WLAN AC N+1 Backup Technology White Paper

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Change History

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

Issue 03 (2018-04-10)

This issue is the third official release to match WLAN products in V200R009C00, with the following updates:

- Added license synchronization.

Issue 02 (2017-08-22)

This issue is the second official release to match WLAN products in V200R007C20, with the following updates:

- Modified the maximum number of backup APs supported by an AC.
- Added the description of how APs can discover an AC.
- Added the process of selecting a primary AC by priority.

Issue 01 (2014-05-15)

This issue is the first official release.

AC N+1 Backup Technology White Paper

Keywords

N+1, backup, AP going-online, AC switchover, AP switchback, primary AC, backup AC

Abstract

AC N+1 backup technology uses one AC as the backup of multiple primary ACs. When a primary AC fails, APs managed by it are switched to the backup AC. When the faulty primary AC recovers, APs are switched back to it. This document describes the background, implementation, customer benefits, and typical application scenarios of AC N+1 backup.

Acronyms and Abbreviations

Acronym and Abbreviation	Full Name
AC	Access Controller
AP	Access Point
STA	Station
WLAN	Wireless Local Area Network
CAPWAP	Control And Provisioning of Wireless Access Points

Contents

1 Background

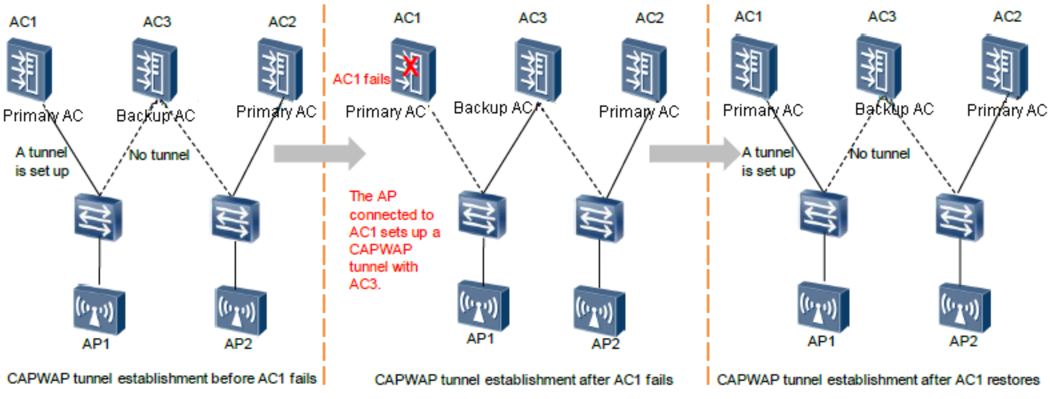
In the AC + Fit AP architecture, ACs play an important role. An AC manages all APs connected to it through Control and Provisioning of Wireless Access Points (CAPWAP) tunnels, including configurations, versions, and alarms. An AC also provides important functions such as user management and data forwarding (tunnel forwarding).

On a network, each AC may manage tens to hundreds of APs, depending on the network scale. If an AC fails, tens or hundreds of APs, as well as hundreds or thousands of STAs connected to these APs will be affected. New STAs cannot connect to the network, and online STAs may be forced to go offline. To prevent this problem, AC backup is required to improve network reliability.

AC backup modes include hot backup and cold backup. In AC hot backup networking, if the active AC fails, APs and online STAs can switch to the standby AC without going online again. This switchover mode does not affect services in local forwarding mode and interrupts services for several seconds in centralized forwarding mode. In AC cold backup networking, if the active AC fails, APs and online STAs are forced to go offline and go online again, which results in service interruption. Huawei supports both hot and cold backup solutions.

The AC N+1 backup solution described in this document is a cold backup solution. In AC N+1 backup mode, an AP sets up a CAPWAP tunnel only with a primary AC. When the primary AC fails, the AP sets up a CAPWAP tunnel with the backup AC. The backup AC delivers configurations to the AP again. After the primary AC recovers, the AP switches back to the original primary AC and obtains configurations from the primary AC again.

Figure 1-1 AC N+1 backup



As shown in the preceding figure, ACs work in N+1 backup mode. AC3 functions as the backup AC of AC1 and AC2. AP1 sets up a CAPWAP tunnel with AC1, and AP2 sets up a CAPWAP tunnel with AC2. When AC1 fails, AP1 detects the fault and sets up a CAPWAP tunnel with AC3. After setting up a CAPWAP tunnel with AC3, AP1 detects the status of AC2. When detecting that AC1 recovers, AP1 disconnects from AC3, and sets up a CAPWAP tunnel with AC1 again.

2 Implementation

Huawei's AC N+1 backup solution does not pose specific requirements on device models. That is, the AC6605, AC6005, ACU2, and AC6800V can be used as primary and backup ACs. The value of *N* varies depending on the number of backup APs supported by an AC, that is, the number of AP IDs that can be configured on an AC. Note that the AC N+1 backup feature does not change the number of APs managed by an AC. The following table lists the different specifications of AC models.

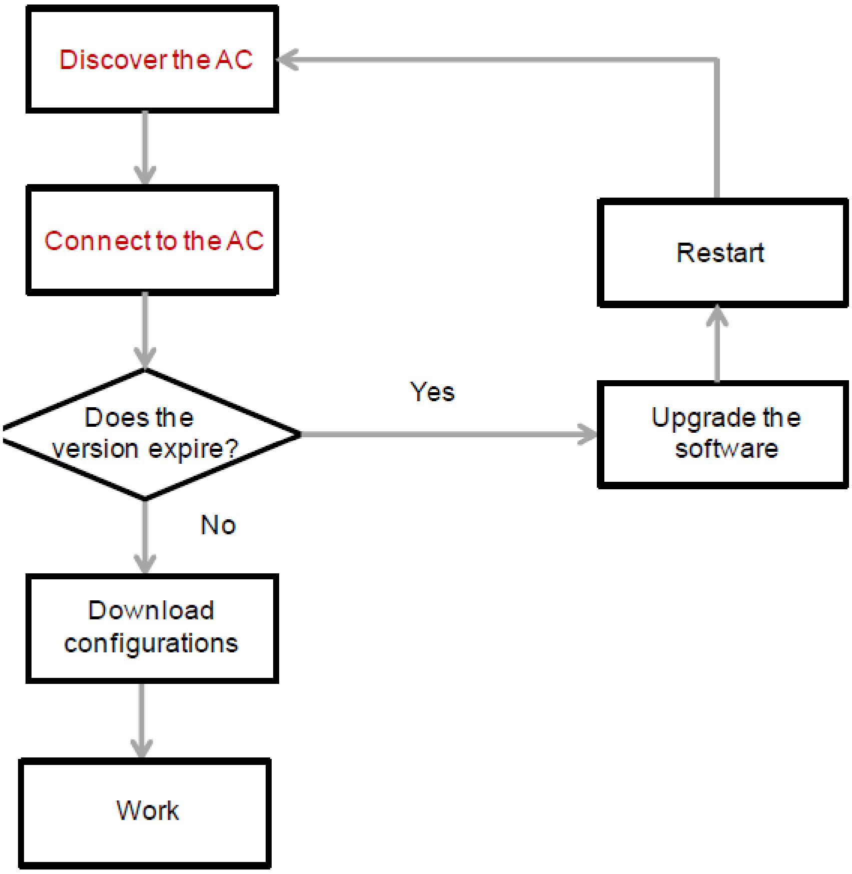
AC Model	Number of Supported AP IDs	Number of Managed APs
AC6005	8K	256
AC6605	8K	1K
ACU2	8K	2K
AC6800V	30K	10K

When AC N+1 backup is used, consider the AC selection when APs go online, switchover when a primary AC fails, and switchback when the primary AC recovers.

2.1 AP Going-Online Process

The process for an AP to go online is a standard process defined in the CAPWAP protocol. The following figure shows the entire process (DTLS encryption is optional and therefore not presented here). This document does not describe the data exchange between the AP and AC in each phase of the process. For details, see the CAPWAP protocol. In AC N+1 backup networking, how an AP discovers an AC and chooses the primary AC is described in this section.

Figure 2-1 Process for an AP to go online



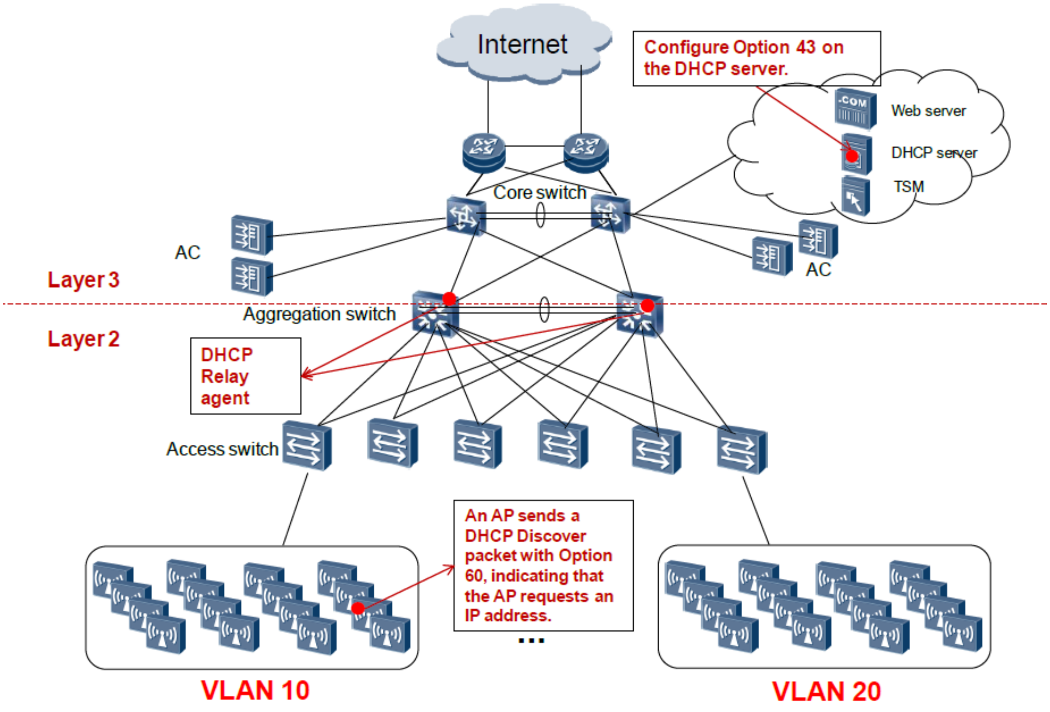
Discovering an AC

An AP can discover an AC in static or dynamic mode:

- Static: An AC IP address list is pre-configured on the AP. When the AP goes online, the AP unicasts a Discovery Request packet to each AC whose IP address is specified in the preconfigured AC IP address list. After receiving the Discovery Request packet, the ACs send Discovery Response packets to the AP. The AP then selects an AC to establish a CAPWAP tunnel based on the received Discovery Request packets.
- Dynamic: An AP can dynamically discover an AC in DHCP, DNS, or broadcast mode.
  - DHCP mode: The AP obtains the IP address of the AC through the DHCP service and unicasts a Discovery Request packet to the AC. The AC then responds to the AP with a Discovery Response packet.
  - DNS mode: The AP obtains the domain name of the AC and the IP address of the DNS server through the DHCP service. The AP then sends a request to the DNS server to obtain the IP address mapping the AC domain name. After obtaining the AC IP address, the AP unicasts a Discovery Request packet to the AC. The AC then responds to the AP with a Discovery Response packet.
  - Broadcast mode: The AP broadcasts a Discovery Request packet to automatically discover ACs in the same network segment. The AP then selects an AC to establish a CAPWAP tunnel based on the Discovery Response packets received from available ACs.

The DHCP mode is used as an example to describe this process.

Figure 2-2 Different management VLANs for APs



In the application scenario shown in the preceding figure, the aggregation switches function as the boundary between Layer 2 and Layer 3. Static IP addresses are configured for the ACs. The APs dynamically obtain IP addresses from the DHCP server in DHCP mode. The DHCP server is deployed at Layer 3. Therefore, you need to configure DHCP relay on the gateways, and configure Option 43 on the DHCP server.

1. An AP sends a DHCP Discover packet carrying Option 60, indicating that the AP requests an IP address.
2. The DHCP Discover packet is forwarded to the DHCP server by a gateway functioning as the DHCP relay agent.
3. After processing the DHCP Discover request from the AP, the DHCP server assigns an IP address to the AP from the IP address pool based on information such as the ID and VLAN of the AP. At the same time, the DHCP server sends AC IP address information in the specified VLAN to the AP through Option 43.
4. The AP obtains information such as its IP address and lease from subsequent packets exchanged with the DHCP server.

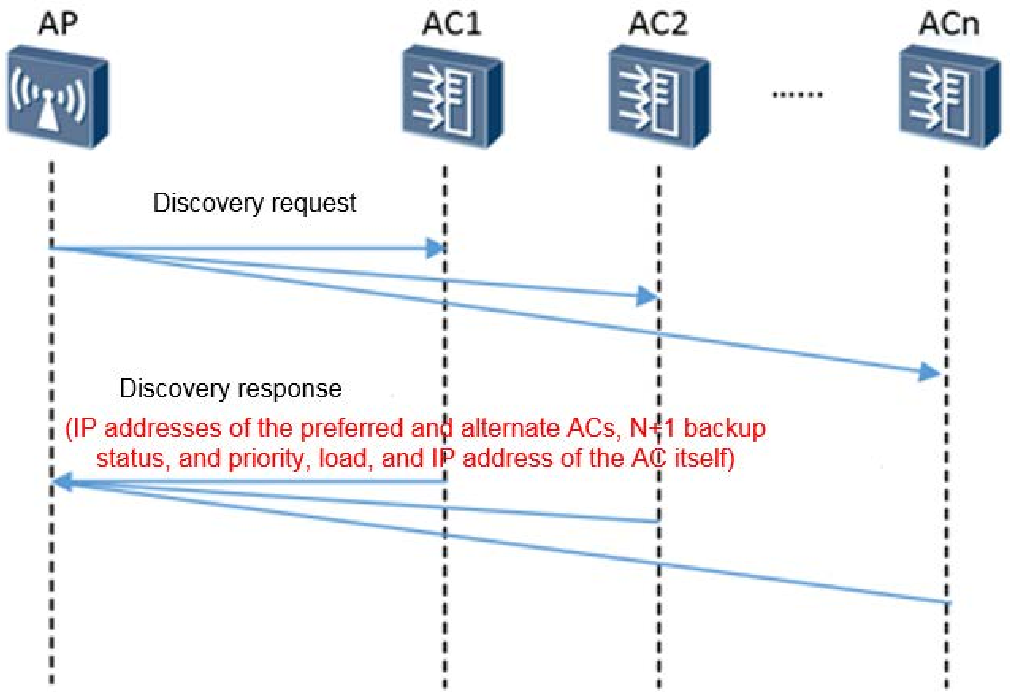
Connecting to the AC

After obtaining ACs' IP addresses during AC discovery, an AP can select an AC to set up a communication connection. If the AP obtains only one IP address of an AC, the AP can set up a CAPWAP tunnel only with this AC and go online on this AC. This process does not involve selection for the primary AC. When an AP obtains IP addresses of multiple ACs in the AC discovery process, the AP needs to select an AC to set up a CAPWAP tunnel and go online on the AC.

The following describes how an AP selects a primary AC from multiple ACs.

Step 1 The AP obtains AC information.

Figure 2-3 Obtaining AC information



After obtaining IP addresses of multiple ACs, the AP unicasts Discovery Request packets to all the ACs. Upon receiving the Discovery Request packets, each AC replies with a Discovery Response message carrying the IP addresses of the preferred and alternate ACs, N+1 backup status, and priority, load, and IP address of the AC itself.

Step 2 Select a primary AC.

After receiving the Discovery Response packets from the primary and backup ACs, the AP selects a primary AC according to the following preferred sequence to establish a CAPWAP tunnel:

1. The AP checks the preferred AC. If there is only one preferred AC, this AC functions as the primary AC. If there are multiple preferred ACs, the AC with the lightest load is selected as the primary AC. If the ACs have the same load, the AC with the smallest IP address is selected as the primary AC.
2. If no preferred AC is available, the AP checks alternate ACs. If there is only one alternate AC, the AP selects this AC as the primary AC. If there are multiple alternate ACs, the AP selects the AC with the lowest load as the primary AC. If the alternate ACs have the same load, the AP selects the AC with the smallest IP address as the primary AC.
3. If no alternate AC is available, the AP compares AC priorities and selects the AC with the highest priority as the primary AC. A smaller value indicates a higher priority.
4. If the AC priorities are the same, the AP selects the AC with the lowest load as the primary AC.
5. When the ACs have the same load, the AP compares the ACs' IP addresses and selects the AC with the smallest IP address as the primary AC.

NOTE

When planning an N+1 backup network, ensure that the predefined primary AC can be selected from the specified preferred ACs and alternate ACs so that all APs can go online on the predefined primary AC. If no preferred or alternate AC is available, the primary AC can be selected by comparing AC priorities. If the AC priorities are the same, the APs select the primary AC based on loads and IP addresses. This cannot ensure that the APs go online on the predefined primary AC.

Step 3 Establish a CAPWAP link to connect to the AC.

An AP establishes a CAPWAP link with the selected primary AC and joins the AC. After the configurations are delivered to the AP, the AP can properly run, STAs connected to the AP can go online, and services can be properly forwarded.

If a link fails to be set up and a backup AC is configured on the primary AC, the AP sets up a CAPWAP link with the backup AC. If no backup AC is specified on the primary AC, the AP needs to select a new primary AC from multiple ACs and connects to the new primary AC.

In the process of selecting a primary AC, when no information about the preferred and alternate ACs is configured on the ACs, the primary and backup ACs are selected based on priorities.

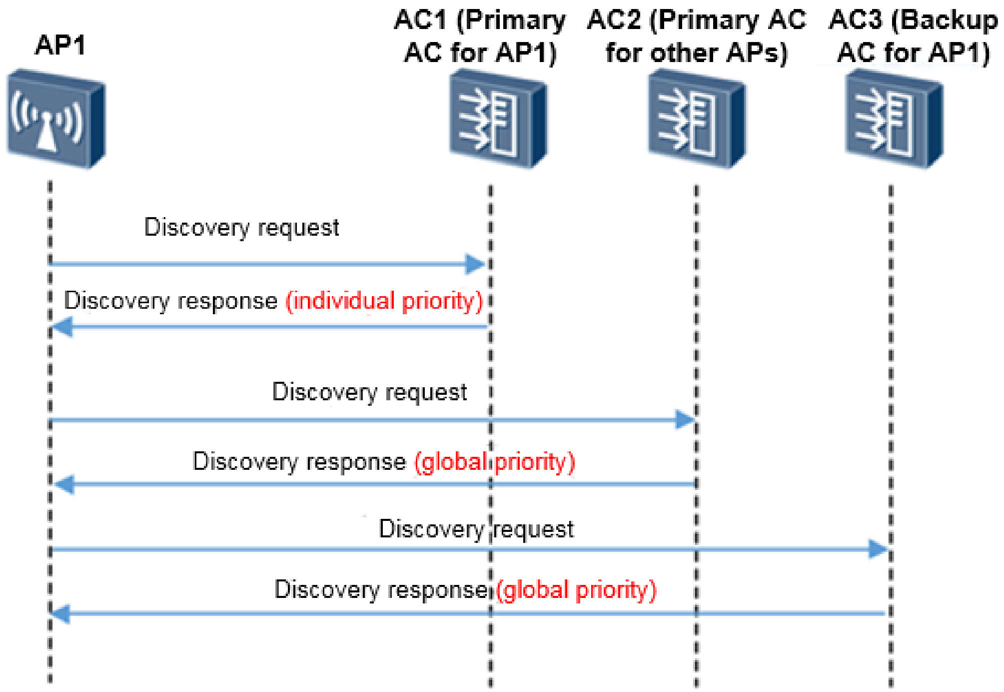
An AC has two types of priorities:

- Global priority: AC priority configured for all APs. For example, the global priority of primary AC1 and primary AC2 is 6, and the global priority of the backup AC is 5. (A smaller value indicates a higher priority.) The global priority of a backup AC must be higher than that of primary ACs so that an AP can broadcast packets to discover and connect to the backup AC when its primary AC fails.
- Individual priority: AC priority configured for a single AP or APs in an AP group. For example, the AC individual priority for AP1 is 3 on the primary AC1.

AC priorities are determined as follows:

The configured priority is carried in the Discovery Response packet sent by an AC. When receiving a Discovery Request packet from an AP, the AC checks whether an individual priority has been specified for the AP. If not, the AC replies a Discovery Response packet carrying the global priority. If so, the AC replies a Discovery Response packet carrying the individual priority. Properly setting priorities on the primary and backup ACs can control the AC to which APs go online.

Figure 2-4 Priorities carried in Discovery Response packets sent by ACs of different roles



After receiving priorities of ACs, the AP compares the priorities and connects to the AC with the highest priority. The AP compares priorities at different levels first and then those at the same level as follows:

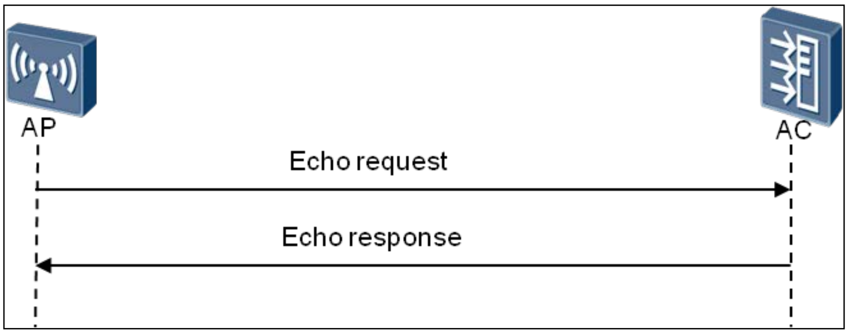
- Priorities at different levels: The individual priority is higher than the global priority at the wired side. For example, the AP obtains the individual priority of AC1 and global priorities of AC2 and AC3. An AC's individual priority is higher than its global priority. Therefore, the AP goes online on AC1.
- Priorities at the same level: A smaller priority value indicates a higher priority. For example, after the AP obtains AC1's global priority 6 and AC2's global priority 5, the AP goes online on AC2.

----End

2.2 AC Switchover

After an AP and its connected AC work properly, they periodically check the CAPWAP tunnel status. They exchange keepalive packets and echo packets to maintain the CAPWAP data tunnel and control tunnel, respectively. The AP determines whether the AC is faulty based on the CAPWAP control tunnel status.

Figure 2-5 Control tunnel keepalive



The keepalive process between the AP and AC is as follows:

1. The AP sends Echo Request packets to the AC at each echo detection interval. The value of echo detection interval ranges from 20s to 300s, and the default value is 25s.
2. After receiving an Echo Request packet, the AC replies an Echo Response packet.
3. If the AP receives an Echo Response packet from the AC within a detection interval, the AP sets the timeout count to zero. If the AP does not receive any Echo Response packet from the AC within a detection interval, the AP increases the timeout count by 1 and then sends an Echo Request packet. If the timeout count exceeds the configured maximum value, the AP considers the AC faulty and triggers a switchover. The maximum timeout count ranges from 3 to 120, and the default value is 6.

If the primary AC fails, the AP goes online on the backup AC by directly establishing a link with the backup AC. The IP address of the backup AC is known on the primary AC. This is equivalent to predefining the IP address of the backup AC on the AP. Therefore, the AP establishes a CAPWAP tunnel with the backup AC and goes online on the backup AC.

After the AP goes online on the backup AC, it obtains configurations from the standby AC. If configurations on the primary and backup ACs are different, the difference on the primary AC cannot be delivered to the AP. If the configurations on the primary AC are required, modify the configurations on the backup AC accordingly.

2.3 Revertive Switchover

When the primary AC fails, the AP can connect to the backup AC. After the primary AC recovers, the AP needs to connect to the primary AC again so that the backup AC is accessible to APs connected to other primary ACs.

If an AP goes online on the backup AC for the first time during the period when the primary AC fails, the AP needs to connect to the primary AC when the primary AC recovers.

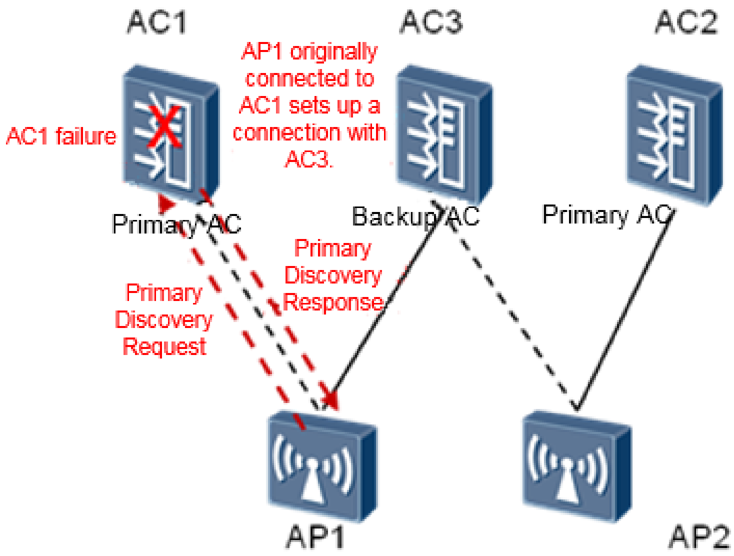
The AP connected to the backup AC detects the status of the primary AC. When finding that the primary AC recovers, the AP disconnects from the current AC, sets up a new CAPWAP tunnel with the primary AC, and goes online on the primary AC.

1. The AP detects the status of the primary AC.

The AP uses Primary Discovery Request messages defined by CAPWAP to determine whether a preferred or primary AC is available. If the AP has the configuration of a primary AC but is connected to another AC, the AP sends Primary Discovery Request messages to detect when its primary AC will become available. In most cases, the interval for sending

Primary Discovery Request messages cannot exceed that for sending Echo Request messages. The two intervals are the same on Huawei APs.

Figure 2-6 Detecting the status of a primary AC



When the primary AC recovering from a failure receives a Primary Discovery Request message, the AC responds with a Primary Discovery Response message to the source IP address carried in the received Primary Discovery Request message.

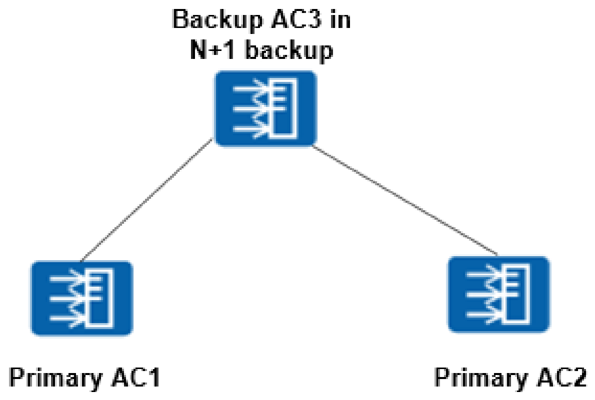
2. The AP falls back to the primary AC.

Based on information carried in the Primary Discovery Response packet received from the primary AC, the AP determines whether the revertive switchover function is enabled on the AC. If not, the AP does not trigger a revertive switchover. If so, the AP checks the AC priority. The priority carried in the Primary Discovery Response packet is the individual priority, which is higher than the global priority of the backup AC. Therefore, the AP determines that the priority of the primary AC is higher, and triggers a revertive switchover.

2.4 License Synchronization

In an N+1 cold backup scenario, primary devices can back up licenses to the backup device, so the backup device does not need to load a license, reducing deployment costs. The following compares the AP license requirements in the traditional N+1 cold backup mode and the N+1 cold backup mode supporting license synchronization.

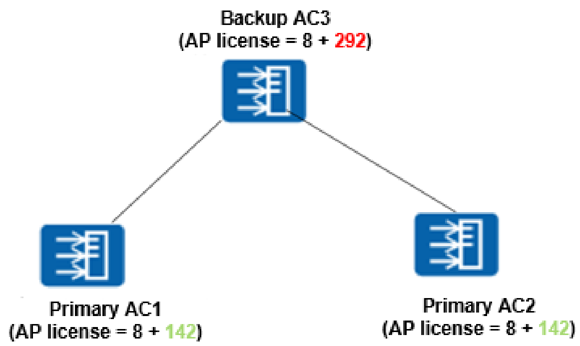
Figure 2-7 Traditional AC N+1 cold backup mode



As shown in Figure 2-7, AC1 and AC2 are primary ACs, and AC3 is their backup AC. The three ACs are deployed in the N+1 cold backup networking. AC1 and AC2 both connect to 150 APs.

In the traditional N+1 cold backup networking, a license for access of eight APs is bundled with an AC for sales. Therefore, 142 more AP licenses (150 – 8 = 142) need to be purchased for both AC1 and AC2. When AC1 and AC2 are faulty, all online APs on the two ACs are switched to AC3. To provide sufficient license resources, AC3 requires 292 licenses (150 + 142 = 292). Therefore, a total of 576 AP licenses (142 x 2 + 292 = 576) need to be purchased for network deployment.

Figure 2-8 AC N+1 cold backup supporting license synchronization



In license synchronization N+1 cold backup networking, a license for access of eight APs is bundled with an AC for sales. Therefore, 142 AP licenses need to be purchased for both AC1 and AC2. In this way, there will be 150 licenses on both AC1 and AC2. With license synchronization, the primary ACs synchronize license resources to the backup AC3 through the Primary Discovery Request packet. In this case, the backup AC3 has a total of 308 AP licenses (150 + 150 + 8 = 308). When AC1 and AC2 are faulty, all online APs on the two ACs are switched to AC3, which can provide sufficient license resources for 300 APs. Therefore, a total of 284 AP licenses (142 x 2 = 284) need to be purchased for network deployment, which saves 292 licenses (576 – 284 = 292) compared with traditional N+1 cold backup.

3 Customer Benefits

AC N+1 backup improves network reliability when a primary AC fails. This technology requires only one backup AC for *N* primary ACs, reducing network construction costs.

- Improved network reliability

  AC N+1 backup uses one backup AC for primary ACs, which improves network reliability. When an AP detects the failure of its connected primary AC through CAPWAP tunnel heartbeat packets, the AP immediately sets up a CAPWAP tunnel with the backup AC to connect to the network. This ensures WLAN service continuity for users even in the event of a primary AC failure.

- Lower network construction costs

  In the N+1 backup solution, multiple primary ACs share one backup AC. Huawei N+1 backup solution uses one backup AC to support a maximum of four primary ACs. Compared with the 1+1 backup solution, this solution reduces the deployment of three ACs, lowering device procurement costs and reducing the number of network elements (NEs) to be maintained.

  License synchronization allows customers to purchase only one license for the primary and backup ACs, reducing the investment in licenses.

- Guaranteed network consistency

  Detecting the status of the primary AC ensures that an AP can connect to the primary AC once it recovers, helping quickly restore the original network status. The revertive switchover mechanism ensures that the network runs as designed. In addition, this mechanism reduces the number of online APs on the backup AC, ensuring the network capacity.

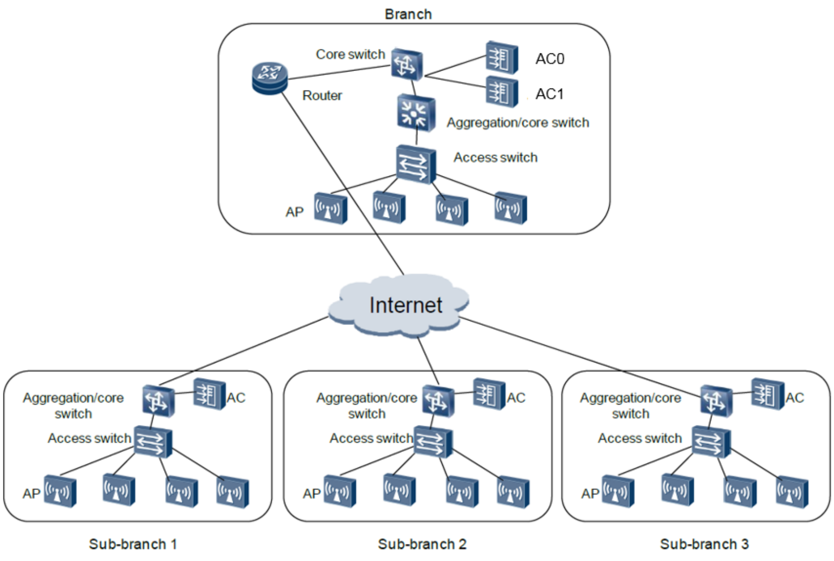
4 Application Scenario

N+1 backup can be widely used in scenarios that do not require hot standby. This solution can also provide backup services for up to 4K APs.

4.1 Bank

A bank has one branch and three sub-branches in a city. Both the branch and sub-branches have WLAN coverage. One AC is deployed at each sub-branch to manage local APs. This AC and APs are connected over a Layer 2 network and belong to the same management VLAN. Two ACs are deployed at the branch: AC1 and AC0. AC1 is the management AC for APs in the branch. AC0 is the backup for AC1 and the ACs in sub-branches. When the AC in a sub-branch fails, all APs managed by the faulty AC establish CAPWAP tunnels with AC0 in the branch and go online on AC0. After the faulty AC recovers, the APs disconnect from AC0, connect to the recovered AC, and come back online on the AC.

Figure 4-1 AC N+1 backup networking for the bank

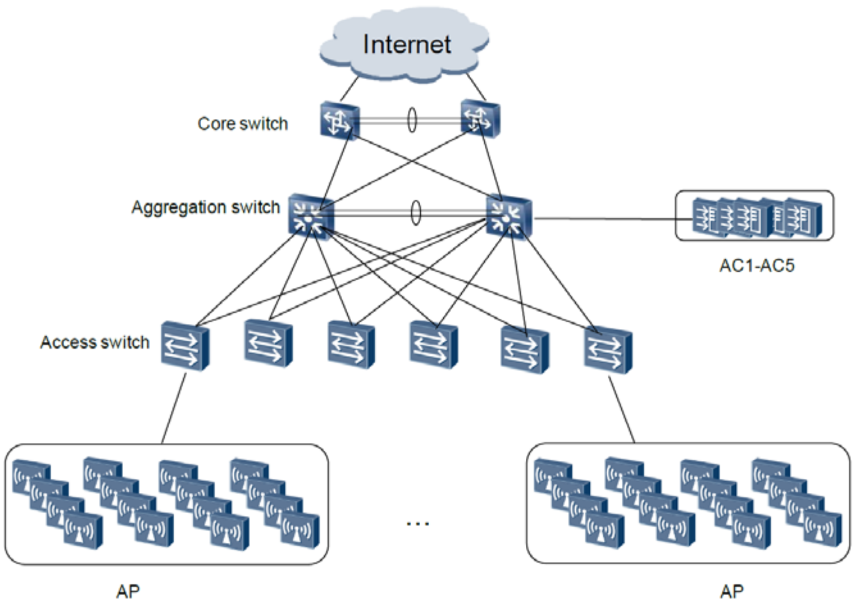


The configuration commands for each NE are not provided here. The key configurations of N+1 backup are as follows:

- Configure a global priority of each AC. Ensure that the backup AC (AC0) has a higher global priority than the primary ACs. A smaller value indicates a higher priority.
- Configure an individual priority for each AP on the primary ACs, which can be configured and modified in batches.
- Enable the revertive switchover function on the backup AC.
- Configure the backup AC's IP address on the primary ACs.
  - Configure IP addresses of primary ACs on the backup AC so that each AP can obtain its primary AC's IP address during the revertive switchover. If the primary AC is faulty when the AP goes online, the AP goes online on the backup AC first. If the IP address of the primary AC is not configured on the backup AC, the AP does not know whether to perform a revertive switchover and where to switch back to.
  - Configure the IP address of the backup AC on the primary ACs. When a primary AC is faulty, APs can quickly find the backup AC for unicast access.
- Configure settings for all APs on the backup AC.

4.2 Stadium

Figure 4-2 AC N+1 backup networking for a stadium



A large number of ACs are deployed in a stadium to provide WLAN access for users in a stadium. N+1 backup is used to reduce the number of backup ACs, thereby lowering network construction costs.

In the network topology for the stadium illustrated in Figure 4-2, aggregation switches form the boundary between Layer 2 and Layer 3. ACs and APs are connected over a Layer 2 network and belong to the same management VLAN. Five ACs are deployed on the network, among which four act as primary ACs and the other one as the backup AC. When a primary AC fails, APs managed by the AC go online on the backup AC. After the primary AC recovers, the APs connect to the primary AC, and go online on it again. For details about the key configurations, see the preceding bank scenario.