

Installation Guide

Celona Medium Power Access Point AP 13



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Introduction

This document provides the necessary guidance to help the user enable services on the Celona Indoor / Outdoor Access Point AP 13 capable of private 4G connectivity. This guide provides an overview of the AP capabilities and the installation procedures that must be accompanied.

About the AP

Celona AP 13 is a 3GPP Release 15 compliant 4G Access Point (AP) with internal antenna that supports the 3550 – 3700 MHz Citizens Broadband Radio Service (CBRS) spectrum band. It includes two internal radios that support 2x2 MIMO (multiple-input, multiple-output), 64-QAM modulation, and carrier aggregation (CA). It can be pole or wall mounted.

Installation Instructions

Ensure the packaging is not damaged or wet. If it is, or if any items inside are missing or damaged, contact Celona at support@celona.io for instructions. The table below contains the shipping list showing the quantity of each item that should be received.



Item	Qty	Description
AP 13 unit	1	Confirm tag on the unit to ensure received model is correct
PoE injector	1	 PoE injector and PoE cable
Installation bracket assembled kit	1	Assembled kit: Installation bracket (x1) Omega (x4) M10 * 160 outer hex bolt (x4) M10 flat gasket (x4) M10 spring gasket (x4) M10 nut (x4) Unassembled / Individual kit: M10 flat gasket (x6) M10 spring gasket (x6) M10 nut (x6) M8 (x80) expansion bolt (x2) 
OT Ground Terminal	2	For ground cabling

Installation Preparation

Installation Overview

The Celona AP 13 can be pole or wall mounted and has one integrated 4-port 13.5 dBi 65D antenna. Before you mount and deploy your access point, we recommend that you perform a wireless design to determine the best location to install your access point.

The AP requires an operational Celona Edge for discovery and network service. Celona recommends installation and deployment of the Celona Edge prior to installation of access points. Have the following information about your wireless network design available:

- Locations for access point installation
- Mounting requirements for each location

Installing the access point involves the following steps:

1. Mounting and Powering the Access Point
2. Access Point Discovery and Provisioning
3. Configuring the Access Point

Personnel

Celona recommends that installation personnel review this entire installation guide prior to beginning the installation. Please note that installing the AP on a cell tower, building, or other structure may require at least two people or a qualified tower crew. Installation personnel must follow standard safety precautions concerning height, electricity, and other regulations.

Network Design Plan

Each cell site may be unique in terms of the type and number of components to install, the coverage area, the user requirements, and so forth. Identify the structure on which the AP equipment will be installed, the intended height where the antenna and AP will be attached, the degree of antenna down tilt, and other necessary specifications that may impact the success of the installation.

Materials and Tools

Tables that follow describe the materials required during the installation. The total output EIRP (Equivalent Isotropic Radiated Power) is governed by Part 96 regulations of FCC and hence power is automatically calculated and regulated by Celona software.

Item	Description
Power cable	< AWG16, e.g., AWG14
Power plug	The plug that connects the power cable to the electricity supply
Ethernet cable	CAT6 rated for outdoor use
Ground cable	Shorter than 330 feet (100 meters)

Interfaces

Interface Name	Description
ETH/POE+	RJ-45 interface (FE/GE)
	Used for power supply, debug or data backhaul.
	PoE++, complies with IEEE 802.3bt standard

Installation Preparation

LEDs

The Celona AP 13 has 4 LEDs providing the following visual statuses for Power, Cellular status (1 and 2), Alarm.

LED	Color	Status	Description
PWR	Green	Steady on	Power is on
		OFF	No power supply
CELL1	Green	OFF	CELL1 is inactive
		Fast flash: 0.1 s on, 0.1 s off	CELL1 is deactivated
		Slow flash: 1 s on, 1 s off	CELL1 is activated
CELL2	Green	OFF	CELL2 is inactive
		Fast flash: 0.1 s on, 0.1 s off	CELL2 is deactivated
		Slow flash: 1 s on, 1 s off	CELL2 is activated
ALM	Red	Steady on	Hardware alarm
		OFF	No alarm

Ethernet ports

The Celona AP 13 has one 100/1000 Ethernet port.

Power input

In addition to AC power, the Celona AP 13 supports IEEE 802.3bt (POE++) connectivity to drive internal circuitry. POE++ can be provided by a POE++ injector or a POE++ capable switch. The drawn power is ≤ 30 W.



Installation Preparation

GPS

Built-in GPS synchronization for AP 13.

Location and Environment

When determining where to place the AP, you need to consider factors such as climate, hydrology, geology, the possibility of earthquakes, reliable electric power, and transportation access. Avoid locating the AP in areas where there may be extreme temperatures, harmful gases, unstable voltages, volatile vibrations, flames, explosives, or electromagnetic interference (e.g., large radar stations, transformer substations). The AP is not certified for HAZLOC installation. Also, avoid areas that are prone to impounded water, soaks, leakage, or condensation.

Environmental Specifications

Item	Description
Operating Temperature	-40°F to 131°F / -40°C to 55°C
Storage Temperature	-49°F to 158°F / -45°C to 70°C
Humidity	5% to 95% RH
Atmospheric Pressure	70 kPa to 106 kPa
Safety voltage	42 V to 58 V

Installation

Some cell site structures may have existing frameworks for attaching the AP. For purposes of explaining the installation procedure, this section assumes the AP will be installed on a support pole or on a wall.

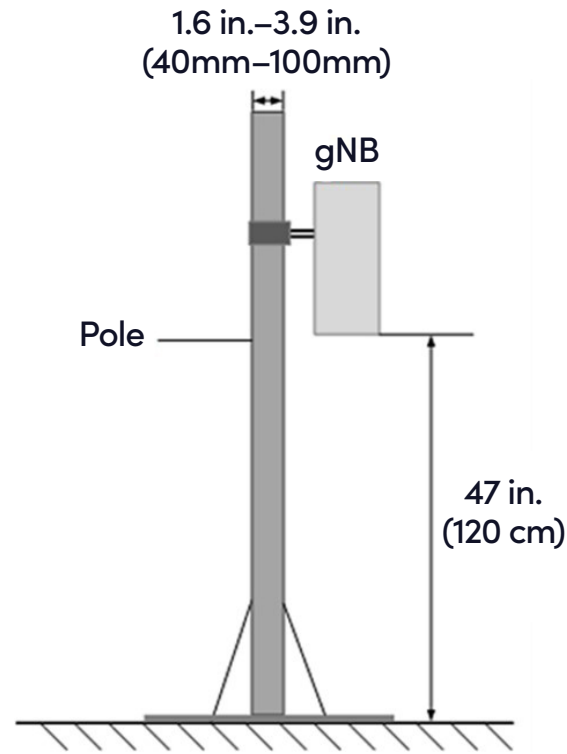
Process Overview

Figure below provides an overview of the installation process.

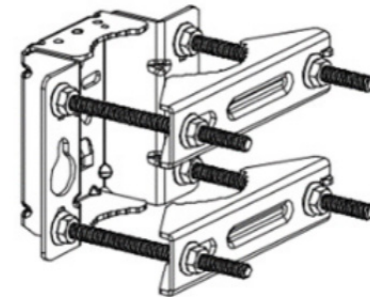
- Installation Process Overview
- Install AP to the pole (or wall)
- Connect the Ethernet and ground cables
- Power on device
- Check LEDs

Pole Installation

Check to ensure the diameter of the pole is in the range of 1.6–2.8 inches (40–70 mm). The position of the AP on the pole should be at least 47 inches (120 cm) in height.



The AP 13 mounting bracket is assembled before packing and includes two components: the preassembled bracket on the back of the device and the pole or wall mounting bracket.

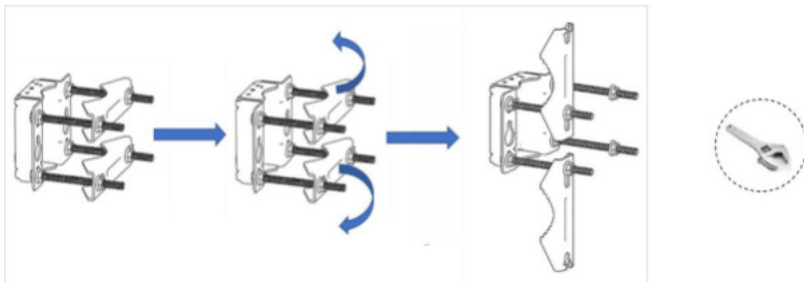


Pole or Wall Mounting Bracket

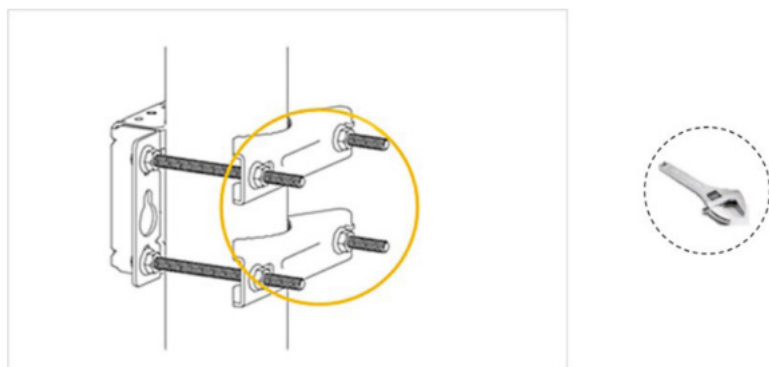
Installation

Follow the steps below to install the AP 13 on a pole.

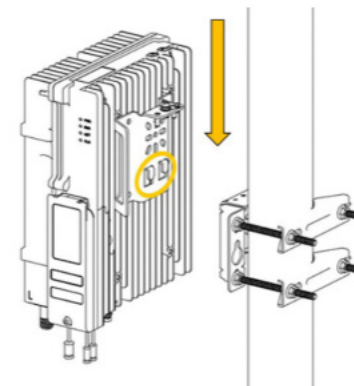
1. Unscrew the nuts of the pole mounting bracket, slide the two clamps to the left, and turn them up or down



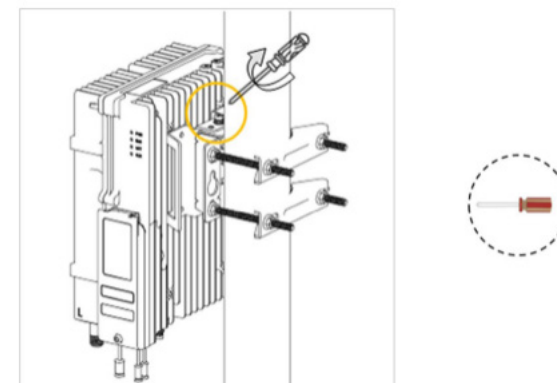
2. Place the pole mounting bracket against the pole and return the clamps to the horizontal position. Slide the clamp to the right and retighten the nuts.



3. Hold the AP 13 vertically and align the two pins on the AP 13 bracket with the pin holes on the pole mounting bracket. Push the AP 13 down until the hooks are firmly attached to the corresponding slots on the pole mounting bracket.



4. Tighten the bolt and screw on the top of the AP 13 with a Phillips-head screwdriver.

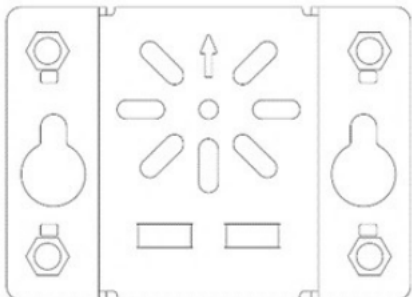


5. Once the installation is complete, proceed to “Connect Cables” section.

Installation

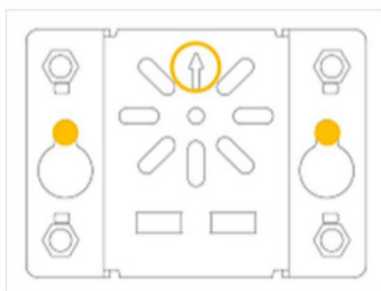
Wall Installation

Ensure the wall can bear at least four times the weight of the AP 13. The wall mounting bracket is shown below.

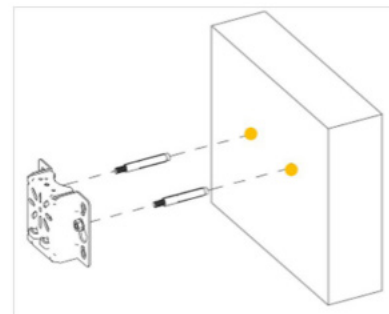


Follow the steps below to install the AP 13 on a wall.

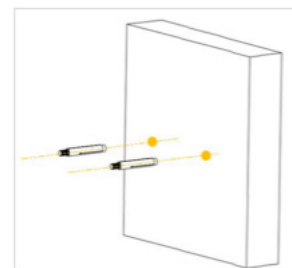
1. Place the wall mounting bracket on the wall with arrow point up and mark the drilling location using a pencil or marker.



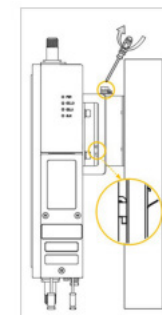
2. Drill two 0.4 in. (10 mm) diameter by 2.8 in. (70 mm) deep holes in the wall at the marked locations and insert expansion bolts.



3. Hang the wall mounting bracket on the expansion bolts and fasten it with flat washers, spring washers, and nuts.



4. Hold the AP 13 vertically and align the two pins on the AP 13 bracket with the pin holes on the pole mounting bracket. Push the AP 13 down until the hooks are firmly attached to the corresponding slots on the pole mounting bracket. Then, tighten the screw to complete the installation.



5. Once the installation is complete, proceed to the “Connect Cables” section.

Installation

Connect Cables

General requirements:

- Bending radius of antenna feeder cable: $7/8" > 250\text{mm}$, $4/5" > 380\text{mm}$
- Bending radius of jumper cable: $1/4" > 35\text{mm}$, $1/2"$ (super soft) $> 50\text{mm}$, $1/2"$ (ordinary) $> 127\text{mm}$
- Bending radius of power cable and grounding cable: $>$ triple the diameter of the cable

Bind the cables according the type of the cable; intertwining and crossing are performance impacting and hence forbidden. An identification label should be attached after the cable is laid for cataloguing and referencing.

Grounding cable requirement:

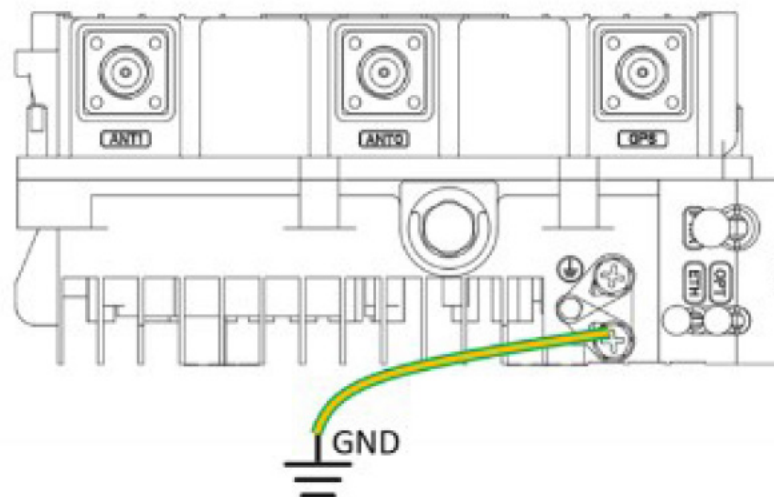
- The grounding cable must connect to the grounding point.
- The grounding cable must be separated from the signal cables with sufficient distance to avoid signal interference.

Connect Ethernet Cable

- Connect the Ethernet cable to the ETH interface in the wiring cavity. Lay the Ethernet cable along the wire groove and stretch it out of the wiring cavity from the ETH hole.
- The Ethernet cable connects to the PoE interface of the PoE adapter. The PoE adaptor must be placed in the distribution box for waterproofing.
- The LAN interface of the PoE adaptor connects to a LAN switch or a router for maintenance and backhaul.

Connect Ground Cable

Prepare the grounding cable according to the actual measurements and requirements of the specific installation site. The AP 13 has two grounding screws located on the bottom of the unit as shown below.



Unscrew one grounding screw, connect one end of the ground cable to the grounding screw, and fasten it again. The other end of the ground cable needs to connect to a good grounding point.

When the AP has been installed in a proper position, connect all the cables and wires. Seal and weatherproof all the connections after the testing have been successfully completed.

Installation

Power on to Check LEDs

Power on the AP and check that the LED indicators are lighting as expected. Refer to the LED descriptions detailed in earlier sections of this document.

Checking AP Status

The Celona AP 13 is designed to be plug-and-play, and therefore arrive pre-configured. The status is inferred by the LEDs and subsequently by connecting a mobile device to the Celona AP. A properly connected AP will show the Celona logo as the operator on the mobile's screen.

Certified Professional Installation

The Celona AP 13 is a Class-B, FCC Part 96 certified device. Class-B devices are required to be professionally installed by a Certified Professional Installer (CPI). The CPI is a FCC approved personnel and has legal authority to validate and confirm the installation with a digital signature.

The following information must be entered for each AP 13 by the CPI and the information must be signed off by a CPI with current standing.

- GPS coordinates: Latitude, Longitude, Height, Height Type (either a value above sea level or a value above ground level)
- Antenna details: Antenna Azimuth, Antenna Downtilt, Antenna Gain, Eirp Capability (Conductive power), Antenna Beamwidth, Antenna Model

The CPI information detailed above is packaged alongside the AP's FCC ID, the operator's ID (user ID) and signed with CPI's private key.

The CPI ensures the above values are verified for each AP and signs off the CPI data with the, CPI Identification, CPI Name and Certified Installation time.

The CPI information is securely uploaded per AP to the Celona Orchestrator over a HTTPs interface. Celona Edge uses the information for each AP when it registers the APs with the Spectrum Manager.

Regulatory Compliance

FCC Compliance

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. Any Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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.

Warning: This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 12 inches (30 cm) between the radiator & your body.

Solution Architecture

The high level architecture that enables the Celona AP 13 is shown below.

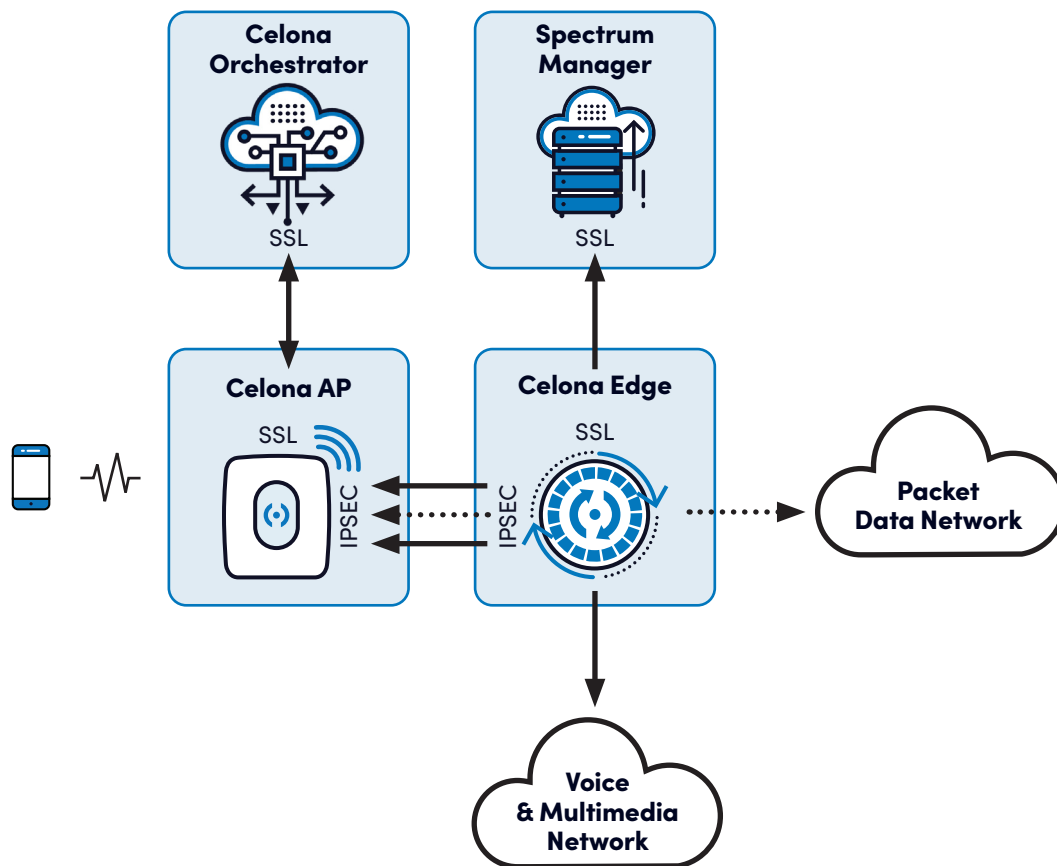


Figure 1

The system consists of the essential functions detailed in Figure 1: System Architecture. The Celona Orchestrator performs AP authentication, validates the AP's serial number, determines the network the AP needs to connect to and finally directs the Celona AP 13 to the serving Celona Edge.

Each Celona AP 13 obtains service via its serving Celona Edge. The Celona Edge registers the Celona AP 13, arbitrates spectrum with a FCC approved Spectrum Access Service (SAS) system in the United States and algorithmically determines the most optimal radio parameters for the AP.

The Celona Edge becomes automatically aware of the Celona AP 13's location and its existing surrounding radio environment. Once the AP is admitted by the Celona Edge, the AP is able to commence radio transmissions and service the mobile stations.

Celona AP 13 capabilities

The following sections give the reader the capabilities of the Celona Indoor Access Point (AP), which is based on the Qualcomm platform. The AP hosts functions to provide the following services:

- Resource management with admission and flow control
- Encryption of user data and control streams
- Registering mobile stations with Celona Edge for connectivity services
- Paging the mobile stations that are in power save mode
- Fairness in allocation of resources across multiple stations in uplink & downlink directions
- Measurement configurations and handling of mobility of mobile stations

Access Point Discovery and Provisioning

The AP will connect to the Celona Orchestrator for provisioning and discover the Celona Edge within the network on-premises or in the private/public cloud based on the site assignment. The AP will then connect directly to the Celona Edge and establish control and data plane connections. Once this is completed, the 4G LED on the AP will turn blue, signifying the private 4G network is operational. This will take approximately 2-3 minutes.

Configuring the Access Point

The Celona AP 13 supports zero-touch provisioning. The AP is preconfigured with details necessary to discover the Celona Orchestrator and the Celona Edge automatically. After the AP discovers the Celona Orchestrator and the Celona Edge, the AP gets provisioned with operational parameters and is authorised to transmit. The Celona Edge alone controls the radio frequency transmission of the Celona AP 13.

Once the AP has gone operational, it will be able to provide services to mobile stations. The mobile stations can interact with the enterprise network via the Celona Edge. The user data and control signals are encrypted. The Celona AP 13 performance is periodically monitored by the Celona Edge and operational parameters are continually optimised if necessary. Refer to the Celona Orchestrator configuration guide for detailed instructions on configuring Celona access points.

Operations and Maintenance

The Celona AP 13 is operationally maintained by the Celona Orchestrator and Celona Edge using NETCONF. Celona AP 13's radio parameter provisioning, performance monitoring and fault monitoring occur over the NETCONF interface. The AP supports the following technical reports from the Broadband Forum

Fault management

TR-157 Amendment 5

Celona AP 13's performance is monitored between every 5 minutes and 15 minutes based on the periodicity determined by the Celona Edge. If a fault surfaces on the AP, the fault is automatically propagated by the AP to the Celona Edge and the Celona Orchestrator.

Security

The Celona AP 13's interfaces are secured by IPSEC or SSL. The certificates required to establish HTTPs connections with the Celona Orchestrator and IPSEC with the Celona Edge are provisioned at the factory.

If the certificates on the Celona AP 13 need to be updated or replaced, the process is automatically triggered and managed by the Celona Edge. The certificates conform to the industry compliant X.509 standard.

The IPSEC gateway is provisioned within the Celona AP 13 through the Celona Orchestrator. IKEv2 is used to establish the IPSEC tunnel between the Celona AP 13 and Celona Edge.

Phase and time synchronisation

Celona AP 13 supports Time Division Duplex (TDD) which has strict requirements for maintaining time and phase synchronisation so that it does not interfere with neighbouring APs. The Celona AP 13s have a built in, high fidelity GPS chip that can establish location as well as maintaining clock synchronisation.

The AP's carrier frequency accuracy, time and phase drifts are disciplined by the onboard GPS clock. If the AP cannot obtain a GPS lock for any reason, Celona AP 13 synchronises with a Precision Time Protocol (PTP) server to maintain time, phase and frequency synchronisation.

Operations and Maintenance

Data and voice connectivity

As seen in figure 2, mobile stations can obtain data and/or voice connectivity via the Celona Edge after the Celona AP 13 has its radio enabled. Celona AP 13 automatically determines the capability of mobile stations before determining whether requested services can be accommodated.

Celona AP 13 and Celona Edge perform admission control for the mobile station and Celona Edge enforces authentication of the mobile station before accepting service requests. Further, Celona Edge and Celona AP 13 encrypt all control signals and user data between the mobile station and the Celona Edge.

Celona AP 13 employs sophisticated adaptive modulation & code rate control for adapting mobile stations' link according to the dynamic channel conditions seen on the air interface between the mobile stations and Celona AP 13. Celona AP 13 also employs effective power control to keep transmit powers from the mobile stations as low as practicable.

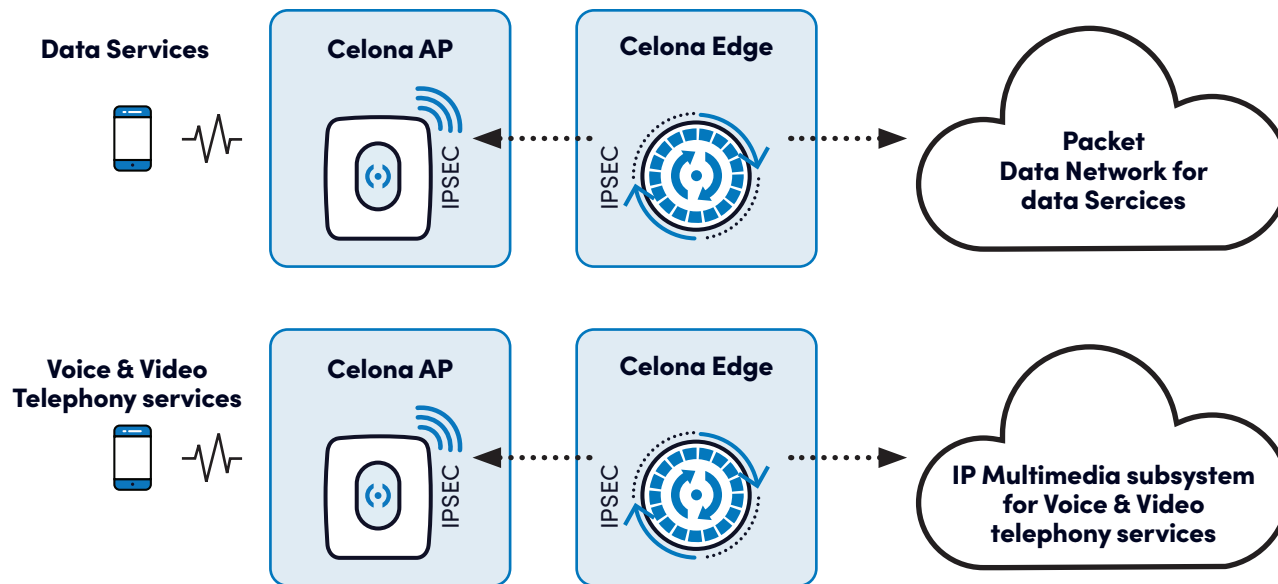


Figure 2

Operations and Maintenance

Radio access technology

Celona AP 13 implements an extensive set of 3GPP world-wide standards to provide advanced, 4th generation packet radio service to mobile stations.

AP radio access technology	Technical specifications
Advanced 4th generation (4G) Long Term Evolution (4G-Advanced)	<ul style="list-style-type: none">All relevant Release 12 specifications from 3GPP36.331 Release 12 – Radio Resource Control36.321 Release 12 – Media Access Control36.322 Release 12 – Radio Link Control36.323 Release 12 – Packet Data Convergence36.413 Release 12 – S1 Application interface36.423 Release 12 – X2 Application interface29.274 Release 12 – eGTP control plane29.281 Release 12 – eGTP user plane36.211 Release 12 – Physical channels and modulation36.212 Release 12 – Physical channel multiplexing and coding36.213 Release 12 – Physical layer procedures36.214 Release 12 – Physical layer measurements

Supported frequency band

Celona AP 13 supports frequency ranges from 3400 MHz to 3800 MHz. The operational frequencies are however limited to a narrower range, from 3550 MHz to 3700 MHz, which is commonly labeled as the CBRS spectrum in the United States or the 4G Band 48. Any Celona AP 13 within a Celona private 4G network is automatically assigned frequency and power levels by Celona's unique Self Organizing Network (SON) software function, after the Celona Edge retrieves available frequency channels per AP from SAS, given each AP's geo-location.

Seamless session mobility

If there are multiple Celona AP 13s in the system all connecting to the same Celona Edge, the Celona AP 13s can enable seamless mobility for mobile stations. The source and target Celona AP 13s handle the transfer of contextual information corresponding to existing flows set up for the mobile station automatically.

Coverage area

The coverage area of each Celona AP 13 depends on a number of factors:

- Transmit power authorized by the Spectrum Manager
- Transmit power set on the Celona AP 13 by Celona Edge
- Number of other APs operating on the same frequency in the geographic area
- Proximity of other APs operating on a different frequency but in the same band
- Building type and material types used within the building
- Expected minimum for data rate at the edge of coverage

Transmit power

The Celona AP 13 can transmit at a maximum power of 1 Watt per channel inclusive of internal gain.

Operations and Maintenance

Supported system bandwidth

The Celona AP 13 supports two concurrent RF chains. The two RF chains provide two distinct cellular sectors. The following combinations of system bandwidth are possible depending on authorisation provided by the Spectrum Manager.

Sector 1	Sector 2	Aggregated bandwidth (one AP)
20 MHz	20 MHz	40 MHz
10 MHz	10 MHz	20 MHz
5 MHz	5 MHz	10 MHz
20 MHz	-	20 MHz
10 MHz	-	10 MHz
5 MHz	-	5 MHz

The AP 13 is a dual carrier eNodeB and is based on 4G Release 15. When the antenna configuration is arranged in such a way that overlapping coverage of two orthogonal carriers exists, the AP supports two-component carrier aggregation (CCA). CCA provides the ability to take two component carriers and bond them into one, thus allowing an effective doubling of achievable data rate. Each component carrier can be as wide as 20 MHz and hence, CCA provides an aggregated bandwidth of up to 40 MHz.

The AP has ability to aggregate any two channels from across the full Citizens Broadband Radio System (CBRS) range, even channels that are not adjacent.

Troubleshooting

Power LED is not green:

- Ensure the AP 13 has a POE++ (802.3bt) connection.
- Please check for loose connections between the POE++ injector / POE++ switch and the Celona AP 13.

Contacting Support

Celona support is available via support@celona.io.

Warranty

As part of an active Celona subscription, Celona AP 13s come with a limited warranty that includes advanced replacement for RMA.



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