Research and Implementation of Future Network IPV9

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***Abstract*—Nowadays, IPv4 has been difficult to meet the needs of the Internet in terms of performance, address space, security, etc. In order to solve the relevant needs of IPv4, protocols such as IPv6 and IPV9 have been born. This article introduces the current status and characteristics of IPv4 and IPv6, compares with IPV9, summarizes the relevant characteristics of IPV9, and introduces the production process of IPV9, its protocol composition, system architecture and related application introduction. IPV9 is controlled by my Chinese core technology and has independent intellectual property rights, which is the foundation of my country's future network.**

Keywords-Future Network; Decimal System; IPV9

I. IP

A. The Introduction of IP

IP(Internet Protocol), is the network layer Protocol in the TCP/IP architecture.

When we use the Internet, the most important question is whether my messages and actions can be successfully sent and whether I can receive messages from the outside. Today, our needs are fundamentally assured through IP. Sending and receiving is actually a kind of information transmission, our various operations will be various applications in the form of packets for transmission. The problem is getting from the beginning to the end, and it's not a direct highway, but a ladder of different routes that takes multiple hops to get there. The purpose of IP is to solve the problems of network connection and computer communication. Each IP address consists of a network address (NetID) and a host address (HostID). A network address represents which network in the Internet it belongs to, and a host address represents which host in that network it belongs to.

B. The Introduction of IP Address

IP Address(Internet Protocol Address), is a unified address format that assigns a logical address to each network and host on the Internet, just like our mobile phone number, which can be used to mask the physical address differences while making communication more convenient.

All IP addresses consist of network ID and host ID. Depending on the network ID and host ID, the Internet commission has defined five IP address types to suit networks of different capacities, namely class A to class E. Among them, A, B and C are the basic classes, while D and E are used as multicast and reserved. This is shown in figure 1.

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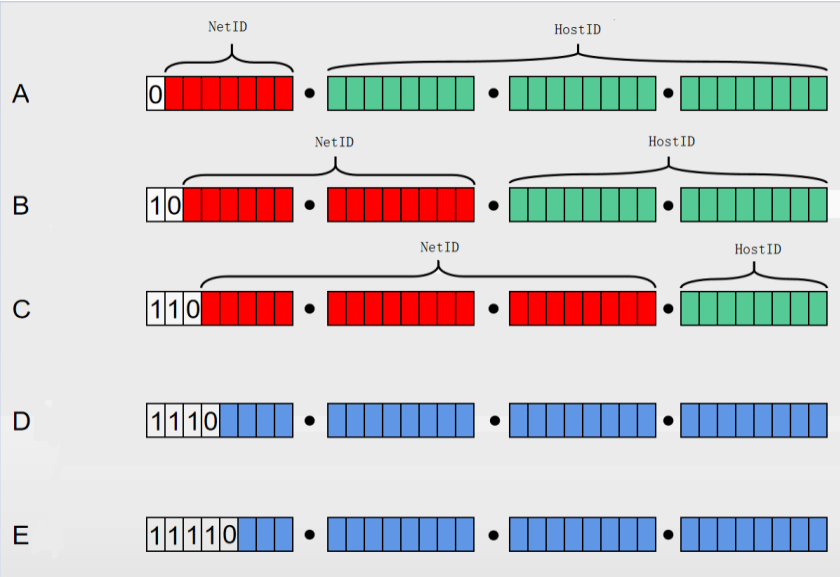

Figure 1. IP address

II. The Features and Problems of IPv4 and IPv6

A. *The Present Situation of IPv4*

IPv4 has played a key role in the development of networks, but with the expanding of network size, it can not meet the demand of network development, the first is the address resources are exhausted, lead directly to address the crisis, although no classification of addressing CIDR technology, network address translation NAT technology to alleviate the crisis, but still can't solve the problem.

The second problem is the expansion of routing table. The topology structure of address space directly leads to the fact that the form of address allocation is irrelevant to the network topology. With the growth of the number of networks and routers, the over-expansion of routing table increases the cost of searching and storage and becomes the bottleneck of the Internet. At the same time, the length of packet head is not fixed, so it is very inconvenient to extract, analyze and select the route by hardware, so it is difficult to improve the throughput rate of route data. Then there is the uneven distribution of IP addresses, because of the origin of the United States, more than half of all addresses are owned by the United States, resulting in a serious imbalance in the distribution of IP addresses.

There is also a lack of QoS (Quality of Service) support. IPv4 did not want to be open to the public at the beginning of the design, so it is very lacking in security, and it is difficult to provide rich QoS functions for real-time multimedia, mobile IP and other commercial services, although later The developed protocols such as RSVP provide QoS support, but the cost of planning and constructing an IP network is relatively high.

B. *The Features and Problems of IPv6*

IPv4 is a widely deployed Internet protocol. The IPv4 protocol is simple, easy to implement and interoperable. However, with the rapid development of the Internet, the deficiencies of IPv4 design have become increasingly obvious. IPv4 address space is insufficient, and the number of routing table entries that need to be maintained is too large. To solve these problems, the IETF designed IPv6. Compared with IPv4, IPv6 has the following features：

- IPv6 has a larger address space. In IPv4, the length of the IP address is 32 bits, that is, there

are 2^32-1 addresses; In IPv6, the length of an IP address is 128 bits, or 2^128-1 addresses. Compared with the 32-bit address space, the address space is greatly increased.

- IPv6 uses smaller routing tables. IPv6 address assignment follows the principle of Aggregation at the beginning, which enables the router to represent a subnet with an Entry in the routing table, greatly reducing the length of routing table in the router, and improving the router's forwarding speed of packets.
- IPv6 adds enhanced Multicast support and Flow Control, which allows for the development of multimedia applications on the network and provides a good network platform for QoS Control.
- IPv6 adds support for Auto Configuration. This is the improvement and extension of DHCP protocol, making network management more convenient and fast.
- IPv6 has Better header formatting, it uses a new header format with options that are separated from the base header and can be inserted between the base header and the upper data if desired. This simplifies and speeds up the routing process because most options do not need to be routed.

Despite the obvious advantages of IPv6, the number of IPv4 routers is huge, and the transition from IPv4 to IPv6 is a gradual process, with IPv6 being backward compatible. Therefore, IPv6 and IPv4 will coexist for a long time to come. In addition, IPv6 has a big flaw in the design idea of its address structure. IPv6 confuses the network hierarchy in design. The interface ID embeds the physical address into the logical address layer, which on the one hand leads to the limitation of the physical address space to the empty IP address. Security does not belong to the content of the IP layer, so it is inappropriate to design security technology in the IP layer. Because with the development of security technology, security methods and key length will constantly change, so the development of security technology will eventually lead to the requirements of IP address redesign. Due to the chaotic logic of the network hierarchy, IPv6 creates far more new problems than it solves.

III. The Introduction of IPV9

A. The Production of IPV9

In 1998, Chinese researcher Xie Jianping proposed IPV9, which means "Method of using whole digital code to assign address for computer." IPV9 is a "nickname" borrowed from the American concept of IP. In order to distinguish China's IPV9 from America's IPv4 and IPv6, the V in China's IPV9 is uppercase, not lowercase. The patent covers the new address coding design, the new addressing mechanism and new address three technical architecture design, form a new system of IP network at the bottom of the core technology, on the basis of the design of the new framework, to form a network system that is connected and compatible to cover the existing network (the Internet using IPv4 and IPv6 technologies).

In 2011, the authoritative professional agencies of the us government confirmed legally and technically that China owns the core technologies of the sovereign network under the IP framework, which are different from the existing technologies of the us Internet and have independent intellectual property rights. This is the IPV9 patented technology, the official name of the patent is "the method of assigning addresses to computers in full numeric code."

China's IPV9 was approved in 2001 (CN98 1 22785), and has been granted patents in more than 10 countries and regions including South Africa, Turkey, kazakhstan, Russia, the republic of Korea, the democratic People's Republic of Korea, Hong Kong, Canada, Singapore, Australia, Mexico and Norway.

In 2004, IPV9 applied for the us patent, which was successively issued by the us Patent Office seven times with "non-final rejection opinions" and six times with final rejection letters. During this period, IT was repeatedly criticized by senior members of the US IETF and famous IT companies in the US.

In December 2011, The United States Patent and Trademark Office (PTO) officially issued the patent certificate No. and US 8,082,365, and stated in its notification of approval that the applicant's verification report was "very convincing".

IPV9 protocol refers to the 0-9 Arabic digital network as virtual IP address, and the decimal system as the text of the representation method, that is, a convenient way to find the use of the Internet users; For efficiency and end-user convenience, some of the addresses can be used as domain directly; It has an infinite number of allocatable IP addresses, with a maximum of 2 by 2048 bits, and is the cornerstone of the future digital world. At the same time, due to the use of the original computer network, cable broadcast television network and telecommunications network business classification code, therefore, also known as the "new generation of secure and reliable information integrated network protocol."

B. The Characteristics of IPV9

Compared with IPv4 and IPv6, IPV9 has more obvious features and advantages, mainly reflected in the following points:

1) Address space is huge

IPV9 has a larger address space than IPv4/IPv6. IPv4 defines the bit length of IP address is 32, that is, there are 232-1 addresses; While the length of IPv6 is 128, that is, 2128-1 addresses, the standard length of an IPV9 address is 2256-1, with 42 layers address structure design will be 10256-1 (21024-1). To put it mildly, if IPv6 were widely used, every grain of sand in the world would have an IP address. Then after IPV9 is widely used, the smallest molecule of bright matter in the whole universe will have a corresponding address. It is no exaggeration to say that if IPV9 is fully applied, every cell and living gene in the world can be assigned to an IPV9 address. Layer 42 is the asset management address (including legal digital currency space) compatible with ean-ucc128 barcode length.

2) Route tables are smaller

IPv6 has a smaller routing table than IPv4. The address allocation of IPv6 follows the principle of Aggregation at the beginning, which enables the router to represent a subnet with an Entry in the table, this greatly reducing the length of routing table in the router, and improving the speed of forwarding packets in the routing table.

The routing table of IPV9 is very small, and the address allocation of IPV9 follows the principle of Geo-spatial clustering from the beginning, which enables IPV9 router to represent a country subnet and an application subnet with a single record, it greatly reducing the length and cleanliness of routing table in the router, and improving the speed of forwarding packets by routing table. At the same time, this subnet can express a specific geographical location, for example, we assign the IPV9 address segment of Shanghai as 86[21[5]/96, then in other routers of the same level, only one route pointing to the address segment of 86[21[5]/96 can realize the IPv9 address routing of Shanghai. According to this logic, only one route is needed from country to country. For example, the route to China is 86/64. The IPv4 routing table is large and irregular, and the IPv6 routing table is smaller than IPv4, but the IPv6 routing table contains no geographic information and the routing is messy.

3) Automatic configuration support

IPV9 adds support for automatic configuration of variable length addresses, which is an improvement and extension of DHCP protocol of IPV9, making network management more convenient. IPV9 supports multicast, and supports the ISO/IEC C6 future network << naming and addressing >>TCP/IP/M model, and

supports long packet code streams for virtual and real circuits. This allows multimedia applications on the web to ensure video quality and reduce overhead, provide faster and faster applications such as industrial controls and unmanned vehicles, and provide better and cheaper service over the Internet than IPv6.

4) Address length could be select

IPV9 address length has a variety of options, which can realize the change of 16, 32, 64, 128, 256, 512 and 1024 bit address length, and select the most appropriate address length according to different usage scenarios to reduce the routing overhead.

5) Dual encryption

The address length of IPV9 is long enough to realize dual encryption from the transmission of source and target addresses, which plays an important role in some specific network transmission fields. IPV9 network makes use of logical isolation features to make network information transmission more secure and effective.

6) Add location information to the address

IPV9 addresses can be embedded with geo-location information, as well as personal and industry ID information, this making IP addresses uniquely tied to personal information.

7) Compatible with previous addresses

IPV9 address is backward compatible with IPv4/IPv6 address. In order to absorb the upgrade difficulty of IPv6 incompatibility with IPv4, IPV9 protocol remains and unchanged, so that IPv4/IPv6 upgrade to the new version of IPV9, the upgrade cost is very low.

8) Sovereignty is different

IPv4/IPv6 addresses Spaces and copyright ownership: United States.

IPV9 address space and copyright ownership: China.

IPV9 has its own intellectual property rights and was proposed by The Internet Assigned Numbers Authority (IANA), but it is China that has succeeded in developing and mastering the core technology. Compared with IPv4/v6, China has the core patent digital domain system of IPV9 technology, which is of great significance for the future development of China's network and the mastery of the security of cyberspace.

C. The Construction of IPV9 Protocol

The IPV9 protocol includes message protocol, address protocol, transition protocol, mobile communication protocol, etc, as shown in figure 2.

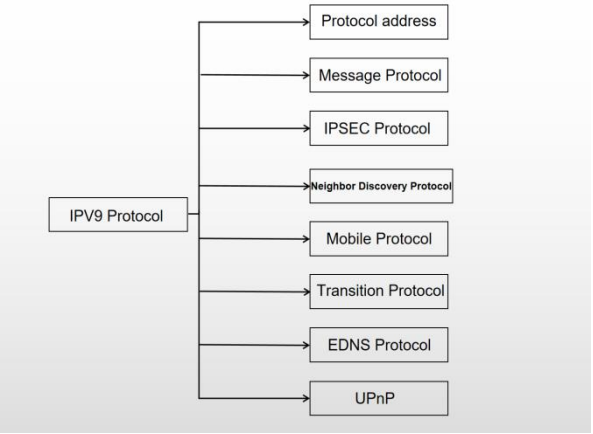

Figure 2. IPV9 protocol

1) Address Protocol

The IPV9 network expands the number of address bits to 256 bits, realizing a huge addressing space. And according to different data transmission methods, IPV9 addresses are divided into three types: unicast, anycast and multicast. In summary, it is the difference between one-to-one, one-to-one recent and one-to-many. Unicast type Each interface is configured with an identifier, and the packet identifies the identifier to reach the specified interface; an identifier in any on-demand type represents a group of interfaces of different nodes, and the shortest path interface is selected through a routing protocol And transmit the data packet to the interface; multicast is to use the multicast address to send the data packet to each

interface indicated by the identifier, and the shortest path interface will not be selected. IPV9 uses the "decimalization and brackets" approach in two forms:

a) Use the complete brackets to represent 2048 bits. In this way, the brackets can be ignored when entering a web address in the browser's address bar.

b) Divide the 256-bit address into 8 segments, each segment being 32 bits, "a [b] [c] [d] [e] [f] g [h". IPV9 addresses are very compatible with IPv4 and IPv6. The mapping relationship is shown in table 1 and table 2. The addresses of IPv4 and IPv6 are kept intact in the last bit address segment, and the value of the first address is used as an identifier to point to IPv4 or IPv6.

TABLE I. MAPPING RELATIONSHIP FROM IPV4 TO IPV9

Address number	1-96	97-128	129-160	161-256
Length (bits)）	96	32	96	32
Mapping	0[0[0	0	0	IPv4 address

TABLE II. MAPPING RELATIONSHIP FROM IPV4 TO IPV9

Address number	1-96	97-192	193-256
Length (bits)）	96	32	96
Mapping	1[0[0	0	IPv6 address

For IPV9 nodes in tunneling technology, they need to be assigned IPv4/IPv6 compatible addresses to communicate with other nodes in the corresponding network. The mapping strategy for this situation is shown in table 3, where the first prefix is 1000000000, the 000 and 001 values in the token bit correspond to IPv4 and IPv6 respectively, and the rest are reserved for future function expansion.

TABLE III. IPV9 COMPATIBILITY WITH IPV4/IPV6

Address number	1-10	11-29	30-32	33-96	97-128	129-214	215-256
Length (bits)）	10	19	3	64	32	96	32
Content	prefix	keep	mark	0	scope	IPv6	IPv4 address

2) Message Protocol

TABLE IV. IPV9 MESSAGE PROTOCOL

Version number	**Traffic Flow Type**				**Flow Label**
	Address length	***Priority traffic class***	***Address authentication***	***Absolute Traffic***	
Payload Length	Next Header				Limit jump times
Source Address（256bit）					
Destination Address（256bit）					
Time					
Identification Code					

The total header length of IPV9 is 72 bytes, which is more than that of IPv4 but more concise. The format is shown in table 4, which consists of ten parts: protocol version number, communication flow type, payload length, stream label, next header, hop limit, source address, destination address, time, identification code, etc.

In IPV9, the optional information of other layers is placed in the extended header between the high-level protocol header and the IPV9 header, and its structure is shown in table 5. An IPV9 packet can carry one or more or even no extension headers, and each subsequent extension header location is marked in its previous header.

TABLE V. EXTENSION HEADERS

IPV9 header **Next header=TCP**	**TCP header + data**		
IPV9 header Next header=route	IPV9 header Next header=TCP	TCP header + data	
IPV9 header Next header=route	IPV9 header Next header=data segment	IPV9 header Next header=TCP	TCP data segment Header + data

3) Transition Protocol

The IPV9 transition protocol specifies the IPV9 transition header format and the definition of the address text representation, addressing model, and node address, including a detailed description of the currently defined transition header and address format.

The header in the transition period uses the original IPv4 header, and only changes the version number to 9 to distinguish it from the original IPv4 header. The last two segments of the IPV9 address are adopted for the interim address, which is 64 bits in total.

D. The System Architecture of IPV9

IPV9/Future Network root domain name server system, consisting of a parent root server, a master root server, 13 equal-name root domain name servers named by 13 English N-Z, Top-level domain name servers of 239 countries and regions like .CHN,.USA,.HKG,.MAC, routing management systems, application servers and 10 Gigabit backbone routers. Its working principle is that 13 root domain name servers read the main root server first, then read the parent root server, and after obtaining the data, they will spread to the whole network. Only 13 root domain name servers can access this hidden distribution host. This hidden publishing host is maintained. 13 root domain name servers read its data, which is read by the mirror server, and then spread to the entire network. The IPV9 root domain name server system is shown in Figure 3.

The root name server is the highest-level domain name server in the Internet domain name system (DNS). It is mainly used to manage the Internet's home directory, and is responsible for providing authorized domain name server addresses for Top Level Domain TLD resolution. It is the necessary infrastructure for constructing the Internet. Many computer scientists refer to the root domain name server as "truth", which shows its importance. Currently, the Internet's root domain name server, gTLD, and ccTLD are all managed and controlled by ICANN (Internet Corporation for Assigned Names and Numbers) authorized by the US government. Attacking the root domain name server is the most direct and deadly method of attacking the Internet. In the existing Internet, the root server is completely controlled by the United States, which poses a great risk to other

countries. The 13 IPV9 root DNS that can adapt to IPv4 networks, IPv6 networks, and IPV9 networks, use decimal network technology to organize, build, secure, controllable, face global users, and serve Chinese, English, digital and other languages , And can provide personalized broadband multimedia communication services on the communication network to provide English, digital, Chinese domain name resolution function. The IPV9 resolution system can ensure that the domain used by online users are resolved by the domain server to obtain the IP address of the corresponding access object, which is compatible with the current various domain services.

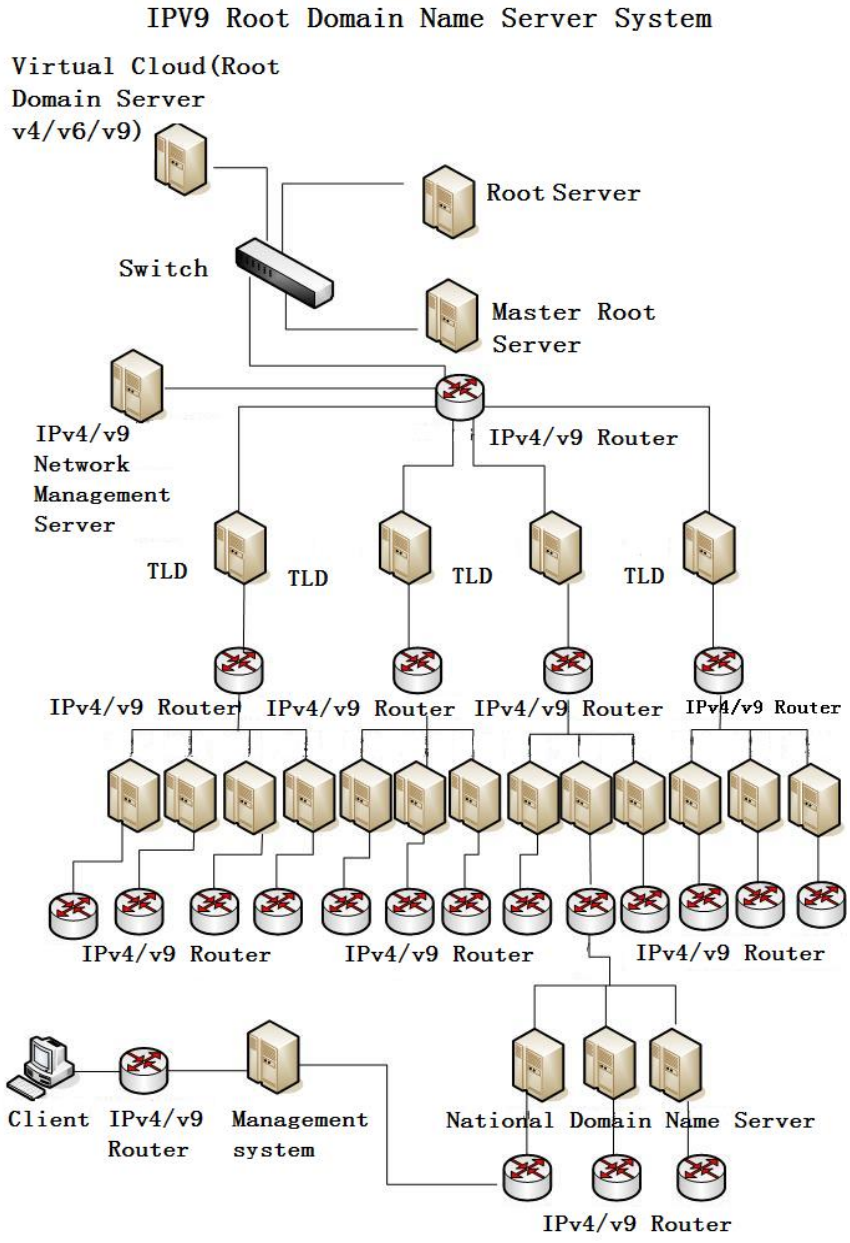

Figure 3. The System of IPV9 Root Name Server

This 13 root domain name resolution systems based on IPV9, able to adapt to IPv4 network, IPv6 network, IPV9 network, through the organization and construction of decimal network technology, with a safe and controllable appearance for global users, and can provide services and personality in various languages Provide broadband, multimedia communication service communication network to provide English, digital, Chinese domain name resolution function. The IPV9 resolution system can ensure that the domain names used by online users are resolved by the domain name server to obtain the IP address of the corresponding access object, and can also send requests for non-numeric domain names to the corresponding English domain name server or Chinese domain name server, as well as various Language domain name servers, while providing digital domain name resolution functions, are also compatible with providing Chinese and English domain name resolution services.

E. The Architecture Design of IPV9

The conventional data packet exchange of the current TCP / IP protocol cannot support true real-time applications and circuit switching, and the application of circuit transmission of sound or images in the four-layer protocol. In addition, the existing TCP / IP protocol is a connectionless and unreliable data packet protocol with a maximum packet length of 1514 bytes. With the integration of voice, image and data, the establishment of a new network theoretical foundation has become an urgent task. The design purpose of IPV9 is to avoid large-scale changes of the existing IP protocol, leading to the next-generation Internet can be backward compatible. The main idea of the design is to merge the IP protocol of TCP/IP with circuit switching. Using a router compatible with the two protocols, the designer envisions that through a series of protocols, the addresses of the three protocols (Ipv4/Ipv6/IpV9) Simultaneous use in the Internet, gradually replacing the current Internet structure without excessively affecting the current Internet. Due to the rational design of IPV9, it has received the attention of ISO and the International Internet Association.

1) The level system of IPV9

The IPV9 system uses a three-layer circuit / four-layer packet hybrid network architecture, and adopts the communication network transmission mode of authentication before communication rules. It was first proposed by China and has formed a demonstration project. The architecture is shown in Figure 4.

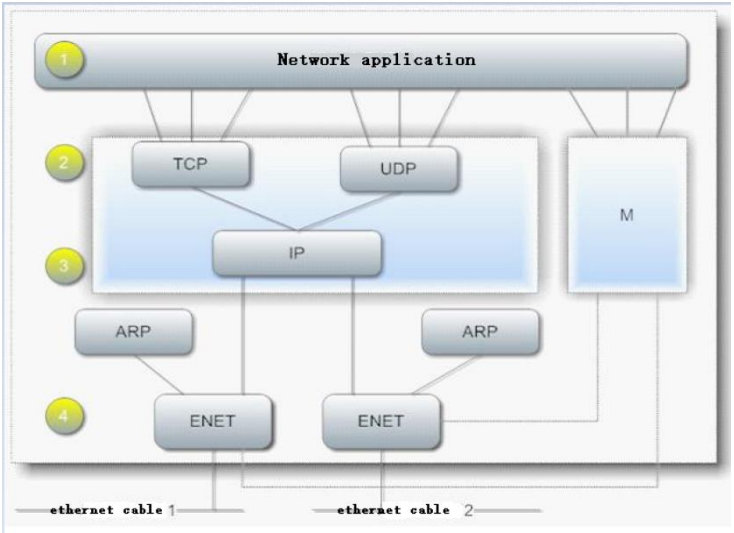

Figure 4. The level system of IPV9

2) The Connection of IPV9

IPV9's TCP / IP / M protocol, in addition to inheriting the existing TCP / IP protocol connectionless and unreliable data packet protocol, also develops absolute code streams and long stream code classes. Long packets can reach more than tens of megabytes. Can use three layers to directly transmit telephone and cable TV data to establish a four-layer three-layer transmission protocol with the new transmission theory. The connection method is shown in Figure 5.

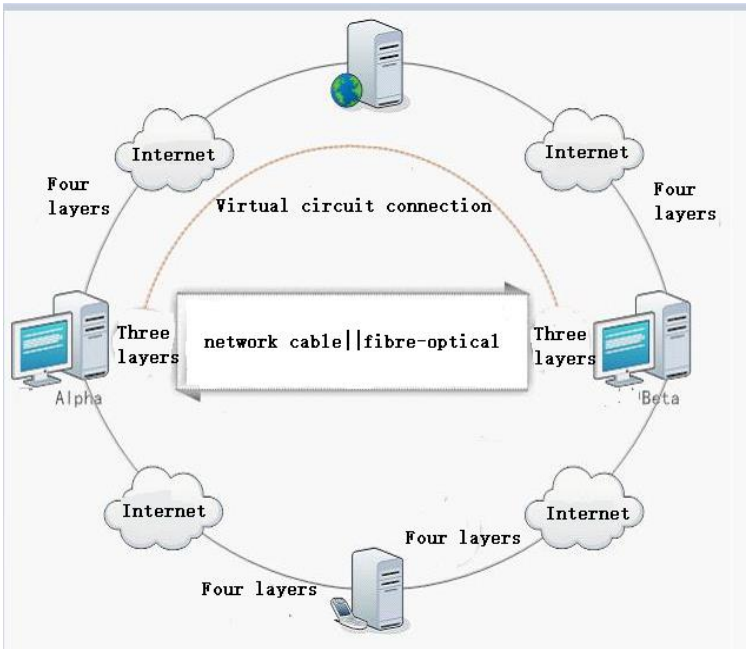

Figure 5. The Connection of IPV9

The IPV9 network management system is a comprehensive network management system that provides network monitoring and other functions based on a web interface. It can monitor various network parameters and server parameters to ensure the safe operation of the server system; it also supports IPV4 and IPV9 protocols, and provides a flexible notification mechanism to allow system administrators to quickly locate and solve various problems.

Through the use of IPV9 design routers, clients, protocol conversion routers and other equipment to build a pure IPV9 network, IPV9/IPv4 hybrid network to achieve a new generation of independent intellectual property security and control of the Internet system. Including the domestically-controlled and self-controllable IPV9/future network root domain name system, promoting technology integration, business integration, and data integration to achieve cross-layer, cross-region, cross-system, cross-department, and cross-business collaborative management and services. Take data centralization and sharing as a means to build a nationally integrated national big data center and gateway bureau, speed up the promotion of domestically made independent and controllable alternative plans, and build a safe and controllable information technology system. Be independent of the control of the US domain name system and realize an independent domain name system.

F. The Application Examples of IPV9

1) The application of 5G-future network/IPV9 movie network release application

Now the 5G network of China Unicom Beijing and China Mobile Suzhou have been directly connected through the IPV9 fiber routing backbone node of

Beijing University of Posts and Telecommunications and the IPV9 national backbone optical cable network, and achieved the world's first time End-to-end 500Mbps to 1000Mbps speed on May 21 this year. On the IPV9 national backbone network +5G local access/5G core network, the digital film program network distribution work was successfully carried out, and the national network distribution of Chinese movies was first entered in the new era of "one hour".

2) "Health Tai'an " IPV9 Big Data Platform

"Health Tai'an "IPV9 big data platform project relies on the existing backbone optical cable and user transmission access network of Shandong Broadcast Network Co. Ltd. Tai'an Branch, using IPV9 network technology to upgrading and construction, cover the medical and health institutions of the city, county, township and village levels and the medical insurance bureau, the administrative department and the finance bureau of Tai'an, and further expand to families and individuals. The bandwidth meets the requirements of healthy Tai'an big data business and can be sustainable. The expansion realizes compatible security operation between IPV9 network and IPv4 network (also realizes logical security isolation between IPV9 and IPv4 and IPv6 networks).

IV. CONCLUSION

Nowadays, the lack of IP addresses has become the main reason restricting its development. IPV9 has a huge address capacity, and it is better than IPv6 in terms of security, compatibility, efficiency, and cost savings. It is more suitable in China Development. This article introduces the characteristics, production process, protocol and composition of IPV9. IPV9 is independently developed by Chinese and has independent intellectual property rights. At the same time, it can solve the remaining problems of IPv4 and can be the core key technology of the next generation Internet. The new network should not be an upgrade of the old network, but a new network system structure. If it can be promoted, it will definitely promote the great development of the Internet.

REFERENCE

[1] Information technology-FutureNetwork-Problem statement and requirement-Part 5: Security, ISO/IEC DTR 29181-5, 2014, 12.

[2] HeYudan, Zhu Lian, etc. Commercial radio-frequency identification tag data format. SB/T 10530-2009, 2010, 03.

[3] Xie Jianping, Kong Ning, Etc. Domain name specification based on RFID Technology used for products and service. SJ/T11605-2016, 2016, 06.

[4] Wang Wenfeng, Xie Jianping, etc. Product and service digital identification format for information procession.SJ/T11603-2016, 2016.06.

[5] Xie Jianping etc. Digital domain name specification, SJ/T11271-2002, 2002.07.

[6] Xie Jianpingetc. A method of assigning addresses to network computers using the full decimal algorithm[P]. CN: ZL00135182.6, 2004.2.6.

[7] Tang Xiaodan etc. Computer Operating System (third edition) [M]. Xi'an: Xidian university press, 2010

[8] Xie Jianping, Xu Dongmei, etc. Digital domain name specification.SJ/T11271-2002, 2002.07.