

A Hybrid Active DAS that Solves Coverage Issues for Voice and Data



By Michiel Lotter, CTO and VP of Engineering at Nextivity

Cel-Fi QUATRA In-Building Enterprise Cellular Coverage System is an active DAS hybrid specifically designed by Nextivity to resolve spotty cellular coverage, poor voice quality, dropped calls, and dead zones that continue to impact employees and visitors in enterprise buildings. Nextivity worked directly with global operators to create this unique carrier-grade solution that combines the best of active and passive DAS with the Cel-Fi Technology Platform (CTP). The CTP was first launched in 2009 in the first generation Cel-Fi products, and has since been widely-adopted by operators and enterprises around the world. Unlike traditional active DAS installations that are typically deployed in venues larger than 1,000,000 sq. ft., Cel-Fi QUATRA can be installed in just days (compared to months typical of DAS solutions) by a certified installer and at a price point that fits within a typical enterprise budget, delivering returns for the investment.

Why Cel-Fi QUATRA is Revolutionary

Cel-Fi QUATRA combines analog and digital technology to deliver the best-performing in-building coverage solution on the global market. With 100dB of gain, QUATRA has 1000x more gain than other products typical to the category.

In the QUATRA solution, the donor signal is digitized at the head end (called a Network Unit or NU in Cel-Fi terms), distributed to up to six remote units (called Coverage Units or CUs) over Category cable. This lossless distribution method enables much simpler RF planning, and eliminated the need for coax between the head end and remote units. At the CU (remote) the signal is converted back to analog RF, boosted, and retransmitted. Each Cel-Fi QUATRA CU has RF output ports, as well. Therefore,

a CU can be used to drive a distributed antennas system (DAS) field, if it suits the space. There are three different commercial model Cel-Fi QUATRA families: QUATRA 1000 (Single Carrier); QUATRA 2000 (Dual Carrier); and, QUATRA 4000 (Multi- Carrier). There is a public safety emergency responder radio communications system (ERRCS) QUATRA variant as well, called QUATRA RED. (www.cel-fi.com/quatrdred)



Cel-Fi QUATRA 4000 Network Unit



Cel-Fi QUATRA 4000 Coverage Unit

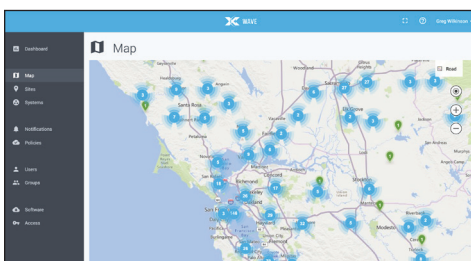
Cel-Fi QUATRA uses purpose-built Intelliboost ASICs (developed by Nextivity) that rapidly process signals, enabling the system to support the very low-latency requirements of 4G LTE and 5G. Today, Cel-Fi QUATRA supports all the main FDD LTE bands globally. The QUATRA 4000 adds TDD LTE to platform. As network operators roll out 5G using dynamic spectrum sharing (DSS) in the sub 6 GHz bands, QUATRA will support those bands as well.

The intelligent digital architecture of Cel-Fi QUATRA includes many features, such as self-configuration and self-optimization, automatic gain control to maximize system power, uplink power control to the macro network, advanced digital echo-cancellation and feedback control, uplink gating, and signal qualification (channels are individually qualified for boosting, so noise or very poor signals won't be amplified and won't degrade the network).

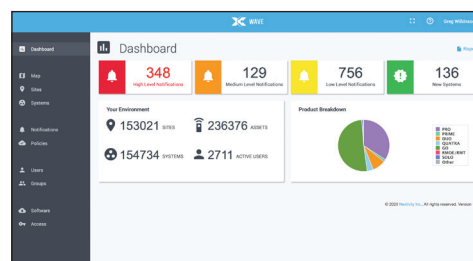
QUATRA distributes RF over Category cable, standardized around Cat 5e (or better). Using higher grade Category cable enables longer distances between the NU and CU. Fiber-optic cable is not required in a QUATRA solution, therefore no trenching or other costly fiber laying processes are required. Given QUATRA's output power is 250mW, passive intermodulation (PIM) testing is not required, offering even greater ease-of-installation. QUATRA remotes (called Coverage Units or CU) are powered via Power over Ethernet (PoE) so the solution's CUs can be placed in optimum locations in ceilings or on walls, without requiring the installation of new power outlets.

Ongoing monitoring and maintenance of Cel-Fi QUATRA is easy with Cel-Fi WAVE, Nextivity's SOC 2 Type 1 certified Network Management System (NMS). Cel-Fi WAVE is a mature cloud-based remote management platform, designed on top of Microsoft's carrier-grade, globally scaled, Azure IoT platform. It can be accessed by IT staff, integrators, or carriers. APIs can be made available for cloud-to-cloud connections, where needed. Alarms and alerts are delivered via text, SMS, or dashboard using "if this then that" (IFTTT) methods. Custom alarms and alerts can be created in minutes with the alarm builder, and saved to a standard profile.

Cel-Fi WAVE Portal



System
Location Map



Dashboard

Which Cel-Fi QUATRA do you need?

Cel-Fi QUATRA 4000i
Multi-Carrier



Network Unit Coverage Unit

Cel-Fi QUATRA 4000
Multi-Carrier



Network Unit Coverage Unit

Cel-Fi QUATRA 2000
Dual Carrier



Network Unit Coverage Unit

Cel-Fi QUATRA 1000
Single Carrier

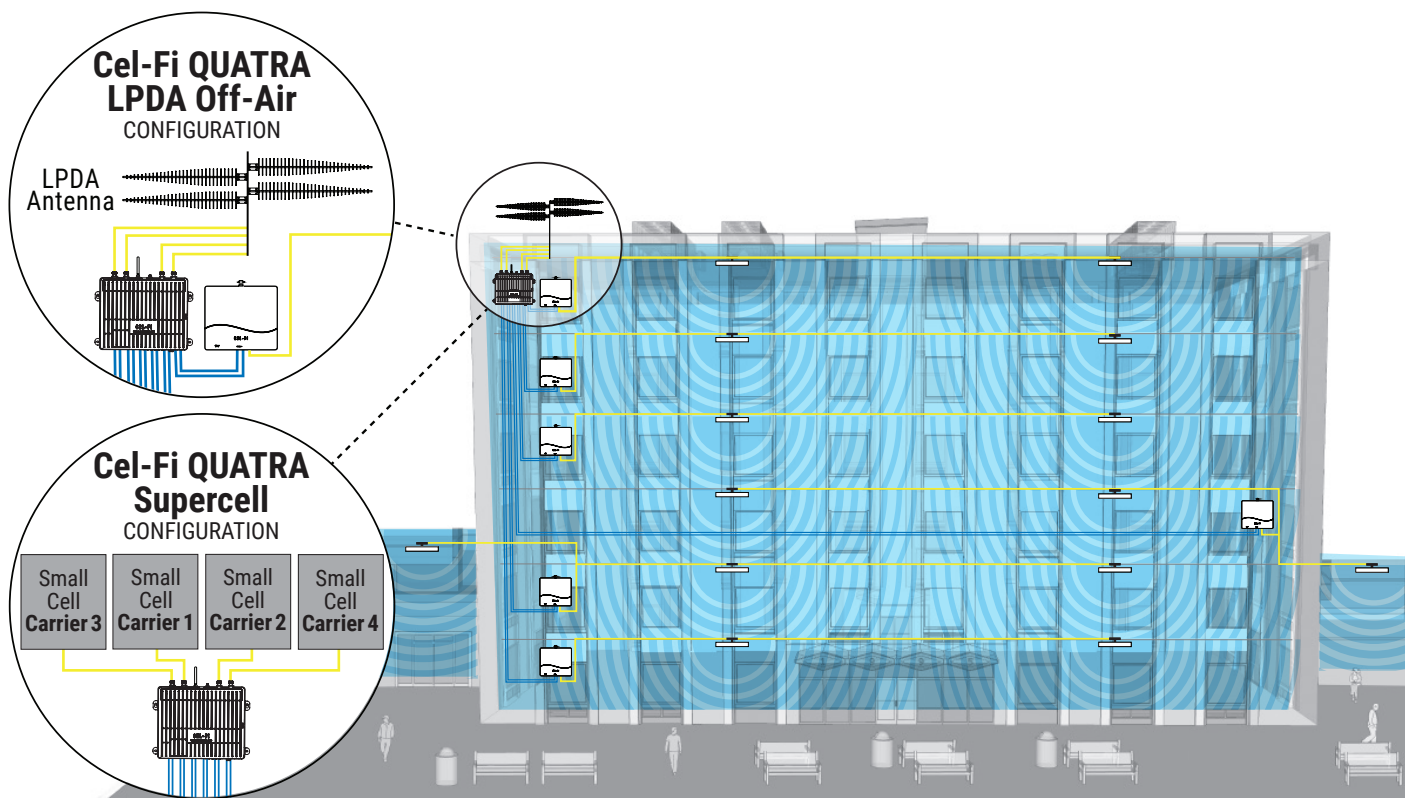


Network Unit Coverage Unit

Model Family	Carrier Support Capability	Scalable Coverage per Network Unit (up to Sq. Ft.)	Coverage Unit per Network Unit	Max Gain (up to dB)	Donor Source Options		Coverage Antenna Options (passive elements available)	PoE	Bands Supported
					Off-Air Mode	Supercell Mode			
Q4000i Part 90	Multi	75,000	6	100	Yes	Yes	Included Blade / External	Yes	2/4/5/12/13/25 / 26/30/41/71
Q4000 Part 20	Multi	75,000	6	100	Yes	Yes	Included Blade / External	Yes	2/4/5/12/13/25
Q2000	Dual	50,000	4	100	Yes	No	Internal / External	Yes	2/4/5/12/13/25
Q1000	Single	50,000	4	100	Yes	Yes	Internal / External	Yes	2/4/5/12
									2/4/5/13
									1/3/8/20
									1/7/8/20
									1/3/7/8
									3/5/7/28

How Cel-Fi QUATRA Innovated Installation

Cel-Fi QUATRA can be deployed either off-air or tethered to small cell(s), with the approach determined according to a variety of factors, including the usable signal available and the capacity requirements.



Off-Air Mode

The off-air configuration maximizes coverage up to 75,000 sq. ft. per (QUATRA 4000) NU with up to six CUs for Cel-Fi QUATRA 4000, and up to 50,000 sq. ft. per (QUATRA 1000/2000) NU with up to four CUs for Cel-Fi QUATRA 1000 / 2000. Cel-Fi QUATRA solutions can leverage as many NUs as needed for the environment and size of structure and can be deployed to support one or multiple carriers.

Supercell Mode

In densely-populated venues additional capacity may be needed, in which case Cel-Fi QUATRA can be tethered to one or more small cells. This is also known as a Supercell. A Supercell distributed the coverage and capacity of the small cell in a uniform way, through the Coverage Units. Supercells are inherently uncomplicated from a planning and deployment point of view and are far more resilient to potential interference or performance degradation.

Cost-Effective with Faster Project Timelines

The cost of installing a Supercell or an off-air Cel-Fi QUATRA system is economical compared to the cost of installing a traditional active DAS system for a similar size venue. The complexity and time it takes to install an active DAS can also be problematic since an active DAS requires an extensive number of steps related to planning, surveying, sourcing, configuration, installation, laying fiber, testing, and commissioning. Many of these steps – such as site surveys, design, validation, and commissioning require specific high-level RF, electrical, and/or engineering expertise. Most onerous of all, an active DAS typically requires some sort of a signal source from the operator which usually entails some form of contractual agreement. These agreements can be quite difficult to complete.

Leaders in Innovation and Built for Installers

While many of these steps are needed with Cel-Fi QUATRA installation, the system's proprietary chipset and software are designed to simplify and accelerate the process. QUATRA is guaranteed to seamlessly integrate with the macro network and other connected elements without causing interference, using installation tools provided. After installation, QUATRA is designed to self-adjust and adapt to changes in the environment or network to maximize performance and maintain reliability.

Carrier-Grade and Network Safe

The Cel-Fi QUATRA system's gain is dynamic and automatically controlled through the embedded firmware. This is an important consideration as cellular networks are not static. They adjust throughout the day, depending on usage and loading, and a variety of other factors. Carriers are constantly shifting hardware and software resources to meet customer requirements. For example, additional bandwidth may be added to a tower, or shifted from one frequency to another. Cel-Fi QUATRA automatically and dynamically, adjusts itself to the network conditions it senses. This maintains the best possible customer experience and eliminates unnecessary maintenance truck rolls. Cel-Fi's intelligent interface with the network resources are one of the main reasons cellular carriers globally are using Cel-Fi as a key part of their network infrastructure.

Active DAS Hybrid Solution is Better

The combined capabilities of an active DAS and the digital architecture of Nextivity's Cel-Fi product line eliminates problems associated with other indoor cellular coverage technologies, and offers the following advantages:

- **Most Gain:** Up to 100 dB Max Gain per Operator
- **Carrier-Grade Network Safe:** Signal boost without overloading the network with amplified noise

- **Dual Mode:** Off-Air and Supercell Mode
- **Digital Distribution:** Head End (NU) to Remote (CU) over Category cable
- **Power over Ethernet:** Remotes powered over Ethernet, for simplicity and ease
- **Scalable:** Multi-Carrier – Up to 75,000 Sq Ft per Network Unit, eases expansion
- **Planning Tools:** tools for estimates, planning, installation, and optimization.
- **RF Optimization:** Dynamically tunes to operator network frequencies, making the network more efficient
- **Cel-Fi WAVE Platform:** System management options available for enterprises that want to implement alarms and alerts.

Driving Down Cost and Complexity for Enterprise Buildings

The cost of a traditional active DAS solution, in particular for the medium or small-sized venue, can be 10 or more times the cost of Cel-Fi QUATRA, putting them out of range of most enterprise budgets. Simpler solutions such as femtocells and Wi-Fi calling are available but do not have the reliability, quality of service, or management capabilities that a business requires. There's also an OPEX component when it comes to small cells and broadband that can put the total cost of ownership outside of a reasonable return. Venues that range in size from 30,000 to 1,000,000 sq. ft. are particularly challenged with the price/performance gap, because they are too large for affordable consumer-grade solutions and too small for high-performance neutral host DAS.

Cel-Fi QUATRA addresses this gap by eliminating the need for costly RF engineering, using Cat 5e (or better) cabling to connect the NU with the CUs, and powering the system to the CUs via Power over Ethernet from a single power supply centralized at the NU. This also means the CUs can be easily mounted just about anywhere, from wall to ceiling, wherever coverage is needed.

Nextivity chose to standardize on dedicated Cat 5e cabling to simplify IT requirements. (Higher grade cable can be used, and will yield longer distances from NU to CU, but is not required.) The NU and CU may be separated by as much as 200 meters when the optional Cel-Fi QUATRA Range Extender (QRE) is placed inline. If using Cat 7 cable the separation distance can be 300 meters. The QRE is powered by the NU and doesn't require additional power.

Cel-Fi QUATRA advantages begin in the planning and design phases, with both the BOM Estimator Tool and iBwave design templates, for more complex designs. There is commitment to excellence to make the installer's life easier and the deployment pristine, with Cel-Fi WAVE installation and optimization tools. Cel-Fi WAVE continues its work after deployment to service updates and allowing the integrator to monitor the system remotely.

Cel-Fi Blade Antenna (Included)



Cel-Fi QUATRA 4000 Range Extender



Cel-Fi LPDA-R High-Gain Directional Antenna



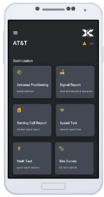
Cel-Fi Low-Profile Antenna



Cel-Fi COMPASS is an RF installation tool that enables installers and integrators to install and optimize Cel-Fi equipment. Cel-Fi QUATRA 1000 / 2000 previously required an Internet connection to be commissioned and managed; COMPASS obviates the need for an Internet connection. Cel-Fi QUATRA 4000 can now be brought online simply using Cel-Fi COMPASS. The Cel-Fi COMPASS is accessed by the Cel-Fi WAVE PRO app via Bluetooth. The Cel-Fi COMPASS can also connect via Ethernet to the Cel-Fi QUATRA Network Unit.



Cel-Fi COMPASS



Cel-Fi WAVE PRO

Installation Features:

- Activate/Deactivate the system
- Update software
- Change Antenna Settings
- Set the bands to relay
- Change IP Settings

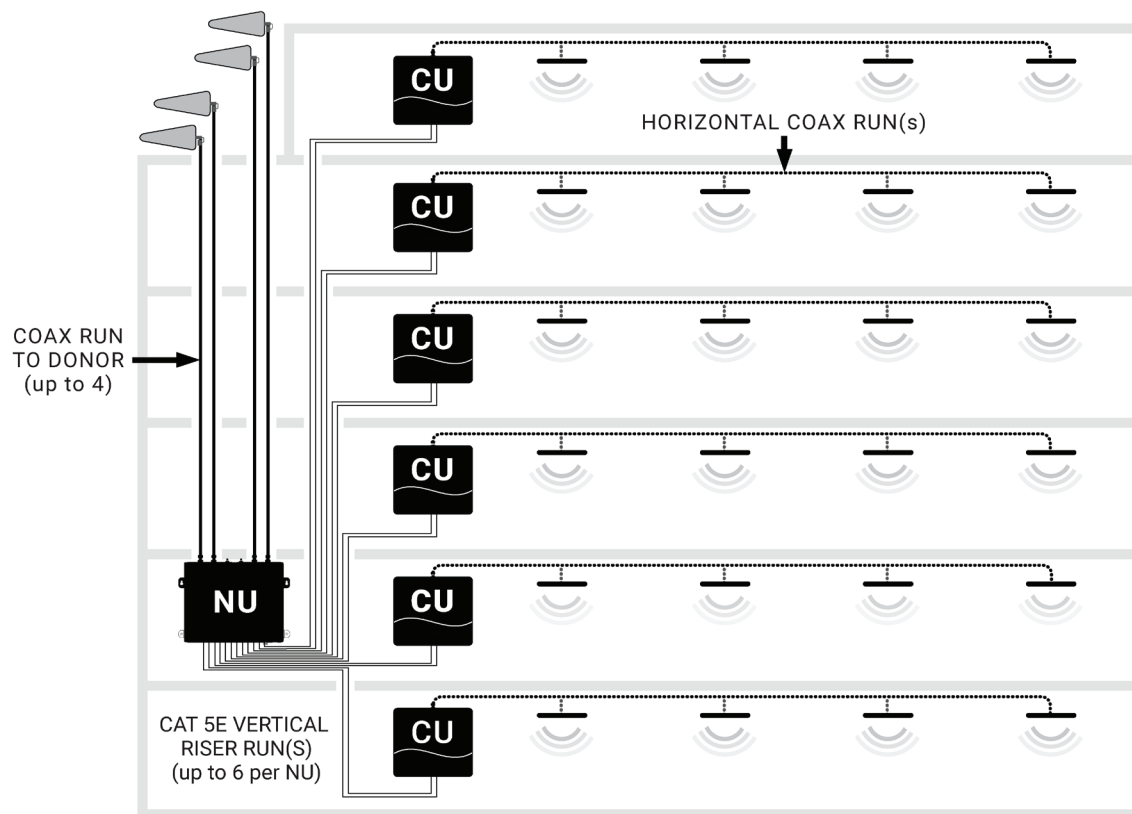
Optimization Features:

- Antenna Position test (when connected to a Directional Antenna with the Cel-Fi Antenna Mount)
- Full Signal Report (when connected to an Antenna)
- Serving Cell Report (when connected to an Antenna)
- Speed Test
- Cel-Fi WAVE PRO is available on both smartphones and tablets from the following app stores:




Off-Air Mode Configuration: When Signal is Available

Off-Air configurations use capacity from the operator's existing macro network, extending it indoors where it is needed. This can be the fastest and easiest way to provide indoor coverage as it does not require any fixed backhaul (small cell or femto), contracts, or lengthy permit processes.



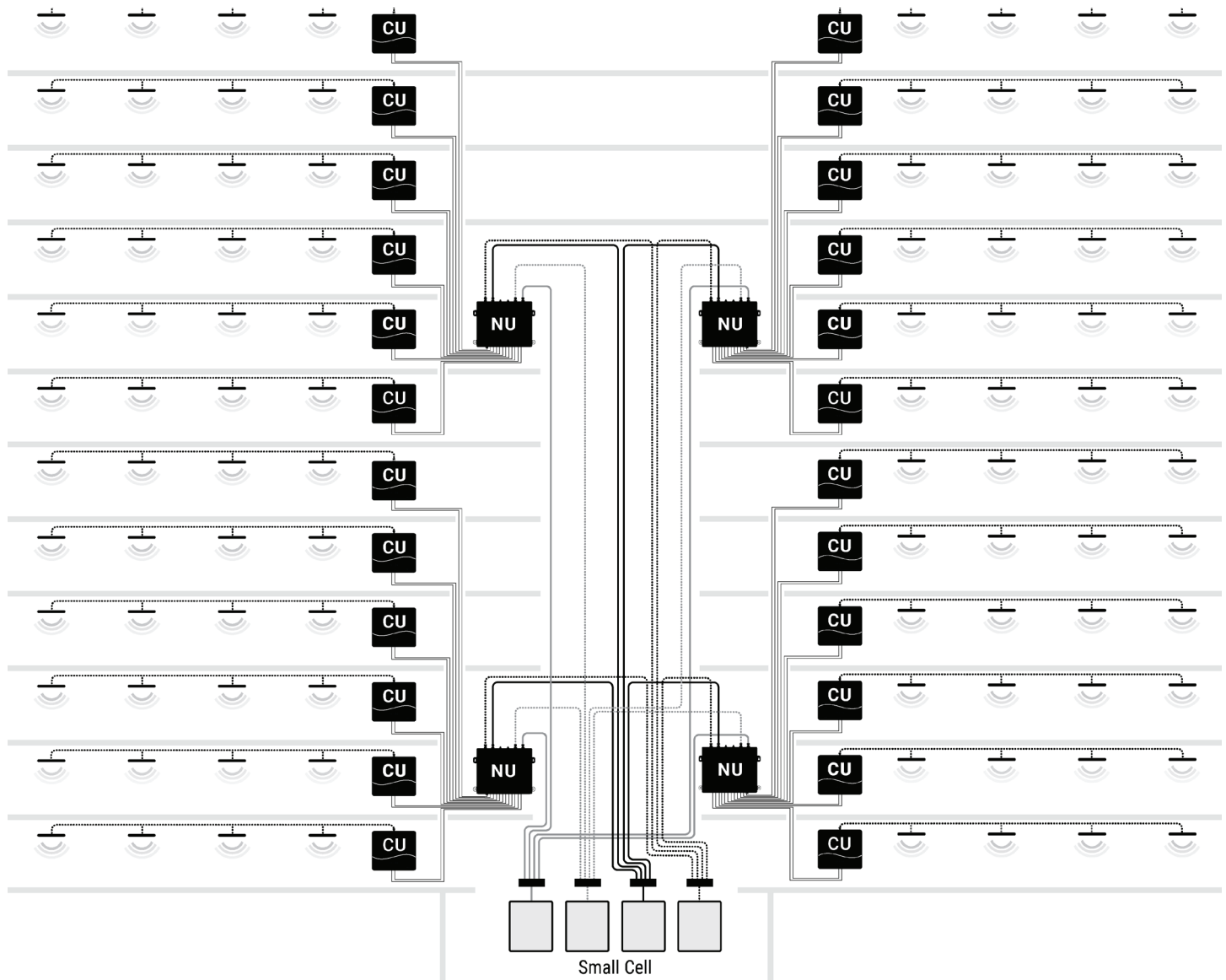
Example: Off Air Install, 75K ft² building

Quality of the donor signal provided to the system is perhaps the most important factor in the installation outcome for an off-air configuration. Nextivity offers a selection of suitable donor antennas. Using a high-gain directional donor antenna can be a good way to achieve the best signal quality. Nextivity offers mounting solutions, an outdoor pole mount, and an indoor/outdoor wall mount. Guided by Nextivity's Antenna Positioning software, as part of the WAVE platform, in minutes the antenna can be mounted, positioned, and aimed properly for best donor signal input.

Another advantage of the off-air configuration is that CUs or distributed Passive Antennas only need to be placed where coverage problems exist in the building. In this configuration, the existing macro signal is only being boosted where it is lacking, and a handset that migrates between Cel-Fi QUATRA and macro-covered areas is simply seeing a better macro signal everywhere.

Supercell® Mode Configuration: When No Signal is Available or Dense Environments

In the Supercell configuration, a small cell is used as the donor for Cel-Fi QUATRA. (Any small cell can be used with Cel-Fi QUATRA, as long as the supported bands of the small cell match the bands supported by QUATRA. There are several QUATRA band variations available.



Example: Supercell Install, 300K ft² building

The Supercell created by the small cell/active DAS hybrid provides uniform access to the capacity introduced by the small cell. Supercells are inherently uncomplicated from a planning and deployment point of view and are far more resilient to the potential of interference. Larger or more densely populated installation sites can often benefit from the signal capacity delivered by a dedicated small cell donor. This configuration facilitates a uniform signal distribution throughout a larger area.

Hybrid Install, Off-Air + Supercell

There are times when both Off-Air and Supercell Modes are used together in the same integration. When one or more operators can leverage outside signals, but others cannot. The System Integrator can decide to use a hybrid approach, taking off-air signals from carriers with good service and implementing small cells for the remaining carriers.

There are also cases where a system may be commissioned initially with off-air donor signals and then changed to small cell later. This approach can be useful when there's an urgent need for immediate coverage, but carrier agreements or small cell readiness lags.

Conclusion

Until now, the industry has struggled to provide affordable indoor cellular coverage solutions for enterprise venues under 1,000,000 sq. ft. Existing consumer-grade BDA passive DAS solutions have been limited in performance, while active DAS has been too complex and costly. The Cel-Fi QUATRA In-Building Enterprise Cellular Solution is the first to meaningfully address the obstacles to indoor coverage for the enterprise, so that massive and rapid deployment can occur to resolve black holes, dropped calls, and poor cellular quality that impacts most companies in this space.

Cel-Fi QUATRA builds on the digital architecture of Nextivity's proven operator-class coverage solutions to improve indoor cellular service in the enterprise, with the lowest total cost of ownership (TCO) of any solution available on the market.

Configurations are flexible and can be scaled to the unique needs of each venue, future-proofing the system for company growth. Off-air configurations are designed to quickly bring outdoor coverage indoors. Supercell configurations are designed to improve the effectiveness of local small cell capacity, while providing better coverage for larger or more densely populated facilities and effectively offloading from a burdened macro network.

With Cel-Fi QUATRA intelligence and toolsets, installations are highly optimized. Digital distribution via Category cabling, Power over Ethernet (PoE), all help to make the certified installer's job easier and keeps the CAPEX and OPEX of the system at an affordable level for most enterprise budgets.

Cel-Fi QUATRA is available through Nextivity's distribution partners around the globe. For more information, visit www.cel-fi.com/QUATRA. To become a certified partner, visit www.cel-fi.com/partnership.

About the Author



Mr. Lotter has 25 years of experience in the field of wireless communication. Prior to joining Nextivity he was the Senior Director responsible for platform development in the Mobile Communications BU at Broadcom, which he joined as part of the firm's acquisition of Zyray Wireless of which he was a co-founder and Vice-President, Engineering. Prior to Zyray he spent 8 years with Alcatel Networks. Mr. Lotter holds a Ph.D. from the University of Pretoria in Electrical Engineering. Additionally, he has authored and co-authored a number of journal and conference papers, as well as two books on wireless communications and is the named inventor or co-inventor on 31 issued patents with several more pending.