



By Joe Schmelzer, Senior Director of Products at Nextivity

As a unique active DAS hybrid solution, Cel-Fi QUATRA is the newest technology in the market for addressing spotty cellular coverage, poor voice quality, dropped calls, and dead zones that continue to plague employees and visitors in middleprise buildings (venues 10,000-500,000 sq. ft.). Unlike traditional DAS installations that are typically deployed in venues 500,000 sq. ft. and larger, QUATRA can be installed in just days (compared to months typical of DAS solutions), and at a price point that meets the middleprise budget.

A Primer on Cel-Fi QUATRA

Cel-Fi QUATRA is a scalable, carrier-approved in-building cellular solution that solves coverage issues in middleprise venues. This unique hybrid solution combines the best of active DAS with the intelligent Cel-Fi coverage technologies that have been widely adopted by carriers around the world.

Unlike a passive DAS – where the cellular signal is distributed as analog RF from the head end over coax cable, and attenuates (loses power) as it travels from the signal source – Cel-Fi QUATRA uses scalable digital technology that delivers a cellular signal that is up to 1000x stronger at the end point, combining CAT 5e cabling for RF and Power over Ethernet, with no signal attenuation right to the perimeter of the building.

In the QUATRA solution, the donor signal is digitized at the head end (called a Network Unit or NU), distributed to the remote units (called Coverage Units or CUs) over twisted pair Ethernet, converted back to analog radio signal, and retransmitted. Cel-Fi QUATRA uses purpose-built ASICs (developed by Nextivity) that process these signals extremely fast, enabling the system to support the very low-latency requirements of 3G and 4G LTE. Today, Cel-Fi QUATRA supports all the main FDD LTE bands globally. The next-generation chipset, already back from the fab, will add TDD LTE to the technology lineup, and provides a platform for 5G.



Figure 1: Cel-Fi QUATRA configurations for Small Cell and Off Air.

Cel-Fi QUATRA can be deployed either off-air or tethered to a small cell, with the approach determined based, among a variety of factors, on the size of the venue and the number of cellular users.

The off-air configuration maximizes coverage up to 50,000 sq. ft. per NU. 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.

In densely populated venues where additional capacity is needed, Cel-Fi QUATRA can be tethered to one or more small cells. This latter option – also known as a Supercell (i.e., a large single cell versus multiple small cells) – provides uniform access to the capacity delivered 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 or performance degradation considerations.

The cost of installing a Supercell or an off-air Cel-Fi QUATRA system is economical compared to the cost of installing an active DAS system for a similar size venue. The complexity and time it takes to install an active DAS is also problematic for the middleprise as an active DAS requires an extensive series of planning, surveying, sourcing, configuration, installation, laying fiber, testing, and commissioning steps. Many of these steps – such as site surveys, design, validation, and commissioning – require specific high level RF, electrical and/or engineering expertise.

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 self-configuring and self-optimizing, and 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.

Importantly, the Cel-Fi QUATRA's system gain management is dynamic, automatically controlled. Cellular networks are not static. They "breathe" throughout the day, depending on usage and loading. 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, dynamically, adjusts itself to the network conditions it senses. This maintains the best possible customer experience, and eliminates unnecessary maintenance truck rolls.

Cel-Fi QUATRA distributes RF over Ethernet (RFoE) using a Cat 5e (or better) cable. Fiber is not required in a QUATRA solution, and no passive intermodulation (PIM) testing or other costly fiber laying skills are required. Cel-Fi QUATRA leverages Power-over-Ethernet (PoE) so the solution's Coverage Units can be placed in optimum locations in ceilings or on walls, without requiring the installation (and compliance review!) of new power outlets. Ongoing monitoring and maintenance of Cel-Fi QUATRA is easy with Nextivity's Network Management System (NMS), named Cel-Fi WAVE. 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. Use the standard set of alarms and alerts, delivered via text, SMS, or dashboard. Or, WAVE's "if this then that" (IFTTT) notification interface allows for easy customization.

Slim Bill of Materials and Minimal Installation Equipment

As noted above, Cel-Fi QUATRA consists of two main components. A Network Unit (NU) is the head end of the system, serves as the hub and receives the donor signal from the off-air or small cell signal source. One NU can be connected to up to four Coverage Units (CU). The CU is the point of coverage distribution. It performs like an active omni-directional antenna. The CU can alternatively be used like a remote unit, driving passive antennas from its MIMO RF port. Nextivity offers a variety of MIMO and SISO antennas that can be used for either donor or server points. Nextivity antennas are highly-recommended, as they are designed to match the frequencies and requirements of the QUATRA product, and their performance is assured.

The components for an installation include:



Figure 2: Cel-Fi QUATRA elements for installation.

Cel-Fi QUATRA Solution

- Network Unit (NU *ref 1*). One or more, depending on the coverage requirements
- Each NU can support up to four CUs
- Coverage Unit (CU ref 2)
- Access to Cel-Fi WAVE NMS (Network Management System) for provisioning and monitoring
- Wall/Ceiling mounting equipment (included with each unit)

Optional Cel-Fi components

- QUATRA Range Extender (QRE) for any NU-to-CU link that is greater than 100m.
- Small cell interface (SCIF *ref 3*) when a small cell serves as the donor signal
- External donor antenna (for off-air installs)

Standard (off-the-shelf) Components

- Cat 5e (or better) cable
- Standard low-voltage (IT) tools

Planning

Phase 1:

When planning a Cel-Fi QUATRA solution installation, the current signal levels throughout the building should be measured first. This can be done using a smartphone's "test mode". Access to the test mode function will vary depending on the phone vendor and can usually be found in the smartphone's user guide online. A floor plan with rough building dimensions and knowledge of existing LAN resources within the building are also recommended.

The only measurements needed for installation are the signal levels in the venue, to determine where coverage is needed, the optimum locations for the equipment. The signal measurements should be recorded on the floor plan. More sophisticated RF surveys and designs are not required, but are also fine to use if the software and know-how is readily available.

Signal measurements will be used to determine the best options for how the donor cellular signal will be supplied. If there is no usable cellular signal at the building's exterior, or roof (with a Cel-Fi donor antenna) a small cell can be used. (You will need a dedicated Internet feed!) However, a small cell alone may not fix all dead zones due to internal construction obstacles, like stairwells or metal walls. Some small cells may have signal dominance issues at the building's perimeter, where outside macro signal sources are present, causing handsets to jump back and forth from small cell to macro, causing QoS degradation and issues.

These problems are resolved when Cel-Fi QUATRA is connected to a small cell. Cel-Fi QUATRA optimizes the capacity from the small cell through interference management, and extends the signal coverage uniformly throughout the venue right to the building perimeter, providing dominance over the macro network in offices along external building walls. This Supercell configuration provides a small to mid-sized enterprise with a lower total cost of ownership (TCO) for uniform capacity than deploying multiple small cells.

Installation and Provisioning

Phase 2:

As mentioned earlier, Cel-Fi QUATRA has intelligent features to simplify the installation. Cel-Fi WAVE NMS platform access is available to installers, and an integral part of the install process. A simple method, driven by WAVE, walks the installer through the commissioning process step-by-step. When completed, the Cel-Fi QUATRA system is fully-enabled.



Figure 3: Cel-Fi QUATRA can be installed with existing IT professionals or specialty integrators.

A basic knowledge of LAN cabling is needed to connect the NU and each of the CUs with Cat 5e (or better) cabling. Cable connections should be gigabit 1000BaseT compliant. With the use of the QUATRA Range Extender (QRE), an additional 100 meters can be added to the distance between the NU and CU. With the QRE, the CUs can be placed up to 200 meters (655 feet) from the NU. This allows considerable flexibility and range in placing the CUs so a cellular signal is present even where there are construction obstacles or no coverage previously.

The NU and external antenna, if one is used, need to be mounted according to the diagrams below. When using a small cell as a donor signal, it should be mounted with the NU in a protected area, and the CUs located at least 10 meters (33 feet) from the NU.

Nextivity's Wideband MIMO Antenna is the perfect signal source for Cel-Fi QUATRA in an off-air configuration. A highly-intuitive and easy-to-use Antenna Positioning application is provided via the WAVE portal to facilitate antenna setup. Without the need of any specialized tools, an installer can mount and aim the antenna perfectly in minutes.

Monitoring and Management

Phase 3:

Once everything is up and running, Cel-Fi QUATRA can be monitored and managed remotely using the Cel-Fi WAVE portal. Cel-Fi WAVE enables integrators, carriers or IT staff, to do a number of things, such as track and archive the status of one or multiple units over time, and receive notifications (online or via text or email) if a system alert or alarm has been triggered.

Matching In-building Coverage Technology to Real World Resources

With over 1.5 million commercial buildings from 10,000 to 500,000 sq. ft. in the U.S. alone (according to the U.S. Energy Information Administration), system integrators and installers have their work cut out to deliver the in-building cellular coverage commercial users demand. The ease and speed of installation with a Cel-Fi QUATRA solution goes a long way toward maximizing existing manpower to meet this demand.



Figure 4: Read how the 211 Headquarters went from no cellular signal to supporting thousands of guests. Click here to learn more.

As the system is installed with ubiquitous Cat 5e cabling, system integrators can leverage the wealth of competent enterprise IT resources to pull cable, which is not possible with other solutions that utilize fiber. This collaboration not only augments available manpower, but can also lower the cost of installation for the enterprise user. Factoring in the unique design and intelligent tools provided with the solution, QUATRA can be installed as a single or multi-carrier solution at a fraction of the cost of an active or passive DAS, or multiple small cells.

Analog repeaters and Passive DAS systems readily available to enterprise typically provide 70dB of peak gain. At 100 dB of peak gain, QUATRA delivers 1000x more power. This stronger signal provides a larger coverage footprint in environments where the incoming signal is weak, requires fewer antennas, and ensures the strongest possible uniform signal is available for the users throughout the building.

In addition, QUATRA seamlessly coexists with the macro network and other connected elements on the network without causing interference or generating a rise in the noise floor. Because the system is self-configuring, self-optimizing, and designed to self-adjust and maximize performance by adapting to changes in the environment or network, Cel-Fi QUATRA eliminates the historical complexities (like setting gain) of installing and maintaining an in-building cellular coverage solution.

Unlike other solutions in the market for the middleprise, a Cel-Fi QUATRA installation can easily be completed within days to deliver immediate improvements in cellular coverage. If a small cell is required for additional signal capacity at the venue, Cel-Fi QUATRA can be installed while waiting for the small cell to be delivered. Once the small cell is delivered, this active DAS hybrid can simply be connected to the small cell for the donor signal.

By matching the technology to real-world resources, Cel-Fi QUATRA supports the middleprise in-building cellular ecosystem in multiple ways:

- Integrators have a product to add to their portfolios for a fast installation when their commercial customers complain about poor cellular coverage in their buildings.
- In-house IT departments now have a carrier-approved option to solve the problem of dropped calls and poor coverage without exceeding their budgets, with scalability for future expansion.
- Carriers are provided with a network-safe, ROI-positive, solution to augment and complement their small cell initiatives, and to keep their middleprise customers happy.
- Small cell manufacturers can leverage the technology to alleviate the complexities and cost factors that have prohibited small cell adoption in this market.

For detailed installation instructions and/or product features for Cel-Fi QUATRA, visit <u>www.cel-fi.com/quatra</u>.

About the Author



Joe Schmelzer is Senior Director of Products at Nextivity. He has developed a variety of products and industrial devices for chipset vendors, OEMs, and service providers, including products for Sony, Qualcomm, Google, Verizon Wireless, AT&T, Dell and HP. He enjoys speaking opportunities and writing. For more information, contact sales@cel-fi.com or visit www.cel-fi.com.

April 2018

