



IBM SWG – Enterprise Networking Solutions

z/OS - An IPv6-Ready platform - should I care?



Alfred B Christensen – alfredch@us.ibm.com
Raleigh, NC, US

z/OS - An IPv6-Ready platform - should I care?

Date and time:	Thursday 5 th November, 2009 from 10:30 to 11:30
Program:	Network Management working group
Speaker:	Alfred B Christensen, IBM
Abstract:	Have you heard of IPv6 and wondered what it is all about? Have you seen the press about finally running out of IPv4 addresses in 2011 - 2012? This session will provide an introduction to IPv6 in general and specifically to IPv6 on z/OS, providing an overview of the IPv6 protocol and its major components. It will also answer key questions such as why IPv6 is important, what are the benefits of IPv6 when compared to IPv4, when will IPv6 become prevalent, and what are some of the transition issues which must be addressed when enabling IPv6 support.

One-day IBM ITSO workshop on how to assess, plan for, and implement the z/OS V1R11 Communications Server enhancements:

System z Networking Technologies Update, WRZ005GB

Starts 10th November 2009 for 1 day in Bedfont Lakes, U.K.

Contact Name: Khaled Ibrahim - Khaled_Ibrahim@uk.ibm.com

<http://www.redbooks.ibm.com/projects.nsf/WorkshopIndex/>

Trademarks, notices, and disclaimers

The following terms are trademarks or registered trademarks of International Business Machines Corporation in the United States or other countries or both:

- ▶ Advanced Peer-to-Peer Networking®
- ▶ AIX®
- ▶ alphaWorks®
- ▶ AnyNet®
- ▶ AS/400®
- ▶ BladeCenter®
- ▶ Candle®
- ▶ CICS®
- ▶ DB2 Connect
- ▶ DB2®
- ▶ DRDA®
- ▶ e-business on demand®
- ▶ e-business (logo)
- ▶ e business (logo)®
- ▶ ESCON®
- ▶ FICON®
- ▶ GDDM®
- ▶ HiperSockets
- ▶ HPR Channel Connectivity
- ▶ HyperSwap
- ▶ i5/OS (logo)
- ▶ i5/OS®
- ▶ IBM (logo)®
- ▶ IBM®
- ▶ IMS
- ▶ IP PrintWay
- ▶ IPDS
- ▶ iSeries
- ▶ LANDP®
- ▶ Language Environment®
- ▶ MQSeries®
- ▶ MVS
- ▶ NetView®
- ▶ OMEGAMON®
- ▶ Open Power
- ▶ OpenPower
- ▶ Operating System/2®
- ▶ Operating System/400®
- ▶ OS/2®
- ▶ OS/390®
- ▶ OS/400®
- ▶ Parallel Sysplex®
- ▶ PR/SM
- ▶ pSeries®
- ▶ RACF®
- ▶ Rational Suite®
- ▶ Rational®
- ▶ Redbooks
- ▶ Redbooks (logo)
- ▶ Sysplex Timer®
- ▶ System i5
- ▶ System p5
- ▶ System x
- ▶ System z
- ▶ System z9
- ▶ Tivoli (logo)®
- ▶ Tivoli®
- ▶ VTAM®
- ▶ WebSphere®
- ▶ xSeries®
- ▶ z9
- ▶ zSeries®
- ▶ z/Architecture
- ▶ z/OS®
- ▶ z/VM®
- ▶ z/VSE

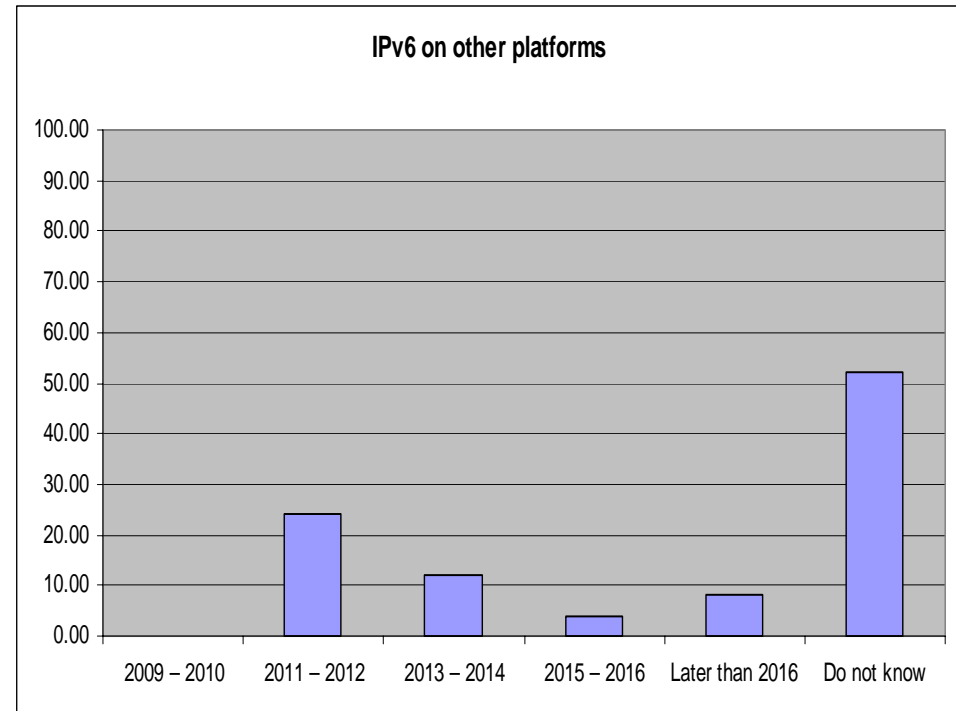
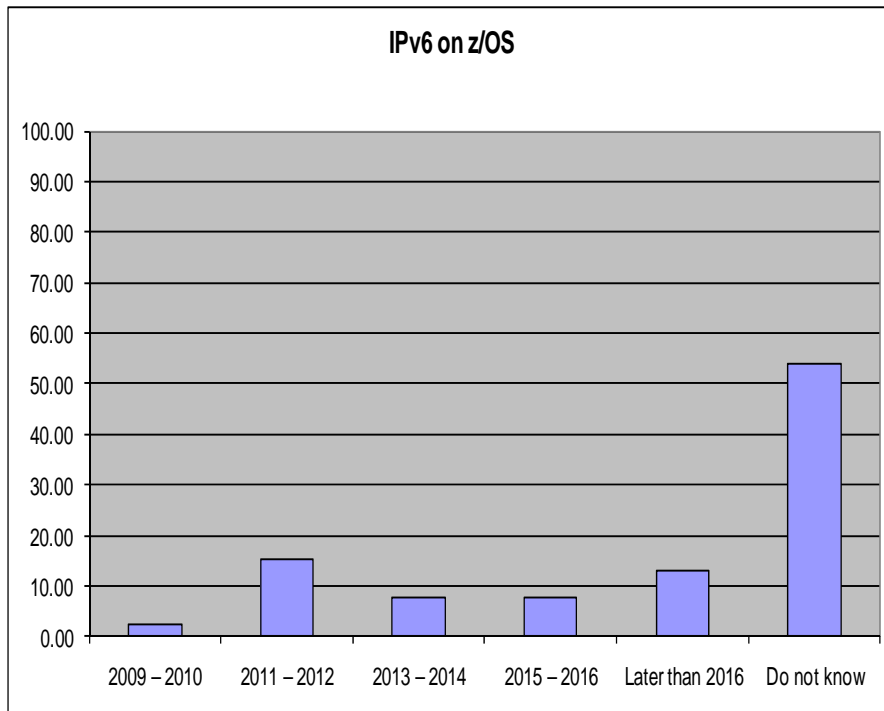
- ▶ Java and all Java-based trademarks are trademarks of Sun Microsystems, Inc. in the United States, other countries, or both.
- ▶ Microsoft, Windows, Windows NT, and the Windows logo are trademarks of Microsoft Corporation in the United States, other countries, or both.
- ▶ Intel, Intel Inside (logos), MMX and Pentium are trademarks of Intel Corporation in the United States, other countries, or both.
- ▶ UNIX is a registered trademark of The Open Group in the United States and other countries.
- ▶ Linux is a trademark of Linus Torvalds in the United States, other countries, or both.
- ▶ Red Hat is a trademark of Red Hat, Inc.
- ▶ SUSE® LINUX Professional 9.2 from Novell®
- ▶ Other company, product, or service names may be trademarks or service marks of others.
- ▶ This information is for planning purposes only. The information herein is subject to change before the products described become generally available.
- ▶ Disclaimer: All statements regarding IBM future direction or intent, including current product plans, are subject to change or withdrawal without notice and represent goals and objectives only. All information is provided for informational purposes only, on an “as is” basis, without warranty of any kind.

All performance data contained in this publication was obtained in the specific operating environment and under the conditions described and is presented as an illustration. Performance obtained in other operating environments may vary and customers should conduct their own testing.

Refer to www.ibm.com/legal/us for further legal information.

When do our z/OS shops believe they will need IPv6?

- The majority of z/OS customers, who answered the question, did not know
 - Expectations are that it will be needed slightly earlier on other platforms than z/OS
- It is time to start thinking and preparing now !

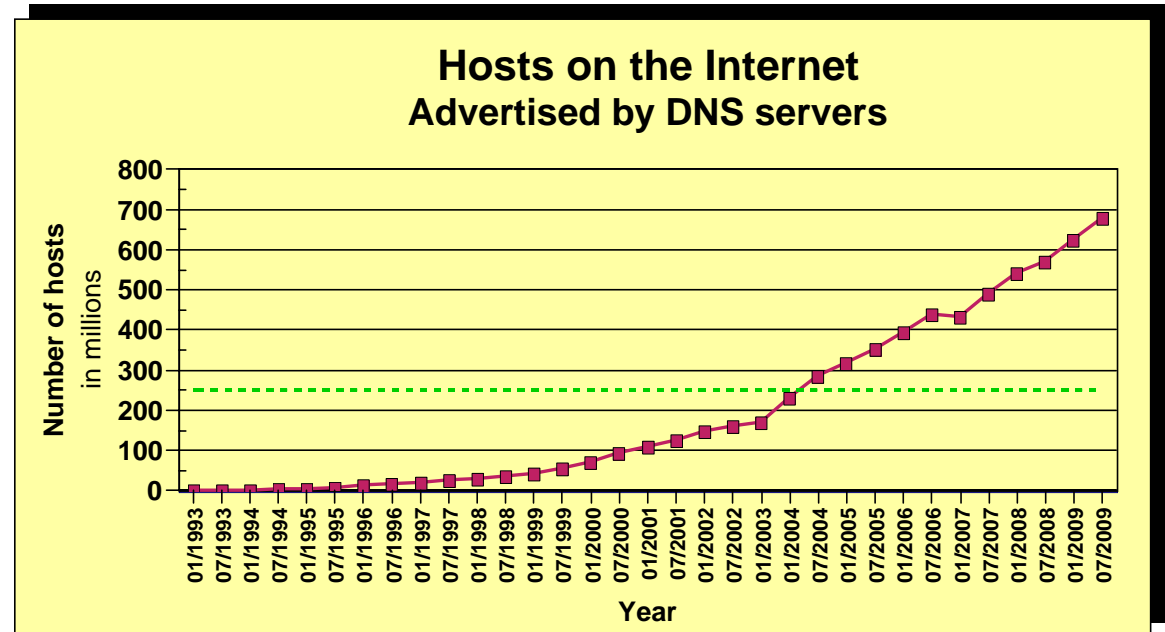


Source: Survey conducted by ENS early 2009 among a selected set of customers (39 responses to this question)

IPv4 address usage since early 1993



- **Projected Internet Assigned Numbers Authority (IANA) Unallocated Address Pool Exhaustion**
 - July 2011
- **Projected Regional Internet Registries (RIR) Unallocated Address Pool Exhaustion**
 - April 2012
- **z/OS Communications Server continues to focus on IPv6 standards currency**
 - US DoD/NIST
 - IPv6 Forum



- What is the upper practical limit (the ultimate pain threshold) for number of assigned IPv4 addresses? Some predictions said 250,000,000 (250 million), others go up to 1,000,000,000 (one billion or one milliard).
- Source: <https://www.isc.org/solutions/survey>
- Source: <http://www.potaroo.net/tools/ipv4/index.html>
- Source: <http://penrose.uk6x.com/>

**If you want to stay in business after 2011/2012, you'd better start paying attention!
Do not worry, the sky isn't falling – IPv4 and IPv6 will coexist for many years to come. Your applications need to be able to use both. If you write directly to the TCP/IP sockets layer, you need to start changing those applications.**

Is Doomsday approaching?



IPv4 Address Report - Mozilla Firefox

File Edit View History Bookmarks Tools Help

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

Most Visited Latest Headlines WRAL CNN Politiken JP NY Times AA.com Nordea

IPv4 Address Report

This report is auto-generated by a daily script. The report you are seeing here was generated at 26-Jun-2009 07:58 UTC+1000.

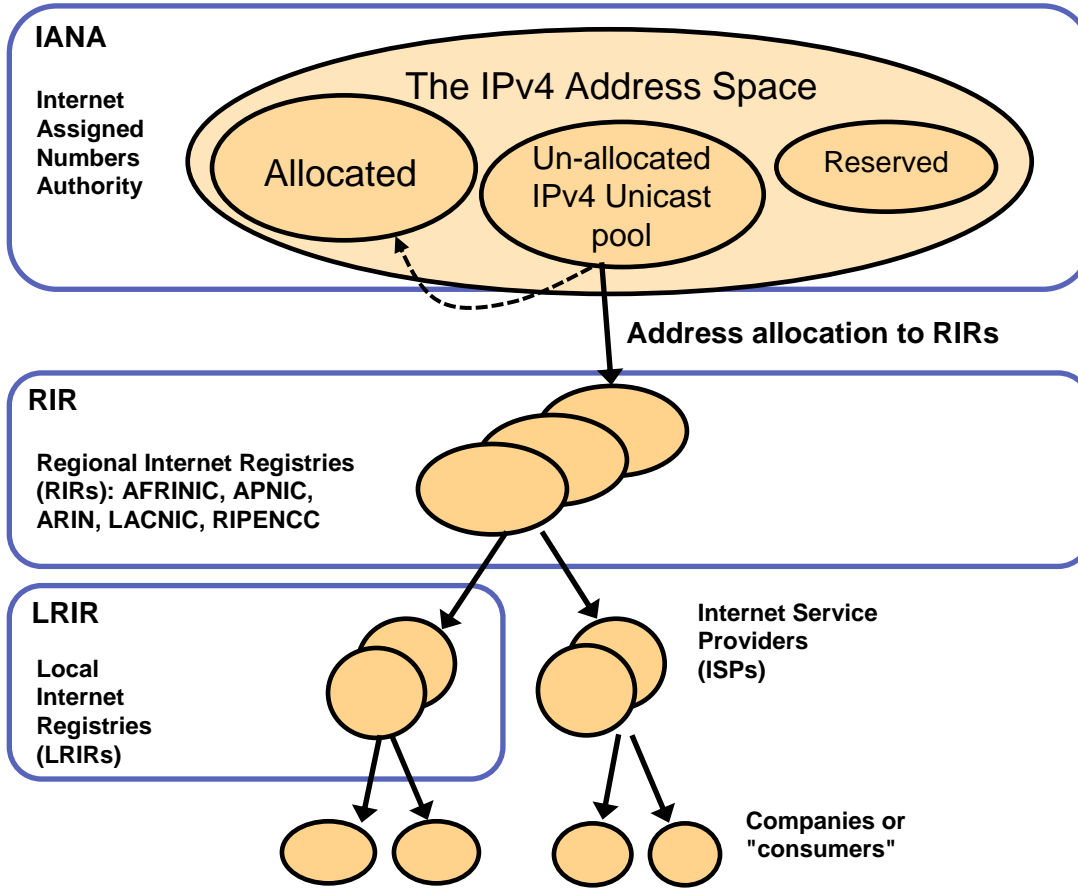
Projected IANA Unallocated Address Pool Exhaustion: 02-Jul-2011

Projected RIR Unallocated Address Pool Exhaustion: 03-Apr-2012

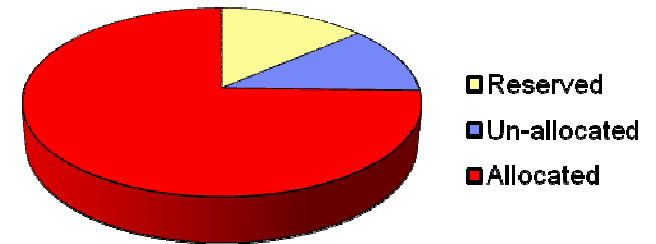
Done



How the IPv4 address space is managed



IPv4 Address Pool Status per June 2009

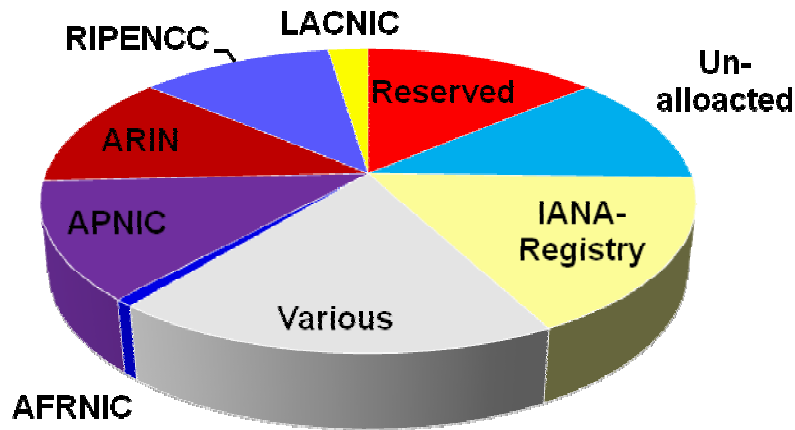


The most current predictions estimate that the un-allocated pool will be exhausted July 2011. Some of the assigned but not advertised space may potentially be re-used to prolong the life of IPv4.

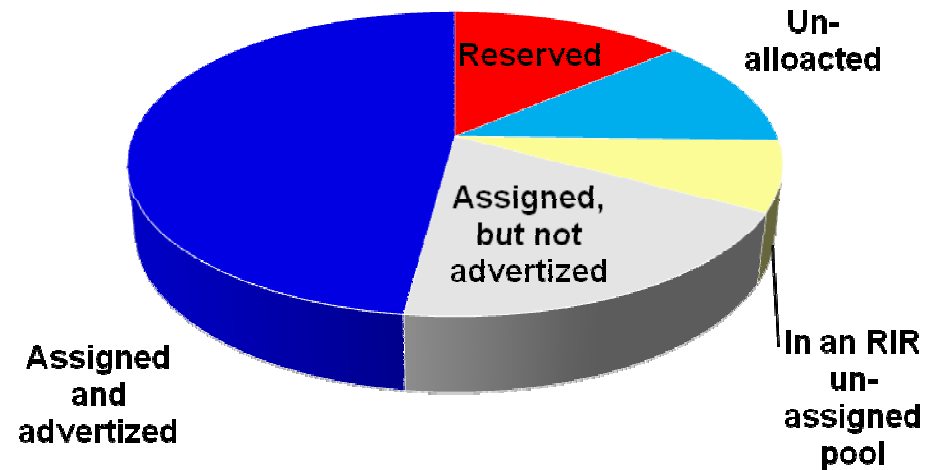
Source: "IPv4 Address Report" - <http://www.potaroo.net/tools/ipv4/>

IPv4 address space data as of June 2009

IPv4 Address Pool Status Breakdown by RIR



IPv4 Address Pool Status Breakdown by use

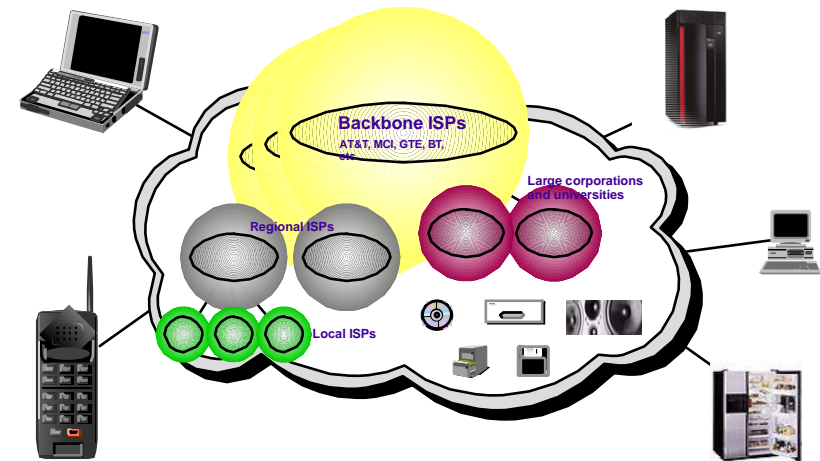


- Reserved:** Reserved by the IETF
- Un-allocated:** Available to be allocated to the RIRs
- IANA-Registry:** Addresses assigned directly by the IANA from before the time of regional registries
- Various:** Space allocated to various registries (before regional registries were introduced)
- AFRNIC:** Africa, portions of the Indian Ocean
- APNIC:** Portions of Asia, portions of Oceania (includes Australia, China, India)
- ARIN:** Canada, United States, islands in the Caribbean Sea and North Atlantic Ocean
- RIPENCC:** Europe, the Middle East, Central Asia
- LACNIC:** Latin America, portions of the Caribbean

It's this simple: IPv4 addresses are running short!

- Forget about fancy IPv6 features as a reason for moving to IPv6
- IPv6 deployment is inevitable
 - Literally running out of IPv4 addresses
 - IPv4 address pool projected to be exhausted soon
 - To minimize disruption, IPv6 needs to be in place and in actual use before exhaustion occurs
 - No other credible alternative to IPv6
 - Only alternative is IPv4 with significant increase in NAT
 - Increased use of private addresses and resulting address collisions
 - Complete loss of globally unique addressing
 - Even NAT requires pools of public IPv4 addresses
- All major vendors have maturing IPv6 product lines
 - All IBM operating systems support IPv6, with middleware and application support starting to ship as well
 - Router vendors (such as Cisco) have supported IPv6 for several years
 - Microsoft VISTA was IPv6-enabled “out of the box”

The Internet - a worldwide digital utility.

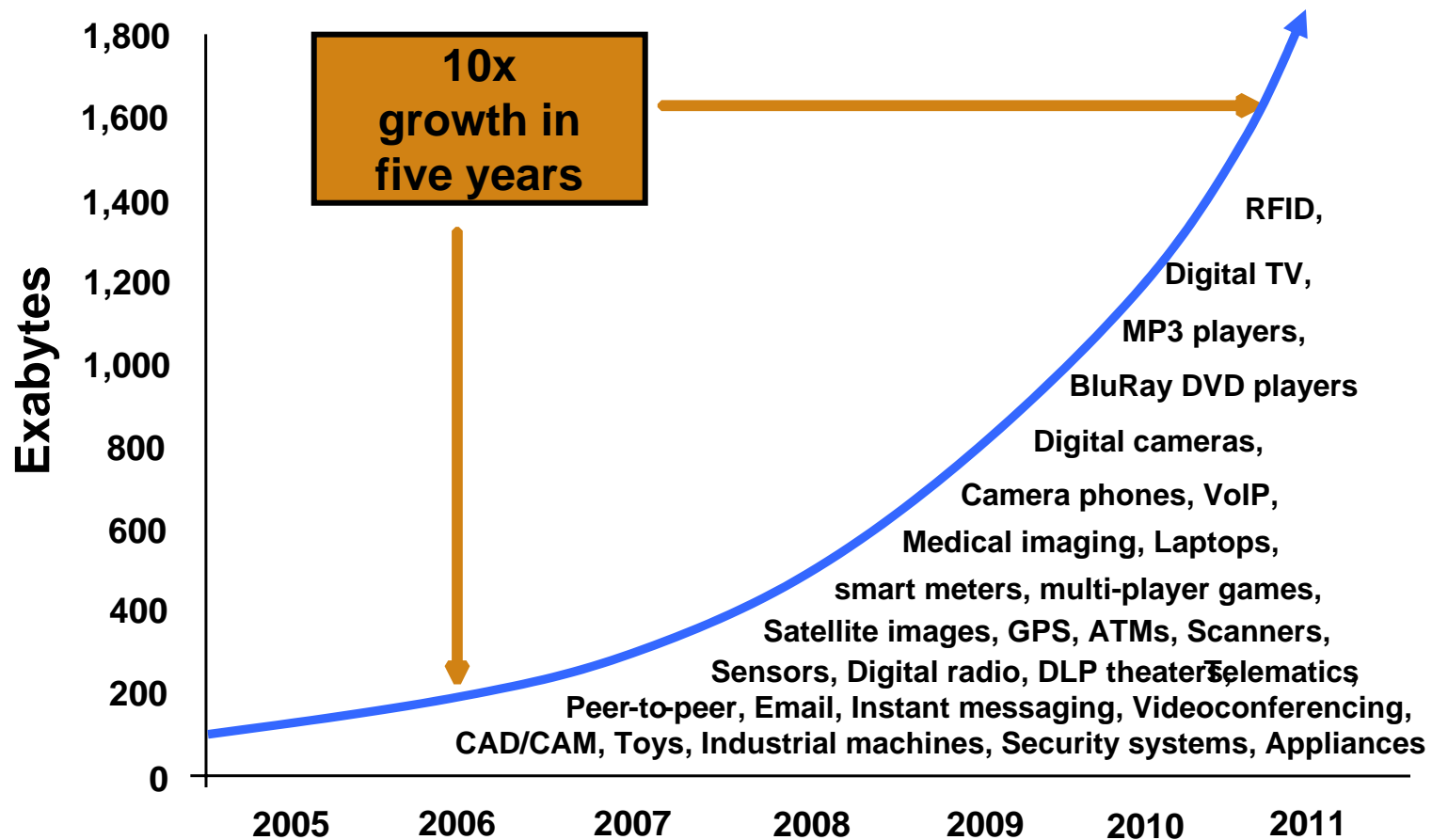


Connectivity for **anyone** from **anywhere** (car, plane, home, office) to **anything!**

More and more "push" applications being deployed in the wireless market space.

IPv6 promises true end-to-end connectivity for peer-based collaborative solutions.

By 2011, the world will be 10 times more instrumented than it was in 2006.
Internet connected devices will leap from 500M to 1 Trillion



Approximately 70% of the digital universe is created by individuals, **but enterprises are responsible for 85% of the security, privacy, reliability, and compliance.**

What is IPv6?

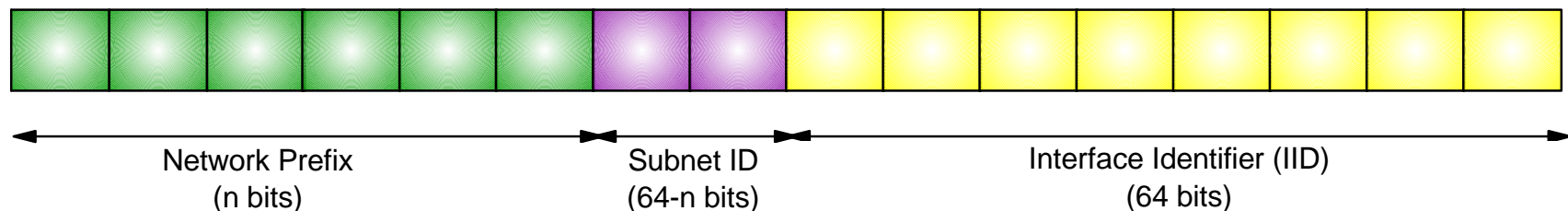
- **IPv6 is an evolution of the current version of IP, which is known as IPv4**
 - Work on new IETF standard started in early 90's
 - Not backward compatible, but migration techniques defined
- **Today's IPv4 has 32 bit addresses**
 - Practical limit is less than 1 billion useable global addresses
- **IPv6 provides almost unlimited number of addresses**
 - IPv6 addresses are 128 bits
 - No practical limit on global addressability
 - Enough address space to meet all imaginable needs for the whole world and for generations to come
 - More addresses *cannot* be retrofitted into IPv4
- **Other improvements important, but secondary:**
 - Facilities for automatic configuration
 - Improved support for site renumbering
 - End to end IP security
 - Mobility with route optimization (important for wireless)
 - Miscellaneous minor improvements

IPv4 Address:
9.67.122.66

IPv6 Address:
2001:0DB8:4545:2::09FF:FEF7:62DC

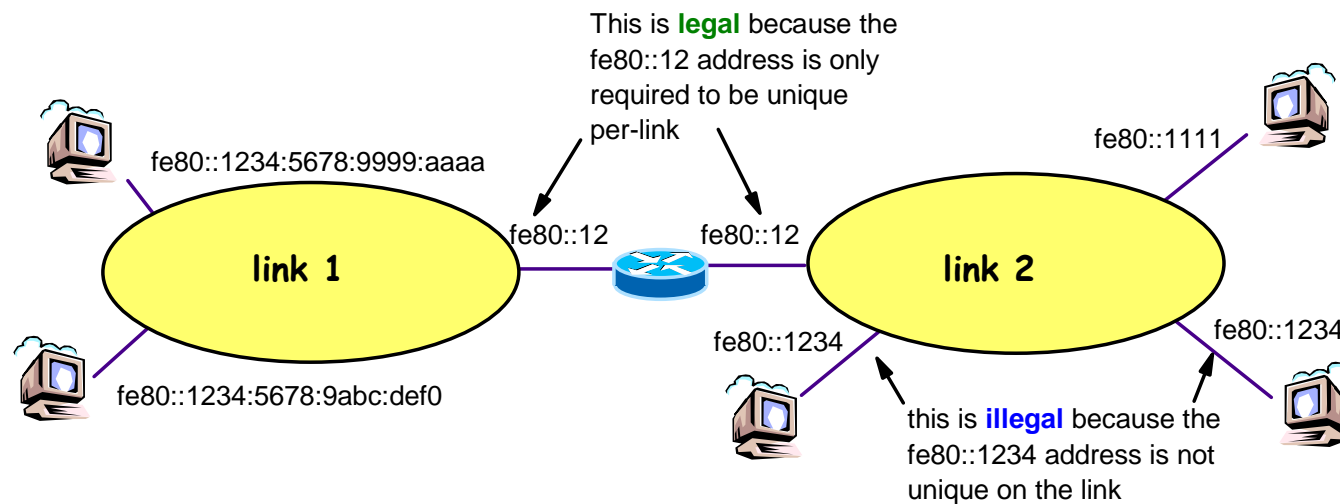
Important IPv6 technical features

- **IPv6 header and extensions header**
 - Streamlined IPv6 header
 - Optional extensions for fragmentation, security, etc.
- **Routers no longer fragment forwarded datagrams**
- **Extended IP Address**
 - Address space increased to 128 bits
 - Provides 340,282,366,920,938,463,463,374,607,431,768,211,456 addresses
 - Enough for 1.8×10^{19} addresses per person on the planet
 - A 64-bit subnet prefix identifies the link
 - Followed by a 64-bit Interface Identifier (IID)
 - IID derived from IEEE identifier (i.e., MAC address)
 - Only leftmost 64 bits available for routing and "network addressing"
 - The rightmost 64-bits identify the host on the target link
- **Neighbor Discovery and Stateless Autoconfiguration**
 - Router Discovery and Neighbor Unreachability Detection (NUD)
 - Address configuration with no manual or server-based configuration
- **IPv4/IPv6 Coexistence and Transition Mechanisms**
 - Coexistence for IPv4 and IPv6
 - Tunneling and transition mechanisms
- **Common addresses and prefixes**
 - $::/128$ – INADDR6_ANY (the unspecified address)
 - $::1/128$ – IPv6 loopback address
 - $FF00::/8$ – Multicast addresses
 - $FE80::/8$ – Link-local addresses
 - $FC00::/7$ – Unique local IPv6 address
 - Anything else – Globally unique IPv6 address



IPv6 scoped unicast addressing

- **Concept of scoped unicast addresses part of architecture**
- **Link-local addresses for use on a single link**
 - Primarily used for bootstrapping and infrastructure protocols such as Neighbor Discovery
 - Address = well-known link-local prefix plus node-generated IID
- **Unique Local IPv6 Unicast addresses for use within a site**
 - Like net 10 (not routable in the Internet backbone)
 - Site-local addresses
 - Part of early IPv6 standards. meant to address some similar issues
 - But introduced a lot of complexity
 - Has been deprecated by the IETF
- **Global address prefixes are provided by ISPs**



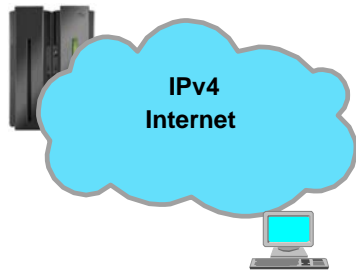
Who is currently taking the lead on IPv6 deployment?

- US Department of Defense (DoD)
 - IPv6 compliance requirements detailed
 - All platforms offered to DoD must meet very specific IPv6 capabilities
- Other US government institutions through the National Institute of Standards and Technologies (NIST)
 - NIST has also published detailed IPv6 compliance requirements
 - Generally platforms offered to any US government institution must meet these very specific IPv6 requirements
- Worldwide, other organizations are closely looking at the IPv6 compliance tests done according to the IPv6 forum – the IPv6-Ready Phase 1 and Phase 2 logo certification
 - z/OS V1R5 is IPv6-Ready Logo Phase 1 certified
 - z/OS V1R8 is IPv6-Ready Logo Phase 2 certified
 - z/OS V1R10 is IPv6 certified according to the US DoD IPv6 requirements
- Russia has begun developing similar IPv6 compliance requirements
- The European Union is trying to jump-start IPv6 deployment within the European Union
- Japan and China have had operational IPv6 networks for a few years

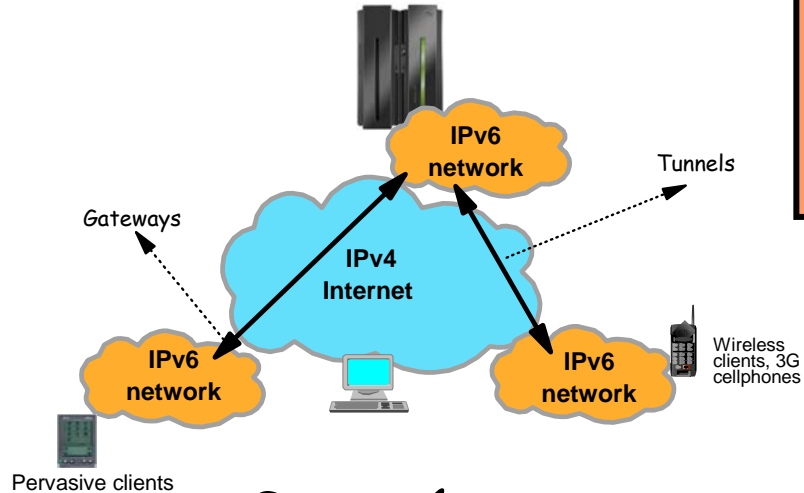


IPv4 to IPv6 Internet evolution

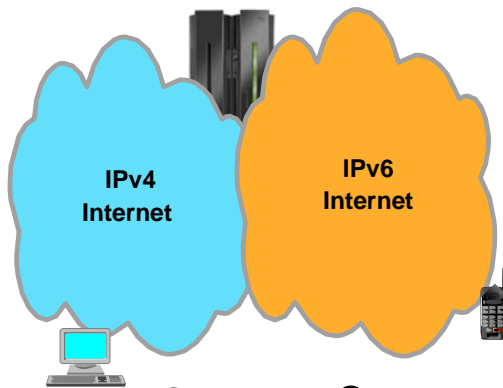
So where are we? In stage 1, preparing to move to stage 2.



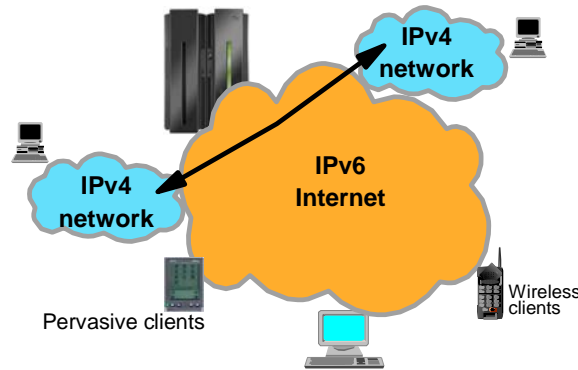
Yesterday



Stage 1



Stage 2



Stage 3

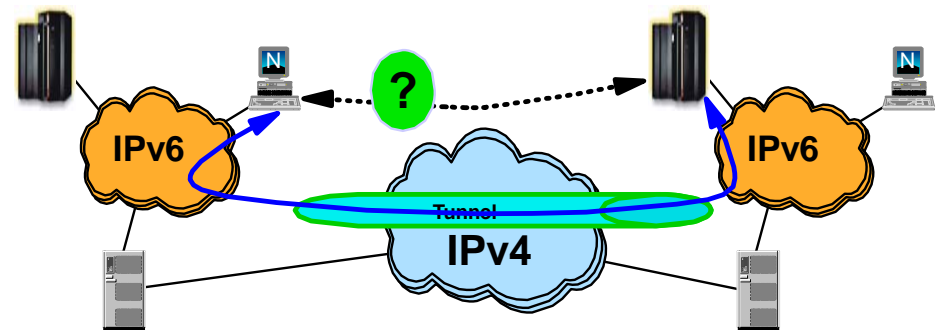
There may be a stage 4 with only IPv6, but it will take some years to get there.

General transition considerations

1

How do we share the physical network so that both IPv4 and IPv6 can be transported over one and the same physical network?

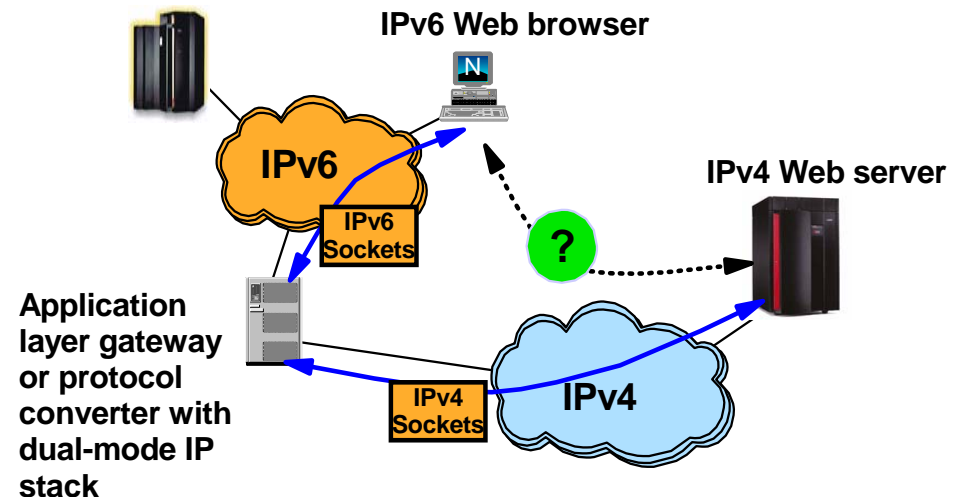
- Dual-stack
- Tunneling of IPv6 over IPv4



2

How do applications that have not yet been enhanced to support IPv6 communicate with applications that have been enhanced to support IPv6?

- Dual-stack
- Application Layer Gateways (ALG)
- Network Address Translation – Protocol Translation (NAT-PT)



Isn't IPv6 enablement just a network engineering exercise?

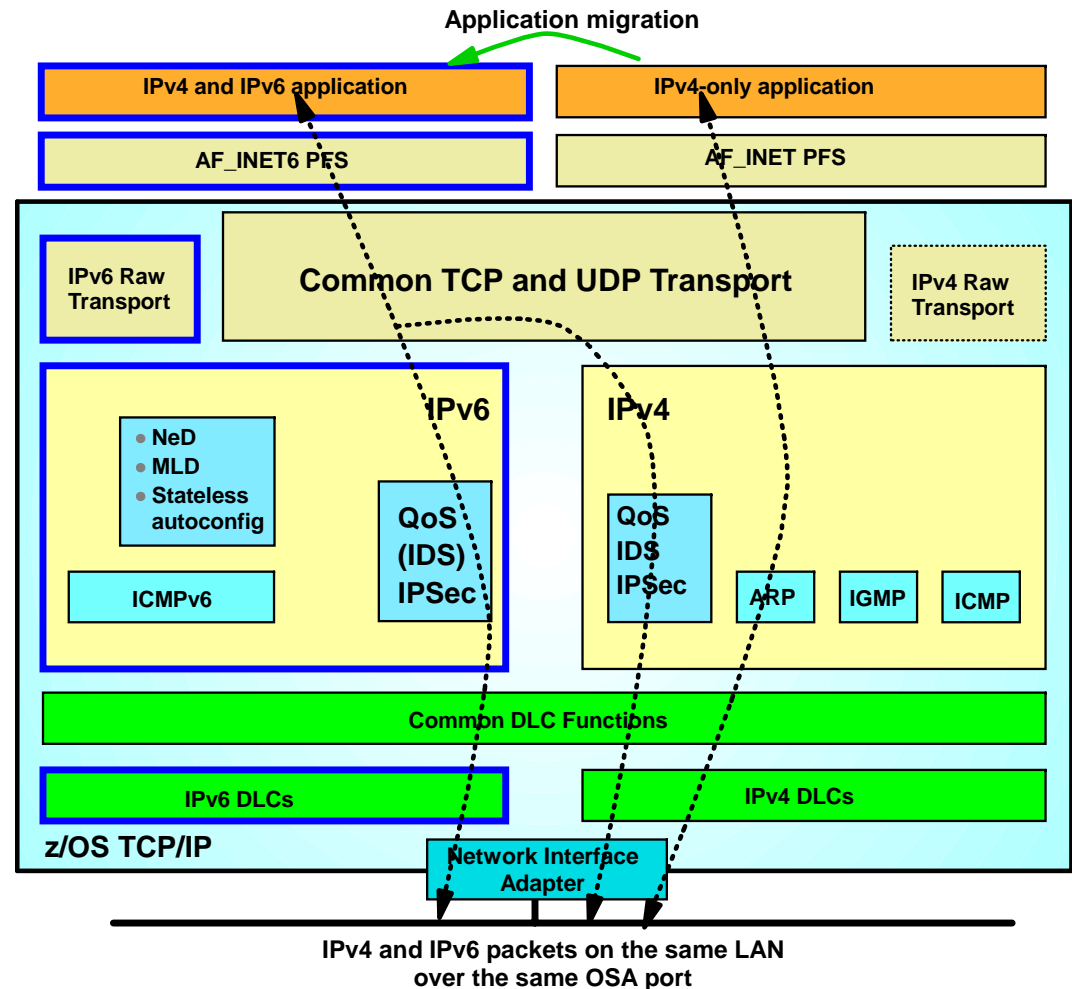
- Wish so !!

- A few facts:
 - The network infrastructure will have to be updated to support IPv6 network infrastructure functions, such as neighbor discovery (an auto-addressing technology), IPv6 routing tables (OSPFv3), ICMPv6, Name servers with IPv4 and IPv6 addresses, DHCP servers for IPv6, etc.
 - Layer-3 routers
 - Firewalls
 - Intrusion Detection devices
 - Application layer gateways (ALGs)
 - Etc.
 - The physical media you use today can carry both IPv4 and IPv6 – so no new cabling (!)
 - A TCP/IP stack must be updated to support IPv6 – alongside with IPv4 (known as dual-mode TCP/IP stack)
 - IPv6 requires a new sockets interface, known as AF_INET6 (Addressing Family IPv6)
 - IPv4 sockets programs today use AF_INET, which is IPv4 only. An AF_INET sockets program can communicate with an IPv4 sockets partner only
 - Sockets programs that are updated to support AF_INET6 can communicate with both IPv4 and IPv6 sockets partners

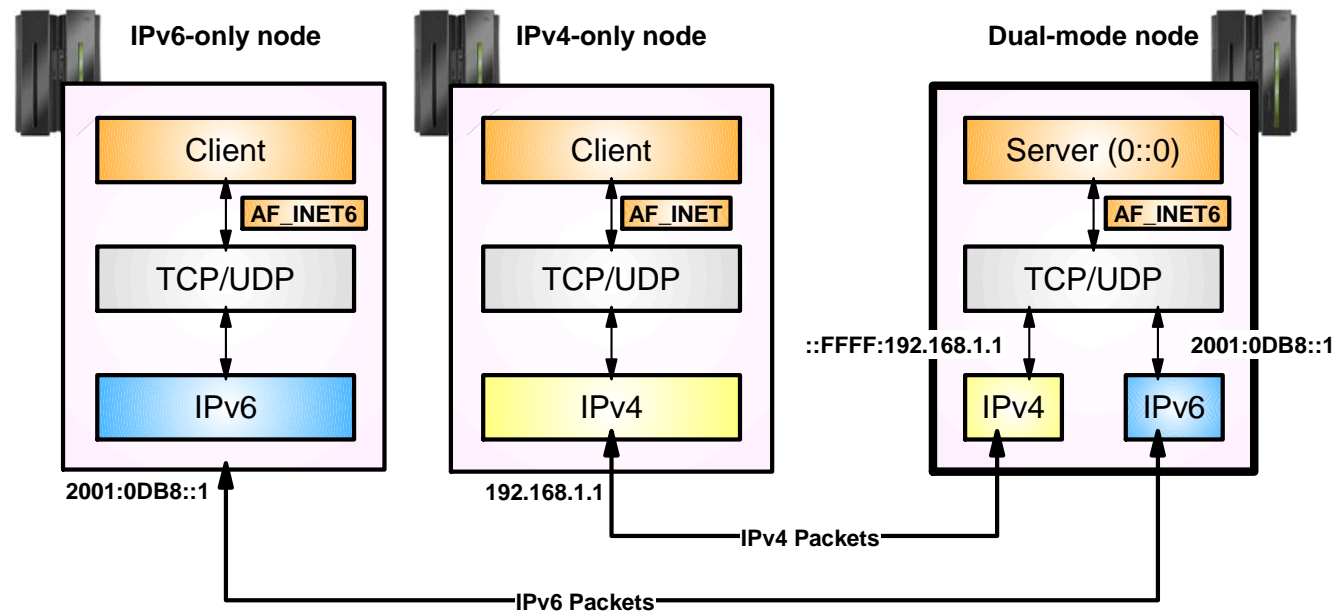
- Sockets programs must be updated to talk IPv6 !!

z/OS TCP/IP is a dual-mode TCP/IP stack

- A dual-mode (or dual-stack) TCP/IP implementation supports both IPv4 and IPv6 interfaces – and both old AF_INET and new AF_INET6 applications.
- The dual-mode TCP/IP implementation is a key technology for IPv4 and IPv6 coexistence in an internet.
- For AF_INET6 applications, the common TCP or UDP transport layer determines per communication partner if the partner is an IPv4 or an IPv6 partner - and chooses IPv4 or IPv6 networking layer component based on that.
- Raw applications make the determination themselves when they choose IPv4 or IPv6 raw transport.

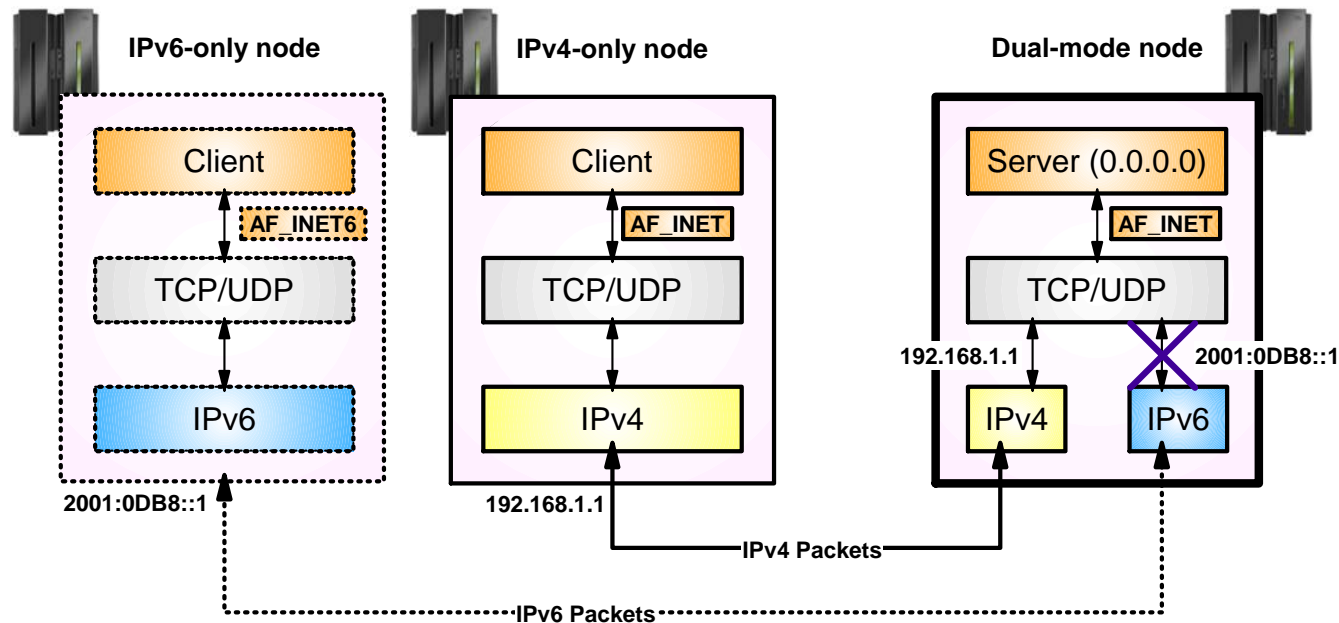


IPv6-enabled application on a dual mode stack



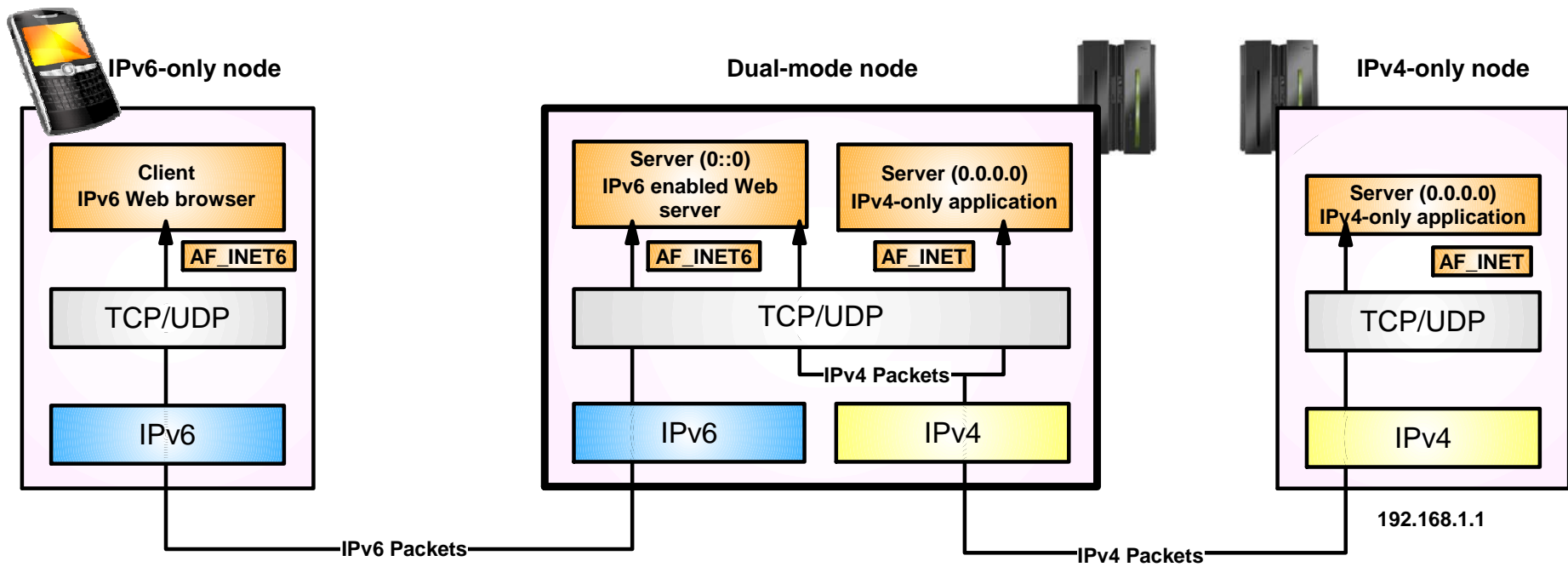
- An IPv6-enabled application can communicate with both IPv4 and IPv6 peers
 - A single socket can be used to send or receive traffic from either IPv4 or IPv6 partners
 - IPv4 packets to the IPv4 partner and IPv6 packets to the IPv6 partner
 - No changes need to be made to the partner application
- An IPv6-enabled application uses AF_INET6 sockets for both IPv4 and IPv6 partners
 - An IPv4 address is mapped to IPv6 addresses by the Transport Layer in the TCP/IP stack
 - Uses a special address format which identifies the IPv6 address as an IPv4-mapped IPv6 address
 - For example, 9.67.115.69 would be represented as ::FFFF:9.67.115.69

IPv4-only application on a dual-mode stack



- An IPv4 application running on a dual-mode stack can communicate with an IPv4 partner.
 - The source and destination addresses will be native IPv4 addresses
 - The packet which is sent will be an IPv4 packet
- If partner is IPv6 running on an IPv6 only stack, then communication fails
 - If partner was on dual-mode stack, then it would fit in previous page discussion
 - The partner only has a native IPv6 address, not an IPv4-mapped IPv6 address
 - The native IPv6 address for the partner cannot be converted into a form the AF_INET application will understand

Accessing IPv4-only applications through an IPv6 application layer gateway (ALG)

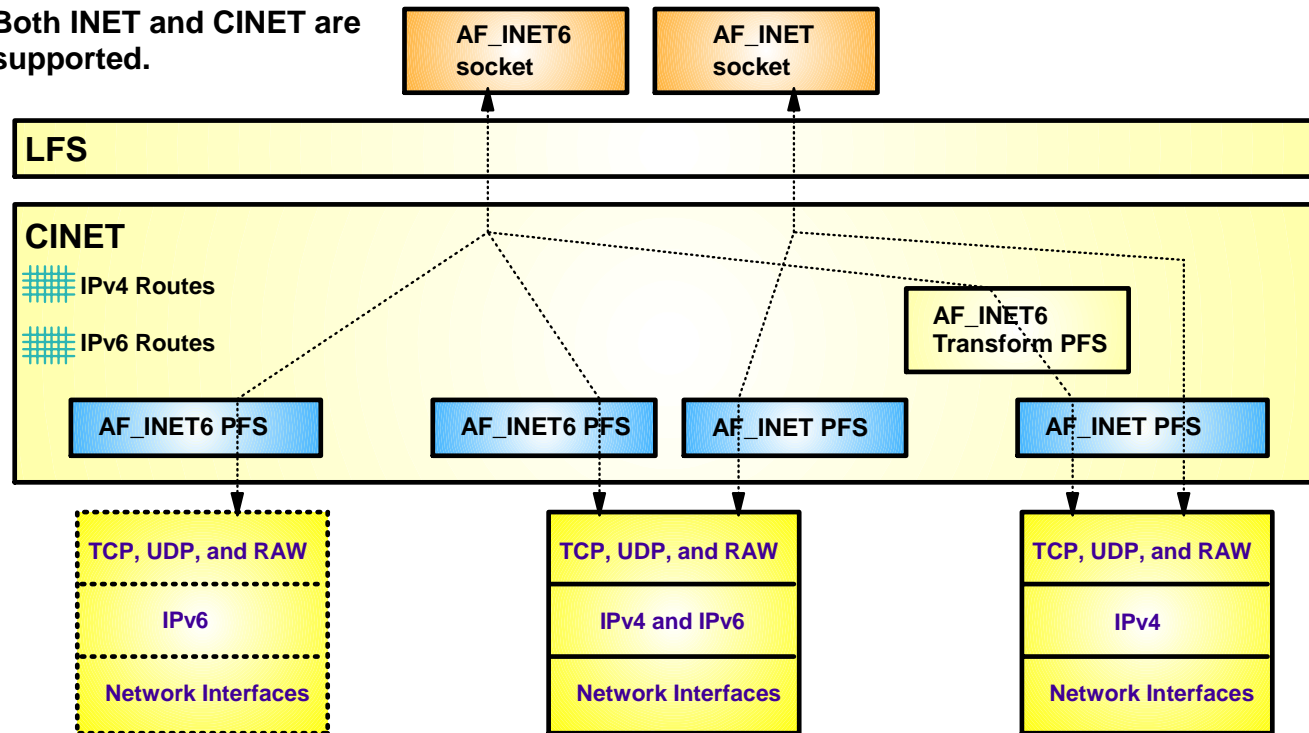


- An IPv6-only client can access IPv4-only servers via an IPv6 “proxy”
 - The IPv6 proxy communicates with the IPv6-only client using IPv6, and accesses the IPv4-only server using IPv4
 - The IPv4-only server may be on the same node as the IPv6 proxy, or may reside on a different node
 - The use of a backend IPv4-only server is, in most cases, completely transparent to the IPv6 client

Enabling IPv6 support on z/OS

IPv6 is enabled at an LPAR level via an option in BPXPRMxx to enable AF_INET6 support. Both INET and CINET are supported.

When IPv6 is enabled, a z/OS TCP/IP stack will always have an IPv6 Loopback interface. You can define real IPv6 interfaces in addition to the loopback interface.



IPv6-only TCP/IP Stack
This will not be the case on z/OS for the foreseeable future! An AF_INET6 stack is required to also support AF_INET!

Dual Mode TCP/IP Stack
A z/OS TCP/IP stack will always come up as dual-mode if AF_INET6 is enabled in BPXPRMxx

IPv4-only TCP/IP Stack
(such as AnyNet or an OEM TCP/IP stack)

- ▶ Existing AF_INET sockets programs will continue to work as they always did - no difference in behavior or support.
- ▶ AF_INET6 enabled sockets programs will be able to communicate with IPv4 partners (just as before they were changed to support IPv6), but in addition to that they will also be able to communicate with IPv6 partners.

Netstat output format LONG or SHORT

- When IPv6 is enabled, most netstat reports will look different because of the potential for long IPv6 addresses.
 - Without IPv6 enabled, Netstat uses what is known as a SHORT report format
 - It is possible to have both local and remote IP address in one 80-character line
 - You can override the SHORT format by coding IPCONFIG FORMAT LONG
 - With IPv6 enabled, Netstat uses a LONG report format
 - Each IPv6 address may potentially be up to 45 characters long, which makes it impossible to have both local and remote IPv6 addresses in a single 80-character line
- Make sure you update any netstat screen-scraping REXX programs you might have developed in the past!

```
MVS TCP/IP NETSTAT CS V1R11          TCPIP Name: TCPCS          12:50:02
User Id  Conn      State
-----  ----      -
MYINETD1 00000025 Listen
  Local Socket:  9.42.104.161..23
  Foreign Socket: 0.0.0.0..0
TN3270A  00000045 Listen
  Local Socket:  ::..23
  Foreign Socket: ::..0
TN3270A  00001B5E EstablsH
  Local Socket:  ::ffff:9.42.105.45..23
  Foreign Socket: ::ffff:9.50.52.109..58646
Application Data:  EZBTNSRV TCPABC81 TSO10001 ET B
```

Steps for moving to an IPv6 Environment

1. Network access

- A LAN can carry both IPv4 and IPv6 packets over the same media
- An OSA-EXPRESS port can be used for both IPv4 and IPv6
- Update TCP/IP Profile to include the INTERFACE statement(s) for any IPv6 interfaces
- For LPAR-LPAR communication for IPv6, several options exist:
 - using QDIO to a shared LAN (or a Shared OSA)
 - MPCPTP6 interfaces (via XCF if on the same sysplex or ESCON CTC links)
 - IPv6 HiperSocket connections (if on the same CEC)

2. IPv6 address selection

- Obtain an address block from your ISP, or use one of your IPv4 addresses to create a 6to4 prefix
- For test purposes, site-local IPv6 addresses is sufficient, but avoid using them in production
- Should look into using emerging “Unique Local IPv6 Unicast Addresses” instead of site-local
- IPv6 addresses can be assigned to the IPv6 Interfaces and static VIPAs
- Addresses can be manually configured on the INTERFACE statement in the TCP/IP Profile or auto-configured using Neighbor Discovery Stateless Auto-configuration
 - VIPA addresses must be manually configured

Steps for moving to an IPv6 Environment

3. DNS setup

- DNS BIND 9 Name Server can be used for both IPv4 and IPv6 resources
- Continue to use the existing host name for IPv4 connectivity to avoid possible disruption in network connectivity and IPv4-only applications on an IPv6-enabled stack
- Create a new host name to be used for IPv6 and IPv4 connectivity
- Optionally, a third host name which may be used only for IPv6 can be configured
- If using stateless auto-configuration to define IPv6 addresses, static VIPA addresses should be stored in DNS since the auto-configured addresses will change over time

4. INET or Common INET

- Both are supported for IPv6, but INET is much simpler
- Running IPv4 and dual-mode stacks under CINET is not recommended - run dual-mode stacks in a separate LPAR from IPv4 only stacks
 - All z/OS TCP/IP stacks in an LPAR are either IPv4-only or dual-mode
 - Based on your BPXPRMxx definitions
 - Only case where this could become an issue is if you start CA's TCPAccess TCP/IP stack side-by-side with a z/OS TCP/IP stack in an LPAR that have been enabled for IPv6 in the BPXPRMxx parmlib member
- AF_INET6 NETWORK statement must be coded in BPXPRMxx before starting IPv6-enabled stacks

Steps for moving to an IPv6 Environment

5. Selection and placement of IPv6 to IPv4 protocol converter or application gateway

- z/OS does not implement any functions that will allow IPv6-only nodes to communicate with z/OS-resident AF_INET applications, so an outboard protocol converter or application-layer gateway component may be needed
- This component will only be needed if the test configuration includes IPv6-only platforms
- Various technologies are being made available by various vendors; SOCKS64 seems the simplest technology right now

6. Connectivity to non-local IPv6 locations

- Tunneling may be needed between a router connected to the LAN that z/OS is connected to, and a router at another location where IPv6 test equipment is located

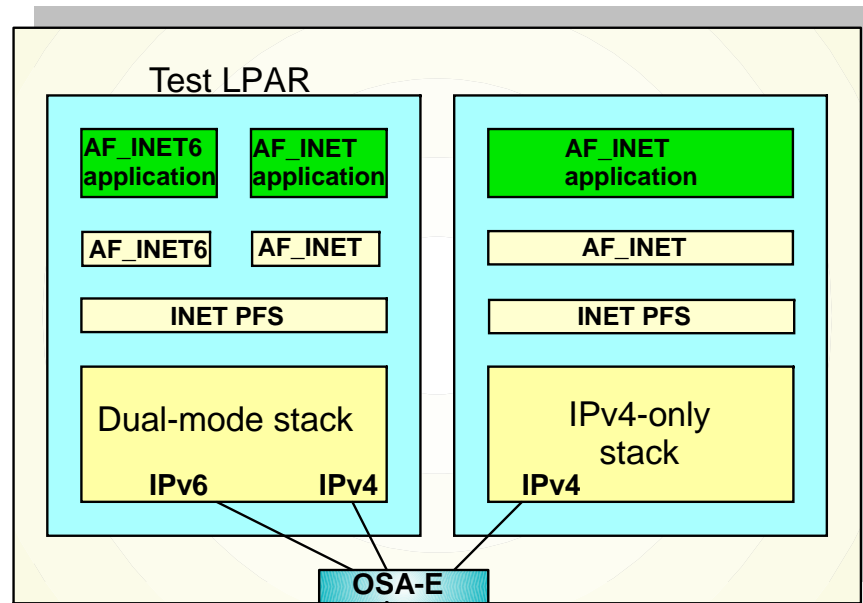
Accessing z/OS over IPv6 from a remote site

Remember: You can enable IPv6 today on z/OS without impact to your existing IPv4 users.

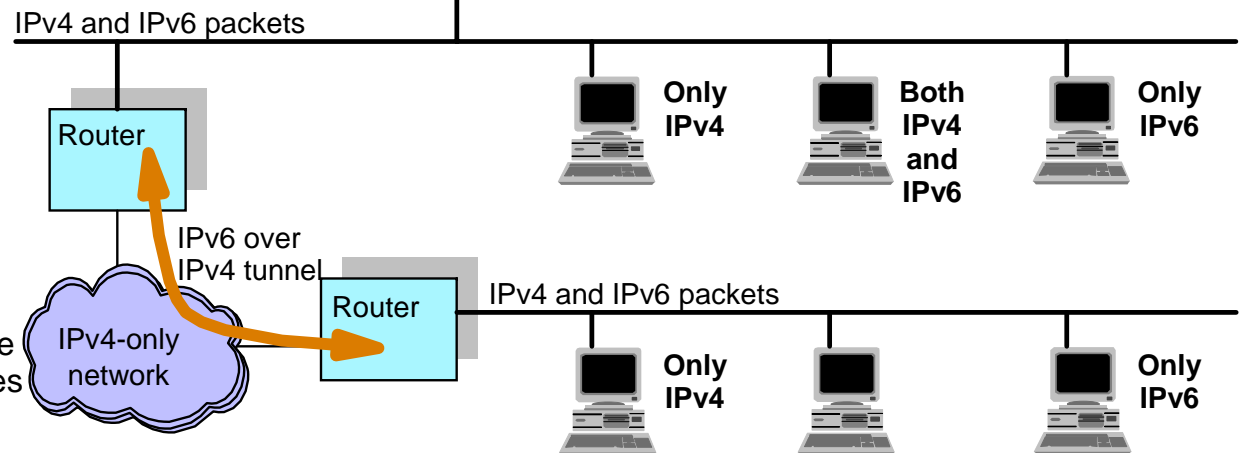
Do it on your test system – initially without defining any IPv6 interfaces.

All IPv4 communication continues to work as before.

Use IPv6 over IPv4 tunneling when native IPv6 connectivity does not exist



z/OS CS does not support being a tunnel endpoint, although it can route traffic through an intermediate tunnel



z/OS and IPv6 - certifications

- z/OS V1R5 is IPv6 Ready Phase 1 certified by the IPv6 Forum
- z/OS V1R8 is IPv6 Ready Phase 2 certified by the IPv6 Forum
- z/OS V1R10 is IPv6 certified according to the US DoD IPv6 requirements!
 - See the “Special Interoperability Test Certification of the IBM z/OS Version 1.10 Operating System for IBM Mainframe Computer Systems for Internet Protocol Version 6 Capability”
 - From US government, Defense Information Systems Agency, Joint Interoperability Test Command
 - (http://jitc.fhu.disa.mil/adv_ip/register/certs/ibmzosv110_dec08.pdf)

“The IBM z/OS Version 1.10 operating system for IBM mainframe computer systems has met the Internet Protocol (IP) Version 6 (IPv6) Capable interoperability requirements of an Advanced Server as described in the Department of Defense (DoD) Information Technology Standards Registry, “DoD IPv6 Standard Profiles for IPv6 Capable Products Version 2.0,” 1 August 2007, reference (c). The IBM z/OS Version 1.10 operating system for IBM mainframe computer systems has successfully completed the related IPv6 Interoperability portions of the “DoD IPv6 Generic Test Plan (GTP) Version 3,” August 2007, reference (d), and is certified for listing on the Unified Capabilities (UC) Approved Products List (APL) as IPv6 Capable.”

What can you do today? Start learning, planning, and testing!



- ❑ **Develop a multi-step plan**
 - Eventual goal is fully IPv6-enabled dual-stack operating environment
- ❑ **Choose a target date for being IPv6-enabled**
 - Work backwards in developing a timeline on when key steps need to be completed
- ❑ **Develop detailed plan for each sub-step**
 - To resolve critical dependencies in the necessary timeframe
- ❑ **Not too early to begin planning today**
 - Need for IPv6 may occur quickly and with little advanced warning
 - Rapid realization that IPv6 is needed
 - Take several years to actually get IPv6 deployed
 - Need to have IPv6 already in use (and tested) before it becomes a requirement that it be used operationally
- ❑ **Develop an internal addressing plan for distributing/managing IPv6 addresses**
 - Determine how IPv6 addresses will be obtained
 - Either from your ISP, or from a Regional Internet Registry (RIR)
 - Consider whether Unique Local Addresses are appropriate
- ❑ **Understand your ISPs IPv6 plans**
- ❑ **Perform a detailed inventory of all systems**
 - Determine what is involved in IPv6-enabling them
 - All network hardware and software
 - All client and server hardware, software and applications
- ❑ **Develop plans to ensure all components are IPv6-enabled according to a workable timeline**
 - Work with vendors to understand their plans for adding IPv6 support for all critical components
- ❑ **Determine how end users will use IPv6 services**
 - Likely involve tunneling initially
 - But need IPv6-capable routers on the edge links where clients connect
 - Need to provide remote IPv6 access
- ❑ **Develop plans for IPv6 training, education and consulting**

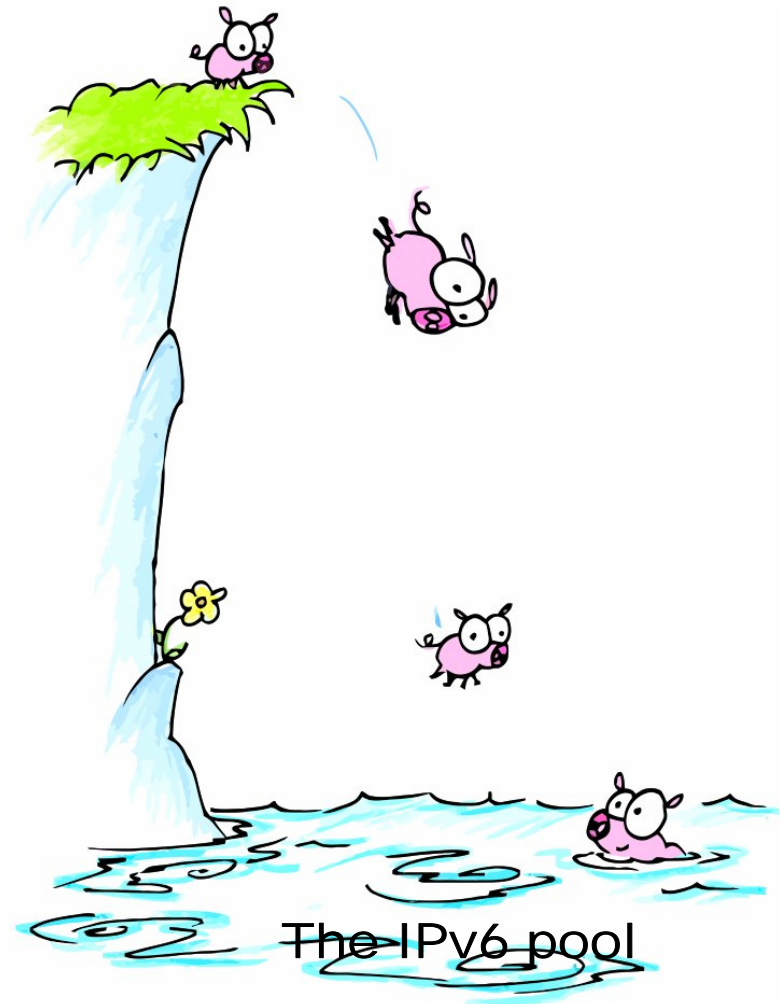
Things to consider ..

***z/OS is ready for IPv6
– are you?***

Phase-1





Phase-2



For more information



URL		Content
http://www.twitter.com/IBM_Commserver		IBM Communications Server Twitter Feed
http://www.facebook.com/IBMCommserver		IBM Communications Server Facebook Fan Page
http://www.ibm.com/systems/z/		IBM System z in general
http://www.ibm.com/systems/z/hardware/networking/		IBM Mainframe System z networking
http://www.ibm.com/software/network/commserver/		IBM Software Communications Server products
http://www.ibm.com/software/network/commserver/zos/		IBM z/OS Communications Server
http://www.ibm.com/software/network/commserver/z_lin/		IBM Communications Server for Linux on System z
http://www.ibm.com/software/network/ccl/		IBM Communication Controller for Linux on System z
http://www.ibm.com/software/network/commserver/library/		IBM Communications Server library
http://www.redbooks.ibm.com		ITSO Redbooks
http://www.ibm.com/software/network/commserver/zos/support/		IBM z/OS Communications Server technical Support – including TechNotes from service
http://www.ibm.com/support/techdocs/atmastr.nsf/Web/TechDocs		Technical support documentation from Washington Systems Center (techdocs, flashes, presentations, white papers, etc.)
http://www.rfc-editor.org/rfcsearch.html		Request For Comments (RFC)
http://www.ibm.com/systems/z/os/zos/bkserv/		IBM z/OS Internet library – PDF files of all z/OS manuals including Communications Server

For pleasant reading