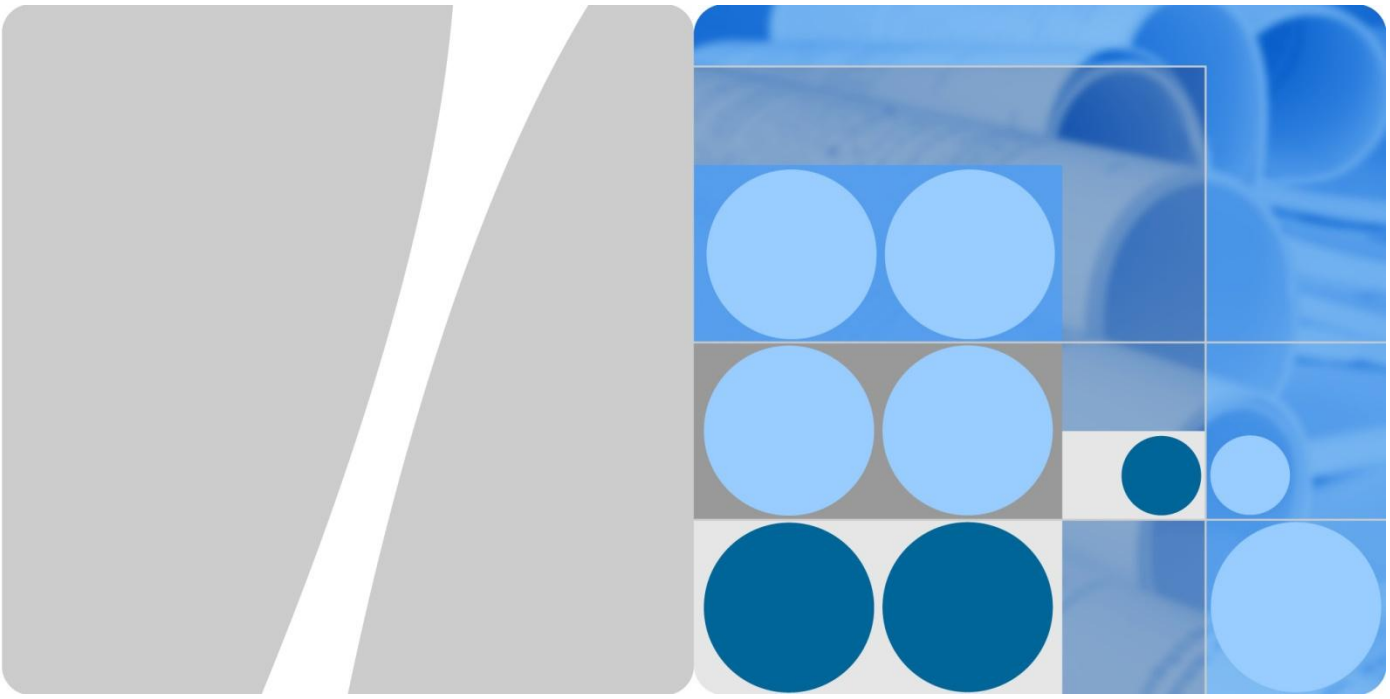

WLAN mDNS Technology White Paper

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WLAN mDNS Technology White Paper

Keywords: WLAN, mDNS, multi-screen sharing

Abstract: Innovative multi-screen sharing applications, such as Airplay and AirPrint, are only applicable to family scenarios and cannot be used in enterprises. To enable mDNS application in enterprises, Huawei offers the mDNS relay component (deployed on a switch) and mDNS gateway component (deployed on an AC).

Acronyms and abbreviations

Acronym/Abbreviation	Full Name
SSID	Service Set Identifier
BSSID	Basic Service Set Identifier
CAPWAP	Control And Provisioning of Wireless Access Points
mDNS	multicast DNS

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1 Overview

Multicast DNS (mDNS) is the domain name service based on multicast technology. It is an open standard that implements zero configuration networking.

mDNS-capable devices include server devices and client devices. TV sets and printers are server devices, whereas smartphones and tablets are client devices. An mDNS server broadcasts service information on the local network, and listens on and responds to service requests from clients. Then smart terminals can discover the mDNS server and use the mDNS service.

Figure 1-1 mDNS application

With mDNS technology, music on a smart terminal (smartphone or tablet) can be placed on a stereo device near the smart terminal, video programs on the smart terminal can be displayed on a TV, and documents on the smart terminal can be printed by the nearest printer. However, mDNS application is restricted within a VLAN. Therefore, mDNS is only applicable for family use and cannot be used in enterprises.

Huawei WLAN products support the mDNS protocol analysis and service control functions, and implement inter-VLAN mDNS application. This makes it possible to apply mDNS technology to enterprises.

2 WLAN mDNS Technology Implement

2.1 Introduction to WLAN mDNS

mDNS implements multi-screen sharing. For example, music on a smart terminal (smartphone or tablet) can be placed on a stereo device near the smart terminal, video programs on the smart terminal can be displayed on a TV, and documents on the smart terminal can be printed by the nearest printer. However, these new applications can only be used at home for the following reasons:

- mDNS application is restricted within a VLAN and is not applicable in enterprises.
- APs forward multicast packets at low speeds, reducing the capacity of the entire wireless network. This is acceptable in family usage scenarios but not acceptable in enterprises.

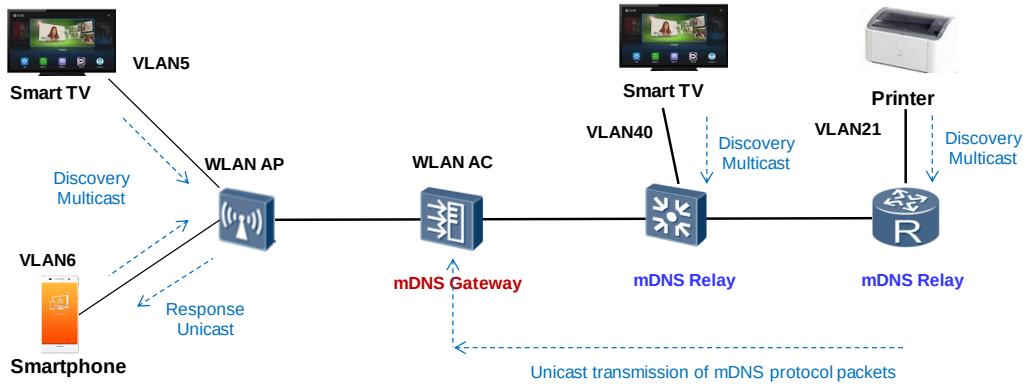
To enable mDNS application in enterprises, Huawei offers the mDNS relay component (deployed on a switch) and mDNS gateway component (deployed on an AC).

- **mDNS relay**: It is deployed in the same VLAN as mDNS-capable devices. It converts mDNS multicast packets into unicast packets and communicates with the mDNS gateway over Layer 3.
- **mDNS gateway**: It collects and records mDNS service information in each VLAN and subnet, and responds to service requests from mDNS clients.

The mDNS relay discovers all devices that can work as mDNS servers, and then sends mDNS service information to the mDNS gateway in unicast mode. When mDNS clients search for mDNS servers, the mDNS relay forwards the requests from the clients to the mDNS gateway in unicast mode. The mDNS gateway then responds to the requests.

Figure 2-1 shows the inter-VLAN mDNS application.

Figure 2-1 mDNS application across VLAN/Layer 3 network



2.2 Principles

2.2.1 mDNS Protocol

Zero configuration networking is implemented using the mDNS and DNS-Based Service Discovery (DNS-SD) protocols.

NOTE

The mDNS protocol is defined in RFC 6762 (Multicast DNS), and the DNS-SD protocol is defined in 6763 (DNS-Based Service Discovery).

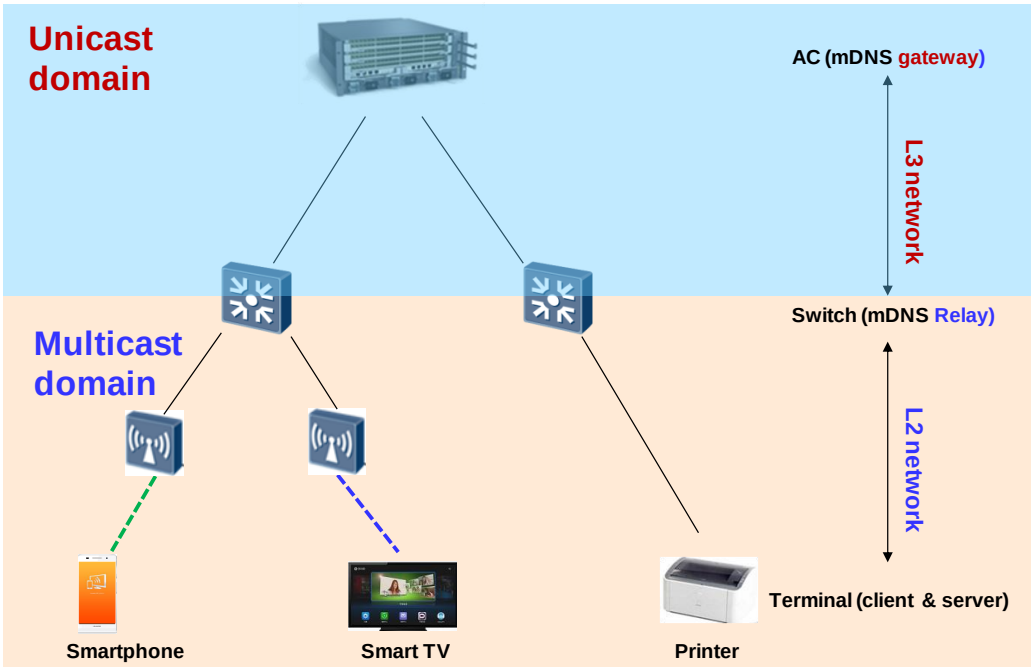
mDNS devices propagate their service information on the local network and listen on service information from other devices. The mDNS protocol enables clients to discover service systems and services without intervention of the administrator.

The mDNS protocol uses a fixed destination IPv4 address 224.0.0.251 (or IPv6 address FF02::FB) and port 5353 for multicast transmission. This protocol works well within a VLAN or a subnet. However, the destination IP address is a link-local address, so mDNS cannot be implemented across a Layer 3 network and different VLANs.

2.2.2 Network Components

In an enterprise network, mDNS servers include printers, smart TVs, and smart set top boxes (STBs). These mDNS servers do not belong to the same VLAN as wireless mDNS clients, such as smartphones and tablets. The mDNS protocol only works at Layer 2 and cannot provide services cross VLANs. Therefore, an mDNS gateway needs to be deployed to forward mDNS packets and maintain service information between VLANs. An enterprise network is usually large, and routers or other devices exist between the client/server and the gateway. Therefore, the switch at the edge of a subnet must provide the mDNS relay function to forward mDNS packets to the gateway.

Figure 2-2 Roles in the mDNS solution



- **mDNS relay**: The devices connecting to TVs or printers run the mDNS relay function (enabled globally, in VLANs, or on interfaces). They listen on service registration packets and forward the packets to the gateway in unicast mode. The mDNS relay devices support periodic detection.
- **mDNS gateway**: enabled global, in VLANs, or on interfaces. The mDNS gateway sends the unicast packets received from the mDNS relay to the CPU, and maintains a service list and other information, including the service name, domain name, IP address, port number, L4 protocol type, and VLAN ID.

In Huawei mDNS solution, the mDNS gateway centrally maintains a database for service resources on the entire network, such as smart TVs and printers, and sends resource lists to clients in unicast mode. After a client discovers a required service, the client and server can perform point-to-point communication using TCP or UDP.

mDNS protocol identification: Huawei network products support mDNS snooping. They can intercept mDNS packets on air interfaces (WLAN products) and wired interfaces (switch and AR products), and record mDNS packet information, including source MAC address, source IP address, inbound interface, and VLAN ID. The mDNS relay sends the intercepted mDNS packets to the mDNS gateway in unicast mode based on the configuration.

Inter-VLAN mDNS packet forwarding: The mDNS relay converts the intercepted mDNS packets into unicast packets and routes the packets to the specified client or server (for example, a smart TV) through the Layer 3 mDNS gateway). The mDNS-to-unicast conversion solves the problems of inter-VLAN mDNS service and AP performance deterioration caused by multicast packets.

2.3 mDNS Service Process

The process of mDNS service across a Layer 3 network is as follows:

1. An mDNS server advertises its host name in unicast mode.
2. The mDNS relay forwards the multicast packet with the host name to the mDNS gateway, which then records the host name and IP address.
3. The mDNS server advertises its service in unicast mode.
4. The mDNS relay forwards the multicast packet with the service information to the mDNS gateway, which then records the service information.
5. A client sends a unicast service request.
6. The mDNS relay forwards the multicast service request to the mDNS gateway.
7. The mDNS gateway sends the search result to the mDNS relay.
8. The mDNS relay forwards the search result in multicast mode.

2.3.2 mDNS Service Advertisement by a Server

An mDNS server sends multicast mDNS packets in the local network segment to advertise its service information. The mDNS relay uses the specified ACL rules to obtain qualified multicast mDNS packets. The mDNS relay forwards the multicast mDNS packets to the local network segment according to the multicast forwarding rule, and also copies the packets, changes the source and destination IP addresses of the packets, and then sends the packets to the mDNS gateway in unicast mode. The mDNS gateway records and registers the service information.

The mDNS relay processes the multicast mDNS packets as follows:

1. The mDNS relay obtains mDNS packets with the destination address 224.0.0.251, protocol type UDP, and destination port 5353.
2. The mDNS relay changes the destination IP address to the gateway IP address, the source IP address to its own IP address, and assigns a transaction ID to a packet. It records the mapping of the client IP address, client VLAN ID, and transaction, and starts the aging timer. Then it sends the modified packet to the mDNS gateway, so that the gateway can register service information and perform conflict detection.

2.3.3 mDNS Service Discovery by a Client

The service discovery process includes steps 5 to 8 in the mDNS service process. The process of sending a query request packet to the mDNS gateway is the same as the process of advertising the mDNS service.

After the mDNS gateway receives the query request from the client, it searches for the requested service in the online service list and domain name table, and returns the search result to the mDNS relay.

The search result is carried in a unicast UDP packet with the source IP address as the gateway IP address, destination IP address as the mDNS relay's IP address, destination port 5353, and protocol type UDP.

After receiving the response packet from the mDNS gateway, the mDNS relay finds information about the client that sends the query request according to the transaction ID in the response packet. The mDNS relay then modifies the response packet by changing the

destination IP address to 224.0.0.251, source IP address to its own IP address, transaction ID to 0 and TTL to 255, and multicasts the packet to the VLAN where the client is located. Finally, the mDNS relay deletes the mapping of client IP address, client VLAN, and transaction ID.

2.3.4 Service Conflict Notification by the Gateway

Clients and servers detect service conflicts and domain name conflicts by sending query request packets. After receiving a service query request from a client, the mDNS gateway matches the packet with the specified ACL and sends the packet to the CPU if the match succeeds. The gateway searches for the requested service in the online service list and domain name table, and sends a response packet to the mDNS relay. Conflict After receiving the response, the client takes measures to handle the conflict (if any).

2.3.5 mDNS Service Discovery by the Gateway

If a VLAN contains only mDNS servers that have started before network connections are established, the servers do not inform the mDNS gateway what services they provide. In this case, the mDNS gateway needs to periodically update the service list and server states.

When a response packet sent from a server reaches the mDNS relay, the packet is processed on the control plane of the mDNS relay as follows:

The mDNS relay changes the destination IP address to the gateway address and the source IP address to its own IP address. The relay does not assign a transaction ID to the packet and does not record the mapping of the client IP address, client VLAN ID, and transaction ID.

The mDNS relay then sends the modified response packet to the mDNS gateway.

2.4 Logical Network Elements and Functions

Huawei enterprise mDNS solution is implemented in the following way:

1. The mDNS gateway centrally maintains an online service list.
2. The mDNS relay converts multicast mDNS packets into unicast packets in a VLAN so that the packets can be forwarded at Layer 3.
3. Clients and servers then use IP to communicate with each other.

2.4.2 mDNS Gateway

Huawei WLAN ACs have an mDNS gateway module, which provides the following functions:

- Responds to mDNS requests sent from clients in unicast mode.
- Identifies and intercepts mDNS protocol packets, and sets up a resource database to maintain resource information on the entire network. Resource information includes IP addresses and names of service providers.
- Sends mDNS request packets to request for information about service provider devices in a specified network segment, such as printers, audio devices, and TVs.

Key points about mDNS gateway implementation are as follows:

- If a server connects to a network and obtains an IP address before the mDNS gateway is deployed, the server does not report its service to the gateway. Therefore, the gateway needs to periodically detect servers that connect to its Layer 2 network.
- The default service aging time of a smart TV is 2 minute. According to the mDNS protocol, an mDNS device sends a query request after 80% of the timer value elapses (120s x 80% = 96s). The default query interval defined by Huawei is 90s (configurable). That is, if the default setting is used, Huawei devices will send a query request before the aging timer of a smart terminal times out. This reduces the network resources consumed by service query.
- When a record maintained by the mDNS gateway is about to expire, the gateway sends a query request packet to the mDNS relay. In the packet, the source address is the gateway IP address, the destination address is the relay IP address, and the transaction ID is 0. The mDNS relay finds that the transaction ID of the packet is 0 and therefore it cannot find the VLAN ID of the client or server. Then the relay multicasts the query request to all VLANs connected to it, and obtains service information in all these VLANs.

2.4.3 mDNS Relay

Huawei LAN switches integrate the mDNS relay module, which provides the following functions:

- Supports configuration of the mDNS relay destination address, that is, the destination AC's IP address.
- Converts multicast mDNS packets into unicast packets with the destination IP address and the AC's IP address.
- Forwards mDNS unicast packets according to the normal forwarding process.

Key points about mDNS relay implementation are as follows:

- To enable mDNS packets to be transmitted to the mDNS gateway, the mDNS relay needs to change the destination IP addresses of the packets to the gateway IP address.
- To enable the response packets to be sent back to the relay, the relay needs to change the source IP addresses of packets to its own IP address.
- The transaction ID field is used as a keyword to match the request and response packets sent from clients with the request and response packets sent from the gateway.
- To find the VLAN of a client after according to a response packet sent from the gateway, the mDNS gateway needs to record the source address, VLAN information, and allocate a transaction ID when it changes the source and destination IP address of a packet sent to the gateway. (Clients send the transaction ID of multicast mDNS packets to 0, so multicast forwarding is not affected.)
- According to the mDNS protocol, a client can communicate with the relay if the client considers that the response packet is sent from the same network segment of is a multicast packet. Therefore, to communicate with clients, the relay needs to modify a response packet by changing the source IP address to the IP address of the local Layer 2 network, the destination to the mDNS multicast address 224.0.0.251, TTL to 255, and transaction ID to 0.

2.4.4 Exception Handling

Periodic Update Based on Aging Time

The mDNS gateway maintains a list of services available on the network. Each service has an aging time. When 80% of the aging time elapses, the gateway sends a query request to the relay. The relay multicasts the request in the local network segment. If a valid response is received, the gateway resets the aging timer. If no valid response is received, the queried service has become invalid. If the gateway does not receive any registration message for this service, it deletes the service from the service list.

Periodic Detection

If period detection is enabled on the mDNS relay, the relay sends multicast service query requests in the local network segment when the detection timer expires.

If period detection is enabled on the mDNS gateway, the gateway sends multicast service query requests in the directly connected network segments when the detection timer expires.

The detection interval is configurable, and the default interval is 90s.

Service Conflict Handling

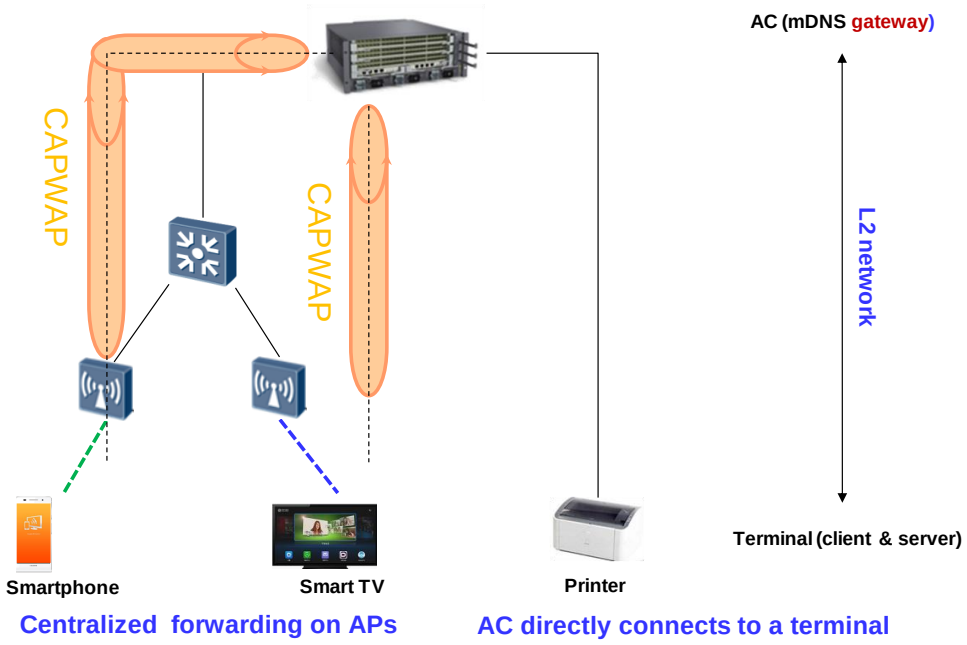
If the service names or host names of mDNS servers conflict, the gateway sends a defend message to the relay in the network segment where the conflict occurs. The relay then multicasts the defend message in the network segment.

Service Process When the Gateway Starts Later Than Servers

An mDNS gateway may start later than servers on the network. If clients send service query requests, they cannot find valid mDNS service because the gateway does not have a complete network service list. To solve this problem, the gateway actively sends service query requests to discover available services after it is powered on.

2.5 Special Scenarios

Figure 2-3 Centralized forwarding on APs and direct connection between an AC and a terminal



2.5.2 Centralized Forwarding on APs

When APs use the centralized forwarding mode, data packets sent from smart terminals are forwarded to the AC through Control and Provisioning of Wireless Access Points (CAPWAP) tunnels. The mDNS service process is the same as that in the scenario where terminals are directly connected to the AC. For details, see section 2.5.3 "Direct Connection Between an AC and a Terminal."

2.5.3 Direct Connection Between an AC and a Terminal

If smart terminals are in the same network segment as an AC, the mDNS relay is not required. The mDNS gateway accepts mDNS packets with a multicast destination address, and records VLAN IDs of mDNS packets when it records entries in the service list and host table. When the gateway sends packets to the directly connected terminals, it sets the destination IP address to the mDNS multicast address and sets the VLAN ID in the packets.

3 Characteristics of Huawei WLAN mDNS Technology

3.1 Inter-VLAN mDNS Service

Due to limitation of the mDNS protocol, the mDNS service is only applicable to small-scale LANs. Therefore, mDNS is mainly used in family scenarios and seldom used in enterprises. Huawei products support mDNS relay and mDNS gateway functions, which implement inter-VLAN mDNS service.

3.2 mDNS Service Across a Layer 3 Network

The mDNS relay and mDNS gateway components integrated on Huawei products not only provide inter-VLAN mDNS service, but also support the mDNS service across a Layer 3 network.

3.3 mDNS Service on Wired and Wireless Networks

Huawei integrates the mDNS relay component on switches and integrates the mDNS gateway component on wireless ACs. You can deploy both the mDNS relay and mDNS gateway on a network to provide mDNS service across VLANs and Layer 3 networks. Alternatively, you can deploy the mDNS gateway alone to implement inter-VLAN mDNS service.

Both wired and wireless terminals can function as mDNS clients or servers, no matter which networking is used.

4 Typical Networking and Applications

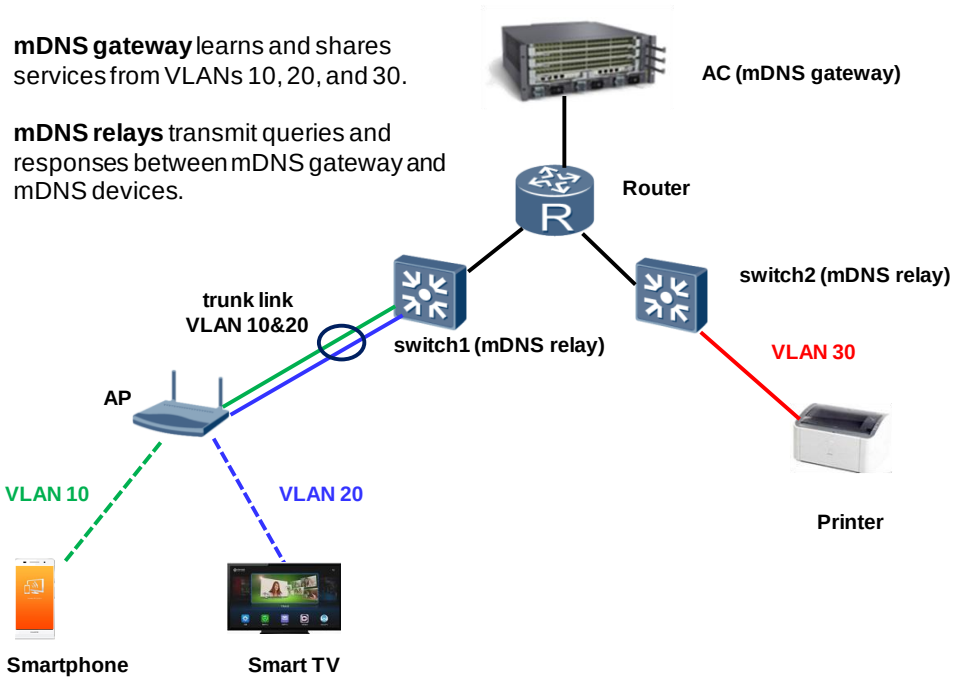
Depending on locations of mDNS devices and the AC, mDNS can be applied in three typical networking modes.

4.1 Networking with mDNS Relay

When mDNS devices connect to an AC through a Layer 3 network, the mDNS relay component is required to forward mDNS traffic to the AC.

Figure 4-1 shows the typical networking with mDNS relay devices. In this networking, the smartphone, smart TV, and printer are located in different VLANs or network segments, and a router is deployed between the terminals and the AC. The mDNS relay devices forward mDNS service advertisements and query requests. The mDNS gateway records services on the network and responds to query requests.

Figure 4-1 Networking with mDNS relay



The AP uses the direct forwarding mode. It converts wireless traffic sent from the smartphone and smart TV into wired network traffic and sends the traffic to switch 1. The AP and switch 1 use trunk interfaces to send packets of the two VLANs. With the mDNS relay function enabled, the switches change destination IP addresses of mDNS packets in each VLAN into a unicast address, and then send the packets to the AC. The AC maintains the service information and responds to query requests. In this way, terminals can discover services in different VLANs and network segments.

In this scenario, you need to perform the following configurations:

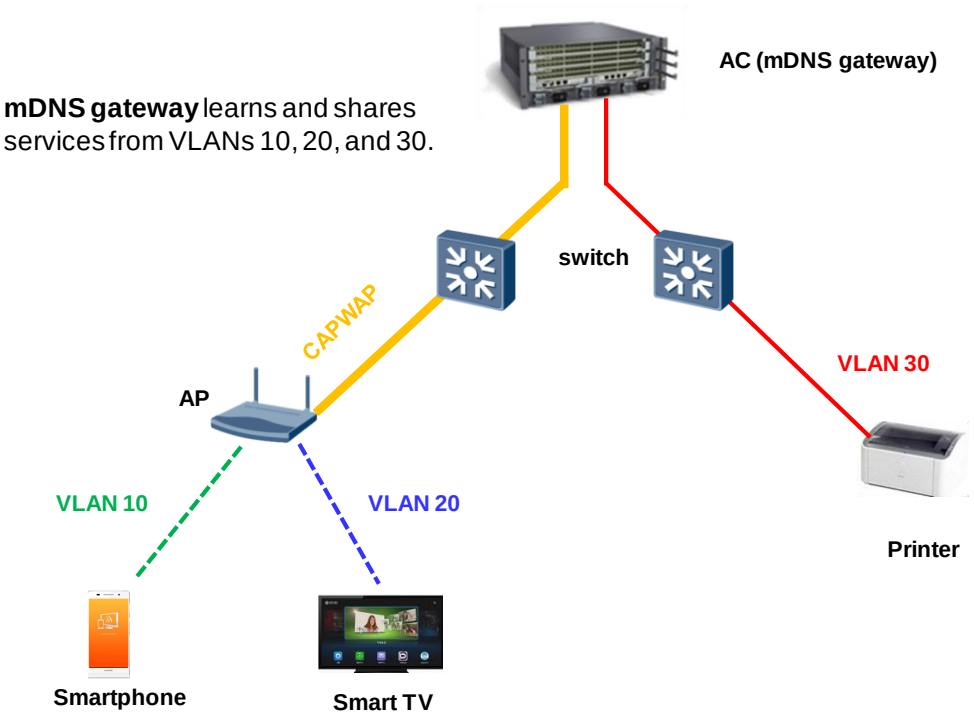
- Enable the mDNS gateway function on the AC.
- On switch 1, configure the gateway IP address and enable the mDNS relay function in VLAN 10 and VLAN 20.
- On switch 2, configure the gateway IP address and enable the mDNS relay function in VLAN 30.

4.2 Networking Without mDNS Relay

When mDNS devices are located in the same VLAN or network segment as the AC, mDNS relay is not required.

Figure 4-2 shows the networking without mDNS relay. The smartphone, smart TV, and printer are located in different VLANs, but they are in the same VLAN as the AC (or connected to the AC through CAPWAP tunnels). The mDNS gateway records services on the network and responds to query requests.

Figure 4-2 Networking without mDNS relay



The AP uses the centralized forwarding mode, and forwards traffic from the smartphone and smart TV to the AC through the CAPWAP tunnel. The printer is also in the same VLAN as the AC. The switch between the printer and AC forwards traffic following the normal Layer 2 forwarding process. With the mDNS gateway function enabled, the AC maintains services in VLANs 10, 20, and 30, and responds to query requests, allowing service discovery across VLANs and network segments.

After mDNS devices discover services using the mDNS protocol, traffic of the corresponding applications is not processed by the mDNS protocol, and the mDNS gateway does not participate in service traffic forwarding. Therefore, a routing module is required to forward service traffic across VLANs and network segments. The routing function can be implemented by configuring VLANIF interfaces on the AC or deploying a router.

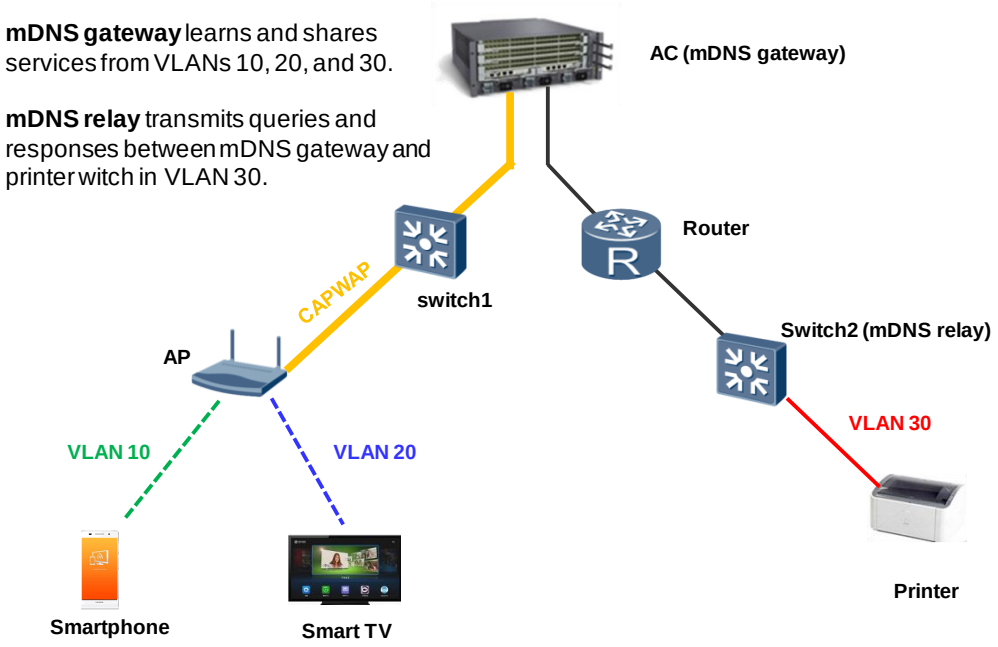
In this scenario, you need to enable the mDNS gateway function on the AC.

4.3 Hybrid Networking

In a hybrid networking, some mDNS devices belong to the same VLAN as the AC, while mDNS devices do not. In this case, deploy mDNS relay for the terminals that do not belong to the same VLAN as the AC.

Figure 4-3 shows the hybrid networking.

Figure 4-3 Hybrid networking



In this scenario, you need to perform the following configuration:

- Enable the mDNS gateway function on the AC.
- On switch 2, configure the gateway IP address and enable the mDNS relay function in VLAN 30.