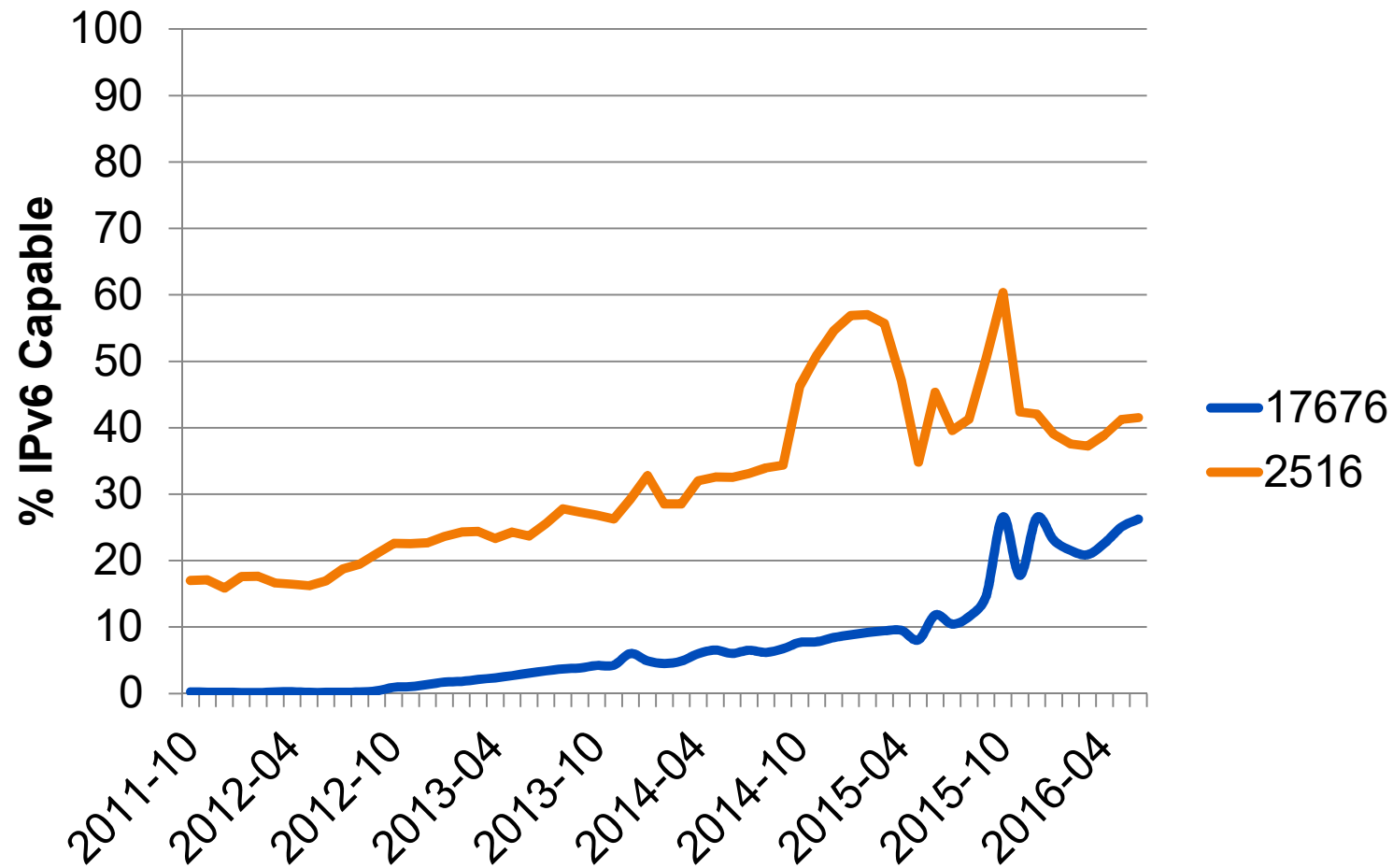
# SK Telecom (Korea)



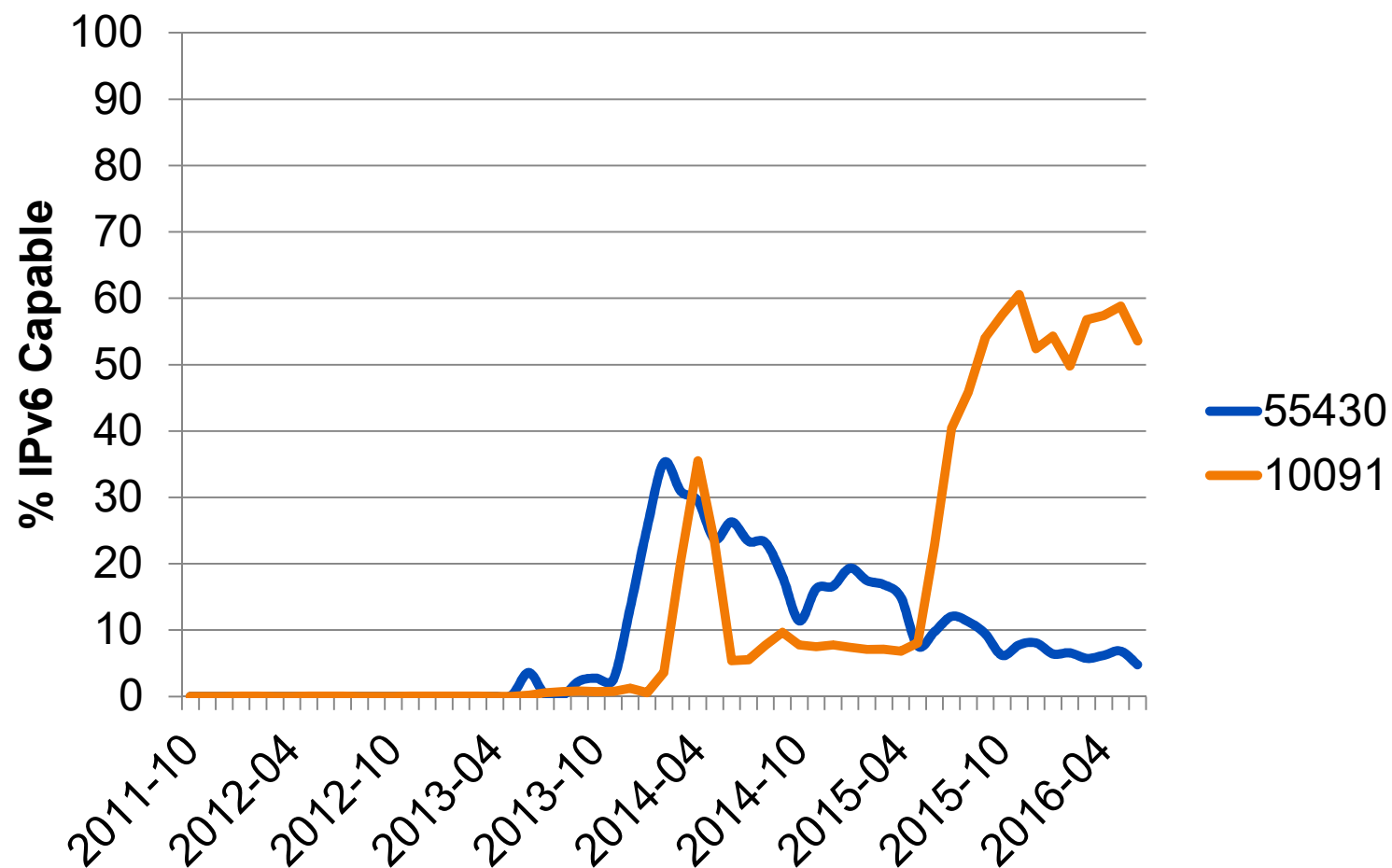
# TMNET (Malaysia)



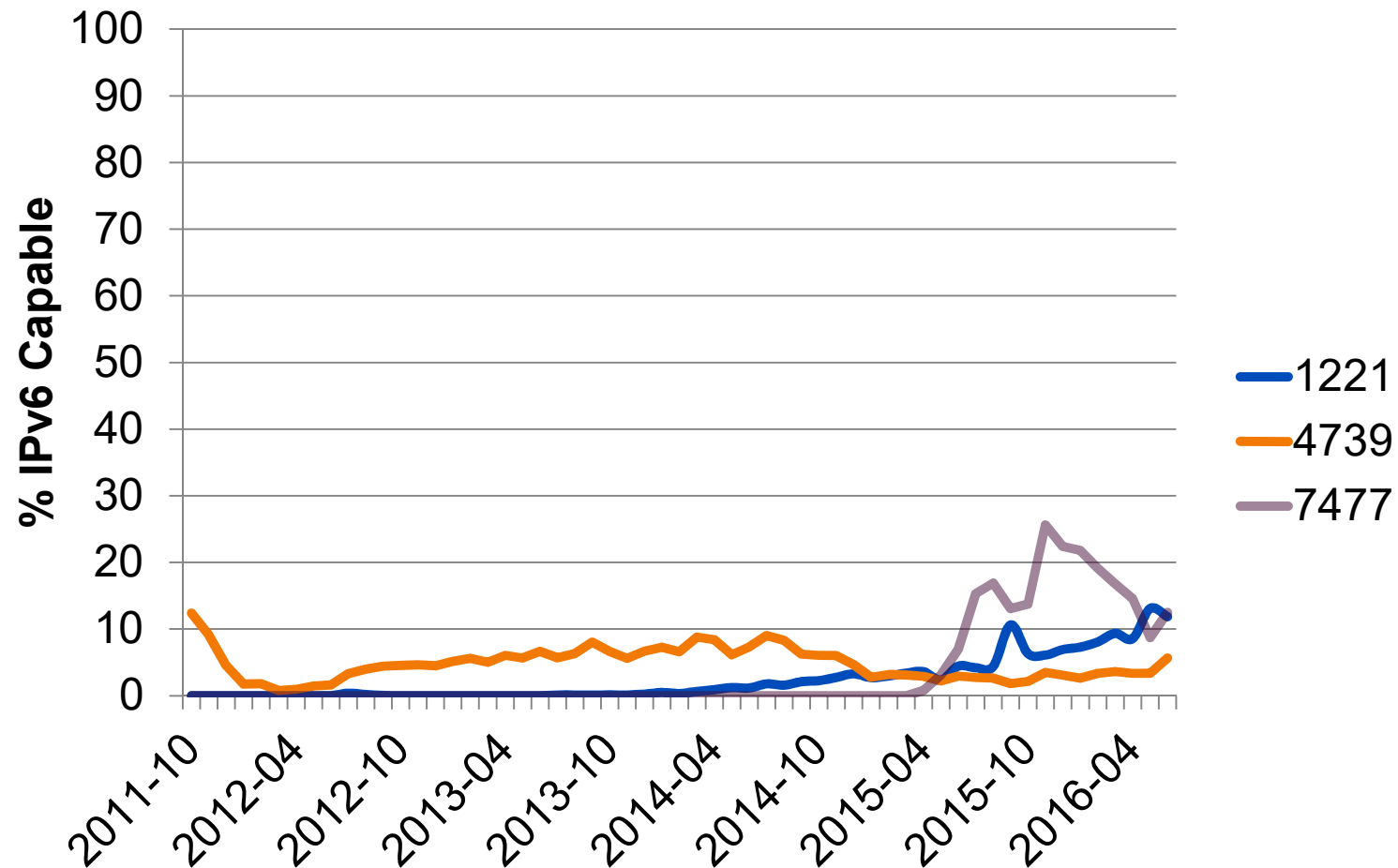
# Softbank-BB, KDDI (Japan)



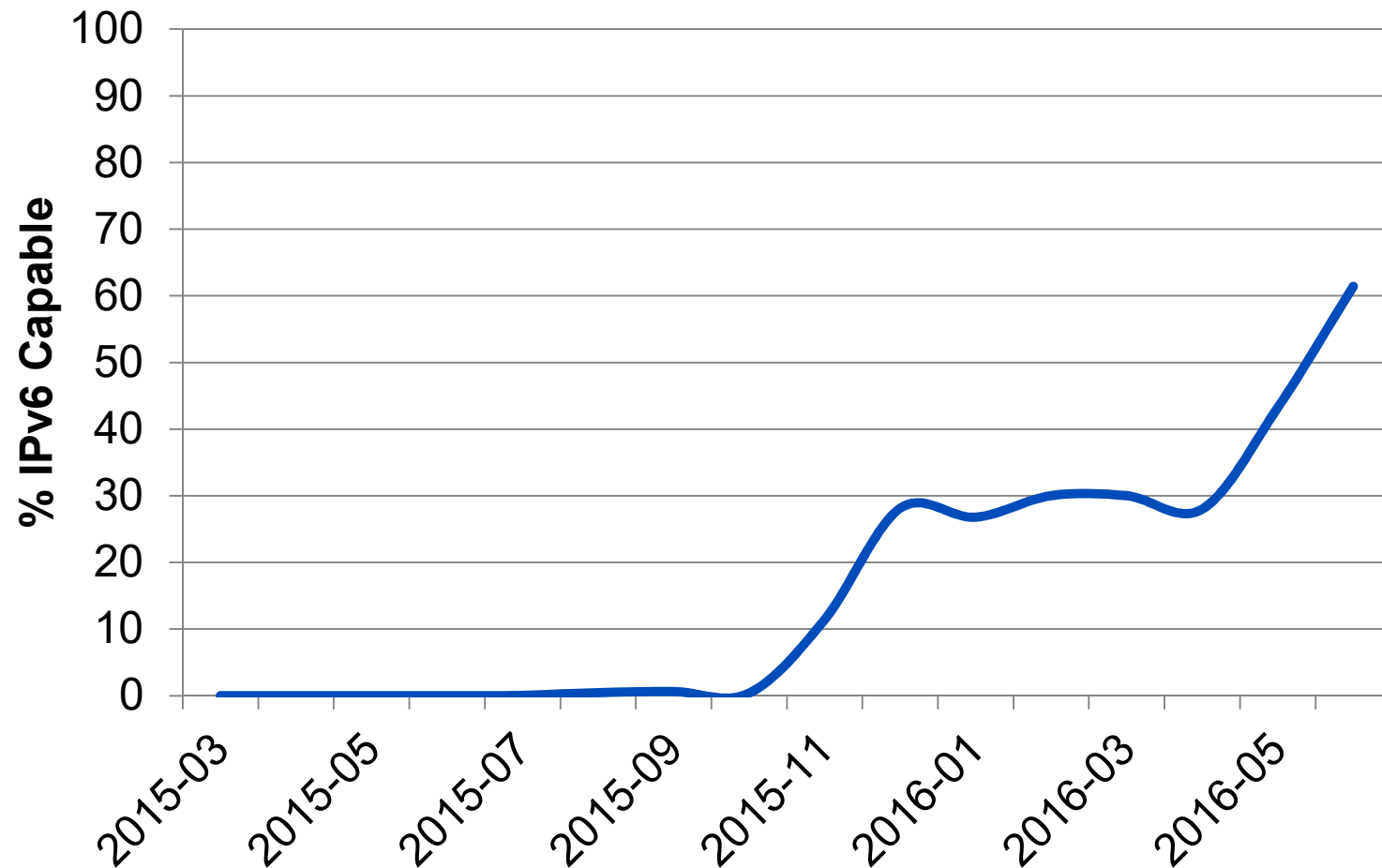
# StarHub, StarHub CableVision (Singapore)



# Telstra, Internode, Skymesh(Australia)

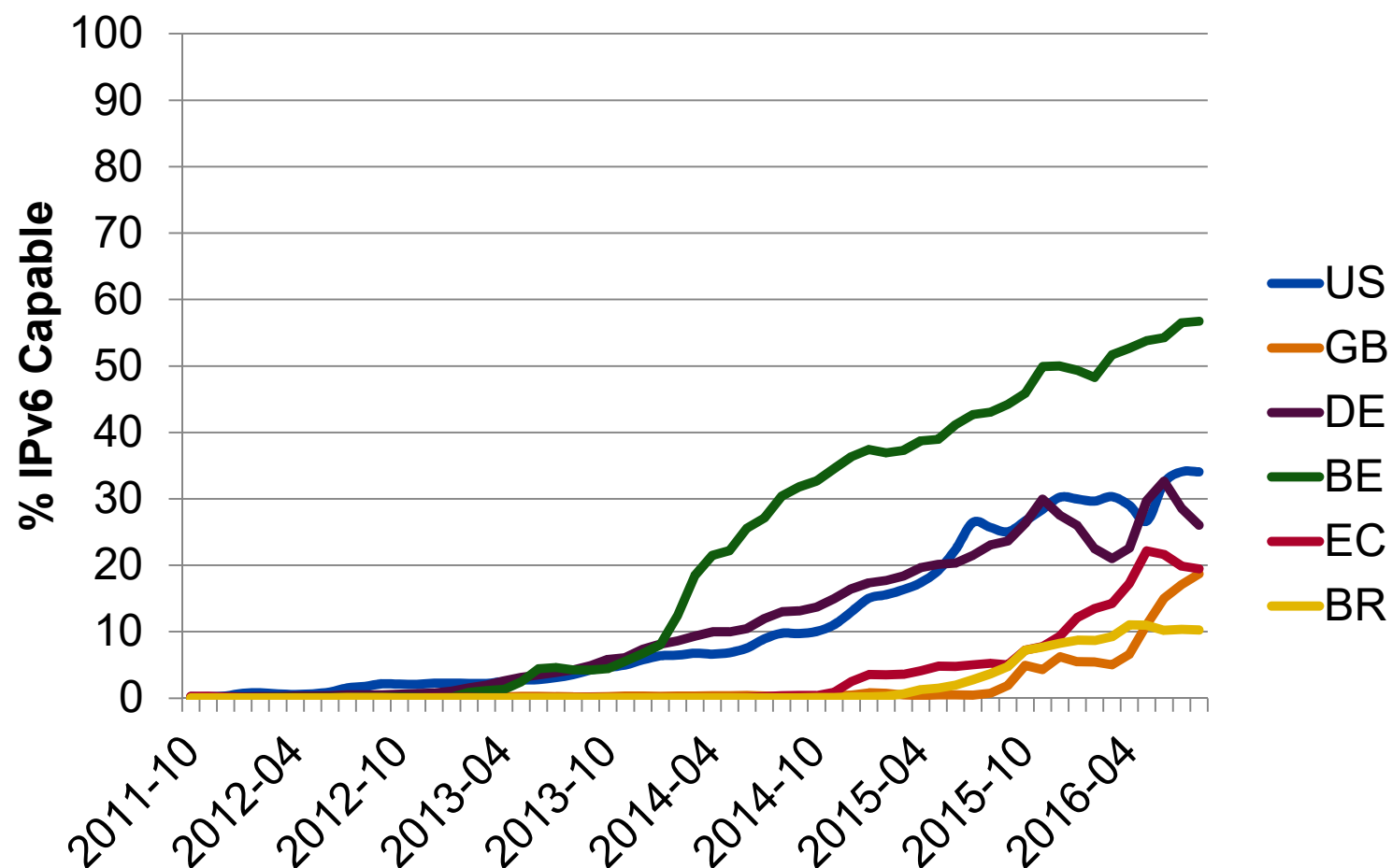


# FoxTel (covered by Telstra AS1221)





# High IPv6 capability, selected economies Worldwide



# Top 10 by sample, US

ASN	AS Name	IPv6 Capable	IPv6 Preferred	# Samples
AS7922	Comcast Cable Communications, Inc.	63.94%	59.61%	15183499
AS7018	ATT Services, Inc.	82.35%	75.41%	8786575
AS701	MCI, Inc. dba Verizon Business	0.19%	0.07%	4441014
AS20115	Charter Communications	0.12%	0.07%	3553099
AS22773	Cox Communications Inc.	27.41%	25.64%	3343513
AS22394	Cellco Partnership / Verizon Wireless	89.83%	82.61%	2481142
AS209	Qwest Communications Company, LLC	0.15%	0.12%	2345500
AS20057	ATT Mobility LLC	10.75%	10.72%	2319243
AS20001	Time Warner Cable Internet LLC	45.62%	42.29%	2095293
AS5650	Frontier Communications of America	0.13%	0.07%	2033956

# Top 10 by Sample, BE

ASN	AS Name	IPv6 Capable	IPv6 Preferred	# Samples
AS5432	Proximus NV	46.61%	44.57%	748462
AS6848	Telenet N.V.	71.65%	68.86%	677668
AS12392	Brutele SC	75.58%	73.77%	186270
AS47377	Mobistar SA	0.16%	0.31%	41583
AS21502	NC Numericable S.A.	0.00%	0.15%	31925
AS44944	BASE Company NVSA	0.54%	0.30%	15995
AS2611	BELNET	8.44%	7.66%	9588
AS41756	Orascom Telecom Algeria Spa	0.00%	0.06%	7119
AS29587	schedom vof	0.00%	0.27%	6699
AS51964	Equant Inc.	0.00%	0.05%	5919

# Top 10 by Samples, GB

ASN	AS Name	IPv6 Capable	IPv6 Preferred	# Samples
AS5607	Sky UK Limited	80.40%	77.50%	1204542
AS2856	British Telecommunications PLC	1.03%	1.36%	997424
AS5089	Virgin Media Limited	0.01%	0.29%	996553
AS43766	MTC KSA	0.00%	0.17%	700175
AS13285	TalkTalk Communications Limited	0.00%	0.30%	251670
AS12576	EE Limited	0.15%	0.62%	227929
AS9105	Tiscali UK Limited	0.00%	0.71%	212562
AS60339	Hutchison 3G UK Limited	0.18%	0.53%	125502
AS6871	PlusNet plc.	0.09%	0.50%	108235
AS43234	TalkTalk Communications Limited	0.00%	0.46%	85316

# Top 10 by Samples, DE

ASN	AS Name	IPv6 Capable	IPv6 Preferred	# Samples
AS3320	Deutsche Telekom AG	49.75%	48.27%	458699
AS3209	Vodafone GmbH	0.10%	0.45%	152898
AS31334	Vodafone Kabel Deutschland GmbH	68.68%	65.13%	102266
AS24940	Hetzner Online GmbH	2.94%	3.17%	99927
AS200185	X AND MAIL SA	0.00%	1.27%	97150
AS6805	Telefonica Germany GmbH Co.OHG	0.47%	0.67%	88338
AS28753	Leaseweb Deutschland GmbH	42.59%	0.92%	73588
AS6830	Liberty Global Operations B.V.	49.23%	46.45%	69495
AS8972	PlusServer AG	0.31%	0.23%	68920
AS13301	United Gameserver GmbH	95.00%	93.58%	42799

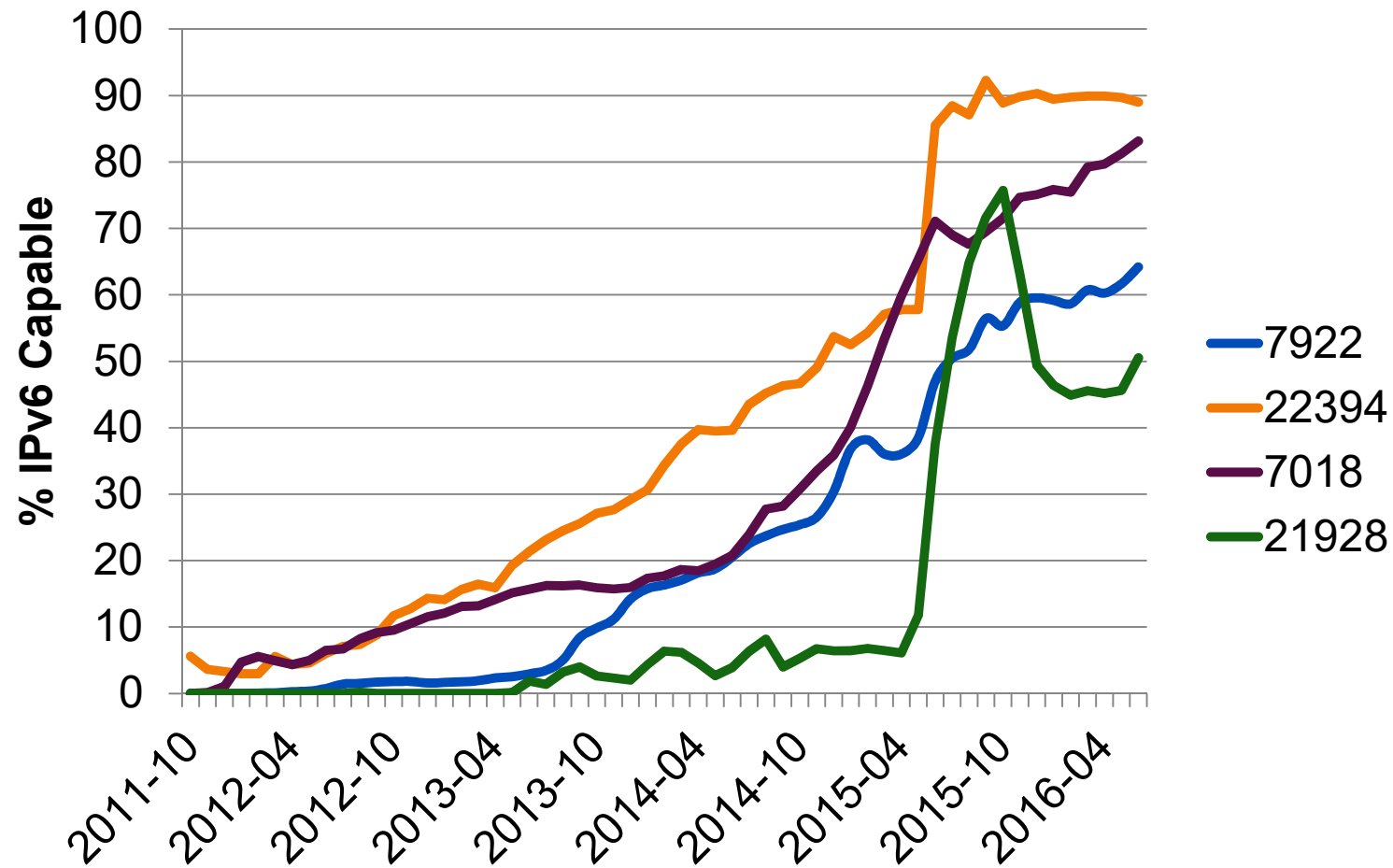
# Top 10 by Samples BR

ASN	AS Name	IPv6 Capable	IPv6 Preferred	# Samples
AS28573	CLARO S.A.	21.70%	20.57%	1137039
AS18881	Global Village Telecom	18.38%	17.49%	733235
AS7738	Telemar Norte Leste S.A.	4.73%	4.79%	479215
AS27699	TELEFNICA BRASIL S.A	2.82%	2.79%	346391
AS8167	Telecom SA - Filial Distrito Federal	3.40%	3.43%	287345
AS26599	TELEFNICA BRASIL S.A	16.10%	15.55%	100746
AS26615	Tim Celular S.A.	10.54%	10.25%	97656
AS53006	ALGAR TELECOM SA	0.08%	0.36%	52185
AS22085	Claro SA	0.69%	0.67%	41421
AS14868	COPEL Telecom S.A.	28.89%	28.05%	31891

# Top 10 by Samples, EC

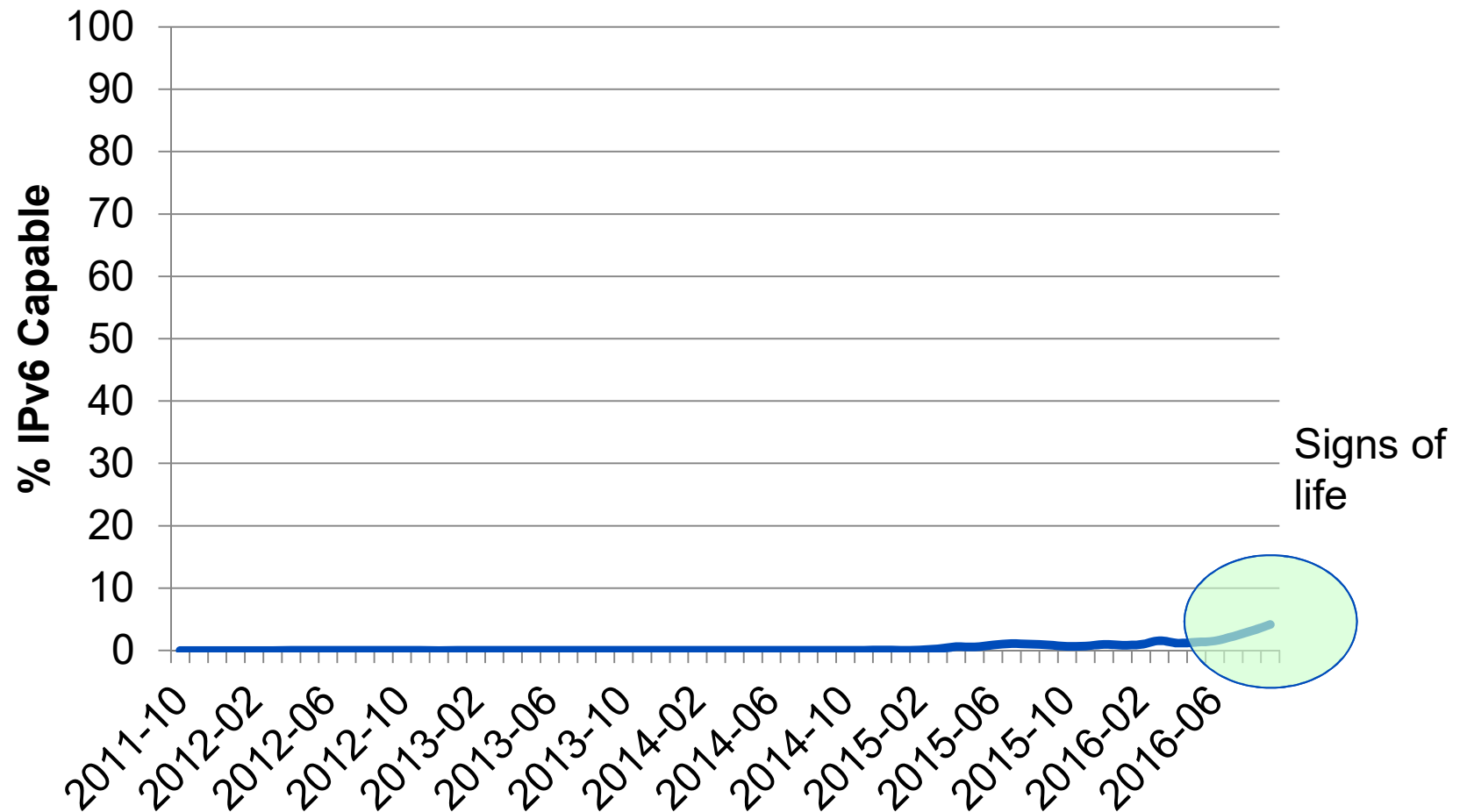
ASN	AS Name	IPv6 Capable	IPv6 Preferred	# Samples
AS14420	TELECOMUNICACIONES - CNT EP	47.23%	45.65%	1030170
AS14522		0.01%	0.34%	290709
AS52257	S.A	0.01%	0.36%	193433
AS27947	S.A	0.04%	0.45%	182426
AS27738	S.A.	0.00%	0.25%	180584
AS23487		0.02%	0.25%	112428
AS19114	S.A.	0.04%	0.15%	108965
AS27668	EP	0.01%	0.39%	99701
AS22724	S.A.	0.01%	0.30%	80768
AS28006	TELECOMUNICACIONES - CNT EP	0.01%	0.54%	25867

# Comcast, AT&T, Verizon, T-Mobile

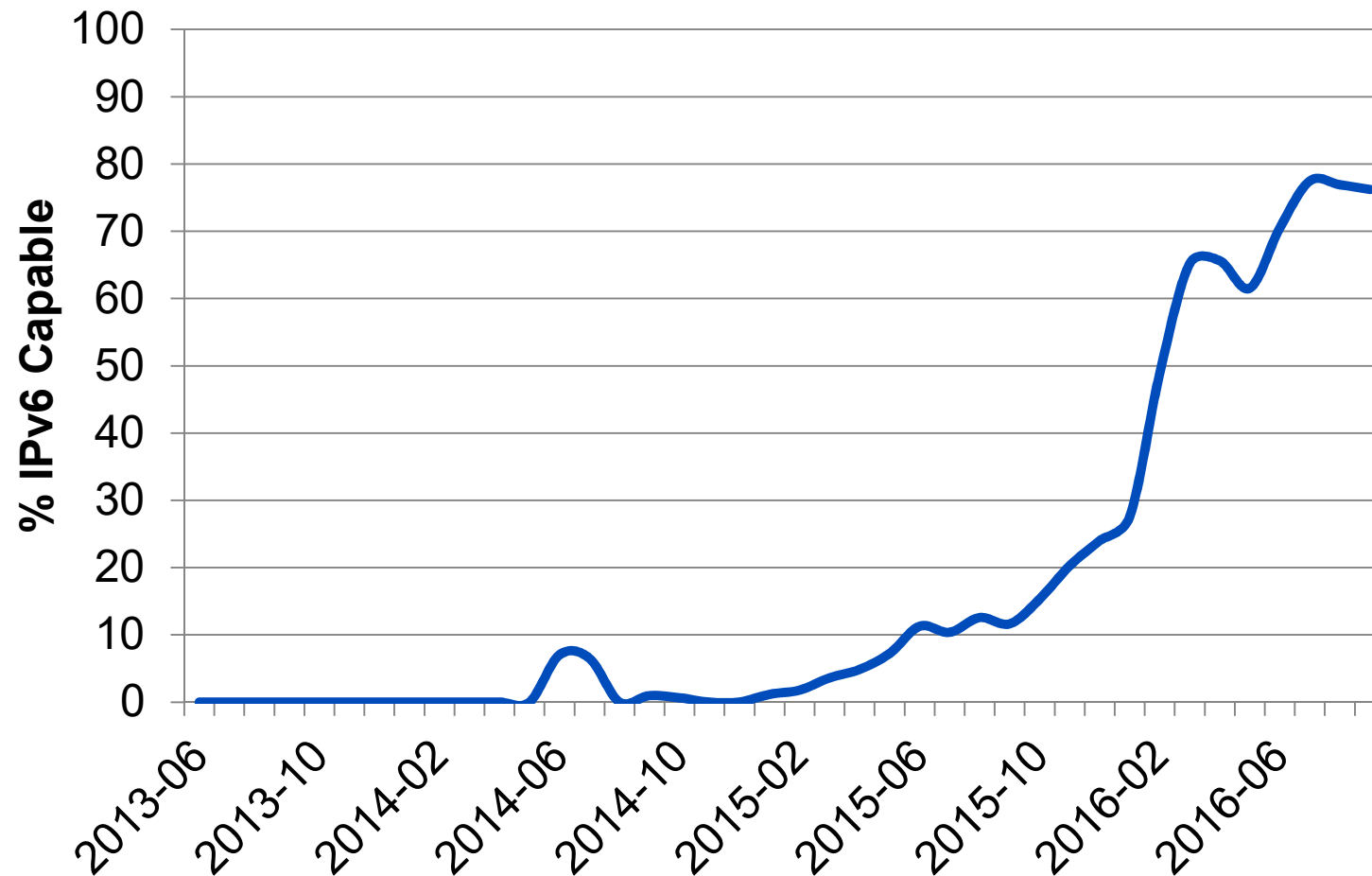




# India is on 4.15%



# It's Reliance/Jio AS55836



# Reliance/Jio

- Just announced Nationwide 4G/LTE
- They're offering free voice nationwide if you take the data plan
- It's a totally dual-stacked deployment.
- They are hungry for business and have capital behind them
- A Single ISP can lift an economy's IPv6 – They're growing.

# What about Hong Kong?

# Top 10 IPv6 Capable

ASN	AS Name	IPv6 Capable	IPv6 Preferred	# Samples
AS55536	PACSWITCH GLOBAL IP NETWORK	92.66%	0.10%	48042
AS4528	The University of Hong Kong	65.09%	58.33%	636
AS57169	EDIS GmbH	50.86%	46.97%	643
AS133929	TWOWIN CO., LIMITED	22.66%	22.69%	3597
AS24334	Cyberport Hong Kong	15.30%	15.30%	281
AS10103	HK Broadband Network Ltd.	9.24%	0.63%	4590
AS45187	Rackspace IT Hosting AS	5.20%	5.02%	2309
AS36351	SoftLayer Technologies Inc.	2.59%	1.95%	6765
AS3661	The Chinese University of Hong Kong	1.60%	1.47%	815
AS9381	Wharf TT Ltd.	1.12%	0.08%	16643

# Top 10 IPv6 Samples

ASN	AS Name	IPv6 Capable	IPv6 Preferred	# Samples
AS9269	Hong Kong Broadband Network Ltd.	0.00%	0.05%	1130340
AS4760	PCCW Limited	0.10%	0.16%	1074426
AS9304	Hutchison Global Communications	0.02%	0.20%	282108
AS38819	HKCSL GPRS NETWORK	0.00%	0.03%	141436
AS9908	HK Cable TV Ltd	0.00%	0.13%	130239
AS17924	SmarTone Mobile Communications Ltd	0.00%	0.03%	104084
AS9231	China Mobile Hong Kong Company Ltd	0.00%	0.02%	92589
AS55536	PACSWITCH GLOBAL IP NETWORK	92.66%	0.10%	48042
AS10118	Hutchison Telephone Company Limited	0.00%	0.05%	43918
AS9444	Hong Kong Telecomms (HKT) Ltd	0.00%	0.01%	29471

# Hong Kong by Numbers



7,352,962	people
5,919,134	users
80%	penetration
730	ASes
274B	GDP

IPv4	412 in BGP
11,686,400	addresses
1.59	per head
93%	visible

IPv6	110 in BGP
1,133,878	M addresses
154,207	per head
13%	visible
2%	capability

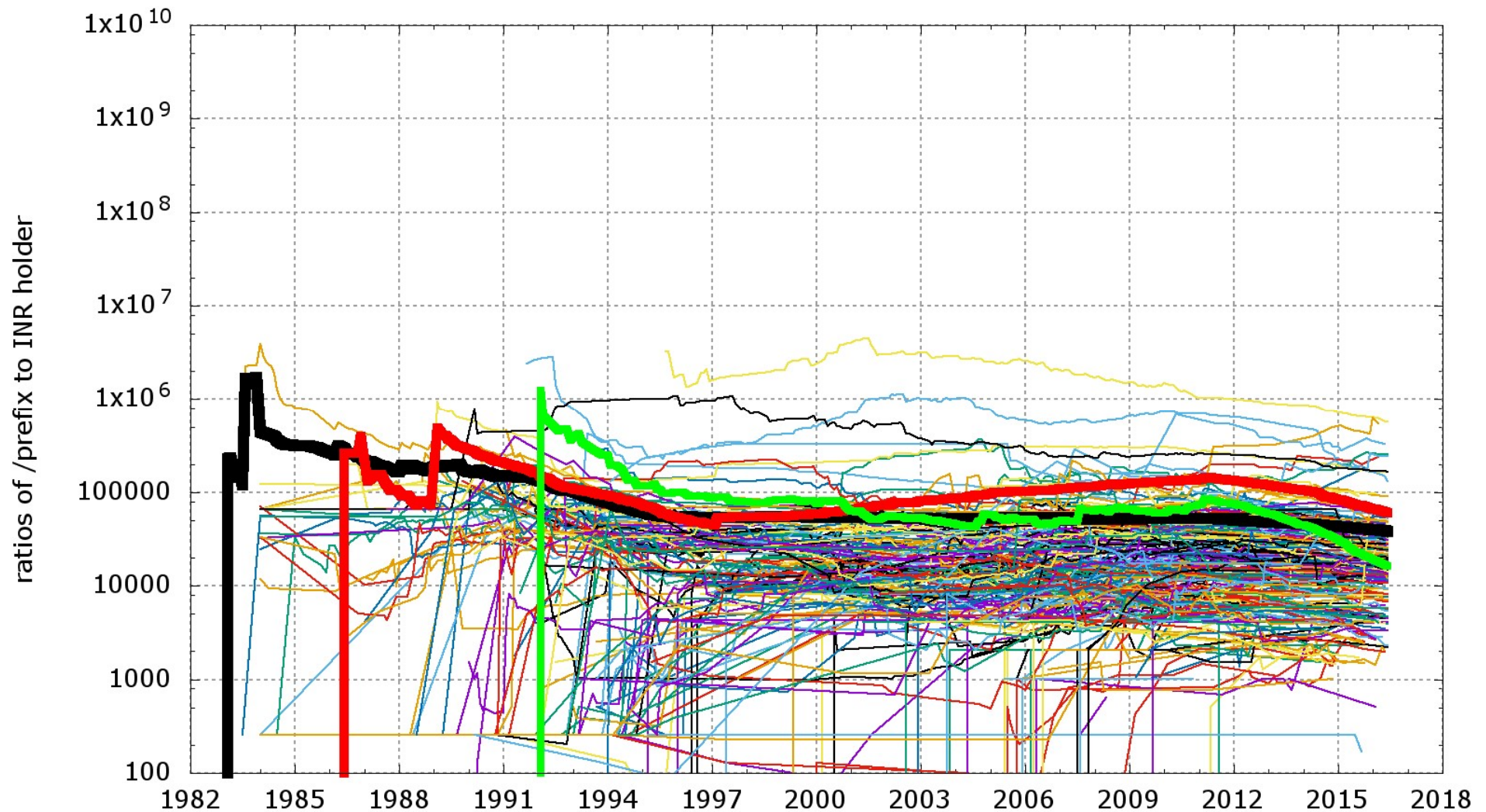
**So: is this an address distribution problem?**



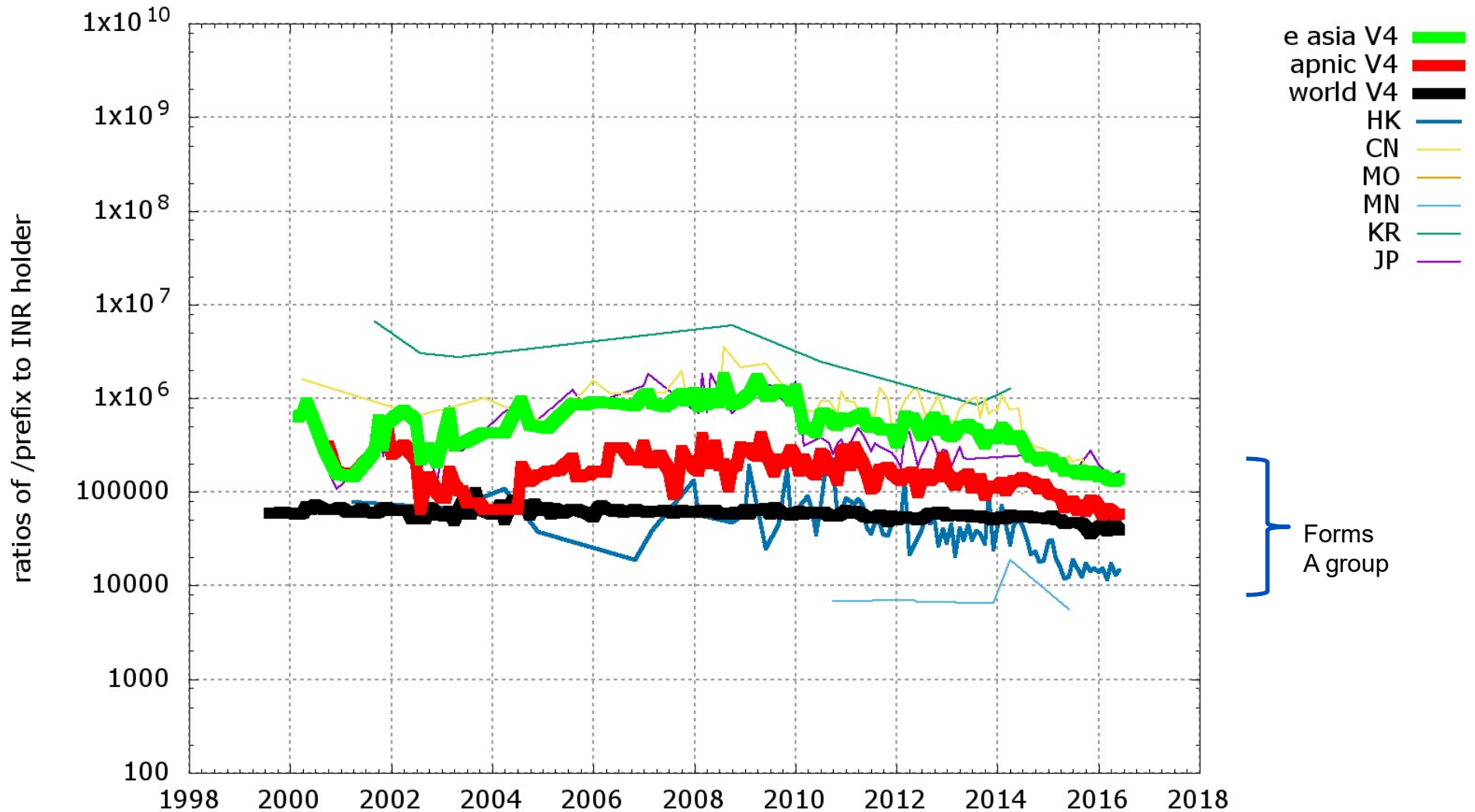
# No! This mostly isn't a distribution problem

- Lets look at some history
  - Growth in distinct INR holders by economy over time
  - Amount of IPv4, IPv6 by INR holder count by economy over time
- What kinds of trend do we see?

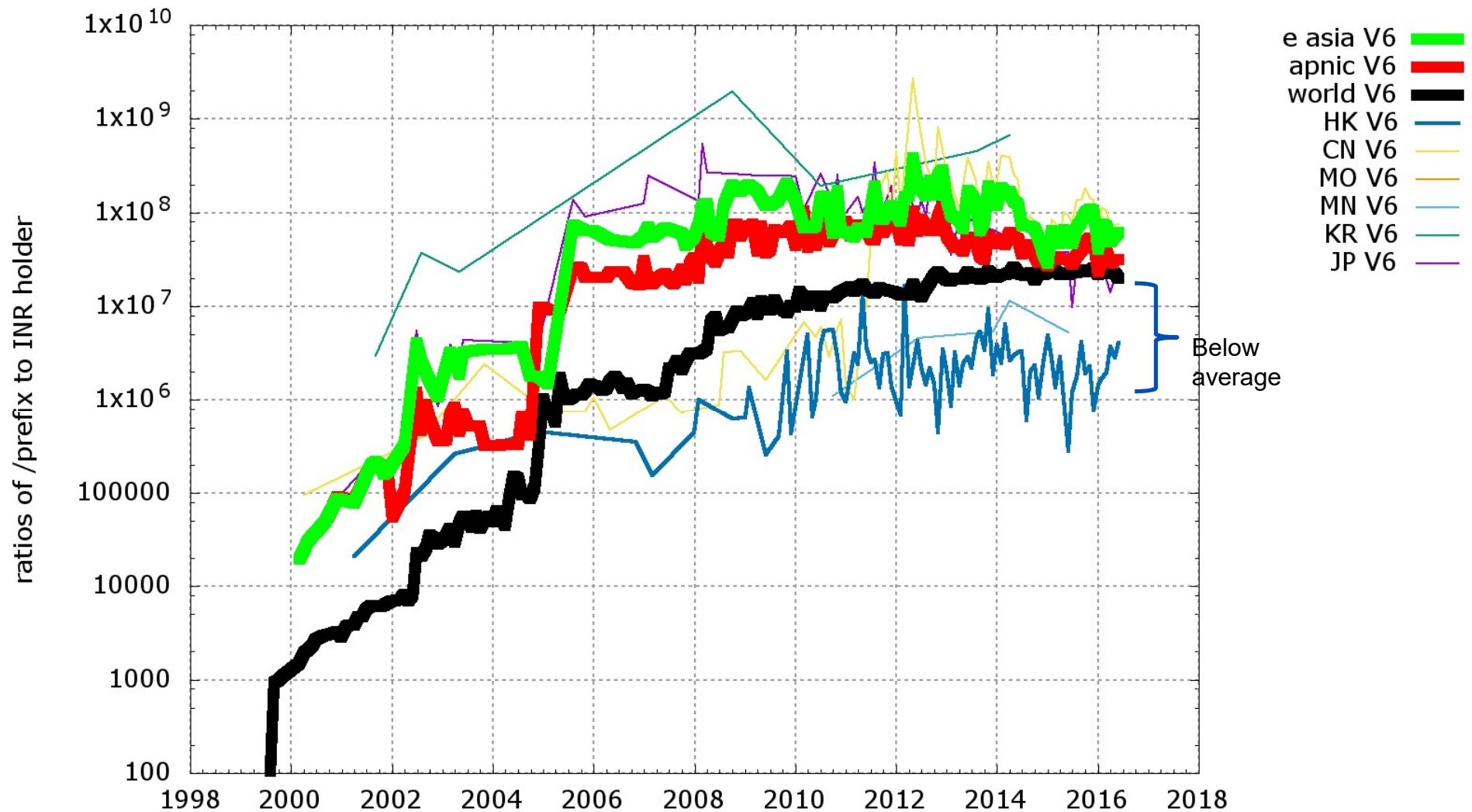
# IPv4 by economy by holder, world



## IPv4 by economy by holder, E Asia



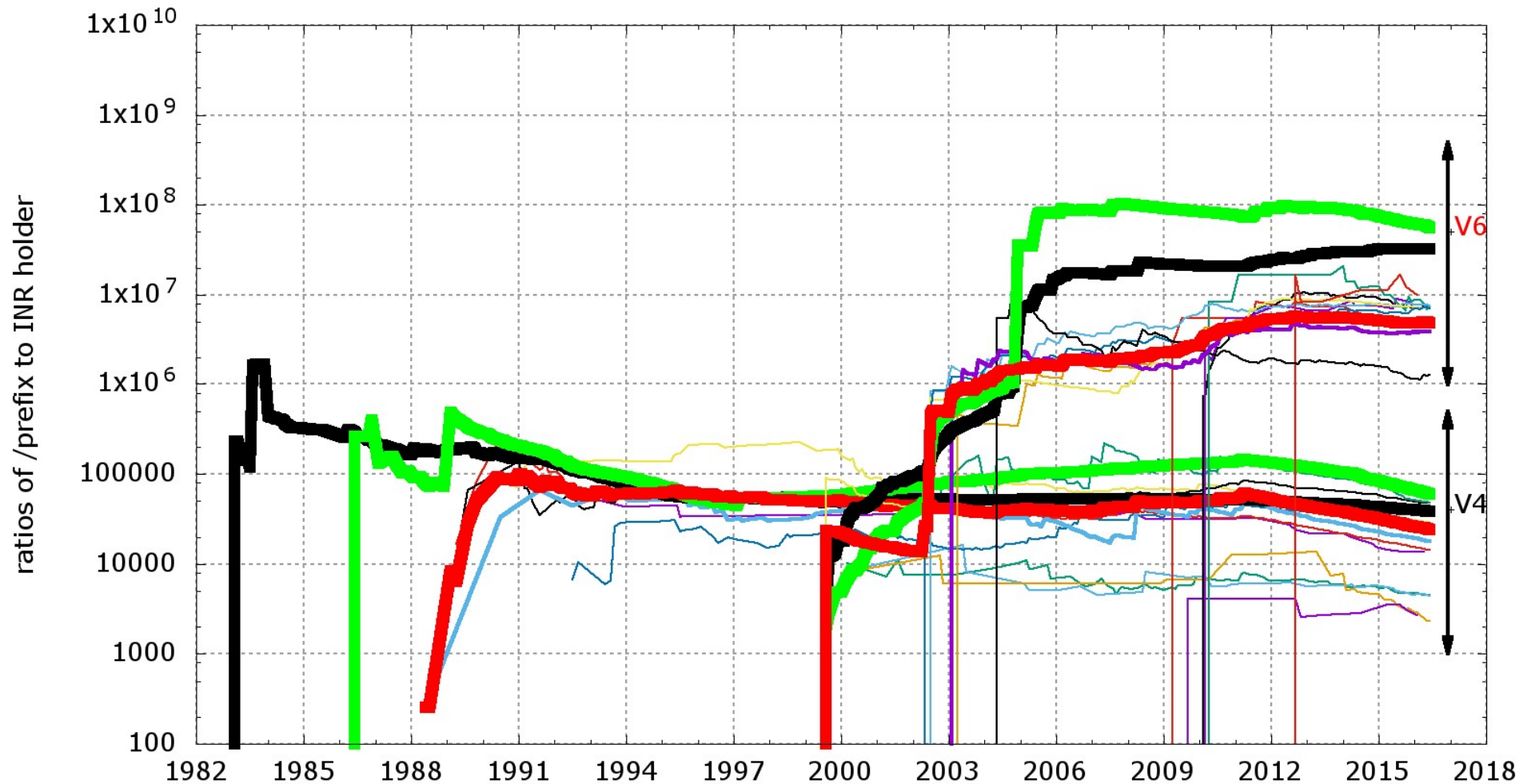
# IPv6 by economy by holder E Asia





# Overall Things are better in IPv6

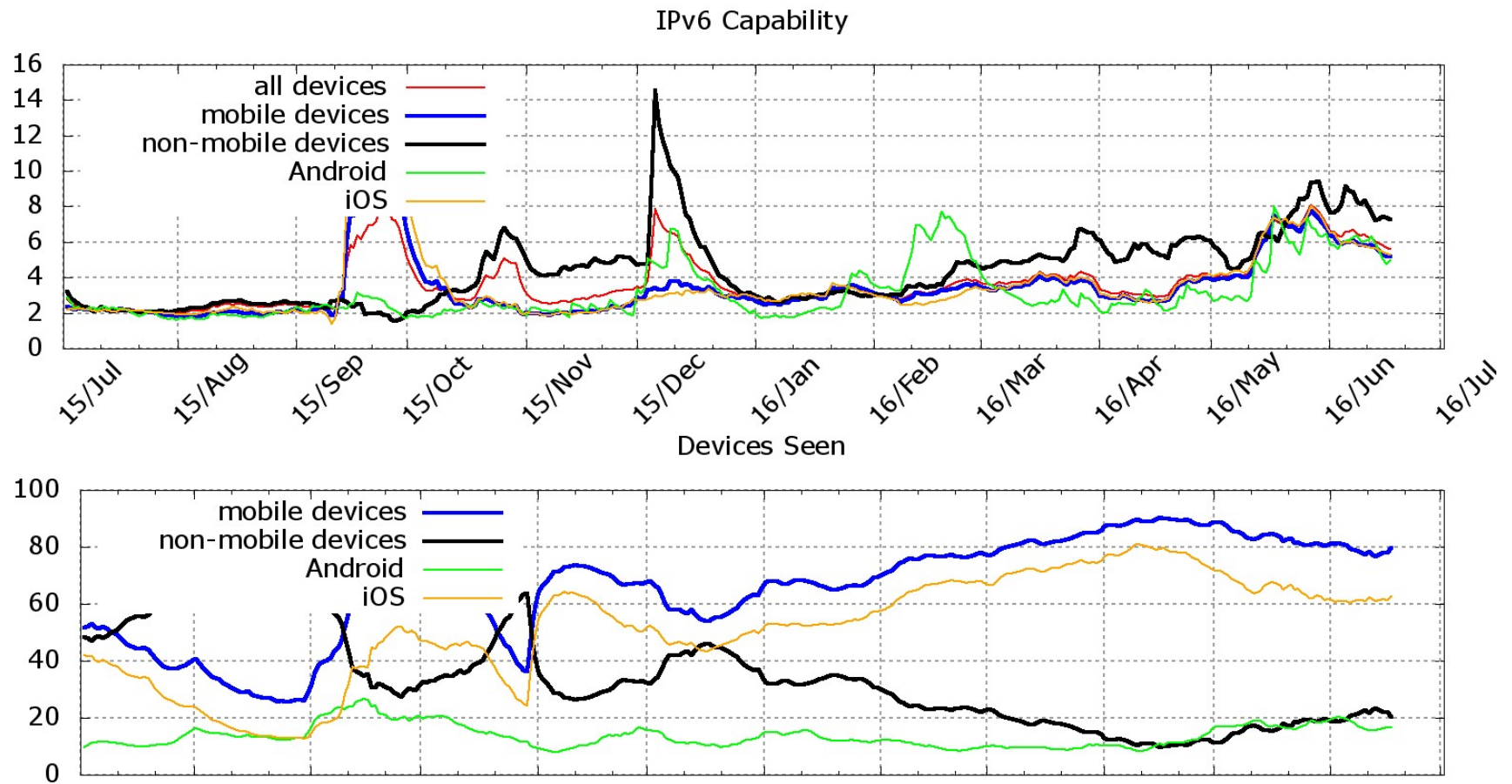
prefix per registrant by economy, APNIC region and Worldwide with means, v4/v6



# What kinds of deployment are working worldwide?

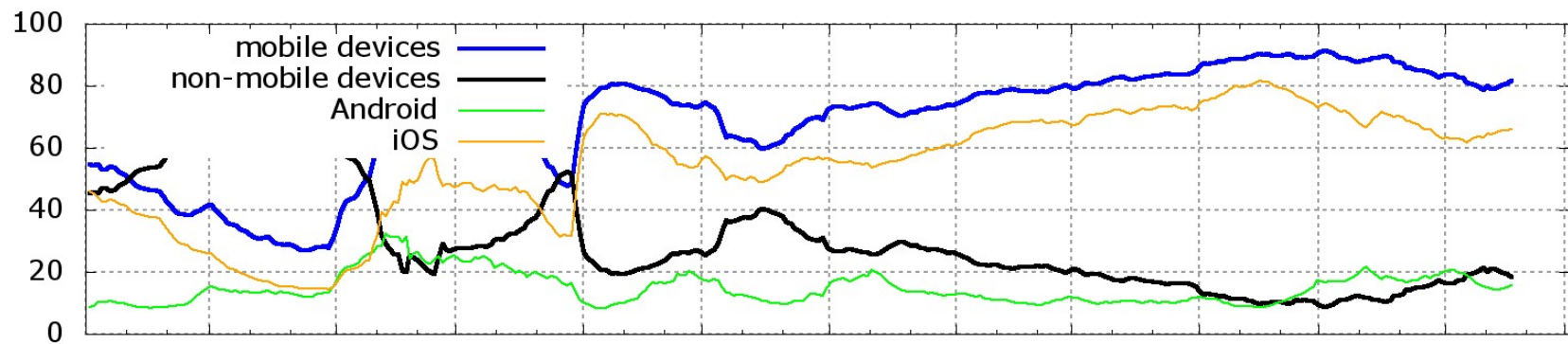
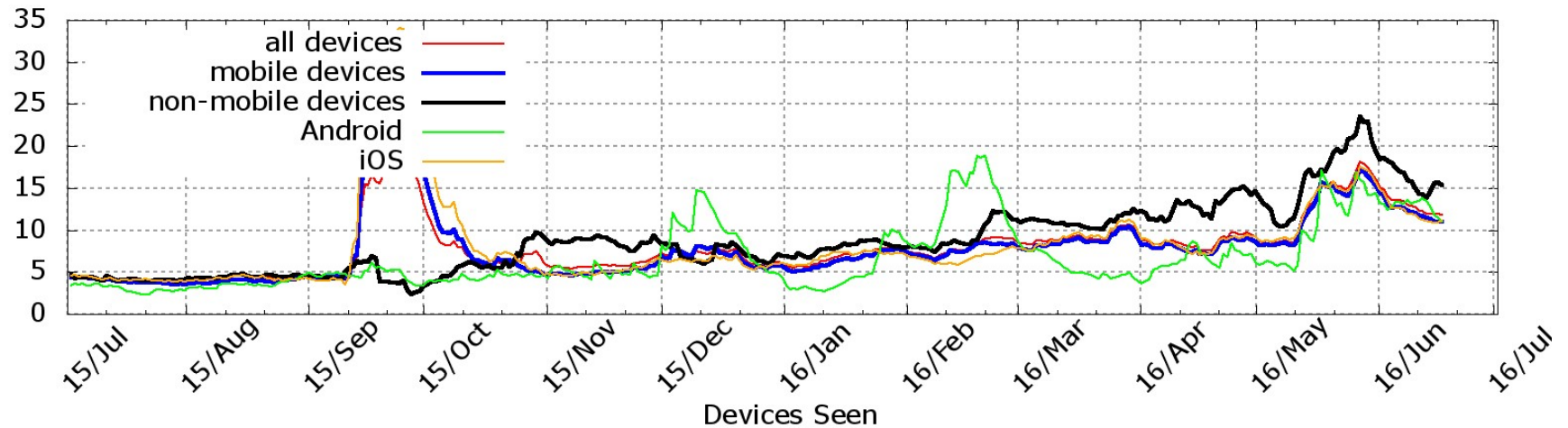
- Drill down into the APNIC data, by ASN and Economy
- Within the ASN or Economy, what kinds of devices are using IPv6?
- Plot the IPv6 capability by device category
  - Mobile vs 'Desktop'
  - Android vs iOS
- Note: we don't control the presentation ratio by device type: this is outside our control
  - So the absolute numbers don't mean very much
  - There is undoubtedly a lot of internet on mobile devices
- Note: mobile device doesn't necessarily mean on cellular carrier
  - But we know many ISPs are cellular ISPs

# IPv6 by Device: AU



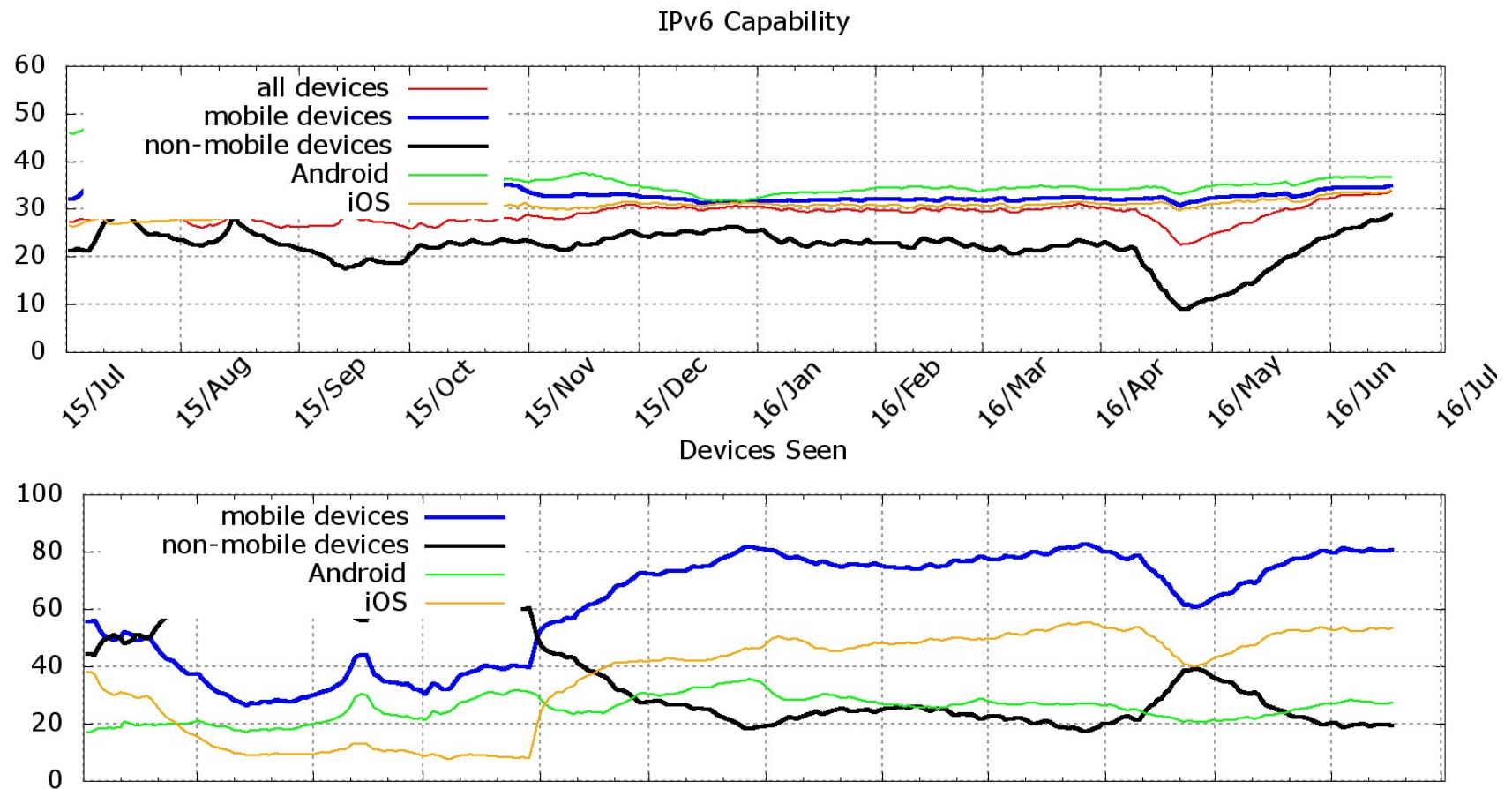
# AS1221

IPv6 Capability ASN-TELSTRA Telstra Pty Ltd,AU



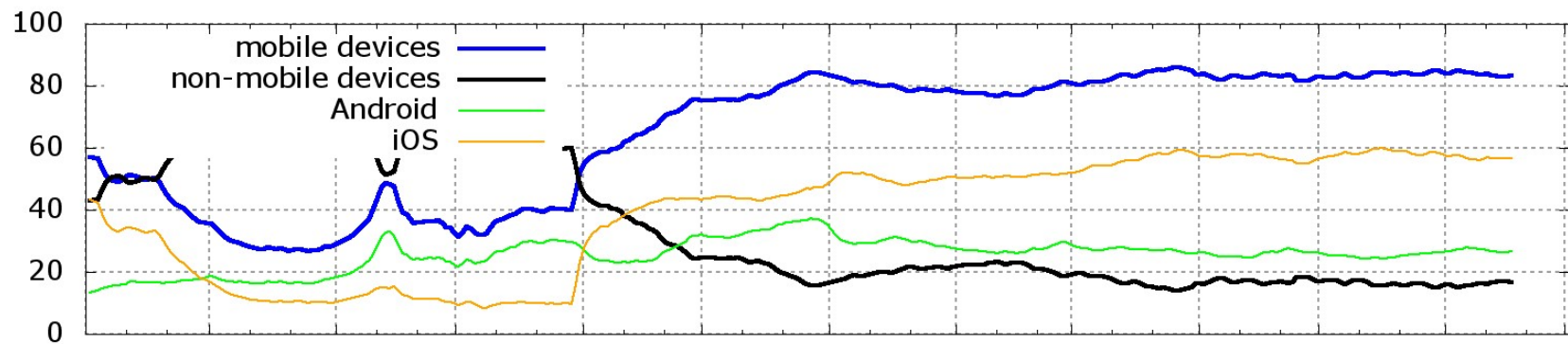
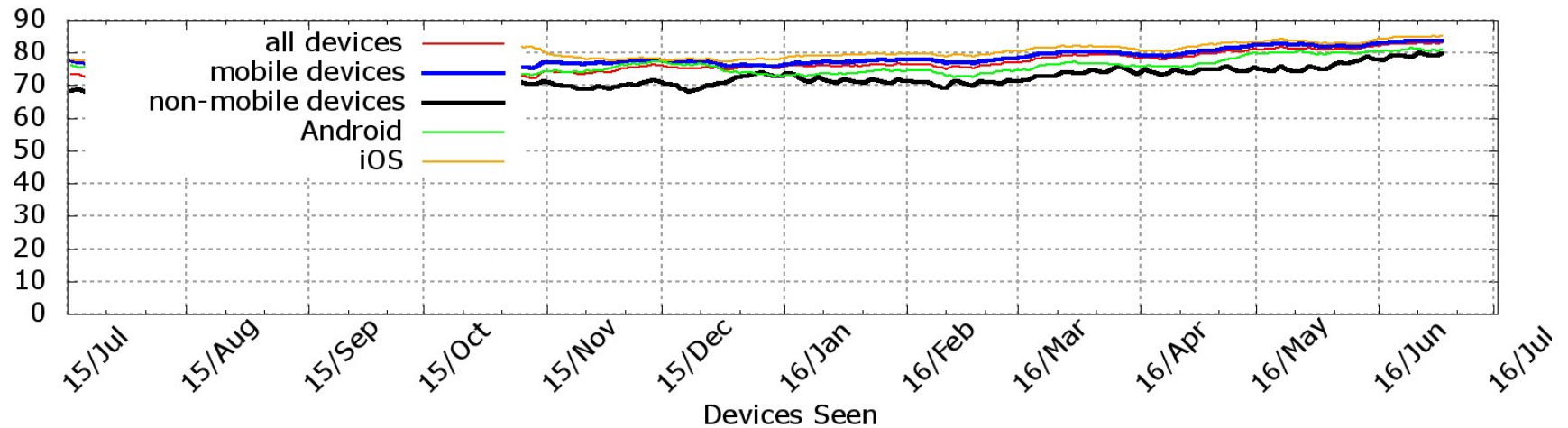


# IPv6 by Device, US



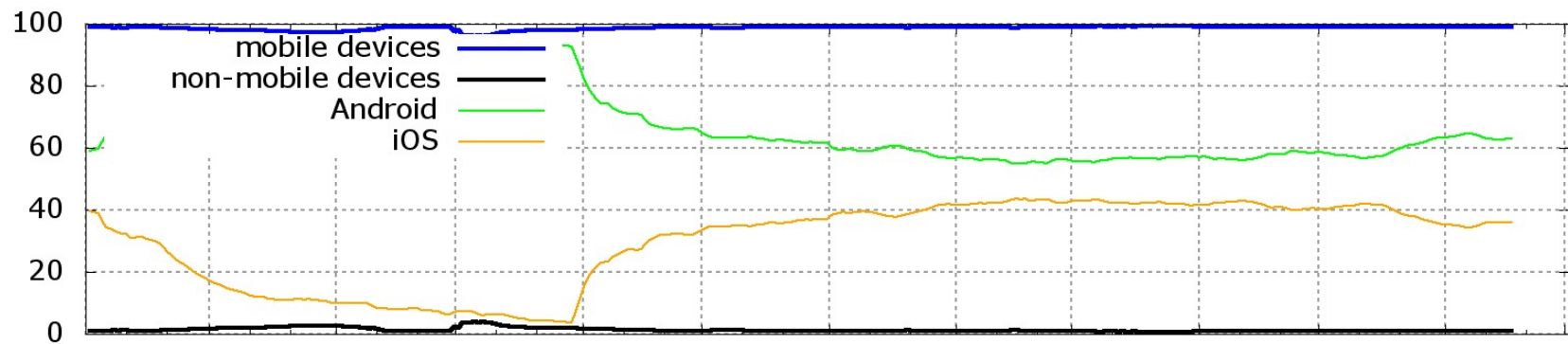
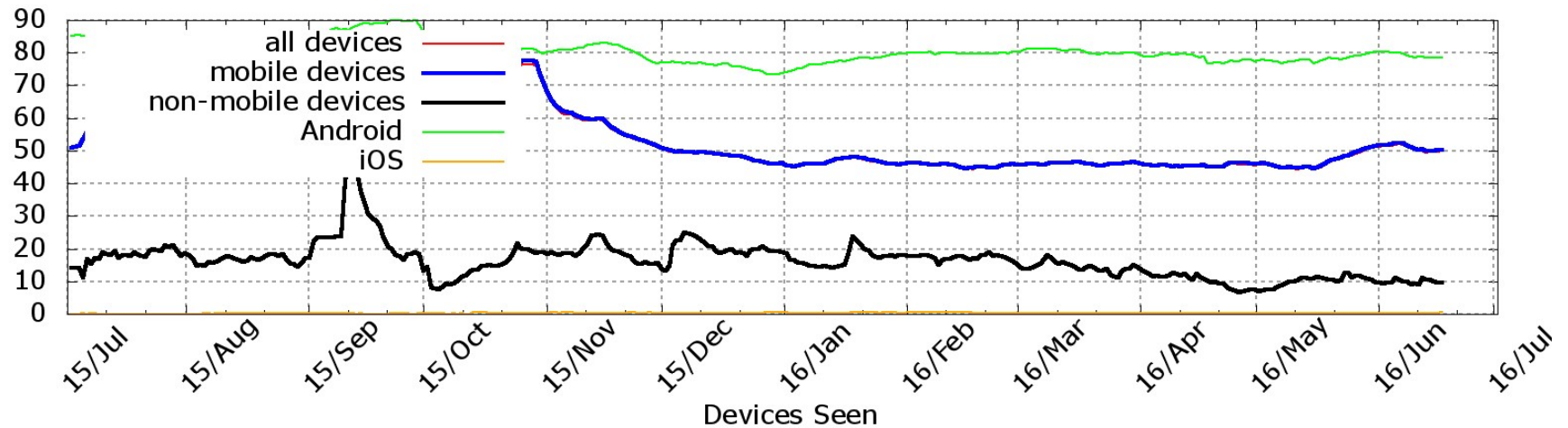
# AS7018

IPv6 Capability ATT-INTERNET4 - ATT Services, Inc.,US



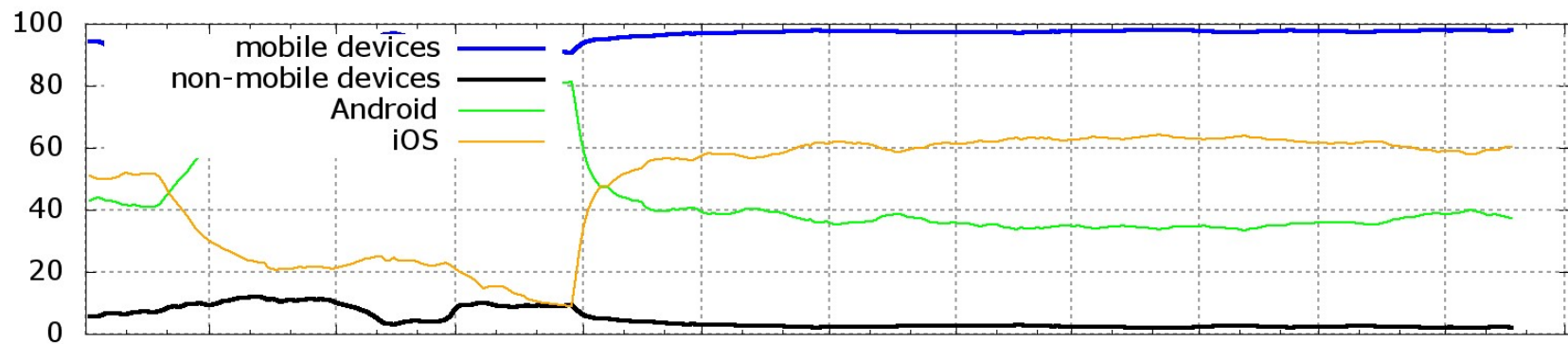
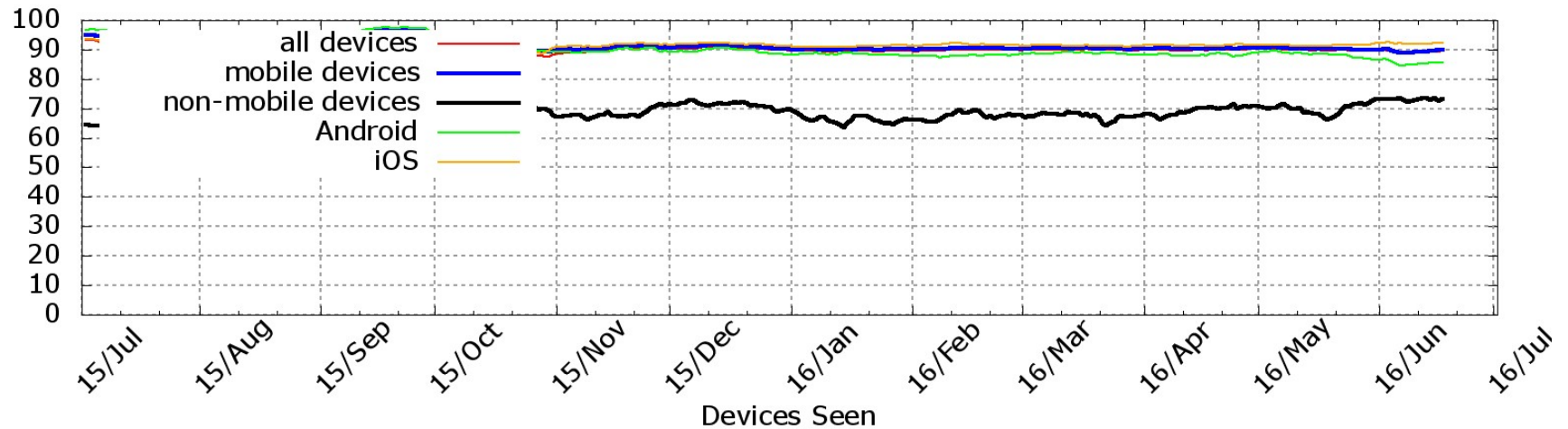
# AS21928

IPv6 Capability T-MOBILE-AS21928 - T-Mobile USA, Inc.,US

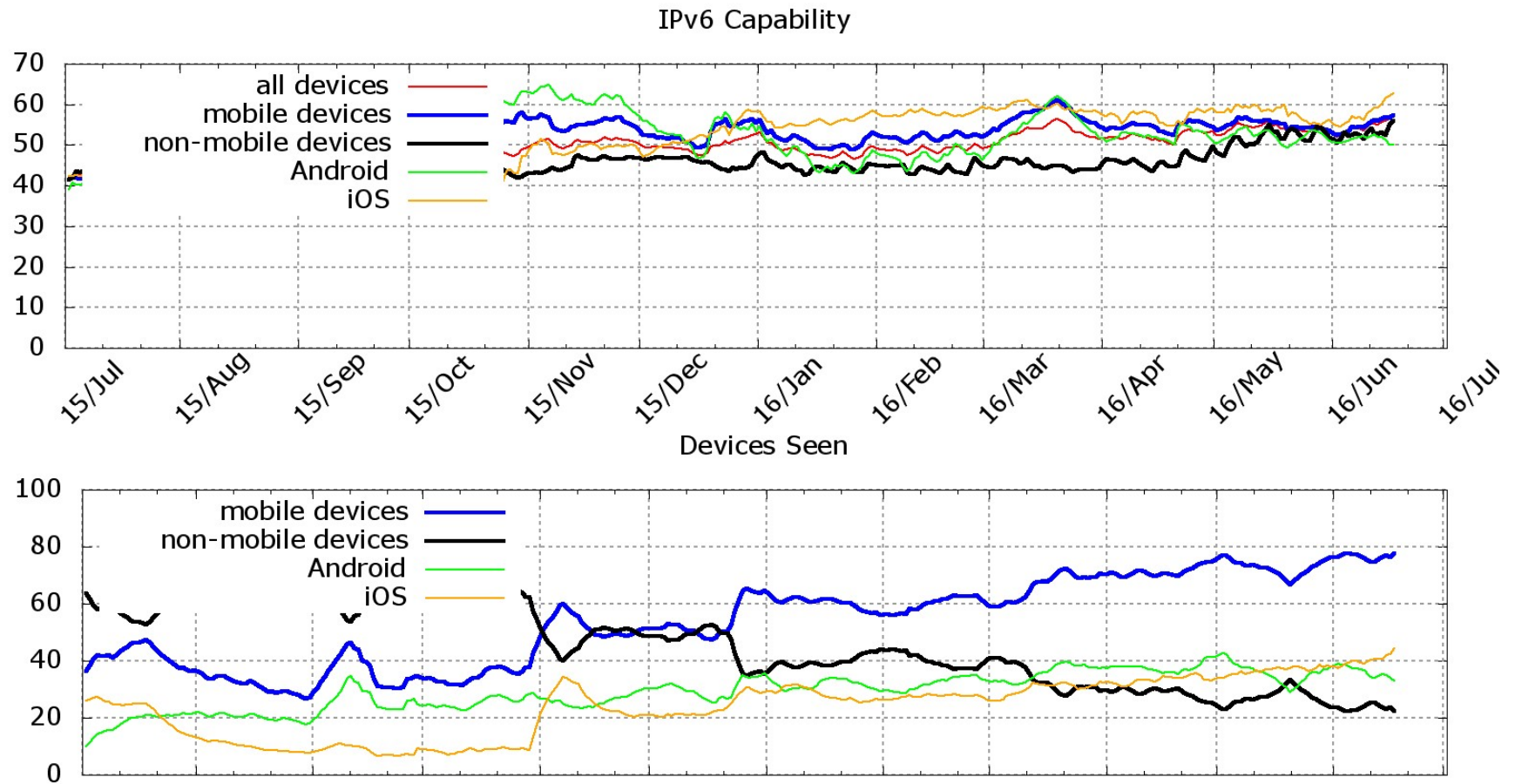


# AS22394

IPv6 Capability CELLCO - Cellco Partnership DBA Verizon Wireless,US



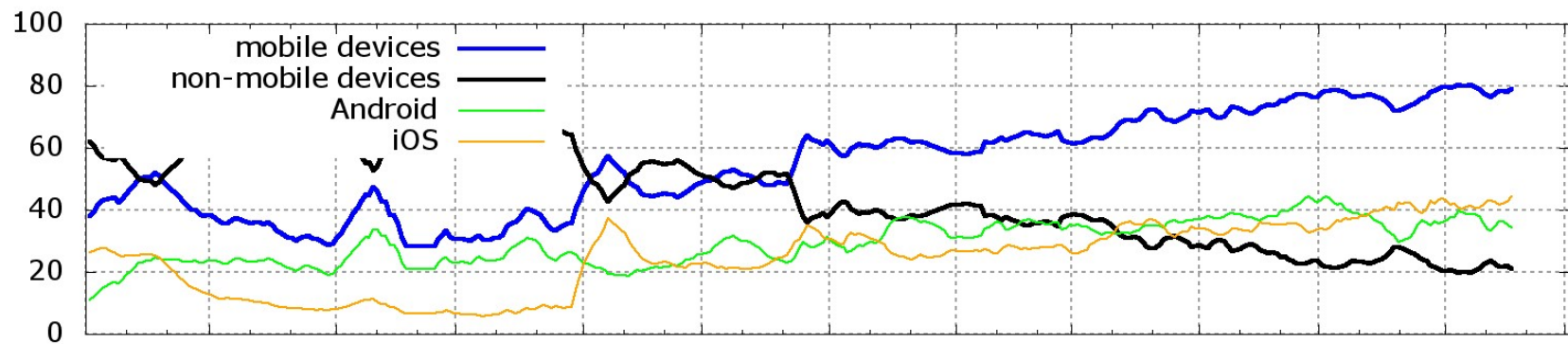
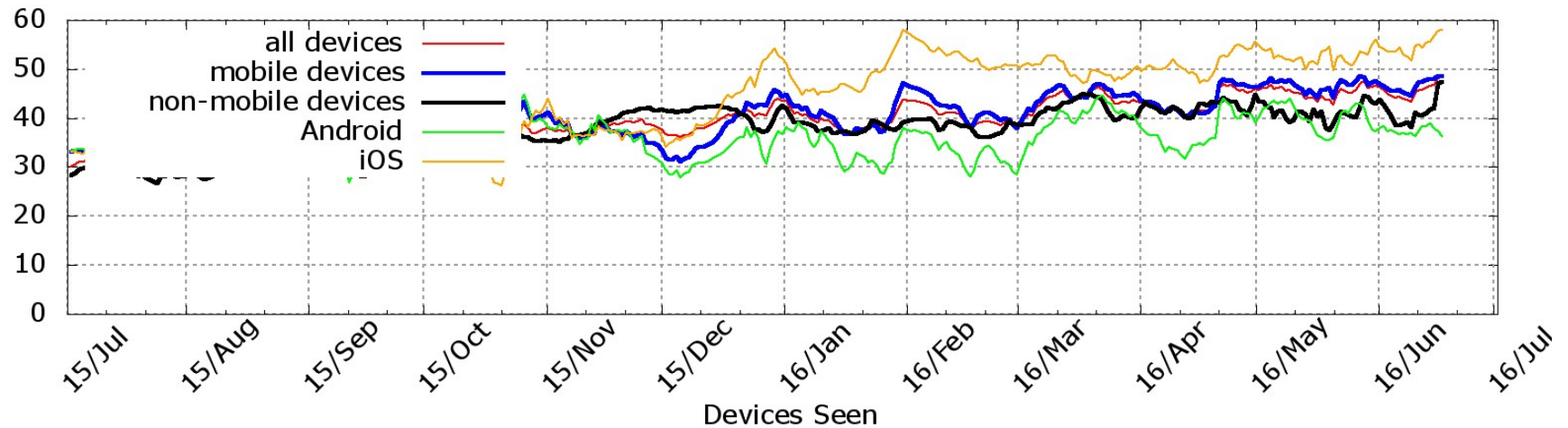
# IPv6 by Device: BE





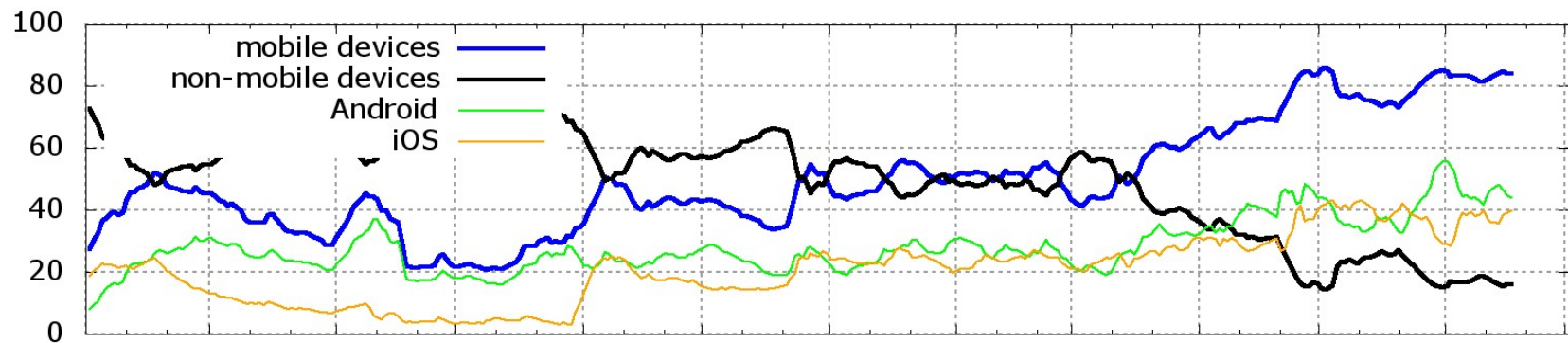
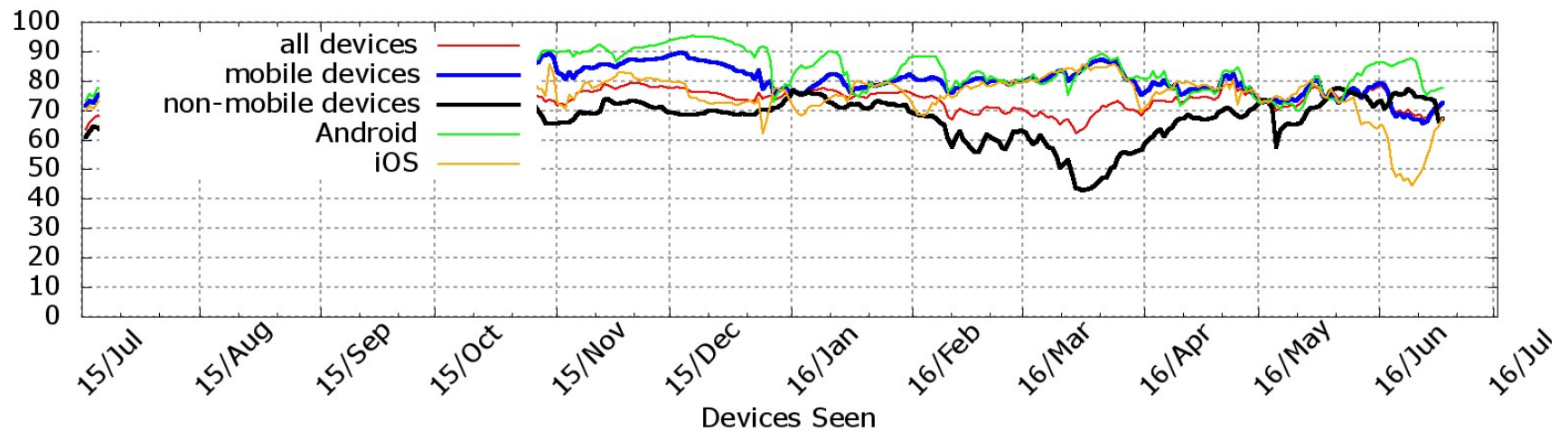
# AS5432

IPv6 Capability BELGACOM-SKYNET-AS Proximus NV,BE

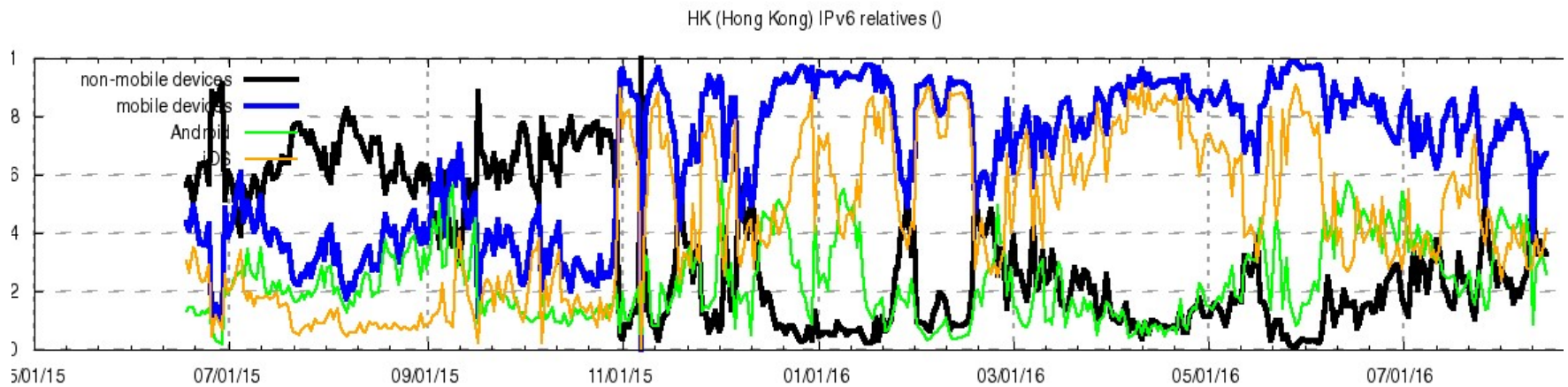
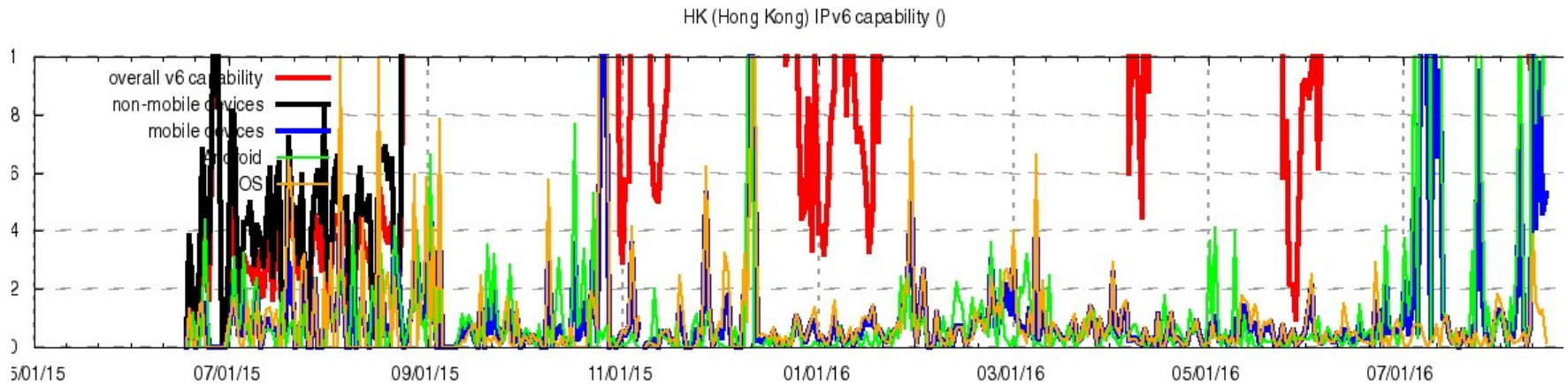


# AS12392

IPv6 Capability ASBRUTELE Brutele SC,BE

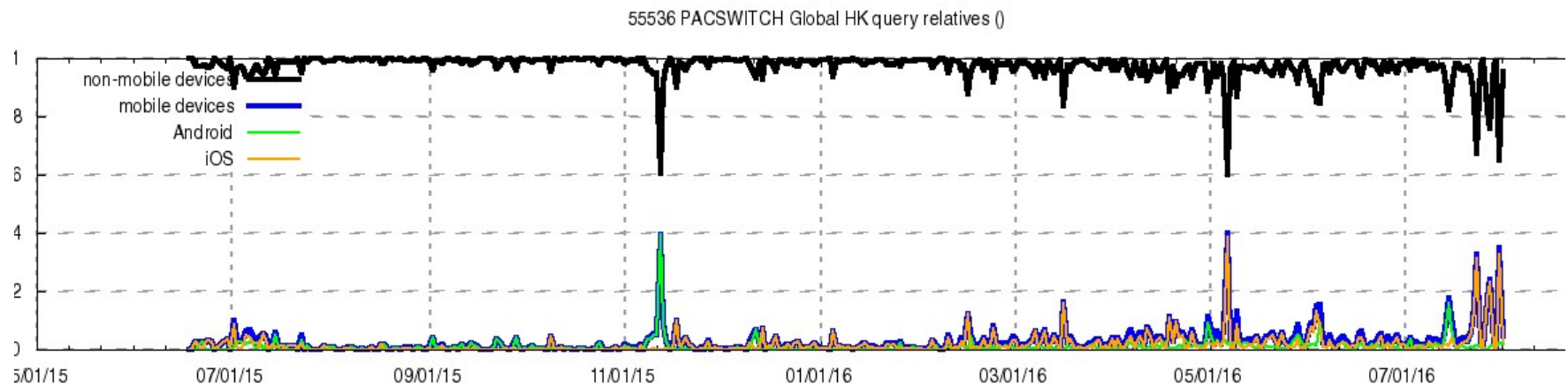
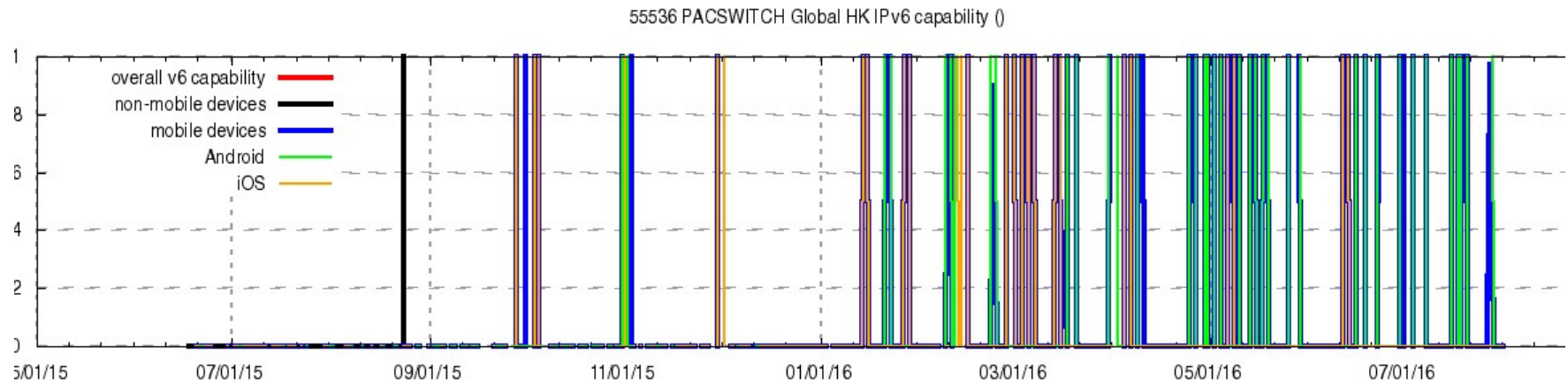


# And you guys





# And you guys



# Observations

- Successful deployments now exist worldwide in commercial, large-scale networks
- Cable networks
  - True dualstack, neutral to device type, high visibility across all devices
    - (Comcast, Sky)
- Cellular networks
  - True dualstack, Native-IPv6+464XLat.
    - (T-Mobile, SK-Telecom)
    - (Restricts service to iOS devices at this time but Apple will move)
- Fiber and ADSL networks
  - (Telstra, Internode, ATT, TMNET)

# Observations

- There is unlikely to be a significant avoidance of cost by delaying IPv6 deployment
  - You have to buy and deploy a CGN anyway
- Momentum is now with ISPs, carriers and content providers who are deploying dual-stack
  - IoT and multi-device owning users like IPv6
  - Facebook likes IPv6
  - Google and LinkedIn like IPv6
  - Apple now requires IPv6 capable apps (since June)

# Observations

- This is not primarily a resource distribution problem
- This is very probably a capital investment problem.
  - And a logistical problem: it takes planning
  - Deployment strategies are out there, in carriers and Isps who you don't compete with directly, there is a lot to learn from deployment models used overseas
- If you don't deploy IPv6, you may risk falling behind in international competitiveness, and become less attractive for significant ICT investment which expects IPv6

# Lets think about Sky for a minute.

**Sky completes roll out of IPv6 becoming the first major UK Internet provider to future-proof its service for customers**

**06 September 2016**

Sky today announces that over 90% of its broadband customers are now IPv6 enabled, future-proofing its network for millions of customers.

Ensuring customers broadband connections are IPv6 ready is an essential development for Sky customers using the Internet. IPv6 will provide an almost limitless supply of IP addresses, so customers can continue to enjoy using the Internet across multiple devices without risk of losing connection.

Whether it's watching their favourite TV shows online, buying concert tickets or online shopping, Sky is committed to providing its customers with a reliable broadband experience, as the Internet transitions to the next-generation addressing standard.

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# Yea. Lets talk about Sky

- Mohamed Hammady, Chief Technical Officer, Sky UK commented: *"Technical leadership is part of Sky's DNA. We were the first carrier in the UK to introduce 100Gb/s fibre optic technology for our core network, and the first European adopter of Cisco's latest carrier grade routers, the NCS6000 series, bringing 8Tb/s technology to our super-core. And now, we're enabling the network to IPv6, future-proofing millions of customers' broadband connections. All these developments help us to support customers' huge demand for viewing TV on multiple devices and demonstrate Sky's commitment to giving customers the best broadband experience."*



# Yea. Lets talk about Sky

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## Juuuust one more thing about Sky

- Sky viewers are going to watch the Hong Kong Rugby Sevens on IPv6.
- What are you guys doing about capital investment in the future?
- Is Technical Leadership in your DNA?

# Questions!

