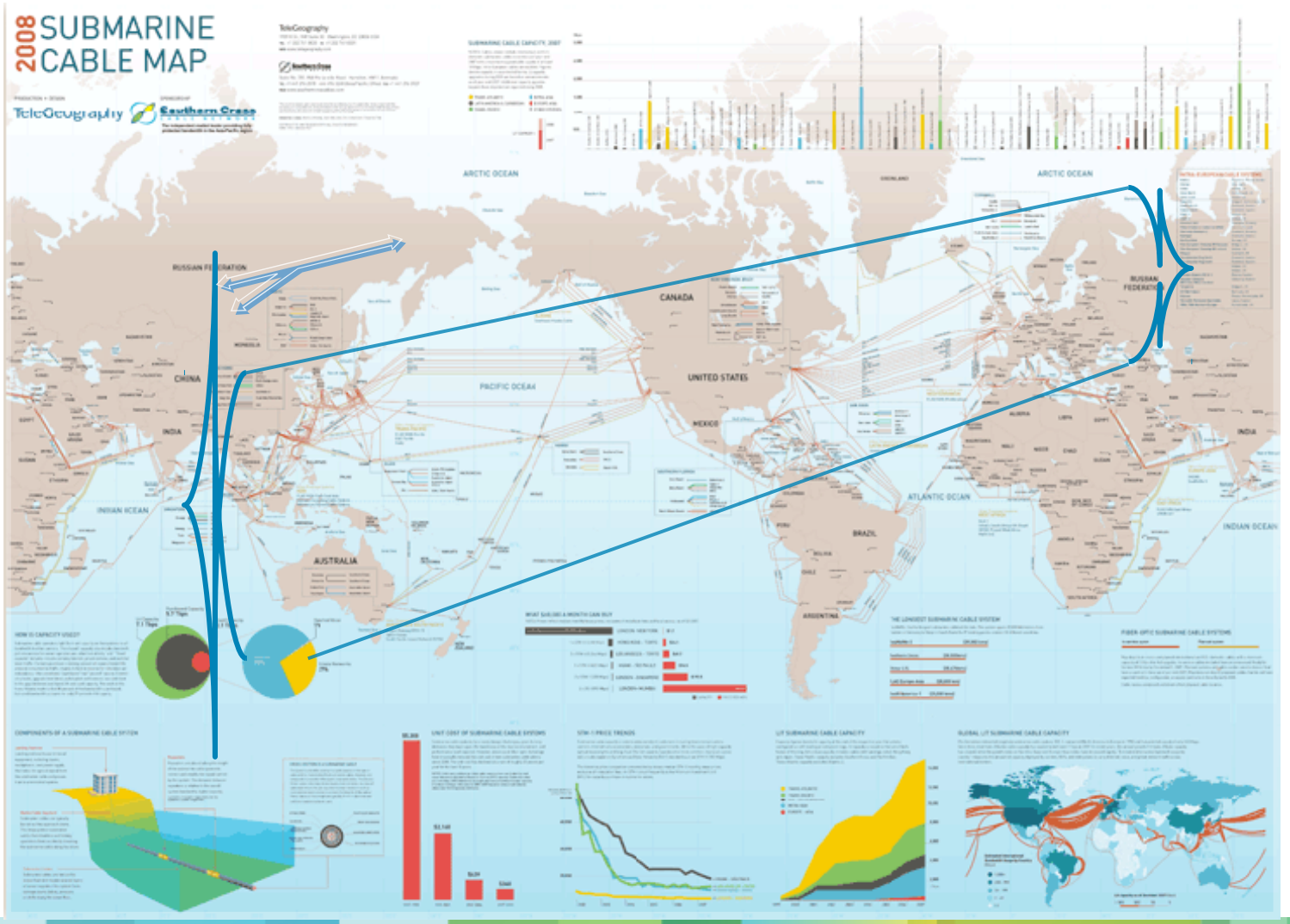
Fred Baker
Cisco Systems

Multi-year expectations: Bringing IPv6 up Taking IPv4 down

Photo: Fredrik Garneij

Where Is the Broadband Internet Today?

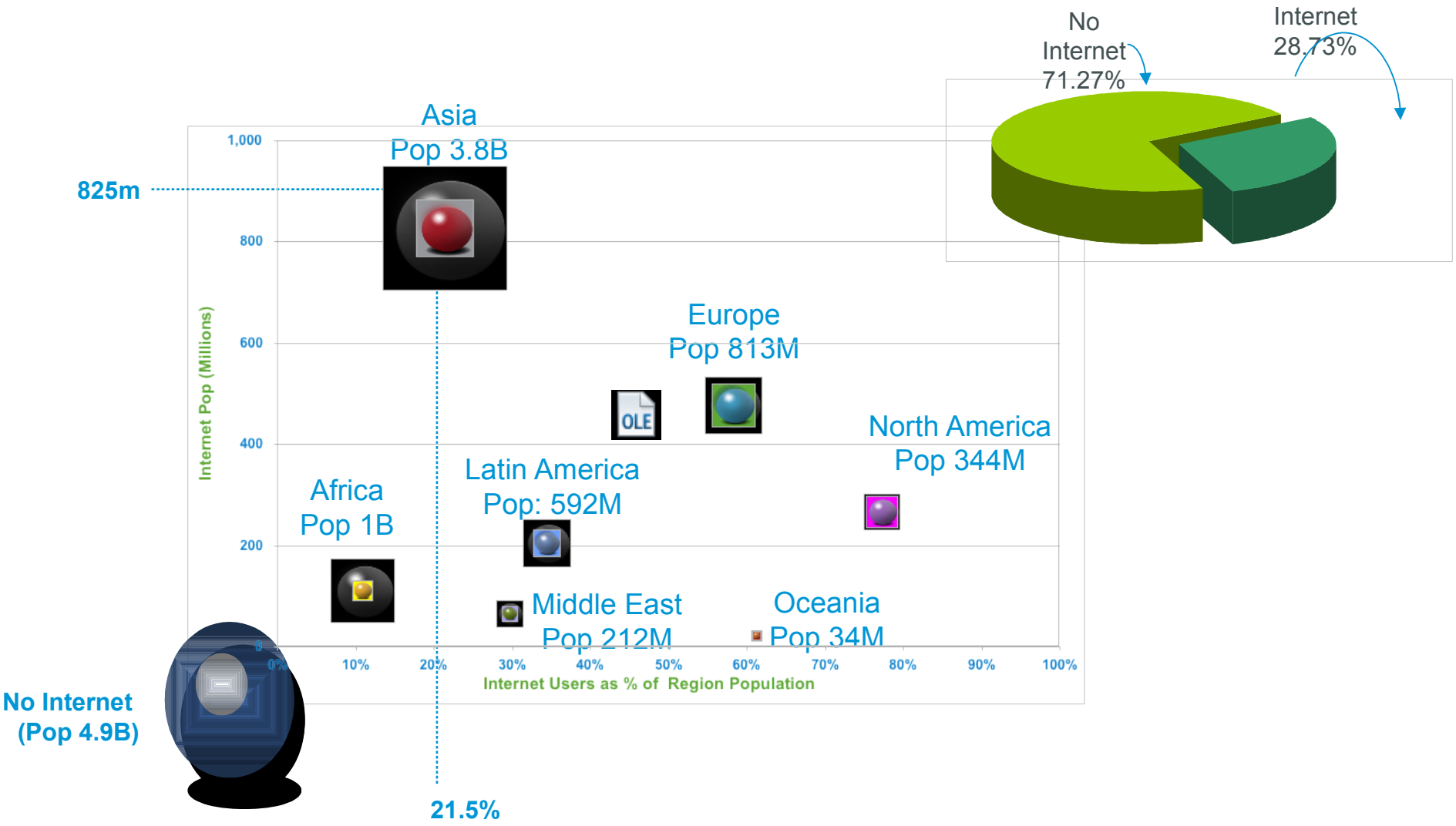
The Europe/America/East Asia/ANZ Fiber Corridor



Map copyright 2008 TeleGeography

Today

Internet Usage by World Region June 2010



Source: http://www.internetworldstats.com/stats.htm June 2010

Connectivity today

Global Stats:

- Over 2.2B Internet Users (33% of total population)
- 5.9B mobile-cellular subscriptions (87% of world population)
- 1.2B mobile broadband subscriptions (twice as many as fixed-wired broadband subscriptions)

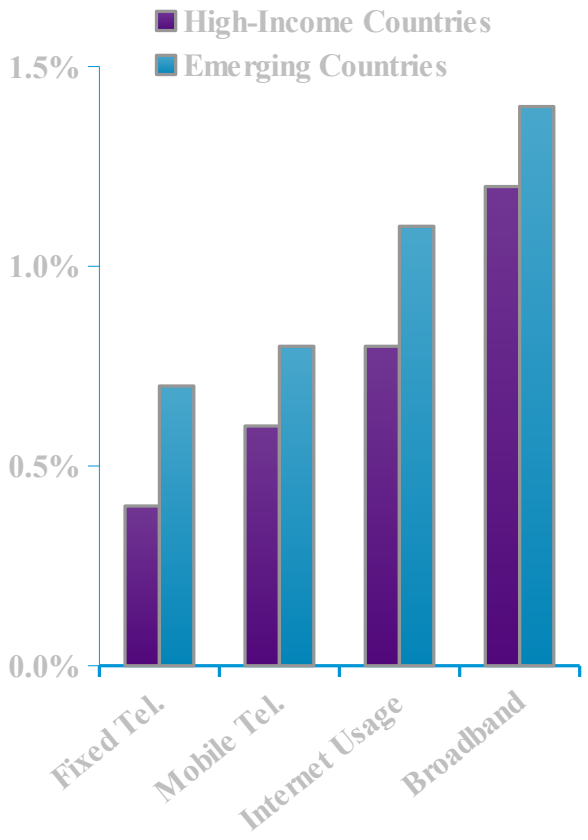
Source: ITU, 2011

Impact:

- In 2010: The Internet for the G-20 countries, the Internet "amounted to 4.1 percent of GDP, or $2.3T…"
- By 2016, it will be $4.2T. "If it were a national economy, the Internet economy would rank in the world's top five."
- In some countries, the Internet is contributing up to 8 percent of GDP.

Source: BCG,

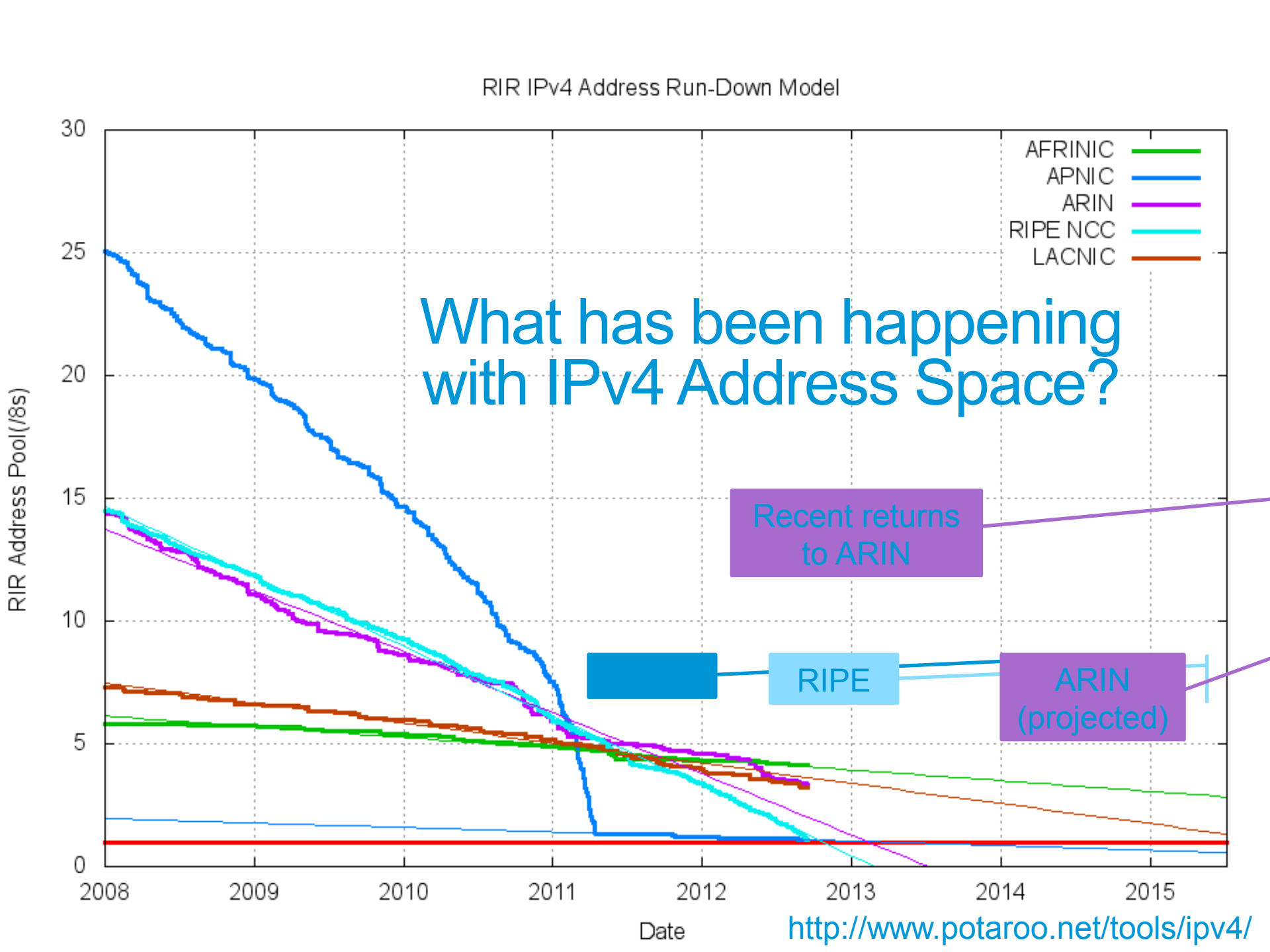
Incremental Annual GDP Growth from Every Ten Percent Points Difference in ICT Penetration

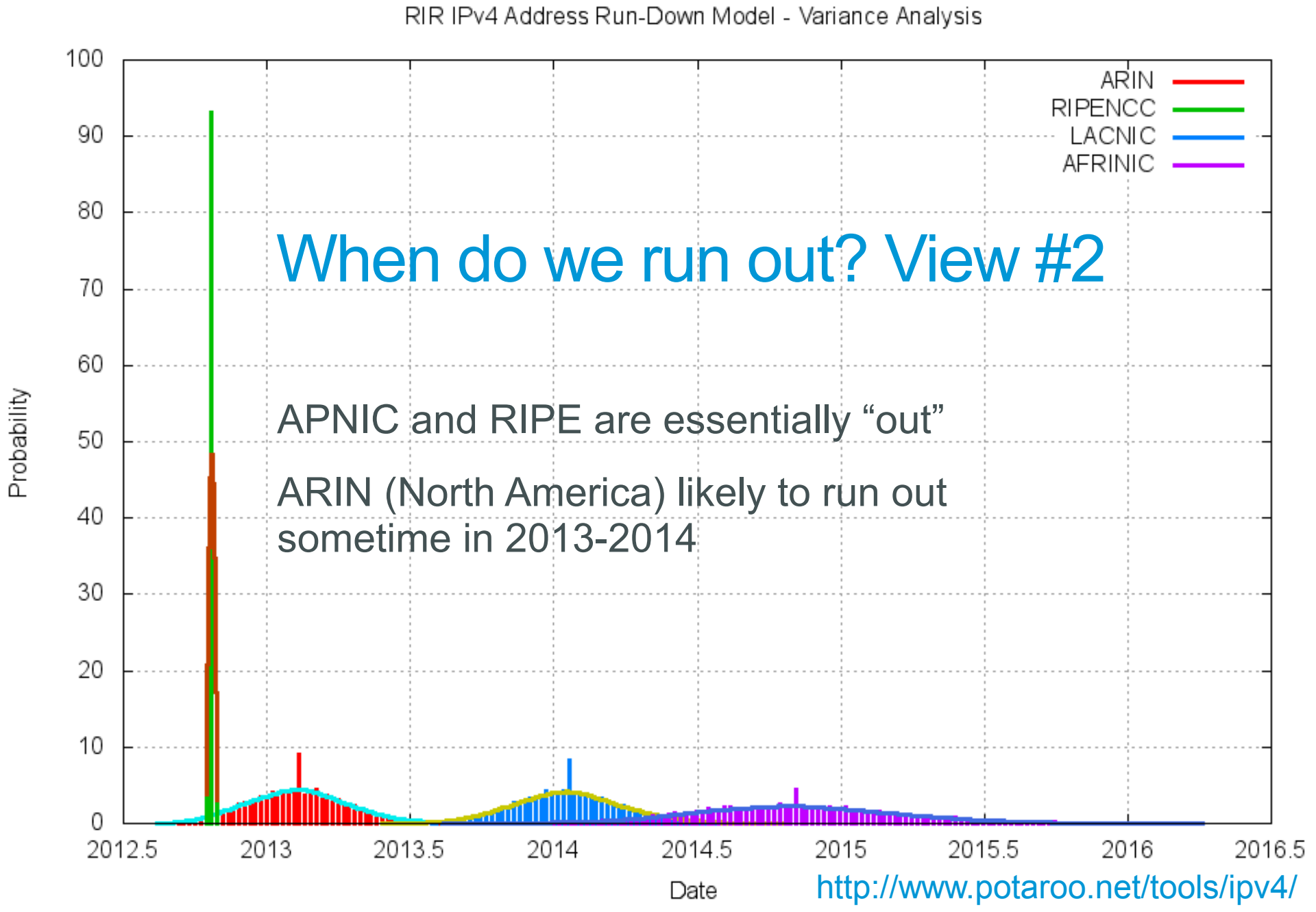


Source: World Bank, 2009

Courtesy Robert Pepper, formerly FCC, now Cisco VP Government Affairs

A quick look at IPv4


RIR IPv4 Address Run-Down Model
AFRINIC
APNIC
ARIN
RIPE NCC
LACNIC
What has been happening with IPv4 Address Space?
Recent returns to ARIN
RIPE
ARIN (projected)
RIR Address Pool(/8s)
Date
30
25
20
15
10
5
0
2008
2009
2010
2011
2012
2013
2014
2015
http://www.potaroo.net/tools/ipv4/

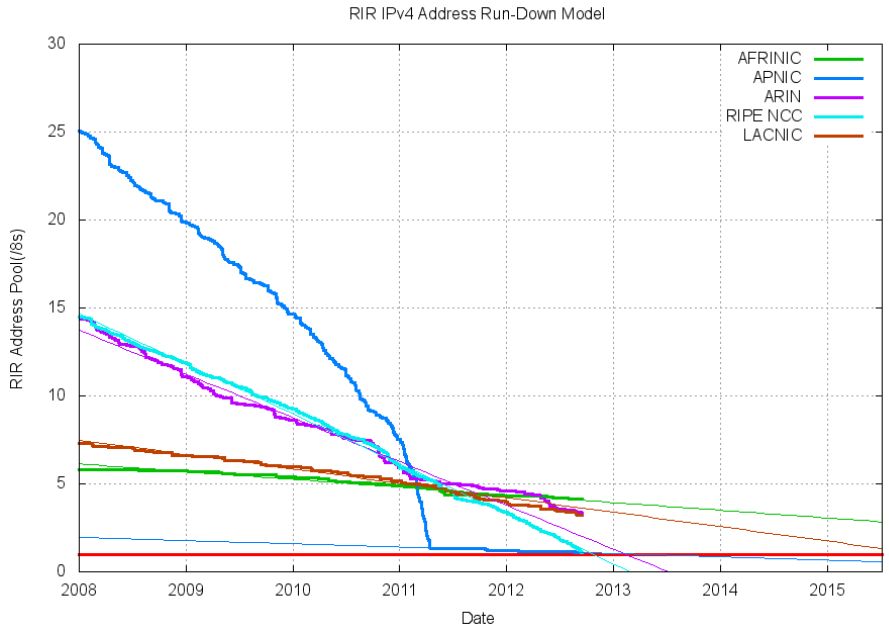


When do we run out? View #2

APNIC and RIPE are essentially “out”

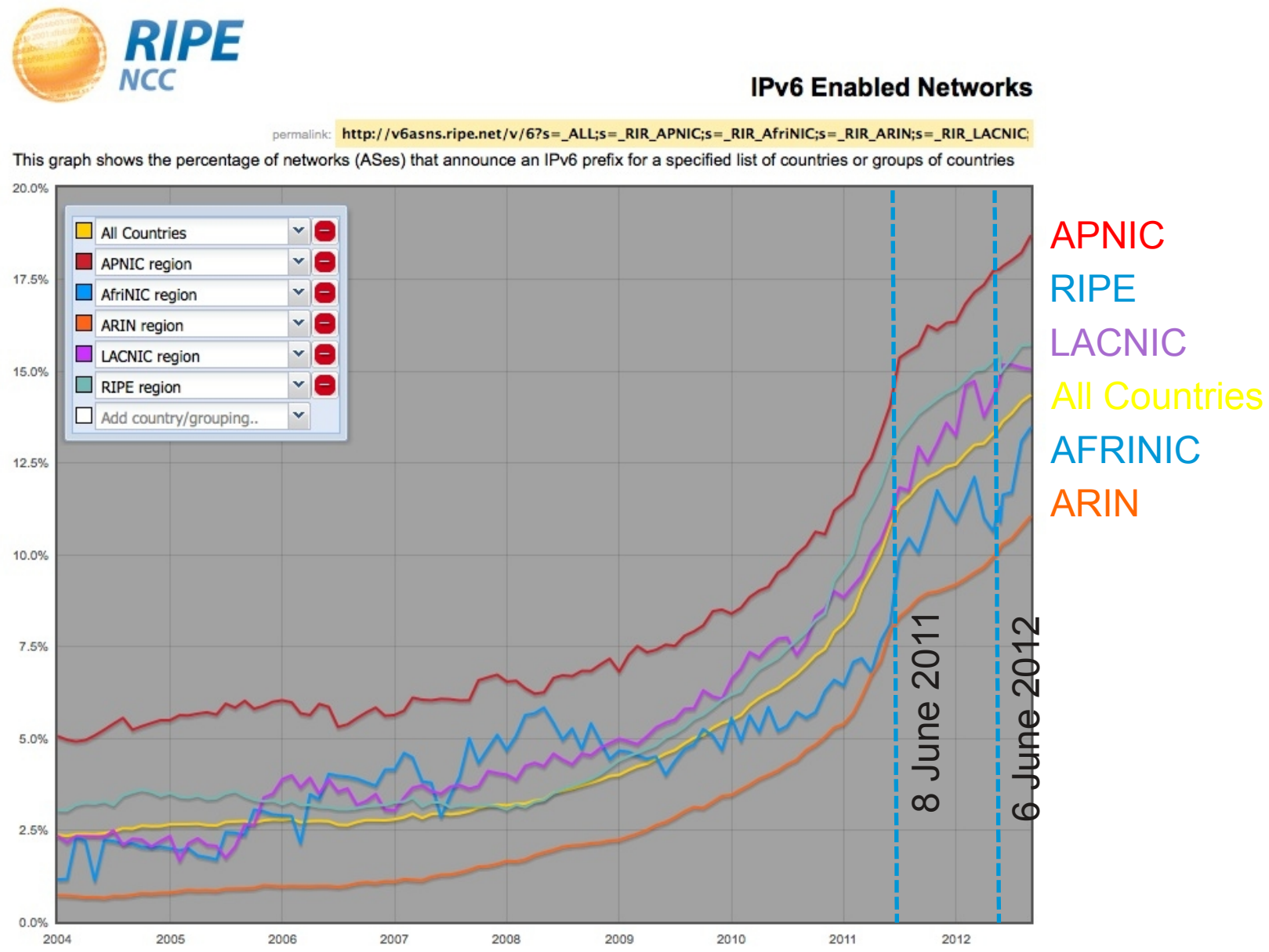
ARIN (North America) likely to run out sometime in 2013-2014

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



- Fixed and mobile networks, and content providers, are deploying IPv6 throughout their networks
- There are strong pressures to do so from the perspective of business operations
- There is a question of timing
- Networks are not on the verge of collapse
- Networks are working out strategic plans to ensure their and their customer's futures
- Businesses respond to their businesses realities
- Most find a need to keep their IPv4 services running while deploying IPv6
- Some find more urgent needs than others

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



Growth in IPv6 advertisements by region

Motivations for deployment

A truly simplistic model of the Internet from a business perspective

Many components
Internet Core – transit providers

Content Providers – Google, Facebook, YouTube

Enterprise Networks

Residential Broadband

Mobile Internet/Telephone

Different motivations
Source of revenue

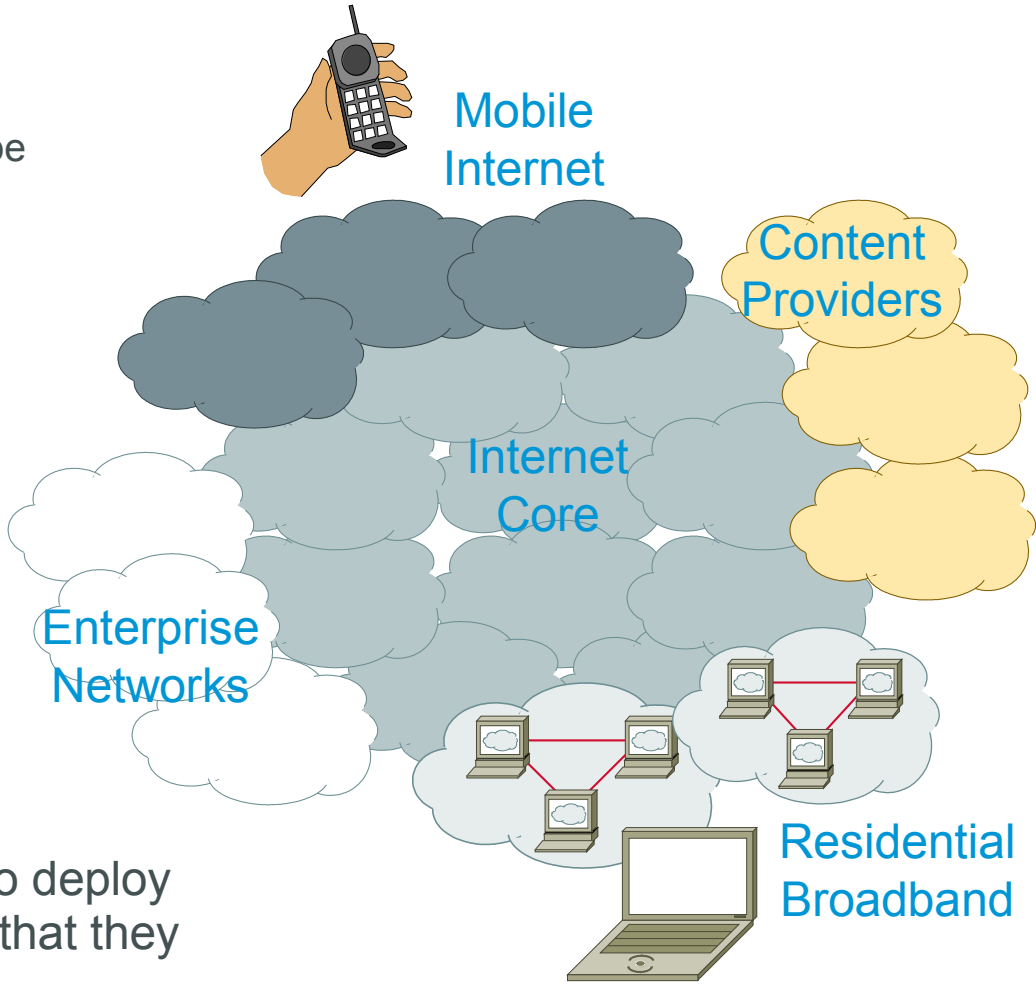
Need for addresses

Location-based services

Simple access to entire Internet

Lawfully Authorized Electronic Surveillance

People and companies are motivated to deploy a technology when it solves a problem that they believe they have



Definition: SEP (“Somebody Else’s Problem”)

“An SEP is something we can't see, or don't see, or our brain doesn't let us see, because we think that it's somebody else's problem.... The brain just edits it out, it's like a blind spot. If you look at it directly you won't see it unless you know precisely what it is. Your only hope is to catch it by surprise out of the corner of your eye.”

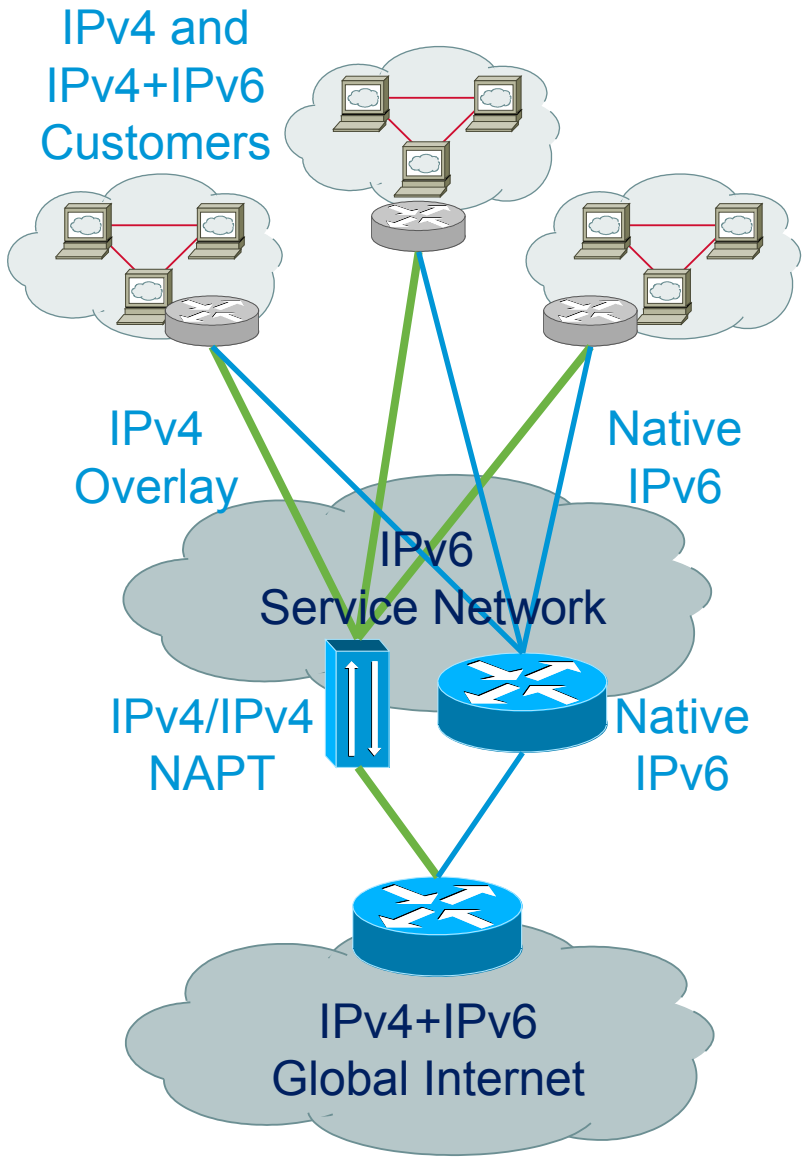
Book 3, Hitchhiker’s Guide to the Galaxy, Douglas Adams

New Provider Example

A provider mentioned on nanog@nanog.org is starting from a miniscule (/22) IPv4 allocation
Net solution: he has to deploy an IPv6 network and carry IPv4 as an overlay or in translation

That has issues for IPv4-only customers providing services
Global IPv4 address space will be expensive and potentially unavailable
due to APNIC policy

Hence, customers will need to provide IPv6-capable applications from the start.



Not “Somebody Else’s Problem”

More Common Provider Example

Providers today may have IPv4 resources for various services

For a while…

IPv6 deployment takes a year or more for hardware/software audit, upgrade planning, and actual deployment

Hence, important to keep IPv4 running during IPv6 deployment and a while afterwards

In some cases, providers are already using IPv4/IPv4 NAPT internally

Especially mobile providers

Net effect for them: **complexity**

Complexity results in capital and operational costs, which are passed on to customers

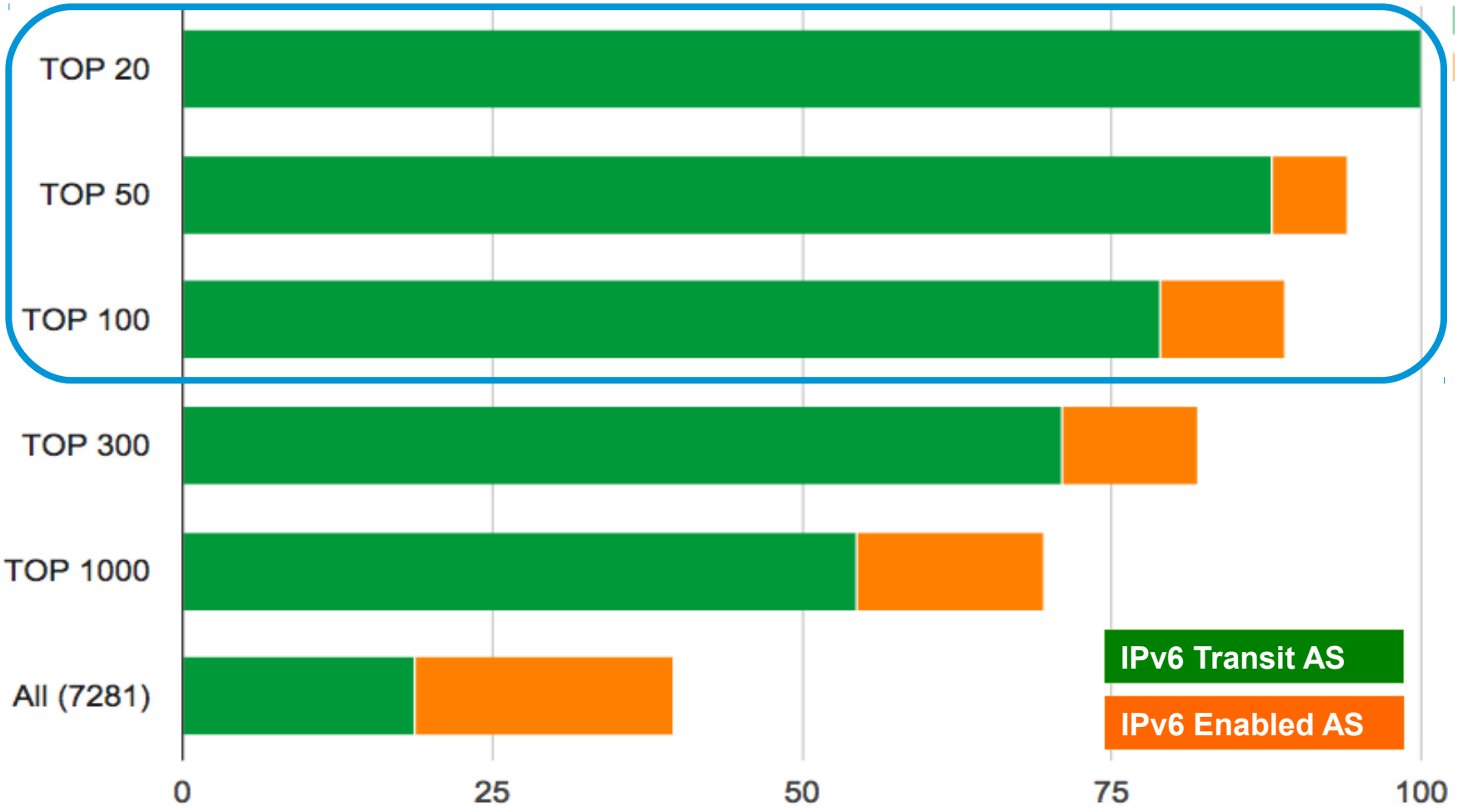
IPv6 Offers the opportunity to making operations simpler

Consistent address space makes it easier to route traffic to a subscriber, and identify a subscriber for various reasons

We have a number of customers telling us they want to limit the coexistence period within their own networks to something approximating a single equipment deployment cycle – *a couple of years*.

Can be “Somebody Else’s Problem”

IPv6 Internet Core (Transit AS's) per Route Views



http://6lab.cisco.com/stats/

Definitions:
"IPv6 Transit" implies current IPv6 transit to at least one other AS
"IPv6 Enabled" implies a terminal node in IPv6 but Transit in IPv4

Content Providers

The business of a content provider is…
To provide informative content to its customers

Who is the customer?
If you're paying for the content, you're the customer

If it's free to you, you are integral to the product being sold

Eyeballs, **location** of eyeballs, marketing **statistics and insight**, **demographic** intelligence, search criteria, Digital Rights Management

*Content providers need to know your geographic and topological **location** and **interests,** and associate that with **identity** and **relationship,** to deliver their product to their **customers***
IPv4 CGN obscures location, makes security diagnosis and service deployment harder

IPv6 global addressing permits folks to determine topological location and by extension probable physical location

Identities? Relationships?

An Aside…

Per sociological research

If all of my friends have a given opinion or medical situation, I probably do too

If all of my friends {smoke|drink|gamble|…}, I probably do too

There are statistically significant inferences that can be made about me given knowledge of my friends – and about my friends given knowledge of me

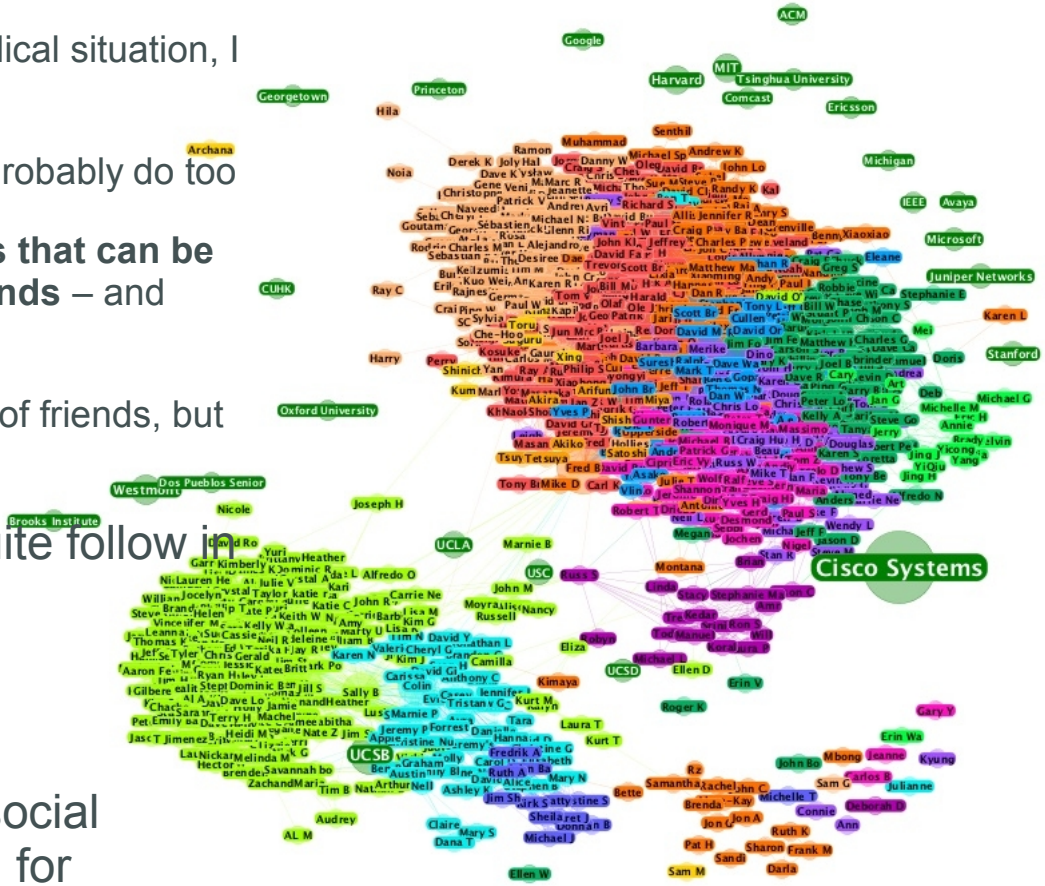
This is also true, to a lesser degree, of friends of friends, but not F of F of F

Per UCSD Research: this doesn't quite follow in computer social networks

10,000 FB friends are too many friends

Look at "photo friends", "respondent friends"

Knowledge of a person and his/her social networks provides information useful for business purposes



http://connectedthebook.com/
Facebook TouchGraph

Mobile Internet (was: Mobile Telephone)

Business models for communications

- PSTN:

Location matters, distance matters, billable unit is the minute

- Internet:

Location and distance irrelevant, billable unit is the month or the megabyte

- Mobile Internet:

Billable unit is the month or the megabyte

Unless you're roaming (a different version of distance)

Location is important: cell location important to service, also a commodity to sell

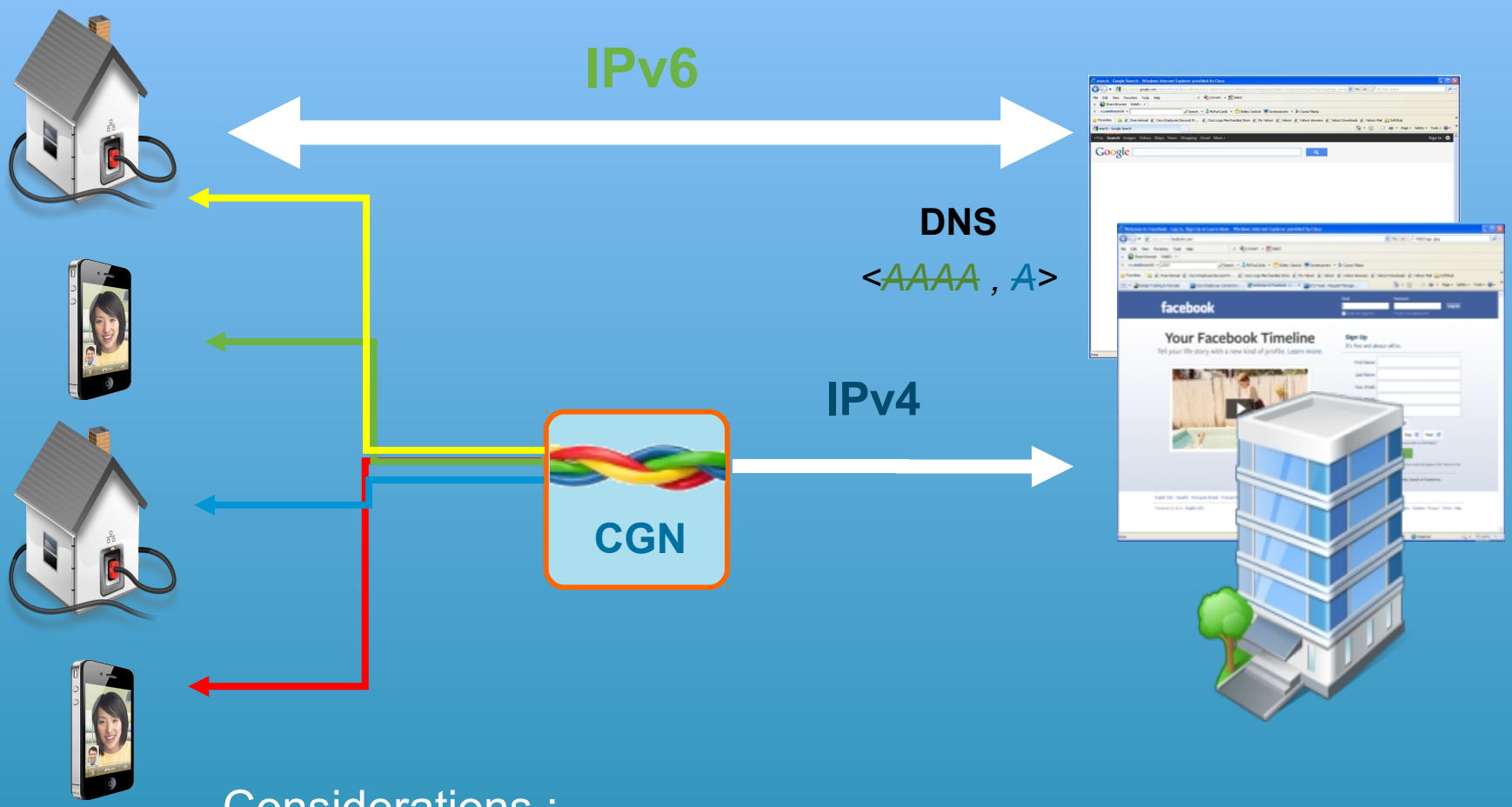
So is the set of parties you call, or who call you.

Value of IPv6 to Mobile Internet

- Prior to Release 9, IPv4 and IPv6 require separate network attachments; pay accordingly
- Simplify network – less internal NATs, simpler debugging

Not "Somebody Else's Problem"

IPv6 – “Full Spectrum” Internet



Considerations :
Transparency to application, Innovation, Scale, Security, Cost

What's the problem with Carrier NAPT?

My daughter's house was broken into on 1 October 2012

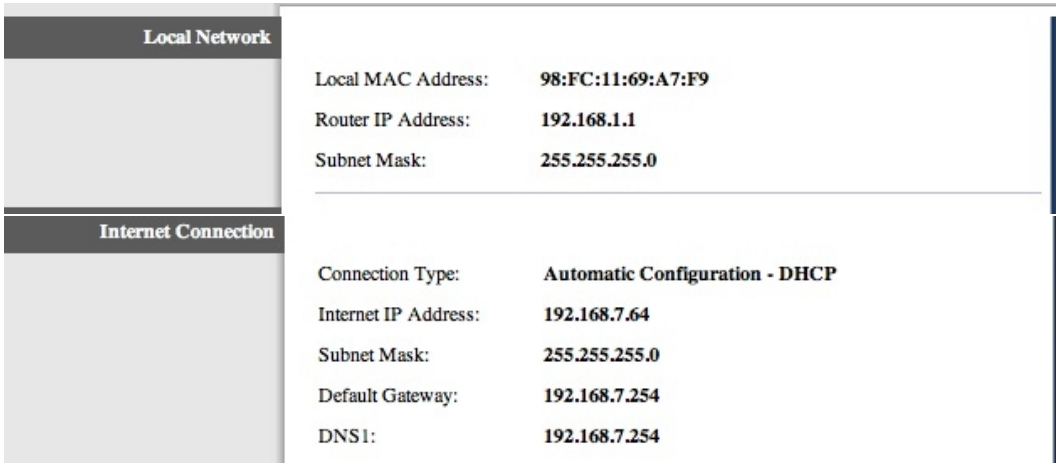
A couple of days later, I bought a video surveillance system and her husband and I installed it.

Surveillance and recording – fine.

The product includes a DDNS service:

Record a name and a NAPT translation in the home router

iPhone, Android, Windows, and MacOSX Apps now advertised as being able to view the video record and manage the system



Oops: upstream NAPT.

Why do people mistake NAT for a security service?

No IPv6 service

Implication

An advertised business service could not be delivered due to address multiplexing

Enterprise Networks

Enterprise networks:
Internal networks operated by companies for their own purposes

What are those purposes?
To communicate to/with customers

To communicate to/with partners

To communicate internally

Enterprise networks are usually in control of their internals, and able to renumber or in other ways work around address shortages
Larger enterprises may be structured as business entities around a central “ISP”, in which case they also share the characteristics of ISPs and Content Providers

But they are concerned about customers and partners, and will deploy an IPv6 web/mail presence to ensure that they can communicate with those

Primary issue driving enterprise deployment:
Network and management complexity

Can be “Somebody Else’s Problem”

Enterprise networks and SEPs

A problem stops being “somebody else’s problem” when it becomes “my problem”.

Such as when they can no longer deliver or gain a service that is important to them

Why would an enterprise view IPv4 address shortage as “my problem”?

When fixing it solves a problem they have

When it gets in the way of communicating with customers

When it gets in the way of communicating with partners and suppliers

When it gets in the way of internal operations

Residential Broadband Networks

ISPs that offer services to homes and small businesses

Counterpart of enterprise IT services to their customers – email, web hosting, etc.

Consumer services such as entertainment.

Primary target of current LAES legislation

Implication: **everything we have said about ISPs, Content Providers, and Enterprise Networks applies to them**.

Some of the largest, such as Comcast and Time-Warner, are leading the IPv6 deployment charge.

To their customers, IPv4 vs. IPv6 is definitely "somebody else's problem" ***unless they are being denied a service or are unable to communicate with someone for lack of it***

Equipment turnover likeliest help in consumer deployment

“When do you think IPv6 will be more important than IPv4?”

- **Adoption follows an “Adoption curve”:**

The more users adopt, the more users adopt, over a period of time

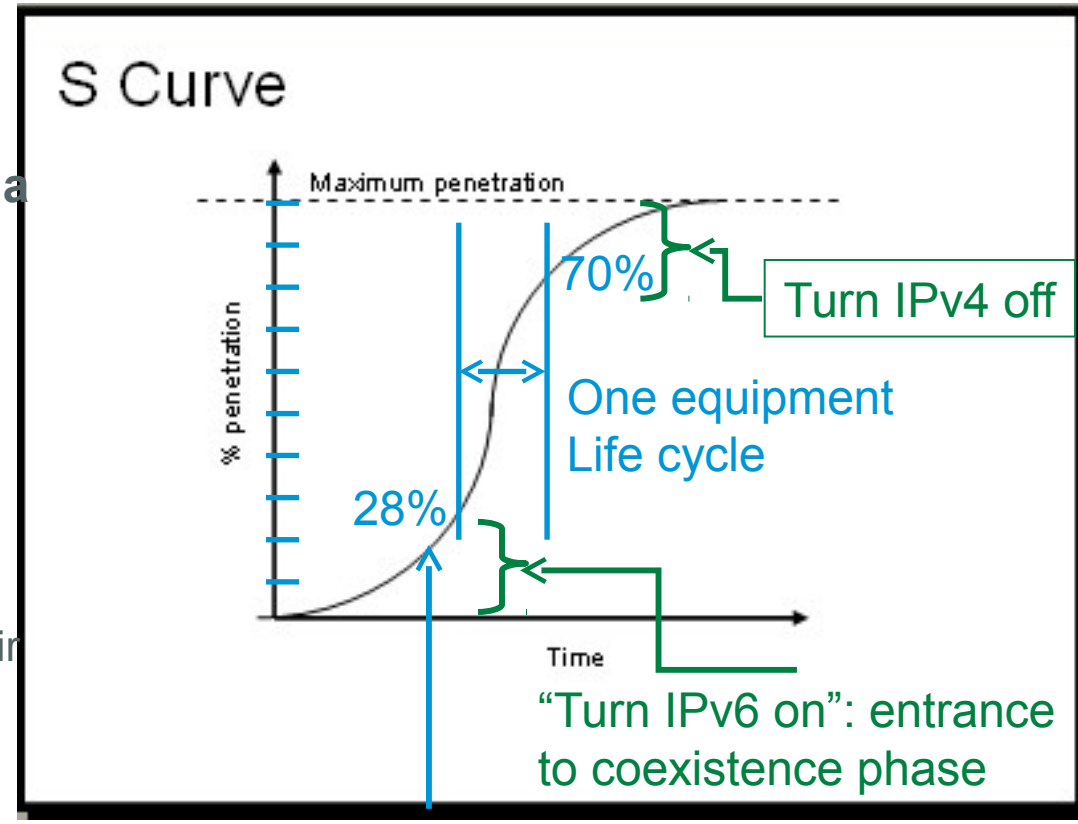
- **ISP deployment relatively easy as a consensus develops that it is needed**

That gets us only part-way there

- **How do we drive unsophisticated users and networks towards deployment?**

It has to appear feasible and desirable to users: users have to believe it works for their purposes

Tools have to support businesses of providers and edge networks



We are here: 15% Worldwide

Transition technologies available

Primary target today:

In IPv4 networks, Dual Stack deployment

In green fields, IPv6-only deployment is actively considered

Solutions for difficult points in IPv4 networks

- 6rd solution pioneered by Free

"6to4 done right"

Enables an IPv6 network to auto-tunnel over an IPv4-only domain, which might be a network or a piece of equipment

- NAT64 translation

Enable IPv6 hosts to access IPv4 services

Enable IPv4 hosts to access IPv6-only services with IPv4-mapped addresses

Solutions for IPv4 turn-down

Expect ds-lite, predictable Address+Port ("MAP") solutions, and others

Translation *of limited utility* in this phase, as translation doesn't facilitate IPv4 access to non-mapped IPv6 addresses

Changing Internet workload

Changing applications

Every 3-5 years, the Internet fundamentally changes in the payload it carries
1990: FTP, Network News, telnet

1992: World Wide Web, SMTP, multicast, experimental voice/video

1995: WWW with multiple sessions in parallel, Voice on IP

2000: Peer to Peer file sharing in various forms

2003: Web 2.0 applications like MySpace, Facebook, BitTorrent File Sharing

2008: Cyberlockers replacing file sharing

1990-present: Rise of video in various forms

Lately: Map/Reduce and Hadoop – data center distributed applications

Next…

On the commercial backbone, video is becoming dominant, primarily from ICPs that colocate with some or all of an ISP's POPs

In private networks (Smart Grid, Health Care, Public and Private Safety) we see distributed telemetry and distributed control.

Changing user expectations

The changing home network

- Imagine a high end home network:

Audio/Video

Wireless

Telecommuting

Home Area Network

- What is the HAN?

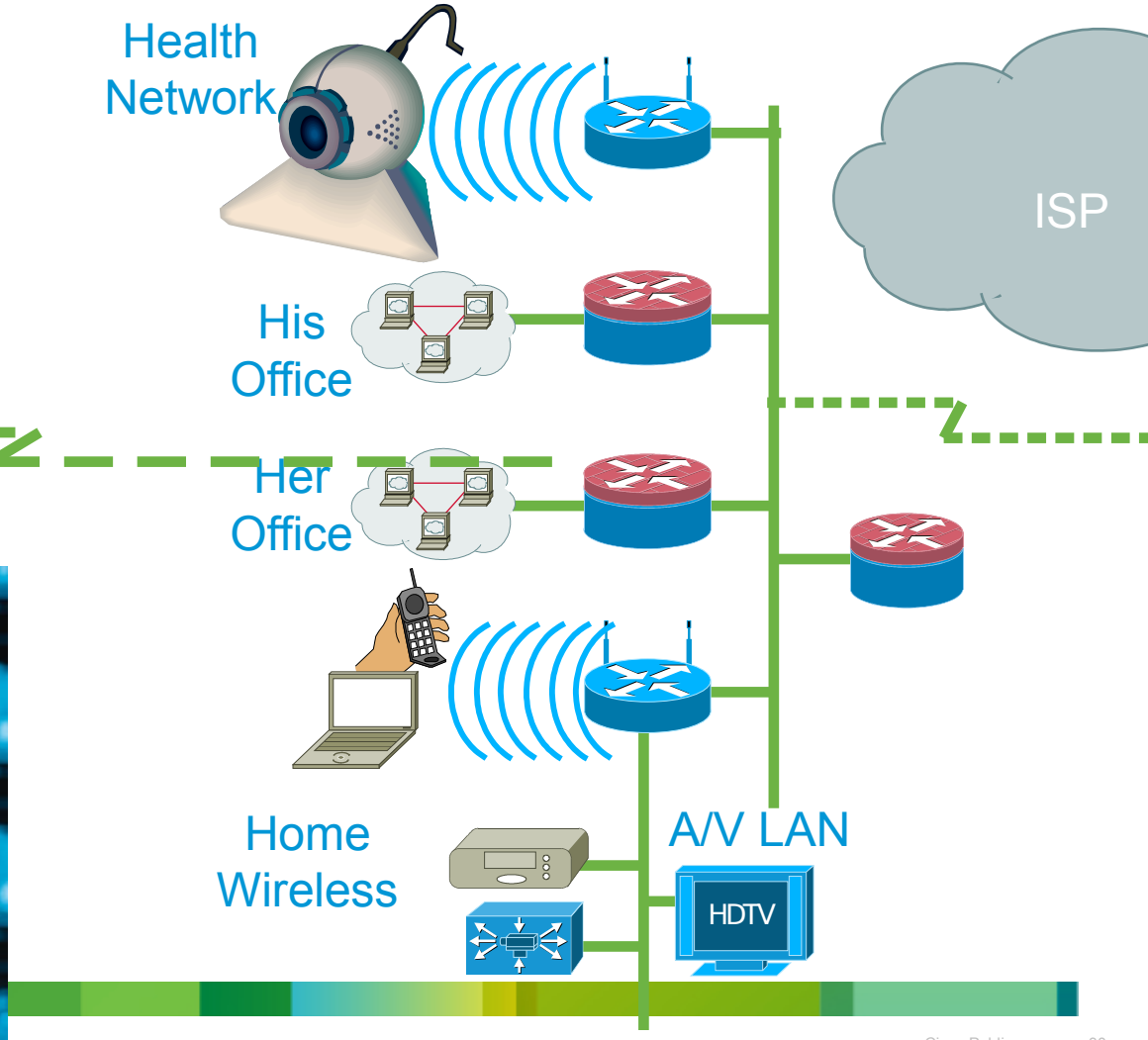
Network connecting sensors in the home

Communications with utilities

Services to residents

Related to sensor networks for health…

- Infrared
- Motion sensors
- Heart Monitors
- Pedometers
- …



v6ops: IETF standards for operators of IP networks

"Given the global lack of available IPv4 space, and limitations in IPv4 extension and transition technologies, this document advises that IPv6 support is no longer considered optional."

RFC 6540, BCP 177: "IPv6 Support Required for All IP-Capable Nodes"

What is v6ops arguing about?

Summary of several drafts:

"How to deploy an IPv6-only network given that a lot of content is today reachable primarily by IPv4"

The obvious solution:

"Deploy IPv6 in your existing IPv4 network, achieving dual stack"

In mobile networks

- One often pays by network attachment or by connection.
- Handsets are often single-stack (IPv4), and may only use on connection at a time.
- For networks with a lot of legacy equipment, this pushes toward IPv4-only for some equipment and IPv6-only for other equipment, but dual stack is only in the latest releases.

Issues preventing deployment?

Product readiness

Standards for capabilities: IPv6-ready logo, US Government Spec, RIPE 554

That said:

Few vendors really ready for IPv6-only networks

Enterprise RFPs not really driving in that direction

Result:

Vendors provide IPv6 capabilities when customers say they need them,

Depend on IPv4 if not needed “today”.

Business issues

CPE Routers starting to support IPv6,

Not a consumer selling point

Not necessarily supported by FIOS/DSL/Cable ISPs yet – DHCP-PD, etc.

Result:

Features are implemented when product managers believe that they will make products fly off store shelves.

Broadband ISPs struggle with the notion of IPv6 operational implementation when consumer products don’t support it.

What do I do next?

Some questions:

1. What is my strategy? What is the cost of doing nothing?
2. Have you assessed risk and security related to IPv6?

Planned the implementation of the mitigation solutions?

3. Are the relevant staff trained for IPv6?
4. Has an IPv6 assessment of your infrastructure and applications been performed? What hardware or software needs an update?
5. Did you get IPv6 address space from the RIR or your Service Provider with an addressing plan?
6. Do your upstream service providers support IPv6?

Have you negotiated service agreements for it?

7. Are your purchasing, development and service policies and guidelines aligned for IPv6?
8. Do you have a deployment and maintenance plan in place?
9. When IPv4 is turned off, there will still be issues. What will you do about them?

Thank you.