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On Identification of Internet of Things

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Abstract

In this paper, Identification Challenge of the Internet of Things has been studied, in particular, the recent Identity Protocols IPv4 and IPv6. Remarks based on mathematical reasoning raised on the latest Identity Protocol IPv6 concerning the possibility of redundancy in the length of the 128-bit binary sequence of IPv6 and some algorithms implemented on data portion of the sequence.

Keywords: sensor; source; receiver; device; destination; IPv4; IPv6; identification protocol; privacy; and security.

1. Introduction:

Internet of Things (IoT) can be described by objects that are capable of sensing, communicating, and interacting with the environment. The deployment of IoT will yield a smart society that is a society on which every things surrounding us is smart such as homes, cars, road, air, science, education, business, communication, ... etc [1, 2]. Connecting all objects through the world, mean billions of users exchanging and storing data. This will raise the question of unique address to each object and the privacy and security of the data exchanged between them. In such world human will take a minor rule according to the wide range of application of the IoT in society [3]. Deployment of IoT faces many challenges, among them, the Identification challenge. A unique identification for any device, (source or receiver) or in general for any object is vital in the IoT. That is any object must have a unique address. The recent identification protocols IPv4 and IPv6 are not simultaneously compatible and the number of users of the internet is growing rapidly in billions which will be out of the 32-dimensional space of IPv4.

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2. The Identity Protocols IPv4 and IPv6

Identity protocol (IP) is a communication protocol that deals with the identification and location of a device or object in the internet or in any network. In another word, any device, or object has an Identification address in any network or internet.

IPv4 was the first identification protocol used in the internet which represents a 32-dimensional vector space on a binary field that consists of four octets with address space consists of a 32-bit binary sequence. The number of available addresses will be 2^{32} which provide approximately 4.3 Billion addresses for devices. With the high demands on new addresses, the IPv4 is no more capable of satisfying future needs, although up to May 2014, the IPv4 was carrying 96% of internet traffic worldwide [4, 5, 6, 7].

IPv6 is a 128-dimensional vector space on a binary field which is a 128-bit binary sequence that provides 2^{128} addresses. The number 2^{128} is a huge number. It is approximately 3.4×10^{38} addresses. These addresses are represented by partitioning the 128-bit sequence to 8 parts each part consists of 4 hexadecimal digits separated by colon [4, 6, 7]. That is an address in IPv6 could be:

3001:000:ab04:1100:efcd:0000:0000:0000

Where 3001 is 0011 0000 0000 0001 while ab04 is 1010 1011 0000 0100

In other ward

1 → 0001, 2 → 0010, ..., 9 → 1001, a → 1010, b → 1011, ..., f → 1111.

In IPv6, the size of the host identifier of an address is fixed to 64 bit while the other 64 bit for algorithms and mechanisms that perform different jobs on the addresses such as exchanging traffic between IPv4 and IPv6, detecting double address, security, ..., etc. In short IPv6 sequence of 128-bit is partitioned to two 64-bit portions one for addresses and the other for rules and algorithms. Also in the addresses spaces of IPv4 and IPv6 there are two types of addresses, local and global and this put more work on tunneling addresses between IPv4 and IPv6.

3. Remarks on the IPv6

By 1996, IPv6 was defined [4] as a result of great effort from many specialists worked on the Identification protocol since they knew that IPv4 will be not capable of supporting future demands. Although IPv6 is gaining ground from IPv4 and responding to the future high demands and having features not present in IPv4 but still a few remarks on IPv6 may be put as follows:

Is there any redundancy in the length of the addresses space (128 bit)? Consequently, is there any redundancy algorithms?

At 2010 the world population reached 6.8 Billion while the devices increased to 12.5 Billion with an average 1.84 device for every person. In 2009 a Chinese research concluded that the number of devices doubles every

5.32 year. A prediction to the growth of world population and devices connected to internet [1] as shown below in billion (B).

Table 1. Growth of World Population and Devices

Year	2003	2010	2015	2020
World population	6.3 B	6.8 B	7.2 B	7.6 B
Connected devices	500 M	12.5 B	25 B	50 B
Average	0.08	1.84	3.47	6.58

The US Census Bureau predicted the world population on 2010 to be 7 Billion. The United Nations prediction from 2010 up to 2100 run to three possibilities low, medium, and high with 6, 10, and 16 Billion respectively [8]. Below a discussion for two worst cases:

1- Working with the worst case possible, the maximum number of population in year 2100 will be 16 Billion. The predicted number of population in 2020 will be 7.6 Billion while the expected number of devices connected to the internet will be 50 Billion .The ratio is $(50/7.6) \approx (6.58)$. If this ratio is constant then the expected number of devices in 2100 will be $6.58 \times 16 = 105$ Billion and a 37-bit binary sequence is sufficient for identification.

2- Considering the most exaggeration case on which the Chinese research predicted that the number of devices doubles every 5.32 year then the number of devices in 2100 is computed as follows:

2100 – 2020 = 80 year on which, the devices double every 5.32 year. In this case the devices doubles $(80 / 5.32) \approx 15$ times and then their number is computed by the following recurrence relation

$$a_{n+1} = 2 a_n , \text{ where } a_0 = 50 \times 10^9 , n = 0,1,\dots,15$$

Hence $a_{15} = 2^{15} \times 50 \times 10^9 \approx 16 \times 10^{14}$ the expected number of devices on 2100.

Since $2^{10} = 1024 > 10^3$ and $50 < 2^6$

Hence the predicted number of devices in 2100 will be

$$2^{15} \times 50 \times 10^9 < 2^{15} \times 2^6 \times 2^{30} = 2^{51}$$

This mean a binary sequence of 51 bits will provide sufficient identification addresses to the objects in 2100.

So a 51-bit sequence provides addresses to future demands up to year 2100 without a necessity to have local addresses and then an injective 1-1 function from IPv4 space to IPv6 space will provide new addresses to the IPv4 addresses without a need for tunneling algorithm or duplicate address algorithm.

4. Conclusion:

This paper studied the recent identity protocols IPv4 and IPv6 toward having most optimal identification protocol that responds to all demands up to year 2100 with minimum number of bits in the addresses space. A Mathematical computations showed that a 51-bit binary sequence is enough for such addresses space with less number of algorithms needed such as exchanging protocol between IPv4 and IPv6 and checking double addresses.

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