A Semantic-rich Identifier Mapping Management Mechanism for Personalized Application

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Abstract

With the rapid proliferation of the Internet and the swift advancement of related technologies, the scope and depth of network services continue to expand, making the Internet increasingly ubiquitous. At present, the technical system based on IP network identification faces fundamental challenges such as network rigidity, single bearer capacity, overloaded data packet encapsulation, and difficulty in mitigating unknown threats. The Internet infrastructure and operating model reliant on traditional network identification are progressively unable to satisfy the growing demands for personalized scenarios. Considering the aforementioned issues, this paper introduces a Semantic-Rich Identifier Mapping (SRIM) management mechanism tailored for personalized application requirements. This mechanism primarily comprises addressing, mapping relationship storage, query mechanisms, and reserved mapping algorithm interfaces. By employing a semantic-rich identifier fusion addressing mechanism, the communication identifier is generated according to a specific algorithm, ensuring the confidentiality and uniqueness of the communication identifier. Additionally, the design of the mapping relationship storage and query mechanism guarantees the transmission rate of the identifier information and the data's reliability. Through the reserved mapping algorithm interface of the semantic-rich identifier and the transmission policy, more targeted algorithms can be developed to implement personalized transmission policies for each packet in different scenarios. This mapping algorithm interface between the semantic-rich marker and transmission policy enables the realization of a customized transmission policy for each packet, catering to the distinct requirements of various situations.

Keywords: Semantic-rich, Identifier mapping, Fusion Addressing

1 Introduction

With the emergence of mobile applications, VR applications, and IoT-related services, Internet services have become increasingly diversified, and many new services now demand higher network capabilities, such as high bandwidth, ultra-low latency, and exceptional reliability [1] [2]. In the TCP/IP-based Internet architecture, IP serves as the core link for the Internet's successful development. The current hourglass architecture of the Internet is centered around the general network layer, with the IP protocol layer acting as the "narrow waist" of the Internet architecture [3]. This layer fulfills the minimum functions required for global interconnectivity and serves a crucial linking role.

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However, the original design of IP was intended for point-to-point communication, making it unsuited for the current Internet landscape, which is primarily dominated by distributed networks [4]. Consequently, several fundamental issues arise when the design principles of traditional Internet are applied to emerging businesses and services.

The traditional Internet is designed to function as a single, abstract network. As the primary identifier in the traditional Internet, IP addresses can effectively identify device identity information at the network layer and pinpoint device location within the network to accomplish path addressing and data packet routing between hosts and networks [5]. IP addresses, a unified identification address format provided by the IP protocol, assign a unique identifier to every interface of every host or router on the Internet worldwide.

IP addresses allocate a logical address to every network and host on the Internet, shielding devices from physical address differences. IP addresses serve as a distributed database that maps domain names to corresponding IP addresses.

However, the current IP identification management and allocation exhibit several drawbacks, particularly when applied to personalized applications and scenarios, such as user-centric services, customized content delivery, and privacy-sensitive communications. These drawbacks include cumbersome and complex address management configuration, low user-friendliness, poor manageability, high costs, and a propensity to cause address waste and conflict. Additionally, traditional IP-based systems struggle to achieve dynamic real-time allocation and recovery of IP/MAC addresses, lack data presentation and visualization for personalized management, offer limited support for user-specific access control, and suffer from poor performance processing capabilities. These issues render the traditional IP-based network identification unable to meet the communication requirements of personalized services in various Internet scenarios. Consequently, the need for innovative research to address these challenges and develop tailored solutions for personalized applications has become an industry consensus.

To address these challenges, this paper introduces a Semantic-Rich Identifier Mapping (SRIM) management mechanism tailored for personalized application requirements. This mechanism primarily comprises addressing, mapping relationship storage, query mechanisms, and reserved mapping algorithm interfaces. By employing a semantic-rich identifier fusion addressing mechanism, the communication identifier is generated according to a specific algorithm, ensuring the confidentiality and uniqueness of the communication identifier. Additionally, the design of the mapping relationship storage and query mechanism guarantees the transmission rate of the identifier information and the data's reliability.

The main contributions of this paper include (1) the proposal of a novel semantic-rich identifier mapping management mechanism that addresses the limitations of traditional IP-based network identification systems; (2) the design of a fusion addressing mechanism based on semantic-rich identifiers, which enhances the confidentiality and uniqueness of communication identifiers; (3) the analysis of the proposed system's performance by comparing it with traditional TCP/IP and NDN network architectures, demonstrating its advantages in terms of mobility, security, and efficiency.

The remainder of this paper is organized as follows: Section 2 reviews related work on network identification and addressing technologies; Section 3 presents the design of the SRIM system, including its goals, principles, and functional framework; Section 4 analyzes the performance of the proposed system, comparing it with existing solutions such as LISP+ALT and LISP-TREE; and finally, Section 5 concludes the paper and discusses future research directions in the development of semantic-rich identifier systems for personalized applications. assessed and compared with the current mainstream mapping systems, LISP-TREE and LISP+ALT. The results show that SRIM also holds significant advantages in transmission performance.

2 Related work

In recent years, numerous scholars have conducted research and development in novel network identification and addressing technologies. They have designed new network systems that incorporate various types of identification, including content identification, identity identification, and geospatial identification. These new systems aim to address the limitations of traditional IP-based network identification and have demonstrated promising performance in small-scale, incremental experiments. Some of these systems include the Location Identity Separation Protocol (LISP), Host Identification Protocol (HIP), and Named Data Networking (NDN), which are discussed in detail below.

Location Identity Separation Protocol (LISP) LISP [6] (Locator/Identifier Separation Protocol) is a network protocol based on identity and location separation mechanisms, proposed by Cisco. Currently, research efforts both domestically and internationally focus on building mapping systems in the landmark separation network using LISP. Several centralized solutions have been proposed, primarily including LISP-NERD [7], LISP-DHT [8], LISP-TREE [9], and LISP+ALT [10].

Host Identification Protocol The Host Identity Protocol (HIP) is a host-based identity and location separation protocol that introduces a host identity layer between the network and transport layers of the TCP/IP architecture, as well as a new Host Identity (HI) space between the domain name space and the IP address space. HIP was initially designed to address security issues and did not consider addressing routing scalability problems.

Named Data Networking Named Data Networking (NDN) [11] shifts the focus from the "where" to the "what" of existing networks, exploring content/service-centric network architectures and adopting content names at the waist of the hourglass model. The NDN name adopts a hierarchical semantic design similar to URI, which affects the forwarding efficiency of the network layer and has poor scalability.

Table 1 provides a comparison of different technologies in terms of mobility, security, scalability, deployment, and routing optimization.

Table 1: Comparison of different technologies in multiple aspects

Technology	Mobility	Security	Scalability	Deployment	Routing Optimization
LISP	Medium	Medium	High	Medium	High
HIP	High	High	Medium	High	Medium
NDN	High	High	Medium	High	High

Identification Network System and Key Technologies Zhang Hongke's team developed an intelligent identification network system [12], effectively addressing the network technical bottlenecks of high mobility, low latency, and reliable communication. In the integrated identification network, the access switching router (ASR) is introduced to replace the access identification with the routing identification at the edge of the core network and the access network.

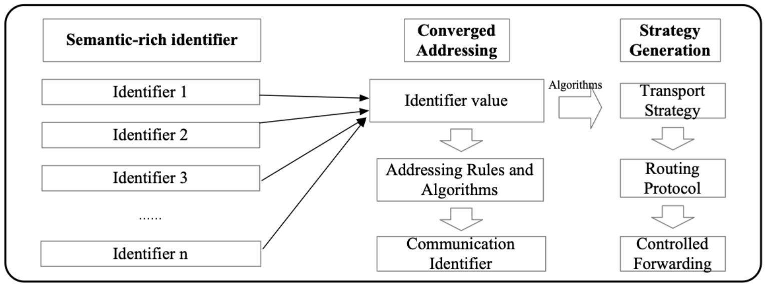

Figure 1: The general idea of the fusion addressing mechanism based on semantic-rich identifier

Industrial Internet Unified Identification Technology: Handle System The Handle System [13] is part of the Digital Object Architecture (DOA). The original DNS resolution system is oriented towards host resolution only. Handle, on the other hand, is oriented towards the generic resolution of digital objects (information) with finer management granularity. The system is a distributed system.

Through the analysis of the specific research status in this field, it can be seen that current domestic and international research on identification systems mostly focuses on single limitations and lacks comprehensive consideration. Moreover, traditional networks are more cumbersome and lengthy processes for obtaining identity. It is foreseeable that research on the semantic-rich identifier system and key technologies of the information network will become a major original subject with significant research and innovation potential.

3 Design

In this section, we present the design of the Semantic-Rich Identifier Mapping (SRIM) management mechanism for personalized application requirements. The design is divided into three main parts: (1) Design Goals and Principles, which outline the objectives and guidelines for the SRIM system; (2) The Functional Framework and Model of Message Passing Model Based on Communication ID, which describes the main components and processes of the SRIM system; and (3) Fusion Addressing Mechanism Based on Semantic-Rich Identifiers, which details the addressing and mapping mechanisms employed in the SRIM system.

3.1 Design Goals and Principles

A semantic-rich identifier refers to the identification of addresses, users, devices, services, and data. Converged addressing involves embedding information with an implicit semantic-rich identifier in data packets to realize the associated verification of users, devices, applications, and data within data packets. The concept of a semantic-rich identifier fusion addressing mechanism is primarily employed to address the limitations of traditional IP-based network identification, such as address information exposure and user traceability challenges [14]. By fusing semantic-rich identifier information, encoding and generating communication identification, and mapping it to routing identification, data transmission is realized through multiple routing protocols and lays the addressing foundation for routing enhancement, association verification, and packet integrity verification [15].

Figure 1 illustrates the concept of the semantic-rich identifier fusion addressing mechanism.

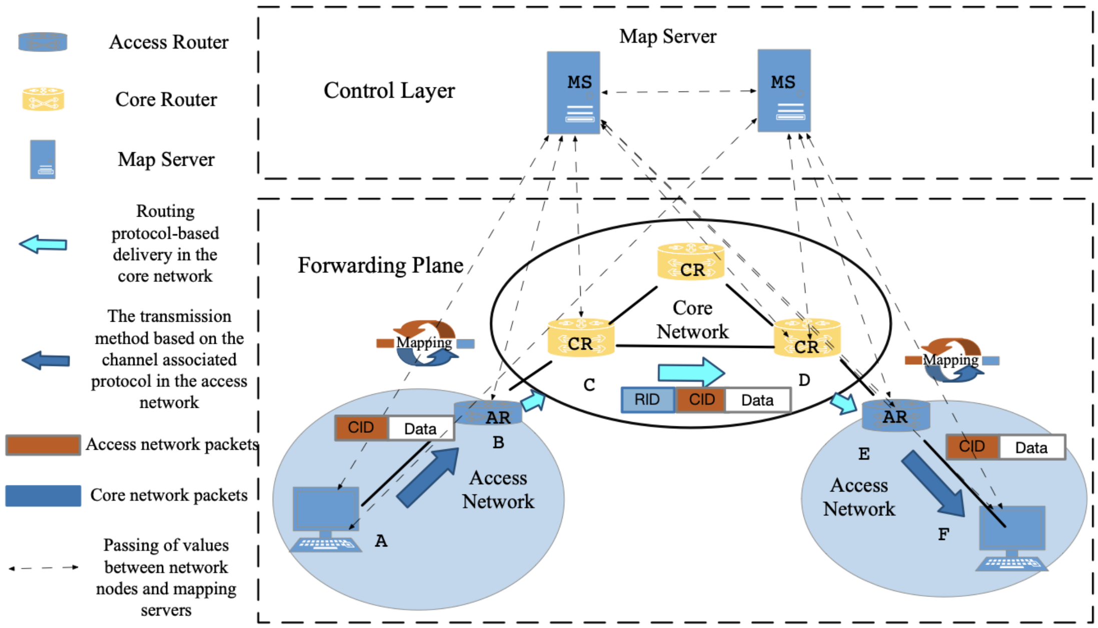

Figure 2: The general idea of the fusion addressing mechanism based on semantic-rich identifier

It is primarily employed to achieve addressing and routing. By fusing the semantic-rich identifier information, the encoding generates a communication identification and maps it to a routing identification, enabling data to be routed through various protocols. This approach lays the foundation for route enhancement, association verification, and packet integrity verification.

3.2 The Functional Framework and Model of Message Delivery Model Based on Communication ID

In this subsection, we describe the main components and processes of the SRIM system, including communication ID registration and maintenance, communication ID code generation, communication ID extraction and analysis, and communication ID mapping and forwarding. These components and processes work together to support the fusion addressing mechanism based on semantic-rich identifiers and enable efficient and secure communication in the network.

3.2.1 The Overall Process of Fusion Addressing

The overall process of converged addressing is shown in Figure 2. A mapping server is deployed on the control plane. This server is a distributed KV (key-value) storage server, and its functions include maintaining the KV table of semantic-rich identifiers and the mapping of communication identifiers and routing identifiers, among others. This allows the network element node to obtain the corresponding semantic-rich identifier information in the KV table by communicating the identification value. The forwarding plane is mainly composed of user terminals, access routers (AR), core routers (CR), and other routers, and it completes the addressing and forwarding of data packets.

The entire network is divided into two namespaces: communication ID and routing ID. The communication ID (CID) is generated by fusing five types of entities: addresses, users, devices, services, and data. Routing IDs (RID) are based on existing addressing systems, such as IPv6. In the access network, the terminal uses the communication identifier to construct data transmission, while in the core network, the routing identifier is used for forwarding. The binding and update are completed through the mapping mechanism between the two.

A typical packet forwarding process is as follows:

1. User terminal A first connects to the mapping server to initiate authentication, and after passing authentication, the semantic-rich identifier information of terminal A is output as a communication identifier through MD5 encryption. AR_B reports the mapping relationship of [communication identifier, semantic-rich identifier 1, semantic-rich identifier 2, ..., semantic-rich identifier n] to the mapping server MS, which receives the mapping relationship and stores it in the network-wide mapping database.

2. Terminal A transmits data after obtaining the communication identifier of terminal F. The source and destination communication identifiers of terminal A's data packets are CID_A and CID_F, respectively.

3. The access router AR_B resolves the origin-destination communication identifier in the network layer message. The mapping server returns information about the semantic-rich identifier corresponding to the source and destination communication identifiers and stores the key-value pairs of the communication identifier and the semantic-rich identifier in the cache of the network element node. The cache contents of the network element node are updated according to the cache replacement algorithm.

4. In the access router AR_B, the access router generates a routing identity carrying the routing policy based on the semantic-rich identity information, encapsulates the terminal data according to the protocol used for the routing identity, adds the routing identity header externally, and then forwards it in the core network.

5. The access router AR_B addresses the routing forwarding table according to the destination routing identifier and sends the data packet to the next hop, such as the core router CR_C.

6. After the core router CR_C receives the packet, it parses the network layer header of the accompanying routing protocol in the data part of the message, resolves the communication identity of the source and destination, and accesses the mapping server with the communication identity as a key to obtain the semantic-rich identity information of the source and destination nodes. The core router CR_C performs security verification based on the identity information and drops the illegitimate messages if they do not pass. If the messages pass the verification, they will be forwarded according to the next hop pointed to by the routing protocol.

7. After receiving the data packet, the access router AR_E decapsulates the data packet, obtains the MAC of the destination communication ID based on the ID resolution protocol, and then uses the MAC address of AR_E as the source MAC address and the MAC address of the terminal F corresponding to the destination communication ID as the destination MAC address, performing forwarding.

8. After receiving the message, the destination host F parses the message, obtains the semantic-rich identifier information through the communication identifier, and performs security verification to obtain the data.

3.3 Fusion Addressing Mechanism Based on Semantic-Rich Identifiers

In this subsection, we detail the fusion addressing mechanism based on semantic-rich identifiers, which is a key component of the SRIM system. This mechanism is responsible for generating communication identifiers by fusing semantic-rich identifier information, as well as mapping these identifiers to routing identifiers for efficient and secure communication in the network. The fusion addressing mechanism includes the following functions:

3.3.1 Communication ID Registration Maintenance

The terminal collects semantic-rich identifiers such as addresses, users, devices, services, and data, and stores them in the cache database of network element nodes and distributed databases for maintenance. This ensures that the semantic-rich identifier information is globally consistent and available.

3.3.2 Communication ID Code Generation

The terminal encodes the semantic-rich identifier information, processes the semantic-rich identifier information using a hash algorithm and generates a fixed-length communication identification (for example, using the MD5 algorithm, the generated communication identification is 128 bits in length). The communication identification is used as the key, and the semantic-rich identifier information is stored as a value, facilitating subsequent communication identification analysis.

3.3.3 Communication ID Extraction and Analysis

The network element node extracts the communication identification information from the data header. Based on the communication identification, it queries to obtain the corresponding semantic-rich identifier information and further acquires the identification of addresses, users, devices, services, data, and other identifiers based on the coding rules. This provides the data basis for other functions.

3.3.4 Communication ID Mapping Forwarding

A communication ID and routing ID mapping system is established. When data enters the network, the access network element parses the terminal communication ID, performs policy verification and routing ID extraction through the mapping system, and then encapsulates and forwards the terminal data. When data exits the network, it is decapsulated by the access network element and forwarded based on the communication identifier.

These functions work together to support the fusion addressing mechanism based on semantic-rich identifiers, enabling the SRIM system to provide efficient and secure communication in the network while addressing the limitations of traditional IP-based network identification. By employing this mechanism, the SRIM system can also support personalized application requirements and adapt to different network conditions and traffic patterns.

In summary, the revised "Design" section presents a coherent and logically structured description of the proposed SRIM system, including its design goals and principles, functional framework and model, and fusion addressing mechanism based on semantic-rich identifiers. The figures have been retained to provide visual illustrations of the concepts and processes discussed in the text, helping readers better understand the main components and processes of the SRIM system, as well as its advantages over existing solutions.

4 Performance Analysis

4.1 Qualitative Analysis: Comparison of SRIM with Conventional Identity Mapping Mechanisms

Compare the identity mapping mechanism of SRIM with that under conventional networks. The comparison results are as follows.

DNS (Domain Name System) DNS is mapping domain names to IP addresses. The steps it goes through to accomplish this function are as follows: 1. The user requests the domain name to access the website. 2. Check the local DNS cache. 3. Queries the local DNS servers. 4. The local DNS servers are queried on a cascading basis. 5. The authoritative DNS servers return the IP address. 6. The IP address is returned to the user's computer.

ARP (Address Resolution Protocol) ARP is the mapping of IP addresses to MAC addresses. The steps it goes through to accomplish this function are as follows. 1. The computer needs to send a packet to the target computer. 2. Check the local ARP cache. 3. Send an ARP request broadcast. 4. The target computer replies with an ARP response. 5. The computer stores the MAC address in the ARP cache table. 6. The computer knows the target MAC address and sends the packet.

SRIM SRIM can obtain the corresponding IP address and MAC address with a single access. The process is as follows: 1. The client requests the corresponding multi-dimensional identification information from the server via the corresponding communication identification cid. 2. The server returns the corresponding multi-dimensional identification information to the client based on the client's request. 3. The client parses the corresponding multi-dimensional identification to obtain the corresponding IP address and MAC address.

Through the above comparison, it is obvious that SRIM shows higher efficiency and simpler operation steps in the process of obtaining relevant identification information. Compared with the traditional marking management mechanism, SRIM has the unique advantage of being able to obtain different marking information in one request, which is an innovation that cannot be realized by the previous marking management mechanism.

4.2 Qualitative Analysis: Performance Advantages of Semantic-Rich Identifiers Compared to Traditional TCP/IP and NDN Architectures

To comprehensively demonstrate the performance advantages of the semantic-rich identifier architecture, we use the traditional TCP/IP network architecture and NDN network architecture as references for comparison. The performance of the semantic-rich identifier system has been improved in three aspects: mobility, security, and efficiency.

Mobility Traditional TCP/IP networks have the original design flaw of binding identity and location and do not support mobility. NDN networks use content-based addressing to unbind resources and locations, supporting mobility. However, the semantic-rich identity architecture can describe different multi-dimensional attributes according to various application scenarios. Through different multi-dimensional attributes, a communication identifier suitable for a given scenario and a corresponding semantic-rich identifier is constructed. This allows the identification and representation of user identity, communication service, and resource content to be independent of the user's location, naturally supporting user mobility.

Safety In the traditional TCP/IP network, there is the problem of binding the network and the user, resulting in low security. In contrast, the NDN network adopts content-based signature and encryption mechanisms, which improves network security. In the semantic-rich identifier architecture, the routing identifier is generated based on the device's location attribute, and the identifier does not carry any information that can characterize the user's identity, avoiding security risks.

Efficiency In the TCP/IP network, there is a lack of sufficient support for multicast, and with the increasing demand for content sharing in the future, there is a hidden danger of network inefficiency. The NDN network adopts a specially designed caching mechanism, which can improve network efficiency. The semantic-rich identification system architecture uses semantic-rich identification to locate resources and improve the access speed of resources in different scenarios. The mapping of semantic-rich identifiers to routing identifiers ensures efficient network forwarding.

4.3 Quantitative Analysis: Comparison with the Parsing Overhead of LISP+ALT and LISP-TREE

First, the parsing overhead of this system is compared with that of LISP+ALT and LISP-TREE (the iterative mode with better performance). It has been pointed out in the literature that LISP-DHT has a large resolution delay, so LISP-DHT is not considered in the performance comparison of this paper. Although some mapping requests can be completed in one step of the parsing process and do not need to go through all steps, the performance comparison considers a complete parsing process in the mapping system.

To calculate the parsing overhead, the transmission overhead and the processing overhead are considered separately. Note that the forwarding overhead is not considered in this paper. If the device only forwards data without searching and other operations, the processing overhead is 0. According to the parsing process described in Section 3.2, the parameters defined by the hierarchical mapping system are shown in Table 2. The analysis processes of LISP-TREE and LISP+ALT are shown in Figure 4-1, with each line representing a step. Based on these parsing procedures, the parameters defined for LISP-TREE and LISP+ALT are shown in Table 3.

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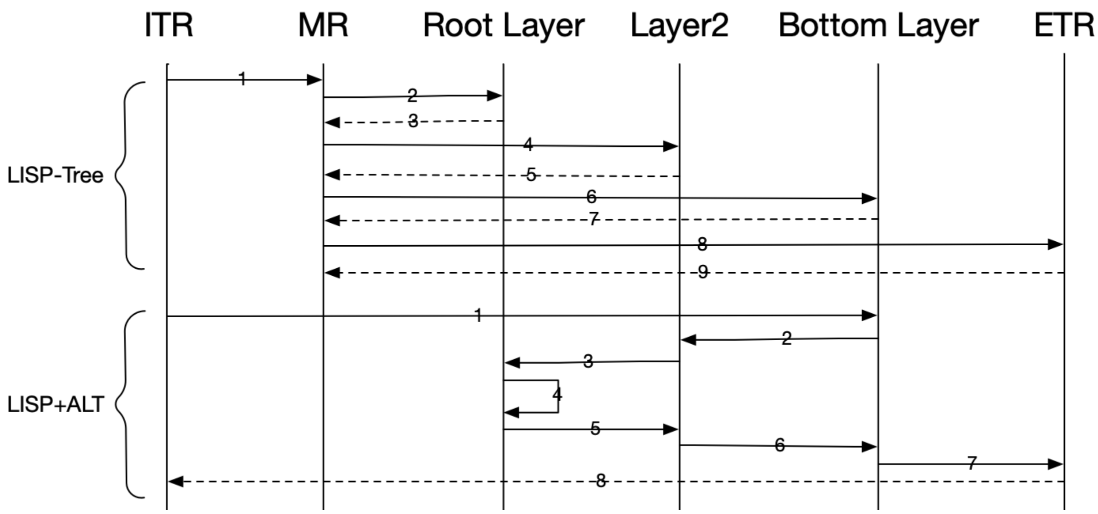

Figure 3: The parsing process of LISP-TREE and LISP+ALT

of LISP-TREE and LISP+ALT according to the literature. Based on these parsing procedures, the parameters defined for LISP-TREE and LISP+ALT are shown in Table 3.

Transmission overhead is related to the distance between network entities. In order to obtain the relative cost of LISP-TREE, LISP+ALT, and SRIM system, it is assumed that if two devices are directly connected, the distance is 1; if the two devices are in the same AS domain, the distance is 5; if the two devices are within different ASs, the distance is 10.   is a proportional constant between distance and transmission cost, that is, transmission cost C_{tran}=l×δ [16] . Note that if the distance is set to a different value, the value of the transmission overhead will change, but the relative relationship between LISP-TREE, LISP+ALT, and the transmission overhead of the hierarchical mapping system will not change.

Table 2: Parameters defined by Semantic-Rich Identifier System (SRIM)

Parameter	**Meaning**	**Value**
C_{ims}	Transmission overhead between ASR and CR or MS	$\delta \times 1$
C_{cc}	Transmission overhead between CRs within an AS	$\delta \times 5$
α_{ms}	MS processing overhead	1
α_{mca}	CR and ASR processing mapping overhead	1
α_{ca}	Overhead of CR and ASR for other function processing	1

The processing overhead is related to the number of entries in the mapping table to be queried and the data structure of the resource storage. In this system, the mapping entries in the cache of the mapping server and the network element node are stored using a hash table, and the time complexity is O(1). When the corresponding semantic-rich identifier is queried through the communication identifier, the mapping server is accessed only when the local cache does not exist. The probability that the local cache does not exist is p, where the value of p is 0.07 [17].

Assuming that the search in LISP-TREE and LISP+ALT is based on the longest prefix

Table 3: Parameters defined by LISP-TREE and LISP+ALT

Parameter	Meaning	Value
C_{imr}	Transmission overhead between ITR and MR in LISP-TREE	$\delta \times 1$
C_{mr1}	Transmission overhead between MR and root layer in LISP-TREE	$\delta \times 10$
C_{mr2}	Transport overhead between MR and layer 2 in LISP-TREE	$\delta \times 10$
C_{mr3}	Transport overhead between MR and bottom layer in LISP-TREE	$\delta \times 10$
C_{ib}	Transport overhead between ITR and incremental router in LISP+ALT	$\delta \times 5$
C_{l12}	Transport overhead between root layer and layer 2 in LISP+ALT	$\delta \times 10$
C_{l23}	Transport overhead between layer 2 and bottom layer in LISP+ALT	$\delta \times 10$
C_{me}	Transmission overhead between MR and ETR in LISP-TREE	$\delta \times 10$
C_{be}	Transport overhead between underlying router and ETR in LISP+ALT	$\delta \times 5$
C_{rr}	Transmission overhead between root routers in LISP+ALT	$\delta \times 10$
C_{ie}	Transmission overhead between ITR and ETR in LISP+ALT	$\delta \times 10$
α_{al1}	Processing overhead of LISP+ALT root layer	$\log(256+8)$
α_{tl1}	Processing overhead of LISP-TREE root layer	$\log 256$
α_{l2}	Layer 2 processing overhead in LISP-TREE and LISP+ALT	$\log 6000$
α_{l3}	Low-level processing overhead in LISP-TREE and LISP+ALT	$\log(k)$
α_{etr}	Processing overhead of ETR in LISP-TREE and LISP+ALT	$\log 100$

matching, the longest prefix matching is mostly implemented by binary trees, so the complexity of the search is proportional to the logarithm of the length of each layer of the table. According to the literature [18], the length of each layer table can be obtained. In LISP-TREE, the root server only stores the information of the second layer, so the table length of the root layer is 256. However, the root layer in LISP+ALT stores the information of the root layer in addition to the information of the second layer, so the table length is 256+8. The number of child nodes of the second layer is about 1000 6072, and this paper uses 6000 as the table length of the second layer. Since the table lengths at the root and layer 2 are fixed, the parsing overhead is mostly related to the bottom layer. The underlying table length is related to the number of prefixes it stores. Assuming that there are N underlying routers or mapping servers in an autonomous domain and using 150 as the number of prefixes in each autonomous domain, we get:

$$N = \frac{150}{k} \tag{1}$$

To calculate the resolution cost, assume that the number of prefixes connected to an access switch router is 100, so α_{etr}=log100. Based on the above analysis, the parameter values in the third column in Tables 2.1 and 2.2 are obtained. The parsing overhead C includes the transmission overhead C_tran and the processing overhead C_proc, namely

$$C = C_{tran} + C_{proc} \tag{2}$$

According to the parsing process of the hierarchical mapping system in Section 2.2.3 and the parsing process of LISP-TREE and LISP+ALT in Figure 2.11, the parsing costs C_{hms}, C_{tree} and C_{alt} of the three mapping systems are:

$$\begin{cases} C_{srim} = pC_{ims} + C_{cc} + p\alpha_{ms} + \alpha_{ca} + \alpha_{mca} \\ C_{tree} = 2C_{imr} + 2C_{mr1} + 2C_{mr2} + 2C_{mr3} \\ \qquad 2C_{me} + \alpha_{tl1} + \alpha_{l2} + \alpha_{l3} + \alpha_{etr} \\ C_{alt} = C_{ib} + 2C_{i23} + 2C_{l12} + C_{rr} + C_{be} \\ \qquad +2\alpha_{al1} + 2\alpha_{l2} + 2\alpha_{l3} + \alpha_{etr} \end{cases} \tag{3}$$

Where β is the weight coefficient in the search, the classic value is 0.7 [18], and the classic value of δ is 0.2 [18]. The relationship between parsing cost and k is shown in Figure 4. The results show that this system (SRIM) has the lowest parsing overhead compared with LISP-TREE and LISP+ALT.

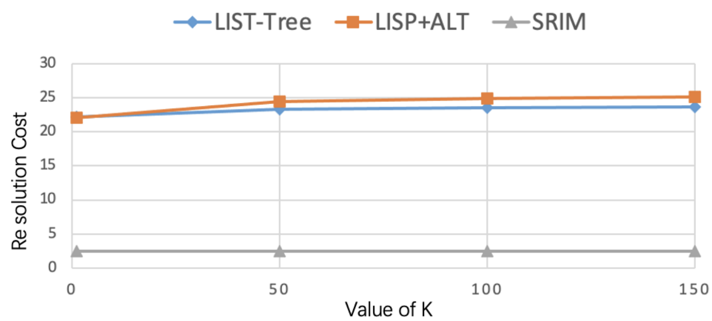

Figure 4: The resolution cost versus the values of k

5 Conclusion

This paper presents the research and design of a semantic-rich identifier naming and implementation method, constructing a multi-dimensional unified identifier and naming strategy suitable for various working scenarios. The proposed SRIM mechanism addresses the limitations of traditional IP-based network identification systems, such as network rigidity, single bearer capacity, overloaded data packet encapsulation, and difficulty in mitigating unknown threats.

The advantages and characteristics of the semantic-rich identification system are: at the identification level, the user's identity is independent of the location, achieving endogenous support for mobility and security; the semantic-rich identification used to describe the identity has compound semantics, which can accurately represent the diverse requirements of future networks and make it convenient for the network to understand the user's intent; the semantic-rich identifier used to describe the location has multiple meanings of network location and spatiotemporal location, allowing the network to provide services for users to select nodes with the optimal "location" to realize intelligent routing and decision-making.

However, there are some potential limitations and challenges in the deployment of the proposed SRIM mechanism. For instance, the scalability and efficiency of the system in large-scale and complex network environments need to be further investigated. Moreover, the integration of the SRIM mechanism with existing network infrastructure and protocols may require additional efforts in terms of compatibility and interoperability. The additional capabilities provided by the SRIM mechanism, such as enhanced mobility, security, and efficiency, may come at the cost of increased complexity in the system design and management.

Future research directions include optimizing the SRIM mechanism for real-world applications, addressing the identified limitations and challenges, and exploring the potential integration with other emerging network technologies and architectures.

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