Aerohive Deployment Guide

For HiveAP and HiveManager Devices

Aerohive Technical Publications

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P/N 330002-06, Rev. A

HiveAP Compliance Information

Federal Communication Commission Interference Statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected
- Consult the dealer or an experienced radio/TV technician for help

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment. This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

In compliance with FCC Part 15 regulations, the HiveAP automatically discontinues transmission if there is no valid information to transmit or if there is an operational failure.

Important: FCC Radiation Exposure Statement

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20 centimeters (8 inches) between the radiator and your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Wireless 5 GHz Band Statements

To comply with FCC and ETSI regulations when HiveAPs are deployed outdoors, do not use channels 36, 40, 44, and 48 in the 5.15-5.25 GHz band.

Because military radar systems use some bands in the 5 GHz spectrum, WLAN devices operating in these bands must use DFS (Dynamic Frequency Selection) to detect radar activity and switch channels automatically to avoid interfering with radar operations. DFS is required for WLAN devices operating within the 5.25–5.35 GHz UNII-2 and the 5.47–5.725 GHz UNII Mid-Band spectrums in the FCC regions of North America and the ETSI regions in the European Community. DFS is not required for WLAN devices operating in the 5.725-5.850 GHz spectrum in FCC regions. (The 5.725-5.850 GHz spectrum is not available for wireless use in ETSI regions.) HiveAP 300 series models support DFS-FCC and DFS-ETSI and are permitted to operate in the 5.25–5.35 GHz and 5.47–5.725 GHz bands in outdoor deployments in the FCC and ETSI regions.

Note: The term "IC" before the radio certification number signifies that Industry Canada technical specifications were met.

Industry Canada - Class B

This digital apparatus does not exceed the Class B limits for radio noise emissions from digital apparatus as set out in the interference-causing equipment standard entitled "Digital Apparatus," ICES-003 of Industry Canada.

Cet appareil numérique respecte les limites de bruits radioélectriques applicables aux appareils numériques de Classe B prescrites dans la norme sur le matériel brouilleur: "Appareils Numériques," NMB-003 édictée par l'Industrie.

Wi-Fi Certification

The Wi-Fi CERTIFIED™ Logo is a certification mark of the Wi-Fi Alliance®. The Aerohive HiveAP 20 ag has been certified for WPA™, WPA2™, WMM® (Wi-Fi Multimedia™), WMM Power Save, and the following types of EAP (Extensible Authentication Protocol):

- EAP-TLS
- EAP-TTLS/MSCHAPv2
- PEAPv0/EAP-MSCHAPv2
- PEAPv1/EAP-GTC
- EAP-SIM

EC Conformance Declaration

Marking by the above symbol indicates compliance with the Essential Requirements of the R&TTE Directive of the European Union (1999/5/EC). This equipment meets the following conformance standards:

- EN 60950-1 (IEC 60950-1) - Product Safety
- EN 301 893 - Technical requirements for 5 GHz radio equipment
- EN 300 328 - Technical requirements for 2.4 GHz radio equipment
- EN 301 489-1 / EN 301 489-17 - EMC requirements for radio equipment

Countries of Operation and Conditions of Use in the European Community

HiveAPs are intended to be operated in all countries of the European Community. Requirements for indoor vs. outdoor operation, license requirements and allowed channels of operation apply in some countries as described below.

- Before operating a HiveAP, the admin or installer must properly enter the current country of operation in the command line interface as described in "Appendix A Country Codes" on page 189.

  Note to U.S. model owners: To comply with U.S. FCC regulations, the country selection function has been completely removed from all U.S. models. The above function is for non-U.S. models only.

- HiveAPs automatically limit the allowable channels determined by the current country of operation. Incorrectly entering the country of operation might result in illegal operation and cause harmful interference to other systems. The admin is obligated to ensure HiveAPs are operating according to the channel limitations, indoor/outdoor restrictions and license requirements for each European Community country as described in this section.
- HiveAPs can be operated indoors or outdoors in all countries of the European Community using the 2.4 GHz band: Channels 1 - 13, except where noted below.
  - In Italy, you must apply for a license from the national spectrum authority to operate a HiveAP outdoors.
  - In Belgium outdoor operation is only permitted using the 2.46 - 2.4835 GHz band: Channel 13.
  - In France outdoor operation is only permitted using the 2.4 - 2.454 GHz band: Channels 1 - 7.
- HiveAPs using the 5.15–5.25 GHz band (Channels 36, 40, 44, 48) are restricted to indoor use when operated in the European Community. Because the frequency ranges 5.25–5.35 and 5.47–5.725 are affected by DFS (Dynamic Frequency Selection), HiveAP 20 and 28 models block channels 52, 56, 60, 64, and 100, 104, 108, 112, 116, 120, 124, 128, 132, 136, 140.

The availability of some specific channels and/or operational frequency bands are country dependent and are firmware programmed at the factory to match the intended destination. The firmware setting is not accessible by the end user.

- The 5 GHz Turbo Mode feature is not allowed for operation in any European Community country. You can find the current setting for this feature in two places. In the HiveManager GUI, click **Configuration** > **Network Objects**> **Radio Profiles >** *profile* **> Advanced**. In the HiveAP CLI, enter this command: **show radio profile** *profile*. By default, Turbo Mode is disabled.

Declaration of Conformity in Languages of the European Community

English	Hereby, Edgecore, declares that this Radio LAN device is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC.
Finnish	Valmistaja Edgecore vakuuttaa täten että Radio LAN device tyyppinen laite on direktiivin 1999/5/EY oleellisten vaatimusten ja sitä koskevien direktiivin muiden ehtojen mukainen.
Dutch	Hierbij verklaart Edgecore dat het toestel Radio LAN device in overeenstemming is met de essentiële eisen en de andere relevante bepalingen van richtlijn 1999/5/EG. Bij deze Edgecore dat deze Radio LAN device voldoet aan de essentiële eisen en aan de overige relevante bepalingen van Richtlijn 1999/5/EC.
French	Par la présente Edgecore déclare que cet appareil Radio LAN est conforme aux exigences essentielles et aux autres dispositions relatives à la directive 1999/5/CE.
Swedish	Härmed intygar Edgecore att denna Radio LAN device står I överensstämmelse med de väsentliga egenskapskrav och övriga relevanta bestämmelser som framgår av direktiv 1999/5/EG.
Danish	Undertegnede Edgecore erklærer herved, at følgende udstyr Radio LAN device overholder de væsentlige krav og øvrige relevante krav i direktiv 1999/5/EF.
German	Hiermit erklärt Edgecore, dass sich dieser/diese/dieses Radio LAN device in Übereinstimmung mit den grundlegenden Anforderungen und den anderen relevanten Vorschriften der Richtlinie 1999/5/EG befindet". (BMWi) Hiermit erklärt Edgecore die Übereinstimmung des Gerätes Radio LAN device mit den grundlegenden Anforderungen und den anderen relevanten Festlegungen der Richtlinie 1999/5/EG. (Wien)
Greek	με την παρουσα Edgecore δηλωνει οτι radio LAN device συμμορφωνεται προσ τισ ουσιωδεισ απαιτησεισ και τισ λοιπεσ σΧετικεσ διαταξεισ τησ οδηγιασ 1999/5/εκ
Italian	Con la presente Edgecore dichiara che questo Radio LAN device è conforme ai requisiti essenziali ed alle altre disposizioni pertinenti stabilite dalla direttiva 1999/5/CE.
Spanish	Por medio de la presente Manufacturer declara que el Radio LAN device cumple con los requisitos esenciales y cualesquiera otras disposiciones aplicables o exigibles de la Directiva 1999/5/CE.
Portuguese	Manufacturer declara que este Radio LAN device está conforme com os requisitos essenciais e outras disposições da Directiva 1999/5/CE.

HiveAP 20 ag Safety Compliance

Power Cord Safety

Please read the following safety information carefully before installing a HiveAP.

Warning: Installation and removal of HiveAPs must be carried out by qualified personnel only.

- HiveAPs must be connected to an earthed (grounded) outlet to comply with international safety standards.
- Do not connect HiveAPs to an A.C. outlet (power supply) without an earth (ground) connection.
- The appliance coupler (the connector to the unit and not the wall plug) must have a configuration for mating with an EN 60320/IEC 320 appliance inlet.
- The socket outlet must be near the HiveAP and easily accessible. You can only remove power from a HiveAP by disconnecting the power cord from the outlet.
- HiveAPs operate under SELV (Safety Extra Low Voltage) conditions according to IEC 60950. The conditions are only maintained if the equipment to which they are connected also operates under SELV conditions.
- A HiveAP receiving power through its PoE (Power over Ethernet) interface must be in the same building as the equipment from which it receives power.

France and Peru only:

HiveAPs cannot be powered from IT* supplies. If your supplies are of IT type, then a HiveAP must be powered by 230 V (2P+T) via an isolation transformer ratio 1:1, with the secondary connection point labelled Neutral, connected directly to earth (ground).

* Impédance à la terre

Important! Before making connections, make sure you have the correct cord set. Check it (read the label on the cable) against the description on the following page.

Power Cord Set	
U.S.A. and Canada	The cord set must be UL-approved and CSA certified.
	Minimum specifications for the flexible cord: - No. 18 AWG not longer than 2 meters, or 16 AWG - Type SV or SJ - 3-conductor
	The cord set must have a rated current capacity of at least 10 A.
	The attachment plug must be an earth-grounding type with NEMA 5-15P (15 A, 125 V) or NEMA 6-15 (15 A, 250 V) configuration.
Denmark	The supply plug must comply with Section 107-2-D1, Standard DK2-1a or DK2-5a.
Switzerland	The supply plug must comply with SEV/ASE 1011.
U.K.	The supply plug must comply with BS1363 (3-pin 13 A) and be fitted with a 5 A fuse that complies with BS1362.
	The mains cord must be <HAR> or <BASEC> marked and be of type HO3VVF3GO.75 (minimum).
Europe	The supply plug must comply with CEE7/7 ("SCHUKO").
	The mains cord must be <HAR> or <BASEC> marked and be of type HO3VVF3GO.75 (minimum).
	IEC-320 receptacle.

Veuillez lire attentivement les informations de sécurité relatives à l'installation d'un point d'accès HiveAP.

Avertissement: L'installation et la dépose de points d'accès HiveAP doivent être effectuées uniquement par un personnel qualifié.

- Les points d'accès HiveAP doivent être connectés sur le secteur par une prise électrique munie de terre (masse) afin de respecter les standards internationaux de sécurité.
- Ne jamais connecter des points d'accès HiveAP à une alimentation électrique non-pourvue de terre (masse).
- Le boitier d'alimentation (connecté directement au point d'accès) doit être compatible avec une entrée électrique de type EN 60320/IEC 320.
- La prise secteur doit se trouver à proximité du point d'accès HiveAP et facilement accessible. Vous ne pouvez mettre hors tension un point d'accès HiveAP qu'en débranchant son alimentation électrique au niveau de cette prise.
- Pour des raisons de sécurité, le point d'accès HiveAP fonctionne à une tension extrêmement basse, conformément à la norme IEC 60950. Les conditions de sécurité sont valables uniquement si l'équipement auquel le point d'accès HiveAP est raccordé fonctionne également selon cette norme.
- Un point d'accès HiveAP alimenté par son interface réseau Ethernet en mode POE (Power over Ethernet) doit être physiquement dans le même bâtiment que l'équipement réseau qui lui fournit l'électricité.

France et Pérou uniquement:

Un point d'accès HiveAP ne peut pas être alimenté par un dispositif à impédance à la terre. Si vos alimentations sont du type impédance à la terre, alors le point d'accès HiveAP doit être alimenté par une tension de 230 V (2P+T) via un transformateur d'isolement à rapport 1:1, avec le neutre connecté directement à la terre (masse).

Cordon électrique - Il doit être agréé dans le pays d'utilisation	
Etats-Unis et Canada	Le cordon doit avoir reçu l'homologation des UL et un certificat de la CSA.
	Les spécifications minimales pour un cable flexible - AWG No. 18, ou AWG No. 16 pour un cable de longueur inférieure à 2 mètres. - Type SV ou SJ - 3 conducteurs
	Le cordon doit être en mesure d'acheminer un courant nominal d'au moins 10 A.
	La prise femelle de branchement doit être du type à mise à la terre (mise à la masse) et respecter la configuration NEMA 5-15P (15 A, 125 V) ou NEMA 6-15P (15 A, 250 V).
Danemark	La prise mâle d'alimentation doit respecter la section 107-2 D1 de la norme DK2 1a ou DK2 5a.
Suisse	La prise mâle d'alimentation doit respecter la norme SEV/ASE 1011.
Europe	La prise secteur doit être conforme aux normes CEE 7/7 ("SCHUKO"). LE cordon secteur doit porter la mention <HAR> ou <BASEC> et doit être de type HO3VVF3GO.75 (minimum).

Bitte unbedingt vor dem Einbauen des HiveAP die folgenden Sicherheitsanweisungen durchlesen.

Warnung: Die Installation und der Ausbau des Geräts darf nur durch Fachpersonal erfolgen.

- Das Gerät sollte nicht an eine ungeerdete Wechselstromsteckdose angeschlossen werden.
- Das Gerät muß an eine geerdete Steckdose angeschlossen werden, welche die internationalen Sicherheitsnormen erfüllt.
- Der Gerätestecker (der Anschluß an das Gerät, nicht der Wandsteckdosenstecker) muß einen gemäß EN 60320/IEC 320 konfigurierten Geräteeingang haben.
- Die Netzsteckdose muß in der Nähe des Geräts und leicht zugänglich sein. Die Stromversorgung des Geräts kann nur durch Herausziehen des Gerätenetzkabels aus der Netzsteckdose unterbrochen werden.
- Der Betrieb dieses Geräts erfolgt unter den SELV-Bedingungen (Sicherheitskleinstspannung) gemäß IEC 60950. Diese Bedingungen sind nur gegeben, wenn auch die an das Gerät angeschlossenen Geräte unter SELV-Bedingungen betrieben werden.

Stromkabel. Dies muss von dem Land, in dem es benutzt wird geprüft werden:	
U.S.A. und	Der Cord muß das UL gepruft und war das CSA beglaubigt.
Kanada	Das Minimum spezifikation fur der Cord sind: - Nu. 18 AWG - nicht mehr als 2 meter, oder 16 AWG. - Der typ SV oder SJ - 3-Leiter
	Der Cord muß haben eine strombelastbarkeit aus wenigstens 10 A.
	Dieser Stromstecker muß hat einer erdschluss mit der typ NEMA 5-15P (15A, 125V) oder NEMA 6-15P (15A, 250V) konfiguration.
Danemark	Dieser Stromstecker muß die ebene 107-2-D1, der standard DK2-1a oder DK2-5a Bestimmungen einhalten.
Schweiz	Dieser Stromstecker muß die SEV/ASE 1011Bestimmungen einhalten.
Europe	Europe Das Netzkabel muß vom Typ HO3VVF3GO.75 (Mindestanforderung) sein und die Aufschrift <HAR> oder <BASEC> tragen. Der Netzstecker muß die Norm CEE 7/7 erfüllen ("SCHUKO").

Liability Disclaimer

Installation of Aerohive equipment must comply with local and national electrical codes and with other regulations governing this type of installation. Aerohive Networks, its channel partners, resellers, and distributors assume no liability for personal injury, property damage, or violation of government regulations that may arise from failing to comply with the instructions in this guide and appropriate electrical codes.

Chapter 2 The HiveAP 20 ag Platform

The Aerohive HiveAP 20 ag is a new generation wireless access point. HiveAPs have the unique ability to self-organize and coordinate with each other, creating a distributed-control WLAN solution that offers greater mobility, security, quality of service, and radio control.

This guide combines product information, installation instructions, and configuration examples for both the HiveAP and HiveManager platforms. This chapter covers the following topics relating to the HiveAP:

HiveAP 20 Product Overview

The HiveAP 20 ag is a multi-channel wireless AP (access point). It is compatible with IEEE 802.11b/g (2.4 GHz) and IEEE 802.11a (5 GHz) standards and supports a variety of Wi-Fi (wireless fidelity) security protocols, including WPA (Wi-Fi Protected Access) and WPA2.

You can see the hardware components on the HiveAP in Figure 1. Each component is described in Table 1.

Figure 1 HiveAP 20 Hardware Components

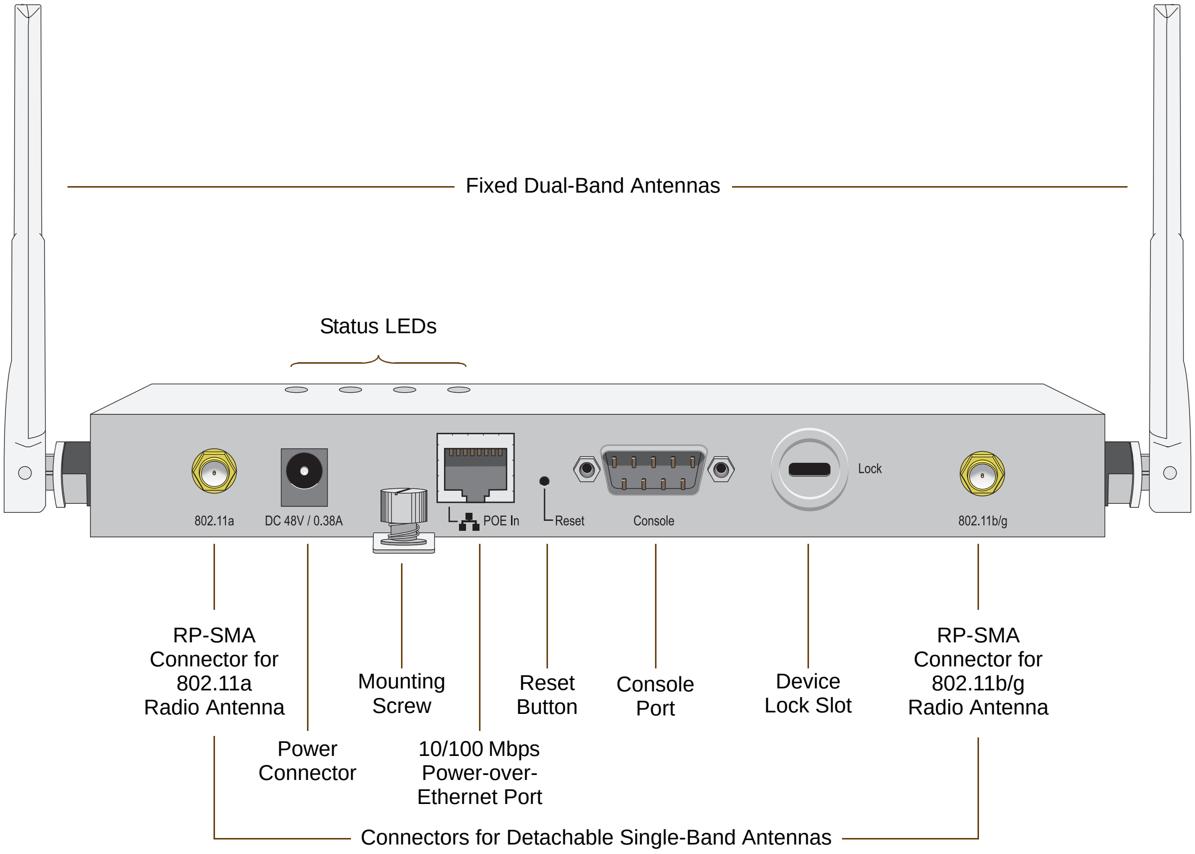

Fixed Dual-Band Antennas
Status LEDs
802.11a
DC 48V / 0.38A
POE In
Reset
Console
Lock
802.11b/g
RP-SMA Connector for 802.11a Radio Antenna
Mounting Screw
Reset Button
Console Port
Device Lock Slot
RP-SMA Connector for 802.11b/g Radio Antenna
Power Connector
10/100 Mbps Power-over-Ethernet Port
Connectors for Detachable Single-Band Antennas

Table 1 HiveAP 20 Component Descriptions

Component	Description
Fixed Dual-Band Antennas	The two fixed omnidirectional dipole antennas can operate at two radio frequencies: 2.4 GHz (for IEEE 802.11b/g) and 5 GHz (for IEEE 802.11a). For details, see "Antennas" on page 30.
Status LEDs	The status LEDs convey operational states for system power, and the LAN, Access, and Mesh interfaces. For details, see "Status LEDs" on page 29.
802.11a RP-SMA Connector	You can connect a detachable single-band antenna, such as the Pulse W1028 dipole antenna for the 5 GHz band, to the male 802.11a RP-SMA (reverse polarity-subminiature version A) connector. Note that doing so disables the adjacent fixed antenna.

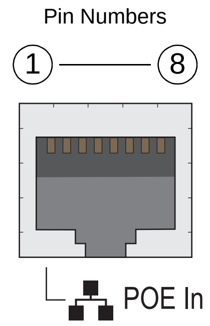
Component	Description
Power Connector	The 48-volt DC power connector (0.38 amps) is one of two methods through which you can power the HiveAP 20. To connect it to a 100 – 240-volt AC power source, use the AC/DC power adaptor that is available as an extra option. Because the HiveAP does not have an on/off switch, connecting it to a power source automatically powers on the device.
Mounting Screw	To mount the HiveAP 20 on a surface, attach the mounting plate that ships with the product to the HiveAP by inserting the two pins on the underside of the chassis into slots in the plate and tightening the mounting screw. For details, see "Mounting the HiveAP 20" on page 31.
10/100 Mbps PoE Port	The 10/100-Mbps Ethernet port supports IEEE 802.3af PoE (Power over Ethernet) and receives RJ-45 connectors. The HiveAP can receive its power through an Ethernet connection to PSE (power sourcing equipment) that is 802.3af-compatible, such as one of the PoE injectors available as an optional accessory from Aerohive. (If you connect the HiveAP to a power source through the power connector and PoE port simultaneously, the device draws power through the power connector and automatically disables PoE.) The HiveAP can also connect to the wired network or to a wired device (such as a security camera) through this port. It is compatible with 10/100Base-T/TX and automatically negotiates half- and full-duplex connections with the connecting device. It is autosensing and adjusts to straight-through and cross-over Ethernet cables automatically. It also automatically adjusts for 802.3af Alternative A and B methods of PoE. For details, see "Ethernet and Console Ports" on page 28.
Reset Button	The reset button allows you to reboot the device or reset the HiveAP to its factory default settings. Insert a paper clip, or something similar, into the Reset pinhole and press the reset button. To reboot the device, hold the button down between 1 and 5 seconds. To return the configuration to the factory default settings, hold it down for at least 5 seconds. After releasing the button, the Power LED goes dark, and then glows steady amber while the firmware loads and the system performs a self-test. After the software finishes loading, the Power LED glows steady green. To disable the reset button from resetting the configuration, enter this command: **`no reset-button reset-config-enable`** Pressing the button between 1 and 5 seconds will still reboot the HiveAP, but pressing it for more than 5 seconds will not reset its configuration.
Console Port	A male DB-9 serial port to which you can make a console connection using an RS-232 (or "null modem") cable. The management station from which you make a serial connection to the HiveAP must have a VT100 emulation program, such as Tera Term Pro© (a free terminal emulator) or Hilgraeve Hyperterminal® (provided with Windows® operating systems). The following are the serial connection settings: bits per second: 9600, data bits: 8, parity: none, stop bits: 1, flow control: none.
Device Lock Slot	You can physically secure the HiveAP by attaching a lock and cable (such as a Kensington® notebook lock) to the device lock slot. After looping the cable around a secure object, insert the T-bar component of the lock into the slot on the HiveAP and turn the key to engage the lock mechanism.
802.11b/g RP-SMA Connector	You can connect a detachable single-band antenna, such as the Pulse W1038 dipole antenna for the 2.4 GHz band, to the male 802.11b/g RP-SMA connector. Note that doing so disables the adjacent fixed antenna.

Ethernet and Console Ports

There are two ports on the HiveAP 20: a 10/100Base-T/TX Ethernet port and a male DB-9 console port. Both ports use standard pin assignments.

The pin assignments in the PoE (Power over Ethernet) Ethernet port follow the TIA/EIA-568-B standard (see Figure 2). The PoE port accepts standard types of Ethernet cable—cat3, cat5, cat5e, or cat6—and can receive power over this cable from power sourcing equipment (PSE) that is 802.3af-compatible. Such equipment can be embedded in a switch or router, or it can come from purpose-built devices that inject power into the Ethernet line en route to the HiveAP. Because the PoE port has autosensing capabilities, the wiring termination in the Ethernet cable can be either straight-through or cross-over.

Figure 2   PoE Wire Usage and Pin Assignments



(View of the PoE port on the HiveAP)

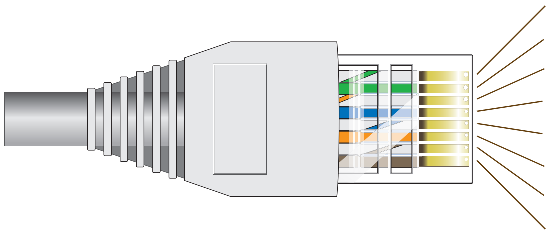
		802.3af Alternative A (Data and Power on the Same Wires)		802.3af Alternative B (Data and Power on Separate Wires)
Pin	**Data Signal**	**MDI**	**MDI-X**	**MDI or MDI-X**
1	Transmit +	DC+	DC–	– – –
2	Transmit -	DC+	DC–	– – –
3	Receive +	DC–	DC+	– – –
4	(unused)	– – –	– – –	DC+
5	(unused)	– – –	– – –	DC+
6	Receive -	DC–	DC+	– – –
7	(unused)	– – –	– – –	DC–
8	(unused)	– – –	– – –	DC–

MDI = Medium dependent interface for straight-through connections

MDI-X = Medium dependent interface for cross-over (X) connections

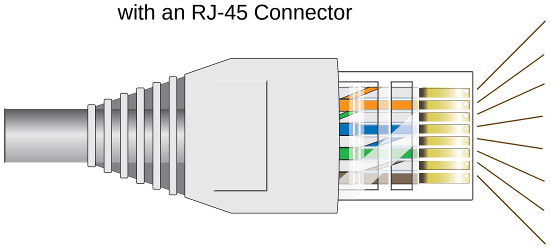
The PoE port is auto-sensing and can automatically adjust to transmit and receive data over straight-through or cross-over Ethernet connections. Likewise, it can automatically adjust to 802.3af Alternative A and B power delivery methods. Furthermore, when the Alternative A method is used, the PoE port automatically allows for polarity reversals depending on its role as either MDI or MDI-X.

T568A-Terminated Ethernet Cable
with an RJ-45 Connector



Pin	T568A Wire Color
1	White/Green
2	Green
3	White/Orange
4	Blue
5	White/Blue
6	Orange
7	White/Brown
8	Brown

T568B -terminated Ethernet Cable
with an RJ-45 Connector



Pin	T568B Wire Color
1	White/Orange
2	Orange
3	White/Green
4	Blue
5	White/Blue
6	Green
7	White/Brown
8	Brown

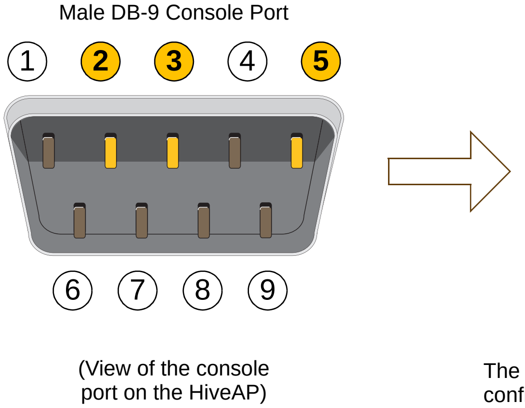
T568A and T568B are two standard wiring termination schemes. Note that the only difference between them is that the white/green + solid green pair of wires and the white/orange + solid orange pair are reversed.

For straight-through Ethernet cables—using either the T568A or T568B standard—the eight wires terminate at the same pins on each end.

For cross-over Ethernet cables, the wires terminate at one end according to the T568A standard and at the other according to T568B.

The pin assignments in the male DB-9 console port follow the EIA (Electronic Industries Alliance) RS-232 standard. To make a serial connection between your management system and the console port on the HiveAP, you can use a null modem serial cable, use another serial cable that complies with the RS-232 standard, or refer to the pin-to-signal mapping shown in Figure 3 to make your own serial cable. Connect one end of the cable to the console port on the HiveAP and the other end to the serial (or COM) port on your management system. The management system must have a VT100 terminal emulation program, such as Tera Term Pro© (a free terminal emulator) or Hilgraeve Hyperterminal® (provided with Windows® operating systems).

Figure 3 Console Port Pin Assignments



RS-232 Standard Pin Assignments

Pin	Signal	Direction
1	DCD (Data Carrier Detect)	(unused)
2	**RXD (Received Data)**	**Input**
3	**TXD (Transmitted Data)**	**Output**
4	DTR (Data Terminal Ready)	(unused)
5	**Ground**	**Ground**
6	DSR (Data Set Ready)	(unused)
7	RTS (Request to Send)	(unused)
8	CTS (Clear to Send)	(unused)
9	RI (Ring Indicator)	(unused)

The above pin assignments show a DTE (data terminal equipment) configuration for a DB-9 connector complying with the RS-232 standard. Because this is a console port, only pins **2**, **3**, and **5** need be used.

Status LEDs

The four status LEDs on the top of the HiveAP 20 indicate various states of activity through their color (dark, green, amber) and illumination patterns (steady glow or blinking). The meanings of the various color + illumination patterns for each LED are explained below.

Power

- Dark: No power
- Steady green: Powered on and the firmware is running normally
- Steady amber: Firmware is booting up or is being updated
- Blinking amber: Alarm indicating firmware failure

LAN

- Dark: Ethernet link is down or disabled
- Steady green: Ethernet link is up but inactive
- Blinking green: Ethernet link is up and active

Access

- Dark: Wireless link is disabled
- Steady green: Wireless link is up but inactive
- Blinking green: Wireless link is up and active

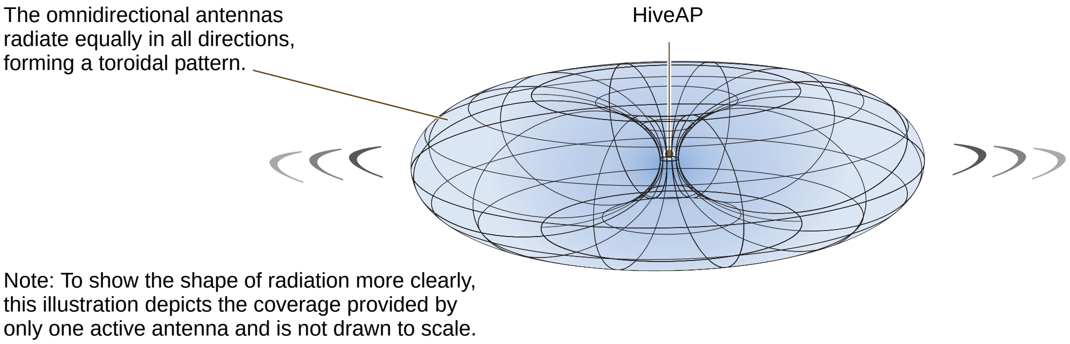
Mesh

- Dark: Wireless link is disabled
- Steady green: Wireless link is up but inactive
- Blinking green (fast): Wireless link is up and the HiveAP is searching for other hive members
- Blinking green (slowly): Wireless link is up and active

Antennas

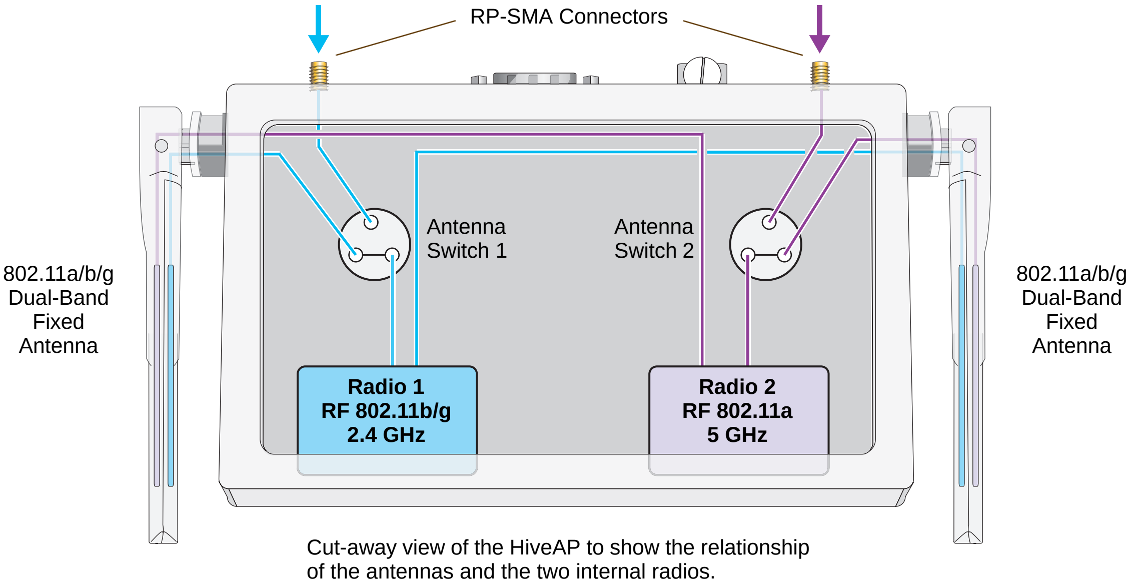
The HiveAP 20 includes two fixed dual-band antennas with 3-dBi gains. These antennas are omnidirectional, providing fairly equal coverage in all directions in a toroidal (donut-shaped) pattern around each antenna. When the antennas are vertically positioned, coverage expands primarily on the horizontal plane, extending horizontally much more than vertically. See Figure 4, which shows the toroidal pattern emanating from a single vertically positioned antenna. To change coverage to be more vertical than horizontal, position the antennas horizontally. You can also resize the area of coverage by increasing or decreasing the signal strength.

Figure 4 Omnidirectional Radiation Pattern


The omnidirectional antennas radiate equally in all directions, forming a toroidal pattern.
HiveAP
Note: To show the shape of radiation more clearly, this illustration depicts the coverage provided by only one active antenna and is not drawn to scale.

The pair of fixed dual-band antennas operate concurrently in two different frequency ranges: 2.4 GHz (IEEE 802.11b/g) and 5 GHz (IEEE 802.11a). Using two different frequency ranges reduces the probability of interference that can occur when numerous channels operate within the same range. Conceptually, the relationship of antennas and radios is shown in Figure 5.

Figure 5 Antennas and Radios


RP-SMA Connectors
Antenna Switch 1
Antenna Switch 2
802.11a/b/g Dual-Band Fixed Antenna
802.11a/b/g Dual-Band Fixed Antenna
Radio 1 RF 802.11b/g 2.4 GHz
Radio 2 RF 802.11a 5 GHz
Cut-away view of the HiveAP to show the relationship of the antennas and the two internal radios.

If you connect an external antenna to an RP-SMA connector, you must enter the following command to move the appropriate interface from the adjacent fixed antenna to the external antenna:

```
interface interface radio antenna external
```

The wifi0 interface links to radio 1 (frequency range = 2.4 GHz for IEEE 802.11b/g), and the wifi1 interface links to radio 2 (frequency range = 5 GHz for IEEE 802.11a). These interface-to-radio relationships are permanent. However, the interface-to-antenna relationships can be shifted. In other words, you can change which antenna—fixed or external—the wifi0 and wifi1 interfaces use. For example, to link the wifi0 interface to an external antenna connected to the 802.11b/g RP-SMA connector (for radio 1), enter the following command:

```
interface wifi0 radio antenna external
```

If you do not enter this command, the wifi0 interface and all its subinterfaces (wifi0.1, wifi0.2, wifi0.3 … wifi0.7) continue to use both fixed antennas.

Note: After entering the above command, the radio to which you attached the external antenna uses the external antenna and the fixed antenna on the opposite side of the HiveAP. Attaching an external antenna only disconnects the adjacent fixed antenna. Note the two antenna switches shown in Figure 5 on page 30.

To unlink the wifi0 interface from the external antenna and return it to the fixed antennas, enter this command:

```
interface wifi0 radio antenna internal
```

MOUNTING THE HIVEAP 20

Using the mounting plate and track clip, you can mount the HiveAP 20 to the tracks of a dropped ceiling grid. Using just the mounting plate, you can mount the HiveAP to any surface that can support its weight (1.5 lb., 0.68 kg).

Ceiling Mount

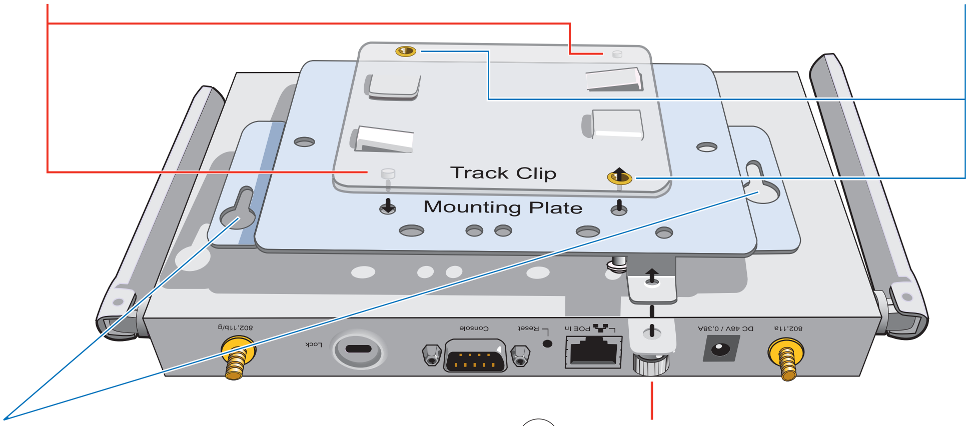
To mount the HiveAP 20 to a track in a dropped ceiling, you need the mounting plate, track clip, and two cross-head screws that ship with the track clip. You also need a cross-head screw driver and—most likely—a ladder.

Attach the track clip to the mounting plate, and then attach the clip-plate combination to the HiveAP 20, as shown in Figure 6.

Figure 6 Attaching the HiveAP 20 to the Mounting Plate and Track Clip

1 Align the two projecting posts on the underside of the track clip with holes in the mounting plate.

2 Using the two cross-head screws that ship with the track clip, fasten the mounting plate to the track clip.

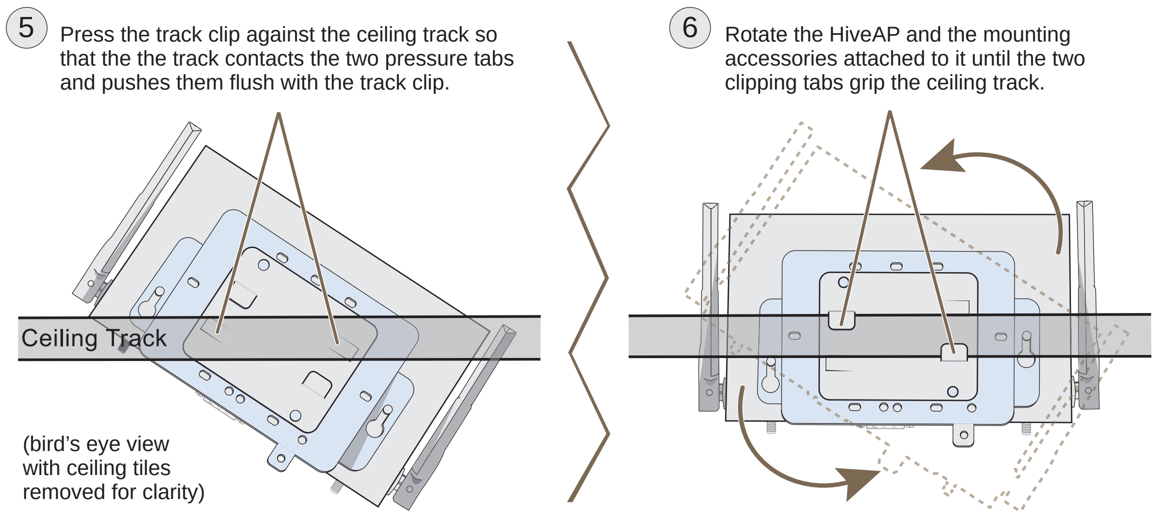


3 Insert the pins on the underside of the HiveAP into the two slots in the mounting plate.

4 Use the mounting screw to secure the HiveAP to the plate.

Nudge the ceiling tiles slightly away from the track to clear some space. Then attach the track clip to the ceiling track as shown in Figure 7. When done, adjust the ceiling tiles back into their former position.

Figure 7 Attaching the HiveAP to a Dropped Ceiling Track



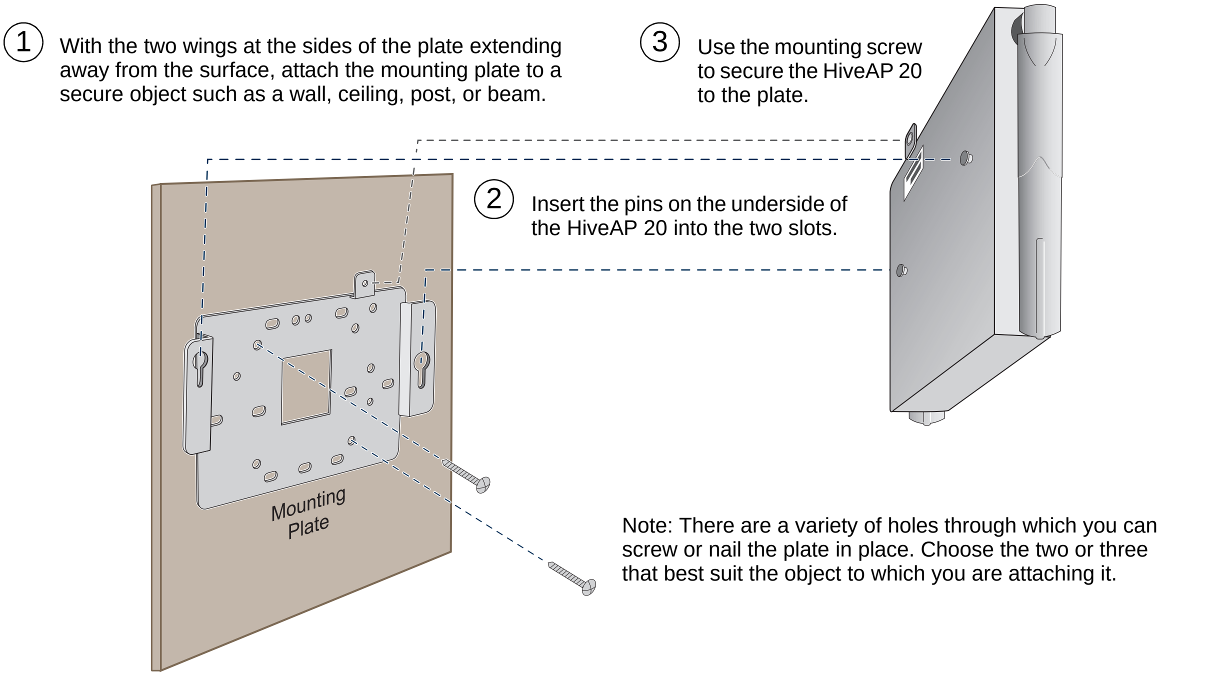
5 Press the track clip against the ceiling track so that the the track contacts the two pressure tabs and pushes them flush with the track clip.

6 Rotate the HiveAP and the mounting accessories attached to it until the two clipping tabs grip the ceiling track.

Surface Mount

You can use the mounting plate to attach the HiveAP 20 to any surface that supports its weight, and to which you can screw or nail the plate. First, mount the plate to the surface, and then attach the device to the plate, as shown in Figure 8.

Figure 8 Mounting the HiveAP on a Wall



1 With the two wings at the sides of the plate extending away from the surface, attach the mounting plate to a secure object such as a wall, ceiling, post, or beam.

2 Insert the pins on the underside of the HiveAP 20 into the two slots.

3 Use the mounting screw to secure the HiveAP 20 to the plate.

Note: There are a variety of holes through which you can screw or nail the plate in place. Choose the two or three that best suit the object to which you are attaching it.

DEVICE, POWER, AND ENVIRONMENTAL SPECIFICATIONS

Understanding the range of specifications for the HiveAP 20 is necessary for optimal deployment and device operation. The following specifications describe the physical features and hardware components, the power adapter and PoE (Power over Ethernet) electrical requirements, and the temperature and humidity ranges in which the device can operate.

Device Specifications

- Chassis dimensions: 8 1/4" W x 1" H x 4 15/16" D (21 cm W x 2.5 cm H x 12.5 cm D)
- Weight: 1.5 lb. (0.68 kg)
- Antennas: Two fixed dual-band 802.11a/b/g antennas, and two RP-SMA connectors for detachable single-band 802.11a or 802.11b/g antennas
- Serial port: DB-9 (bits per second: 9600, data bits: 8, parity: none, stop bits: 1, flow control: none)
- Ethernet port: autosensing 10/100Base-T/TX Mbps, with IEEE 802.3af-compliant PoE (Power over Ethernet)

Power Specifications

- AC/DC power adapter:
  - Input:100 – 240 VAC
  - Output: 48V/0.38A
- PoE nominal input voltages: 48 V, 0.35A
- RJ-45 power input pins: Wires 4, 5, 7, 8 or 1, 2, 3, 6

Environmental Specifications

- Operating temperature: 32 to 122 degrees F (0 to 50 degrees C)
- Storage temperature: -4 to 158 degrees F (-20 to 70 degrees C)
- Relative Humidity: Maximum 95%

Chapter 3 The HiveAP 28 Outdoor Platform

The Aerohive HiveAP 28 is a new generation wireless access point that is customized for outdoor use. It is mountable in any direction and on any hard surface, post, or wire strand. It can receive power either through an Ethernet cable or power cord.

Note: Do not open the HiveAP 28 chassis. There are no serviceable parts inside.

This guide combines product information, installation instructions, and configuration examples for both the HiveAP and HiveManager platforms. This chapter covers the following topics relating to the HiveAP 28:

HIVEAP 28 PRODUCT OVERVIEW

The HiveAP 28 is a multi-channel wireless AP (access point) for outdoor use. It is compatible with IEEE 802.11b/g (2.4 GHz) and IEEE 802.11a (5 GHz) standards and supports a variety of Wi-Fi (wireless fidelity) security protocols, including WPA (Wi-Fi Protected Access) and WPA2.

You can see the hardware components on the HiveAP 28 in Figure 1. Each component is described in Table 1.

Figure 1 HiveAP 28 Hardware Components

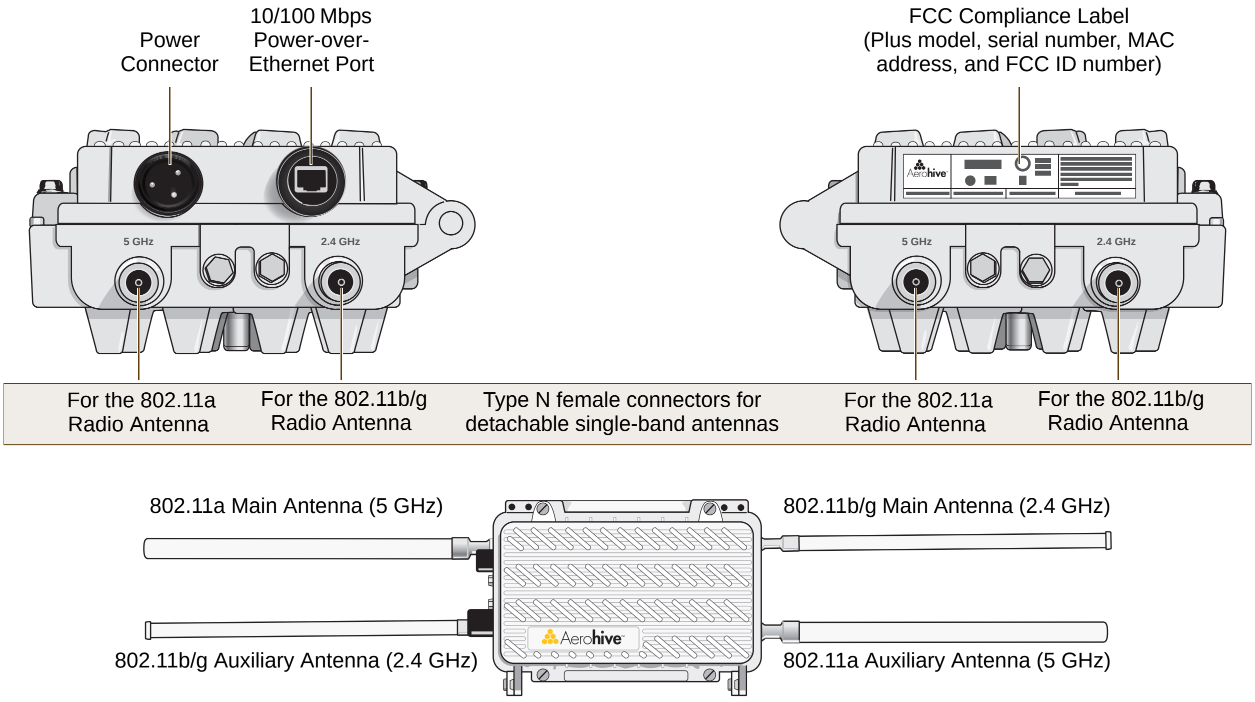

Power Connector
10/100 Mbps Power-over-Ethernet Port
FCC Compliance Label (Plus model, serial number, MAC address, and FCC ID number)
5 GHz
2.4 GHz
Aerohive
5 GHz
2.4 GHz
For the 802.11a Radio Antenna
For the 802.11b/g Radio Antenna
Type N female connectors for detachable single-band antennas
For the 802.11a Radio Antenna
For the 802.11b/g Radio Antenna
802.11a Main Antenna (5 GHz)
802.11b/g Main Antenna (2.4 GHz)
Aerohive
802.11b/g Auxiliary Antenna (2.4 GHz)
802.11a Auxiliary Antenna (5 GHz)

Table 1 HiveAP 28 Component Descriptions

Component	Description
Detachable Single-Band Antennas	The two pairs of detachable omnidirectional dipole antennas operate at two radio frequencies: one pair at 2.4 GHz (for IEEE 802.11b/g) and the other at 5 GHz (for IEEE 802.11a). For details, see "Antennas" on page 39.
Type N Connectors (Female)	Attach antennas to the HiveAP 28 through these connectors. For details, see "Attaching Antennas" on page 44.
Waterproof Power Connector	Using the power connector is one of two methods through which you can power the HiveAP 28. To connect it to a 100 – 240-volt AC power source, use the power cable that ships with the product as an extra option. Because the HiveAP does not have an on/off switch, connecting it to a power source automatically powers on the device. The power source must have a readily accessible service disconnect switch incorporated into the fixed wiring installation so that you have the ability to turn the power on and off. (The other method that the HiveAP can obtain power is through its PoE port.)

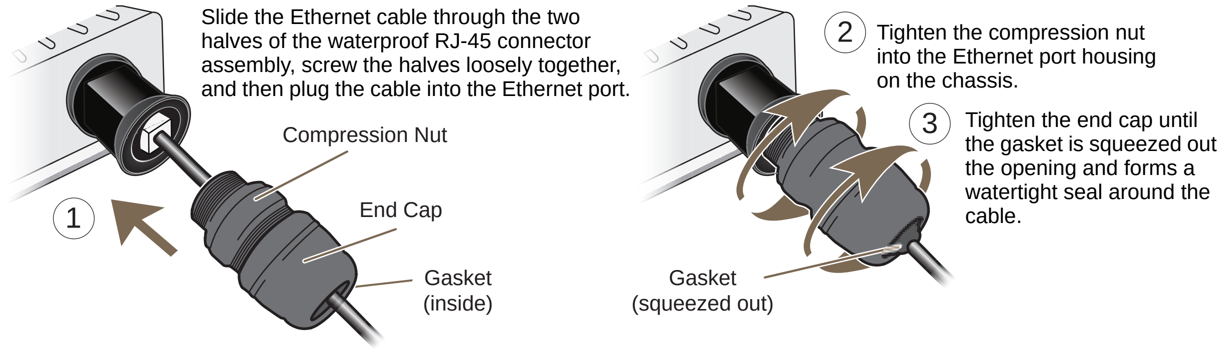
Component	Description
10/100 Mbps PoE Port	The 10/100-Mbps Ethernet port supports IEEE 802.3af PoE (Power over Ethernet) and receives RJ-45 connectors. The HiveAP can receive its power through an Ethernet connection to PSE (power sourcing equipment) that is 802.3af-compatible, such as one of the PoE injectors available as an optional accessory from Aerohive. (If you connect the HiveAP to a power source through the power connector and PoE port simultaneously, the device draws power through the power connector and automatically disables PoE.) The HiveAP 28 can also connect to the wired network or to a wired device (such as a security camera) through this port. It is compatible with 10/100Base-T/TX and automatically negotiates half- and full-duplex connections with the connecting device. It is autosensing and adjusts to straight-through and cross-over Ethernet cables automatically (MDI/MDI-X). It also automatically adjusts for 802.3af Alternative A and B methods of PoE. For details, see "Ethernet Port".

Ethernet Port

The HiveAP 28 has a 10/100Base-T/TX PoE (Power over Ethernet) port. Its pin assignments follow the TIA/EIA-568-B standard (see Figure 2 on page 28). The PoE port accepts standard types of Ethernet cable—cat3, cat5, cat5e, or cat6—and can receive power over this cable from power sourcing equipment (PSE) that is 802.3af-compatible. Such equipment can be embedded in a switch or router, or it can come from purpose-built devices that inject power into the Ethernet line en route to the HiveAP. Because the PoE port has autosensing capabilities, the wiring termination in the Ethernet cable can be either straight-through or cross-over (MDI/MDI-X). For outdoor deployments use weatherproofed shielded twisted pair (STP) Ethernet cables.

To ensure a waterproof seal for the Ethernet connection, use the RJ-45 connector assembly, which comes in three parts: a compression nut, end cap, and gasket.

Figure 2 Connecting the Ethernet Cable


Slide the Ethernet cable through the two halves of the waterproof RJ-45 connector assembly, screw the halves loosely together, and then plug the cable into the Ethernet port.
Compression Nut
End Cap
Gasket (inside)
1
2
Tighten the compression nut into the Ethernet port housing on the chassis.
3
Tighten the end cap until the gasket is squeezed out the opening and forms a watertight seal around the cable.
Gasket (squeezed out)

1. Insert one end of the Ethernet cable through the waterproof RJ-45 connector assembly and plug the cable into the Ethernet port.
2. Tighten the compression nut by twisting it clockwise into the Ethernet port housing on the chassis.
3. Tighten the end cap by twisting it clockwise onto the compression nut and tighten until the rubber gasket emerges and wraps itself around the Ethernet cable.

   The Ethernet connection is now sealed and waterproof.

4. Connect the other end of the Ethernet cable to PSE (power sourcing equipment) such as a power injector if the HiveAP 28 receives power through PoE, or directly to a network device such as a switch if it receives power through a power cord.

   > Note: *To prevent damage to the HiveAP 28 or power injector when using PoE to provide power, connect the Ethernet cable from the power injector to the HiveAP 28, and connect the injector to a power jack before applying power.*

   If the Ethernet cable connects the HiveAP to another device that is indoors, you must install appropriate lightning protection at the point before it enters the building. Failing to do so might cause damage to the equipment as well as serious injury or death.

> Note: *When the HiveAP acts as a mesh point and does not use the Ethernet port, cover the Ethernet port with a connector cap to prevent water intrusion and possible safety hazards.*

Power Connector

The HiveAP 28 can receive power through an Ethernet cable using PoE or through a power cord. Aerohive recommends using either PoE or wiring the power cord directly to a 100 – 240-volt AC power source. Only plug the power cord into an electric outlet when configuring the device before deployment or when testing it in the lab.

> Note: *When the HiveAP receives power through PoE, cover the power connector with a connector cap to prevent water intrusion and possible safety hazards.*

To connect the power cord to the HiveAP 28:

1. Align the slot in the power cord plug with the small tab at the top of the three-pin power connector, and slide the plug firmly over the pins until it is fully seated in the power connector.
2. Slide the cover over the connector and tighten it by turning the cover clockwise.
3. Install a lightning protector between the HiveAP 28 and its power source.
4. When possible, run the cord through a conduit to protect it from the elements. Where the cord is exposed, allow enough slack in it to create a drip loop. Leaving some slack in the cord lets water run away from the connections at each end. Use only a weatherproof power cord, such as the cord that ships with the HiveAP 28.
5. Strip the other end of the power cord and wire it directly to a power source, such as a junction box that has a service disconnect switch that you can use to turn the power on and off. Also, because the HiveAP 28 does not have short-circuit (over current) protection built into it, it relies on the protection provided by the power source to which you connect it. Ensure that the protective device, such as a circuit breaker, is not rated greater than 15A. Furthermore, if you need to install the HiveAP 28 in a wet or damp location, the AC branch circuit that is powering it must be provided with ground fault protection (GFCI), as required by Article 210 of the National Electrical Code (NEC).

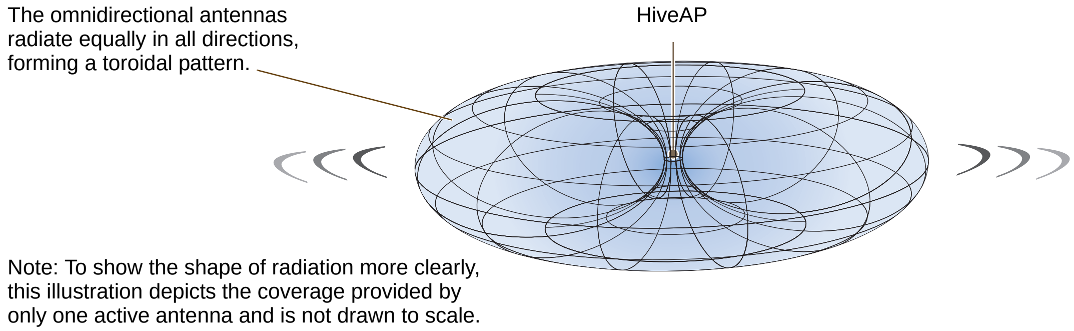
   > Note: *The HiveAP 28 must be grounded. Do not operate it unless there is a suitably installed ground conductor. Contact the appropriate electrical inspection authority or an electrician if you are uncertain that suitable grounding is available.*

Antennas

The HiveAP 28 includes two detachable single-band antennas with 8dBi gains (802.11b/g) and two detachable single-band antennas with 10dBi gains (802.11a). These antennas are omnidirectional, providing fairly equal coverage in all directions in a toroidal (donut-shaped) pattern around each antenna. When the antennas are vertically positioned, coverage expands primarily on the horizontal plane, extending horizontally much more than vertically. See Figure 3, which shows the toroidal pattern emanating from a single vertically positioned antenna. Note that when high gain antennas are added, the torus shape becomes somewhat elongated or compressed. If the HiveAP 28 is mounted higher than 20 feet the center of the torus curves inward so that the connection quality, directly underneath the center of the HiveAP 28, becomes compromised.

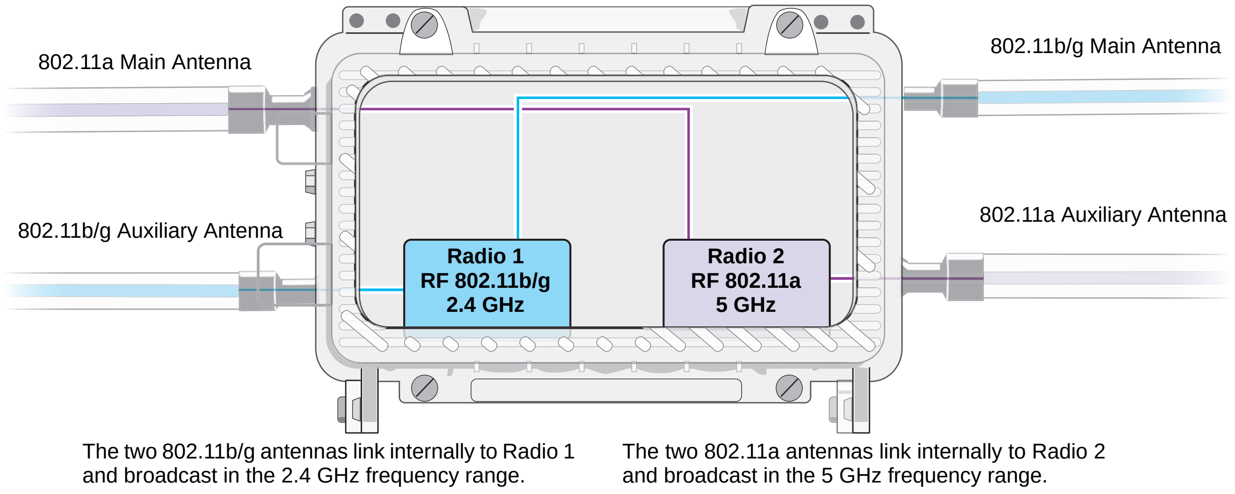
To change coverage to be more vertical than horizontal, position the HiveAP so that the antennas are on a horizontal plane. You can also resize the area of coverage by increasing or decreasing the signal strength.

Figure 3 Omnidirectional Radiation Pattern


The omnidirectional antennas radiate equally in all directions, forming a toroidal pattern.
HiveAP
Note: To show the shape of radiation more clearly, this illustration depicts the coverage provided by only one active antenna and is not drawn to scale.

The pairs of antennas operate concurrently in two different frequency ranges: 2.4 GHz (IEEE 802.11b/g) and 5 GHz (IEEE 802.11a). Using two different frequency ranges reduces the probability of interference that can occur when numerous channels operate within the same range. Conceptually, the relationship of antennas and radios is shown in Figure 4. (For information about attaching the antennas to the HiveAP 28, see "Attaching Antennas" on page 44.)

Figure 4 Antennas and Radios


802.11a Main Antenna
802.11b/g Main Antenna
802.11b/g Auxiliary Antenna
802.11a Auxiliary Antenna
Radio 1
RF 802.11b/g
2.4 GHz
Radio 2
RF 802.11a
5 GHz
The two 802.11b/g antennas link internally to Radio 1 and broadcast in the 2.4 GHz frequency range.
The two 802.11a antennas link internally to Radio 2 and broadcast in the 5 GHz frequency range.

Note: The HiveAP 20 uses the **`interface`** *`interface`* **`radio antenna external`** *command to enable an external antenna attached to it. Entering this command on the HiveAP 28 disables the antenna on the opposite side of the device from the radio to which the interface is linked and results in a loss of diversity.*

MOUNTING THE HIVEAP 28 AND ATTACHING ANTENNAS

Using the mounting accessories (available separately) you can mount the HiveAP in various locations:

- "Pole Mount" on page 41 – Mount the HiveAP 28 on a pole such as a street light.
- "Strand Mount" on page 42 – Suspend the HiveAP 28 from a cable or phone line.
- "Surface Mount" on page 43 – Mount the HiveAP 28 on a flat surface such as a wall or beam.

You can mount the HiveAP 28 in any of these locations as long as the object to which you mount it and the attaching screws can support its weight (9 lbs., 4.08 kg).

After mounting the HiveAP 28, attach the antennas as explained in "Attaching Antennas" on page 44.

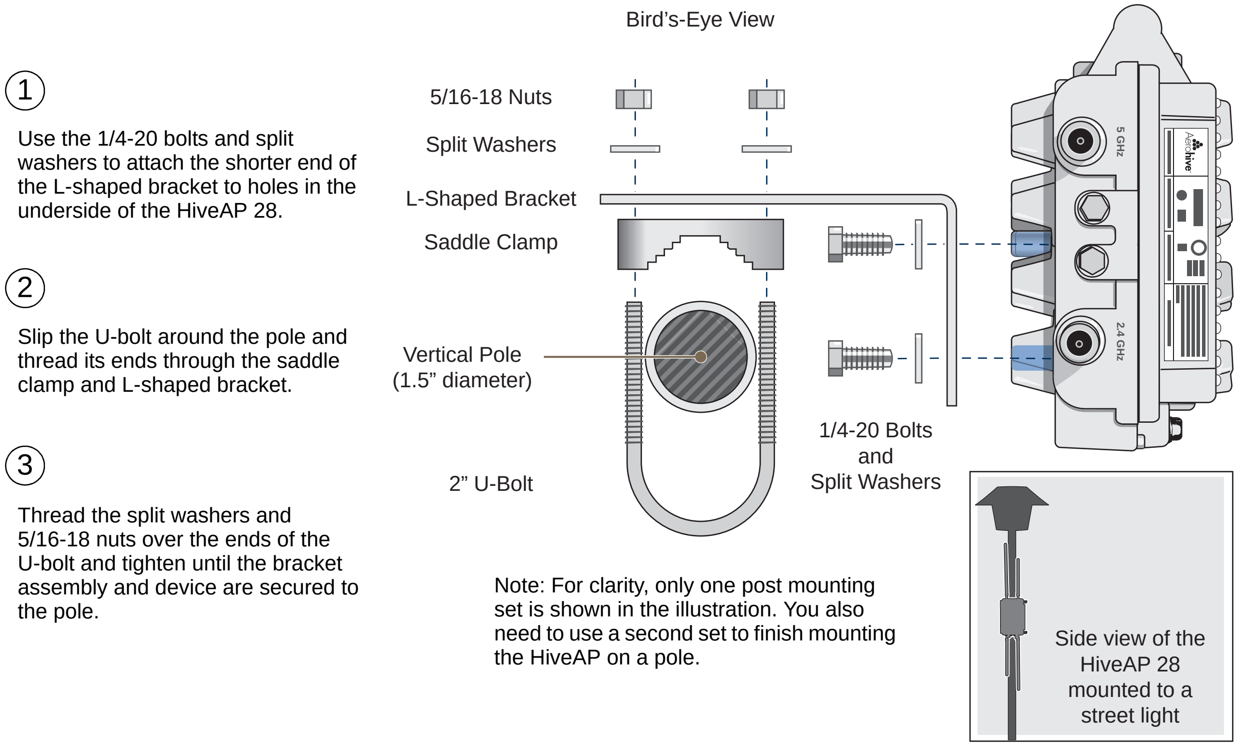
Before you mount the HiveAP 28 and attach antennas, read the following warnings and cautions:

- To install the HiveAP 28, you must be a qualified installation professional, licensed or certified in accordance with local regulations.
- Use lightning arrestors and ground both the HiveAP 28 and any separately mounted antennas.
- Do not connect or disconnect antennas or cables from the HiveAP 28 during periods of lightning activity.
- If you need to place the HiveAP 28 in an explosive environment, such as in an oil refinery, mine, or any place where there is flammable gas, it must first be encased in an ATEX enclosure.
- To comply with RF (radio frequency) exposure limits, do not place antennas within 6.56 feet (2 meters) of people.
- Do not locate antennas near overhead power lines or other electric light or power circuits, or where they can come into contact with such circuits. When installing antennas, take extreme care not to come into contact with these circuits, which might cause serious injury or death. For proper installation and grounding of the antenna, refer to national and local electrical codes: NFPA (National Fire Protection Association) 70, National Electrical Code Article 810 (U.S.); Canadian Electrical Code, Part I, CSA 22.1 and Section 54 (Canada); and if local or national electrical codes are not available, refer to IEC (International Electrotechnical Commission) 364, Part 1 through 7 (other countries).
- To prevent damage, avoid over-tightening the connectors, nuts, and screws used to mount the HiveAP 28 and antennas.

Pole Mount

To mount the HiveAP 28 to a pole with a 1.5-inch diameter, you need two sets of the L-shaped brackets, two 2" U-bolts, saddle clamps, and the nuts, bolts, and washers shown in Figure 5. You also need a wrench to tighten the nuts and bolts securely.

Figure 5 Attaching the HiveAP 28 to a Pole



1 Use the 1/4-20 bolts and split washers to attach the shorter end of the L-shaped bracket to holes in the underside of the HiveAP 28.

2 Slip the U-bolt around the pole and thread its ends through the saddle clamp and L-shaped bracket.

3 Thread the split washers and 5/16-18 nuts over the ends of the U-bolt and tighten until the bracket assembly and device are secured to the pole.

Note: For clarity, only one post mounting set is shown in the illustration. You also need to use a second set to finish mounting the HiveAP on a pole.

1. Align two of the holes in the shorter end of the bracket with two of the holes in the HiveAP, insert the two bolts through the washers and bracket, and screw them into the holes in the HiveAP 28 chassis, using a wrench to tighten the bolts so that the bracket is securely attached.

   Note: Repeat this step to attach the other bracket to the HiveAP. However, this time, place the long end of the bracket in the opposite direction of the first one for better stability. For example, if you attached the first bracket with its long end positioned toward the outside edge of the device, install this second bracket with the long end of the bracket toward the middle.

2. Holding a saddle clamp against the inside of the long end of one of the L-shaped brackets, slip a U-bolt around the pole and thread it through the two holes in the saddle clamp and L-shaped bracket.

   Note: One of the holes in the bracket is arc-shaped so that you can adjust the angle of the mounted device if necessary.

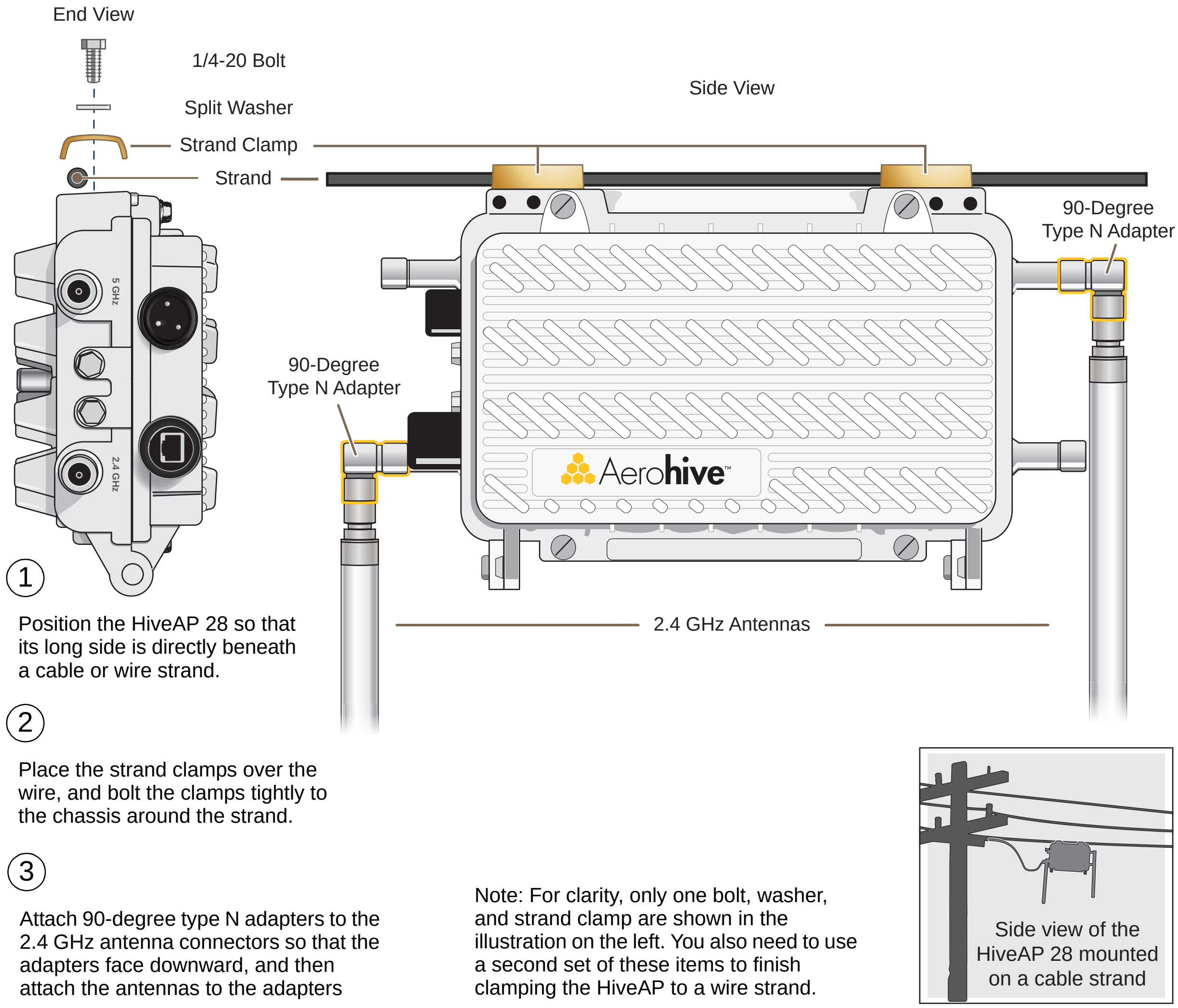
3. Thread a split washer and 5/16-18 nut to each end of the U-bolt, and tighten them with a wrench to secure the U-bolt firmly to the pole.

   Note: Repeat steps 2 and 3 to attach the other U-bolt and saddle clamp to the remaining L-shaped bracket and secure the HiveAP 28 to the pole.

Strand Mount

The HiveAP 28 outdoor platform can also be mounted on a cable or strand of wire as shown in Figure 6. When mounted on a wire strand, use 90-degree N type adapters (not included) to orient the antennas vertically. If you do not use the adapters and orient the antennas horizontally, the area covered will be far less.

Figure 6   Clamping the HiveAP 28 to a Wire Strand



Position the HiveAP 28 so that its long side is directly beneath a cable or wire strand.

Place the strand clamps over the wire, and bolt the clamps tightly to the chassis around the strand.

Attach 90-degree type N adapters to the 2.4 GHz antenna connectors so that the adapters face downward, and then attach the antennas to the adapters

Note: For clarity, only one bolt, washer, and strand clamp are shown in the illustration on the left. You also need to use a second set of these items to finish clamping the HiveAP to a wire strand.

Side view of the HiveAP 28 mounted on a cable strand

To mount the HiveAP 28 on a wire or strand, you need a wrench and two 1/4-20 bolts, split washers, strand clamps, and 90-degree type N adapters. In the following instructions, you use only the 2.4 GHz antennas.

1. Position the HiveAP 28 so that its long side (with three holes at each end) is underneath a cable or wire strand running lengthwise along the upper side of the chassis (for the proper orientation, see the inset in Figure 6).
2. Place the strand clamp over the wire and use the 1/4-20 bolt and split washer to secure the strand between the clamp and chassis.

   Note: Repeat the preceding steps to fasten the other end of the HiveAP 28 to the cable or wire strand.

3. Attach the 90-degree type N adapters to the two 2.4 GHz antenna connectors and then attach the antennas to the adapters so that the antennas face downward. For details, see "Attaching Antennas" on page 44.

Surface Mount

You can use the mounting plate to attach the HiveAP 28 to any surface that supports its weight (9 lbs., 4.08 kg), and to which you can screw or nail the plate. First, mount the plate to the HiveAP 28, and then attach the plate to the surface, as shown in Figure 7. Note that the screw heads that you attach to the wall or surface must be small enough for the keyholes on the mounting plate to slip over them.

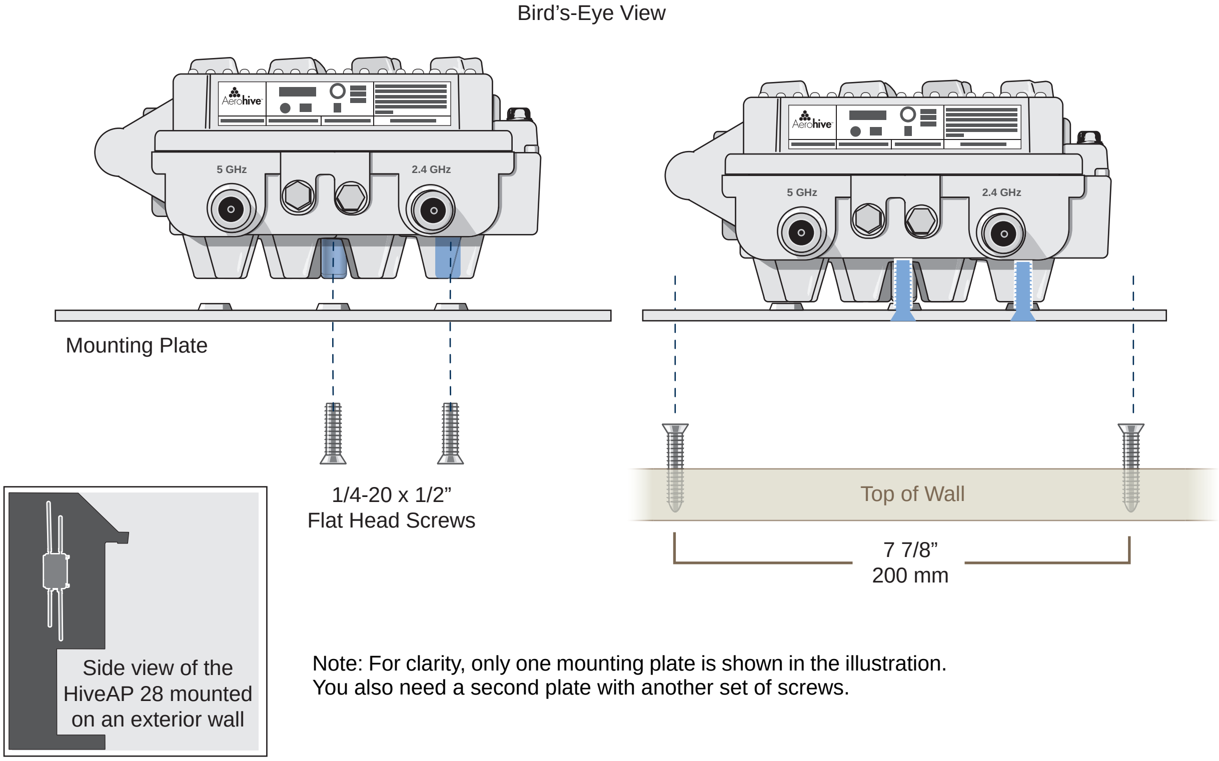
> *Note: Because the metal in a wall can degrade the radio signal pattern, Aerohive recommends using sector antennas instead of omnidirectional antennas when mounting the device on a wall.*

Figure 7 Mounting the HiveAP 28 on a Wall

1 With the ridged edge of the holes on the mounting plates facing the HiveAP 28, use 1/4-20 x 1/2 inch screws to secure the two mounting plates to its underside.

2 Attach four screws to a secure object such as a wall or beam. Space them 8 1/8" (206 mm) apart vertically and 7 7/8" (200 mm) apart horizontally.

3 Guide the screws fastened to the wall through the keyholes in the mounting plates.



Note: For clarity, only one mounting plate is shown in the illustration. You also need a second plate with another set of screws.

To mount the HiveAP 28 to a surface like a wall, you need two mounting plates, four 1/4-20 x 1/2" flat head screws, four screws (no bigger than 5/16"), and a screw driver:

1. Align the ridged edge of one of the mounting plates with two of the holes located on the underside of the HiveAP 28, and use two 1/4-20 x 1/2" flat head screws to secure the plate against the HiveAP 28. Then attach the other mounting plate to the HiveAP 28 in the same way.
2. Attach four 5/16" screws to a wall or beam. They must be 8 1/8" (206 mm) apart vertically and 7 7/8" (200 mm) apart horizontally to accommodate the keyholes on the mounting plates.
3. Guide the keyholes over the screws fastened to the wall and push downward after the screw heads have cleared the keyholes.

Attaching Antennas

You can connect the antennas directly to the HiveAP 28 or mount them separately. Although connecting the antennas directly to the device typically provides better performance, in some cases the location of the HiveAP might not be a good location for the antennas; for example, if the HiveAP 28 is mounted on a reinforced concrete wall that interferes with radio coverage. In such cases, mounting the antennas separately in a more open location can improve coverage; however, bear in mind that cables introduce loss into the overall signal strength and that the longer the cable connecting the antennas to the HiveAP 28, the greater the loss will be.

Note: Cover any unused antenna connectors with a connector cap to prevent water intrusion and possible safety hazards.

Connecting Antennas Directly to the HiveAP 28

The two 2.4 GHz and two 5 GHz antennas that ship with the HiveAP 28 have male Type N connectors that you can connect directly to the female Type N antenna connectors on the HiveAP 28. You can also use self-amalgamating PTFE (polytetrafluoroethylene) tape, which is available separately from Aerohive, to create a waterproof seal at the points of attachment.

To attach the antennas:

1. Remove the antenna connector covers from the HiveAP 28 (leave the covers on any connectors that you do not plan to use), and make sure that the surface of the connectors on the HiveAP 28 and the connectors on the antennas are clean.
2. If you are using PTFE tape, wrap the tape around the threads on the HiveAP 28 antenna connectors as follows:
   - 2.1. Starting at one end of the threads on one of the connectors, stretch the tape and wrap it in half-lap layers until you cover the threads completely.
   - 2.2. Wrap the tape in the opposite direction to bring it back onto itself for one full wrap.
   - 2.3. Place one thumb on the tape at the point of termination and stretch the tape until it breaks.
   - 2.4. Repeat the preceding steps to cover all the connectors to which you will attach antennas.
3. Connect the 2.4 GHz antennas to the 2.4 GHz antenna connectors. (To tighten an antenna, turn the antenna base cap—the textured metal band that encloses the connector—clockwise over the tape-covered threads of the HiveAP antenna connector.)

   Their connections are now sealed and waterproof.
4. Repeat the preceding steps to connect the 5 GHz antennas.

Mounting Antennas Separately

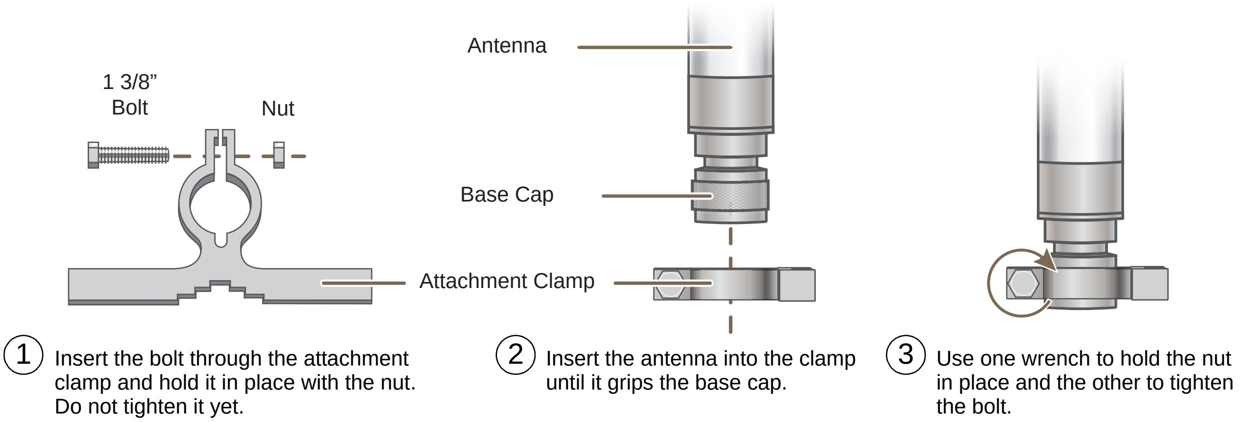
In addition to connecting antennas directly to the HiveAP 28, you can also mount them separately and run a cable between the antennas and the device. Use either male-to-female cables with Type N connectors or use male-to-male or female-to-female cables with cable gender changers. (The antennas have male Type N connectors and the HiveAP 28 has female Type N connectors.)

Note: Using cables to mount antennas separately causes some signal loss and using a cable gender changer can cause even more. The amount of loss varies from product to product, so refer to the documentation accompanying the cables and gender changer you use for information. To minimize loss, Aerohive recommends using LMR400 cables and using the shortest cables possible.

You can mount antennas at the top of a pole as shown in Figure 8 and Figure 9, or to a flat surface. If you must mount the antenna lower on a pole, the pole must be nonmetallic—such as one made from a hard plastic like PVC (polyvinyl chloride)—so that it does not distort the signal. Aerohive recommends that antennas be installed away from power lines and obstructions that can interfere with radio coverage.

For each antenna that you mount, you need an attachment clamp, a 1 3/8" bolt and nut, a V-bolt, two washers and two nuts, a hose clamp, and two wrenches.

Figure 8 Securing an Antenna to an Attachment Clamp



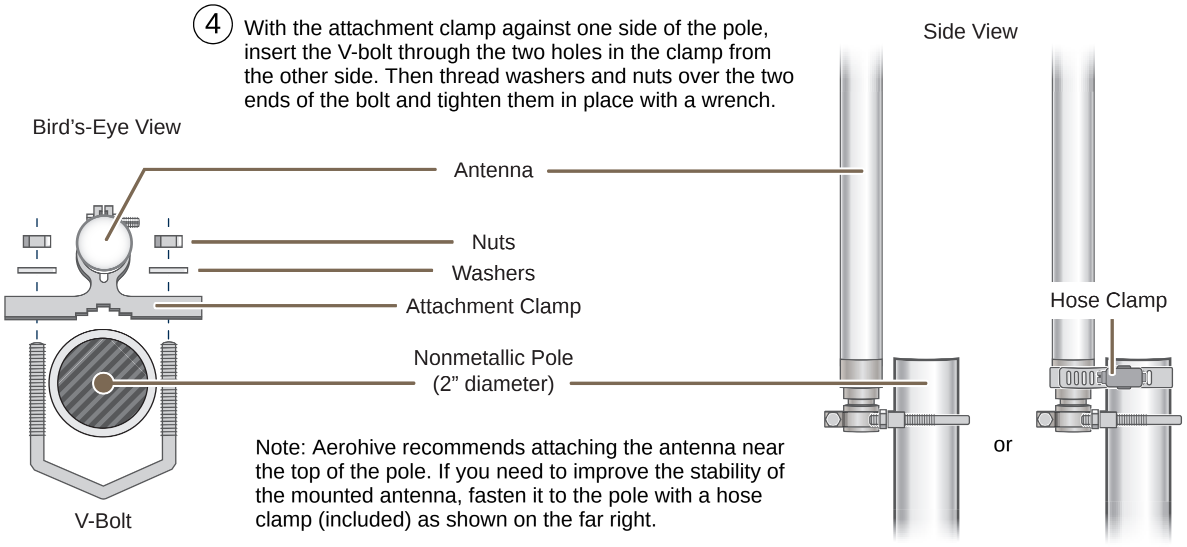
1 Insert the bolt through the attachment clamp and hold it in place with the nut. Do not tighten it yet.

2 Insert the antenna into the clamp until it grips the base cap.

3 Use one wrench to hold the nut in place and the other to tighten the bolt.

1. Insert the 1 3/8" bolt through the attachment clamp and screw a nut loosely onto its end.
2. Place the antenna base cap inside the attachment clamp.
3. Using a pair of wrenches, tighten the nut to the bolt until the clamp grips the base cap firmly.

Figure 9 Mounting an Antenna to a Pole



4 With the attachment clamp against one side of the pole, insert the V-bolt through the two holes in the clamp from the other side. Then thread washers and nuts over the two ends of the bolt and tighten them in place with a wrench.

Note: Aerohive recommends attaching the antenna near the top of the pole. If you need to improve the stability of the mounted antenna, fasten it to the pole with a hose clamp (included) as shown on the far right.

4. To mount the antenna on a nonmetallic pole, place the attachment clamp against the pole, thread the V-bolt through the holes on the attachment, the washers, and nuts, and use the wrenches to tighten the nuts to the bolt. (Optional) For added stability, fasten the top of the antenna to the pole with the hose clamp.

   To mount the antenna directly to a flat surface, run bolts or screws (not included) through the two holes in the attachment clamp, and fasten them firmly to the surface.

Note: Radio coverage might be limited if the surface acts as an obstruction.

5. Make sure that all the antenna and cable connectors are clean. If you are using PTFE tape, wrap the tape around the threads on the HiveAP 28 antenna connectors as explained in "Connecting Antennas Directly to the HiveAP 28" on page 44.
6. Assuming that you are using male-to-female cables, connect the female Type N connector on the cables to the male connectors on the antennas.
7. Connect the male Type N connectors on the cables to the female antenna connectors on the HiveAP 28.

Device, Power, and Environmental Specifications

Understanding the range of specifications for the HiveAP is necessary for optimal deployment and device operation. The following specifications describe the physical features and hardware components, the power adapter and PoE (Power over Ethernet) electrical requirements, and the temperature and humidity ranges in which the device can operate.

Device Specifications

- Chassis dimensions: 13 13/16" W x 4 3/8" H x 8 3/8" D (35 cm W x 11 cm H x 21 cm D)
- Weight: (9 lbs., 4.08 kg)
- Antennas: Two detachable single-band 8dBi 802.11b/g antennas and two detachable single-band 10dBi 802.11a antennas
- Maximum Transmission Power: 20 dBm
- Ethernet port: autosensing 10/100Base-T/TX Mbps, with IEEE 802.3af-compliant PoE (Power over Ethernet)

Power Specifications

- AC/DC power adapter:
  - Input:100 – 240 VAC
  - Output: 17 watts
- PoE nominal input voltages: 48 V, 0.35A
- RJ-45 power input pins: Wires 4, 5, 7, 8 or 1, 2, 3, 6
- RF power output:

802.11b RF (8-dBi Omnidirectional Antenna, Model S2406BFNM)			
Frequency	2412 MHz	2437 MHz	2462 MHz
Peak Power Output (dBm)	14.20	14.00	14.20
802.11g RF (8-dBi Omnidirectional Antenna, Model S2406BFNM)			
Frequency	2412 MHz	2437 MHz	2462 MHz
Peak Power Output (dBm)	16.20	16.80	15.00
802.11a RF (10-dBi Omnidirectional Antenna, Model S4908WBF)			
Frequency	5745 MHz	5785 MHz	5825 MHz
Peak Power Output (dBm)	17.80	17.40	17.60

Environmental Specifications

- Operating temperature: -40 to 140 degrees F (-40 to 60 degrees C)
- Storage temperature: -40 to 194 degrees F (-40 to 90 degrees C)
- Relative Humidity: Maximum 100%

Chapter 4 The HiveAP 340 Platform

The Aerohive HiveAP 340 is a high-performance and highly reliable 802.11n wireless access point. The HiveAP 340 provides dual concurrent 802.11b/g/n and 802.11a/n radios for 3x3 MIMO (Multiple In, Multiple Out) and dual 10/100/1000 Ethernet ports for link aggregation or link redundancy. Its power management system uses a concept called smart PoE (Power over Ethernet) to adjust its power consumption automatically in response the available power in different environments. Smart PoE supports the IEEE 802.3af standard and the 802.3at pre-standard.

This chapter covers the following topics relating to the HiveAP 340:

HiveAP 340 Product Overview

The HiveAP 340 is a multi-channel wireless access point. It is compatible with IEEE 802.11b/g/n (2.4 GHz) and IEEE 802.11a/n (5 GHz) standards and supports a variety of Wi-Fi (wireless fidelity) security protocols, including WPA (Wi-Fi Protected Access) and WPA2.

You can see the hardware components on the HiveAP in Figure 1. Each component is described in Table 1.

Figure 1   HiveAP 340 Hardware Components

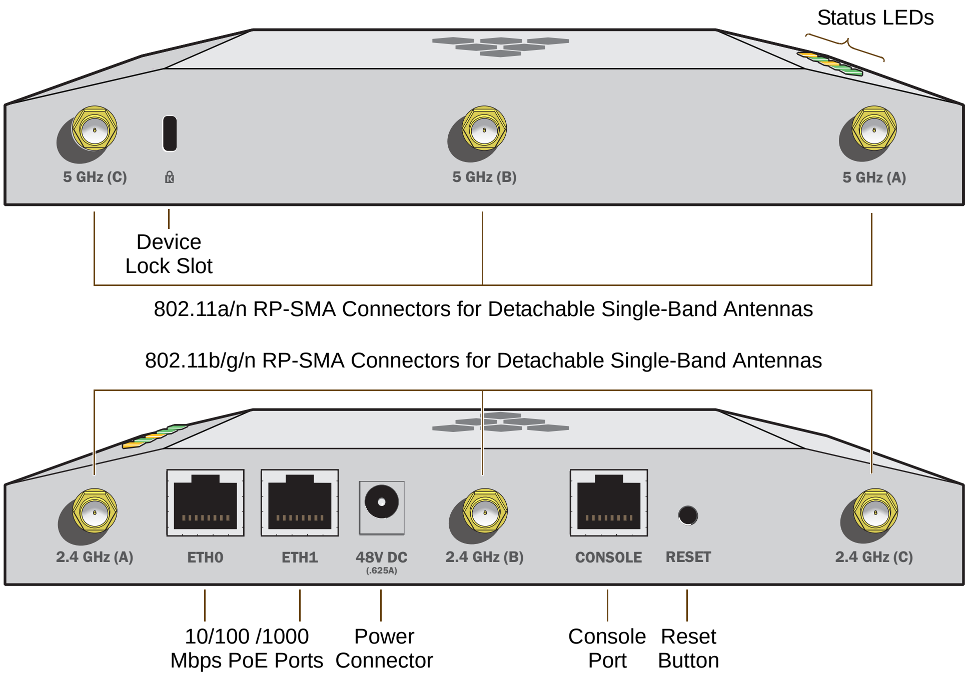


Table 1   HiveAP 340 Component Descriptions

Component	Description
Status LEDs	The status LEDs convey operational states for system power, firmware, Ethernet interfaces, and radios. For details, see "Status LEDs" on page 54.
Device Lock Slot	You can physically secure the HiveAP by attaching a lock and cable (such as a Kensington® notebook lock) to the device lock slot or by using the lock adapter that is included in the mounting kit and a padlock. For more information, see "Locking the HiveAP 340" on page 59.
802.11a/b/g/n RP-SMA Connectors	You can connect up to six detachable single-band antennas to the male 802.11a/b/g/n RP-SMA (reverse polarity-subminiature version A) connectors. Connect the longer antennas, which support 2.4 GHz frequencies (for IEEE 802.11b/g/n), to the connectors on the side panel with the Ethernet ports. Connect the shorter antennas, which support 5 GHz frequencies (for IEEE 802.11a/n), to the connectors on the side panel with the device lock slot. For details, see "Antennas" on page 54.

Component	Description
10/100/1000 Mbps PoE Ports	The two 10/100/1000-Mbps Ethernet ports—ETH0 and ETH1—support IEEE 802.3af and 802.3at PoE (Power over Ethernet) and receive RJ-45 connectors. The HiveAP can receive power through one or both Ethernet connections from PSE (power sourcing equipment) that is compatible with the 802.3af standard and the forthcoming 802.at standard, such as one of the PoE injectors available as an optional accessory from Aerohive. (If you connect the HiveAP to a power source through the power connector and PoE ports simultaneously, the device draws power through the power connector and automatically disables PoE.) You can configure ETH0 and ETH1 as two individual Ethernet interfaces, combine them into an aggregate interface to increase throughput, or combine them into a redundant interface to increase reliability. You can connect the HiveAP 340 to a wired network or to a wired device (such as a security camera) through these ports using bridging. They are compatible with 10/100/1000Base-T/TX and automatically negotiate half- and full-duplex connections with the connecting device. They are autosensing and adjust to straight-through and cross-over Ethernet cables automatically. For details, see "Ethernet and Console Ports" on page 50.
Power Connector	The 48-volt DC power connector (0.625 amps) is one of two methods through which you can power the HiveAP 340. To connect it to a 100 – 240-volt AC power source, use the AC/DC power adaptor that is available as an extra option. Because the HiveAP does not have an on/off switch, connecting it to a power source automatically powers on the device.
Console Port	You can access the CLI by making a serial connection to the RJ-45 console port. The management station from which you make a serial connection to the HiveAP must have a VT100 emulation program, such as Tera Term Pro© (a free terminal emulator) or Hilgraeve Hyperterminal® (provided with Windows® operating systems). The following are the serial connection settings: bits per second: 9600, data bits: 8, parity: none, stop bits: 1, flow control: none. For details, see "Ethernet and Console Ports" on page 50.
Reset Button	The reset button allows you to reboot the device or reset the HiveAP to its factory default settings. Insert a paper clip, or something similar, into the Reset pinhole and press the reset button. To reboot the device, hold the button down between 1 and 5 seconds. To return the configuration to the factory default settings, hold it down for at least 5 seconds. After releasing the button, the Power LED goes dark as the system reboots. Then it pulses green while the firmware loads and the system performs a self-test. After the software finishes loading, the Power LED glows steady green. To disable the reset button from resetting the configuration, enter this command: **`no reset-button reset-config-enable`** Pressing the button between 1 and 5 seconds will still reboot the HiveAP, but pressing it for more than 5 seconds will not reset its configuration.

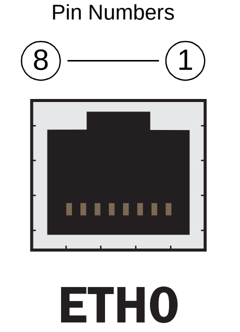
Note: The rear surface of the HiveAP 340 is used for heat dissipation to reduce the internal temperature. Consequently, it can become hot, so use caution when handling it.

Ethernet and Console Ports

There are three ports on the HiveAP 340: two RJ-45 10/100/1000Base-T/TX Ethernet ports and an RJ-45 console port.

The pin assignments in the PoE (Power over Ethernet) Ethernet ports follow the TIA/EIA-568-B standard (see Figure 2). The ports accept standard types of Ethernet cable—cat3, cat5, cat5e, or cat6—and can receive power over this cable from power sourcing equipment (PSE) that is 802.3af-compatible. If you use cat5, cat5e, or cat6 cables, the HiveAP 340 can also support 802.3at-compliant PSE. Such equipment can be embedded in a switch or router, or it can come from purpose-built devices that inject power into the Ethernet line en route to the HiveAP. Because the PoE ports have autosensing capabilities, the wiring termination in the Ethernet cable can be either straight-through or cross-over.

Figure 2 PoE Wire Usage and Pin Assignments



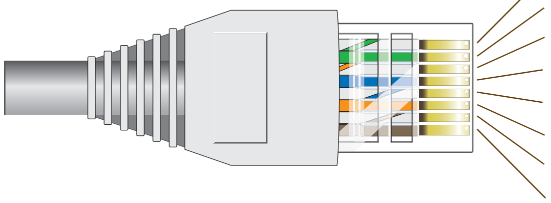
(View of the ETH0 PoE Port on the HiveAP 340)

		802.3af Alternative A (Data and Power on the Same Wires)		802.3af Alternative B (Data and Power on Separate Wires)	802.3at Wiring Options			
Pin	Data Signal	MDI	MDI-X	MDI or MDI-X	1	2	3	4
1	Transmit +	DC+	DC–	– – –	DC1+	DC1–	DC1+	DC1–
2	Transmit -	DC+	DC–	– – –	DC1+	DC1–	DC1+	DC1–
3	Receive +	DC–	DC+	– – –	DC1–	DC1+	DC1–	DC1+
4	(unused)	– – –	– – –	DC+	DC2+	DC2+	DC2–	DC2–
5	(unused)	– – –	– – –	DC+	DC2+	DC2+	DC2–	DC2–
6	Receive -	DC–	DC+	– – –	DC1–	DC1+	DC1–	DC1+
7	(unused)	– – –	– – –	DC–	DC2–	DC2–	DC2+	DC2+
8	(unused)	– – –	– – –	DC–	DC2–	DC2–	DC2+	DC2+

MDI = Medium dependent interface for straight-through connections
MDI-X = Medium dependent interface for cross-over (X) connections

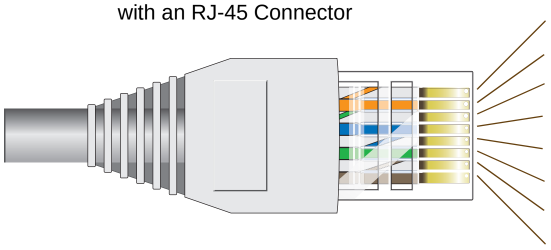
The PoE ports are auto-sensing and can automatically adjust to transmit and receive data over straight-through or cross-over Etherne connections. L kewise, they can automatically adjust to 802.3af Alternative A and B power delivery methods. Furthermore, when the Alternative A method is used, the ports automatically allow for polarity reversals depending on their role as either MDI or MDI-X. In 802.3at, the 1/2 and 3/6 wire pairs connect to DC source 1 and 4/5 and 7/8 pairs to DC source 2 in PSE. Although the exact polarity depends on the PSE design, the HiveAP 340 Ethernet ports can support all possible options.

T568A-Terminated Ethernet Cable with an RJ-45 Connector



Pin	T568A Wire Color
1	White/Green
2	Green
3	White/Orange
4	Blue
5	White/Blue
6	Orange
7	White/Brown
8	Brown

T568B -terminated Ethernet Cable with an RJ-45 Connector



Pin	T568B Wire Color
1	White/Orange
2	Orange
3	White/Green
4	Blue
5	White/Blue
6	Green
7	White/Brown
8	Brown

T568A and T568B are two standard wiring termination schemes. Note that the only difference between them is that the white/green + solid green pair of wires and the white/orange + solid orange pair are reversed.

For straight-through Ethernet cables—using either the T568A or T568B standard—the eight wires terminate at the same pins on each end.

For cross-over Ethernet cables, the wires terminate at one end according to the T568A standard and at the other according to T568B.

Smart PoE

The HiveAP 340 applies the Aerohive concept of smart PoE to adjust power consumption as necessitated by varying levels of available power. No adjustments are needed when the power level is 17.5 W (watts) or higher. If the available power drops to a range between 16 and 17.5 W, the HiveAP disables the ETH1 interface. If the level drops to the 14.4 – 16 W range, it then switches from 3x3 MIMO (Multiple In, Multiple Out) to 2x3 (see "MIMO" on page 55). In rare cases when the power drops between 12 and 14.4 W and further power conservation is necessary, the HiveAP reduces the speed on ETH0 from 10/100/1000 Mbps to 10/100 Mbps. Finally, in the event that there is a problem with the PoE switch or Ethernet cable and the power falls between 0 and 12 W, the HiveAP disables its wireless interfaces and returns its ETH0 and ETH1 interfaces to 10/100/1000 Mbps speeds. Through the application of smart PoE, the HiveAP 340 can make power usage adjustments so that it can continue functioning even when the available power level drops.

Aggregate and Redundant Interfaces

By default ETH0 and ETH1 act as two individual Ethernet interfaces. When both interfaces are connected to the network and are in backhaul mode, the HiveAP transmits broadcast traffic only through ETH0. The HiveAP transmits broadcast traffic through ETH1 only when ETH0 does not have network connectivity. When both Ethernet interfaces are connected to the network and are in access mode, then the HiveAP transmits broadcast traffic through all the access interfaces: ETH0, ETH1, and all wireless subinterfaces in access mode.

In addition to using ETH0 and ETH1 as individual interfaces, you can combine them into an aggregate interface (agg0) to increase throughput, or combine them into a redundant interface (red0) to increase reliability. The logical red0 and agg0 interfaces support all the settings that you can configure for Ethernet interfaces except those pertaining to physical link characteristics such as link speed. See the sections below for configuration information.

Aggregate Interface

You can increase throughput onto the wired network by combining ETH0 and ETH1 into a single logically aggregated interface called "agg0". The aggregate interface effectively doubles the bandwidth that each physical interface has when used individually. In this configuration, both Ethernet ports actively forward traffic, the HiveAP applying an internal scheduling mechanism based on the source MAC address of each packet to send traffic through the aggregate member interfaces. To configure an aggregate interface, enter the following commands:

```
interface eth0 bind agg0
interface eth1 bind agg0
```

In addition to configuring the HiveAP, you must also configure the connecting switch to support EtherChannel. For example, the following commands bind two physical Ethernet ports—0/1 and 0/2—to the logical interface port-channel group 1 on a Cisco Catalyst 2900 switch running Cisco IOS 12.2:

```
Switch#conf t

Switch(config)#interface port-channel 1
Switch(config-if)#switchport mode access
Switch(config-if)#spanning-tree portfast
Switch(config-if)#exit

Switch(config)#interface fastEthernet 0/1
Switch(config-if)#switchport mode access
Switch(config-if)#channel-group 1 mode on
Switch(config-if)#spanning-tree portfast
Switch(config-if)#exit
Switch(config)#int fastEthernet 0/2
Switch(config-if)#switchport mode access
Switch(config-if)#channel-group 1 mode on
Switch(config-if)#spanning-tree portfast
Switch(config-if)#exit
Switch(config)#exit

Switch#wr mem
```

Finally, you must cable the Cisco switch and the HiveAP together: Cisco 0/1 to HiveAP eth0, and Cisco 0/2 to HiveAP eth1.

Redundant Interface

If a single Ethernet link provides sufficient bandwidth and speed, such as a 1000 Mbps link, but you want to ensure link redundancy, you can connect the two Ethernet ports to the same switch—or to two different switches—and configure them to act as a redundant interface called "red0". In this mode, only one Ethernet interface is actively forwarding traffic at any one time. If eth0 is active and eth1 is passive and eth0 loses its connection, the HiveAP switches over to eth1. To configure a redundant interface, enter the following commands:

```
interface eth0 bind red0 primary
interface eth1 bind red0
```

The interface that you specify as primary is the one that the HiveAP uses when both interfaces have network connectivity. Because the HiveAP uses eth0 as the primary interface by default, it is unnecessary to specify "primary" in the first command above. However, it is included to make the role of eth0 as the primary interface obvious.

Note: No extra configuration is necessary on the connecting switch or switches to support a redundant interface.

Interface Selection for the Default Route

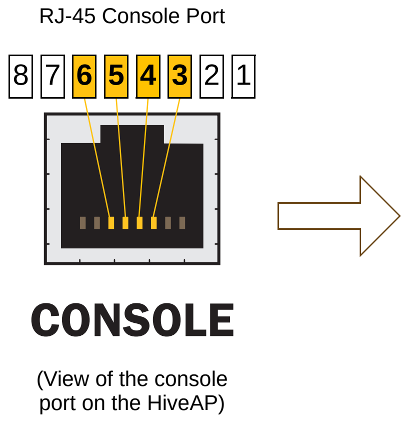
In cases where there are multiple active interfaces in backhaul mode, the HiveAP uses the following logic to choose which interface to use in its default route:

- If there is an Ethernet interface and a wireless interface in backhaul mode, the HiveAP uses the Ethernet interface in its default route.
- If there are multiple Ethernet interfaces in backhaul mode, the HiveAP chooses which one to use in its default route in the following order:
  - It uses red0 or agg0 if one of them has at least one member interface bound to it and its link state is UP.
  - It uses ETH0 if neither red0 nor agg0 has any member interfaces and the link state for ETH0 is UP.
  - It uses ETH1 if neither red0 nor agg0 has any member interfaces, the link state for ETH0 is DOWN, and the link state for ETH1 is UP.

Console Port

The pin-to-signal mapping in the RJ-45 console port is shown shown in Figure 3.

Figure 3   Console Port Pin Assignments



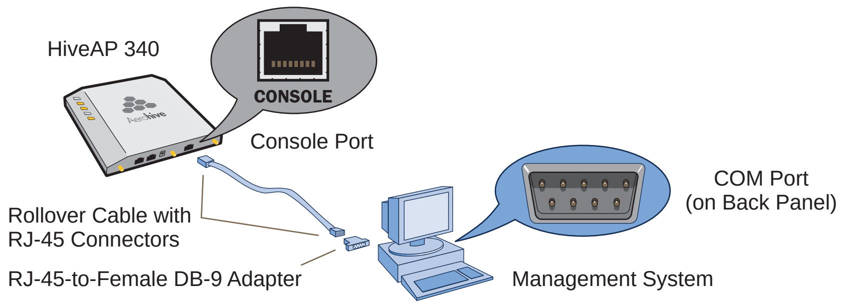
Console Port Pin Assignments

Pin	Signal	Direction
1	RTS (Request to Send)	Output, unused
2	DTR (Data Terminal Ready)	Output, unused
3	**TXD (Transmitted Data)**	**Output**
4	**Ground**	**Ground**
5	**Ground**	**Ground**
6	**RXD (Received Data)**	**Input**
7	DSR (Data Set Ready)	Input, unused
8	CTS (Clear to Send)	Input, unused

Because this is a console port, only pins **3**, **4**, **5**, and **6** are currently in use.

To make a serial connection between your management system and the HiveAP, you can use the console cable that is available as an extra option. Insert the RJ-45 connector into the HiveAP 340 console port, and attach the DB-9 connector to the serial (or COM) port on your management system. The management system must have a VT100 terminal emulation program, such as Tera Term Pro© (a free terminal emulator) or Hilgraeve Hyperterminal® (provided with Windows® operating systems). If you want to make your own serial cable and adapter, refer to Figure 3.

Figure 4   Wiring Details for Making a Serial Cable with an RJ-45-to-Female DB-9 Adapter



Console Port (HiveAP 340)	RJ-45-to-RJ-45 Rollover Cable		RJ-45-to-Female DB-9 Adapter		Management System
Signal	RJ-45 Pin	RJ-45 Pin	RJ-45 Pin	DB-9 Pin	Signal
RTS (Request to Send)	1	8	1	8	CTS (unused)
DTR (Data Terminal Ready)	2	7	2	6	DSR (unused)
TXD (Transmitted Data)	3	6	3	2	RXD
Ground	4	5	4	5	Ground
Ground	5	4	5	5	Ground
RXD (Received Data)	6	3	6	3	TXD
DSR (Data Set Ready)	7	2	7	4	DTR (unused)
CTS (Clear to Send)	8	1	8	7	RTS (unused)
-	-	-	-	9	RI (Ring Indicator, unused)

Status LEDs

The five status LEDs on the top of the HiveAP 340 indicate various states of activity through their color (dark, green, amber, and red) and illumination patterns (steady glow or pulsing). The meanings of the various color + illumination patterns for each LED are explained below.

Power

- Dark: No power
- Steady green: Powered on and the firmware is running normally
- Pulsing green: Firmware is booting up
- Steady amber: Firmware is being updated
- Pulsing amber: Alarm indicating a firmware issue has occurred
- Steady red: Alarm indicating a hardware issue has occurred

ETH0 and ETH1

- Dark: Ethernet link is down or disabled
- Steady green: 1000 Mbps Ethernet link is up but inactive
- Pulsing green: 1000 Mbps Ethernet link is up and active
- Steady amber: 10/100 Mbps Ethernet link is up but inactive
- Pulsing amber: 10/100 Mbps Ethernet link is up and active

WIFI0 and WIFI1

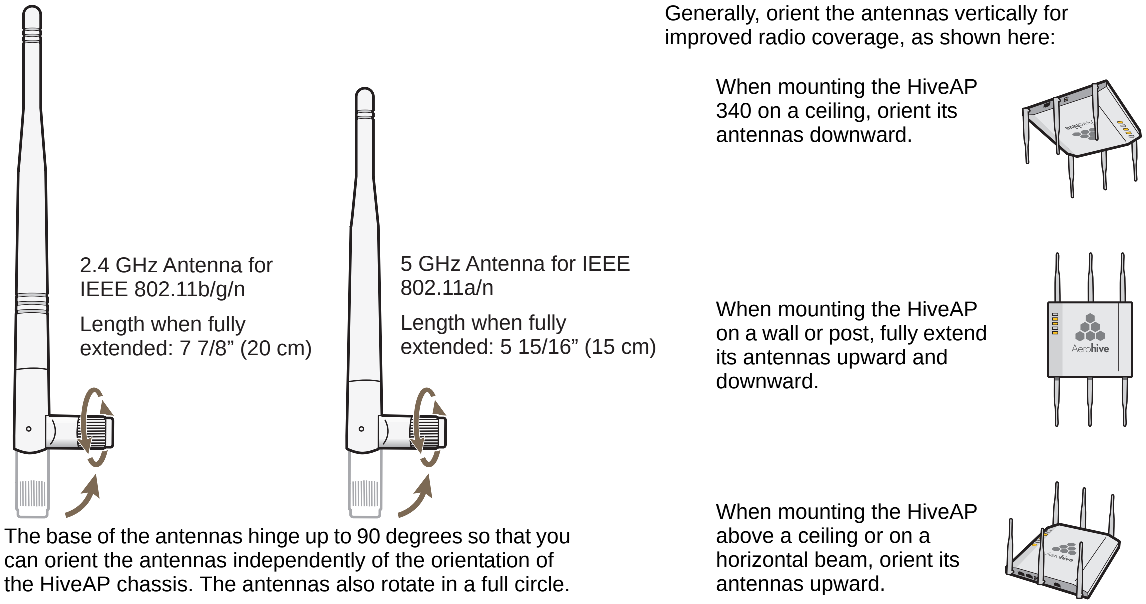
- Dark: Wireless interface is disabled
- Steady green: Wireless interface is in access mode but inactive
- Pulsing green: Wireless interface is in access mode and active
- Steady amber: Wireless interface is in backhaul mode but inactive
- Pulsing amber: Wireless interface is in backhaul mode and is connected with other hive members
- Alternating green and amber: Wireless interface is in backhaul mode and is searching for other hive members

Antennas

Antennas are an integral part of the HiveAP 340. The HiveAP 340 can accept up to six detachable dipole antennas. The three shorter antennas are designed for the 5 GHz band and have a 2-dBi gain. The three longer antennas are designed for the 2.4 GHz band and have a 4.9-dBi gain. These antennas are omnidirectional, providing fairly equal coverage in all directions in a toroidal (donut-shaped) pattern around each antenna (see Figure 4 on page 30). For greater coverage on a horizontal plane, it is best to orient the antennas vertically. So that you can easily do that whether the HiveAP chassis is mounted horizontally or vertically, the antennas hinge and swivel (see Figure 5 on page 55.)

Although hive members automatically adjust their signal strength according to their environments, you can resize the area of coverage by increasing or decreasing the signal strength manually by entering the `interface { wifi0 | wifi1 } radio power <number>` command, where `<number>` can be from 1 to 20 and represents a value in dBm.

Figure 5 HiveAP 340 Antennas



2.4 GHz Antenna for IEEE 802.11b/g/n

Length when fully extended: 7 7/8” (20 cm)

5 GHz Antenna for IEEE 802.11a/n

Length when fully extended: 5 15/16” (15 cm)

The base of the antennas hinge up to 90 degrees so that you can orient the antennas independently of the orientation of the HiveAP chassis. The antennas also rotate in a full circle.

Generally, orient the antennas vertically for improved radio coverage, as shown here:

When mounting the HiveAP 340 on a ceiling, orient its antennas downward.

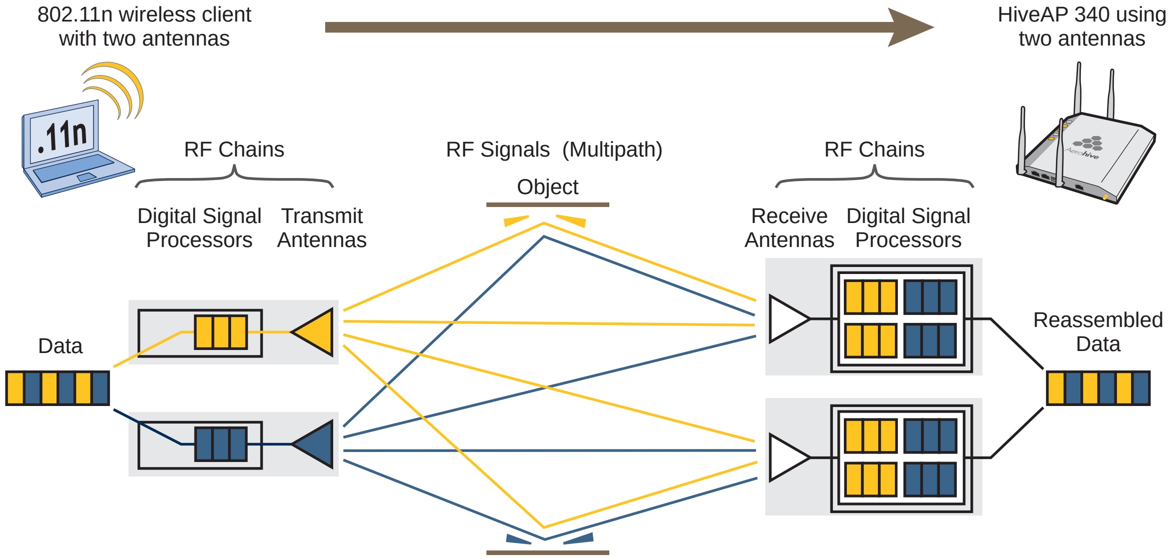
When mounting the HiveAP on a wall or post, fully extend its antennas upward and downward.

When mounting the HiveAP above a ceiling or on a horizontal beam, orient its antennas upward.

MIMO

MIMO (Multiple In, Multiple Out) is a major WLAN advancement introduced in the IEEE 802.11n standard in which multiple RF links are formed on the same channel between the transmitter and receiver simultaneously. To accomplish this, the transmitter separates a single data stream into multiple spatial streams, one for each RF chain (an antenna + various digital signal processing modules linked to the antenna). The transmit antennas at the end of each RF chain then transmit their spatial streams. The recipient’s receive antennas obtain streams from all the transmit antennas. In fact, due to multipath, they receive multiple streams from each transmit antenna. The receive antennas pass the spatial streams to the digital signal processors in their RF chains, which take the best data from all the spatial streams and reassemble them into a single data stream once again (see Figure 6).

Figure 6 2x2 MIMO (2 Transmit Antennas x 2 Receive Antennas)


802.11n wireless client with two antennas
.11n
HiveAP 340 using two antennas
RF Chains
RF Signals (Multipath)
RF Chains
Object
Digital Signal Processors
Transmit Antennas
Receive Antennas
Digital Signal Processors
Data
Reassembled Data

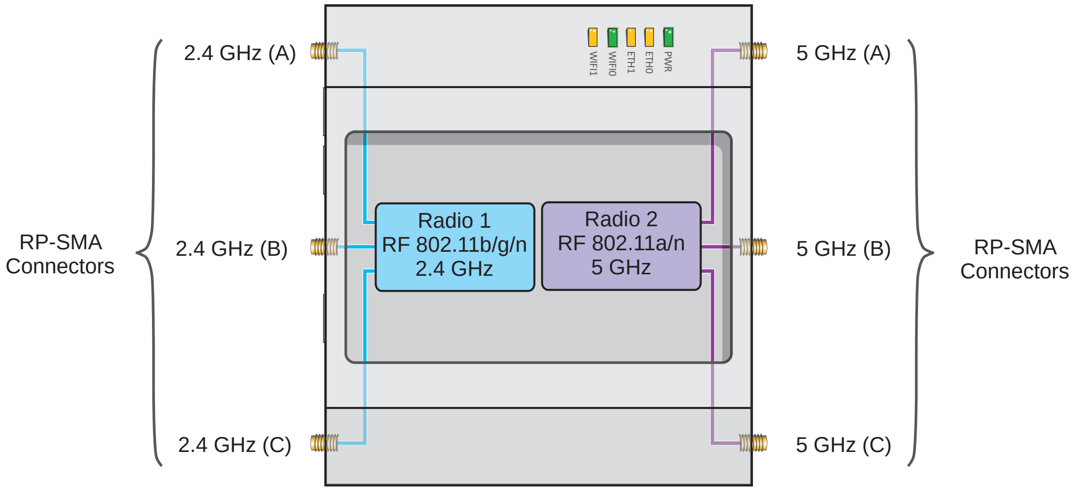
In previous 802.11 standards, access points and clients each employed a single set of components, or RF chain, for transmitting or receiving. Although two antennas are often used for diversity, only the one with the best signal-to-noise ratio is used at any given moment, and that antenna makes use of the single RF chain while the other antenna remains inactive. A significant improvement that MIMO introduces is to permit each antenna to have its own RF chain and for all antennas to function simultaneously. For the HiveAP 340, you can connect up to three antennas per radio and configure the radio to use two or three transmit chains and two or three receive chains.[1] Using two or three transmit and receive chains simultaneously increases the amount of data that can flow across the WLAN and accelerates the processing of that data at each end of the wireless link.

Another major aspect of MIMO is how it turns multipath signals from a curse to a boon. As a radio signal moves through space, some objects reflect it, others interfere with it, and still others absorb it. The receiver can end up receiving multiple copies of the original signal, all kind of muddled together. However, the digital signal processors in the multiple receive chains are able to combine their processing efforts to sort through all the received data and reconstruct the original message. Furthermore, because the transmitter makes use of multiple RF chains, there is an even richer supply of signals for the receive chains to use in their processing. To set the transmit and receive RF chains for a radio profile, enter the following commands:

```
radio profile <name> transmit-chain { 2 | 3 }
radio profile <name> receive-chain { 2 | 3 }
```

There are two sets of antennas—three antennas per set—that operate concurrently in two different frequency ranges: 2.4 GHz (IEEE 802.11b/g/n) and 5 GHz (IEEE 802.11a/n). Using two different frequency ranges reduces the probability of interference that can occur when numerous channels operate within the same range. Conceptually, the relationship of antennas and radios is shown in Figure 7.

Figure 7 Antennas and Radios



Cut-away view of the HiveAP 340 to show the relationship of the antennas and the two internal radios

The wifi0 interface links to radio 1 (frequency range = 2.4 GHz for IEEE 802.11b/g), and the wifi1 interface links to radio 2 (frequency range = 5 GHz for IEEE 802.11a). These interface-to-radio relationships are permanent.

When deciding how many antennas to use, consider the types of wireless clients—802.11n only, 802.11g/n, 802.11b/g/n, or 802.11a/n—the area needing coverage, and the RF environment.

[1] The convention for presenting the configuration of transmitting and receiving MIMO RF chains is TxR. For example, a HiveAP 340 radio functioning in access mode might be configured to use two RF chains for transmitting and three for receiving. In that case, its configuration can be presented as "2x3". In general, the number of receive antennas is equal to or greater than the number of transmit antennas.

Using MIMO with Legacy Clients

In addition to supporting up to 300-Mbps throughput per radio for 802.11n clients, MIMO (Multiple In, Multiple Out) can improve the reliability and speed of legacy 802.11a/b/g client traffic. When an 802.11a/b/g access point does not receive acknowledgement that a frame it sent was received, it resends that frame, possibly at a somewhat lower transmission rate. If the access point must continue resending frames, it will continue lowering its transmission rate. As a result, clients that could get 54-Mbps throughput in an interference-free environment might have to drop to 48- or 36-Mbps speeds due to multipath interface. However, because MIMO technology makes better use of multipath, an access point using MIMO can continue transmitting at 54 Mbps, or at least at a better rate than it would in a pure 802.11a/b/g environment, thus improving the reliability and speed of 802.11a/b/g client traffic.

Although 802.11a/b/g client traffic can benefit somewhat from an 802.11n access point using MIMO, supporting such legacy clients along with 802.11n clients can have a negative impact on 802.11n client traffic. Legacy clients take longer to send the same amount of data as 802.11n clients. Consequently, legacy clients consume more airtime than 802.11n clients do, causing greater congestion in the WLAN and reducing 802.11n performance.

By default, the HiveAP 340 supports 802.11a/b/g clients. You can restrict access only to clients using the IEEE 802.11n standard. By only allowing traffic from clients using 802.11n, you can increase the overall bandwidth capacity of the access point so that there will not be an impact on 802.11n clients during times of network congestion. To do that, enter the following command:

```
radio profile <string> 11n-clients-only
```

You can also deny access just to clients using the IEEE 802.11b standard, which has the slowest data rates of the three legacy standards, while continuing to support 802.11a and 802.11g clients. To do that, enter the following command:

```
no radio profile <string> allow-11b-clients
```

By blocking access to 802.11b clients, their slower data rates cannot clog the WLAN when the amount of wireless traffic increases.

MOUNTING THE HIVEAP 340

Using the mounting plate and track clips, you can mount the HiveAP 340 to the tracks of a dropped ceiling grid. Using just the mounting plate, you can mount the HiveAP to any surface that can support its weight (3.3 lb., 1.5 kg).

Ceiling Mount

To mount the HiveAP 340 to a track in a dropped ceiling, you need the mounting plate, two track clips, and two Keps nuts, all of which ship as an option with the HiveAP 340. You also need a drill and—most likely—a ladder.

Nudge the ceiling tiles slightly away from the track to clear some space. Attach the track clips to the ceiling track, and then fasten the mounting plate to the clips, as shown in Figure 8. When you have the mounting plate in the correct location, cut or drill a hole in the ceiling through which you can then pass the Ethernet and power cables.

Figure 8 Attaching the Track Clips and Mounting Plate to the Ceiling Track

(worms's eye view with ceiling tiles removed for clarity)

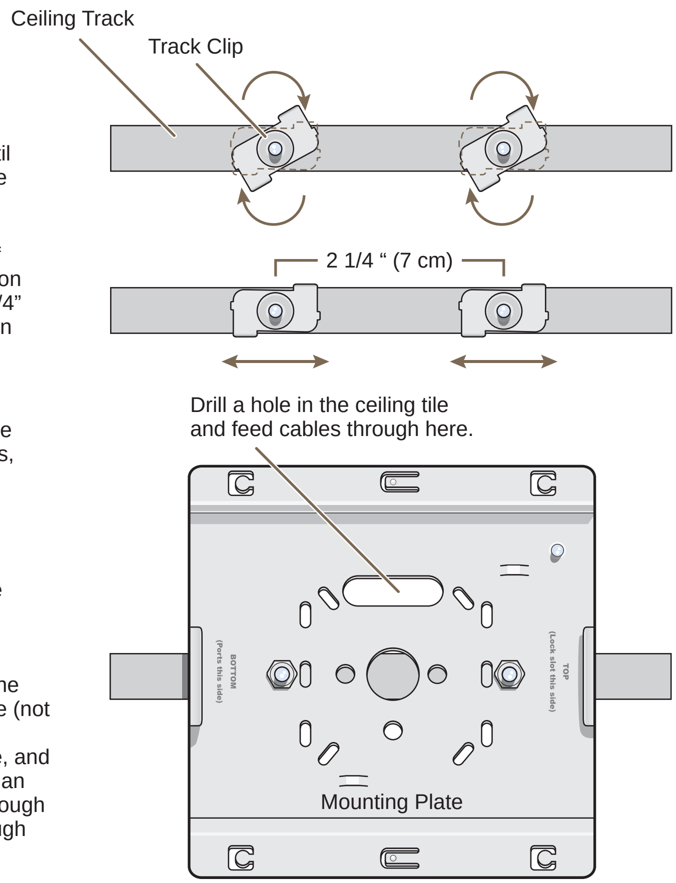
1 Press the track clips against the ceiling track and swivel them until they snap into place, gripping the edges of the track.

If necessary, slide one or both of the clips along the track to position them at the proper distance (2 1/4" or 7 cm) to fit through the holes in the mounting plate.

2 Insert the mounting track over the screws attached to the track clips, and use the Keps nuts to fasten the plate firmly to the screws on the clips.

Use a wrench to tighten the nuts firmly to the bolts and secure the plate to the track.

3 Through the oblong opening in the plate, drill a hole in the ceiling tile (not shown). Then pass one or both Ethernet cables through the hole, and if you plan to supply power from an AC power source rather than through PoE, pass the power cable through as well.


Ceiling Track
Track Clip
2 1/4 " (7 cm)
Drill a hole in the ceiling tile and feed cables through here.
BOTTOM (Ports this side)
TOP (Lock slot this side)
Mounting Plate

Attach the HiveAP 340 to the mounting plate and connect the cables, as shown in Figure 9 on page 59.

> *Note: You can tie the cables to the tie points (small arched strips) on the mounting plate to prevent them from being pulled out of their connections accidentally.*

Figure 9 Attaching the HiveAP 340 to the Mounting Plate and Connecting Cables

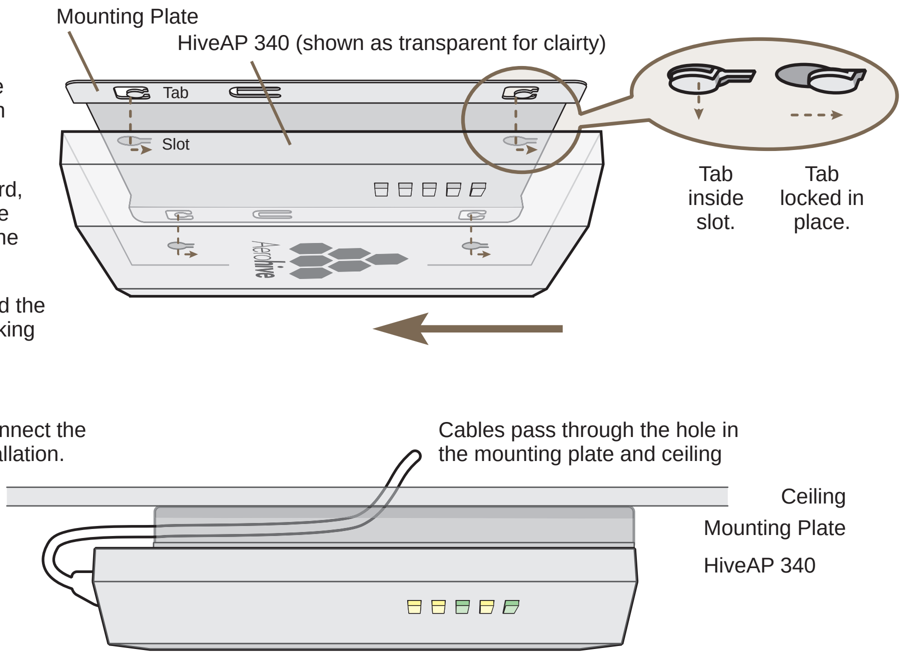
(side view)

4 With the HiveAP 340 upside down, align its port side with the bottom end of the plate.

5 Push the HiveAP 340 upward, inserting the four tabs on the plate into the four slots on the HiveAP 340.

6 Slide the HiveAP 340 toward the bottom end of the plate, locking the tabs inside the slots.

7 Attach the antennas and connect the cables to complete the installation.


Mounting Plate
HiveAP 340 (shown as transparent for clairty)
Tab
Slot
Tab inside slot.
Tab locked in place.
Cables pass through the hole in the mounting plate and ceiling
Ceiling
Mounting Plate
HiveAP 340

When done, adjust the ceiling tiles back into their former position.

Locking the HiveAP 340

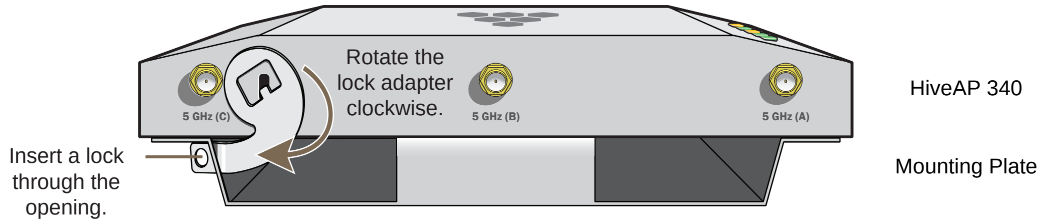
To lock the HiveAP 340 to the mounting plate, use either a Kensington lock or the lock adapter that is included with the mounting kit and a small padlock (not included).

To use a Kensington lock, loop the cable attached to the lock around a secure object, insert the T-bar component of the lock into the device lock slot on the HiveAP, and then turn the key to engage the lock mechanism.

To use the lock adapter :

1. Insert the T-shaped extension on the adapter into the device lock slot, and rotate it clockwise so that the curved section extends through the slot in the mounting plate (see Figure 10).

   Figure 10 Locking the HiveAP 340 to the Mounting Plate

   
   Rotate the lock adapter clockwise.
5 GHz (C)
5 GHz (B)
5 GHz (A)
HiveAP 340
Mounting Plate
Insert a lock through the opening.

2. Link a padlock through the opening in the adapter and engage the lock to secure the HiveAP 340 to the mounting plate. The opening is 1/8" (0.3 cm) in diameter at its narrowest.

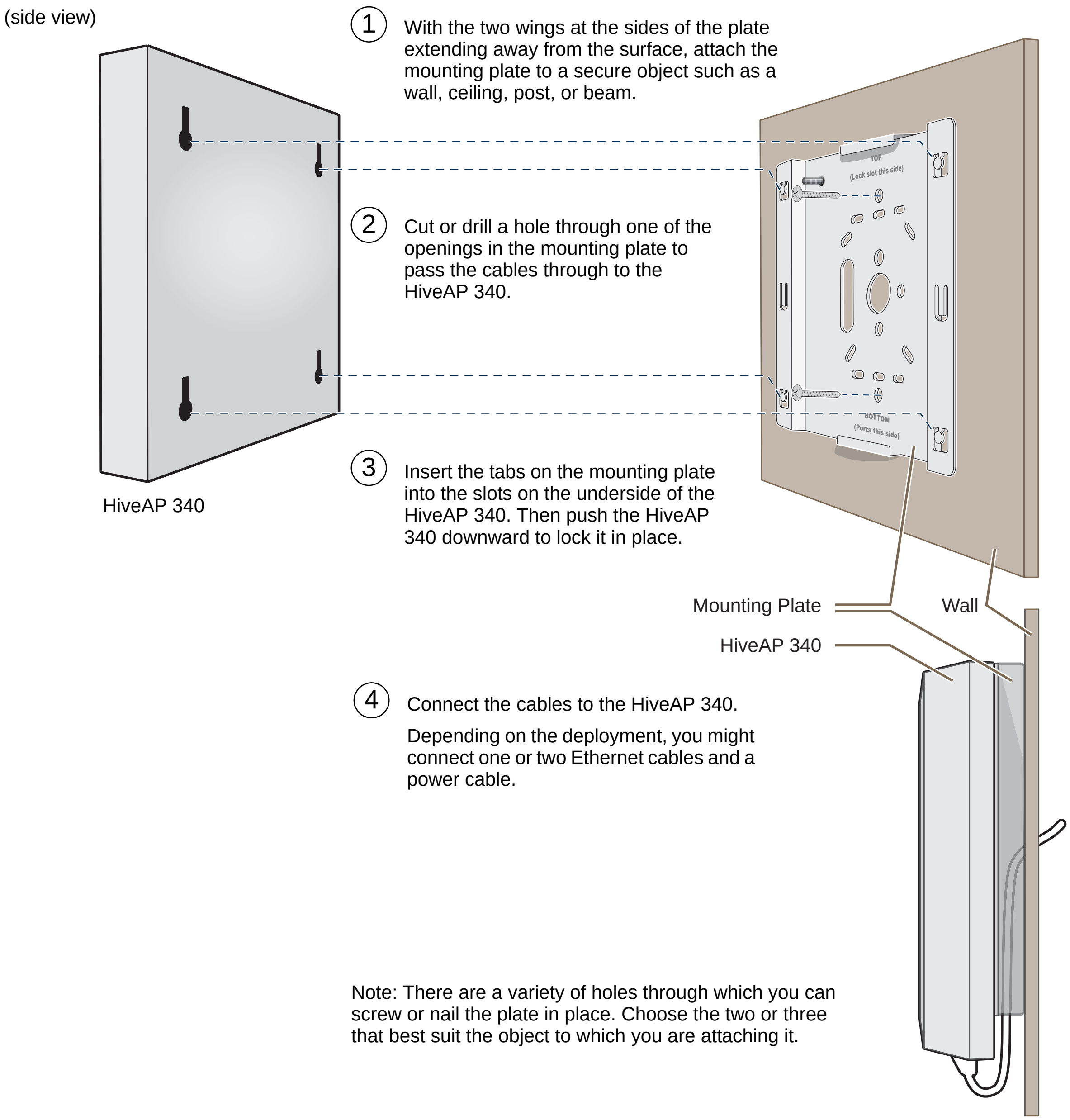
Surface Mount

You can use the mounting plate to attach the HiveAP 340 to any surface that supports its weight, and to which you can screw or nail the plate. First, mount the plate to the surface. Then, through one of the two large openings in the plate, make a hole in the wall so that you can pass the cables through to the HiveAP.

> *Note: You can tie the cables to the tie points on the mounting plate to prevent them from being pulled out of their connections accidentally.*

Finally, attach the device to the plate, and connect the cables, as shown in Figure 11.

Figure 11 Mounting the HiveAP on a Wall



1 With the two wings at the sides of the plate extending away from the surface, attach the mounting plate to a secure object such as a wall, ceiling, post, or beam.

2 Cut or drill a hole through one of the openings in the mounting plate to pass the cables through to the HiveAP 340.

3 Insert the tabs on the mounting plate into the slots on the underside of the HiveAP 340. Then push the HiveAP 340 downward to lock it in place.

4 Connect the cables to the HiveAP 340.

Depending on the deployment, you might connect one or two Ethernet cables and a power cable.

Note: There are a variety of holes through which you can screw or nail the plate in place. Choose the two or three that best suit the object to which you are attaching it.

DEVICE, POWER, AND ENVIRONMENTAL SPECIFICATIONS

Understanding the range of specifications for the HiveAP 340 is necessary for optimal deployment and device operation. The following specifications describe the physical features and hardware components, the power adapter and PoE (Power over Ethernet) electrical requirements, and the temperature and humidity ranges in which the device can operate.

Device Specifications

- Chassis dimensions: 8 1/2" W x 1 1/4" H x 8" D (21.5 cm W x 3.2 cm H x 20.3 cm D)
- Weight: 3 lb. (1.36 kg)
- Antennas: Three omnidirectional 802.11b/g/n antennas, and three omnidirectional 802.11a/n antennas
- Serial port: RJ-45 (bits per second: 9600, data bits: 8, parity: none, stop bits: 1, flow control: none)
- Ethernet ports: autosensing 10/100/1000 Base-T/TX Mbps; both ports are compliant with the IEEE 802.3af standard and the forthcoming 802.at standard for PoE (Power over Ethernet)

Power Specifications

- AC/DC power adapter:
  - Input:100 – 240 VAC
  - Output: 48V/0.38A
- PoE nominal input voltages:
  - 802.3af: 48 V/0.35A
  - Pre-802.3at: 48 V/0.625A
- RJ-45 power input pins: Wires 4, 5, 7, 8 or 1, 2, 3, 6

Environmental Specifications

- Operating temperature: -4 to 131 degrees F (-20 to 55 degrees C)
- Storage temperature: -40 to 176 degrees F (-40 to 80 degrees C)
- Relative Humidity: Maximum 95%

Chapter 5 The HiveAP 320 Platform

The Aerohive HiveAP 320 is a high-performance and highly reliable 802.11n wireless access point. The HiveAP 320 provides dual concurrent 802.11b/g/n and 802.11a/n radios for 3x3 MIMO (Multiple In, Multiple Out) and dual 10/100/1000 Ethernet ports for link aggregation or link redundancy. Its power management system uses a concept called smart PoE (Power over Ethernet) to adjust its power consumption automatically in response the available power in different environments. Smart PoE supports the IEEE 802.3af standard and the 802.3at pre-standard.

This chapter covers the following topics relating to the HiveAP 320:

Note: The HiveAP 320 supports all same 802.11n features as the HiveAP 340. Of particular interest is its support of MIMO (Multiple Input, Multiple Output). For more information, see "MIMO" on page 55 and "Using MIMO with Legacy Clients" on page 57.

HIVEAP 320 PRODUCT OVERVIEW

The HiveAP 320 is a multi-channel wireless access point. It is compatible with IEEE 802.11b/g/n (2.4 GHz) and IEEE 802.11a/n (5 GHz) standards and supports a variety of Wi-Fi (wireless fidelity) security protocols, including WPA (Wi-Fi Protected Access) and WPA2.

You can see the hardware components on the HiveAP in Figure 1. Each component is described in Table 1.

Figure 1 HiveAP 320 Hardware Components

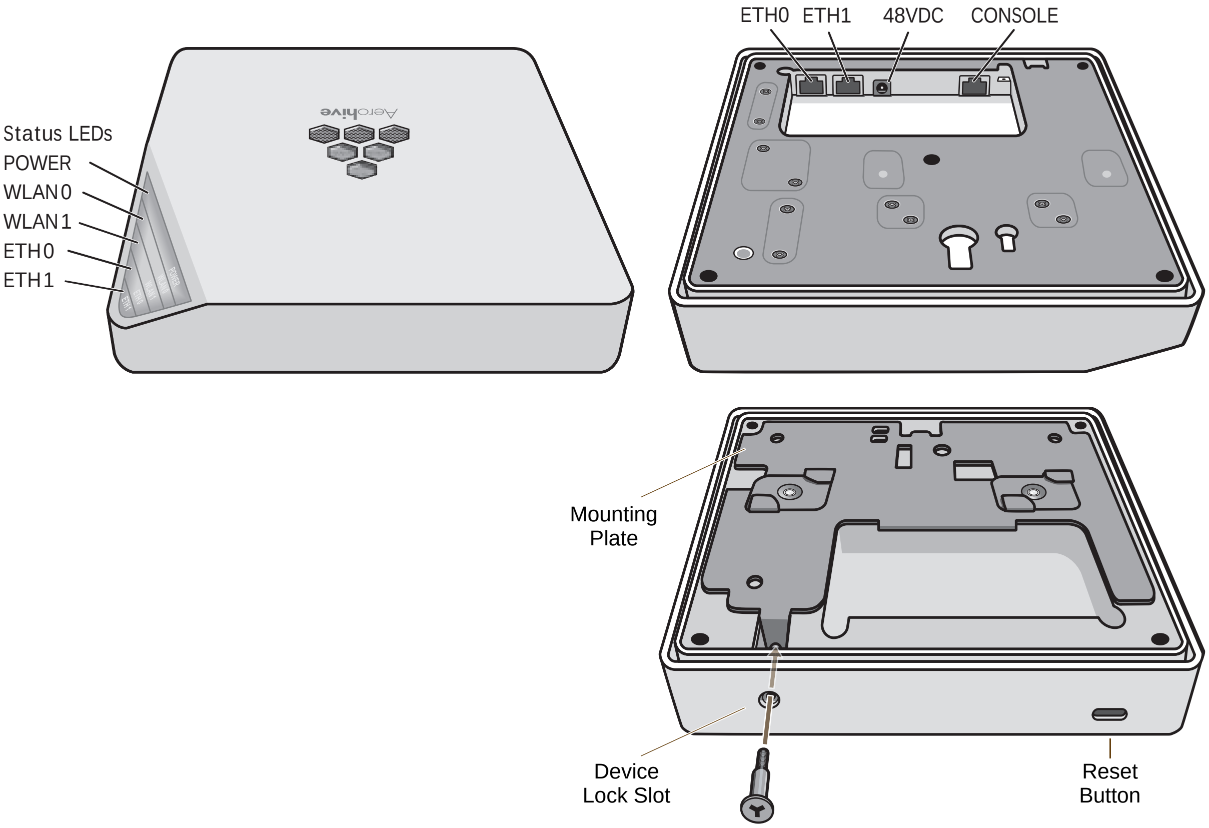


Table 1 HiveAP 320 Component Descriptions

Component	Description
Status LEDs	The status LEDs convey operational states for system power, firmware, Ethernet interfaces, and radios. For details, see "Status LEDs" on page 66.
ETH0 10/100/1000 Mbps PoE Port and ETH1 10/100/1000 Mbps Port	The two 10/100/1000-Mbps Ethernet ports—ETH0 and ETH1—receive RJ-45 connectors. The HiveAP can receive power through an Ethernet connection to the ETH0 port from PSE (power sourcing equipment) that is compatible with the 802.3af standard and the forthcoming 802.at standard. Aerohive provides suitable PoE injectors as an optional accessory. (If you connect the HiveAP to a power source through the power connector and the ETH0 PoE port simultaneously, the device draws power through the power connector and automatically disables PoE.)

Component	Description
	You can configure ETH0 and ETH1 as two individual Ethernet interfaces, combine them into an aggregate interface to increase throughput, or combine them into a redundant interface to increase reliability. You can connect the HiveAP 320 to a wired network or to a wired device (such as a security camera) through these ports using bridging. They are compatible with 10/100/1000Base-T/TX and automatically negotiate half- and full-duplex connections with the connecting device. They are autosensing and adjust to straight-through and cross-over Ethernet cables automatically. For details, see "Ethernet and Console Ports" on page 66.
48VDC Power Connector	The 48-volt DC power connector (0.625 amps) is one of two methods through which you can power the HiveAP 320. To connect it to a 100 – 240-volt AC power source, use the AC/DC power adaptor that is available as an extra option. Because the HiveAP does not have an on/off switch, connecting it to a power source automatically powers on the device.
Console Port	You can access the CLI by making a serial connection to the RJ-45 console port. The management station from which you make a serial connection to the HiveAP must have a VT100 emulation program, such as Tera Term Pro© (a free terminal emulator) or Hilgraeve Hyperterminal® (provided with Windows® operating systems). The following are the serial connection settings: bits per second: 9600, data bits: 8, parity: none, stop bits: 1, flow control: none. For details, see "Ethernet and Console Ports" on page 66.
Device Lock Slot	You can physically secure the HiveAP by attaching it to a mounting plate that is clipped to a ceiling track and then using a screw with a unique head design to fasten the HiveAP to the mounting plate through the device lock slot. The screw and special screw driver that fits the slot on the screw head are included in the mounting kit. For more information, see "Locking the HiveAP 320" on page 69.
Reset Button	The reset button allows you to reboot the device or reset the HiveAP to its factory default settings. Insert a paper clip, or something similar, into the Reset pinhole and press the reset button. To reboot the device, hold the button down between 1 and 5 seconds. To return the configuration to the factory default settings, hold it down for at least 5 seconds. After releasing the button, the Power LED goes dark as the system reboots. Then it pulses green while the firmware loads and the system performs a self-test. After the software finishes loading, the Power LED glows steady green. To disable the reset button from resetting the configuration, enter this command: **`no reset-button reset-config-enable`** Pressing the button between 1 and 5 seconds will still reboot the HiveAP, but pressing it for more than 5 seconds will not reset its configuration.

Note: The rear surface of the HiveAP 320 is used for heat dissipation to reduce the internal temperature. Consequently, it can become hot, so use caution when handling it.

Ethernet and Console Ports

There are three ports on the HiveAP 320: two RJ-45 10/100/1000Base-T/TX Ethernet ports and an RJ-45 console port.

The pin assignments in the PoE (Power over Ethernet) Ethernet ports follow the TIA/EIA-568-B standard (see Figure 2 on page 50). The ports accept standard types of Ethernet cable—cat3, cat5, cat5e, or cat6. The ETH0 port can receive power over the Ethernet cable from power sourcing equipment (PSE) that is 802.3af-compatible. If you use cat5, cat5e, or cat6 cables, the ETH0 port can also support 802.3at-compliant PSE. Such equipment can be embedded in a switch or router, or it can come from purpose-built devices that inject power into the Ethernet line en route to the HiveAP. Because the PoE ports have autosensing capabilities, the wiring termination in the Ethernet cable can be either straight-through or cross-over.

The HiveAP 320 supports the following features on its Ethernet ports:

- The HiveAP 320 supports smart PoE on its ETH0 port to adapt its power consumption to changes in the amount of power available to it over Ethernet from PSE (power sourcing equipment). For more information, see "Smart PoE" on page 51.
- The two Ethernet interfaces can be configured as aggregate interfaces for increased throughput and redundant interfaces for increased reliability. For more information, see "Aggregate and Redundant Interfaces" on page 51.

Through the RJ-45 console port, you can make a serial connection between your management system and the HiveAP. The pin-to-signal mapping of the RJ-45 console port is the same as that for the HiveAP 340, which is shown shown in Figure 3 on page 53. Similarly, cabling and connection details for the HiveAP 320 are same as those for the HiveAP 340 (see Figure 4 on page 53).

Status LEDs

The five status LEDs on the top of the HiveAP 320 indicate various states of activity through their color (dark, green, amber, and red) and illumination patterns (steady glow or pulsing). The meanings of the various color + illumination patterns for each LED are explained below.

Power

- Dark: No power
- Steady green: Powered on and the firmware is running normally
- Pulsing green: Firmware is booting up
- Steady amber: Firmware is being updated
- Pulsing amber: Alarm indicating a firmware issue has occurred
- Steady red: Alarm indicating a hardware issue has occurred

ETH0 and ETH1

- Dark: Ethernet link is down or disabled
- Steady green: 1000 Mbps Ethernet link is up but inactive
- Pulsing green: 1000 Mbps Ethernet link is up and active
- Steady amber: 10/100 Mbps Ethernet link is up but inactive
- Pulsing amber: 10/100 Mbps Ethernet link is up and active

WIFI0 and WIFI1

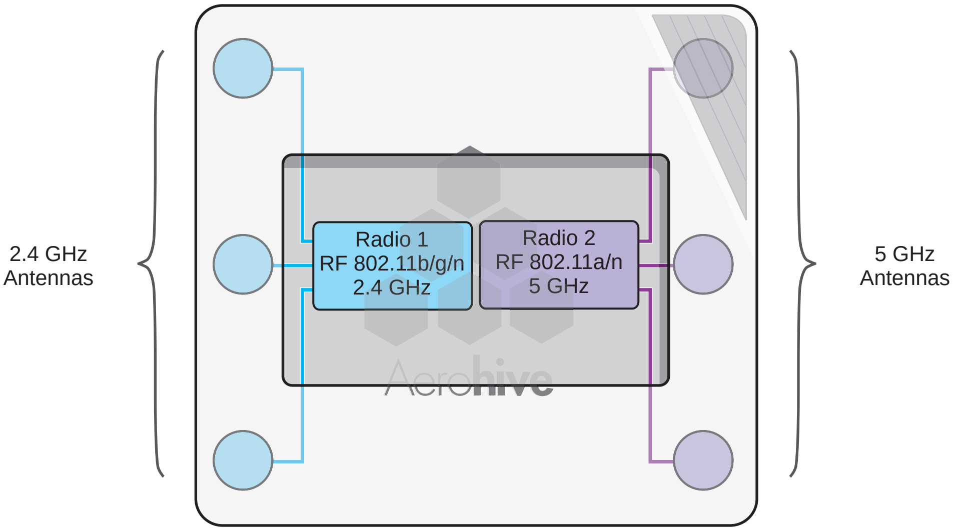
- Dark: Wireless interface is disabled
- Steady green: Wireless interface is in access mode but inactive
- Pulsing green: Wireless interface is in access mode and active
- Steady amber: Wireless interface is in backhaul mode but inactive
- Pulsing amber: Wireless interface is in backhaul mode and is connected with other hive members
- Alternating green and amber: Wireless interface is in backhaul mode and is searching for other hive members

Antennas

Antennas are an integral part of the HiveAP 320. The HiveAP 320 has six internal single-band antennas. Three of the antennas operate in the 2.4-GHz band (IEEE 802.11b/g/n) and have a 2-dBi gain. The other three antennas operate in the 5-GHz band (IEEE 802.11a/n) and have a 3-dBi gain. All antennas are omnidirectional, providing fairly equal coverage in all directions in a toroidal (donut-shaped) pattern around each antenna (see Figure 4 on page 30).

The three three 2.4-GHz antennas link to radio 1, and the three 5-GHz antennas link to radio 2. Conceptually, the relationship of antennas and radios is shown in Figure 2.

Figure 2 Antennas and Radios



Cut-away view of the HiveAP 320 to show the relationship of the antennas and the two internal radios

The wifi0 interface links to radio 1 (frequency range = 2.4 GHz for IEEE 802.11b/g), and the wifi1 interface links to radio 2 (frequency range = 5 GHz for IEEE 802.11a). These interface-to-radio relationships are permanent.

Although hive members automatically adjust their signal strength according to their environments, you can resize the area of coverage by increasing or decreasing the signal strength manually by entering the `interface { wifi0 | wifi1 } radio power <number>` command, where `<number>` can be from 1 to 20 and represents a value in dBm.

MOUNTING THE HIVEAP 320

Using the mounting plate and track clips, you can mount the HiveAP 320 to the tracks of a dropped ceiling grid. Using just the mounting plate, you can mount the HiveAP to any surface that can support its weight (2 lb., 0.68 kg).

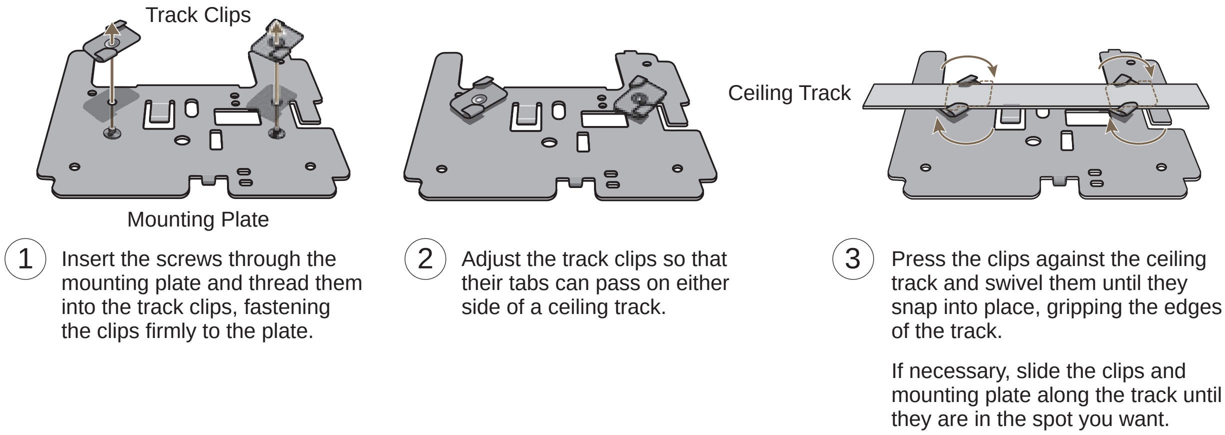
> *Note: In addition to these methods, you can also mount the HiveAP 320 on a table using the set of four rubber feet that ship with the product. Simply peel the rubber feet off the adhesive sheet and press them against the underside of the HiveAP in its four corners.*

Ceiling Mount

To mount the HiveAP 320 to a track in a dropped ceiling, you need the mounting plate, two track clips, and two Keps nuts. all of which ship as an option with the HiveAP 320. You also need a drill and—most likely—a ladder.

Nudge the ceiling tiles slightly away from the track to clear some space. Fasten the track clips to the mounting plate, and then attach them to the ceiling track, as shown in Figure 3.

Figure 3 Attaching the Track Clips and Mounting Plate to the Ceiling Track



1 Insert the screws through the mounting plate and thread them into the track clips, fastening the clips firmly to the plate.

2 Adjust the track clips so that their tabs can pass on either side of a ceiling track.

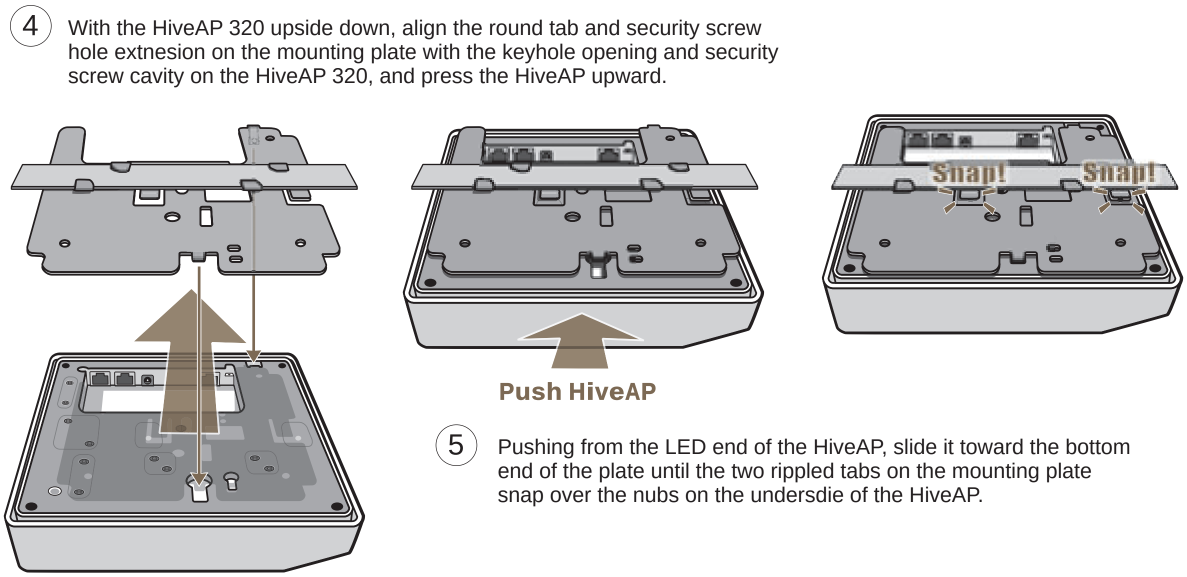
3 Press the clips against the ceiling track and swivel them until they snap into place, gripping the edges of the track.

If necessary, slide the clips and mounting plate along the track until they are in the spot you want.

When you have the mounting plate in the correct location, cut or drill a hole in the ceiling through which you can then pass the Ethernet and power cables. Pass the cables through the hole and attach them to the HiveAP 320, leaving some slack so that you can easily maneuver the HiveAP into place, attaching it to the mounting plate as shown in Figure 4 on page 69.

> *Note: For clarity, the power and Ethernet cables are not shown in the illustrations.*

Figure 4   Attaching the HiveAP 320 to the Mounting Plate



4 With the HiveAP 320 upside down, align the round tab and security screw hole extnesion on the mounting plate with the keyhole opening and security screw cavity on the HiveAP 320, and press the HiveAP upward.

5 Pushing from the LED end of the HiveAP, slide it toward the bottom end of the plate until the two rippled tabs on the mounting plate snap over the nubs on the undersdie of the HiveAP.

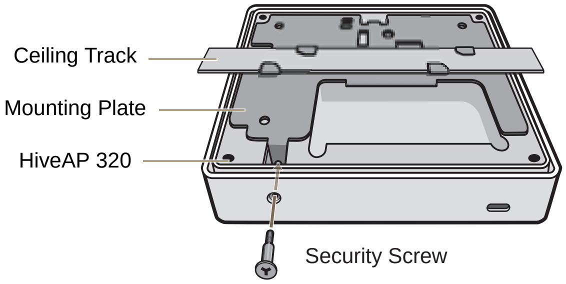
When done, adjust the ceiling tiles back into their former position.

Locking the HiveAP 320

To lock the HiveAP 320 to the mounting plate, use the security screw and bit that are included with the mounting kit. You will also need a screw driver or an electric drill that will accept the bit.

1. Insert the security screw through the hole in the HiveAP 320 and begin to thread it into the hole in the mounting plate (see Figure 5).

Figure 5   Locking the HiveAP 320 to the Mounting Plate



Note: The ceiling tiles are removed for clarity.

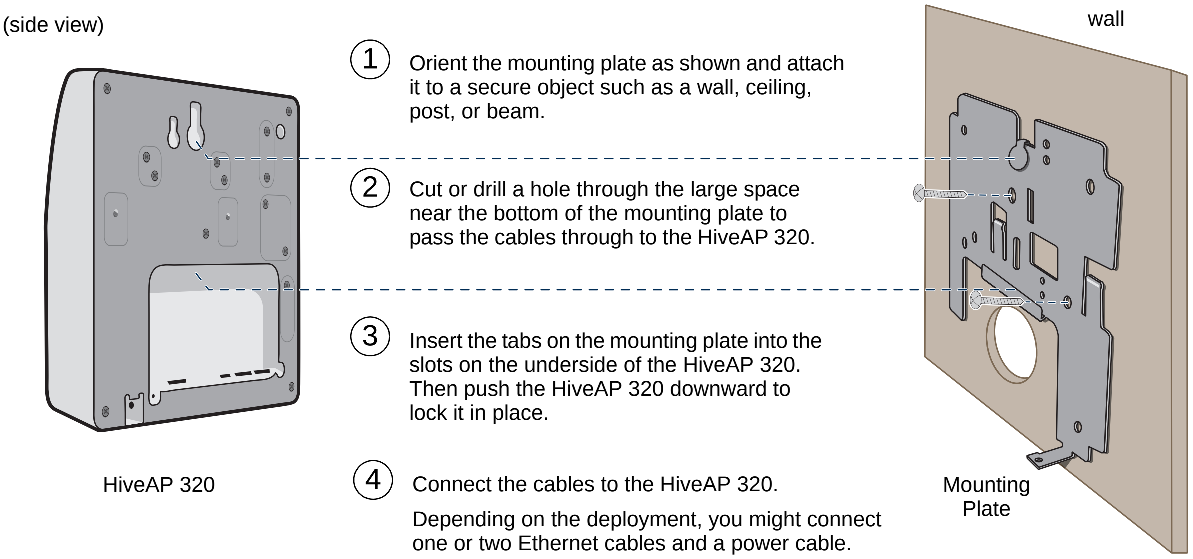
2. With the security screw bit in a screw driver or electric drill, tighten the screw into place, securing the HiveAP to the mounting plate.

Surface Mount

You can use the mounting plate to attach the HiveAP 320 to any surface that supports its weight, and to which you can screw or nail the plate. First, mount the plate to the surface. Then, through the large opening in the lower part of the plate, make a hole in the wall so that you can pass the cables through to the HiveAP.

Finally, attach the device to the plate, and connect the cables, as shown in Figure 6.

Figure 6 Mounting the HiveAP 320 on a Wall



1. Orient the mounting plate as shown and attach it to a secure object such as a wall, ceiling, post, or beam.
2. Cut or drill a hole through the large space near the bottom of the mounting plate to pass the cables through to the HiveAP 320.
3. Insert the tabs on the mounting plate into the slots on the underside of the HiveAP 320. Then push the HiveAP 320 downward to lock it in place.
4. Connect the cables to the HiveAP 320.

   Depending on the deployment, you might connect one or two Ethernet cables and a power cable.

Note: There are a variety of holes through which you can screw or nail the plate in place. Choose the two or three that best suit the object to which you are attaching it.

Note: You can use the locking screw to secure the HiveAP 320 to the mounting plate. For information, see "Locking the HiveAP 320" on page 69.

DEVICE, POWER, AND ENVIRONMENTAL SPECIFICATIONS

Understanding the range of specifications for the HiveAP 320 is necessary for optimal deployment and device operation. The following specifications describe the physical features and hardware components, the power adapter and PoE (Power over Ethernet) electrical requirements, and the temperature and humidity ranges in which the device can operate.

Device Specifications

- Chassis dimensions: 7 7/8" W x 1 1/2" H x 7 7/8" D (20 cm W x 3.8 cm H x 20 cm D)
- Weight: 2 lb. (0.68 kg)
- Antennas: Three omnidirectional 802.11b/g/n antennas, and three omnidirectional 802.11a/n antennas
- Serial port: RJ-45 (bits per second: 9600, data bits: 8, parity: none, stop bits: 1, flow control: none)
- Ethernet ports: two autosensing 10/100/1000 Base-T/TX Mbps ports; the ETH0 port is compliant with the IEEE 802.3af standard and the forthcoming 802.at standard for PoE (Power over Ethernet)

Power Specifications

- AC/DC power adapter:
  - Input:100 – 240 VAC
  - Output: 48V/0.38A
- PoE nominal input voltages:
  - 802.3af: 48 V/0.35A
  - Pre-802.3at: 48 V/0.625A
- RJ-45 power input pins: Wires 4, 5, 7, 8 or 1, 2, 3, 6

Environmental Specifications

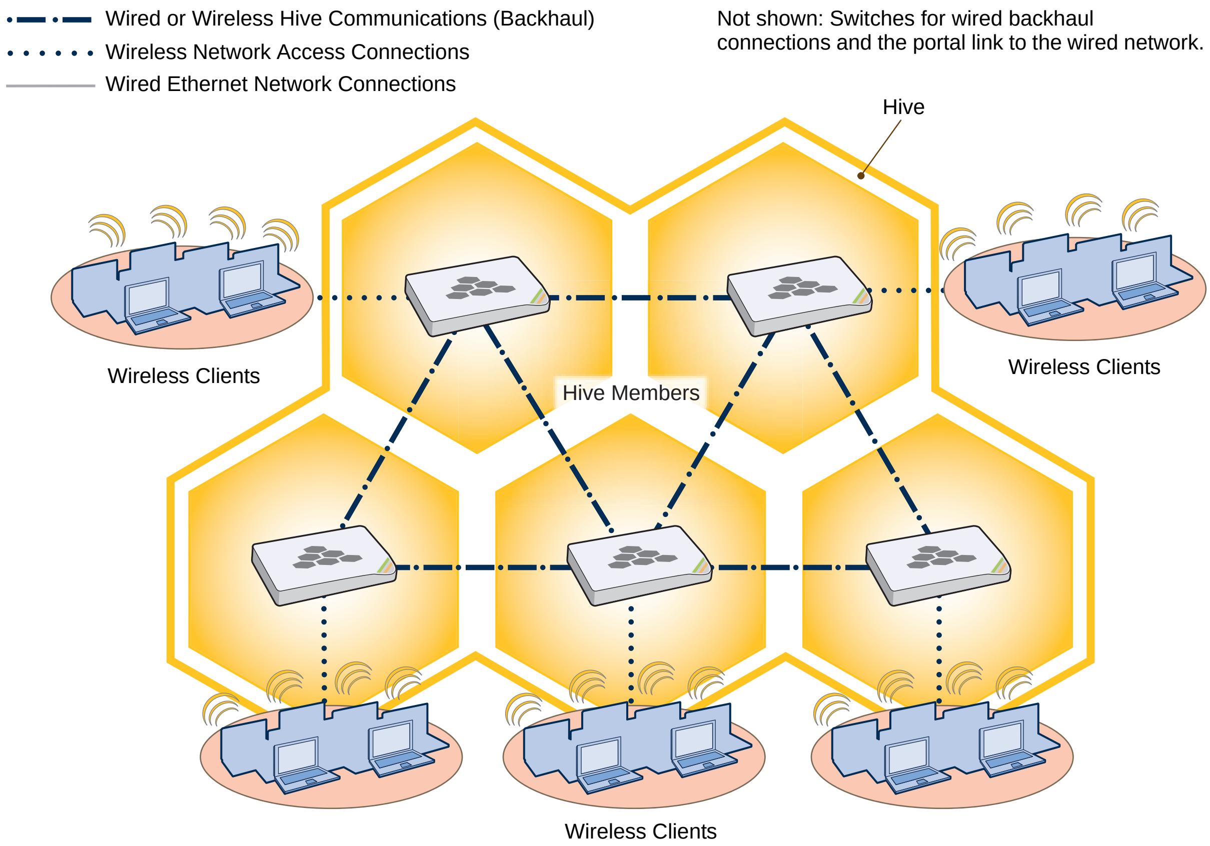
- Operating temperature: 32 to 104 degrees F (0 to 40 degrees C)
- Storage temperature: -4 to 158 degrees F (-20 to 70 degrees C)
- Relative Humidity: Maximum 95%

Chapter 10 HiveOS

You can deploy a single HiveAP and it will provide wireless access as an autonomous AP (access point). However, if you deploy two or more HiveAPs in a hive, you can provide superior wireless access with many benefits. A hive is a set of HiveAPs that exchange information with each other to form a collaborative whole (see Figure 1). Through coordinated actions based on shared information, hive members can provide the following services that autonomous APs cannot:

- Consistent QoS (quality of service) policy enforcement across all hive members
- Coordinated and predictive wireless access control that provides fast roaming to clients moving from one hive member to another
- Best-path routing for optimized data forwarding
- Automatic radio frequency and power selection

Figure 1 HiveAPs in a Hive



Wired or Wireless Hive Communications (Backhaul)
Wireless Network Access Connections
Wired Ethernet Network Connections
Hive
Wireless Clients
Wireless Clients
Hive Members
Wireless Clients

Not shown: Switches for wired backhaul connections and the portal link to the wired network.

COMMON DEFAULT SETTINGS AND COMMANDS

Many major components of HiveOS are automated and typically require no further configuration. For example, radio power and frequency selection occurs automatically, as does route learning. Also, after defining a hive and its security protocol suite, all HiveAPs belonging to that hive automatically initiate and maintain communications with each other.

Additionally, there are many default settings that simplify the setup of a HiveAP because these are the typical settings for many of the most common deployments. The following are some important default settings and the commands necessary to change them if you need to do so:

	Default Settings	Commands
mgt0 interface	DHCP client = enabled	To disable the DHCP client: **no interface mgt0 dhcp client** To set an IP address: **interface mgt0 ip** *ip_addr netmask*
	VLAN ID = 1	To set a different VLAN ID: **interface mgt0 vlan** *number*
wifi0 and wifi1 interfaces	wifi0 mode = access wifi1 mode = backhaul	To change the mode of the wifi0 or wifi1 interface: **interface** { **wifi0** | **wifi1** } **mode** { **access** | **backhaul** }
	wifi0 radio profile = radio_g0 wifi1 radio profile = radio_a0	To change the radio profile of the wifi0 or wifi1 interface to a different, previously defined profile: **interface** { **wifi0** | **wifi1** } **radio profile** *string*
	antenna = internal	To have the wifi0 interface use an external antenna: **interface** { **wifi0** | **wifi1** } **radio antenna external**
	channel = automatic selection	To set a specific radio channel: **interface** { **wifi0** | **wifi1** } **radio channel** *number*
	power = automatic selection	To set a specific transmission power level (in dBms): **interface** { **wifi0** | **wifi1** } **radio power** *number*
Default QoS policy	def-user-qos policy: user profile rate = 54,000 Kbps user profile weight = 10 user rate limit = 54,000 Kbps mode = weighted round robin for Aerohive classes 0 - 5; strict forwarding for classes 6 - 7 classes 0 - 4 rate limit = 54,000 Kbps class 5 rate limit = 10,000 Kbps classes 6 - 7 rate limit = 512 Kbps	To change the default QoS policy: **qos policy def-user-qos qos** *ah_class* { **strict** *rate_limit* **0** | **wrr** *rate_limit weight* } **qos policy def-user-policy user-profile** *rate_limit weight* **qos policy def-user-policy user** *rate_limit*
User profile	default-profile: group ID = 0 policy name = def-user-qos VLAN ID = 1	You cannot change the group ID or QoS policy name for the default user profile. To change its VLAN ID: **user-profile default-profile vlan-id** *number*

CONFIGURATION OVERVIEW

The amount of configuration depends on the complexity of your deployment. As you can see in "Deployment Examples (CLI)" on page 161, you can enter a minimum of three commands to deploy a single HiveAP, and just a few more to deploy a hive.

However, for cases when you need to fine tune access control for more complex environments, HiveOS offers a rich set of CLI commands. The configuration of HiveAPs falls into two main areas: "Device-Level Configurations" and "Policy-Level Configurations" on page 156. Consider your deployment plans and then refer to the following sections for guidance on the commands you need to configure them.

Note: To find all commands using a particular character or string of characters, you can do a search using the following command: **show cmds | { include | exclude }** *string*

Device-Level Configurations

Device-level configurations refer to the management of a HiveAP and its connectivity to wireless clients, the wired network, and other hive members. The following list contains some key areas of device-level configurations and relevant commands.

- Management
  - Administrators, admin authentication method, login parameters, and admin privileges

    ```
    admin { auth | manager-ip | min-password-length | read-only | read-write |
          root-admin } …
    ```

  - Logging settings

    ```
    log { buffered | console | debug | facility | flash | server | trap } …
    ```

- Connectivity settings
  - Interfaces

    ```
    interface { eth0 | wifi0 | wifi1 } …
    ```

  - Layer 2 and layer 3 forwarding routes

    ```
    route mac_addr …
    ```

    ```
    ip route { default | host | net } ip_addr …
    ```

- VLAN assignments

  For users:

  ```
  user-profile string qos-policy string vlan-id number attribute number
  ```

  For hive communications:

  ```
  hive string native-vlan number
  ```

  For the mgt0 interface:

  ```
  interface mgt0 vlan number
  ```

- Radio settings

  ```
  radio profile string …
  ```

Policy-Level Configurations

Policies control how wireless clients access the network. The following list contains some key areas of policy-level configurations and relevant commands.

- QoS settings

```
qos { classifier-map | classifier-profile | marker-map | marker-profile |
      policy } …
```

- User profiles

```
user-profile string …
```

- SSIDs

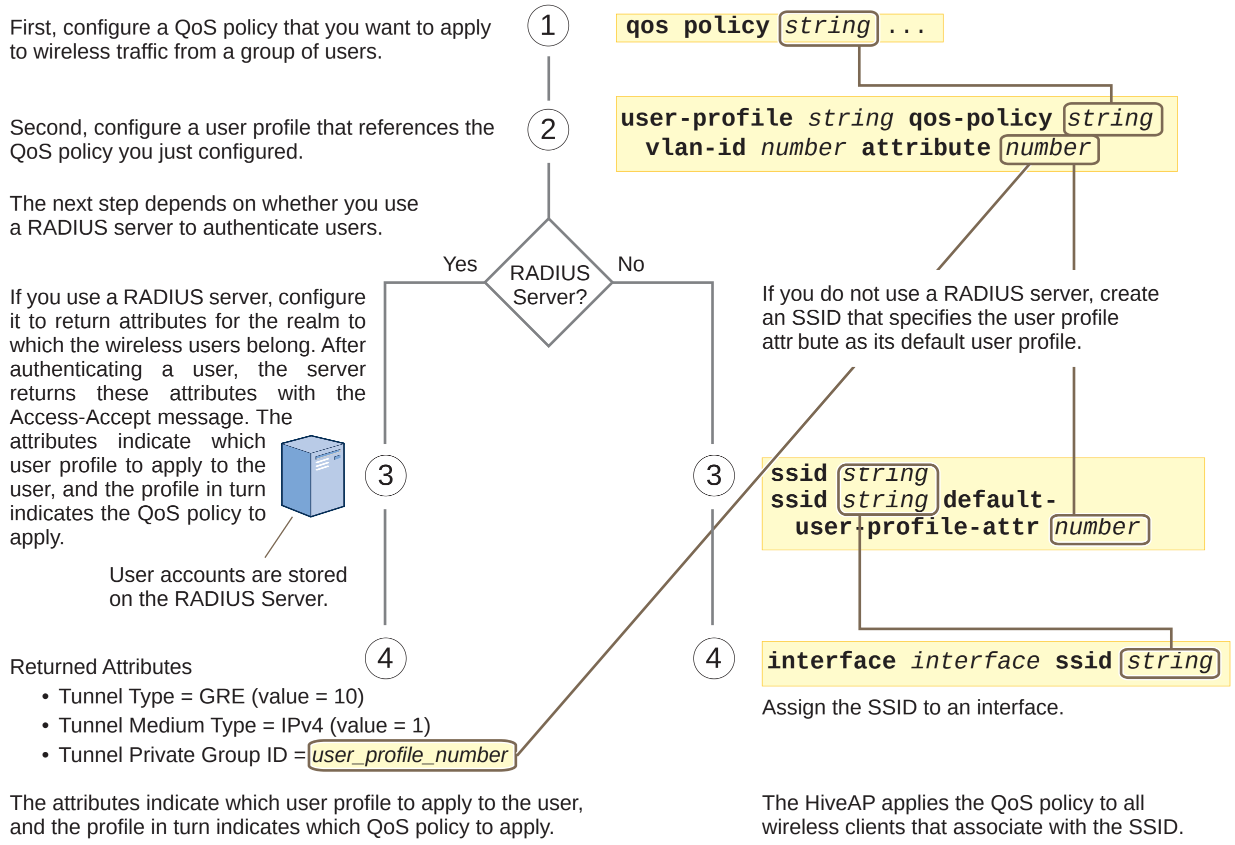
```
ssid string …
```

- AAA (authentication, authorization, and accounting) settings for IEEE 802.1X authentication

```
aaa radius-server …
```

While the configuration of most HiveOS features involves one or more related commands, to define and apply a QoS policy to a group of users, you must configure several different but related features: a QoS policy, a user profile, and—if you do not authenticate users with a RADIUS server—an SSID that references the user profile, and a subinterface to which you assign the SSID. The configuration steps are shown in Figure 2.

Figure 2 Steps for Configuring and Applying QoS



First, configure a QoS policy that you want to apply to wireless traffic from a group of users.

```
qos policy string ...
```

Second, configure a user profile that references the QoS policy you just configured.

```
user-profile string qos-policy string
  vlan-id number attribute number
```

The next step depends on whether you use a RADIUS server to authenticate users.

If you use a RADIUS server, configure it to return attributes for the realm to which the wireless users belong. After authenticating a user, the server returns these attributes with the Access-Accept message. The attributes indicate which user profile to apply to the user, and the profile in turn indicates the QoS policy to apply.

User accounts are stored on the RADIUS Server.

Returned Attributes

- Tunnel Type = GRE (value = 10)
- Tunnel Medium Type = IPv4 (value = 1)
- Tunnel Private Group ID = *user_profile_number*

The attributes indicate which user profile to apply to the user, and the profile in turn indicates which QoS policy to apply.

If you do not use a RADIUS server, create an SSID that specifies the user profile attr bute as its default user profile.

```
ssid string
ssid string default-
  user-profile-attr number
```

```
interface interface ssid string
```

Assign the SSID to an interface.

The HiveAP applies the QoS policy to all wireless clients that associate with the SSID.

HIVEOS CONFIGURATION FILE TYPES

HiveOS supports several types of configuration files: running, current, backup, bootstrap, default, and failed.

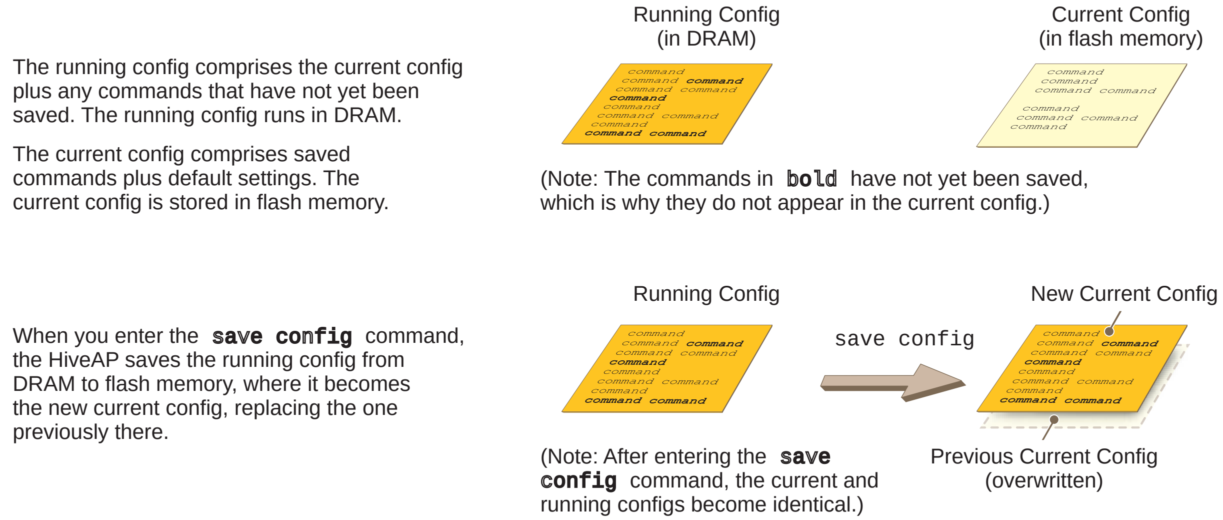
The **running** configuration (config) is the configuration that is actively running in DRAM. During the bootup process, a HiveAP loads the running config from one of up to four config files stored in flash memory:

- **current**: a flash file containing a combination of default and admin-defined settings. During the bootup process, this is the first config that the HiveAP attempts to load as the running config. This is also the file to which you typically save commands from the running config (you can also save them to the bootstrap config). See Figure 3.
- **backup**: a flash file that the HiveAP attempts to load during the reboot process if there is a newly uploaded current config file or if it cannot load the current config file. See Figure 4 on page 158 and Figure 5 on page 158.
- **bootstrap**: a flash file containing a second config composed of a combination of default and admin-defined settings. The HiveAP fails over to this config when you enter the `reset config` command or if both the current and backup config files fail to load. See Figure 6 on page 160.
- **default**: a flash file containing only default settings. If there is no bootstrap config, the HiveAP reverts to this config when you enter the `reset config` command or if both the current and backup config files fail to load. See Figure 6 on page 160.

Note: There is also a failed config file, which holds any backup config that fails to load. See Figure 5 on page 158.

When using the CLI, the two most frequently accessed config types are the running config and current config. When you enter a command in the running config, the HiveAP performs it immediately. However, because the running config is stored in volatile memory (DRAM), the commands are not yet permanent and will be lost when the HiveAP next reboots. For your configuration settings to persist after rebooting, enter the `save config` command. This command saves the running config to the current config, which is a file stored in nonvolatile (flash) memory. See Figure 3.

Figure 3 Relationship between Running and Current Config Files



The running config comprises the current config plus any commands that have not yet been saved. The running config runs in DRAM.

The current config comprises saved commands plus default settings. The current config is stored in flash memory.

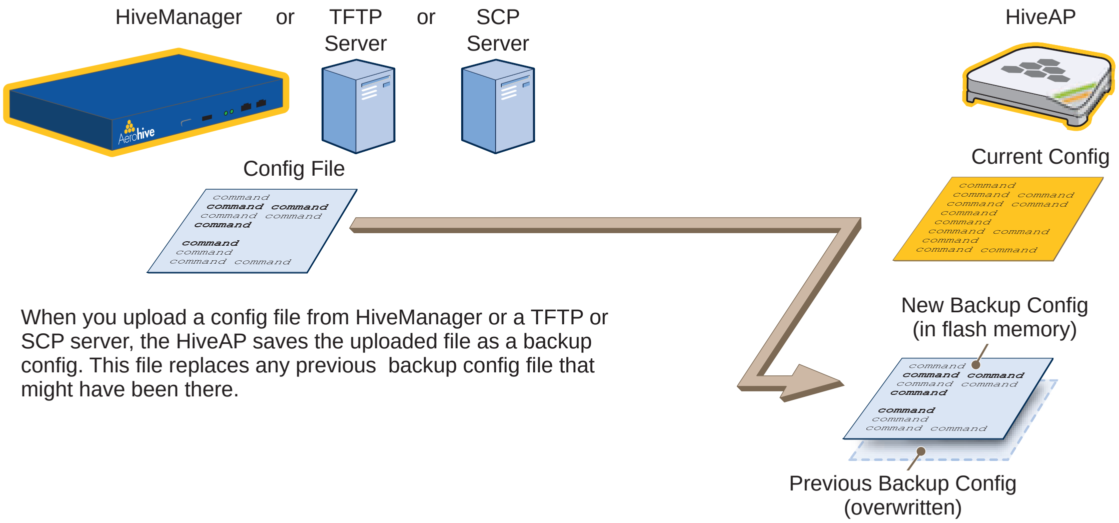
(Note: The commands in **bold** have not yet been saved, which is why they do not appear in the current config.)

When you enter the `save config` command, the HiveAP saves the running config from DRAM to flash memory, where it becomes the new current config, replacing the one previously there.

(Note: After entering the `save config` command, the current and running configs become identical.)

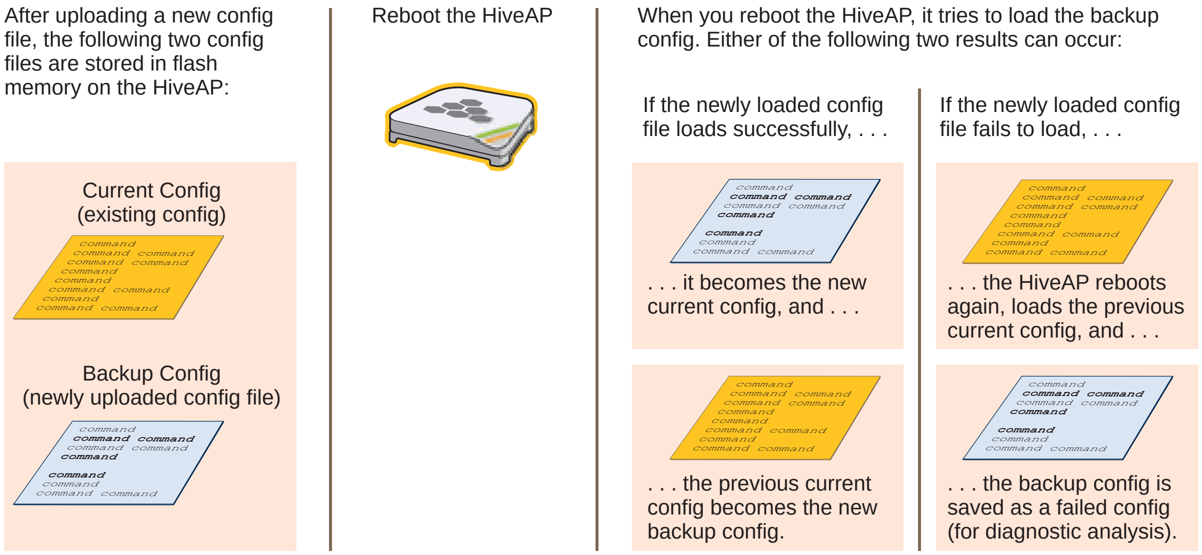
When you upload a configuration file from HiveManager or from a TFTP or SCP server, the HiveAP stores the uploaded file in the backup config partition in flash memory, where it remains until the HiveAP reboots. If there is a backup config file already stored in flash, the newly uploaded file overwrites it. See Figure 4.

Figure 4   Relationship between Current and Backup Config Files during a File Upload


HiveManager
or
TFTP Server
or
SCP Server
HiveAP
Config File
Current Config
New Backup Config (in flash memory)
Previous Backup Config (overwritten)
When you upload a config file from HiveManager or a TFTP or SCP server, the HiveAP saves the uploaded file as a backup config. This file replaces any previous backup config file that might have been there.

When the HiveAP reboots, it attempts to load the the newly uploaded config file. If the file loads successfully, the HiveAP makes that file the new current config and makes the previous current config the new backup config. If the file does not load successfully, the HiveAP reboots again and loads the previous current config file. The HiveAP saves the file it was unable to load as a failed config for diagnostics. See Figure 5.

Figure 5   Relationship between Current and Backup Config Files while Rebooting a HiveAP


After uploading a new config file, the following two config files are stored in flash memory on the HiveAP:
Current Config (existing config)
Backup Config (newly uploaded config file)
Reboot the HiveAP
When you reboot the HiveAP, it tries to load the backup config. Either of the following two results can occur:
If the newly loaded config file loads successfully, . . .
. . . it becomes the new current config, and . . .
. . . the previous current config becomes the new backup config.
If the newly loaded config file fails to load, . . .
. . . the HiveAP reboots again, loads the previous current config, and . . .
. . . the backup config is saved as a failed config (for diagnostic analysis).

Note: To upload and activate a config file from HiveManager , see "Uploading HiveAP Configurations" on page 150. To upload and activate a config file from a TFTP or SCP server using the CLI, use the following commands:

```
save config tftp://ip_addr:filename current { hh:mm:ss |  now | offset hh:mm:ss }
save config scp://username@ip_addr:filename current { hh:mm:ss | now | offset
  hh:mm:ss }
```

When a HiveAP ships from the factory, it is loaded with a default config file, which acts initially as the running and current configs. If you enter and save any commands, the HiveAP then stores a separate config file as the current config, combining the default settings with the commands you entered and saved. If you want to return to the default settings, you can press the reset button (see "Reset Button" on page 27) or enter the **`reset config`** command. A HiveAP might also return to the default config if both the current and backup configs fail to load, which might happen if you update the HiveOS firmware to an image that cannot work with either config.

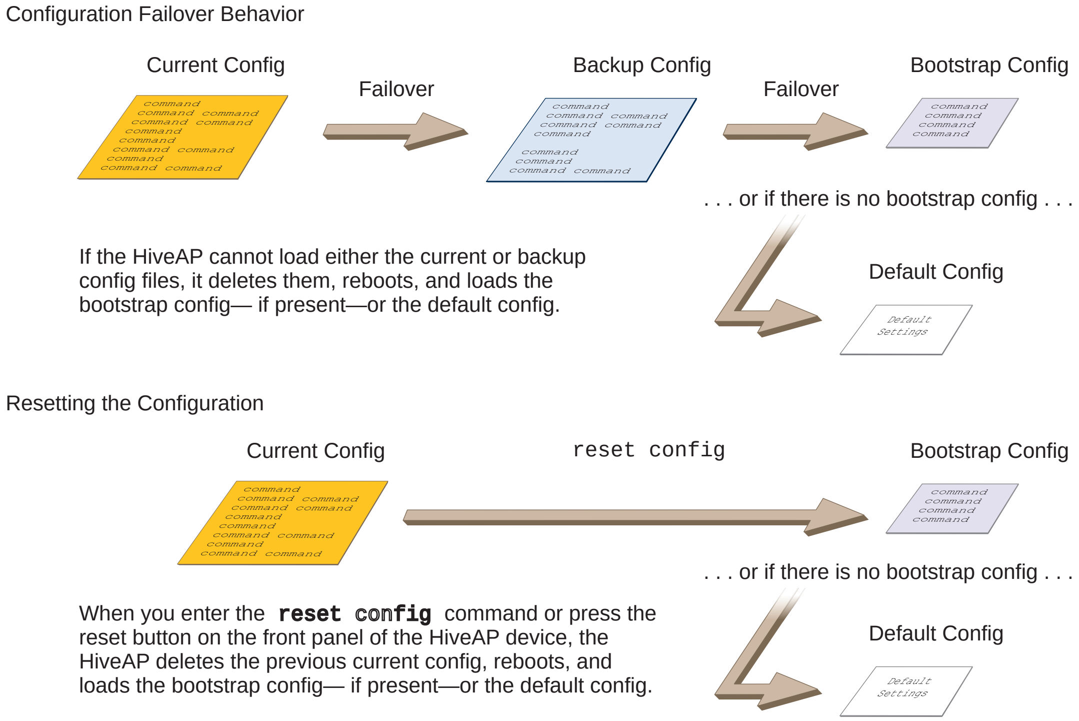
Note: You can disable the ability of the reset button to reset the configuration by entering this command: **`no reset-button reset-config-enable`**

Reverting to the default config can be very useful, especially in the early stages when you are still learning about HiveOS and are likely to be experimenting with different settings. However, retaining the ability of a HiveAP to revert to its default settings after its deployment can present a problem if it is a mesh point in a hive. If the HiveAP reverts to the default config, it will not be able to rejoin its hive. Consequently, it will not be able to get an IP address through DHCP nor be able to communicate with HiveManager (assuming that you are managing it through HiveManager). In this case, you would have to make a serial connection to the console port on the HiveAP and reconfigure its hive settings through the CLI.

To avoid the above situation, you can use a bootstrap config. A bootstrap config is typically a small config file that comes last in the boot order (current – backup – bootstrap) and that replaces the default config as the one a HiveAP loads when you reset the configuration. See Figure 6 on page 160.

Note: Be careful to remember the login name and password defined in the bootstrap config file. If they become lost or forgotten, you must obtain a one-time login key from Aerohive technical support. To get the key, you must already have had a support contract in place. The first one-time login key is free. After that, there is a small handling fee for each additional key.

Figure 6 Relationship of Current, Backup, Bootstrap, and Default Config Files



If the HiveAP cannot load either the current or backup config files, it deletes them, reboots, and loads the bootstrap config— if present—or the default config.

When you enter the **reset config** command or press the reset button on the front panel of the HiveAP device, the HiveAP deletes the previous current config, reboots, and loads the bootstrap config— if present—or the default config.

To create and load a bootstrap config, make a text file containing a set of commands that you want the HiveAP to load as its bootstrap configuration (for an example, see "Loading a Bootstrap Configuration" on page 179). Save the file locally and then load it with one of the following commands:

```
save config tftp://ip_addr:filename bootstrap
save config scp://username@ip_addr:filename bootstrap
```

Note: Similar to the way that a current config consists of the commands you added on top of the default config, a bootstrap config consists of default definitions and settings plus whatever other settings you configure.

After it is loaded, you can enter the following command to view the bootstrap file: **show config bootstrap**

If you want to run the bootstrap config, enter the following commands:

```
load config bootstrap
reboot
```

When the bootstrap config loads, enter the login parameters you defined for that configuration. To return to your previous current config file, enter the following commands:

```
load config backup
reboot
```

Chapter 11 Deployment Examples (CLI)

This chapter presents several deployment examples to introduce the primary tasks involved in configuring HiveAPs through the HiveOS CLI.

In "Deploying a Single HiveAP" on page 162, you deploy one HiveAP as an autonomous access point. This is the simplest configuration: you only need to enter and save three commands.

In "Deploying a Hive" on page 165, you add two more HiveAPs to the one deployed in the first example to form a hive with three members. The user authentication method in this and the previous example is very simple: a preshared key is defined and stored locally on each HiveAP and on each wireless client.

In "Using IEEE 802.1X Authentication" on page 170, you change the user authentication method. Taking advantage of existing Microsoft AD (Active Directory) user accounts, the HiveAPs use IEEE 802.1X EAP (Extensible Authentication Protocol) to forward authentication requests to a RADIUS server whose database is linked to that of the AD server.

In "Applying QoS" on page 173, you apply QoS (Quality of Service) filters to user traffic so that delay-sensitive voice traffic receives higher priority than other more delay-resistant traffic.

Note: To focus attention on the key concepts of an SSID (first example), hive (second example), and IEEE 802.1X authentication (third example), QoS was intentionally omitted from these examples. However, the QoS settings you define in the last example can apply equally well to the configurations in the others.

In "Loading a Bootstrap Configuration" on page 179, you load a bootstrap config file on the HiveAPs. When a bootstrap config is present, it loads instead of the default config whenever HiveOS is reset or if the current and backup configs do not load. This example shows how using a bootstrap config can help minimize theft and increase convenience.

Because each example builds on the previous one, it is recommended to read them sequentially. Doing so will help build an understanding of the fundamentals involved in configuring HiveAPs.

If you want to view just the CLI commands used in the examples, see "CLI Commands for Examples" on page 182. Having the commands in blocks by themselves makes it easy to copy-and-paste them at the command prompt.

The following are the equipment and network requirements for these examples:

- Equipment
  - Management system (computer) capable of creating a serial connection to the HiveAP
  - VT100 emulator on the management system
  - Serial cable (also called a "null modem cable") that ships as an option with the HiveAP product. You use this to connect your management system to the HiveAP.

  Note: You can also access the CLI by using Telnet or SSH (Secure Shell). After connecting a HiveAP to the network, make either a Telnet or SSH connection to the IP address that the DHCP server assigns the mgt0 interface.

- Network
  - Layer 2 switch through which you connect the HiveAP to the wired network
  - Ethernet cable—either straight-through or cross-over
  - Network access to a DHCP server
  - For the third and fourth examples, network access to an AD (Active Directory) server and RADIUS server

Example 1: Deploying a Single HiveAP

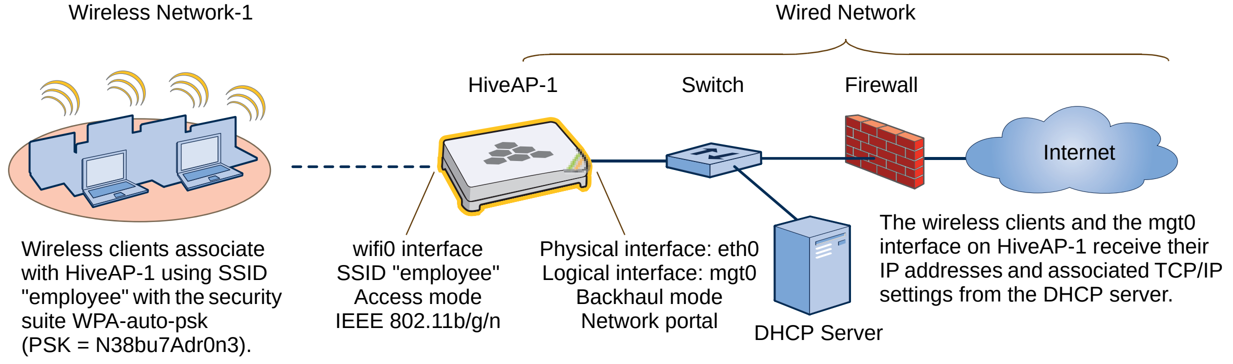
In this example, you deploy one HiveAP (HiveAP-1) to provide network access to a small office with 15 – 20 wireless clients. You only need to define the following SSID (service set identifier) parameters on the HiveAP and clients:

- **SSID name**: employee
- **Security protocol suite**: WPA-auto-psk
  - WPA – Uses Wi-Fi Protected Access, which provides dynamic key encryption and mutual authentication of the client and HiveAP
  - Auto – Automatically negotiates WPA or WPA2 and the encryption protocol: AES (Advanced Encryption Standard) or TKIP (Temporal Key Integrity Protocol)
  - PSK – Derives encryption keys from a preshared key that the client and HiveAP both already have
- **Preshared key**: N38bu7Adr0n3

After defining SSID "employee" on HiveAP-1, you then bind it to the wifi0 interface, which is in access mode by default. The wifi0 interface operates at 2.4 GHz (in accordance with the IEEE 802.11b, g, and n standards). This example assumes that the clients also support 802.11b, g, or n.

Note: By default, the wifi1 interface is in backhaul mode and operates at 5 GHz to support IEEE 802.11a. To put wifi1 in access mode so that both interfaces provide access—the wifi0 interface at 2.4 GHz and the wifi1 interface at 5 GHz—enter this command: **`interface wifi1 mode access.`** *Then, in addition to binding SSID "employee" to wifi0 (as explained in step 2), also bind it to wifi1.*

Figure 1 Single HiveAP for a Small Wireless Network


Wireless Network-1
Wired Network
HiveAP-1
Switch
Firewall
Internet
Wireless clients associate with HiveAP-1 using SSID "employee" with the security suite WPA-auto-psk (PSK = N38bu7Adr0n3).
wifi0 interface
SSID "employee"
Access mode
IEEE 802.11b/g/n
Physical interface: eth0
Logical interface: mgt0
Backhaul mode
Network portal
DHCP Server
The wireless clients and the mgt0 interface on HiveAP-1 receive their IP addresses and associated TCP/IP settings from the DHCP server.

Step 1 Log in through the console port

1. Connect the power cable from the DC power connector on the HiveAP to the AC/DC power adaptor that ships with the device as an option, and connect that to a 100 – 240-volt power source.

   Note: If the switch supports PoE (Power over Ethernet), the HiveAP can receive its power that way instead.

   The Power LED glows steady amber during the bootup process. After the bootup process completes, it then glows steady green to indicate that the firmware is loaded and running.

2. Connect one end of an RS-232 serial (or "null modem") cable to the serial port (or Com port) on your management system.
3. Connect the other end of the cable to the male DB-9 or RJ-45 console port on the HiveAP.

4. On your management system, run a VT100 terminal emulation program, such as Tera Term Pro© (a free terminal emulator) or Hilgraeve Hyperterminal® (provided with Windows® operating systems). Use the following settings:
   - Bits per second (baud rate): 9600
   - Data bits: 8
   - Parity: none
   - Stop bits: 1
   - Flow control: none

   For HiveAPs set with "FCC" as the region code, the Initial CLI Configuration Wizard appears. For HiveAPs set with "world" as the region code, a prompt appears to set the country code for the location where you intend to deploy the HiveAP. To set the country code, enter the **`boot-param country-code`** *`number`* command, in which *`number`* is the appropriate country code number. For a list of country codes, see "Appendix A Country Codes" on page 189.

5. Because you do not need to configure all the settings presented in the wizard, press **N** to cancel it.

   The login prompt appears.

6. Log in using the default user name *admin* and password *aerohive*.

Step 2 Configure the HiveAP

1. Create an SSID and assign it to an interface.

   ```
   ssid employee
   ssid employee security protocol-suite wpa-auto-psk ascii-key N38bu7Adr0n3
   ```

   You first create an SSID named "employee" and then define its protocol suite and preshared key (N38bu7Adr0n3) in standard ASCII (American Standard Code for Information Interchange) text.

   ```
   interface wifi0 ssid employee
   ```

   You assign the SSID to the wifi0 interface, which is in access mode by default. When you make this assignment, the HiveAP automatically creates subinterface wifi0.1 and uses that for the SSID. (The HiveAP 20 series supports up to seven subinterfaces per Wi-Fi interface for a possible maximum total of 14 SSIDs when both wifi0 and wifi1 are in access mode. The HiveAP 300 series supports up to eight per interface for a possible maximum total of 16.) A HiveAP can use one or two Wi-Fi interfaces in access mode to communicate with wireless clients accessing the network, and a Wi-Fi interface in backhaul mode to communicate wirelessly with other HiveAPs when in a hive (see subsequent examples).

2. (Optional) Change the name and password of the root admin.

   ```
   admin root-admin mwebster password 3fF8ha
   ```

   As a safety precaution, you change the default root admin name and password to *mwebster* and *3fF8ha*. The next time you log in, use these instead of the default definitions.

   Note: By default, the minimum password length is 5 characters. You can change the minimum length by entering the following command: **`admin min-password-length <number>`** *(The minimum password length can be between 5 and 16 characters.)*

3. (Optional) Change the host name of the HiveAP.

   ```
   hostname HiveAP-1
   ```

4. Save your changes to the currently running configuration, and then log out of the serial session.

   ```
   save config
   exit
   ```

   The HiveAP configuration is complete.

Step 3 Configure the wireless clients

Define the "employee" SSID on all the wireless clients. Specify WPA-PSK for network authentication, AES or TKIP for data encryption, and the preshared key *N38bu7Adr0n3*.

Step 4 Position and power on the HiveAP

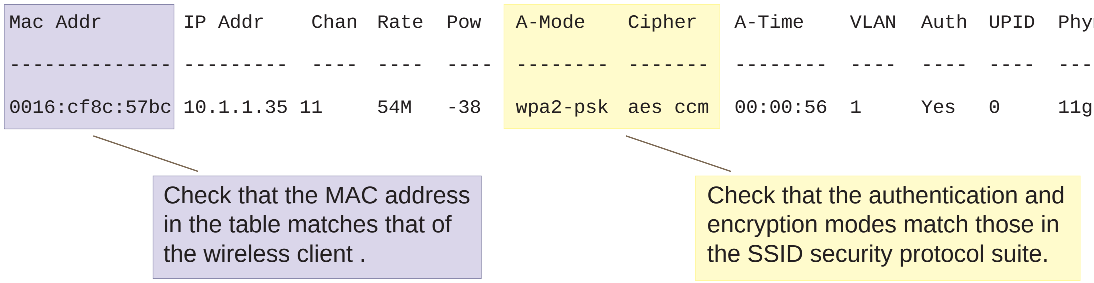
1. Place the HiveAP within range of the wireless clients and, optionally, mount it as explained in the mounting section in the chapter about the HiveAP model that you are using.
2. Connect an Ethernet cable from the PoE In port to the network switch.
3. If you have powered off the HiveAP, power it back on by reconnecting it to a power source.

   When you power on the HiveAP, the mgt0 interface, which connects to the wired network through the eth0 port, automatically receives its IP address through DHCP (Dynamic Host Configuration Protocol).

Step 5 Check that clients can form associations and access the network

1. To check that a client can associate with the HiveAP and access the network, open a wireless client application and connect to the "employee" SSID. Then contact a network resource, such as a web server.
2. Log in to the HiveAP CLI, and check that you can see the MAC address of the associated client and an indication that the correct SSID is in use by entering the following command:

```
show ssid employee station

Chan=channel number; Pow=Power in dbm;

A-Mode=Authentication mode; Cipher=Encryption mode;

A-Time=Associated time; Auth=Authenticated;

UPID=User profile Identifier; Phymode=Physical mode;
```



```
Mac Addr       IP Addr    Chan Rate Pow   A-Mode    Cipher   A-Time    VLAN Auth UPID Phymode
-------------- ---------  ---- ---- ----  --------  -------  --------  ---- ---- ---- -------
0016:cf8c:57bc 10.1.1.35 11    54M  -38   wpa2-psk  aes ccm  00:00:56  1    Yes  0    11g
```

Check that the MAC address in the table matches that of the wireless client .

Check that the authentication and encryption modes match those in the SSID security protocol suite.

> *Note: You can also enter the following commands to check the association status of a wireless client:* **`show auth`**, **`show roaming cache`**, *and* **`show roaming cache mac <mac_addr>`**.

The setup of a single HiveAP is complete. Wireless clients can now associate with the HiveAP using SSID "employee" and access the network.

EXAMPLE 2: DEPLOYING A HIVE

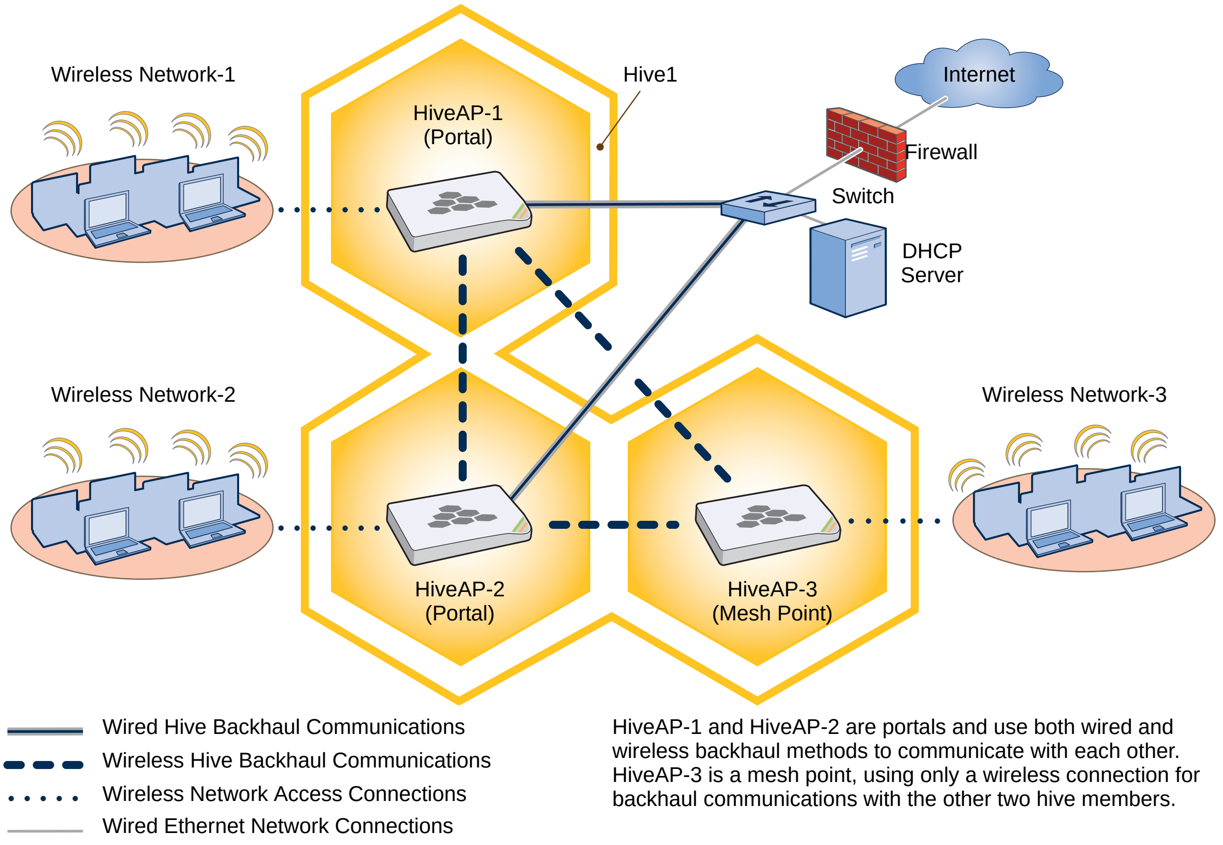
Building on "Deploying a Single HiveAP" on page 162, the office network has expanded and requires more HiveAPs to provide greater coverage. In addition to the basic configuration covered in the previous example, you configure all three HiveAPs to form a hive within the same layer 2 switched network. The following are the configuration details for the hive:

- **Hive name**: hive1
- **Preshared key for hive1 communications**: s1r70ckH07m3s

Note: The security protocol suite for hive communications is WPA-AES-psk.

HiveAP-1 and -2 are cabled to a switch and use the native ("untagged") VLAN for wired backhaul communications. They communicate with each other over both wired and wireless backhaul links, the wired link taking precedence. However, HiveAP-3 only communicates with HiveAP-1 and -2 over a wireless link (see Figure 2). Because HiveAP-1 and -2 connect to the wired network, they act as portals. In contrast, HiveAP-3 is a mesh point.

Figure 2 Three HiveAPs in a Hive



HiveAP-1 and HiveAP-2 are portals and use both wired and wireless backhaul methods to communicate with each other. HiveAP-3 is a mesh point, using only a wireless connection for backhaul communications with the other two hive members.

Note: If all hive members can communicate over wired backhaul links, you can then use both radios for access. The wifi0 interface is already in access mode by default. To put wifi1 in access mode, enter this command: **`interface wifi1 mode access`**. *In this example, however, a wireless backhaul link is required.*

Step 1 Configure HiveAP-1

1. Using the connection settings described in the first example, log in to HiveAP-1.
2. Configure HiveAP-1 as a member of "hive1" and set the security protocol suite.

   `hive hive1`

   You create a hive, which is a set of HiveAPs that collectively distribute data and coordinate activities among themselves, such as client association data for fast roaming, route data for making optimal data-path forwarding decisions, and policy enforcement for QoS (Quality of Service) and security.

   `hive hive1 password s1r70ckH07m3s`

   You define the password that hive members use to derive the preshared key for securing backhaul communications with each other. The password must be the same on all hive members.

   `interface mgt0 hive hive1`

   By setting "hive1" on the mgt0 interface, you join HiveAP-1 to the hive.

   `save config`

3. Before closing the console session, check the radio channel that HiveAP-1 uses on its backhaul interface, which by default is wifi1:

```
show interface

State=Operational state; Chan=Channel;

Radio=Radio profile; U=up; D=down;

Name      MAC addr         Mode      State Chan  VLAN Radio      Hive   SSID

-------   --------------   --------  ----- ----  ---- --------   -----  --------

Mgt0      0019:7700:0020      -      U      -     1      -       hive1    -

Eth0      0019:7700:0020   backhaul  U      -     1      -       hive1    -

Wifi0     0019:7700:0024   access    U      11    -    radio_ng0   -      -

Wifi0.1   0019:7700:0024   access    U      11    -    radio_ng0 hive1  employee

Wifi1     0019:7700:0028   backhaul  U      149   -    radio_na0   -      -

Wifi1.1   0019:7700:0028   backhaul  U      149   1    radio_na0 hive1    -
```

The wifi1 interface and the wifi1.1 subinterface are in backhaul mode and are using channel 149. Both wifi1 and wifi1.1 use the default radio profile radio_na0. (Depending on the HiveAP model, the default profile might be radio_a0.) This is a profile for radio2, which operates in the 5 GHz frequency range as specified in the IEEE 802.11a and n standards.

   HiveAP-1 is set to use wireless interface wifi1 and its subinterface wifi1.1 for backhaul communications.

   Write down the radio channel for future reference (in this example, it is 149). When configuring HiveAP-2 and -3, make sure that they also use this channel for backhaul communications.

   `exit`

Step 2 Configure HiveAP-2 and HiveAP-3

1. Power on HiveAP-2 and log in through its console port.
2. Configure HiveAP-2 with the same commands that you used for HiveAP-1:

```
ssid employee

ssid employee security protocol-suite wpa-auto-psk ascii-key N38bu7Adr0n3

interface wifi0 ssid employee

hive hive1

hive hive1 password s1r70ckH07m3s

interface mgt0 hive hive1
```

3. (Optional) Change the name and password of the superuser.

```
admin superuser mwebster password 3fF8ha
```

4. Check that the channel ID for wifi1 and wifi1.1 is now 149.

```
show interface
```

   If the channel ID for wifi1 and wifi1.1 is not 149, set it to 149 so that HiveAP-2 uses the same channel as HiveAP-1 for backhaul communications.

```
interface wifi1 radio channel 149
```

   Setting the channel for the parent interface (wifi1) sets it for all its subinterfaces. An interface in backhaul mode only needs one subinterface, which by default is wifi1.1.

```
save config

exit
```

5. Repeat the above steps for HiveAP-3.

Step 3 Connect HiveAP-2 and HiveAP-3 to the network

1. Place HiveAP-2 within range of its clients and within range of HiveAP-1. This allows HiveAP-1 and -2 to send backhaul communications to each other wirelessly as a backup path in case either member loses its wired connection to the network.
2. Connect an Ethernet cable from the PoE In port on HiveAP-2 to the network switch.
3. Power on HiveAP-2 by connecting it to a power source.

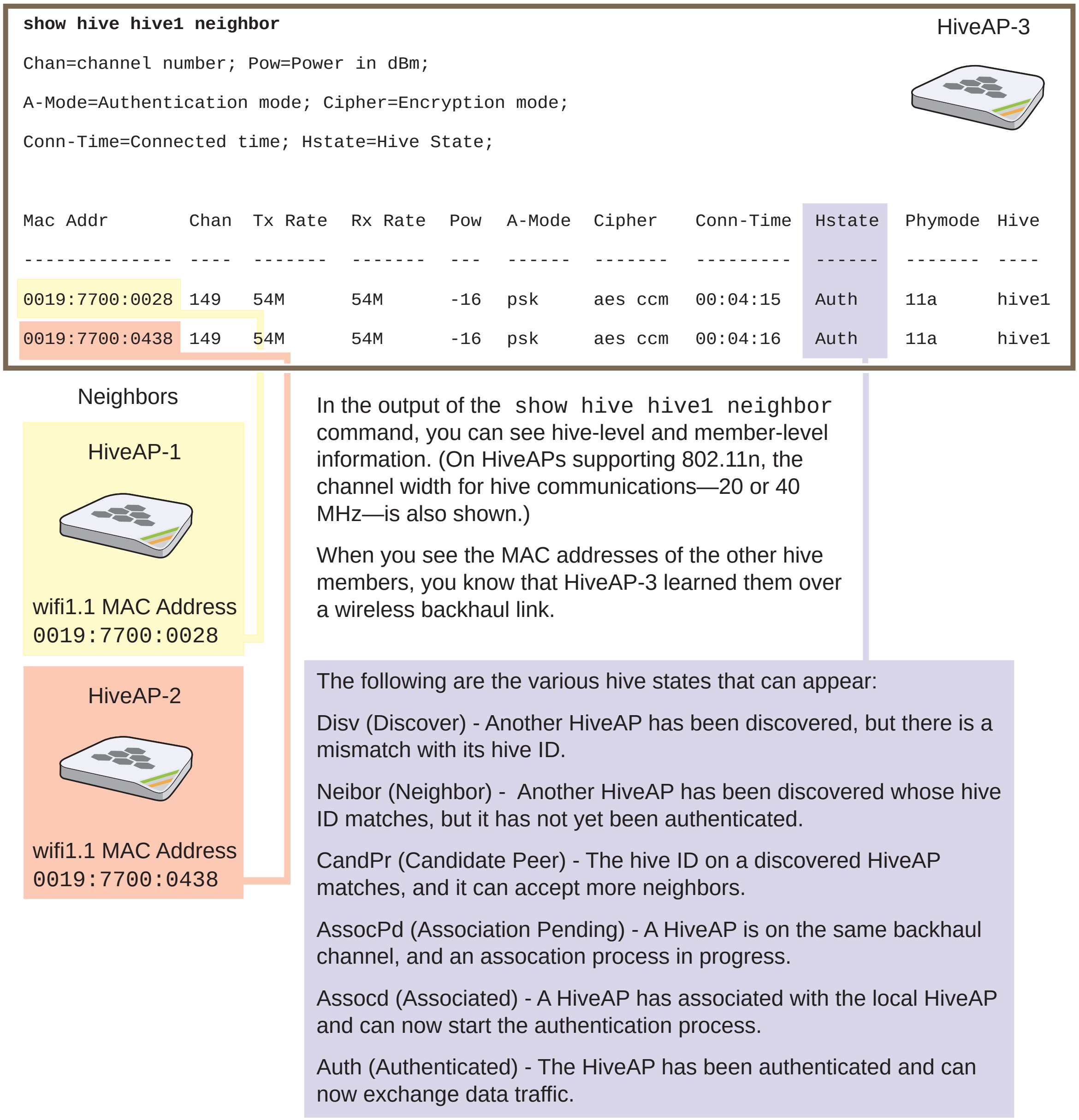
   After HiveAP-2 finishes booting up (indicated when the Power LED changes from steady amber to steady green), it automatically discovers another member of hive1 (HiveAP-1). The two members use a preshared key based on their shared secret (*s1r70ckH07m3s*) to authenticate each other and AES to encrypt wired backhaul communications and AES-CCMP to encrypt wireless backhaul communications between themselves. You can tell when they have formed a hive because the Mesh LED changes its blinking pattern from a fast to slow.

4. Place HiveAP-3 within range of its wireless clients and one or both of the other hive members.
5. Power on HiveAP-3 by connecting it to a power source.

After HiveAP-3 boots up, it discovers the two other members of hive1 over a wireless backhaul link. The members authenticate themselves and establish a security association for encrypting backhaul communications among themselves. HiveAP-3 then learns its default route to the wired network from the other hive members. If the other members send routes with equal costs—which is what happens in this example—HiveAP-3 uses the first route it receives. When it learns this route, it can communicate with the DHCP server to get an IP address for its mgt0 interface.

6. Check that HiveAP-3 has associated with the other members at the wireless level.

Log in to HiveAP-3 and enter this command to see its neighbors in hive1:



```
show hive hive1 neighbor
Chan=channel number; Pow=Power in dBm;
A-Mode=Authentication mode; Cipher=Encryption mode;
Conn-Time=Connected time; Hstate=Hive State;

Mac Addr        Chan  Tx Rate  Rx Rate  Pow  A-Mode  Cipher   Conn-Time  Hstate  Phymode  Hive
--------------  ----  -------  -------  ---  ------  -------  ---------  ------  -------  ----
0019:7700:0028  149   54M      54M      -16  psk     aes ccm  00:04:15   Auth    11a      hive1
0019:7700:0438  149   54M      54M      -16  psk     aes ccm  00:04:16   Auth    11a      hive1
```

In the output of the `show hive hive1 neighbor` command, you can see hive-level and member-level information. (On HiveAPs supporting 802.11n, the channel width for hive communications—20 or 40 MHz—is also shown.)

When you see the MAC addresses of the other hive members, you know that HiveAP-3 learned them over a wireless backhaul link.

The following are the various hive states that can appear:

Disv (Discover) - Another HiveAP has been discovered, but there is a mismatch with its hive ID.

Neibor (Neighbor) - Another HiveAP has been discovered whose hive ID matches, but it has not yet been authenticated.

CandPr (Candidate Peer) - The hive ID on a discovered HiveAP matches, and it can accept more neighbors.

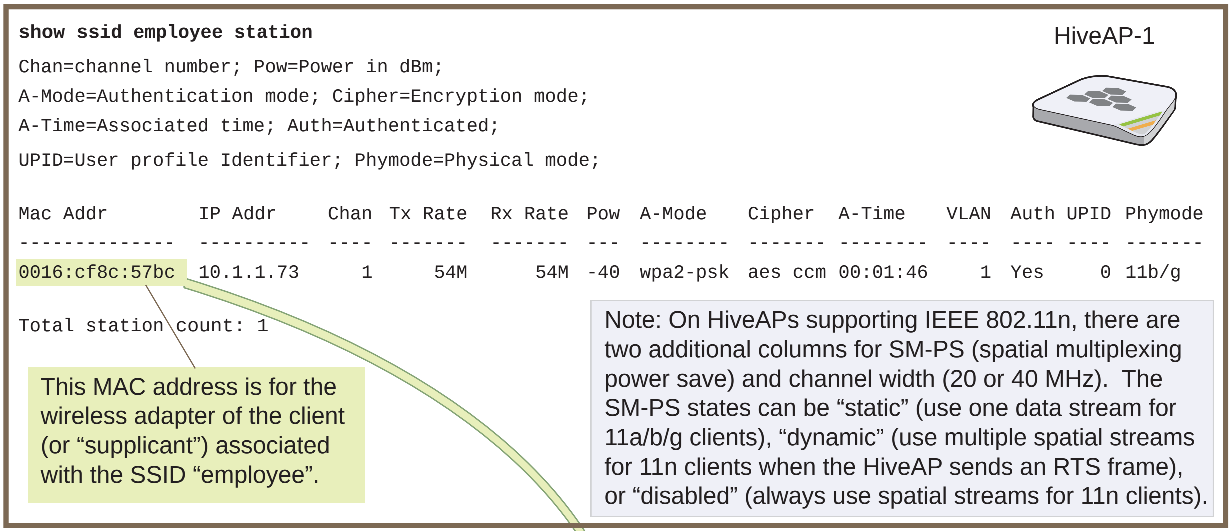
AssocPd (Association Pending) - A HiveAP is on the same backhaul channel, and an assocation process in progress.

Assocd (Associated) - A HiveAP has associated with the local HiveAP and can now start the authentication process.

Auth (Authenticated) - The HiveAP has been authenticated and can now exchange data traffic.

7. To check that the hive members have full data connectivity with each other, associate a client in wireless network-1 with HiveAP-1 (the SSID "employee" is already defined on clients in wireless network-1; see "Deploying a Single HiveAP"). Then check if HiveAP-1 forwards the client's MAC address to the others to store in their roaming caches.

   After associating a wireless client with HiveAP-1, log in to HiveAP-1 and enter this command:

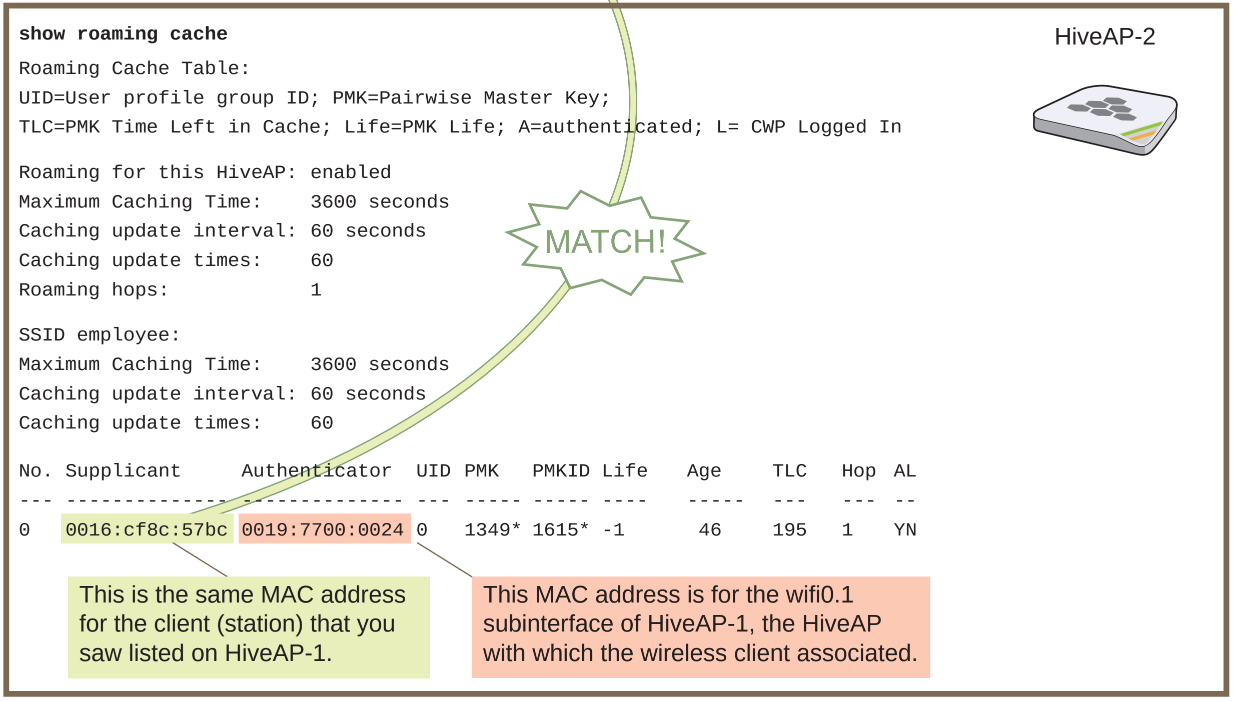


```
show ssid employee station
Chan=channel number; Pow=Power in dBm;
A-Mode=Authentication mode; Cipher=Encryption mode;
A-Time=Associated time; Auth=Authenticated;
UPID=User profile Identifier; Phymode=Physical mode;

Mac Addr        IP Addr     Chan  Tx Rate  Rx Rate  Pow  A-Mode    Cipher   A-Time    VLAN  Auth UPID  Phymode
--------------  ----------  ----  -------  -------  ---  --------  -------  --------  ----  ---- ----  -------
0016:cf8c:57bc  10.1.1.73      1      54M      54M  -40  wpa2-psk  aes ccm  00:01:46     1  Yes     0  11b/g

Total station count: 1
```

This MAC address is for the wireless adapter of the client (or “supplicant”) associated with the SSID “employee”.

Note: On HiveAPs supporting IEEE 802.11n, there are two additional columns for SM-PS (spatial multiplexing power save) and channel width (20 or 40 MHz). The SM-PS states can be “static” (use one data stream for 11a/b/g clients), “dynamic” (use multiple spatial streams for 11n clients when the HiveAP sends an RTS frame), or “disabled” (always use spatial streams for 11n clients).

   Then log in to HiveAP-2 and enter this command:



```
show roaming cache
Roaming Cache Table:
UID=User profile group ID; PMK=Pairwise Master Key;
TLC=PMK Time Left in Cache; Life=PMK Life; A=authenticated; L= CWP Logged In

Roaming for this HiveAP: enabled
Maximum Caching Time:    3600 seconds
Caching update interval: 60 seconds
Caching update times:    60
Roaming hops:            1

SSID employee:
Maximum Caching Time:    3600 seconds
Caching update interval: 60 seconds
Caching update times:    60

No. Supplicant      Authenticator  UID PMK   PMKID Life    Age    TLC   Hop  AL
--- --------------  -------------- --- ----- ----- ----    -----  ---   ---  --
0   0016:cf8c:57bc  0019:7700:0024 0   1349* 1615* -1       46    195   1    YN
```

This is the same MAC address for the client (station) that you saw listed on HiveAP-1.

This MAC address is for the wifi0.1 subinterface of HiveAP-1, the HiveAP with which the wireless client associated.

   When you see the MAC address of the wireless client that is associated with HiveAP-1 in the roaming cache of HiveAP-2, you know that HiveAP-1 and -2 are successfully sending data over the backhaul link.

   Repeat this to confirm that HiveAP-3 also has a backhaul connection with the other members.

Step 4 Configure wireless clients

Define the "employee" SSID on all the wireless clients in wireless network-2 and -3. Specify WPA-PSK for network authentication, AES or TKIP for data encryption, and the preshared key *N38bu7Adr0n3*.

The setup of hive1 is complete. Wireless clients can now associate with the HiveAPs using SSID "employee" and access the network. The HiveAPs communicate with each other to share client associations (to support fast roaming) and routing data (to select optimal data paths).

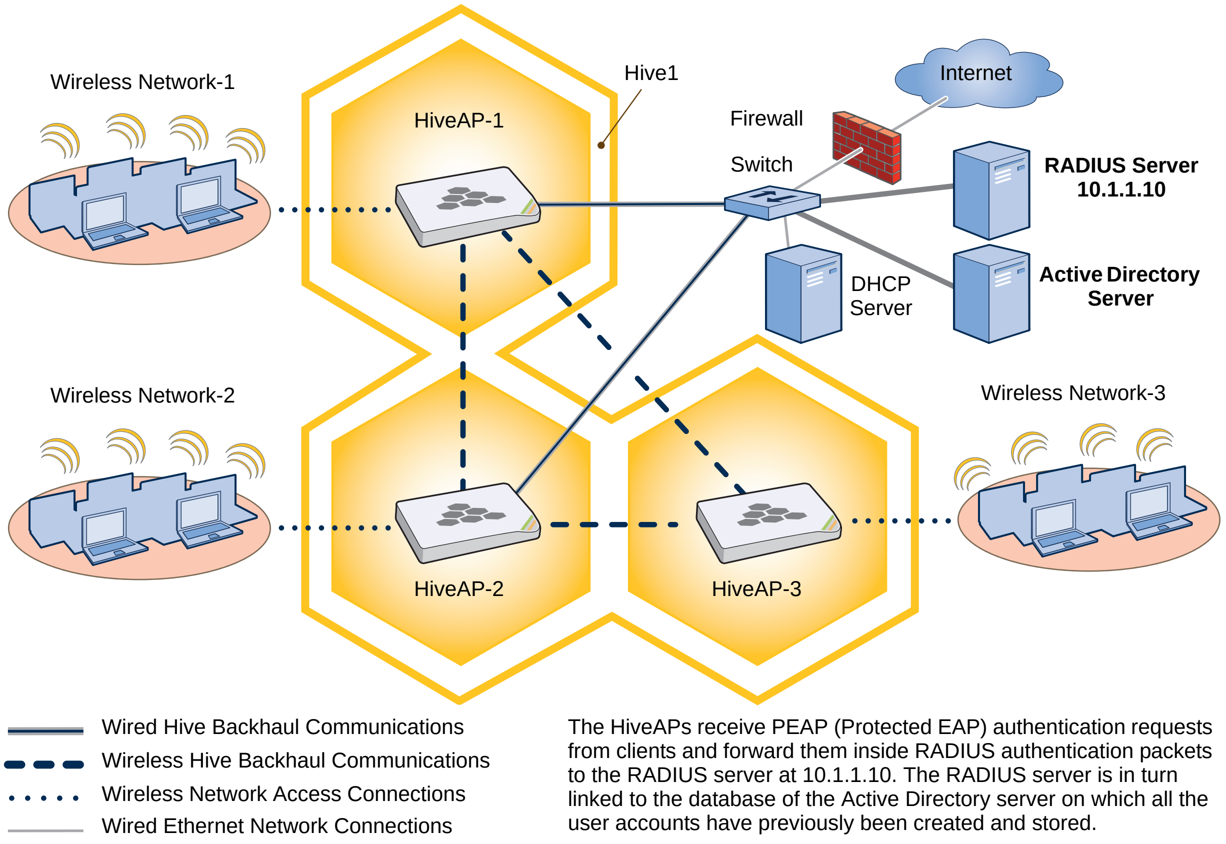
EXAMPLE 3: USING IEEE 802.1X AUTHENTICATION

In this example, you use a Microsoft AD (Active Directory) server and a RADIUS server to authenticate wireless network users. To accomplish this, you make the following modifications to the hive set up in "Deploying a Hive":

- Configure settings for the RADIUS server on the HiveAPs
- Change the SSID parameters on the HiveAPs and wireless clients to use IEEE 802.1X

The basic network design is shown in Figure 3.

Figure 3 Hive and 802.1X Authentication



The HiveAPs receive PEAP (Protected EAP) authentication requests from clients and forward them inside RADIUS authentication packets to the RADIUS server at 10.1.1.10. The RADIUS server is in turn linked to the database of the Active Directory server on which all the user accounts have previously been created and stored.

Note: This example assumes that the RADIUS and AD servers were previously configured and populated with user accounts that have been in use on a wired network (not shown). The only additional configuration on these servers is to enable the RADIUS server to accept authentication requests from the HiveAPs.

Step 1 Define the RADIUS server on the HiveAP-1

Configure the settings for the RADIUS server (IP address and shared secret) on HiveAP-1.

```
aaa radius-server first 10.1.1.10 shared-secret s3cr3741n4bl0X
```

The IP address of the RADIUS server is 10.1.1.10, and the shared secret that HiveAP-1 and the RADIUS server use to authenticate each other is "s3cr3741n4b10X". You must also enter the same shared secret on the RADIUS server when you define the HiveAPs as access devices (see step 5).

Step 2 Change the SSID on HiveAP-1

1. Change the authentication method in the SSID.

   ```
   ssid employee security protocol-suite wpa-auto-8021x
   save config
   ```

   The protocol suite requires WPA (Wi-Fi Protected Access) or WPA2 security protocol for authentication and key management, AES or TKIP encryption, and user authentication through IEEE 802.1X.

2. Enter the **show interface mgt0** command and note the dynamically assigned IP address of the mgt0 interface. You need to know this address to define HiveAP-1 as an access device on the RADIUS server in step 5.

   ```
   exit
   ```

Step 3 Configure HiveAP-2 and HiveAP-3

1. Log in to HiveAP-2 through its console port.
2. Configure HiveAP-2 with the same commands that you used for HiveAP-1:

   ```
   aaa radius-server first 10.1.1.10 shared-secret s3cr3741n4bl0X
   ssid employee security protocol-suite wpa-auto-8021x
   save config
   ```

   Note: Although all HiveAPs in this example use the same shared secret, they can also use different secrets.

3. Enter the **show interface mgt0** command to learn its IP address. You need this address for step 5.

   ```
   exit
   ```

4. Log in to HiveAP-3 and enter the same commands.

Step 4 Modify the SSID on the wireless clients

Modify the "employee" SSID on all the wireless clients in wireless network-2 and -3. Specify WPA or WPA2 for network authentication, AES or TKIP for data encryption, and PEAP (Protected EAP) for user authentication.

Step 5 Configure the RADIUS Server to accept authentication requests from the HiveAPs

Log in to the RADIUS server and define the three HiveAPs as access devices. Enter their mgt0 IP addresses (or fully-qualified domain names) and shared secret.

Step 6 Check that clients can form associations and access the network

1. To check that a client can associate with a HiveAP and access the network, open a wireless client application and connect to the "employee" SSID. Then contact a network resource, such as a web server.
2. Log in to the HiveAP CLI, and check that you can see the MAC address or the associated client and an indication that the correct SSID is in use by entering the following command:

```
show ssid employee station
Chan=channel number; Pow=Power in dBm;
A-Mode=Authentication mode; Cipher=Encryption mode;
A-Time=Associated time; Auth=Authenticated;
UPID=User profile Identifier; Phymode=Physical mode;

Mac Addr        IP Addr     Chan  Tx Rate  Rx Rate  Pow  A-Mode   Cipher  A-Time    VLAN  Auth UPID  Phymode
--------------  ----------  ----  -------  -------  ---  -------- ------- --------  ----  ---- ----  -------
0016:cf8c:57bc  10.1.1.73      1      54M      54M  -40  8021x    aes ccm 00:02:34     1  Yes      0  11b/g

Total station count: 1
```

Check that the MAC and IP addresses in the table match those of the wireless client .

Check that the authentication and encryption modes match those in the SSID security protocol suite.

> *Note: You can also enter the following commands to check the association status of a wireless client:* **`show auth`**, **`show roaming cache`**, *and* **`show roaming cache mac <mac_addr>`**.

The setup for using IEEE 802.1X is complete. Wireless clients can now associate with the HiveAP using SSID "employee", authenticate themselves through IEEE 802.1X to a RADIUS server, and access the network.

EXAMPLE 4: APPLYING QOS

In this example, you want the hive members to prioritize voice, streaming media, and e-mail traffic. First, you map distinguishing elements of these traffic types to three Aerohive QoS (Quality of Service) classes:

Class 6: voice traffic from VoIP phones with MAC OUI 00:12:3b (the OUI for all phones in the network)

Voice traffic is very sensitive to delay and cannot tolerate packet loss without loss of voice quality. When other traffic is competing with voice traffic for bandwidth, it becomes essential to prevent that traffic from interfering with voice traffic. Because voice traffic for a single call requires very little bandwidth—typically from 8 to 64 Kbps depending on the voice codec used—a good approach for setting its rate is to calculate the bandwidth necessary for a voice call plus related telephony traffic from a single user's computer, softphone, or handset and then multiply that by the potential number of concurrent VoIP users.

Class 5: streaming media using the MMS (Microsoft Media Server) protocol on TCP port 1755

Although streaming media is also time sensitive, streaming media software for both clients and servers offers limited buffering to prevent choppy sounds and pixelated video when network congestion occurs. Because congestion for more than a few seconds can adversely effect streaming media, it is important to assign this type of traffic a higher priority than other types, but its priority should be lower than that for voice, which is even more sensitive to delay.

Class 3: data traffic for e-mail using the following protocols:

SMTP (Simple Mail Transfer Protocol) on TCP port 25

POP3 (Post Office Protocol version 3) on TCP port 110

Then you create classifier profiles that reference these traffic-to-class mappings. You bind the profiles to the wifi0.1 and eth0 interfaces so that hive members map the traffic matching these profiles that arrives at these interfaces to the proper Aerohive classes.

You next define a QoS policy that defines how the hive members prioritize and process the traffic mapped to Aerohive classes 6, 5, and 3. The QoS policy (named "voice") is shown in Figure 4 on page 174 and has these settings:

Class 6 (voice)

Forwarding: strict (Hive members forward traffic mapped to this class immediately without queuing it.)

Maximum rate for all class 6 traffic: 512 Kbps, which supports an 8- to 64-Kbps VoIP call (depending on the compression that the codec provides) plus other telephony traffic such as DHCP, DNS, HTTP, and TFTP.

Class 5 (streaming media)

Forwarding: WRR (weighted round robin) with a weight of 90

By assigning class 5 a higher weight (90) than class 3 and 2 weights (class 3 = 60, class 2 = 30), you give streaming media roughly a 3:2 priority over class 3 traffic and a 3:1 priority over class 2 traffic.

Maximum traffic rate for all class 5 traffic: 20,000 Kbps

You change the bandwidth available for streaming media when there is no competition for it (the default rate for class 5 is 10,000 Kbps on HiveAPs that do not support the IEEE 802.11n standard and 50,000 Kbps on HiveAPs that do. However, you do not set the maximum rate (54,000 or 1,000,000 Kbps, depending on the HiveAP model that you are configuring) to ensure that streaming media does not consume all available bandwidth even if it is available.

Class 3 (e-mail)

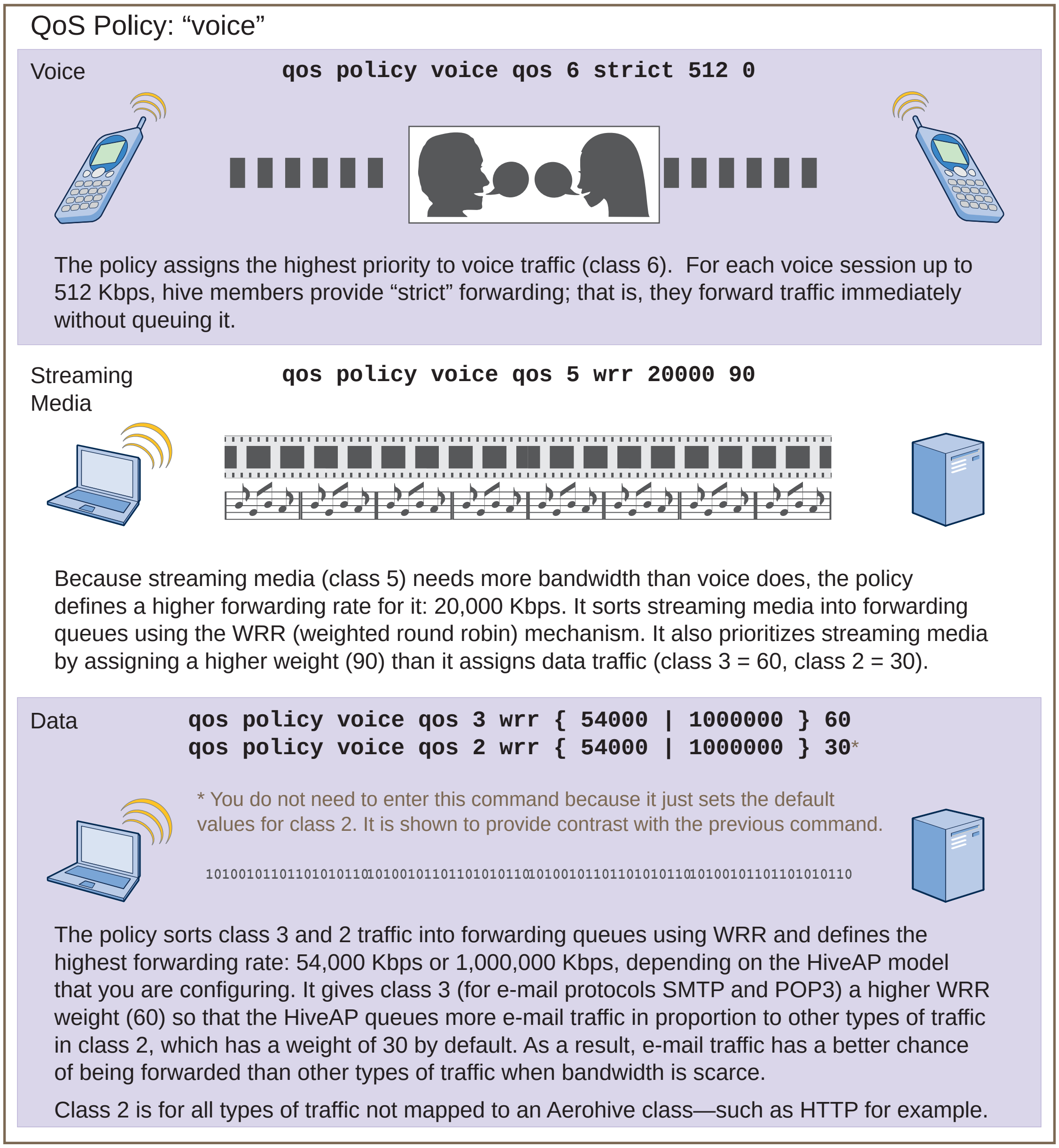
Forwarding: WRR with a weight of 60

To help ensure that e-mail traffic remains flowing even when other types of data traffic compete with it for available bandwidth, you elevate its priority by mapping SMTP and POP3 traffic to class 3 and giving that class a higher weight (60) than the weight for class 2 traffic (30).

Maximum traffic rate for all class 3 traffic: 54,000 or 1,000,000 Kbps (the default, depending on the HiveAP)

Note: The HiveAP assigns all traffic that you do not specifically map to an Aerohive class to class 2, which by default uses WRR with a weight of 30 and a rate of 54,000 or 1,000,000 Kbps, depending on the HiveAP.

Figure 4   QoS Policy "voice" for Voice, Streaming Media, and Data



```
qos policy voice qos 6 strict 512 0
```

The policy assigns the highest priority to voice traffic (class 6). For each voice session up to 512 Kbps, hive members provide “strict” forwarding; that is, they forward traffic immediately without queuing it.

```
qos policy voice qos 5 wrr 20000 90
```

Because streaming media (class 5) needs more bandwidth than voice does, the policy defines a higher forwarding rate for it: 20,000 Kbps. It sorts streaming media into forwarding queues using the WRR (weighted round robin) mechanism. It also prioritizes streaming media by assigning a higher weight (90) than it assigns data traffic (class 3 = 60, class 2 = 30).

```
qos policy voice qos 3 wrr { 54000 | 1000000 } 60
qos policy voice qos 2 wrr { 54000 | 1000000 } 30*
```

* You do not need to enter this command because it just sets the default values for class 2. It is shown to provide contrast with the previous command.

The policy sorts class 3 and 2 traffic into forwarding queues using WRR and defines the highest forwarding rate: 54,000 Kbps or 1,000,000 Kbps, depending on the HiveAP model that you are configuring. It gives class 3 (for e-mail protocols SMTP and POP3) a higher WRR weight (60) so that the HiveAP queues more e-mail traffic in proportion to other types of traffic in class 2, which has a weight of 30 by default. As a result, e-mail traffic has a better chance of being forwarded than other types of traffic when bandwidth is scarce.

Class 2 is for all types of traffic not mapped to an Aerohive class—such as HTTP for example.

Note: This example assumes that the RADIUS and AD servers were previously configured and populated with user accounts and have been serving a wired network (not shown). The only additional configuration is to enable the RADIUS server to accept authentication requests from the HiveAPs.

Finally, you create a user profile "employee-net" and apply the QoS policy "voice" to the user profile on each hive member. You also configure the RADIUS server to return attributes in its authentication responses to indicate the user group to which the hive members then assign users.

Step 1 Map traffic types to Aerohive QoS classes on HiveAP-1

1. Map the MAC OUI (organizational unit identifier) of network users’ VoIP phones to Aerohive class 6.

   ```
   qos classifier-map oui 00:12:3b qos 6
   ```

   In this example, all network users use VoIP phones from the same vendor whose OUI (that is, the MAC address prefix) is 00:12:3b. When HiveAP-1 receives traffic from a client whose source MAC address contains this OUI, it assigns it to Aerohive class 6.

2. Define the custom services that you need.

   ```
   service mms tcp 1755

   service smtp tcp 25

   service pop3 tcp 110
   ```

   The MMS (Microsoft Media Server) protocol can use several transports (UDP, TCP, and HTTP). However, for a HiveAP to be able to map a service to an Aerohive QoS class, it must be able to identify that service by a unique characteristic such as a static destination port number or a nonstandard protocol number. Unlike MMS/UDP and MMS/HTTP, both of which use a range of destination ports, MMS/TCP uses the static destination port 1755, which a HiveAP can use to map the service to an Aerohive class. Therefore, you define a custom service for MMS using TCP port 1755. You also define custom services for SMTP and POP3 so that you can map them to Aerohive class 3. By doing so, you can prioritize e-mail traffic above other types of traffic that the HiveAP assigns to class 2 by default.

3. Map services to Aerohive classes.

   ```
   qos classifier-map service mms qos 5

   qos classifier-map service smtp qos 3

   qos classifier-map service pop3 qos 3
   ```

   Unless you map a specific service to an Aerohive QoS class, a HiveAP maps all traffic to class 2. In this example, you prioritize voice, media, and e-mail traffic by assigning them to higher QoS classes than class 2, and then by defining the forwarding and weighting mechanisms for each class (see step 3).

Step 2 Create profiles to check traffic arriving at interfaces on HiveAP-1

1. Define two classifier profiles for the traffic types "mac" and "service".

   ```
   qos classifier-profile employee-voice mac

   qos classifier-profile employee-voice service

   qos classifier-profile eth0-voice mac

   qos classifier-profile eth0-voice service
   ```

   Classifier profiles define which components of incoming traffic HiveAP-1 checks. Because you specify "mac" and "service", it checks the MAC address in the Ethernet frame header and the service type (by protocol number in the IP packet header and port number in the transport packet header). If it detects traffic matching a classifier-map, it maps it to the appropriate Aerohive class. However, before this can happen, you must first associate the profiles with the interfaces that will be receiving the traffic that you want checked. This you do with the next two commands.

2. Associate the classifier profiles with the employee SSID and the eth0 interface so that HiveAP-1 can classify incoming traffic arriving at these two interfaces.

```
ssid employee qos-classifier employee-voice
```

```
interface eth0 qos-classifier eth0-voice
```

By creating two QoS classifiers and associating them with the employee SSID and eth0 interface, HiveAP-1 can classify traffic flowing in both directions for subsequent QoS processing; that is, it can classify traffic flowing from the wireless LAN to the wired LAN, and from the wired LAN to the wireless LAN.

Note: If the surrounding network employs the IEEE 802.11p QoS classification system (for wired network traffic) or 802.11e (for wireless network traffic), you can ensure that HiveAP-1 checks for them by entering these commands:

```
qos classifier-profile eth0-voice 8021p
qos classifier-profile employee-voice 80211e
```

Step 3 Apply QoS on HiveAP-1

1. Create a QoS policy.

For HiveAPs supporting IEEE 802.11a/b/g:

```
qos policy voice qos 5 wrr 20000 90
```

```
qos policy voice qos 3 wrr 54000 60
```

For HiveAPs supporting IEEE 802.11a/b/g/n:

```
qos policy voice qos 6 strict 512 0
```

```
qos policy voice qos 5 wrr 20000 90
```

```
qos policy voice qos 3 wrr 1000000 60
```

By default, a newly created QoS policy attempts to forward traffic mapped to classes 6 and 7 immediately upon receipt. This immediate forwarding of received traffic is called "strict" forwarding. To assign strict forwarding to VoIP traffic from phones whose MAC OUI is mapped to class 6, you simply retain the default settings for class 6 traffic on HiveAPs supporting 802.11a/b/g data rates. For HiveAPs supporting 802.11n data rates, the default user profile rate is 20,000 Kbps for class 6 traffic, so you change it to 512 Kbps.

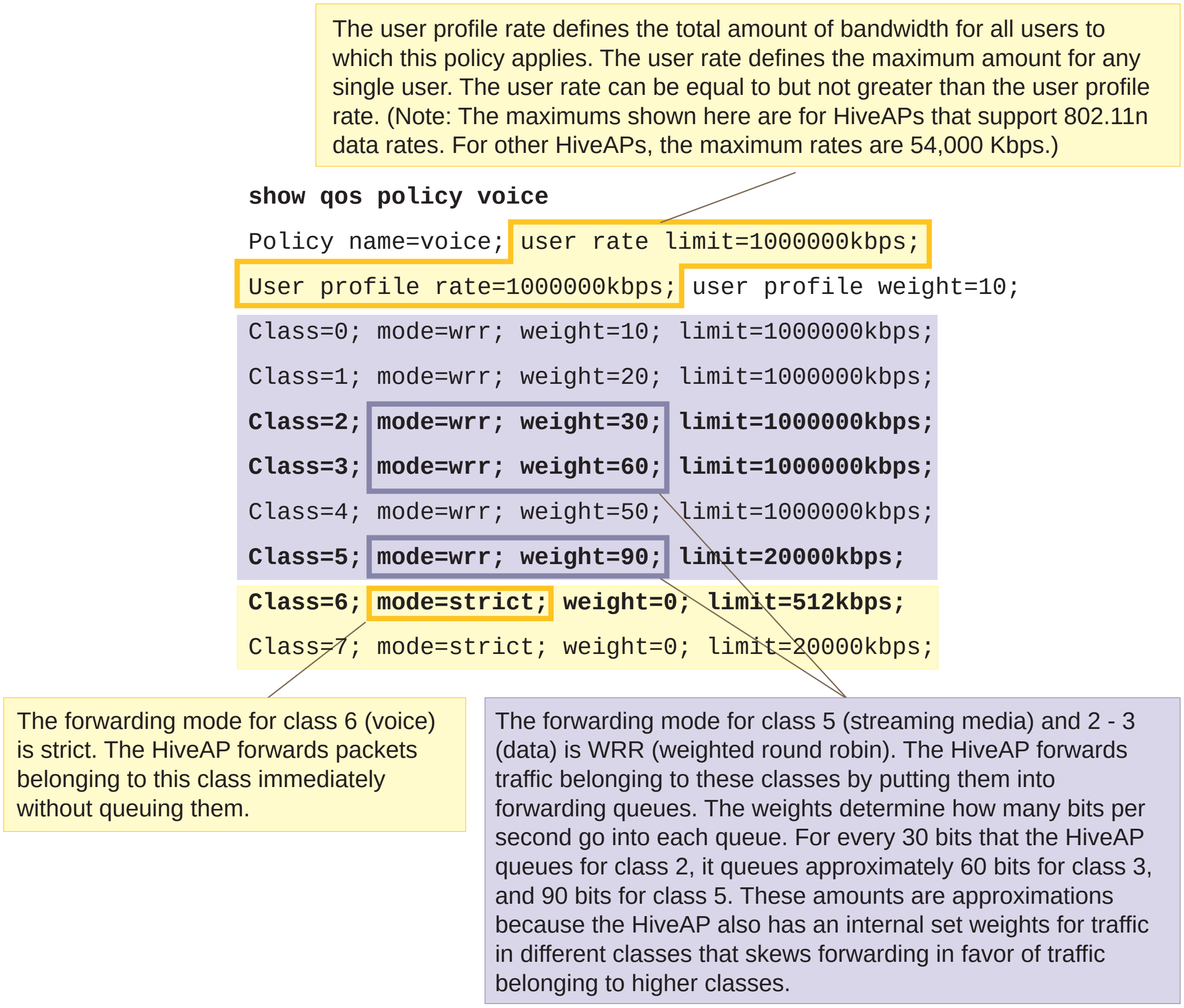
For classes 5 and 3, you limit the rate of traffic and set WRR (weighted round robin) weights so that the HiveAP can control how to put the rate-limited traffic into forwarding queues. You use the default settings for class 2 traffic.

When you enter any one of the above commands, the HiveAP automatically sets the maximum bandwidth for all members of the user group to which you later apply this policy and the bandwidth for any individual group member. You leave the maximum traffic rate at the default 54,000 Kbps or 1,000,000 Kbps—depending on the HiveAP model that you are configuring—for the user group. You also leave the maximum bandwidth for a single user at 54,000 or 1,000,000 Kbps, so that if a single user needs all the bandwidth and there is no competition for it, that user can use it all.

Also by default, the traffic rate for this policy has a weight of 10. At this point, because this is the only QoS policy, the weight is inconsequential. If there were other QoS policies, then their weights would help determine how the HiveAP would allocate the available bandwidth.

The QoS policy that you define is shown in Figure 5. Although you did not configure settings for Aerohive QoS classes 0, 1, 2, 4, and 7, the policy applies default settings to them. The HiveAP assigns all traffic that you do not specifically map to an Aerohive class to class 2, which uses WRR with a weight of 30 and a default rate of 54,000 or 1,000,000 Kbps. Because nothing is mapped to classes 0, 1, 4, and 7, their settings are irrelevant.

Figure 5 QoS Policy "voice"



The user profile rate defines the total amount of bandwidth for all users to which this policy applies. The user rate defines the maximum amount for any single user. The user rate can be equal to but not greater than the user profile rate. (Note: The maximums shown here are for HiveAPs that support 802.11n data rates. For other HiveAPs, the maximum rates are 54,000 Kbps.)

```
show qos policy voice
Policy name=voice; user rate limit=1000000kbps;
User profile rate=1000000kbps; user profile weight=10;
Class=0; mode=wrr; weight=10; limit=1000000kbps;
Class=1; mode=wrr; weight=20; limit=1000000kbps;
Class=2; mode=wrr; weight=30; limit=1000000kbps;
Class=3; mode=wrr; weight=60; limit=1000000kbps;
Class=4; mode=wrr; weight=50; limit=1000000kbps;
Class=5; mode=wrr; weight=90; limit=20000kbps;
Class=6; mode=strict; weight=0; limit=512kbps;
Class=7; mode=strict; weight=0; limit=20000kbps;
```

The forwarding mode for class 6 (voice) is strict. The HiveAP forwards packets belonging to this class immediately without queuing them.

The forwarding mode for class 5 (streaming media) and 2 - 3 (data) is WRR (weighted round robin). The HiveAP forwards traffic belonging to these classes by putting them into forwarding queues. The weights determine how many bits per second go into each queue. For every 30 bits that the HiveAP queues for class 2, it queues approximately 60 bits for class 3, and 90 bits for class 5. These amounts are approximations because the HiveAP also has an internal set weights for traffic in different classes that skews forwarding in favor of traffic belonging to higher classes.

2. Create a user profile and apply the QoS policy to it.

```
user-profile employee-net qos-policy voice attribute 2
```

You apply the QoS policy "voice" to all users belonging to the user-profile "employee-net" with attribute 2. On the RADIUS server, you must configure attribute 2 as one of the RADIUS attributes that the RADIUS server returns when authenticating users (see step 5 on page 179).

Note: When HiveAP-1 does not use RADIUS for user authentication, you must assign the user profile to an SSID. To do that, use the following command: **ssid employee default-user-profile-attr 2**

```
save config
exit
```

Step 4 Configure HiveAP-2 and HiveAP-3

1. Log in to HiveAP-2 through its console port.
2. Configure HiveAP-2 with the same commands that you used for HiveAP-1:

```
qos classifier-map oui 00:12:3b qos 6
service mms tcp 1755
service smtp tcp 25
service pop3 tcp 110
qos classifier-map service mms qos 5
qos classifier-map service smtp qos 3
qos classifier-map service pop3 qos 3
qos classifier-profile employee-voice mac
qos classifier-profile employee-voice service
qos classifier-profile eth0-voice mac
qos classifier-profile eth0-voice service
ssid employee qos-classifier employee-voice
interface eth0 qos-classifier eth0-voice
```

For HiveAPs supporting IEEE 802.11a/b/g:

```
      qos policy voice qos 5 wrr 20000 90
      qos policy voice qos 3 wrr 54000 60
```

For HiveAPs supporting IEEE 802.11a/b/g/n:

```
      qos policy voice qos 6 strict 512 0
      qos policy voice qos 5 wrr 20000 90
      qos policy voice qos 3 wrr 1000000 60
user-profile employee-net qos-policy voice attribute 2
save config
exit
```

3. Log in to HiveAP-3 and enter the same commands.

Step 5 Configure RADIUS server attributes

1. Log in to the RADIUS server and define the three HiveAPs as RADIUS clients.
2. Configure the following attributes for the realm to which the wireless user accounts in network-1, -2, and -3 belong:
   - Tunnel Type = GRE (value = 10)
   - Tunnel Medium Type = IP (value = 1)
   - Tunnel Private Group ID = 2

The RADIUS server returns the above attributes for all wireless users it authenticates from network-1, -2, and -3. The HiveAP uses the combination of returned RADIUS attributes to assign users to the user group 2 ("employee-net"). It does not use them to create a GRE tunnel, which the tunnel type attribute might lead you to think.

When there is more traffic than available bandwidth, the HiveAP applies the "voice" policy. It performs strict forwarding for voice and uses a WRR (weighted round robin) scheduling discipline for directing streaming media and data traffic to queues to await forwarding. The QoS configuration is complete.

EXAMPLE 5: LOADING A BOOTSTRAP CONFIGURATION

As explained in "HiveOS Configuration File Types" on page 157, a bootstrap config file is typically a small set of commands to which a HiveAP can revert when the configuration is reset or if the HiveAP cannot load its current and backup configs. If you do not define and load a bootstrap config, the HiveAP reverts to the default config in these situations, which can lead to two potential problems:

- If both the current and backup configs fail to load on a HiveAP acting as a mesh point in a hard-to-reach location—such as a ceiling crawlspace—the HiveAP would revert to the default config. Because a mesh point needs to join a hive before it can access the network and the default config does not contain the hive settings that the mesh point needs to join the hive, an administrator would need to crawl to the device to make a console connection to reconfigure the HiveAP.
- If the location of a HiveAP is publicly accessible, someone could press the reset button on the front panel of the device to return the configuration to its default settings, log in using the default login name and password (*admin*, *aerohive*), and thereby gain complete admin access. (Note that you can disable the ability of the reset button to reset the configuration by entering this command: **`no reset-button reset-config-enable`**)

A bootstrap configuration can help in both of these situations. For the first case, a bootstrap config with the necessary hive membership settings can allow the HiveAP to connect to the network and thereby become accessible over the network for further configuring. For the second case, a bootstrap config with a number of obstacles such as a hard-to-guess login name and password and a disabled access subinterface can make the firmware inaccessible and the device unusable.

HiveAP-1 and -2 are in locations that are not completely secure. HiveAP-3 is a mesh point in a fairly inaccessible location. To counter theft of the first two HiveAPs and to avoid the nuisance of physically accessing the third HiveAP, you define a bootstrap config file that addresses both concerns and load it on the HiveAPs.

Step 1 Define the bootstrap config on HiveAP-1

1. Make a serial connection to the console port on HiveAP-1, log in, and load the default config.

   ```
   load config default
   
   reboot
   ```

   You do not want the bootstrap config to contain any of your previously defined settings from the current config. Therefore, you load the default config, which has only default settings. When you begin with the default config and enter the commands that define the bootstrap config, the bootstrap config will have just those commands and the default config settings.

2. Confirm the `reboot` command, and then, when you are asked if you want to use the Aerohive Initial Configuration Wizard, enter **no**.
3. Log in using the default user name *admin* and password *aerohive*.
4. Define admin login parameters for the bootstrap config that are difficult to guess.

   ```
   admin root-admin Cwb12o11siNIm8vhD2hs password 8wDamKC1Lo53Ku71
   ```

   You use the maximum number of alphanumeric characters for the login name (20 characters) and password (16 characters). By mixing uppercase and lowercase letters with numbers in strings that do not spell words or phrases, you make the login much harder to guess.

   Note: Be careful to remember the login name and password defined in a bootstrap config file. If they become lost or forgotten, you must obtain a one-time login key from Aerohive technical support. To get the key, you must already have had a support contract in place. The first one-time login key is free. After that, there is a small handling fee for each additional key.

5. Leave the various interfaces in their default up or down states.

   By default, the wifi0 and wifi0.1 interfaces are down, but the mgt0, eth0, wifi1, and wifi1.1 subinterfaces are up. The hive members need to use wifi1.1, which is in backhaul mode, so that HiveAP-3 can rejoin hive1 and, through hive1, access DHCP and DNS servers to regain network connectivity. (By default, mgt0 is a DHCP client.) You leave the eth0 interface up so that Hive-1 and Hive-2 can retain an open path to the wired network. However, with the two interfaces in access mode—wifi0 and wifi0.1— in the down state, none of the HiveAPs will be able provide network access to any wireless clients. Wireless clients cannot form associations through wifi1.1 nor can a computer attach through the eth0 interface—because it is also in backhaul mode—and obtain network access through the mesh.

6. Define the hive settings so that any of the three HiveAPs using the bootstrap config can rejoin the grid.

   ```
   hive hive1
   
   hive hive1 password s1r70ckH07m3s
   
   interface mgt0 hive hive1
   ```

   When a HiveAP boots up using the bootstrap config, it can rejoin hive1 because the configuration includes the hive name and password and binds the mgt0 interface to the hive. This is particularly useful for HiveAP-3 because it is a mesh point and can only access the wired network after it has joined the hive. It can then reach the wired network through either of the portals, HiveAP-1 or HiveAP-2.

7. Save the configuration as a bootstrap config.

   ```
   save config running bootstrap
   ```

   If anyone resets the current configuration, the HiveAP will load this bootstrap config and thwart any thief from accessing the configuration and any wireless client from accessing the network.

Step 2 Save the bootstrap config to a TFTP server

1. Check the configurations to make sure the settings are accurate.

   ```
   show config bootstrap
   ```

   Check that the settings are those you entered in the previous step for the bootstrap config.

   ```
   show config backup
   ```

   Note that the backup config is the previous current config. This is the configuration that has all your previously defined settings.

2. Return to the previous current config.

   ```
   load config backup
   reboot
   ```

3. When HiveAP-1 finishes rebooting, log back in using the login parameters you set in "Example 1: Deploying a Single HiveAP" on page 162 (*mwebster*, *3fF8ha*).
4. Check that the current config is the same as your previous current config.

   ```
   show config current
   ```

5. Save the file as bootstrap-hive1.txt to the root directory of your TFTP server running on your management system at 10.1.1.31, an address received by the same DHCP server and in the same subnet as the HiveAP addresses.

   ```
   save config bootstrap tftp://10.1.1.31:bootstrap-hive1.txt
   ```

Step 3 Load the bootstrap config file on HiveAP-2 and HiveAP-3

1. Make a serial connection to the console port on HiveAP-2 and log in.
2. Upload the bootstrap-hive1.txt config file from the TFTP server to HiveAP-2 as a bootstrap config.

   ```
   save config tftp://10.1.1.31:bootstrap-hive1.txt bootstrap
   ```

3. Check that the uploaded config file is now the bootstrap config.

   ```
   show config bootstrap
   ```

4. Repeat the procedure to load the bootstrap config on HiveAP-3.

The bootstrap configs are now in place on all three HiveAPs.

CLI Commands for Examples

This section includes all the CLI commands for configuring the HiveAPs in the previous examples. The CLI configurations are presented in their entirety (without explanations) as a convenient reference, and—if you are reading this guide as a PDF—as an easy way to copy and paste the commands. Simply copy the blocks of text for configuring the HiveAPs in each example and paste them at the command prompt.

Note: The following sections omit optional commands, such as changing the login name and password, and commands used to check a configuration.

Commands for Example 1

Enter the following commands to configure the SSID "employee" on the single HiveAP in "Deploying a Single HiveAP" on page 162:

```
ssid employee

ssid employee security protocol-suite wpa-auto-psk ascii-key N38bu7Adr0n3

interface wifi0.1 ssid employee

save config
```

Commands for Example 2

Enter the following commands to configure three HiveAPs as members of "hive1" in "Deploying a Hive" on page 165:

HiveAP-1

```
hive hive1

hive hive1 password s1r70ckH07m3s

interface mgt0 hive hive1

save config
```

HiveAP-2

```
ssid employee

ssid employee security protocol-suite wpa-auto-psk ascii-key N38bu7Adr0n3

interface wifi0.1 ssid employee

hive hive1

hive hive1 password s1r70ckH07m3s

interface mgt0 hive hive1

save config
```

HiveAP-3

```
ssid employee
ssid employee security protocol-suite wpa-auto-psk ascii-key N38bu7Adr0n3
interface wifi0.1 ssid employee
hive hive1
hive hive1 password s1r70ckH07m3s
interface mgt0 hive hive1
save config
```

Commands for Example 3

Enter the following commands to configure the hive members to support IEEE 802.1X authentication in "Using IEEE 802.1X Authentication" on page 170:

HiveAP-1

```
aaa radius-server first 10.1.1.10 shared-secret s3cr3741n4bl0X
ssid employee security protocol-suite wpa-auto-8021x
save config
```

HiveAP-2

```
aaa radius-server first 10.1.1.10 shared-secret s3cr3741n4bl0X
ssid employee security protocol-suite wpa-auto-8021x
save config
```

HiveAP-3

```
aaa radius-server 10.1.1.10 shared-secret s3cr3741n4bl0X
ssid employee security protocol-suite wpa-auto-8021x
save config
```

Commands for Example 4

Enter the following commands to configure the hive members to apply QoS (Quality of Service) to voice, streaming media, and data traffic in "Applying QoS" on page 173:

HiveAP-1

```
qos classifier-map oui 00:12:3b qos 6
service mms tcp 1755
service smtp tcp 25
service pop3 tcp 110
qos classifier-map service mms qos 5
qos classifier-map service smtp qos 3
qos classifier-map service pop3 qos 3
qos classifier-profile employee-voice mac
qos classifier-profile employee-voice service
qos classifier-profile eth0-voice mac
qos classifier-profile eth0-voice service
ssid employee qos-classifier employee-voice
interface eth0 qos-classifier eth0-voice
```

For HiveAPs supporting IEEE 802.11a/b/g

```
      qos policy voice qos 5 wrr 20000 90
      qos policy voice qos 3 wrr 54000 60
```

For HiveAPs supporting IEEE 802.11a/b/g/n

```
      qos policy voice qos 6 strict 512 0
      qos policy voice qos 5 wrr 20000 90
      qos policy voice qos 3 wrr 1000000 60
```

```
user-profile employee-net qos-policy voice attribute 2
save config
```

HiveAP-2

```
qos classifier-map oui 00:12:3b qos 6
service mms tcp 1755
service smtp tcp 25
service pop3 tcp 110
qos classifier-map service mms qos 5
qos classifier-map service smtp qos 3
qos classifier-map service pop3 qos 3
qos classifier-profile employee-voice mac
qos classifier-profile employee-voice service
qos classifier-profile eth0-voice mac
qos classifier-profile eth0-voice service
ssid employee qos-classifier employee-voice
interface eth0 qos-classifier eth0-voice
```

For HiveAPs supporting IEEE 802.11a/b/g

```
      qos policy voice qos 5 wrr 20000 90
      qos policy voice qos 3 wrr 54000 60
```

For HiveAPs supporting IEEE 802.11a/b/g/n

```
      qos policy voice qos 6 strict 512 0
      qos policy voice qos 5 wrr 20000 90
      qos policy voice qos 3 wrr 1000000 60
user-profile employee-net qos-policy voice attribute 2
save config
```

HiveAP-3

```
qos classifier-map oui 00:12:3b qos 6
service mms tcp 1755
service smtp tcp 25
service pop3 tcp 110
qos classifier-map service mms qos 5
qos classifier-map service smtp qos 3
qos classifier-map service pop3 qos 3
qos classifier-profile employee-voice mac
qos classifier-profile employee-voice service
qos classifier-profile eth0-voice mac
qos classifier-profile eth0-voice service
ssid employee qos-classifier employee-voice
interface eth0 qos-classifier eth0-voice
```

For HiveAPs supporting IEEE 802.11a/b/g

```
      qos policy voice qos 5 wrr 20000 90
      qos policy voice qos 3 wrr 54000 60
```

For HiveAPs supporting IEEE 802.11a/b/g/n

```
      qos policy voice qos 6 strict 512 0
      qos policy voice qos 5 wrr 20000 90
      qos policy voice qos 3 wrr 1000000 60
user-profile employee-net qos-policy voice attribute 2
save config
```

Commands for Example 5

Enter the following commands to create bootstrap config files and load them on the hive members in "Loading a Bootstrap Configuration" on page 179:

bootstrap-security.txt

```
admin root-admin Cwb12o11siNIm8vhD2hs password 8wDamKC1Lo53Ku71

hive hive1

hive hive1 password s1r70ckH07m3s

interface mgt0 hive hive1
```

HiveAP-1

```
save config tftp://10.1.1.31:bootstrap-security.txt bootstrap

show config bootstrap
```

HiveAP-2

```
save config tftp://10.1.1.31:bootstrap-security.txt bootstrap

show config bootstrap
```

HiveAP-3

```
save config tftp://10.1.1.31:bootstrap-meshpoint.txt bootstrap

show config bootstrap
```

Chapter 12 Traffic Types

This is a list of all the types of traffic that might be involved with a HiveAP and HiveManager deployment. If a firewall lies between any of the sources and destinations listed below, make sure that it allows these traffic types.

Traffic Supporting Network Access for Wireless Clients

Service	Source	Destination	Protocol	SRC Port	DST Port	Notes
DHCP	unregistered wireless client	HiveAP wifi subinterface in access mode	17 UDP	68	67	Required for captive web portal functionality
DNS	unregistered wireless client	HiveAP wifi subinterface in access mode	17 UDP	53, or 1024 - 65535	53	Required for captive web portal functionality
GRE	HiveAP mgt0 interface	HiveAP mgt0 interface	47 GRE	N.A.	N.A.	Required to support DNX* and layer 3 roaming between members of different hives
HTTP	unregistered wireless client	HiveAP wifi subinterface in access mode	6 TCP	1024 - 65535	80	Required for captive web portal functionality
HTTPS	unregistered wireless client	HiveAP wifi subinterface in access mode	6 TCP	1024 - 65535	443	Required for captive web portal functionality using a server key
RADIUS accounting	HiveAP mgt0 interface	RADIUS server	17 UDP	1024 - 65535	1813†	Required to support RADIUS accounting
RADIUS authentication	HiveAP mgt0 interface	RADIUS server	17 UDP	1024 - 65535	1812†	Required for 802.1X authentication of users

* DNX = dynamic network extensions

† This is the default destination port number. You can change it to a different port number from 1 to 65535.

Traffic Supporting Management of HiveAPs

Service	Source	Destination	Protocol	SRC Port	DST Port	Notes
CAPWAP*	HiveAP mgt0 interface	HiveManager MGT or LAN port	17 UDP	12222	12222	Required for HiveAPs to discover the HiveManager and send it alarms, events, and reports
NTP	HiveAP mgt0 interface	HiveManager MGT or LAN port	17 UDP	1024 - 65535	123	Required for HiveAP time synchronization with the HiveManager

* Control and Provisioning of Wireless Access Points

Service	Source	Destination	Protocol	SRC Port	DST Port	Notes
SNMP	HiveAP mgt0 interface	SNMP manager	17 UDP	1024 - 65535	161	Required for reporting alarms and events to an SNMP manager and to HiveManager if not using CAPWAP
SNMP traps	HiveAP mgt0 interface	SNMP manager	17 UDP	1024 - 65535	162	Required for sending SNMP traps to an SNMP manager and to HiveManager if not using CAPWAP
SSHv2	HiveManager MGT port	HiveAP mgt0 interface	6 TCP	1024 - 65535	22	Required for the HiveManager to manage and upload files to HiveAPs

Traffic Supporting Device Operations

Service	Source	Destination	Protocol	SRC Port	DST Port	Notes
Aerohive Cooperative Control Messages	HiveAP mgt0 interface	HiveAP mgt0 interface	17 UDP	3000*	3000*	Required for hive communications and operates at layer 3
Aerohive Cooperative Control Messages	HiveAP wifi1.1 or eth0 interface	HiveAP wifi1.1 or eth0 interface	N.A.	N.A.	N.A.	Required for hive communications and operates at the LLC (Logical Link Control) sublayer of layer 2
AeroScout Reports	AeroScout engine	HiveAP mgt0 interface	17 UDP	1024 - 65535	1144	Required to report tracked devices to an AeroScout engine
DHCP	HiveAP mgt0 interface	DHCP server	17 UDP	68	67	By default, a HiveAP gets its IP address through DHCP.
HTTPS	management system	HiveManager MGT port	6 TCP	1024 - 65535	443	Required for administration through the HiveManager GUI
NTP	HiveAP mgt0 interface, or HiveManager MGT port	NTP server	6 TCP	1024 - 65535	123	Required for time synchronization with an NTP server
SMTP	HiveManager MGT port	SMTP server	6 TCP	1024 - 65535	25	Required for the HiveManager to send e-mail alerts to admins
SSHv2	management system	HiveAP mgt0 interface or HiveManager MGT port	6 TCP	1024 - 65535	22	Used for secure network access to the HiveAP or HiveManager CLI, and (SCP) for uploading files to and downloading files from HiveAPs and for uploading images to HiveAPs and HiveManager
syslog	HiveAP mgt0 interface	syslog server	17 UDP	1024 - 65535	514	Required for remote logging to a syslog server
Telnet	management system	HiveAP mgt0 interface	6 TCP, 17 UDP	1024 - 65535	23	Used for unsecured network access to the HiveAP CLI
TFTP	TFTP server or mgt0	HiveAP mgt0 or TFTP server	17 UDP	1024 - 65535	69	Used for uploading files to and downloading files from HiveAPs

* This is the default destination port number. You can change it to a different port number from 1024 to 65535.

Appendix A Country Codes

When the region code on a HiveAP is preset as "world", you must set a country code for the location where you intend to deploy the HiveAP. This code determines the radio channels and power settings that the HiveAP can use when deployed in that country. For HiveAPs intended for use in the United States, the region code is preset as "FCC"—for "Federal Communications Commission"—and the country code is preset for the United States. You can see the region code in the output of the `show boot-param` command.

To set a country code when the region is "world", enter the following command, in which *`number`* is the appropriate country code number: **`boot-param country-code`** *number*

Note: Be sure to enter the correct country code. An incorrect entry might result in illegal radio operation and cause harmful interference to other systems.

To apply radio settings for the updated country code, reboot the HiveAP by entering the **`reboot`** command.

To see a list of the available channels available for the country code that you have set on the HiveAP, enter the following command: `show interface { wifi0 | wifi1 } channel`. For example, the output for the `show interface wifi0 channel` command on a HiveAP whose region code is FCC and country code is 840 (United States) shows that channels 1 through 11 are available. If a channel does not appear in this list, you cannot configure the radio to use it.

The following list of country codes is provided for your convenience.

Countries and Country Codes

Albania 8

Algeria 12

Argentina 32

Armenia 51

Australia 36

Austria 40

Azerbaijan 31

Bahrain 48

Belarus 112

Belgium 56

Belize 84

Bolivia 68

Bosnia and Herzegovina 70

Brazil 76

Brunei Darussalam 96

Bulgaria 100

Canada 124

Chile 152

China (People’s Republic of China) 156

Colombia 170

Costa Rica 188

Croatia 191

Cyprus 196

Czech Republic 203

Denmark 208

Dominican Republic 214

Ecuador 218

Egypt 818

El Salvador 222

Estonia 233

Faeroe Islands 234

Finland 246

France 250

France2 255

Georgia 268

Germany 276

Greece 300

Guatemala 320

Honduras 340

Hong Kong (S.A.R., P.R.C) 344

Hungary 348

Iceland 352

India 356

Indonesia 360

Iran 364

Iraq 368

Ireland 372

Israel 376

Italy 380

Jamaica 388

Japan 392

Japan1 (JP1) 393

Japan2 (JP0) 394

Japan3 (JP1-1) 395

Japan4 (JE1) 396

Japan5 (JE2) 397

Japan6 (JP6) 399

Japan7 (J7) 4007

Japan8 (J8) 4008

Japan9 (J9) 4009

IJapan10 (J10) 4010

Japan11 (J11) 4011

Japan12 (J12) 4012

Japan13 (J13) 4013

Japan14 (J14) 4014

Japan15 (J15) 4015

Japan16 (J16) 4016

Japan17 (J17) 4017

Japan18 (J18) 4018

Japan19 (J19) 4019

Japan20 (J20) 4020

Japan21 (J21) 4021

Japan22 (J22) 4022

Japan23 (J23) 4023

Japan24 (J24) 4024

Jordan 400

Kazakhstan 398

Kenya 404

Korea (North Korea) 408

Korea (South Korea, ROC) 410

Korea (South Korea, ROC2) 411

Korea (South Korea, ROC3) 412

Kuwait 414

Latvia 428

Lebanon 422

Libya 434

Liechtenstein 438

Lithuania 440

Luxembourg 442

Macau 446

Macedonia (The Former Yugoslav Republic of Macedonia) 807

Malaysia 458

Malta 470

Mexico 484

Monaco (Principality of Monaco) 492

Morocco 504

Netherlands 528

New Zealand 554

Nicaragua 558

Norway 578

Oman 512

Pakistan (Islamic Republic of Pakistan) 586

Panama 591

Paraguay 600

Peru 604

Philippines (Republic of the Philippines) 608

Poland 616

Portugal 620

Puerto Rico 630

Qatar 634

Romania 642

Russia 643

Saudi Arabia 682

Singapore 702

Slovakia (Slovak Republic) 703

Slovenia 705

South Africa 710

Spain 724

Sri Lanka 144

Sweden 752

Switzerland 756

Syria 760

Taiwan 158

Thailand 764

Trinidad y Tobago 780

Tunisia 788

Turkey 792

U.A.E. 784

Ukraine 804

United Kingdom 826

United States 840

United States (Public Safety; FCC49) 842

Uruguay 858

Uzbekistan 860

Venezuela 862

Vietnam 704

Yemen 887

Zimbabwe 716