

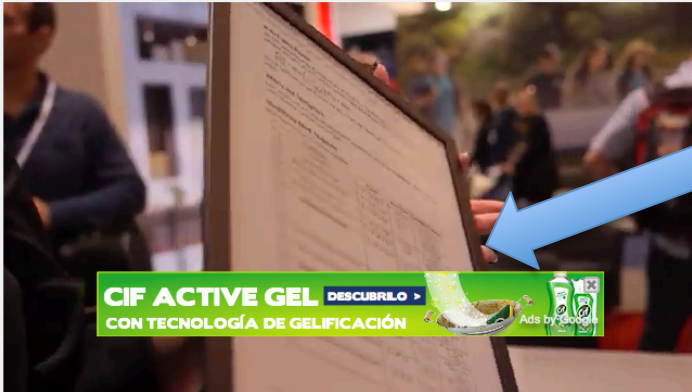
Drilling down into networks from the APNIC data

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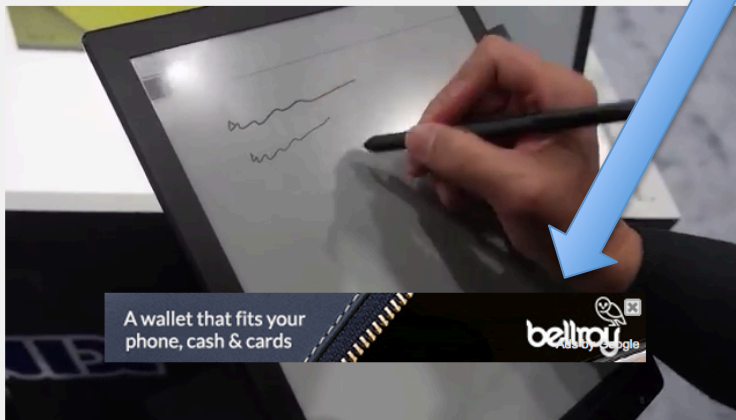
APNIC uses adverts to measure

YouTube



E Ink Booth Tour at CES 2014, Sony DPT-S1,

netronix

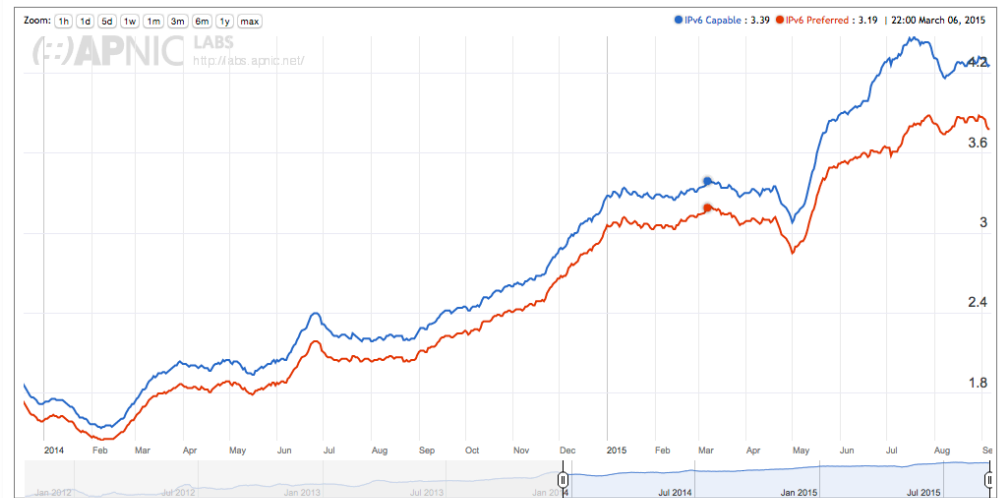


Netronix shows 13.3" flexible E Ink digitizer sub-400gr
i.MX6 Solo Lite Android note taker

The overlay box is running an advert
-It's active code.

We make graphs like this from the data

IPv6 Country Deployment for World (XA)



APNIC measurement system

- Running since 2010
- A collection of specific websites, and advertising channel based collections
- End-User measurement directly in the browser
- “what can people really do”
- Currently 12-15 million samples per day
 - 8m usable outcomes
- Adjusted by ITU user statistics to account for placement biases

APNIC used flash to measure

- Flash had many issues
 - Its not installed by default on many OS, Browsers
 - Users disable it
- Increasingly its being abused
 - Long list of exploits
 - Spam and other bad behaviours
 - Intrusive advertising 'capturing' the screen

End of flash: news at 11

- After many years, google has responded to community complaint and closed off 'default run' for 3rd party flash content on web pages
 - As of September 1, flash does not run by default unless identified as critical for the web page
 - Third party flash (adverts) in particular affected

End of flash: news at 11

- As a result, our random harvest of end user capability from flash has ended.
- We had a plan...

Start of HTML5

- The advertising ecology has moved from flash to HTML5 (javascript) with tighter controls on what can be done inside the advert
- We developed javascript for measurement some time ago, and had code ready to run
 - (if you want to add javascript based measurements to your website, we can talk)

Start of HTML5

- We got approval from google to continue our measurements inside an HTML5 model
- This has been running in parallel with Flash based collection since June
- We have now cut over to exclusively measuring end-user behaviours using HTML5
 - There is some discontinuity in the data but we believe the fundamental measurement is consistent: We see what end users see

Flash had its limits

- It turns out, the vast majority of our flash measurement ran on Windows platforms
 - Flash on OSX, in firefox required hand installation
 - Some Android systems came with flash installed
 - Most didn't
 - Few iOS devices had flash

Flash had its limits

- Because Windows doesn't run much on cellular networks (except through 'mifi' devices and windows phones which have very small market share)
- We had little insight into Mobile device networks
 - We saw 'mifi' views of 3 & 4G, and WiFi, but not much of the true cellular network.

HTML5 offers new opportunities

- We now see a much more ‘interesting’ mix of operating systems and browsers
 - We see Android and iOS devices
- We now have insights into the behaviours of these devices on cellular networks as well as WiFi

Eyeball share

- APNIC's advert is placed on random devices
 - Google has a consistent record of a near-linear rate of presentation onto new IP addresses
 - There is no obvious bias to any specific provider
 - There are clear biases to economies which accept cheap adverts, which we adjust for using the ITU model of world population and registered subscribers

Eyeball share

- What we see is therefore a first approximation reflection of relative share of those eyeballs
 - Its not 'market share' but it is eyeball, browser based share.
 - In some economies (KR) it doesn't look a good fit
- We also see into corporate, transit and other networks
 - Some of these have quite large 'footprints' of users (Facebook, Opera, Google)

Some significant recent deployments

- If we look into some recent big deployments can we see how the different end-user devices are affected by the IPv6 technology?

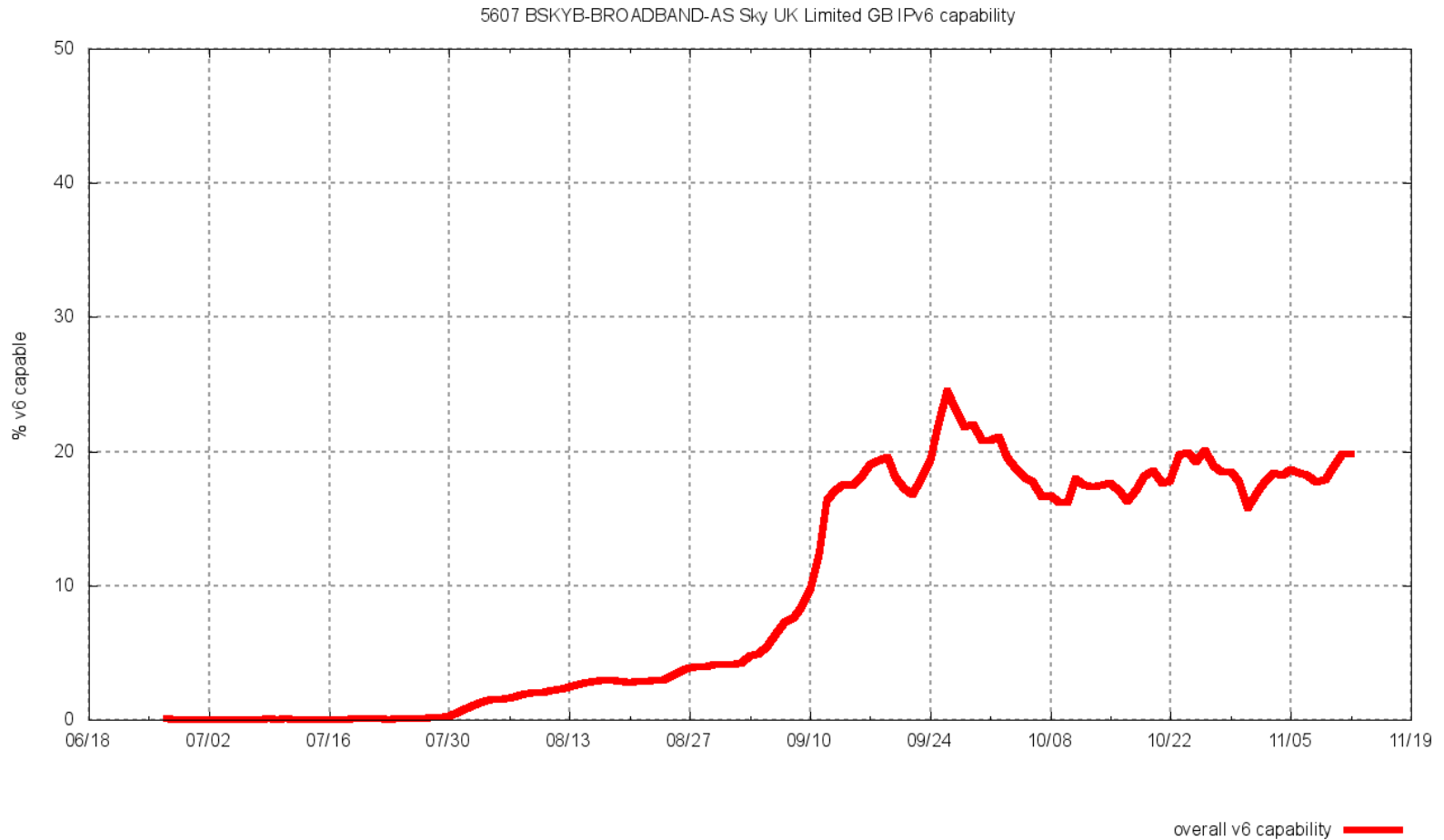
Some significant recent deployments

- Sky UK
- Cable provider, nationwide
 - No cellular, but lots of home WiFi
 - Upgrading 80,000 customers per night to IPv6
- Top-3 provider of broadband in the UK from their own data
 - Currently the top ranked end-user provider in the UK from our eyeball data
 - <http://stats.labs.apnic.net/v6pop?c=GB&d=2>

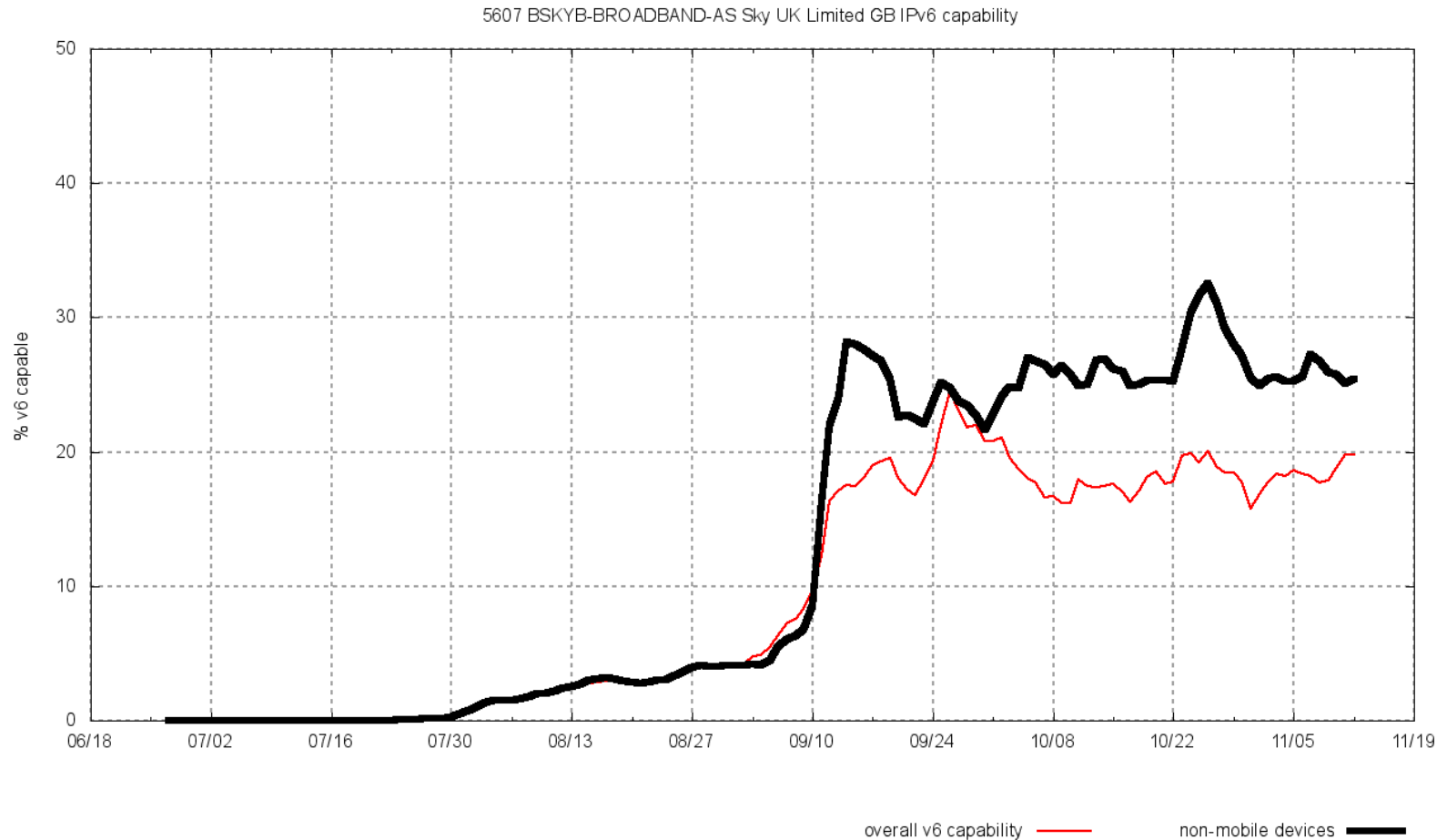
ASN ranked by eyeball share

ASN	AS Name	IPv6 Capable	IPv6 Preferred	Eyeball share
AS5607	BSKYB-BROADBAND-AS Sky UK Limited	16.76%	16.07%	20.35%
AS5089	NTL Virgin Media Limited	0.02%	0.01%	19.00%
AS2856	BT-UK-AS BT Public Internet Service	0.01%	0.01%	17.54%
AS13285	OPALTELECOM-AS TalkTalk Communications Limited	0.01%	0.01%	6.41%
AS12576	ORANGE-PCS EE Limited	0.01%	0.01%	4.05%
AS9105	TISCALI-UK Tiscali UK Limited	0.00%	0.00%	2.59%
AS60339	H3GUK Hutchison 3G UK Limited	0.01%	0.00%	2.36%
AS6871	PLUSNET PlusNet plc.	0.15%	0.13%	2.14%
AS43234	TT-AOLUK-AS TalkTalk Communications Limited	0.01%	0.01%	1.73%
AS21321	ARETI-AS Areti Internet Ltd.	48.51%	48.44%	1.65%

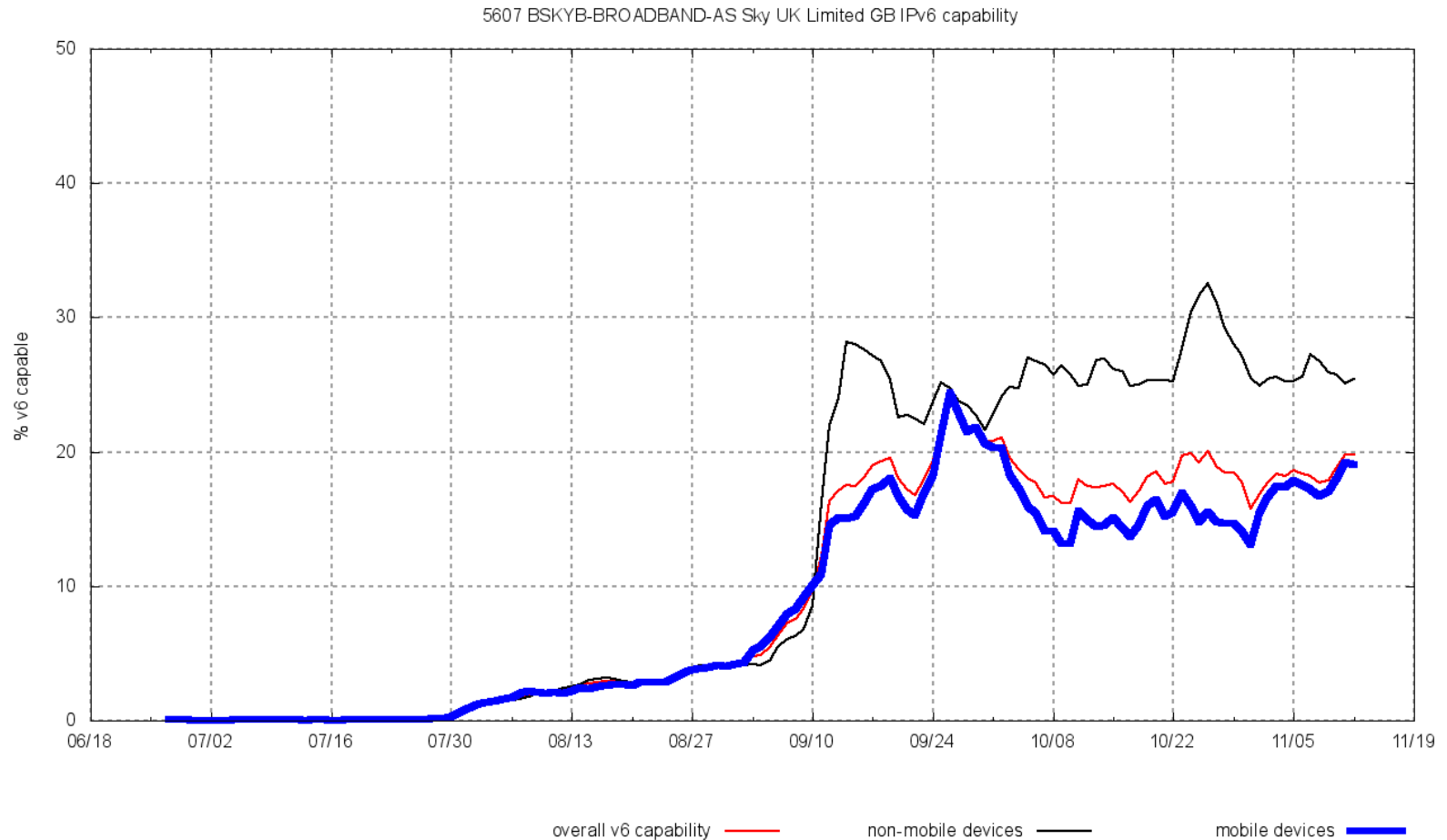
Sky Broadband Overall IPv6



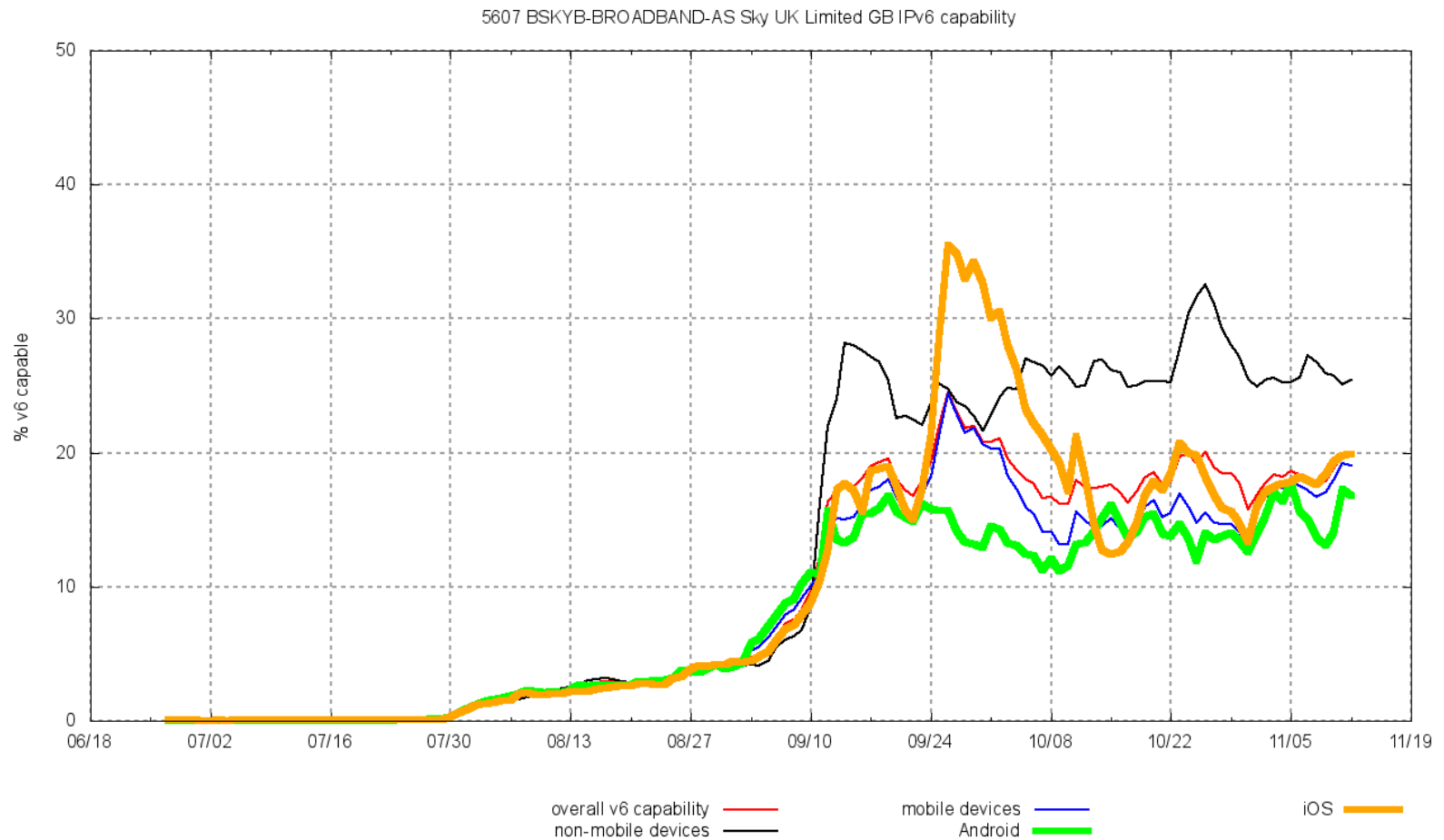
Sky Broadband non-mobile IPv6



Sky Broadband Mobile device IPv6



Sky Broadband iOS/Android IPv6



Cable doesn't disadvantage

- No strong bias to any device type (desktop, mobile) or OS (Windows, OSX, Android, iOS)
 - All wifi connected devices behind v4 only base stations show lower effective IPv6 capability
- Sky is a dual-stack deployment in mix of PPP, IPoE, centrally managed cable modem plan
- The UK is likely to get to 20%+ IPv6 capability by 2016 at this rate of deployment (it has slowed but they continue to convert customers)
- What will competitor providers do?

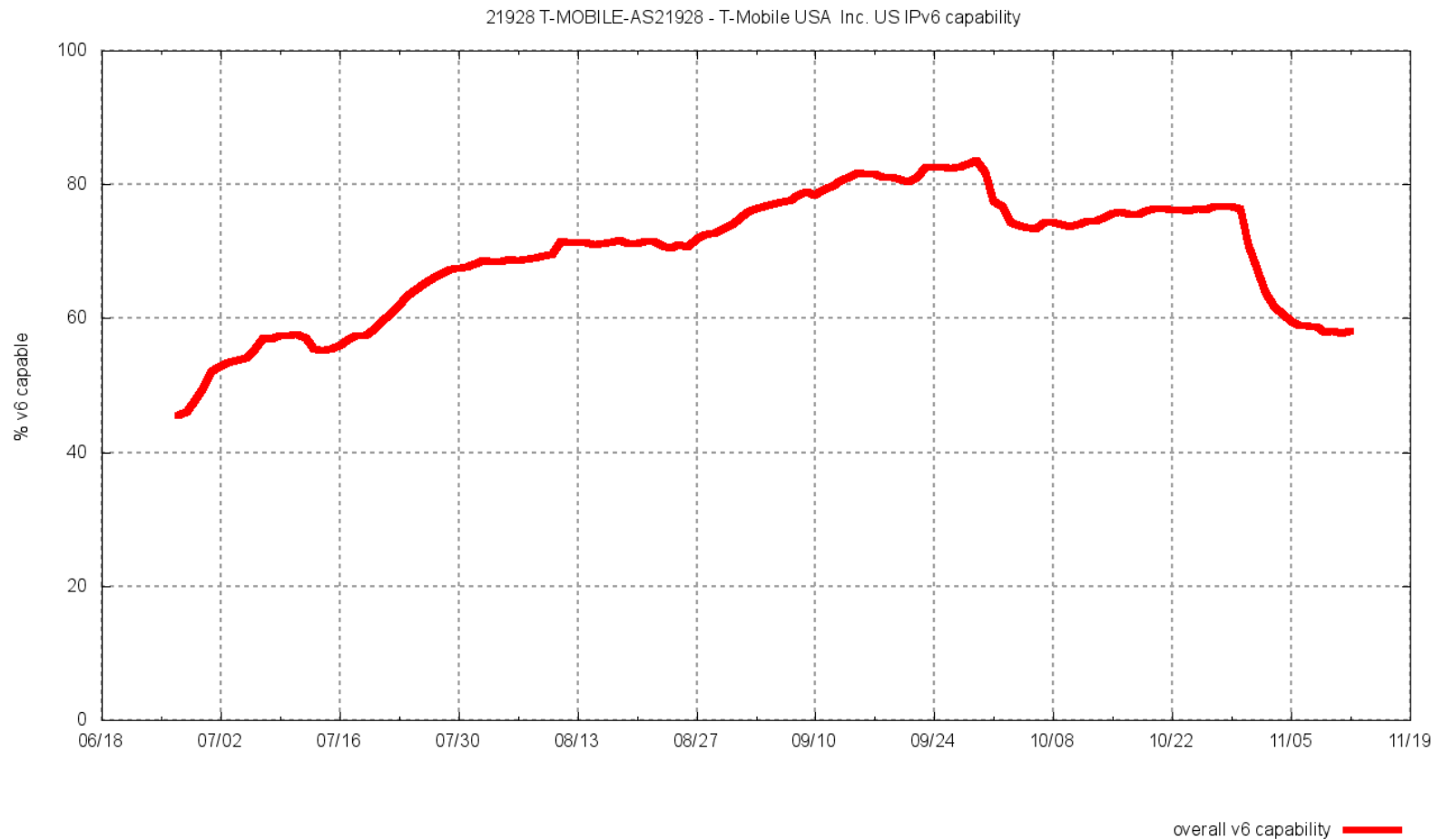
iOS and 464xlat

- Apple made a decision NOT to implement 464xlat mechanisms
 - iOS devices on a v6 cellular network do not support 464xlat.
- Therefore where there is significant iOS deployment, 464xlat excludes iOS
- Can we see this?

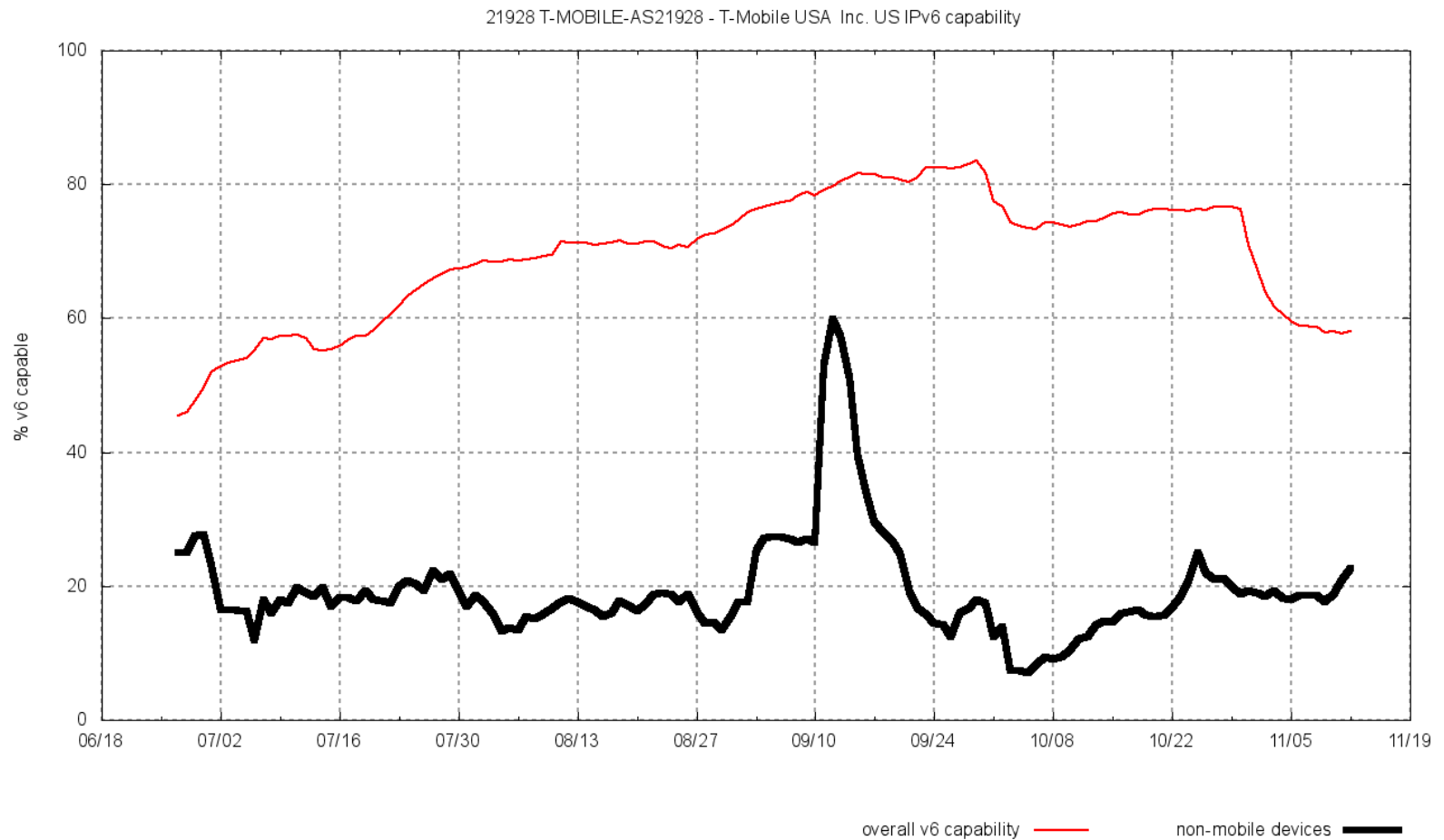
T-Mobile

- We know T-Mobile USA deployed 464xlat
 - Pure IPv6 with translation for IPv4
- It's predominantly a Cellular provider with some WiFi services
- It should have a strong signal of IPv6 capability
 - With no significant iOS usage

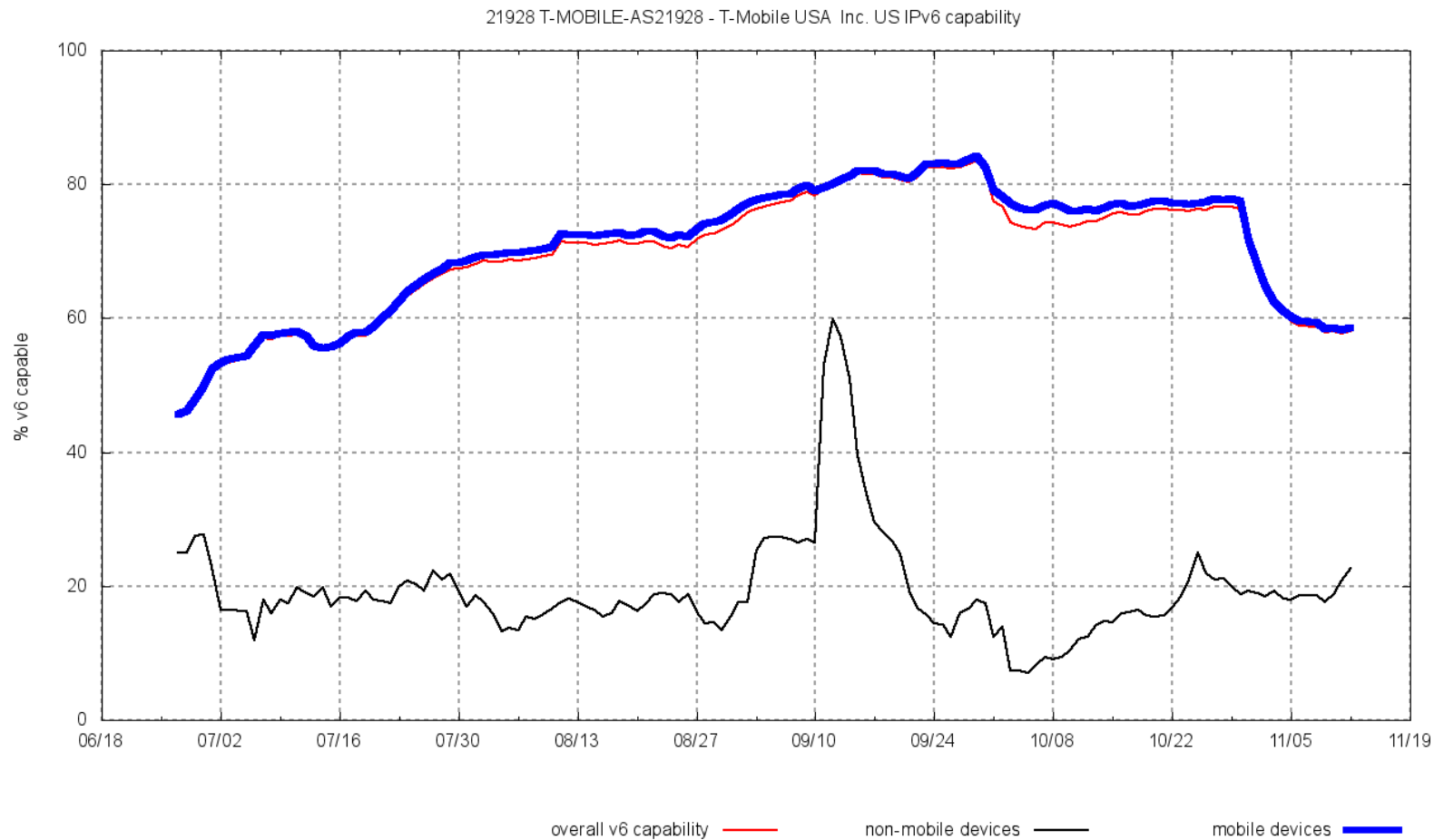
T-Mobile



T-Mobile

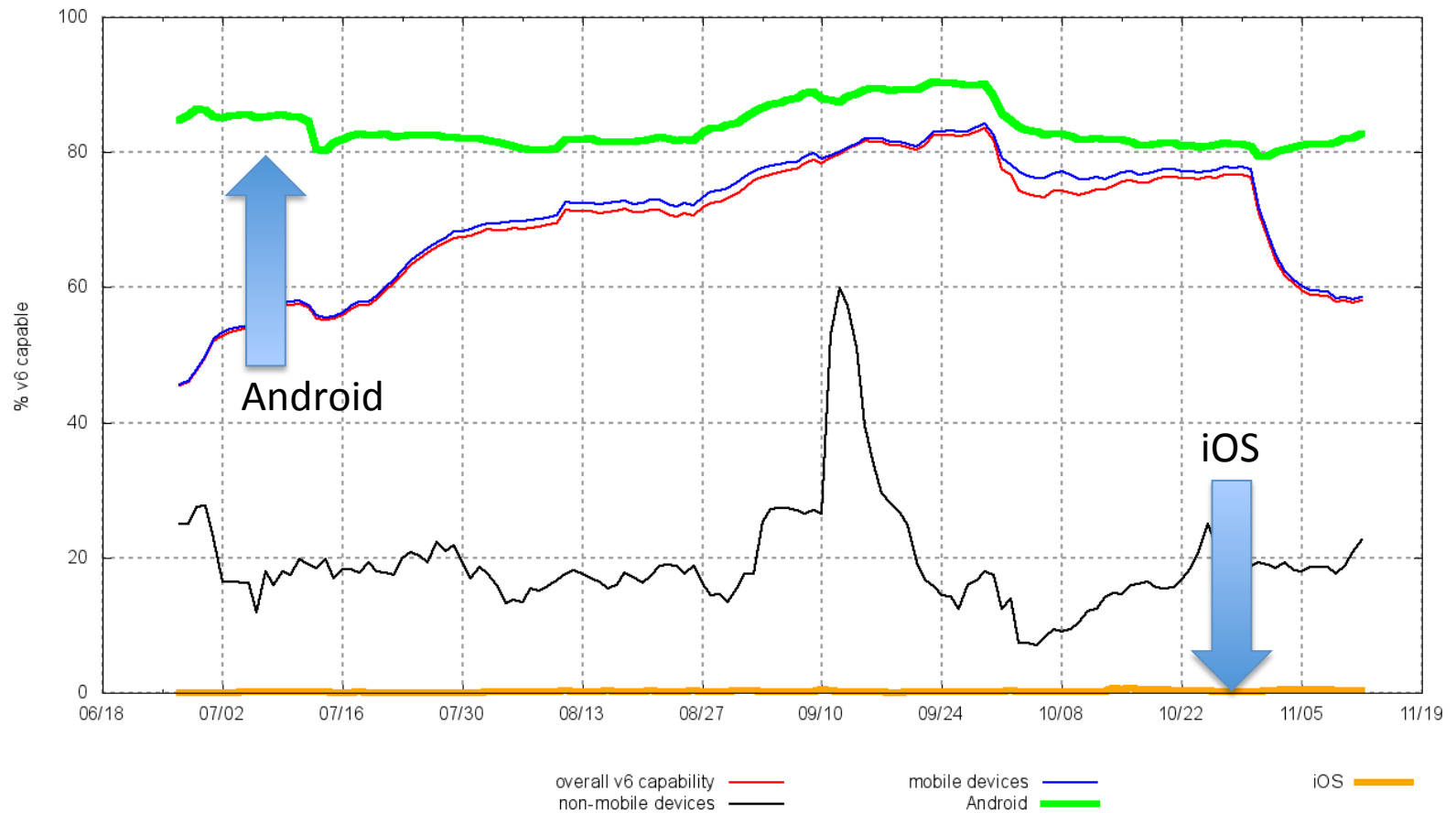


T-Mobile



T-Mobile

21928 T-MOBILE-AS21928 - T-Mobile USA Inc. US IPv6 capability



464XLat works

- The mechanism clearly works
 - Android devices show remarkably high, consistent level of IPv6 capability
- With Google, Facebook, Cloudflare, Akamai now routinely supporting dual-stack content it is likely a significant % of traffic flows over IPv6 and reduces pressure on the CGN/NAT requirement for IPv4
- The technology will not make sense for a company with large iOS handset deployment

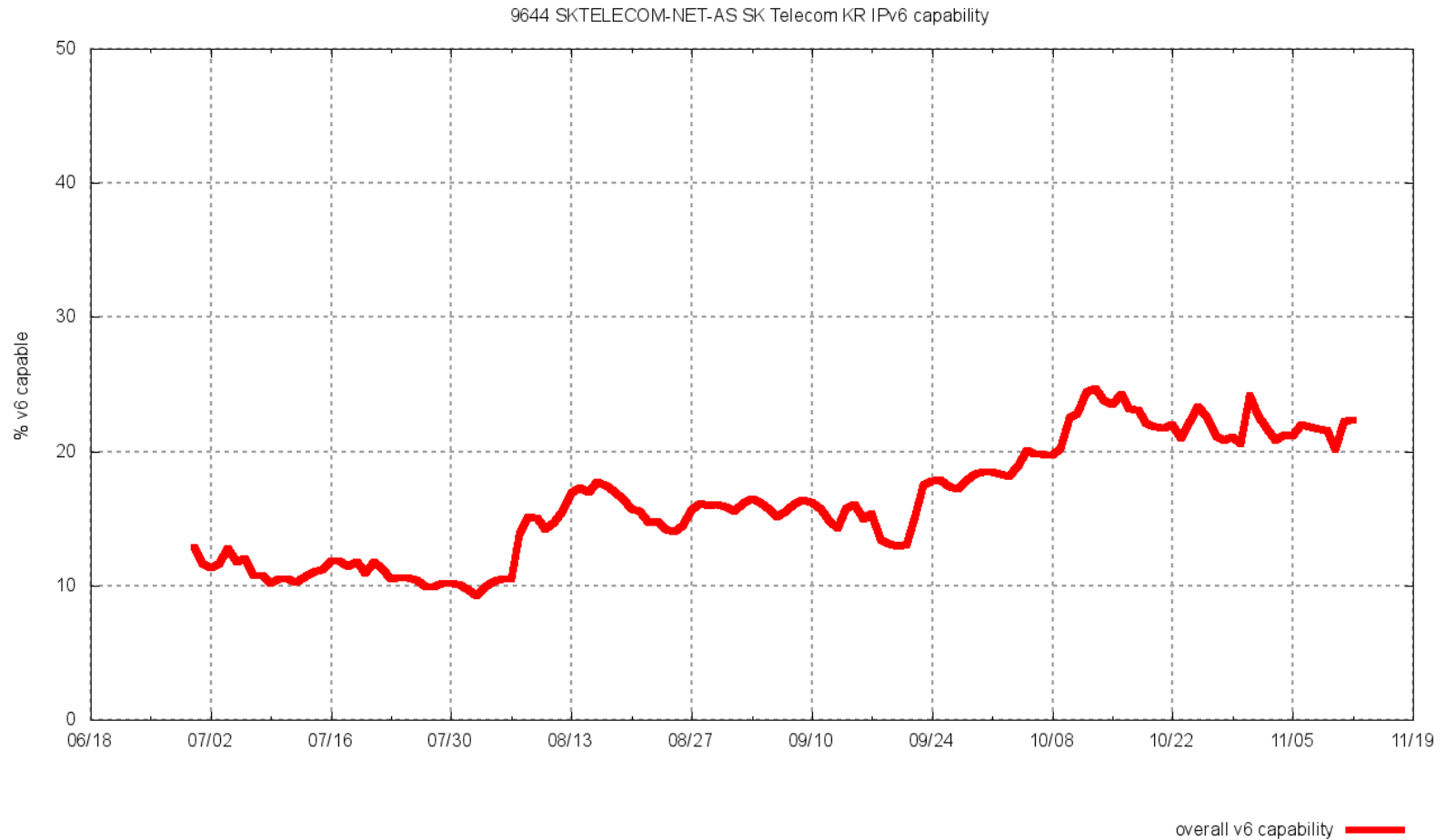
Korea is moving!

- Early Broadband adoption nationwide
- Significant investment in technology locked to IPv4
 - No upgrade option to CPE devices deployed nationwide
 - National data network includes switching technology and other investments which block IPv6
- But one cellular provider has deployed 464xlat..

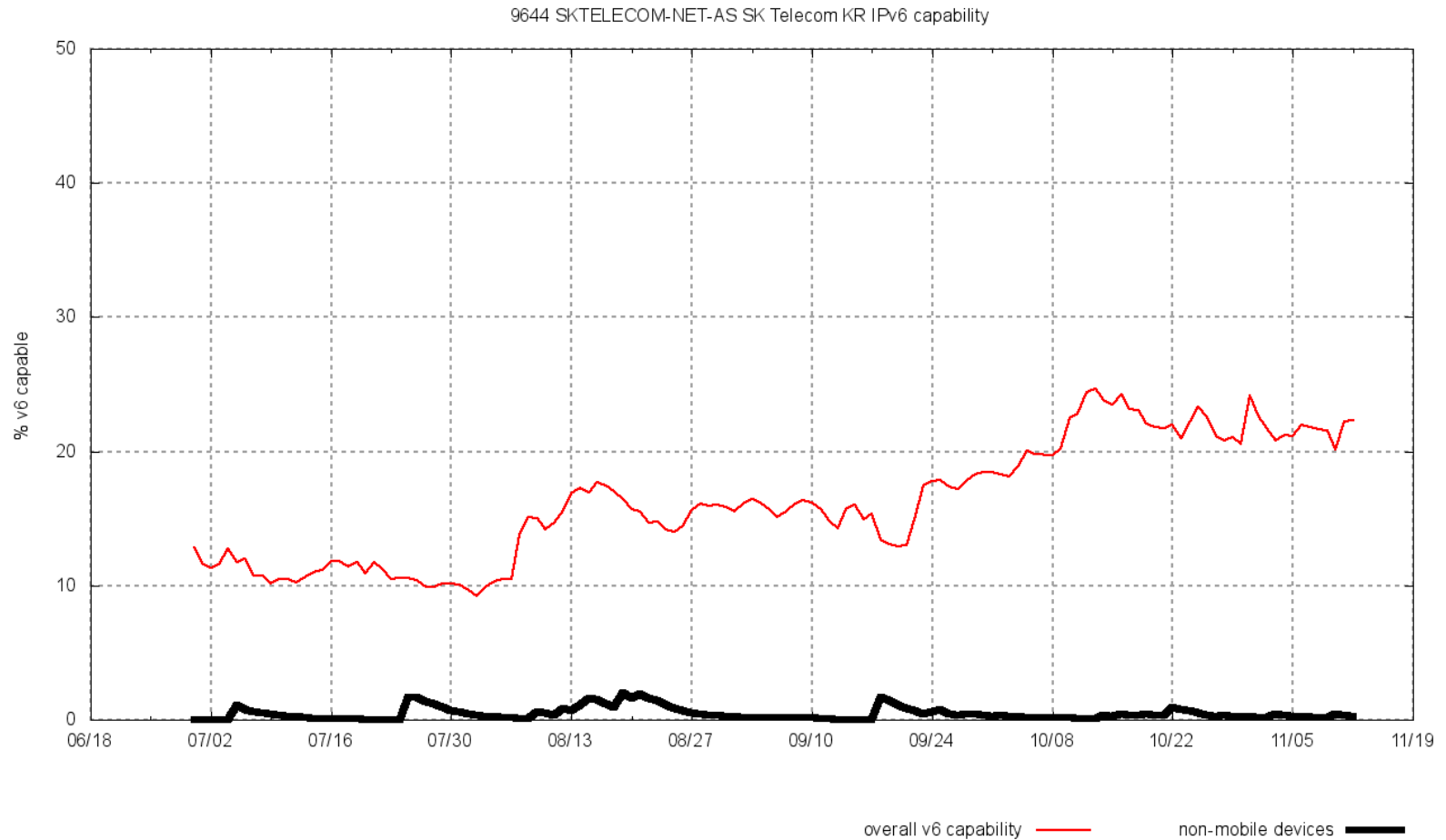
SK Telecom

- 20m customers
 - in market of approx ~49m mobile devices
 - (more than one device per user)
- KR has more mobiles than broadband at home
 - ~20m premises
- Approx 4m customers already converted to 4G-LTE
 - Running multiple APN, non upgraded devices v4 only

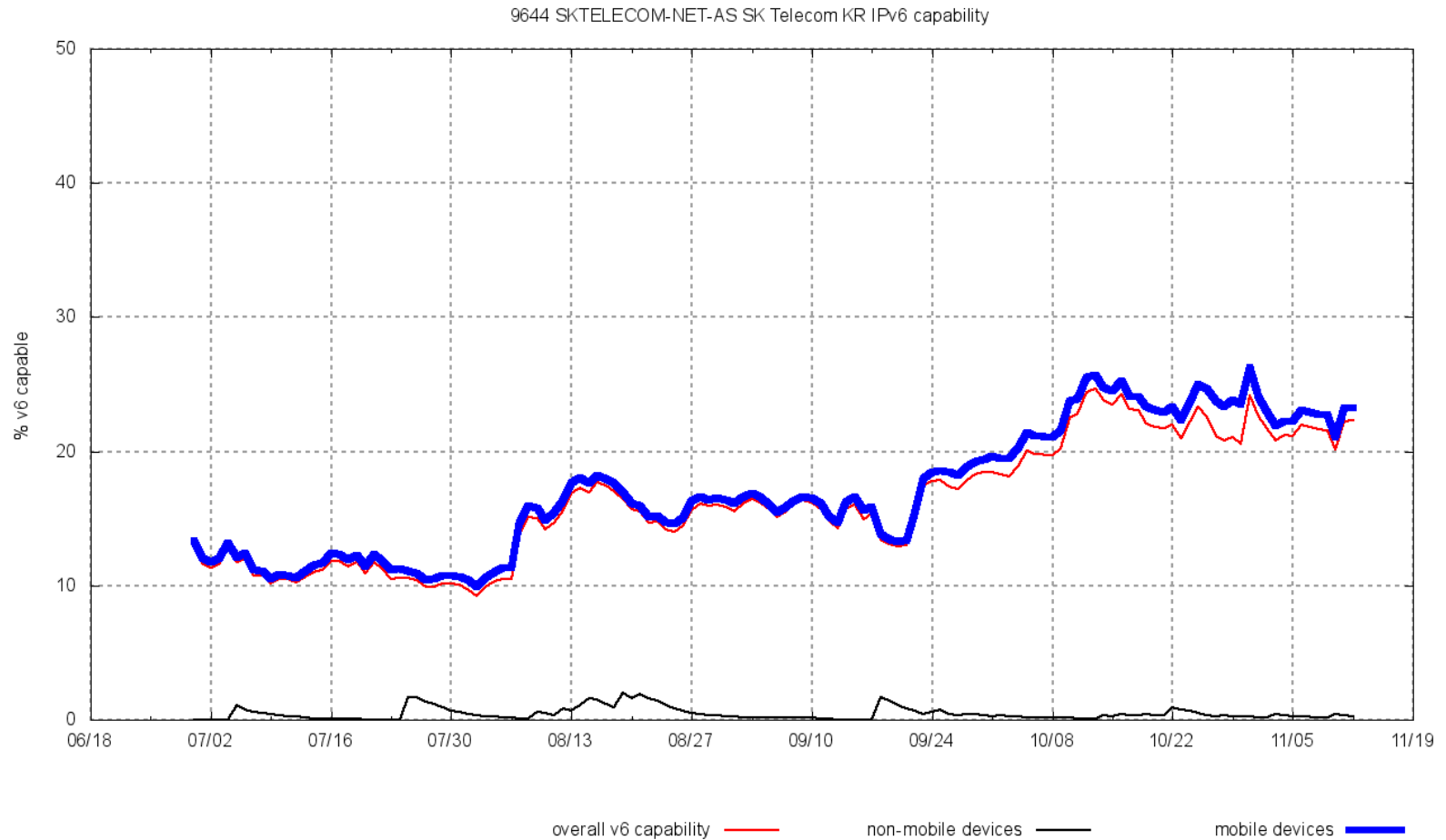
S-K Telecom overall IPv6



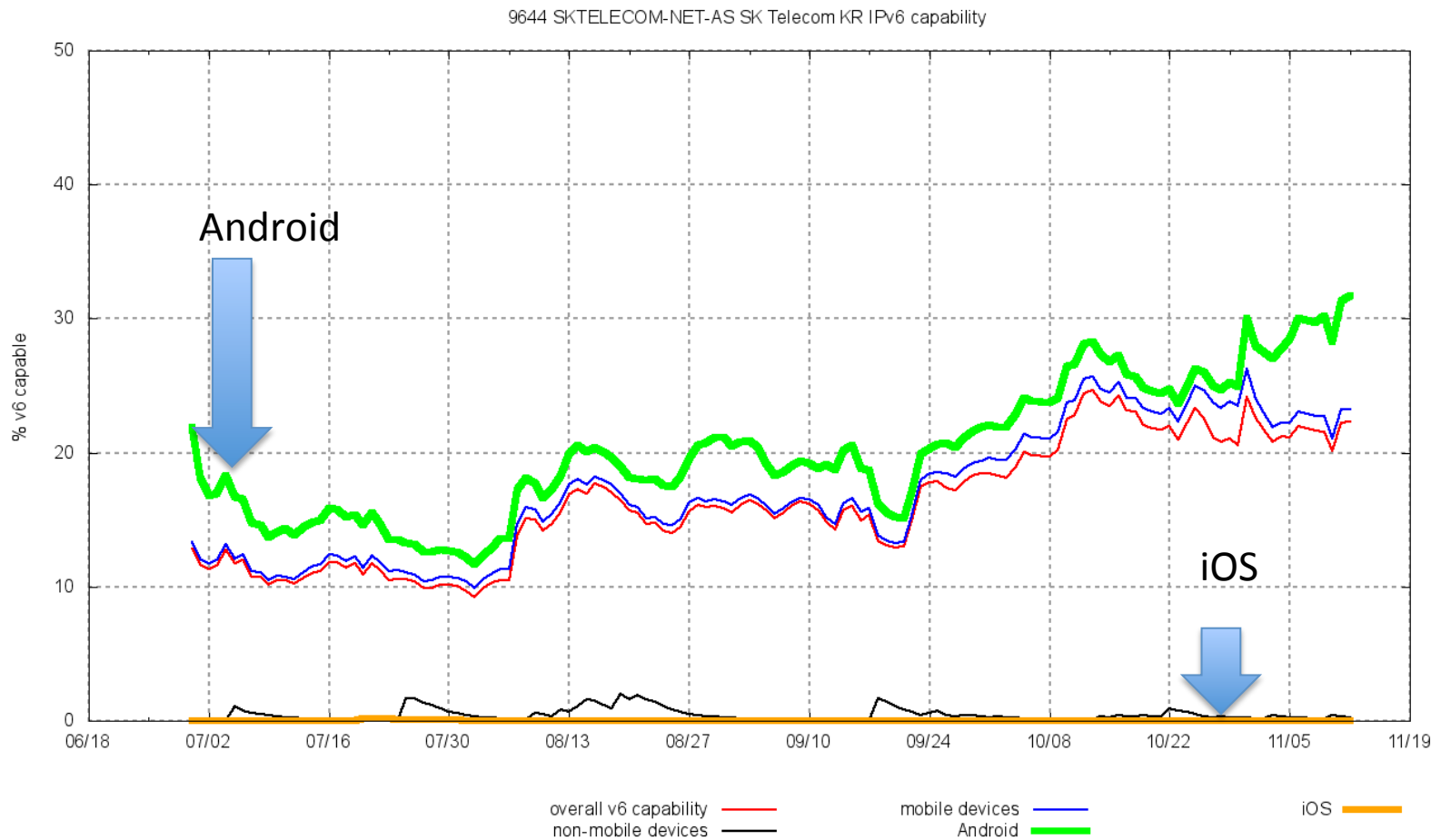
S-K Telecom non-mobile IPv6



S-K Telecom mobile IPv6



S-K Telecom iOS/Android IPv6



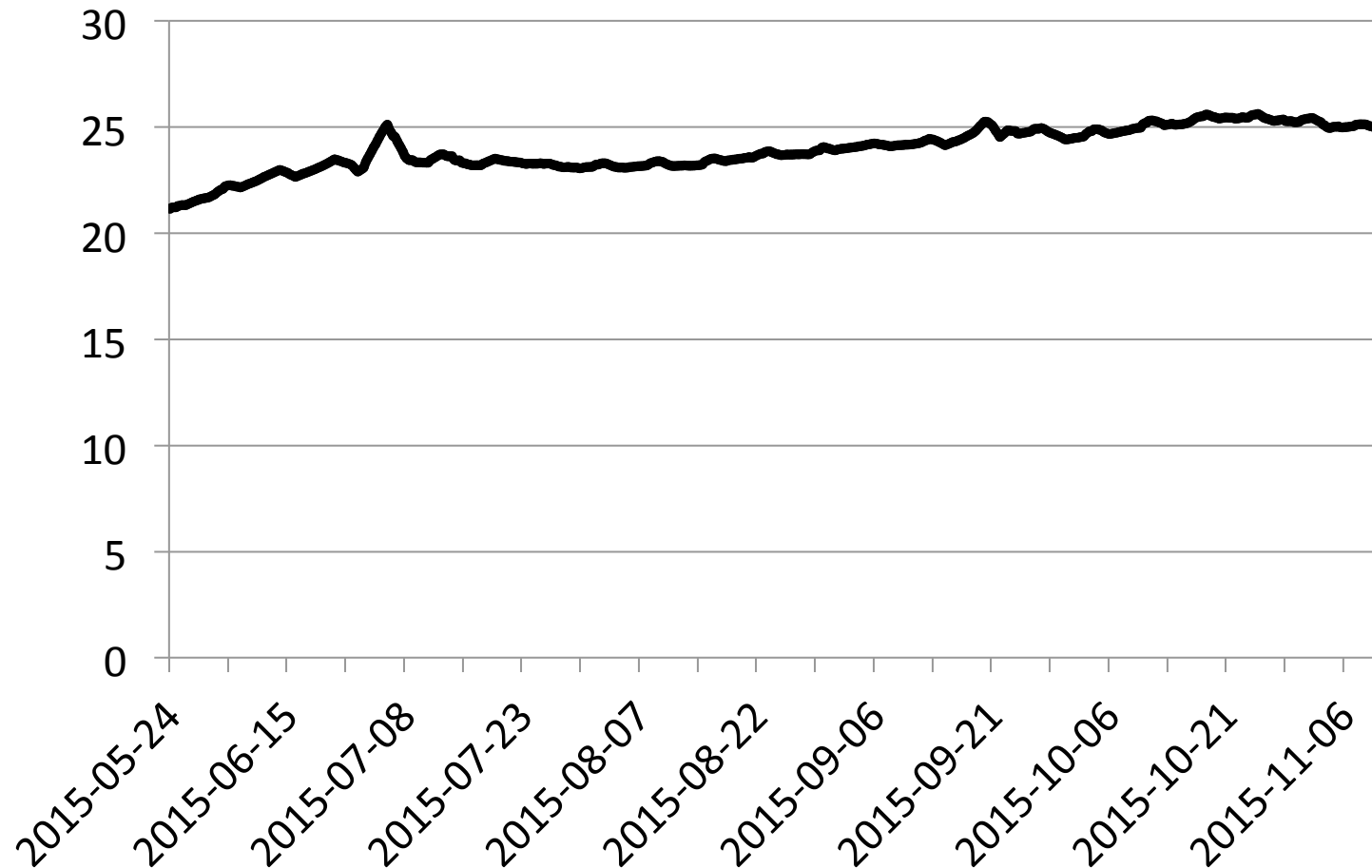
S-K Telecom

- Clear signal of 464xlat effect on iOS devices
- Lower overall penetration rate
- Technology deployment in cellular avoids pitfalls of legacy IPv4-only broadband deployments
- KR national IPv6 probably exceeds 2% from this single deployment
 - (our eyeball share figures for KR don't reflect local market conditions well)

Can we see this signal anywhere else?

- High Android, Low iOS v6 capability is a strong signal of 464xlat deployment
- Contrast with roughly equalized IPv6 capability of true dual-stack Cellular, Cable & ADSL based deployments
 - no bias against iOS exists

IPv6 Capability:US



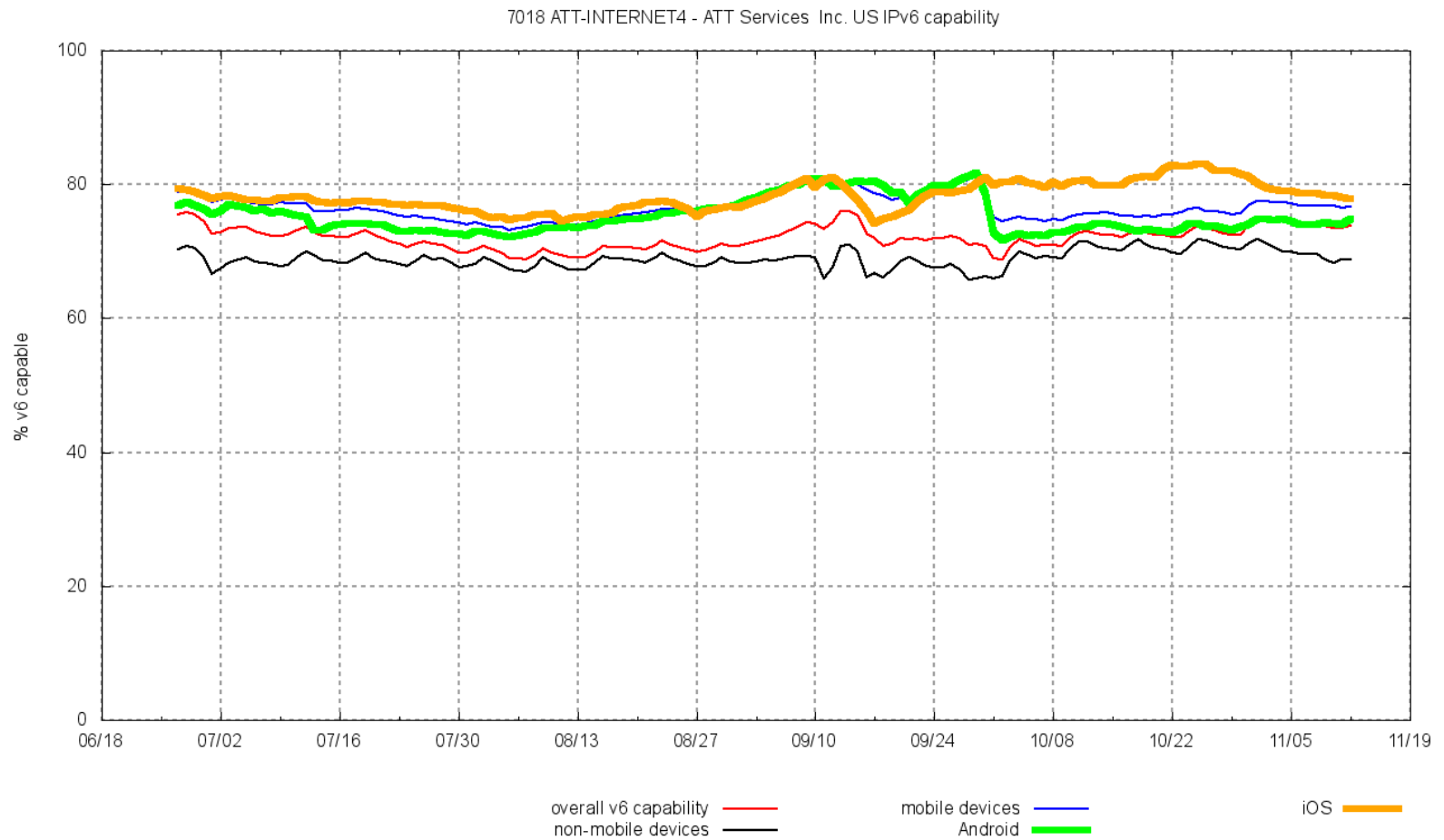
ASN ranked by eyeball share

ASN	AS Name	IPv6 Capable	IPv6 Preferred	Eyeball share
AS7922	COMCAST-7922 - Comcast Cable Communications, Inc.	55.49%	51.15%	15.91%
AS7018	ATT-INTERNET4 - ATT Services, Inc.	72.54%	67.10%	8.78%
AS701	UUNET - MCI Communications Services, Inc. dba Verizon Business	0.10%	0.02%	5.23%
AS16509	AMAZON-02 - Amazon.com, Inc.	0.01%	0.00%	3.84%
AS20115	CHARTER-NET-HKY-NC - Charter Communications	0.08%	0.02%	3.44%
AS22773	ASN-CXA-ALL-CCI-22773-RDC - Cox Communications Inc.	0.65%	0.53%	3.38%
AS22394	CELLCO - Cellco Partnership DBA Verizon Wireless	89.29%	82.42%	3.09%
AS21928	T-MOBILE-AS21928 - T-Mobile USA, Inc.	69.55%	68.71%	2.75%
AS209	CENTURYLINK-US-LEGACY-QWEST -	0.12%	0.06%	2.60%

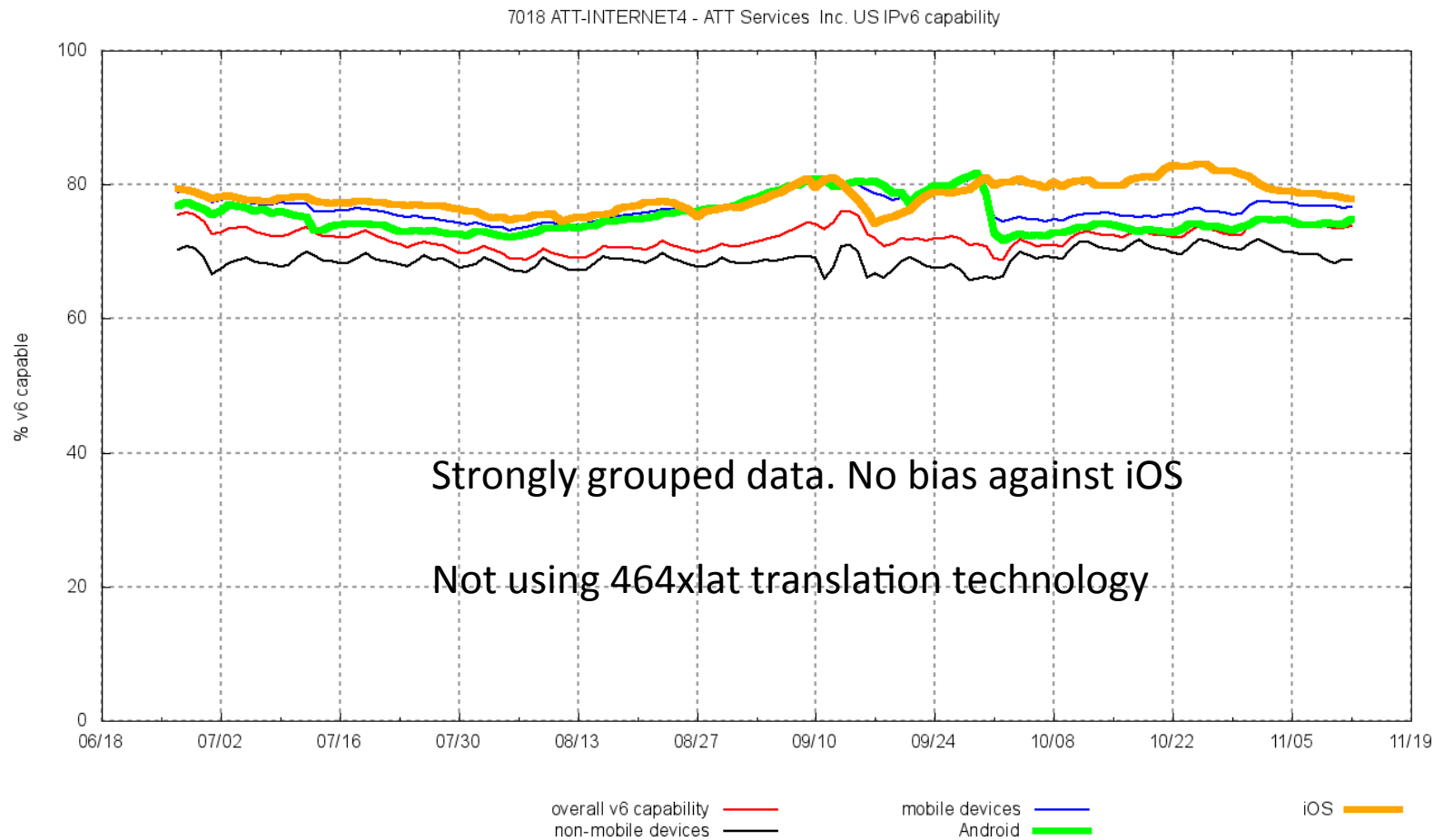
USA

- AT&T –both cellular and home service delivery
 - IPv6 deployment believed to be true dual-stack
- Verizon Cellular, some WiFi based services
 - Dual-stack IPv6 deployment on cellular/WiFi
- Comcast –large national cable provider
 - Dual-stack deployment on cable
 - Many legacy users
 - Has a significant ‘triple play’ model in IPv6
- Sprint, mix of different services including T-1 backbone, Wireless, Cellular

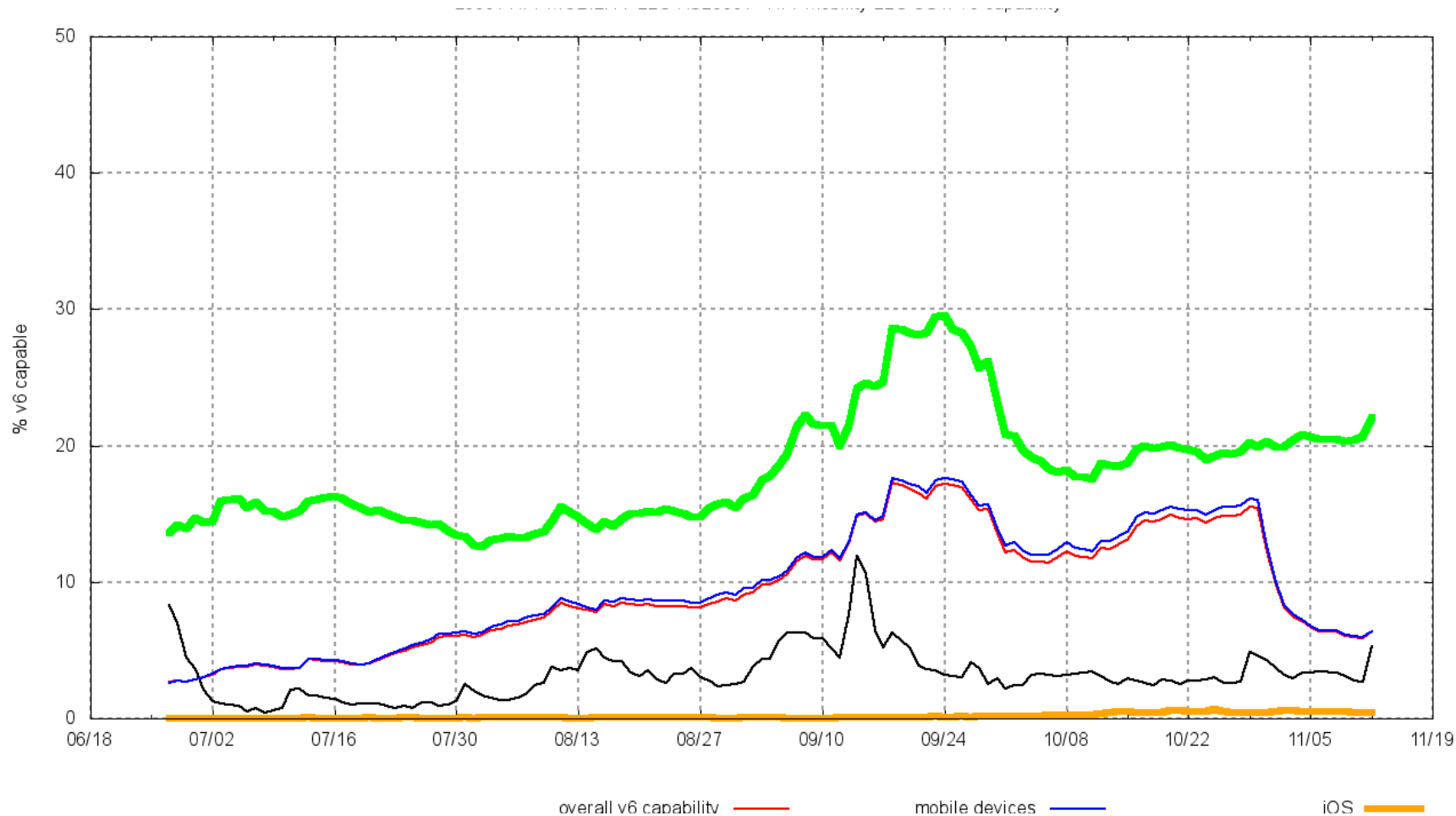
AT&T



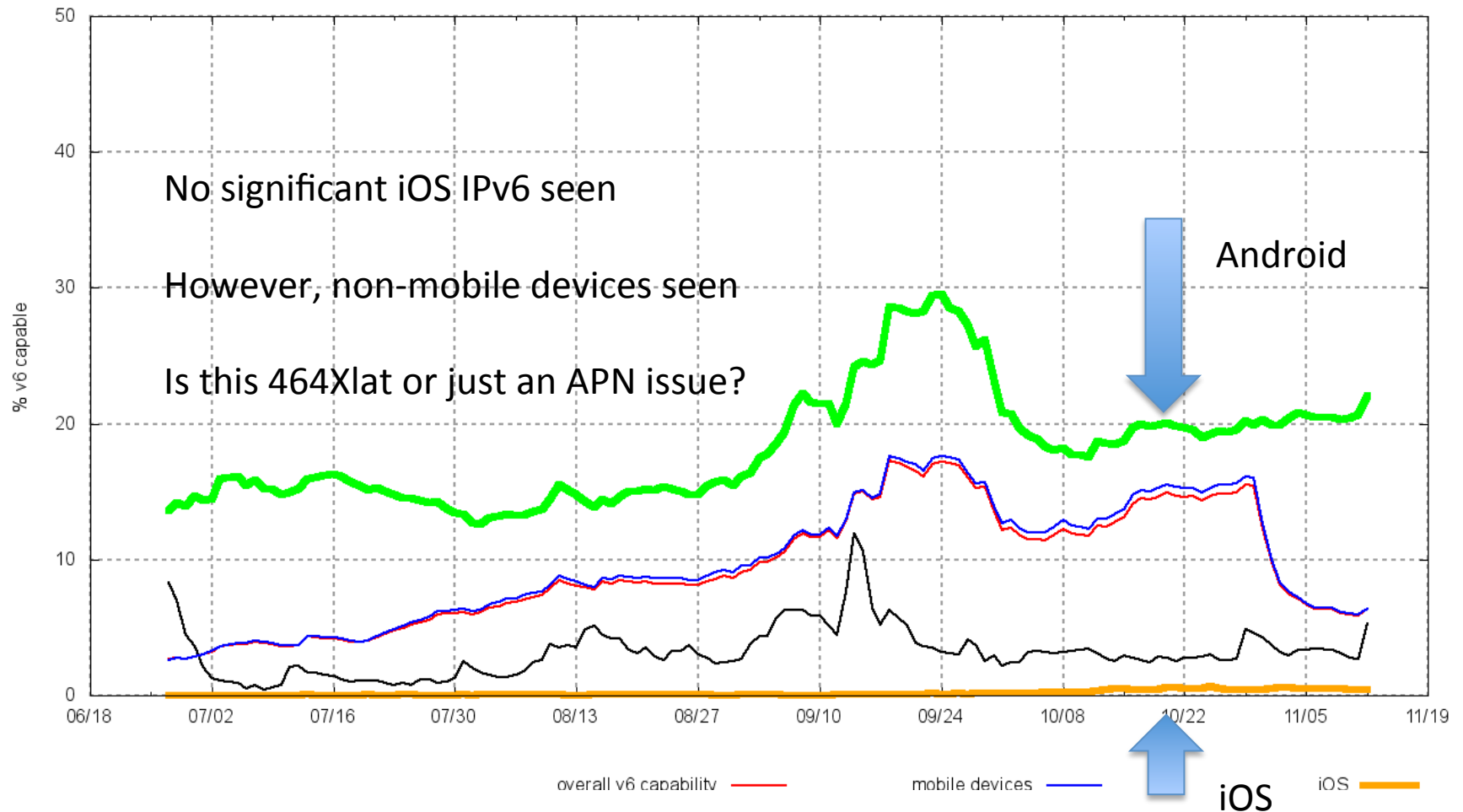
AT&T



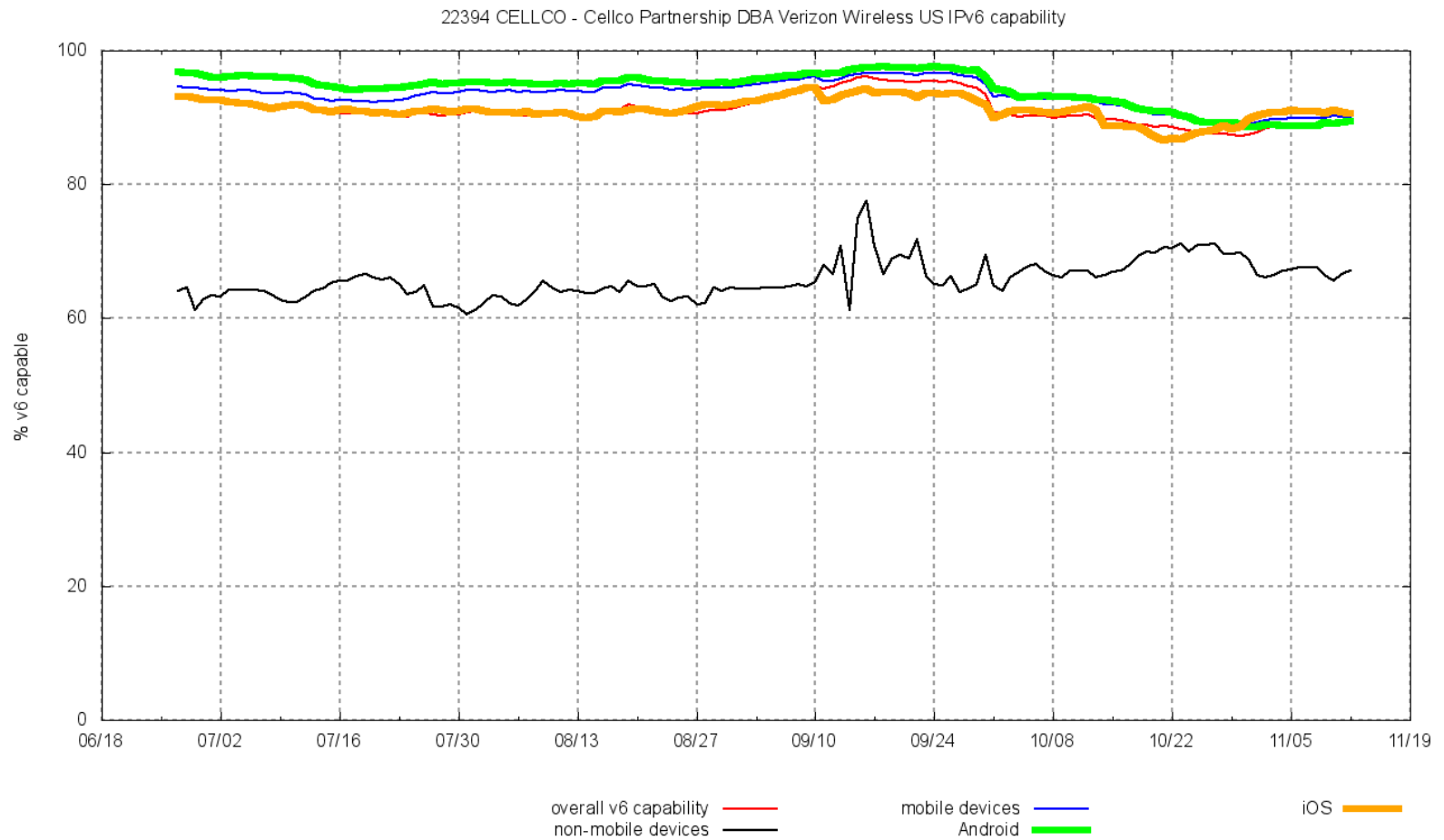
AS20057 AT&T Mobility



AS20057 AT&T Mobility

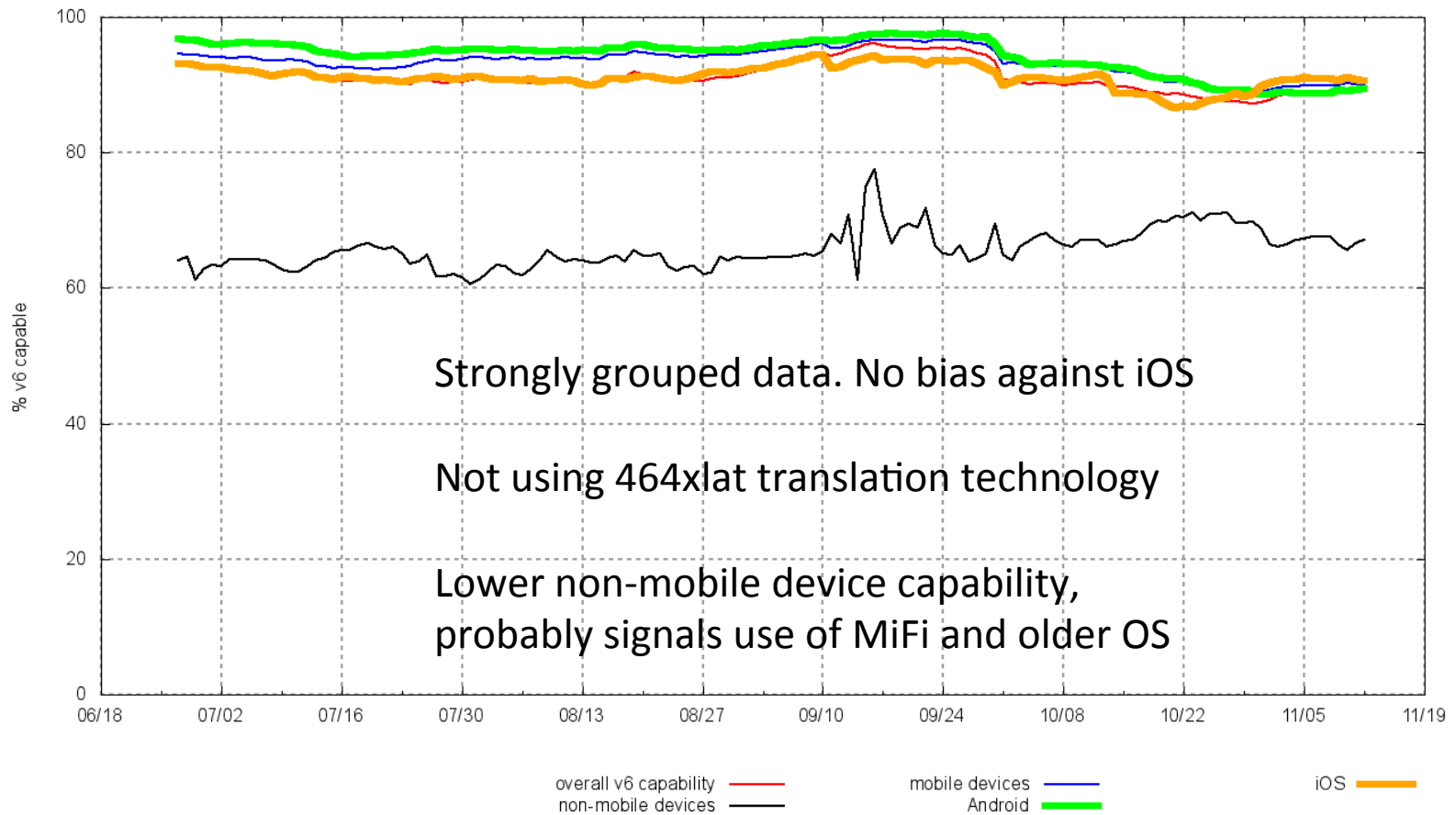


Verizon



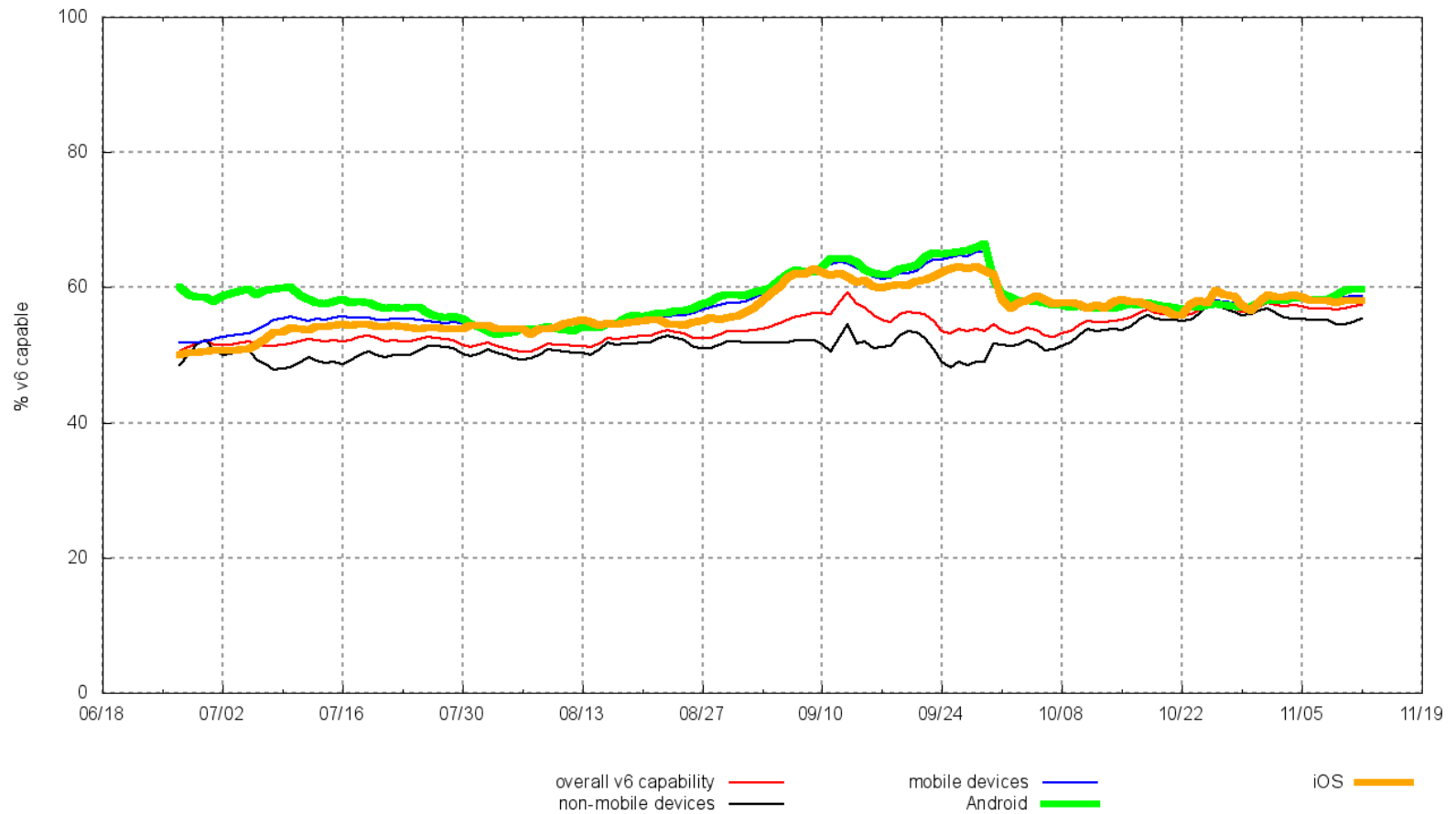
Verizon

22394 CELLCO - Cellco Partnership DBA Verizon Wireless US IPv6 capability



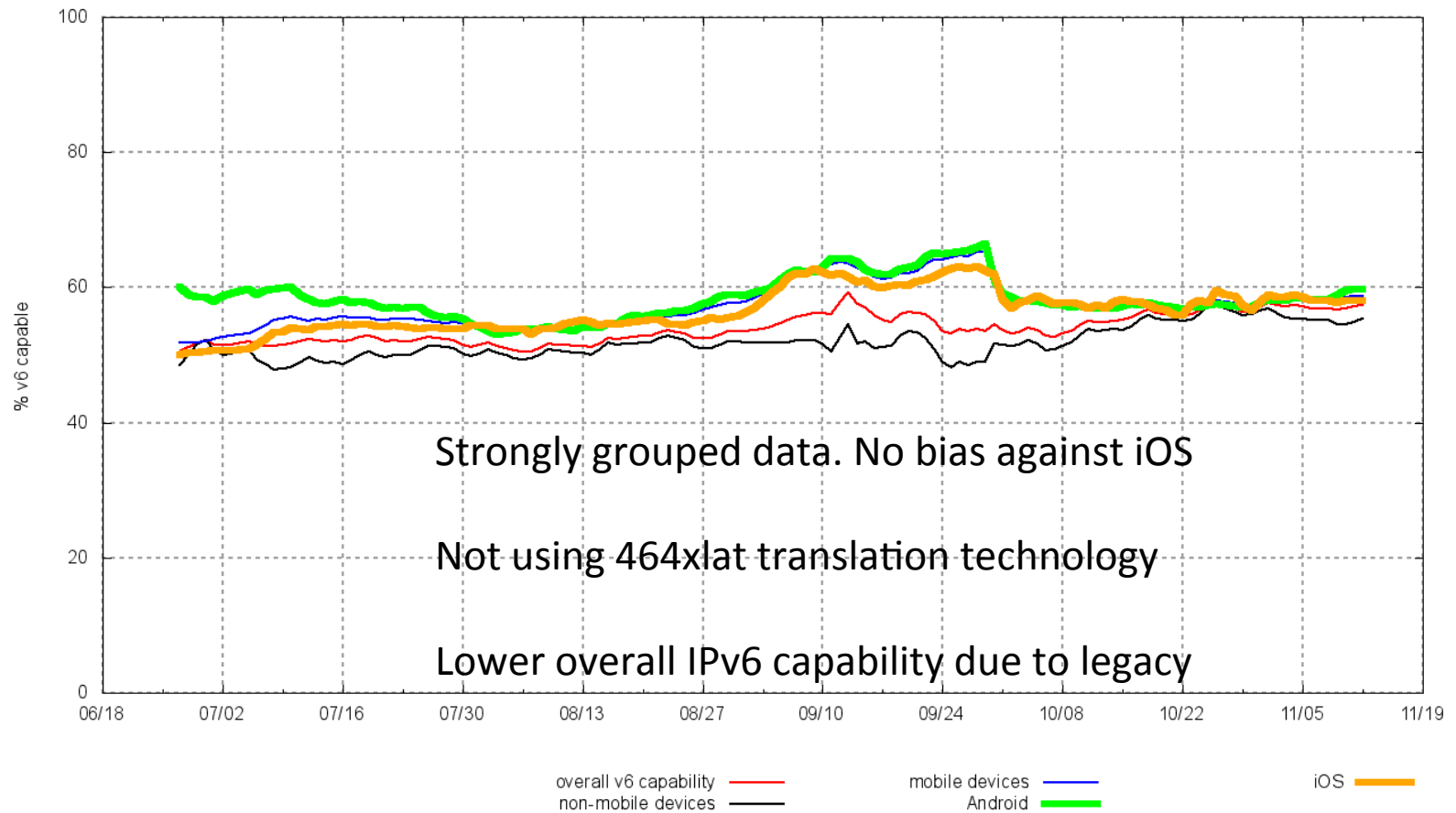
Comcast

7922 COMCAST-7922 - Comcast Cable Communications Inc. US IPv6 capability

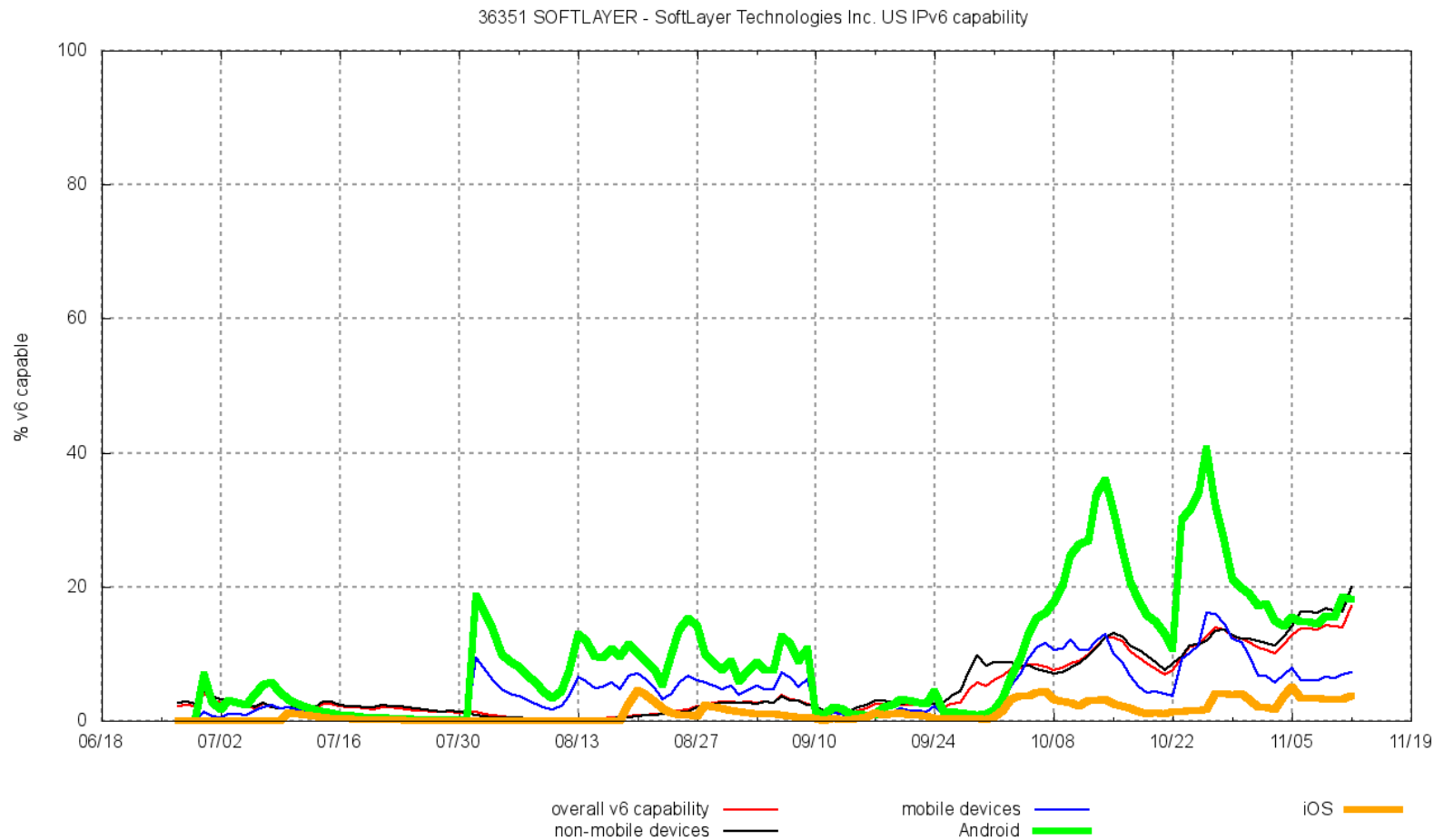


Comcast

7922 COMCAST-7922 - Comcast Cable Communications Inc. US IPv6 capability

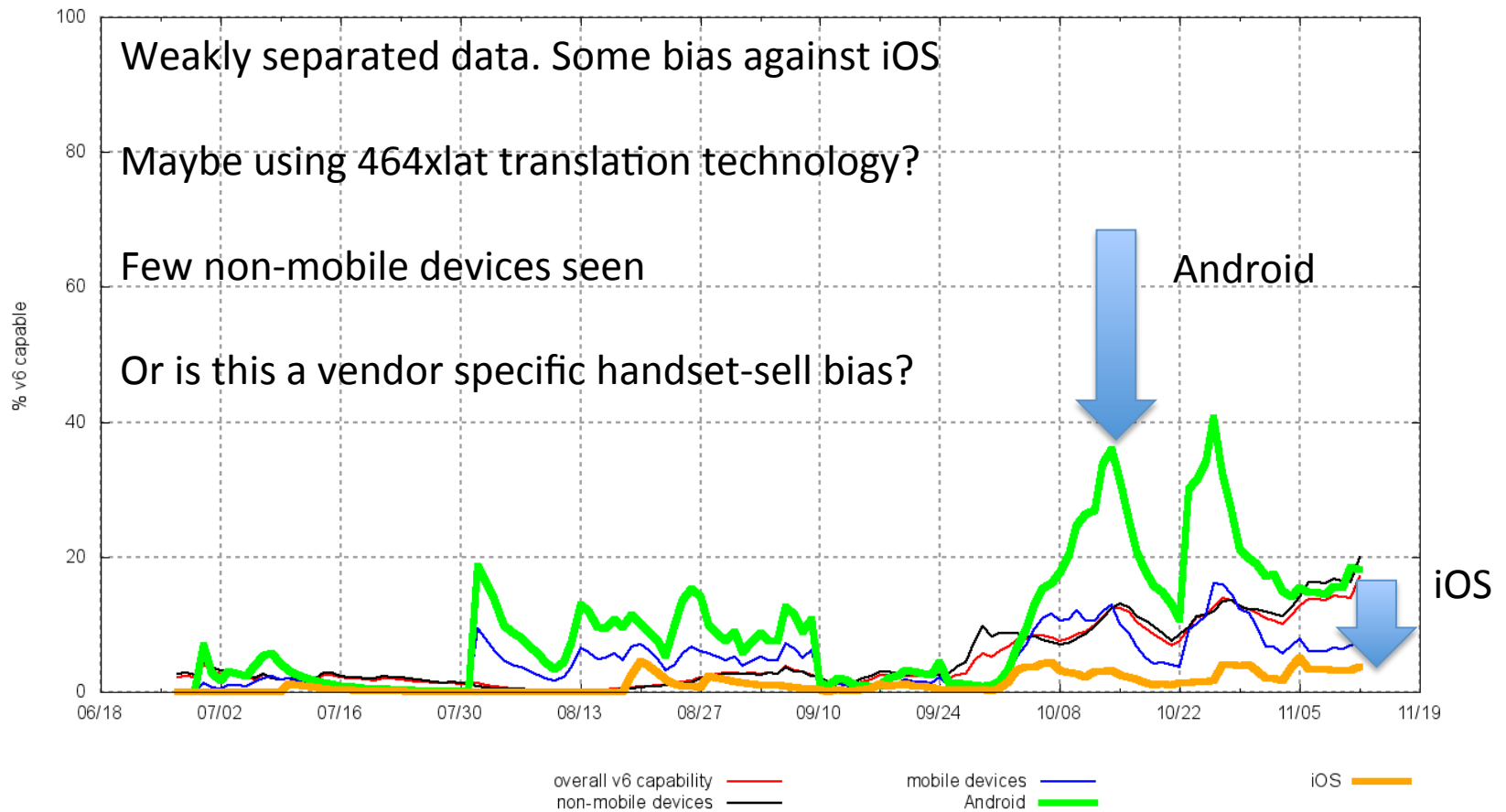


AS3651 Sprint BB6



AS3651 Sprint BB6

36351 SOFTLAYER - SoftLayer Technologies Inc. US IPv6 capability



Anywhere else?

- Can we see signals in any other ASN?
- Orange Poland

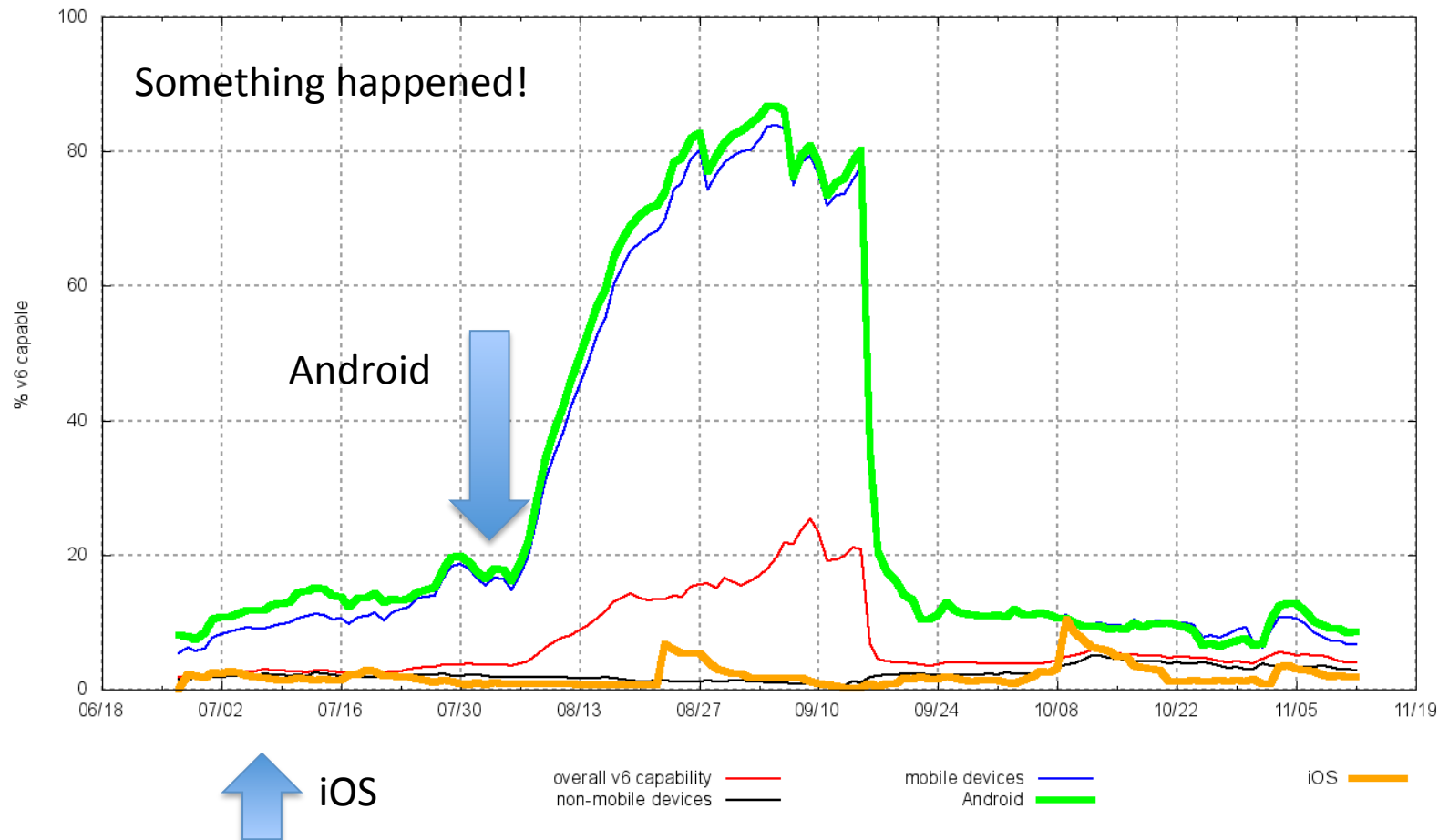
Orange Poland



↑ iOS

Orange Poland

5617 TPNET Orange Polska Spolka Akcyjna PL IPv6 capability

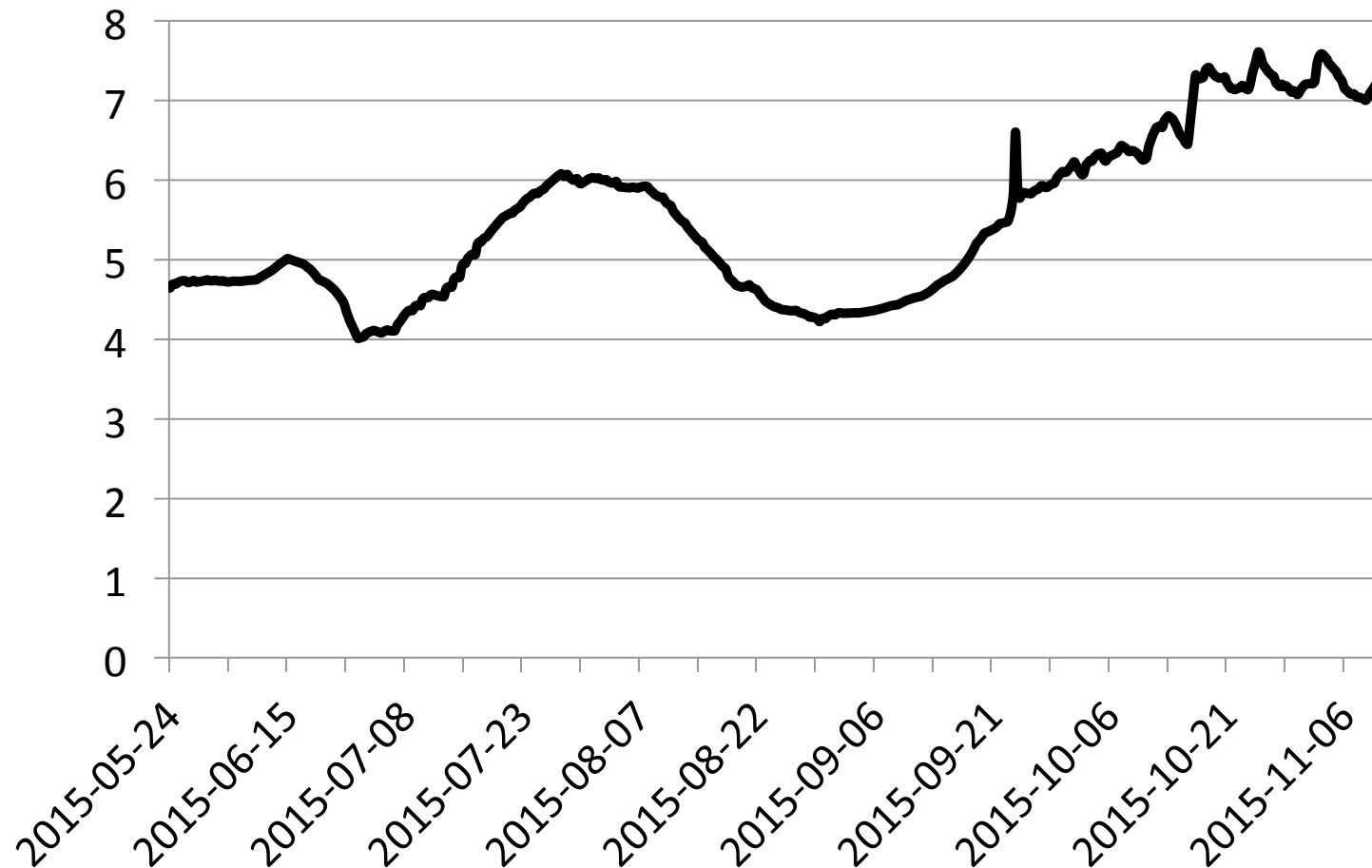


Orange Poland

- Noting a pretty long-lived anomaly in the measurement, the overall impression is of a lower iOS IPv6 capability behind this ASN.
 - When IPv6 capability surges it tracks Android devices very strongly
- Maybe iPhone 6 sales took off and they're doing a non-v6 APN?

Any other big deployments?

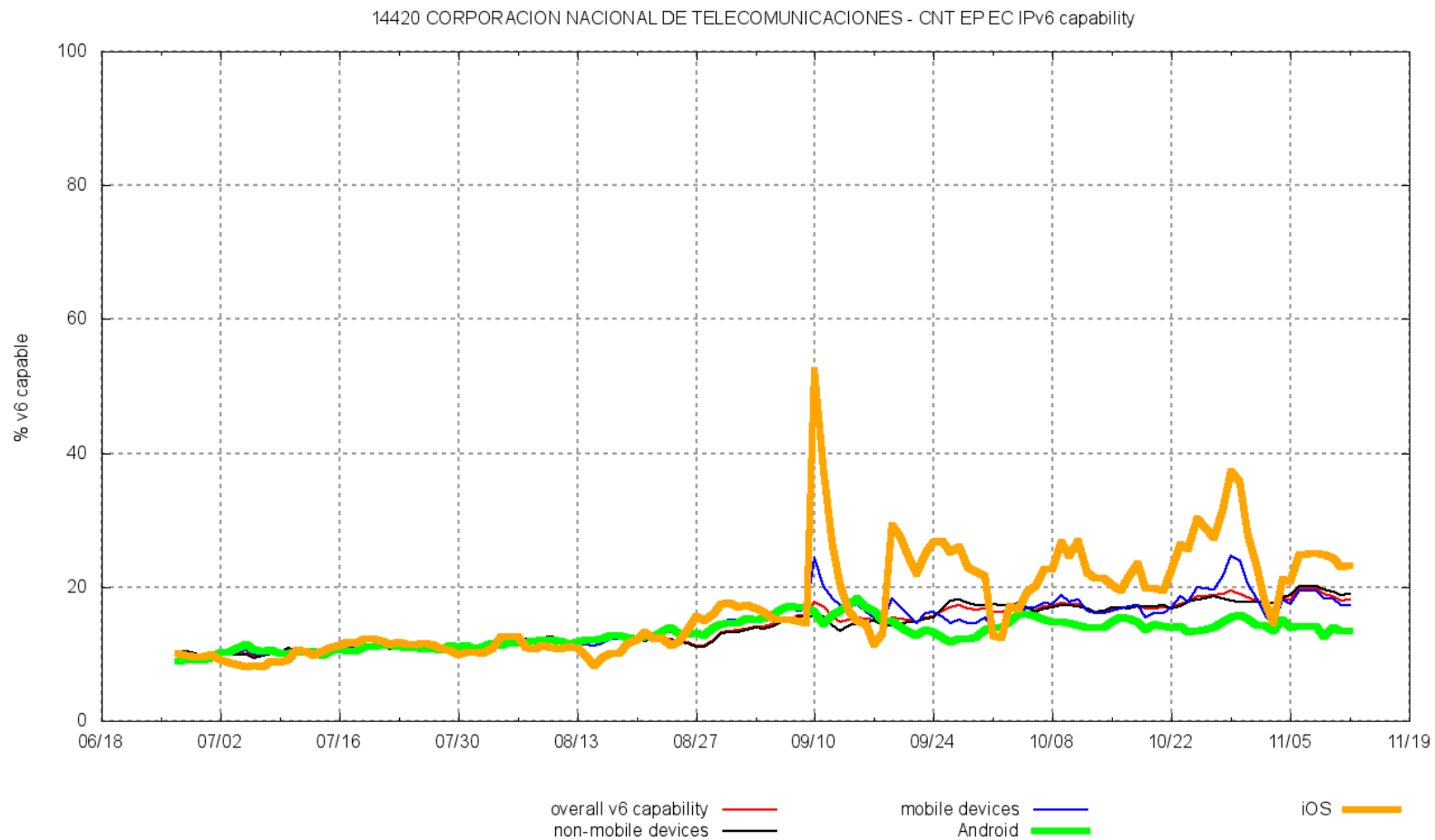
IPv6 Capability:EC



ASN ranked by eyeball share

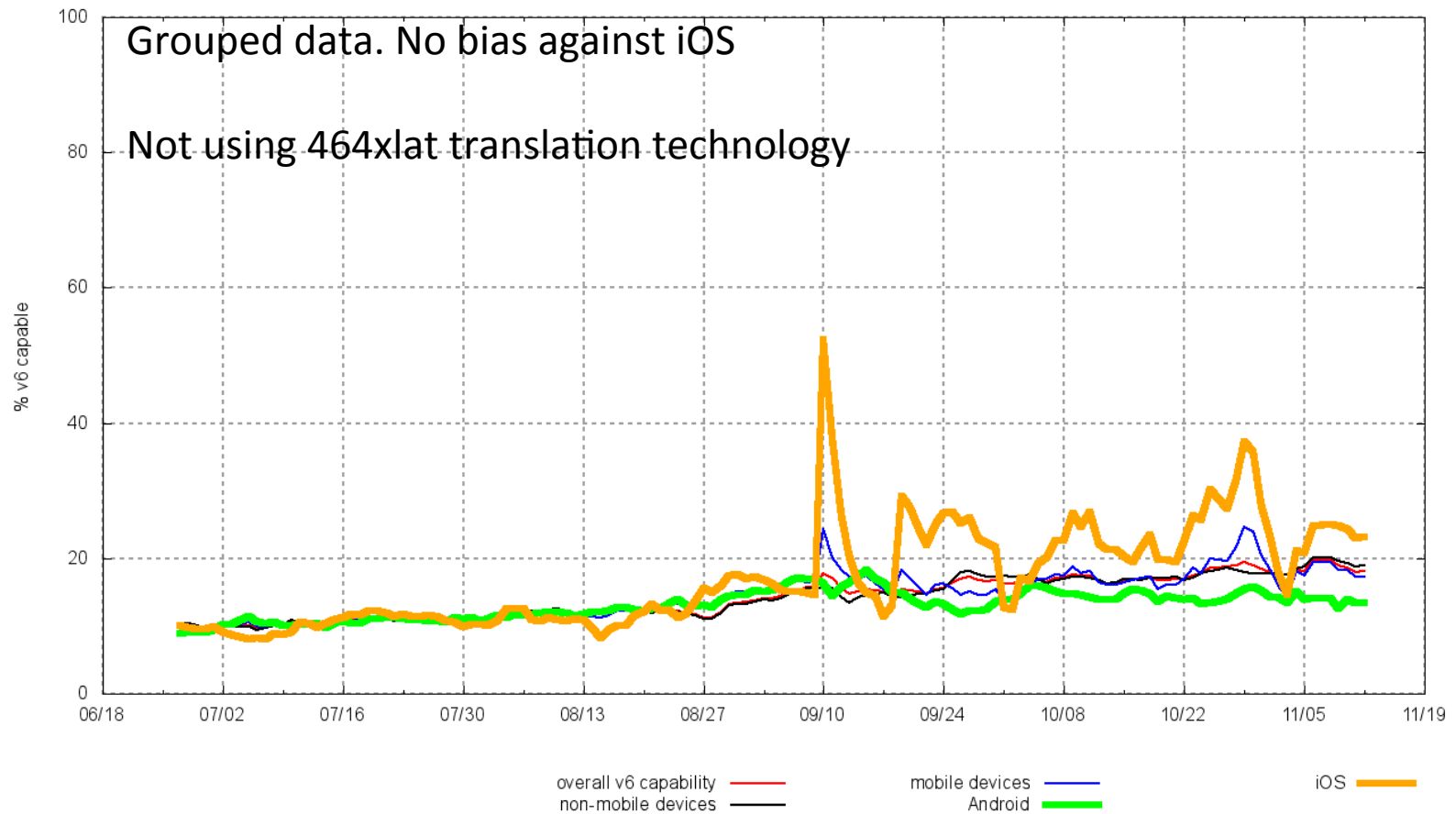
ASN	AS Name	IPv6 Capable	IPv6 Preferred	Eyeball share
AS14420	CORPORACION NACIONAL DE TELECOMUNICACIONES - CNT EP	15.08%	14.24%	44.24%
AS27947	Telconet S.A	0.28%	0.27%	14.65%
AS14522	Satnet	0.00%	0.00%	14.07%
AS27738	Ecuadortelecom S.A.	0.00%	0.00%	7.88%
AS27668	ETAPA EP	0.01%	0.01%	4.30%
AS22724	PUNTONET S.A.	0.00%	0.00%	3.66%
AS23487	CONECCEL	0.01%	0.00%	3.26%
AS19114	Otecel S.A.	0.01%	0.01%	2.50%
AS28006	CORPORACION NACIONAL DE TELECOMUNICACIONES - CNT EP	0.00%	0.00%	1.64%
AS52257	Telconet S.A	0.00%	0.00%	0.79%

AS14420 CORPORACION NACIONAL DE TELECOMUNICACIONES - CNT EP

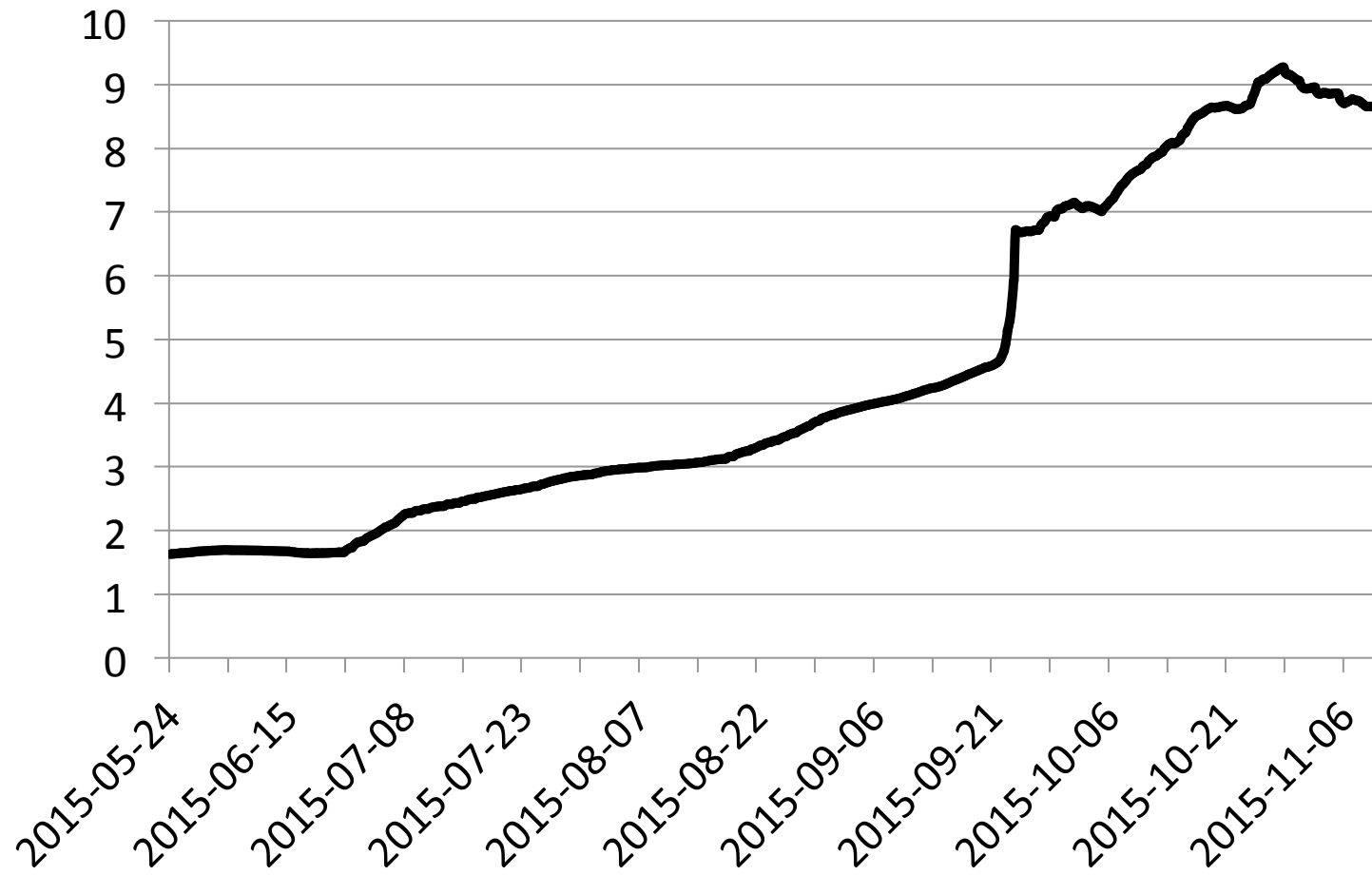


AS14420 CORPORACION NACIONAL DE TELECOMUNICACIONES - CNT EP

14420 CORPORACION NACIONAL DE TELECOMUNICACIONES - CNT EP EC IPv6 capability



IPv6 Capability:BR

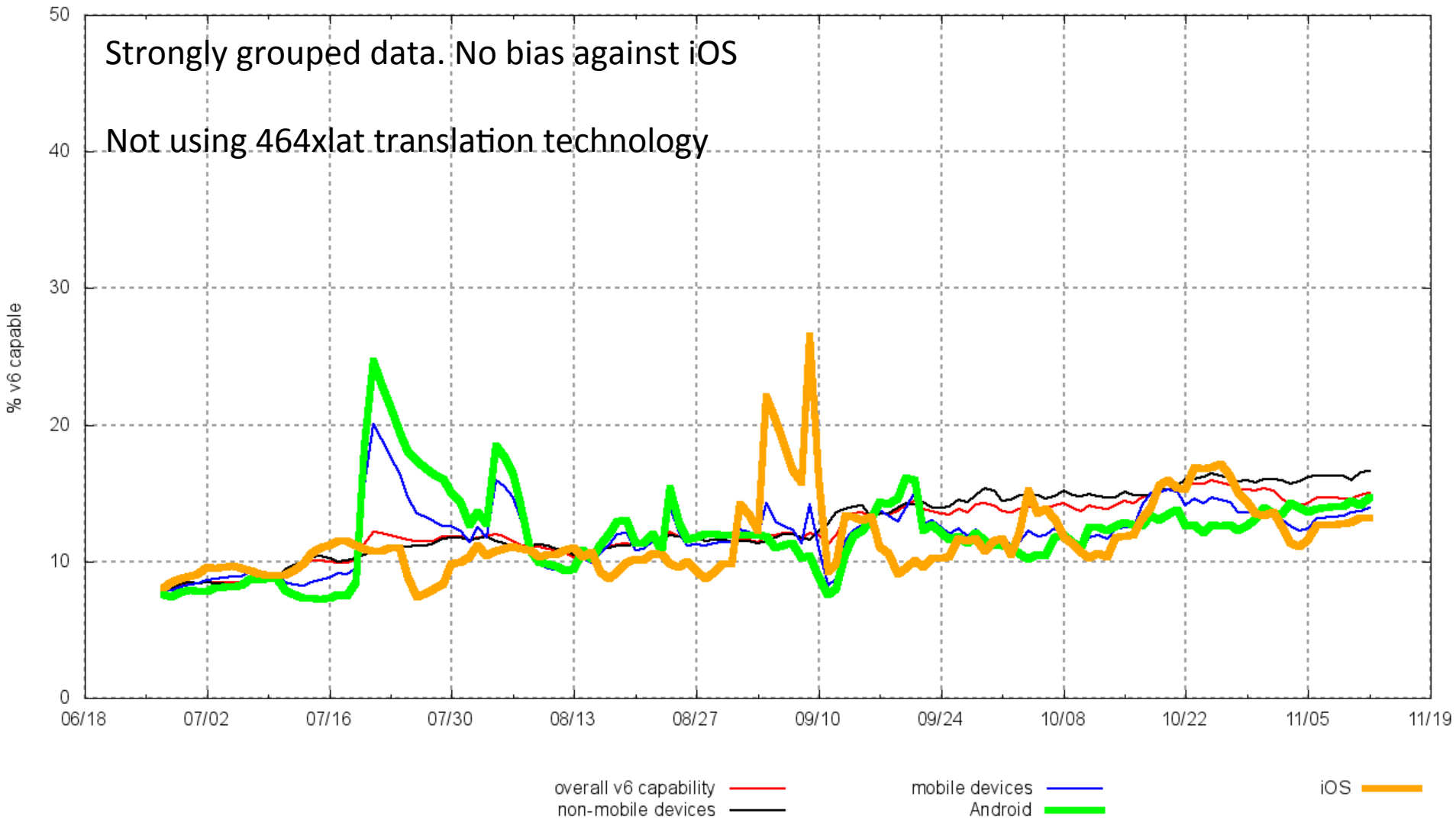


ASN ranked by eyeball share

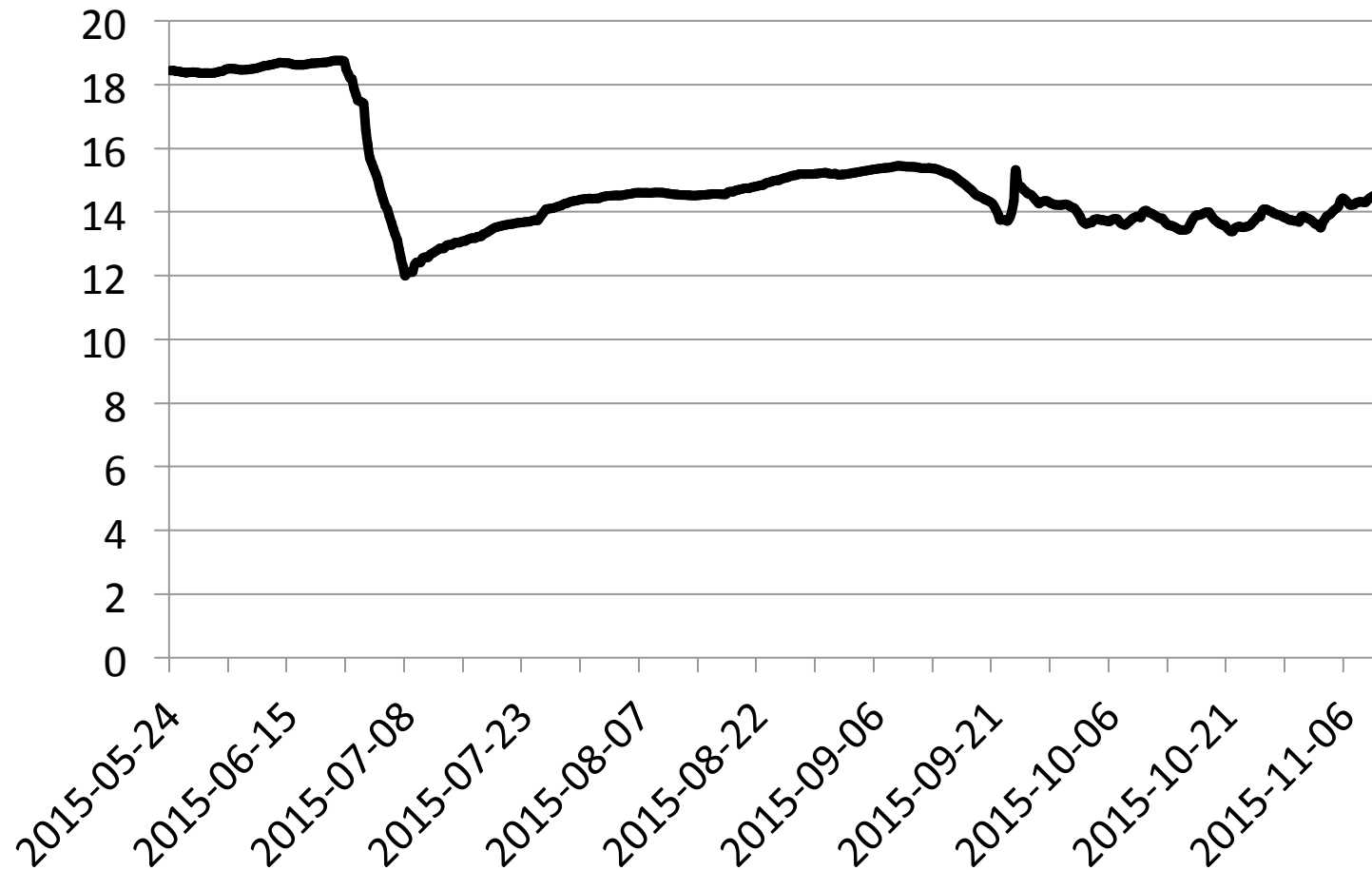
ASN	AS Name	IPv6 Capable	IPv6 Preferred	Eyeball share
AS28573	CLARO S.A.	13.01%	12.15%	24.70%
AS18881	Global Village Telecom	15.96%	14.50%	16.75%
AS7738	Telemar Norte Leste S.A.	1.14%	1.08%	11.15%
AS27699	TELEFNICA BRASIL S.A	2.82%	2.57%	8.46%
AS8167	Brasil Telecom SA - Filial Distrito Federal	0.83%	0.78%	6.58%
AS26599	TELEFNICA BRASIL S.A	2.49%	2.28%	2.39%
AS26615	Tim Celular S.A.	0.05%	0.03%	1.46%
AS53006	ALGAR TELECOM SA	0.04%	0.03%	1.33%
AS13591	Brasil Telecom Comunicacao Multimidia	0.00%	0.00%	1.00%
AS4230	CLARO S.A.	0.12%	0.02%	0.68%

AS28573 Claro, Brasil

28573 NET Servios de Comunicacao S.A. BR IPv6 capability



IPv6 Capability:PE

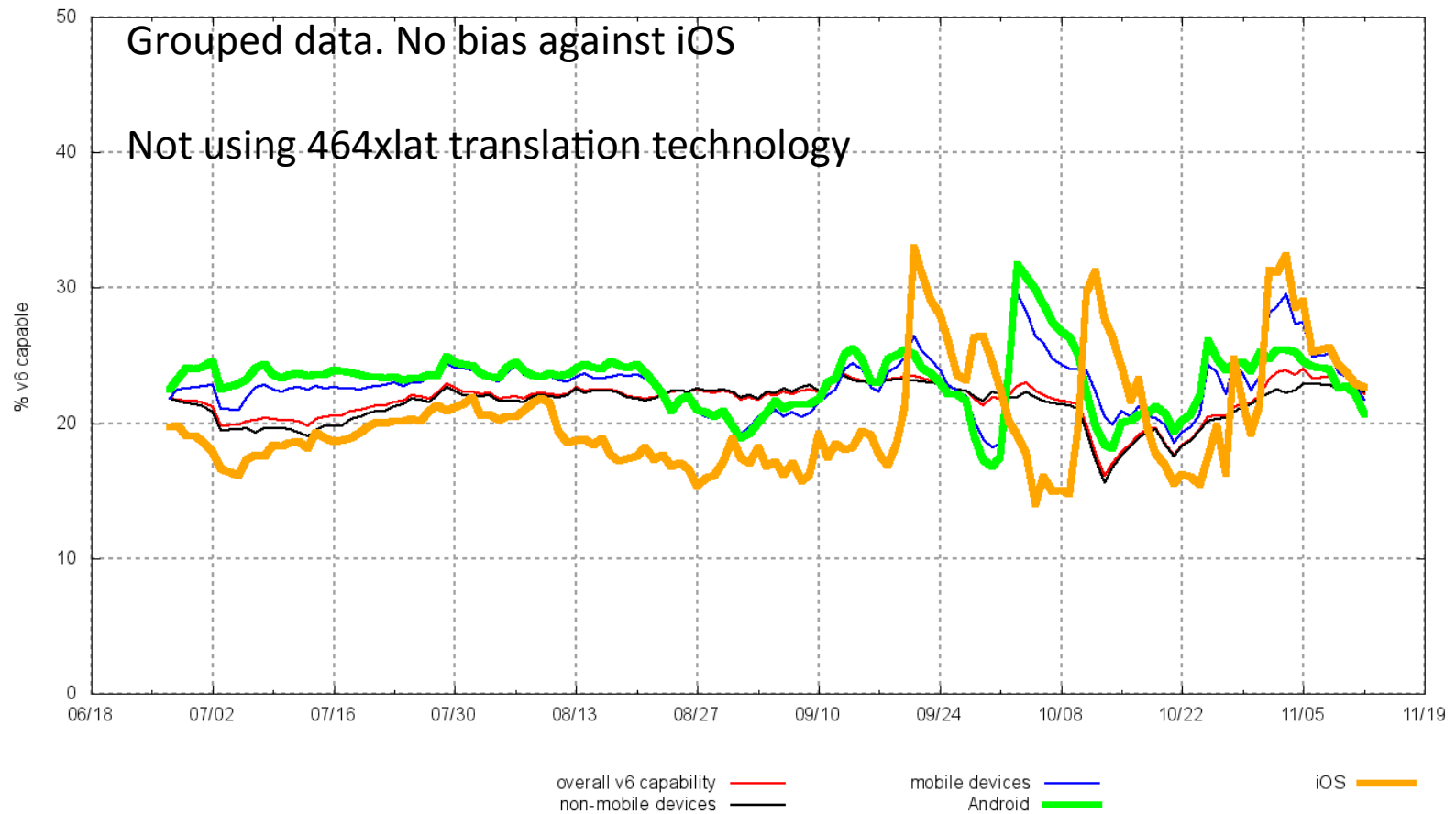


ASN ranked by eyeball share

ASN	AS Name	IPv6 Capable	IPv6 Preferred	Eyeball share
AS6147	Telefonica del Peru S.A.A.	20.02%	19.13%	80.42%
AS12252	America Movil Peru S.A.C.	0.03%	0.02%	15.55%
AS262253	ECONOCABLE MEDIA SAC	0.17%	0.13%	0.73%
AS27843	OPTICAL TECHNOLOGIES S.A.C.	0.14%	0.13%	0.73%
AS52400	Olo del Peru S.A.C	0.00%	0.00%	0.70%
AS262210	VIETTEL PER S.A.C.	0.05%	0.02%	0.57%
AS19180	AMERICATEL PERU S.A.	0.16%	0.14%	0.42%
AS263224	EMPRESA DE TELECOMUNICACIONES MULTIMEDIA ALFA	0.00%	0.00%	0.29%
AS21575	ENTEL PERU S.A.	0.06%	0.01%	0.24%
AS28032	INTERNEXA PERU S.A	0.04%	0.02%	0.14%

AS6147 Telefonica Del Peru

6147 Telefonica del Peru S.A.A. PE IPv6 capability



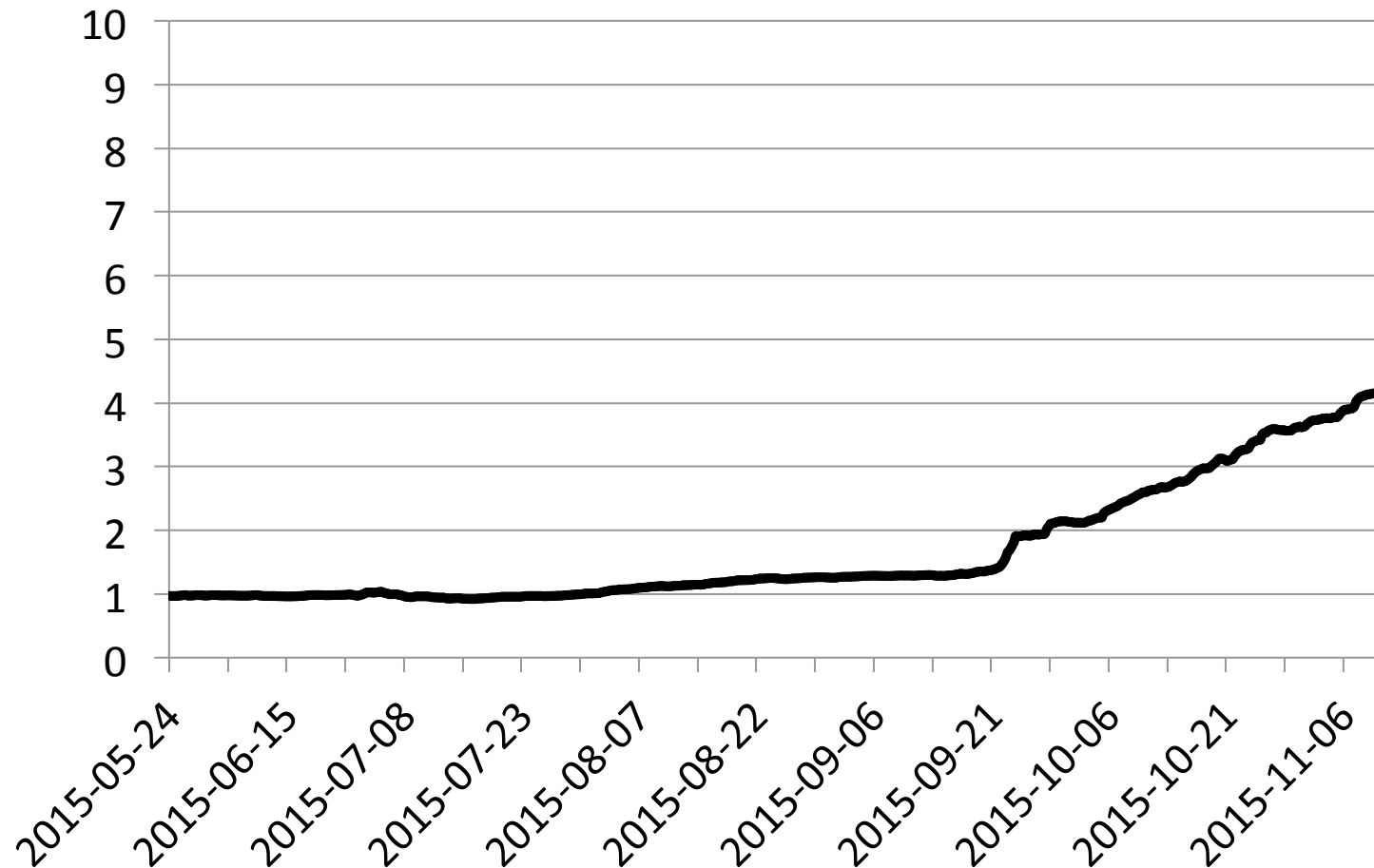
Low iOS presence

- I*believe* that the relative cost of iOS devices in LAC region is high:
 - ‘Apple-tax’: consistent worldwide pricing
 - Some economic factors in different national economies (import taxes, foreign currency controls)
 - Signs that LAC consumers with direct access to US markets shop in the USA, for significant purchases like an iPhone
- Android devices are much more price-variant
 - High and low end units available from a range of providers including trading relationships in BRICS

If little iOS.. Then XLAT can work!

- Low penetration of iOS means that 464Xlat is not a barrier to significant customer volume
- If it makes sense economically to favour a transition mechanism like 464Xlat, the evidence is that it works, and will reduce pressure on your IPv4 address bindings on any NAT/CGN
- However, no signs of significant deployment of XLAT in LAC region

IPv6 Capability:CA

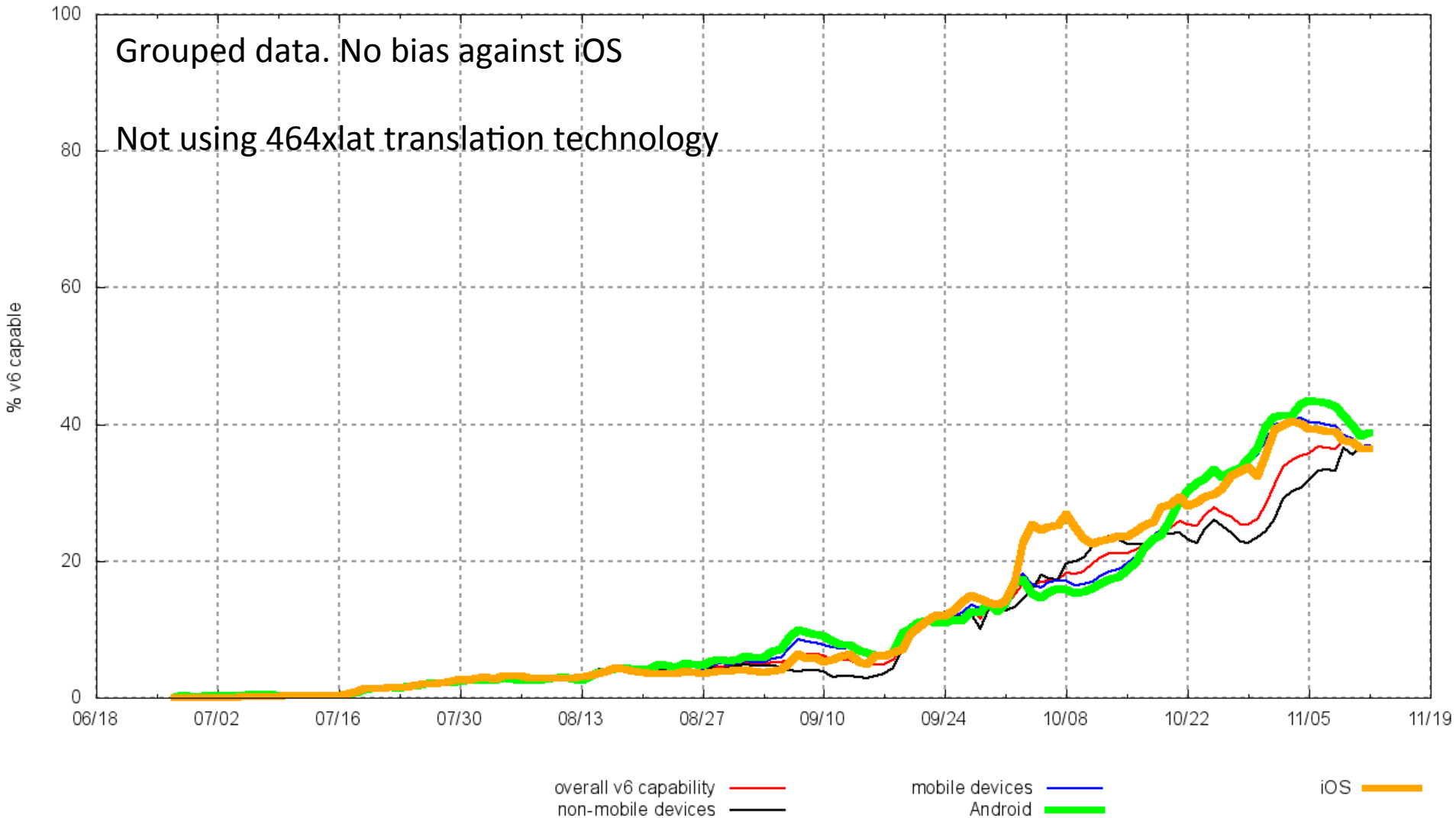


ASN ranked by eyeball share

ASN	AS Name	IPv6 Capable	IPv6 Preferred	Eyeball share
AS812	ROGERS-CABLE - Rogers Cable Communications Inc.	0.66%	0.05%	16.20%
AS6327	SHAW - Shaw Communications Inc.	0.04%	0.01%	15.04%
AS852	ASN852 - TELUS Communications Inc.	18.45%	16.89%	14.63%
AS577	BACOM - Bell Canada	0.01%	0.01%	14.57%
AS5769	VIDEOTRON - Videotron Telecom Ltee	2.56%	2.34%	7.56%
AS7992	COGECOWAVE - Cogeco Cable	2.11%	1.86%	3.04%
AS855	CANET-ASN-4 - Bell Aliant Regional Communications, Inc.	0.04%	0.00%	2.87%
AS5645	TEKSAVVY - TekSavvy Solutions, Inc.	0.87%	0.77%	2.55%
AS803	SASKTEL - Saskatchewan Telecommunications	0.01%	0.00%	1.46%
AS7122	MTS-ASN - MTS Allstream Inc.	0.03%	0.02%	1.44%

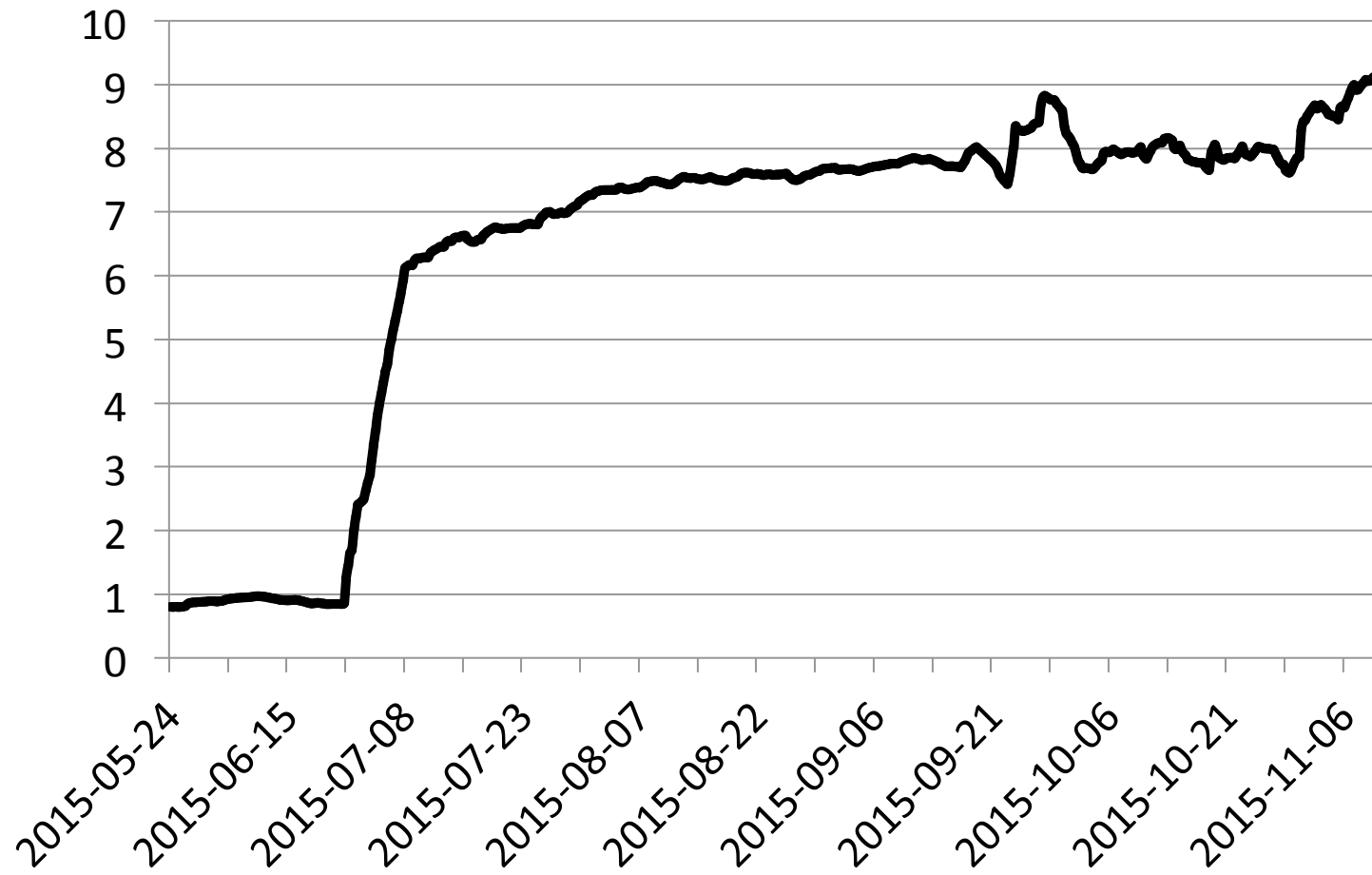
AS852 - TELUS Communications Inc.

852 ASN852 - TELUS Communications Inc. CA IPv6 capability



Other worldwide deployments

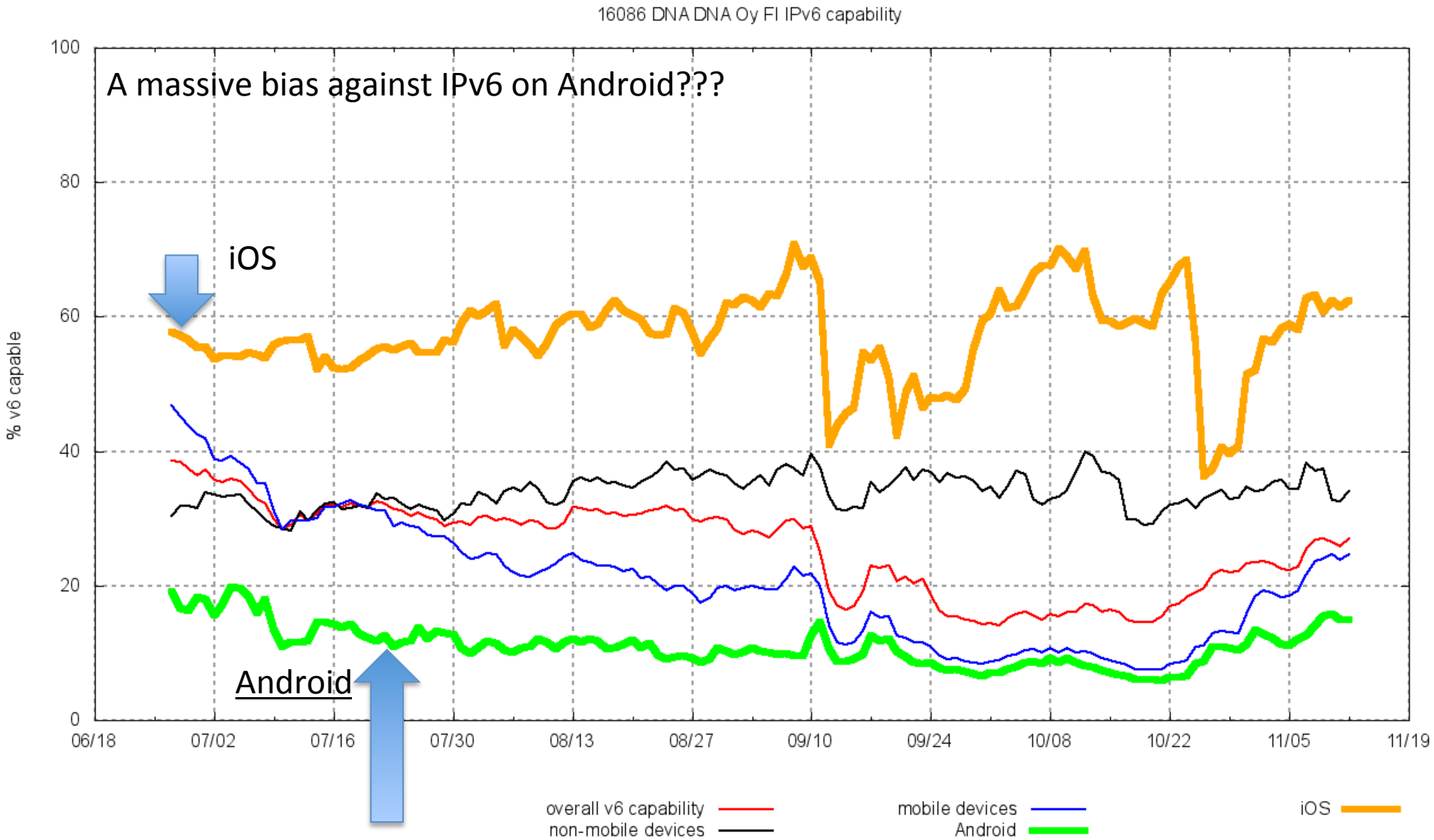
IPv6 Capability:FI



ASN ranked by eyeball share

ASN	AS Name	IPv6 Capable	IPv6 Preferred	Eyeball share
AS1759	TSF-IP-CORE TeliaSonera Finland Oyj	0.14%	0.09%	25.16%
AS16086	DNA DNA Oy	18.83%	17.80%	23.03%
AS790	EUNETFI Elisa Oyj	4.05%	3.96%	21.24%
AS719	ELISA-AS Elisa Oyj	0.62%	0.14%	16.72%
AS2586	UNINET-AS Elisa Eesti AS	4.14%	4.12%	5.16%
AS15527	ANVIA Anvia Oyj	0.07%	0.01%	1.85%
AS1741	FUNETAS CSC - Tieteen tietotekniikan keskus Oy	6.79%	6.69%	1.44%
AS24751	MULTIFI-AS Jakobstadsnejdens Telefon Ab	0.02%	0.02%	0.50%
AS39699	SSPOY-AS SSP Yhtiot Oy	0.16%	0.04%	0.50%
AS29422	NBLNETWORKS-AS Nebula Oy	1.56%	1.30%	0.42%

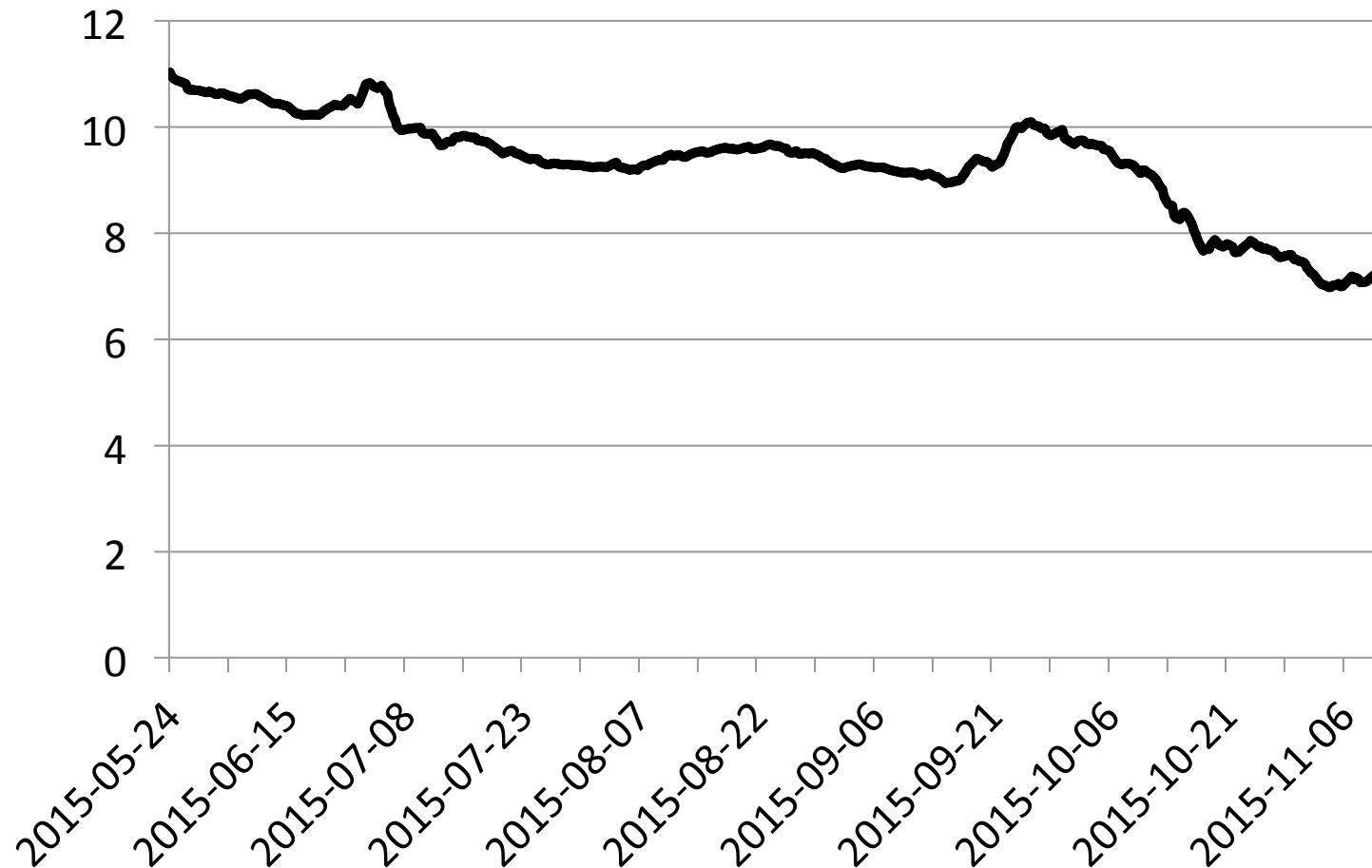
AS16086 DNA DNA Oy



Ok.. I can't explain this.

- Maybe this is a DHCPv6 deployment without DHCPv6-PD?
- Hard to understand why there would be a systematic bias against Android devices favouring iOS,
 - compared to 464xlat which is understood to bias against iOS capability

IPv6 Capability:NO

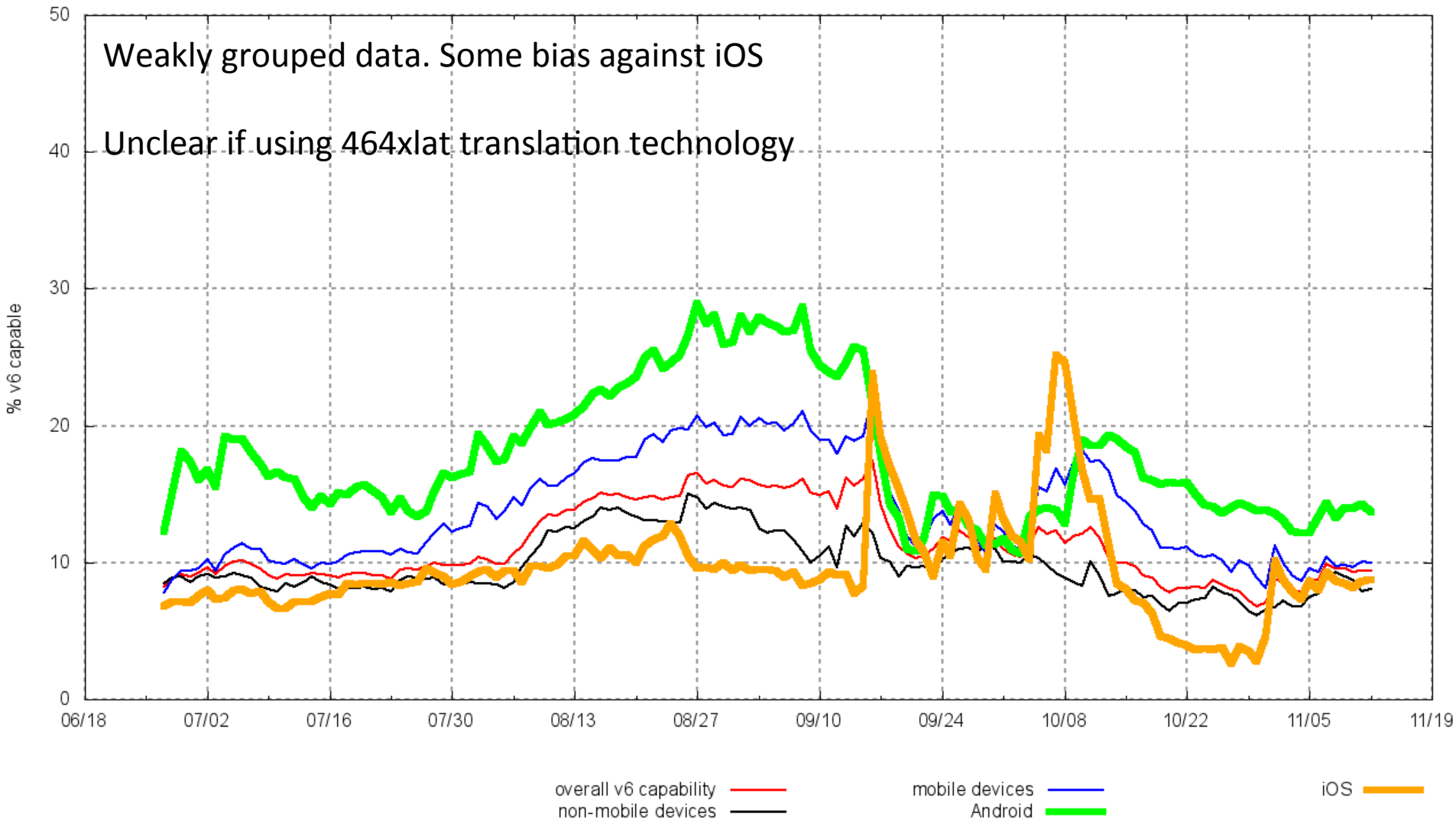


ASN ranked by eyeball share

ASN	AS Name	IPv6 Capable	IPv6 Preferred	Eyeball share
AS2119	TELENOR-NEXTEL Telenor Norge AS	9.76%	9.20%	50.99%
AS29695	ALTIBOXAS Altibox AS	1.74%	1.68%	10.22%
AS41164	GET-NO Get AS	27.05%	23.28%	8.48%
AS15659	NEXTGENTEL NextGenTel AS	0.04%	0.04%	6.22%
AS2116	ASN-CATCHCOM Broadnet AS	0.06%	0.03%	5.16%
AS224	UNINETT UNINETT, The Norwegian University Research Network	17.84%	16.29%	3.04%
AS12929	NETCOM-AS TeliaSonera Norge AS	0.05%	0.01%	2.64%
AS39832	NO-OPERA Opera Software ASA	51.75%	22.83%	2.24%
AS49455	LOQAL-AS Loqal AS	0.03%	0.00%	1.07%
AS15765	MIMER Tafjord Marked AS	1.57%	1.48%	0.96%

AS2119 Telenor Norge AS

2119 TELENOR-NEXTEL Telenor Norge AS NO IPv6 capability

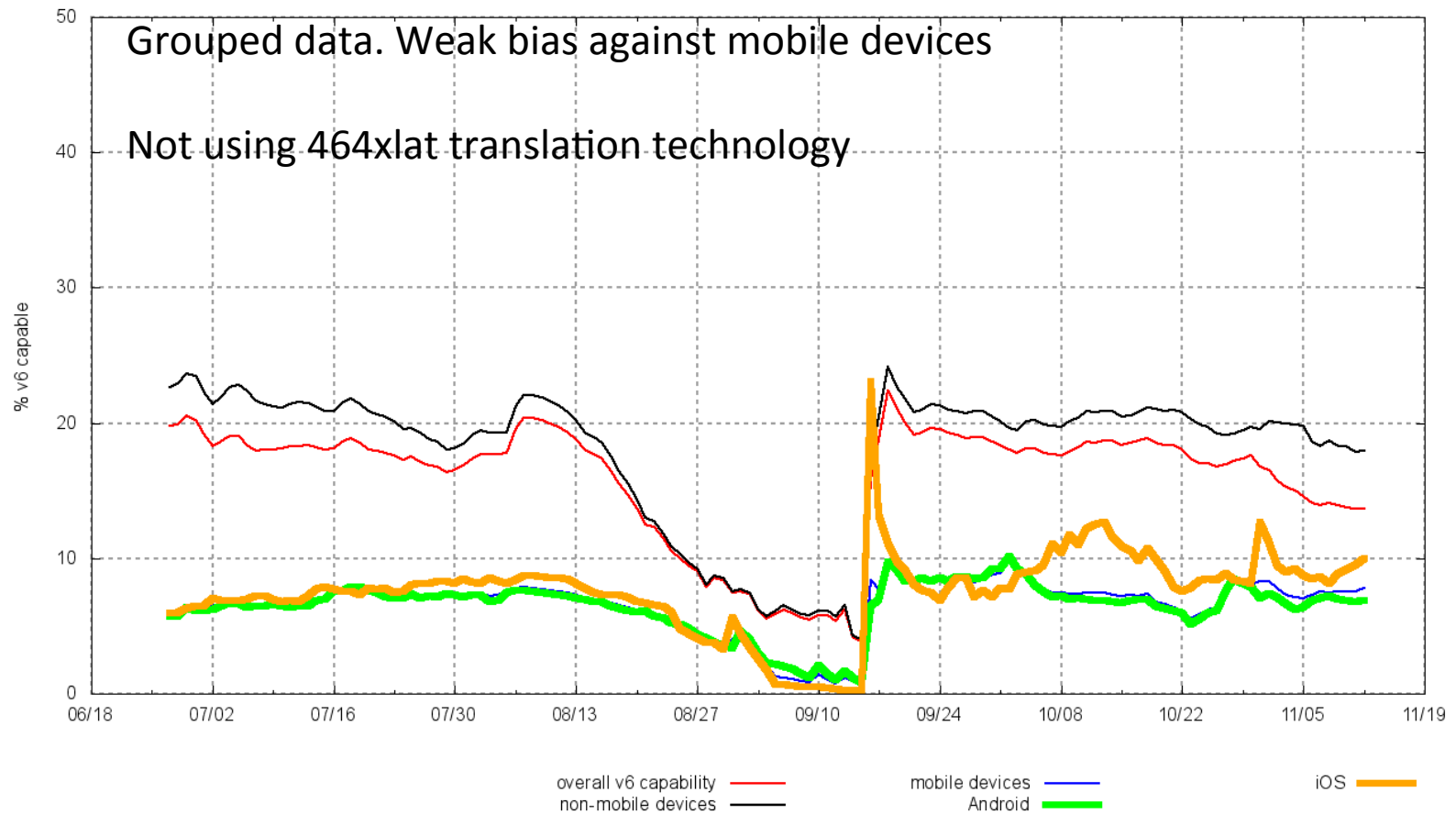


Romanian deployments of Significance

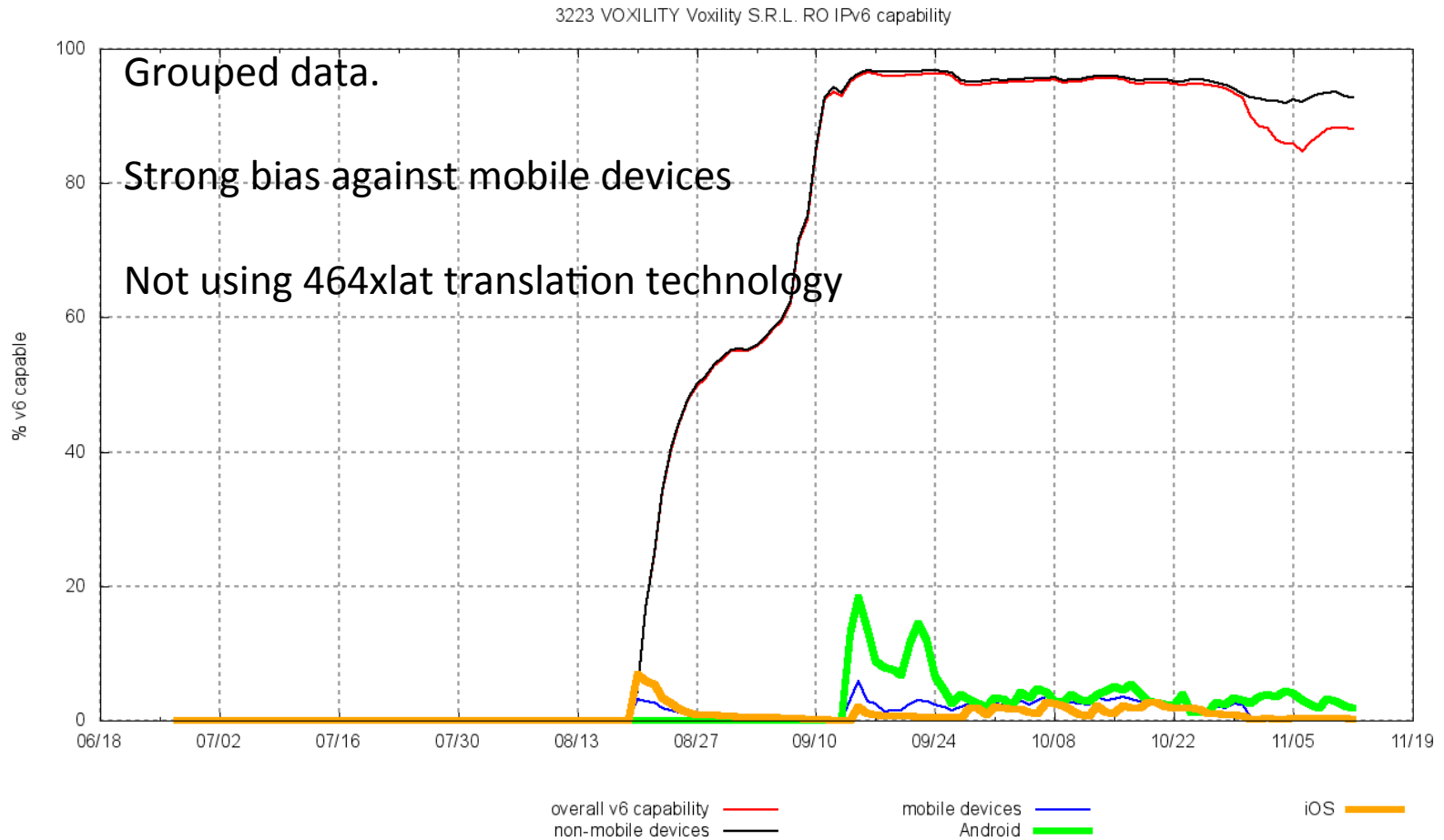
- AS8708 RCS-RDS SA
- AS3223 Voxility S.R.L.
- Both show significantly lower IPv6 capability on mobile devices, suggesting they are predominantly cable/ADSL deployments, with local WiFi not propagating an IPv6 prefix or using a transition mechanism which doesn't support mobile devices.

AS8708 RCS-RDS SA

8708 RCS-RDS RCS RDS SA RO IPv6 capability



AS3223 Voxility S.R.L.



Conclusions

- APNIC has moved away from a dependency on Flash and gained insight into more devices
- APNIC is now able to see inside Mobile & Cellular networks, and see significant deployment differences emerge from transition method, technologies
- Transition mechanisms like 464xlat work and can boost IPv6 capability in the right circumstances
 - Reduces pressure on CGN/NAT address devices
 - Cannot support iOS, which may not matter in some markets

Thank You!

- Thanks to Google, ISC, RIPE NCC for hosting and assistance with the research programme
- If you are interested in IPv6 measurements there is a lot to talk about over a beer...

Thank You!

