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PERFORMANCE EVALUATION OF VARIOUS IPV6 MAXIMUM TRANSMISSION UNITS (MTUS) IN PACKET SWITCHED NETWORK

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Abstract

Communication over the internet has been in the increase, as hosts rate of growth in the network has been a worrisome situation. IPv4 has been inadequate for robust communication purposes and IPv6 protocol was developed to ameliorate the challenges of various network delaying processes in IPv4 mechanism; even in a situation where the two protocols co-existed, employing various techniques (dual-stack, tunneling and translator), serious challenges were still encountered. Fragmentation processes in IPv6 involved large sizes of fragmented packets in the network and MTUs varies in sizes from one network to the other. And one of the primary objective of MTU is to accept the required size of fragmented packet for further transmission to the destination where reassembling is performed. Fragmentation process of a large size of packet using IPv4 have a serious problem in packet transmission; Propagation delay, queuing, overload and jitter are attributes of issues in IPv4 network. This analysis is to determine the required IP network size suitable for maximum data transfer with tremendous speed and also provide an increase bandwidth for future networks using packet switch techniques.

Keywords: Fragment, offset, maximum transmission unit, IPv6, IPv4, datagram

1. Introduction

Packet switched is a connectionless technique. Packets in this technique are routed randomly, and each packet strives to access the fastest routes to enable it get to the target destination, using the shorted possible time. There is no underlined format for packet transmission, the physical electronic devices or equipment are used as hardware in the process of packet transmission [1]. IPv6 have a maximum utilized bandwidth to accommodate the data size of this robust network, due to the scalability and versatility of IPv6 in handling above 40bytes. Header size is a possibility in improving the speed of the routing of packages whose efficiency overturn IPv4. Global prefix of IPv6 has 48bits long, the ID interface with device on the network uses 64bits addresses and subnet of 16bits [2]. IPv4 are operated on 32bits, which is why IPv6 have a large bit size of 128bits address space, classless inter domain routing (CIDR). This is an indication that the number of addresses available per host, in the network, is 10^{30}; the range of sections is 8 of 16bits, each expressed in hexadecimal (HEXTET).

1.2 Information addressing modes

In networking, addressing mode refers to a method on how we address a host on the network. IPv6 offers several types of modes by which a single host can be addressed. More than one host can be addressed at once or the host at closest distance can be addressed as seen in table 1.

Table 1, various addresses, codes and applications are used in IPv6 protocol.

SN	Address mode	Address code	Applications
1	Global unicast	2000::/3	Publicly routable
2	Unique Local	FC00::/7	Routable in the LAN
3	Link Local	FE80::/10	Not Routable
4	Multicast	FF00::/8	Address for Groups
5	Anycast	2000::/3	Shared Address

1.2.1 Unicast

In unicast mode of addressing, an IPv6 interface (host) is uniquely identified in a network segment. The IPv6 packet contains both source and destination IP addresses. A host interface is equipped with an IP address which is unique in that network segment. A network switch or router when it receives a unicast IP packet, destined to single host, sends out one of its outgoing interface which connects to that particular host.

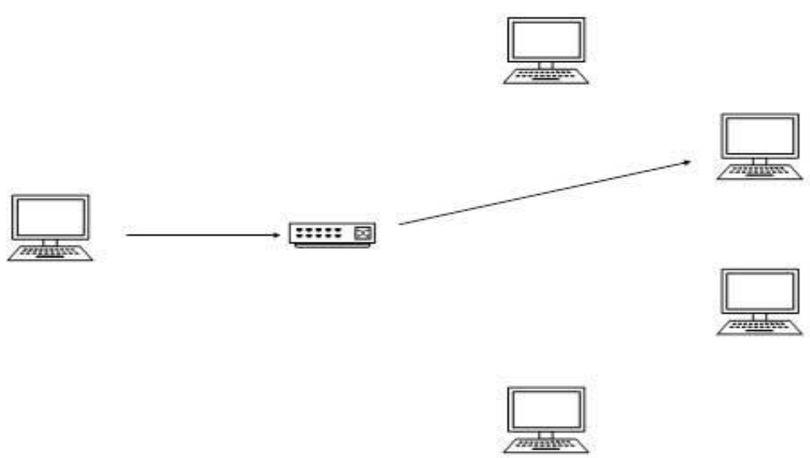

Fig. 1: Unicast Messaging (redrawn)

1.2.2 Multicast

The IPv6 multicast mode of address is same as that of IPv4. The packet destined to multiple hosts is sent on a special multicast address. All hosts interested in that multicast information, need to join that multicast group first. All interfaces which have joined the group receive the multicast packet and process it, while other hosts not interested in multicast packets ignore the multicast information.

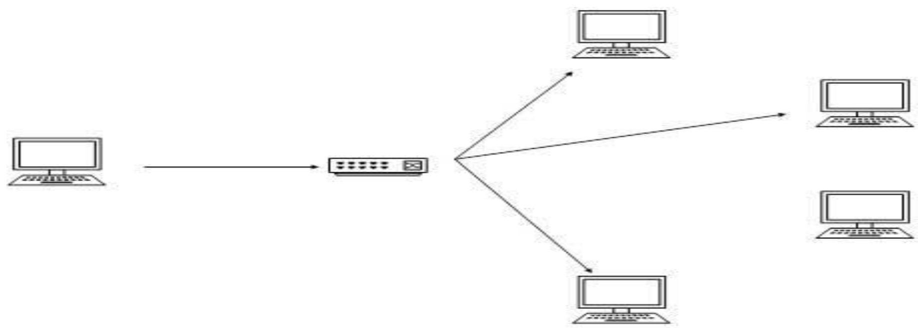

Fig. 2: Multicast Messaging (redrawn)

1.2.3 Anycast

With the development of a new address system of IPv6 called Anycast addressing, multiple interfaces (hosts) are assigned same Anycast IP address. When a host wishes to communicate with a host equipped with an Anycast IP address, it sends a Unicast message. With the help of complex routing mechanism, that Unicast message is delivered to the host closest to the Sender, in terms of Routing cost.

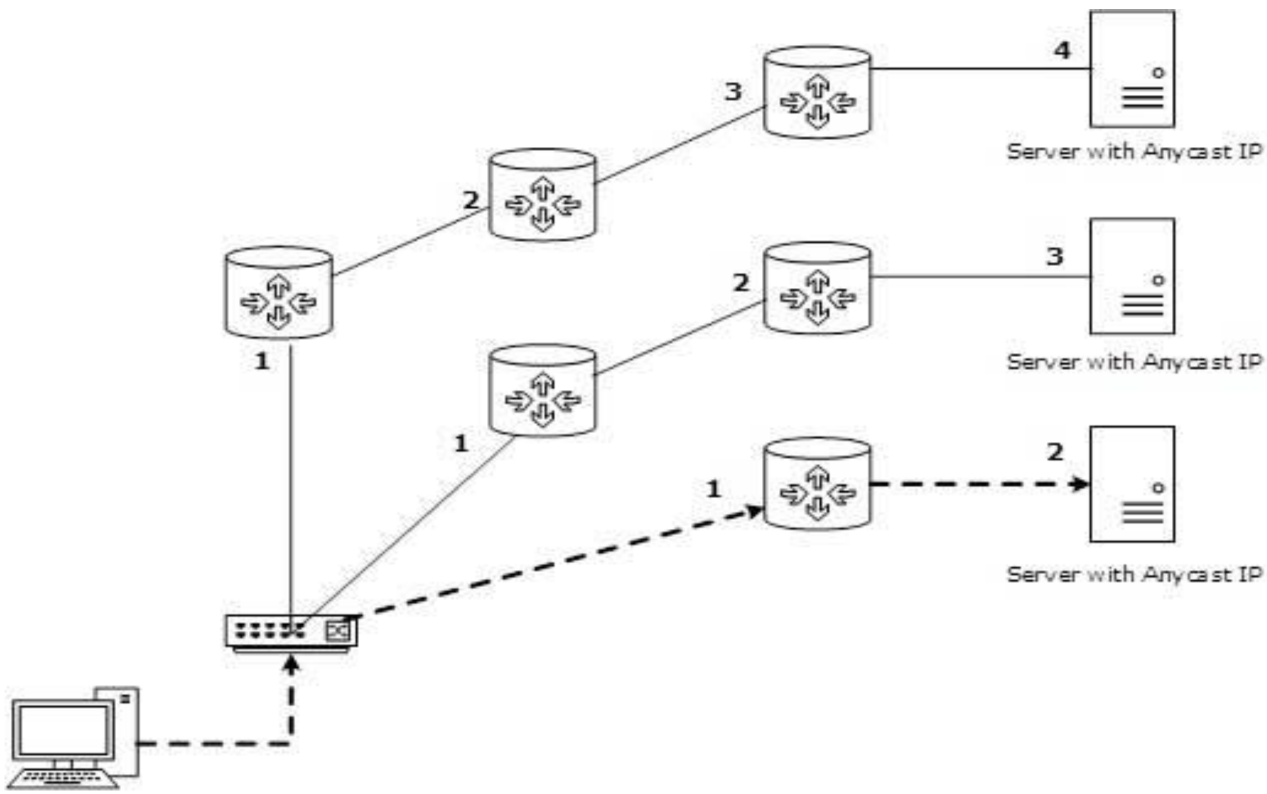

Fig. 3: Anycast Messaging (redrawn)

Table 2, Basic features of IPv4 and IPv6 protocols in connectionless network

SN	features	IPv4 protocol	IPv6 protocol
1	Large Address Space	4bits	256bits
2	Simplified header	Complex header	Simplified header
3	End-to-end connectivity	Use NAT & other translator components	Host-to-host on internet
4	Auto-configuration	Used DHCP server	Support stateful and Stateless config. Mode

5	Faster forwarding /Routing	Mandatory header	Routing decision are fast
6	IPSec	Poor network security	Secured security
7	Broadcast	Used Ethernet and token ring	Multicast to link with multiple hosts
8	Any-cast	Do not support	Support Any-cast mode
9	Mobility	Do not support	Support IP confg. & ext. headers
10	Enhanced Priority	Used 6bits DSCP and 2bits ECN	Traffic class and flow label
11	Smooth transition	NAT address	Large IP address Scheme
12	Extensibility	40 bytes is provided	120tes is provided

2. Reviewed works

Previous research papers show the differences in the performance of the IPv4 and IPv6 protocols, as in the case of [3], who carried out tests about the size of the packets, bandwidth, segment size, size of the buffer and size of the Maximum Transfer Unit (MTU) in packet routing and commutation. RFC3142 [4] of the Internet Society's network working group describes an IPv6 retransmission translator (TRT) for IPv4, which allows hosts only to exchange IPv6 traffic (TCP, UDP) with IPv4 hosts, in order to optimize resources within the same network and allow migration from IPv4 to IPv6. In the same way, [5] consider the effect of network performance analysis for networks based on IPv4 and IPv6 and empirically evaluated measurements related to performance, delay and instability. Another case of the evaluation of UDP-IPv6 is the study of modern operating systems to determine the parameters of quality of service (QoS) through IPv6 networks [6]. However, due to the increased overload in IPv4 and its interaction with the operating system hosting this communication protocol can generate network performance problems, in the case of [7]. Through the use of network traffic generators (Iperf, Netperf, D-ITG and IP Traffic), it is possible to emulate traffic and VoIP in test environments that guarantee reliable experiments. This is confirmed in [7] and [8], where the sizes of the payload and datagrams are varied to monitor the performance of the network. In the same way, [9, 10] proposes a method to determine the optimal input variables by applying genetic algorithms to check the effectiveness of the traffic generator D-ITG [11] and the time cost of the variables that affect the performance of IPv4 and IPv6 networks. Also used are the network tools to analyze the performance of the network through the measurement of the unidirectional delay and the round trip time of the packets that traverse the network [12, 13]. The authors in [14, 15] show the results of laboratory experiments to determine the effects on Jitter over VoIP when the IPv6 tunnel is used in IPv4. In addition, [17 and 18] compare the performance of an IPv4 network and IPv6 in a peer-to-peer connection with client server architecture and showed the differences in bandwidth, in a similar way [14] propose that IPv6 and NAT64 networks offered better performance against the NAT44 network in almost all metrics in the UDP mode test. Zhou et al, 2010 in [19], perform the comparison of delay and loss performance over time between IPv6 and IPv4 and verified that the main reason for the worst performance comes from IPv6 over IPv4 tunnels instead of native IPv6 paths.

The most efficient codes for the transport of VoIP in IPv6 networks is taken as reference in the study according to [20] who experimented with different networks using the IPv6-to-IPV4 tunneling mechanism to analyze the parameters of delay, instability and performance. This allows for analyzing the situation of the use of Voice Activity Detection / Discontinuous Transmission / Comfort Noise Generation (VAD / DTX / CNG) that can significantly reduce the speed of transmission of packets. The recommendations in [21] and [22] are also considered as the bases of the study of the structures of operation, understanding and coding of voice signals. On the other hand, according to [17] RTP is used to diagnose the functions of the end-to-end network transport protocol for applications that transmit data in real time, such as: audio, video or data, [16].

3. Fragmentation

Fragmentation process of data in the network layer is a remote technique in a 3-layer system which is an independent routing of data packets in the network. Data packet cannot be transmitted in block to a network, they must be broken into segments based on the MTU sides, in IPv4 MTUs sizes are smaller compared with IPv6 MTUs. Fragmentation is done at the network layer at the destination end of the network as the source end does not require this process.

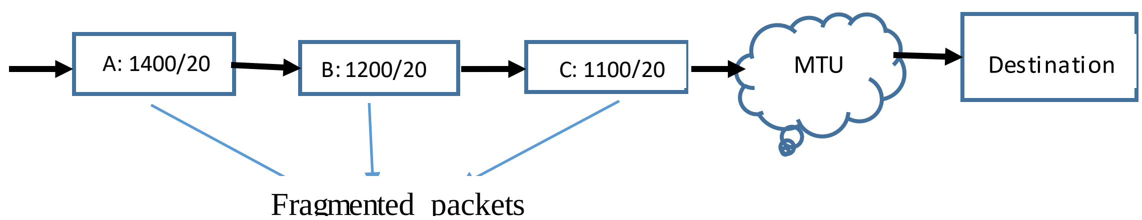

Figure 4. IPv6 model for fragmentation

Determination of various data packets in the network, which involved packets sizes of 1400, 1200 and 1100 data sizes: the maximum transmission unit for this network is 505B and IP header of 20B. When summed, it becomes 525B. This is the maximum size required at the network layer. Results obtained from the three data packets show that, the offset value for each data packet in the network is the same for first, second and third fragment respectively. As seen in tables 3 - 5, the data packet sizes are not considered during fragmentation, rather the maximum transmission unit of the network. That is, the larger the MTU, the better the throughputs, latency and jitter across the network. Routers and switches are sensitive electronic components to the network [1]

3.1 The parameters in fragmentation:

a. Classifying the fragments based on MTU size, if is IPv4 on 32 bits and for IPv6 on 64bits, identification number
b. Identifying fragment with offset value of zero, which is designated as first fragment.
c. Identifying the number of bytes in the first fragment and searching for fragment with offset equal to the number of bytes which is divided by one byte and name as next fragment.
d. The step is repeated for some number of times (probably as many times as possible to fragment all the data packet in the network)

Where no value is left to be fragmented, (DF) not is fragment in such a situation where all the data packet is fragmented.

Table 3. First fragmented data packet

Data packet	IP header	MTU packet	IP header
1400	20	505	20

Fragmented size	505	505	390
MF	1	1	0
Offset value	504	504	392
Offset determination	0	504/8	1008/8
Offset result	0	63	125
segment	1	2	3

Table 4. Second fragmented data packet

Data packet	IP header	MTU packet	IP header
1200	20	505	20

Fragmented size	505	505	190
MF	1	1	0
Offset value	504	504	192
Offset determination	0	504/8	1008/8
Offset result	0	63	125
segment	4	5	6

Table 5. Third fragmented data packet

Data packet	IP header	MTU packet	IP header
1000	20	505	20

Fragmented size	505	505	90
MF	1	1	0
Offset value	504	504	92
Offset determination	0	504/8	1008/8
Offset result	0	63	125
Segment	7	8	9

4. Discussion

The offset values determination of fragmented data packet are the same for all data sizes and larger data size latency and throughput have some microseconds delay during fragmented process, and IPv4 packets are delayed because the of insufficient IP address assigned to host on the network. Data packets in IPv6 have less latency and improved throughput in transmission. Although the offset values differ in sizes and more fragment at the tail end falls to zero.

As seen from figures 5, 6, 7 the MTUs sizes are not the same, but fragmented values are the same in the figures and this is applied on the layer three applications. Some packet headers are the same but different in packets sizes this packets are segmented in word, page, double pages, etc., for easy transmission.

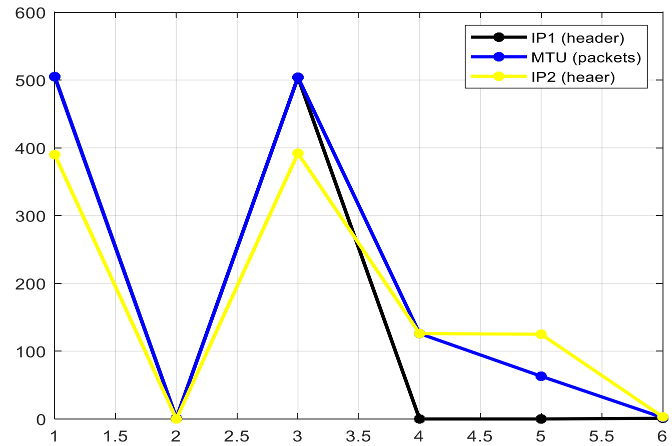

Figure 5. First fragmented data packet

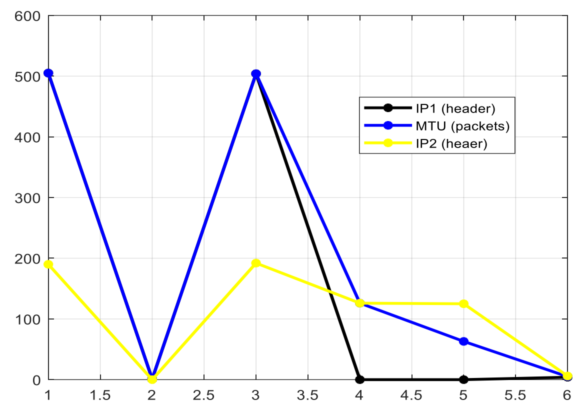

Figure 6 Second fragmented data packet

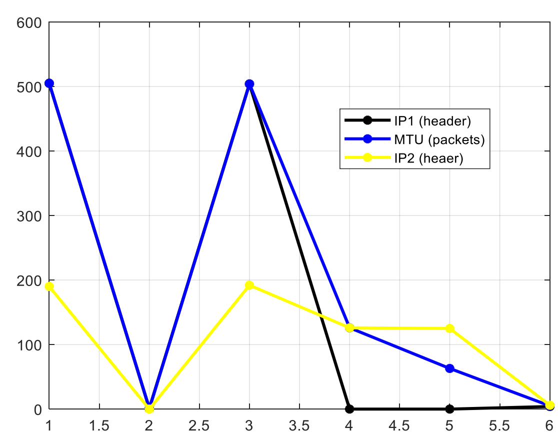

Figure 7. Second fragmented data packet

5. Conclusion/Recommendation

IPv6 has vast features to envelop any fragmented size of MTU, and the flexibility of data with IPv6 MTUs is robust in terms of speed and routing, due to the depletion condition of IPv4 address, which is a setback factor to network hosts, and its complex security features. The transition process of IPv4 to IPv6 has been in slow space, NCC and other network authorities should completely deploy IPv6 systems and avoid dual stack processes of combination of the two networks for the recent network, for a robust and flexibility network system

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