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Powering Small Cells With the Communications Power Grid

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July 23, 2019

Small cell power options include adding power conversion devices and connecting them with small cells where backbone cabling already is in place. In greenfield applications, deploying new copper cables may be easier, quicker and less expensive than waiting on the utility company to do so.

Small cells are transforming communications networks. They fill the macro cells' coverage gaps in a way that is especially effective in urban canyons. They also provide additional capacity that offloads traffic from macro cells. Although they are useful tools for 4G/LTE deployment, small cells are absolutely essential for 5G wireless communications. Without them, it is hard to imagine successfully achieving the latency requirements necessary for autonomous vehicles and other rapid-response applications.

The market forecasts are bullish, with the Small Cell Forum forecasting over 10 million outdoor small cells by 2025. Yet, though small cells projects are being built today, deployment is still far from routine. Overcoming major issues such as spectrum, backhaul and siting has been at the forefront for network builders. And although there have been significant successes in these areas, another often forgotten issue looms as an obstacle to routine deployment: power. Why? A usable source of electricity does not always coincide with the optimal location for the small cell. And connecting with the grid can be expensive and time-consuming, perhaps jeopardizing the business case and deployment timelines.

Fortunately, there are alternatives to tapping the grid at every small cell site. Cable TV (CATV) providers, often referred to as multiple systems operators (MSOs), and telecom carriers have copper cables distributed throughout their serving areas. These copper cables are ideal for carrying power to a remotely deployed small cell. And they overcome the two biggest concerns: cost and time-to-market. When equipped with power conversion devices, these MSO and telco cables transform from dormant, unused capacity to a new power delivery network called the communications power grid (CPG).

Communications Power Grid

Wireline telecom carriers have millions of miles of twisted-pair copper cables deployed in the outside plant network. Because of copper's limited bandwidth, carriers began systematically replacing copper in the feeder portion of the network with high-bandwidth fiber-optic cable. The modest success of fiber-to-the-home cabling notwithstanding, most homes remain connected with the network via copper cables. And because of wireless substitution and the gradual transition to IP-based connections, there is a tremendous amount of excess capacity in these copper networks.

MSOs that originally built their distribution networks with coaxial cables also have vast networks of deployed copper. Originally, the CATV network included amplifiers to deliver programming to customers. Amplifiers added noise and cost, so fiber-optic cable was introduced from the head end to remote locations, allowing operators to segment their plant and minimize the number of amplifiers. The resulting architecture came to be known as hybrid fiber coax, or HFC. The amplifiers were energized by power supplies that converted utility power and also enabled battery backup for the OSP facilities. In a similar manner as telecom, the copper cables (coax) still make up the majority of connections to homes and businesses.

In both situations, a continuous copper path exists between end users and a common point in the service provider's network. This path is capable of delivering a current from the centralized location, where the grid is accessed, to distributed devices such as small cells. Power conversion equipment may be required at the end points, but the hard part is already done — the distribution network is installed, available and, in most cases, already paid for.

Small Cell Power Requirements

Power requirements for outdoor small cells vary considerably. Some are designed for AC power, others for DC. The power consumption ranges from under 100 watts up to 500 watts per device. At some sites, a single small cell is deployed, whereas others may have three or more. Yet, despite this variability, the communications power grid is capable of meeting the small cell powering needs.

Another issue for small cells is the question of backup power. In coverage applications, backup is usually required just as it is with the macro cell. But in capacity situations, the operator is normally content to let the macro cell take over the load if the small cell is suddenly without utility power. This approach makes sense today, but it will not make as much sense when autonomous vehicles depend on constant communications. Battery backup could be required even sooner because younger, video-intensive customers may not stay with carriers whose networks don't prevent video buffering. Regardless, some form of backup power is expected to be needed in the future, though the timing is uncertain.

How Does CPG Work?

Telecom networks use a technique known as remote line power (RLP). The network provider determines the location for the centralized source of power, typically with ready access to the grid. There, power equipment is used to convert the utility AC power to -48 Vdc, which can also be used to simultaneously trickle-charge batteries, if present. The -48 Vdc power is fed to a special DC–DC converter called an upconverter. This unit converts the -48 Vdc to ±190 Vdc to minimize losses in the cables. To ensure technician safety, the power is limited to 100 watts per circuit. For devices requiring more than 100 watts, additional circuits or cable pairs are provisioned. All of this equipment is housed in an outdoor enclosure that is either ground- or pole-mounted.

At the small cell site, a downconverter transforms the voltage back to −48 Vdc to operate the small cell. This downconverter is sealed for outdoor deployment and can be strand-mounted to avoid unnecessary pole attachment fees. If the small cell is AC-powered, an additional piece of equipment, also strand mountable, is required to convert the DC back to AC.

For hybrid fiber-coaxial networks, the centralized power supply is already in place as part of the MSO's original network. At the small cell site, a new piece of equipment called a gateway is inserted on the line. The gateway's output is 89 Vac, a voltage that can energize an AC-powered small cell. If the small cell is DC-powered, then the strand-mountable piece of equipment previously mentioned can be installed to convert the AC to DC.

Although both the RLP and HFC techniques address power and real estate issues, there is an added advantage when powering with an HFC network. The gateway and power supplies can be equipped with a cable modem that enables them to provide the backhaul as well as power. The modem is made to meet the Data Over Cable Service Interface Specification (DOCSIS), an international telecommunications standard. With the gateway, power supplies and modem, the MSO can supply both the power and backhaul, eliminating the need for additional fiber and the logistics of interacting with other network providers.

Choosing the Right Technique

There is no silver bullet when it comes to powering small cells. The unique requirements of the application and the site will usually prescribe the best power solution. If an AC-powered small cell can be placed on a light pole that is equipped with a source of usable electricity, then local power would be the ideal choice, provided battery backup is not needed. When that situation is not an option, which is usually the case, remote power is the natural choice.

Remote line power from the telco or HFC power from the MSO are both potential options, depending on the service provider's coverage, capacity and willingness to work with the wireless provider. The MSO or telco must have networks that can provide ready connections to the small cells. Otherwise, OSP construction projections are required, which put us back in a similar situation as tapping the grid.

However, there is another possibility to use when neither the MSO nor the telco has networks in place to serve the small cells. These applications, sometimes referred to as greenfield, can be served by deploying new copper cable alongside the fiber backhaul. The copper cable is inexpensive and the incremental labor cost is negligible, provided both the copper and fiber are deployed at the same time. *Frequently, the two are combined in a single cable called a composite fiber/copper cable.*

Does It Really Work?

There have already been several successful applications using both RLP and HFC techniques. HFC power was used to power over 19,000 small cells in the New York City area and in locations ranging from Tampa, Florida to Chile, including Citizen Broadband Radio Service trials, in addition to small cell networks. RLP power was used to power Southern California locations at more than 4,000 sites, as well as locations in the Baltimore-Washington area, Houston and others. In addition, there are industry standards that govern deployment and ensure safety for technicians and users. Deployment guidelines are still being developed to streamline the process, but the solutions are viable today.

Conclusion

For 5G to become the prolific, all-reaching network of tomorrow, it is imperative that deployment become a routine and repeatable process. The communications power grid can transition power from being an obstacle to becoming an enabler. With the backbone cabling already in place, turning up the CPG is a straightforward process of adding power-conversion devices and connecting them with the small cells. In greenfield applications, deploying new copper may be easier, quicker and less expensive than waiting on the utility company.

The CPG provides a compelling alternative to local power provided by the electrical utility. It can be a win-win solution: The small cell service provider benefits from an inexpensive power solution that can be deployed quicker than utility power, while the MSO or telco benefits from transforming underused assets into revenue-producing power cables. And the utility may also benefit as it offers the same amount of power, but in fewer locations and with less engagement with the network builder. Although the CPG is not a silver bullet for powering small cells, it significantly advances the cause and makes routine deployment a real possibility.

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