Final Report

Future Internet Addressing (FI Address)

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1. INTRODUCTION

The architecture and operational methods of Future Internet (FI) are not yet clear. So, proposing any specific solution for addressing could be too much ambitious at this point. However, what we could do from our current status of knowledge is that we could take lessons from the issues, challenges, and problems discovered in the current Internet and then we could think about possible solutions to surmount the hurdles in some way. Also, we could think about including new facilities and services that we expect from Internet services in the near future. As 'addressing' is one of the core issues in Internetworking, in this article, I'll try to touch upon some of the critical points we could work on when considering the addressing methods in Future Internet.

2. WHAT'S WRONG WITH THE CURRENT IP ADDRESS?

Today's Internet is facing lots of challenges. The rapid growth of user population, as well as multiple other factors including multi-homing, traffic engineering, and policy routing, have been driving the growth of the Default Free Zone (DFZ) routing table size at an increasing and potentially alarming rate [1]. Though there are many issues to tackle when talking about Internet addressing, this article focuses only on dealing with specific features that might be required in Future Internet address.

Today's Internet does not tell in which geographical location a device is exactly located. The IP address uniquely identifies a device and by employing some methods we could find out the location of a device. However, it is not possible to determine the location of a device just by seeing its IP address (if needed). Incorporating this type of feature in Internet address might help the network operators (or, naive users) to efficiently manage the network structures and operations, to select the nearest or short distance server for any particular task, to allow the users to get an idea about the physical placements of servers and user terminals, etc.

Another problem in today's Internet is that the addressing mechanism does not allow mobility of a device with the same address. A device in one place needs a complete different address in another location.

Considering the absence of these features in IP address, this article proposes a novel way of addressing the devices in Future Internet (FI). As mentioned earlier, since the overall structure of the FI is not yet clear and the whole issue is under scrutiny, the idea might seem a bit optimistic.

This article focuses on ensuring the following features in the addressing scheme of Future Internet:

- The addressing scheme should be able to provide direct information about the exact geographical location of a device
- But the identity of the device must be the same in all locations so that it does not get a new ID in different locations
- This '*Location revealing*' aspect could be turned on/off based on requirement

3. THOUGHTS FOR PRACTITIONERS: FUTURE ADDRESSING

One of the famous quotes from Yakov Rekhter which is sometimes referred to as "Rekhter's Law" is "*Addressing can follow topology or topology can follow addressing. Choose one*". If addressing dominates topology, then there are many scopes of thinking about the network's structure and methods of operation. This article prefers that the addressing should dominate topology, i.e., the topology of the Future Internet should be based on required addressing mechanism, so that we could have the desired features in the Internet addresses.

A possible way of addressing in Future Internet could be with the splitting of Identifier and Locator. This particular feature is not present in today's IP address. IP address generally serves both as an endpoint identifier for the transport layer and a locator for the routing protocols. For our case, we need such an addressing scheme that will not only identify the device uniquely but also could tell us about the exact location of the device alongside supporting mobility of the device. If required, the geographical location of the device could be kept hidden from other entities. In that case, only the device identifier has to serve the purpose for the routing protocols.

While talking about addressing structure in Future Internet, a very novel idea might not be appropriate or could be very difficult to implement in practical scenarios. The reason for this is

that the routing and communications among the devices depend on the address structure used in the network. Also, if the address structure cannot support other associated issues like mobility, security, Quality of Service (QoS), etc. then it won't be helpful in realistic environments. Alongside these expected characteristics, we need to include some futuristic views that could facilitate the expectations for Future Internet. Hence, we need to combine the ideas that we have learnt from practical achievements from the past and some of the futuristic views that we would like to incorporate in future. Taking all these requirements and thoughts into account we could think about an address structure that looks like Figure 1.

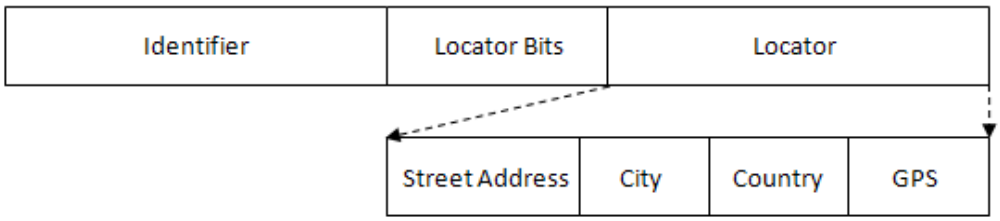

Figure 1: FI Address Structure

Let us explore all the parts of this FI address structure. It has mainly three portions:

- Identifier
- Locator Bits
- Locator

Descriptions of each part are presented below.

IDENTIFIER PART

This could be any globally unique identity of each device. Possible structure for this part could be: → Content of the device + Device's name

Content of the device could help for '*Content-based routing*' in Future Internet. Each type of content could be given an identifier and device's name could be chosen uniquely over the globe. Further investigations are required how each device could be named uniquely throughout the globe. It could be something like the '*Fingerprint*' of human beings which is unique for each individual in earth. In fact, the fingerprint pattern (expressed as an identity) of the owner of the device could be the name of the associated device.

LOCATOR PART

The locator portion could help for quick routing and identifying the geographical location of the device. There could be several ways of handling this portion in the future addressing structure. One of the design goals for this FI address is:
Just by seeing the address, the geographical location of the device could be determined. Again, when required, the location revealing feature could be kept secret from others.

To facilitate this feature, the locator portion could be divided into some segments as follows (Figure 1):

- Street Address field
- City field
- Country field
- GPS (Global Positioning System) reading field

LOCATOR BITS PART

The fields in 'Locator' part could be revealed or kept hidden based on the value set for the 'Locator Bits' portion. This portion has two bits. Based on four binary combinations, how the locator bits are used for revealing or hiding the location of the device is shown in Table 1.

Table 1. Locator Segment Based on Locator Bits

Locator Bits		Meaning
00	→	No Information (All zeros) **[0, 0, 0, 0]**
01	→	Only GPS reading **[0, 0, 0, GPS]**
10	→	City and Country Information **[0, City, Country, 0]**
11	→	Street Address, City, Country Information, GPS reading **[Street Address, City, Country, GPS]**

When locator bits are set to '00', locator portion contains all zeros. Hence, the FI address looks just like the unique identifier with trailing zeros. In such a case, the address does not reveal the geographical location of the device and routing is done based on the unique global identifier.

When locator bits are set to '01', only GPS reading that tells about the exact geographical location of the device is revealed. In such a case, the entire address could give anybody the idea about the exact geographical location of the device. However, from the surface, this is not much informative unless a person knows about the geographical positioning system. For example, a person who does not know how the latitudes and longitudes are calculated and which values

mean what, could not be sure about the country, city or the address of the device just by seeing the entire FI address.

When locator bits are set to ‘10’, city and country information are revealed publicly. Hence, anybody can get the information about the device’s city and country just by seeing the address. However, exact geographical location is not revealed so that an expert cannot get the idea where the device is exactly located.

When locator bits are set to ‘11’, all the information is revealed so that both an expert or a naive person can get the idea about the exact location and address of the device seeing the FI address.

MORE THOUGHTS

Remaining research issues could be how many bits are to be used for the segments of the locator portion or identifier portion. Also for street address, city, and country, character type data are required for easy expression. In reality it is difficult to memorize long list of numbers or bit sequence to represent various things. So, plain texts as we use in normal life could be used for these segments. As an example, each country in this world could be denoted with a two letter character sequence [2] like Bangladesh could be represented by ‘BD’, Korea could be represented by ‘KR’, etc. If it is difficult to understand or not user-friendly, a three-letter acronym could be used like Bangladesh with ‘BAN’, Korea with ‘KOR’, etc.

Now, another requirement we have is that the addressing structure must also support mobility. The structure presented here could provide the mobility of the device/user without any change in the identifier field. So, the device could move from one place to another where the segments of street address, city, country, and GPS readings would only changed. This address structure could meet our requirements for Future Internet. Associated issues like QoS, security, etc. could be thought of based on the proposed idea.

4. CONCLUSIONS

The idea presented in this report tries to combine the lessons learnt from reality and futuristic views towards developing an addressing structure for Future Internet. What seems to be impossible today might become a reality in near future. Moreover, as Future Internet itself is an ‘*under scrutiny*’ research issue, combining the lessons learnt from experience and ideas from

innovative minds could be the best approach towards developing Future Internet addressing structure.

5. REFERENCES

[1] Meyer, D., Zhang, L., and Fall, K., "Report from the IAB Workshop on Routing and Addressing", RFC 4984, IETF Report, September 2007, Available at: http://www.ietf.org/rfc/rfc4984.txt, accessed 04 December, 2008.

[2] http://www.kellerinternetmarketing.com/country_abbreviation_acronym_finder.php