Research on the Application of the IPv6 Network Protocol

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Abstract. With the rapid development of computer network technology, network applications have been very popular in people’s lives and work. The computer network technology includes many aspects, mainly including the communication technology and the computer technology. Although the network application has been relatively impeccable now, although people can contact anyone anywhere at any time through the network, it is still not perfect enough, and there are still great bottlenecks in the network technology. The network protocol plays an important role in the network technology. At present, the IPv4 protocol is more widely used in the Internet than others. Although the IPv6 protocol also has some applications, it is used less widely. For this reason, it is very necessary to research the application of the IPv6 network protocol. This paper mainly studies the main technical performance of the IPv6 network protocol, and introduces its application with specific examples. This paper analyzes the tunnel technology, network address translator technology and dual-stack technology of IPv6. And this paper introduces the basic configuration of the IPv6 address and of the static routing according to a specific type of router.

1. Introduction

Although the Internet based on the IPv4 network protocol has a wide range of applications, the shortcomings of its network structure have been turning more and more obvious with the rapid increase of network users, among which the lack of network address is very evident. The IPv6 technology is a good solution to the problem of the insufficient IPv4 address space. Moreover, compared with the IPv4 technology, IPv6 has been significantly strengthened in its scalability and security, mainly including the large address space, the stateless automatic configuration, the network layer security and the service level and so on. The IPv6 network protocol can provide sufficient network addresses and better network performance, which is the inevitable trend of the development of the Internet in the future. However, replacing IPv4 with IPv6 cannot be achieved overnight, and it needs to be transited slowly from IPv4. For a long time, IPv6 and IPv4 will be used simultaneously. Therefore, it is necessary to study the conversion technology from IPv4 network to IPv6 network while studying IPv6[1].

2. The IPv6 Network Protocol

2.1. The Overview

The IPv6 protocol has the characteristics of the efficient structure of packet, the sufficient address space, the automatic address configuration, the unity of security policy and the high efficiency of neighbor discovery mechanism. IPv6 improves the original structure of packet, and the packet header in the structure of packet is divided into two parts: the fixed one and the expanded one, so that it can practice differentiated storage, and the process of protocol processing is further simplified. The address space
used in the IPv6 network is 128 bits, so that the huge address space can effectively solve the problems of network congestion and insufficient address space in the IPv4 network.

2.2. The IPv6 Address
IPv4 has a 32-bit address length, which can theoretically address 16 million networks and 4 billion hosts. However, the number of available network addresses and host addresses are greatly reduced after using the three types of A, B, C addressing, so that the current IP addresses are almost exhausted. IPv6 is composed of 128-bit binary numbers, namely 32-bit hexadecimal numbers, and it is usually represented by 8 groups (4-bit/group) of hexadecimal numbers. The sufficient ground space of IPv6 will greatly meet the demand for address growth with the emergence of network smart devices[2].

2.3. The IPv6 and IPv4 Header Format
The IPv6 header format is shown in Figure 1, and the IPv4 header format is shown in Figure 2.

![Figure 1. Basic IPv6 Header](image1)

![Figure 2. IPv4 Header](image2)

The structure of the IPv6 header is much simpler than the one of the IPv4 header. The IPv6 header deletes many domains which are not commonly used in the IPv4 header, and puts them into the options and the header extensions. The options in IPv6 have stricter definition.

IPv4 has 10 fixed-length domains, 2 address spaces and several options, while IPv6 has only 6 domains and 2 address spaces.

Although the IPv6 header takes up 40 bytes, which is 1.6 times longer than the IPv4 header of 24 bytes, it is fixed in length (while the IPv4 header is variable in length), so it does not need to consume too much memory capacity.

The six domains of the header length, the service type, the identifier, the flag, the segment offset and the header checksum in IPv4 are deleted. The name or some functions of the three domains of the total length of the structure of packet, the protocol type and the survival time are changed, and the option function is completely changed. Two new domains are added, namely the priority and the flow label[3].

The great simplification of the IPv6 header format effectively reduces the processing overhead of the router or the switch for the header. At the same time, IPv6 strengthens the support for the extended
header and the options, which not only makes the forwarding more effective, but also provides sufficient support for loading new applications in the network in the future. Each IPv6 packet can have 0, 1 or more extension headers. Each extension header is determined by the domain of “the next header” of the previous header.

The most obvious difference between the IPv4 and the IPv6 addresses is the length: the IPv4 addresses are 32 bits long while the IPv6 addresses are 128 bits long.

The IPv4 addresses can be divided into two to three different parts (the network identifier, the node identifier, and sometimes the subnet identifier). The IPv6 addresses have larger address space and can support more fields.

RFC2373 defines three kinds of IPv6 address types:

Unicast: the identifier with a single interface. The Packet sent to a unicast address will be sent to the interface of this address identifier.

Multicast: the identifier of a set of interfaces (generally belonging to different nodes). The packet sent to a multicast address will be sent to all the interfaces of this address identifier.

Anycast: the identifier of a set of interfaces (generally belonging to different nodes). The package sent to a broadcast address will be sent to one of the interfaces of this address identifier (the “nearest” is selected according to the calculation method of the routing protocol for the distance).

3. The Key IPv6 Technologies

3.1. The IPv6 Tunnel Technology

The tunnel technology is the basic means of communication between IPv6 individual subnets in the transition stage. The core idea of the tunnel technology is to make the existing IPV4 network become a carrier to establish the communication of IPV6 by encapsulating the IPV6 data message into the IPV4 data message. The transmission of the data message between the nodes at both ends of the tunnel is carried out through the IPV4 mechanism, and the tunnel is regarded as a channel of direct connection. In short, the idea of the tunnel strategy is that the router encapsulates the IPV6 data packet into IPV4, and the “protocol” field of the IPV4 data packet header is set to “41”, indicating that the net charge of this set is an IPV6 set, that the source address and the destination address of the IPV4 data packet correspond to the IPV4 address of the tunnel entrance and exit, respectively, and that, at the exit of the tunnel, the IPV6 data packet is taken out and transmitted to the destination site. The tunnel technology only requires modifications at the entrance and the exit of the tunnel, and there is no requirement for other parts, so it is very easy to realize this technology. The advantage of the tunnel technology lies in the transparency of the tunnel. The communication between the IPv6 hosts can ignore the existence of the tunnel, and the tunnel only plays the role of a physical channel. Although the tunnel technology is widely used in the early evolution from IPv4 to IPv6, it cannot achieve the communication between the IPv4 host and the IPv6 host. A tunnel has an entrance point and an end point. In order to let the data pass, the address of the two endpoints must be known. It can be direct to determine the entrance point, because it appears at the boundary of the IPV4 infrastructure, while it is more complex to determine the end point of the tunnel[4].

3.2. The Network Address Translator Technology

The Network Address Translation (NAT) technology regards the IPv4 address and the IPv6 address as the internal address and as the global address respectively, or vice versa. For example, when the internal IPv4 host communicates with the external IPv6 host, the IPv4 address (equivalent to the internal address) is transformed into the IPv6 address (equivalent to the global address) in the NAT server, and the server maintains a mapping table of the IPv4 and IPv6 address. On the contrary, when the internal IPv6 host communicates with the external IPv4 host, the IPv6 host is mapped to an internal address, and the IPv4 host is mapped to a global address. The NAT technology can solve the problem of interoperability between the IPv4 host and the IPv6 host[5].
3.3. The Dual-Stack Technology
The dual-stack mechanism is to make the IPv6 network node have an IPv4 stack and an IPv6 stack, while supporting the IPv4 protocol and the IPv6 protocol. IPv6 and IPv4 are network-layer protocols with similar functions, and both of them are applied to the same physical platform and carry the same transport-layer protocol TCP or UDP. If a host supports both the IPv6 protocol and the IPv4 protocol, then this host can communicate with the host that only supports the IPv4 protocol or the IPv6 protocol.

4. The Simple Application

4.1. The Basic Configuration of the IPv6 Address
This paper takes the ZXR10 ZSR router as an example to illustrate how to use.

The IPv6 address is configured in the interface configuration mode, and the steps are as follows:
Firstly, enter into the interface configuration mode.
interface <interface-name>

Secondly, set the IPv6 addresses of the interface.
Enable ipv6.
ipv6 enable
Set the IP address of the interface.
ipv6 address <ipv6-prefix>/<prefix-length>

Assume that the slot 3 of ZXR10 ZSR has a Gigabit Ethernet interface board, and the IPv6 address should be configured on the second interface. The specific configuration is shown in Figure 3:

To facilitate maintenance and diagnosis, ZXR10 ZSR provides relevant viewing and debugging commands.
Display the details of the IPv6 interface.
show ipv6 interface [<interface-name>]
Display the simple information of the IPv6 interface.
show ipv6 interface [<interface-name>] brief

4.2. The Basic Configuration of the IPv6 Static Routing
The IPv6 static routing and the IPv4 static routing are very similar, and both of them refer to the routing information that the network administrator specifies to the routing table through configuration commands. It does not establish the routing table according to routing algorithm like the dynamic routing. When configuring the dynamic routing, it is sometimes necessary to send the routing information of the entire Internet to a router, which makes it difficult for the router to load. At this time, the static routing can be used to solve this problem. Using the static routing only needs less configuration to avoid the use of the dynamic routing. But in a routing environment with multiple routers and multiple paths, configuring the static routing will become complicated.
The configuration of the static routing mainly includes the following procedures:
Configure the IPv6 static routing.
ipv6 route
Display the information of the IPv6 routing table.
show ipv6 route
Displays various types of routing statistics in summary for the IPv6 routing table.
show ipv6 route summary
5. Conclusion

By comparing and analyzing the message structures of IPv4 and IPv6, it is found in this paper that there is serious weakness in the IPv4 network address, while the IPv6 protocol has the characteristics of efficient message structure, sufficient address space, automatized address configuration, the unity of security policy and the efficiency of neighbor discovery mechanism and so on. However, at present, the IPv4 network is widely used and cannot be completely replaced by the IPv6 network, which requires a certain transition time. This paper also analyzes the tunnel technology, network address translator technology and dual-stack technology of IPv6. Finally, this paper introduces the basic configuration of the IPv6 address and of the static routing according to a specific type of router. IPv6 is a very important network protocol, so it is very necessary to research the application of the IPv6 network protocol. It is important to research the application of the IPv6 network protocol on Internet of Things (IOT) in the future.

References

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