

# IPv6

## Executive Briefing

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# Executive Briefing on the New Version of the Internet Protocol

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## WHO SHOULD READ THIS BRIEFING?

This briefing is for non-technical board directors and senior management at organisations for which information technology is business critical. It focuses on the implications for your business, but those in technology roles may also find it a useful resource for discussing the issues with non-technical colleagues.

## ABSTRACT

The Internet equivalent of a telephone number is known as an Internet Protocol address, or IP address for short. Just as you need someone's telephone number to call him or her, network technology needs an address when instructed to dispatch a packet of data from one computer to another.

Today, the Internet mostly uses IP version 4 (IPv4) but this is now reaching the limits of its capacity. IPv6 is the next generation protocol that provides vastly expanded address space, allowing the Internet to grow to many billions of times its current size.

You should consider the implications of this and decide what action your organisation needs to take to prepare for migration to IPv6. Advantages of making your organisation visible over IPv6 include:

- Make yourself accessible to those customers and other stakeholders using IPv6
- Integrate your adoption of IPv6 into your existing investment and renewal programme to minimise long-term costs
- Guarantee your ability to grow in the future; and
- Demonstrate that you are a forward-looking organisation, planning for the future.

## Happy 40<sup>th</sup> birthday!

The Internet community celebrated the network's 40<sup>th</sup> birthday October 2009. Time for a mid-life crisis you might ask? Not here. Usage statistics<sup>1</sup> estimate nearly 1.7 billion people have Internet access at the end of 2009; that's one in four people on the planet and three times the number at the turn of the Century.

We're growing the Internet infrastructure continuously to meet demand and do more and more with it. In business. In government. In life. The massive explosion of devices we're connecting to the Internet is the crux of this issue.

Until just a few years ago most people considered Internet access to entail sitting down at a computer, yet of course the mass market has now embraced mobile phone Internet access wholeheartedly. And whether you've heard of it or not, the so-called Internet of Things is about to arrive in a big way (see "The Internet of Things" box).

## How can I reach you?

The Internet isn't the first network to grow beyond expectations. Remember the "Big Number" marketing campaign in the UK in 2000? It communicated the change of telephone numbers in several major cities, driven by the need to provide more numbers.

You need someone's number to call him or her. You need a physical address to tell the cab driver where to take you. Similarly, when instructed to dispatch a packet of data from one computer (or "thing") to another, the communications technology that routes the network traffic needs an address.

## INTERNET PROTOCOL ADDRESSES

The Internet equivalent of a telephone number is known as an Internet Protocol address, or IP address for short.

## Where to?

Right now, the answer to that question could be any one of around 4.3 billion addresses. That's how many addresses the most widely deployed version of the Internet Protocol can accommodate. This version is known as version 4, or IPv4 for short, and has been applied since the early 1980s.

So you can see where this is going. We're running out of addresses. Three decades ago, before the World Wide Web, before computers arrived in the workplace let alone homes, and a long time before mobile phones, Google, Skype, Facebook or anything involving "things", 4.3 billion sounded quite a lot. But it doesn't any more.

We now see that the massive growth of the Internet means that we will no longer be able to meet demand beyond 2012. That is why a new protocol, IPv6, was developed (see "Internet Protocol version 6" box).

Like IPv4, IPv6 is free. But there is a snag; IPv6 and IPv4 are not immediately interoperable.

## *The Internet of Things*

This term is exactly what it says on the tin... a network of objects, or things, not typically connected to the network at present. This includes things such as central heating, cars, lighting, power distribution, temperature and other environmental sensors, clothes and even fast moving consumer goods packaging.

The Internet of Things will have as much impact on the way we live, the way we do business and the way we run government, as the Internet has to date. If you'd like to read more about some of the ways it might do so, Intel paints its vision<sup>2</sup> under the title "15 billion", a name taken from its forecast that 15 billion devices will be connected by 2015.

## *Internet Protocol version 6*

As the legendary ZX Spectrum hit the shops in 1982, the Internet Systems Consortium<sup>3</sup> notes that there were just 235 Internet hosts. Not much of a strain on those 4.3 billion IPv4 addresses then. But now the organisations responsible for allocating IP addresses expect to have exhausted unallocated IPv4 addresses towards the end of 2011 or some time in 2012.

How does IPv6 compare to IPv4?

In terms of the number of addresses, rather than prefixing a digit or two to the IPv4 addresses as we've done for telephone numbers in the past, IPv6 actually has addresses four times the length of IPv4. That means IPv6 has approximately  $3.4 \times 10^{38}$  addresses, or to be precise:

340,282,366,920,938,463,463,374,607,431,768,211,456.

That should accommodate Intel's 15 billion vision twenty billion billion billion times over!

## **What does all this mean for you?**

The Internet does not stop working when we exhaust unallocated IPv4 addresses. Your own network carries on working, and the networks of your customers, suppliers and partners keep humming. Indeed, the Millennium Bug, so-called Y2K, was far more exciting from a doomsday perspective!

But you, your organisation and your technical team cannot ignore IPv6. It may be hard to see why given the paragraph above and the other priorities competing for your time and resources, but despite the absence of an equivalent to British Telecom deciding when to switch off the old numbers, there are some serious issues at play here. There are motivations to adopt IPv6 based on avoiding disadvantage, and motivations based on IPv6's technical advantages.

## AVOID DISADVANTAGE

The critical question you and your colleagues need to answer is:

***Would we like external systems running IPv6 to see us, to be able to address us just as they can today over IPv4?***

Would you like your partners, suppliers and customers to be able to work with you over IPv6? To email you over IPv6? To view your website over IPv6? To access your Web services (as appropriate) over IPv6? Assuming that some of your employees will want to interact with your systems from their own devices, would you like to facilitate these over IPv6? Or more simply, would you like to avoid any disadvantage of effectively shutting the door on anyone looking for you, looking to work with you, over IPv6?

Some people might assert that there's no need to bother with IPv6 whilst everyone continues to have IPv4 capability. But that's a little like saying why bother with IPv4 when people can telephone or write to us? IPv6 is here, now. It is unavoidable and there are no excuses (see "What's NAT?" box). IPv6 will replace IPv4 in the long-term.

Do you really want your organisation to respond blankly in the interim, to have no response at all, to anyone looking for you over IPv6?

Your technical team and service providers will place devices at your gateways to do the translation, and they will make sure your website is hosted in a manner that allows it to be served over IPv4 and IPv6. IPv6 addresses are free, and you only need translation servers at your gateways, so this is a low cost project.

The IT technical community describes the facility to work over both IPv4 and IPv6 as dual stacked. You will now appear dual stacked to the rest of the world even though your internal networks remain IPv4.

## *So where do domain names come in?*

IP addresses aren't immediately memorable, particularly the much lengthier IPv6 ones. So whilst computers love numbers, humans prefer names. For example, which of these would you rather work with personally?

**http://www.ripe.net** (the domain name)

Or **http://193.0.19.25** (the IPv4 address)

Or **http://2001:610:240:11::c100:1319** (the IPv6 address)?

This is somewhat akin to storing friends' telephone numbers under their name in your mobile phone, but there is a difference. Whereas you have to update a friend's record in your contacts list manually should they change their number, owners of domain names manage the association of the domain names with IP addresses themselves.

When you use a domain name, for example in your browser or in an email address, the name is looked up in the domain name system to find the IP address required to route your query to the right place, and this is all invisible to the typical Internet user.

## **COMPETITIVE ADVANTAGE**

To repeat the point, making yourself visible over IPv6 avoids the disadvantage that some of your customers might not be able to see you in the future. But given that the transition is inevitable in the longer term, perhaps you should consider grasping a competitive advantage by running your internal networks with IPv6 sooner rather than later? What are those advantages?

Obviously, if you are in the technical services industry yourself, then dual stacking all your systems sooner than later means you'll be able to differentiate from your also-ran competitors. You will be perceived as more capable and diligent. You will be able to respond more quickly to future invitations to tender that demand IPv6 capability; no last minute rush to qualify, consuming time and

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effort that should instead be focused on converting the business. Moreover, imagine the confidence you can project to potential clients when you can draw on case studies to show what you can do.

But what about those outside the technical services industry? Moving your internal network to IPv6 does have a number of operational advantages. Here are two.

Firstly, let's assume that you and your colleagues are quite typical in your increasing adoption of high definition video during the course of your work, such as video services, self-teaching and distance learning modules, event streaming, webcasting for internal communications, video calling and conferencing. Perhaps you use telepresence<sup>4</sup>, or you might be considering it. You won't be surprised to hear that this trend is placing an increasingly heavy burden on your network.

IPv6 can come to your rescue here as it operates with higher network efficiency and can deliver superior quality of service by effectively prioritising network traffic associated with real-time multimedia.

In technical terms, IPv6 makes it possible to achieve enhanced frame and transmission rates and bandwidth usage. This is just one reason for example that China opted to run some audio-visual aspects of the 2008 Olympics network with IPv6.

Secondly, you may like to know that IPv6 has a more unified security framework. So if the most robust security is top of your list of concerns, you should investigate this benefit of IPv6 too.

At the very least, and to minimise or indeed eliminate any cost overhead of adopting IPv6, you should make sure your organisation's future procurement of hardware, operating systems and applications mandates IPv6 capability. For example, it is not generally advised to attempt the transition with Microsoft Windows XP, but Microsoft Windows 7 is ready out of the box, as are Apple's Mac OS X and some Linux distributions. Your organisation will then, through the natural replenishment cycle, become IPv6 ready.

## *What's NAT?*

NAT stands for Network Address Translation, and the sole purpose for raising it here is that it is the main excuse people use for not doing anything about IPv6. The easiest way to explain NAT is by metaphor to the way your organisation manages physical post.

You and all your colleagues in your physical office building share the same address as far as the outside world is concerned and the sender cannot instruct the Royal Mail to deliver directly into your hands. Yet each of you has a unique address as far as your organisation is concerned, be that a desk or a so-called pigeonhole, at which your mail arrives courtesy of another system, your internal post system.

Many organisations' IT networks operate similarly. Each device (eg, server, PC, IP telephone) is given a unique address, known only to your internal network, and your communication with the outside world is routed via a gateway, the equivalent of the post room. It's the gateway's address that you can publish to the world.

So it is easy to picture a situation where an organisation employing thousands of people needs only have a handful of IPv4 addresses in much the same way they may only have a handful of buildings.

But unfortunately this approach means that direct end-to-end communication is impossible, requiring as it does an interim translation. This is problematic for some applications and services, although NAT's interim step is often regarded as helpful in securing an IPv4 network. This does not mean non-NAT IPv6 is less secure however, as IPv6 provides for end-to-end addressability without requiring end-to-end connectivity.

As future IP addresses will be used to address the billions of devices and other things outside corporate walls, and there are technical advantages to the associated service providers in avoiding the intermediary step of NAT in such instances, IPv6 is coming regardless of your organisation's perspective on the matter. Whether you have NAT or no NAT.

## Next steps to IPv6

Above all, you must ensure that your organisation is aware of this issue and has undertaken a planning assessment of the steps you will need to take to make your organisation visible over IPv6, and the corresponding timescale.

This Executive Briefing is accompanied by the “IPv6 Project Planning Guide” to help more technical staff design your transition process, and both documents are available at [www.6uk.org.uk/resources](http://www.6uk.org.uk/resources).

To keep you up to date on IPv6 news, the RIPE NCC, the Regional Internet Registry responsible for allocating IP addresses across Europe, maintains a news page at [www.ipv6actnow.org/category/all-news](http://www.ipv6actnow.org/category/all-news).

This issue is of critical importance to the future of your business. You may find solace however in knowing that once your organisation is IPv6 ready, you'll most likely never have to think about Internet Protocol again.

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<sup>1</sup> AMD <http://www.50x15.com>

<sup>2</sup> Intel <http://www.intel.com/embedded/15billion>

<sup>3</sup> <https://www.isc.org/solutions/survey/history>

<sup>4</sup> <http://en.wikipedia.org/wiki/Telepresence>