IPv6 status and Prospects

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The Theme of the Talk

- There are many current considerations of the shape of the future Internet
  - The only immediate candidate is IPv6
- Information on what it is, why it will come, and what it will bring are vital to all
  - But the planning for the transition is slow
- The EC and the European research community are ready to move in this direction
  - I will indicate what is happening here
- The transition will require training
  - Some of the training initiatives will be mentioned here

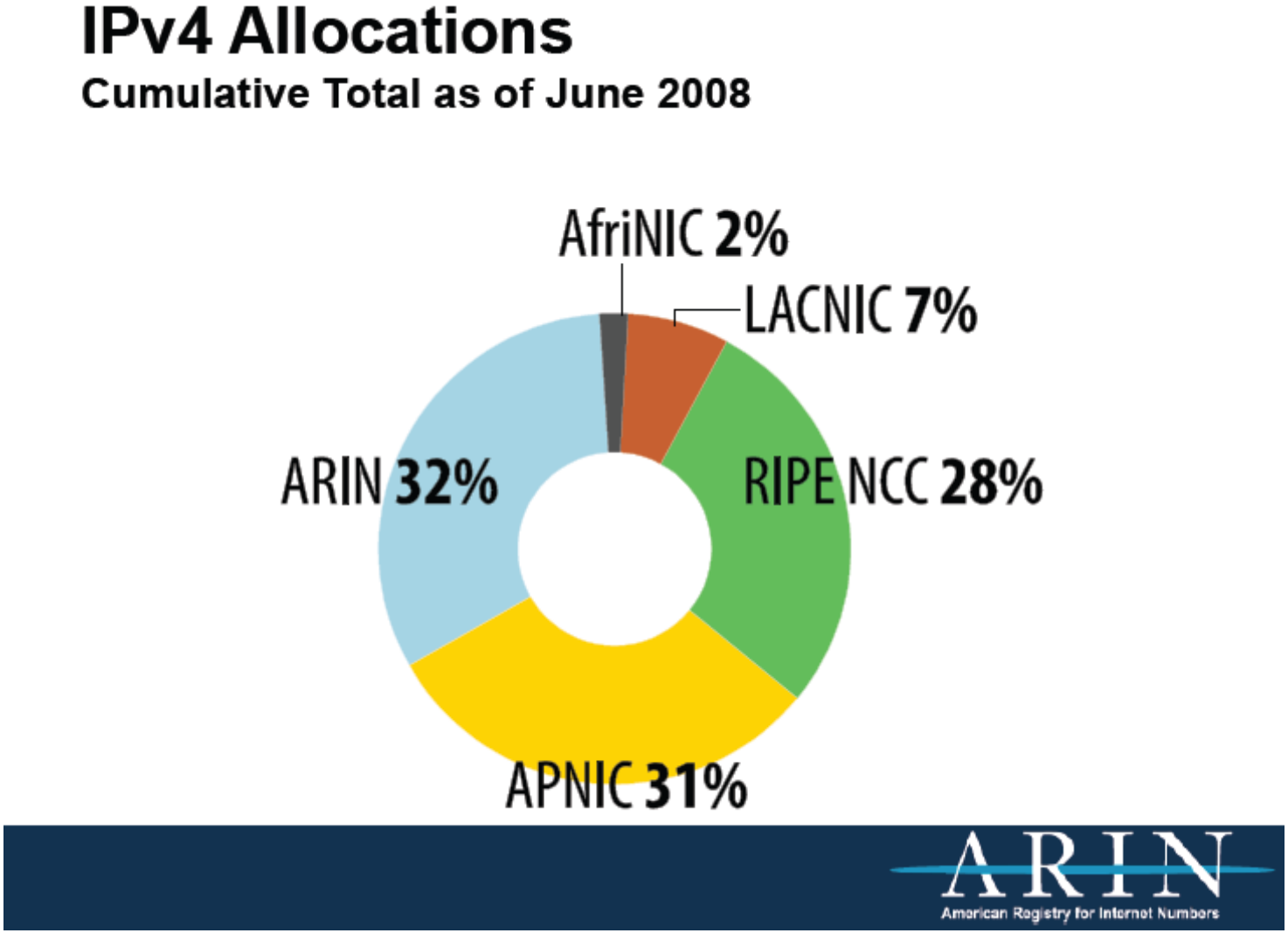
IPv4, IPv6 and Address Depletion

- Because of its 32 bit address length, IPv4 has 256 blocks of 16 M addresses – called a /8
- There is a mechanism for allocating the addresses
  - But they are being used up at a rapid rate
- There are many aspects of IPv4 protocols that one thinks now need improvement
  - But address depletion is an important driver
- We decided around 1990 that a re-think of current IPv4 protocols was needed
  - Result was IPv6
  - Much larger address space and other improvements

Mechanism of IPv4 Address Allocation

- IPv4 addresses used to be allocated in an *ad hoc* fashion
  - I personally held two /8 blocks for .UK and .Int!
- Now there is a system of Internet Registries
  - World (IANA), Regional (RIRs), and Local (LIRs)
  - RIRs allocate blocks to Local Internet Registries (LIRs)
  - LIRs allocate blocks to end users
- IANA allocates /8 blocks to RIRs – No charge
  - RIRs have their own policies on such allocations
  - LIRs have their own policies subject to some RIR rules
  - All provisions are only on a cost recovery basis
- See http://www.nro.net/documents/comp-pol.html

IPv4 Allocations by Region



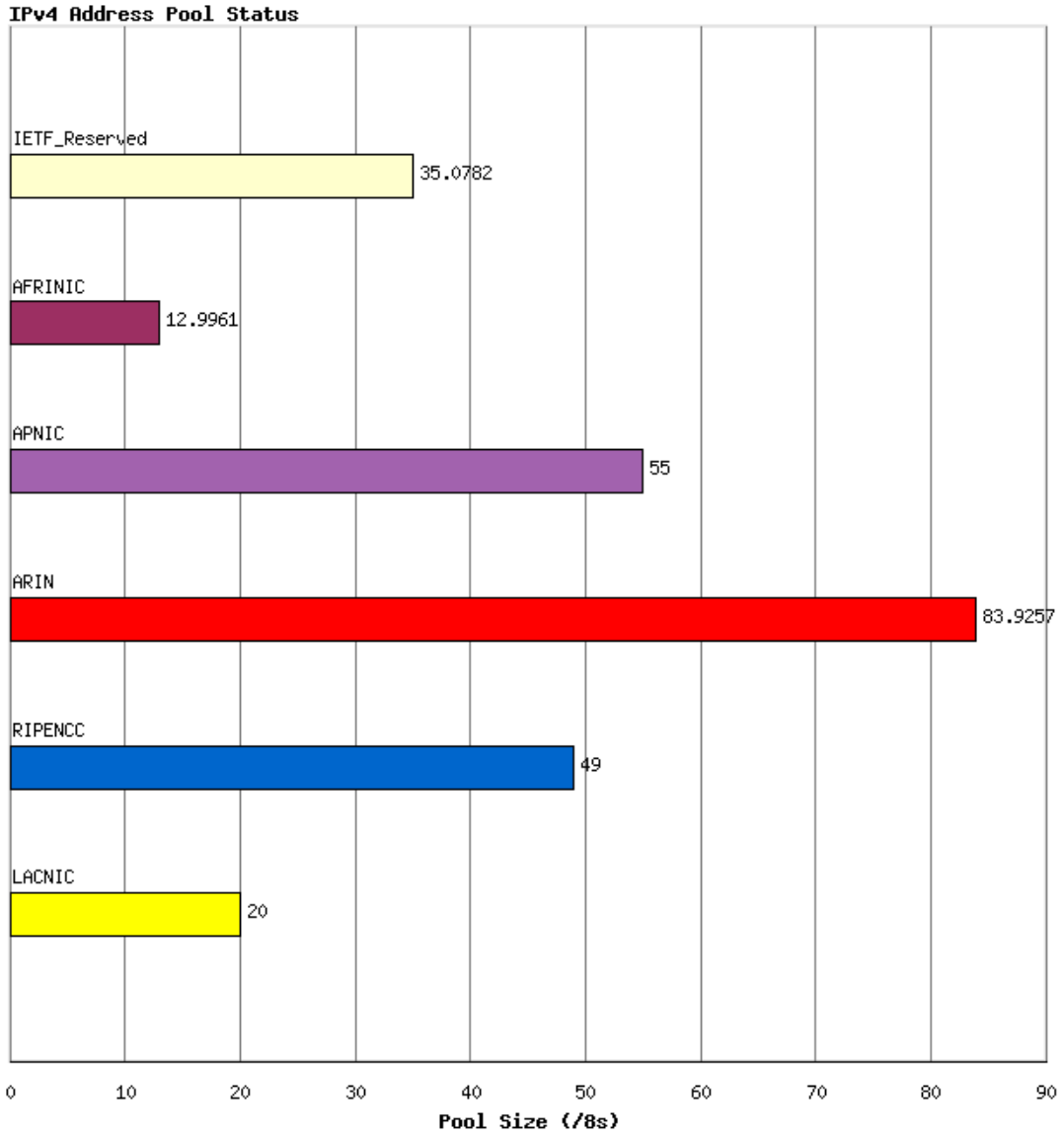
Urgency due to Address Depletion

- Address depletion stated too often
  - but now there
  - http://www.potaroo.net/tools/ipv4/
- Address Exhaustion defined as when Last /8 reached
- Triggers new emergency mechanisms to conserve space
- IANA reached last 5 /8s in February 11
  - Allocated last 5 /6 blocks to RIRs
  - APNIC reached last /8 in April 2011
- Will only get much smaller number of global IPv4
  - Stricter rules on use of allocations
- Has impact on new applications which need global
  - applications (particularly with security) or p-p

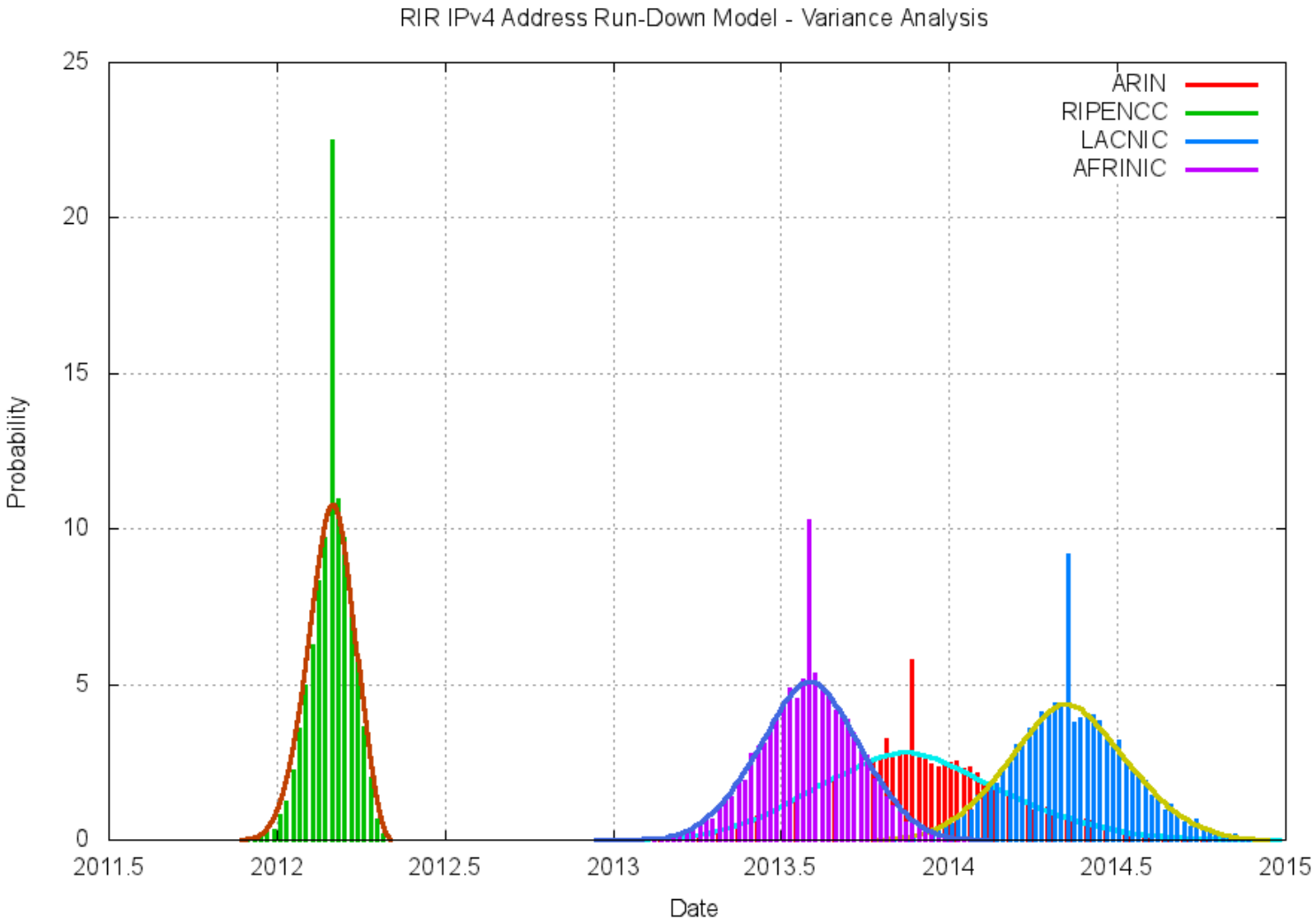
Estimate of RIR Exhaustion Date

- When exhaustion date reached much firmer allocation policies are introduced
- Estimated Exhaustion Dates (at current rates)
  - APNIC:19-Apr-2011
  - RIPENCC:28-Feb-2012
  - AFRINIC:31-Jul-2013
  - ARIN:20-Nov-2013
  - LACNIC:08-May-2014
- Exhaustion date does not mean end, but much stricter rules on allocation – e.g. at most 1 K address
  - Policy will differ in different regions

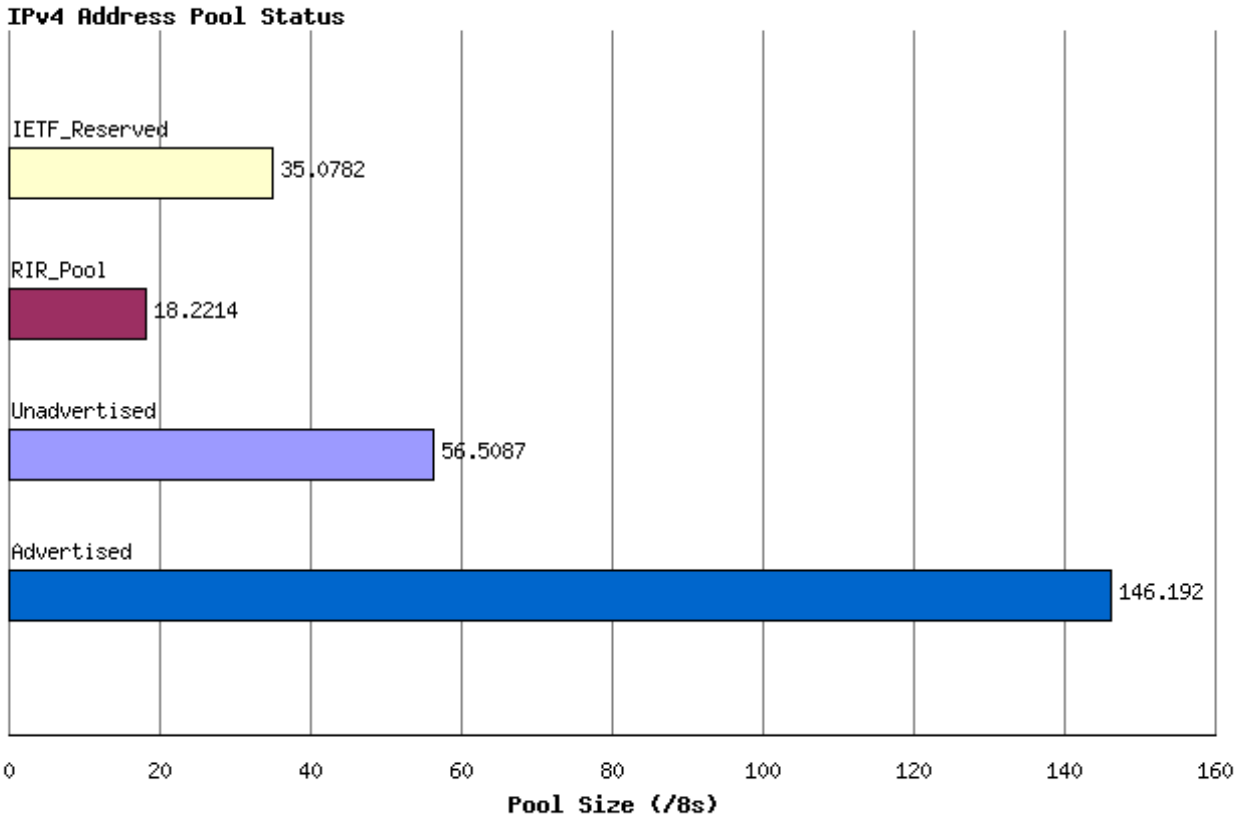
IPv4 Allocations by Region – 2/11



Exhaustion Date Estimate Variance



IPv4 /8s In Various Categories



Address Problem by Region

- Mature regions have much larger historic allocations
  - Hence have less urgency to move to IPv6
- Asia-Pacific and Africa have much worse problem
  - Many have major interest in large-scale growth
  - Particularly China, Japan, Korea must move fast
- Since the only protocol stack which has been properly designed is IPv6, the above countries have gone into routine operation earlier with IPv6
- However this is now changing also in other regions

Activities in Region

- Mature regions have much larger historic allocations
  - Hence have less urgency to move to IPv6
- Asia-Pacific and Africa have much worse problem
  - Many have major interest in large-scale growth
  - Particularly China, Japan, Korea had to move fast
- All three have large deployments
  - CERNET-2 all IPv6 with 10 Gbps
  - China says they will go all IPv6 by 2016
  - Japan has had WIDE development project since 1999

What is IPv6

- **Successor to current IPv4 Internet Protocol**
  - Under development since about 1993
  - Ratified as Standard by IETF around 2001
- **Principal characteristics**
  - Much more address space – 128 bits instead of 32
  - Mobile IP support mandatory (better than in IPv4)
  - IPSEC mandatory (could be done in IPv4)
  - Better auto-configuration
  - Better multicast
  - More space for flow-control options
  - More efficient processing of header options

Why was it not adopted years ago?

- Needed complete new suite of programs in each component of the infrastructure and terminal
  - Virtually all the components are now in place
  - Mostly in dual-stack mode so that either version usable
- Needed clear concept of how to do transition
  - This will clear be done via dual-stack
  - Mechanisms for operational transition now defined
- Needed technical and/or economic reason to move
  - Killer applications only slowly emerging
  - Address space depletion put off by technical measures and less serious in North America and Europe
  - Considerable concerns of cost/benefit of transition – training, equipment, disruption

Current Status

- Impact of address depletion imminent
- Major studies done on cost of transition
  - E.g. GSA, DoD in US
- Research activities 2000-2006 showed ease of putting dual-stack in the network core and terminals
  - DoD pilots and testbeds 2005-2007
- Most Research networks now dual-stack
- Terminal equipment often has IPv6 1st choice
  - Microsoft since Vista, IPv6 preferred, goes to IPv4 if needed
  - Mobile have IPv6 since v 4.1 of WIN-CE6, Symbian OS7.0 Linux and BSD have long had IPv6 standard
  - Most big providers move to dual stack
    - Though not all applications as complete (e.g. Cisco VoIP/CUCM)
- June 8 IPv6 day

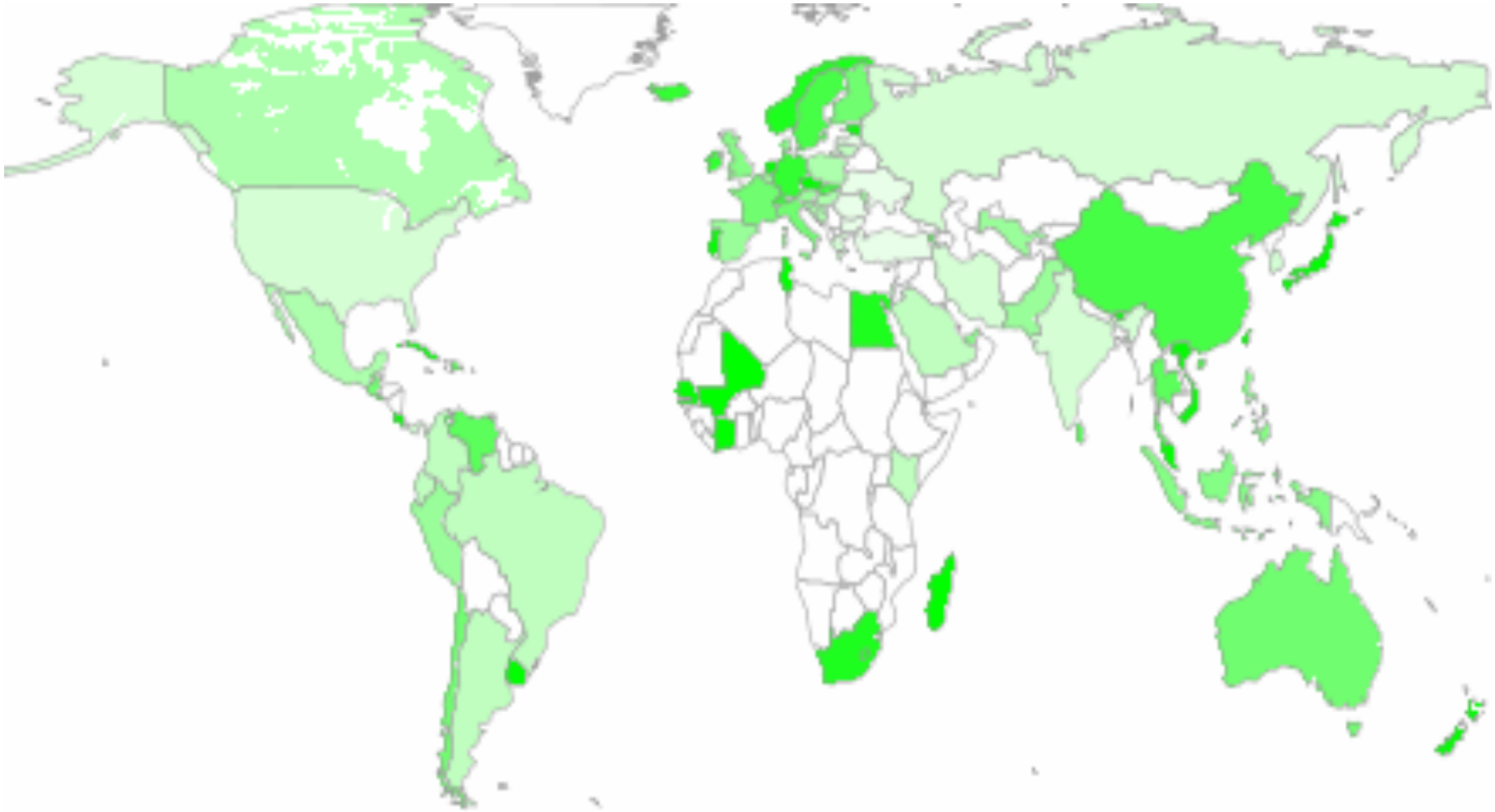
IPv6 Day

- Big providers showed IPv6 readiness
  - Google, Yahoo, Akimai, Cisco
- Large User Organisations showed they were ready
  - E.g. NRENs, SPAWAR, some enterprise sites
- Traffic proportion IPv6 still low – typically 0.1%
  - But went up 60% on day dropping to 30% thereafter#
- However there were few real problems
  - Most solved on the day
- Expect steady migration of major services permanent
  - Also expect IPv6 week in February 12

Ratio of IP6/IPv4 AS Distribution 1/09

Dark/medium/light green show >10%, 5%-10%, <5%

Clearly South Africa is an early adopter



Stages of Adoption of IPv6

- There have been many studies of the stages needed to transition to IPv6
  - A good one was published by the ECC committee of CEPT
- The report outline the stages for public IPv6 transition:
  - 1 The core backbones must go dual-stack
  - 2 The ISP must embrace dual-stack working
  - 3 Content servers must become IPv6 accessible
  - 4 User equipment may become dual stack
- The report also analyses the progress of the different countries along this path
  - In general, it is a long haul to get organisations transitioned

US DoD Transition Good Case Study

- 2001 Electronics Board tasked to produce strategy
- 2003 Came up with broad policy
  - All new systems from 03 be IPv6 capable, IPv4 Interoperable
  - Support testbed (NAVIPv6) in university
  - Identify a at least 3 major projects that could be IPv6 Pilots
  - Transition 2005 – 2007
  - DISA manage and control all IPv6 address space for DoD
- Set up labs and testbeds
  - With ever increasing functionality
- Set major standards for DoD
- Built database of accredited suppliers and applications
  - Working closely with industry

Japan More General Strategy

- **WIDE Project worked on IPv6 from 2000**
  - Strong involvement from industry
  - Director, Murai, moved to Prime Minister's Office
  - Built IPv6 infrastructure around 2000
  - KAME to provide IPv6 OS around 2000
  - Worked on mobile applications (and cars)
  - Equipped major building in Keio U for energy monitoring and conservation
- **Sony early research activity including 6NET**
  - 2004 stated all relevant future projects would be IPv6
  - Withdrew from effort on in games in 6NET to continue it in Japan
  - Games are p – p and need the IPv6 addresses

European Framework Research

- **Significant pilot network projects 2000 – 2005**
  - 2000-2003 6INIT (infrastructure), 6WINIT (mobile apps)
  - 2003-2005 Serious Pilots 6NET (network plus apps), EuroIX (Internet exchanges), Security
- **Training and Applications 2006 – 2009**
  - 2006-2010 6LINK, 6DISS, 6DEPLOY, 6CHOICE
  - 2007-2009 Civil Protection (U2010), 6Power, 6SAT
- **From 2010 no particular IPv6 Projects**
  - But assume that most projects will use IPv6 in their execution
- **Research Infrastructure GEANT dual stack**
  - Most European NRENs also dual stack
  - Very few universities have much IPv6

Many Actively Promoting IPv6

- IPv6 Forum frequent Awareness Meetings
  - Many national IPv6 Task Forces
  - IPv6 Readiness Logos
- 2008: European Commission IPv6 Action plan
  - Propose 25% users be able to connect with IPv6 by 2010
  - Proposes EC and EU e-Gov sites be enabled
- 2009: 1st EU Agency provides IPv6 web access
  - European Network &Information Security Agency (ENISA)
- IPv6 EU Deployment Monitoring Survey
  - By TNO, GNKS Consult and RIPE
  - 610 respondents, including government bodies, ISPs, other technology houses, and education

Survey results: European IPv6 use

- 79% have or in process of getting IPv6 addresses
  - 97% of educational institutes have IPv6 addresses
- 17% using IPv6
  - 8% of ISPs are using IPv6
- 30% concerned about IPv4 depletion
  - Compared with 48% concerned outside the EU
- Why not deployed yet?
  - 70% No business case
  - 57% lack of user demand

New Protocols

- Survey indicates lack of interest or understanding of urgency
- Neither organisations nor user understand the impact of protocol progress over last eight years
- IETF has concentrated on IPv6 with new protocols
  - Many could be developed for IPv4, but have not been
  - Examples are improved 6LowPAN (low power protocols), ROHC (Robust Header Compression), MIP6 (mobile users), NEMO (mobile networks), MANEMO (Mobile ad hoc)
- Thus many of the future applications do not really have good IPv4 protocol support

Future Driving Needs for IPv6

- Know predicting future is a mug's game
- Mobile Important driver
  - IMS needs global access, agreed that it be IPv6
  - As VoIP goes mobile, needs many addresses, not IPv4
- Smart grids being developed globally
  - Needs many addresses
- All peer-peer traffic
  - Games, VoIP, Conferencing, Supplier push advertising
- Major interactive automobile services
  - Again problems of data push if private addresses

Smart [power] Grid

- **Smart Grids are being developed globally**
  - **Make grid more efficient – potential large cost savings**
    - US estimated $56-112 Billion saving in 20 years
  - **Earliest examples**
    - 2005: Italy - Telegestore project €2.1B – annual savings €500M per year!
- **2009: US Smart Grid Initiative - $8.1 Billion**
  - **40 Million smart meters**
  - **http://www.nist.gov/smartgrid**
  - **Smartgrid BoF at IETF76 in Japan, Nov 2009**
  - **Happening fast – standards to be ready by end 2010**
- **Large number of addresses => Need for IPv6**
  - **Could be done with IPv4 and private address spaces but would be much harder and constrain customers**

Emergency Communications

- U-2010 showed applicability of IPv6
  - Significant Luxembourg demo with fire, police & ambulance
- Some of the conclusions of the EC IP
  - Gateway to TETRA, but much better performance
  - Large-scale addressing of sensor networks
  - Capability of dealing with adhoc network
  - Ability to deal with security of sensor nets and media
  - Addressing size allows federation of different agencies on specific VPNs
  - Autoconfiguration allows easier set up of networks when infrastructur has been destroyed
- Requires relevant authorities to look at transition questions in the light of current TETRA deployments

Personal Communications

- Few VoIP and Conferencing systems fully IPv6
  - Though with scale envisaged, IPv6 would be needed
- Some Open Source products already enabled
  - ISABEL, VIC/RAT, Linphone, SIP-Communicator
    - Though not all completely IPv6-tested yet
  - OPENSER and ASTERISK have open-source IPv6 versions
- Less Commercial products fully available, but e.g.
  - Cisco has product (with limited protocol support)
  - Tandberg is IPv6 ready
  - There Is still very limited inter-vendor testing

What should we do for Services

- Ensure backbone networks are dual stack
- Ensure your main servers can run dual-stack
  - Web, file, message
- Ensure your local infrastructure has dual-stack capability
  - Running via tunnels to other islands if necessary
- Evaluate major software systems you use are IPv6-ready
  - Ensuring new procurements have dual stack upgrade clauses
- Ensure that terminal equipment is IPv6-ready
- Start running dual-stack in your organisation
- Start running some IPv6 services – like conferencing or web
  - Using tunnels if other infrastructure not ready

What should we do for new Apps

- **Once you are running some sort of IPv6 infrastructure, it is worth exploring where advanced IPv6 features would help, e.g.**
  - **Mobile applications or ones with ad hoc nodes, where MIPv6, NEMO or MANEMO will be useful**
  - **Peer-peer applications, where you will run out of address space**
  - **Large-scale monitoring applications, where both large address space and 6LoWPAN will help**
  - **Emergency situations where the address space helps automated VPN construction, auto-configuration helps and the built-in IPv6 are particularly helpful**

Training

- Clearly training is a major need
  - There are already many initiaiives
- Cisco Academy recently reviewed all its module
  - Now many consider IPv6
- 6DISS and now 6DEPLOY IPv6 training project
  - Has produced some 30 modules for IPv6 training
  - Provides about a dozen 3-day courses each year
    - Mainly in emerging economies
  - Has strong practical component, with local and remote labs
  - Labs provided by Cisco
    - Paris, Sofia and Mauritius active
    - Bangalore, Bishkek, Istanbul, Nairobi, Tbilisi, S.America soon
    - Now mainly routers, soon also VoIP and Sensor nets

6DEPLOY Project

- 6DEPLOY is training Project
  - Has produced some 30 modules for training
  - Provides dozens 3-day training each year
  - Sometimes shorter
  - Has strong practical component using labs
- Cisco donated labs to project
  - By end of 2011 20 labs, 2 in this region
- All labs now have standard equipment
- Some act as Standard Labs
  - Common booking system, procedures, addressing
- Workshops can use labs locally, remotely, together

Intentions of Project and Labs

- The intention is to develop centres of expertise
- The labs are distributed regionally in order to encourage them to foster regional training
  - Are concentrating on emerging economies
- Cisco provides hardware and initial software support
- The 6DEPLOY Project provides an initial training workshop
- The intention is that the institutions quickly become self-sufficient and do their own training
- It is hoped that the labs will all cooperate strongly

New Features in Labs Planned

- **Server-based software routers**
  - Based on Cloud Computing
  - Will co-operate with physical routers
  - Will be able to use physical or virtual routes locally or remotely
  - Some will be provided in remote labs, some will be provided as a cloud for Internet use
- **Developing some new applications areas**
  - VoIP, Conferencing, Sensor Neworks
  - Standard Labs may be equipped with these in the future

This Workshop

- Today we have launched the Almaty Lab
- This is the first introductory workshop
- We hope that this will inaugurate major IPv6 training in Kazakhstan
  - This centre is not nearly enough
- It is intended that this lab be used locally for training
  - But also remotely both for other 6DEPLOY courses and for many others locally
- We hope that this will start the deployment of IPv6 in the country and the region