METRO CELLS DEPLOYMENT CONSIDERATIONS

STRATEGIC WHITE PAPER

Deployment constraints with small cells are much the same as with any radio frequency (RF) technology. In addition to these limitations are the usual issues of site selection, leasing, and property access. This white paper discusses the practical implications of mounting and powering.

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MOUNTING

Whether it is the side of a building, a lamppost, or a utility pole, it should be accepted that the technology underpinning small cells will likely change over time. Therefore, it is a near-imperative that some sort of quick connect arrangement be manifest in their design. A simple arrangement based on a docking station, as provided for the Alcatel-Lucent lightRadio™ metro cells solution, is proposed below.

Figure 1. Example of a metro cell docking arrangement based on the Alcatel-Lucent lightRadio metro cell

POWERING

Small cells, such as metro and enterprise cells, provide a challenge for deployment in regard to power and battery backup systems. Because it is likely that many small cells will be deployed in a network, powering methods that are easy to implement, reliable, repeatable, and do not require periodic maintenance are preferred. Additionally, the installation of small cell systems needs to be coordinated between utility providers and licensed installation personnel.

The paragraphs below summarize several common power configurations that are applicable to various small cell deployments covering a wide range of operator approaches.

Direct internal AC or DC power conversion

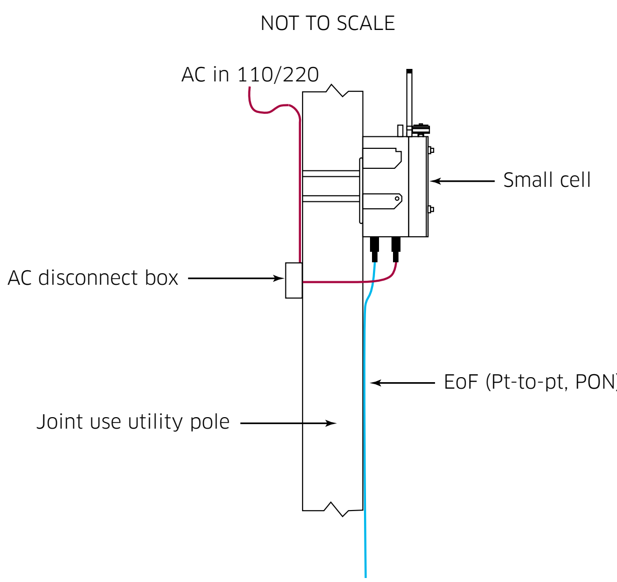
The easiest and most convenient method for distributing power to a small cell is to provide AC or DC service directly to the unit, with an internal power converter to reduce the AC or DC input to the voltage levels required for the internal components. When this is the case, an AC or DC feed will need to be available at each small cell deployment site. Typically, wide range converters are available that support 110/220 VAC or +24/-48VDC operation — one product variant supports AC inputs, while a second product variant that supports DC input. It is even possible to provide a single product variant that supports both AC and DC inputs, but trade-offs must be made in terms of cost and size.

There are several design important considerations that should be mentioned, which are outlined below:

- Small cells typically require passive conduction cooling to limit maintenance; therefore, designers of these AC-DC or DC-DC power converters have fewer choices for low-cost solutions.
- Providing full surge protection to design standards can increase the size of the power converters, thereby increasing the size of the small cells. Designers may opt for first level surge protection to be located externally to the small cell enclosure for this reason.
- Many operators desire some minimal amount of battery backup to protect against brown-out situations, but they do not want to deploy large, heavy and expensive batteries. In these cases, a small capacitor network can be provided externally (located in a custom AC disconnect box) that provides a few seconds of battery life depending on the power draw of the small cell system. In these configurations the small cell accepts a DC voltage input from the capacitor network in addition to the AC input. The small cell enclosure and power converter design must initially be performed with this in mind if this type of configuration is to be supported.
- A DC feed is usually uncommon at a small cell site, making external AC-DC conversion necessary. One common approach would be to use an external AC-DC power cabinet with an option for battery backup; however, battery backup poses significant challenges. For that reason, pole and facade mounting methods employing smaller and lighter cabinets tend to be better suited when this is the case.

An example of a pole-mounted small cell system with internal AC-DC conversion is shown in Figure 2.

Figure 2. Pole-mounted AC powered small cell



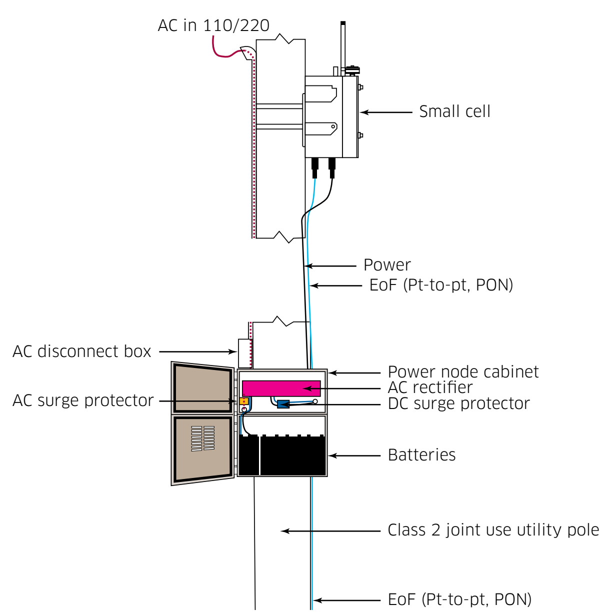
External AC-DC rectification with battery backup

A second approach to powering small cell systems is to provide an external power cabinet with AC-DC rectification with optional battery backup. In this situation, the small cell itself has an internal DC-DC converter that accepts either a +24 V DC or 48 V DC input. The power cabinet converts 110/220 V AC input to the desired DC voltage using a shelf of rectifiers. Selection of these rectifiers is dependent on the total power requirements for the small cell system. Required surge protection to meet applicable standards can be located in the power cabinet as well. The battery compartment of the power cabinet can be sized based on the type of batteries and the amount of holdover time desired. There are many important design considerations associated with this configuration as well.

- The size of the power cabinet is an important factor in selection, especially for pole- and wall-mounted systems. Alternatively, larger cabinets can be mounted at ground level or on a rooftop, near the small cell system.
- For outdoor deployments, a conduction cooled power cabinet is desired to eliminate the need for fans that decrease reliability, increase periodic maintenance, and increase noise. These conduction cooled cabinets are larger, heavier, and more costly than cabinets that are fan cooled.
- Batteries add significant size and weight to the power cabinet. Traditional lead-acid batteries have lower reliabilities, product lifetimes, and require more batteries than new technologies. New technologies such as lithium-ion batteries have higher reliability, longer life, and can result in smaller/lighter power cabinets. However, they are significantly more expensive. Operators should assess their specific needs when selecting a battery technology. Regardless of battery selection, a heater is required in cold climates.
- Power cabinets need to be located where they are easily accessible by maintenance and installation personnel, but securely protected from vandalism and thieves. Optimally, the power cabinet should be located as close as possible to the small cell.
- Monitoring of external batteries and rectifiers for status and failures is desired by operators.

An example of a pole-mounted DC input small cell with a pole-mounted AC-DC power cabinet is shown in Figure 3.

Figure 3. Pole-mounted DC powered small cell with battery backup



Powering small cells using Power over Ethernet and derived power from copper pairs

For certain applications where the power requirements are small (< 50 W), Power over Ethernet (PoE) as well as power derived from copper pairs using very high bit-rate digital subscriber line (VDSL) are viable options. This can typically apply to indoor or outdoor small cells where the RF output power is in the range of < 250 mW per transmit path. When the RF power is greater than this, the total power draw requirements of the system will typically exceed the maximum allowable by the PoE standard, mainly due to the low efficiencies of the power amplifier components. Note that there are several options available for these applications:

- PoE with up to 26 W capacity allowable
- PoE+ with up to 52 W capacity allowable
- Customized solutions using PoE injectors that can support higher power requirements but are more expensive and not in accordance with the PoE standards. In these cases, the small cell power converter derives DC voltage from the Ethernet interface which is also used as the backhaul interface.

As it pertains to remote powering using VDSL, the governing factors are going to be required throughput and DC loss over distance.

In most cases, the ability to leverage remote powering over VDSL is going to depend on the type of metro cell, its power, and how much throughput is expected of it. A single technology metro cell (for example, Long Term Evolution [LTE] or Wideband Code Division Multiple Access [W-CDMA]) will consume considerably less power than a multi-standard unit (around 100 W versus roughly 300 W). Moreover, attempting to satisfy fewer subscribers is less demanding of throughput, requiring fewer pairs of VDSL to satisfy it. And lastly, lower bandwidths of LTE (for example, 5 MHz versus 20 MHz) will also require reduced throughput.

The graph provided in Figure 4 illustrates what can be expected of power over xDSL at various distances using assorted wire gauges over the last mile. As shown, four individual 26AWG feeds (derived from one pair of copper; transmit and receive) can deliver around 300 W at distances up to about 3000 feet. However, we know from previous discussions that two VDSL2 pairs can only deliver the full capacity of an LTE 10 MHz band (about 60 Mb/s downlink and 18 Mb/s uplink) at distances up to 2100 feet. Therefore, the limiting factor in this instance is bandwidth over distance, not necessarily power over distance unless something less than the full 10 MHz LTE band is acceptable. Conversely, a single technology metro drawing only 92 W can easily be powered at this same distance (3100 feet) using four feeds while delivering 28.8 Mb/s and 8.9 Mb/s, downlink and uplink respectively, over a single 5 MHz wide band. This is outlined in Table 1.

Table 1. Typical rate/reach of VDSL2 to satisfy LTE at 5 MHz bandwidth

VDSL2 REACH IN FEET TO SERVE 5 MHZ LTE SPECTRUM CAPACITY TARGET RATE: 28.8 MB/S DOWN – 8.9 MB/S UP			
Pairs	28.8 Mb/s downlink	8.9 Mb/s uplink	Maximum distance (feet)
1	3,100 ft.	2,200 ft.	2,200 ft.
2	5,000 ft.	3,100 ft.	3,100 ft.
4	>6,000 ft.	3,400 ft.	3,400 ft.
8	>6,000 ft.	~3,900 ft.	3,900 ft.

Based on measurements with:
VSL2 17a; 5 xtalk; TNMR = 6 dB, INP = 1 and delay = 8 ms
Crosstalk model 99% worse case

Figure 4. DSL rate versus reach and powering

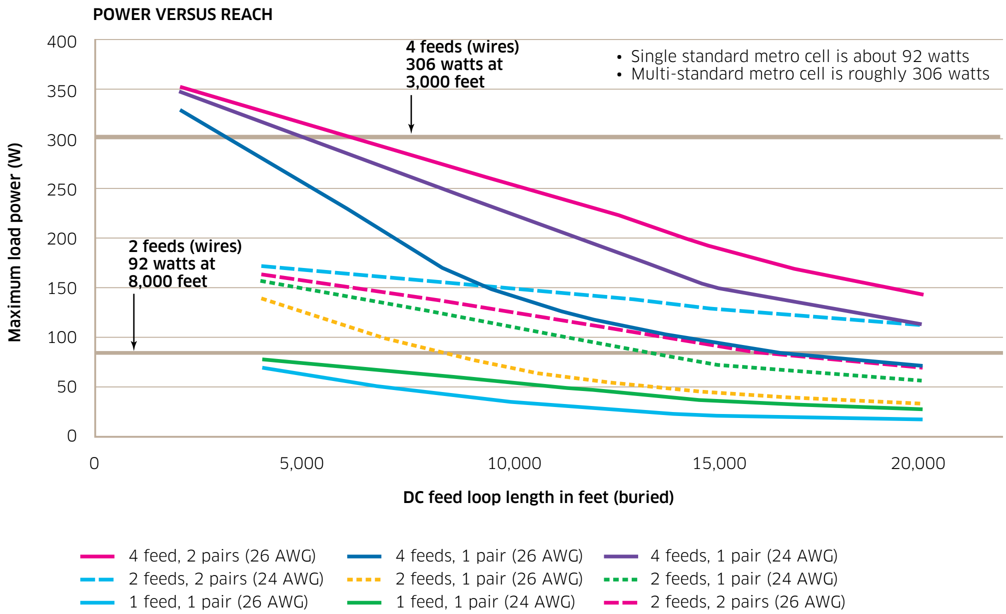


Table 2 summarizes the typical options and requirements that are expected to be considered when it comes to small cells.

Table 2. Small cells powering considerations

Key Considerations	Outcomes	Cabinet Required
Powering options	Direct AC 120/240V	No
	-48 VDC direct	No
	Line powered ± 190 V – this is power over DSL: specific to DSL+ outdoor deployments only	Yes
Battery backup	If yes, reserve time?	Yes
Separate transport device	Cabinet only required if separate non SAR aggregator deployed	Yes
DC/AC primary surge protection	A separate primary surge protector is required on the AC or DC input feeding the site; does not require a cabinet to support this?	No
1-second AC holdup	Power sags or glitches in the AC power grid will take down service	Yes/No

SUMMARY

Many options must be made available for small cell deployments and these can usually be customized in accordance with an operator's needs. The key aspects of selecting an option are:

- Type of power availability at the site and how this is to be distributed to the small cell system
- Location of the small cell system assets and proper coordination with utility providers and licensed installation personnel is important
- Power requirements for the small cell system, including peripheral equipment, which also dictates the size of a power cabinet
- Mounting method (pole, wall, building, ground) of the small cell system influences the type, size and weight that can be accommodated
- Requirements for battery backup and the level of holdover time add size and weight
- Reliability and maintenance needs
- Cost

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