IPv6 Migration Solution for WAN

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Huawei NE routers: Empowering your network

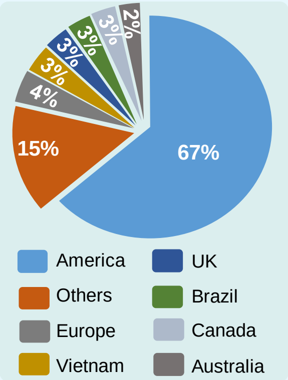
Challenges

With "Internet+" unveiled, the new Internet-derived service landscape is changing dramatically. In this context, terminals move closer together along with burgeoning Internet technology, big data, cloud computing, and Artificial Intelligence (AI). However, the existing Internet construction is based on the IP protocol stack, and the crawling IPv4 live network struggles to accommodate the Internet's development and evolution.

① The depletion of IPv4 and non-consecutive address allocation severely limits network evolution.

As basic resources of the Internet, independent IP addresses need to be assigned to each device.

- The 32-bit long worldwide IPv4 addresses total 4.3 billion. However, they are not evenly distributed. The U.S. enjoys nearly half, whereas some countries hold less than 256.
- Non-consecutive IPv4 address allocation leads to difficulties in summarizing routes. Consequently, the routing table is large in scale and demands numerous memory resources, which deteriorates forwarding efficiency and increases costs.
- Although network address translation (NAT) temporarily alleviates IPv4 address depletion, NAT renders low efficiency and performance.



② The development of emerging technology businesses, such as the Internet of Things (IoT), is restricted.

Emerging technology businesses, such as the IoT, industrial interconnection, and AI have posed new requirements on networks:

- Emerging technology sectors require numerous IP addresses, and global public IPv4 addresses became exhausted in 2011, as announced by the Internet Assigned Numbers Authority (IANA).

- IPv4 addresses are difficult to automatically configure or re-address, which fails to meet requirements for configuring a large number of terminals.
- IPv4 has limited control and support for multicast services and streams, which raises hurdles for the growth of new media applications.

③ The IPv4 framework does not support E2E security.

Future networks involve connections between people and objects requiring higher network security, and IPv4 falls short of envisioned security requirements for future networks.

For example, someone stealing a self-driving car to commit dangerous illegal acts.

- Unfortunately, security **was not deliberately designed** since the advent of IPv4, and the existing framework does not support E2E security.
- The adaptation of NAT technology on an IPv4 network disables source tracing and management.

④ IPv6 is pivotal to basic national competitiveness, and the inevitable IPv4-to-IPv6 transition is driven by national policies.

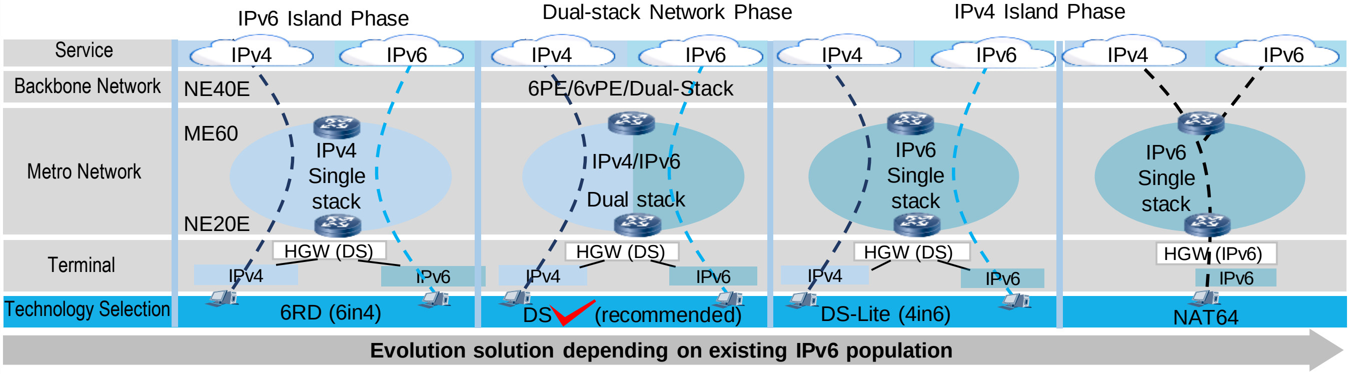
Widely regarded as the core protocol of next-generation Internet, IPv6 affords various advantages in managing address exhaustion, improving network performance, providing high security, and applying automated configuration. Today, global carriers have reconstructed mobile networks supporting IPv6, and the Chinese and U.S. governments have issued IPv6 deployment plans.

In November 2017 the State Council of China issued the Action Plan for Advancing the Extensive Deployment of Internet Protocol Version 6 (IPv6) to trigger the industry transformation of the Internet's next-generation.

In September 2010 the U.S. government released plans to transition to IPv6, and in July 2012 updated the Planning Guide/Roadmap Toward IPv6 Adoption, which explicitly required all government Internet public services to support IPv6 by the year's end. The U.S. government's internal office network fully supported IPv6 by the end of 2014.

Solution

Since IPv6 is inevitable, Huawei — a leading IPv6 provider — offers an all-around solution to the IPv4-to-IPv6 transition, building stable, secure, reliable, and future-oriented networks for customers.



Solution	Technical Characteristics	Advantages	Disadvantages
6RD	IPv6 is rapidly deployed on IPv4 networks by upgrading customer-premises equipment (CPE) and deploying IPv6 rapid deployment (6RD) carrier-grade NAT (CGN).	Supported rapid deployment and IPv6.	1. IPv4 addresses are difficult to save. 2. The evolution to dual-stack (DS) or DS-Lite is required.
DS	E2E IPv4/IPv6 DS deployment is supported.	Uses mature technology and is widely recognized by most carriers and enterprises globally.	Two protocol stacks need to be managed.
DS-Lite	IPv4 over IPv6 is supported, and CGN is deployed to support IPv4.	Future-oriented networks only support IPv6.	Relatively progressive technology is difficult to deploy and maintain.
NAT64	Terminals are only IPv6 capable, and IPv4 access services must be converted using NAT64.	Transitions directly to IPv6 and is simple to deploy and maintain.	1. NAT performance bottlenecks 2. NAT application level gateway (ALG)-induced service scalability restrictions 3. Unsupported IPv4-dominant scenarios

Benefits

Numerous IP addresses facilitating future evolution

- 128-bit long IPv6 addresses total of 2^128 – 1.
- Every grain of sand on Earth can be assigned a network address.

Key features facilitating emerging technology business development

- Numerous IP addresses and automated configurations fulfill emerging technology business requirements.
- All-around mobile support capabilities accommodate various technology sectors.
- The multicast/stream support and QoS enhancements underpin the development of new multimedia applications.

Higher efficiency and lower TCO

- IPv6 follows the clustering principle, greatly reducing routing table size and improving forwarding efficiency.
- Memory usage, and hardware costs are greatly reduced.

New security architecture and higher network security

- IPv6 is traceable and manageable.
- IPv6 supports Layer 3 data encryption and verifies IP packets, greatly enhancing network security.
- The large number of IPv6 addresses enhances anti-sniffing capability and reduces network security risks.

Key Technologies

Three technical directions for migrating the WAN to IPv6:

Phase I: IPv6 Island

Both IPv4 and IPv6 protocol stacks are installed on all terminals and network nodes, which allows information exchange between IPv4 and IPv6 nodes.

Phase II: Dual-Stack

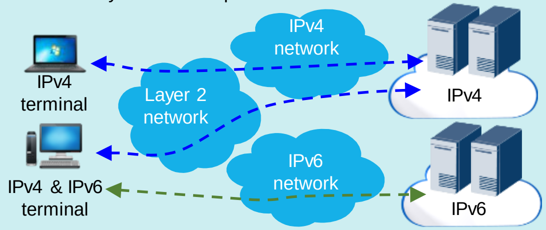
Tunneling technology interconnects separate IPv6/IPv4 networks on an IPv4/IPv6 network — for example, 6-over-4, 4-over-6, 6RD and 6PE tunnel.

Phase III: IPv4 Island

Translation technology interworks between IPv6- and IPv4-only networks. Border translation devices forcibly convert fields in the IP header, including the address carried in the packet body — for example, NAT64.

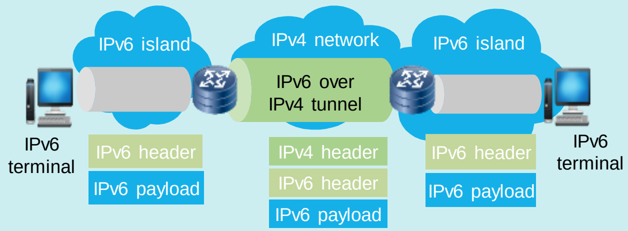
Dual-Stack technology

In the DS network architecture, nodes can communicate with IPv6 and IPv4 at the same time. Applications can use either IPv6 or IPv4, and the DS network is applicable to second phase IPv6 reconstruction that can seamlessly transition to phase three.



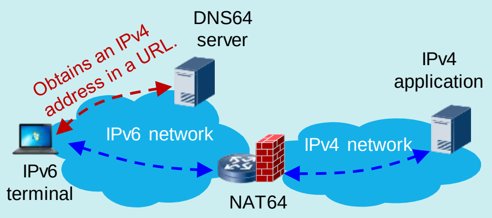
- Superior interoperability, simple application, and gradual transition to IPv6 for applications.
- Fully matched IPv4/IPv6 dual-stack phases with seamless transition to IPv6-only.
- Supported by all Huawei NE routers, which is the mainstream technology used by carriers.

Tunneling technology



- IPv6 island phase: IPv6 packets are the payload in IPv4/Multiprotocol Label Switching (MPLS) packets and connect to IPv6 islands across the IPv4 network.
- IPv4 island phase: IPv4 packets are the payload in IPv6/MPLS packets connecting multiple IPv6 islands on the IPv6 network.
- Tunneling technology: Applicable to IPv6-incapable network devices. Tunneling technology was the mainstream until 2010.
- Some tunneling technologies are obsolete.

Translation technologies



Necessary supplementary technologies in phases I and III of IPv6 migration to enable IPv4 and IPv6 hosts access to each other. For example, NAT64 applies when IPv6 islands access IPv4 networks. A Domain Name System IPv6-to-IPv4 (DNS64) server converts an IPv4 address, carried in a uniform resource locator (URL), to a destination IPv6 address, and then sends the packet to clients. The NAT64 device converts the IPv6 address to IPv4 before the packet is sent to the network. NAT64 can provide IPv6-dominant data centers with IPv4 services. Consequently, NAT64 is less used on IPv4-dominant networks, and all translation technologies confront issues related to NAT ALG and translation performance bottlenecks.

Recommended Products

NE40E Series Service Routers

Core layer

NE40E-X16A

NE40E-X8A

NE40E-X3A

NE20E-S Series Service Aggregation Routers

Aggregation layer

NE20E-S16A

NE20E-S8A

NE20E-S4

NE20E-S2F

NE08E and NE05E Series Service Access Routers

Access layer

NE05E-SQ

NE05E-S2

NE08E-S6/S6E

NE08E-S9

Product Highlights

Technology Research

Leading IPv6 standard development

- Leads the development of IETF standards related to IPv6 routing and VPN.
- One of the key makers of international IPv6 standards and contributed to 16 IETF RFCs and 3 BBF TRs.
- Leads the development of IPv6 standards in China and dominates all IPv6 standards related to WAN covering from terminals to network devices in China, and contributes to 15 national standards.

Product Preparation

The most capable IPv6 product vendor in China

- All NE routers support IPv6 dual-stack.
- No. 1 in terms of IPv6-ready logos within China, and No. 2 among communications equipment vendors in the world.

Commercial Deployment

A pioneer for mature commercial IPv6 use in China

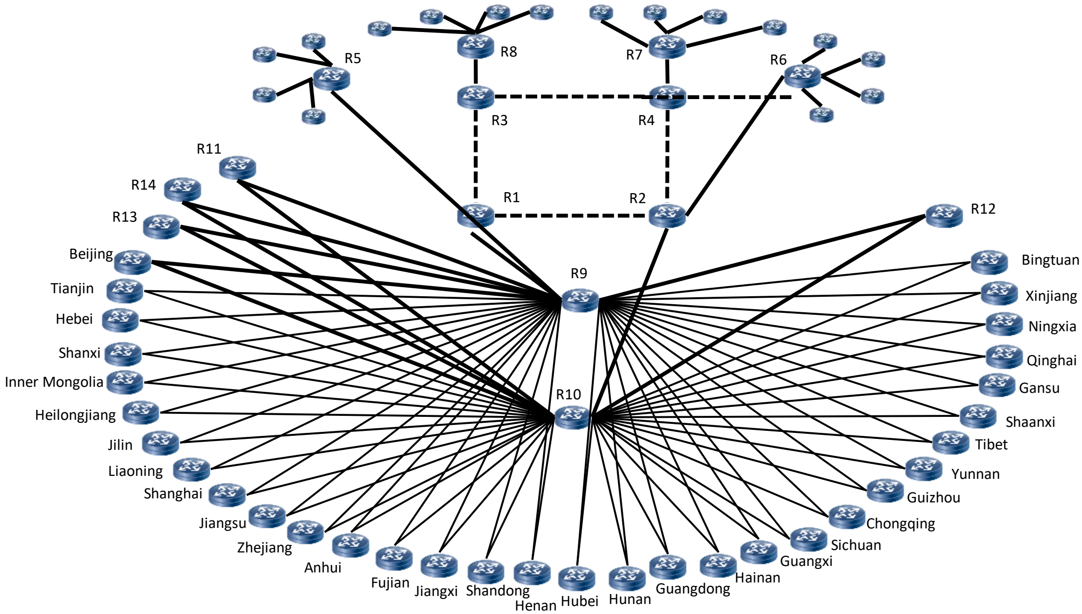
- The only vendor participating in the construction of six CNGI backbone networks in China.
- Fully involved in large-scale commercial IPv6 use for the top 3 carriers in China since 2012.
- Participates in the deployment of key IPv6 pilot industries for enterprise networks — finance, broadcasting, media, and entertainment.

Future Planning

Leading the next-generation of IPv6 WAN construction

- Technology leader in unified IPv6 and SDN evolution.
- Leading the research and practice of future-proof IPv6 security, mobile IPv6, and IoT IPv6.
- Exclusively earned the bid for the Cernet2 next-generation IPv6 experiment network.

Case National eGovernment Extranet of the IPv6 Backbone Network



Requirements

- In 2013, the Chinese government required levels 1, 2, and 3 of the national eGovernment extranets to cultivate IPv4/IPv6 dual-stack bearer capabilities within the next five years.
- National eGovernment extranets acquire IPv6 service capabilities through upgraded network devices and architecture.
- Technologies, such as VPN, provide differentiated services for users of different protocol stacks.

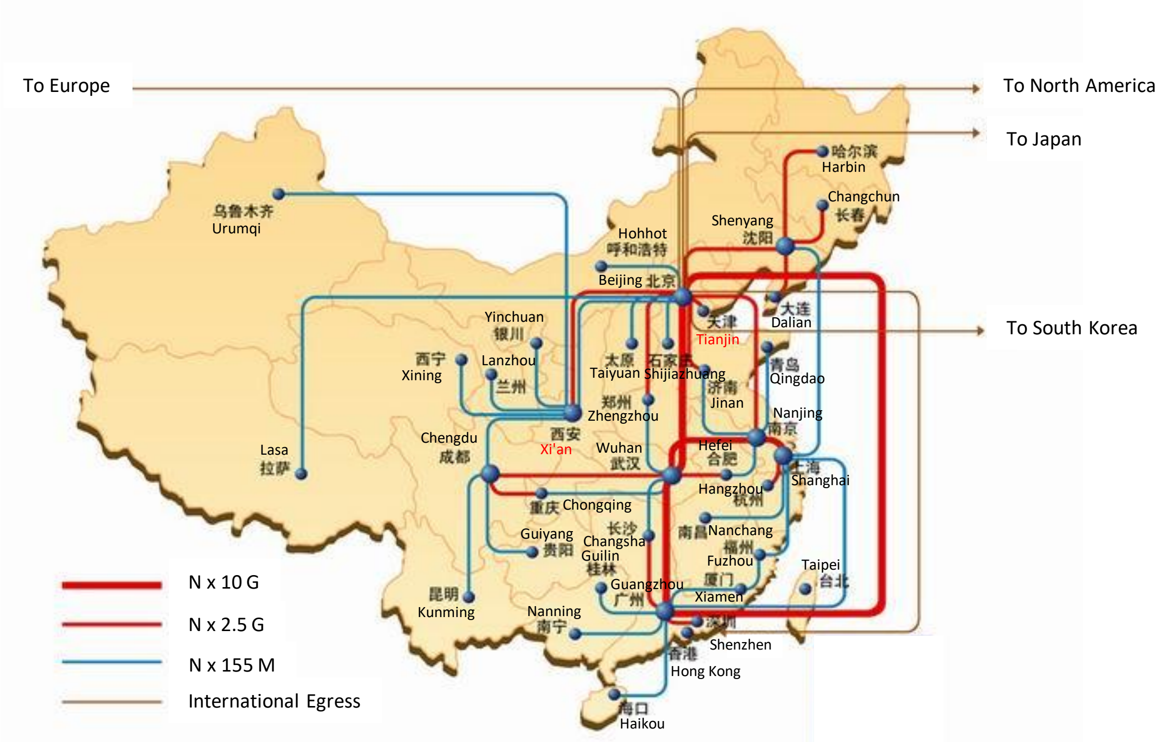
Solution

- Advanced and mature MPLS technologies: deploy the NE40E-X8 on central WAN nodes, the NE20E-S and NE20E-X6 on provincial nodes, the NE20E-S on government department nodes, and the NE20E-X6 on metro aggregation nodes.
- The entire network has IPv6 service bearer capabilities allowing IPv6 access between servers and end users. DS technology is deployed at the Internet egress to allow mutual access between external IPv6 resources and intranet users.
- MPLS VPN provides refined services for users with different protocol stacks and enhances service security on the entire network.

Benefits

- DS technology enables the entire network to carry IPv6 services and apply mutual access between external IPv6 resources and intranet terminals.
- MPLS VPN and QoS features pave the way for various services.
- Huawei provides a custom solution for IPv6 backbone network construction, and our reliable products and high-quality services lay a solid foundation for stable and reliable eGovernment extranet operation on a national level.

Case The China Next-Generation Internet (CNGI) Project



Requirements

- Network coverage and bandwidth need to expand and provide high-speed access for universities from the State 211 Project in China.
- Network service bearer capabilities need to improve and deliver common services for national higher education, science, and research disciplines.
- Supports a smooth evolution to IPv6 networks.

Solution

- As the mainstream device vendor of Cernet2, Huawei provides core and access NE40E routers on the 400G platform to carry 17 regional nodes.
- The NE40E supports IPv6 and multi-service bearers. Each slot on the NE40E can smoothly expand from 40 Gbit/s to 400 Gbit/s, accommodating bandwidth growth for the next three to five years.
- Build an MPLS TE network. 10 Gbit/s POS boards connect to Dense Wavelength-Division Multiplexing (DWDM) systems to provide high-speed router IP links with a transmission rate of 10 Gbit/s.

Benefits

- The network is designed to properly provide high-speed access for universities from State 211 Project in China.
- Multi-service bearer and IPv4/IPv6 DS capabilities enable the uniform bearer of both scientific research services and common higher education services, as well as being capable of smooth evolution to future networks.

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Jointly presented by
Router Ethernet Marketing Support Dept. & Network Information Dept.

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