



CEL-FI[™] QUATRA

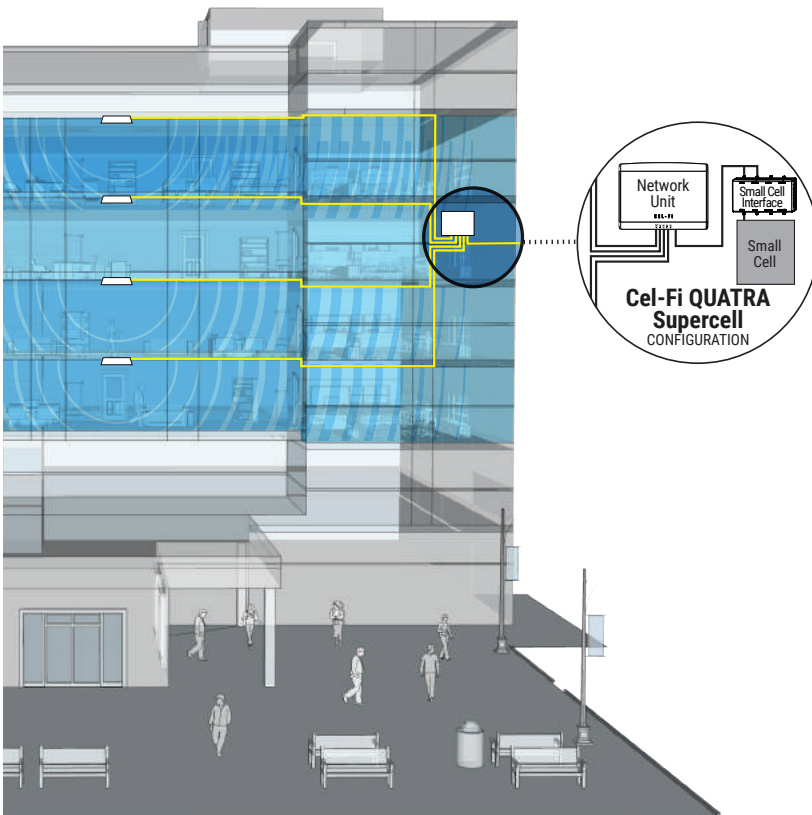
In-Building
Cellular
Solution

Cel-Fi QUATRA Supercell™ Helps Deliver Great Cellular Service to the Middleprise

There is no one-size-fits-all solution for cellular coverage challenges that frustrate tenants, employees, and guests inside middleprise buildings (i.e., those that are up to 500,000 sq. ft.). Building materials, walls, and natural obstructions that block the cellular signal from carrier towers are often the cause of poor cellular service and dead zones in buildings. To complicate matters, there are several common situations when the macro signal simply can't penetrate into these buildings.

Leading integrators, Atlantic Technology Group and Pacific Services, have the answer. Configuring Cel-Fi QUATRA as a Supercell has helped these solution providers tackle problematic scenarios such as pilot pollution, no option for roof-top antennas, macro network congestion in a busy downtown location, and more — all while keeping client costs down.

Cel-Fi QUATRA is an active DAS hybrid for venues from 10,000 to 500,000 sq. ft. or larger that resolves in-building cellular spotty coverage, poor voice quality, and dropped calls plaguing employees and visitors. It can be configured to amplify the cellular signal of one or multiple carriers either from the macro network off-air up to 100 dB gain or from a small cell.



A Supercell is created when Cel-Fi QUATRA is tethered to one or more small cells for the donor signal (i.e. a large single cell versus multiple small cells). It extends the cellular capacity provided by the small cells uniformly throughout the building right to its perimeter for less than the cost for similar coverage using small cells alone. Also, while interference can occur between small cells installed in proximity, this does not occur with a Supercell.

The following case studies show the flexibility and effectiveness of a Supercell in solving some of the most difficult cellular in-building connectivity challenges. They also show how the proprietary, intelligent tools included with Cel-Fi QUATRA provide integrators with greater ease in optimizing the system design for any unique environment encountered.

To find out how Cel-Fi QUATRA Supercell can provide the best quality cellular signal for the middleprise — no matter what stands in the way — contact www.cel-fi.com/quatra/whitepaper.



Cel-Fi QUATRA Supercell™ Brings Reliable Cellular Signal to Rural Law Enforcement Agency

ABOUT THE PROBLEM

LAW ENFORCEMENT

- Federal law enforcement agency with a 60,000 square foot canine training facility
- Rural location with very weak signal from the macro network outside the building
- External roof-top antenna did not improve the donor signal sufficiently

A federal law enforcement agency was experiencing cellular coverage challenges in its 60,000 sq. ft. canine training facility located in a rural area in Virginia, about 60 miles outside of Washington, DC. There are approximately 30 employees working in the facility who rely on their cell phones to be in constant communications with colleagues, but a weak cellular signal outside the kennel meant they were disconnected inside the building.

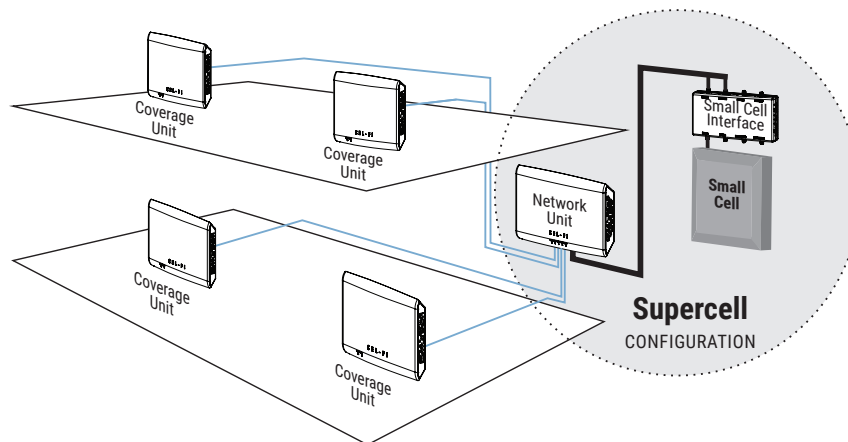
The agency enlisted Atlantic Technology Group (ATG), an AT&T Solution Provider based in Rockville, MD that provides cellular solutions for the middleprise, to create a reliable solution that would bring a signal into the facility. ATG decided to install a Cel-Fi QUATRA Supercell.

"Originally, we tried to install QUATRA at the facility where we relied on the macro network and used a roof-top antenna to try to pick up the donor signal from there, but we just weren't able to get enough donor signal to create a reliable solution," says Connelly. "This ended up being one of the scenarios when using a Supercell makes the most sense."



Atlantic Technology Group

- AT&T Solution Provider
- Established in 2002
- Based in Rockville, MD
- Services include mobility applications, wireless devices and lifecycle management
- Customers include Healthcare, Fleet Management, Field Service, Business Continuity and Mobile Office.



CONFIGURING THE SUPERCCELL

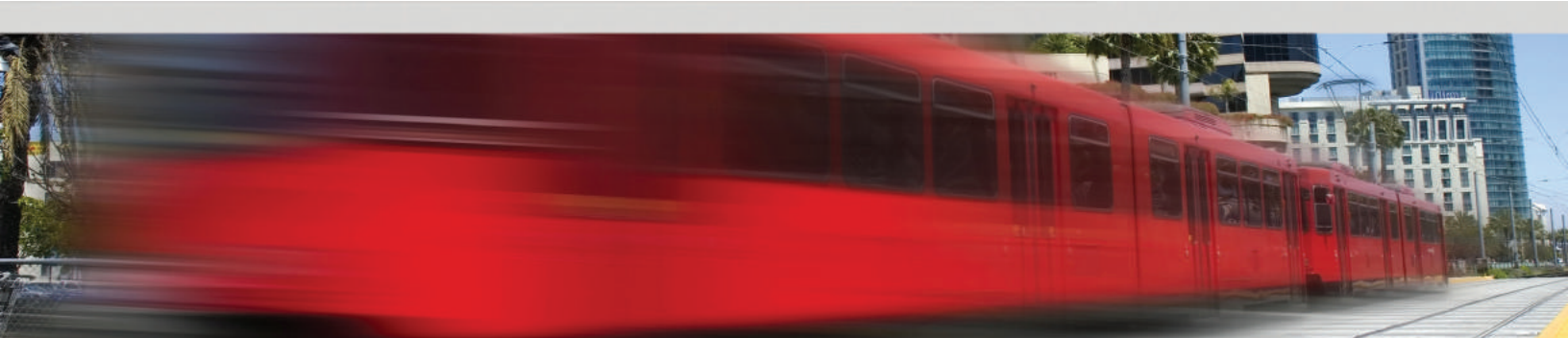
The facility has two floors, approximately 60,000 square feet in combined size. Initially, two Cel-Fi QUATRA Network Units (NUs), the head ends of the QUATRA system, were installed, one for each floor. The NUs were connected with Cat 5e cable to remote internal antennas (called Coverage Units or CUs) – three were installed on the first floor and two on the second. As QUATRA leverages Power-over-Ethernet (PoE), CUs were conveniently placed at the optimum locations without the need to add power outlets.

As there was zero donor signal coming into the building, ATG ordered a small cell from the carrier to provide the donor signal capacity needed. Once the small cell was received and installed, the two NUs were simply connected to it with a small cell interface. Cel-Fi QUATRA utilizes

RF-over-Ethernet (RfE) to extend the capacity provided by the small cells throughout the building to the CUs. As soon as the small cell was connected, the Supercell lit up the building with the cellular coverage needed.

"We like the QUATRA technology. It's cost effective, and the turnaround time to install a system is relatively short," says Dan Connelly, president of ATG. "It gives us the diagnostic tools we need to confirm it is working well, or if there is a shortcoming, to rapidly understand where the shortcoming is."

To ensure the installation provided good cellular coverage throughout the venue where needed, ATG always uses the Cel-Fi WAVE application, according to Connelly. "It's the kind of tool that validates that everything looks good, and we've got enough signal coming in. That's definitely a part of the installation process. We were able to get this location from zero bars to five bars pretty quickly."



Metropolitan Transit Agency Uses Cel-Fi QUATRA Supercell™ to Resolve Pilot Pollution and In-building Coverage Challenges

ABOUT THE PROBLEM

TRANSIT AUTHORITY

- Southern California-based metropolitan transit system occupying the 9th and 10th floors of an office building in a downtown core, with a combined square footage of 40,000
- Dropped calls and poor cellular connections were a constant employee complaint
- LEED glass windows and concrete floor construction blocked the carrier signal
- Roof-top antennas were not an option due to a helicopter pad and pilot pollution

Employees of a public transit service provider operating in Southern California were constantly complaining about dropped cellular calls or not being able to make calls at all while inside the agency's offices located in a busy, downtown core. To provide a solution that would solve the frustration that its employees were feeling, the transit agency brought on board Pacific Services, a San Clemente-based wireless integrator and Verizon and AT&T Solutions Provider for public safety, cellular, Wi-Fi, and microwave systems.

Pacific Services found that LEED glass windows and concrete floors were blocking the cellular signal. Compounding the problem, the 9th and 10th floors where the offices were located were above the height of the macro towers. To resolve the poor cell reception, Pacific Services decided to install a Cel-Fi QUATRA Supercell.

Initially, Pacific Services looked at installing QUATRA off-air, but the building owner would not consider placing an antenna on the roof as there was a roof-top helicopter pad. Although the macro signal outside the building was good, pilot pollution was a concern as there were too many pilot cell sites visible.

"One of the challenges on cellular systems when you put up a donor antenna is to pull the signal from a certain macro site. That's called the pilot. Most donor antennas have a beam width that's fairly wide, which means they can see multiple sites or you might have a site close by but there's another one behind it. The system sometimes will try to jump from one to another," explains Gary Greening, Vice President of Operations at Pacific Services. "In a fairly populated metropolitan area where there are sites all around it, it becomes more difficult to isolate the one you want to pull the signal from. In this case, too many sites were seen which would confuse the system. We decided to isolate it down to a small cell, which we can control, and it's only one pilot source for the signal."



Pacific Data Comm

- Established in 1985, based in San Clemente, CA
- Wireless integrator and for public safety, cellular, Wi-Fi and microwave systems
- Customers include government agencies, major telecom carriers, long haul fibre companies, Fortune 500 companies, United States Marine Corps, and Air Force
- Verizon and AT&T Solution Provider

SETTING UP THE SUPERCCELL

The public transit agency occupies the ninth and tenth floors of a 10-storey building with a total square footage of 40,000 on the two floors.

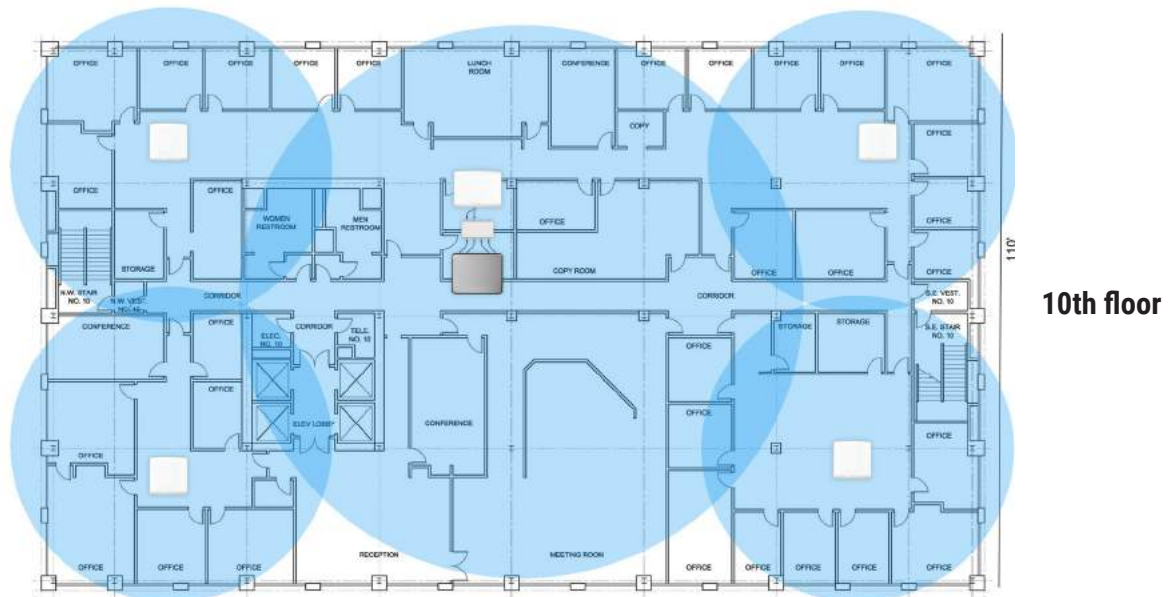
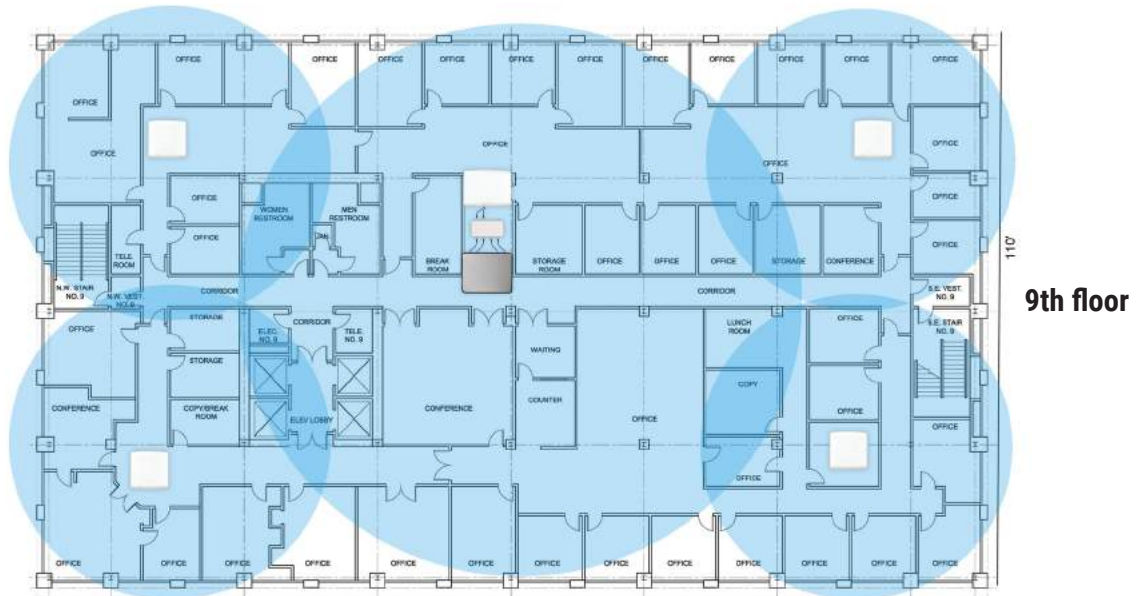
A Verizon small cell was installed in the IT closets in the center of each floor. Each small cell was connected to a Cel-Fi QUATRA Network Unit (NU) that was mounted on a wall in the closets.

Using Cat 6 cable, the NUs were connected to four remote internal antennas (called Coverage Units or CUs) on each floor to extend the capacity provided by the small cells uniformly throughout the floors. As QUATRA leverages PoE, the CUs were conveniently placed at the optimum locations, evenly spaced per floor on the ceiling tiles facing down, without the need to add power outlets.

"The QUATRA Supercell greatly enhances the ability of a small cell to extend to a lot of different areas," says Greening. "You can broaden the footprint in a building or multiple floors, or we even have done multiple buildings off one small cell signal source."

This has a major impact on the cost of the solution, according to Greening. "Every time you put in another small cell, each one costs \$3,000 to \$5,000. Each one has to have its own GPS antenna. Each one has to have a backhaul connection to the ethernet network. It's not convenient. If it's in different parts of the building, you may not have a way to get that GPS antenna on there, and you may not have the power where you want it."

"As Cel-Fi QUATRA uses PoE, it's really easy. Just extend the cable out and hang a coverage antenna where you need coverage," Greening explains. "Cel-Fi QUATRA is one of our leading solutions for medium to small clients under 500,000 square feet, and it's been very successful. We have been able to install a QUATRA Supercell for 50 to 60 percent less than the cost of other proposals the clients received."





Cel-Fi QUATRA Supercell™ Brings Cellular Service to Multi-Use Buildings

ABOUT THE PROBLEM

MULTI-USE COMMERCIAL REAL ESTATE

- 200,000 square-foot, multi-use building with commercial and residential tenants and below ground level parking garage
- Spotty cellular coverage in the parking garage caused safety concerns
- Commercial and residential spaces are not wired for traditional phone lines

Complying to Public Safety Regulations

A new 4-story building in Korea Town, Los Angeles needed to comply with National Fire Protection Association (NFPA) regulations for emergency responder radio coverage. To bring the public safety frequencies inside the building and the two parking garage floors below ground level, the building owners engaged Pacific Services.

Simultaneously addressing cellular coverage issues

As the building owners were concerned about the safety of their tenants in the below ground parking garage, Pacific Services recommended also testing cellular coverage while testing the emergency responder frequencies.

“When tenants are in the parking garage at night, even though there are cameras in the garage, having a cellular phone connection makes the garage much safer for them in an emergency,” says Gary Greening, VP Operations at Pacific Services. “After surveying the garage and finding no cellular coverage down there at all, we went ahead and surveyed the rest of the floors of the building. There was basically spotty coverage everywhere.”

In the parking garage, the thick solid concrete walls and underground location blocked any macro cellular signal. The building itself is in a pocket of other high rises – an 8-story building on one side and a big commercial building behind it – that blocked sufficient macro signal from penetrating into the upper floors. The entire ground floor of the building is occupied by retail stores, while the three floors above are apartments. These residential floors were all wired for cable and Wi-Fi, but not for conventional phone lines, so tenants were expected to use their own cell phones.

The building owners were willing to invest in good cellular coverage for better safety in the parking garage and for tenant use on both the commercial and residential floors. Pacific Services decided to install a Cel-Fi QUATRA Supercell as the solution to amplify both AT&T and Verizon signals inside the entire building.

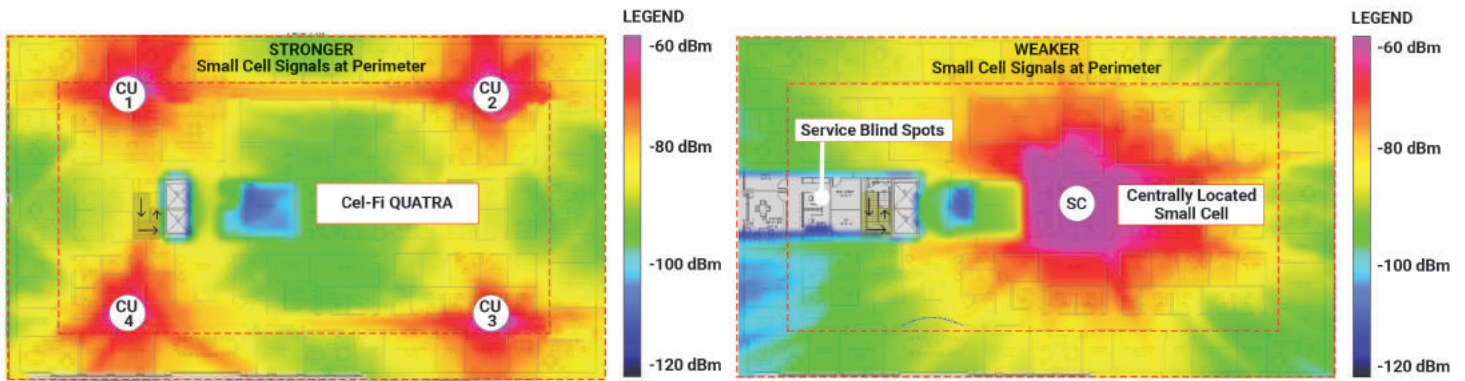


DEPLOYING THE SUPERCCELL TO ADDRESS SAFETY CONCERNS AND MORE

Pacific Services ordered two small cells from AT&T and two from Verizon. The small cells were installed in the utility closet on the bottom level of the parking garage. Five Cel-Fi QUATRA Network Units (NUs) were installed in close proximity to the small cells inside the utility closet and each NU was connected to one Verizon small cell and one AT&T small cell.

According to Greening, conduit had already been installed from the basement utility closet to all floors of the building, so Pacific Services ran Cat 6 cabling from the NUs vertically up the conduit to access panels on each floor. The cabling was then run down the halls to the Cel-Fi QUATRA coverage units (CUs). The CUs were attached exposed on the ceilings. Greening prefers an external attachment as it makes it easier to access the CUs during installation and afterwards for maintenance, and as they matched the paint on the hallways, the contractor was happy with how they looked.

A Cel-Fi QUATRA Supercell uses RF-over-Ethernet (RfOE) to extend the capacity provided by the small cells throughout the building to the CUs. In addition, the system uses PoE, so Pacific Services was able to place two to three CUs in optimum locations in the hallways on each floor



and in the parking garage, without having to add power outlets. The CUs were only needed in the hallways on the upper floors to provide good signal inside all the apartments and shops.

"We have tested other competitive products at the low end that would not be able to do that. We would have had to put antennas inside each of the apartments to try to get that kind of coverage," says Greening. "The output power of Cel-Fi QUATRA is very good when it has a clean donor signal like in a Supercell, and the penetration is excellent."

The Supercell install took two days to complete once the small cells were deployed. The public safety system was installed at the same time. The intuitive management tools provided by Nextivity helped to ensure a faster installation and facilitate more efficient technical support and maintenance.

"If there's a problem with the network, the Cel-Fi Wave application will tell us. It has a great interface, so you can quickly see what your network is doing from a cell phone, or from a laptop or an iPad," says Greening. "The management is very good through the portal, and if we see the signals from the small cell have stopped working, we can call the right technical people at the carriers to say we need some assistance to get it working again, before we dispatch a truck to get out and see the customer."

"The best part is the customer and the tenants now have peace of mind, and the reality is this solution might save a life," he adds.



CEL-FI
QUATRA

**BEYOND
BETTER
COVERAGE**

- High-quality solution for the middleprise
- Supports multi-carrier 3G/4G/LTE voice and data
- Carrier-approved and unconditionally network safe
- Can be monitored and managed using Cel-Fi WAVE

Specifications

Power 54 VDC @ 2.22 Amp via external supply (51.3 to 56.7 VDC tolerance)
(network unit) External supply: 100 to 240 VAC, 47 – 63Hz
 Power consumption less than 120W max
 Network Unit provides power to Coverage Units over Cat5e (PoE)

Environmental Operating temperature: 0° to 40°C
 Storage temperature: -25° to 60°C
 Convection Cooling
 Relative humidity: 0% to 95%, noncondensing
 RoHS II 2011/65/EU
 IP20

Installation Mounting hardware included
 NU may be wall mounted (solid or hollow)
 CU may be wall or ceiling mounted
 1 NU supports 1 to 4 CUs
 iBwave supported

Radio Performance Total boost all-channel bandwidth 75 MHz (2x2 MIMO uses double bandwidth per channel)
(check product version for specific band support) DL Maximum NU in-band donor level -40dBm
 DL Maximum NU survival donor level 30dBm
 UL Maximum CU donor level -20dBm.
 Maximum UL power 24dBm EIRP bands 1, 2, 3, 4, 7, 8
 Maximum UL power 20dBm EIRP band 5, 12, 13, 20
 Maximum DL power 12dBm per 5 MHz EIRP bands 1, 2, 3, 4, 7, 8
 Maximum DL power 10dBm per 5 MHz EIRP bands 5, 12, 13, 20
 LTE 5/10/15/20 MHz and WCDMA 3.84/5 MHz bandwidths

Physical Specifications	Network Unit	Coverage Unit
	264 x 185 x 62mm	225 x 185 x 37mm
	1.2 kg (40.8 oz.)	0.83 kg (29.2 oz.)

Connections 4x CU RJ45 Proprietary Gigabit link
 100m max CU cable length Cat5e
 200m max CU cable length with Cel-Fi QUATRA Range Extender (Cat5e or Cat6)
 PoE IEEE 802.3at
 RJ45 LAN management port (10/100 Fast Ethernet)
 RJ45 LAN management output port (10/100 Fast Ethernet)
 2x MIMO External RF Input (QMA Female 50 ohm)

Compliance 3GPP TS 25.143 Rel.10
(check individual product version for specific regional compliance) 3GPP TS 36.143 Rel.10
 CE
 FCC Part 15, 20, 22, 24, 27
 ISED Canada
 UL 62368-1/CSA C27.2
 Bluetooth BQB

System Management Cel-Fi WAVE cloud portal
(software) Cel-Fi WAVE Remote Management:

- Status (list and map)
- Commissioning
- Diagnostics
- Software Updates
- Settings
- Reporting
- Alarms & Notifications

Product Name	Model Number	Frequency (MHz)	Bands Supported	MIMO Support	Crossover Support
QUATRA 1000	Q34-2/4/5/12	1900 / 1700 / 850 / 700a	2, 4, 5, 12	4, 12	2, 5
QUATRA 1000	Q34-2/4/5/13	1900 / 1700 / 850 / 700c	2, 4, 5, 13	4, 13	2, 5
QUATRA 1000	Q34-1/3/8/20	2100 / 1800 / 900 / 800	1, 3, 8, 20	3, 20	1, 8
QUATRA 1000	Q34-1/3/7/8	2100 / 1800 / 2600 / 900	1, 3, 7, 8	3, 7	1, 8
QUATRA 1000	Q34-1/7/8/20	2100 / 2600 / 900 / 800	1, 7, 8, 20	7, 20	1, 8
QUATRA 1000	Q34-3/5/7/28	1800/850/2600/700 APT	3, 5, 7, 28	3, 28	5, 7
QUATRA 2000	Q34-4/5/12/13/25	1700/850/700a/700c/1900	4, 9, 12, 13, 25	n/a	n/a

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