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Introduction to IPv6

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The future of the Internet

According to experts, the Internet as we know it will face a serious problem in a few years. Due to its rapid growth and the limitations in its design, there will be a point when no more free addresses are available for connecting to new hosts. At that point, no more new web servers can be set up, no more users can sign up for accounts at ISPs, and no more new machines can be set up to access the web or participate in online games -- some people might call this a serious problem.

Several approaches have been made to solve the problem. A very popular approach is to *not* assign a worldwide unique address to every user's machine, but rather to assign them "private" addresses, and hide several machines behind one official, globally unique address. This approach is called "Network Address Translation" (NAT, also known as "IP masquerading"). It has problems, as the machines hidden behind the global address can't be addressed, and as a result of this, opening connections to them -- which are used in online gaming, peer-to-peer networking, etc. -- is not possible. For a more in-depth discussion of the drawbacks of NAT, see [RFC3027].

A different approach to the problem of Internet addresses getting scarce is to abandon the old Internet protocol with its limited addressing capabilities, and use a new protocol that does not have these limitations. The protocol -- or actually, a set of protocols -- used by machines connected to form today's Internet is known as the TCP/IP (Transmission Control Protocol, Internet Protocol) suite, and version 4 currently in use has all the problems described above.

Switching to a different protocol version that does not have these problems of course requires for a "better" version to be available. And actually, there is a better version. Version 6 of the Internet Protocol (IPv6) fulfills future demands on address space, and also addresses other features such as privacy, encryption, and better support of mobile

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Assuming a basic understanding of how today's IPv4 works, this article is intended as an introduction to the IPv6 protocol. The changes in address formats and name resolution are covered. After that, it is shown how to use IPv6 -- even if your ISP doesn't offer it -- by using a simple-yet-efficient transition mechanism called 6to4. The goal is to to get online with IPv6, giving example configurations for BSD Unix and Linux.

What good is IPv6?

When telling people to migrate from IPv4 to IPv6, the question you usually hear is "Why?". There are actually a few good reasons to move to the new version:

- Bigger address space
- Support for mobile devices
- Built-in security

Related Reading:

DNS and Bind, 4th Edition
By Paul Albitz & Cricket Liu
4th Edition April 2001
0-596-00158-4, Order Number: 1584
622 pages, $44.95

Bigger address space

The bigger address space IPv6 offers is the most obvious enhancement it has over IPv4. While today's Internet architecture is based on 32-bit wide addresses, the new version has 128-bit technology available for addressing. Thanks to the enlarged address space, workarounds like NAT don't have to be used anymore. This allows full, unconstrained IP connectivity for today's IP-based machines as well as upcoming mobile devices like PDAs and cell phones -- all will benefit from full IP access through GPRS and UMTS.

Mobility

When mentioning mobile devices and IP, it's important to note that a special protocol is needed to support mobility, and implementing this protocol -- called "Mobile IP" -- is one of the requirements for every IPv6 stack. Thus, if you have IPv6 going, you have support for roaming between different networks, with global notification when you leave one network and enter the other one. Support for roaming is possible with IPv4 too, but there are a number of hoops that need to be jumped in order to get things working. With IPv6, there's no need for this, as support for mobility was one of the design requirements for IPv6. See [RFC3024] for some more information on the issues that need to be addressed with Mobile IP on IPv4.

Security

Besides support for mobility, security was another requirement for the successor to today's Internet Protocol version. As a result, IPv6 protocol stacks are required to include IPsec. IPsec allows authentication, encryption, and compression of IP traffic. Except for application-level protocols like SSL or SSH, all IP traffic between two nodes can be handled without adjusting any applications. The benefit of this is that all applications on a machine can benefit from encryption and authentication, and that policies can be set on a per-host (or even per-network) basis, not per application/service. An introduction to IPsec with a roadmap to the documentation can be found in [RFC2411], the core protocol is described in [RFC2401].

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