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# Barriers for Adopting Internet Protocol Version6

Computer Science

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**ABSTRACT**

*With the explosive growth of the Internet in the scalability of current technologies has become a significant issue. The current version of Internet Protocol version 4 (IPv4) apart from some other drawbacks limits the number of available IP addresses. The next version of IP, version 6 (IPv6), provides a comprehensive solution to several limitations of current Internet technology. However, to date Ipv6 has not been widely adopted. This paper deals with the most valuable and considerable drivers of the adoption of IPv6. Besides the drivers and barriers in adoption of IPv6.*

## 1. Introduction

The Internet is mainly based on one protocol; the Internet Protocol. Version 4 of the Internet Protocol is developed in the 1970's and is the protocol that is common at the moment for Internet traffic. After examining a number of proposals, the Internet Protocol version 6 is settled in January 1995 and since then also known as the "next generation Internet Protocol". Although widespread implementation over the world is necessary within a couple of years mainly because the address space of the Internet Protocol version 4 is almost running out of addresses, we don't see many companies taking consideration about implementing version 6 of this protocol.

"The added value of the IP is the efficient provision of end-to-end connections of arbitrary duration between any points on the globe. Once information is converted into IP packets these can run over any access and link technology connecting the IP routers. This is the definition of a truly open technology[9]."

During the rapid expansion referred to as the 'dotcom boom', the need for adoption of the next version of the Internet Protocol (IPv6) was much discussed and promoted. The reason given was that the explosive growth of Internet companies, bandwidth, and services required a greater address space than possible with the current version, IPv4. (Cooper & Yen, 2004) Many of the Internet Service Providers (ISPs) are now analyzing when the complete IPv4 address space is used. Because many ISPs still have their own blocks of unused IPv4 addresses at the moment of worldwide exhaustion.

**IPv4 :** Defined in RFC 791, IPv4 is the first version of the protocol to be deployed on ARPANET, which then became the Internet. As such, IPv4 was widely called simply "IP" and only came into wide discussion as "IPv4" once IPv6 came into common conversation. IPv4 includes 32 bits in the header for address space,which at 4,294,967,296 addresses seemed sufficient for the conceivable number of computing devices at the time[8].

**IPv5 :**According to RFC 1819, IPv5 describes the Internet Stream Protocol, Version 2 (ST2), an experimental connection-oriented protocol to support data streams to single or multiple destinations. This RFP states that "ST2 is part of the IP protocol family and serves as an adjunct to, not a replacement for, IP".

**IPv6 :**IPv6 is the replacement for the protocol commonly known as "IP." RFC 2460, the most recent standards document regarding IPv6, states the following with regard to IPv6: IPv6 is a new version of the Internet Protocol, designed as the successor to IP version 4 (IPv4) [RFC-791]. The changes from IPv4 to IPv6 fall primarily into the following categories[8]:

- Expanded Addressing Capabilities;
- Header Format Simplification;
- Improved Support for Extensions and Options;
- Flow Labeling Capability;
- Authentication and Privacy Capabilities.

## 2. Current status

While much of the Ipv6 technology set could be described as operationally ready, IPv6 hosts and service delivery platforms are being deployed, and a visible proportion of the network operating entities on the Internet are undertaking various forms of IPv6 deployments, the real level of uptake of IPv6 in the Internet today in terms of services and, by inference, packets, remains quite small. The metric that could be regarded as perhaps the best pointer of the current level of IPv6 usage is the web server access data, and the actual value of the relative rate of IPv6 use appears to be around 0.3% of the IPv4 use, or a relative level of 3 parts of IPv6 per 1,000 of IPv4. The encouraging observation is that the relative use of IPv6 in today's internet as compared to IPv4 is increasing, so that while the internet continues to grow it appears that IPv6 use is growing at a slightly faster rate. On the other hand, it also appears that while the relative numbers are increasing, IPv6 is still a very small proportion of the IPv4 Internet, and by whatever metric one would claim is a "critical mass" of IPv6 usage, we've yet to achieve and, and it may still be quite some years off yet.

## 3. Advantages v6 compared to v4

IPv6 is more than just a large address space. IPv6 has been streamlined over its predecessor. (Roese, 2004) But the 128 bit length address not only solves the problem of exhaustion, it also restores the end-to-end Internet transparency [4]. IPv6 enforces geographic and regional addressing, where organizations will have common "prefixes" based on where they are located and the provider through whom they are connecting. This is similar to the way public phone networks operate IPv6 actually offers solutions adapted for all encountered problems: almost unlimited addressing space, end-to-end secure access for P2P applications, automatic terminal and router configuration, and terminal mobility[7].

Ken Cheng of Foundry Networks states the main difference between IPv6 and IPv4 is the obvious increase in IP addresses. The need for more IP addresses has become a huge issue for a variety of reasons: because intelligent devices increasingly require unique IP addresses; because electronic devices have increased dramatically in highly populated countries such as India and China; and because of "always on" mobile devices whose addresses change as they transition between connection points. Auto configuration is another big difference between IPv4 and IPv6. Currently, configuration is done either manually or using DHCP (Dynamic Host Configuration Protocol), which adds operational costs due to management difficulties and additional network complexity.

Anycast addressing—also available in basic IPv6 specifications—compared to traditional multicast techniques, constitutes a very effective way of locating a DNS server and, generally, all types of servers.IPv6 also brings an immediate solution to end-to-end security of transmission that is not always possible through NAT-based IPv4 architectures[7]. IPv6 has also brought security to the forefront by requiring IPSec for host-level end-to-end security.

The address space is a major step forward and the major driving factor for the technology. Nearly everyone understands that IPv6 has a bigger address. Routing will be simpler, but it forces the end devices to do Path MTU Discovery. While the users may not care much about byte alignments, the engineers look to the details like 64-bit aligned packets to help improve efficiency and ease of implementation. This means faster and cheaper network devices in the long term. IPv6, however, added features like Neighbor Discovery and local addressing to make IPv6 more plug-and-play. Many in the IT community believe that the inherent auto configuration capabilities in IPv6 will make the network easier to operate and manage so that the migration will pay for itself in the long run. Table 1 gives some of the key differences between current implementations (IPv4) and IPv6.

| Features | IPv4 | IPv6 |
|---|---|---|
| IP address space | 4 billion | $3.40282367 \times 10^{38}$ |
| Configuration | Manual | Plug & Play, automatic node discovery |
| Security | Optional | Mandatory. Embedded encryption & authentication |
| Mobility | Mobility need to be configured | Integrated Mobility |
| Network Management | Expensive and Complex | Cheaper and simple |
| Address | Format Multicast & Broadcast | Unicast, Anycast and Multicast |
| More Applications | No support for future applications | 3G applications and beyond |

**Table 1: Key differences between IPv4 and Ipv6**

**4. Barriers for adoption**

The problem with being an early adopter (as an organization) is that the leading edge of using new technologies is often also referred to as the 'bleeding edge' due to the risk of failure. New technologies will have bugs, may integrate poorly with the existing systems, or the marketing benefits may simply not live up to their promise. Of course, the reason for risk taking is that the rewards are high – if you are using a technique that your competitors are not, then you may gain an edge on your rivals. It may be also useful to identify how rapidly a new concept is being adopted. When a product or service is adopted rapidly this is known as 'rapid diffusion'. The access to the Internet is an example of this. In developed countries the use of the Internet has become widespread more rapidly than the use of TV, for example. It seems that in relation to Internet access and interactive TV, Internet-enabled mobile phones are relatively slow-diffusion products[5].

**4.1 Early-adopter**

The barriers to private enterprises moving to IPv6 are many; cost, complexity and business value are a few. One of the issues facing early adopters is the risk associated with the adoption of a new standard. This is caused by the fact that relatively little information exists regarding IPv6. Many experts have noted that using IPv6 networking could result in decreased network security for a certain period during which network operators become more familiar with the new protocol and hackers identify flaws in initial IPv6 implementations. Unfortunately there appear to be no clear "early adopter" rewards for IPv6. The scarcity of information on the subject of IPv6 migration costs, merged with the reality that many organizations are not sold on the supposed benefits offered by the Internet Protocol version 6, is making the case for upgrading difficult to argue.

The negative repercussions of successful standards are most visible in issues of "lock-in", where an old standard is so widespread and entrenched that switching costs are sufficiently high to dissuade agents from adopting a new standard. Apart from switching costs, the network effects involved may also cause coordination problems, as agents will have to coordinate a move to a new standard. In spite of the advantages that IPv6 offers, network operators have yet to shift from IPv4, both due to switching costs, induced by the scale of the network, as well as coordination problems. Since IPv6 network traffic cannot flow over an IPv4 network, all machines connected to, and running, the Internet must be upgraded at the same time [3].

**4.2 Application legacy**

Another economic factor is marinating IPv4 application, which is also a technical issue. It is very important that current applications which run on IPv4 can also run on IPv6. Most probably it will be some applications cannot be ported to IPv6 and end user will not be motivated to implement IPv6, since the interested applications cannot work on IPv6 network but the need for IPv6 features may affect the legacy of marinating IPv4 application[3]. Some other application based barriers for adopting IPv6 are caused by the fact that many of the back office applications of ISPs (i.e. Enterprise Resource Planning applications) are used to check constraints in IPv4 form, where the input is expected to be an IP address. These applications have to be changed in order to accept IPv6 form IP addresses as input.

Today, there are only a few enterprises that need worldwide host-to-host connectivity, and in fact, many enterprises utilize NAT as a security mechanism, and will not likely change that any time soon. Furthermore, experts generally agree that implementing any new protocol, such as IPv6, would be followed by an initial period of increased security vulnerability and that additional network staff will be necessary to address new threats posed by a dual network environment (DoC, NIST, and NTIA 2004). During this period, more security holes would probably be found in IPv6 than in IPv4, and IPv4 networks would continue to have, at a maximum, the same level of security issues as they do currently[10].

**4.3 Dual-stack**

IPv4 is expected to remain until IPv6 deployment has made it unnecessary. Given the lack of urgency for American companies to migrate, many providers will need to offer service over both protocols for the foreseeable future. This will increase, not decrease, costs in the short-term as the work that provides routing and other infrastructure will be duplicated[8]. For many enterprises, the lack of enterprise-specific applications and the administrative overhead of running dual-stack networks can override the benefits of IPv6. Some providers, especially those not geared towards consumers, may determine this expense is unnecessarily and only provide service over IPv6, which will restrict their markets. Other businesses may find themselves forced to deploy IPv6 as a result of partner demands despite not feeling the limitations of IPv4 themselves[8]. The return on investment in the IPv6 business case is simply not evident in today's ISP industry[9].

Because major applications for IPv6 have yet to emerge, it is more difficult to quantify their potential benefits[11]. Besides that, many companies are used to see the adoption of IPv6 as an expensive project and are not putting any effort in performing research to the business opportunities. In fact, there is no way to launch a business off of IPv6 until a "fair amount" of IPv6 infrastructure is put in place. The problem with the search for a "killer application" is that there will not be any until after at least some IPv6 infrastructure is implemented and it becomes an easy way to simply dismiss IPv6, since transition costs are nontrivial.

**5. Drivers for adoption**

Although the shortage of IPv4 address space is often seen as the main driver for adoption of IPv6 . Many Internet Service Providers still have an own reserved free range of IPv4 addresses, enough to use for the next several years since Internet Service Providers are used to request addresses with thousands at a time.

**5.1 Address space**

Added address space is not interesting, since enterprise networks can well be run with RFC 1918 private addresses. This fact remains as long as there is no need to give all hosts an address that can be reached from outside one's network. However, when IP-based telephony really takes off, communications need to done end-to-end between participating hosts. This might be a problem with IPv4 and private addresses since there is a need to use NATting devices which could disrupt communication flow. Many potential benefits hinge on removing and/or changing the management of middle boxes, such as NAT devices and firewalls, because they currently disrupt certain types of host-to-host connections[10].

IPv6 addressing space opens a new field that simplifies access for the final user. Consequently, it is no longer necessary to create complex solutions to get around NAT-type mechanisms that no longer have a place[7]. Near-term benefits include increased use of Voice over IP (VolP) and new mobile data services. Long-term benefits potentially include increased Internet security and efficiency gains from removing NATs[10]. In addition, IPv6 will reestablish the end-to-end model that was lost with the introduction of network address translation (NAT) in the IPv4 world. The problems that protocols like SIP and H.323 encounter today with NAT will be eliminated.

### 5.2 Security
IPv6 is a lot more secure than IPv4, even the makeup of IPv6 with its almost unlimited addresses makes it less vulnerable to attacks. "That because the IPv6 address space is so large, randomly scanning for systems that are vulnerable is completely infeasible. IPv6 adoption could be a significant driver (and potentially a necessary step) for networks to move to a more secure networked environment[7].

IPv6 offers a great increase in Internet scalability, but this scalability is not limited to the increase in addresses that first comes to mind. In fact, as can be seen, this is not even an immediate reason to consider IPv6. IPv6 removes the need for NAT and the barriers it imposes. IPv6 also offers other advantages that could save businesses money, especially in terms of bandwidth. The journey to full IPv6, however, will be a long one. Many businesses whose primary function is not content creation, Internet services, or telecommunications may not see why it is even necessary, but once IPv4 can be disabled, new services will be possible in a much less hostile landscape. (Cooper & Yen, 2004)

IPv6 has the potential to lower costs associated with application development for software vendors and to reduce the costs of network management and the installation and testing of new applications for all enterprises. (Gallaher & Rowe, 2005) The per-address cost can be reduced dramatically through the elimination of various forms of dynamic address translation technologies, as well as the elimination of the scarcity premium factor in IPv4 address mechanisms. Application complexity can also be reduced, and the diversity of application models can be broadened. This model of universal addressing allows for many forms of peer-to-peer networking models as well as supporting communication transaction security models that reply on end-to-end coherence. (Huston, 2006) Increased security is a frequently mentioned benefit associated with IPv6. (Gallaher & Rowe, 2005)

In addition, longer-term benefits may be realized from a decrease in IT costs for internal network operations (accruing throughout the supply chain) and from simplified R&D for new products and services developed by vendors. (Gallaher & Rowe, 2005)

### 5.3 Voice over IP
"The tactical response to the need to acquire the minimum number of addresses for a business is Network Address Translation. Not only did this allow a business to setup multiple systems under one address, but also it provided a security benefit in obfuscating addressing from outside the business. Next generation Voip networks based on IPv6 address current problematic issues such as lack of inherent Quality of Service (QoS) in many IP networks, and end-to-end integrity of the VoIP signaling and bearer paths. QoS and robustness necessary if VoIP is to replace the Transportation Demand Management infrastructure worldwide." Protocol limitations and NAT issues make it difficult to carry Voip packets across firewalls in the current IPV4 based set up, along with security vulnerabilities, IPv6 deals with these and QoS issues.

One of the protocols most seriously affected by this translation is Voice over IP (VOIP). Although intra-organization VOIP would unaffected (unless NAT is deployed in the intranet), replacing the Public Switch Telephone Network (PSTN) interface to the outside would be prevented as inter organization communication would need to be converted to regular telephony. With the presence of a NAT device, the flow VoIP telephone to external VoIP telephone is broken. Because many organizations use standard non routable addressing, it is not unlikely that telephones in both organizations might have the same IP address, resulting in confusion for the devices. Therefore, even initiating a conversation would not be possible because there is no globally unique identifier by which the remote VoIP telephone can be contacted by another device. Even if the IP addresses are not identical, however, the presence of the NAT makes initiating a connection from the outside impossible, preventing directly dialing the remote telephone device[8].

Other capabilities have also been developed in direct response to critical business requirements for scalable network architectures, improved security and data integrity, integrated quality-of-service (QoS), automatic configuration, mobile computing, data multicasting, and more efficient network route aggregation at the global backbone level. Multicasting is an important feature of IPv6 that replaces the IPv4 broadcast feature by supporting both unicast and multicast functions.

### Conclusions
The increased IP address space is often seen as the main driver for IPv6 adoption. This increased address space causes NATting devices to become unnecessary since they are used to overcome the shortage of IPv4 address space. This will reestablish the end-to-end communications model that was lost by the use of Network Address Translation.Another driver for adoption of IPv6 can be found in security. Since the address space of IPv6 is that large, scanning for addresses will become almost impossible and IPv6 includes mandatory IPSec, an important security protocol.Integrated quality-of-service, automatic configuration, mobile computing and data multicasting are some of the small drivers for adopting IPv6. These drivers are not often seen as enablers for IPv6.

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