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Research paper

Enhancing the internet performance by restructuring IPV6 basic header

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Abstract

The infirmity of IPv4 in oblige the quickened development in requirements for unassigned IPv4 internet addresses blaze a trail for the emersion of new version of the internet protocol with quadruple address length to past all urgent need for web and applications in future using 128 bits address. Our paper highlights the major drawback in this new version of internet protocol which lies in its eighty presents overhead in the each packet fundamental header due to the origin and target addresses length which affect the internetworking performance. Then we nominate a solution after carrying out a study that aims to propose a new address length that enhances the general efficiency and utilization of the web and reduces the overhead by decreasing the address length. But at the same time is able to oblige the quickened development in requirements for assigned internet addresses in far future. This study produced a prediction table that predicts each IP address size between 32 bits and 64 bits in which year will all its available IP addresses for this size will be consumed.

Keywords: *IPV4 Protocol; Ipv6 Protocol; IPV6 Consumption Rate; Ipv6 Header; IP Allocation Prediction; Internet Efficiency.*

1. Introduction

For the last few years, internet protocol version four has been confronting amazingly a major issue because of its restricted address space where it utilizes just 32-bits which is no more adequate to oblige the quickened development in requirement for unassigned IPv4 internet addresses [2]. Then, internet protocol version six has been presented as a solution for the expected IP insufficiency issue by growing up the number of IP addresses to meet all urgent need for web and applications in future using 128 bits address length instead of only 32-bits Which will provide a huge endless number of addresses.

This paper emerge a noteworthy extra load in the IPv6 basic datagram header where the address possesses eighty percent of the whole header. So we use the number of ipv4 addresses allocated from year 1983 to year 2017 and the number of ipv6 addresses allocated from year 2000 to year 2017 depending on charts taken from RIR website[1] to carry out a study keeping in mind the end goal to predict when a certain IP size length has all its generated addresses and list the date of consumption for several address lengths with intention to propose a new address length to enhance the general efficiency and utilization of the web and reduce the overhead by decreasing the address length.

In our study we construct a table that shows the cumulative allocated IP addresses for both ipv4 and ipv6 in order to use these data to predict the number of allocated IP addresses in future. In order to do that we will derive another table that shows the value of increment in IP addresses number in each year relatively to one year before then we will construct a linear chart for this table in order to study the changes in IP addresses increment from year 1984 to year 2017 then we will conclude the best way to predict the future increments in each year. Then we will predict the number of allocated IP addresses for several years after 2017, after that we will generate a table that shows the number of generated IP addresses for several different sizes of IP. Finally we will use this table and the table of predicted number of allocated IP addresses in future to predict the year in which each address size all its IP addresses will be allocated. This will give a clear picture of whether the IPv6 address size is the most suitable one or we should nominate a smaller one to enhance the overall performance of the internet.

Serving our purpose of elicitation in which year an IP address with n bits size will have all its addresses reserved we will construct a table that shows several IP addresses with different sizes and the corresponding number of available IP addresses for each size, and we will construct another table that determines for each IP address size in which year will all its available IP addresses will be consumed.

2. The new internet protocol version background

Internet protocol controls the movement of data through the internet using network layer in each host or router from the exporter all the way to its final destination. All network interfaces for any node over the internet or any network owns a distinct address that belongs either to internet protocol version four or version six. The same internet node may have internet protocol version four and version six addresses; the internet protocol version four addresses are partitioned into 4 groups of bits each with length equal to 8 bits. Some of these groups refer to the current network and the others refer to the current internet node and each group is written using a decimal number between 0 and 255. The addresses in internet protocol version six are partitioned into 16 groups of bits each with length equal to 8 bits [3], [4]. Some of these groups is refer to the current network and the others refer to the current internet node, each group is written using two hexadecimal digits number between 00 and FF.

Internet Protocol version six is constructed to supplant internet protocol version four. It was characterized in December 1998 by the

Internet Engineering Task Force. The principal representation which remains overwhelming use right now is an Internet layer systematic convention for parcel exchanged and internetworking through any network. It additionally represents new options that streamline the address allocation task and network address reallocation while switching among different internet suppliers. The protocol subnet length has been institutionalized by settling the length of host ID part to 64 bits in order to encourage constructing the ID automatically using data link layer frame physical address. It also expands the horizon of options delivered for users much more than the antecedent protocol which makes this protocol overcome Ipv4 easily. IPv6 gives a few administrations and capacities that make IPv6 a prevalent web convention like fitting and-play auto setup, quality of administration stream mark [5], [6], multicasting, rearranged preparing by switches, , multicast listener revelation messages, ICMPv6 router solicitation and augmentation headers and much more.

3. How does the new internet protocol version solves the previous version problem

The primary purpose behind acquainting version six of the internet protocol is to conquer the worries of the quick development in web which requests increasingly unassigned internet protocol addresses to be accessible to oblige this development. IANA version four unassigned address pool depletion is unquestionable [1]. Because of the insufficient number of addresses provided by the antecedent protocol version which is not any more adequate to the web requirements, in addition to what has been mentioned before number of researchers anticipation related to needs to new internet protocol that gives adaptability to further development and extension has turned out to be earnest. What's more, the principal highlight of this internet protocol ought to be the number of corresponding addresses generated by this protocol.

Internet protocol version six is the most appropriate candidate for handling IPv4 depletion issue since its address length is (128 bits). These Sixteen bytes or 128 bits can suit 340,282,366,920,938,463,463,374,607,431,768,211,456 different network interfaces which imply that there are sufficient addresses for each segment in the universe [5]. This huge number will not confront the fatigue issue even after a billion years.

4. The new internet protocol major issue

In the event that we take, a quick glance at internet protocol basic datagram ignoring data part each datagram should include basic fields such as origin sender of datagram 128 bits address, final target 128 bits address, version of the internet protocol, how many bytes this datagram is and other fields as in figure 1. Figure 1 show that the number of bits in the header is 320 bits, 256 bits out of 320 bits is reserved for origin and final target addresses. We conclude that eighty percent of the fundamental header is reserved for both addresses. This is viewed as a major internet protocol version six drawback that will adversely affect the internet performance due to addresses number of bits in comparison with the bits of other fields in header [5-7]. To achieve our main goal in this paper which is enhancement of the internet efficiency, we will suggest to get rid of some of the 320 bits in each datagram by shrinking both the origin and the target address length. The following study is carried out to nominate new length for an internet protocol addresses which is shorter in length but at the same time the number of addresses provided by the new length to be sufficiently substantial with the goal that it can oblige should mimic the necessities of the world in the far future.

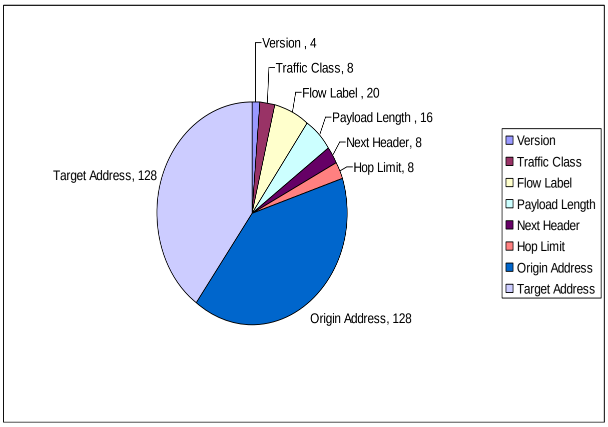

Fig. 1: Size in Bits for Each Basic Fields in Ipv6 Datagram Header.

5. Consumed IP addresses (1983 – 2017)

In this section we will present the number of IP addresses allocated from year 1983 to year 2017 depending on two charts taken from RIR website [1] in 30/3/2017. First we will derive table that reflects the number of allocated ipv4 addresses from first chart, after that we will derive table that reflects the number of allocated ipv6 addresses from second chart then we will derive third table that shows the cumulative allocated IP addresses for both ipv4 and ipv6 in order to use these data to predict the number of allocated IP addresses in future.

5.1. Consumed IPV4 addresses (1983 – 2017)

The following chart in Figure 2 shows the allocation of ipv4 addresses from year 1983 to year 2017. As we can see, the number of ipv4 addresses consumed during this period is growing up exponentially starting from 1792 IP addresses for year 1983 until it has reached 3640531832 IP addresses in year 2017.

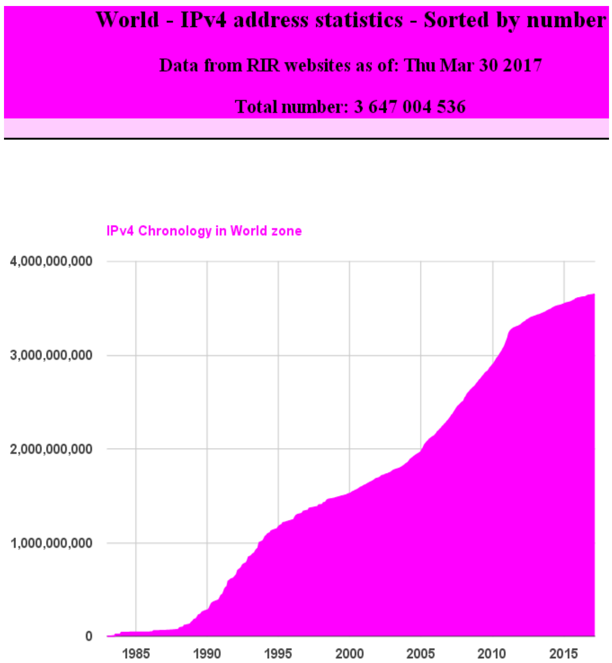

Fig. 2: Total Number of Ipv4 Addresses in Each Month from 1985 to 2017 [1].

In order to derive a table that represents number of ipv4 addresses consumed in each year from 1983 to 2017. Knowing that the above chart gives the number of addresses in each month we will consider number of consumed ipv4 addresses in first the month of each year in the above chart and so the result table (table 1) will be as follows:

Table 1: Number of Ipv4 Addresses Consumed in Each Year from 1983 to 2017

Year	Number of IPv4 addresses
1983	1,792
1984	39,264,768
1985	40,655,616
1986	42,653,440
1987	58,848,000
1988	70,870,784
1989	158,322,176
1990	277,408,512
1991	436,488,704
1992	643,755,520
1993	849,472,256
1994	1,037,399,040
1995	1,163,527,680
1996	1,238,995,968
1997	1,338,610,048
1998	1,401,468,032
1999	1,474,832,640
2000	1,520,257,536
2001	1,606,495,776
2002	1,685,328,992
2003	1,761,725,672
2004	1,843,104,360
2005	1,967,120,392
2006	2,147,511,888
2007	2,320,718,104
2008	2,507,878,040
2009	2,709,628,904
2010	2,891,925,592
2011	3,149,258,744
2012	3,320,092,248
2013	3,413,165,176
2014	3,480,403,576
2015	3,541,115,768
2016	3,606,379,896
2017	3,640,531,832

As we can see in the above table, the number of ipv4 addresses consumed start with relatively small number in year 1983. This number is multiplied by 21911.14 the next year then it increases but with smaller rate less than 2 until year 1989 where the consumption in this year is more than double of the consumption in the previous year, after that the consumption rate decreases to less than the double in each year in respect to one year before until the last year.

5.2. Consumed IPV6 addresses 2000 – 2017

The following chart in Figure 3 shows the allocation of ipv6 addresses from year 2000 to year 2017. As we can see, the number of ipv4 addresses consumed during this period is growing up exponentially starting from 2531328 ipv6 addresses for year 2000 until it reaches 13584326377 ipv6addresses in year 2017.

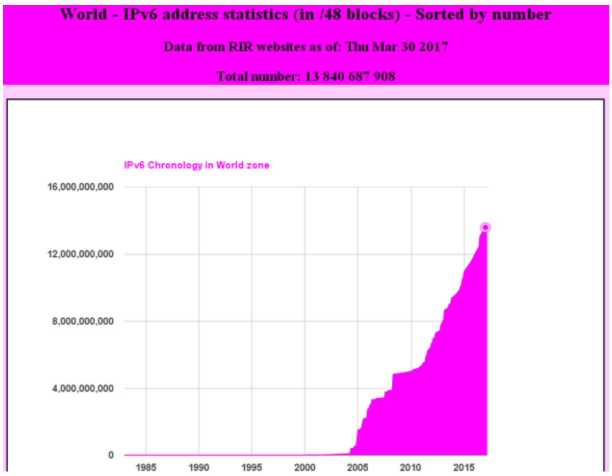

Fig. 3: Total Number of Ipv6 Addresses in Each Month from 2000 to 2017 [1].

In order to derive a table that represents number of ipv6 addresses consumed in each year from 2000 to 2017, we will consider the number of consumed ipv6 addresses in the first month of each year in the above chart and so the result table (table 2) will be as follows:

Table 2: Number of Ipv4 Addresses Consumed in Each Year from 1983 to 2017

Year	Number of IPv6 Addresses
2000	2,531,328
2001	6,922,240
2002	13,148,165
2003	38,936,597
2004	70,098,987
2005	1,492,271,189
2006	2,740,600,930
2007	3,389,997,216
2008	3,852,682,089
2009	4,873,807,959
2010	4,986,613,174
2011	5,326,634,970
2012	6,657,140,811
2013	8,012,674,065
2014	9,449,317,306
2015	10,896,345,470
2016	11,937,783,921
2017	13,584,326,377

As we can see in the above table, the number of ipv6 addresses consumed rate is 3 times in year 2001 with respect to the number of ipv6 addresses consumed in the first year, then in year 2002 the number goes to approximately the double of its value in year 2001 which then rises to more than the double in year 2003 than the number in the year 2002, after that the consumption number of ipv6 addresses is less than the double in each year with respect of the year before it whereas in year 2008 it decreases to 1.136 times of the previous year, in the same way it decreases more in 2010 to 1.02 times of the number in 2009. In last year the consumption number is approximately 1.134 times of the year 2016.

5.3. Cumulative allocation for both of ipv4 and IPV6 (1983 - 2017)

Now we need to derive a table that represents the cumulative allocation for both of IPv4 and IPv6 from year 1983 to year 2017 which will be used later to predict in which year all addresses for a specific address length will be allocated. Table 3 below is derived from both tables table 1 and table 2 simply by adding the corresponding numbers of allocated IP addresses in each year.

Table 3: Number of Ipv4 and Ipv6 Addresses Consumed in Each Year from 1983 to 2017

Year	Number of IPv4 and IPv6 Addresses
1983	1,792
1984	39,264,768
1985	40,655,616
1986	42,653,440
1987	58,848,000
1988	70,870,784
1989	158,322,176
1990	277,408,512
1991	436,488,704
1992	643,755,520
1993	849,472,256
1994	1,037,399,040
1995	1,163,527,680
1996	1,238,995,968
1997	1,338,610,048
1998	1,401,468,032
1999	1,474,832,640
2000	1,522,788,864
2001	1,613,418,016
2002	1,698,477,157
2003	1,800,662,269
2004	1,913,203,347
2005	3,459,391,581
2006	4,888,112,818

2007	5,710,715,320
2008	6,360,560,129
2009	7,583,436,863
2010	7,878,538,766
2011	8,475,893,714
2012	9,977,233,059
2013	11,425,839,241
2014	12,929,720,882
2015	14,437,461,238
2016	15,544,163,817
2017	17,224,858,209

6. IP allocation prediction

In order to predict the future number of cumulative allocated IP addresses for both IPv4 and IPv6 addresses, we will derive another table that shows the value of increment in IP addresses number in each year relatively to one year before, then we will construct a linear chart for this table in order to study the changes in IP addresses increments from year 1984 to year 2017. Then we can conclude the best way to predict the future increments in each year. After that we will predict the number of allocated IP addresses for several years after 2017, next we will generate a table that declare the number of generated IP addresses for several different sizes of IP. Finally, we will use this table and the table of the predicted number of allocated IP addresses in future to predict the year in which each address size all its IP addresses will be allocated. This will give a clear picture of whether the IPv6 address size is the most suitable one or we should nominate a smaller one to enhance the overall performance of the internet.
The following Table 4 shows the value of increment in IP addresses number in each year from the increment in year 1984 in relative of year 1983 until the last increment in year 2017 in relative to year 2016.

Table 4: The Increment in Number of IP Addresses Number in Each Year from 1984 to 2017

Year	The Increment Value
1984	39262976
1985	1390848
1986	1997824
1987	16194560
1988	12022784
1989	87451392
1990	119086336
1991	159080192
1992	207266816
1993	205716736
1994	187926784
1995	126128640
1996	75468288
1997	99614080
1998	62857984
1999	73364608
2000	47956224
2001	90629152
2002	85059141
2003	102185112
2004	112541078
2005	1546188234
2006	1428721237
2007	822602502
2008	649844809
2009	1222876734
2010	295101903
2011	597354948
2012	1501339345
2013	1448606182
2014	1503881641
2015	1507740356
2016	1106702579
2017	1680694392

In the above table, we can notice the fluctuation in IP addresses increments value among the years in the table, that suggest there is no relatively consistent increment rate, in other words the increments rate turns up from increasing in increments rate to decreasing in increments rate and vice versa. To see this more clearly, we will construct the chart that reflects table 4 as follows:

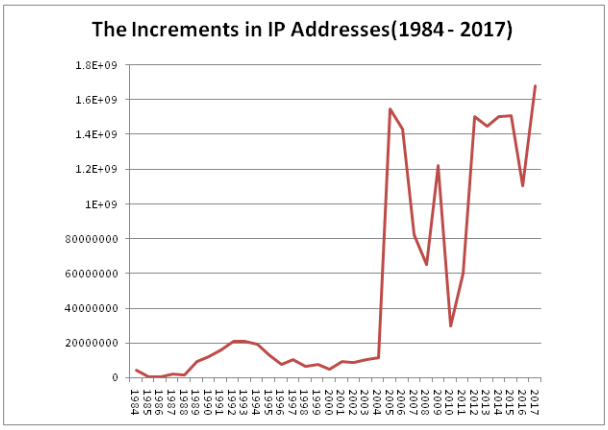

Fig. 4: How Increment in Number of IP Addresses Number In Each Year Changes from 1984 to 2017.

In the above chart, in Figure 4, the fluctuation in IP addresses increments value is obvious. First in the period between year 1984 and year 1988 the increments rate is approximately constant. After 1988 increment rate rises until it reaches 205716736 in year 1993 then it decreases until it reaches 47956224 in year 2000. Then it rises to 112541078 in year 2004 after that, its jumps to value of 1546188234 in year 2005. That means the increment in this year is approximately 13.74 times than the year before it. After 2005, the increment decreases until it reaches 649844809 in year 2008, one year after it jumps again to 1222876734 the year after that it descends sharply to 295101903 but after that it rises sharply to 1501339345 in year 2012 then it stay relatively constant until year 2015 so it's descends sharply again on year 2016 to 1106702579 and in the last year it reaches the maximum increment in the number of allocated IP addresses which is 1680694392.
Now we will choose increment rate with intention to determine future allocated IP addresses for a number of years. Considering all increments in allocated addresses we notice that the maximum increment in the number of allocated IP addresses is 1680694392. So if we apply it on all future prediction for consumed IP addresses, this will provide us with maximum prediction according to all other increments of consumption addresses which will accommodate the need to find the expected limit for any IP address size.
Serving our purpose of elicitation in which year an IP address with n bits size will have all its addresses reserved, we will construct a table that shows several IP addresses with different sizes what will be there corresponding the number of available IP addresses for each size. Table 5 shows the number of IP addresses for each IP address size from 32 bits to 64 bits. The reason to stop at 64 bit size is that it represents half of the bits of IPv6 address size and double of IPv4 in bits size.

Table 5: The Number of IP Addresses for Each IP Address Size from Address Size of 32 Bits to Address Size 64 Bits

IP Address Size in bits	Number of Addresses
32	4294967296
33	8589934592
34	17179869184
35	34359738368
36	68719476736
37	137438953472
38	274877906944
39	549755813888
40	1099511627776
41	2199023255552
42	4398046511104
43	8796093022208
44	17592186044416
45	35184372088832
46	70368744177664

47	140737488355328
48	281474976710656
49	562949953421312
50	1125899906842620
51	2251799813685250
52	4503599627370500
53	9007199254740990
54	35184372088832
55	36028797018964000
56	72057594037927900
57	144115188075856000
58	288230376151712000
59	576460752303423000
60	1152921504606850000
61	2305843009213690000
62	4611686018427390000
63	9223372036854780000
64	18446744073709600000

The last step to decide the most appropriate size in bits for addresses in internet protocol to accommodate the growing demands on addresses and at the same time to utilize the internet protocol header packet size by reducing the origin and target addresses size and ameliorate the performance of transferring packets, we will construct another table that determines for each IP address size in which year will all its available IP addresses for this size will be consumed.

Table 6: The Predicted Exhibition Date for Each IP Address Size from Address Size of 32 Bits to Address Size 64 Bits

IP Address Size in bits	Exhibition Date
32	XXXX
33	XXXX
34	XXXX
35	2027
36	2047
37	2088
38	2170
39	2333
40	2660
41	3315
42	4623
43	7240
44	12473
45	22941
46	43875
47	85744
48	169481
49	336957
50	671908
51	1341810
52	2681613
53	5361220
54	10720433
55	21438859
56	42875711
57	85749415
58	171496823
59	342991634
60	685981271
61	1371960536
62	2743919067
63	5487836129
64	10975670253

As shown table 6, the number of years between 32-bits and 64-bits of IP address size is growing up beginning from year 2027 for address estimate 35-bit until the year of 10975670253 for address size 64-bits with period of 10975668226 years.
For 35-bit IP address measure the consumption date in year 2027, and for few following IP address sizes to size 40-bits the estimated consumption date in the table the date gets to be distinctly in the twenty-first century. From that point forward, the predicted date growing rate increases rabidly so that for next five addresses the date will be 22941, after that for address size 50 bits consuming date grow very dramatically to year 671908, this dramatically rises up continuo exponentially to date 21438859 for size of 55-bit. For size of 60 bits the consumption date will Consists of 9 digits (685981271). Finally 64 bit address size will allocate all of its address space at year of 10975670253.
Diminishing the IPv6 address length from 128-bits down to 64-bit, this size can suit up to 1.84467E+19 internet protocol addresses with huge period of time until year 10975670253 , which is approximately forever. Because of that, no reason Oblige us to be tenaciouswith 128-bits IP address length while 64-bit address achieves the dream of getting rid of forty percent of internet protocol core datagram size which is viewed as a critical diminishment that will enhance the general internet efficiency.

7. Conclusion

This paper emerge a noteworthy extra load in the IPv6 basic datagram header where the address possesses eighty percent of the whole header. We carry out a study keeping in mind the end goal to predict when a certain IP size length has all its generated addressed possessed and list date of consumption for several address lengths with intention to propose a new address length to enhance the general efficiency and utilization of the web and reduce the overhead by decreasing the address length. We construct table that shows the cumulative allocated IP addresses for both ipv4 and ipv6 then we use this table to predict the number of allocated IP addresses in future. In order to do that, we derive another table that shows the value of increment in IP addresses number in each year relatively to one year before then we construct a linear chart in order to study the changes in IP addresses increments from year 1984 to year 2017. After that we suggest the best way to predict the future increments in each year. Then we predict the number of allocated IP addresses for several years after 2017, and we generate a table that declare the number of generated IP addresses for several different sizes of IP. Finally we use this table and the table of predicted number of allocated IP addresses in future to predict the year in which each address size between 32-bits and 64-bits of IP address size has all its IP addresses allocated. As a result we conclude that diminishing the IPv6 address length from 128-bits down to 64-bit, this size can suit up to 1.84467E+19 internet protocol addresses with huge period of time until year 10975670253 , which is approximately forever. Because of that, no reason Oblige us to be tenacious with 128-bits IP address length while 64-bit address achieves the dream of getting rid of forty percent of internet protocol core datagram size which is viewed as a critical diminishment that will enhance the general internet efficiency.

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