The Introduction of Internet Protocol Version 6 (IPv6) Implementation in North Carolina Public Universities in Response to the Digital Millennium Act of 1998

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ABSTRACT

IPv4, as the driving force of the Internet, has reached its limit. The American Registry for Internet Numbers (ARIN) depleted its free address space on September 24th, 2015. (American Registry for Internet Numbers, 2015). Any new address requests must be made to facilitate the transition to IPv6. The idea of depletion is not new. The Request for Comments has been around for nearly twenty years. (Internet Task Engineering Force, 1998) Various factors have led to the delay of mass IPv6 deployment but the role of the Digital Millennium Copyright Act is usually not mentioned. Resolving these problems will hasten the transition to IPv6. The current IPv6 deployment currently stands at just over 15% as of November 2016. (Google, 2016) A seamless transition will depend on a much more rapid response considering the lack of IPv4 addresses.

The following paper will examine the relationship between the DMCA and IP4. It will further examine the role of the RIAA which has contributed. The paper will finally examine how the newer IPv6 technology will affect the delicate relationship going forward. Resolving this question may be the key to unlocking IPv6 to a very large population of users.

INTRODUCTION

The Internet Protocol has revolutionized the world of technology. Few technologies currently exist that do not rely on some sort of Internet access. The current iteration, version 4 also known as IPv4, of the protocol, however, has aged and now nears the end of its life. The need for replacement of IPv4 was long ago predicted and modifications made to the protocol to resolve addressing and security concerns. The new protocol, named IPv6, solved the problem of addressing shortages by expanding the addressing range and removing undesirable parts of IPv4 such as broadcasting. IPv6 is poised to take technology where IPv4 simply could not.

Network engineers have welcomed IPv6 with surprisingly apathetic attitude. The lack of urgency stems from an unwillingness of private sector network engineers to scrap their already sizeable investment in network technologies. It, additionally, comes from the fear of increased complexity in network and application configurations. The goal of these companies is to generate profits for their stakeholders. A system that brings added complexity will meet resistance as the adage, “if it isn’t broken, don’t fix it” applies. Network engineers and corporate accountants alike will simply not want to spend considerable capital until necessary.

Universities have a unique reason for their delays in the transition. The lethargic response can be partially related to the same corporate reasons that have stalled progress. Universities, however, have the additional responsibility of being an internet service provider (ISP) for the student and staff populations. A large, fast network infrastructure combined with a desire to access the latest music and movies leads some to attempt to obtain items via file sharing programs and torrents.

The most common of these violations are for illegally sharing music, video, and software. Illegal file sharing has a long history and is tied to the uprising of the Internet. The digitization of

music allowed higher quality copies to be made and disseminated with a previously unknown efficiency. Cassette tape recordings had a greatly reduced playback quality and difficult to reproduce in mass quantities. Digitization, however, made recordings accessible in a near-studio quality. Replication, unlike the cassette, was incredibly easy. Anyone could copy put the digital media on a server and give access in a matter of seconds. The immediate crush of real and perceived copyright violations brought about several acts which changed the definition of copyright.

Copyright owners appropriately sought legal recourse and legislation led to the Digital Millennium Copyright Act of 1998 (DMCA) which gave greater protection to copyright owners in cases of infringement. Legal challenges of the DMCA ran through all levels of the courts but ultimately culminated with copyright owner wielding broad powers through the courts. Copyright owners have exercised that power by not just pursuing the copyright violators but also the internet service providers. The fear of copyright liability forced universities to come up with practices that satisfy their standards for best effort network monitoring.

A BRIEF HISTORY OF IPv4

The ironic twist of the upgrade to IPv6 is that we've seen the scenario before. IPv4 itself came to prominence as a replacement of the Advanced Research Projects Agency Network's (ARPANET) network. ARPAnet began as the first packet switching network in 1969. (Stewart, 2000) Four years later, TCP was the core protocol. (Kozierok, 2005) The TCP/IP protocol suite then became the official suite in March 1982. (Dalakov, 2016) The transition, however, came with consternation as many vendors felt that a full move to TCP/IP was not warranted. Many felt that ARPAnet would suffice as a networking protocol. The transition, however, went forward despite the resistance.

If IPv4 had stayed within the realms of military and research, version 6 would not be necessary. Version 4 of Internet Protocol had a theoretical limit of 2^{32} IP addresses and computers had not become a household item. Four billion IP addresses appeared sufficient at the time. The transition to global networks began in 1985 and quickly spread in popularity. Commercialization quickly increased the popularity of the protocol to the point where computer scientists realized that the number of 32-bit addresses would be insufficient.

IPv6 resolved the addressing issue by expanding addressing from a 32-bit structure to a 128-bit structure expanding the possible number of IP addresses from four billion to approximately 340 quadrillion (10^{38}) addresses. (Wigmore, 2009) The greater range of IP addresses should permanently resolve the issue of a lack of addresses but version 4 implemented a way to extend its range.

Private IP addressing extended the number of IPv4 addresses by reserving specific address ranges and marking them as non-routable on the public Internet. RFC1918 specified ranges 10.0.0.0 – 10.255.255.255 (10.0.0.0/8), 172.16.0.0 – 172.31.255.255 (172.16.0.0/12), and

192.168.0.0 – 192.168.255.255 (192.168.0.0/16). (Internet Engineering Task Force, 1996) The IP ranges are assigned on internal network and can be used repeatedly on internal network segments. The Internet facing side of the network will still use public IP addresses. The use of private IP addresses has given companies additional time to stay on IPv4. The time extension has come at the cost of security. Private addressing, and by extension, Network Address Translation has several flaws which make it nearly impossible to completely secure.

A BRIEF HISTORY OF THE DMCA

The Digital Millennium Copyright Act of 1998 was signed into law per President Bill Clinton as an amendment to the original copyright laws of the United States. (Association of Research Libraries, 2016) The amendment in the law updated rules governing the copying of digital media. The wildly popular rise of the Internet coincided with a sharp increase of digital media. The old copyright laws were never designed to handle the ease of digital copying and Supreme Court rulings left a wide swath of gray area.

One of the main sources of copyright infringement came with illegal downloads of music files. The closest relation to illegal downloads came in the copying of television recordings from video cassettes and music recordings of audio. The case held that television recordings did not constitute a copyright violation. Any copying of the music amounted to time shifting for private use and not a copying intended to defraud copyright holders. One of the key components of the ruling came from the quality of the cassettes. The reduced quality of the recordings did not meet the standard require to constitute infringement. (Electronic Frontier Foundation, 2015) Digital copying differed from previous recordings as the quality reduction in copies remained the same as the original recordings.

Distribution of said copies became much easier than the old system as Internet access grew by leaps and bounds. Peer to peer networks became ultimately popular amongst users who wished to share files. They also came under scrutiny as the files shared often skirted the lines of copyright infringement. The landmark case of MGM Studios versus Grokster, Ltd. gave power to copyright holders and spelled the end of peer to peer networks. Mark Gorton, chief executive officer of Limewire, stated that “Some people are saying that as long as I don't actively induce infringement, I'm O.K. I don't think it will work out that way...[the Court] has handed a tool to

judges that they can declare inducement whenever they want to." (Zeller, 2005) The fear of lawsuits from the Grokster ruling still holds today and many universities fear the liability held by Grokster.

HOW UNIVERSITIES PROTECT THEMSELVES

Universities protect themselves by establishing “best effort” network monitoring on their networks. The best effort practices include monitoring network connections for unusual activity such as large bandwidth consumption, connections to known questionable IP addresses or multiple simultaneous connections. When the connection is recognized and identified as a possible copyright violation, the IP and MAC address are flagged and identified. (Shue & Thaxton, 2016)

The MAC address is then matched to a known list which identifies the owner of the address. A letter of notice is then sent to the owner which then informs them of the violation and gives them the option to remedy the violation. The notification serves also as a notice that further violations will place the violator, not the University, at risk. The transition, however subtle, now absolves the University from blame.

IPv6 brings a new set of problems. IPv4 associates the IP and MAC addresses with DHCP. DHCPv6 instead uses a DHCP Unique Identifier (DUID). The DUID is designed to never change in a network and “unambiguously identify all hosts (including the DHCPv6 server itself) rather than single interfaces on any host” (Coffeen, 2015). The DUID does not change but the possibility of duplicate DUIDs does exist. (Coffeen, 2015) Duplicate DUIDs would mean a manual change of the DUID and the beginning of a tracking nightmare. The larger address space, once thought to be a huge plus, now becomes a massive nightmare as an offender can simply become lost in the much larger forest of address space. The looming presence of copyright liability combined with the issues of implementing IPv6 have made universities hesitant to fully deploy it on campuses.

SUMMARY

University network administrators have a difficult job as a speedy network and the availability of current media tempts users to commit copyright violations. No monitoring system is foolproof but universities had established common ground between restricting network access and simply allowing copyright violations to go unchecked. The delicate balance was established because monitoring within IPv4 could easily track MAC address which allowed copyright violators to be found and reprimanded for the infringements.

IPv6's attempt to enhance these features has actually led to more difficulties which threatens to upset the balance between copyright holders and network administrators. The inability to reliably monitor IPv6 means that it cannot be reliably deployed without risking litigation from the copyright holders.

IPv6, like IPv4, will depend on researchers to use and take advantage of its new features before widespread commercial deployment. We have been through this before as IPv4 replaced ARPAnet. The upgrade to IPv6 will undoubtedly take us through the same trials as the move to its predecessor but the exhaustion of IPv4 not only makes this move necessary but imperative to the survival of the Internet as a whole.

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