



## Constructing High Quality IP Core Network

**What we need is not only a network, but also the services that network can provide.**

**-----Huawei-3Com**

Constructing networks is much like building bridges or roads. Safe and smooth transport depends on high quality of the project and on proper control and efficient management on the whole as well. Moreover, the transport network needs to be expanded and optimized unceasingly to satisfy the demands from the development of population and economy.

And network construction is to achieve goals of corresponding services, including IT system of the enterprise, electronic government, electronic commerce, online education or productivity system. To adjust to the demands of the current service objectives and technological development, the IP network will develop from the network providing simple connectivity into one of "high quality service".

As the center of IP network, the high quality IP core network must feature five essentials (high performance of service, scalability, high quality service, high security of service, high reliability of service, and manageability and optimization of service) and must be capable of evolution to next generation IP core network (IPv6).

### I. Present Situation and Direction of IP Network

With the booming of Internet and information technology, the types and traffic of network services grew in large numbers. In addition to FTP, E-mail, WWW and other traditional services, electronic government, online banking, ERP, SCM, CRM, data gather are just emerging, and the real-time services including video services, IP telephony, online education have become new hot issues. These services all need IP network to carry. Therefore, there are high demands for the network in terms of service performance, QoS, security, reliance and management mode.

From the perspective of technological development, in recent years IPV6, data concentration, grid computing, network storage, wireless mobility, real-time messaging has become new trends in technology. These technologies optimize and readjust the network resources and provide new service mode for the network. IPv6 aims at overall optimization of

the IP network architecture so as to enlarge the network capacity and enhance the security, management and QoS capabilities. Data concentration, grid computing, and network storage are all logic consolidation of the computing resources and storing resources in the network. Wireless mobility improves service mobility and enlarges network coverage. Real-time messaging provides an interactive service mode on a real-time basis...

The quick update of technologies requires more powerful service adjusting and upgrading capabilities of the IP networks. For example, since data concentration can be understood as a highly reliable star service model and grid computing is a loose ring service model, IP networks should be able to meet the requirements of these two types of services. Since deployment of IPv6 cannot be accomplished in one action, IP networks must have capabilities of evolution of services.

With the rapid growth of large-capacity switching chip, network processor (NP) and ASIC technologies, the traditional parameters such as capacity and performance are no longer the main factors that restrict the development of IP networks. Service is the real challenge that the IP networks are faced with. To achieve the service objectives, the IP networks must demonstrate better capabilities in QoS, security, reliability, high performance, manageability. Among them, QoS as a pending problem is the focus of attention. Security and reliability are the safeguards for efficient operation of services: it is hard to imagine the value of unsafe or unreliable network for customers. High performance is still of great importance, but here performance not only refers to performance of IP transmission, but also entails high service performance and scalability of the network. Last, the service management capability must be enhanced, but manageability has always been the weakness of IP networks.

The development of IP network has gone through three phases in recent years:

In Phase 1 (before 2001), IP network could only provide simple connectivity. In this phase, there was little diversity in services, and there were few key services. The network mainly carried E-mail, file transfer, information declaration and other data services, and the data transmitted were mainly text and picture information. The network just made its best effort to transmit services. Access control could be performed for services or users, and differentiated service was not possible.

In Phase 2 (about 2001-2004), IP networks enhanced capabilities of access control and user management. In this phase, IP networks gradually broke away from the simple and extensive developing mode. A typical example is the network model capable of operation and management which was advocated by Huawei in 2001. This model has been very successful both in terms of technology and market. Technologies of operability and manageability have intelligentized the edge of network to some extent, but they could not completely solve those problems that are becoming more and more salient such as QoS, security, reliability and service management.

In phase3 (2004-), the IP network is developing with the aim of "providing high quality service". With the fast development of IP network technologies and services, services carried

by the network are more and more diversified, and there are more and more key services. In terms of service type, voice, video and data services can all be borne by the IP network. In terms of key services, ERP, CRM, SCM, electronic commerce, productivity and finance systems are maturing. Different services have different demands for QoS, security and reliability, which requires that the IP networks should be capable of differentiated high quality service. Therefore, QoS, security, reliance, service performance and scalability and service management become the key demands of the network.

All in all, to adjust to the demands of the current service objectives and technological development, the IP network will develop from the network providing simple connectivity and control into one of "high quality service".

## II. High Quality IP Core Network

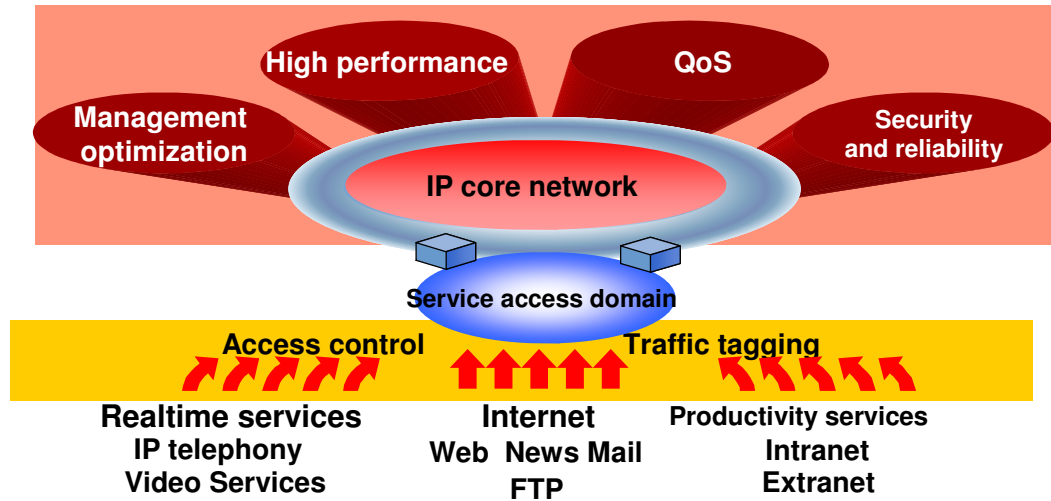
What is the IP core network?

In the traditional hierarchical model, there are core layer, distribution layer and access layer in a network. Core layer performs high speed data forwarding, distribution layer provides flow convergence, and access layer carries out flow access and access control. This division is based on the traffic model, which is more suitable for networks designed for providing bandwidth and simple connectivity but not suitable for a network which is centered on services. From the point of view of service, the core layer and distribution layer only provide overall bandwidth but cannot provide more refined service control and guarantee. To solve this problem, Huawei-3Com has put forward a brand new "high quality service network model".

The high quality service network model divides the IP network into two parts: "IP core network" and "service access domain". Similar to the original access layer, the service access domain performs service access, service access control, traffic tagging. In addition, security management and other functions are added to this domain. "IP core network" covers the original core network, distribution layer and corresponding service management parts, which provides such capabilities as end-to-end QoS, service security, reliance, service high performance and service management and optimization.

The high quality service network model is not a kind of traffic model (because services cannot be distinguished from each other by traffic); rather, it is a service model (end-to-end service guarantee). In this model, the original core layer and distribution layer work in combination—"IP core network"—to guarantee high quality service. "IP core network" is the nerve center of the network, which can be dynamically aware of services and implement powerful QoS guarantee and security strategies, and can perform optimization and adjustment according to service changes.

# High Quality Service Network Model



**Service oriented, not traffic oriented**

How to design a high quality IP core network has become the key objective of network construction. In the view of Huawei-3Com, there are five essentials to the high quality IP core network:

- High performance of service and scalability
- High quality service
- High security of service
- High reliability of service
- Manageability and optimization of service

Among them, high quality service is the core demand, while the other four work together to guarantee it.

## 5 Essentials of High Quality IP Core Network



### Constructing IP core network centered on high quality service

#### 1. High performance of service and scalability

For the IP core network, traditional parameters such as network capacity and performance are the basic demands. For example, current IP core networks usually deploy 10G/2.5Gbps and other high speed links, and switching capacity of the core nodes has exceeded 500Gbps, sometimes it even reaches the level of Tbps. However, the IP core network also entails high performance of service, of course, not only high performance of IP transmission.

To realize high performance of service, design of network and core nodes should demonstrate the principle of "equal emphasis on service and performance". That is to say, while the network provides traditional IP transmission capability, it should be capable of processing a large number of services (VPN, Voice, IPTV, Video, Mail...). Moreover, it should do all this at full wire speed. Fortunately, with the mature commercial use of 10Gbps NP and ASIC technologies, the IP core network constructed with the core router and the new generation core switch developed by Huawei-3Com has this capability.

Furthermore, as the development of new services and new technologies are very fast, powerful capability of scalability is required on the IP core network so as to keep the capacity and performance up to date. On the one hand, capacity and bandwidth are upgrading and updating rapidly, the IP core network should be capable of hardware upgrading and expansion to protect customers' investment. On the other hand, new services and new technologies are emerging every day, which requires the IP core network to be capable of evolution of service.

"High performance of service and scalability" is the most basic demand of IP core

network.

## **2. High quality service**

High quality service is to solve the QoS.

The IP core network can bear a variety of services, including multi-media services such as IP telephony, video conference, IPTV, and data services such as file transfer, E-mail, WWW and online games. From the point of view of QoS, different services have different demands for such key parameters as bandwidth, delay, jitter, and error/packet loss rate. IP telephony and video conference are sensitive to delay and jitter (delay<150ms, jitter<10ms). Data services are not sensitive to delay, but they have high demand for reliance of network transmission (low packet loss rate).

The traditional IP network can simply transmit various services without guaranteeing the QoS of these services. A special network is often needed to be constructed to guarantee the QoS of some important services, for example, Video network and productivity network. Therefore, the high quality IP network must solve the problem of QoS for bearing multi-service. Different from the traditional IP network which employs static QoS solution, more intelligence is required on the high quality IP core network. Here the network intelligence is no longer simply access control and tagging. It is now represented in dynamic awareness of service, guarantee of network resources (such as CPU resource of Node's equipment, Buffer, and bandwidth), and dynamic adjustment of network resources...

Dynamic awareness of service is the basis of QoS policy and security policy. The flow of this process is as follows: the edge devices of the IP core network triggers awareness of a specific service as per the feature of the traffic flow, flow tagging and the threshold of flow statistics. Service awareness can be performed by edge node independently or in combination with the system management system. In this way, overall deployment of policies is facilitated. As new services are emerging constantly, the edge node of the IP core network should have powerful capability of intelligent processing and service flexibility.

On the basis of service awareness, the IP core network should realize guarantee of bandwidth. First, the IP core network should provide bandwidth resources for each type of services. For example, it should allocate 384K end-to-end bandwidth for video service, 25K end-to-end bandwidth for voice service, and 8M bandwidth for data service. Resources for key services should be first guaranteed in case of insufficient bandwidth or network abnormality.

Moreover, the network is in constant changes. Addition of new services or increase of traffic flow often occurs in the network. This requires that the IP core network should be capable of dynamic adjustment of bandwidth. For example, when a new service is added, the IP core network may allocate an independent tunnel or dynamically adjust the LSP bandwidth to reserve some resources for the new service; when the traffic of a certain service is growing to exceed the planned threshold, the IP core network may dynamically adjust the bandwidth allocated to this service.

In addition to the bandwidth, the real-time services including video conference and IP telephony also have a requirement on other parameters such as low delay and low delay jitter. These parameters mainly depend on the powerful capability of hardware queue schedule by the IP core network. Besides, some key services are sensitive to packet loss. Solution of this problem will depend overall scheduling provided by the IP core network. The self-recovery technology of <50ms path can also minimize the number of lost packets caused by fault in the network as well.

In recent years, the end-to-end QoS technology of the IP networks has made much progress, and such technologies as DiffSev, MPLS TE and MPLS VPN have been integrated more closely. To meet the demands of the high quality IP core network, MPLS VPN and MPLS traffic engineer technology can be combined to realize bandwidth guarantee and dynamic adjustment. Specific technologies involved include DS Aware TE, VPN Aware TE and so on. Among them, the VPN Aware TE technology of Huawei-3Com can specifically allocate the resources to each VPN level, and it is capable of dynamic service awareness and adjustment. It is one of the best solutions at present.

### **3. High security of service**

The security of the IP core network lies in the security of service, especially that of traffic flow. For example, if there is flow attack of the virus on a provincial video conference, or if such a conference is interfered with by the enterprise traffic flow, mosaics, abnormal image, or broken connection will be caused, just like the case when the frequency band of a satellite is interrupted. Because of the importance of the IP core network, once the key services are interrupted, great losses and impacts that will result are beyond estimation or measurement.

The IP core network is required to implement safe separation on different services and allocate independent logic networks for them so as to avoid interference from each other. The combination of MPLS VPN, VLAN, QinQ and other technologies can divide a physical enterprise network into multiple independent "logic networks", and each type of service can obtain a part of the network resources for use, including address space, routing forward table, bandwidth, tunnel and QoS. The edge node of the IP core network can automatically identify services and map them into different VPNs.

In addition to safe separation, the safe subtunnel technology can also be employed to protect traffic flow (band) of the key services from DOS flow attack because illegal traffic cannot occupy resources of the safe subtunnel. The safe subtunnel technology is designed by Huawei-3Com to guarantee security of traffic. For some key services borne by the IP core network, it can provide bandwidth guarantee and security similar to ATM PVC.

Nevertheless, it is impossible to guarantee the network security by any one technology. Instead, the security strategies have to be adjusted in step with changes in the state of security with various elements considered such as time, space and network hierarchy. Therefore, in terms of long-term development, there is a need for the establishment of a dynamic security defense system for the IP core network so that the edge node can cooperate with the service

management system to realize dynamic security authentication, virus defense and intrusion defense. Among them, the service management system provides security authentication, virus awareness and dynamic refreshing of intrusion awareness policy, and the edge node perform user quarantine and dynamic defense.

#### **4. High reliability of service**

Reliability of service depends on reliability of IP core network. With the increase of key services in the network, the importance of the network reliability has gained weight. The electricity network paralysis accident of the United States shows that a network failure may result in great economic, or even political losses.

The high quality IP core network is a reliable end-to-end network. Its reliability lies in three levels—service, network, and device.

On the service level, it should be ensured that service will not be interrupted in the life cycle of the IP core network. The life cycle of a network includes the whole process of network maintenance, upgrading and expansion, and network optimizing reconstruction. On the service level, the IP core network is constantly available in all phases throughout its life cycle.

On the network level, the IP core network should be capable of self-recovery of <50ms links and paths. Among resilient link technologies are Resilient Packet Ring (RPR), APS, Link aggregation technologies. All of these technologies can realize self-recovery of 50ms link. IP/MPLS fast rerouting can realize self-recovery of network paths or tunnels of 50ms.

On the device level, carrier-class high reliability design is required for devices of the IP core network. For the key devices such as the switched network, main processing unit, interface unit, power supply and fan, redundancy design should be employed to support hot backup and hot swap. At the same time, online upgrading, hot patching and other technologies should be adopted for software to avoid interruption of service when the software is upgraded or when new functions are added. In addition, the whole-system HA of the IP core network should be 99.999%, and the uninterrupted forwarding technologies such as NSF/NSR should be supported.

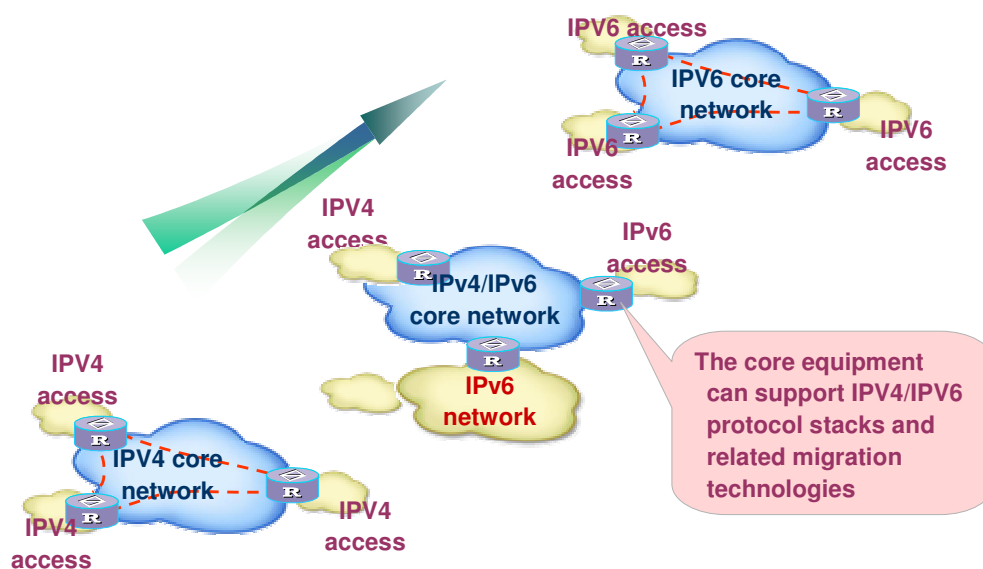
#### **5. Manageability and optimization of service**

Management has always been the weak part of IP network, and is a problem that the high quality IP network should solve. First, management of the IP core network should be realized, which includes network management and service management. Though management, the network will be capable of constant optimization.

"Complex technology, simple management". The IP core network involves a large number of complex technologies such as QoS, security, and reliability. However, to make full use of the advanced technologies and improve the overall efficiency of the IP core network, the complex details of these technologies should be shielded so as to make management simple, visual and efficient.

Service management includes VPN management, QoS management and security management. VPN management divides a physical network into multiple logic service networks (VPNs) and can allocate network resources specifically for each VPN. QoS management consists of such parts as QoS deployment, service performance monitoring and traffic engineer management. It cooperates closely with VPN so as to provide reliable end-to-end service. Security management mainly involves user access control and security policy management. Though service management system, service deployment and daily maintenance can be easily carried out conveniently, and optimization of resource allocation can be conveniently adjusted.

## Evolution of IP Core Network - From IPV4 to IPV6



**IP core network can bear IPV4 and IPV6 traffic simultaneously for smooth migration.**

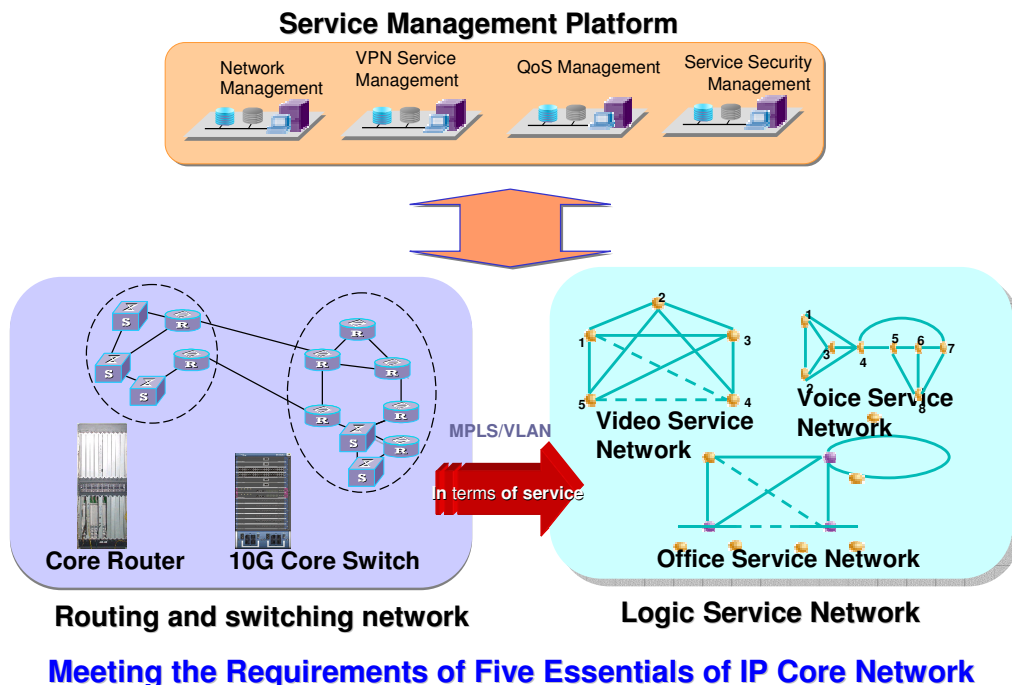
After understanding the five essentials of the IP core network, let's take a look at the next generation IP core network. The rapid development of consumer services, wireless mobility and distributed computing has pushed the development of IPv6 technology and its use in business. The next generation IP core network will be a comprehensive high quality network based on IPv6. After IPv6 technology is introduced, the security, QoS, system management and capacity of the IP core network will be farther improved. Nonetheless, the process of evolution from IPv4 network to IPv6 network will continue for several to more than ten years. In the meanwhile, the IP core network needs to bear IPv4 and IPv6 traffic. Therefore, it will be a basic requirement for the IP core network devices to support IPv4/IPv6 and various technologies of transition.

### III. Huawei-3Com IP Core Network Solution

Huawei-3Com IP Core Network solution is comprised of three major components: "routing

and switching network", "logic service network", and "service management platform". These components fully facilitate the five essentials of High Quality IP Core Network and provide smooth migration to IPv6 core network.

## Huawei-3Com IP Core Network



**Routing and switching network:** (high performance of service, scalability, high reliability of service)

The routing and switching network consists of high end network device, physical link and topology. It mainly performs large-capacity IP/MPLS service switching, and is the corner stone for end-to-end high quality service. The objectives of designing the basic routing and switching network are high performance of service, scalability, and high reliability of carrier-class services. The devices for constructing the routing and switching network are core router of Quidway NE series and the core switch of Quidway S series. Both are from Huawei-3Com. The NE router and S series core switch are designed with the notion of "equal emphasis on service and performance, and smooth migration". They have large capacity and high performance, and can provide powerful service capability and upgrading capability: MPLS, IPv6, multicast, security, QoS... Besides, both the VRP network operating system and the high end network products of Huawei-3Com can satisfy the demand for carrier-class high reliability.

**Logic service network (high quality service, high security of service)**

Through such technologies as MPLS VPN and VLAN, the routing and switching network could be divided into multiple logic service networks, which should be provided with high quality service capability and service security. The key technologies involved in the logic service network include MPLS VPN, QinQ, MPLS TE, VPN Aware TE, and HoPE.

In the field of MPLS technologies, Huawei-3Com Company VRP network operating

system not only conforms to the traditional standards in this industry, but also has a variety of patent technologies such as HoPE (hierarchy of PE in MPLS VPN), VPN Aware TE/subtunnel, PE-CE ISIS and LOCAL RT. These technologies greatly enhanced the QoS, security, flexibility and scalability of end-to-end services provided by the MPLS network, and have made Huawei-3Com become an innovator to MPLS solution.

#### **Service management platform: (service manageability, optimization)**

Huawei-3Com service management platform comprises network management (Quidview), VPN management (VPN Manager), service quality management (QoS Manager) and service security management (CAMS). Quidview manages the topology and NEs of the routing and switching network, while VPN Manager and QoS Manager manage the logic service network. The range of CAMS management over security spans the routing and switching network and the logic service network. VPN Manager, QoS Manager, CAMS, and Quidview can function independently of each other, or integrate to work in combination with VRP network operating system to provide a whole end-to-end service management solution for the IP core network.

#### **Next generation IP core network**

At present, Huawei-3Com has a whole line of high end IPv6 network products, and is the first manufacturer in China to obtain the IPV6 equipments certification. Under the unified VRP network operating system, both the high end router and the high end switch can support IPv4/IPv6 protocol stack and related technologies of transition, thus guaranteeing smooth migration of the IP core network to IPV6.

Huawei-3Com Company is a main manufacturer participating in construction of the backbone network of China Next Generation Internet (CNGI). In terms of experimentation of CNGI, three experimental networks have been established with the Quidway network devices: CIT, China Netcom, and Huawei.

Huawei-3Com IP core network solution is based on the rich experience of the company in constructing IP core networks. Since 2001, Huawei and Huawei-3Com have gradually become main developer of IP core networks all over the world. Quidway high end products have successfully entered 43 countries and regions, constructing a number of large-scale IP core networks including EU 14 Countries Data Backbone Network, Britain FiberNet National Backbone Network, Brazil VANT Telecom National Backbone Network, Germany Finance National Backbone Network, Russia E-Government, Algeria Natural Gas Company National Backbone Network, China National Electricity Dispatch Network, China Ministry of Public Security tier 1 Network, China Telecom National Backbone Network.

**With our long term devotion to innovation of high-end network technologies, Huawei-3Com works hand in hand with you in constructing high quality IP core network.**