



XI'AN, CHINA  
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# Understanding the IPv6 landscape

**APNIC**



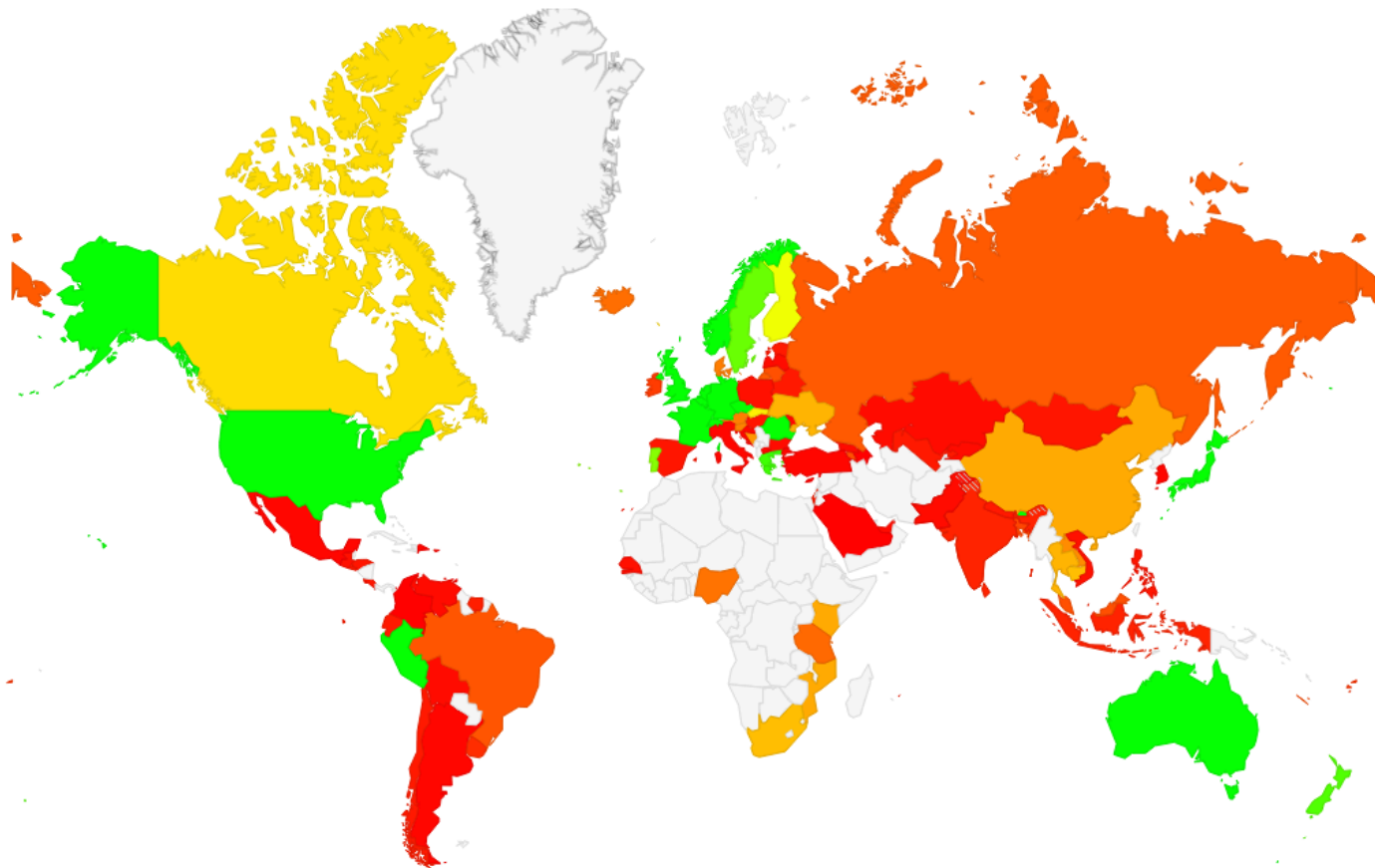
# George Michaelson

Research Scientist



# Understanding the IPv6 landscape

- Many measures
  - Volume of packets at Exchange points, Trunks & Interconnects
  - Percentage of significant websites enabled for IPv6
  - Volume of IPv6 prefixes assigned in region/economy/industry-sector
  - End user behaviour
- APNIC is measuring end-user client readiness
  - “If I enable IPv6 in my network, can my clients make use of it”
  - “how many people behind my infrastructure are already using IPv6”
  - “how many people prefer IPv6 if offered a dual-stack resource”
- There isn't a single-line answer: the landscape is complicated
  - Large variances in capability by economy, region, industry-sector



# Why so much variance?

- Short answer: we don't know.
- Longer answer(s)
  - Local conditions vary by pricing, distance, technology, regulation...
  - Customer access looks to require (re)capitalization of the CPE
    - Where are you in your ROI and ageing of the existing capital investment?
  - LTE looks to be a good candidate for motivated people to deploy IPv6 but...
    - Many telephony deployments are now an 'outsource' and IPv6 is not in the default offering
    - Handsets do not necessarily cope well with multiple protocols
  - Some of this may be distortions due to limitations in measurement
    - We can't reliably measure iOS or non-flash on some devices (yet)

# How we measure

- Targeted additions to websites (JavaScript)
  - One-line addition to existing markup
  - Can perform 1:n subsample, back off daily, weekly/monthly
  - Can blacklist known problematical networks
  - Pro: Simple, Targeted, Quick
  - Con: Prone to website specific distortions, oversampling
- Flash advertising: paid adverts with flash tests embedded
  - Random clients, worldwide (can target)
  - \$100 p.d == 350,000 tests
  - Pro: Large random sample
  - Con: Can't measure phones, mobile devices (flash restrictions)

# Whats happening now?

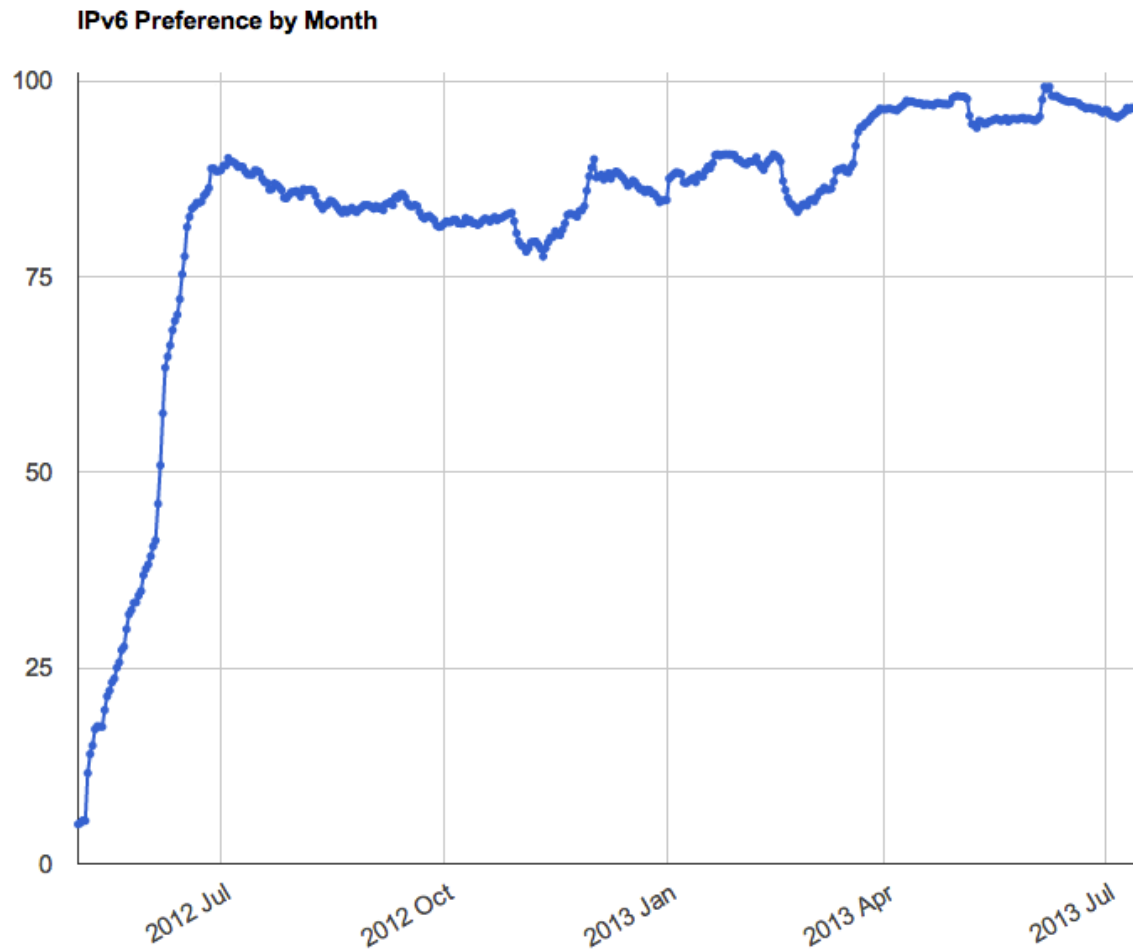
- Four rough sub-classes of IPv6 uptake being seen:
  - All the way
  - Slope
  - Wavy
  - Not happening
- Each has different consequences, implications for people in the same circumstance, or considering their deployment strategy
- Which one are you?

# All the way

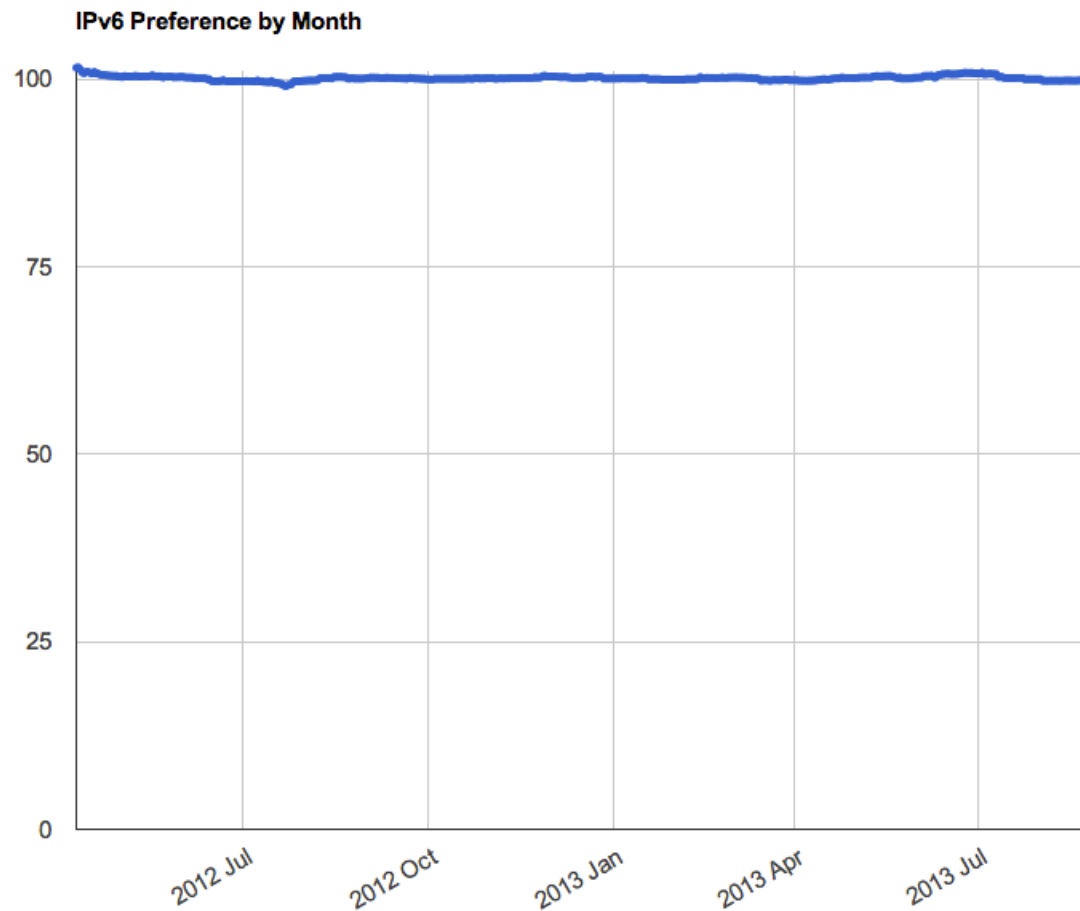
- Typically Academic and Research networks
  - High degree of modern OS, equipment
  - Little CPE: mostly campus networks with direct high speed Ethernet attachment
  - Can saturate at 60%+ but can go to 100% penetration
- Examples: Curtin Uni, Indiana GigaPOP
- If you are in this category WELL DONE
  - You probably don't need to be reading this slide pack!



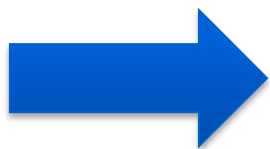
# Curtin University



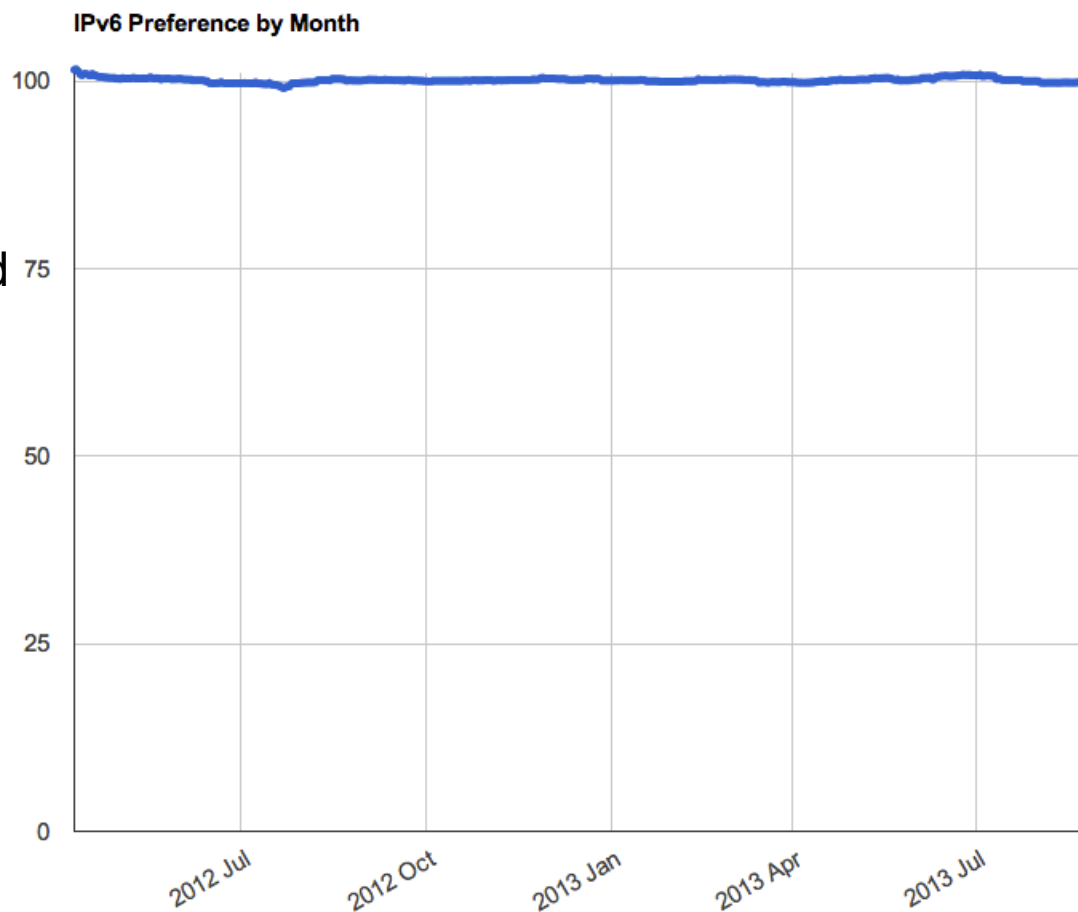
# Indiana GigaPOP



# Indiana GigaPOP



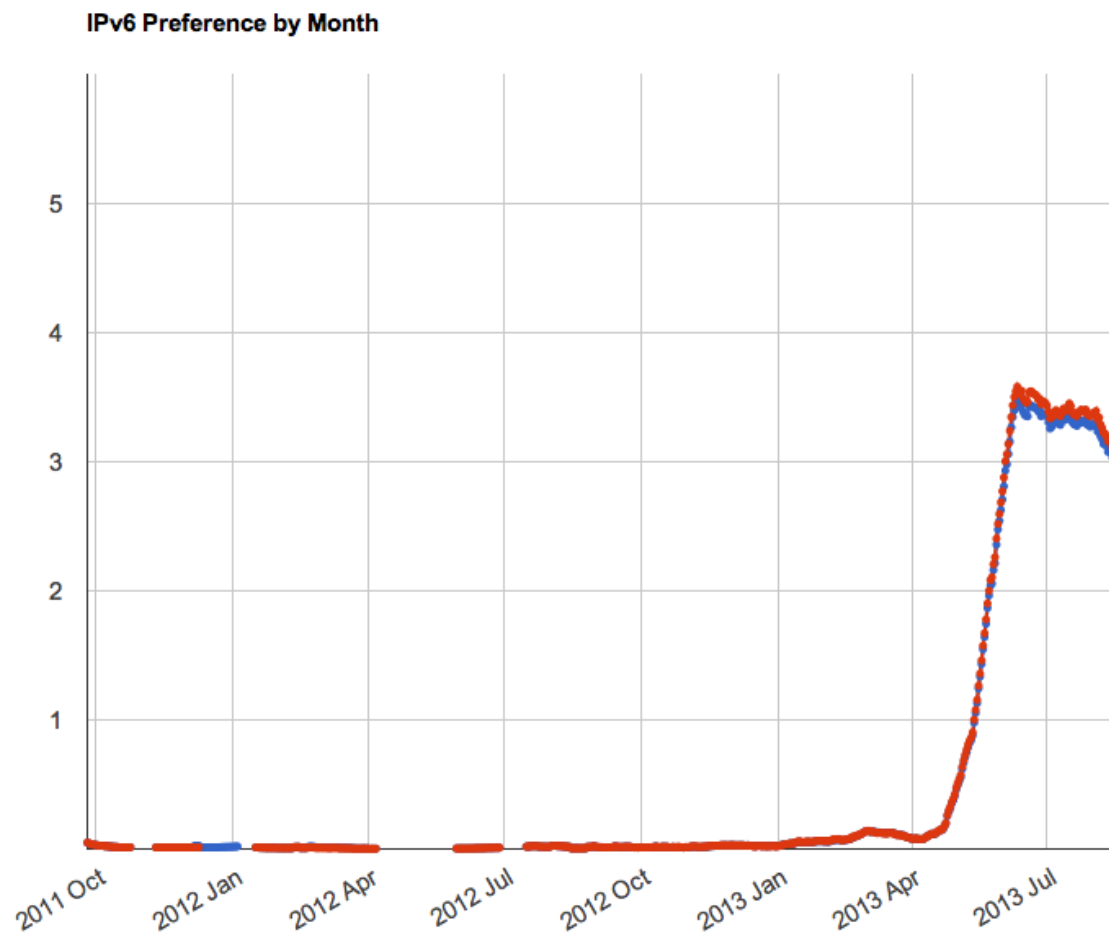
They'd deployed  
Before we started  
Measuring.



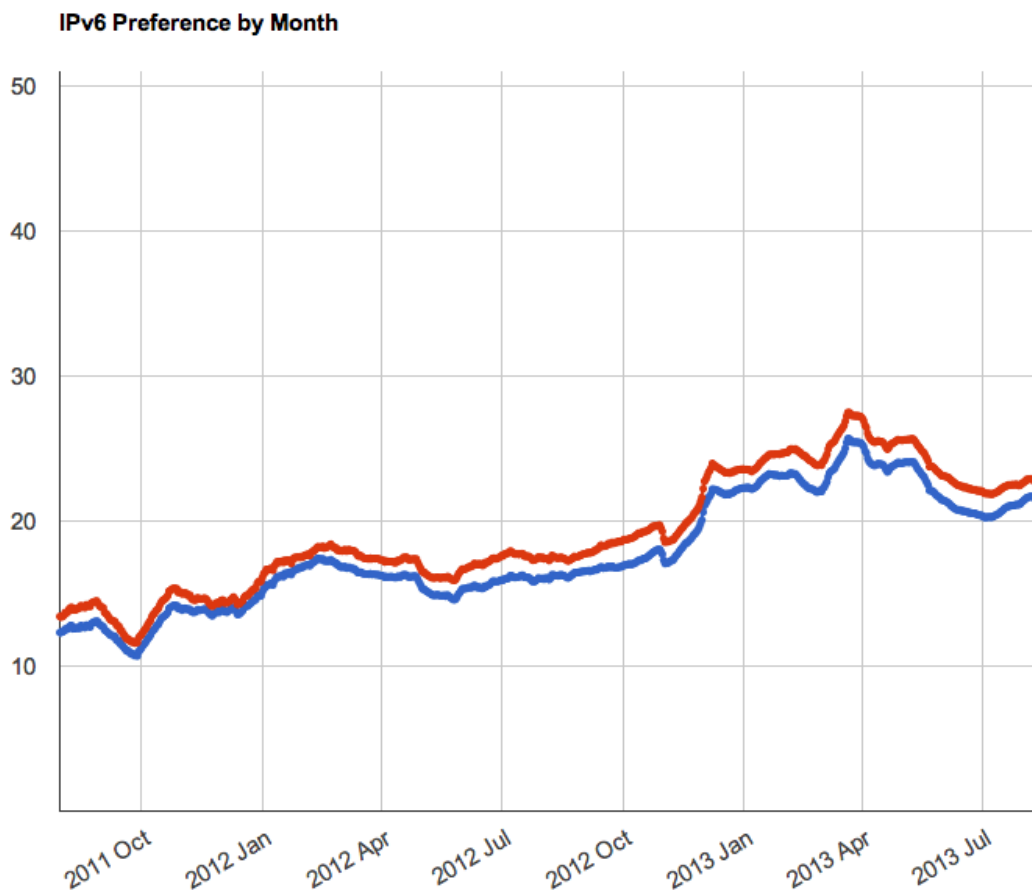
# All the way, but goes to a shelf

- initial early adoption, rapid rise to a saturation level, then stable at some level
  - Typically between 5% and 20% but can be higher
  - Reflects penetration of IPv6 enabled end devices capable of being measured, against total population of users
    - NAT, older CPE, Windows XP at 30% (declining)
- Examples: ForthNet, FreeNet, CERNET, Swisscom, JANET
- *Some indications from ISPs that this undercounts, their CPE can be enabled but we don't "see" end user activity*
- Some players in this category are using 6rd, centrally managed CPE
  - All turn on at close to the same time, so reach saturation quickly

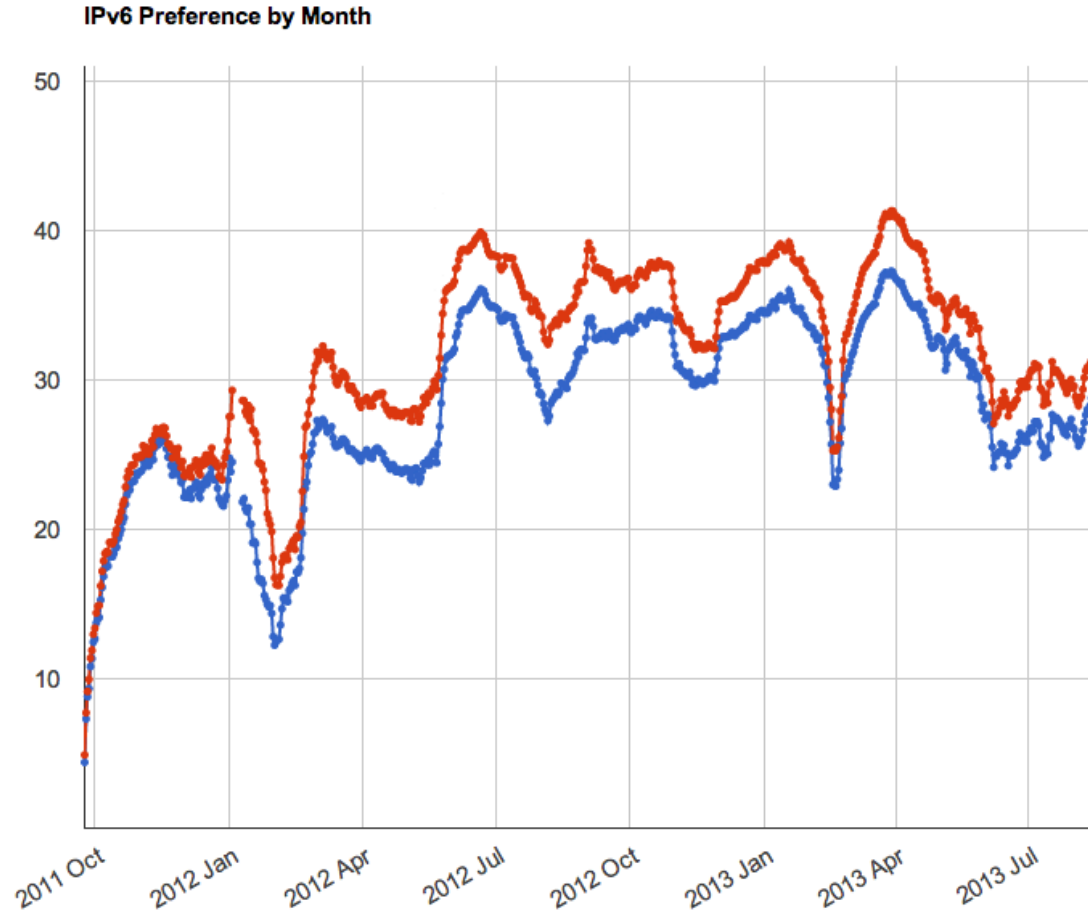
# Forthnet (GR) recent 6rd deployment



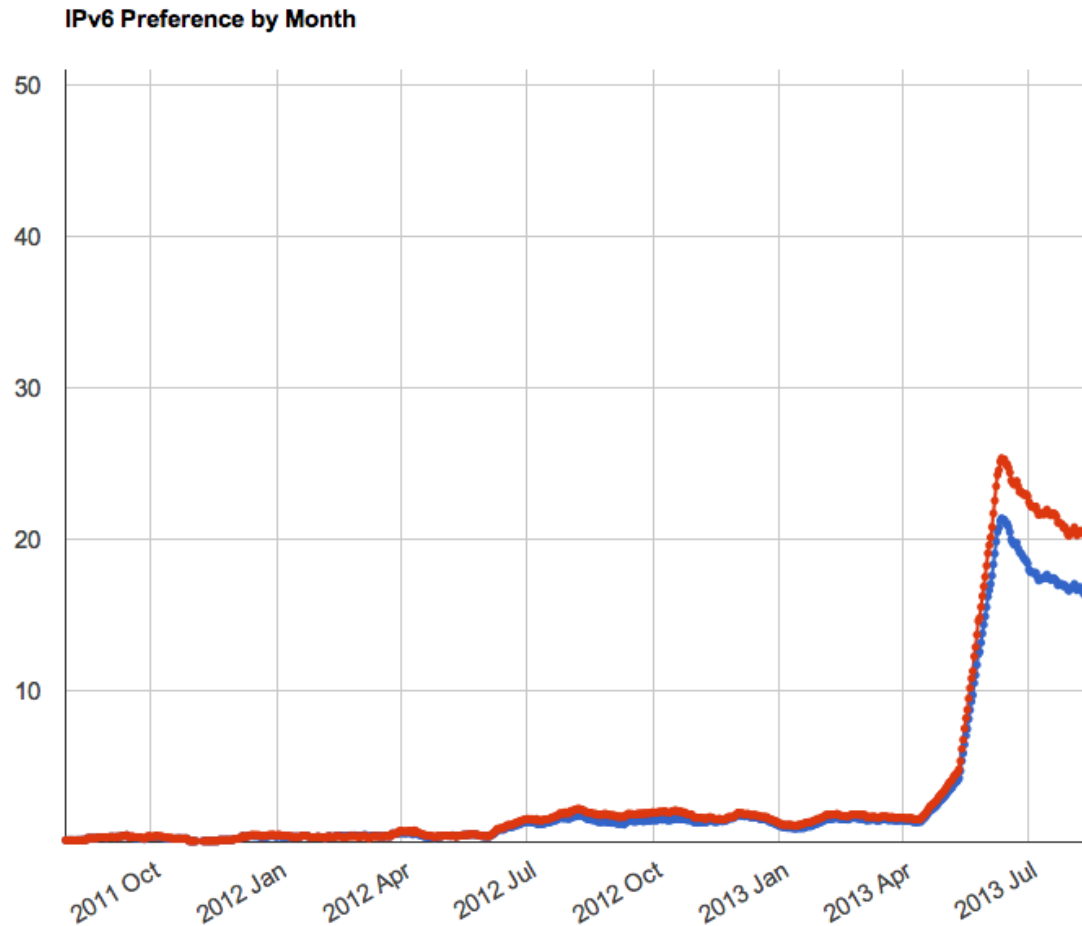
# FreeNet (FR) mature deployment 6rd



# China Education and Research Net

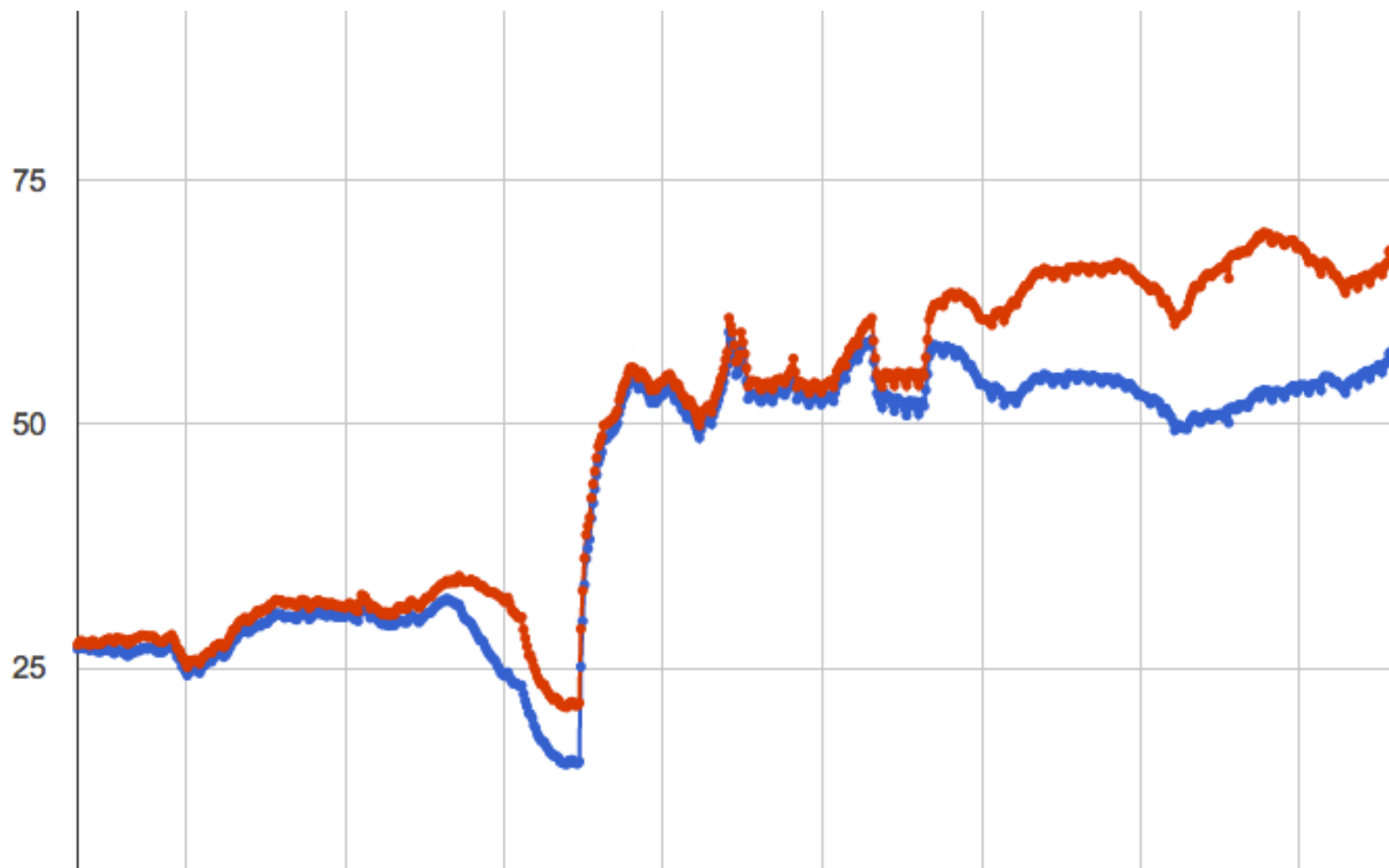


# Swisscom (CH) 6rd deployment

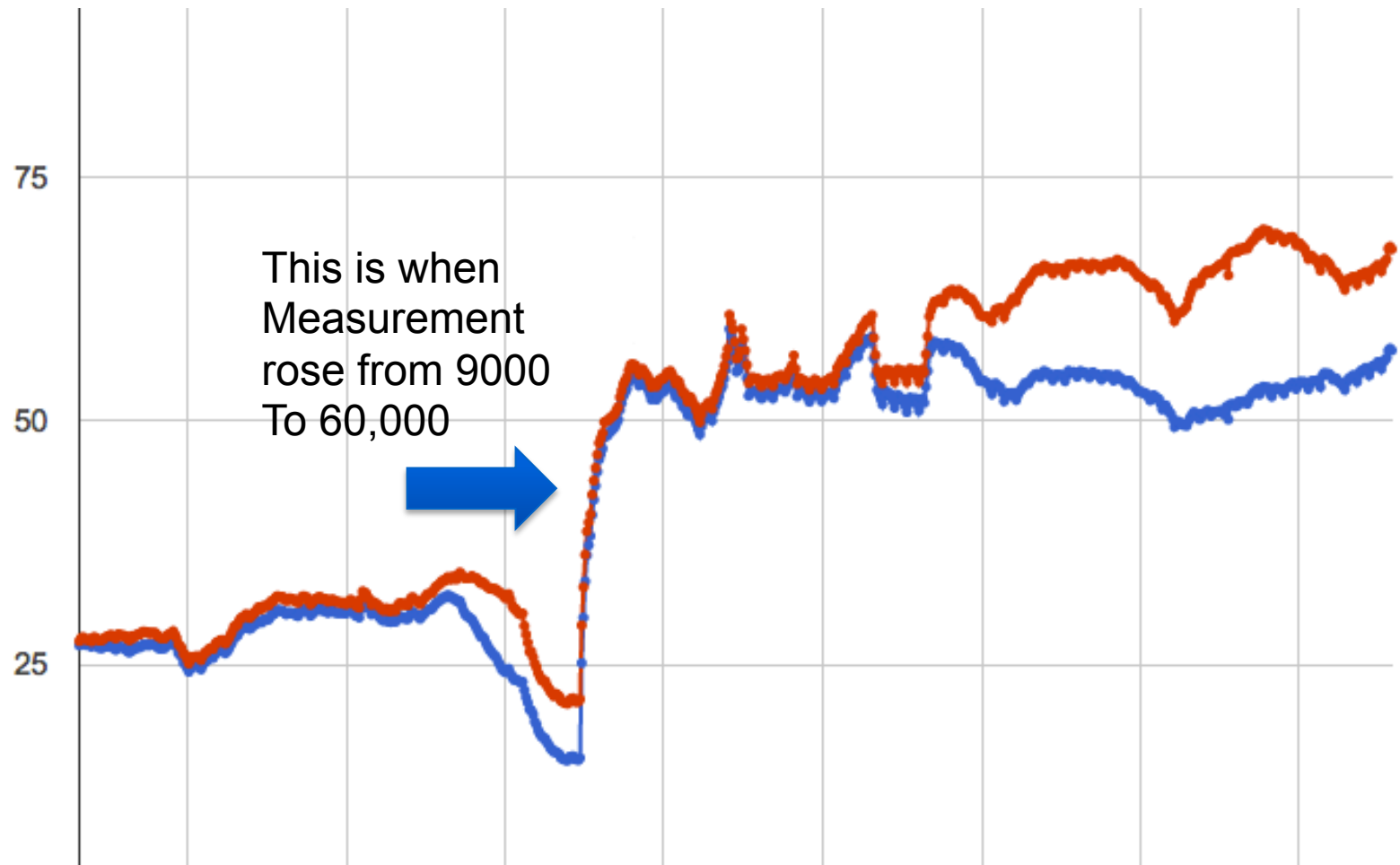




# JANET(UK) Mature Academic Network



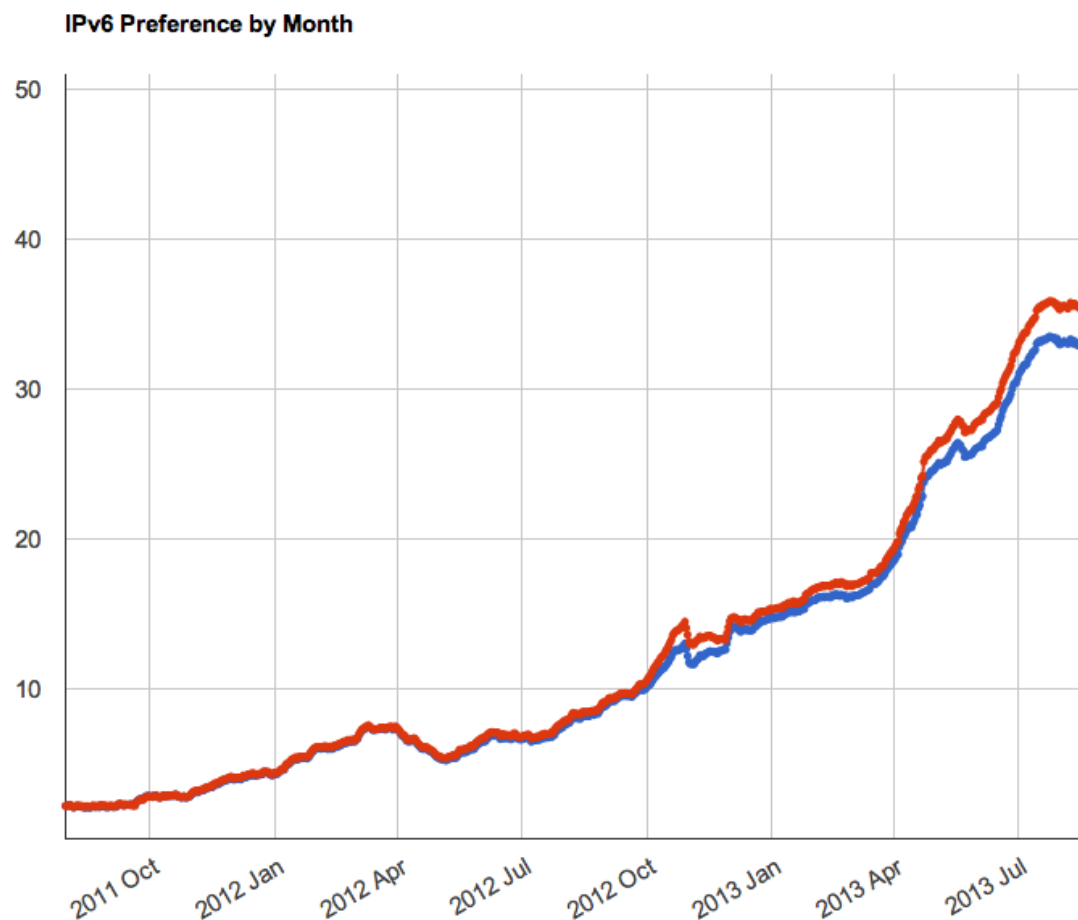
# JANET(UK) Mature Academic Network



# Slope

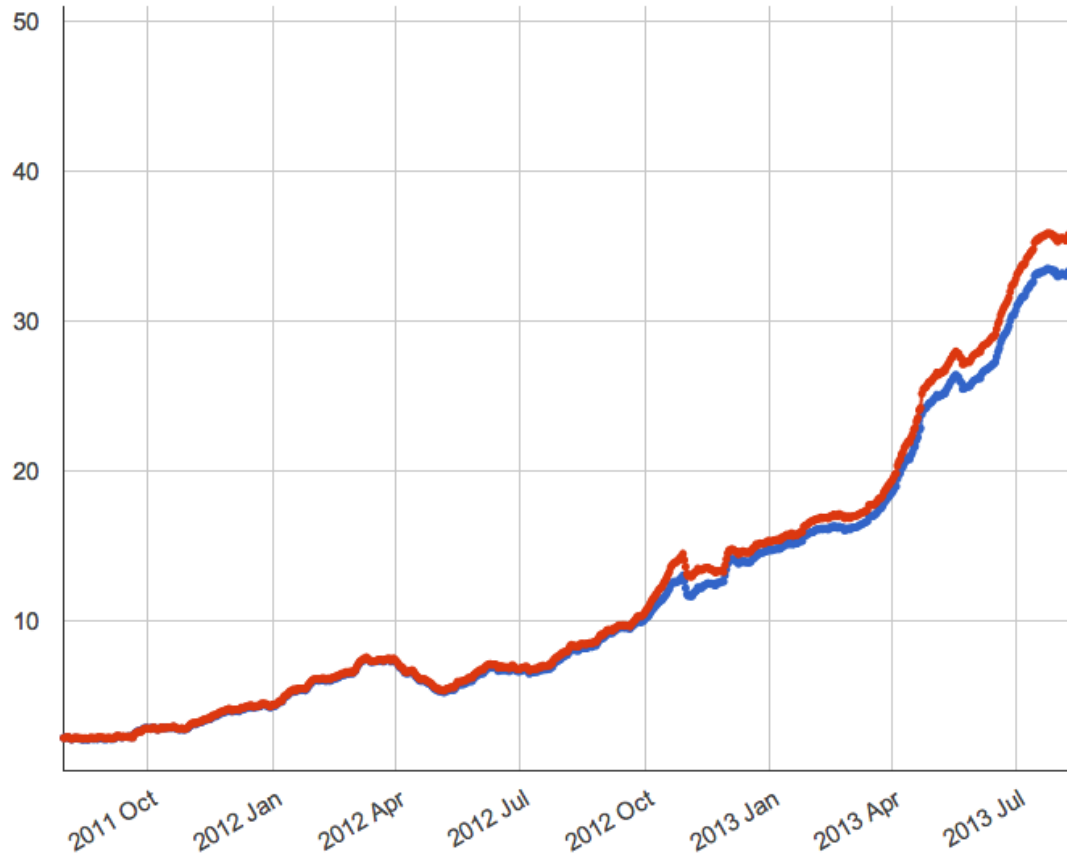
- ISP in early stages of deployment, staged deployment
- No or few legacy users, or replacing CPE
- May be heading to a shelf, but hasn't got to the cutoff point.
  - If no legacy, the cutoff may not be low! (Verizon, LTE deployment)
- Examples: Verizon, KDDI
- Where the line is going to 'end' isn't clear. At least one example on this pack was still in growth mode, 2 months ago and has just (possibly) turned an inflection corner.

# Verizon: LTE, legacy-free



# Verizon: LTE, legacy-free

IPv6 Preference by Month

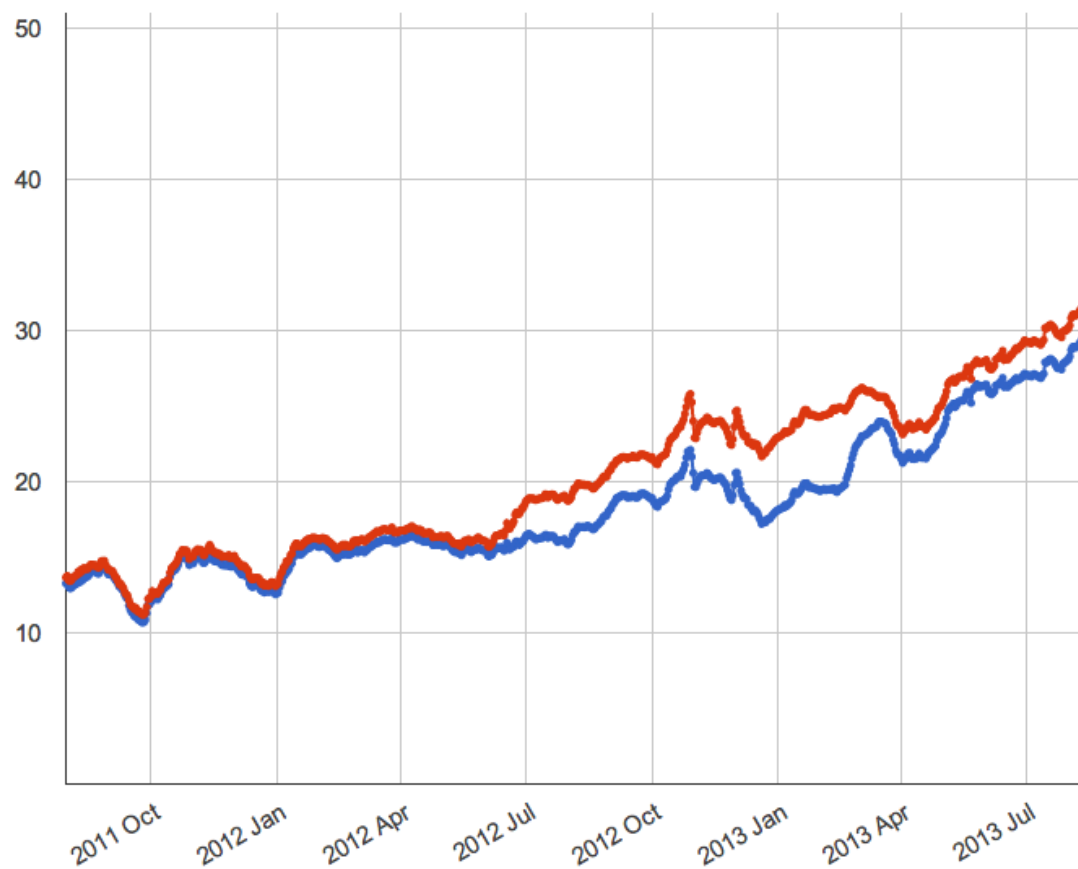


Is this a shelf?



# KDDI

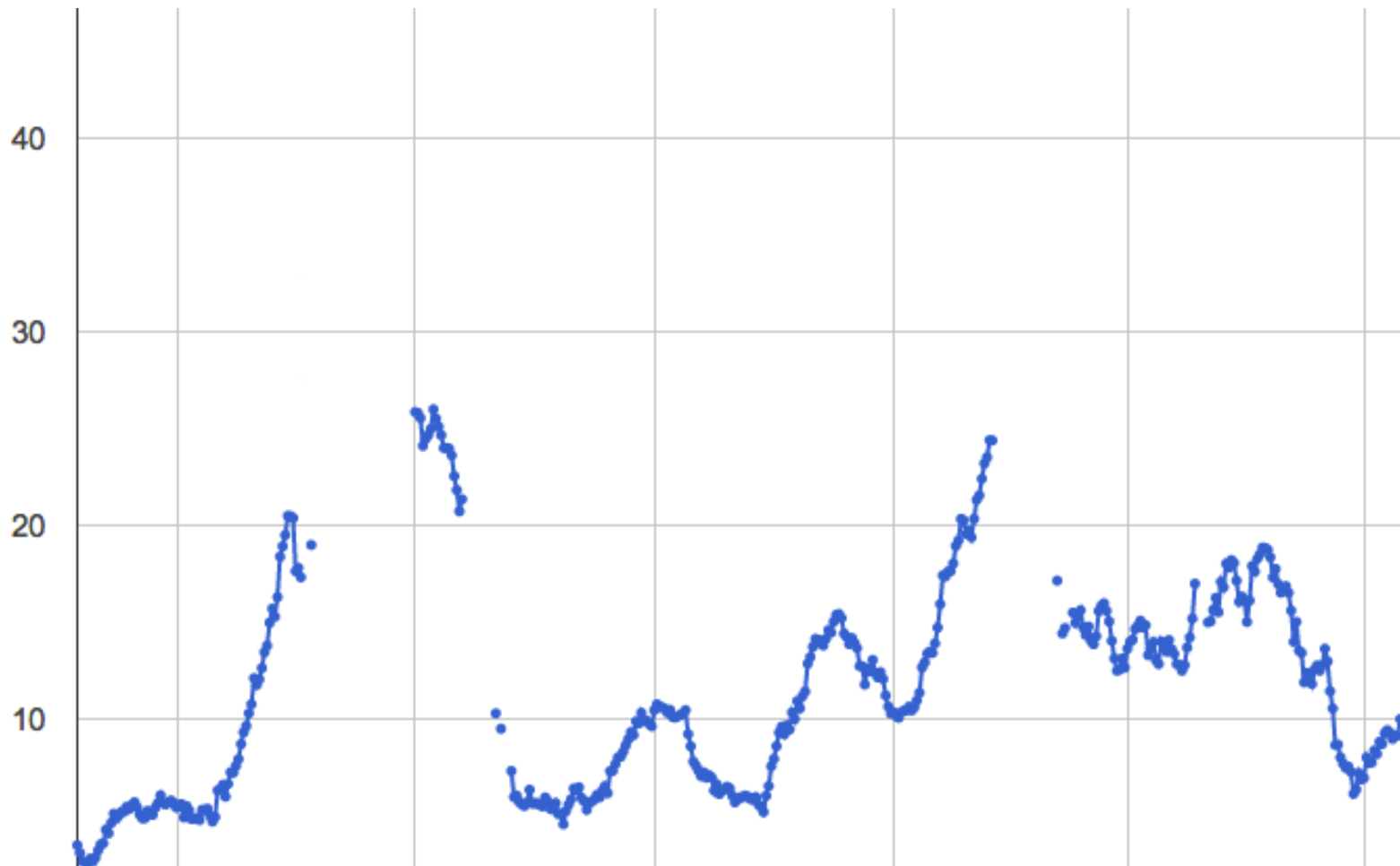
IPv6 Preference by Month



# Wavy

- Varying visibility into the experiment despite apparently high numbers
- Unstable dynamics of usage
- May reflect firewalls, interception devices, or other dynamics limiting visibility to the experiment
- Examples: China
- We can't reliably measure, so the exact dynamics from our data won't help inform you

# Academica Sinica (CN)

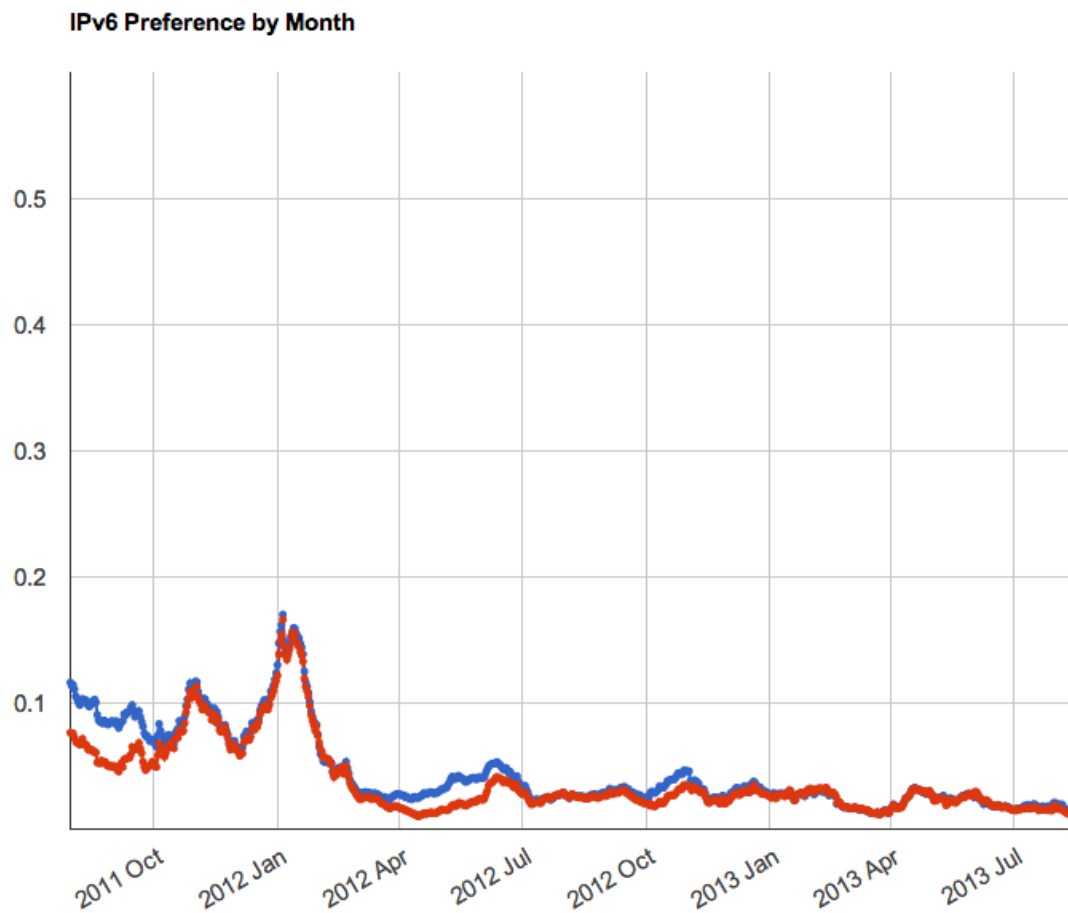




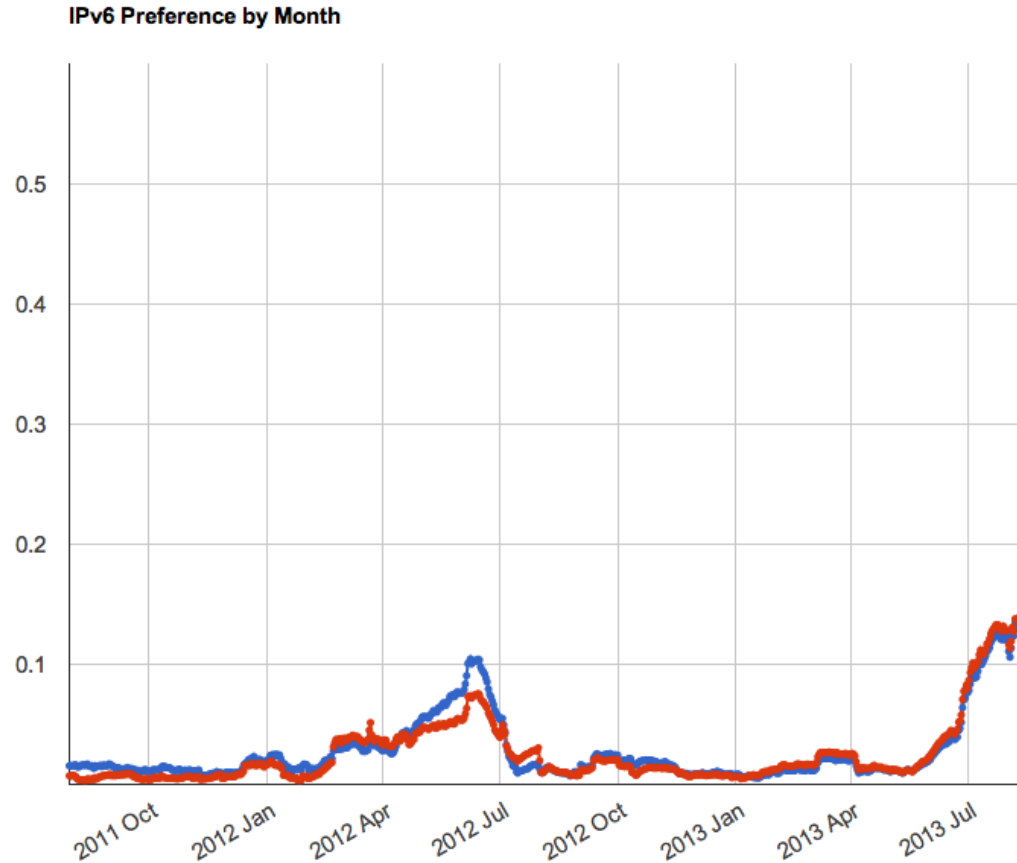
# Not happening

- Little or no evident IPv6 despite large volume of experiments
  - CPE incapable of upgrade,
  - pricing & other factors limiting uptake
- Devices incapable of running flash or javascript but invoked into measurement
  - Behind CGN, Proxy devices
- Example: KR, Telstra ...

# Korea (all ASN)



# Telstra (AU) recent early-stage tests?



# Drilling down into an economy

- Global Economy figure can be expanded into per-AS view
- AS with significant adoption
- AS with little or no adoption
- AS with IPv6 via other AS

# Example: Singapore top 12

ASN	AutNum	Network Name	count	%capable	%preferred
24482	SGGS-AS-AP	SG.GS	213	28.2407	25.463
7472	NUS-AS-AP	Computer Centre	343	18.5714	17.4286
55430	STARHUBINTERNET-AS-NGNBN	Starhub Internet Pte Ltd	7526	15.6201	13.5184
4773	MOBILEONELTD-AS-AP	MobileOne Ltd. Mobile/Internet Service Provider Singapore	37415	10.2471	9.20672
18106	VIEWQWEST-SG-AP	Viewqwest Pte Ltd	832	1.4068	0.820633
10091	SCV-AS-AP	StarHub Cable Vision Ltd	17526	1.08992	0.397366
9506	MAGIX-SG-AP	Magix Broadband Network	151312	0.396424	0.378137
132047	MYREPUBLIC-SG	MyRepublic Ltd.	2588	0.191424	0.191424
17547	QALA-SG-AP	M1 CONNECT PTE. LTD.	2718	0.144718	0.108538
4657	STARHUBINTERNET-AS	StarHub Internet Exchange	3862	0.301432	0.100477
3758	ERX-SINGNET	SingNet	9300	0.0837872	0.0628404
45143	SINGTELMOBILE-AS-AP	SINGTEL MOBILE INTERNET SERVICE PROVIDER Singapore	7465	0.0929738	0.0531279

# General observations

- Innate IPv6 capability is baked into OSX, Windows, Linux/Unix, many 3G & LTE handsets, 3G/LTE modems.
  - Legacy is a declining problem, but there is a large XP overhang
- Most of the problems with deployment in scale relate to intermediate CPE/home-router boxes.
  - We believe in almost all cases, the significant heavy lifting to deliver IPv6 to the core has been done, or is tractable on current equipment
- There are some downside risks to ‘adding’ IPv6 to your services without planning
  - Additional delays during connection if gethostbyname() returns IPv6 addresses and they don’t respond
  - More is not always better: same entity on IPv4 and IPv6 looks like two different things, both will be tried if its offline

# Questions you can ask yourself

- Do I understand my local landscape?
  - What are other people in my economies of interest doing?
  - Do I have a window for a competitive advantage?
  - Am I falling behind?
- Where am I, in a capital investment cycle?
  - Good time to require end-user IPv6 is baked into CPE purchases
- Are IPv6 customers valuable customers?
  - Yes. They appear to be high end users, looking for quality/ distinguishing services
- What are my competitors doing?
  - Comcast announced IPv6 some time ago. It only 'took off' recently
  - IPv6 growth can come very quickly, from a low base

# Questions you can ask yourself

- What percentage of users in my client base could use IPv6
  - Hint: the newer their platform, the higher the count
  - Hint: if you accept mobile data roaming in 3 or 4 G, then you may already have people roaming onto you who use IPv6 (remember all data trombones back to their home provider in a tunnel)
- We undercount iOS and Android. So things can be better than we show if that's your core client platform
- How close is my IPv6 backhaul to my IPv4 transit paths?
  - It's a good idea to try and make them congruent.
  - 'follow the money'
  - If your V4 transit isn't providing IPv6, look around.



# Questions you can ask yourself

- I think I'm on the slope
  - Where are you going to hit? 10% - 20% - 60% 100%
- I think I've plateaued
  - If you're under 20% it may be XP or other blockers.
  - Maybe the way you're deploying has a hiatus?
- I look hard to measure/variable data
  - Think about hosting Javascript and getting more data
- I'm on 100%
  - Why are you reading this slidepack!

# How you can help

- More measurements are better!
- Place the Javascript ad on popular websites relevant to your interests
  - Local, national weather sites. Radio stations. Newspapers
    - Avoids sample bias, captures cross-provider end-user traffic
  - Specific webs can work too: eg Tertiary education samples collected in UK from JANET homed webpages
- Help us by funding flash adverts
  - We can target specific client interests, economies, times of day
  - Data for developing internet economies, Africa, Pacific needs improvement

# Join in!

- Run the javascript:
  - Contact [research@apnic.net](mailto:research@apnic.net) to get experiment id
  - One line of `</script>` embedded in your web
    - Can restrict return rate, sample, exclude networks
- Help us with flash advertising
  - We can target flash campaigns to specific regions, keywords, networks
  - \$100 p.d. gets 250,000 measurements