A case study of Address Depletion Problem in Ipv4 Using Impact of APNIC RIR Exhaustion and LIR Exhaustion

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ABSTRACT

The research paper focused on problem of address depletion problem in IPV4 with impact RIR exhaustion and LIR exhaustion. While the primary reason for IPv4 address exhaustion is insufficient design capacity of the original Internet infrastructure, several additional driving factors have aggravated the shortcomings. Each of them increased the demand on the limited supply of addresses, often in ways unanticipated by the original designers of the network. The current Systems that require inter-continental connectivity will have to deal with exhaustion mitigation already due to APNIC exhaustion. At APNIC, existing LIRs could apply for twelve months stock before exhaustion when they were using more than 80% of allocated space allocated to them. Since 15 April 2011, the date when APNIC reached its last /8 block, each (current or future) member will only be able to get one allocation of 1024 addresses (a /22 block) once. As the slope of the APNIC pool line on the Geoff Huston's projection of the evolution of the IP pool for each RIR chart to the right shows, the last /8 block would have been emptied within one month without this policy. By APNIC policy, each current or future member can receive only one /22 block from this last /8 (there are 16384 /22 blocks in the last /8 block). Since there are around 3000 current APNIC members, and around 300 new APNIC members each year, APNIC expects this last /8 block to last for many years. The main focus of the paper to study the above defined problem.

Keyword: APNIC, NAT44, Denial of services Attack, network address translation (NAT).

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1. Introdcution

The IPv4 was created with no security in mind. Because of its end-to-end model, IPv4 relies on the end-hosts to provide the appropriate security during communication. Below are some security threats on IPv4: Denial of Service Attacks (DOS): it is an attempt to make a computer resource unavailable to its intended users. One common method involves flooding the target host with requests, thus preventing valid network traffic to reach the hostViruses & Worms's distribution: these malicious code/programs can propagate themselves from one infected or compromised hosts to another. This distribution is aided by the small address space of IPv4Man-in-the-middle attacks (MITM): an attacker is able to read, insert and modify at will messages between two hosts without either hosts knowing that their communication has been compromised. This is because IPv4's lack of suitable authentication mechanisms. Fragmentation attacks: Different Operating system has their own method to handle large IPv4 packets and this attack exploits that method. For example the "ping of death" attacks. This attack uses many small fragmented ICMP packets which when reassembled at the destination exceed the maximum allowable size for an IP datagram which can cause the victim host to crash, hang or even reboot. Port scanning and reconnaissance: this is used to scan for multiple listening ports on a single, multiple or an entire network hosts.

2. History of Backward Of This Research

The main objective for successful transition is to allow IPv6 and IPv4 hosts to interoperate. A second objective is to allow IPv6 hosts and routers to be deployed in the Internet in a highly diffuse and incremental fashion, with few interdependencies. The third objective is easy transition for end- users, system administrators, and network operators. The IPv6 transition mechanisms are a set of protocol mechanisms implemented in hosts and routers, with some operational guidelines for addressing and deployment, designed to make the transition to work with as little disruption as possible. These will ensure that IPv6 hosts can interoperate with IPv4 hosts in the Internet up until the time when IPv4 addresses run out. The IPv6 transition mechanisms provide a number of features, including: Incremental upgrade and deployment. Individual IPv4 hosts and routers may be upgraded to IPv6 one at a time without requiring other hosts or routers to be upgraded at the same time. New IPv6 hosts and routers can be installed one by one. Minimal upgrade dependencies.

3. Related Problem Scenario of This Study

i. ***Address Depletion Problem***
While the primary reason for IPv4 address exhaustion is insufficient design capacity of the original Internet infrastructure, several additional driving factors have aggravated the shortcomings. Each of them increased the demand on the limited supply of addresses, often in ways unanticipated by the original designers of the network.

ii. ***Mobile Devices***-As IPv4 increasingly became the de facto standard for networked digital communication and the cost of embedding substantial computing power into hand-held devices dropped, mobile phones have become viable Internet hosts. New specifications of 4G devices require IPv6 addressing.

iii. ***Always-On Connections***-Throughout the 1990s, the predominant mode of consumer Internet access was telephone modem dial-up. The rapid increase in the number of the dial-up networks increased address consumption rates, although it was common that the modem pools, and as a result, the pool of assigned IP addresses, were shared amongst a larger customer base. By 2007, however, broadband Internet access had begun to exceed 50% penetration in many markets.[11] Broadband connections are always active, as the gateway devices (routers, broadband modems) are rarely turned off, so that the address uptake by Internet service providers continued at an accelerating pace.

iv. ***Internet Demographics***-There is hundreds of millions of households in the developed world. In 1990, only a small fraction of these had Internet connectivity. Just 15 years later, almost half of them had persistent broadband connections.[12] The many new Internet users in countries such as China and India are also driving address exhaustion.

v. ***Inefficient Address Use***-Organizations that obtained IP addresses in the 1980s were often allocated far more addresses than they actually required, because the initial classful network allocation method was inadequate to reflect reasonable usage. For example, large companies or universities were assigned class A address blocks with over 16 million IPv4 addresses each, because the next smaller allocation unit, a class B block with 65536 addresses, was too small for their intended deployments. Many organizations continue to utilize public IP addresses for devices not accessible outside their local network. From a global address allocation viewpoint, this is inefficient in many cases, but scenarios exist where this is preferred in the organizational network implementation strategies. Due to inefficiencies caused by subnetting, it is difficult to use all addresses in a block. The host-density ratio, as defined in RFC 3194, is a metric for utilization of IP address blocks that is used in allocation policies.

vi. ***Early Mitigation Efforts***-Efforts to delay address space exhaustion started with the recognition of the problem in the early 1990s, and include: Use of network address translation (NAT), in which many computers share one IP address, but which makes the computers behind the NAT unaddressable from the outside, breaking end-to-end connectivity, Use of private network addressing, Name-based virtual hosting of web sites, Tighter control by regional Internet registries on the allocation of addresses to local Internet registries, Network renumbering and subnetting to reclaim large blocks of address space allocated in the early days of the Internet, when the Internet used inefficient classful network addressing

vii. ***Exhaustion Dates And Impact***
On 31 January 2011, the last two unreserved IANA /8 address blocks were allocated to APNIC according to RIR request procedures. This left five reserved but unallocated /8 blocks. In accord with ICANN policies, IANA proceeded to allocate one of those five /8s to each RIR, exhausting the IANA pool,[2] at a ceremony and press conference on 3 February 2011. The various legacy address blocks with administration historically split among the RIRs were distributed to the RIRs in February 2011.APNIC was the first regional Internet Registry to run out of freely allocated IPv4 addresses, on 15 April 2011. This date marked the point where not everyone who needed an IPv4 address could be allocated one. As a consequence of this exhaustion, end-to-end connectivity as required by specific applications will not be universally available on

the Internet until IPv6 is fully implemented. However, IPv6 hosts cannot directly communicate with IPv4 hosts, and have to communicate using special gateway services. This means that general-purpose computers must still have IPv4 access, for example through NAT64, in addition to the new IPv6 address, which is more effort than just supporting IPv4 or IPv6. The demand for IPv6 is expected to ramp up to pervasiveness over three to four years.[6] In early 2011, only 16–26% of computers were IPv6 capable, while only 0.2% preferred IPv6 addressing[9] with many using transition methods such as Teredo tunneling.[7] About 0.15% of the top million websites are IPv6 accessible. Complicating matters, 0.027% to 0.12% of visitors cannot reach dual-stack sites, but a larger percentage (0.27%) cannot reach IPv4-only sites.IPv4 exhaustion mitigation technologies include IPv4 address sharing to access IPv4 content, IPv6 dual-stack implementation, protocol translation to access IPv4 and IPv6-addressed content, and bridging and tunneling to bypass single protocol routers. Early signs of accelerated IPv6 adoption after IANA exhaustion are evident.[5]

viii. Regional Exhaustion

All the RIRs have set aside a small pool of IP addresses for the transition to IPv6 (for example carrier-grade NAT), from which each LIR can typically get at most 1024 in total. ARIN and LACNIC [27] reserves the last /10 for IPv6 transition. APNIC, and RIPE NCC have reserved the last obtained /8 block for IPv6 transition. AFRINIC reserves a /11 block for this purpose.[28] When only this last block remains, the RIRs supply of IPv4 addresses is said to be "exhausted". Regional Internet registries .APNIC was the first RIR to restrict allocations to 1024 addresses for each member, as its pool reached critical levels of one /8 block on 14 April 2011.The APNIC RIR is responsible for address allocation in the area of fastest Internet expansion, including the emerging markets of China and India. RIPE NCC, the regional Internet registry for Europe, was the second RIR to deplete its address pool on 14 September 2012.[4]On 10 June 2014, LACNIC, the regional Internet registry for Latin America and the Caribbean, was the third RIR to deplete its address pool.ARIN was exhausted in July 2015. After IANA exhaustion, IPv4 address space requests became subject to additional restrictions at ARIN,[8] and became even more restrictive after reaching the last /8 in April 2014.[6] AfriNIC is expected to exhaust within several years.[9]

4. Impact of APNIC RIR Exhaustion and LIR Exhaustion

Systems that require inter-continental connectivity will have to deal with exhaustion mitigation already due to APNIC exhaustion. At APNIC, existing LIRs could apply for twelve months stock before exhaustion when they were using more than 80% of allocated space allocated to them.[4] Since 15 April 2011, the date when APNIC reached its last /8 block, each (current or future) member will only be able to get one allocation of 1024 addresses (a /22 block) once.[1][2] As the slope of the APNIC pool line on the "Geoff Huston's projection of the evolution of the IP pool for each RIR" chart to the right shows, the last /8 block would have been emptied within one month without this policy. By APNIC policy, each current or future member can receive only one /22 block from this last /8 (there are 16384 /22 blocks in the last /8 block). Since there are around 3000 current APNIC members, and around 300 new APNIC members each year, APNIC expects this last /8 block to last for many years.[3] Since the redistribution of recovered space, APNIC is distributing an additional /22 to each member upon request. The 1024 addresses in the /22 block can be used by APNIC members to supply NAT44 or NAT64 as a service on an IPv6 network. However at a new large ISP, 1024 IPv4 addresses might not be enough to provide IPv4 connectivity to all the customers due to the limited number of ports available per IPv4 address.[4].The Regional Internet Registries (RIRs) for Asia (APNIC) and North America have a policy called the Inter-RIR IPv4 Address Transfer Policy, which allows IPv4 addresses to be transferred from North America to Asia. The ARIN policy was implemented on 31 July 2012.[7].Estimates of the time of complete IPv4 address exhaustion varied widely in the early 2000s. In 2003, Paul Wilson (director of APNIC) stated that, based on then-current rates of deployment, the available space would last for one or two decades.[8] In September 2005, a report by Cisco Systems suggested that the pool of available addresses would deplete in as little as 4 to 5 years.[9] In the last year before exhaustion, IPv4 allocations were accelerating, resulting in exhaustion trending to earlier dates.

5. Conclusion

The conclusion of the research paper discussed the brief introduction of IPv4 has brought lots of debates to the IT industry, as well as to security communities, and the discussions do not seem likely to come to an end soon. Some people think all organizations should complete their transition to IPv6 as soon as possible, while others think it is not very urgent to accomplish the task. From the security point of view, the discussions are quite similar. In this paper, we looked into the by no means complete list of discussion topics related IPv4 Systems that require inter-continental connectivity will have to deal with exhaustion mitigation already due to APNIC exhaustion. At APNIC, existing LIRs could apply for twelve months stock before exhaustion when they were using more than 80% of allocated space allocated to them especially in terms of security. After elaborating current prevalence status of IPv6 in today's networks, we have briefly discussed some technical, transitional, and management related issues.IPv6 is the next network protocol and brings some new features. Some of them are quite exciting, such as the availability of a vast number of IP addresses. After all, according to latest research, most vulnerability is at the application layer. As a result, the network layer and IPv6 have little or no impact on tackling today's attacking vectors. Lots of security considerations would stay the same as they are in IPv4. We need to carefully study the requirement for the transition and address the security related issues on the implementation.

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