



## Layer 2 and Layer 3 Roaming

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An integral concept for wireless networks is device roaming. It is important to understand what roaming is, how and when it occurs, what types of roaming there are, and how the types differ. One of the obvious benefits of WLAN IP Phones compared to wired IP Phones is the ability of the user to move from place to place while having a conversation. But unlike cellular phone services, where coverage areas are usually nationwide or international, WLAN IP Phones have smaller coverage areas. In addition, administrators of WLAN IP Phone networks need to understand and consider their IP addressing schemes before deploying WLAN IP Phones. They need to consider how WLAN IP Phone coverage overlays with the Layer 2 and Layer 3 addressing within the IP network. A Layer 2 network is defined as a single IP subnet and broadcast domain, while a Layer 3 network is defined as the combination of multiple IP subnets and broadcast domains.

The following sections explain roaming concepts and how roaming works:

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- [Layer 2 Roaming, page 5-2](#)
- [Layer 3 Roaming, page 5-4](#)

### Roaming Terminology

In voice systems, roaming usually refers to physical movement and the locations from which a call can originate. For 802.11 data networks, roaming also refers to physical movement, but it is often associated with data connectivity while physically moving.

For purposes of this document, the following terms apply to roaming:

- **Pre-call roaming**  
This type of roaming occurs when a user with a Cisco 7920 Wireless IP Phone moves from place to place (within a campus or between sites) before making a voice call. This roaming may occur within a Layer 2 VLAN or across Layer 3 subnet boundaries. If it is within a Layer 2 VLAN, the IP address on the Cisco 7920 phone will remain the same. If it is across a Layer 3 boundary and DHCP is enabled on the Cisco 7920 phone, then the phone will recognize that it is no longer in the previous subnet and will use DHCP to obtain a new IP address.
- **Mid-call roaming**  
This type of roaming occurs when a user with a Cisco 7920 Wireless IP Phone moves from place to place (within a campus or between sites) while a voice call is active on the phone.



**Note**

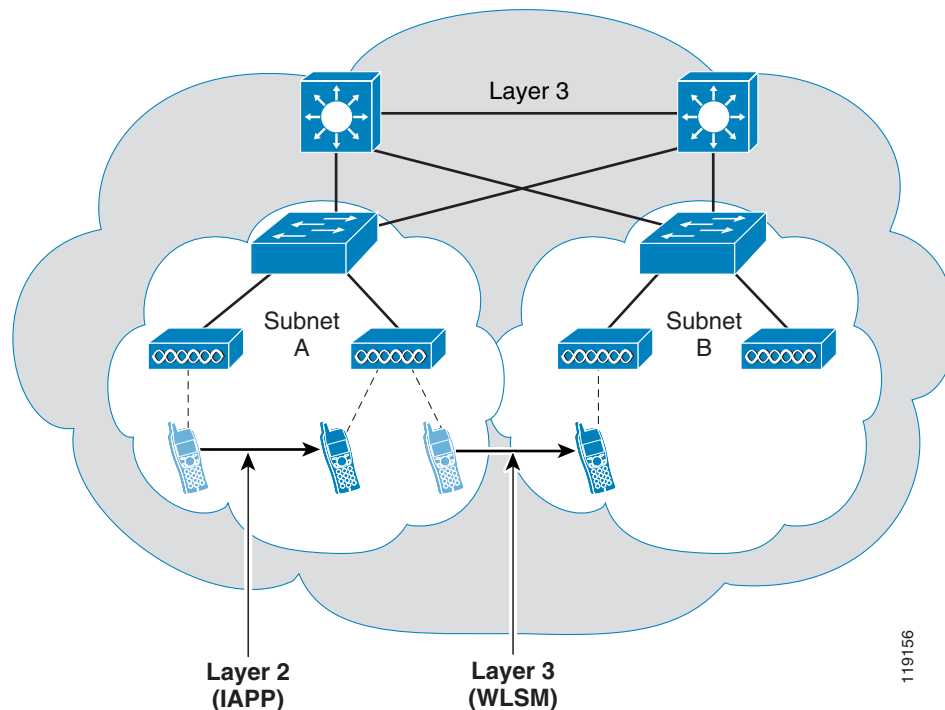
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Throughout the remainder of this document, the terms "roam" and "roaming" refer to mid-call roaming.

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The Cisco 7920 Wireless IP Phone currently supports both Layer 2 and Layer 3 roaming. The Cisco 7920 phone itself supports Layer 2 roaming, but Layer 3 roaming requires the use of a Cisco Wireless LAN Services Module (WLSM) in the network. Figure 5-1 illustrates Layer 2 and Layer 3 roaming behavior.

**Figure 5-1 Layer 2 and Layer 3 Roaming**



## Layer 2 Roaming

Layer 2 roaming occurs when a WLAN device (for example, a Cisco 7920 phone) moves far enough that its radio associates with a different AP. With Layer 2 roaming, the original and the new AP offer coverage for the same IP subnet, so the device's IP address is still valid after the roam.

Cisco 7920 phones perform a Layer 2 roam for any of the following reasons:

- Initial boot-up of the Cisco 7920 phone is considered a roaming event because the phone is associating with a new AP.
- If the Cisco 7920 phone does not receive beacons from the associated AP, it believes that the AP is no longer available. If the Cisco 7920 phone does not receive three consecutive beacons and its unicast packet to the AP is not acknowledged, the phone will begin the roaming process to another AP.
- The Cisco 7920 phone periodically scans for a better AP. Because initial startup is considered to be a roaming event, all client stations have roamed at least once. After the roaming process is completed, the client station maintains the list of eligible roam targets. When all AP information is received (channel update and current AP update), the phone evaluates its current AP against the list of eligible roam targets. If conditions change on the current AP (low RSSI or high QBSS) so that one of the APs in the client's stored list now appears to be a better choice than the current AP, the phone will start a handoff procedure to associate with the better AP.

- A change in SSID or encryption type on the Cisco 7920 phone will also cause Layer 2 roaming.

Once one of these events occurs, the Layer 2 roaming process proceeds as follows:

1. The Cisco 7920 phone looks at its list of eligible roam targets (APs with a matching SSID and encryption type) and chooses the best candidate. The phone then attempts to associate and authenticate with this AP. If either the association or authentication fails, the phone tries the next best candidate AP.



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**Note** As a Cisco 7920 phone roams between APs, it re-authenticates with each new AP.

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2. The candidate AP (AP B) sends a null-MAC multicast message using the source address of the Cisco 7920 phone. This message updates the CAM tables in upstream switches and directs further LAN traffic for the phone to AP B and not AP A.
3. AP B sends a MAC multicast message using its own source address to tell the old AP (AP A) that AP B now has the client associated to it. AP A receives this multicast message and removes the client MAC address from its association table. This message uses the Inter-Access Point Protocol (IAPP).

The Cisco 7920 phone uses the following variables to determine the best AP for Layer 2 roaming:

- RSSI

The Cisco 7920 phone uses the Received Signal Strength Indicator (RSSI) to determine the signal strength of available APs within an RF coverage area. Initially, the phone attempts to associate with the AP that has the highest RSSI value as well as matching authentication and encryption type.

- QBSS

The QoS Basis Service Set (QBSS) is a beacon information element (IE) that enables the AP to communicate its channel utilization to the Cisco 7920 phone. Because APs with high channel utilization might not be able to handle voice traffic effectively, the phone uses the QBSS value to determine if it should attempt to roam to another AP.

When roaming, the Cisco 7920 phone uses the following process to determine which AP should be the next candidate:

1. Determine which APs have an RSSI that is above the threshold of the currently associated AP.
2. Determine which APs are advertising QBSS in their beacons. These APs are considered handoff candidates before APs that are not advertising QBSS. If any of these APs meet the threshold criteria, begin the roaming process.
3. If no APs advertise QBSS, then RSSI is the only value used to determine roaming. Cisco recommends, however, that you enable QBSS on all APs used for voice deployments.
4. RSSI always takes precedence over QBSS if both thresholds have been met.

The amount of time it takes for the Cisco 7920 phone to roam between APs depends on which of the following security models is used (average times are listed):

- Layer 2 roaming with Static WEP: less than 100 ms
- Layer 2 roaming with LEAP and local ACS authentication: 200 to 400 ms



**Note**

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Delay times with LEAP could be longer than 200 to 400 ms if the Cisco ACS is heavily used by other applications such as remote-access dial-up, VPN, TACACS authentication, and so forth.

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Layer 2 roaming time represents the time between the last RTP packet seen on AP-1 and the first RTP packet seen on AP-2. It also includes the time it takes to re-authenticate and re-associate with AP-2.

Figure 5-2 shows a sample trace of a Cisco 7920 phone roaming to a new AP, as well as the LEAP messaging between the phone and the AP.

**Figure 5-2 Wireless Packet Trace of Cisco 7920 Phone Roaming**

Packet	Source	Destination	BSSID	Protocol	Data Rate	Channel	Signal	Size	Delta Time	Relative Time
32	AP1200 - 2	7920	AP1200 - 2	EAP Request	11.0	1	100%	82		00.000000
33	7920	AP1200 - 2	AP1200 - 2	EAP Response	11.0	1	100%	53	00.002129	00.002129
34	AP1200 - 2	7920	AP1200 - 2	EAP Request	11.0	1	100%	82	00.015799	00.017928
35	7920	AP1200 - 2	AP1200 - 2	EAP Response	11.0	1	100%	80	00.007655	00.025583
37	AP1200 - 2	7920	AP1200 - 2	EAP Success	11.0	1	100%	82	00.024313	00.049896
38	7920	AP1200 - 2	AP1200 - 2	EAP Request	11.0	1	100%	64	00.008010	00.057906
40	AP1200 - 2	7920	AP1200 - 2	EAP Response	11.0	1	100%	82	00.017285	00.075191
41	AP1200 - 2	7920	AP1200 - 2	EAPOL-Key	11.0	1	100%	97	00.001223	00.076414

Layer 2 roaming with either Static WEP or LEAP provides acceptable QoS using either G.711 or G.729. If LEAP is used, Cisco recommends that you define users locally on the Cisco ACS because using off-ACS databases can result in unpredictable response times, which could adversely affect overall QoS during Layer 2 roaming.

## Layer 3 Roaming

Layer 3 roaming occurs when a client moves from an AP that covers one IP subnet to an AP that covers another IP subnet. At that point, the client would no longer have an IP address and default gateway that are valid within the new IP subnet. Because the client's IP address and default gateway are no longer valid, its existing data sessions or voice calls will fail because the remote client can no longer reach the local client.

With the release of the new Cisco Catalyst 6500 Series Wireless LAN Services Module (WLSM), the Cisco 7920 phone now supports Layer 3 mobility while using Static WEP. Cisco Centralized Key Management (Cisco CKM) enables the Cisco 7920 phone to achieve full Layer 3 mobility while using LEAP. For details about the Cisco WLSM, refer to the product documentation available at

[http://www.cisco.com/en/US/products/hw/modules/ps2706/tsd\\_products\\_support\\_series\\_home.html](http://www.cisco.com/en/US/products/hw/modules/ps2706/tsd_products_support_series_home.html)



### Note

For WLAN deployments in multi-story buildings, where the WLANs on each floor have different subnets, take extra care in the RF site survey to ensure that stations on one floor do not roam to WLANs on floors above or below.