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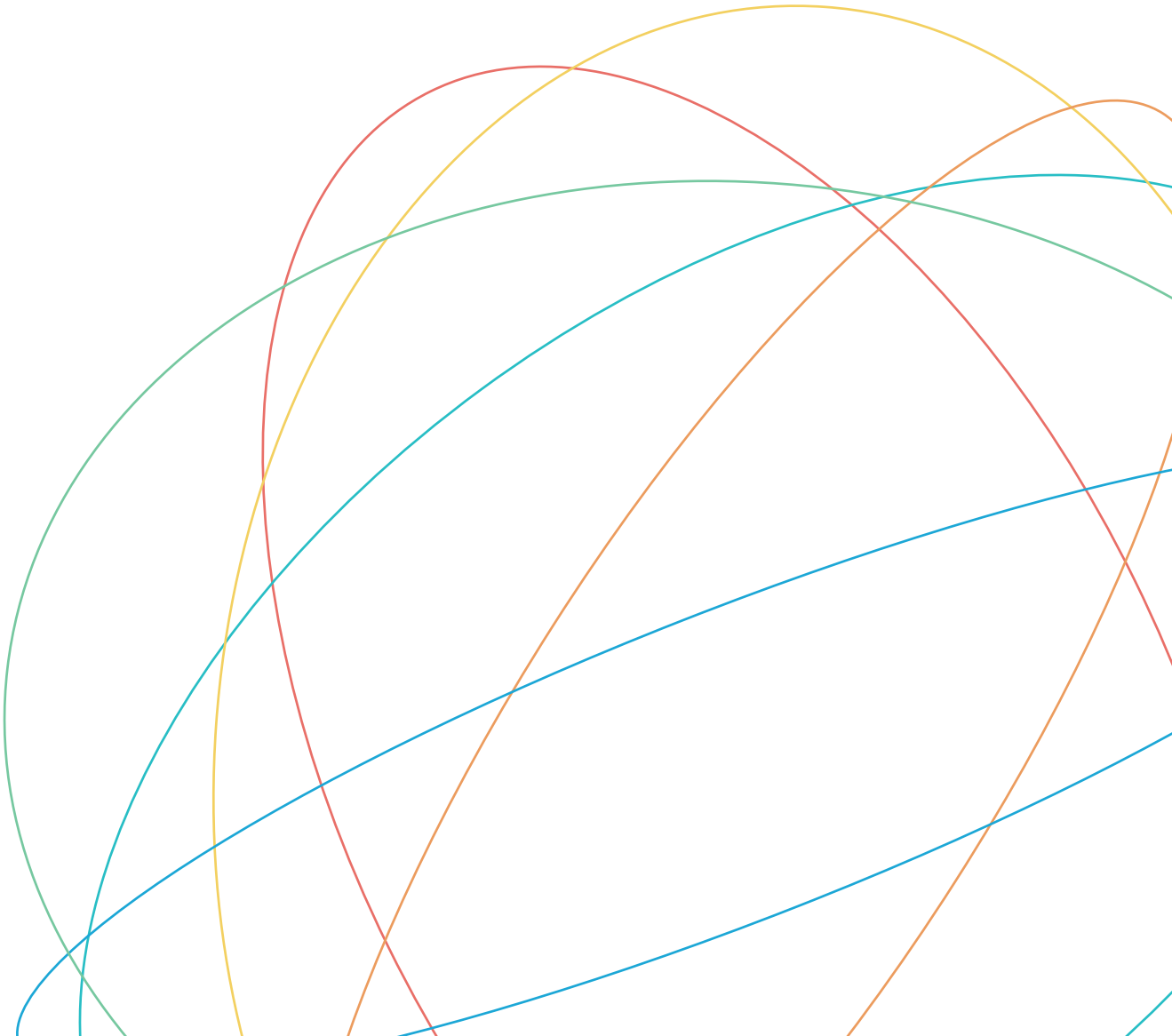
whitepaper

Huawei Agile Campus Solution

Technology White Paper - Wired and Wireless Convergence



Wired and Wireless Convergence Technology White Paper

Keywords: Wired and wireless convergence, unified authentication, ENP connection, ASIC connection

Abstract: Wired and wireless convergence solution is one of the sub-solutions of Huawei Agile Campus Network Solution. In the wired and wireless convergence solution, unified management, authentication, and policy control can be performed on the agile switches integrated with WLAN AC functions for wired and wireless users. This solution implements centralized traffic forwarding, easy traffic control, and ultra simplified management, providing a brand-new experience for access users.

Acronyms and Abbreviations:

Acronyms and Abbreviations	Full Name
AC	access controller
AP	access point
ASIC	application–specific integrated circuit
CAPWAP	Control and Provisioning of Wireless Access Points
ENP	Ethernet Network Processor
PPPoE	Point to Point Protocol over Ethernet
WLAN	wireless local area network

1 Overview

1.1 Background and Challenges

On the traditional wired and wireless campus network, wired and wireless networks can be separated or integrated.

- Wired and wireless separation (independent AC bypass): APs connect to the network through the access switch, and the AC is an independent WLAN device that connects to the gateway switch in bypass mode. Wired and wireless network management and data forwarding are separate.
- Wired and wireless integration (AC card): APs connect to the network through the access switch, and the AC card on the gateway switch is used. Although the AC is integrated into the gateway switch, the wireless AC and wired gateway switch are independent management units. Wired and wireless data are forwarded separately.

In the preceding two deployment modes, wired and wireless traffic are processed on the switch and AC separately. In this case, wired and wireless traffic forwarding, network management and fault rectification, and authentication and access policy setting and control implementation are separate on wired and wireless networks. This increases the workload of troubleshooting, and management and control.

In addition, wireless data traffic forwarding on traditional campus networks has the following performance bottlenecks:

In independent forwarding mode, when wired traffic and wireless traffic are forwarded separately, the wireless forwarding capability is 20 Gbit/s.

As the 802.11ac 1000M access era is coming and BYOD becomes popular, the AC will become the bottleneck due to limited forwarding capabilities and interfaces. Though forwarding capabilities and interface and user management are normal, the AC on the wireless side becomes the bottleneck. The wired and wireless networks cannot share switch capabilities, which wastes network resources.

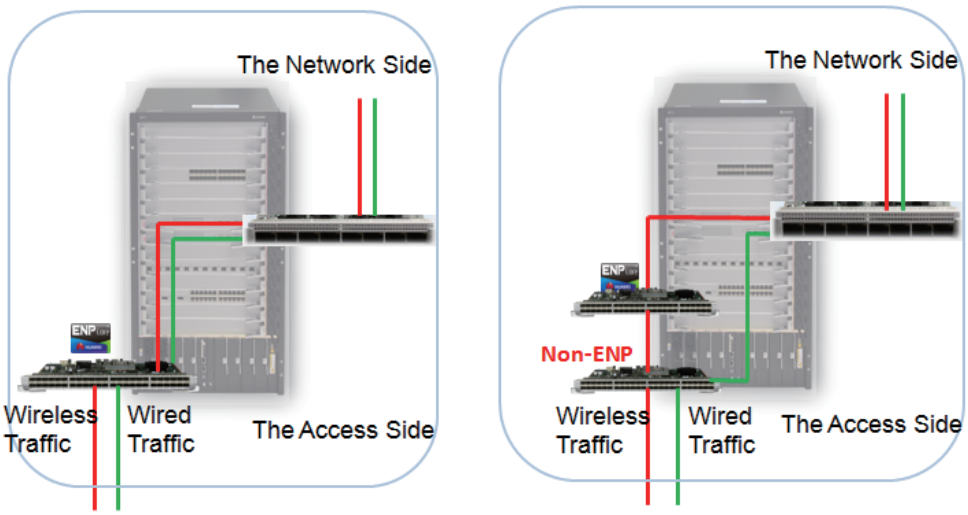
In centralized forwarding mode, traffic is forwarded to the independent AC or AC card. That is, an unnecessary failure point is added.

1.2 Solution

The agile switch equipped with the ENP card provides AC functions. After the agile switch is integrated with AC functions, it uniformly manages wired and wireless traffic, authenticates wired and wireless users, and controls policies, implementing wired and wireless convergence.

Wired and wireless convergence provides the following two networking modes, as shown in Figure 1-1.

Figure 1-1Wired and wireless convergence networking



- Networking mode 1 (shown in the left figure): The wired and wireless services are transmitted to the ENP card.
- Networking mode 2 (shown in the right figure): The wired and wireless services can be transmitted to the non-ENP card. The non-ENP card does not provide the WLAN AC function, so the wireless services need to be redirected to the ENP card to process.

These two networking modes solve the problem that wireless traffic passing through the AC needs to be forwarded by the switch in centralized forwarding mode, and also eliminate the wireless traffic forwarding bottleneck.

Wired and wireless convergence brings the following benefits to customers.

Improved Forwarding Capacity

On a traditional network, the switch cannot parse CAPWAP packets. As a result, the AC must be deployed in bypass mode (or an AC card is used), and wireless service traffic needs to be forwarded to the AC in one-armed mode after passing through the switch. This complicated forwarding path causes an unnecessary delay, and also suffers from the limited AC forwarding performance, restricting the entire forwarding capacity of wireless service traffic.

Wired and wireless convergence technology can process CAPWAP encapsulation packets on a card of a modular device. The decapsulated wireless packets can be forwarded like wired packets. The forwarding path is simple, so that the forwarding capacity is no longer the bottleneck.

Unified User Policy and Management

On a traditional network, the policy control point is a switch for wired users and an AC for wireless users. As a result, the policy control points and management points for wired and wireless users are decentralized, which hinders network management and maintenance. Wired and wireless convergence technology can provide the unified management point for wired and wireless users, and integrate the control and management points on one device.

High Reliability

In the 1+1 backup scheme of a traditional independent AC solution, an additional channel must be prepared for two ACs to complete data synchronization between them. Technologies such as VRRP/BFD are usually used between the two ACs for synchronization and keep-alive. The software is synchronized between different devices, so the real-time performance and reliability are not high.

Wired and wireless convergence technology uses the built-in reliability technology on switches (CSS/CSS2+LAG technology on modular switches) to implement device-level and link-level redundancy backup. The MPU on the device controls AC data in centralized manner. All the ENP cards share AC data and automatically synchronize the data in real time. No extra channel needs to be set up using software protocols between the ENP cards to synchronize AC data, which implements high real-time performance and reliability.

Flexible Capacity Expansion

The old running networks only had wired services. With business development, wireless services need to be added. If Huawei S7700, S9700, and S12700 switches are used, the physical network rarely needs to have major adjustments and changes as long as ENP cards are used to implement wired and wireless convergence deployment. WLAN services can be flexibly deployed on ENP cards. Wireless services can be transmitted to an ENP or ASIC card. The same service deployment mode can be selected on one switch, or two modes can co-exist.

When there are many wireless users and much service traffic, the native AC mode can be selected. As the number of users increases, capacity expansion can be performed on ENP cards.

Fast Roaming Speed

A switch equipped with ENP cards functions as the AC. As the entire device (including the CSS/CSS2 cluster) is an AC, the APs connected to different ENP cards are uniformly managed and controlled by the MPU. Wireless users roam on the APs connected to different ENP cards, implementing inter-AP roaming. These APs are actually managed by the same AC. The MPU synchronizes and updates entries of the users connected to different ENP cards. Compared with roaming across independent fixed ACs or independent AC cards, inter-AP roaming does not require inter-card tunnels, but provides a short forwarding path and fast roaming speed in the same control plane.

Integrated Management Page

The AC management plane is separated from the switch no matter whether an independent AC or modular AC card is used on a traditional network.

Wired and wireless convergence technology does not need an independent AC or AC card, but uses an agile switch to provide convergence technology. Wireless units can be displayed as agile switch cards on the NMS, implementing a unified management page.

2 Technical Implementation

2.1 Implementation

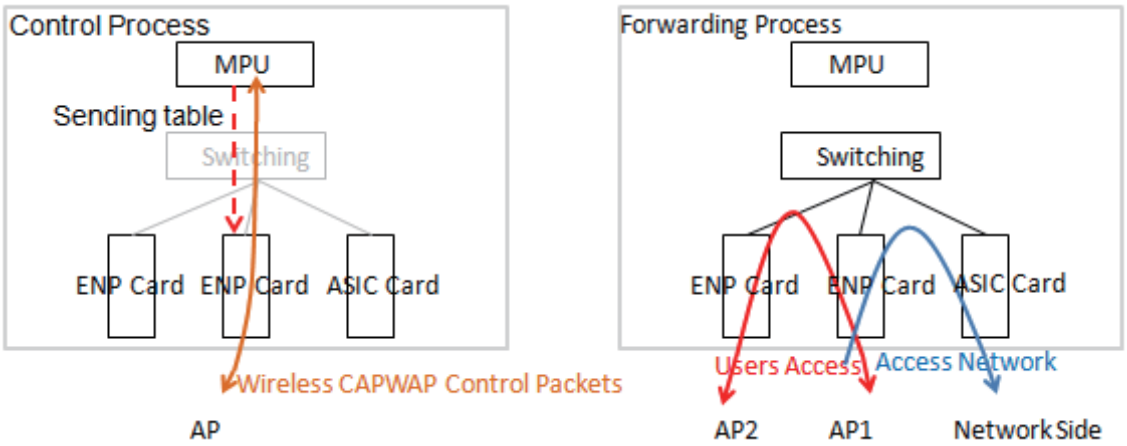
Huawei ENP chips support basic wired network packet identification, processing, and forwarding capabilities of commercial ASIC, and the programmable capability of the multi-core CPU. The combination of these functions completely meets the requirements of wired and wireless convergence. Not only traditional wired packets can be processed, but also CAPWAP packets can be identified and processed through programming. Moreover, the single-engine hardware structure of one ENP card is simple.

There are two connection modes of ENP cards for wired and wireless convergence. The identification and handling process of wired services is the same as that of traditional switches.

- Connection mode 1: Wired and wireless services are transmitted to ENP cards. The ENP cards can identify WLAN wireless control packets and send them to MPU to process, which implements AP management of the AC. As the entire device is an AC, the APs connected to different ENP cards are managed on the MPU in a centralized manner. The MPU delivers the CAPWAP encapsulation and decapsulation entries of the APs connected to the ENP cards, and the ENP cards identify and forward the wireless data packets.

Figure 2-1 shows the native AC control and forwarding process (wire services are transmitted to ENP cards).

Figure 2-1Native AC control and forwarding process (wire services are transmitted to ENP cards)

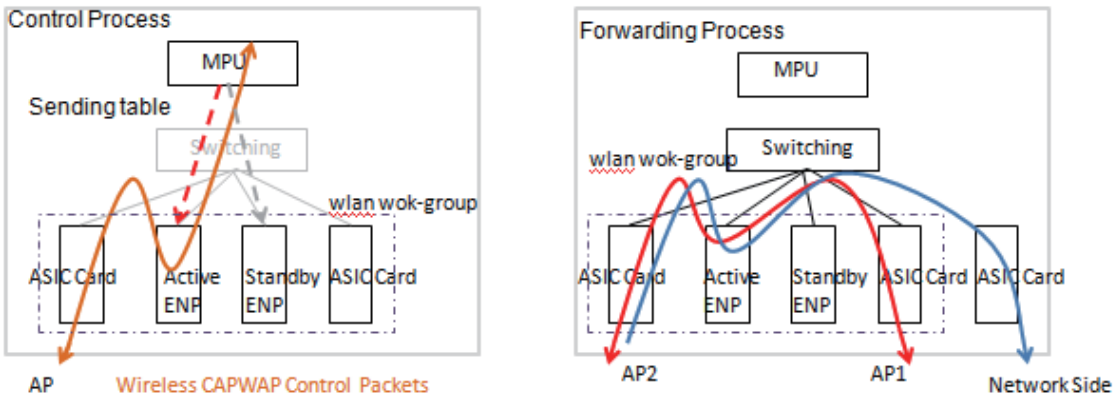


- Connection mode 2: This mode is extended based on native AC technology, which applies to the scenario where ENP and ASIC cards are both installed. Before deploying this scenario, a WLAN work group needs to be configured and bound with several ASIC cards and master/slave ENP cards. The ASIC cards are used for user access, and the master ENP card is in Active state by default. Wireless services need to be redirected to the master ENP card. When the master ENP card is faulty, the slave ENP card changes to Active state and wireless services are automatically switched to the slave ENP card for processing, ensuring that services are not interrupted.

The difference between two connection modes is that the second connection mode enables wireless service traffic to be redirected to the ENP card for processing. The wireless data packet processing process on the ENP card and the AP management and control process on the AC are similar in the two connection modes.

Figure 2-2 shows the native AC control and forwarding process (wire services are transmitted to ASIC cards).

Figure 2-2Native AC control and forwarding process (wire services are transmitted to ASIC cards)

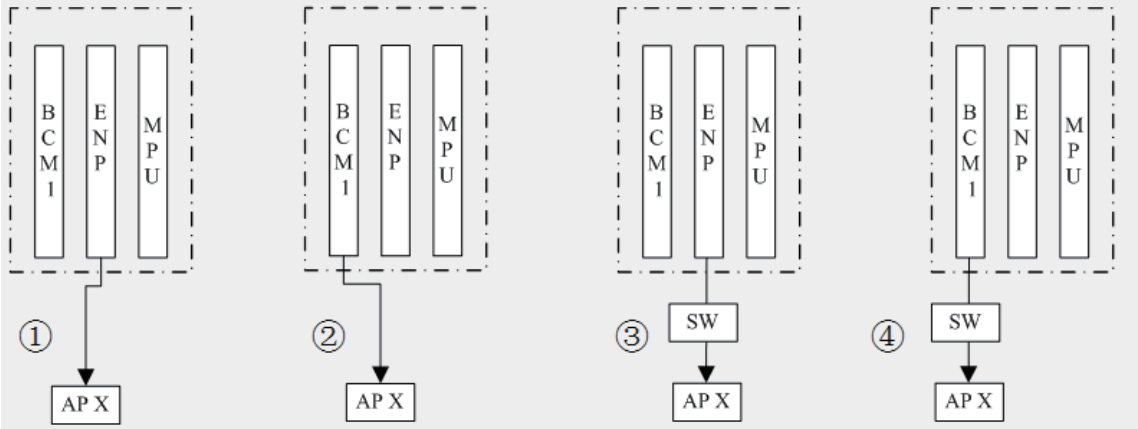


The S7700, S9700, and S12700 modular series switches equipped with ENP cards and S5720HI fixed switches with ENP chips are capable of wired and wireless convergence.

AP Connection Schemes

In the wired and wireless convergence solution of campus networks, APs can be classified into four types according to different uplink connections, as shown in Figure 2-3.

Figure 2-3AP connection schemes



There are the following four AP connection schemes:

- Connecting to an ENP card on an agile switch: Wireless traffic is transmitted to the ENP card.
  - » In centralized forwarding mode, the ENP card performs CAPWAP tunnel encapsulation and decapsulation for wireless data traffic.
  - » In local forwarding mode, the ENP card does not perform CAPWAP tunnel encapsulation for wireless data traffic.
- Connecting to an ASIC card on an agile switch: Wireless traffic is transmitted to the ASIC card. As the ASIC card has no wireless CAPWAP tunnel processing capability, wireless traffic needs to be redirected to the ENP card.
- Connecting to an ENP card on an agile switch through a traditional access/aggregation switch
- In centralized forwarding mode, wireless data traffic is encapsulated in CAPWAP tunnels, and transparently sent to the agile switch through the traditional access/aggregation switch. Then the ENP card on the agile switch performs CAPWAP tunnel encapsulation and decapsulation for the wireless data traffic.
- In local forwarding mode, the ENP card does not perform CAPWAP tunnel encapsulation for wireless data traffic.
- Connecting to an ASIC card on an agile switch through a traditional access/aggregation switch: Wireless traffic is transmitted to the ASIC card through a traditional access/aggregation switch. As the ASIC card has no wireless CAPWAP tunnel processing capability, wireless traffic needs to be redirected to the ENP card.

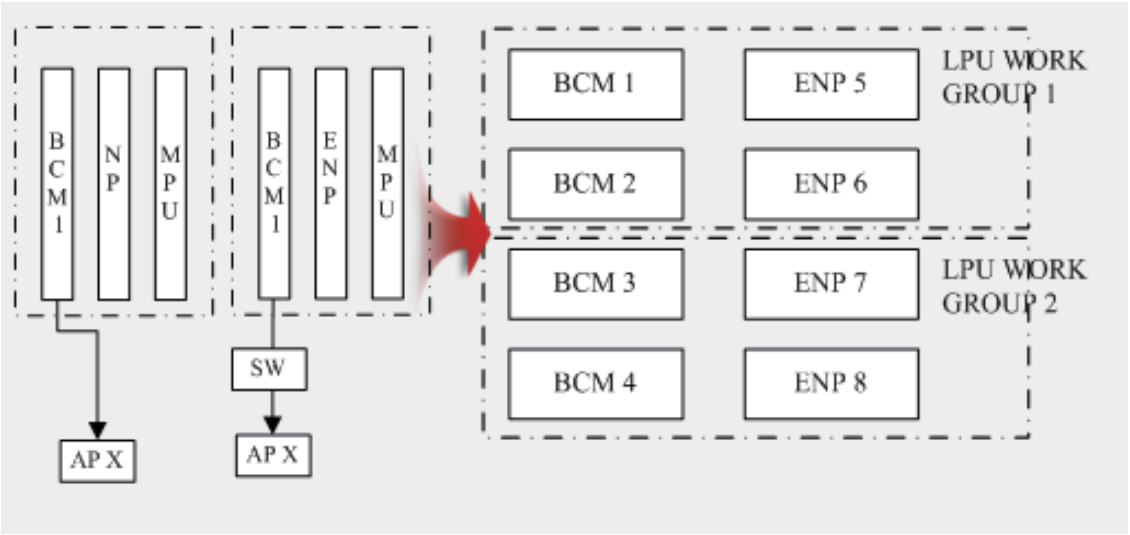
Wireless Traffic Processing on an ENP Card

As described in AP connection schemes (1) and (3), in centralized forwarding mode, an AP is directly connected to an ENP card on an agile switch or connected to the ENP card through a traditional switch. In this case, the ENP card on the agile switch provides the CAPWAP tunnel processing capability. When wireless traffic arrives at the ENP card through centralized forwarding, the ENP card supports wireless traffic encapsulation and decapsulation to implement wireless traffic forwarding.

Wireless Traffic Processing on an ASIC Card

As shown in Figure 2-4, an AP is directly connected to an ASIC card or connected to the ASIC card through a traditional switch. The ASIC card has no wireless CAPWAP tunnel processing capability. In this case, an LPU work group is configured to bind the ASIC and ENP cards. After wireless traffic is transmitted to the ASIC card, the agile switch automatically redirects the wireless data packets to the ENP card that has the wireless CAPWAP tunnel processing capability.

Figure 2-4Processing the wireless traffic transmitted to the ASIC card



A maximum of four LPU work groups can be configured. The implementation is as follows:

1.A group contains several ASIC cards, one master ENP card, and one slave ENP card. Only one ENP card is in ACTIVE state.

2.Two ENP cards work in hot standby mode. User entries, CAPWAP encapsulation and decapsulation tables, and VAP query table are synchronized on the master and slave ENP cards.

3.The CAPWAP traffic transmitted to the ASIC cards in the same group is redirected by the ASIC cards to the master ENP card.

4.When the master ENP card is abnormal, the redirection rule on the ASIC card is switched and packets are imported to the slave ENP card.

5.After the master ENP card is recovered after restart, traffic is switched back to the master ENP card until the slave ENP card is faulty.

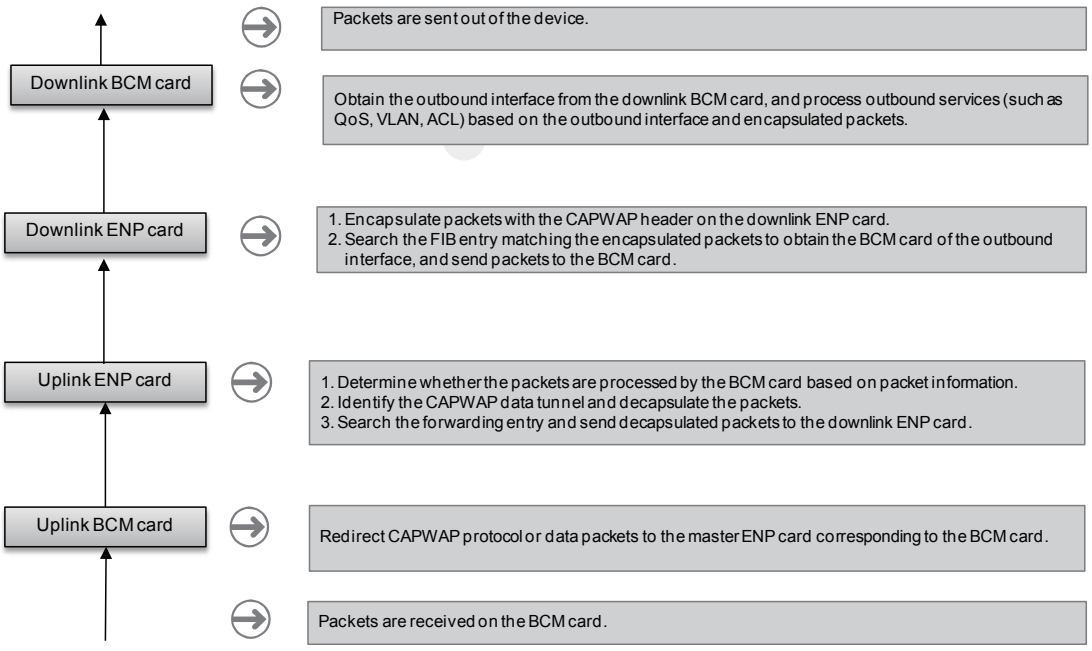
The restrictions for configuring an LPU work group are as follows:

- One ASIC card can belong to only one group.
- One ENP card can function as the master only in one group.
- One ENP card can belong to only one group.
- The master and slave ENP slot numbers must be different in one group.

Forwarding Process of Wireless Traffic Transmitted to an ASIC Card in Centralized Forwarding Mode

In centralized forwarding mode, wireless traffic is transmitted to an ASIC card and forwarded by an agile switch, as shown in Figure 2-5.

Figure 2-5Forwarding process of wireless traffic transmitted to an ASIC card in centralized forwarding mode



Step 1 When wireless traffic is transmitted to the ASIC card, the CAPWAP protocol or data packets are redirected from the ASIC card to the master ENP card. The matching conditions include the AC IP address, IP type, UDP port number 5246 or 5247, and STP status.

Step 2 The ENP card determines the wireless process of the ASIC card connecting to the AP according to the special information carried in the packets.

Step 3 The ENP board identifies the CAPWAP data tunnel and decapsulates the wireless CAPWAP packets.

Step 4 The switch looks up the forwarding information base (FIB) for the decapsulated packets and sends them to the downlink ENP card according to the matching forwarding entry.

Step 5 The downlink ENP card performs CAPWAP tunnel encapsulation for the packets.

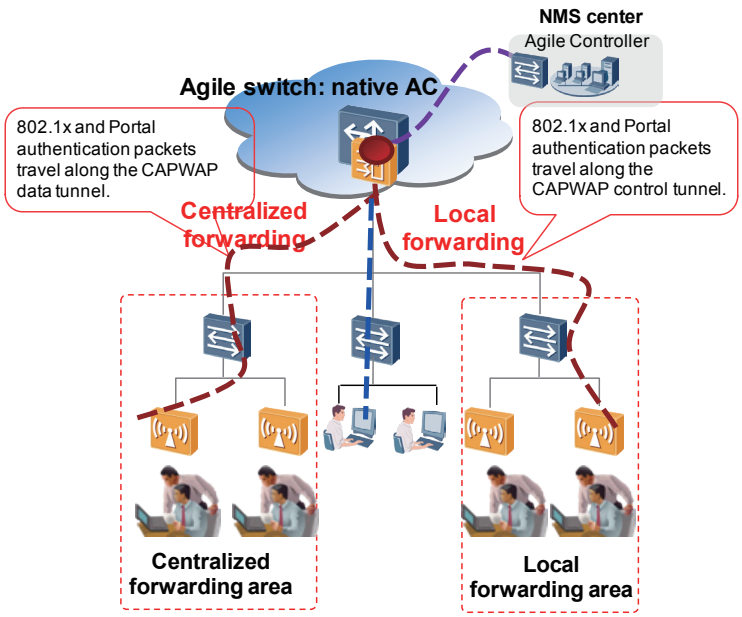
Step 6 The switch looks up the FIB again for the complete encapsulated packets, obtains the egress ASIC card, and sends the packets to the card.

Step 7 The downlink ASIC card processes downlink services on the egress interface and then sends the packets out of the device.

2.2 Centralized Authentication of Wired and Wireless Users on an Agile Switch

The agile switch (with built-in native AC) functions as the unified authentication point for wired and wireless users on the campus network, as shown in Figure 2-6.

Figure 2-6Unified authentication of wired and wireless users



- Centralized authentication of wireless users on the agile switch

» In the centralized forwarding scenario, 802.1X and Portal authentication packets as the data traffic are sent to the agile switch through the CAPWAP data tunnel.

» In the local forwarding scenario, 802.1X and Portal authentication packets can be configured to enter the CAPWAP control tunnel and then sent to the agile switch to complete the authentication process.

- Authentication of wired users on the agile switch

The agile switch is enabled with 802.1X and Portal authentication and completes the authentication process of wired users.

2.3 Roaming Switchover of Wireless Users Through an Agile Switch

The agile switch with built-in native AC controls wireless users who roam from one AP to another AP. Users do not need to log in again and re-authentication is not required.

The STA has associated with AP1. The process of switching to AP2 is as follows:

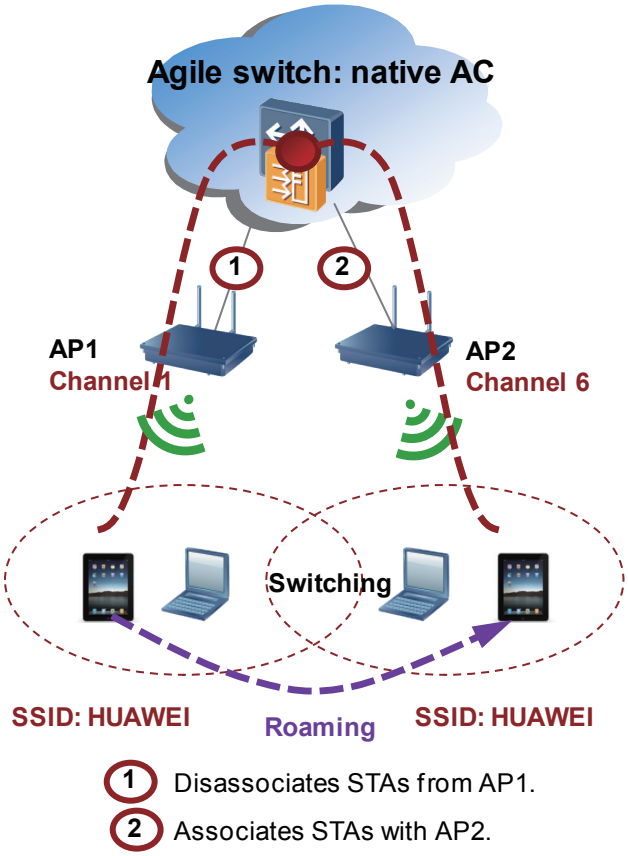
1.The STA sends an 802.11 request frame over each channel. If AP2 receives the 802.11 request frame over channel 6 (a channel used by AP2), AP2 sends a response frame over channel 6. After the STA receives the response frame, it determines to associate with AP2.

2.The STA disassociates with AP1, as indicated by (1) in the following figure. The STA sends an 802.11 disassociation frame over channel 1 to AP1 to disassociate with it.

3.The STA sends an association request over channel 6 to AP2. Then AP2 sends an association response to the STA to associate with the STA, as indicated by (2) in the following figure.

The roaming precautions are as follows:

- For roaming between two APs, ensure that the APs are configured with the same SSID.
- The two APs must be managed by the same agile switch.



2.4 ENP Card Types

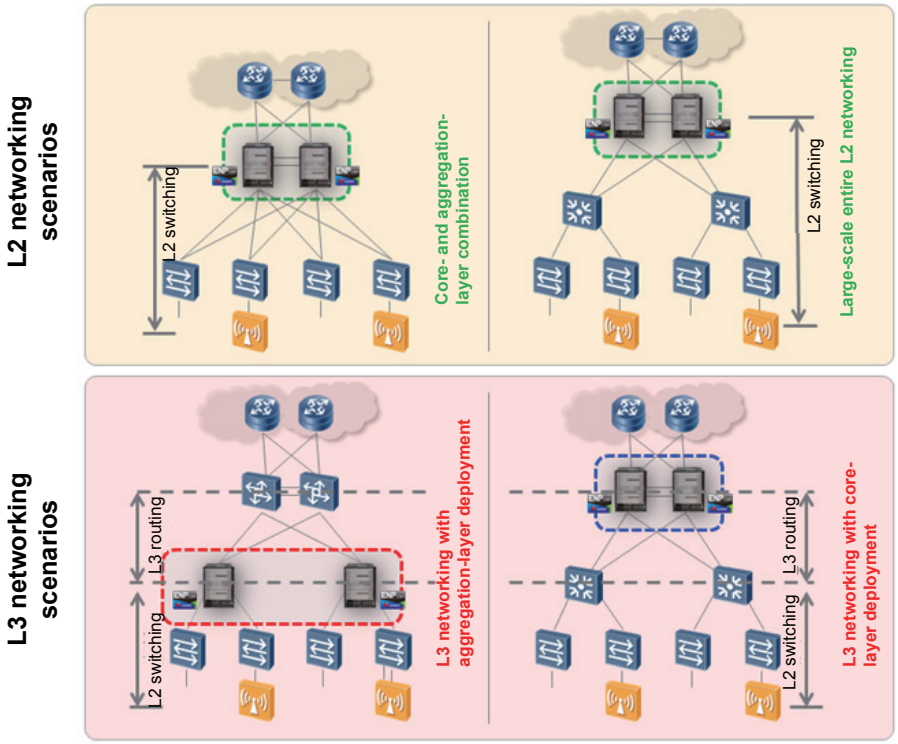
The following table lists the ENP card supported by agile switches.

ENP Card Type	Description
G48SX1E	48GE optical interfaces (X1E)
G48TX1E	48GE optical interface (X1E)
S04SX1E	4*10GE optical interfaces + 24GE optical interfaces + 8GE electrical interfaces (combo) (X1E)
S08SX1E	8*10GE optical interfaces + 8GE optical interfaces + 8GE electrical interfaces (combo) (X1E)

3 Typical Application Scenarios

3.1 Connecting a Wireless AP to an ENP Card

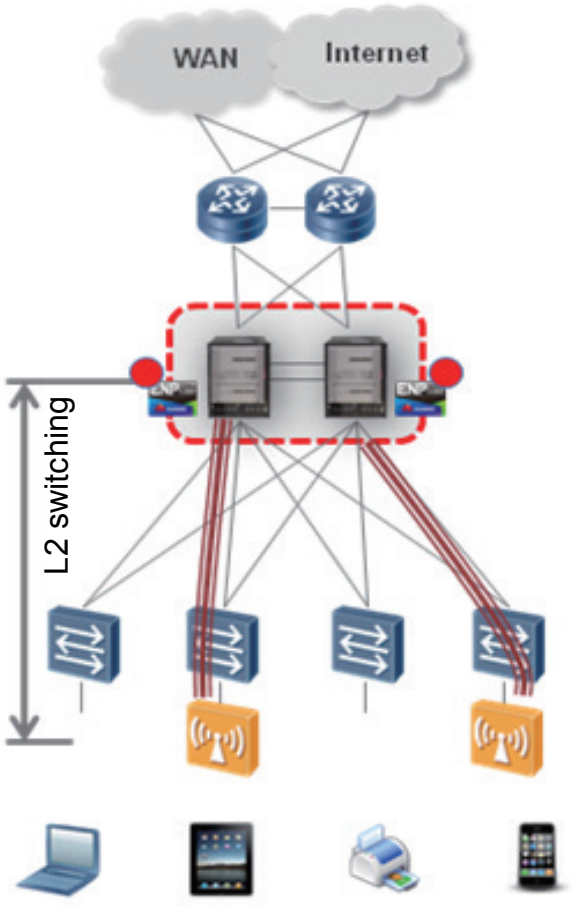
The following figure shows four typical scenarios of native AC. Wired and wireless services are transmitted to ENP cards.



3.1.1 Layer 2 Network Deployment for Small and Medium Enterprises

Small and medium enterprises usually deploy a 2-layer network, that is, core and access layers, as shown in Figure 3-1.

Figure 3-1Network deployment of small and medium enterprises



Deploying the Wired and Wireless Convergence Management Point

A modular switch equipped with ENP cards is deployed at the core layer and functions as the wired and wireless convergence management point. Wired and wireless services are transmitted to the ENP cards.

Deploying Reliability

The devices at the core layer form a CSS/CSS2 cluster to improve inter-device backup.

Deploying User Authentication

- 802.1x authentication is deployed for wireless users, and the authentication point is deployed at the core-layer convergence management point.
- If wired users require high access security, 802.1x authentication is deployed. If the security requirement is not high, Portal authentication is recommended. The authentication point is deployed at the core-layer convergence management point.

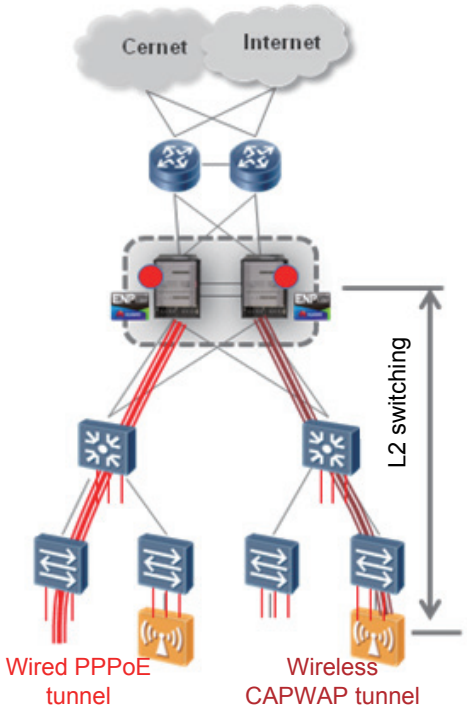
Deploying the Forwarding Model

- Centralized forwarding is deployed for wireless traffic in tunnel mode, implementing centralized control on wireless traffic.
- Local forwarding is used for wired traffic, providing easy and convenient deployment.

3.1.2 Layer 2 Network Deployment for Large Enterprises

Compared with a Layer 2 network where one device functions as both the aggregation device and core device, a 3-layer large Layer 2 network is applied in large-scale campuses with many access users, typically in colleges and universities, as shown in Figure 3-2.

Figure 3-2Network deployment of large enterprises



Deploying the Wired and Wireless Convergence Management Point

A modular switch equipped with ENP cards is deployed at the core layer and functions as the wired and wireless convergence management point. Wired and wireless services are transmitted to the ENP cards.

Deploying Reliability

The devices at the core layer form a CSS/CSS2 cluster to improve inter-device backup.

Deploying User Authentication

- 802.1x authentication is deployed for wireless users, and the authentication point is deployed at the core-layer convergence management point.
- PPPoE authentication can be deployed for wired users. PPPoE achieves centralized forwarding of wired users' services in tunnel mode on the authentication point, and isolates services transmitted from downstream devices to the authentication point. The authentication point is deployed at the core-layer convergence management point.

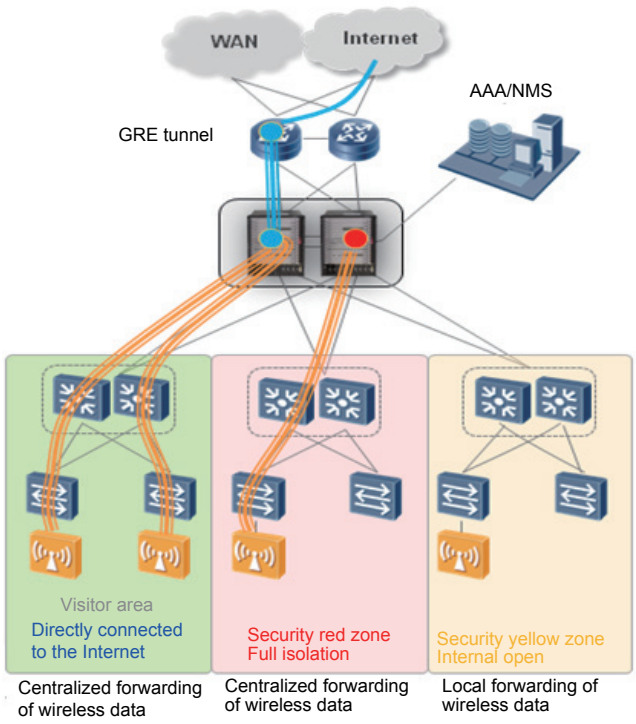
Deploying the Forwarding Model

- Centralized forwarding is deployed for wireless traffic in tunnel mode, implementing centralized control on wireless traffic.
- If PPPoE authentication is used for wired users, centralized traffic forwarding is logically performed. If other authentication modes are used for wired users, local forwarding traffic is performed, with easy and convenient deployment.

3.1.3 Core-Layer Convergence Management Point on a Layer 3 Network

If existing aggregation devices are used and do not have the wired and wireless convergence management capability, the convergence management point can be deployed at the core layer.

Figure 3-3Deploying the core-layer convergence management point on a Layer 3 network



Deploying the Wired and Wireless Convergence Management Point

A modular switch equipped with ENP cards is deployed at the core layer and functions as the wired and wireless convergence management point on the entire network. Wired and wireless services are transmitted to the ENP cards.

Deploying Reliability

The devices at the core layer form a CSS/CSS2 cluster to improve inter-device backup.

Deploying User Authentication

Portal authentication is deployed for both wired and wireless users, and the authentication point is deployed at the core-layer convergence management point.

Deploying the Forwarding Model

- Red zone

» Wireless user traffic is sent through tunnels to the core layer in centralized forwarding mode, implementing centralized control on wireless traffic.

» Local forwarding is used for wired traffic, providing easy and convenient deployment.

- Yellow zone

Local forwarding is used for both wired and wireless user traffic, with easy and convenient deployment.

- Guest area

» Wireless user traffic is sent through tunnels to the core layer for centralized forwarding.

» Wired user traffic is sent to the aggregation layer when port isolation is deployed at the access layer, and then a GRE tunnel is established from the aggregation layer to the core-layer convergence management point to send the wired user traffic to the core layer for centralized forwarding.

» A GRE tunnel for wired and wireless service traffic is set up between the convergence management point and egress router to directly send the traffic to the egress router. The users are restricted by the egress router and can only access the Internet.

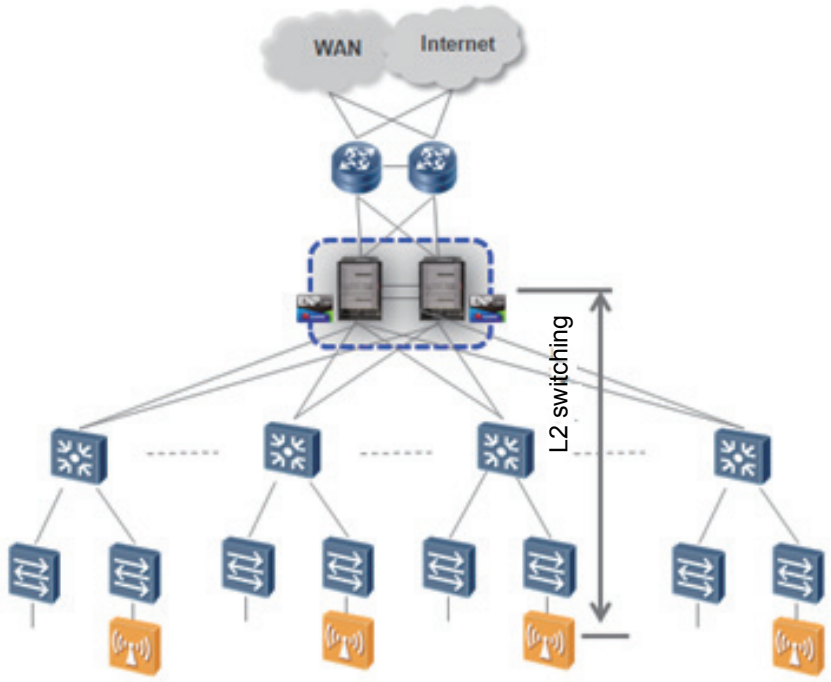
3.2 Wireless AP Connecting to an ASIC Card

User hosts cannot detect whether their wired and wireless services are transmitted to ENP or ASIC cards. Therefore, the scenario in which an AP is connected to an ASIC card is similar that in which the AP is connected to an ASIC card, which is not mentioned in this section. The following sections describe the scenarios in which ENP and ASIC cards are both installed.

3.2.1 Many Scattered Wireless Service Access Points

On a large campus network, access switches are scattered, and the S12700/S9700/S7700 core switches are connected to many aggregation and access switches. APs need to be deployed on almost all access points, but there are only a few wireless users on each access point. To save customers' investments, the network scheme in which devices are equipped with both ASIC and ENP cards can be used. In this scheme, wireless services are transmitted to ASIC cards, and a small number of ENP cards are configured to process wireless services in a centralized manner. The number of ENP cards will be subsequently increased with the development of wireless services.

Figure 3-4Convergence deployment for many scattered access points



Deploying the Wired and Wireless Convergence Management Point

A modular switch equipped with ENP cards is deployed at the core layer and functions as the wired and wireless convergence management point. Wired and wireless services are transmitted to the ASIC cards on the core switch.

Deploying Reliability

- The devices at the core layer form a CSS/CSS2 cluster to improve inter-device backup.
- One ASIC card is selected respectively from two frames of the core device. The interfaces on the two ASIC cards are configured as a link aggregation group (LAG) and then connected to the access switch. These two ASIC cards must belong to the same WLAN work group. The master and slave ENP cards configured in the work group performs hot backup for wireless services.

Deploying User Authentication

- 802.1x authentication is deployed for wireless users, and the authentication point is deployed at the core-layer convergence management point.
- If wired users require high access security, 802.1x authentication is deployed. If the security requirement is not high, Portal authentication is recommended. The authentication point is deployed at the core-layer convergence management point.

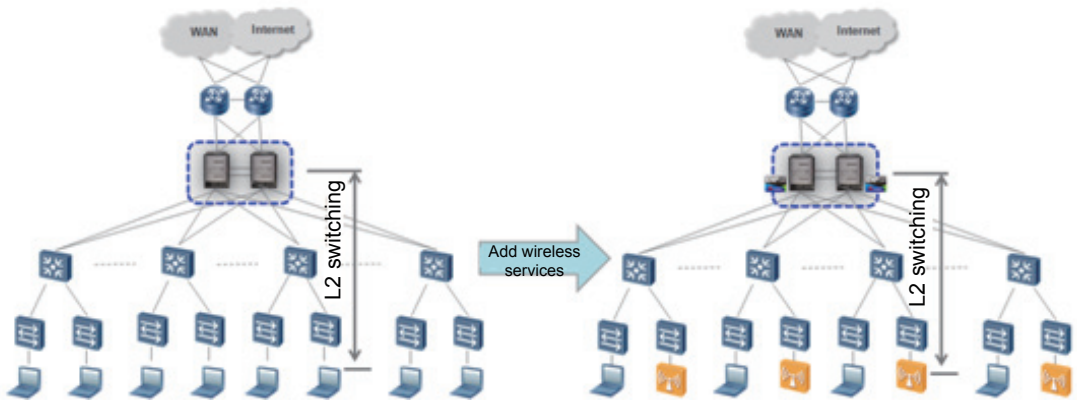
Deploying the Forwarding Model

- Centralized forwarding is deployed for wireless traffic in tunnel mode, implementing centralized control on wireless traffic.
- Local forwarding is used for wired traffic, providing easy and convenient deployment.

3.2.2 Adding Wireless Services on an Old Wired Network

The old network only carries wired services, and the aggregation and access switches are connected to ASIC cards. With business deployment, wireless services need to be deployed. Native AC can be used with the ENP and ASIC cards, without adjusting the interfaces connected to the S12700/S9700/S7700 and downlink switches. ENP cards are directly added to complete wireless service deployment. The deployment description is similar to that in section 3.2.1 "Many Scattered Wireless Service Access Points" and is not described again.

Figure 3-5Adding wireless services on an old wired network



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