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The Simulation Research of Campus Network Technology Based on IPv6

Lizhen Zhao[a]*, Fan Yang[b], Yuming Zhao[b]

[a] *Educational Technology and Computer Center, Zhaoqing University, Zhaoqing, Guangdong China*
[b] *School of Computer Science, Zhaoqing University, Zhaoqing, Guangdong China*

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Abstract

Aiming at the issues of smooth transition from IPv4 to IPv6 and interoperability in technical coexistence period about campus network, discussing the technical characteristics of IPv6 protocol, GNS3 and OPNET simulator, combined with the status of weakness of IPv6 technology , lack of IPv6 technology planning and financial support for network upgrade in the vast majority of colleges, adopted the simulation methods to build a network model of IPv4 and IPv6 to achieve the technologies study such as topology design, network configuration and testing, network performance design and evaluation of IPv6 campus network under the low-cost conditions.

1. Introduction

As IPv6 technology matures, its technical superiority also highlights and various IPv6 test network and IPv6 resources and services construction continue to accelerate the pace. At present, the world has been established 6Bone (IPv6 demonstration of the worldwide backbone network), 6REN (IPv6 Research Education Network), BNS (the U.S. high-speed backbone service network), Zama Network (the first commercial IPv6 service network), 6NET (EuropeanIPv6 trial network), and CNGI demonstration network of china - the CERNET2 networks [1]. The IPv6 network testing, applications and interconnection will lead to the evolution of network architecture, which brings the

* Corresponding author: sdzlz@zqu.edu.cn

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Internet demand for services the new changes. Especially the construction of CNGI demonstration network in China (CERNET2) laid a solid foundation for the overall network structure, key technology and talent training for national public information infrastructure and information resources construction [2]. Nearly 100 colleges and universities have realized the campus network from IPv4 to IPv6 transition upgrade, which also increased other colleges and universities to expedite the study of IPv6 technology and network upgrades in the sense of urgency and a sense of crisis. How to achieve the interoperability issues of the campus network from IPv4 to IPv6 smooth transition as well as technical co-existence has becomes an important issue facing these colleges and universities currently. This paper makes use of simulation methods to build IPv4 and IPv6 network model and to carry out simulation research such as IPv6 campus network topology design, network configuration and testing, network performance design and evaluation under low cost by discussing the IPv6 protocol and the technical characteristics of the GNS3 simulator and OPNET simulation, combining with the present status of Pv6 technology weakness of vast majority of colleges and universities and lack of network upgrade planning and financial support.

2. The Technical Advantages of IPv6

IPv6 abandons the drawbacks of IPv4, at the same time inherits many of its advantages, so IPv6 shows a more technical advantages.

2.1 Address Management Advantage

IPv6 address management advantages embody three aspects, such as enlargement of address space, reasonable and automatic address assignment configuration and mobility support [3]. First, IPv6 uses 128-bit address length, provides 2128 addressing space to meet addressing the requirements of any "objects" in the foreseeable future decades. Second, the increaseing of address length , not only increases the number of addresses but also improves the quality of address assignment. IPv6 address, consist of unicast, multicast and anycast as well as a large number of reserved addresses (about 85% of the total IPv6 address), which are used to deal with the problem of addressing unforeseen. Unicast address is divided into global cluster address, link and site local address compatible with the IPv4 address, as well as reserved for NSAP and IPX address. IPv6 abolishs the concept of the IPv4 address classes, uses 64-bit host number and 64-bit network number, which can be further divided to facilitate the clustering and routing. Third, IPv6 address provides auto-configuration capability, which can be divided into the stateless auto-configuration [4] and stateful auto-configuration. A node only need take IEEE-EUI-64 address of link layer as the host number, combining with the local network number provided by your ISP, to get unique IPv6 address by IPv6 auto-configuration, realizes "plug and play", which greatly simplifys the complexity of network management and control, better supports mobile network address management and implementation. In addition, IPv6 addresses are owned by the ISP [5], which avoids the trouble of the user-configured address and address waste and ISP routing clustering difficulty.

2.2. Advantages of improved header

Improvements of IPv6 header mainly embody two aspects. First, simplifying the basic header, eliminating some fields such as identifier, flag, checksum and offset in the IPv4 header, which simplifies the processing of the header; Second, extending header, which can follow basic header with optional way and maximum

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flexibility(according to factual need, extending header may be zero, one and more). Most of the extending header is not handled by the router, therefore, the efficiency of the router to forward be improved.

2.3 Advantages of Improved Routing

First of all, IPv6 improvements ICMP and upgrades ICMP to ICMPv6, on the basis of maintaining the basic functions of the original ICMP, which combines many functions of the different protocols of IPv4 and makes these functions to become many protocols related to new routing features. ND (Neighbor Discovery) is the important function of ICMPv6, which is used to manage the communication between nodes on the same link to replace the Data Link Layer ARP, inhibits broadcast storms, increase security. Second, IPv6 inter-domain routing replaces the original BGP-4 with IDRP (Inter Domain Routing Protocol). Third, IPv6 gets rid of the hop-by-hop datagram fragmentation in IPv4, and uses the source host fragmentation mechanism, by the NDP [6] (neighbor discovery protocol) to realize the neighbor discovery and to determine the Path MTU to provide information for IPv6 source host fragmentation. The improvement of IPv6 routing, simplifies the IPv6 routing header, reduces fragmentation overhead of the router, and greatly reduces the complexity of the hosts and routers.

2.4 Built-in Security Mechanisms

Security in general, consists of authentication, confidentiality and integrity. Built-in security mechanisms of IPv6 comprises IPsec, AH and ESP and realizes AH and ESP by extending header. IPsec fulfills authentication and confidentiality requirements, AH (Authentication Header) is the head certification mechanism defined by RFCl826 [7], which ensures that the recipient of the datagram source is reliable, and not changed during transmission through the certification process. ESP (Encrypted Security Payload) is a safety net load defined by RFC 1827[8], which ensure only legitimate recipient can read the contents of the datagram by an encryption technology.

2.5 Enhanced QoS

The IP4 take a "best effort" transmission, QoS is difficult to guarantee. IPv6 provides a good support for QoS, especially the transmission of VoIP and other real-time data stream by setting priority, label of the data flow, resource reservation, etc.

3. IPv6 Campus Network Simulation Based On the GNS3

GNS3 is an excellent network virtualization software having graphical interface, running on multiple platforms (including Windows, Linux, Mac OS, etc.), which can be used for the virtual experience of Cisco IOS configuration or to test the network deployed in the real router configuration. Usually, in order to provide a virtual network host or network server with different abilities, GNS3 will work with other virtual machine software such as VPCS, Vmware. Simulating IPv6 campus network by GNS3, usually includes five aspects such as the simulated network topology, configuration the parameters of the IPv6 network, installation and configuration of network services, network connection to the host (server), testing of IPv6 network connectivity.

3.1 Construction of IPv6 Campus Network Simulation Topology

At present, the basic idea to build IPv6 campus network is to transmit IPv6 packets in IPv4 network and provide IPv6 testing network service through

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the establishment of the IPv6 test network on the basis of the original IPv4 campus network, dual stack, tunneling and other technologies. Figure 1 is a simulated IPv6 campus network topology map using GNS3, the left part simulates original IPv4 campus networks, R6 simulates the campus network ISP (CERNET), the export of R1 simulates campus network firewall, R5 is simulation of the campus network core switch, R4 simulates campus network aggregation layer switches, C1 and C2 are IPv4 and IPv6 simulation test network, R2 simulates campus border exports, providing ISATAP tunneling connection, R3 simulates IPv4/IPv6 dual-stack router, R7 simulates pure IPv6 network CERNET2.

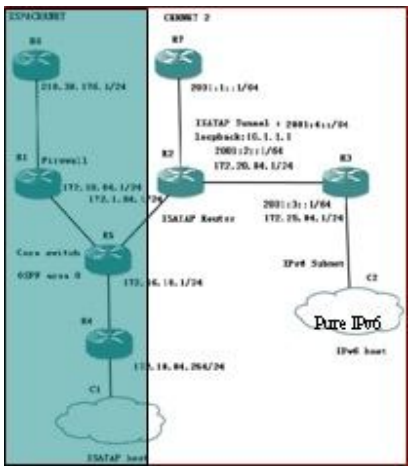

Fig.1. Simulated topology of IPv6 campus network

3.2 Parameter Configuration

Parameter configuration in Figure 1 focuses on the border router R2, which need to be configured as IPv4/IPv6 dual-stack, at the same time establish the ISATAP tunneling. Main configuration include: opening the router's IPv6 forwarding function, configuring the loopback interface parameters (used as the origin address of the ISATAP tunnels), configuring the ISATAP tunneling interface parameters, configuring the IPv4 network interface parameters, configuring IPv6 network interface parameters, enabling the OSPFv3 routing protocol and OSPF routing protocol. On this basis, the IPv6 protocol configuration on router R3 and the IPv6 network connected to it and configuration of pure IPv4 network components (including R6, R1, R4, R5, C1) according to IPv4 parameter system should be taken place.

3.3 IPv6 Network Testing

The testing of network in Figure 1 can be divided into IPv4/IPv6 connectivity testing of the network layer and IPv4/IPv6 services to access testing on application layer. When Connectivity testing, we can connect virtual host or a real host to the network, and upgrade the host to IPv6 (such as in the Windows family of operating systems to install the IPv6 protocol stack), after configure the ISATAP tunnels interface we can ping successfully. For service to access testing, according to need we can construct network service on a virtual machine or directly access the IPv4/IPv6 services on a real host.

4. IPv6 Campus Network Simulation Based on OPNET

IPv6 campus network simulation using OPNET, mainly simulates a variety of network structure and network performance and analyses results, to get network deployment scenarios on the basis of network modeling.

4.1 Establishing a simulation network model

According to distribution of the actual location of the campus network, combining with the network functions and the different objects, we construct the simulation of IPv4/IPv6 dual-stack network model including the office subnet (Office NET), teaching subnets (Teaching Net), and routing

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and switching subnet. The network topology was shown in Figure 2.

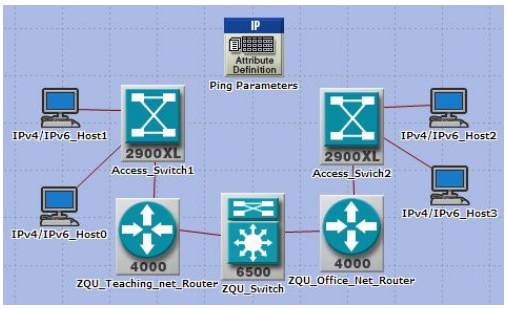

Fig.2. The Model of IPv4/IPv6 Dual-Stack network

In Figure 2 ZQU_Teaching_net and ZQU_Office_net represent teaching subnet and office subnets in different locations; each with a Cisco4000 router to simulate subnet gateway connect to each other through 1GB fiber optic lines connecting to ZQU_Switch. Within each subnet a switch Cisco2900XL switch is used to simulate subnet access switch respectively, and two hosts are used to simulate network nodes in subnets. Each node in the network supports IPv4 and IPv6 dual-stack and gateway router supports both the RIP and RIPng routing protocol.

4.2 The Main Parameters Configuration

First we set the IPv6 parameters of the two gateway routers through IPv6 Parameters settings, including the interface name, setting the Link Local address, set the Global address. Because it is a dual-stack model does not involve a tunnel encapsulation operation, it should Tunnel Interface is set to none. Second, choose the way of IPv4 and IPv6 IP Routing Protocols agreement. IP Ping Parameters OPNET in an IP properties configuration module is used to store and collect the relevant data of the simulation required, mainly in the IP the Version, Interval, Packet the Size, Timeout, Record the Router and so on. Third, configure the host IP Host Parameters host IPv6 parameters.

4.3 Collect Statistics

The definition of simulation statistics can be chose in the main modeling menu of OPNET by performing "DES→ Choose Individual Statistics". OPNET simulation statistics are divided into Global Statistics, Nodes Statistics and Link Statistics, while link statistics has nothing to do with the performance of IPv4 and IPv6, so we can choice relevant indicators (Figure 3) in Nodes Statistics to simulate in order to obtain different performance running both IPv4 and IPv6 in the same node, also can choose related indicators (Figure 4) in global statistics to simulate to obtain the different performance of the entire network running IPv4 and IPv6.

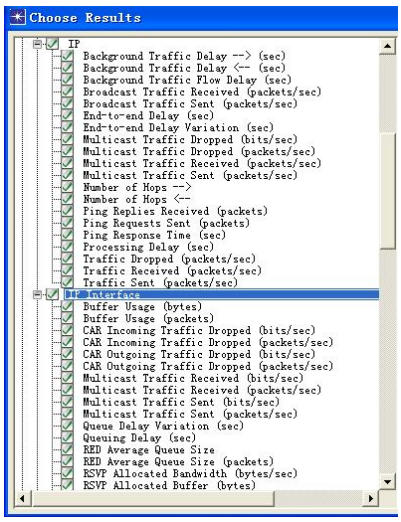

Fig. 3. Nodes Statistics in OPNET

4.3 Running Simulation and Analyzing Results

We configure or run simulation in main menu of the OPNET modeling through "DES → the Configure/Run Discrete Event Simulation" to create simulation results of selected statistic. Then, through running of "DES→Results→View Results or Compare Results" to view or comparatively analyses simulation results. In fact, in the case of the same network model topology, we can configure parameters according to the pure IPv4, pure IPv6 network, IPv4/IPv6 coexistence network

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to create different network simulation models and define the same simulation statistics, and compare and analyze the same performance of IPv4 and IPv6 according to the technical features of IPv6 to verify the performance of the characteristics of IPv6 technology in the network.

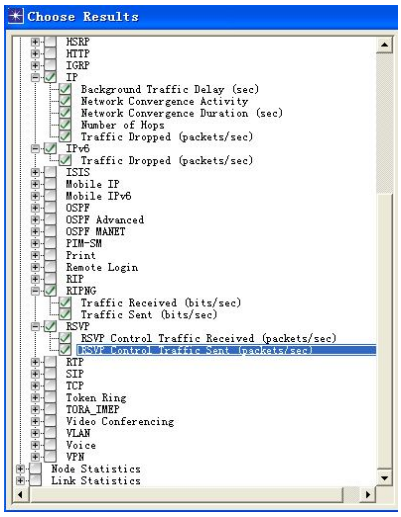

Fig. 4. Global Statistics in OPNET

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