Design and Research of New Network Address Coding

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***Abstract*—To solve a series of problems caused by address space and information security of contemporary Internet, Chinese scientists have proposed a new generation of network architecture. Since the release of IPv4 RFC791 in 1981, it has become the first widely used Internet of things protocol due to its characteristics of easy implementation and good operability. It constitutes the basic protocol of current Internet technology. However, due to the defects in address classification, address resources are largely wasted. As the scale of the Internet continues to grow, especially the number of addresses used to surge, the address shortage has limited the Internet further development. IPv6 has solved the problem of insufficient IPv4 addresses to some extent, but it is not widely for more than 20 years used because it integrates the information of physical layer and application layer, which confuses the network layer and brings many security risks. Based on the study of IPv4 and IPv6, this paper proposes a new generation network architecture, which is designed from the aspects of addressing model, address writing, address prefix writing and address type. The address structure is compatible with IPv4 and IPv6, so that the previous design results can be retained, fundamentally solve the space address and information security issues, and provide a new solution for the next generation of Internet applications and research.**

Keywords-Network Architecture; The Network Address; IPV9; IPv4; IPv6

PREFACE

Because IPv4 addresses are allocated on a first-come-first-served, on-demand basis, the distribution imbalance makes address allocation flawed. With the continuous development of the Internet (especially the explosive growth of the scale and the surge of address use), some inherent defects of IPv4 are gradually exposed, mainly focusing on address shortage. IPV4 does not provide encryption and authentication mechanisms to ensure the secure transmission of confidential data resources and other aspects. Although the use of NAT ("Network Address Translation"), CIDR ("Classless Inter-Domain Routing") and other technologies can alleviate the IPv4

DOI: 10.21307/ijanmc-2019-031

crisis to some extent. But in fact, it has not fundamentally solved the problem. At the same time, it will bring new problems in cost, quality of service, security and other aspects, posing greater challenges.

To solve the problem of insufficient IPv4 addresses, scientists proposed IPv6.However, due to the limitations of the technology era, there are many defects in the design of IPv6 address structure. Not satisfied with the 128-bit address length, the designers did not follow the principle of transparency between different protocol layers and added the physical layer address and the application layer in the design of IPv6 address segment (the protocol of the network layer), which led to a series of fatal problems.

"IPv9" is an idea proposed in the early 1990s by the IETF (The Internet Engineering Task Force) in the June 1992 issue of RFC 1347 to address the deficiencies in Internet address domain names.In May 1995, IETF unilaterally abandoned its cooperation with ISO (International Organization for Standardization), disbanded TUBA, the institute for IPv9 research, and terminated its organized research and development activities for IPv9. However, no intellectual property rights and valuable technical data were formed in this research.

Inspired by RFC 1347, Xie Jianping, a Chinese expert, formed the Chinese IPV9 research and development team with Shanghai general chemical technology research institute as the gathering center. The difference between uppercase and lowercase indicates that the IPV9 developed in China is not a technical version following the Internet.

IP version 9 (IPV9) is a new version of the Internet protocol, also known as the decimal network, digital domain name. The decimal network technology protocol is developed independently by our country. The emergence of IPV9 fundamentally solves the problems of insufficient address and network security.

I. New Network Address IPV9

A. Network Address

Internet addresses are assigned by ICANN（the Internet Corporation for Assigned Names and Numbers）.The association appoints three local organizations for the assignment of addresses: INTERNIC for North America, RIPENCC for Europe and APNIC for the Asia Pacific region. The purpose of uniform allocation is to ensure that the network address has global uniqueness, and the host address is assigned by the system administrator of each network. Therefore, the uniqueness of the network address and the host address within the network ensures the uniqueness of the IP address.

B. IPV9

IPV9 decimal network/digital domain name system (IPV9).Based on the study of IPv4 and IPv6, the following changes are proposed. IPV9 expands the address length to 2048 bits, reduces the network overhead by means of indefinite length and non-location, and guarantees the network security. This article defines the IPV9 address architecture, including a detailed description of the currently defined IPV9 address format.

C. IPV9 header format

The format design of IPV9 system header is shown in table 1.

TABLE I. IPV9 HEADER FORMAT

Version number	communication stream type				stream label
	Address length	Priority class traffic	Address the authentication	Absolute traffic	
Payload length	Next head				hop limit
source address (16-2048 bit)					
Destination address (16-2048 bit)					
time					
Authentication code					

The design of table 1 is explained below.

1) Version: 4-bit length, Internet protocol version number. For IPV9, this field must be 9.

2) Category: 8 bits in length. 3 bits high is used to specify the address length, the value is 0 ~ 7, is the power of 2, the address length is 1Byte ~ 128Byte; the default value is 256 bits. Among them, 0 is 16 bits, 1 is 32 bits, 2 is 64 bits, 3 is 128 bits, 4 is 256 bits, 5 is 512 bits, 6 is 1024 bits, 7 is 2048 bits. The last five bits specify the communication class and authentication for the source and destination addresses.0 to 15 is the priority value, where 0 to 5 is used to specify the priority class of the traffic; 6 to 7 are used to specify the communication method of authentication before communication. The address of packet sending is used for traffic control and whether authentication of source address and destination address is required.8 to 14 are used to specify absolute traffic that will not fall back when congestion is encountered; 15 for virtual circuits; 16 and 17 respectively assign audio and video, called absolute value, to ensure the uninterrupted transmission of audio and video. Other values are reserved for later use.

3) Flow label: With a length of 20 bits, it is used to identify packages belonging to the same business flow.

4) Net load length: The length is 16 bits, including the net load byte length, that is, the number of bytes contained in the packet after IPV9 header.

5) Next header: The length is 8 bits. This field indicates the protocol type in the field following the IPV9 header.

6) Hop limit: The length is 8 bits, and this field will be reduced by one every time a node forwards a packet.

7) Source address: 8-bit bit ~ 2048-bit bit, specifying IPV9 packet sender address. Use of variable length and location method.

8) Destination address: The length is 8 bit ~ 2048 bit, and the destination address of IPV9 packet is specified. Use of variable length and location method.

9) Time: Used to control the lifetime of the address in the header.

10) Authentication code: It is used to identify the authenticity of the address in the header.

II. IPV9 ADDRESS SPACE

A. Type of address

IPV9 addresses specify 256-bit identifiers for interfaces and interface groups. There are three types of addresses:

1) Unicast. A single interface has an identifier. A packet sent to a unicast address is passed to an interface identified by that address.

2) Arbitrary cast. Typically, a set of interfaces belonging to different nodes has an identifier. A packet sent to an arbitrary cast address is passed to an interface identified by that address that is the closest measured by the routing protocol distance.

3) Multicast. Typically, a set of interfaces belonging to different nodes has an identifier. A packet sent to a multicast address is passed to all interfaces at that address.

There are no broadcast addresses in IPV9, and its functionality is being replaced by multicast addresses. In this article, fields within the address are given a specified name, such as "user." When the name is followed by an identifier (such as "user ID"), it is used to represent the content of the name field. When a name is used with a prefix (such as "user prefix"), it represents all addresses up to and including this field.

In IPV9, any fields that are all "0" and all "1" are valid values unless specifically excluded. In particular, the prefix can contain a "0" value field or end with a "0".

B. Addressing model

All types of IPV9 addresses are assigned directly to the interface, not to the node.IPV9 unicast addresses belong to a single interface. Because each interface belongs to a single node, a node of multiple interfaces, any of its unicast addresses can be used as the identifier for that node. All interfaces need at least one link local unicast address. A single interface can specify multiple IPV9 addresses (unicast, arbitrary cast, multicast) or ranges of any type. Unicast addresses with greater link range are not required for interfaces that go from non-neighbor or to non-neighbor and are not the origin or destination of any IPV9 packets. This is sometimes used for point-to-point interfaces. There is one exception to this addressing model:

Handle the case of multiple physical interface implementations. If the state that emerges in the Internet layer is an interface, a unicast address or a group of unicast addresses can be assigned to multiple physical interfaces. This is useful for load-sharing across multiple physical interfaces.

Current IPV9 extends the Ipv4 model, with a subset prefix associated with a link. Multiple subset prefixes can be specified to the same link.

III. TEXT REPRESENTATIONS OF IPV9 ADDRESSES

This article has developed a way to represent IPV9 addresses, including “Brackets decimal” representation, "Curly braces" representation, and "Parentheses" representation.

A. Brackets decimal

The bracket decimal can be expressed in the following two ways:

The first method： 2048 bits are represented by "[]".The 2048 bits in "[]" are expressed in decimal and can be written in indefinite length. And you can omit the "[]" when writing in the browser.

The second method ：The 256-bit IPV9 address representation is in the form of "y[y] [y] [y] [y] [y] [y]".

Each y represents a 32-bit portion of the address and is represented in decimal.232 =4294967296, so each “y” is a decimal number of ten digits. Each digit that is distinct from the decimal system ranges from 0 to 9.For example, the range of the first digit from the left is 0 to 4, so that there will be no overflow. For example:

0000170170[0000062062[0000000000[0000000000[0000000000[0000000000[0000210210[0000422422

In address representation, multiple consecutive zeros to the left of each decimal number can be omitted, but a decimal number that is completely zero needs to be represented by a zero. For example, the above address can be written as:

170170[62062[0[0[0[0[210210[422422

To simplify the representation of addresses, successive all-zero fields in the address can be replaced by a pair of square brackets "[X]" (X is the number of segments in the all-zero field).For example, the above address can be abbreviated as:

170170[62062[4][210210[422422

Another example:

0[0[0[0[0[0[0[1 can be abbreviated as [7]1

0[0[0[0[0[0[0[0 can be abbreviated as [8]

B. Decimal braces

This method divides the 256-bit address into four 64-bit decimal Numbers represented by curly braces separating them. The representation is in the form of "Z}Z}Z}Z", where each "Z" represents a 64-bit portion of the address and is represented in decimal. It's exactly the same as "Y", and it's compatible with "Y". You can mix the two. This greatly facilitates the current compatibility of these Ipv4 addresses in IPV9.Such as:

z}z}z}z;
z}z}y]y]y]y;
z}z}y]y]y]d.d.d.d;
z}z}z}y]d.d.d.d;
z}z}z}y]J.J.J.J;

In particular, the last address format is the most useful. Such as:

0}0}0}0]193.193.193.193

You can write it like this: {3}0]193.193.193.193

Finally, it should be noted that in symbolic representation, the brackets and Curly braces are used without distinction. That is, "{" and"} ", "[" and"] "are not dissimilar, since this will not cause any side effects and is more convenient for users.

C. Parentheses representation

Since IPV9 has an address length of 256 bits, whether you use four or eight segments, there are still many bits in each segment. For example, with an 8-segment representation, each segment still has 32 bits. This is what happens in a paragraph:

……]00000000000000000000000000110100]……

……]01011111111111111111111111111111]……

Such a situation is not only cumbersome input, and it is easy to lose less or more, the user is not conducive to the number of dazzling.For convenience, the parenthesis representation -- (K/L) is introduced.Where "K" means 0 or 1 and "L" means the number of 0 or 1.In this way, the above two examples can be abbreviated as:

……]（0/26）110100]……

……]010（1/29）]……

D. Text representation of address prefixes

The IPV9 address scheme is similar to the super netting and CIDR schemes of Ipv4 in that the address prefix is used to represent the network hierarchy. On the representation of IPV9 address prefix, a representation similar to CIDR is adopted, which is as follows:

IPV9 address/address prefixes length.

Where, IPV9 address is written in IPV9 address representation. The address prefix length is the length of consecutive bits that form the address prefix from the left. At this point, it is important to note that IPV9 addresses use decimal Numbers, but prefix length refers to binary. Therefore, prefixes must be calculated carefully. In binary Numbers is not intuitive, after consideration, it is considered that the IPV9 address prefix can be converted to hexadecimal is easier to understand, but the IPV9 address is still expressed in decimal Numbers.

For example, the 200-bit address prefixes 1314[0[0[0[224[169[0 can be expressed as:

1314[0[0[0[343[150[0[0/200
Or 1314[3]224[169[0[0/200
Or 1314[0[0[0[224[169[2]/200
Or 1314[3]224[169[2]/200

Note that in the representation of the address prefix, the IPV9 address portion must be legal. The IPV9 address to the left of the slash "/" must be restored to the correct address. In this address prefix, you can see that the address prefix is 200 in length. So, the prefix is really just the first 6 bits of the entire address plus the first 8 bits of paragraph 7 (32 times 6+8=200).So the key is in the seventh paragraph of the address.

This paragraph is expressed in hexadecimal as:"********". Because in hexadecimal, one digit is 4 bit, the prefix includes only the first two "*". Knowing this, you know that the value of this segment is 00000000 (hex) ~00FFFFFF (hex), or 0~16777215 in decimal. (Or this paragraph may be expressed in binary as: "**** **** **** **** **** **** **** ****". Because in binary, one bit is one bit, so the prefix includes the first eight "*", the range of values in this section is0000 0000 0000 0000 0000 0000~0000 0000 0000 1111 1111 1111 1111 1111That is, decimal 0~16777215.)

The IPV9 address portion can be generated by a pure address prefix by appending a 0 to its right, or it can be a real IPV9 address that contains the address prefix. For example, the address prefix in the above example can also be expressed as:

1314[3]224[169[a[b/200

"a" is any decimal number between 0 and 16777215, and "b" is any decimal number between 0 and 4294967296.

IV. IPV9 ADDRESS TYPE

1) Pure IPV9 address

The form of this address is Y[Y[Y[Y[Y[Y[Y[Y

Each Y represents a decimal integer from 0 to 232 =4294967296

2) IPV9 addresses compatible with Ipv4

The form of the address is Y[Y[Y[Y[Y[Y[Y[D.D.D.D

Each Y represents a decimal integer from 0 to 232 =4294967296. D represents a decimal integer between 0 and 255 from the original Ipv4.

3) IPV9 addresses compatible with Ipv6

The form of this address is: Y[Y[Y[Y[X:X:X:X:X:X:X:X

Each Y represents a decimal integer from 0 to 232=4294967296.The X represents a hexadecimal number that originally Ipv6 ranged from 0000 to FFFF.

4) Special compatibility address

In order to upgrade from Ipv4 and Ipv6 to IPV9 smoothly, some compatible addresses are designed. Among them, some Ipv6 addresses are designed to be compatible with Ipv4 addresses. To smooth the transition to IPV9 addresses, prefix these addresses appropriately. In order to make their representation more intuitive and avoid errors caused by negligence in writing, the abbreviation method is introduced:

y[y[y[y[x:x:x:x:x:x:d.d.d.d

Where, each "y" represents the address as 32 bits, represented in decimal. Each "x"represents the original Ipv6 address of 16 bits, in hexadecimal. Each "d" represents the original Ipv4 address of 8 bits, expressed in decimal.Such as:

0[0[0[0[14714747[1199933[223556889[147258369

Can be written as: 0[0[0[0[E0:877B:12:4F3D:D53:3519:3.198.252.1

Or: [4] E0:877B:12:4F3D:D53:3519:3.198.252.1

Such as: 0[0[0[0[0[0[0[562159487

Can be written as:[4]::33.129.223.127

(Analysis: ":" is IPv6 address compression form of the representation, multiple 0 blocks of a single continuous sequence by the double colon symbol "::".Decimal 562159487 is expressed as 33.129.223.127 in decimal.)

5) [] full decimal address

In order to facilitate the logistics code and decimal address application. Category number 5 is recommended. In the power of 10 to the power of 512, the method of fixed length and non-positioning is adopted according to the application needs.

6) IPV9 address of transition period

IPV9 can be compatible with IPv4 and IPv6 technical protocols for the Internet, but IPv4 and IPv6 technical protocols cannot be anti-compatible with IPV9.The concept of compatibility is parallel coexistence, gradual and moderate transfer of applications and data services, rather than direct replacement or replacement of existing protocols.

In order to solve the problem of IPv4 smooth transition to IPV9, considering the existing Internet has invested a lot of money so far, we specially designed IPV9's transition address, and took out a segment 232to allocate IPv4.Small changes can be made to the current system, where IPV9 has a section of J.J.J.J. where each J represents a decimal number from 0 to 28 which is 0 to 255.Where the previous [7] can be omitted in the middle of the local address, that is, local users (or designated users) can use J.J.J.J. to directly use and the original Ipv4 D.D.D.D. distinction.At the same time, this part of the user in order to smooth the transition to full decimal can be allocated at the same time decimal. In order to improve the software and hardware in the future without the need to reallocate addresses, such as [7]5211314 can be written as [7]3.48.155.175 in the region in an IP network can be directly written with 3.48.155.175, so that the original terminal can be used.There should be new records in the IPV9 DNS records for compatibility between the original user and the current user.The interim IPV9 address system can be modified to the original IPv4 system.Meanwhile, the Ipv4 header is used, but the version number is 9 to distinguish the original IPv4.However, the original terminal equipment may be used by user terminals in the territory.

When the address length is 16 bits when the class number is 0, the IPv4 physical address is discarded and the IPv4 host 16-bit address is used. The representation is decimal 65535 or dot decimal 0-255.0-255 as in hexadecimal FF.FF.

When the class number is 1, the address length is 32 bits, represented by decimal 0-4294967295 and the corresponding character length or dot decimal 0-255.0-255.0-255.0- 255.0-255 as in hexadecimal FF.FF.FF.FF

When the class number is 2, the address length is 64 bits, represented by decimal 10 or the corresponding character length.

When the class number is 3, the address length is 128 bits, represented by decimal or the corresponding character length.

When the class number is 4, the address length is 256 bits, represented by decimal or the corresponding character length.

When the class number is 4, the address length is 512 bits, denoted by decimal or the corresponding character length.

When the class number is 5, the address length is 1024 bits, denoted by decimal or the corresponding character length.

When the category number is 6, the address length is 2048 bits, represented by decimal or the corresponding character length.

When the class number is 7, the address length is an unfixed bit, represented by the corresponding decimal length or the corresponding character length.

V. ALLOCATION OF ADDRESS PACE

Specific types of IPV9 addresses are identified by the high boot bit field in the address. The length of these boot bit fields varies. In the protocol, they are called the format prefix FP.

TABLE II. IPV9 ADDRESS FORMAT PREFIX 1

Format prefix FP (n bits)	Address (256-n bits)

TABLE III. IPV9 ADDRESS FORMAT PREFIX 2

Format prefix FP (n bits)	Address (2048-n bits)

The following is an overview of the various address type prefixes.

TABLE IV. IPV9 ADDRESS FORMAT PREFIX FOR THE ORIGINAL ALLOCATION TABLE

	Address type	**Format prefix (binary code)**	**Format prefix (decimal code range)**	**Proportion of address space**
1	Reserved address	0000 0000 00	0——4194303	1/1024
2	Unassigned address	0000 0000 01	4194304——8388607	1/1024
3	IPV9 Decimal Network Working Group	0000 0000 1	8388608——16777215	1/512
4	IPX reserved address	0000 0001 0	16777216——25165823	1/512
5	Unassigned address segment	0000 0001 1	25165824——33554431	1/512
6	Unassigned address segment	0000 0010	33554432——50331647	1/256
7	Unassigned address segment	0000 0011	50331648——67108863	1/256
8	Unassigned address segment	0000 0100	67108864——83886079	1/256
9	Unassigned address segment	0000 0101	83886080—100663295	1/256
10	Unassigned address segment	0000 011	100663296— 134217727	1/128
11	Unassigned address segment	0000 1 0	134217728—201326591	1/ 64
12	Unassigned address segment	000 0 1 1	201326592—268435455	1/ 64
13	Unassigned address segment	0001 0	268435456—402653183	1/32
14	Unassigned address segment	00 0 1 1	402653184—536870911	1/32
15	Unassigned address segment	0010 0	536870912—671088639	1/32
16	Unassigned address segment	001 0 1	671088640—805306367	1/32
17	Unassigned address segment	0011	805306368—1073741823	1/ 16
18	Aggregable global unicast address	0100	1073741824—1342177279	1/16
19	Unassigned address segment	0101	1342177280-1610612735	1/16
20	Unassigned address segment	011	1610612736—2147483647	1/ 8
21	Geographical area unicast address	100	2147483648—2684354559	1/ 8
22	Geographical area unicast address	10 1	2684354560—3221225471	1/ 8
23	Unassigned address segment	1100	3221225472—3489660927	1/16
24	Unassigned address segment	1101	3489660928—3758096383	1/16
25	Unassigned address segment	1110 0	3758096384—3892314111	1/32
26	Unassigned address segment	1110 10	3892314112—3959422975	1/64

27	Unassigned address segment	1110 11	3959422976—4026531839	1/64
28	Unassigned address segment	1111 00	4026531840—4093640703	1/64
29	Unassigned address segment	1111 01 0	4093640704—4127195135	1/ 128
30	Unassigned address segment	1111 01 1	4127195136—4160749567	1/ 128
31	Unassigned address segment	1111 100	4160749568—4194303999	1/ 128
32	Unassigned address segment	1111 1010	4194304000—4211081215	1/256
33	Unassigned address segment	1111 1011	4211081216—4227858431	1/256
34	Unassigned address segment	1111 1100	4227858432—4244635647	1/256
35	Unassigned address segment	1111 1101	4244635648—4261412863	1/256
36	Unassigned address segment	1111 1110	4261412864—4278190079	1/256
37	Unassigned address segment	1111 1111 0	4278190080—4286578687	1/512
38	Unassigned address segment	1111 1111 100	4286578688—4288675839	1/2048
39	Local link unary address	1111 1111 1010	4288675840—4289724415	1/4096
40	Station single address	1111 1111 1011	4289724416—4290772991	1/4096
41	Multi-address	1111 1111 11	4290772992—4294967295	1/1024
42	Full decimal address	0	0 — 10 512	0 — 10 512

The aggregate global unary address and the cluster address belong to the unary address, they do not have any difference in form, only in the propagation mode of the message is different. Therefore, the same format prefix 0100 is used for the polymerizable monocular and cluster address assignments. The proposed network vendor monocular addresses and geographic area monocular addresses are merged into a polymerizable monocular address.

Both the local link unary address and the station unary address are used in the local scope. In order to facilitate the router to speed up the identification of these two kinds of addresses, two address format prefixes, 1111 1111 1010 and 1111 1111 1011, were assigned to them respectively.

Because the processing method of multi-destination address on the router and host is quite different from the processing method of single-destination address and cluster address, an address format prefix 1111 1111 11 was also assigned to the multi-destination address.

The design also reserved address space for "decimal Internet address and domain name decision and allocation organization" and IPX address. The corresponding address format prefix is 0000 0000 1 and 0000 0001 0.Some special addresses of IPV9, such as unspecified addresses, local return addresses and ipv4-compatible addresses, are prefixed by 0000 0000 00 as the address format.

Due to the length of this article, only the address format in the IPV9 address architecture is described in detail. For more knowledge of IPV9, please refer to the related articles.

VI. THE CONCLUSION

IPV9 is the core and key technology of the next generation Internet. In this paper, IPV9 address coding is researched and a new address coding is proposed.IPV9 increases the length of IP addresses from 32 bits and 128 bits to 2048 bits, and the default is 256 bits, to support more address hierarchies, more addressable nodes, and simpler automatic address configurations. In order to reduce the network overhead, the fixed location method is adopted, changed the encoding of header options to allow more efficient forwarding. Reduce restrictions on option length for greater flexibility in introducing new options in the future. IPV9 adds expansionary support for IP address encryption and authentication, data integrity, and data privacy (optional). The new network address is not only the update and upgrade of the old network address, but also a brand new Internet system structure, which has laid a solid foundation for promoting the extensive application and integrated development of Internet and Internet of things.

INTRODUCTION OF XIE JIANPING

Xie Jianping, male, was born in Shanghai, China in 1951. He is a Chinese expert in the International Standards Organization (ISO/IEC JTC1/SO6). As the "decimal network standard working group" and "Electronic Labeling Standard Working Group Data Format Group" of the Ministry of Industry and Information Technology of the People's Republic of China, the "New Generation Security Controllable Information Network Technology Platform Overall Design" expert group and the Internet of Things Joint Standards Working Group Leader of the team. It is also the main editor of the ISO/C6 "Future Network naming and addressing" Chinese member.

Professor Xie has obtained more than 90 multinational patents. The patents on network resources, terminal equipment, networks transmission and information platform include "Methods for allocating addresses to computers using Internet with full digital codes" and "Methods for allocating computer addresses with all-decimal algorithms for networked computers", "Method and apparatus for implementing trusted network connection through a router or switch", "Method for uniformly compiling and allocating addresses of networked computers and intelligent terminals", "Decimal Gateway", "An IPV9/IPV4 NAT Router", "An IPV9 Website Browser Plugin", "A new generation of IPV9 routers", "A Networked Tax Control System and Its Method" and "Digital Remote Video Surveillance System Device"

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