
Internet Protocol Version 6

The Next Generation Internet

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After this workshop you will be able to answer questions;

- Why do we need IPv6?
- World Wide development status of IPv6.
- Why 128bits for IPv6?
- What are the programs that support IPv6?
- Comparison of IPv6 versus IPv4
- What are the main advantages of IPv6

Why is the name IPv6 and not IPv5?

- On any IP header, the first 4 bits are reserved for the protocol version
- 4: is already used for IPv4
- 5: is reserved for the Stream Protocol (STP, RFC 1819/ Internet Stream Protocol Version 2) [which never really made it to the public]
- The next free number was 6. Hence IPv6 was born!

IPv4 – Introduction

- Current version of IP, version 4, is 20 years old
- IPv4 has shown remarkable ability to move to new technologies
- New versions of IP to address some specific problems have been proposed
 - Discuss IPv6 in this lecture
- IP has accommodated dramatic changes since original design
 - Basic principles still appropriate today despite
 - Changes in hardware technologies
 - Heterogeneous networks
 - Increase in scale

What's new in IPv6?

- Address size
 - IPv6 addresses are 128bits
- Header format
 - Entirely different
- Extension headers
 - Additional information stored in optional extension headers, followed by data
- Support for audio and video
 - Flow labels and quality of service allow audio and video applications to establish appropriate connections
- Extensible
 - New features can be added more easily

IP Address Allocation History

1981 - IPv4 protocol published

1985 ~ 1/16 of total space

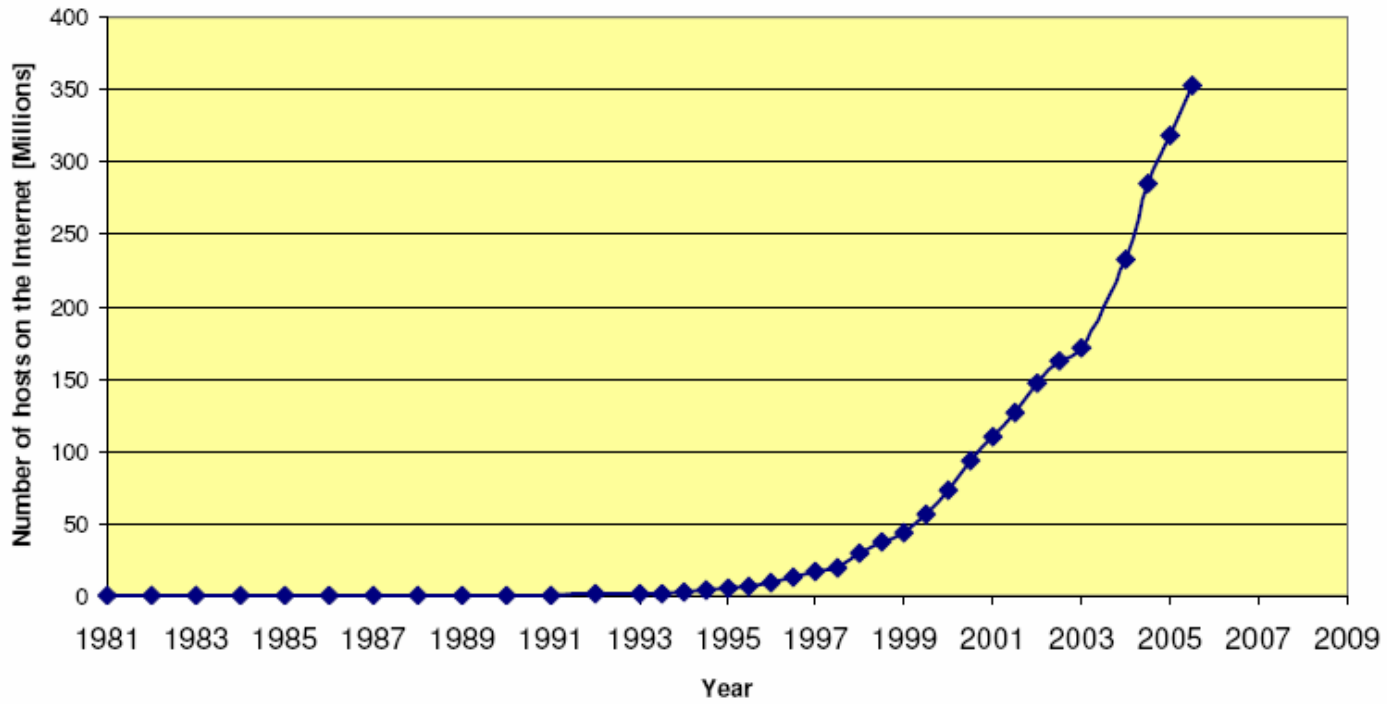
1990 ~ 1/8 of total space

1995 ~ 1/4 of total space

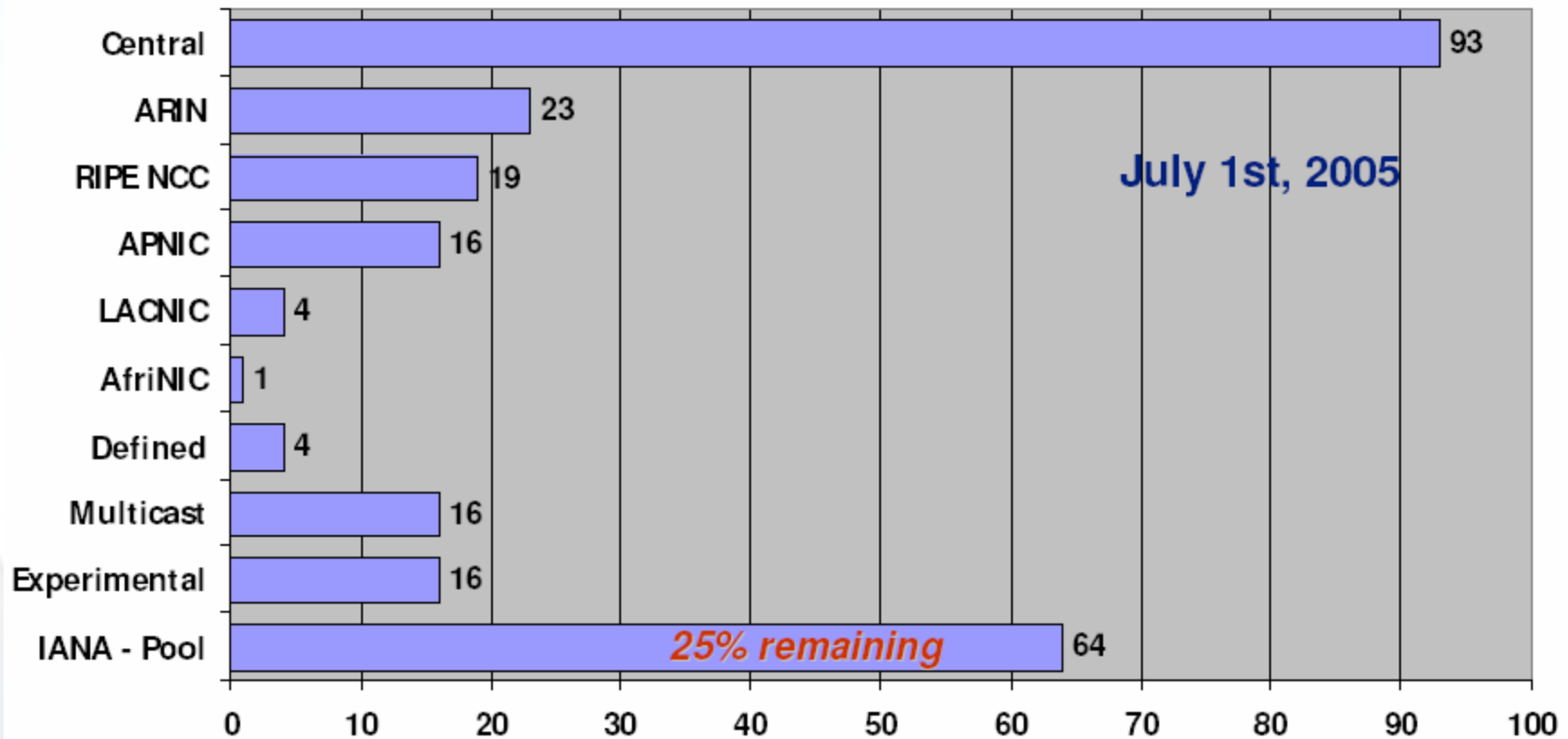
2000 ~ 1/2 of total space

- This despite increasingly intense conservation efforts
 - PPP / DHCP address sharing
 - CIDR (classless inter-domain routing)
 - NAT (network address translation)
 - plus some address reclamation
- Theoretical limit of 32-bit space: ~4 billion devices
practical limit of 32-bit space: ~250 million devices
(see RFC-3194)

IPv4 Growth Development since Internet launch

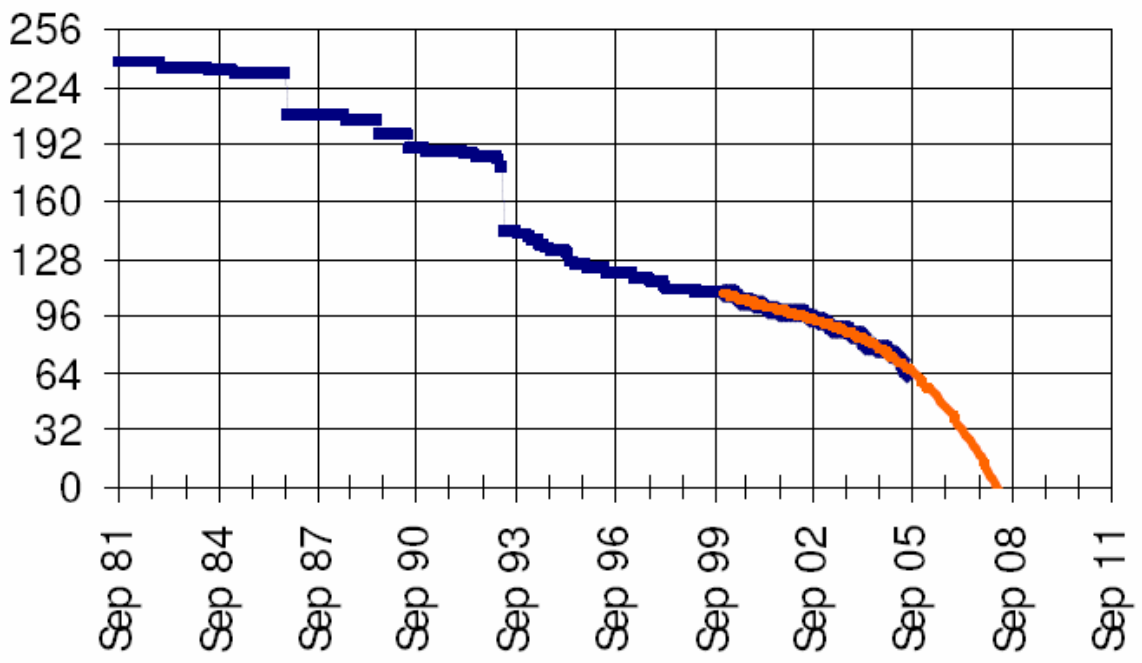


Distribution of IPv4 addresses by /8



IANA allocated 22 /8's between Jan 1, 2004 – Jan 1, 2005 typical RIR re-allocation period 9-12 months

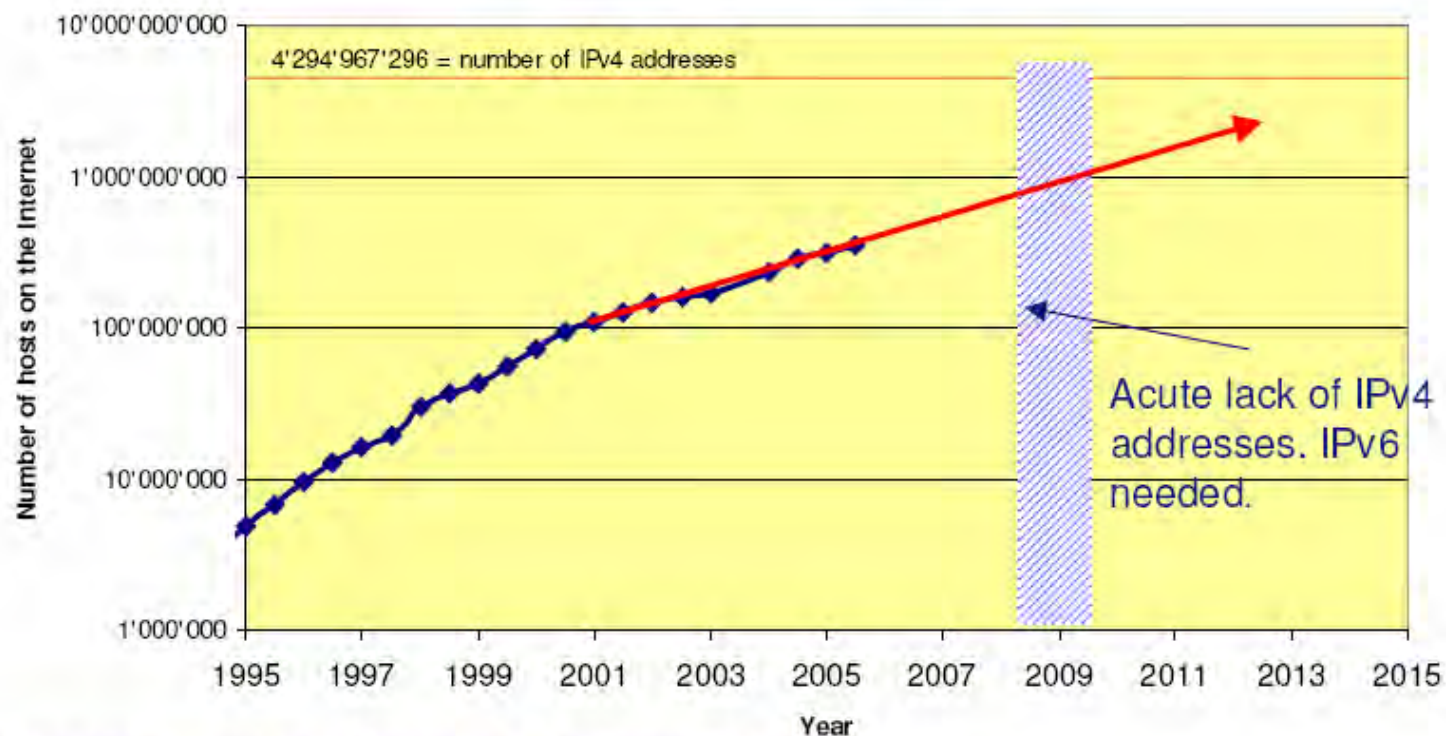
IPv4 /8 pool



Full discussion in Cisco Internet Protocol Journal:
http://www.cisco.com/en/US/about/ac123/ac147/archived_issues/ipj_8-3/ipv4.html



IPv4 Projection of Lifetime
Base: Development of last 4 years



Source: Internet Systems Consortium, Inc.

<http://www.isc.org/index.pl?ops/ds/>

Why Internet Protocol Version 6?

only compelling reason: more IP addresses!

- for billions of new users (China, India,...)
- for billions of new devices (mobile phones, cars, appliances,...)
- for always-on access (cable, xDSL, ethernet-to-the-home,...)
- for applications that are difficult, expensive, or impossible to operate through NATs (IP telephony, peer-to-peer gaming, home servers,...)
- to come to an end with NATs to improve the robustness, security, performance, and manageability of the Internet

Other Benefits of IPv6

- server-less plug-and-play possible
- end-to-end, IP-layer authentication & encryption possible
- elimination of “triangle routing” for mobile IP
- other minor improvements

NON-benefits:

- quality of service (same QoS capabilities as IPv4)
 - flow label field in IPv6 header may enable more efficient flow classification by routers, but does not add any new capability
- routing (same routing protocols as IPv4)
 - except larger address allows more levels of hierarchy
 - except customer multihoming is defeating hierarchy

Why IPv6? (Business Reasons)

- demand from particular regions
 - Asia, EU
 - technical, geo-political, and business reasons
 - demand is now
- demand for particular services
 - cellular wireless (especially 3GPP[2] standards)
 - Internet gaming (e.g., Sony Playstation 2)
 - use is ≥ 1.5 years away (but testbeds needed now)
- potential move to IPv6 by Microsoft?
 - IPv6 included in Windows XP, but not enabled by default
 - to be enabled by default in next major release of Windows
 - use is ≥ 1.5 years away

How was IPv6 Address Size Chosen?

- some wanted fixed-length, 64-bit addresses
 - easily good for 10^{12} sites, 10^{15} nodes, at .0001 allocation efficiency (3 orders of mag. more than IPng requirement)
 - minimizes growth of per-packet header overhead
 - efficient for software processing
- some wanted variable-length, up to 160 bits
 - compatible with OSI NSAP addressing plans
 - big enough for auto-configuration using IEEE 802 addresses
 - could start with addresses shorter than 64 bits & grow later
- settled on fixed-length, 128-bit addresses
(**340,282,366,920,938,463,463,374,607,431,768,211,456** in all!)

Implementations

- IPv6 is shipping as a standard feature on most major IP platforms today
 - BSD Unix (all flavors), Cisco, Compaq, Ericsson, HP, IBM, Juniper, Linux, Microsoft, Nokia, Sun, and many more
- in many cases, still missing major pieces
 - e.g., IPsec for IPv6, mobility, multicast, QoS,...
- implementations have been well-tested at frequent multi-vendor events

Implementations

- The research networks:
 - Native connection to the research networks backbones (Internet2, ESnet, GEANT)
 - IPv6 Land Speed record by CERN and CalTech of 983 mbps
<http://info.web.cern.ch/info/Press/PressReleases/Releases2003/PR09.03EInternet.html>
- The implementers:
 - Asia:
 - Japan to convert IT infrastructure to IPv6 by 2005
 - DOD to transition to IPv6 by 2008
<http://www.dod.mil/releases/2003/nr20030613-0097.html>
- The commercial world:
 - Major vendors (started to) ship IPv6 enabled products

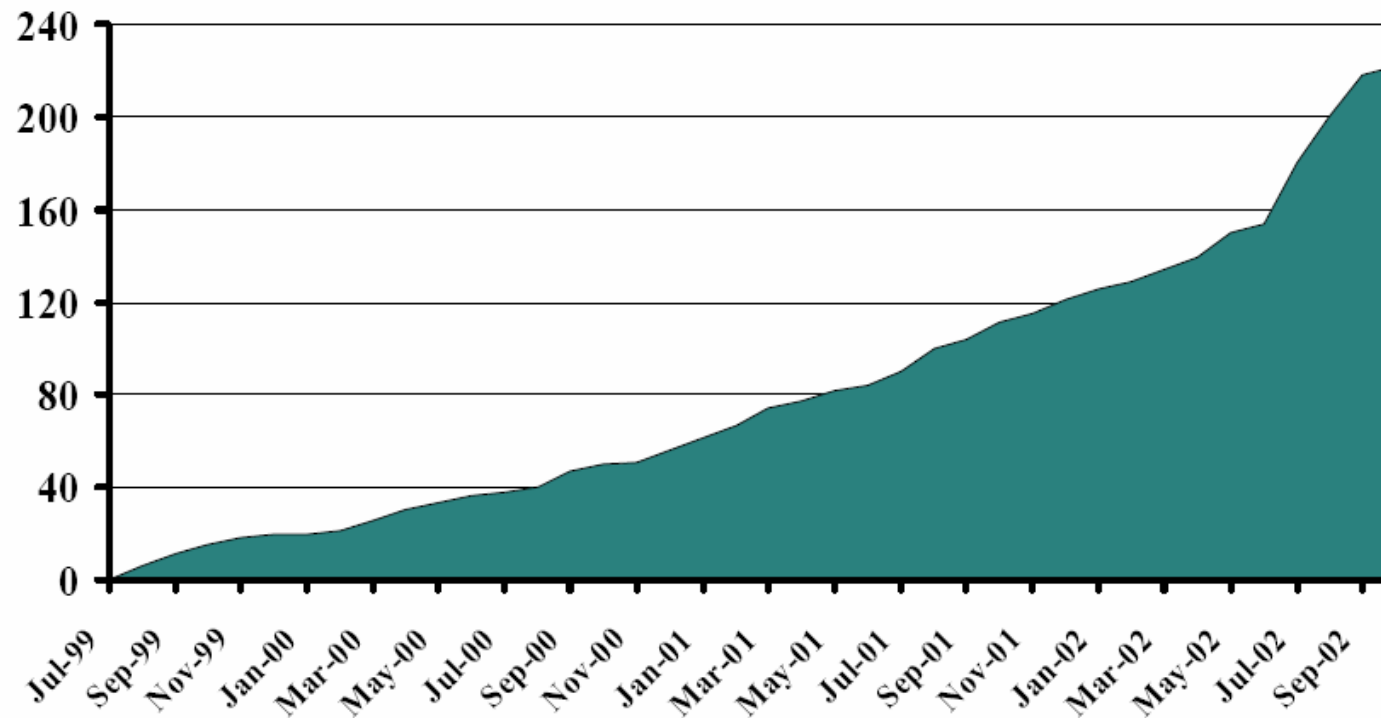
Current IPv6 ISP Deployment

#	Country	ISPs
1	Japan	47
2	US	24
3	Germany	20
4	South Korea	14
5	UK	8
6	Netherlands	7
7	Europe	6
8	Austria	6
9	France	6
10	Taiwan	6
11	Mexico	5
12	Finland	5
13	Italy	5
14	Canada	4
15	Sweden	4

#	Country	ISPs
16	Norway	4
17	Poland	4
18	Switzerland	4
19	Australia	4
20	China	4
21	Portugal	3
22	Singapore	3
23	Thailand	3
24	Russia	2
25	Ireland	2
26	Spain	2
27	Lithuania	2
28	Denmark	2
29	Malaysia	2
30	Brazil	1

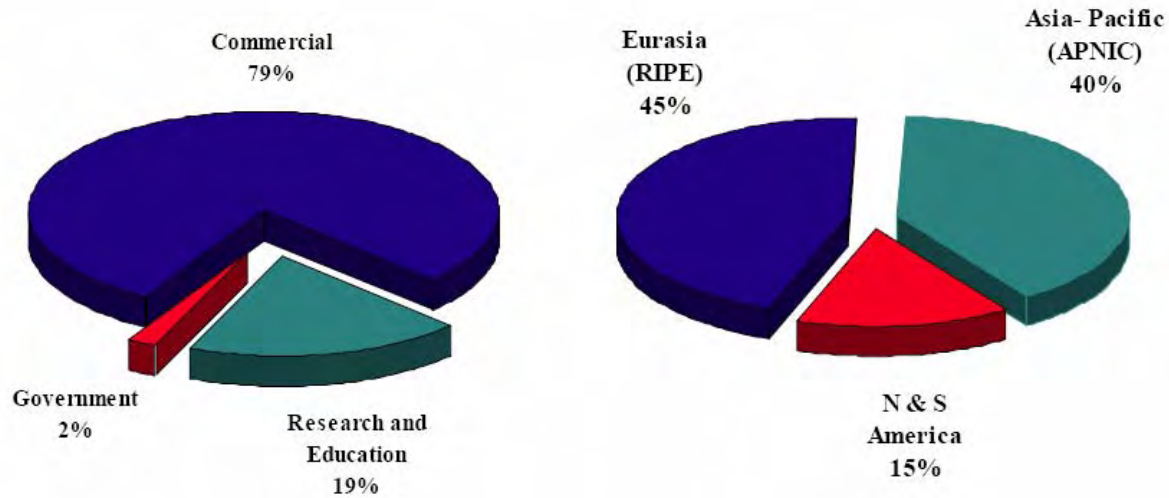
#	Country	ISPs
31	Luxembourg	1
32	Greece	1
33	Belgium	1
34	Czech	1
35	Hungary	1
36	Estonia	1
37	Cyprus	1
38	Yugoslavia	1
39	Turkey	1
40	UAE	1
41	Papua New Guinea	1
42	India	1

222 ISPs in 39 Months



IPv6 Internet demonstrates the trend of doubling in size every year.

Distribution of Production IPv6 ISPs



Projected DoD Timeline

2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	
IPv4: Mandatory Standard E2E Protocol*			IPv4: Mandatory Standard E2E Protocol*						IPv6: Mandatory Standard E2E Protocol*		
IPv6: Emerging Standard E2E Protocol*			IPv6: Mandatory Standard E2E Protocol*						IPv6: Mandatory Standard E2E Protocol*		
IPv4											
IPv6											

Software which supports IPv6

- Apache – Web Server
- Mozilla – Web Browser
- BIND – DNS Server
- Sendmail – E-mail Server
- SSH
- More programs are available
<http://www.ipv6.org/v6-apps.html>

IPv6 is already available in Japan
IPv6 capable products for diverse triple play offerings...

Panasonic Webcam

IPv6対応
 屋外タイプ
 パン&チルト
 音声

設置ポイントが広がる
 屋外タイプ




目よけハウジング・スタンド使用前

NEW
BB-HCM331
 本体希望小売価格 89,800円(税別・取付調整費別)

【付属品】
 ・ACアダプター(コード長 約10 m)
 ・ACコード(コード長 約1.8 m)
 ・スタンド
 ・目よけハウジング
 ・セットアップCD-ROM



Oki IPv6 TV Set Top Box



Broadband access router
 NTT MN9300 (dual stack)

カメラコントロールユニット

IPv6対応[®]
 無線LAN規格 (IEEE802.11a/b/g) 対応



スタンド使用時

NEW
BB-HGW502
 本体希望小売価格 74,800円(税別・取付調整費別)

【付属品】
 ・ACアダプター(コード長 約1.8 m)
 ・ACコード(コード長 約56 cm)
 ・イーサネットケーブル(ケーブル長 約1 m)
 【カテゴリ5 ストレートケーブル】
 ・スタンド

【対応機種】
 ・ネットワークカメラ:BB-HCM311、HCM331、HCM371/
 KX-HCM180、HCM1、HCM2
 ・無線LANアダプター:BB-HGA102

Panasonic WLAN router

The needs of IPv6..

Though IPv6 today has all the functional capability of IPv4,

- implementations are not as advanced (e.g., with respect to performance, multicast support, compactness, instrumentation, etc.)
- deployment has only just begun
- much work to be done moving application, middleware, and management software to IPv6
- much training work to be done (application developers, network administrators, sales staff,...)
- many of the advanced features of IPv6 still need specification, implementation, and deployment work

Summary

- IPv4 basic abstractions have been *very* successful
- IPv6 carries forward many of those abstraction... but, all the details are changed
 - 128-bit addresses
 - Base and extension headers
 - Source does fragmentation
 - New types of addresses
 - New address notation

Resources

- The 6Bone
<http://www.6bone.net/>
- IPv6
<http://www.ipv6.org/>
- IPv6 Forum
<http://www.ipv6forum.com/>
- North American IPv6 Task Force
<http://www.nav6tf.org/>

Thanks to..



www.consulintel.es

For Donating the IPv6 Books to Our Workshop.

