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Thoughts on the development of novel network technology

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Abstract In this paper, we explore potential innovations that could lead to breakthrough developments in Internet technologies. The deep integration of the Internet and economic society brings professionalized service capacity demand, while existing Internet infrastructure with its current technological systems still face a number of challenges, such as intelligence, diversification, personalization, robustness, and efficiency. First, we analyze the actual foundation of innovation and specify the basic technical features of a novel network. Then, we propose a fully dimensionally definable open architecture as the primary direction, and consider reshaping baseline technologies as a starting point and discuss the core operational mechanisms of the novel network based on such reshaped baseline technologies.

Keywords novel Internet technology, open architecture, full-dimensional definability, diversified addressing and routing, intelligence, general robust control

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1 Introduction

With the sustainable development of network technologies and applications, especially the emergence and usage of big data, cloud computing, and artificial intelligence (AI), the Internet is now witnessing a new accelerated fission-like revolution that urges significant revolutions in all social sectors and profoundly changes the mental space, time span, and dimension of human thought. The Internet has become a major information infrastructure that is highly related to national economies and social development, and has deeply impacted the improvement of social productivity, economic prosperity, social transformation, and career opportunities. Therefore, the Internet has provided a powerful fundamental support for speeding up the development of innovative countries and the realization of “cyber power” and “intelligent societies”.

In recent years, the application of the Internet has expanded rapidly, and the problem of “how to make full use of the network” has essentially been solved. However, in the face of demand professional service capacity that comes from the deep integration of the Internet with economic society, the development of Internet technology concept has failed to fully support the extension of network applications. The existing network infrastructure and the development of the technical system still face a series of major challenges that must be addressed from the perspective of intelligence, diversification, personalization, high-robustness, and high-efficiency, which restrict their wider and deeper support for economic and social development [1]. In other words, “What kind of network works better?” has become the core problem to be solved urgently.

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In the last ten years, academic and industrial researchers have focused on novel network technologies, and numerous relevant researchers have proposed various solutions and corresponding technologies that have been implemented in a variety of scenarios and where the technologies demonstrate strong vitality [2]. In particular, the development of various technologies, such as open architecture based on software-defined networking (SDN) [3, 4] and network function virtualization (NFV) [5, 6], have experienced rapid growth and will enter mature development stages in the next five to eight years. Such technologies are expected to eliminate the barriers to the continuous innovation and evolution of Internet technologies. When promoting incremental deployment and evolutionary development of the Internet, we should focus on completely adopting novel ideas, reforming the basic Internet technology systems, strengthening structural innovation, and promoting the change of technology development from plug-in-focused to endogeneity forms. Building a novel network with intelligence, diversification, personalization, high robustness, and high efficiency is the next step toward development.

In terms of Internet development in China, due to a late start, we have invested heavily in cost, time, and labor in the process of development, and related industries are suffering from development restrictions associated with dependency on core technologies. Therefore, in the development of the new network transformation, our mission in the new era is to seize deeper and broader areas of development opportunities, promote Internet technology in China to evolve from following to leading, and achieve historical communication industry transformation from a “big communication industry power” to a “strong communication technology power”.

In this paper, we analyze the main challenges facing current network development. We propose an open architecture based on a full-dimensional definition (software definability on all network elements) as the primary direction and reshaping baseline technologies as the starting point. In addition, we expound the basic technical features and core mechanism that a novel network should possess, which explores ways to the Internet technology innovation and breakthrough and provide references for scientific and technological researchers.

2 Main challenges of Internet development

As the deeply coalesced development of the Internet and economic society, Internet plus and industry 4.0 have become the new pillars of the national economy. The number of roles the Internet plays has been increasing, which stimulates business and consumer demands. Diversified terminal types, continuous development of access methods, and human-human, human-machine, machine-machine, and network-network communication have all become commonplace. Thus, to satisfy these demands, the network must provide diversified, personalized, intelligent, efficient, and robust services to satisfy the massive business needs.

Faced with the evolution of such demand, existing Internet technology architectures are imbalanced and insufficient. Thus, satisfying the ubiquitous scenarios of various requirements of users is difficult, and this makes the current network incapable in terms of quality, safety, integration, expansion, controllability, efficiency, and mobility. As currently configured, the Internet is faced with great challenges in terms of dealing with huge and complicated service demands.

Main challenge 1: The self-enclosed network structure and rigid baseline technology restrict the diversified network development, the ability to provide professional network services, and the application of innovative network technologies.

Reviewing Internet history, it has evidently always used closed architecture and baseline technologies, such as rigid transmission protocols, route control, and transmission mode based on IP thin waist model, which is simple and limited and simplex in network function structure. Consequently, the ability to support ubiquitous information services, diversified network services, guaranteed communication quality, and safe and reliable information exchange have been seriously limited [7].

Tracing back to the cause of this phenomenon or pattern, we can find that the self-enclosed network structure and rigid baseline technologies were selected due to market rather than technological factors.

In an enclosed model, the baseline technology will be strengthened as soon as it dominates. Admittedly, in a self-enclosed network architecture and rigid baseline technology, development based on simple network demand, limited service types, and monotonous scene-based operating mechanism provided strong support for the rapid spread and maturation of the Internet in the early stages.

However, along with the status establishment of the Internet as a global infrastructure, the demand for diversification and professionalization of services continues to increase. However, the network resources supplying and scheduling mechanisms represented by best effort transmission and statistical multiplexing are congenitally deficient, while major technological innovations has always failed to be implemented in the network. Therefore, the contradiction between "energy" and "efficiency" exist at all times and cannot be solved fundamentally. Consequently, increasing network resources or putting patches on existing technologies passively to promote the network capabilities can not necessarily bring about the increase of effectiveness, and the Internet is becoming more and more bloated.

Main challenge 2: Diversified development of the Internet significantly increases the complexity of transmission control, resource management, and configuration maintenance in the currently ossified network transmission mechanism and leads to low network efficiency and poor user experience.

At present, the Internet has developed from a non-real-time traffic load in the early stage to the current foundation of text, image, audio, and video integrated content. The Internet gradually became the basic way to connect a variety of real-world production and living elements, showing a trend of terminal type, access type, device form, and business scenario diversification.

However, the Internet's existing operational mode is rigid, and simple technical fixes and manual configuration management scheduling mechanisms have been unable to meet the ubiquitous demand scenarios arising from diversified development of the network, resulting in increased complexity of network transmission control, resource management, configuration, and maintenance. Moreover, the costs of network operations and maintenance have also increased significantly [8]. At the same time, the indices and models used to describe network functions and the performance of the existing network, and the corresponding method to match the needs of users require profound changes. Further, such indices and models are unable to adapt to network demands in the ubiquitous scenarios, thus leading to the low network efficiency and poor user experience.

Several factors must be considered for the development of novel network technologies.

- How to equip the network with "unmanned driving" ability to satisfy ubiquitous network demands?
- How to eliminate reliance on manual or ossified mechanisms in structural optimization, resource allocation and management, service bearing and service quality, network monitoring and failure location, and other aspects?
- How to fully absorb and use the progress in AI technologies, reduce the cost of network transmission control, resource management and maintenance, and simultaneously make the network capable of self-development?
- How to address various disadvantages such as inefficient operation and other unfavorable situations due to human cognitive limitations in a complex network environment?
- How to guide the upgrade of cyber resource management and operation mode from traditional and simple mode?

Main challenge 3: Uncertain disturbances, such as random failures in network nodes and links, and loopholes and backdoors in network element systems, occur frequently, which makes the general robustness problem in the Internet increasingly urgent.

The rapid expansion on network scale and the huge complexity of all kinds of network elements often disturb or damage the operation of the Internet due to uncertainty, resulting in performance degradation or even loss of functionality, thereby limiting its ability to satisfy user service requirements.

In fact, the Internet still lacks the ability to help software or hardware systems resist uncertain disturbances, including backdoor or other "dark functions". Thus, the quality control problem that was originally associated with a target object or network element design and manufacturing process will reluctantly "overflow" to become the main security challenge, and that is how the "Pandora's box" of the

Internet is opened. The behavior of producers or enterprises that "do not undertake the safety of software and hardware products" or "do not bear any responsibility for the consequences caused by product safety" can be attributed to the generalized robustness problem of network.

Therefore, neither network reliability nor credibility can be guaranteed, and providing satisfactory service quality and enhancing network resilience against all kinds of threats are also important challenges facing the network. To achieve this goal, several efforts should be undertaken, which include restoring the business reputation of products, dealing with the heavy risks of cyberspace, locking "the evil" back into the Pandora box, researching general robust control technologies to suppress uncertain failures (e.g., node or link failure), and prevent uncertain threats (e.g., system backdoor and loophole).

3 Realistic basis for network technology innovation

Academia and industry have been concerned with the development of a novel network and corresponding technologies for many years, and domestic and foreign researches have provided a good realistic basis for breaking the dilemma of network development and innovative technology. Among these approaches, SDN and NFV provide an open environment foundation for network innovation, and various technologies, such as diversified addressing, AI, and general robust control techniques, provide core elements for innovative network technology. In addition, the full release of the "Silicon Bonus" (the exploitation of semiconductor devices) and "Optical Bonus" (the exploitation of the spectrum of light) also gives aid to offer a realistic basis for innovative network technology.

3.1 Technologies such as SDN/NFV provide open environment foundation for network technology innovation

In recent years, open programmable networks represented by SDN, NFV, and other related technologies develop well, and their flexible scheduling and management of computing, storage, and network resources through the separation of forwarding and control mechanism make traffic routing in network schedule as required. In addition, based on reconfigurable functions and programmability, the network has become open, extensible, and evolving, so as to enhance the transmission efficiency and optimize the allocation of resources [9]. Among them, open programmability represents a deep abstraction of the overall network functions and behaviors and the customization of software programming, and its core idea is an open programmable interface for network nodes and the use of a programming language to send powerful programming instructions to network devices. Finally, open programmability can realize management as required and can facilitate rapid deployment of network functions and behaviors [10]. NFV emphasizes that by deploying these functions on virtualized resources to make the network provide various advantages, such as flexibility, dynamic resource expansion, and energy efficiency [11]. Meanwhile, NFV also supports the combination of virtualized and physical resources, which has a broader application. SDN and NFV create innovative network technologies and test environments for open architectures and programmable technologies, and equip the network with the technological and environmental foundation required to advance from a closed architecture to an open architecture.

As for related researches, our country has supported a series of "973 Projects" and "863 Projects" (released by Ministry of Science and Technology of the People's Republic of China). In addition, CENI (China Environment Network Infrastructure), a major national science and technology infrastructure project, which explores the open networks relative to system architecture, key technologies, operation mechanisms, and network testing. Among them, our country's original reconfigurable network technology [12] has clearly proposed an open future network system that addresses the "closed" and "rigid" constraints in traditional network technology, which can release the vitality of technological innovations.

In terms of engineering practice, from large operators to data centers and all kinds of dedicated networks, SDN and NFV have already been used in large scale to improve network capabilities. All future development strategies proposed by major operators at home and abroad have identified SDN and NFV as one of the main technical basis for network construction. In addition, China has opened an innovative new-generation network architecture test facility that covers sixteen cities and has made breakthroughs in software-defined routing and switching equipment and intelligent information resource scheduling systems, thus obtaining a batch of achievements with independent intellectual property rights.

3.2 Breakthroughs in many key technologies have provided core foundations for network technology innovation

The notion of everything defined by software has evolved from theory to practice, which has allowed software-defined technologies to flourish, such as software-defined forwarding (SDF) [13], software-defined interconnection (SDI) [14], software-defined hardware (SDH) [15], software -defined protocol (SDP) [16], and software-defined chips (SDC) [17]. The above technologies can define topologies, protocols, hardware and software, and interfaces of basic networks in all dimensions, so as to provide diversified and personalized applications with fine-grained and definable network components and services. "Software-defined" ideas have been implemented in the whole chain of applications and practices across the Internet, which supports not only personalized service networks for different types of communication but also the rapid deployment of existing typical protocols and various new protocols. This technology can effectively improve the utilization of network resources, reduce maintenance costs, and bring about technological advancements, such as advances in network architectures, equipment reforms and network operation modes.

Moreover, diverse addressing and routing technologies are brewing a major breakthrough. The real world has shown a colorful development trend that combines traditional addressing modes, such as post encoding and doorplate, and new addressing modes, such as "service-oriented addressing and routing" and "spatial coordinate-oriented addressing and routing", consequently showing a great vitality under efficient and diversified services. The network space, which is strongly associated with the physical world, has also shown matching technologies of diversified addressing and routing technologies. Although for a long period of time in the future, the addressing and routing technologies based on IPv4/v6 will continue to play important roles, and addressing content-centric routing [18, 19], spatial coordinate location-centric addressing [20], and identification separation-centric routing [21] will develop quickly in recent years. Further, such technologies have demonstrated good performance in real applications.

Research on "unmanned driving" technologies for ubiquitous networking is active. In recent years, big data analysis, AI, and other technologies have developed vigorously, based on which the establishment of self-driven intelligent operation mechanisms has become the focus of academic and industrial exploration. Professor Clark et al. [22] put forward "knowledge plane" , which proposed to build self-configuration, self-adaptation, and self-repair of the network based on AI and cognitive systems. Meanwhile, Mestres et al. [23] put forward knowledge-defined network that dynamically monitors the network state and performs analysis and makes decisions based on a machine learning algorithm so as to optimize network configuration and performance. At home and abroad, both mainstream manufacturers and Internet companies, such as HUAWEI, CISCO, ZTE, Google, and Alibaba, are also striving to explore the intelligent operation of complex networks and have demonstrated preliminary achievements.

Finally, the mimic construction technology provides a feasible way to solve the general robust control problem in the network [24]. This general robust control problem can essentially cope with structural defects, such as static states, deterministic form, and similarities relative to backdoor or loophole attacks. Using the uncertain relationship between network service functions and the apparent network structure, a function-equivalent dynamic structure in information systems or processing devices can undoubtedly disrupt or destroy the stability of a backdoor and loophole attack chain, so as to deal with network security threats with uncertain scenes. With this knowledge, Chinese scientists and technical workers put forward mimic construction technology and have carried out equipment development and application tests in file storage, routing, and domain name services. Innovative system construction technology provides a new solution for the general robustness problem under current situation that the hardware supply chain in information system is unsafe globally.

3.3 The release of "Silicon Bonus" and "Optical Bonus" provides realistic foundation for network technology innovation

The performance of network chips and devices is one of the material foundations for the development of networks. In recent years, the "Silicon Bonus" and "Optical Bonus" have been released continuously, which improve core network components, promote infrastructure innovation and the development of core devices and systems, and provide a foundation for network technology innovation.

In "Silicon Bonus", the technological level of core network components improves continuously. In addition, the computing, storage, and transmission capacities of core network equipment also greatly increase, which not only provides important support for the deployment and implementation of new network technologies but also expands the innovation logic of new network technology. Based on this, network evolution is no longer confined to the unilateral promotion of "transmission" capability but is developing into an integrated upgrading mode based on the integration of transmission, computation, and storage technologies. Through dynamic conversion and combined application of storage, computing, and transmission capabilities, network service capabilities have improved significantly.

In "Optical Bonus", technological progress, such as multi-wavelength processing and multicore optical cables, constantly improves the performance record of optical fiber and devices, contributing to greater available bandwidth of the novel network technologies, thus achieving stronger network service ability with such more bandwidth resources. This enables emerging network technologies to focus on the core mechanism and logic of network, so as to solve the core problems faced during the development of the network in a deeper and more fundamental manner.

4 Basic technological features of novel network

Based on the above knowledge, we believe that the novel network should have various basic technological features, including full-dimensional definability, diversified addressing and routing, intelligence, and general robustness. These features can be used to determine the "openness gene", "function gene", "efficiency gene", and "robustness gene" of a novel network, providing continuous propelling for network development with the endogeneity function of genes.

4.1 "Openness gene" of novel network with full dimensional definability

With the ever-growing varieties of network business forms, business network requirements are becoming more and more diverse and changeable. However, the traditional network architecture is rigid and self-enclosed, and its service capacities are limited and determined. This leads directly to a wider gap between business requirements and intrinsic network abilities, thus making it difficult or even impossible to support the evolving network development that the network business needs.

The primary technical features of the novel network are to replace the rigid and enclosed architecture of traditional network, to support full-dimensional definability for hardware and software, interfaces, chips and protocols under an open architecture. In this manner, it makes the operation mechanism of the network no longer restricted by simple functions or technologies, and enables flexible organization and adaption for multidimensional resources in the network, which can not only meet the diverse business needs in service flexibility and business adaptability but also adapt to future complex and uncertain evolution.

Therefore, the novel network will determine the "openness gene" with full-dimensional definability and support open network architectures. Its features can be summarized as follows. First, it changes the rigid operation of current networks and becomes a provider in the "network function component market" mechanism. Second, it enables dynamic assembly and construction of diverse applications to establish a customized function chain. Third, it builds customized service component chain matching and dynamically deploys personalized applications to achieve flexible adaption.

The implementation of the full-dimensional definability in open network architectures will free the novel network from the baseline risk of technology monopoly, and inner openness can promote efficient innovations at all levels. The function and working mechanisms of the network will no longer be subject to a specific protocol. The service capacity of nodes will no longer be dependent on the initial implant design, and the service capacity space will break free from the restrictions of known protocols and mechanisms to achieve transformation from a network defined by known protocols to a demand-driven network form and service ability, which can fully meet the evolving network business model needs.

4.2 "Function gene" of novel network with diversified address routing

At present, IP is the only way of addressing in traditional networks, but it cannot meet the diversified, pluralistic, and specialized application needs. The pattern of heavy burden on IP thin waist has made the Internet evolve slowly because of the loss of diverse internal vitality.

In fact, the diversity of natural species has provided a scientific theoretical basis for building a harmonious and diversified network community. The pluralistic species found in nature form a harmonious and unified development pattern because they complement, restrict, and balance each other. Without the accumulation of competitive variation and the continuation of innovation, the biosphere will gradually become apoptotic due to homogenization.

Therefore, the novel network should redefine its "function genes" by diversified address routing and embody the multi-integration development in its basic network functions, thus building a systematic network function generation and on-demand evolution mechanism based on the expression of gene information. At the same time, the address routing based on diversified identities will also provide a basic environment for innovative baseline network technology, and it will provide support for deep integration of resources for diversified business requirements. Through collaborative technology innovation and complementary advantages of a diversified identification address space, many disadvantages that existed in the current network are solved by an innate endogenous way, thus improving service ability, security, mobility, and resource utilization.

4.3 "Efficiency gene" of novel network with network intelligence

The goal of network intelligence is that on the basis of full-dimensional definition and diversified address routing, the self-driving mechanism of "perception-decision-adaptation" will be established with the constraints of network transmission efficiency, node running efficiency, service bearing efficiency, and service delivery efficiency. Based on this, such mechanism can realize intelligent adaptation of network resource management and transmission control, together with the automation of network operations and maintenance, thus making the network convenient and intelligently adjustable to the change in environment and user needs.

The "efficiency gene" of the novel network is determined by network intelligence, which makes the "process of network usage" and "experience of network usage" no longer a concern of users. The users' concerns are then attributed to a simple dualization problem related to the "purpose of network usage". At this time, the network can be coordinated between a massive number of users, network elements, and services. According to the users' network purposes, network services are directly determined and also dynamically adaptive to the change of the user's needs, thus releasing the potential ability of the network fundamentally.

The network intelligence will fully draw on the research achievements of human society, the internal operations of biological organisms, and the wisdom of biological groups, and then expand the depth and breadth of the application of human wisdom in the construction and operation of the network, and finally achieve "originate from the real-world aspiration while surpass existing form in real world". The intelligent network can automatically deduce the appropriate network resource composition, node cooperation, operation control, etc. based on human language-like description, and can adjust and optimize according to actual operational factors. At the same time, for meeting user and business needs, the intelligent network is also able to adapt and optimize based on the accumulation of "experience", and with intelligent perception, big data, and AI, the network can continuously self-optimize the service performance to meet the actual demand.

4.4 "Robustness gene" in novel network with general robust control

The novel network must possess the "robustness gene" in the general robust control structure, which not only effectively inhibits the influence of traditional uncertain disturbance in the target object but also maintains robustness of the system service function and performance under artificial disturbances, such as loopholes and backdoors, thus countering the negative influence of the absence of general robust control on service quality.

Relative to the general robust control requirements of the novel network, it is not the ultimate goal of the defender to make an attack effect uncertain or to disintegrate the uncertain disturbance to a certain degree. The ideal is that the effect of certain or uncertain disturbance caused by known or unknown threats can be transformed into a reliability problem with a controlled probability by given structure or mechanism so as to solve the problems with the aid of existing reliability theory.

Therefore, implanting the general robustness gene into the network, introducing robust control mechanism to the network and platform designs, and devising a complete network robust control architecture can help the network not only restrain uncertain failures, such as node or link failure, but also prevent the influence of uncertain threats, such as backdoors and system vulnerabilities, thus realizing "robust construction of network elements, robust control of the network, and robust service provision". This is a necessary requirement of the novel network for steady service provision.

5 Core novel network mechanism relative to reconstruction of baseline technologies

With the novel network, we believe that baseline technologies will no longer be a rigid shackle of transmission protocols, forwarding modes, and routing control as in traditional closed environments, but remolded into diversified addressing and routing, network intelligence, and general robust control based on fully dimensionally definable open network architecture. Next, we will discuss the core mechanism of the novel network under baseline technology reconstruction from four aspects including basic operating environment, multiple function composition, service delivery mode, and operation guarantee mechanism.

5.1 Fully dimensionally definable open network architecture

Fully dimensionally definable techniques, such as SDH, SDI, SDF, and SDC, are the foundation of open network innovation. Under the fully dimensionally definable open architecture, the novel network, based on definable components and flexible organization, can establish a fully dimensionally definable infrastructure, including connection, hardware, protocol, and forwarding mechanisms, thus achieving definability in the whole chain of basic connections, nodes, networks, and so on.

First, in order to protect the existing services and network facilities to adapt to the evolution of the network, the fully dimensionally definable components and operating platform under the open architecture must have good stability, which means that the components must ensure both incremental protocol and application deployment and normal operations. Second, to ensure that the network can take on positive changes under multi-dimensional evaluation indicators to satisfy the changes in business requirements and novel application deployment, the components must have an adaptive internal structure, that is, packet processing and network protocols that can dynamically change on demand. Third, on the basis of the variable structures of the components, the inner structure and component resources should be adjusted in a flexible and undetectable manner so as to achieve dynamic network service and application needs.

5.2 Diversified addressing and routing

Diversified network applications require various addressing and routing modes, as well as efficient and flexible addressing and routing. Specifically, we think that the addressing and routing mechanisms of novel networks should include but not be limited to the following.

• Addressing and routing based on IPv4/v6. This method adopts a hierarchical address mode, automatic address configuration, source authentication, and so on. It has strong flexibility and fast processing ability and will continue to play an important role in the novel network.

• Addressing and routing based on content identification. This mode transforms the network communication mode from "where"-centric to "what"-centric and regards all data content in the network as information that can be transmitted, thus realizing direct connection to content instead of the host interconnection.

• Addressing and routing based on identification. This method can effectively solve the problems of security, mobility, scalability, and user experience by separating identity and location, by separating resources and locations, and by separating access and core networks.

• Addressing and routing based on spatial location coordinates. This method is based on the network location coding of the meshing grid on the Earth and can realize direct mapping between the network space and real space position, thus providing support for improving network application efficiency.

5.3 "Perception-decision-adaption" fused with intelligent management and maintenance

Through the introduction of swarm intelligence and AI technologies, the novel network establishes the intelligent management and transmission of "perception-decision-matching". It adopts the intelligent coordination control of network resources and intelligent transmission optimization and service bearing of intelligence adaption to realize large-scale network intelligent management and transmission based on the service experience.

Intelligent network management and transmission of "perception-decision-adaption" integration includes three aspects.

• Perception: Dynamic and real-time perception of network services and resource distribution through various technologies, such as ubiquitous interconnection and definable perception, to generate a full network view based on a unified description model of high-level perception semantics while supporting definability of perception objects, perception actions, association rules, and functional allocation of network agents.

• Decision: In consideration of complicated network states, variable traffic behavior, and uncertain business models, the network generates complex uncertain business and resource related decisions, resource management strategies, and maintenance rules using a real-time decision network.

• Adaptation: For the adaptability of network structure to changing business requirements under a complex and uncertain network, novel technologies (such as SDN, NFV, and reconfigurable technologies) can be used for route scheduling, function reconfiguration, resource configuration, service loading, and other adaptive adjustments, thus enhancing the network's business adaptability and scalability, and supporting dynamic cooperative distribution and deep fusion of cross domain resources, which endows the network with a flexible organization and continuous evolution ability.

5.4 Endogenous robust control mechanism

In the case of increasing uncertainty, in order to achieve robust construction of network elements, robust control, and robust services, the novel network needs to build a "high reliability, high credibility, and high availability" endogenous robust control mechanism.

Based on mimic structure technologies inspired by biological ecosystems, dynamic heterogeneous redundancy is introduced into the network, and a negative feedback mechanism is used to deal with the uncertain failure disturbances in the system. The endogenous robust control mechanism based on mimicry has the following five characteristics:

- Backdoor, artificial, or deterministic uncertain disturbances of the target object are transformed into uncertain events at a system level;
- Disruptive events are transformed into the probability-controllable reliability problem;
- The strategy scheduling and multidimensional dynamic negative feedback mechanism based on the mimicry decision can trigger the “uncertainty” effect for the perspective of disturbance initiators;
- With the aid of the expression mechanism of “relatively correct” axiom logic, the uncertainty disturbance can be perceived without disturbance information or behavior characteristics;
- Non-traditional disturbance factors are transformed or normalized to classical reliability and robustness problems.

6 Conclusion

To practice the mission of Internet researchers, exploiting SDN and NFV technologies under an open framework, reconstructing baseline technologies as the foundation, creating a development model of incremental deployment, innovating the novel network of “China intelligence”, promoting the communication network technology in China from “following” to “leading”, and achieving the transformation from “big communication industry power” to a “strong communication technology power” are the basic elements of emerging network innovation. Starting from the main challenges facing network development, this paper puts forward basic technological features as well as probes into the core mechanisms of the novel network, which can serve as reference for network scientists and technicians.

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