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Intercommunication Strategy about IPv4/IPv6 coexistence networks based on Application Layer Gateway

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ABSTRACT

The combination of ALG and NAT-PT can achieve the communication between IPv6 and IPv4 network, but there are still many problems because of network complexity. This article combines NAT-PT and uses class E address pool to give a comprehensive and detailed analysis of improvements about the problems in the process of ALG communication, studying initiating communication process from the IPv4 and IPv6 ends, analysis of the relationship between the address pool mapping, to experiment the scheme and verify the feasibility. The scheme solves the NAT-PT gateway at both ends of the same and different protocol communications much easier, and also solves the shortage problem in IPv4 address of address pool.

Key words: IPv6; IPv4; NAT-PT; ALG; address pool

INTRODUCTION

At present, we have no new IPv4 address that can be assigned; the remaining IPv4 address is only enough to support up to recent years at most. IPv6 and NAT is the choice of current network. If the operators use NAT, it will lead to intercommunication problems, regulatory difficulties and the unsupported SIP applications. Therefore, IPv6 is still the first choice. However, the address of IPv4 and IPv6 is incompatible, so the transition to IPv6 still needs a process. Now IPv6 backbone has been existed. What's more, IPv6 network construction has been a certain scale. Thus how to make IPv4 and IPv6 interconnect with each other is urgent to be solved.

NAT-PT [1] (network address and protocol translation) is a comprehensive translation technology with SIIT protocol translation algorithm, NAT Address Mapping, which solves the communication problem between pure IPv4 and pure IPv6 network. However, some protocols can't get the information in the packet unless by the help of ALG, and DNS-ALG is the key technology to achieve the intercommunication between pure IPv4 network and IPv6 network.

NAT-PT and DNS-ALG [2] have been proposed to solve the interoperability for IPv4 and IPv6 network, but with the constant enlargement of IPv6 network, IPv4 address pool need more IPv4 address, but the problem of IPv4 address shortage became a limited. Based on the original scheme, this paper introduces class E [3] address pool, the use of class E address pool Instead of IPv4 address of the IPv4 address pool, solving the shortage problem in IPv4 address of address pool.

NAT-PT MECHANISM

The basic idea of NAT-PT mechanism is IPv4 and IPv6 host respectively using IPv4 and IPv6 protocol to communicate with each other in NAT-PT gateway. By the help of the middle NAT-PT gateway to make network layer protocols header converse between IPv6 and IPv4 to adapt the other side of protocol type, if it is the communication for IPv6 side, it should be set IPv6 prefix conversed by IPv4 address so that IPv4 address

can be identified; if it is the communication for IPv4 side, it should set class E address pool for the corresponding IPv4 address which is conversed by IPv6. The domain name space between hosts of IPv6 network and IPv4 network must be the end to end globally unique, and NAT-PT needs to translation the corresponding application layer data packet with ALG.

NAT-PT module is composed of three main parts [4] that include NAT and PT, DNS-ALG, which NAT and PT work in IP layer, and DNS-ALG works in the application layer.

Network Address Transition (NAT) part achieves the mapping conversion between IPv4 address and IPv6 address through class E address pool. According to the needs, it can set not only dynamic mapping but also static mapping. it stores Mapping the record to address mapping table, when the communication is established, conversion gateway only read the received the port number, address, protocol type field of data packets, operation in accordance with the Hash algorithm, then according to the calculation result to lookup, insert, delete operation with address mapping table, the final to complete the processing of data packet. M-Hash algorithm lookup table method can find the address mapping table, so as to improve the search efficiency.

Protocol Conversion (PT) part is mainly responsible for the conversion between IPv4 protocol and IPv6 protocol, especially for IP header and ICMP header, and converses each field of IP header in IPv4 and IPv6 packets based on the semantic differences to construct new IP header. Due to the possible existence of fragmentation header, so it is necessary to check whether it has fragmentation header before protocol translation. The message translation can be begun after the fragmentation header translation.

ALG [5] module is mainly responsible for network applications when the network load contains the IP address information, such as DNS-ALG, FTP-ALG, SIP-ALG etc. DNS-ALG is NAT-PT necessary module in mapping transformation.

IPV6 AND IPV4 COMMUNICATION PROCESS

The process of communication initiated by IPv4 side and the working principles of communication initiated by IPv6 side both needs ALG participation. We will explain the specific working principles of ALG below in detail. The communication ways of various ALG working models seem similar, so we will introduce them on the basis of the main DNS-ALG. DNS-ALG makes some treatments about the DNS message at an application scale so that the message could correctly reflect IPv4/v6 site domain name and address information, and DNS-ALG maintenance domain name and the list of address mapping to realize the communication management. In the process of realizement, IPv6 DNS server and IPv4 DNS server use the same domain space, so it needs to make some correction for IPv4/v6 DNS. At the same time, with the increase of IPv6 network, the former address pool can not satisfy the need of translation. Therefore, we use class E address as address pools for realizing the original address pools which are insufficient or the problem of low translation.

(1) IPv6 initiated communication

When the communication is initiated by IPv6 host to IPv4 host, the working principles are as follows:

a) When the messages sent by the host of IPv6 network to IPv4 network reach NAT-PT gateway When the gateway receives the data packet, which the application layer data are analyzed, and then decide whether the message to the ALG module for conversion;

b) If the data message does not contain the application layer data, then find mapping records of address mapping table, if not find the corresponding mapping record, establishing new mapping records insert address mapping table, through the ALG module handles the data packet to carry out the address mapping operation according to the address and port information; then will data packets which complete the address port conversion transformed to the protocol conversion module.

c) NAT-PT gateway just judges whether the message is to be sent to IPv4 network, if it is, it will take use of the dynamic mapping relation allocated by IPv6 side and converse IPv6 address message source to IPv4 addresses, if it is not, the source of IPv6 side will directly access to the purpose site.

d) If the format of IPv6 address in the message is prefix::v4 address [6], it extracts IPv4 address which lows 32-bit as the purpose IPv4 address of conversion; otherwise, the conversion will not succeed.

e) After IPv6 header conversed as IPv4 header, the purposed IPv6 address taken off prefix will become IPv4 address. According to the normal forwarding process, the equipment will send the massage to IPv4 network and eventually reaches its destination. Meanwhile, the mapping relationship between IPv6 address and conversed IPv4 address will be recorded to the equipment.

f) The purposed host of IPv4 network receives the message through NAT-PT switches (the message source address is an address of NAT-PT equipment or class E address pool); it will be returned to message and routed to NAT-PT equipment after the upper treatment; the NAT-PT equipment will make opposite address and protocol transition according to the records of mapping relationship, and then it will send IPv6 message back to the source equipment of IPv6 network.

(2) IPv4 initiated communication

When IPv4 host initiates the communication to IPv6 host, it can establish the mapping relationship of IPv6 and IPv4 through sending DNS query information, then this connection could make NAT-PT conversion with this mapping relationship. At the same time, NAT-PT needs to know the corresponding IP address of IPv4 DNS and IPv6 DNS. As the communication is initiated, NAT-PT needs to do the adress distribution task with DNS-ALG, and updates its own address mapping. It needs the help of DNS-ALG when IPv4 host visits IPv6 host. Among them, A is a kind of resource record format defined by IPv4 domain name system, AAAA is a kind of resource record format defined by IPv6 domain name system. Taking the visit of IPv4 host to IPv6 host as an example, the communication process is as follows.

a) IPv4 host sends the DNS analytical request to IPv4 DNS server, queries the DNS IPv6 host address, IPv4 DNS checks its own records, fails the lookup, turns to the NAT-PT gateway.

b) DNS-ALG intercepts this request, finding it is a request from IPv4 network, thus recorrects the type value in resource records from A to AAAA, then forwards it to IPv6 DNS server.

c) IPv6 DNS server receives this request, searches the record, gets IPv6 address. The type is still AAAA, replies to the DNS-ALG.

d) DNS-ALG detects this message is from IPv6 network, just communicates with NAT-PT, the NAT-PT takes an IPv4 address from the class E address pools as a pseudo IPv4 address, estabishes the mapping relationship with IPv6 address of purposed host and then writes on the mapping table, turns this pseudo IPv4 address to the DNS-ALG.

e) DNS-ALG corrects the TYPE from AAAA to A, and responses this pseudo IPv4 address to IPv4 host request.

f) DNS-ALG does not participate the communication any more, while IPv4 host takes this pseudo IPv4 address as the destination address and communicates with IPv6 host.

g) NAT- PT gateway intercepts and uses the pseudo IPv4 address as the IP group of the destination address, looks for the corresponding IPv6 address in the mapping table to replace IPv6 address of the purposed host, adds the prefix before IPv4 address to compound the pseudo IPv6 address.NAT-PT does the work of the part of protocol conversion and reconstructs the IP header.

h) Completes the work of address conversion and the protocol translation, the translation gateway will send out the message which is eventually received by IPv6 host. The communication schematic diagram is shown in Fig. 1.

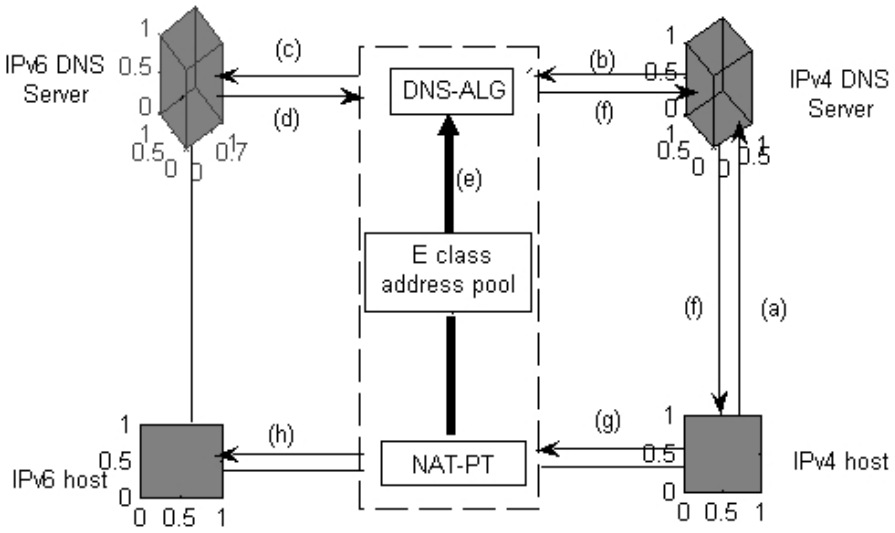

Fig. 1: The schematic diagram of DNS-ALG working model

No matter the communication initiated by IPv4 side or IPv6 side, it both needs to distribute the address from the class E address pool to meet the communication need, and it also needs to do the work of adding network prefix to meet the realization in IPv6 network communication.

PROBLEMS AND IMPROVEMENT PLAN

It will be returned the right results as the two sides of NAT-PT gateway: the pure IPv4 network and pure IPv6 network. If one of the sides is double stack protocol or the two sides are double stack protocols, it will have to directly communicate through the NAT-PT gateway when the nodes are in the same protocol. Through the process of NAT – PT, it will have two times' translation on the condition of non-need translation, then come back to the former translation. This kind of result not only decreases the communication efficiency but also wastes the relevant limited NAT-PT gateway resource. Therefore, when we use NAT-PT gateway under the complicated net circumstances, in some cases it will not only affect the gateway efficiency but also the realization of gateway function. In the view of the above problems, this paper modifies the treatment process of NAT-PT gateway communication, and puts forward the corresponding improvement plans.

(1) Choose the NAT-PT conversion through some conditions

For the address selection problems that generated when DNS-ALG communicates with double stack nodes, making modifications about the NAT-PT gateway rules by programming and selecting the protocols before the conversion that the message sent out in order to achieve the purpose of preferential access to appropriate address. If the two protocols are different, automatically open the NAT-PT protocol gateway to make protocol translation aims at realizing the communication at two different sides; while if they are same, directly pass the NAT-PT gateway and there is no need to do address conversion and protocol translation in order to realize the same protocol communication. Of course, it also can make the same protocol not pass NAT-PT, just relying on the BRT elevated interchange network to realize the same protocol communication.

(2) Send the query message after conversion by two steps

If IPv6 visits to IPv4, when AAAA query pass the NAT–PT gateway, the DNS-ALG will firstly converse the query address to the DNS server on the side of IPv4 network, and the DNS-ALG will not generate the query message of the A record type temporarily. If the DNS server has AAAA, it will return these records, and then they are answered back to IPv6 node by DNS-ALG. If the DNS server does not understand AAAA query nor has relevant node's AAAA record, it will return a wrong message.

When DNS-ALG receives this wrong message or no, then taking the second step operation, sending an A query which relates to this node through DNS-ALG. If this query returns IPv4 addresses, according to the response message generated from the AAAA record, the DNS-ALG will converse it to the corresponding IPv6 node. If they are not successful, it will return errors. Through these two operations, decreasing the times of

DNS-ALG conversion and quickening the speed of communication.

(3) Add or delete the DNS records to realize the message inquiry
As for the situation that IPv4 accesses to the double stack network, design a cache in the internal side of the gateway's DNS-ALG module. If the record type of the query message is A, add a corresponding entry in the cache. When it responses that the message has passed, compare it with the query message record in the cache. If the corresponding query record in the cache is A type, DNS-ALG will no longer translate these record parts, it will only converse these addresses by the gateway and then send back to the query node. If the query record is AAAA type, the DNS-ALG will converse the response message. After the end of the conversion about the response message and it is sent out, just delete the corresponding entry in the DNS-ALG query message cache. Similarly, when IPv6 visits Dual-stack network by NAT-PT, it also needs to design a reversed cache to realize the direct communication between IPv6 host and IPv6 host.

NETWORK INTERCOMMUNICATION IMPLEMENTATIONS

(1) The deployment and configuration of experiment network
NAT-PT gateway use Linux server to implement, by starting the NAT-PT function, and use the double card. Configure the IPv4 address in the IPv4 side, with the IPv6 address on the IPv6 side routing interface. In IPv4 side, we configure DNS server, PC; IPv4 server provides Domain Name Service for IPv4 host. In IPv6 network, IPv6 server provides domain name service for IPv6 host. In order to achieve access to the IPv4 host from IPv6 host, the use of dynamic address mapping and DNS-ALG to achieve this function; through the static address mapping to achieve IPv4 host visit IPv6 host. The network topology structure is shown in Fig. 2.

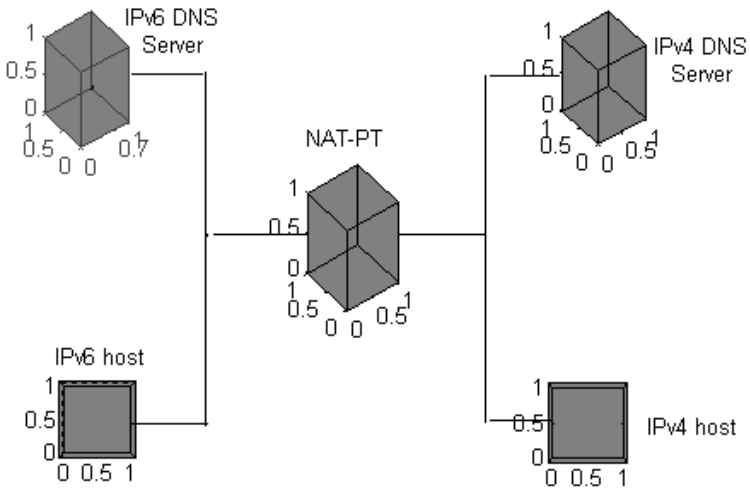

Fig. 2: The topology of experimental network

The main configuration commands are as follows:
dns server 218.196.240.8
natpt address-group 2 218.196.240.140 218.196.240.143
natpt prefix 1000::
natpt v4bound dynamic acl number 2000 prefix 1000::
natpt v6bound dynamic prefix 1000:: address-group 2
interface 0/0:
ip address 218.196.240.142 255.255.255.192
natpt enable
interface 0/1 :
ipv6 address 2001:250:4809:3::1/64
natpt enable
ip route-static :: 218.196.240.129
ipv6 route-static :: 0 2001:250:4809::1

(2) The experimental analysis
By the experiment, we realized the communication of IPv4 network and IPv6 network. As shown in the following image access route to the web site. As shown in fig.3, fig.4.

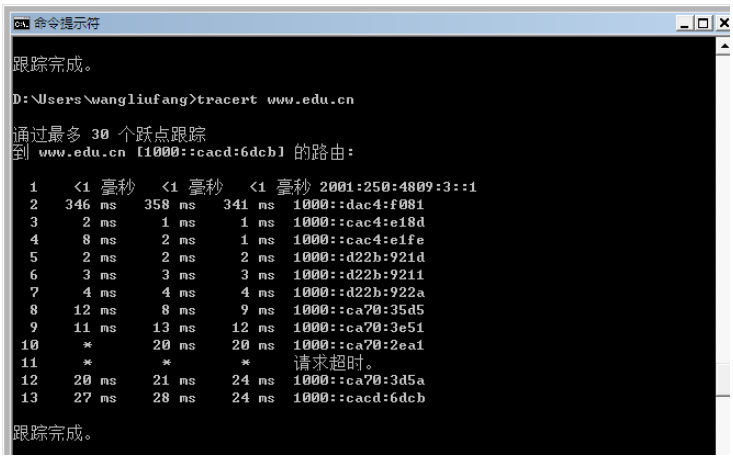

Fig.3: Tracert ipv4 site

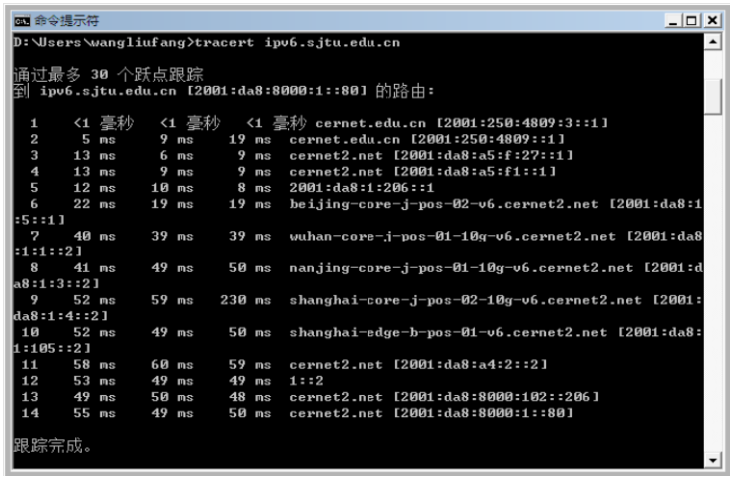

Fig.4: Tracert ipv6 site

By doing experiments in the Linux [7] and various operating system, the experimental process must be paid attention to the correct configuration the address, routing and DNS-ALG, otherwise it will lead to network.

In the experimental process, should pay attention to the following aspects:
a) The intermediate address mapping is not with the destination address in the same network segment. Such as: IPv4 and IPv6 communication, the destination address is: 2001::0, then you cannot use this address as a prefix, otherwise the NAT-PT device interface converts the IPv6 package, and the conversion packets may be lost.

b) Add a parameter "no-pat" configuration in dynamic mapping, or only from the ipv6 end to Ping the intermediate address through ipv4 mapping, cannot ping the ipv4 address through ipv6 mapping.

c) From the IPv4 side to initiate the test, IPv4 mapping address and DNS A record address consistent.

ALG solves the problem of IPv4 and IPv6 address choice and a variety of applications communication between the different networks. However, how to achieve rapid translation issue still needs further study in the communication.

CONCLUSION

By improving the defects that existed in the NAT-PT equipment and Application Layer Gateway, realize some exchange of basic applications and solve the application level protocol commnication problem by correcting some partial functions in the NAT-PT gateway. With the further improvement of the NAT-PT gateway, it is possible to realize the total exchange between IPv4 and IPv6 network in the near future.

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