



IPV6 OVERVIEW

**ITU IPv6 and
IoT Workshop**

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HISTORY OF INTERNET

- 1969: Steve Crocker makes the first Request for Comment (RFC 1): “Host Software.”
- 1970: ARPANET hosts start using Network Control Protocol (NCP).
- 1971: 23 hosts connect with ARPANET (UCLA, SRI, UCSB, University of Utah, BBN, MIT, RAND, SDC, Harvard, Lincoln Lab, Stanford, UIUC, CWRU, CMU, NASA/Ames).
- 1972: InterNetworking Working Group (INWG) is created with Vinton Cerf as Chairman to address the need for establishing agreed-upon protocols. Telnet specification (RFC 318) is published.
- 1973: First international connections to the ARPANET are made at the University College of London (England) and Royal Radar Establishment (Norway). Bob Metcalfe’s Harvard PhD thesis outlines the idea for Ethernet. File transfer specification (RFC 454) is published.
- 1976: Queen Elizabeth II sends an email.
- 1981: Minitel (Teletel) is deployed across France by France Telecom.

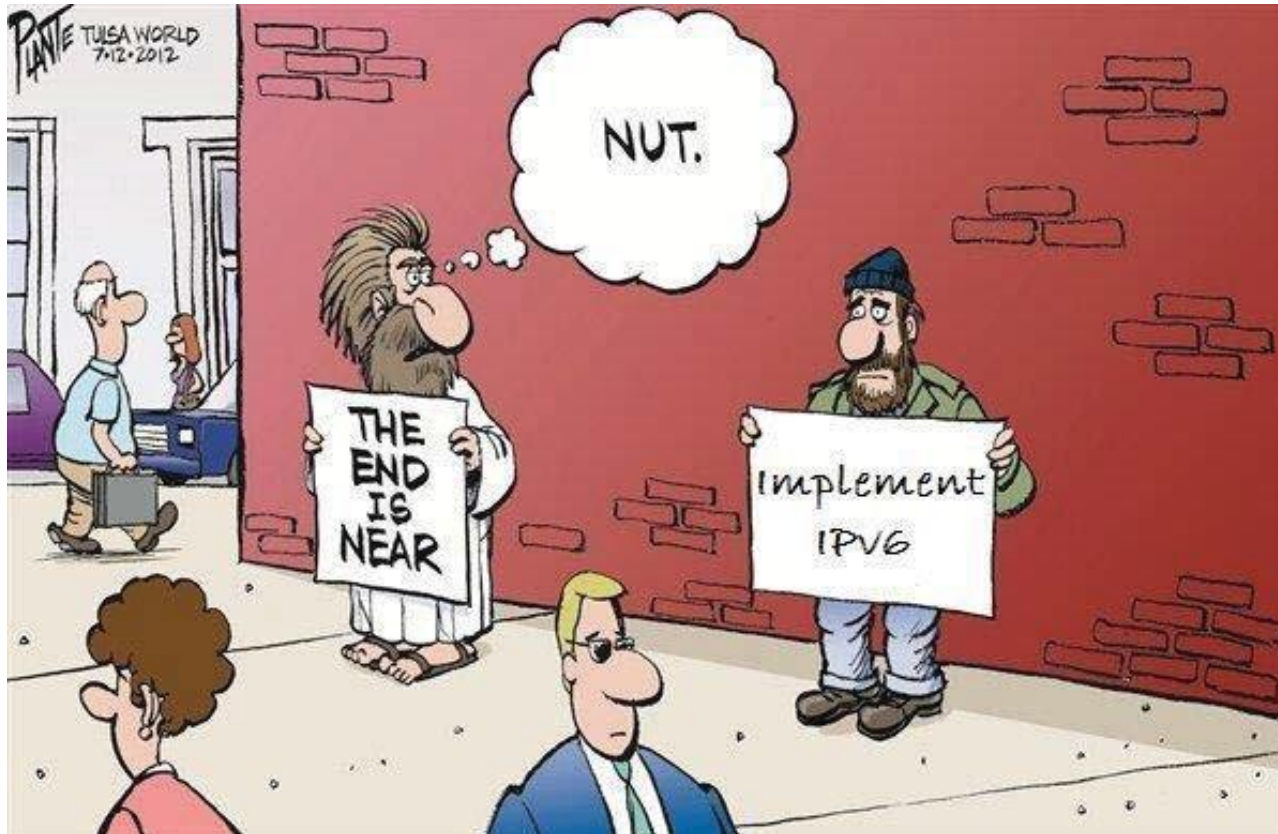
HISTORY OF INTERNET

- 1983: The cutover from NCP to TCP/IP happens on January 1.
- 1984: The number of hosts breaks 1,000.
- 1987: An email link is established between Germany and China using CSNET protocols, with the first message from China sent on September 20. The thousandth RFC is published. The number of hosts breaks 10,000.
- 1988: An Internet worm burrows through the Net, affecting 10 percent of the 60,000 hosts on the Internet.
- 1989: The number of hosts breaks 100,000. Clifford Stoll writes *Cuckoo's Egg*, which tells the real-life tale of a German cracker group that infiltrated numerous U.S. facilities.
- 1991: The World Wide Web (WWW) is developed by Tim Berners-Lee and released by CERN.
- 1992: The number of hosts breaks 1,000,000. The World Bank comes online.

HISTORY OF INTERNET

- 1993: The White House comes online during President Bill Clinton's time in office. Worms of a new kind find their way around the Net—WWW Worms (W4) are joined by Spiders, Wanderers, Crawlers, and Snakes.
- 1994: Internet shopping is introduced; the first spam mail is sent; Pizza Hut comes online.
- 1995: The Vatican comes online. Registration of domain names is no longer free.
- 1996: 9,272 organizations find themselves unlisted after the InterNIC drops their name service as a result of their not having paid their domain name fees.
- 1997: The 2,000th RFC is published.

HISTORY OF INTERNET



IS IPV6 SIMILAR TO Y2K?



What is the 2000 problem @ Y2K?

“The **Year 2000 problem** (also known as the **Y2K problem**, the **millennium bug**, the **Y2K bug**, or simply **Y2K**) was a notable problem for both digital (computer-related) and non-digital documentation and data storage situations which resulted from the practice of abbreviating a four-digit year to two digits.” **Wikipedia**.



IPv6?

“..the fact that Internet Protocol version 4(**IPv4**) addresses **are running out** and calls your attention to what we are doing about it.” **American Registry for Internet Numbers (ARIN)**.

What people say about Y2K: “..estimated at between \$100 billion and \$600 billion, **was mostly wasted..**” Cecil Adams, Connect Savannah.

What people say about IPv6: “ISPs, enterprises and network equipment vendors report that there are ``**no concrete business drivers for IPv6.**” Internet Society (ISOC).

GLOBAL INTERNET MANAGEMENT

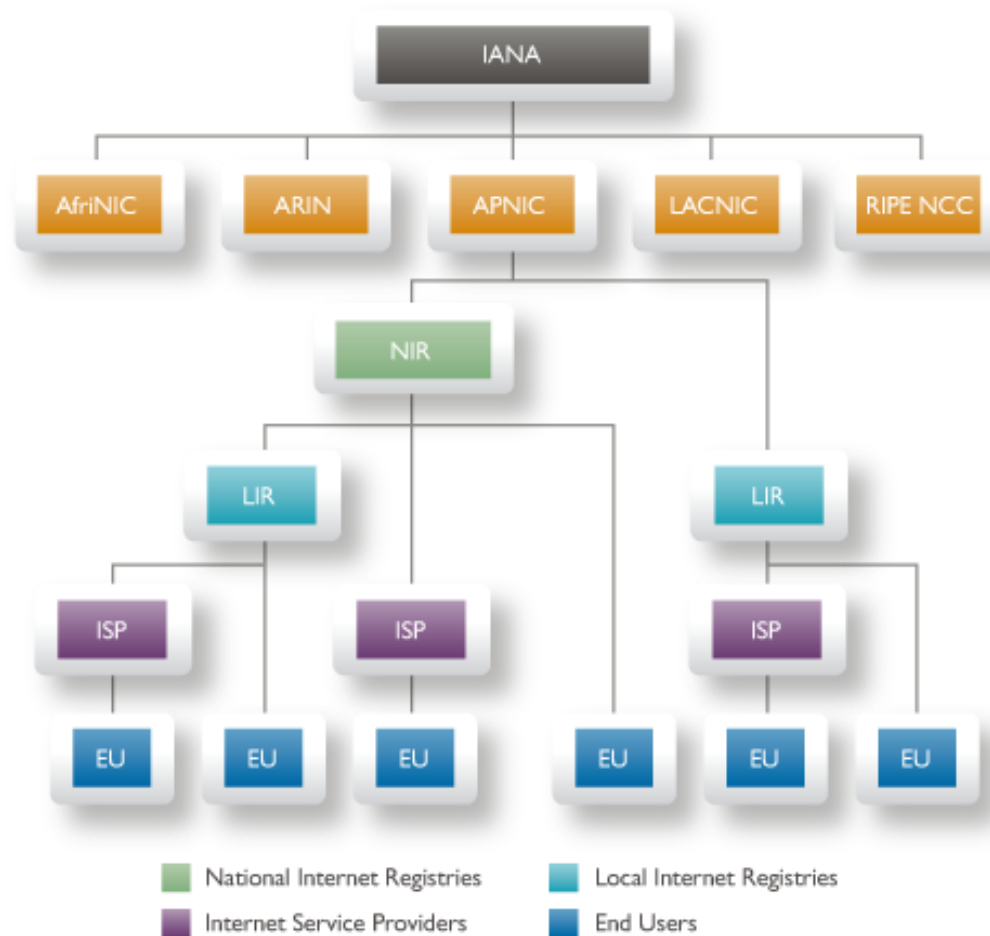
- ❑ Several organizations form a framework for global Internet governance.
 - ❑ Internet Assigned Numbers Authority (IANA)
 - ❑ 5 Regional Internet Registries (RIR)
- ❑ The 5 RIRs are geographical distributed



ROLES OF AN RIR

- ❑ IPv6 address allocation, management, and deployment measurement
- ❑ Research, education, and information distribution about IPv6
- ❑ Community outreach and liaison.
- ❑ Representation in forums, such as the ITU, OECD, the Internet Governance Forum (IGF), and ICANN

WHAT IS THE HIERARCHY FOR THE GLOBAL ADDRESS ALLOCATION?



ISSUES WITH IPV4

Can IPv4 address be depleted?

Answer: **Yes & No**

<http://www.iana.org/assignments/ipv4-address-space/>

| | | | | | | | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
| 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 |
| 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 |
| 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 |
| 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 |
| 96 | 97 | 98 | 99 | 100 | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 |
| 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 | 121 | 122 | 123 | 124 | 125 | 126 | 127 |
| 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 | 141 | 142 | 143 |
| 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 |
| 160 | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 |
| 176 | 177 | 178 | 179 | 180 | 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 |
| 192 | 193 | 194 | 195 | 196 | 197 | 198 | 199 | 200 | 201 | 202 | 203 | 204 | 205 | 206 | 207 |
| 208 | 209 | 210 | 211 | 212 | 213 | 214 | 215 | 216 | 217 | 218 | 219 | 220 | 221 | 222 | 223 |
| 224 | 225 | 226 | 227 | 228 | 229 | 230 | 231 | 232 | 233 | 234 | 235 | 236 | 237 | 238 | 239 |
| 240 | 241 | 242 | 243 | 244 | 245 | 246 | 247 | 248 | 249 | 250 | 251 | 252 | 253 | 254 | 255 |

Last updated: April 2011

 Unallocated

 Allocated

IPV4 ADDRESSES ARE RUNNING OUT.

- ❑ The big blocks of IPv4 addresses that are assigned by IANA was exhausted around April 2011.
- ❑ RIRs running out IPv4 that cause ISPs, wireless carriers, governments, and major corporations suffers from lack of IPv4 address
- ❑ Old address blocks will have to be better managed, and split the old address blocks even further, i.e. further subnets
 - ❑ This causes more routing fragmentation and performance issues.
- ❑ Organizations try to extend IPv4 lifetime using CIDR and NAT

IPCALYSE



https://inetcore.com/project/ipv4ec/images/ipv4ec_iana_en.png

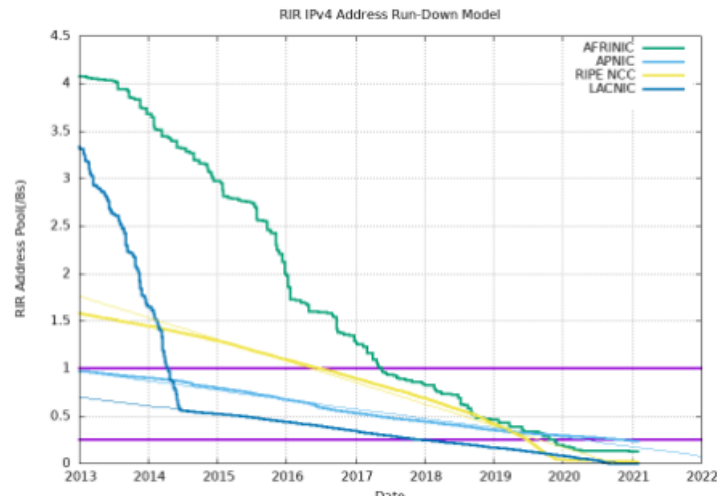
IPV4 ADDRESS REPORT

This report generated at 31-Jan-2021 08:00 UTC.

IANA Unallocated Address Pool Exhaustion:
03-Feb-2011

Projected RIR Address Pool Exhaustion Dates:

| RIR | Projected Exhaustion Date | Remaining Addresses in RIR Pool (/8s) |
|-----------|---------------------------|---------------------------------------|
| APNIC: | 19-Apr-2011 (actual) | 0.2357 |
| RIPE NCC: | 14-Sep-2012 (actual) | 0.0199 |
| LACNIC: | 10-Jun-2014 (actual) | 0.0001 |
| ARIN: | 24 Sep-2015 (actual) | 0.0003 |
| AFRINIC: | 31-Dec--1 | 0.1294 |

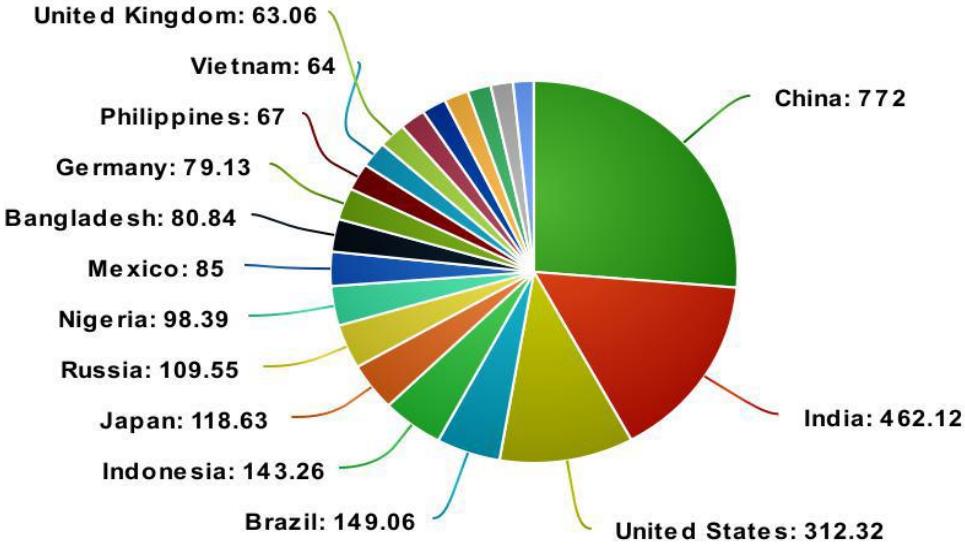


<https://www.potaroo.net/tools/ipv4/index.html>

GLOBAL INTERNET USER GROWTH

Top 20 Countries With Most Internet Users

whichcountry.co



CIDR AND NAT

❑ Classless Inter Domain Routing

- ❑ Class A, B and C had network/host boundary.
- ❑ CIDR puts the boundary on any bit.

❑ Network Address Translation

- ❑ Connection from private block is made.
- ❑ Allocate public address/ports, record in rules.
- ❑ Outgoing packets have private address and port replaced.
- ❑ Incoming packets have public address and port replaced.
- ❑ NAT made it possible to use fewer addresses. Idea: rewrite addresses using rules. Allows use of private address space.

IPV4 AND IPV6 BOTTOM LINE

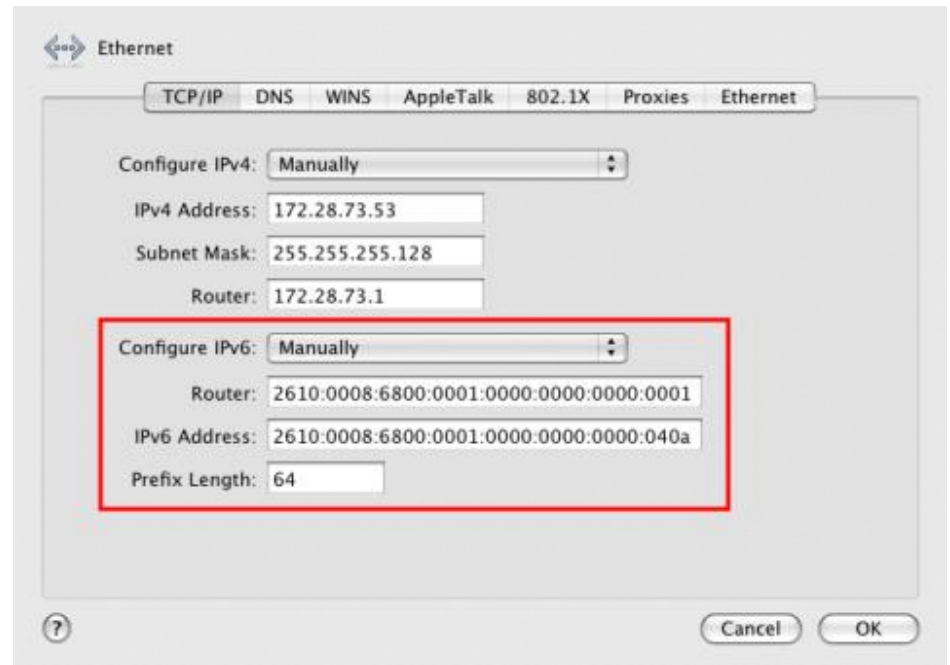
- ❑ We're running out of IPv4 address space.
- ❑ IPv6 must be adopted for continued Internet growth.
- ❑ IPv6 is not backwards compatible with IPv4.
- ❑ We must maintain IPv4 and IPv6 simultaneously for many years.
- ❑ IPv6 deployment has begun.

WHAT IS IPV6?

Developed in the 1990s

IPv6 is...?

IPv1, v2, v3, v5.. IPv9?



| Features | IPv4 | IPv6 |
|----------|-------------------------|---|
| Size | 32 bits | 128 bits |
| Space | 4,294,967,296 | 340,282,366,920,938,463,463,374,607,431,768,211,456 |
| Notation | dotted decimal notation | hexadecimal with colons |

GOALS IN DESIGNING IPV6

- Larger Address Space
- Better Management of Address Space
- Elimination of “Addressing Kludges”
- Easier TCP/IP Administration
- Modern Design for Routing
- Better Support for Multicasting
- Better Support for Security
- Better Support for Mobility

KEY FEATURES OF IPV6

- Better extensibility (extension headers).
- Built in autoconfiguration (DHCP/PPP still possible).
- Mandatory IPsec.
- More integrated multicast.
- ARP replaced with Neighbour Discovery.

HOW IPV4 AND IPV6 CAN CO-EXIST

- ❑ The Internet current must run both IP versions (IPv4 & IPv6) at the same time. (When done on a single device, this is called the “dual-stack” approach.)
- ❑ Today aggressive deployment is already underway: Today, there are organizations attempting to reach your mail, web, and application servers via IPv6...

COMMON MISCONCEPTIONS

- The introduction of IPv6 puts our current IP infrastructure—our networks and services—at risk.
- The IPv6 protocol is immature and hasn't proven that it stands the test of time or whether it is capable of handling the requirements.
- The costs of introducing IPv6 are too high
- With Stateless Address Autoconfiguration, we will not be able to control or monitor network access

COMMON MISCONCEPTIONS.....

- Our Internet Service Provider (ISP) does not offer IPv6 services, so we can't use it.
- It would be too expensive and complex to upgrade our backbone.”
- It would be too complex and expensive to port all of our applications to IPv6.
- We have enough IPv4 addresses; we don't need IPv6.

CAN WE USE IPV6 NOW?



CAN WE USE IPV6 NOW?



FreeBSD®



CentOS



ubuntu

CAN WE USE IPV6 NOW?

Source - <http://www.sfc.wide.ad.jp/InternetCAR/about/more.html>

InternetCAR



Kitchen Appliances



Botanics v6

FIVE STEPS ON THE PATH TO IPV6

- ❑ **Focus on IP address design and management.**
 - ❑ Start the IPv6 prefix assignment application process now. Stop worrying about conserving addresses and start thinking about adding meaning to individual hex digits.

- ❑ **Update network support systems**
 - ❑ Do you have an internal DNS infrastructure? Can nameservers support both IPv4 A and IPv6 AAAA records? If they're dual stacked, how do they respond to a name query when there are both IPv4 and IPv6 addresses assigned?

- ❑ **Budget for security updates and expertise**
 - ❑ End-to-end IPsec notwithstanding, security systems tend to be the problem children in IPv6 deployments. Not everything will survive the transition, so allocate some funds here.

FIVE STEPS ON THE PATH TO IPV6

❑ Understand the lingo

- ❑ Tools for monitoring, logging, alarms, configuration management, and change management have to understand IPv6, not speak it.

❑ Have end-to-end training

- ❑ Don't limit IPv6 education to IT. Going all-IPv6 positions your company as a technology leader. Make sure customer-facing personnel can tell the story.

HARDWARE AND SOFTWARE SUPPORT FOR IPV6



List of IPv6 enabled vendor/hardware/software list

1. http://www.ipv6ready.org/phase-1_approved_list
2. <http://www.ipv6-to-standard.org/>
3. http://www.deepspace6.net/docs/ipv6_status_page_apps.html
4. http://en.wikipedia.org/wiki/Comparison_of_IPv6_application_support
5. <http://www.ipv6forum.com/>



IPv6 Standards

IPv6 Ready Logo Program

<http://www.ipv6ready.org>



IPv6 Education

Certification Logo Program





THANK YOU