One Net

Huawei Small- and Medium-sized Hospital Network Solution

HUAWEI TECHNOLOGIES CO., LTD.

HUAWEI

1. Overview

The 21st century is witnessing a rapid transformation where hospitals scattered across countries and regions around the world have taken extraordinary measures in reshaping their medical services. Specialized hospitals and medical research centers are being put into full-scale use. Also, R&D facilities have separate divisions that run clinical trials. Furthermore doctors practicing at affiliated hospitals can better diagnose a specific disease. Meanwhile, community hospitals provide local residents' with patient healthcare services and medical treatment to quickly diagnose ailments such as colds or diseases. Apart from medical diagnosis and treatment, early prevention in screening for potential diseases like cancer or diabetes, have effectively helped control the spread of communicable diseases. These approaches enable modern medical institutions to provide a complete healthcare package including prevention, diagnosis, treatment, and recovery.

With advancements in medicine through clinical trials, hospitals are taking a growing stance to implement a rather collective way on of conducting medical services instead of doctors' individually performing operations. As a result, doctors must now collaborate more than ever with, X-ray technicians, registered nurses (RN) and other specialist to provide end-to-end medical services utilizing advanced medical technologies. Hospitals have always been faced with mounting challenges in the medical service industry however it is only through enhanced competitiveness where they will be able to become more cost-effective and highly-efficient and improve its level quality of service (QoS). Moreover, reforms in the healthcare industry along with recent changes in the national medical insurance and co-payment policies have intensified the competition between public and private hospitals, clinics, pharmacies and other licensed practitioners and other specialized medical practices serving the medical service field.

1.1 ICT Application in Small- and Medium-sized Hospitals

Information and communications technology (ICT) is gradually being applied in hospitals worldwide and will definitely play a leading role in enhancing a hospital's ability to deliver modern, innovative services to patients. Specifically, hospitals that use advanced network and digital technologies will be leaders in providing patient services such as archiving health records, transmitting x-rays across facilities, allowing for electronic billing and insurance claims processing and post-processing medical information. In addition, leading hospitals will improve care and increase healthcare worker efficiency through the use of advanced medical equipment and software systems.

An increasing number of small- and medium-sized hospitals and local community clinics have begun providing more modern, patient-oriented medical services. This enhanced quality of service, will result in better quality of patient care and increased patient satisfaction.

2. Huawei Small- and Medium-sized Hospital Network Solution

Constructing a complete IP network is the key to deploying ICT applications for medical services. For example, multiple core service application systems such as, the Hospital Management Information System (HMIS) and Clinical Information System (CIS) are deployed to safeguard patient health records, family medical histories, increases revenues, and gives hospitals an innovative edge over the competition. To reach these goals, these hospitals attach great importance to reliability and security on their network. However, due to limited capital and budget restraint, small- and medium-sized hospitals cannot construct their network all at one time. To achieve a desired ROI, these hospitals must first construct a scalable network where existing services can be expanded to bring new services online. Therefore, these hospitals put costs as no.1 priority before making decision on over key operating factors involving their network, such as security, reliability, and scalability of their network.

2.1 Requirement Analysis

The ICT application system of small- and medium-sized hospitals consists of the HMIS, CIS, and Telehealth.

The HMIS, also known as Hospital Information System (HIS), is comprised of the following subsystems:

- Outpatient and emergency registration

- Outpatient management and billing

- Inpatient management subsystem

- Pharmacy and dispensary management

- Medical record management

- Medical statistics

The following features are provided:

- Provides graphical and text information.

- Has low data traffic, which bursts for a short time in a specific subsystem, for example, the outpatient service system.

- Enables frequent access to patients' medical records, check and inspection results, and information the prices on prescription drugs pricing.

- Holds financial statements and patient's history information.

These subsystems typically require high network security and maintenance. The HMIS also shares highlighted solution features and network performance capabilities in stability, accuracy, security, and data processing with guaranteed continuous service.

The CIS includes the following subsystems:

- Inpatient medical advice management

- Nursing information
- Outpatient workstation
- Clinical lab check report
- Medical imaging diagnosis report processing
- Radiology department information management
- Pathology department information

These subsystems can display information in a diagram or image form and can transmit large amounts of data, putting strain on network bandwidth capacity.

The Telehealth system not only transmits high-definition videos and high-quality voice and data, but it is seamlessly interoperable with external networks. To maximize the use of these functions, the Telehealth depends on a high-performance, robust network with high security mechanisms in place and is backed with guaranteed QoS capabilities.

When it comes to service type, small- and medium-sized hospitals have almost the same number as that of large-sized hospitals. The network of small- and medium- sized hospitals deploy hundreds of information subsystems in a broad scope. For instance, this network covers many sites including doctors-patient consulting rooms, nurse stations, registration offices, outpatient/inpatient departments, pharmacies, billing departments, emergency room, and the emergency responding department. It is obvious that as rich network applications are introduced and the demand of medical services increases, the network size of small- and medium-sized hospitals will expand. The network also transmits videos, voice, and data of each ICT application system, allowing shared access to public information. The network can also directly connect to external networks of other hospitals, medical insurance systems, public health platforms, Inter-America Institute for Cooperation on Agriculture (IICA), and bank and credit card systems. Integrated and open networks inevitably pose risks on a communications network. Fortunately, all ICT application systems have high network security. A secure and effective network design of these systems depends on the following aspects:

- High speed and high reliability

Hospitals construct high-speed backbone networks to quickly transmit data and allow non-blocking data to be exchanged between application systems of multiple departments. Reliability design covers:

  – Key component redundancy, link redundancy, and hot swappable boards

  – Core and aggregation layers in load balancing and two-node cluster backup mode

  – Switch cluster and stacking technologies that ensure network reliability and simplify network architecture

- Scalability

The design of a hierarchical network ensures that devices at the core and aggregation layers are scalable and allow network capacity and service expansion.

- Security

Security plays a vital role in the construction of the small- and medium-sized hospital network for it must ensure that critical information such as billing statements, patient information and patient health records, and medical histories on treatment are safely secured. Furthermore, a complete security policy control system needs to be installed to enhance security access controls along the network's physical space.

- Superb QoS guaranteed

To provide better user experience and effectively transmit videos, voice, and service data in real time, a complete QoS system must be set up.

- Maintainability and manageability

Network manageability ensures that a hospital's network is operating properly. To maintain high manageability, hospitals have to build a low-cost, easy-to-use network management system that can effectively support various IT devices.

2.2 Solution Description

Hospitals use an increasing number of ICT applications to advance their medical services, putting an array of medical network applications into clinical use. However, any network failure may result in serious consequences and directly impact patient care and the hospitals' business operations. To prevent network failure, hospitals must focus on enhancing its network's availability and reliability. Huawei, backed by its advanced technologies and rich networking experience in the medical service industry, provides economical and highly-efficient network solution suites for small- and medium-sized hospitals. Huawei's network solutions are also cost effective

and reduce the need for additional skilled technicians to manage and operate the network.

Medium-sized hospitals: Specific medical departments are scattered throughout the hospital. Each building is set up with an access layer and an aggregation layer. Aggregation switches placed in different buildings are connected to core switches located in the central building. This approach enables the network of medium-sized hospitals to contain three layers: the access layer, the aggregation layer, and the core layer. In addition to vertical hierarchy, this network has is highly scalable.

The following figure shows the architecture of a medium-sized hospital network.

Architecture of Medium-sized Hospitals' Network
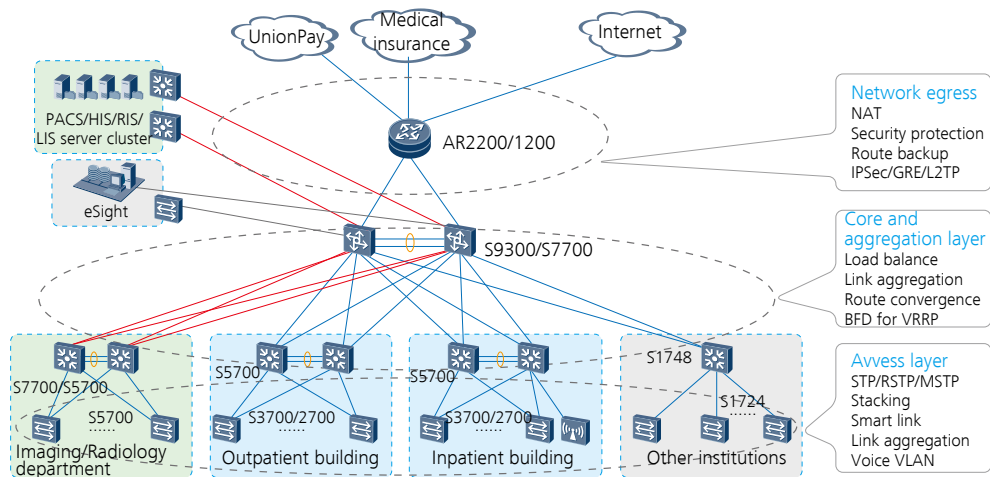
Small-sized hospitals: Departments of small-sized hospitals are closely located in a small number of buildings within the hospital facilities. By constructing small-sized hospitals with a two-layer network, construction costs are reduced, networking complexity is minimized, and maintenance is simplified.

The following figure shows the architecture of a small-sized hospital network.

Architecture of Small-sized Hospitals' Network
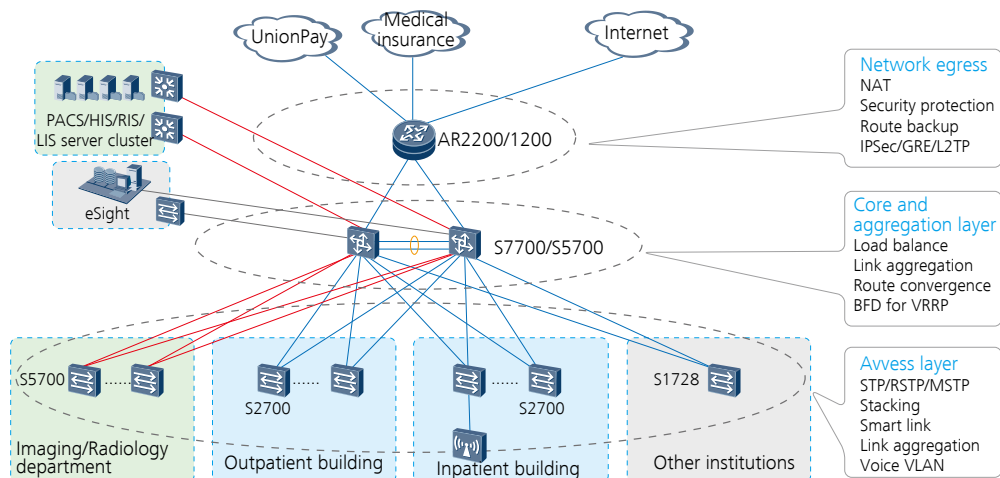
Core Layer

The core layer of the network is deployed in the central equipment room of a small- and medium-sized hospital. At this layer all service packets are transmitted over the network supported by high-speed bandwidth, switching, and routing. The core layer connects each service aggregation point with a server cluster and provides the function of service switching. The following describes several core layer features:

* Redundancy of network devices, capable of processing and forwarding multi-services at high-speeds

* High-density 10G and GE interface boards to ensure subsequent network expansion

* Quick route convergence that prevents link failure from occurring during rerouting route flapping

* High-capacity stacking which simplifies network configurations

* Intelligent traffic load balancing that maximizes server efficiency and prevents service interruptions

It is highly recommended that Small- and medium-sized hospitals use Huawei S9300 or S7700 10GE chassis terabit Ethernet core routing switches. These switches are deployed in load balancing and two-node cluster backup mode, obtaining higher performance from devices. A large number of 10G and GE optical ports and optical modules can be configured to operate under different transmission distances. They are used to allow high-speed connection between aggregation switches and core switches.

Huawei S9300 and S7700 series provide multi-service cards such as firewalls, Network Address Translation (NAT), IP Security (IPSec), Access Controllers (ACs), and load balancers. The S9300 and S7700 series integrate multiple functions to simplify network structure and lower users' investment, therefore meeting hospitals' requirements for growing medical services.

The S9300 series is the first of its kind to use the advanced switching fabric cluster technology in the industry, greatly differentiating itself from the interface board cluster technology.

The following figure shows methods for implementing the two types of cluster technologies.
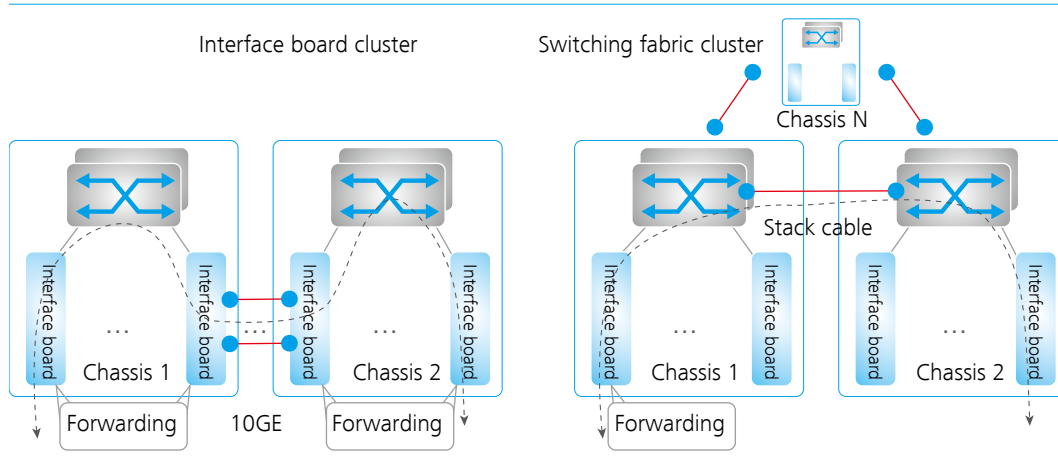
The Huawei switching fabric cluster technology has already been applied in the core network of hospitals. This technology has the following advantages:

Simplified configuration and management

After switching fabrics are clustered, the number of managed devices declines by more than a half. In addition, networking is simplified. The network does not need to use complex protocols, such as the Spanning Tree Protocol (STP), SmartLink, and Virtual Router Redundancy Protocol (VRRP).

Fast fault convergence

The fault convergence time is restricted to less than 1 ms. This advantage greatly reduces the number of link and node failures on the network.

## High bandwidth of clusters, without occupying service interfaces

The S9300 series provide a non-blocking Cluster Switch System (CSS) to eliminate the second switchover. The cluster card does not occupy slots of a specific service interface board and provides 256 Gbit/s bandwidth. Additionally, the bandwidth can be seamlessly upgraded to 640 Gbit/s. Therefore, the S9300 series protect customers' investment.

Aggregation Layer

As the center hub of local access layer, the aggregation layer aggregates all local network traffic and forwards data between VLANs. Therefore, the aggregation layer must have higher performance and stability than the access layer. Furthermore, the center hub isolates the access layer from the core layer, preventing any faults in the access layer from affecting the core layer.

For small- and medium-sized hospital networks, aggregation layer devices are selected based on the traffic volume and service characteristics at the aggregation layer. For example, the PACS processes large size data such as color Doppler ultrasounds and CT scans; therefore, devices with high processing performance capabilities need to be used for PACS. The following configuration is recommended for the aggregation layer: Huawei S7703 and S5700-28C-EI-24S with two 10GE upstream links dual homed to two core switches.

When services need to be upgraded, the interface forwarding capacity of the already in place aggregation switches may be insufficient. New hardware equipment may need to be added. However even with newly installed aggregation nodes connecting, configuring, and managing them, will still pose complexities. The stack technology can solve this problem. Huawei aggregation switches support the iStack function, as shown in the figure:
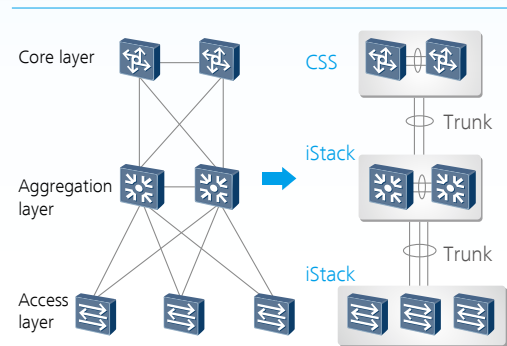
The iStack technology connects multiple switches through stacking interfaces to form a virtual switch. When multiple switches are stacked, they provide various enhanced functions which can be seamlessly managed as one switch. The iStack technology has the following advantages:

Simple management and network operating

The network topology is simplified and complex protection protocols such as STP are not required. In iStack, access control protocols run uniformly as if they were operating on one switch. For example, the routing protocol calculates routes uniformly on the virtual switch. Therefore, switches in the iStack do not need to exchange many protocol packets. This greatly simplifies network operations and shortens the convergence time when route flapping occurs.

Powerful network expansibility

The network administrator can increase ports, bandwidth, and processing capacity of an iStack by simply adding member switches. Slight changes may need to be made on its topology and links.

Robust performance and high reliability

Route convergence and inter-device link aggregation are speed up. The device-level 1:N backup ensures non-stop services.

The iStack technology increases the switching capacity and port density by several times to improve the virtual system performance.

Access Layer

The access layer contains edge devices that provide access and control for terminals and enforce QoS policy according to service characteristics. To provide power for IP phones and APs, access switches must provide the PoE function. Generally, VLANs need to be configured at the access layer to provide the following functions:

Separate broadcast domains

If no VLAN is assigned, then the Layer 2 network will remain as a large broadcast domain. All packets are broadcast to all interfaces in the domain. On a large Layer 2 network, an overwhelming amount of broadcast packets consume bandwidth resources. With VLANs installed the broadcast domain size is greatly reduced (each VLAN is a broadcast domain). Packets broadcast over a transmission line only within a VLAN. Therefore, VLANs improve link efficiency, network security and simplify network management.

Isolate services and users

Users and services operating in different VLANs are completely separated from each other. This improves service and network security and isolates users from accessing each other's sites.

Make user access flexible

Generally, one VLAN is configured on multiple devices in a LAN. Users can access network and use services no matter which switches they access. Access flexibility is improved.

Access switches are selected based on service characteristics. For example, PACS which processes large-size data therefore, devices with high processing performance need to be used for the PACS. Huawei S5700 switches that provide Gigabit Ethernet access to the desktop are recommended. The S5700 switches are dual homed to aggregation switches. For the HSI service, Huawei S3700/S2700 switches are recommended to provide 100 Mbit/s to the desktop. They can be dual homed to aggregation switches or connected to aggregation switches through single links. For

delay-sensitive services, Huawei S1700 switches are recommended. They can be connected to aggregation switches through single links.

Egress Routers

The egress routers provide uniform Internet access; therefore, each hospital department does not need to access the Internet independently. This facilitates network management and saves costs. Since hospitals accept payments by cash and insurance, their networks must be directly connected to bank and health insurance networks either through leased lines or VPNs. Egress routers must provide various VPNs for remote medicine and remote education. Huawei AR2200 and AR1200 series routers are recommended. AR G3 is Huawei third-generation AR routers. They use multi-core processor and distributed switching fabric structure. The device performance is twice of the similar products in industry. AR G3 series routers integrate the router, switch, firewall, voice, AP, VPN, and 3G functions and allow various access methods including PON, GE/FE, xDSL, and E1. They support the PoE function and hot swappable cards and can be applied to various scenarios.

eSight

Industry networks all share the following characteristics: multi-vendor, multi-type, and low skill. Huawei eSight can be customized to seamlessly integrate the industry's networks. In addition to managing multi-vendor IP devices for hospitals, eSight uniformly manages printers, fax and copy machines. Without the need of a dedicated server or client, eSight provides a user friendly graphic user interface for device management, reducing costs and simplifying installation and maintenance. When an incident occurs in a hospital normally an evacuation announcement is heard over the PA or a fire alarm is rung. With Huawei eSight solution all incidents activated are centrally gathered and uniformly managed. In addition to alarm generating, eSight also provides public safety monitoring to create smarter buildings, as shown in the following figure:
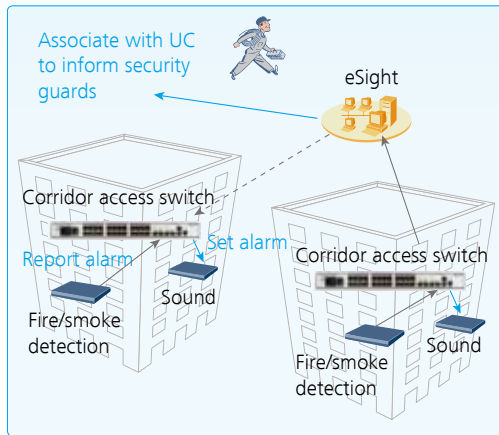
Characteristics: The monitoring ports on network devices implement safeguards and alarm management over IP networks without increasing costs. When an emergency event occurs, in addition to the sound and light alarms, a short message is sent to the security guards notifying them that an incident has occurred on their premises. eSight also works with IP video surveillance systems for added security protection. The network management platform detects when an alarm has occurred and can deliver its precise location.

2.3 Wireless Access

Wireless network allows quick access from various mobile terminals compared with wired lines. This form of flexible networking resolves cabling problems and reduces cabling costs. Small-sized hospitals can use the Fat AP deployment mode, as shown here in this figure:
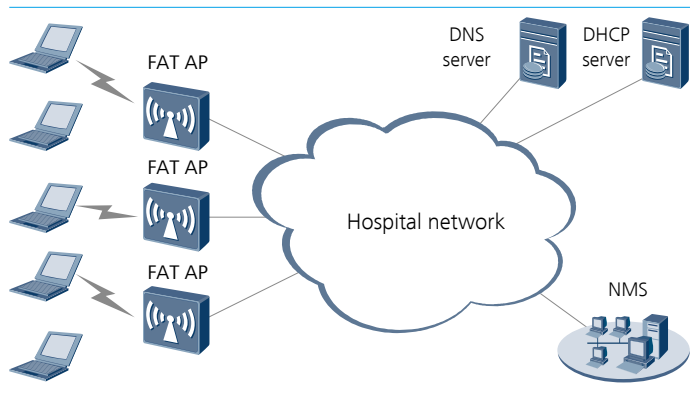
Medium-sized hospitals can use the AC+AP deployment mode, as shown in the figure:
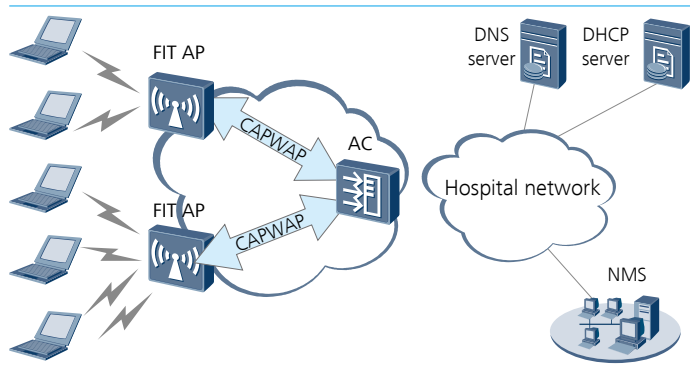
Huawei provides both individual AC products and AC cards installed on core switches S9300 and S7700. These products simplify networks and protect investments. Huawei APs include 802.11a/b/g/n-compliant APs, single-frequency and dual-frequency APs, and indoor, indoor distributed, and outdoor APs, can be applied to various scenarios.

2.4 Typical Configurations for Small- and Medium-sized Hospital Networks

Medium-sized Hospital Networks

Product	Description	Quantity
Core layer		
AR2200	Multi-service access router	1
S9306/S7706	Chassis, distributed, high port density, terabit core routing switch, supporting cluster	2
Aggregation layer		
S7703	Chassis, distributed, high port density, terabit core routing switch	2
S5700-28C-EI-24S	Box, 24 100/1000M optical, 10GE uplink, Layer 3 aggregation switch, supporting stack	Several
Access Layer		
S5700-28C-EI	Box, 24GE/FE electrical, 1000M uplink, Layer 3 switch, supporting stack	Several
S2700	Box, 24 or 48 10/100M access, 1000M uplink, Layer 2 access switch, supporting PoE, AC/DC, and stack	Several
S1700	Box, 1000M access, 1000M uplink, Layer 2 access switch, supporting stack	Several
WLAN		
AC card	S9300/S7700 WLAN value-added card	1
WA6x3/WA6x1	Wireless network access point	Several
Network management		
eSight	Network management system	1

Small-sized Hospital Networks

Product	Description	Quantity
Egress router		
AR1200	Multi-service access router	1
Core and aggregation layer		
S7703/S5700	Chassis, distributed, high port density, terabit core routing switch Or 1000M box aggregation/core switch, supporting stack	2
Access Layer		
S5700-28C-EI	Box, 24GE/FE electrical, 1000M uplink, Layer 3 switch, supporting stack	Several
S2700	Box, 8, 16, 24 or 48 10/100M access, 1000M uplink, Layer 2 access switch, supporting PoE, AC/DC, and stack	Several
S1700	Box, 1000M access, 1000M uplink, Layer 2 access switch, supporting stack	Several
WLAN		
WS6603	Box, wireless network access controller	1
WA6x3/WA6x1	Wireless network access point	Several
Network management		
eSight	Network management system	1

3. Huawei Small- and Medium-sized Hospital Network Solution Characteristics

After 20-years of research and development, Huawei has become a leading information and communication solution provider. Huawei has professional R&D teams providing end-to-end solutions to its customers. Huawei has created global, regional, and national service teams to better serve clients in over 130+ countries. Huawei employs over 13,000 customer service specialists providing 24/7 technical support to customers.

High reliability

Network reliability is extremely important for hospitals. Huawei provides a very reliable, robust network solution through hardware and software features. Huawei's access switches have 6 kV surge protection capability. The 6 kV surge protection device is 30 times more efficient than conventional 2 kV surge protection devices. Core switches use redundant control boards, power supplies, and fans in addition device backup and link redundancy is used on key nodes. Huawei switches support link aggregation, ISSU, VRRP, and Ethernet OAM.

High performance, easy expansion, simple maintenance

GE and 10GE interfaces implement line-speed forwarding. Core switches are equipped with unprecedented high-density 40x10GE interface cards. Access devices support the stack function and the core devices support the CSS function. These features combined result in a network that is easy to expand and has fewer nodes to manage, simplifying network maintenance.

High security

The One Net solution interoperates with third party NAC's. Huawei devices perform authentication, authorization, and accounting (AAA) on access users according to pre-defined policies. They support 802.1x, portal, guest VLAN, and dynamic user access authentication.

Energy saving

The One Net solution is extremely power efficient. Box switches do not use fans for cooling. Chassis switches use multiple fans for cooling different areas in the chassis and adopt the fuzzy fan speed adjustment mode. All Huawei switches comply with IEEE802.11az, reducing power consumption by 30% compared with similar industry products out in the market.

Sustained evolution

All Huawei IP devices are built on Huawei's proprietary software platform VRP, and are compatible with each other. Huawei devices also use chipsets that have been developed by Huawei. Huawei has made significant investments in development and advanced research around emerging network technologies and will continue to provide innovative solutions to our customers.

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