



IPv6 Fact Sheet

Introduction

Internet Protocol (IP) addresses are the unique numeric identifiers assigned to every computer or device that is connected to the Internet. So while we use names, for example, www.icann.org, to identify ICANN's website, the computers themselves don't actually talk to the name, they talk to the unique number associated with that name. That number is the IP address.

The original Internet Protocol, **IPv4**, was developed in the early 1980s and served the global Internet community for more than three decades. IPv4 had a capacity of just over four billion IP addresses, which was enough for the experiment that the Internet started as in the 1980s. But IPv4 is a finite space, and after years of rapid Internet expansion, the pool of available unallocated addresses for IPv4 has been fully allocated to Internet services providers (ISPs) and users.

Only 3.7 billion IPv4 addresses are usable by ordinary Internet access devices. The others are used for special protocols, like IP Multicasting. Today, none of those 3.7 billion IPv4 addresses remain unallocated.

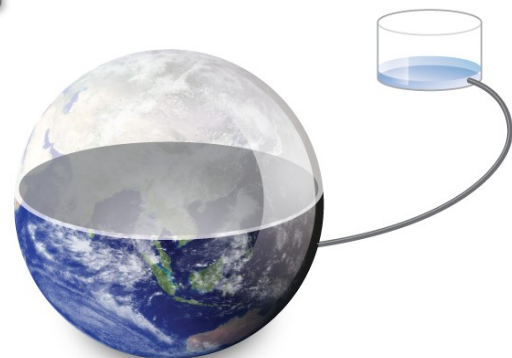
There are almost seven billion people on the planet, and many of those people want to have more than one device that has network connectivity. That's why we need **IPv6**, the next generation of the Internet protocol that has a massively bigger address space than IPv4. Compared to IPv4's 32-bit address space of four billion addresses, IPv6 has a 128-bit address space, which is 340 undecillion addresses—that's not a number you hear every day!

Over the past year, major content providers and access networks have started offering IPv6 services to ordinary Internet users.

Because IPv6 is so large, it should last us considerably longer than the 30 years we have gotten so far got from IPv4. ISPs generally assign many thousands of network segments, called a /64, to a single subscriber connection at home, school, or business. Giving every person on Earth a connection with a /48 would barely dent the available IPv6 address space. In fact, while the Earth's orbit around the Sun is only big enough to contain 3,262 Earths, it would take 21,587,961,064,546 Earths like ours to use all the addresses in the part of the IPv6 space we now use. That's a lot of addresses for a rapidly growing Internet!



IPv4 capacity



What Do IP Addresses Look Like?

Those numbers in IPv4, the fourth version of the Internet protocol, look like this: 192.0.2.53. IPv6 addresses are written in hexadecimal, which can fit more information into fewer digits. Colons separate the segments of IPv6 addresses instead of dots; for example, 2001:0db8::53. In fact, when you see two colons side by side in an IPv6 address, you know that all the segments between them contain only zeros. You would have to expand the example address to 2001:0db8:0000:0000:0000:0000:0053 without those colons.

How are IPv6 Addresses Distributed?

IP addresses are distributed in a hierarchical system. As the Internet Assigned Numbers Authority (IANA) functions operator, ICANN allocates IP addresses to the five Regional Internet Registries (RIRs) around the world, and the RIRs then allocate smaller IP address blocks to ISPs and other network operators. From there, the ISPs and other Internet operators assign the addresses to the individual Internet connections used by most computer users.

ICANN's Board of Directors ratified the policy governing the allocation of IPv6 address space to RIRs in September 2006. The key policy elements are:

- RIRs receive IPv6 blocks in /12 units
- RIRs can receive an additional block when they have used 50 percent of their existing allocation.
- The number of /12 units RIRs receive is based on a formula established by IANA.

What is a /12 unit?

A /12 is a block 1,048,576 times the size of the minimum allocation made by RIRs to ISPs and other network operators. Some ISPs run very large networks and receive blocks thousands of times larger than the minimum, but a /12 allows for at least tens of thousands of allocations to organizations running networks before the block is fully allocated.

To give you a sense of how many IP addresses are in a /12 block: All five RIRs were allocated a /12 of IPv6 address space in 2006. As of the end of 2010, none of them had requested additional address space.

The Policy details

The IPv6 policy contains a formula for determining when an RIR qualifies for additional IPv6 address space and how much it can receive. To qualify for additional IPv6 address space, the RIR must have less than 50 percent of a /12 left, or it must not have

enough space to meet its members' needs for the coming nine months.

Defining the variables

The variables in the policy's formula are *available space* and *necessary space*. All an RIR's IPv6 address space is considered available for allocation unless it is a *reservation* that will expire within the next three months, or is fragmented.

The policy's formula considers recent history and future projects to determine how much address space an RIR might need in the future. The formula works this way: First, simple averaging is used to determine the number of addresses allocated per month during the past six months. This average helps determine how much space an RIR is expected to need in the near term. If the RIR's *available space* is not enough for the next nine months of allocations, the RIR qualifies for additional address space.

Special needs

The policy also allows special facts to be taken into account when calculating how much additional IPv6 address space an RIR qualifies to receive. They might apply if there was a new regional policy or external factors "such as new infrastructure, new services within the region, technological advances or legal issues." In all cases, the RIR must explain the change in consumption rate or the impact of the new policy, or must provide an analysis of the external factors. If an RIR's data is not sufficiently clear, it can be questioned.

The calculation

Once this information is collected, the calculation can go forward:

Necessary Space = Average Number of Addresses Allocated Monthly during the Past 6 Months x Length of Period in Months

Although each RIR provides all these data to ICANN's IANA Department with its request, most of the data are published every day in a

standard format log file, and are mirrored on the IANA FTP site. But whether the calculation is done by ICANN staff or by an observer, using the data published by the RIRs makes calculating the results simple. The numbers can be entered in a spreadsheet that calculates how much space the RIR qualifies for based on the formula.

Who Sets These Policies?

These distribution policies are developed in the RIRs' regional public policy forums. The process is very similar to the consensus-based, bottom-up approach used to develop other ICANN policies, which are typically guided by ICANN's supporting organizations. The RIRs allocate addresses to ISPs and other network operators according to the policies developed in these public policy forums in which representatives from industry, governments and civil society participate.

These forums are open to participation by anyone with access to email. Discussions happen via open, archived mailing lists and at open meetings. RIR membership is not required to fully participate in the policy development process.

Any individual can submit a global policy proposal. The proposal can be submitted to an individual RIR's policy-making process, like any other regional policy proposal, or they can be submitted directly to the Address Supporting Organization Address Council (ASO AC). The ASO AC is the body that makes sure a global policy proposal has properly reached consensus in all five RIR regions before the proposal is sent to the ICANN Board of Directors to be ratified.

The ASO AC can be contacted through the addresses listed on its web site at: <http://aso.icann.org/contact/>.

Are the Internet and its technology ready for the transition to IPv6?

Most of the existing systems that we are using

today actually support IPv6 already. So the laptops that we have in front of us support IPv6 and have done so for quite some time. IPv6 is not dramatically different on the network from IPv4, and those machines that we were using 30 years ago were capable of IPv4. So if the kind of computers that were running thirty years ago could run IPv4, then pretty much any cell phone (or probably pocket calculator) could run IPv6 today, if you really wanted it to.

How can I get IPv6 connectivity?

If you're an average home user, it's up to your ISP to initiate the transition from IPv4 to IPv6 on your network. In most cases, you won't have to do anything. If you are required to change something, such as your Internet router, your ISP will let you know.

Which RIR runs the open policy forum for my region?

RIRs serve regions of roughly continental scope, with one RIR per continent. A list of regions and places served can be found on the NRO web site at <http://www.nro.net/about-the-nro/regional-internet-registries>.

Where can I find out more about IP address management?

Go to <http://audio.icann.org/icann-start-05-ipv6-20100429-en.mp3> to listen to an e-learning podcast about IPv6. You can read its transcript at <http://icann.org/en/learning/transcript-icann-start-05-29apr10-en.pdf>.

More information about IP address management can also be obtained from ICANN, the RIRs and the Address Supporting Organization's Address Council:

- <http://www.icann.org>
- <http://www.nro.net>
- <http://aso.icann.org>