

celona

# Celona Outdoor Access Point AP-11

Installation Guide



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## Introduction

This document provides the necessary guidance to help the user enable services on the Celona Outdoor CBRS LTE Access Point (AP), AP-11. This guide provides an overview of the AP capabilities and also the installation procedures that must be accompanied.

### About the AP

The Celona AP-11 is a 3GPP Release 12 compliant with external antenna support, operating within the 3550 – 3700 MHz Citizens Broadband Radio Service (CBRS) spectrum band. It includes two external radios that support 2x2 MIMO (multiple-input, multiple-output), 256-QAM modulation, and carrier aggregation (CA). It can be pole, mast, or wall mounted.

### Installation Instructions

Ensure the packaging is not damaged nor wet. If it is, or if any items inside are missing or damaged, contact Celona at [support@celona.io](mailto:support@celona.io) for instructions. Table below contains the shipping list showing the quantity of each item that should be received.

Item	Qty	Description
AP-11 unit	1	Confirm tag on the unit to ensure received model is correct. 
Power adaptor	1	100 to 277 VAC, 48 VDC, 0 to 4.17A, 200W
Power terminal	1	2 wires green terminal
Power plug	1	Standard power plug, USA
Optical module	2	SFP, LC optical module

GPS antenna assembled kit	1	Assembled kit: GPS antenna GPS fixing accessories Unassembled / Individual kit: M4 * 12 screw * 3 GPS jumper cable * 1
Installation bracket assembled kit	1	Assembled kit: Installation bracket *1 Omega *4 M10 * 160 outer hex bolt * 4 M10 flat gasket * 4 M10 spring gasket * 4 M10 nut * 4 Unassembled / Individual kit: M10 flat gasket * 6 M10 spring gasket * 6 M10 nut * 6 M8 * 80 expansion bolt * 2
OT Ground Terminal	2	For ground cabling
Cold Shrink Tubes	6	Installation accessory
Warranty	1	Printed document
Certification	1	Printed document

## Installation Preparation

### 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. When AP-11 is operating in dual carrier mode, Sector 1 uses ANT2 and ANT3 and Sector 2 uses ANT0 and ANT1.

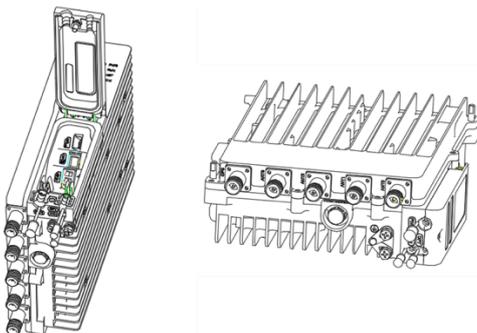
### Materials and Tools

Table that follow describe the materials required during the installation. The antenna elements chosen must support the channel of operation. 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
RF antenna cable	50-ohm feeder
RF antenna	Omni or directional NOTE: For dual carrier operation, the operator may select one 4-port or two 2-port Radio Frequency (RF) antennas to install with the eNB. When AP-11 is operating in dual carrier mode, Cell 1 uses ANT2 and ANT3 and Cell 2 uses ANT0 and ANT1.
Optical fiber	Single mode optical fiber
Ethernet cable	CAT6 rated for outdoor use Shorter than 330 feet (100 meters)
Ground cable	16mm <sup>2</sup> diameter (yellow-green wire)

### Interfaces

Figure shows the interfaces on the AP-11. The LEDs and interfaces are explained in tables below.



Interface Name	Description
PWR	Power supply: -48VDC (-60V to -42V)
GPS	Port for optional external Global Positioning System (GPS) antenna, N-female connector
ANT0	Port for external RF antenna 0, N-female connector
ANT1	Port for external RF antenna 1, N-female connector
ANT2	Port for external RF antenna 2, N-female connector
ANT3	Port for external RF antenna 3, N-female connector
OPT	Optical backhaul interface for connecting to external transmission network and used for data backhaul
ETH	RJ-45 interface, used for debugging or data backhaul

## LEDs

Identity	Color	Status	Description
PWR	Green	Steady on	Power is on
		OFF	No power supply
ACT	Green	Steady on	The cell is activated
		OFF	The cell is not activated
RUN	Green	Fast flash: 0.125s on, 0.125s off	The software is initialising
		Slow flash: 1s on, 1s off	The board is operating normally
		OFF	No power input, or faulty board
ALM	Red	Steady on	Hardware alarm, e.g., VSWR alarm
		OFF	No alarm

## 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.

## Grounding

In installations where the antenna mast is much higher than the nearest alternative tall structure, the AP, antenna, and GPS must be protected against lightning. Following are guidelines concerning grounding.

- The yellow-green ground wire must be at least 16mm<sup>2</sup>.
- Always place the grounding as near as possible to the equipment.
- The AP must be connected to a reliable outdoor grounding point (earth) using one ground screw.

The connection of the grounding points and the ground bar need to be tight and reliable. Rustproof the terminals as required. Simple methods to rust proofing include application of rust prevention paint, anti-oxidation coating, or grease.

## Installation

Some cell site structures may have existing frameworks for attaching the AP and antenna. 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 GPS antenna on the AP
- Install AP to the pole (or wall)
- Mount the antenna equipment
- Connect the Ethernet and ground cables
- Power on device
- Check LEDs

### Weatherproofing

To protect the connection points from weather and climate, clean each connection point before installing cold shrink tubes, per the following Figure.

- Insert the cable into the cold shrink tube.
- Tighten the connector.
- Push the cold shrink tube to the top joint and pull out the strip.

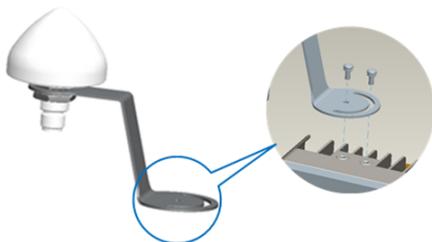
- Ensure the cold shrink tube is tightly fitted with the connection.



## Install GPS Antenna

Read the following requirements before installing the GPS antenna on the AP.

- GPS works best when line of sight exists with the sky. Ensure no major blockage from buildings in the vicinity. Ensure the space atop is at least 45 degrees unblocked by any buildings.
- If possible, avoid installing the GPS antenna in the vicinity of any other transmitting and receiving devices, to avoid interference. The GPS antenna should be installed within 45 degrees to the lightning rod.
- The GPS antenna system is assembled in manufacturing before packing. The only installation step is to fix the GPS mounting bracket on the eNB with the M4\*14 screws, as shown in Figure below.



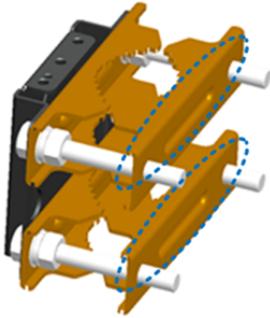
## Install AP on Pole or Wall

### Install on Pole

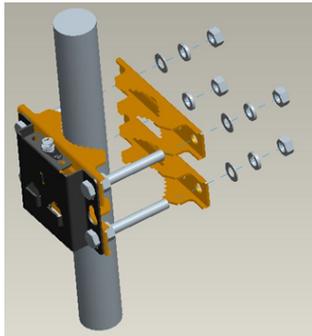
The AP mounting bracket is assembled at manufacturing before packing. The only action required by the installer is to fix the assembly on the pole.

Check to ensure the diameter of the pole is in the range of 1.6-3.9 inches (40-100 mm). The position of the AP on the pole should be at least 47 inches (120 cm) in

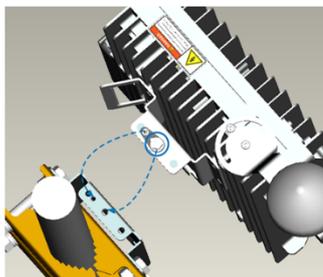
height. Follow the steps below to install the eNB on a pole. Take the two outer omegas off of the bracket.



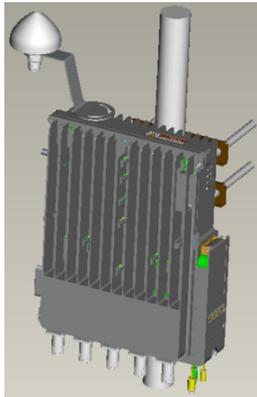
Attach the bracket to the pole, considering the height requirements above. Make sure the arrow on the installation bracket is pointing upward. Fit the threaded rod on the bracket to the pole, and then pass the two omegas through the threaded rods. Fasten with 4 flat gaskets, 4 spring gaskets, and 4 nuts.



Using the 2 pins on the bracket on the back of the AP, attach the AP to the mounting bracket on the pole. Push the AP until the hook is firmly attached to the mounting bracket.



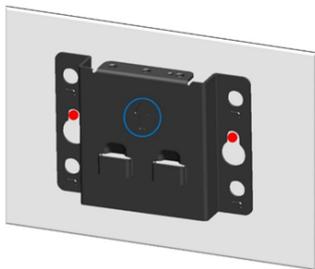
Tighten the screws on the top of the bracket on the AP using a cross screwdriver to complete the installation.



## Install on Wall

The installer must make a clear determination if the wall can support the AP enclosure. Ensure that the wall can bear at least several times the weight of the AP as a sustained load. Follow the steps below to install the AP-11 on the wall.

- Take apart the assembled installation bracket.
- Fit the installation bracket on the wall and mark the drilling locations. Make sure the arrow on the installation bracket is pointing upward.



- Drill two 0.4in/10mm diameter and 2.8in/70mm deep holes in the wall at the marked locations.
- Check the up/down direction of the installation rack, and then fix the AP to the wall using M8\*80 expansion screws.
- Tighten the screws on the top of the bracket on the AP using cross a screwdriver.

## 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
- The minimum bending radius of the optical fiber is 20 times the diameter of the optical fiber.

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.

**Optical fiber cable requirement:**

- Avoid circling and twisting.
- Avoid binding on a turn.
- Avoid pulling and weighing down the optical fiber.

**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 GPS Antenna Cable**

- Insert the GPS jumper into a cold shrink tube.
- Connect one end of the GPS jumper to the GPS antenna.
- Push the cold shrink tube to the top joint and pull out the strip.
- Connect the other end of the GPS jumper to the GPS interface on the AP, which also needs weatherproof protection.

**Connect RF Cable**

- Open the dust caps of the ANT0, ANT1, ANT2, and ANT3 interfaces.
- Insert the RF cables into cold shrink tubes.
- Connect one end of the RF cables to the ANT0, ANT1, ANT2, and ANT3 interfaces on the AP and tighten them with a wrench. When the AP-11 is operating in dual carrier mode, Cell 1/Sector 1 uses ANT0 and ANT1 and Cell 2/Sector 2 uses ANT2 and ANT3.
- Push the cold shrink tube to the top joint and pull out the strip.
- Connect the other end of the RF cables to the external antennas, which also

need weatherproof protection.

## **Connect WAN Interface Cable**

### **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.

### **Connect Fiber Optical Cable**

- Unscrew the 3 screws on the cover of the AP's wiring cavity using an M4 cross screwdriver. Open the wiring cavity. Connect the optical fiber to the OPT interface in the wiring cavity. Lay the optical fibers along the wire groove and stretch them out of the wiring cavity from the OPT hole. The redundant fiber should wind neatly.

## **Connect Power Connector**

Since the length of cable needed for power varies from site to site, the two ends of the power adaptor are bare terminal ends. The installer would need to make the power cable according to the actual measurements of the installation site and assemble the power plug and power terminal on the two ends of the power adaptor. Strip 0.47in/12mm of the insulating layer with a wire stripper which is then used for connecting to the connector. The power cord length is ideally kept below 330 ft/100m.

The connection steps for the power cable are as follows.

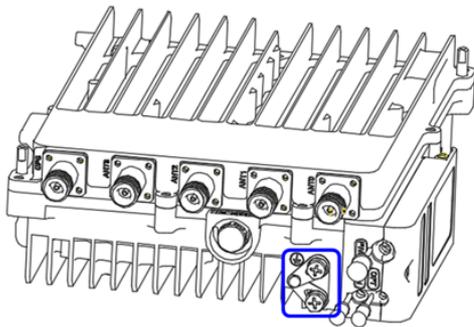
- Assemble the power plug. The power plug will be installed on the end of the input direction. Refer to the labels on the power plug for connecting the live wire, neutral wire, and ground wire to the corresponding terminals separately and tighten the screws. Assemble the power terminal. The power terminal will be installed on the end of the output direction. Refer to the figure below to connect the live wire and neutral wire.



- Connect the power cable to the PWR interface in the wiring cavity.
- The power cable lays along the lint slot and stretches out the wiring cavity from the PWR port.
- The input of the power adaptor connects to the outlet. If the outlet is outdoors, place the power adaptor Outdoors. If the outlet is outdoors, place the power adaptor in a waterproof box.
- After the cable connection is complete in the wiring cavity, tighten the screws on the cover to close the wiring cavity using an M4 cross screwdriver.

## Connect Ground Cable

Prepare the grounding cable according to the actual measurements and requirements of the specific installation site. The AP-11 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.

## Install Antenna Feeder System

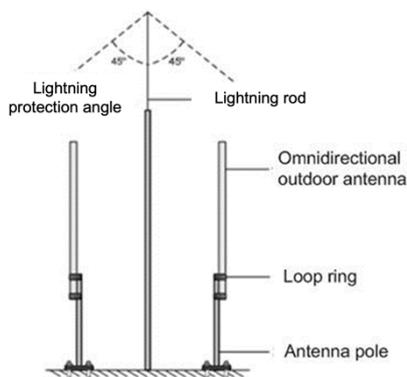
There are two kinds of outdoor antennas, omni-directional and directional.

- Adhere to the following guidelines when installing an omni-directional

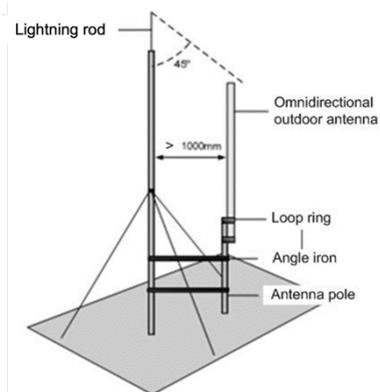
antenna. The diameter of the pole should be 1.4in/35mm to 2in/50mm. A typical case is to use the 50mm-diameter round-steel-made pole (with details depending on the specific antenna type). Make sure that the top of pole and the clamp beneath the antenna are at the same level after installing the omni-directional antenna on the pole. Make sure the antenna is high enough to meet the coverage requirements, and that the antenna top falls within the 45 degrees safety angle towards an independent lightning rod. Refer to Figure: Omni antenna installation.

- In case it is impossible to install an independent lightning rod due to environmental limitations, the installation method shown in Figure: Alternative omni antenna installation can be used. Be aware that the pole supporting the lightning rod should be kept at least 1m away from the omnidirectional outdoor antennas.

Omni antenna installation



Alternative omni antenna installation

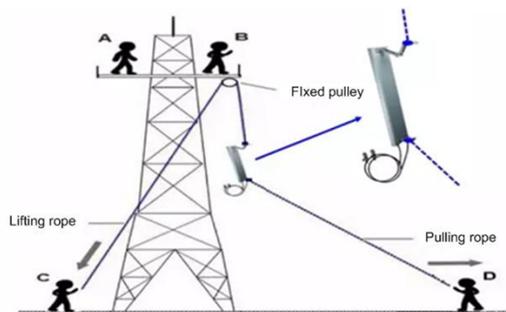


## Install Directional Antennas

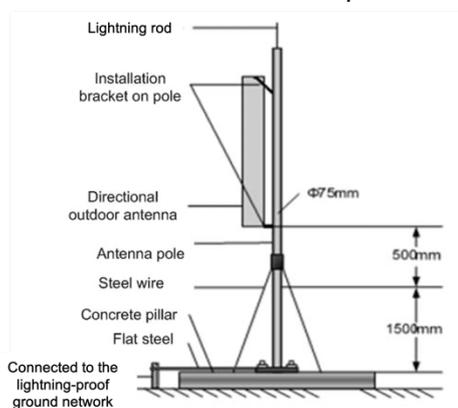
Assemble the directional antenna as demonstrated below.



To install the antenna on a tower or other structure, use a pulley to transport the antenna assembly to the platform, as shown below. Follow standard safety rules when working at these heights.



Fix the pole vertically to the ground, or to concrete pillars on a rooftop, using expansion screws. Fasten the pole with steel wires. Then, mount the directional outdoor antenna onto the pole using the installation rack as shown below.



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.

## **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-11 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-11 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-11 by the CPI and the information must be signed off by a CPI with current standing.

- GPS coordinates: Latitude, Longitude, Height, HeightType (either a value above sea level or a value above ground level)
- Antenna details: AntennaAzimuth, AntennaDowntilt, AntennaGain, EirpCapability (Conductive power), AntennaBeamwidth, AntennaModel

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.



- Registering mobile stations with Celona Edge for Voice and Data services.
- Data only or Voice only or Data + Voice service.
- Paging the mobile stations that are in power save mode.
- Fairness in allocation of resources across multiple mobile stations in both uplink and downlink directions.
- Measurement configurations and handling of mobility of mobile stations.

## Discovery

The Celona AP-11 supports zero-touch provisioning. The AP is preconfigured with details necessary to discover the Celona Orchestrator and the Celona Edge automatically. After the DP 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-11. Once the AP has begun operational, it is able to provide services to mobile stations. The mobile stations can connect with the Packet data network as well with Voice and multimedia networks via the Celona Edge.

The user data and control signals are encrypted. The Celona AP-11's performance is periodically monitored by the Celona Edge and operational parameters are continually optimised if necessary.

## Operations and Maintenance

The Celona AP-11 is operationally maintained by the Celona Orchestrator and Celona Edge using the Broadband Forum standard TR-069.

Celona AP-11's radio parameter provisioning, performance monitoring and fault monitoring occur over the TR-069 interface. The AP supports the following technical reports from the Broadband Forum.

AP Management data model	Technical Report (TR) identifiers
Configuration management	TR-196 Issue 2 TR-181 Issue 2 Amendment 5
Performance management	TR-262

Fault management	TR-157 Ammendment 5
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Celona AP-11's performance is monitored between every 5 minutes and 15 minutes based on 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 Celona Orchestrator.

## Security

The Celona AP-11's interfaces are secured by IPSEC or SSL. The certificates required to establish HTTPs connections with the Celona Orchestrator, IPSEC with the Celona Edge are provisioned at the factory.

If the certificates on the Celona AP-11 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 at the Celona AP-11 through the Celona Orchestrator. IKEv2 is used to establish the IPSEC tunnel between the Celona AP-11 and Celona Edge.

## Phase and time synchronisation

Celona AP-11 is a "Time division duplex (TDD)" LTE small cell. TDD small cells have strict requirements for maintaining time and phase synchronisation so that they do not interfere with neighbouring APs.

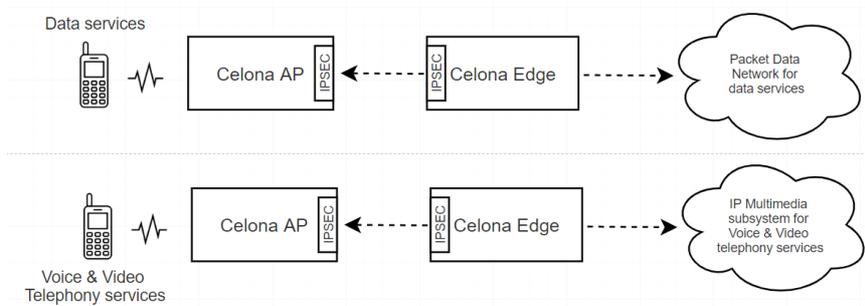
The Celona AP-11s have a built in, high fidelity GPS chip that can establish location as well as maintaing clock synchronisation. The AP's carrier frequency accuracy, time and phase drifts are disciplined by the onboard GPS clock.

If the AP cannot obtain a GPS lock for any reason, Celona AP-11 synchronises with a Precision Time Protocol (PTP) server to maintain time, phase and frequency synchronisation.

## Data and voice connectivity

As seen in the figure below, mobile stations can obtain data and/or voice connectivity via the Celona Edge after the Celona AP-11 has its radio enabled. Celona AP-11 automatically determines the capability of mobile stations before determining whether requested services can be accommodated.

Celona AP-11 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-11 encrypt all control signals and user data between the mobile station and the Celona Edge.



Celona AP-11 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-11. Celona AP-11 also employs effective power control to keep transmit powers from the mobile stations as low as practicable.

## Power save mode

Celona AP-11 enables power save options on the mobile stations. When a mobile station has encountered a long lull in data volume or a voice call / video call is terminated, Celona AP-11 monitors traffic volume on each flow enabled at the mobile station.

When the traffic volume is null for a duration of time, duration determined by the Celona AP-11 based on mobile capability as well as current loading in the system, Celona AP-11 enables Power save mode on the mobile station.

While in power save mode, the mobile station is able to turn off its receiver and transmitter functions for the most part except for essential functions. This increases the battery standby time on the mobile stations.

When the mobile station is in power save mode and if there is user data destined towards the mobile station, Celona Edge pages the mobile station indicating data arrival via the Celona AP-11 in order to awaken the station.

## Radio access technology

Celona AP-11 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 (LTE-Advanced)	All relevant Release 12 specifications from 3GPP 36.331 Release 12 – Radio Resource Control 36.321 Release 12 – Media Access Control 36.322 Release 12 – Radio Link Control 36.323 Release 12 – Packet Data Convergence 36.413 Release 12 – S1 Application interface 36.423 Release 12 – X2 Application interface 29.274 Release 12 – eGTP control plane 29.281 Release 12 – eGTP user plane 36.211 Release 12 – Physical channels and modulation 36.212 Release 12 – Physical channel multiplexing and coding 36.213 Release 12 – Physical layer procedures 36.214 Release 12 – Physical layer measurements

## Supported frequency band

Celona AP-11 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 by the Spectrum Manager .

The frequency range from 3550 MHz to 3700 MHz are commonly labeled as CBRS Band or Band 48. The Spectrum Manager is a FCC approved network node and limits the Celona AP-11's functions to the CBRS Band.

## Seamless session mobility

If there are multiple Celona AP-11s in the system all connecting to the same Celona Edge, the Celona AP-11s can provide seamless service to the mobile stations. The mobile stations may establish data and/or multimedia sessions within the coverage area of one Celona AP-11 and seamlessly migrate to a coverage area provided by a different Celona AP-11. The source and target Celona AP-11s handle the transfer of contextual information corresponding to existing flows setup for the mobile station automatically.

## Coverage area

The coverage area of each Celona AP-11 depends on a number of factors some of which are indicated below.

- Transmit power authorised by the Spectrum Manager and is set on the Celona AP-11 by Celona Edge.
- Number and proximity of other APs (Celona AP-11s or other APs) operating on the same frequency in the geographic area, or on a different frequency but in the same band.
- Building type and material types used at, near and around the installation site, along with expected minimum for data rate at the edge of coverage.

## Transmit power

The Celona AP-11 can transmit at a maximum power of 1 Watt per channel. An external gain of upto 17dBi can be applied this by attaching external antenna.

## Supported System bandwidth

The Celona AP-11 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-11 is a dual carrier eNodeB and is based on LTE Release 12. 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.

## Support and Warranty

Celona support is available on the web at <https://celona.io/support> where information about warranty on Celona's outdoor APs can also be found.