IPv6 Status and Uses

Peter T. Kirstein*

*Department of Computer Science. University College London, UK

Abstract –The paper provides an introduction to a talk on nature, scope, urgency of need of introduction and some important applications of the next generation IPv6 protocol. While the general characteristics are well-known, the talk gave data on the urgency of the need for deployment. Some of the newer protocols that depend on IPv6 are disussed. Some newer applications, particularly Smart Grids and Personal Communications are discussed specifically. An urgent need for training has been identified in a companion project (6DEPLOY). Some of its accomplishments are mentioned.

Keywords: ARPANET. IPv6, new protocols, smart metering, protocol transition, training.

1 INTRODUCTION

When I was asked to give a keynote to IWIN2011, I neither knew the interests of the audience nor the depth at which a subject should be addressed. It was clear that it should be about the current network activity, but even here there was a wide choice. I decided that the status and prospects of IPv6, as the next generation of Internet activities, seemed appropriate. While in the actual talk, it was the status of IPv6 and various activities around it that was presented. I was asked in this introduction to present some background on my previous work on the Internet. After some thought, I decided that this was indeed very appropriate. First I was of the generation that had lived through a previous transition of network technologies. Second, I had been very occupied in dealing with legacy infrastructure while moving as rapidly as possible into the next generation; this again would apply with the opportunities that were going to be offered by IPv6. Finally, while the present audience might be well aware of of the status and extent of Japanese activities in this area, the world scene would be much less familiar to them. By putting in some of the historical activity, the world perspective would become much more comprehensible.

In Section 2, I give a brief account of our activities in the context of ARPANErpanet, and then in Section 3, those in the context of the Internet with IPv4. In Section 4, we progress then to the current status of IPv6 and some future directions. The present situation is much more complex than that in 1981, when we were changing to the Internet, and the extent of the user community much larger – including many less network-aware. Hence we discuss some training with which we are involved.

2 FROM ARPANET TO INTERNET

The UK activities here have been well-documents in [1], [2]. In 1973, the Kjeller national computer Centre in Norway and the UCL Institute of Computer Science each got a Terminal Interface Message Processor (TIP) which could be connected to the Arpanet. The TIP could support some 32 terminals, either local or coming in by telephone lines. It could also support three additional computers. Because of the way the communications were configured at the time, there was a satellite connection at 9.6 Kbps to Kjeller and then a 9.6 Kbps undersea cable link to UCL. The main purpose of the Norway site had been to connect in a seismic array. While a substantial computer at the computer centre was connected to that TIP, the only way of using it was by going physically to the Computer Centre; the owners had no interest in providing access to remote users, and did not connect the TIP terminal ports to the telephone network. By contrast, the UCL TIP was immediately connected up to the telephone network with some 8 lines and to a large IBM-360/195, the largest machine at that time in the academic community in the UK. That machine was located in the Rutherford and Appleton Laboratory (RAL), some 100 Kms from UCL, and connected by a reasonably slow leased line.

On the one hand, we used the TIP capability to the full to allow users to dial in to the TIP over the telephone network. The only action of the UCL computer was to force users dialing into the TIP to provide a username/password (this facility had not yet been implemented on the TIP. On the other hand, the RAL machine was already the hub of a centralized computer network with links to many UK universities. These links ran remote job entry services, but also had a limited capability to communicate with users on another such link; this was a so-called HASP terminal normally running on a small IBM-1130 computer. My group programmed its PDP-9 mini-computer so that it simulated a HASP terminal, and thus could communicate to users on other such terminals, could transmit files and could run jobs. The PDP-9 was attached to the TIP as if it was a standard ARPANET terminal running all the ARPANET protocols. Since this configuration provided exactly the termination required by both ARPANET and HASP, it was easy to arrange that users of the HASP system could access computers on the ARPANET, and that users of Hosts on the ARPANET could use the RAL machine [3]. Moreover, since some machines on the ARPANET already ran electronic mail, these facilities provided UK academic users access to electronic mail. Over the next 15 years, these services were progressively enhanced – requiring only that our facilities kept pace with the developments in each country separately; it was not necessary for the evolving systems in the two countries to synchronise their implementations with each other. Thus the US side could evolve from the early ARPANET NCP to the much more sophisticated IPv4 Internet with all its advanced features including the Domain Name System. The UK could evolve from its early centralized HASP system, through its more distributed SRCNet, and then its complete family of so-called Coloured book protocols with its Name Registration Scheme , before it finally converged also onto the IPv4 Internet. The evolution of the UK system is well described in [1] [7]. Throughout this period, my UCL group ensured that complete interoperability was maintained.

Throughout this period we also undertook network advances – though trying to ensure relative compatibility across the Atlantic where feasible. Thus we were an important member of the DARPA SATNET experiment [4]; indeed we were the only partner to use it in a service capacity in the early '80s for our UK-US service. We did one of the first three implementations of TCP/IP, and were the first to go over to using the IPv4 protocols in an Internet service capacity – a year before the ARPANET went over to those protocols in January 1983. On the UK side, we provided access over the emerging UK packet services, again using them in a service role to run IP over them to the ARPANET. We did the first facsimile transmission over ARPANET [5]. We provided the first conversions between the internationally standardized X.400 mail systems and the Internet SMTP mail.

The transition from the original NCP to IP was traumatic for US Host sites; each Host had to change its communications protocols. The transition for the UK sites was not noticed by them – only by us. We ran the old protocol conversions on our old PDP9s, while we developed our new systems on new PDP-11s. Since the Internet protocols became very stable on these newer machines, thanks to excellent engineering by the Berkeley UNIX group, it was mainly necessary to port our coloured book code and modify the conversions. This we were able to do at leisure. However, when I say traumatic above, it was very limited in scope. There were only just over 200 Hosts on the ARPANET on transition, and almost all of these were in an R & D environment. Very few were even in important commercial situations.

The way we connected networks was different initially from the standard DARPA approach. This led to the first paper categorizing the way networks could be connected [6], and later a discussion of how we provided the relay services [7].

Of course the group did many other activities on computer networks and their applications during the subsequent decades, but these are not germane to the main subject of the talk.

3 FROM IPV4 TO IPV6

In 1974, only 5 years after the ARPANET went live, we realized that a new protocol suite was needed. It was then that we started working on Cerf and Bob Kahn's Internet Protocol. By 1992, around a decade after IPv4 went live, we realized its lifetime was also limited. This was the time when the World Wide Web was coming into prominence, and it was clear we would eventually run out of address space for new entities. As a result, one started working on the next generation Internet protocols. The result was IPv6, whose basic standards were ratified by 2001. This not only increased substantially the address space, but also cleaned up in a number of problem areas. It also specified a number of features as obligatory, which had been omitted from the original IPv4 standards, though they had been defined later. Examples of these are security and mobility support.

It is beyond the scope of both this introduction and the talk itself to give any description of the huge volume of work and publicatoins of work on IPv6. Just as we started working on IPv6 implementations long before the basic standards were ratified. We were using it in an EU project on network management as early as 1998 [8]. Once the basic specifications had been ratified in 1998, a number of actions happened in parallel. These included the following:

- Considering how the multitude of existing further standards would fit above IPv6.
- Ensure that the different applications interests would be catered for by the new standard
- Worked on standards for new functionality, only on the basis of IPv6 – e.g. network mobility and low power networks
- Started defining a transition strategy for moving from IPv4 to IPv6
- Developing a series of implementations.

The Japanese were particularly active in this phase of the development with Open Source implementations and testing in the context of the Kame, USAGI and Tahi projects [9], [10]. From 2001, there were also a series of application trials under the auspices of the WIDE project [11].

Some of the characteristics of IPv6, the status of its implementations and the rate at which address space was running out are discussed in the slides. This also gives a snapshot of the status in September 2011.

The huge address space of IPv6 was needed by, and facilitates, many new applications. Some examples of these in emergency communications and smart power are discussed also in the talk.

The transitioning of organizations to the new standard has been very slow – as is again discussed in the talk. One reason for this has been identified as the need for training and the need to transition applications which were not written with this transition in mind. Again some projects to provide training are described in the talk [12].

Although the transition to IPv6 has been very slow, it is now gathering pace – in view of the increasing difficulty of getting IPv4 address space. There are now many experts – both as consultants and as educators – to aid with the trasition to IPv6. There are many national bodies set up under the auspices of the IPv6 Forum [13] to help with the conversion. There is even an "IPv6 Ready" award that one can obtain to verify that any particular implementation is aligned to the standards [14].

We are incomparably better prepared to move over to IPv6 – both in scale and sophistication. However, in view of the numbers involved, the current transition will be much more more challenging than that in 1982.

A strong contributor to the difficulty of the current transition plan, is the large numbers of members of other communities that will be involved this time. As we move into areas like Electric power generation and distribution, automobile design, building automation and emergency communication, Their communities are only now moving slowly towards incorporating IPv4. Since they are making their large investments now, it will be very difficult for them to undertake the new task of getting to understand why IPv6 is the way they ought to move. I fear that in many of these categories, most will equip themselves first with IPv4, and there may be a long interval before they understand that IPv6 would allow them to make full advantage of the IPv6 features. That have been heard.

(Received November 27, 2011)

REFERENCES

[1] P. T. Kirstein, "Early Experiences with the ARPANET and INTERNET in the UK", IEEE Annals of Computing, Vol.21, No.1, pp.38-44 (1999).
[2] P. T. Kirstein, "The early History of Packet Switching in the UK", IEEE Communications Magazine, Vol.47, No.2, pp.18-26 (2009).
[3] P. L. Higginson, P. T. Kirstein, and A. V. Stokes, "The Problems of Connecting Hosts into ARPANET via Frondend Computers", Workshop on Distributed Computer Systems, Darmstadt (1974).
[4] P. T. Kirstein, C. Bradbury, R. C. Cringle, H. R. Gamble, R. Minder, D. McNeill, J. Cole, R. Bressler, and D. L. Mills, "SATNET Applications Activities", Proc. Nat. Telecom. Conf., Washington, 45.1.1-45.1.7 (1979).
[5] P. T. Kirstein, and S. Yilmaz, "Facsimile Transmission in Message Processing System with Data Management", Proc. 4th ICCC, pp.717-726 (1978).
[6] V. G. Cerf, and P. T. Kirstein, "Issues in Packet Network Interconnection", Proc. IEEE, Vol.66, No.11, pp.1386-1408 (1978).
[7] P. T. Kirstein, "The Network Relay and Protocol Translation Services Provided by University College London", Proc. Conf. Comm. Distrib. Systems, pp.316-338, Springer Verlag, Berlin (1984).
[8] Q. Cabell, P. T. Kirstein, T. Pagtzis, T. Tiropanis, and L. Wang, "The Use of TINA Principles in the Management of Internet Multimedia Conferences", Proc. IS&N99, Barcelona, pp.482-498 (1999).
[9] http://www.kame.net/project-overview.html
[10] http://www.cu.ipv6tf.org/pdf/v6esaki.pdf
[11] Internet2 Speakers Bureau: People: Hiroshi Esaki
[12] 6DEPLOY - IPv6 Deployment and Support - Tutorials
[13] IPv6 Forum: Driving IPv6 Deployment
[14] http://www.ipv6ready.org/IPv6
[15] Real Help for your Network's IPv6 Transition | ZDNet

Peter T. Kirstein was born in Germany in 1933. He grew up in England and obtained his BA in Mathematics and Electrical Engineering from Cambridge University in 1954, a Ph.D in Electrical Engineering from Stanford University in 1957 and a D.Sc. from London University in 1970. After a period at Stanford University, CERN in Geneva, and US General Electric Research and Development Center based in Zurich, he joined the University of London Institute of Computer Science in 1967, first as Reader and becoming in 1970 Professor of Computer Communications Systems. In 1973 he joined the Department of Statistics and Computer Science of University College London, In 1980 he was appointed as the first Head of its Department of Computer Science, a post he held from 1980 until 1994. For the following decade he was Director of Research. Currently he participates in several research projects concerned with aspects of computer networks - e.g. satellites, security, IPv6 and the "Internet of Things". He is a Fellow of many professional bodies including the Royal Academy of Engineering, British Computer Society, Institute of Physics, Institution of Electrical Technology, Senior Member Institution of Electrical and Electronic Engineers. He is a Foreign Fellow of the US National Academy of Engineering and the American Academy of Arts and Science. His awards for his work on computer networks include Commander of the British Empire, Lifetime Achievement award of the Royal Academy of Engineering, Postel Award, ACM Communications Society and Senior Medal of the Institute of Electrical Engineers.

IPv6 status and Uses

Peter T. Kirstein
University College London

19 June 2011 IWIN Workshop 1

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
- Many regions 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
- What are the advantages, and why must it happen?

19 June 2011 IWIN Workshop 2

Contents of Talk

- The Internet and IPv4 and address depletion
- What is IPv6, and its advantages
- How near is transition to IPv6?
- New Protocols and IPv6 drivers
- Some important applications that would benefit
- Training and 6DEPLOY

19 June 2011 IWIN Workshop 3

Contents of Talk

- *The Internet and IPv4 and address depletion*
- What is IPv6, and its advantages
- How near is transition to IPv6?
- New Protocols and IPv6 drivers
- Some important applications that would benefit
- Training and 6DEPLOY

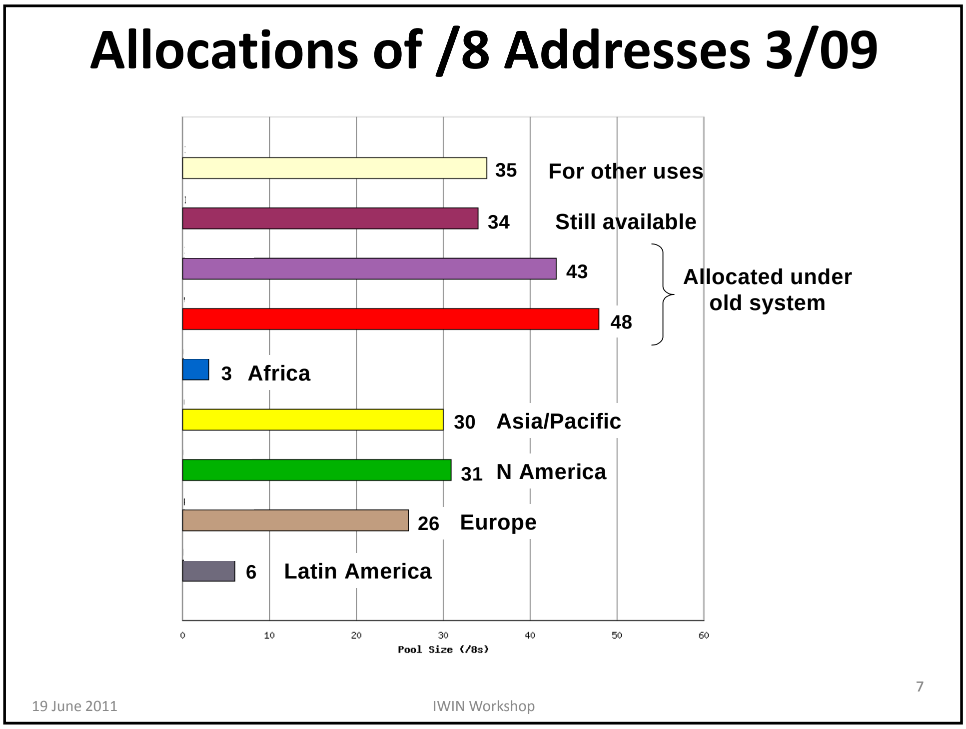
19 June 2011 IWIN Workshop 4

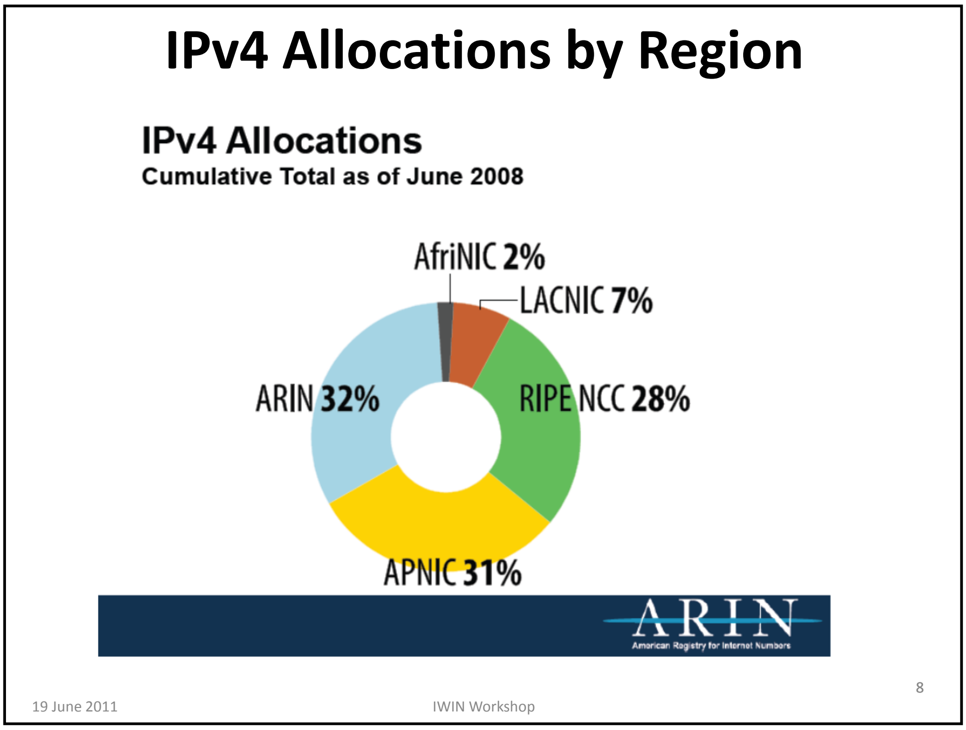
IPv4, IPv6 and Address Depletion

- 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


Allocations of /8 Addresses 3/09
35 For other uses
34 Still available
43
48
Allocated under old system
3 Africa
30 Asia/Pacific
31 N America
26 Europe
6 Latin America
0 10 20 30 40 50 60
Pool Size (/8s)
19 June 2011
IWIN Workshop
7

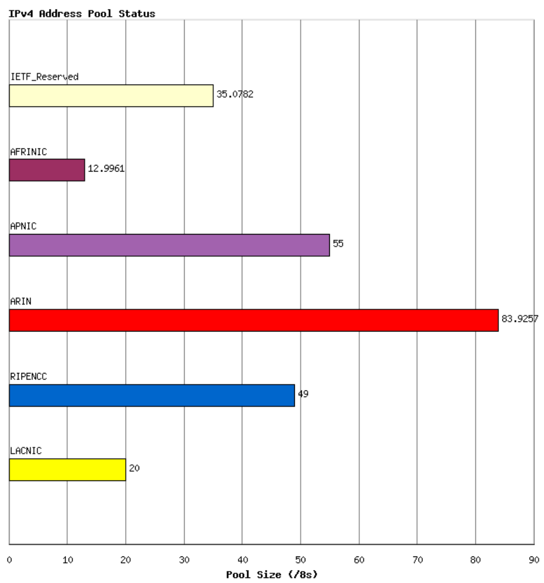

IPv4 Allocations by Region
IPv4 Allocations
Cumulative Total as of June 2008
AfriNIC 2%
LACNIC 7%
ARIN 32%
RIPE NCC 28%
APNIC 31%
ARIN
American Registry for Internet Numbers
19 June 2011
IWIN Workshop
8

Estimate of RIR Exhaustion Date

- Exhaustion defined as when last /8 is reached
- 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

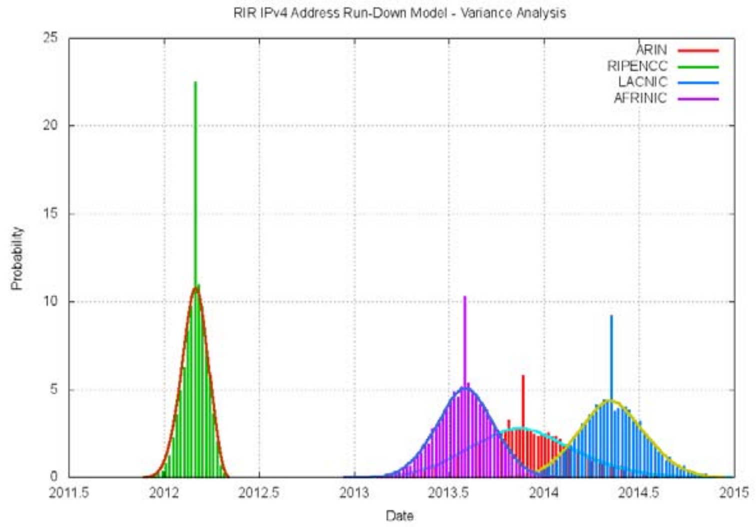
19 June 2011 IWIN Workshop 9

IPv4 Allocations by Region – 2/11



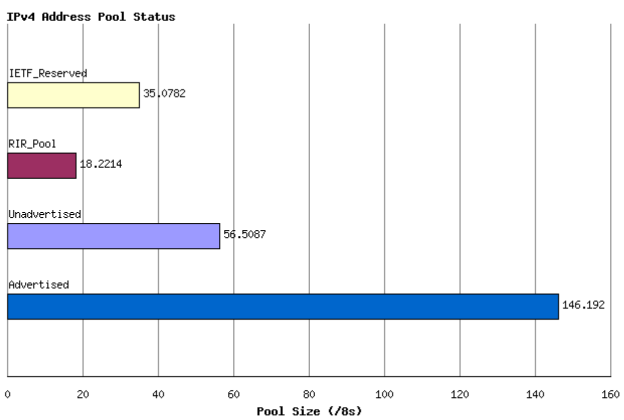
19 June 2011 IWIN Workshop 10

Exhaustion Date Estimate Variance



19 June 2011 IWIN Workshop 11

IPv4 /8s In Various Categories



19 June 2011 IWIN Workshop 12

Urgency due to Address Depletion

- Address depletion stated too often
  - but now there
  - http://www.potaroo.net/tools/ipv4/
- Address Exhaustion when lLast /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
- Has impact on new applications which need global
  - applications (particularly with security) or p-p

Activities in Regions

- 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

Contents of Talk

- The Internet and IPv4 and address depletion
- ***What is IPv6, and its advantages***
- How near is transition to IPv6?
- New Protocols and IPv6 drivers
- Some important applications that would benefit
- Training and 6DEPLOY

19 June 2011 IWIN Workshop 15

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

19 June 2011 IWIN Workshop 16

Some Newer Protocols

- Since 2000, most new protocol work in IETF has concentrated on IPv6 versions
  - Could have done IPv4, but often did not bother
- Is reflected in many recent protocols
  - Better mobility support (MIP6) – no triangular routing
  - Multicast now more deployable
  - Robust Header Compression (ROHC)
  - Low-power support for wireless (6LoWPAN
  - More support for Quality of Service (in Header, but not always implemented in routers yet)
- Nevertheless, most concentrate on Address Space

19 June 2011 IWIN Workshop 17

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

19 June 2011 IWIN Workshop 18

Contents of Talk

- The Internet and IPv4 and address depletion
- What is IPv6, and its advantages
- ***How near is transition to IPv6?***
- New Protocols and IPv6 drivers
- Some important applications that would benefit
- Training and 6DEPLOY

19 June 2011 IWIN Workshop 19

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

19 June 2011 IWIN Workshop 20

IPv6 Day

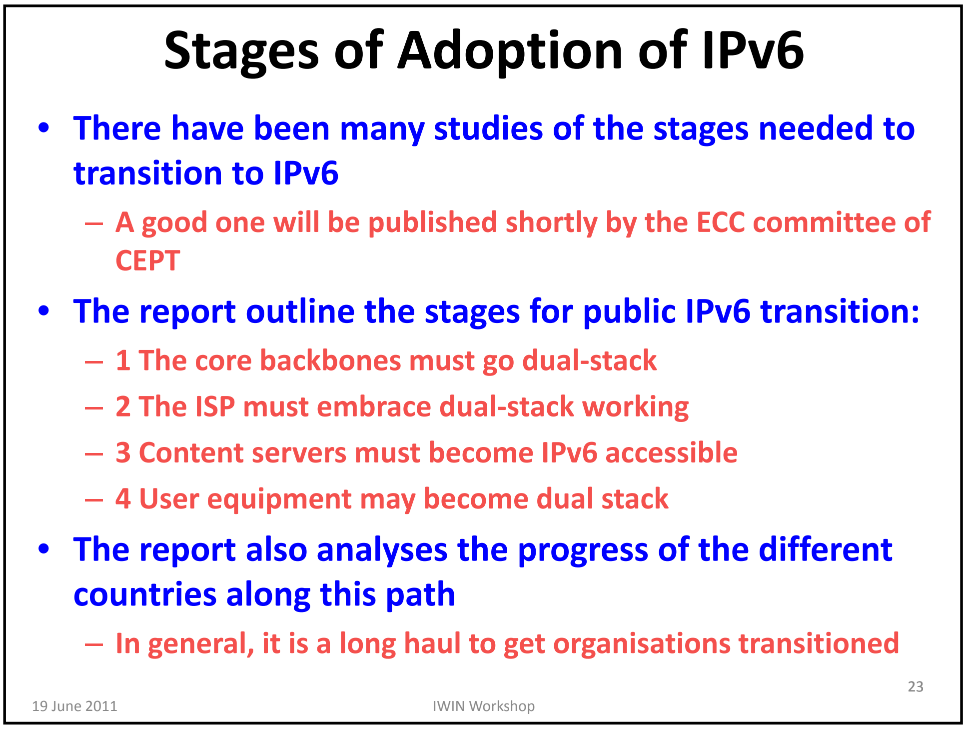
- Big providers showed IPv6 readiness
  - Google, Yahoo, Akimai, Cisco
- Large User Organisations showed they were ready
  - E.g. NRENs, SPAWAR, some enterprise sites
- Traffic proportion IPv6 still low – typically 0.1%
  - But went up 60% on day dropping to 30% thereafter#
- However there were few real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

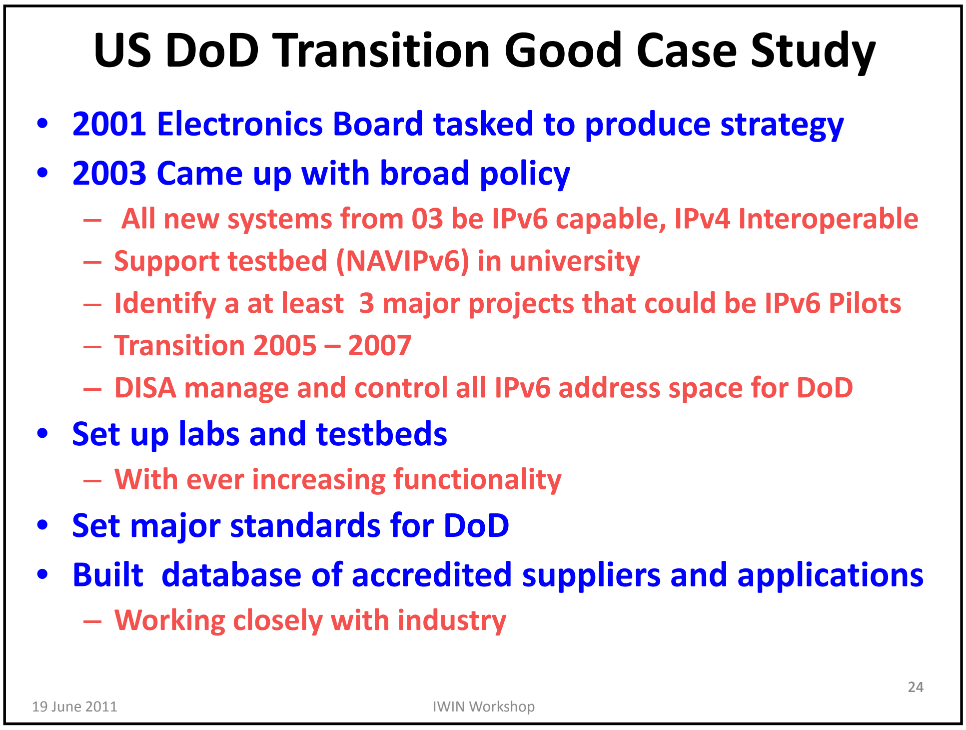
19 June 2011 IWIN Workshop 21

The Pioneers Advance Slowest

- Europe and North America started Internet earliest
  - Have by far largest allocations, hence less need to move fast
  - Have large deployment, so reluctant to move fast
  - Have most advanced components, so loathe to move fast
- China, Japan, Korea have greatest need and incentive
  - Do not have same reserves of IPv4 address space
  - Have more capital to invest currently
  - Would like to leap-frog Europe and North America
- US main computer components well developed for IPv6
- Europe and N. America slow to move processes and applications to IPv6

19 June 2011 IWIN Workshop 22


Stages of Adoption of IPv6
• There have been many studies of the stages needed to transition to IPv6
– A good one will be published shortly 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
19 June 2011
IWIN Workshop
23


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
19 June 2011
IWIN Workshop
24

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

19 June 2011 IWIN Workshop 25

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

19 June 2011 IWIN Workshop 26

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

19 June 2011 IWIN Workshop 27

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

19 June 2011 IWIN Workshop 28

Contents of Talk

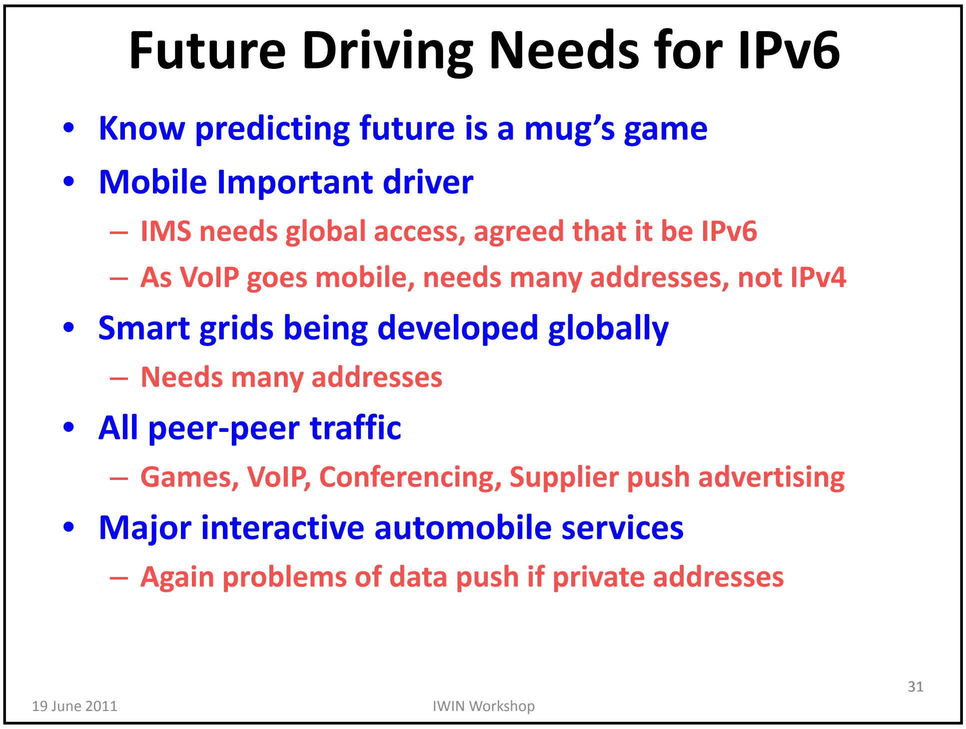
- The Internet and IPv4 and address depletion
- What is IPv6, and its advantages
- How near is transition to IPv6?
- *New Protocols and IPv6 drivers*
- Some important applications that would benefit
- Training and 6DEPLOY

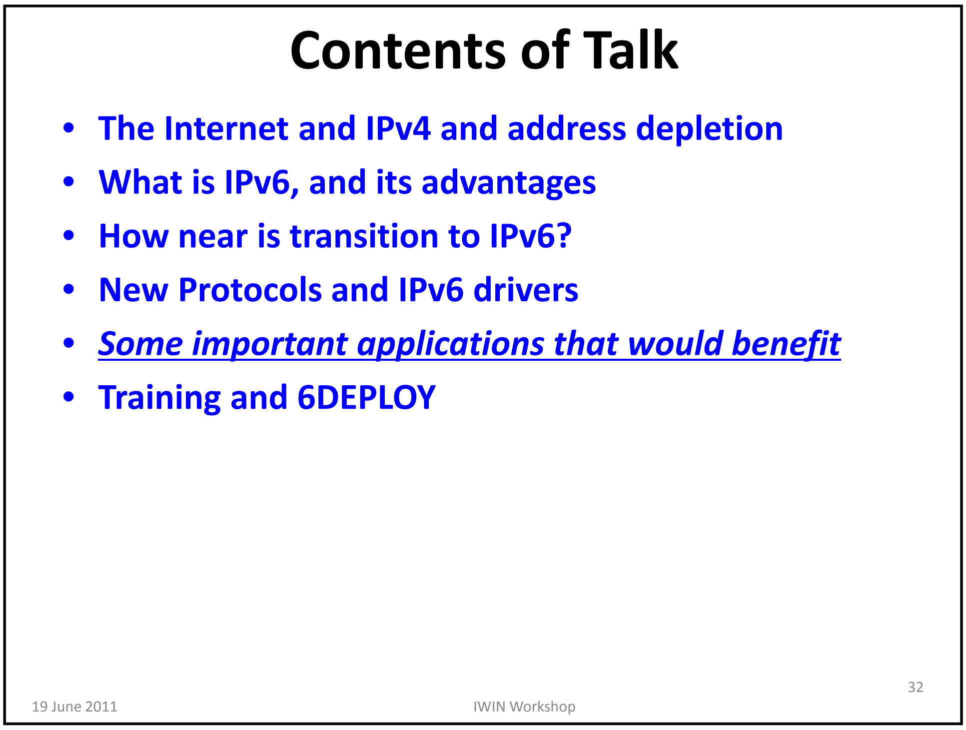
19 June 2011 IWIN Workshop 29

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

19 June 2011 IWIN Workshop 30


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
19 June 2011
IWIN Workshop
31


Contents of Talk
• The Internet and IPv4 and address depletion
• What is IPv6, and its advantages
• How near is transition to IPv6?
• New Protocols and IPv6 drivers
• Some important applications that would benefit
• Training and 6DEPLOY
19 June 2011
IWIN Workshop
32

The Internet of Things

- There is a general agreement that the ***Internet of Things (IOT)*** will be the biggest future Internet User
  – Though nobody really knows how and what it is
- The EC has a major IOT programme
  – Which has world-wide international links
- At least the EC programme believes that while many end-devices will not be IP, wide-area communication must be Internet
  – They even believe it will have to be IPv6
- Several projects are investigating the role of IPv6
  – Including IOT6 which includes UCL

19 June 2011 IWIN Workshop 33

IOT6

- IOT6 is investigating how IPv6 addressing can be used to reach non-IP entities
  – Here the large address space and the local use of multicast may allow robust use of gateways
- Wide Area it will capitalise on the strengths of IPv6
- Its gateways will be mulit-level, and may be distributed – using IPv6 features
- We will investigate which information should be carried at the packet level
  – And which must be at the application level
- There will be a major practical demonstration in automating new buildings

19 June 2011 IWIN Workshop 34

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
    - 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

19 June 2011 IWIN Workshop 35

Europe moving to Smart Grid BUT

- Electricity and Gas embracing remote meter reading
  - But motivation is narrow and industry interest dominated
  - Example is British Gas use with GPRS and without Internet
- If they go Internet at all, use heavily NATs with IPv4
- Customers may want their own LAN-based system that includes all utilities, local generation and local control
  - This will need IPv6 for addressing and protocol reasons
  - If working with NATed IPv4 utilities, will require complex G/w
- It is not clear how this will evolve in Europe
  - For instance British Gas is NOW introducing "smart meters" which will use GPRS to utility, and special ZIGBEE to customer
- We pray that new start-ups will obsolete the majors

19 June 2011 IWIN Workshop 36

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
  - Support for mobility in IPv6 particularly important

19 June 2011 IWIN Workshop 37

Emergency Communications Future

- Some Europeans very interested in U-2010 results
- Most concerned at the size of present deployments
  - Even IPv4 new to most
  - Strong pressure to deploy TETRA
  - Mobile operators interested in IPv6 mainly for IMS
- This is in spite of clear advantages of IPv6 for this application
- Requires relevant authorities to look at transition questions in the light of current TETRA deployments

19 June 2011 IWIN Workshop 38

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 (and is now Cisco)
  - There Is still very limited inter-vendor testing

19 June 2011 IWIN Workshop 39

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

19 June 2011 IWIN Workshop 40

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

19 June 2011 IWIN Workshop 41

Contents of Talk

- The Internet and IPv4 and address depletion
- What is IPv6, and its advantages
- How near is transition to IPv6?
- New Protocols and IPv6 drivers
- Some important applications that would benefit
- *Training and 6DEPLOY*

19 June 2011 IWIN Workshop 42

Training

- Clearly training is a major need
  - There are already many initiaiives
- Cisco Academy recently reviewed all its module
  - Now many consider IPv6
- ISOC, Regional Registeries and some commercial courses
- The 6DEPLOY series of IPv6 training projects
  - Provides one to three day courses each year
    - Mainly in emerging economies
  - Has strong practical component, with local and remote labs
  - provided by Cisco

19 June 2011 IWIN Workshop 43

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

19 June 2011 IWIN Workshop 44

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
  - Now mainly routers, with locally supplied PCs
  - soon also VoIP and Sensor nets
- Cisco provides hardware and software support
- 6DEPLOY 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

19 June 2011 IWIN Workshop 45

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

19 June 2011 IWIN Workshop 46

Location of 6DEPLOY Laboratories

- Cisco has established laboratories in four continents
- Europe
  - Bulgaria (Sofia), Czech Republic (Prague), France (Paris), Hungary (Budapest), Slovenia (Ljubljana), Spain (Madrid),
- Asia
  - Georgia (Tbilisi), India (Bangalore), Kyrgyzstan (Bishkek),
- Africa
  - Cameroon (Yaounde), Egypt (Cairo), Ghana (Accra) Kenya (Nairobi), Mauritius (Ebene), Rwanda (Kigali)
- America
  - Columbia (Bogota),

19 June 2011 IWIN Workshop 47

Some Closing Thoughts

- The Internet is now all pervasive
- While it can no longer change in a revolutionary way, it will change hugely in an evolutionary one
- The next step must be IPv6
  - Transition has been slow, but must now speed up
- USA has led the provision of IPv6-based components
- However South and East Asia are leading the transition
- Some huge new applications *should* be based on IPv6
  - A combination of blinkered and short-term thinking may prevent this happening in some regions
- Training is vital everywhere for the transition
  - special measures are needed in emerging countries

19 June 2011 IWIN Workshop 48