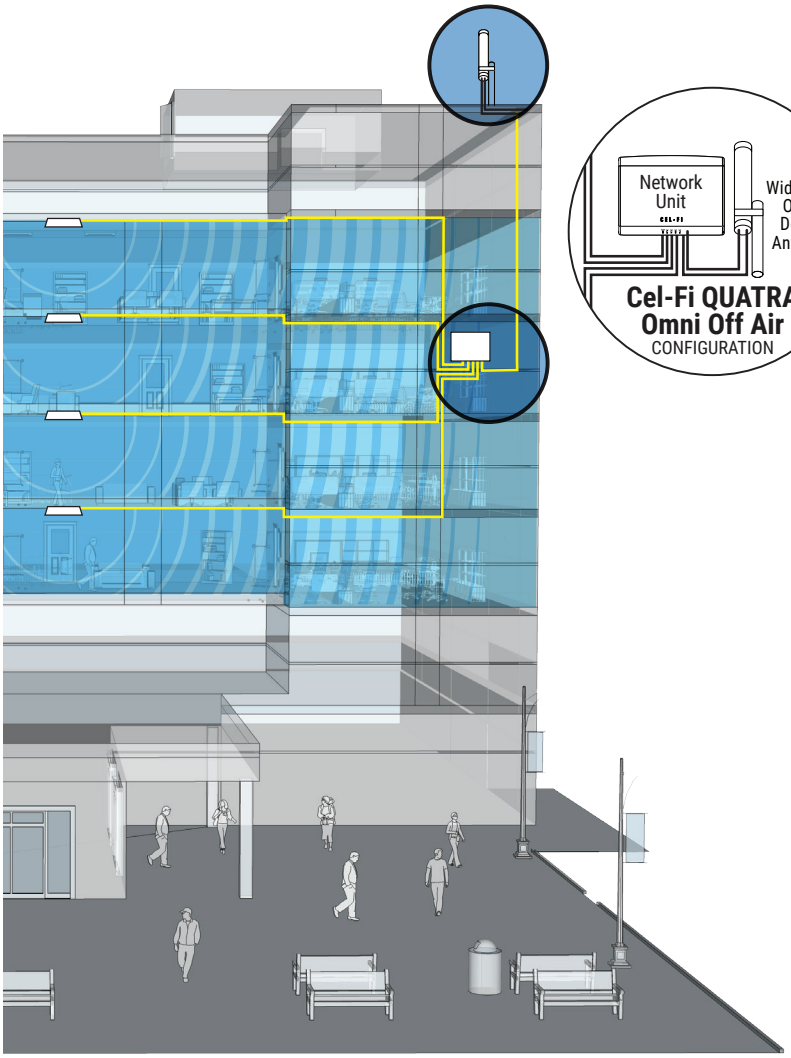
CEL-FI by NEXTIVITY™

CEL-FI™ QUATRA

Active
DAS
Hybrid

Superior Cellular Coverage for the Middleprise

Superior Technology Means Superior Cellular Coverage



In-building cellular coverage is all about distributing cellular signals to where they need to be: users. Over the last decade, there have been tremendous advances in the technology that amplifies the cellular signal from the macro network inside buildings, where cellular devices are used the most, so subscribers experience high-quality cellular connectivity without dropped calls, echoing, slow downloads and black holes.

An enormous investment in research and development by Nextivity has gone into a new breed of digital cellular coverage technology – the Cel-Fi product line. It has the system intelligence, power and gain to amplify cellular signal from a small cell or off air that uniformly lights up a building or campus to provide exceptional coverage – with the ease of installation and maintenance, and total cost of ownership not available with earlier technologies.

The case studies that follow show the effectiveness of this technology in resolving in-building cellular connectivity issues for all major carriers with off-air installations of Cel-Fi QUATRA, the active DAS hybrid that was developed by Nextivity specifically for the middleprise.

Cel-Fi QUATRA connects cellular power users at campus area apartments

An apartment complex consisting of six buildings in Tempe, Arizona housed students attending nearby Arizona State University, and young professionals attracted to its proximity to the Tempe Marketplace. The stucco exterior coupled with its LEED certification made it impossible for cellular signals to penetrate the buildings. There was literally zero indoor coverage on the first two floors with poor coverage on the two top levels.

ABOUT THE PROBLEM

CELL PHONE SIGNAL A MUST-HAVE AMENITY FOR MILLENNIALS

The lack of indoor coverage was resulting in a high tenant turnover rate of the largely millennial renters. Those who did stay were not shy about voicing their displeasure—including online. With its reputation at stake, the compound owners called in Illuminati Labs to provide indoor coverage for all four major carriers.

"This demographic has grown up in a digital world. Their cell phones are their lifeline, so they need good coverage," explains Adam Rubey, co-founder of Illuminati Labs. "If we failed to provide that, they would continue to look for alternative living arrangements and posting negative reviews about the building."

An initial assessment of the first 162,000 square feet 4-story building uncovered several challenges. The "hard lid" ceilings in the hallways meant that the team could not simply lift the tiles to access the grid, making cabling more difficult. The aesthetics of the building limited Illuminati's ability to place units in certain places. And since the building was occupied, the team was only able to work within certain timeframes during the day.

ABOUT THE SOLUTION

EXPANDED COVERAGE THAT LOOKS GOOD, TOO

Illuminati Labs decided to install Cel-Fi QUATRA, an active DAS hybrid that delivers uniform, in-building cellular coverage and specifically addresses the challenges of poor voice quality, dropped calls, and dead zones in buildings from up to 10,000 to 500,000 sq. ft.

In the first building, a total of two Cel-Fi QUATRA Network Units (NUs), the headends of the system, and eight Coverage Units (CUs), the remote units that distribute the signal, were installed in each of the hallways to provide residents with 4G service for all four major carriers throughout the building (chart on next page).

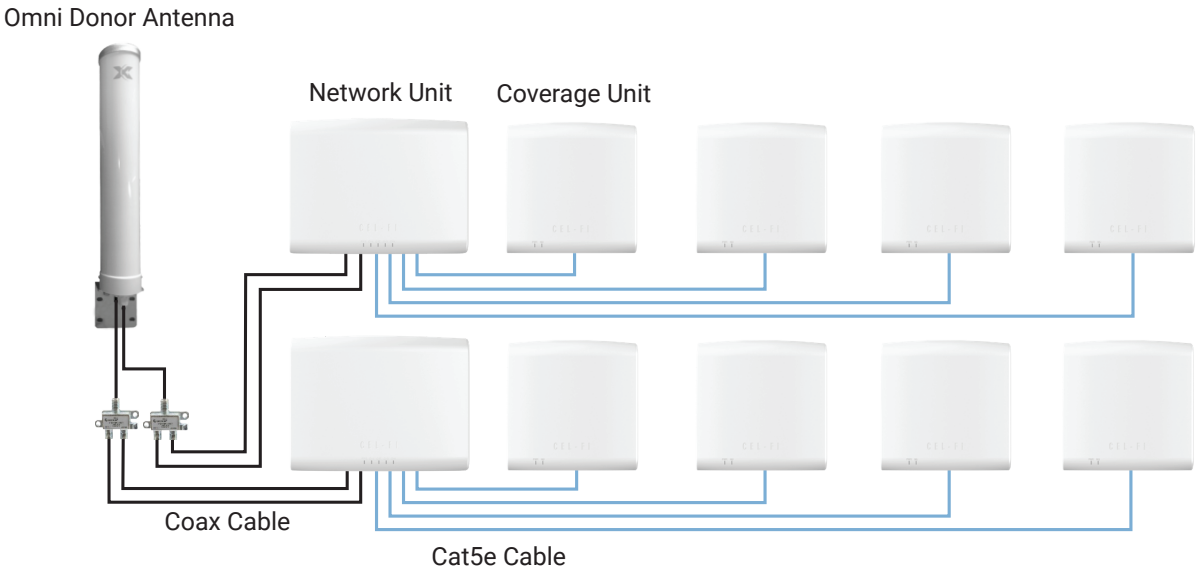
Illuminati Labs

- Headquartered in Boulder, Colorado
- 12 employees
- Offers cell phone signal boosters to clients in the hospitality, real estate, healthcare, education, and other industries
- Aims to provide rooftop-quality cell coverage from the penthouse to below ground
- Marquis clients include the Marriott, Hilton, and Hampton Inn brands

"In apartments, the owners don't want any of the equipment inside the individual units where behind closed doors they could be touched by occupants, so having the equipment out in a common area prevents this," explains Rubey. "QUATRA CUs will cover a 100-foot radius where

everyone else on the market covers a 50-foot radius. This gives you more of a coverage bubble that goes up and down floors as well as just on that individual floor. We were able to use half as many units and stagger and spread them out in the hallways to get great coverage throughout the building and save them money in the design."

As the building had unique details on the ceilings, such as up-lighting and cove-lighting, the owners also had aesthetic concerns in retrofitting the building with cabling and devices. "They didn't want to see these devices, so having half as many was a positive. But most importantly, QUATRA uses Cat5e cabling and it's so much easier to run a Cat5e down to a coverage unit as opposed to an RG-11 garden hose that doesn't bend, doesn't turn, and it's big and bright blue. It's hard to hide that huge RG-11 garden hose down a hallway," says Rubey.

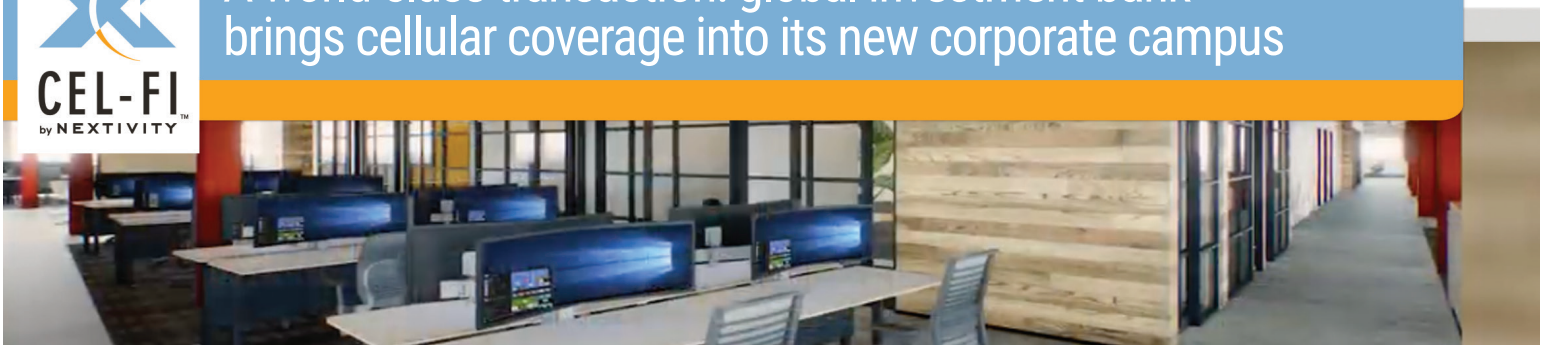


REPEAT PERFORMANCES

It took Illuminati's five-man team three days to complete the installation of the first building. The owners were so pleased with the results, Illuminati has already installed Cel-Fi QUATRA in the second apartment building in the complex, and the other four buildings are scheduled for installation over the next 18 months.

"Having a strong cellular connection inside a building is no longer optional, especially for millennials," says Rubey. "With Cel-Fi QUATRA, it's easy to make always-on connectivity a reality for those who need it most."

A world-class transaction: global investment bank brings cellular coverage into its new corporate campus



One of the world's most recognizable investment banks purchased and renovated a six-story office building in New Jersey, creating a world-class corporate campus for hundreds of back office employees in operations and technology. The modern complex features amenities such as a fitness center, lounge, conference rooms, café, and walking trails. But one thing was missing from the seven-story building: good indoor cellular coverage.

ABOUT THE PROBLEM

During the renovations the IT installers were having trouble getting cell signal and were experiencing dropped calls, so the bank approached one of the carriers for a solution. Historically a traditional active Distributed Antenna System (DAS) would have been recommended by the carrier, but this was off the table because it would have taken a year to install and employees were moving into the building in two months. So instead, the carrier recommended Cel-Fi QUATRA, an active DAS hybrid.

The bank engaged Atlantic Technology Group based in Maryland to install the solution.

"The building is beautiful, but the new windows blocked out RF signals from penetrating indoors. This is a common problem in new buildings," explains Dan Connelly, founder and owner of Atlantic Technology Group. "We put together a proposal to improve the customer's cell reception for all four carriers – Verizon, AT&T, T-Mobile and Sprint – with Cel-Fi QUATRA. We could install the system within a few weeks at about a third of the cost of an active DAS."

ABOUT THE SOLUTION

MINIMAL TIME INVESTMENT FOR A QUICK RETURN

The six floors of the building, five above ground and one below, are each 55,000 square feet. Each floor was fitted with two Cel-Fi QUATRA Network Units (NUs), the headends of the system—one to provide coverage for AT&T and Verizon subscribers, and the other for T-Mobile and Sprint customers. Each NU was then connected by ethernet cable to four Coverage Units (CUs), the remote units that distribute the signal to provide strong, uniform coverage throughout the floor. A total of 12 NUs and 48 CUs were installed in the building. Six Cel-Fi Wideband Omni Donor antennas were placed on the roof to provide strong donor signal.

Atlantic Technology Group used the Cel-Fi WAVE remote monitoring and management platform to manage the installation. Connelly explains, "We always use the Cel-Fo WAVE app. After we attach the network unit, we log into the Cel-Fi WAVE app remotely with a cellular router and made sure that we have a really good donor signal and the rooftop antennas are optimized. We make sure that the coverage units have sufficient gain. Then finally we walk the floor with the client, just to make sure everybody's happy with the end result."

Atlantic Technology Group

- Headquartered in Rockville, Maryland
- 15 employees
- Established in 2002
- Total solution provider of mobility applications, devices and lifecycle management services

The customer was happy. The installation was complete within three weeks. "We went from zero to one bar in some areas of the building to three or four bars. The customer was pleased we resolved the coverage problems before the employees moved in," says Connelly."

Atlantic Technology Group plans to outfit the bank's underground parking garage with a Cel-Fi GO Smart Signal Booster in the near future.

Cel-Fi QUATRA drives cellular coverage underground in commercial parking garage

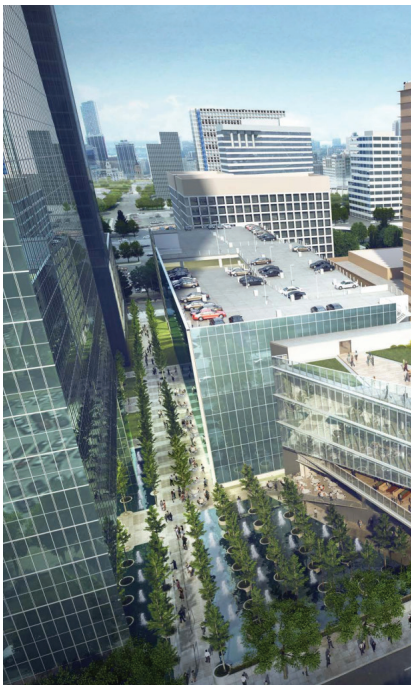
Fountain Place is an architectural landmark in Dallas. The iconic skyscraper, which features 1.2 million square feet of office space, is surrounded by nearly 200 fountains and gardens that attract locals and visitors alike. The acclaimed commercial building, which has been standing since 1986, is owned by Goddard Investment Group.

ABOUT THE PROBLEM

What lies below the 58-storey concrete and steel building is a three-floor, 400,000 square foot parking garage with 850 spaces, and a mechanical room. Because it is subterranean, cellular signals cannot penetrate through the gravel and dirt. As a result, office tenants were not able to continue, initiate, or receive calls beyond the garage's periphery.

A HYBRID SOLUTION LIKE NO OTHER

Goddard Investment Group had initially decided to go with a traditional active distributed antenna system (DAS) to bring the outdoor signal underground. However, the active DAS solution proved to be a bigger roadblock than the problem itself: after three years, the system was still not built, and would only provide coverage for two carriers.



Because Mullenix was in need of a cost-effective solution without further delays, he changed gears and called Bob Merola, Chief Technology Officer at Wytec International, a wireless integrator based in San Antonio, Texas, and asked if he could do something.

"I told him we could. We recommended Cel-Fi QUATRA active DAS hybrid because it offers all the benefits of an active DAS, but at a much more attractive price point," says Merola. "It also delivers 1000 times the signal gain of a BDA passive DAS (booster) and can provide coverage for all four major carriers. QUATRA is simply a far superior technology to other solutions available today for the middleprise space."

While the original active DAS system provided coverage for only two carriers, Merola felt coverage for all four major carriers was important. He explains, "At night, if someone were to trip and fall and get hurt, they need to be able to call somebody. With no cell service, you can't call somebody for help. There were emergency phones located throughout the space, but if you can't walk, you can't get to the phone. You need to have access to your cellular, so it's a safety thing. They needed to have this to make sure that their tenants were safe going to and from their vehicles."

Although price was a driving factor for Mullenix, the ability to install a solution without involving the carriers was equally as attractive because it could be deployed much faster. Wytec could have Cel-Fi QUATRA installed and providing coverage on all four major carrier networks in less than two months.

ABOUT THE SOLUTION

A SPEEDY INSTALLATION AT HALF THE COST

To begin, Merola and his team determined the configuration of the Cel-Fi QUATRA using iBwave. "We were able to save them more than half of what they were going to spend on the active DAS solution," he says. "But we actually increased to all four carriers, rather than just two that were planned with the active DAS, and we installed everything in conduit, so in a straight comparison, it was a lot less than half."

Wytec mounted four donor antennas outside on the elevator shaft of a 10-story above-ground parking structure adjacent to Fountain Place. The team then ran the cables in conduit down into the basement, where the mechanical room was located. Twelve NUs (Network Units that are the headend units of the QUATRA system) were placed in two racks in the underground mechanical room. Utilizing ethernet cable and cable extenders, 44 CUs (Coverage Units that are the remote units that broadcast the signal) were distributed throughout the garage's three floors.

"Normally, the NUs are mounted on a wall or in a closet," explains Merola. "By putting them in the mechanical room, we could mount an equipment rack, cable management, and ladder tray, so the installation was, to me, second to none."

The Wytec team also put all of the CUs in NEMA-certified enclosures to protect them from being damaged by water from pressure washers that are used when the garage was cleaned. "We wanted to make sure there wouldn't be any damage to the CUs," says Merola. "We had to retrofit the boxes a bit to accommodate the adapters to mount the equipment, but it wasn't difficult."

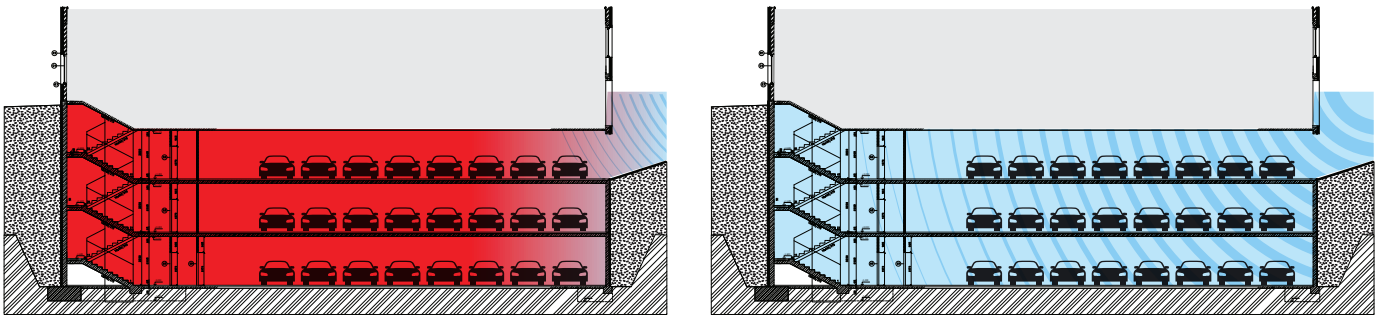
wytec | INTERNATIONAL

Wytec International

- Based in San Antonio, Texas
- 15 employees and growing
- Delivers new, fast, and reliable wireless products and services with carrier-grade quality and stability
- Solutions and services provided to companies of all sizes, offering features not found in fiber optics

The entire project took 61 days to complete, from signing the agreement to complete installation. Using the intuitive Cel-Fi WAVE remote monitoring and management platform, Wytec was able to commission and monitor the system within eight hours, versus the several days usually required to accomplish the same thing with a traditional DAS solution.

"On projects like this, it's more typical to see people hauling big cables and heavy equipment around. Your headends are usually the size of a data center," says Merola. "With Cel-Fi QUATRA everything is compact. It fits very well into a small closet. The antennas are small. The ethernet cabling is small and faster to install. Overall, QUATRA is a great fit from a budgetary, functionality, and technology perspective."



A WELCOME SURPRISE

All three levels of the below-ground parking garage at Fountain Place now receive reliable, high-quality cellular signal. Mullenix says, "It went from not being able to hold a phone call to being able to make a phone call. We went from having nothing to having a signal."

CEL-FI™ QUATRA | ACTIVE DAS HYBRID

- **High-quality solution for the middleprise**
- **Supports multi-carrier 3G/4G/LTE voice and data**
- **Carrier-approved and unconditionally network safe**
- **Uses Cat5 or better**
- **Remote monitored and managed using Cel-Fi WAVE**

Specifications

Power *(network unit)*
- 54 VDC @ 2.22 Amp via external supply (51.3 to 56.7 VDC tolerance)
- 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 *(check product version for specific band support)*
- Total boost all-channel bandwidth 75 MHz (2x2 MIMO uses double bandwidth per channel)
- 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 *(check individual product version for specific regional compliance)*
- 3GPP TS 25.143 Rel.10
- 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 *(software)*
- Cel-Fi WAVE cloud portal
- 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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