Chapter 1
IPv6-Based IoT Smart Cities

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ABSTRACT

In the process of Internet evolution, the transition from IPv4 to IPv6 has become inevitable and fairly urgent. IANA (Internet Assigned Numbers Authority) has finally exhausted the global IPv4 address space, which leaves the community no choice but pushes forward the IPv6 transition process. IPv4 and IPv6 networks both will exist during the transition period, while the two are not compatible in nature. Therefore, it is indispensable to maintain the availability, as well as to provide the inter-communication ability of IPv4 and IPv6. Years ago, a series of transition techniques were actually proposed. However, because of their technical immatureness, they failed to cover the solution space well. Some of these techniques were even obsoleted by IETF due to their flaws.

INTRODUCTION

The Internet has been remarkably successful in scaling from a small community of users to a global network of networks serving more than a billion users. Over a short period it has also become a fundamental infrastructure for economies and societies around the world. Along the way, what was being interconnected expanded from one mainframe per university or company, to a one computer per person paradigm, to a multi-device environment, including greater use and all forms of access. In the future, vast numbers of objects may be connected to the Internet.

Growth in the use of the Internet has meant greater demand for Internet addresses. IP addresses combine “WHO”, “WHERE” and “HOW” roles in the Internet’s architecture. Internet addresses uniquely identify devices on the network i.e. “endpoints”, enabling the identification of the parties to a communication transaction (“WHO” role). In addition, addresses are used by the network to transfer data as they determine the network location of the identified endpoint (“WHERE” role). Addresses are also used to support routing decisions (“HOW” role). Therefore, IP addresses enable connection to the Internet, both through identification of the endpoints to a conversation and enabling the carriage of the data of the conversation through the network.

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IPv6 is a new version of the Internet layer protocol (IP) in the TCP/IP suite of protocols. It replaces the current Internet protocol layer commonly referred to as IPv4. IPv6 is not new. RFC 2460 (IPv6) was released in December 1998. It has been more than a decade, so where are we with IPv6?

The transition between today's IPv4 Internet and the future IPv6-based one will be a long process during which both protocol versions will coexist. Moving from IPv4 to IPv6 is not straightforward and guidelines to simplify transition between the two versions have to be standardized. Network transition has been discussed in detail; however applications should be reviewed to complete the porting process.

Existing applications are written assuming IPv4. Only very recently IPv6 has been taken into account. Unless most of basic distributed applications are available now; there is too much work to do yet. The aim of this paper is to provide general recommendations to be taken into account during the porting process of applications and services to IPv6. This will allow developers to move smoothly their applications into the new environment.

IPv4 has been the network layer protocol since the very early stage of the Internet. The scale of IPv4 Internet has become far larger than one could ever imagine when designing the protocol. Currently IPv4 Internet is facing a series of problems including address exhaustion, routing scalability, and broken end-to-end property. IANA (Internet Assigned Numbers Authority) had run out of global IPv4 address pool in Feb 2011, while simulations show that within 3 years all the RIRs (Rigional Internet Registries) will exhaust their IPv4 address space. On the other hand, the scale of Internet is still growing fast, especially on the user side where the number of Internet-enabled mobile devices increases rapidly. This leads to continuous demands for new IP address allocation, which seems impossible to satisfy with IPv4. ChinaTelecom, one of the largest telecom ISPs (Internet Service Providers) in the world claims that by the end of 2012, they will use up all the IPv4 addresses they have acquired or can acquire. Besides, the prefix de-aggregation caused by address block subdivision, multihoming and traffic engineering has caused a burst in Global IPv4 RIB (Routing Information Base) and FIB (Forwarding Information Base). The Internet is suffering from this routing scalability problem. Moreover, the wide use of NAT has broken down the fundamental end-to-end property all over the Internet.

The objective of this chapter is divided in three parts. The first analyzes in which conditions is possible the transition to IPv6 without changing applications. This chapter includes recommendations on how to proceed when source code is not available and explains which mechanisms can be used. The second is the main part. It starts describing IPv6 transition scenarios from the application point of view. The focus is on analyzing existing applications looking for characteristics, which usually should be reviewed during transition to IPv6. It includes a brief description of basic socket interface extensions for IPv6, fully described in RFC2553. The chapter concludes providing general recommendations for new IPv6 applications. In the future all IPv4 networks will be IPv6 however during a long period mixed scenarios with both IPv4 and IPv6 will be the real environments. Therefore, new applications should be designed to work only in a pure IPv6 environment, but a design to allow mixed IPv4 and IPv6 environment is better now.

TRANSITION TO IPV6 WITHOUT CHANGING APPLICATIONS

Many methodologies have been studied to support transition to IPv6 depending on initial network architectures. To make IPv6 network available to the user it's necessary to provide a great number of IPv6