Overview of the Internet and IPv6

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Agenda

- About the Internet
- About TCP/IP
  - About Internet Protocol (IP)
  - Anatomy of the Internet
- IP address
  - Difference between IPv4 and Ipv6
- IPv6 transition technologies
- IPv6 in national policies
  - Some examples
  - Successful IPv6 deployment
- IPv6 capacity development efforts

- About the Internet
- About TCP/IP
  - About Internet Protocol (IP)
  - Anatomy of the Internet

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About the Internet

- The Internet is a global system of interconnected computer networks that use the **standard Internet protocol suite (TCP/IP)** to serve several billion users worldwide.

http://en.wikipedia.org/wiki/Internet

About the Internet

- It is **a network of networks** that consists of **millions of private, public, academic, business, and government networks**, of local to global scope, that are linked by a broad array of electronic, wireless and optical networking technologies.

http://en.wikipedia.org/wiki/Internet

About the Internet

- The Internet carries an **extensive range of information resources and services**, such as the inter-linked hypertext documents of the World Wide Web (WWW), the infrastructure to support email, and **peer-to-peer** networks.

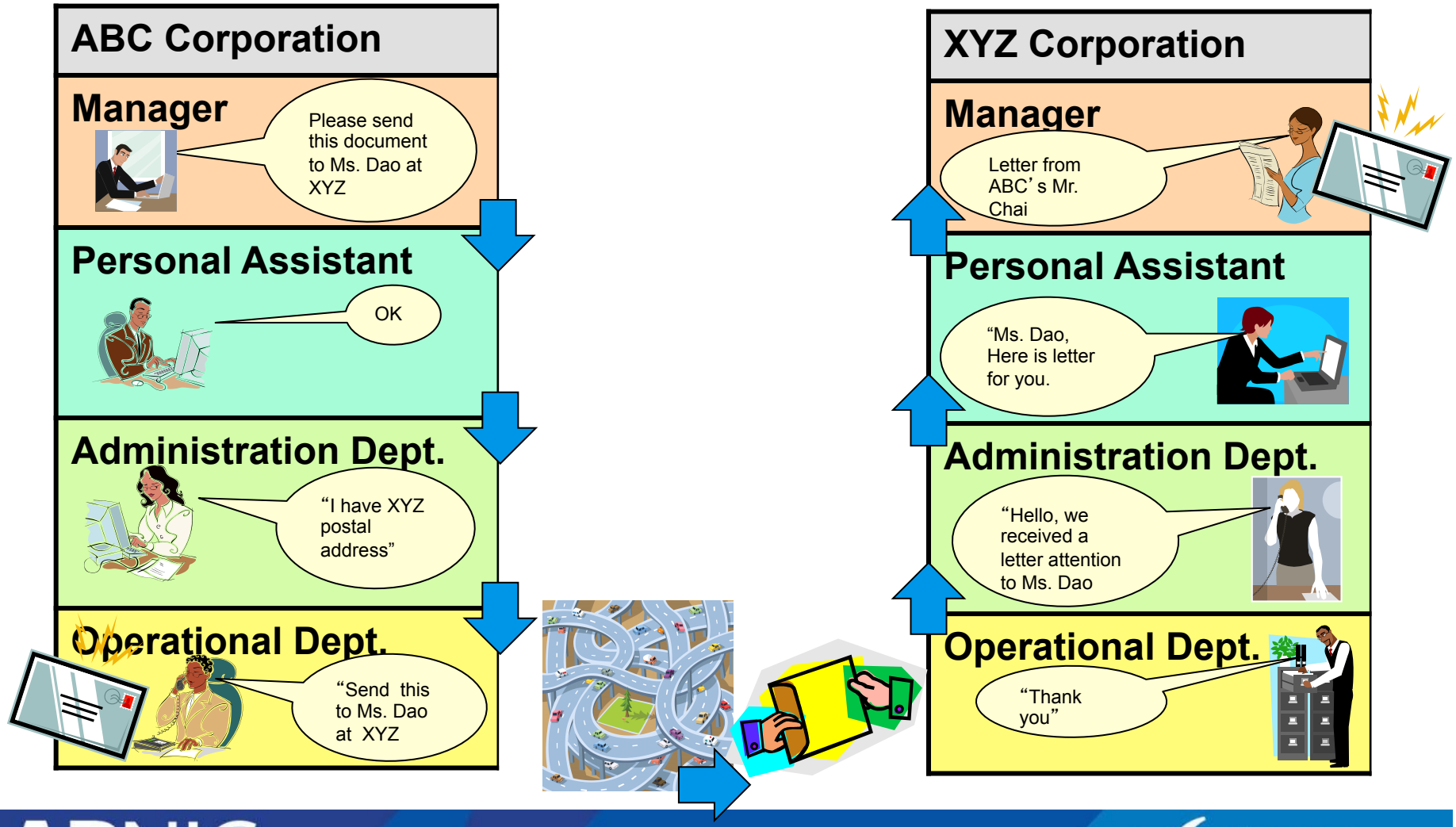
http://en.wikipedia.org/wiki/Internet

About TCP/IP

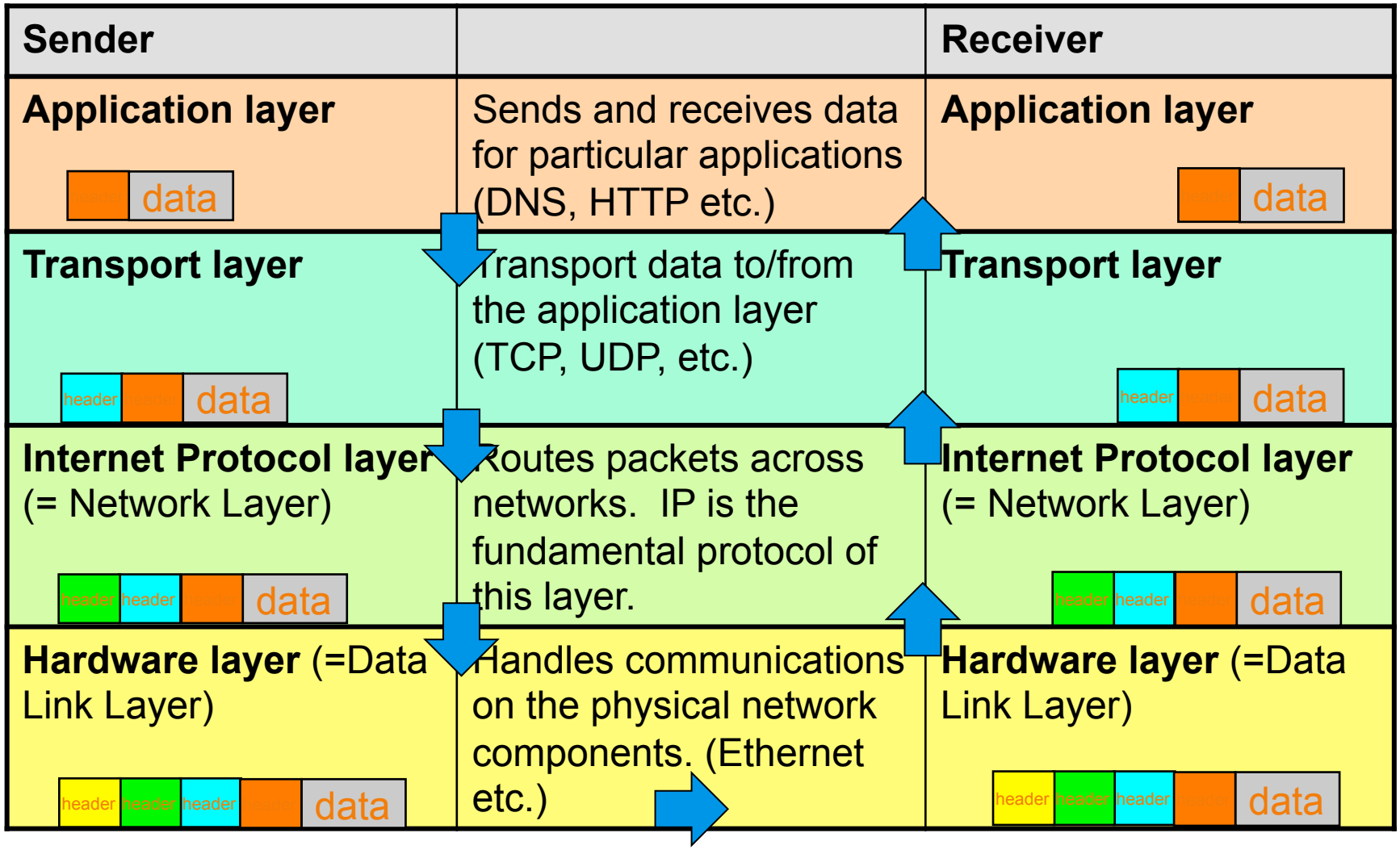
- TCP/IP
  - Transmission Control Protocol and Internet Protocol
  - Internet Protocol Suite
  - The set of communication protocols used for the Internet and other similar networks
- Communication Protocols
  - The set of standard rules for data representation, signaling, authentication, and error detection required to send information over a communication channel

http://en.wikipedia.org/wiki/Communications_protocol

Staged (layered) communication in our daily life



Staged (layered) communication in the Internet

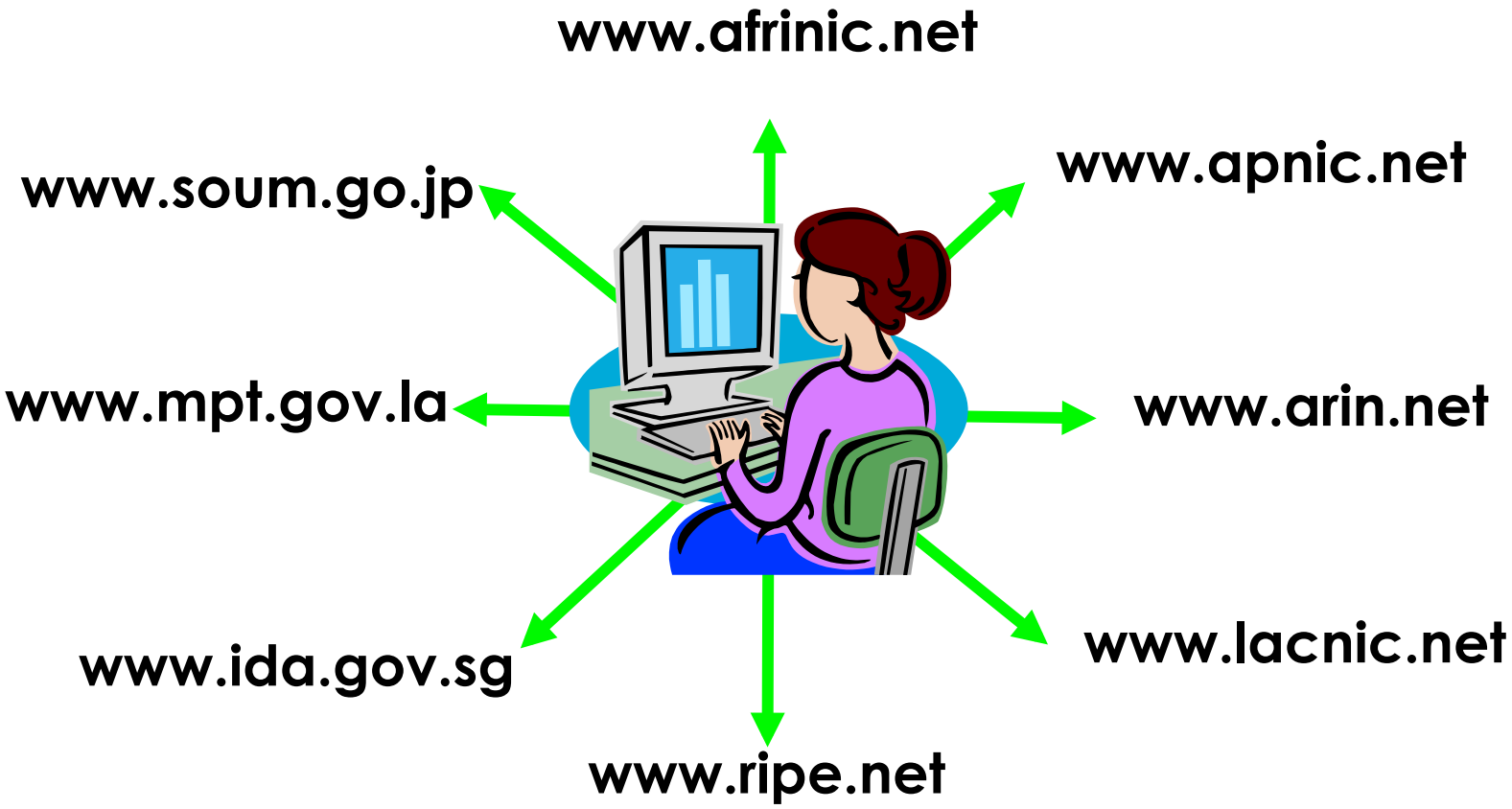


Ref: Guide to Integrating Forensic Techniques into Incident Response

What is an IP address?

- An **Internet Protocol (IP) address** is a number that identifies a device on a computer network
  - A number
  - Every device directly connected to the Internet needs a unique IP address
- NOT a domain name
- Two types of IP addresses
  - IPv4 and IPv6

On the Internet, you are nothing but an IP address!



On the Internet, you are nothing but an IP address!

www.afrinic.net
196.216.2.6
2001:42d0:0:200::6

www.apnic.net
203.119.102.244
2001:dd8:8:701::244

www.arin.net
192.149.252.124
2001:500:4:13::124

www.lacnic.net
200.3.14.147
2001:13c7:7002:4128::147

www.ripe.net
193.0.6.139
2001:67c:2e8:22::c100:68b

www.ida.gov.sg
23.49.236.201
2600:1415:8:180::21bc

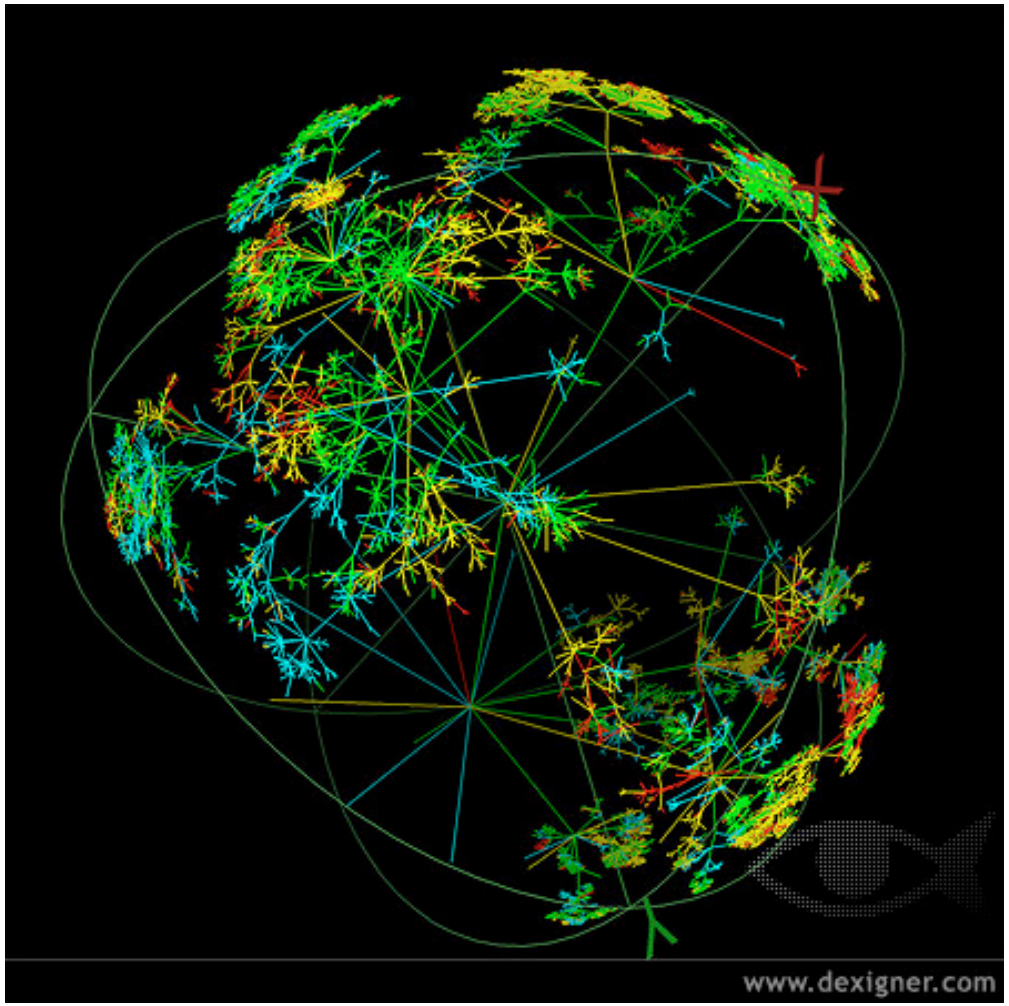
www.mpt.gov.la
203.110.66.41

www.soumu.go.jp
202.214.160.1
2001:240:bb5c:8008::1:8103

About the Internet

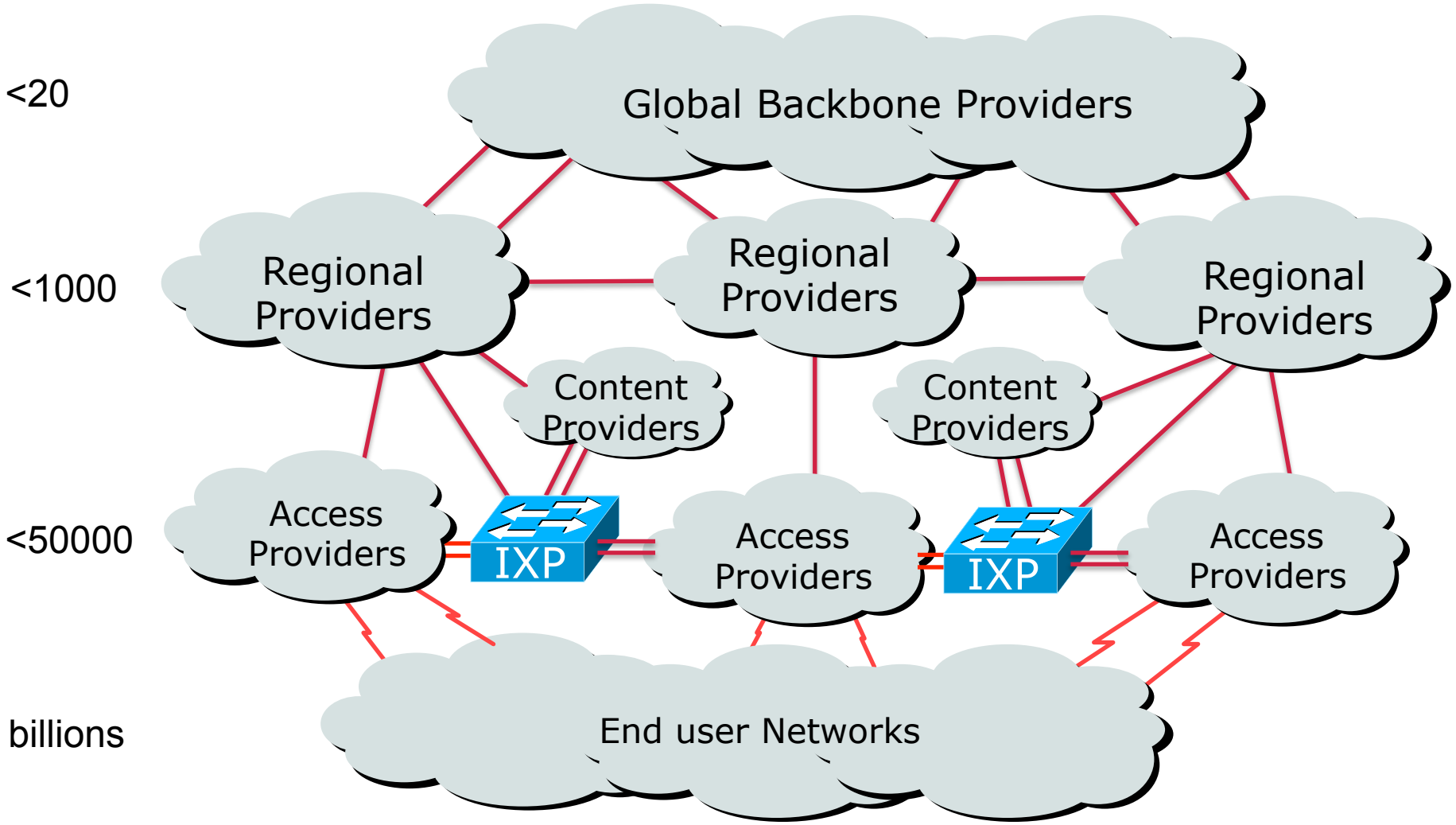
- Open, decentralised, peer to peer (end-to-end) network
  - No single organisation operates or controls the Internet
- No single point of failure
  - If one path stops working, an alternative path will be found autonomously (if the path exists)
- Intelligence of the network lives at the edge not in the core
- Which is why the Internet works so well in the way it does

Image of the Internet



http://www.dexigner.com/news/13783

Hierarchy of the Internet



Introduction to the Internet, by Philip Smith, 30/06/2014

Transferring IP Packets across Networks

- Relationship between end users and their upstream service provider
- Relationship between service providers themselves (infrastructure and content):
  - **Transit: carrying traffic for a fee**
  - **Peering: carrying traffic for no fee**

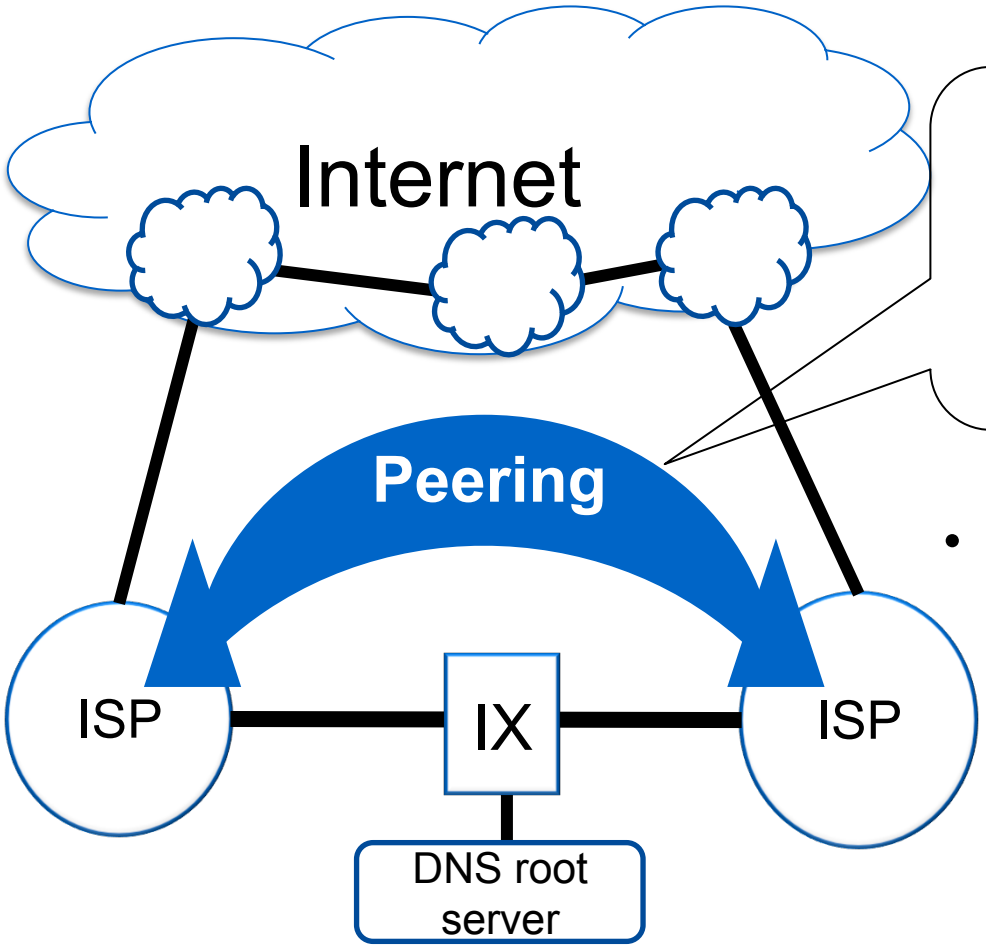
Transferring IP Packets across Networks

- Internet is successful because it is predominantly made up of peering (for free) between service providers
- Transit arrangements (at cost) are made as a last resort, when access to content is not available by peering

Transferring IP Packets across Networks

- Transit: a financial business relationship between two service operators
  - Like any other business relationship between two organisations
- Peering:
  - Private peering: private interconnection between two service providers who agree to exchange routes and traffic for free
  - Public peering: interconnection between many service providers at a neutral location, where routes and traffic are exchanged for free
- Internet Exchange Point facilitates public peering
  - Required for a successful, high capacity, highly fault tolerant Internet economy

Merits of using IX



- Exchanging Traffic at IX Points
  - High Bandwidth
  - Low Latency
  - Cost Efficiency
  - Direct Relationship
- Peering with Internet Infrastructure such as root servers

importance of IP Peering by Yoshiki Ishida, JPIX, presented at APEC TEL49, April 2014

Importance of IX

- Importance of IX = Importance of Local Peering
- Related Activities
  - WCIT/ITR
  - OECD Paper
    - **Internet Traffic Exchange Market Developments and Policy Challenges**
  - ISOC IXP Toolkit
- More to be explained by Philip in this afternoon ☺

importance of IP Peering by Yoshiki Ishida, JPIX, presented at APEC TEL49, April 2014

- IP address
- IPv6 transition technologies

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About APNIC

Resource service

- IPv4, IPv6, ASNs
- Reverse DNS delegation
- Resource registration
    - Authoritative registration server
        - Whois
        - IRR

Policy development

- Facilitating the policy development process
- Implementing policy changes

Information dissemination

- APNIC conferences
- Web and ftp site
- Publications, mailing lists
- Outreach seminars

Training

- Face to Face Workshops
    - Subsidized for members
- free eLearning

Functionalities of IP

- Services provided by IP
  - Bridge a gap between heterogeneous networks, e.g.,
    - Ethernet, Wi-Fi, token ring and etc.
  - Specify communication parties
    - Who sends packets to whom?
    - IP addresses
- In terms of functionality of IP, IPv4 and IPv6 are same

IP Addresses: IPv4 vs. IPv6

IPv4	IPv6
Deployed 1981	***Deployed 1999***
32-bit address 192.149.252.76	***128-bit address*** ***2001:DB8:0234:AB00:0123:4567:8901:ABCD***
Address space 2^{32} = ~4,000,000,000	***Address space*** ***2^{128} = ~340,000,000,*** ***000,000,000,000,000,*** ***000,000,000,000,000***
Security, autoconfig, QoS, mobility added later (IPSec etc)	***Security, autoconfig, QoS*** ***"built-in" (IPSec etc)***
Reached the final /8: April 2011	***Projected lifetime: Indefinite****

* We don't know how long IPv6 will last, but the RIRs we cannot contemplate IPv6 exhaustion in the foreseeable future

IP addressing: IPv4

- IPv4
  - 32 bits of address space = 2^{32} combinations that are available

    = 4,294,967,296 unique IP addresses

  - IP addresses usually represented in dot-decimal **prefix notation** (4 fields and separated by ".")
    - 11000000 10101000 00010100 00001010

      192 . 168 . 20 . 10
  - E.g. /8 of IPv4
    - = 2^{24} IPv4 addresses = 16,777, 216 IPv4 addresses

IP addressing: IPv6

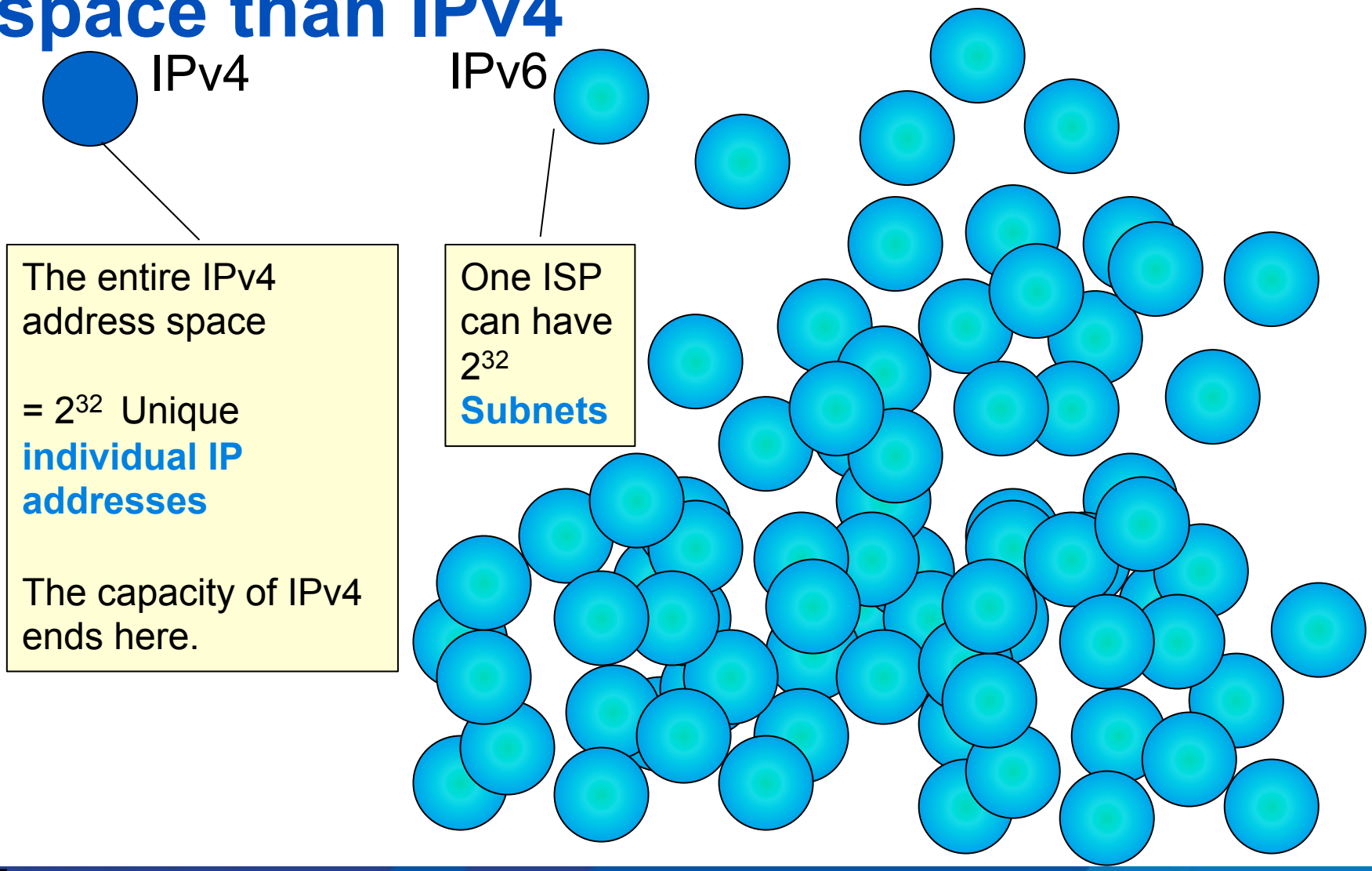
- IPv6
  - 128 bits of address space = 2^{128} combinations that are available =

    340,282,366,920,938,463,463,374,607,431,768,211,456, unique IP addressees

  - IP addresses usually represented in hexadecimal notation (8 fields and separated by ":")
    - 0010 0000 0000 0001 0000 0000 0000 1010 (6 more fields)

      2 0 0 1 : 0 0 0 A
  - E.g., /32 of IPv6
    - = 2^{32} Subnets (each subnet can have $2^{\wedge 64}$ IPv6 addresses)

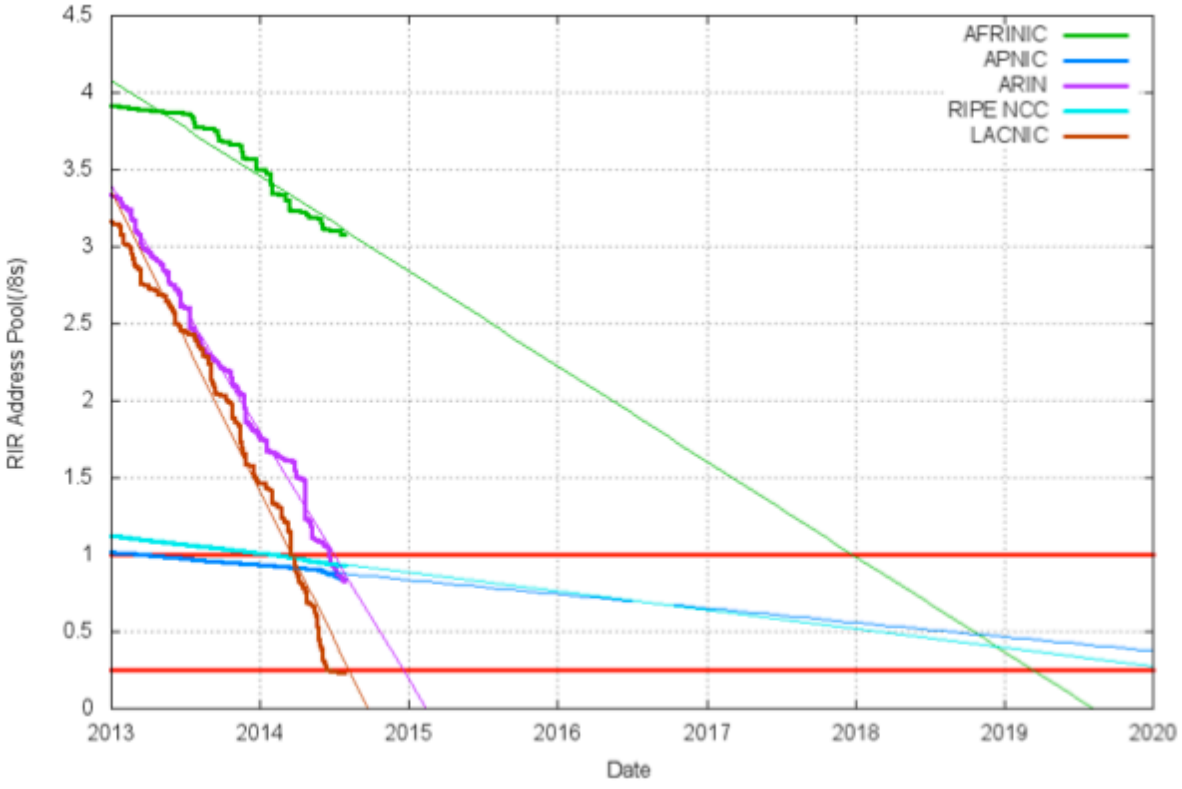
IPv6 provides a much bigger address space than IPv4



IPv4 address exhaustion

- IANA unallocated IPv4 address pool exhaustion
  - 3rd Feb 2011
- Where are we now?

Status and projection of IPv4 address consumption



RIR	Date	Remaining /8s
AFRINIC	16/07/2014	3.0749
APNIC	19/04/2011	0.8372
ARIN	20/02/2015	0.8309
RIPE NCC	14/09/2012	0.9274
LACNIC	10/06/2014	0.2333

http://www.potaroo.net/tools/ipv4/

So why IPv6 adoption has been slow?

- It's a simple business reality:
  - Highly competitive environment
  - A company will always spend its available resources on profit-making activities
  - Who will replace legacy Customer Premises Equipment (CPE)?
  - Extending IPv4 life time with Carrier Grade Nat (CGN)
- Fundamental nature of IPv6
  - Not many customers are demanding IPv6
    - IPv4 and IPv6 do exactly the same
  - It appears to be no pressing immediate business case for deploying IPv6

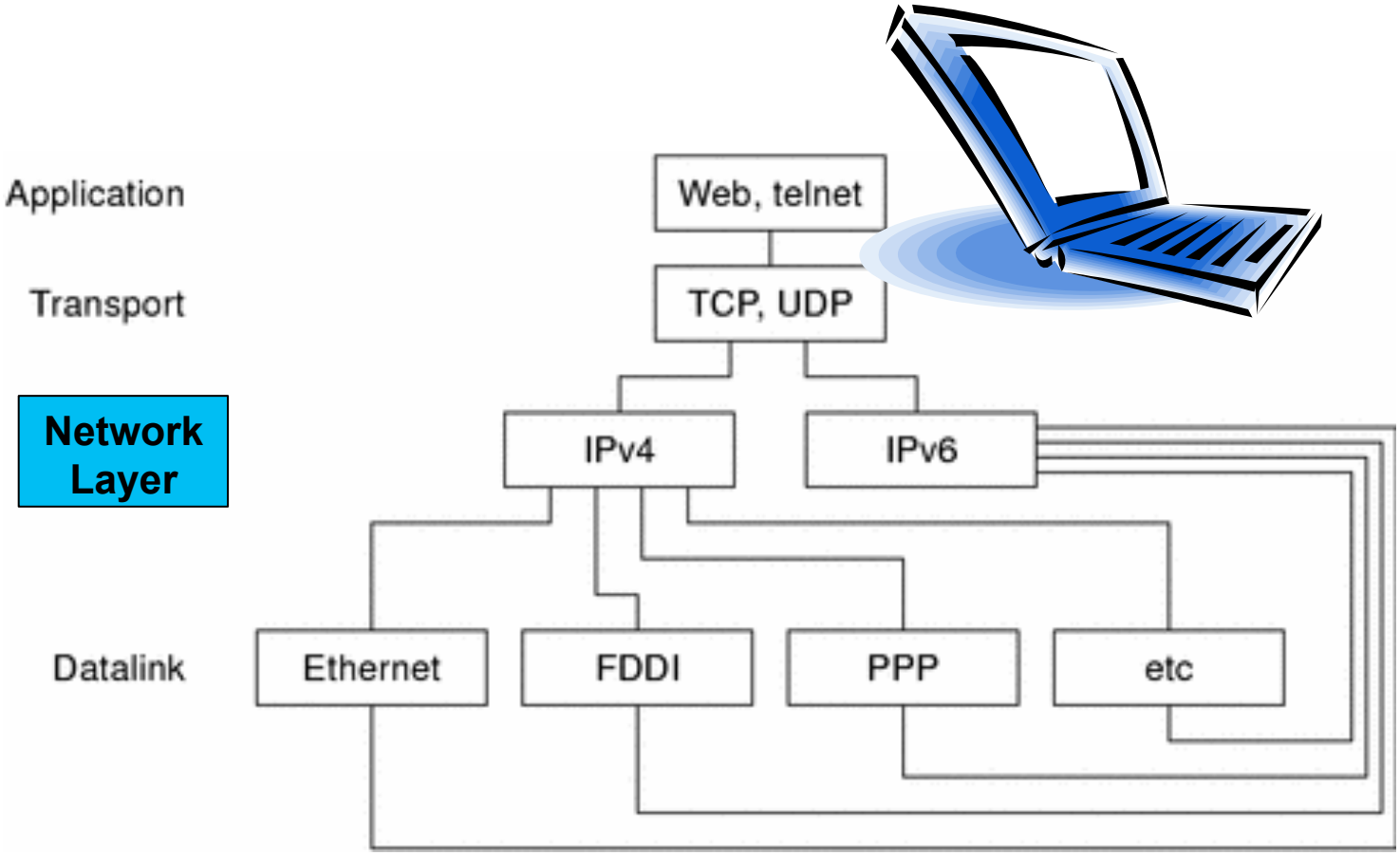
The challenges…

- IPv6 is not simply a substitute for IPv4
  - The process may take more than 10 years
  - IPv4 and IPv6 networks will co-exist for many years
  - IPv4 addresses will still be needed during the IPv6 adoption period
- Need to consider long-term costs to maintain IPv4-only networks
  - Consumer NAT and CGN
  - Complex architecture and renumbering
  - Complexity of applications
  - Cost of IPv4 addresses

More devices need to connect too!

Billions of them
Internet of Things (IoT)?

Transition mechanism: Dual Stack



http://docsun.cites.uiuc.edu/sun_docs/C/solaris_9/SUNWaadm/IPV6ADMIN/p21.html

Strategies available fro service providers

- Doing nothing
  - Wait and see what competitors do
  - Business not growing, so don't care what happens
- Extend life of IPv4
  - Force customers to NAT
  - Buy IPv4 address space on the marketplace
- Deploy IPv6
  - Dual-stack infrastructure
  - IPv6 and NATed IPv4 for customers
  - 6rd (Rapid Deploy) with native or NATed IPv4 for customers
  - DS-Lite or 464XLAT with native IPv6 and NATed IPv4 fro customers
  - Or other combinations of IPv6, IPv4 and NAT

Choice 1: Doing Nothing

- Advantages:
  - Easiest and most cost effective short term strategy
- Disadvantages:
  - Limited to IPv4 address availability (RIRs or marketplace)
  - No Access to IPv6
  - Negative public perception of Service Providers (SPs) as a laggard
  - Strategy will have to be reconsidered once IPv4 address space is no longer available

Choice 2: Prolonging IPv4

- This means:
  - Deploying NAT more widely
  - IPv4 address trading/market
- Advantages:
  - Continues what is known
  - Public addresses still available for ISP public infrastructure
- Disadvantages:
  - Customers forced to use NAT
  - Investment in large NAT devices
  - Rearchitecting network infrastructure around NAT
  - Address reputation (NAT as well as traded addresses)

Choice 2: Prolonging IPv4

- NAT issues:
  - Restricts provision of services to those with public addresses
  - Reputation of shared addresses
    - Behavioural, security, liability
  - Lawful intercept
  - Tracking and logging association of address/port and subscriber
  - Performance & scaling of NAT devices
  - Double or even Triple NAT likely
  - “How many ports does one user need?”
  - etc.

Choice 2: Prolonging IPv4

- Address transfer issues:
  - Routability of transferred addresses
  - Reputation of transferred addresses
  - More rapid growth of Internet routing table
  - Risk to integrity of routing system if transfers are unregistered
  - Cost to acquire addresses
  - Financial pressure on operators to dispose of addresses they still require

Choice 3: Deploying IPv6

- Original goal of IPv6 developers – Dual Stack
  - IPv6 running alongside IPv4
  - Public addresses for both IPv4 and IPv6
  - Once IPv6 universally deployed, IPv4 would be turned off
- Now:
  - Dual stack with public addresses still possible in some places
  - In other places, Dual Stack means public IPv6 and NATed IPv4
  - Not all network operators have deployed IPv6
  - Not all infrastructure devices can support IPv6
  - Meaning “transition” techniques required to “bypass” those

Choice 3: Deploying IPv6

- Advantages:
  - Network runs both IPv4 and IPv6
  - Once IPv6 universally available, IPv4 is simple to turn off
- Disadvantages
  - Depends on Public IPv4 address availability, or NATs
  - New protocol, staff training
  - New protocol, updated/new equipment
  - Extra resources on existing equipment (eg RIB/FIB limits)
  - Protocols are incompatible: IPv6 cannot talk to IPv4 and vice-versa
  - Updating end-user CPE

Choice 3: Deploying IPv6

- In addition to Dual Stack, Transition Techniques maybe also be required:
  - Means of getting IPv6-only to talk to IPv4-only

    NAT64
  - Transport IPv6 over IPv4-only infrastructure

    Tunnels & 6rd
  - Transport IPv4 over IPv6-only infrastructure

    DS-Lite, 464XLAT

Which choice will you make?

- Doing nothing
  - Costs nothing
- Prolonging IPv4
  - Impact of taking IPv4 addresses back from customers?
  - Economics of deploying NAT?
    - e.g. Lee Howard's (TimeWarner Cable) whitepaper on the economics of NATs
    - http://conference.apnic.net/data/36/cost-of-cgn_1377486548.pdf
  - Operational impact, depending on regulatory requirements
    - Lawful intercept, logging, user tracking, reputation
  - Address transfer costs and address reputation
    - Routing system integrity – may have addresses but are they routable?

Which choice will you make?

- Deploying IPv6
  - Apparently easiest option
  - Most network infrastructure devices support both IPv4 and IPv6
  - Devices not supporting IPv6 need upgrading/replacing
  - Staff training?
  - Operational management tools?
  - Last mile infrastructure impacts (especially if contracted)
  - Transition technologies needed (eg NAT64, 6rd, 464XLAT…)

IPv6 deployment choices? Summary

- Doing nothing feels safe
  - But is it future proof?
- Prolonging IPv4 uses familiar technologies
  - But what will it cost?
  - Will it scale?
  - What will the end-user impact be?
  - What will the operator impact be?
- Deploying IPv6 is new
  - Protocol looks and feels like IPv4
  - Infrastructure upgrades and training costs are real
  - Avoids the unknowns of prolonging IPv4 with more NAT

- IPv6 in national policies
  - Some examples
  - Successful IPv6 deployment
- IPv6 capacity development efforts

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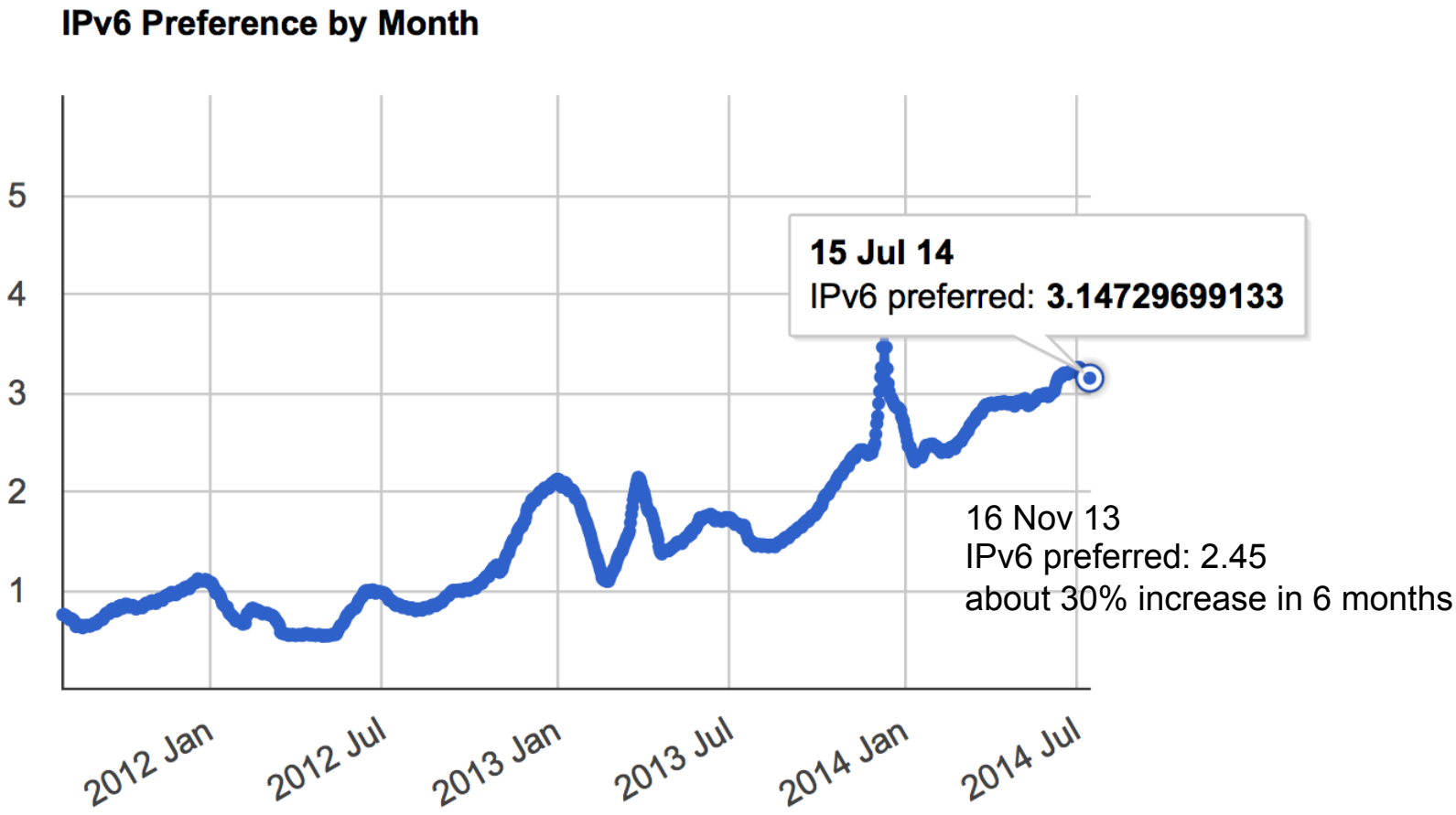
Explanation on data

- IPv6 end users readiness level measurement
  - By APNIC R&D
  - http://labs.apnic.net/ipv6-measurement/
  - Conduct a small set of tests to check the client's ability to successfully use IPv6 via web browsers
  - Collecting data over two years period
  - One of many statistics to measure IPv6 readiness level
    - IPv6 readiness has multi dimensions

IPv6 measurement - End user readiness: World



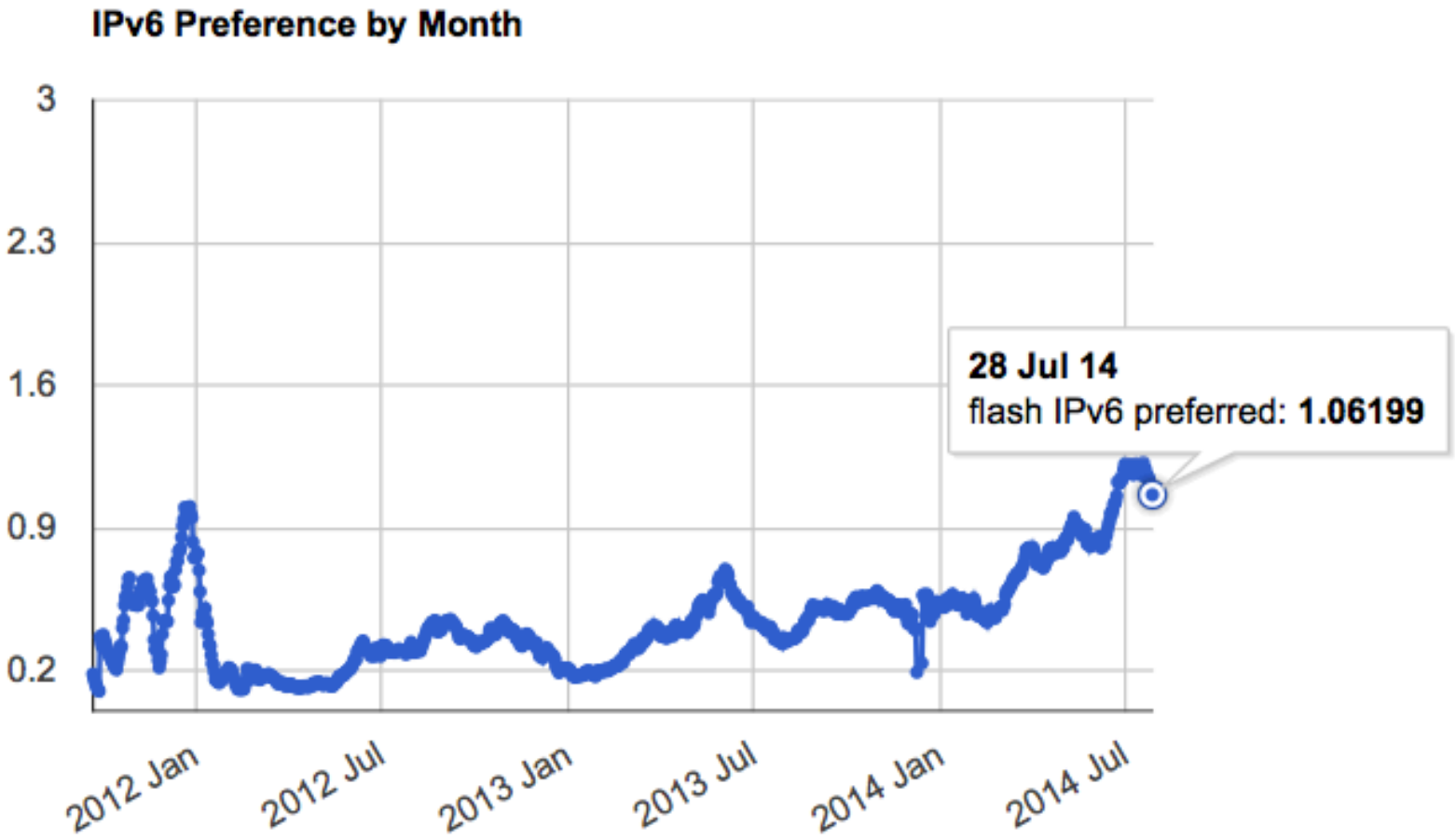
Data source from “flash” and “JavaScript” and including viewers from mobile devices

http://labs.apnic.net/ipv6-measurement/Regions/001%20World/ as of 17/07/2014

Australia

- A Strategy for the Implementation of IPv6 in Australian Government Agencies
  - Version 1 in 2007, Version 2 in 2009
  - All government agencies should have IPv6 capable hardware and software platforms by 2012
  - To operate dual stack IPv4 and IPv6 environment by 2015
    - Stage 1: Preparation (Jan 2008 – Dec 2009)
    - Stage 2: Transition (Jan 2010 – Dec 2011)
    - Stage 3: Implementation (Jan 2012 – Dec 2012)
- Internode: IPv6 commercial service is available since 2008
  - About 14% of end users can access IPv6 networks and resouces
- Telstra: IPv6 commercial service for enterprises since 2011

Australia: Stats

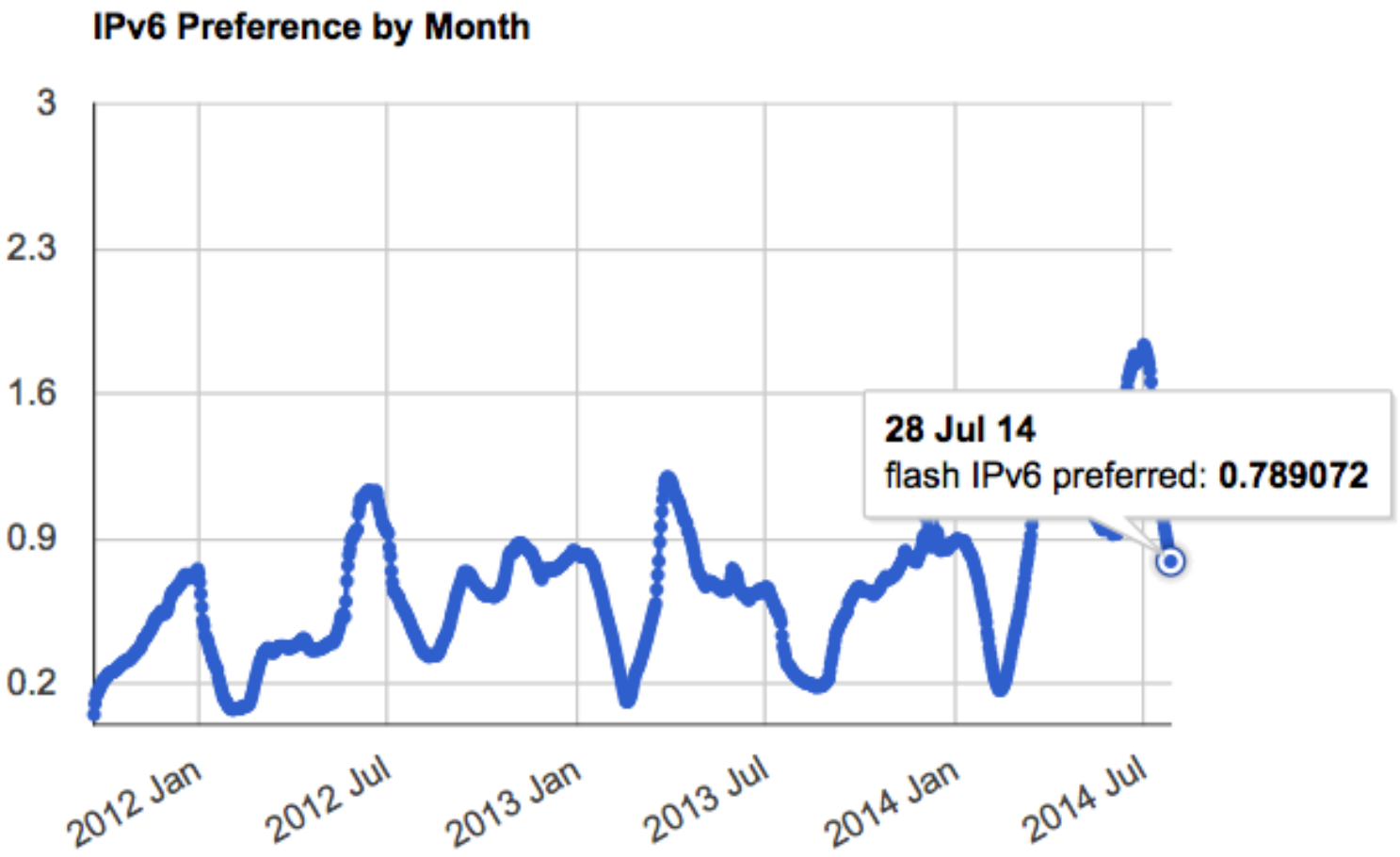


http://labs.apnic.net/ipv6-measurement/Economies/AU/

China

- Announcement made by the Chinese State Council in Nov 2011
  - IPv6 mandates to the Industry
    - "China will put Internet Protocol version 6 (IPv6) into small-scale commercial pilot use and form a mature business model by the end of 2013, the State Council recently said at an executive meeting about the main goals and road map for the China Next Generation Internet project" (People's Daily Online, Jan 2012, http://english.people.com.cn/90778/7696495.html)
    - 3 million users for each operators by 2013
    - 25 million users by 2015
  - SPs in China are responding to this mandate
    - "IPv6 Deployment Experience in China Telecom" (@APNIC36, Aug 2013)
      - http://conference.apnic.net/data/36/0828ipv6-deployment-experience-in-ctv4_13770491941.pdf
      - More than 3 mil IPv6 subscribers by the end of 2013, more than 8mil by the end of 2015
    - IPv6 Progress in China Mobile (@APNIC34, Aug 2012)
      - http://conference.apnic.net/__data/assets/pdf_file/0007/50668/ipv6-progress-in-china-mobile-20120829_1345773579.pdf
      - Starting IPv6 commercial service 2014 - 2015

China: Stats



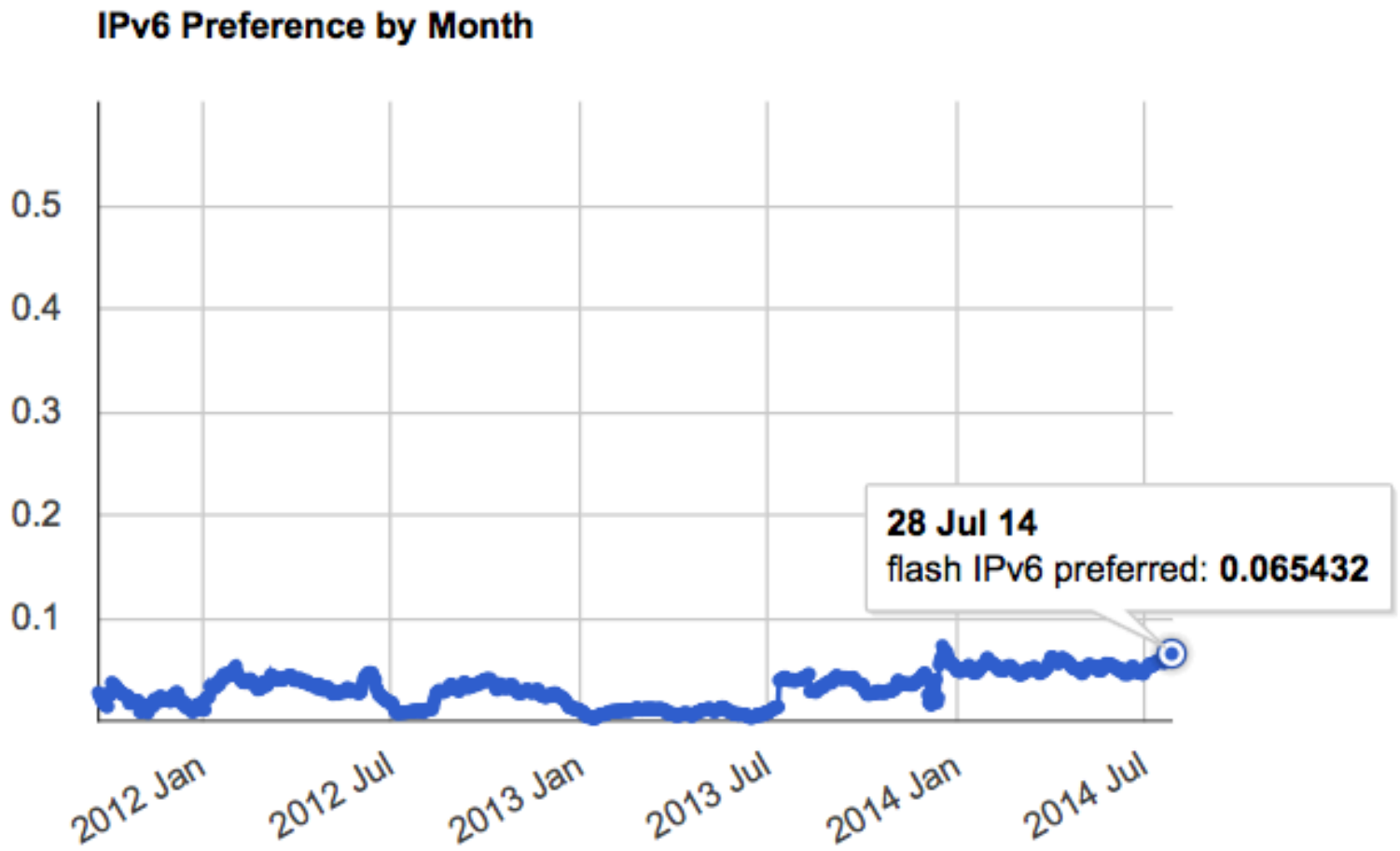
http://labs.apnic.net/ipv6-measurement/Economies/CN/

India

- National IPv6 deployment roadmap (version 2)
  - The original version was issued in June 2010
- Recommendations for Internet multi-stakeholders
  - Enable IPv6 services at all new enterprise customers (connecting to the Internet after Jan 2014)
  - Enable IPv6 services at all new retail wire line customers (connecting to the Internet after July 2014)
  - Enable IPv6 services for LTE customers (connecting to the Internet after June 2013)
  - All content and application providers to adopt iPv6 for new contents and applications by June 2014
  - All new .in domain to be compulsorily on dual stack from Jan 2014
  - All governments complete transition to IPv6 by Dec 2017

http://conference.apnic.net/__data/assets/pdf_file/0006/58533/DOT-PPT-APIPv6TF-Agarwal-ver2.pdf

India: Stats



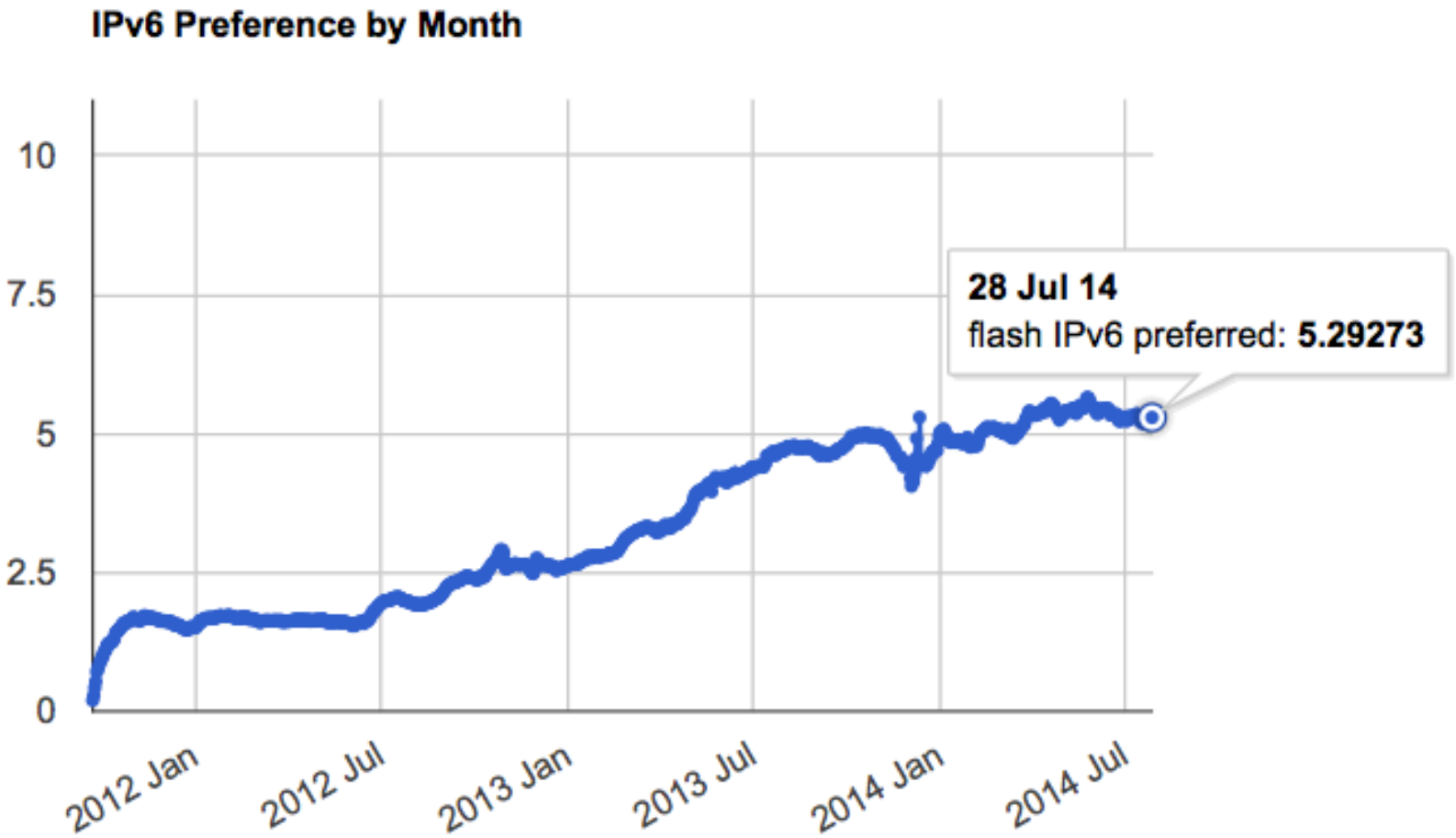
http://labs.apnic.net/ipv6-measurement/Economies/IN/

Japan

- Ministry of Internal Affairs and Communications conducts regular IPv6 Study Group
  - Partnership between the public and private sectors
    - Detailed field level discussions
  - Most recent one on July 2013
    - Active discussion on CGN: concerns on its relatively high costs, possible negative impact to end users
    - Update on usage of existing IPv6 test bed (APs and CPs)
    - Discussion on potential formats of IPv6 service deliveries: Default IPv6 services
      - Some providers are experiencing positive result
    - Discussion on IPv6 services in mobile networks
    - Discussion on developing IPv6 security guidelines

http://www.soumu.go.jp/main_sosiki/joho_tsusin/policyreports/chousa/ipv6_internet/02kiban04_03000222.html

Japan: Stats



http://labs.apnic.net/ipv6-measurement/Economies/JP/

Korea

- IPv6 interconnection agreement among ISPs in Korea
  - Wired network: 3 major ISPS (KT, SKB, LGU+) adopted IPv6 at their backbone and IXs (Dec 2012)
- Mobile network: A joint project of Korea Internet & Security Agency (KISA) and SK Telecom (Number one mobile network operator in Korea) to test IPv6 on LTE mobile network (Dec 2012)
  - Android devices on NAT64 successfully worked
  - http://www.youtube.com/watch?v=wYzN0c7go4M
  - IPv6 traffic monitoring and billing system etc. need to be prepared before commercializing the service

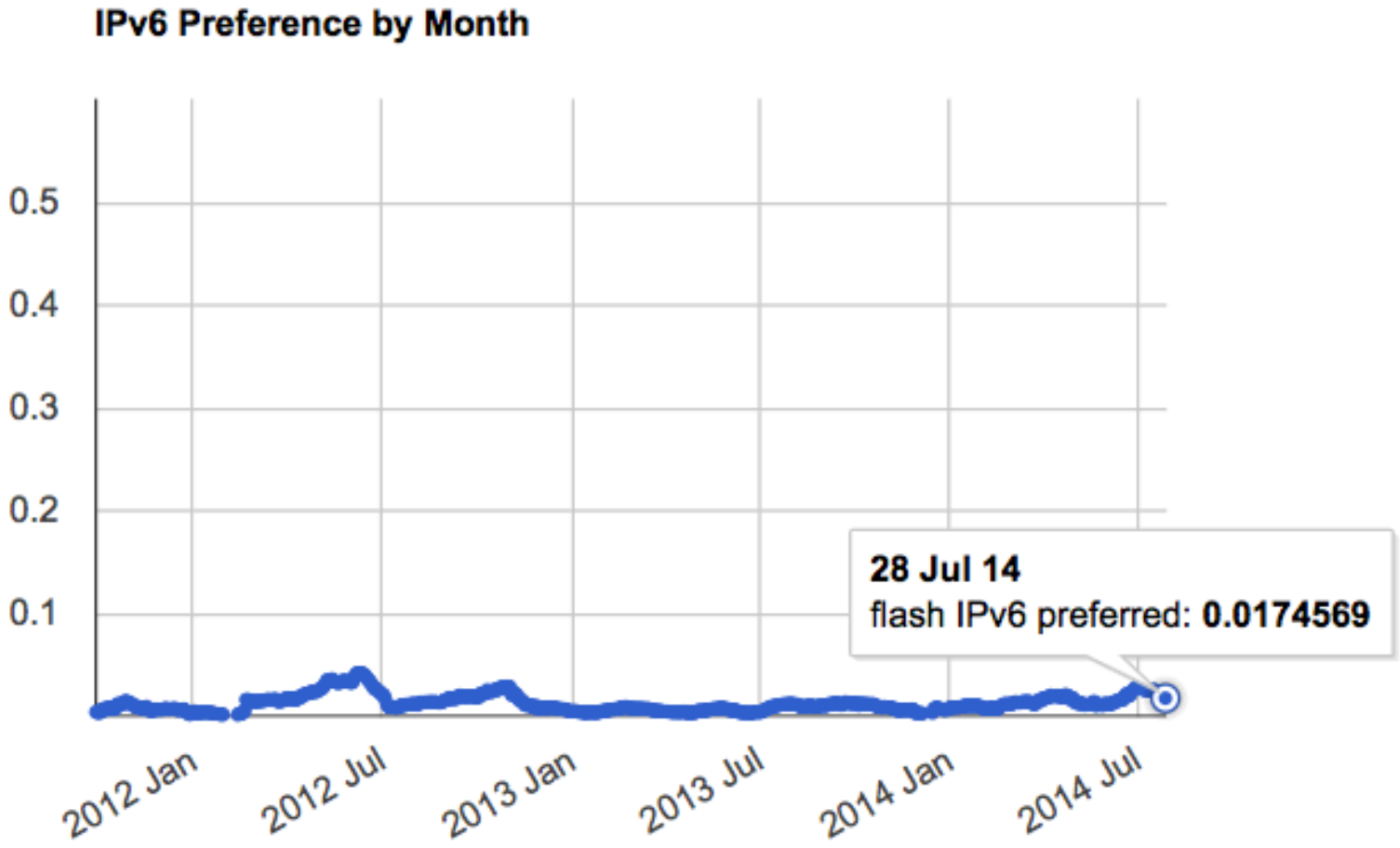
http://conference.apnic.net/__data/assets/pdf_file/0009/58455/ipv6-deployment-update-from-koreakisa_youngsun-la_1361361191.pdf

Korea

- IPv6 industry survey conducted by KISA (2013)
  - Relatively low response rate: level of interest toward IPv6?
  - Identified IPv6 challenges and requirements
    - Lack of experts and IPv6 technical knowledge
    - Lack of R&D test environment
    - Market's needs and government's plans
- Development of guideline document by the government
- Conducting performance measurement

http://conference.apnic.net/data/36/apnic36_nirsig_krnic_updateyoungsun-la_20130822_1377152839.pdf

Korea: Stats

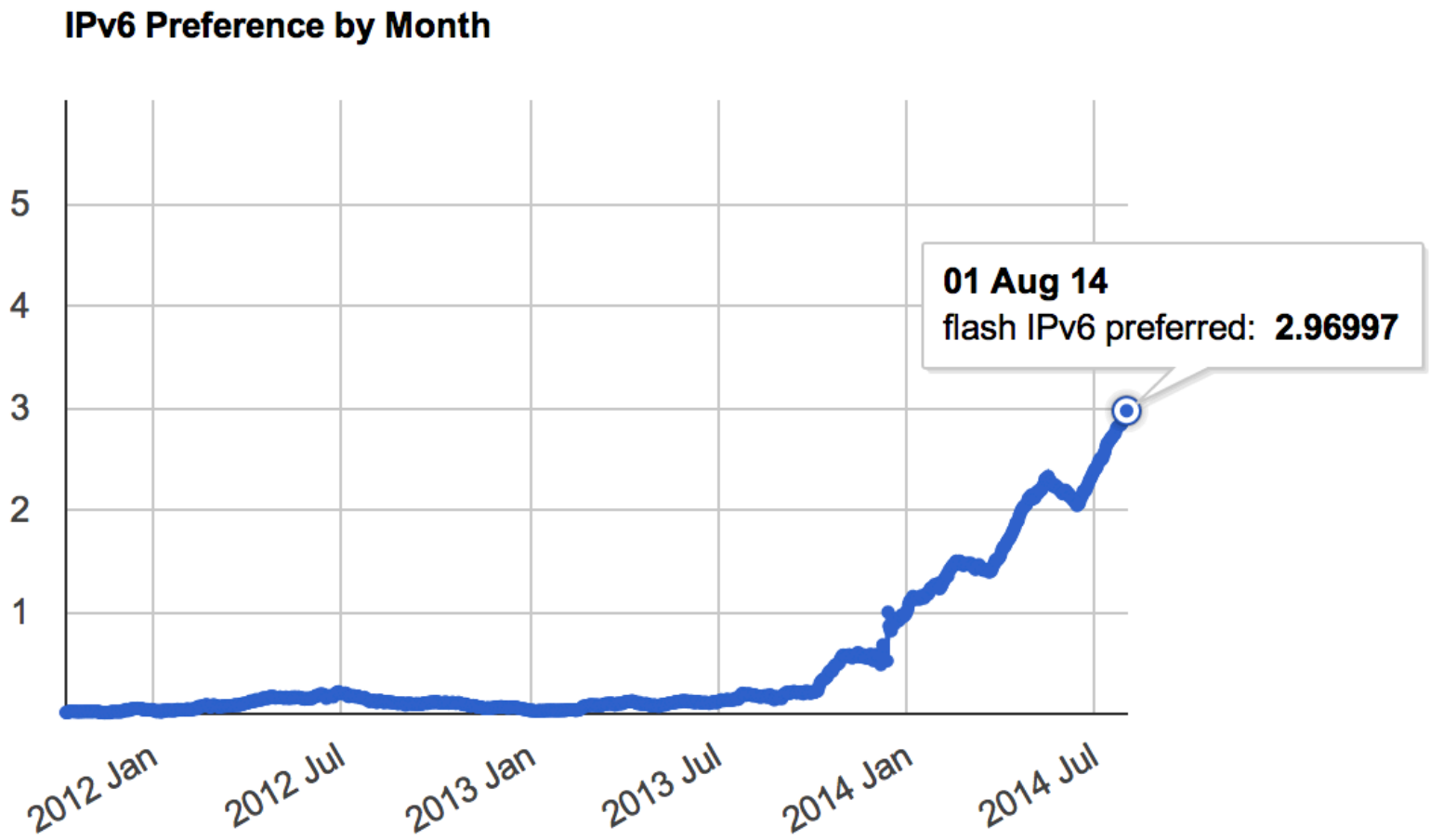


http://labs.apnic.net/ipv6-measurement/Economies/KR/

Malaysia

- Malaysia National Agenda
  - Malaysian Information, Communications and Multimedia Services 886 (MyICAMS886): Goals for 2006 - 2010
  - IPv6 is part of the plan to support future growth of the infrastructure
- Government wise initiative on IPv6 to support partnership between public and private sectors
  - Guidelines on IPv6 Implementation and Compliance Test by Malaysian Communications and Multimedia Commission (MCMC), 2012
- National Committee for IPv6 Monitoring and Development chaired by Ministry of Information, Communication and Culture (MICC)

Malaysia: Stats



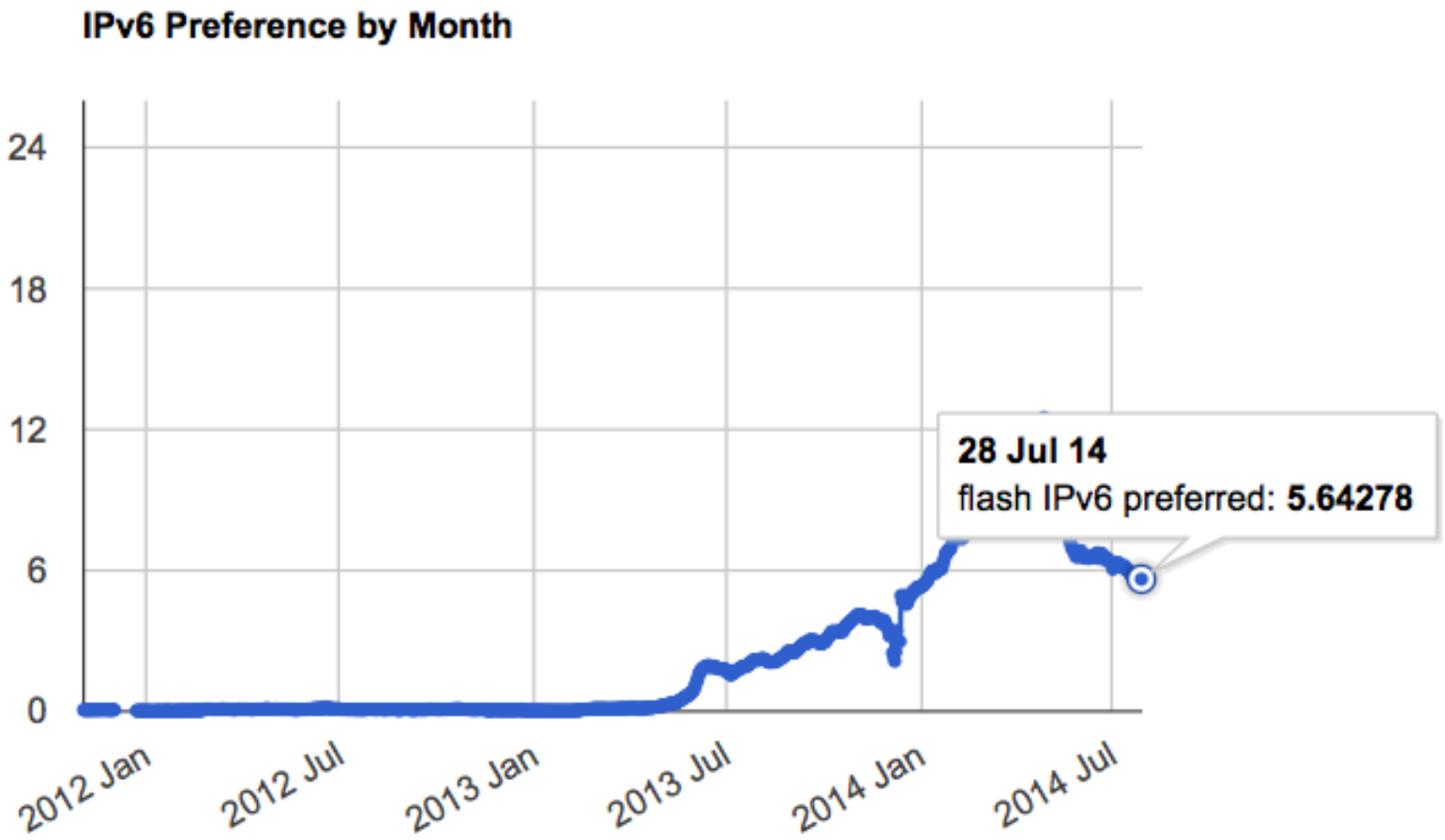
http://labs.apnic.net/ipv6-measurement/Economies/bn/MY

Singapore

- IPv6 Transition Program lead by Infocomm Development Authority (iDA) of Singapore
  - To apply multi-stakeholder approach in conjunction with “pull” and “push” strategies to support IPv6 adoption
    - Create Initial IPv6 demand by enterprises, government agencies, content and application providers
    - Create IPv6 supply by network providers
    - Drive competency across multi-stakeholders
    - Ensure IPv6 and IPv4 performance equity by hardware and software vendors
    - Raise awareness on IPv6 across multi-stakeholders
    - Managing IPv4 address exhaustion mainly by network providers
  - To address the issue of IPv4 exhaustion and to facilitate the smooth transition of the Singapore infocomm ecosystem to IPv6
  - To promote IPv6 adoption in the local industry
    - OneAsia Host, MobileOne, Starhub etc.

http://www.ida.gov.sg/Infocomm-Landscape/Technology/IPv6

Singapore: Stats



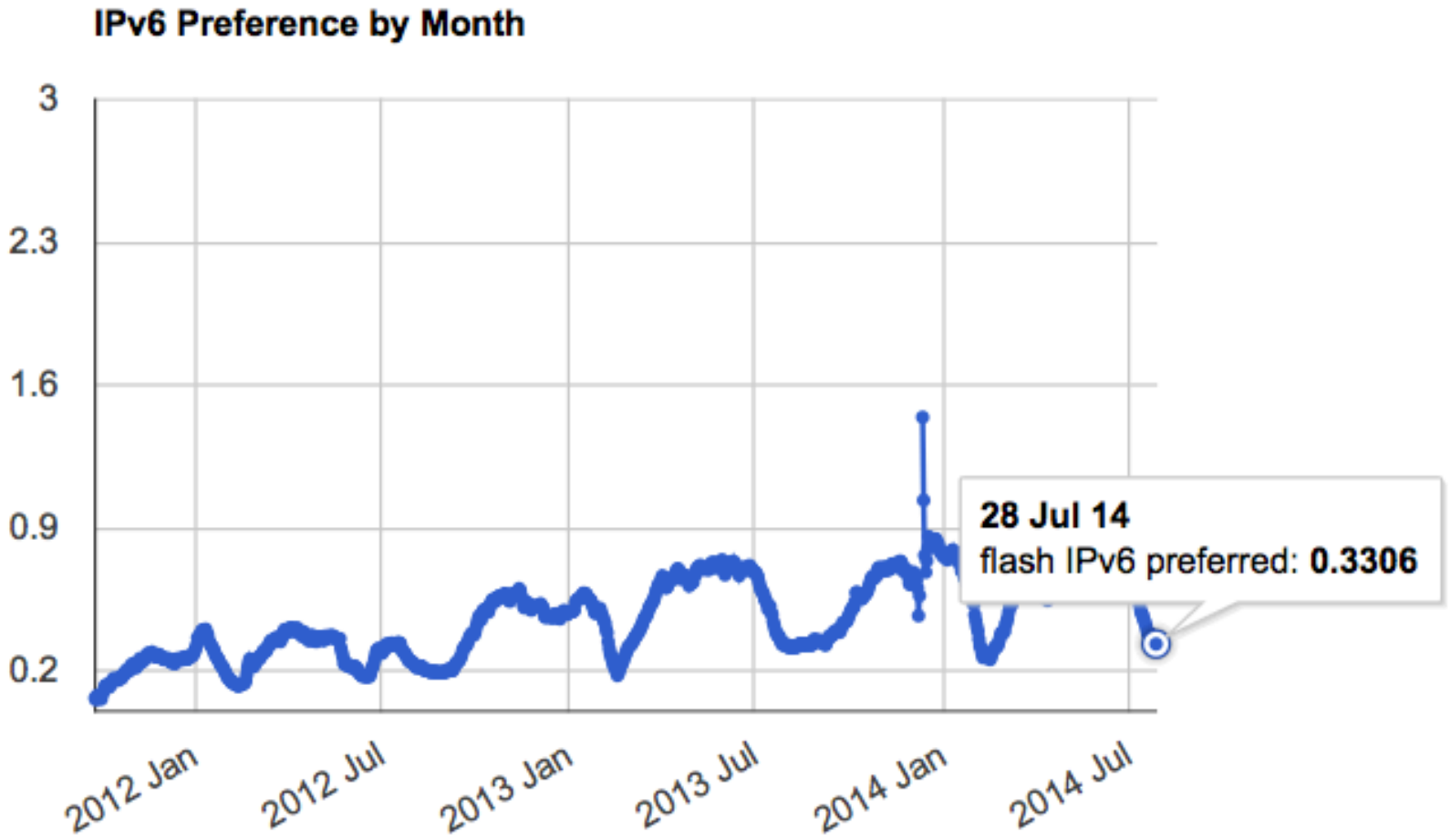
http://labs.apnic.net/ipv6-measurement/Economies/SG/

Taiwan

- “IPv6 Upgrade Promotion Program” lead by Ministry of Transportation and Communications
  - 2012 – 2013: Enable dual stack among 50% of public network services (Web, DNS, email)
  - 2014 – 2015: Enable dual stack the remaining public network services
  - Monitoring IPv6 deployment status in Taiwan
  - TWNIC’s active engagement

http://conference.apnic.net/36/program#/speaker/Sheng-Wei%20Kuo

Taiwan: Stats

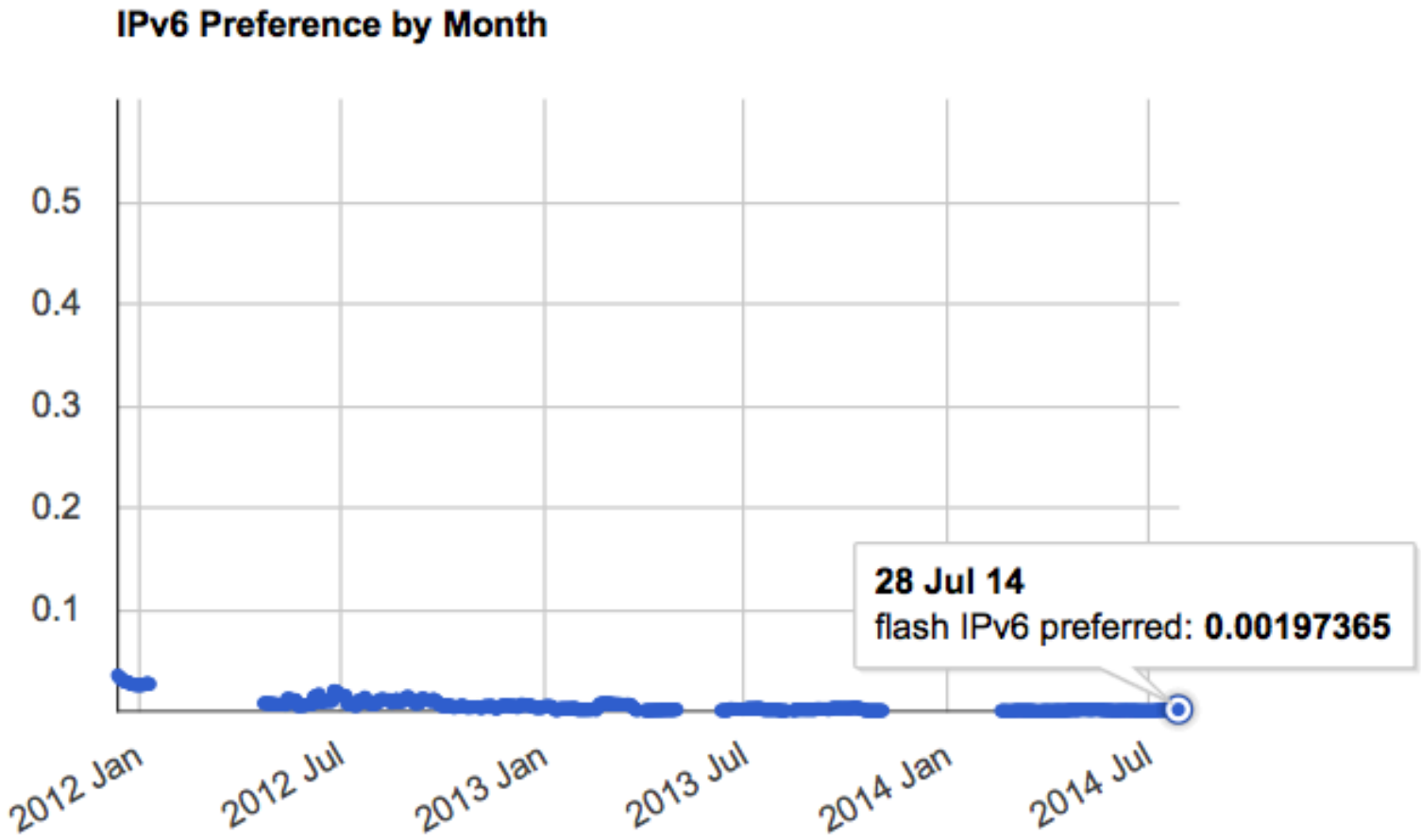


http://labs.apnic.net/ipv6-measurement/Economies/TW/

Vietnam

- Continuous support provided by Ministry of Information and Communications, Vietnam National IPv6 Task Force and VNNIC to raise IPv6 awareness and skill up trainings
  - Vietnam IPv6 Day Conference in 2012 and 2013
  - Vice Minister of MIC and CEOs of top 8 local ISPs officially launched IPv6 service, May 2013
  - IPv6 infrastructure security workshop for network engineers coordinated by VNNIC
    - Collaboration with JANOG members
  - Coordinated IPv6 Workshop at ASEAN ICT SMEs Conference, March 2014
    - To do information sharing among ASEAN nations

Vietnam: Stats



http://labs.apnic.net/ipv6-measurement/Economies/VN/

Information sharing: APEC TEL IPv6 Guidelines

- Published in 2010
  - APNIC contributed its development
- Scope of the document
  - **Lead the industry by example in adopting IPv6**
    - Ensuring governments' online presence via IPv4+IPv6
    - **New procurement requirements** with IPv6
      - Be ready with transition – do not buy legacy equipment!
  - **Partnership between governments and industry**
    - Periodic information exchange and collaboration
  - **Human capacity development**
    - Enhance IPv6 skills of technical staff
    - IPv6 training programs to be shared
  - **International and cross-agency cooperation**
    - Sharing information on IPv6 Best Current Practice
    - Avoid duplicating efforts IPv6 implementation

http://www.apec.org/~/media/Files/Groups/TEL/2010_APEC-TEL-IPv6-guidelines-FINAL.doc

Summary: Governments' support

- IPv6 awareness among governments' in the AP region is very high
  - Many initiatives from governments has been implemented
    - Partnership between the public and private sectors in various forms
    - Developing national policies and guidelines and roadmaps to enable IPv6
    - Enabling IPv6 in government networks
    - Mandating for IPv6 readiness in government procurement for ICT goods and services
    - Raising IPv6 awareness among key people in the government and industry
    - Providing timely skill up training
    - Monitoring IPv6 deployment measurement and share information with industry
    - Include the necessity of IPv6 deployment in ministerial statements
- Continuous engagement with industry will help

Recipe for proactive IPv6 support

- Many encouraging activities have been seen in the AP region
  - Updating government ICT procurement criteria with IPv6
  - Policies to support deploying IPv6 in government networks with clear mandate goals and timeframe
    - Leading the industry by examples in adopting IPv6
  - Partnership between public and private sectors, e.g.,
    - Establishing certification mechanism to recognize “IPv6 ready” products
    - Launching IPv6 project to raise IPv6 awareness among key stakeholders
    - Promoting IPv6 activities through media, events, competitions, awards etc.
  - Human capacity development
    - Supporting IPv6 skill up trainings to the industry

Recommendations for Laos

- Encourage “multi-stakeholder” approach:
  - Promote cooperative efforts among governments, industry and users
  - Develop a coherent strategy to sustain the transition framework between IPv4 and IPv6
    - Establish a clear guidelines to support IPv6 deployment in SATRC
- Keep up-to-date with topics of IPv4 address exhaustion and IPv6 transition
- IPv6 skill up – Capacity development
  - Peer support among network operators within/out of Laos
  - Network Operators Group

How APNIC can contribute

- IPv6 capacity development Provide
  - "IPv6 Workshops" in collaboration with regional organizations
- Monitoring IPv6 readiness
  - labs.apnic.net
- APNIC works closely with external partners and community groups to share knowledge and information
  - 15 NOGs in the region (and more to come)
  - APEC TEL, APT, ASEAN, ITU, and SPC, etc.
- Contribute to your multi-stakeholder outreach efforts
  - Regional conferences

APNIC Training and Engineering Assistance

- Building capacity with APNIC Training
  - To support resilient and scalable Internet infrastructure
    - IPv4 to IPv6 Transition, IPv6 Workshop, Network Security, Routing and BGP etc.

- **Engineering Assistance** provided by Internet experts
  - Cost recovery basis direct assistance – IP peering, IPv4 and IPv6 network, Internet infrastructure security

Extensive IPv6 informaton
www.apnic.net/ipv6

You're Invited!

- APNIC 38: Brisbane, Australia, 9-19 Sep 2014

- APRICOT 2015: Fukuoka, Japan, 24 Feb-6 Mar 2015

THANK YOU

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