

A New Generation of Poles for 5G Small Cell Infrastructure – Capabilities and Requirements

5G mmWave network deployment will depend largely on small cell street poles to meet coverage requirements in urban areas. Next-generation poles combine and conceal all the 5G/4G electronics, power and connectivity electronics needed to create a small cell site. Through scalable manufacturing, testing and fast turnaround times, these poles can reduce time-to-deployment, simplify installation and make it easier to upgrade.

The leading role of small cell poles in 5G infrastructure

To make 5G wireless services a reality, small cell sites using mmWave radios are being installed to provide sufficient coverage in high density areas. Their higher frequencies exhibit increased propagation loss that limits inter-site distances (ISD) to roughly a tenth of a mile, so 5G small cell sites must be lower to the ground and in closer proximity to one another than previous wireless generations. In dense, high-volume urban areas, 5G small cell sites are becoming prevalent all over busy city streets, plazas and neighborhoods, co-existing with lighting poles and other street furniture. To avoid cluttering up these urban areas, carriers, tower companies and municipalities have recognized that street lighting poles are obvious platforms for 5G small cell sites.

A new generation of 5G small cell poles needs to be highly integrated to meet the sometimes-conflicting requirements for quickly standing up wireless service while minimizing disruption on the citizens and businesses the network serves. These “integrated poles” have to maximize the needs of the service providers and the municipalities, providing:

- Optimal location and orientation of 5G radios
- Integration of power control, metering and protection
- Quick connection to high-bandwidth fiber backhaul connections
- Protection of the electronics, and a way for power to be easily disconnected
- Easy upgrade ability as 5G spectrums and technologies evolve
- Support for standard and LED street lighting
- Upcoming smart city functionality such as sensors and EV charging

Most importantly, small cell poles have become a common element in the urban landscape. They fit in seamlessly with the rest of the architecture, public spaces and pedestrian right of ways. Because each city has its own history, challenges, ordinances and aspirations, these poles need to be easily adapted to different designs, yet be based on a standard product for streamlined customizing and manufacturing.



Components of next-gen small cell poles with concealment

Next-generation small cell poles combine and conceal all the elements needed for a complete 5G small cell site to support a carrier's deployment priorities: optimal performance, fast time to market and upgrade ability.

They include:

- AC- or DC-powered 5G mmWave and 4G radios
- AC/DC rectifiers or remote powering units
- Fiber connectivity enclosures
- RF combiners/duplexers
- Alarm systems and intrusion sensors
- Forced-cooled ventilation systems
- AC and DC power distribution panels with utility smart energy metering
- Electrical protection

The pole can be defined in several segments—pole top, mid pole, base and foundation—each with specific functions.

Pole toppers for radio/antenna assemblies

Small cell poles mount the 4G/5G antennas and/or radios in pole toppers to optimize performance and concealment options. The overriding characteristic should be flexibility in configuration, so the radios can be positioned optimally (and eventually upgraded) depending on the needs of that particular site. The pole manufacturer must be able to provide a concealment material that does not interfere with the 5G radio signals.

To meet required coverage patterns, multi-tenant siting and future upgrades, pole toppers should have a uniform form factor that can host different brands of 5G radios, as well as be backwards compatible to lower frequency bands. With unique mounting options, the form factor should support different orientations of the radios, radios on different levels, on top of one another or back-to-back.

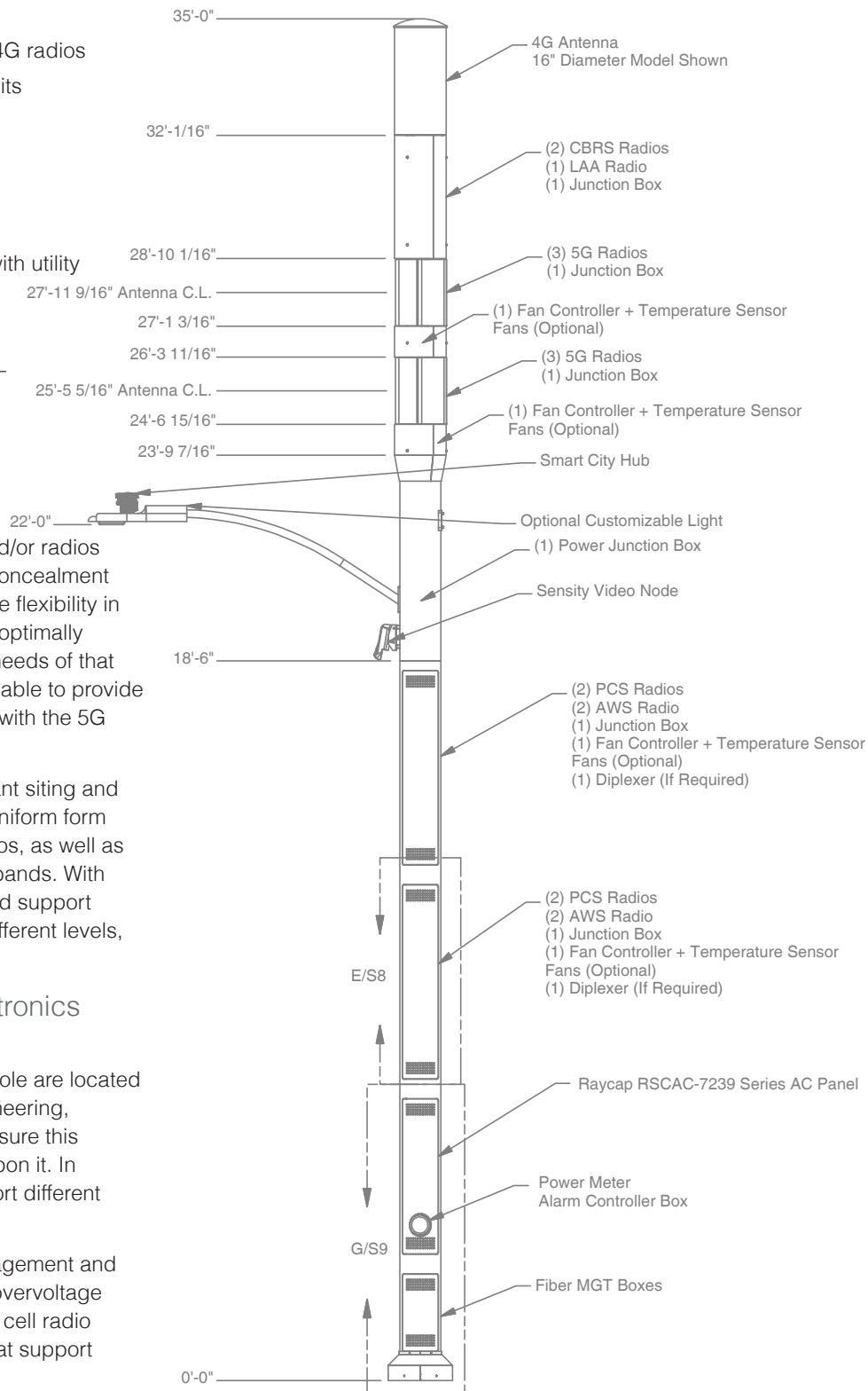
Mid-pole sections incorporate electronics and attachments

Most of the electronics in an active small cell pole are located in the mid-pole section. Exact design, engineering, manufacturing and testing are important to be sure this section can support all the requirements put upon it. In addition, it must be easily customized to support different equipment configurations.

Inside, the mid-pole section holds power management and connectivity equipment. It integrates a robust overvoltage surge protection to protect sophisticated small cell radio systems. It will also include fiber enclosures that support flexibility and optimal fiber organization.

The manufacturer must be able to do precise positioning to maximize the density of electronics. For example, a railing system inside the Raycap Small cell Pole makes it easy to

Small cell poles are the backbone of 5G infrastructure in urban environments.



Raycap's STEALTH fully concealed small cell poles are built to meet certain specifications and maintain maximum RF performance. They are designed for flexibility, performance and aesthetics. We offer pole varieties which can be delivered fully integrated, with color options.

change position of the radios up or down depending on the configuration needed for a particular deployment. It also provides conduits for clean cabling, with proper labeling for identification and maintenance.

With electronic density comes heat, so the pole must have specific systems for dissipating heat, and the manufacturer should do very accurate thermal analysis and test measurements (as per international standard GR 487) for the entire integrated pole to ensure performance.

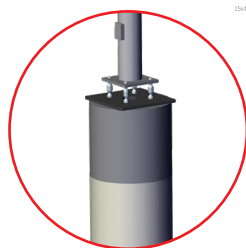
The mid-pole section often incorporates lighting or attachments that need to match existing light poles in the vicinity. It can be engineered to re-use existing luminaires to reduce site costs and lead time. Pole owners should also have the option to incorporate optional hand holds and doors. All the doors should have options for locking (including electronic locking) to control access.

Given the complex functionality of integrated poles, pole owners should consider an integration service which can install and test the radios and associated electronics prior to shipping (see next section).

Bases encapsulate power and backhaul electronics

In the base, the integrated small cell pole meets up with power from the utility. It integrates a convenient disconnect and meter base, and location for a smart meter. The integrated pole bases may also hold power equipment and fiber enclosures to simplify connection to fiber backhaul. The manufacturer should be able to accommodate different form factors, hole patterns for the foundation and clamshell structures.

The bases must be designed for absolute minimum form factor, while remaining fully functional, to meet municipal standards for appearance and right of way. They incorporate various railing systems with drawers for pulling out the equipment, if needed.



Raycap can provide customers with traditional poured-in-place foundation designs, as well as alternative pre-fabricated foundation options to help expedite deployment.

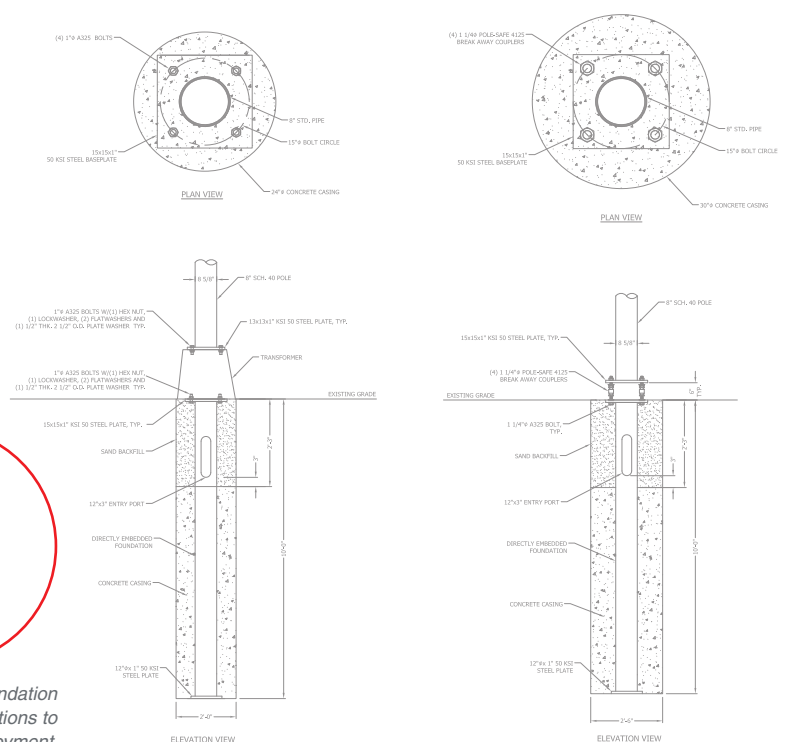
To suit varying needs of municipality streets and utility services, integrated poles must be mounted on any type of foundation: traditional poured-in-place designs, or pre-fabricated foundations to help expedite deployment. Other options for foundations can include direct embedded, mechanical/helical, pre-cast and break-away mechanisms.

UL listing ensures safety in installation and use

Given the ready-to-install promise of integrated small cell poles, they should streamline customer deployments by having obtained a UL certification. This assures that the small cell pole meets applicable requirements for safety performance standards as well as relevant listing requirements per the NFPA 70 National Electrical Code. It also facilitates approval by local inspectors and authorities, and allows carriers and tower companies to provide a level of differentiation in their offerings to cities and municipalities to gain quicker acceptance

Raycap next generation small cell poles are fully integrated, UL listed and shipping today, at scale.

Optional Pre-fab Foundation





InvisiWave is proven to conceal 5G radios with minimal signal loss.

True 5G small cell concealment

With one or more small cell sites on every street, municipalities are rightly concerned about the aesthetic implications. Fortunately, there are now materials that can cover 5G radios with very little or no impact on performance. Raycap has developed a unique 5G mmWave concealment material that meets the needs of 5G bandwidth and gigabit speeds, while minimizing dB loss.

Raycap's exclusive InvisiWave solution for pole mounts is approved for use at mmWave frequencies, after extensive research and testing at the 24GHz, 28GHz and 39GHz bands—even as high as 100GHz. It is also fully backwards compatible with all commonly used sub-6GHz frequencies, so radios from different generations can be combined in the same enclosure. We've confirmed this performance by conducting measurements in an RF anechoic chamber using network and spectrum analyzers, specifically measuring losses over the 700MHz-52GHz range. We have conducted specialized measurements to evaluate absorption when concealment surface is wet, and we did proximity testing and several beamforming pattern measurements. Raycap has also developed an RF model to simulate RF losses and pattern distortion phenomena in any mmWave frequency band.

The InvisiWave material works today in pole toppers, surrounds and radomes on integrated pole configurations, as well as in panel products like chimneys, cupolas, screen walls, and other rooftop concealments. It is fabricated from RF-friendly material with a smooth, hydrophobic surface and durability to stand up to environmental extremes.

Manufacturing and installation considerations

Raycap's small cell poles answer another challenge to 5G site infrastructure: rapid time to deployment. They are engineered to be easily customized for a particular need, manufactured at scale and delivered with no surprises.

Industry know-how speeds deployment

Concealed and partially concealed small cell poles are manufactured, assembled and tested at Raycap's factories under controlled conditions. They arrive at a customer's site ready for integration and deployment. Small cell poles need to incorporate 120/240 VAC industry-standard load centers and surge-protection devices suitable for use as service equipment (SUSE) with NO conditions per UL and NEC. Raycap's specialty-designed AC disconnects employ its Strikesorb® 30-A-2CHV surge protective devices, capable

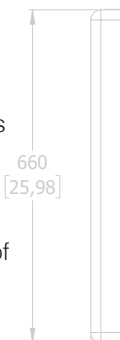
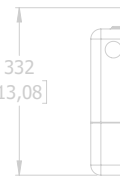


of withstanding direct surge currents up to 5kA (10/350 μ s) and induced surge currents up to 60 kA (8/20 μ s). Raycap overvoltage protection (OVP) products are the industry-standard for cell site surge protection and connectivity, and have been a trusted name with carriers for the past 20 years.

Manufacturing ability ensures delivery and quality

Raycap's design and manufacturing facilities in Charleston SC have the capacity to produce more than 1,000 poles per month. This includes a steel facility with in-house cutting, drilling, sawing, forming, welding, powder coating, integration and cabling. It's location in Kearny NJ specializes in custom sheet metal and the development of customized enclosures, shrouds, mounting hardware and brackets. All this is to say that Raycap is not dependent on other vendors for the customizing and scalability needed to meet a range of deployment projects.

Quality inspection and testing are fundamentally important to complex solutions like integrated poles. Performing all measurements in a controlled environment minimizes complications during field installation and minimizes commissioning and activation time. The testing group should bring experience in the field of environmental testing according to UL, NEBS, GR, ISO, EN, MIL and ASTM standards.



Concealed poles are part of complete 5G infrastructure

Every municipality and utility has its own approach to solving its 5G deployment trade-offs. While fully concealed poles are key for rolling out 5G wireless networks, other configurations of small cell nodes—partially concealed and non-concealed—can suit specific site requirements. It's straightforward to mount and conceal 5G small cell sites on buildings, monuments, signs and other elements of the urban city scape. This range of solutions makes it easier for network operators to specify the right combination of small cell sites for any deployment.

Side mounted: Whether due to lack of space, permit restrictions or the cost of power and fiber connections, active equipment (concealed antennas and connectivity enclosures) can be installed on or at the side of an existing light pole or other utility asset.

Wall-mounted: Wall side-mounted box concealments complement existing construction, and hand-crafted faux brick, block, stucco, and stone textures seamlessly blend with buildings.

Rooftop: Ballasted (non-penetrating) concealment pods disguise rooftop antennas using a steel frame, center mast pipe, steel clamp-on bulkheads and a radome. These standard frames allow for reduced engineering cost and lead time plus the optimized framing material makes manufacturing and installation a breeze.



About Raycap

Raycap is an international manufacturer and technology leader with decades of experience providing innovative infrastructure solutions for customers in the telecom, energy, defense, transportation, and other industrial markets. Its solutions protect mission-critical applications and ensure the best possible system availability. The company's product portfolio includes lightning and surge protection technologies, structured cabling and connectivity solutions, power management systems, custom enclosures, cabinets, and wireless network concealments. Since its founding in 1987, the company has experienced continuous growth. Its engineering expertise, test laboratories, and multiple manufacturing facilities guarantee quality, reliability, and innovation. Product design, testing, and approval processes comply with all international safety standards. Raycap operates in the United States, Germany, Greece, Cyprus, Slovenia, Romania, and China.

For more information on Raycap products, visit raycap.com.

*Talk to Raycap about its concealed
small cell poles and other 5G
infrastructure solutions.
Contact us today at info@raycap.com*

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