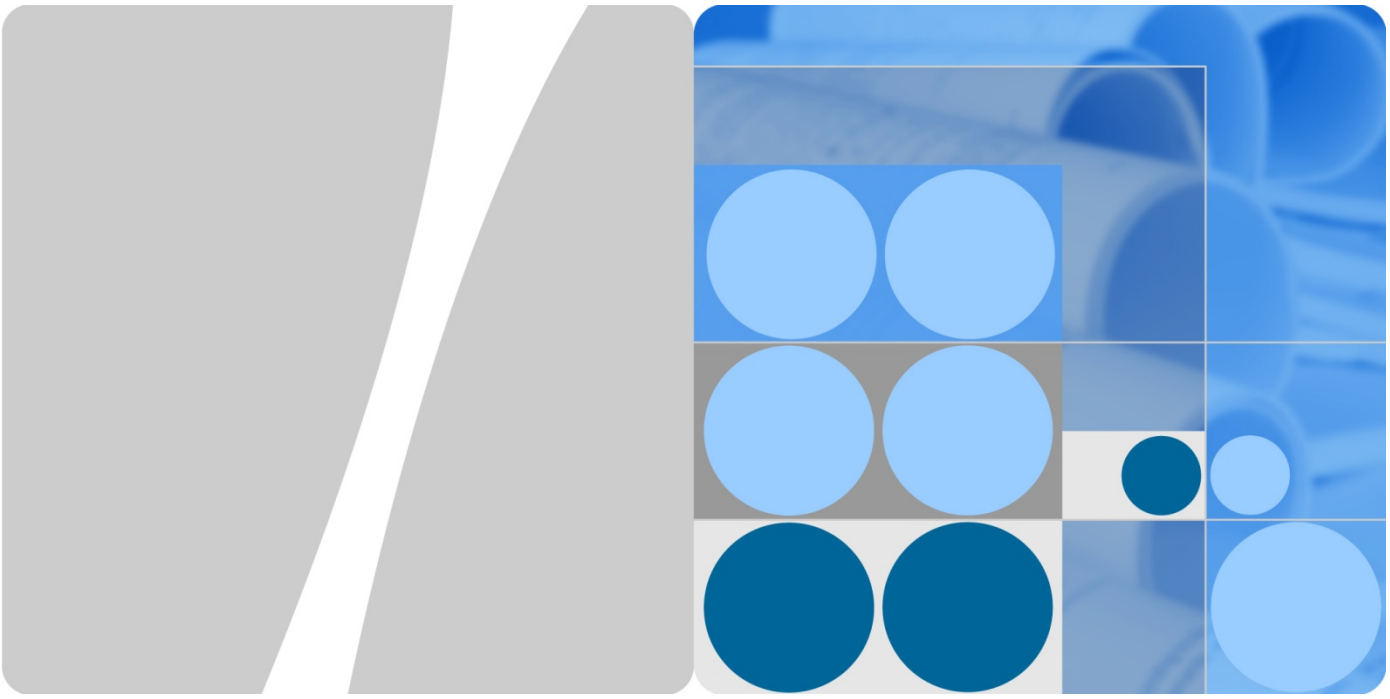

AC HSB Technology White Paper

Issue 2.0

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Huawei Technologies Co., Ltd.

Address: Huawei Industrial Base
Bantian, Longgang
Shenzhen 518129
People's Republic of China

Website: http://enterprise.huawei.com

Change History

Changes between document issues are cumulative. The latest document issue contains all the changes made in earlier issues.

Issue 01 (2014-05-15)

This issue is the first official release.

Issue 02 (2018-03-27)

This issue is the second official release.

This issue is released to match WLAN products in V200R007C20 and has the following updates:

1. Added the descriptions of the background, customer benefits, and application scenarios of AC hot standby (HSB).
2. Added the implementation and process diagrams in chapter 2 "Implementation."

AC Hot Standby Technology White Paper

Keywords:

Hot standby, HSB, VRRP, dual-link, AP going-online, active/standby switchover, active/standby switchback, active AC, standby AC

Abstract:

AC hot standby (HSB) allows the same service to be backed up on two ACs. If the active AC fails, STAs do not need to initiate association authentication again and STA services are automatically switched to the standby AC. When the active AC recovers, services are switched back to the active AC without any interruption. This document describes how implementation and typical application scenarios of AC HSB.

Acronyms and Abbreviations:

Acronyms and Abbreviations	Full Name
AC	Access Controller
AP	Access Point
STA	Station
WLAN	Wireless Local Area Network
CAPWAP	Control And Provisioning of Wireless Access Points
HSB	Hot Standby
VRRP	Virtual Router Redundancy Protocol

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1 Background

As networks rapidly develop and applications become more diversified, various value-added services (VASs) such as Internet Protocol television (IPTV) and video conferencing are widely deployed. In this case, network interruption may affect a large number of services and cause great losses. Therefore, demands for network infrastructure reliability are increasing. In practice, however, it may be inevitable to witness network faults and service interruption due to various reasons. A reliable network system requires that system functions be not affected by a fault. To meet this requirement, the network system needs to have device and link redundancy designed and switchover policies deployed.

The backup function allows backup of devices, links, and service information and fast service switchover upon faults, ensuring continuity of network services. Currently, Huawei WLAN ACs support the following backup modes:

- HSB: can be achieved in dual-link or Virtual Router Redundancy Protocol (VRRP) mode. The active and standby ACs can back up related information in real time. During an active/standby switchover or switchback, STAs do not need to go online again. HSB features fast active/standby switchover, little service impact, and high reliability. This backup mode is applicable to scenarios with high reliability requirements.
- Dual-link backup: refers to dual-link cold backup. Dual-link backup allows two ACs on an AC + Fit AP network to manage APs simultaneously. APs set up Control And Provisioning of Wireless Access Points (CAPWAP) tunnels with both ACs. One AC functions as the active AC to provide services for the APs, while the other works in standby mode and does not provide services. If the active AC fails or the CAPWAP tunnel between the active AC and an AP becomes faulty, the standby AC replaces the active AC to manage the AP and provides services for the AP. In dual-link backup mode, STA information is not backed up. During an active/standby switchover or switchback, STAs need to go online again and services are interrupted temporarily. This backup mode is applicable to scenarios without high reliability requirements.
- N+1 backup: On an AC + Fit AP network, N+1 backup uses one AC as a backup for multiple primary ACs. When the network runs properly, an AP establishes a CAWAP tunnel only with the primary AC to which the AP connects. If the primary AC fails or the CAPWAP tunnel between the primary AC and AP becomes faulty, the backup AC replaces the primary AC to manage the AP. The backup AC then establishes a CAPWAP tunnel with the AP to provide services for it. N+1 backup is a cold backup mode, and does not back up AP or STA information. An AP establishes a CAPWAP tunnel with only one AC. During an active/standby switchover or switchback, the AP and STAs must go online again and services are interrupted temporarily. The service interruption time in N+1 backup mode is longer than that in dual-link backup mode. One AC can be a backup for multiple primary ACs. This backup mode is applicable to scenarios with low reliability but high cost control requirements.

The following chapters describe implementation, customer benefits, and application scenarios of the HSB mode of WLAN ACs.

2 Implementation

2.1 Concepts

In HSB mode, there are two devices, one acting as the active device and the other the standby device. The active device forwards services and the standby device is in monitoring state. The active device sends its status information and other information that needs to be backed up to the standby device in real time. If the active device becomes faulty, the standby device takes over services from the active service.

AC HSB allows the same service to be backed up on two ACs. Network access control (NAC), WLAN, and Dynamic Host Configuration Protocol (DHCP) services can be backed up in HSB mode. Any change of preceding information is saved on both ACs in a timely manner. If the active AC fails or physical upstream or downstream link of the AC becomes faulty, STAs do not need to initiate association authentication again, and STA services are automatically switched to the standby AC.

AC HSB is implemented in either of the two modes depending on the key technology used:

- VRRP HSB: supports HSB between ACs.
- Dual-link HSB: supports HSB between ACs, load balancing, and HSB between ACs at Layer 3.

NOTE

- Dual-link HSB: APs establish CAPWAP tunnels with both the active and standby ACs.
- VRRP HSB: The VRRP protocol is used for backup.

In dual-link HSB mode, APs establish CAPWAP tunnels with both the active and standby ACs. The sequence in which APs or AP groups select the active AC can be specified to allow the APs to support different active/standby scenarios, achieving load balancing on the active and standby ACs. In VRRP HSB mode, two ACs are virtualized into one virtual AC. Therefore, load balancing is not supported. In addition, the active and standby ACs are negotiated by exchanging VRRP packets. The VRRP packets can be transmitted only on Layer 2 networks, but cannot be forwarded across Layer 3 networks. Therefore, ACs do not support VRRP HSB over Layer 3.

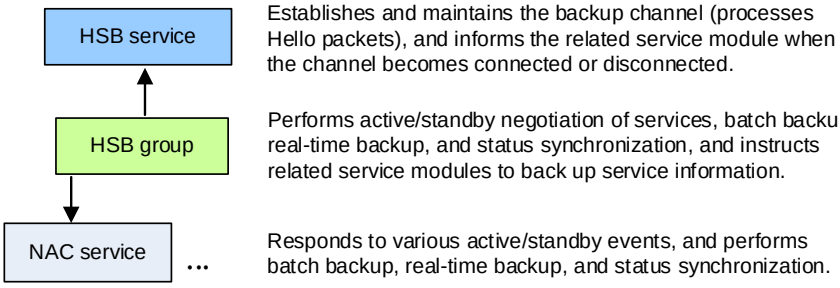
To support HSB, two ACs must be of the same model, use the same networking mode, and have the same configurations (excluding the configuration of management port IP addresses on the ACs).

2.2 HSB Public Mechanism

The HSB public mechanism provides only two public services as follows:

- HSB service: establishes and maintains active/standby channels, and provides interfaces for sending and receiving channel connection/disconnection events and packets for active and standby service modules.
- HSB group: is bound to an HSB service and provides data backup channels for active and standby service modules. An HSB group is bound to a VRRP instance, and negotiates the active and standby instances using the VRRP mechanism. Additionally, an HSB group requests each service module to process batch backup, real-time backup, and active/standby switchover events.

Figure 2-1 Relationship between an HSB system and service modules

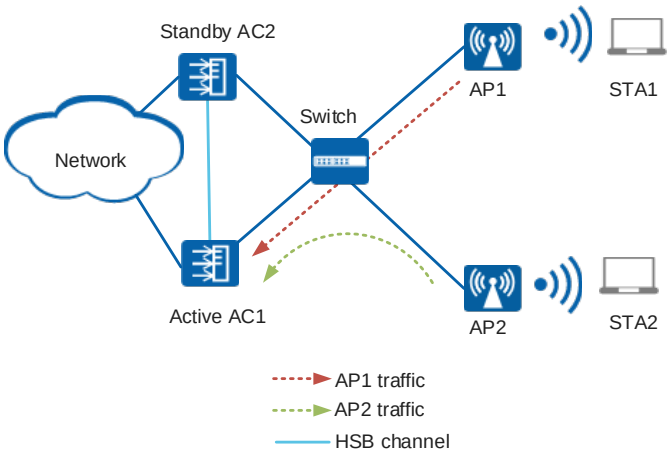


Currently, ACs support only one HSB service and one HSB group.

2.3 VRRP HSB

In VRRP HSB scenarios, services that require HSB are bound to the same HSB group. The HSB group informs the services of the current AC status and active/standby switchover events, and receives and sends backup data through the interface provided by the HSB group.

Figure 2-2 VRRP HSB



As shown in the preceding figure, AC1 and AC2 are deployed in VRRP HSB mode. According to the ACs' active and standby states that are negotiated by the VRRP instance bound to the HSB group, the VRRP group selects AC1 as the active AC and AC2 as the standby one. That is, the active AC in the HSB group is the same as the active AC in the VRRP group. AC1 backs up related service information to AC2 through the HSB channel provided by the HSB service. If AC1 is faulty, VRRP HSB triggers an active/standby switchover or switchback based on the internal mechanism.

The following analyzes the active/standby status negotiation, data backup, active/standby switchover, and active/standby switchback processes of the VRRP HSB mechanism.

- Active/Standby status negotiation

  After an AC VRRP HSB environment is built, the two ACs send VRRP packets carrying priority information (represented by the **Priority** field) to each other through the HSB channel. The active and standby ACs are negotiated according to the priorities in the VRRP packets. After the active and standby ACs are determined, the active AC sends gratuitous Address Resolution Protocol (ARP) packets to notify the connected devices or hosts of its virtual MAC address, and forwards packets for the devices and hosts. Additionally, the active AC periodically sends VRRP Advertisement packets to all backup devices in the VRRP group to advertise its configuration (such as priority) and running status.

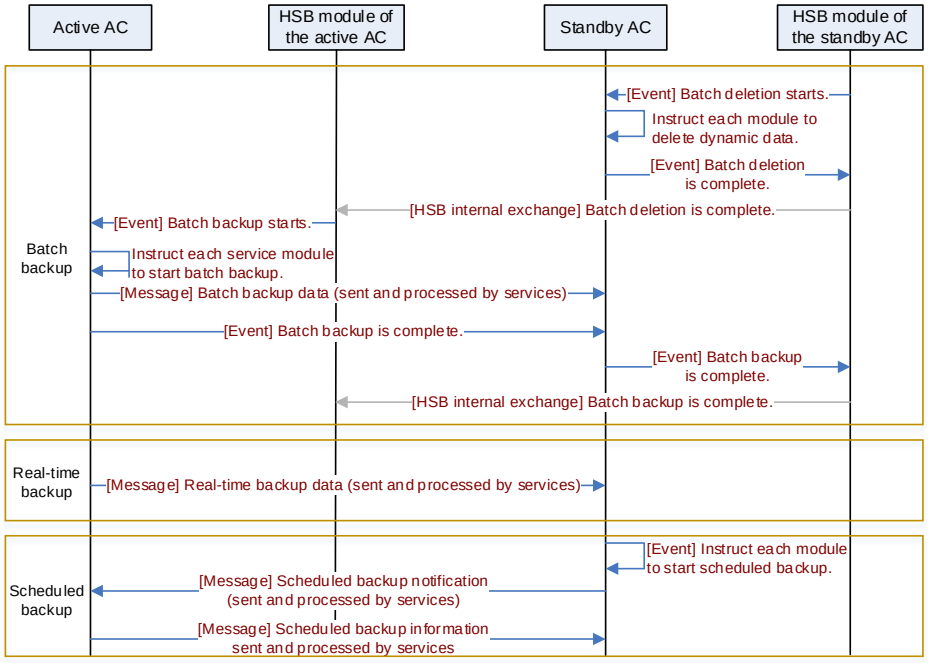
- Data backup

  Information that needs to be backed up in VRRP HSB mode includes STA entries, CAPWAP tunnel information, and AP entries. Batch backup, real-time backup, and scheduled backup are supported.

  - Batch backup: The active AC synchronizes all existing session entries to the standby AC at one time. This is a batch backup process. Batch backup is triggered immediately after the active and standby ACs are determined.
  - Real-time backup: If new session entries are generated during the system running of an AC, the service module of the AC detects whether the active/standby ACs exist and whether the current AC is in active state. If so, the service module invokes the HSB service to send backup information to the peer service module. This is a real-time backup process.
  - Scheduled backup: To ensure consistency of entries on the active and standby ACs, the standby AC checks whether session entries on itself are the same as those on the

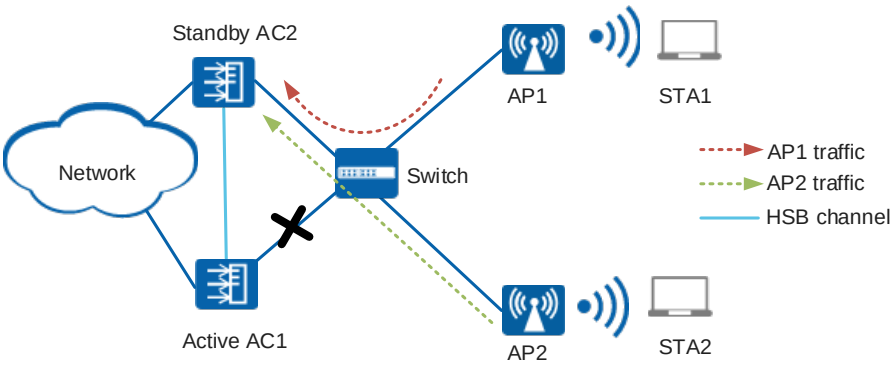
active AC every 30 minutes. If not, the standby AC synchronizes session entries from the active AC. This is a scheduled backup process.

Figure 2-3 VRRP HSB process



- Active/Standby switchover
  - When the downstream link of the active AC is disconnected, an active/standby switchover is triggered. Figure 2-4 shows the switchover process in this case.

Figure 2-4 Active/Standby switchover triggered by a downstream link disconnection of the active AC

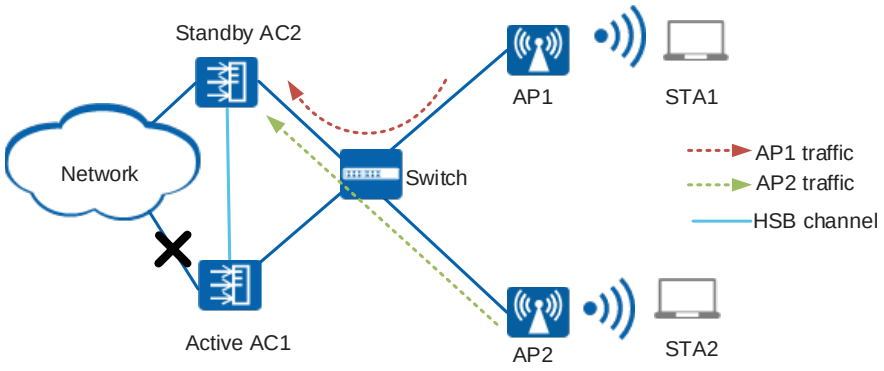


When the downstream link of the active AC is disconnected, the HSB group detects that the VLANIF interface is down and requests the HSB group of the standby AC to enter the independent running state through the HSB channel. After receiving the event, the HSB group requests service modules to change the AP state to normal. When the downstream link of the active AC is disconnected, the VRRP mechanism detects a VRRP heartbeat timeout and changes the VRRP status of the active AC to master. At the same time, the HSB service detects the AC status change. After the

offset timer expires, the VRRP group sends a gratuitous ARP packet containing the virtual address of the VRRP group to activate the link. The standby AC then starts to manage APs.

- When the upstream link of the active AC is disconnected, an active/standby switchover is triggered. Figure 2-5 shows the switchover process in this case.

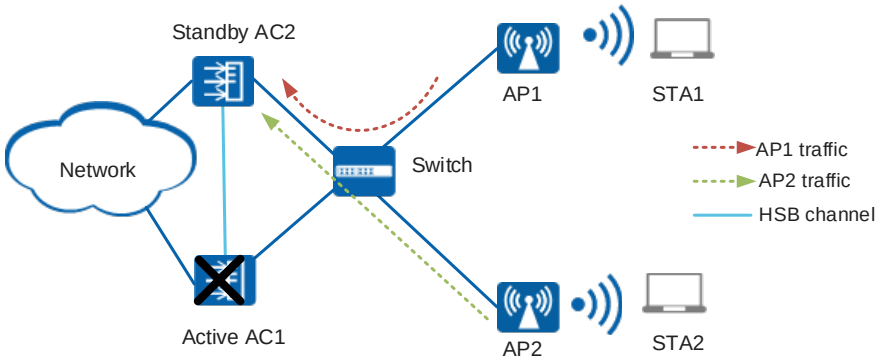
Figure 2-5 Active/Standby switchover triggered by an upstream link disconnection of the active AC



VRRP association is configured to monitor upstream links of or interfaces on ACs. When the upstream link of the active AC is disconnected, the VRRP group reduces the priority of the active AC and triggers a VRRP active/standby switchover. Note that the master and backup devices in the VRRP group must work in preemption mode.

- When the active AC is faulty or restarts, an active/standby AC switchover is triggered. Figure 2-6 shows the switchover process in this case.

Figure 2-6 Active/Standby switchover triggered by a fault of the active AC



When the active AC is faulty, the HSB channel is disconnected and the HSB module cannot notify the active AC of the fault.

If the default heartbeat timeout period of the HSB channel is 15s (5 x 3s), the standby AC must wait until the VRRP timer expires (3s by default) before becoming the new active AC. When the HSB group detects that the VRRP status of the standby AC changes, it determines its own status. Because the heartbeat of the HSB channel does not time out, the HSB group does not request service modules to change the AP status when detecting that its own status is backup. The HSB group status changes to independent running only after the heartbeat of the HSB channel times out. The HSB

group then requests service modules to change the AP status. The active/standby switchover is completed.

If the heartbeat timeout period of the HSB channel is set to 2s (1 x 2s) and the VRRP heartbeat timeout period to 3s (1 x 3s), after the active AC is powered and restarted, the HSB group status changes before the VRRP status changes. In this case, the HSB group requests service modules to change the AP status immediately after the VRRP timer expires. The active/standby switchover is completed. Because the heartbeat interval of HSB channel is short, it is recommended that the HSB channel be connected through one cable to prevent backup data loss.

- Active/Standby switchback

  When the link of the original active AC (AC1) recovers, an active/standby switchback is triggered after the switchback delay expires. The original standby AC (AC2) will become the new standby AC again. The switchback process is as follows:

  When the link of AC1 recovers, the VRRP status changes from **Initialize** to **Backup** and the listening time is 3s. When receiving a VRRP packet from AC2, AC1 starts the switchback delay.

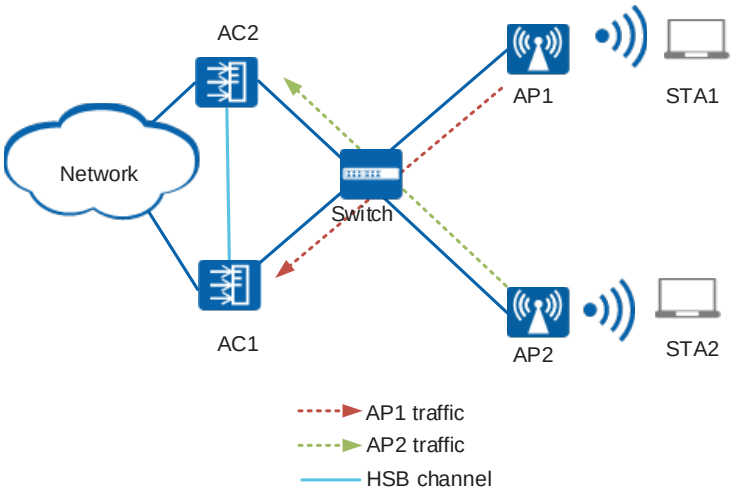
  When the VRRP status of AC1 changes from **Initialize** to **Backup**, the HSB group detects the change, and then triggers batch deletion and batch backup to ensure consistency of data on AC1 and AC2. The corresponding AP status changes to standby.

  After the switchback delay expires, the VRRP status of AC1 changes to master, and AC1 sends gratuitous ARP packets to connected devices. When detecting that the VRRP status has changed to master, the HSB group on AC1 immediately negotiates the active/standby status with the HSB group on AC2. As a result, AC1 plays the active role, and the AP status changes to normal on AC. AC2 is the standby AC, and the AP status changes to standby on AC2. The active/standby switchback is completed and services are restored.

2.4 Dual-Link HSB

In dual-link HSB mode, the HSB service is directly bound to services. In this case, the HSB system only sends and receives backup data, and the dual-link mechanism maintains STAs' active/standby states.

Figure 2-7 Dual-link HSB



As shown in the preceding figure, AC1 and AC2 are deployed in dual-link HSB mode. Only the HSB service is bound to services to provide a dual-link HSB channel. An AP establishes CAPWAP tunnels with the ACs, and differentiates the active and standby ACs based on the priorities in the CAPWAP packets delivered by the ACs. In typical cases, for service traffic on AP1, AC1 is the active device and AC2 is the standby one. AC1 processes all service traffic on AP1 and transmits session information to AC2 through the HSB channel for backup. AC2 does not process service traffic from AP1 and only serves as the backup for AC1. For service traffic on AP2, AC2 is the active device and AC1 is the standby one. AC2 processes all service traffic from AP2 and transmits session information to AC1 through the HSB channel. AC1 does not process service traffic from AP2 and only serves as the backup for AC2. On the network, AC1 forwards service traffic of AP1 and AC2 forwards service traffic of AP2. In this way, service traffic is load balanced on the ACs. AC1 and AC2 can also be deployed in dual-link HSB mode at Layer 3.

The following analyzes the active/standby status negotiation, data backup, active/standby switchover, and active/standby switchback processes of the dual-link HSB mechanism.

- Active/Standby status negotiation

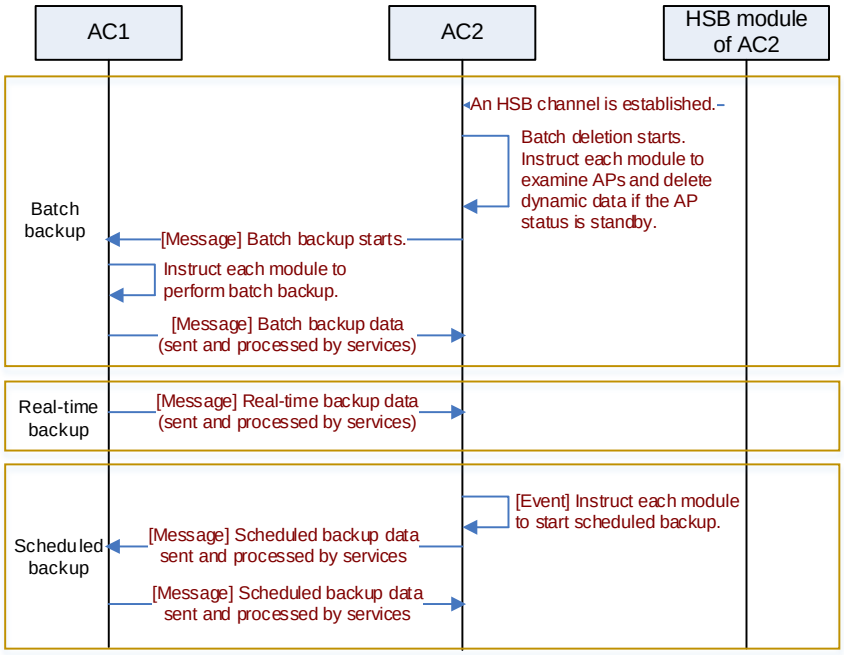
  To establish an active CAPWAP tunnels with an AC, the AP needs to select the preferred AC in the discovery phase. After the dual-link HSB function is enabled in the discovery phase, the AP sends CAPWAP Discovery Request packets to the ACs in unicast or broadcast mode. The ACs working properly will respond to the AP with CAPWAP Discovery Response packets containing the IP addresses of the preferred and alternate ACs, dual-link HSB flags, and priorities, loads, and IP addresses of the ACs. After receiving the Discovery Response packets, the AP selects the active AC based on IP addresses of the preferred and alternate ACs, and priorities, loads, and IP addresses of the ACs, and establishes an active CAPWAP tunnel with the active AC.

  To prevent configuration errors due to repeated service configuration delivery, the AP starts to establish a backup CAPWAP tunnel with the standby AC only after the configuration of the active CAPWAP tunnel to the active AC has been established and delivered. The AP sends a unicast CAPWAP Discovery Request packet to the standby AC. After receiving the packet, the standby AC responds to the AP with a CAPWAP Discovery Response packet containing the IP addresses of the preferred and alternate ACs, dual-link backup flags, loads, and priorities of the ACs. The AP knows that the dual-link HSB function is enabled after receiving the CAPWAP Discovery Response packet, and saves the priority of the standby AC.

- Data backup

  In dual-link HSB mode, STAs' access authentication information is backed up through HSB channels. In this way, more STA encryption and authentication methods are supported and services are not interrupted during an active/standby switchover or switchback. Dual-link HSB backup modes include real-time backup, batch backup, and scheduled backup.

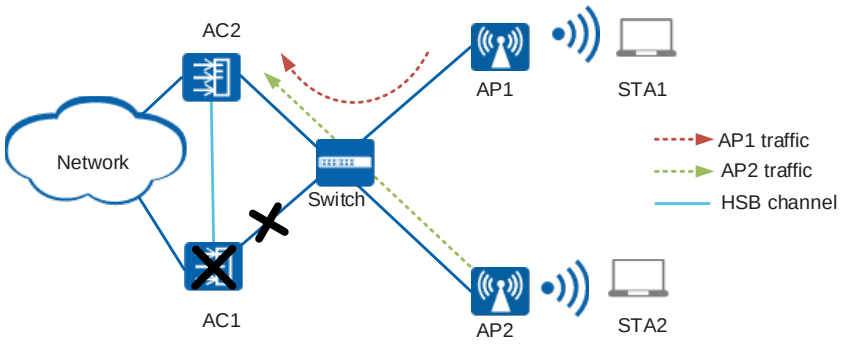
Figure 2-8 Data backup process in dual-link HSB mode



- Active/Standby switchover

  In dual-link HSB mode, an active/standby switchover is determined and performed by APs. When the active AC is faulty or its downstream link is disconnected, an active/standby switchover is triggered. Figure 2-9 shows the switchover process.

  Figure 2-9 Active/Standby switchover triggered by a fault or downstream link disconnection of the active AC



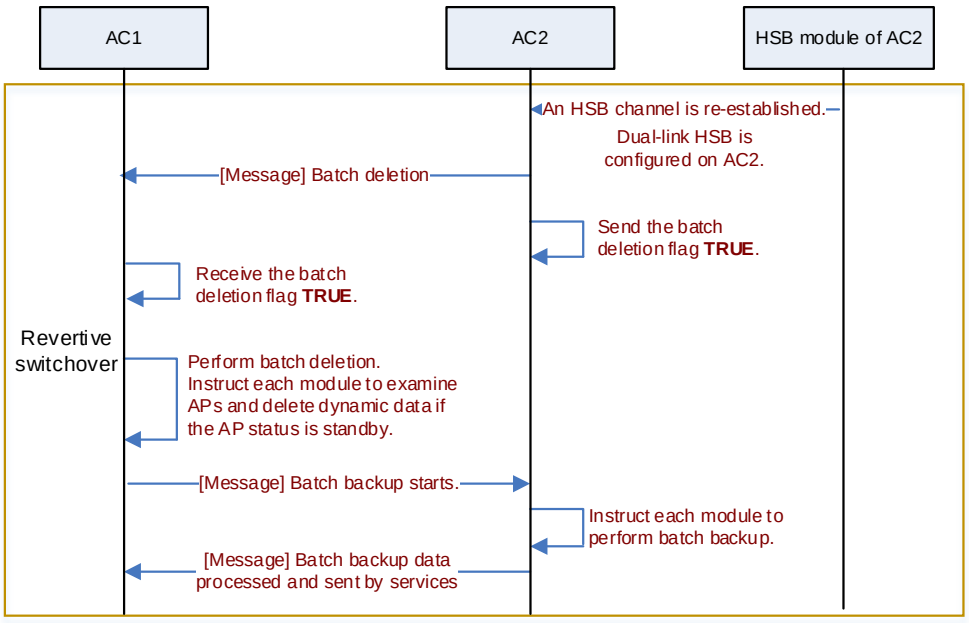
  After establishing dual links with the active and standby ACs, the AP periodically sends Echo packets to the ACs to monitor the link status. The active/standby states of the links are specified in the Echo packets. If the link between AC1 and the switch is disconnected or AC1 is faulty, the AP waits until three heartbeat packets sent to AC1 time out, and then sets the flag in the next Echo packet sent to AC2 to 1 to activate the backup link. AC2 then takes over to manage APs, ensuring service continuity.

- Active/Standby switchback

  The AP periodically sends Discovery Request packets to check whether the original active link recovers. If so, the AP switches STA data back to the active link because the

link has a higher priority than the current one. To prevent frequent switchovers caused by network flapping, the AP requests the ACs to perform an active/standby switchback after 20 Echo intervals, and then sends STA data to the new active AC.

Figure 2-10 Active/Standby switchback process in dual-link HSB mode



3 Customer Benefits

AC HSB brings the following benefits:

- STAs do not need to initiate re-authentication.

  WLAN ACs support three backup modes: dual-link cold backup, N+1 cold backup, and HSB. In dual-link cold backup and N+1 cold backup modes, services cannot be recovered after an active/standby switchover triggered by an active AC failure or active/standby switchback when the original active AC recovers. STAs need to be re-authenticated to recover services. In VRRP HSB or dual-link HSB mode, the active and standby ACs back up STA authentication and login information in real time. When the active and standby ACs switch or switch back, STAs can recover services on the ACs requiring no re-authentication.

- STAs are unaware of service switchovers.

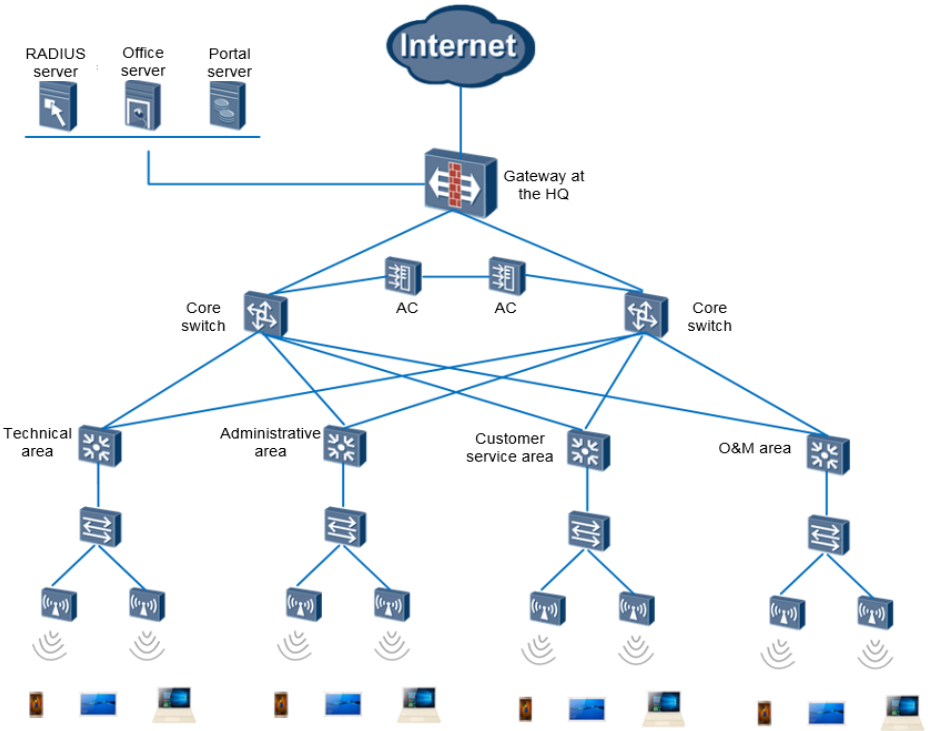
  When an AC on a network with no backup is faulty, maintenance engineers need to respond rapidly to locate and rectify the fault. The service interruption period may be long. When the ACs are deployed in cold backup mode, services are switched to the standby AC if the active AC is faulty. In this case, network service restoration takes nearly 20 minutes. Interruption of importance services on the network will cause great loss to customers. However, the network interruption period is controllable. When the ACs are deployed in HSB mode and the HSB tunnel signal is good, services are rapidly switched to the standby AC if the active AC is faulty. When the active AC restores, services can be rapidly switched back to the active AC. Network interruption has little impact on services of common customers, and even no obvious impact on even important services.

4 Application Scenario

4.1 Enterprise

An enterprise wants to construct a WLAN campus network to provide converged wired and wireless access for users in the independent technical, administrative, customer service, and maintenance office areas. It desires to build a secure, reliable, easy-to-manage, and easy-to-maintain WLAN to provide network access for its employees and guests. Figure 4-1 shows the network diagram of the enterprise. Each office area is assigned its own VLAN. That is, a Layer 3 network is deployed between the ACs and APs, and the ACs are connected to the core switches in bypass mode. The enterprise uses the VRRP HSB mode to deploy ACs. Two ACs are deployed, one as the active AC (AC1) to manage all APs and the other as the standby AC (AC2). If the link of AC1 is unavailable, the system rapidly switches services to AC2. When the link of AC1 recovers, the system switches services back to AC1.

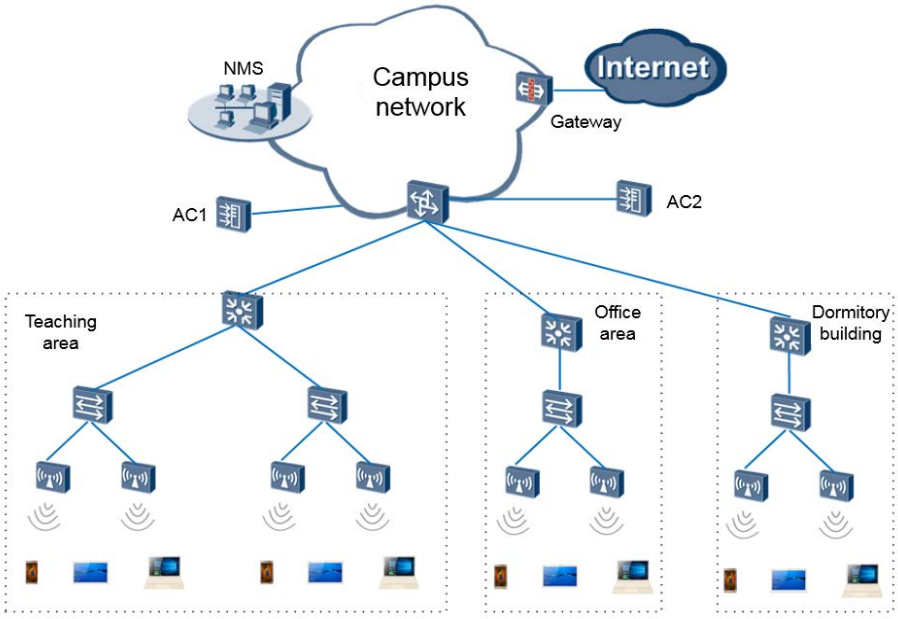
Figure 4-1 Network topology of the enterprise



4.2 University

A university deploys a WLAN using Huawei's WLAN solution. The following figure shows the network topology.

Figure 4-2 Network topology of the university



The ACs are deployed in dual-link HSB mode in two equipment rooms. AC1 manages APs in the teaching area, while AC2 manages those in the office area and dormitory buildings. If AC1 is faulty, AC2 takes over to manage the APs that are managed by AC1 originally.