Internet Directions and Issues

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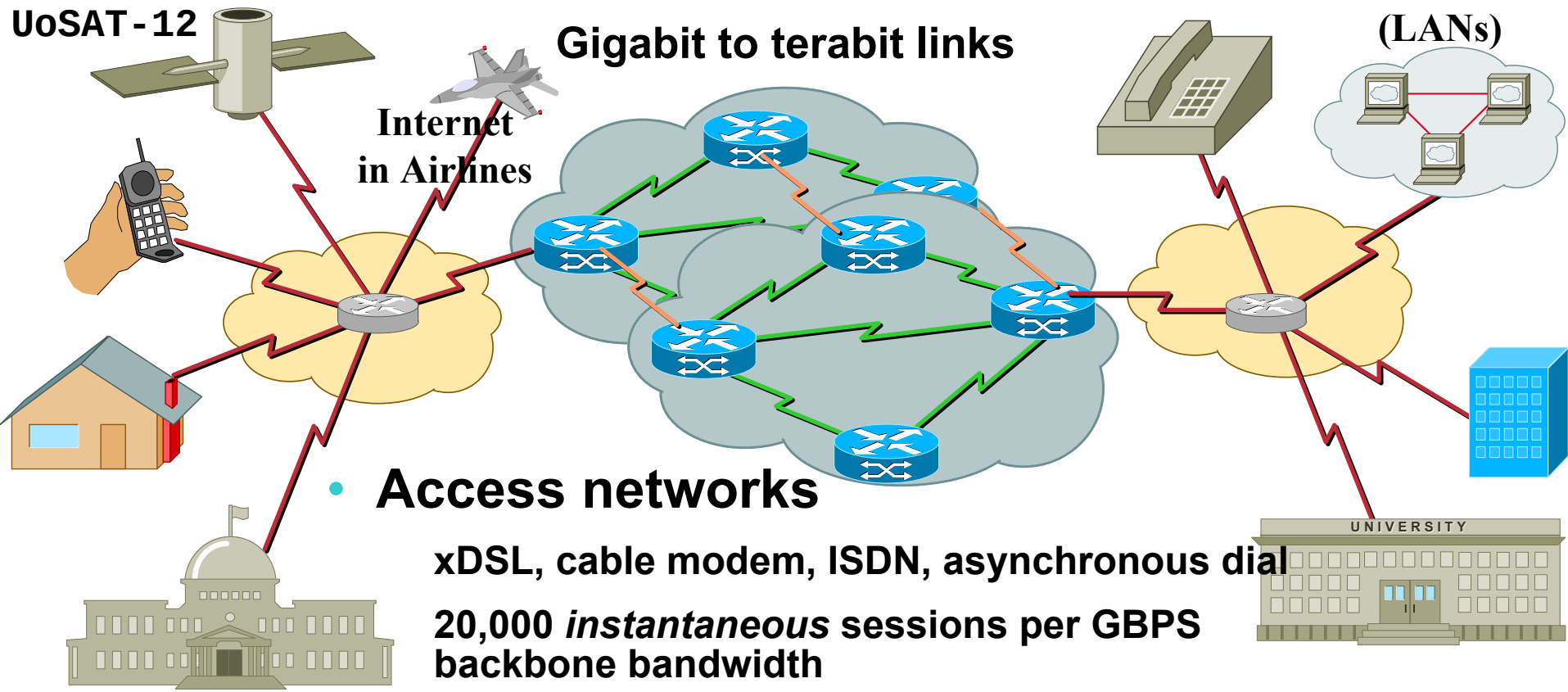
Some of these slides are courtesy from Fred Baker

Today's Internet

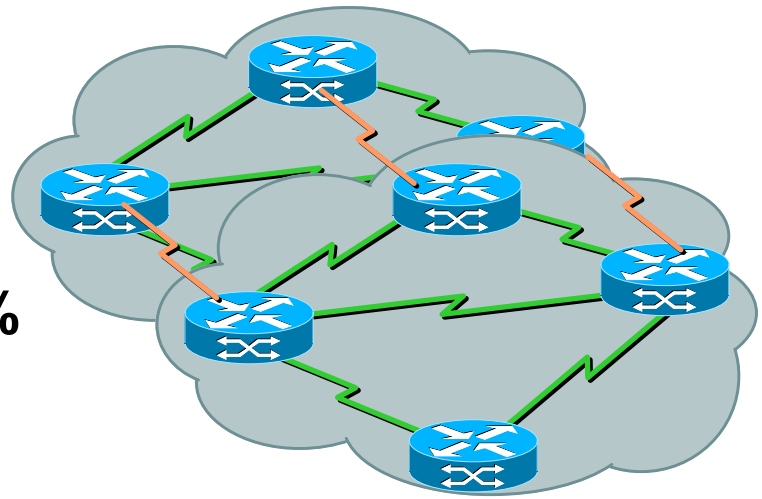
- The optical internet backbone
  - Gigabit to terabit links



- Access networks
  - xDSL, cable modem, ISDN, asynchronous dial
  - 20,000 *instantaneous* sessions per GBPS backbone bandwidth

What's doing well?

- In a word, bandwidth
  - In the core
  - In broadband access
  - In Large Corporate Networks
- LANs and Core WANs run < 10% utilized
  - Qwest commented recently that their 10 GBPS backbone is 2.5% utilized



Current trends in a down economy

- **Internet traffic growth is still increasing:**
  - **Fiber deployment slowed down**
  - **The best rumors say usage is doubling annually, not every quarter**
  - **Service providers, awash in bandwidth, are simply absorbing load**
- **Broadband buildout: doing well?**
  - **Deployment in metropolitan areas growing with demand**
  - **Not ubiquitous: but did you really expect it to be?**

Questions from the Service Providers:

- **What will spur more utilization, and therefore revenue?**

  New applications that consume bandwidth

- **How can I reduce service to traffic that is costing me money?**

  New applications in which homes are servers but don't pay for the bandwidth

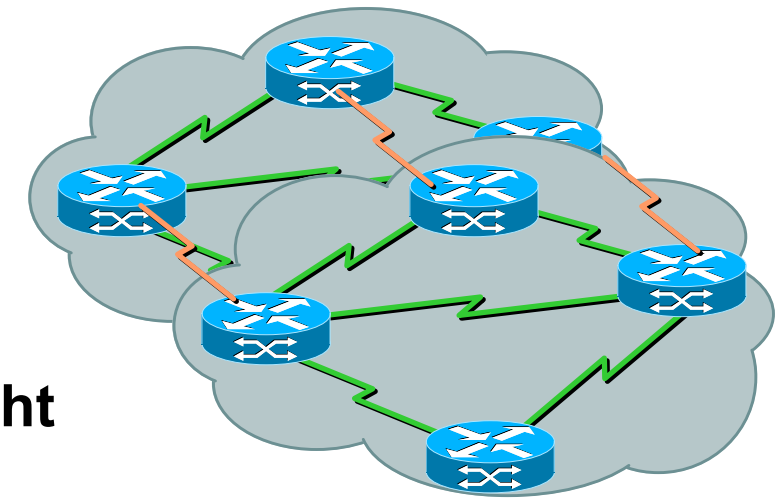
Growing applications

- **Peer to Peer application models**

  Morpheus, Gnutella, etc

- **Multiparty Games**

  Interactions modeled on Flight Simulator, video combat games

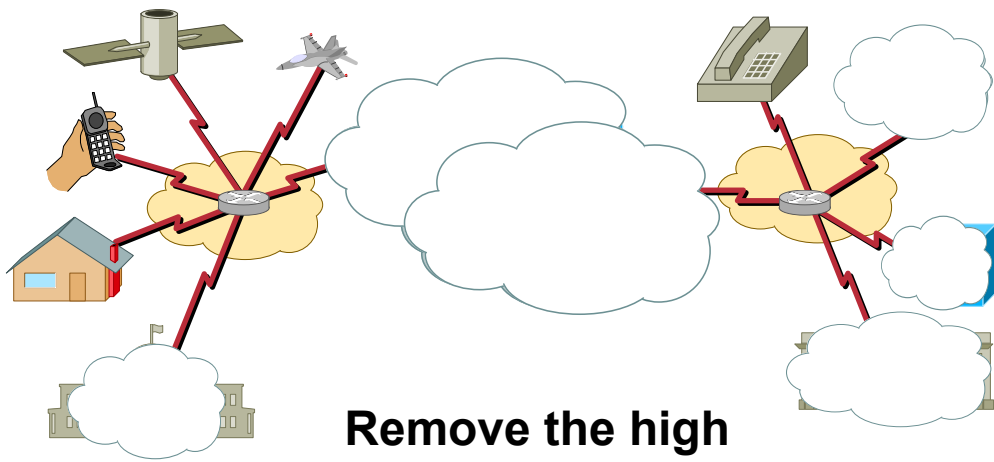


Service model mismatch

- **Service Providers:**
  - **“We want to entertain you”**
  - **Client/Server applications in which many users access relatively few servers at hosting sites**
  - **Video on Demand**
- **Application Designers:**
  - **“Facilitate us entertaining ourselves and each other”**
  - **Peer to peer model**
  - **Server in the home**
  - **Morpheus, Gnutella, Gaming**

Where are the problems?

- End user bandwidth
  - Broadband deployment not as fast as expected
  - 3G Mobile Internet lacking significant capability
- Delay and loss experienced by end users is largely due to
  - Server overload
  - Database design
  - Firewalls and Gateways
  - Overloaded access links or smaller ISPs



Remove the high bandwidth regions

Issues to overcome

“Here there be dragons”

The big issues in the Internet

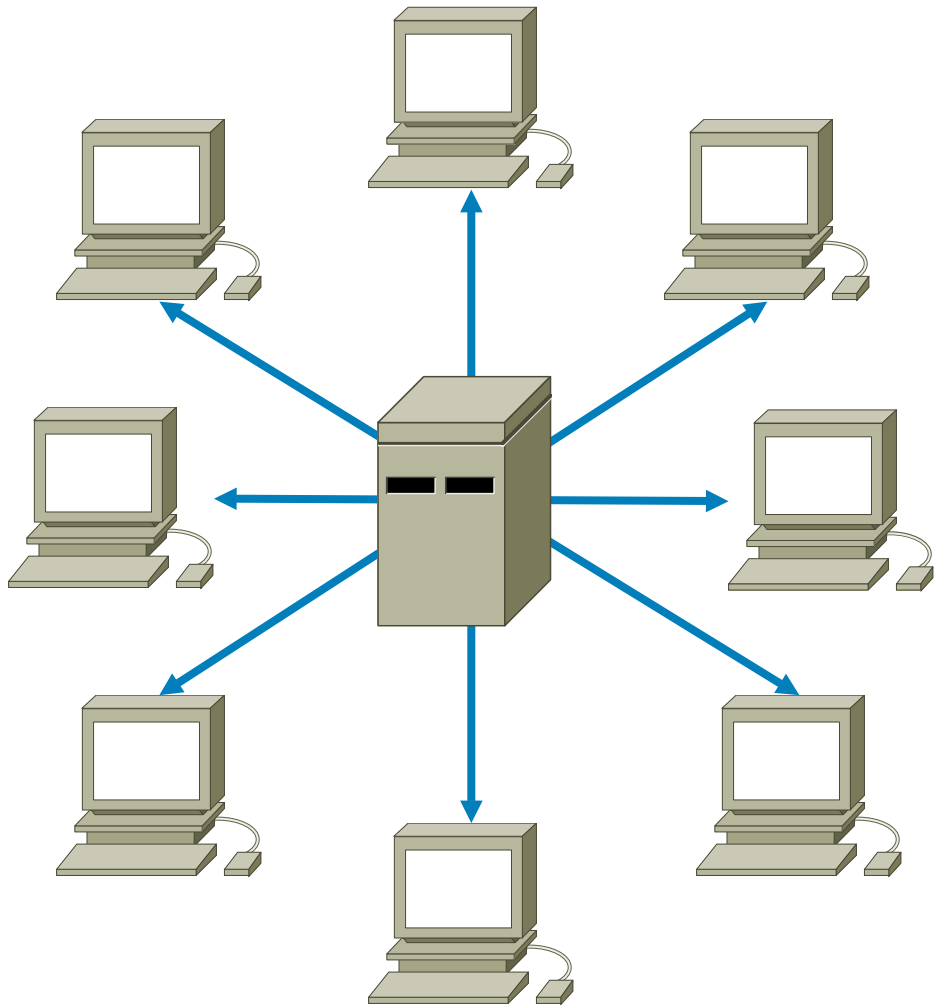
- **Technical Issues**
  - **Scale**
  - **Trust**
  - **Predictability**
  - **Applications and Architectures**
- **Non-technical issues**
  - **Services, Settlements, and Billing**
  - **Political and Regulatory Issues**

Authentication/Authorization dichotomy

- **Worms, viruses**
  - **Intent is to destroy the network**
  - **Access control required to analyze and eliminate**
- **Unauthorized Access**
  - **Use your machine for unintended purposes**
- **Peers in games**
  - **Can I signal directly rather than to a server?**
- **Can I control who I send content to, or who uses it?**
  - **Intellectual property issues**

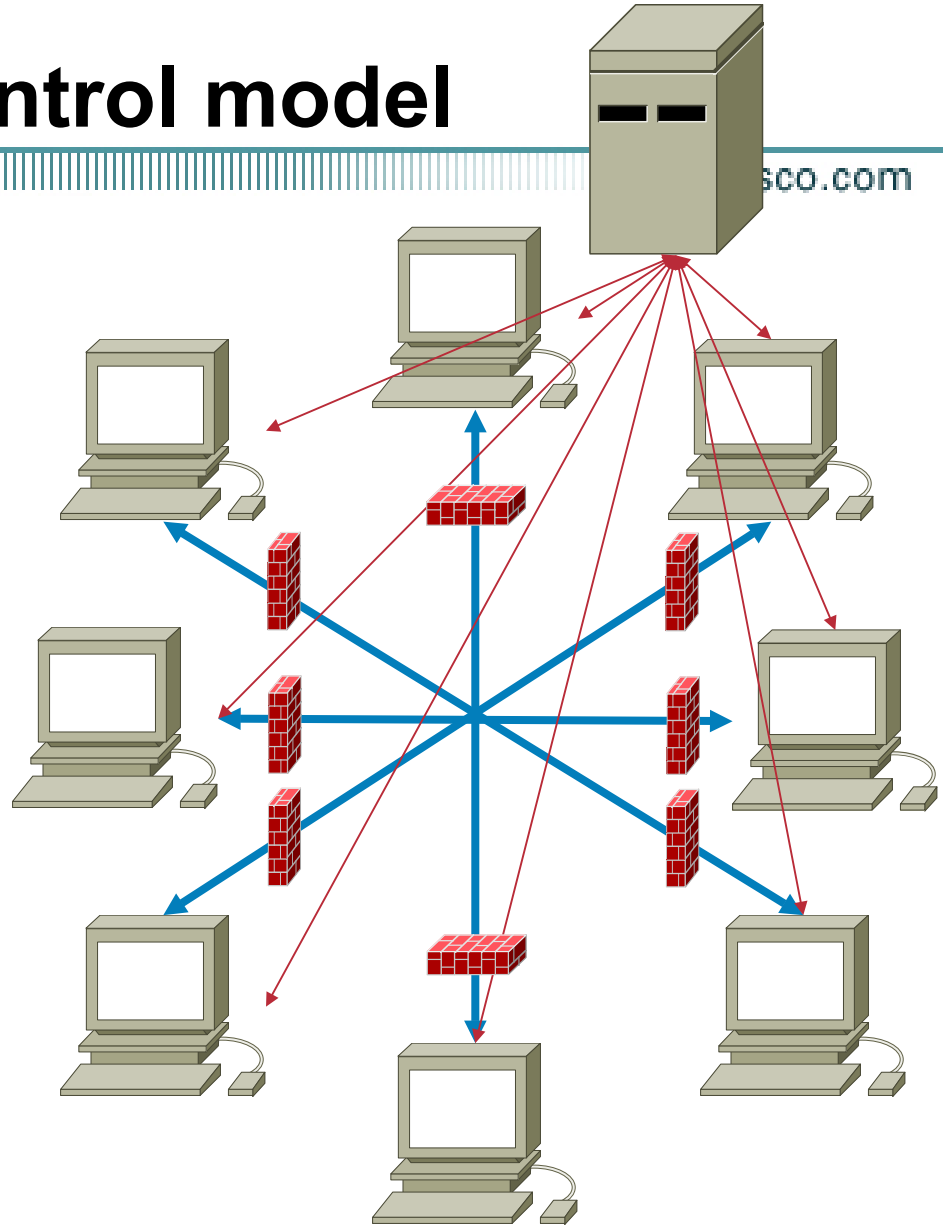
Client/Server Access control

- We trust people to access servers and do limited operations on them



Peer-peer access control model

- Model with all the same access control and therefore accountability
- Utilizes compute capability of peer computers to perform game



Here's the hard part

- I have to be able to address the peer computers across perimeter security (global addresses)
- I have to be able to keep out the bad guys
  - Good intrusion detection and avoidance
- I have to be able to convince Mom, Dad, and the service provider that this is OK
- We have to manage IPR issues related to content

Going forward

Client/Server Architecture is breaking down

- **For web:**

  Sufficient to have clients in private address spaces access servers in global address space

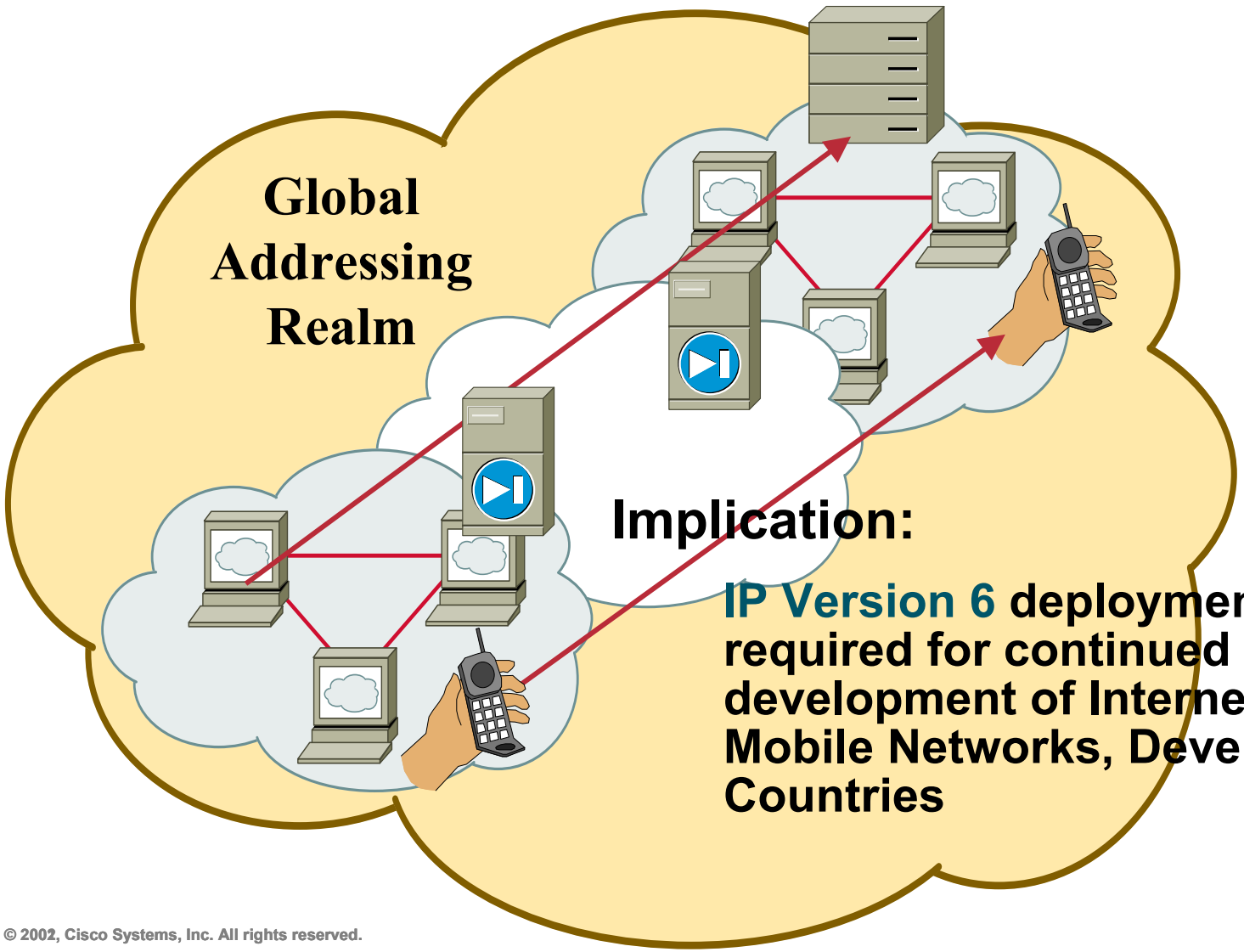
- **Peers behind the firewall**

  need an address when you call them

Implications of breakdown

- **Difficult to deploy new applications**
  - **Because we have to change the firewalls as well as the end systems**
  - **We are forced into hub-and-spoke application architectures even in peer-to-peer applications**
- **Network becoming more complex**
  - **Therefore more difficult to manage and use**

Need an end to end naming and addressing architecture



Implication:

IP Version 6 deployment required for continued development of Internet in Mobile Networks, Developing Countries

Ad Hoc Authentication and Authorization is not scaling

- But we knew that…
- Global Public Key Infrastructures (PKI) are hard as well

Need a web-of-trust model that is deployable and usable

- **Access Control**
  - **Who are you?**
  - **What may you do?**
- **What will I trust you for?**

Changing service model

- The Internet is about interaction, not entertainment
- Service models have to be built on concept where “client” or “server” may be seen as the ISP’s customer
- Customer must be accountable for usage

IPv6
Integration & Co-Existence

IPv6: The Application's Convergence Layer

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Forget a preconceived idea: not only PC's but all things are connected,

So millions of addresses and Plug & Play capability are required = IPv6

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)

Do We Really Need a Larger Address Space?

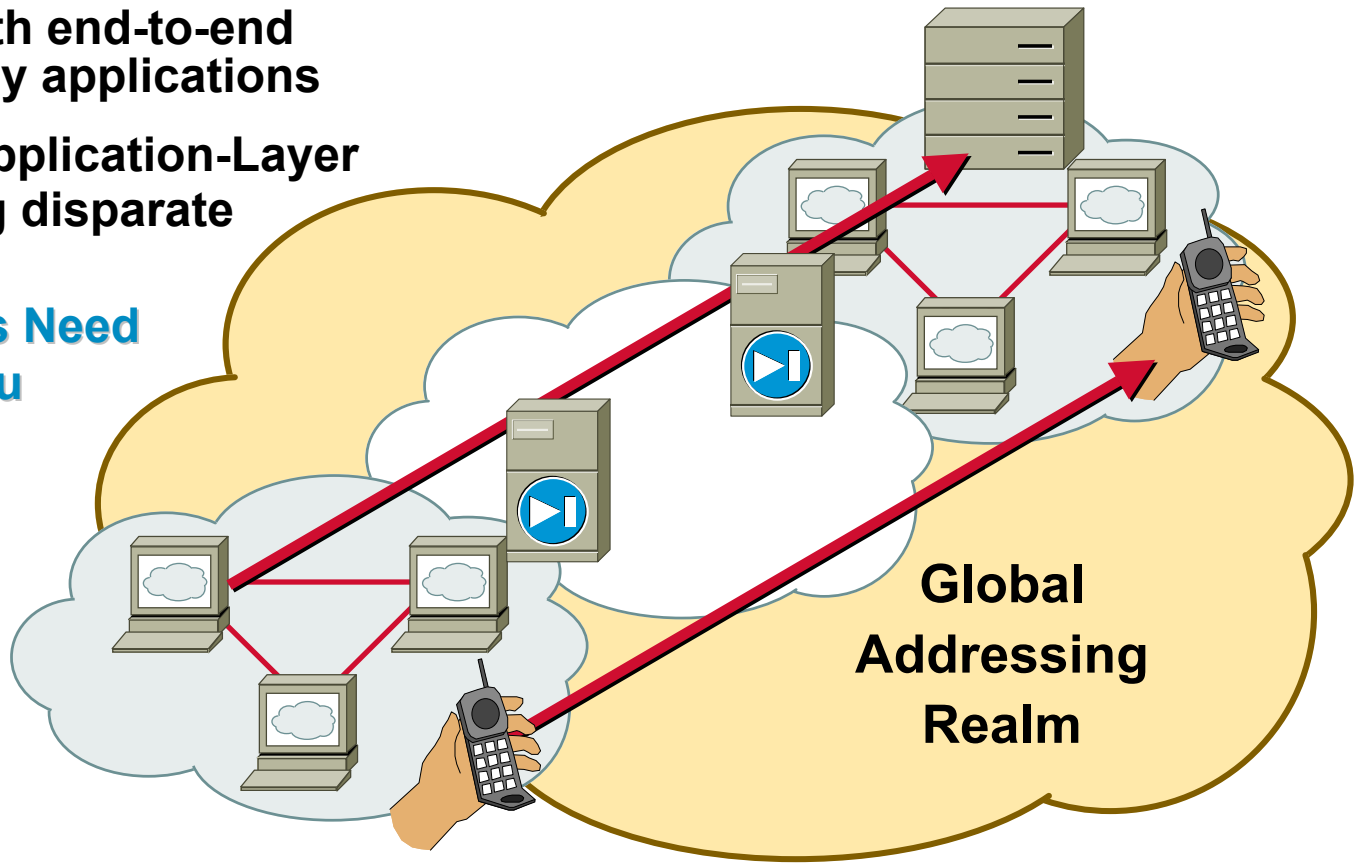
- Internet Users or PC
  - ~530 million users in Q2 CY2002, ~945 million by 2004
  - (Source: Computer Industry Almanac)
  - Emerging population/geopolitical and Address space
- PDA, Pen-Tablet, Notepad,…
  - ~20 millions in 2004
- Mobile phones
  - Already 1 billion mobile phones delivered by the industry
- Transportation
  - 1 billion automobiles forecast for 2008
  - Internet access in Planes
- Consumer devices
  - Billions of Home and Industrial Appliances

Coming Back to an End-to-End Architecture

New Technologies/Applications for Home Users

'Always-on'—Cable, DSL, Ethernet-to-the-home, Wireless,…

- Internet started with end-to-end connectivity for any applications
- Today, NAT and Application-Layer Gateways connecting disparate networks
- **Always-on Devices Need an Address When You Call Them**, eg.
  - Mobile Phones
  - Gaming
  - Residential Voice over IP gateway
  - IP Fax

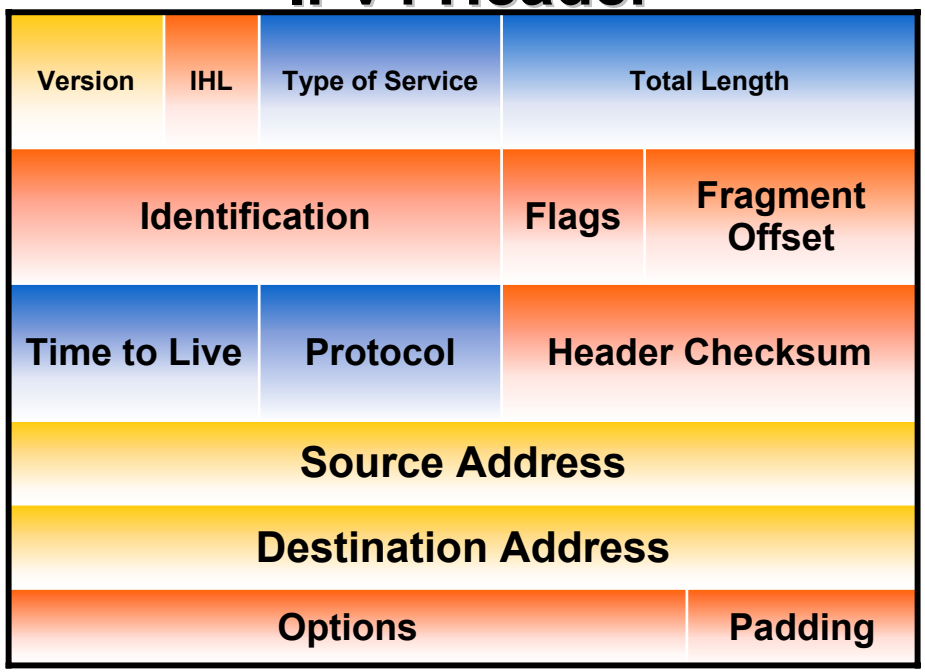


IPv6 Technology Scope

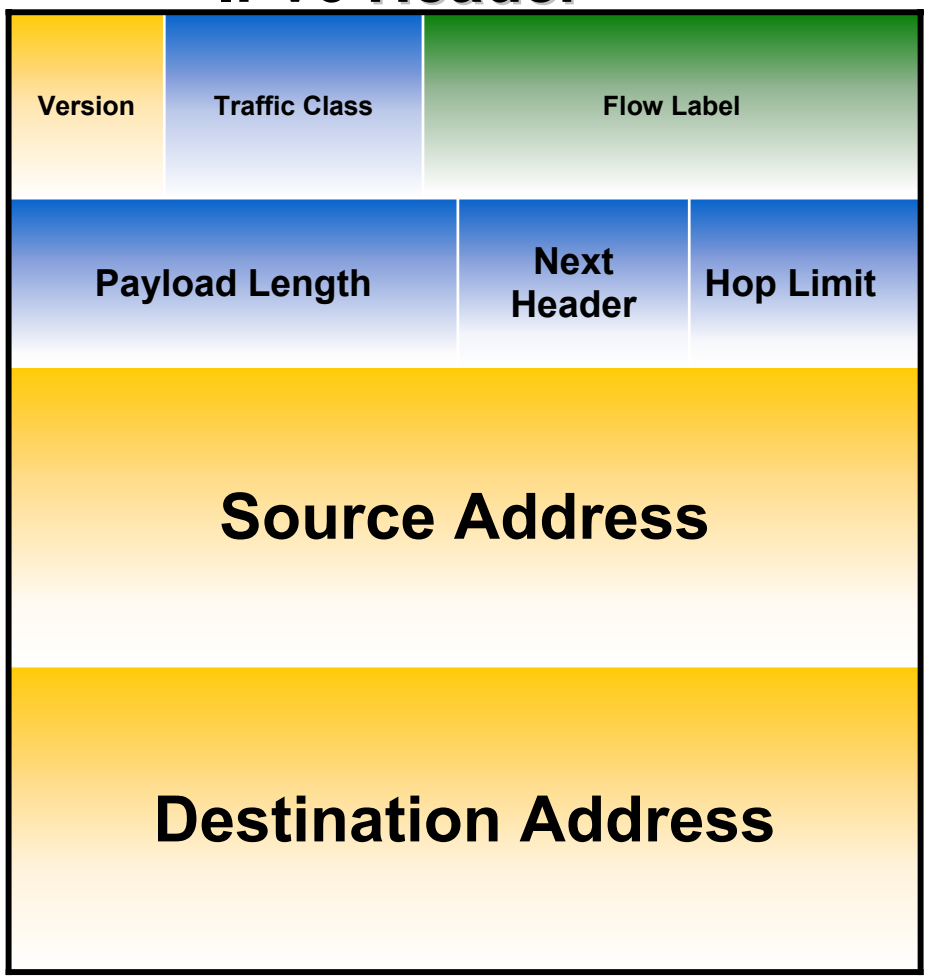
IP Service	IPv4 Solution	IPv6 Solution
	32-bit, Network Address Translation	128-bit, Multiple Scopes
	DHCP	Serverless, Reconfiguration, DHCP
	IPSec	IPSec Mandated, works End-to-End
	Mobile IP	Mobile IP with Direct Routing
	Differentiated Service, Integrated Service	Differentiated Service, Integrated Service
	IGMP/PIM/Multicast BGP	MLD/PIM/Multicast BGP,Scope Identifier

IPv4 & IPv6 Header Comparison

IPv4 Header



IPv6 Header



Legend

- field's name kept from IPv4 to IPv6
- fields not kept in IPv6
- Name & position changed in IPv6
- New field in IPv6

IPv6 Markets

- National Research & Education Networks (NREN) & Academia
- Geographies & Politics
- Wireless (PDA, 3G Mobile Phone networks, Car,...)
- Home Networking
  - Set-top box/Cable/xDSL/Ethernet-to-the-home
  - Eg. Japan Home Information Services initiative
- Distributed Gaming
- Consumer Devices
- Enterprise
  - Requires full IPv6 support on O.S. & Applications
- Service Providers

IPv6 O.S. & Applications support

- All Operating Systems have an IPv6 stack at some stage of completeness
  - All Unix flavours (Sun Solaris, HP Unix, Compaq True64, SGI, IBM AIX, BSD (kame), Linux,…
  - Microsoft Windows flavours, MacOS X, Compaq OpenVMS,…
- Focus is now on the Applications
  - Ie: Microsoft .NET server, BSD Kame project
- But still need additional vendors
  - Ie: Oracle & SAP
- See playground.sun.com/ipv6 and www.hs247.com for latest update

IPv6 & Geo-Politics

- China
  - Is establishing an IPv6 collaboration with Japan
- Europe
  - European IPv6 Task Force, www.ipv6-taskforce.org
    - IPv6 2005 roadmap recommendations – Jan. 2002
  - European Commission IPv6 project funding: 6NET & EuroIX
- Japan
  - Formal announce to support IPv6 in the “e-Japan Initiative” plan, 2000
  - IPv6 Promotion council
  - Tax incentive program, 2002-2003
- U.S.
  - North-America IPv6 Task Force

6NET Project Overview

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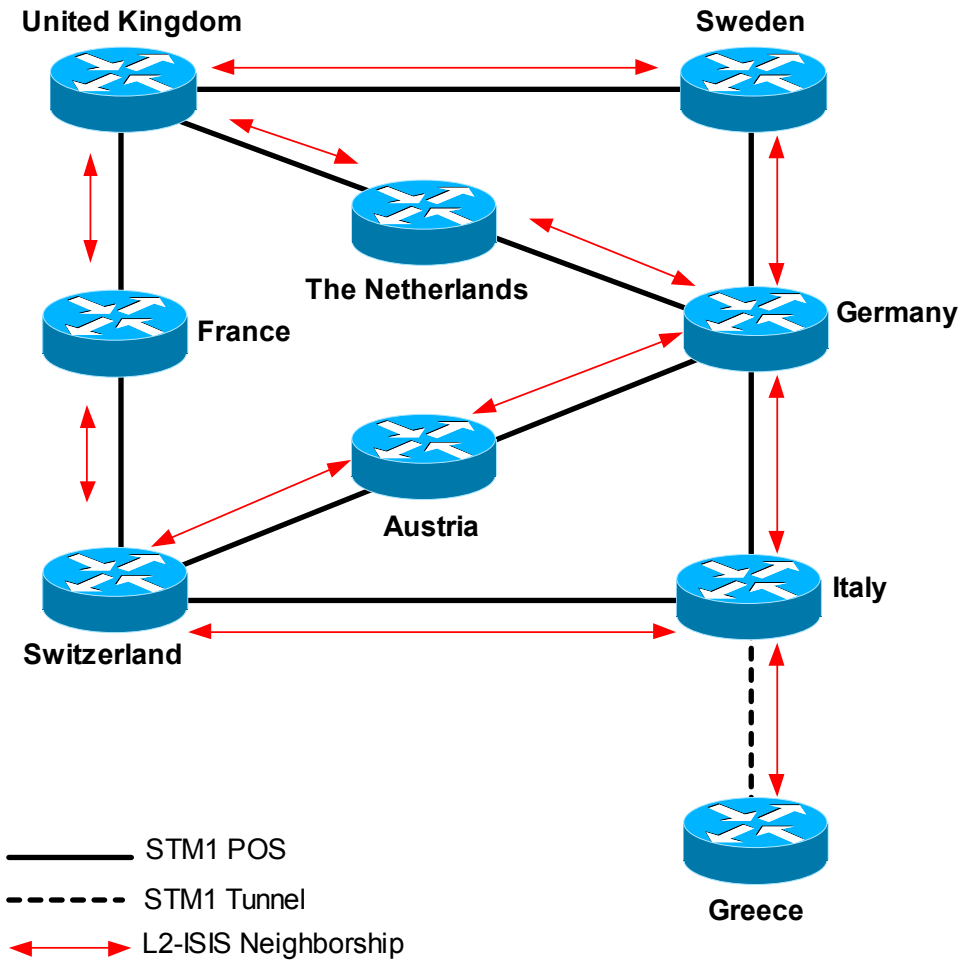
- **An IPv6 testbed for the European Community**
  - **3 year research project**
  - **European Commission funding: 9,5M €**
- **31 partners**
- **7 Work Packages**
- **www.6net.org**
- **Cisco 12400 and 7200 series**



Service Providers Market

- **Several Market segments**

  have to get an IPv6 prefix from their Regional Registry

  http://www.ripe.net/ripencc/mem-services/registration/ipv6/ipv6allocs.html

  Bootstrap process including plans for commercial services over the next 12 months

  – **IPv6 Internet eXchange (IX)**

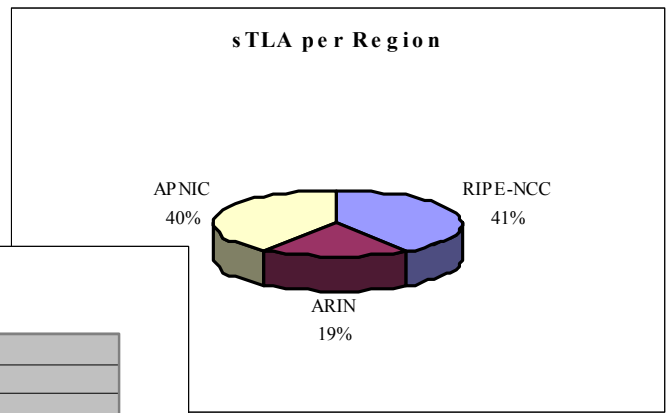
  – **Wireless**

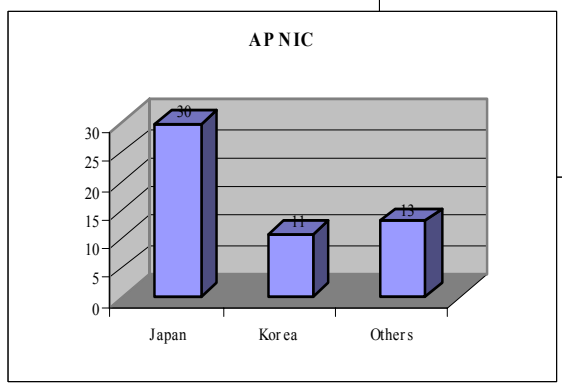
  – **Carriers**

  – **Regional ISP**

  – **Greenfield**

- **No easy ROI computation**

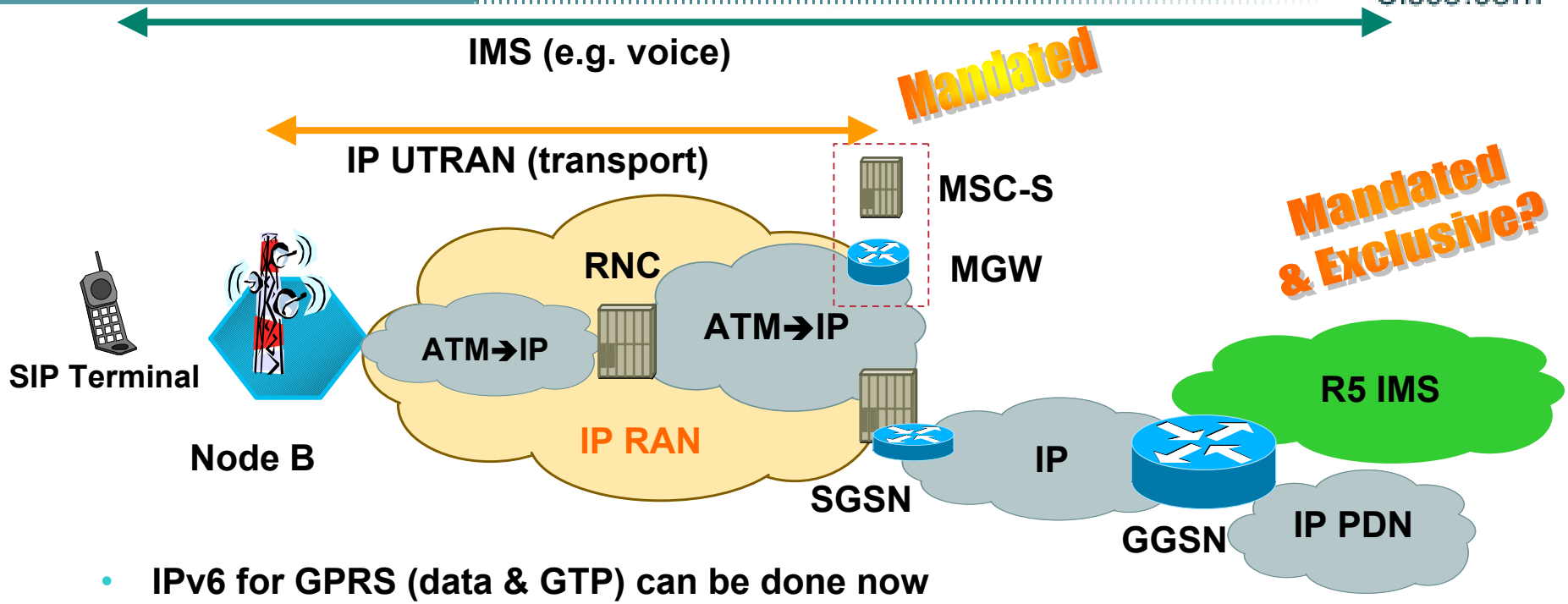




IPv6 & Wireless

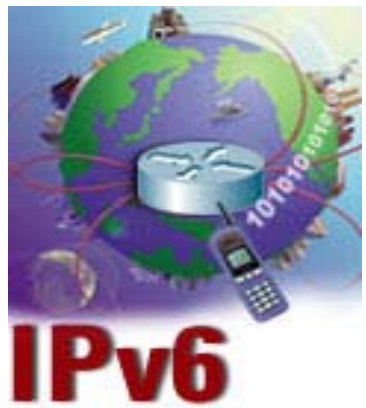
- **Market segments**
  - **Mobile phone industry goes to IP: 3GPP/3GPP2/MWIF**
  - **Vertical markets need the infrastructure: Police, Army, Fire Department, Transports**
  - **Some Public 802.11 deployment already run IPv6**
- **Key driver is the client's device, ie: handset**
  - **Eg. Symbian 7.0**
- **Before to open a commercial services, several phases happen**
  - **RFP/RFI – Integration – Trial – Deployment – Commercial**

IPv6 on 3G Networks



- IPv6 for GPRS (data & GTP) can be done now
  - Mentioned in 2G and 3G R3+ specifications
  - But no IPv6 (or dual stack) handset
- IPv6 is mandatory for Internet Multimedia Subsystem (IMS) in 3GPP Release 5
  - But R'5 slipped to November 02 for complete IMS definition
- IP UTRAN in R'5
  - Shall be IPv6, IPv4 optional and dual-stack recommended
  - Does not preclude ATM UTRAN

IPv6 – for an Ubiquitous Internet



- **Connect Everything to the Internet**
  - ***Simply (Plug & Play) and Safety***
- **Enjoy the Internet Everywhere & Anywhere**
  - ***Broadband, wireless,…***
  - ***China, India, Africa,…***
- **Play, Learn, and Live on the Internet for Everybody**
  - ***Peer to Peer & Client/Servers applications***
  - ***Global reachability as well as community of interest***
  - ***Home Information Services***
- **We need One Internet**
  - **Global communications enhances business, trade, research**

Questions?

How to get an IPv6 Address?

- **How to get address space?**

  Real IPv6 address space now allocated by APNIC, ARIN and RIPE NCC to ISP

APNIC	**2001:0200::/23**
ARIN	**2001:0400::/23**
RIPE NCC	**2001:0600::/23**

- **6Bone 3FFE::/16**
- **6to4 tunnels 2002::/16**
- **Enterprises will get their IPv6 address space from their ISP.**
- **Further information on www.cisco.com/ipv6**

IPv6 Prefix Allocations: APNIC
(whois.apnic.net) – April 2002

WIDE-JP-19990813 2001:0200::/35
NUS-SG-19990827 2001:0208::/35
CONNECT-AU-19990916 2001:0210::/35
NTT-JP-19990922 2001:0218::/35
KT-KR-19991006 2001:0220::/35
JENS-JP-19991027 2001:0228::/35
HINET-TW-20000208 2001:0238::/35
IIJ-JPNIC-JP-20000308 2001:0240::/35
IMNET-JPNIC-JP-20000314 2001:0248::/35
CERNET-CN-20000426 2001:0250::/35
INFOWEB-JPNIC-JP-2000502 2001:0258::/35
BIGLOBE-JPNIC-JP-20000719 2001:0260::/35
6DION-JPNIC-JP-20000829 2001:0268::/35
DACOM-BORANET-20000908 2001:0270::/35
ODN-JPNIC-JP-20000915 2001:0278::/35
TANET-TWNIC-TW-20001006 2001:0288::/35
SONYTELECOM-JPNIC-JP-20001207 2001:0298::/35
CCCN-JPNIC-JP-20001228 2001:02A8::/35
KORNET-KRNIC-KR-20010102 2001:02B0::/35
NGINET-KRNIC-KR-20010115 2001:02B8::/35
INFOSPHERE-JPNIC-JP-20010207 2001:02C0::/35
OMP-JPNIC-JP-20010208 2001:02C8::/35
ZAMA-AP-20010320 2001:02D0::/35
SKTELECOMNET-KRNIC-KR-20010406
2001:02D8::/35

HKNET-HK-20010420 2001:02E0::/35
DTI-JPNIC-JP-20010702 2001:02E8::/35
MEX-JPNIC-JP-20010801 2001:02F0::/35
SINET-JPNIC-JP-20010809 2001:02F8::/35
PANANET-JPNIC-JP-20010810 2001:0300::/35
HTCN-JPNIC-JP-20010814 2001:0308::/35
CWIDC-JPNIC-JP-20010815 2001:0310::/35
STCN-JPNIC-JP-20010817 2001:0318::/35
KREONET2-KRNIC-KR-20010823 2001:0320::/35
MANIS-MY-20010824 2001:0328::/35
SAMSUNGNETWORKS-KRNIC-KR-20010920
2001:0330::/35
U-NETSURF-JPNIC-JP-20011005 2001:0338::/35
FINE-JPNIC-JP-20011030 2001:0340::/35
QCN-JPNIC-JP-20011031 2001:0348::/35
MCNET-JPNIC-JP-20011108 2001:0350::/35
MIND-JPNIC-JP-20011115 2001:0358::/35
V6TELSTRAINTERNET-AU-20011211 2001:0360::/35
MEDIAS-JPNIC-JP-20011212 2001:0368::/35
GCTRJP-NET-20011212 2001:0370::/35
THRUNET-KRNIC-KR-20011218 2001:0378::/35

OCN-JP-20020115 2001:0380::/35
AARNET-IPV6-20020117 2001:0388::/35
HANINTERNET-KRNIC-KR-20020207
2001:0390::/35
HOTNET-JPNIC-JP-20020215 2001:0398::/35
MULTIFEED-JP-20020319 2001:03A0::/35
GNGIDC-KRNIC-KR-20020402 2001:03A8::/35
KMN-IPV6-20020403 2001:03B0::/35
SO-NET-JP-20020409 2001:03B8::/35

IPv6 Prefix Allocations: ARIN
(whois.arin.net) – April 2002

ESNET-V6 2001:0400::/35

VBNS-IPV6 2001:0408::/35

CANET3-IPV6 2001:0410::/35

VRIO-IPV6-0 2001:0418::/35

CISCO-IPV6-1 2001:0420::/35

QWEST-IPV6-1 2001:0428::/35

DISN-LES-V6 2001:0430::/35

ABOVENET-IPV6 2001:0438::/35

SPRINT-V6 2001:0440::/35

UNAM-IPV6 2001:0448::/35

GBLX-V6 2001:0450::/35

STEALTH-IPV6-1 2001:0458::/35

NET-CW-10BLK 2001:0460::/35

ABILENE-IPV6 2001:0468::/35

HURRICANE-IPV6 2001:0470::/35

EP-NET 2001:0478::/35

DREN-V6 2001:0480::/35

AVANTEL-IPV6-1 2001:0488::/35

NOKIA-1 2001:0490::/35

ITESM-IPV6 2001:0498::/35

IPV6-RNP 2001:04A0::/35

AXTEL-IPV6-1 2001:04A8::/35

AOLTIMEWARNER 2001:04B0::/35

WAYPORT-IPV6 2001:04B8::/35

PROTEL-RED-1-V6 2001:04C0::/35

UNINET-NETV6-1 2001:04C8::/35

IPv6 Prefix Allocations: RIPE-NCC (whois.ripe.net) – April 2002

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EU-UUNET-19990810 2001:0600::/35
DE-SPACE-19990812 2001:0608::/35
NL-SURFNET-19990819 2001:0610::/35
UK-BT-19990903 2001:0618::/35
CH-SWITCH-19990903 2001:0620::/35
AT-ACONET-19990920 2001:0628::/35
UK-JANET-19991019 2001:0630::/35
DE-DFN-19991102 2001:0638::/35
RU-FREENET-19991115 2001:0640::/35
GR-GRNET-19991208 2001:0648::/35
DE-ECRC-19991223 2001:0650::/35
DE-TRMD-20000317 2001:0658::/35
FR-RENATER-20000321 2001:0660::/35
EU-NACNET-20000403 2001:0668::/35
EU-EUNET-20000403 2001:0670::/35
DE-JIPPII-20000426 2001:0678::/35
DE-XLINK-20000510 2001:0680::/35
FR-TELECOM-20000623 2001:0688::/35
PT-RCCN-20000623 2001:0690::/35
SE-SWIPNET-20000828 2001:0698::/35
PL-ICM-20000905 2001:06A0::/35
BE-BELNET-20001101 2001:06A8::/35
SE-SUNET-20001218 2001:06B0::/35
IT-CSELT-20001221 2001:06B8::/35
SE-TELIANET-20010102 2001:06C0::/35
DK-TELEDANMARK-20010131 2001:06C8::/35
RU-ROSNIIROS-20010219 2001:06D0::/35
PL-CYFRONET-20010221 2001:06D8::/35
NL-INTOUCH-20010307 2001:06E0::/35
FI-TELIVO-20010321 2001:06E8::/35
SE-DIGITAL-20010321 2001:06F0::/35
UK-EASYNET-20010322 2001:06F8::/35
NO-UNINETT-20010406 2001:0700::/35
FI-FUNET-20010503 2001:0708::/35
UK-INS-20010518 2001:0710::/35
CZ-TEN-34-20010521 2001:0718::/35
ES-REDIRIS-20010521 2001:0720::/35
UK-VERIO-20010717 2001:0728::/35
AT-TELEKABEL-20010717 2001:0730::/35
HU-HUNGARNET-20010717 2001:0738::/35
DE-VIAG-20010717 2001:0740::/35
DE-ROKA-20010817 2001:0748::/35
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UK-NETKONECT-20010918 2001:0758::/35
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DE-CYBERNET-20011008 2001:0768::/35
IE-HEANET-20011008 2001:0770::/35
LT-LITNET-20011115 2001:0778::/35
DE-NORIS-20011203 2001:0780::/35
FI-SONERA-20011231 2001:0788::/35
EU-CARRIER1-20020102 2001:0790::/35
EU-DANTE-20020131 2001:0798::/35
DE-TELEKOM-20020228 2001:07A0::/35
FR-NERIM-20020313 2001:07A8::/35
DE-COMPLETEL-20020313 2001:07B0::/35
NL-BIT-20020405 2001:07B8::/35
DE-BELWUE-20020411 2001:07C0::/35