IPv6 status and Imperatives

Peter T. Kirstein

University College London

Acknowledgements

- CAIDA's IPv6 & IPv4 topo maps
- Quantifying the Extent of IPv6 Deployment
  - By Elliott Karpilovsky, Alexandre Gerber, Dan Pei, Jennifer Rexford, and Aman Shaikh. PAM2009
- John King's IPv6 and BT talks
- EU IPv6 survey - RIPE, TNO, GKNS

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**

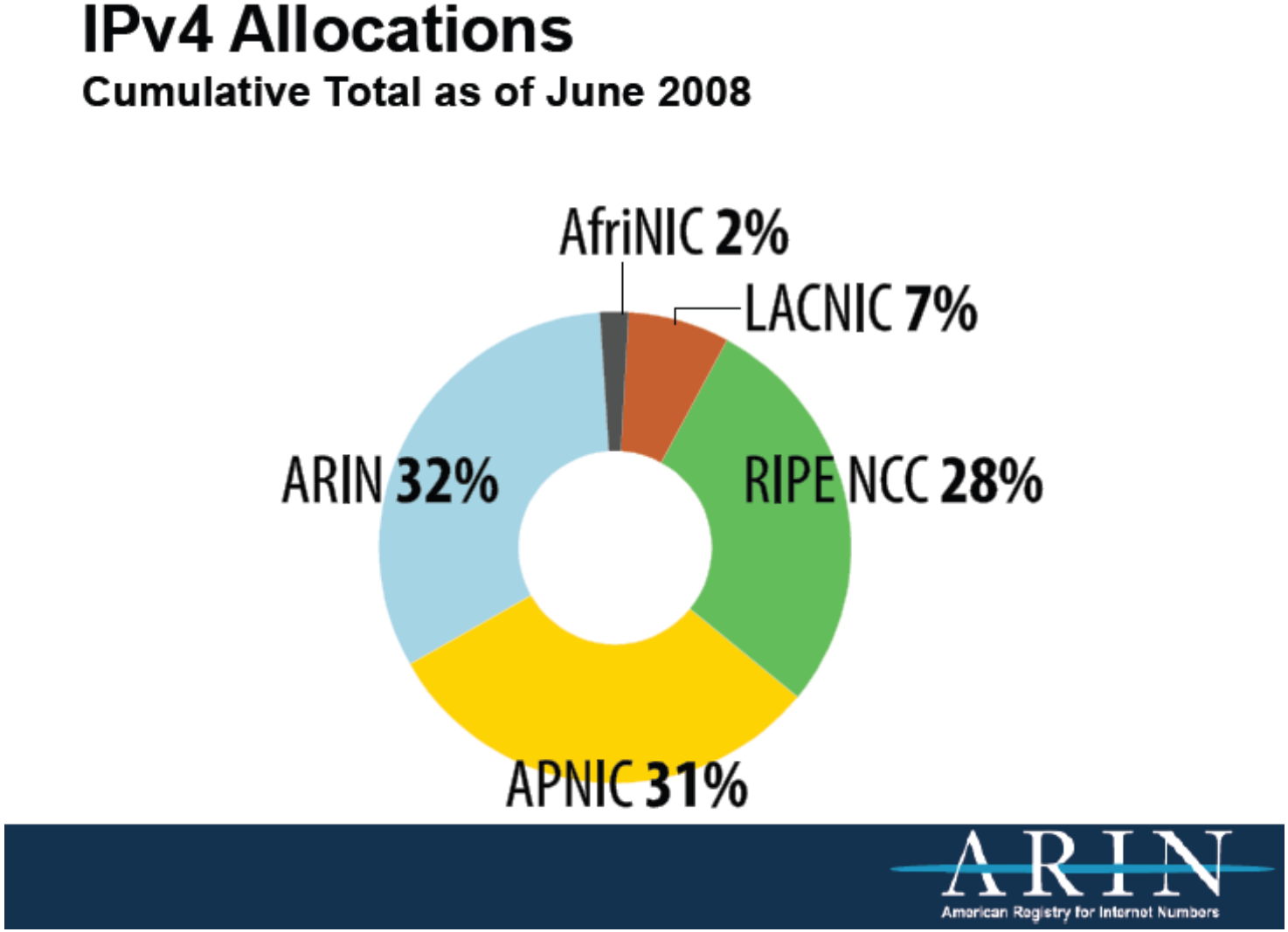
Current Status

- 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 telephones have IPv6 since version 6
  - LINUX has long had IPv6 standard
  - Google completely dual stack
    - Though not all applications as complete (e.g. Cisco VoIP)
- Many important policy announcements made

Urgency due to Address Depletion

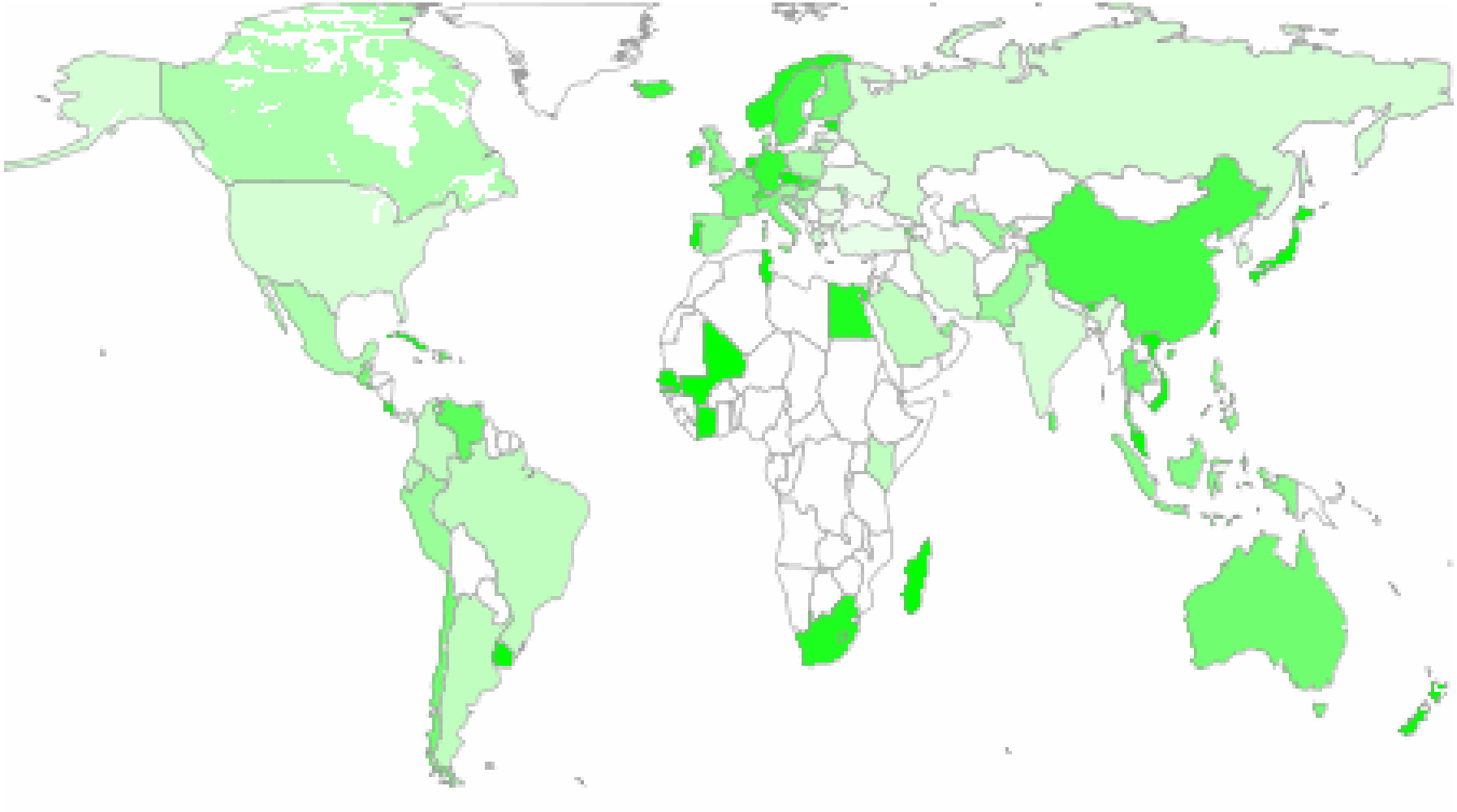
- **Address depletion stated too often, but now imminent**
  - **IANA provides /8s to RIRs; RIRs distribute to organisations**
- **http://www.potaroo.net/tools/ipv4/ has current status**
  - **IANA runs out 3/9/11, RIRs 28/8/12**
  - **Obviously not accurate, but gives idea of imminence**
- **Clearly more serious for those with few addresses now**
  - **But market in IP addresses may materialise soon**
  - **Will hinder easy change of suppliers in some industries**
    - **E.g. mobiles (have agreed to move to IPv6 for IMS)**
    - **Smart Grids (would require use of private addresses, necessitating re-numbering of meters etc)**
    - **Many p-p applications (particularly with security)**

IPv4 Allocations by Region



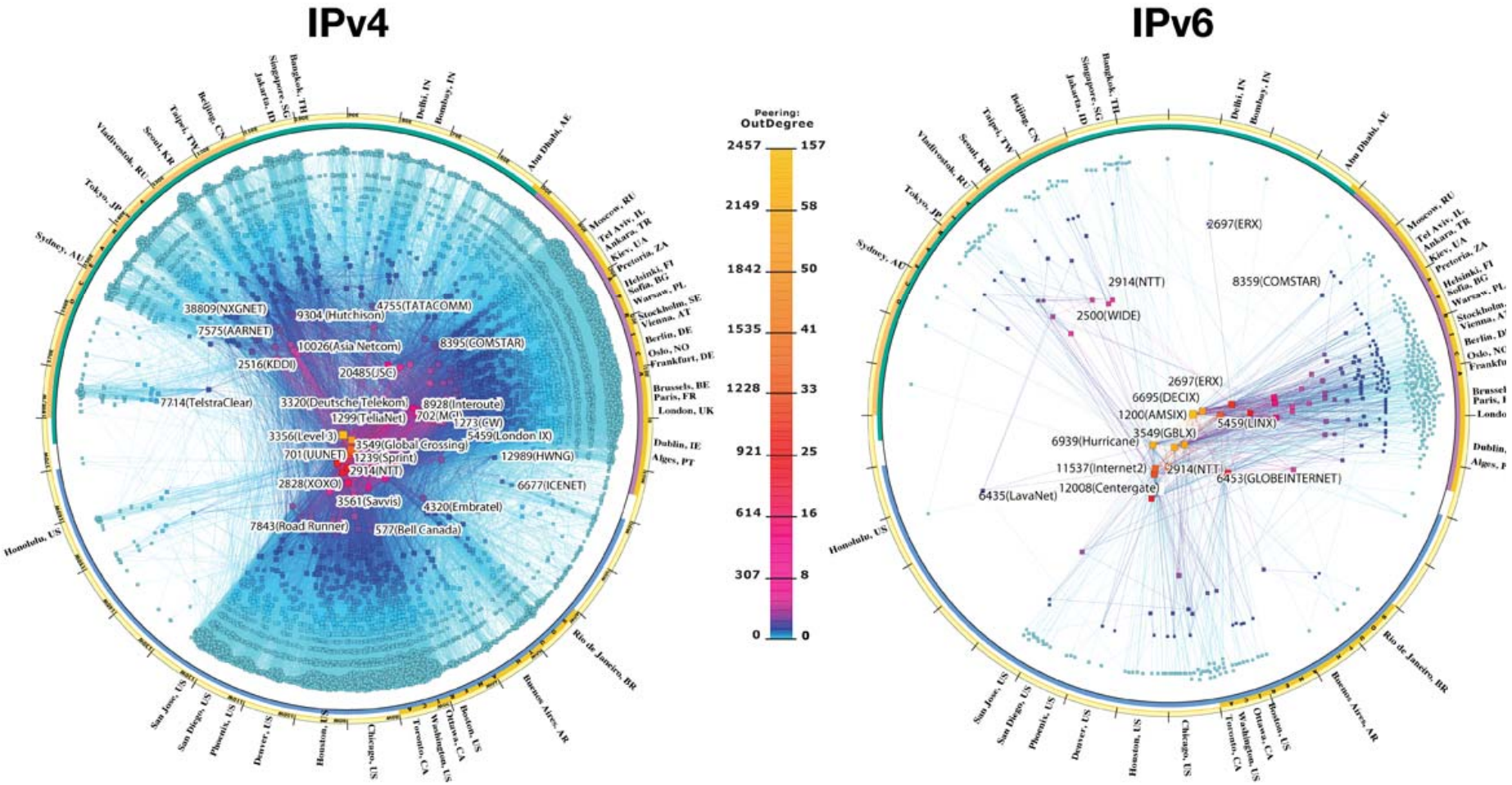
Ratio of IP6/IPv4 AS Distribution 1/09

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



IPv4 & IPv6
INTERNET TOPOLOGY MAP
JANUARY 2009

AS-level INTERNET GRAPH



US/Global deployment

- **IPv6 traffic: 0.001% of tier-1 US ISP**
  - **Mostly DNS, ICMP and tunnels**
- **Address allocation stats indicate IPv6 uptake**
  - **But too early to draw reliable growth projections**
- **Only 52% (IPv4:87%) of allocated addresses are ever advertised by BGP**
  - **Of these 'use latency' is averages 173 (IPv4: 52) days**
- **Increasing use of tunnels (Teredo) for P2P**
  - **97% of tunnelled traffic is P2P**

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

EC Actively Promoting IPv6

- **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**

Emergency Communications

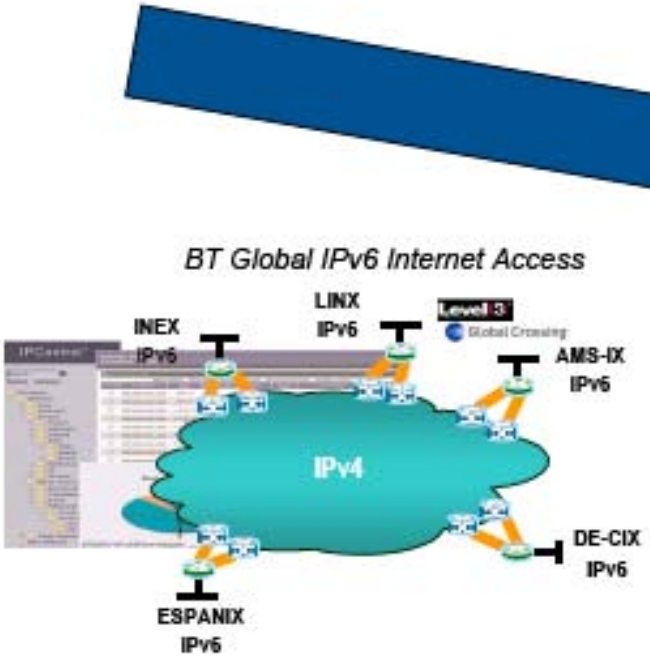
- U-2010 showed applicability of IPv6
  - Significant Luxembourg demo with fire, police & ambulance
- Some of the conclusions of the EC IP
  - Gateway to TETRA, but much better performance
  - Large-scale addressing of sensor networks
  - Capability of dealing with adhoc network
  - Ability to deal with 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

UK Deployment

- **No lead from government**
  - MOD done limited study of protocol, particularly for areas where interoperability with US is vital
  - NHS Network, Digital Broadband report no mention of IPv6
- **BT has been developing IPv6 support**
  - Setup IPv6 research networks
    - UK, Ireland, Germany, Spain
  - Performing limited commercial trials
  - Plans to deploy
    - 2010: Domestic Broadband Trials, Global MPLS trials
    - 2011: Integration of IPv6 into Ireland core network
    - 2011+ Full Platform/Product Integration
- **A small number of UK ISPs offer IPv6**

BT Internet Access Plans

IPv6 Timeline



Domestic Broadband Network Trial

Global MPLS Integration of IPv6 into BT Ireland core

Full Platform/Product Integration

2008 2009 2010 2011

Plans and Timescales subject to change

The Call to Action

- IPv6 is coming fast, UK is behind most others
- New activities will require it; start now
  - It is dangerous to ignore it. We need the experience and time to adjust
  - The tools and components are now there
  - As crunch time approaches, IP addresses may become short fairly quickly
- While long dual stack expected, remember analogue → digital transition
  - BT Planned 5 yr transition, but reduced it to 18 month due to cost of running two parallel systems.

What can we do?

- Government should consider IPv6 transition at similar level to further deployment of Internet
- Public utilities should consider IP6 impact now
  - And start taking appropriate measures
- ISPs, mobile and broadband providers should ensure that they have a transition plan in place
- Institutions envisaging activities like energy saving and communications should consider the transition
- Users should request IPv6 access from their ISPs and broadband providers

Specific Actions

- All large procurements should envisage IPv6 operation during their lifetime
  - Lack of transition capability should disqualify bids
- E-Government applications should become IPv6-enabled as soon as possible
- Many new large-scale applications should envisage IPv6 from the outset – e.g. smart grids, civil protection
  - IPv6 considerations should be part of all such specifications
- IPv6 training should be stepped up
  - Probably with some interim government funding

What can we do?

- Government should consider IPv6 transition at similar level to further deployment of Internet
  - Particularly with view to new applications like home care, smart grids, emergency provisions
- Public utilities should consider IP6 impact now
  - And start taking appropriate measures
- ISPs, mobile and broadband providers should ensure that they have a transition plan in place
- Institutions envisaging activities like energy saving and communications should consider the transition
- Users should request IPv6 access from their ISPs and broadband providers

Act Now It is becoming late